THE REPUBLIC OF MALAWI
THE MINISTRY OF TRANSPORT AND PUBLIC WORKS

THE REPUBLIC OF MALAWI

THE PREPARATORY SURVEY REPORT FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE

JUNE 2019

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

KATAHIRA & ENGINEERS INTERNATIONAL

EI
JR
19-081

THE REPUBLIC OF MALAWI
THE MINISTRY OF TRANSPORT AND PUBLIC WORKS

THE REPUBLIC OF MALAWI

THE PREPARATORY SURVEY REPORT FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE

JUNE 2019

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

KATAHIRA & ENGINEERS INTERNATIONAL

Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Katahira & Engineers International.

The survey team held a series of discussions with the officials concerned of the Government of the Republic of Malawi, and conducted a field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Malawi for their close cooperation extended to the survey team.

June, 2019

Itsu Adachi
Director General,
Infrastructure and Peacebuilding Department
Japan International Cooperation Agency

Summary

1. Project Background

Lilongwe City—the capital of Malawi and the survey area for the project—has struggled to provide sufficient infrastructure in response to increasing demands amid urban sprawl derived from population growth. Since the national land use plan has yet to be revised since its proclamation in 1986, in addition, a discrepancy between its plan and development conditions came into existence, which makes it imperative to set forth a development plan to carry out appropriate urban development.

Against this backdrop, the Government of Malawi called upon the Government of Japan to assist in the preparation of the Study on Urban Development Master Plan for Lilongwe in the Republic of Malawi (hereinafter referred to as the master plan). In response, the Japan International Cooperation Agency (JICA) implemented the relevant study from 2009 to 2010, thereby coming up with the master plan.

Based on the results of the master plan, Malawi officially requested Japan in 2010 to provide its assistance for a high-priority project aimed at relieving traffic congestion in Lilongwe. The thrust of the request was to widen a total length of 11-kilometer National Road No. 1 (M1 Road) and access roads. In 2011, accordingly, JICA implemented the Preparatory Survey on the Project for the Improvement of Major Roads in the City of Lilongwe (hereinafter referred to as the Preliminary Survey), revising details of the request as shown below.

1) Original Request (March 2010)

1st Priority

- Widening of M1 Road from Mchinji Roundabout to Kawale South/Community Center Junction: L = 4.6 kilometers (km), W = 25.5 meters (m)
- Widening and improvement of Murray Road (urban road): L = 1.08 km, W = 21/26 m
- Improvement of Kenyatta Road (urban road) from the junction of M1 Road to the junction of Murray Road: L = 0.23 km, W = 12.5 m
- Installation of traffic signal facilities, 18 signals (including signal equipment controlling four signals)
- Construction of a bridge along the existing Lilongwe River Bridge on M1 Road: L = 75 m (3 spans x 25 m), a height from river: H = 8m

2nd Priority

- Widening of M1 Road from Area 18 Roundabout to Mchinji Roundabout: L = 3.9 km, W = 25.5 m
- Widening of M1 Road from Kawale South/Community Canter Junction to Chidzanja Junction: L = l.9 km, W = 25.5 m
- Construction of a bridge along the existing Lilongwe River Bridge on M1 Road: L = 45 m (3 spans x 15 m), a height from river: H = 8 m

2) Minutes for the Preliminary Survey (July 2011)

- Widening of M1 Road ranging from Mchinji Roundabout to Chidzanja Junction: L = 6.5 km, W = 25.5 m
- Installation of traffic signal facilities at junctions in need
- Construction of a bridge in parallel with the existing Lilongwe River Bridge proximate to Old Market: L = 75 m (3 spas x 25 m)

2. Outline of Survey Results and Contents of This Project

JICA dispatched the preparatory survey team to the Republic of Malawi for the execution of outline design for Improvement M1 Road. The 1st field survey is from 21 October to 9 December 2017, the 2nd field survey is from 22 January to 14 February 2018 and the 3rd field survey is from 11 to 17 November 2018. During the field surveys, the team conducted the discussions with the respective

Republic of Malawi officials and the site survey of the project. The team carried out the outline design for the appropriate contents of the Project based on the results of the field surveys and prepared the draft report of the survey.

JICA dispatched the team to the Republic of Malawi from 7 to 17 May 2019 for the explanation of the draft report and the team had discussions, confirmation and agreement regarding the contents of the draft report.

The finally agreed contents of the Project are shown below.

- Four-lane widening between Sunbird Lilongwe Hotel Junction and Lubani Junction (L = 2.75 km)
- Improvement of 7 intersections

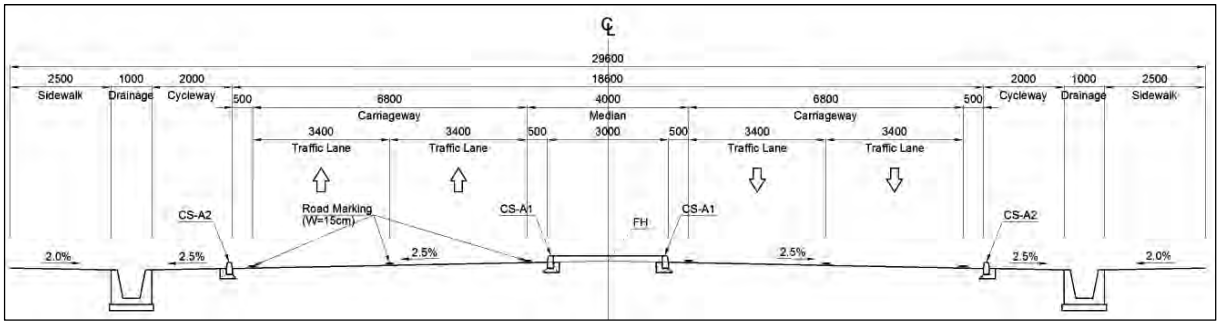
Major components of the project are shown in below.

Table 1 Major Components of the Project

Project Component	Specification
Four-lane Widening of the Existing Road	L=2.75 km (Sunbird Lilongwe Hotel Junction to Lubani Junction)
Reconstruction of the Lilongwe River Bridge (including demolition of the existing bridge)	Existing bridge: W=10.5 m, L=75.0 m, New bridge: W=34.7 m, L=78.0 m
Intersection Improvement	7 intersections
Street Light Installation	144 units
Traffic Signal Installation	For vehicle 122 signal, for pedestrian 78 signal
Crosswalk Installation	40 locations
Installation of Pedestrian Fencing on the Median Strip	L=1,332 m

The typical cross sections for non-built-up areas and built-up areas are shown in Figure 1.

【Non-built-up Area】



【Built-up Area】

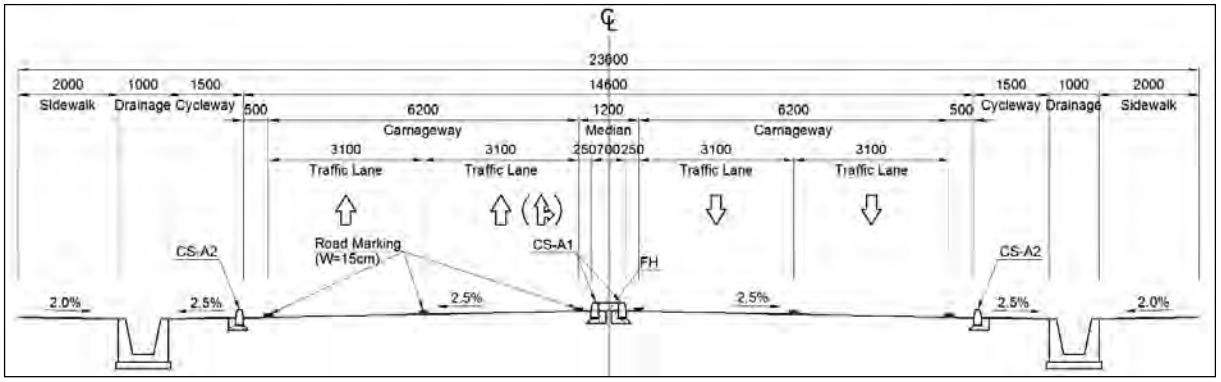


Figure 1 Typical Cross Section

The outline of project components are shown in below.

Table 2 Outline of Components

Descriptions		Specification	
Scope of Project		Total Length 2.750 km (STA. 1+200 ~ 3+950)	
Typical Cross Section		Non-built-up Area (STA. 2+370 ~ 2+680)	Built-up Area (Other Sections)
		• Total width:29.600m • Carriageway:3.400m×4 • Cycleway:2.000m • Median:4.000m • Shoulder:0.500m • Sidewalk:2.500m	• Total width:23.600m • Carriageway:3.100m×4 • Cycleway:1.500m • Median:1.200m • Shoulder:0.500m • Sidewalk:2.000m
Pavement Structure	Surface Course Binder Course	• Carriageway: Asphalt Concrete Surface Course (50mm) Asphalt Concrete Binder Course (50mm) • Sidewalk: Inter Locking Block (60mm)	
	Base Couse	Sta.1+200.000 ~ Sta.1+840.000 • Carriageway: Base Course Mechanical Stabilized (150mm) Sub-base Course Crusher-run (250mm) Sta.1+840.000 ~ Sta.3+950.000 • Carriageway: Base Course Mechanical Stabilized (200mm) Sub-base Course Crusher-run (300mm) • Sidewalk: Sand (20mm), Crusher-run (100mm)	
Road Drainage Facility		• U-Type Drainage (Bottom width 300~1200mm) • Transverse Drainage RC Pipe (Diameter φ600mm, φ900mm)	
Road Ancillary Facility		• Traffic Signal • Road Marking • Crosswalk • Pedestrian Fencing • Bus Stop • Guard Post • Street Lights • Post Cone・Stud	
Bridge		• Three-span Continuous PC T-type Girder Bridge L=78.000m	
Revetment		• Mat Gabion	

3. Project Period and Estimated Project Cost

If the project is implemented by Japanese grant aid, a total of 13.0 months and 41.0 months will be required respectively for the project design and construction. The project cost borne by the Government of Malawi is estimated at USD 3.19 million.

4. Project Evaluation

(1) Relevance

The followings explain the relevance of the project implemented under Japanese grant aid.

1. The project aimed at traffic decongestion in the center of Lilongwe City, Malawi's capital is expected to alleviate traffic congestion and establish high-quality infrastructure which contributes the city's economic activities. In addition, the project is foreseen to improve the Nakara Corridor, or the regional economic corridor of the landlocked country. The project also corresponds to the thrust of Japanese policy towards Malawi and the sixth Tokyo International Conference on African Development (TICAD VI).
2. In response to increasing traffic volumes in line with population growth in Malawi, the improvement of the M1 Road will contribute to achieving sustainable economic growth and Goal 11 of the United Nations' Sustainable Development Goals (SDGs).
3. The project is designed to mainly improve the M1 Road which connects states and counties in Malawi and serves as a main route to neighboring countries such as Zambia, Tanzania and Mozambique, making it possible to materialize the transport and ICT infrastructure strategy of the Malawi Growth and Development Strategy (MGDS) III (2017-2022) proclaimed by the Government of Malawi in 2017.

(2) Effectiveness

The project is predicted to produce the following effects.

1. Quantitative Effects

Quantitative Effects

Indicator	Baseline Value (performance in 2018)	Target Value as of 2027 (three years after project completion)
Number of passengers (person/day)	86,000	133,000
Traffic volume (vehicle/day)	26,000	41,000
Volume capacity ratio (VCR)	1.63	0.93

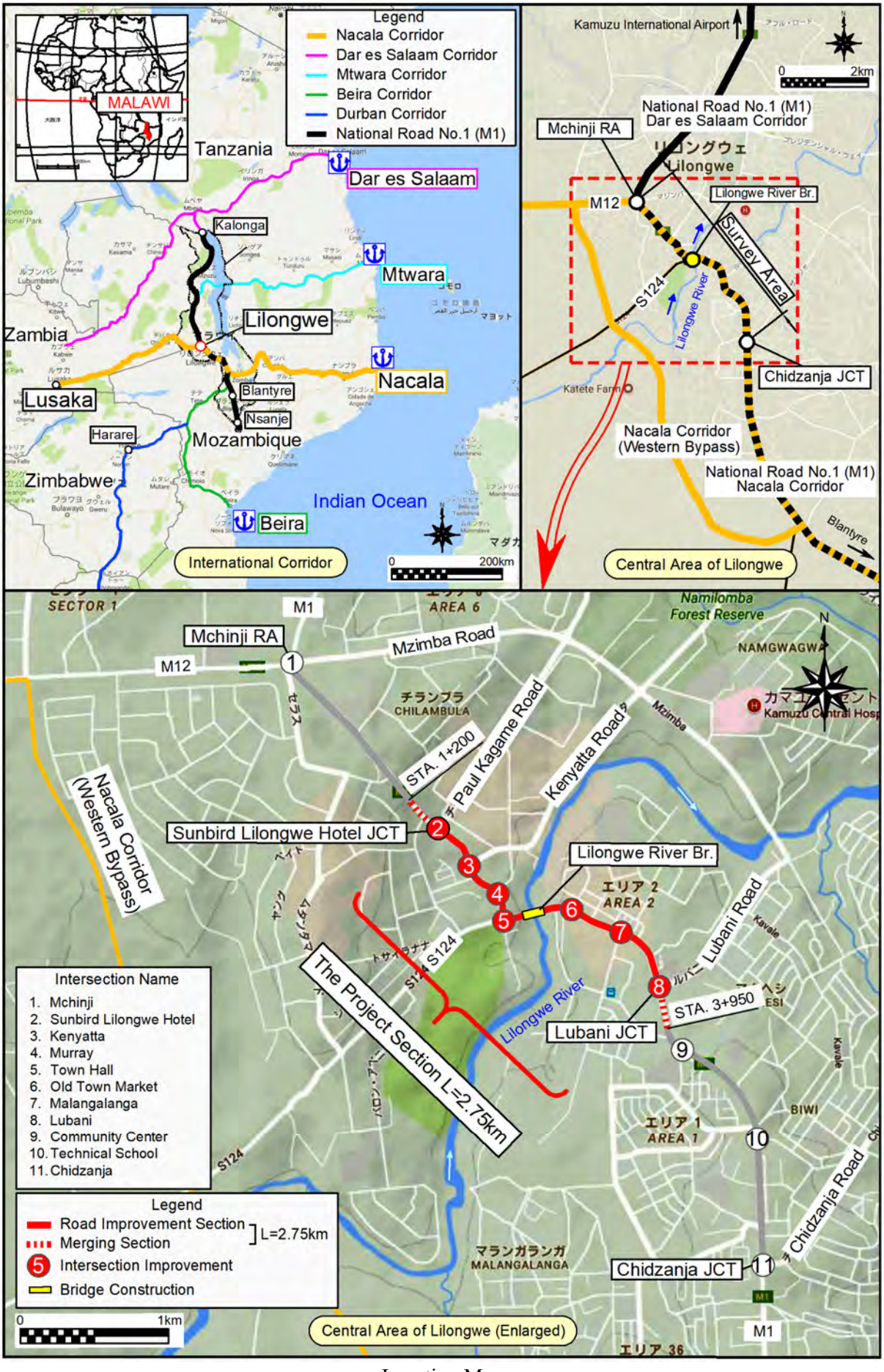
Note: The indicators above present values measured at the Lilongwe River Bridge.

2. Qualitative Effects

- A smooth and stable traffic network can be secured along the project alignment.
- Residents can enjoy improved access to social services, e.g., medical and educational services.
- Traffic decongestion and a clear separation between a carriageway and a sidewalk can curb traffic accidents.

Contents

Appendices



Location Map

Perspective (Town Hall Intersection : STA. 2+340)

Perspective (Lilongwe River Bridge : STA. 2+690)

Perspective (In front of the Mosque : STA. 3+050)

List of Figures, Tables & Photos

Figures

Tables

Photos

List of Abbreviations

Abbreviation	Full Form
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
AfDB	The African Development Bank
ASJ RTN-Model	ASJ Prediction Model For Road Traffic Noise
ARAP	Abbreviated Resettlement Action Plan
BOD	Biochemical Oxygen Demand
CBR	California Bearing Ratio
CCAP	Church of Central Africa Presbyterian
Cl	Chlorine
Ca	Calcium
CBR	California Bearing Ratio
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
dBA	Decibel (A-Weighted)
DBST	Double Bituminous Surface Treatment
DO	Dissolved Oxygen
EAD	Environmental Affairs Department
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EIB	The European Investment Bank
EMA	Environmental Management Act
ESAL	Equivalent Single Axle Load
ESIA	Environmental and Social Impact Assessment
EU	The European Union
F	Fluorine
FC	Fecal Coliform
FMB	First Merchant Bank
GDP	Gross Domestic Product
GRC	Grievance Redress Committee
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HWL	High Water Level
ICT	Information and Communication Technology
ILO	International Labour Organization
IMF	International Monetary Fund
IUCN	International Union For Conservation of Nature
JCT	Junction
JICA	Japan International Cooperation Agency
JRA	Japan Road Association
K	Kalium
KPA	Key Priority Area
LAB	Local Action For Biodiversity
LAeq	Equivalent Sound Level
LCC	Lilongwe City Council
LED	Light Emitting Diode
LSVA	Lilongwe Street Vendors Association

Abbreviation	Full Form
LWB	The Lilongwe Water Board
MBS	The Malawi Bureau of Standards
Mg	Magnesium
MGDS III	Malawi Growth and Development Strategy III
MoTPW	The Ministry of Transport and Public Works
MLHUD	The Ministry of Lands, Housing and Urban Development
MR	Resilient Modulus
MULHUD	Ministry of Lands, Housing and Urban Development
MW	Megawatts
MWK	Malawian Kwacha
Na	Natrium
NO_2	Nitrogen Dioxide
O_3	Ozone
ODA	Official Development Assistance
PAPs	Project Affected Persons
Pb	Plumbum
PC	Pre-Stressed Concrete
PCU	Passenger Car Unit
pH	Power of Hydrogen Ions
PM	Particulate Matter
PSI	Present Serviceability Index
PWL	Power Level
RA	The Roads Authority
RAP	Resettlement Action Plan
RC	Reinforced Concrete Construction
ROW	The Right of Way
SADC	Southern African Development Community
SATCC	Southern Africa Transport and Communications Commission
SDGs	Sustainable Development Goals
SIM	Subscriber Identity Module Card
SN	Structural Number
SO_2	Sulfur Dioxide
SO_4	Sulphate
SPM	Suspended Particulate Matter
SS	Suspended Solid
STA	Station
SATCC	Southern Africa Transport and Communications Commission
TDS	Total Dissolved Solid
TICAD	Tokyo International Conference On African Development
TOR	The Terms of Reference
UNAIDS	Joint United Nations Programme On HIV and AIDS
USD	United States Dollar
VCR	Volume Capacity Ratio
VU	Vulnerable
WB	World Bank
WHO	World Health Organization
ZA	Zirconium

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Project Background

Lilongwe City—the capital of Malawi and the survey area for the project—has struggled to provide sufficient infrastructure in response to increasing demands amid urban sprawl derived from population growth. Since the national land use plan has yet to be revised since its proclamation in 1986, in addition, a discrepancy between its plan and development conditions came into existence, which makes it imperative to set forth a development plan to carry out appropriate urban development.

Against this backdrop, the Government of Malawi called upon the Government of Japan to assist in the preparation of the Study on Urban Development Master Plan for Lilongwe in the Republic of Malawi (hereinafter referred to as the master plan). In response, the Japan International Cooperation Agency (JICA) implemented the relevant study from 2009 to 2010, thereby coming up with the master plan.

Based on the results of the master plan, Malawi officially requested Japan in 2010 to provide its assistance for a high-priority project aimed at relieving traffic congestion in Lilongwe. The thrust of the request was to widen a total length of 11-kilometer National Road No. 1 (M1 Road) and access roads. In 2011, accordingly, JICA implemented the Preparatory Survey on the Project for the Improvement of Major Roads in the City of Lilongwe (hereinafter referred to as the Preliminary Survey), revising details of the request as shown below.

1) Original Request (March 2010)

1st Priority

- Widening of M1 Road from Mchinji Roundabout to Kawale South/Community Center Junction: L = 4.6 kilometers (km), W = 25.5 meters (m)
- Widening and improvement of Murray Road (urban road): L = 1.08 km, W = 21/26 m
- Improvement of Kenyatta Road (urban road) from the junction of M1 Road to the junction of Murray Road: L = 0.23 km, W = 12.5 m
- Construction of traffic signal facilities, 18 signals (including signal equipment controlling four signals)
- Construction of a bridge along the existing Lilongwe River Bridge on M1 Road: L = 75 m (3 spans x 25 m), a height from river: H = 8m

2nd Priority

- Widening of M1 Road from Area 18 Roundabout to Mchinji Roundabout: L = 3.9 km, W = 25.5 m
- Widening of M1 Road from Kawale South/Community Canter Junction to Chidzanja Junction: L = l.9 km, W = 25.5 m
- Construction of a bridge along the existing Lilongwe River Bridge on M1 Road: L = 45 m (3 spans x 15 m), a height from river: H = 8 m

2) Minutes for the Preliminary Survey (July 2011)

- Widening of M1 Road ranging from Mchinji Roundabout to Chidzanja Junction: L = 6.5 km, W = 25.5 m
- Installation of traffic signal facilities at junctions in need
- Construction of a bridge in parallel with the existing Lilongwe River Bridge proximate to Old Market: L = 75 m (3 spas x 25 m)

In the subsequent survey titled “The Preparatory Survey for the Project of Major Roads in the City of Lilongwe (hereinafter referred to as the Survey)”, the necessity and relevance of the proposed project—which has yet to be implemented more than six years since the bilateral agreement— were verified, and its plan was reviewed as a grant aid project. Also, a design was outlined, and project

costs were estimated through the Survey. Considering current conditions and challenges of the project road, environmental and social conditions and future traffic demands, the following project scope was determined in a way to maximize project benefits and lift a burden from Malawi.

Agreed Project Scope (October 2018)

- Widening of M1 Road to four lanes ranging from the M1 junction with Paul Kagame Road at Sunbird Lilongwe Hotel to the M1 junction with Lubani Road at Lilongwe CCAP: L = 2.75 km (including reconstruction of the Lilongwe River Bridge)
- Improvement of seven major junctions

Note: Details are presented in 2-1-2 Project Outline and 2-2-1-1 Scope of the Project.

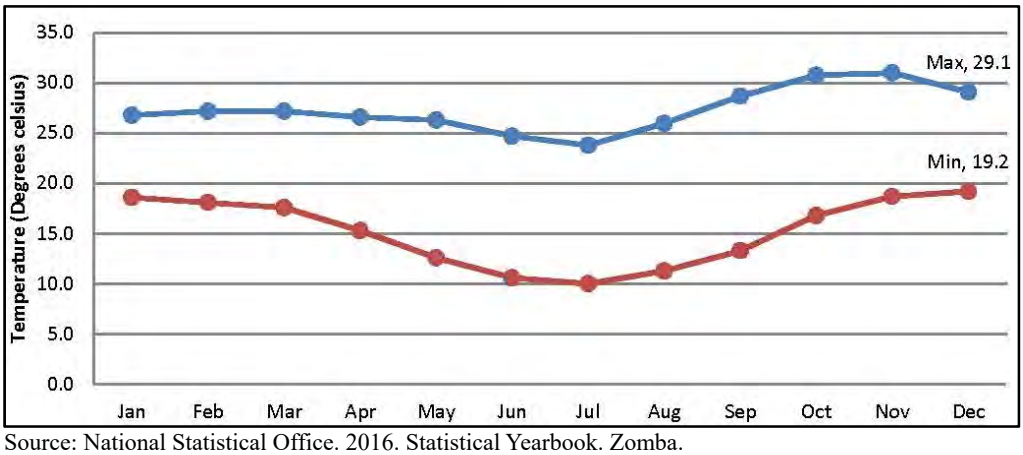
1-2 Natural Conditions

(1) Location and Climate Condition of the Project Site

The Republic of Malawi is a landlocked country whose land amounts to 94,000 square kilometers (km^2) and water 24,000 km^2 (predominantly Lake Malawi). The country shares its border with Mozambique, Tanzania, and Zambia. As the project area, Lilongwe is located at the center of Malawi and extends as big as 393 km^2.

When it comes to climate, Malawi falls into the subtropical category and features a rainy season between November and May and a dry season for the rest of the year. The annual rainfall highly varies across the nation and from year to year. While the average annual precipitation in Kasungu District located in the west of Malawi hovers around 897 millimeters (mm) from 2000 to 2001, for example, that of Mulanje District in the southeast region exceeds 2,000 mm. During the same period, it was by and large dry and featured droughts across the nation.

The maximum temperature reaches 32 degrees Celsius (°C) around October, but the temperature soars up in lowlands such as Shire Valley. When the temperature plunges the most, the temperature stands at around 24 °C at maximum and 10 °C at minimum.



Source: National Statistical Office. 2016. Statistical Yearbook. Zomba.

Figure 1-2-1 Average Monthly Maximum and Minimum Temperatures in Lilongwe

(2) Topography and Geography

Topographically, Malawi's territory is mostly located in the high lands. As for Lilongwe, its land lies on a relatively flat land with an altitude from 1,000 to 1,200 m above sea level. Soil type in Lilongwe city is mainly Lixisos which is clay soil developed in intensive tropical weathering conditions and sub-humid to semi-arid climate.

(3) Hydrology

Not only the Lilongwe River crossing the project site but also three other rivers, i.e., Lingadzi, Nankhaka, and Chankhandwe run through Lilongwe City. In particular, the Lilongwe River, the biggest among the four rivers, serves as a main water resource to supply water to 80% of districts in Lilongwe by means of the Lilongwe Water Board (LWB). Water is taken upstream of the project road.

In addition, wetlands, dubbed *Dambo* are found in Lilongwe just as in the central, southern, and eastern Africa. In particular, Lilongwe has large wetlands in the northeast part. These wetlands not only retain rich biodiversity but also play an important role in flood control and water purification.

(4) Natural Parks, Natural Reserves, and Other Protected Areas

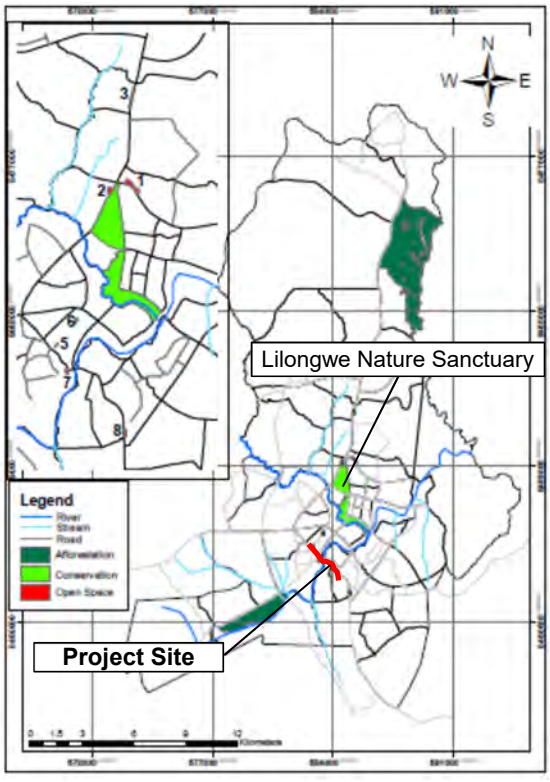
With a view to conserving natural environment and rare species, the National Parks and Wildlife Act in Malawi designates "National Parks" and "Wildlife Reserves" and restricts any act to give impacts on the environment. The reserved areas are scattered all over the country but are not located near the project site.

However, a sanctuary called the Lilongwe Nature Sanctuary is situated in Lilongwe. The sanctuary is designed to run an environment education and recreation facility and secures biodiversity in an area of over 137 hectares (ha). It is open to the public and utilized as a natural observation facility. Also, the sanctuary accommodates rare species including endangered species and is attached with the Wild Center, which is built to cure injured wild animals.

Considering that the sanctuary is located 2 to 3 km northeast from the project site, the project is not expected to give negative impacts on the sanctuary.

Source: Africaguide, www.africaguide.com.

Figure 1-2-2 Malawi's Natural Parks and Wildlife Reserves



Source: City of Lilongwe Biodiversity Report 2013, LAB

Figure 1-2-3 Lilongwe Nature Sanctuary

1-3 Environmental and Social Considerations

1-3-1 Environmental Impact Assessment

1-3-1-1 Project Components which Affect Environmental and Social Considerations

The project is designed to improve an arterial road in Lilongwe City, the capital of Malawi and thereby expected to contribute to strengthening the city's transport capacity and revitalizing its socio-economic activities. The major scope of the project is presented in Table 1-3-1.

Table 1-3-1 Major Scope of the Project

Project Component	Specification
Four-lane Widening of the Existing Road	L=2.75 km (Sunbird Lilongwe Hotel Junction to Lubani Junction)
Reconstruction of the Lilongwe River Bridge (including demolition of the existing bridge)	Existing bridge: W=10.5 m, L=75.0 m、 New bridge: W=34.7 m, L=78.0 m
Intersection Improvement	7 intersections
Street Light Installation	144 units
Traffic Signal Installation	For vehicle 122 signal, for pedestrian 78 signal
Crosswalk Installation	40 locations
Installation of Pedestrian Fencing on the Median Strip	L=1,332 m

The project site is described in Figure 1-3-1. Study items for environmental and social considerations include not only the major scope of the project above but also installation of a temporary road (L=279m) and bridge for detour (L=80m), and facilities needed for construction, e.g., borrow pits, quarry sites, and waste disposal sites.

Road construction and operation may give rise to negative environmental and social impacts and require land acquisition and involuntary resettlement. As of now, on the other hand, derivative, secondary, and cumulative impacts are not expected to occur.

Because the project is an improvement project of an existing road, significant negative impacts against environment is not expected. And the project requires small scale land acquisition and negative impacts against some vendors but does not require a large scale involuntary resettlement. Therefore the project is fallen into category B of the JICA Guidelines for environment and social considerations.

Figure 1-3-1 Project Site

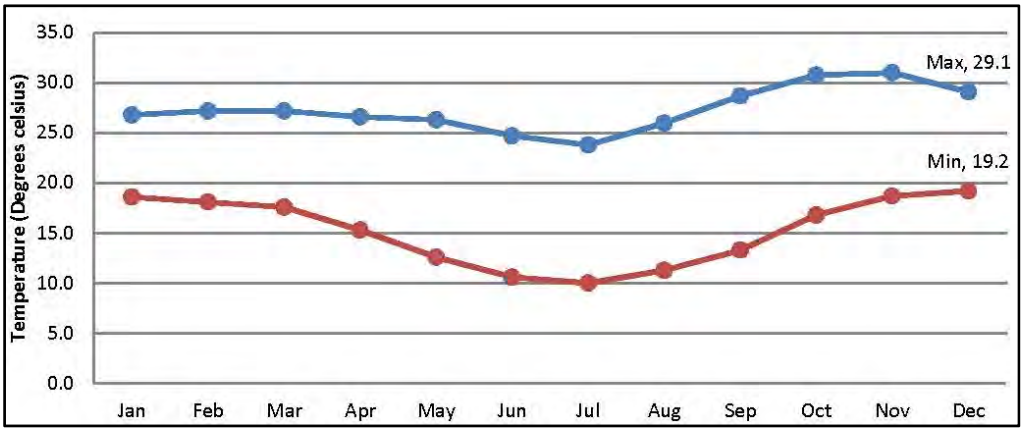
1-3-1-2 Outlines of Environmental and Social Conditions

(1) Location and Climate Condition of the Project Site

The Republic of Malawi is a landlocked country whose land amounts to 94,000 square kilometers (km^2) and water 24,000 km^2 (predominantly Lake Malawi). The country shares its border with Mozambique, Tanzania, and Zambia. As the project area, Lilongwe is located at the center of Malawi and extends as big as 393 km^2.

When it comes to climate, Malawi falls into the subtropical category and features a rainy season between November and May and a dry season for the rest of the year. The annual rainfall highly varies across the nation and from year to year. While the average annual precipitation in Kasungu District located in the west of Malawi hovers around 897 millimeters (mm) from 2000 to 2001, for example, that of Mulanje District in the southeast region exceeds 2,000 mm. During the same period, it was by and large dry and featured droughts across the nation.

The maximum temperature reaches 32 degrees Celsius (°C) around October, but the temperature soars up in lowlands such as Shire Valley. When the temperature plunges the most, the temperature stands at around 24 °C at maximum and 10 °C at minimum.



Source: National Statistical Office. 2016. Statistical Yearbook. Zomba.

Figure 1-3-2 Average Monthly Maximum and Minimum Temperatures in Lilongwe

(2) Topography and Geography

Topographically, Malawi's territory is mostly located in the high lands. As for Lilongwe, its land lies on a relatively flat land with an altitude from 1,000 to 1,200 m above sea level. Soil type in Lilongwe city is mainly Lixisos which is clay soil developed in intensive tropical weathering conditions and sub-humid to semi-arid climate.

(3) Hydrology

Not only the Lilongwe River crossing the project site but also three other rivers, i.e., Lingadzi, Nankhaka, and Chankhandwe run through Lilongwe City. In particular, the Lilongwe River, the biggest among the four rivers, serves as a main water resource to supply water to 80% of districts in Lilongwe by means of the Lilongwe Water Board (LWB). Water is taken upstream of the project road.

In addition, wetlands, dubbed *Dambo* are found in Lilongwe just as in the central, southern, and eastern Africa. In particular, Lilongwe has large wetlands in the northeast part. These wetlands not only retain rich biodiversity but also play an important role in flood control and water purification.

(4) Natural Parks, Natural Reserves, and Other Protected Areas

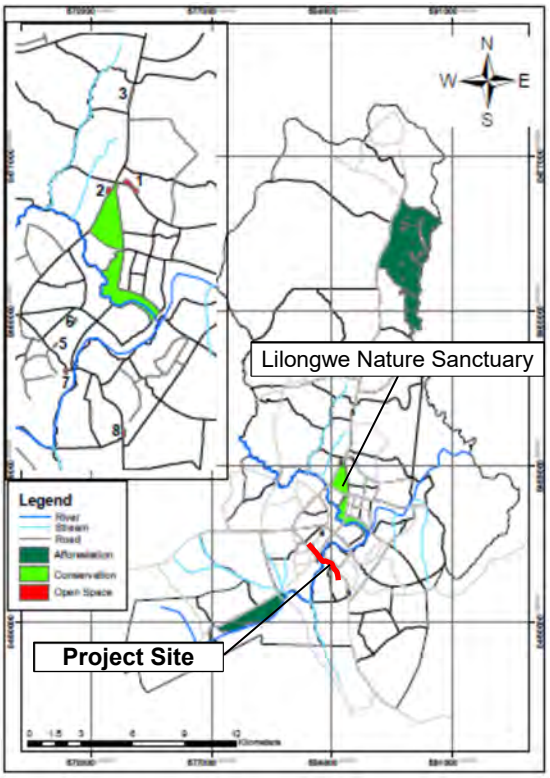
With a view to conserving natural environment and rare species, the National Parks and Wildlife Act in Malawi designates “National Parks” and “Wildlife Reserves” and restricts any act to give impacts on the environment. The reserved areas are scattered all over the country but are not located near the project site.

However, a sanctuary called the Lilongwe Nature Sanctuary is situated in Lilongwe. The sanctuary is designed to run an environment education and recreation facility and secures biodiversity in an area of over 137 hectares (ha). It is open to the public and utilized as a natural observation facility. Also, the sanctuary accommodates rare species including endangered species and is attached with the Wild Center, which is built to cure injured wild animals.

Considering that the sanctuary is located 2 to 3 km northeast from the project site, the project is not expected to give negative impacts on the sanctuary.

Source: Africaguide, www.africaguide.com.

Figure 1-3-3 Malawi's Natural Parks and Wildlife Reserves



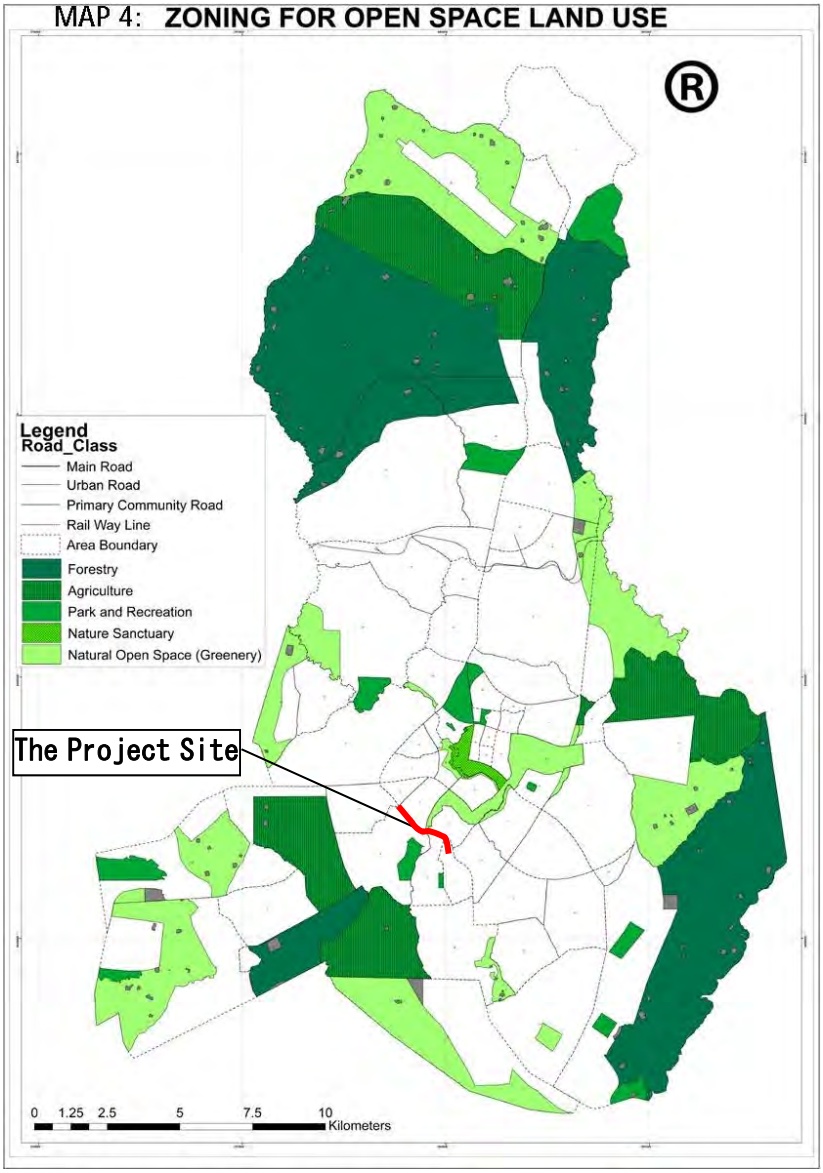
Source: City of Lilongwe Biodiversity Report 2013, LAB

Figure 1-3-4 Lilongwe Nature Sanctuary

(5) Ecosystem

1) Ecosystem

Lilongwe features Savanna grassland and Miombo woodlands. Vegetation including forests, green spaces, and agricultural lands is spotted in the north, east and southwest peripheral areas of the city. Since surrounding areas of the project site are already developed due to urbanization, vegetation is barely found.



Source: Local Action for Biodiversity. 2013. *LAB Biodiversity Report: City of Lilongwe*. Lilongwe.

Figure 1-3-5 Vegetation in Lilongwe

2) Endangered Species

As shown in Chapter 1-3-1-2 (4), Pangolin (*Manis temminckii)* and Red Mahogany *(Khaya anthotheca)* which are found in the Lilongwe Nature Sanctuary are classified into "Endangered" and "Vulnerable" according to the criteria of the IUCN Red List of Threatened Species.

(6) Cultural Heritage

The Old District Office, which is located in the south of the Town Hall (near STA2+400) and built in 1940, is considered a historically important building in the city. Because the project is planned to avoid the Old District Office, the project will not cause direct impacts including demolition. Moreover, construction work also will not affect because works which give large vibration is not used; the construction is temporally work; and the Old District Office and the construction site is separated more or less. In case that some problems happen during the construction, contractors, consultants and the project proponents (Road Authority) will consult and implement appropriate measures such as adopting of alternative construction methods.

Photo 1-3-1 Old District Office in the South of Town Hall

(7) Pollution Control

The Malawi Bureau of Standards (MBS), which is in charge of the establishment of domestic standards for pollution control, has set standards for air quality, water quality (drinking water), and noise. Since Malawi's standards are generally same as international levels.

1) Air Quality

Malawi's air quality standards in place are presented inTable 1-3-2. For particulate matters, Malawi has stricter standards than WHO Guidelines. Standards of the other pollutants is higher values than international standards. In addition to environmental standards for air quality, standards for emissions from automobiles and plants are enacted.

Table 1-3-2 Air Quality Standards of Malawi and WHO Guidelines

Pollutant	Unit	Averaging Period	Malawi's Standards	WHO Guidelines
Suspended PM (SPM)	$\mu g/m^3$	Annual	0.5	-
Coarse Particulate Matter (PM_{10})	$\mu g/m^3$	24 hours	25	$50\mu g/m^3$
Fine Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	Annual	8	$10\mu g/m^3$
Carbon monoxide (CO)	ppm	1 hour	35	-
	ppm	8 hours	9	-
Sulphur dioxide (SO_2)	ppm	24 hours	0.08	$20\mu g/m^3$
	ppm	Annual	0.02	-
Nitrogen dioxide (NO_2)	ppm	24 hours	0.12	-
	ppm	Annual	0.03	$40\mu g/m^3$
Ozone (O_3)	ppm	1 hour	0.12	-
Lead (Pb)	$\mu g/m^3$	Annual	0.50	$0.50\mu g/m^3$
Photo-chemical oxidants (as ozone)	ppm	1 hour	0.10	-
	ppm	4 hours	0.08	-

Source: ESIA report; and WHO. 2006. *WHO Air Quality Guidelines Global Update 2005*. Copenhagen.

2) Noise

Malawi's standards for noise control are presented in Table 1-3-3. Its standard limits for noise are almost equivalent or slightly stricter than those of WHO Guidelines.

Table 1-3-3 Noise Standards of Malawi and WHO Guidelines

Category of Area	Malawi's Standards (equivalent continuous sound level, dBA)		WHO Guidelines for Community Noise (WHO, 1999)	
	Daytime (6:00-21:00)	Night (21:00-6:00)	Daytime (6:00-21:00)	Night (21:00-6:00)
A - Industrial Area	75	70	70	70
B - Commercial Area	65	55	70	70
C - Residential Area	55	45	55~50	
D - Silence Zone	50	40	-	-

Source: Kizum Dam ESIA report and WHO. 1999. *Guidelines for Community Noise*. London.

3) Water Quality

Malawi has standard limits for drinking water quality, but environmental standards for public water bodies have yet to be established.

Table 1-3-4 Drinking Water Quality Standards of Malawi and WHO Guidelines

Item	Malawi's Standards	WHO Guidelines
pH	5.0-9.5	6.5-8.5
EC (μS/cm)	< 700	-
TDS (mg/l)	< 450	< 600
Cl (mg/l)	< 100	< 200
SO_4 (mg/l)	< 200	< 250
F (mg/l)	< 0.70	< 1.50
Na (mg/l)	< 100	< 100
K (mg/l)	< 25	-
Ca (mg/l)	< 80	-
Mg (mg/l)	< 30	-

pH = power of hydrogen ions, EC = electrical conductivity, TDS = total dissolved solids, Cl = chlorine, SO_4 = sulphate, F = fluorine, Na = natrium, K = kalium, Ca = calcium, Mg = magnesium
Source: ESIA report.

(8) Basic Information on Socio-Economic Conditions

1) Population and Socio-Economic Conditions

Population

Malawi's population stood at 13 million as of 2008. When it comes to its capital city, Lilongwe accommodated 1.9 million people in the same year. While the country has 0.974 male-to-female ratio on average, the capital's sex ratio amounts to 1.047, which indicates that men outnumber women in Lilongwe.

Table 1-3-5 Population Trend of Malawi and Lilongwe

Region	Population (1,000s)				Intercensal Growth Rates (%)		
	1977	1987	1998	2008	1977/ 1987	1987/ 1998	1998/ 2008
Malawi	5,547.5	7,988.5	9,933.9	13,077.2	3.7	2.0	2.8
Lilongwe (Rural)	-	976.6	1,346.4	1,230.8	-	2.9	3.1
Lilongwe (City)	-	223.3	440.5	674.4	-	6.3	4.3

Source: National Statistical Office. 2016. *Statistical Yearbook*. Zomba.

Economic Indicators

Malawi's gross domestic product (GDP) stood at US$ 5,080 million in 2013, the fourth least among 15 Southern African Development Community (SADC) states. As of 2014, the country achieved 6.0% of annual GDP growth rate, the fifth highest among SADC states and US$ 376 of per-capita GDP, the least among SADC states.

Economy and Employment

Lilongwe mainly involves in finance, retail, construction, transport, public administration, tourism and tobacco manufacturing, which leads to employment and population growth. Active small enterprises also greatly contribute to the economy. About 27% of the population is employed in small businesses, but the absence of favorable markets and roads and restrictions on finance and business have become stumbling blocks for economic growth.

Poverty

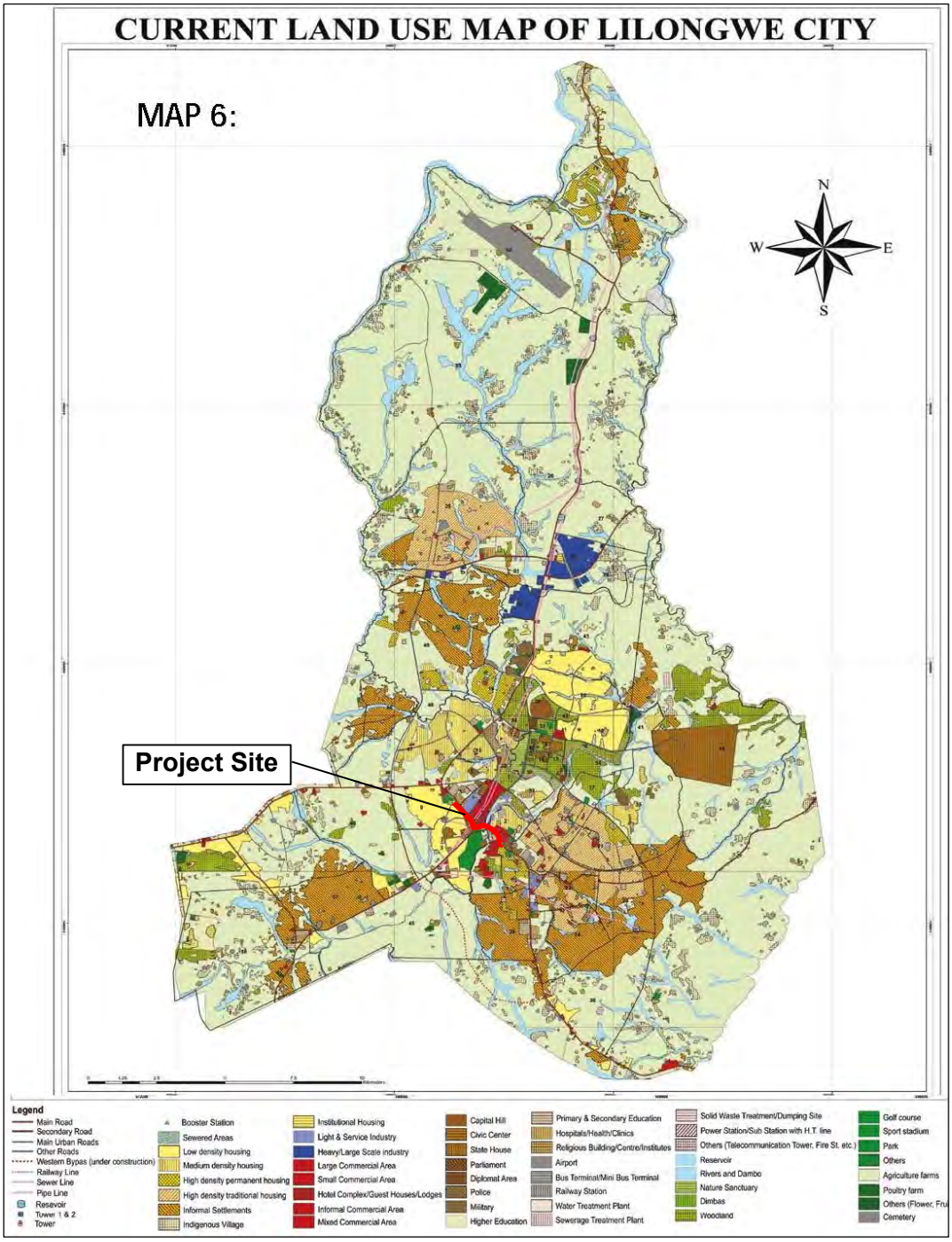
The imbalance between rapid urbanization and insufficient employment opportunities in the city have caused 25% of poor population and 9% of ultra-poor population.

Public Transport

A mini bus is the most common mode of public transportation in Lilongwe. About 32% of the citizens use mini buses. Also, the taxi service is available but costly. The condition of the city's road infrastructure is so poor to accommodate a rising number of vehicles. Numerous citizens often travel on foot but faces more traffic accidents due to increasing cars. Accordingly, the maintenance of roads including sidewalks is desirable.

2) Land Use

Figure 1-3-6 portrays the current land use patterns in Lilongwe. Most districts are covered with forests, Savanna, and agricultural lands, but the south part in Lilongwe has underwent a development process. When it comes to the project site, the roadside consists of commercial and high-density residential areas, and residential areas are situated at the back of the roadside.



Source: Local Action for Biodiversity. 2013. LAB Biodiversity Report: City of Lilongwe. Lilongwe

Figure 1-3-6 Current Land Use Patterns in Lilongwe

(9) Current Conditions of the Environment Around the Project Site and Expected Environmental and Social Impacts

1) Current Conditions of the Surroundings of the Project Site

The project site is the M1 road, which runs through the center of Lilongwe, and the areas along the road have been already developed. The project site ranging from the Sunbird Lilongwe Hotel Junction (no. 2 in Figure 1-3-7) to the Town Hall Roundabout (no. 5) is a central commercial area where large-scale shopping malls are gathered and has been greatly developed (Photo 1-3-2). In the section between the Town Hall and the Old Market, the project road crosses the Lilongwe River, which is the biggest in the city (Photo 1-3-3). From the river to Malangalanga Junction (no.

7) is the Old Town where a large-scale commercial area on the west side of the river expands to the Lubani Junction (no.8), the ending point of the project scope (Photo 1-3-4). The other road sections which are excluded from the project scope, i.e., the north of the Sunbird Lilongwe Hotel Junction (no. 2) and the south of the Lubani Junction (no. 8) are low-density areas where houses, schools, churches and graves are scattered (Photo 1-3-5).

Figure 1-3-7 Location of the Project Site

Photo 1-3-2 In front of the Kenyatta Junction

Photo 1-3-3 Lilongwe River

Photo 1-3-4 Old Town

Photo 1-3-5 South Side of the Lubani Junction

2) Expected Environmental Impacts

As pre-evaluation for scoping, expected negative impacts against the environment are shown from field reconnaissance as below. Environmental impacts caused by the project are estimated to be very small because the project is not accompanied with the construction of a new road but the improvement of the existing road and because the roadside is located at the center of the city and already developed. On the other hand, construction activities of the project may cause negative impacts.

Major expected environmental impacts caused by the project are as follows:

(i) negative impacts on air quality and noise caused by the operation of construction machinery during construction;

(ii) negative impacts on water quality of the Lilongwe River during construction of a bridge;

(iii) disposal of wastes generated during construction; and

(iv) cutdown of roadside trees.

The project scope of the M1 road has roadside trees in places. The roadside trees form good road scenery, and provides citizen with a place of relaxation. Since the closest trees are at ten meter from the road center, they may be affected.

3) Expected Social Impacts (land acquisition and resettlement)

As pre-evaluation for scoping, expected negative impacts on land acquisition and resettlement are show on below.

In the project, the improvement of the existing road is not a new road development. Therefore large

scale land acquisition and resettlement are not expected. Since the right of way (ROW) of the M1 road is designated as 36 meters (m) according to the Public Road Act, it is expected that land acquisition for the project is very little. However, the road width at the center of the city is currently narrower especially from STA1+900 to 2+300, and there are fences of roadside buildings within the width of 30 m.

Along the road at the center of the city, vendors and hawkers run their business, and thereby their business may be affected by the project. Vendors and hawkers can be divided those at STA2+000 in the New Town and those at STA2+600 in the Old Town.

On the other hand, Installation of the detour road needs land acquisition because the road runs private lands. However resettlement is not expected because there are no residences.

Around STA2+000

At a parking space adjacent to the southwest road, or the opposite side of the Nico Center, souvenir vendors are gathered together (Photo 1-3-6). An empty space proximate to the street stalls was provided by Lilongwe City for business use, so some vendors are running their business there (Photo 1-3-7).

Photo 1-3-6 Street Stalls at STA2+000

Photo 1-3-7 Alternative Space for Street Stalls Provided by Lilongwe City

Around STA2+600

Among street stalls located at the project roadside in the market of the Old Town, some vendors run their business within the ROW. In particular, a crop of vendors close to the Lilongwe River slightly stick out to the road but can easily move their street stalls on the spot (Photo 1-3-8). Around 20 street stalls were spotted adjacent to the river. Also, some neighboring vendors located beneath a pedestrian deck occupy a pedestrian road with their temporary stalls (Photo 1-3-9).

Photo 1-3-8 Street Stalls Around STA2+600 (Right Side of Project Road)

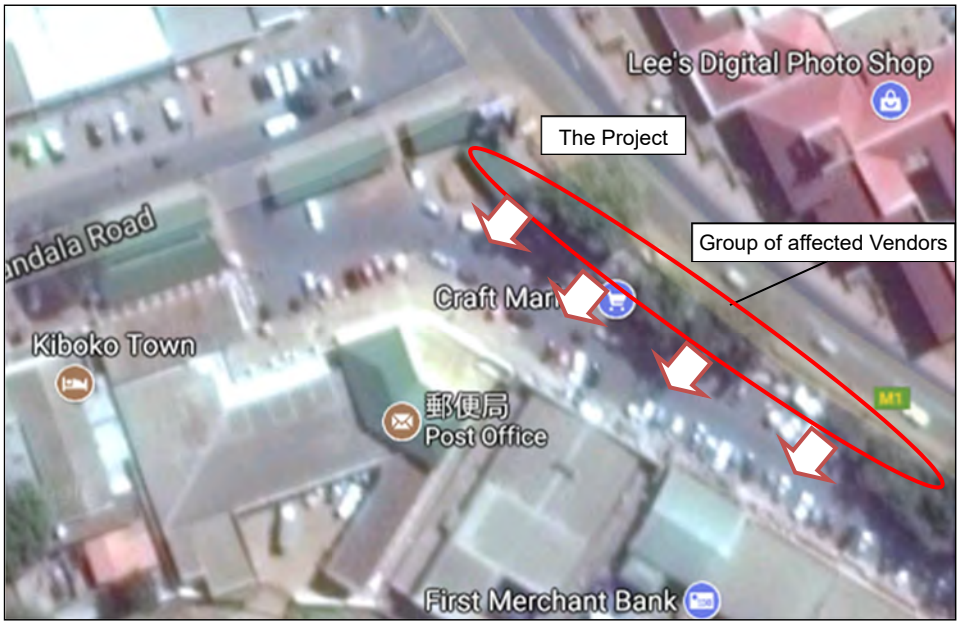
Photo 1-3-9 Street Stalls Around STA2+600 (Under Pedestrian Deck)

Regarding vendors running their business on the project road, the LCC stated that the vendors will be set back such as Figure 1-3-8.

Since the space allocated for vendors is adjacent to the current business site of vendors, they can readily relocate themselves and will not have to temporarily close their business due to relocation.

In the case of vendors at STA2+600, it is problematic that their street stalls stick out to the road, so Lilongwe City has been negotiating with them regarding their relocation to the market along the Lilongwe River.

Vendors affected by the project were reconfirmed through a survey of an abbreviated resettlement action plan (ARAP).



Source: JICA Survey Team prepared based on Google Maps

Figure 1-3-8 Relocation Plan for Vendors Around STA2+000

1-3-1-3 National Framework Regarding Environmental and Social Consideration

(1) Legal Framework

1) Major Legislations and Policies on Environmental Protection

Table 1-3-6 delineates Malawi's major environmental legislations and policies.

Table 1-3-6 Malawi's Environmental Legislations and Policies

Legislation / Policy	Detail
Constitution of the Republic of Malawi, 1994 (Amendment, 2010)	The Constitution proclaims that the country should avoid environmental degradation with a view to securing healthy living and working environments.
Environmental Management Act (EMA), 1996 (Amendment, 2017)	The fundamental law related to environmental protection in Malawi delineates responsible line ministries and agencies, organizations, and a procedure to implement EIA.
Guidelines for Environmental Impacts Assessment, 2007	Malawi's EIA Guidelines describes a procedure for the implementation of EIA.
Environmental and Social Management Guidelines in the Road Sector, 2007	The Guidelines is designed for the Road Authority to apply environmental and social considerations for the implementation of road projects and includes mitigation measures regarding road projects.
Health and Safety Guidelines for Malawi Road Sector, 2007	The Guidelines describes ILO standards for construction contractors and consultants involving in road construction and maintenance and safety and sanitation issues during and after construction.
National Parks and Wildlife Act, 1992 (Amendment, 2017)	The Act prescribes authorities in charge of the management of ecosystem, national parks, and wildlife reserves.
Malawi Forestry Act, 1997 (Amendment, 2017)	The Act stipulates the preservation of forest resources and the permission of tree cutting for road projects.
Town and Country Planning Act, 1991	The Act prescribes the submission of the project implementation plan.
Fisheries Conservation and Management Act, 1997	The Act stipulates the permission related to fishery at rivers and lakes which should be obtained prior to project implementation.

2) EIA System

According to Part V (Environmental Impact Assessment Audit and Monitoring) of the Environmental Management Act (EMA), it is mandatory to carry out EIA study depending on types and scales of projects. A detailed procedure of EIA study is described in the Guidelines for Environmental Impacts Assessment (EIA Guidelines) drafted by the Environmental Affairs Department (EAD).

(2) EIA Procedure

For prescribed projects which requires EIA study, a project proponent should prepare the Project Brief and submit it to the EAD. Items which should be included in the Project Brief are described in Appendix C of the EIA Guidelines.

Then, the EAD reviews the submitted Project Brief and decides whether the project requires EIA study or not. If the project does not require EIA study, the authority will give its permission to the project proponent.

If the project requires EIA study, on the other hand, the EAD will notify that the project proponent should implement EIA study. Accordingly, the project proponent should prepare the terms of reference (TOR) and submit them to the EAD. The EAD examines TOR and decides whether it will give a permission for the project. The project proponent is expected to conduct EIA study in compliance with the approved TOR and submit the EIA report to the EAD. The authority carries out a review for the EIA report and give a permission if there is no problem. However, the EAD sometimes gives the green light with several strings attached. In principle, EIA study is implemented under the responsibility of the project proponent.

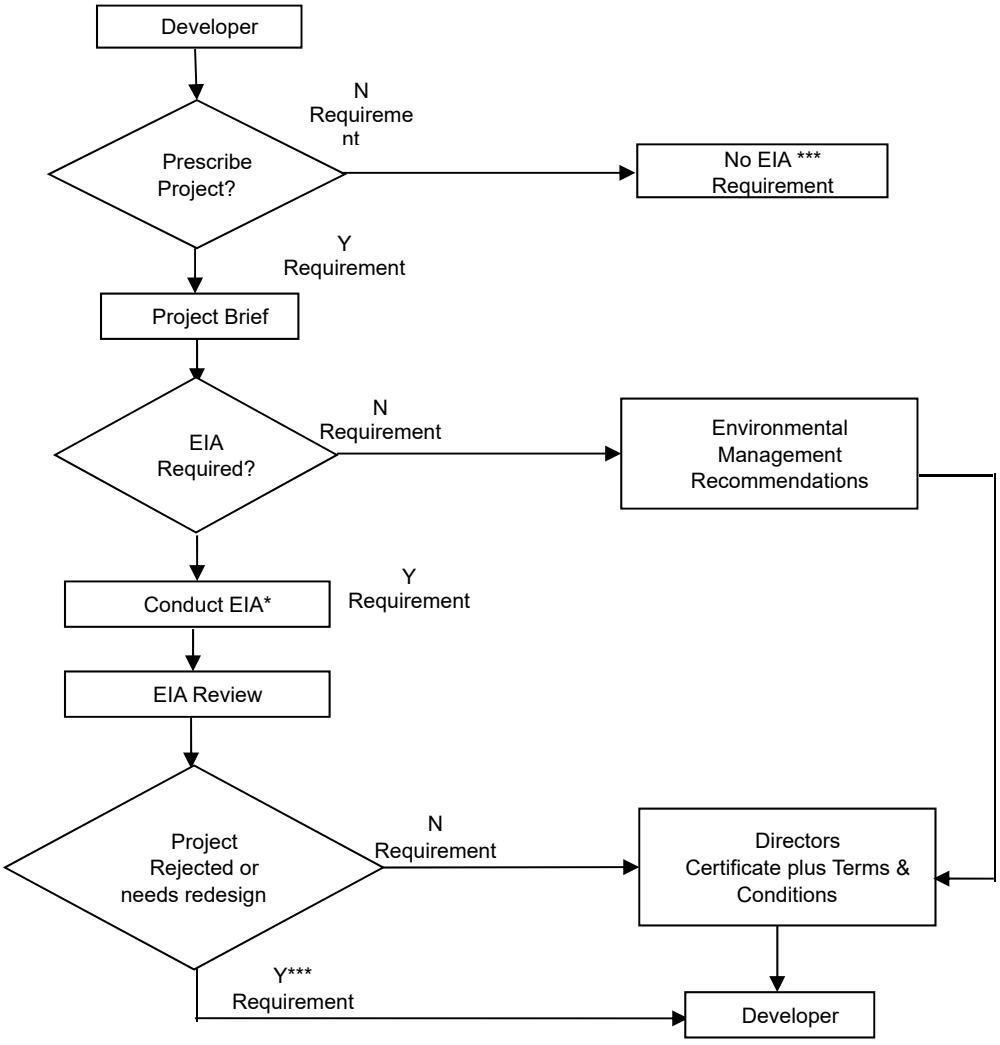
The review procedure of the EAD is as follows:

(i) Screening (to decide whether the project requires EIA study): 15 days

(ii) Scoping (to review the TOR of EIA study): 10 days

(iii) Review of the EIA draft report: 50 days

(iv) Review of the EIA revised report: 25 days



* Based on TOR approved by EAD.

*** The licensing authority should submit to the Director a copy of the license with attached project brief for record purposes.

*** The Developer may appeal to the Environmental Appeals Tribunal if not satisfied by the decision

Source: Ministry of Natural Resources, Energy and Environment. 2007. *Guidelines for Environmental Impact Assessment*.

Figure 1-3-9 Malawi's EIA Procedure

(3) EIA-Required Projects and Types of Reports

Categories of projects which mandatorily require or might require EIA study are prescribed in Appendix B of the EIA Guidelines. Infrastructure projects which mandatorily require EIA study are as follows:

LIST A List of projects for which EIA is mandatory

INFRASTRUCTURE PROJECTS

A4.1 Construction of new sanitary sewerage works, or expansion of existing sanitation sewerage works, to serve a population of more that 5,000 people.

A4.2 Construction of new storm sewerage works, or expansion of existing storm sewerage works, to drain an area of greater than 10 ha.

A4.3 Any new sewerage outfall to a receiving water body or location of sewerage systems or septic tanks within 1 km of a water body.

A4.4 Construction or expansion of septic tanks servicing more that 100 people 20

	homes or which receive more than 100 cubic metres per day of waste water.
A4.5	Construction of new highways and feeder roads or expansion of a existing highways and feeder roads.
A4.6	Construction of new airport and airstrips or expansion of existing and airstrip and their ancillary facilities.
A4.7	Construction of hospitals with a bed capacity of greater than 200 beds, or expansions of existing hospitals to a capacity of greater than beds.
A4.8	Construction of new, or expansions to existing, railway lines.
A4.9	Construction of new, or expansions to existing port or harbor facilities.
A4.10	Establishment or expansion of industrial estates.

Source: Ministry of Natural Resources, Energy and Environment. 2007. *Guidelines for Environmental Impact Assessment.*

For this project, the project proponent is expected to implement EIA study and follow the relevant procedure in accordance with Malawi's EIA system since the project aimed at expanding the existing road corresponds to the types of infrastructure projects which requires EIA study.

(4) Public Consultations and Information Disclosure

Article 25.2 of the EMA prescribes that the EIA report should be disclosed. In addition, Appendix G of the EIA Guidelines not only specifies stakeholder consultations but also describes methods and timing of consultations. As far as the timing of consultations is concerned, the guidelines recommend flexible implementation in response to circumstances of each project but gives the following examples for appropriate consultation timing: (i) when arranging the TOR for EIA study, (ii) when conducting EIA study, (iii) when reviewing the EIA report, and (iv) when approving the EIA report.

(5) EIA-Related Authority

In Malawi, the EIA procedure is led by the EAD. The authority not only reviews the submitted Project Brief and TOR but also carries out screening and scoping and give a permission for projects.

(6) Analysis of and Countermeasures for Gaps Between JICA Guidelines and Malawi's Legislations

Table 1-3-7 demonstrates gaps between JICA Guidelines and Malawi's EIA system and plausible gap-filling measures. Malawi's legislations do not stipulate a wide range of EIA study items. In this regard, the study will fill the gaps and be designed to avoid and minimize environmental and social impacts.

Table 1-3-7 Comparison of JICA Guidelines and Malawi's EIA System

Item	JICA Guidelines	Malawi's Legislation	Gap-Filling Measure
Underlying Principles	[JICA Guidelines Appendix 1.1] Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	[EIA Guidelines, Appendix E] The examination of alternatives on concerned matters" is described.	There is no significant gap. The Survey Team will prepare multiple alternatives and mitigation measures to avoid and minimize impacts.

Item	JICA Guidelines	Malawi's Legislation	Gap-Filling Measure
Information Disclosure	[JICA Guidelines Appendix 2] ・ EIA reports must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them. ・ EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perpetual by project stakeholders such as local residents and copying must be permitted.	[EMA 25.3] There is no provision about the language used in an EIA report except for the disclosure of an EIA report to residents.	Since English is the official language in Malawi, the EIA report will be written in English.
Social Acceptability	[JICA Guidelines, Appendix 1.5] For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of the project plans. [JICA Guidelines, Appendix 2] ・ In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. ・ Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.	[EIA Guidelines, Chapter 2.4] A public consultation should be held in the period between the preparation of the project brief and the EIA report. In addition, the relevant information should be disclosed to residents.	There is no significant gap. Stakeholder meetings will be held at the beginning of EIA study and at the completion of EIA draft report.
Scope of Impacts to Be Assessed	[JICA Guidelines, Appendix 1.3] ・ The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.	There is no provision on items for evaluation	According to JICA Guidelines, various items will be evaluated for EIA study.

Item	JICA Guidelines	Malawi's Legislation	Gap-Filling Measure
	[JICA Guidelines, Appendix 1.3] In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	There is no provision on derivative, secondary and cumulative impacts and indivisible project impacts.	Derivative, secondary, cumulative impacts, and indivisible project impacts will be evaluated within reasonable scope.
Monitoring / Grievance Redress Mechanism	[JICA Guidelines, Appendix 1.8] ・ Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. ・ When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on a procedure to be adopted with a view to resolving problems.	There is no clear provision on the disclosure of monitoring results.	The Survey Team will encourage counterparts to disclose the monitoring results.
Ecosystem and Biota	[JICA Guidelines, Appendix 1.6] Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	[EIA Guidelines, Appendix D] As one of project screening criteria, the project should not be located in and not affect any environmentally-sensitive areas such as national parks, wetlands, and productive agricultural lands.	Since the project is set to improve the existing road located at the center of the city, it does not convert or deteriorate important biota or forests.
Indigenous Peoples	[JICA Guidelines, Appendix 1.8] Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	There is no stipulation on the preservation of indigenous peoples.	Since the project is set to improve the existing road at the center of the city, it does not directly affect any indigenous peoples.

1-3-1-4 Comparison of Alternative Project Plans (No Action Option Included)

The Survey Team undertook a comparative analysis on alternative project plans including no action option.

(1) No Action Option

The project road, as the major economic corridor, has suffered from severe traffic congestion, which deters the smooth flow of logistics in Lilongwe.

If the project is not undertaken at all, it will be difficult for Malawi to implement the Malawi Growth and Development Strategy (MGDS), or the mid-term national development strategy, which is designed to improve safety and efficiency in the major corridor and secure economical transport services. Also, no action option is predicted to worsen environmental impacts such as air quality and noise caused by traffic jams. This option is not accompanied with negative environmental impacts including air quality, noise, and water quality, land acquisition and resettlements. As a result of the comparison of positive and negative impacts, the Survey Team came to a conclusion that the Malawi government cannot adopt no action option.

(2) Other Alternative Project Plans with Different Project Scopes

Considering current conditions and challenges of the M1 National Road, environmental and social conditions and traffic demand projection, the Survey Team examined the project scope in a way to heighten project effects and lift financial burdens of the Malawi government (Table 1-3-8).

As a result, first, the original plan requested by the Malawi counterpart was excluded since it is expected to add heavy burdens on Malawi. Among the three other project options, Plan 2 and Plan 3 are expected to correspond with future transport networks in Lilongwe which are proposed in JICA's Study on Urban Development Master Plan for Lilongwe in the Republic of Malawi. In addition, Plan 3 is deemed appropriate in that the plan includes the expansion of the road in high-density districts.

Although Plan 1 and Plan 2 are priority on project cost, burdens on Malawi and environmental and social impacts, there is a possibility that traffic demand of mid-term will not be satisfied. Considering these issues and project effects which is the original purpose of the project, Plan 3 was proposed.

Table 1-3-8 Comparison of Alternative Project Plans

Item	Plan 1	Plan 2	Plan 3	Original Plan
Project Outline				
	➢ Widening of the carriageway to four lanes between Junctions 5 and 6 ➢ Improvement of Junctions 2,3, 4, 5, 6, 7, and 8	➢ Widening of the carriageway to four lanes between Junctions 5 and 6 ➢ Improvement of Junctions 2,3, 4, 5, 6, 7, and 8 ➢ Construction of a two-lane bridge located 350 m upstream	➢ Widening of the carriageway to four lanes between Junctions 3 and 8 ➢ Improvement of Junctions 2,3, 4, 5, 6, 7, and 8 ➢ Construction of a two-lane bridge located 350 m upstream	➢ Widening of the carriageway to four lanes in all sections ➢ Improvement of all junctions from Junction 1 to Junction 11

Item		Plan 1	Plan 2	Plan 3	Original Plan
Project Feature		➢ Minimize Malawi's burdens for relocation of utility facilities and trees ➢ Improve roads and junctions with highest urgency, for example, widening of the existing bridge and improvement of Junction 6, which will greatly reduce traffic congestions ➢ Pedestrians will be in danger during bridge construction ➢ Construct a five-lane bridge (four lanes & a right-turn lane)	➢ Minimize Malawi's burdens for relocation of utility facilities and trees ➢ Improve roads and junctions with highest urgency, for example, widening of the existing bridge and improvement of Junction 6, which will greatly reduce traffic congestions ➢ The safety of pedestrians will be secured in that mini buses will make a detour towards a two-lane bridge located 350 m upstream ➢ Construct a six-lane bridge, which makes it possible to build a part of road transport networks suggested in JICA's Study on Urban Development Master Plan for Lilongwe in the Republic of Malawi	➢ Malawi's burdens for relocation of utility facilities and trees amount to US$ 1.8 million ➢ Improve roads and junctions with highest urgency, for example, widening of the existing bridge, improvement of Junction 6, and the widening of the road in high-density districts, which will greatly reduce traffic congestions ➢ The safety of pedestrians will be secured in that mini buses will make a detour towards a new two-lane bridge located 350 m upstream ➢ Construct a six-lane bridge, which makes it possible to build a part of road transport networks suggested in JICA's Study on Urban Development Master Plan for Lilongwe in the Republic of Malawi	➢ Malawi's burdens for relocation of utility facilities and trees amount to US$ 5.3 million ➢ Improve roads and junctions at all sections which have low urgency but require improvement as of 2040 ➢ Pedestrians will be in danger during bridge construction ➢ Construct a five-lane bridge (four lanes & a right-turn lane)
Project Component	Bridge	➢ Construct a 90-meter-long bridge with two lanes (including a right-turn lane) at the existing bridge location ➢ Construct a two-lane bridge adjacent upstream	➢ Construct a 90-meter-long bridge with two lanes at the existing bridge location ➢ Construct a two-lane bridge adjacent upstream ➢ Construct a 90-meter-long bridge located 350 m upstream with two lanes	➢ Construct a 90-meter-long bridge with two lanes at the existing bridge location ➢ Construct a two-lane bridge adjacent upstream ➢ Construct a 90-meter-long bridge located 350 m upstream with two lanes	➢ Construct a 90-meter-long bridge with two lanes at the existing bridge location ➢ Construct a two-lane bridge adjacent upstream
	Road	➢ Widen the 280-meter-long approach road accompanied by the widening of the existing bridge between Junctions 5 and 6	➢ Widen the 280-meter-long approach road accompanied by the widening of the existing bridge between Junctions 5 and 6 ➢ Improve the 500-meter-long approach road	➢ Widen the 1,700-meter-long road between Junctions 3 and 8 to four lanes ➢ Improve the 500-meter-long approach road connected to a new bridge located 350 m upstream	➢ Widen the 5,730-meter-long road between Junctions 1 and 11 to four lanes

Item		Plan 1	Plan 2	Plan 3	Original Plan
			connected to a new bridge located 350 m upstream		
	Junction	➢ Improve junctions from Junctions 2 to 8 swarmed with traffic congestions and numerous pedestrians ➢ Install traffic lights and crosswalks	➢ Improve junctions from Junctions 2 to 8 swarmed with traffic congestions and numerous pedestrians ➢ Install traffic lights and crosswalks	➢ Improve junctions from Junctions 2 to 8 swarmed with traffic congestions and numerous pedestrians ➢ Install traffic lights and crosswalks	➢ Improve all junctions ➢ Install traffic lights and crosswalks
Construction Cost Ratio		1.0	1.5	1.8	2.0
Cost Covered by Malawi		USD 0.3 million	USD 0.7 million	USD 1.6 million	USD 5.3 million
Project Effect & Issue		➢ The bridge expanded to four lanes will resolve the current bottleneck issue and accommodate short-term traffic demands by 2020. ➢ Due to limited project scope and induced traffic in line with the elimination of decongestion at the bridge, the section around the bridge probably will not be able to fulfill mid-term traffic demands by 2030.	➢ The construction of a new bridge located 350 m upstream will accommodate mini buses accounting for 40% of the traffic of the existing bridge and fulfill mid-term traffic demands by 2030. ➢ Due to limited project scope and induced traffic in line with the elimination of decongestion at the bridge, the section around the bridge probably will not be able to fulfill mid-term traffic demands by 2030. ➢ If a bus depot can be installed at the left riverside of Lilongwe River where a base camp for construction used to be located, the congestion of the existing bus depot might be eased.	➢ The construction of a new bridge located 350 m upstream will accommodate mini buses accounting for 40% of the traffic of the existing bridge and fulfill mid-term traffic demands by 2030. ➢ Since the congested section around the existing bridge will be also expanded to four lanes, mid-term traffic demands by 2030 will be fulfilled throughout all sections. ➢ If a bus depot can be installed at the left riverside of Lilongwe River where a base camp for construction used to be located, the congestion of the existing bus depot might be eased.	➢ The bridge expanded to four lanes will resolve the current bottleneck issue and accommodate short-term traffic demands by 2020. ➢ The decongestion of the bridge section and the road expansion to four lanes in all sections cannot fulfill increasing traffic demands around the bridge by inducing extra traffic around the bridge. As of 2030, therefore, the bottleneck issue will reoccur around the bridge.

Item	Plan 1	Plan 2	Plan 3	Original Plan
Natural Environment	➢ Since the project has the most limited scope, impacts on air quality and noise will be at the minimum level. ➢ The cutdown of roadside trees will be minimized.	➢ Since the project has the second smallest scope following Plan 1, impacts on air quality and noise will be also the second smallest. ➢ The construction of bridges will be undertaken at two different places, so impacts on water quality of the Lilongwe River will be increased. ➢ The cutdown of roadside trees will be minimized, equivalent to Plan 1.	➢ Since the project scope is larger than Plan 2, impacts to air quality and noise will be bigger than those of Plan 2. ➢ The construction of bridges will be undertaken at two different places, so impacts on water quality of the Lilongwe River will be increased. ➢ More roadside trees will be cut down compared to Plan 2.	➢ Since the project scope is the largest among all options, impacts on air quality and noise will be maximized. ➢ The cutdown of roadside trees will be maximized.
Land Acquisition & Resettlement	➢ There is almost no possibility for land acquisition. Due to minimized project scope, impacts of resettlement will be at the minimum level. However, the relocation of vendors might occur.	➢ There is almost no possibility for (private) land acquisition. However, the relocation of roadside vendors might occur. Also, the plan might require the resettlement of residents living around the construction site for the upstream bridge.	➢ Land acquisition might occur along the project road. There might be the relocation of roadside vendors and the resettlement of residents living around the construction site for the upstream bridge.	➢ Land acquisition might occur along the project road. There might be the relocation roadside vendors.
Comprehensive Evaluation (ranking)	3	2	1	4

Finally, the project scope was decided to the scope of Table 1-3-1 in terms of project cost and construction period (Section 1-3).

1-3-1-5 Scoping and TOR for Environmental and Social Considerations Study

(1) EIA Scoping

As a result of the comparative review of alternative project plans, Plan 3 was selected as aforementioned. Accordingly, the preliminary scoping for Plan 3 was carried out. The result of scoping is presented in Table 1-3-9.

Table 1-3-9 Result of EIA Scoping

No.	Impact Item	Assessment		Reason for Assessment
		Before / During Construction	Operation	
Pollution				
1	Air pollution	B-	D	**Construction Phase**: The operation of construction machinery and vehicles is expected to generate air pollution. **Operation Phase**: The project will increase traffic volume, but decrease emission volume of pollutants due to improvement of driving speed. Therefore deterioration of air quality is not expected.
2	Water pollution	B-	D	**Construction Phase**: Turbid water derived from the construction site might exacerbate water quality of the Lilongwe River. **Operation Phase**: Significant water pollution will not occur since the project is set to improve the existing road.
3	Soil contamination	B-	D	**Construction Phase**: Oil leakage from decrepit or ill-maintained construction machinery and vehicles might bring about soil contamination. **Operation Phase**: Soil contamination will not occur since the project is set to improve the existing road.
4	Waste	B-	D	**Construction Phase**: Construction wastes will be generated. **Operation Phase**: Wastes will not be generated since the project is set to improve the existing road.
5	Noise and vibration	B-	D	**Construction Phase**: Noise and vibration caused by construction might affect adjacent areas. **Operation Phase**: Because the increase of traffic volume is expected approximately 35% (average of project section 23,682 to 32,182 vehicles per day), the increase of noise and vibration is expected approximately 1dB. Therefore, negative impacts are not expected.
6	Ground subsidence	D	D	**Construction / Operation Phase**: Ground subsidence will not occur because the project does not accompany utilization of groundwater and large scale land development.
7	Odor	D	D	**Construction / Operation Phase**: The project which is a common road and bridge project has no construction work occurring odor.
8	Sediment	D	D	**Construction Phase**: The discharge of hazardous materials and heavy metals which can affect sediments of the nearby river is not expected to occur. **Operation Phase**: Sediments will not be affected since the project is set to improve the existing road.
Natural Environment				
9	Protected areas	D	D	Construction / **Operation Phase**: There is no protected area adjacent to the project site.
10	Ecosystem	B-	D	**Construction Phase**: Roadside trees might be cut down during construction. **Operation Phase**: Ecosystem will not be affected considering that the project is set to improve the existing road and that there is no important ecosystem including protected areas nearby.
11	Hydrology	C	C	**Construction / Operation Phase**: Currents of the Lilongwe River might be affected provided that a bridge pier is installed.
12	Underground water	D	D	**Construction Phase**: The level or quality of underground water will not be affected since the project is not accompanied with the installation of underground structures.

No.	Impact Item	Assessment		Reason for Assessment
		Before / During Construction	Operation	
13	Geographical / Geological features	D	D	**Construction Phase**: Construction will not give an impact on geology and topography since the project is related to road and bridge construction. **Operation Phase**: Geological or topographical features will not be affected since the project is set to improve the existing road and install a new bridge.
Social Environment				
14	Involuntary resettlement	B-	D	**Construction Phase**: There might be project-affected persons (PAPs) since the project requires the relocation of street stalls and shops. **Operation Phase**: Involuntary resettlement of residents will not occur during operation.
15	Poor people	B-	D	**Pre-Construction / Construction Phase**: Economic impacts will occur in case that poor people need to relocate from the project site. **Operation Phase**: Direct impacts on poor people will not occur since the project is set to improve the existing road.
16	Indigenous people / Ethnic minorities	D	D	**Pre-Construction / Construction / Operation Phase**: Residence of indigenous people and ethnic minorities will not be affected since the project will be carried out at the center of the city.
17	Local economy Including employment and livelihood	B±	B+	**Construction Phase**: In case of involuntary resettlement of residents, their employment and livelihood might be affected. On the other hand, local people will have increased employment opportunities created by the project. **Operation Phase**: As a whole, the local economy will enjoy a great economic growth thanks to transport facilitation.
18	Utilization of land or local resources	D	D	**Construction / Operation Phase**: Current land use or local resources will not be affected since the project is set to improve the existing road.
19	Water Utilization / Rights to water usage	D	D	**Construction / Operation Phase**: Water usage or rights to water usage will not be affected since the project is set to improve the existing road and install a new bridge.
20	Existing infrastructures or services	D	D	**Construction / Operation Phase**: Existing infrastructures or services will not be affected since the project is set to improve the existing road and install a new bridge.
21	Social structures such as social capital or local decision-making institutions	D	D	**Construction / Operation Phase**: Social capital or social organizations including local decision-making institutions will be affected since the project is set to improve the existing road and install a new bridge.
22	Uneven distribution of benefits and damages	B-	D	**Construction Phase**: Uneven distribution of benefits and damages might be generated in case of involuntary resettlement of residents. **Operation Phase**: Uneven distribution of benefits and damages will directly occur since the project is set to improve the existing road and install a new bridge.
23	Conflict of local interests	D	D	**Construction / Operation Phase**: Conflicts of local interests will not occur since the project is set to improve the existing road and install a new bridge.
24	Cultural heritage	D	D	**Construction / Operation Phase**: Even though the Old District Office, or the local cultural heritage, is located along the project road, it will not be affected because the project is planned to deviate from the cultural heritage.

No.	Impact Item	Assessment		Reason for Assessment
		Before / During Construction	Operation	
25	Landscape	D	D	**Construction / Operation Phase**: No zone reserved for landscape is located along the project road. No significant impact on adjacent landscape is expected since the project is set to improve the existing road and install a new bridge.
26	Gender	D	D	**Construction / Operation Phase**: The project will not give negative impacts on gender since it is set to improve the existing road and install a new bridge.
27	Child rights	D	D	**Construction Phase**: The terms of references concerning construction of the project prohibit child labor, so impacts on child rights will not occur. **Operation Phase**: Child rights including the segregation of school routes will not be affected since the project is set to improve the existing road and install a new road.
28	Risks of infectious diseases including HIV/AIDS	B-	D	**Construction Phase**: There are concerns about the outbreak of infectious diseases caused by non-resident workers from outside. **Operation Phase**: Direct risks to spread infectious diseases including HIV/AIDS will not be generated since the project is designed to improve intra-city traffic situations.
29	Working conditions including occupational safety	B-	D	**Construction Phase**: Safety and sanitation environments of workers can be worsened if the project proponent does not pay keen attention to safety measures for construction. **Operation Phase**: Working conditions will not be affected since the project is set to improve the existing roads and install a new bridge.
Others				
30	Transboundary impacts and climate change	B-	D	**Construction Phase**: Greenhouse gases like carbon dioxide will be generated due to the operation of construction machinery and vehicles. In addition, the cutdown of roadside trees will cause a reduction in the absorption of greenhouse gases including carbon dioxide. **Operation Phase**: Transboundary impacts and impacts on climate change will not occur since the project is set to improve the existing road.

A± = Significant positive/negative impact is expected; B± = Positive/negative impact is expected to some extent; C± = The extent of positive/negative impact is unknown. Therefore, a further examination is needed, and the impact can be clarified as EIA study progresses; D = No impact is expected.

(2) TOR for EIA Study

Based on the result of EIA scoping, the Survey Team prepared the TOR with regard to study items and study methodology. Table 1-3-10 illustrates the TOR for EIA study.

Table 1-3-10 TOR for EIA Study

No.	Impact Item	Study Item	Study Methodology
Pollution			
1	Air pollution	▪ Current air quality ▪ Environmental standards in Malawi and other countries ▪ Prediction of air quality during construction	▪ Preliminary review of existing literature and field study ▪ Confirmation of provisional project activities, project methods, and types of construction machinery and vehicles ▪ Prediction of air pollution in accordance with the diffusion model

No.	Impact Item	Study Item	Study Methodology
2	Water pollution	▪ Current water quality of the roadside river, the Lilongwe River ▪ Project and construction plans	▪ Preliminary review of existing literature and field study
3	Soil contamination	▪ Precautionary measures for oil leakage during construction	▪ Confirmation of project activities, project methods, project duration, and types of construction machinery and vehicles
4	Waste	▪ Current condition of provisional waste disposal facilities ▪ Wastes expected to be generated during project implementation	▪ Field study and interview with relevant institutions
5	Noise and vibration	▪ Current condition of noise and vibration ▪ Confirmation of environmental standards ▪ Residential areas, hospitals, and schools along the project road ▪ Impacts during construction	▪ Preliminary review of existing literature and field study ▪ Interview ▪ Confirmation of project activities, project methods, project duration, project location, project scope, types of construction machinery and vehicles, duration and location to operate construction machinery and vehicles, the number and routes of construction vehicles in operation, and duration of operation of construction vehicles
Natural Environment			
6	Ecosystem	▪ Trees expected to be cut	▪ Field study ▪ Preliminary review of existing literature
7	Hydrology	▪ Current condition of neighboring lakes and rivers ▪ Impacts during construction	▪ Preliminary review of existing literature ▪ Field study ▪ Project plan especially for bridge construction
Social Environment			
8	Involuntary resettlement	▪ Size of land acquisition and resettlement ▪ Preparation of abbreviated resettlement action plan (ARAP) in case of land acquisition or resettlement	▪ Confirmation of affected areas via field study and satellite pictures ▪ ARAP study
9	Poor people	▪ Confirmation of the presence of and impacts on the poor among affected residents	▪ Census survey (RAP study)
10	Local economy Including employment and livelihood	▪ Current condition of incomes and livelihood of affected residents	▪ Socio-economic survey (RAP study)
11	Uneven distribution of benefits and damages	▪ Current condition of incomes and livelihood of affected residents	▪ Socio-economic survey (RAP study)
12	Risks of infectious diseases including HIV/AIDS	▪ Current condition of infectious diseases including HIV/AIDS	▪ Preliminary review of existing literature
13	Working conditions including occupational safety	▪ Measures for occupational safety	▪ Study on similar cases including construction contracts
Others			
14	Transboundary impacts and climate change	▪ Reduction in absorption rates of greenhouse gases caused by the cutdown of trees	▪ Field study ▪ Confirmation of absorption amounts of greenhouse gases by trees through preliminary review of existing literature

1-3-1-6 Results of the Environmental and Social Considerations Study

(1) Air Pollution

1) Current Conditions

Even though Malawi has its own environmental standards for air quality and emissions standards for vehicles, the country has yet to be equipped with appropriate measurement devices. For this reason, the Survey Team could not carry out reliable field study for ambient air quality (Table 1-3-2). Since residential or commercial areas exist around the project sites, the main source of air pollutants is assumed to derive from vehicles. During stakeholder meetings, residents are concerned about dusts generated by construction works.

