

UNIVERSITY OF CAPE TOWN



The siting of public transport facilities in a predominately low to middle-income area, Klapmuts, on the outskirts of a metropolitan city, Cape Town

A 60-credit minor dissertation

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Abstract:

The motivation for this study pertains to the Integrated Development Plan (IDP) for the Stellenbosch Municipal area identifying Klapmuts as an area in high need for formalising public transport infrastructure. The need for formalised public transport has arisen due to the envisaged future growth of Klapmuts, and the status quo of minibus-taxi operations in Klapmuts.

The aim of this research was to critically evaluate relevant guidelines and policy documentation to aid in the siting of public transport facilities in a low to middle-income area, using Klapmuts, located on the outskirts of a metropolitan city, Cape Town as the study area. From a critical assessment of current practices, a warranting and siting practice for public transport and associated infrastructure was formulated which takes cognisance of the social and demographic characteristics of a typical low to middle-income area, as well as budgetary prioritisation and policy constraints imposed by the various planning and legislative entities to ensure that infrastructure is provided for in an efficient and effective manner. The warranting and siting practice developed in this dissertation serves to identify the public transport needs associated with affected groups including operators, passengers, and the community as a whole, and propose facilities and locations of facilities to cater for these needs. The methodology for the warranting and siting practice for minibus-taxi ranks and terminals, involves identifying the current needs for the study area, describing those considerations used to select a type of facility, and developing evaluation criteria which can quantitatively compare sites in order to derive the most optimal alternatives for future investment.

The application of the warranting and siting practice for the Klapmuts case concluded that three decentralized minibus-taxi facilities should be constructed instead of one singular minibus-taxi facility. These three proposed facilities are located in areas that best accommodate both existing developments, as well as future developments.

The warranting and siting practice developed is designed to be flexible, and it is acknowledged that in actuality, each area or potential site will have its own unique characteristics and therefore planning and engineering judgment should be used when this practice is applied.

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1 Introduction

1.1 Motivation for Research

1.1.1 Klapmuts Locational and Social Overview

Klapmuts is located within the Stellenbosch local municipality. Surrounded by the rural areas of the Cape Winelands and located approximately 50km from Cape Town CBD it lies adjacent to the main Cape Town – Johannesburg railway line and the R44 linking Stellenbosch and Paarl. It also lies in close proximity (approximately 15km) to the towns of Paarl, Stellenbosch, and Franschhoek. (Stellenbosch Municipality , 2011, pp. 3-2)

The focus area of this research study can be seen in Figure 1.

Figure 1: Research Focal Area- Klapmuts



The 2011 South African Census notes that Klapmuts has a population of approximately 7700 individuals. There are approximately 1958 dwelling units, with the total area being some 1.76 km² in size. The economic profile of the area is predominantly low to medium income, with a high prevalence of unemployment. Car ownership is low, with a strong dependency on Non-Motorised

Transport (NMT) and public transport, for both rail and minibus-taxi. (Stellenbosch Municipality , 2011, pp. 3-2)

The population is distributed amongst different suburbs, namely Bennettsville, Klapmuts SP, Mandela City and Weltevrede Park. Below summarizes the population of Klapmuts according to its various residential suburbs.

Table 1: Klapmuts Population according to its various Residential Suburbs

Suburb	2011 Census Population
Bennettsville	1249
Klapmuts SP	129
Mandela City	664
Weltevrede Park	5661
Total	7703

1.1.2 Problem Statement

The White Paper on National Transport Policy of 1996 prepared by the Department of Transport states that, transport infrastructure has the ability to either grow or stunt economic and social development and, to ensure that economic growth is achieved, transport infrastructure must be provided for in a safe, reliable, effective, efficient, accessible, affordable and needs driven manner. (Chetty & Phayane, 2012, p. 665)

The mini- bus taxi industry in South Africa plays a pivotal role in public transport provision owing to the fact that the majority of the population are captive to public transport as a result of their economic status and their inability to afford private vehicles. Due to the increasing demand for public transport provision in South Africa, and the minibus-taxi industries demand responsive nature, this has led to destructive competition between transport modes. Owing to the fact that minibus-taxi operations are demand responsive, sporadic, and essentially unplanned, there is often a misalignment between infrastructure provided and minibus-taxi operations. It is therefore a problematic undertaking for the responsible authority to align infrastructure with minibus-taxis without having definitive insight into current and future minibus-taxi operations. (Chetty & Phayane, 2012, p. 665)

There have been multiple demands for the provision of improved or formalised public transport facilities in South Africa through ward councillors and the relevant stakeholders in the minibus-taxi industry, as well as requests by minibus-taxi associations for the development of association

specific facilities. Chetty & Phayane argue that on a local and national level these demands are often treated in isolation, with no consideration or understanding given to the relationship between land use and transport, as well as prioritisation, budgetary and policy constraints enforced by the relevant planning authorities and respective legislative entities. (Chetty & Phayane, 2012, p. 665)

1.1.2.1 The demand for 'formalized' minibus-taxi services and public transport infrastructure in Klapmuts

Over the past ten years, the population in Klapmuts has increased from 3000 residents to a current population of 7700 (2011). This population growth has been supported by the development of some 2000 residential units. Furthermore, the Klapmuts area has been earmarked for future residential development and the population is expected to show significant growth over the medium term. (Stellenbosch Municipality, 2011, pp. 3-2)

Over the past few years, there has been increasing demand for landowners and private developers to further develop specific precincts in Klapmuts. Owing to the increasing demand for further development, Stellenbosch Municipality appointed town planners, Messers MCA, to design a development growth model. It was founded on the ultimate development intentions reflected in the Klapmuts Spatial Development Framework of 2007 with phased development over time. (BKS Group (Pty) Ltd, 2008)

Since 2008, the inception date of the Klapmuts Growth Model, very little development has taken place in Klapmuts besides the implementation of a council housing program. However, future development is expected, and Table 2 depicts the development intentions going forward.

Table 2: Klapmuts Land Use and Development Extent

Period	Residential Units	Commercial (m ² GLA)	Industrial (m ² GLA)	Total (Industrial & Commercial GLA m ²)
2017	2381	220 270	123 709	343 979
2027	8407	263 769	275 584	539 353

(BKS Group, 2008)

At present, minibus-taxi services are provided in Klapmuts, however, the needs of both commuters and operators are not catered for due to minibus-taxi infrastructure being relatively 'informal' in nature, and a large contingent of illegal operators infringing on legal operations.

The type and functionality of minibus-taxi facility can be categorised into one of the two following definitions below, as stated in the NDoT guidelines, and will be used as terms of reference for chapters to follow.

Minibus-taxi rank: *A place usually within the road reserve at which minibus-taxis are allowed to stop for passengers to board and alight the vehicle. Dissimilar to minibus-taxi stops, minibus-taxi ranks allow minibus-taxis to stop for a duration of time.*

Minibus-taxi terminal: *A location, usually off street at the common end of one or more routes where minibus-taxis can wait and passengers can board and alight.*

There are currently three 'informal' pick-up and drop-off points for minibus-taxi operations in Klapmuts. The first of these minibus-taxi pick up and drop off points, Site 1, is an informal taxi ranking facility that is based at the Shoprite Centre (adjacent to the BP Garage) just off Old Paarl Road in Klapmuts. Three taxi bays have been provided for taxi use only. These taxi bays have been formalised through legally required demarcated white lines, with signage in the form of a pole collar, and a white 'T' within a circle painted alongside each of the taxi embayments. Figure 2 below illustrates the layout of the Site 1 minibus-taxi ranking facility.

Figure 2: Minibus-taxi Site 1, Shoprite Centre, Klapmuts



At Site 2, an 'informal' taxi rank is situated on a gravel patch just off Merchant Street. The site lacks any form of infrastructure (embayments, sidewalks, lighting, amenities or signage) and there is little information designating the site as a minibus taxi pick up and drop off point. There is no infrastructure provision and no taxi bay demarcation of any form. Site 2 does not facilitate passenger safety or enhance the passenger's travelling experience. Figure 3 below illustrates the Site 2 taxi rank.

Figure 3: Minibus-taxi Site 2, Merchant & Adam Street, Klappmuts



The third minibus-taxi site, Site 3, is located on a gravel patch to the northeast of Jacobs Street and to the south-west of Adams Street. The site can be termed 'informal' as it lacks any formalized infrastructure such as taxi bays, access points, pedestrian sidewalks, shelters, lighting or any form of passenger amenity. This can be seen in Figure 4 below.

Figure 4: Minibus-taxi Site 3, Jacobs Street & Adams Street, Klappmuts



As noted earlier, there is little to no formal infrastructure present at the various minibus-taxi sites in Klapmuts. In summary, Figure 5 below indicates the type of facility, whether it be 'formal' or 'informal', as well as the type of infrastructure present at the minibus-taxi site.

Figure 5: Description of Facilities & Amenities at current minibus-taxi sites

Site No.	Facility Name	Status*		Type**			On/Off Street		Paving		Amenities	
		F	I	T	BA	H	ON	OFF	YES	NO	Shelters	Lighting
1	Shoprite shopping centre	✓			✓	✓		✓	✓			✓
2	Merchant Street & Adams Street		✓		✓	✓		✓		✓		
3	Jacobs Street & Adams Street		✓		✓	✓		✓		✓		

*Status: **F**=Formal and **I**= Informal **Type: **T**=terminus for buses, **BA**= Boarding & Alighting Facility and **H**= holding area

Due to the envisaged future growth of Klapmuts and the current nature of minibus-taxi service provision, the Integrated Development Plan (IDP) for the Stellenbosch Municipal area has identified the need for the development of 'formalized' public transport facilities. These public transport facilities are to be flexible enough to accommodate the current taxi passenger demand, as well as envisaged passenger demand that will materialise in line with growth envisaged in the Klapmuts Growth Model. (Stellenbosch Municipality, 2013, p. 47)

1.2 The Aim of Research

The planning and design of public transport facilities involve the creation and evaluation of various alternatives. Although it is feasible to build infrastructure without evaluating multiple alternatives, it is suggested that in order to construct infrastructure that is efficient in nature and that makes use of optimal resource allocation, a thorough analysis comparing and evaluating all possible alternative needs to be conducted. (Pienaar, 1998, pp. 1-1)

Infrastructure development requires large sums of capital expenditure and within certain economic climates, where economic growth is stunted or on the decline, resources need to be optimally allocated so that maximum return on investment can be achieved. Therefore, infrastructure projects should be prioritised based upon their effectiveness and efficiency. Their effectiveness relating to their ability to meet standards, policies and customer needs, and their efficiency concerning their input versus output with respect to resources. (Pienaar, 1998, pp. 1-1)

At present, the National Department of Transport Guidelines (NDoT), 2007, are in place for the planning and construction of mini-bus taxi facilities in South Africa. Due to the dynamic nature of public transport some of the original approaches depicted in these guidelines are deemed outdated, thus, relevant research papers and reports will be critiqued, and form a supplement to these guidelines when answering research questions.

The aim of this dissertation is to critically evaluate the relevant guidelines and policy documentation to aid in the siting¹ of public transport facilities in low to middle-income areas in South Africa. From a critical assessment of current guidance and practices, a warranting² and siting practice for public transport and associated infrastructure will be formulated which will take cognisance of the social and demographic characteristics of a typical low to middle-income area, as well as budgetary and policy constraints imposed by the various planning and legislative entities to ensure that infrastructure is provided for, in an efficient and effective manner. The warranting and siting practice developed will be applied to the Klapmuts context to assist in the warranting and siting of minibus-taxi facilities so that the demands and needs of the relevant stakeholders are met. (Chetty & Phayane, 2012, p. 671)

The above-mentioned issues are rearticulated into research questions below which will form the basis of this minor dissertation, and ultimately aid in the siting of minibus-taxi terminals and ranks in Klapmuts.

¹ Siting of public transport facilities entails the optimal placement of facilities to meet the needs of various stakeholders whilst still complying with various stakeholder requirements

² Warranting of public transport are the needs of various stakeholders or statutory requirements that give rise to the need for the implementation of a facility.

1. The first question is – *“What warrants the implementation and construction of road based public transport infrastructure, with specific focus on minibus-taxi terminals and ranks?”* The warranting process used in this research paper is to align with South African legislative guidelines. If South African guidelines on this matter are deemed inadequate to address this issue, they will be supplemented with international good practice and case studies.

2. The second question is - *“What criteria and evaluation methods should be used when ranking potential sites for the construction of road based public transport facilities?”* These criteria are to align with South African legislature, guidelines, policies, as well as the various constraints incurred by the local planning authority (Stellenbosch Municipality).

3. The third question is- *“what type, number and location of public transport facilities are required for the Klapmuts context?”* The warranting process established above will give input on what type of facility needs to be provided. The criteria to be established above, in conjunction with the quantitative and qualitative input for each, will be used to perform a prioritisation process which will give insight into the ranking of alternatives in terms of investment options.

1.3 Research Scope and Limitations

As stated previously, the objective of this dissertation is to critically evaluate policy and guideline documentation that is currently used when siting public transport facilities in South Africa. From this review process, a warranting and siting practice will be formulated which will form the basis when identifying potential sites for the construction of public transport facilities in a low to middle-income area (Klapmuts). To address this research problem, the following aspects were reviewed; the warranting process of mini-bus taxi services, the warranting process for the implementation of mini-bus taxi facilities, criteria used in the evaluation process for identifying potential mini-bus taxi facility sites, as well as policy and South African guideline documentation used in the planning and construction of these facilities and associated infrastructure.

To optimally locate public transport facilities, a clear understanding of the current and future demand for public transport needs to be understood. Due to time and financial constraints, it was not feasible to undertake primary data collection to establish the status quo of public transport service provision and infrastructure in Klapmuts. Therefore, secondary data obtained from a local engineering consultancy firm, Aurecon, Cape Town, will be used in the analysis section of this document. The data used in the analysis section of this document was collected in January 2016, and is therefore deemed relevant in order to give a clear understanding of the status quo of public transport provision for the study area.

1.4 Organisation of Document

The *abstract* and the *summary of contents* for this minor dissertation are found in the first few pages of this document. The table of contents, as well as the list of figures and tables, can be found thereafter. The main body of the document then proceeds, with the outline of each of chapter summarised below:

Chapter 1 introduces the Research Topic to be presented in this document. This chapter states the motivation for choosing the research topic, the problem statement and the aims of this research document.

Chapter 2 contains the Research Methodology that is to be used to address the problem statement, and ultimately aid in developing a warranting and siting practice for public transport infrastructure, that is to be applied to a low to middle-income area.

Chapter 3 is the Review of Literature that is relevant to the subject and supplements the topic of research. The research topic closely relates to the body of knowledge that addresses the planning and design of public transport facilities, and more closely the optimal siting of public transport facilities. This chapter will critically assess policy documentation, legislation, international good

practices, transport infrastructure appraisal techniques, and other relevant material that relate to this topic of research, as well as ascertain the linkages to the identified body of literature.

Chapter 4 is based on a critical elaboration of South African guidelines and International good practices with regards to the placement and design of public transport facilities, as well as cognisance of various policy and budgetary constraints imposed by the relevant authorities, a warranting and siting practice for minibus-taxi terminals and ranks will be developed.

Chapter 5 contains the Findings and Analysis of secondary data. These findings will aid in the understanding of the current status quo of public transport provision, the public transport network, current and future demand for public transport, pedestrian movement patterns, and ultimately result in quantitative and qualitative inputs for the warranting and siting practice developed in Chapter 4.

Chapter 6 is the practical application of the warranting and siting practice developed in Chapter 4 of this document. This warranting and siting practice is to inform the decision on what type of minibus-taxi facilities are required, as well as the optimal locations for these facilities.

Chapter 7 consolidates the research argument into recommendations and conclusions.

The Reference list and the Appendices can be found at the end of the document.

2 Research Method

2.1 Introduction

The purpose of this dissertation is to identify potential sites for the construction of public transport facilities in a low-to-middle income area, Klapmuts, on the outskirts of a metropolitan city, Cape Town. The primary objective, when providing public transport facilities, is ensuring that the needs of all users including the relevant authorities that govern the area are met whilst still complying with policies, design standards, and financial constraints.

In order to answer the research questions posed in Chapter 1 of this document, two strategies were followed. The first of these strategies being a literature review of policy documentation, legislation, international practices, transport infrastructure appraisal technique's, and other relevant material that relates to this topic of research. The second strategy followed was the analysis of secondary data, as to ascertain the status quo public transport service provision, current and envisaged public transport demand, and pedestrian movement patterns in Klapmuts.

2.2 Literature Review

In order to address the first three research questions posed in the Aim of Research section of this document, policy documents, guidelines, statutory material pertaining directly to the municipal governance and management of Klapmuts, as well as international practices relating to placement and design of bus stops and terminals will be consulted.

The first research question, what warrants implementation and construction of road based public infrastructure, specifically focusing on mini-bus taxi terminals, will be addressed by critically elaborating on policy material, more specifically the Moving South Africa report presented by the South African Department of Transport. This report details ideal daily passenger demands to support the implementation of various types of road based public transport services. From the review of this policy document, a warranting process for road based public transport services will be formulated. This warranting process, together with the analysis of secondary data pertaining to the status quo of public transport provision in Klapmuts, will aid in identifying the most applicable public transport service(s) to cater for the demand.

The second research question, what criteria and evaluation methods should be used when ranking potential sites for the construction of road based public transport facilities, will be answered based on a critical elaboration of policy documents pertaining to public transport service provision, South African guidelines for the design and placement of minibus-taxi facilities, as well as international practices for the design and placement of bus stops and terminals. From this review, a warranting

process will be formulated for road based public transport facilities, namely mini-bus taxi terminals and ranks.

Subsequent to the first and second research questions being addressed, a siting practice for the placement of facilities will be developed. The criteria and considerations for the placement of facilities will be aided by a review of local guidelines, as well as international practices. Other supporting material pertaining to this topic of research will be consulted if deemed to complement existing guidelines and practices.

The fourth issue to be addressed in this dissertation is to decide on the location, type and number of public transport facilities to be provided in Klapmuts. The warranting process established above will give input on what types of facilities need to be provided. The criteria to be established above, in conjunction with the quantitative and qualitative inputs obtained from the secondary data analysis and site visits, will be used to perform a prioritisation process, which will give insight into the ranking of alternatives in terms of investment options.

2.3 Empirical Research

In order to determine the status quo of public transport service provision in Klapmuts, secondary data obtained from Aurecon, Cape Town, will be analysed in conjunction with site visit observations. The secondary data obtained includes the following; pick up and drop off points of passengers, public transport services route confirmation, passenger demand profiles and service frequencies for various modes offered. This information, coupled with site visits and observations, will form quantitative and qualitative information in order further guide the warranting and siting practice developed for public transport infrastructure.

2.3.1 Collection of Data

As previously mentioned, due to time and financial constraints, primary data was unable to be collected, however secondary data collected by various authorities and private entities will be used in addressing the research topic.

2.3.2 Secondary Data

The following secondary data will be used as follows:

- **Minibus-taxi passenger demand survey:** Secondary data will be used to review the status quo of public transport service provision in Klapmuts. The available secondary data entails pick up and drop off points of passengers, route confirmation, passenger demand profiles and service frequencies of various modes offered, with the predominant focus on minibus-taxi operations.

A minibus-taxi passenger demand survey was undertaken on the 2nd and the 3rd of December for a 13-hour (06:00-19:00) period at the three minibus-taxi sites (Site 1: Shoprite, Site 2: Merchant & Adams Street, Site 3: Jacobs & Adams Street), to gain a better understanding of taxi operations within, to and from Klapmuts. The mini-bus taxi survey was conducted over two weekdays (Wednesday, Thursday), as it is assumed that peak period demand for mini-bus taxi services will occur on a weekday and not a weekend due to commuters travelling more on a given weekday for work purposes, schooling etc.

Surveyors were stationed at all three sites for the 13 hours, and all taxi movements associated with these sites were recorded. Information captured included (i) Arriving and departing times of mini-bus taxis; (ii) origin and destination points of minibus taxis; (iii) passengers boarding and alighting and fares charged for the various routes operated.

Using GoMapp, a public transport mapping application, mini-bus taxi routing information for Klapmuts was obtained. Surveyors were instructed to travel along the primary routes (Klapmuts-Paarl, Klapmuts-Stellenbosch, and Klapmuts Internal Route(s)) during the peak periods of operation with a cellular device using GoMapp software. During the journey, the GoMapp software, with the assistance of Geographical Positioning System (GPS), was able to record the exact route followed by the mini-bus taxis, as well as recording all pick-up / drop-off points along the route. (Aurecon, Cape Town, 2016)

- **A high-level pedestrian movement pattern review:** Secondary data will be used to assess pedestrian movement patterns within Klapmuts. This secondary source evaluates the pedestrian 'directions of approach' and volumes at various pedestrian hotspots.

The importance of such review is to better understand pedestrian movements and desire lines in Klapmuts, and establish the general flow of non-motorised transport during both the morning and evening and evening peak periods.

The pedestrian survey was conducted in Klapmuts on Wednesday 2nd of December 2015. Surveyors were positioned at pedestrian hotspots based on initial pedestrian movement observations. Information collected at these pedestrian hotspots included i) directions of approach ii) and associated pedestrian volumes (Aurecon, Cape Town, 2016)

- **Travel Demand Assessment:** In order to ascertain current and future demand for public transport in Klapmuts, the Klapmuts growth model developed by the spatial planning authority of Stellenbosch will be reviewed. The Klapmuts growth model indicates both vehicle and person trips volumes for each of the current and future development precincts in Klapmuts. The growth model identifies three broad time frames, 2012, 2017 and 2027 for vehicular traffic and person trip prediction. Vehicular and person trip projections and

forecasts were based upon COTO trip generation guidelines (Stellenbosch Municipality, 2008)

2.3.3 Primary Data

A site visit will be conducted to establish the status quo of identified sites. The information collected from this will form as an input to the Multi-Criteria Analysis (MCA) for both the location of facilities, as well as the prioritisation of alternatives.

2.4 Conclusion

The purpose of this chapter was to define the research methodology of this study, elaborate on how information is going to be obtained, as well as how the warranting and site practice is going to be developed for public transport infrastructure based on a literature review and empirical research.

3 Literature Review

3.1 Introduction

Due to the current financial climate experienced in South Africa, efficient and effective implementation of public transport facilities is essential in promoting economic and social development within the country. The current economic status of South Africa has resulted in a large majority of the population being captive to public transport use. According to the National Household Travel Survey (NHTS) of 2013, on average approximately 40% of work based trips are conducted by means of public transport, and roughly 20% of trips undertaken by walking. This emphasises the need for further investment in public transport services and associated infrastructure. (Statistics South Africa , 2013)

The issue arises in that investments in public transport service provision and associated infrastructure is often an expensive exercise. In order to ensure that maximum return or benefit is achieved on investment, multiple investment alternatives need to be evaluated. To ascertain whether investment options have the ability to promote economic and social growth, they need to be compared based on their effectiveness and efficiency if hypothetically implemented. (Pienaar, 1998, pp. 1-1)

This chapter strives to unpack policies, guidelines and good practices that shape the way the siting of public transport facilities is currently undertaken in South Africa. The first section of this chapter addresses the policies and guidelines that are used to plan and manage public transport facilities in South Africa. This section will clearly define the various components that make up public transport facilities, as well as highlight the general function of these facilities. Following on from this, detailing Spatial Development Frameworks, Urban Design Manuals, and Population Growth models, will be critiqued to ascertain the prerequisites and requirements stipulated by the relevant planning authorities that govern the Klapmuts area. Thereafter, international good practices with respect to the placement and design of bus stops, will be assessed.

Furthermore, guidelines and research papers will be evaluated to establish what warrants the investment in public transport facilities, as well as what public transport facilities should be implemented in specific cases.

Subsequently, this document seeks to better understand how investment options are prioritised, particularly referring to investment options that concern public transport facilities.

In summary, the questions to be addressed in the literature review section of this document are as follows:

- *What standard of public transport service provision is mandatory in a South Africa context given various policy requirements?*
- *What do South African policy and guideline documents dictate in terms of the functioning of road based public transport, with a specific focus on minibus-taxi service provision?*
- *What warrants the implementation and construction of minibus-taxi services and associated infrastructure?*
- *What are the current guidelines followed when planning and siting minibus-taxi facilities in South Africa?*
- *What are international good practices concerning the siting of paratransit facilities?*
- *What criteria and evaluation methods are used when ranking potential sites for the construction of road based public transport facilities?*
- *When identifying potential sites for the construction of minibus-taxi facilities, do the evaluation criteria differ when the setting is a low to middle income settlements in South Africa?*

These findings will inform the warranting and siting practice that will be developed later in this document which will ultimately be used to site minibus-taxi terminals and ranks in Klapmuts.

3.2 Policy and Guidelines

Public transport service provision in South Africa has been and still remains a hindrance in achieving economic and social development. South Africa, from a political and social standpoint, is littered with past transgressions (Apartheid being the prime example) that have more often than not shaped the spatial layout of cities and towns in a negative way, leaving large groups of South Africans far distances away from essential public amenities (schools, health facilities, places of employment etc.). (Walters, 2013, p. 35)

Due to the influence of apartheid on the spatial layout of cities in South Africa, and low-income housing developments generally constructed on the outer fringes of cities based on low acquisition costs of land, these two occurrences have ultimately put immense strain on the public transport systems in South Africa which serves to bridge the distance gaps created. At present, the South Africa government is challenged with finding a balance between safe, reliable and cost-effective public transport in the midst of other pressing issues such as providing schools, low-income housing, security and basic needs to the population. (Walters, 2013, p. 35)

Whilst considering the above-mentioned issues, a number of studies have been undertaken to better understand public transport service provision in South Africa. These studies have formed the basis of various public transport strategies and policy documentation, which are briefly reviewed in the section below, keeping the above-mentioned research questions in mind. Due to the nature of the research statement in this document, policy documentation only concerning land based transport will be reviewed.

The second part of the section will review guidelines that have specific reference to the design, planning, and management of public transport facilities in South Africa. These guidelines will be reviewed to establish what factors need to be considered when selecting potential sites for the development of public transport facilities.

The third and last part of this section will focus on policy documentation that makes specific reference to the study area of this dissertation, Klapmuts. The review of such documentation will give insight into the requirements of local planning authorities that have direct influence and oversight for public transport in Klapmuts.

3.2.1 Policy Framework- Road Based Public Transport

3.2.1.1 *The White Paper on National Transport Policy, 1996*

The White Paper on National Transport Policy (1996) was formulated under the close supervision of the National Department of Transport (NDoT) in response to existing policy documentation which, at the time, did not take into account the ever-changing environment of the transport sector. The South African government included the transport sector in an investment 'priority' list as a sector that has the potential to enhance the social and economic development of the country if effective and efficient decisions are made within it. The White Paper on National transport policy comprises of visions, goals and strategic objectives that are to be used to guide the transport sector in South Africa. (Behrens & Wilkinson, 2001, p. 11)

The vision for the transport sector of South Africa as depicted in the White Paper on National Transport policy is as follows:

“Provide, safe, reliable, effective, efficient and fully integrated transport operations and infrastructure which will best meet the needs of freight and passenger customers at levels of service in a fashion which supports government strategies for economic and social development whilst being environmentally and economically sustainable”

The goals stipulated in this policy document are listed below:

- To enable customers requiring transport for people or good to access the transport system in ways which best satisfy their chosen criteria;
- To improve the safety, reliability, quality, and speed of transporting goods and people;
- To invest in infrastructure or transport systems in ways which satisfy, social, economic, or strategic investment criteria;
- To achieve the above objectives in a manner which is economically and environmentally sustainable, and minimize negative side effects.

With respect to the first listed goal, the aim is to create a transport system that promotes both accessibility and mobility, whilst at the same time allowing passengers the option to choose between various modes of transport when it is economically feasible to do so. (Department of Transport , 1996, p. 9)

At present, the safety, security and reliability of transport modes are unacceptable, with thousands of lives lost each year due to below standard and unmaintained vehicles transporting passengers. This policy document aims to align all modes of transport with international best practice standards. (Department of Transport , 1996, p. 9)

The investment in transport infrastructure is a long-term commitment. Therefore, it is important that the investments made promote both economic and social development. Generally speaking, there is often a trade-off between infrastructure investment and improving the level of service provision. The aim is to provide a high-level service, but at the same time minimise infrastructure costs. It is often a difficult trade-off between the two, with the higher levels of service improving the economy of the country, whilst infrastructure investment promoting social development. (Department of Transport , 1996, p. 11)

As stated by the National White Paper on Transport Policy, for investment to be made in transport-related infrastructure, an analysis on return on investment (ROI) is required prior to investment. Investment decisions are to be made based upon set criteria, which include, the lifetime cost of investment, returns on investment, returns to the transport sector and returns to the customer make use of the infrastructure. (Department of Transport , 1996, p. 11)

The provision of transport often creates negative costs and externalities that are often too hard to recoup. The National White Paper on transport therefore encourages the investment in alternatives that promote environmental sustainability. During the selection phase of investment options, alternatives are to be compared based on their environmental costs and benefits. These costs are then to be represented in both economic and environmental terms. (Department of Transport , 1996, p. 11)

The strategic objectives which are used to ensure that the vision and mission statement of this policy document are achieved, and are of relevance to both land passenger transport and the research topic of this document, will be discussed below.

The strategic objectives mentioned in this policy document are broken up into three broad categories, namely funding, spatial and customer based objectives.

With respect to funding objectives, the National White Paper on Transport Policy states that there must be sustainable and dedicated funding which is to be used to support transport-related infrastructure, operations, and enforcement. (Department of Transport , 1996, p. 35)

The aim of the spatial objectives is to improve accessibility and mobility within South Africa with regards to land based transport. As mentioned previously, the apartheid period created imbalances in travel distance and travel times. Specifically, the White Paper looks to rectify this imbalance by means of ensuring that commuters' distances, on average, are not greater than 40 kilometres in each direction. Due to the sustainable, economic and social benefits of public transport use, the aim is to create a public transport sector in which the modal split is 80:20 in favour of public transport over private transport. To promote the economic and social growth within rural areas in South Africa, the aim is to reduce the disutility and need to travel. To do so public

transport services and areas of attraction, particularly places of employment, need to be in walking distance of dwelling areas. (Department of Transport , 1996, p. 35)

From a customer orientated point of view, the aim is to provide transport services that are universally accessible thus allowing the needs of all users to be met. To improve levels of accessibility and mobility within the South Africa, the aim is to ensure that walkability is reduced to a maximum of one kilometre in urban areas. From an 'affordability' perspective, the National White Paper on Transport Policy states that commuters should not spend more than ten percent of their disposable income on transport. By enforcing such measures, this will promote the usage of public transport which is economically and more sustainable than private vehicle use. (Department of Transport , 1996, p. 36)

3.2.1.2 *The Moving South Africa Strategy, 1998*

The Moving South Africa Strategy (MSA) was formulated by the NDoT in 1998, with the purpose being to develop a long-term 20-year strategic transport framework for the country based on the 1996 National White Paper on Transport Policy. The long-term transport strategies developed in this legislative document recommend the following:

- Consolidating large scale, line haul public transport services to a select few corridors;
- Encouraging the development of high-density mixed land use developments within these corridors to support the public transport services offered;
- Promoting modal economics by ensuring that the most effective mode in terms of cost and service is delivered based on the needs and characteristics of the given corridor;
- Improving the level of service delivered with respect public transport provision by means of allowing competition between modes in the form of competitive tendering and concession schemes. (Walters, 2013, p. 36)

More specific to the topic of research in this paper, the MSA document developed a set of guidelines to be used when deciding on the type of public transport service to implemented in a given corridor. The CSIR Human Settlement guideline emphasises that these are only guidelines and that, depending on the context of the area in question, professional discretion may be required to evaluate the specific transport needs of the area. The conditions needed for the implementation of certain public transport services as stipulated in the MSA guidelines are seen below:

- When a transport corridor experiences volumes in excess of 40,000 passengers per day per direction, it is recommended that either a rail service or dedicated transport infrastructure be constructed to accommodate the high demand. It is suggested that the stations or terminals that serve this type of transport corridor have the capacity to allow for

transfer between modes. It is envisaged that bus and minibus-taxi services will act as feeder services to the primary line haul public transport service of the corridor.

- It is recommended that for a transport corridor that experiences between 10,000 and 40,000 passengers per day per direction, that either a Bus Rapid Transit (BRT) system or Light Rail Transit (LRT) system must be implemented. It is also envisaged that conventional bus and minibus-taxi services will act as feeder services to the primary line-haul public transport service that operates in the corridor.
- Corridors that are characterised by low ridership, less than 10, 000 passengers per day per direction, are recommended to comprise of public transport services that operate in mixed traffic, with a small number of signalised priority schemes. These low-ridership corridors generally function as feeder corridors to larger, higher volume corridors. The line-haul or feeder services provided for in this type of corridor usually consist of conventional bus services or minibus-taxi services. (CSIR, 2000)

3.2.1.3 The National Land Transportation Transition Act, 2000

The National Land Transport Transition Act (NLTTA) of 2000, was passed by the South African government in December 2000. The purpose of the NLTTA 2000 document was to constitute all policies recommended in the National White Paper on Transport Policy and the Moving South Africa documents. The Act comprises of principles which are to be used in the furtherance of public transport in South Africa, whilst ensuring that all spheres of government are aware of their function in achieving the aim of the Act. The Act also brought about the formation of various institutional arrangements such as the Operating License Board, Provincial Tribunal, and National Transport Tribunals (Behrens & Wilkinson, 2001, p. 18)

The aim of the Act as stated in the NLTTA 2000 is as follows:

“To provide for the transformation and restructuring of the national land transport system of the Republic, and to provide for incidental matters; give effect to the national policy concerning the first phases of the process, and achieve a smooth transition to the new system applicable nationally”

The NLTTA 2000 was formulated to address the current issues experienced in the transport sector of the country at the time of publication of the document. The issues include spatial segregation caused by the apartheid era, inadequate levels of public transport service provision, and private vehicle dependency. Principles used to address the above-mentioned issues, and that are of specific reference to the topic of research in this document, will be discussed below. (Wosiyana, 2005, p. 663)

The Act comprises of two main chapters, specifically Chapter 2 of the Act which advises policies, frameworks and requirements on a national level, and Chapter 3 addressing issues that are of provincial concern. (Behrens & Wilkinson, 2001, p. 19)

As stated in the NLTTA 2000, Chapter 2, the principles below concern the determination, formulation, development and application of land transport policy in the Republic of South Africa:

- Public Transport services-
 - Public transport must be affordable to the public
 - Public transport systems should be designed in a way so that the following objectives are achieved:
 - Transport Interchanges should allow for efficient modal transfer
 - Cost efficiency and service quality are at an optimum
 - Scarce resources are optimally allocated
 - Add value to customers that make use of service
 - Reduce negative effects on the environment
 - Appropriate modes should be selected for corridors based on their ability to reduce the total system costs of travel. If a mode change is deemed necessary, an assessment of the impacts of this change on passengers needs to be undertaken prior to a final decision being made.
 - The needs of those envisaged to be using the public transport system need to be considered in the planning process.
 - It's essential that public transport services are planned to ensure that those who are less economically fortunate benefit from subsidy schemes, this improving their levels of accessibility and mobility.
- All role-players involved must strive to achieve an effective land transport system through integrated planning, provision and regulation of infrastructure and services and diligent and effective law enforcement;
- Public transport service, infrastructure and facilities must allow for the efficient and effective integration of road based public transport modes;
- Safety and effective law enforcement must be promoted as vital factors in land transport management and regulatory systems, and the efforts in this regard of all competent;
- For the purpose of land transport planning and the provision of land transport infrastructure and facilities, public transport must be given priority over private transport;
- Scarce resources for the provision of land transport must be used optimally;
- Investment in infrastructure and operations must promote economic, financial, technical and environmental sustainability;
- Effectiveness and efficiency must be promoted in the provision and operation of land transport services and administering land transport matters;

- Coordination of institutional functions in land transport must be promoted;
- Land transport functions must be integrated with related functions such as land use and economic planning and development through among others, development of corridor, and densification and infilling, and transport planning must guide land use and development planning;
- The needs of special categories of passengers must be considered in planning and providing public transport infrastructure, facilities and services, and these needs should be met as far as possible by the system provided for mainstream public transport;
- The participation of all interested and affected parties, including vulnerable and disadvantaged persons, in transport planning must be promoted, taking into account that people must have the opportunity to develop the understanding, skills and capacity necessary to achieve equitable and effective participation;
- The computerised land transport information systems of the national government, provinces, municipalities and transport authorities must be compatible with one another and must be so designed as to allow mutual access as well as access to the systems of the provinces' boards and the systems of planning authorities;
- All spheres of government must promote public transport and the flow of interprovincial transport and cross-border road transport;
- The principle of user charging or cost recovery from direct users must be applied wherever appropriate and possible, in that such users should pay for all or most of the costs related to the service or activity in question. (National Department of Transport, 2000)

The NLTTA Act of 2000 also addressed the minibus-taxi licensing issue. Prior to the Act being passed, permits were issued to minibus-taxi operators without adequate planning with regards to the demands and the needs of the market. As a result of this, minibus-taxi routes were often over traded which resulted in destructive competition between operators, which in some cases led to violence. The NLTTA Act legislated that these 'permits' be converted to 'Operating licenses'. Operating licenses were to comprise of clearly defined routes, and be issued based upon Public Transport plans. (van Ryneveld, 2010, p. 23)

3.2.1.4 Public transport strategy documents, 2007

In 2007, the NDoT published two transport related strategy documents, namely the Public Transport Strategy, and The Public Transport Action Plan- Phase 1 (2007-2010): Catalytic Integrated Rapid Public Transport Network Projects. The primary objectives of these two strategic documents were to outline a management plan for public transport in South Africa, but at the same time taking cognisance of the imminent implementation of Bus Rapid Transit (BRT) systems in various cities in South Africa. These strategic documents concentrated on two main areas, the first of them being the upgrade of various modes of transport in South Africa. The modal upgrade

program comprised of smaller programmes such as the consolidation of the rail sector; the National Rail plan; the enactment of the minibus-taxi recapitalisation programme; the improvement of law enforcement governing the transport sector; and the refinement of bus subsidy schemes in South Africa. The second focal point was the provision for Integrated Rapid Public Transport Networks (IRPTNs) in the main metropolitan cities in South Africa. (Walters, 2013, p. 36)

The vision of the Public Transport Strategy document is to create an environment in which 85% of a given metropolitan's population in South Africa is within walking distance, less than one kilometre, from a public transport corridor. Another goal is to make public transport more favourable than private transport, with the aim that public transport modal share will increase by 20% with respect to work based trips by the year 2020. To allow for minimum resistance when transferring between various modes of transport, the aim is to implement an integrated ticketing system over the next five to ten-year horizon. With respect to public transport facility provision, the aim is to provide facilities that are secure, safe, well-lit and accessible by all potential users. (Walters, 2013, p. 36)

The Public Transport Action plan is a further elaboration on the Public Transport Strategy document. The public transport action plan focuses on the main metropolitan cities in South Africa, with specific attention given to the minibus-taxi recapitalisation programme, the rail consolidation, and refurbishment programme, as well as the action plan to refine the bus subsidy and tendering arrangements. The Action plan intended for the replacement of 75, 000 minibus-taxis and the upgrading of 2000 train coaches by the year 2010.

