Kenya Urban Roads Authority
Ministry of Roads
City Council of Nairobi
Ministry of Local Government
The Republic of Kenya

No.

PREPARATORY STUDY
ON
THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS
IN
THE REPUBLIC OF KENYA

November 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Project for the Construction of Nairobi Western Ring Roads in the Republic of Kenya.

JICA sent to Kenya a survey team from March 23 to April 30, 2009.

The team held discussions with the officials concerned of the Government of Kenya, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kenya in order to discuss a draft outline design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kenya for their close cooperation extended to the teams.

November, 2009

Toshiyuki Kuroyanagi
Director General,
Economic Infrastructure Department
Japan International Cooperation Agency

November, 2009

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on the Project for the construction of Nairobi Western Ring Roads in the Republic of Kenya.

This survey was conducted by Katahira & Engineers International, under a contract to JICA, during the period from March 2009 to November 2009. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kenya and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kenji Isomoto
Project Manager,
Preparatory Survey Team on the Project
for the Construction of Nairobi Western
Ring Roads in the Republic of Kenya

Katahira & Engineers International

Summary

1. Outline of the Country

The Republic of Kenya is located in the eastern Africa and the equator passes at the middle of the country. The territory is facing the Indian Ocean on the east coast.

The population is 12.41 million in 2007, the territory is 197 thousands sq.km in area, GDP is 24 billion dollars and GDP per capita is 640 dollars. The major industry is agriculture representing by main products i.e. coffee, tea, gardening plants and so on. The shares of GDP are 26% of primary industry, 18% of secondary industry and 56% of tertiary industry. And 60% of employed population has worked in agriculture sector.

2. Background of the Project

Infrastructure development of Kenya is a very important issue for enhancing economic development of not only the own country but also those of surrounding countries as well, since Kenya plays the role as a logistics networks hub for those surrounding countries trough its sea port of Mombasa.

However, not enough development of the infrastructures have spoiled further economic growth of the country, the Government of Kenya has worked out for the "Investment Program for Economic Recovery Strategy for Wealth and Employment Creation: IP-ERS, 2008-2012" in March 2004, and listed up the development of basic infrastructures among those as one of topics for "Economic Growth".

It has set the "Improvement of Road Network and Safety" and the "Improvement of Efficiency and Safety of Urban Transport" especially in regard to the road, which bears 80% of passenger transport, and 76% of freight, as the development result.

Furthermore, as the succeeding plan of IP-ERS, "Kenya Vision 2030" has been developed in 2008, and as the first period mid-term plan among those, the developments of all transport related infrastructures, including road sector, has been stipulated in the "First Medium Term Plan in 2008-2012".

In City of Nairobi, which is the national largest and capital, without efficient arrangement of the circumferential roads, and with rapid increase of population, traffic jams have been intensified. Consequently, such condition has exerted on car operation and become also cause of increase of maintenance expenses and traffic accidents.

As a result, the City of Nairobi suburban worker has been forced the burden of high fare, and it has become the present condition for many, especially low income earners, that they have not

been able to afford to cover the fare of the public transport due to its relatively high fare comparing to the previous level.

Population of the city is presumed to increase from the present level of 3.0 million people to 4.3 million people in 2025. In line with such growth, it is expected that traffic conditions, including traffic jam, would be getting worse and worse. And, from the viewpoint that, counter measure is needed very much, since economic development of the country is vital.

Under such circumstances, the Government of Japan had implemented "the Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya" between 2004 and 2006, which designates the traffic networks improvement of the Nairobi Metropolitan Area as purpose, based on the request from the Kenya. In the study, pre-feasibility study for the was executed for the urgent projects which are necessary to cope earlier.

This study is the preparatory study of the Japan's Grant Aid for the construction of 3 segments of missing link including sidewalk and small bridges with 8.4 km in total length which is the component of the pre-feasibility in the previous Master Plan study based on the request of the government of Kenya in July 2007.

3. Outline design of the study and contents of the project

JICA dispatched the preparatory study team to Kenya between 23 March 2009 and 30 April 2009 for the execution of outline design study for 3 missing links, about 8.4 km in total length, and the team conducted the discussions with concerned Kenyan officials and investigations of the project site.

After coming back Japan, the team carried out outline design for the appropriate contents of the Project based on the result of the field survey and prepared the draft report of the study for the result of outline design.

JICA dispatched the team to Kenya between 21 October 2009 and 28 October 2009 for the explanation of draft report and the team made discussions, confirmation and agreement regarding the contents of the draft report.

The contents of the Project finally agreed are shown below.

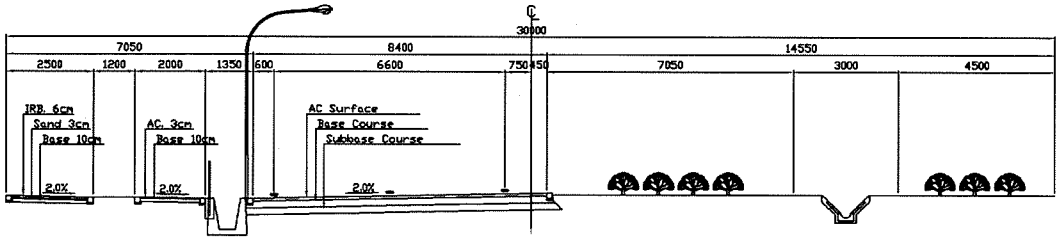
1) Missing Link No.3 : Kileleshwa Police Station ~ Westland Roundabout, 1.76 km
2) Missing Link No.6 : Oloitokitok Road ~ Kileleshwa Police Station, 2.85 km
3) Missing Link No.7 : James Gichuru Road ~ Ngong Road, 3.75 km

Road design requirements are as follows.

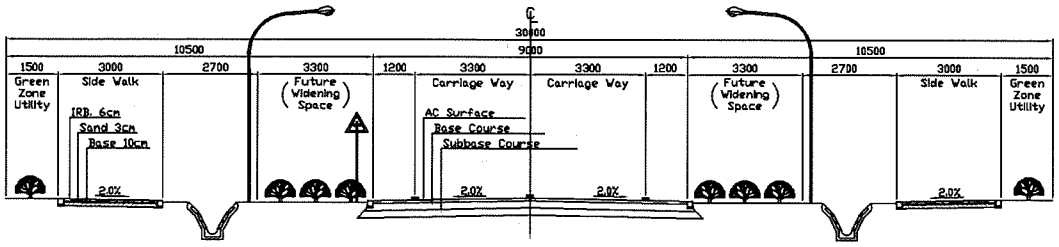
Contents	Established Requirements	Sources
Classification	Urban Collector Road	GoK's Road Design Guidelines
Design Speed	50 km/hr	GoK's Guidelines (50 ~ 70 km/hr)
Lane Width	3.30 m	GoK's Guidelines (3.0 ~ 3.5 m)
Median Width	1.50 m (0.60 m)	GoK's Guidelines & AASHTO[1]
Shoulder Width	0.60 m	GoK's Guidelines (0.6 ~ 2.5 m)
Sidewalk Width	2.50 m	GoK's Guidelines (2.0 ~ 3.0 m)
Cycle Track Width	2.00 m	GoK's Guidelines (2.0 m or more)
Initial Design Period for Pavement	15 years	GoK's Guidelines (15 years or less)
Maximum Gradient※	8.0 %	Other Countries (US, UK, Australia, Japan, etc.) Requirements

※Note: Maximum gradient of 8.0% is applied for newly construction segments only, however that of which along existing segments may vary and sometimes exceeds this requirement.

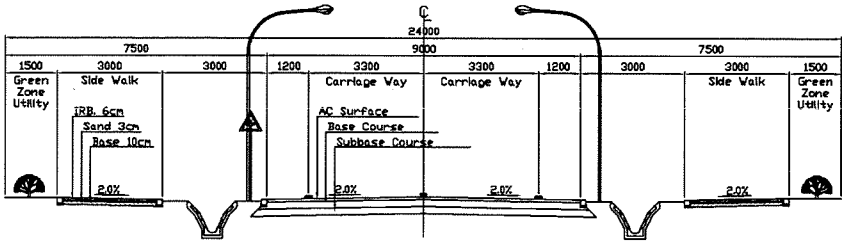
Typical cross sections are prepared 3 types depending on the function of the road and secured width of Right of Way.



Typical Cross Section for Circumferential Road Segment (for ML3/6/7)
RoW=100ft (30.48m)



Typical Cross Section for Radial Road Segment-1 (for ML7)
RoW=100ft (30.48m)



Typical Cross Section for Radial Road Segment-2 (for ML6)
RoW=80ft (24.38m)

[1] American Association of State Highway & Transportation Officials

Summary of facilities under the Project is shown below.

Facilities	Specifications	Unit	Quantity
Road Length	ML3 (1.76km) / ML6 (2.85km) / ML7 (3.75km)	l. km	8.36
Carriageway Pavement	Surface Course (Hot Asphalt Concrete) t=30mm / 86,815m^2, and t=50mm / 9,540m^2	sq. m	113,719
	Base Course (Hot Asphalt Concrete) t=45mm / 86,815m^2, and t=50mm / 9,540m^2	sq. m	113,719
	Upper Subbase Course (Mechanical Stabilized Aggregate) t=150mm~200mm	sq. m	104,249
	Lower Subbase Course (Crusher Run) t=200mm~350mm	sq. m	109,234
Sidewalk Pavement	Interlocking Block (w=2.5~3.0m)	sq. m	18,781
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	18,311
Access Approach Pavement	Surface Course (Hot Asphalt Concrete) t=30mm	sq. m	3,932
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	3,932
Cycle Track Pavement	Surface Course (Hot Asphalt Concrete) t=30mm	sq. m	26,167
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	26,167
Storm Water Drainage (Side)	U-Shape Concrete Drain (Bottom Width = 300mm)	l. m	5,408
	V-Shape Concrete Drain (Bottom Width = 450mm)	l. m	4,420
	Street Inlet w/ Sandpit	sets	487
	RC Pipe Culvert (Inner Diameter = 600mm)	l. m	6,179
Storm Water Drainage (Cross)	Portal Culvert (W = 5.2 + 6.9 + 5.2 m) x (H = 5.95 m) x (L = 15.2 m)	set	1
	Portal Culvert (W = 3.6 + 3.6 + 3.6 m) x (H = 3.7 m) x (L = 15.2 m)	set	1
	Box Culvert (W = 4.2 m) x (H = 5.5 m) x (L = 19.35 m)	set	1
	Box Culvert (W = 2.5 m) x (H = 1.6 m) x (L = 44.0 m)	set	1
	Double Pipe Culvert 2 x (D = 1,200 mm) x (L = 32.0 m)	set	1
Block Stone	Curb Stone Block	l. m	9,997
	Border Stone Block	l. m	35,323
Traffic Signs	Warning & Regulatory Signs (excluding Informatory Signs)	set	431
Road Markings	Centre Line (w=150mm), Shoulder Line (w=150mm), Cross Walk (w=450mm), Stop Line (w =300mm), etc.	l. m	55,500

4. Implementation Schedule and Project Cost

In case the Project is implemented by Japan's Grant Aid, the period for the detailed design is 7.0 months and the implementation period is 24.5 months in total.

The cost borne by Kenyan side to implement the Project is estimated at 156 million Kenya shillings.

5. Verification of appropriateness of the Project

It is expected the following effects by implementing the Project.

(1) Direct Effect

- Travel time at off peak hour will be shorten from present level of 14 minutes to 8 minutes on 4.61 km of ML3 &6 section and from present 13 minutes to 6 minutes on 3.75 km of ML7 section.
- Usage of road by pedestrians and bicycle will be safe and comfortable by constructed sidewalk and bicycle lane.

(2) Indirect Effect

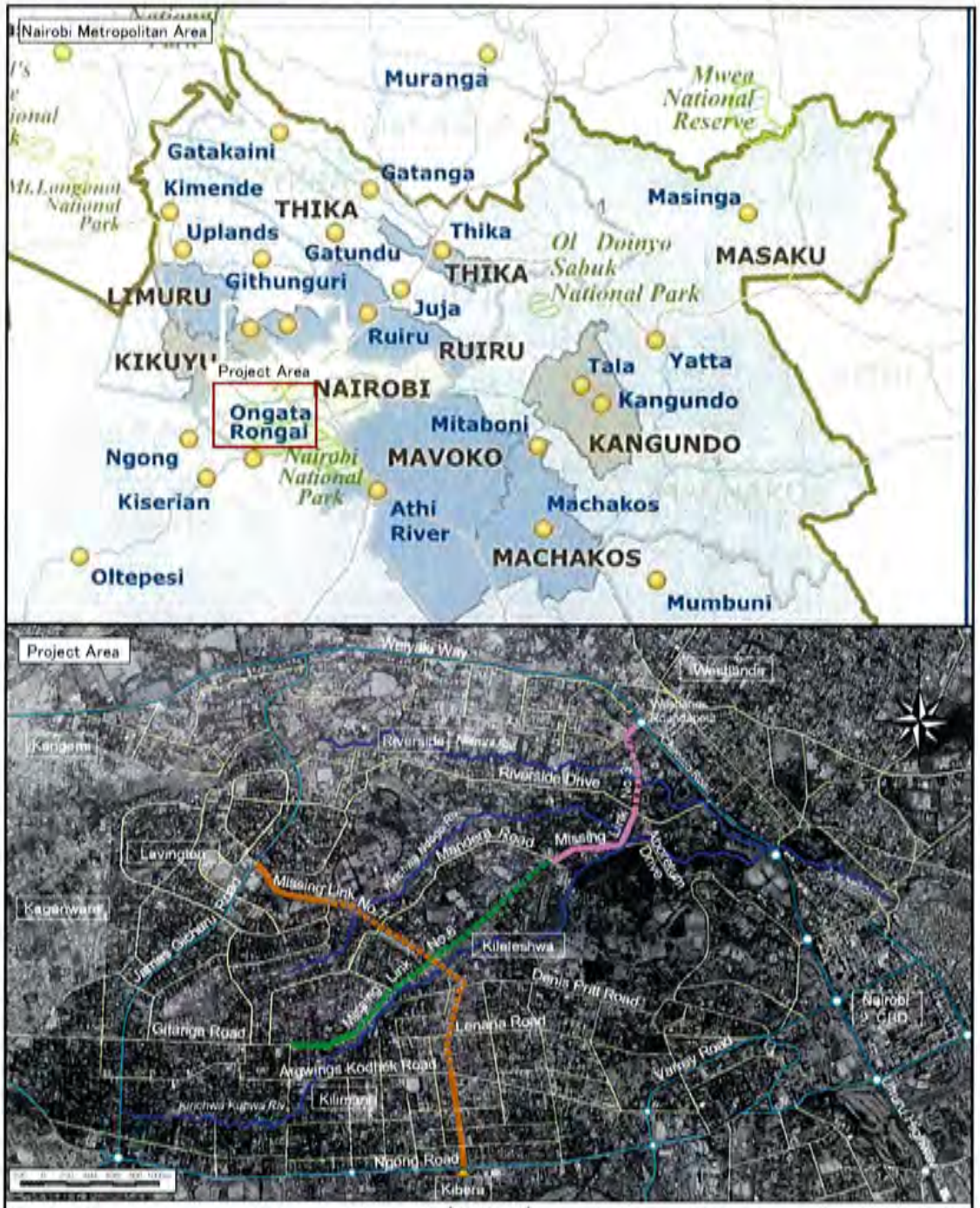
- The traffic congestions on the surrounding roads will be mitigated by the construction of missing links.
- The accessibility of logistic will be improved and it will contribute on the revitalization of regional economy.

The Project is expected above effects and it will secure the smooth and safety urban transport, revitalize regional social and economical activities and contribute the improvement of living environment for the residents generally. Therefore it is confirmed the appropriateness of the implementation of the Project by Japan's Grant Aid. It guesses that the effects of this project will be lager if the road network of Nairobi city is farther developed and the maintenance is executed certainly.

Contents

[Appendices]

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in Kenya
4. Minutes of Discussions
5. Technical Note
6. Design Data



LOCATION MAP

Perspective（ML6 / Radial Road）

Perspective（ML6 / ML7 Intersection）

List of Figures & Tables

Abbreviations

AASHTO	: American Association of State Highway and Transport Officials
AC	: Asphalt Concrete
CBR	: California Bearing Ratio
CCN	: City Council of Nairobi
EIA	: Environmental Impact Assessment
ESAL	: Equivalent Single Axle Load
GOK	: Government of Kenya
JICA	: Japan International Cooperation Agency
KURA	: Kenya Urban Roads Authority
ML	: Missing Link
M/D	: Minutes of Discussions
MOLG	: Ministry of Local Government
MOR	: Ministry of Roads
NEMA	: National Environment Management Authority
NMT	: Non Motorized Traffic
PAPs	: Project Affected Persons
RAP	: Resettlement Action Plan
RC	: Reinforced Concrete
ROW	: Right-of-Way
WB	: World Bank

CHPTER 1 BACKGROUND OF THE PROJECT

1-1 Background

Kenya has the function of the hub of logistics with their key port in Mombasa not only for themselves but also for neighbor countries. The development of infrastructure of Kenya is an important issue on the view of the promotion of economic growth of Kenya and the logistics of neighbor countries. However insufficient development of infrastructure is a factor of disturbance of economic activities. The government of Kenya issued the national development plan i.e. "Investment Program fro Economic Recovery Strategy for Wealth and Employment Creation : IP-ERS 2008~2012" on March, 2004. IP-ERS shows that the development of basic infrastructure is one of the issues for the economic growth. Regarding road sector, which has share of passenger and cargo at 76% and 80% respectively, the development target is set up to improve of safety road network and to improve effectiveness and safe of urban traffic. While "Kenya Vision 2030" was prepared in 2008 as the succeeding development plan of IP-ERS. "First Medium Term plan 2008~2012" is shown in that plan and it is mentioned the development of traffic infrastructure including the road sector.

