LEKARIAP E. M. MSC. 2017

A MACROSCOPIC SPATIAL MODEL ANALYSIS OF TRAFFIC FLOW: A CASE STUDY OF NYERI TOWN

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(Civil Engineering)

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

2017

A Macroscopic Spatial Model Analysis of Traffic flow: A case study of Nyeri town

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A Thesis Submitted in partial fulfilment for the Degree of Master of Science in Civil Engineering in the Jomo Kenyatta University of Agriculture and Technology

2017

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

Signature... Date ....

Edwin Mararo Lekariap

This thesis has been submitted for examination with our approval as the university supervisors

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DEDICATION

This thesis is dedicated to my wife, Mrs. Gladys Malinoi Lekariap, my children, Barbara Naitore Lekariap and Erin Naisenya Lekariap for their love, encouragement and for giving me easy time during my studies.

ACKNOWLEDGEMENTS

His steadfast love for me never ceases, His mercies never come to an end. They are new every morning and great is His faithfulness….Thank you Dear Lord, for how far you have brought me. I am forever grateful to you.

I would like to express my sincere appreciation to my Supervisors for their countless support. Prof. Abiero Gariy, your constructive criticism, guidance and pieces of advice have helped me in diverse ways and I say, I am deeply indebted to you. Prof. Josphat K.Z. Mwatelah,I am forever grateful for your words of encouragement, moral support, friendship, and not forgetting the pieces of advice you have been giving me.
To Eng. Joseph Nkadayo (Former Director General, Kenya Urban Roads Authority), Eng. Silas Kinoti (Current Ag. Director General, Kenya Urban Roads Authority) and Eng. Jacinta Mwangi (Regional Manager, Kenya Urban Roads Authority – Central Region), I say I am grateful to you for allowing me to use the MetroCount Vehicle Classifier to collect data for this research and for giving me time off to attend all the presentations and progress reporting at the University.

My profound gratitude also goes to Robert Muthungu, Peter Gathua, Felix Rotich and Wahome Gichohi, who assisted in diverse ways in collection of data for Nyeri town.

Special thanks also go to the following: Sarah Omai and Maryanne Wanjiku for assisting me in putting the data together and analysis: to my colleague, Nicholas Chelugo for the company, your support and encouragement. I cherish you all.

Finally, my appreciation will not be complete without saying I am forever grateful to my wife Mrs. Gladys Malinoi Lekariap, daughters, Barbara Naitore Lekariap and Erin Naisenya Lekariap, my parents; Mr and Mrs Lekariap, and My brothers, Mr.Stephen Lekariap and Mr Julius Lekariap.

Thank you all for your love and support.

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ABBREVIATIONS/ACRONYMS

APRS	Automatic Position Reporting systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CBD	Central Business District
CSV	Comma Separated Value
GIS	Geographic Information System
GPS	Global Positioning System
HCM	Highway Capacity Manual
JKUAT	Jomo Kenyatta University of Agriculture and Technology
LOS	Level of Service
LUP	Land Use Planning
LUT	Land Use-Transport
MFD	Macroscopic Fundamental Diagram
MV	Measured Value
OD	Origin-Destination
PHF	Peak Hour Factor
SABIMOS	Satellite Based Information Management Operating System
SMS	Space Mean Speed
TMS	Time Mean Speed
TRL	Transport Research Laboratory
TXT	Text format
V/C	Volume to Capacity
WGLUP	Working Group on Integrated Land Use Planning
$\mathbf{R^2}$	Coefficient of determination

ABSTRACT

Traffic flow analysis is an essential component of a town's traffic and transport systems since these flows could, and often do, lead to the occurrence of congestion on our roads. Traffic congestion is a growing problem not only in Nyeri, but also in most major towns of Kenya, resulting from rapidly increasing population and the crowding of motorized traffic onto a limited street network. This objective of the research was to perform spatial analysis of traffic flows on the key road links in Nyeri town. On those selected road links the study also established fundamental traffic flow models and derived the flow characteristics associated with traffic operations in Nyeri town, determined the characteristics of a Macroscopic Fundamental Diagram (MFD) for Nyeri town and assessed whether it is a property of the network infrastructure and control or a property of the travel demand. In this research, MetroCount Vehicle Classifier was used to collect traffic flow intensity and velocity data at seven different locations of the network. The analysis of the data was performed by the MetroCount Traffic Executive MCReport and the desired variables/parameters; speed, volume and density; were compared and their relationships established. From this research, the MFD derived from the data serve as a road network performance indicator, which shows the performance levels of Nyeri town in terms of traffic flow. The research was used to determine the capacity of the road network and the level of congestion in different links thereby determining the adequacy of the network. It was found that the speeds in Nyeri town are moderate and that the volumes of traffic in Nyeri town are low. However, this should not have been case, since when the volume of a network is low; the speeds are expected to be high. From the research, it was found that a MFD exists for Nyeri town; however, it depicted the non-congestion phase of the "full" diagram. The results of this research will lead to better traffic management and improve mobility and accessibility in Nyeri town. Researches in land use components should be investigated to determine how they influence or explain some of the results of this research.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Traffic flow analysis is an essential component of a town's traffic and transport systems since these flows could, and often do, lead to the occurrence of congestion on our roads (Williams, 1997). Global cities and towns face rising traffic congestion problems. This situation is getting worse and is becoming a major concern of the general public (Weisbrod et al., 2003). Traffic congestion is a condition of traffic delay, because the number of vehicles using a road exceeds the operational capacity of the network to handle it (Weisbrod et al., 2003). Congestion has several causes such as: the volume of traffic being close to the maximum capacity of the road link (where congestion is occurring), and as a result of too many vehicles crowding available road space. It can also be caused by traffic accidents or road maintenance works resulting in reduced capacity of the network at that particular location and time.

Congestion has a number of negative effects: productive hours are lost and this has adverse effects on the economy; it also contributes to air pollution (which has a debilitating effect on quality of life) and global warming. In view of these effects of congestion, there is need to manage traffic congestion and help reduce its effects. This could be done through effective traffic management, which has become an increasingly significant task that involves schemes to guide traffic flows effectively (Weisbrod et al., 2003). Congestion occurs on individual links within a network thereby making it a localised problem. The cause has to do with spatial-temporal distribution of demand and supply which therefore makes it possible to experience its effect when considering the performance of the entire network, hence making it a macroscopic issue. This then points out to the fact that network operators should be able to relate the effects of these localised congestion situations on road links to the entire network, which calls for appropriate indicators to be used to measure network performance (Weisbrod et al., 2003).

Analysis of traffic flow and modeling of vehicular congestion has mainly relied on fundamental laws, inspired from physics using analogies with fluid mechanics, and many particles systems among others. One main difference between physical systems and vehicular traffic is that humans make choices in terms of routes, destinations and driving behavior, which creates additional complexity to the system. While most of the traffic science theories make a clear distinction between free-flow and congested traffic states, empirical analysis of spatio-temporal congestion patterns has revealed additional complexity of traffic states and non-steady state conditions (Munoz & Daganzo, 2003; Helbing et al., 2009). Thus, the known fundamental diagram, initially observed for a stretch of highway to provide a steady-state relationship between speed, density and flow, is not sufficient to describe the additional complexity of traffic systems; it also contains significant experimental errors in the congested regime for a highway stretch (Kerner & Rehborn, 1996) or for a city street (Geroliminis, 2008). Nevertheless, it was recently observed from empirical data in Downtown Yokohama that by aggregating the highly scattered plots of flow versus density from individual loop detectors, the scatter almost disappeared and a well defined Macroscopic Fundamental Diagram exists (Geroliminis, 2008). The determined MFD is important in the study of the performance of the road networks.

Performance of road networks over the years is typically measured at link and intersection levels and this makes it quite difficult when assessing the performance of an entire network. To be able to put effective traffic and transport management practices in place for an entire town, it is ideal to consider measuring performance of roads at higher levels. This will also help in determining the state of the network. The performance of a town's road network which can be studied at a macro level could be attributed to the planning of the town. A well planned town has, as part of its network characteristics, good accessibility and mobility, thus, less congestion.

In order to help improve accessibility and mobility, planners ought to study and understand how space is used for transport and how this space can be managed effectively. A Macroscopic Fundamental Diagram (MFD) shows the relation between average flow in the network and the network's average traffic density or speed (Gonzales, et al., 2008).

1.2 Background of Nyeri Town

Nyeri town was initially the administrative headquarters of the country's former Central Province. Following the dissolution of the former provinces by Kenya's new constitution in 2010, Nyeri is now the largest town in the newly created Nyeri County, with a population of about 119,273 (National Bureau of Statistics, 2009). The population increase from 98,908 in 1999 to 119,273 in 2009 may also have contributed to an increase in economic activities and businesses over the years. Modern shopping centres and department stores that were found in much larger cities and towns have been opened in Nyeri as a result of the booming economic activities. The town also serves as a host to festivals, live music and other activities both on weekdays and on weekends. Its proximity to Kenya's capital city of Nairobi and towns like Nanyuki, Meru and Nakuru, and tourist sites and parks like Mt. Kenya and Aberdare's has also been another major factor in the increase in the city's economic activity.

Nyeri is served by a reasonably well-maintained tarmac road network connecting it to Nairobi, Nakuru, Nanyuki, Othaya and other surrounding towns. Most transportation of cargo to and from Nyeri is by road. However the town has a largely underutilized railway station at Kiganjo, on the branchline of the railway from Nairobi to Nanyuki, and airstrips at Mweiga and Nyaribo. The main mode of public passenger transport to, from, and within Nyeri is by way of fourteen-seater minibus taxis (matatus), though un-metered saloon car taxis are also widely used.

The above-stated increase in population, business and economic activities also has effects on traffic flow in the town. In view of that, the Municipality ought to engage in urban planning and management measures to ensure effective flow of traffic. This will enhance traffic circulation in the town, thereby enhancing the town's mobility and accessibility levels.

1.3 Statement of the Problem and Justification

In Nyeri town, despite the intensive road network expansion and the limited number of vehicle ownership compared to the other sub Saharan countries, traffic congestion has now become a threat to the town economic growth by restraining the commuters' mobility especially at peak hours. In addition to waiting time for the limited public transport vehicles, both private car users and public transport users experience forced delays within the congested traffic lanes. Hence, late arrival to work places and appointments for social or business activities has become common. Despite the problem being recognized by all road users and transport professionals as a threat to the economy, there is no significant attempt for quantitative research done on the extent of the traffic flow and congestion in Nyeri.

Traffic congestion has an economic cost on the productivity of the urban communities and on the economy. Primarily, traffic congestion is an outcome of insufficient traffic management in the town, insufficient capacity of the roads to cope up with the existing traffic volume. It is also an outcome of inadequate public transport, fixed working time, and poor land-use or transport- land-use planning integration. In addition, long travel time or travel delay, affect business users time productivity and increasing fuel consumption and wastage. These are the main impact of vehicles congestion which are prevailent. Therefore, this research has been initiated to assess traffic characteristics in Nyeri town and estabish models that are specific to this town, that can be used to assess the congestion levels in Nyeri.

1.4 Research Questions

i. What are the fundamental traffic flow models and flow characteristics associated with traffic operations in Nyeri town?
ii. What are the characteristics of a Macroscopic Fundamental Diagram for Nyeri town?
iii. Is Macroscopic Fundamental Diagram a property of the network infrastructure and control or of the demand in Nyeri town?

1.5 Research Objectives

The study was guided by both the general objectives and a set of three specific objectives as stated hereafter.

1.5.1 General Objective

The main objective of this research is to perform spatial analysis of traffic flows in Nyeri town.

1.5.2 Specific Objectives

i. To establish fundamental traffic flow models and derive the flow characteristics associated with traffic operations in Nyeri town
ii. To determine the characteristics of a Macroscopic Fundamental Diagram (MFD) for Nyeri town
iii. To assess the Macroscopic Fundamental Diagram in order to determine whether it is a property of the network infrastructure and control or of the demand in Nyeri town

1.6 Significance of the Study

Nowadays, with the increase of traffic demand, traffic jams occur frequently in Nyeri town urban areas. This is because people need to use the common infrastructures with limited capacity at the same time, especially during rush hours. Traffic congestion might give rise to traffic delays, traffic costs, economic losses, traffic pollution, and even lower degree of safety. It has a direct effect on our quality of life. It includes considerable costs for the community and a great deal of effort to be devoted in every large town to reduce the negative impact of this phenomenon.

The findings of this study will enrich existing body of knowledge in that it will be a reliable source of reference materials for scholars, authors, academicians, and researchers in civil and infrastructural engineering. Moreover, the study is anticipated to benefit other parties of the societies such as the town administration of Nyeri Urban Area and Kenya Urban Roads Authority who can use the findings of this study in formulating policy recommendations to improve traffic system in the town. This will likely result in peaceful, comfortable, sustainable and economical traffic system and to also use its resources efficiently and ensure the town's sustainability by solving the problem of traffic congestion.

1.7 Scope and Limitation of the Research

1.7.1 Scope

The research was conducted in Nyeri town which is the headquarters for Nyeri County. It was limited to only seven major arterial roads around Nyeri town and data was collected on these roads at locations within a radius of 3.0 km from the town centre. The roads considered in this study are all two lane single carriage way, ranging from functionality class D to B. Nyeri-Kingongo is a national trunk road linking the Nyeri and Kingongo town centers. Nyeri-Nyahururu is also a national trunk road linking the town centres of Nyeri and Nyahururu. Nyeri-Nyahururu, Nyeri-Ruringu and Ruringu-Marua are the other national trunk roads linking their various principal town centers. Nyeri-Kiganjo is a class C road feeding Nyeri-Kingongo road. Ruringu-Othaya is the other class C road linking the provintially importanat centres of Ruringu and Othaya. Nyeri-Tetu is a class D road and links the locally important centres. All the roads in this study are in good condition and are properly maintained. There are no visible pot holes or any other road defects. The traffic cernsus involved a macroscopic approach where traffic data were collected and analyzed at an aggregated level.

The research was conducted over a period of 18 days between January, 2015 and February 2015.

1.7.2 Limitation

There were time and budget constraints when conducting field survey. This challenge was overcome by limiting the study to a radius of 3 km from the town centre. Another setback was lack of full documents on road network characteristics from concerned organizations. This was addressed by ensuring that the tools employed to collect the data from the field tallied with the study objectives. On the other hand, some of the persons from whom the target was sought were quite reluctant to divulge the requisite information. The researcher clarified that the study was exclusively for academic purposes and also that the findings would be shared with town administrators who would likley benefit from such in their strategy formulation for the town's road network.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents concepts, and both theoretical and empirical review touching on macroscopic fundamental diagram for spatial analysis and traffic flow. More so, the conceptual framework that guided the study is outlined. The literature reviewed is critiqued with the aim of identifying research gaps.

2.2 Transport within Cities and Towns

Transportation serves many useful purposes in our day-to-day lives. The level of mobility and accessibility provided by transport systems have been playing essential roles in not only shaping countries and influencing the location of social and economic activities, but also, influencing the form and size of cities permitting access to people and resources (Zuidgeest, 2005). The transport process eventually leads to trips being produced and distributed between and within zones. The traffic flows that result from transportation, according to Zuidgeest (2005), may on the longer-term change activity patterns such as shifts in modal choice and trip frequency choice and eventually land-use patterns.

In urban planning processes for a town, the need to consider an efficient approach to curb the negative effects of traffic flows on networks is required. To really understand traffic flows within towns and be able to address the problems that come with it, the various components of urban traffic need to be studied, and that leads to the study of the fundamentals of traffic flow below.

2.3 Networks and Traffic Flow

A town's transport system may be characterised as a network with a set of nodes (interchanges and intersections), links (linear features that provide movement) and loading elements (Ben-Akiva et al., 2001). The nodes are those locations where movements are originating, ending and are being transferred and have attributes such as node numbers and locations (Rodrigue et al., 2005). The segment between two nodes is a link and each link has its own characteristics such as length, number of lanes, capacity, free flow speed and direction. Ben-Akiva et al. (2001) describes the loading elements as those areas where traffic is either generated or attracted. In this respect, they can either be nodes or loading links and therefore, are a generalisation of the zone centroid nodes.

In traffic flow, the movement of discrete units (vehicles or people) on these links is of great importance and these units move without the influence of the other, yet they may interact (Taylor et al., 2000). It therefore becomes appropriate to know how different components interact with one another on road links to form traffic streams. This gives an idea as to how they contribute to congestion on roadways, so that measures are put in place to reduce it to appreciable levels (Geroliminis & Daganzo, 2008).

2.4 Traffic Flow Parameters and their relationships

Parameters used to describe traffic streams could be categorised as microscopic (considering the behaviour of individual vehicles in a traffic stream with respect to each other) or macroscopic (considering traffic stream as a whole). Some microscopic traffic flow parameters include spacing and headway, whereas density, speed and volume/ flow could be seen as macroscopic parameters.

2.4.1 Microscopic Flow Parameters

Although this research looked at spatial analysis of traffic and a macroscopic Fundamental Diagram (MFD), which are at a network level, it is also appropriate to look at other microscopic parameters at their individual link and intersection levels because these individual links together form the network. Headway and spacing are two characteristics of microscopic traffic flow because they relate to individual pairs of vehicles within traffic streams. Spacing is the distance between successive vehicles in a traffic stream; this is measured from common reference points on the vehicles (back wheel, front bumper and rear axle). Headway, which is a time component, is the time between successive vehicles as they pass a point on a roadway, also measured between common reference points on the vehicles (Geroliminis & Daganzo, 2008).

2.4.2 Macroscopic Flow Parameters

The relationship between macroscopic flow parameters gives rise to the MFD out of which valuable information could be obtained to control demand-side policies to improve mobility in neighbourhoods (Geroliminis & Daganzo, 2008). These parameters describe traffic stream for a given time interval by a single value of each - which applies to the traffic stream as a whole. The macroscopic variables discussed under this section are density, volume and speed.

2.4.2.1 Density

Vehicles fill up available road spaces gradually from time to time when moving to areas of traffic demand. According to Maerivoet et al. (2005), density, as a macroscopic parameter, can be used to determine how crowded a section of a roadway is. This parameter can be used to assess traffic performance once a relation between density and traffic flow is established.

Density is defined as the number of vehicles that occupy a given length of a roadway/ lane and is generally expressed as vehicles per kilometre [veh/km]. The measurement of density is difficult but can be computed from the other macroscopic parameters (speed and volume) or estimated. The density *(k)* for single lane traffic is defined as:

$$k=\frac{N}{D} \qquad (2.01)$$

Where N is the number of vehicles on the length of road segment considered and D is the length of road section covered by the vehicles.

Density can also be derived using speed and flow as:

$$k=\frac{q}{s_u} \qquad (2.02)$$

Where k is the density in vehicles per kilometre [veh/km], q is the flow in vehicles per hour [veh/hr] and s_u, the space mean speed in kilometres per hour [km/hr].

According to McShane and Roess (1990), density is a very important parameter in terms of traffic demand because it relates to it directly. Based on that, different land use types generate traffic and the trips produced from them produce density which in turn produces flow and speed. Not only does density relate to demand but it also measures the quality of traffic flow, as it measures the proximity of vehicles to one another and demonstrates the degree of freedom to manoeuvre within traffic streams (Highway Capacity Manual, 2000). Therefore, it is obvious how density as a parameter can help assess the performance of road networks because it gives the idea of the number of vehicles occupying a given distance of a roadway; and this parameter indicates whether the road network is able to cope with traffic volume demand levels.

2.4.2.2 Volume and Flow

To be able to derive valuable information from an MFD for transport planning purposes, a relation between density and flow that is established could be of help. Different land use types affect the number of trips produced and distributed between places and these trips characterise traffic flows.

Traffic volume, which is often used interchangeably as intensity, traffic flow and throughput, is defined as the number of vehicles that pass a point on a road or a given lane per unit time. Typical units of volume are vehicles per day [veh/day], vehicles per hour [veh/hr] or vehicles per second [veh/sec]. In planning, designing and operation of road facilities, May (1990) explains that knowledge about traffic flow plays very important roles, the examples of instances where such knowledge can be applied are:

i.) Flow measurements are used in origin-destination (OD) studies. The trips obtained from such studies come from the need to move from and to these origin-destination zones as a result of the land use activities.

ii.) Flow measurements are vital for spatial correlation or variation analysis between different areas since it gives an idea of how different areas correlate or show variations when flows on these different links constituting the different areas are aggregated over time.

Traffic flow *(q)* in veh/hr is given as:

$$q = \frac{N}{T} \qquad (2.03)$$

Where *N* is the number of vehicles that passed a fixed point (detector) and *T* is the time over which that flow is measured.

Peak flow rates are important parameters in capacity analysis (Highway Capacity Manual, 2000). The Highway Capacity Manual (HCM) (2000) suggests 15 minutes interval for most operational and design analysis since flow rate variations for shorter periods are unstable, and are difficult to establish. This suggestion has been complied with in trying to establish the MFD by considering the relation between flow and speed over 15-minute intervals.

The 15-minute period of the ratio of hourly volume to maximum flow rate (or the peak hour factor, PHF) is given as:

$$PHF = \frac{Q}{4Q_{15}} \qquad (2.04)$$

Where Q is the hourly volume (in veh/ hr) and Q_{15} *is* the maximum 15-minute volume within the hour (in vehicles)

2.4.2.3 Speed and Travel Time

Speed, which is a very important parameter that can be related with flow to give an MFD for a given area, is defined as a rate of motion, expressed as distance per unit time. A typical unit is kilometres per hour (km/h). It is the inverse of the time taken to traverse a given length of roadway. Accessibility levels for neighbourhoods which can be enhanced by the use of MFDs can be determined by knowing the levels of speeds and travel times on such networks, and showing the relationship of the speed with flow. Speed and travel time are used as indications of the level of service (LOS) on road networks so they can be used as network performance measures (May, 1990).

Different vehicles travelling at different speeds on a roadway constitute a traffic stream, therefore a distribution of each of the vehicle speeds should be considered in speed analysis. From this distribution, McShane and Roess (1990) point out that an "average" may be obtained to characterise the entire traffic stream. Two ways of computing average speeds are the time mean speed (TMS) and the space mean speed (SMS). TMS is the average speed of all vehicles passing a point on a roadway over a period of time. This is given as:

$$U_{TMS} = \frac{1}{n}\sum_{i=1}^{n}\left(D/_{ti}\right) \quad \text{.........} \quad (2.05)$$

Where n is the number of observed vehicles, D is the distance traversed and t_i, the travel time for the *ith* vehicle. The SMS shows the average speed of all vehicles occupying a given section of a roadway over a period of time. This is given as:

$$U_{SMS} = \frac{nD}{\sum_{i=1}^{n} ti} \quad \text{.........} \quad (2.06)$$

2.5 Theoretical Review

This section reviews theories and models that touch on MFD and traffic flow.

2.5.1 Traffic Flow Theory

Transportation, which is seen as a system that considers the complex relationships between its core elements such as networks, nodes and demand, plays an essential role in our daily lives (Rodrigue et al., 2005). This relation gives rise to the flow of traffic on road networks. The mathematical representation of the interactions between vehicles, their operators and the infrastructure can be explained by traffic flow theories which seek to understand and develop optimal road networks that will allow the movement of traffic efficiently and help reduce congestion (Gartner et al., 1992). Road space is limited and traffic engineers have to maximise the capacity of the road as much as possible. The measurement of the capacity and what influences it, lie at the core of traffic flow theory (O'Flaherty & Bell, 1997).

According to Rodrigue et al. (2005), the sole aim of transportation is to meet demand levels for mobility. In this regard, Maoh et al. (2009) see travel demand modelling as an important factor in transport planning processes in that demand levels could directly be as a result of the outcome of varied economic activities, without which they would not occur; so there is the need to be able to predict demand levels so as to plan towards their effects.

Although traffic flow plays these requisite roles, their negative effects on the environment is one that should be well considered. An indirect effect of congestion caused by transportation is pollution (air and water); and this affects health standards of people. Also to talk about are its safety issues because growing traffic is linked to growing number of accidents and fatalities. With respect to its environmental effects, Rodrigue et al. (2005) are emphatic that “decisions relating to transport need to be evaluated taking into account the corresponding environmental costs”.

Other cost considerations which have effects on economies can also be seen from the delays spent in congestion; and although transportation may have these negative effects, it plays very essential roles by supporting transport demands that are generated by the diversity of activities that are brought forth by the urban society.

2.5.2 The Fundamental Diagrams (Models)

How effective a roadway system is can be evaluated based on a number of elements which include the number of vehicles that can travel on the road, the speeds at which these vehicles can travel, the density of vehicles along the roadway, the distances between these vehicles and the freedom to manoeuvre. These qualitative and quantitative measures affect each other in one way or the other and the derivation of the macroscopic parameters which relate to form the MFD have been shown below.

When vehicles move in a traffic stream, a relationship exists between spacing *(s)* and the density *(k)* of the stream of vehicles on a given length of a roadway. This is given by:

$$s = \frac{1}{k} \quad \text{.......... (2.07)}$$

Also, the headway *(h)* between these vehicles in a stream is the inverse of traffic flow *(q),* thus:

$$h = \frac{1}{q} \quad \text{.......... (2.08)}$$

And the headway *(h)* between two vehicles travelling at spacing *(s)* with a speed *(u)* is given by:

$$h = \frac{s}{u} \quad \text{.......... (2.09)}$$

Substituting equations 2.07 and 2.08 into 2.09 gives the relation between the macroscopic variables flow, speed and density as:

$s = uk$………………………………………………………………………….. (2.10)

This equation represents the behaviour of one parameter with respect to the other and is the basis for the fundamental diagram since it involves a relation between traffic flow, traffic speed and traffic density. The sections below show how each of these parameters relate to the other and what kind of information can be obtained from them. As part of this research, the application of data from metro count devices was analysed to give rise to the MFD. Based on the interpretation from the diagram, information obtained from it can be used by planners and traffic engineers to further plan traffic circulation within a study area such as Nyeri town.

2.5.2.1 Speed- Density Model

The development of a traffic flow model begins with a relation between speed and density (van Maarseveen et al., 2005). The relationship between these two parameters provides essential information for planning purposes, which is one reason why the MFD is being investigated for Nyeri. In real life situations, a typical example of this relation is shown in Figure 2-1. The graph shows that when a single road user uses the roadway he/she could drive at any desirable speed because density *(k)* is low; this desirable speed is the free-flow speed *(u_o)* since the choice of speed is not limited by other road users except by road condition. When more and more drivers begin using the roadway, density increases and the speed decreases significantly (because of the many interactions amongst vehicles) till the road capacity is reached. When the product of density and speed results in the maximum flow, the capacity is reached and the speed at this point is referred to as optimum speed u_c, often called critical speed, (Highway Capacity Manual, 2000).

At a point in time, density becomes so high such that all vehicles stop and speed is now zero; the density at this point is the jam density, k_j. Information such as the measure of these parameters from this diagram (Figure 2.1) will aid the town authorities in planning the town by knowing how various land uses contribute to this u-k diagram as a result of land use transport interactions. Also, the town's free flow and critical speeds are essential for planning, traffic management and safety purposes. Knowledge about the town jam density helps to put in place effective measures to control traffic flow in the city so that the city's flows do not get to such high levels of density.

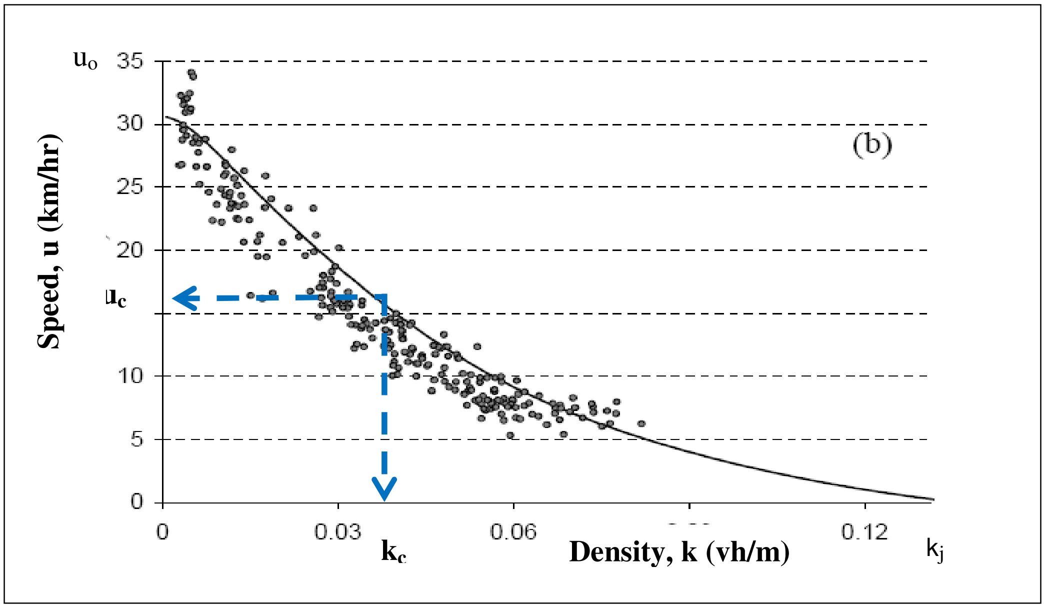

Figure 2-1: Speed- density relation for the city of Yokohama, Japan (Geroliminis & Daganzo, 2008).

This kind of relation between speed and density can be shown theoretically as:

$$u = u_c\left(1 - \frac{k}{k_j}\right) \quad (2.11)$$

Where k is the density, k_c is the critical density, k_j is the jam density, u is the speed, u_o is the free speed and u_c is the critical speed.

2.5.2.2 Speed- Flow Model

An aggregation of the average speed *(u)* and flow *(q)* of vehicles on the road network in the Nyeri town could establish a relation such as in Figure 2-2, if the town has the overall traffic characteristics as such. Density *(k)* can be derived from equation 2.11 as:

$$k = k_j\left(1 - \frac{u}{u_c}\right) \quad \text{......} \quad (2.12)$$

Substituting equation 2.12 into 2.10, the flow can be obtained as shown in equation 2.13

$$q = k_j\left(u - \frac{u^2}{u_o}\right) \quad \text{......} \quad (2.13)$$

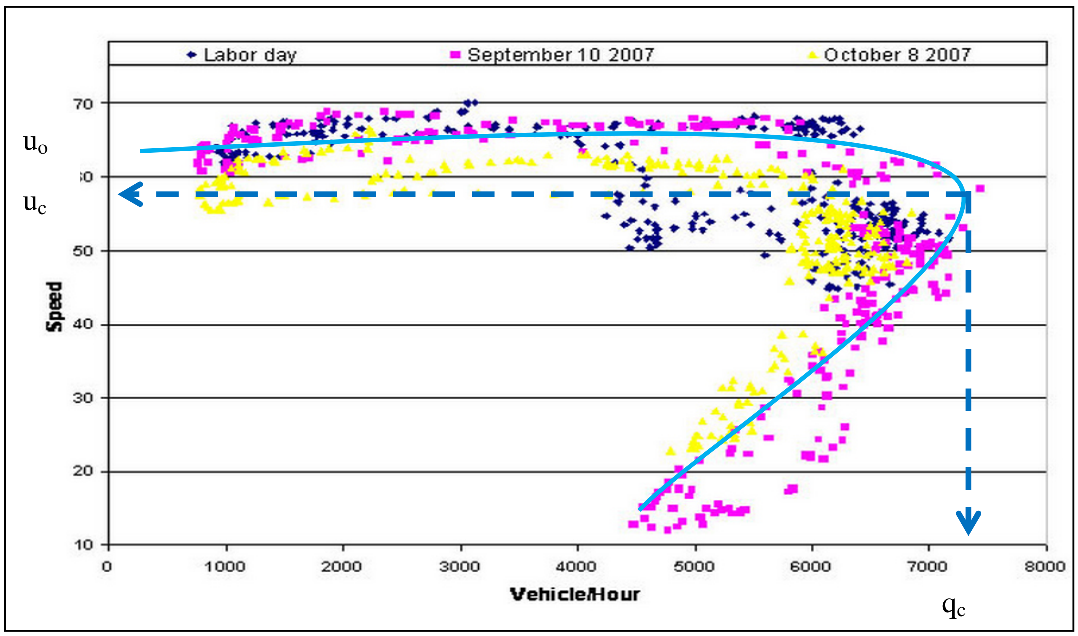

Figure 2-2: Speed-Volume Relationship, Northbound I-405 (Los Angeles), for three Mondays in September-October 2007 (Federal Highway Administration, 2009)

Through the study of the relationship between these parameters, one is able to interpret and know the kind of relation between land use and transport that contributes to this type of graph. Initially with no vehicles on the roadway, speed and flow are both zero. As the number of vehicles increases, the flow increases and speed decreases due to the vehicles interactions, until a capacity is reached; then flow decreases with decreasing speed. The capacity of the road is reached at this point. Also at this point, the maximum flow *(q_c)* and critical speed *(u_c)* can be known. These are vital information that can help engineers and planners further to plan towns to meet the ever increasing traffic demand levels.

2.5.2.3 Flow- Density Model

The third model, which is a relation between flow on a network and the corresponding density, is a fundamental diagram of traffic flow. Theoretically, this model can be obtained as shown in equation 2.14. It is derived by comparing equations 2.10 and 2.11. Thus flow q-k diagram is illustrated in Figure 2-3:

$$q = u_c\left(k - \frac{k^2}{k_j}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.14)$$

Where q is the flow, u_o is the free speed, k is the density and k_j is the jam density

Some characteristics of an ideal flow-density relationship which serve as very useful information for planning purposes are that when there are no vehicles on the road way (thus no flow), density is also zero. When the flow increases, density also increases till the road reaches its capacity when flows reduce because density is increasing. At this capacity, the critical density of the road can be known. From such models, it is possible to determine what the jam density and maximum flow of the town are.

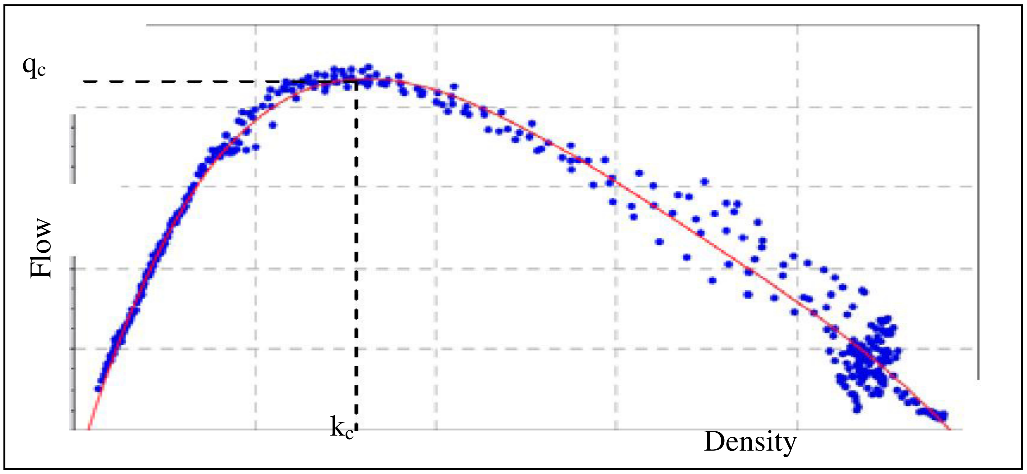

Figure 2-3: Relation between flow and density for the city of San Francisco network (Geroliminis & Daganzo, 2007)

The discussions on the relationships between the three macroscopic parameters show that speeds, volumes and densities required for planning and traffic operation purposes can be found in these diagrams. It is only after modelling and establishing such diagrams, information can be obtained to plan a town and road networks so as to be able to accommodate the ever increasing traffic demand. Once the information is factored in planning purposes, mobility and accessibility will also be enhanced.

2.5.3 Level-of-Service (LOS)

Talking about the performance of road networks which can be studied by the use of the above described fundamental diagrams, the LOS concept also helps to describe a range of operating conditions on a particular facility. The LOS for each facility is determined from a measure of effectiveness; and the three primary measures used by the HCM to determine LOS are speed and travel time, density and delay (McShane & Roess, 1990). According to Papacostas and Prevedouros (2001), estimates of average delays for each vehicle using a road facility determine the performance of the facility, with short delays resulting in good LOS and long delays resulting in poor LOS. LOS is described by six levels (A-F). Each of the six level scale definitions of

LOS is explained (McShane and Roess, 1990; Highway Capacity Manual, 1998) below:

LOS A shows conditions of free flow where the presence of vehicles on the road do not greatly affect others in any way. Flows in this range do not affect speeds of travel and it is easy to maneuver (lane changes, merging and diverging movements) within the traffic stream. Minor disruptions to flow are easily absorbed at this level without a change in travel speed. At LOS B, the presence of vehicles is noticeable and average speeds are the same as in the free flow level, but drivers have slightly less freedom to maneuver. Minor disruptions are easily absorbed, although localized deterioration in level of service was more obvious.

The influence of traffic density on operations becomes vivid during LOS C and the presence of other vehicles begins to restrict the ability to maneuver within the traffic stream. At this level, average speeds remain at free flow states but drivers need to adjust their course to find gaps they can pass or merge. Queues may form behind any significant traffic disruption and minor disruptions may be expected to cause serious local deterioration in service. The LOS where average speeds begin to decline with increasing flows and the ability to maneuver is severely restricted is LOS D. At this level, breakdowns can occur quickly in response to smaller increases in flow. Maneuvering within the traffic stream is now a bit difficult. Only minor disruptions can be absorbed without the formation of extensive queues and that leads to the deterioration of service to LOS E and LOS F.

LOS E shows operations at near capacity and there is very minimum spacing between the vehicles in the traffic stream. The limits for the level of service are approached and most disruptions will cause queues to form and service to deteriorate to LOS F. Maneuvering is difficult at this level of service. At LOS F, which is the worst operating condition, queues are formed behind points of breakdowns such as accidents. Although LOS is identified as a qualitative measure that needs to reflect user perceptions of quality of service, comfort and convenience (Zhang & Prevedouros, 2004), it does not do much when dealing with area or town-based performances to reflect the quality of service provided by road networks. All the six levels of scale of the LOS denote the performance of road segments from time to time as vehicles fill available road spaces and they are to some extent confined to individual segments.

2.6 Empirical Review

This section illustrates a review of empirical studies that have so far been conducted in respect of macroscopic fundamental diagram and traffic flow.

2.6.1 The Need for Traffic Analysis

Sumalee and Watling (2003) postulate the point of view that the interactions between different components of a road network, such as the demand and supply sides (e.g. the link-flow volumes in the network), is the main mechanism that defines the state of the network. As these components interact, there can be variations in the link capacities of networks. The different forms of interactions have been summarised in Figure 2.4.

The performance of road networks is a key area that transport engineers and network operators pay great attention to. It is ideal to know how the road network has performed in the past, how it is performing now and how its future can be planned to meet increasing demand levels. The assessment of the performance of the network helps determine if the performance is meeting set strategic or operational goals. In traffic analysis studies, network operators need to know if they are achieving an efficient form of utilization of the network, given the capital investment made in the infrastructures provided.

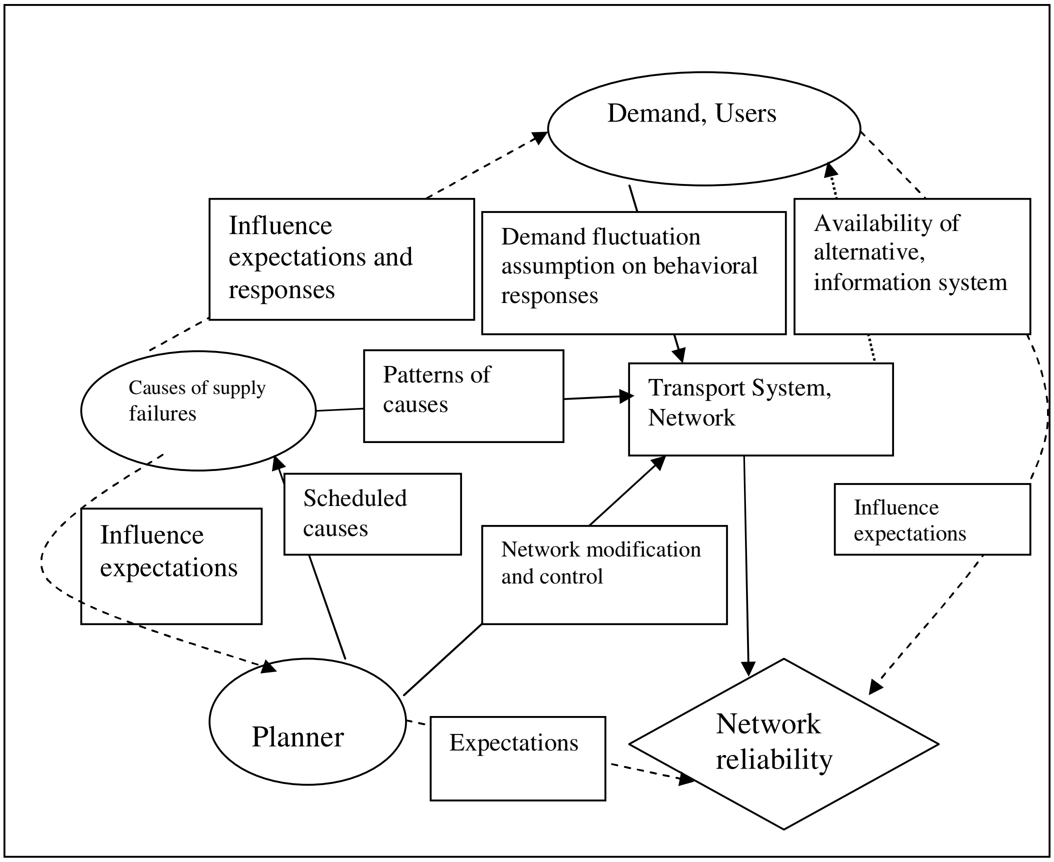

Figure 2-4: Conceptual Framework for the analysis of transport network reliability (Sumalee & Watling, 2003)

2.6.2 Network Reliability

How reliable the road networks are, is becoming an increasingly important attribute of road networks and also a concern for planners and engineers in network design (Yin & Ieda, 2002; Dimitriou et al., 2007). This is because a network that is unreliable has effects on the lives of commuters and the economy of the nations, giving concern to studying the reliability of networks during area-wide studies. Bell and Iida (1997) define reliability from systems engineering point of view, as the degree of stability of the quality of service that a system normally offers; and in a transport system such as a road network, travel demand flows and the physical network may contribute to how reliable the network is. A similar idea shared by Liu et al. (2004) is that "reliability, by its nature, implies something about the certainty or stability of travel time of any particular trip under repetition".