2) Impacts During Construction

Air pollutants such as nitrogen dioxide (NO_2), particulate matter (PM), and dusts will be created by the operation of construction machinery in the construction phase. However, dusts which were singled out as a main concern of residents during stakeholder meetings are expected to fall short of the standard limit, so significant negative impacts are not predicted (Table 1-3-11).

Table 1-3-11 Estimated Dust Amounts During Construction

Type of Construction Work	Base Dust Amount Generated Around Construction Site ($t/km^2/8h$)	Working Days per Month	Dust Amount (t/km^2/month)	Standard Limit (t/km^2/month)
Embankment	0.04	26	1.04	20
Slope Forming	0.07	26	1.82	
Piling (Earth Drill)	0.02	26	0.52	

Note: The standard limit refers to Japanese guidelines called "Regarding the implementation of the legislation with regard to the prevention of spike tire dust" (3 July 1990, Ministry of the Environment)

3) Mitigation Measures

To mitigate negative impacts on air quality during construction, the maintenance and inspection of construction machinery will be sufficiently implemented, and the operation time for construction machinery will be minimized in compliance with a reasonable work plan. Due to this procedure, emission of pollutants and greenhouse gasses will be decreased. In addition, water will be sprinkled to restrain dust generation.

(2) Water Pollution

1) Current Conditions

In order to verify the current condition of water pollution in the Lilongwe River, water quality was surveyed at the upstream side of the river. The survey result is portray ed in Table 1-3-12.

Table 1-3-12 Result of Water Quality Survey

Item	Survey Result (Survey Date)		Malawi's Standards for Water Quality	
	Rainy Season (14 March 2018)	Dry Season (31 May 2018)	Waste Water	Drinking Water
pH	7.63	7.53	6.5-9.0	5.0-9.5
EC (μS/cm)	216	245	-	＜700
DO (mg/l)	6.10	5.16	>5.0	-
BOD (mg/l)	2.20	2.80	20	-
COD (mg/l)	14.1	11.80	60	-
SS (mg/l)	97	140	30	-
FC (counts/100ml)	100	300	-	-

pH = power of hydrogen ions, EC = electrical conductivity, DO = dissolved oxygen, BOD = biochemical oxygen demand, COD = chemical oxygen demand, SS = suspended solids, FC = faecal coliform

Note: The water quality was investigated at around 100 m upstream of the Lilongwe Bridge.

Source: ESIA report.

All items except suspended solids (SS) are below Malawi's standard limit for drainage, but concentrations of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are slightly high, which indicates water pollution is under progress. In addition, SS concentration and water turbidity level are quite high.

2) Impacts During Construction and Mitigation Measures

The installation of bridge piers and the embankment near bridges are foreseen to make turbid water flow into the river. As for the installation of bridge piers, the river flow will be converted by piling up of sandbags before construction, and then construction works will be carried out in a way that the river water remains intact and that turbid water does not flow in the river. Concerning the embankment, the protection of slopes such as turfing will be carried out as soon as possible to restrain the inflow of turbid water. During construction, monitoring will be conducted for water quality with the naked eye and through water sampling. In case that turbidity of the Lilongwe River is significantly increased by the project, the construction method will be reviewed, and additional mitigation measures will be adopted.

(3) Soil Contamination

The operation of construction machinery or vehicles might give rise to oil leakage and ensuing soil contamination. In this regard, the maintenance and inspection of construction machinery and vehicles will be carried out in a regular basis in order to prevent possible oil leakage.

(4) Waste

Construction wastes including surplus earth and concrete debris will be generated due to project implementation. Lilongwe City designates a waste disposal site located eight kilometers (km) south from the project site. Capacity of the disposal site is unclear. As of now, wastes are disposed in the area of roughly 3~4 hectare. Thus, wastes created by this project will be dumped at the designated site.

In the event that construction wastes are discarded other than the designated site, environmental impacts may occur. During construction, waste disposal will be monitored to make sure that construction wastes are transported to the designated site.

Source: Prepared by Survey Team based on Google Maps (left).

Figure 1-3-10 Waste Disposal Site for the Project

(5) Noise and Vibration

1) Current Conditions

Malawi has its environmental standards for noises but has yet to be equipped with appropriate measurement devices as the case of ambient air quality. Therefore, the Survey Team could not conduct a field survey. Since there are residential or commercial areas around the project site, no noticeable noise source exists, and instead traffic noise will be predominant. Based on current traffic volumes of the project road, the roadside noise level is estimated to range between 65 and 70 decibels (dB), which slightly exceeds Malawi's environmental standards for noise[1]. On the other hand, facilities which are susceptible to traffic noise such as school do not exist along the project road.

2) Impacts During Construction

The noise level around the project site is predicted to increase due to the operation of construction machinery and vehicles. Table 1-3-13 exhibits the result of predictions about construction noise level based on the sound propagation calculation.[2]

Table 1-3-13 Estimated Noise Level During Construction

Construction Work		Noise Level Measured at Road Shoulder and Rear Area				Malawi's Noise Standards (dBA)		Community Noise Guidelines (dBA)	
Type	PWL (dB)	0 m	5 m	10 m	15 m	Day Time 6:00-21:00	Night Time 21:00-6:00	Day Time 6:00-21:00	Night Time 21:00-6:00
Excavation	119	91.0	87.5	85.0	83.0	A: 75 B: 65 C: 55 D: 50	A: 70 B: 55 C: 45 D: 40	A: 70 B: 70 C: 50-55	A: 70 B: 70 C: 50-55
Asphalt Pavement	108	80.0	76.5	74.0	72.0				

A = industrial area, B = commercial area, C = residential area, D = silence zone

The estimated noise levels are quite high in general, and the ambient noise level is negligible. Considering the fact that the estimated noise levels are instantaneous figures and that Malawi's noise standards are based on the equivalent continuous A-weighted sound pressure level (LAeq) in decibels measured over a stated period of time, however, we cannot make a direct comparison between the estimated figures and standard limits. LAeq is determined by the noise level and duration. If construction machinery is operated for eight hours a day, the noise level decreases by three decibels from the estimates presented in the table. In addition, one hour of machinery operation, the noise level declines by 12 dB from the estimates.

3) Mitigation Measures

As aforementioned, the noise level during construction is heavily dependent on the operation duration of construction machinery, and thereby it is desirable to shorten the operation time as much as possible. Also, it is helpful to arrange additional measures if necessary, for example, the installation of construction walls or noise barrier.

(6) Ecosystem

1) Current Conditions and Impacts Caused by the Project

The neighborhood of the project site has been urbanized, but a considerable number of trees stand along the roadside in the most sections of the project road. Also there are some trees in the detour

[1] ASJ RTN-Model 2013 was utilized to estimate the roadside noise level based on current traffic volumes verified through the study.

[2] The noise power level (PWL) is in conformity with the Technical Methodology of Road Environmental Impact Assessment (2007). The prediction is calculated in accordance with sound attenuation over distance.

route. Trees which might be affected by this project are described in Table 1-3-14. As a total, 151 trees are expected to be cut down for project implementation. Among them, eight Red Mahogany trees classified into “Vulnerable” (VU) category by the IUCN Red List of Threatened Species will be affected. These are not natural species but planted species.

Table 1-3-14 List of Trees Affected by the Project

No.	Scientific Name	English Name	Abundance (number of trees)	IUCN Red List Status
1	*Khaya anthotheca*	Red Mahogany	8	Vulnerable
3	*Albiziz lebbeck*	Woman’s tongue	8	Not evaluated
4	*Faiderbia albilda*	Camel Thorn	2	Not endangered
Total number of protected trees to be cleared			18	
FRUIT TREES				
5	*Mangifera indica*	Mango	2	Common
Total Number of Fruit Trees to be cleared			2	
AVENUE TREES				
13	*Senna siamea*	Cassia	25	Not endangered
14	*Senna spectabilis*	Cassia	10	Not endangered
15	*Delonix regia*	Flamboyant	4	Not endangered
17	*Jacaranda mimosfolia*	Jacaranda	6	Not endangered
Total Number of Avenue Trees to be cleared			45	
Detour Road				
	Albiziz lebbeck	Woman’s tongue	3	Not evaluated
	Senna siamea	Cassia	3	Not endangered
	Musa balbisiana	Banana	76	Not evaluated
	Psidium littorale	Guava	4	Not evaluated
Total Number of Trees in the Detour Road to be cleared			86	
Total Number of Plants to be cleared			151	

Source: ESIA report.

Photo 1-3-10 Red Mahogany Along the Project Road

2) Mitigations Measures

The roadside trees provide not only favorable road landscape but also citizens with a shade for relaxation. In response to tree cutting, it is recommended to replant new trees. Tree cutting and replanting will be carried out through consultations with and consents from the Ministry of Forest. Regarding locations of replanting, there is no room in the project site. Southern section of Lubani JCT which has a plenty of road width or lands of neighbor public institution such as school will be candidate. Same species and numbers should be planted as possible, and totally trees more than the number of affected trees will be replanted.

(7) Hydrology

The project road crosses the Lilongwe River which passes through the center of Lilongwe. Also, the project is set to construct a bridge over the river. Since the bridge will be built in the river, the flow of the river might be undermined. As countermeasures, a bridge structure plan has been examined. For example, the negative impacts on water flow will be alleviated by installing three bridge spans and wall-type piers.

(8) Involuntary Resettlement

1) Current Conditions and Expected Impacts

According to Malawi's relevant legislation, the ROW of the M1 National Road is designated as 36 m, but private lands encroach upon parts of the ROW especially at the center of the city, narrowing down the width of roads. In addition, a certain number of vendors run their business along the road in the downtown area.

The project is accompanied with about 0.57 hectare of land acquisition and the demolition of structures including walls and fences. Also, 268 project-affected persons (PAPs) including roadside vendors need to relocate elsewhere, but they are not expected to lose their residence and livelihood since they are economically displaced.

2) Mitigation Measures

The ARAP report was prepared for the project after the implementation of census and socio-economic surveys. Regarding land acquisition and resettlement, the ARAP report specifies that compensation will be made in compliance with Malawi's legislations and JICA Guidelines. Accordingly, Malawi's implementing agency will carry out land acquisition and resettlement.

(9) Poor People, Local Economy and Uneven Distribution of Benefits and Damages

The average monthly household income of PAPs amounts to MWK 349,000. Considering that the average size of households is 6.5 persons, PAP's per-capita daily income is USD 2.5, a bit higher than the international poverty line, USD 1.9 (for each person per day).[3] However, the lowest monthly household income level of PAPs is around MWK 10,000, below the poverty line. In order to mitigate impacts of resettlement on PAPs including the poor and female-headed households, a 10% of additional compensation will be offered to impoverished PAPs.

(10) Infectious Diseases Including HIV and AIDS

As of 2016, Malawi has 36,000 (31,000-45,000) new HIV infections, 24,000 (20,000-31,000) AIDS-related deaths, and one million HIV patients. In the country, the key populations who are mostly affected by HIV are sex workers (24.9%) or gay men and men who have sex with men (17.3%). Since 2010, HIV incidence and AIDS-related deaths are on the decline but the infection risk is still high especially for young women in urban areas.[4]

Since construction workers are expected to flow in the project site, there is a possibility to increase HIV incidence through prostitution. Therefore, it is essential to prevent the outbreak of infection diseases by implementing education and awareness programs during construction.

(11) Working Conditions

Since the project involves the operation of construction machinery, improper operation of machinery might lead to accidents. In addition, falling accidents can happen because the project is accompanied with high-altitude construction works for bridges. Accordingly, it is necessary to

[3] According to the International Monetary Fund (IMF), the poor is defined as a person who lives with less than US$ 1.9 per day.

[4] UNAIDS website: http://www.unaids.org/en/regionscountries/countries/malawi

set up an appropriate safety plan and carry out safety measures based on the plan. In the view of gender consideration, a same wage shall be paid for a same type of job, and ladies' toilet will be provided.

(12) Transboundary Impacts and Climate Change

The project entails the cutdown of 151 roadsides and in detour road. In general, trees contribute to absorbing or holding greenhouse gases like carbon dioxide (CO_2). Since most of roadside trees are already grown up, however, the absorption rate of greenhouse gases is expected to be low.

As part of mitigation measures, replanting will be implemented in response to the cutdown of roadside trees. Moreover, saplings which can absorb a great amount of greenhouse gases will be planted in order to absorb and hold much more greenhouse gases.

1-3-1-7 Impact Assessment

The results of EIA Study are demonstrated in Table 1-3-15.

Table 1-3-15 Results of EIA Study

No.	Impact Item	Scoping		EIA Study		Reason for Assessment
		Before / During Construction	Operation	Before / During Construction	Operation	
Pollution						
1	Air pollution	B-	D	B-	N/A	**Construction Phase**: Operation of construction machinery and vehicles will give rise to air pollution.
2	Water pollution	B-	D	B-	N/A	**Construction Phase**: Turbid water derived from construction sites might exacerbate water quality of the Lilongwe River.
3	Soil contamination	B-	D	B-	N/A	**Construction Phase**: Oil leakage from decrepit or ill-maintained construction machinery and vehicles might bring about soil contamination.
4	Waste	B-	D	B-	N/A	**Construction Phase**: Construction wastes will be generated. In case that wastes are discarded elsewhere other than the designated waste disposal site, environmental impacts might occur.
5	Noise and vibration	B-	D	B-	N/A	**Construction Phase**: Noise and vibration caused by construction works might affect the neighbourhood.
6	Ground subsidence	D	D	N/A	N/A	-
7	Odour	D	D	N/A	N/A	-
8	Sediment	D	D	N/A	N/A	-
Natural Environment						
9	Protected areas	D	D	N/A	N/A	-
10	Ecosystem	B-	D	B-	N/A	**Construction Phase**: Roadside trees will be cut down during construction.

No.	Impact Item	Scoping		EIA Study		Reason for Assessment
		Before / During Construction	Operation	Before / During Construction	Operation	
11	Hydrology	C	C	B-	B-	**Construction / Operation Phase**: Currents of the Lilongwe River might be affected, providing that a bridge pier is installed in the river.
12	Underground water	D	D	N/A	N/A	-
13	Geographical / Geological features	D	D	N/A	N/A	-
Social Environment						
14	Involuntary resettlement	B-	D	B-	N/A	**Construction Phase**: Around 0.57 hectares of land acquisition and the relocation of vendors and street shops are needed. As a total, there will be around 268 PAPs (economic resettlement).
15	Poor people	B-	D	B-	N/A	**Construction / Operation Phase**: Economic impacts will be generated since some PAPs are classified into the poor.
16	Indigenous people / Ethnic minorities	D	D	N/A	N/A	-
17	Local economy Including employment and livelihood	B±	B+	B±	B+	**Construction Phase**: In case of the involuntary resettlement, employment and livelihood of PAPs might be affected. On the other hand, local people will have increased employment opportunities created by the project. Operation Phase: Transport facilitation induced by the project will lead to a great growth factors of local economy.
18	Utilization of land or local resources	D	D	N/A	N/A	-
19	Water Utilization / Rights to water usage	D	D	N/A	N/A	-
20	Pre-existing infrastructures or services	D	D	N/A	N/A	-
21	Social structures such as social capital or local decision-making institutions	D	D	N/A	N/A	-
22	Uneven distribution of benefits and damages	B-	D	B-	N/A	**Construction Phase**: Uneven distribution of benefits and damages might be generated in case of involuntary resettlement.
23	Conflict of local interests	D	D	N/A	N/A	-
24	Cultural heritage	D	D	N/A	N/A	-

No.	Impact Item	Scoping		EIA Study		Reason for Assessment
		Before / During Construction	Operation	Before / During Construction	Operation	
25	Landscape	D	D	N/A	N/A	-
26	Gender	D	D	N/A	N/A	-
27	Child rights	D	D	N/A	N/A	-
28	Risks of infectious diseases including HIV/AIDS	B-	D	B-	N/A	**Construction Phase**: There are concerns about the outbreak of infectious disease caused by non-resident workers from outside.
29	Working conditions including occupational safety	B-	D	B-	N/A	**Construction Phase**: Safety and sanitation environments of workers can be worsened if constructors do not pay keen attention to safety measures.
Others						
30	Transboundary impacts and climate change	B-	D	B-	N/A	**Construction Phase**: Greenhouse gases like carbon dioxide will be generated due to the operation of construction machinery and vehicles. Tree cutting will decrease absorption rates of greenhouse gases like carbon dioxide.

A± = Significant positive/negative impact is expected; B± = Positive/negative impact is expected to some extent; C± = The extent of positive/negative impact is unknown. Therefore, a further examination is needed, and the impact can be clarified as EIA study progresses; D = No impact is expected.

1-3-1-8 Mitigation Measures and Concomitant Costs

Table 1-3-16 demonstrates mitigation measures and accompanying costs. Construction-related mitigation costs are covered by the general construction service fees.

Table 1-3-16 Mitigation Measures and Expected Costs (Before/During Construction)

No.	Impact Item	Mitigation Measure	Cost	Implementing Entity	Responsible Entity
Pollution					
1	Air pollution	▪ Spray water during construction ▪ Carry out routine inspection of construction machinery ▪ Operate construction machinery in a reasonable level such as avoiding unneeded idling and operation	To be included in construction service fees	Contractor	Roads Authority
2	Water pollution	▪ Form embankment slopes ▪ Protect slopes in the early phase (turfing)	MWK 6.5 million for slope formation, slope protection covered by construction service fees	Contractor	Contractor and Roads Authority

No.	Impact Item	Mitigation Measure	Cost	Implementing Entity	Responsible Entity
3	Soil contamination	▪ Carry out routine inspection of construction machinery ▪ Operate construction machinery in a reasonable level	To be included in construction service fees	Contractor	Contractor and Roads Authority
4	Waste	▪ Dispose construction wastes in the designated waste disposal site	To be included in construction service fees	Contractor	Contractor and Roads Authority
5	Noise and vibration	▪ Carry out routine inspection of construction machinery ▪ Operate construction machinery in a reasonable level such as avoiding unneeded idling and operation	To be included in construction service fees	Contractor	Roads Authority
Natural Environment					
6	Ecosystem	▪ Replant trees in response to the cutdown of roadside trees	MWK 1.3 million	Lilongwe City Council (LCC) and Roads Authority	Roads Authority
7	Hydrology	▪ Come up with a design which can prevent the deterrence of the river flow (wall type pier)	To be included in consulting fees	D/D consultants	Roads Authority
Social Environment					
8	Involuntary resettlement	▪ Carry out land acquisition and resettlement based on ARAP	MWK 1,427,369,621 (ARAP)	LCC	LCC and Roads Authority
9	Poor people	▪ Carry out land acquisition and resettlement based on ARAP	To be included in No.8	LCC	LCC and Roads Authority
10	Local economy Including employment and livelihood	▪ Carry out land acquisition and resettlement based on ARAP	To be included in No.8	LCC	LCC and Roads Authority
11	Uneven distribution of benefits and damages	▪ Carry out land acquisition and resettlement based on ARAP	To be included in No.8	LCC	LCC and Roads Authority
12	Risks of infectious diseases including HIV/AIDS	▪ Implement education and awareness programs targeting construction workers	To be included in construction service fees	Contractor	Roads Authority
13	Working conditions including occupational safety	▪ Prepare a construction safety plan	To be included in construction service fees	Contractor	Roads Authority
Others					
14	Transboundary impacts and climate change	▪ Carry out routine inspection of construction machinery ▪ Operate construction machinery in a reasonable level such as avoiding unneeded idling and operation ▪ Replanting after the cutdown of roadside trees	To be included in construction service fees	Lilongwe City Council and Roads Authority	Roads Authority

1-3-1-9 Monitoring Plan

The monitoring plan is presented in Table 1-3-17.

Table 1-3-17 Monitoring Plan (Before/During Construction)

No.	Impact Item	Monitoring Item	Location	Timing	Cost	Responsible Entity
Pollution						
1	Air pollution	▪ Verify environmental measures in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the following conditions during construction: - Sprinkling of water during construction - Routine inspection of construction machinery - Reasonable operation of construction machinery	Construction sites	At any time during construction	Included in routine tasks of consultants	Roads Authority
2	Water pollution	▪ Verify environmental measures in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the following conditions during construction: - Current conditions of water quality of the Lilongwe River with the unaided eye - Progress of slope formation and protection (turfing)	Construction sites	At any time during construction	Included in routine tasks of consultants	Roads Authority
		▪ Conduct water quality survey	Construction sites	Twice a year during construction	US$ 950 per water quality survey	Roads Authority
3	Soil contamination	▪ Verify environmental measures in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the implementation of routine inspection of construction machinery	Construction sites	At any time during construction	Included in routine tasks of consultants	Roads Authority
4	Waste	▪ Verify environmental measures in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify conditions of waste disposal	Waste disposal site	At any time during construction	Included in routine tasks of consultants	Roads Authority and Lilongwe City Council
5	Noise and vibration	▪ Verify environmental measures in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the following conditions during construction: - Routine inspection of construction machinery - Reasonable operation of construction machinery	Waste disposal site	At any time during construction	Included in routine tasks of consultants	Roads Authority
Natural Environment						
6	Ecosystem	▪ Check a tree cutting and	-	Before	Included in	Roads

No.	Impact Item	Monitoring Item	Location	Timing	Cost	Responsible Entity
		replanting plan		construction	routine tasks of consultants	Authority and Lilongwe City Council
		▪ Verify replanting progress	Replanting sites	Before construction and at any time during construction	Included in routine tasks of consultants	Roads Authority and Lilongwe City Council
7	Hydrology	▪ Verify the project design	-	During D/D stage	-	Roads Authority
Social Environment						
8	Involuntary resettlement	▪ Verify the ARAP report	-	Before construction	-	Roads Authority and Lilongwe City Council
		▪ Verify the implementation of land acquisition and resettlement	Project sites	Before construction and at any time during construction	Included in ARAP	Roads Authority and Lilongwe City Council
9	Poor people	▪ Verify the implementation of land acquisition and resettlement	Project sites	Before construction and at any time during construction	Included in ARAP	Roads Authority and Lilongwe City Council
10	Local economy including employment and livelihood	▪ Verify the implementation of land acquisition and resettlement	Project sites	Before construction and at any time during construction	Included in ARAP	Roads Authority and Lilongwe City Council
11	Uneven distribution of benefits and damages	▪ Verify the implementation of land acquisition and resettlement	Project sites	Before construction and at any time during construction	Included in ARAP	Roads Authority and Lilongwe City Council
12	Risks of infectious diseases including HIV/AIDS	▪ Verify education and awareness programs in the construction plan	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the implementation of education and awareness programs	-	At any time during construction	Included in routine tasks of consultants	Roads Authority
13	Working conditions including occupational safety	▪ Verify the construction plan (safety plan)	-	Before construction	Included in routine tasks of consultants	Roads Authority
		▪ Check the implementation of mitigation measures	Construction sites	At any time during construction	Included in routine tasks of consultants	Roads Authority
Others						
14	Transboundary impacts and climate change	▪ Verify routine inspection of construction machinery ▪ Verify reasonable operation of construction machinery	Construction sites	At any time during construction	Included in routine tasks of consultants	Roads Authority
		▪ Verify the implementation of replanting	Replanting sites	Before construction and at any time during construction	Included in routine tasks of consultants	Roads Authority

The monitoring process is portrayed in Table 1-3-18.

Table 1-3-18 Monitoring Process

	2019	2020	2021	2022	2023	2024
Project Implementation	(D/D, TA) Detail Design Tendering					
	(Construction)	Preparation of Construction	Road Detour Road, Temporary Bridge Demolition of Existin g Bridge	Bridge		
Monitoring of Environmental and Social Considerations	▲Environmental License	Review of ESIA report				Monitoring on construction stage
		Land Acquisition and Resettlement				
		Monitoring of RAP				

1-3-1-10 Implementation Structure

The Roads Authority (RA), or the implementing agency will be the major responsible entity for monitoring. In specific, the Environmental and Social Planner under RA's Planning Section will carry out monitoring. Considering that the Lilongwe City Council (LCC) will be responsible for waste management and tree cutting and replanting, the council will implement monitoring in cooperation with the RA. In addition, monitoring results will be reported to the Environmental Affairs Department (EAD) and JICA.

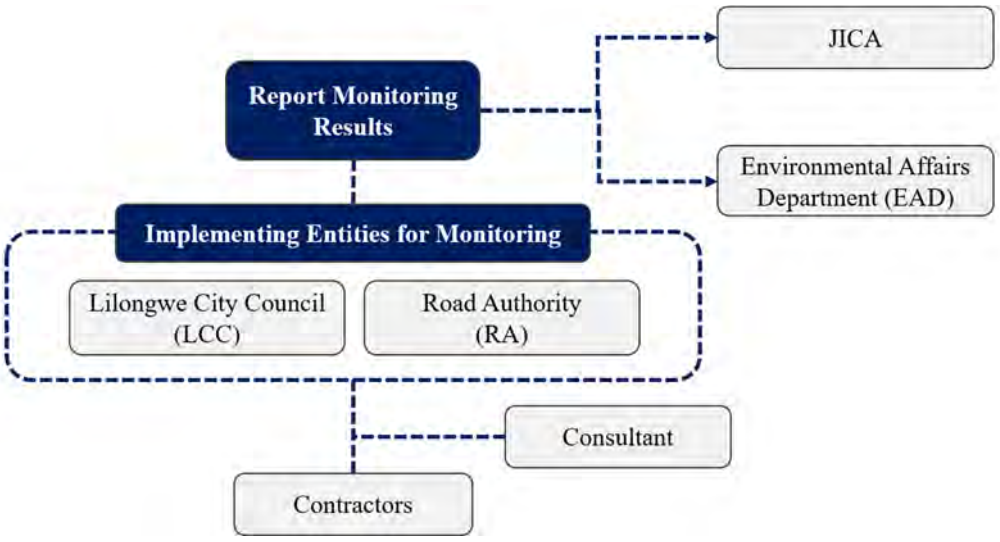


Figure 1-3-11 Implementation Structure for Monitoring

1-3-1-11 Public Consultations

Two rounds of public consultations were carried out during EIA study. While the first consultation was arranged to explain the project outline and collect opinions from stakeholders, the second was set to gather their opinions regarding the results of EIA study.

(1) First Round of Public Consultations

- Consultation Method: Individual interview
- Consultation Period: 27 February to 2 March 2018
- Participants: 77 major stakeholders related to the project (69 men and 8 women including

stakeholders from roadside businesses, schools and a religious facility, vendors, and government employees)

- Notification Method: Delivery of the notification letter issued by the RA
- Purpose: Explain the project outline and collect opinions of stakeholders
- Major Opinions: All stakeholders consented to the implementation of the project and commented on requests and concerns as follows.

Requests and Concerns of Stakeholders	Responses of Project Proponents (Consultants)
• Traffic congestion on the M1 road will be eased. • Drainage on the road will be improved. • The project will contribute to local economic development. • The project will contribute to the improvement of traffic safety.	-
[Concerning the Project Plan] • The improved road should be planned in accordance with international standards. • It is desirable that the developer should install street lights and crosswalks. • It is desirable that the developer should install road signs. • It is desirable that the developer should install reliable traffic lights. • What is worrisome is that the improved road might aggravate overspeed and increase traffic accidents. • Parking spaces are insufficient. • The improved road needs durability. • The project should be carried out by experienced constructors. • Appropriate compensation should be made for affected people or businesses. • It might be difficult to run a business due to decongestion.	• Streetlights, crosswalks and road signs will be appropriately installed. • Regarding parking space, spaces for buses and taxies will be installed by LCC. • The affected persons of the project will be compensated based on the RAP. • Solution of road congestion will activate economy and contribute business activities.
[Concerning Environmental and Social Considerations] • Dusts and noise will be generated during construction. • It is desirable to phase in the road construction to prevent a complete traffic blockade. • It is desirable that the developer should pay considerable attention not to cause much noise near the mosque and should not deploy construction machinery near it. • It is desirable that the developer should install a wall between construction sites and commercial areas. • It is desirable that the developer should shorten the project duration as much as possible.	• The project proponents will consider environmental protection to carry out water sprinkling, etc.
[Concerning Resettlement and Consent Building] • It is necessary to implement enough consultations between PAPs and the project proponent. • It is desirable that the project proponent should make compensation for the loss of business property. • It is desirable that consultations should be implemented before construction.	• To the affected persons, consultation and compensation will be carried out according to the RAP.

Source: ESIA Report.

(2) Second Round of Public Consultations

- Consultation Method: Community meeting
- Consultation Period: 10 June 2018
- Participants: 45 major stakeholders related to the project (40 men and 5 women including stakeholders from roadside businesses, schools and a religious facility, vendors, and government employees)

- Notification Method: Delivery of the notification letter issued by the RA
- Purpose: Explain the project outline, expected impacts, and entitlements and collect opinions of stakeholders
- Major Opinions: As the first round of stakeholder consultations, all stakeholders consented to the implementation of the project and commented on requests and concerns as follows.

Requests and Concerns of Stakeholders	Responses of Project Proponents (Consultants)
• Traffic congestions on the M1 road will be alleviated. • While negative impacts on businesses might occur in the short term, especially during construction, traffic flows and movement will be improved in the long run.	-
[Concerning the Project Plan] • Air and noise pollution will be increased due to vehicles. • The project might give rise to chronic HIV/AIDS incidence. • Conflicts between construction workers and citizens might occur due to income imbalance. • The project might lead to land encroachment and silt accumulation in the Lilongwe River.	• Solution of road congestion will decease environmental burden, and contribute business activities in the city. • Since the project is an improvement of existing roads, significant environmental impacts such as land erosion are not expected.
[Concerning Environmental and Social Considerations] • The project might incur some losses related to construction works. • Construction vehicles might incur traffic accidents. • The project might generate wastes through construction and demolition works and incur oil leakage. • Construction wastes might pollute the Lilongwe River.	• To the affected persons, consultation and compensation will be carried out according to the RAP. • The project proponents will consider environmental protection and safety during construction.
[Concerning Resettlement and Consent Building] • The project will incur the loss of vendors, gasoline stands, fences, and billboards.	• To the affected persons, consultation and compensation will be carried out according to the RAP.

Source: ESIA Report.

1-3-2 Land Acquisition and Resettlement

1-3-2-1 Necessity of Land Acquisition and Resettlement

(1) Project Components Which Require Involuntary Resettlement

Since the project entails the widening of parts of the existing road, the improvement of junctions, and the construction of detour roads, it gives rise to land acquisition and demolition of existing structures. Also, the project gives rise to the relocation of street stalls on the road. Table 1-3-1 describes the project scope.

Malawi's Public Roads Act No.8, 2017 stipulates that the project road shall have 36 m of the ROW. Accordingly, the project is designed in conformity with the ROW.

(2) Review of Alternative Initial Designs

At the initial project design stage, multiple project scopes were examined to accomplish the project's main goal. The examination of alternatives factored in the minimization of land acquisition and involuntary resettlement (Section 1-3-1-4).

1-3-2-2 Legal Framework Regarding Land Acquisition and Resettlement

(1) Outline of Relevant Legislations

Table 1-3-19 demonstrates main legislations and policies on land acquisition and resettlement in Malawi.

Table 1-3-19 Legislations and Policies on Land Acquisition and Resettlement in Malawi

Legislation / Policy	Detail
Constitution of the Republic of Malawi, 1994 (Amendment, 2010)	The Constitution clarifies land ownership and prescribes no expropriation without compensation. It also stipulates that land acquisition for public purposes can be implemented under the assumption of appropriate compensation.
National Land Policy, 2002	The Policy is designed to promote socio-economic development by securing land tenure and free transactions and ensure fairness regarding resettlement.
Land Act, 1965 (Amendment, 2016)	The Act is the fundamental legislation stipulating land tenure, land transactions, and land use. Also, the Act delineates the administrative jurisdiction for land and the land classification, that is, public land and private land.
Customary Land Act, 1967 (Amendment, 2016)	The Act relates to the management and administration of customary land which is customarily owned by tribes.
Lands Acquisition Act, 1970 (Amendment, 2017)	The Act prescribes land acquisition and compensation. In specific, it stipulates that compensation should be disbursed in cash in a lump sum. Furthermore, according to the Act, the amount of compensation should be calculated by an independent valuer and include business loss, land loss, and other expenses.
Public Roads Act, 1962 (Amendment, 1989)	The Act, or the fundamental law for roads prescribes the road width in conformity with road standards and compensation for land conversion from private land to a public road.

(2) Procedure for Land Acquisition and Resettlement

In Malawi, land acquisition and resettlement are implemented in accordance with the Public Road Act (1962) and the Land Acquisition Act (1970). The transfer of land tenure is determined by the results of negotiations between the Ministry of Lands, Housing and Urban Development (MLHUD) and relevant local governments.

Regarding the acquisition of private land, the following procedure should be complied with. First, the project proponent should submit a necessary land acquisition plan to the local government concerned. Under the approval by the local government concerned, the project proponent can then apply for land acquisition to the MLHUD. In this case, the ministry implements the following procedure for the period of 60 days from the application date. First, the MLHUD appoints independent valuers and empowers them to evaluate land and asset values. Subsequently, the ministry delivers the result to a land owner and carries out negotiations for compensation with the owner. If compensation is made, the private land is transferred to the government, and the ministry announces the fact via its official gazette.

(3) JICA's Resettlement Policy

JICA's resettlement policy is enumerated as follows:

1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
2. When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
3. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
4. Compensation must be based on the full replacement cost as much as possible.
5. Compensation and other kinds of assistance must be provided prior to displacement.
6. For projects that entail large-scale involuntary resettlement, resettlement action plans (RAPs) must be prepared and made available to the public. It is desirable that the RAPs include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
7. In preparing a RAP, consultations must be held with the affected people and their communities

based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

8. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of RAPs.
9. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

The above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principles based on World Bank OP 4.12 are as follows.

10. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including a population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers by others who wish to take advance of such benefits.
11. Eligibility to Benefits include the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
12. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
13. Provide support for the transition period between displacement and livelihood restoration.
14. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
15. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared.

In addition to the above core principles of the JICA policy, it also lays emphasis on a detailed resettlement policy inclusive of all the above points; a project specific resettlement plan; an institutional framework for implementation; a monitoring and evaluation mechanism; a time schedule for implementation; and a detailed Financial Plan etc.

(4) Comparison of JICA Guidelines and Malawi's Legislations

Table 1-3-20 demonstrates gaps between JICA Guidelines and Malawi's legislations and the project's resettlement policies.

Table 1-3-20 Comparison of JICA Guidelines and Malawi's Legislations

No.	JICA Guidelines	Malawi's Legislations	Gaps Between JICA Guidelines and Malawi's Legislations	Project's Resettlement Policies
1	[JICA Guidelines Appendix 1.7.1] Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	No legislation directly stipulates land acquisition and resettlement, but EIA Guidelines states that alternatives should be examined in order to minimize impacts.	Since the examination of alternatives is implemented during EIA, there is no significant gap.	Alternatives are examined in order to minimize impacts derived from land acquisition and resettlement.
2	[JICA Guidelines Appendix 1.7.1] When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	The Land Acquisition (Amendment) Act (Act 9 of 2017) stipulates that impacts of resettlement should be minimized and that appropriate compensation should be made in case of resettlement.	There is no significant gap.	The project proponent will examine alternatives to minimize impacts and comply with JICA Guidelines regarding the compensation level.

No.	JICA Guidelines	Malawi's Legislations	Gaps Between JICA Guidelines and Malawi's Legislations	Project's Resettlement Policies
3	[JICA Guidelines Appendix 1.7.2] People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	The Lands Acquisition (Amendment) Act (Act 9 of 2017) stipulates compensation not only for tangible losses including lands and structures but also for intangible losses including jobs and businesses.	No legislation prescribes maintenance of current livelihood.	If necessary, the project proponent will examine measures for restoring livelihood and comply with JICA Guidelines.
4	[JICA Guidelines Appendix 1.7.2] Compensation must be based on the full replacement cost as much as possible.	According to the Lands Acquisition (Amendment) Act (Act 9 of 2017), compensation is determined by a market price and additionally includes resettlement costs.	There is no significant gap.	Monitoring will be implemented in order to confirm whether appropriate compensation is made.
5	[JICA Guidelines Appendix 1.7.2] Compensation and other kinds of assistance must be provided prior to displacement	The Lands Acquisition (Amendment) Act (Act 9 of 2017) prescribes that compensation should be paid in one lump sum, but no legislation stipulates the timing of compensation.	There is no provision about the timing of compensation.	Compensation prior to resettlement will be suggested.
6	[JICA Guidelines Appendix 1.7.4] For projects that entail large-scale involuntary resettlement, RAPs must be prepared and made available to the public.	No legislation stipulates the preparation of a RAP.	In case that involuntary resettlement occurs, the RAP needs to be prepared.	According to the expected resettlement scale, an ARAP will be prepared.
7	[JICA Guidelines Appendix 1.7.4] In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	No legislation stipulates the explanation and information disclosure towards PAPs or project-affected communities.	Measures need to be taken according to JICA Guidelines.	The explanation on the project will be made towards expected PAPs.
8	[JICA Guidelines Appendix 1.7.4] When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	No legislation stipulates the explanation and information disclosure towards PAPs or project-affected communities.	Measures need to be taken according to JICA Guidelines.	The explanation will be carried out in languages which PAPs can understand (Chewa or English).
9	[JICA Guidelines Appendix 1.7.3] Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	No legislation stipulates the participation of PAPs in the project.	Measures need to be taken according to JICA Guidelines.	Requests raised during public consultations will be reflected in the RAP.
10	[JICA Guidelines Appendix 1.7.3] Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	The Public Roads Act, 2017 prescribes an appeal to the High Court on grievances regarding resettlement and compensation but does not clarify a detailed procedure.	Measures need to be taken according to JICA Guidelines.	A grievance redress mechanism will be clarified in the RAP.

No.	JICA Guidelines	Malawi's Legislations	Gaps Between JICA Guidelines and Malawi's Legislations	Project's Resettlement Policies
11	[WB OP 4.12 Para 6] Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers by other who wish to take advantage of such benefits.	No legislation stipulates the implementation of a RAP study including census and socio-economic surveys.	Measures need to be taken according to JICA Guidelines.	The project proponent will carry out a series of surveys including census and socio-economic surveys and prepare an ARAP.
12	[WB OP 4.12 Para.15] Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.	The Land Acquisition Act stipulates the protection of formal legal rights to land, but no legislation prescribes the rights of squatters, street vendors, and occupants without formal legal rights to land.	Measures need to be taken for PAPs who do not have rights according to JICA Guidelines.	The project proponent will carry out census and socio-economic surveys for all PAPs and prepare an ARAP.
13	[WB OP 4.12 Para.11] Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.	Options except compensation are not prescribed in any legislations.	The desire of PAPs needs to be considered.	Figuring out preferences of PAPs via census and socio-economic surveys and public consultations, the project proponent will reflect them on the methods for compensation and other assistances.
14	[WB OP 4.12 Para.6] Provide support for the transition period (between displacement and livelihood restoration).	No legislation prescribes any assistances for PAPs during resettlement	If livelihood assistances are required after resettlement, the project proponent needs to consider the adoption of further assistances.	Assistances for PAPs which were found necessary through census and socio-economic surveys or public consultations will be integrated into the ARAP.
15	[WB OP 4.12 Para.8] Particular attention must be paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women, and children, ethnic minorities, etc.	No legislation prescribes any assistances for vulnerable PAPs.	Measures need to be taken according to JICA Guidelines.	If vulnerable groups are included in PAPs, relevant considerations will be examined.
16	[WB OP 4.12 Para.25] For a project that entails land acquisition or involuntary resettlement of more than 200 people, a resettlement action plan is to be prepared.	No legislation prescribes the preparation of a RAP.	Measures need to be taken according to JICA Guidelines.	An ARAP will be prepared with consideration for the scale of impacts.

(5) Land Acquisition and Resettlement Policy of the Project

Regarding the existence of gaps between its national legislations and JICA Guidelines, the Malawi government adopts the following policy for this project.

(i) The policy aims at plugging the gaps between national laws and JICA Guidelines and specifies entitlements of PAPs in accordance with types and severity of losses. If there is a gap between national legislations and JICA Guidelines in terms of resettlement, viable

measures will be examined in a way to fulfill both regulations.

(ii) Alternatives are examined in a way to avoid or minimize resettlement.

(iii) In case that resettlement is unavoidable, sufficient compensation or assistance will be made in order to improve or at least restore the livelihood of PAPs.

(iv) Compensation or assistance will be provided to all people who have the following impacts:

- Negative impacts on living standards;
- Negative impacts on rights to residence, rights to land use and permanent or temporary rights to agricultural land, grazing land, business sites, tenancy, annual or perennial crops and trees, and other real estates;
- Temporarily or permanently negative impacts on opportunities for income generation, businesses, jobs and business sites of residents; and

(v) Regardless of land ownership and social status, all PAPs will be eligible for compensation or assistance. If census and asset inventory surveys prove that a person in question is residing, working, running his/her business or farming in the project-affected areas, he or she will be eligible for compensation or assistance.

(vi) If parts of assets are lost and the rest of the assets are not enough to sustain future livelihood, the owner will be considered for resettlement.

(vii) Temporal impacts will also be considered in the RAP.

(viii) The RAP will be prepared in compliance with Malawi's legislations on land acquisition and resettlement and JICA Guidelines on resettlement.

(ix) Compensation will be made with consideration for replacement costs.

(x) The geographical conditions and productivity of the resettlement site should be equivalent to those of the pre-resettlement site.

(xi) Assistance for resettlement will be provided not only for immediate losses but also for the transition period in order to restore living standards of PAPs. In detail, this assistance can take the form of short-term employment, special benefits, and income compensation.

(xii) The RAP should take into account negative impacts on the needs of most vulnerable PAPs. In addition, assistance should be provided for improving their socio-economic status. The most vulnerable include impoverished people, people without land ownership, indigenous people, minorities, women, children, senior citizens, and disabled people.

(xiii) PAPs will participate in the preparation and implementation of the RAP.

(xiv) Regarding this project, rights of PAPs, and mitigation measures under examination against negative impacts, opinions of PAPs and their community will be collected. In addition, PAPs will participate in the decision-making process for resettlement if possible.

(xv) The entire costs needed for land acquisition, compensation, and income restoration will be prepared within the agreed period. The whole cost required for resettlement will be paid by the Malawi government.

(xvi) Physical resettlement will not be implemented until compensation and assistance required for resettlement are provided. Infrastructure in the resettlement site will be sufficiently aligned before resettlement. Asset acquisition, disbursement of compensation, resettlement, and livelihood restoration activities should be completed before construction except that expropriation is ruled by the court.

(xvii) Organizational and management systems which help efficiently prepare and implement the RAP will be established before the resettlement process begins. The systems entail human resources required for the management of monitoring for public consultations, land acquisition, and income restoration activities.

(xviii) As parts of the resettlement management system, an appropriate mechanism for monitoring, evaluation, and reporting will be set up.

1-3-2-3 Scale and Scope of Land Acquisition and Resettlement

The project is accompanied with the acquisition of 0.57 hectare of land, the demolition of structures including fences, and 287 PAPs. PAPs are business owners including street vendors, employees and land owners and do not include any residents who lose their residence and are forced to resettle.

(1) Census Survey

Table 1-3-21 presents the result of a census survey of PAPs. The business conditions of PAPs are illustrated in the following pictures.

Table 1-3-21 Result of Census Survey

Category	Business Condition	Photo	No. of Employers	No. of Employees	Total
Street vendors	SIM / pre-paid card sellers	1-3-11, 1-3-12	18	3	21
	Souvenir sellers as tenants	1-3-13	35	41	76
	Souvenir sellers equipped with their own makeshift stalls	1-3-14	32	21	53
	Vendors at the Old Market adjacent to the Lilongwe Bridge	1-3-15	103	15	118
Land owners	-	-	3	-	3
Businessmen in possession of fixed business facilities	Gasoline station	1-3-16	1	12	13
	Shops (land owners)	-	1	-	1
Others	Horticulture	-	2	-	2
Total			195	92	287

Source: ARAP Report

Photo 1-3-11 SIM / Pre-paid Card Sellers

Photo 1-3-12 SIM / Pre-paid Card Sellers

Photo 1-3-13 Souvenir Sellers as Tenants

Photo 1-3-14 Souvenir Sellers Equipped with Makeshift Stalls

Photo 1-3-15 Vendors at the Old Market Adjacent to the Lilongwe Bridge

Photo 1-3-16 Gasoline Station

On the stakeholder meeting before the census survey, Cut-off-date was declared as commencement date of the census survey.

(2) Land and Asset Survey

Table 1-3-22 demonstrates land acquired and assets dismantled by the project.

Table 1-3-22 Project-Affected Land and Assets

Category	Item	Unit	Quantity	Note
Land	Old town	m^2	950	commercial area
	Detour route	m^2	4,754	commercial and unused area
	Total	m^2	5,704	
Asset	Billboard	no.	11	-
	Road sign	no.	21	-
	Fruit tree	no.	82	-
	Tree (indigenous species)	no.	21	-
	Tree (exotic species)	no.	48	-
	Block wall	m	264	-
	Fence	m	96	-
	Building structure (Gasoline stand)	no.	1	-

Source: ARAP Report.

(3) Household and Livelihood Survey

The composition of PAP households is presented in Table 1-3-23. Average numbers of household members are 6.5. The numbers of children in a household are 3.0.

Table 1-3-23 Composition of PAP Households

Item	Average	Minimum	Maximum
No. of household members	6.5	3	12
No. of children in household	3.0	1	6

Source: ARAP Report.

The income and food expense levels of PAPs are presented in Table 1-3-24.

Table 1-3-24 Monthly Income and Food Expense of PAPs

Item		Average	Minimum	Maximum
Monthly income	Main source	MWK 281,250	MWK 60,000	MWK 600,000
	Secondary source	MWK 68,000	MWK 40,000	MWK 150,000
Monthly food expense		MWK 104,400	MWK 45,000	MWK 180,000

Source: ARAP Report.

The daily food expense level of PAPs is described in Table 1-3-25.

Table 1-3-25 Daily Food Expense of PAPs

Daily Food Expense Range	Percentage
MWK 1,500 ~ 2,000	8.0%
MWK 2,001 ~ 3,000	44.0%
MWK 3,001 ~ 4,000	28.0%
MWK 4,001 ~ 5,000	16.0%
More than MWK 5,000	4.0%
Total	100.0%

Source: ARAP Report.

Table 1-3-26 portrays the education level of PAPs. According to the survey, 92% of respondents attained primary or secondary education.

Table 1-3-26 Education Level of PAPs

Education Level	Percentage
Cannot read / write	4.0%
Primary certificate	44.0%
Secondary certificate	48.0%
Other certificates	4.0%
Total	100.0%

Source: ARAP Report.

Accessibility to public services including electricity and piped water is presented in Table 1-3-27.

Table 1-3-27 Asset Ownership and Accessibility to Public Services

Methods to Use Electricity and Water		Percentage
Use electricity for lighting		60.0%
Possess a TV		76.0%
Methods for water use	Share a water pipe	28.0%
	Use piped water in a plot	52.0%
	Use piped water in a dwelling house	8.0%
	Use a well	12.0%

Source: ARAP Report.

(4) Socially Vulnerable Groups

Among the PAPs, the number of women is forty, occupies 14 percent. The female PAPs include five heads of household. Juvenile and minority are not included in the PAPs. The average PAP household income amounts to about USD 16 a day, which is above World Bank's international poverty line of USD 1.90 a day per capita even when considering the size of PAP households. However, the minimum PAP household income hovers at around USD 4.6 a day, below the international poverty line, and thereby PAPs arguably include impoverished people.[5]

1-3-2-4 Measures for Compensation and Assistance

(1) Compensation for Loss

The project entails land acquisition and the demolition of existing structures due to the expansion of the existing road. Accordingly, land owners with formal legal rights are expected to have compensation equivalent to a market price and 30 percent of additional fees, i.e., disturbance fees and costs of any registration and transfer taxes. When it comes to economic displacement, employers will be compensated for relocation fees and business losses, and employees affected by the project will be separately compensated.

On the other hand, business facilities of PAPs are mostly makeshift street stalls which can be readily relocated, so there will be no compensation for the facilities except for a gasoline station.

(2) Measures for Livelihood Restoration

Street vendors can continue their business after simple relocation and are not forced to change their livelihoods, so specific measures for livelihood restoration will not be arranged.

(3) Resettlement Site

In the case of SIM / pre-paid card sellers and vendors at the Old Market, their business will not be bothered by relocation. For vendors at the Old Market who install street stalls on the road, Lilongwe City has ushered them to relocate to a vacant space in the Old Market. Regarding the vendors who are operating in front of NICO Center, LCC is aiming to set them back. Although the relocation might decrease a parking space, it is a plausible measure in terms of physical conditions.

(4) Entitlement Matrix

Table 1-3-28 delineates the entitlement matrix for the project.

[5] World Bank website: http://www.worldbank.org/en/news/press-release/2015/10/04/world-bank-forecasts-global-poverty-to-fall-below-10-for-first-time-major-hurdles-remain-in-goal-to-end-poverty-by-2030.

Table 1-3-28 Entitlement Matrix

Type of Loss	Entitled Persons	Entitlements	Intent / Requirement	Responsibility
A. COMMERCIAL LAND				
Loss of commercial land	Owner with registered title	All (cash) payments for land lost at full replacement cost;	Payment for lost assets, assistance to reorganize on existing land or relocate on alternate land and support for transition period.	LCC / RA
		Disturbance allowance 30% to cover land transition costs; processing of title documents		LCC / RA
B. STRUCTURES				
Loss of Commercial structure	Owner with title deed or registration certificate	All (cash) payments for land and structure will be made at full replacement costs.	Payment for lost assets, assistance to reorganize on existing land or relocate on alternate land and support for transition period.	LCC / RA
		All payments at full replacement cost in material, cash, or a combination of both according to the actual loss to repair or rebuild the structure to original or better condition when remaining land sufficient to rebuild upon;		LCC / RA
		For structures not having sufficient land to rebuild upon will be entitled to the following:		LCC / RA
		All (cash) payments for land and structure at full replacement cost (for materials and labor) in material, cash, or a combination of both, WITHOUT deduction for depreciation or salvageable materials;		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
Loss of Commercial Structure	Owner of registered business	Payment at full replacement cost in material, cash, or a combination of both according to the actual loss to repair or rebuild the structure to original or better condition when remaining land sufficient to rebuild upon;	PAPs will relocate as soon as payment is released and clear the area in the agreed timeframe. Transition assistance and income restoration.	LCC / RA
		Payment for any associated loss of income while commercial structure is being rebuilt.		LCC / RA
		For structures not having sufficient land to rebuild upon will be entitled to the following:		LCC / RA
		All (cash) payments for structure lost at full replacement cost (for materials and labor) in material, cash, or a combination of both, WITHOUT deduction for depreciation or salvageable materials;		LCC / RA
		Assistance to locate alternative		LCC / RA

Type of Loss	Entitled Persons	Entitlements	Intent / Requirement	Responsibility
		plot for relocation;		
		For income losses cash payment not exceeding three times the average annual net profits from business, as shown by the books of accounts, for three calendar years immediately preceding acquisition or livelihood restoration grant, whichever is higher		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
Loss of commercial Structure	Tenant/operator of registered business	If there is partial loss of structure, PAP has the option to stay with the owners agreement OR if PAP choses to move out, cash assistance for 6 months rental allowance AND	Cash payment for rental allowance or cash value of remaining lease, assistance for finding alternate rental accommodation and support for income losses and during transition period.	LCC / RA
		Payment for any associated loss of income while commercial structure is being rebuilt.		LCC / RA
		If there is complete loss of structure, PAP will be entitled to the followings:		LCC / RA
		Cash for the value of the remaining lease OR		LCC / RA
		Cash assistance to cover rental arrangements for minimum period of 6 months of equivalent standard and advance payments as determined by the chief valuer to owner on a case to case basis whichever is higher AND		LCC / RA
		For income losses cash payment not exceeding three times the average annual net profits from business, as shown by the books of accounts, for three calendar years immediately preceding acquisition or livelihood restoration grant, whichever is higher		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
Loss of commercial Structure	Owner or operator of non-registered business /vendor	For structure – all payments for structure lost at full replacement cost in material, cash, or a combination of both according to the actual loss; AND	Payment for lost assets, transition assistance and income restoration	LCC / RA
		For income - cash payment equivalent to 6 months income OR		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
Loss of rental accommodation	Tenant, user with lease	If there is partial loss of rental accommodation, PAP has the	Cash payment for rental allowance or cash value	LCC / RA

Type of Loss	Entitled Persons	Entitlements	Intent / Requirement	Responsibility
		option to stay with the owners agreement OR if AP choses to move out, cash assistance for 6 months rental allowance AND	of remaining lease, assistance for finding alternate rental accommodation and support during transition period.	
		Assistance in finding new affordable rental accommodation AND		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
		If there is complete loss of rental accommodation, AP has the option of cash for the value of the remaining lease OR		LCC / RA
		Cash assistance to cover rental arrangements for minimum period of 6 months of equivalent standard and advance payments as determined by the chief valuer to owner on a case to case basis whichever is higher.		LCC / RA
		Assistance in finding new affordable rental accommodation AND		LCC / RA
		Shifting allowance as per the entitlement matrix schedule		LCC / RA
C. OTHER PRIVATE PROPERTIES OR SECONDARY STRUCTURES				
Partial or complete loss of other property or secondary structure (i.e., billboards, fences, etc.)	Owners of structures (regardless if the land is owned or not)	All (cash) payments for affected structure at full replacement cost; OR	Payment for loss and relocation if required	LCC / RA
		Cost of repair of structure to original or better condition; OR		LCC / RA
		Cash assistance for relocation of structure.		LCC / RA
D. LOSS OF INCOME OF EMPLOYEES OR HIRED LABORERS				
D.1. Temporarily Affected				
While business re-establishes (i.e. reorganizing on remaining land or relocating in the same area)	All affected employees, wage or daily laborers in private or government businesses	Cash payment for lost salary/wages for each month PAP cannot work; OR	Businesses will be encouraged to retain existing employees	LCC / RA
			Payment for lost income during business re-establishment	LCC / RA
D.2 Permanently Affected				
Job loss due to relocation of business to another area or business operator decides not to re-establish	All affected employees, wage or daily laborers in private or government businesses	Cash payment for 6 months' salary/wages and	Payment for lost income, rehabilitation package to provide support and income restoration	LCC / RA
		Project will encourage employers to provide severance pay for employees; AND		LCC / RA
		Preferential access to project construction employment opportunities; AND		LCC / RA

Type of Loss	Entitled Persons	Entitlements	Intent / Requirement	Responsibility
E. Special Assistance				
Effects on vulnerable PAPs	Vulnerable PAPs including the poor, elderly PAPs, female-headed households, and disabled	Assistance to vulnerable households will be given an additional 10% compensation	Assistance, over and above payment for lost assets, to reduce impacts of resettlement which can disproportionately affect the already vulnerable and to ensure that the project does not simply re-establish levels of poverty, vulnerability or marginalization	LCC / RA
Any unanticipated adverse impact due to project intervention	Any unanticipated consequence of the project will be documented and mitigated based on the spirit of the principles agreed upon in this policy framework.			LCC / RA
F. Public Assets, i.e., Road Signs, Power Lines, and Water Mains				
Public Assets	Public Institutions	Cash payment at full replacement cost for all damaged assets; OR		LCC / RA
		reinstatement of structures or property if not damaged to its original position		LCC / RA

Source: ARAP Report.

1-3-2-5 Grievance Redress Mechanism

(1) Organizations with Regard to the Grievance Redress Procedure

The following organizations will be engaged in the grievance redress procedure of the project.

Lilongwe City Council (LCC)

The LCC will take a main role in the RAP implementation for the project and establish the Grievance Redress Committee (GRC) to accept complaints from PAPs. The committee will consist of representatives from the LCC, the RA, the MLHUD, independent valuers, the Lilongwe Street Vendors Association (LSVA), and stakeholders especially women groups.

Roads Authority (RA)

The RA is not directly involved in the RAP implementation but is supposed to assist the LCC as the project proponent if necessary. In addition, the authority will engage in the grievance redress process as a GRC member.

Lilongwe Street Vendors Association (LSVA)

The LSVA is an organization to coordinate common interests among vendors in the Lilongwe City and provides a two-way channel of communications between the LCC and street vendors in the city. The association will also engage in the grievance redress process as a GRC member.

Grievance Redress Procedure

The grievance redress procedure can be divided into the following three steps.

Step 1: Documenting Grievances

A grievance is filed to the GRC and documented for verification. Based on opinions collected from the parties concerned, for example, the LSVA in case of street vendors, the grievance is put in writing.

Step 2: Lodging Grievances to the GRC Secretariat

Regarding the grievance documented at the first step, the GRC secretariat carries out consultations with the parties concerned and suggests solutions in oral or writing for aggrieved persons.

Step 3: Legal Measures

If the grievance is not settled at the second stage, the legal process will be pursued. If an aggrieved person cannot receive any response from the GRC within 15 days from the receipt of the grievance, he or she can exercise constitutional rights by bringing the grievance to the formal court system for remedy. Then, the aggrieved party will be exempted from all relevant costs including litigation expenses.

1-3-2-6 Institutional Mechanism for RAP Implementation

The LCC, the RA, and the MLHUD will engage in land acquisition and resettlement.

Lilongwe City Council (LCC)

The council will carry out consultations and make compromise with PAPs and implement resettlement in terms of land acquisition and resettlement. Also, the LCC will establish the GRC and deal with grievances.

Ministry of Lands, Housing and Urban Development (MULHUD)

The ministry will evaluate land and assets and make compensation for any loss.

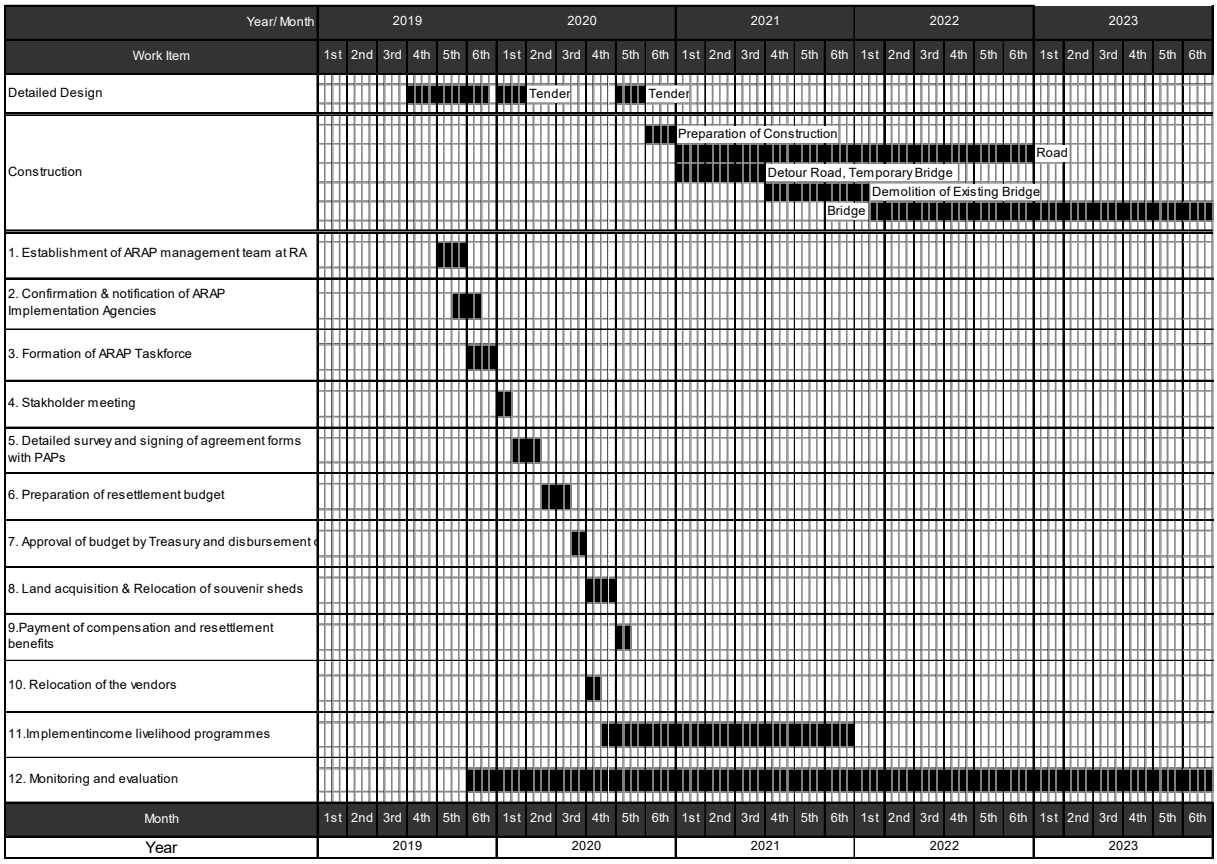
Roads Authority (RA)

The authority will implement monitoring with regard to land acquisition and resettlement and prepare and submit monitoring reports.

1-3-2-7 RAP Implementation Schedule

Table 1-3-29 shows the implementation schedule for land acquisition and resettlement.

Table 1-3-29 RAP Implementation Schedule



1-3-2-8 Costs and Budgets

Costs for land acquisition and resettlement are presented in Table 1-3-30.

Table 1-3-30 Costs for Land Acquisition and Resettlement

Name	No / Length	Unit	Rate (MWK)	Total (MWK)
Billboards	11	No.	2,500,000.00	27,500,000
Road signs	21	No.	500,000.00	10,500,000
Fruit trees	2	No.	10,123.27	20,247
Indigenous - large (detour)	3	No.	30,000.00	90,000
Indigenous trees (medium)	18	No.	16,000.00	288,000
Exotic trees - large (detour)	3	No.	20,000.00	60,000
Exotic trees	45	No.	20,000.00	900,000
Fruit trees -guava (detour)	4	No.	23,517.21	94,069
Fruit trees - bananas (detour)	76	No.	20,294.32	1,542,368
Brick fences	264	m	45,000.00	11,880,000
Chain link wire fence	96	m	35,000.00	3,360,000
Land compensation	0.095	ha	900,000,000.00	85,500,000
Land compensation (detour)	0.475	ha	900,000,000.00	427,500,000
Structures (LL filling station)	1	No.	-	416,500,000
Disturbance allowances (30% of permanent land take)	30% of land take	-	30% of land take	153,900,000
Shifting allowances for business owners (depending on the distance)	195	No.	110,000.00	21,450,000
Allowances for business losses	195	No.	90,000.00	17,550,000
Employees compensation (filling station)	12	No.	50,000.00	600,000
Employees compensation (Lilongwe bridge, FMB, and Mobile Money kiosks)	80	No.	128,000.00	10,240,000

Name	No / Length	Unit	Rate (MWK)	Total (MWK)
Base value	-	-	-	1,189,474,684
Contingency (20% of the of the base value)	20% of base value	-	20% of base value	237,894,937
Grand Total Amount				**1,427,369,621**

Source: ARAP Report.

Unit costs of the compensations are below;

- Land costs which are assessed by registered land values, considering neighboring area;
- Costs of trees is based on 2010's gadget of Department of Forestry;
- Disturbance allowance is based on the rates of World Bank projects on sub-Sahara Africa area;
- Loss of business is based on the rates of the other Malawi project (Millennium Challenge Corporation Project; and
- Employee compensation is six months of monthly salary.

1-3-2-9 Monitoring System and Monitoring Form

The RA, or the implementing agency will implement monitoring on land acquisition and resettlement and report the results to JICA. The monitoring system is presented in Figure 1-3-12.

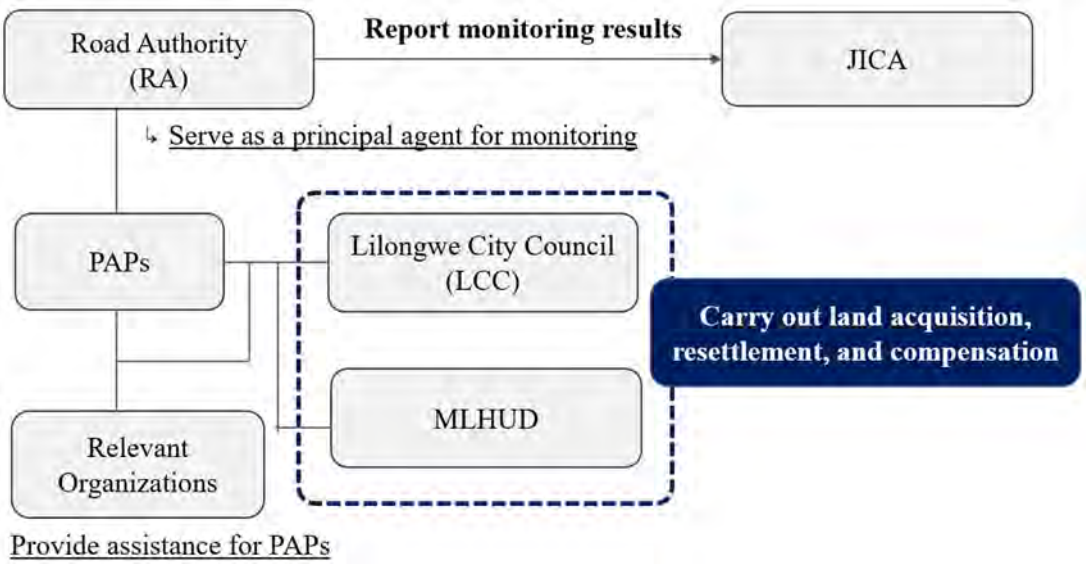


Figure 1-3-12 Monitoring System for Land Acquisition and Resettlement

The internal monitoring form is demonstrated in Table 1-3-31.

Table 1-3-31 Internal Monitoring Form

Category	Indicator	Quarter No. Review (%)	Cumulative (%)	Recommended Action	Responsibility
Land Acquisition & Resettlement	**Are resettlement implementation activities being carried out in concert with an agreed implementation plan?**				
	Percentage of the disbursement of resettlement funds				
	Number of PAPs who have signed consent papers				
	Percentage of the completion of land acquisition				

Category	Indicator	Quarter No. Review (%)	Cumulative (%)	Recommended Action	Responsibility
	Percentage of PAPs given entitlements according to numbers and categories of losses set out in the Entitlement Matrix				
	Progress in the restoration of social infrastructure and services				
Livelihood Restoration	**Are PAPs able to access schools, health facilities, public transports and cultural sites and activities?**				
	Percentage of PAPs who have received income and livelihood restoration supports				
	Percentage of businesses which have received entitlements including payments for a net loss caused by the shutdown of business and the suspension of production				
Disclosure	Number of consultations held as scheduled				
Grievance Redress System	Number of complaints filed by non-PAPs				
	Number of disclosure meetings held				
	Number of grievances handled by the Market Committee				
	Number of grievances handled by the GRC				
	Number of grievances referred to the legal court system				
Assistance to Vulnerable Groups	Number of identified vulnerable PAPs				
	Actions taken to avoid or mitigate negative impacts towards vulnerable groups				
	Number of complaints lodged by vulnerable groups				
Monitoring of Impacts	What kinds of changes have occurred in terms of professions, production, and use of resources compared to the pre-project situation?				
	What kinds of changes have occurred in terms of income and expenditure patterns compared to pre-project situation?				
	Have changes occurred in the level of living costs compared to the pre-project situation?				
	What kinds of changes have occurred in key social and cultural parameters with regard to living standards?				
	What kinds of changes have occurred for vulnerable PAPs?				
Assessment	Overall assessment on the accomplishment level of RAP implementation				

1-3-2-10 Public Consultations

Two rounds of public consultations were carried out during ARAP study. The consultation was implemented in combination with EIA study to explain the project outline and collect opinions from stakeholders.

(1) First Round of Public Consultations

- Consultation Method: Individual interview
- Consultation Period: 27 February to 2 March 2018
- Participants: 77 major stakeholders related to the project (69 men and 8 women including stakeholders from roadside businesses, schools and a religious facility, vendors, and government employees)
- Notification Method: Delivery of the notification letter issued by the RA
- Purpose: Explain the project outline and collect opinions of stakeholders
- Major Opinions: All stakeholders consented to the implementation of the project and commented on requests and concerns in terms of land acquisition and resettlement as follows.

Requests and Concerns Regarding Land Acquisition and Resettlement	Responses of Project Proponents (Consultant)
Appropriate compensation should be made for PAPs or project-affected businesses.	A survey of Resettlement Action Plan is conducted. Based on the survey, project affected persons will be compensated appropriately.
Decongestion might reduce business sales.	The project will solve the road congestion, and activate economy. This will give positive impacts to the business.
Sufficient consultations between PAPs and the project proponent should be implemented.	The project proponents will consult with the PAPs to agree.
Compensation should be made for the loss of business facilities.	In case that the PAPs loses due to the resettlement, appropriate compensations will be done based on the RAP.
Consultations should be carried out before construction	The project proponents will continue consultation with the PAPs before the project implementation.

Source: ARAP Report.

(2) Second Round of Public Consultations

- Consultation Method: Community meeting
- Consultation Period: 10 June 2018
- Participants: 45 major stakeholders and PAPs related to the project (40 men and 5 women including stakeholders from roadside businesses, schools and a religious facility, vendors, and government employees)
- Notification Method: Delivery of the notification letter issued by the RA
- Purpose: Explain the project outline, expected impacts, and entitlements and collect opinions of stakeholders
- Major Opinions: As the first round of stakeholder consultations, all stakeholders consented to the implementation of the project and commented on requests and concerns as follows.

Opinions, Requests and Concerns Regarding the Project Implementation	Responses of Project Proponents (Consultants)
• Traffic congestions on the M1 road will be alleviated. • While negative impacts on businesses might occur in the short term, especially during construction, traffic flows and movement will be improved in the long run.	-
[Concerning Resettlement and Consensus Building] • The project will cause the demolition of street stalls, gasoline stands, fences, and billboards.	In case that the PAPs loses due to the resettlement, appropriate compensations will be done appropriately based on the RAP.

Source: ARAP Report.

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

2-1-1 National Goal and Project Objective

The Government of Malawi formulated the Malawi Growth and Development Strategy (MGDS) III (2017-2022) to contribute to the attainment of Malawi's long-term development aspirations enshrined in Vision 2020. The overarching theme for the MGDS III is "Building a Productive, Competitive and Resilient Nation". The strategy identifies five Key Priority Areas (KPAs): (i) Agriculture, Water Development and Climate Change Management; (ii) Education and Skills Development; (iii) Transport and ICT Infrastructure; (iv) Energy, Industry and Tourism Development; and (v) Health and Population.

The Key Priority Outcome of the Transport and ICT Infrastructure Area is "Enhanced equitable access to social and economic services, local and international markets through safe, reliable and affordable transport and ICT infrastructure," and one of the major strategies is to develop transport corridors in order to improve the competitiveness of Malawian goods and services in its local and international markets.

The objective of the Project is to realize the goal of the Transport and ICT Infrastructure Area in MGDS III by upgrading National Road No. 1 (M1 road), which is the main route to each provincial capital neighboring Zambia, Tanzania and Mozambique.

Table 2-1-1 National Policy and Goal and Project Objective

National Policy	Overarching Theme of MGDS III Building a Productive, Competitive and Resilient Nation
National Goal	Key Priority Outcome of Transport and ICT Infrastructure Area Enhanced equitable access to social and economic services, local and international markets through safe, reliable and affordable transport and ICT infrastructure
Project Objective	Realization of the goal of the Transport and ICT Infrastructure Area in MGDS III by upgrading the M1 road, which is the main route to each provincial capital and neighboring Zambia, Tanzania and Mozambique.

2-1-2 Project Outline

The Project is designed to upgrade the M1 road into a four-lane carriageway between Sunbird Lilongwe Hotel Junction and Lubani Junction including reconstruction of the Lilongwe River Bridge. It is expected to contribute to improving transportation capacity in Lilongwe City and boosting Malawi's socio-economic growth. Major components of the project are shown in Table 2-1-2.

Table 2-1-2 Major Components of the Project

Project Component	Specification
Four-lane Widening of the Existing Road	L=2.75 km (Sunbird Lilongwe Hotel Junction to Lubani Junction)
Reconstruction of the Lilongwe River Bridge (including demolition of the existing bridge)	Existing bridge: W=10.5 m, L=75.0 m, New bridge: W=34.7 m, L=78.0 m
Intersection Improvement	7 intersections
Street Light Installation	144 units
Traffic Signal Installation	For vehicle 122 signal, for pedestrian 78 signal
Crosswalk Installation	40 locations
Installation of Pedestrian Fencing on the Median Strip	L=1,332 m

2-2 Outline Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Scope of the Project

The project scope which maximizes project effects and minimizes the burden of the Government of Malawi was determined in the light of current status and issues of the project road, its surrounding social and environmental conditions, and the result of traffic demand forecasts (Table 2-2-1).

In the first place, the Government of Malawi requested Japanese assistance for 5.80 kilometers (km) of the road section ranging from Mchinji Roundabout to Chidzanja Junction. According to comprehensive technical examination by the survey team, however, the original request will increase the total construction cost including the replacement cost of the existing bridge and extend construction duration. In this regard, the survey team suggested an alternative to narrow down the project scope to 2.75 km of the road section from Sunbird Lilongwe Hotel Junction to Lubani Junction, and thereby the two governments agreed on the revised project scope below (Appendix 4.4 for M/D concluded on 14 November 2018).

Requested Scope of the Project	• Four-lane widening between Mchinji Roundabout and Chidzanja Junction (L = 5.80 km) • Improvement of 11 intersections
Revised Scope of the Project	• Four-lane widening between Sunbird Lilongwe Hotel Junction and Lubani Junction (L = 2.75 km) • Improvement of 7 intersections

Figure 2-2-1 Scope of the Project

Table 2-2-1 Future Traffic Demand

Section			Y 2018					Y 2027 (3 years after completion)					Y 2034 (10 years after completion)				
			Lane No	Traffic Demand (Veh/day)	Traffic Demand (PCU/day)	Traffic Capacity (PCU/day)	VCR (Volume Capaciti Ratio)	Lane No	Traffic Demand (Veh/day)	Traffic Demand (PCU/day)	Traffic Capacity (PCU/day)	VCR (Volume Capaciti Ratio)	Lane No	Traffic Demand (Veh/day)	Traffic Demand (PCU/day)	Traffic Capacity (PCU/day)	VCR (Volume Capaciti Ratio)
1	Mchinji RA - Selous Road	① – ②	2	16,716	16,829	24,000	70%	2	20,295	20,432	24,000	85%	2	27,899	28,087	24,000	117%
2	Selous Road - Colby Road		2	19,368	19,499	24,000	81%	2	23,827	23,988	24,000	100%	2	30,157	30,361	24,000	127%
3	Colby Road - Sunbird Lilongwe Hotel JCT		2	18,008	17,588	24,000	73%	2	21,969	21,457	24,000	89%	2	30,173	29,470	24,000	123%
4	Sunbird Lilongwe Hotel JCT - Kenyatta JCT	② – ③	2	21,481	21,044	16,000	132%	4	33,018	32,346	41,000	79%	4	46,889	45,934	41,000	112%
5	Kenyatta JCT - Mandala Road	③ – ④	2	24,133	24,120	16,000	151%	4	36,794	36,775	41,000	90%	4	52,760	52,732	41,000	129%
6	Mandala Road - Murry JCT		2	16,030	16,029	16,000	100%	4	25,860	25,859	41,000	63%	4	41,320	41,318	41,000	101%
7	Murry JCT - Town Hall RA	④ – ⑤	2	20,016	20,596	16,000	129%	4	31,104	32,005	41,000	78%	4	48,678	50,088	41,000	122%
8	Town Hall RA - Old Town Market JCT (West side)	⑤ – ⑥	2	25,739	26,005	16,000	163%	4	39,766	40,176	43,000	93%	4	56,299	56,881	43,000	132%
9	Old Town Market JCT (West side) - Old Town Market JCT (East side)	⑥ – ⑦	2	14,838	14,668	16,000	92%	4	25,677	25,383	43,000	59%	4	45,678	45,154	43,000	105%
10	Old Town Market JCT (East side) - Malangalang JCT		2	14,871	14,668	16,000	92%	4	25,734	25,383	41,000	62%	4	39,233	38,698	41,000	94%
11	Malangalanga JCT - Lubani JCT	⑦ – ⑧	2	18,034	18,157	16,000	113%	4	31,779	31,995	41,000	78%	4	42,303	42,591	41,000	104%
12	Lubani JCT - Community Center JCT	⑧ – ⑨	2	18,232	18,760	24,000	78%	2	19,887	20,463	24,000	85%	2	26,793	27,569	24,000	115%
13	Community Center JCT - Technical School JCT (North side)	⑨ – ⑩	2	20,380	20,840	24,000	87%	2	22,840	23,356	24,000	97%	2	30,371	31,056	24,000	129%
14	Technical School JCT (North side) - Technical School JCT (South side)		2	17,384	17,750	24,000	74%	2	21,932	22,394	24,000	93%	2	32,979	33,675	24,000	140%
15	Technical School JCT (South side) - Chidzanja North JCT	⑩ – ⑪	2	18,845	20,110	24,000	84%	2	21,872	23,341	24,000	97%	2	26,611	28,398	24,000	118%
16	Chidzanja North JCT - Chidzanja JCT		2	16,632	21,140	24,000	88%	2	18,128	23,042	24,000	96%	2	20,851	26,503	24,000	110%
Average of sections between② and ⑧			-	19,388	19,399	16,000	121%	-	31,532	31,548	41,393	76%	-	45,763	45,782	41,393	111%
Average of whole sections			-	18,763	19,217	21,063	91%	-	25,133	25,645	30,384	84%	-	34,588	35,215	30,384	116%

Note: the circled numbers in the table indicate the JCT numbers on the map of the previous page

2-2-1-2 Design Policy

(1) Design Contents

In this survey, designs of road sections for improvement, bridges, intersections with access roads, connections of road drainage facilities, and a detour road during construction will be carried out as shown in Section 2-2-1-1 Scope of the Project.

(2) Design Standards

Road Geometric Design Standards

The Code of Practice for the Geometric Design of Trunk Roads—drafted in September 1998 and reprinted in July 2001 by the Southern Africa Transport and Communications Commission (SATCC)—and its addendum (March 2015), the supplemental standard in Malawi will be basically applied for road geometric design. As for detailed design items which are not prescribed in the above-mentioned standards, however, the Japanese Government Order Concerning the Road Design Standards by the Japan Road Association (JRA, 2015) will be utilized.

Drainage Facility Design

The Japanese Road Earthwork and Drainage Guideline (JRA, 1987) will be applied for drainage facility design since SATCC standards do not deal with the relevant issue.

Road Pavement Design

The Guide for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO, 1993) will be basically applied for road pavement design. Additionally, a comparative analysis on pavement design based both on the AASHTO Guide and the Code of Practice for the Design of Road Pavement—drafted in September 1998 and reprinted in July 2001 by the SATCC—will be carried out to confirm the results of road pavement design.

Bridge Design

The bridge design will be drawn up based on the Code of Practice for the Design of Road Bridges and Culverts (SATCC, September 1998), which has been applied in Malawi. In addition, the Specifications for Highway Bridges in Japan (JRA, 2012) will be utilized for structural design items, which SATCC standards do not stipulate.

(3) Geometric Structure of the Project Road

In terms of the horizontal road alignment, the existing center line of the right-of-way will continue to be that of the widened road. For the lane configuration, in addition to the road widening from two to four carriageways, the installation of median strips, bicycle lanes, and sidewalks is examined in order to secure safety of bicycles and pedestrians. In addition, the longitudinal road alignment will be the same with that of the existing road, but the road gradient around the Lilongwe River Bridge shall be gentler with a view to mitigating traffic congestion caused by slow-speed vehicles

The existing bridge, which does not fulfill river conditions because of insufficient clearance below the bridge girder, will be replaced by a new bridge which meet the river conditions and accommodate future traffic volumes with its expanded width.

(4) Natural Conditions

The project facility plan and design are carried out based on the results of climate, topographical, geotechnical, and hydrological surveys. Peculiar natural conditions to be considered is a rainwater inflow from the roadside, which are reflected in the road drainage design. Other natural conditions do not give great impacts on the road and bridge plan and design and the construction plan.

There are not any natural parks, natural reserves or other preserved areas since the project area has been urbanized.

(5) Socio-economic Conditions

Cargo-handling spaces, bus stops, and sidewalks with enough widths will be installed because of frequent parking and stopping of commercial vehicles and many mini-buses and pedestrians on the project road. In addition, the road plan which does not entail the relocation of important cultural buildings such as the Old District Office and religious facilities like a mosque. At the same time, the project road will be improved in a way that a large-scale relocation of roadside commercial facilities is not accompanied.

2-2-2 Basic Plan

2-2-2-1 Basic Concept

(1) Positioning and Structural Issues of the Project Road

The project road, as parts of the Nacala Corridor, serves as an urban road, a community road, and an international trunk road, passing through the center of commercial districts in Lilongwe City. Nevertheless, it only has two lanes and cannot fully manage traffic at its main intersections, which leads to chronic traffic congestion. In particular, heavy traffic congestion is observed at the entry and exit points of commercial districts as well as near the Lilongwe River Bridge.

The intersection at the Lilongwe River Bridge, or the Old Town Market Junction is connected to a bus terminal, which accommodates all intra- and inter-city buses, so bus traffic accounts for around half of the total traffic volumes at the Lilongwe River Bridge. Moreover, traffic conditions are quite terrible due to unreliable traffic signals, the absence of a right-turn lane, and insufficient sidewalk capacity on the bridge since which the carriageway overflows with pedestrians. Accordingly, it is necessary to take fundamental measures to address these issues.

In addition, the survey team found that the Lilongwe River Bridge had yet to secure vertical clearance required for river management, so that it is necessary to replace the current bridge.

(2) Pedestrians and Bicycles

Even though many pedestrians and bicyclers use the project road, its conditions are not deemed safe due to narrow sidewalks and poor bicycle passages. To ensure road safety and eliminate stumbling blocks to road traffic, the project is designed to install sidewalks with adequate width, bicycle lanes, and safety facilities such as crosswalks and pedestrian fences.

(3) Relocation of Affected Assets

The widening of the project road entails resettlement and relocation of obstacles and parking lots including parking spaces of service roads, but it is necessary to consider the burdens of the Government of Malawi and establish a plan to minimize the project-affected assets. When it comes to the relocation of parking lots, in particular, the space for bus stops and loading and unloading areas will be secured as an alternative since it is difficult to install a new parking lot.

2-2-2-2 Road and Pavement Design

(1) Geometric Design

1) Design Standards

In principle, the SATCC standards and its addendum are adopted for the geometric design as mentioned in Section 2-2-1-2. In addition, Japan's Road Structure Ordinance is applied for geometric design standards described neither in the SATCC standards nor in its addendum.

- Draft Code of Practice for the Geometric Design of Trunk Roads (SATCC, September 1998/reprinted in July 2001)
- Draft Code of Practice for the Design of Road Pavement (SATCC, September 1998/reprinted in July 2001)
- Japan's Road Structure Ordinance (Japan Road Association, June 2015)

2) Design Class and Cross-Sectional Elements

As the project road is an arterial road located in an urban area, the C2 design class (design speed = 50 km/h) is applied according to the table below as presented in Table 2-2-2.

In the case of a short section of about 2.75 km as in this project, it is desirable to design a road with the same width at all sections. In order to avoid impacts on houses and buildings as much as possible, however, the project section will be divided into "Built-up Area" and "Non-built-up Area" and have reduced widths for built-up areas.

Table 2-2-2 Adopted Design Class (C2)

Functional Classification			Design Class	Design Traffic Flow Range (AADT)*	Typical Surfacing	Road Type	Width (m)		Design Speed / Terrain (km/hr)			Urban/ Semi-Urban
							Carriageway	Shoulder[1]	Flat	Rolling	Mountain	
		Arterial	C1	11000 - 30000	Paved	Dual carriageway	2x7.40	3.00	120	100	80	50
			C2	11000 - 30000	Paved	Dual carriageway (urban)	2x6.80	(2.00)	-	-	-	50
			C3	11000 - 25000	Paved	4-lane, 2-way	14.20	3.00	120	100	80	50
	Collector		C4	5000 - 12000	Paved	2-lane, 2-way	7.40	2.50	120	100	80	50
			C5	1000 - 7000	Paved	2-lane, 2-way	6.80	2.00	100	80	70	50
Access			C6	500 - 3000	Paved	2-lane, 2-way	6.20	1.50	80	70	60	50
			C7	150 - 500	LVSR	2-lane, 2-way	6.20	1.25	60	50	40	50
			C8	75–150	LVSR	2-lane, 2-way	5.50	1.00	70	60	50	50
			C9	150–500	Unpaved	2-lane, 2-way	9.00	-	60	50	40	50
			C10	50-250	Unpaved	2-lane, 2-way	7.00	-	60	50	40	30

Source: Addendum to SATCC standards.

Median (four-lane dual)

Economic factors and availability of land (urban areas) often limit the width of medians. The minimum width of medians can be reduced as narrow as 1.20 m to 3.0 m.

Source: Addendum to SATCC standards.

Footway

Standard footway widths are:		
Absolute minimum:	1.2 m	(for bridge decks)
Desirable minimum:	1.5 m	(two persons can pass each other closely)
Light volume:	2.0 m	(two persons can pass each other comfortably)
Heavy volume:	3.0 m +	(space for three persons)

Source: Addendum to SATCC standards.

Recommended Widths for Cycle Facilities

Type	Minimum Width (m) up to 100 cyclists/h	Standard Width (m) 100 - 300 cyclists/h	Width for Heavy Usage (m) above 300 cyclists/h
Cycleway (separate from carriageway)	2.0	2.5	3.5
Combined cycleway and footway	2.0	3.0	4.5
Cycle lane (one way)	1.5	2.0	2.5

Source: Addendum to SATCC standards.

3) Typical Cross Section

Based on the above-mentioned design standards, the different width for each road element will be adopted as shown below. The typical cross sections for non-built-up areas and built-up areas are shown in Figure 2-2-2. Although the reduced width is adopted to all the road elements of built-up areas in principal, sidewalks or bicycle lanes will be widened at the sections with high volumes of pedestrians or bicycles if necessary.