In the city of Nairobi where is the biggest city in Kenya, the traffic congestion becomes serious problem such as the travel time at peak hour being more than double of off peak, because of the ineffective road network with cut off links on the ring roads and/or rapid increase of population. Such situations are caused the increase of maintenance cost and traffic accidents and affected vehicle operation.

In the results, labors in Nairobi area are enforced expensive traffic fare, so many low income people can not use the public transport. The traffic safety of residents also becomes problem. The population of the city of Nairobi is forecasted to increase from 3.0 million to 4.3 million. The traffic situation including congestion will be worsened.

Under these conditions, the government of Kenya requested to conduct "The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area" to Japan for the improvement of road network of Nairobi area. To response with this request, Japan International Cooperation Agency : JICA carried out an analysis of transport network in metropolitan area and a study of master plan for the development of transport network. In addition, pre-feasibility study of urgent projects, which need early measures, were conducted.

The government of Kenya requested Japan's Grant Aid on the project of the construction of three missing links, total length 8.4 km including sidewalk and small bridges, in July 2007. This study is the preparatory study for this project which is based on the pre-feasibility study in "The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area".

1-2 Natural Conditions

Kenya is located at east coast of Africa and the equator pass through the middle of the country. Territory is 583 thousands sq.km and bordered on Somalia in east, Ethiopia and Sudan in north, Uganda in west and Tanzania in south. Regarding topography, narrow coastal plain is located in south east along Indian Ocean but the most of the area is highland more than 1,200 m in altitude with savannah. The Project area is the city of Nairobi and located at hilly land on the east of large graben belt passing through the center of the country. The altitude is nearly 1700 m.

The climatic condition is basically warm and dry. There are rain season twice in a year. The heavy rain season, which is an effect of monsoon form south east, comes from March to May and the light rain season comes around November. Average rainfall is about 1,000 mm in a year and the temperature is not moved so much through a year with 20oC of yearly mean temperature.

The geology was made of mainly basalt which spread hilly land. It was created by blasted magma from large graben belt. It is observed outcrop of many basalt bedrocks in Nairobi.

1-3 Environmental and Social Consideration

Based on the Environmental Management and Coordination Act, the Project Report and Environmental Impact Assessment Study Report including results of Social Census Survey, Resettlement Action Plan, Concurrent 4 Public Hearings, as well as their Q&A, regarding Proposed Road Project for the Missing Link Roads No. 3, 6, & 7 (hereinafter referred to be as "Project") was submitted to the National Environmental Management Authority (hereinafter referred to be as "NEMA") from the Ministry of Local Government (hereinafter referred to be as "MoLG") as the proponent in association with the City Council of Nairobi (hereinafter referred to be as "CCN"), since the Project Roads are passing through the western residential area of Nairobi and they have confirmed that existences of valuable trees species and temporary occupiers along the corridors as shown in Table 1-3-1.

Table 1-3-1 Number of Temporary Occupiers & Affected People

Corridor	Temporary Occupiers	Direct Affected People
ML3	81	202
ML6	16	25
ML7	208	801
Total	305	1,028

NEMA, who received the Project Report and EIA Study Report, has reviewed and also circulated them to all concerned authorities and then advertised to the public for period of one month, has released Environmental Impact Assessment Licence to the proponent MoLG for implementation of the Project subject to 18 conditions on 15 September 2009 as shown in the Appendices.

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 BASIC CONCEPT OF THE PROJECT

2-1-1 Overall Goal and Project Purpose

Infrastructure development of the Republic of Kenya (hereinafter referred to be as "Kenya") is a very important issue for enhancing economic development of not only the own country but also those of surrounding countries as well, since Kenya plays the role as a logistics networks hub for those surrounding countries trough its sea port of Mombasa.

However, not enough development of the infrastructures have spoiled further economic growth of the country, the Government of Kenya (hereinafter referred to be as "GoK") has worked out for the "Investment Program for Economic Recovery Strategy for Wealth and Employment Creation: IP-ERS, 2008-2012" in March 2004, and listed up the development of basic infrastructures among those as one of topics for "Economic Growth".

It has set the "Improvement of Road Network and Safety" and the "Improvement of Efficiency and Safety of Urban Transport" especially in regard to the road, which bears 80% of passenger transport, and 76% of freight, as the development result.

Furthermore, as the succeeding plan of IP-ERS, "Kenya Vision 2030" has been developed in 2008, and as the first period mid-term plan among those, the developments of all transport related infrastructures, including road sector, has been stipulated in the "First Medium Term Plan in 2008-2012".

In City of Nairobi, which is the national largest and capital, without efficient arrangement of the circumferential roads, and with rapid increase of population, traffic jams have been intensified. Consequently, such condition has exerted on car operation and become also cause of increase of maintenance expenses and traffic accidents.

As a result, the City of Nairobi suburban worker has been forced the burden of high fare, and it has become the present condition for many, especially low income earners, that they have not been able to afford to cover the fare of the public transport due to its relatively high fare comparing to the previous level.

Population of the city is presumed to increase from the present level of 3.0 million people to 4.3 million people in 2025. In line with such growth, it is expected that traffic conditions, including traffic jam, would be getting worse and worse. And, from the viewpoint that,

counter measure is needed very much, since economic development of the country is vital.

Under such circumstances, the Government of Japan (hereinafter referred to be as "GoJ") had implemented "the Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya" between 2004 and 2006, which designates the traffic networks improvement of the Nairobi Metropolitan Area as purpose, based on the request from the GoK.

In addition, the GoJ has also received the request of the Grant Aid of the matter from the GoK, and executed "Preliminary Study" in August 2008. As a result, it could recognize the necessity and propriety of executing the Basic Design Study.

- ✓ Overall Goal : Reduction of the transport cost which leads the improvement of road circumstance of the Nairobi Metropolitan Region

- ✓ Project Purpose : 1) Improvement of Accessibility between Western Area (where Nairobi River and Kirichwa Kubwa & Ndogo Rivers split the Area) and City Centre and Eastern Area of the City of Nairobi
  2) Reduction of Trip Time and Traffic Accidents for both MT (Motorized Transport) and NMT (Non Motorized Transport) Users

2-1-2 Basic Concept of the Project

Construction of the urban collector roads of following missing sections in the City of Nairobi, including storm water drainage, sidewalk & cycle tracks, and bridges to achieve above mentioned project purpose is proposed;

1) Missing Link No.3 : between Kileleshwa Police Station and Westlands Roundabout (1.76km)[1]
2) Missing Link No.6 : between Ole Odume Road and Kileleshwa Police Station (2.85km)[2]
3) Missing Link No.7 : between James Gichuru Road and Ngong Road (3.75km)[3]

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1 ML3 / Paved Section-1; Kileleshwa Police Station [Mandera Rd] - Arboretum Dr - Riverside Dr (0.95km), Unpaved Section; Riverside Dr - Lantana Rd (0.66km), and Paved Section-2; Lantana Rd - Westlands Roundabout (0.15km)

2 ML6 / Paved Section; Ole Odume Rd - Mazeras Rd (0.45km), and Unpaved Section; Mazeras Rd - ML7 ~ Kileleshwa Police Station [Mandera Rd] (2.40km) /

3 ML7 / Paved Section-1; James Gichuru Rd - Mugumo Rd (0.75km), Unpaved Section; Mugumo Rd - ML6 ~ Denis Pritt Rd - Argwings Kodhek Rd (2.20km), and Paved Section-2; Argwings Kodhek Rd - Ngong Rd (0.80km)

2-2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2-2-1 Design Policy

(1) Basic Policy

Based on the original request from the GoK on July 2007, project routes were confirmed with GoK officials as shown in the previous section 1-2.

Despite the fact that GoK's medium-long term objective is to formulate 2-lane dual carriageway corridors in the area, for short term objective at this point of time, to formulate 2-lane single carriageway as provisional measures is the first priority.

Therefore, roads supposed to be constructed under this project shall be most likely a half of the proposed 2-lane dual carriageway basically, and all design works shall be carried out in line with this concept as its basic design policy.

However, forecasted traffic demands on the segments compose circumferential road (whole segments of ML3, segment between 1+500 and ending point of ML6, and segment between 1+800 and ending point of ML7) and radial roads (segment between beginning point and 1+500 of ML6, and segment between beginning point and 1+800 of ML7) will be quite different as show in Table 2-2-1.

Table 2-2-1 Forecasted Traffic Demands on the Missing Links (Average)

(Unit; PCU[4] per Day)

Sections	2010	2015	2020	2025
Radial Roads	16,300	22,300	26,500	29,800
Circumferential Roads	21,800	29,800	35,500	39,900

For instance, along radial road segments, forecasted traffic demands will not exceed the capacity of standard 2-lane single carriageway road (2,500 PCU per Hour) even in 2025[5] and particular segment between beginning point and 1+500 of ML6 where its Right of Way (RoW) width is limited as 80ft (24.38m) and elevation gap between both sides of the RoW is significant due to its terrain features.

4 Passenger Car Unit

5 Target Year for Long Term Programme under Nairobi Urban Transport Master Plan, GoK-JICA, March 2006

Under such conditions, proposed cross sections for the segments compose radial roads shall be designed as 2-lane single carriageway road as a final configuration without considering future widening spaces except segment between beginning point and 1+800 of ML7 where same segment is designated as proposed Bypass Link Road between Northern Bypass and Southern Bypass in the medium-long term programme and its RoW width is 100ft (30.48m) to accommodate future widening spaces for possible extra traffic demand.

In addition to above, necessity of cycle tracks is evaluated based on the descriptions in the two guidelines[6&7] provided by GoK and World Bank (WB), respectively.

According to the guideline by GoK;

- ✓ Cyclist can mix with vehicular traffic of all kinds at speeds less than 35 km/hr.
- ✓ They can also mix safely with vehicles at speeds of up to 65 km/hr provided volume are low and the percentage of heavy vehicle is not high.
- ✓ Above 65 km/hr some form of segregation or additional lane is necessarily.

According to the guideline by WB;

- ✓ At the lowest residential access level, usually only movement on foot or two-wheeler is required, and all movement can mix on the same track. These tracks and roads are NMT domain.
- ✓ At the main transit level, the use of urban corridor carriageways is restricted to motor vehicles only, and NMT movement has to be completely separated.
- ✓ In between these two cases, a gradual increase in traffic separation is desirable.

Considering nature of project roads, independent cycle tracks shall be provided separately outside the vehicle carriageway along circumferential road segments, and mixed cycle tracks shall be provided on the wide shoulder of the vehicle carriageway along radial road segments with visual separations such as clear marking lines and symbols on the tarmac.

(2) Natural Environmental Conditions Policy

As for natural conditional feature of the subject area of the cooperation programme, various private and commercial facilities are observed mainly in the area along the proposed roads.

Topographically, for example, a maximum difference of elevation with around 6m between

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6 Section 8.3, 2nd Draft, Road Design Guidelines for Urban Roads, Kenya Urban Transport Infrastructure Project (KUTIP), Ministry of Local Government, Government of Kenya, August 2001

7 Section 14.2, Productive and Liveable Cities, Guidelines for Pedestrian and Bicycle Traffic in African Cities, prepared as part of the Urban Component of the World Bank Sub-Saharan Africa Transport Program, January 2001

both sides of the road and a steep hill with a maximum gradient of 14% is observed in some segments.

As for road plan, it is necessary to consider whether entrance level of the area is secured or not while easing gradient economically along the proposed roads at the same time.

Furthermore, it is also necessary to consider providing construction plan while securing counter measures for the residents against noise and vibration as well as mobility for the road users along the proposed roads at the same time.

Considering abovementioned all factors, based on the measurements obtained from the results of topographic surveys, geological investigations, and traffic surveys through local re-contract scheme shall be fully utilized for the comprehensive judgments and design works.

(3) Socio-Economic Conditions Policy

As mentioned in the previous section, from the results of the traffic demands forecast, two typical cross sections are provided for the circumferential and radial road segments respectively.

Furthermore, road facilities for the public transport and non-motorized transport, such as bus bays, side walks, and cycle tracks, are provided for the commuters who do not possess private cars which are still majorities of the citizens in the Nairobi Metropolitan Area.

(4) Construction & Procurement Conditions Policy

Construction materials shall be selected based on the quality, cost, and reliability of procurements. And efficient construction plan shall be provided considering local conditions of supply for materials, machines, and labours.

(5) Practical Use Policy for Local Contractors

Most of local contractors are able to provide construction materials, machines, and labours. However, as mentioned in the sub-section (2) above, Japanese engineers' supervisory is necessarily due to schedule control and difficulties of the construction works for the entire segments along the proposed project roads.

(6) Operation and Maintenance Conditions Policy

For storm water drainage, basically open channel shall be provided for easy operation and maintenance. And bridges shall be designed as maintenance free structures.

(7) Grade Setting Policy for Facilities

As mentioned in the previous section, two typical cross sections are provided for the circumferential and radial road segments respectively.

The design speed is basically set up at 50 km/hr. However it is adopted 30 km/hr for the special value, if the geometric design cannot satisfy the requirements within the available right of way. The speed limit 30 km/hr is also introduced at approaches of roundabout intersections.

For bridges, most economical portal and pipe culverts are selected since driftwoods are not observed, and very low water is observed during dry seasons, and catchment area of each river is relatively limited.

(8) Construction Method Policy

In regard to quality control, necessary procedures and standards of the material testing and measurement inspections shall be clearly specified in the design drawings and the specifications, and carried out appropriately for assuring quality control.

In regard to scheme of execution, safety to the residents, road users, and authorized construction personnel and consideration to environment shall be secured first of all, furthermore, the scheme of execution to minimize influence to present traffic flow during the construction period shall be proposed.

(9) Social Environmental Consideration Policy

Following points shall be considered at the time of the planning, designing, and construction to minimize potential influences to environment and society;

- ✓ The road alignment plan shall be executed within the RoW to minimize the land acquisitions.
- ✓ The road profile and cross section plans shall be executed to minimize excess constructive scraps and excess materials shall be managed appropriately in accordance with the regulations.
- ✓ The construction plans shall be executed to maintain existing number of lanes and minimize traffic jams during the construction stages.
- ✓ The mitigation measures to prevent noise, vibration, and dust shall be implemented appropriately during the construction stages.
- ✓ The conditions indicated in the EIA Licence shall be fully complied.

2-2-2 Basic Plan (Construction Plan)

(1) Design Guidelines

Basically, the Bridge Design Manual[8] and the Road Design Guidelines[9] prepared by GoK were adapted, and other similar design guidelines of United States, United Kingdom, Australia, and Japan have been compared.

(2) Road Design Requirements

Road design requirements and their sources exchanged with GoK as Technical Notes are summarized in Table 2-2-2.

Table 2-2-2 Road Design Requirements

Contents	Established Requirements	Sources
Classification	Urban Collector Road	GoK's Road Design Guidelines
Design Speed	50 km/hr	GoK's Guidelines (50 ~ 70 km/hr)
Lane Width	3.30 m	GoK's Guidelines (3.0 ~ 3.5 m)
Median Width	1.50 m (0.60 m)	GoK's Guidelines & AASHTO[10]
Shoulder Width	0.60 m	GoK's Guidelines (0.6 ~ 2.5 m)
Sidewalk Width	2.50 m	GoK's Guidelines (2.0 ~ 3.0 m)
Cycle Track Width	2.00 m	GoK's Guidelines (2.0 m or more)
Initial Design Period for Pavement	15 years	GoK's Guidelines (15 years or less)
Maximum Gradient※	8.0 %	Other Countries (US, UK, Australia, Japan, etc.) Requirements

※Note: Maximum gradient of 8.0% is applied for newly construction segments only, however that of which along existing segments may vary and sometimes exceeds this requirement.

(3) Typical Cross Sections

As mentioned in the previous section, typical cross sections are determined based on the functions of the proposed roads and secured widths as right of way of each segment.

For the circumferential road segments (whole of ML3, between 1+500 and ending point of ML6, and between 1+800 and ending point of ML7), a 2-lane single carriageway configuration with separated independent cycle track between sidewalk and carriageway is

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8 Standard Drainage Structures Manual, Part 1, Standard Small Span Concrete Bridges, Bridge Section, Roads Department, Ministry of Public Works, Government of Kenya, January 1987

9 2nd Draft, Road Design Guidelines for Urban Roads, Kenya Urban Transport Infrastructure Project (KUTIP), Ministry of Local Government, Government of Kenya, August 2001

10 American Association of State Highway & Transportation Officials

selected as a part of the 2-lane dual carriageway configuration considering future widening works as shown in Figure 2-2-1.