In road network reliability, Dimitriou et al. (2007) and Sumalee and Watling (2003), share similar views that the level of stability of the transport network system can be related to its ability to respond to and meet the expected demand levels under different circumstances (e.g. variability in flows and physical network capacities). A typical example where a network is reliable is where the network is able to cope with variations in demand over different days of a week by maintaining a constant average travel time between different origin-destination pairs (Ang & Tang, 1990).

The focus of this research is to determine factors from the Macroscopic diagrams that will ensure that the road network in Nyeri improves accessibility and mobility levels, thus reducing travel times and improving on its reliability, and that is what transport planners and engineers seek to do. Before improvements are made to the current network structure in terms of planning and engineering, network indicators will have to be used to assess present performance of the network.

2.6.3 Traffic/ Network Performance Indicators

The performance of a country or region's economy, according to Lo et al. (1999), Chen et al. (2002) and Tang et al. (2005), depends heavily on an efficient and reliable transportation system to provide accessibility and provide safe and efficient movement of goods and people. This same view is shared by the University of Applied Science Technikum Wien (2009), that the performance of transport systems has a crucial role for individual mobility and the welfare and economic growth of all nations.

As discussed previously, the effectiveness of a road system can be evaluated based on a number of elements which include the number of vehicles that can travel on the road, the speeds at which these vehicles can travel, the density of vehicles along the roadway, the distances between these vehicles and the freedom to maneuver among lanes. These are both qualitative and quantitative measures that could help to establish how road networks are performing in terms of meeting traffic demands.

An indicator, which helps to monitor and assess progress of work of a project or system, can be used to measure the performance of road networks in terms of traffic flow. In this regard, Newton (2001), confirms that performance indicators are essential because they could measure aspects of the performance of say, cities or road networks, and are intended to identify which sections of these entities are meeting desirable aims. Some of the network performance indicators that have been discussed for the purpose of this research have been described below.

The Transport Research Laboratory (TRL, 2009) emphasizes that there is a need for performance of road networks to be monitored over time so as to enable road managers to give attention to reducing congestion and improve travel time reliability. In the analysis of the reliability of road networks or transport systems, Lo et al. (1999) and Chen et al. (2000) when citing Bell and Iida (1997) point out the fact that although the analysis is of great importance, very little attention has been given to it. They define travel/journey time reliability as the "probability that a trip between a given origin-destination (OD) pair can be made successfully within a specified interval of time for a given level of traffic demand in the network". This makes travel time an important indicator of transportation systems performance. But Nicholson and Du (1997), give uncertainties of travel time reliability on road networks. These uncertainties stem from two sources: variations in demand flows or variations in arc capacities (as cited in Chen et al., 2002). Hence two definitions for travel time reliability exist depending on the source of variability (Chen et al., 2002). The first, concerned with daily flow variations, is suitable for evaluating network performance under normal traffic conditions; the second considers variations due to degradation and is suitable for both normal and abnormal traffic conditions.

Two approaches are mainly available for measuring travel time reliability of road transportation system. These include mathematical based travel time reliability measurements (Asakura & Kashiwadhani, 1991; Lee et al., 2000; Chen et al., 2003) and empirical measures (FHWA Report, 2006). Mathematical reliability measurements are developed based on conventional User Equilibrium (UE) route choice principle, where as empirical measures are developed based on travel time distribution which is obtained by travel time history of users' experience for the particular link/road.

Since travel time reliability considers the distribution of travel time probability and its variation across the road network, the higher the travel time variance is, the lower is the travel time reliability (Nicholson et al., 2003). It is also true that under ideal conditions travel time reliability would have a variance equal to zero. Indeed, the increase of its variance will therefore significantly reduce its reliability. However, the relationship between travel time variance and its reliability is not linear; hence, it cannot be generally accepted that a double of travel time variance will lead to a half of its reliability. To conclude, the great travel time fluctuation will have significant impact on transport network reliability.

The studies by Chen and Recker (2000) and Chen et al. (2002) on reliability measures of road networks define connectivity reliability as the probability that network nodes are connected. Terminal reliability (the existence of a path between a specific OD pair) is seen as a special case in connectivity reliability (Iida & Wakabayashi, 1989). According to Chen and Recker (2000) and Chen et al (2002), the condition that satisfies a network being successful is that for a given node pair, at least each path should be operational. A path consists of a set of roadways or arcs. Chen and Recker (2000) and Chen et al. (2002) state that even in situations like earthquakes, connectivity reliability analysis may be ideal but there is an underlying inadequacy in that it only allows for either a state that operates at full or complete failure at zero capacity. This binary approach limits applications where arcs are performing between these two extreme conditions therefore reliability and risk assessment outputs obtained through this approach may be misleading for normal conditions.

Most of the existing reliability studies of road networks only focus on travel time and connectivity reliability which may not be sufficient for a network performance measure (Chen et al., 2002). Bell and Iida (1997) when quoting Chen and Recker (2000) share similar views because they emphasize that although it is very necessary to assess the reliability of transport systems, very few reliability studies exist.

Capacity reliability is a new network performance indicator that has recently been introduced by Chen et al. (1999) and Chen et al. (2002). They define capacity reliability as the probability that the network's capacity can successfully accommodate a certain level of O-D demand at an acceptable service quality (Lo et al., 1999; Chen et al., 2002). The capacities for network links may change from time to time due to various reasons such as the blockage of one or more lanes due to traffic accidents or other incidences. Capacity reliability explicitly considers the uncertainties associated with arc capacities by treating roadway capacities as continuous quantities subject to routine degradation due to physical and operational factors.

Reliability of road network capacities depend on several factors of which demand levels is one. Road networks are designed to carry certain base travel demand levels and recent studies have shown that when demand levels are lower than the base demand levels, networks exhibit a very high level of reliability but once demand levels increase, capacity reliability deteriorates and fails completely when the levels go higher than the base levels (Chen et al., 2002). A capacity related reliability measure differs from the conventional maximum flow model in which driver behavior is explicitly considered. To model everyday situations, capacity of a Iink is treated as a random variable to allow for different levels of degradation. This reliability measure provides a probabilistic way to assess the existing network capacity, which could be used to improve the planning, design, and operation of transportation networks. It can be integrated into the traditional planning process to model networks under uncertainty to better quantify the performance of the network.

The level of service concept has gone through a lot of developments as far back as the 1950s till now. Its formal introduction in the Highway Capacity Manual (HCM) was in 1965 (Highway Capacity Manual, 1965). In the 1985 version of the manual, it was defined by six levels (A to F) in relation to several traffic conditions like a combination of travel time and the ratio of traffic flow rate to the capacity, because travel time was recognized as a dominant factor of the service quality (Highway Capacity Manual, 1985) as cited in Kita (2000).

According to Zhang et al (2004), previous editions of the Manual (Highway Capacity Manual 1985; Highway Capacity Manual, 1998) defined LOS as “a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and passengers”. The phrase “perception by motorists and passengers” was removed from the 2000 edition (Highway Capacity Manual, 2000; Zhang & Prevedouros, 2004). The 2000 version of the Manual defines LOS as “a qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience”. Although “perception” is no longer used to define LOS in HCM 2000, Zhang and Prevedouros (2004) are of the view that there is no doubt that LOS is a qualitative measure that needs to reflect user perceptions of quality of service, comfort and convenience.

2.6.4 Macroscopic Fundamental Diagram (MFD)

Macroscopic models common to traffic-related simulations have a long history, with the study of fundamental diagrams by Greenshields (Greenshields, 1935) as cited in (Muñoz, 2004). According to Dixit and Radwan (2007), the measurements and relationships that exist between macroscopic variables (speed, density and flow) have been broadly studied for traffic streams theoretically and practically (Edie, 1963; Gazis, 1974) as cited in Dixit and Radwan (2007). Works by Wardrop (1952) and Smeed (1968) dealt with the development of macroscopic models for arterials, and were later extended to general networks (Wardrop, 1952; Smeed, 1968) (as cited in Geroliminis, 2008).

Geroliminis and Daganzo (2008) in their experimental findings show that MFDs can be used to control demand and improve mobility and accessibility within a city. This can be done with pricing, rationing and/or perimeter control strategies based on neighborhoods’ accumulation and speeds, such as those proposed in Daganzo (2007) and Geroliminis and Daganzo (2007). Simple versions of these strategies are already being used: for example in London, Stockholm and Singapore (pricing); in Beijing - a test in anticipation of the 2008 Olympics, and Mexico City (rationing); and in Zurich (perimeter traffic control). But by knowing the MFD and monitoring the state of traffic continuously, transportation managers can now see whether their system is in a state that is producing the desired accessibility levels for all modes and at all times. Therefore, existing strategies can be refined.

Typically, an MFD can be put into four phases (A, B, C, D) as shown in Figure 2.5and each of these phases shows the different state of the network with increasing traffic flow.

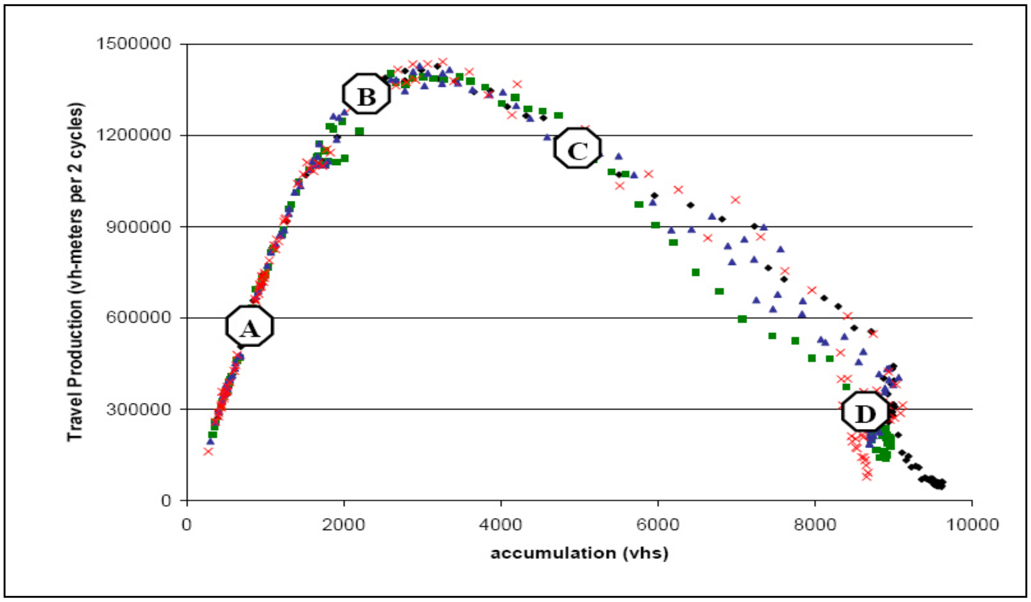

Figure 2-5: A typical MFD for the City of San Francisco (Geroliminis & Daganzo, 2007)

For the above diagram in Figure 2-5, phase A shows the condition when the system is under saturated and the average speed is about 25 km/hr with an accumulation of about 952 vehicles. As demand increases the system moves to state B where the vehicle - miles travelled is near the maximum and the average speed is 17 km/hr with an accumulation of 2143 vehicles. At this stage, engineers can tell at what accumulation the system experiences its maximum capacity, and this can be useful for planning purposes as well as knowing the land use activities that contribute to that accumulation. In phase C congestion is broad, long queues are observed and the average speed drops to 7 km/hr (with an accumulation of 5337 vehicles). In state D the output is near to zero (at jam density), and the majority of vehicles are stopped (with accumulation of 8943 vehicles). Once again, knowledge about the jam density could assist in putting in management measures to manage the density within the town from getting to such high levels, thereby reducing congestion.

2.6.5 Transport and Land Use Interaction

Land use planning (LUP) has been defined and described in as "a programme of state intervention in land use and environmental change to mediate conflicts of interests over how land should be used, developed and coordinate individual activities which if left to proceed otherwise would lead to an environment for living that is characterized by negative externalities, inefficient use of land and services, inequity and unfair distribution of resources" (Nnkya, 1998).

Land use and transport interaction, as seen by Shaw and Xin (2003), is a dynamic process that involves changes over spatial and temporal dimensions between the two systems. Changes in land use systems can have effects on travel demand patterns and induce changes in transport systems. Land use changes affect travel demand and access to transport systems also has effects on land use due to the interconnection between land use and transport. The increase in demand to travel as a result of land use changes calls for the provision of additional transport facilities; and accessibility levels are enhanced with the provision of these facilities. This may also lead to the development of new land uses, leading to increasing demand which feeds into the process again symbolizing the need to really consider land use and transport planning in an urban planning process.

Transport plans that underscore the land use planning approach may influence settlement patterns so as to increase accessibility to shops, jobs and institutions without the need to travel by car or by minimizing the usage of cars and minimizing the distance travelled. Volume of traffic generated by different land uses varies during different periods of the day but there is usually a predictable pattern of such traffic volumes (Oduwaye, 2007). This variation between geographical areas comes about as a result of the way towns are planned. Planning helps decide where to put what and for what reasons.

Although Land Use Transport (LUT) interaction has some positive feedbacks, negative feedbacks may also arise as a result of the level of interaction. The planning status of some towns takes shape along areas of well-developed road networks which also increases the number of trips to those areas as a result of the improved level of accessibility. The trip patterns to those zones are as a result of demand from those areas, coupled with improved accessibility that lead to congestion on those links and junctions in the road network. This may call for further improvements to the road network. Over time, it becomes increasingly difficult for road controlling authorities to respond to the increase in demand for road travel due to the high costs of urban road schemes and the adverse social and environmental impacts of road building. Land fragmentation may also occur at areas where new roads are to be constructed to link newly developed locations to town centres. Changing traffic patterns can have effects on businesses. The types of these land use activities may change in response to altered traffic patterns and accessibility.

With this basis of LUT interaction, it is possible that an MFD for the town of Nyeri was affected by the different land use types in the town because these and other land use types generate and attract different trips at different times of the day; so information from such a diagram is expected to be channelled into further planning of the town so that accessibility and mobility levels was enhanced. The study of an MFD for the town requires that consideration is also given to the land use component as well. This is because the level of land use - transport interaction for any town translates into traffic flow and as an obvious phenomenon land use and its related activities generate and distribute trips between places. These trips could (and often do) lead to the occurrence of congestion on our roads and the development of MFDs assist in evaluating demand-side policies to help reduce congestion.

Studies into the spatial arrangement of different land uses and their transport components would then give an idea on how land use and transport interactions have influence on an MFD for a particular town. This is because the spatial arrangement could have influence on traffic flows which describe the state of performance of the town as determined by an MFD. Land use changes can have effects on travel demand patterns and induce changes in transport systems. Increasing demand to travel as a result of land use changes then calls for the provision of additional transport facilities; accessibility levels are enhanced with the provision of these facilities. The mobility and accessibility levels in towns that arise as a result of land use transport relations can therefore be studied from an MFD established for the town.

2.7 The Use of GIS in Traffic Flow Analysis and Management

Geographic information systems (GIS) have helped to shape the evolution of transportation engineering and planning and now serve as an integral element in managing traffic and transportation systems. Given the complex multimodal and multi jurisdictional issues that fall under the umbrella of traffic management, many GIS transportation applications have been designed for collection, analysis, and distribution of data. The ability to combine maps with extensive databases makes GIS ideal for considering spatial and temporal dimensions of traffic systems (Han et al., 2002).

The ability to share, manage, model, and visualize data has and will lead to break throughs in gathering traffic data, disseminating travel information and advisories, increasing the safety of transportation systems, and optimizing transit. As it is not possible to canvas an entire roadway network with traffic cameras (nor is it possible to have enough people to view that many cameras), one must rely on traffic data such as speeds and volumes to assess performance of a system. Given spiraling congestion of traffic across the globe, this data is also necessary for analyzing and then optimizing transportation systems. Likewise, transit systems must also be optimized through sensitivity to demand and intelligent transportation planning. Finally, an optimized system will only perform as well as the motorists, who require information to make good decisions and who should be afforded a system that is safe. All of these needs may be effectively and efficiently facilitated through the application of open, compatible GIS platforms.

Travel times and speeds are the data traditionally used when assessing the level ofservice provided by a highway network. Unfortunately, the availability of this data is typically restricted to point sensor locations. Data may only be gathered where a sensor, such as a loop detector, is present, but cost of installation and maintenance, and the necessity to make cuts inpavement for installation, limit the number of sensors that can be installed. An appealing alterative to the traditional point sensor is the probe sensor, where a vehicle in the system relays speed and location data. Meaker and Horner (2004) explore an existing source for this probe data: the network of Automatic Position Reporting systems (APRS) that have been established by amateur radio operators principally to serve mobile radio stations. These APRS collect location and speed data from mobile Global Positioning System (GPS) receivers in probe vehicles, which then becomes available in real-time over the internet. Large amounts of this data are available in urban areas, particularly along the west coast and in the northeast. Since the location data is geo referenced, it may then be brought into a GIS as a layer of points for traffic assessment and analysis.

GIS may be used not only for estimating parameters of traffic, but also for estimating the parameters of specific traffic elements. Since heavy trucks account for a disproportionate share of incidents and resulting injuries and fatalities, these vehicles deserve special attention in traffic analysis and volume estimation. Unfortunately, state-of-the-practice commodity-based and vehicle-based modeling techniques tend to perform marginally at best. Using classification counts, socio-economic data, and statistical models, however, a GIS platform can be developed that provides more accurate truck volume, flow, and percentage estimates than can be derived from existing methods. Moreover, the platform may allow for automatic updates to reflect new data (Boilé & Golias, 2004).

Shifts and increases in population create new and complicated demands that existing transportation infrastructure is poorly equipped to accommodate. A large, dense population and issues of cost often mean that more highway lanes cannot simply be added or number of buses increased. Thus, it is necessary to make the best of existing infrastructure and optimize current and new additions to mass transit.

Seeing a solution to Indian transportation issues through optimal use of public transportation through integrated transportation planning, Vermaand Dhingra (2005) developed a GIS-based model for establishing an optimal rail corridor as part of the larger goal of creating an efficient demand-sensitive multimodal mass transit system. The model identifies transit demand and then uses an heuristic algorithm in *TransCAD* GIS software to identify an optimal rail corridor, which can then be displayed graphically.

Naturally, traffic performance is at the mercy of any dangers to motorists that are present in the system. Traffic accidents stop or slow traffic in the direction of flow, create queues, slow traffic in the opposite direction ("rubbernecking"), and continue to adversely affect traffic flow well after they have been cleared. To make matters worse, these dangers may not be readily apparent when engaging in transportation planning or safety analysis. GIS can again be helpful in this regard, as demonstrated by Khattak and Shamayleh (2005). They first learned that GIS data visualization is successfully being used for transportation safety, public information relaying, and land use and transportation integration applications. They then succeeded in-gathering light detection and ranging (LiDAR) data, inputting the data into ArcView, creating 3-D models, and visually identifying areas that contained obstacles to safe passing and stopping sight distances.

Montufar (2002) demonstrated that the benefits of GIS could be extended to heavy truck safety analysis as it relates to road design, traffic engineering, and highway maintenance. GIS stands out from other techniques due to its ability to integrate collision,location, and traffic databases and conduct spatial analyses.

It is safe to say that traffic management and transportation systems have a great deal to gain from continued use of GIS. Spatial analysis and data visualization open new windows in transportation analysis and safety assessment. Graphical representations of data aid analysis can be used to keep travelers informed and able to make intelligent decisions, whether on the road, at a transit station, or at home.

Integrated GIS databases allow for effective, efficient, user-friendly data storage, management, and distribution. GIS-based modeling applications allow for a better understanding of the transportation system than was once possible and can be used to optimize existing or planned systems. Real-time traffic performance as determined by GIS can be crucial for traffic monitoring and incident management.

2.8 Conceptual Framework

The study was guided by the conceptual framework as shown in Figure 2.6 relating the dependent and independent variables.

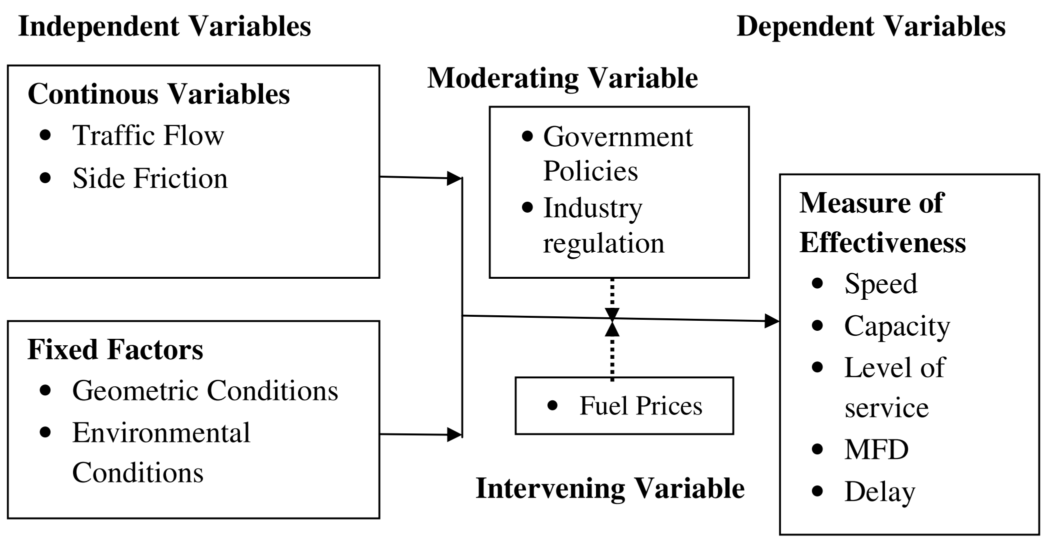

Figure 2-6: Conceptual Framework

In this framework, there are certain factors influencing traffic flow. The dependent variables (or measures of effectiveness, MOE) that are usually considered in traffic studies are:

i) Speed, including free-flow speed (a key parameter in many models);
ii) Capacity (the maximum stable flow which a road can carry);
iii) Flow/capacity ratio (often used as an indication of whether extra capacity is needed and also an input to determine level-of- service for some road types as indicated in HCM 2000)
iv) Level of service (a concept used to define degree of driving 'comfort' and the drivers' freedom to manoeuvre);

v) Delay (for an individual vehicle, the difference between its free-flow (or desired) travel time and its actual travel time)

vi) Number of stops

vii) Bunching (the proportion of vehicles which are travelling in platoons other than as leading vehicles).

Independent variables that are expected to affect measures of effectiveness was categorized in two classes: continuous variables and fixed factors. These are explained as follows:

i) Continuous variables

- Traffic flow
- Side friction

ii) Fixed factors

- Geometric conditions
- Environmental conditions

The main 'measure of effectiveness' (MOE) that was selected to describe road link performance is speed. This includes operating speed (at a given level of flow and friction) and free flow speed. The independent variable that was focussed on more in this study was traffic flow.

2.9 Summary of the Reviewed Literature

The review covered most of the key areas in the analysis of speed, flow and Density. Perhaps of most importance was the review of models of speed and flow. The general literature was particularly valuable in guiding the approach to model-selection and fitting, and in drawing attention to some of the associated difficulties. This literature is of value because some types of roadside activity discussed are similar to those in Nyeri. They provide some key guidelines to some practical issues in relation to this thesis, where methodologies and types of speeds, flows and densities are important aspects of relevance.

Although an MFD has been researched for a large city like Yokohama in Japan, it has not been used to predict the performance of the city in terms of mobility and accessibility. And it is in this line that this research intends to establish fundamental traffic flow diagrams for Nyeri town in Kenya and to derive the flow characteristics associated with traffic operations in the town. Transport activities within towns and how trips are being generated and distributed between and within activity locations may on the longer-term change activity patterns and land-use patterns (Zuidgeest, 2005). Therefore, there is need to consider appropriate indicators for area-wide studies for towns since segment-based indicators may not be enough for urban planning and management purposes, although they can serve other useful purposes. By virtue of this, the MFD is a typical example of such indicators that could help improve towns' accessibility and mobility levels.

To be able to describe the states of road networks, traffic analysis need to be performed and it can be deduced if such networks are effective and reliable or not. Together with such studies, indicators were required to describe the performance of the networks and examples of such indicators discussed included travel/ journey time reliability, connectivity reliability, capacity reliability, LOS and the MFD. All, apart from the MFD consider road performances at disaggregate link and intersection levels. This makes the MFD, an appropriate indicator for the research purpose.

Next is the interaction between land use and transport since this interaction could affect the shape of an MFD. Changes in land use systems can have effects on travel demand patterns and induce changes in transport systems. The increase in demand to travel as a result of land use changes calls for the provision of additional transport facilities; and accessibility levels are enhanced with the provision of these facilities. The effects of transport system changes on land use and vice versa, not only occurs at varying spatial scales but also at varying temporal scales (Shaw and Xin 2003). Traffic demand variations between geographical areas are as a result of the way cities are planned.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter identifies the data requirements for the research. The types of data and how they were collected, which is essential to help provide answers to the research questions, were discussed in this chapter. The instruments required in collecting the data and how these data were validated is mentioned in the chapter as well. Useful information was derived from data through analysis. Lastly, a brief description of the analysis is made.

Methodological framework that looks at the steps to be taken to analyse the data in this research is shown in Figure 3.1. The approach to establishing an area-based indicator for a town like Nyeri is based primarily on the relationship between average traffic flow and speed for the entire network. The data for this relation was collected by MetroCount Vehicular Classifier over a period of time. Developing very effective strategies to enhance traffic flow conditions on road networks require knowledge on the state of road at any point in time and space.

This data was prepared and analysed in different ways to obtain the desired variables/ parameters that needed to be compared so that explanations, conclusions and recommendations can be made. The relationship between average traffic flow and speed for the network was an area of focus since this establishes the MFD, which was used to assess the performance of the town's road network. The types of variables considered was guided by the objective of the study and the method of approach. In this case the method of approach was 'macroscopic' based on data collection of traffic characteristics at an aggregated level.

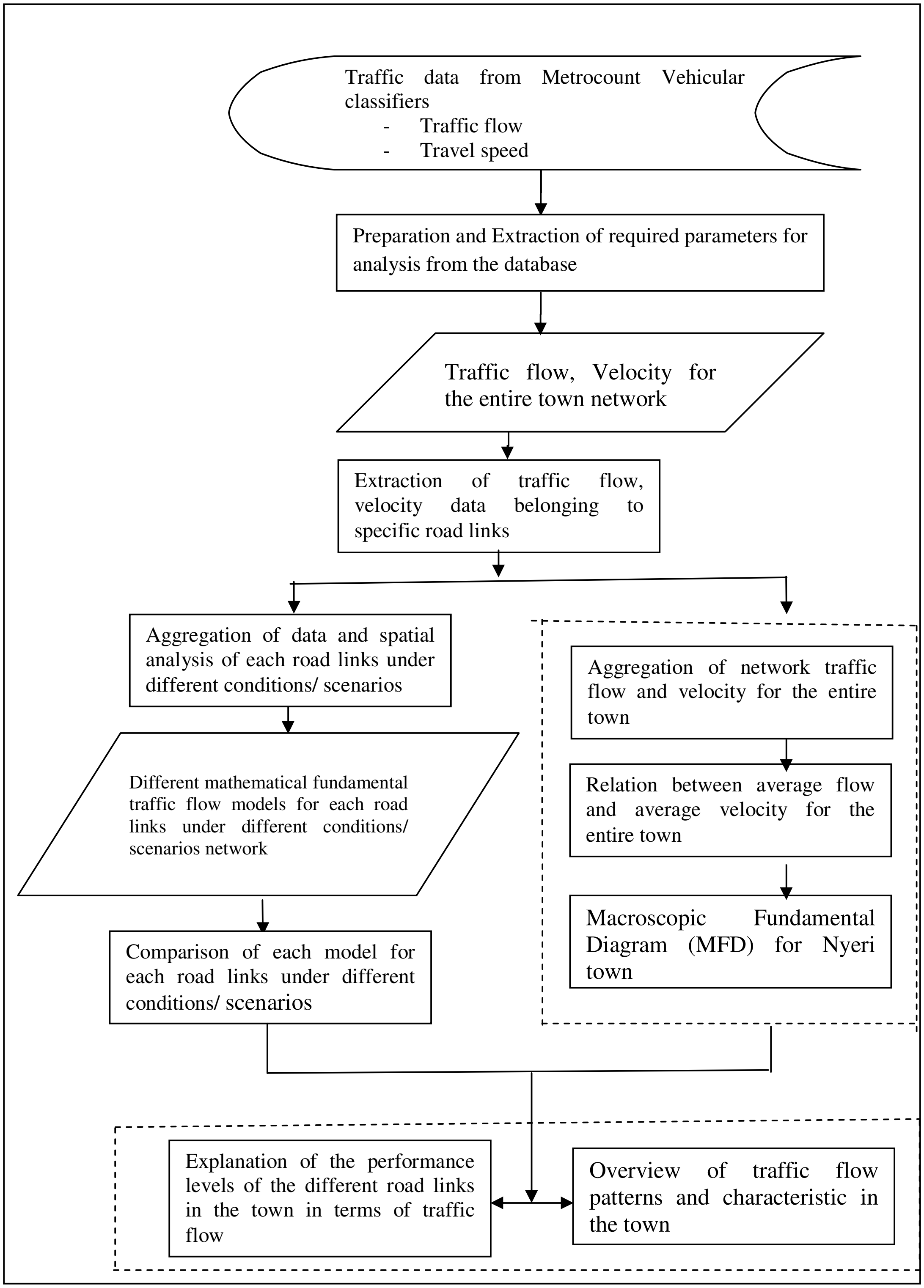

Figure 3-1: Methodological Framework for Analyzing the Data

3.2 Types of Data and Sources

Due to the nature of information required, speed, flow and density, and the unavailability of secondary traffic flow data for Nyeri town, collection of primary data for this study was done. The type of data that was collected was macroscopic based on traffic characteristics at an aggregated level. The process of identification and selection of such variables is explained below:

The dependent variables mentioned earlier was screened as follows:

i. Level of service (LOS) was not be used as it is basically meant to present results easier to understand than if the numerical values of the measurements of effectiveness (MOE's) and service measures are reported directly. Essentially, level of service (LOS) ratings are more useful to decision makers who are not analytically oriented and often prefer to have a single number or letter to represent a condition.
ii. Delay implies the definition of a free-flow travel time, or free-flow 'slowness'. It is rather appropriate for long stretches of roadway than what is involved in this study. Essentially, it is a critical performance measure on interrupted - flow facilities, where control delay is the principal service measure for evaluating LOS at intersections. It was considered rather unfeasible in this case because of the short stretches of the roads involved.
iii. Number of stops is used to describe the quality of traffic performance. It is most useful in corridor studies where percentages of stops are likely due to numerous availability of intersections. It was thus considered not relevant in this particular study where intersections were not included.
iv. Bunching was considered to be potentially attractive on 2 lane-2 way rural roads, but less suitable to urban roads on an experimental study like the one at hand.

Hence the main data that was selected to describe road link performance is speed and capacity. This included operating speed (at a given level of flow), free flow speed, maximum flow.

In this particular study, the focus on the independent variables, earlier mentioned, was more on continuous variable, that is traffic flow.

3.3 Sampling

Nyeri town is linked to other surrounding towns by several arterial roads and numerous collector roads that connect to the arterial roads. Data for this study was collected on the seven major arterial roads around Nyeri town. Table 3.1 shows the major links considered around Nyeri town with their lengths, travel lanes and functionality.

Table 3.1: Major Arterial Roads (Links) considered around Nyeri town

Link	**Length(Km)**	**No. of travel lanes**	**Functionality class**
Nyeri-King'ong'o	2.0	2	B5
Nyeri-Kiganjo	9.4	2	C75
Nyeri-Nyahururu	100.2	2	B5
Nyeri-Tetu	6.0	2	D434
Nyeri-Ruring'u	3.0	2	B5
Ruring'u-Marua	6.0	2	B5
Ruring'u-Othaya	30	2	C70

The sites where the data were collected in each road link is shown in Figure 3.2.

Urban roads in Nyeri town are functionally classified as arterial, collector, or local streets. Arterial roads are designated for major traffic movements with high volumes and high design speed. Collectors are designated for reduced movement function and may be either primary or secondary. Local roads are designated primarily for accessibility. All the roads are two-lane two-way facilities. The common lane width for arterials is between 3.5m –3.7m and for collector and local roads is between 3.0m – 3.5m. Most of arterial and collector roads have shoulders some of which are unpaved. Speed limits for major arterial range from 50 km/h – 80 km/h depending on location within the town area while for most collectors is below 50 km/hr, and most local roads are rarely posted with any speed limits. Parking lanes are common on downtown streets, which are local streets and essentially function for accessibility. Mostly, collector and local roads outside the Central Business District (CBD) are characterized by unpaved and undesignated walkways. Generally, only part of the observed network especially arterial and collector roads was suitable for this study.

According to the Road Design Manual, the Nyeri-Kingongo, Nyeri-Nyahururu, Nyeri Ruringu, and Ruringu-Marua roads are desired to have full level of access control. The level of access can also be reduced to partial control on this road due to practical reasons and financial constraints. The desirable level of access for Nyeri-Kiganjo and Ruringu Othaya roads is either full or partial control but can be reduced to partial control. Nyeri Tetu roads is desired to have partial level of access control and can be reduced to unrestricted access control.

The Identification of traffic conditions involved primarily two items, which include vehicle composition and directional distribution as explained below:

a) Vehicle composition

The motor traffic was identified to constitute mostly of passenger cars, light vehicles (jeeps, pickups, micro-vans, utility vehicles), mini-buses, and few large buses, big trucks, and motorcycles (two-wheeled and three-wheeled vehicles).

b) Directional distribution

Traffic flow was recorded for both directions for the two-lane two-way roads. Environmental characteristics of road links, which are expected to affect traffic characteristics, are described below as an input to the selection of the study sites:

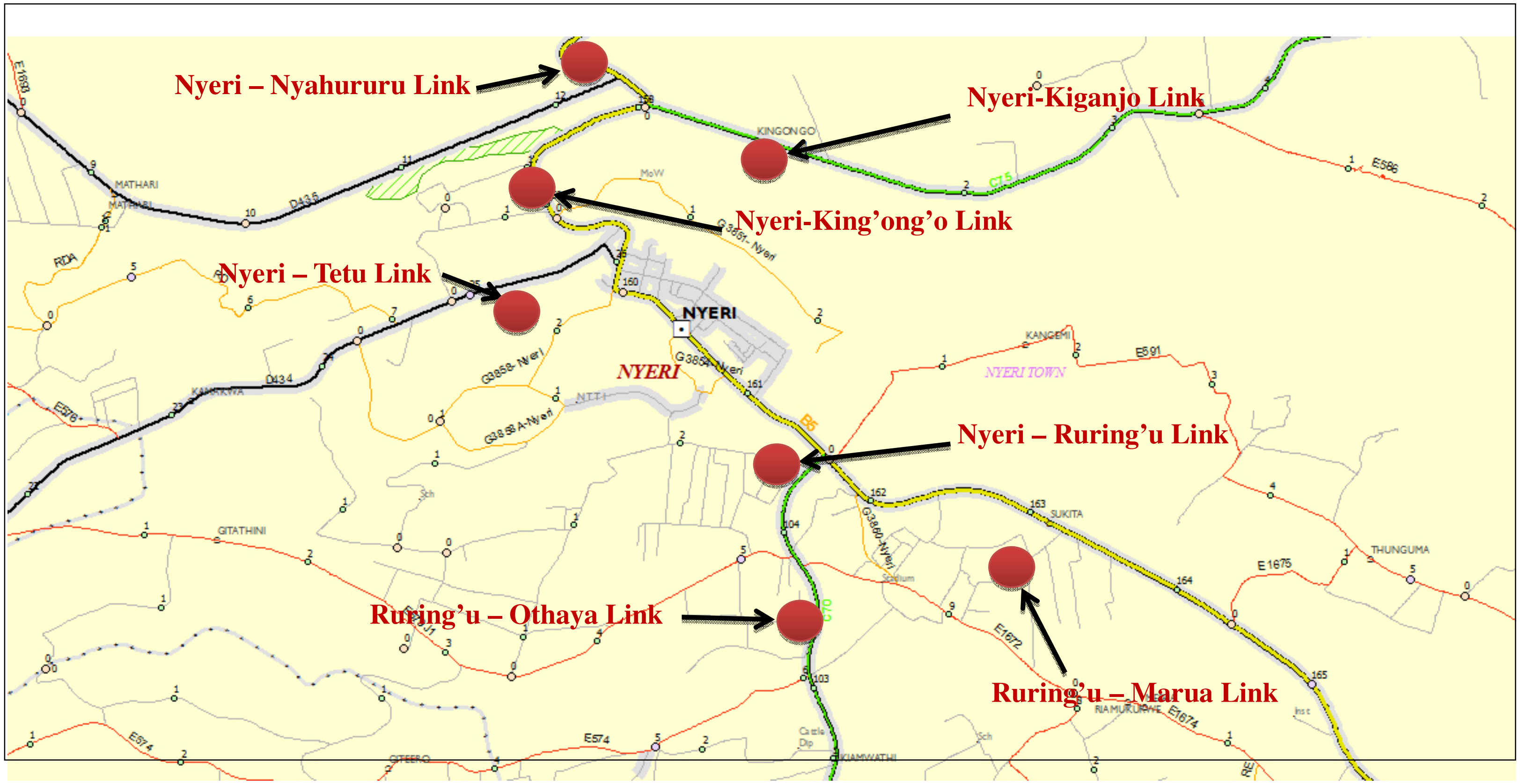

Figure 3-2: Nyeri town, it's environ and the major links considered in this study.Location characteristics/Type of area:

Traffic facilities are traditionally classified according to the type of area in which they are located. This was reflected in the case of urban and suburban areas where the intensity of roadside activities varied accordingly, i.e. higher in the urban region and lower in the suburban, In essence, location characteristics or area type have potential influence on traffic operations. In Nyeri town, it was found that the town centre (CBD) is comprised of short streets with numerous junctions and compact human activity, while the urban area that surrounded the centre had relatively long streets and spaced junctions with comparatively low roadside activities. The suburban areas comprised of arterial highways with few junctions and varying degrees of roadside activities. The study was therefore carried at the urban and suburban areas of Nyeri.

i.) Weather conditions

Weather conditions include various factors such as rain, wind, fog, smoke, and clouds. Most of these factors affect speeds and capacities by reducing visibility (Brimblecombe,1981). In particular rain affects both speed and capacity by reducing visibility and causing a wet road surface (Lamm, et al., 1990). Rains are common in Nyeri, and therefore the data collection was done both when the surface is dry and and wet.

ii.) Time of day

Capacities of road links may vary by time of day, due to the changing mix of trip purposes, e.g. commuters may drive more urgently and know the network better than others. Also night traffic characteristics are different from daytime characteristics, i.e. speeds are likely to be higher in the day than at night due to good visibility. However, the objective of this study is not limited to the time of the day hence data collection was done throughout the day, both day and night.

iii.)Surface condition

Poor road surface condition (potholes and unevenness) reduces capacity. Data was therefore collected in sections with poor, fair or good road surface conditions.

All sites were selected in places with good site clearance, and data was collected during same times of the day and night to ensure similar weather conditions. In effect, this excluded variations in physical configurations of the study sites and weather/time variations.