3.2.1.5 National Land Transport Act, 2009

The National Land Transport Act of 2009 replaced the NLTTA of 2000 and focussed on the further restructuring and transformation of land-based transport in South Africa.

One of the main reasons for the formulation of the NLTA 2009 was due to the failure of the NLTTA 2000 to create transport-related authorities at a local level to take responsibility for the planning and management of public transport in South Africa. Prior to the implementation of the NLTA, there was considerable disjoint with the respect to which level of government, either provincial or city level, should have responsibility for public transport. The NLTA concluded that jurisdiction of public transport is devolved to the lowest most capable tier of government. (van Ryneveld, 2010, p. 24)

The NLTA of 2009 made provision for the revised institutional arrangements for the issuing of operating licenses and long distance passenger transport. The NLTA also aimed to rectify the ineffective integration between road based and rail transport by the establishment of intermodal planning committees. (Walters, 2013, p. 37)

3.2.1.6 Summary of Findings in Policy Documents

The review of South African transport policy documents in this section has, directly and indirectly, answered some of the research questions posed earlier in this document. The National White Paper on Transport Policy gave specific reference to what level of transport service needs to be provided in South Africa. The mission statement of this policy document is to provide safe, reliable, efficient and integrated transport services that cater to the needs of passenger and freight customers alike, while still aligning with the South African government's aim of endorsing social and economic development. This policy document also gave insight into policies and factors that need to be considered when planning and developing public transport facilities in South Africa. The first of these factors was to improve accessibility and mobility around public transport facilities by ensuring that commuters do not walk for more than a kilometre to reach public transport services. Safety and reliability were also factors emphasised in this policy document, therefore reinforcing the need to provide reliable transport services that take place in a safe environment. Another area of importance stated the investing in alternatives that bring about the greatest return or benefit on investment, while still being sustainable in nature. It is proposed that multiple criterion analysis techniques are used when evaluating and prioritising between various transport infrastructure investment alternatives. (Department of Transport , 1996)

The Moving South Africa policy document of 1998 lists primary objectives which consolidates transport services to a select few corridors, promote mix-land use densification around transport corridors and ensure that the most cost effective and efficient modes are implemented in these corridors. This policy document succeeded in answering one of the research questions of this dissertation which deal with the warrants needed in implementing certain types of public transport services. For a transport corridor that has high volumes of ridership, in excess of 40,000 passengers per direction per day, it is proposed that heavy rail is the primary mode of transport serving the corridor. For a medium ridership corridor, with passenger volumes exceeding 10,000 passengers per direction per day, either LRT or BRT systems should be implemented. Those corridors with less than 10,000 passengers per direction per day are proposed to be served by minibus-taxis and conventional bus services. (Department of Transport , 1998)

The National Land Transport Transition Act of 2000 aided in addressing the research questions that deal with criteria and factors that need to be considered when planning and choosing between possible sites for the development of public transport facilities. The NLTTA of 2000 puts emphasis on the fact that transport interchanges must be constructed to allow for modal transfer; resources must be optimally located; the transport service provided must be of added value to the customer; the needs of transport users need to be considered in the planning process; the implementation of the most cost effective transport system from a user and authoritarians perspective; infrastructure alternatives chosen based upon their potential burden to the environment; and that investments in

transport infrastructure must be economically, socially and environmentally sustainable. (South African Government , 2000)

3.2.2 Klapmuts Policy and Statutory Context

The section below reviews policy documentation that is of specific relevance to Klapmuts. The policy material reviewed below gives the planner or relevant authority a better understanding of Klapmuts. In these policy documents the needs and future plans for the area are dictated. This policy material does not state what types of public transport facilities ought to be provided, or where they must be situated, but highlights areas of concern that should be considered in the public transport planning process.

3.2.2.1 Provincial Spatial Development Framework

The Western Cape: Provincial Spatial Development Framework (WCPSDF) of 2005 proposes that certain precincts within Klapmuts that have prominent potential and high needs should be considered for future development. The framework also points out areas where infrastructure is below the desired standards of the authority. Due to the envisaged future growth of Klapmuts, and the high need to upgrade infrastructure in the area, short to medium term strategies are proposed by the WCPSDF. These strategies are in accordance with those of the Cape Winelands District Municipality, and include the following:

- Protection of agricultural and scenic areas from the intrusion of low-density housing;
- Redefining the urban edge;
- Further development of transport linkages;
- Promotion of tourism, agricultural industry, and other economic drivers (Stellenbosch Municipality, 2007, p. 6).

3.2.2.2 Cape Winelands Spatial Development Framework

As stated by the Cape Winelands Spatial Development Framework (CWSDF), Klapmuts is defined as a rural town. The principal objective of authorities responsible for rural towns in South Africa is to improve the social equity within the area. A rural town is expected to perform a supporting role to rural hinterlands, as well as support the agricultural industry. (Stellenbosch Municipality, 2007, p. 6)

As mentioned above, authorities aim to improve the social well-being of residents in rural towns. This is to be achieved by 'social' investment (i.e. schools, health care facilities, public transport, upskilling programmes etc.). However, due to the growing needs of rural towns and the limited financial support, resources need to be optimally located.

Klapmuts is not demarcated as a public housing sector area. Therefore, the CWSDF proposes that the authority reduces the supply of subsidised housing in the area. In response to the above initiatives, and to ensure economic and social growth is achieved, it is advised that infrastructure and transport services are improved in Klapmuts. (Stellenbosch Municipality, 2007, p. 7)

Furthermore, the CWSDF notes the following guiding development principles, a number of which are pertinent to Klapmuts:

- Promote accessibility to hinterland areas;
- Clearly defining the urban edge to prevent the occurrence of urban sprawl;
- Provision of facilities that promote integration of infrastructure;

3.2.2.3 Stellenbosch Municipality Spatial Development Framework

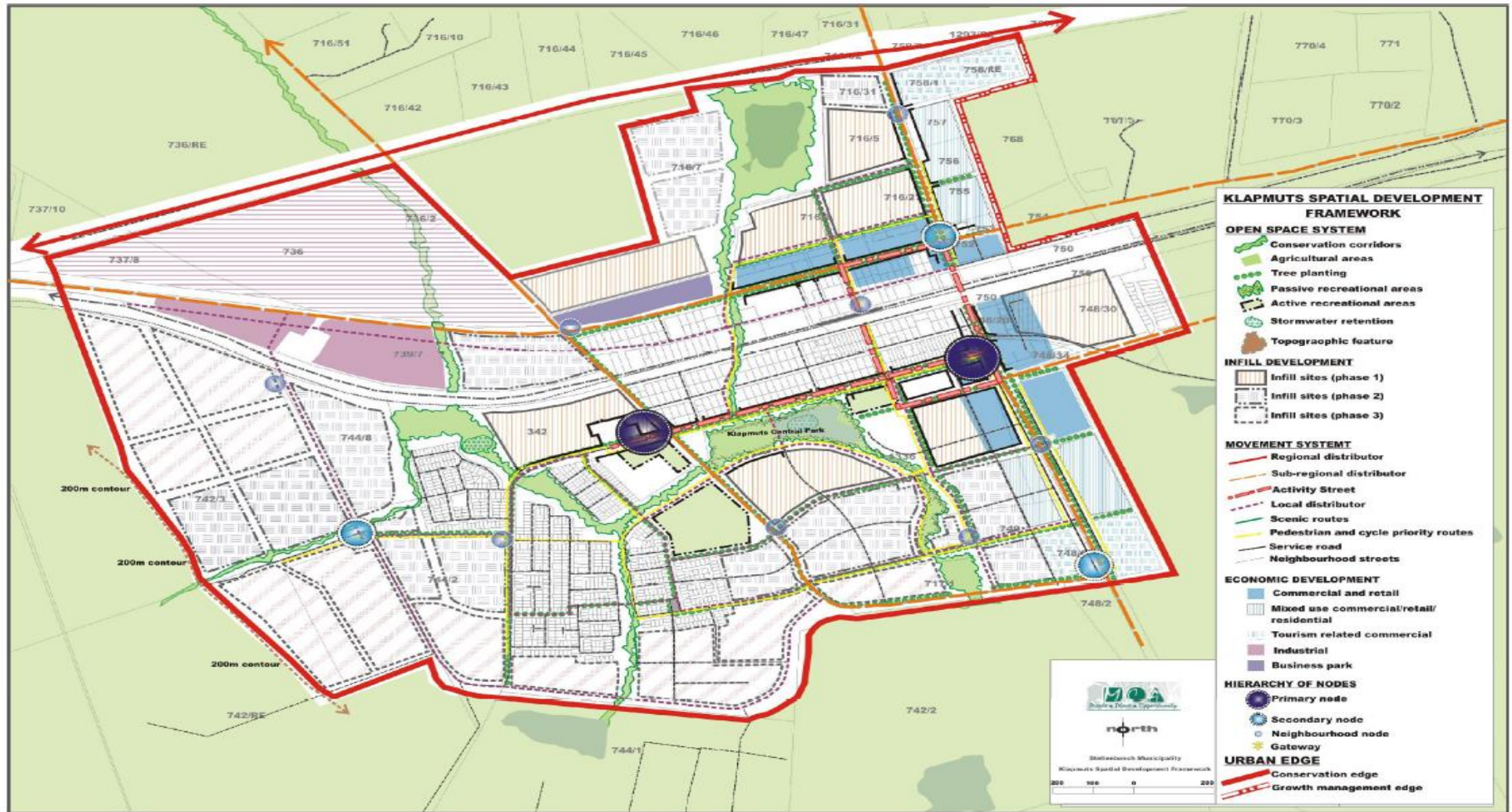
The Stellenbosch Municipality Spatial Development Framework recommends that the following guiding principles be applied to the Klapmuts sub area:

- Recognition that Klapmuts is termed as a development node, and that focus be given to urban growth;
- Further research into the growth potential of the area, and its ability to cater for the needs of residents;
- Clearly defining the urban edge to promote smart and sustainable growth;
- Conservation of ecology in the area.

3.2.2.4 Klapmuts Spatial Development Framework

The Klapmuts Spatial Development Framework (2007) frames the envisaged development of the area as illustrated in **Error! Reference source not found.** below.

Figure 6: Klapmuts Spatial Development Framework



(Stellenbosch Municipality, 2007)

3.2.2.5 Klapmuts Growth Strategy

The Klapmuts Growth Strategy was devised to aid in the decision-making process with regards to low-income housing. The Klapmuts Growth strategy pursued sustainable development over the short to medium term, and is based upon population projections of 1585 people in 2010 and 1778 in 2015. The current population as of 2016 is approximately 7700 residents which indicates that the strategy failed to recognise the scale and complexities of the area, and is therefore deemed irrelevant for further review in this study. (Stellenbosch Municipality, 2007)

3.2.2.6 Summary of Findings in Klapmuts specific policy documentation

Klapmuts is earmarked for extensive infrastructure development and population growth in the near future, but at present lacks infrastructure with the means of meeting the needs of residents. To promote economic and social growth within Klapmuts, it is recommended that infrastructure, as well as public transport service provision, be improved. Klapmuts is defined as a rural town, and thus 'social capital' investment is one of the main priorities for authorities. As a result of the many needs of a rural town (i.e. education, clinics, social development programs etc.), funds are limited and thus resources need to be optimally located. Authorities are actively reducing the financial investment of subsidised housing in Klapmuts, but in response to this, policy material suggests that public transport, as well as general infrastructure, be upgraded. From a spatial development perspective, one of the main objectives is to improve access to agricultural lands for emerging farmers. To prevent urban sprawl and low-density housing infringing on agricultural and scenic areas, it is recommended that the urban edge is clearly defined. By clearly defining the urban edge this will result in densification, ultimately supporting public transport service provision in the area.

3.2.3 Public Transport Facility and Planning Design Guidelines

The section to follow reviews transport guidelines that are presently used in the planning and design of public transport facilities in South Africa. The review of these various transport guidelines will aid in establishing what factors need to be taken into consideration when designing mini-bus taxi facilities, with a specific focus on the considerations that attributed to the warranting and siting of mini-bus taxi facilities. The considerations identified in the of these transport guidelines will be used in developing a warranting and siting practice for mini-bus taxi facilities which will be applied to the Klapmuts context.

As a result of the ever-changing nature of public transport, guidelines may not be up to date. Therefore, documents that act as complements or support to the mentioned guidelines will be reviewed as well and taken into consideration when developing a warranting an siting practice for mini-bus taxi facilities.

3.2.3.1 *Bus Terminals and Bus Stations: Planning and Design Guidelines, 1986*

This guideline is the first wide-ranging report by the National Department of Transport that elaborates on how bus associated infrastructure should be planned and constructed in the built environment in South Africa. In summary the guideline gives recommendations on warrants for bus facilities, the layout of facilities, as well as the positioning of facilities in relation to various land-use types. As a result of a large contingent of operators and manufacturers in the South African market, the guideline aims to recommend plans and designs that meet the needs of all parties. Those areas of reference to the siting of bus facilities in the guideline will be reviewed in detail below.

3.2.2.1.1 Functions of Terminals and Bus Stations

Definitions of bus related infrastructure as stated by the National Institute for Transport and Road Research are as follows:

Terminal: *A special area, including buildings, structures, and equipment at the end of transport facility, for the storage, transfer, handling and reception of vehicles, passengers, and materials.*

Station: *An enclosed or partially covered area, the main function of which is to allow large volumes of public transport passengers to change mode or to alight or board public transport.*

Bus stop: *A designated point, usually marked by a post, at which a bus stops for passengers boarding and alighting.*

3.2.2.1.2 Need for a Terminal or Bus Station

The guideline mentions key factors that should be considered prior to implementing bus-related facilities. These factors being:

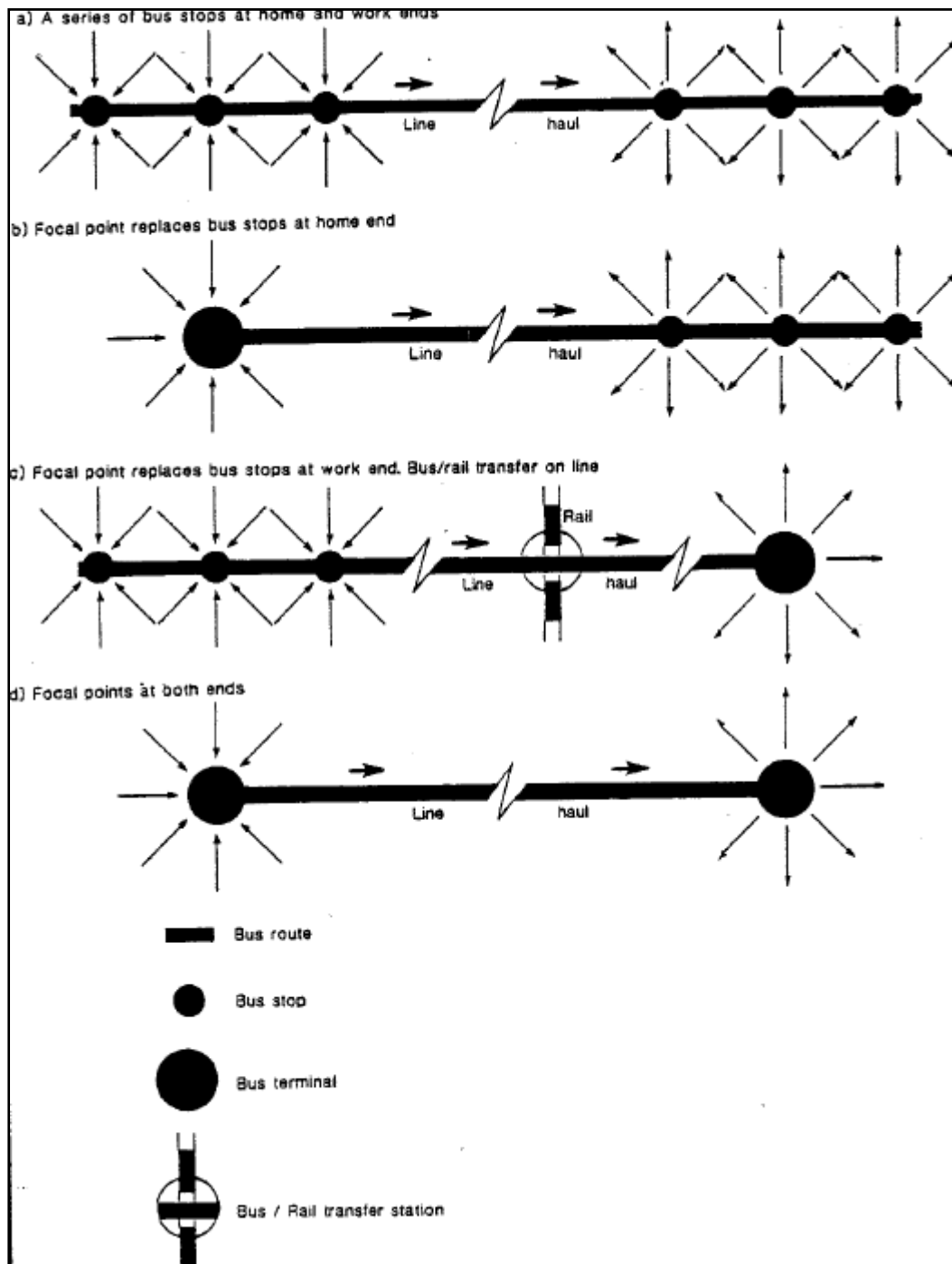
- Bus Operations
- Passenger Considerations
- Traffic Operations
- Location and Land Use Considerations
- Economics

If bus facilities are required, the extent of these facilities is to be based upon the amount of buses departing in the peak periods, as well as the envisaged number of passengers boarding and alighting at these facilities. (Department of Transport, 1986, pp. 2-3)

Bus Operations

Bus operating policies and strategies often state the need for certain types of facilities. Operations themselves can also depict the type, as well as placement of facilities. The guideline gives reference to how different types of bus distribution systems can affect the size and type of facility needed. This is shown in Figure 7.

Figure 7: Bus Service Distribution Patterns



(Department of Transport, 1986, pp. 2-5)

Figure 7 a) Is an example of where a bus service has multiple pick up and drop off points in both the residential area and the employment area. The start points and end points of the route are defined as terminals, but they are demarcated and constructed no differently than the intermediate bus stops.

Figure 7 b) Illustrates a bus operation where all intermediate stops in the residential area are instead concentrated at one point. Passengers generally reach this focal point by either feeder services (bus, minibus-taxi etc.) or by means of walking or cycling.

Figure 7 c) Depicts a passenger distribution system that is highly prevalent in South Africa. This system comprises of multiple boarding and alighting points in the residential area, but generally one focal point for boarding and alighting in the areas of employment. As a result of the concentrated demand in the employment area, specific type of facilities might be required. Along these routes, there is often a point that allows for modal transfer. At this point, facilities that allow for efficient modal transfer need to be provided.

Figure 7 d) illustrates a passenger distribution system that has focal areas in both the residential area, as well as the employment area.

The guideline emphasises that, preceding the decision on what type of bus facility to implement, the benefits need to be weighed up against the disadvantages. Factors that also should be considered are the convenience or inconvenience experienced by the commuters, as well as the financial costs of implementing certain types of facilities. (Department of Transport, 1986)

There are multiple benefits to consolidating multiple stops into one focal point in either a residential area or a work area. One of the main reasons as stated by the guideline is that by having a singular focal point, all of the demand is concentrated in one area, thus allowing for easier implementation of less demand intensive routes.

It is also suggested that each situation is treated on its own merit and that, depending on the situation, certain passenger distribution patterns will be better suited than others. Therefore, various passenger distribution systems should be evaluated. Factors to be added to the evaluation process are; cost implications for all parties involved, convenience for the commuter, suitability of sites and cost savings incurred. (Department of Transport, 2007)

Passenger Considerations

From a passenger perspective, the guideline recommends that facilities be placed and constructed with the end user in mind. The aim is to provide a facility that is in walkable distance of commuter areas of production and attraction. Another beneficial reason for consolidating multiple stops into one larger stop is that the focal point attracts large sums of commuters, making the provision of public amenities (shelter, kiosks, toilets, seats etc.) more economically feasible. (Department of Transport, 1986, pp. 2-8)

Traffic Operations

Decisions on whether to place a facility on or off street, must carefully consider the current and expected traffic volumes of the area in question. By placing a facility on-street, this often creates delays as the vehicle picking up or dropping off passenger's blocks traffic in the lane. If facilities are to be provided on-street, the guideline recommends that they are placed in areas where there is little traffic movement. Placing facilities on-street on higher order roads is not advised due to the high operating speeds, which makes boarding and alighting the vehicle dangerous for the commuter. (Department of Transport, 1986, pp. 2-9)

Location and Land Use Considerations

As mentioned previously, the guideline proposes that bus facilities be in walkable distance of commuter areas of trip production and attraction. An understanding of the mutual impacts between bus facilities and surrounding land use types is essential as this will give the planner an indication of the potential benefits and disadvantages. Bus facilities often spur development in the near vicinity. To ensure that a bus facility is well supported with regards to passenger numbers, the land surrounding the facility needs to be appropriately zoned by the authority. (Department of Transport, 1986)

Land value increases the closer one gets to the centre of the city or town. Often, due to the high prices, it is not economically feasible to construct one central facility. As a result, facilities often need to be placed on the periphery of the city or town. Facilities located away from the centre of the town offer less coverage. Therefore, trade-offs and decisions need to be made between coverage and cost. (Department of Transport, 1986)

Economics

As mentioned earlier, due to the economic climate in South Africa and the growing needs of those below the poverty line, authorities often lack the financial means to construct bus facilities. The guideline emphasizes that the lack of public transport facilities could, however, impede the country further as commuters are deprived of means of getting to places of employment. Therefore, despite

the financial constraints, a cost-benefit analysis should be performed to ascertain the true costs and benefits of a facility. (Department of Transport, 1986)

In summary, when deciding between types of facilities, on-street or off-street, central or on the periphery, various alternatives should be evaluated based on passenger convenience, capital costs, availability of the site and the mutual impact of the facility and the surrounding area. (Department of Transport, 1986)

3.2.3.2 Guidelines for the Design of Mini/Midibus- Taxi Facilities,2007

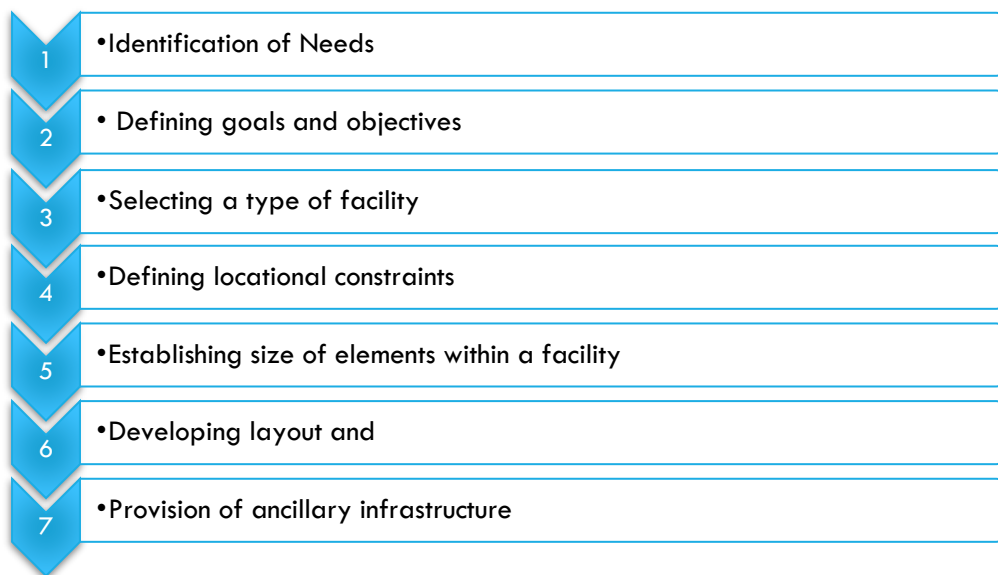
The guideline for the design of mini/midi-bus taxi facilities was formulated by the Department of Transport in 2007, in response to the new fleet of mini/midibus-taxis as part of the taxi recapitalisation programme. The 2007 guideline is an adaptation of the previous guideline, Guidelines for the Design of Combi Taxi Facilities (1989), in order accommodate the revised dimensions of the new mini/midi-bus taxi fleet. The revised dimensions of mini/midi-bus taxis have been approved by the Inter-Departmental Steering Committee (IDC), who are responsible for the implementation and management of the taxi recapitalisation programme. The 2007 guideline has also made provision for statutory requirements stipulating that public transport infrastructure be Universally Accessible (UA) in design. (Department of Transport, 2007)

One of the primary objectives of this guideline is to integrate mini/midibus-taxi services with other modes of transport while still creating an environment that is safe and convenient for the end user. The guideline gives mention to the barriers that prevent adequate mini/midibus-taxi service provision and gives recommendations on how to overcome these barriers by elaborating on important elements in the planning and design of mini/midibus-taxi facilities. These elements include the locational constraints, the warrant for a particular type of facility, capacity and size considerations, geometric parameters, and layouts that allow for seamless integration between transport modes. Those elements in the planning and design process that are of relevance to the siting of mini/midibus-taxi facilities will be further explained in the section to follow. (Department of Transport, 2007)

3.2.2.2.1 Planning Procedure

This guideline gives reference to a recommended 'planning procedure' that is suggested to be followed when deciding on the nature of mini/midibus-taxi facilities to be provided. Due to the ever-changing nature of mini/midibus-taxi operations in South Africa, it is recommended that a simple more adaptable procedure is followed compared to a comprehensive and complex one. The guideline, therefore, proposes that the following procedure is followed:

Figure 8: Guidelines for the Design of Mini/Midibus-taxi facilities: Planning Procedure



(Department of Transport, 2007)

The research question posed within this dissertation focuses on the warranting siting of public transport facilities. Therefore, the steps in the above-mentioned planning procedure that aid in optimal siting of facilities will be reviewed in greater detail. These steps include; the identification of needs, defining goals and objectives, selecting a type of facility and defining locational constraints.

3.2.2.2.2 Identification of Needs

The first step in the planning of facilities for mini/midibus-taxi services is to establish the needs of all the relevant stakeholders. The stakeholders involved in mini/midibus-taxi service provision are namely the passengers, operators, and community. To better understand the needs of each of these parties, one must establish the problems faced by each of these parties in terms of mini/midibus-taxi service provision. The guideline makes mention of possible factors that can be used in establishing whether there is a need for formalised mini/midibus-taxi facilities or not. Table 3, below lists these factors for each of the various parties.

Table 3: Factors to Identify Needs

Passenger	Operator	Community
• Availability of Facility	• Availability of facilities	• Environmental Impact
• Walking distance	• Passenger attraction	• Traffic Congestion
• Security	• Capacity	• Social Issues
• Ancillary Facilities	• Safety	
• Comfort	• Ancillary facilities	
• Convenience	• Accessibility	
• Other transport mode	• Control of service	

(Department of Transport, 2007)

The guideline also specifies that the factors mentioned in Table 3 can also be used when evaluating the performance of existing facilities.

3.2.2.2.3 Defining Goals and Objectives

The second step in the planning procedure for mini/midibus-taxi facilities is to define the desired goals and objectives of the project. Goals, as defined in the guideline, are idealised end states that planners and authorities strive for. Objectives are defined as specific results that are aimed to be achieved given financial and time constraints. Objectives should be quantifiable, thus allowing the level of accomplishment to be ascertained. Objectives in the sense of planning mini/midibus-taxi facilities should therefore address the needs of those, directly and indirectly, involved in service provision. The guideline identifies holistic objectives for the planning, design and implementation of mini/midibus-taxi facilities in South Africa. The list of outcomes as stipulated in the guideline is as follows:

- Promote the use of mini/midibus-taxis
- Improve the capacity of the current public transport system
- Improve operational efficiency
- Reduce congestion within immediate road network
- Reduce the pollutants
- Provide adequate capacity in the peak periods to reduce waiting times at facilities
- Improve safety
- Provide security and comfort
- Promote retail business in specific areas
- Minimise conflicts between passengers and vehicles
- Improve mobility

The guideline also gives mention to the fact that objectives must be realistic as well as measurable. The measurability of each of the objectives will give an indication to the planning authority on whether the facility has been successfully implemented or not. (Department of Transport, 2007, pp. 4-1)

3.2.2.2.4 Types of Facilities

In South Africa, the term 'taxi' and the term 'rank' are commonly misused when describing public transport services. The term 'taxi' in a South African context can either be defined as metered small vehicle that transports commuters based on the commuters' discretion or as a vehicle, either a minibus or midibus, that transports commuters in an unscheduled nature along major transport corridors. Metered taxi services generally charge customers a per kilometre rate as the user has the ability to define the route followed as well as the exact origin and destination points. Mini/Midibus-taxis generally operate within defined transport corridors and this has a set charge rate for each of the corridors travelled. (Department of Transport, 2007)

The definition for the term 'Minibus-taxi' and 'Midibus-taxi' as stated in the guideline is as follows:

Minibus-taxi: "A motor vehicle designed, or lawfully adapted by a registered manufacturer in compliance with the Road Traffic Act, no. 29 of 1989, to carry from nine to 18 seated persons, excluding the driver."

Midibus-taxi: "A motor vehicle designed, or lawfully adapted by a registered manufacturer in compliance with the Road Traffic Act, no. 29, to carry from 19 to 35 seated persons, excluding the driver."

There are four different types of mini/midibus-taxi facilities, namely stops, ranks terminals and holding areas. However, in South Africa, the term 'rank' is often used to describe all of these facilities which is incorrect as each of them has their own inherent characteristics. Below are definitions for each of these types of facilities as described in the planning of mini/midibus-taxis guideline.

Mini/Midibus-taxi stop: *A place usually within the road reserve at which mini/midibus-taxis are allowed to stop for passengers to board and alight the vehicle. Mini/midibus-taxis are prohibited from holding at a mini/midibus-taxi stop.*

Mini/midibus-taxi rank: *A place usually within the road reserve at which mini/midibus-taxis are allowed to stop for passengers to board and alight the vehicle. Dissimilar to mini/midibus-taxi stops, mini/midibus-taxi ranks allow mini/midibus-taxis to stop for a duration of time.*

Mini/midibus-taxi terminal: *A location, usually off street at the common end of one or more routes where mini/midibus-taxis can wait and passengers can board and alight.*

Mini/midibus-taxi holding area: *An area, usually off-street, where mini/midibus-taxis hold before proceeding to loading points and where generally there is no passenger activity. A holding area can either be included within or be separate from a terminal facility.*

Within in these various types of mini/midibus-taxi facilities, the following elements can be observed:

Mini/midibus-taxi bays: *A stopping space off the travelled way reserved for a mini/midibus-taxi.*

Berth: *An authorised bay at a public transport facility where vehicles stop for passengers boarding and alighting and where vehicles hold or queue before proceeding to load.*

Loading Island: *A pedestrian island especially intended for the protection of passengers from other traffic while they wait to board or alight the vehicle at a public transport facility.*

3.2.2.2.4 Factors affecting the type of facility

Depending on the situation, the implementation of certain types of mini/midibus-taxi facilities will be better suited than others. When deciding on what facility to implement, the guideline recommends that the following be considered prior to a decision being made:

- Current mini/midi
- bus-taxi operations
- Passenger considerations
- Traffic Considerations
- Location and land use considerations
- Costs

The above-mentioned considerations will be elaborated on further to better understand what needs to be considered when deciding on a type of facility to implement.

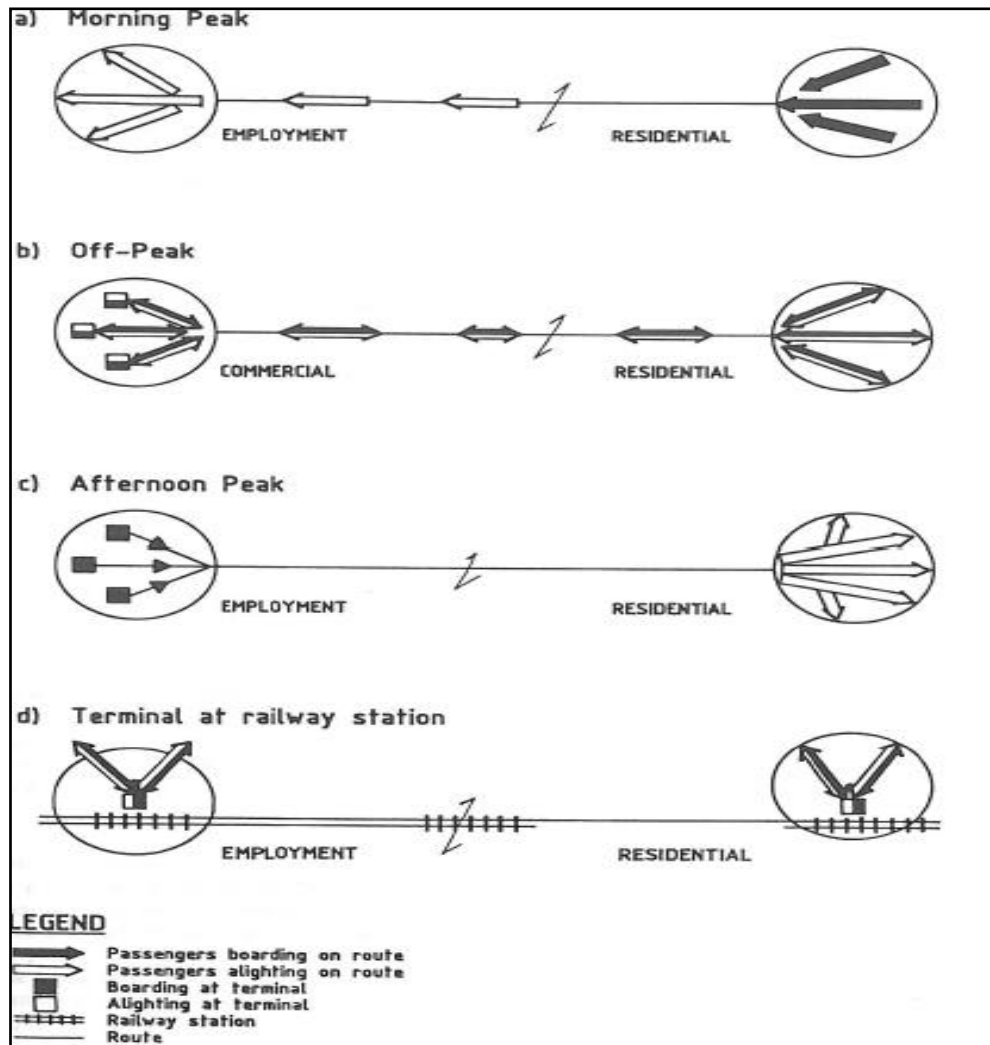
Mini/midibus-taxi operations

Mini/midi-bus taxi operations are relatively informal in nature, with drivers abiding by rules instituted by the regulating authority and the respective mini/midibus-taxi associations. The regulating authority has jurisdiction over which routes or corridors mini/midibus-taxis are allowed to operate along but has no control over the fares charged to the commuters. As a result of their relative flexibility with respect to operations, mini/midibus-taxis can easily adapt to fluctuating demands. (Department of Transport, 2007, pp. 5-4)

Relative to other modes of public transport in South Africa, mini/midibus-taxis loading and off-loading of characteristics are vastly different. The predominant reasons for this being the lack of adequate facilities to accommodate operations, as well as the deficiency of law enforcement along transport corridors. (Department of Transport, 2007, pp. 5-4)

Typical travel patterns of mini/midibus-taxis in South Africa can be seen in Figure 9.

Figure 9: Examples of Mini/midibus-taxi Operations



(Department of Transport, 2007)

Figure 9 a). In the morning (AM) peak period, commuters are picked up from various points in the residential area and transported to places of employment. A small amount of pickup and drop off points are defined, whilst the majority are demand driven and at the request of the commuter. The strongest movement direction in the morning peak period is away from the residential area.

Figure 9 b). On average, during the off-peak periods, the predominant mini/midibus-taxi movement directions is spread between residential and commercial.

Figure 9 c). During the afternoon (PM) peak periods, the principal movement pattern is away from the area of employment to the residential area. Generally, pick up points in afternoon peak are concentrated to a few sites, and drop-off sites in the residential area are scattered and at the request of the commuter.

Figure 9 d). Illustrates a situation in which major facilities are required at both ends of the route. These major facilities are required when there is a modal transfer taking place between modes, allowing commuters to transfer to another mode and travel along another route.