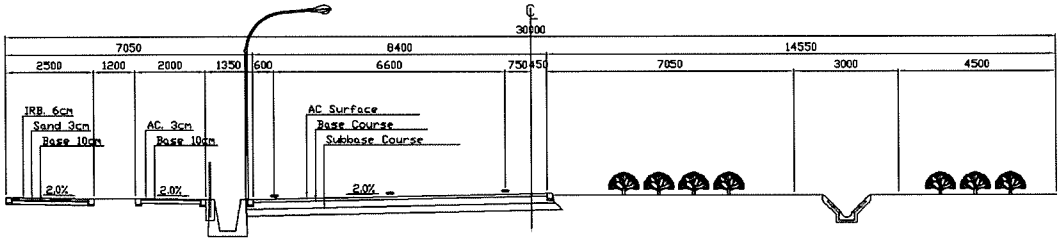


Figure 2-2-1 Typical Cross Section for Circumferential Road Segment (for ML3/6/7) RoW=100ft (30.48m)

For the radial road segments (between beginning point and 1+500 of ML6, and between beginning point and 1+800 of ML7), a single carriageway with mixed cycle tracks on the wide shoulders at each side of the carriageway is selected as final configuration without considering future widening works except radial road segment of ML7 as shown in Figure 2-2-2 and Figure 2-2-3.

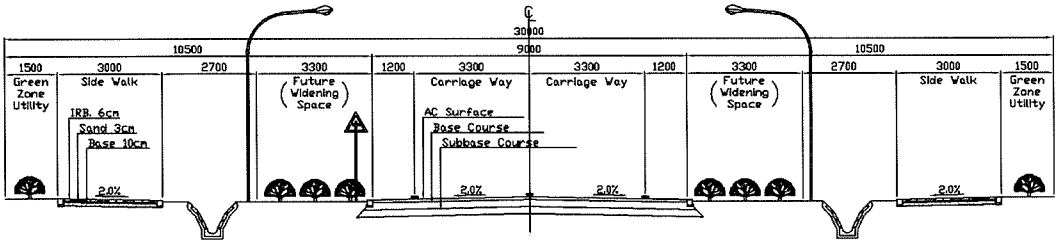


Figure 2-2-2 Typical Cross Section for Radial Road Segment-1 (for ML7) RoW=100ft (30.48m)

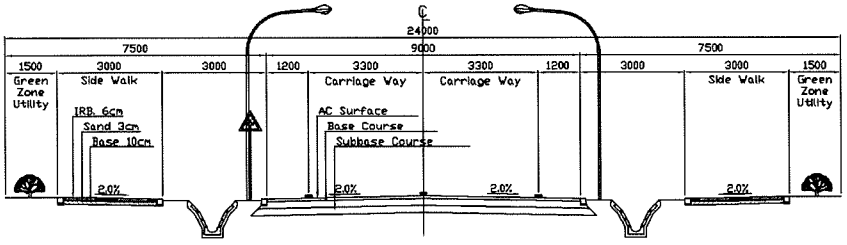


Figure 2-2-3 Typical Cross Section for Radial Road Segment-2 (for ML6) RoW=80ft (24.38m)

(4) Pavement Compositions

Design Standard

✓ AASHTO Guide for Design of Pavement Structures, 1993

Design Period (Service Life)

✓ 8 years (2013-2020)

In the Technical Notes exchanged with GoK, an initial design period was set as 15 years based on the Kenyan guidelines as shown in Table 2-2, however, considering various hypotheses in the future traffic demand forecast, and introduction of AASHTO standard for pavement design[11], much shorter design period shall be adopted to avoid cost overrun in line with periodical monitoring of actual traffic volume by segments to determine logical thickness of the pavement during the service period in the future.

In this plan, assuming overlay (re-carpeting) works will be carried out in line with widening works for upgrading circumferential road segments to a 2-lane dual carriageway configuration by 2020 (mid term target year in the Master Plan), a design period of 8 years from 2013 to 2020 was adapted as a practical initial design period.

Design Traffic Volume

Observed Traffic Volume at Major Intersections and Forecasted Traffic Demands by segments are shown in the Annex 3.1.

18,000-LB ESAL[12] per Vehicle by Each Category

18 kilo pounds (80 kN) ESAL per vehicle by each category are calculated from AASHTO Guidelines assuming heavy vehicle entries are minimized. Results of the calculations are shown in the Annex 3.2 (3).

Subgrade Design CBR[13]

Subgrade Design CBRs obtained from field investigation works for each segment are shown in the Annex 3.2 (1).

Pavement Materials

Considering quality, cost, and supply conditions of local materials, following pavement materials are selected;

✓ Surface & Base Course	;	Hot Asphalt Mixtures
✓ Upper Subbase Course	;	Mechanical Stabilized Gravel (CBR>80)
✓ Lower Subbase Course	;	Crusher Run (CBR>30)

[11] Comparing thickness of pavements by different design standards of Kenya, UK, US, and Japan, pavement structure calculated from Kenyan standard is the thinnest followed by UK, Japan, and US. Therefore, that of US standard (i.e. AASHTO) is the thickest, hence strongest and still thicker than that of design period of 15 years by Kenyan standard.

[12] Equivalent Single Axle Load

[13] California Bearing Ratio

✓ *Replaced* Subgrade	;	Strong enough excavated material from adjacent segments and/or borrow pit for the segments where subgrade design CBR is less than 6 (for ML3 : CBR>6, for ML7 : CBR>15 shall be selected)
✓ Sidewalk	;	Interlocking Block (t=60mm) widely utilized in the City and reinstalled easily even removed for public utility installations
✓ *Independent* Cycle Track	;	Hot Asphalt Mixture (t=30mm) for smooth riding conditions for bicycle

Calculations of Pavement Structures

Pavement structures and various factors indicated in the AASHTO Guide for Design of Pavement Structures, 1993 were adapted.

(5) Intersection Plans

Based on the forecasted future traffic demands, micro simulation analysis, road alignments and/or profiles before and after the intersections, and restrictions of the right of way, especially truncations for all major and minor intersections along proposed roads except Westlands Roundabout where improvement work was carried out in 2005 as pilot project under the Nairobi Urban Transport Master Plan, appropriate type of intersections, either conventional or roundabout (including twin roundabout), are selected and designed systematically as shown in Figure 2-2-4. Detailed criteria and scoring are summarized in the Appendices.

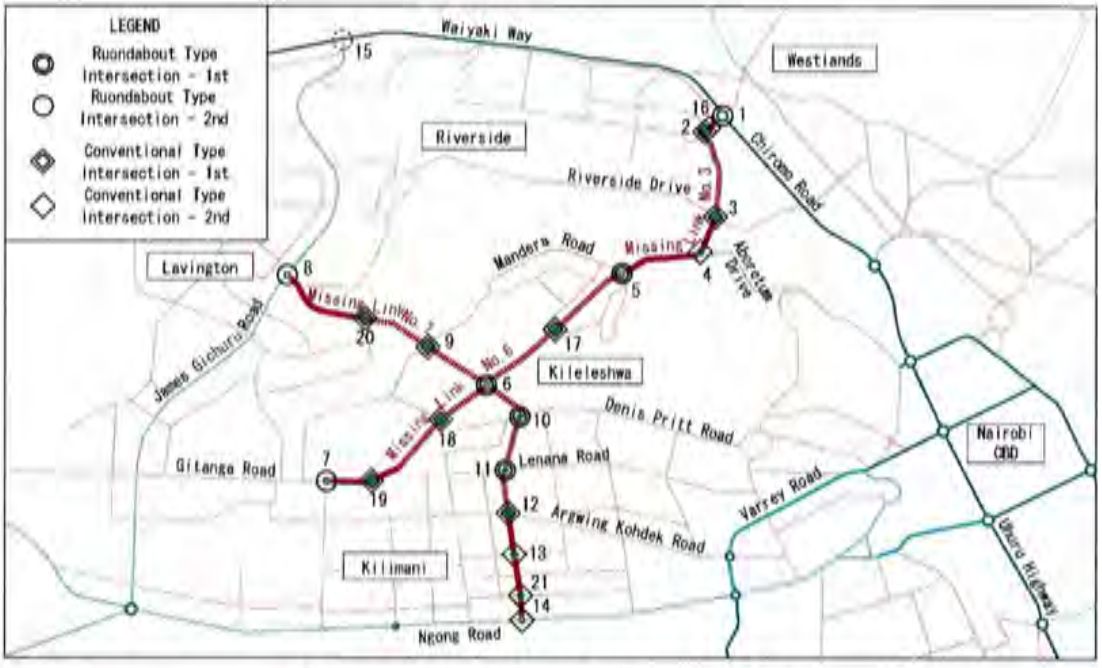


Figure 2-2-4 Selected Intersection Type

In regard to the intersection modifications, improvement works might be very difficult to stop or divert all traffic pass through subject intersection after the service started, therefore, full configurations (approach and departure lanes to/from the intersections shall be 2-lane dual for circumferential road segments and 2-lane single for radial road segments) were applied and designed from the initial stage.

In addition to above, where the segment distances between two adjacent intersections are relatively short[14], are designed to be as 2-lane dual carriageway from the initial stage due to prevention of possible traffic jams and physical limitations to narrow it once from 2-lane dual to 2-lane single then widen again to 2-lane dual in short distance along those segments and profile for one of them is very steep (13%).

(6) Storm Drainage Plan

In the Pre-Feasibility Study implemented under "the Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya" in 2005, the storm drainage was designed as combination of L-type gutter and pipe culvert with inlet under the edge of carriageway pavement.

However, malfunction of storm drainage system are reported constantly and the clogging and lost of functions are observed during the field work period of this programme due to accumulation of earth and sand without proper maintenance works in the most of catchments and pipe culverts along various roads in the City of Nairobi.

In order to be able to make the maintenance works easily, open-typed drainage is proposed instead of close-typed one where applicable.

Furthermore, where sufficient space is available, well-distributed semi-circle type drainage is arranged as much as possible and where space is limited, U-shaped drainage is arranged.

Storm water collected by above-mentioned drainage system is mainly guided to nearest river, however, where proposed roads and the rivers are far each other, existing drainages between the private plots along proposed roads and/or drainage along crossing roads are utilized to drain such storm water with appropriate care.

Where intersections and access approaches to the private plots are located, reinforced concrete (RC) pipe culvert with inner diameter of 600 mm and inlet with sand pit at both ends is installed to avoid possible clogging by accumulated earth and sand and to provide easy

[14] Segment between Arboretum Drive and Riverside Drive (300m), and segment between Lantana Road and Westlands Roundabout (150m)

maintenance.

Where bus bays are located, combination of open-typed drainage with RC covering plates under waiting space are arranged to avoid and provide the same, and also cut costs for both construction and maintenance.

Dimension Plan for Storm Drainage

Dimensions of open ditch and pipe culvert are determined based on the following run-off calculations.

Design Volume of Precipitation

Design volume of precipitation is calculated by Gumbel Method based on the last 40 years precipitation records obtained from the Dagoretti Corner Observatory near the site as follows;

- ✓ Open Ditch ; 91.9 mm/hr (3-year probability)
- ✓ Pipe Culvert ; 106.6 mm/hr (5-year probability)

Calculation of Run-off Volume

Volume of run-off is calculated by Rational Formula as follows;

- ✓ $Q = 1 / 3.6 \times A \times C \times I$

  Where, Q : Run-off Volume (m^3/sec)
  A : Catchment Area (km^2)
  C : Coefficient of Run-off (Tarmac = 0.8)
  I : Intensity of Rainfall (mm/hr)

Dimension Design of Storm Drainage

Sizes of open ditch and pipe culvert are determined based on the Manning's Formula for velocity of flow with about 20% extra room above the calculated depth of water (cross section area of flow) as follows;

- ✓ $V = 1 / n \times R \wedge (2/3) \times I \wedge (1/2)$

  Where, V : Velocity of Flow (m/sec)
  n : Coefficient of Roughness
  (Concrete Pipe = 0.013, and Concrete Ditch = 0.015)
  C : Hydraulic Mean Depth (Cross Section Area of Flow / Wetted Perimeter)
  I : Flow Surface Gradient

All calculation results for storm drainage systems are summarized in the Annex 2-5.

(7) River Crossing Structure Plan

Location of Proposed River Crossing

Three (3) rivers crossing this project roads at some locations, and three (3) new structure constructions and two (2) existing structure replacements are subjects under this design works due to widening and profile improvement as shown in Table 2-2-3;

Table 2-2-3 Location of Proposed River Crossing Structures

Routes	Rivers	Locations	Current Conditions	Proposed Type
ML3	Nairobi River	1+200	RC Slab Bridge (for Pedestrian)	New Portal Culvert (W=5.2+6.9+5.2 x H=5.95 x L=15.2)
ML7	Kirichwa Dogo River	1+040	Pipe Culvert (D500 x 1)	New Pipe Culvert (D=1200 x 2)
ML7	Kirichwa Kubwa River	1+935	RC Slab Bridge (1-lane w/o sidewalk)	New Portal Culvert (W=3.6+3.6+3.6 x H=3.7 x L=15.2)
ML3	Kirichwa Dogo River	0+700	RC Slab Bridge (2-lane w/ sidewalk)	Replace w/ Box Culvert (W=2.5 x H=1.6 x L=44.0)
ML3	Kirichwa Kubwa River	0+650 (Arboretum)	RC Slab Bridge (2-lane w/o sidewalk)	Replace w/ Box Culvert (W=4.2 x H=5.5 x L=19.35)

Selection of Foundation Type

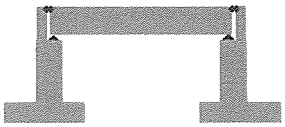
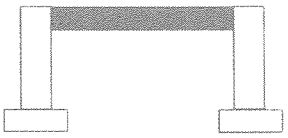
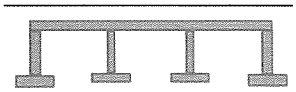
Geotechnical Investigations (In-Situ Borings and Core Sampling Tests) have been carried out during the field investigation period at assumed locations for bridge abutments. As results, base rocks composed from Basalt are confirmed within around 2m below of the ground surfaces at all locations.

Further more, based on the unconfined compression test at laboratory, modified N-values with over 50 are reported, and they are confirmed that strong enough to support required loads. Therefore, direct foundation is recommended for all type of the river crossing structures.

Selection of River Crossing Structures

River crossing structure is usually designed to be as short as possible due to economical reason as a whole. Under this design works, neither drift woods nor high water level were observed, therefore, either slab-bridge or culvert with partition walls is recommended as river crossing structure type as shown in the Table 2-2-4. And considering base rock presence, freedom from profile alignment design as well as maintenance free perspectives, culvert type structures (portal, box, or pipe) are selected.

Table 2-2-4 Selection of River Crossing Structures

Contents	RC Girder Bridge	Integral Abut Bridge	Portal Culvert Bridge
Sketch			
Economy	1.0	0.9	0.8
Moment	Bending moment is large at mid span	Bending moment is not so large at mid span	Bending moment is relatively small at mid span
Structure	Super-structure and sub-structure is separated, therefore very simple	Super-structure and sub-structure is connected, therefore slightly complicated	Super-structure and sub-structure is connected, therefore slightly complicated
Maintenance	Maintenance cost will be required for shoe and expansion joint replacements in the future	Maintenance cost will be minimum since no extra parts are required, except bottom plates	Maintenance cost will not be required, since there are no extra parts.
Construction	Super-structure and sub-structure is constructed independently, therefore it is easy to construct	Super-structure and sub-structure is constructed together, therefore proper procedures are required	Profile is lower than other types, therefore it is relatively easy to construct
Comfortless	Expansion joints are installed at both ends, therefore, excess vibration and noise are avoidable	Expansion joints are not required at both ends, therefore, excess vibration and noise are avoidable	There is no difference with filling section, therefore, no vibration and noise are produced
Quake Proof	Anti quake devices is required	It is relatively quake proof due to rigid flame structure	It is quake proof due to rigid flame structure
General Evaluation	Fair	Excellent	Very Excellent

Base on the field investigations, it is judged that double pipe culvert with D1200 (currently only single D500 pipe is installed) will be sufficient enough to handle design water level at river crossing along ML7 on Kirichwa Ndogo River.

Further more, existing two slab bridges, near the intersection of ML3 with Arboretum Drive, are big enough to handle current water level and look still good condition as structure.

However, considering widening and profile improvement works that filling works over existing ground level are required, no design sheets are available to review strength of the structures, and possible leaks from the joints between old structures and newly extended ones are anticipated, completely new structures are proposed by demolishing existing ones and replacing with new ones instead.

In general, Kenya is the largest good quality cement manufacturing country in East Africa Region, and had also manufacturers for reinforced bar meeting with British Standards. Therefore, all materials required for river crossing structures are available from domestic market.

And selected structure types are basically maintenance free and no specific operation and maintenance works are required except periodical routine inspections for supplemental facilities, such as guardrails and pavements.

(8) Supplemental Facilities Plan

Road Safety Facilities

Traffic signs (warning & regulatory signs except informatory signs) and road markings are installed based on Kenyan standards.

Guardrails are installed at the edge of the carriageway along the river crossing points and their approaches, and high filling sections. In addition, guard fences are installed between cycle track and U-shape drainage as well as at the edges of sidewalks along high filling sections for securing NMT users' safety.

Street lights are already installed along existing sections; therefore newly opened section should have them as same manner as existing sections in terms of security and uniformity of such facilities.