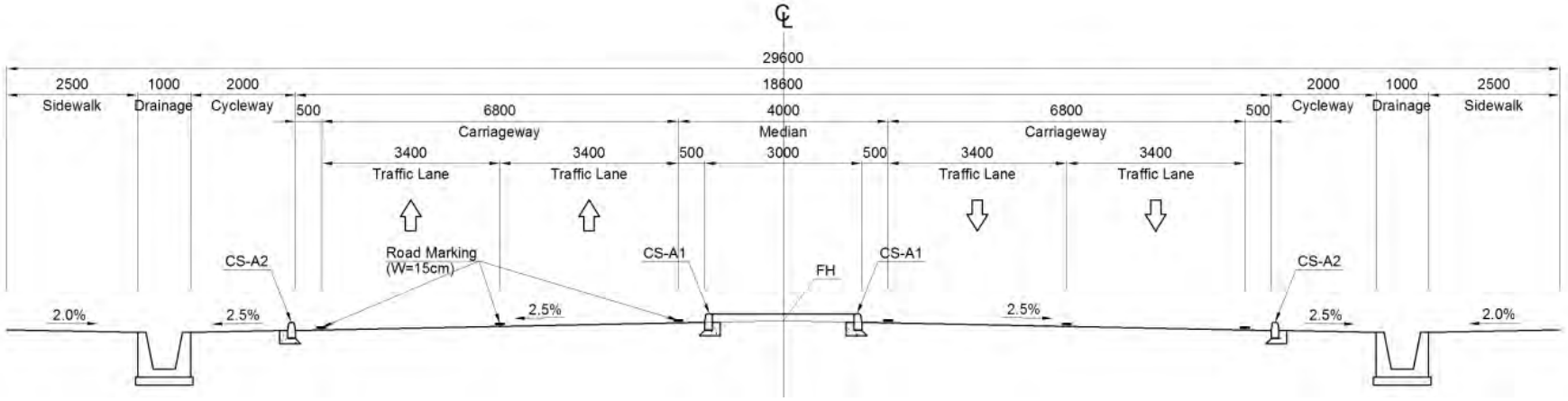
- Carriageway width: 2×x 6.80 m for non-built-up areas or 2×6.20 m for built-up areas
- Median strip width: 3.00 m for non-built-up areas or 1.20 m for built-up areas
- Shoulder width: 0.50 m
- Bicycle lane width: 2.00 m for non-built-up areas or 1.50 m for built-up areas
- Sidewalk width: 2.50 m for non-built-up areas or 2.00 m for built-up areas
  Note: The sidewalk width includes the width of road facilities (W = 0.5 m). The width could be expanded or utilization of the service road could be considered in the section with heavy pedestrians. (Section 2-2-2-2 (2))
- Drainage width: 1.00 m

Each road component is laid out with a focus on safety:

- The height of median strips stands at 16 centimeters (cm) as Malawi's standard.
- Pedestrian fences are to be installed on the median strips but not on the sidewalk to secure its width as large as possible.
- Considering the use and the speed of bicycles in the project area, bicycle lanes shall be installed at the edge of a carriageway, not on the sidewalk.
- Curbs of 16 cm in height (Malawi's standard) shall be installed at the boundary between a carriageway and a bicycle lane in order to ensure safety of bicycles.
- A drainage ditch without a lid shall be installed at the boundary between a carriageway and a sidewalk. This can prevent vehicles from entering the sidewalk. This arrangement is also desirable from the viewpoint of smooth road surface drainage.
- As pedestrians need to cross a drainage ditch at the intersection, the ditch requires lids there. In this case, guard posts shall be installed to prevent vehicles from entering the sidewalk.
- In general, the sidewalk is the outermost component of the road. At the section where the existing service road serves as a living street[1], however, the sidewalk shall be installed at the inner space of the living street in terms of continuous walking and easy access to bus stops and crosswalk.

[1] A living street is a street designed primarily with the interests of pedestrians and as a social space where people can meet. The road is still available for motor vehicles, but its design is aimed at reducing both the speed and dominance of motorized transport. Vehicles are also restricted to be parked at designated bays. Woonerf (Dutch) is often dubbed instead of the living street.

【Non-built-up Area】



【Built-up Area】

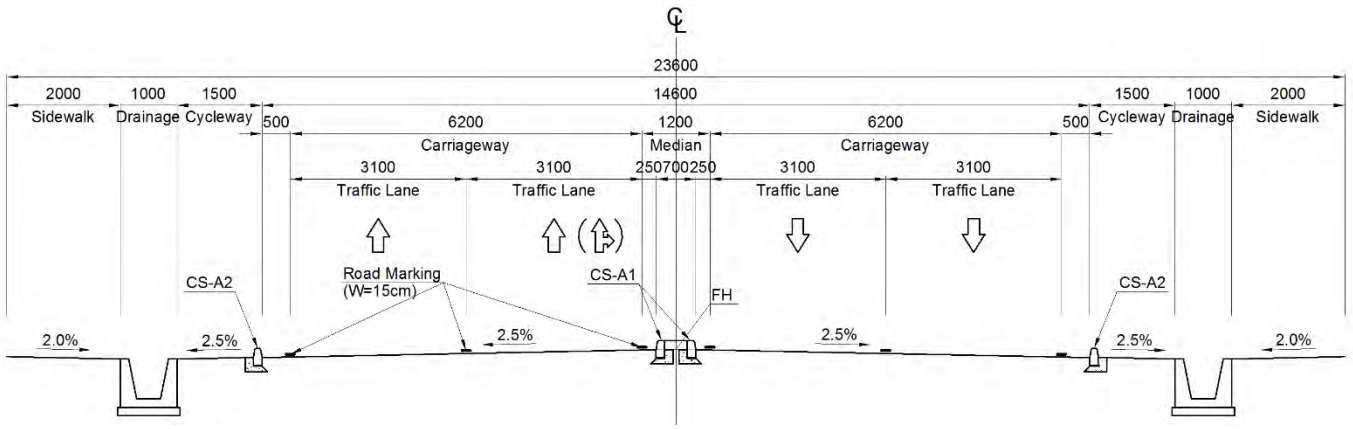


Figure 2-2-2　Typical Cross Section

4) Alignment

The desirable minimum curve radius at a design speed of 50 km/h is 150 meters (m). Since the minimum curve radius of the existing road stands at about 180 m, in principle, the road is to be widened while maintaining the existing alignment. The clothoid curve is applied to secure a driver's comfort and safety.

While avoiding impacts on roadside buildings and private land, on the other hand, it is necessary to install a right- or a left-turn lane to manage traffic at the intersections, particularly at (i) Sunbird Lilongwe Hotel, (ii) Nico Center, (iii) Town Hall, (iv) Old District Office, the local historic heritage, (v) the Lilongwe River Bridge, (vi) Old Town Market, (vii) Mosque, even though the road width is narrow. Accordingly, a flexible road alignment will be designed in conformity with the current land use.

(2) Service Road Design

At the sections where a service road is currently being maintained, it will be first expanded to four lanes and then be reallocated to a carriageway and a sidewalk. Regarding the reallocation of a service road, a road space will be reorganized, taking into account its current use and conditions and paying attention to the followings:

- **To secure a walking space in line with pedestrian traffic;**
- **To secure a parking space for loading and unloading;**
- **To install bus stops; and**
- **To secure a driveway to parking lots which are installed behind roadside facilities**

The specific cross sectional elements are examined in compliance with the following policy. Since the current width of service roads varies from place to place and is not consistent, it shall be designed in a flexible manner in the light of the current status.

Case 1: When a service road is wide enough to provide a vehicle traffic space:

- **While securing a width of 2.0-meter exclusive sidewalks, a one-way service road shall be installed only in the case that the rest width amounts to 4.0 m or more.**
- **Guard posts shall be installed at 1.5-meter intervals between the sidewalk and the living street to prevent vehicles from entering the sidewalk.**
- **The service road will serve as a living street and thereby secure a sufficient space for pedestrians in line with demands.**
- **In principle, vehicle parking and stopping shall be prohibited at the service road except for very brief stops, e.g., getting on and off and loading and unloading. Since guard posts are installed within the width of 4.0 m, in particular, overtaking parked vehicles is actually implausible, so that longstanding parking will be voluntarily restrained.**

Case 2: When a service road is NOT wide enough to provide vehicle traffic space:

- **All the space to the boundary of private land shall be maintained as a sidewalk (exclusive walking space).**
- **A loading and unloading space which size enables two small cars to park and pull over shall be installed in a carriageway.**

(3) Intersection Design

1) Basic Conditions

Roundabouts, which do not require traffic lights and electric supply, are found at some intersections of the M1 road. For the project, in particular, the Town Hall Roundabout is the case. The low traffic management capacity of the roundabout arguably deters smooth traffic flow and thereby is attributable to traffic congestion. As power supply is expected to be stabilized in the near future, the roundabout shall be converted to a crossroad equipped with a signaling control system with a view to increasing its traffic management capacity. The current non-signalized T-intersections shall be also equipped with the signaling control system because road safety will be significantly reduced due to road dualing and the ensuring traffic increase. The following items will be mainly noted to design intersections:

- The Town Hall Roundabout shall be converted to a crossroad with traffic lights.
- In principle, all T-intersections shall be equipped with a signaling control system.
- The lane configuration and the signal phasing pattern shall take right-turning vehicles into consideration.
- Pedestrian signal lights shall be installed.
- Lighting on crosswalks shall be installed.

2) Design Vehicle

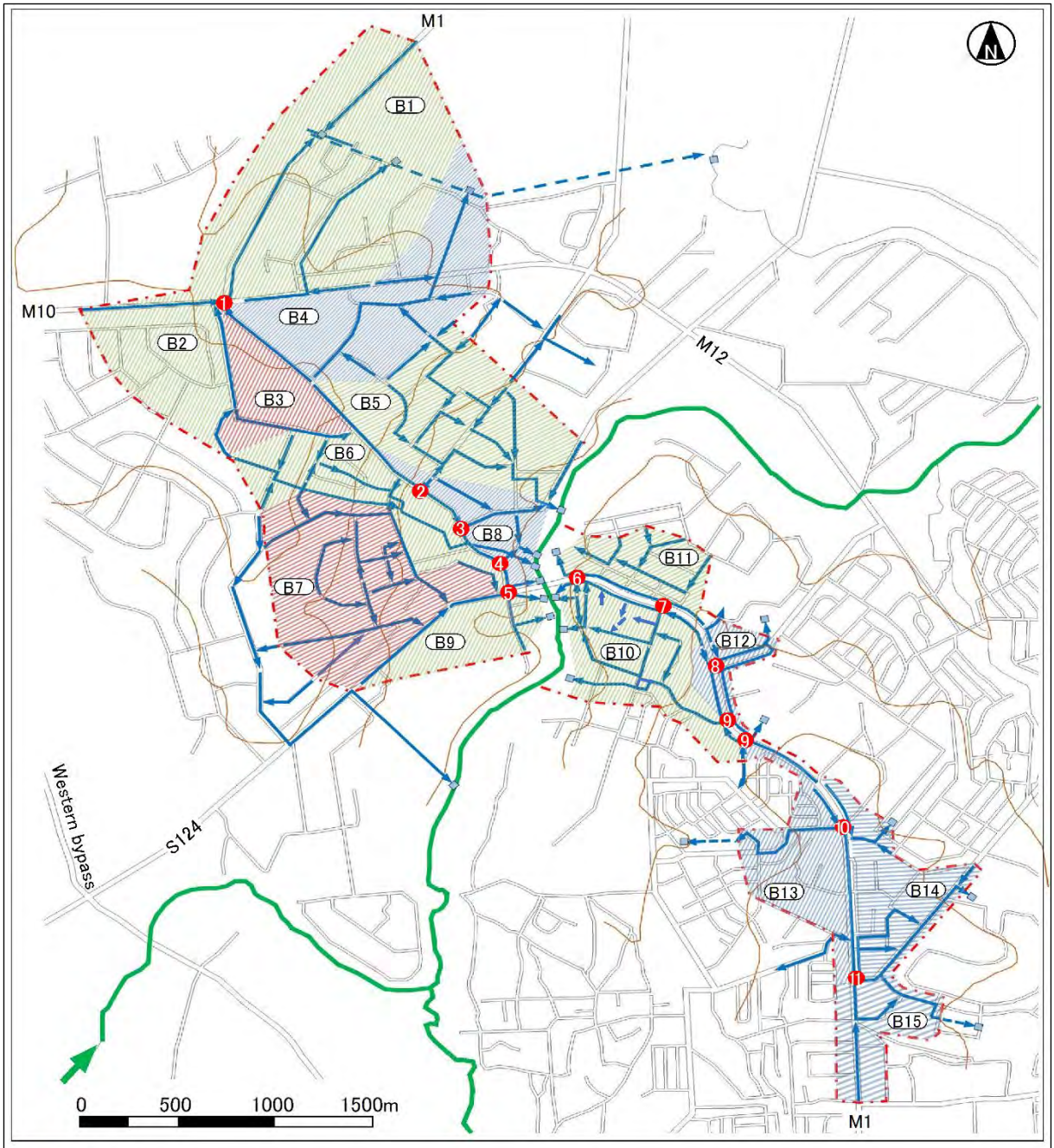
Even though large vehicles are restricted to pass through specific sections of the project road, semi-trailers and trucks are actually found on the road. In this regard, intersections will be designed in the light of large vehicle traffic.

(4) Drainage Design

1) Basic Conditions

A drainage channel will be installed between a bicycle lane and a sidewalk in view of smooth drainage of road surface, pedestrian safety, and the relationship between buildings and roadside trees.

The drainage plan will be established in consideration of the rainwater inflow from around the road. The drainage basins which rainwater flows into the M1 road is shown in Figure 2-2-3 as “Drainage basins where drain to the area along the M1 road”.



Major intersection

① Mchinji
② Sunbird Lilongwe Hotel
③ Kenyatta
④ Murray
⑤ Town Hall
⑥ Old Town Market
⑦ Malangalanga
⑧ Lubani
⑨ Community Center
⑩ Technical School
⑪ Chidzanja

: Lilongwe river
: Drainage direction
: Flow outlet
: Drainage boundary
: Contour

: Drainage basins where drain to the area along the M1 road
: Drainage basins where drain from the area along the M1 road
: The drainage of the M1 road does not flow but the stream ends are the same drainage section

Drainage basin (ha)						
	B1	121.1	B6	38.5	B11	20.8
	B2	35.8	B7	67.9	B12	13.1
	B3	22.6	B8	19.3	B13	34.2
	B4	62.8	B9	21.6	B14	30.9
	B5	63.6	B10	41.2	B15	22.9

Figure 2-2-3 Current Drainage System

2) Basic Structure

The basic drainage structure is a U-shaped. The cross-sectional dimension was determined by drainage calculation.

3) Discharge Calculation

The estimation of drainage discharge factors in the following conditions:

a) Probable Rainfall Year

Three years for pavement and side slope and 10 years for road crossing culvert

b) Design Rainfall Intensity

As shown below, the design rainfall intensity, or T (hour (hr)) maximum rainfall intensity was estimated with the Mononobe formula based on the rainfall data from 1981 to 2017 obtained from the Chitedze Research Station.

$$\text{T (hr) maximum rainfall density } \gamma_T \text{ (mm/hr)} = \frac{R_{24}}{24}\left(\frac{24}{T}\right)^{2/3}$$

where

R_{24} : daily rainfall (mm/day)
T : travel time (hr), for urban areas like Lilongwe City, T = 10 min = 0.17 hr

Table 2-2-3 Design Rainfall Intensity

Return Period	Daily Rainfall (mm/hr)	Rainfall Intensity (mm/hr)	Remarks
3 years	82.52	93.2	pavement and side slope
10 years	103.15	116.5	road crossing culvert

c) Calculation of Runoff Amount

In order to decide the size of drainage structures, the runoff amount was estimated with the rational formula below.

$$Q(m^3/s) = \frac{1}{3.6 \times 10^6} \cdot c \cdot \gamma \cdot a$$

where Q (m^3/s): *Design discharge*

c: *runoff coefficient*
carriageway 0.83
shoulder and side slope 0.33
space along the road 0.30

γ: *design rainfall intensity (mm/hr)*

a: *basin area (m^2)*

d) Calculation of the Capacity of Drainage Facilities

Flow capacity was estimated with the formula as shown below.

$$Q\left(m^3/s\right) = v \cdot a$$

where Q: discharge $\left(m^3/s\right)$

$v\ (m/s)$: Average velocity by means of the Manning formula

$$v = 1/n \cdot R^{2/3} \cdot I^{1/2}$$

n: roughness coefficient

n = 0.015 in case that concrete is casted on the site

R (m): hydraulic radius,

R = A/S

A (m^2):cross-sectional area

S (m): wetted perimeter

I: inclination

A (m^2): Cross-sectional area, 80% of the area applied to this calculation for the safety reason

4) Drainage Outlet Design

Replacement of the existing outlet facility is recommendable in case that its capacity is not enough to discharge local drainage water.

(5) Ancillary Facility Design

(i) **Traffic Signal**: As a result of a comparison between Japan-made and South Africa (SA)-made traffic signals, the latter turned out to be less expensive than the former in terms of equipment and transport costs, so that SA traffic signals fare better with maintenance and management. In addition, SA traffic signals have been already utilized in Malawi. In this regard, SA traffic signals which use a commercial power system and are concreted over the bottom of steel pillars to prevent robbery will be installed.

(ii) **Road Marking**: Appropriate road markings to secure smooth traffic and safety will be installed.

(iii) **Crosswalk**: Crosswalks will be installed at an appropriate position in accordance with pedestrian volumes. Also, crosswalks will be installed where existing pedestrian bridges are demolished. In particular, traffic lights for pedestrians will be installed at all crosswalks located at junctions, especially where a lot of pedestrians cross the road.

(iv) **Pedestrian Fencing**: In order to secure the safety of pedestrians and the smoothness of traffic, pedestrian fencing as well as the aforementioned crosswalks will be installed at the sections with heavy pedestrian volumes.

(v) **Bus Stop**: Bus stops will be installed after taking into consideration the current usage of existing bus stops, spots with numerous passengers, and marginal spaces after construction of road widening.

(vi) **Guard Post**: Road facilities including rubber poles will be installed to prevent vehicle entry at the places where vehicles are likely to enter pedestrian roads.

(vii) **Street Light**: Street lights which have a commercial power system, use LED lights, and are made with concrete pillars will be installed at an interval of 50 m along the entire road alignment to secure pedestrian safety.

(viii) **Post Cone and Road Stud**: In order to secure vehicle and pedestrian safety, post cones and road studs which reflect vehicle lights in the nighttime will be installed at the runoff sections.

(6) Pavement Design

1) Pavement Design of New Road Sections

For the project, new road sections will be designed in compliance with the AASHTO Guide for

Design of Pavement Structures, but the relevance of the pavement design will be verified in comparison with the SATCC standards generally applied in Malawi.

a) Preliminary Examination of Future Traffic Volume

Based on the result of a traffic volume survey, the future traffic volumes (Table 2-2-1 Future Traffic Demand) during the first ten years of operation are estimated.

Considering the number of mini buses and heavy vehicles and the division of the entire alignment into two sections, accordingly, maximum cumulative values of equivalent single axle load (ESAL) are calculated. The calculation and results are shown in Tables 2-2-4 and 2-2-5.

Table 2-2-4 Calculation of Design Loads

Kenyatta JCT ～ Murray JCT Traffic Volume（vehicle/day）

YEAR		MOTORBIKE / TUK TUK	MINIBUS	LIGHT VEHICLE	HEAVY VEHICLE						TOTAL
					2 AXIS	3 AXIS	4 AXIS	5 AXIS	6 AXIS	SUB-TOTAL	
1	2024	2,152	8,635	28,129	407	118	6	3	90	624	39,540
2	2025	2,219	8,902	28,999	420	122	6	3	93	644	40,764
3	2026	2,286	9,169	29,869	433	126	6	3	96	664	41,988
4	2027	2,234	8,961	29,191	424	122	6	3	93	648	41,034
5	2028	2,303	9,238	30,094	437	126	6	3	96	668	42,303
6	2029	2,372	9,515	30,997	450	130	6	3	99	688	43,572
7	2030	2,443	9,801	31,927	464	134	6	3	102	709	44,880
8	2031	2,517	10,095	32,885	478	138	7	3	105	731	46,228
9	2032	2,592	10,397	33,871	492	142	7	3	108	752	47,612
10	2033	2,670	10,709	34,887	507	146	7	3	111	774	49,040
2023～2032（10 Years）Total Vehicle			95,422	-	4,512	1,304	63	30	993		
One-sided large traffic volume per lane*			38,169	-	1,805	522	25	12	397		
Axis equivalent conversion factor			0.012	-	0.381	1.269	2.349	3.429	4.509		
Equivalent weight for 10 years			458	-	688	662	59	41	1,790		
Equivalent Single Axle Load						W18= 1.350 ×10 ^{6}					

Note: It is assumed that 80% of one-sided large traffic passes in one lane of a four-lane road.

Technical school JCT～Chidzanja JCT Traffic Volume（vehicle/day）

YEAR		MOTORBIKE / TUK TUK	MINIBUS	LIGHT VEHICLE	HEAVY VEHICLE						TOTAL
					2 AXIS	3 AXIS	4 AXIS	5 AXIS	6 AXIS	SUB-TOTAL	
1	2024	816	8,278	11,639	1,147	332	16	9	252	1,756	22,489
2	2025	841	8,534	11,999	1,182	342	16	9	260	1,809	23,183
3	2026	866	8,790	12,359	1,217	352	16	9	268	1,862	23,877
4	2027	849	8,608	12,104	1,191	345	16	9	263	1,824	23,385
5	2028	875	8,874	12,478	1,228	356	17	9	271	1,881	24,108
6	2029	901	9,140	12,852	1,265	367	18	9	279	1,938	24,831
7	2030	928	9,414	13,238	1,303	378	18	10	288	1,997	25,577
8	2031	956	9,697	13,635	1,342	389	19	10	296	2,056	26,344
9	2032	985	9,988	14,044	1,382	401	19	10	305	2,117	27,134
10	2033	1,014	10,287	14,465	1,424	413	20	10	314	2,181	27,947
2023～2032（10 Years）Total Vehicle			91,610	-	12,681	3,675	175	94	2,796		
One-sided large traffic volume per lane*			36,644	-	5,072	1,470	70	38	1,118		
Axis equivalent conversion factor			0.012	-	0.381	1.269	2.349	3.429	4.509		
Equivalent weight for 10 years			440	-	1,932	1,865	164	130	5,041		
Equivalent Single Axle Load						W18= 3.494 ×10 ^{6}					

Note: It is assumed that 80% of one-sided large traffic passes in one lane of a four-lane road.

Table 2-2-5 Comparison of Design Loads

Section	Design Load ESAL
Sta.1+200 - Sat.1+840	w18 = 1.350×10^{6}
Sta.1+840 - Sat.3+950	w18 = 3.494×10^{6}

b) Roadbed CBR

The results of the roadbed CBR test are shown in Figure 2-2-4. Also, the figure "6", or the lowest value of the test results is adopted for the CBR value used for design.

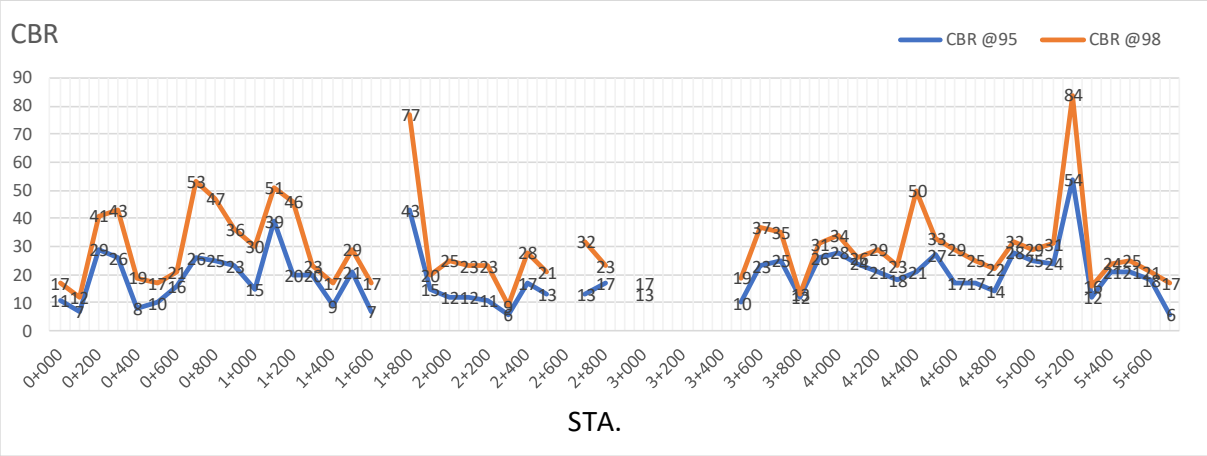


Figure 2-2-4 Roadbed CBR Test Results

c) Pavement Design in Compliance with the SATCC Standards

The pavement thickness is determined by traffic class (T1-T8) in accordance with single axle loads which are derived from total traffic volumes for each type of vehicles and subbase class (S1-S8) in conformity with the California bearing ratio (CBR).

The section ranging from Sta.1 + 200 to Sta.1 + 840 is classified into T3 (0.7-1.5 million ESAs) with 1.35 million ESAs, while the section spanning from Sta.1 + 840 to Sta.3 + 950 is categorized into T5 (3.0-6.0 million ESAs) with 3.49 million ESAs. Since the CBR value used for the design of the existing road is "6" as described above, in addition, the subbase class is S3 (CBR 5-7), and the pavement thickness is shown in Figure 2-2-5.

Section	Asphalt Concrete Course	Base Course	Subbase Course
Sta.1+200 - Sat.1+840	50 mm	175 mm	225 mm
Sta.1+840 - Sat.3+950	50 mm	200 mm	300 mm

Since Malawi has an annual rainfall of more than 250 millimeters (mm), the country is classified into wet regions according to the SATCC standards.

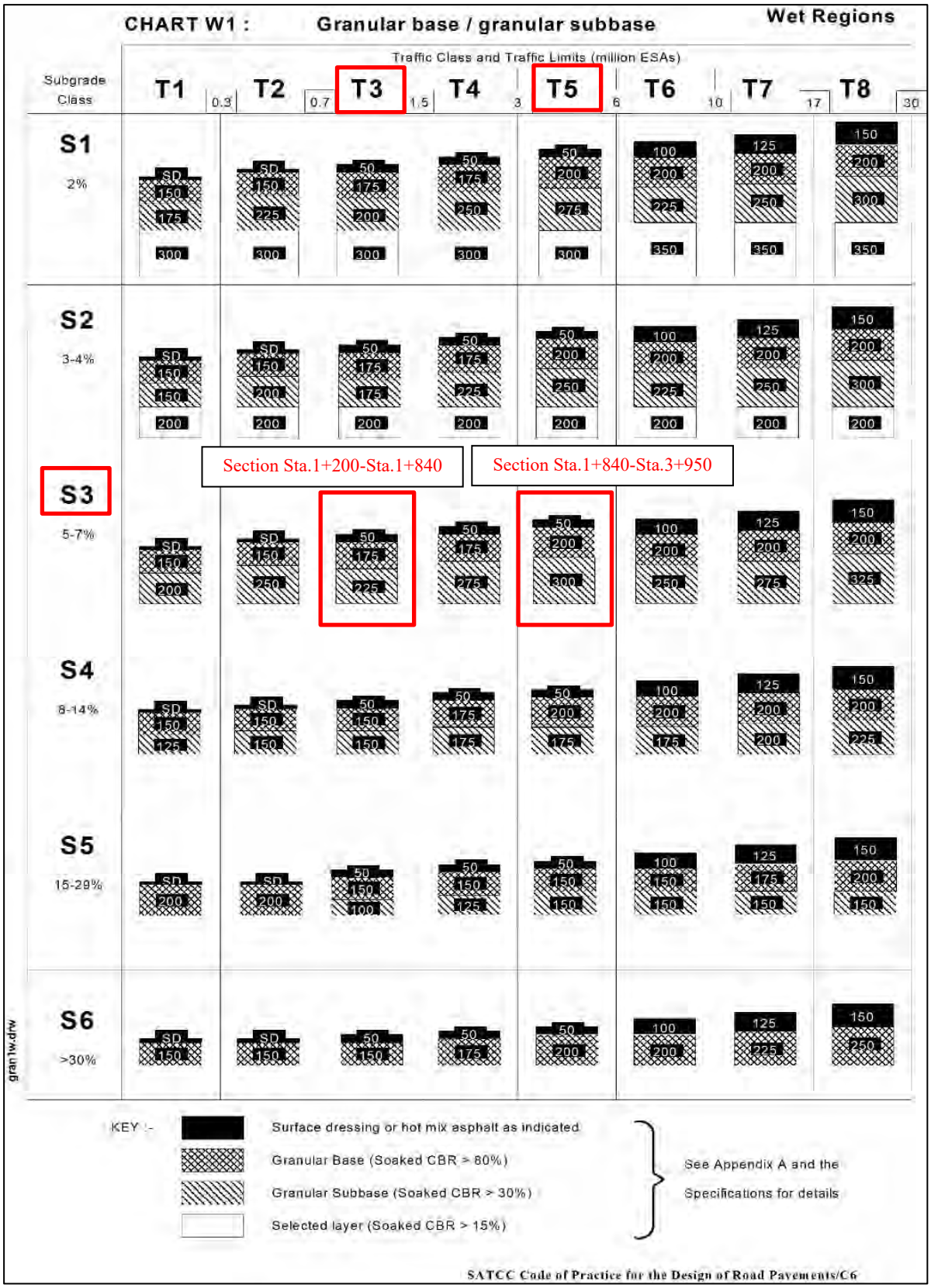


Figure 2-2-5 Pavement Structure by SATCC Standards

d) Pavement Design in Compliance with the AASHTO Guide

When it comes to design conditions in conformity of the asphalt pavement design method of the AASHTO guide, the following parameters are utilized.

Table 2-2-6 Pavement Design Conditions by the AASHTO Guide

Design Period	: 10 years	
Traffic Load	: Sta.1+200 - Sat.1+840 : Sta.1+840 - Sat.3+950	w18 = 1.350×10^6 w18 = 3.494×10^6
Reliability (R)	:	90%
	: ZR	-1.282
	: S0	0.45
Terminal Serviceability Index	: P0	4.2
	: Pt	2.5
Bearing Capacity of Roadbed (Resilient Modulus (MR))	: MR = 1500×converted CBR value	CBR = 6
Pavement Layer Coefficient	: AC	0.39
	: Base course	0.135（CBR ≥ 80）
	: Subbase course	0.108（CBR ≥ 30）
Drainage Coefficient	: Base course	1.0
	: Subbase course	1.0

Table 2-2-7 Required Pavement Structural Number (SN)

Condition	Design Value	
Traffic ESAL (w18)	1.350×10^6	3.494×10^6
Standard Deviation (ZR)	-1.282	-1.282
Combined Standard Error (S0)	0.45	0.45
Operational Index Difference (ΔPSI=P0-Pt)	4.2－2.5 = 1.7	4.2－2.5 = 1.7
Bearing Capacity of Roadbed(Resilient Modulus (MR))	9,000	9,000
Subgrade CBR Rate (%)	6	6
Required Pavement Structural Number (SN)	3.405	3.970

Calculation of Pavement Design

The equation and constants given by the AASHTO guide are referred to as follows:

CASE 1: w18 = 1.350×10^6

Asphalt Pavement

Pavement Structure Index

Pavement Structure		M1 Lilongwe
Traffic ESAL	W18	1,350,000
Confidence Coefficient	R (%)	90
Standard Deviation	ZR	-1.282
Combined Standard Error	S0	0.45
Initial Serviceability Index	P0	4.2
Terminal Serviceability Index	P1	2.5
P0-P1	ΔPSI	1.7
CBR rate (%) Subgrade	CBR	6
Resilient Modulus (=1500× CBR)	MR	9,000
Target Structural Number	SN	3.405

$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log10[\Delta PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_R)-8.07$

Tentative Calculation log10(W18)=	6.130
Calculation of right side=	6.130

Suggestion of Structure index of New Pavement Structure

New Pavement Structure	Drain Coefficient (m)	Layer Index (a)	
Pavement Structure Design Section			M1 Lilongwe
Asphalt Concrete (cm)	-	0.440	10.0
Base Course (cm)	1.0	0.135	15.0
Subbase Course (cm)	1.0	0.108	25.0
Prpposal Structural Number (SN)			3.59

SN=a1*D1+a2*m2*D2+a3*m3*D3

CASE 2: w18 = 3.494×10^6

Asphalt Pavement

Pavement Structure Index

Pavement Structure		M1 Lilongwe
Traffic ESAL	W18	3,494,000
Confidence Coefficient	R (%)	90
Standard Deviation	ZR	-1.282
Combined Standard Error	S0	0.45
Initial Serviceability Index	P0	4.2
Terminal Serviceability Index	P1	2.5
P0-P1	ΔPSI	1.7
CBR rate (%) Subgrade	CBR	6
Resilient Modulus (=1500× CBR)	MR	9,000
Target Structural Number	SN	3.970

$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log10[\Delta PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_R)-8.07$

Tentative Calculation log10(W18)=	6.543
Calculation of right side=	6.543

Suggestion of Structure index of New Pavement Structure

New Pavement Structure	Drain Coefficient (m)	Layer Index (a)	
Pavement Structure Design Section			M1 Lilongwe
Asphalt Concrete (cm)	-	0.440	10.0
Base Course (cm)	1.0	0.135	20.0
Subbase Course (cm)	1.0	0.108	30.0
Prpposal Structural Number (SN)			4.07

SN=a1*D1+a2*m2*D2+a3*m3*D3

e) Required and Adopted Pavement Thickness

The following tables demonstrate the calculation result of pavement thickness at the new road section in accordance with the two standards, i.e., the SATCC standards and the AASHTO guide. AASHTO pavement structure has a bigger required pavement structure index than that of the SATCC, the pavement design by the AASHTO guide fulfills the SATCC standards.

Table 2-2-8 **Required Pavement Thickness**

Section	1) Sta.1+200 - Sat.1+840		2) Sta.1+840 - Sat.3+950	
Pavement Structure	SATCC Guide	AASHTO Standards	SATCC Guide	AASHTO Standards
Surface + Binder	50 mm	100 mm	50 mm	100 mm
Base Course	175 mm	150 mm	200 mm	200 mm
Subbase Course	225 mm	250 mm	300 mm	300 mm
Adopted Pavement Structure		○		○

2) Pavement Design of Existing Road Sections

The maintenance method of the existing road pavement was examined. The field survey found that the cracking ratio of the existing pavement stood at 10-20% at all road sections. According to the above-mentioned future traffic volume estimation, in addition, the maximum large-vehicle traffic volume per lane is predicted to reach 908 vehicles/lane/day (2,269/2×0.8) in a decade of operation. Figure 2-2-6 presents maintenance and repair methods in accordance with the correlation of the cracking ratio of the existing pavement and traffic volumes.

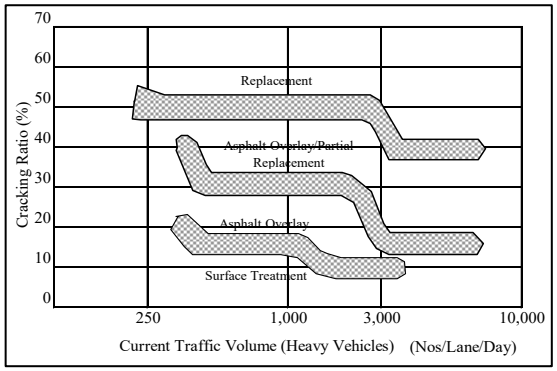


Figure 2-2-6 Cracking Ratio and Pavement Maintenance Method

The Guidelines for Road Maintenance and Repair published by the Japan Road Association (JRA) stipulates that an asphalt overlay and partial replacement should be carried out for more than 30% of cracking ratio and that all layers including subbase course should be replaced for more than 50% of cracking ratio. Since the existing road sections feature a low cracking ratio, its pavement is thought to be in good condition and thereby reusable.

The survey team conducted the Benkelman Beam test to measure the deflection of the existing road. The selection of the rehabilitation method of the exiting pavement is contributed by the relation of the deflection amount. Figure 2-2-7 indicates the relationship between Benkelman Beam deflection amounts and road maintenance and repair methods which is specified in the JRA guidelines.

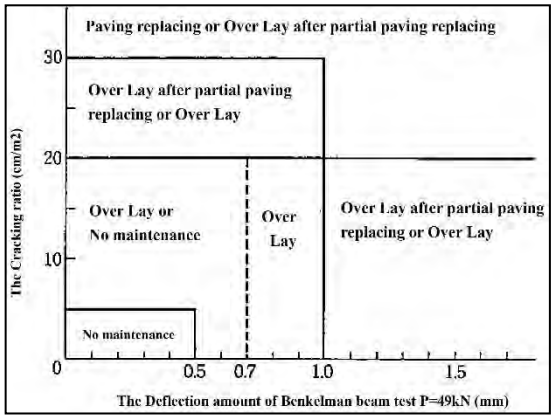


Figure 2-2-7 Benkelman Beam Test and Road Maintenance and Repair Methods

The survey team figured out that the existing pavement had a maximum deflection amount of less than 1.0 mm and a cracking ratio of less than 20 cm/m^2, so that it corresponds to overlay, overlay or no maintenance, and no maintenance as described in Figure 2-2-7.

Since the asphalt concrete course of the existing road sections is as thin as 3 cm and lacks durability, it will be eliminated and installed as thick as that of the new expanded road sections.

All Section: Sta.1+200 - Sta.3+950	The existing basecourse will be retained as new subbase and new pavement construction will start from basecourse on the new subbase.

2-2-2-3 Bridge Design

(1) Basic Conditions

1) Standards

The bridge design will be drawn up based on the Code of Practice for the Design of Road Bridges and Culverts (SATCC, September 1998), which has been applied in Malawi. In addition, the Specifications for Highway Bridges in Japan (JRA, 2012) will be utilized for structural design items, which SATCC standards do not stipulate.

2) Road Conditions

A bridge is designed in accordance with the road design which covers the section from the Town Hall Roundabout to the Old Town Market Junction where the bridge is located.

The bridge cross section is designed as follows. Because it is difficult for a PC bridge to set a cross beam of over 30 m in length, separated two bridges will be constructed for inbound and out bound traffic. The two bridges will be located as close to each other as possible for the appropriate road alignment.

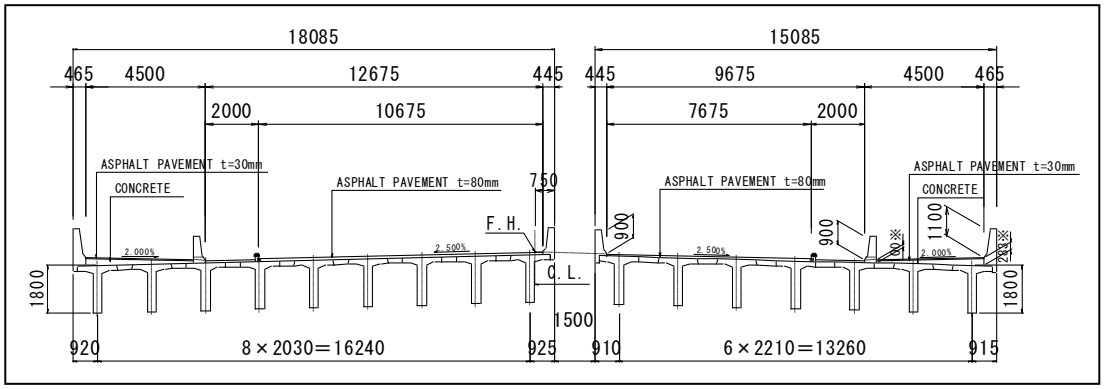


Figure 2-2-8 Bridge Cross Section

The road cross section of the existing bridge is narrow as shown in Figure 2-2-9. And, as described later, the current bridge does not secure enough vertical clearance from the design water level, requiring its replacement.

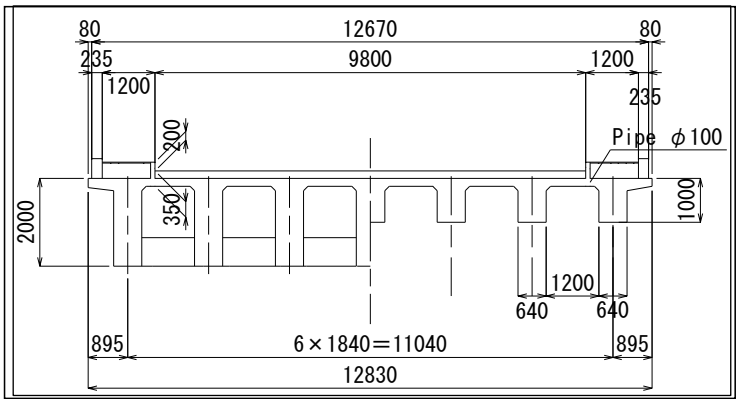


Figure 2-2-9 Road Width of the Existing Bridge

The location of a new bridge and road alignment around the bridge is shown in Figure 2-2-10.

By extending the road to the upstream side of the current bridge at the lower part of Figure 2-2-10, it would be possible to avoid the relocation of the Old Town Market and nearby vendors.

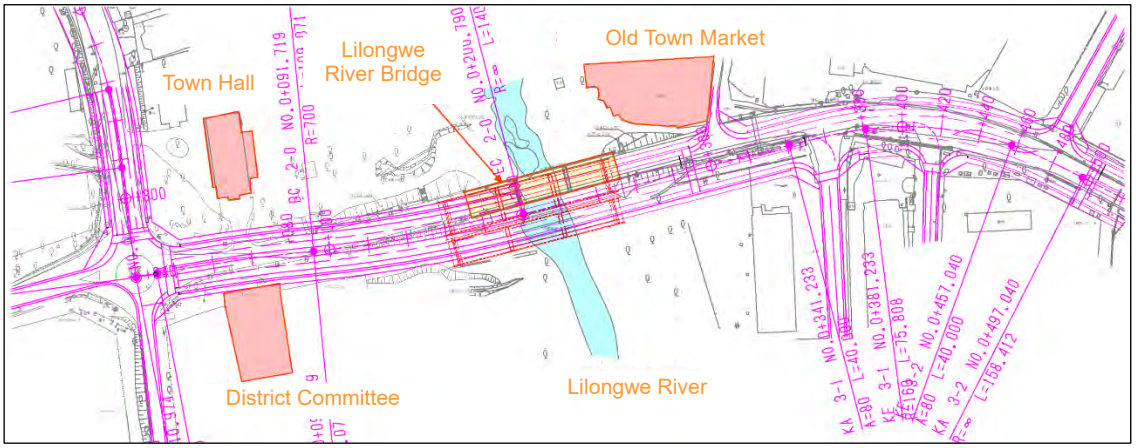


Figure 2-2-10 Location of a New Bridge and Road Alignment around the Bridge

3) River Conditions

- Planned water flow rate: Planned water flow rate is determined based on a 50-year return period considering the discharge flow of Kamuzu Dam.
- Span length： The span length is determined not to fall below that of the existing bridge.
- Planned water level: The design water level at the bridge is determined by hydraulic analysis.
- Clearance below the bridge girder: The clearance amounts to 1.0 m based on Malawi's practices.

4) Design Load

【Design Live Load】

The design live load prescribed in “code of practice for the design of road bridges and culverts” (hereinafter referred SATCC Standards 2.6) will be applied. Unprescribed crowd loads will be determined, referring to Malawi's practices of 5.0 kN/m^2. The wheel load for the floor slab design will stand at 100kN, the same value of SATCC standards and Specifications for Highway Bridges (Japan Road Association, 2012 version). The vehicle load will take into account NA and NB24 loadings according to SATCC Standards 2.6.1.1.

5) Earthquake Effect

According to the SATCC standards, the design seismic intensity of Method A—when a rock consists of the base—is 0.02.[2] In the case of Malawi, earthquakes with a magnitude between M6 to M6.9 have broken out over the past century within 100 km of Lilongwe City.

[2] PART 2: SPECIFICATION FOR LOADS - 3.10 Earthquake Action.

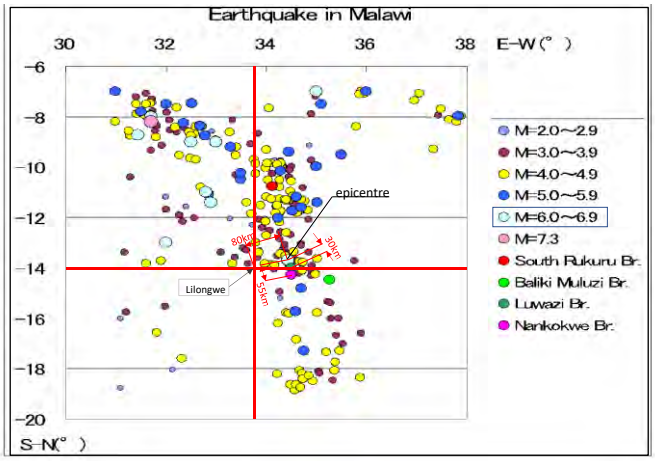


Figure 2-2-11 Earthquake in Malawi

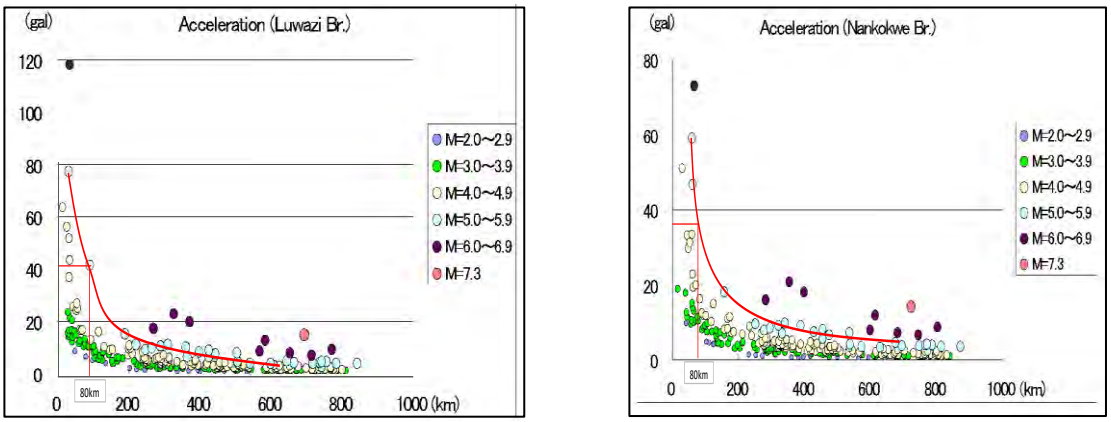


Figure 2-2-12 Point Acceleration Due to Earthquakes with a Magnitude of 6.0-6.9 (Left: Luwazi Bridge, Right: Nankokwe Bridge)

Assuming a distance of 80 km from the epicenter and interpreting the acceleration rate based on distance attenuation effects as presented in the two estimation graphs (Figure 2-2-12), the acceleration rate in Lilongwe City is estimated to reach 30-40 gal. The range roughly corresponds with 0.03g of the seismic acceleration rate for Category VI which is specified in the SATCC standards and most widely used in South Africa.
Considering that the acceleration generated in a structure is generally 2 to 3 times that of the ground surface, it is assumed to be 2.5 times on average.

$$40 \text{ gal} \times 2.5 = 100 \text{ gal}$$

In this sense, the design horizontal seismic intensity is assumed to be 0.10, which is equal to the figure used for the past grant aid bridge projects in Malawi.

6) Ground Conditions

Ground conditions are established based on the result of geological survey during the first round of field surveys.

a) Assumed Bedrock Line

The estimated bedrock line is shown in Figure 2-2-13.

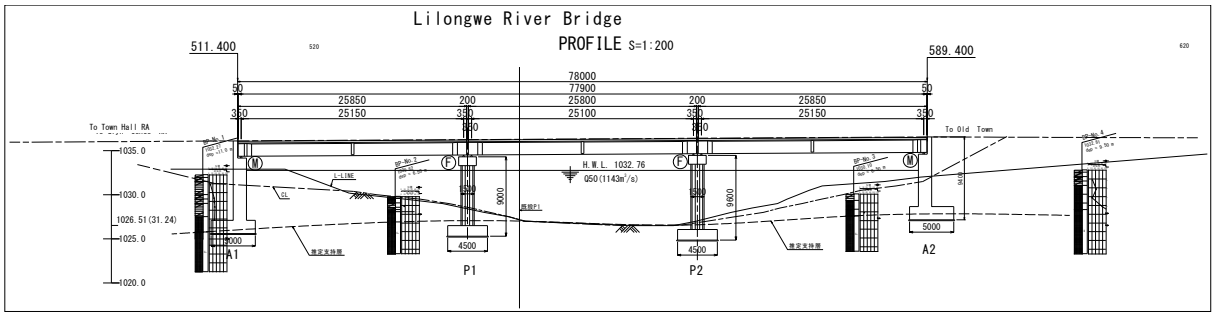


Figure 2-2-13 Assumed Bedrock Line

At No. 2 boring spot near the P1 bridge pier, rocks were found around 2.5 m from the ground surface. Since no continuous rock outcrop was found upstream and downstream of the bridge pier (Photo 2-2-1), however, the bedrock line at the starting point is established by connecting a riverbed where a rock outcrop is discovered and a rock found at No. 1 boring spot near the A1 abutment.

Photo 2-2-1 Current Condition near the Bridge Pier

b) Establishment of Supporting Layers

Rocks of C_H grade or higher are identified below the bedrock line and will be chosen as a fundamental supporting layer. The riverbed area is, however, thought to face weathering due to dryness and wetness, and accordingly the supporting layer is set to be 50 cm below the current riverbed.

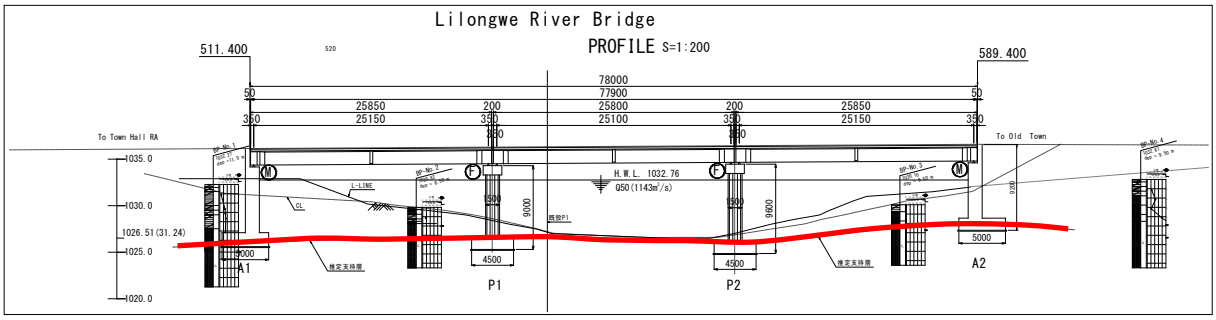


Figure 2-2-14 Assumed Supporting Layer

(2) Bridge Plan

The feasibility to use the current bridge will be examined when designing the road widening and the sidewalk improvement for the Lilongwe River Bridge. In addition, the span length ratio and the extension of a bridge will be also reviewed in a way to fulfill river conditions.

1) Continuous Use of the Current Bridge

The plan to construct a new bridge and use the current bridge in parallel has the following problems.

- The design water level measured by hydraulic analysis reaches the main girder of the current bridge.
- The required clearance of 1.0 m below the girder cannot be secured

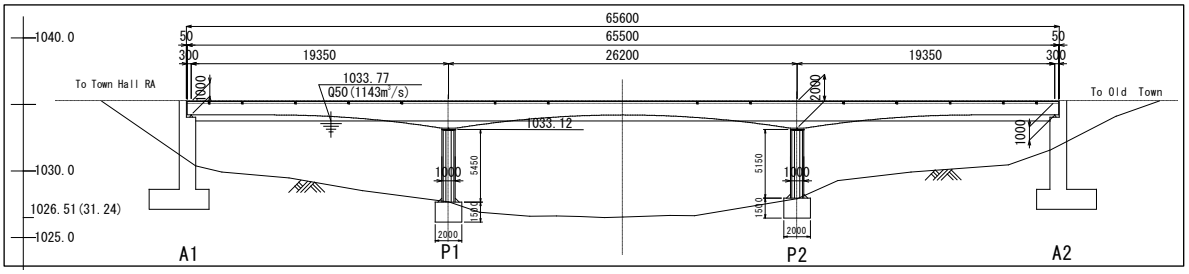


Figure 2-2-15 Side View of the Current Bridge

In this regard, it is impossible to use the current bridge in the future and design a new bridge in conformity with the current bridge in terms of its span ratio and height of road surface.

2) Two-Span Layout

The two-span layout secures the required clearance below the bridge girder while maintaining the bridge length and observing specifications for the standard span length.

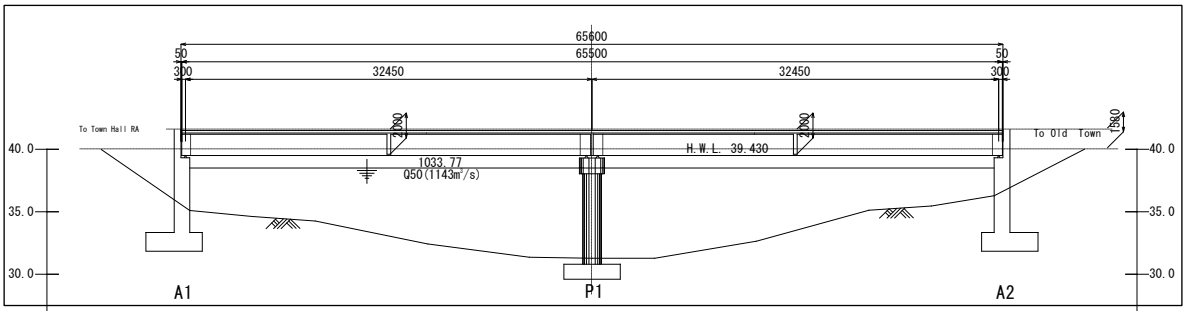


Figure 2-2-16 Side View of the Two-Span Layout

- **The required clearance of 1.0 m below the bridge girder is secured.**
- **The girder height stands at 2.0 m and the road surface will became higher than the current road surface as much as about 1.6 m.**
- **Impact on the Old Town Market is large.**

3) Three-Span Layout

In order to mitigate impacts on the Old Town Market, the layout is extended to three spans by fixing the position of the A2 abutment and pulling the A1 abutment.

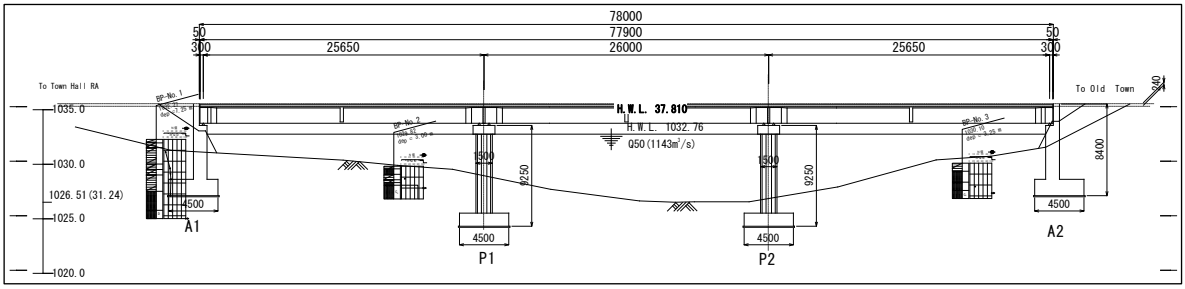


Figure 2-2-17 Side View of the Three-Span Layout

- **The required clearance of 1.0 m below the bridge girder is secured.**
- **The specified span length is satisfied.**
- **The girder height stands at 1.8 m. Since the high water level (HWL) is lower than that of the two-span layout, the current road surface is lifted up by 30 cm.**

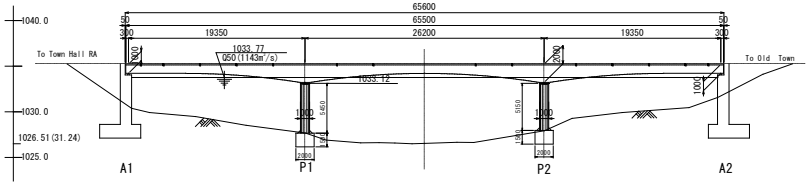
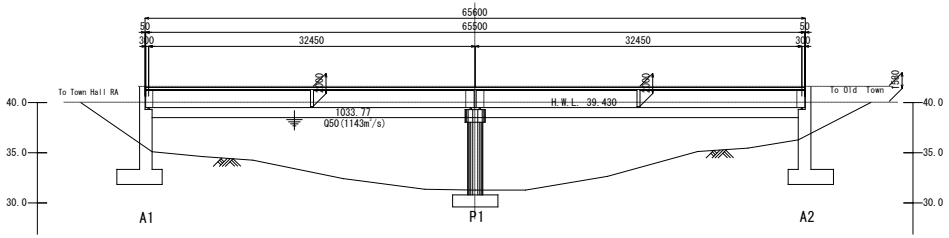
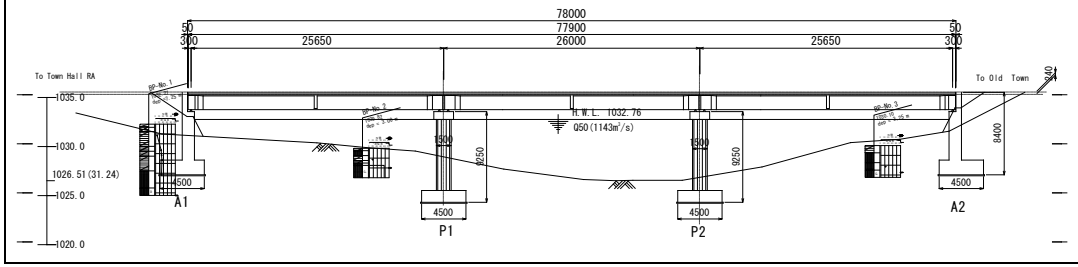
Table 2-2-9 Water Level by the Number of Spans

Bridge	Discharge (m^3/s)	Water Depth (m)	Water Level (m)	Difference in Water Level (m)
Planned Bridge (3-span): apprx.78 m	Q = 1,143 50-year return	6.25	1,032.76	1.01
Current Bridge (2-span): apprx.65 m		7.26	1,033.77	

4) Review on the Bridge Length and the Number of Spans

- **The current bridge will be reconstructed because the current span ratio and height of road surface cannot meet river conditions.**
- **The bridge length of the two-span layout will be about 66 m in case of no change in the location of the current two abutments, but the embankment behind the A1 abutment might undermine the water flow.**
- **The three-span layout extending the bridge to the A1 abutment will be adopted with a view to lowering the design HWL and mitigating adverse impacts on the water flow caused by the embankment behind the A1 abutment.**

Table 2-2-10 Comparison of Bridge Lengths and Span Numbers

Side View	Outline of Structure	River Condition		Evaluation
Plan 1: Continuous Use of the Current Bridge 	✓ A new bridge will be constructed in conformity with the location of abutments and piers of the current bridge, and thereby the bridge width will be expanded. ✓ The design HWL reaches girders. ✓ It is not possible to use the current bridge.	Clearance below the girder Inhibition of the river cross-sectional area ×	× ○	Not Adopted
Plan 2: Two-span Layout 	✓ The two-span layout has the same bridge length with the current bridge. ✓ The HWL will not be changed, and the bridge surface will be 1.6 m higher than the existing road surface, which makes it impossible to have access to the Old Town Market. ✓ The gap with the current HWL amounts to 0.6 m. Moreover, the embankment behind the A1 abutment might undermine the water flow.	Clearance below the girder Inhibition of the river cross-sectional area ○	○ ○	Not Adopted
Plan 3: Three-span Layout 	✓ The layout will fulfill the existing span length and be extended to the A1 abutment. ✓ The layout will address an impediment to the water caused by the embankment behind the A1 abutment and restrain the design HWL as high as the current level. ✓ The current road surface will be lifted by 30 cm, so the Old Town Market is accessible.	Clearance below the girder Inhibition of the river cross-sectional area ○	○ ○	Adopted

5) Review Policy for Bridge Appurtenances

【Guard Fence】

A guard fence for a sidewalk will be installed at the outside of the sidewalk, and a guard fence for vehicles will be installed between a sidewalk and a carriageway and at the median stripe. Both types of guard fences will be made of concrete and feature wall railings in view of convenient maintenance and management.

【Bearing Shoe】

The seismic design will correspond with Japanese design for earthquakes of Level 1 magnitude, and the existing Type A bearings will be installed. In view of maintenance and management, rubber supports will be installed.

【Expansion Joint】

Due to a narrow space, Malawi often uses buried joints. A crack on the road pavement might deteriorate driving quality and performance and damage the end of girders. In this regard, expansion joints which are highly efficient in preventing water leakage will be selected.

【Drainage System】

The current bridge drains the road surface water by means of the natural flow to the Lilongwe River. However, the absence of drain pipe on the bridge brings out water splashes on girders and substructures. Conducting a drainage estimation at the detailed design stage, the required catch basins and drain pipes which reach the bottom of girders will be installed to drain water properly. In addition, slab drains will be installed to thoroughly eliminate water under the road pavement. Lastly, a waterproof layer will be added on the entire surface of the bridge with a view to preventing infiltration of the road surface water onto girders.

(3) Bridge Type

1) Type of Superstructures

The three-span layout was adopted above, and the maximum span length is 26.0 m. The type of a superstructure was examined based on the said span composition.

a) Alternative Superstructure Type

In terms of the economic feasibility and the workability, three types of superstructures were singled out for a span length of 26.0 m.

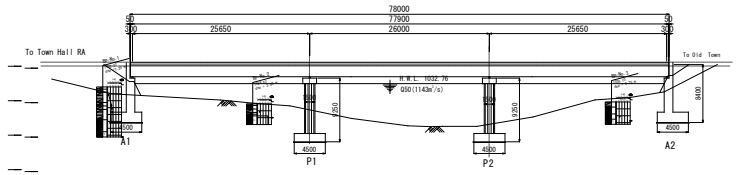
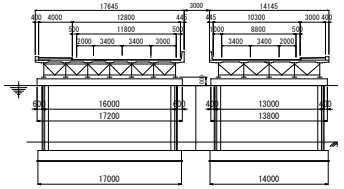
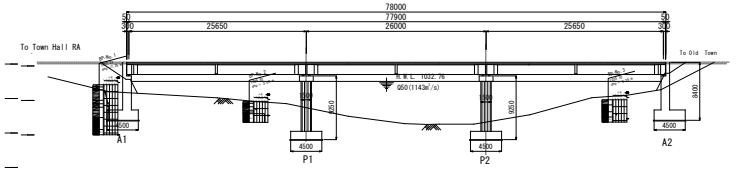
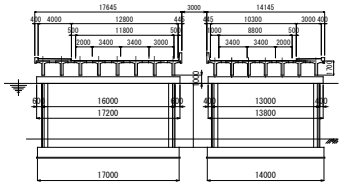
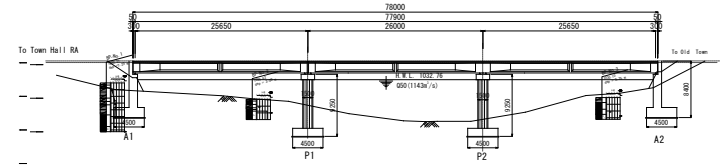
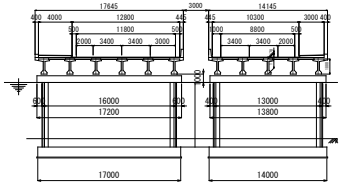
- Three-span plate girder bridge;
- Three-span continuous PC T-type girder bridge; and
- Three-span continuous composite PC girder bridge

Even though a cast in place concrete girder bridge (a hollow slab bridge and a box girder bridge) fulfills the specified span length, it was not selected due to longer construction period in the river and higher risks of water pollution.

b) Comparative Review

The three types of superstructures above are compared in terms of construction costs, procurement of materials and members, and erection methods.

Table 2-2-11 Comparison of Superstructure Types

Side View	Cross-sectional Drawing	Structure/Maintenance Feature	Cost	Procurement /Erection Method	Evaluation
Plan 1: Three-Span Continuous Plate Girder 		✓ Three-span continuous plate girder bridge ✓ RC deck slab ✓ Less number of expansion joints ✓Driving performance and maintenance and management considered ✓ Periodic painting required	1.4	【Japan/Third Country】 Structural steel, rebar, and appurtenances 【Malawi】 Concrete Crane Erection	×
Plan 2: Three-Span Continuous PC T-Type Girder 		✓ Three-span continuous PC T-type girder bridge ✓ Less number of expansion joints ✓Driving performance and maintenance and management considered ✓ PC slab with high durability	1.0	【Japan/Third Country】 PC strand, rebar, and appurtenances 【Malawi】 Concrete Girder erection	○
Plan 3: Three-Span Continuous Composite PC Girder 		✓ Three-span continuous composite PC girder bridge ✓ Precast segments ✓ Less number of expansion joints ✓Driving performance and maintenance and management considered ✓ Rationalized structure of slab construction	1.1	【Japan/Third Country】 PC strand, rebar, precast boards, and appurtenances 【Malawi】 Concrete Girder erection	×

2) Substructure Design

a) Abutment Type

Abutments are as high as 10 m. A reversed T-type abutment was selected in comparison with other alternatives such as the gravity type (h = 3~5m), the buttress type (h = 12~15 m), the ramen type (h = 10~15m), and the box type.

b) Pier Structure

i) Pier Embedment

Article 62.2 of the Cabinet Order Concerning Structural Standards for River Management Facilities, etc. stipulates the pier embedment depth should be over 2 m from the planned or deepest riverbed. If the riverbed surface has almost no difference, however, the pier embedment can be implemented below the riverbed surface. In case that the pier bottom reaches a rock, and the rock is exposed on the riverbed, the pier bottom must be under the riverbed surface.

Photo 2-2-2 Boring Core

According to the geotechnical investigation, hard rocks are exposed on the riverbed of the Lilongwe River (Photo 2-2-2).

In this regard, piers will be embedded in a supporting layer in view of the workability and the economic feasibility. A gabion will be laid to prevent backfill soil runoff and new scouring (Figure 2-2-18).

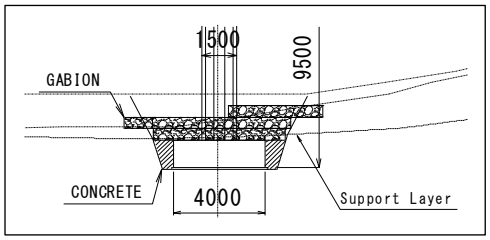


Figure 2-2-18 Pier Embedment

ii) Pier Structure

Since piers stand in the river and might deter the water flow, wall-type piers will be adopted in compliance with Article 62 of the Cabinet Order Concerning Structural Standards for River Management Facilities, etc.

iii) Scour Prevention

Gabions generally used in Malawi will be installed to prevent scouring of the riverbed (Figure 2-2-19).

As shown in Figure 2-2-20, in addition, leveling concrete will be placed at the rock excavation area, and a gabion will be laid at the earth and sand excavation area. The construction area covers the area influenced by pier installment.

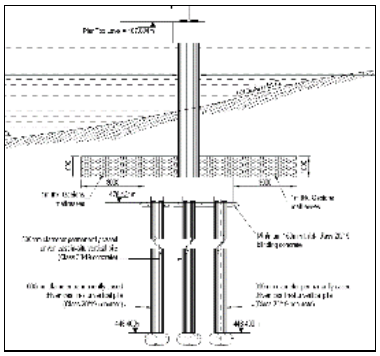


Figure 2-2-19 Scour Prevention Method

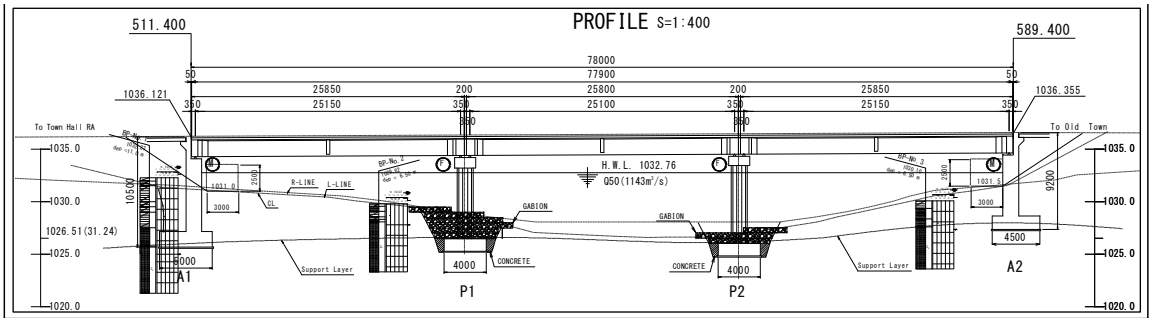
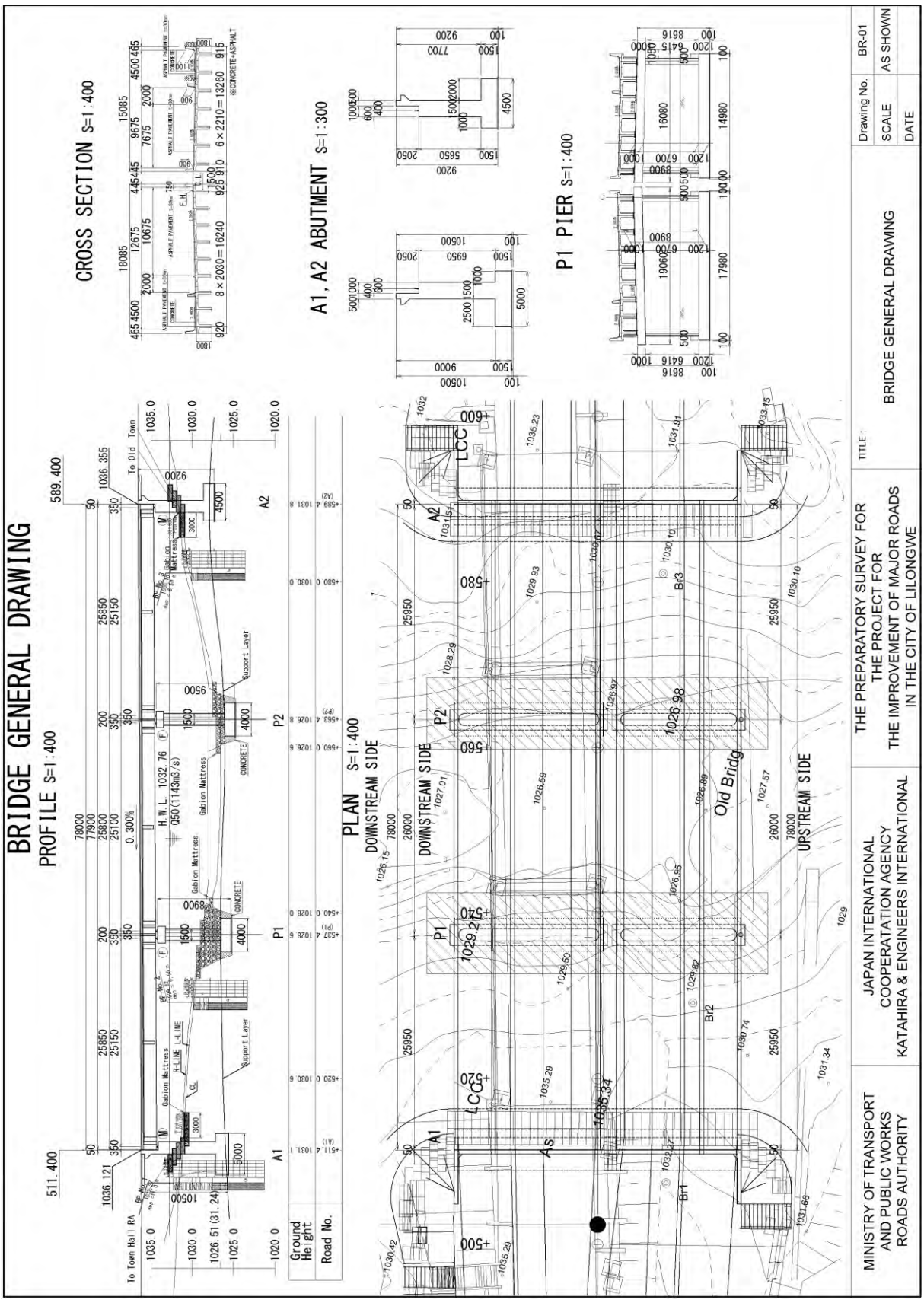


Figure 2-2-20 Gabion Mat

3) Bridge General Drawing



2-2-2-4 Detour Road Design

(1) Pre-conditions of the Detour Route

Seven alternatives for the detour route are shown in Figure 2-2-21. Alternatives 1, 5, 6, and 7 were excluded at the first screening stage in view of pre-conditions, i.e., the use of a ready-made temporary bridge, no hindrance of the temporary bridge to the river flow, no resettlement, and no increase in distance of pedestrian detours. Table 2-2-12 shows the comparison of three alternatives for the detour route—Alternatives 2-4.

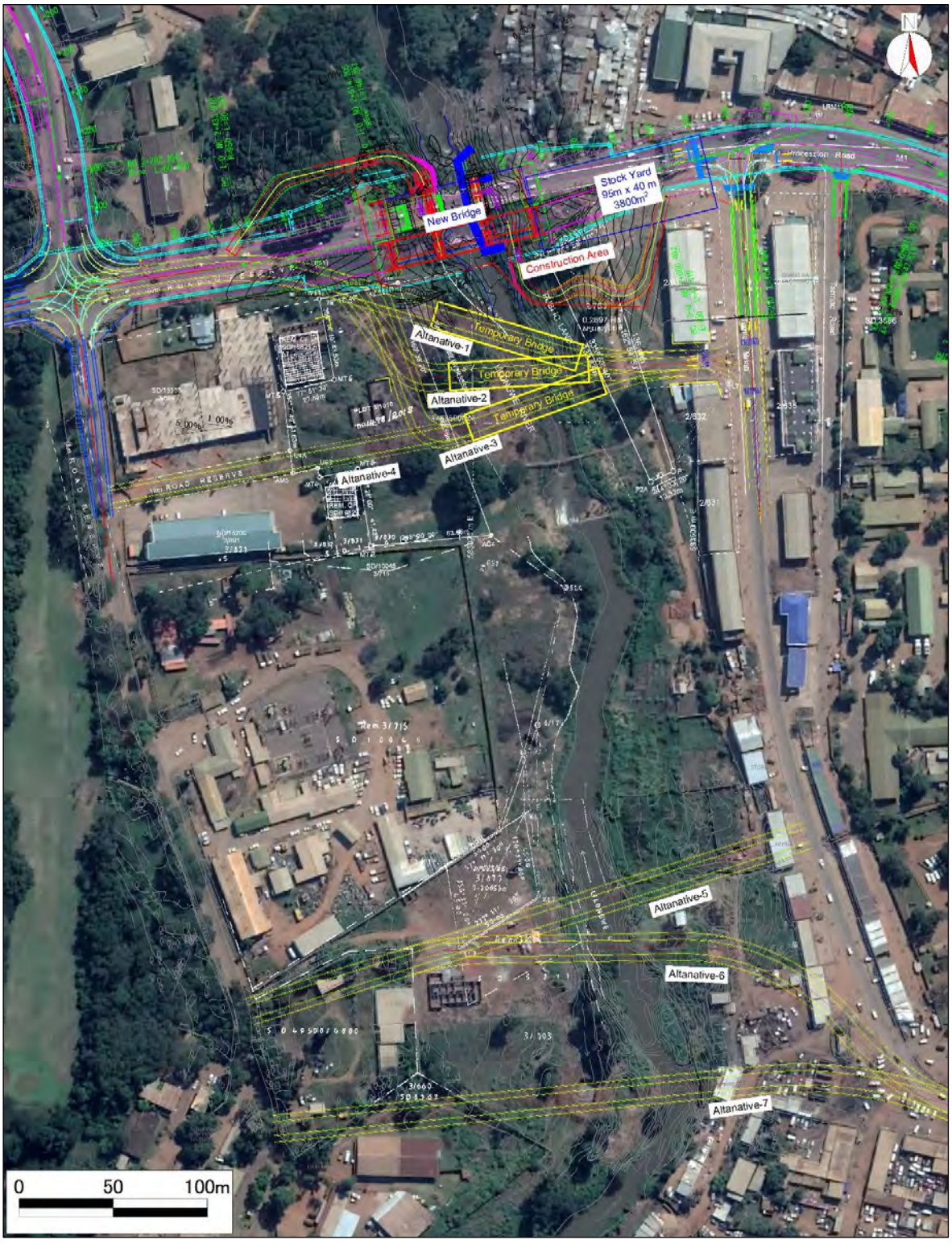
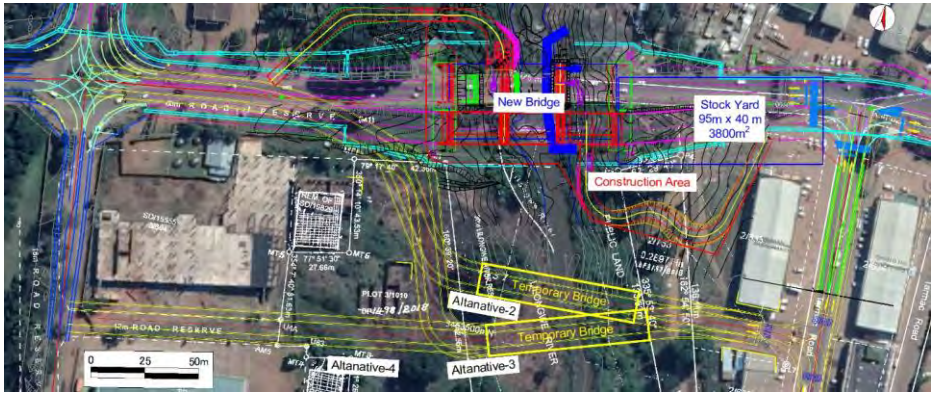


Figure 2-2-21 Location of Seven Alternatives for the Detour Route

Table 2-2-12 Comparison of Three Alternatives for the Detour Route

Site Plan			
Alternative	Alternative 2	Alternative 3	Alternative 4
1.River Conditions	• Greater river blockage compared to the other alternatives. 3rd Place	• Excellent because it is perpendicular to the river flow direction. 1st Place	• Excellent because it is perpendicular to the river flow direction. 1st Place
2. Construction Cost (Direct construction cost)	Distance / Cost Temp. bridge 80 m 0. 550 billion yen Access Road 255 m 0.026 billion yen Total 329 m 0.576 billion yen 1st Place	Distance / Cost Temp. bridge 80 m 0.550 billion yen Access Road 285 m 0.029 billion yen Total 360 m 0.579 billion yen 3rd Place	Distance / Cost Temp. bridge 80 m 0.550 billion yen Access Road 279 m 0.028 billion yen Total 354 m 0.578 billion yen 2nd Place
3. Road Alignment	• Among three curves, the two sharp curves are not as acute as Alternative 3. The alignment on the east side of the bridge is good. 2nd Place	• Among four curves, the two sharp curves are close to an angle of 90 degrees. Therefore, it is considered a poor road alignment. 3rd Place	• There are two curves, however, since they are nearly straight, the design speed of 50km/h can be maintained. This is considered to be the best road alignment. 1st Place
4. Construction Feasibility Construction Period	• Since it is relatively close to houses under construction, the construction feasibility is poor. • The total extension is the shortest among all the alternatives, and the construction period is the shortest. 2nd Place	• The construction feasibility is the worst because it is the closest to houses under construction. • The total extension is the longest, and the construction period is the longest. 3rd Place	• The construction feasibility is the best because it is the farthest from the main bridge. • The total extension is the second longest, and the construction period is the second longest. 1st Place
5. Environmental impacts and Land acquisition	• Environmental impacts are so different from the other alternatives. • The land acquisition area is minimal. 1st Place	• Environmental impacts are not so different from the other alternatives. • The land acquisition area is the largest. 3rd Place	• Environmental impacts are not so different from the other alternatives. • The land acquisition area is the second largest. 2nd Place
Overall Evaluation	It is not recommended because the river blockage is large compared to the other alternatives. Not recommended	It is not recommended because the alignment is bad and because the land acquisition area is large. Not recommended	It is recommended because it has the best alignment and is the farthest from the main bridge, and additionally its construction feasibility is good. Recommended alternative

(2) Cross-sectional Configuration of the Detour Road

For the detour road, the following conditions will be considered while establishing the minimum width. The standard cross section is shown below:

1. Safe traffic of large vehicles shall be secured.
2. Passage of bicycles on the road shoulder shall be secured.
3. The boundary between a carriageway and a sidewalk—installing curbs and guard rails—will be secured
4. A width of more than 2 m for the sidewalk will be secured.
5. Since the road deck of the temporary bridge has a two-meter horizontal span, a minimum of seven spans totaling a width of 14 m will be required.

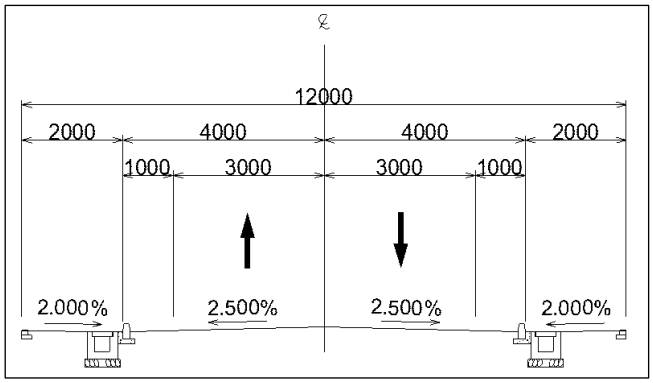


Figure 2-2-22 Standard Cross Section (Width = 12 m)

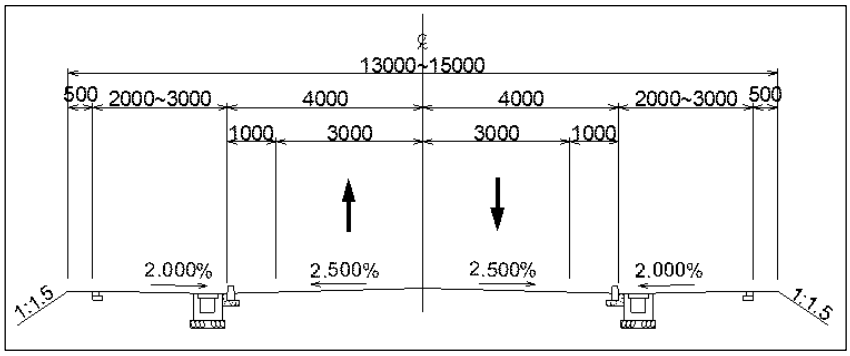


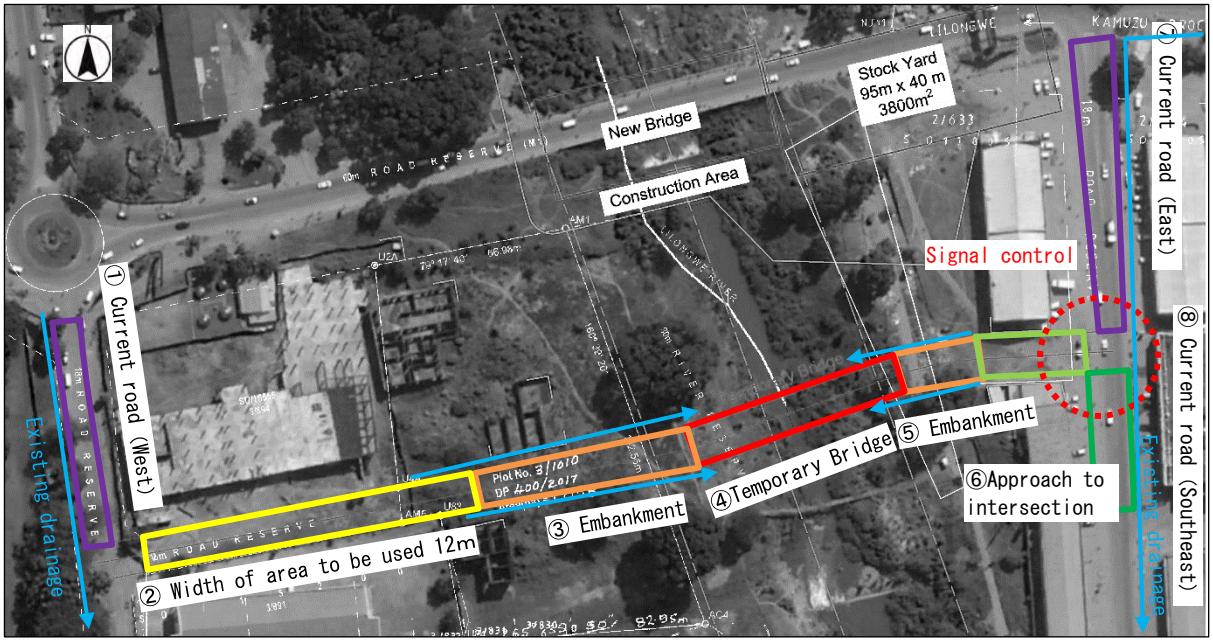
Figure 2-2-23 Standard Cross Section (Embankment Section)

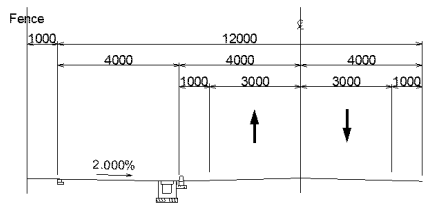
Malawi's standards for slope cutting and embankment use a 1:4 grade to recover from vehicle deviations. However, the boundary between at the road and sidewalk in the project road is not affected by vehicles.

In this regard, a stable slope is secured based on the JRA guidelines when it comes to the embankment section and around abutments, and accordingly the embankment slope was set to 1:1.5.

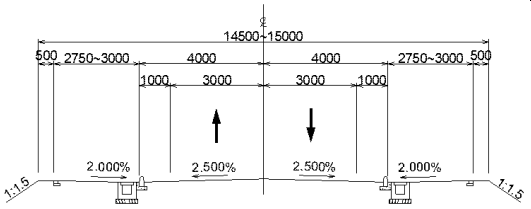
Slop Cutting: Sandy soil	5 m or less	1 : 1.0
Embankment : Sandy soil 5 m or less 1 : 1.5,	5 m or more	1 : 1.8

The next page demonstrates a site plan and a cross-sectional drawing for each section of the detour road.

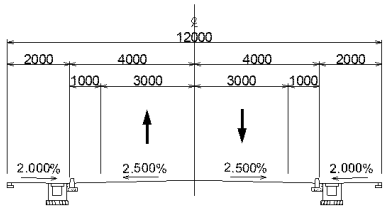




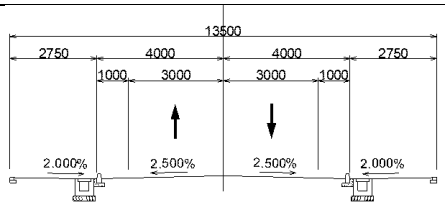
■① Present Road (West)※Only install the 4-meter-long sidewalk, drainage ditches, curbs, and road marks



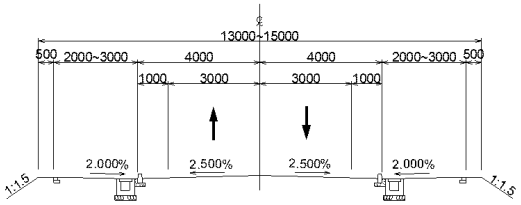
■⑤ Detour Road (Embankment)



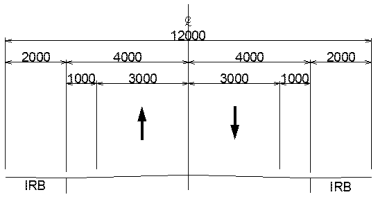
■② Detour Road (12 m in width)



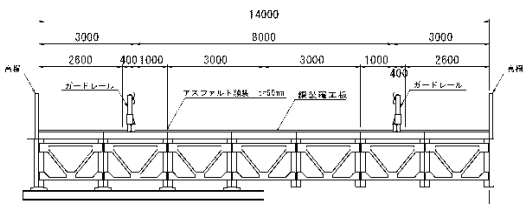
■⑥ Detour Road (In front of an intersection)



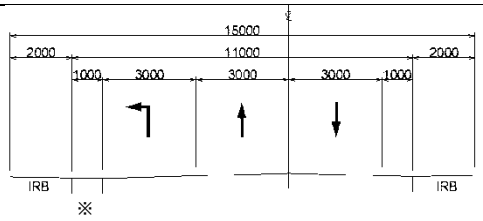
■③ Detour Road (Embankment)



■⑦ Present Road (East)
※ Only install of road marks



■④ Temporary Bridge



■⑧ Existing Road (Southeast)
※Only install a one-meter pavement and road marks

Figure 2-2-24 Site Plan and Cross-Sectional Drawing for Each Section of the Detour Road

(3) Pavement Design of the Detour Road

1) Carriageway

The detour road is located at the M1 road. The detour road passing through the urban area is expected to accommodate a traffic volume of approximately 28,000 vehicles per day in 2021 and thereby will be paved with asphalt in view of vehicle safety, driving performance, and the roadside environment.