3.4 Establishment of Fundamental Traffic flow Models and deriving the flow characteristics associated with traffic operations in Nyeri town

3.4.1 Traffic Data and Collection Methods

In order to meet this objectives, it was necessary to undertake a field data collection exercise that covers the whole town. The primary source of traffic data collection is through establishment of regular manual traffic counting programmes and spontaneous automatic counters along the public road network. Origin – Destinations survey is a special way of carrying out traffic counts/survey, whereby the data collected relates to the use of the road by vehicle category. The various types and methods used to collect traffic data provide good and valuable coverage of the required traffic information for decision making and planning of both development and maintenance of the road network. The approach to data collection focussed to address the following traffic flow variables:

i) traffic flow,
ii) average speed
iii) traffic density,

The detector that was used for data collection in this study is the MetroCount vehiclular classifier.

The main field equipments that was used in the measurements of speed, flow and density data included the following: field vehicle, a MetroCount vehicle classsifier, clipboards, tape measure and pencil. The laboratory equipments are considered both as relevant for data collection as well as for data reduction; they included a computer installed with metrocount classifier program (MetroCount Traffic Executive), pencil and paper.

The use of MetroCount Vehicular Classifier in Data Collection

The MetroCount Vehicle Classifier System is a portable vehicle classifier, designed for short term data collection using axle sensors.The MetroCount Vehicle Classifier System is a sophisticated combination of both hardware and PC-based software, with a strong emphasis towards data analysis and interpretation.

The MetroCount Vehicle Classifier System is comprised of the following components:

i) MetroCount Roadside Unit,
ii) MetroCount Traffic Executive, and
iii) MetroCount Signature System.

The Roadside Unit is the hardware component of the MetroCount Vehicle Classifier System.

It stores data as time-stamped axle hits on each of the sensors, with better than millisecond accuracy, forming an axle stream. It is important to remember the Roadside Unit never actually stores vehicles or axle counts (MetroCount Traffic Data Specialist, 2002). The Roadside Unit is controlled via a standard RS-232 serial communication port, using MCSurvey for desktop and laptop PCs, or MCSetLite for Pocket PCs.

The Roadside Unit can be installed in a variety of ways, with either one or two sensors. The most common approach is to use the **Classifier Sensor Layout** which requires two sensors in parallel, usually one metre apart. This sensor configuration maximises the amount of information that can be obtained from the stored axle stream, by the analysis software on the PC. The information includes the common parameters of volume, class, speed, direction, headway and so on.

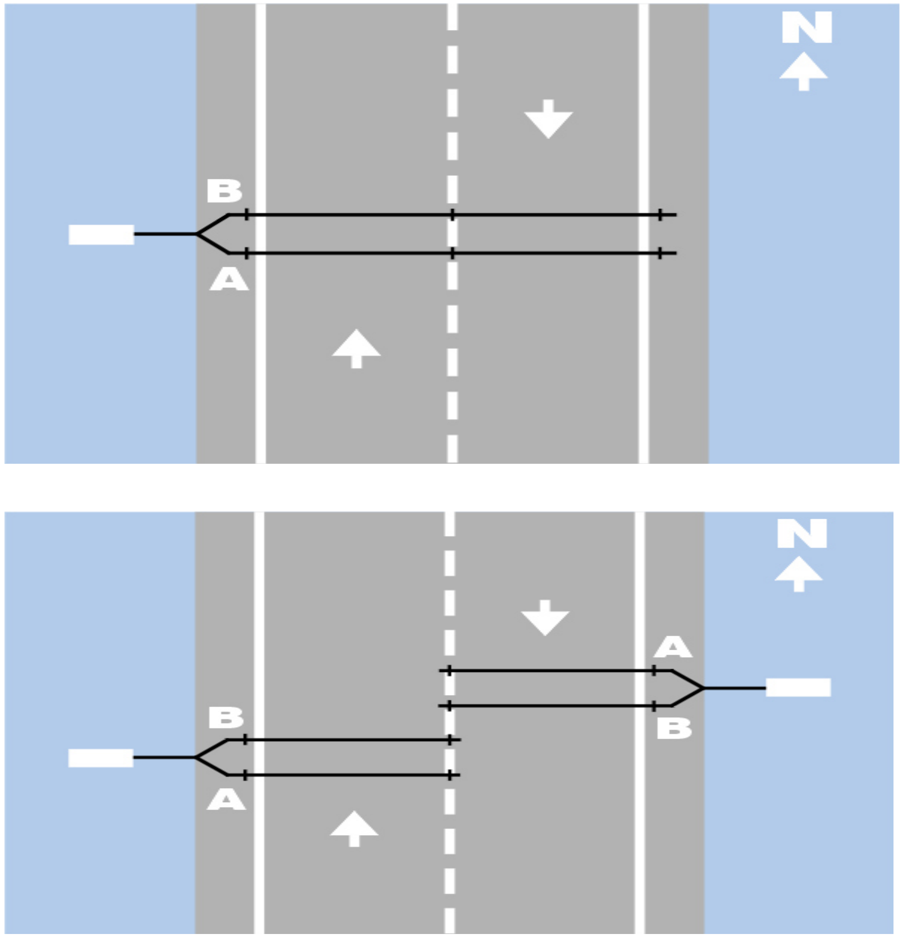

Figure 3-3: Examples of Classifier Sensor Layouts (Left-hand driving)

The Roadside Unit can also be used in several **Count Sensor Layouts**, to obtain short-term count information. Each of the sensors can be placed independently of each other and across multiple lanes. Alternatively, the sensors can be used in a split mode. Either of these sensor configurations allow you to obtain not only basic volume information, but also traffic characteristics.

Digital Debounce is an important feature of the Roadside Unit. Consider the case of rubber tubes and air switches as the Roadside Unit's sensors. When a wheel passes over a tube, the air switch may actually register a number of hits, only separated by a few milliseconds. This is commonly caused by the tubes slapping or slow moving vehicles.

The Digital Debounce eliminates these spurious hits so that the logged axle stream only contains one time-stamped axle event for each axle. For example, with a debounce time of 30ms, all hits for a period of 30 milliseconds after the first detected hit are ignored. When the Roadside Unit is setup, you select a debounce time in milliseconds (ms) that is suitable for the survey site, based on the Sensor Layout and expected speed of the vehicles at the site. For a Classifier Sensor Layout, the typical debounce time is 30 milliseconds. For a Count Sensor Layout, a debounce setting as low as 10 milliseconds would be used. These times are acceptable for the majority of sites, assuming a secure sensor installation and a quality roadbase. Even if the Roadside Unit logs some spurious hits, the analysis software automatically removed the. Settings above the default 30 milliseconds are rarely required. Using a mobile PC in the field, you can use real-time axle views to ensure there is a direct correlation between axle hits and what is being logged by the Roadside Unit.

Traffic intensity data from metro counts was collected at different locations of the network over certain durations and at the same period. The same applies to velocity data to be collected by the metro counts. The data was collected for two and half week's periods from January 2015 to February 2015. For the traffic velocity data, speed profiles were derived by Metro Count Vehicle Classifiers. This consumer data helped determine realistic average roadway speeds for different times of the day and different days of the week.

3.4.2 Data Preparation, Validation and Reliability Checks

Series of operations were performed on the primary datasets, so as to prepare them for analysis in further stages.

3.4.3 Data Limitations

Amid financial and time constraints, it was important to develop cost-effective, simple, and accurate methods for data recording, storage and reduction. Traffic flow and speed data collected by MetroCount Vehicular classifier faces some limitations to some extent and the data for this particular research is not an exception. Some detectors are very sensitive so they record two very close vehicles as one long vehicle. This was solved during analysis where the data scan was done by comparing the tube

A hits with tube B hits and removing the unsuitable data. Vandalism of the tubes and in some cases the classifier themselves, also contributed to lack of data on some the locations at sometimes. This was solved by sensitizing the persons living around the areas on the importance of getting the data. The local administration was also involved in the process and they provided administration police patrols at night in the locations where the classifiers were placed.

3.4.4 Data Analysis

Traffic data analysis was performed by the MetroCount Traffic Executive MCReport. The power of MCReport lies in the simple philosophy of the MetroCount Vehicle Classifier System store every axle event. Axle stream data analysis opens up a world of possibilities for characterising a survey site. MCReport used the classification analysis to analyse the collected data:

i.) Classification Analysis

Classification analysis interprets the axle stream, stored in the MetroCount data files, in three steps:

1. Axle stream partitioning.
2. Classification.
3. Report formatting.

Firstly, MCReport performs the complex task of examining the axle stream and partitioning groups of axles into likely vehicles. This was based on a number of time and distance parameters, determined by MCReport. The second step was to apply a classification scheme to the partitioned groups of axles. MCReport offers a choice of built-in, standard and special-purpose classification schemes. Other classification schemes can be added to MCReport using External Schemes.

The final step was to assemble the classified vehicles into a formatted report. MCReport provides a vast array of report formats for characterising traffic behaviour, and solving real-world problems.

The analysis output and presentation were;

i) Vehicle counts which are presented as a time based reports on a 24 hour format with user defined hourly breakdown time drops of 15 minutes.
ii) Vehicle flow which is presented as a report of time based plot of total vehicle volume.
iii) Velocity dipersion which are time based plots showing relative speed densities. It highlights the relationship between speed and traffic density in a site.
iv) Speeds which are presented as a time based plot of average vehicles speeds per selected intergration period.
v) Data scan which is presented as a report validating a single data file based on a set of adjustable rules and boundaries.
vi) Audit of data quality which is presented as a time based plot comparing the number of axles recorded for both A and B sensors displayed graphically.
vii) Dispersion plots which are presented as a scatter plot of speed versus separation, volume versus speed and density versus volume.
viii) Queued vehicles which are presented as a queued list showing lead and trailing vehicles

Note that from an end-users point of view, this process occurred seamlessly. However, it is beneficial to have a basic understanding of this process to aid the interpretation of the results MCReport produces.

3.5 Determination of the Characteristics of Macroscopic Fundamental Diagram for Nyeri town and Assessment of Macroscopic Fundamental Diagram whether it is property of network infrastructure and control or of demand

3.5.1 Traffic Data and Collection Methods

In order to meet this objectives of this study, the following data was collected:

i.) Free flow speed

ii.) Critical speed

iii.) Maximum flow

iv.) Critical density

v.) Jam density,

Also the detector that was used for data collection in this study is the MetroCount vehiclular classifier and the main field and laboratory equipments used to measure the above variables are MetroCount vehicle classsifier, clipboards, tape measure and pencil, a computer installed with metrocount classifier program (MetroCount Traffic Executive) and paper.

The data was also collected over a period of time, from January 2015 to February 2015.

3.5.2 Data Limitations

The data coolected to achieve this objective face the same limitations as eralier stated in the data coolected for the first objective.

3.5.3 Data Analysis

The data analysis was also performed by the MetroCount Traffic Executive MCReport. MCReport also used the classification analysis and event count to analyse the collected data in the same steps as earlier stated:

i.) Classification Analysis

The analysis output and presentation were;

i) Speeds which are presented as a time based plot of freeflow speeds and average vehicles speeds per selected intergration period.
ii) Maximum Vehicle flow which is presented as a report of time based plot of total vehicle volume.
iii) Velocity dipersion which are time based plots showing relative speed densities. It highlights the relationship between speed and traffic density in a site and gives critical and jam densities
iv) Speed statistics which are presented as report of speed limits and percentiles and all speed statistics grouped by hour of the day.
v) Adjusted flow which is presented as a report showing AADT and ADT

ii.)Event Count Analysis

Event count analysis will involve the interpretation of user-selectable events – usually counts. MCReport refers to the definition of an event as the Count Method, which may be one of the following:

i) raw axle counts,
ii) axle counts divided by 2,
iii) axle counts divided by a custom factor,
iv) following gaps, defined as a starting gap and a following gap.

The analysis output and presentation were;

i) Event List Report which is presented as a text list report of events
ii) Weekly event count which is presented as a table of hourly event counts, peaks and averages

3.6 Summary

This section describes the methods that were used in the research for the data analyses. Literature by other researchers concerning this research was considered broadly. The volume and speed data collection by MetroCount vehicular classifier was described and these data were received in *ECO* formats. Data of this nature also need some amount of preparation and validation and the extensive processes that went into the data validation have been mentioned. The analyses were performed in different phases by generating average speeds from the speed profiles and then establishing relations between the described variables for the town and selected road links of the town. The limitations of the dataset have also been explained. The data was analysed in three phases.

The first phase dealt with generating the average speeds for each road segment from the speed profile data provided by MetroCount vehicular classifier. The speed profiles shows the behaviour of changes in average speeds during a given time period for a road element.

The second phase looked at the performance of spatial analysis for selected road links based on the derived speed, volume and density data. Relationships between average speeds, average volume and density were established for the town and selected road links in the town. The MFD for town was then derived.

Finally, the characteristics of the MFD for Nyeri town were assessed and the MFD for the selected road links were evaluated to determine whether they are a property of network infrastructure and control or they are of demand.

CHAPTER FOUR

RESULTS ANALYSIS AND DISCUSSIONS

4.1 Introduction

This chapter discusses the various forms of spatial analyses that have been performed in this research. The spatial analyses cover the entire town and selected links. Details of how the volume data were aggregated and analyzed have been described. The derivations of the average speeds for each road segment were obtained and are also described. As part of the analyses, speed-volume relations, speed – density relationship and volume – density relationship for the town and selected links of the town have been described. Results from the analyses have been shown and further discussed.

4.2 Traffic Flow Data

Traffic flow data collected over a two and half week period for all the roads was averaged to obtain data for a virtual week and then a virtual day as shown in Table in Appendix 3. Analysis of the volume data gave rise to the average volume graph of the town as shown in Figure 4-1.

The preliminary analysis of traffic flow for all the roads indicates that the shape of the volume graph is in line with the shape of such graphs for other urban areas where the morning peak occurs between 0800hrs and 1100hrs whilst the afternoon peak volume occurs between 1700hrs and 1900hrs.However in this case, the afternoon peak periods recorded slightly higher volume than the morning peak periods which is not usually the case in other urban areas since in the morning most road users make mandatory trips between 0800 hrs and 1100 hrs where as in the evening the peak is usually lower but spread over a longer period of time as indicated by Gonzales E.J et al (2009) in their working paper of Multimodal Transport Modelling for Nairobi, Kenya. Insights and recommendations with an evidence-Based model.. This is an indication that other factors are influencing the evening traffic. This is true because most of the people working in Nyeri do not live in there. They only come to work in the morning but leave immediately after work to their homes in Nanyuki, Karatina, Kerugoya and

Nairobi. Again, Nyeri town has been known to be a crime prone area and this could also make people to move away from town early enough to avoid these crimes. In fact, Nyeri town is referred to as a 'dead town' after 2100hrs since very few people are found in the town CBD beyond 2100hrs. These two factors therefore explain the higher peaks in the evening.

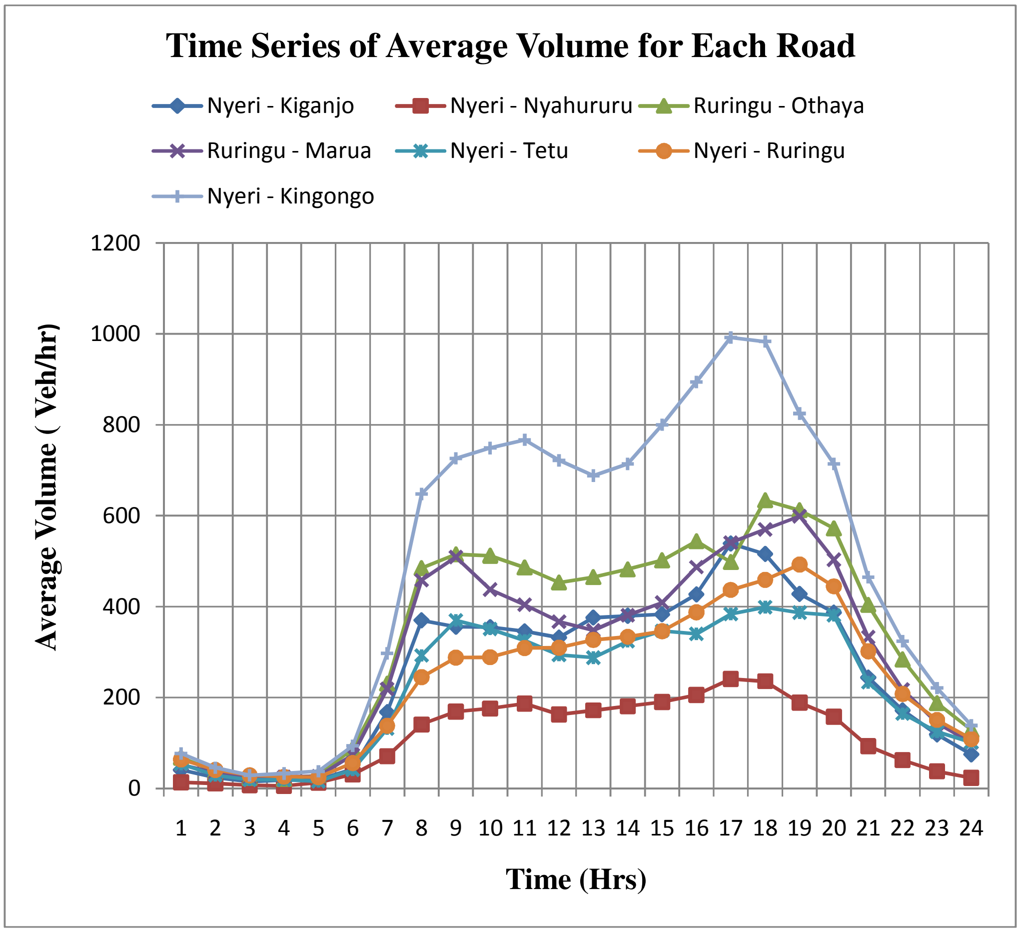

Figure 4-1: Average Volume plot

There was a clear repeatability of hourly variations on all roads. Vehicle volume was below 200veh/hr before 0600hrs and then increased steadily up to 0100hrs when the volume rose to 767veh/hr. Volume started decreasing steadily from 767veh/hr to 688veh/hrs between 0100 hrs and 1300hrs. Between 1300hrs and 1700hrs, the volumes started to rise up from 688veh/hr to a maximum of 992veh/hr. There was a drastic decrease in the volumes between 1800hrs and 0300hrs when the volumes were at the minimum, 24veh/hr.

An analysis of Volume – Capacity ratio was done to determine the congestion levels of each road as shown in Figure 4.2. The basic Capacity of a 2 – lane 2-way road is 2,000 veh/h as indicated by the HCM (2000)

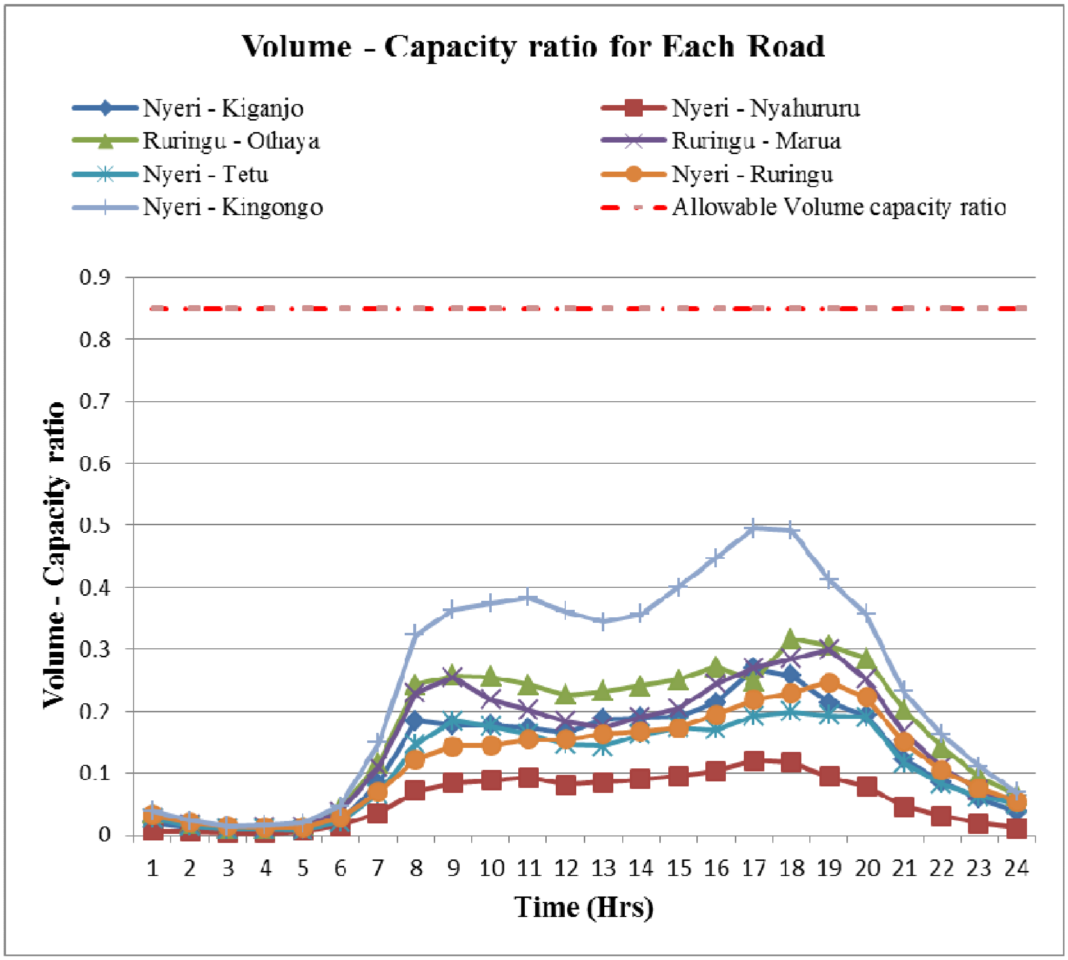

Figure 4-2: Volume – Capacity Ratio plot

Volume capacity ratio (V/C) is one of the most used indexes to assess traffic status in towns, in which V is the total number of vehicles passing a point in one hour and C for the maximum number of cars that can pass a certain point at the reasonable traffic condition.

From the above analysis, all studied road networks have free flow condition since all the V/C ratio is less than 0.85 according to the HCM (2000).

4.3 Speed Data

A time series data of speed on all the links was generated is show in tables in Appendix 2. Analysis of the speed data was performed and the following graph was generated as shown in Figure 4-3.

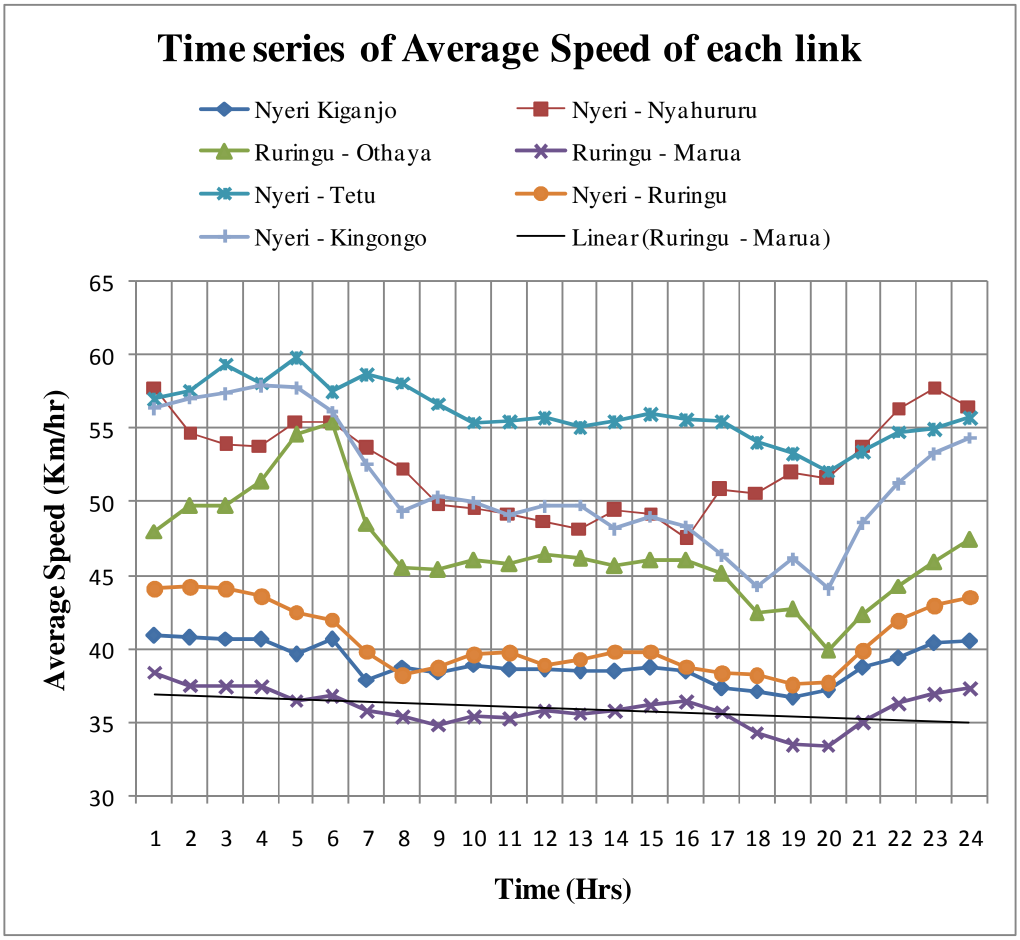

Figure 4-3: Average Speed plot

The average speed for all the links combined was 44.5 km/hr. The highest speeds were recorded between 2200hrs and 0500hrs. These speed correspond with the times when traffic volume is the lowest hence there is little vehicle interactions. Speed in all the links decreases gradually from 0600hrs until 0900hrs then increased till 1000hrs when they stabilised up to 1500hrs. The speeds then started decreasing up to

2000hrs when the lowest speeds were recorded. The speed graph shows that morning peak periods are 0700hrs to 1000hrs and evening peaks occur between 1600hrs and 2000hrs which corresponded with the volume graph indicated. It is worth noting that the links which have low volumes recorded higher speeds, like the Nyeri – Nyahururu link and Nyeri – Tetu link which recorded low volumes but higher speeds, more than the posted speed limits (50 Km/hr) for these links in urban areas. From studies done by the Roads safety Authority of Ireland, Free Speed Survey 2011, it was found that, on urban primary roads with a posted speed limit of 50 km/hr, the average speeds that vehicles travel is between 39km/hr – 61 km/hr. From the speed data above, it was found that all links except Ruringu – Marua link had average speeds within that range. This means that the flow in Nyeri town is inconsistent with travel flow on other towns. The speeds on Ruringu – Marua link are low giving an indication that other factors are influence the travel patterns on that link, and this probably could be because along that link, there are a lot of residential buildings which influences the traffic flows because most residents who go to work and to the town board vehicles there. And because of lack of sufficient bus stops, public service vehicles stop anywhere to collect passengers, hindering traffic flow and reducing speeds of moving vehicles.

4.4 Establishment of Fundamental Traffic flow Models and deriving the flow characteristics associated with traffic operations in Nyeri town

With the data generated by the MetroCount Vehicle Classifier, it was thus possible to plot speed vs. flow for every analysis period of one hour. These plots were developed for each studied site and were critically examined as described below.

4.4.1 Speed-flow Model

Two links roads, Nyeri – Kingongo link and Ruringu – Marua link were selected for presentation here because of their unique characteristics. Nyeri – Kingongo link had the highest volume where as Ruringu – Marua link recorded the lowest speeds. The speed-flow analysis began with the inspection of the speed flow plots for each site. Figure 4-4 and Figure 4-5 shows the plots for the two sites. The plots show one-hour speed-flow data collected in eighteen days in 2015. Analysis of variance test was performed to establish if the data sets of the eighteen days were not significantly different. The results showed that they were not; hence they were combined and 24 one-hour speed-flow data points representing twenty four hours were obtained. Speed-flow model from two link roads were analysed and compared. The speed-flow plots for all the other links are as shown in Appendix 3.

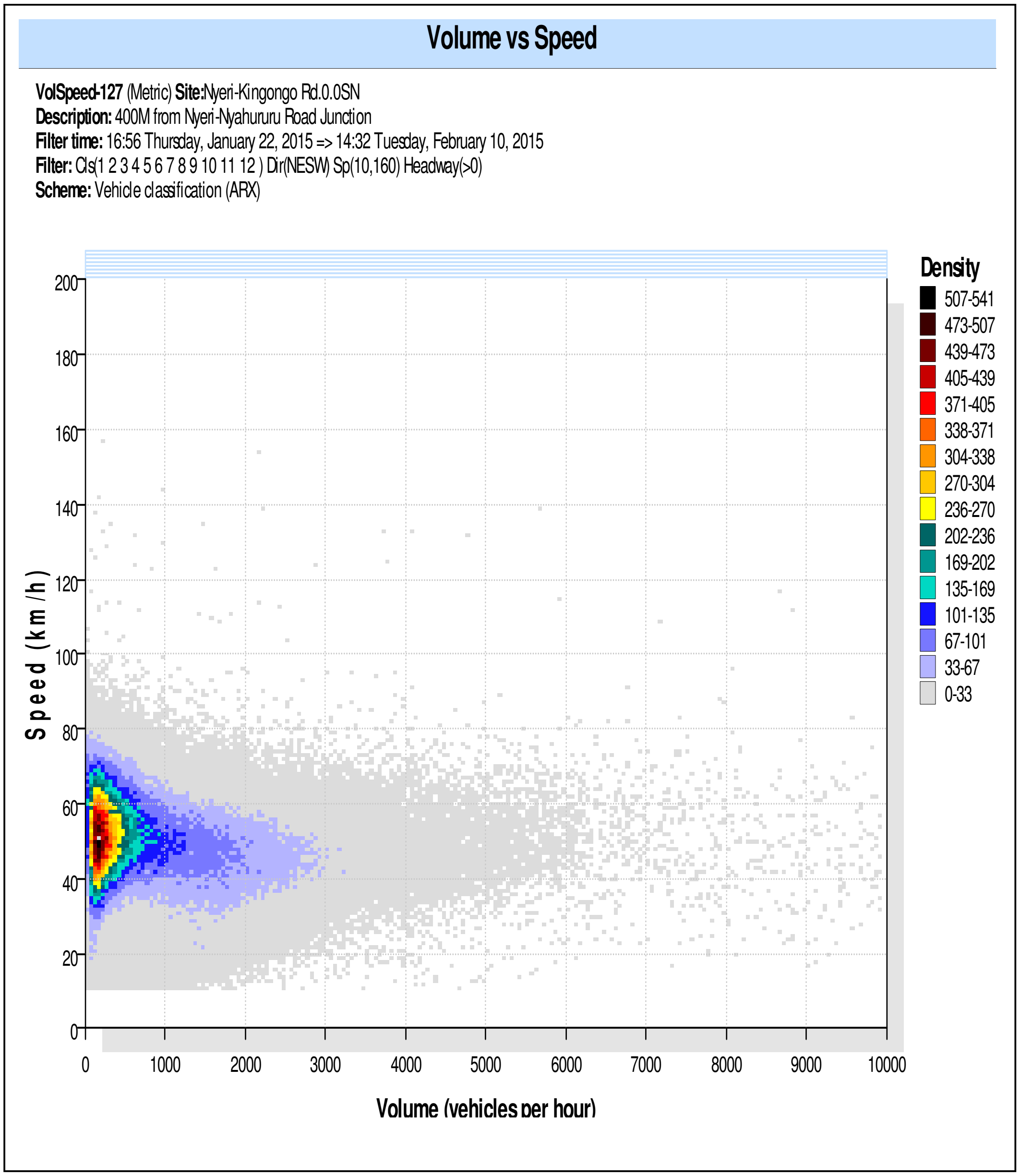

Figure 4-4: Speed-flow plots for the Nyeri – King'ong'o link.

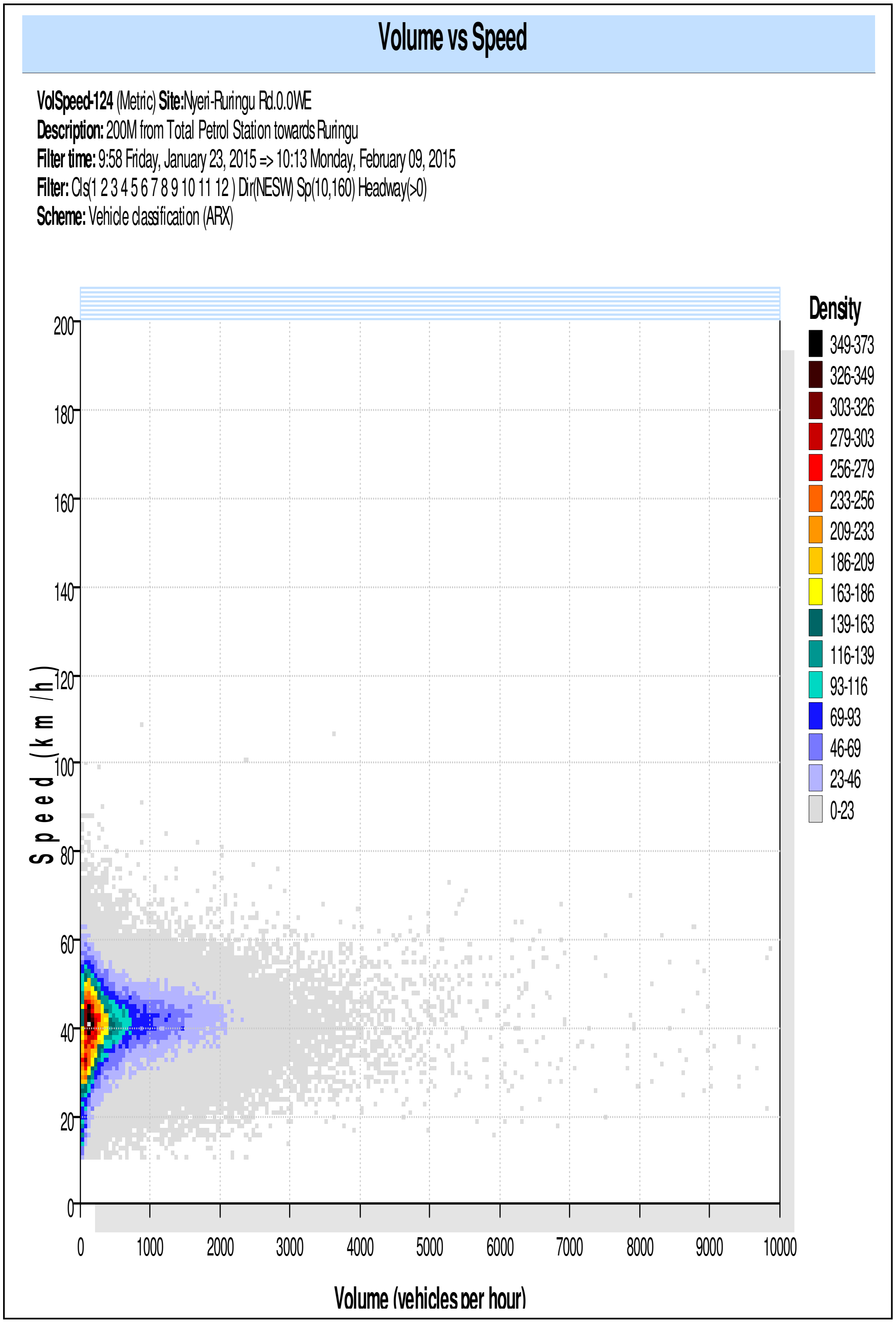

Figure 4-5: Speed-flow plots for the Ruringu –Marua link.

Observing the plots above carefully, it is noticed that most of the sites show more evidently the linear relationship between speed and flow. Furthermore, it is also observed that full range flow was not observed on all the individual sites. Particularly it is noted that capacity flow was not approached on all sites. However, almost all sites experienced flow points low enough to indicate free-flow speed (i.e. flows in the range of 0 - 800 veh/hr). Based on this observation, it was concluded that the linear model sufficed to describe traffic flow relationships on many of the studied sites. To verify this, the linear model was calibrated by the field data as described below:

The generalized linear model is depicted as:

Equation: $u = a - b.q$ ………………………………………………………… (4.1)

Where: u = operating speed (km/hr), a = u_f (km/hr) (u_f = free flow speed), b = slope coefficient and q = flow (veh/hr)

Linear models calibrated for the individual surveyed sites are depicted in the figures in Appendix 3 and table 4.1.

Table 4.1: Speed-flow linear models for the individual links.

Site	Model	R^2	Reference Model from Appendix 3
Nyeri-King'ong'o	u = 56.929-0.0116q	0.8581	Figure 7-1
Nyeri-Nyahururu	u = 56.213-0.0327q	0.7254	Figure 7-5
Nyeri-Kiganjo	u = 40.644-0.0064q	0.7752	Figure 7-2
Nyeri-Ruringu	u = 43.777-0.0133q	0.815	Figure 7-6
Nyeri-Tetu	u = 58.109-0.009q	0.4489	Figure 7-7
Ruringu-Othaya	u = 51.193-0.0131q	0.6172	Figure 7-4
Ruringu-Marua	u = 37.548-0.0053q	0.7092	Figure 7-3
Entire Network Combined	**u = 49.149-0.0017q**	**0.8408**	Figure 7-8

The calibration results above indicate that in general the linear model explained the flow characteristics of the road links as depicted by the R^2-values obtained from the calibration process. On case by case basis, there is only one site which is not well explained by the linear model, this is the Nyeri-Tetu: $R^2 = 0.4489$. This suggested that there are alternative models, Greenshield model, Greenberg model and underwood model, that could best explain the observed speed-flow relationships. The section below investigates these models.

4.4.2 Speed – Density Model

Inspection of speed-flow data plots in figure 4.3 indicated that linear models could suffice to describe many of them. However some of the plots especially those which exhibited wider data ranges gave some clues as to which is the most suitable form of model to use. Such sites were particularly not very well described by the linear model (i.e. low values of R^2 in Table 4.1). Observing Figure 4.3, this was most evident on four sites (Ruring'u – Othaya, Ruring'u – Marua, Nyeri – King'ong'o and Nyeri- Tetu), where the speed-flow relationship 'curved under' or at least started to do so. Linear models cannot sufficiently describe such cases; (i.e. single-regime linear speed-flow models do not have the intuitively useful 'curve-under' characteristic at capacity, indeed they cannot indicate capacity at all) hence an option of other models is preferred. The 'curve-underr' characteristic of speed-flow relationship do occur on individual sites as exhibited in figure 4.3 above, but it is more likely to occur when data from many sites are combined as the data range widens from very low to very high levels. In such cases there are various models that have a 'curve-under' shape that are useful, and they include and not limited to the following:

a. Greenshields model: (May, 1990)

Equation: $u = a – b\,k$ or $q = k_j\,u – k_j\,u^2/u_f$ ……………………………….……………........ (4.2)

Where; u = operating speed (km/hr); a = free-flow speed (u_f) (km/hr); $b = u_f/k_j$; k_j= jam density (veh/km); k = density (veh/km) and q = flow (veh/hr)

b. Greenberg model: (May 1990)

Equation: $u = u_o \ln (k_j/k)$ …………………………………………..…...…. (4.3)

Where: u= speed (km/hr); u_o = optimum speed (speed at maximum flow) (km/hr); k_j= jam density (veh/km) and k = density (veh/km)

c. Underwood model: (May 1990)

Equation: u = a. exp. (-b. D) …………………………………………...…. (4.4)

Where: $a = u_f$ = free-flow speed (km/hr); $b = 1/k_o$; k = density (veh/km); k_o = optimum density (density at maximum flow) (veh/km)

The objective of selecting among the general models was to identify one that describes adequately the field data of the studied sites. It is important to note that, only three of the many available models were considered in this study because of their seasoned application in several other studies and their very nature of simplicity. It is also important to note that it is unlikely that any given type of model would be the 'best' for all sites of the studied road types. Important is to find one which is the most generalizable, though it might not be the ideal in some particular cases. The following section describes how the 'most adequate' model among the above three was selected during this study.

The selection among the prescribed general models was made based on two criteria, which included: (a) goodness-of-fit (R -value) and (b) Visual fit to field data.