Access Approaches

Paved access approaches (AC t=30mm) are provided for all existing entrances along proposed roads where such facilities are required and/or demolished due to installation of new sidewalks, greenbelts, cycle tracks, drainages, and/or carriageways.

Bus Bays

Bus bay with shelter at roughly every 500m interval is installed for reducing traffic jams during alighting from and/or boarding to the buses and mini-buses along the proposed roads.

Underground Public Utilities

Based on the field investigations, several underground public utility lines, such as power, telecommunication, optical fibber, water and sewer, are observed. Approximate layouts are confirmed with data from and/or hearing to those providers, however depth of those lines are not well confirmed since nobody has such data.

In addition, GoK requested Japanese side to pre-install hand holes and ducts along proposed

roads under sidewalks to avoid re-excavation works after opening the roads for service, and initially such precast hand halls at every 50m interval and PVC ducts (D=200 x 4 for power lines, and D=150 x 4 for telecommunication and traffic signal) are arranged to install.

Unfortunately, due to cost overrun, except hand holes and ducts for traffic signals around the intersections, all other extra ducts are discarded from the cost estimate under Grant Aid scheme, and reverted back as GoK's obligations.

Underground Water Prevention Measure

During the field investigation works, presence of high underground water is observed just below existing section of ML3 (last 150m between Lantana Road and Westlands Roundabout).

To prevent future deterioration of pavements along abovementioned section, underground drainage pipes with small holes shall be installed beneath the surface water drainages to reduce underground water level below minus 1.2m from the ground level.

Under minus 1.2m from the ground level, hard base rock presence is confirmed.

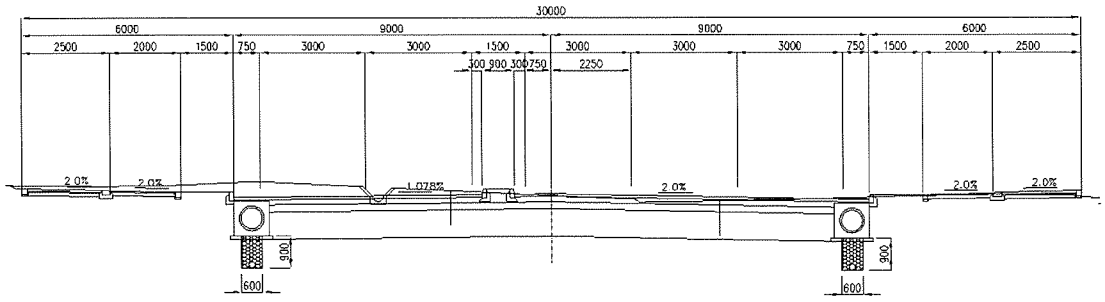


Figure 2-2-5 Underground Water Prevention Measure

2-2-3 Outline Design Drawing

Contents of the facilities under basic design scheme are summarized in Table 2-2-5.

Table 2-2-5 Contents of the Facilities under Basic Design Scheme

Facilities	Specifications	Unit	Quantity
Road Length	ML3 (1.76km) / ML6 (2.85km) / ML7 (3.75km)	l. km	8.36
Carriageway Pavement	Surface Course (Hot Asphalt Concrete) t=30mm / 86,815m^2, and t=50mm / 9,540m^2	sq. m	113,719
	Base Course (Hot Asphalt Concrete) t=45mm / 86,815m^2, and t=50mm / 9,540m^2	sq. m	113,719
	Upper Subbase Course (Mechanical Stabilized Aggregate) t=150mm~200mm	sq. m	104,249
	Lower Subbase Course (Crusher Run) t=200mm~350mm	sq. m	109,234
Sidewalk Pavement	Interlocking Block (w=2.5~3.0m)	sq. m	18,781
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	18,311
Access Approach Pavement	Surface Course (Hot Asphalt Concrete) t=30mm	sq. m	3,932
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	3,932
Cycle Track Pavement	Surface Course (Hot Asphalt Concrete) t=30mm	sq. m	26,167
	Subbase Course (Mechanical Stabilized Aggregate) t=100mm	sq. m	26,167
Storm Water Drainage (Side)	U-Shape Concrete Drain (Bottom Width = 300mm)	l. m	5,408
	V-Shape Concrete Drain (Bottom Width = 450mm)	l. m	4,420
	Street Inlet w/ Sandpit	sets	487
	RC Pipe Culvert (Inner Diameter = 600mm)	l. m	6,179
Storm Water Drainage (Cross)	Portal Culvert (W = 5.2 + 6.9 + 5.2 m) x (H = 5.95 m) x (L = 15.2 m)	set	1
	Portal Culvert (W = 3.6 + 3.6 + 3.6 m) x (H = 3.7 m) x (L = 15.2 m)	set	1
	Box Culvert (W = 4.2 m) x (H = 5.5 m) x (L = 19.35 m)	set	1
	Box Culvert (W = 2.5 m) x (H = 1.6 m) x (L = 44.0 m)	set	1
	Double Pipe Culvert 2 x (D = 1,200 mm) x (L = 32.0 m)	set	1
Block Stone	Curb Stone Block	l. m	9,997
	Border Stone Block	l. m	35,323
Traffic Signs	Warning & Regulatory Signs (excluding Informatory Signs)	set	431
Road Markings	Centre Line (w=150mm), Shoulder Line (w=150mm), Cross Walk (w=450mm), Stop Line (w =300mm), etc.	l. m	55,500

Basic design drawings are presented from next page, and contents of the drawings are summarized in Table 2-2-6.

Table 2-2-6 Contents of the Basic Design Drawings

Title of the Drawings	Number of the Drawings
Abbreviation	AB-1
Location	G-1
Typical Cross Sections	TC-1~4
Plans	PL-1~26
Profiles	PR-1~14
Cross Sections	CS-1~30
Access Approach	AC-1
Curb & Tree Circle	CT-1
Drainages	DR-1, 2
Retaining Wall	RR-1
Bus Bay	BS-1
Guard Rails	GR-1, 2
Guard Fence	GF-1
Guard Post and Hamp	GP-1
Hand Hole	HH-1
Street Light	ST-1
Road Marking	RM-1
Road Sign	RS-1, 2
Intersection Details	IS-1~19
Bridge Details	BR-1~4

THE PREPARATORY SURVEY
ON
THE PROJECT FOR THE CONSTRUCTION
OF
NAIROBI WESTERN RING ROADS
IN
THE REPUBLIC OF KENYA

NOVEMBER 2009

DRAWINGS

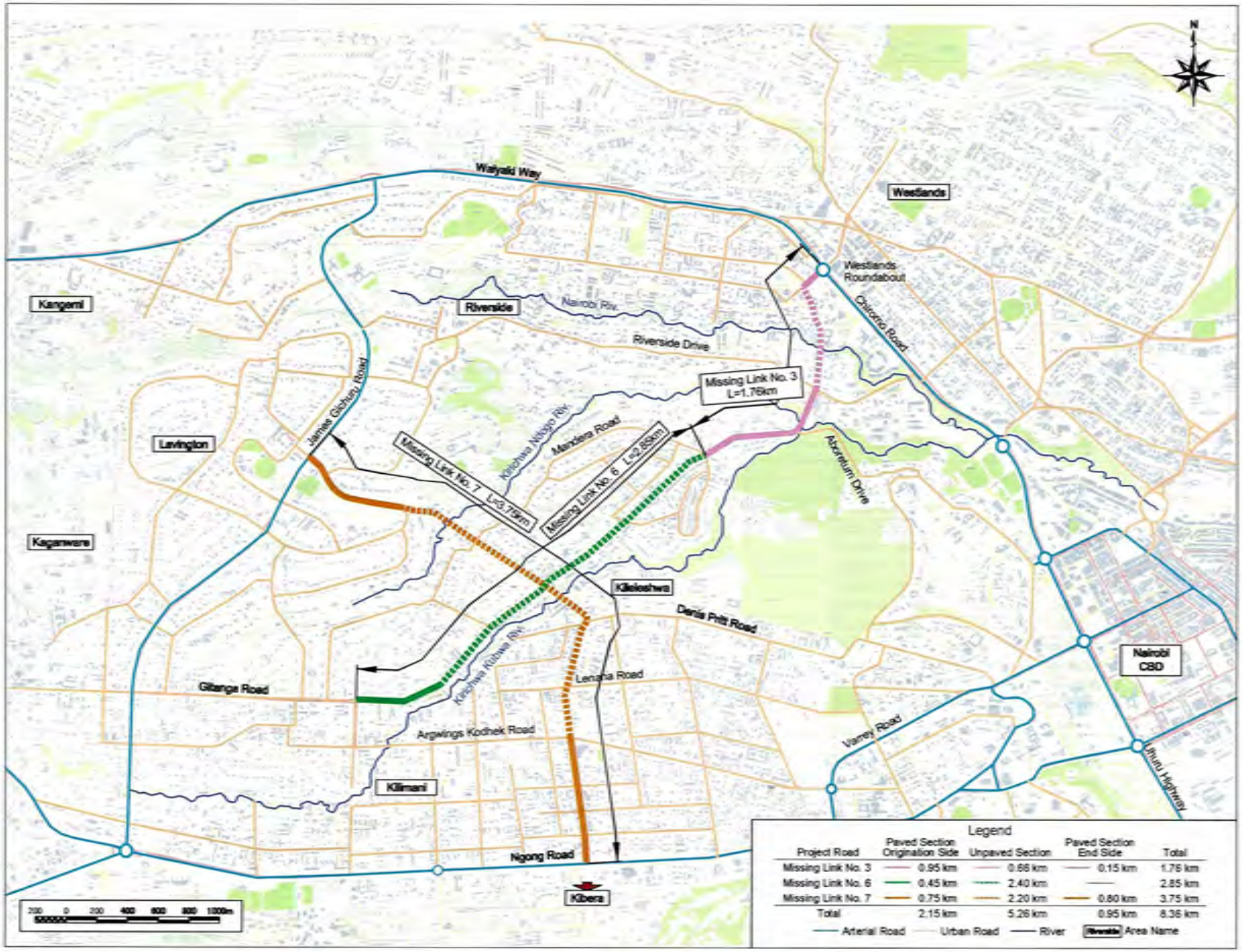
JAPAN INTERNATIONAL COOPERATION AGENCY

DRAWING INDEX

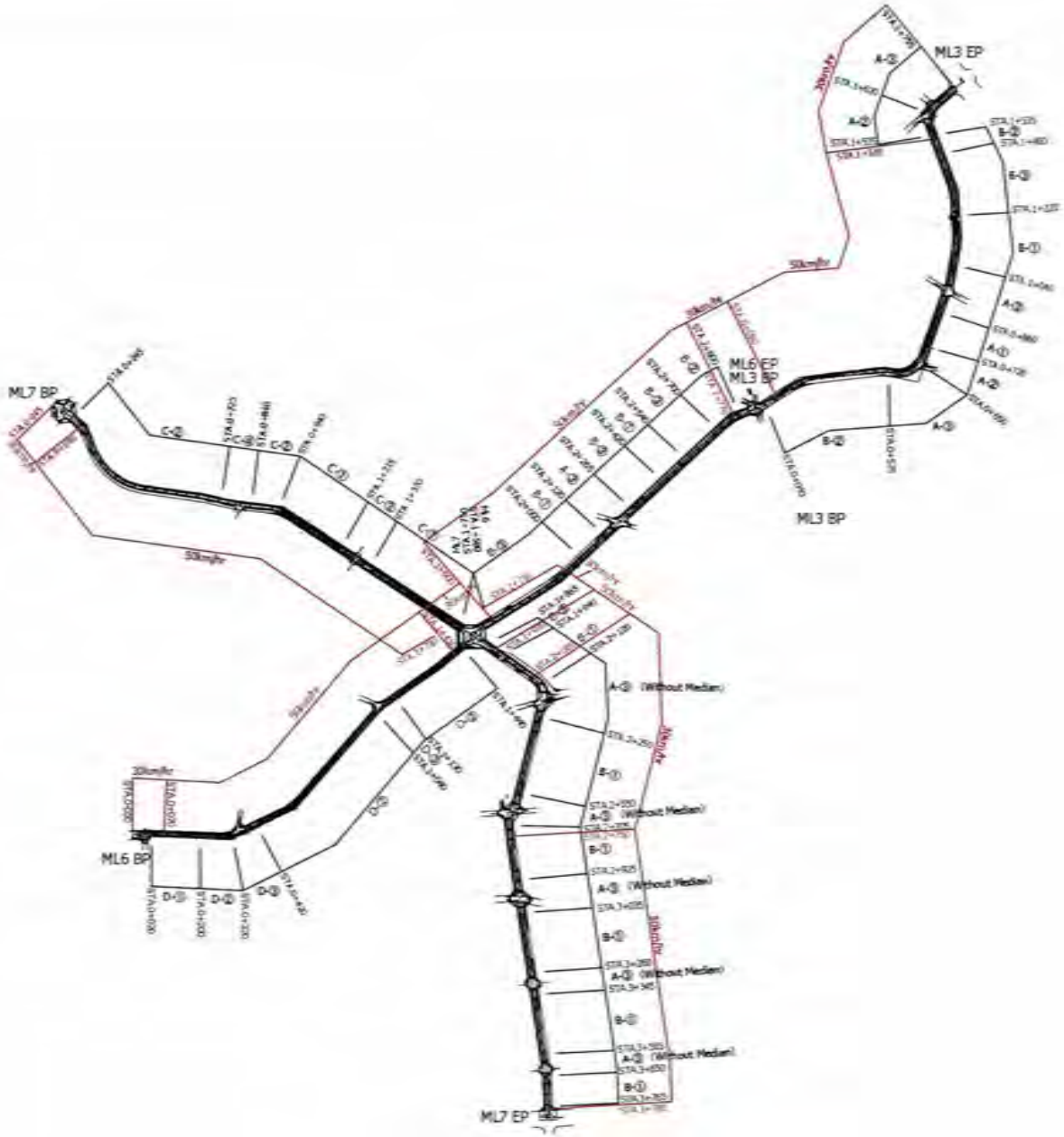
ABBREVIATION LIST

CLASSIFICATION(1)	CLASSIFICATION(2)	CLASSIFICATION(3)	CLASSIFICATION(4)	ABBREVATION
ACCES WAY				AC
CURBS	CURB STONE			CS-A
				CS-B
	VERGE BLOCK			VB
GREEN BELT				GB
TREE CIRCLE				TRC
DRAINAGE	CONCRETE DITCH	INSTALLATION AT FLAT AREA	WITH CRUSHED STONE BASE	DC-450A1
			WITHOUT CRUSHED STONE BASE	DC-450A2
		INSTALLATION AT SLOPE AREA	WITH CRUSHED STONE BASE	DC-450B1
			WITHOUT CRUSHED STONE BASE	DC-450B2
	INVERT BLOCK DRAIN	PERMANENT TYPE		DV-A
		TEMPORARY TYPE		DV-B
	CONCRETE PIPE CURVERT	ϕ600・FIX BASE, LOGOTITUDIAL TYPE	WITH CRUSHED STONE BASE	DP-600A1
			WITHOUT CRUSHED STONE BASE	DP-600A2
		ϕ600・FIX BASE, CROSSING TYPE	WITH CRUSHED STONE BASE	DP-600B1
			WITHOUT CRUSHED STONE BASE	DP-600B2
CATCH BASIN	600*600*1200	NOS.OF CONNECTING PIPE 1	WITHOUT COVER	CB-A1
		NOS.OF CONNECTING PIPE 2	WITHOUT COVER	CB-A2
		NOS.OF CONNECTING PIPE 3	WITHOUT COVER	CB-A3
		NOS.OF CONNECTING PIPE 4	WITHOUT COVER	CB-A4
	900*900*1200	NOS.OF CONNECTING PIPE 2	WITHOUT COVER	CB-B2
		NOS.OF CONNECTING PIPE 3	WITHOUT COVER	CB-B3
		NOS.OF CONNECTING PIPE 4	WITHOUT COVER	CB-B4
	600*900*1200	NOS.OF CONNECTING PIPE 1	WITHOUT COVER	CB-C1
		NOS.OF CONNECTING PIPE 2	WITHOUT COVER	CB-C2
		NOS.OF CONNECTING PIPE 3	WITHOUT COVER	CB-C3
	600*600*1200	NOS.OF CONNECTING PIPE 1	WITH COVE	CB-A1-C
		NOS.OF CONNECTING PIPE 2	WITH COVE	CB-A2-C
		NOS.OF CONNECTING PIPE 3	WITH COVE	CB-A3-C
	900*900*1200	NOS.OF CONNECTING PIPE 2	WITH COVE	CB-B2-C
		NOS.OF CONNECTING PIPE 3	WITH COVE	CB-B3-C
		NOS.OF CONNECTING PIPE 4	WITH COVE	CB-B4-C
RETAINING WALL	RETAINING WALL	INSTALLATION AT SIDE OF ROAD, CONCRETE FACE WITH SLOPE		RW-A
		INSTALLATION AT SIDE OF ROAD, CONCRETE FACE WITHOUT SLOPE		RW-B
		INSTALLATION AT TOE OF SLOPE		RW-C
	RIPRAP			RR
GUARD RAIL	ON THE GROUND			Gr-4E
	ON THE STRUCTURE			Gr-2B
GUARD FENCE				GF
GUARD POST				GP
HAND HOLE				HH
STREET LIGHTNING	SINGLE LANP			ST-1

KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ABBREVIATION LIST	Drawing No.	AB-1
				SCALE	NON SCALE
				DATE	AUG. 2009

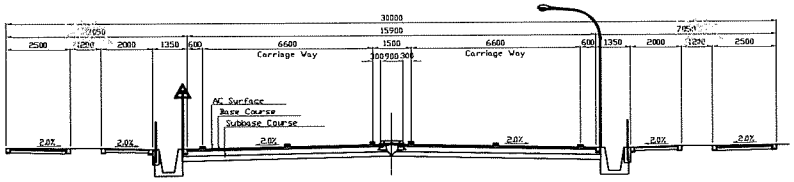


KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE: **LOCATION MAP**	Drawing No.	G-01
				SCALE	1/2500
				DATE	AUG. 2009

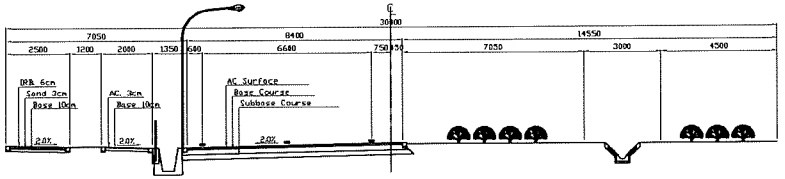


KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : LAYOUT OF TYPICAL CROSS SECTION	Drawing No.	TC-1
				SCALE	NON SCALE
				DATE	AUG. 2009

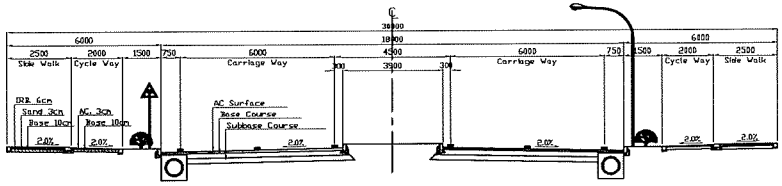
A-① M3 Ring Road Section (Standard Type)
Row=30m, Nos. of Lane=4
Location of Lanes : Both Sides (with Median)



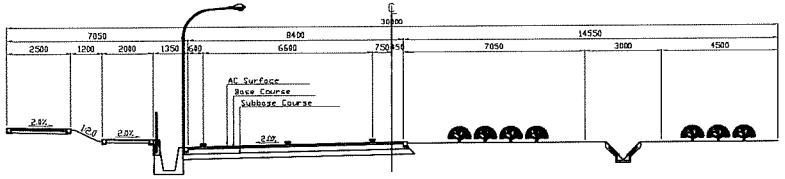
B-① M3, 6&7 Ring Road Section (Standard Type)
Row=30m, Nos. of Lane=2
Location of Lanes : One Side



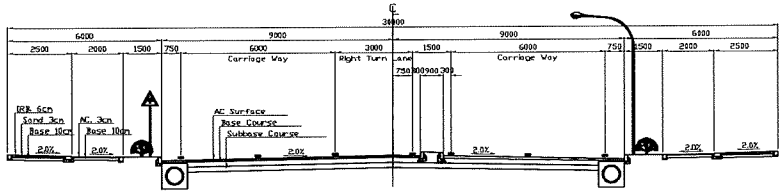
A-② M3 Ring Road Section (Special Type with Wide Median nearby IS)
Row=30m, Nos. of Lane=4
Location of Lanes : Both Sides (with Median)



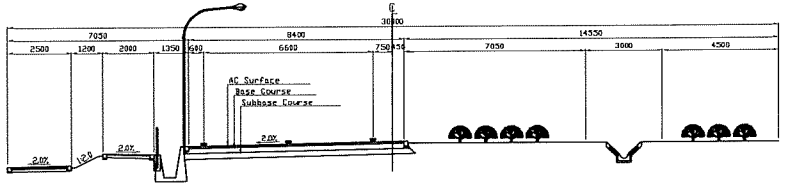
B-② M3, 6&7 Ring Road Section (Special Type with Gentle Slope between Sidewalk and Cycleway)
Row=30m, Nos. of Lane=2
Location of Lanes : One Side



A-③ M3, 6&7 Ring Road Section (Standard Type with Right Turn Lane at IS)
Row=30m, Nos. of Lane=4
Location of Lanes : Both Sides (with Median)

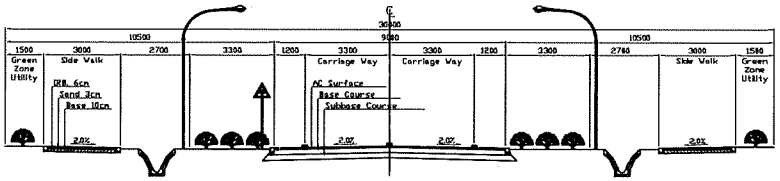


B-③ M3, 6&7 Ring Road Section (Special Type with Gentle Slope between Sidewalk and Cycleway)
Row=30m, Nos. of Lane=2
Location of Lanes : One Side

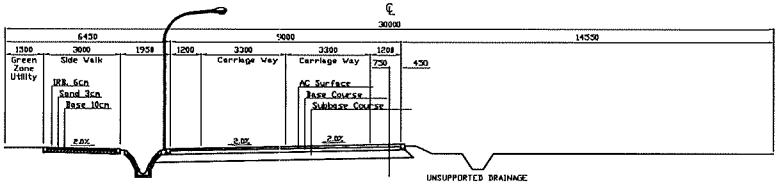


KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : TYPICAL CROSS SECTION (1)	Drawing No.	TC-2
				SCALE	1/200
				DATE	AUG. 2009

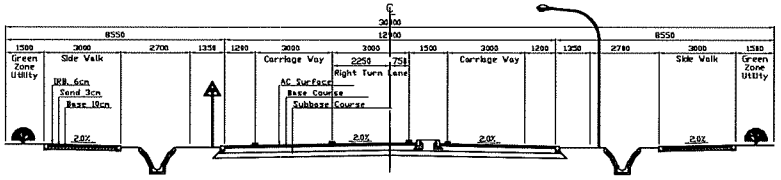
C-① M7 Radial Road Section (Standard Type)
Row=30m, Nos. of Lane=2
Location of Lanes : Both Sides (without Median)



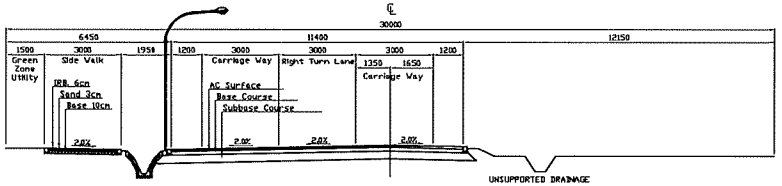
C-② M7 Radial Road Section (Special Type)
Row=30m, Nos. of Lane=2
Location of Lanes : One Side



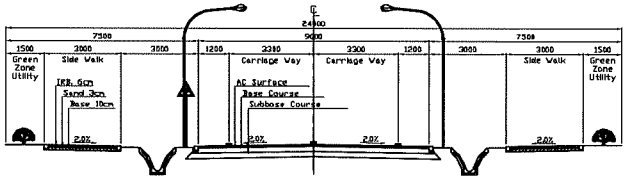
C-③ M7 Radial Road Section (Standard Type with Right Turn Lane at IS)
Row=30m, Nos. of Lane=2
Location of Lanes : Both Sides (with Median)



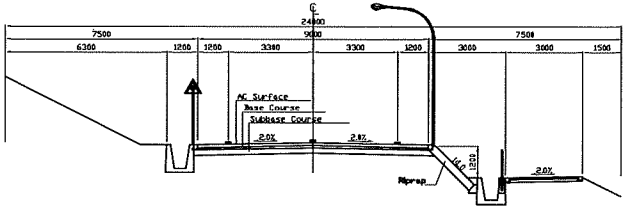
C-④ M7 Radial Road Section (Special Type with Right Turn Lane at IS)
Row=30m, Nos. of Lane=2
Location of Lanes : One Side (without Median)



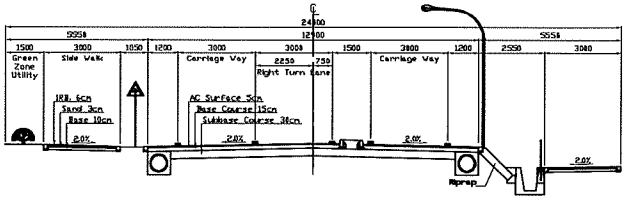
D-① M6 Radial Road Section (Standard Type)
Row=24m, Nos. of Lane=2
Location of Lanes : Both Sides (without Median)



D-② M6 Radial Road Section (Special Type with Slope between Carriageway and Sidewalk)
Row=24m, Nos. of Lane=2
Location of Lanes : Both Sides (without Median)



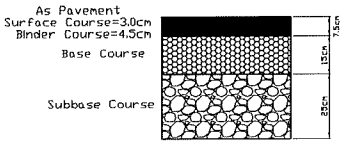
D-③ M6 Radial Road Section (Special Type with Right Turn Lane at IS)
Row=24m, Nos. of Lane=2
Location of Lanes : Both Sides (with Median)



KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE: TYPICAL CROSS SECTION (2)	Drawing No.	TC-3
				SCALE	1/200
				DATE	AUG. 2009

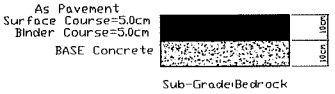
①ＭＬ６ Radial Road Section(Standard Type)

ML6:0+000～0+500



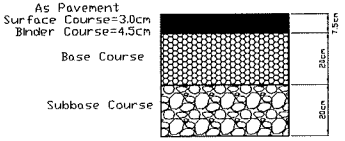
②ＭＬ６ Radial Road Section(Special Type)

ML6:0+500～1+440



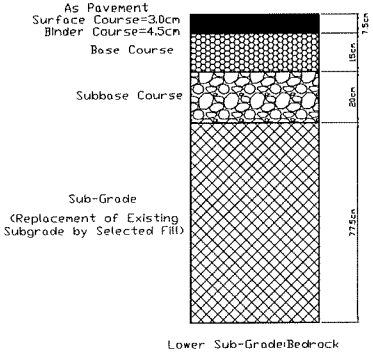
③ＭＬ３＆６ Ring Road Section(Standard Type)

ML6:1+560～2+864
ML3:0+000～1+610



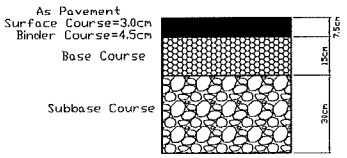
④ＭＬ３ Ring Road Section(Special Type)

ML3:1+610～1+755



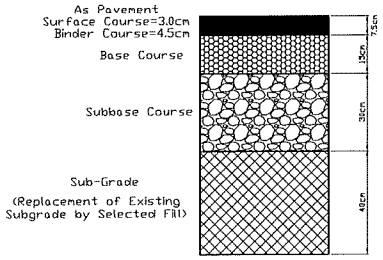
⑤ＭＬ７ Radial Road Section(Standard Type)

ML7:0+250～1+751



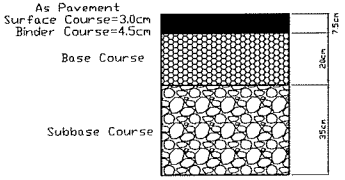
⑥ＭＬ７ Radial Road Section(Special Type)

ML7:0+000～0+250



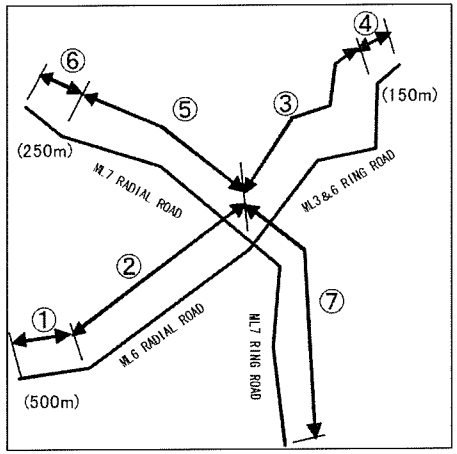
⑦ＭＬ７ Ring Road Section(Stabdard Type)

ML7:1+751～3+780
(ML6:1+400～1+560)

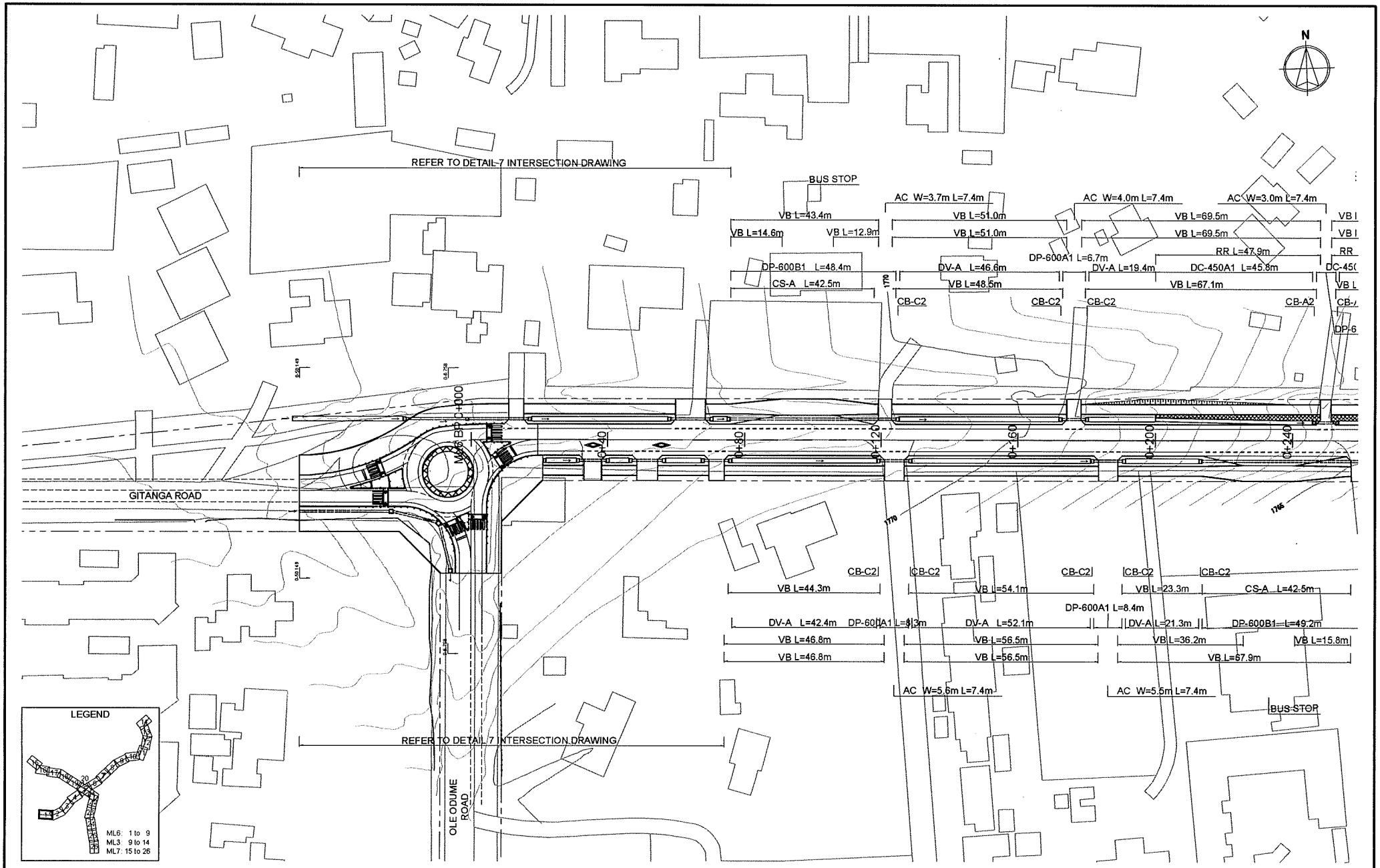


Note : Base Course - Mechanical Stabilized Crushed Stone
Subbase Course - Crusher run