The design criteria for pavement thickness of the detour road will be the same with those of the main road section, the thick AASHTO pavement thickness. Since the detour road will be used for 31 months from the initiation of construction, the number of vehicles used for calculating the pavement thickness will be estimated for three years beginning from 2021. Since a CBR survey on the road surface drew more than six conclusions, it was calculated with the CBR6 just as the main road section.

As a result of a traffic survey, the ESAL (18 kip single axis weight equivalent conversion value) of the detour road ranging from the Town Hall Roundabout to the Old Town Market Junction. As a result, the ESAL was calculated as w18 = 0.626 x 106.

Annual YEAR		MOTORBIKE / TUK TUK	MINIBUS	LIGHT VEHICLE	HEAVY VEHICLE						TOTAL
					2 AXIS	3 AXIS	4 AXIS	5 AXIS	6 AXIS	SUB-TOTAL	
2021.7 Open the detour road	**2021**	1,925	6,360	18,624	468	136	7	3	104	718	27,627
(Detour road period 31 months)	**2022**	1,982	6,551	19,183	482	140	7	3	107	740	28,456
2023.12 Close the detour road	**2023**	2,042	6,748	19,758	497	144	7	4	110	762	29,310
2021～2023（3 years）Total Vehicle			19,659	-	1,447	420	21	10	321		
One-sided large traffic volume per lane*			11,795	-	868	252	13	6	193		
Axis equivalent conversion factor			0.012	-	0.381	1.269	2.349	3.429	4.509		
Equivalent weight for 3 years			142	-	331	320	31	21	870		
Equivalent Single Axle Load						W18=	0.626	×10 ^{6}			

Note: It is assumed that 60% of heavy traffic passes in one lane.

The calculated pavement thickness for the detour road in accordance with the AASHTO guide using the ESAL is shown below.

Detour	AASHTO
・ Surface layer + base layer	100 mm
・ Upper base course	100 mm
・ Lower base course	200 mm

2) Sidewalk

The rubble pavement cannot collect the water with a covered drainage ditch in the sidewalk, so there is a risk that the water from the detour road is not captured by the ditch and flow into private property. In this regard, a sidewalk will be paved by means of the simple pavement method—asphalt pavement of 30 mm in thickness and basecourse materials of 100 mm in thickness.

The simple pavement method, or the double bituminous surface treatment (DBST) has a high probability of being damaged during the 31-month operation period and will probably need to be repaved because of the void that is generated by the compression effect of the embankment on the road.

By using a roadbed made of highly porous crushed stones, it is possible to suppress the soil runoff from the lower surface of the pavement due to rainwater, and the follow-up performance is excellent even if even if voids are generated. Since the occurrence of potholes is controlled, in addition, the durability of asphalt pavement is considered to be higher than the DBST. In consequence, it is desirable to adopt the simple pavement method in view of the comfort and safety of pedestrians.

3) Current Section

The maintenance costs or repair costs, e.g., pavement repair costs during construction of the detour road section are included in construction costs. In addition, some sidewalks of the existing detour road sections will be paved by means of the simple pavement method—asphalt pavement of 30 mm in thickness and basecourse materials of 100 mm in thickness.

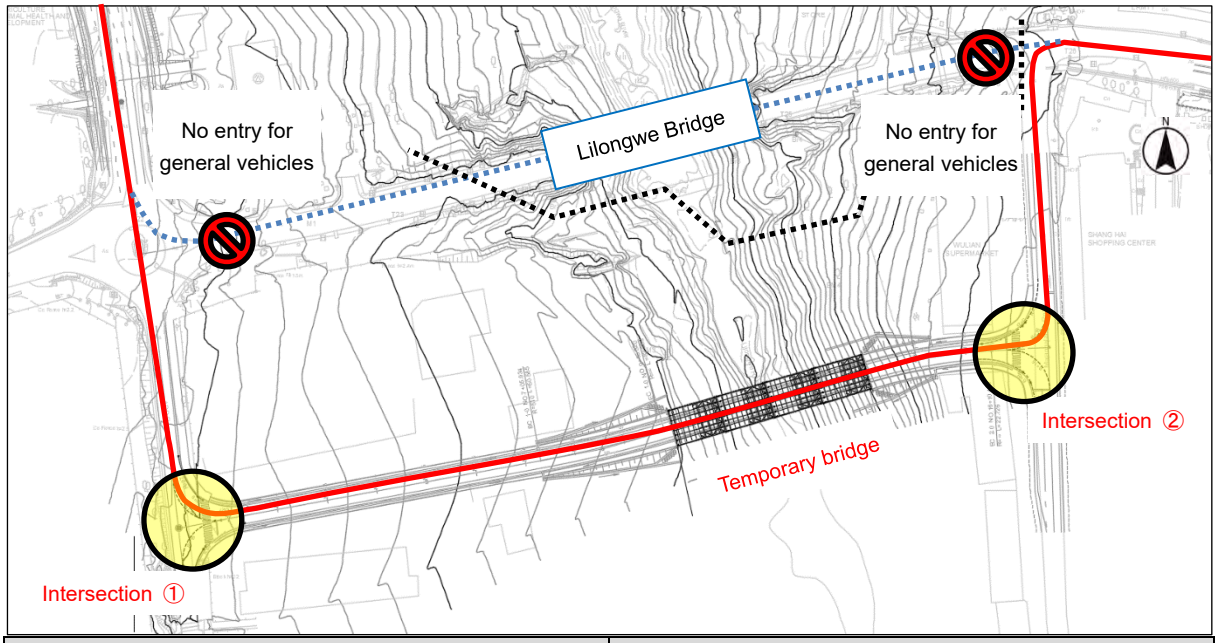
(4) Treatment of the Current Detour Road

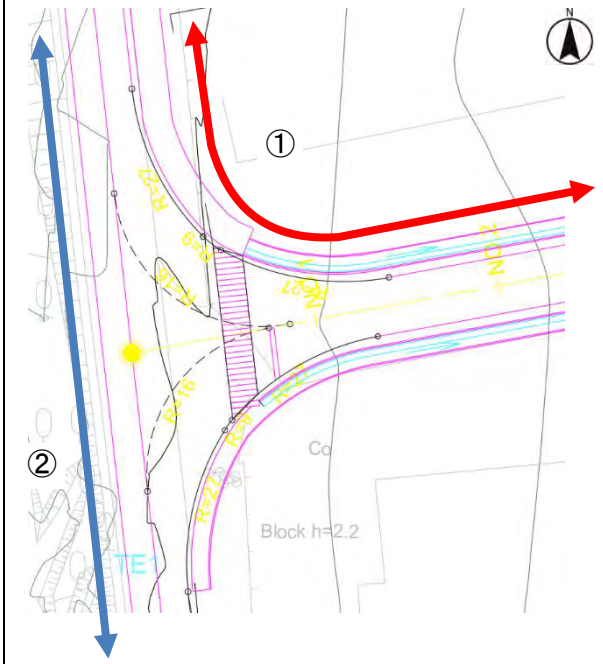
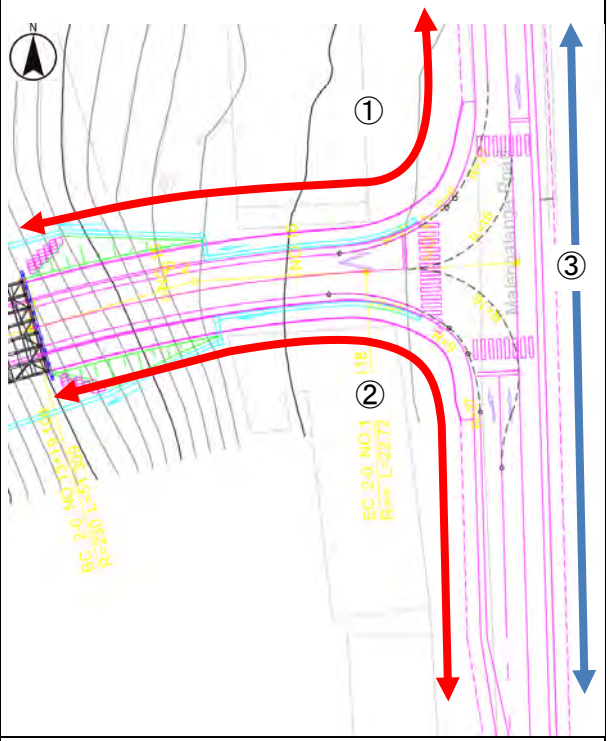
While utilizing the existing pavement on the detour road, road markings will be equipped to secure vehicle safety. The following illustrates the treatment of the present detour road.

1. ① Current Road (West) • Since pedestrians cannot use the left side of the existing road due to drainage ditches and roadside trees, a sidewalk of 4 m in width will be installed and simply paved at the right side of the existing road.	 ＜Heading the North Direction＞
2. ⑦ Current Road (East) • Since both sides of sidewalks are paved with interlocking blocks, they will continuously serve as sidewalks of the detour road.	 ＜Heading the North Direction＞
3. ⑧ Current road (Southeast) • Since the sidewalk is paved with interlocking blocks, it will continuously serve as a sidewalk of the detour road. • Since the left road shoulder is currently paved with interlocking blocks, its pavement of 40 m in length (surface and base course of 50 mm in thickness and basecourse of 100 mm in thickness) will be replaced.	 ＜Heading the South Direction＞

(5) Intersection Design

Since traffic on the M1 road will be transferred directly to the detour road during bridge construction, the detour road (red line) shown in the figure below will accommodate most traffic. Therefore, the survey team prepared an intersection plan for Intersections 1 and 2.



Intersection ①	Intersection ②
	
① The main traffic goes towards the north-east direction. ② There is almost no vehicle traffic in the north-south direction. There is no need to control intersections by traffic signals.	① The main traffic goes towards the north-west direction. ② There is also a great amount of traffic from the south to the west due to mini-bus traffic heading a bus depot in the south. For this reason, a left-turn lane will be installed in the south-west direction. ③ There is almost no vehicle traffic in the north-south direction. The signal-controlled intersection is required. A traffic signal from the main road section is planned to be temporarily used.

(6) Drainage Ditches

A drainage ditch on the detour road will be covered with the U300 lid and connected to the foot of the embankment section in the same way for the main carriageway, directing the water towards the Lilongwe River. A gabion will be installed at the end of a drainage ditch in order to prevent scouring.

(7) Street Lights

Street lights will be installed at the minimum on the detour road since the existing bridge is not lighted and since there are restrictions on land use. In particular, no street light can be installed where the sidewalk of 2 m in width exists at a narrower section of the detour road (12 m in width). Therefore, street lights are arranged at a minimum of five places as shown in the right table. The details on street lights are described in Section 2.4.

No.	STA.	Distance (m)
1	0+005	—
2	0+120	115
3	0+195	70
4	0+285	90
5	0+345	60

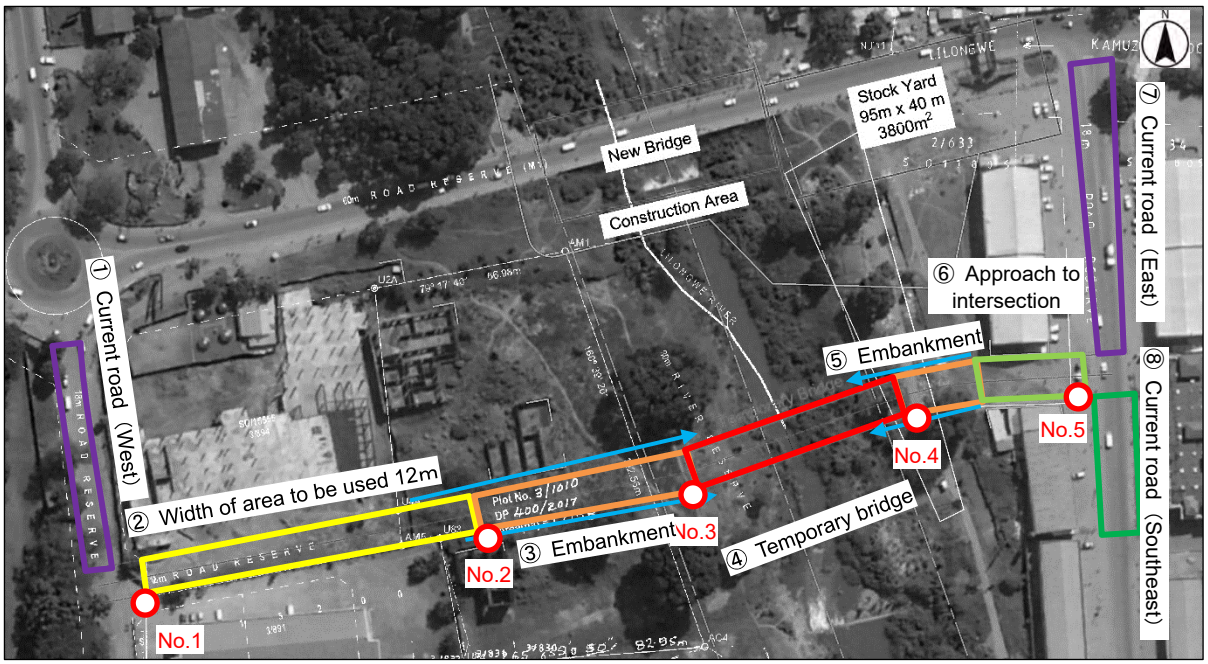


Figure 2-2-25 Positions of Street Lights on the Detour Road

(8) River Conditions

The structure of a temporary bridge will not be short of the flow capacity at the current bridge position since it will be installed all year round.

Condition 1 [Design HWL]: At the time of the first field survey, the past maximum water level obtained by an interview with the staff of the Ministry of Transport and Public Works (MoTPW) during the first field survey and the riverbed slope (1/470) in the vicinity of the top of the existing bridge pier (1033.12) will be considered.

Condition 2 [Clearance Below the Bridge Girder]: A clearance of more than 60 cm below the girder will be secured not to undermine the water flow due to driftwood.

Condition 3 [Span Length]: For the existing bridge, the minimum span of 19.5 m or more to prevent a blockade will be secured.

Condition 4 [Bridge Length]: The length of the existing bridge will reach 65.6 m or more to secure the flow capacity of the existing bridge (Figure 2-2-26).

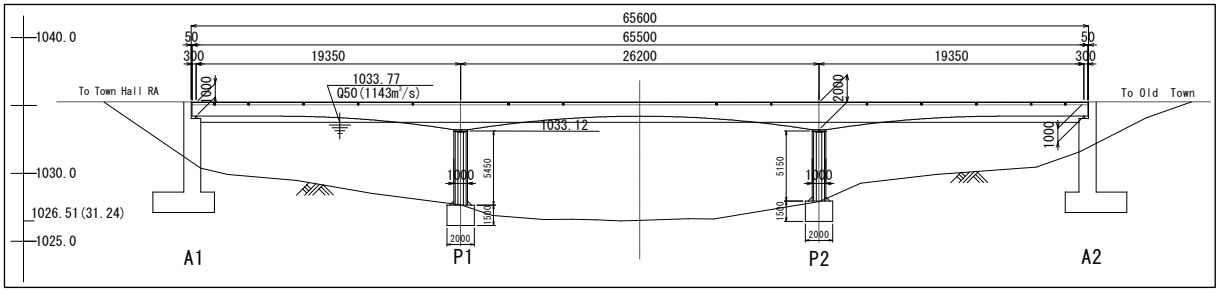


Figure 2-2-26 Side View of the Existing Bridge

(9) Structure of the Temporary Bridge

Japan's emergency bridge applies to the temporary bridge stretched over a detour route for the project. The emergency bridge has a girder type and a truss type, and the applicable width of the truss type is confined to 8 m due to the structure of a floor set. In this regard, it is uneconomical since two sets are required for the design width.

Even if a large H-type steel is used, the temporary pier type is uneconomical and thus is not reviewed since the factory processing is required to install horizontal structures.

Instead, the girder type that can be placed in line with the road width is adopted. Substructures will include pile bent piers (two rows of piles) made of H steel piles for both abutments and piers. The backfill of abutments will be retained by self-standing parent piles with horizontal arrow plates.

Even though it is a temporary bridge, its load-bearing capacity will be equal to that of a new bridge for a general use over a long period—about three years. For substructures, the horizontal force by means of live loads will be considered.

(10) Surface Height of the Temporary Bridge

Design HWL	1,033.1 + 130 m × 1/470 = 1,033.40
Clearance below the girder	0.600
Girder height	1.300
Pavement	0.050
Lining plate	0.210
Road surface height	1035.56 (the minimum value)

(11) Longitudinal Design of the Detour Road and the Temporary Bridge

The longitudinal design of detour roads and temporary bridges is prepared based on the following four conditions.

(i) The minimum road surface height determined by river conditions secures a clearance of 60.35 cm from HWL 1,033.40 and reaches 1,035.56 with an additional height of 1.56 m from the bottom of the girder to the road surface. The road surface height at the A1 abutment will be the CP of the longitudinal design.

(ii) The slope at the starting point (the left bank) is 2.400% down to the river side, and the slope change point satisfying Condition (i) is assumed to be located at No. 6 + 10.000. Since No. 6 is a narrow section of 12 m in width and thereby is not able to be filled or cut, it needs to be rubbed against the current ground.

(iii) The slope from the ending point (the right bank) is 2.500% down to the river side, and the slope change point is assumed to be located at No.15. As the ending point is connected to an

intersection, a gentle intersection slope of 2.500% and a minimum section length of 40 m are applied.

(iv) As the two slope change points in Conditions (ii) and (iii) are connected, the resulting gradient stands at 3.781%.

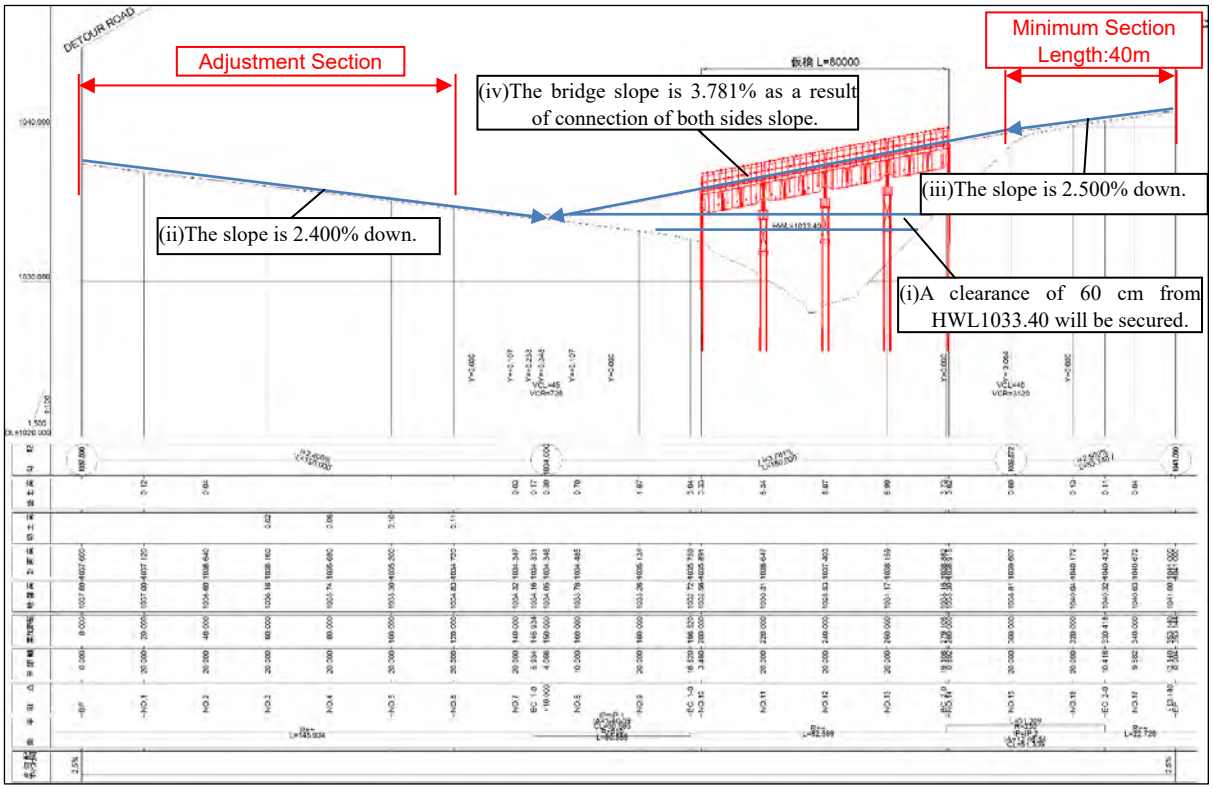
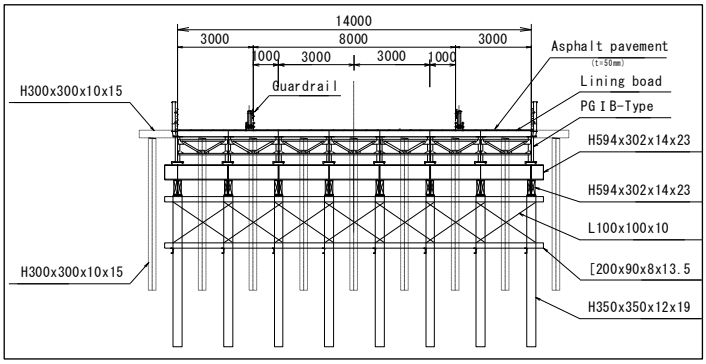


Figure 2-2-27 Profile of Detour Road and Temporary Bridge

(12) Examination on Bridge Length and Span Ratio



In addition to the afore-mentioned river conditions, the abutment structure of a temporary bridge can be singled out as an item to be considered when deciding the bridge length. Since the depth of the supporting layer at this point is assumed to be located below the current riverbed, ordinary concrete abutments require supporting piles and need to be dismantled after construction, which makes it uneconomical. For this reason, the pile vent structure by H-shaped steel pile will be adopted for the bridge abutments just like the bridge piers.

Since this structure cannot receive earth pressure, the backside embankment will be built by the self-standing earth retaining method, or the parent pile cross-slab method (see the figure below). The application range of the self-standing earth retaining method is the embankment of about 4 m in height according to the Guideline on Temporary Construction of Road Earthworks (p. 150).

Based on the above-mentioned conditions and assumptions, the survey team examined the position of abutment and the span length ratio.

- The A2 abutment will be located at No. 14+0, where the backfill is as high as 4 m.
- The total length of a temporary bridge will be 80 m with four spans. The length of each span

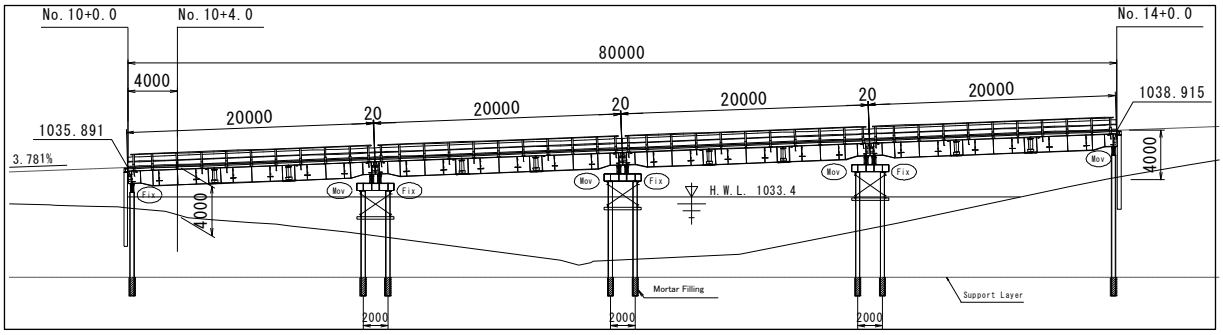
will be 20 m.※ The minimum span length is determined based on River Condition 3.

※ Because the girder length of the temporary bridge is in increments of 1.0 m increments, it will be rounded up to 20 m from 19.5 m.

- A 50-ton suspension crawler crane will be used for girder installation and be able to procured from Malawi.

The rationales behind adopting the afore-mentioned structure are as follows:

- The backfill of the A1 abutment is as high as 4 m at No. 10+4, and the shortest bridge length is 76.0 m.
- Based on River Condition 3, the number of spans is three (n = 76/19.5 = 3.9).
- In case of three spans, the span length amounts to 25.3 m, and when using an existing product, the total bridge length is 78.0 m (26.0 × 3 = 78.0 m). In this case, the girder size will be one rank higher than the girder with 20-meter spans, so that the effect of shortening the bridge length will be small, which makes it uneconomical—about 15% increase in costs for superstructures and substructures combined compared to the four-span alternative.
- In addition, a 100-ton lifting crane will be needed to construct the girder, which is also uneconomical since the crane cannot be procured locally.



(13) Foundation of the Temporary Bridge

1) Selection of Supporting Layer

Based on the result of a geological survey, the weathered rock layer under the ground surface was chosen as a supporting layer. Since a weathering pattern varies with places and the depth, however, a line connecting points which have an N value of 50 or more is considered the supporting layer. In case of the riverbed, the supporting layer is located 50 cm below the surface layer.

2) Pile Construction Method

In order to secure the bearing capacity of pile tips, it is necessary to embed piles in a quality supporting layer at the depth of about 2 m in accordance with the Guideline on Temporary Construction of Road Earthworks. Because it is impossible to drive a pile into a weathered rock and a medium hard rock with the vibration method, the pre-boring method by means of down-the-hole hammers will be utilized. In addition, pier piles are temporary construction materials and will be pulled out for its removal, and thereby the pile tips will be coped with the vibration method instead of the mortar filling method.

(14) Handling of a temporary detour bridge

A temporary bridge will be designated temporarily for the following reasons.

- It is a temporary structure to be used for general traffic.
- It is procured either from Japan or a third country due to a difficulty in local procurement.
- Because its installation takes as long as 31 months, its design equals that of a permanent bridge.

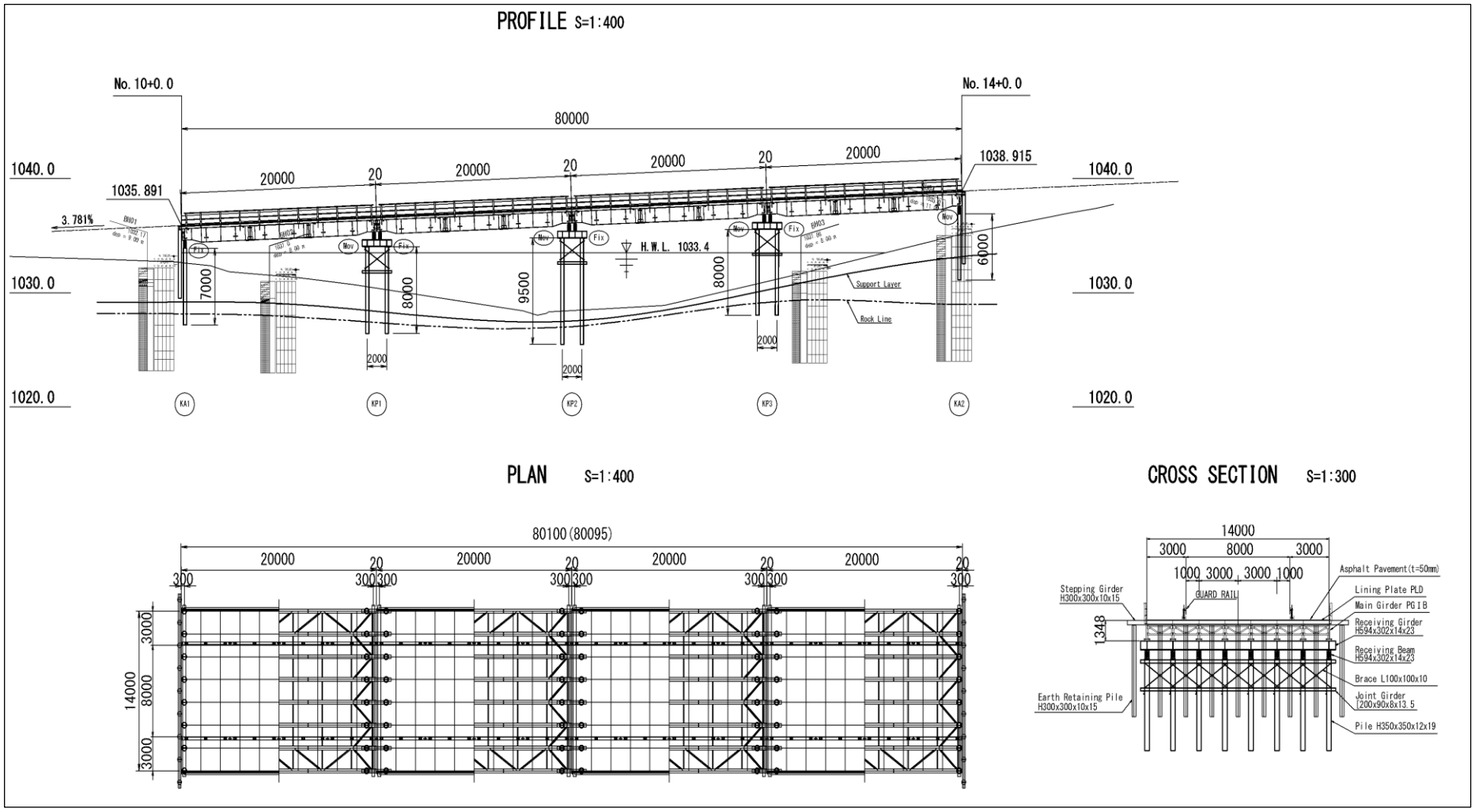


Figure 2-2-28 Temporary Bridge General Drawing

(15) Pavement of the Temporary Bridge

A anti-slip pavement on a lining board will be carried out in view of driving performance and safety. Since a bridge pavement thickness stands at 50 mm according to the previous design data, a pavement on the lining plate of the temporary bridge will have a thickness of 50 mm including the surface layer and the base layer with a dense-grade asphalt mix (Photo 2-2-3).

Based on the fact that Japan's assistance includes the removal of the temporary bridge, a sheet between the lining board and pavement will be installed for smooth pavement elimination.

For sidewalks, a simple pavement, or an asphalt pavement of 30 mm in thickness will be implemented just like detour roads.

Photo 2-2-3 Example of Bridge Pavement

Photo 2-2-4 Water Pipes of the Existing Bridge

(16) Relocation of Obstacles

The relocation of water and sewer pipes installed on the existing bridge will be carried out by Japan (Photo 2-2-4).

The temporary water supply plan during construction of water and sewer pipes is shown in Figure 2-2-29.

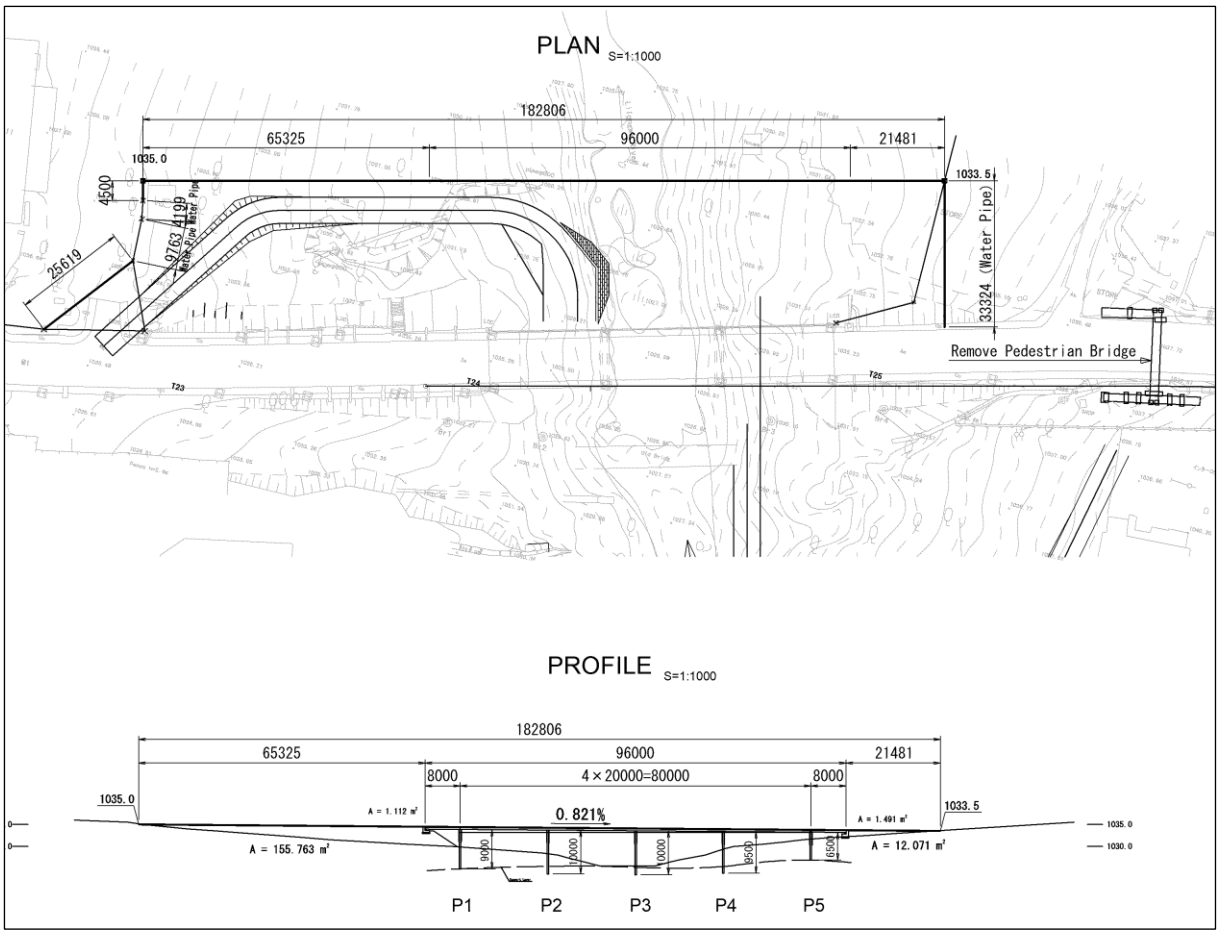


Figure 2-2-29 Temporary Water Supply Plan During Construction of Water and Sewer Pipes

2-2-3 Outline Design Drawing

Outline design drawings are presented from the next page, and its contents are summarized in Table 2-2-13.

Table 2-2-13 Contents of Outline Design Drawings

Drawing Name	Drawing Number
Abbreviation List	AB-01
Location Map	LM-01
Typical Cross Section	TC-01 ～ TC-02
Key Plan	KP-01 ～ KP-03
Plan	PL-01 ～ PL-10
Profile	PR-01 ～ PR-10
Intersection Plan	IS-01 ～ IS-07
Curb Stone	CU-01 ～ CU-04
Drainage Structure	DR-01 ～ DR-11
Bust Stop Detail	BS-01
Unloading Place Detail	UP-01
Access Way	AC-01
Retaining Wall	RW-01 ～ RW-02
Guard Fence	GF-01
Guard Post	GP-01
Road Marking	RM-01
Post Cone and Stud	PS-01
Road Sign	RS-01 ～ RS-02
Street Lighting	SL-01 ～ SL-02
Traffic Signal Plan	TP-01 ～ TP-04
Detail of Traffic Signal	TS-01 ～ TS-04
Hand Hole	HH-01
Bridge General Drawing	BR-01
Superstructure	BR-02 ～ BR-03
Substructure	BR-04 ～ BR-09
Detail of Gabion	MG-01 ～ MG-03
Stairway at the Bridge	SW-01
Key Plan for Detour Road	DKP-01
Plan for Detour Road	DPL-01
Profile for Detour Road	DPR-01
Typical Cross Section for Detour Road	DTC-01
Temporary Bridge General Drawing	DGE-01
Detail of Sand Bag	DSB-01
Water and Drainage Pipe Bridge	WGE-01
Location of Existing Utilities on the Ground	UG-01 ～ UG-10
Location of Existing Utilities Underground	UU-01 ～ UU-10
Total	111 Pages

THE PREPARATORY SURVEY
FOR
THE PROJECT
FOR
THE IMPROVEMENT OF MAJOR ROADS
IN
THE CITY OF LILONGWE

APRIL 2019

DRAWINGS

JAPAN INTERNATIONAL COOPERATION AGENCY

DRAWING INDEX

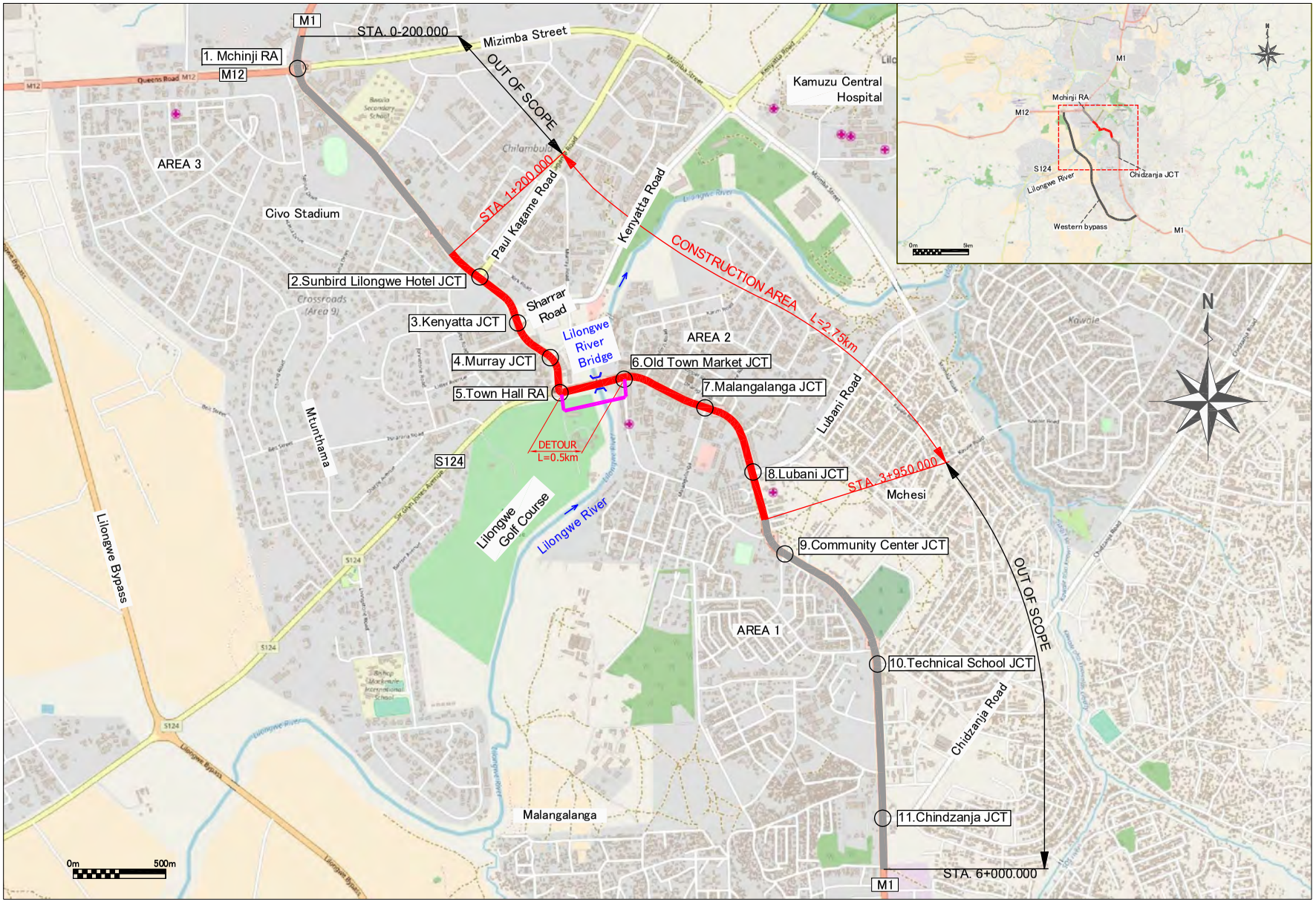
No.	Title	Drawing No.				
1	ABBREVIATION LIST	AB	-	01		
2	LOCATION MAP	LM	-	01		
3	TYPICAL CROSS SECTION	TC	-	01	-	02
4	KEYPLAN	KP	-	01	-	03
5	PLAN	PL	-	01	-	10
6	PROFILE	PR	-	01	-	10
7	INTERSECTION PLAN	IS	-	01	-	07
8	CURB STONE	CU	-	01	-	04
9	DRAINAGE STRUCTURE	DR	-	01	-	11
10	BUS STOP DETAIL	BS	-	01		
11	UNLOADING PLACE DETAIL	UP	-	01		
12	ACCESS WAY	AC	-	01		
13	RETAINING WALL	RW	-	01	-	02
14	GUARD FENCE	GF	-	01		
15	GUARD POST	GP	-	01		
16	ROAD MARKING	RM	-	01		
17	POST CONE AND STUD	PS	-	01		
18	ROAD SIGN	RS	-	01	-	02
19	STREET LIGHTING	SL	-	01	-	02
20	TRAFFIC SIGNAL PLAN	TP	-	01	-	04
21	DETEIL OF TRAFFIC SIGNAL	TS	-	01	-	04
22	HAND HOLE	HH	-	01		
23	BRIDGE GENERAL DRAWING	BR	-	01		
24	SUPERSTRUCURE	BR	-	02	-	03
25	SUBSTRUCTURE	BR	-	04	-	09
26	DETAIL OF GABION	MG	-	01	-	03
27	STAIRWAY AT THE BRIDGE	SW	-	01		
28	KEY PLAN FOR DETOUR ROAD	DKP	-	01		
29	PLAN FOR DETOUR ROAD	DPL	-	01		
30	PROFILE FOR DETOUR ROUD	DPR	-	01		
31	TYPICAL CROSS SECTION FOR DETOUR ROAD	DTC	-	01		
32	TEMPORARY BRIDGE DENERAL DRAWING	DGE	-	01		
33	DETAIL OF SAND BAG	DSB	-	01		
34	WATTER AND DRAINAGE PIPE BRIDGE	WGE	-	01		
35	LOCATION OF EXISTING UTILITIES ON THE GROUND	UG	-	01	-	10
36	LOCATION OF EXISTING UTILITIES UNDERGROUND	UU	-	01	-	10

TOTAL 111 SHEETS

ABBREVIATION LIST

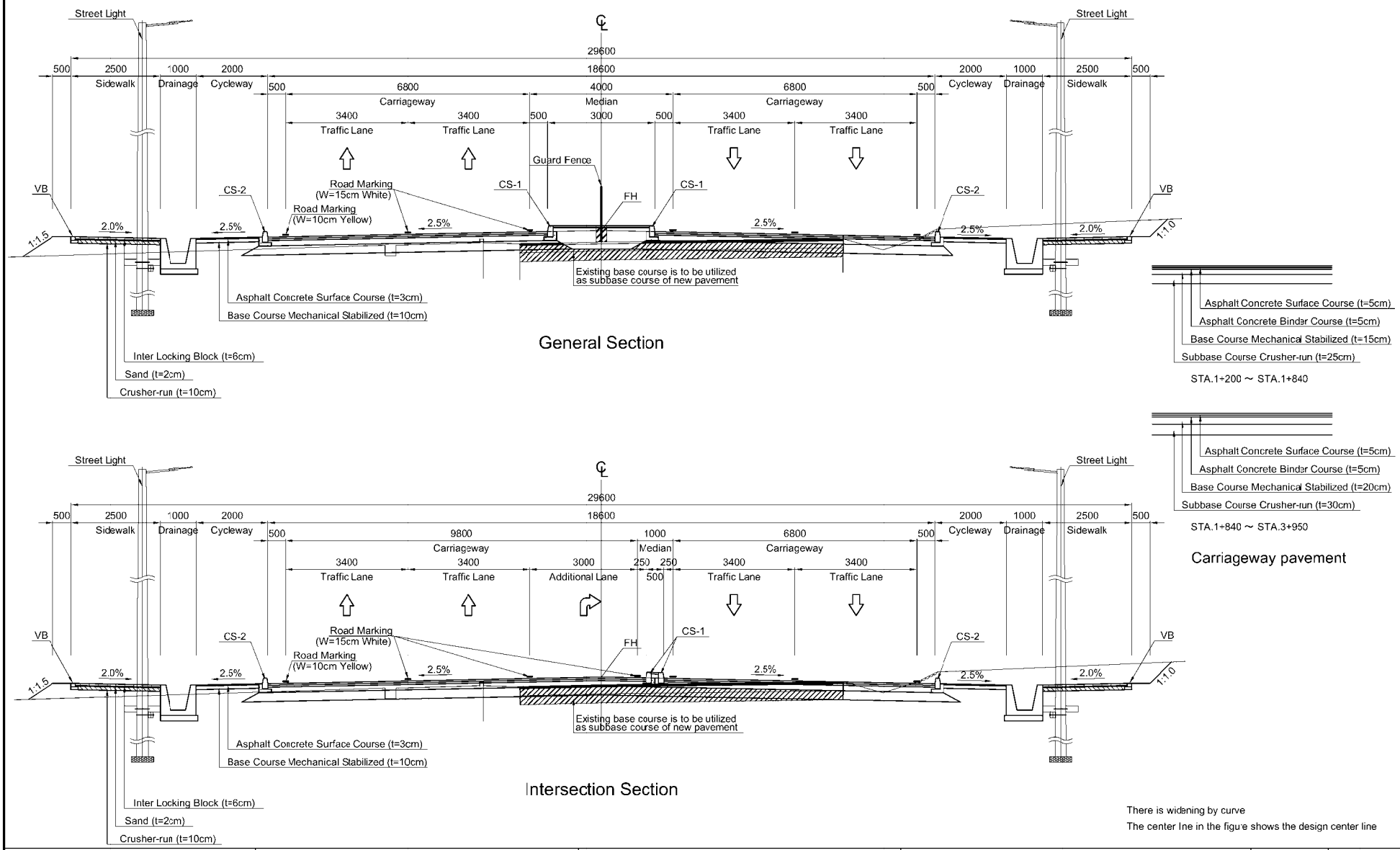
CLASSIFICATION(1)	CLASSIFICATION(2)	CLASSIFICATION(3)	CLASSIFICATION(4)	DRAWING NO.	ABBREVIATION
CURBS	CURB STONE	FOR MEDIAN SECTION	B125×H300×L600	CU-01	CS-1
		FOR GENERAL SECTION	B100×H300×L600	CU-01	CS-2
		FOR THE NARROWEST MEDIAN SECTION	B200×H300×L600	CU-01	CS-2-200
		FOR GRINDING OF GENERAL SECTION	B100～150×H140～300×L600	CU-01	CS-3
		FOR RIDES AND DRAINAGE SECTION	B150×H140×L600	CU-01	CS-4
	VERGE BLOCK		B125×H100×L600	CU-01	VB
DRAINAGE	U SHAPE DRAIN	OPEN TYPE	W=600mm, H=600mm	DR-01	U-600
		OPEN TYPE	W=700mm, H=700mm	DR-01	U-700
		OPEN TYPE	W=800mm, H=800mm	DR-01	U-800
		WITH CONCRETE COVER TYPE	W=300mm, H=400mm	DR-01	U-300(C)
		WITH CONCRETE COVER TYPE	W=600mm, H=600mm	DR-01	U-600(C)
		WITH CONCRETE COVER TYPE	W=700mm, H=700mm	DR-01	U-700(C)
		OPEN TYPE WITH REINFORCING BARS	W=1000mm, H=1000mm	DR-02	U-1000
		OPEN TYPE WITH REINFORCING BARS	W=1200mm, H=1200mm	DR-02	U-1200
		WITH CONCRETE COVER AND REINFORCING BARSTYPE	W=800mm, H=800mm	DR-02	U-800(C)
		WITH CONCRETE COVER AND REINFORCING BARSTYPE	W=1000mm, H=1000mm	DR-02	U-1000(C)
		WITH CONCRETE COVER AND REINFORCING BARSTYPE	W=1200mm, H=1200mm	DR-02	U-1200(C)
	CONCRETE BOX CULVERT		W=1000,H=1000 WITH CONCRETE BASE	DR-03	BX1000
			W=1300,H=1300 WITH CONCRETE BASE	DR-03	BX1300
			W=1500,H=1500 WITH CONCRETE BASE	DR-03	BX1500
	CONCRETE PIPE CULVERT				
		φ600	WITH 360 DEGREE CONCRETE BASE	DR-04	DP-600
		φ900	WITH 360 DEGREE CONCRETE BASE	DR-06	DP-900
	CATCH BASIN	B900-L900-H1000	WITH CONCRETE COVER	DR-05	CB-1
		B1000-L1000-H1300	WITH CONCRETE COVER	DR-05	CB-2
		B1100-L1100-H1500	WITH CONCRETE COVER	DR-05	CB-3
		B1300-L1300-H1800	WITH CONCRETE COVER	DR-7	CB-4
		B1500-L1500-H1600	WITH CONCRETE COVER	DR-7	CB-5
		B1700-L1700-H2000	WITH CONCRETE COVER	DR-7	CB-6
		B1700-L1700-H2700	WITH CONCRETE COVER	DR-7	CB-7
GUARD FENCE			H=1100,L=3000 WITH CONCRETE BASE	GF-01	GF
GUARD POST		CONCRETE 21 N/mm2	H=600, φ150 WITH CONCRETE BASE	GP-01	GP

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : ABBREVIATION LIST	Drawing No.	AB-01
				SCALE	
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION MAP	Drawing No.	LM-01
				SCALE	S=1/10000
				DATE	

Standard Section



General Section

STA.1+200 ~ STA.1+840

Intersection Section

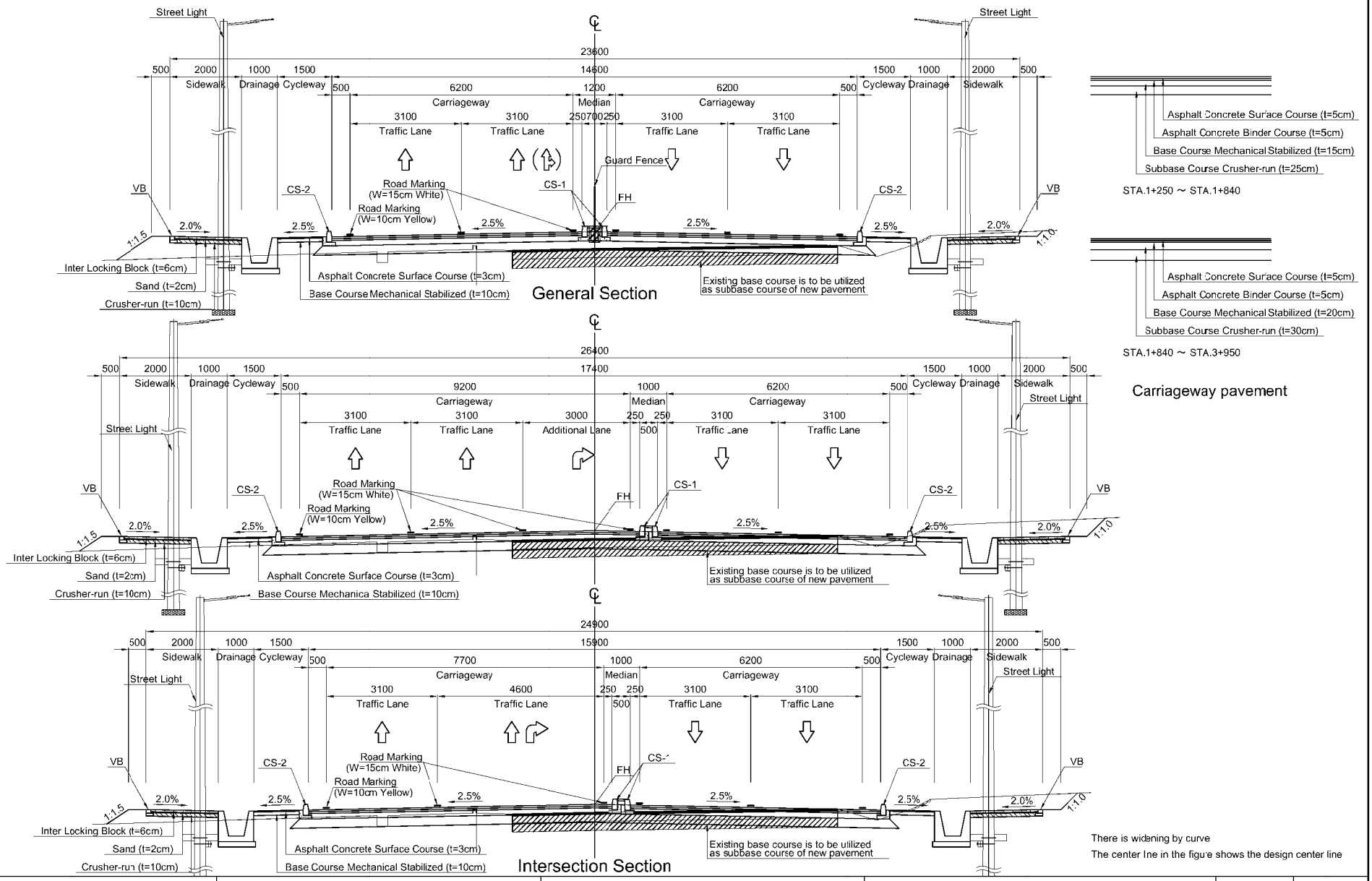
STA.1+840 ~ STA.3+950

Carriageway pavement

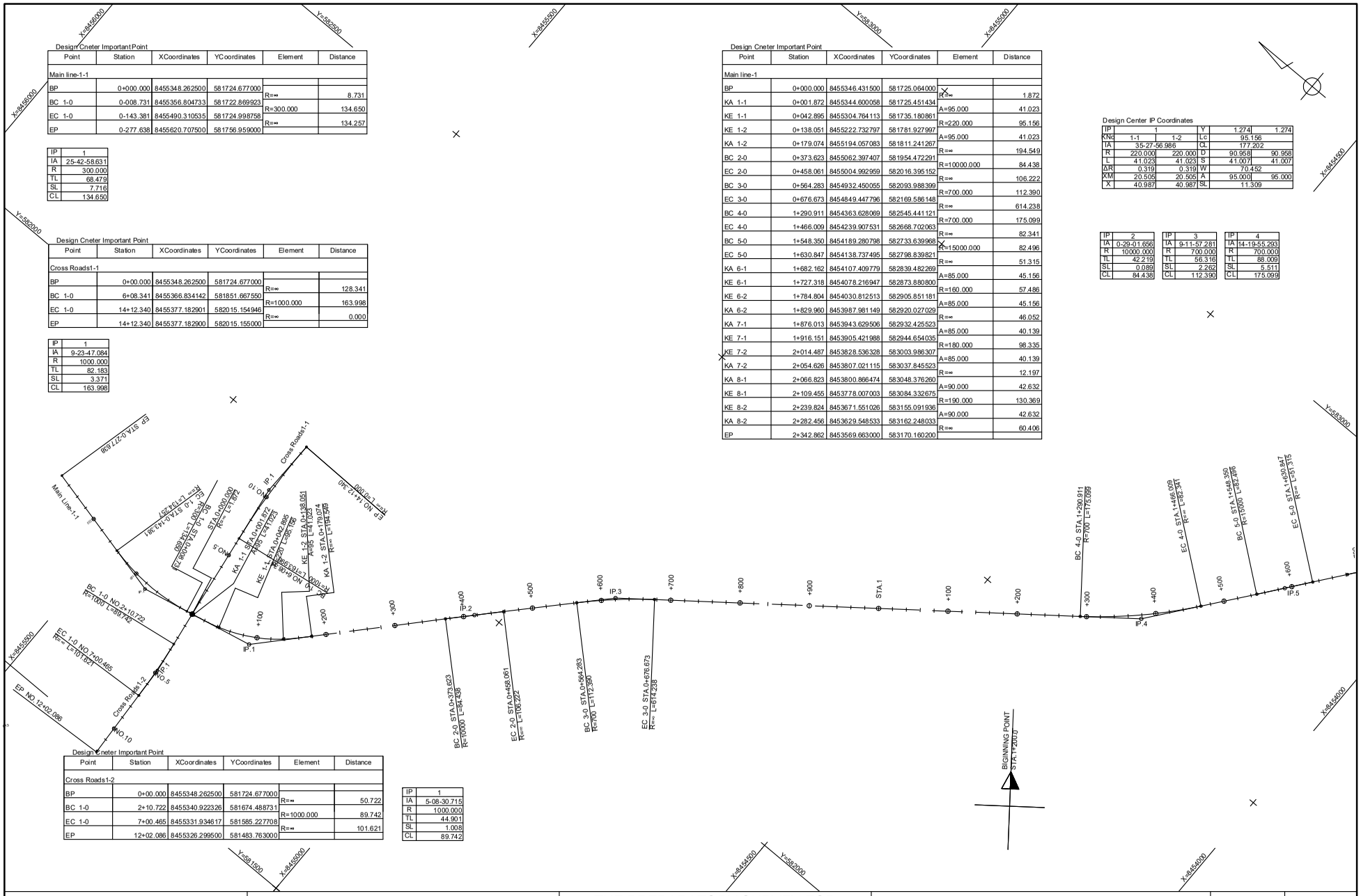
There is widening by curve
The center line in the figure shows the design center line

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TYPICAL CROSS SECTION (1)	Drawing No.	TC-01
				SCALE	S=1/100
				DATE	

Narrow Section



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TYPICAL CROSS SECTION (2)	Drawing No.	TC-02
				SCALE	S=1/100
				DATE	



Design Cneter Important Point

Point	Station	XCoordinates	YCoordinates	Element	Distance
Main line-1-1					
BP	0+000.000	8455348.262500	581724.677000		
				R=∞	8.731
BC 1-0	0-008.731	8455356.804733	581722.869923		
				R=300.000	134.650
EC 1-0	0-143.381	8455490.310535	581724.998758		
				R=∞	134.257
EP	0-277.638	8455620.707500	581756.959000		

IP	1
IA	25-42-58.631
R	300.000
TL	68.479
SL	7.716
CL	134.650

Design Cneter Important Point

Point	Station	XCoordinates	YCoordinates	Element	Distance
Cross Roads1-1					
BP	0+00.000	8455348.262500	581724.677000		
				R=∞	128.341
BC 1-0	6+08.341	8455366.834142	581851.667550		
				R=1000.000	163.998
EC 1-0	14+12.340	8455377.182901	582015.154946		
				R=∞	0.000
EP	14+12.340	8455377.182900	582015.155000		

IP	1
IA	9-23-47.084
R	1000.000
TL	82.183
SL	3.371
CL	163.998

Design Cneter Important Point

Point	Station	XCoordinates	YCoordinates	Element	Distance
Main line-1					
BP	0+000.000	8455346.431500	581725.064000		
				R=∞	1.872
KA 1-1	0+001.872	8455344.600058	581725.451434		
				A=95.000	41.023
KE 1-1	0+042.895	8455304.764113	581735.180861		
				R=220.000	95.156
KE 1-2	0+138.051	8455222.732797	581781.927997		
				A=95.000	41.023
KA 1-2	0+179.074	8455194.057083	581811.241267		
				R=∞	194.549
BC 2-0	0+373.623	8455062.397407	581954.472291		
				R=10000.000	84.438
EC 2-0	0+458.061	8455004.992959	582016.395152		
				R=∞	106.222
BC 3-0	0+564.283	8454932.450055	582093.988399		
				R=700.000	112.390
EC 3-0	0+676.673	8454849.447796	582169.586148		
				R=∞	614.238
BC 4-0	1+290.911	8454363.628069	582545.441121		
				R=700.000	175.099
EC 4-0	1+466.009	8454239.907531	582668.702063		
				R=∞	82.341
BC 5-0	1+548.350	8454189.280798	582733.639968		
				R=15000.000	82.496
EC 5-0	1+630.847	8454138.737495	582798.839821		
				R=∞	51.315
KA 6-1	1+682.162	8454107.409779	582839.482269		
				A=85.000	45.156
KE 6-1	1+727.318	8454078.216947	582873.880800		
				R=160.000	57.486
KE 6-2	1+784.804	8454030.812513	582905.851181		
				A=85.000	45.156
KA 6-2	1+829.960	8453987.981149	582920.027029		
				R=∞	46.052
KA 7-1	1+876.013	8453943.629506	582932.425523		
				A=85.000	40.139
KE 7-1	1+916.151	8453905.421988	582944.654035		
				R=180.000	98.335
KE 7-2	2+014.487	8453828.536328	583003.986307		
				A=85.000	40.139
KA 7-2	2+054.626	8453807.021115	583037.845523		
				R=∞	12.197
KA 8-1	2+066.823	8453800.866474	583048.376260		
				A=90.000	42.632
KE 8-1	2+109.455	8453778.007003	583084.332675		
				R=190.000	130.369
KE 8-2	2+239.824	8453671.551026	583155.091936		
				A=90.000	42.632
KA 8-2	2+282.456	8453629.548533	583162.248033		
				R=∞	60.406
EP	2+342.862	8453569.663000	583170.160200		

Design Center IP Coordinates

IP	1		Y	1.274	1.274
KNd	1-1	1-2	Lc	95.156	
IA	35-27-56.986		CL	177.202	
R	220.000	220.000	D	90.958	90.958
L	41.023	41.023	S	41.007	41.007
ΔR	0.319	0.319	W	70.452	
XM	20.505	20.505	A	95.000	95.000
X	40.987	40.987	SL	11.309	

IP	2
IA	0-29-01.656
R	10000.000
TL	42.219
SL	0.089
CL	84.438

IP	3
IA	9-11-57.281
R	700.000
TL	56.316
SL	2.262
CL	112.390

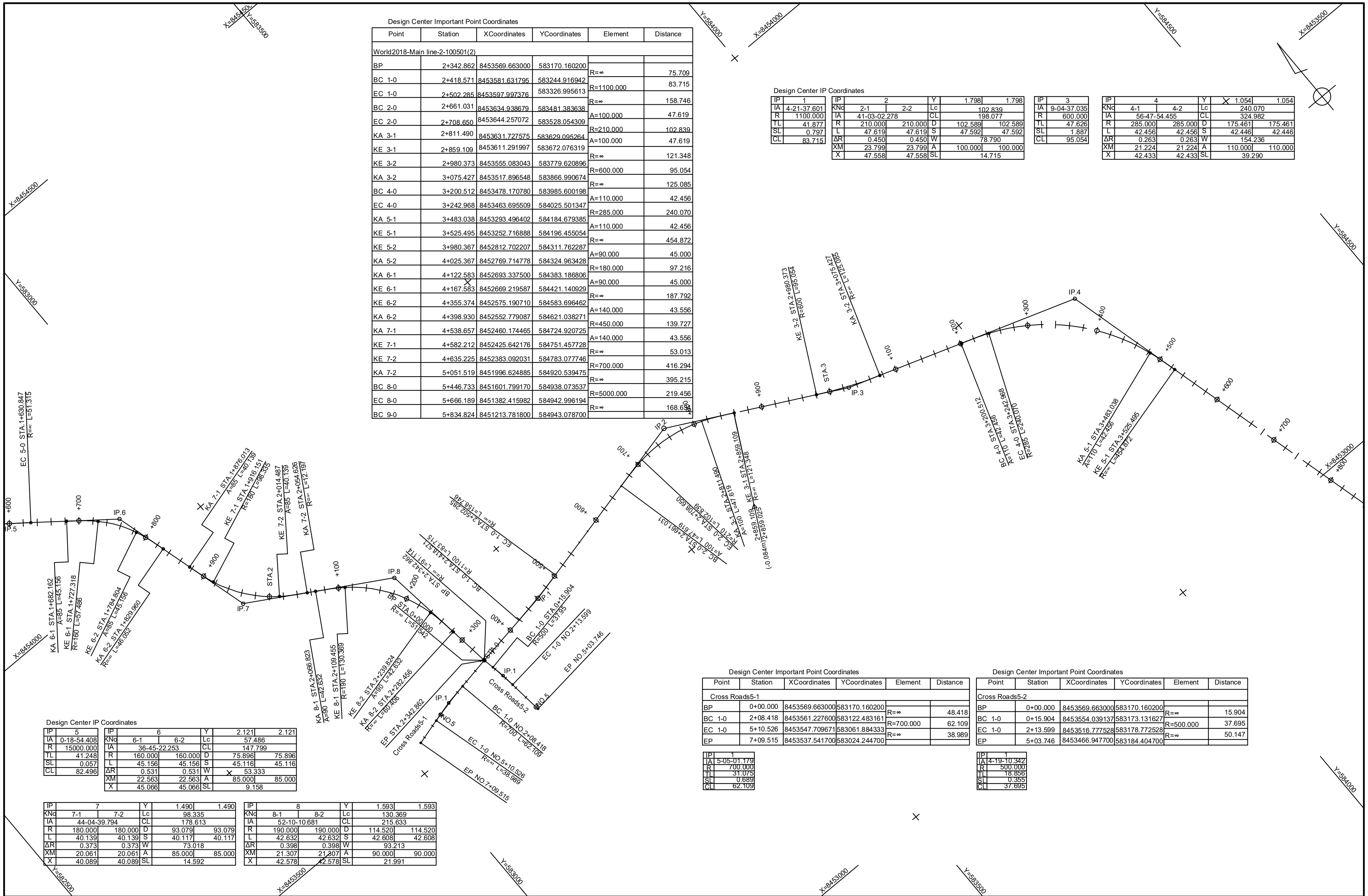
IP	4
IA	14-19-55.293
R	700.000
TL	88.009
SL	5.511
CL	175.099

Design Cneter Important Point

Point	Station	XCoordinates	YCoordinates	Element	Distance
Cross Roads1-2					
BP	0+00.000	8455348.262500	581724.677000		
				R=∞	50.722
BC 1-0	2+10.722	8455340.922326	581674.488731		
				R=1000.000	89.742
EC 1-0	7+00.465	8455331.934617	581585.227708		
				R=∞	101.621
EP	12+02.086	8455326.299500	581483.763000		

IP	1
IA	5-08-30.715
R	1000.000
TL	44.901
SL	1.008
CL	89.742

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : KEY PLAN (STA.0-162.950-STA.1+600)	Drawing No.	KP-01
				SCALE	S=1/2500
				DATE	



Design Center Important Point Coordinates

Point	Station	XCoordinates	YCoordinates	Element	Distance
World2018-Main line-2-100501(2)					
BP	2+342.862	8453569.663000	583170.160200	R=∞	75.709
BC 1-0	2+418.571	8453581.631795	583244.916942	R=1100.000	83.715
EC 1-0	2+502.285	8453597.997376	583326.995613	R=∞	158.746
BC 2-0	2+661.031	8453634.938679	583481.383638	A=100.000	47.619
EC 2-0	2+708.650	8453644.257072	583528.054309	R=210.000	102.839
KA 3-1	2+811.490	8453631.727575	583629.095264	A=100.000	47.619
KE 3-1	2+859.109	8453611.291997	583672.076319	R=∞	121.348
KE 3-2	2+980.373	8453555.083043	583779.620896	R=600.000	95.054
KA 3-2	3+075.427	8453517.896548	583866.990674	R=∞	125.085
BC 4-0	3+200.512	8453478.170780	583985.600198	A=110.000	42.456
EC 4-0	3+242.968	8453463.695509	584025.501347	R=285.000	240.070
KA 5-1	3+483.038	8453293.496402	584184.679385	A=110.000	42.456
KE 5-1	3+525.495	8453252.716888	584196.455054	R=∞	454.872
KE 5-2	3+980.367	8452812.702207	584311.762287	A=90.000	45.000
KA 5-2	4+025.367	8452769.714778	584324.963428	R=180.000	97.216
KA 6-1	4+122.583	8452693.337500	584383.186806	A=90.000	45.000
KE 6-1	4+167.583	8452669.219587	584421.140929	R=∞	187.792
KE 6-2	4+355.374	8452575.190710	584583.696462	A=140.000	43.556
KA 6-2	4+398.930	8452552.779087	584621.038271	R=450.000	139.727
KA 7-1	4+538.657	8452460.174465	584724.920725	A=140.000	43.556
KE 7-1	4+582.212	8452425.642176	584751.457728	R=∞	53.013
KE 7-2	4+635.225	8452383.092031	584783.077746	R=700.000	416.294
KA 7-2	5+051.519	8451996.624885	584920.539475	R=∞	395.215
BC 8-0	5+446.733	8451601.799170	584938.073537	R=5000.000	219.456
EC 8-0	5+666.189	8451382.415982	584942.996194	R=∞	168.63
BC 9-0	5+834.824	8451213.781800	584943.078700		

Design Center IP Coordinates

IP	1
IA	4-21-37.601
R	1100.000
TL	41.877
SL	0.797
CL	83.715

IP	2		Y	1.798	1.798
KNo	2-1	2-2	Lc	102.839	
IA	41-03-02.278		CL	198.077	
R	210.000	210.000	D	102.589	102.589
L	47.619	47.619	S	47.592	47.592
ΔR	0.450	0.450	W	78.790	
XM	23.799	23.799	A	100.000	100.000
X	47.558	47.558	SL	14.715	

IP	3
IA	9-04-37.035
R	600.000
TL	47.626
SL	1.887
CL	95.054

IP	4		Y	1.054	1.054
KNo	4-1	4-2	Lc	240.070	
IA	56-47-54.455		CL	324.982	
R	285.000	285.000	D	175.461	175.461
L	42.456	42.456	S	42.446	42.446
ΔR	0.263	0.263	W	154.236	
XM	21.224	21.224	A	110.000	110.000
X	42.433	42.433	SL	39.290	

Design Center IP Coordinates

IP	5
IA	0-18-54.408
R	15000.000
TL	41.248
SL	0.057
CL	82.496

IP	6		Y	2.121	2.121
KNo	6-1	6-2	Lc	57.486	
IA	36-45-22.253		CL	147.799	
R	160.000	160.000	D	75.896	75.896
L	45.156	45.156	S	45.116	45.116
ΔR	0.531	0.531	W	53.333	
XM	22.563	22.563	A	85.000	85.000
X	45.066	45.066	SL	9.158	

IP	7		Y	1.490	1.490
KNo	7-1	7-2	Lc	98.335	
IA	44-04-39.794		CL	178.613	
R	180.000	180.000	D	93.079	93.079
L	40.139	40.139	S	40.117	40.117
ΔR	0.373	0.373	W	73.018	
XM	20.061	20.061	A	85.000	85.000
X	40.089	40.089	SL	14.592	

IP	8		Y	1.593	1.593
KNo	8-1	8-2	Lc	130.369	
IA	52-10-10.681		CL	215.633	
R	190.000	190.000	D	114.520	114.520
L	42.632	42.632	S	42.608	42.608
ΔR	0.398	0.398	W	93.213	
XM	21.307	21.307	A	90.000	90.000
X	42.578	42.578	SL	21.991	

Design Center Important Point Coordinates

Point	Station	XCoordinates	YCoordinates	Element	Distance
Cross Roads5-1					
BP	0+00.000	8453569.663000	583170.160200	R=∞	48.418
BC 1-0	2+08.418	8453561.227600	583122.483161	R=700.000	62.109
EC 1-0	5+10.526	8453547.709671	583061.884333	R=∞	38.989
EP	7+09.515	8453537.541700	583024.244700		

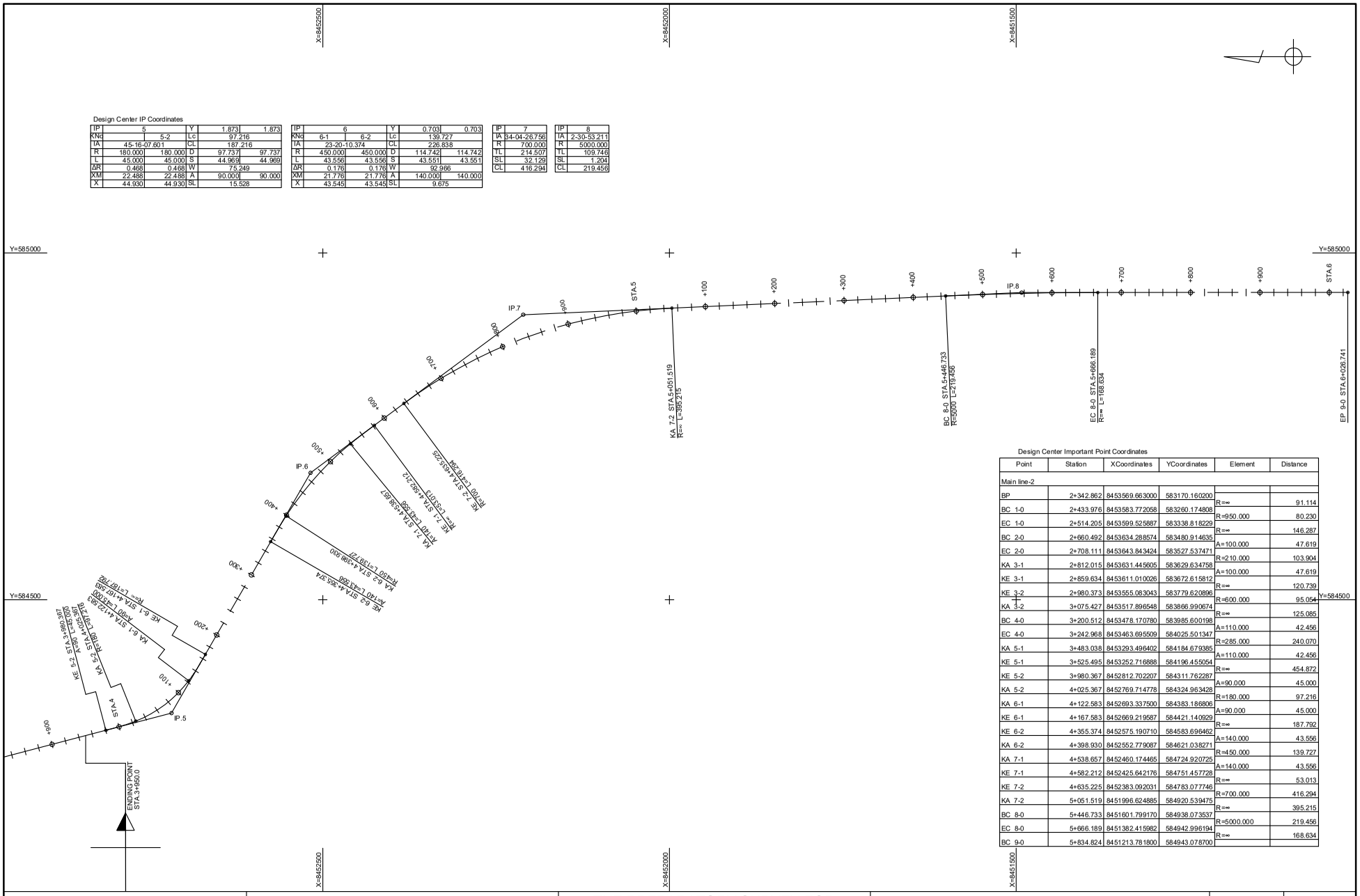
IP	1
IA	5-05-01.179
R	700.000
TL	31.075
SL	0.689
CL	62.109

Design Center Important Point Coordinates

Point	Station	XCoordinates	YCoordinates	Element	Distance
Cross Roads5-2					
BP	0+00.000	8453569.663000	583170.160200	R=∞	15.904
BC 1-0	0+15.904	8453554.039137	583173.131627	R=500.000	37.695
EC 1-0	2+13.599	8453516.777528	583178.772528	R=∞	50.147
EP	5+03.746	8453466.947700	583184.404700		

IP	1
IA	4-19-10.342
R	500.000
TL	18.856
SL	0.355
CL	37.695

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : KEY PLAN (STA.1+600-STA.3+800)	Drawing No. KP-02 SCALE S=1/2500 DATE



Design Center IP Coordinates

IP	5		Y	1.873	1.873
KNo		5-2	Lc	97.216	
IA	45-16-07.601		CL	187.216	
R	180.000	180.000	D	97.737	97.737
L	45.000	45.000	S	44.969	44.969
ΔR	0.468	0.468	W	75.249	
XM	22.488	22.488	A	90.000	90.000
X	44.930	44.930	SL	15.528	

IP	6		Y	0.703	0.703
KNo	6-1	6-2	Lc	139.727	
IA	23-20-10.374		CL	226.838	
R	450.000	450.000	D	114.742	114.742
L	43.556	43.556	S	43.551	43.551
ΔR	0.176	0.176	W	92.966	
XM	21.776	21.776	A	140.000	140.000
X	43.545	43.545	SL	9.675	

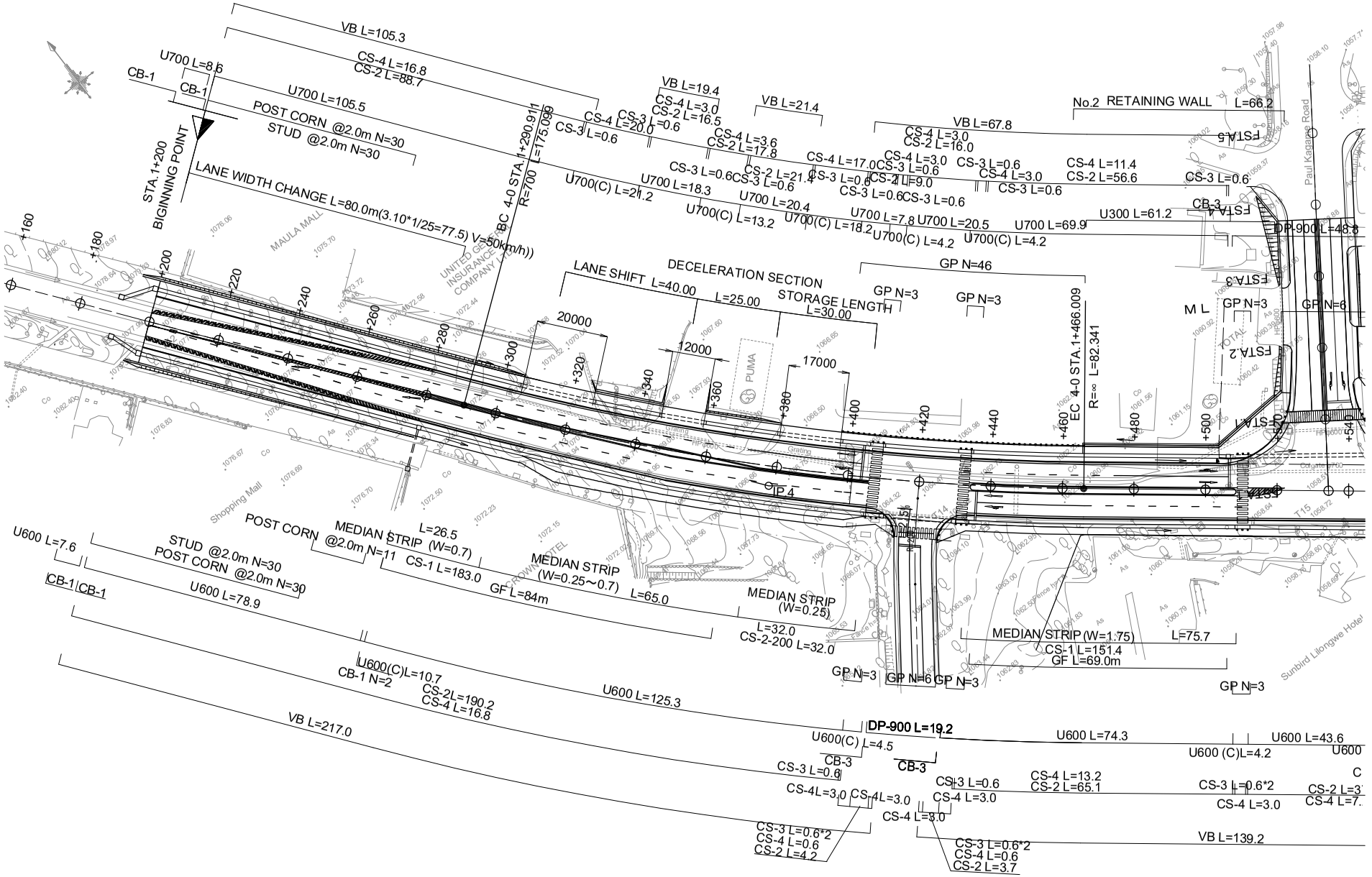
IP	7
IA	34-04-26.756
R	700.000
TL	214.507
SL	32.129
CL	416.294

IP	8
IA	2-30-53.211
R	5000.000
TL	109.746
SL	1.204
CL	219.456

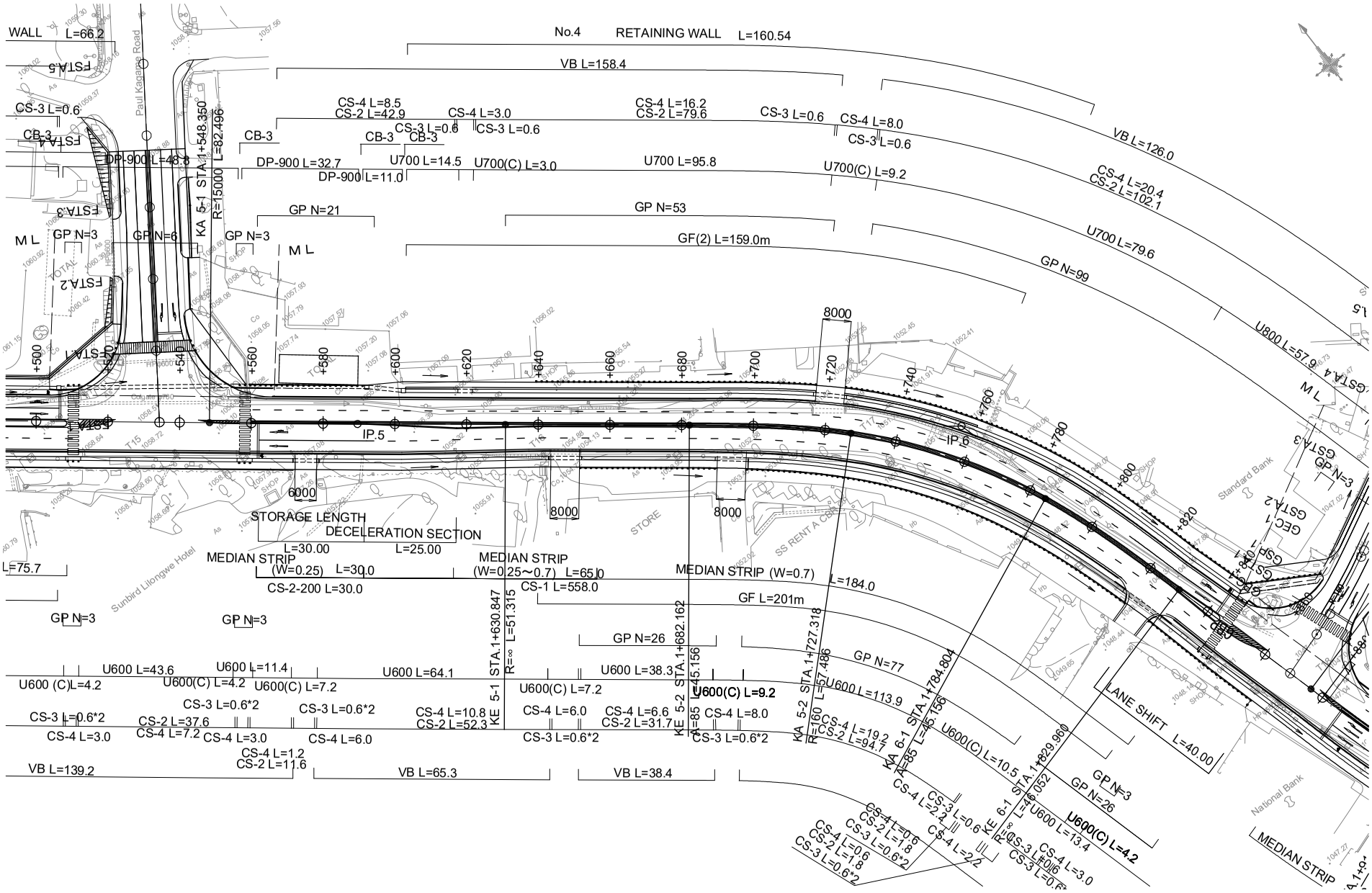
Design Center Important Point Coordinates

Point	Station	XCoordinates	YCoordinates	Element	Distance
Main line-2					
BP	2+342.862	8453569.663000	583170.160200		
				R=∞	91.114
BC 1-0	2+433.976	8453583.772058	583260.174808		
				R=950.000	80.230
EC 1-0	2+514.205	8453599.525887	583338.818229		
				R=∞	146.287
BC 2-0	2+660.492	8453634.288574	583480.914635		
				A=100.000	47.619
EC 2-0	2+708.111	8453643.843424	583527.537471		
				R=210.000	103.904
KA 3-1	2+812.015	8453631.445605	583629.634758		
				A=100.000	47.619
KE 3-1	2+859.634	8453611.010026	583672.615812		
				R=∞	120.739
KE 3-2	2+980.373	8453555.083043	583779.620896		
				R=600.000	95.054
KA 3-2	3+075.427	8453517.896548	583866.990674		
				R=∞	125.085
BC 4-0	3+200.512	8453478.170780	583985.600198		
				A=110.000	42.456
EC 4-0	3+242.968	8453463.695509	584025.501347		
				R=285.000	240.070
KA 5-1	3+483.038	8453293.496402	584184.679385		
				A=110.000	42.456
KE 5-1	3+525.495	8453252.716888	584196.455054		
				R=∞	454.872
KE 5-2	3+980.367	8452812.702207	584311.762287		
				A=90.000	45.000
KA 5-2	4+025.367	8452769.714778	584324.963428		
				R=180.000	97.216
KA 6-1	4+122.583	8452693.337500	584383.186806		
				A=90.000	45.000
KE 6-1	4+167.583	8452669.219587	584421.140929		
				R=∞	187.792
KE 6-2	4+355.374	8452575.190710	584583.696462		
				A=140.000	43.556
KA 6-2	4+398.930	8452552.779087	584621.038271		
				R=450.000	139.727
KA 7-1	4+538.657	8452460.174465	584724.920725		
				A=140.000	43.556
KE 7-1	4+582.212	8452425.642176	584751.457728		
				R=∞	53.013
KE 7-2	4+635.225	8452383.092031	584783.077746		
				R=700.000	416.294
KA 7-2	5+051.519	8451996.624885	584920.539475		
				R=∞	395.215
BC 8-0	5+446.733	8451601.799170	584938.073537		
				R=5000.000	219.456
EC 8-0	5+666.189	8451382.415982	584942.996194		
				R=∞	168.634
BC 9-0	5+834.824	8451213.781800	584943.078700		