The guideline states that when deciding on what type of facility to implement, mini/midibus-taxi operations of the area in question should be reviewed. Those elements from mini/midibus-taxi operations perspective that will affect the type of facility chosen are the amounts of routes served as well as whether mini/midibus-taxis will have to wait or hold when the demand is low. (Department of Transport, 2007, pp. 5-6)

It is suggested that mini-bus stops be located along routes, situated in a way so that they can serve more than one route. Ranks are to be located at the end of routes, and it is recommended that they serve individual routes. Terminals, on the other hand, are to be located at the end of routes and should have the capacity to serve more than one route. Holding areas are to be provided if there are lengthy waiting times in the off-peak periods with minimal passenger activity. Holding areas are to be situated away from terminals and ranks, thus freeing up congestion (Department of Transport, 2007, pp. 5-6)

When deciding on what type of facility to implement, the needs of operators, mini/midibus-taxi associations, and passengers' needs to be understood. Consequently, the planner or authority responsible for the implementation of facilities is expected understand the interconnected relationship dynamic between all affected parties prior to a decision being made. (Department of Transport, 2007, pp. 5-6)

Passenger Considerations

Mini/midibus-taxi facilities are designed with a specific function in mind. That function can either be a boarding or alighting function or a passenger transfer function between vehicles or different modes. In some instances, both the boarding and alighting function, as well as the modal transfer function, are required. Regardless of what facility type(s) is decided on, each facility must be designed and located in a way that promotes passenger safety and convenience. The guideline proposes that this can be achieved by reducing the walking distance of commuters and potential conflict areas between vehicles and passengers. (Department of Transport, 2007, pp. 5-7)

The guideline therefore proposes that the following factors be considered prior to a decision being made on what type of facility to implement:

- Expected passenger numbers
- Expected waiting times
- Catchment area potential of facilities

- Number of transfers

Traffic Considerations

Depending on the facility chosen, each type of mini/midibus-taxi facility attracts a certain amount of vehicular and passenger demand. The guideline emphasises that vehicular conflict, and passenger and vehicular conflict should be kept to a minimum. From a pedestrian and vehicular perspective, the following should be considered when deciding on the type of facility:

- The capacity of the road system (Level of Service)
- Traffic Volumes
- The number of operational mini/midibus-taxis

Road hierarchy plays a pivotal role when deciding on what type of mini/midibus-taxi facility to implement. On primary roads, where the traffic volumes and operating speeds are relatively high in comparison to secondary roads, traffic friction is to be avoided. To mitigate this potential 'friction', off-street facilities are to be provided. On secondary roads, where traffic volumes and operating speeds allow for a certain degree of 'friction', on-street facilities can be implemented. (Department of Transport, 2007, pp. 5-9)

Location and Land Use

When deciding on what type of public transport facility to implement, cognisance of current and future spatial layouts need to be considered. The size and the type of facility implemented is largely dependent on the size of the area. The guideline proposes that small urban areas that are 'walkable' and are abundant in large open spaces can be served by one central facility. Larger urban areas on the other hand should be served by multiple facilities, to ensure the catchment area of the service is within the walkable range of potential commuters. (Department of Transport, 2007, pp. 5-9)

The availability of land, whether it is kerbside or off-street, will determine what types of facilities can be implemented. In a South African context urban areas are relatively dense, with only a few open spaces for the construction of large off-street terminals. It is therefore generally easier to construct facilities within the road reserve. (Department of Transport, 2007)

The guideline also stipulates that there must be a thorough understanding of the mutual influence between land use type and the type of facility. Land use surrounding facilities will determine the nature of operations as well as what type of commuters the facility will attract. The type of facility itself will also impact the surrounding area as it attracts both formal and informal traders. (Department of Transport, 2007, pp. 5-9)

Cost

As a result of South Africa's economic and social climate, the total cost of a facility is often the decisive factor in building a facility or not. The bid rent theory best describes the relationship between land cost and the distance from the central business district. Land situated centrally (CBD) is in high demand due to its increased levels of accessibility but this increase in accessibility comes at an increased monetary cost. Therefore, the acquisition cost of centrally locating a facility within a CBD is greater than locating it on the periphery of the urban area. (Department of Transport, 2007)

The guideline depicts that the following costs should be considered when investing in mini/midibus-taxi facilities:

- Acquisition costs of land
- Design and construction cost
- Costs and benefits to the operators
- Environmental costs
- Operating costs of facility

3.2.2.2.5 Location and Land Use considerations

As previously mentioned, mini/midibus-taxi operations are considered demand responsive and seek to meet the demands of commuters at geographical points of least resistance. The efficient and effective functioning of mini/midibus-taxi facilities is largely dependent on site location. Due to the nature of mini/midibus-taxi facilities being immersed in the urban environment, there are numerous spatial relationships that need to be understood prior to deciding on potential sites. Thus, when deciding on a location for a mini/midibus-taxi facility, the needs and desires of potential commuters are to be considered as well as a thorough understanding of the impact of the facility on surrounding land types and vice versa. The considerations that are influential on selecting site location will be expanded on below. (Department of Transport, 2007, pp. 6-1)

Passenger Considerations

To minimise disutility, facilities should be located in geographical positions that reduce the walking distance for commuters. The walking distance is defined as the distance between a facility and the commuter's origins and destinations. The guideline also reinforces previous policy statements on walkability by stating that facilities should be within walking distance (400m to 500m) of common origin and destination points of commuters. (Department of Transport, 2007)

The reason for placing stops 400m to 500m apart is as a result of the following factors; walking long distances is a safety risk to commuters as the probability of pedestrian and vehicle conflict is

higher. South Africa is also known for its alarming crime statistics and thus commuters do not feel safe walking for extended periods of times. As mentioned above, mini/midibus-taxis collect and drop off passengers at points of least resistance, so if facilities are vastly spaced mini/midibus-taxis will often make stops at places that are more convenience to the commuter. This informal stopping often takes place at undesignated areas which often impedes on traffic conditions and congests pedestrian sidewalks. (Department of Transport, 2007, pp. 6-2)

Traffic Considerations

The guideline recommends that for a mini/midibus-taxi facility to be unimpeded by external traffic, its needs to be positioned in such a way so that there is relative ease when accessing the greater road network. Commuters and pedestrians tend to be in high concentrations in the near vicinity of intersections, so logically one would want to position a facility adjacent to an intersection. The guideline advises against such positioning as there are higher probabilities of unwanted conflicts between vehicles and pedestrians. It is therefore proposed that, if the facility is located on-street, it be positioned mid-block to avoid these undesirable conflicts. (Department of Transport, 2007, pp. 6-2)

On high order roads, with high operating speeds, mini/midibus-taxi traffic rarely hinder existing traffic conditions as mini/midibus-taxis are unable to informally stop unless there are designated stopping areas. However, on low order roads, where there is slower moving traffic and a great deal more activity along the sidewalks, facilities must be placed in areas that reduce congestion. (Department of Transport, 2007, pp. 6-2)

Land Use Considerations

The guideline gives reference to the fact that local spatial development and growth frameworks should be consulted prior to a decision being made on mini/midibus-taxi infrastructure. Spatial Development Frameworks (SDF) guide planners regarding envisaged spatial layouts, to ensure that future developments are constructed in an orderly manner. Population growth frameworks depict current and predicted future population concentrations allowing planners to provide facilities and infrastructure that caters for both current and future demands. (Department of Transport, 2007)

Mini/midibus-taxi operations and associated infrastructure can have positive, and negative impacts on certain land-use types. The guideline states that mini/midibus-taxi facilities adjacent to retail areas and office complexes often have beneficial impacts. From a retail perspective, if mini/midibus-taxi facilities are in the near vicinity, this will make the retail area more accessible thus promoting commercial activities. However, mini/midibus-taxi facilities are generally associated with littering and noise, thus hindering commercial activities for luxury goods retailers.

Mini/midibus-taxi facilities adjacent to 'office' areas allow for easier access to areas of employment, but consideration should be given to the negative effects of min-bus taxi facilities such as noise pollution, littering, crowding of areas etc. In residential areas, it is advised that smaller facilities be constructed as these facilities have reduced negative impacts as a result of their size. If larger facilities are deemed necessary, the guideline proposes that they are constructed off-street and away from high concentrations of a residential area. (Department of Transport, 2007, pp. 6-7)

Site Availability

Other considerations that need to be taken into deliberation when siting a facility is the availability of land, the size of the land available, the ownership, as well as the zoning of the land. (Department of Transport, 2007, pp. 6-7)

3.2.3.3 Design Guidelines for Public Transport Facilities

The Design Guidelines for Public Transport Facilities forms part of a City of Cape Town initiative, with the primary aim of restructuring all elements of public transport service provision in Cape Town. The primary objectives of the guideline were as follows:

- Prioritising public transport and the quality of life of commuters
- Ensuring effective and efficient integration of all forms of land based transport
- Investment in alternatives that promote efficiency and sustainability

The recommended nature of transport facilities in South Africa as stated by the guideline is as follows:

- Positioned in areas with high accessibility
- Constructed in unison with open space
- Facilities allow for informal trading to take place
- The facility is to be supported by high-density housing
- Facilities should promote both comfort and security. (Naude , et al., 2005)

The guideline assessed the status quo of current transport interchanges in Cape Town to ascertain typical problems preventing efficient and effective operations. The main issues being that, generally, facilities are designed in such a way that it enables them to be easily modified for increasing demand. Large occurrences of pedestrian and vehicle conflict were observed, the predominate cause being inadequate space for the boarding and alighting of passengers. Of the facilities surveyed in the report, a large majority of them lacked basic amenities such as seating, protection from the elements, and features that cater to the needs of those physically and mentally disabled. (Schalekamp, 2007, p. 30)

3.2.3.4 Guidelines for Human Settlement Planning and Design

The guideline for Human Settlement Planning and Design was compiled by the CSIR (Council for Scientific and Industrial Research) with the aim of establishing standards for the construction of settlements in South Africa. The guideline proposes standards that seek to produce settlements that are vibrant and sustainable. The CSIR defines a human settlement as a built environment where people reside, work and engage in social and recreational activities. (CSIR, 2000)

The guideline states that public transport routes, particularly mini-bus and bus routes, be as direct as possible, and advised that circular routes are to be avoided. If multiple road based public transport services are offered, routes should not be less than 800 metres apart to ensure that each respective service has sufficient demand. (CSIR, 2000, p. 18)

When deciding on the location of public transport facilities, the guideline recommends that full access is given to health clinics, old age homes, schools and areas of high pedestrian activity. As mentioned in other guidelines and policy documents, the CSIR Human Settlement guideline reinforces the idea that walking distance to the nearest stop should not be greater than 400 metres. (CSIR, 2000, p. 19)

The guideline proposes that the following be considered when implementing minibus-taxi or bus services in an area for the first time:

- Minibus-taxi or bus routes should connect activity centres;
- If bus services are implemented, the corner radii should be sufficient to accommodate the turning movement of busses;
- For bus services where the expected buses per hour on the road is greater than 30, the width of the road should be between 7.3m and 9m.

To ensure that commuters experience minimal disutility when walking to minibus-taxi or bus stops, the following should be provided:

- The provision of pedestrian facilities (sidewalks, ramps, stops etc.) that are free of obstructions;
- Pedestrian facilities are to be well lit with artificial light, this making routes and facilities safer for commuter use;
- A facility is deemed 'safe' if its placed in area that is overlooked by human activity;
- Amenities such as seating, shelters, kiosks etc. improve the overall commuter perception of the facility;
- Stops should be conveniently placed relative to the entrances of buildings and facilities of high activity

The spacing of stops relative to each other has a high impact on the operating speeds of vehicles. The guideline recommends that for a bus or minibus-taxi service to operate efficiently, stops need to be placed 800 metres apart from one another. In high areas of activity where multiple routes start and end, stops should be placed more or less 300 metres apart. If a railway station is present in the area, a stop should be provided in the near vicinity of the station precinct to minimise walking between modes. (CSIR, 2000, p. 21)

When siting public transport facilities, cognisance of sight distance requirements is essential to ensure the safety of all road users. The guideline recommends that following sight distances, expressed in meters, be adhered to given the speed limit (km/h) of the road in question. (CSIR, 2000, p. 21)

Table 4: Sight Distance Requirements

Speed Limit (km/h)	Minimum Distance After Left turn (m)
50	23
65	31
80	38

(CSIR, 2000, p. 21)

3.2.3.5 Article supporting current Public Transport Guidelines

The section below reviews an article written by Chetty & Phayane (2012) which was formulated in response to the authors (Chetty & Phayane) deeming certain sections of the Design of Combi Taxi facilities guideline as archaic due to the ever-changing nature of minibus-taxi operations in South Africa. More specifically, this document was to aid in the effective and efficient implementation of public transport facilities along concentrated public transport routes in the EThekweni Municipal area. (Chetty & Phayane, 2012)

As previously mentioned, unsolicited demands for facilities create large amounts of pressure on authorities. Chetty & Phayane state that for transport infrastructure requests to be co-ordinated, consideration needs to be given to the needs of all affected parties, however at the same time ensuring that budgetary constraints imposed by authorities are met. When designing a facility, the needs of the user need to be taken into consideration. Chetty & Phayane (2012) identify typical needs of commuters that make use of minibus-taxis in South Africa:

- To improve the standard of public transport provision and reduce disutility experienced whilst travelling;
- Provide facilities that cater for multiple vehicle sizes;
- Eradicate vehicle and pedestrian conflict;
- Facilities must be universally accessible compliant;
- Congestion surrounding public transport facility to be mitigated by adherence to design standards

The need for public transport facilities arises through the occurrence of the following; a newly constructed development, minibus-taxi or buses obstructing vehicular traffic whilst picking up and dropping off passengers along a road, the need for the improvement of equity in an area, as well as to reduce vehicular and pedestrian conflict. (Chetty & Phayane, 2012, p. 668)

The research paper by Chetty & Phayane (2012), defines the warranting process for road based public transport facilities and separates warrants into either primary warrants or secondary warrants. Primary warrants focus on passenger demand for a given area or route. If passenger demand for the day exceeds 500 passengers, or the peak hour demand is greater than 100, this then triggers a primary warrant for the development of public transport facilities. Secondary warrants, on the other hand, are triggered when passenger demand for the day is less than 500 or the peak hour demands are less than 100. If passenger demand for an area or route falls within the secondary warrant category, the justification and prioritisation for a facility are done by qualitative means. Chetty & Phayane (2012), propose the use of the following qualitative measuring analysis tool in the secondary warranting process of public transport facilities:

- Environmental Criteria
- Improvement of Equity
- Traffic Delays and Conflicts
- Pedestrian Safety Issues

Alternatives are to be compared from an environmental perspective. Those alternatives that result in the least amount of disruption to the environment, and are favourable to the society as whole should be considered over those which are not. If passenger demand is less than required for a primary warrant but the facility has the potential to promote accessibility and mobility, and in turn improve the equity of the area, it should be considered for development. If an area or road is experiencing traffic delays as a result of mini-bus or taxis stopping in undesignated areas, public transport facilities should be considered to alleviate this. One of the main objectives of public transport service provision in South Africa is to create an environment that is safe for pedestrians. If an area is renowned for increased incidences of vehicular and pedestrian conflict, a facility could be used to mitigate these occurrences. (Chetty & Phayane, 2012, p. 668)

After the warranting process is complete, prioritisation of alternatives is to be based upon each of the alternatives ability to meet the needs of the user, whilst still complying with the financial constraints imposed by the relevant authorities. Given the economic climate of South Africa, Chetty & Phayane (2012) propose that preference is given to areas of greatest demand, followed by informal facilities that have no amenities; followed by stops and embayment's; and then lastly to alternatives that generate less than 500 passengers a day or less than 100 passengers in the peak hour. (Chetty & Phayane, 2012, p. 668)

3.2.3.6 Summary of Findings in Guideline Documents

From the above review of policy guidelines and supporting documentation, one can see that there is clear intent from the National Department of Transport to improve the standard of public transport provision in South Africa. The above guidelines state that facilities should cater for the needs of all users and that design features of facilities must be Universally Accessible (UA) compliant. When deciding on what type of facility to implement, be it a rank, stop, embayment etc., one needs to consider the current operations of the area, the current and expected passenger demand, traffic conditions, as well as the cost of various types of facilities. In South Africa, and especially for low to middle-income areas, authorities often lack the financial means to implement comprehensive services and facilities. Therefore, the most cost-effective facilities and services for the given area need to be selected. When deciding on locations for public transport facilities, one of the primary objectives is to minimise the disutility experienced by the commuter. It is recommended that facilities be within walking distance for commuters. Locations of facilities are also dependent on current and future traffic conditions. The aim as stated in the guidelines above is to situate facilities in areas where conflict points between vehicles and vehicles and pedestrians and vehicles are minimised. For public transport facilities to generate sufficient demand to support the service offered, land use types surrounding the facility need to be appropriately zoned. Public transport facilities must also be strategically positioned to ensure that that they complement existing facilities or land use types.

3.3 International Good Practices

3.3.1 Introduction

Recognised international practices pertaining to the planning and design of bus stop and terminal facilities were reviewed due to a lack of comprehensive guidelines concerning the planning and design of paratransit facilities, particularly terminals, ranks, and stops. Although bus services and paratransit services differ considerably in terms of the size of vehicle operated, and type of service offered, there are similarities in the way that facilities are planned. These similarities were observed when reviewing the NDoT guidelines for the design of both bus facilities and minibus-taxi facilities. As a result of this observation, guidelines for the planning and design of bus facilities are deemed as relevant supporting material when planning paratransit facilities.

The section below expands on current International Good practice techniques that are applied in the siting and design of bus stops and bus terminals.

3.3.1.1 TCRP Report 19: Guidelines for the Location and Design of Bus Stops, 1996

The Transit Cooperative Research Program (TCRP) devised a guideline named the 'Guideline for the Location and Design of Bus Stops' in 1996. The TCRP guideline was formulated based on a review of 28 transit agency manuals, as well as numerous field studies and observations which aid in supporting their rationale. The primary function of this guideline was to establish a good practice for the location and design of bus stops in various functioning environments. These guidelines seek to assist transit agencies in designing and locating bus stops that promote safety, accessibility, mobility and convenience. The guideline states that there are two key issues affecting the optimal design and placement of facilities, namely, street-side considerations and curb-side considerations. Street-side considerations are defined as factors related to the roadway that influences the functioning of bus services. Curb-side factors are considerations off the roadway that affect the safety, convenience, and comfort of passengers. The sections to follow expatiates on the universal concerns confronted by transit agencies when siting and designing facilities; the various street side considerations; as well curb side considerations. (Transit Cooperative Research Program, 1996, p. 1)

3.3.1.1.1 Universal Concerns

Bus stops act as an interface between the commuters and bus services provided. The primary aim of a bus service is to provide a system that is safe, punctual and promotes mobility and accessibility in the area. Due to a bus stop being a vital component in a transport system, its location and design can directly affect the performance of the system as a whole. The TCRP guideline has identified universal concerns with regards to bus stop design and location that can directly influence the performance and user perception of the transport system. These universal concerns being:

- **Transit System Performance:** Performance of a transit service can be graded according to travel time. Time being expressed as a cumulative combination of walking time to a bus stop, waiting time at a bus stop, in-vehicle travel time travel and time from a bus stop to a final destination. The location of a bus stop has the ability to reduce total travel time and, therefore, optimum placement of stops is pivotal in ensuring satisfactory levels of service;
- **Traffic Flow:** Due to the nature of bus operations, with passengers boarding and disembarking the vehicle at various demarcated stops along a roadway, there is often conflict between vehicles and vehicles and passengers and vehicles. The location of a facility, therefore, determines the degree of potential perilous conflict;
- **Safety:** The aim is to create a transit service that is safe for all users, including the parties responsible for bus operations. Pedestrian safety can be improved by implementing safety features such as pedestrian crossings, sidewalks, passenger waiting areas etc. leading to bus stops. By doing so, the accessibility of bus stops is improved. A secure environment for bus operators can be constructed by minimizing the conflict with pedestrians and other vehicles. For example, bus re-entry into a lane can be made safer by implementing a merging lane;
- **Security:** Security, as defined by the TCRP guideline, is termed as an individual's feeling of well-being. Security of a bus stop is directly correlated to the extent of lighting at a bus stop, as well as whether a facility is visible from nearby developments. (Transit Cooperative Research Program, 1996, p. 5)

3.3.1.1.2 Street Side Factors

The TCRP guideline states that the following street side factors should be cogitated when locating and designing a bus stop on a roadway:

Placement Considerations- Stop Spacing

The spacing of bus stops has the ability to influence the performance of a transit system. The spacing of stop affects walking time, which affects total travel time, and consequently, affects the catchment area potential of the transit system. The TCRP guideline highlights the various trade-offs between various bus stop spacing techniques. The first school of thought suggests that stops be placed at every block, approximately between 200 and 300 meters apart. The trade-offs to this approach are that shorter walking distances are created for commuters, but this subsequently leads to frequent stopping along a route, which results in an increase in travel time. The second approach is to space stops out, greater than 300 meters apart, thus minimizing frequenting stopping and reducing in-vehicle travel time. This, however, increases walking time and reduces the catchment area potential of the transit service. However, the generally more accepted approach to placing stops is to situate them at major trip generators. (Transit Cooperative Research Program, 1996, p. 18)

General placement considerations

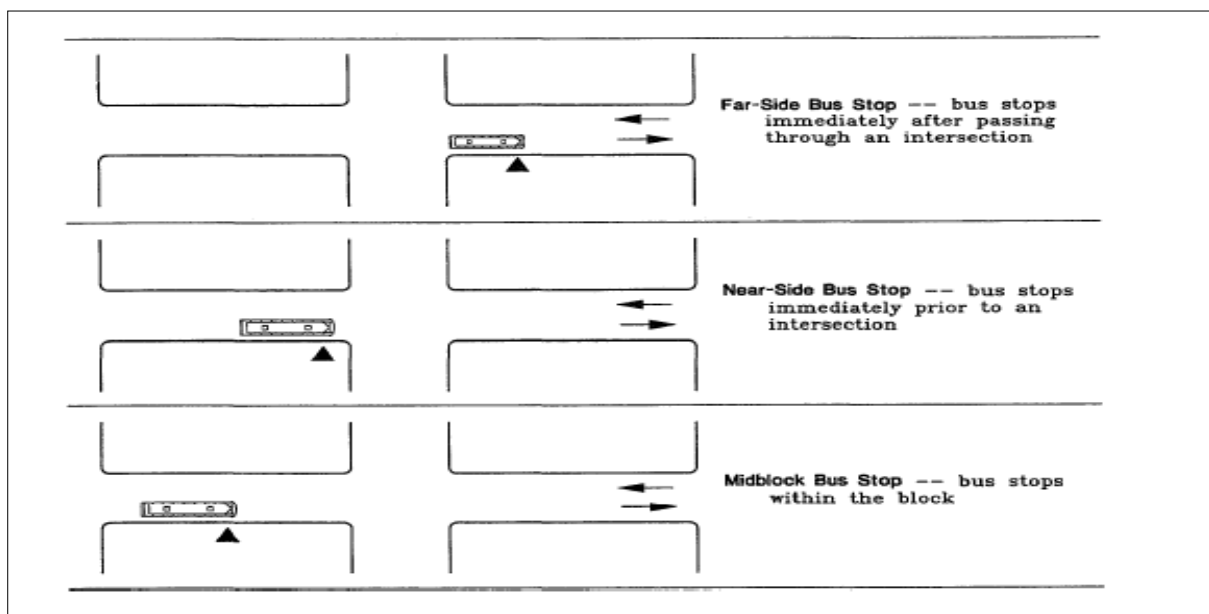
When siting bus stops, the predominant consideration is catchment area potential, and subsequent to that is safety, another key consideration. Hence, stops should be situated in areas that are free of conflict with other vehicles, pedestrians, and other road users. The TCRP guideline affirms that the following aspects should be considered from a general perspective when siting bus stops:

- Alleviate potential for commuter and vehicular conflict;
- Implement transit infrastructure and associated features that are Universally Accessible (UA) compliant;
- Bus stops ought to be supported by pedestrian orientated infrastructure (pedestrian crossings, dropped curbs etc.);
- In the immediate vicinity of key trip generators;
- Adequate street lighting (Transit Cooperative Research Program, 1996, p. 19)

Placement of Bus stops- Far-side, Near-side or Mid-block

When placing stops on a roadway, stops can either be placed far side, near side or mid-block. Figure 10, below, illustrates the various placement options. The TCRP guideline was established based on the United States of America (USA) road regulations, hence in Figure 10 the vehicles are depicted stopping on the right-hand side of the road.

Figure 10: Bus Stop placement options



(Transit Cooperative Research Program, 1996, p. 20)

The advantages and disadvantages of the various placement options can be seen in Table 5 below.

Table 5: Advantages & Disadvantages of bus stop placement options

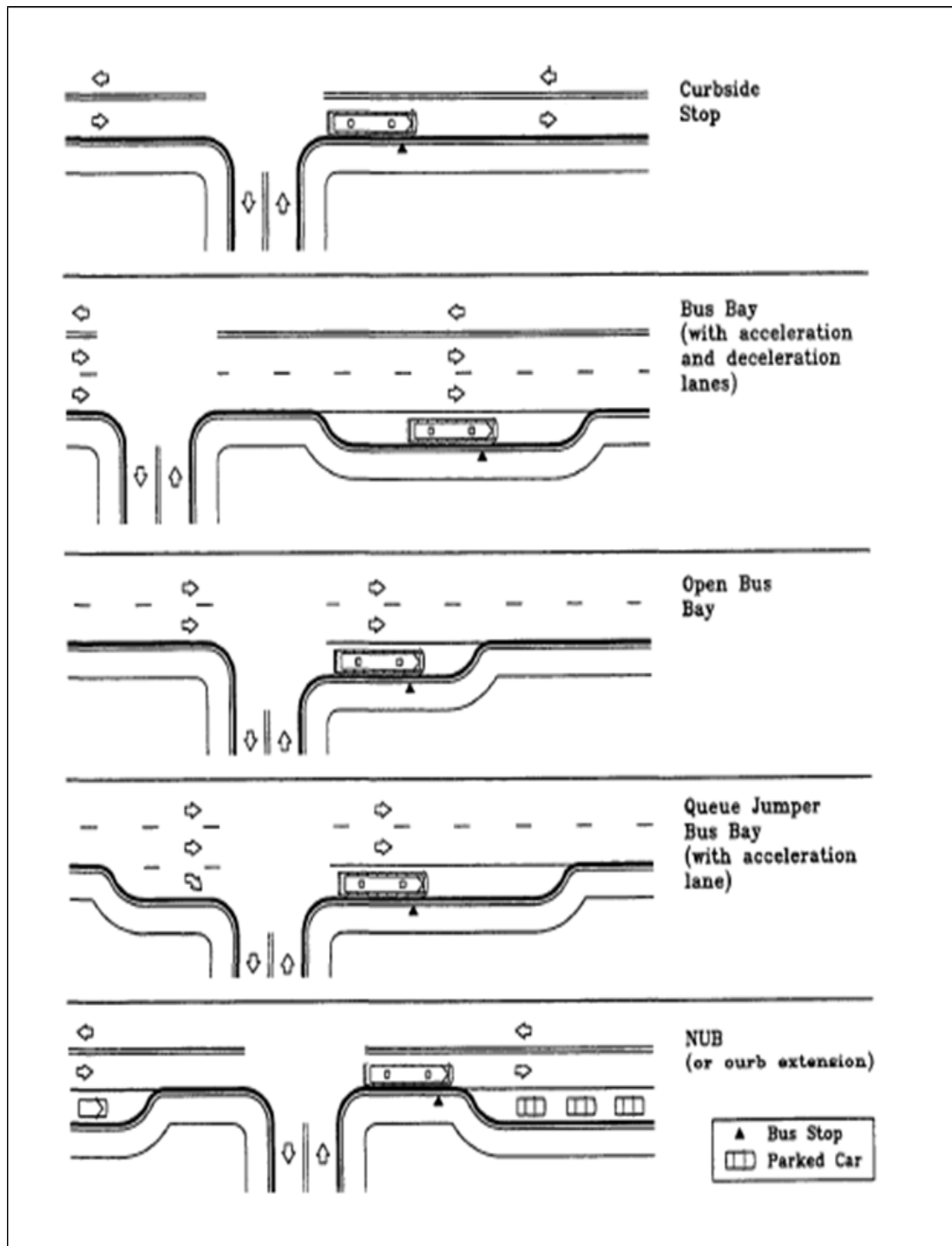
	Advantages	Disadvantages
Far-Side Stop	<ul style="list-style-type: none"> • Minimize conflicts between right-turning vehicles and buses • Provides additional right turn capacity by making curb lane available for traffic • Minimize sight distance problems on approaches to intersection • Encourages pedestrians to cross behind the bus • Create shorter deceleration distances for bus • Drivers can take advantage of breaks in traffic flows as a result of the intersection 	<ul style="list-style-type: none"> • Intersections may become congested in peak periods due to buses stopping • May obstruct sight distance for crossing vehicles • May increase sight distances for crossing pedestrians • Can cause a bus to stop far side after stopping for a red light, which interferes with both bus operations and all other traffic • Could result in traffic queued into intersection when a bus stopped is stopped in travel lane
Near-Side Stop	<ul style="list-style-type: none"> • Minimizes interference when traffic is heavy on the far side of the intersection • Allows passengers to access buses closest to crosswalk • Results in the width of the intersection being available for the driver to pull away the curb • Eliminates the potential of double stopping • Allows passengers to board and alight while the vehicle is stopped at a red light 	<ul style="list-style-type: none"> • Increase conflicts with right turning vehicles • May result in stopped buses obscuring curb side traffic control devices and crossing pedestrians • May cause sight distance to be obscured for cross vehicles stopped to the right of the bus • May block the through lane during the peak period with queuing buses • Increases sight distance problems for crossing pedestrians
Mid-block Stop	<ul style="list-style-type: none"> • Minimize sight distance problems for vehicles and pedestrians • May result in passenger waiting areas experiencing less pedestrian congestion 	<ul style="list-style-type: none"> • Requires additional distance for no parking restrictions • Encourages patrons to cross street at mid-block(jaywalking) • Increases walking distance for patrons crossing at intersections

(Transit Cooperative Research Program, 1996, p. 21)

3.3.1.1.3 Types of Stops

Various forms of street-side stops can be constructed on a roadway. These types of stops being, curb-side, bus bay, open bus bay, queue jumper bus bay and nub. The layout configurations of each of these stops within a roadway are illustrated in Figure 11 below.

Figure 11: Type of Bus Stops



(Transit Cooperative Research Program, 1996, p. 22)

Curb-side stops

When positioning a stop curb-side, be it far-side, near-side or midblock, there needs to be sufficient space to allow for bus operations to take place in a safe and efficient manner. The TCRP guideline recommends that approximately 30m of space is required along the curb-side for both near-side and far side stops, and roughly 45m for mid-block stops. (Transit Cooperative Research Program, 1996, p. 24)

The number of bus embayment's required at a given stop is dependent on two factors, namely, the rate of bus arrival in the peak hour, and the expected passenger loading time. The TCRP guideline proposes the following, Table 6, be used as a basis when deciding on how many embayment's to provide at a given stop.

Table 6: Capacity Required (Bays) When Passenger Loading time at stop is:

Peak- Hour Bus Flow	Capacity Required (Bays) When Passenger Loading Time at Stop is:				
	10 Seconds	20 Seconds	30 Seconds	40 Seconds	60 Seconds
15	1	1	1	1	1
30	1	1	1	1	2
45	1	1	2	2	2
60	1	1	2	2	3
75	1	2	2	3	3
90	1	2	2	3	4
105	1	2	3	3	4
120	1	2	3	3	5
150	2	3	3	4	5
180	2	3	4	5	6

(Transit Cooperative Research Program, 1996, p. 24)

Bus-Bay

A bus-bay is separate of a traffic lane and is positioned just off the normal section of a roadway. This placement configuration allows passengers to board and alight the vehicle in a safer manner and allows other vehicles to pass freely, with no lane blockage created. Bus-bays are generally constructed along major arterials where mobility is prioritized. Bus-bays are also generally positioned near major trip generators to accommodate the large flux of passengers in the peak hour in a safe means. (Transit Cooperative Research Program, 1996, p. 27)

The TCRP guidelines suggest that bus-bays be considered when the following factors are present:

- Vehicular volumes in curb-side lane exceed 250 vehicles per hour;
- Posted speed limit in excess of 60km/h;

- 10 or more buses passing the stop in an hour;
- Passenger volumes greater than 30 boarding an hour;
- Dwell time in peak hour exceeds 30 seconds;
- If type of service dictates layovers at the stop;
- Area is renowned for pedestrian and vehicular conflict;
- Sight distance constraints (i.e. hills, curves);
- Road reserve width allows for the construction of bus bays (Transit Cooperative Research Program, 1996, p. 27)

When siting a curb side stop either near side, far side or midblock, the TCRP guideline recommends the following:

- Far-side placement of curb side stops is desirable, although site specific conditions might suggest otherwise. To improve the effectiveness of such placement position, the intersection ought to be signalized so that gaps in the traffic can be created;
- Near-side stops should be avoided to reduce potential conflict with right-turning (left-turning- South Africa) vehicles, and to prevent obstruction of pedestrian activity around the intersection;
- Mid-block stops are not advised either unless bus stops are supported by non-motorised transport infrastructure linking them to major trip generators (Transit Cooperative Research Program, 1996, p. 27)

Open Bus Bay

An open bus bay is an adaptation of a conventional bus bay. The variance between an open bus bay and a conventional bus bay is that there is an embayment that is open on the far side of the intersection, as illustrated in Figure 11. Benefits of this configuration type entail no interference to the flow of traffic in the lane, and bus drivers can easily navigate into the embayment. The disadvantage of this type of stop configuration is the lengthening of the pedestrian crossing at the intersection as a result of the width of the embayment provided. (Transit Cooperative Research Program, 1996, p. 30)

Queue Jumper Bus Bay

Queue Jumper Bus bays give priority to buses at congested intersections. This stop configuration comprises of a right turning lane on the near side and an open bus bay on the far side of the intersection. The right turning lane allows buses to pass through the congested intersection unimpeded by other vehicular traffic. (Transit Cooperative Research Program, 1996, p. 32)

The TCRP guideline proposes that these types of stops should be constructed along major arterials to improve the flow and mobility of traffic along the arterial. The following factors should also be present to warrant the construction of a Bus Jumper Bus Bay:

- Bus services passing the stop exceeds four buses per hour on average;
- Peak hour vehicular volumes in the curb lane exceed 250;
- The Level of Service (LOS) of the intersection is a D or greater (Transit Cooperative Research Program, 1996, p. 32)

Nub

Nub stops are located at the far side of an intersection just prior to a parking lane, as depicted in Figure 11. Buses stop in-lane and therefore there is no need to for the driver to navigate into an embayment, thus functioning very similar to curb-side stops as mentioned above. This bus stop configuration bestows a greater area for waiting and the placement of other bus related amenities (benches, shelters, kiosks etc.) (Transit Cooperative Research Program, 1996, p. 34)

The TCRP guideline commends that a Nub bus stop should be implemented if a site exhibits the following characteristics:

- Pedestrian hotspot area;
- Sidewalks are congested with pedestrians and NMT;
- Buses currently stop in-lane (Transit Cooperative Research Program, 1996, p. 34)

2.3.1.1.4 Curb-Side Factors

The TCRP guideline states that the following curb-side factors should be cogitated when locating and designing a bus stop:

Pedestrian Access

To enhance pedestrian access and safety to a bus stop the following features should be provided. The first of these features is the provision of adequate lighting for both the bus stop, as well as pedestrian and NMT routes leading to the bus stop. Attention should also be given to Universal Accessibility (UA) constraints when designing a bus stop. Therefore, sidewalks must be a minimum of 3 feet in width, and curb drops should be present to allow wheelchair users to access the stop. Sidewalks constructed in the immediate vicinity of the bus stop should be linked to the greater pedestrian network to allow for improved levels of accessibility. (Transit Cooperative Research Program, 1996, p. 57)

Another means of improving access to bus stops is co-ordinating them with surrounding developments. Accessibility and increased patronage can be anticipated if bus stops are connected to major trip generators. (Transit Cooperative Research Program, 1996, p. 57)

Universal Accessibility Requirements

As mentioned above, UA requirements need to be taken into deliberation when constructing and designing bus stops. Features that need attention include obstacles, surfaces, and signs.

When siting a bus stop, the site needs to be inspected for any obstacles that might hinder the accessibility of the site by persons with disabilities. Consequently, no unwarranted protrusions should be present that hinders the movement of persons in wheelchairs. Persons who are partially sighted struggle to see obstacles that are between the heights of 27 inches and 80 inches therefore bus stop amenities such as phone booths and rubbish bins must be suitably positioned. (Transit Cooperative Research Program, 1996, p. 61)

Surfaces in the immediate vicinity of a bus stop must be slip resistant, firm, at a suitable grade for wheelchair access, and have tactile surfaces to accommodate those who are visually impaired. If a surface is at an incline or decline, the gradient should not exceed 1:20 otherwise a ramp needs to be provided. (Transit Cooperative Research Program, 1996, p. 61)

Signage and pedestrian signals should be designed in such a way so that cognisance is given to those who are disabled. (Transit Cooperative Research Program, 1996, p. 61)

3.3.1.2 TCRP Synthesis 117- Better On-Street Bus Stops: A Synthesis of Transit Practice, 2015

2.3.1.2.1 Introduction

The design and placement of bus stops in the built environment is gaining greater attention due to transit agencies and relevant authorities acquiring a better understanding of a bus stops ability to alter the functioning of an urban area. Various guidelines, as mentioned above, have been formulated to aid authorities in the placement of bus stops. Nonetheless, these guidelines haven been formulated from a traffic and transport engineering perspective. The objective of this synthesis report is to unearth the successful approaches and major issues experienced when designing, locating and constructing a bus stop from an authorities and stakeholder's perspective. (Transit Cooperative Research Program, 2015, p. 1)

2.3.1.2.2 Major Findings

The major concluding remarks of this synthesis report include the following:

- The placement of bus stops far at the side of an intersection is greatly favoured over positioning them either mid-block or near side. The respondents reasoning for this

including pedestrian safety, reduced delay from traffic signals, fewer hazardous conflict points with other vehicles, and the ease of accessing and egressing embayment's;

- Respondents then prioritized factors that directly relate to the effective and efficient functioning of bus stops. Stop spacing was considered the most imperative factor followed by adjacent trip generators, general accessibility of the site, universal accessibility, safety, sight distance and the presence of sidewalks and crosswalks. (Transit Cooperative Research Program, 2015, p. 19)

3.3.1.3 *Bus planning and operation in urban areas: a practical guide, 1989*

The spacing between bus stops and bus terminals plays a pivotal role in the efficiency and effectiveness of the bus system as a whole. The spacing between facilities, be it between consecutive bus stops or between a bus terminal and a bus stop, affects both passengers and operators. Passengers pursue minimal disutility whilst making use of public transport, therefore, they want to spend as little time as possible travelling, which includes both walking time and in-vehicle travel time. Operators aim to provide a service that is convenient for passengers, thus minimising walking distance, however, still want to maintain high vehicular operating speeds. High vehicular operating speeds are achieved by increasing spacing between facilities, thus resulting in improved system efficiency as buses accelerate and decelerate less frequently, allowing for consistent headways to be achieved. Consequently, operators strive to site bus facilities, both stops and terminals, in positions that allow for a balance between reduced walking distances and high vehicular operating speeds. (Pienaar, 1998)

As stated by Giannopolous (1989), the following should be considered when siting bus terminals:

- Located in the immediate vicinity of major trip generators and attractors;
- Positioned in areas of high concentrated passenger demand;
- Cognisance of route configuration;
- In areas that reduce vehicular and pedestrian conflict;
- In areas that promote ease of access for pedestrians;

3.3.2 Summary of International Good Practice Findings

When placing, and designing bus stops, cognisance of both street side and curb side factors is fundamental.