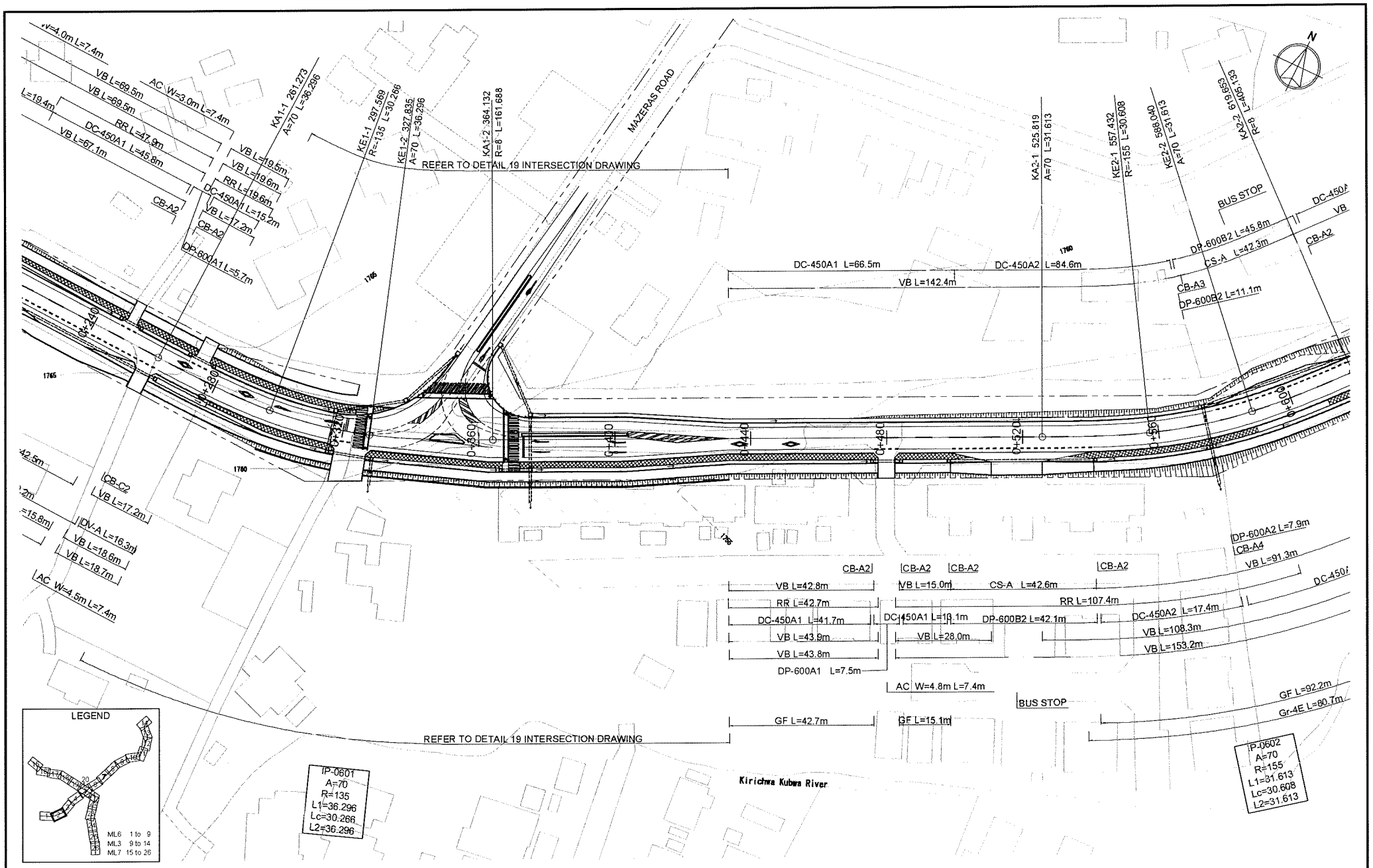
Layout of Pavement Type



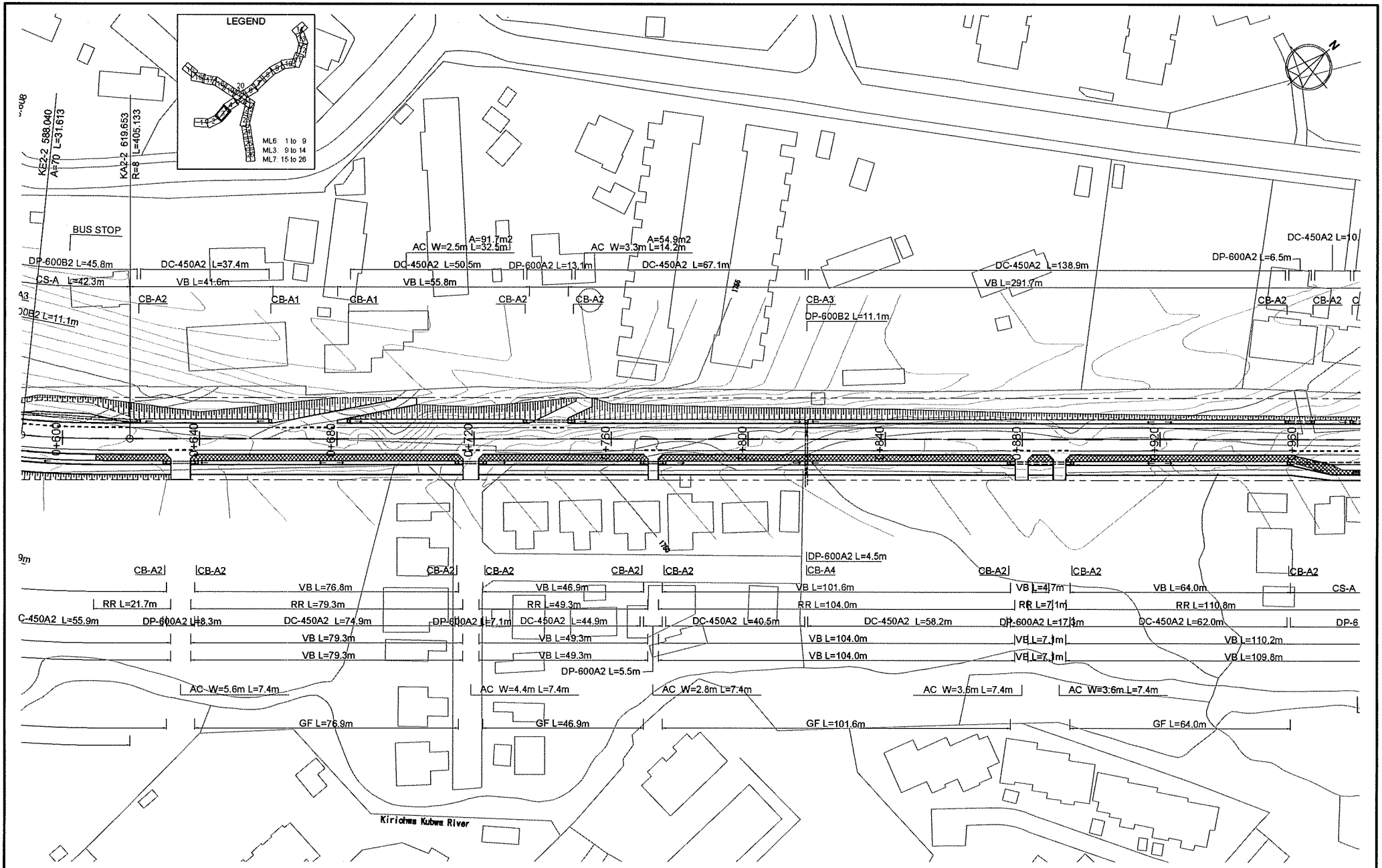
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : PAVEMENT COMPOSITION	Drawing No.	TC-4
				SCALE	1/20
				DATE	AUG. 2009



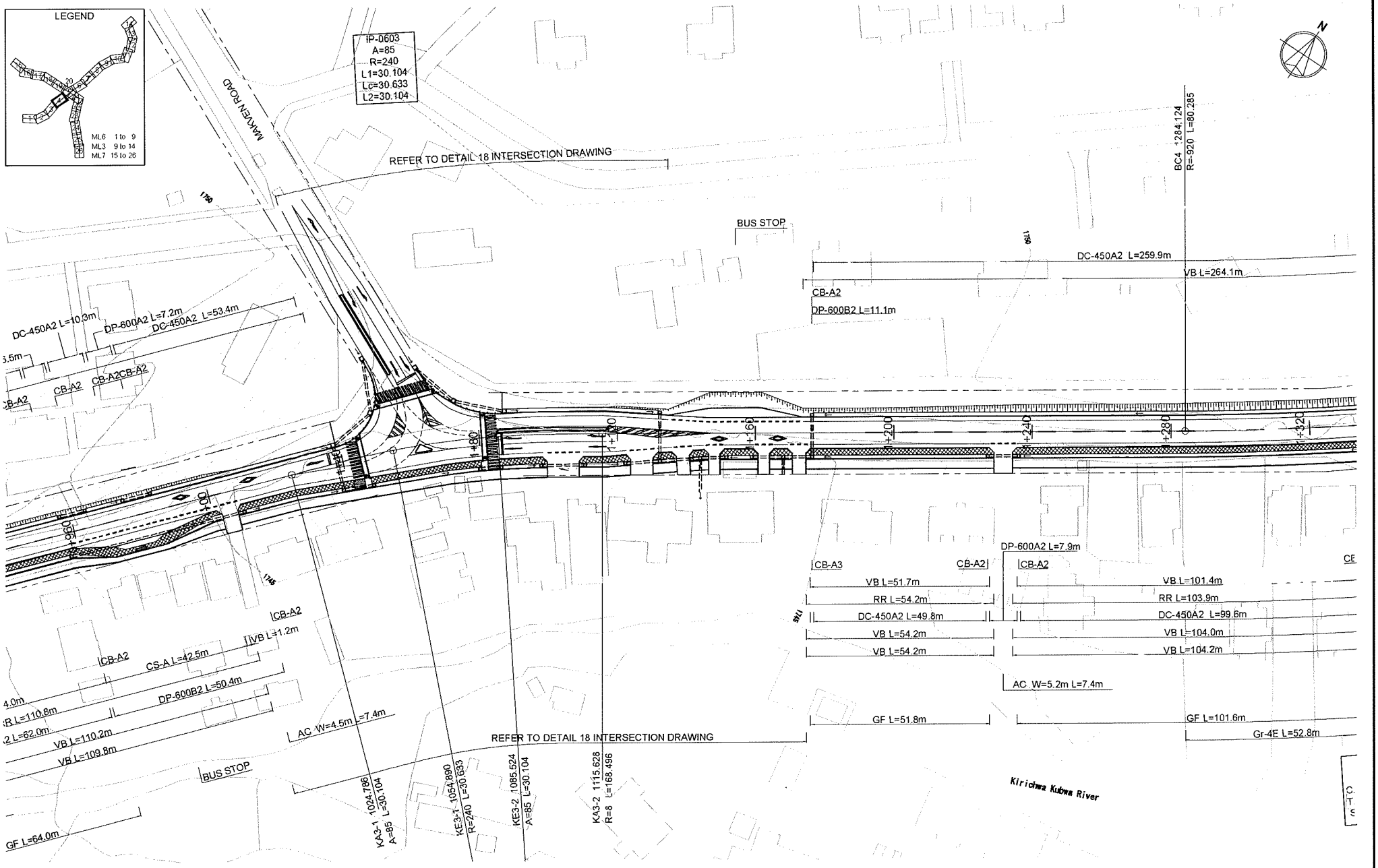
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 0+000 to STA. 0+240	Drawing No.	PL-1
				SCALE	1/1000
				DATE	AUG. 2009



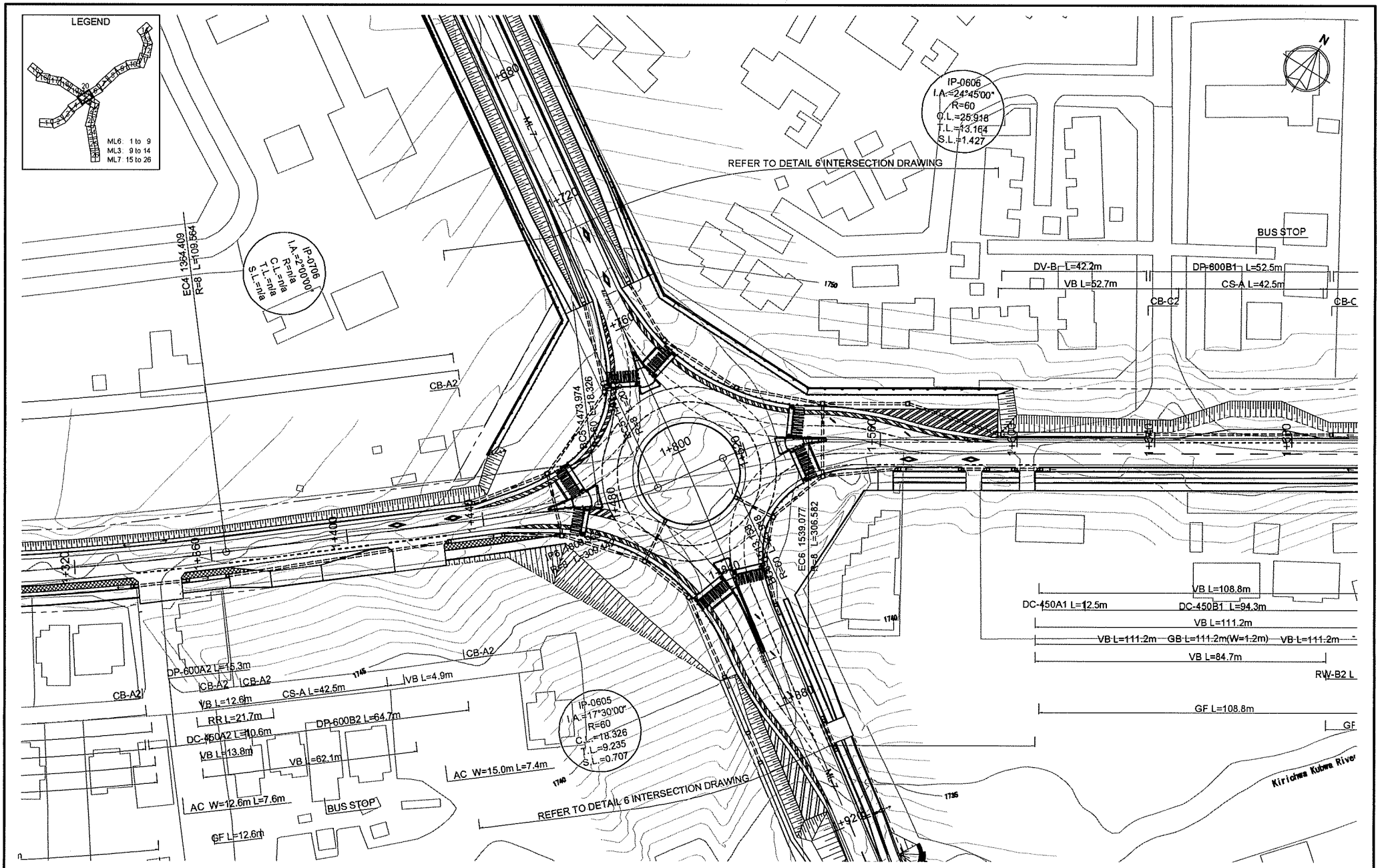
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 0+240 to STA. 0+600	Drawing No.	PL-2
				SCALE	1/1000
				DATE	AUG. 2009



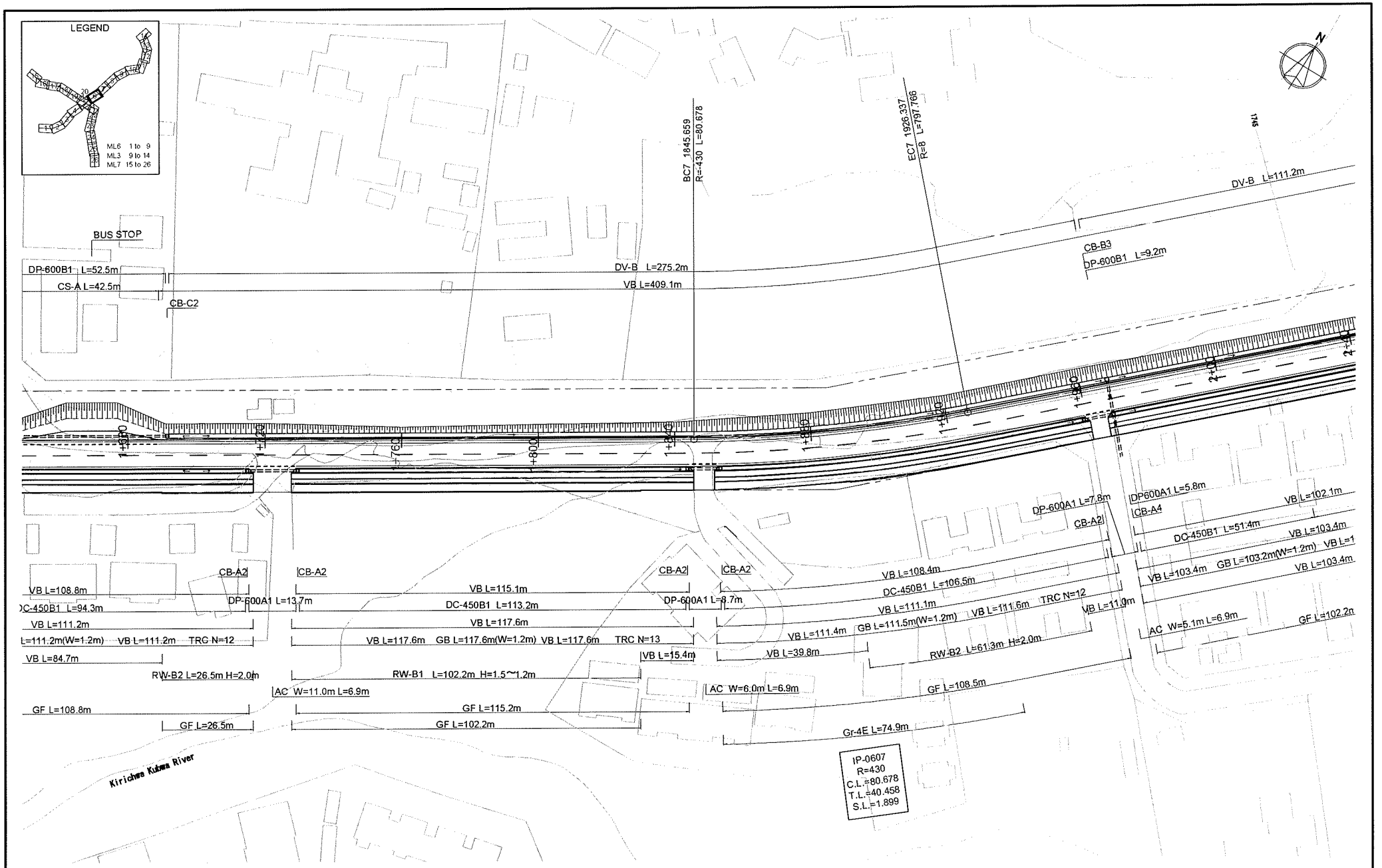
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 0+600 to STA. 0+960	Drawing No.	PL-3
				SCALE	1/1000
				DATE	AUG. 2009