(a). Goodness-of-fit (R-value):

The linear general model, which explained well most of the studied sites is described in terms of speed-flow data that were obtained in the field, whereas the three other general models depicted above are all, described in terms of speed and density. To calibrate them, the speed-flow field data were changed to speed-density data using the following transformation:

k = q / u ……………………………………………………………...…….. (4.5)

Where: k = density (veh/km); q = flow (veh/hr) and u = speed (km/hr)

Nyeri – King'ong'o site, which showed wide flow range in the field was used to test the goodness of these three general models. Firstly the speed-flow field data were transformed into speed-density data as shown in figure 4-6:

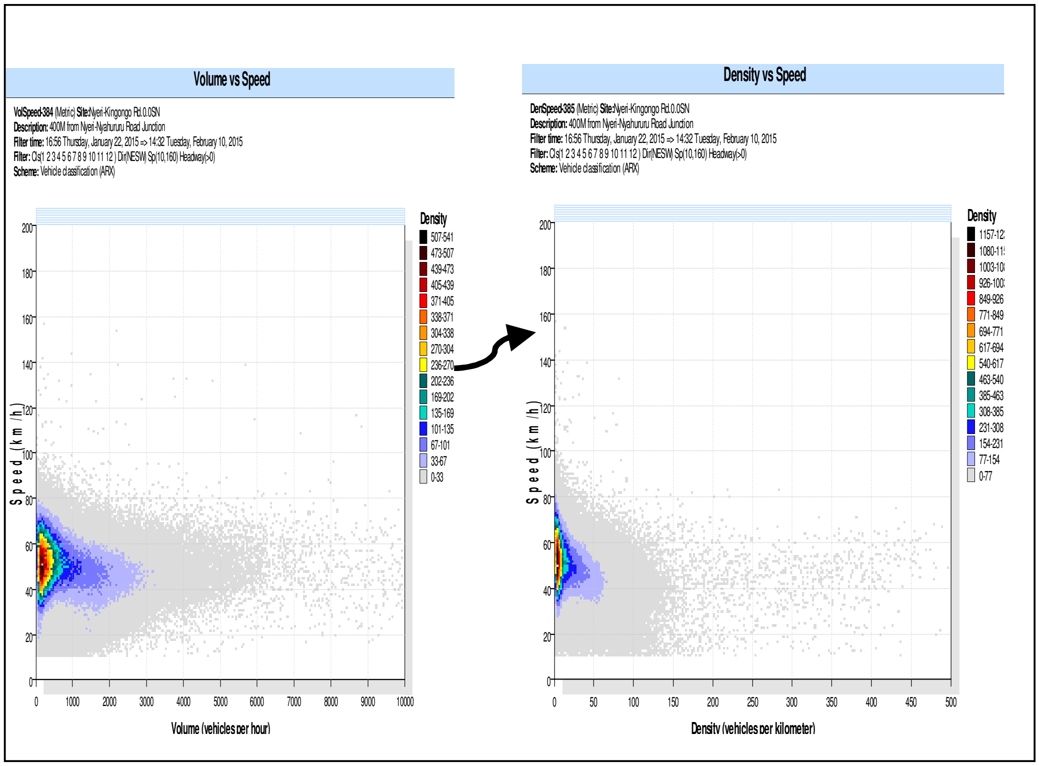

Figure 4-6: Transformation of speed-flow field data into speed-density data.

Each of these models was calibrated by the newly obtained speed-density data, and the model fitting was performed as described below:

Figure 4-7, shows the speed-density data points for Nyeri – King'ong'o site fitted with the three calibrated general models. The fitness (best-fit) of each model is portrayed by its R -value. The calibrated models are shown as follows:

- Greenshields model: $u = -0.5445k + 56.768$ ($R^2=0.8814$) ……..…. .....(4.6)
- Underwood model: $u = 56.86e^{-0.011k}$ ($R^2=0.8767$) ………....……....... (4.7)
- Greenberg model: $u = -3.104\ln k + 56.761$($R^2=0.887$) ………....…........ .(4.8)

Where: k = density (veh/km) and u = Speed (km/hr)

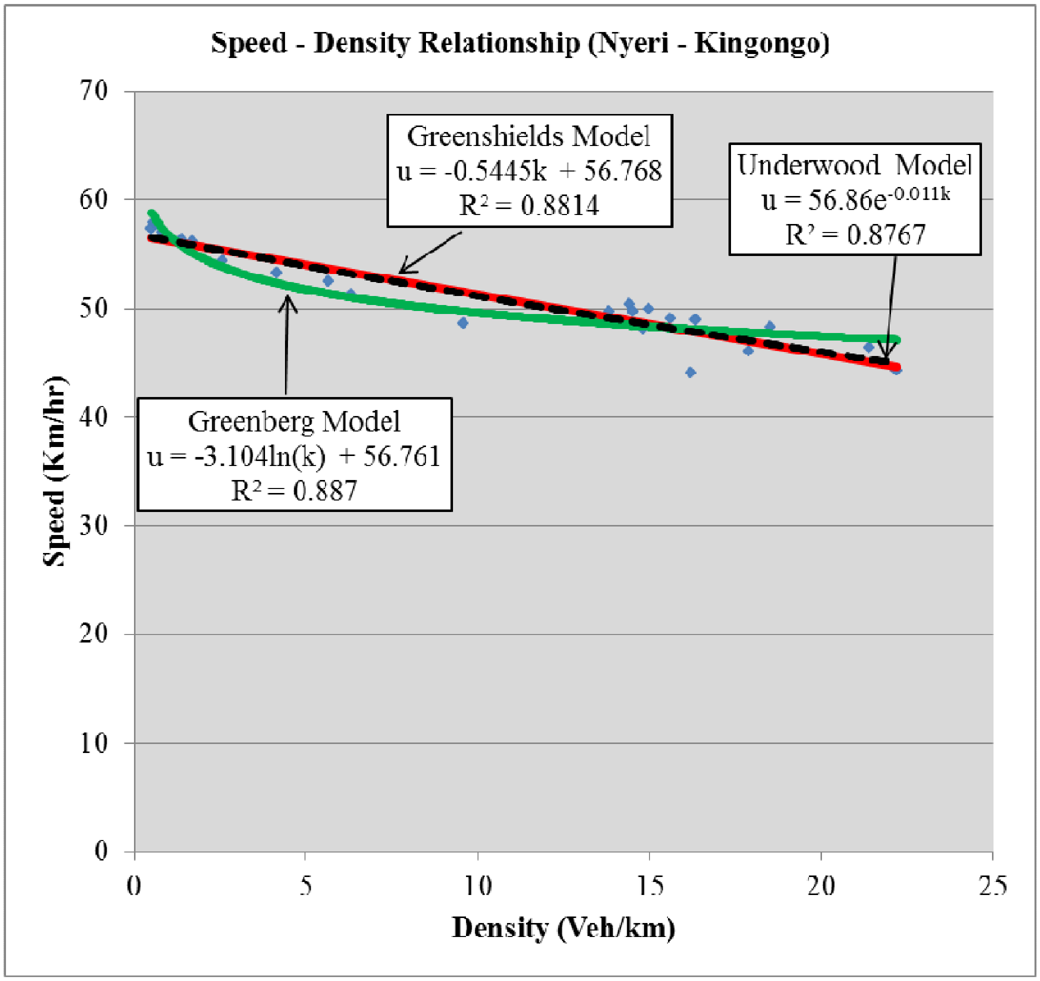

Figure 4-7: Speed-density plot for Nyeri – King'ong'o site fitted with calibrated general models.

According to the test of goodness-of-fit, the model that described the field data more adequately was the Greenberg model, which showed the highest R^2-value of 0.887 as depicted in equation 4.8. This was not far-off from the Greenshields model that scored the R^2-value of approximately 0.8814, whereas the Underwood model was considered the least suitable because of a low value R^2-value of 0.8767. This models are therefore non linear because they indicate the "curving-under" characteristics of the fundamental diagram.

However, further consideration was made based on the visual-fit to the speed-flow field data as described in section (b) below:

(b). Visual-fit to _field data.

Figure 4.8 shows the same site, where each speed-density regression line (Greenshield, Greenberg and underwood) was transformed back into a best-fit (linear) speed-flow model and superimposed upon the speed-flow field data points. The main objective was to observe visually what model fitted best the speed-flow field data; in the sense that could give approximate capacity flows as observed in the field.

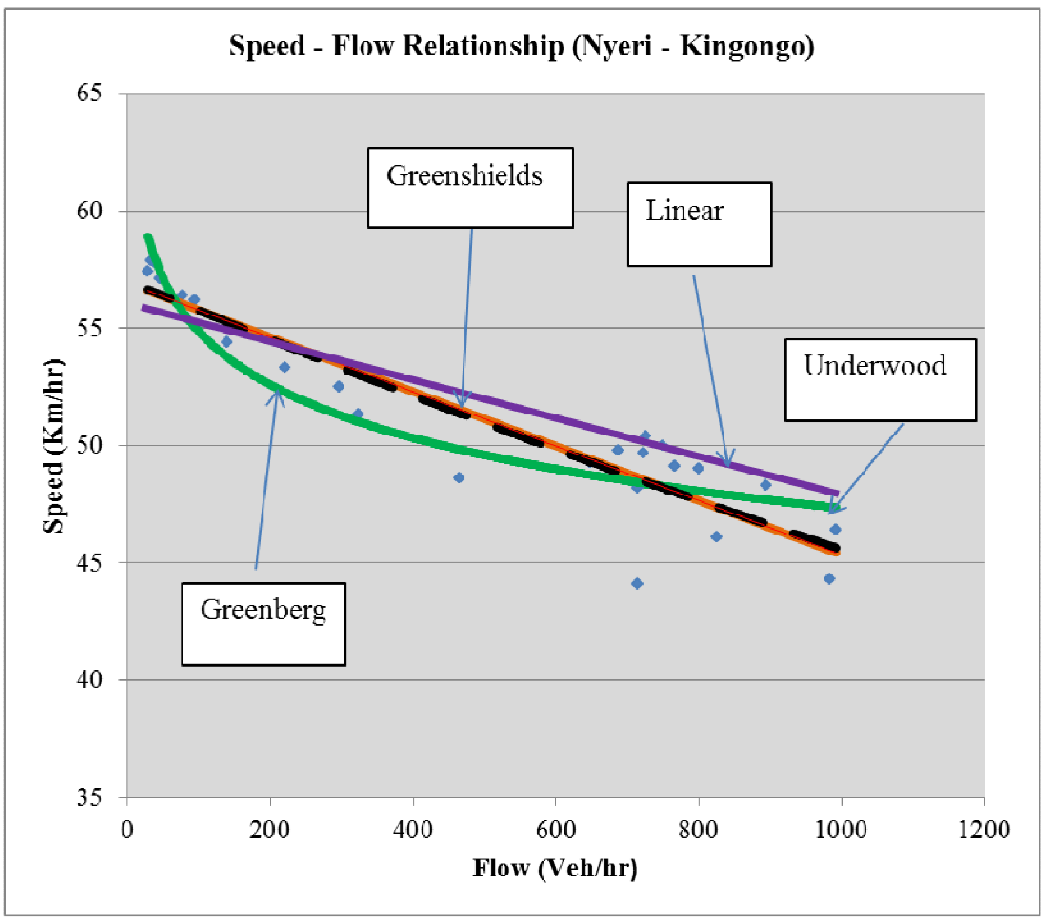

Figure 4-8: Speed-flow models superimposed on the speed-flow field data points

Careful observation of figure 4-8 above showed that the Greenshields model fitted better the speed-flow field data than the other models. In a sense it described the 'curving-under' characteristic of the field data more adequately than the others. More qualification of this adequacy can be explained in empirical terms as follows: The maximum flow rates observed in the field (figure 4-6) was 1,600 veh/hr, which suggested that it was approaching its capacity because it was starting to 'curve-under'. According to what was observed in the field, the Greenshields model gave a reasonable prediction of the site's capacity. Other models particularly the Greenberg and the linear models were observed to overestimate capacity flows, and in cases where one tries to find free flow speed by extrapolating the model, the Greenberg model would give undesirably high free-flow speeds. However, it is usually recommended to find empirical free-flow speed from the field rather than depending on model approximation/prediction. The Underwood model however gave capacity prediction closely to the Greenshields model, which made it to be nearly as good.

Based on the two criteria, the Greenshields model was chosen as the most appropriate model for the studied site as it depicted comparatively high R-value for the goodness-of-fit as well as good prediction of field capacity value which was reflected by its adequate visual-fit.

Th models calibrated, from the Greenshields model, for the individual surveyed sites are depicted in figures in appendix 4 and in table 4.2.

Table 4.2: Calibrated Speed-Density models for the individual links.

Site	Model	R^2	Reference Model from Appendix 4
Nyeri-King'ong'o	u = -0.5445k + 56.768	0.8814	Figure 7-9
Nyeri-Nyahururu	u = -1.6428k + 56.193	0.7601	Figure 7-12
Nyeri-Kiganjo	u = -0.2446k + 40.631	0.7925	Figure 7-10
Nyeri-Ruringu	u = -0.5061k + 43.672	0.8258	Figure 7-13
Nyeri-Tetu	u = -0.5136k + 58.167	0.4874	Figure 7-14
Ruringu-Othaya	u = -0.5891k + 51.195	0.6635	Figure 7-15
Ruringu-Marua	u = -0.1857k + 37.548	0.7424	Figure 7-11
Entire Network Combined	**u = -0.0752k + 49.099**	**0.8649**	Figure 7-16

4.4.3 Flow – Density Model

Two links roads, Nyeri – Kingongo link and Nyeri– Nyahururu link were selected for presentation here because of their unique characteristics. Nyeri – Kingongo link had the highest volume where as Nyeri - Nyahururu link recorded the lowest volumes. The Flow-Density analysis began with the inspection of the flow - Density plots for each site shown in figure 4-9 and for the entire network combines shown in figure 4-10 . The speed-flow model in this study was used mainly to obtain the critical flow (maximum flow) and to re-examine the critical speed and free flow speed values. The flow - density plots for all the other links are as shown in Appendix 5.

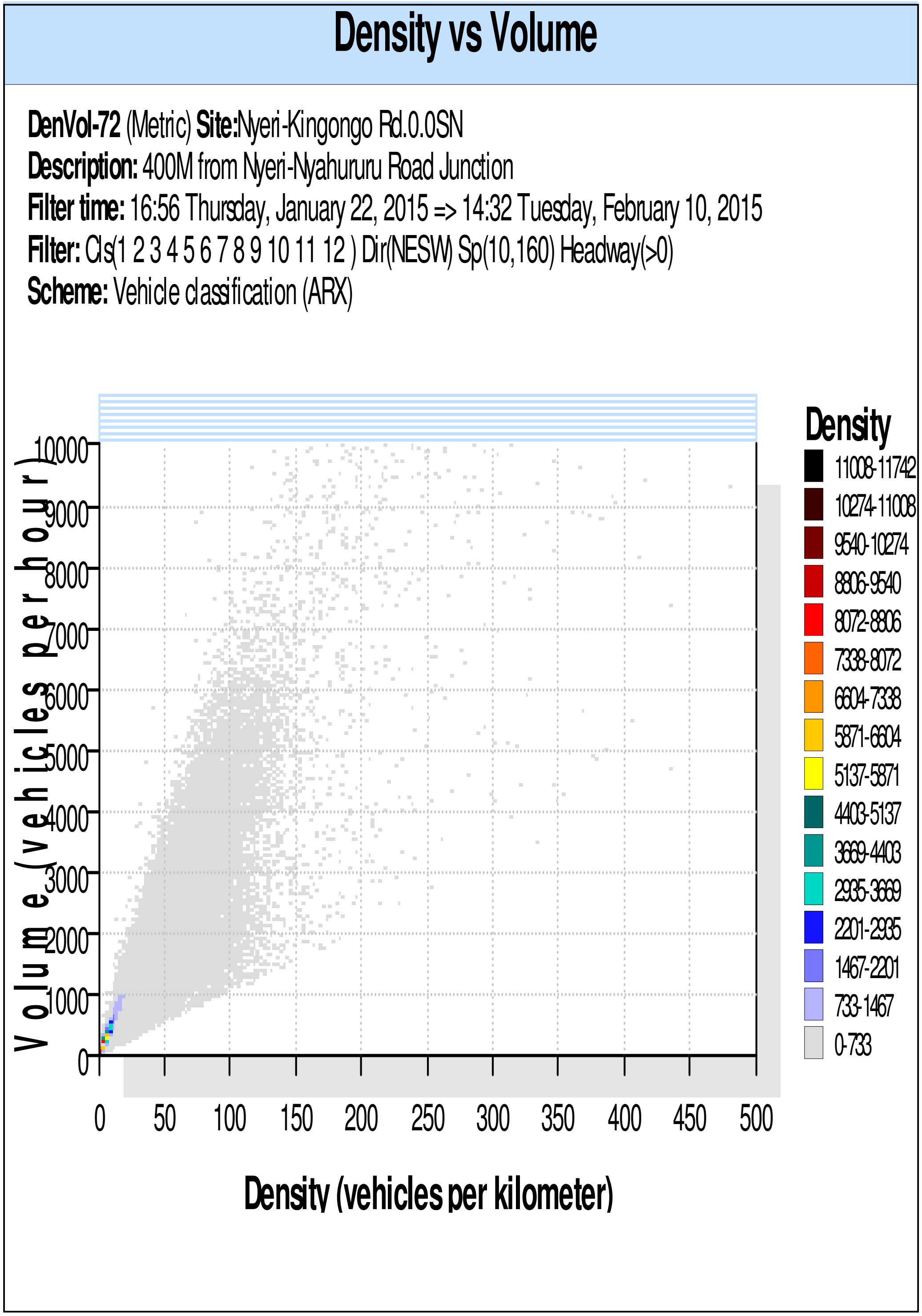

Figure 4-9: Flow-Density plots for the Nyeri - King'ong'o link

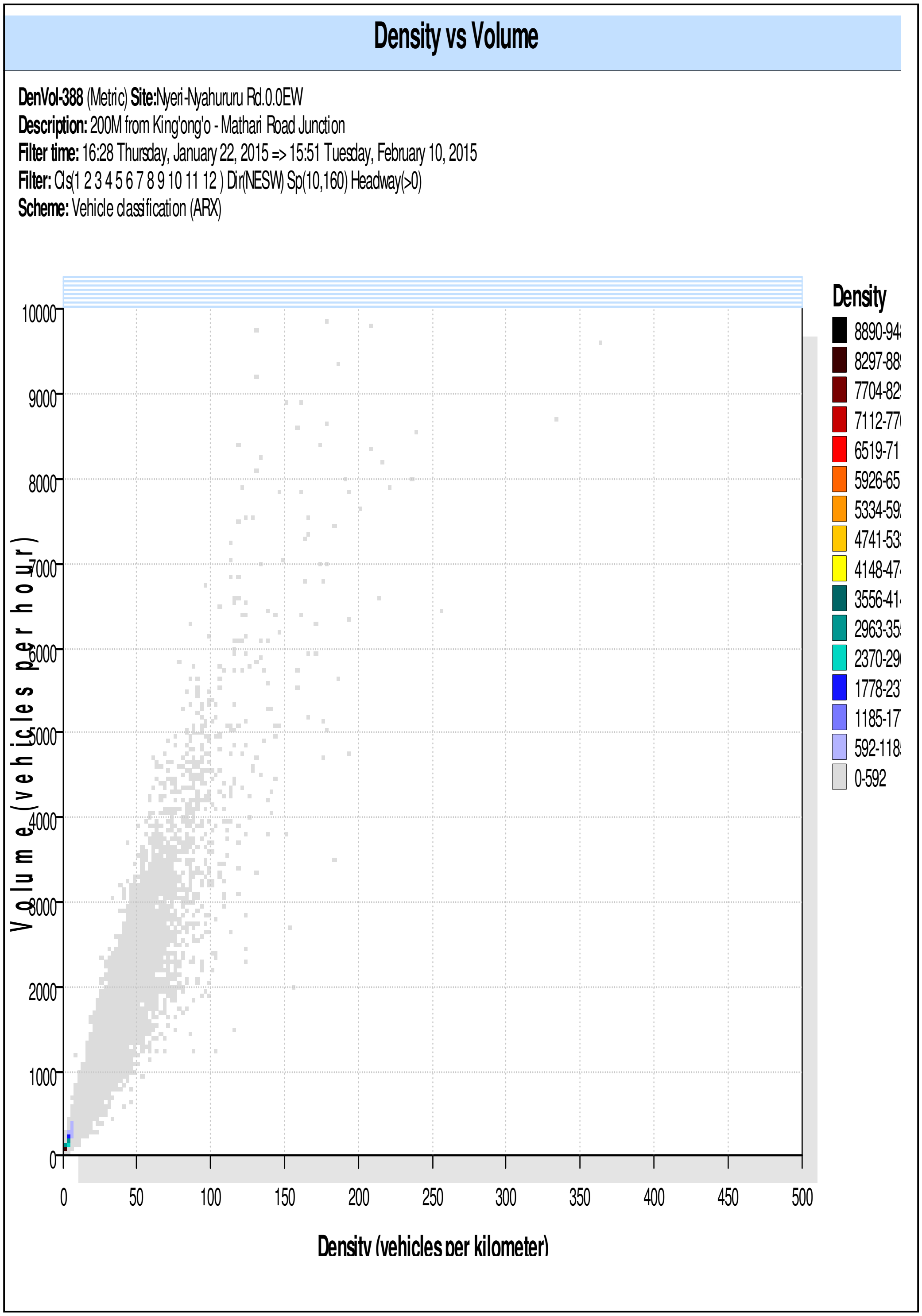

Figure 4-10: Flow-Density plots for the Nyeri – Nyahururu link

To verify this, the model was calibrated by the field data as described below:

The generalized model is depicted as:

Equation: $q = u_f (k-k^2/k_j)$.....…………………………………………………… (4.9)

Where: q = flow (veh/hr), u_f = Free flow speed, k = density and k_j = jam density

The data obtained from the models is presented in table 4.3 and the Flow – Density model for each link are presented in figures in Appendix 5.

Table 4.3: Calibrated Flow-Density models for the individual links.

Site	**Model**	**R^2**	**Reference Model from Appendix 5**
Nyeri-King'ong'o	$q = -0.4606k^2 + 55.474k$	0.9968	Figure 7-17
Nyeri-Nyahururu	$q = -0.9472k^2 + 53.587k$	0.9973	Figure 7-21
Nyeri-Kiganjo	$q = -0.2453k^2 + 40.645k$	0.9994	Figure 7-20
Nyeri-Ruringu	$q = -0.373k^2 + 42.448k$	0.9992	Figure 7-22
Nyeri-Tetu	$q = -0.6023k^2 + 58.744k$	0.9979	Figure 7-23
Ruringu-Othaya	$q = -0.6473k^2 + 51.908k$	0.9957	Figure 7-19
Ruringu-Marua	$q = -0.234k^2 + 38.182k$	0.9986	Figure 7-18
Entire Network Combined	**$q = -0.0767k^2 + 49.225k$**	**0.9984**	Figure 7-24

The figures in appendix 5 and the above table show that the relation that exists between average volume and average density for the entire town can be modelled by the equation below:

$q = -0.0767 k^2 + 49.225 k$ ………..……………………………………….…….(4.10)

Where: q = flow (veh/hr) and k = density

The dependent (volume) and independent (density) variables are average values for the entire town and occur at one kilometre interval. The tables also show that a very strong negative relationship (R^2 of 0.9984) exists between volume and density. The R^2 value of 0.9984 shows that for the town, the average traffic density can account for 99.84 % of the variations in the average volumes and this implies that only 0.16 % of the variation in volume cannot be explained by the densities in this model.

The model showed that there were no traffic plots in the congestion phase of the full diagram. This showed that there is little congestion associated with traffic volumes in Nyeri town. This is an indication that other factors are causing the congestion being experienced currently in Nyeri. The major factors are probably the road infrastructure (road condition and side parking facilities) and driver driving behaviour.

The flow characteristics associated with traffic operations in Nyeri town derived from the models are tabulated in Table 4.4.

Table 4.4: Flow characteristics associated with traffic operations in Nyeri

Link	Volume	Speed	Density
Nyeri-King'ong'o	$q = -0.4606k^2 + 55.474k$	$u = -0.5445k + 56.768$	$k = (56.7678 - u) / 0.5445$
Nyeri-Nyahururu	$q = -0.9472k^2 + 53.587k$	$u = -1.6428k + 56.193$	$k = (56.193 - u) / 1.6428$
Nyeri-Kiganjo	$q = -0.2453k^2 + 40.645k$	$u = -0.2446k + 40.631$	$k=(40.631-u) / 0.2446$
Nyeri-Ruringu	$q = -0.373k^2 + 42.448k$	$u = -0.5061k + 43.672$	$k=(43.672-u) / 0.5061$
Nyeri-Tetu	$q = -0.6023k^2 + 58.744k$	$u = -0.5136k + 58.167$	$k=(58.167-u) / 0.5061$
Ruringu-Othaya	$q = -0.6473k^2 + 51.908k$	$u = -0.5891k + 51.195$	$k=(51.195-u) / 0.5891$
Ruringu-Marua	$q = -0.234k^2 + 38.182k$	$u = -0.1857k + 37.548$	$k=(37.548-u) / 0.1857$
Entire Network Combined	$\mathbf{q = -0.0767k^2 + 49.225k}$	$\mathbf{u = -0.0752k + 49.099}$	$\mathbf{k=(49.099-u) / 0.0752}$

4.5 Determination of the Characteristics of Macroscopic Fundamental Diagram for Nyeri town

After the analysis and establishment of traffic flow models, the flow characteristics, flow (volume), speed and density, associated with Nyeri town were derived. The determination of the characteristics of the Macroscopic Fundamental Diagram (MFD) for Nyeri town from the data and the derived equations were done and are tabulated in Table 4.5.

The characteristics are;

i) Free flow speed = u_f
ii) Jam density = k_j
iii) Maximum flow = q_c
iv) Critical speed = u_c
v) Critical density = k_c

From the flow density model established, the free flow speed (u_f) and the jam density(k_j) was obtained for each studied link and for the whole network in general. Using equation 4.9 and models in Table 4.3, the two characteristics of the MFD were determined as below;

Equation 4.9 is simplified as below;

$q = -(u_f/k_j)\,k^2 + u_f\,k$ ....(4.11)

From models in table 4.3 and using the model for Nyeri –Kingongo as an example, the following characteristics were found;

$(u_f/k_j) = 0.4606$ ....(4.12)

And

$u_f = 55.474$ Km/hr ....(4.13)

substituting equation 4.13 into equation 4.12 we get the jam density (k_j) as below;

$k_j = (55.474 / 0.4606) = 120.44$ veh/km ....(4.14)

The same was done on all the links and for the entire links combined and the results are as shown in table 4.5 below.

After getting these two characteristics, the other characteristics were also computed. The condition for maximum flow (q_c) is achieved when,

$k_c = k_j/2$ ....(4.15)

$u_c = u_f/2$ ....(4.16)

And using Nyeri – Kingongo as an example,

$k_c = 120.44 / 2 = 60.22$ veh/km ....(4.17)

$u_c = 55.474 / 2 = 27.737$ km/hr ....(4.18)

And substituting the above values for k_c and u_c into equation 4.11, maximum flow is established as below

$q_c = - (u_f/k_j)\, k_c^2 + u_f\, k_c$ ....(4.19)

And using the values from the flow density in Table 4.3 and the determined values of k_c, the q_c is determined as below;

$q_c = -0.4606kc^2 + 55.474k_c$ ....(4.20)

$q_c = -0.4606(60.22^2) + 55.474(60.22) = 1{,}670.3$ veh/km ....(4.21)

The values for kc, uc and qc were computed for all the links and for the entire network combined and tabulated in Table 4.5;

Table 4.5: Characteristics of Macroscopic Fundamental Diagram for Nyeri town

Link	u_f	k_j	k_c	u_c	q_c
Nyeri-King'ong'o	55.474	120.44	60.22	27.737	1,670.30
Nyeri-Nyahururu	53.587	56.57	28.29	26.794	757.91
Nyeri-Kiganjo	40.645	165.7	82.85	20.323	1,683.67
Nyeri-Ruringu	42.448	113.8	56.9	21.224	1,207.66
Nyeri-Tetu	58.744	97.53	48.77	29.372	1,432.37
Ruringu-Othaya	51.908	80.19	40.1	25.954	1,040.65
Ruringu-Marua	38.182	163.17	81.59	19.091	1,557.55
Entire Network Combined	**49.225**	**641.79**	**320.89**	**24.613**	**7,897.98**

The above characteristics are useful in planning Nyeri town since engineers and planners are able to understand the critical values of volume for each road, such that when it is approached, they can plan for the traffic flow better and prevent congestion.The critical speeds also help the planners and engineers to understand when interventions are required on the network.

4.6 Assessment of Macroscopic Fundamental Diagram whether it is property of network infrastructure and control or of demand

The assesment of the derived MFD for Nyeri town started with critically looking at the plots and assessing the links that congestion occur. The speed, volume and Density data was used and from the plots and the models derived, it was found that no congestion occur in roads links leading to Nyeri town. This therefore means that the MFD for Nyeri town is not determined by the land use hence not a property of demand.

An analysis performed by Thompson (1967) on the relationship between speed and flow in central London in 1967 showed a linear decreasing relationship between average speed and flow (Thomson 1967) as cited in (Geroliminis and Daganzo

2008). And this suggested that the streets in the data set were not very congested. These results are not different from what Nyeri town is exhibiting, that a linear decreasing relation between average speed and flow exists, therefore suggesting that on the whole, and Nyeri town experiences very little congestion. This is shown in the graphs (Figures 4-3 and 4.4) where only the non-congestion part of the MFD is shown. Although the MFD exists for the town, the data suggests that Nyeri town does not yet have the overall traffic flow characteristics that provided all the states of the diagram, and this shows how well the town is performing in terms of traffic flow, and how effective traffic flow is, at the town-scale level.

Since the speed limit is 50 km/hr, the design capacity for all the roads is taken as 2,000 veh/hr. This means that all the road links were operating with capacities below their design capacity. This shows that the speeds recorded are entirely influenced by the network infrastructure and controls as opposed to demand.

Nyeri – Kiganjo, Nyeri – Ruringu, and Ruringu – Marua had free flow speeds which were slightly below the PSL for the network. This could mean that they might have experinced congestion, though minimal, some time during the study period. Since the models showed that no congestion is occuring at Nyeri in terms of demand, it therefore means that other factors are causing the congestion being experienced in the above links in Nyeri town. Network infrastructure (road condition, bus stops, bumps) and driver behaviour are causing these jams experienced in Nyeri town. The property of network that affects the MFDare as below;

Redundant Network – Nyeri's street network lacks redundancy which is one of the causes of the town's inconsistent congestion. The network does not provide sufficient route choice and often there are no roads available to divert traffic around incidents or locations of congestion.

Homogeneous Network – Nyeri's streets are hierarchical. Major arterials are paved and serve the purpose of connecting neighborhoods while local streets are often inadequately maintained and offer poor connectivity. In turn, traffic is concentrated onto the main streets and the side streets cannot feasibly serve through traffic.

Negligible Effect of Turning Vehicles – Turning vehicles have a disfavorable effect on the MFD because turning maneuvers interrupt regular traffic flows. This is particularly problematic in Nyeri because there are many unsignalized intersections, where left turning vehicles can cause substantial traffic delays.

4.7 Summary

Analyses that were carried out in this research have been described in this chapter. This enables relevant information to be derived from the data. The genesis of the analyses was with the preparation and aggregation of volume data to 1-hour intervals and also the derivation of average travel speeds from the MetroCount Vehicular Classifier MCReport software; and the volume and speeds suggest the morning and evening peak periods are 0800hrs – 1100hrs and 1700hrs – 1900hrs respectively.

In a bid to minimize the utilization of most heavily used links that experience congestion in road networks, so to avoid the formation of bottlenecks on links, traffic re-routing has been recommended. This helps to reduce the amount of traffic flow on heavily used links that experience congestion during certain times of the day and directs them unto less congested ones. In re-routing care should be taken so as not to worsen the performance of the already better performing links. It therefore becomes ideal if studies are able to show how much traffic volume should be re-routed. Once this is known, measures can be put in place to ensure that the effectiveness of all such links. The MFD suggested that the town does not experience any higher levels of congestion because the relation between average speed and average volume gave a linearly decreasing straight line. Similar results were obtained after choosing some segments out of the total number with speed profiles and even transforming the data.

Traditionally, the volume-capacity ratio is used to determine the level of congestion on road segments. In this research, exploration has been made on how the average speeds relative to free flow speeds can be used to determine degrees of congestion on road links. This approach can be used when determining the congestion levels on segments, if the capacities of road segments are unavailable and one has the free flow speeds available.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This research was fundamentally aimed at performing spatial analysis of traffic flows in in Nyeri town; and series of analysis were performed to that effect. As per the specific research objectives the following conclusions can be drawn:

1. The series of analysis performed with the collected data established a clear macroscopic fundamental diagram for Nyeri town hence there is a Fundamental Diagram for Nyeri Town. However, these particular diagrams depicted the non-congestion phase of the "full" diagram, since there were no traffic plots that occurred in the congestion phase of the diagram. This shows that even though congestion is occurring in Nyeri town, it is not caused by traffic volumes reaching maximum since the town may not yet have the overall traffic flow characteristics that provided all the regimes of the full diagram. The analysis with the data suggested that the morning and evening peak periods for Nyeri town are 0800 hours - 1100 hours and 1700 hours - 1900 hours respectively. Generally, the evening peaks tend to show a slightly higher volume and a slightly reduced speed levels as compared to the morning peaks which is not usually the case in other urban areas where the morning peak is usually higher than the evening peak. The higher traffic in the morning and evening is probably attributed to people going to works in the morning and back to their homes in the evening. There is less traffic at night because Nyeri town is not active at night and past 9.00 P.M, the empty of people and therefore most of the traffic experienced at night is through traffic.
2. The research indicated that some road links indeed performed better than others. All the considered links relatively performed worse between and during morning and evening peak periods. Performance levels were very good from 2300 hours till 0530 hours the following day. It was found from the research that the traffic characteristics for Nyeri town indicated the non-congested phase of the fundamental diagram (a linearly decreasing relation between speed and volume).

3. From the analyses, it was found that speed, traffic volumes and densities have relations and their traffic flow characteristics for Nyeri town were derived. Nyeri town demonstrated a very high level of correlation between speeds, volume and density and models were established for the town demonstrating these levels of relation.
4. From the analyses, the characteristics of Macroscopic Fundamental Diagram for Nyeri town were determined. These characteristics were; free flow speed, critical speed, jam density, critical density and maximum flow. These characteristics are very important in assessing the behaviour of the network in order to further plan traffic flow within the town.
5. It was found that all the road links were operating with capacities below their design capacity. This shows that the speeds recorded are not influenced by land use hence not a property of traffic demand. This therefore means that the MFD generated for the town is influenced by the properties of the network and control. Poor road condition, lack of bus stops, lack of control facilities for turning traffic, many speed bumps in the roads and driver driving behaviour are then network and control features that influenced the MFD.

5.2 Recommendations

Based on the observations and findings from the research, recommendations have been made and possible areas of extension for this research have been summarised below;

5.2.1 Recommendations

1. The main reason that the road operators are interested in MFDs is that they have shown good prospects on real time traffic control. However, effects of using MFD for traffic control in Nyeri town are not clear now. Hence, it is meaningful to generate a strategy of using MFD for traffic control in this town. The important issues include sub-network division, control measures selection and effects evaluation.

2. Furtherance to the establishment of fundamental traffic flow models and deriving flow characteristics associated with traffic operations in Nyeri town, it is recommended that this type of study should be replicated in other towns so that the MFDs serves as network performance indicators for traffic management purposes. In addition to that, researches could be performed for different towns on how a town's network structure (land use and transport planning) affects its MFD.
3. In a bid to minimize the utilization of most heavily used links that experience congestion in road networks, so to avoid the formation of bottlenecks on links, it is recommended that traffic re-routing should be done.

5.2.2 Areas for further research

1. The level of interaction between land use and transport cannot be underestimated as deduced from other researches. This interaction is seen by Shaw and Xin (2003), as a dynamic process that involves changes over spatial dimensions between the two systems, and changes in land use systems can have effects on travel demand patterns and induce changes in transport systems. With regards to this, it is advocated that future researches in this domain considers land use components and investigate how they influence traffic flows.
2. The data available for this research covered 18 days, 12 weekdays and 6 weekends. Due to time constraint, the research was restricted to these days only. Further studies should be carried out into the other days where traffic variations for these days could be determined and further explored. For instance, traffic variations could be studied between weekdays and weekends so that traffic circulation within the town would be well understood. Under this same theme, it is recommended that the designed capacities of the road segments are provided so that further analyses that pertain to comparing the performance levels of different links can be undertaken.

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APPENDICES

Appendix 1: Traffic flow data for Virtual day on each link and for the entire network

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-250 -- English (ENU)

Datasets:

Site:	**[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction:	7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration:	10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier:	EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 153156 / 153587 (99.72%)

*** Virtual Day - Total=8361, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
68	**38**	**23**	**21**	**29**	**88**	**231**	**485**	**515**	**512**	**486**	**453**	**465**	**482**	**502**	**544**	**598**	**634**	**612**	**572**	**404**	**284**	**188**	**129**
24	10	7	6	6	12	36	95	**137**	123	125	114	113	121	124	130	146	150	**160**	152	121	80	54	38
19	11	6	6	7	25	49	116	**129**	124	129	112	113	121	122	133	149	**163**	150	150	105	78	49	33
15	9	6	5	8	20	62	**127**	127	132	116	114	119	120	124	143	150	**166**	151	145	92	68	46	31
10	8	5	5	8	31	83	**149**	122	133	116	113	121	119	132	137	153	**155**	151	126	85	59	38	27

AM Peak 0730 - 0830 (541), AM PHF=0.91 PM Peak 1715 - 1815 (644), PM PHF=0.97

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-251 -- English (ENU)

Datasets:

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 98991 / 100709 (98.29%)

*** Virtual Day - Total=5819, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
64	**41**	**29**	**26**	**25**	**56**	**138**	**245**	**288**	**289**	**309**	**310**	**327**	**334**	**346**	**388**	**437**	**459**	**493**	**445**	**302**	**208**	**151**	**109**
20	12	6	6	5	9	23	55	69	77	78	74	**78**	82	79	94	100	111	115	**121**	91	59	42	33
18	10	8	7	6	14	29	63	72	70	81	73	**77**	89	88	100	111	117	117	**122**	80	55	39	27
14	10	7	6	6	15	37	65	72	76	75	81	**85**	87	91	97	114	118	**130**	108	66	49	38	26
11	9	8	7	8	18	49	62	75	66	75	**81**	88	76	89	97	113	113	**132**	94	65	45	31	23

AM Peak 1145 - 1245 (320), AM PHF=0.95 PM Peak 1830 - 1930 (504), PM PHF=0.96

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive

Vehicle Counts (Virtual Day)

VirtVehicleCount-252 -- English (ENU)

Datasets:

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)

In profile: Vehicles = 52700 / 52880 (99.66%)

*** Virtual Day - Total=2780, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
14	**11**	**7**	**6**	**13**	**31**	**71**	**141**	**169**	**176**	**187**	**163**	**172**	**181**	**190**	**206**	**241**	**236**	**189**	**158**	**93**	**63**	**38**	**24**
5	3	2	1	2	7	12	27	44	41	**44**	40	44	43	46	48	56	**63**	48	45	31	19	10	7
3	3	2	2	2	5	16	35	43	41	**48**	42	43	45	48	51	56	**66**	48	41	25	17	10	7
3	3	2	1	4	9	20	39	42	46	**50**	41	42	45	46	50	**61**	58	45	38	19	13	9	6
3	2	2	2	4	10	22	41	40	**47**	46	39	43	48	50	57	**68**	50	47	33	18	14	9	4

AM Peak 0945 - 1045 (189), AM PHF=0.95 PM Peak 1630 - 1730 (257), PM PHF=0.94

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-253 -- English (ENU)

Datasets:
Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)

Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 116137 / 116548 (99.65%)

*** Virtual Day - Total=6132, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
41	**24**	**15**	**18**	**19**	**43**	**168**	**370**	**356**	**355**	**346**	**332**	**376**	**380**	**383**	**427**	**539**	**516**	**428**	**387**	**244**	**172**	**119**	**75**
13	7	4	5	4	6	19	77	**94**	85	84	83	93	99	93	98	121	**152**	106	104	70	49	33	26
11	5	4	6	6	8	28	**93**	92	89	88	82	95	93	94	106	**138**	133	106	101	66	44	32	18
9	6	4	3	4	12	44	**93**	84	91	85	85	95	95	100	107	**134**	117	108	100	57	40	30	17
8	5	3	3	5	16	78	**108**	86	89	89	82	93	93	96	116	**146**	114	109	82	51	38	24	14

AM Peak 0715 - 0815 (387), AM PHF=0.90 PM Peak 1615 - 1715 (569), PM PHF=0.94

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive

Vehicle Counts (Virtual Day)

VirtVehicleCount-254 -- English (ENU)

Datasets:

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)

Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 225644 / 226460 (99.64%)

*** Virtual Day - Total=11984, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
77	**46**	**29**	**33**	**38**	**94**	**297**	**648**	**726**	**749**	**767**	**722**	**688**	**714**	**800**	**894**	**992**	**983**	**825**	**714**	**465**	**324**	**221**	**139**
25	13	8	8	8	16	39	128	195	181	**193**	188	173	179	178	216	235	**259**	210	197	139	91	64	45
21	12	7	10	9	20	57	159	177	183	**193**	181	176	181	194	219	248	**254**	209	187	125	88	57	35
16	12	7	7	10	25	83	171	175	189	**195**	180	169	179	205	230	**251**	241	207	180	105	75	54	30
15	9	7	8	12	33	119	191	179	**195**	185	172	170	175	223	230	**257**	229	199	150	95	70	46	29

AM Peak 0945 - 1045 (777), AM PHF=0.99 PM Peak 1630 - 1730 (1022), PM PHF=0.99

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-255 -- English (ENU)

Datasets:
Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.

Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 102289 / 102397 (99.89%)

*** Virtual Day - Total=5422, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
54	**29**	**19**	**19**	**16**	**42**	**132**	**293**	**370**	**351**	**326**	**294**	**288**	**324**	**347**	**340**	**384**	**399**	**387**	**381**	**234**	**165**	**125**	**102**
19	8	5	6	4	6	20	63	**95**	92	91	76	71	81	84	85	93	**96**97	103	71	47	33	32	
13	9	4	6	4	9	28	69	**94**	87	78	75	69	79	91	85	96	**98**96	102	62	42	32	27	
11	7	4	4	4	12	35	74	**91**	86	80	73	73	81	87	86	92	**103**	94	93	51	41	30	24
10	5	5	4	4	15	50	87	**90**	86	77	70	75	84	84	84	**104**	102	101	83	49	35	29	20

AM Peak 0800 - 0900 (370), AM PHF=0.97 PM Peak 1645 - 1745 (401), PM PHF=0.97

Numbers have been rounded to the nearest integer.

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-256 -- English (ENU)

Datasets:
Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**

Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 132791 / 133285 (99.63%)

*** Virtual Day - Total=7265, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
52	**35**	**23**	**26**	**27**	**74**	**219**	**458**	**509**	**438**	**404**	**367**	**348**	**381**	**409**	**487**	**541**	**570**	**599**	**503**	**333**	**218**	**144**	**101**
17	10	6	6	7	11	32	93	**132**	116	102	96	80	95	96	113	128	134	**151**	136	104	62	41	32
13	9	6	6	6	17	46	112	**130**	103	104	94	86	96	101	124	136	144	**152**	130	85	57	37	26
13	8	5	7	7	18	64	123	**125**	110	98	90	90	95	105	125	139	146	**151**	127	75	51	35	23
10	8	6	8	9	27	77	**130**	122	110	100	86	92	95	107	124	139	**146**	145	111	69	48	31	20

AM Peak 0745 - 0845 (517), AM PHF=0.98 PM Peak 1745 - 1845 (600), PM PHF=0.98

Numbers have been rounded to the nearest integer.

Traffic Counts (Volume) – Virtual Day for the entire network

MetroCount Traffic Executive
Vehicle Counts (Virtual Day)

VirtVehicleCount-257 -- English (ENU)

Datasets:
Site: **[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:
File: Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier: EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)

Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0

Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)

Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 881708 / 885866 (99.53%)

*** Virtual Day - Total=46496, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
356	**217**	**140**	**144**	**163**	**413**	**1217**	**2565**	**2848**	**2793**	**2792**	**2607**	**2629**	**2760**	**2918**	**3181**	**3597**	**3686**	**3417**	**3055**	**2004**	**1385**	**952**	**656**
119	61	37	37	35	66	174	521	**745**	694	709	664	643	690	692	760	874	**938**	857	829	605	394	268	206
94	57	35	40	38	95	246	627	**716**	680	712	652	651	695	728	784	882	**947**	849	805	531	368	249	165
78	54	34	32	41	108	334	671	**694**	709	691	655	664	692	737	796	895	**919**	857	764	451	326	233	152
65	45	34	35	48	145	464	**746**	693	710	679	635	671	682	761	841	**946**	881	854	656	417	298	202	132

AM Peak 0745 - 0845 (2902), AM PHF=0.97 PM Peak 1645 - 1745 (3751), PM PHF=0.99

Numbers have been rounded to the nearest integer.

Appendix 2: Speed data for each link and for the entire network

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-397 -- English (ENU)

Datasets:

Site:	**[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier:	ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 116137 / 116548 (99.65%)

Speed Statistics by Hour

SpeedStatHour-397

Site: Nyeri-Kiganjo Rd.0.0SN
Description: **400M from Nyeri-Nyahururu Road Junction**
Filter time: **16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 116137, **Posted speed limit** = 50 km/h, Exceeding = 6318 (5.44%), Mean Exceeding = 54.69 km/h, **Maximum** = 159.6 km/h, **Minimum** = 10.0 km/h, **Mean** = 38.3 km/h, **85% Speed** = 45.4 km/h, **95% Speed** = 50.0 km/h, **Median** = 38.2 km/h, **20 km/h Pace** = 28 - 48, **Number in Pace** = 95985 (82.65%), **Variance** = 64.75, **Standard Deviation** = 8.05 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	774	0.7%	12.2	65.7	40.9	41.4	48.2	52.9	75	9.7%
0100	452	0.4%	12.0	67.7	40.8	41.8	48.6	52.6	46	10.2%
0200	285	0.2%	15.7	65.9	40.7	41.0	48.6	53.6	34	11.9%
0300	333	0.3%	18.2	96.2	40.6	40.7	47.2	50.8	31	9.3%
0400	362	0.3%	12.2	74.7	39.6	38.9	46.4	50.8	24	6.6%
0500	818	0.7%	13.7	67.1	40.6	41.0	47.9	52.2	85	10.4%
0600	3188	2.7%	10.2	108.9	37.9	37.8	45.4	50.0	176	5.5%
0700	7027	6.1%	10.2	127.1	38.8	38.9	45.7	50.0	375	5.3%
0800	6761	5.8%	10.0	153.3	38.4	38.5	46.1	51.1	443	6.6%
0900	6746	5.8%	10.2	131.7	38.9	38.9	46.1	50.8	401	5.9%
1000	6574	5.7%	10.1	152.7	38.6	38.9	45.7	50.4	366	5.6%
1100	6302	5.4%	10.6	152.7	38.6	38.5	45.4	50.0	330	5.2%
1200	7143	6.2%	10.1	136.3	38.5	38.5	45.7	50.0	389	5.4%
1300	7220	6.2%	10.3	159.6	38.5	38.5	45.7	50.4	421	5.8%
1400	7286	6.3%	10.2	108.4	38.7	38.9	45.7	50.0	385	5.3%
1500	8001	6.9%	10.0	137.8	38.5	38.5	45.4	50.4	448	5.6%
1600	9979	8.6%	10.4	148.2	37.3	37.4	44.3	49.0	421	4.2%
1700	9796	8.4%	10.1	158.5	37.1	37.1	43.9	48.6	359	3.7%
1800	8140	7.0%	10.2	133.3	36.7	36.7	43.9	48.6	300	3.7%
1900	7353	6.3%	10.3	91.9	37.2	37.1	43.9	48.2	267	3.6%
2000	4644	4.0%	10.4	97.8	38.7	38.9	46.1	50.4	272	5.9%
2100	3262	2.8%	11.2	70.2	39.4	39.6	47.2	51.8	246	7.5%
2200	2268	2.0%	10.0	67.5	40.4	40.3	47.9	53.6	253	11.2%
2300	1423	1.2%	10.1	67.5	40.5	40.3	49.0	53.6	171	12.0%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-398 -- English (ENU)

Datasets:

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 52700 / 52880 (99.66%)

Speed Statistics by Hour

SpeedStatHour-398

Site: Nyeri-Nyahururu Rd.0.0EW
Description: **200M from King'ong'o - Mathari Road Junction**
Filter time: **16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 52700, **Posted speed limit** = 50 km/h, Exceeding = 28745 (54.54%), Mean Exceeding = 58.87 km/h, **Maximum** = 159.2 km/h, **Minimum** = 11.4 km/h, **Mean** = 50.6 km/h, **85% Speed** = 61.9 km/h, **95% Speed** = 68.4 km/h, **Median** = 51.1 km/h, **20 km/h Pace** = 41 - 61, **Number in Pace** = 33635 (63.82%), **Variance** = 132.64, **Standard Deviation** = 11.52 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	266	0.5%	23.8	89.8	57.8	60.1	68.8	76.7	192	72.2%
0100	204	0.4%	25.8	89.6	54.7	56.5	68.8	74.9	132	64.7%
0200	134	0.3%	18.7	88.2	53.9	54.0	67.3	77.0	86	64.2%
0300	123	0.2%	16.1	76.8	53.8	56.2	69.1	74.2	79	64.2%
0400	247	0.5%	23.8	95.1	55.5	56.2	66.6	73.8	182	73.7%
0500	595	1.1%	15.0	93.3	55.5	56.2	66.6	74.2	449	75.5%
0600	1348	2.6%	13.4	119.2	53.6	54.4	65.9	72.0	860	63.8%
0700	2687	5.1%	11.9	96.3	52.3	52.6	63.7	69.8	1620	60.3%
0800	3216	6.1%	13.0	91.3	49.8	50.4	60.5	67.3	1691	52.6%
0900	3335	6.3%	15.6	93.8	49.6	50.0	60.8	67.3	1704	51.1%
1000	3560	6.8%	13.2	89.2	49.2	49.7	60.1	67.0	1753	49.2%
1100	3089	5.9%	12.0	94.7	48.7	49.3	59.4	65.9	1483	48.0%
1200	3262	6.2%	13.3	115.2	48.2	49.0	59.8	66.6	1534	47.0%
1300	3434	6.5%	16.4	88.7	49.4	50.0	60.5	67.0	1732	50.4%
1400	3607	6.8%	12.5	96.9	49.2	50.0	60.5	67.3	1829	50.7%
1500	3850	7.3%	14.5	115.0	47.5	48.2	59.0	65.5	1710	44.4%
1600	4529	8.6%	11.4	146.1	50.8	51.1	61.6	68.0	2508	55.4%
1700	4490	8.5%	12.9	159.2	50.6	50.8	60.5	67.3	2417	53.8%
1800	3585	6.8%	19.2	112.1	52.0	52.2	61.9	68.0	2145	59.8%
1900	2994	5.7%	15.0	91.6	51.6	51.5	61.2	68.0	1707	57.0%
2000	1776	3.4%	23.0	89.2	53.8	54.4	63.7	71.3	1174	66.1%
2100	1198	2.3%	18.1	101.8	56.4	56.5	66.6	73.1	893	74.5%
2200	717	1.4%	13.0	91.7	57.8	58.3	69.1	76.0	548	76.4%
2300	454	0.9%	26.9	98.2	56.5	57.6	68.4	74.5	317	69.8%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-399 -- English (ENU)

Datasets:

Site:	**[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction:	7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration:	10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier:	EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 153156 / 153587 (99.72%)

Speed Statistics by Hour

SpeedStatHour-399

Site: Ruringu-Othaya Rd.0.0NS
Description: **300M from Nairobi-Nyeri Rd Junction**
Filter time: **10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 153156, **Posted speed limit** = 50 km/h, Exceeding = 49778 (32.50%), Mean Exceeding = 58.95 km/h, **Maximum** = 148.6 km/h, **Minimum** = 10.0 km/h, **Mean** = 45.0 km/h, **85% Speed** = 57.6 km/h, **95% Speed** = 65.9 km/h, **Median** = 44.3 km/h, **20 km/h Pace** = 33 - 53, **Number in Pace** = 91226 (59.56%), **Variance** = 155.82, **Standard Deviation** = 12.48 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	1216	0.8%	11.3	96.2	48.0	46.8	61.6	71.3	486	40.0%
0100	688	0.4%	10.1	94.6	49.7	49.0	63.0	76.0	328	47.7%
0200	414	0.3%	12.3	95.2	49.7	48.6	61.9	74.5	190	45.9%
0300	385	0.3%	11.3	87.8	51.4	51.5	66.2	73.4	207	53.8%
0400	520	0.3%	12.3	90.0	54.6	54.0	69.8	79.6	315	60.6%
0500	1581	1.0%	11.0	109.1	55.4	54.4	72.4	82.1	976	61.7%
0600	4152	2.7%	10.8	148.6	48.5	48.2	61.9	71.3	1885	45.4%
0700	8738	5.7%	10.5	125.4	45.5	44.6	58.0	65.9	2988	34.2%
0800	9261	6.0%	10.0	108.9	45.4	44.6	56.9	65.2	2945	31.8%
0900	9222	6.0%	10.7	97.1	46.0	45.4	57.6	65.5	3259	35.3%
1000	9230	6.0%	10.0	98.3	45.8	45.4	58.0	66.2	3309	35.9%
1100	8610	5.6%	10.2	96.5	46.4	45.7	58.3	65.9	3228	37.5%
1200	8844	5.8%	11.1	122.4	46.1	45.4	58.7	66.2	3167	35.8%
1300	9150	6.0%	10.6	99.3	45.6	45.0	58.3	66.2	3181	34.8%
1400	9537	6.2%	10.2	97.8	46.0	45.7	58.0	65.9	3421	35.9%
1500	10051	6.6%	10.3	110.7	46.0	45.7	58.3	66.6	3629	36.1%
1600	10763	7.0%	10.1	136.0	45.1	44.6	57.2	64.8	3567	33.1%
1700	11417	7.5%	10.0	98.0	42.4	41.8	54.7	63.0	2923	25.6%
1800	11007	7.2%	10.2	92.1	42.7	41.8	55.4	63.7	2843	25.8%
1900	10296	6.7%	10.3	101.7	39.9	38.9	51.1	60.1	1783	17.3%
2000	7265	4.7%	11.0	102.5	42.3	41.0	54.0	62.3	1675	23.1%
2100	5107	3.3%	11.1	97.9	44.3	42.8	56.2	65.5	1426	27.9%
2200	3384	2.2%	11.0	95.4	45.9	44.6	58.3	68.0	1166	34.5%
2300	2318	1.5%	11.6	98.9	47.4	46.1	60.1	70.9	881	38.0%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-400 -- English (ENU)

Datasets:

Site:	**[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction:	6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration:	10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier:	EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 132791 / 133285 (99.63%)

Speed Statistics by Hour

SpeedStatHour-400

Site: Ruringu-Marua Rd.0.0WE
Description: **300M from Ruringu - Othaya Road Junction**
Filter time: **10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 132791, **Posted speed limit** = 50 km/h, Exceeding = 8703 (6.55%), Mean Exceeding = 55.06 km/h, **Maximum** = 157.4 km/h, **Minimum** = 10.0 km/h, **Mean** = 35.3 km/h, **85% Speed** = 44.3 km/h, **95% Speed** = 51.5 km/h, **Median** = 33.8 km/h, **20 km/h Pace** = 25 - 45, **Number in Pace** = 101791 (76.66%), **Variance** = 78.64, **Standard Deviation** = 8.87 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	930	0.7%	10.2	67.4	38.4	37.1	49.3	57.6	135	14.5%
0100	628	0.5%	10.4	78.2	37.5	36.7	49.0	55.8	87	13.9%
0200	416	0.3%	13.0	71.3	37.4	36.7	47.5	56.5	45	10.8%
0300	466	0.4%	11.3	74.9	37.4	35.3	49.3	58.3	66	14.2%
0400	490	0.4%	13.6	70.8	36.5	34.6	47.9	55.8	63	12.9%
0500	1323	1.0%	13.8	73.6	36.8	35.6	46.8	54.4	132	10.0%
0600	3942	3.0%	10.4	80.4	35.8	33.8	45.7	54.0	375	9.5%
0700	8237	6.2%	11.2	123.6	35.4	34.2	43.9	51.1	497	6.0%
0800	9170	6.9%	10.4	73.7	34.8	33.8	42.8	50.4	500	5.5%
0900	7892	5.9%	10.8	98.1	35.4	34.2	43.6	50.4	451	5.7%
1000	7671	5.8%	10.4	92.2	35.3	33.8	43.9	51.5	505	6.6%
1100	6969	5.2%	11.2	149.3	35.8	34.2	44.6	52.6	526	7.5%
1200	6610	5.0%	10.8	71.6	35.6	33.8	45.4	52.2	503	7.6%
1300	7248	5.5%	11.7	75.1	35.8	34.2	45.4	52.2	530	7.3%
1400	7769	5.9%	10.2	102.3	36.2	34.6	46.4	52.9	652	8.4%
1500	8872	6.7%	12.4	157.4	36.4	34.9	46.1	52.2	722	8.1%
1600	9736	7.3%	10.5	93.6	35.7	34.2	45.0	51.5	675	6.9%
1700	10263	7.7%	10.2	105.4	34.3	33.1	43.9	50.4	575	5.6%
1800	10778	8.1%	10.0	122.4	33.5	32.4	42.5	49.3	484	4.5%
1900	9060	6.8%	10.3	69.1	33.4	32.8	41.0	46.8	235	2.6%
2000	5992	4.5%	10.2	69.5	35.0	34.2	42.8	49.3	279	4.7%
2100	3918	3.0%	10.3	67.8	36.3	35.3	45.0	51.1	262	6.7%
2200	2587	1.9%	10.7	78.4	36.9	36.0	46.1	54.0	233	9.0%
2300	1824	1.4%	10.8	73.1	37.3	36.7	46.8	53.6	171	9.4%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-401 -- English (ENU)

Datasets:

Site:	**[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction:	7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration:	17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier:	ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 102289 / 102397 (99.89%)

Speed Statistics by Hour

SpeedStatHour-401

Site: Nyeri-Tetu Rd.0.0NS
Description: **400M from Nyeri-Kingongo Road Junction**
Filter time: **17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 102289, **Posted speed limit** = 50 km/h, Exceeding = 70573 (68.99%), Mean Exceeding = 60.91 km/h, **Maximum** = 149.5 km/h, **Minimum** = 11.3 km/h, **Mean** = 55.3 km/h, **85% Speed** = 66.2 km/h, **95% Speed** = 75.2 km/h, **Median** = 54.7 km/h, **20 km/h Pace** = 45 - 65, **Number in Pace** = 67752 (66.24%), **Variance** = 135.66, **Standard Deviation** = 11.65 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	1021	1.0%	21.9	113.4	57.0	56.5	70.2	83.2	710	69.5%
0100	557	0.5%	19.6	111.1	57.6	57.2	68.8	78.5	419	75.2%
0200	359	0.4%	11.3	100.4	59.4	58.3	70.9	81.0	292	81.3%
0300	369	0.4%	20.4	93.2	58.1	58.3	69.5	77.4	285	77.2%
0400	311	0.3%	15.4	97.4	59.8	58.3	72.7	83.2	251	80.7%
0500	792	0.8%	13.1	108.8	57.5	57.2	71.3	80.6	576	72.7%
0600	2509	2.5%	17.3	141.0	58.7	58.3	71.6	81.4	1929	76.9%
0700	5562	5.4%	13.6	117.6	58.1	57.6	69.1	79.2	4292	77.2%
0800	7033	6.9%	15.2	113.9	56.7	56.2	67.3	76.0	5186	73.7%
0900	6672	6.5%	15.1	110.1	55.4	55.1	66.2	73.8	4684	70.2%
1000	6190	6.1%	15.5	115.1	55.5	55.1	65.9	74.9	4355	70.4%
1100	5586	5.5%	12.4	119.1	55.7	55.1	65.9	74.5	3964	71.0%
1200	5474	5.4%	11.6	119.9	55.1	54.7	65.5	74.5	3768	68.8%
1300	6152	6.0%	11.6	124.1	55.5	55.1	65.5	74.2	4372	71.1%
1400	6584	6.4%	14.1	103.5	56.0	55.4	66.2	74.9	4760	72.3%
1500	6125	6.0%	15.0	104.6	55.6	55.1	65.9	74.2	4354	71.1%
1600	6919	6.8%	12.8	110.6	55.5	54.7	66.2	74.2	4864	70.3%
1700	7588	7.4%	14.5	103.9	54.1	53.3	64.4	72.7	5067	66.8%
1800	7352	7.2%	12.8	104.3	53.3	52.9	63.7	72.4	4690	63.8%
1900	7235	7.1%	14.5	149.5	52.1	51.5	61.6	69.5	4203	58.1%
2000	4443	4.3%	16.2	110.0	53.4	52.6	64.4	73.8	2727	61.4%
2100	3142	3.1%	11.9	112.1	54.8	54.0	66.6	76.0	2019	64.3%
2200	2372	2.3%	15.5	110.8	55.0	54.4	67.0	77.8	1532	64.6%
2300	1942	1.9%	16.8	110.8	55.7	55.1	68.4	78.8	1274	65.6%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-402 -- English (ENU)

Datasets:

Site:	**[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction:	6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration:	9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:	
File:	Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier:	ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 98991 / 100709 (98.29%)

Speed Statistics by Hour

SpeedStatHour-402

Site: Nyeri-Ruringu Rd.0.0WE
Description: **200M from Total Petrol Station towards Ruringu**
Filter time: **9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 98991, **Posted speed limit** = 50 km/h, Exceeding = 9728 (9.83%), Mean Exceeding = 54.85 km/h, **Maximum** = 109.0 km/h, **Minimum** = 10.0 km/h, **Mean** = 39.3 km/h, **85% Speed** = 47.5 km/h, **95% Speed** = 52.9 km/h, **Median** = 40.0 km/h, **20 km/h Pace** = 30 - 50, **Number in Pace** = 75017 (75.78%), **Variance** = 84.65, **Standard Deviation** = 9.20 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	1085	1.1%	11.0	99.9	44.1	43.9	53.6	59.4	297	27.4%
0100	705	0.7%	11.7	85.4	44.2	43.9	52.6	59.8	176	25.0%
0200	496	0.5%	15.2	72.0	44.1	43.6	52.9	59.4	124	25.0%
0300	448	0.5%	18.3	72.3	43.6	43.2	52.2	58.0	102	22.8%
0400	431	0.4%	11.0	75.7	42.5	42.5	51.8	58.7	92	21.3%
0500	951	1.0%	11.0	75.8	42.0	41.8	50.4	56.9	152	16.0%
0600	2342	2.4%	11.0	80.9	39.8	39.6	49.3	54.7	328	14.0%
0700	4159	4.2%	10.6	90.6	38.2	39.2	47.2	52.9	360	8.7%
0800	4893	4.9%	10.1	80.3	38.7	39.6	47.9	53.3	513	10.5%
0900	4981	5.0%	10.5	73.2	39.6	40.3	48.2	54.0	554	11.1%
1000	5256	5.3%	10.2	106.1	39.7	40.3	47.9	52.6	496	9.4%
1100	5263	5.3%	11.0	81.3	38.9	39.6	47.2	52.2	452	8.6%
1200	5552	5.6%	10.0	83.0	39.3	40.0	47.5	52.9	518	9.3%
1300	5680	5.7%	10.1	80.9	39.8	40.3	47.5	52.6	535	9.4%
1400	5886	5.9%	10.1	77.7	39.8	40.3	47.9	52.6	557	9.5%
1500	6604	6.7%	10.0	98.2	38.8	39.6	47.2	52.2	580	8.8%
1600	7429	7.5%	10.2	89.7	38.3	39.2	46.4	51.1	508	6.8%
1700	7810	7.9%	10.3	78.1	38.2	39.2	46.4	51.1	531	6.8%
1800	8385	8.5%	10.8	88.0	37.6	38.5	45.4	50.4	486	5.8%
1900	7557	7.6%	10.4	109.0	37.7	38.9	45.4	50.0	387	5.1%
2000	5130	5.2%	11.3	81.9	39.9	40.3	47.9	53.3	510	9.9%
2100	3529	3.6%	12.5	80.5	41.9	41.8	50.0	55.4	548	15.5%
2200	2563	2.6%	12.5	85.3	42.9	42.5	51.8	57.6	539	21.0%
2300	1856	1.9%	11.9	100.3	43.5	43.2	51.5	58.3	383	20.6%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-403 -- English (ENU)

Datasets:

Site:	**[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier:	ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 225644 / 226460 (99.64%)

Speed Statistics by Hour

SpeedStatHour-403

Site: Nyeri-Kingongo Rd.0.0SN

Description: **400M from Nyeri-Nyahururu Road Junction**

Filter time: **16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**

Scheme: Vehicle classification (ARX)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 225644, **Posted speed limit** = 50 km/h, Exceeding = 103957 (46.07%), Mean Exceeding = 58.56 km/h, **Maximum** = 156.7 km/h, **Minimum** = 10.0 km/h, **Mean** = 48.6 km/h, **85% Speed** = 60.1 km/h, **95% Speed** = 67.3 km/h, **Median** = 48.6 km/h, **20 km/h Pace** = 39 - 59, **Number in Pace** = 143482 (63.59%), **Variance** = 144.98, **Standard Deviation** = 12.04 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	1471	0.7%	11.2	125.9	56.4	57.2	70.6	77.8	1019	69.3%
0100	881	0.4%	12.5	106.9	57.1	58.3	72.0	80.3	626	71.1%
0200	548	0.2%	15.0	100.2	57.4	59.4	73.4	79.6	400	73.0%
0300	621	0.3%	12.8	95.7	57.9	59.0	73.8	79.2	458	73.8%
0400	731	0.3%	10.7	103.4	57.8	59.4	70.6	76.7	545	74.6%
0500	1792	0.8%	12.7	95.9	56.2	56.9	69.1	75.6	1249	69.7%
0600	5650	2.5%	10.3	132.6	52.5	52.6	64.4	72.0	3392	60.0%
0700	12321	5.5%	10.3	97.1	49.3	49.7	60.5	67.3	6010	48.8%
0800	13785	6.1%	10.0	156.7	50.4	50.4	61.2	67.7	7208	52.3%
0900	14225	6.3%	10.1	122.3	50.0	50.4	60.8	67.7	7377	51.9%
1000	14564	6.5%	10.4	141.3	49.1	49.7	60.5	67.0	7238	49.7%
1100	13716	6.1%	11.0	134.7	49.7	50.0	60.8	67.3	6994	51.0%
1200	13065	5.8%	10.1	143.5	49.8	50.4	61.6	68.4	6808	52.1%
1300	13559	6.0%	10.0	103.2	48.2	49.7	60.8	67.3	6746	49.8%
1400	14776	6.5%	10.2	127.5	49.0	49.3	60.1	66.6	7135	48.3%
1500	16093	7.1%	10.2	138.3	48.3	48.6	59.0	65.9	7242	45.0%
1600	18110	8.0%	10.6	132.4	46.4	46.8	57.6	63.7	6889	38.0%
1700	18670	8.3%	10.5	124.7	44.3	44.6	55.4	61.9	5756	30.8%
1800	15676	6.9%	10.7	94.7	46.1	46.4	56.5	63.4	5729	36.5%
1900	13559	6.0%	10.3	153.8	44.1	44.3	53.3	59.8	3533	26.1%
2000	8827	3.9%	10.8	122.6	48.6	48.6	59.0	66.2	3975	45.0%
2100	6162	2.7%	10.1	138.6	51.3	51.1	62.6	70.2	3362	54.6%
2200	4195	1.9%	10.1	134.9	53.3	52.9	65.2	73.4	2575	61.4%
2300	2647	1.2%	10.0	97.9	54.4	54.7	68.0	75.6	1691	63.9%

MetroCount Traffic Executive
Speed Statistics by Hour

SpeedStatHour-404 -- English (ENU)

Datasets:

Site:	**[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier:	ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction:	8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration:	16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier:	ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction:	7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration:	10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier:	EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04

Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**

Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier:	ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 881708 / 885866 (99.53%)

Speed Statistics by Hour

SpeedStatHour-404

Site: Nyeri-Kiganjo Rd.0.0SN Nyeri-Nyahururu Rd.0.0EW Ruringu-Othaya Rd.0.0NS Ruringu-Marua Rd.0.0WE Nyeri-Tetu Rd.0.0NS Nyeri-Ruringu Rd.0.0WE Nyeri-Kingongo Rd.0.0SN

Description: **Multiple sites - See Header sheet for site descriptions.**

Filter time: **16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**

Scheme: Vehicle classification (ARX)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Vehicles = 881708, **Posted speed limit** = 50 km/h, Exceeding = 277802 (31.51%), Mean Exceeding = 58.93 km/h, **Maximum** = 159.6 km/h, **Minimum** = 10.0 km/h, **Mean** = 44.5 km/h, **85% Speed** = 57.2 km/h, **95% Speed** = 65.5 km/h, **Median** = 43.6 km/h, **20 km/h Pace** = 33 - 53, **Number in Pace** = 514163 (58.31%), **Variance** = 158.53, **Standard Deviation** = 12.59 km/h

Hour Bins (Partial days)

Time	Bin		Min	Max	Mean	Median	85%	95%	>PSL 50 km/h	
0000	6763	0.8%	10.2	125.9	48.8	47.2	63.4	73.4	2914	43.1%
0100	4115	0.5%	10.1	111.1	48.8	47.5	63.7	74.5	1814	44.1%
0200	2652	0.3%	11.3	100.4	48.9	47.5	64.4	74.9	1171	44.2%
0300	2745	0.3%	11.3	96.2	48.9	47.5	64.4	74.5	1228	44.7%
0400	3092	0.4%	10.7	103.4	49.6	48.6	65.5	74.5	1472	47.6%
0500	7852	0.9%	11.0	109.1	49.5	48.2	65.2	74.9	3619	46.1%
0600	23131	2.6%	10.2	148.6	46.4	45.4	60.8	70.2	8945	38.7%
0700	48731	5.5%	10.2	127.1	45.0	43.9	58.3	66.6	16142	33.1%
0800	54119	6.1%	10.0	156.7	45.1	44.3	58.3	66.2	18486	34.2%
0900	53073	6.0%	10.1	131.7	45.4	44.6	58.0	65.9	18430	34.7%
1000	53045	6.0%	10.0	152.7	45.1	44.3	58.0	65.9	18022	34.0%
1100	49535	5.6%	10.2	152.7	45.2	44.6	58.0	65.5	16977	34.3%
1200	49950	5.7%	10.0	143.5	45.0	44.3	58.0	65.9	16687	33.4%
1300	52443	5.9%	10.0	159.6	44.7	43.9	57.6	65.5	17517	33.4%
1400	55445	6.3%	10.1	127.5	45.2	44.6	57.6	65.5	18739	33.8%
1500	59596	6.8%	10.0	157.4	44.5	43.9	56.9	64.8	18685	31.4%
1600	67465	7.7%	10.1	148.2	43.6	42.8	56.2	64.1	19432	28.8%
1700	70034	7.9%	10.0	159.2	42.3	41.4	54.4	62.6	17628	25.2%
1800	64923	7.4%	10.0	133.3	42.3	41.4	54.7	63.0	16677	25.7%
1900	58054	6.6%	10.3	153.8	41.4	40.3	52.6	60.5	12115	20.9%
2000	38077	4.3%	10.2	122.6	43.7	42.5	55.8	64.1	10612	27.9%
2100	26318	3.0%	10.1	138.6	45.6	44.3	58.3	67.3	8756	33.3%
2200	18086	2.1%	10.0	134.9	46.9	45.7	60.1	69.5	6846	37.9%
2300	12464	1.4%	10.0	110.8	47.7	46.1	61.9	71.6	4888	39.2%

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-179 -- English (ENU)

Datasets:

Site:	**[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction:	7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration:	10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier:	EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 153156 / 153587 (99.72%)

Class Speed Matrix

ClassMatrix-179

Site:	Ruringu-Othaya Rd.0.0NS
Description:	**300M from Nairobi-Nyeri Rd Junction**
Filter time:	**10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Scheme:	Vehicle classification (ARX)
Filter:	Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h) **Speed Totals**

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	%
10 - 20	329	2000	65	312	80	16	12	9	15	17	2	1	2858	1.9%
20 - 30	3206	8610	320	656	146	134	13	51	31	43	6	2	13218	8.6%
30 - 40	10270	25734	593	699	136	322	3	82	29	96	9	8	37981	24.8%
40 - 50	10300	37317	350	941	116	174	.	73	10	32	2	6	49321	32.2%
50 - 60	5188	25892	92	1035	146	66	.	12	5	6	.	.	32442	21.2%
60 - 70	1903	10252	16	610	40	21	.	8	.	1	.	.	12851	8.4%
70 - 80	678	2494	.	195	6	3	.	3	.	1	.	.	3380	2.2%
80 - 90	340	511	.	58	3	6	1	.	1	3	.	.	923	0.6%
90 - 100	62	87	.	9	.	2	.	.	.	.	.	.	160	0.1%
100 - 110	1	9	.	5	.	.	.	.	.	.	.	.	15	0.0%
110 - 120	1	.	.	.	.	.	.	.	.	.	.	.	1	0.0%
120 - 130	.	.	.	2	.	.	.	.	.	.	.	.	2	0.0%
130 - 140	.	2	.	.	.	.	.	.	.	.	.	.	2	0.0%
140 - 150	.	2	.	.	.	.	.	.	.	.	.	.	2	0.0%
150 - 160	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
Class Totals	32278	112910	1436	4522	673	744	29	238	91	199	19	17	153156	
	21.1%	73.7%	0.9%	3.0%	0.4%	0.5%	0.0%	0.2%	0.1%	0.1%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-180 -- English (ENU)

Datasets:

Site:	**[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction:	6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration:	9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:	
File:	Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier:	ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 98991 / 100709 (98.29%)

Class Speed Matrix

ClassMatrix-180

Site: Nyeri-Ruringu Rd.0.0WE
Description: **200M from Total Petrol Station towards Ruringu**
Filter time: **9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	73	3097	4	53	33	12	7	.	4	9	1	1	3294	3.3%
20 - 30	641	9385	82	756	244	63	23	14	19	69	6	3	11305	11.4%
30 - 40	3371	26107	346	3980	445	104	76	74	42	126	3	12	34686	35.0%
40 - 50	3445	26416	305	9056	406	49	128	73	14	77	1	8	39978	40.4%
50 - 60	781	3019	24	4537	89	2	59	9	2	6	.	.	8528	8.6%
60 - 70	74	326	7	606	8	.	7	.	.	.	.	.	1028	1.0%
70 - 80	.	69	1	62	3	.	2	.	.	.	.	.	137	0.1%
80 - 90	.	19	3	4	.	.	1	.	.	.	.	.	27	0.0%
90 - 100	.	.	1	1	1	.	.	.	.	.	.	.	3	0.0%
100 - 110	.	4	1	.	.	.	.	.	.	.	.	.	5	0.0%
110 - 120	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
120 - 130	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
130 - 140	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
140 - 150	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
150 - 160	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
Class Totals	8385	68442	774	19055	1229	230	303	170	81	287	11	24	98991	
	8.5%	69.1%	0.8%	19.2%	1.2%	0.2%	0.3%	0.2%	0.1%	0.3%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-181 -- English (ENU)

Datasets:

Site:	**[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction:	8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration:	16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier:	ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 52700 / 52880 (99.66%)

Class Speed Matrix

ClassMatrix-181

Site: Nyeri-Nyahururu Rd.0.0EW

Description: **200M from King'ong'o - Mathari Road Junction**

Filter time: **16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**

Scheme: Vehicle classification (ARX)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	6	73	.	56	20	3	1	1	.	2	.	.	162	0.3%
20 - 30	10	1468	5	668	150	10	7	3	4	13	.	.	2338	4.4%
30 - 40	29	5299	27	1223	158	20	7	11	9	30	1	.	6814	12.9%
40 - 50	52	12677	41	1622	193	11	5	6	15	18	1	.	14641	27.8%
50 - 60	26	16794	38	1408	117	3	6	2	1	6	.	.	18401	34.9%
60 - 70	17	7753	8	479	18	1	.	.	.	1	.	.	8277	15.7%
70 - 80	9	1678	1	90	2	.	.	.	.	.	.	.	1780	3.4%
80 - 90	.	228	2	21	.	.	.	.	.	.	.	.	251	0.5%
90 - 100	.	21	.	4	.	.	.	.	.	.	.	.	25	0.0%
100 - 110	.	1	.	.	.	.	.	.	.	.	.	.	1	0.0%
110 - 120	.	4	.	.	.	.	.	.	.	1	.	.	5	0.0%
120 - 130	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
130 - 140	.	.	.	.	1	.	.	.	.	.	.	.	1	0.0%
140 - 150	.	3	.	.	.	.	.	.	.	.	.	.	3	0.0%
150 - 160	.	.	.	.	.	.	1	.	.	.	.	.	1	0.0%
Class Totals	149	45999	122	5571	659	48	27	23	29	71	2	0	52700	
	0.3%	87.3%	0.2%	10.6%	1.3%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-182 -- English (ENU)

Datasets:

Site:	**[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier:	ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 116137 / 116548 (99.65%)

Class Speed Matrix

ClassMatrix-182

Site: Nyeri-Kiganjo Rd.0.0SN
Description: **400M from Nyeri-Nyahururu Road Junction**
Filter time: **16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	238	1800	9	125	83	29	9	2	9	36	.	.	2340	2.0%
20 - 30	1516	9117	166	1336	258	87	5	35	55	130	7	2	12714	10.9%
30 - 40	5833	42888	294	3810	426	123	2	50	32	58	1	1	53518	46.1%
40 - 50	4573	34817	100	1635	35	58	3	16	3	7	.	.	41247	35.5%
50 - 60	1187	4406	5	170	3	18	.	6	.	1	.	.	5796	5.0%
60 - 70	115	236	.	23	.	5	.	.	.	.	.	.	379	0.3%
70 - 80	6	18	.	15	.	1	.	.	.	.	.	.	40	0.0%
80 - 90	1	10	.	25	1	.	.	.	.	.	.	.	37	0.0%
90 - 100	.	10	.	8	.	.	.	.	.	.	.	.	18	0.0%
100 - 110	.	6	.	4	.	.	1	.	.	.	.	.	11	0.0%
110 - 120	.	1	.	7	.	.	.	.	.	.	.	.	8	0.0%
120 - 130	.	2	.	5	.	.	.	.	.	.	.	.	7	0.0%
130 - 140	.	.	.	4	.	.	1	.	.	.	.	.	5	0.0%
140 - 150	.	1	.	3	.	.	.	.	.	.	.	.	4	0.0%
150 - 160	.	9	.	4	.	.	.	.	.	.	.	.	13	0.0%
Class Totals	13469	93321	574	7174	806	321	21	109	99	232	8	3	116137	
	11.6%	80.4%	0.5%	6.2%	0.7%	0.3%	0.0%	0.1%	0.1%	0.2%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-183 -- English (ENU)

Datasets:

Site:	**[Nyeri-King'ong'o Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction:	5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration:	16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:	
File:	Nyeri-King'ong'o Rd10Feb2015.EC0 (Plus)
Identifier:	ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 225644 / 226460 (99.64%)

Class Speed Matrix

ClassMatrix-183

Site: Nyeri-King'ong'o Rd.0.0SN
Description: **400M from Nyeri-Nyahururu Road Junction**
Filter time: **16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	%
10 - 20	142	3405	55	529	143	41	29	10	4	24	7	1	4390	1.9%
20 - 30	805	8172	287	1285	198	96	24	53	37	97	11	11	11076	4.9%
30 - 40	5049	23514	800	2054	259	271	5	136	51	166	12	19	32336	14.3%
40 - 50	11484	57147	852	3224	335	318	10	253	72	165	9	16	73885	32.7%
50 - 60	7244	57613	292	2781	359	118	2	101	17	75	2	4	68608	30.4%
60 - 70	2138	24617	48	1143	135	17	2	20	8	13	1	2	28144	12.5%
70 - 80	433	5412	5	219	31	6	.	1	1	2	.	.	6110	2.7%
80 - 90	81	824	.	25	1	.	.	.	.	.	.	.	931	0.4%
90 - 100	4	99	.	2	.	1	.	.	.	.	.	.	106	0.0%
100 - 110	.	11	.	1	.	.	.	.	.	.	.	.	12	0.0%
110 - 120	.	13	.	3	.	.	.	.	.	.	.	.	16	0.0%
120 - 130	.	9	.	2	.	.	.	.	.	.	.	.	11	0.0%
130 - 140	.	10	.	4	.	.	.	.	.	.	.	.	14	0.0%
140 - 150	.	2	.	1	.	.	.	.	.	.	.	.	3	0.0%
150 - 160	.	.	.	2	.	.	.	.	.	.	.	.	2	0.0%
Class Totals	27380	180848	2339	11275	1461	868	72	574	190	542	42	53	225644	
	12.1%	80.1%	1.0%	5.0%	0.6%	0.4%	0.0%	0.3%	0.1%	0.2%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-184 -- English (ENU)

Datasets:

Site: **[Nyeri-Tetu Rd] 400M from Nyeri-King'ong'o Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 102289 / 102397 (99.89%)

Class Speed Matrix

ClassMatrix-184

Site: Nyeri-Tetu Rd.0.0NS

Description: **400M from Nyeri-King'ong'o Road Junction**

Filter time: **17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**

Scheme: Vehicle classification (ARX)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	96	85	.	3	1	3	.	.	.	1	.	.	189	0.2%
20 - 30	588	705	9	39	10	6	.	1	.	5	.	.	1363	1.3%
30 - 40	2724	3699	57	262	51	53	.	13	2	10	1	.	6872	6.7%
40 - 50	4714	17371	125	856	89	83	1	35	6	9	2	1	23292	22.8%
50 - 60	3783	34074	133	869	64	64	.	48	2	7	.	.	39044	38.2%
60 - 70	2024	19456	40	325	16	11	.	13	1	1	.	.	21887	21.4%
70 - 80	882	5785	6	86	3	10	.	2	.	.	.	.	6774	6.6%
80 - 90	378	1785	3	20	.	11	.	.	.	.	.	.	2197	2.1%
90 - 100	55	514	.	14	.	1	.	.	.	.	.	.	584	0.6%
100 - 110	1	63	.	1	.	.	.	.	.	.	.	.	65	0.1%
110 - 120	1	17	.	.	.	.	.	.	.	.	.	.	18	0.0%
120 - 130	.	1	.	.	.	.	.	.	.	.	.	.	1	0.0%
130 - 140	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
140 - 150	.	3	.	.	.	.	.	.	.	.	.	.	3	0.0%
150 - 160	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
Class Totals	15246	83558	373	2475	234	242	1	112	11	33	3	1	102289	
	14.9%	81.7%	0.4%	2.4%	0.2%	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-185 -- English (ENU)

Datasets:

Site:	**[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction:	6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration:	10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier:	EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 132791 / 133285 (99.63%)

Class Speed Matrix

ClassMatrix-185
Site: Ruringu-Marua Rd.0.0WE
Description: **300M from Ruringu - Othaya Road Junction**
Filter time: **10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	95	2906	31	414	156	45	20	2	24	100	1	2	3796	2.9%
20 - 30	883	27801	320	2791	398	119	34	44	49	117	4	4	32564	24.5%
30 - 40	1242	57067	349	2482	296	51	13	25	42	86	6	5	61664	46.4%
40 - 50	418	24365	38	1121	88	10	1	7	10	4	2	.	26064	19.6%
50 - 60	70	7195	9	321	8	1	.	3	.	1	.	.	7608	5.7%
60 - 70	15	910	.	70	1	1	1	.	.	.	.	.	998	0.8%
70 - 80	3	62	.	11	.	.	.	.	.	.	.	.	76	0.1%
80 - 90	.	3	.	.	1	.	.	.	.	.	.	.	4	0.0%
90 - 100	.	5	.	2	.	.	.	.	.	.	.	.	7	0.0%
100 - 110	.	2	.	2	.	.	.	.	.	.	.	.	4	0.0%
110 - 120	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
120 - 130	.	.	.	2	.	.	.	.	.	.	.	.	2	0.0%
130 - 140	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
140 - 150	.	2	.	.	.	.	.	.	.	.	.	.	2	0.0%
150 - 160	.	2	.	.	.	.	.	.	.	.	.	.	2	0.0%
Class Totals	2726	120320	747	7216	948	227	69	81	125	308	13	11	132791	
	2.1%	90.6%	0.6%	5.4%	0.7%	0.2%	0.1%	0.1%	0.1%	0.2%	0.0%	0.0%		

MetroCount Traffic Executive
Class Speed Matrix

ClassMatrix-186 -- English (ENU)

Datasets:

Site: **[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:
File: Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier: EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015

Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)

Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction:	6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration:	10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:	
File:	Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier:	EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (ARX)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 881708 / 885866 (99.53%)

Class Speed Matrix

ClassMatrix-186

Site: Ruringu-Othaya Rd.0.0NS Nyeri-Ruringu Rd.0.0WE Nyeri-Nyahururu Rd.0.0EW Nyeri-Kiganjo Rd.0.0SN Nyeri-Kingongo Rd.0.0SN Nyeri-Tetu Rd.0.0NS Ruringu-Marua Rd.0.0WE

Description: **Multiple sites - See Header sheet for site descriptions.**

Filter time: **16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**

Scheme: Vehicle classification (ARX)

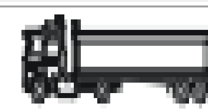
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

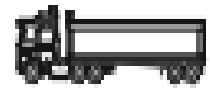
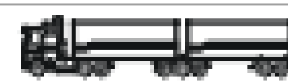
Speed (km/h) / **Class** / **Speed Totals**

Speed (km/h)	1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	%
10 - 20	979	13366	164	1492	516	149	78	24	56	189	11	5	17029	1.9%
20 - 30	7649	65258	1189	7531	1404	515	106	201	195	474	34	22	84578	9.6%
30 - 40	28518	184308	2466	14510	1771	944	106	391	207	572	33	45	233871	26.5%
40 - 50	34986	210110	1811	18455	1262	703	148	463	130	312	17	31	268428	30.4%
50 - 60	18279	148993	593	11121	786	272	67	181	27	102	2	4	180427	20.5%
60 - 70	6286	63550	119	3256	218	56	10	41	9	16	1	2	73564	8.3%
70 - 80	2011	15518	13	678	45	20	2	6	1	3	.	.	18297	2.1%
80 - 90	800	3380	8	153	6	17	2	.	1	3	.	.	4370	0.5%
90 - 100	121	736	1	40	1	4	.	.	.	.	.	.	903	0.1%
100 - 110	2	96	1	13	.	.	1	.	.	.	.	.	113	0.0%
110 - 120	2	35	.	10	.	.	.	.	.	1	.	.	48	0.0%
120 - 130	.	12	.	11	.	.	.	.	.	.	.	.	23	0.0%
130 - 140	.	12	.	8	1	.	1	.	.	.	.	.	22	0.0%
140 - 150	.	13	.	4	.	.	.	.	.	.	.	.	17	0.0%
150 - 160	.	11	.	6	.	.	1	.	.	.	.	.	18	0.0%
Class Totals	99633	705398	6365	57288	6010	2680	522	1307	626	1672	98	109	881708	
	11.3%	80.0%	0.7%	6.5%	0.7%	0.3%	0.1%	0.1%	0.1%	0.2%	0.0%	0.0%		

ARX is a modification of AustRoads94. It removes class 12, moves all other classes up by one, and inserts a cycle class as class 1.