As mentioned above, the following general street side factors should be taken into deliberation when locating and designing a bus stop along a road way. One of the primary aims is to provide an environment that is safe and free of any hazardous conflict between vehicles, pedestrians, and commuters. Bus stops should be accessible by all individuals, hence, infrastructure and facilities provided must be Universally Accessible (UA) compliant. Commuters decidedly prioritize safety

when commuting, therefore, safety measures (adequate lighting, security personnel i.e.) must be provided to ensure a sense of comfort and security is achieved. To ensure that the demand for public transport is met, bus stops should be located at major trip generators. When more specifically locating a bus stop, relative to an intersection, either far side, near side or midblock, there is no definitive elucidation to which option is favoured as each has their own advantages and disadvantages, and therefore it is completely situational dependant.

Curb-side considerations that should be cogitated in the planning and design process are pedestrian access and Universal Accessibility. Bus stops must be connected to the greater pedestrian network in the area by means of pedestrian orientated infrastructure (pedestrian crossing, sidewalks i.e.), to promote accessibility of a stop. Bus stops should not only be connected to the pedestrian network of the area, but they must be completely integrated into the community. Integration achieved by providing mutually beneficial links between bus stops and surrounding land use types. To ensure that placement of stops does not infringe on the well-being of residents, or detract business from business owners, all affected parties ought to be adequately consulted during the planning and design process.

The synthesis report on transit service concludes the following with regards to the placement of bus stops in the built environment. Transit agencies were to provide commentary on which bus stop location is favoured, either far side, near side or midblock, and supply reasoning for such selection. The greater majority of transit agencies were in favour of far side stops due to their safety benefits, improved traffic flows through the intersection, less delay and fewer potential conflict points between vehicles. Primary factors deemed essential by transit agencies when deciding between potential bus stop sites include stop spacing, location relative to major trip generators, accessibility of the site, safety, sight distance and the presence of pedestrian orientated infrastructure.

When siting bus terminals it is concluded that the relevant authority, responsible for the planning of the bus facilities, locate terminals using the following guidance:

- Bus terminals are located in the immediate vicinity of major trip attractors and generators;
- That they site the facilities in areas of high concentrated passenger demand;
- Take cognisance of route configuration;
- Site facilities in areas of reduced vehicular and pedestrian conflict and;
- Select a site that is easily accessible by passengers.

3.4 Transport Infrastructure Appraisal Techniques

3.4.1.1 Introduction

Authorities responsible for the implementation of transport infrastructure are often confronted with difficult choices when it comes to deciding between various alternatives to invest in. Given the various needs of communities throughout South Africa, as well as limited financial resources, authorities need to prioritise investment options. Through appraising each alternative, alternatives will be ranked from most beneficial to least beneficial. Those investment alternatives that bring about the greatest benefit to all parties directly affected will be prioritised over those that reap little to no benefit. This section seeks to explore the various appraisal techniques used when prioritising between transport infrastructure alternatives. The appraisal technique that is deemed the most applicable with regards to prioritising between transport infrastructure alternatives will be used in case study section of this document.

3.4.1.2 Transport Infrastructure Project Appraisal in a South African context

Prior to the compilation of the Third Edition 'Guidelines for Conducting the Economic Evaluation of Urban Transport Projects', transport infrastructure alternatives in South Africa were appraised by means of the Cost-Benefit Analysis (CBA) technique. In 2002, the City of Cape Town adopted the Third edition of this guideline. The guideline proposes that transport infrastructure alternatives ought to be appraised by considering the following factors: income distribution considerations, regional benefit considerations and environmental considerations. (Vanderschuren, et al., 2008)

3.4.1.3 Appraisal Techniques

The section to follow reviews various appraisal techniques including CBA, Multi-Criteria Analysis (MCA), Composite Factors approach and General Equilibrium models. The above-listed appraisal techniques all originate from the same theoretical foundation, where each of them aims to appraise alternatives based on their relative value to society. Each of these techniques establishes a common set of measures which are used to assess the negative and positive impacts associated with each alternative. Weightings are then applied to the various measures based upon their importance in achieving the overall objective of the project. A cumulative rating for the project is then calculated, which in turn is used to compare alternatives. (Schutte & Brits , 2012, p. 97)

Cost Benefit Analysis (CBA)

The project appraisal technique, CBA, considers negative and positive impacts associated with a given project and then equates them to monetary terms. These monetary values are either calculated by willingness-to-pay estimates or actual cost estimates. By equating all impacts to the same measurement (monetary value), the benefits and costs of a project can be compared. (Schutte & Brits , 2012, p. 104)

There are however limitations concomitant with the CBA appraisal practice. The main issue associated with the CBA technique is its inability to accurately link monetary values to security, safety, social and other predominately qualitative in nature issues. (Vanderschuren, et al., 2008)

Multi-Criteria Analysis

The MCA appraisal technique was formulated in response to the limitations experienced in applying the CBA technique. The primary argument in contradiction of the CBA technique is its inability to accurately equate all impacts into monetary terms. The MCA technique, however, accommodates both qualitative and quantitative impact. (Schutte & Brits , 2012, p. 105)

Vanderschuren et al., states that various MCA techniques have been articulated over the years, but literature is yet to conclude that certain techniques are better than others. There are two main MCA techniques applied in practice. The first of these techniques, Weighted Sum method, standardises scores across alternatives, applies a weighting to the various criterion, and then sums the total score per alternative. The second MCA technique, EVAMIX method, is a further extension of the first technique, where scores are standardised across alternatives, then weighted alternatives are compared pair-wise. (Vanderschuren, et al., 2008)

Composite Factors Approach

The Composite Factors approach comprises of a composite scoring technique, in which alternatives are scored based on alternative measurement viewpoints, with the public input being one of the primary measures. When the appraisal technique is applied in an engineering context, the numeric score for each is generally calculated according to three measurement perspectives. These measurement perspectives are the engineering score, the local consult score, and the economic impact score. (Schutte & Brits , 2012, p. 105)

General Equilibrium Models

The CBA appraisal technique predominately analyses direct impacts, whereas the general equilibrium approach focuses on wide-ranging economic impacts. General equilibrium analysis is further divided into two groups, namely, econometric models and input/output (IO) models. Econometric models encompass various mathematical and statistical relationships which are used to comprehend the nature and structure of the economy. Econometric models produce economic forecasts which act as inputs for IO orientated models. IO models model the effect that a project will have on the inputs and outputs of the economy. (Schutte & Brits , 2012, p. 106)

3.4.1.4 Evaluation of Appraisal techniques

Given the nature of this research document, an applicable appraisal technique needs to be selected for the warranting and siting of public transport facilities in Klapmuts. An appraisal technique will be selected based on its ability to address and consider all factors involved in the warranting and siting of public transport facilities process. The foremost requirements of an appraisal technique are its ability to evaluate alternatives (i.e. isolated feasible alternatives from unfeasible alternatives), as well as rank feasible alternatives.

With regards to the CBA technique, for an alternative to be deemed feasible, the benefits need to outweigh the costs or the calculated internal rate of return (IRR) needs to exceed the discount rate of the alternative. When feasible alternatives have been defined, alternatives are ranked either according to their benefit/cost (BC) ratio or their IRR. The MCA technique also allows for alternatives to be evaluated. Feasible alternatives can be selected by means of setting minimum threshold values for the given criterion used to evaluate the alternative. Cumulative scores are calculated for each of the alternatives, which are then used to prioritise alternatives relative to the null alternative. The composite factors approach lacks the ability to evaluate alternatives, as no threshold values can be defined. However, alternatives can be prioritised based on their aggregate score, but this process is unable to isolate feasible alternative from unfeasible alternatives. General Equilibrium models are unable to evaluate and rank alternatives, as no minimum threshold value is stipulated, and no aggregate score is calculated for each alternative. (Schutte & Brits , 2012, p. 105)

The table below, .

Table 7, summarises the various appraisal techniques based on their ability to both evaluate and rank alternatives.

Table 7: Suitability of tools for an appraisal framework

Aspect	CBA	MCA	Composite Factors Approach	General Equilibrium Models
Does it allow evaluation?	Yes	Yes	No	No
Does it allow ranking?	Yes	Yes	Yes	No

3.4.1.5 Conclusion

When deciding between investment alternatives, the objective is to invest in projects that reap the greatest benefits for those directly and indirectly affected by the investment option. To achieve this, alternatives need to be evaluated and ranked accordingly. From the above-mentioned appraisal techniques, the CBA and the MCA techniques are the only appraisal practices that consent alternatives to be evaluated and ranked. There are however limitations to the CBA technique due to its inability to accurately equate safety, security, environmental and social impacts to monetary terms. As a result of this, the MCA technique is considered the most applicable due to its ability to consider both qualitative and quantitative impacts, as well as its capability to evaluate and rank alternatives.

3.5 Conclusion

The aim of this chapter was to assess guidelines and policy documentation that are currently used in the public transport facility planning process in South Africa. This review process would then assist in determining what processes must be followed in order to optimally site public transport facilities in a South African context.

From a South African transport policy perspective, the government aims to provide safe, reliable, efficient and integrated transport services that cater to the needs of passengers and freight customers alike, while still aligning with the goal for endorsing social and economic development. When siting public transport facilities, the National White Paper stated that facilities must endorse mobility and accessibility in the surrounding area. There is also a strong emphasis on reducing the disutility experienced by commuters. Consequently, walking distances, waiting times and safety need to be improved when providing public transport services and associated infrastructure. From an economic point of view, there is a strong consensus to endorse alternatives that bring about the greatest benefit to all stakeholders.

The National Department of Transport's public transport facility guidelines collectively aims to improve the standard of public transport provision in South Africa. Facilities should cater for the needs of all users, including operators, and be universally accessible (UA) compliant. Primary warrants for facilities are based upon envisaged passenger demand. If the envisaged passenger demand does not meet the criteria for a primary warrant, potential areas for development are to be evaluated based upon environmental criteria, improvement of equity, traffic delays and conflicts, and pedestrian safety issues. When deciding on what type of facility to implement, expected passenger demand, traffic conditions, as well as the costs of various types of facilities, must be considered. For facilities to operate efficiently, they need to be optimally placed. To achieve this, it

is proposed that walkability, catchment area potential, vehicular and pedestrian conflict points, as well as land use types surrounding the potential site(s) be considered.

Klapmuts is earmarked for future development based on the projection of substantial population growth over the medium to long term. The town is defined as a low-to-middle income rural town and therefore the authorities' primary objective is to improve the social well-being of the residents. Due to the aforementioned needs for residents in Klapmuts, and a current lack of financial support from the various authorities that govern the area, resources need to be optimally located. This motivation reinforces the need to provide facilities that generate the greatest opportunities to the entire community, that being public transport services, the topic of discussion in this dissertation.

International practices pertaining to the design and placement of bus stops were critically evaluated. General considerations relating to the placement of stops include; creating a safe environment for all parties actively involved in the roadway, ensuring that bus facilities are UA compliant, certifying that the well-being of commuters is maintained by implementing safety features (adequate lighting, security personnel i.e.) at bus stops as well as sidewalks leading to bus stops, and locating bus stops in the immediate vicinity of major trip generators. When more specifically locating a bus stop relative to an intersection, either far side, near side or midblock, there is no definitive elucidation as to which option is favoured as each has their own advantages and disadvantages, and therefore it is completely situational dependant. Another central component in the placement of stops is to ensure that they are integrated into the community. This is attained by linking stops by means of pedestrian orientated infrastructure to the broader ranging pedestrian network, as well as to major trip generators.

The synthesis report on the placement and design of bus stops concludes that the far-side placement of a bus stop is favoured due to its inherent safety attributes. Primary factors deemed essential by transit agencies when deciding between potential bus stop sites include stop spacing, location relative to major trip generators, accessibility of the site, safety, sight distance and the presence of pedestrian orientated infrastructure.

International practices state the various placement options of stops relative to an intersection, and the synthesis report emphasises that far side stops are the most beneficial due to their safety attributes. However, South African guidelines give no consideration to the placement of a stop relative to an intersection. As a result of the above-mentioned, when formulating a warranting and siting practice in Chapter 4 of this document, South African guidelines with regards to the placement and design on road based public transport facilities will be supplemented with relevant statutory requirements and international practices.

When siting bus terminals, it is concluded that the following be taken into consideration; terminals should be located in close proximity to major trip attractors and generators, terminals should be

situated in areas of concentrated passenger demand, cognisance of route configuration as terminals are generally situated at the end or start of a route, site terminals in locations that allow for safe movements for both pedestrians and vehicles, and that chosen location for the terminal promotes ease of access for passengers.

When prioritising between investment alternatives, the objective is to prioritise investment options that are most beneficial to those directly and indirectly affected by them. Given the nature of this study, and the quantitative and qualitative inputs that will inform the final decision, the Multi-Criteria Analysis approach to prioritising alternatives is deemed the most applicable, and therefore will be applied in addressing the research problem of this document.

4 Warranting and Siting Practice for Minibus-taxi Terminals and Ranks

4.1 Introduction

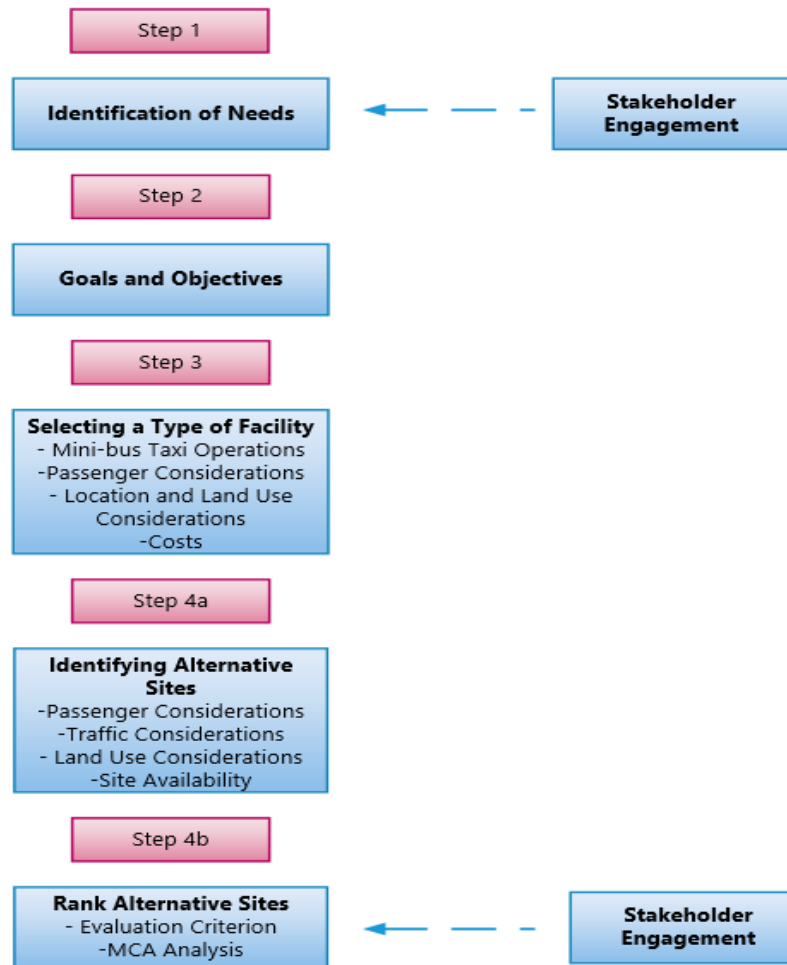
As stated in the sections above, the purpose of this document is to identify potential sites for the construction of public transport facilities, more specifically minibus-taxi facilities, in a low-to-middle income area (Klapmuts), on the outskirts of a metropolitan city (Cape Town). The primary objective, when providing public transport facilities, is ensuring that the needs of all users including the relevant authorities that govern the area are met whilst still complying with policies, design standards, and financial constraints.

The aim of this chapter is to consolidate all literature critically evaluated on in Chapter 3 of this document and formulate a warranting and siting practice for minibus-taxi terminals and ranks. Therefore, the warranting and siting practice that is ultimately developed in this chapter will be informed by South African legislative documents, placement and design guidelines relating to both minibus-taxi and bus services, international good practices relating to the placement of bus stops and terminals, and common practices pertaining to transport infrastructure appraisal techniques. This warranting and siting practice will then be used in addressing the research topic addressed in this document.

4.2 Warranting and Siting Practice

The warranting and siting practice developed is to take cognisance of literature reviewed in Chapter 3 of this document, particularly material concerning the warranting and siting of mini/midibus-taxi terminals and ranks. The warranting and siting process for minibus-taxi terminals and ranks, as illustrated in Figure 12, is adopted from the NDoT guidelines for both the planning and design of mini/midibus-taxi facilities and bus facilities and further clarified in the following sections.

Figure 12: Warranting and Siting and Process



(Department of Transport, 2007)

4.2.1 Step 1: Identification of Needs

As mentioned above, the aim is to provide public transport services and associated infrastructure that caters for the needs of all stakeholders involved, including the governing authority, commuters, operators, residents and business owners. In order to ascertain the needs of all relevant stakeholders', extensive investigations need to take place. Investigations to identify needs can take the form of public participation meetings, site visits, personal conversations, review of planning and policy material pertaining to the study area, general observations and review of surveys relating to the minibus-taxi service provision in the area. The NDoT guidelines for the planning and design of minibus-taxi facilities has proposed the use of the following table, Table 8, when identifying needs for each of the affected parties including passengers, operators and the community as a whole.

Table 8: Factors to Identify Needs

Passenger	Operator	Community
<ul style="list-style-type: none"> • Availability of Facility 	<ul style="list-style-type: none"> • Availability of facilities 	<ul style="list-style-type: none"> • Environmental Impact
<ul style="list-style-type: none"> • Walking distance 	<ul style="list-style-type: none"> • Passenger attraction 	<ul style="list-style-type: none"> • Traffic Congestion
<ul style="list-style-type: none"> • Security 	<ul style="list-style-type: none"> • Capacity 	<ul style="list-style-type: none"> • Social Issues
<ul style="list-style-type: none"> • Ancillary Facilities 	<ul style="list-style-type: none"> • Safety 	
<ul style="list-style-type: none"> • Comfort 	<ul style="list-style-type: none"> • Ancillary facilities 	
<ul style="list-style-type: none"> • Convenience 	<ul style="list-style-type: none"> • Accessibility 	
<ul style="list-style-type: none"> • Other transport mode 	<ul style="list-style-type: none"> • Control of service 	

(Department of Transport, 2007)

These factors, depicted in Table 8, have been reticulated into questions in order to assist with the needs identification process:

Passenger

- **Availability of facility:** *Is there provision of formalised minibus-taxi facilities to cater for the needs of passengers?*
- **Walking distance:** *Do the majority of minibus-taxi commuters walk for longer 5 minutes (400m to 500m) to get to a minibus-taxi terminal or rank?*
- **Security:** *Are there security features in place (lighting, security personnel, pedestrian paths etc.) that ensure the safety of passengers whilst traveling, which include both in-vehicle and out of vehicle travel?*
- **Ancillary facilities:** *If formalised minibus-taxi facilities are provided, do these facilities offer ancillary facilities such as toilets, seats, shelters, waste bins, vehicle washing, lighting, dispatch office and other commercial activities?*

- **Comfort:** Do the current minibus-taxi ancillary facilities reduce passenger utility, by means of providing physical features that improve passenger comfort?
- **Convenience:** Are existing minibus-taxi facilities situated in areas that are convenient for passengers? Thus, are facilities situated in the immediate vicinity of major trips attractors and generators, as well as situated in areas of concentrated passenger demand?
- **Other Modes of Transport:** If other transport modes are present in the study area, do existing minibus-taxi facilities/sites allow for the seamless transfer of passengers between modes?

Operator

- **Availability of a facility:** Is there a provision of formalised minibus-taxi facilities to cater for the needs of minibus-taxi operators?
- **Passenger attraction:** Are existing minibus-taxi facilities appealing to passengers, in the sense that they are aesthetically pleasing and provide the necessary comfort, safety, and convenience that passenger's desire?
- **Capacity:** Is there sufficient capacity at existing facilities to accommodate minibus-taxi operators?
- **Safety:** Are there safety features present, such as lighting, and security personnel that ensure operators' safety whilst providing a service? Are minibus-taxi facilities situated in areas that reduce conflict with other vehicular traffic?
- **Ancillary facilities:** If formalised minibus-taxi facilities are provided, do these facilities offer ancillary facilities such as toilets, seats, shelters, waste bins, vehicle washing, lighting, dispatch office and other commercial activities?
- **Accessibility:** Are existing minibus-taxi facilities easily accessible to existing operators?
- **Control of service:** Are existing minibus-taxi facilities and services overseen by a rank/terminal manager?

Community

- **Environmental impact:** Do existing minibus-taxi facilities negatively encroach on natural fauna and flora in the area?
- **Traffic Congestion:** Do the locations of existing minibus-taxi facilities result in undesirable vehicular conflicts? Do existing facilities locations take cognisance of road hierarchy?

- **Social Issues:** *Do existing minibus-taxi services and associated infrastructure allow for community members to access areas of employment? Are existing facilities negatively impacting on surrounding land uses?*

4.2.2 Step 2: Goals and Objectives

The second step in this warranting and siting practice is to establish what the goals and the objectives are of the project, based on the needs identified in Step 1 above. Goals, as mentioned previously, are idealized states that planners and authorities aim to achieve.

An example of a goal, in the context of providing mini-bus taxi facilities in a low to middle income area in South Africa, is to ensure that the needs of all stakeholders, as stipulated in Table 8 involved are met. Alternative sites will be evaluated on their ability to satisfy these needs, and the most beneficial alternative(s) selected for further investigation and investment.

Objectives, on the contrary, are results that are anticipated to be achieved given time and financial constraints.

4.2.3 Step 3: Selecting a Type of Facility

Subsequent to determining what public transport service is warranted for the study area in question, the type of facilities required to support the selected public transport service need to be distinguished.

For purposes of this dissertation, the primary focus is on the implementation of minibus-taxi terminals and ranks, and therefore considerations concerning the selection of these facilities will be expanded on below.

4.2.3.1 Minibus-taxi Facilities

The following section describes both minibus-taxi terminals and ranks, as well as the layout options of each.

4.2.3.1.2 Types of Facilities

The type and functionality of each of the following minibus-taxi facilities as stated in the NDoT guidelines are as follows:

Minibus-taxi rank: *A place usually within the road reserve at which minibus-taxis are allowed to stop for passengers to board and alight the vehicle. Dissimilar to minibus-taxi stops, minibus-taxi ranks allow minibus-taxis to stop for a duration of time.*

Minibus-taxi terminal: *A location, usually off street at the common end of one or more routes where minibus-taxis can wait and passengers can board and alight.*

4.2.3.1.3 Layout Options

The NDoT's guidelines for the design of mini/midibus-taxi facilities proposes the following example layouts for both mini/midibus-taxi terminals and ranks, as illustrated in Table 9 and Table 10 and Table 11 below.

The layouts proposed below, are in accordance with the dimensional guidelines for the new mini/midibus-taxi fleet, as stipulated by the Inter-Departmental Steering Committee(IDC). The NDoT guidelines of 2007 have been reformed to accommodate the following vehicle types”

- The M2 (10-to 16-seater) Minibus
- The M2 (17- to 23-seater) Midibus
- The M3 (24- to 34-seater) Midibus

Table 9: Proposed On-Street Mini/Midibus-taxi Rank

Proposed On-Street Ranks (with dimensions)		On-Street Rank Options and Characteristics																																												
		<p>(a) Recessed on-street rank (b) curb side on-street rank</p> <p><u>Characteristics:</u></p> <ul style="list-style-type: none"> • Consists of berths parallel to the curb • Operates similarly to a loading lane in a terminal facility • Ideally, only one destination be served and taxis should operate on a non-dependent departure system • Front bay used for loading – others for off-loading and then loading • Sidewalk width of minimum 2.6m to allow for queueing and pedestrian traffic • Recessed ranks are ideal – reduce conflicts and rear-end collisions • In Central streets, ranks can be provided by removing public parking bays next to the curb side • Typical minimum dimensions are 2.2m width and 6.6m length • A curb side rank shall be at least 9.0m away from pedestrian crossing and 5.0m from property line at street corner to ensure sight distance (refer to figure (b)) • A recessed rank shall be at least 6.0m from a pedestrian crossing (refer to figure (a)) 																																												
<table border="1"> <thead> <tr> <th rowspan="2">VEHICLE RANGE</th> <th colspan="8">MINIMUM DIMENSIONS (metres)</th> </tr> <tr> <th>d</th> <th>e</th> <th>k</th> <th>l</th> <th>m</th> <th>n</th> <th>p</th> <th>x</th> </tr> </thead> <tbody> <tr> <td>M2 Minibus</td> <td>6,6</td> <td>2,2</td> <td>2,6</td> <td>5,5</td> <td>4,5</td> <td>9,0</td> <td>5,0</td> <td>6,0</td> </tr> <tr> <td>M2 Midibus</td> <td>8,1</td> <td>2,6</td> <td>2,6</td> <td>5,5</td> <td>4,5</td> <td>9,0</td> <td>5,0</td> <td>6,0</td> </tr> <tr> <td>M3 Midibus</td> <td>8,7</td> <td>2,6</td> <td>2,6</td> <td>5,5</td> <td>4,5</td> <td>9,0</td> <td>5,0</td> <td>6,0</td> </tr> </tbody> </table>		VEHICLE RANGE	MINIMUM DIMENSIONS (metres)								d	e	k	l	m	n	p	x	M2 Minibus	6,6	2,2	2,6	5,5	4,5	9,0	5,0	6,0	M2 Midibus	8,1	2,6	2,6	5,5	4,5	9,0	5,0	6,0	M3 Midibus	8,7	2,6	2,6	5,5	4,5	9,0	5,0	6,0	
VEHICLE RANGE	MINIMUM DIMENSIONS (metres)																																													
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M2 Midibus	8,1	2,6	2,6	5,5	4,5	9,0	5,0	6,0																																						
M3 Midibus	8,7	2,6	2,6	5,5	4,5	9,0	5,0	6,0																																						

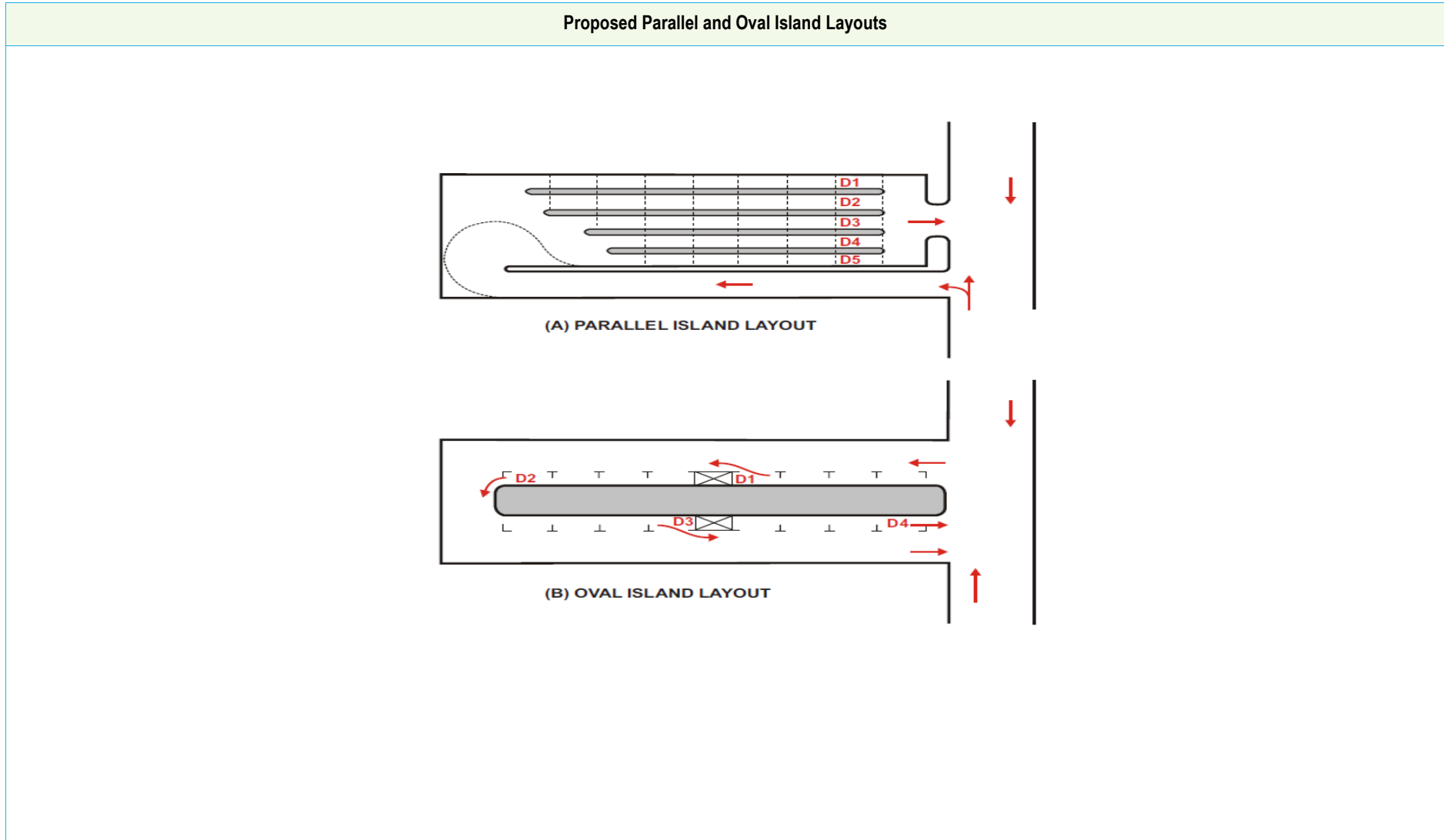
(Department of Transport, 2007)

Table 10: Proposed Off-Street Mini/Midibus-taxi Terminal & Holding area

Proposed Off-street terminal & holding area (with dimensions)		Off-street terminal & holding area Characteristics																																																									
		<p><u>Characteristics:</u></p> <ul style="list-style-type: none"> • Example of an off-street minibus-taxi terminal, comprising of loading and off-loading areas, as well as a holding area • The minimum values represent the absolute minimum dimensions to accommodate minibus-taxi at very low operating speeds. • The desirable dimensions are able to accommodate conventional driving habits and minibus-taxis traveling at normal speeds for a facility • The maximum dimensions are the upper bounds of design specifications. Any dimensions greater than this will hinder the performance of the facility • Loading lanes(e) for an M2 minibus should be a minimum of 2.2m • Loading islands(h) should be a minimum 1.5m • The length of a berth for an M2 minibus should be 6.6m • The holding area comprises of a circulation aisle, as well as holding bays 																																																									
<table border="1"> <thead> <tr> <th rowspan="3">VEHICLE RANGE</th> <th colspan="10">MINIMUM DIMENSIONS (metres)</th> </tr> <tr> <th rowspan="2">a</th> <th colspan="2">b</th> <th rowspan="2">c</th> <th rowspan="2">d</th> <th rowspan="2">e</th> <th rowspan="2">f</th> <th rowspan="2">g</th> <th rowspan="2">h</th> <th rowspan="2">J</th> </tr> <tr> <th>1 WAY</th> <th>2 WAY</th> </tr> </thead> <tbody> <tr> <td>M2 Minibus</td> <td>30,0</td> <td>3,5</td> <td>6,0</td> <td>3,5</td> <td>6,6</td> <td>2,2</td> <td>6,4</td> <td>14,0</td> <td>1,5</td> <td>2,0</td> </tr> <tr> <td>M2 Midibus</td> <td>35,0</td> <td>3,5</td> <td>7,0</td> <td>3,5</td> <td>8,1</td> <td>2,6</td> <td>7,9</td> <td>16,0</td> <td>1,5</td> <td>2,0</td> </tr> <tr> <td>M3 Midibus</td> <td>40,0</td> <td>3,5</td> <td>7,0</td> <td>3,5</td> <td>8,7</td> <td>2,6</td> <td>8,5</td> <td>18,0</td> <td>1,5</td> <td>2,0</td> </tr> </tbody> </table> <p>* Depends on parking angle ** Always raised island with non mountable kerb</p>				VEHICLE RANGE	MINIMUM DIMENSIONS (metres)										a	b		c	d	e	f	g	h	J	1 WAY	2 WAY	M2 Minibus	30,0	3,5	6,0	3,5	6,6	2,2	6,4	14,0	1,5	2,0	M2 Midibus	35,0	3,5	7,0	3,5	8,1	2,6	7,9	16,0	1,5	2,0	M3 Midibus	40,0	3,5	7,0	3,5	8,7	2,6	8,5	18,0	1,5	2,0
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(Department of Transport, 2007)

Table 11: Proposed Mini/Midibus-taxi Parallel and Oval Island Layouts



(Department of Transport, 2007)

4.2.3.2 Capacity Required

The loading area is the most paramount element of a minibus-taxi facility, and ultimately determines the extent of the facility. Dependant on the type of facility, a minibus-taxi facility loading area can comprise of a loading lane which is made up of numerous berths allowing for minibus-taxis to pick up and drop off passengers. The number of loading lanes and berths that need to be provided at a minibus-taxi facility are described below. (Department of Transport, 2007)

Loading Lanes

The number of loading lanes required is dependent on the number of routes served by the facility, the number of minibus-taxis using the facility and the type of facility chosen. Generally, each destination is served by an individual loading lane, unless there is insufficient space to supply the desired number of berths. In this instance, loading lanes for the same destination can be placed alongside one another. (Department of Transport, 2007)

Berths

The number of berths required is dependent on the number of minibus-taxis using the facility, the provision or absence of a holding area, and the nature of the urban environment surrounding the facility. (Department of Transport, 2007)

If the minibus-taxi facility is situated in a metropolitan setting, a berth is expected to provide a function of loading, queueing and holding. The NDoT guideline recommends that one berth is supplied for every three minibus-taxis that are envisaged to make use of the facility. The justification for such an assumption is that one minibus-taxi will be at the facility loading passengers, while the other two minibus-taxis are occupied with inbound and outbound trips respectively. (Department of Transport, 2007)

In a smaller urban area, where route distances are relatively shorter, the NDoT proposes that one berth is supplied for every two vehicles that are envisioned to make use of the facility. The rationale behind such assumptions is that one minibus-taxi will be making use of the facility while the other minibus-taxi is undertaking a trip. (Department of Transport, 2007)

4.2.3.3 Considerations

As stated in the NDoT guidelines, and evaluated in Chapter 3 of this document, the following factors should be considered when deciding on what type of facility to implement:

- Operation Considerations;
- Passenger Considerations;
- Traffic Considerations;

- Location and Land Use Consideration
- Cost (Department of Transport, 2007).

Operation Considerations

The NDoT guideline states that when deciding on what type of facility to implement, operations of the area in question should be reviewed. Those elements from an operations perspective that will affect the type of facility chosen are the numbers of routes served, as well as whether vehicles will have to wait or hold when the demand is low. (Department of Transport, 2007)

Ranks are to be located at the start and end of routes, and it is recommended that they serve individual routes. Terminals, are also to be located at the start and end of routes however should have the capacity to serve more than one route. Holding areas are to be provided if there are lengthy waiting times in the off-peak periods with minimal passenger activity. Holding areas are to be situated away from terminals and ranks, thus freeing up congestion. (Department of Transport, 2007)

Passenger Considerations

Irrespective of what facility is chosen, a facility should promote an environment that is safe for all users. To ensure that a facility can cater for the needs of passengers, the following factors should be taken into consideration, prior to the decision on what facility to implement:

- Expected Passenger Numbers;
- Expected Waiting Times;
- Catchment area potential of facility;
- Number of Transfers (Department of Transport, 2007)

Traffic Considerations

Road hierarchy plays a pivotal role when deciding on what type facility to implement. On primary roads, where the traffic volumes and operating speeds are relatively high in comparison to secondary roads, traffic friction is to be avoided. To mitigate this potential 'friction', off-street facilities are to be provided. On secondary roads, where traffic volumes and operating speeds allow for a certain degree of 'friction', on-street facilities can be implemented. (Department of Transport, 2007)

Location and Land Use Considerations

When deciding on what type of minibus-taxi facility to implement, cognisance of current and future spatial layouts need to be considered. The size and the type of the facility implemented is largely dependent on the size of the area. The guideline proposes that small urban areas that are 'walkable' and are abundant in large open spaces can be served by one central facility. Larger urban areas on the other hand should be served by multiple facilities, to ensure the catchment area of the service is within the walkable range of potential commuters. (Department of Transport, 2007, pp. 5-9)

The availability of land, whether it is kerbside or off-street, will determine what types of facilities can be implemented. In the South African context, urban areas are relatively dense, with only a few open spaces for the construction of large off-street terminals. It is therefore generally easier to construct facilities within the road reserve. (Department of Transport, 2007)

Consideration needs to be given to the mutual impacts between minibus-taxi facilities and surrounding land use. As reviewed in Chapter 3, certain land use types are negatively affected by the immediate presence of minibus-taxi facilities and services. (Department of Transport, 2007)

Cost

As a result of South Africa's economic and social climate, the total cost of a facility is often the decisive factor in building a facility or not. The bid rent theory best describes the relationship between land cost and the distance from the central business district. Land situated centrally (CBD) is in high demand due to its increased levels of accessibility but this increase in accessibility comes at an increased monetary cost. Therefore, the acquisition cost of centrally locating a facility within a CBD is greater than locating it on the periphery of the urban area. (Department of Transport, 2007)

The guideline depicts that the following costs should be considered when investing in minibus-taxi facilities:

- Acquisition costs of land
- Design and construction cost
- Costs and benefits to the operators
- Environmental costs
- Operating costs of facility

For purposes of the warranting and siting practice developed in this dissertation, the costs for design and construction are assumed based on current engineering rates within South Africa, as experienced within the industry. This assumes construction costs of approximately R1200 per

square metre, and design costs as ten percent (10%) of the total construction cost which will be further discussed in the sections to follow.