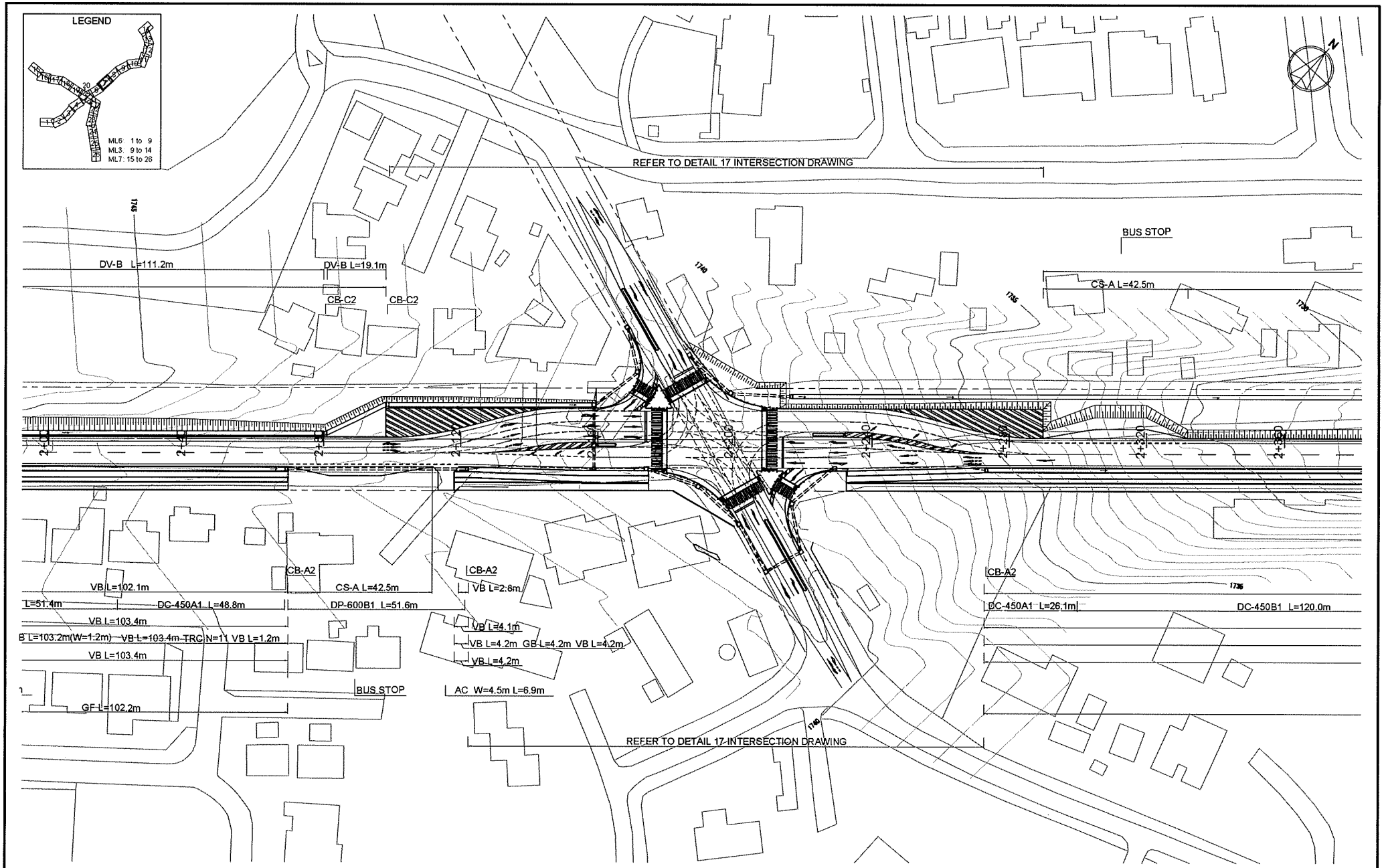
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 0+960 to STA. 1+320	Drawing No.	PL-4
				SCALE	1/1000
				DATE	AUG. 2009



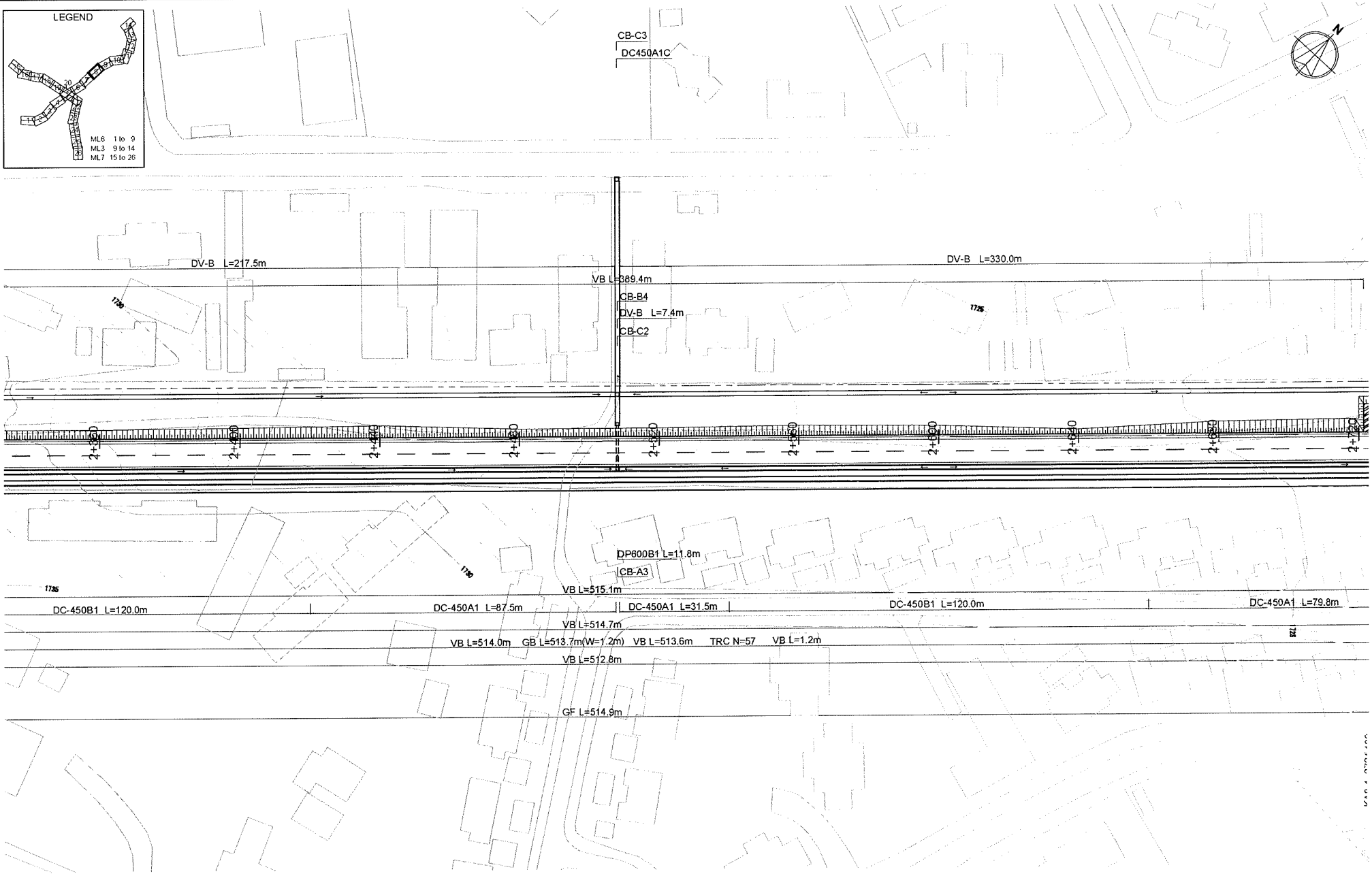
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 1+320 to STA. 1+680	Drawing No.	PL-5
				SCALE	1/1000
				DATE	AUG. 2009



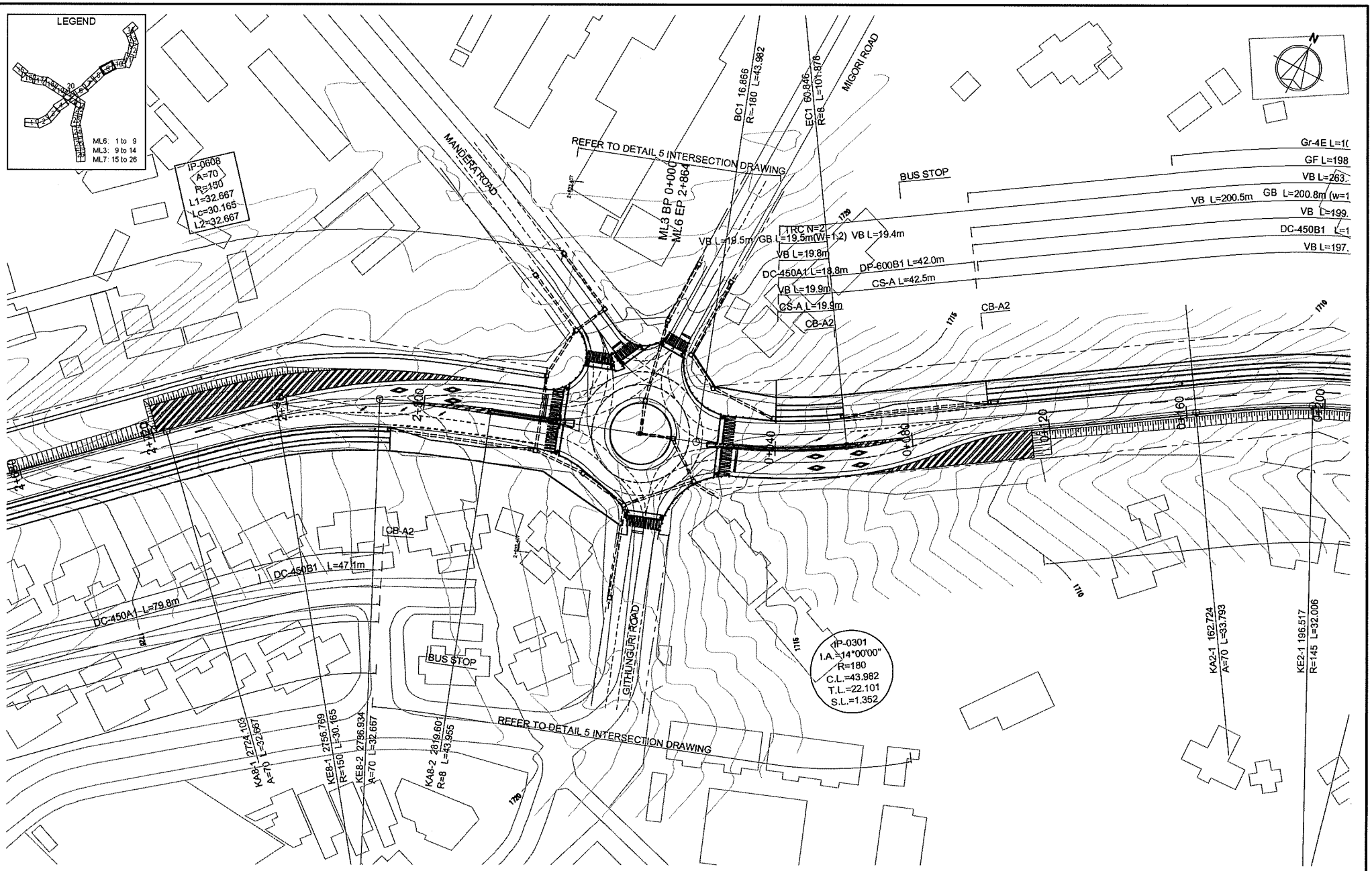
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 1+680 to STA. 2+000	Drawing No.	PL-6
				SCALE	1/1000
				DATE	AUG. 2009



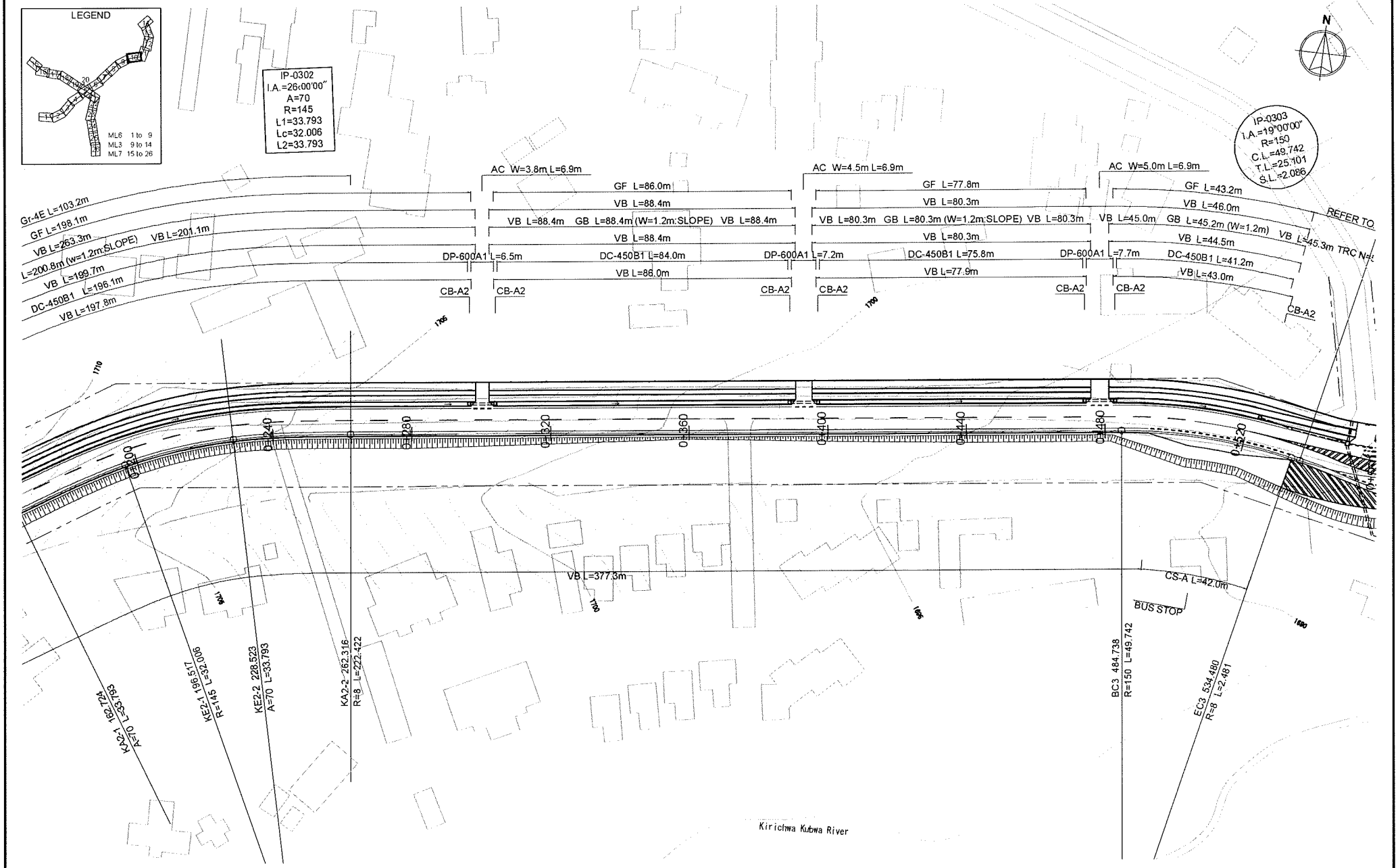
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE: ML6 PLAN STA. 2+000 to STA. 2+360	Drawing No.	PL-7
				SCALE	1/1000
				DATE	AUG. 2009