- **Units:** Metric (m)
- **Car class:** 2
- **Unclassifiable vehicle class:** 13

Axles	Groups	Description	Class		Parameters	Dominant Vehicle	Aggregate
2	1 or 2	Very Short - Bicycle or Motorcycle	MC	1	d(1)<1.7m & axles=2		1 (Light)
2	1 or 2	Short - Sedan, Wagon, 4WD, Utility, Light Van	SV	2	d(1)>=1.7m, d(1)<=3.2m & axles=2		
3, 4 or 5	3	Short Towing - Trailer, Caravan, Boat, etc.	SVT	3	groups=3, d(1)>=2.1m, d(1)<=3.2m, d(2)>=2.1m & axles=3,4,5		
2	2	Two axle truck or Bus	TB2	4	d(1)>3.2m & axles=2		2 (Medium)
3	2	Three axle truck or Bus	TB3	5	axles=3 & groups=2		
>3	2	Four axle truck	T4	6	axles>3 & groups=2		
3	3	Three axle articulated vehicle or Rigid vehicle and trailer	ART3	7	d(1)>3.2m, axles=3 & groups=3		3 (Heavy)
4	>2	Four axle articulated vehicle or Rigid vehicle and trailer	ART4	8	d(2)<2.1m or d(1)<2.1m or d(1)>3.2m axles = 4 & groups>2		

Axles	Groups	Description	Class		Parameters	Dominant Vehicle	Aggregate
5	>2	Five axle articulated vehicle or Rigid vehicle and trailer	ART5	9	d(2)<2.1m or d(1)<2.1m or d(1)>3.2m axles=5 & groups>2		
>=6	>2	Six (or more) axle articulated vehicle or Rigid vehicle and trailer	ART6	10	axles=6 & groups>2 or axles>6 & groups=3		
>6	4	B-Double or Heavy truck and trailer	BD	11	groups=4 & axles>6		
>6	>=5	Double or triple road train or Heavy truck and two (or more) trailers	DRT	12	groups>=5 & axles>6		

Speed Profile for each link

MetroCount Traffic Executive
Speed

Speed-155 -- English (ENU)

Datasets:

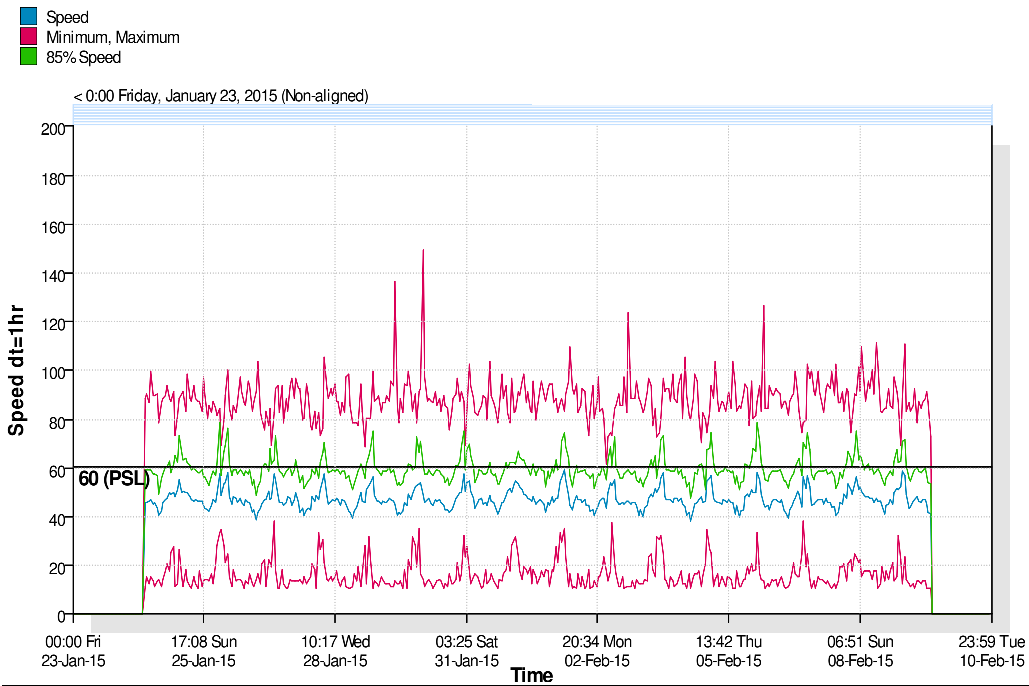
Site: **[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:
File: Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier: EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: **10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 153156 / 153587 (99.72%)

Speed

Speed-220 (Metric) **Site:**Ruringu-Othaya Rd.0.0NS
Description: 300M from Nairobi-Nyeri Rd Junction
Filter time: 10:02 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



MetroCount Traffic Executive
Speed

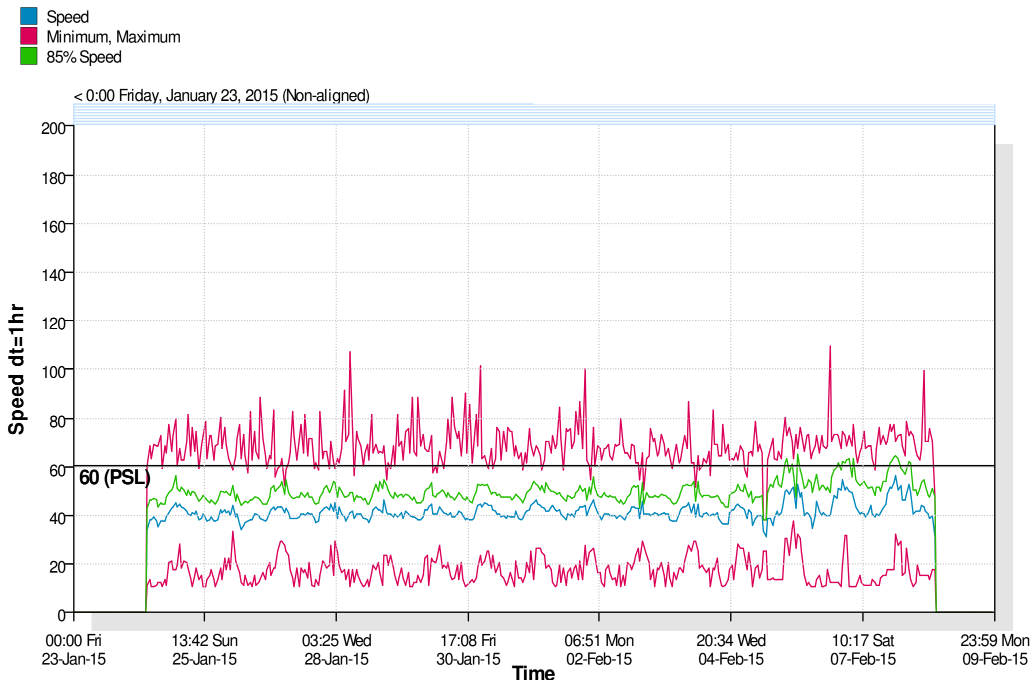
Speed-156 -- English (ENU)

Datasets:
Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 98991 / 100709 (98.29%)

Speed

Speed-219 (Metric) **Site:**Nyeri-Ruringu Rd.0.0WE
Description: 200M from Total Petrol Station towards Ruringu
Filter time: 9:58 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



MetroCount Traffic Executive
Speed

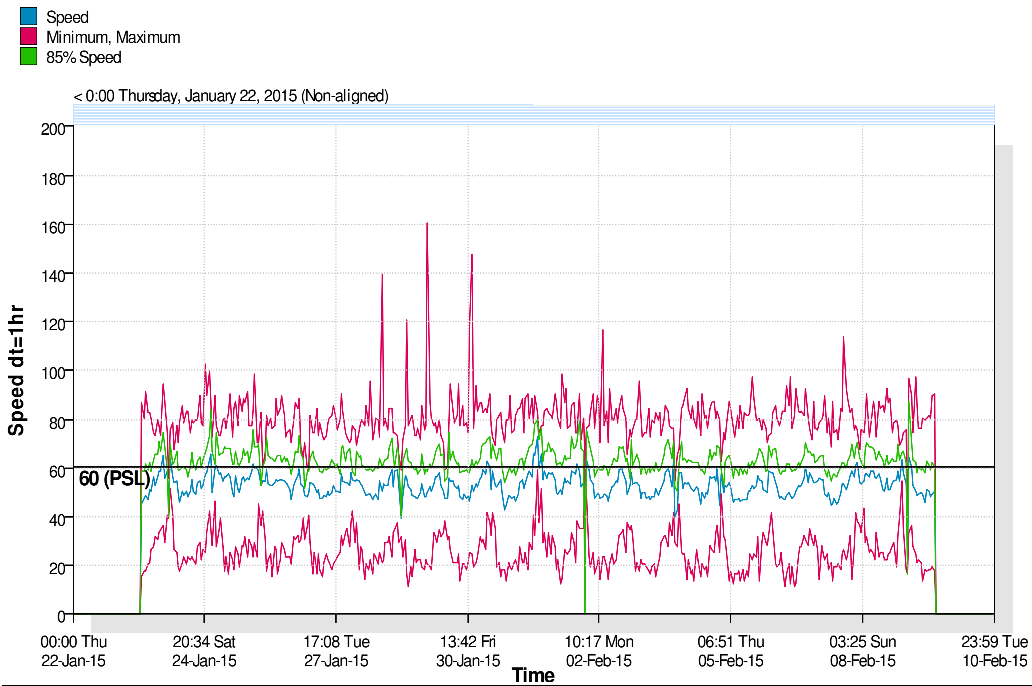
Speed-157 -- English (ENU)

Datasets:
Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 52700 / 52880 (99.66%)

Speed

Speed-218 (Metric) **Site:**Nyeri-Nyahururu Rd.0.0EW
Description: 200M from King'ong'o - Mathari Road Junction
Filter time: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



MetroCount Traffic Executive
Speed

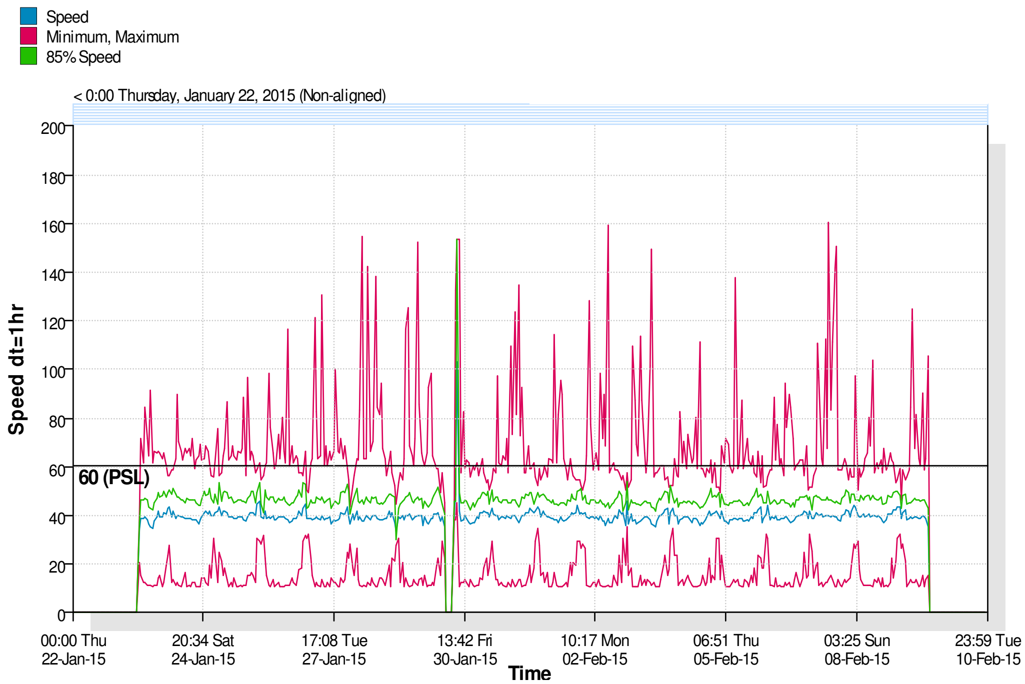
Speed-158 -- English (ENU)

Datasets:
Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 116137 / 116548 (99.65%)

Speed

Speed-217 (Metric) **Site:**Nyeri-Kiganjo Rd.0.0SN
Description: 400M from Nyeri-Nyahururu Road Junction
Filter time: 16:44 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



MetroCount Traffic Executive
Speed

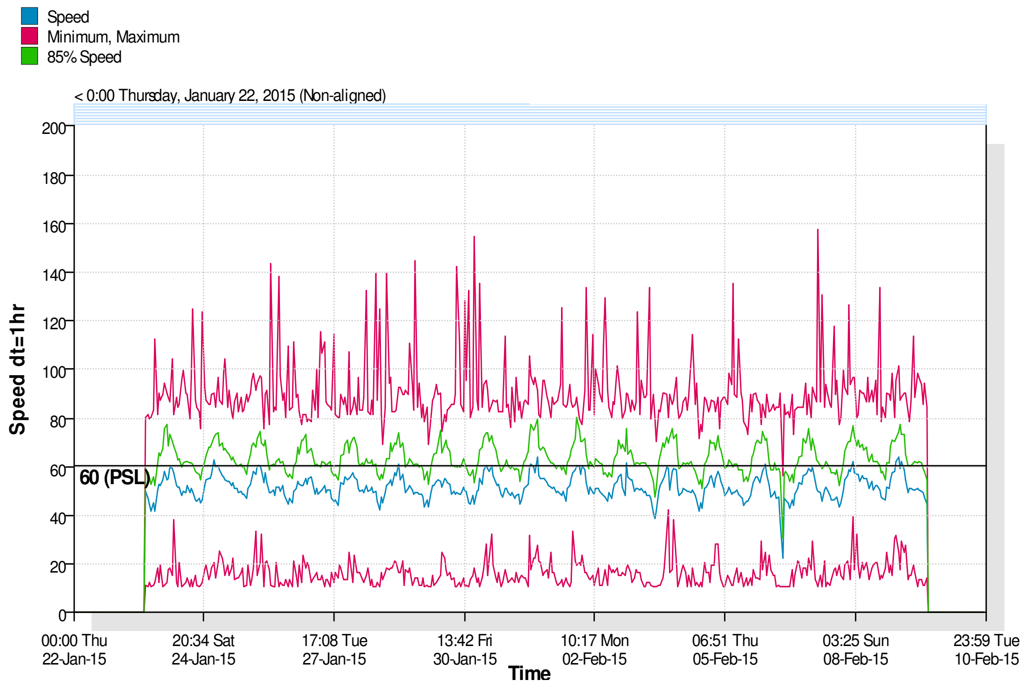
Speed-159 -- English (ENU)

Datasets:
Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 225644 / 226460 (99.64%)

Speed

Speed-216 (Metric) **Site:**Nyeri-Kingongo Rd.0.0SN
Description: 400M from Nyeri-Nyahururu Road Junction
Filter time: 16:56 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



MetroCount Traffic Executive
Speed

Speed-160 -- English (ENU)

Datasets:
Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 102289 / 102397 (99.89%)

Speed

Speed-215 (Metric) **Site:**Nyeri-Tetu Rd.0.0NS
Description: 400M from Nyeri-Kingongo Road Junction
Filter time: 17:04 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)

MetroCount Traffic Executive
Speed

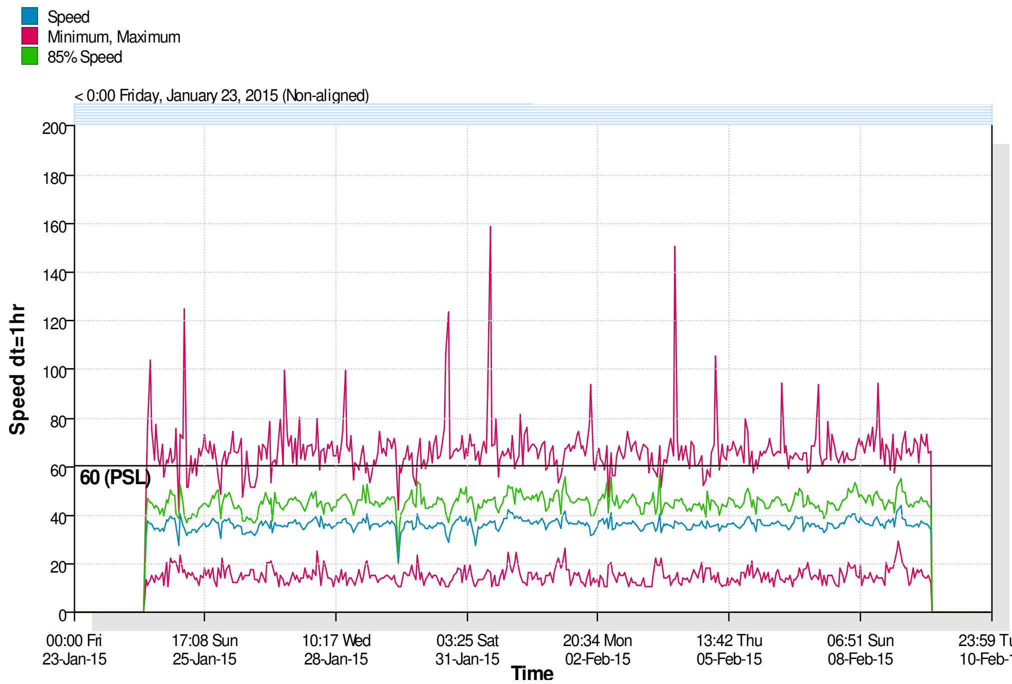
Speed-161 -- English (ENU)

Datasets:
Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 132791 / 133285 (99.63%)

Speed

Speed-214 (Metric) **Site:**Ruringu-Marua Rd.0.0WE
Description: 300M from Ruringu - Othaya Road Junction
Filter time: 10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



Speed Profile for the entire network

<u>MetroCount Traffic Executive</u>
<u>Speed</u>

<u>Speed-162 -- English (ENU)</u>

<u>Datasets:</u>
Site: **[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:
File: Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier: EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)

Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

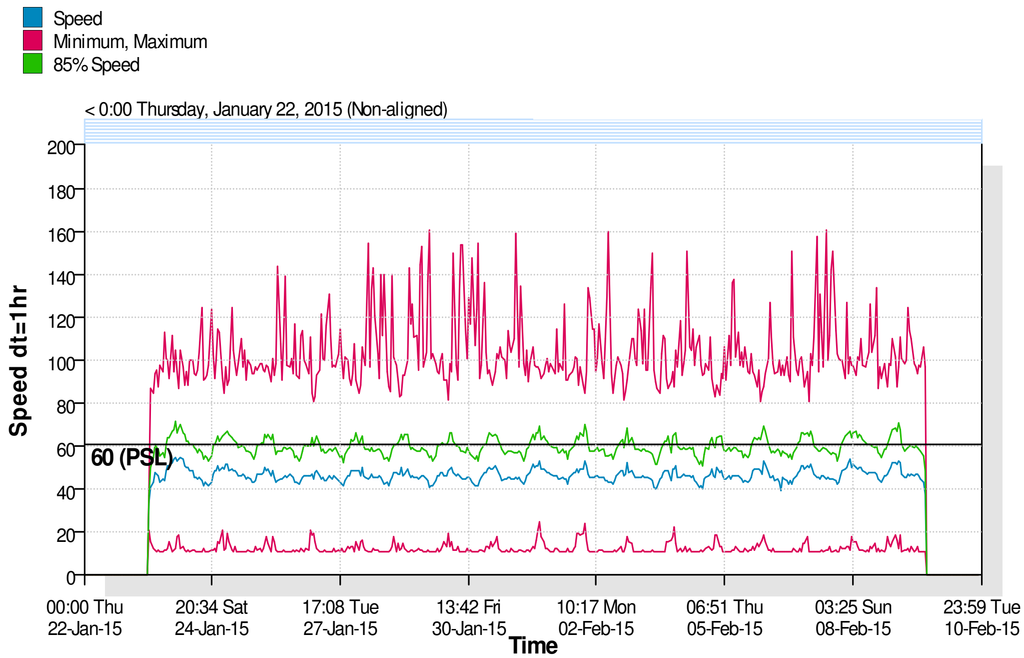
Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 881708 / 885866 (99.53%)

Speed

Speed-213 (Metric) **Site:**Ruringu-Othaya Rd.0.0NS Nyeri-Ruringu Rd.0.0WE Nyeri-Nyahururu Rd.0.0EW Nyeri-Kiganjo Rd.0.0SN Nyeri-Kin
Description: Multiple sites - See Header sheet for site descriptions.
Filter time: 16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)



Appendix 3: Speed - Volume Models for each link and for the entire network combined

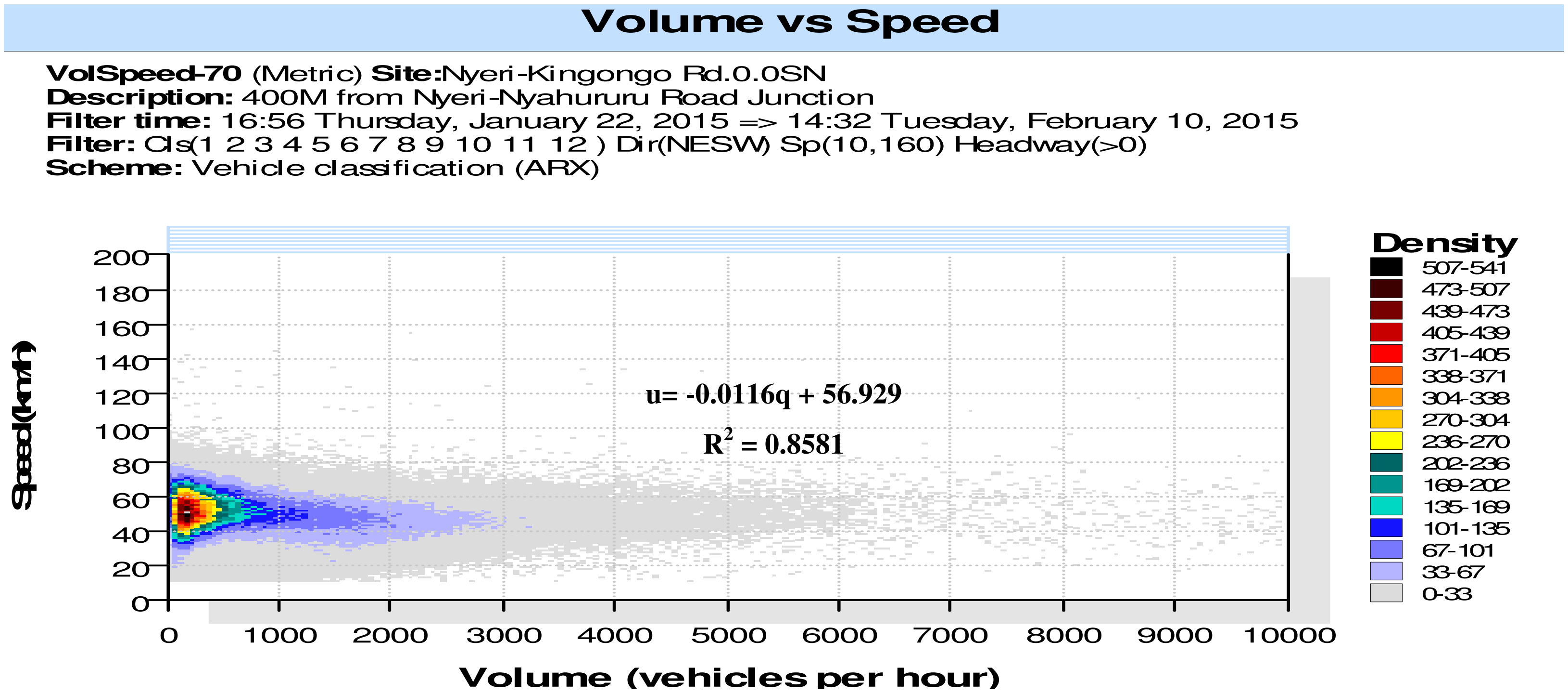


Figure 7-1: Speed - Volume Model for Nyeri – King'ong'o Link

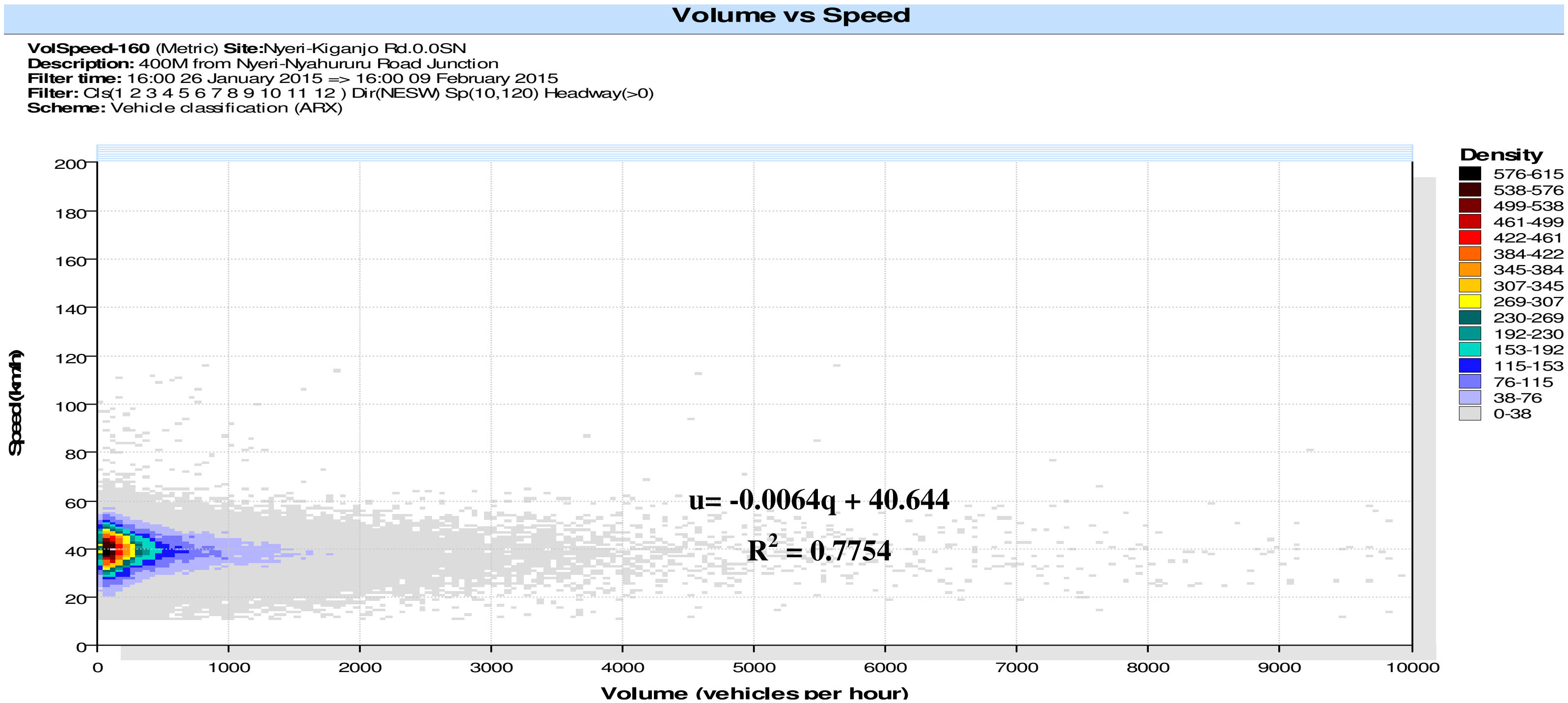


Figure 7-2: Speed - Volume Model for Nyeri – Kiganjo Link

Volume vs Speed

VolSpeed-80 (Metric) **Site:**Ruringu-Marua Rd.0.0WE
Description: 300M from Ruringu - Othaya Road Junction
Filter time: 10:07 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (ARX)