4.2.3.4 Procedure to determine type of facility

Based on the above considerations, the NDoT guideline for the design of mini/midibus-taxi facilities propose that the following procedure be followed when deciding on whether a minibus-taxi terminal or rank should be implemented:

- I. Establish minibus-taxi operational characteristics, including routes operated and numbers of minibus-taxis envisaged to make use of the facility;
- II. Based on mini/midibus-taxi operational characteristics established in step 1, situate mini/midi-bus taxi ranks at the end or start of a singular route and mini/midi-bus taxi terminals at the end or start of multiple routes;
- III. Establish the size of the rank or terminal based on the expected number of mini/midibus-taxi envisaged to make use of this facility;
- IV. Establish whether the rank or terminal can be situated on-street or off-street based on road hierarchy, and what effect the facilities traffic will have on the surrounding road network;
- V. Consider the size of the area that the rank or terminal is expected to serve, and the availability of land to site the facility;
- VI. Consideration of the costs associated with each type of facility. (Department of Transport, 2007)

4.2.4 Step 4A: Identifying Alternative Sites

Due to minibus-taxi service in South Africa being relatively informal in nature, and only being regulated to a certain degree, minibus-taxi taxis aim to collect and drop off passengers at points of least resistance. Therefore, when deciding on a potential location for a minibus-taxi facility, consideration of both minibus-taxi behaviour and transport planning principals need to be taken into deliberation. (Department of Transport, 2007, pp. 6-1)

As a result of the nature of minibus-taxi operations, this can have either a negative or positive affect on the surrounding land use types. The NDoT guideline proposes that when identifying potential sites for the construction of minibus-taxi facilities, that consideration be given to operations, passengers, traffic, and the affect that facility will have on surrounding land use types. These considerations are elaborated on below.

4.2.4.1 Location and Land Use Considerations

Operation Considerations

As mentioned in Step 3 above, existing minibus-taxi route configuration ought to be considered when identifying potential sites for the construction of a formalised facility.

Ranks are to be located at the start or end of routes, and it is recommended that they serve individual routes. Terminals are also located at the start or end of routes, however should have the capacity to serve more than one route. (Department of Transport, 2007)

Passenger Considerations

It is suggested that minibus-taxi facilities, particularly higher capacity facilities such as terminals and ranks, be within a 5-minute walk (400m to 500m) of employment areas, shopping centres, areas of concentrated passenger demand, and other modes of public transport modes. (Department of Transport, 2007)

South African guidelines, policy material, as well as international good practices, put great emphasis on ensuring that public transport services and associated infrastructure are accessible by all. The National White Paper on Transport Policy affirms that from a customer orientated point of view, the aim is to provide transport services that are Universally Accessible (UA) thus allowing the needs of all users to be met. Therefore, potential sites should be easily accessible by all users. (Department of Transport, 1996)

Traffic Considerations

As stated above, in Step 3, road hierarchy plays a pivotal role when deciding on where to implement a facility. On primary roads, where the traffic volumes and operating speeds are relatively high in comparison to secondary roads, traffic friction is to be avoided. To mitigate this potential 'friction', off-street facilities are to be provided. On secondary roads, where traffic volumes and operating speeds allow for a certain degree of 'friction', on-street facilities can be implemented. (Department of Transport, 2007)

Location and Land Use considerations

Minibus-taxi operations and associated infrastructure can have positive, and negative impacts on certain land-use types. The guideline states that minibus-taxi facilities adjacent to retail areas and office complexes often have beneficial impacts. From a retail perspective, if minibus-taxi facilities are in the near vicinity, this will make the retail area more accessible thus promoting commercial activities. However, minibus-taxi facilities are generally associated with littering and noise, thus hindering commercial activities for luxury goods retailers. Minibus-taxi facilities adjacent to 'office' areas allow for easier access to areas of employment, but consideration should be given to the negative effects of minibus-taxi facilities such as noise pollution, littering, crowding of areas etc. In residential areas, it is advised that smaller facilities be constructed as these facilities have reduced

negative impacts as a result of their size. If larger facilities are deemed necessary, the guideline proposes that they are constructed off-street and away from high concentrations of a residential area. (Department of Transport, 2007)

Other considerations that need to be taken into deliberation when siting a facility is the availability of land, the size of the land available, the ownership, the costs (acquisition, construction, design and environmental), and the zoning of the land. (Department of Transport, 2007)

4.2.4.2 Procedure to determine location of potential facilities

Based on the above considerations, the NDoT guideline for the planning and design of minibus-taxi facilities proposes that the following procedure be followed when deciding on the location of potential facilities:

- I. Alternative sites for the construction of minibus-taxi facilities are sited based on the location and land use considerations expanded on above;
- II. Once potential sites have been selected, the second step, Step 4B, is to rank these sites relative to each other by means of the Multi-Criteria Analysis technique, to establish which alternatives are the most beneficial. (Department of Transport, 2007)

4.2.5 Step 4B: Rank Alternative Sites

The section below elaborates on the criteria that will be applied in ranking alternative sites relative to each other. The criteria used in the evaluation processes are separated into two groups, namely, 'Criteria Cluster', and 'Criteria'. 'Criteria Cluster', is the overarching criterion, and the 'Criteria' associated with the 'Criteria Cluster' are the individual criteria that collectively aid in achieving the objective of the 'Criteria Cluster'.

As evaluated in Chapter 3 of this document, South African guidelines, and international good practices pertaining to the planning and design of road based public transport facilities, emphasize that the following factors should be consulted prior to decisions being made with regards to transport facility investment:

- Passenger Considerations
- Traffic Considerations
- Location and Land Use Considerations
- Costs

Due to these factors being highly regarded in ensuring that the most beneficial alternative is implemented, as well as being supported by legislative documents reviewed in Chapter 3 of this document, they will form the basis of evaluating alternatives sites relative to each other.

4.2.5.1 Evaluation Criteria

4.2.5.1.1 Passenger Considerations

Walkable Catchment

The Department of Transport guidelines on the design of mini/midibus-taxi facilities states that to minimise passenger disutility, minibus-taxi facilities, including both terminals and ranks, should be located in geographical positions that reduce the walking distance for commuters. This can be determined by the application of the walkable catchment area methodology as described below. . (Department of Transport, 2007)

The walkable catchment area, as defined in the Guidelines for Human Settlement Planning and Design, is the actual area within a 400m circle radius of a potential site as a percentage of the theoretical area within the same 400-metre circle radius of the potential site. A 400m circle radius comprises of approximately 50 hectares. 'Actual area', comprises of land used for dwellings, but not public open space. The 'theoretical area' is the total area including both dwellings and open public spaces. The greater actual area as a percentage of theoretical area, the greater the 'walkable' catchment of the potential site. For a site or facility to be termed highly 'walkable', 60 percent of the total 400 m circle radius needs to be the actual area. (CSIR, 2000)

Accessibility of Facilities

South African guidelines, policy material, as well as international good practices, put great emphasis on ensuring that public transport services and associated infrastructure are accessible by all. The National White Paper on Transport Policy affirms that from a customer orientated point of view, the aim is to provide transport services that are Universally Accessible (UA) thus allowing the needs of all users to be met. (Department of Transport , 1996)

To ensure that facilities are accessible by all, certain pedestrian orientated features need to be supplied at the facility as well as leading up to the facility. The TCRP guideline for the planning and design of bus stops states the following with regards to universal accessibility requirements at and surrounding public transport facilities:

- Sidewalks present, 3m in width;
- Curb drops;
- Pedestrian crossings;
- Sidewalks linked to greater pedestrian network;
- No unwarranted protrusions;
- Surfaces slip resistant;
- Gradient of ramps not greater than 1:20 (Transit Cooperative Research Program, 1996)

When evaluating the accessibility of facilities, the above-mentioned features need to be taken into deliberation. For the purposes of this dissertation, and the warranting and siting practice developed in this chapter, each identified alternative will be graded on the level of accessibility. An index will be used to ascertain the level of accessibility for each of the alternatives. Each of the above factors is assigned a score of 1. For each of the factors that a site complies with it obtains a score of 1. For each of the factors that it does not comply with, it obtains a score of 0. The higher the score, the greater the accessibility of the facility.

Security

Based on a critical assessment of relevant material relating to the planning and design of transport facilities, there is a general consensus to promote the well-being of commuters. Security of a facility is directly correlated to the extent of lighting at a bus stop, as well as whether a facility is visible from nearby developments. (Transit Cooperative Research Program, 1996)

Therefore, each potential site will be graded on the ability to promote the well-being of commuters. An index will be used to ascertain the level of security associated with each of the identified alternatives. For each of the above-mentioned factors, lighting and the presence of a neighbourhood/community watch, a score of 1 will be assigned. If an alternative complies with one of the above factors it will obtain a score of 1, if it does not then it will be given a score of 0. The higher the total score, the better the security of the alternative.

Passenger Demand

Potential sites will be assessed on their expected daily passenger demand. As stated by Chetty & Phayane (2012) in Chapter 3, areas or sites can be warranted for the construction of formalised minibus-taxi facilities based on their expected demand. If a site is expected to generate a demand of greater than 500 passengers per day, or more than 100 passengers in the peak hour, this will trigger the primary warrant for a facility. If demand is less than 500 passengers per day, or less than 100 passengers in the peak hour, the construction of minibus-taxi facilities can be warranted on their ability to improve the existing situation.

4.2.5.1.2 Traffic Considerations

Traffic Flow

Due to the nature of road based public transport services, with passengers boarding and disembarking vehicles at various demarcated stops and occasional unauthorised stops in the instance of minibus-taxis services along a roadway, there is often conflict between vehicles and vehicles and passenger and vehicles. The location of a facility therefore determines the degree of potential perilous conflict. Facilities that are located off-street and away from congested

intersections are deemed safer in terms of potential conflict than those facilities that are located on-street and at intersections. (Transit Cooperative Research Program, 1996, p. 5)

Consequently, alternatives will be evaluated based on their degree of potential perilous conflict. An index will be used to assess alternatives, with a score of 1 assigned to alternatives if they are located off-street and away from the congested intersection, and a score of 0 if they are situated on-street and in the immediate vicinity of a congested intersection. The greater the score, the less perilous conflict associated with the alternative.

Sight Distance

As stated by the CSIR guidelines, to ensure the safety of all road users, sight distance requirements need to be adhered to. The CSIR guidelines critically evaluated on in Chapter 3 of this document, specify the sight distance requirements, expressed in meters, given the posted speed limit of the road in question. (CSIR, 2000, p. 21)

An index will be used to assess an alternative, given the sight distance requirements. If an alternative adheres to sight distance requirements, a score of 1 will be assigned to the alternative. If an alternative does not comply with the sight distance requirements, it will be assigned a score of 0. Therefore, the higher the score obtained the more feasible the alternative is from a sight distance perspective.

For the relevant authority to approve the location of the facility, the site needs to comply with the sight distance requirement. Due to the importance of sight distance, if the sight does not meet the minimum requirements it will be withdrawn from the evaluation process.

4.2.5.1.3 Passenger Considerations

Facility Location Relative to Major Trip Generators

The National Department of Transport guidelines, as well as international good practices, support the placement of stops in the immediate vicinity of major trip generators. Accessibility and increased patronage can be anticipated if facilities are in the immediate vicinity of major trip generators. Major trip generators, for the purposes of this study, are defined as places of education, medical facilities, places of employment, high-density residential areas, and other public transport services. (Department of Transport, 1986)

An index will be applied to evaluate an alternative location relative to major trip generators. For each major trip generator, as defined above, that an alternative is in the immediate vicinity of, a score of 1 will be assigned to the alternative. If the alternative is not in the immediate vicinity of a major trip generator, a score of 0 will be assigned to the alternative. The greater the score, the more favourable the location of the alternative.

Facility Location Relative to Intersection

As mentioned in Chapter 3 of this document, facilities can either be placed near-side, far-side or mid-block relative to the nearest intersection. From a transit agencies perspective, in practice, far-side stops are favoured over other placement options due to safety benefits, improved traffic flows through the intersection, fewer traffic delays and less likelihood of perilous conflict between vehicles. Near-side stops should be avoided to reduce potential conflict with left-turning vehicles, and to prevent obstruction of pedestrian activity around the intersection. Mid-block stops are not advised either unless bus stops are supported by non-motorised transport infrastructure linking them to major trip generators. (Transit Cooperative Research Program, 1996, p. 27)

An index will be used to assess the effectiveness of facility placement. If an alternative is positioned far-side a score of 1 will be assigned to the alternative. If an alternative is positioned either near-side or mid-block a score of 0 will be assigned to the alternative. The higher the score, the more favoured the proposed placement of the alternative.

Re-zoning

As mentioned in Chapter 3, when selecting a site for the construction of a facility, the zoning-type of the selected land needs to be taken into consideration. If deemed necessary, the site on which the proposed facility is to be situated may require re-zoning to comply with zoning requirements. If the selected land complies with zoning requirements, the alternative will be assigned a score of 1. If the land on which the proposed is to be constructed needs to be rezoned, a score of 0 will be assigned to the alternative. Consequently, a higher score is favoured over a lower score during the evaluation process.

4.2.5.1.4 Cost Considerations

As stated in the National Land Transport Act of 2000, public transport infrastructure and associated infrastructure should be designed and implemented in such a way that the following cost considerations are adhered to, scarce resources are optimally located, and environmental costs are kept to a minimum. (National Department of Transport, 2000)

As a result of policy requirements, and the straining financial climate endured in South Africa presently, alternatives need to be evaluated from a costing perspective. Consequently, alternatives will be evaluated on the following cost considerations: Acquisition Costs of Land, Design & Construction Costs, and Environmental Costs.

Acquisition Costs of Land

An index assessment will be used to evaluate the acquisition of land cost associated with an alternative. If the land on which the proposed alternative is to be constructed is owned by the relevant authority, a score of 1 will be assigned to the alternative. If the land is privately owned, the land will need to be expropriated prior to construction. Therefore, a higher score is more favourable when evaluating alternatives.

Design & Construction Costs

The monetary costs, expressed in Rands (R), of designing and constructing an alternative. For purposes of this dissertation, the costs for design and construction are assumed based on current engineering rates within South Africa, as experienced within the industry. This assumes construction costs of approximately R1200 per square metre, and design costs as ten percent (10%) of the total construction cost.

Environmental Costs

Environmental cost, for the purpose of this document, is termed as whether or not an Environmental Impact Assessment (EIA) or Environmental Permitting Process (EPP) is mandatory based on the location of the site. An EPP will be mandatory if the location of the site triggers any of the GNR 983 (listing notice 1) and GNR 985 (listing notice 3) environmental listings as stated in the National Environment Management Acts (NEMA) (Act 107 of 1998). An EIA is warranted if the site triggers any of the GNR 984 (listings notice 2) environmental listings as stated in NEMA. The environmental listings, GNR 983, 984 & 985 can be found in the appendices. (Department of Environmental Affairs, 1998).

For evaluation purposes, if an EIA or EPP is considered obligatory for the potential site, a score of 0 (unfavourable) will be assigned to the alternative. If the potential site does not result in any NEMA triggers being activated, a score of 1 (favourable) will be assigned to the alternative.

4.2.5.2 Weighting of Criteria

Based on an extensive literature review, as depicted in Chapter 3 of this document, it has been ascertained that certain considerations are prioritised over others when evaluating public transport and associated infrastructure alternatives. The section to follow elaborates on the weightings for each of the 'Criteria Cluster', and the justification for each.

4.2.5.2.1 Passenger Considerations

The set of criteria listed under the criteria cluster, passenger considerations, evaluates the impact the facility will have on the passengers making use of it. This criteria cluster is given a weighting of 40 percent (%) which is used in the multi-criteria analysis process when evaluating the overall

effectiveness of the alternative. Relative to other criteria clusters applied when evaluating the effectiveness of an alternative, it is weighted as the most focal criteria cluster. The justification for this weighting is based on the requirements stipulated in transport policy documentation critiqued in Chapter 3 of this document, as well as the needs of stakeholders directly involved in public transport service provision in Klappmuts (i.e. Stellenbosch municipality, current public transport operators, ward councillors, community, business owners).

4.2.5.2.2 Traffic Considerations

The set of criterion listed under this criteria cluster, traffic considerations, evaluates the alternative from a traffic impact and safety perspective. For multi-criteria analysis purposes, this criteria cluster is given a weighting of 25 percent (%). Relative to another criterion, it is prioritised as the second most important criterion. The National White Paper of 1996 puts great emphasis on ensuring that public transport service provision takes place in the safest manner possible.

4.2.5.2.3 Location and Land Use Considerations

Criteria grouped under this criteria cluster, location and land use considerations, assess the effectiveness of an alternative from a location and land use perspective. This criteria cluster was weighted as the second most important criterion and given a weighting of 25 percent (%) which is to be used in the multi-criteria analysis of the site location. This weighting is justified by the National Department of Transport (NDoT) planning guidelines confirming that public transport facilities must be supported by applicable land use types in the immediate vicinity of the facility.

4.2.5.2.3 Cost Considerations

A further criteria cluster used in evaluating alternatives is the monetary cost associated with an alternative. As mentioned in Chapter 3 of this document, South Africa's economy is under immense duress. Therefore, the most beneficial investment alternatives need to be selected. Realistically resources are limited, but Stellenbosch Municipality, the governing authority of Klappmuts, identifies public transport service provision as a 'high need' and therefore significantly values accessibility and mobility in the Klappmuts area. As a result of this stance, the monetary cost of the facility is lowly ranked in comparison to other alternatives with a weighting of ten percent (10%).

4.2.5.3 Multi-Criteria Analysis

To assess the effectiveness of a potential location relative to other locations and, to ensure the most beneficial investment decision is made, a Multi-Criteria Analysis (MCA) approach will be utilised. "Multi-criteria analysis establishes the preferences between options by reference to an explicit set of objectives that the decision-making body has identified, and for which it has established measurable criteria to assess the extent to which objectives have been identified" (Department for Communities and Local Government, 2009, p. 21). For the purposes of evaluation

between alternatives sites in this document, the weighted sum method of the MCA approach is applied. The following steps are followed when deciding amongst potential locations for the construction of public transport facilities:

- Identification of potential locations, as elaborated in Step 3, for the construction of either a minibus-taxi terminal or rank;
- Ascertaining issues (objectives) that would be affected by the selection of the alternative;
- Expressing these objectives in a measurable manner, either quantitatively or qualitatively;
- Estimating the functioning of each alternative subject to the defined objectives;
- Weighting the scores under each objective, so that a total score can be formulated for each alternative. This total score being used to rank alternatives relative to each other. (Lupton, 2002)

Table 12, below, illustrates the criteria that are going to be applied when evaluating alternative sites by means of the MCA technique.

Table 12: Proposed Evaluation Criteria

Criteria Cluster	Criteria	Measures	Weight
Passenger Considerations	Walkable Catchment	Walkable catchment	40%
	Accessibility of facilities	Qualitative Assessment	
	Security	Qualitative Assessment	
	Passenger Demand	Quantitative Assessment	
Traffic Considerations	Traffic Flow	Qualitative Assessment	25%
	Sight Distance	Qualitative Assessment	
Location and Land Use Considerations	Location relative to major trip generators	Qualitative Assessment	25%
	Facility location relative to intersection	Qualitative Assessment	
	Zoning	Qualitative Assessment	
Costs	Acquisition Costs of land	Qualitative Assessment	10%
	Design & Construction Costs	Rand	
	Environmental Costs	Qualitative Assessment	

4.3 Conclusion

The aim of this chapter was to develop a warranting and siting practice for minibus-taxi terminals and ranks. The warranting and siting practice developed was informed by policy documents, guidelines, international good practices, and other relevant material pertaining to the planning and design of road based public transport facilities. In the subsequent chapters of this document, the warranting and siting practice developed will be applied to the Klapmuts situation in order to address the research topic of this document.

5 Study of Klapmuts

5.1 Introduction

As per the problem statement addressed in Chapter 1 of this document, Klapmuts is deficient in terms of the desired standard of public transport infrastructure required to cater for the needs of the area. The Klapmuts Spatial Development Framework of 2007 has identified the need to formalise transport infrastructure, to ensure that generative and equitable development is achieved for the area. Generative development is termed as the advancement of local economic opportunities, and equitable development has been termed as the promotion of access to social and opportunities. (Stellenbosch Municipality, 2007)

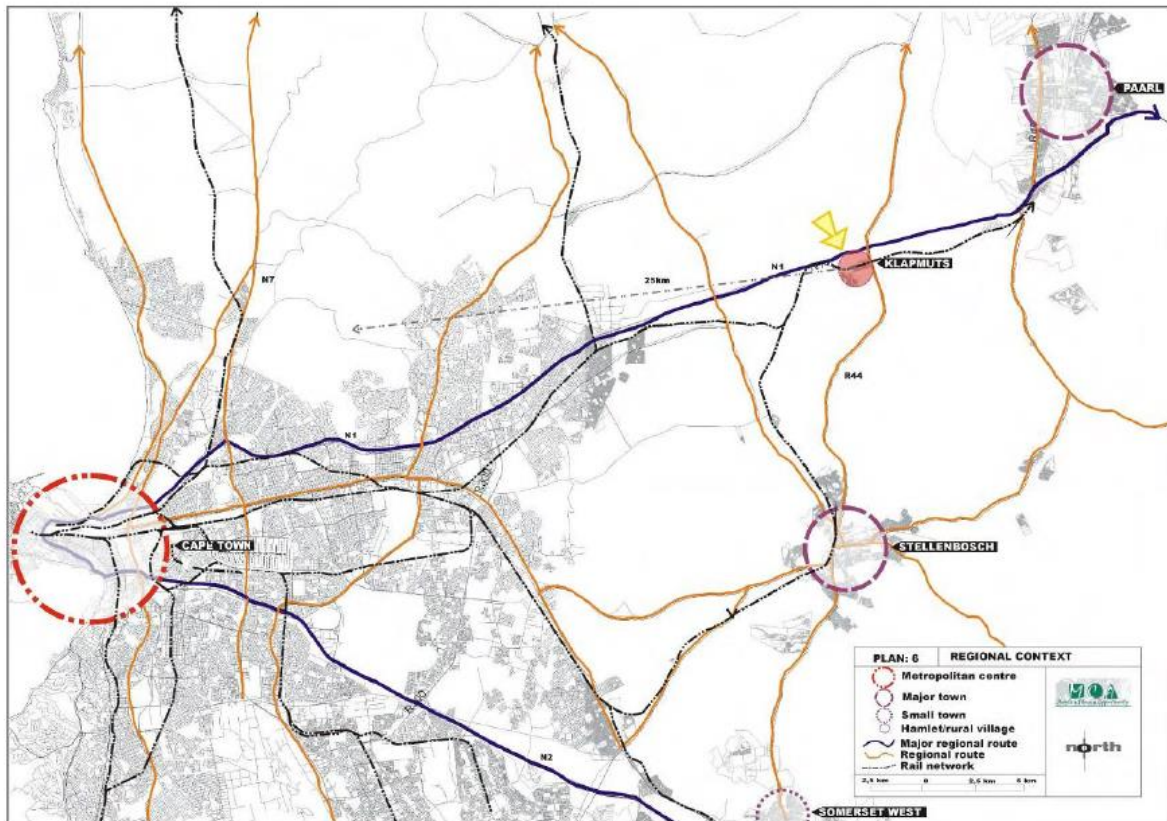
The aim of this chapter is to better understand the study area, in order for an informed decision to be made when applying the warranting and siting practice developed in Chapter 4. This chapter contains findings, and the analysis of secondary data obtained from Aurecon, Cape Town. The findings explained on in this chapter will aid in understanding movement patterns for both vehicles and pedestrians, status quo of public transport service provision, public facilities and establishments, property ownership, and economic activity in Klapmuts. These findings will form inputs, either quantitative or qualitative, into the warranting and siting practice, and will ultimately aid in the siting and prioritisation of potential public transport facilities in Klapmuts.

5.2 Status Quo

5.2.1 Regional Movement

Klapmuts is linked to both Cape Town and Paarl by means of the N1, a regional road. Klapmuts is approximately 50km from Cape Town and 15km from Paarl. Sub-regional roads (R44, R101, R45) connect Klapmuts to Stellenbosch, Wellington, Somerset West and Franschhoek. The regional context of Klapmuts in relation to other urban areas is illustrated in Figure 13.

Figure 13: Regional Context



(Stellenbosch Municipality, 2007, p. 22)

As a result of these regional and sub-regional roads linking Klapmuts to other urban areas, Klapmuts has a high degree of accessibility to regional markets. Train services are also provided in Klapmuts, with the train station located on the northern edge within Klapmuts. The rail network links Klapmuts to the Cape Town Metropole, as well as to the Cape Winelands region. (Stellenbosch Municipality, 2007, p. 23)

Due to Klapmuts being termed as low-to-middle area, the majority of the population is captive to public transport. As a consequence, the rail service accommodates the majority of inbound and outbound trips from Klapmuts. (Stellenbosch Municipality, 2007, p. 23)

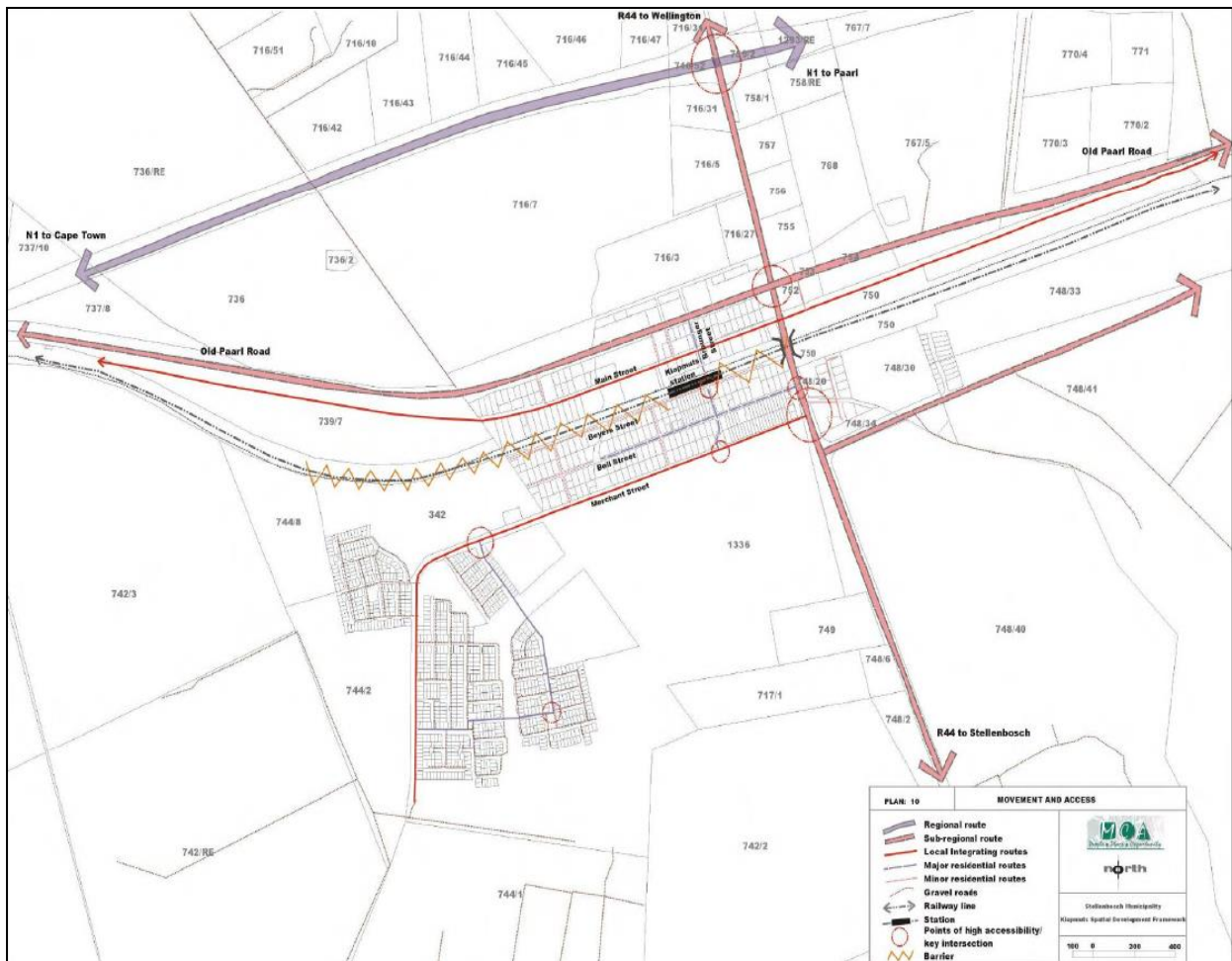
Klapmuts comprises of two main streets, namely Merchant Street which is located to the south of the railway line, and Old Paarl road which is located to the north of the railway line. As a result of the railway line bisecting Klapmuts, this forms a barrier to both vehicular and pedestrian movement. (Stellenbosch Municipality, 2007, p. 23)

There are numerous intersections within the Klapmuts area that bestow points of high accessibility to establishments and economic opportunities. The intersection that provides the highest level of

accessibility is the intersection of the R44 and the N1. As defined by the road hierarchy classification, the R44 road is a Class 2 exiting arterial and the N1 is a Class 1 freeway. Other relevant intersections in terms of accessibility are the R44 and Old Paarl road intersection, and the R44 and Merchant street intersection. (Stellenbosch Municipality, 2007, p. 23)

The existing road network, railway line, and train station precinct, as well as the intersections of high accessibility within the Klapmuts area, are illustrated in Figure 14 below.

Figure 14: Klapmuts- Movement and Access



(Stellenbosch Municipality, 2007)

5.2.2 Local Movement

Klapmuts has a well ordered local street layout, structured in blocks parallel to the railway line. North-south pedestrian and vehicular access are constrained by the railway line. There are two main crossing points of the Klapmuts railway line, namely:

- The R44 bridge crossing, and
- Pedestrian crossing using the Klapmuts railway station street-to-street bridge (Stellenbosch Municipality, 2007).

Facilities and various establishments in Klapmuts are within walking distance however linkages to these areas are inadequate, and there is a necessity to upgrade roads and pedestrian orientated infrastructure to obtain satisfactory levels of accessibility. (Stellenbosch Municipality, 2007, p. 29).

5.2.3 Non-Motorised Transport Linkages

As mentioned above, due to the economic status of the majority of the population in Klapmuts, public transport and walking are the most prevalent modes of transport. NMT infrastructure is limited, with Merchant Street being the only street that has a pedestrian sidewalk. A limiting factor in the provision of NMT infrastructure in Klapmuts is the fact that the majority of roads are very narrow, and road reserves are not wide enough to accommodate pedestrian facilities. The railway station precinct is approximately 1km from the southernmost residential area, with there being little to no formal linkage between the two. (Royal Haskoning DHV, 2016, p. 41)

The residential area to the north of railway station precinct also lacks any form of pedestrian orientated infrastructure. Consequently, the linkages of this residential area and the railway station are weak. (Royal Haskoning DHV, 2016, p. 41)

A high-level pedestrian survey was undertaken by Aurecon in January 2016. The aim of the survey was to better understand pedestrian movements and desire lines in Klapmuts. The intention of the survey was not to indicate pedestrian 'origin' or 'destination' points, but instead 'directions of approach' at each of the observation sites.

Based on the pedestrian volumes at each of the observation sites for both the AM & PM peak hours, prominent pedestrian desire lines were ascertained for Klapmuts, which are illustrated in Figure 15 below.

Figure 15: Klapmuts pedestrian desire lines



5.2.4 Public Transport Provision

5.2.4.1 Overview

Klapmuts is served by three public transport modes, namely rail services provided by PRASA (through Metrorail), a limited bus service for scholar transport and by minibus-taxi services provided by three associations.

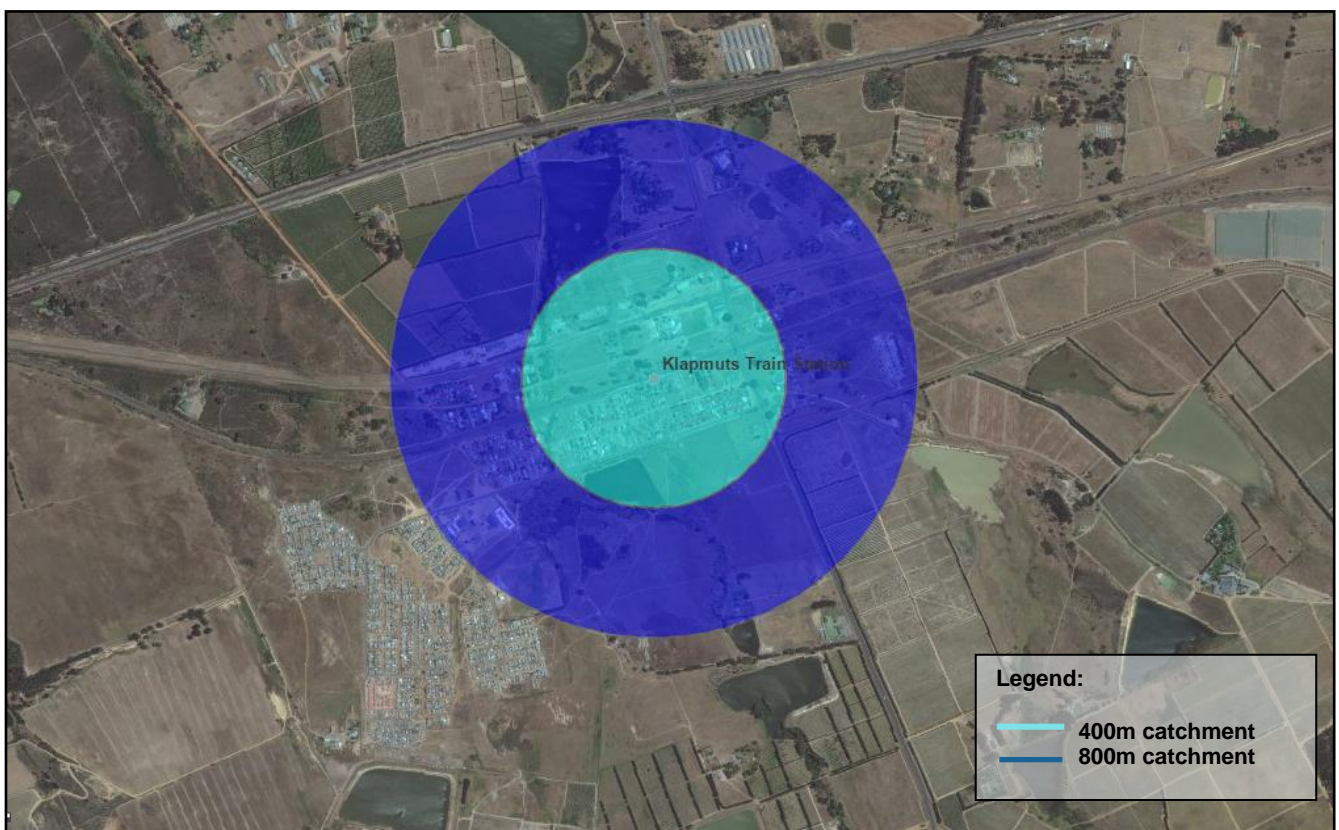
Table 13: Klapmuts Public Transport Context

Rail Utilisation (Average Monthly Ticket Sales)				Minibus-taxi (surveyed daily patronage)
Single Issue	Return	Issues Weekly	Issues Monthly	
6138	963	873	484	1347

Based on the population of Klapmuts, approximately 7700 people, and the passenger utilisation for both rail and minibus-taxis in Klapmuts, as illustrated in Table 13, there is a clear indication that Klapmuts community is significantly captive to public transport.

Rail Services provider, Passenger Rail Agency of South Africa (PRASA), provides a scheduled daily rail service linking Klapmuts to both Cape Town and Wellington. The Klapmuts station precinct is located on the northern edge of the current development, and is not ideally located as the majority of the Klapmuts residents have to walk for over 800m to make use of the service. The catchment area of the station, displayed in 400m and 800m concentric bands, is illustrated in Figure 16 below.

Figure 16: Klapmuts Train Station Catchment Area (400m & 800m)



5.2.4.2 Minibus-taxi Operational Context

Three taxi associations currently (2016) operate within the Klapmuts area, these being the Stellenbosch Taxi Association, Kayamandi Taxi Association, and the Franschhoek Taxi Association. The distribution of routes and Operating Licenses (OL's) amongst the various minibus-taxi associations is reflected in Table 14 below.

Table 14: Minibus-taxi Association- Routes Operated & Operating Licenses

Association	Routes Operated	Operating Licenses Held
Stellenbosch		
Kayamandi		
Franschhoek	2	7

Discussions were held with the above-mentioned associations to understand their respective mini-bus taxi operations from Klapmuts, as well as to gain insight into the working relationship between the associations. At the time of the dissertation, no animosity was reported between the various associations, and all parties were willing to share facilities if formal mini-bus taxi facilities were to be provided.