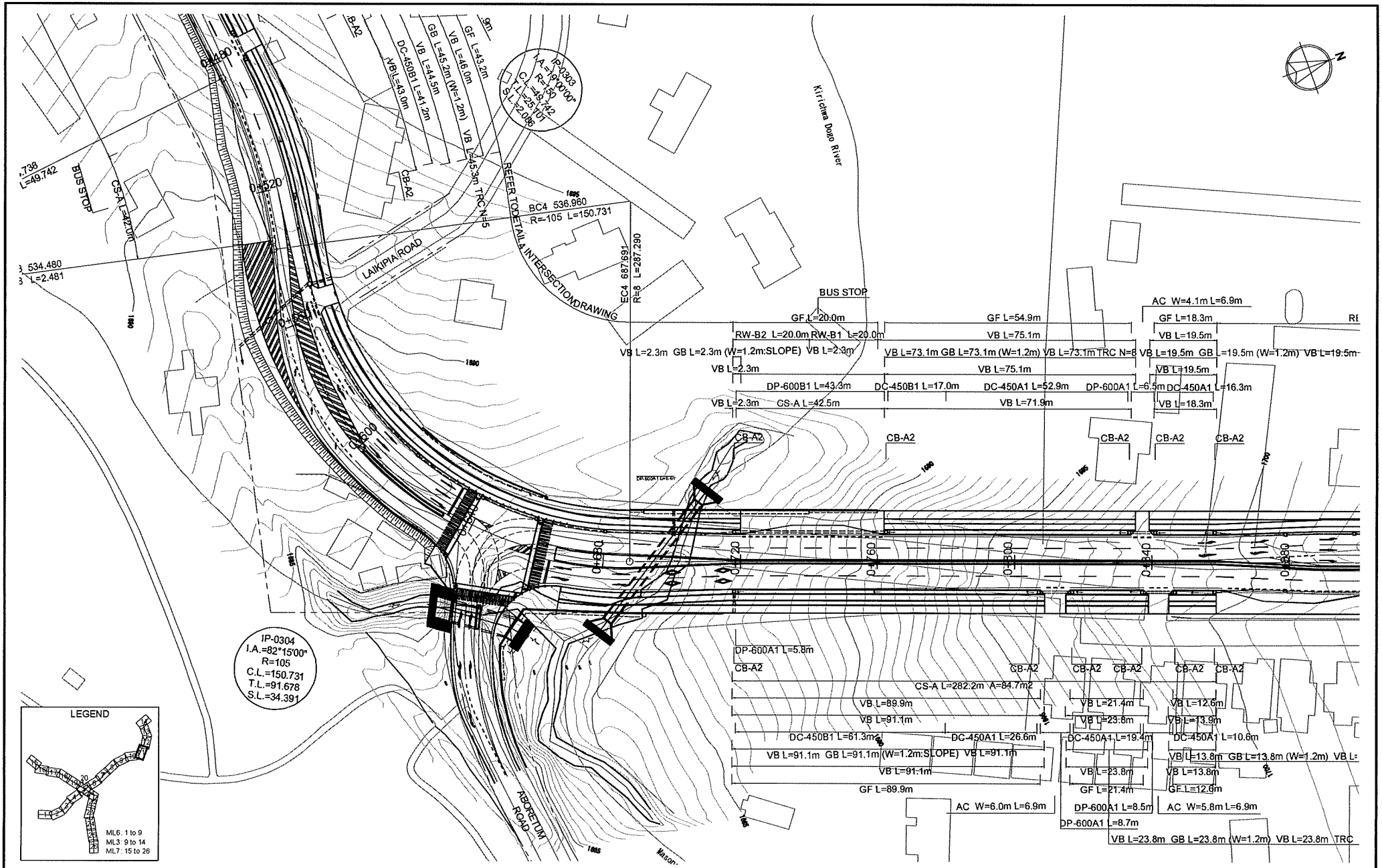
KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN STA. 2+360 to STA. 2+720	Drawing No.	PL-8
				SCALE	1/1000
				DATE	AUG. 2009

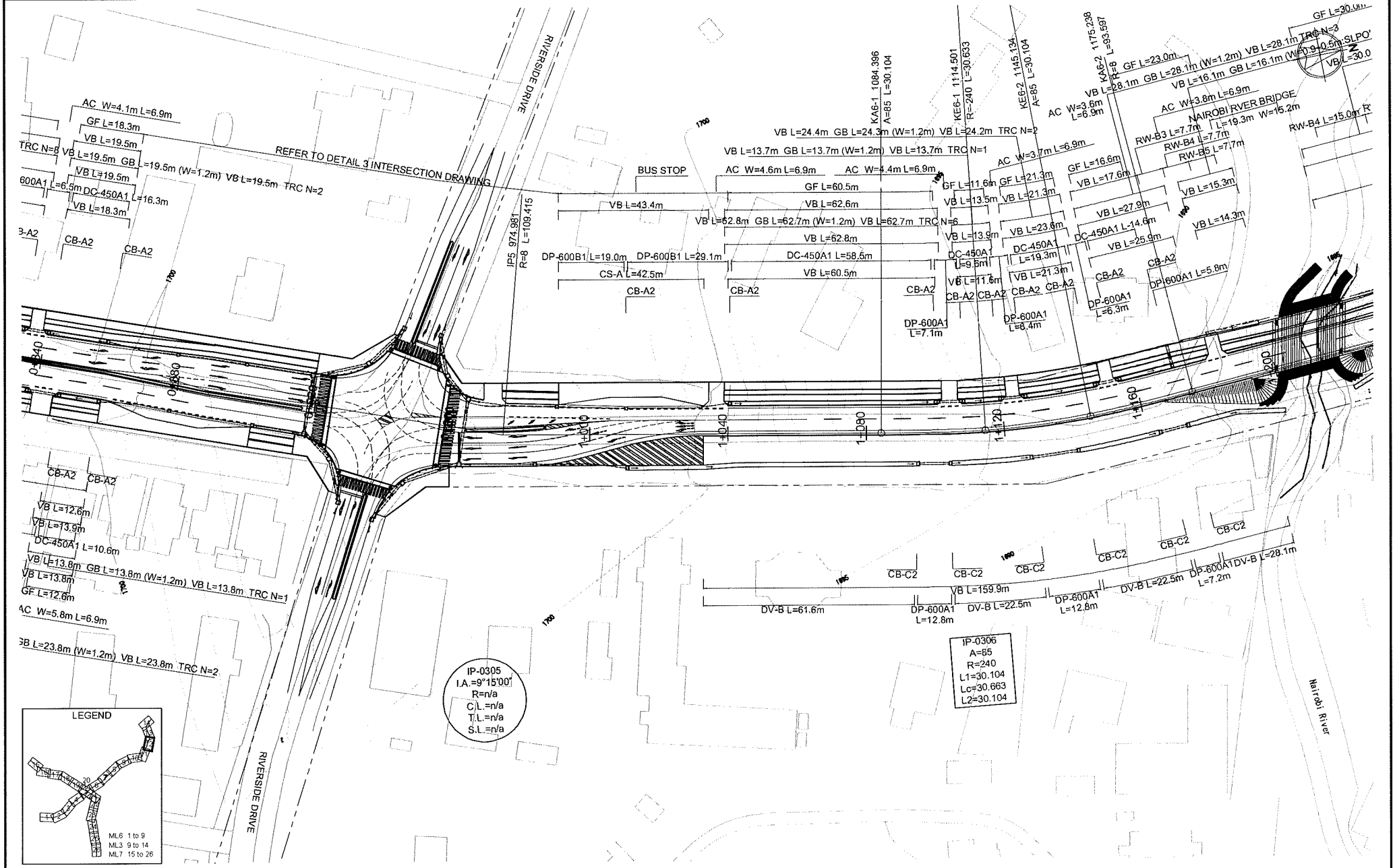


KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML6 PLAN / ML3 PLAN ML6: STA. 2+720 to STA. 2+864(END) ML3: STA. 0+000 to STA. 0+200	Drawing No.	PL-9
				SCALE	1/1000
				DATE	AUG. 2009

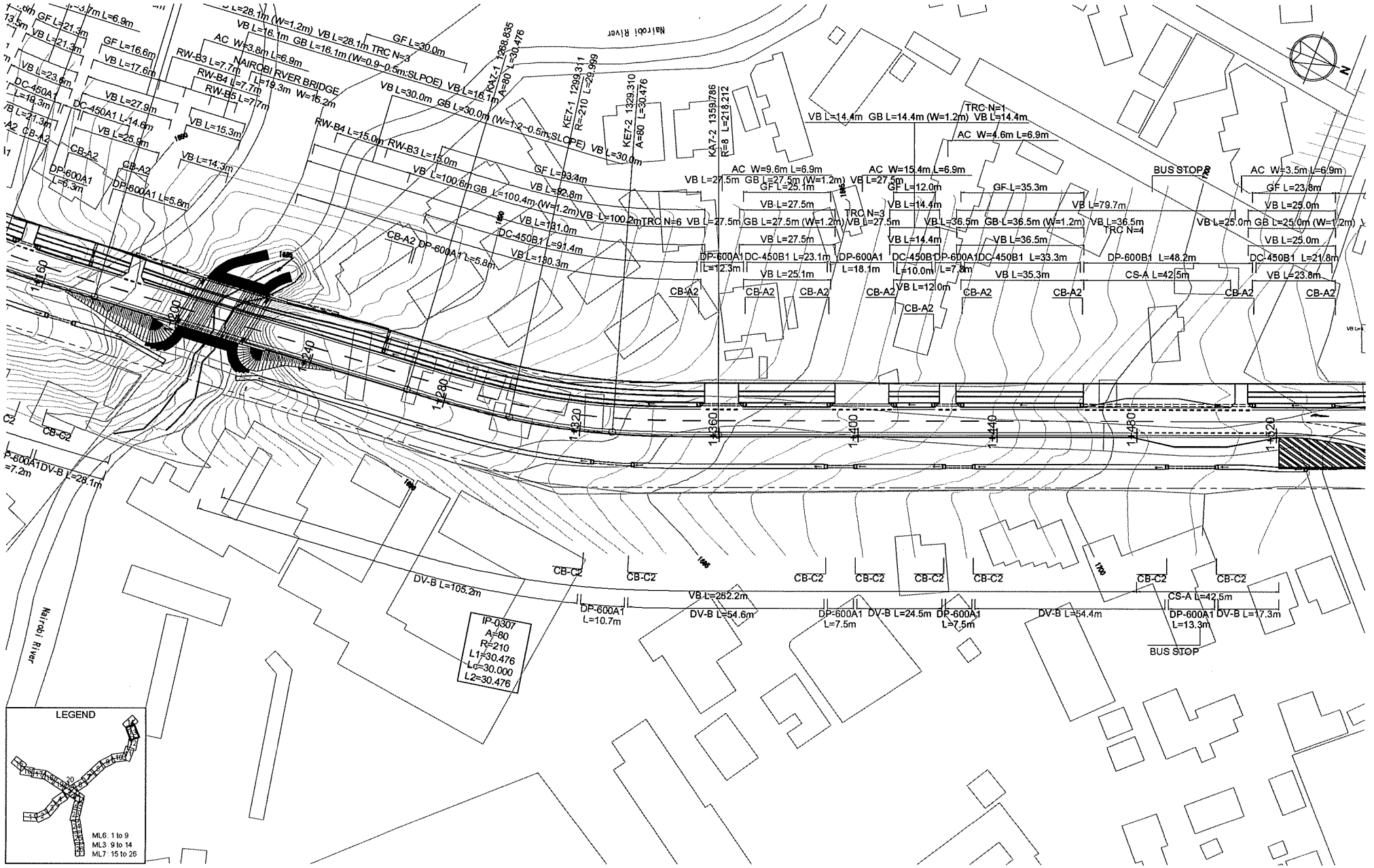


KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML3 PLAN STA. 0+200 to STA. 0+520	Drawing No.	PL-10
				SCALE	1/1000
				DATE	AUG. 2009

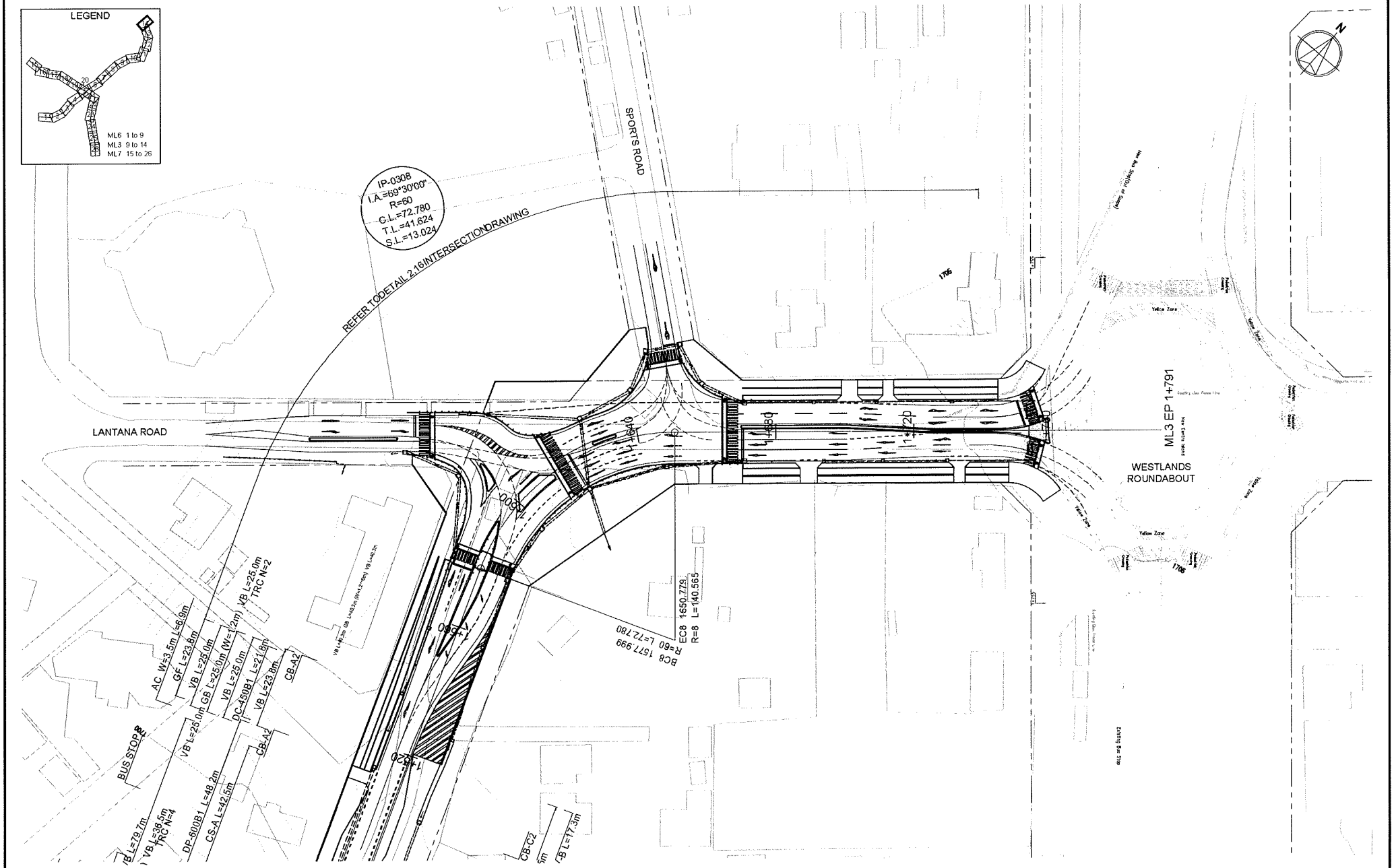

BUS STOP
LAIKIPIA ROAD
REFER TO DETAILED INTERSECTION DRAWING
Kirichwa Dogo River
ABERDTUM ROAD
IP-0304
I.A.=82°15'00"
R=105
C.L.=150.731
T.L.=91.678
S.L.=34.391
IP-0303
I.A.=19°00'00"
R=250
C.L.=46.142
T.L.=23.707
S.L.=2.086
BC4 536.960
R=-105 L=150.731
EC4 687.691
R=8 L=287.290
LEGEND
ML6: 1 to 9
ML3: 9 to 14
ML7: 15 to 26
KENYA URBAN ROAD AUTHORITY
CITY COUNCIL OF NAIROBI
MINISTRY OF LOCAL GOVERNMENT
MINISTRY OF ROADS
JAPAN INTERNATIONAL
COOPERATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL
THE PREPARATORY SURVEY ON
THE PROJECT FOR
THE CONSTRUCTION OF
NAIROBI WESTERN RING ROADS
TITLE :
ML3 PLAN
STA. 0+520 to STA. 0+880
Drawing No. PL-11
SCALE 1/1000
DATE AUG. 2009



KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML3 PLAN STA. 0+880 to STA. 1+200	Drawing No.	PL-12
				SCALE	1/1000
				DATE	AUG. 2009



KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML3 PLAN STA. 1+200 to STA. 1+520	Drawing No.	PL-13
				SCALE	1/1000
				DATE	AUG. 2009



KENYA URBAN ROAD AUTHORITY CITY COUNCIL OF NAIROBI MINISTRY OF LOCAL GOVERNMENT MINISTRY OF ROADS	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE CONSTRUCTION OF NAIROBI WESTERN RING ROADS	TITLE : ML3 PLAN STA. 1+520 to STA. 1+760(END)	Drawing No.	PL-14
				SCALE	1/1000
				DATE	AUG. 2009