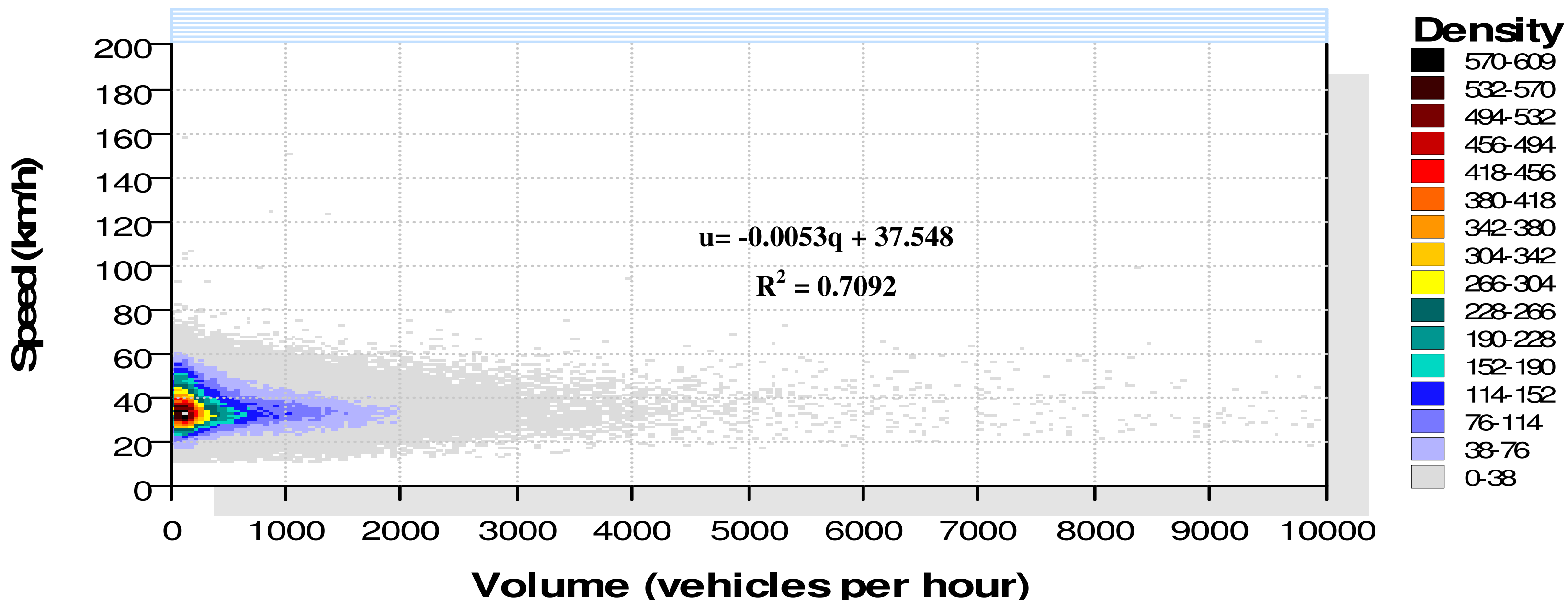


Figure 7-3: Speed - Volume Model for Ruringu-Marua link

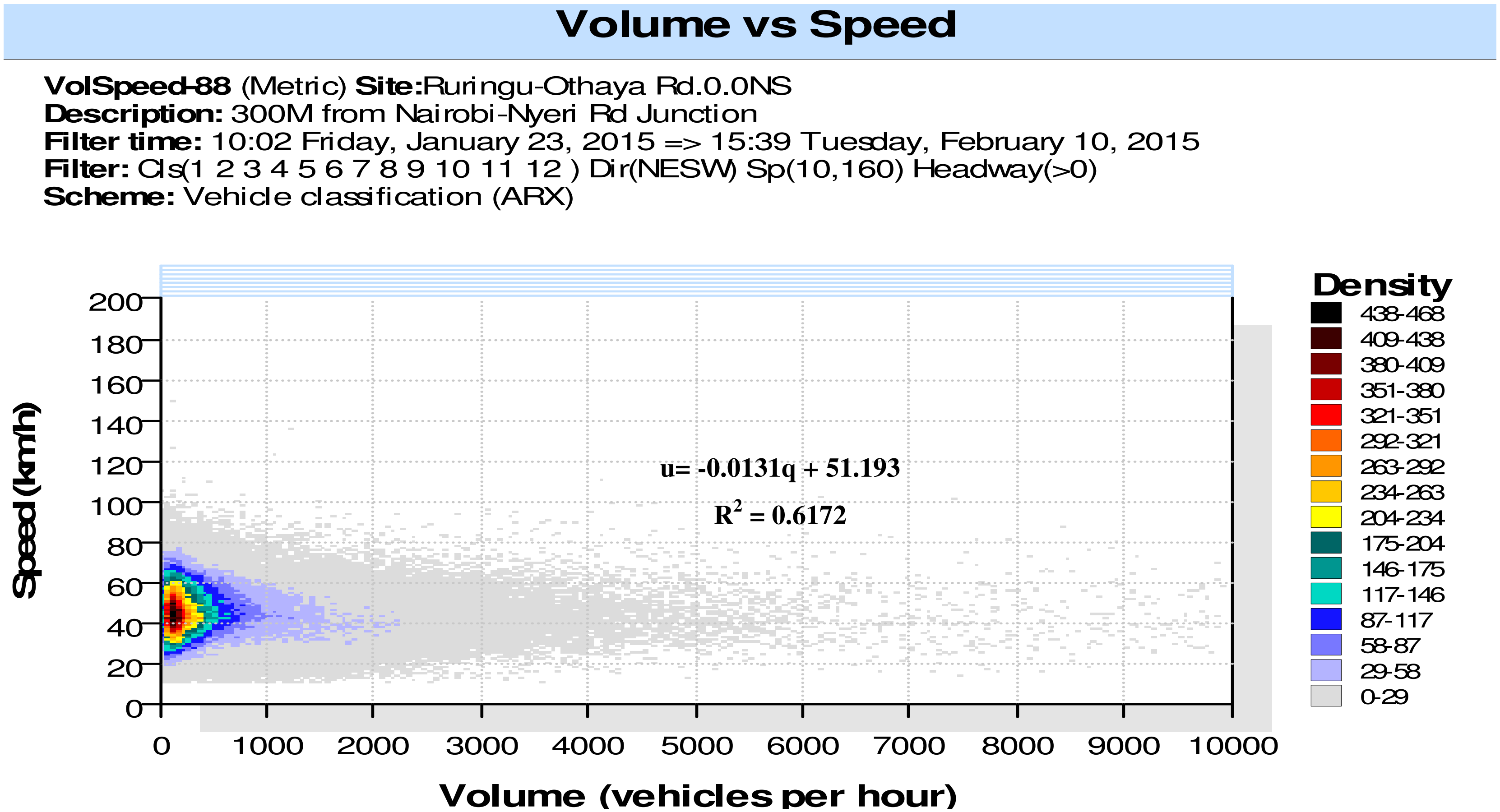


Figure 7-4: Speed - Volume Model for Ruringu-Othaya link

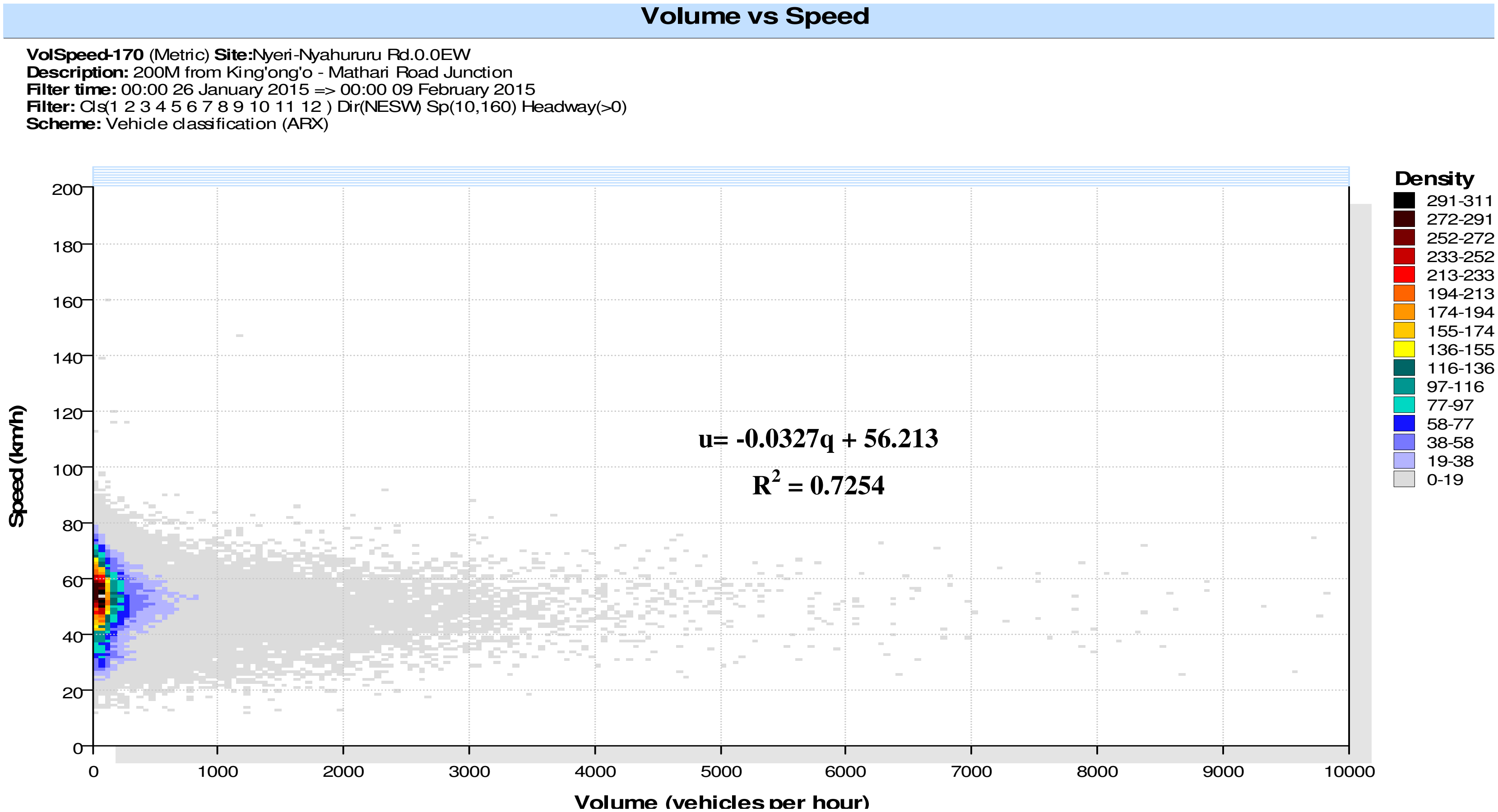


Figure 7-5: Speed - Volume Model for Nyeri-Nyahururu link

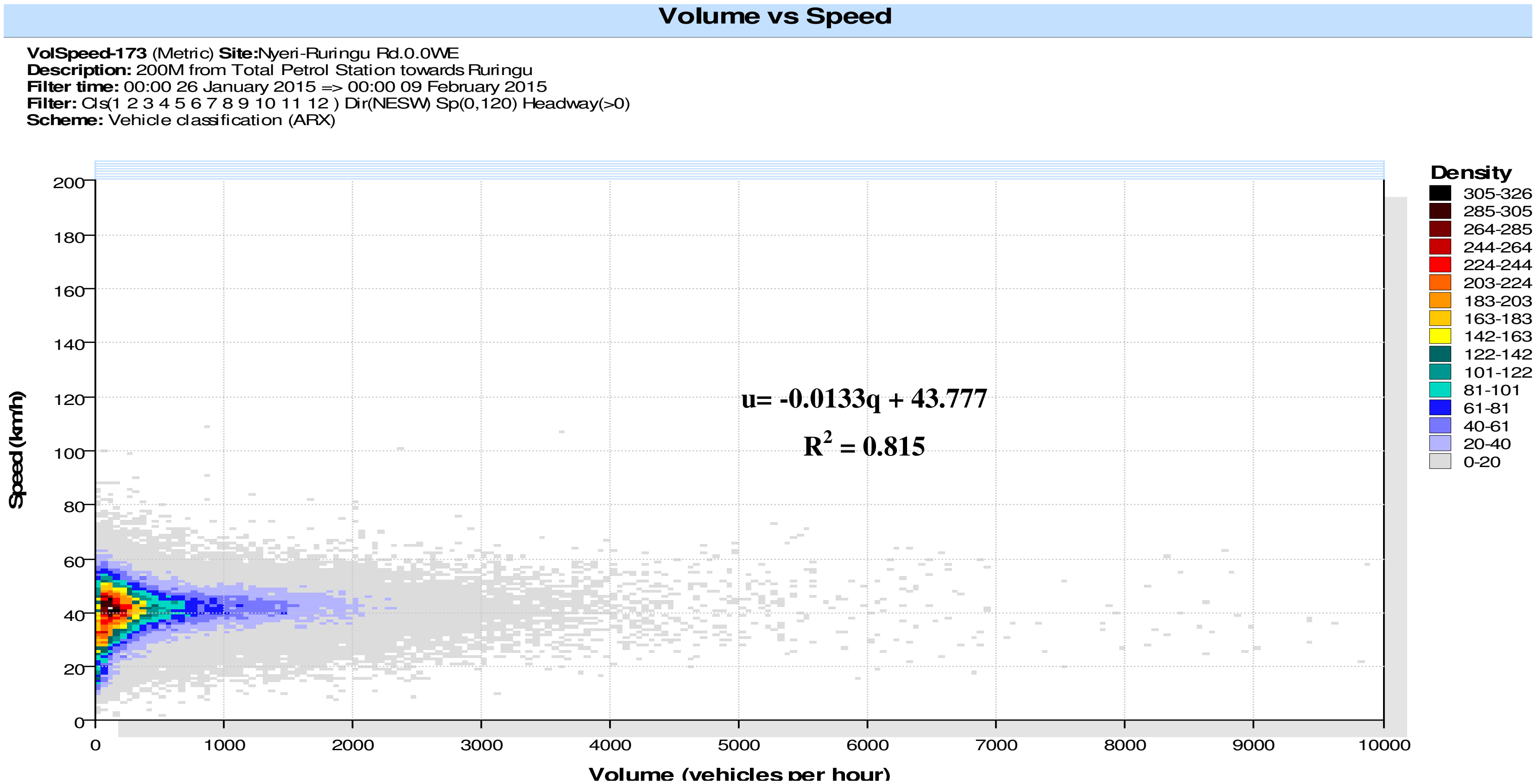


Figure 7-6: Speed - Volume Model for Nyeri-Ruringu link

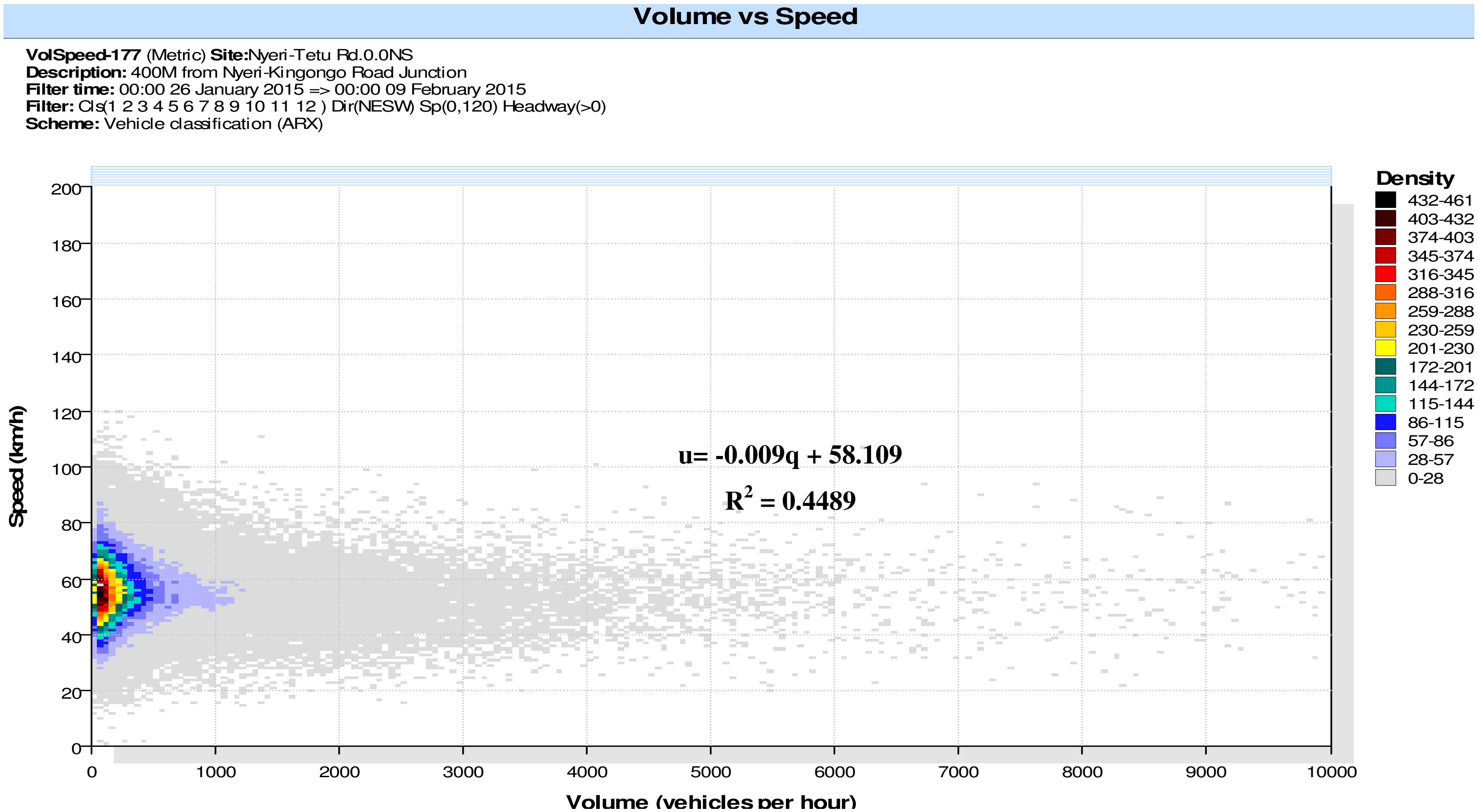


Figure 7-7: Speed - Volume Model for Nyeri-Tetu link

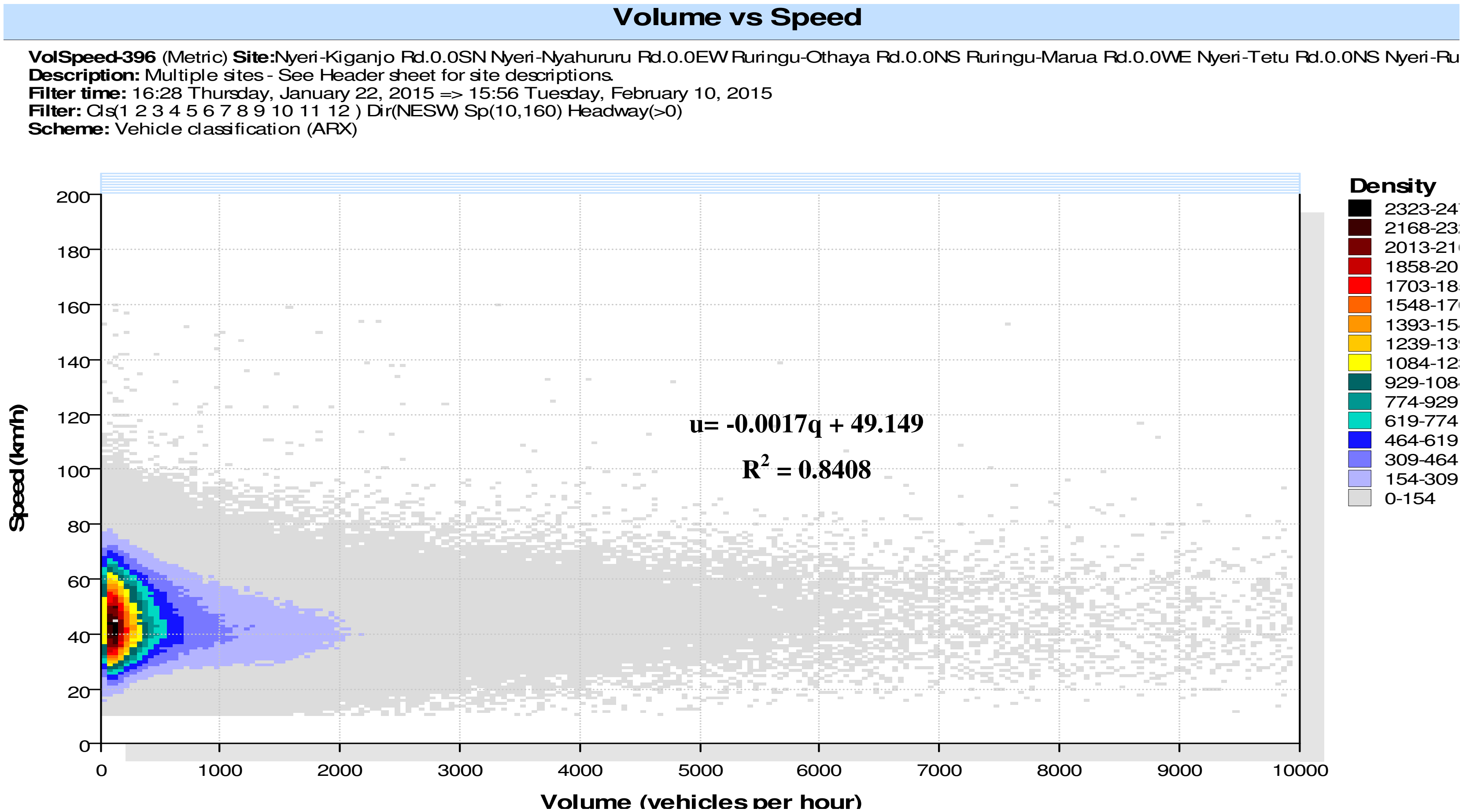


Figure 7-8: Speed - Volume Model for the entire network combined

Appendix 4: Speed - Density Models for each link and for the entire network combined

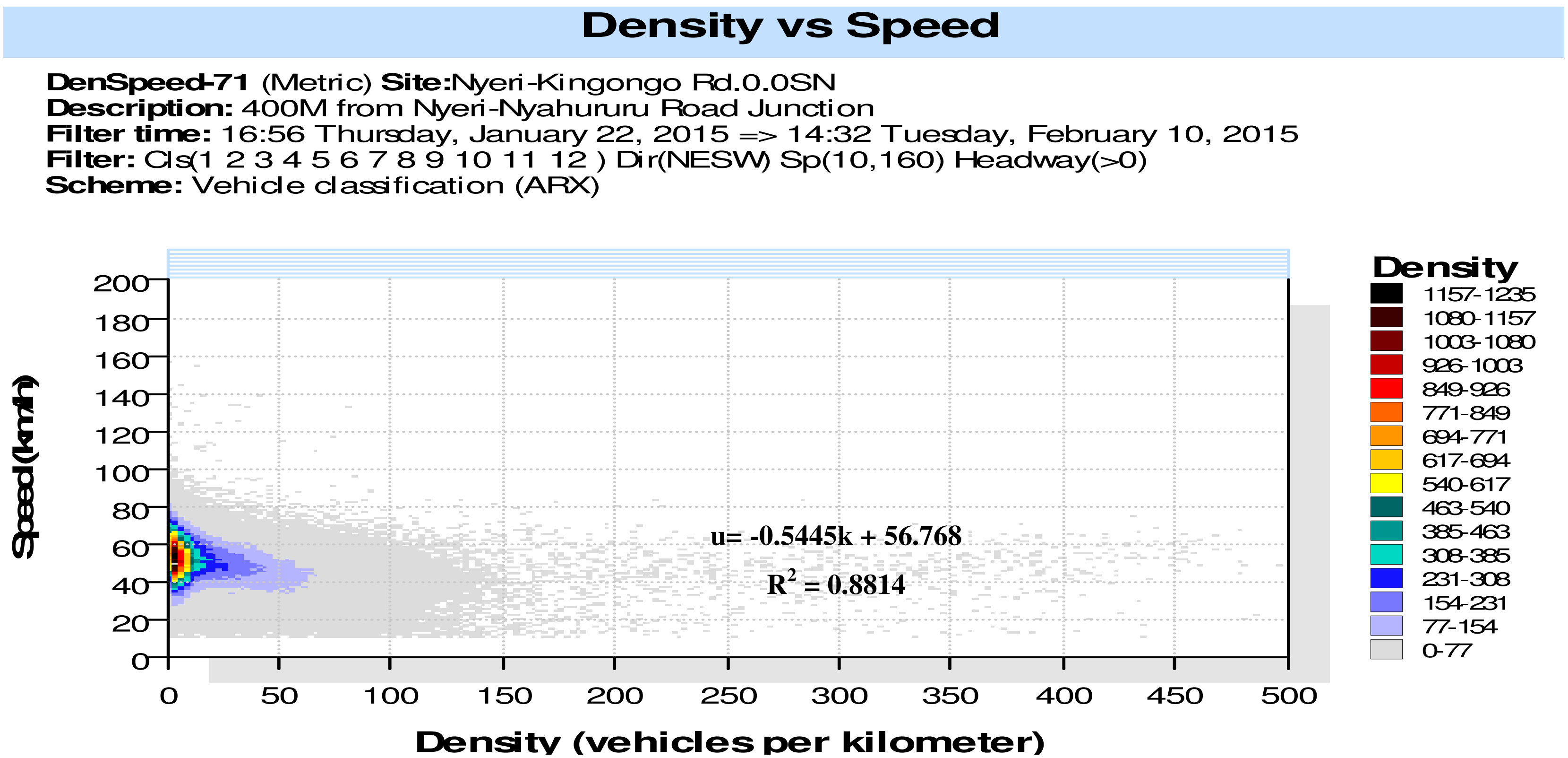


Figure 7-9: Speed - density Model for Nyeri-King'ong'o Road

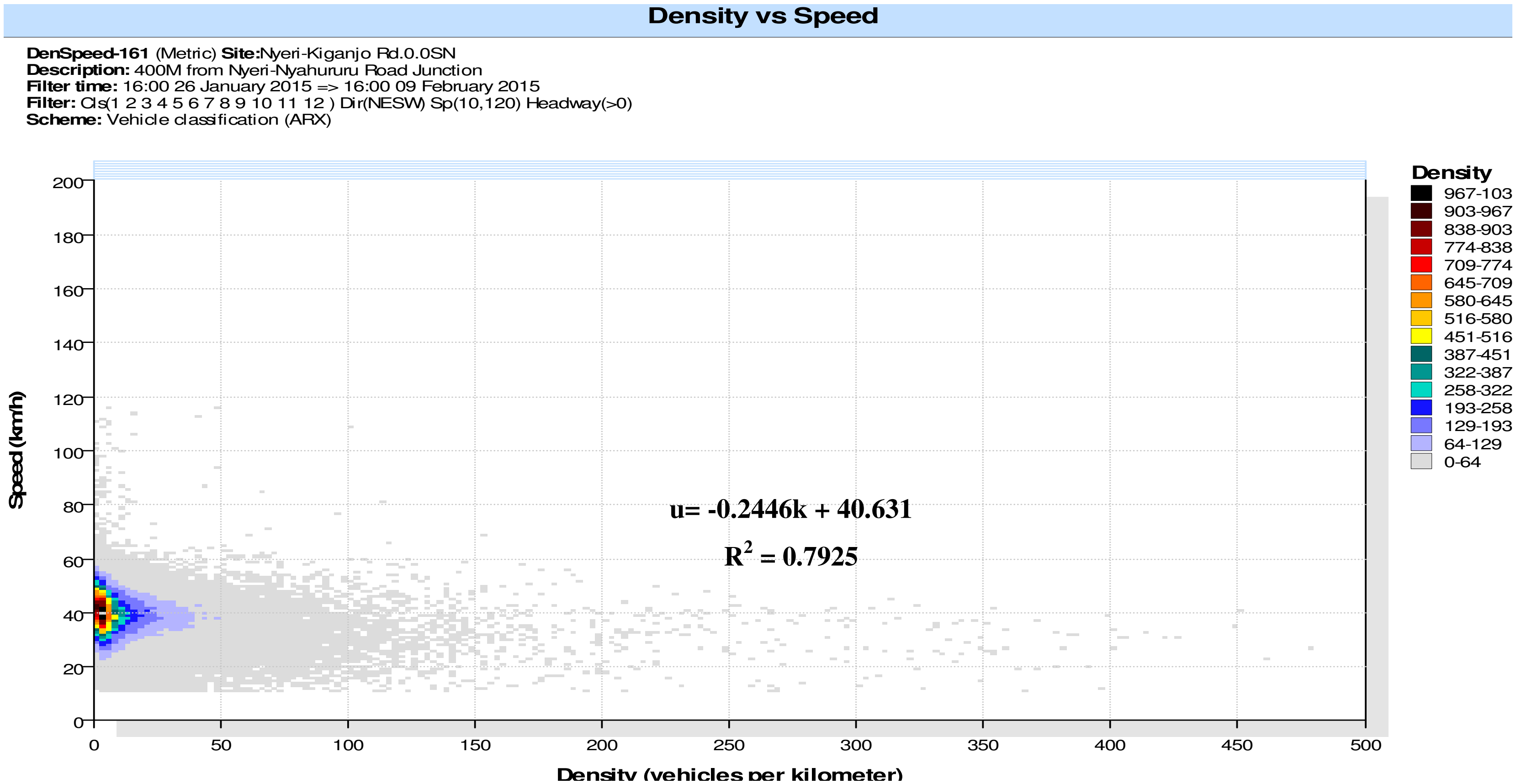


Figure 7-10: Speed - Density Model for Nyeri-Kiganjo road

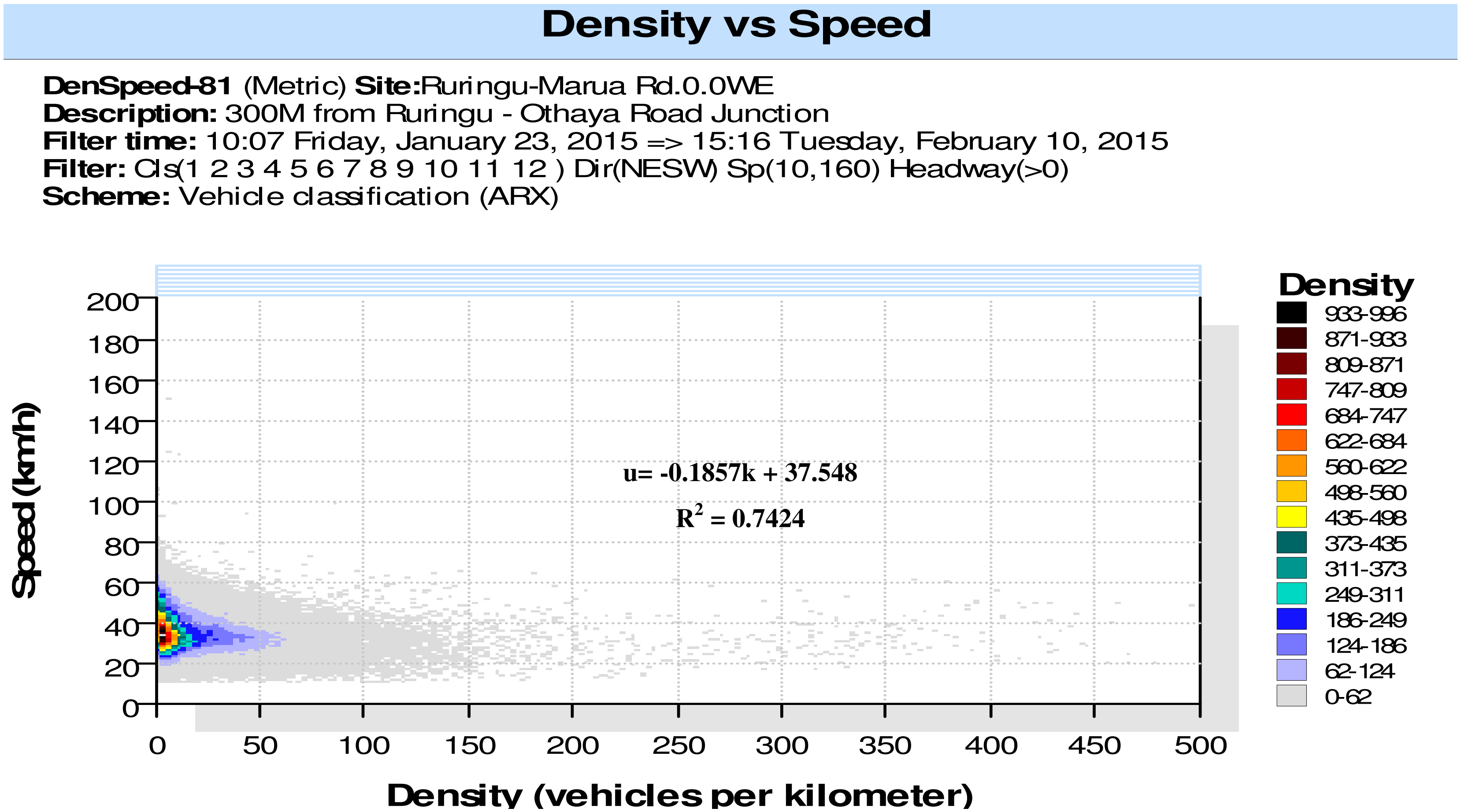


Figure 7-11: Speed – Density Model for Ruringu-Marua Road

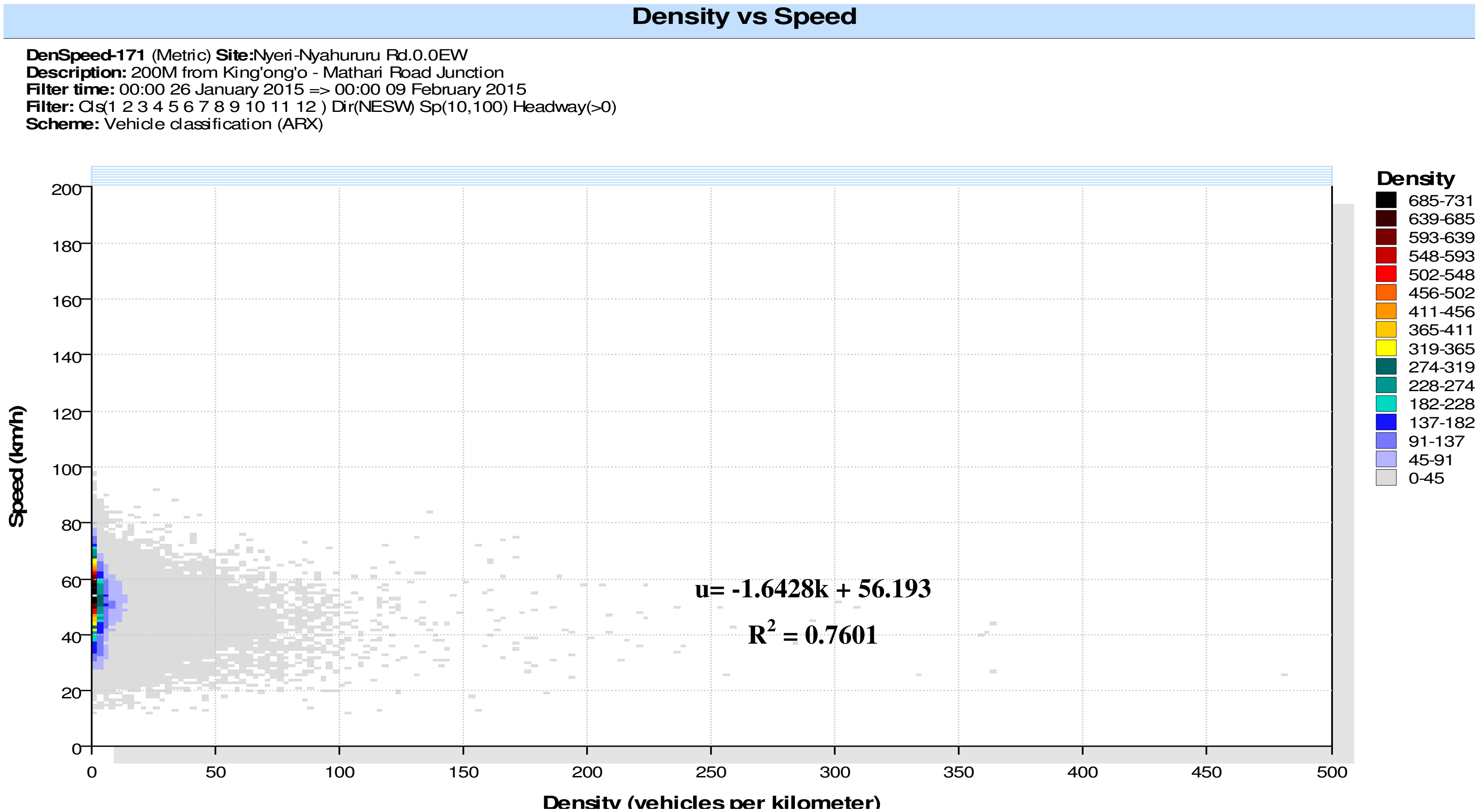


Figure 7-12: Speed -Density Model for Nyeri-Nyahururu Road

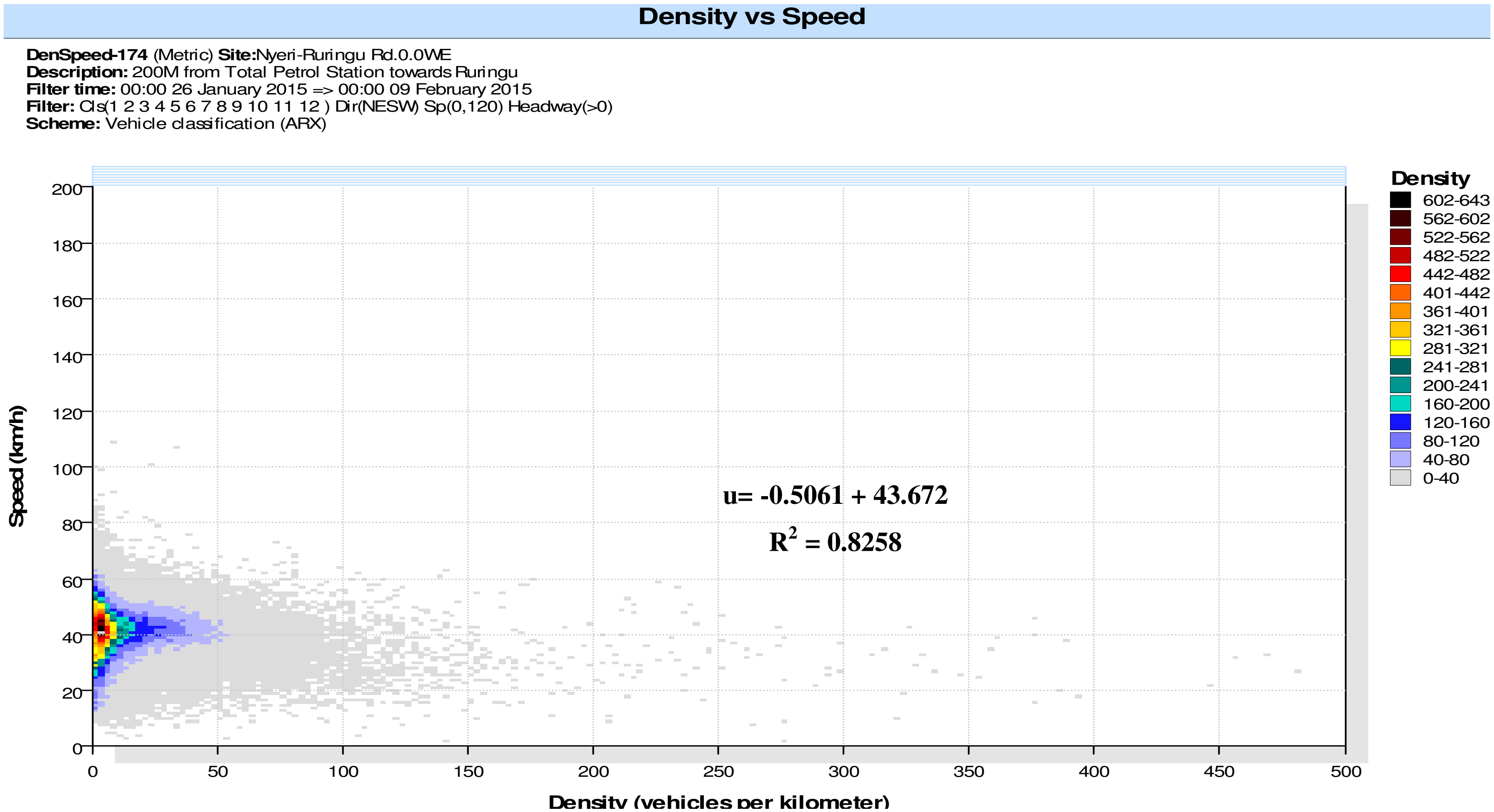


Figure 7-13: Speed – Density Model for Nyeri-Ruringu Road

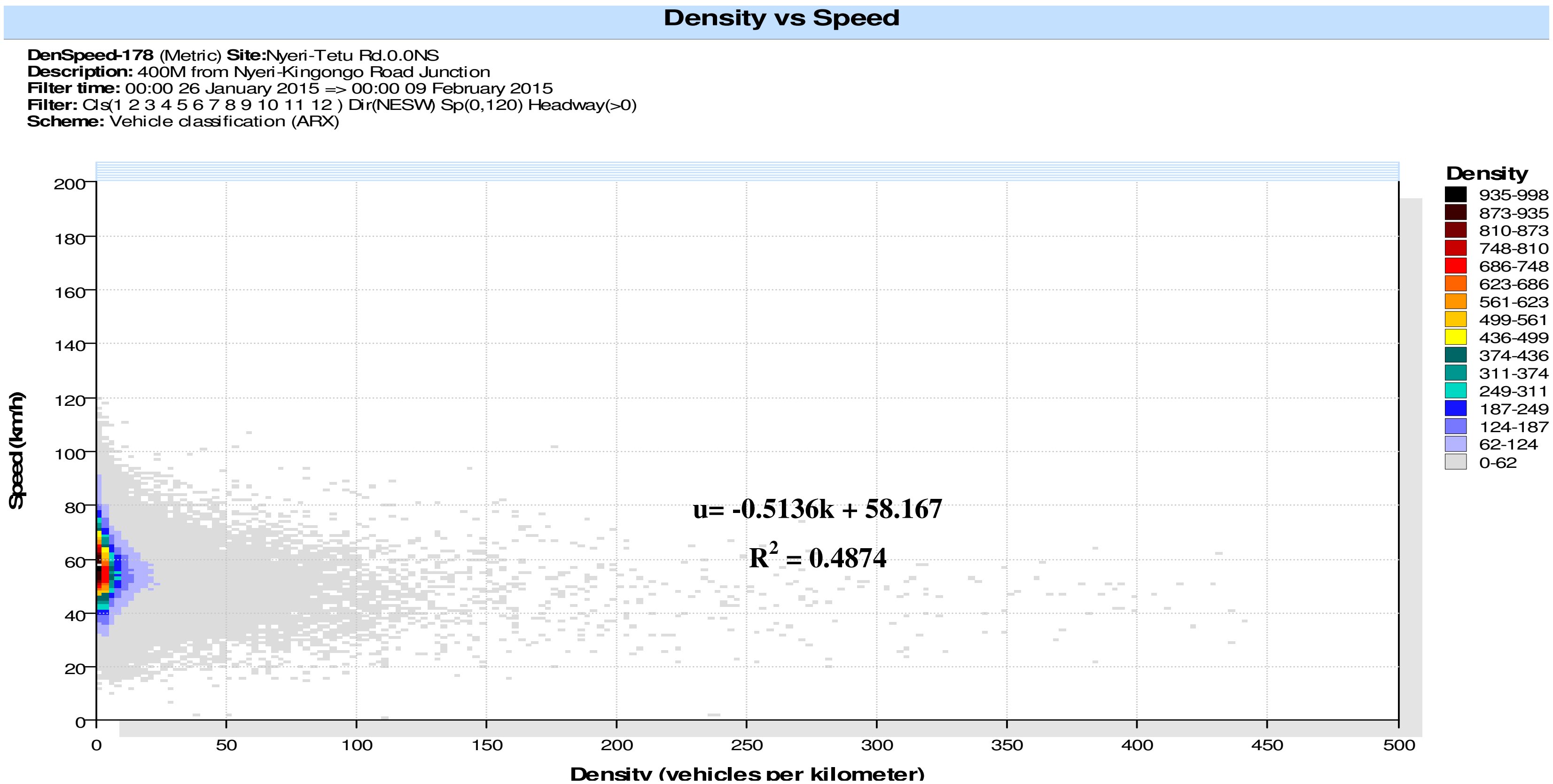


Figure 7-14: Speed – Density Model for Nyeri-Tetu Road

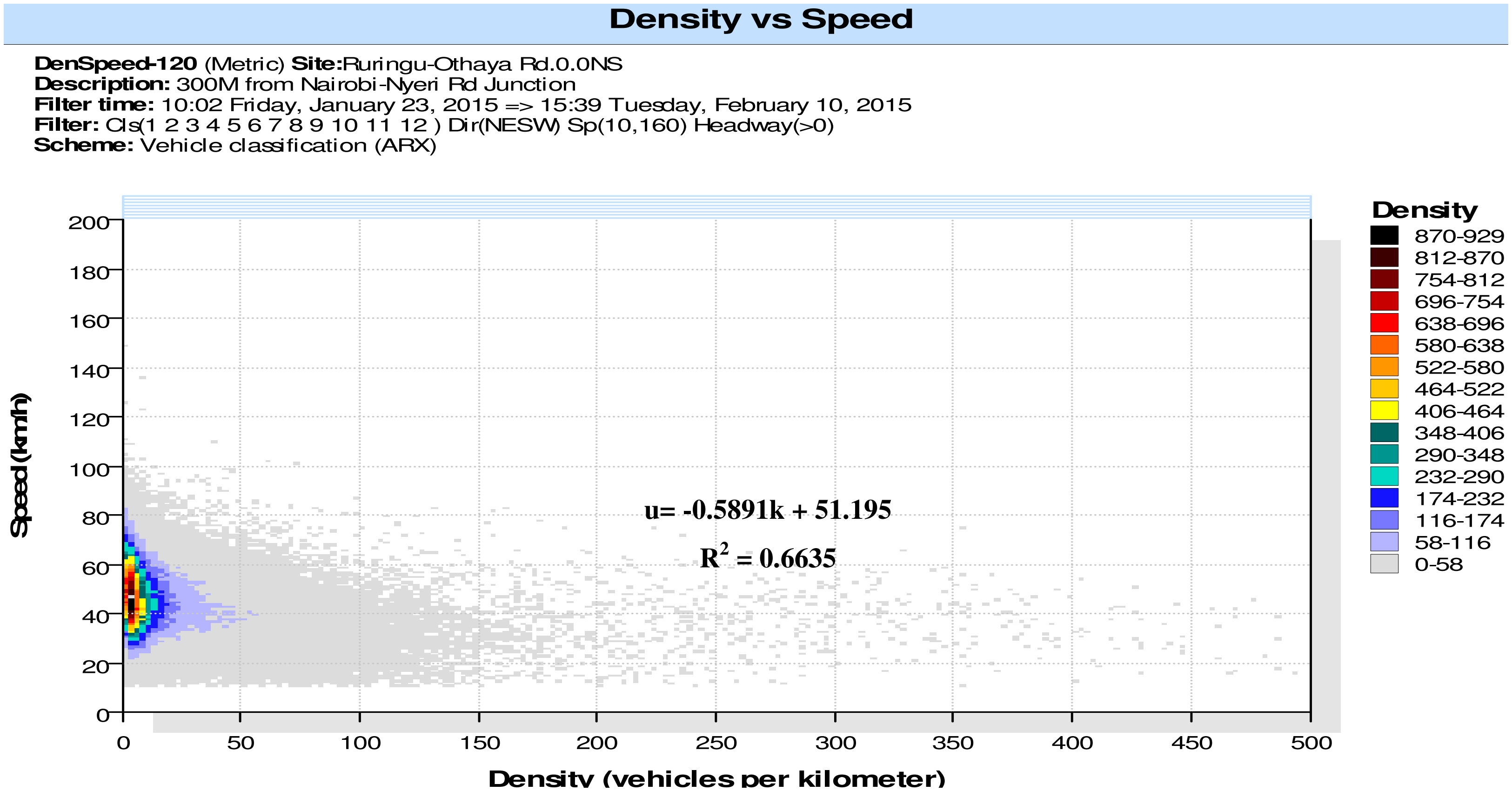


Figure 7-15: Speed – Density Model for Ruring'u-Othaya Road

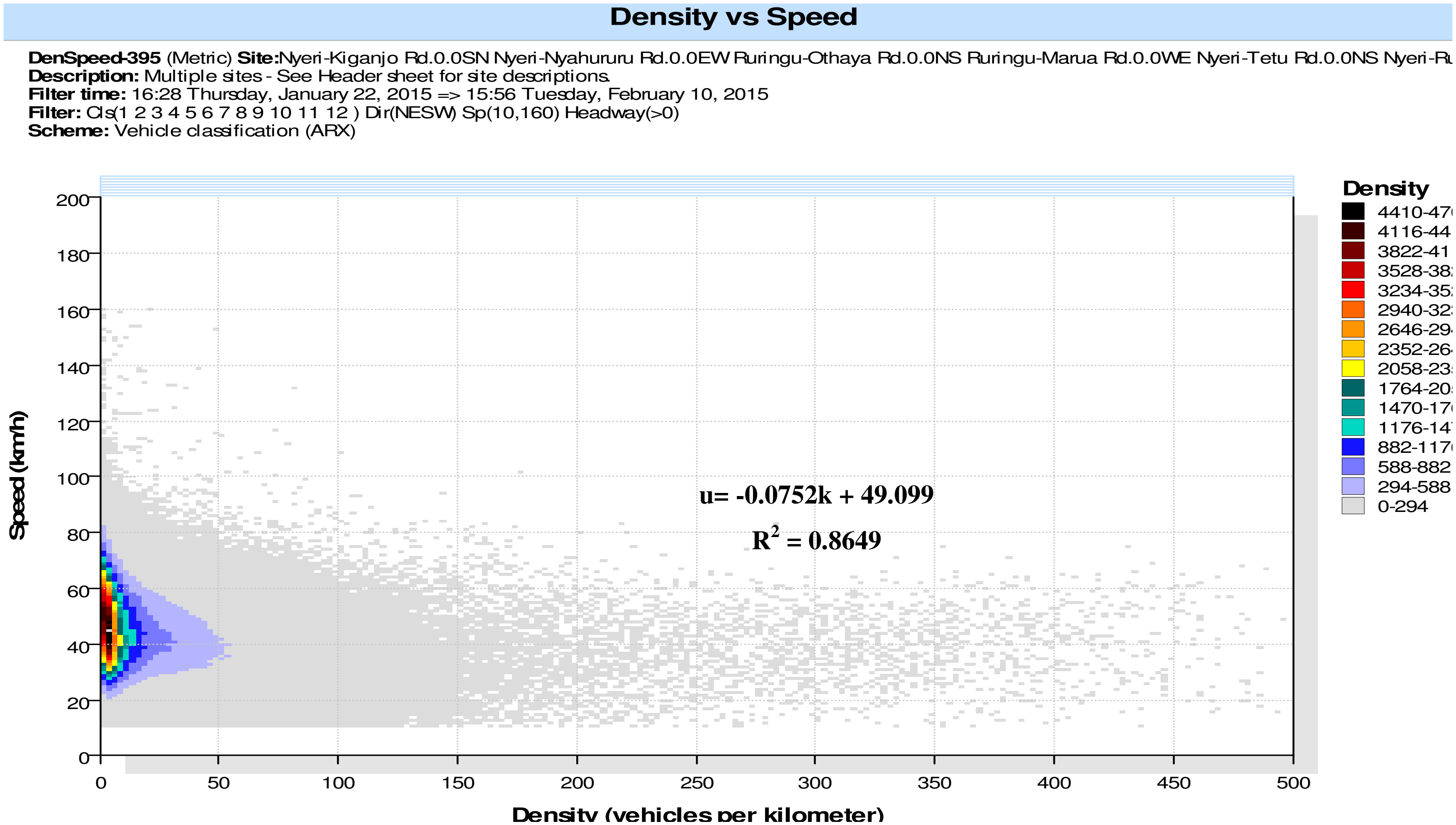


Figure 7-16: Speed – Density Model for entire network combined

Appendix 5: Volume - Density Relationship for each link and the entire network combined