5.2.4.3 Minibus-taxi Facilities

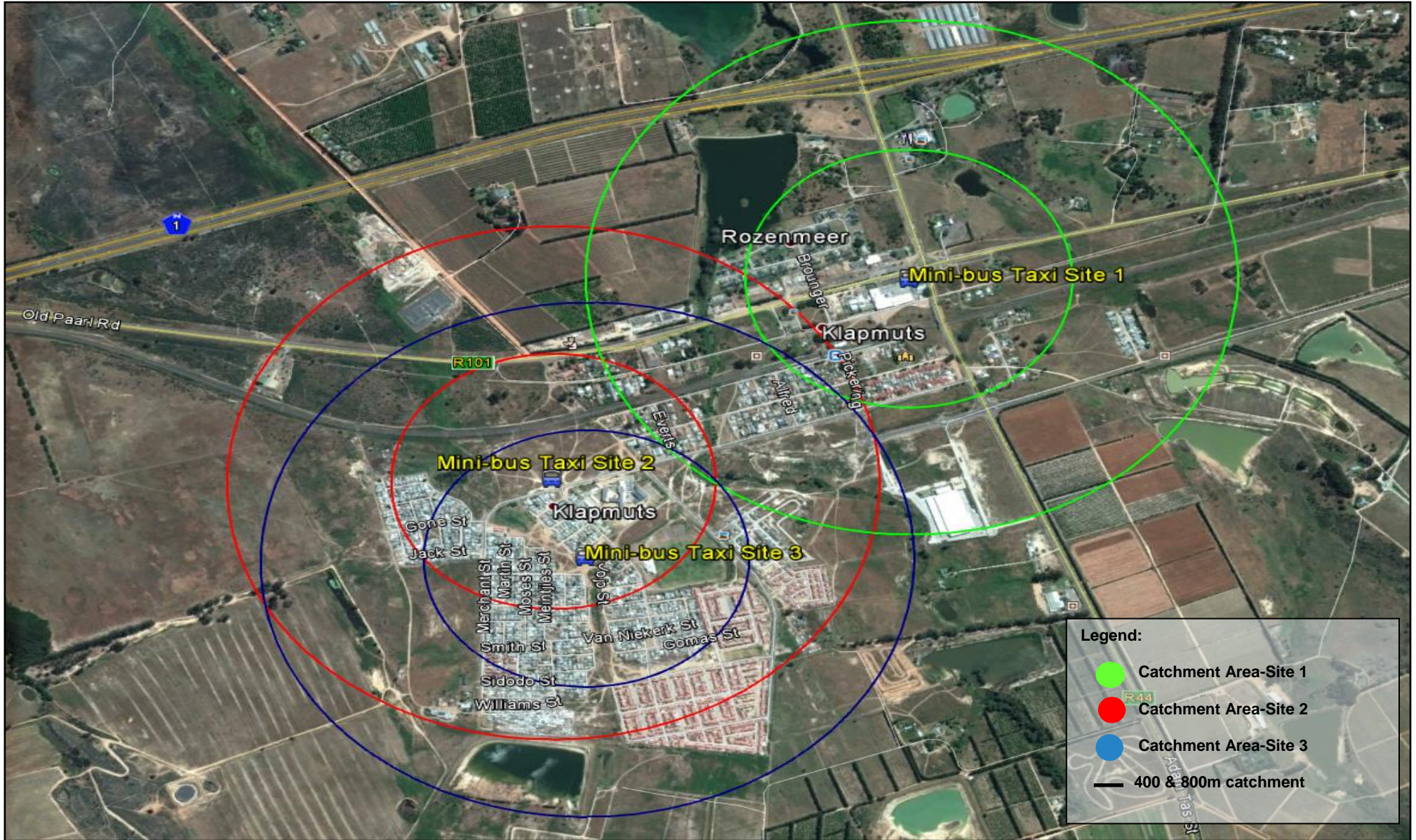
Three minibus-taxi sites currently function as the main pick-up and drop-off points in the Klapmuts area. As mentioned in Chapter 1 of this document, these three sites are categorized as being informal with no formal infrastructure in place. The first site is situated at the Shoprite Centre off Old Paarl road. The second site is situated at the intersection of Merchant Street and Adams Street, and the third site is situated on a gravel patch to the north-east of Jacobs street and to the southwest of Adams Street. Figure 17, below illustrates these locations.

Figure 17: Locality map of current minibus-taxi sites



Figure 18, depicts the catchment area of the existing minibus-taxi sites. Concentric bands illustrate the 400m and the 800m catchment area of each of the sites.

Figure 18: Catchment area of existing minibus-taxi sites



5.2.4.4 Klapmuts Minibus-taxi Routes

The section below further explains the minibus-taxi routes operated from Klapmuts.

5.2.4.4.1 Klapmuts internal routes

An internal “community” service is provided that transports passengers between minibus-taxi site 3 (Jacobs Street & Adams Street) and minibus-taxi site 1 (Shoprite), as well as between minibus-taxi site 2 (Merchant Street & Adams Street) and minibus-taxi site 1. The travel time in the peak operating period for both the forward and reverse direction is approximately five minutes, with a route distance of 2 km. Figure 19 and Figure 20 below, illustrate the internal minibus-taxi routes offered in Klapmuts. Also included are locational markers (yellow) dots indicating frequent pick-up and drop-off points along the route.

Figure 19: Klapmuts internal route: minibus-taxi site 1 – minibus-taxi site 2

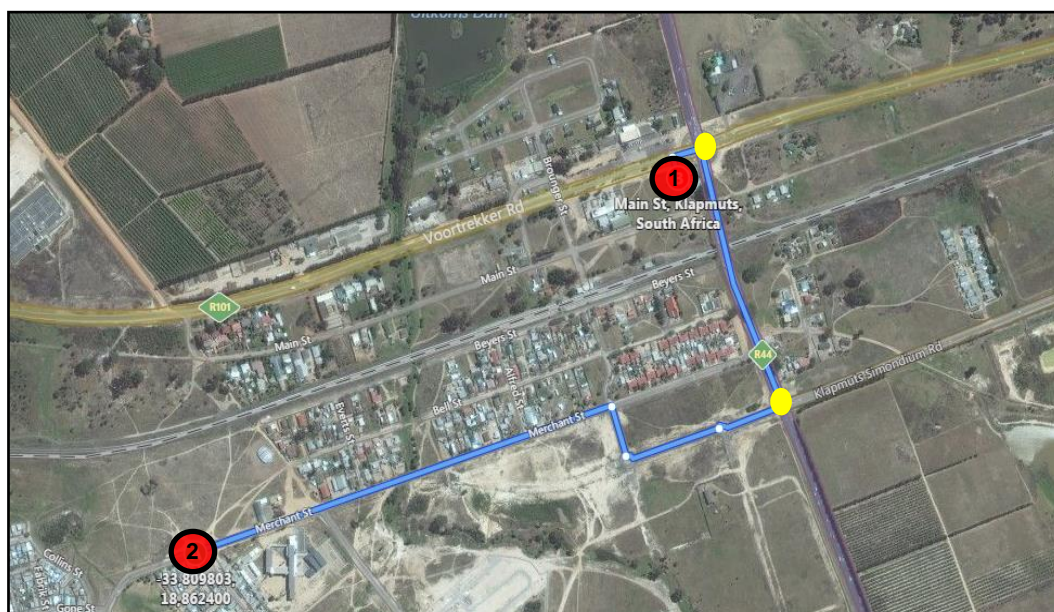
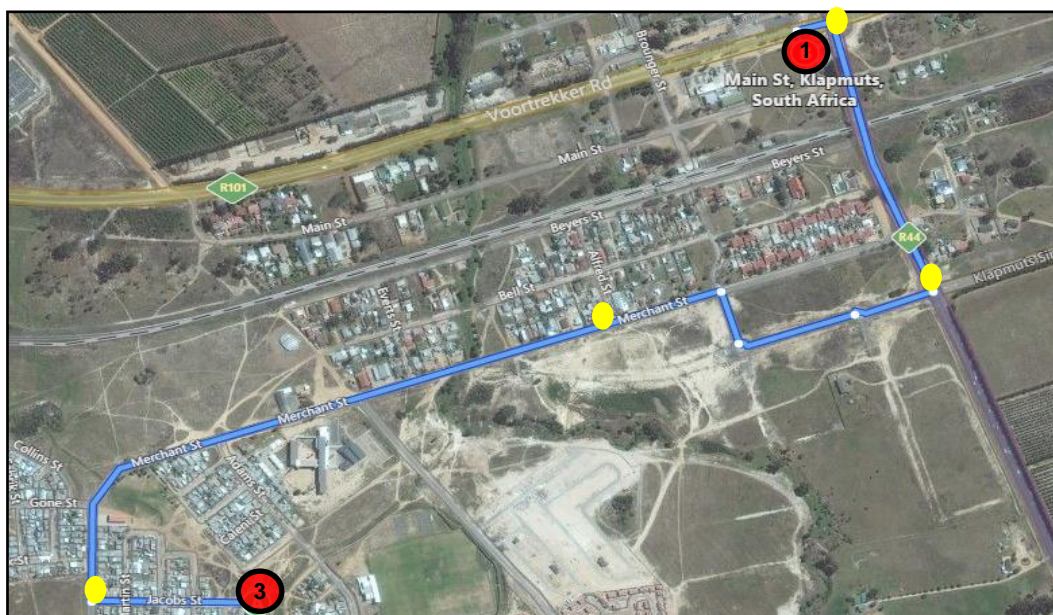


Figure 20: Klapmuts internal route: minibus-taxi site 1- minibus-taxi site 3

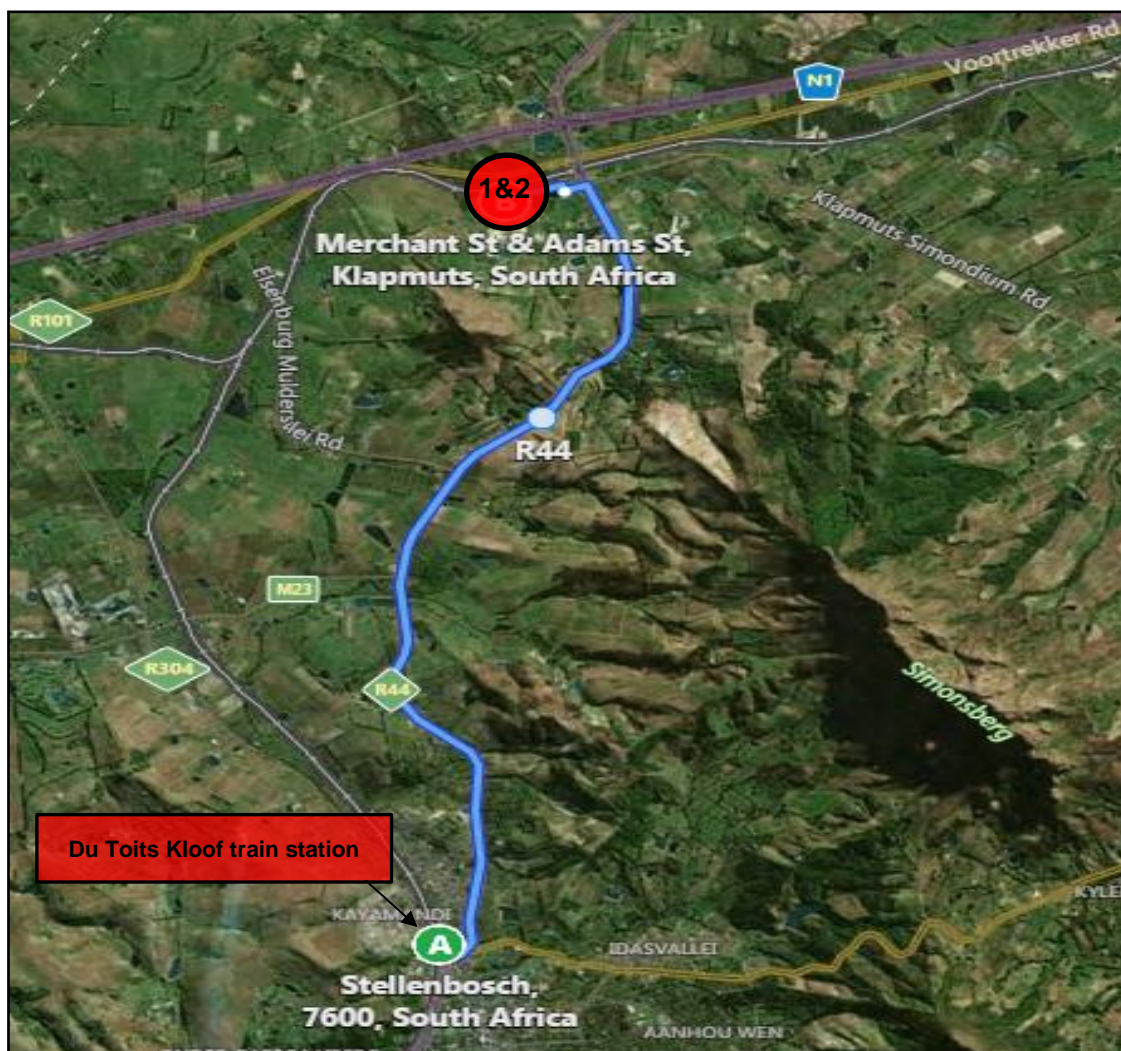


5.2.4.4.2 Klapmuts- Stellenbosch route

The route between Klapmuts and Stellenbosch operates from Site 2 (Merchant Street & Adams Street), Site 3 (Jacobs Street & Adams Street) and Site 1 (Shoprite). The drop-off and collection point in Stellenbosch is not at the main minibus-taxi rank on the corner of Merriman and Bird Street, but at the gravel patch alongside the Du Toits Kloof railway station.

The distance of the 'Klapmuts-Stellenbosch' route is approximately 16 km, with the cycle time of a round trip in the peak hour of operation being approximately 60 minutes, inclusive of dwell time (boarding/alighting/holding) at both the origin and destination points. Figure 21, depicts the route followed from minibus-taxi sites 2 & 3 in Klapmuts to Stellenbosch (Du Toits Kloof train station). Locational markers (yellow dots) indicate the most frequent pick-up and drop-off points along the route.

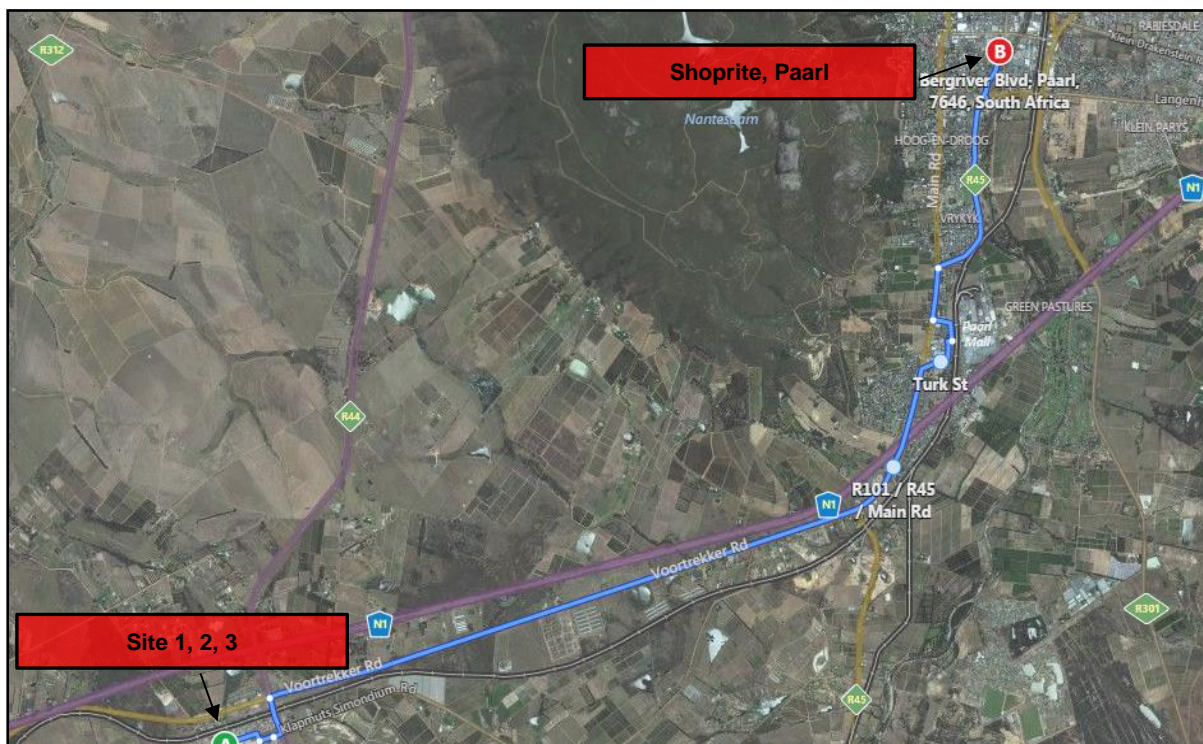
Figure 21: Klapmuts- Stellenbosch (Du Toits Kloof) minibus-taxi route



5.4.4.4.3 Klapmuts- Paarl route

A minibus-taxi service operates between Klapmuts and Paarl. This route operates from minibus-taxi site 1, 2 & 3 to the Shoprite in Paarl. The distance of the 'Klapmuts-Paarl' route in one direction is approximately 14.3 km, with the cycle time of a round trip in the peak hour of operation being roughly 40 minutes. The cycle time is inclusive of between trips dwell time (boarding/alighting/holding) at both the origin and destination points. Figure 22 below, illustrates the route followed.

Figure 22: Klapmuts- Paarl minibus-taxi route

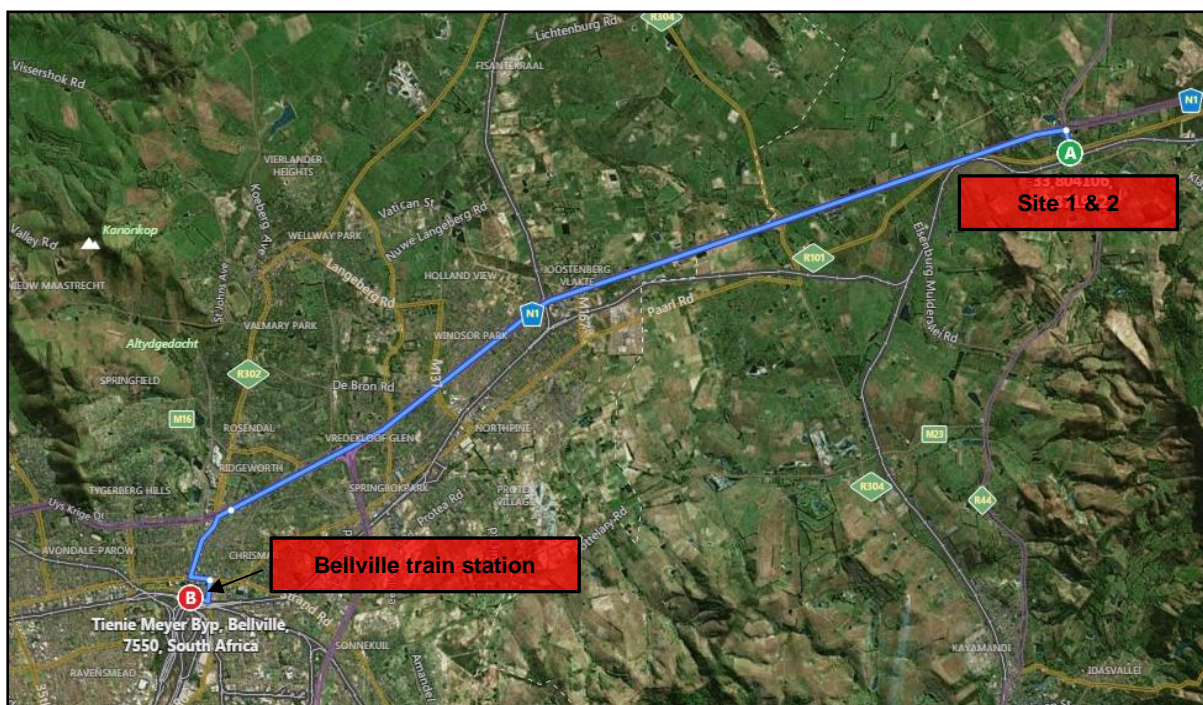


5.4.4.4 Klapmuts- Bellville route

A nominal daily service is provided between Klapmuts and Bellville with an increased number of trips being provided on weekends, responding to the shopping needs of the community. The pick-up and drop-off points in Klapmuts are at minibus-taxi site 1 & 2, with the pick-up and drop-off point in Bellville being at Bellville train station. The service has a low demand, with only 3 departing trips a day from Klapmuts.

The route distance in one direction is approximately 28.8 km, with the cycle time of a round trip in the peak hour being approximately 75 minutes. Figure 23, illustrates the route from minibus-taxi site 1 & 2 in Klapmuts to Bellville trains station.

Figure 23: Klapmuts-Bellville minibus-taxi route

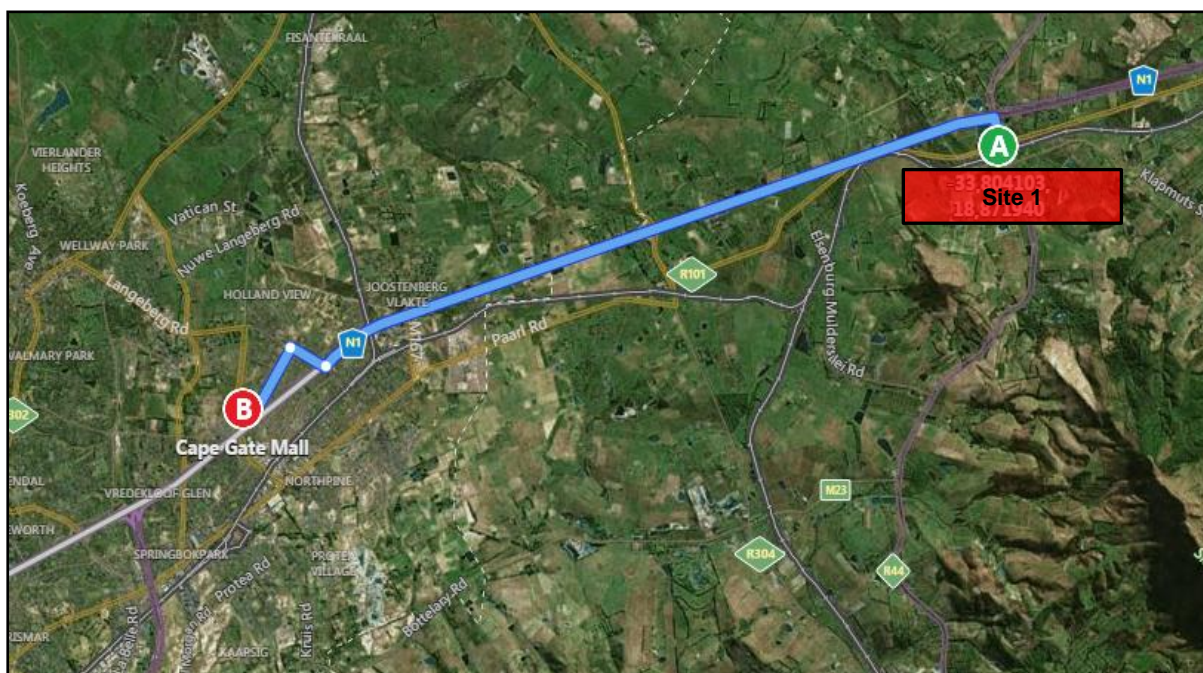


5.4.4.4.5 Klapmuts- Kraaifontein (Cape Gate Mall) route

A service operates between Klapmuts and Kraaifontein (Cape Gate Mall). On any given weekday, there's one departing trip from Klapmuts (minibus-taxi site 1-Shoprite) to Kraaifontein (Cape Gate Mall) with increased services being provided over weekends to accommodate social and shopping activities.

The distance of the 'Klapmuts-Kraaifontein (Cape Gate Mall) in one direction is approximately 19.1 km, with the cycle time of a round trip in the peak hour of operation being approximately 50 minutes. Figure 24, depicts the Klapmuts to Kraaifontein minibus-taxi route.

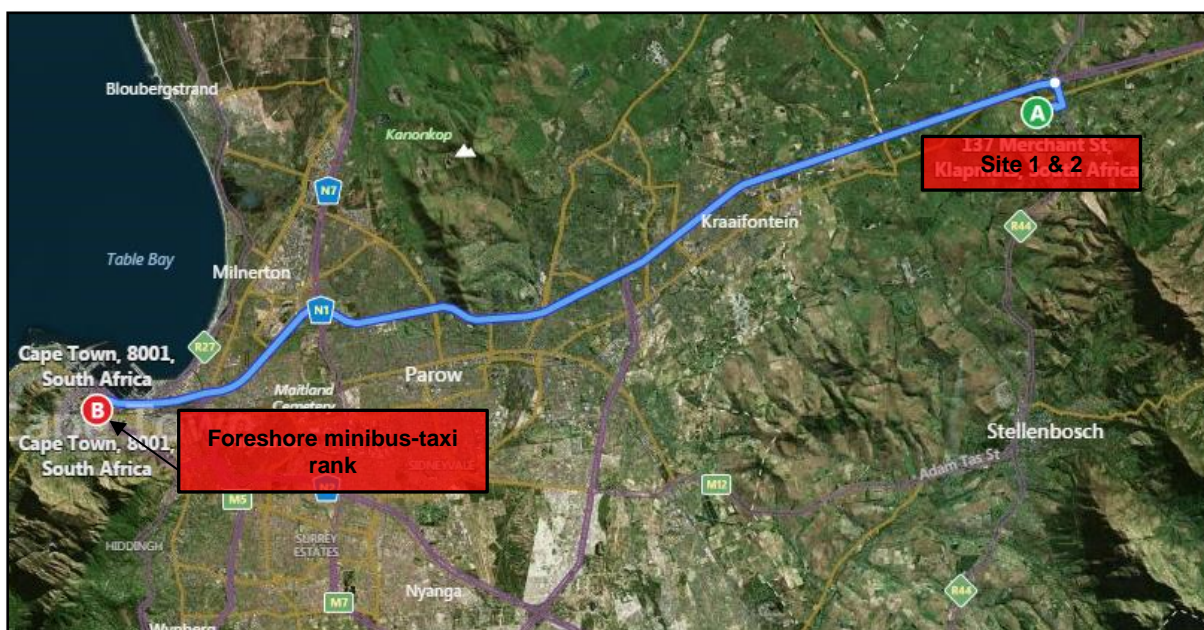
Figure 24: Klapmuts- Kraaifontein (Cape Gate Mall) minibus-taxi route



5.4.4.4.6 Klapmuts- Cape Town route

The service between Klapmuts and Cape Town provides for one trip daily departing Klapmuts on any given weekday in the morning peak period transporting commuters to the minibus-taxi rank in central Cape Town. The pick-up and drop-off points of this route in Klapmuts are at minibus-taxi site 2 & 3. The distance of the 'Klapmuts- Cape Town Taxi rank (Foreshore)' route is approximately 47.7 km, with the cycle time of a round trip in the peak hour of operation being approximately 120 minutes. Figure 25, illustrates this route.

Figure 25: Klapmuts-Cape Town minibus-taxi route



5.2.4.5 Minibus-taxi Survey

On the 2nd and the 3rd of December 2015, a 13 hour (06:00-19:00) minibus-taxi survey was undertaken at the three minibus-taxi sites (Site 1: Shoprite, Site 2: Merchant & Adams Street, Site 3: Jacobs & Adams Street) to gain a better understanding of minibus-taxi operations within, to and from Klapmuts. The minibus-taxi survey was conducted over two weekdays (Wednesday, Thursday), as it is assumed that peak period demand for minibus-taxi services will occur on a weekday and not a weekend due to commuters traveling more on a given weekday for work purposes, schooling etc.

The type of vehicles that were operated on the days of the survey were predominately Quantum minibus-taxis with a seating capacity of 15 passengers. None of the vehicles are universally accessible.

Surveyors were stationed at all three sites for the 13 hours, and all taxi movements associated with these sites were recorded. The information captured included (i) Arriving and departing times of minibus-taxis; (ii) origin and destination points of minibus taxis; (iii) passengers boarding and alighting and fares charged for the various routes operated.

Using GoMapp, a public transport mapping app, minibus-taxi routing information for Klapmuts was obtained. Surveyors were instructed to travel along the primary routes (Klapmuts-Paarl, Klapmuts-Stellenbosch, and Klapmuts Internal Route(s)) during the peak periods of operation with a cellular device using GoMapp software. During the journey, the GoMapp software, with the assistance of Geographical Positioning System (GPS), was able to record the exact route followed by the

minibus-taxis, as well as record all pick-up & drop-off points along the route. The results of the minibus-taxi 'site' survey, as well as the 'route' survey, are summarised below.

5.2.4.5.1 Minibus-taxi Site 1

The minibus-taxi site has demarcated taxi embayments with appropriate signage and adjacent lighting. No passenger facilities or amenities are provided. Four routes operate from this site, and include the following:

- Internal community services between all three minibus-taxi sites
- Minibus-taxi site 1 – Paarl
- Minibus-taxi site 1- Bellville train station
- Minibus-taxi site 1- Kraaifontein (Cape Gate Mall)

Table 15, summarises the weekday average minibus taxi operational information associated with Site 1 (Shoprite).

Table 15: Minibus-taxi Site 1 operations survey summary

Site	Route Name	Period	No. of Departures	Service Capacity	No. of Pax	% Utilisation	Cycle time (min)
Shoprite-Site 1	Klapmuts (Internal)	06:00 - 19:00	31	465	385	82.8	10
Shoprite-Site 1	Paarl	06:00-19:00	3	45	47	100	40
Shoprite-Site 1	Bellville Train Station	06:00-19:00	2	30	29	96	75
Shoprite-Site 1	Kraaifontein (Cape Gate Mall)	06:00-19:00	1	15	16	100	50
Total				555	477		

Table 16, summarise the morning and evening peak hour passenger demand periods, for minibus-taxi site 1.

Table 16: Minibus-taxi Site 1- AM & PM Peak Hour Passenger Demands

Peak Period	Time	Number of Passengers
AM-Peak Hour	09:00	119
PM-Peak Hour	16:00	120

5.2.4.5.2 Minibus-taxi Site 2

This is an informal boarding and alighting facility where the operations take place off-road on a gravel area adjacent to the intersection of Merchant Street and Adams Streets. Four routes operate from this site:

- Site 2- Site 1 (Shoprite)- internal community service
- Site 2- Shoprite Paarl
- Site 2-Bellville Train Station
- Site 2- Stellenbosch

Table 17, summarises the survey period minibus-taxi operational information for Site 2 (Merchant Street & Adams Street).

Table 17: Minibus-taxi Site 2 operations survey summary

Site	Route Name	Period	No. of Departures	Service Capacity	No. of Pax	% Utilisation	Cycle time (min)
Site 2	Klapmuts(Shoprite)	06:00-19:00	20	300	48	16	10
Site 2	Paarl	0600-19:00	33	495	275	56	40
Site 2	Bellville Train Station	06:00-19:00	1	15	9	60	75
Site 2	Stellenbosch	06:00-19:00	2	30	23	77	60
Total				840	355		

Table 18, summarise the morning and evening peak hour passenger demand periods, for minibus-taxi site 2.

Table 18: Minibus-taxi Site 2 -AM & PM Peak Hour Passenger Demands

Peak Period	Time	Number of Passengers
AM-Peak Hour	08:00	67
PM-Peak Hour	15:00	30

5.2.4.5.3 Minibus-taxi Site 3

Site 3 is located at the intersection of Jacobs & Adams Streets. It is an informal holding, with boarding and alighting area that has no supporting infrastructure or passenger amenities. Four routes operate from this site:

- Site 3- Klapmuts (Shoprite) – an internal route
- Site 3 – Shoprite Paarl
- Site 3- Stellenbosch
- Site 3- Cape Town

Table 19, summarises the survey period minibus-taxi operational information for Site 3 (Jacobs & Adams Streets).

Table 19: Minibus-taxi Site 3 operations survey summary

Site	Route Name	Period	No. of Departures	Service Capacity	No. of Pax	% Utilisation	Cycle time (min)
Site 3	Klapmuts(Shoprite)	06:00-19:00	17	255	38	15	10
Site 3	Paarl	0600-19:00	20	300	69	23	40
Site 3	Stellenbosch	06:00-19:00	1	15	0	0	60
Site 3	Stellenbosch	06:00-19:00	1	15	3	20	120
Total				585	110		

Table 20, summarise the morning and evening peak hour passenger demand periods, for minibus-taxi site 3.

Table 20: Minibus-taxi Site 3- AM&PM Peak Hour Passenger Demands

Peak Period	Time	Number of Passengers
AM-Peak Hour	10:00	25
PM-Peak Hour	16:00	17

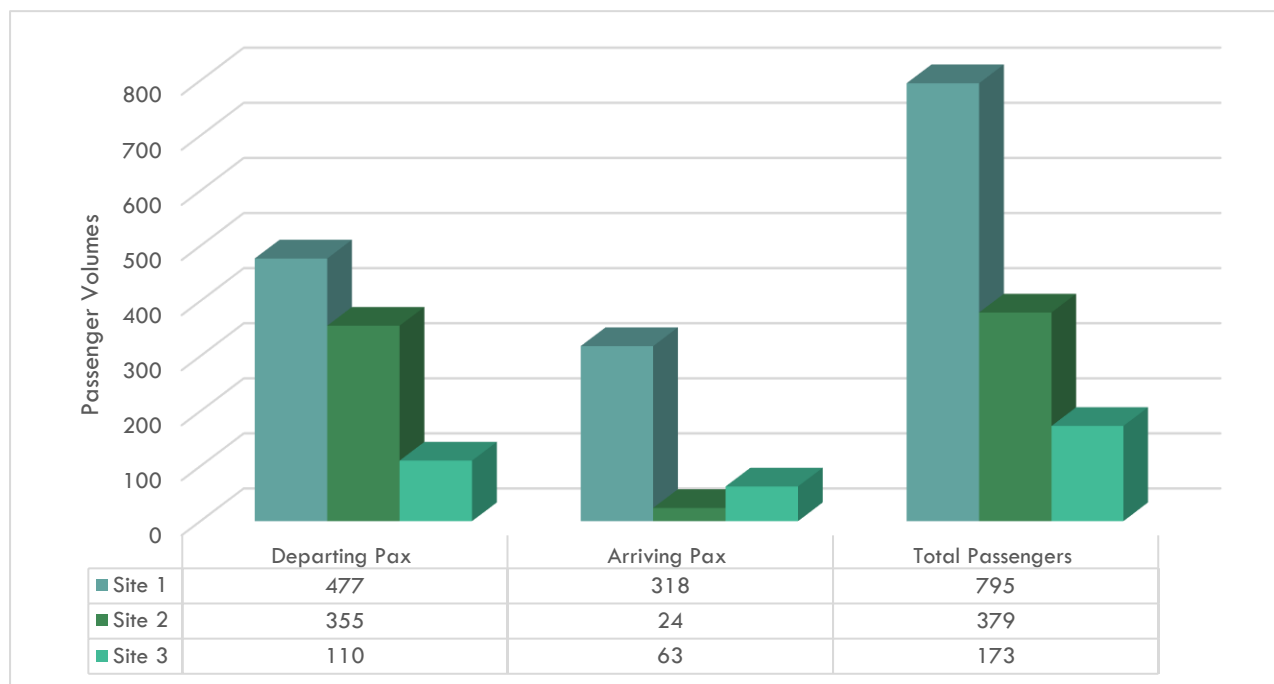
5.2.4.5.4 Comparison Analysis of Existing Minibus-taxi Sites

Figure 33 below, illustrates the surveyed weekday passenger volumes of each of the mini- bus taxi sites in Klapmuts. Site 1 has the highest commuter demand, with total weekday surveyed passenger volumes of approximately 795 commuters. Site 1's passenger demand is approximately twice that of Site 2 (379- Total Passengers), and more or less four times that of Site 3 (173- Total Passengers).

The most frequently travelled route that operates from Site 1 is the Klapmuts 'internal' route that transports passengers between Site 2 & 3 and Site 1. Commuters are attracted to Site 1 as it is situated on the premises of the Shoprite Shopping centre. Site 1 is also in walking distance (+/- 400m) of the Klapmuts train station, and it was observed that commuters use a taxi to Site 1 and then walk to use the train services. Out of all three minibus-taxi sites in Klapmuts, Site 1 is the most accessible as it's in close vicinity of the R101 and N1, and workers are often picked up by other means of transport from this site.

The morning (AM) peak hour of operation for minibus-taxi operations within Klapmuts on average takes place between 09:00-10:00. The afternoon (PM) peak hour of operation on average takes place between 16:00- 17:00.

Figure 26: Comparison of Passenger Volumes (weekday) of the various Minibus-taxi Sites



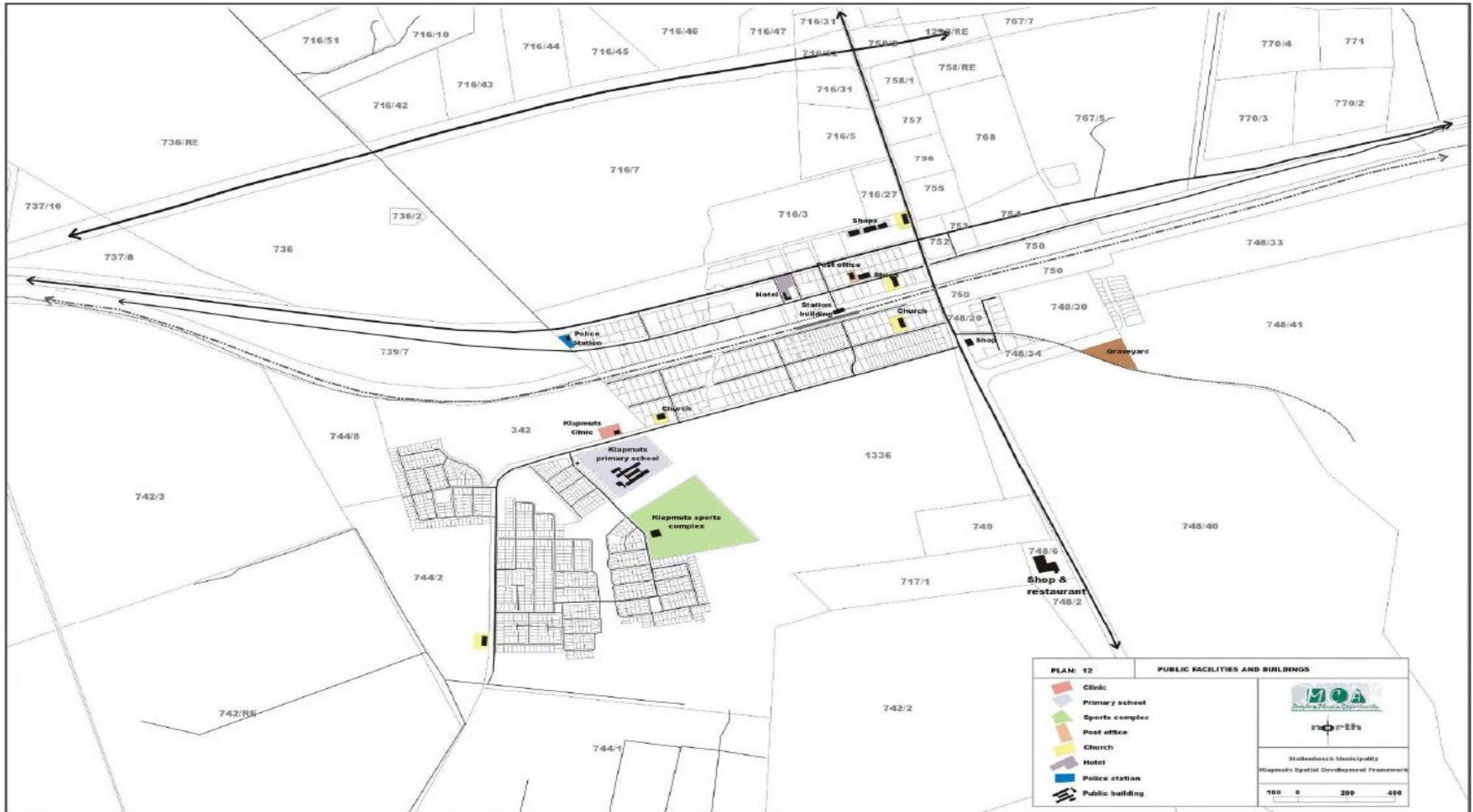
5.2.5 Public Facilities and Establishments

As of 2016, Klapmuts is currently served by the following public facilities and establishments:

- Medical Clinic
- Primary school
- Church
- Sports Complex
- Shopping Mall
- Post Office
- Hotel
- Police station

The location of the above-mentioned facilities and establishments is depicted in Figure 27.