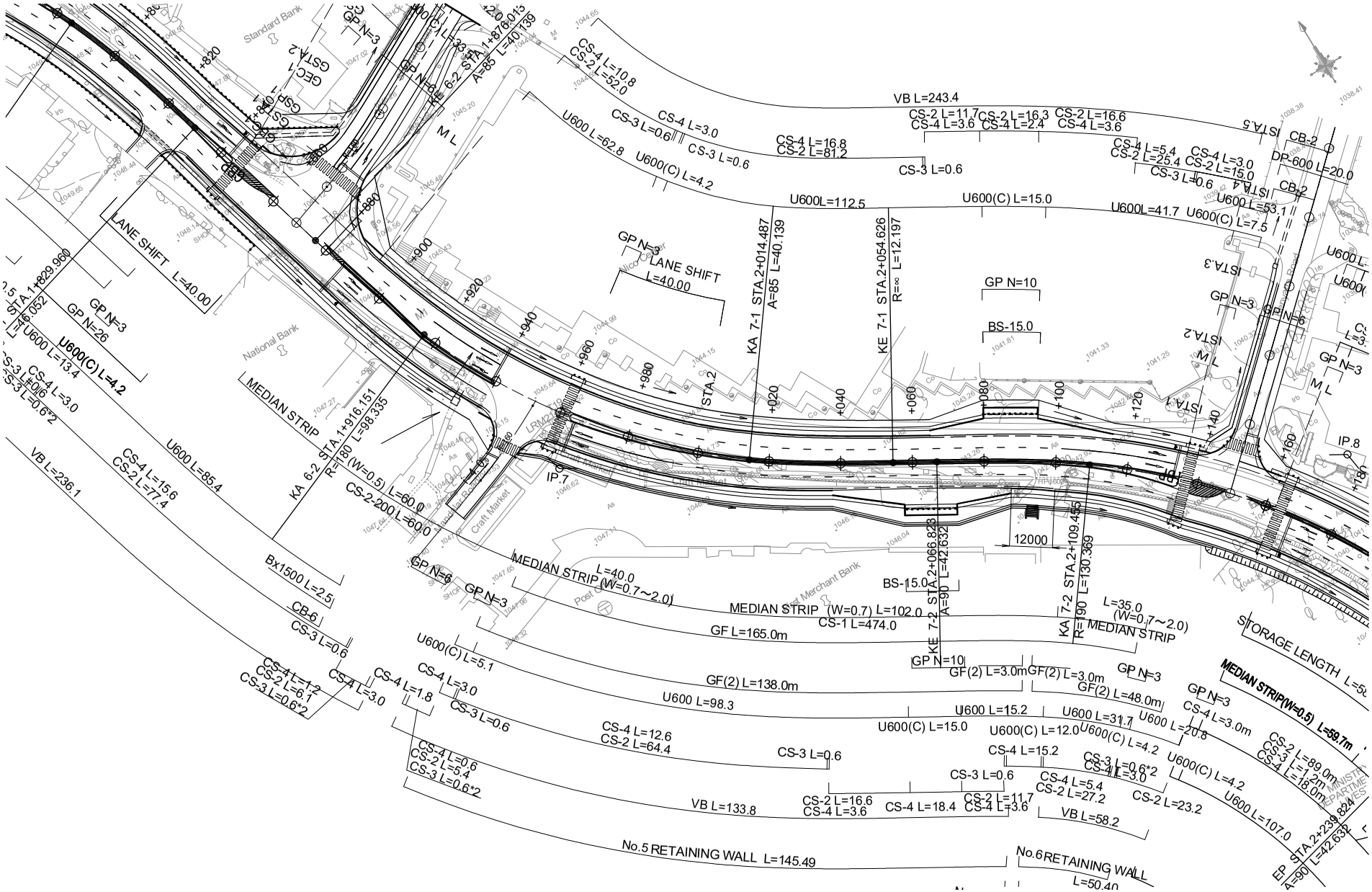
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : KEY PLAN (STA.3+800-STA.6+26.741)	Drawing No.	KP-03
				SCALE	S=1/2500
				DATE	



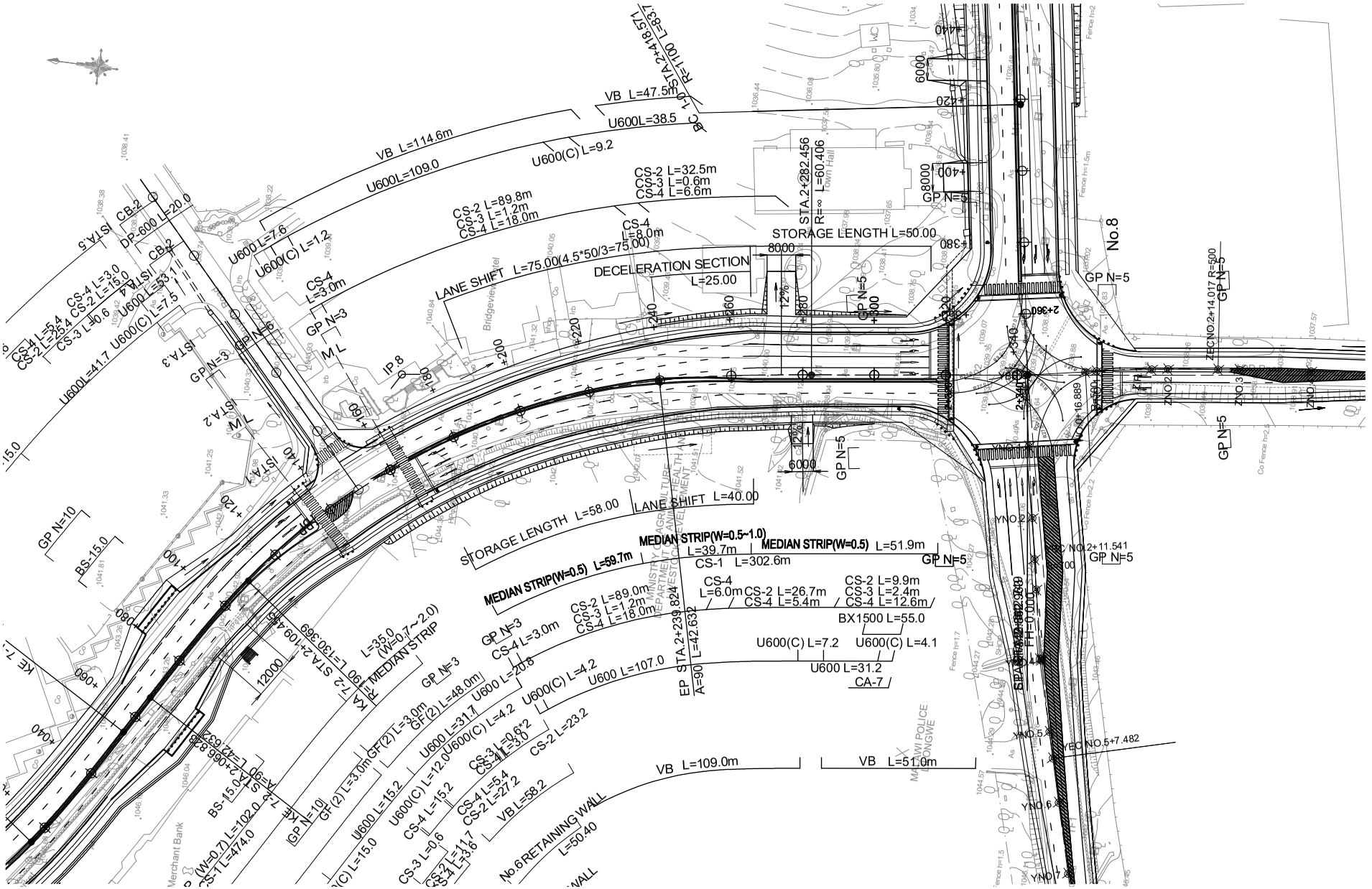
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (1)	Drawing No.	PL-01
				SCALE	S=1/1000
				DATE	



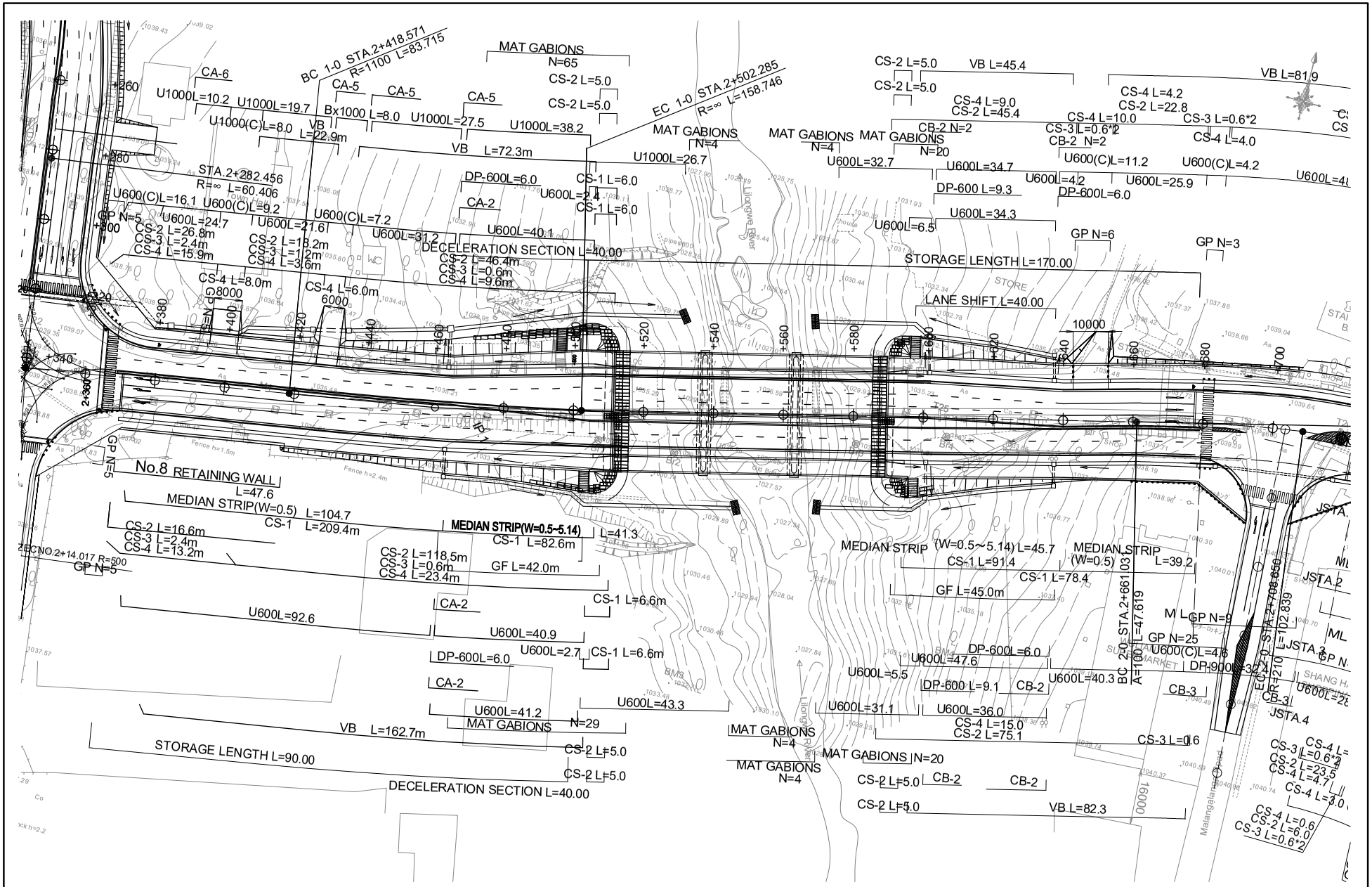
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (2)	Drawing No.	PL-02
				SCALE	S=1/1000
				DATE	



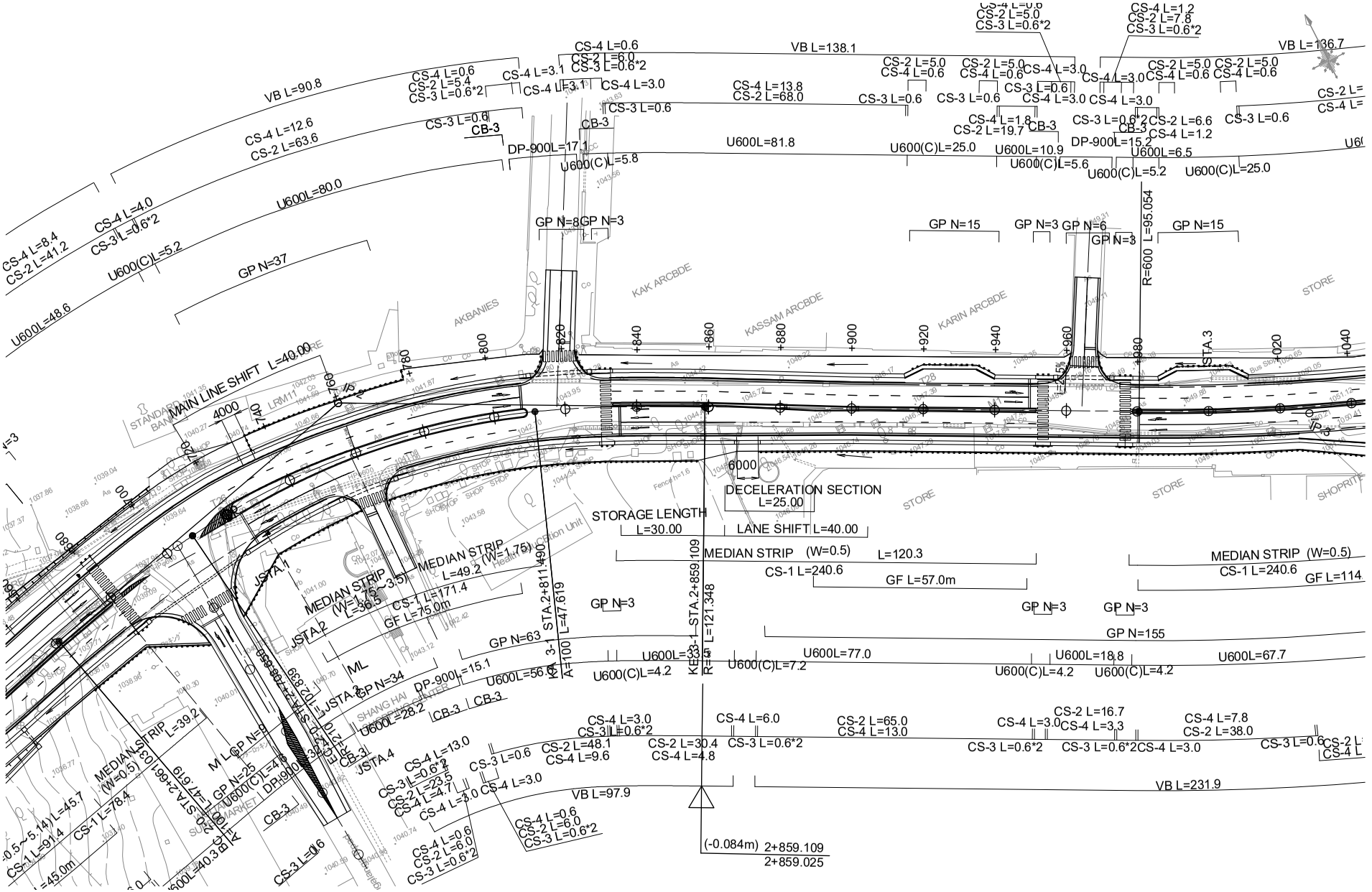
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (3)	Drawing No.	PL-03
				SCALE	S=1/1000
				DATE	



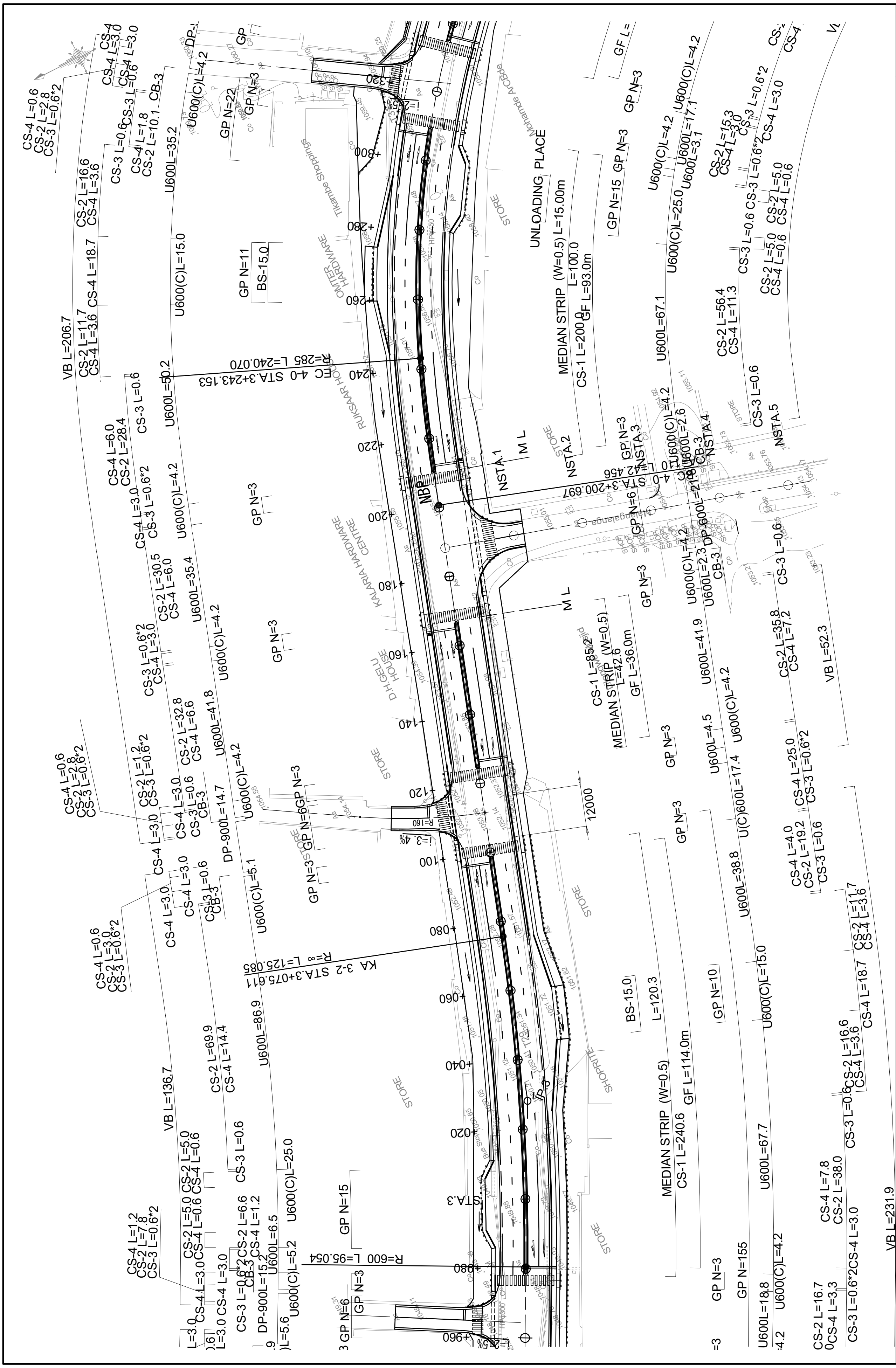
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (4)	Drawing No.	PL-04
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (5)	Drawing No.	PL-05
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (6)	Drawing No.	PL-06
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY

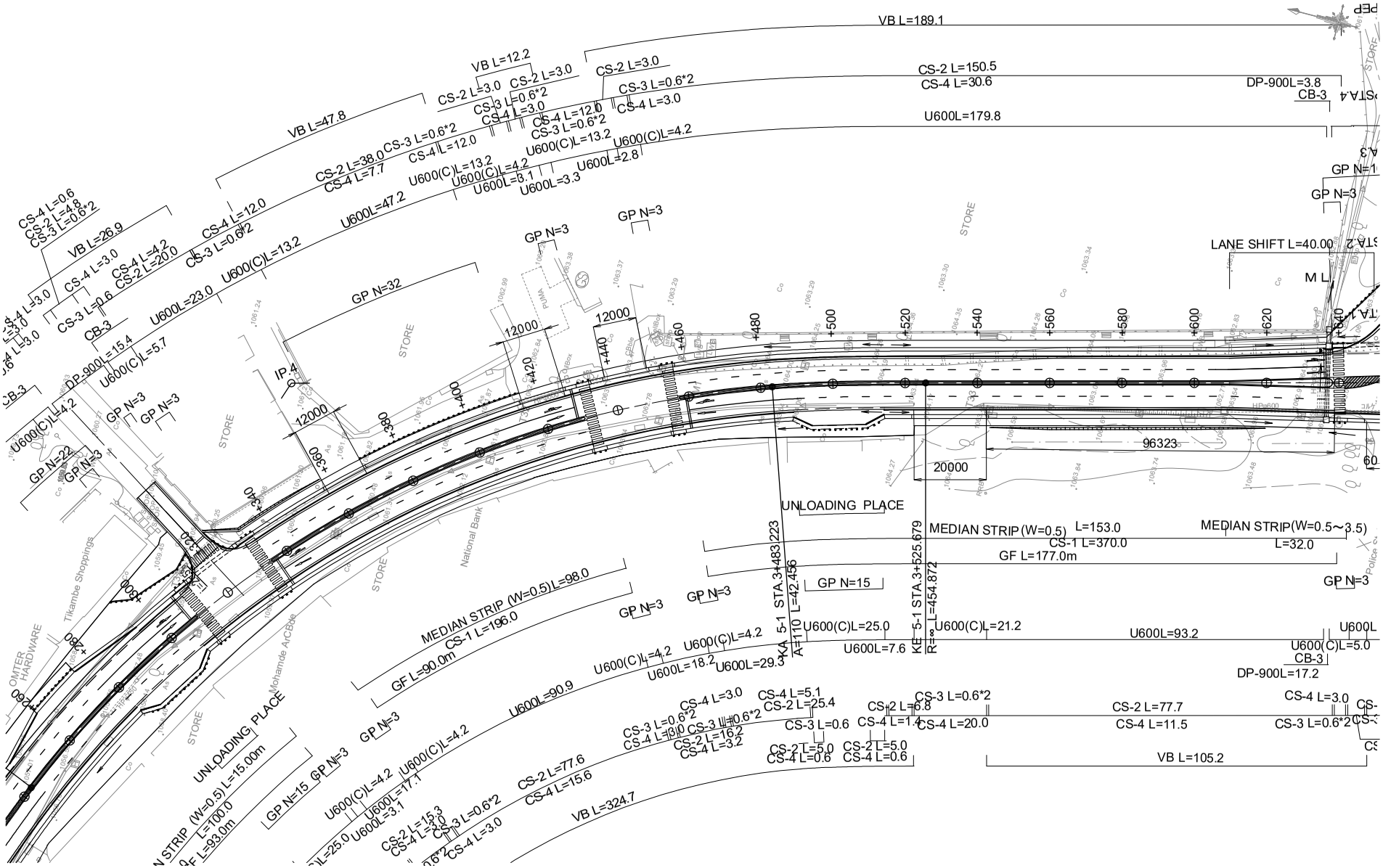
JAPAN INTERNATIONAL COOPERATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL

THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE

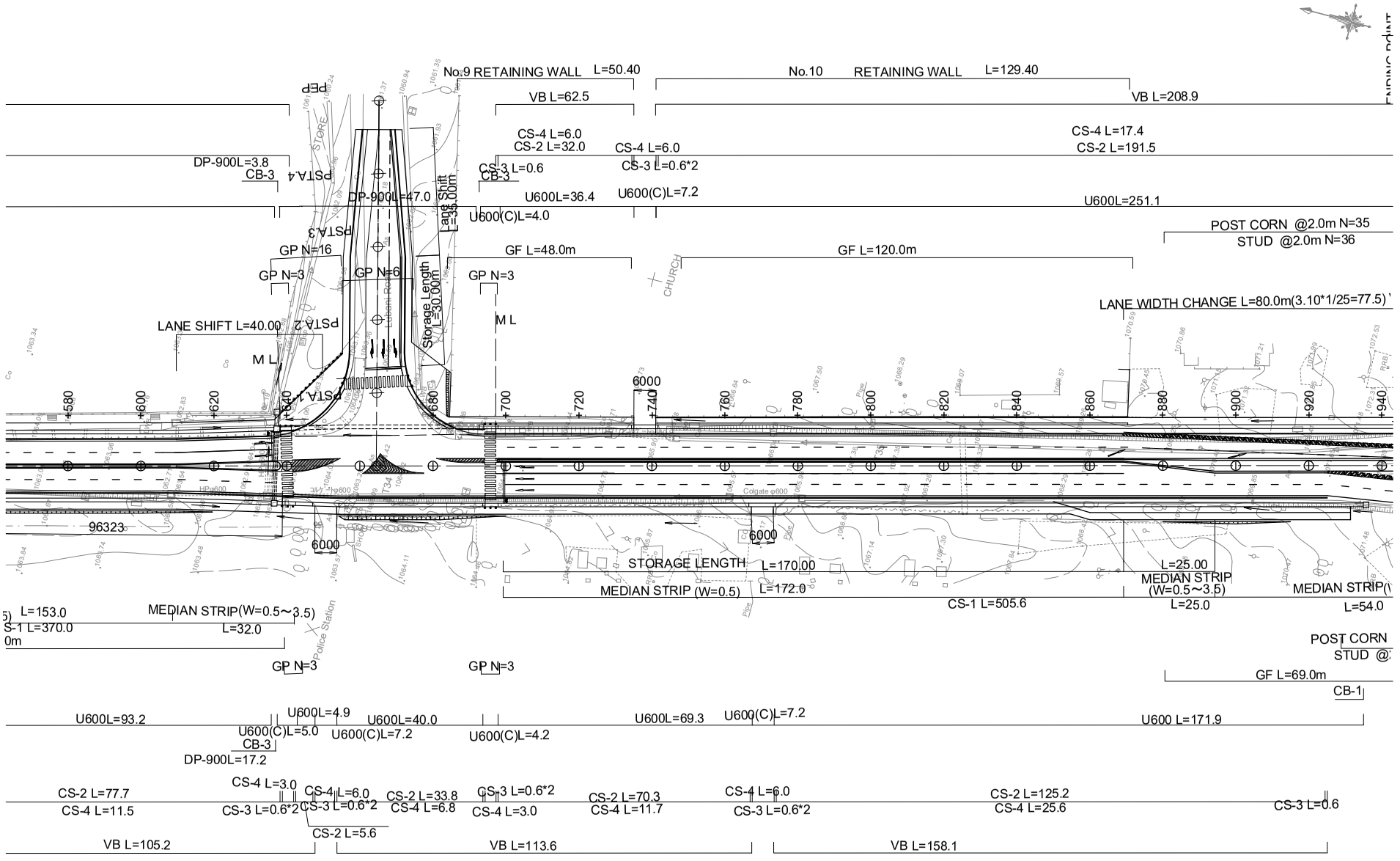
TITLE :

PLAN (7)

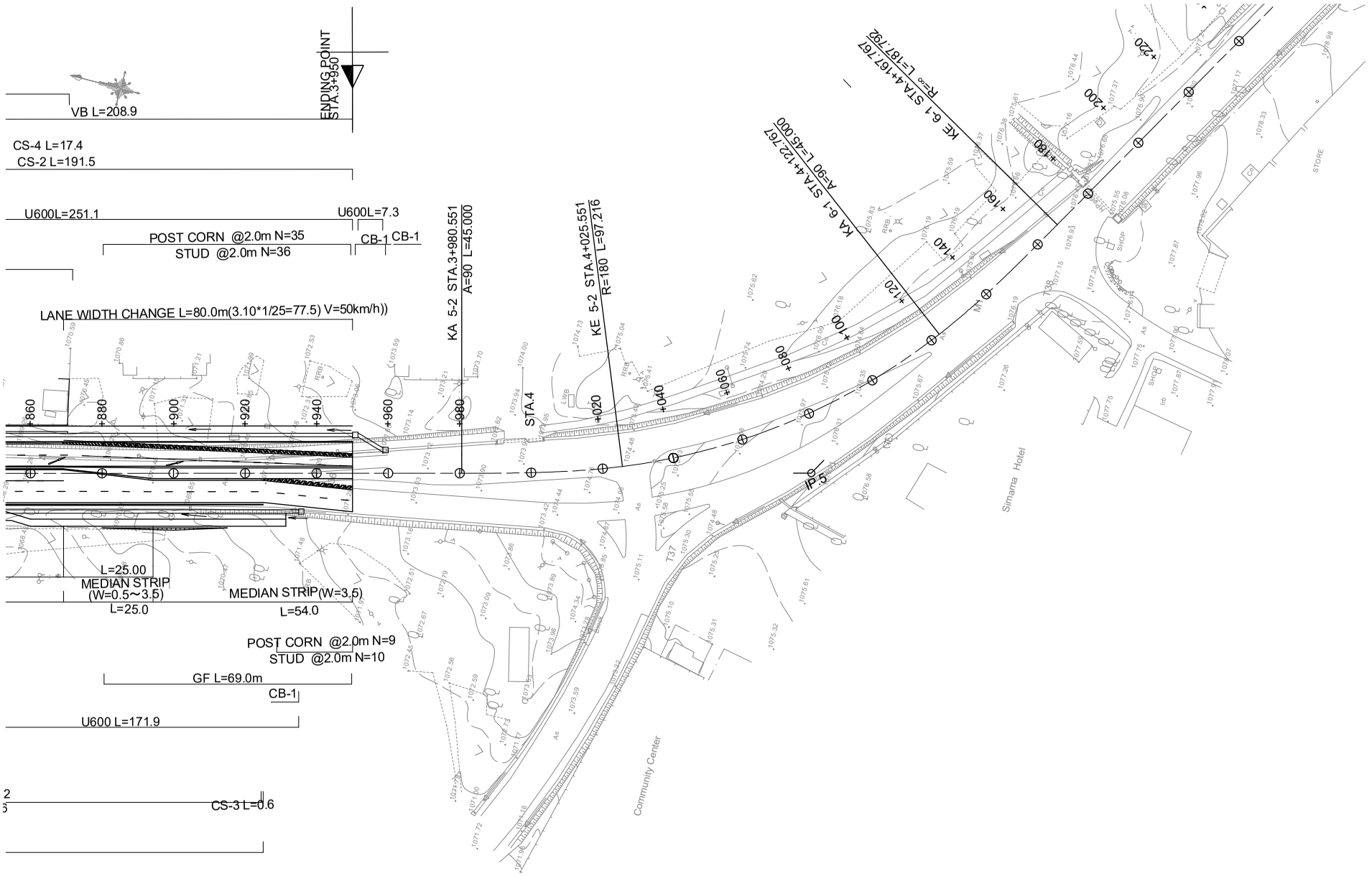
Drawing No.	PL-07
SCALE	S=1/1000
DATE	



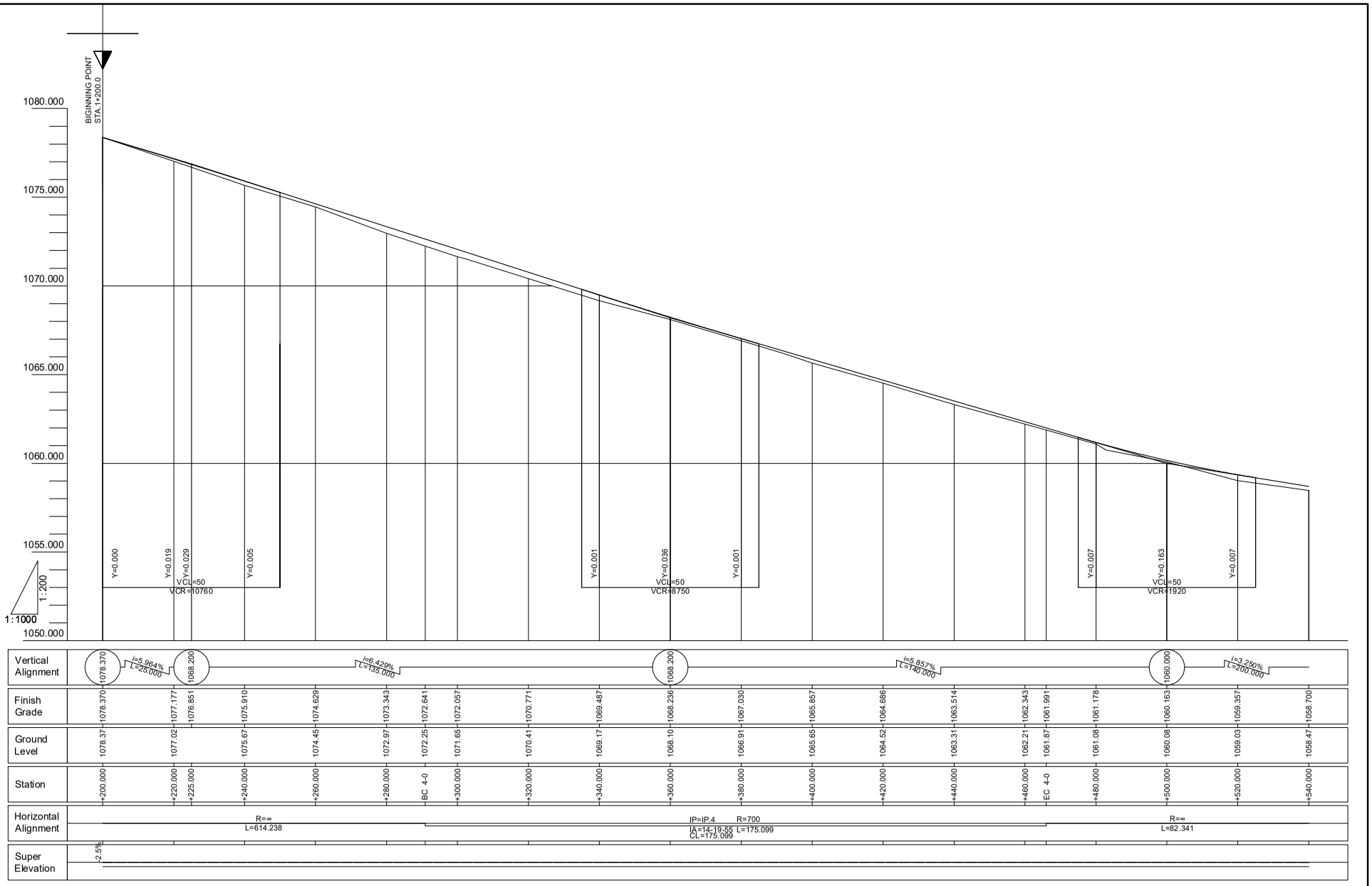
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (8)	Drawing No.	PL-08
				SCALE	S=1/1000
				DATE	



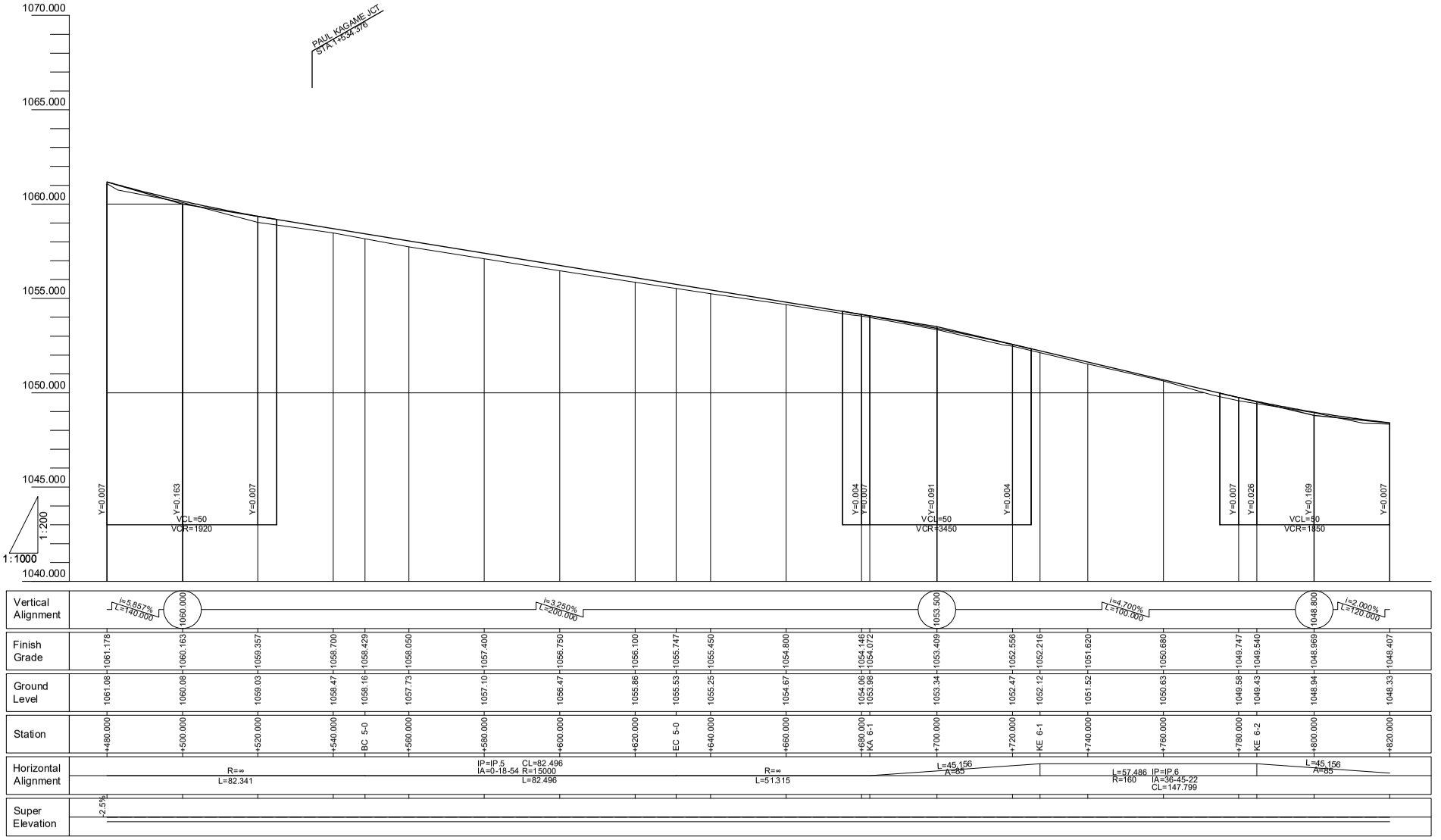
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (9)	Drawing No.	PL-09
				SCALE	S=1/1000
				DATE	



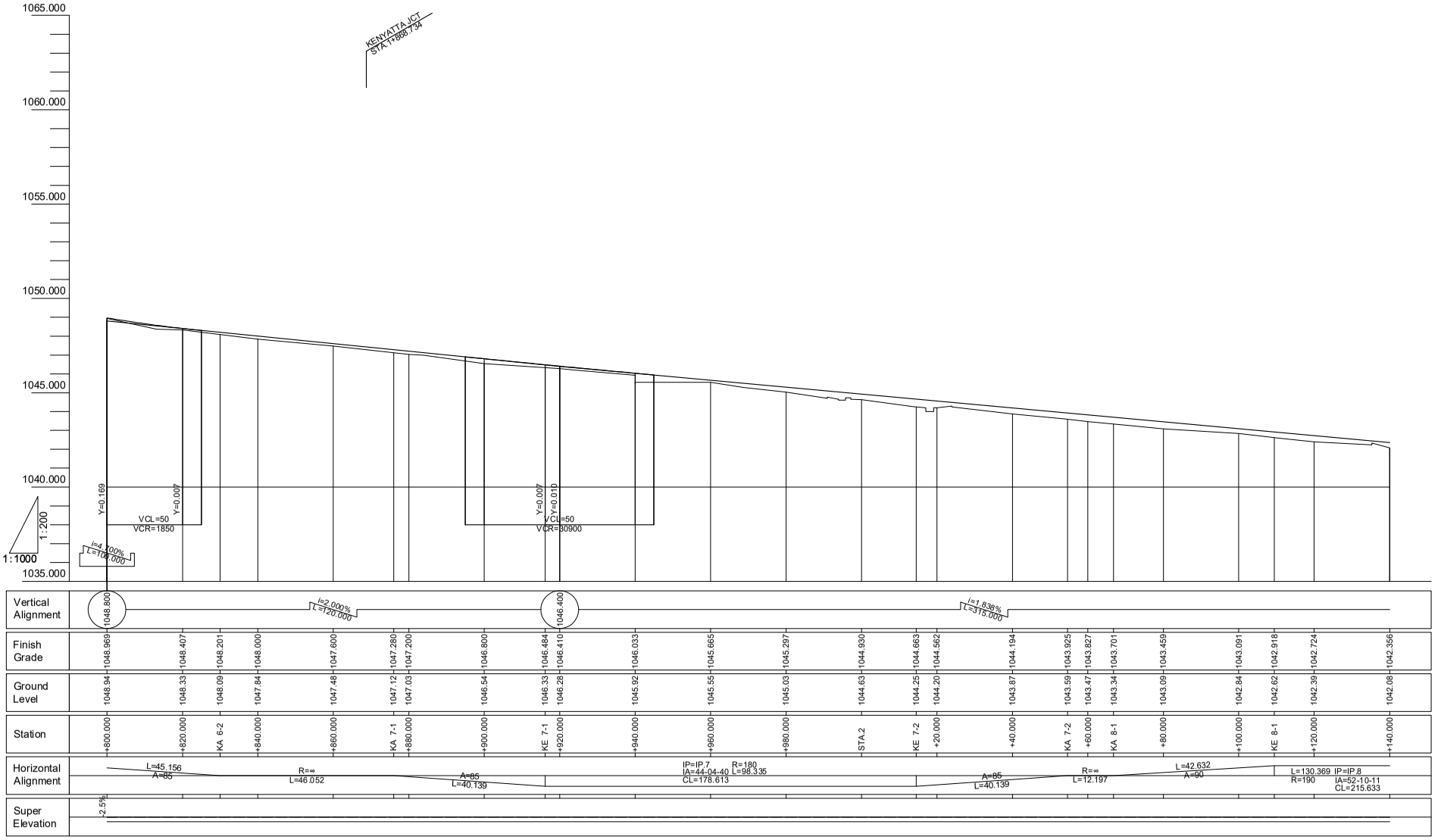
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PLAN (10)	Drawing No.	PL-10
				SCALE	S=1/1000
				DATE	



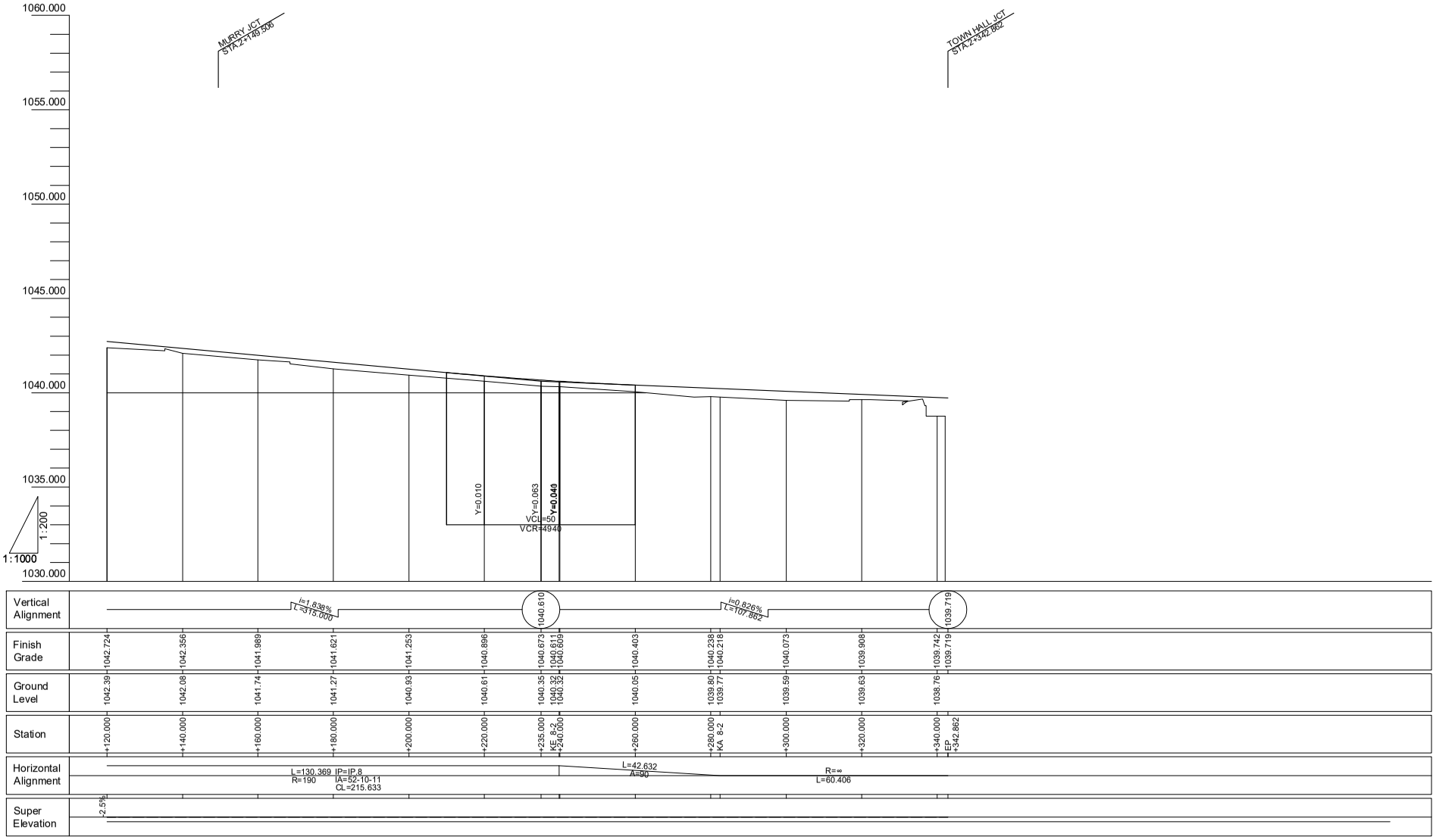
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (1)	Drawing No.	PR-01
				SCALE	V=1/200 H=1/1000
				DATE	



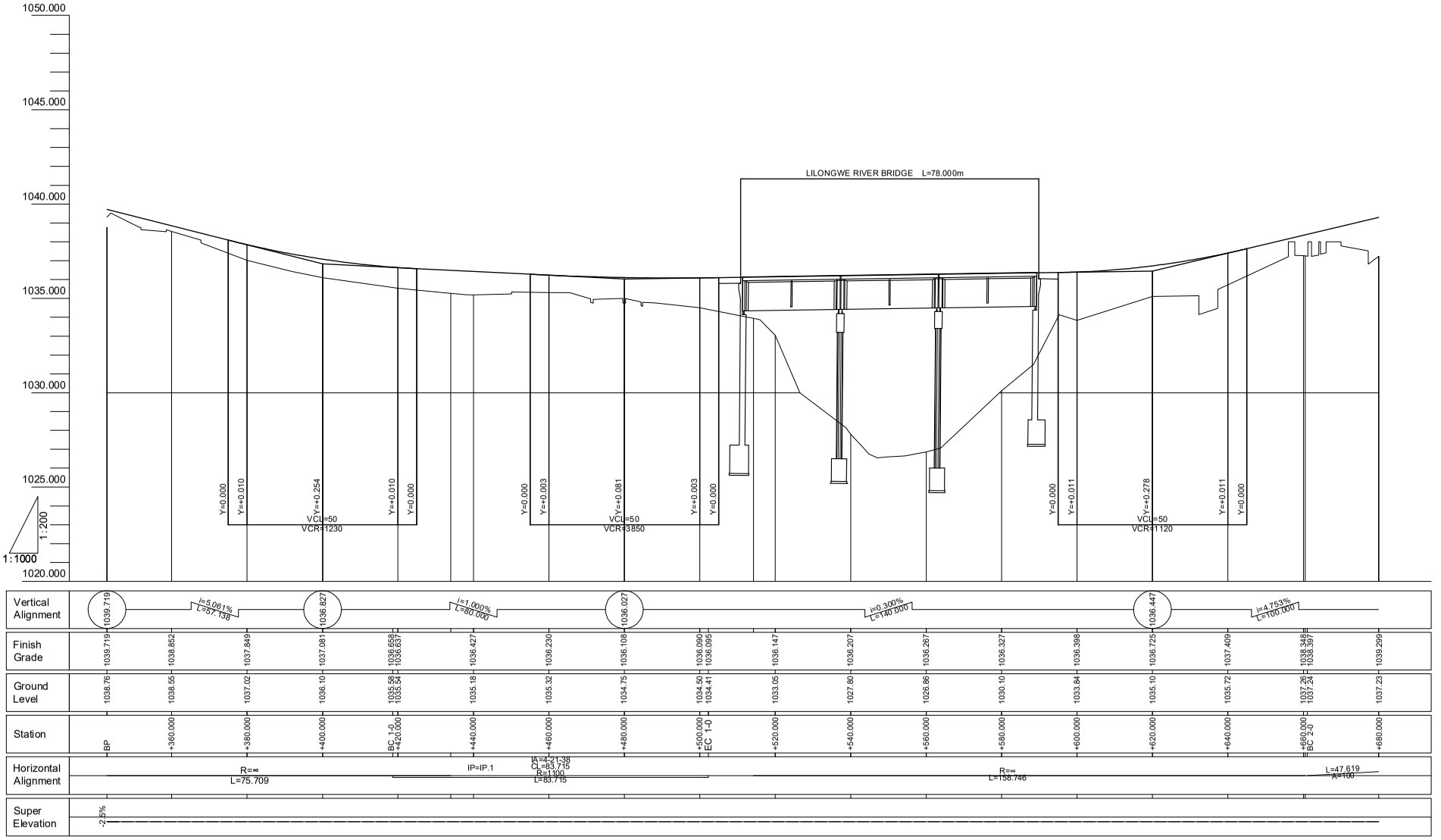
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (2)	Drawing No.	PR-02
				SCALE	V=1/200 H=1/1000
				DATE	



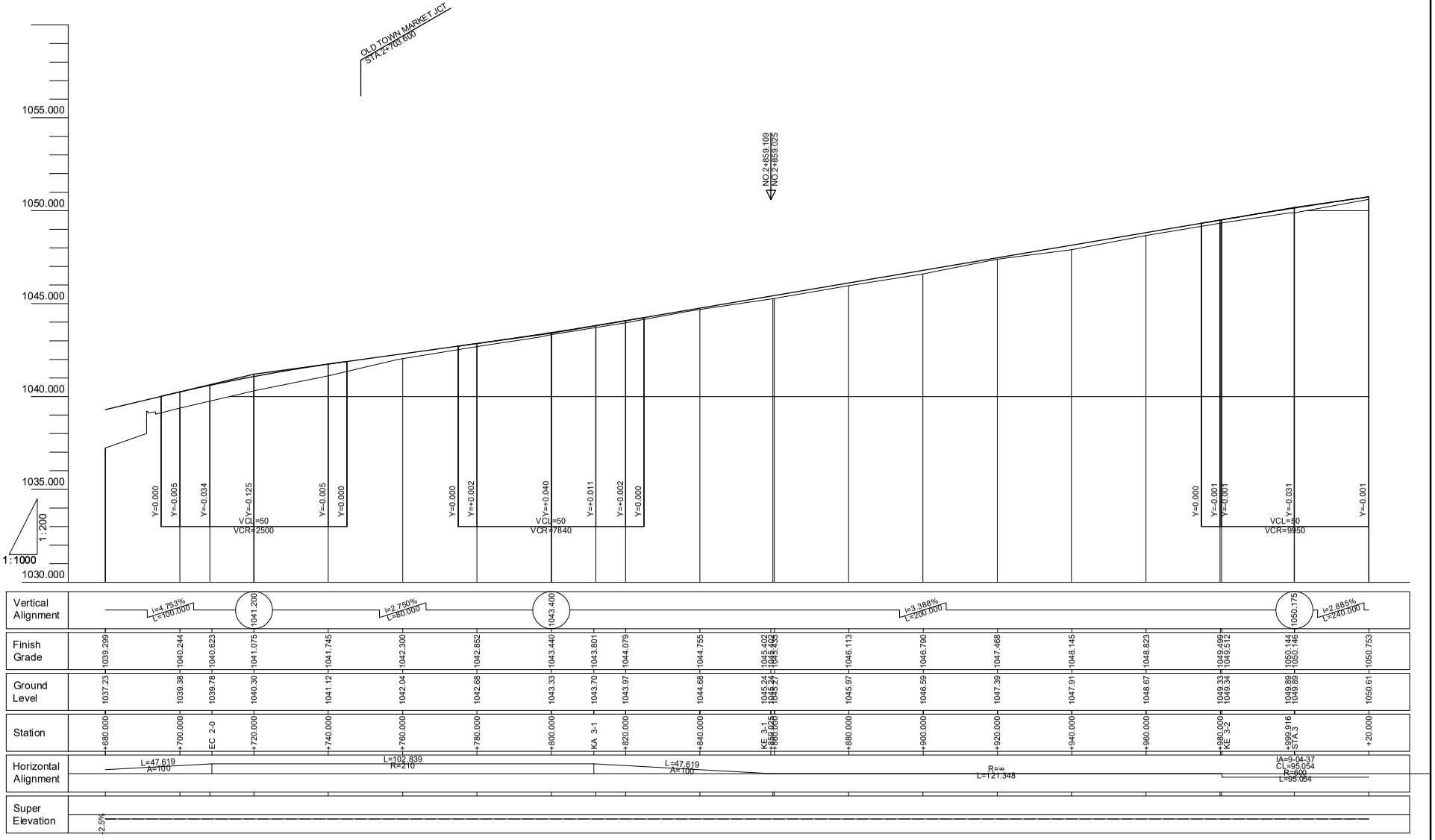
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (3)	Drawing No.	PR-03
				SCALE	V=1/200 H=1/1000
				DATE	



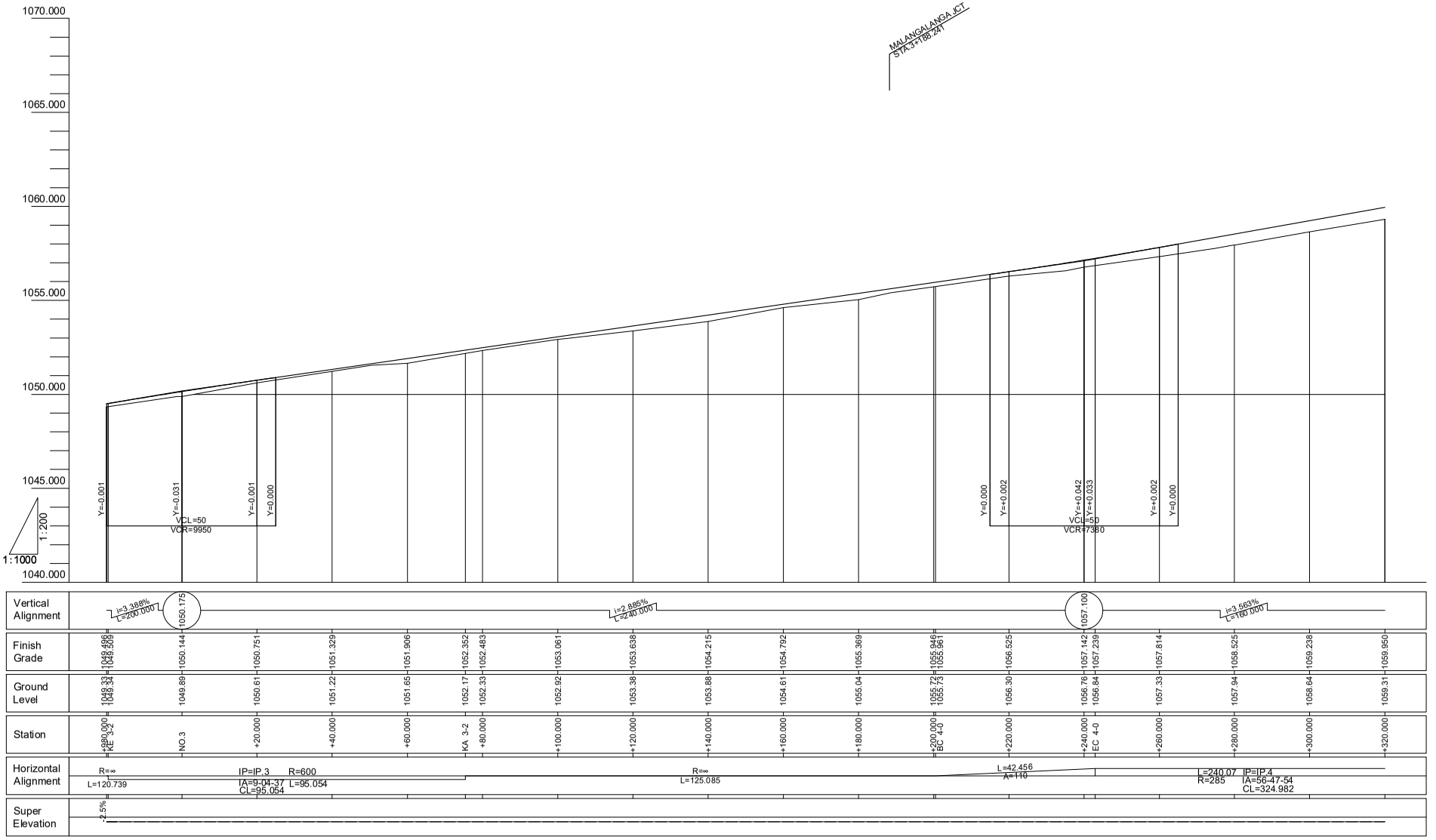
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (4)	Drawing No.	PR-04
				SCALE	V=1/200 H=1/1000
				DATE	



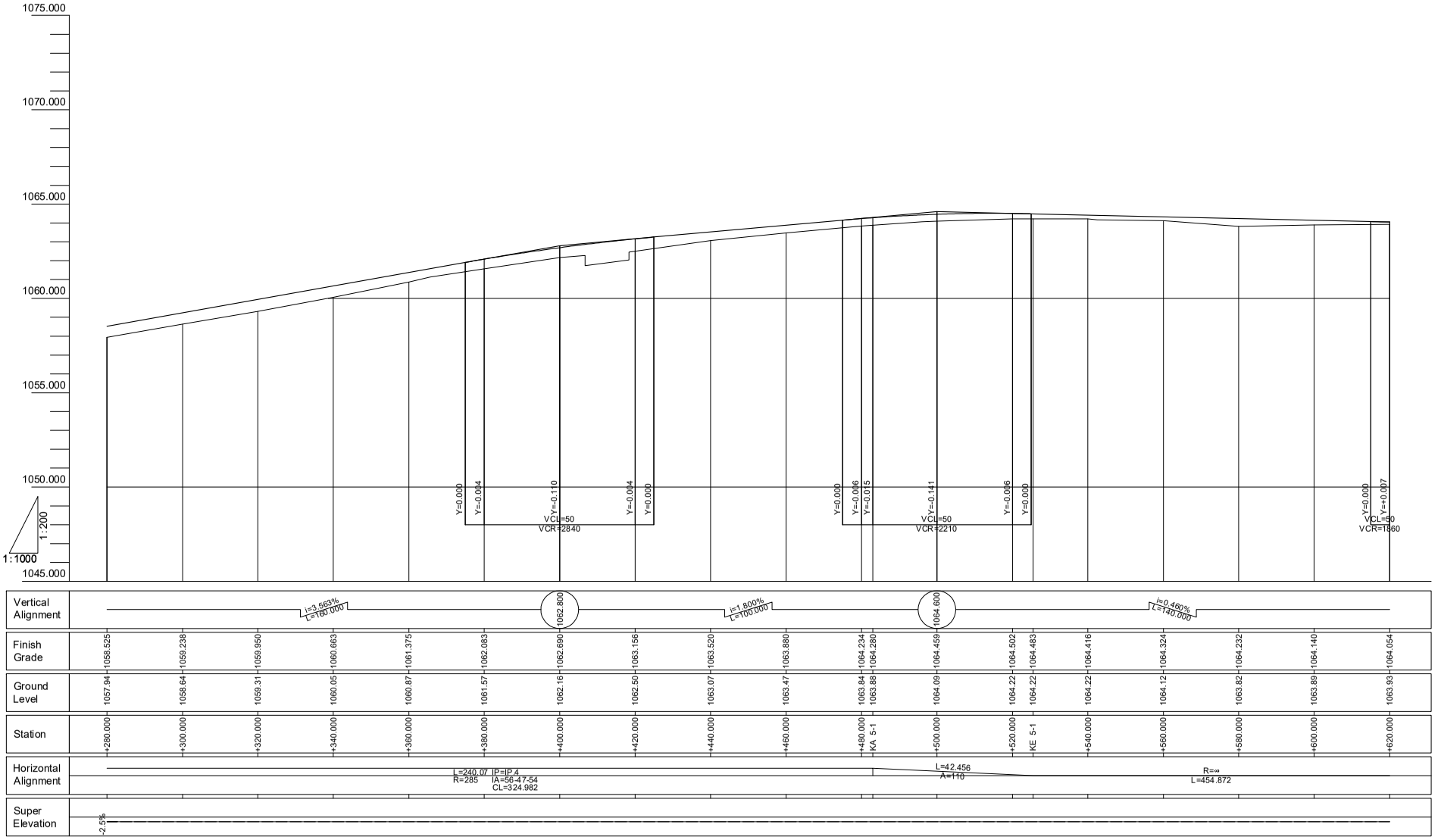
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (5)	Drawing No.	PR-05
				SCALE	V=1/200 H=1/1000
				DATE	



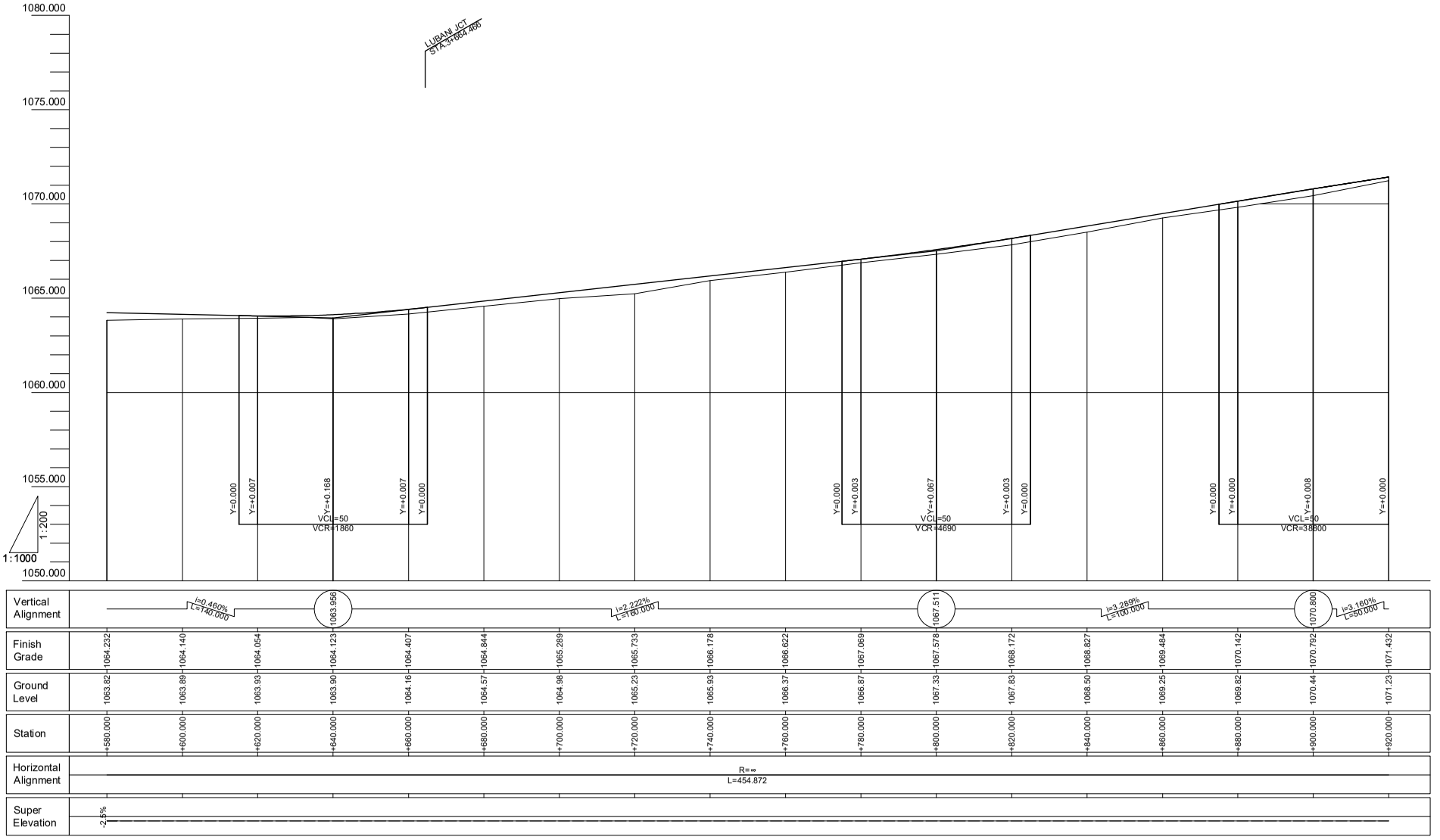
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (6)	Drawing No.	PR-06
				SCALE	V=1/200 H=1/1000
				DATE	



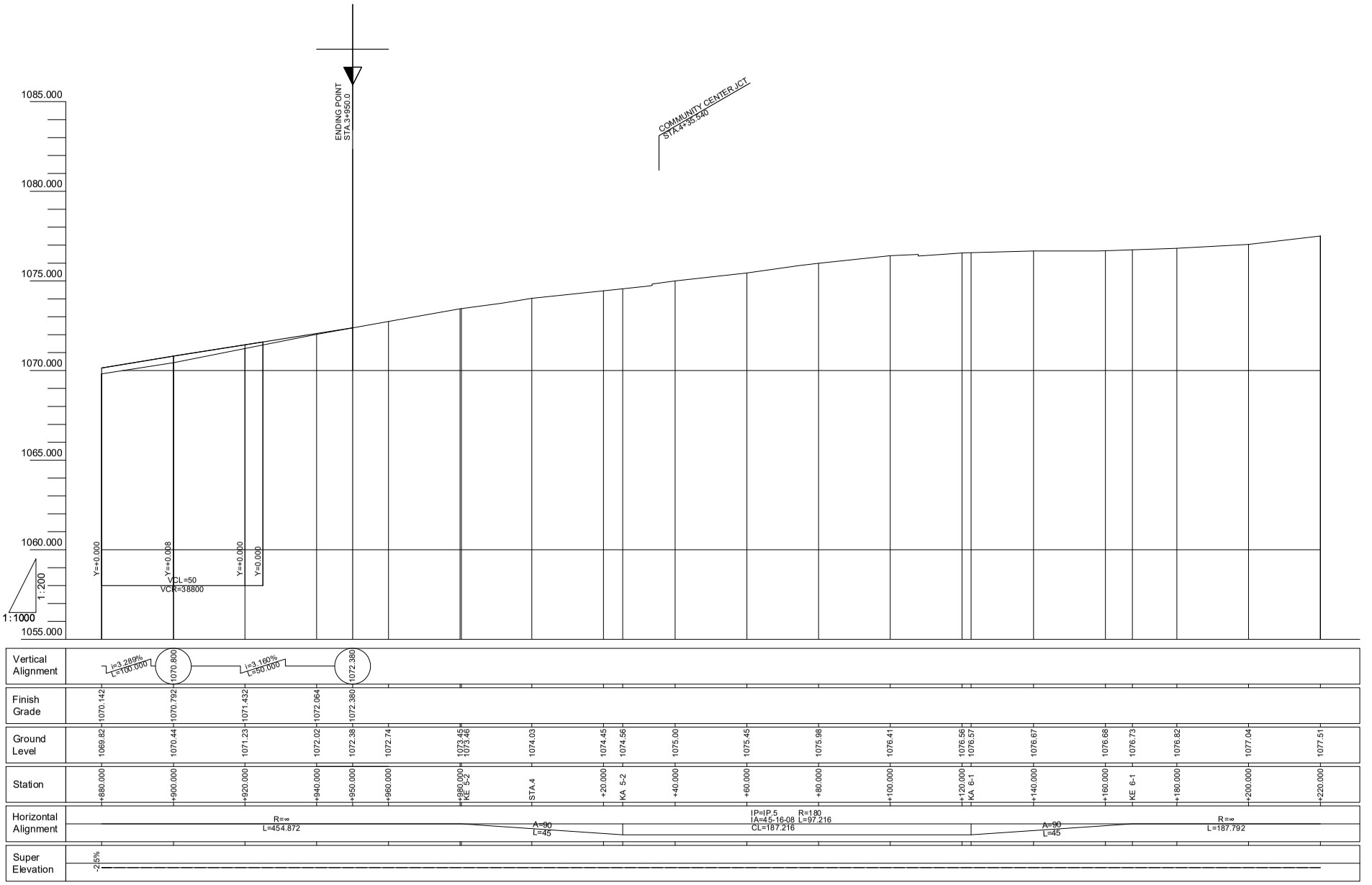
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (7)	Drawing No.	PR-07
				SCALE	V=1/200 H=1/1000
				DATE	



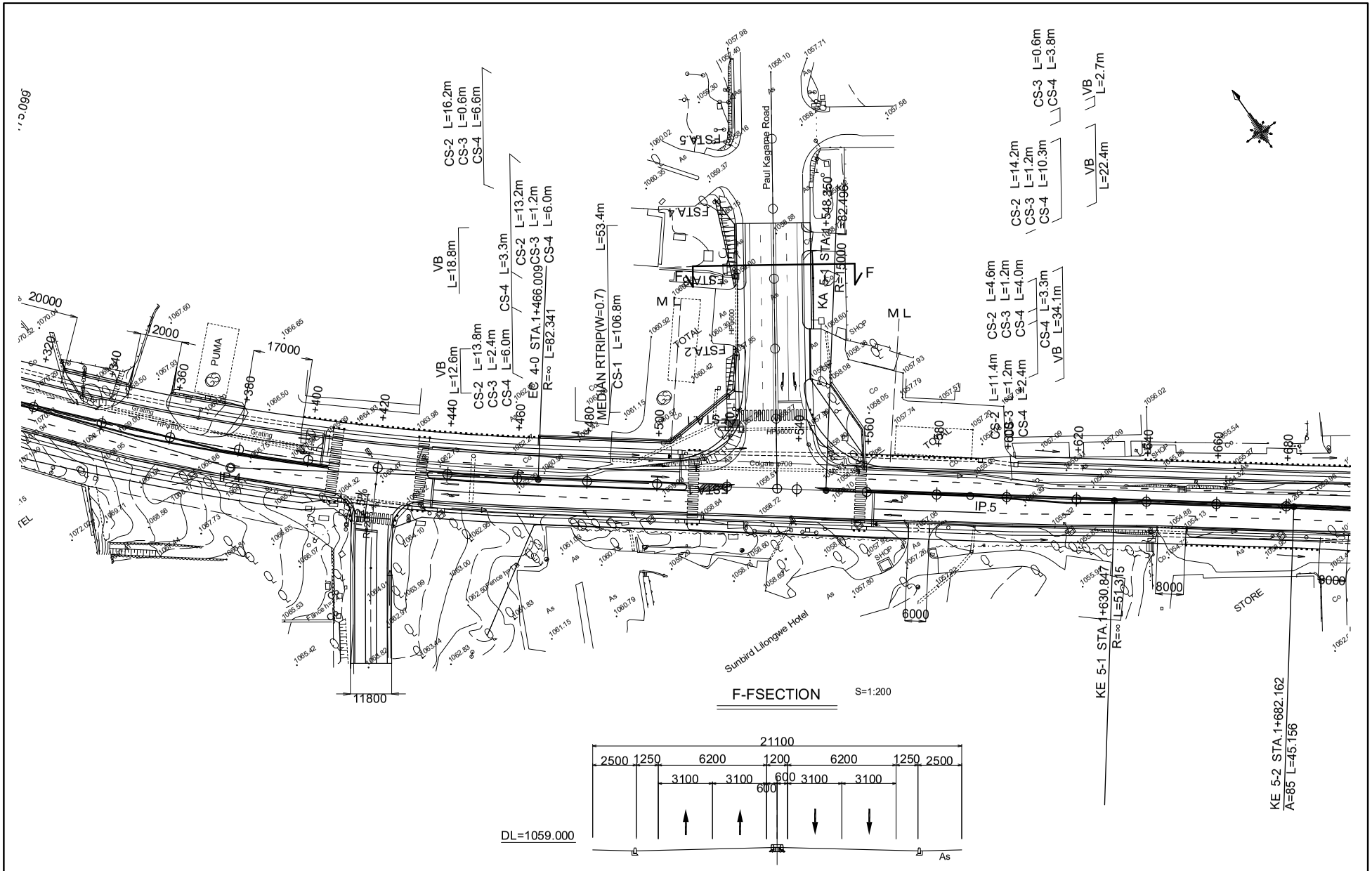
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (8)	Drawing No.	PR-08
				SCALE	V=1/200 H=1/1000
				DATE	



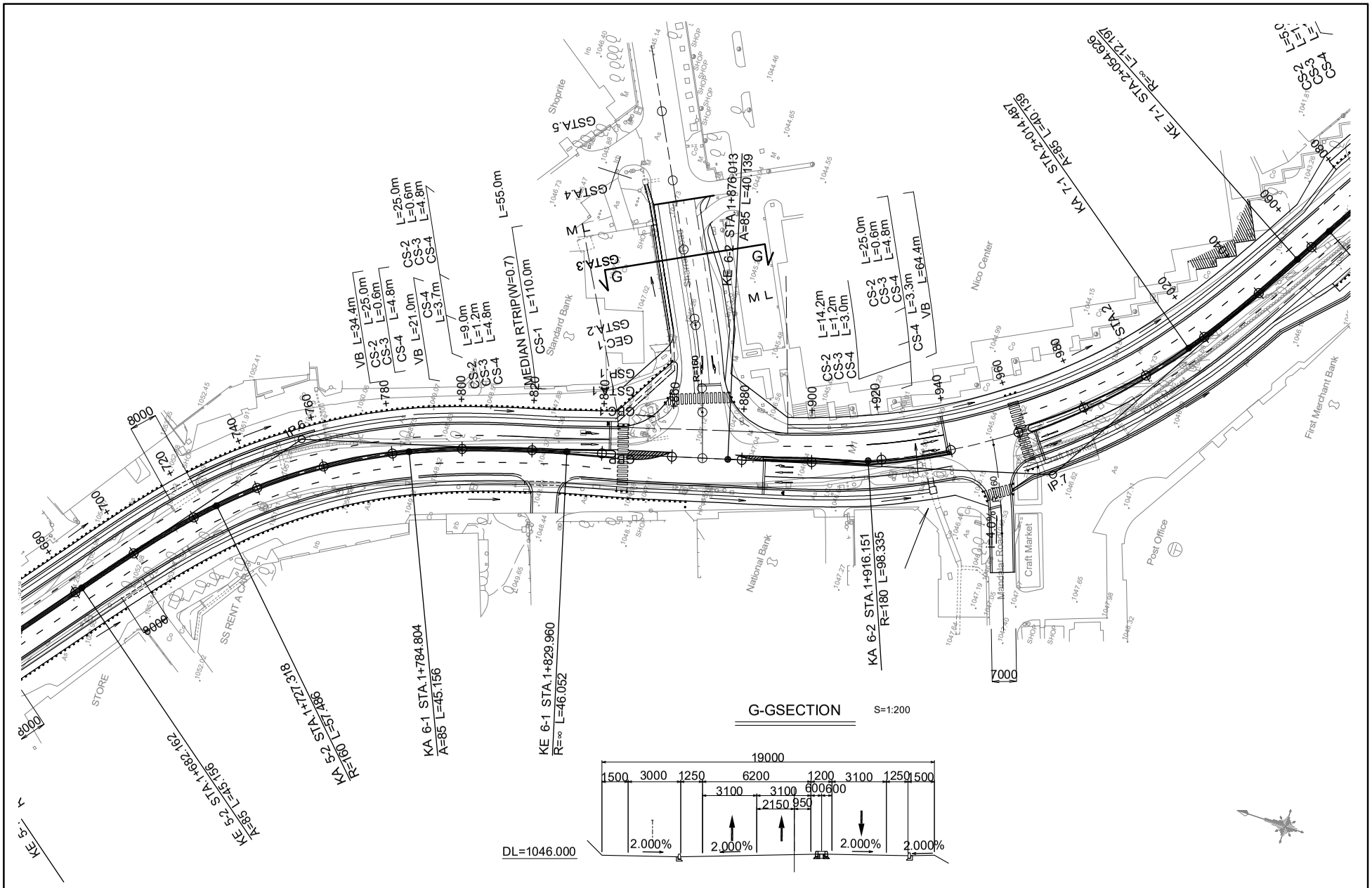
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (9)	Drawing No.	PR-09
				SCALE	V=1/200 H=1/1000
				DATE	



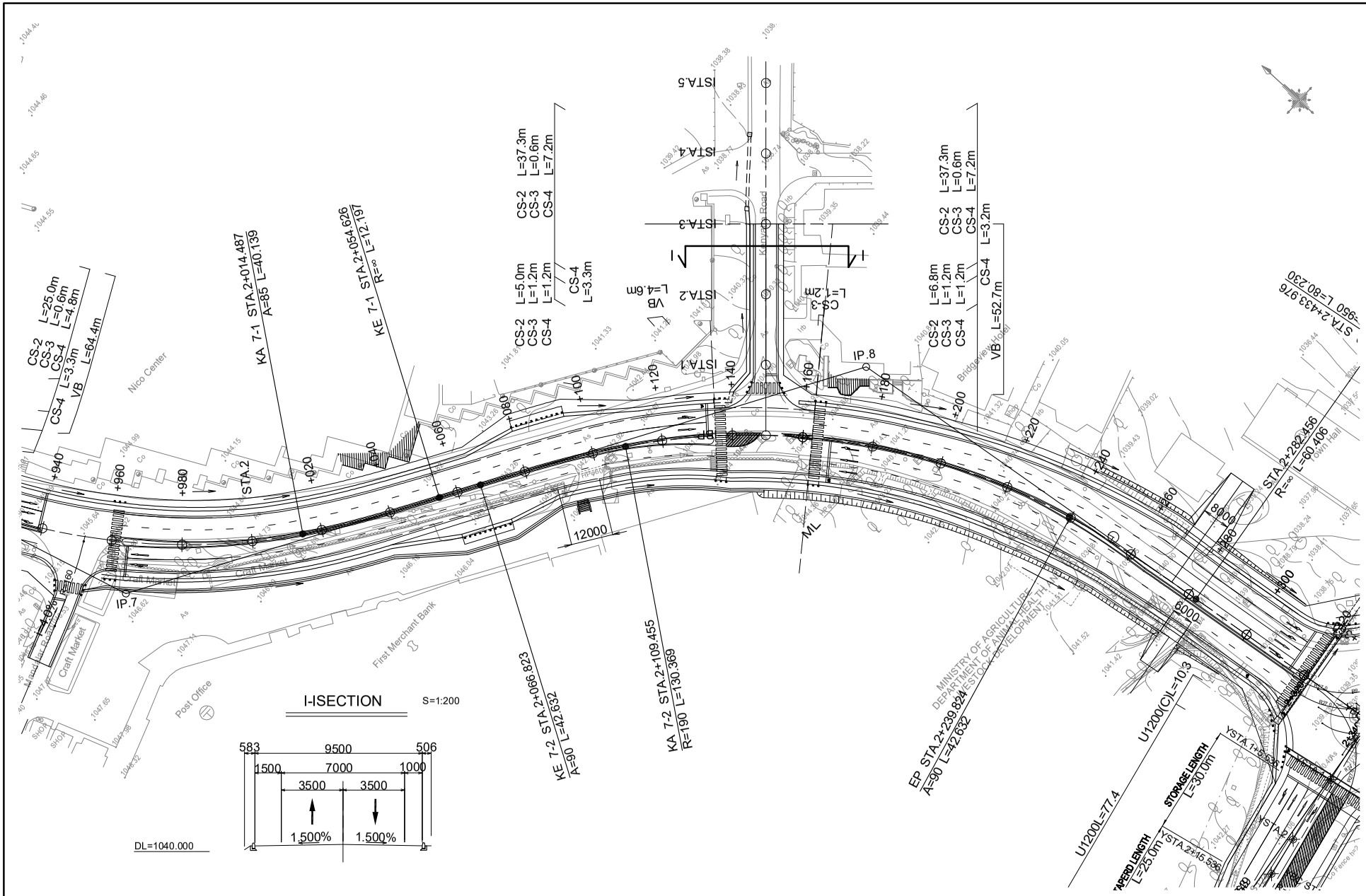
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE (10)	Drawing No.	PR-10
				SCALE	V=1/200 H=1/1000
				DATE	



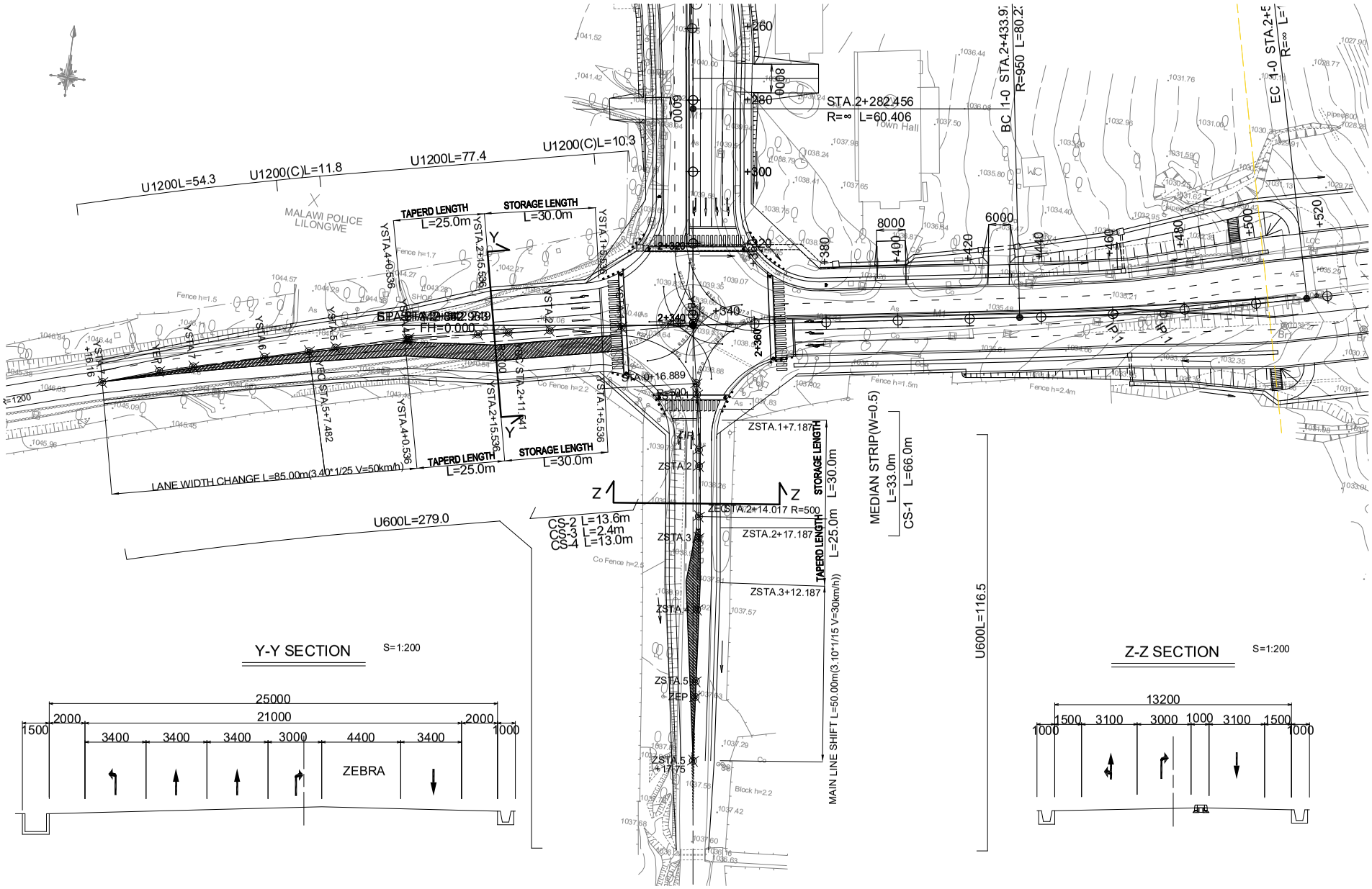
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (1)	Drawing No.	IS-01
				SCALE	S=1/1000
				DATE	



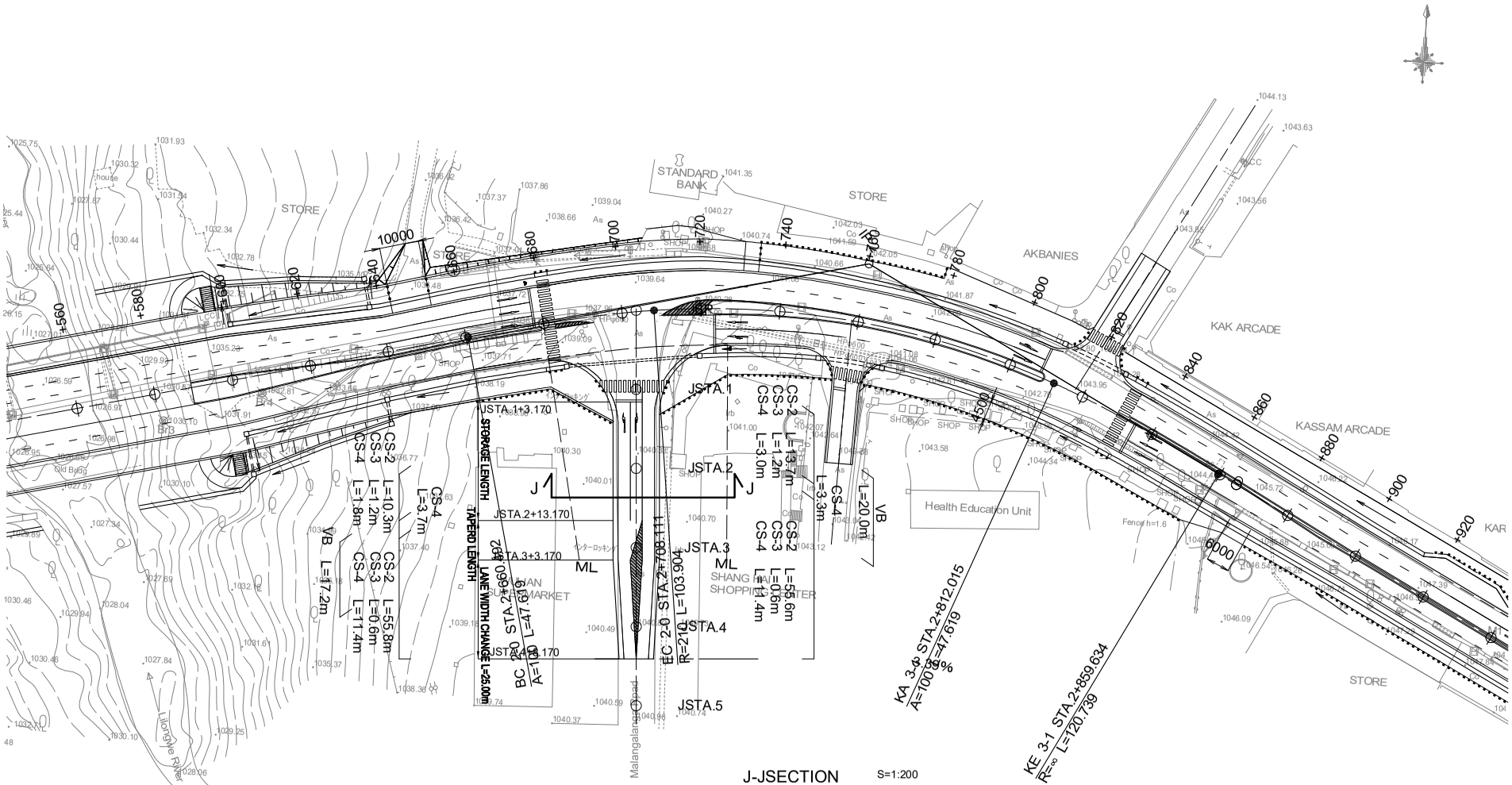
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (2)	Drawing No.	IS-02
				SCALE	S=1/1000
				DATE	