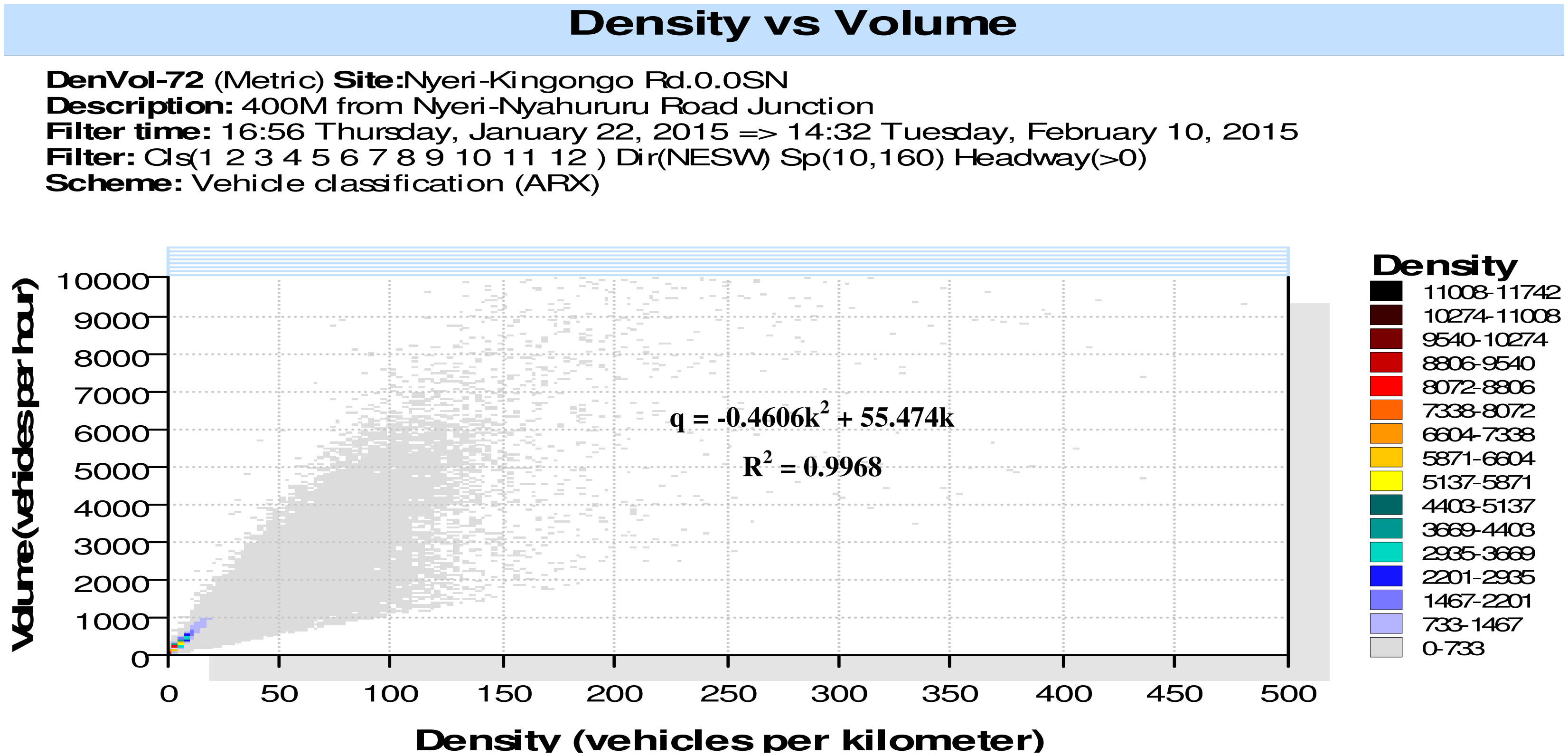


Figure 7-17: Volume - Density Model for Nyeri-King'ong'o link

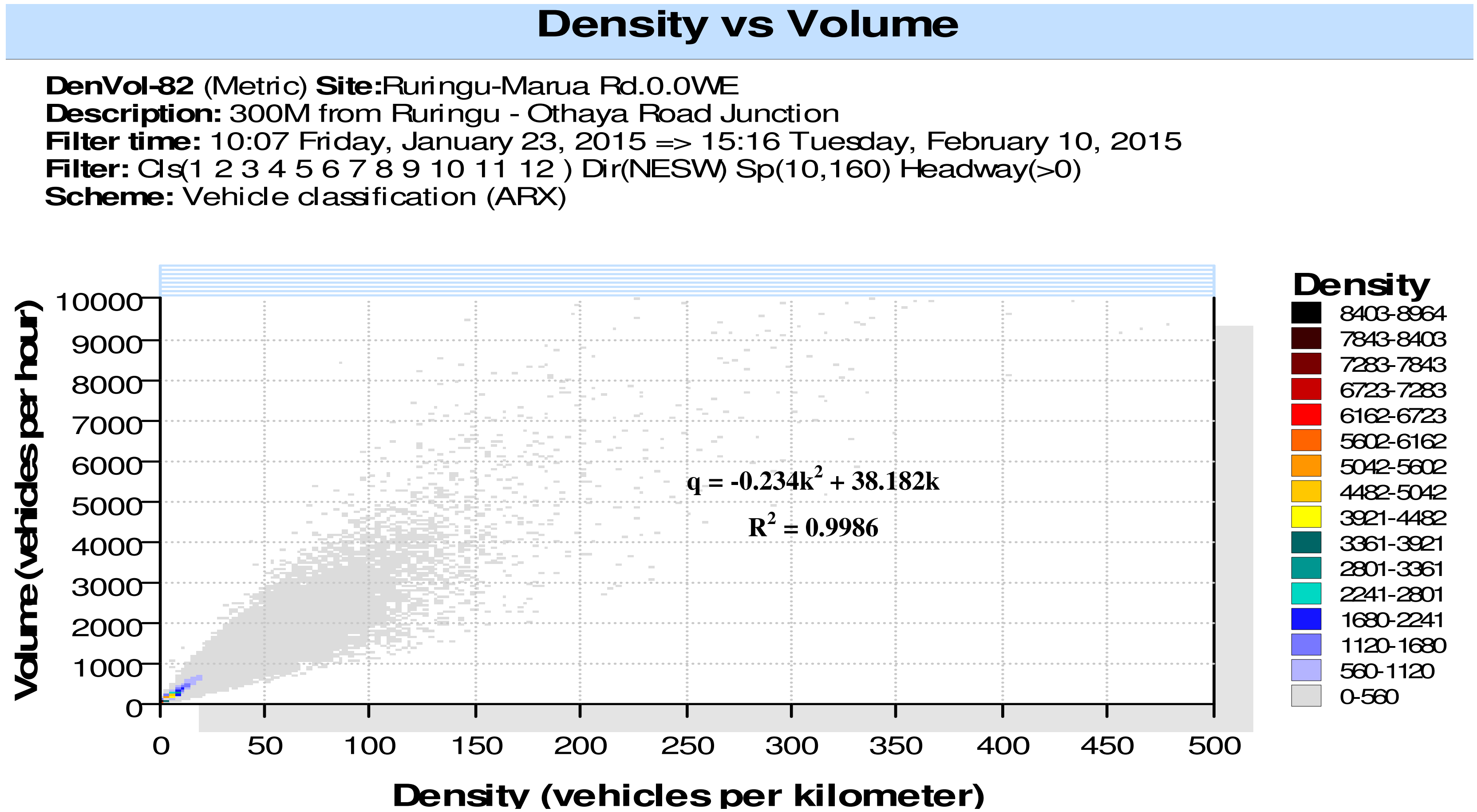


Figure 7-18: Volume - Density Model for Ruringu-Marua link

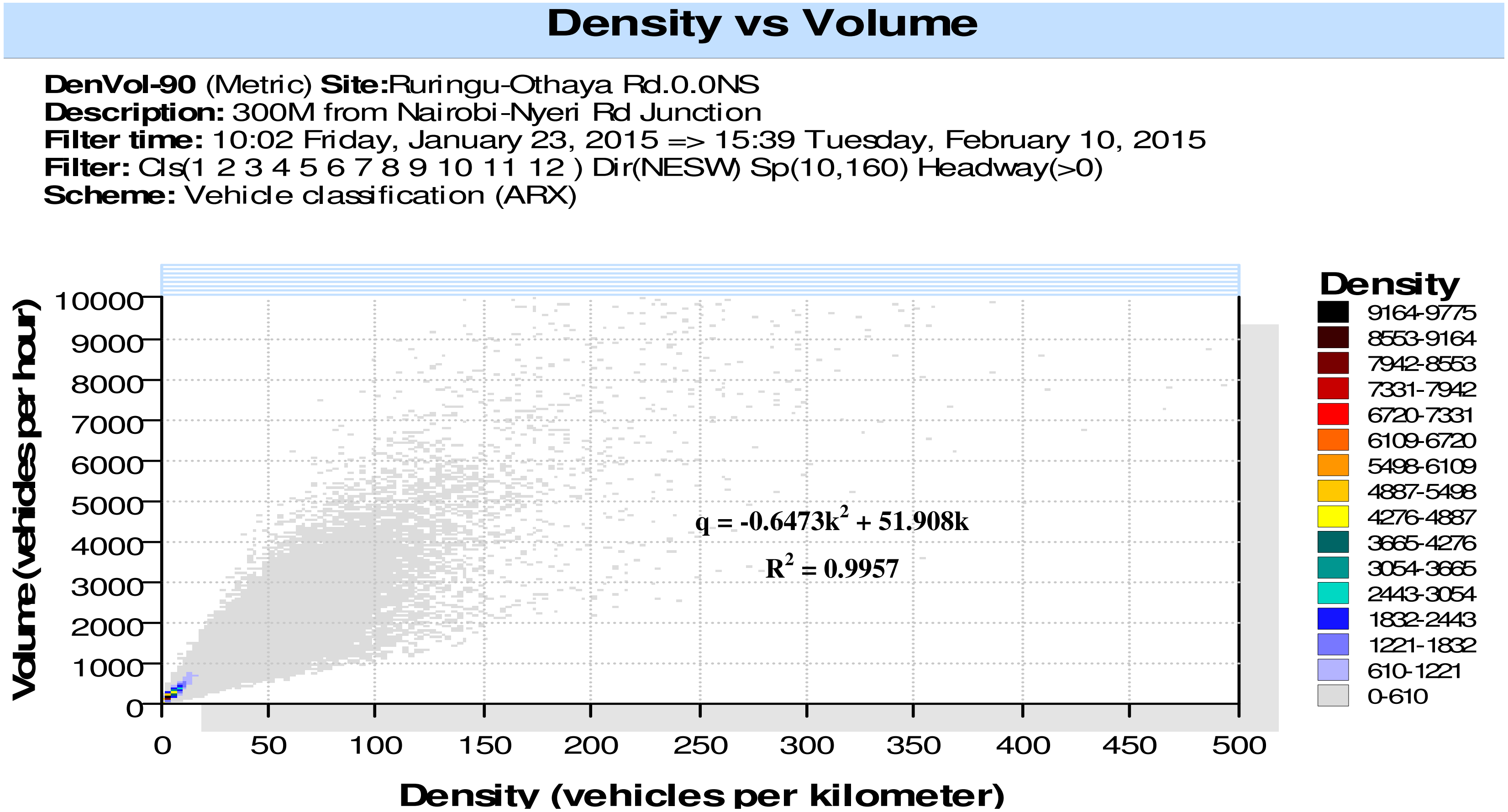


Figure 7-19: Volume - Density Model for Ruring'u-Othaya link

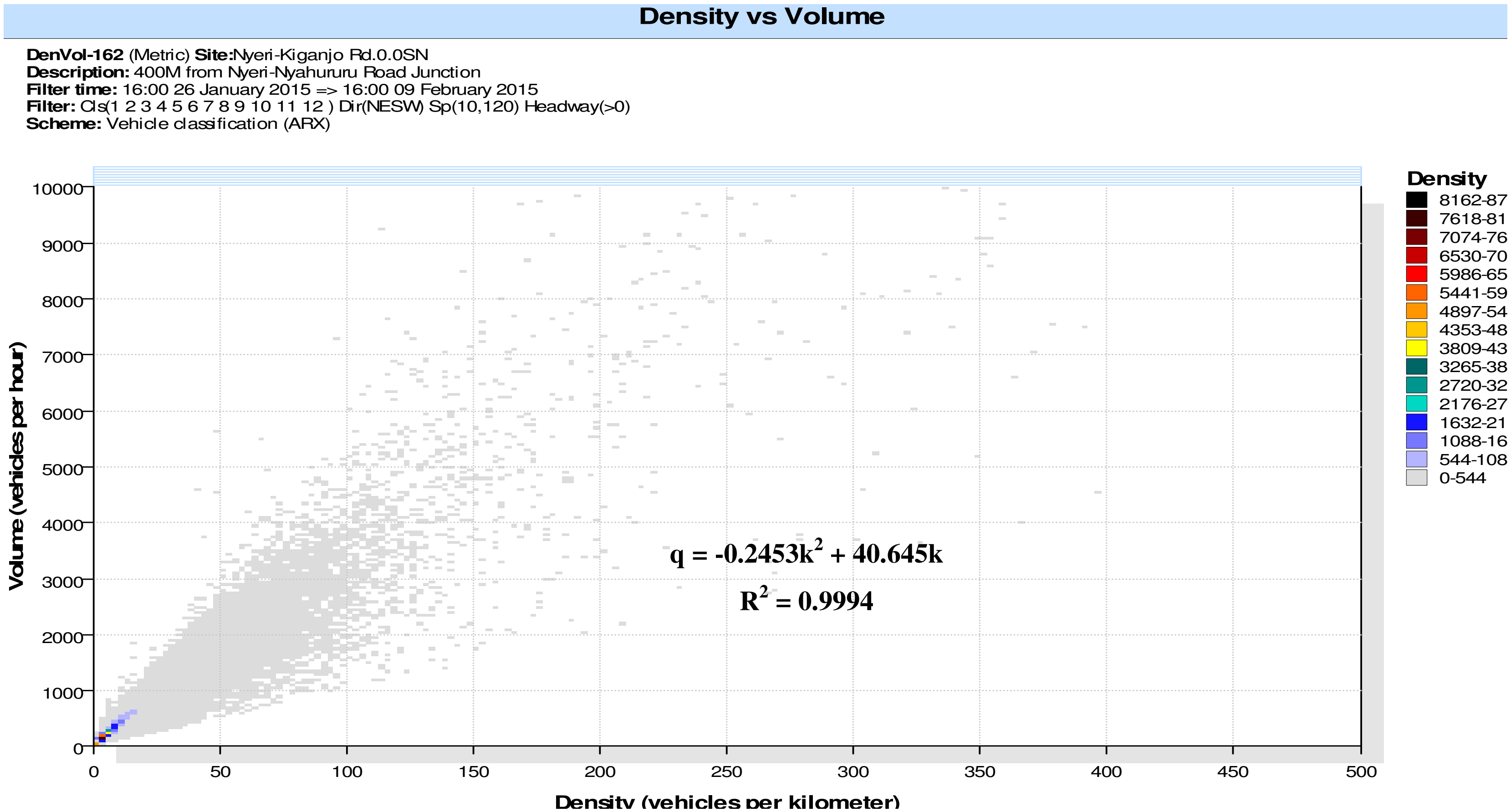


Figure 7-20: Volume - Density Model for Nyeri-Kiganjo link

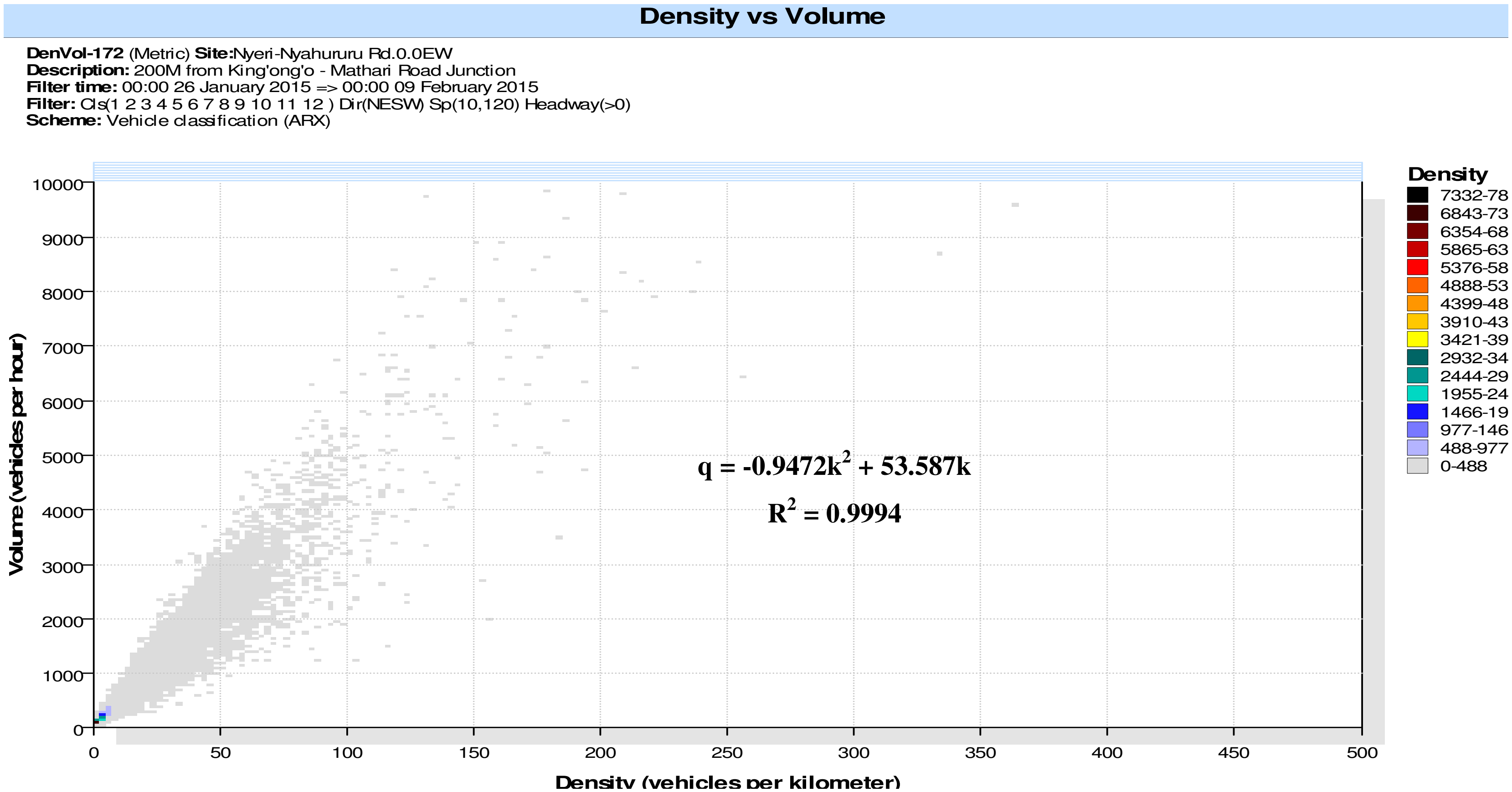


Figure 7-21: Volume – Density Model For Nyeri-Nyahururu link

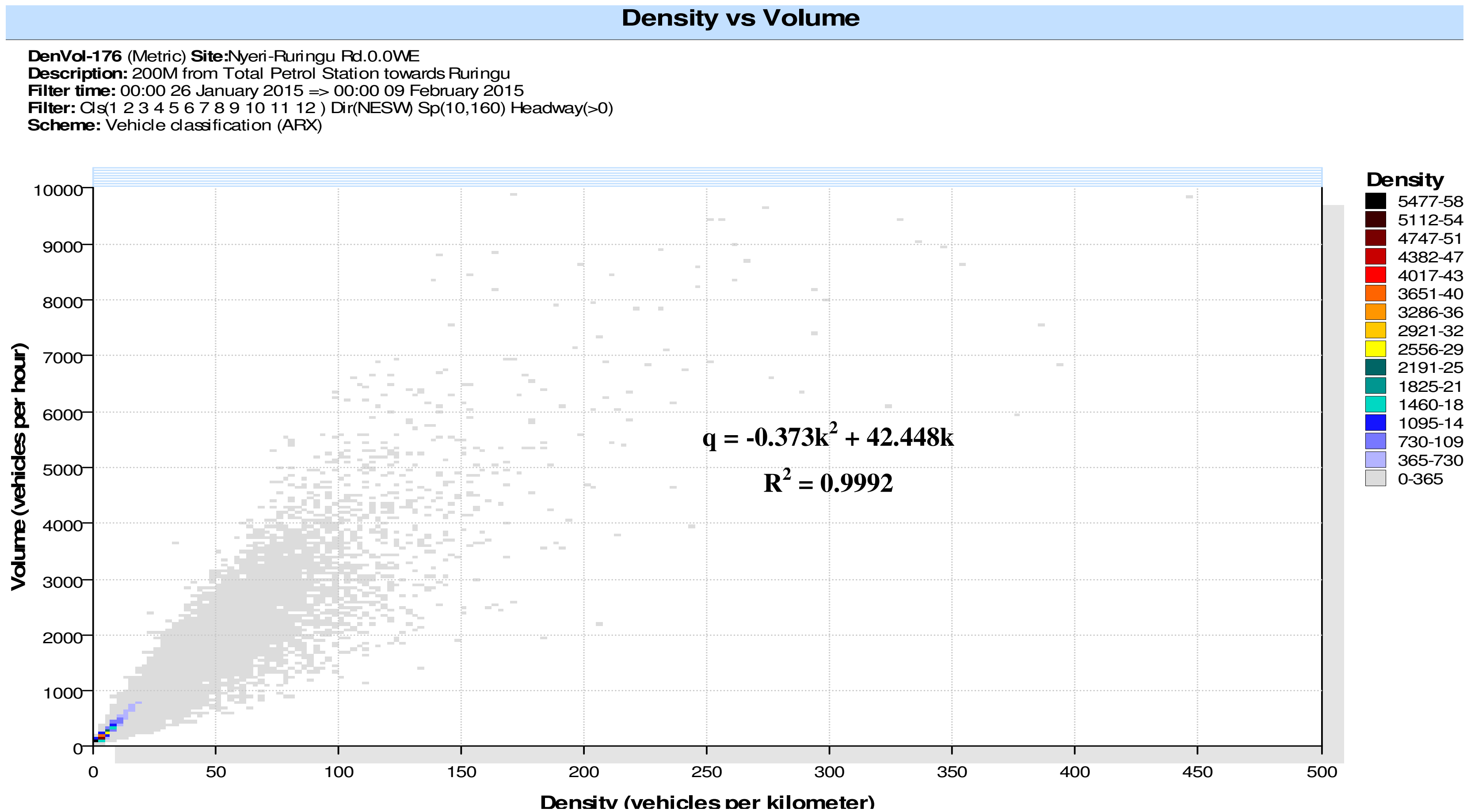


Figure 7-22: Volume - Density Model for Nyeri-Ruring'u Road

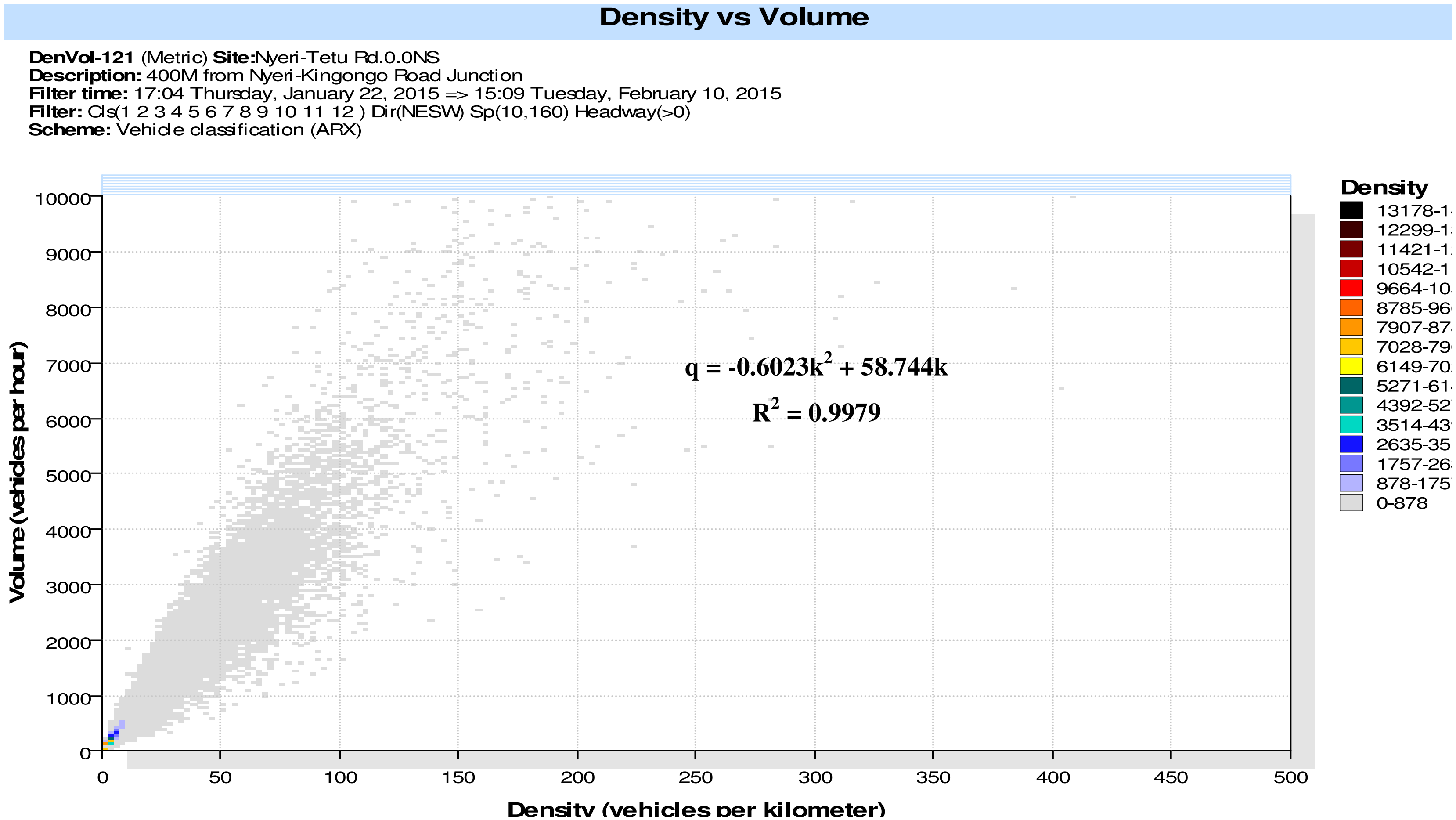


Figure 7-23: Volume - Density Model for Nyeri-Tetu Road

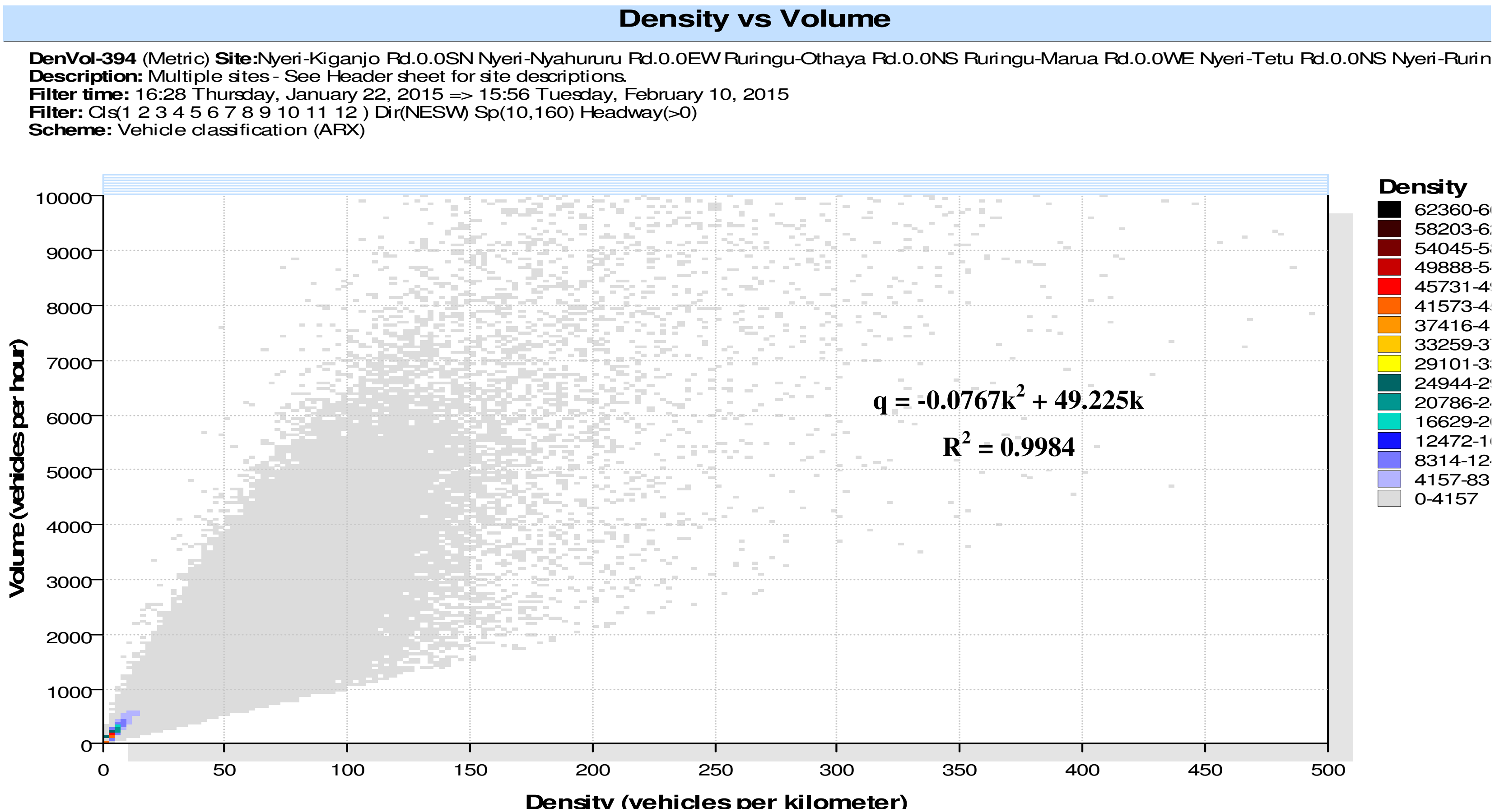


Figure 7-24: Volume - Density Model for the entire network combined

Appendix 6: AADT

MetroCount Traffic Executive
Adjusted Flow

AADT-188 -- English (ENU)

Datasets:
Site: **[Ruringu-Othaya Rd] 300M from Nairobi-Nyeri Rd Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 10:01 Friday, January 23, 2015 => 15:39 Tuesday, February 10, 2015
Zone:
File: Ruringu-Othaya Rd10Feb2015.EC0 (Plus)
Identifier: EQ58T5B8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Ruringu Rd] 200M from Total Petrol Station towards Ruringu**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 9:57 Friday, January 23, 2015 => 10:13 Monday, February 09, 2015
Zone:
File: Nyeri-Ruringu Rd10Feb2015.EC0 (Plus)
Identifier: ES69PSXP MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Nyahururu Rd] 200M from King'ong'o - Mathari Road Junction**
Direction: 8 - East bound A>B, West bound B>A. **Lane:** 0
Survey Duration: 16:28 Thursday, January 22, 2015 => 15:51 Tuesday, February 10, 2015
Zone:
File: Nyeri-Nyahururu Rd10Feb2015.EC0 (Plus)
Identifier: ER21AK78 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kiganjo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:43 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015
Zone:

File: Nyeri-Kiganjo Rd10Feb2015.EC0 (Plus)
Identifier: ER86AD7F MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Kingongo Rd] 400M from Nyeri-Nyahururu Road Junction**
Direction: 5 - South bound A>B, North bound B>A. **Lane:** 0
Survey Duration: 16:55 Thursday, January 22, 2015 => 14:32 Tuesday, February 10, 2015
Zone:
File: Nyeri-Kingongo Rd10Feb2015.EC0 (Plus)
Identifier: ER149GD1 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Nyeri-Tetu Rd] 400M from Nyeri-Kingongo Road Junction**
Direction: 7 - North bound A>B, South bound B>A. **Lane:** 0
Survey Duration: 17:03 Thursday, January 22, 2015 => 15:09 Tuesday, February 10, 2015
Zone:
File: Nyeri-Tetu Rd10Feb2015.EC0 (Plus)
Identifier: ES19H0YM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Site: **[Ruringu-Marua Rd] 300M from Ruringu - Othaya Road Junction**
Direction: 6 - West bound A>B, East bound B>A. **Lane:** 0
Survey Duration: 10:06 Friday, January 23, 2015 => 15:16 Tuesday, February 10, 2015
Zone:
File: Ruringu-Marua Rd10Feb2015.EC0 (Plus)
Identifier: EQ6560AV MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: **16:28 Thursday, January 22, 2015 => 15:56 Tuesday, February 10, 2015**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 160 km/h.
Direction: North, East, South, West (bound)
Separation: All - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile: Vehicles = 881708 / 885866 (99.53%)

Day	Hits	RawVol	DayFac	MonFac	AdjVol - Date
0	----	----------	------	------	---------- - Thursday, January 22, 2015
1	4	16224.000	1.000	1.000	16224.000 - Friday, January 23, 2015
2	**7**	**47904.000**	**1.000**	**1.000**	**47904.000 - Saturday, January 24, 2015**
3	**7**	**41208.000**	**1.000**	**1.000**	**41208.000 - Sunday, January 25, 2015**
4	7	53569.000	1.000	1.000	53569.000 - Monday, January 26, 2015
5	7	53323.000	1.000	1.000	53323.000 - Tuesday, January 27, 2015
6	7	52191.000	1.000	1.000	52191.000 - Wednesday, January 28, 2015
7	7	52498.000	1.000	1.000	52498.000 - Thursday, January 29, 2015
8	7	55073.000	1.000	1.000	55073.000 - Friday, January 30, 2015
9	**7**	**58124.000**	**1.000**	**1.000**	**58124.000 - Saturday, January 31, 2015**
10	**7**	**44715.000**	**1.000**	**1.000**	**44715.000 - Sunday, February 01, 2015**
11	7	54184.000	1.000	1.000	54184.000 - Monday, February 02, 2015
12	7	55076.000	1.000	1.000	55076.000 - Tuesday, February 03, 2015
13	7	54795.000	1.000	1.000	54795.000 - Wednesday, February 04, 2015
14	7	51658.000	1.000	1.000	51658.000 - Thursday, February 05, 2015
15	7	56287.000	1.000	1.000	56287.000 - Friday, February 06, 2015
16	**7**	**57399.000**	**1.000**	**1.000**	**57399.000 - Saturday, February 07, 2015**
17	**7**	**40076.000**	**1.000**	**1.000**	**40076.000 - Sunday, February 08, 2015**
18	6	37404.000	1.000	1.000	37404.000 - Monday, February 09, 2015
19	----	----------	------	------	---------- - Tuesday, February 10, 2015

Total days = 18, Coverage = 4.93%
ADT = 48983.778, SD = 10229.248
AADT = 48983.778, SD = 10229.248

Weekdays = 12, Coverage = 3.29%
AWDT = 49356.833, SD = 11534.960
AAWDT = 49356.833, SD = 11534.960

Weekend days = 6, Coverage = 1.64%
AWET = 48237.667, SD = 7876.791
AAWET = 48237.667, SD = 7876.791

ADT and adjustment factor by month
Jan - Vol = 430114.000, Days = 9, ADT = 47790.444, Adjust = 1.02497, 1/Adjust = 0.97564
Feb - Vol = 451594.000, Days = 9, ADT = 50177.111, Adjust = 0.97622, 1/Adjust = 1.02436

ADT and adjustment factor by day of week
Mon - Vol = 145157.000, Days = 3, ADT = 48385.667, Adjust = 1.01236, 1/Adjust = 0.98779
Tue - Vol = 108399.000, Days = 2, ADT = 54199.500, Adjust = 0.90377, 1/Adjust = 1.10648

Wed - Vol = 106986.000, Days = 2, ADT = 53493.000, Adjust = 0.91570, 1/Adjust = 1.09206
Thu - Vol = 104156.000, Days = 2, ADT = 52078.000, Adjust = 0.94058, 1/Adjust = 1.06317
Fri - Vol = 127584.000, Days = 3, ADT = 42528.000, Adjust = 1.15180, 1/Adjust = 0.86821
Sat - Vol = 163427.000, Days = 3, ADT = 54475.667, Adjust = 0.89919, 1/Adjust = 1.11212
Sun - Vol = 125999.000, Days = 3, ADT = 41999.667, Adjust = 1.16629, 1/Adjust = 0.85742