Figure 27: Location of Public Facilities & Establishments



(Stellenbosch Municipality, 2007)

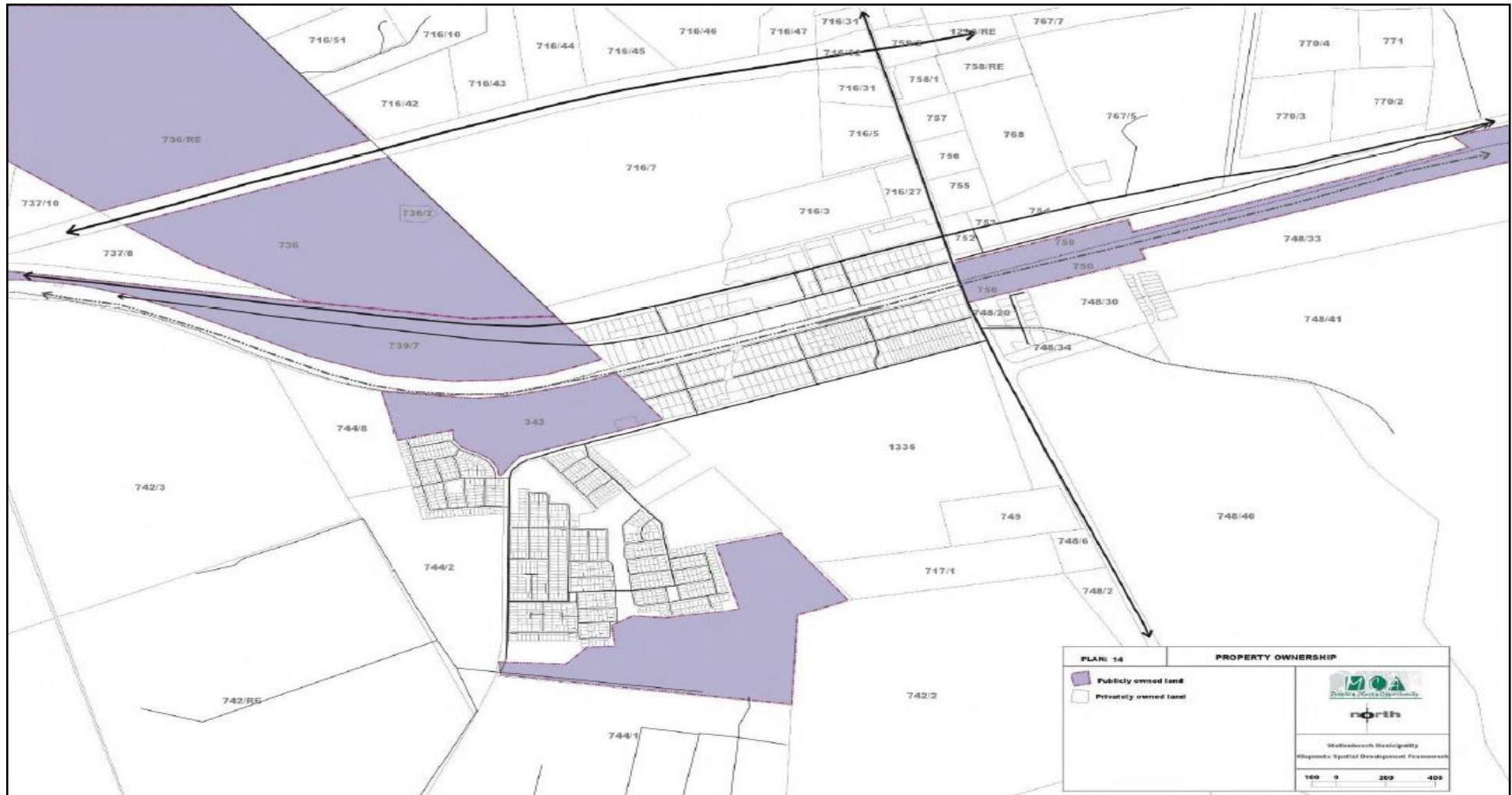
5.2.6 Property Ownership

Property ownership by the governing authority, Stellenbosch Municipality, is vital as it allows the authority to dictate economic and developmental growth in the area. (Stellenbosch Municipality, 2007)

Property ownership is of relevance to this dissertation due the governing authority of Klapmuts, Stellenbosch Municipality, preferring to site minibus-taxi facilities on municipally owned land.

As of 2016, Stellenbosch Municipality owns land parcels 342, 736/2,739/7 & 750. The location of these land parcels, as well as privately owned land in Klapmuts, is displayed in Figure 28 below.

Figure 28: Klapmuts- Property Ownership



(Stellenbosch Municipality, 2007)

5.2.7 Future Development

5.2.7.1 Introduction

The Klapmuts Growth Model was developed to inform the development and finalisation of the Klapmuts Roads Master Plan of 2008. It was founded on the ultimate development intentions reflected in the Klapmuts SDF with phased development over time. (BKS Group, 2008)

The initial Growth model identified three broad time frames, 2012, 2017 and 2027 for vehicular traffic prediction. Vehicular traffic projections and forecasts were based upon NDoT trip generation guidelines.

5.2.7.2 Spatial Development Status

Limited development has occurred within Klapmuts since the 2008 Roads Master Plan study, other than the introduction of 740 council houses. Table 21, indicates the development status that would inform the Growth Model and the development intentions going forward.

Table 21: Klapmuts Land Use and Development Extent

Period	Residential Units	Commercial (m^2 GLA)	Industrial (m^2 GLA)	Total (Industrial & Commercial GLA m^2)
2017	2381	220270	123709	343979
2027	8407	263769	275584	539353

(BKS Group, 2008)

5.2.7.3 Land Uses

Three major land uses have been proposed to support the development of the Klapmuts node. They are residential, commercial and industrial. The residential component has been further divided into four residential types or categories. These are subsidy / social housing, low density (1-9 units/ha), medium to low density (11 to 24 units/ha), medium density (25 to 49 units / ha) and high density (50 to 150 units). The original growth model assumed that development associated with these land uses would be phased over three time periods: 5, 10 and 20 years. Table 20, illustrates the development that has occurred since 2008 and what the currently envisaged development roll-out is for 2017. (BKS Group, 2008)

Figure 29 extracted from the Klapmuts Roads Master Plan documents, depicts the precincts that have been identified for development in the broader Klapmuts area for roads master planning purposes. Two development scenarios were articulated with Scenario 1 (spatial precincts A – Q) effectively to the south of the N1 and Scenario 2 (spatial precincts R & S) to the north of the N1. For the purpose of this study, only Scenario 1 development will be reviewed.

5.2.7.4 Trip Generation

The estimation of trips, both vehicular and pedestrian, for the identified developmental precincts in Klapmuts are based on standard trip generation rates stipulated in the Committee of Transport Officials (COTO) TMH17 manual. The vehicular and person trip generation rates applied in this document are stated in Table 22 below.

Table 22: Trip Generation Rates

Land use	Vehicle Trip Generation Rates	Person Trip Generation Rates*
Residential <i>Subsidy / Social Housing</i>	0.5 trips / unit	94.2 trips / 1000 residents
Residential <i>Low Density (1 – 9 units/ha)</i>	1.5 trips / unit	94.2 trips / 1000 residents
Residential <i>Medium – Low Density (11-24 units / ha)</i>	1.0 trips / unit	94.2 trips / 1000 residents
Residential <i>Medium Density (25-49 units / ha)</i>	1.0 trips / unit	94.2 trips / 1000 residents
Residential <i>High Density (50 – 150 units / ha)</i>	1.0 trips / unit	94.2 trips / 1000 residents
Industrial	0.6 trips / 100m ² GLA	0.6 trips / employee
Commercial	2.1 trips / 100m ² GLA	0.6 trips / employee

(Committee of Transport Officials (COTO), 2013)

5.2.7.5 Trip Generation Projections

Table 23, provides a summary of the revised (inclusive of council housing program) Klapmuts Growth Model for vehicular trips based upon the revised development profile summarised in Table 21, and the vehicle trip generation rates summarised in Table 22.

Table 23: Vehicle Trip Generation (2017 & 2027)

Precinct		2017				10-year period (2027)			
		Com	Ind	Res	Tot	Com	Ind	Res	Tot
A	ERF 1336, FARM 749 (Francois Klomp)	1471		1193	2664	1471		1258	2729
B	Portion of Farm 742& Portion of Farm 748	81		275	356	81		275	356
C	Council Subsidy Scheme	10		268	278	10		268	278
D	Klapmuts Hills Residential Development	184		605	789	414			1783
E	Farm 744/2			495	495	495			495
F	Stellenbosch Country & Wine Estate	12		461	312	12		761	773
G	Klapmuts Infill (Por 8 of Farm 744 & Erf 342)			45	45			170	170
H	Klapmuts Infill (Remainder of Farm 739)		158	81	239		316	81	397
I	Portion 8 of Farm 737						191		191
J	Die Werf	307	38		345	614	76	53	743
K	Livingstone Louw, South of the N1 (Farm 716/7)	1591	141	408	2140	1591	508	680	2779
L	Klapmuts Infill (Remainder of Farm 736)					518	563	186	1267
M	Klapmuts Infill (Portion 5, Farm 716 & Portion 31, Farm 7116)	242		58	300	484		58	542
N	Hooper (Portion 36, Farm 748, Bronkhorst)	863		248	1111	863		248	1111
O	Merkel (Portion 2, Farm 742 & Portion 2, Farm 748)							1031	1031
P	Anura (Portion 41, Farm 748 & Portion 2, Farm 784)					23		194	217
Q	Klapmuts Infill (Portion 1, Farm 744)							722	722

(BKS Group, 2008)

The vehicle trip generation per identified precinct for 2017 is illustrated in Figure 30, and that of the 10-year prediction (2027) in Figure 31.

Figure 30: Vehicle Trip Generation per Precinct (2017)

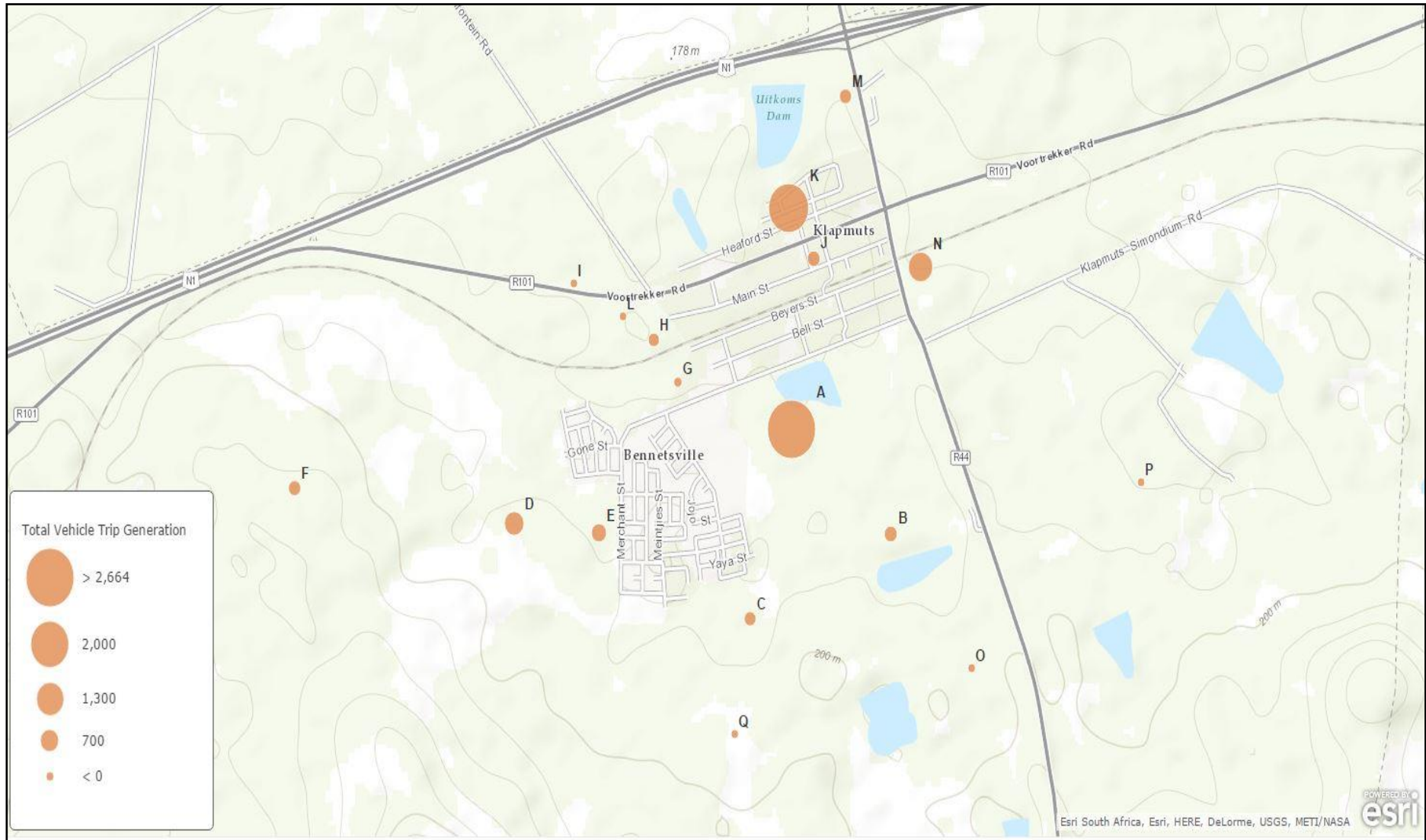
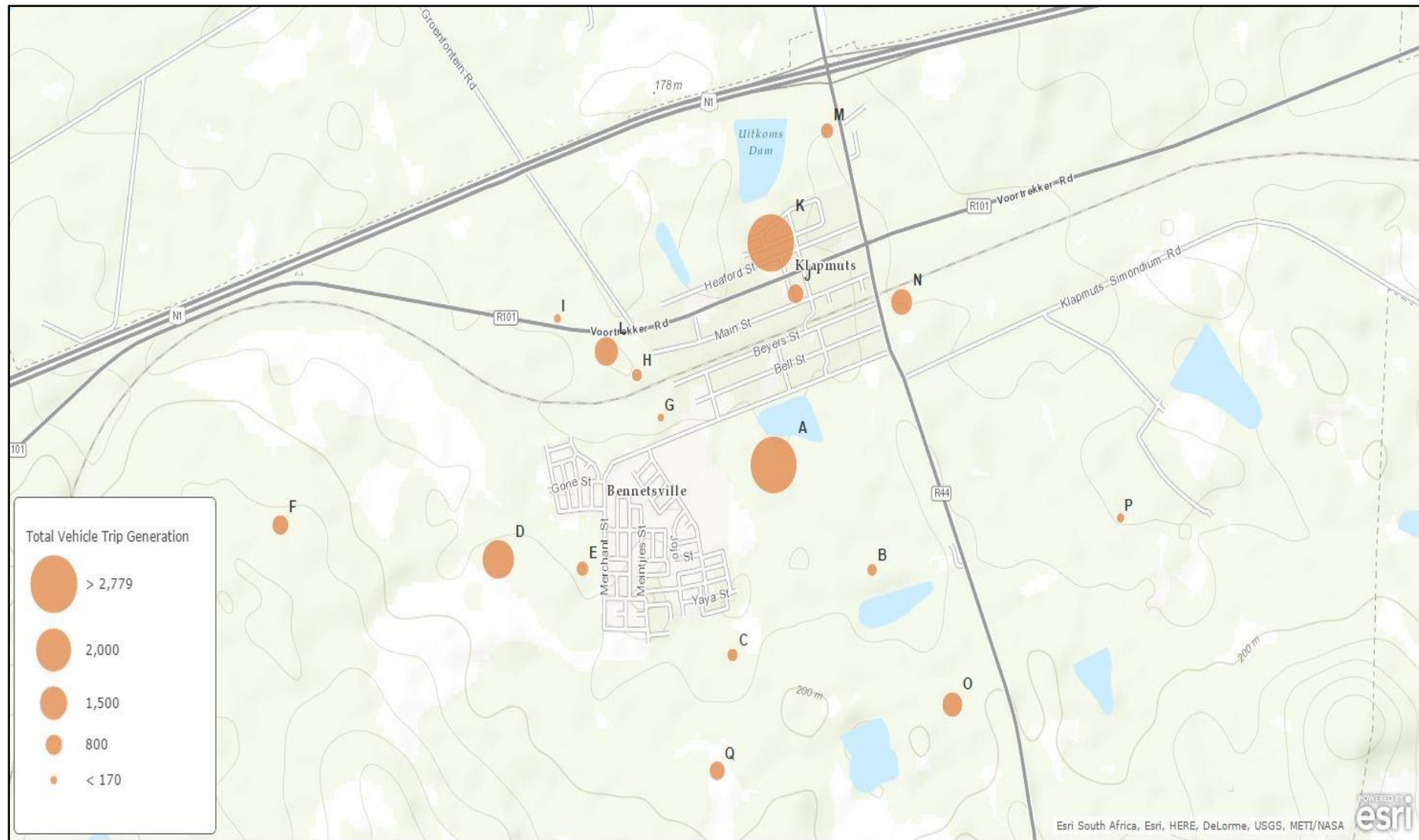


Figure 31: Vehicle Trip Generation per Precinct (2027)



5.2.7.6 Person Trip Projections

The minibus-taxi and pedestrian survey conducted by Aurecon, Cape Town have indicated the level of current public transport and pedestrian activity that occurs within Klapmuts. In order to establish what future demands are for public transport and NMT movements an understanding of the production of person trips per identified precinct is required. Based on the development extent of Klapmuts as stipulated in Table 21, and the person trip rates in Table 22, the person trips associated with each identified precinct is estimated for both 2017 and 2027, which is illustrated in Table 24 below.

Table 24: Person Trips per Precinct (2017 & 2027)

Precinct		2017	10-year Period (2027)
		Total Person Trips	Total Person Trips
A	ERF 1336, FARM 749	429	514
B	Portion of Farm 742& Portion of Farm 748	85	85
C	Council Subsidy Scheme	181	266
D	Klapmuts Hills Residential Development	262	547
E	Farm 744/2	152	152
F	Stellenbosch Country & Wine Estate	106	173
G	Klapmuts Infill (Por 8 of Farm 744 & Erf 342)	31	115
H	Klapmuts Infill (Remainder of Farm 739)	25	25
I	Portion 8 of Farm 737	0	0
J	Die Werf	17	17
K	Livingstone Louw, South of the N1 (Farm 716/7)	209	209
L	Klapmuts Infill (Remainder of Farm 736)	0	57
M	Klapmuts Infill (Portion 5, Farm 716 & Portion 31, Farm 7116)	18	18
N	Hooper (Portion 36, Farm 748, Bronkhorst)	76	76
O	Merkel (Portion 2, Farm 742 & Portion 2, Farm 748)	0	317
P	Anura (Portion 41, Farm 748 & Portion 2, Farm 784)	0	52
Q	Klapmuts Infill (Portion 1, Farm 744)	0	222

(BKS Group, 2008)

The person trip generation per identified precinct for 2017 is illustrated in Figure 32, and that of the 10-year prediction (2027) in Figure 33.

Figure 32: Person Trip Generation per Precinct (2017)

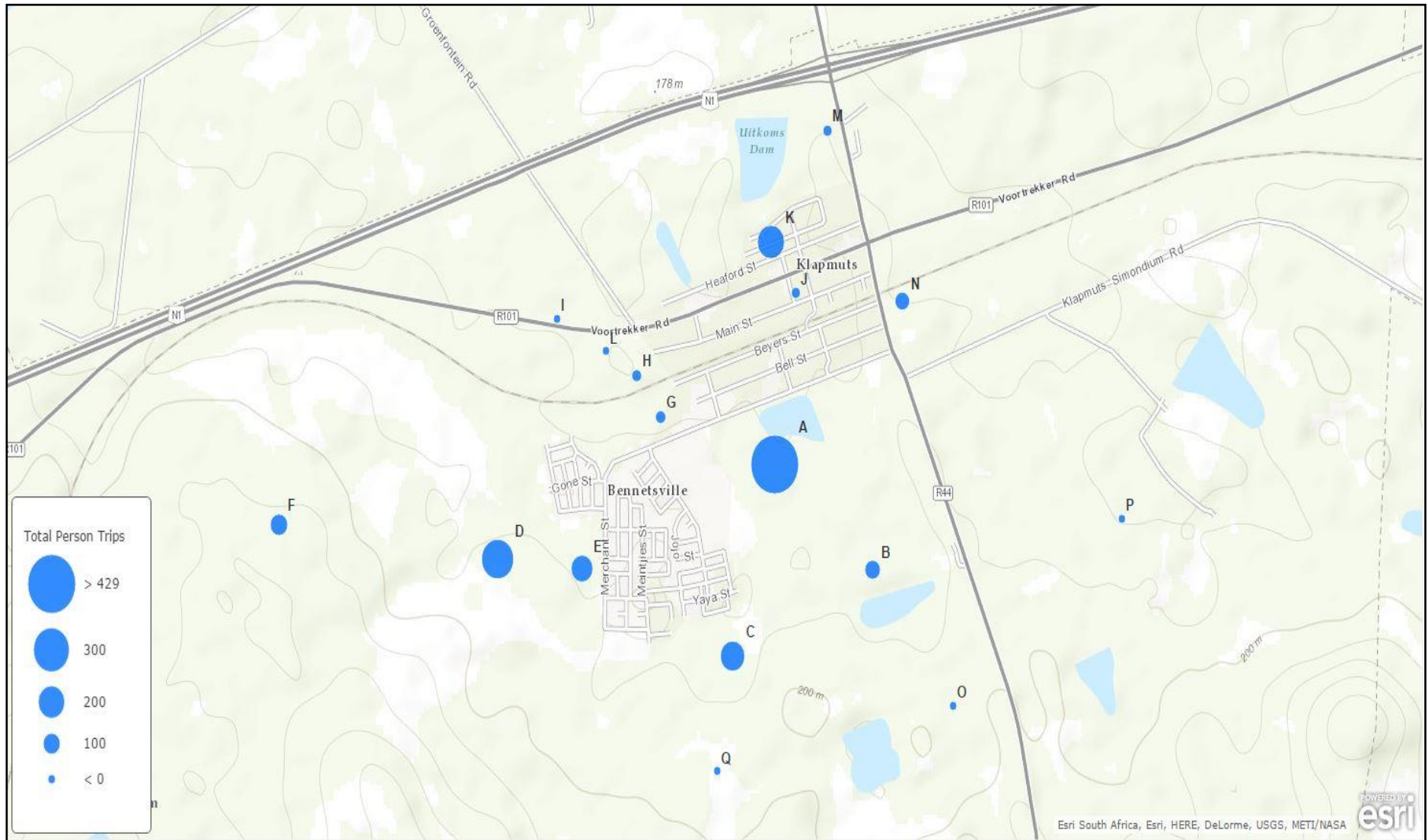
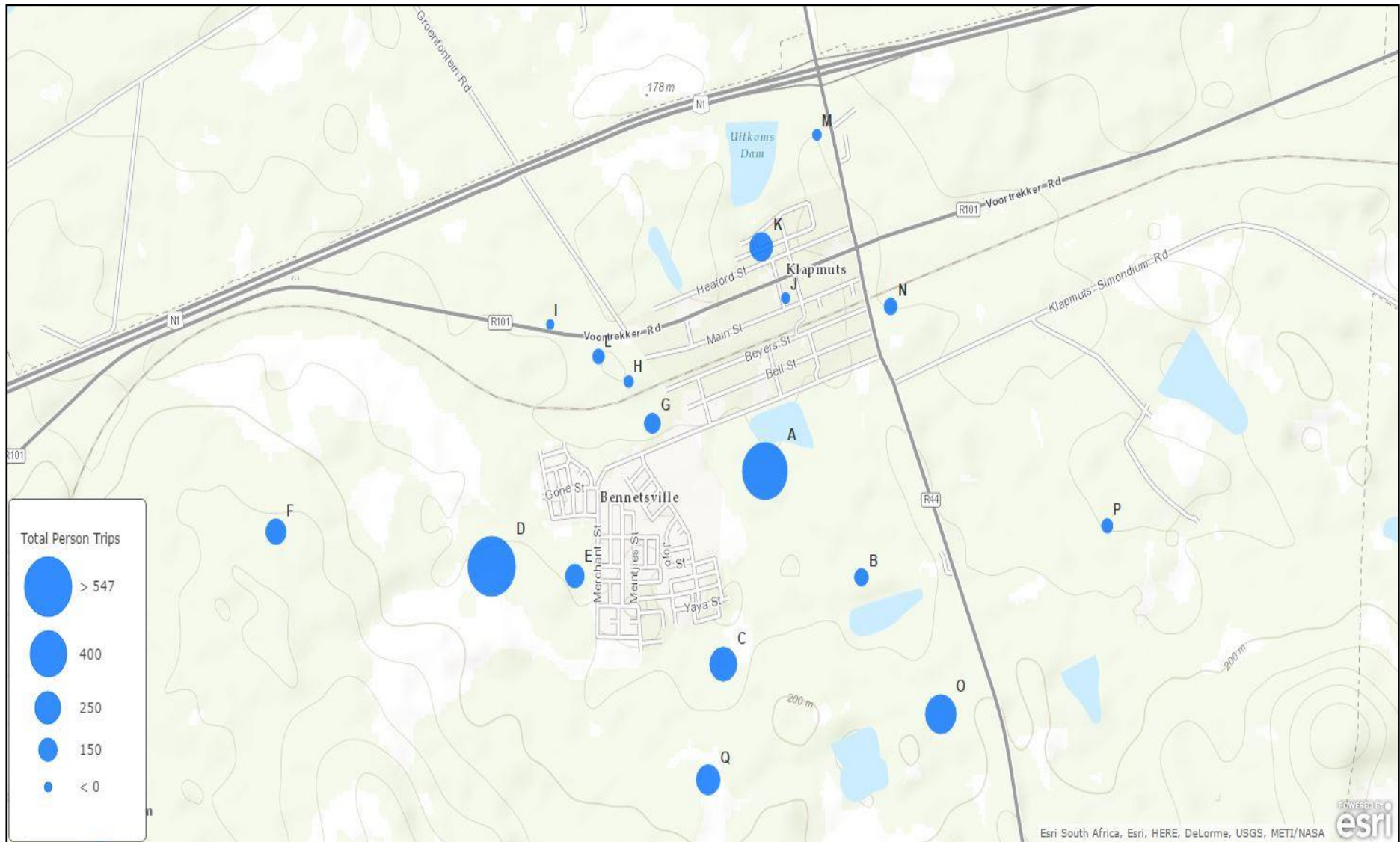


Figure 33: Person Trips per Precinct (2027)



5.2.7.6.1 Modal Split

In order to ascertain what percentage of person trips are associated with public transport, the following modal split assumption was assumed for Klapmuts. As mentioned in previous sections, Klapmuts is termed as a low-to-middle income area, this the majority of the population is captive to public transport and NMT use. The Stellenbosch Comprehensive integrated Transport Plan (CiTP) of 2012 defines the following modal splits, Table 25, given the average income group of the area.

Table 25: Transport Modal Split per Income Group

Income Group	Trips between 0km and 15km	Trips \geq 15km
High Income	100% private	100% private
Upper Middle Income	100% private	100% private
Lower Middle Income	50% private	50% private
Lower Income	20% private	20% private

(Vela VKE Engineers, 2012)

Founded on Table 25, and the economic status of Klapmuts, a modal split of 50% private and 50% public transport is assumed for trips ranging between 0km and 15km, as well as trips greater than 15km.

As mentioned previously, the majority of public trips originating from Klapmuts are conducted by means of the rail service offered. Therefore, based on the minibus-taxi and pedestrian surveys, as well the monthly passenger rail volumes from Klapmuts, a modal split of 60 % rail, 30% road based public transport, and 10 % NMT will be assumed for further analysis in this document. The person trips associated with each of the modes of transport for the identified precincts for both the 2017 and 2027 scenario is illustrated in Table 26 below.

Table 26: Person Trips associated with various modes of transport per Identified Precinct (2017 &2027)

Precinct	Person Trips (2017)			Person Trips (2027)			
	Rail	Road	NMT	Rail	Road	NMT	
A	ERF 1336, FARM 749	129	64	21	154	77	26
B	Portion of Farm 742& Portion of Farm 748	26	13	4	26	13	4
C	Council Subsidy Scheme	54	27	13	80	40	13
D	Klapmuts Hills Residential Development	79	39	27	164	82	27
E	Farm 744/2	46	23	8	46	23	8
F	Stellenbosch Country & Wine Estate	32	16	9	52	26	9
G	Klapmuts Infill (Por 8 of Farm 744 & Erf 342)	9	5	6	35	17	6
H	Klapmuts Infill (Remainder of Farm 739)	8	4	1	8	4	1
I	Portion 8 of Farm 737	0	0	0	0	0	0
J	Die Werf	5	3	1	5	3	1
K	Livingstone Louw, South of the N1 (Farm 716/7)	63	31	10	63	31	10
L	Klapmuts Infill (Remainder of Farm 736)	0	0	3	17	9	3
M	Klapmuts Infill (Portion 5, Farm 716 & Portion 31, Farm 7116)	5	3	1	5	3	1
N	Hooper (Portion 36, Farm 748, Bronkhorst)	23	11	4	23	11	4
O	Merkel (Portion 2, Farm 742 & Portion 2, Farm 748)	0	0	16	95	48	16
P	Anura (Portion 41, Farm 748 & Portion 2, Farm 784)	0	0	3	16	8	3
Q	Klapmuts Infill (Portion 1, Farm 744)	0	0	11	67	33	11

5.3 Conclusion

The aim of this chapter was to establish the status quo of Klapmuts in terms of regional and local movement, non-motorised transport, public transport service provision, public facilities and establishments, property ownership, as well as future development. An understanding of the above-mentioned will form quantitative and qualitative inputs for the warranting and siting practice developed in Chapter 4 that is to be applied to the Klapmuts scenario in Chapter 6 of this document.

6 Practical Application of Public Transport Warranting and Siting Practice

6.1 Introduction

The aim of this chapter is to apply the warranting and siting practice for minibus-taxi terminals and ranks developed in Chapter 4 of this document to the Klapmuts scenario. The application of this warranting and siting practice is to inform the decision on what type of facilities are required in order to support the minibus-taxi service, and where to site these facilities.

6.2 Step 1: Identification of Needs

As alluded to in previous chapters, minibus-taxi services are provided in Klapmuts, however, the needs of both commuters and operators are not catered for due to minibus-taxi infrastructure being relatively 'informal' in nature.

6.2.1 Factors to Identify Needs

To ascertain the needs of the various stakeholders, including passengers, operators and the community as a whole, the questions presented in Chapter 4 of this document will be addressed.

6.2.1.1 *Passenger Needs*

Availability of Facility:

As illustrated in Figure 5, the minibus-taxi site at the Shoprite shopping centre is the only site that has formalised infrastructure. The other existing sites, both Merchant Street & Adams Street and Jacobs Street & Adams Street, do not have any facilities to accommodate passengers. Based on the above-mentioned, there is a need to provide facilities that cater for the needs of both passengers and operators.

Walking Distance:

Due to the area of Klapmuts being relatively small, the existing minibus-taxi sites catchment area, as depicted in Figure 18, have full coverage of the area. Consequently, commuters in Klapmuts do not have to walk further than 400m-500m (5-minute walk) to gain access to minibus-taxi services. Minibus-taxi sites and other establishments in Klapmuts are within walking distance, however as mentioned in Chapter 5 of this document, NMT linkages to these areas are inadequate, and are in urgent need of upgrade.

Security:

At present, passenger safety is a concern in Klapmuts, as only one minibus-taxi site, Shoprite shopping centre, has the presence of security features such as street lighting and security personal.

As mentioned above, there is limited provision of NMT infrastructure linking areas of residence with major establishments and services in Klapmuts, thus making walking to minibus-taxi facilities unsafe.

As a result of the above-mentioned, security measures need to be implemented to ensure the safety of the Klapmuts community whilst commuting between areas of residence, major establishments and services.

Ancillary Facilities:

As depicted in Figure 5, this is limited as no passenger orientated ancillary facilities are provided at the existing minibus-taxi sites. Due to this, when facilities are implemented, they are to be accompanied with ancillary facilities.

Comfort:

At present, none of the existing minibus-taxi sites have shelters or seats. However, toilet facilities are provided at the Shoprite shopping centre minibus-taxi site. Therefore, facilities that proposed are to encompass design features that improve the commuter comfort.

Convenience:

Existing minibus-taxi sites, although informal in nature and lacking any form of formalised infrastructure, are located in close proximity to major trip generators and attractors. Existing minibus-taxi site 1, Shoprite shopping centre, is in the immediate vicinity of both commercial activities, as well as approximately 320m from the Klapmuts train station. As illustrated in Figure 27, both minibus-taxi site 2 and 3 are in close proximity to the Klapmuts Clinic, Klapmuts primary school, and the Klapmuts sports complex.

Other Modes of Transport:

Although existing minibus-taxi site 2 and 3 are within walking distance of the Klapmuts train station precinct, North-south pedestrian movement is restricted due to the presence of the railway line, with the presence of only two main crossing points, namely:

- The R44 bridge crossing, and
- Pedestrian crossing using the Klapmuts railway station street-to-street bridge

Existing minibus-taxi site 1, as mentioned above, is in walking distance of the Klapmuts train station precinct. It was observed that there is a strong pedestrian desire line between both minibus-taxi site 1 and the station, however, there is no provision of pedestrian orientated infrastructure linking

these two facilities. As result of the spatial layout of facilities relative to each other and other modes of transports, seamless transfer of passengers between transport modes is constrained. It is therefore proposed that linkages between other modes of transport are improved in order to promote the seamless transfer of passengers between modes.

6.2.1.2 Operator Needs

Availability of Facility:

As previously mentioned, other than minibus-taxi site 1, there is no provision of formalised infrastructure to cater for the needs of operators. Based on the status quo analysis of Klapmuts, there is a need to provide formalised transport infrastructure, more specifically mini-bus taxi facilities.

Passenger Attraction:

Existing minibus-taxi sites are conveniently located in the immediate vicinity of major establishments, however, lack the desired infrastructure to be aesthetically pleasing and convenient for passengers, thus reducing passenger attraction. Consequently, it is suggested that the facilities that are ultimately proposed are designed in a manner that is aesthetically pleasing to potential commuters, this encouraging the use of the facilities.

Capacity:

At present, there is no formalised minibus-taxi infrastructure at both minibus-taxi 2 and 3. At both these sites, passengers are picked up and dropped off on a gravel patch. At minibus-taxi site 1, there are three dedicated minibus-taxi embayments, and observations and minibus-taxi surveys conclude that there is sufficient capacity to accommodate operators. Therefore, formalised mini-bus taxi facilities need to be provided in order to cater for the passenger demand associated with min-bus taxi site 2 and 3.

Safety:

Minibus-taxi site 1 is the only existing site that provides safety features, including street lighting and security personnel. The other two existing minibus-taxi sites, as mentioned above, are informal sites and lack any form of infrastructure. From a traffic safety perspective, all existing minibus-taxi sites are situated off-street, thus reducing potential perilous conflict with other vehicles. Based on site observations, there is a need for the provision of safety features such as street lighting and security personal at proposed mini-bus taxi sites.

Ancillary facilities:

As depicted in, Figure 5, this is limited as no passenger orientated ancillary facilities are provided at the existing minibus-taxi sites. As a result of this, when facilities are implemented, they are to be accompanied with ancillary facilities.

Accessibility:

Mini bus taxi site 1 is situated at the Shoprite shopping centre. Access to this site is obtained at the intersection of the Shoprite shopping entrance and Old Paarl Road (R101). Minibus-taxi site 2, is situated on the gravel patch at the intersection of Merchant Street and Adams Street. A driveway is provided along Merchant Street to access minibus-taxi site 2. Minibus-taxi site 3 is located on the gravel patch to the North-east of Jacobs Street and to the South-west of Adams Street. There is no provision of a driveway to access the site, and operators have to mount the curb to get to the site. Therefore, if a mini-bus taxi site is proposed at the same location as mini-bus taxi site 3, adequate access to the site in the form of a driveway needs to be provided in order for mini-bus taxi to access the surrounding road network with relative ease.

Control of service:

At present, there is no minibus-taxi facilities manager to control and monitor services in the area.

6.2.1.3 Community**Environmental Impact:**

Minibus-taxi site 2 and 3 are situated on gravel patches. These gravel patches are a result of continuous vehicular and pedestrian movement, thus eroding the natural vegetation associated with the site. To prevent further damage to the surrounding fauna and flora, it is proposed that cognisance of the surrounding environment be taken into deliberation when deciding on the locality of potential sites for the construction of mini-bus taxi facilities.

Traffic Congestion:

It has been observed that minibus-taxis often stop in Merchant Street to pick up and drop off passengers, thus blocking the movement of traffic. In some instances, minibus-taxis stop on the pedestrian sidewalk running parallel to Merchant Street and hinder the movement of pedestrians. Based on this observation, there is a need to provide a formalised mini-bus taxi facility along Merchant Street, this preventing the informal nature of mini-bus taxi operations and improving the flow of traffic.

Social Issues:

Despite there being a lack of formalised minibus-taxi infrastructure, minibus-taxi services still operate between Klapmuts and other economic and recreational hubs, therefore not limiting the Klapmuts community to job opportunities and other social activities.

6.3 Step 2: Goals and Objectives

The purpose of this warranting and siting process is to implement minibus-taxi facilities that cater for current and envisaged passenger demand within the Klapmuts sub-area, whilst still aligning with statutory requirements, guidelines and international good practices evaluated in Chapter 3 of this document.

As alluded to in previous chapters, South Africa's economy is under immense pressure and therefore the most advantageous investment alternatives need to be selected for implementation. Realistically, resources are limited, but Stellenbosch Municipality, the governing authority of Klapmuts, identifies public transport service provision as a 'high need' and therefore significantly values accessibility and mobility over monetary cost.