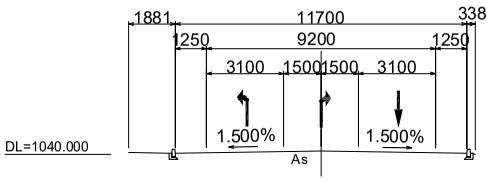
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (3)	Drawing No.	IS-03
				SCALE	S=1/1000
				DATE	



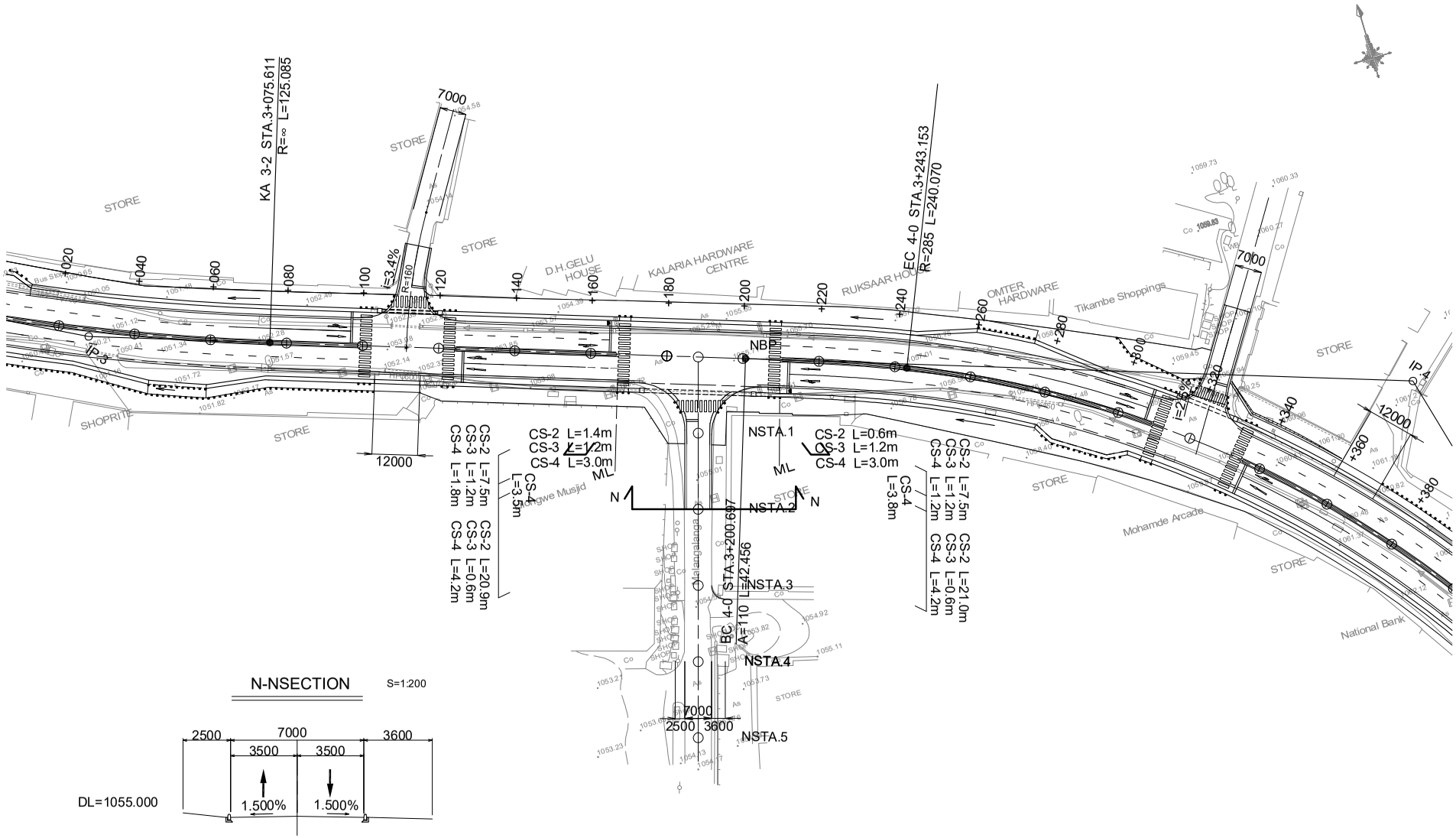
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (4)	Drawing No.	IS-04
				SCALE	S=1/1000
				DATE	



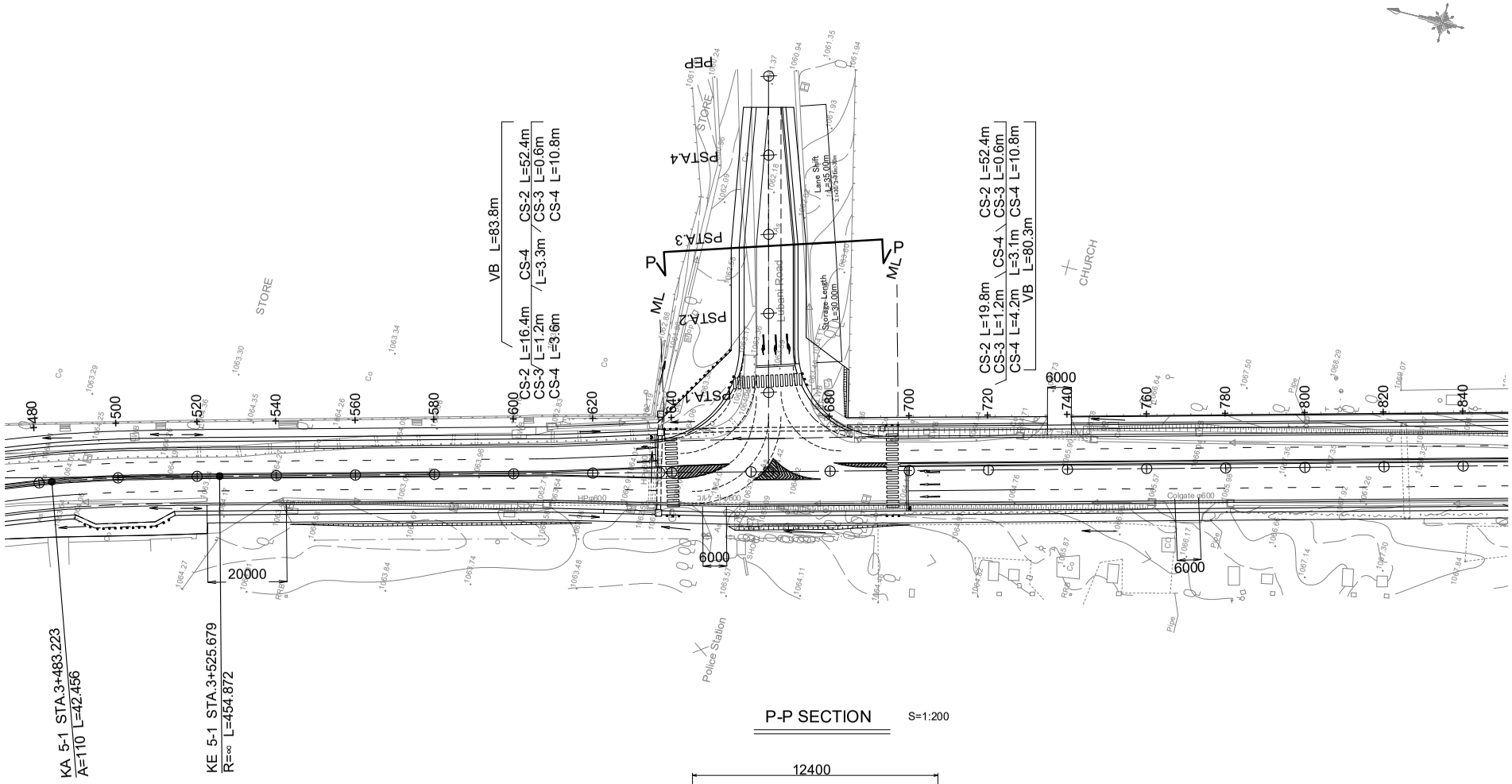
J-JSECTION S=1:200



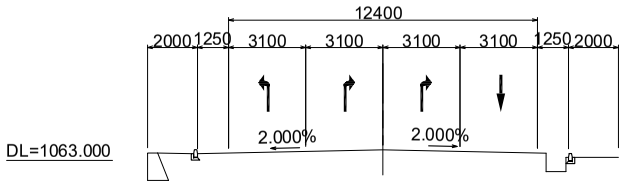
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (5)	Drawing No.	IS-05
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION(6)	Drawing No.	IS-06
				SCALE	S=1/1000
				DATE	



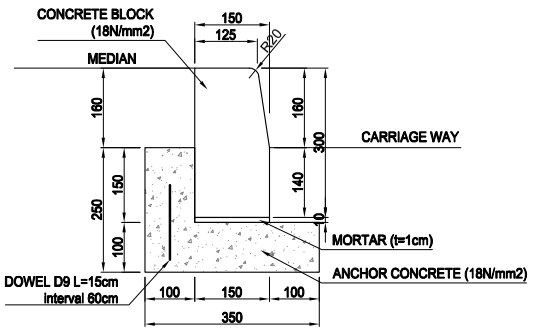
P-P SECTION S=1:200



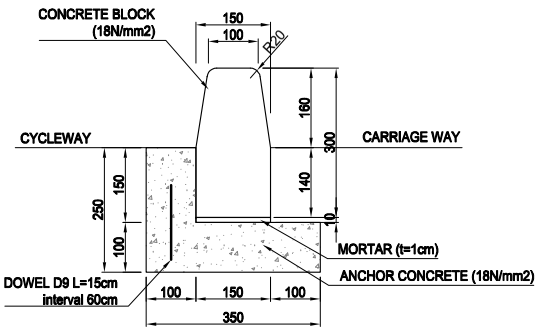
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : INTERSECTION PLAN (7)	Drawing No.	IS-07
				SCALE	S=1/1000
				DATE	

CURB STONE(1)

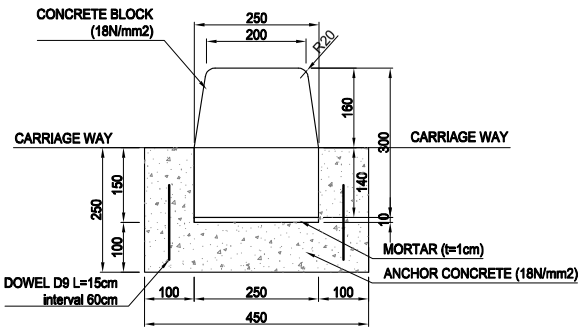
CS-1 S=1/10



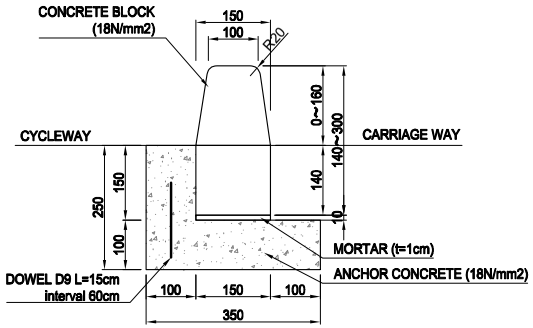
CS-2 S=1/10



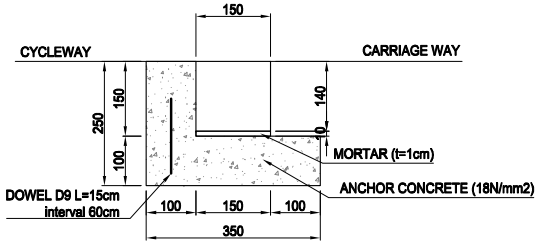
CS-2-200 S=1/10



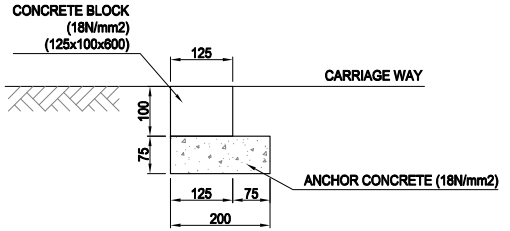
CS-3 S=1/10



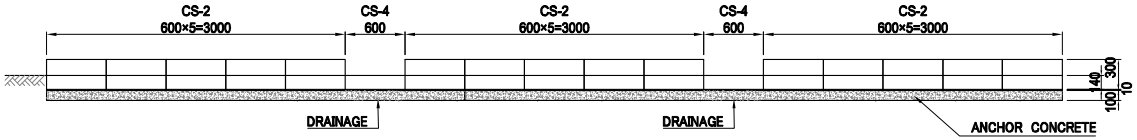
CS-4 S=1/10



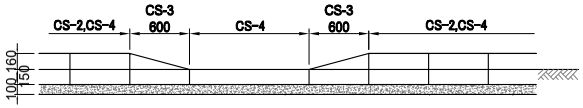
VB(VERGE BLOCK) S=1/10



STANDARD SECTION S=1/50



ENTRANCE SECTION S=1/50

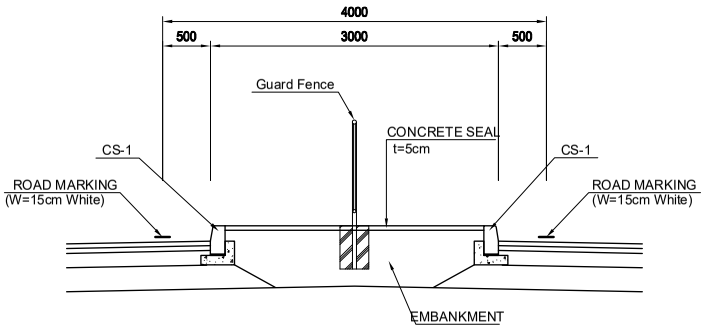


※In the standard part SC-4 is placed every 3m in consideration of road surface drainage.

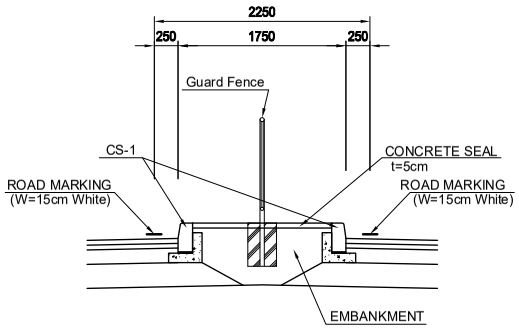
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : CURB STONE(1) CURB STONE LAYOUT	Drawing No.	CU-01
				SCALE	As Shown
				DATE	

CURB STONE(2)(MEDIAN STRIP)

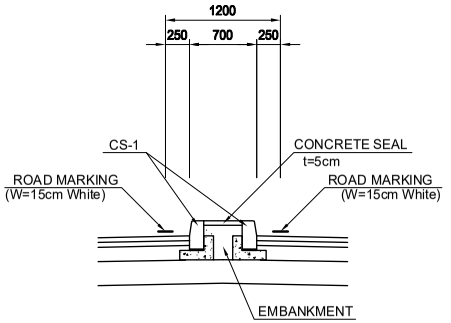
W=3.00m



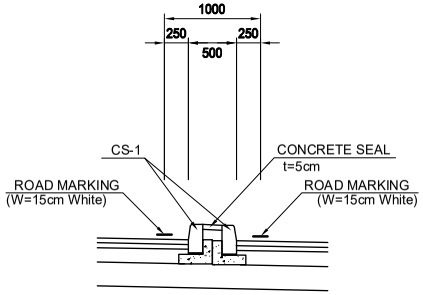
W=1.75m



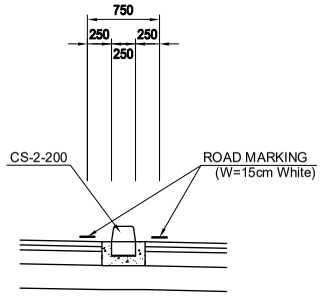
W=0.70m



W=0.50m



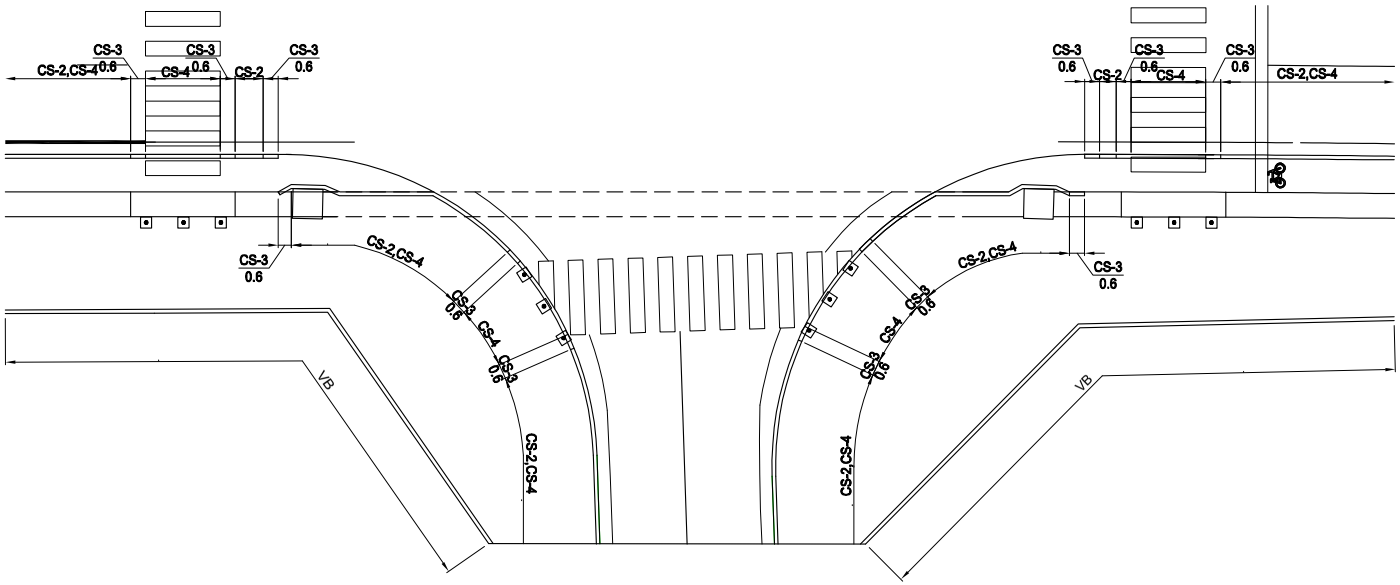
W=0.25m



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : CURB STONE(2) (MEDIAN STRIP)	Drawing No.	CU-02
				SCALE	S=1/50
				DATE	

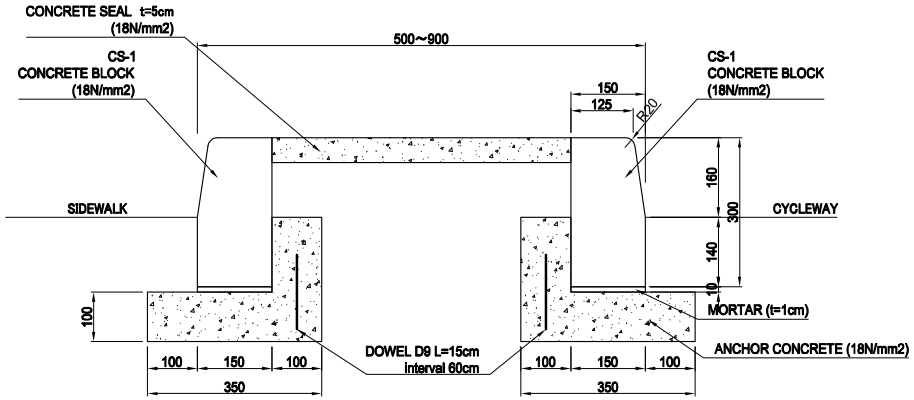
CURB STONE(3)

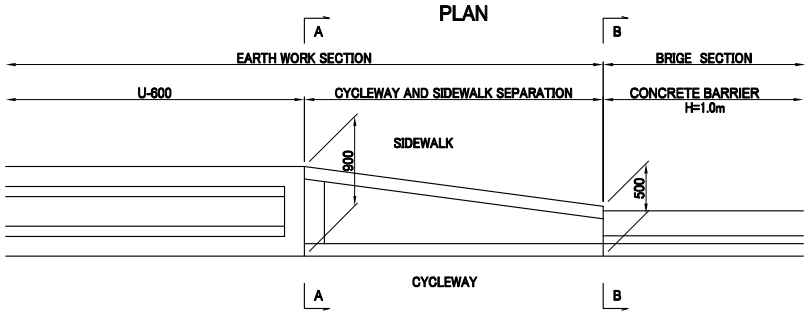
PLAN S=1/200

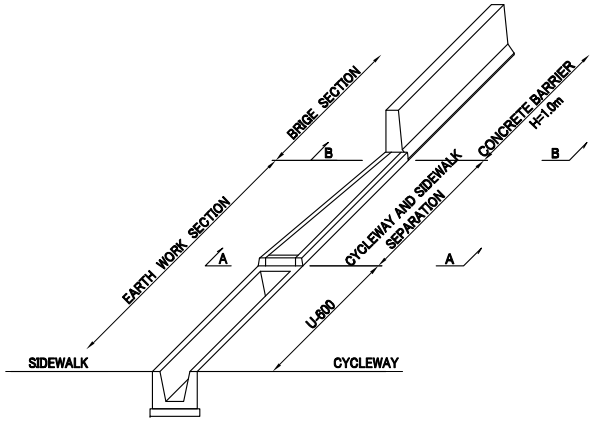


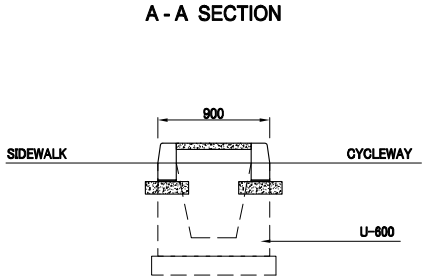
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : CURB STONE(3) INTERSECTION	Drawing No.	CU-03
				SCALE	S=1/200
				DATE	

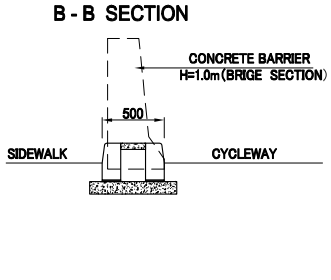
CURB STONE(4) CYCLEWAY AND SIDEWALK SEPARATION







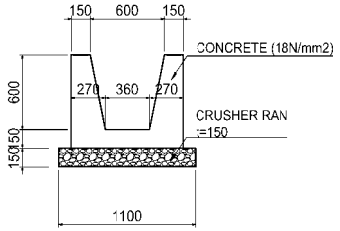




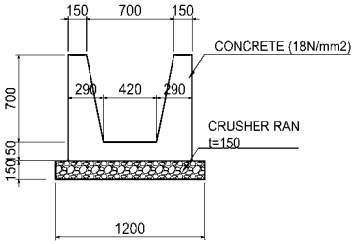
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : CURB STONE(4) CYCLEWAY AND SIDEWALK SEPARATION	Drawing No.	CU-04
				SCALE	S=1/10
				DATE	

DRAINAGE STRUCTURE(1)

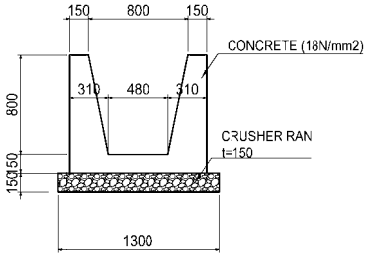
U-600



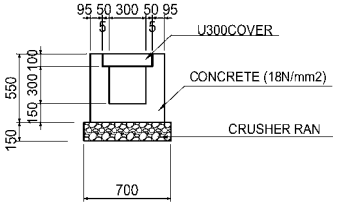
U-700



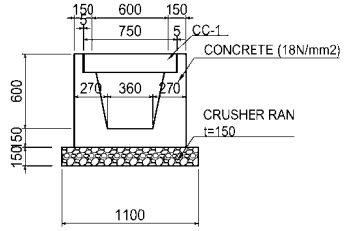
U-800



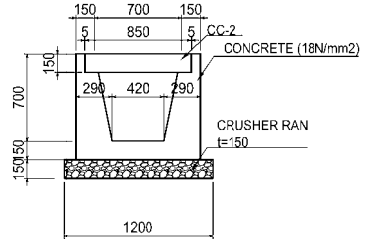
U-300(C)

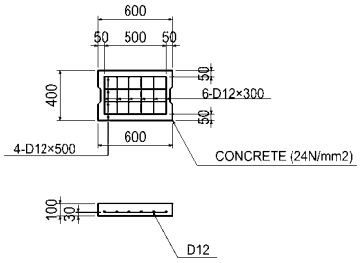


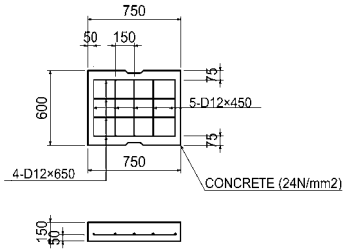
U-600(C)

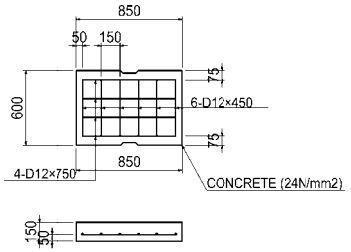


U-700(C)





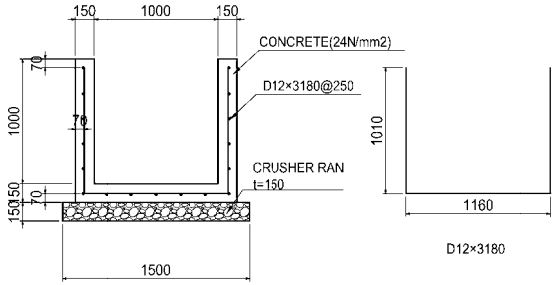




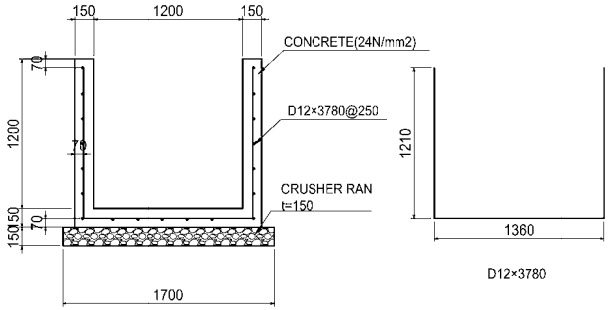
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(1)	Drawing No.	DR-01
				SCALE	S=1/40
				DATE	

DRAINAGE STRUCTURE(2)

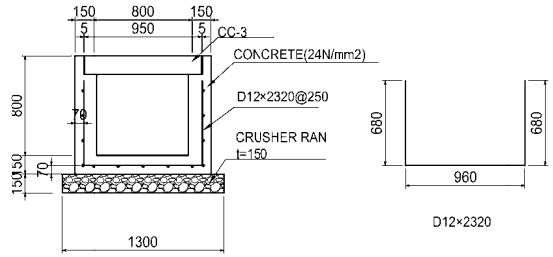
U-1000



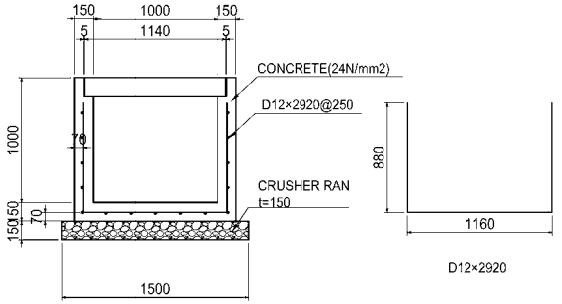
U-1200



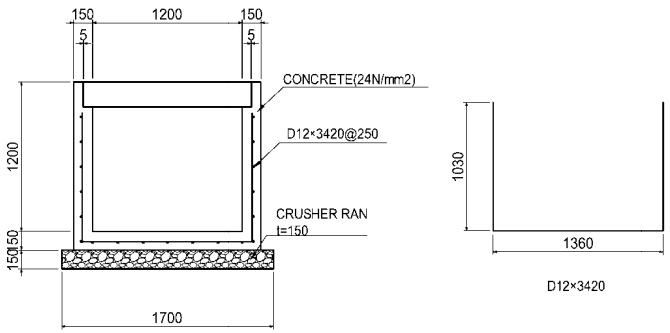
U-800(C)



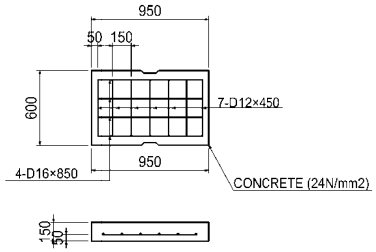
U-1000 (C)

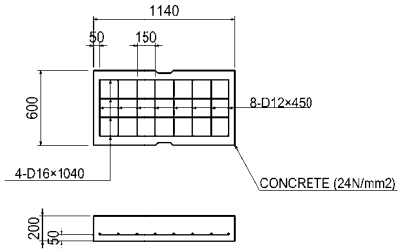


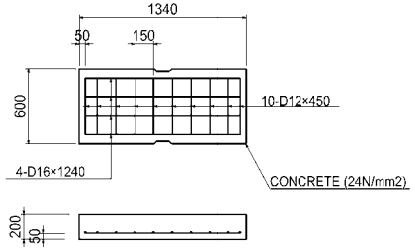
U-1200 (C)



CC-3



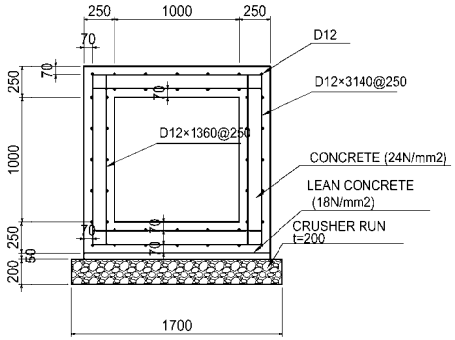




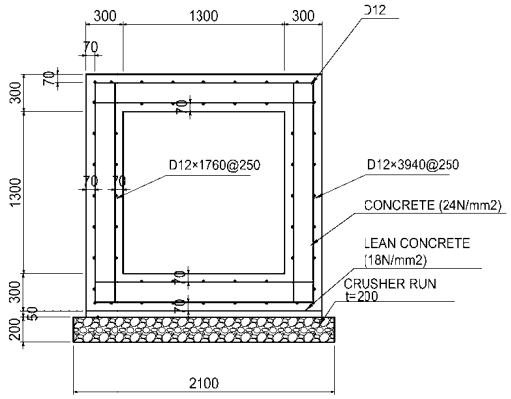
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(2)	Drawing No.	DR-02
				SCALE	S=1/40
				DATE	

DRAINAGE STRUCTURE(3)

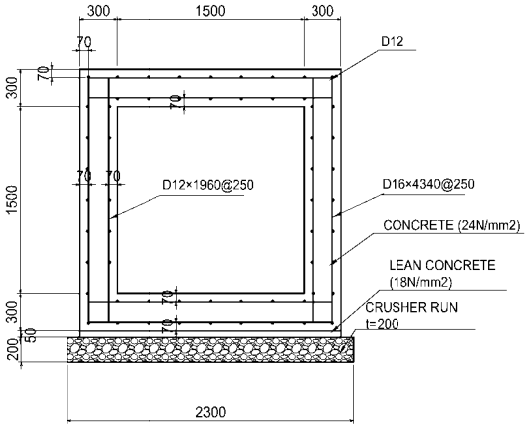
BX 1000

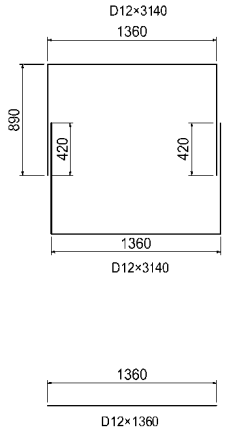


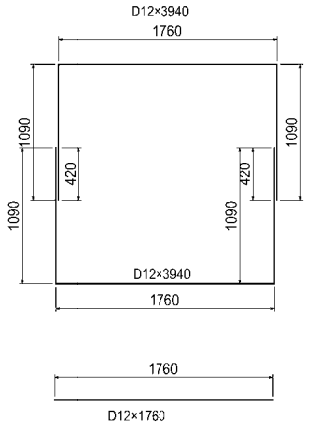
BX 1300

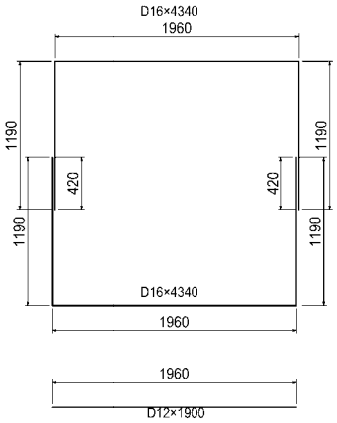


BX 1500





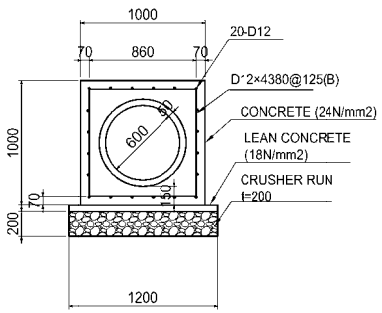




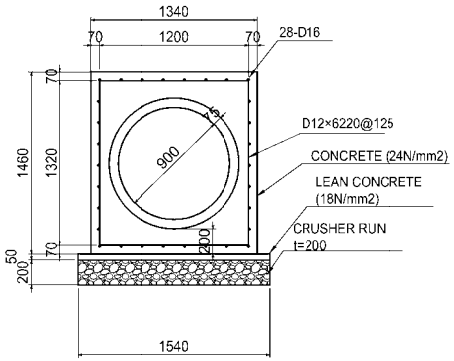
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(3)	Drawing No.	DR-03
				SCALE	S=1/40
				DATE	

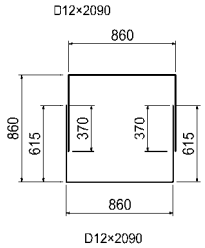
DRAINAGE STRUCTURE(4)

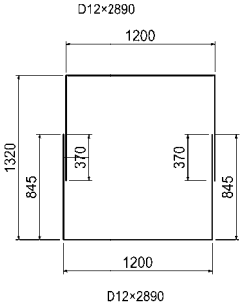
DP-600



DP-900



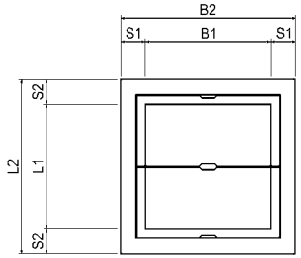




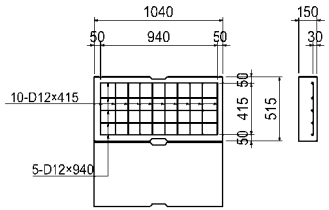
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(4)	Drawing No.	DR-04
				SCALE	S=1/40
				DATE	

DRAINAGE STRUCTURE(5)

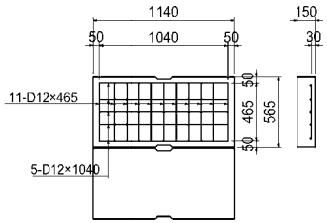
CB-1~3



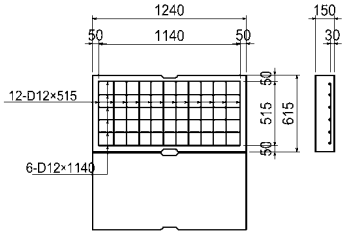
CB-1(C)

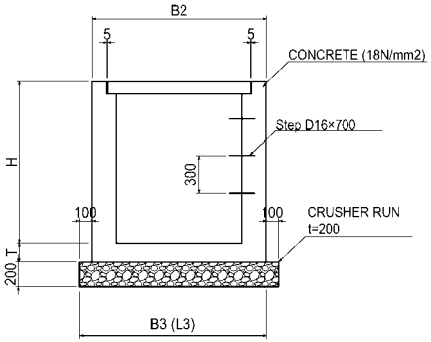


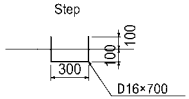
CB-2(C)



CB-3(C)







DIMENSION TABLE

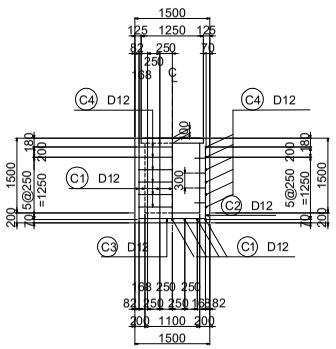
TYPE	H	B1	B2	B3	L1	L2	L3	S1	S2	T	COVER
CB-1	1000	900	1300	1500	900	1300	1500	200	200	150	CB-1(C)×2
CB-2	1300	1000	1400	1600	1000	1400	1600	200	200	150	CB-2(C)×2
CB-3	1500	1100	1500	1700	1100	1500	1700	200	200	150	CB-3(C)×2

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(5)	Drawing No.	DR-05
				SCALE	S=1/40
				DATE	

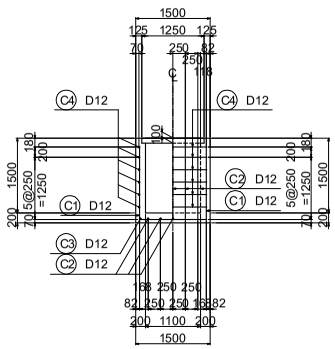
DRAINAGE STRUCTURE(6)

CB-3

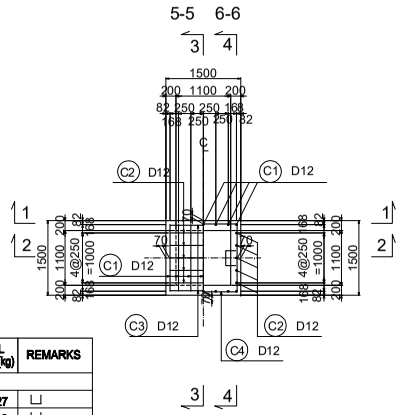
1-1 2-2

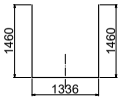


3-3 4-4

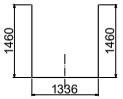


5-5 6-6

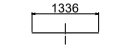




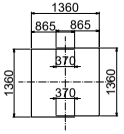
C1 7 - D12 × 4360



C2 5 - D12 × 4360



C3 2 - D12 × 1340



C4 12 - D12 × 3090

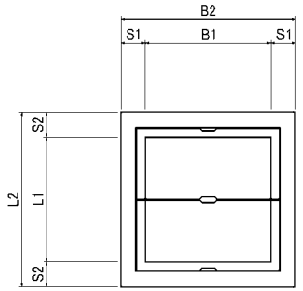
SCHEDULE OF REINFORCEMENT

BAR MARK	SIZE (mm)	LENGTH PAR BAR(mm)	QTY.	UNIT WEIGHT(kg/m)	WEIGHT PAR BAR	TOTAL WEIGHT(kg)	REMARKS
C 1	D12	4360	7	0.888	3.87	27	
2	D12	4360	5	0.888	3.87	19	
3	D12	1340	2	0.888	1.19	2	
4	D12	3090	12	0.888	2.74	33	
					D12	81 kg	
					TOTAL	81 kg	

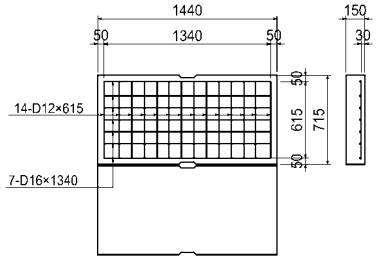
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(6)	Drawing No. DR-06 SCALE S=1/20 DATE

DRAINAGE STRUCTURE(7)

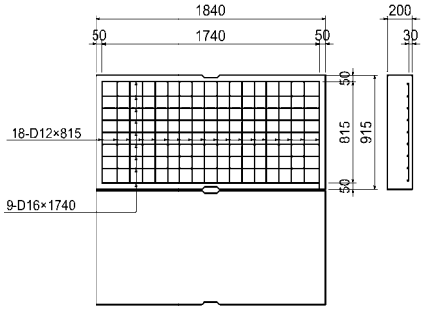
CB - 4~7

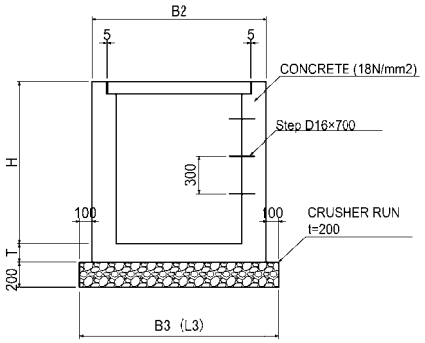


CB-4 (C)

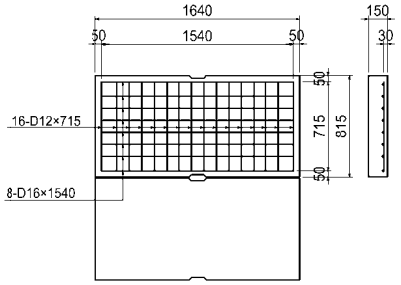


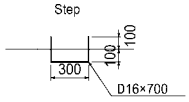
CB-6,7 (C)





CB-5 (C)





DIMENSION TABLE

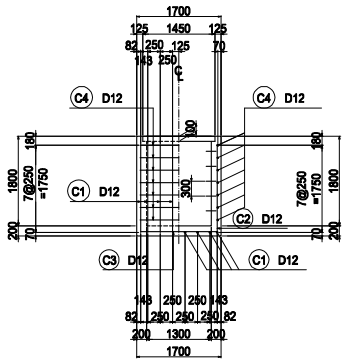
TYPE	H	B1	B2	B3	L1	L2	L3	S1	S2	T	COVER
CB-4	1800	1300	1700	1900	1300	1700	1900	200	200	200	CB-4(C)×2
CB-5	1600	1500	1900	2100	1500	1900	2100	200	200	200	CB-5(C)×2
CB-6	2000	1700	2100	2300	1700	2100	2300	200	200	200	CB-6(C)×2
CB-7	2700	1700	2100	2300	1700	2100	2300	200	200	200	CB-7(C)×2

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(7)	Drawing No.	DR-07
				SCALE	S=1/40
				DATE	

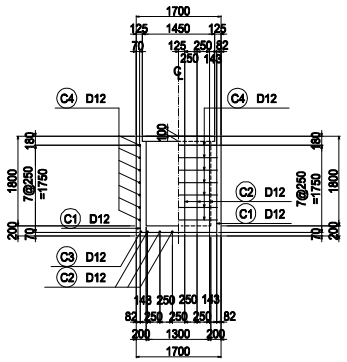
DRAINAGE STRUCTURE(8)

CB-4

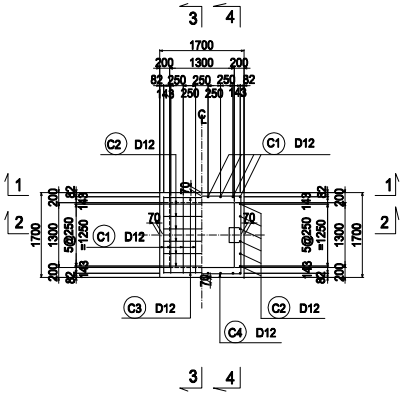
1-1 2-2

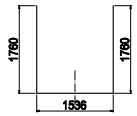


3-3 4-4

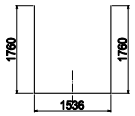


5-5 6-6

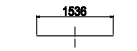




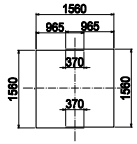
C1 8 - D12 × 5060



C2 6 - D12 × 5060



C3 2 - D12 × 1540



14 - D12 × 3490

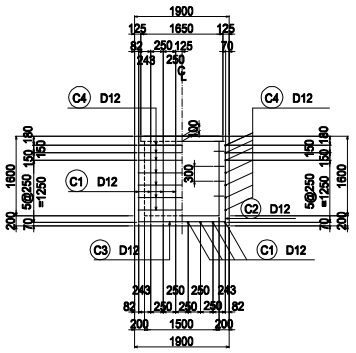
C4

SCHEDULE OF REINFORCEMENT

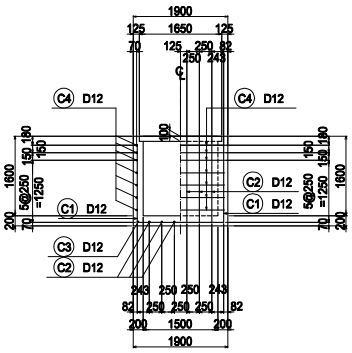
BAR MARK		SIZE (mm)	LENGTH PAR BAR(mm)	QTY.	UNIT WEIGHT(kg/m)	WEIGHT PAR BAR	TOTAL WEIGHT(kg)	REMARKS
C	1	D12	5060	8	0.888	4.49	36	
	2	D12	5060	6	0.888	4.49	27	
	3	D12	1540	2	0.888	1.37	3	
	4	D12	3490	14	0.888	3.10	43	
							D12 109 kg	
							TOTAL 109kg	

CB-5

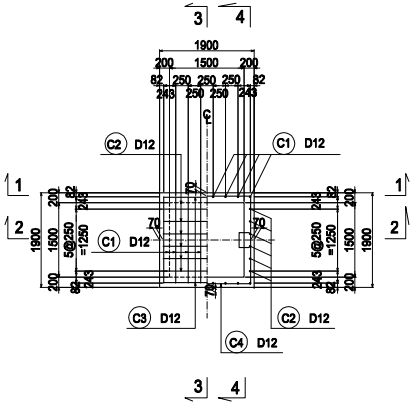
1-1 2-2

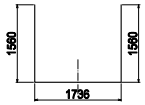


3-3 4-4

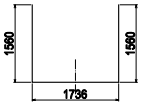


5-5 6-6

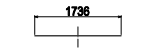




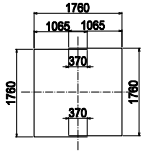
C1 8 - D12 × 4860



C2 6 - D12 × 4860



C3 2 - D12 × 1740



C4 14 - D12 × 3890

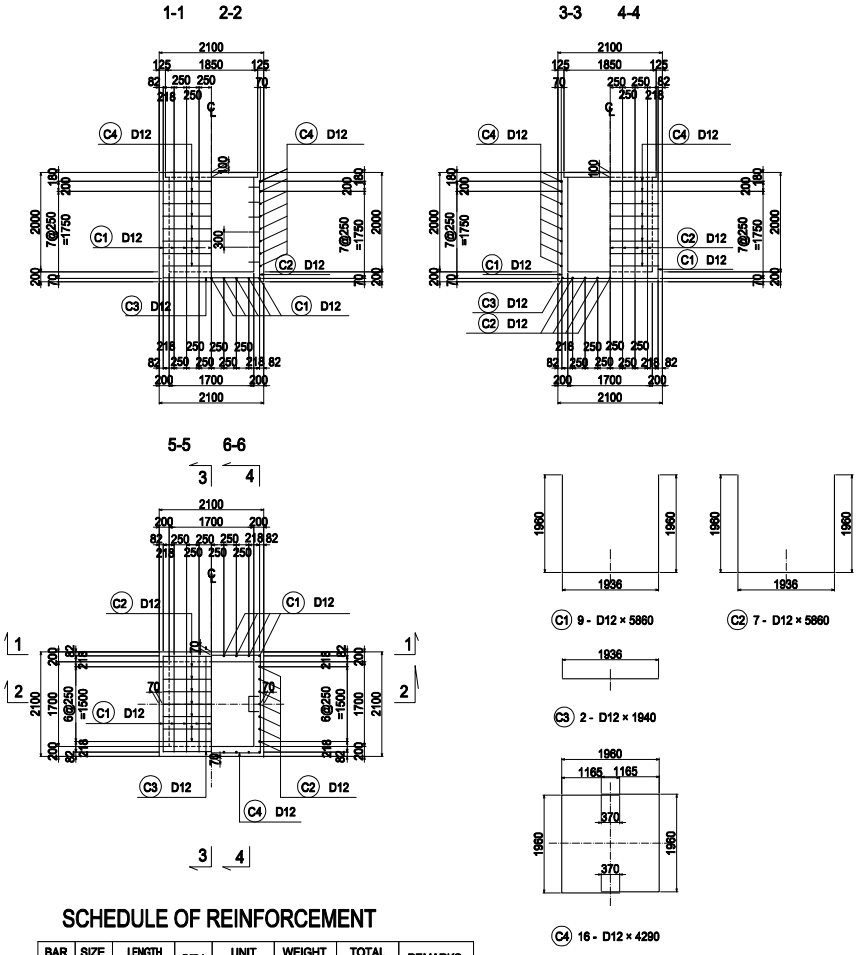
SCHEDULE OF REINFORCEMENT

BAR MARK		SIZE (mm)	LENGTH PAR BAR(mm)	QTY.	UNIT WEIGHT(kg/m)	WEIGHT PAR BAR	TOTAL WEIGHT(kg)	REMARKS
C	1	D12	4860	8	0.888	4.32	35	
	2	D12	4860	6	0.888	4.32	26	
	3	D12	1740	2	0.888	1.37	3	
	4	D12	3890	14	0.888	3.10	43	
							D12 107 kg	
							TOTAL 107 kg	

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(8)	Drawing No. DR-08 SCALE S=1/100 DATE

DRAINAGE STRUCTURE(9)

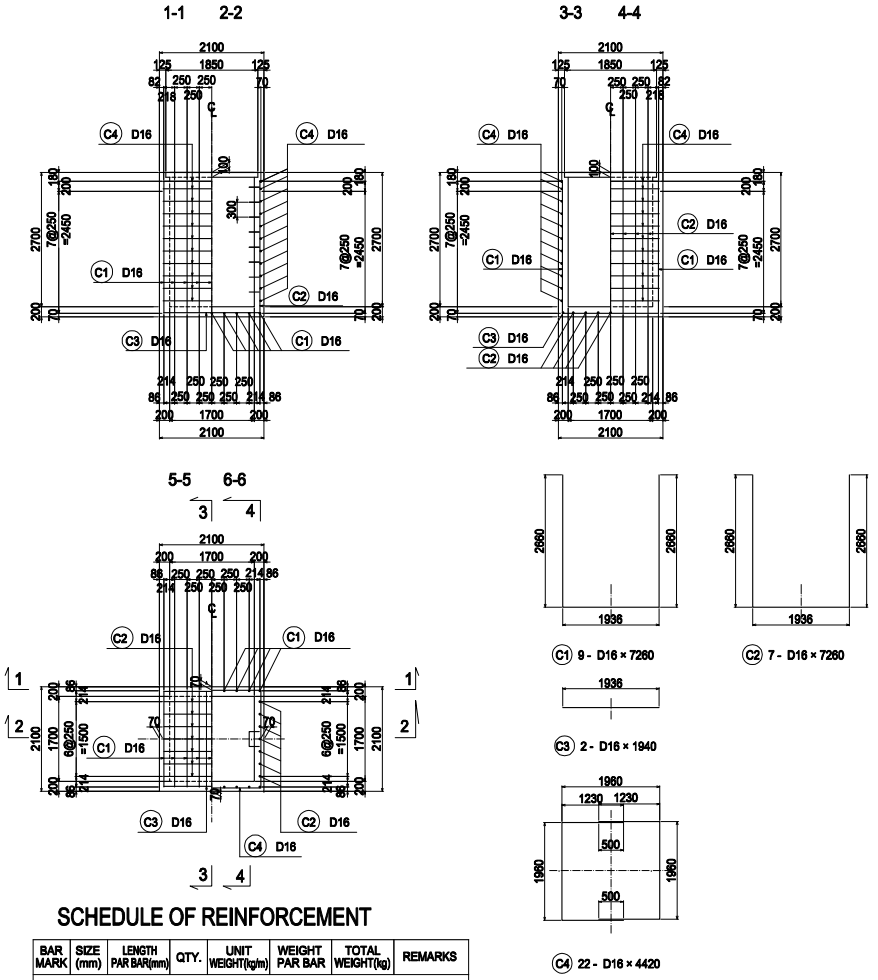
CB-6



SCHEDULE OF REINFORCEMENT

BAR MARK	SIZE (mm)	LENGTH PAR BAR(mm)	QTY.	UNIT WEIGHT(kg/m)	WEIGHT PAR BAR	TOTAL WEIGHT(kg)	REMARKS
C 1	D12	5860	9	0.888	5.20	47	⊔
2	D12	5860	7	0.888	5.20	36	⊔
3	D12	1940	2	0.888	1.72	3	—
4	D12	4290	16	0.888	3.81	61	□
					D12	147 kg	
					TOTAL	147 kg	

CB-7

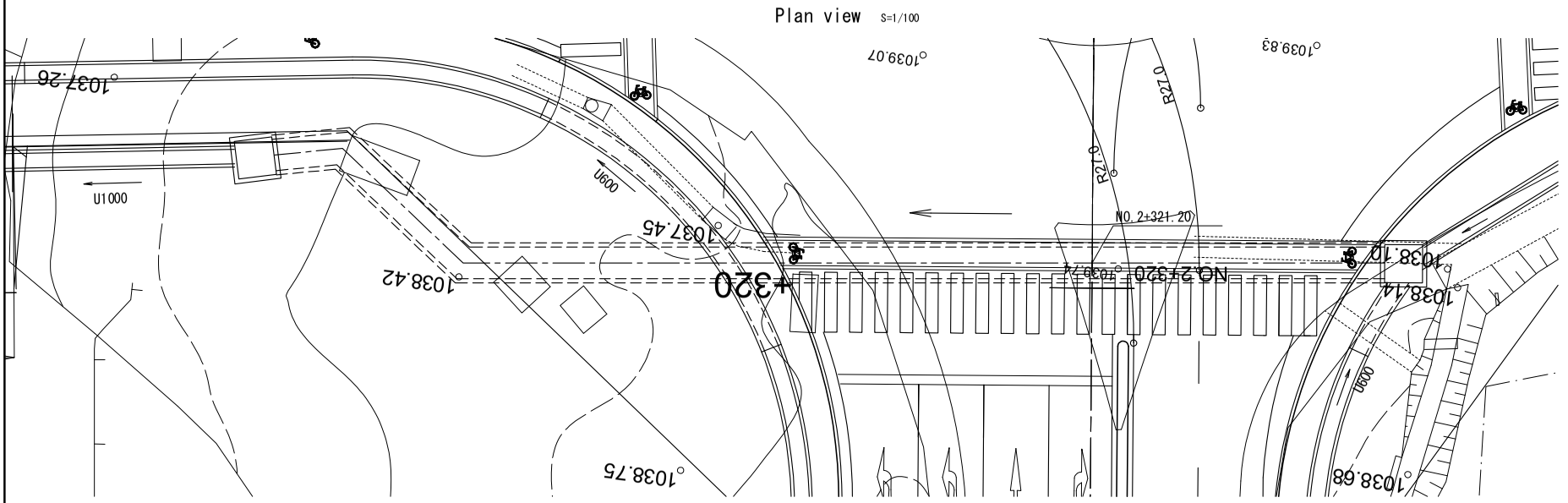


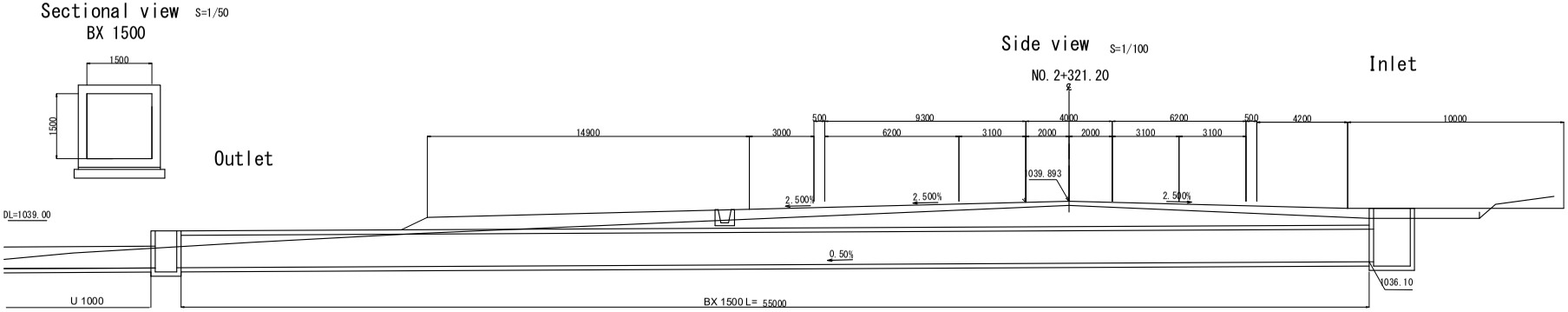
SCHEDULE OF REINFORCEMENT

BAR MARK	SIZE (mm)	LENGTH PAR BAR(mm)	QTY.	UNIT WEIGHT(kg/m)	WEIGHT PAR BAR	TOTAL WEIGHT(kg)	REMARKS
C 1	D16	7260	9	1.579	11.46	103	⊔
2	D16	7260	7	1.579	11.46	80	⊔
3	D16	1940	2	1.579	3.06	6	—
4	D16	4420	22	1.579	6.98	154	□
					D16	343 kg	
					TOTAL	343 kg	

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(9)	Drawing No. DR-9 SCALE S=1/100 DATE

Box Culvert General View (1) STA.2+321.20

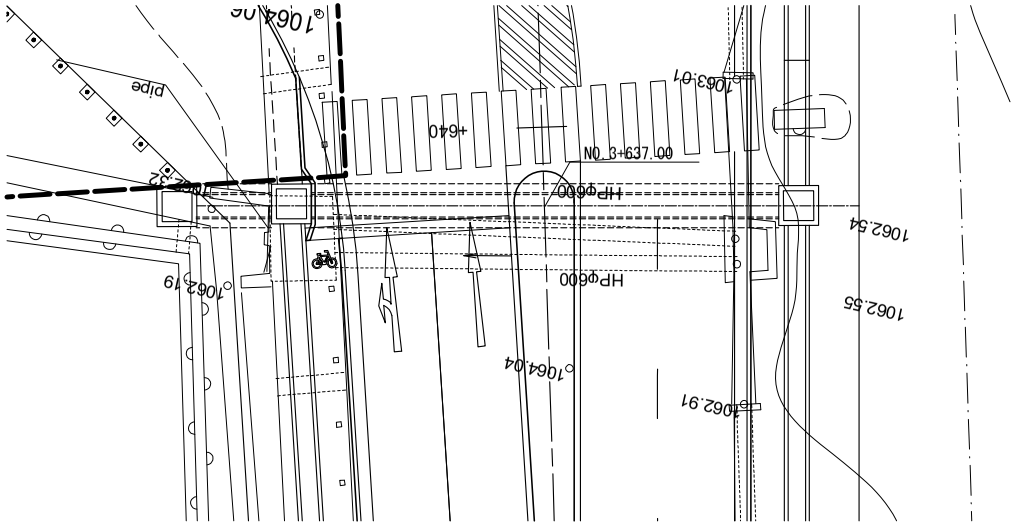




MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(10) BOX CULVURT GENERAL VIEW(1)	Drawing No.	DR-10
				SCALE	S=1/100
				DATE	

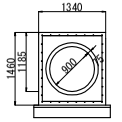
Pipe Culvert General View (2)　STA.3+637.00

Plan view　S=1/100

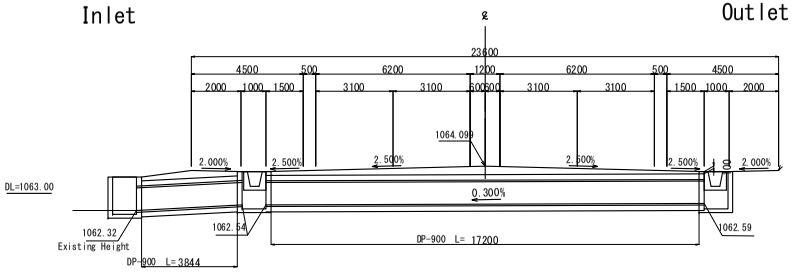


Sectional view　S=1/50

DP-900



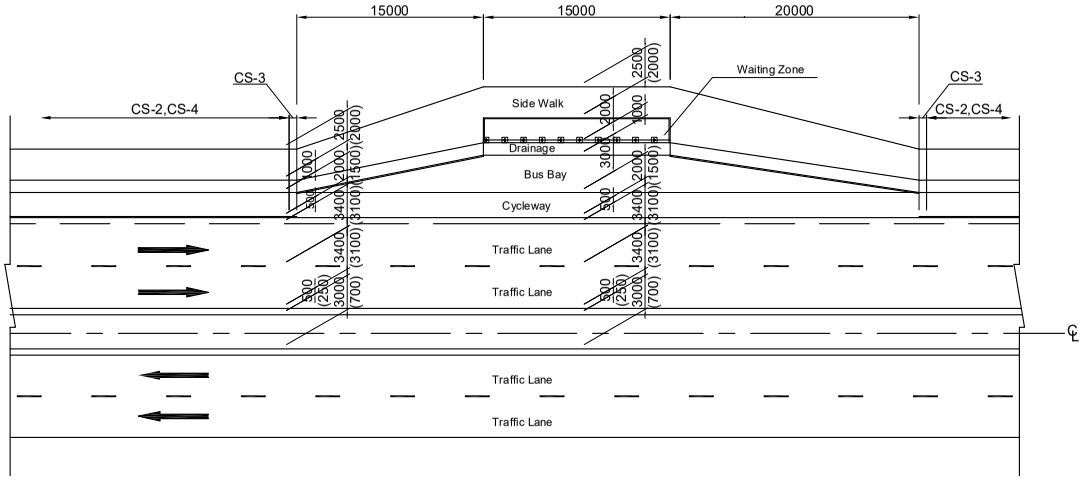
Side view　S=1/100



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DRAINAGE STRUCTURE(11) PIPE CULVURT GENERAL VIEW(2)	Drawing No.	DR-11
				SCALE	S=1/100
				DATE	

BUS STOP

PLAN S=1/400

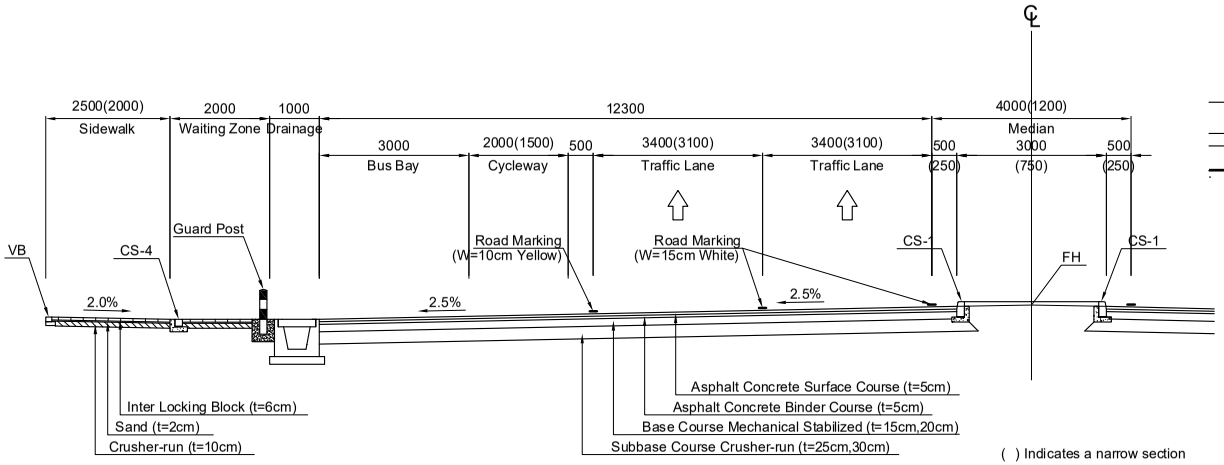


( ) Indicates a narrow section

SCHEDULE OF BUS STOP

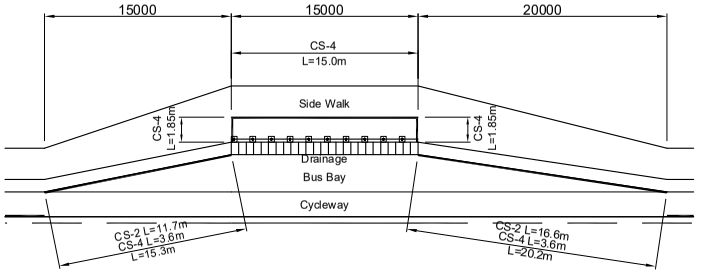
No.	BUS STOP STA.	STANDARD SECTION		NARROW SECTION		REMARK
		Left Side	Right Side	Left Side	Right Side	
1	NO.2+065				○	
2	NO.2+089			○		
3	NO.3+053		○			
	TOTAL		1	1	1	

TYPICAL CROSS SECTION S=1/100



( ) Indicates a narrow section

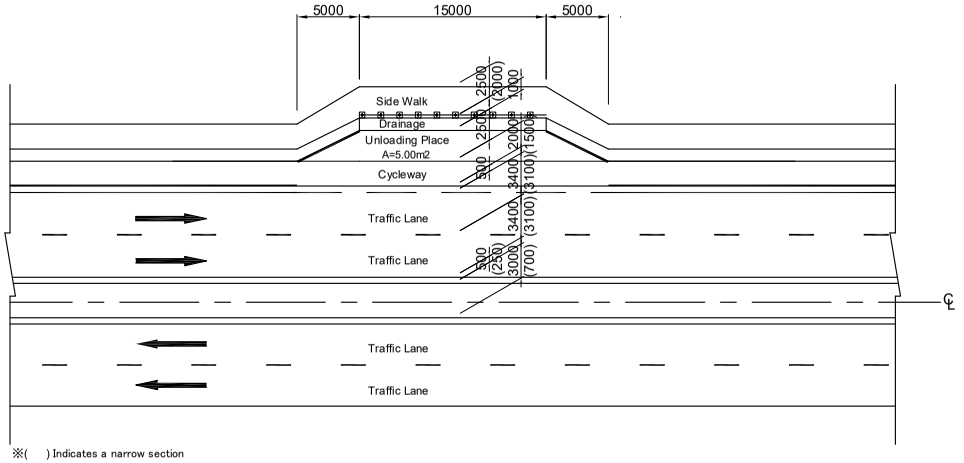
WAITING ZONE S=1/400



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : BUS STOP DETAIL	Drawing No.	BS-01
				SCALE	As Shown
				DATE	

UNLOADING PLACE

PLAN S=1/400

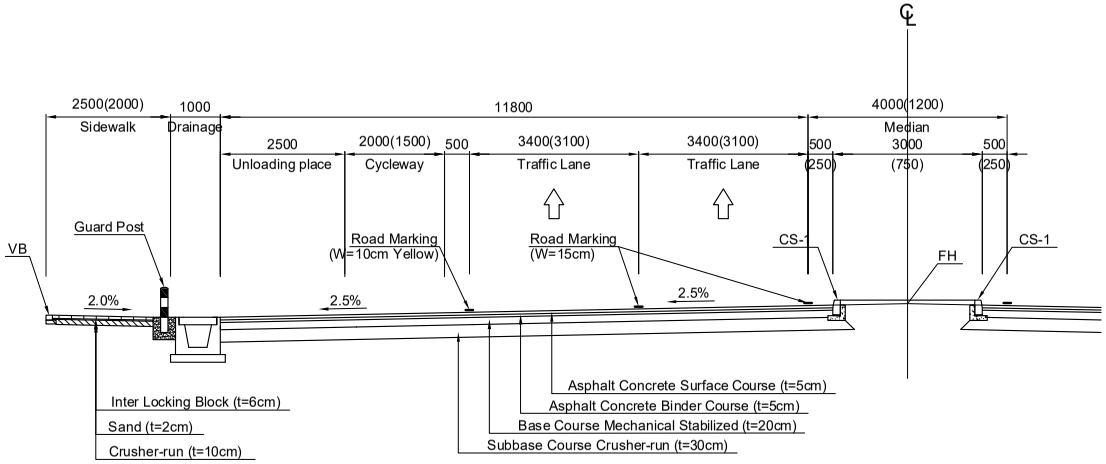


※( ) Indicates a narrow section

SCHEDULE OF UNLOADING PLACE

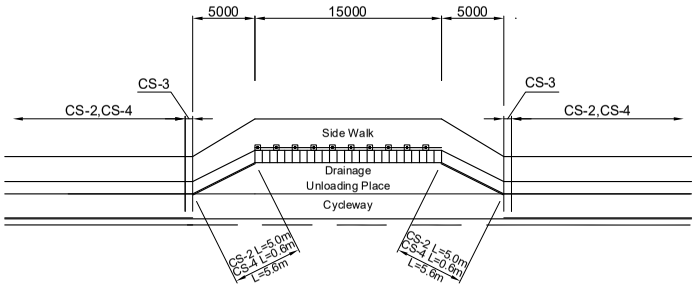
No.	STA.	STANDARD SECTION		REMARK
		Left Side	Right Side	
1	NO.2+930	○		
2	NO.3+000	○		
3	NO.3+290		○	
4	NO.3+500		○	
	TOTAL	2	2	

TYPICAL CROSS SECTION S=1/100



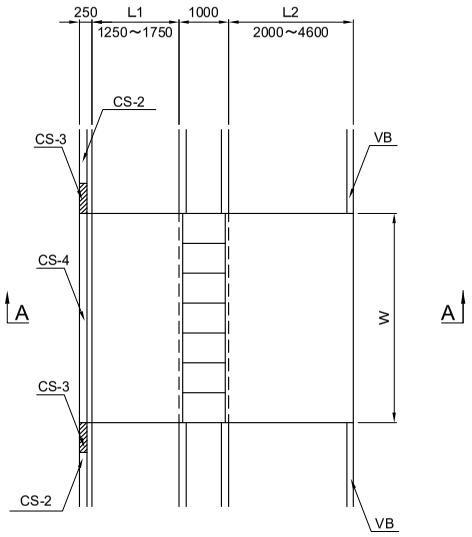
※( ) Indicates a narrow section

UNLOADING ZONE S=1/400



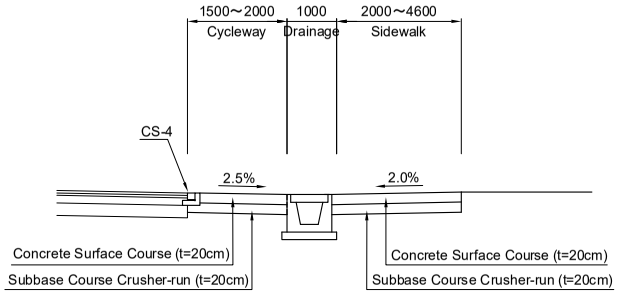
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : UNLOADING PLACE DETAIL	Drawing No.	UP-01
				SCALE	As Shown
				DATE	

ACCESS WAY



SCHEDULE OF ACCESS WAY

NO.	STA.	L/R	W	L1+L2	Area	Drainage	REMARKS
1	1+316	L	20.0	3.25	65.0	U700(C)	
2	1+352	L	12.0	3.25	39.0	U700(C)	
3	1+388	L	17.0	3.25	55.3	U700(C)	
4	1+576	R	6.0	3.35	20.1	U600(C)	
5	1+648	R	8.0	3.35	26.8	U600(C)	
6	1+694	R	8.0	3.35	26.8	U600(C)	
7	1+720	L	8.0	3.25	26.0	U700(C)	
8	2+273	L	8.0	3.35	26.8	U600(C)	
9	2+282	R	6.0	3.35	20.1	U600(C)	
10	2+399	L	8.0	4.35	34.8	U600(C)	
11	2+429	L	6.0	4.35	26.1	U600(C)	
12	2+648	L	10.0	5.85	58.5	U600(C)	
13	2+732	L	4.0	6.35	25.4	U600(C)	
14	2+872	R	6.0	3.35	20.1	U600(C)	
15	3+110	R	12.0	3.35	40.2	U600(C)	
16	3+364	L	12.0	3.35	40.2	U600(C)	
17	3+421	L	12.0	3.35	40.2	U600(C)	
18	3+533	R	20.0	3.35	67.0	U600(C)	
19	3+651	R	6.0	3.35	20.1	U600(C)	
20	3+737	L	6.0	3.35	20.1	U600(C)	
21	3+771	R	6.0	3.35	20.1	U600(C)	

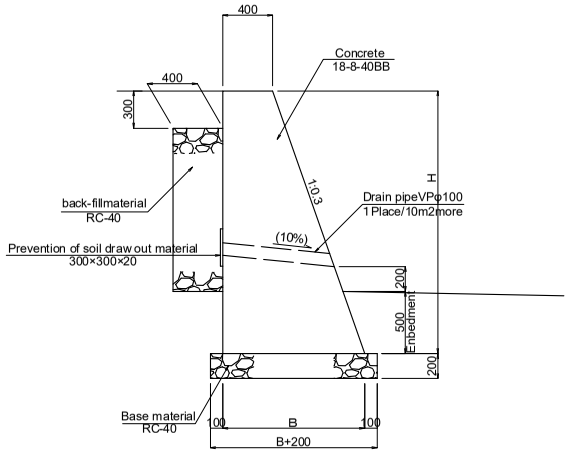


A-A SECTION

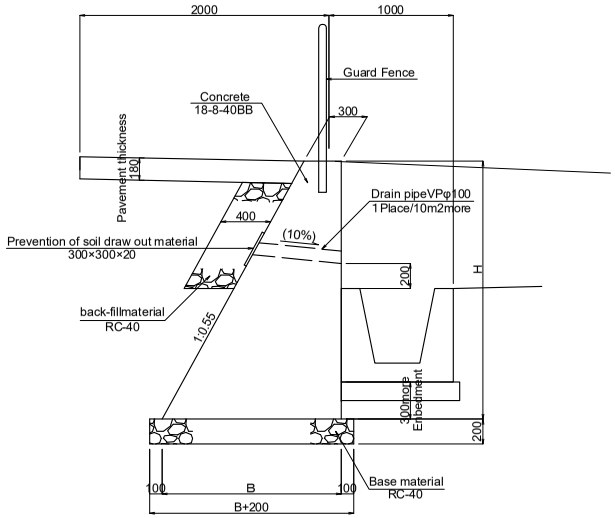
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : ACCESS WAY	Drawing No.	AC-01
				SCALE	S=1/50
				DATE	

RETAINING WALL(1)

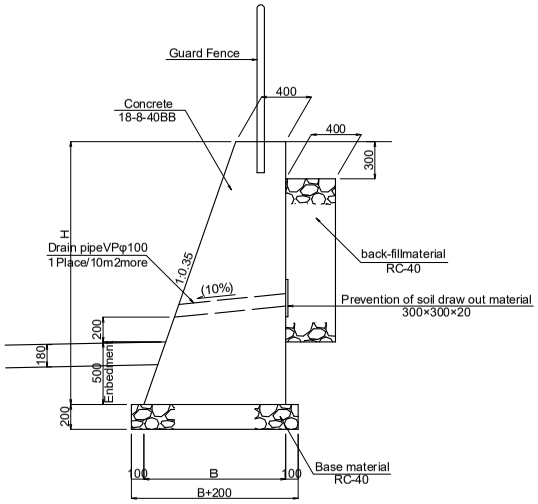
STA.1+460.00~FSTA.1+7.54(L)



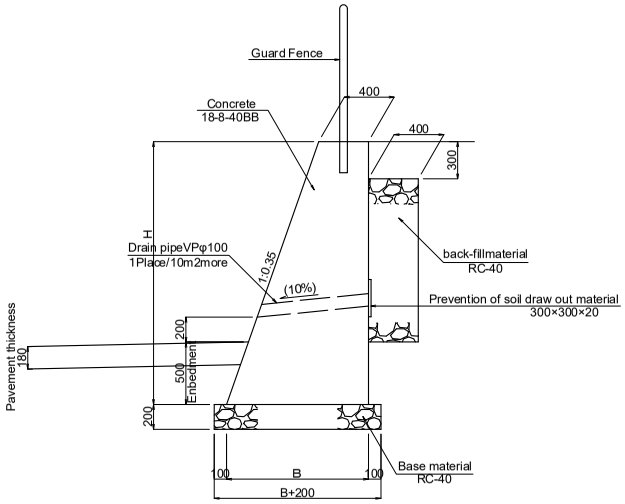
STA.1+603.00~STA.1+760.00(L)



STA.1+953.80~STA.2+092.10(R)



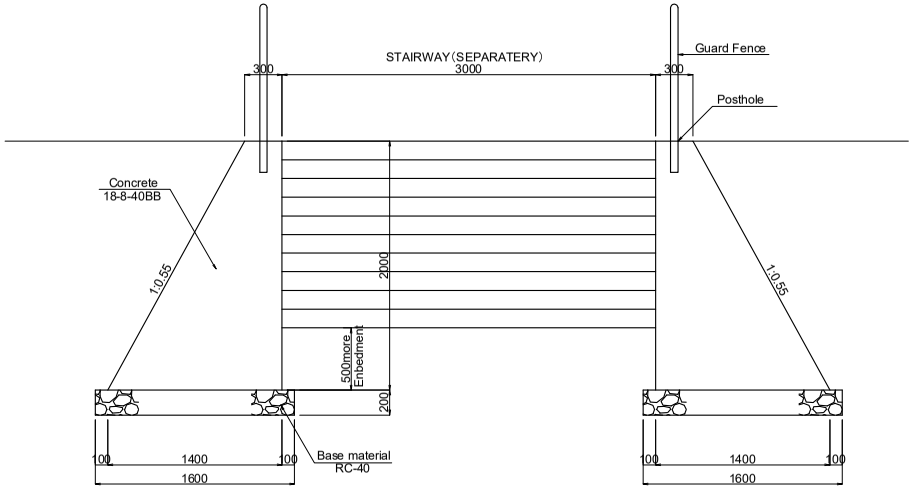
STA.2+095.50~STA.2+149.40(R)



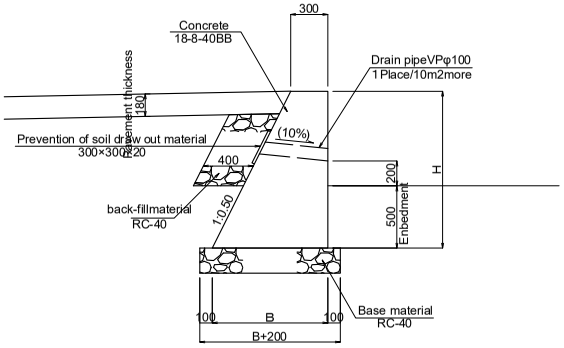
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : RETAINING WALL(1)	Drawing No.	RW-01
				SCALE	S=1/20
				DATE	

RETAINING WALL(2)

STA.2+092.70~STA.2+095.70(R)

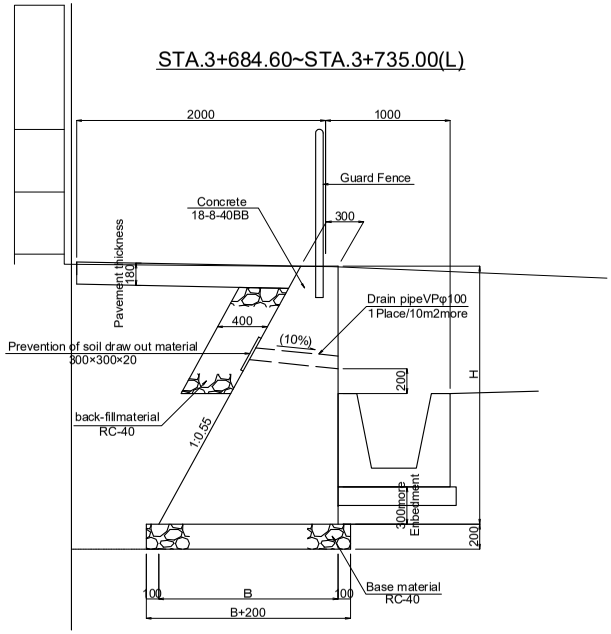


STA.2+371.00~STA.2+418.60(R)



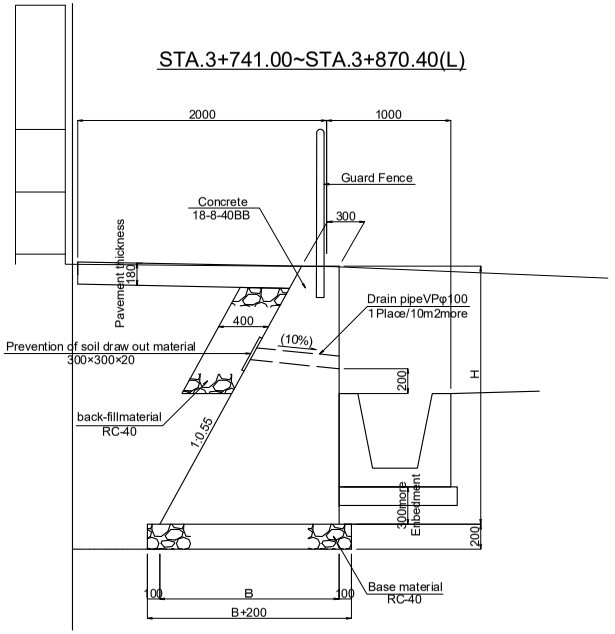
Earth-clipping

STA.3+684.60~STA.3+735.00(L)



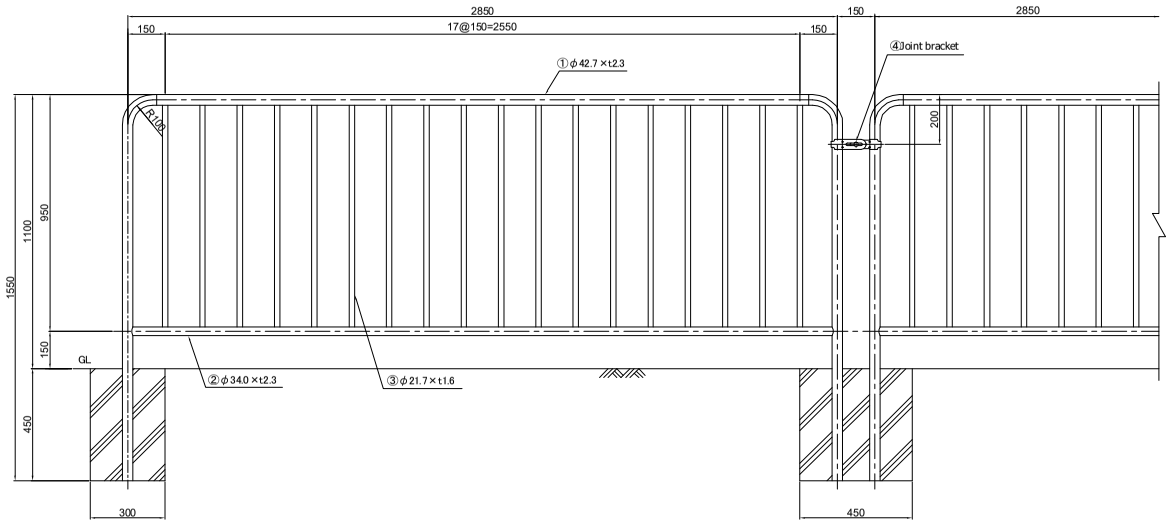
Earth-clipping

STA.3+741.00~STA.3+870.40(L)

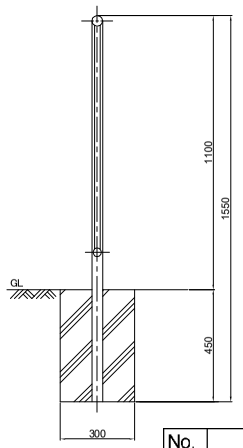


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : RETAINING WALL(2)	Drawing No.	RW-02
				SCALE	S=1/20
				DATE	

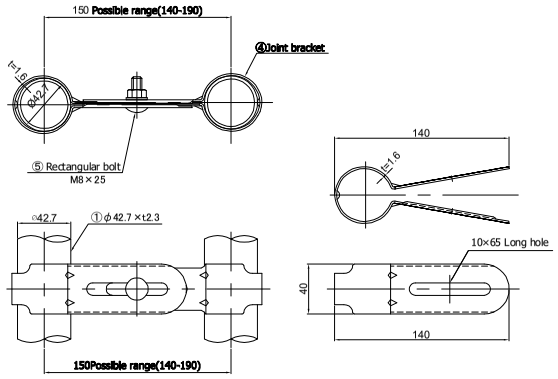
ELEVATION 1/20



SECTION 1/20



Details of Joint bracket 1/4



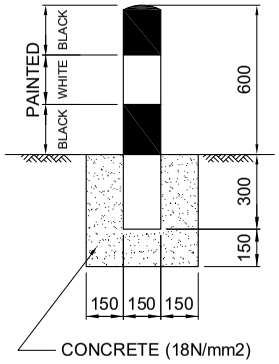
SPECS

No.	Item	Material	Summary
1	Beam pipe	STK400	Zinc plating + Electrostatic powder coating
2	Under beam pipe	STK400	Zinc plating + Electrostatic powder coating
3	Grid pipe	STK400	Zinc plating + Electrostatic powder coating
4	Joint bracket	SGH400	Zinc plating + Electrostatic powder coating
5	Rectangular bolt	240(N/mm2)	Hot dip galvanizing M8x25

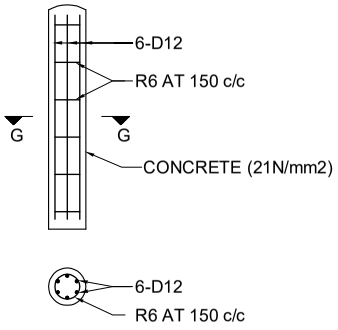
SCHEDULE OF GUARD FENCE

No.	STA.		L(m)	Set
1	1+280 -	1+364	84	28
2	1+430 -	1+510	69	23
3	1+640 -	1+840	201	67
4	1+960 -	2+140	165	55
5	2+460 -	2+510	42	14
6	2+590 -	2+640	45	15
7	2+720 -	2+800	75	25
8	2+890 -	2+950	57	19
9	2+980 -	3+100	114	38
10	3+120 -	3+180	36	12
11	3+210 -	3+310	93	31
12	3+330 -	3+430	90	30
13	3+460 -	3+640	177	59
14	3+880 -	3+950	69	23
Total			1317	416
GF on Embankment				
No.	STA		L(m)	Set
2	1+603 -	1+760	159	53
3	1+961 -	2+092	138	46
4	2+092 -		3	1
5	2+095 -		3	1
6	2+095 -	2+149	48	16
7	3+684 -	3+734	48	16
8	3+748 -	3+868	120	40
Total			519	173

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF GUARD FENCE	Drawing No.	GF-01
				SCALE	AS SHOWN
				DATE	



GUARD POST DETAILS S=1/20

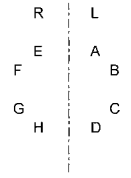


REINFORCEMENT DETAILS S=1/20

SCHEDULE OF GUARD POSTS

GP Intersections

No.	STATION	Type of Intersections	Number of GP								
			L				R				
			A	B	C	D	E	F	G	H	Sub-Total
1	No 1+420	T-IC	3			3	3	3	3		18
2	No 1+535	T-IC	3	3	3	3	3			3	18
3	No 1+870	T-IC	3	3	3		3				12
4	No 1+950	T-IC				3		3	3	3	12
5	No 2+150	T-IC	3	3	3	3	3			3	18
6	No 2+340	X-IC	5	5	5	5	5	5	5	5	40
7	No 2+700	T-IC	3				3	3	3		12
8	No 2+820	T-IC		4	4	3				3	14
9	No 2+965	T-IC	3	3	3	3	3			3	18
10	No 3+110	T-IC	3	3	3	3	3			3	18
11	No 3+190	T-IC	3			3	3	3	3	3	18
12	No 3+325	T-IC	3	3	3	3	3			3	18
13	No 3+450	T-IC	3			3	3			3	12
14	No 3+670	T-IC	3	3	3	3	3			3	18
Sub-Total A											246

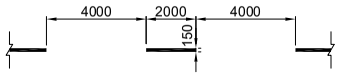


GP Formation of Intersection

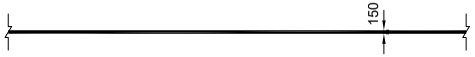
GP Common Area

No.	STATION		SIDE	Number of GP	Remarks
1	1+400	1+470	L	46	
2	1+560	1+600	L	21	
3	1+640	1+700	R	26	
4	1+640	1+720	L	53	
5	1+700	1+820	R	77	
6	1+720	1+860	L	99	
7	1+820	1+880	R	26	
8	2+060	2+080	R	10	Bus Bay
9	2+080	2+100	L	10	Bus Bay
10	2+640	2+650	L	6	
11	2+660	2+700	R	25	
12	2+700	2+760	R	34	
13	2+720	2+780	L	37	
14	2+760	2+860	R	63	
15	2+860	3+100	R	155	
16	2+900	2+940	L	15	Uploading Place
17	2+980	3+020	L	15	Uploading Place
18	3+040	3+060	R	10	Bus Bay
19	3+260	3+280	L	11	Bus Bay
20	3+280	3+300	R	15	Uploading Place
21	3+290	3+320	L	22	Uploading Place
22	3+360	3+420	L	32	
23	3+480	3+520	R	15	Uploading Place
24	3+640	3+660	L	16	
Sub-Total B				839	
Total (A+B)				1085	

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF GUARD POST	Drawing No.	GP-01
				SCALE	AS SHOWN
				DATE	

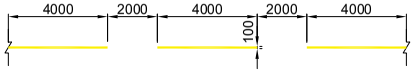


GM1. LANE LINE S=1/200

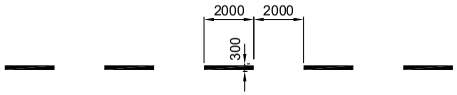


RM1. NO OVERTAKING LINE S=1/200
RM3. CHANNELINZING LINE S=1/200

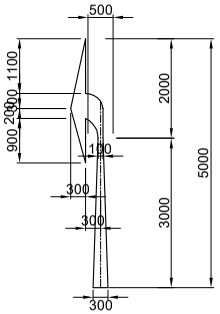
RM4.1. LEFT EDGE LINE S=1/200



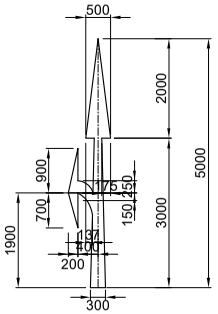
RM13. NO PARKING LINE
(selective times - as shown on secondary message sign to R216)
S=1/200



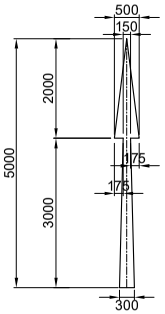
WM2 CONTINUITY LINE S=1/200



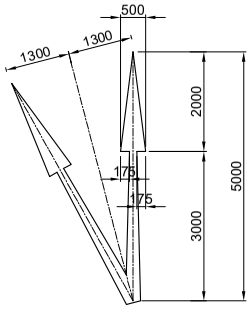
WM7.1. Lane Direction
Arrow (left)
WM7.5. (right)



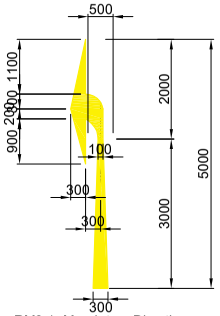
WM7.2. Lane Direction
Arrow (ahead and left)
WM7.4. (ahead and right)



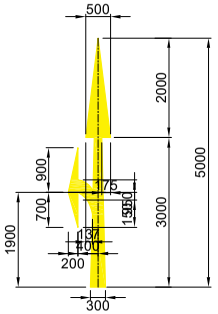
WM7.3. Lane Direction
Arrow (ahead)



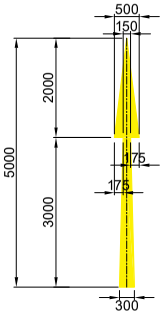
GM3.1. Bifurcation
Arrow (left)
GM3.3. (right)



RM8.1. Mandatory Direction
Arrow (left)
RM8.5. (right)

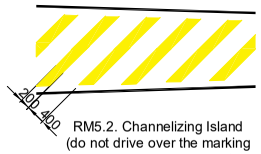


RM8.1. Mandatory Direction
Arrow (ahead and left)
RM8.4. (ahead and right)

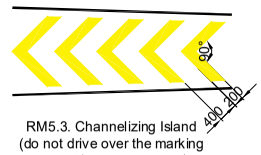


RM8.3. Mandatory Direction
Arrow (ahead)

DIRECTIONAL ARROWS S=1/100

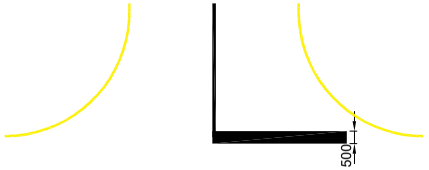


RM5.2. Channelizing Island
(do not drive over the marking
except in an emergency)

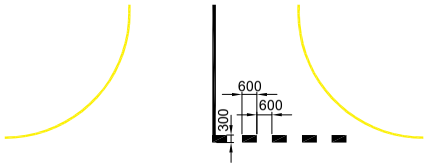


RM5.3. Channelizing Island
(do not drive over the marking
except in an emergency)

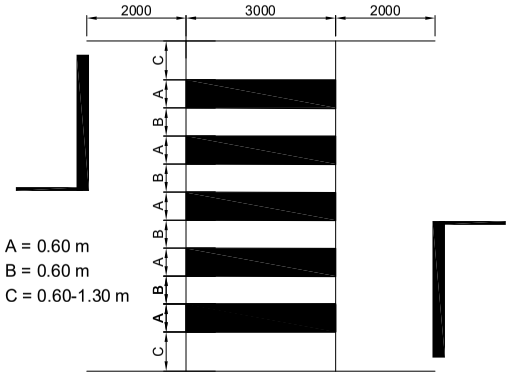
CHANNELIZING ISLAND S=1/50



RTM1 STOP LINE S=1/200

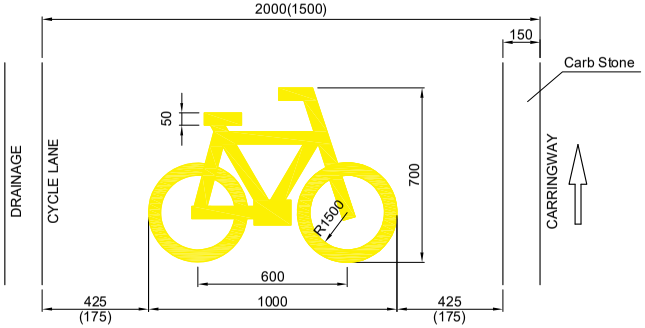


RTM2 GIVE WAY LINE S=1/200



A = 0.60 m
B = 0.60 m
C = 0.60-1.30 m

RTM4. PEDESTRIAN CROSSING
(ZEBRA) MARKINGS S=1/200

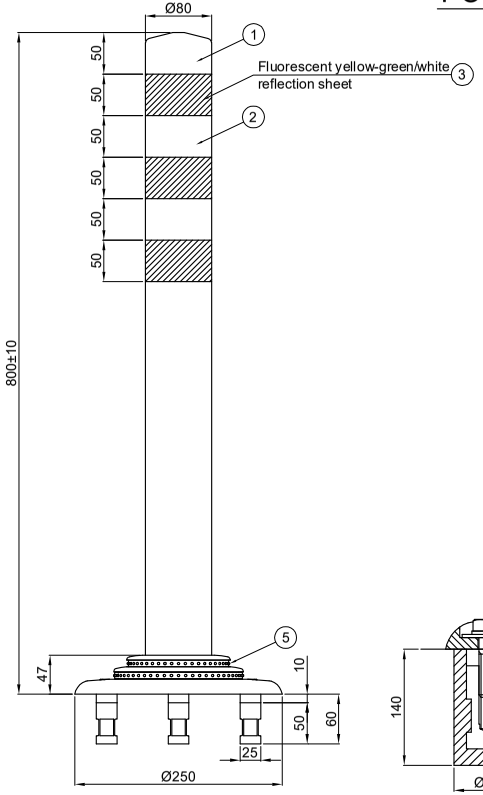


RM17.1. EXCLUSIVE USE LANE
SYMBOL - BICYCLE S=1/50

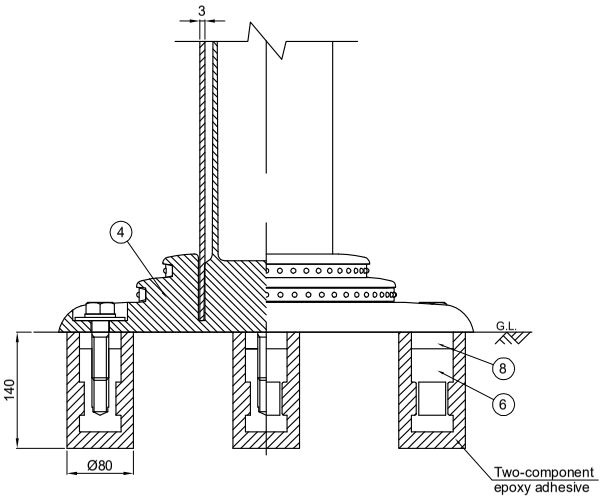
Note: Should be used Malawi standards after consultation with the owner.