Due to the envisaged future growth of Klapmuts, the various needs identified in Step 1, as well as the Integrated Development Plan (IDP) for the Stellenbosch Municipality supporting these needs, it has been established that there is a necessity to provide minibus-taxi facilities that are flexible enough to accommodate the current minibus-taxi passenger demand, as well as envisaged passenger demand that materialises in line with the growth envisaged in the Klapmuts Growth Model. Therefore, the goal statement for the practical application of mini-bus taxi warranting and siting practice to the Klapmuts scenario is as follows: To propose recommendations on the type, number and location of mini-bus taxi facilities to cater for the needs, both present and future, of all relevant stakeholders.

6.4 Step 3: Selecting a Type of Facility

To ascertain what type of facilities are warranted in order to meet the needs of all relevant stakeholders, an analysis of the status quo is required. This step will follow the procedures outlined in Chapter 4, which involved the process required to determine the type of facility, as either a minibus-taxi rank or terminal.

As outlined in section 4.2.3.4, the NDoT guideline for the design of mini/midibus-taxi facilities propose that the following procedure be followed when deciding on whether a minibus-taxi terminal or rank should be implemented. This process is then applied in the sections to follow.

- I. Establish minibus-taxi operational characteristics, including routes operated and numbers of minibus-taxis envisaged to make use of the facility;
- II. Based on mini/midibus-taxi operational characteristics established in step 1, situate mini/midi-bus taxi ranks at the end or start of a singular route and mini/midi-bus taxi terminals at the end or start of multiple routes;
- III. Establish the size of the rank or terminal based on the expected number of mini/midibus-taxi envisaged to make use of this facility;
- IV. Establish whether the rank or terminal can be situated on-street or off-street based on road hierarchy, and what effect the facilities traffic will have on the surrounding road network;
- V. Consider the size of the area that the rank or terminal is expected to serve, and the availability of land to site the facility;
- VI. Consideration of the costs associated with each type of facility. (Department of Transport, 2007)

The first step, procedure (I) above, applies to the existing minibus-taxi sites, 1, 2, and 3 and their current operational characteristics as analysed in Table 27, Table 28 and Table 29 below. The operational characteristics will be used in order to derive the routes operated and numbers of minibus-taxis envisaged to make use of the facility.

Table 27: Existing Minibus-taxi site 1


Existing Situation- Minibus-taxi Site 1	
Location: Shoprite off Old Paarl Road (R101)	Operational Information
	<p>Average Daily Passenger Demand: 795</p> <p>Average Daily Peak Hour Volumes (AM/PM): 119/120</p> <p>Number of Routes Served: 4</p> <p>Estimated number of minibus-taxis making use of the facility: 6</p>

Table 28: Existing Minibus-taxi site 2



Existing Situation- Minibus-taxi Site 2	
Location: Merchant Street & Adams Street	Operational Information
	<p>Average Daily Passenger Demand: 379</p> <p>Average Daily Peak Hour Volumes (AM/PM): 67/30</p> <p>Number of Routes Served: 4</p> <p>Estimated number of minibus-taxis making use of the facility: 6</p>

Table 29: Existing Minibus-taxi site 3

Existing Situation- Minibus-taxi Site 3	
Location: Gravel patch North of Jacobs Street	Operational Information
	<p>Average Daily Passenger Demand: 173</p> <p>Average Daily Peak Hour Volumes (AM/PM): 25/17</p> <p>Number of Routes Served: 4</p> <p>Estimated number of minibus-taxis making use of the facility: 3</p>

6.4.1 Determining the type of facility for the existing sites

Based on the status quo analysis, the following facilities are proposed for the existing minibus-taxi sites as per step (II) in the outlined procedure.

6.4.1.1 Existing Minibus-taxi Site 1

Of all the existing minibus-taxi sites in Klapmuts, minibus-taxi site 1 attracts the greatest demand of passengers. On average, for a given weekday, minibus-taxi site attracts 795 daily passengers. As stated by Chetty & Phayane (2012), if a site has a daily passenger demand in excess of 500, this triggers the primary warrant for the implementation of a facility.

Based on the passenger demand associated with the site and the amount of destinations it serves, it can be seen as a possible site for the implementation of a minibus-taxi terminal.

6.4.1.2 Existing Minibus-taxi Site 2

Existing minibus-taxi site 2, on average, for a given weekday, has daily passenger demand of 379. Passenger demand for this site is less than 500 passengers per day, thus not triggering the primary warrant for a facility however a facility can be implemented at this site based on its ability to improve the existing situation.

Based on the passenger demand associated with the site and the amount of destinations it serves, it can be seen as a possible site for the implementation of a minibus-taxi terminal.

6.4.1.3 Existing Minibus-taxi Site 3

This minibus-taxi site generates the least amount of passenger demand, with approximately 173 passengers making use of this facility on a daily basis. Due to the relatively low demand of passengers, this site does not comply with the primary warrant for a facility, however, a facility can be implemented at this site as it has the means to improve the existing situation.

Due to this site having low passenger demands relative to other sites, and it predominately serving long distance routes, this site is better suited for the implementation of a minibus-taxi rank

6.4.2 Establishing the size of the rank or terminal

Based on the status quo analysis and the warranting of either a rank or terminal, the following sizes are proposed, as illustrated in Table 30, for the existing minibus-taxi sites as per step (III) in the outlined procedure.

Table 30: Establishing the size of the proposed rank or terminal

Existing Minibus-taxi Site	Type of Facility Proposed	Expected Operational Characteristics	Number of Routes Served	Estimated number of minibus-taxis making use of the facility	Capacity Required	
					Loading Lanes ³	Berths ⁴
Existing Minibus-taxi Site 1	Minibus-taxi Terminal	Common end of multiple routes. Facility where passengers can board and alight. Holding area for minibus-taxis.	4	6	4	4
Existing Minibus-taxi Site 2	Minibus-taxi Terminal	Common end of multiple routes. Facility where passengers can board and alight. Holding area for minibus-taxis.	4	6	4	4
Existing Minibus-taxi Site 3	Minibus-taxi Rank	Passengers can board and alight. Minibus-taxis can hold	Low demand	3	N/A	1

³ The number of loading lanes required is dependent on the number of routes served by the facility, the number of minibus-taxis using the facility and the type of facility chosen. Generally, each destination is served by an individual loading lane, unless there is insufficient space to supply the desired number of berths. In this instance, loading lanes for the same destination can be placed alongside one another. (Department of Transport, 2007)

⁴ In a smaller urban area, where route distances are relatively shorter, the NDoT proposes that one berth is supplied for every two vehicles that are envisioned to make use of the facility.

6.4.3 Determining whether the existing sites are on-street or off-street

Road hierarchy plays a pivotal role when deciding on what type facility to implement. On primary roads, where the traffic volumes and operating speeds are relatively high in comparison to secondary roads, traffic friction is to be avoided. To mitigate this potential 'friction', off-street facilities are to be provided. On secondary roads, where traffic volumes and operating speeds allow for a certain degree of 'friction', on-street facilities can be implemented. (Department of Transport, 2007)

As per step (IV) in the NDoT outlined procedures, the existing sites which encompass both ranks and terminals can be defined as either being on-street or off-street, as illustrated in Table 31 below.

Table 31: Determining whether the existing sites are on-street or off-street

Existing Minibus-taxi Site	Type of Facility Proposed	Road hierarchy in immediate vicinity of proposed sites ⁵	Proposed as on-street or off-street
Existing Minibus-taxi Site 1	Minibus-taxi Terminal	R44 – Class 2 Road R101 – Class 2 Road	Off-street
Existing Minibus-taxi Site 2	Minibus-taxi Terminal	Merchant St – Class 4, classified as high activity street	Off-street
Existing Minibus-taxi Site 3	Minibus-taxi Rank	Jacobs St – Class 5	On-street

⁵ As defined by the road hierarchy classification (Stellenbosch Municipality, 2007, p. 23)

6.4.4 Considerations for the size of site and availability of land

The following step (V) stipulated in the procedural guidelines for selecting a type of facility considers the size of the site and the availability of the land for acquisition.

Table 32: Size of proposed facility and availability of land

Existing Minibus-taxi Site	Type of proposed facility	Size of proposed facility ⁶	Availability of land for acquisition ⁷
Existing Minibus-taxi Site 1	Minibus-taxi Terminal	900m ²	Privately owned by Nine Cubed Property – agreement for expansion of existing facility in consultation with Stellenbosch municipality
Existing Minibus-taxi Site 2	Minibus-taxi Terminal	1076m ²	Stellenbosch municipality
Existing Minibus-taxi Site 3	Minibus-taxi Rank	66.12m ²	Stellenbosch municipality

6.4.5 Cost considerations associated with proposed facilities

Considering all of the above, the final step (VI) in the procedure for selecting a type of facility are those costs associated with implementing the proposed facilities for the existing scenario. These are the monetary costs, expressed in Rands (R), for designing and constructing a minibus-taxi facility. For purposes of this dissertation, the costs for design and construction are assumed based on current engineering rates within South Africa, as experienced within the industry. This assumes construction costs of approximately R1200 per square metre, and design costs as ten percent (10%) of the total construction cost. These are further outlined in Table 33 below.

⁶ Size acquired as per the minimum dimensions stipulated in section 4.2.3.1.3 Layout Options

⁷ As per section 5.2.6 Property Ownership, land areas were defined based on public or private ownership

Table 33: Costs associated with proposed facilities

Existing Minibus-taxi Site	Type of proposed facility	Size of proposed facility ⁸	Estimated Cost (in Rands)	Design Cost (in Rands)	Estimated Design & Construction Costs (in Rands)
Existing Minibus-taxi Site 1	Minibus-taxi Terminal	900m ²	1080000	108000	1,188,000.00
Existing Minibus-taxi Site 2	Minibus-taxi Terminal	1076m ²	1291200	129120	1,420,320.00
Existing Minibus-taxi Site 3	Minibus-taxi Rank	66.12m ²	79344	7934.4	87,278.40

⁸ Size acquired as per the minimum dimensions stipulated in section 4.2.3.1.3 Layout Options

6.5 Step 4A: Identifying Alternative Sites

As seen above, currently there are three minibus-taxi sites that serve the Klapmuts community. Of the three minibus-taxi sites, only Minibus-taxi site 1, located at the Shoprite shopping centre off Old Paarl Road, has formalised infrastructure.

As depicted in Step 3, it is proposed that in order to accommodate both passengers, operators and the community as a whole, the existing minibus-taxi site 1 & 2 require the implementation of a minibus-taxi terminal, and existing minibus-taxi site 3 requires the construction of a minibus-taxi rank. These existing sites, as well as the proposed facilities associated with each will, be seen as possible alternatives in the evaluation process.

Alternative locations for the existing mini-bus sites, with their respective proposed upgrades, will be elaborated on below. Locations for alternative sites are based on the location and land use considerations detailed in Chapter 4 of this dissertation and summarised in Table 34 below for ease of reference.

Table 34: Location and Land Use Considerations

Location and Land Use Considerations	
Operation	<ul style="list-style-type: none"> Existing minibus-taxi route configuration ought to be considered when identifying potential sites for the construction of a formalised facility Ranks are to be located at the start or end of routes, and it is recommended that they serve individual routes. Terminals are also located at the start or end of routes, however should have the capacity to serve more than one route
Passenger	<ul style="list-style-type: none"> Minibus-taxi facilities, particularly higher capacity facilities such as terminals and ranks, be within a 5-minute walk (400m to 500m) of employment areas, shopping centres, areas of concentrated passenger demand, and other modes of public transport modes Potential sites should be easily accessible by all users
Traffic	<ul style="list-style-type: none"> Road hierarchy plays a pivotal role when deciding on where to implement a facility. On primary roads, where the traffic volumes and operating speeds are relatively high in comparison to secondary roads, traffic friction is to be avoided. To mitigate this potential 'friction', off-street facilities are to be provided. On secondary roads, where traffic volumes and operating speeds allow for a certain degree of 'friction', on-street facilities can be implemented.
Location and Land Use	<ul style="list-style-type: none"> Minibus-taxi facilities adjacent to retail areas and office complexes often have beneficial impacts Considerations for the availability of land, the size of the land available, the ownership, the costs (acquisition, construction, design and environmental), and the zoning of the land.

All proposed sites will be evaluated according to the criteria stipulated in Chapter 4, and the most beneficial sites recommended for future investment.

Seven sites have been identified for the possible implementation of formalised minibus-taxi facilities, as per the above considerations for location and land use factors.

- **Existing Minibus-taxi Site 1-** the site is located at the Shoprite centre off Old Paarl Road.
- **Existing Minibus-taxi Site 2-** the site is located at the intersection of Merchant and Adams Street
- **Existing Minibus-taxi Site 3-** the site is located on the gravel patch to the North of Jacobs Street.
- **Proposed Site 1-** is located on the same erven (342) as the existing Minibus-taxi site 2, and is seen as an alternative location minibus-taxi site 2. The proposed site is slightly further setback from the road than existing minibus-taxi site 2 and is located far side of the Merchant Street & Adams Street intersection.
- **Proposed Site 2-** is located North-East of the gravel patch that existing Minibus-taxi Site 3 is operating from. The site is on-street and South of the Merchant Street and Adams Street intersection. This site is seen as an alternative location for minibus-taxi site 3.
- **Proposed Site 3-** is situated on Alexander Street. The site is on-street and far side of the immediate intersection. This site is an alternative location for minibus-taxi site 3.
- **Proposed Site 4-** is located in the immediate vicinity of the Klappmuts train station precinct. The proposed site is to be situated on-street. This is an alternative location for existing minibus-taxi site 1.

The evaluation of each of the proposed sites and their expected features are illustrated in the tables below. The methodologies used to determine the score for each site were elaborated in section 4.2.5.1 as part of the Evaluation Criteria.

The locality of the sites that have been identified for the possible implementation of formalised minibus-taxi facilities, and these are illustrated in Figure 34.

Figure 34: Locality of proposed sites for the implementation of minibus-taxi sites



Table 35: Existing Minibus-taxi Site 1

Existing Minibus-taxi Site 1 (Upgraded- Minibus-taxi terminal)			
Location: Shoprite off Old Paarl Road (R101)		Operational Information	
		<p>Average Daily Passenger Demand: 795</p> <p>Average Daily Peak Hour Volumes (AM/PM): 119/120</p> <p>Number of Routes Served: 4</p>	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	28.42 %
	Accessibility	Slip resistant surfaces, no unwarranted protrusions, curb drops present, no ramps necessary	4
	Security	Lighting & Security Personnel present	2
Traffic Considerations	Traffic Flow	Off-street and away from intersection	1
	Sight Distance	Compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Employment area, other public transport, Shopping Centre	3
	Facility location relative to intersection	Far side	1
	Zoning	Not required	1
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R1,188,000.00
	Acquisition Cost of Land	No Acquisition Costs	1

Table 36: Existing Minibus-taxi Site 2


Existing Minibus-taxi Site 2 (Upgraded- Minibus-taxi terminal)			
Location: Merchant Street & Adams Street		Operational Information	
		Average Daily Passenger Demand: 379 Average Daily Peak Hour Volumes (AM/PM): 67/30 Number of Routes Served: 4	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	32.2%
	Accessibility	Pedestrian crossing	1
	Security	Inadequate Lighting & No security personnel	0
Traffic Considerations	Traffic Flow	Off- Street	1
	Sight Distance	Compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Medical Clinic, School, Residential area	3
	Facility location relative to intersection	Near side	0
	Zoning	Agricultural zone. Re-zoning required	0
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R1,420,320.00
	Acquisition Cost of Land	No Acquisition Costs	1

Table 37: Existing Minibus-taxi site 3

Existing Minibus-taxi Site 3 (Upgraded- Mini-Bus Rank)			
Location: Gravel patch North of Jacobs Street		Operational Information	
		Average Daily Passenger Demand: 173 Average Daily Peak Hour Volumes (AM/PM): 25/17 Number of Routes Served: 4	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	37.18%
	Accessibility	Not UA compliant	0
	Security	Inadequate Lighting & No security personnel	0
Traffic Considerations	Traffic Flow	Off-Street	1
	Sight Distance	Compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Residential area, School	1
	Facility location relative to intersection	Mid-block	0
	Zoning	Public open space. Re-zoning required	0
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R87,278.40
	Acquisition Cost of Land	No Acquisition Costs	1

Table 38: Proposed Minibus-taxi site 1


Proposed Minibus-taxi Site 1			
Location: Merchant Street		Passenger Demand	
		<p>Average Daily Passenger Demand: 379 (similar to existing minibus-taxi site 2)</p> <p>Average Daily Peak Hour Volumes (AM/PM): 67/30 (similar to existing minibus-taxi site 2)</p>	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	29.96%
	Accessibility	Pedestrian crossing	1
	Security	Lighting	1
Traffic Considerations	Traffic Flow	Off-Street	1
	Sight Distance	Compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Medical Clinic, School, Residential area	3
	Facility location relative to intersection	Far side	1
	Zoning	Agricultural zone. Re-zoning required	0
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R1,420,320.00
	Acquisition Cost of Land	No Acquisition Costs	1

Table 39: Proposed Minibus-taxi Site 2


Proposed Minibus-taxi Site 2			
Location: Adams Street		Passenger Demand	
		<p>Average Daily Passenger Demand: 173 (similar to existing minibus-taxi site 3)</p> <p>Average Daily Peak Hour Volumes (AM/PM): 25/17(similar to existing minibus-taxi site 3)</p>	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	41.06%
	Accessibility	Not UA compliant	0
	Security	Lighting	1
Traffic Considerations	Traffic Flow	On-street, in-lane	0
	Sight Distance	compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Residential area, School	2
	Facility location relative to intersection	Midblock	0
	Zoning	Not required	1
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R87,278.40
	Acquisition Costs of Land	No Acquisition Costs	1

Table 40: Proposed Minibus-taxi Site 3



Proposed Minibus-taxi Site 3			
Location: Alexander Street		Passenger Demand	
		<p>Average Daily Passenger Demand: 173 (similar to existing minibus-taxi site 3)</p> <p>Average Daily Peak Hour Volumes (AM/PM): 25/17(similar to existing minibus-taxi site 3)</p>	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	53.22%
	Accessibility	Not UA compliant	0
	Security	Lighting	1
Traffic Considerations	Traffic Flow	On-street, indented embayment	1
	Sight Distance	Compliant	1
Location and Land Use Considerations	Location relative to major trip generators	Residential	1
	Facility location relative to intersection	Far side	1
	Zoning	Not required	1
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R87,278.40
	Acquisition Costs of Land	No Acquisition Costs	1

Table 41: Proposed Minibus-taxi Site 4

Proposed Minibus-taxi Site 4			
Location: Train Station Precinct		Passenger Demand	
		<p>Average Daily Passenger Demand: >500 (similar to existing minibus-taxi site 1)</p> <p>Average Daily Peak Hour Volumes (AM/PM): >100 (similar to existing minibus-taxi site 1)</p>	
Criteria Cluster	Criteria	Status	Score
Passenger Considerations	Walkable Catchment	N/A	31.6%
	Accessibility	Not UA complaint	0
	Security	Lighting & Security Personnel	2
Traffic Considerations	Traffic Flow	Off-street	1
	Sight Distance	Complaint	1
Location and Land Use Considerations	Location relative to major trip generators	Other public transport, employment	2
	Facility location relative to intersection	Far side	1
	Zoning	Not required	1
Cost Considerations	Environmental Costs	EIA or EPP not required	1
	Design and Construction Costs	N/A	R1,420,320.00
	Acquisition Costs of Land	No Acquisition Costs	1

6.6 Step 4B: Ranking of Alternative Sites

Step 4B of the warranting and siting practice is to rank alternatives relative to each other. From this ranking process, the relevant planning authority will be able to identify the most beneficial alternatives and their respective locations. Identified alternatives were evaluated according to the following criteria; passenger considerations, traffic considerations, location and land use considerations and cost. The results of the prioritisation process are illustrated in Table 42 below.

Table 42: Prioritisation of Alternatives Summary

Criteria Cluster	Existing Minibus-taxi Site 1	Existing Minibus-taxi Site 2	Existing Minibus-taxi Site 3	Proposed Site 1	Proposed Site 2	Proposed Site 3	Proposed Site 4
Passenger Considerations	0.35	0.13	0.09	0.18	0.15	0.17	0.26
Traffic Considerations	0.25	0.25	0.25	0.25	0.13	0.25	0.25
Location and Land Use Considerations	0.25	0.08	0.06	0.17	0.14	0.19	0.22
Cost Considerations	0.09	0.1	0.07	0.1	0.07	0.07	0.1
Total Score (graded between 0-1)⁹	0.94	0.56	0.47	0.7	0.49	0.68	0.83

*Total scores above are colour graded based on their quantitative values (green being most favourable and red being least)

⁹ The following values were calculated based on those methodologies described in sections 4.2.5.2 and 4.2.5.3

From the above prioritisation process, the most beneficial alternatives for the Klapmuts scenario are existing minibus-taxi site 1, proposed site 4, proposed site 1, and proposed site 3.

Existing Minibus-taxi site 1 and proposed site 4 are the top performing alternatives, and both facilities fall within the primary warrant category. Primary warrants focus on passenger demand for a given area or route. If passenger demand for the day exceeds 500 passengers, or the peak hour demand is greater than 100, this then triggers a primary warrant for the development of public transport facilities. Conversely, only one of these facilities is required, as they are expected to serve the same demand and operate in a very similar manner. From the above analysis, it is therefore recommended that existing minibus-taxi site (upgrading of existing minibus-taxi site 1) is considered for future investment.

To cater for the minibus-taxi needs south of the railway line in Klapmuts, it is recommended that proposed site 1 and proposed site 3 are considered for future investment.

6.7 Conclusion

The aim of this chapter was to apply the warranting and siting practice for minibus-taxi terminals and ranks developed in Chapter 4 of this document to the Klapmuts scenario. The application of this warranting and siting practice was to inform the authority on what type of minibus-taxi infrastructure is required to cater for current and envisaged minibus-taxi demand in Klapmuts. At present, there is no formalised infrastructure to accommodate minibus-taxi services and therefore it is recommended that existing minibus-taxi site 1 and proposed site 1 & 3 are considered for imminent investment.

7 Conclusions and Recommendations

7.1 Introduction

The concluding chapter of this dissertation encompasses a synopsis of the research investigated and addresses the questions posed in Chapter 1 in order to achieve the aims and objectives set out. This chapter also entails recommendations on resolving issues underlined in the Literature review section, Chapter 3, of this document, as well as recommendations to the governing authority of Klapmuts, the Stellenbosch Municipality.

7.2 Overview of the Research Process and Findings

As stated in Chapter 1, the motivation for this study pertains to the Integrated Development Plan (IDP) for the Stellenbosch Municipal area identifying Klapmuts as an area in high need of formalised public transport services. The need for formalised public transport has arisen due to the envisaged future growth of Klapmuts, and the status quo of minibus-taxi operations in Klapmuts.

The aim of this research was to critically evaluate relevant guidelines and policy documentation to aid in the siting of public transport facilities in the low to middle-income area of Klapmuts. From this assessment of current practices, a warranting and siting practice for public transport and associated infrastructure was formulated which takes cognisance of the social and demographic characteristics of a typical low to middle-income area, as well as budgetary prioritisation and policy constraints imposed by the various planning and legislative entities to ensure that infrastructure is provided for in an efficient and effective manner.

The research questions posed in Chapter 1 of this document which form the basis of this minor dissertation, and ultimately aid in addressing the research topic, will be addressed below.

1. *What warrants the implementation and construction of road based public transport infrastructure, with a specific focus on minibus-taxi terminals and ranks?*

The NDoT guideline for the planning and design of minibus-taxi facilities states that minibus-taxi facilities are warranted if the needs of relevant stakeholders, including passengers, operators and the community as a whole are not met.

From a passenger's perspective, if any of the following conditions are not met, this forms the basis for the warranting of a minibus-taxi facility; there are no available facilities, walking distances to existing minibus-taxi pick up and drop off points exceeds 5 minutes (400m-500m), there is lack of security measures in place ensuring the safety of passengers whilst travelling, physical features to improve passengers comfort at facilities are not present, existing minibus-taxi sites are not

conveniently located, and existing facilities do not allow for seamless transfer of passengers between transport modes.

Facilities can also be warranted on the basis that they do not meet the needs of operators. Distinctive needs of minibus-taxi operators in South Africa, as stated by the NDoT guideline, include the availability of a facility, existing minibus-taxi sites deficient of appeal to passengers, there is insufficient capacity at existing minibus-taxi facilities, existing facilities lack accessibility, and there is a deficiency of management of facilities and services.

If the community as a whole is affected by existing minibus-taxi services, including environmental impact, traffic congestion, and social issues, this also warrants the need for implementation of formalised infrastructure.

Subsequent to deciding on what public transport service is warranted for the study area in question, the type of facilities required support the selected public transport service need to be decided on. For the purpose of this dissertation, only the warranting of minibus-taxi terminals and ranks was investigated.

As stated in the NDoT guidelines, the following factors should be considered when deciding on whether to implement a minibus-taxi terminal or rank; operation considerations, passenger considerations, traffic considerations, location and land use considerations and cost.

When siting minibus-taxi terminals and ranks, it's concluded that the following be taken into consideration; facilities should be located in close proximity to major trip generators and attractors, facilities should be located in areas of concentrated passenger demand, a facilities location should allow for the safe movement of both pedestrians and vehicles, and a facilities location ought to promote ease of access for passengers. More specifically, minibus-taxi terminals are to be situated at the end or start of multiple routes, and ranks are to be situated at the end or start of a singular route.

2. *What criteria and evaluation methods are used when ranking potential sites for the construction of road based public transport facilities?*

As evaluated on in Chapter 3 of this dissertation, South African guidelines, and international good practices pertaining to the planning and design of road based public transport facilities, emphasize that the following factors should be consulted prior to decisions being made with regards to transport facility investment; passenger considerations, traffic considerations, location and land use considerations, as well as cost.

Due to these factors being highly regarded in ensuring that the most beneficial alternative is implemented, as well as being supported by legislative documents reviewed in Chapter 3 of this document, they will form the basis of evaluating alternatives sites relative to each other.

When deciding between investment alternatives, in the instance of this dissertation, potential sites for the construction of either minibus-taxi terminals or ranks, the objective is to invest in alternatives that reap the greatest benefits for those directly and indirectly affected by the investment option. To achieve this, alternatives need to be evaluated and ranked accordingly. From the above-mentioned appraisal techniques in Chapter 3, the CBA and the MCA techniques are the only appraisal practices that enable alternatives to be evaluated and ranked. There are however limitations to the CBA technique due to its inability to accurately equate safety, security, environmental and social impacts to monetary terms. As a result of this, the MCA technique is considered the most applicable for evaluating due to its ability to consider both qualitative and quantitative impacts, as well as its capability to evaluate and rank alternatives, and therefore was used when evaluating potential sites for construction of minibus-taxi terminals and ranks in the Klapmuts scenario.

3. Final recommendations on the location, type, and number of public transport facilities to be provided in Klapmuts

Based on the application of the warranting and siting practice developed in Chapter 4 of this dissertation to the Klapmuts scenario, it is proposed that four alternatives are to be considered for possible future investment.

From the prioritisation process, the most beneficial alternatives for the Klapmuts scenario are existing minibus-taxi site 1 (minibus-taxi terminal), proposed site 4 (minibus-taxi terminal), proposed site 1 (minibus-taxi terminal), and proposed site 3 (minibus-taxi rank).

Existing Minibus-taxi site 1 and proposed site 4 are the top performing alternatives, and both facilities fall within the primary warrant category. Conversely, only one of these facilities is required to cater for the needs north of the railway line, as they are expected to serve the same demand and operate in a very similar manner. From the above analysis, it is therefore recommended that existing minibus-taxi site (upgrading of existing minibus-taxi site 1) is considered for future investment.

To cater for the minibus-taxi needs south of the railway line in Klapmuts, it is recommended that proposed site 1 and proposed site 3 are considered for future investment.

7.3 Study Recommendations

The recommendations section to follow comprises of two parts, the first part addressing issues that are underlined in the literature review section of this document, and second part proposes recommendations to the governing authority of Klapmuts, Stellenbosch Municipality.

7.3.1 Recommendations Based on Literature Review

The literature review conducted in this dissertation recognises that the current South African guidelines give no consideration to the placement of a stop relative to an intersection. As a result, this was supplemented with a comprehensive review of International practices. These international practices state that far side stops are the most beneficial due to their safety attributes. As a result of the above-mentioned, it is recommended that when formulating a warranting and siting practice for road based public transport services and associated infrastructures, that South African guidelines pertaining to the placement and design of road based public transport facilities are to be supplemented with relevant statutory requirements and international good practices.

It is further recommended that the NDoT update their policy documents, particularly the policy document concerning the planning of bus terminals and stops which was published in the apartheid era, 1986. As a result of the policy document being compiled in the apartheid era, it does not comply with the Quality of Service Levels associated with contemporary modes of public transport.

7.3.2 Recommendations to the Transport Authority of Klapmuts

The following recommendations which concern the governing authority of Klapmuts, Stellenbosch Municipality:

- I. It is of utmost importance that future developments are monitored and the location and the type of minibus-taxi facility be reviewed accordingly.
- II. A number of NMT linkages need to be reinforced to align with what is stipulated in the Klapmuts Spatial Development Framework. The proposed activity street (Merchant Street) should incorporate an increased provision for NMT movement, while linkages to the Klapmuts railway station should be integrated with a more clearly defined station forecourt area to the South of the station.
- III. The Klapmuts railway station precinct needs to be emphasised as it services the majority of the Klapmuts public transport users. The linkages leading to the railway station precinct, both from the South and the North, need to be strengthened.

- IV. Minibus-taxi facilities need to be connected to greater NMT network in order to improve their walkability and accessibility

The warranting and siting practice developed in this dissertation is to be used in guiding investment decisions pertaining to the implementation of minibus-taxi terminals and ranks in a low to middle income areas in South Africa.

The warranting and siting practice developed is to be used when ascertaining whether there is a need for the implementation of formalized minibus-taxi facilities and, if there is a need, what type of facilities are required in order to satisfy this need. When a decision is made on what type of facilities are required, either minibus-taxi terminals or ranks, the practice developed is used to guide the relevant planning authority in identifying potential locations for the facilities. Lastly, the practice identifies criteria and associated weightings to evaluate how beneficial the proposed minibus-taxi facility alternative is in meeting the needs of all relevant stakeholders including the governing authority, passengers, operators and the community as a whole.

The warranting and siting practice is designed to be flexible, as it is acknowledged that in reality each area or potential site will have its own unique characteristics, and therefore engineering judgment should be used when applying this practice.

There is a need to improve the standard of public transport service provision in South Africa, particularly for low to middle-income areas such as Klapmuts. The objective of this warranting and siting practice is to transform the provision of minibus-taxi services and associated infrastructure in South Africa, whilst still complying with South African legislature, guidelines, policies, as well as financial constraints.

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Appendices

GNR 983-A1:B59LISTING NOTICE 1	
No.	Activity Description
1	Generation of electricity. (Renew. Res) > 20MW
2	Generation of electricity. (Non- Renew. Res) > 20MW
3	Slaughter of animals
4	Concentration of animals for commercial production
5	Concentration of poultry
6	Dev. Of facilities for aquaculture (exceeding 20 000kg/30 000kg/60 000kg)
7	Sea-based aquaculture facilities
8	Hatcheries / agri-industrial facilities (2000m ² /more)
9	Bulk transportation of water/storm water (exceeding 1000m in length)
10	Bulk transportation of sewage/effluent (exceeding 1000m in length)
11	Transmission & distribution of electricity (33KV but less than 275KV)
12	Dev. Of canals/dams/bridges etc. (100m ²)
13	Off-stream storage of water (50 000m ³)
14	Storage & handling of danger. goods (80m ³ > 500m ³)
15	Dev. In coastal public property (<50m ²)
16	Desalination of water (more than 100m ³ /day)
17	Dev. In sea/estuary/litoral zone etc.
18	Placing of materials on dune (veg) - more than 10m ² within litoral zone
19	Infilling/depositing of material (more than 5m ³)
20	Dept. of Minerals
21	Dept. of Minerals
22	Dept. of Minerals
23	Dev. of cemeteries (2500m ² or more)
24	Development of a road
25	Treatment of effluent / sewage (more than 2000m ³ but less than 15000m ³)
26	Dev. on land pre. used for mining (1000m ² or more)
27	Clearance of area of 1Ha - less than 20Ha
28	Dev. on land pre. used for agriculture
29	Release of genetically modified org
30	Any process - NEMA:BA
31	Decommissioning of existing facilities
32	Cont. of dev. where EA=lapsed
33	Underground gasification (100kg/more)

34	Expansion to dev. = permit req.
35	Expansion of land pre. used for mining
36	Expansion - Generation of electrical. (Renew. Res) 10MW/more
37	Expansion - Generation of electricity. (Non- Renew. Res) 10MW/more
38	Expansion - Slaughter of animals
39	Expansion - Concentration of animals for commercial production
40	Expansion - Concentration of poultry
41	Expansion of facilities for aquaculture
42	Expansion of sea-based aquaculture facilities
43	Expansion - Hatcheries/agri-ind. facilities (incr. 2000m ² /more)
44	Expansion - Cemeteries (incr. 2500m ² /more)
45	Expand - Bulk transportation of water/storm water
46	Expand - Bulk transportation of sewage/effluent
47	Expand - Transmission. & distribution. of electricity (< 275KV)
48	Expansion - canals/dams/bridges etc.
49	Expansion - jetties/slipways etc.
50	Expand. - Off-stream water store. (incr. 50 000m ³ /more)
51	Expansion - Storage & handling of danger. Goods (incr. 80m ³ /more)
52	Expand. - Dev. In coastal public prop (incr. 50m ² /more)
53	Desalination of water (produce add. 100m ³ /more)
54	Expansion of facilities in sea/estuary etc.
55	Expansion in sea/estuary/litoral zone
56	Widening of a road (more than 6m - wide OR 1km)
57	Expansion of facilities - treatment of effluent/wastewater/ sewage - increase 15000m ³
58	Increase of coal gasification (exceed 300kg/day)
59	Expansion for refining/extraction/processing of gas/oil/fuel (incr. 50m ³ /more)
60	Expansion of facilities for bulk trans. of dangerous goods
61	Expansion of airports
62	Expansion of fac. for marine telecom.
63	Expansion of fac. for transfer of water (Incr. 50000m ³ /day)
64	Expansion of railway lines/stations
65	Expansion of an island/anchored plat.
66	Expansion of a dam
67	Phased activities for all activities

GNR 984-LISTING NOTICE 2	
No.	Activity Description
1	Generation of electricity. (Renew. Res) < 20MW
2	Generation of electricity. (Non- Renew. Res) < 20MW
3	Facilities for nuclear reaction
4	Storage of dangerous good (more than 500m ³)
5	Refining/extraction/processing of gas/oil/petrol (50m ² /more)
6	Generation/release of emissions
7	Bulk transp. of dangerous goods
8	Dev. of runways (longer than 1.4km) / airports
9	Transmission & distribution of electricity (275KV)
10	Marine telecommunication
11	Transfer of 50000m ³ of water/day
12	Dev. of railway lines/stations
13	Agri-land change to wood product. of 100Ha/more
14	Dev. of an island/anchored platform
15	Clearance of an area (20Ha or more)
16	Development of a dam (wall=5m/more)
17	Activity requiring a mining right
18	Activity requiring an exploration right
19	Removal & disposal of minerals
20	Activity requiring a production right
21	Activity assoc. with primary processing - mineral resource
22	Activity assoc. with primary processing - petroleum resource
23	Reclamation of an island/parts of sea
24	Extraction/removal of peat soils
25	Treatment of effluent/wastewater/ sewage (daily capacity= 15000m ³)
26	Dev. in sea/estuary/litoral zone
27	Development of roads
28	Act. Requiring atmospheric license
29	Expansion of fac. for nuclear reaction

GNR 984-LISTING NOTICE 3	
No.	Activity Description
1	Dev. of billboards exceeding 18m ²
2	Dev. of reservoirs for bulk water supply (<250m ³)
3	Development of masts/towers (exceed 15m tall)
4	Development of a road wider than 4m
5	Development of resorts/lodges/ hotels (>15 ppl)
6	Development of resorts/lodges/ hotels (< 15 ppl)
7	Dev. of aircraft landing strips (1.4km or shorter)
8	Dev. of ground cableways & funiculars
9	Dev. of ziplines more than 100m long
10	Storage & handling of dangerous goods (30m ³ but not more than 80m ³)
11	Dev. of tracks for outdoor racing
12	Clearance of an area (300m ² or more)
13	Dev. of facilities for aquaculture
14	Dev of canals/channels/bridges (more than 10m ²)
15	Transform. of land (more than 1000m ²)
16	Expansion of reservoirs (more than 250m ³)
17	Expansion of resort/lodge/hotel
18	Widening of a road by more than 4m/1km in length
19	Expansion of runways/aircraft landing strips (longer than 1.4km in length)
20	Expand of ground cableways & funiculars
21	Expansion of tracks for outdoor racing
22	Expansion of storage & handling of dangerous goods (expanded by 30m ³ /more but less than 80m ³)
23	Expansion of canals/channels/bridges (more than 10m ²)
24	Expansion of facilities for aquaculture
25	Expansion of ziplines by 100m or more
26	Phased activities for all activities

Application for Approval of Ethics in Research (EIR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

APPLICATION FORM

Please Note:

Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analyzing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: <http://www.ebe.uct.ac.za/ur/ebe/research/ethics.pdf>

APPLICANT'S DETAILS	
Name of principal researcher, student or external applicant	
Luke Phillip Wagner	
Department	
Centre for Transport Studies	
Preferred email address of applicant:	
lukewagner@outlook.com	
If a Student	Your Degree: e.g., MSc, PhD, etc.,
	MPhil
	Name of Supervisor (if supervised):
	Roger Behrens
If this is a research contract, indicate the source of funding/sponsorship	
Click here to enter text	
Project Title	
The siting of public transport facilities in a predominately low to middle-income area, Klapmuts, on the outskirts of a Metropolitan city, Cape Town, South Africa	

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Luke Phillip Wagner	Signed by candidate	19 Oct 2016

APPLICATION APPROVED BY	Full name	Signature	Date
Supervisor (where applicable)	Roger Behrens	Signed by candidate	Click here to enter a date. 20 OCT 16
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).	Click here to enter text		Click here to enter a date
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	G. Sithole Click here to enter text	Signed by candidate	6/12/2016 Click here to enter a date