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : ROAD MARKING	Drawing No.	RM-01
				SCALE	AS SHOWN
				DATE	

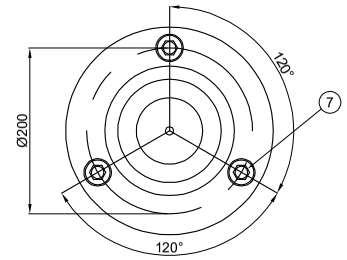
POST CONE



SECTION S=1/6



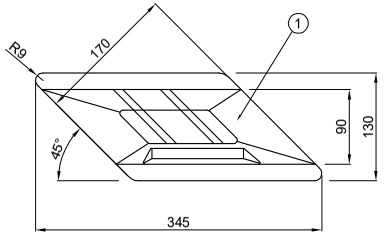
BASE S=1/3



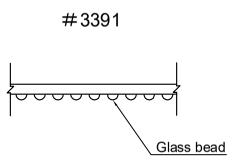
PLAN S=1/6

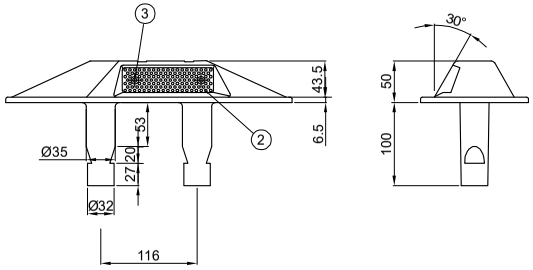
POST CONE				
No.	Items	QTY.	Material	Remarks
1	Cap	1	Special urethane resin	Red Color
2	Main body	1	Special urethane resin	Red Color
3	Reflective material	3	Flexible prism reflection sheet	Fluorescent yellow-green/white
4	Base	1	Special urethane resin	Red Color
5	Reflector	-	Glass beads	White Color
6	Embedded anchor	3	Aluminum alloy	——
7	Mounting bolts	3	Stainless (M10×40)	——
8	Spacer	3	Synthetic rubber	——

STUD



PLAN S=1/6

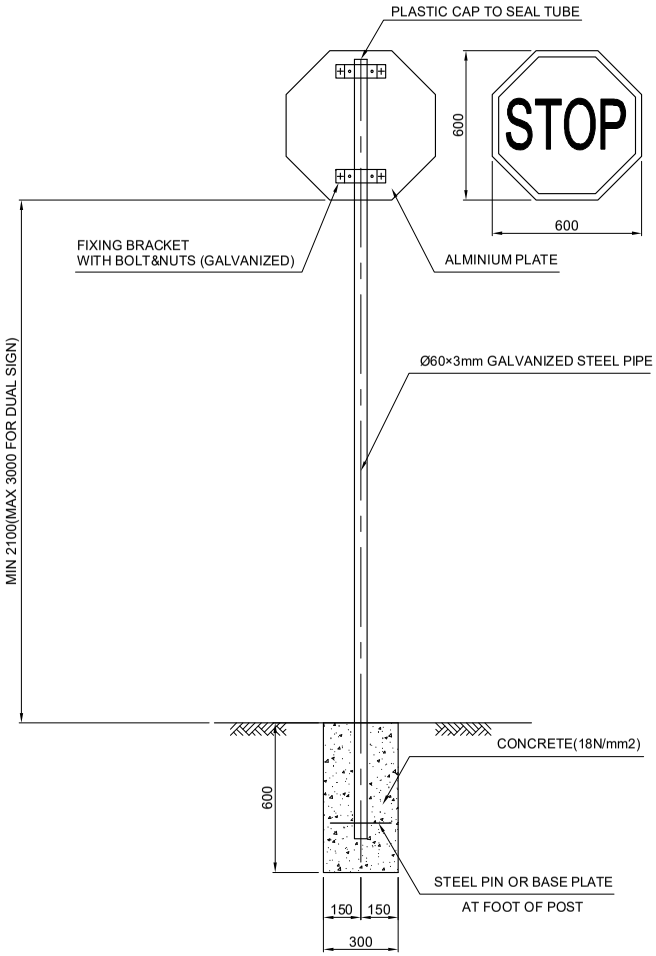




SECTION S=1/6

STUD				
No.	Items	QTY.	Material	Remarks
1	Main body	1	Aluminum alloy	——
2	Reflector	2	Glass bead Ø3.2 aggregate	30×110 (SW3391)
3	Fixing screws	2	SUS	——

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF POST CONE AND STUD	Drawing No. PS-01 SCALE AS SHOWN DATE



Note: Regarding the details, refer to "A Guide to Traffic Signing - Malawi".

DETAIL OF ROAD SIGN S=1/20

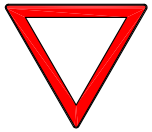
SCHEDULE OF ROAD SIGN

Description	Schedule						Number of Sign Board
R1. STOP	1+640 R	1+690 R	1+725 L	1+820 R	1+860 L	2+735 L	10
	2+865 R	3+370 L	3+450 L	3+645 R			
R2. YIELD	1+325 L	1+395 L	1+660 R	2+280 L	2+280 R	2+405 L	10
	2+435 L	2+655 L	2+755 R	3+765 R			
R3. NO ENTRY	1+860 L	2+865 R					2
R4.1. ONE-WAY (LEFT)	1+860 L	2+735 L	2+865 R				3
R4.3. ONE-WAY (STRAIGHT ON)	1+740 R	1+730 L	3+095 R				3
R110. PEDESTRIANS ONLY	1+405 L	1+405 R	1+435 L	1+435 R	1+500 L	1+500 R	54
	1+560 L	1+560 R	1+840 L	1+840 R	1+895 L	1+940 R	
	1+965 L	1+965 R	2+135 L	2+135 R	2+165 L	2+165 R	
	2+305 L	2+305 R	2+380 L	2+380 R	2+675 L	2+675 R	
	2+725 R	2+750 R	2+765 R	2+810 L	2+835 L	2+835 R	
	2+955 L	2+955 R	2+980 L	2+980 R	3+100 L	3+100 R	
	3+125 L	3+125 R	3+165 L	3+165 R	3+210 L	3+210 R	
	3+310 L	3+310 R	3+335 L	3+335 R	3+415 L	3+430 R	
	3+460 L	3+460 R	3+640 L	3+640 R	3+700 L	3+700 R	
R213. NO U-turn	1+300 L	1+660 R	3+800 R	3+900 L			4
R216. NO PARKING	1+740 R	1+730 L	3+095 R				3
R225. NO MINIBUSES	1+725 L	1+820 R	2+730 L	3+100 R			4
R304. BICYCLE LANE	1+200 L	1+200 R	3+950 L	3+950 R			4
R310-P PARKING AREA FOR MINIBUSES	1+870 L Sharrar Rd.	2+065 R	2+090 L	3+075 R	3+240 L		5
R313-P GOODS VEHICLE PARKING	2+915 L	2+985 L	3+305 R	3+315 L	3+515 R		5
W301. TRAFFIC SIGNALS AHEAD	1+300 L	1+420 R Colby Rd.	1+535 L Paul Kagame Rd.	1+660 R	1+870 L Sharrar Rd.	2+145 L Kenyatta Rd.	13
	2+340 R S124	2+340 R ADD Rd.	2+700 R Wulian SM	3+190 R Malangalanga Rd.	3+665 L Lubani Rd.	3+800 R	
	3+900 L						
W328. ROAD NARROWS BOTH SIDES	1+200 R	3+950 L					2
Total							122

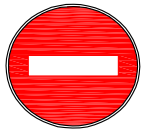
Note: Should be used A Guide to Traffic Signing - Malawi after consultation with the owner.

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : ROAD SIGN (DETAIL AND SCHEDULE)	Drawing No.	RS-01
				SCALE	S=1/20
				DATE	

R1. STOP



R2. YIELD



R3. NO ENTRY

R4.1. ONE-WAY
(LEFT)

R4.3. ONE-WAY
(STRAIGHT ON)

R110. PEDESTRIANS
ONLY

R213. NO U-turn

R216. NO PARKING

R225. NO MINIBUSES

R304. BICYCLE LANE

R310-P. PARKING AREA
FOR MINIBUSES

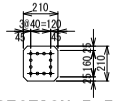
R313-P. GOODS VEHICLE
PARKING

W301. TRAFFIC SIGNALS
AHEAD

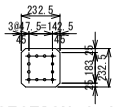
W328. ROAD NARROWS
BOTH SIDES

Note: Should be used Kenyan standards after consultation with the owner.

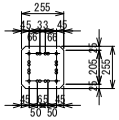
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : ROAD SIGN (TYPE)	Drawing No.	RS-02
				SCALE	NO SCALE
				DATE	



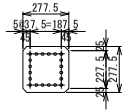
SECTION 5-5
S=1/30



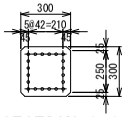
SECTION 4-4
S=1/30



SECTION 3-3
S=1/30

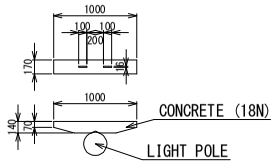


SECTION 2-2
S=1/30

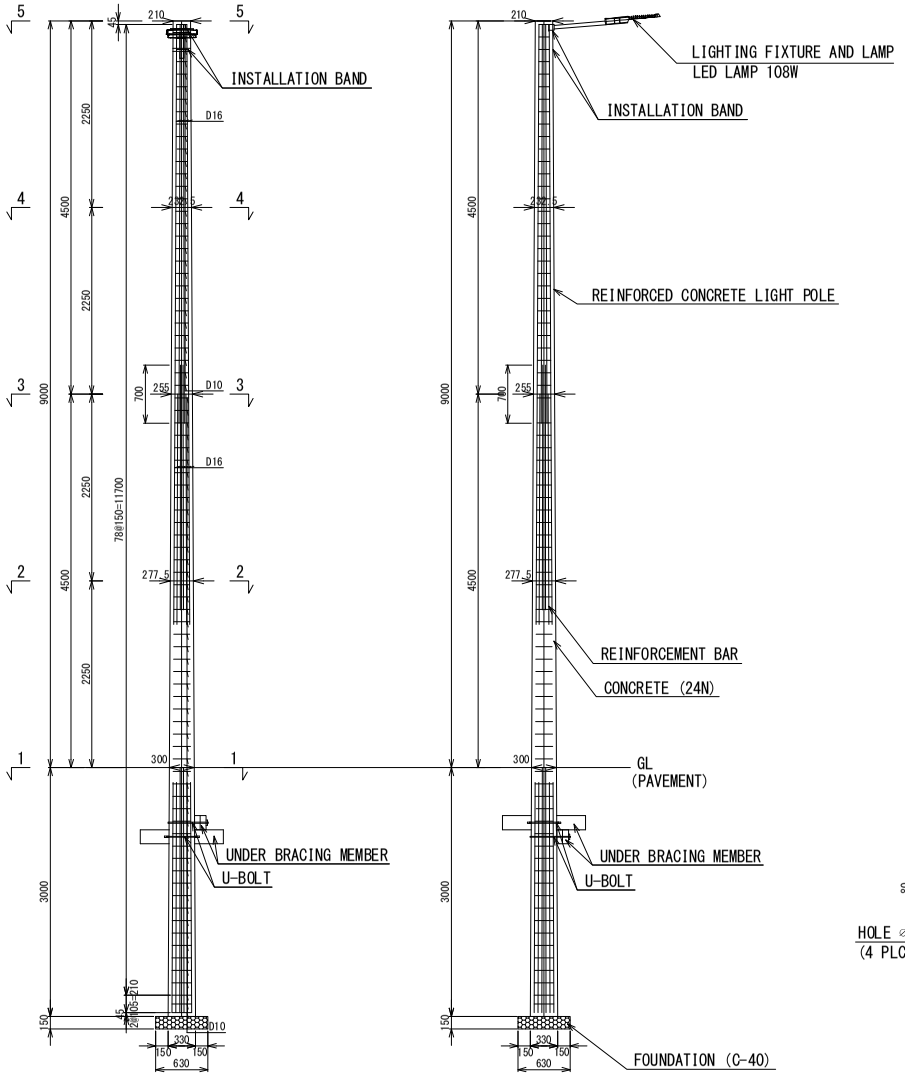


SECTION 1-1
S=1/30

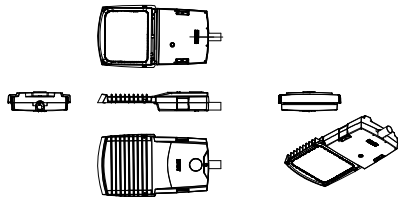
U-BOLT



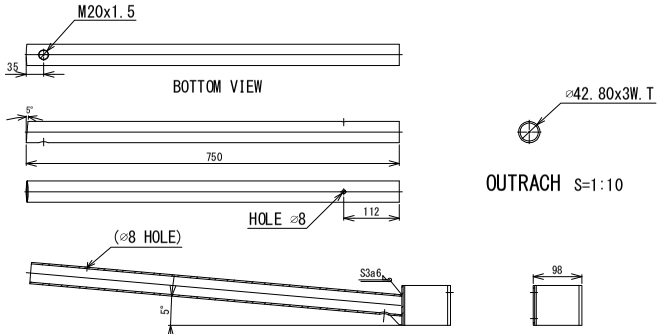
UNDER BRACING MEMBER S=1/60

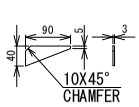


CONCRETE POLE S=1/60

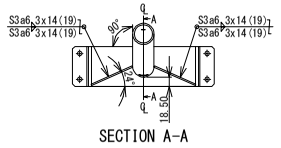


LED Head Light

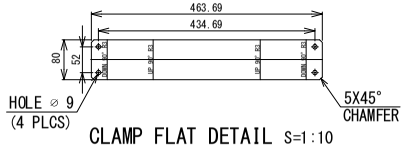




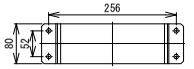
GUSSET S=1:10

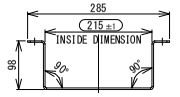


SECTION A-A



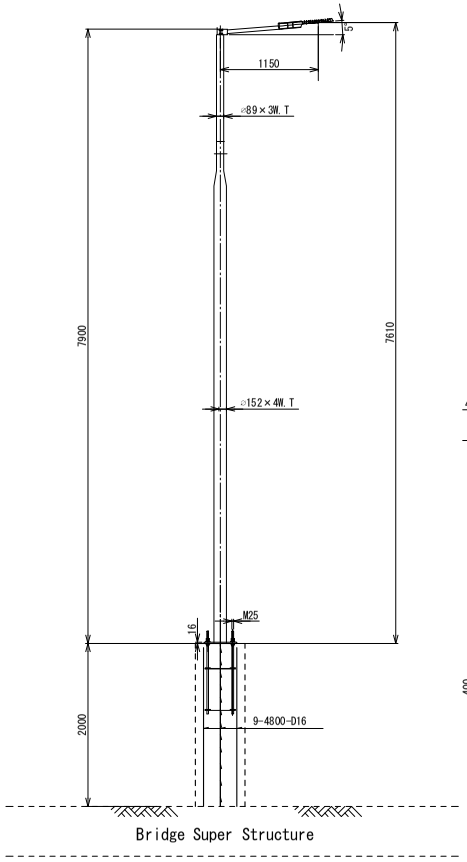
CLAMP FLAT DETAIL S=1:10





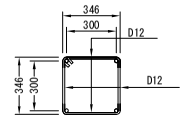
CLAMP FOLDED S=1:10

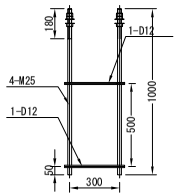
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: DETAIL OF STREET LIGHT	Drawing No.	SL-01
				SCALE	AS SHOWN
				DATE	



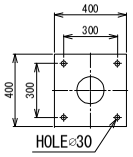
Steel Pole For Bridge

Anchor bolt





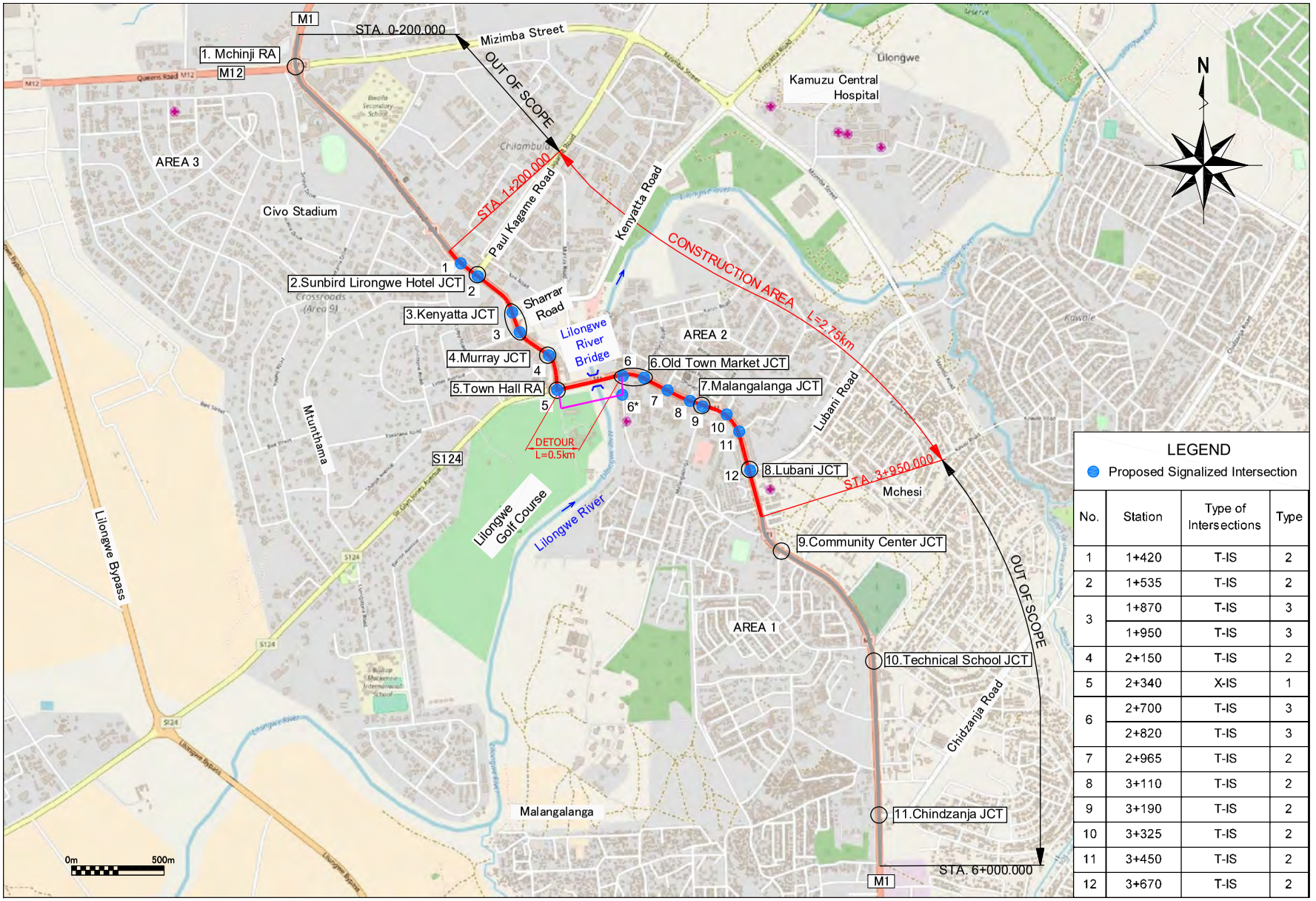
Base Plate



SCHEDULE OF STREET LIGHTS

	Distance	L	R	Distance		Distance	L	R	Distance
	-	1+200	1+200	-		50	2+640	2+640	50
	50	1+250	1+250	50		50	2+690	2+690	50
	50	1+300	1+300	50	IS 7	15	2+705	2+710	20
	50	1+350	1+350	50		10	2+715		
	40	1+390	1+390	40		35	2+750	2+750	40
IS 1	30	1+420	1+410	20		50	2+800	2+800	50
			1+430	20	IS 8	15	2+815	2+820	20
	50	1+470	1+470	40		10	2+825		
	30	1+500	1+500	30		30	2+855	2+855	35
IS 2	20	1+520	1+535	35		50	2+905	2+905	50
	30	1+550				30	2+935	2+935	30
	35	1+585	1+585	50	IS 9	25	2+960	2+965	30
	50	1+635	1+635	50		10	2+970		
	50	1+685	1+685	50		45	3+015	3+015	50
	50	1+735	1+735	50		50	3+065	3+065	50
	50	1+785	1+785	50	IS 10	30	3+095	3+095	30
	50	1+835	1+835	50		25	3+120	3+120	25
IS 3	25	1+860	1+870	35		30	3+150	3+150	30
	20	1+880			IS 11	38	3+188	3+178	28
	40	1+920	1+920	50				3+198	20
IS 4	30	1+950	1+945	25		50	3+238	3+238	40
			1+955	10		50	3+288	3+288	50
	50	2+000	2+000	45	IS 12	27	3+315	3+320	32
	50	2+050	2+050	50		10	3+325		
	50	2+100	2+100	50		45	3+370	3+370	50
IS 5	40	2+140	2+150	50		50	3+420	3+420	50
	20	2+160			IS 13	15	3+435	3+445	25
	40	2+200	2+200	50		20	3+455		
	50	2+250	2+250	50		40	3+495	3+495	50
	50	2+300	2+300	50		50	3+545	3+545	50
IS 6	20	2+320	2+320	20		50	3+595	3+595	50
	40	2+360	2+360	40		40	3+635	3+635	40
	20	2+380	2+380	20	IS 14	15	3+650	3+665	30
	50	2+430	2+430	50		30	3+680		
	50	2+480	2+480	50		35	3+715	3+715	50
Bridge	32	2+512	2+512	32		50	3+765	3+765	50
	26	2+538	2+538	26		50	3+815	3+815	50
	26	2+564	2+564	26		50	3+865	3+865	50
	26	2+590	2+590	26		50	3+915	3+915	50
						35	3+950	3+950	35
S-Total		37	36		S-Total		38	33	
					S-Total		75	69	
					Total		144		

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF STREET LIGHT	Drawing No. SL-02
				SCALE S=1/60
				DATE

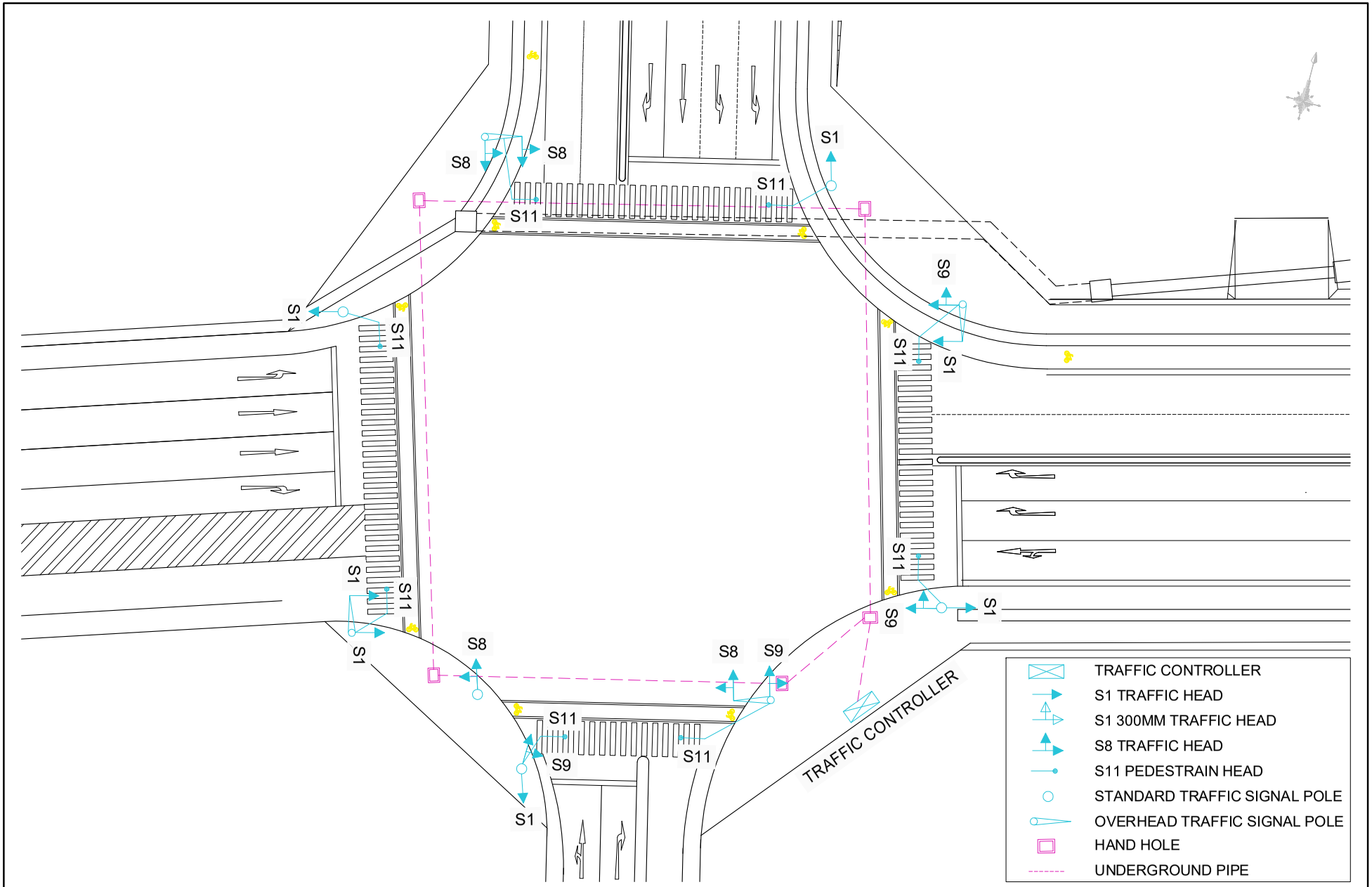


LEGEND

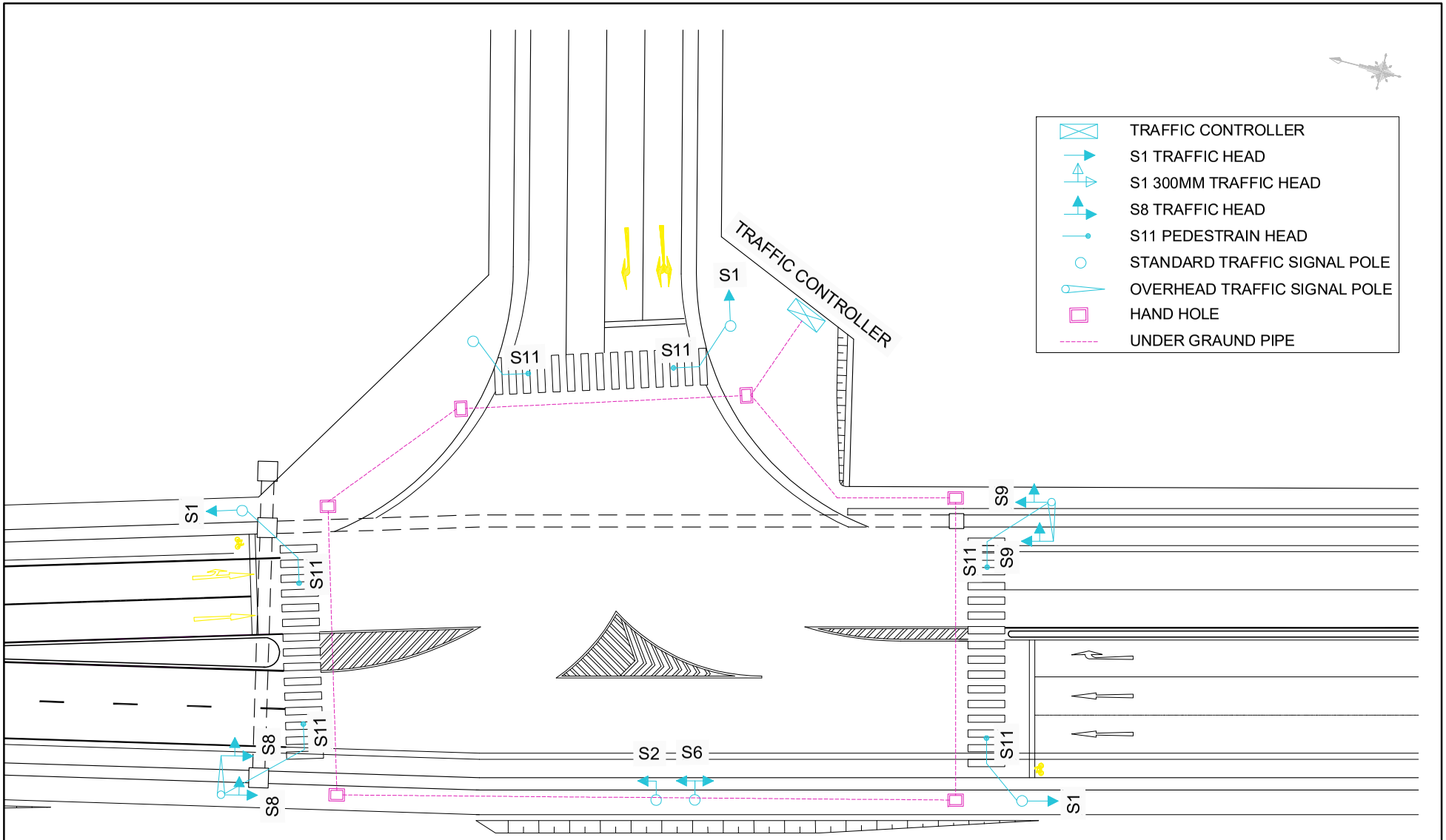
Proposed Signalized Intersection

No.	Station	Type of Intersections	Type
1	1+420	T-IS	2
2	1+535	T-IS	2
3	1+870	T-IS	3
	1+950	T-IS	3
4	2+150	T-IS	2
5	2+340	X-IS	1
6	2+700	T-IS	3
	2+820	T-IS	3
7	2+965	T-IS	2
8	3+110	T-IS	2
9	3+190	T-IS	2
10	3+325	T-IS	2
11	3+450	T-IS	2
12	3+670	T-IS	2

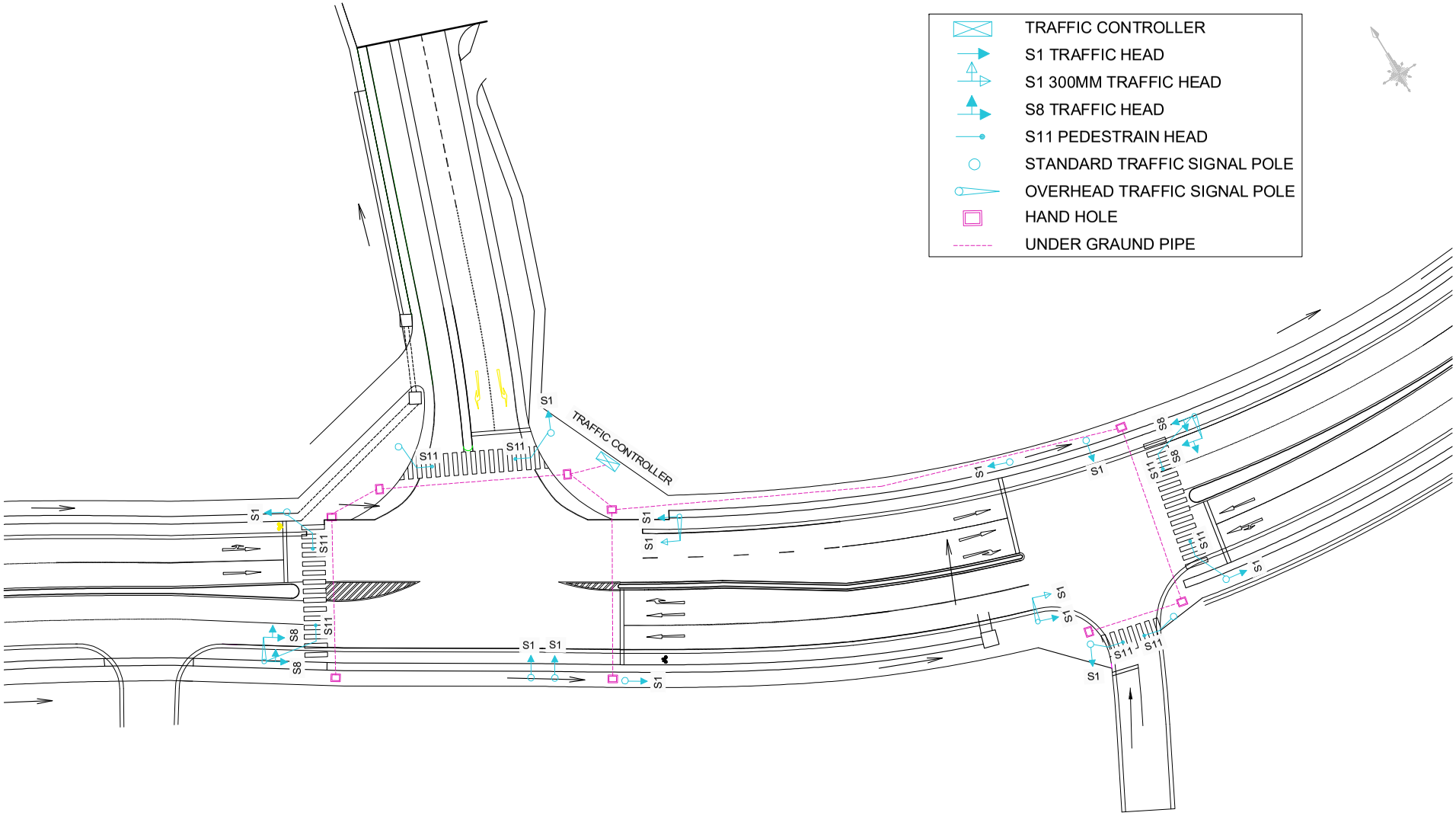
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LAYOUT OF TRAFFIC SIGNAL	Drawing No.	TP-01
				SCALE	S=1/20
				DATE	



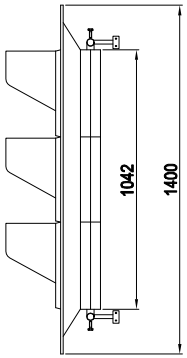
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TRAFFIC SIGNAL PLAN（TYPE-1） (NO.2+400-NO.2+700)	Drawing No.	TP-02
				SCALE	S=1/300
				DATE	

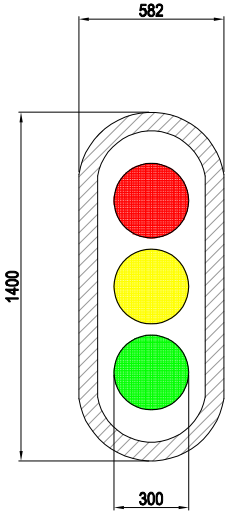


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TRAFFIC SIGNAL PLAN (TYPE-2) (NO.3+600-NO.3+900)	Drawing No.	TP-03
				SCALE	S=1/300
				DATE	

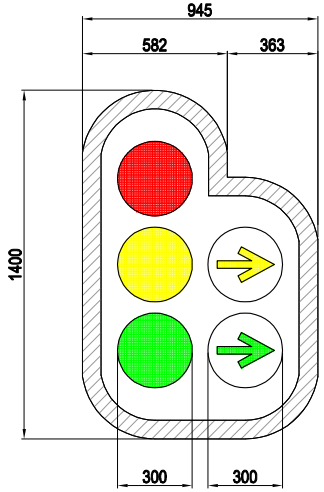


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TRAFFIC SIGNAL PLAN (TYPE-3) (NO.1+800-NO.2+100)	Drawing No.	TP-04
				SCALE	S=1/500
				DATE	

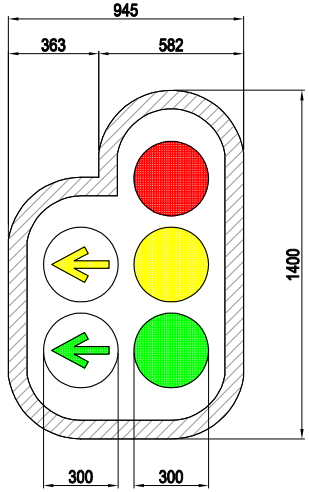




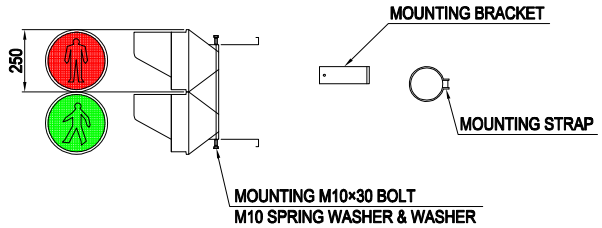
2 - S1
SCALE 1/20



3 - S8
SCALE 1/20

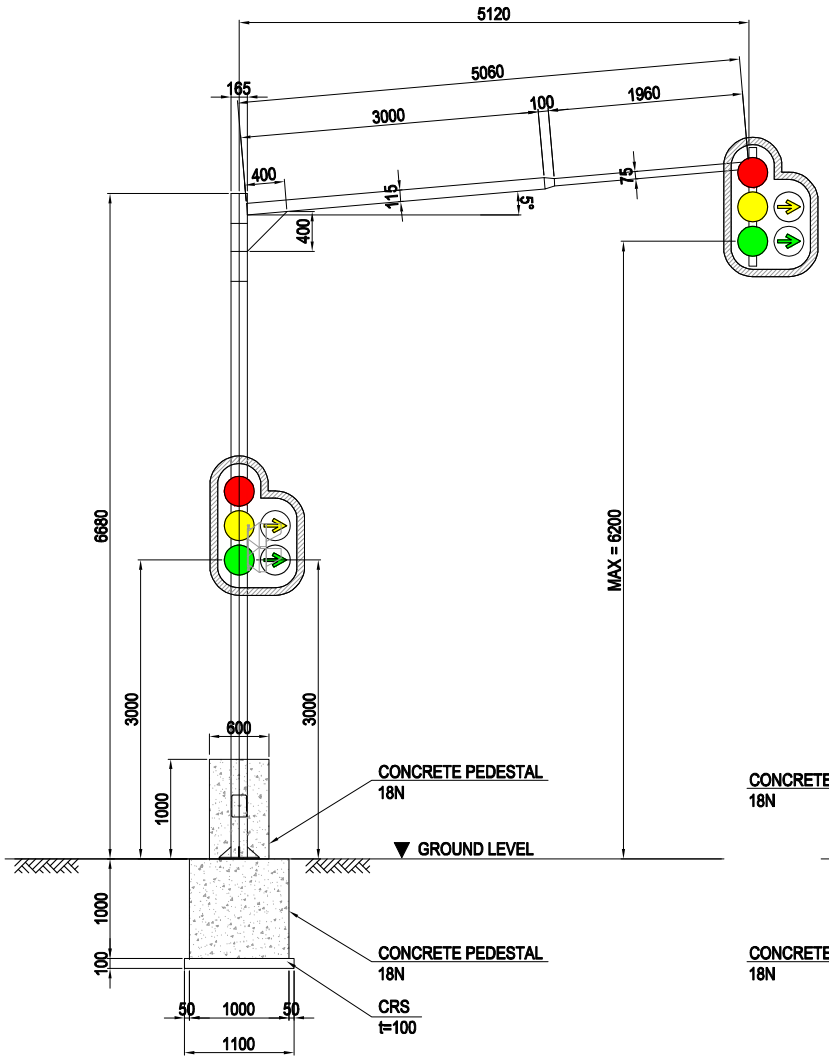


4 - S9
SCALE 1/20

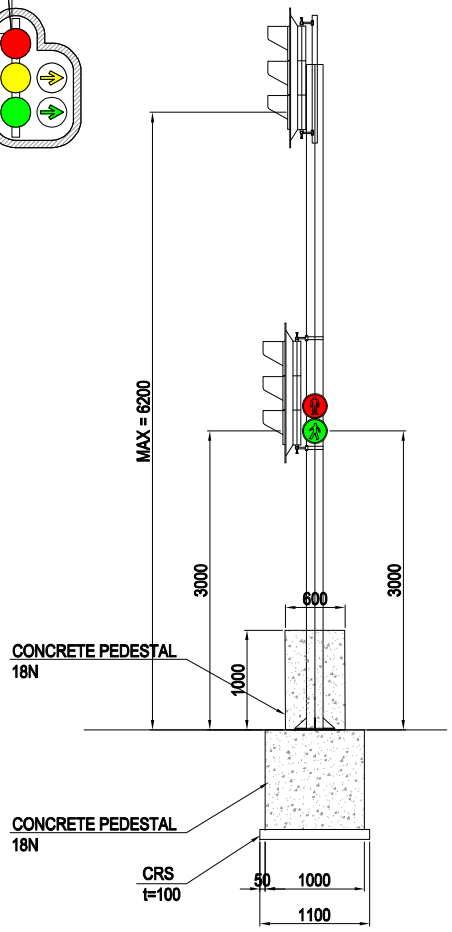


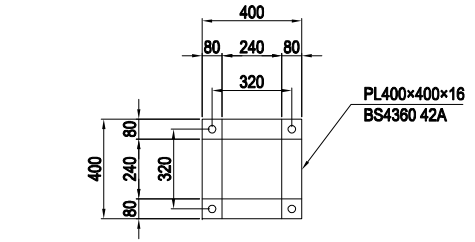
5 - S11
SCALE 1/20

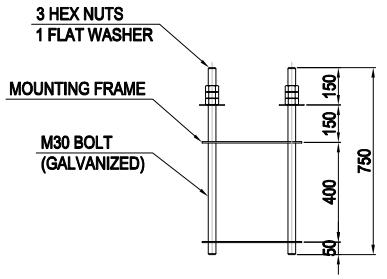
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF TRAFFIC SIGNAL(1)	Drawing No.	TS-01
				SCALE	AS SHOWN
				DATE	



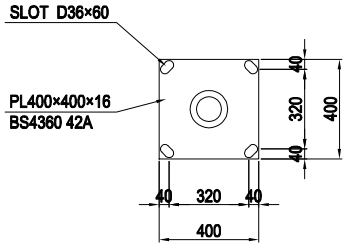
1 - CANTILEVER POLE
SCALE 1/50





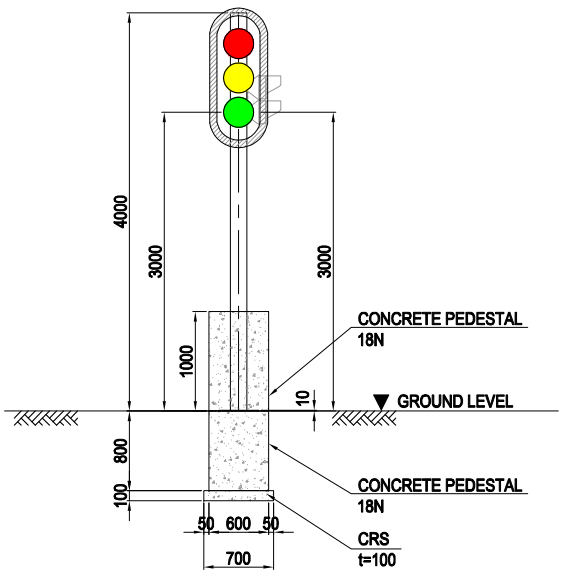


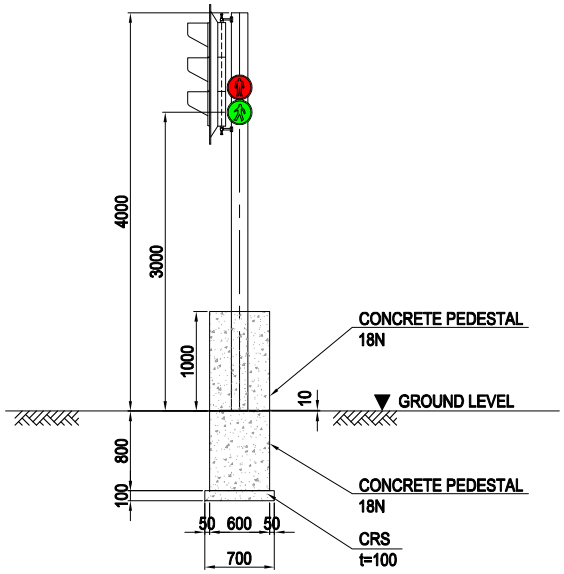
2 - DETAIL OF ANCHOR BOLT
SCALE 1/20



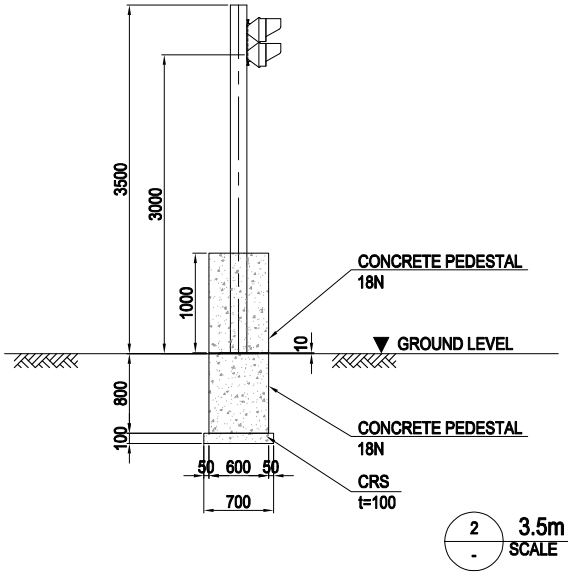
3 - DETAIL OF BASE PLATE
SCALE 1/20

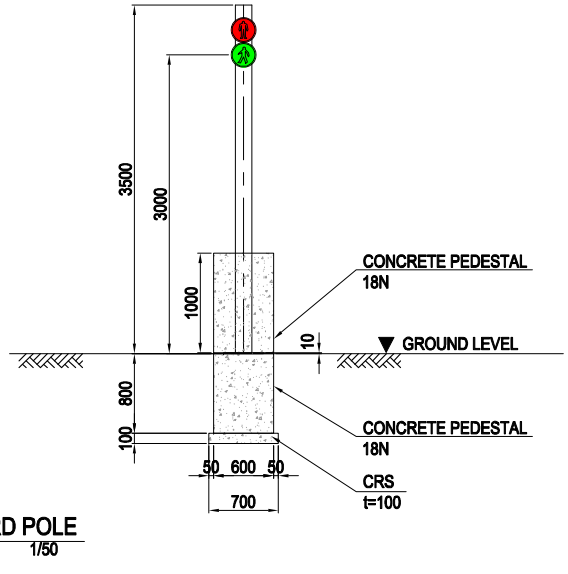
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF TRAFFIC SIGNAL (2)	Drawing No.	TS-02
				SCALE	AS SHOWN
				DATE	



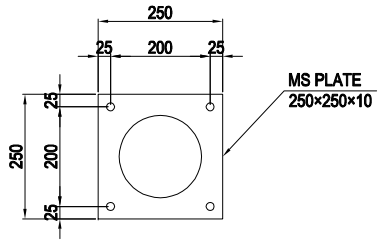


2 - 4.0m STANDARD POLE
SCALE 1/50

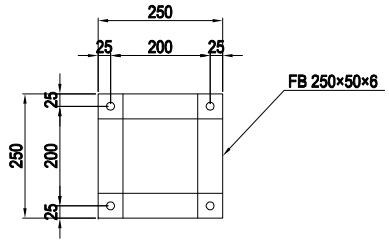


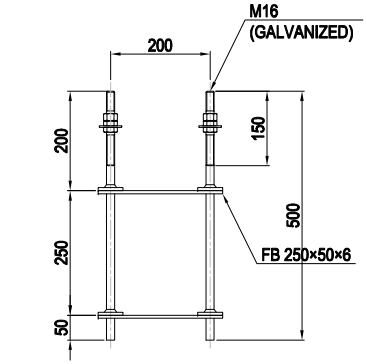


2 - 3.5m STANDARD POLE
SCALE 1/50



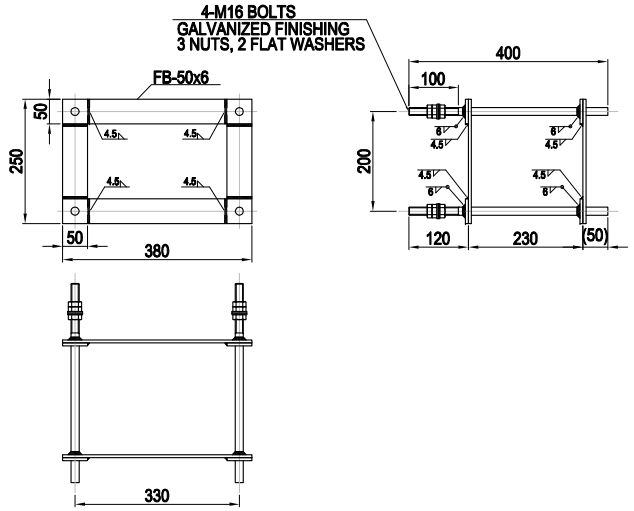
3 - DETAIL OF BASE PLATE
SCALE 1/10



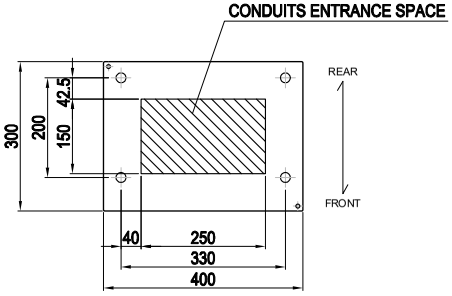


4 - DETAIL OF ANCHOR BOLT
SCALE 1/10

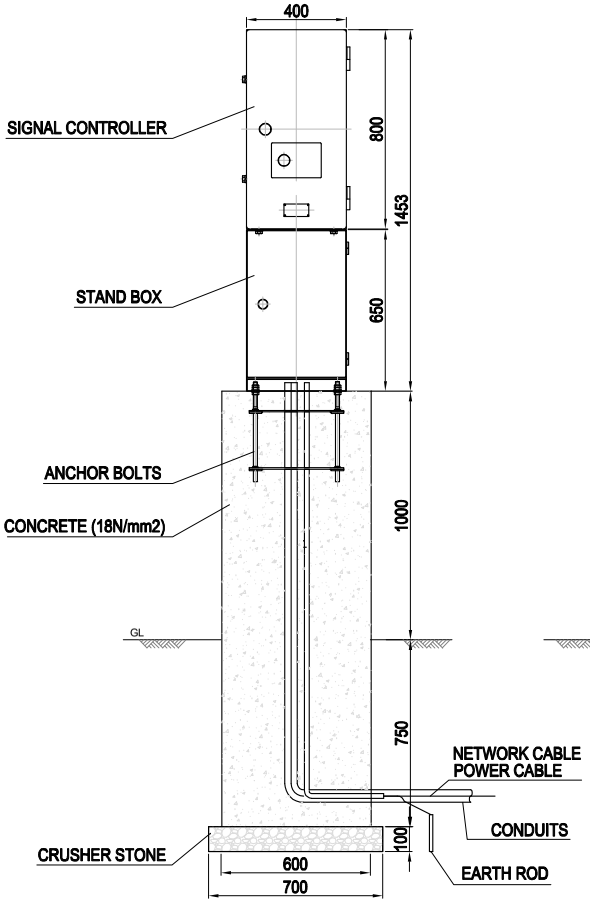
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF TRAFFIC SIGNAL (3)	Drawing No.	TS-03
				SCALE	AS SHOWN
				DATE	



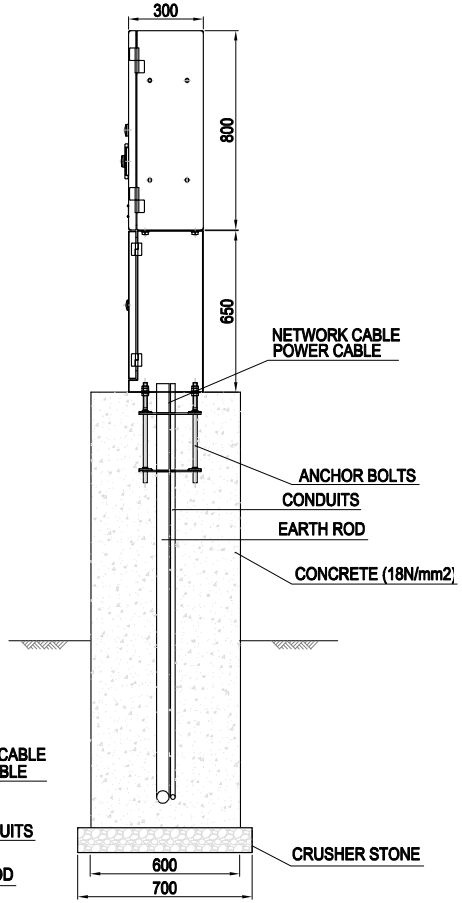
DETAIL OF ANCHOR BOLTS S=1/10



DETAIL OF BOTTOM S=1/10



FRONT VIEW S=1/20



SIDE VIEW S=1/20

【Specification】

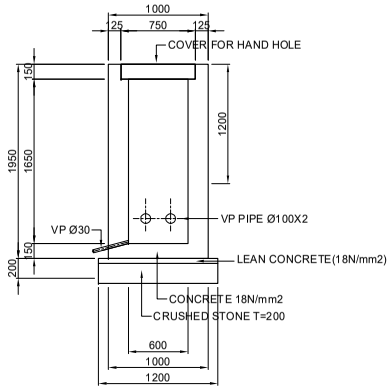
(1) Input requirement AC187～253V, 50/60 Hz
(2) Ambient temperature －20～＋60℃
(3) Relative humidity 40～ 90%
(4) Dimensions 300mm(W) ×200mm (D) × 800mm (H)
Remove heat block boards
(5) Weight Not more than 55kg
(6) No. of steps Maximum 24
(7)No. of light outputs Maximum 24
(vehicle:12, pedestrian:8, arrow-mark:4)
(8)Light output capacity
- 500W per light output
- 1kW per unit
- Maximum output capacity 2kW

【Main functions】

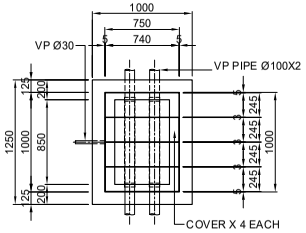
Clock control (date, time)
RECALL function
Fail-safe control
GAP RESPONSIVE function
COORDINATED function
AUTONOMOUS DISTRIBUTED CONTROL-functio

DIAGRAM S=NONE

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF TRAFFIC SIGNAL (4)	Drawing No.	TS-04
				SCALE	AS SHOWN
				DATE	

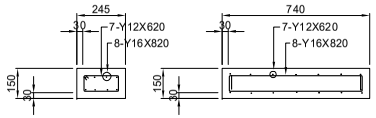


ELEVATION

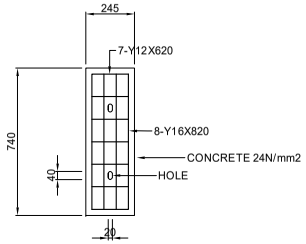


PLAN

HAND HOLE (HH)
S=1/50



SECTION ELEVATION



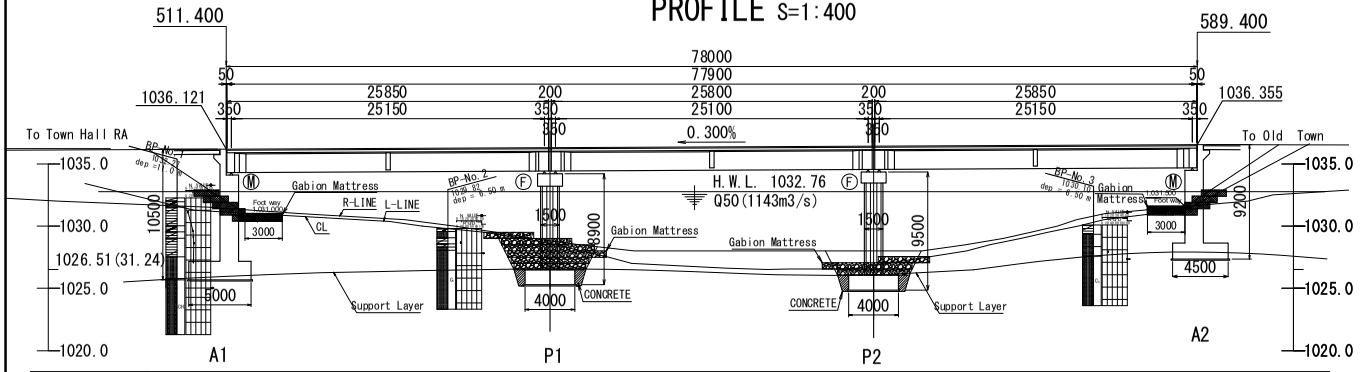
PLAN

COVER FOR HAND HOLE
S=1/25

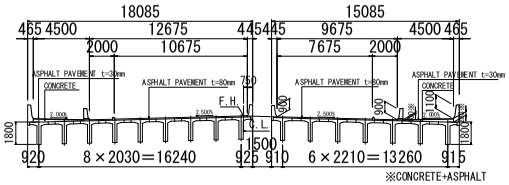
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : HAND HOLE (HH)	Drawing No.	HH-01
				SCALE	AS SHOWN
				DATE	

BRIDGE GENERAL DRAWING

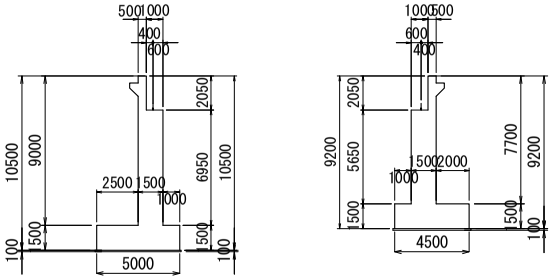
PROFILE S=1:400



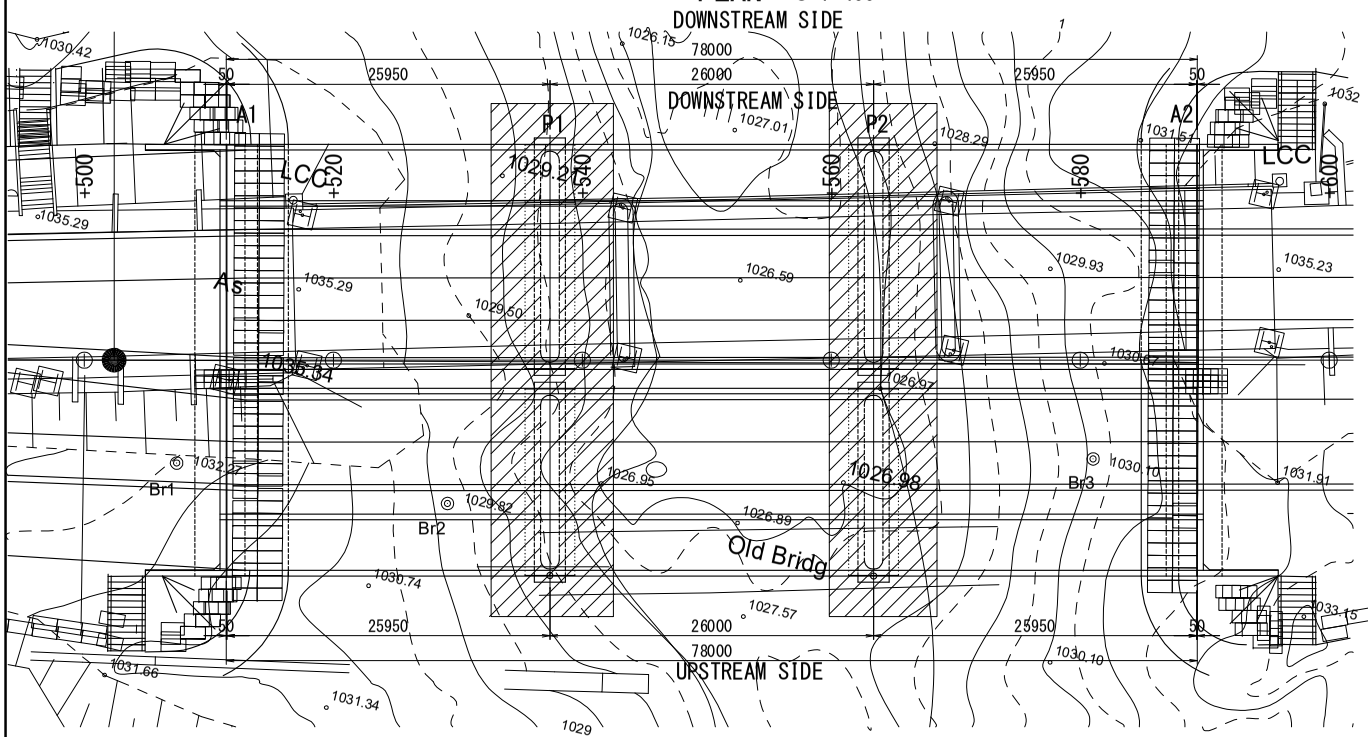
CROSS SECTION S=1:400



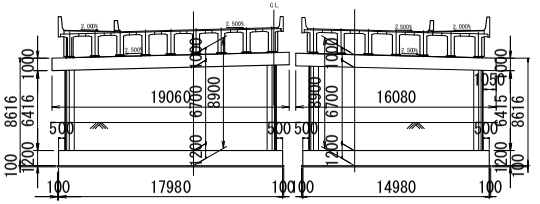
A1, A2 ABUTMENT S=1:300



PLAN S=1:400

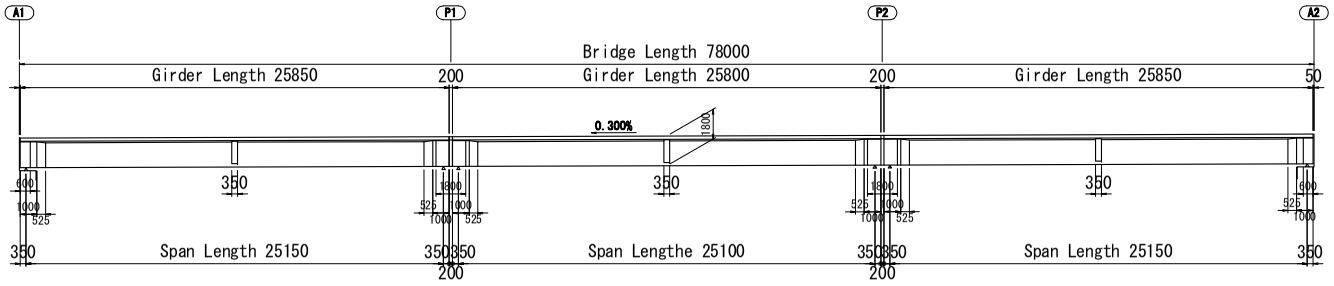


P1 PIER S=1:400

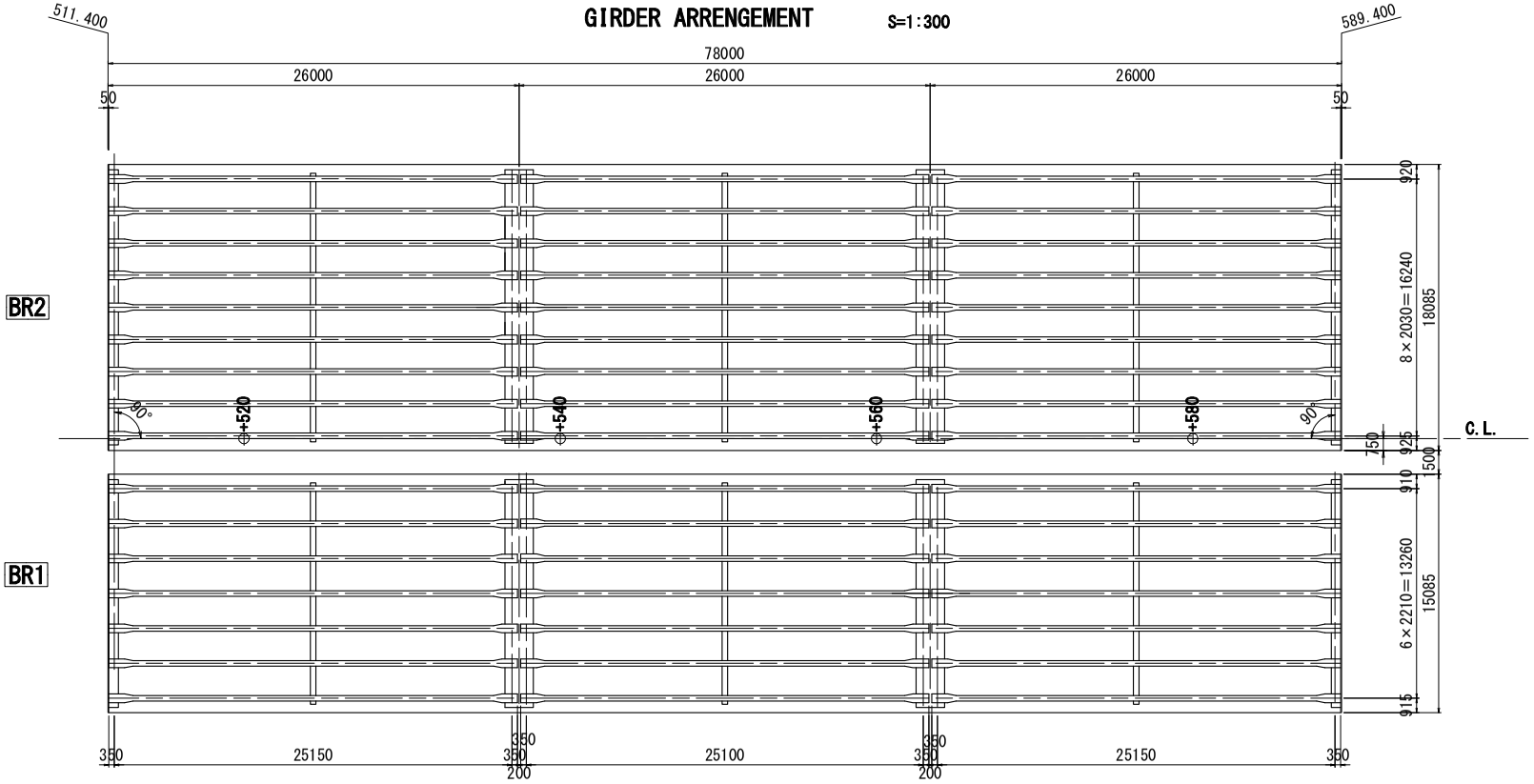


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: BRIDGE GENERAL DRAWING	Drawing No.	BR-01
				SCALE	AS SHOWN
				DATE	

SUPERSTRUCTURE (1) S=1:300



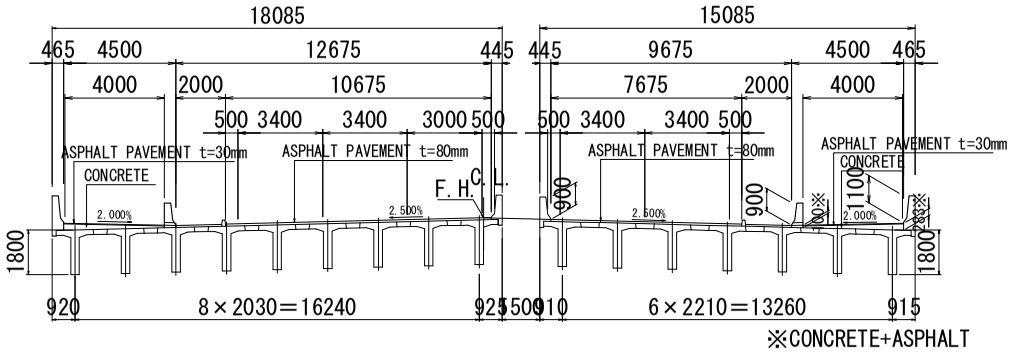
GIRDER ARRENGEMENT S=1:300



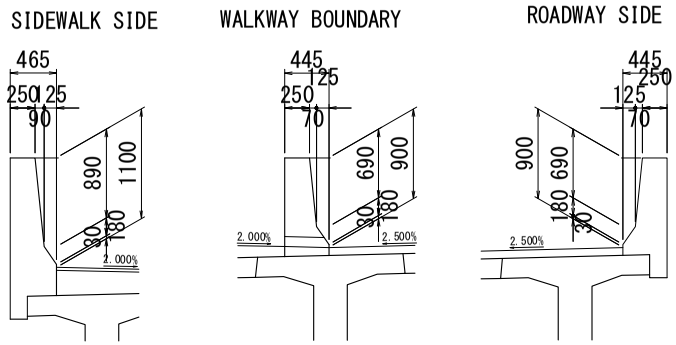
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : SUPERSTRUCTURE (1)	Drawing No.	BR-02
				SCALE	S=1/300
				DATE	

SUPER STRUCTURE (2)

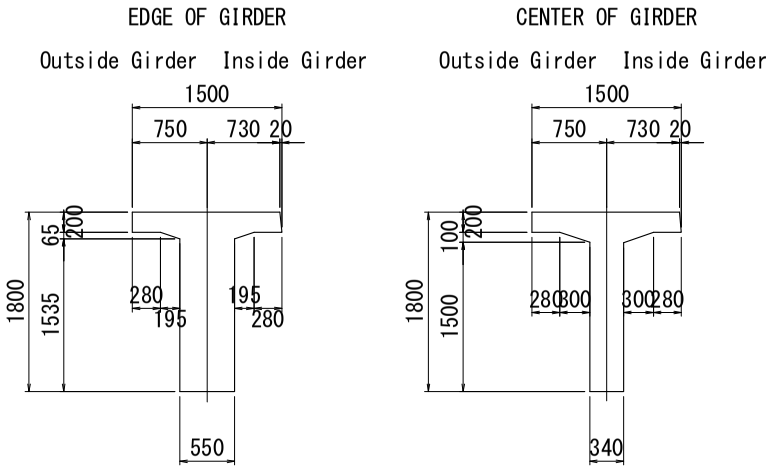
CROSS SECTION S=1:200



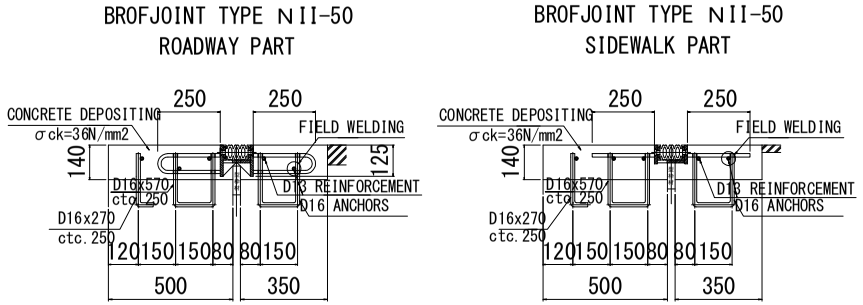
DETAIL OF PROTECTIVE WALL S=1:50



MAIN GIRDER CROSS SECTION S=1:50



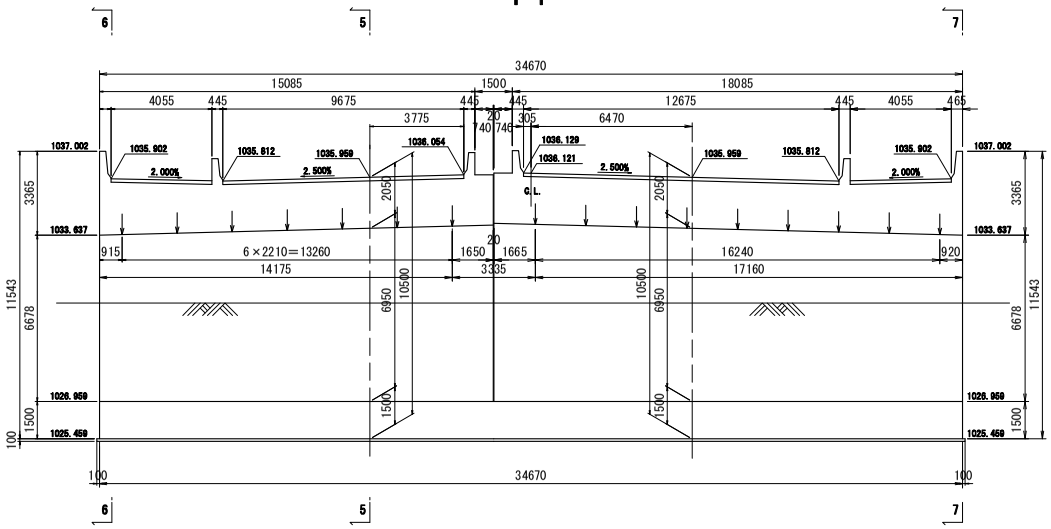
DETAIL OF EXPANSION JOINT S=1:20



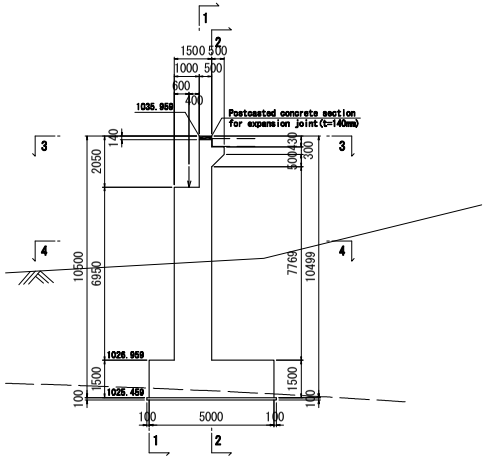
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: SUPERSTRUCTURE (2)	Drawing No.	BR-03
				SCALE	AS SHOWN
				DATE	

SUBSTRUCTURE A1 (1) S=1:200

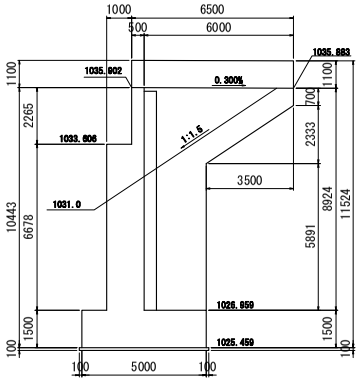
1-1



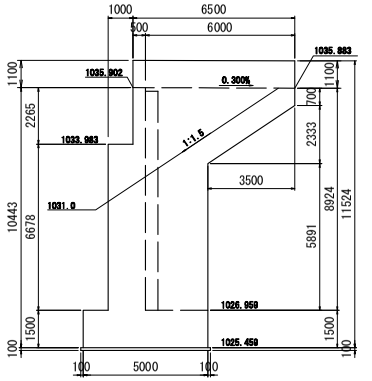
5-5



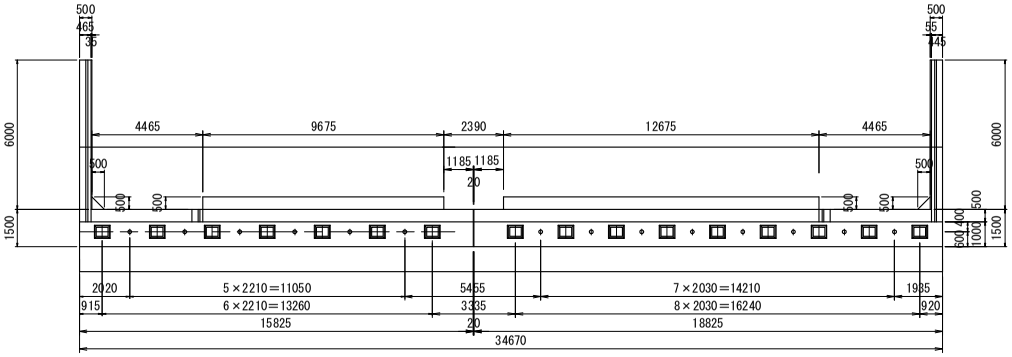
6-6



7-7



3-3

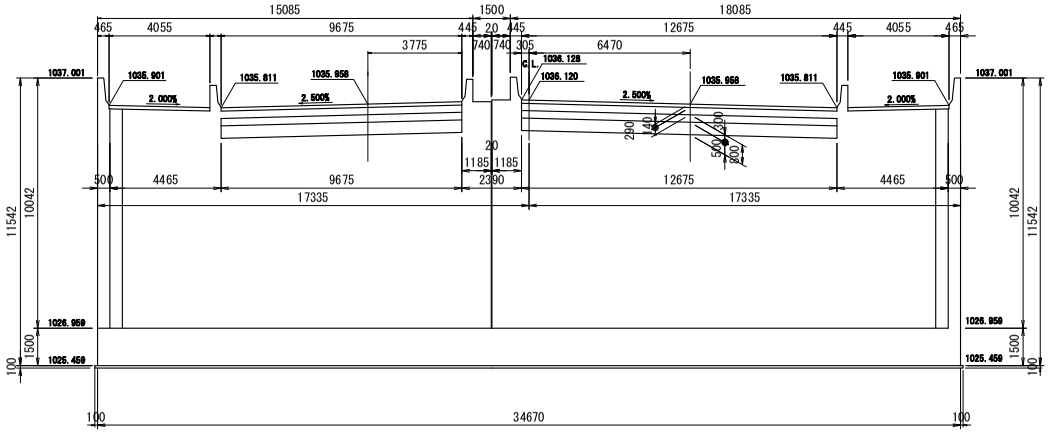


2-120

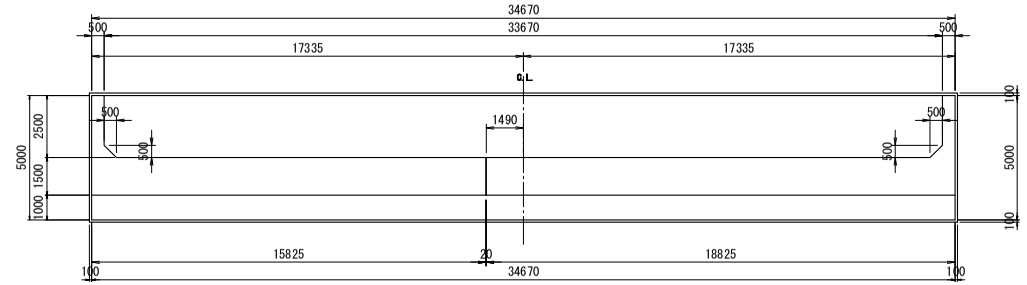
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : SUBSTRUCTURE A1(1)	Drawing No.	BR-04
				SCALE	S=1/200
				DATE	

SUBSTRUCTURE A1 (2) S=1:200

2-2

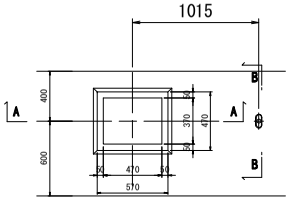


4-4

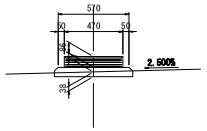


DETAIL OF BEARING S=1:40

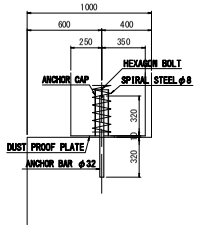
PLAN



A-A



B-B



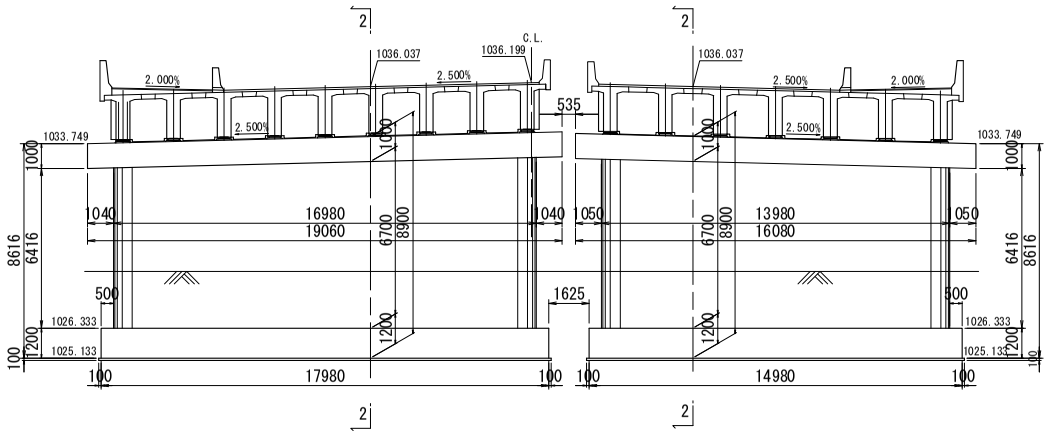
Material

No.	Name	Dimension	Sign	Qty.	Weight(kg)	Note
1	RUBBER BEARING	470×370×86	NR+SS400	16	—	t_r=10mm×4
②	ANCHOR BAR	φ32×650	SS400	14	57.4	
③	ANCHOR CAP	111×50×370	SGP80A	14	45.5	
④	SPIRAL STEEL	φ8×3400	—	14	16.8	
5	DUST PROOF PLATE	200×100×10	Rubber	14	—	
⑥	HEXAGON BOLT	M8×60	—	14	—	
Hot - dip Zinc galvanizing		Galvanizing parts with ◯ on its label				
		Adhesion amount 550g/m² above, 350g/m² bove for bolt				

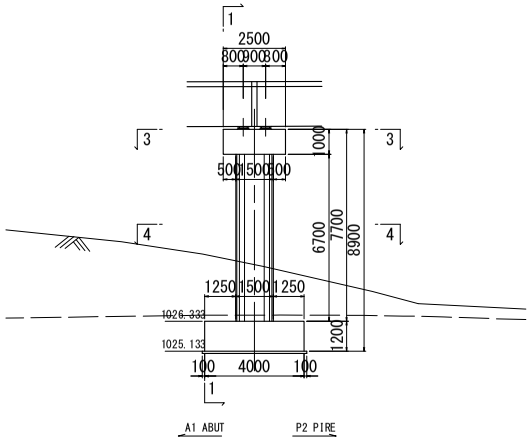
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : SUBSTRUCTURE A1(2)	Drawing No.	BR-05
				SCALE	AS SHOWN
				DATE	

SUB STRUCTURE P1 S=1:200

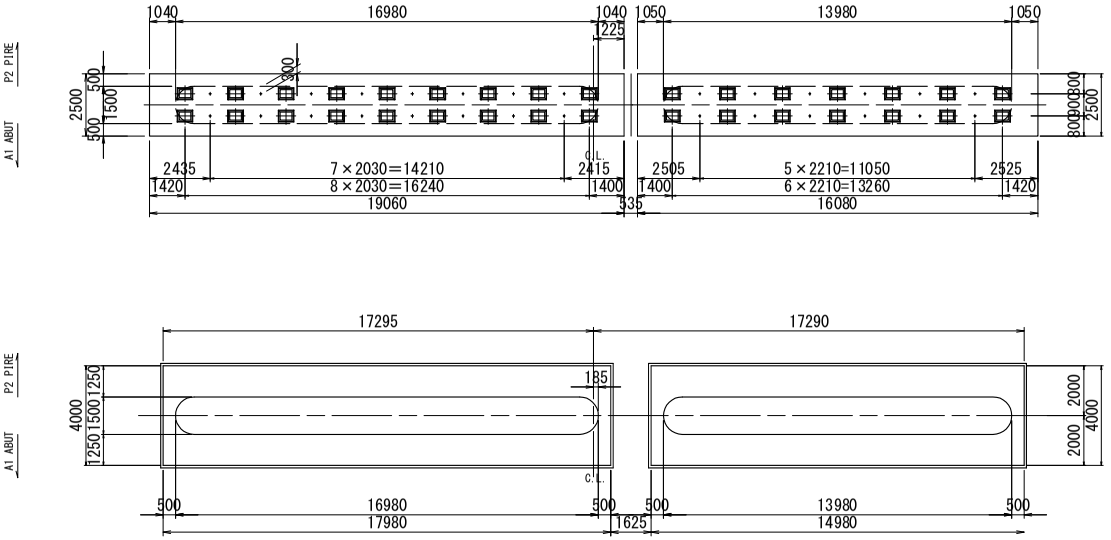
1－1



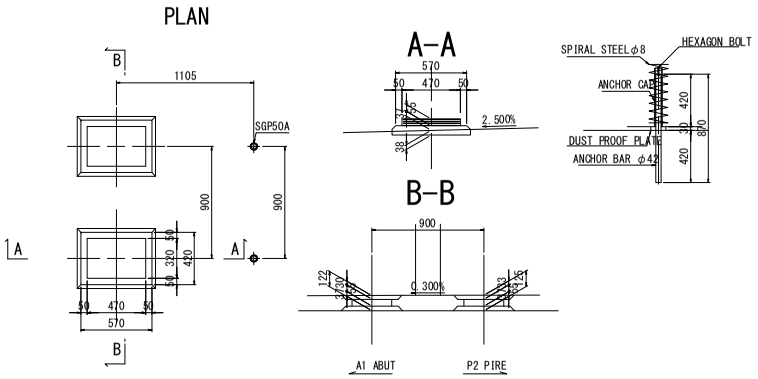
2－2



3－3



DETAIL OF BEARING S=1:40



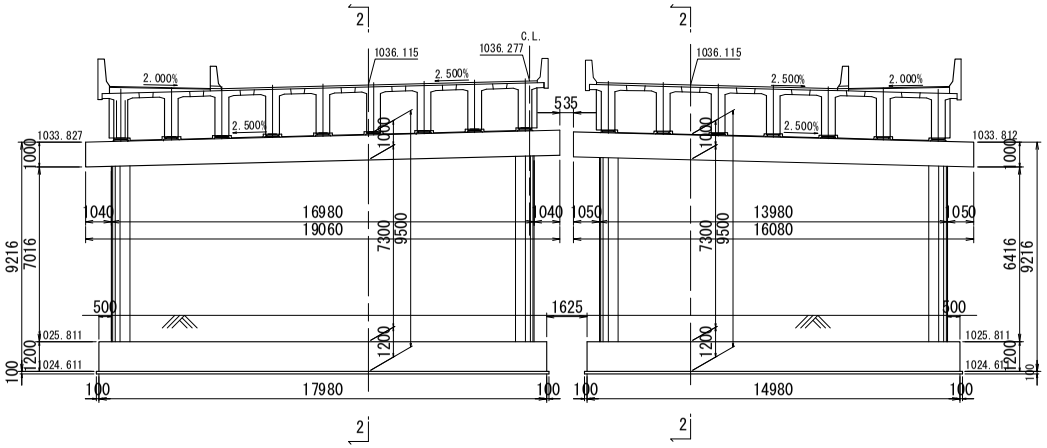
Material

No.	Name	Dimension	Sign	Qty.	Weight(kg)	Note
1	RUBBER BEARING	470×320×55	NR+SS400	32	—	te=14mm×3
②	ANCHOR BAR	φ42×870	SS400	28	265.5	
③	ANCHOR CAP	φ50×470	SGP50A	28	69.9	
④	SPIRAL STEEL	φ8×4700	—	28	52.0	
5	DUST PROOF PLATE	100×100×30	Rubber	28	—	
⑥	HEXAGON BOLT	M8×60	—	28	—	
Hot-dip Zinc galvanizing		Galvanizing parts with on its label				
		Adhesion amount 550g/m2 above, 350g/m2 bove for bolt				

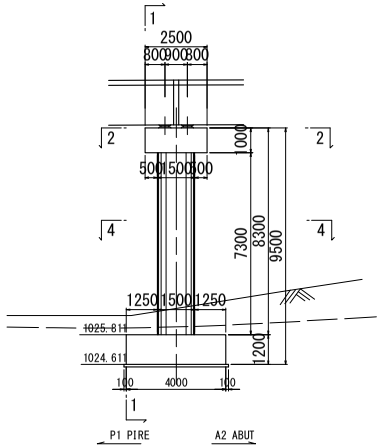
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: SUB STRUCTURE P1	Drawing No.	BR-06
				SCALE	AS SHOWN
				DATE	

SUB STRUCTURE P2 S=1:200

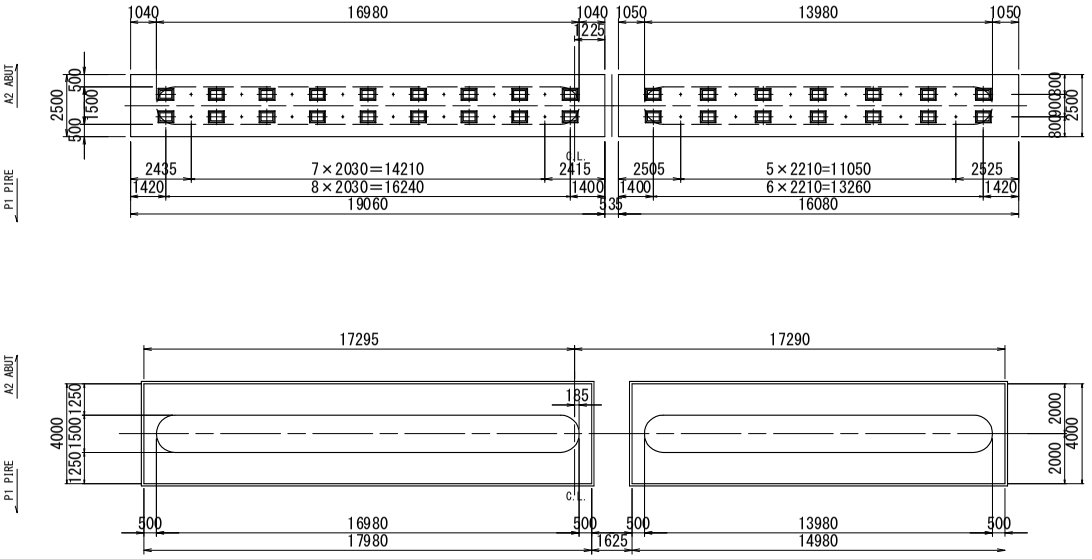
1－1



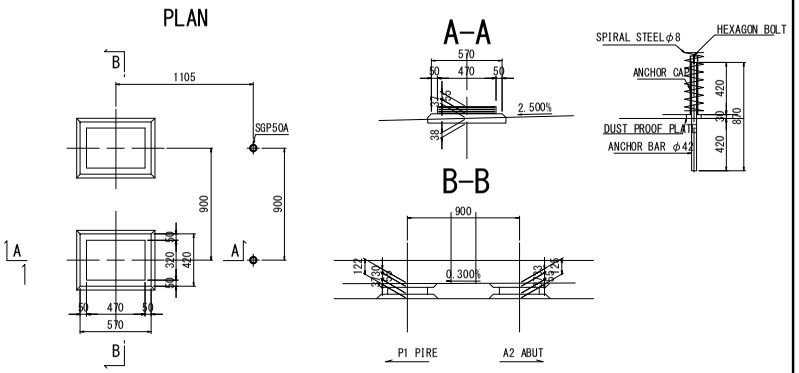
2－2



3－3



DETAIL OF BEARING S=1:40



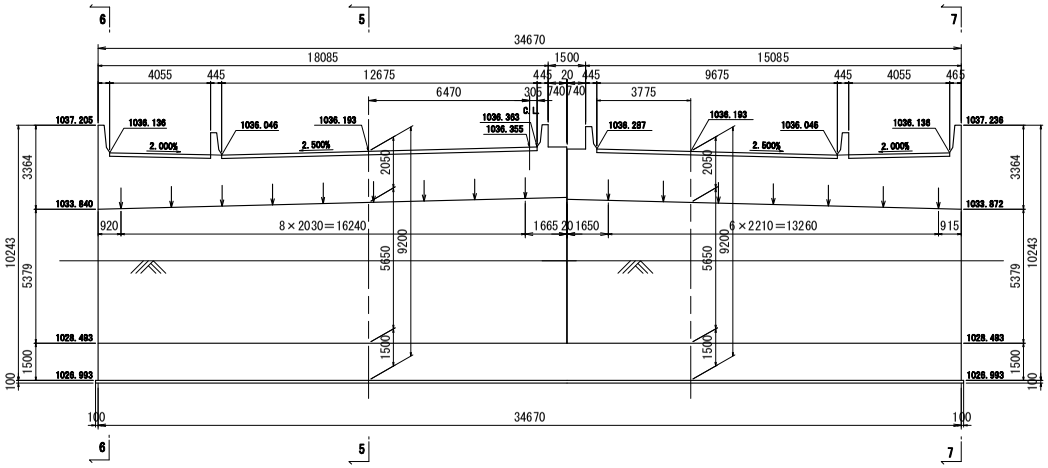
Material

No.	Name	Dimension	Sign	Qty.	Weight(kg)	Note
1	RUBBER BEARING	470×320×55	NR+SS400	32	—	te=14mm×3
②	ANCHOR BAR	φ42×870	SS400	28	265.5	
③	ANCHOR CAP	φ50×470	SGP50A	28	69.9	
④	SPIRAL STEEL	φ8×4700	—	28	52.0	
5	DUST PROOF PLATE	100×100×30	Rubber	28	—	
⑥	HEXAGON BOLT	M8×60	—	28	—	
Hot－dip Zinc galvanizing		Galvanizing parts with on its label				
		Adhesion amount 550g/m2 above, 350g/m2 bove for bolt				

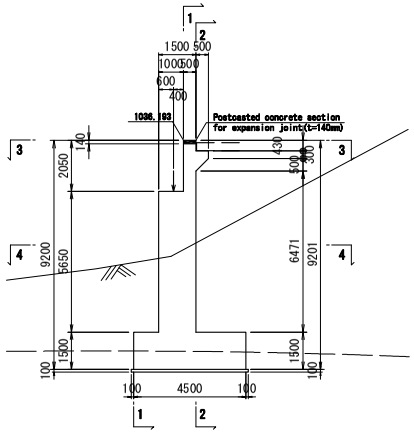
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: SUB STRUCTURE P2	Drawing No.	BR-07
				SCALE	AS SHOWN
				DATE	

SUBSTRUCTURE A2(1) S=1:200

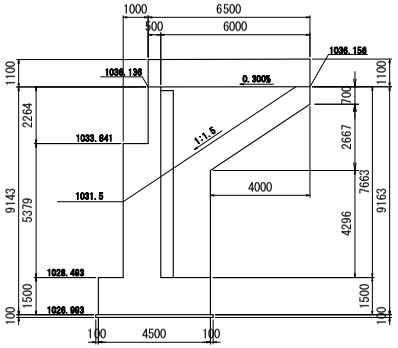
1-1



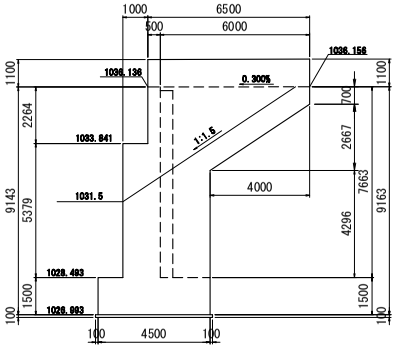
5-5



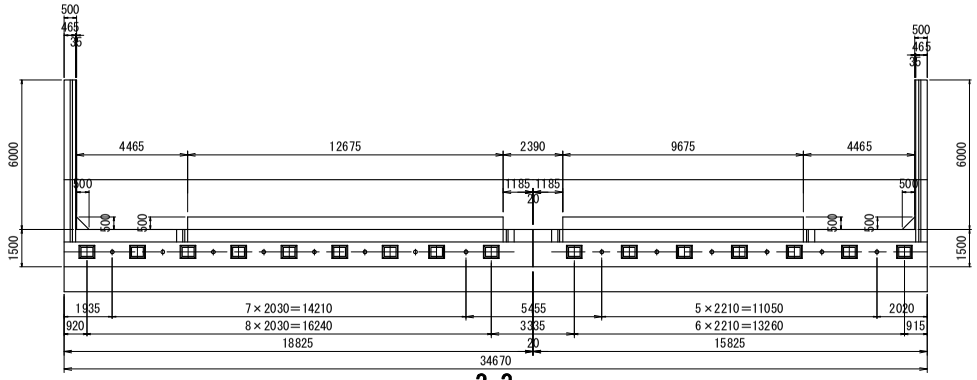
6-6



7-7



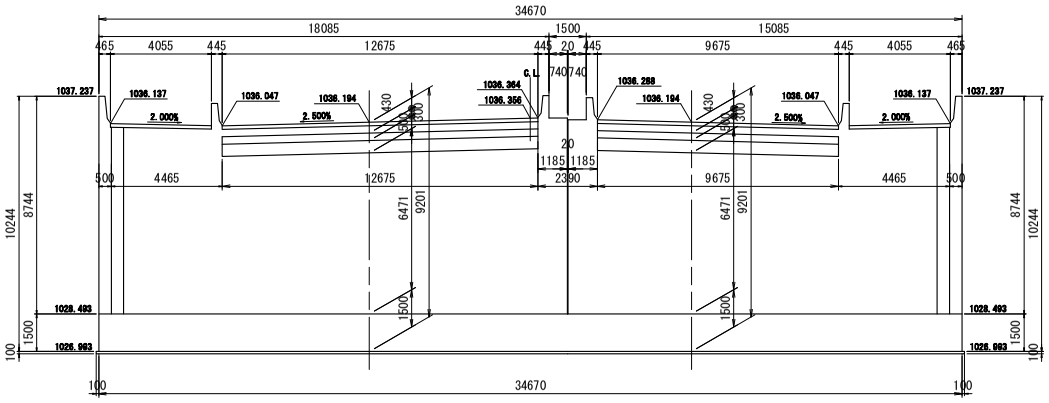
3-3



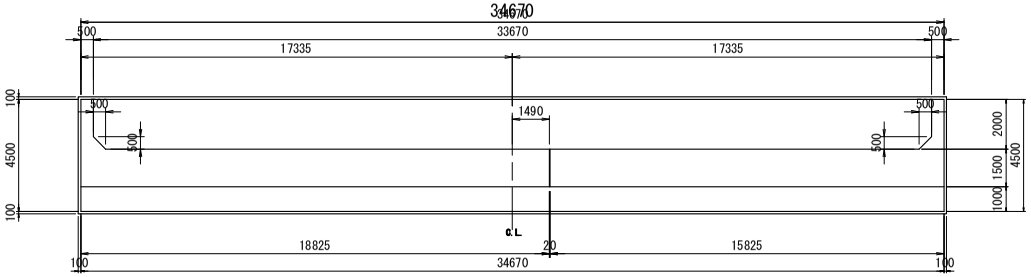
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : SUBSTRUCTURE A2(1)	Drawing No.	BR-08
				SCALE	S=1/200
				DATE	

SUBSTRUCTURE A2(2) S=1:200

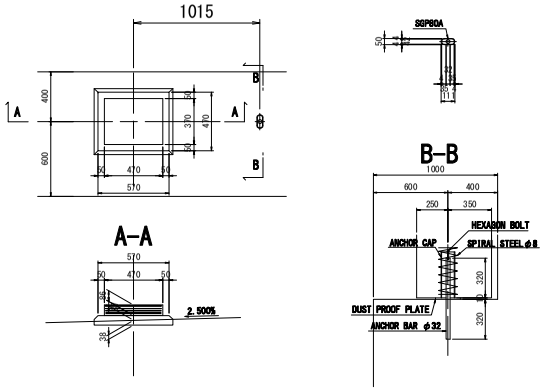
2-2



4-4



DETAIL OF BEARING S=1:40



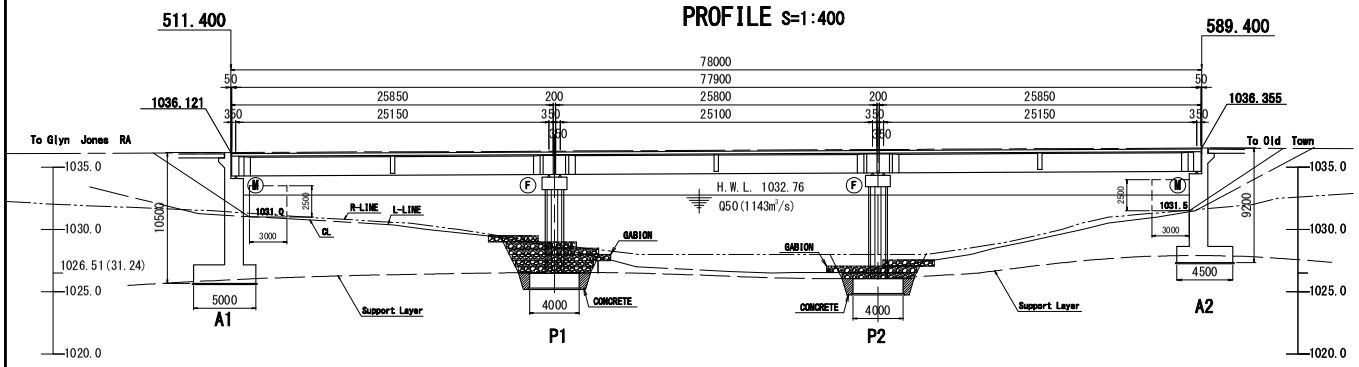
Material

No.	Name	Dimension	Sign	Qty.	Weight(kg)	Note
1	RUBBER BEARING	470×370×86	NR+SS400	16	—	t_s=16mm×4
②	ANCHOR BAR	φ32×650	SS400	14	57.4	
③	ANCHOR CAP	111×50×370	SGP80A	14	45.5	
④	SPIRAL STEEL	φ8×3400	—	14	18.8	
5	DUST PROOF PLATE	200×100×10	Rubber	14	—	
⑥	HEXAGON BOLT	M8×60	—	14	—	
Hot - dip Zinc galvanizing		Galvanizing parts with ◯ on its label				
		Adhesion amount 550g/m² above, 350g/m² bove for bolt				

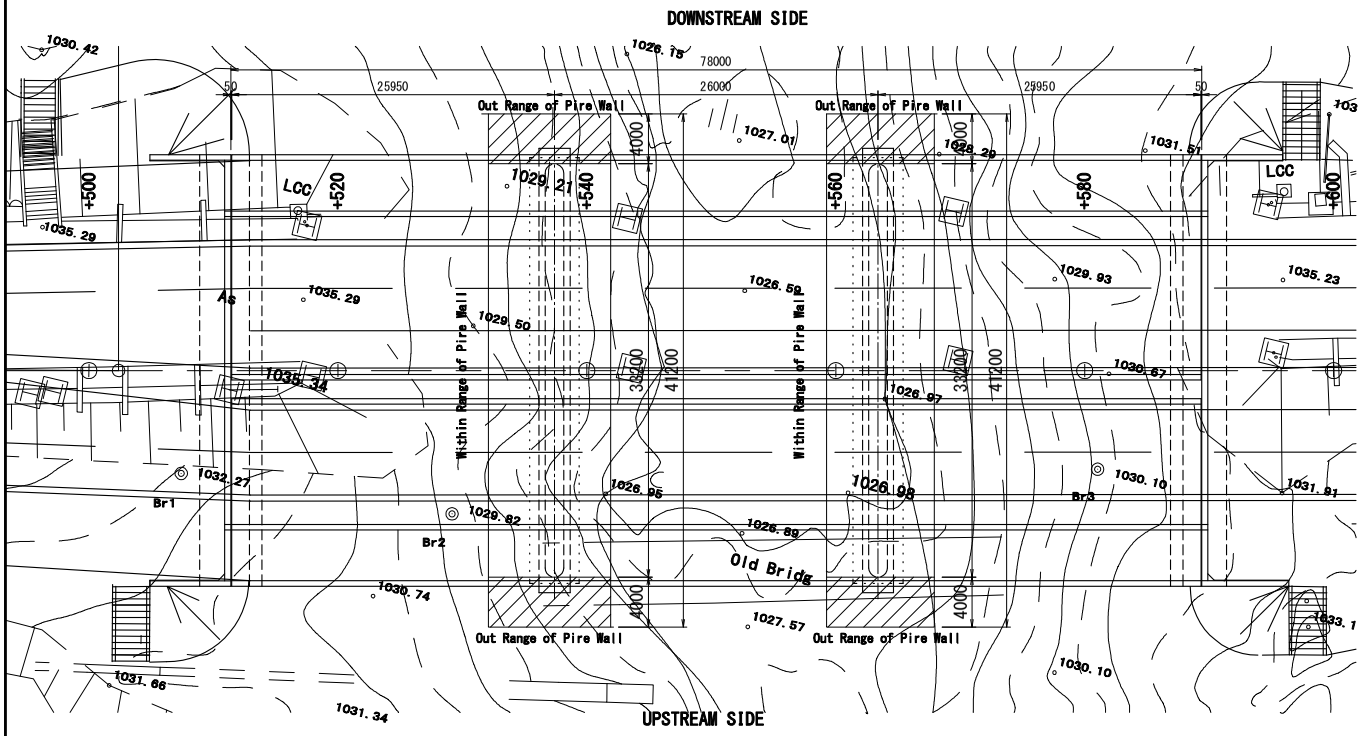
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : SUBSTRUCTURE A2(2)	Drawing No.	BR-09
				SCALE	AS SHOWN
				DATE	

DETAIL OF GABION P1, P2

PROFILE S=1:400

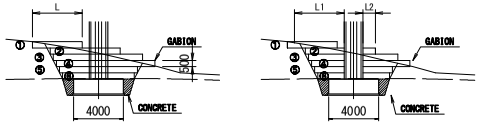


PLAN S=1:400



CROSS SECTION S=1:400

P1



Out Range of Pire Wall

No.	L (m)
①	4.0
②	5.6
③	7.2
④	7.9
⑤	6.3
⑥	5.8

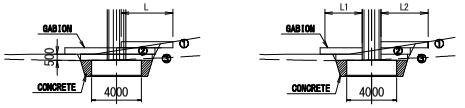
ΣB=8.0m
A=294m²

Within Range of Pire Wall

No.	L1 (m)	L2 (m)
①	4.0	—
②	3.1	1.0
③	2.9	2.8
④	2.6	3.8
⑤	2.4	2.4
⑥	2.2	2.2

ΣB=33.2m
A=976m²

P2



Out Range of Pire Wall

No.	L (m)
①	4.1
②	7.2
③	5.8

ΣB=8.0m
A=137m²

Within Range of Pire Wall

No.	L1 (m)	L2 (m)
①	—	3.8
②	3.4	2.4
③	2.1	2.1

ΣB=33.2m
A=458m²

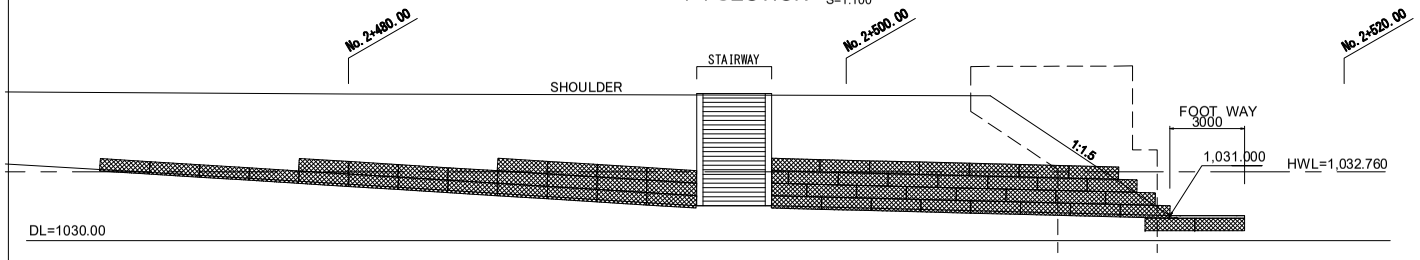
Material

Name	Dimension	Unit	Qty.			Note
			P1	P2	Total	
Cabion	H0.5m B2.0m L1.0m	m³	1270	595	1865	

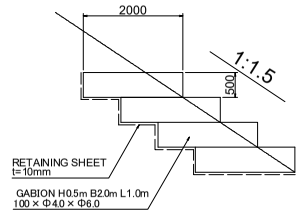
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE: DETAIL OF GABION P1,P2	Drawing No.	MG-01
				SCALE	S=1/400
				DATE	

MAT GABIONS (1)

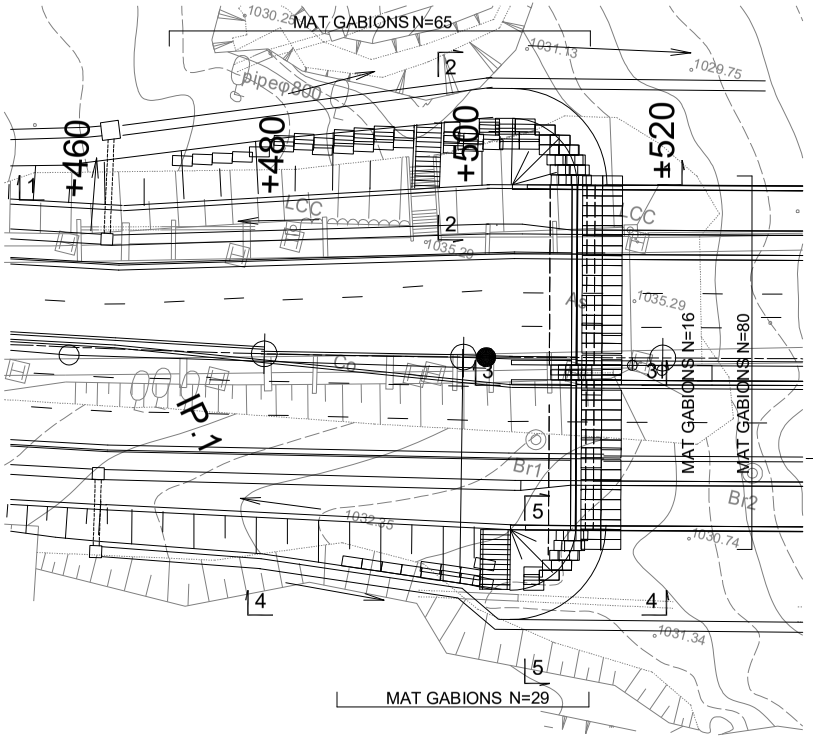
1-1 SECTION S=1:100



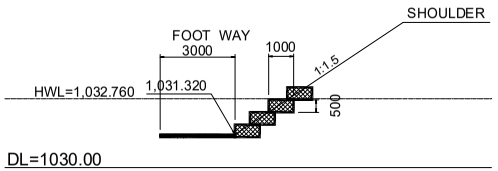
DETAIL S=1:50



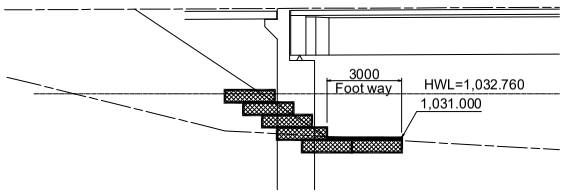
PLAN S=1:250



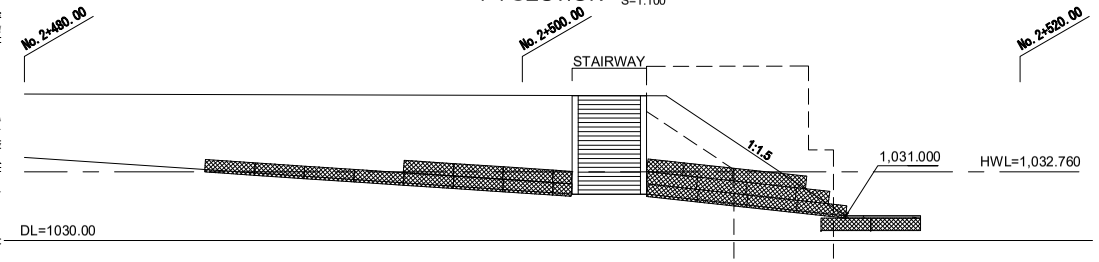
2-2 SECTION S=1:100



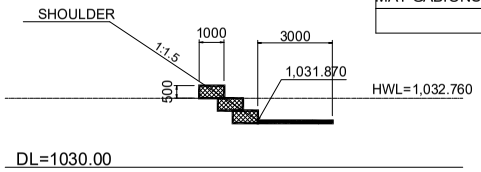
3-3 SECTION S=1:100



4-4 SECTION S=1:100



5-5 SECTION S=1:100



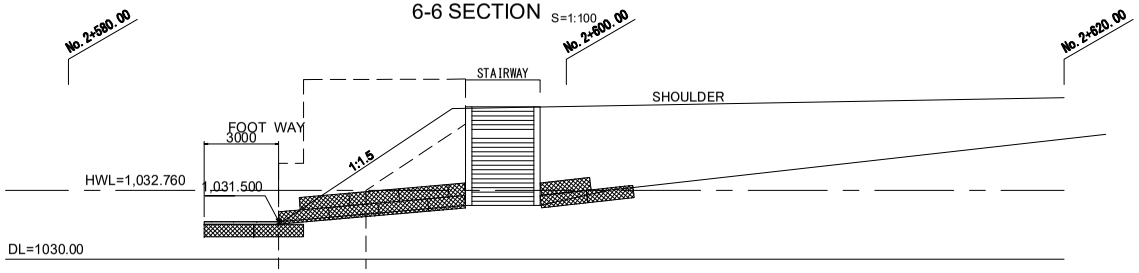
MAT GABIONS QUANTITY 1 SET

ITEM	STANDARD	UNIF	QUANTITY			摘 要
			A1 ABUTMENT SIDE	A2 ABUTMENT SIDE	TOTAL	
MAT GABIONS	H0.5m B2.0m L1.0m		190	134	324	

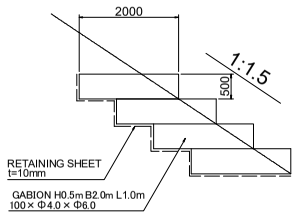
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : MAT GABIONS (1)	Drawing No.	MG-02
				SCALE	As Shown
				DATE	

MAT GABIONS (2)

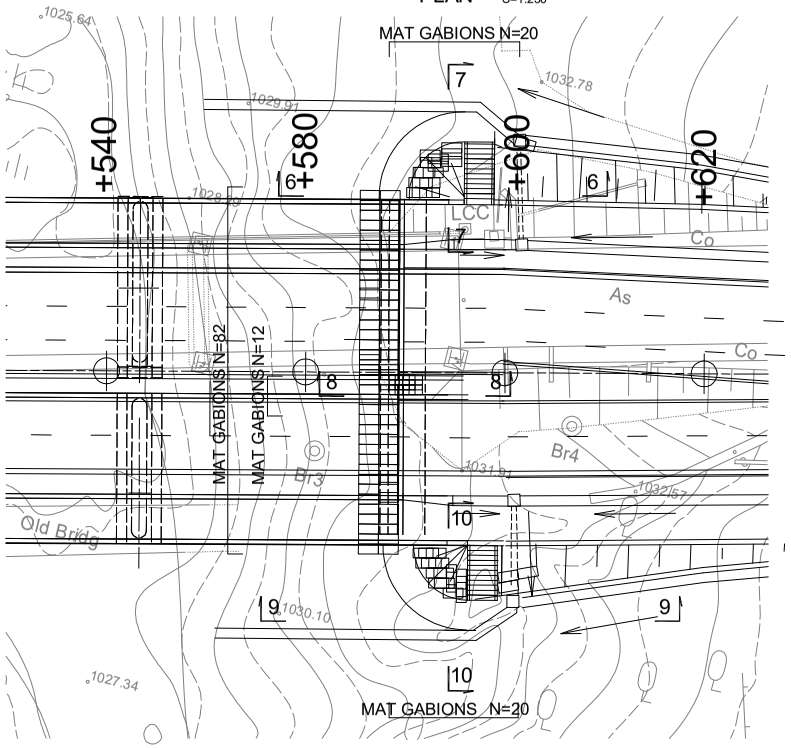
6-6 SECTION S=1:100



DETAIL S=1:50

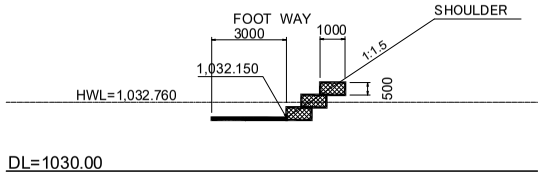


PLAN S=1:250

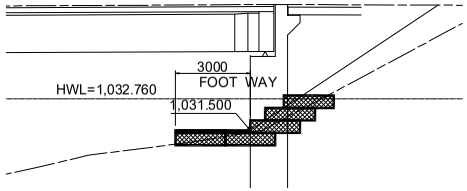


S=1:250

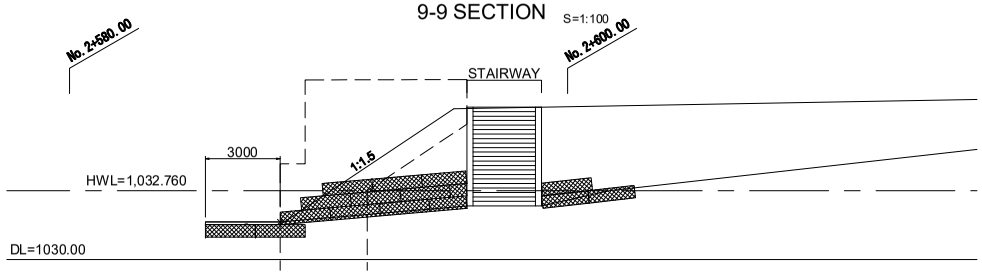
7-7 SECTION S=1:100



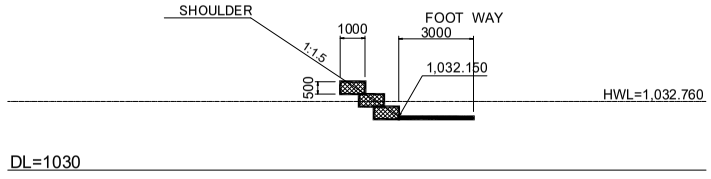
8-8 SECTION S=1:100



9-9 SECTION S=1:100



10-10 SECTION S=1:100

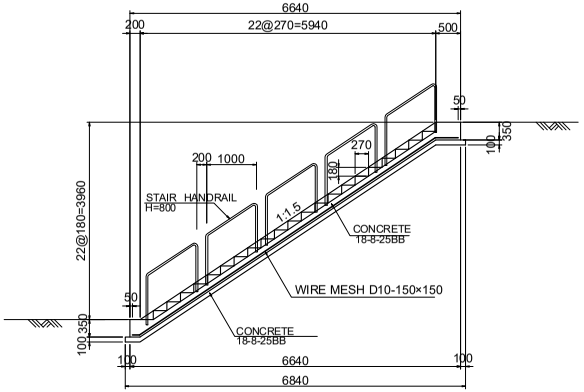


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : MAT GABIONS (2)	Drawing No.	MG-03
				SCALE	As Shown
				DATE	

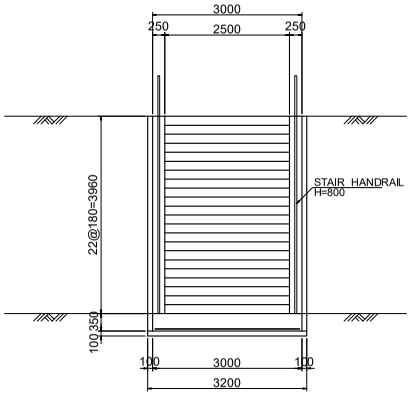
STAIRWAY

STAIRWAY-A S=1/100

SIDE VIEW

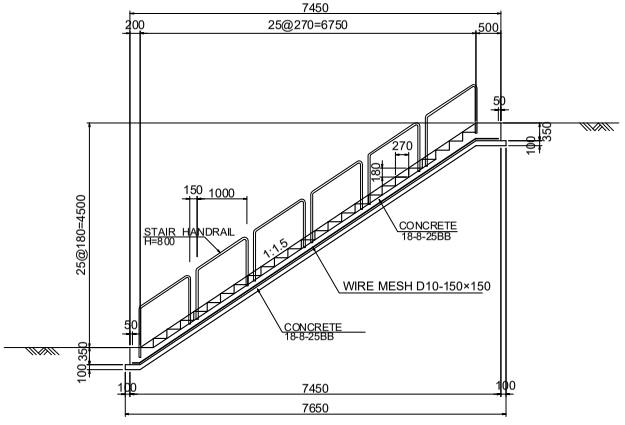


FRONT VIEW

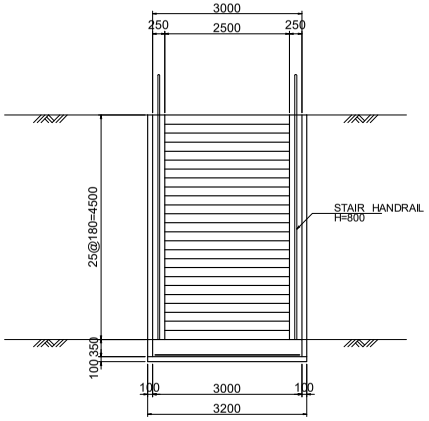


STAIRWAY-B S=1/100

SIDE VIEW

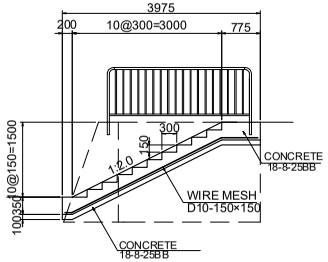


FRONT VIEW

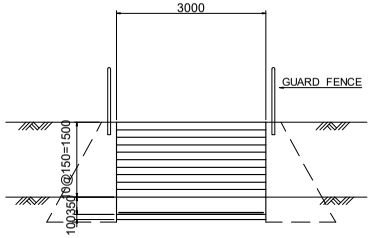


STAIRWAY-C S=1/100
(STA.2+095R)

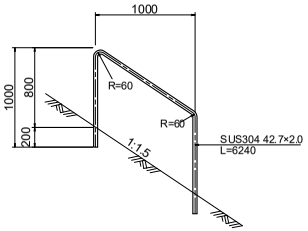
SIDE VIEW



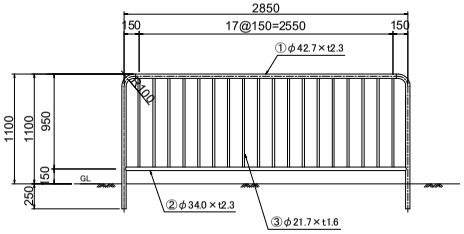
FRONT VIEW



STAIR HANDRAIL S=1/50



GUARD FENCE S=1/50

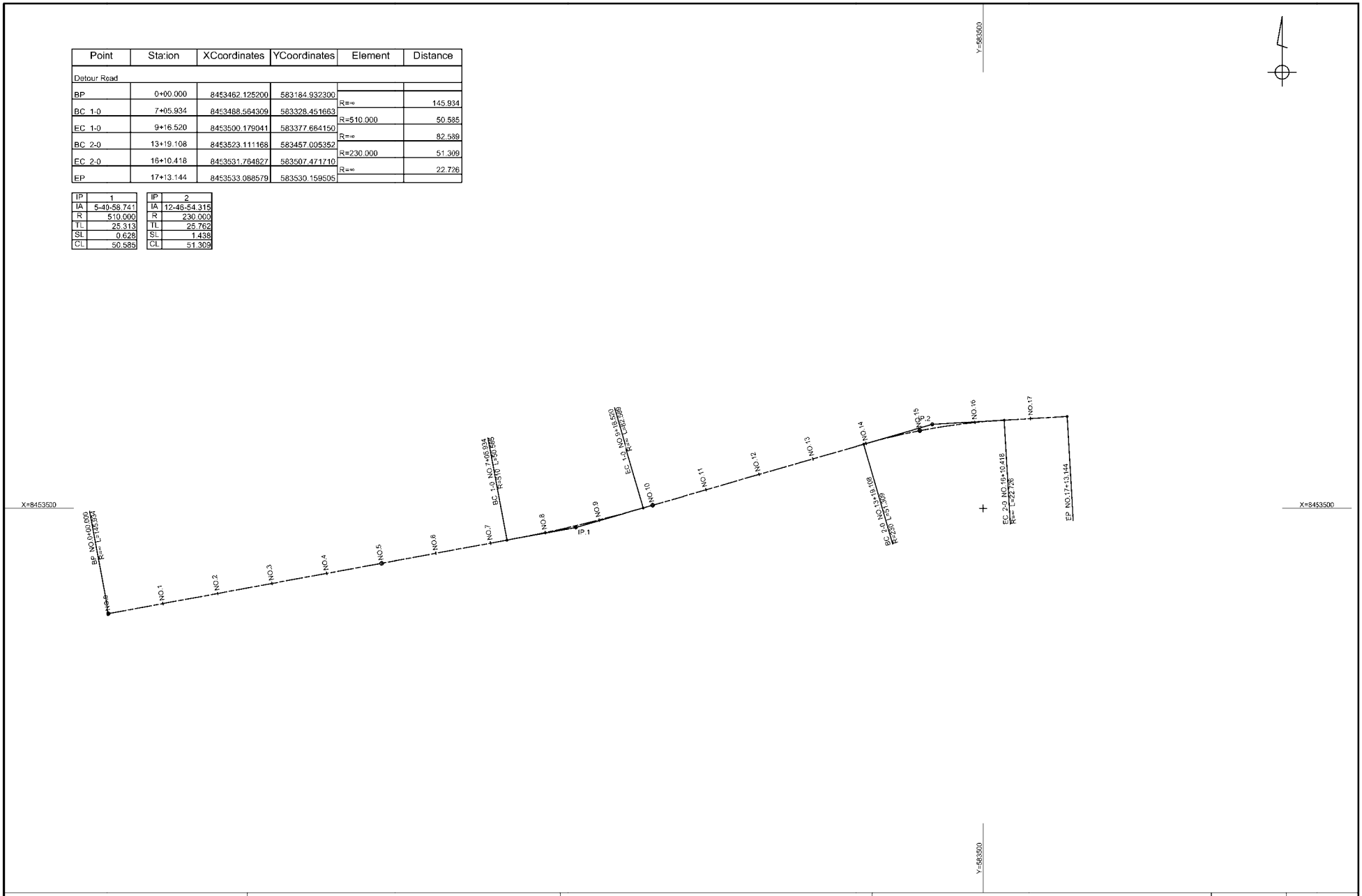


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : STAIRWAY	Drawing No.	SW-01
				SCALE	As Shown
				DATE	

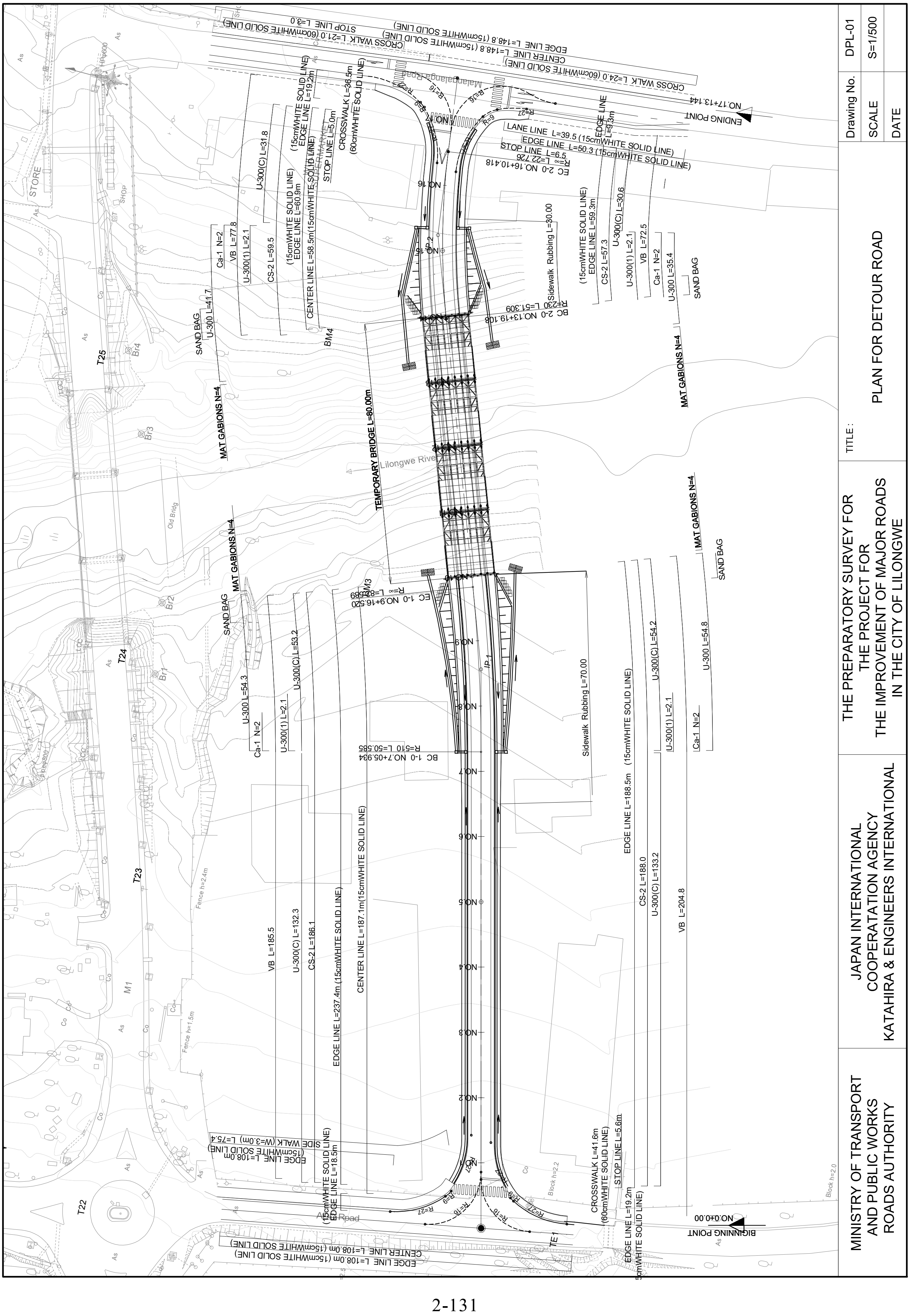
Point	Station	XCoordinates	YCoordinates	Element	Distance
Detour Road					
BP	0+00.000	8453462.125200	583184.932300		
				R=∞	145.934
BC 1-0	7+05.934	8453488.564309	583328.451663		
				R=510.000	50.585
EC 1-0	9+16.520	8453500.179041	583377.664150		
				R=∞	82.589
BC 2-0	13+19.108	8453523.111168	583457.005352		
				R=230.000	51.309
EC 2-0	16+10.418	8453531.764827	583507.471710		
				R=∞	22.726
EP	17+13.144	8453533.088579	583530.159505		

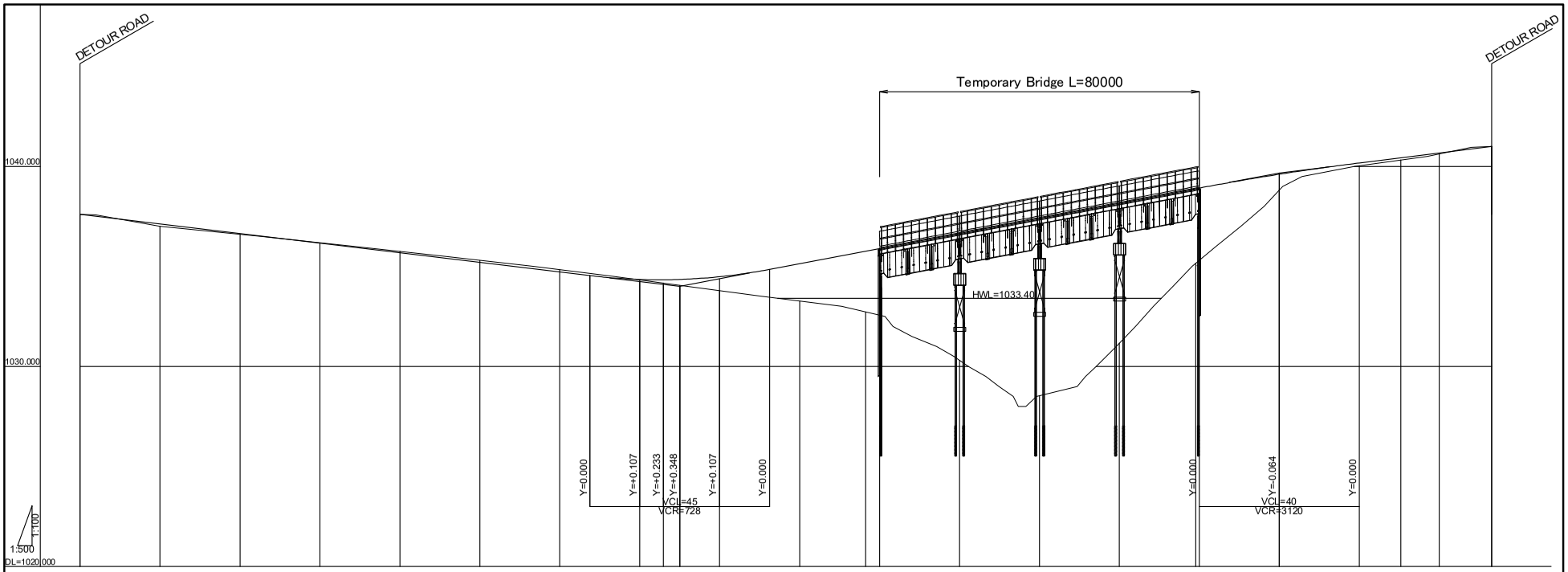
IP	1
IA	5-40-58.741
R	510.000
TL	25.313
SL	0.628
CL	50.585

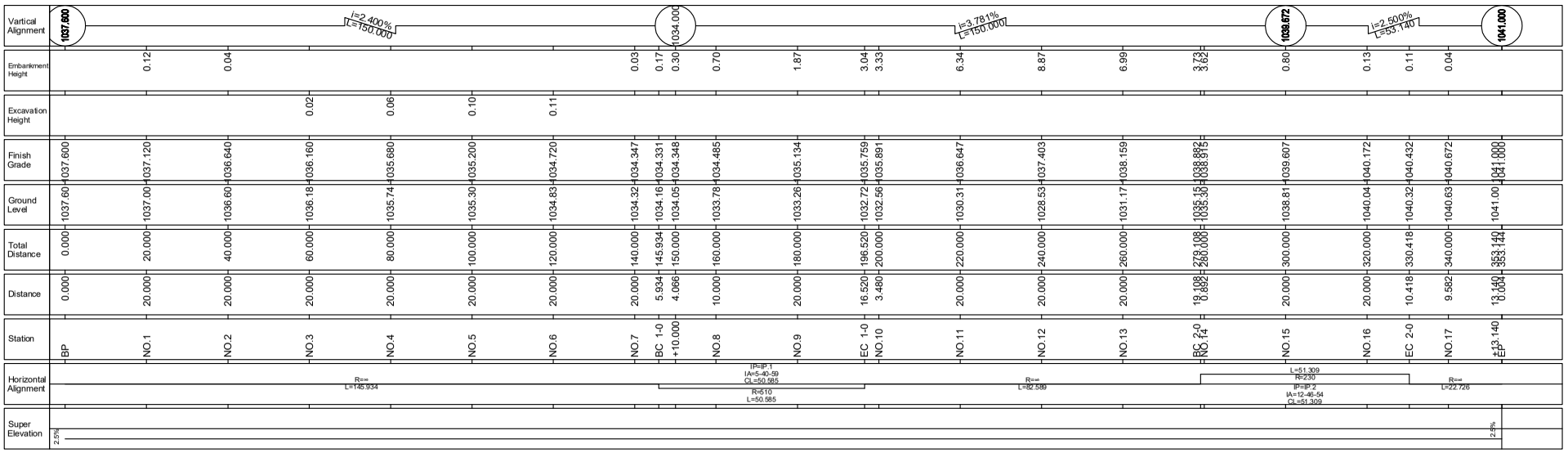
IP	2
IA	12-46-54.315
R	230.000
TL	25.762
SL	1.438
CL	51.309



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : KEY PLAN FOR DETOUR ROAD	Drawing No.	DKP-01
				SCALE	S=1/500
				DATE	

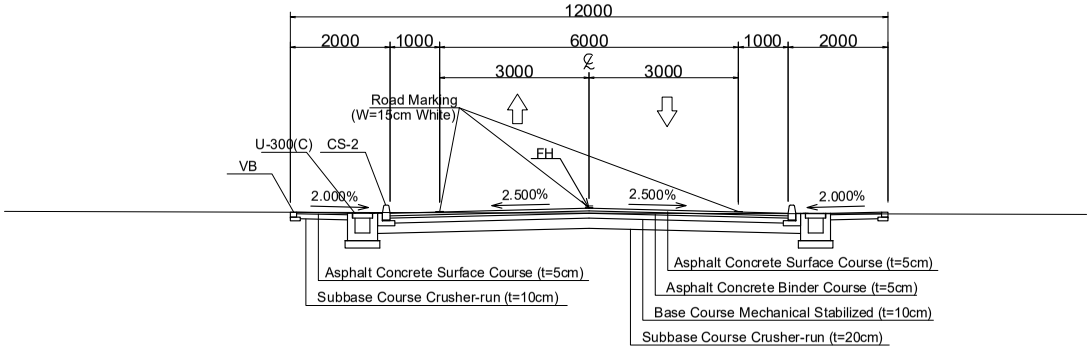

MINISTRY OF TRANSPORT
AND PUBLIC WORKS
ROADS AUTHORITY
JAPAN INTERNATIONAL
COOPERATATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL
THE PREPARATORY SURVEY FOR
THE PROJECT FOR
THE IMPROVEMENT OF MAJOR ROADS
IN THE CITY OF LILONGWE
TITLE :
PLAN FOR DETOUR ROAD
Drawing No.
DPL-01
SCALE
S=1/500
DATE
TEMPORARY BRIDGE L=80.00m
Lilongwe River
MAT GABIONS N=4
SAND BAG
BIGINNING POINT
NO.0+0.00
ENDING POINT
NO.17+13.144



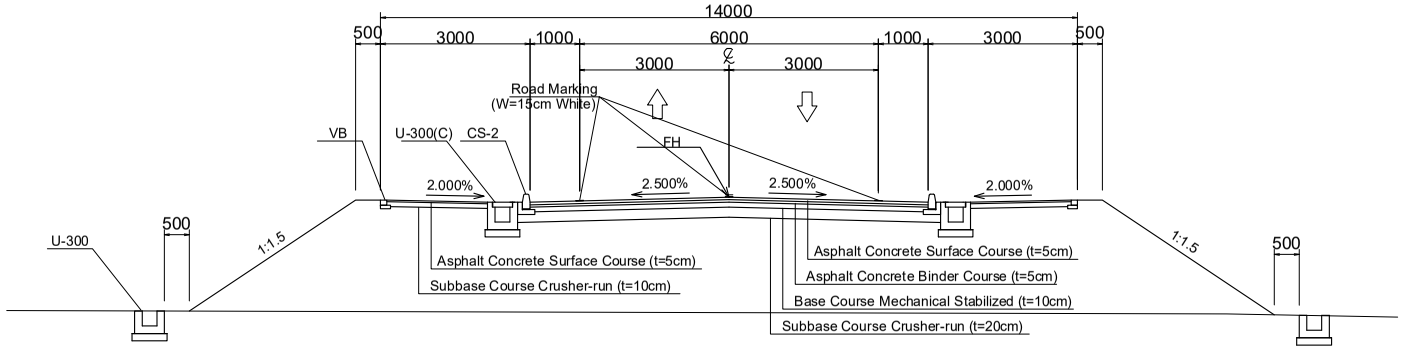


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : PROFILE FOR DETOUR ROAD	Drawing No.	DPR-01
				SCALE	V=1:100 H=1:500
				DATE	

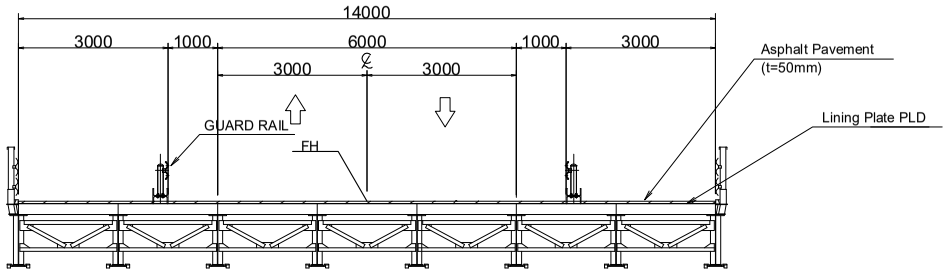
Standard Section



Embankment Section



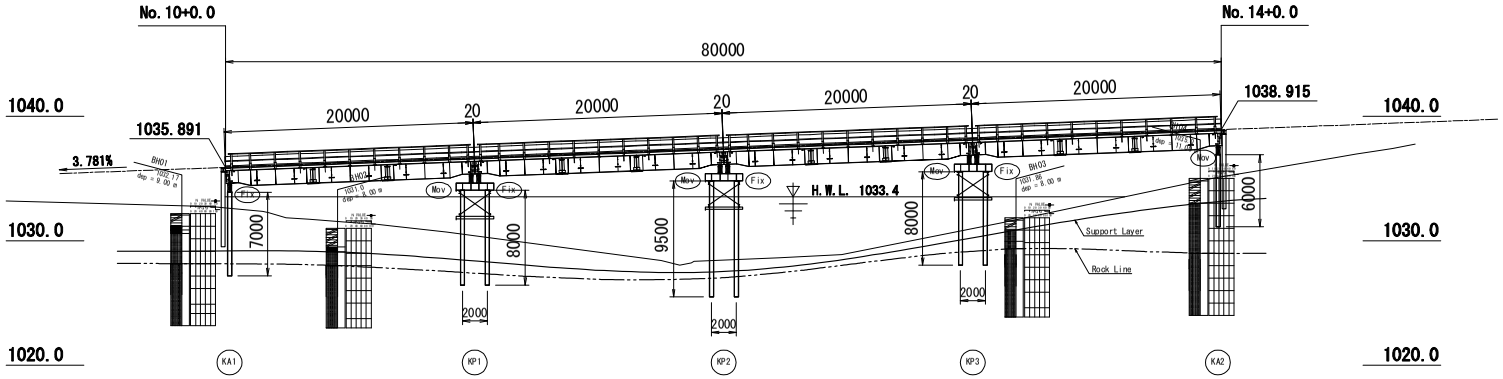
Temporary Bridge Section



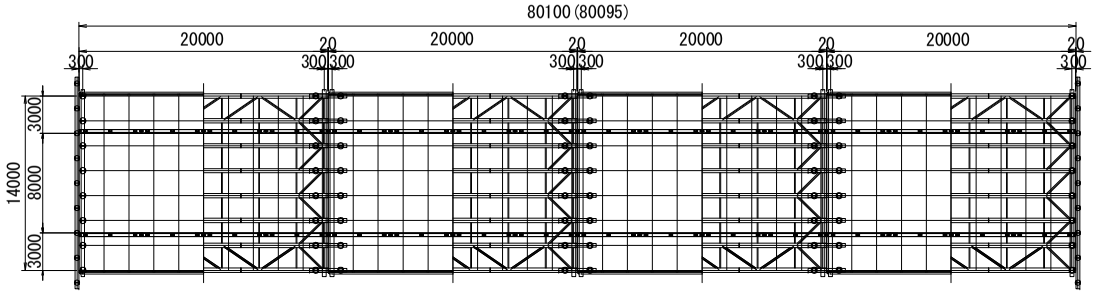
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TYPICAL CROSS SECTION FOR DETOUR ROAD	Drawing No.	DTC-01
				SCALE	S=1/50
				DATE	

GENERAL DRAWING S=1:400
(TEMPORARY BRIDGE)

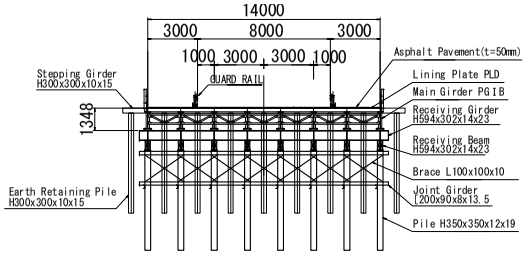
PROFILE S=1:400



PLAN S=1:400



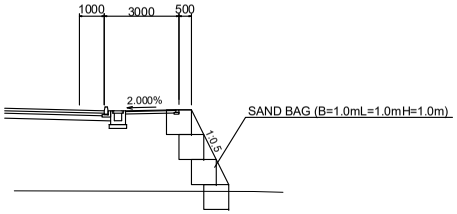
CROSS SECTION S=1:300



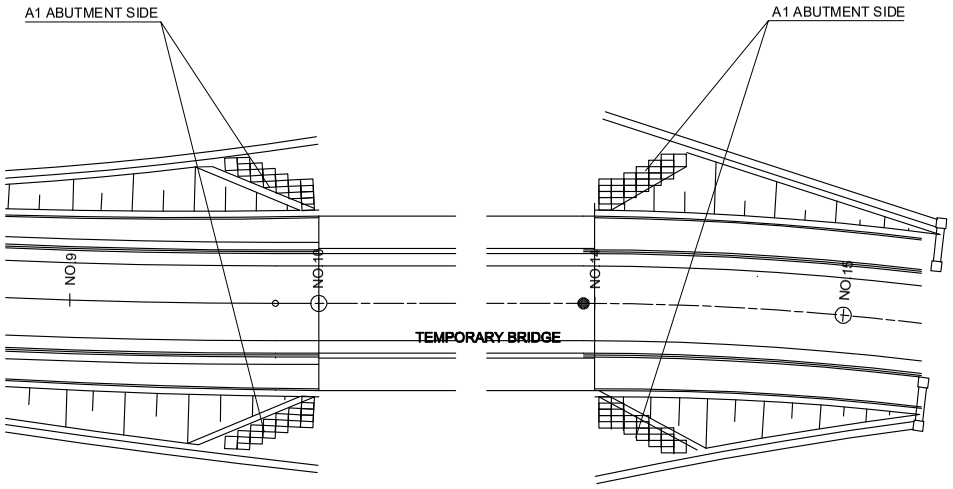
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : TEMPORARY BRIDGE GENERAL DRAWING	Drawing No.	DGE-01
				SCALE	AS SHOWN
				DATE	

SAND BAG

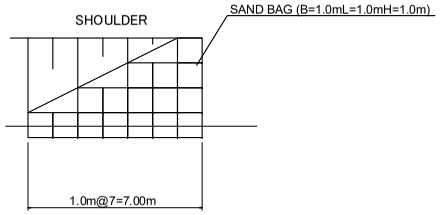
CROSS SECTION



PLAN S=1:200



PROFILE

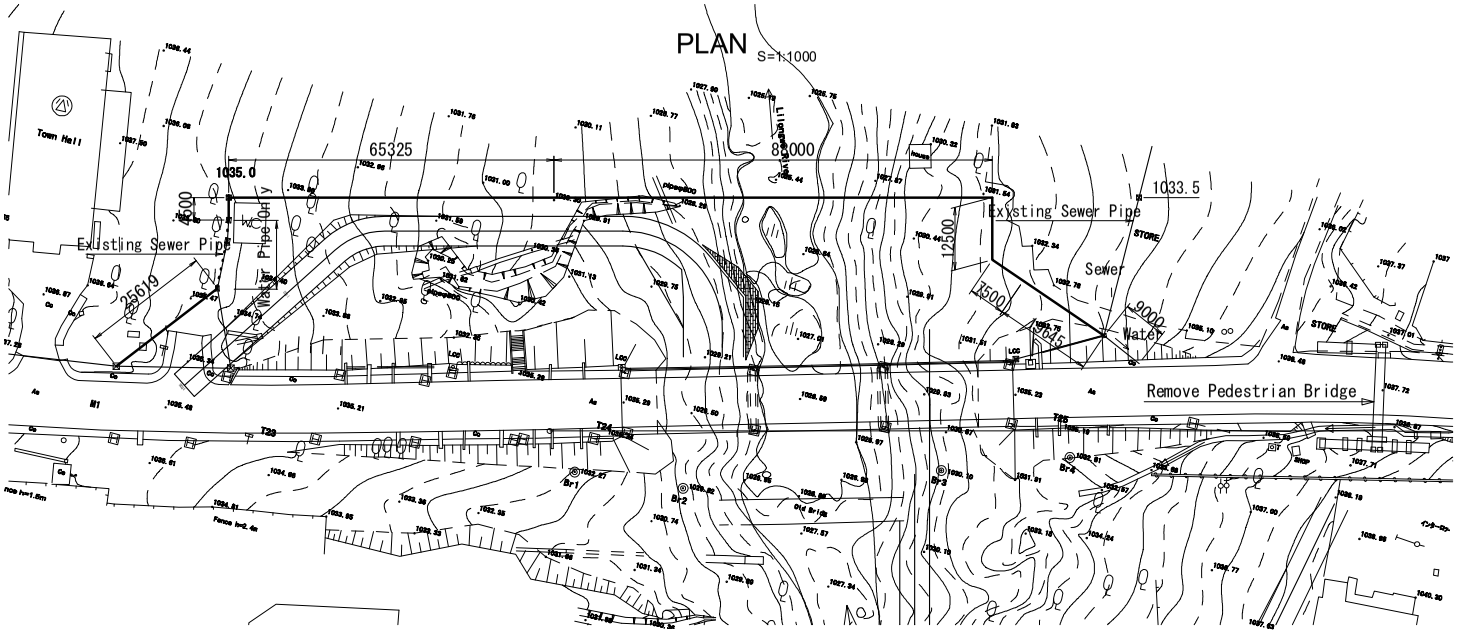


SAND BAG QUANTITY 1 SET

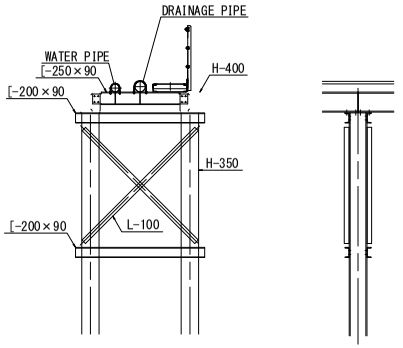
ITEM	STANDARD	UNIF	QUANTITY		
			A1 SIDE	A2 SIDE	TOTAL
SAND BAG	H1.0m B1.0m L1.0m		32	32	64

MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : DETAIL OF SAND BAG	Drawing No.	DSB-01
				SCALE	S=1:100
				DATE	

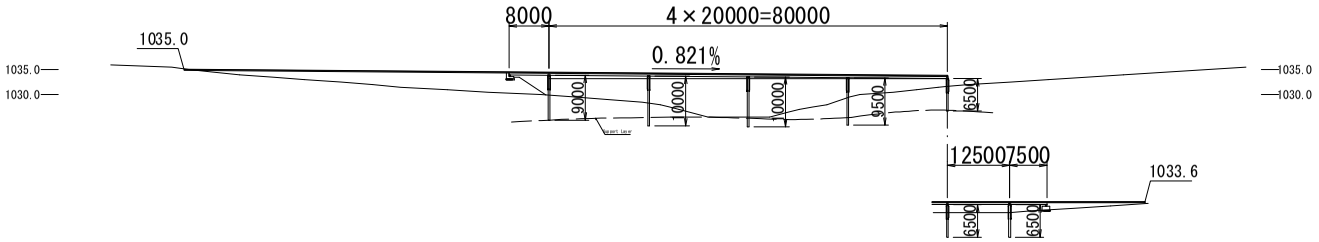
PLAN S=1:1000



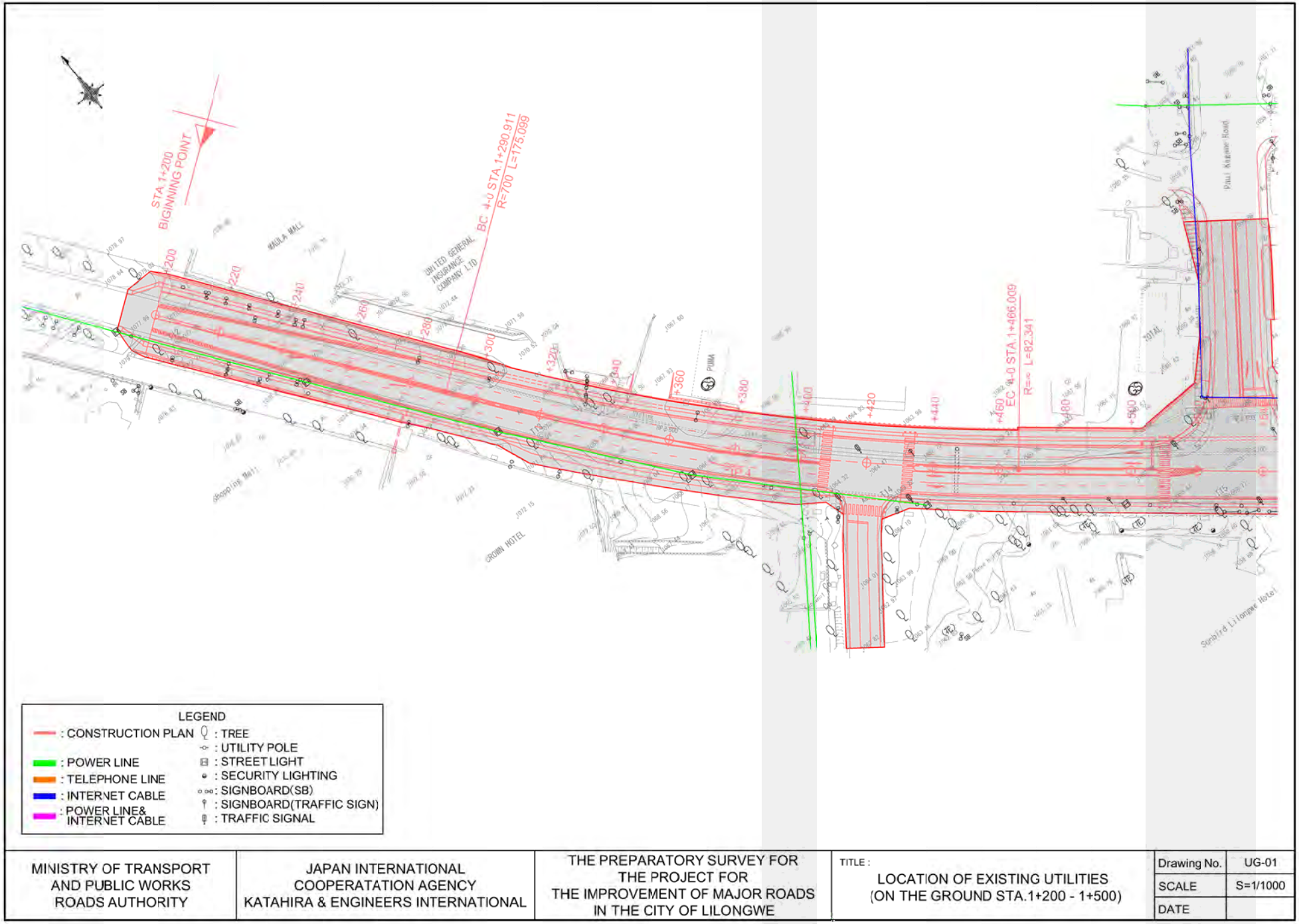
CROSS SECTION S=1:100

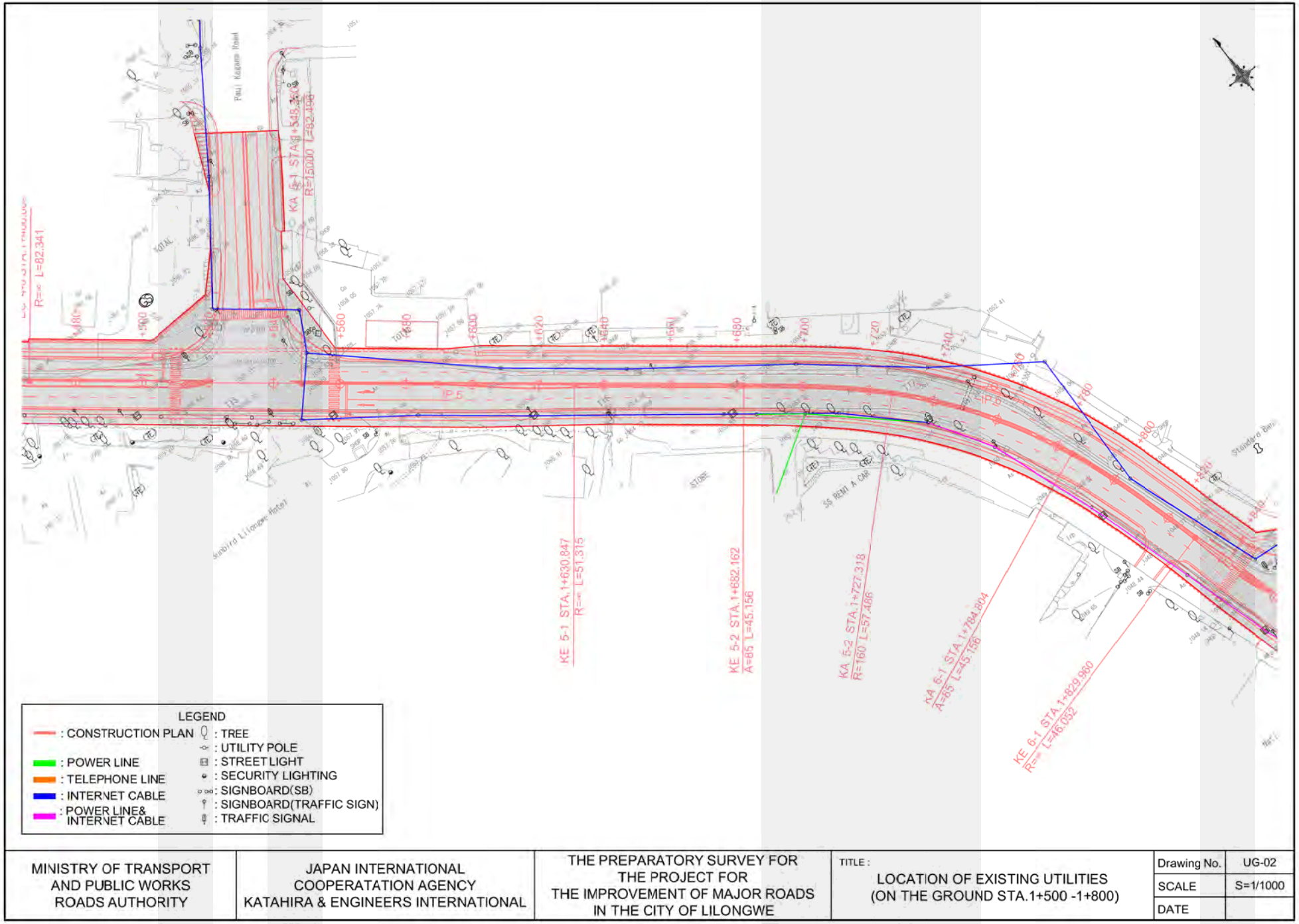


PROFILE S=1:1000

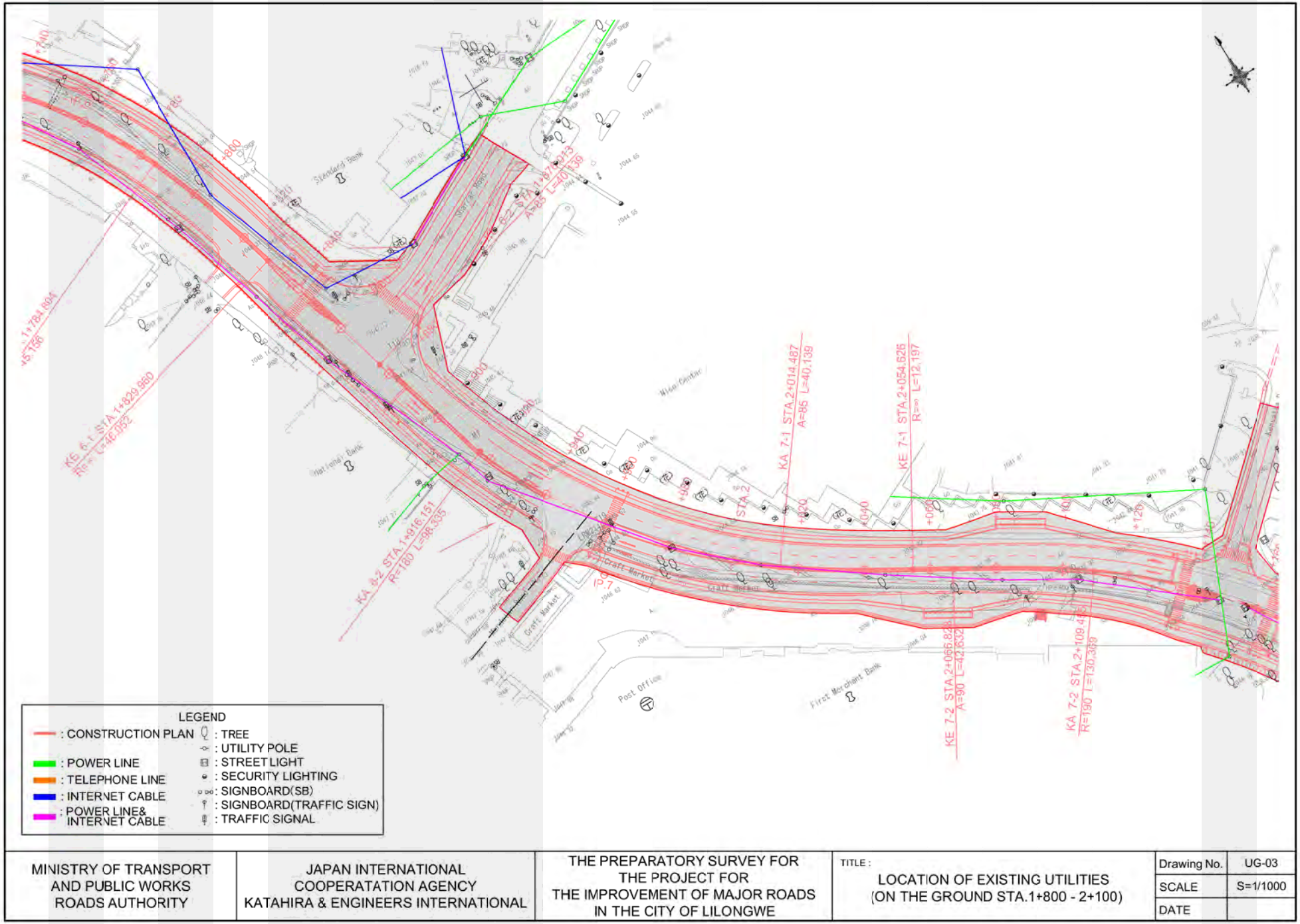


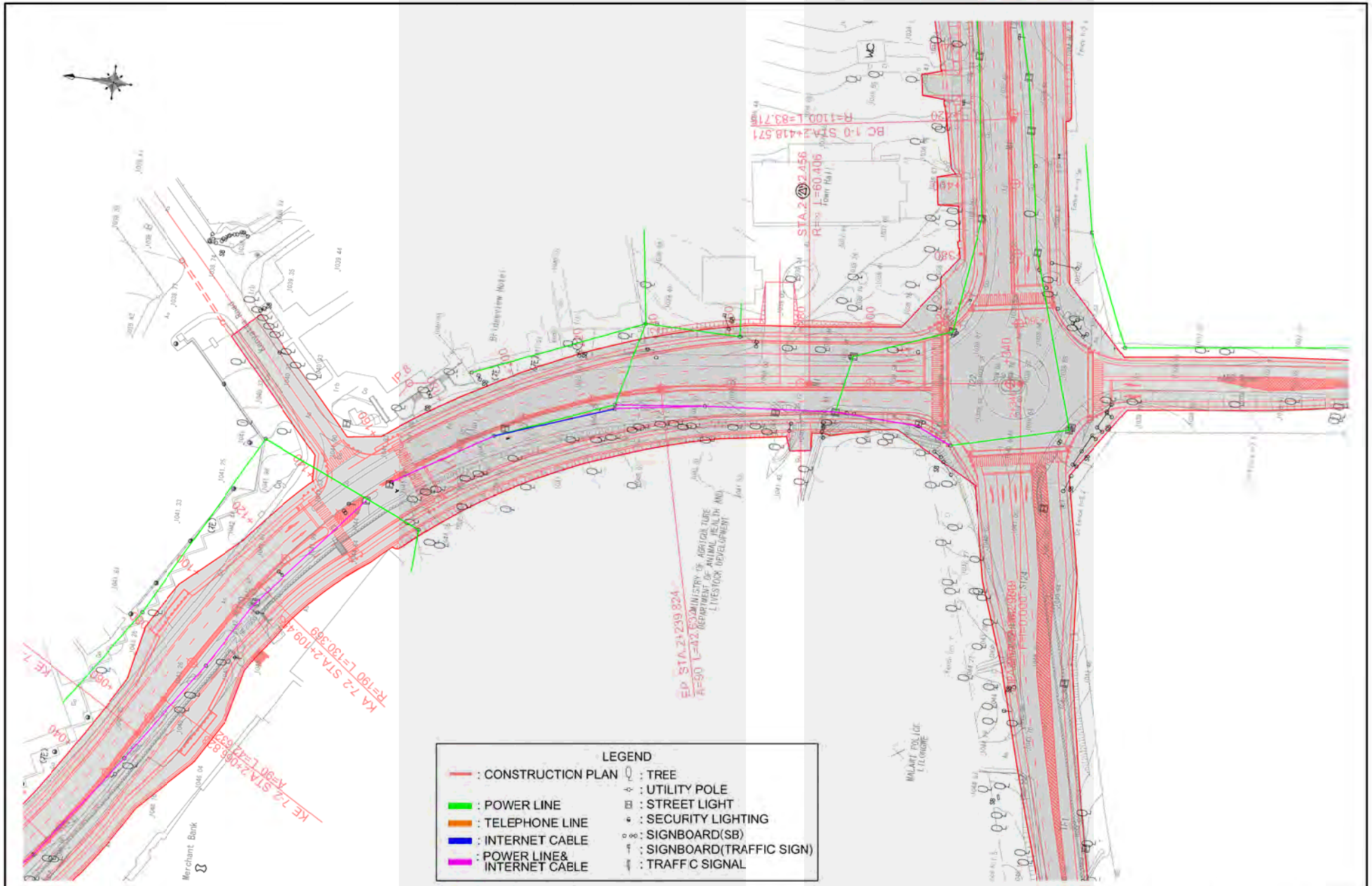
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : GENERAL DRAWING WATER AND DRAINAGE PIPE	Drawing No.	WGE-01
				SCALE	AS SHOWN
				DATE	


STA.1+200
BIGINNING POINT
BC 4-0 STA.1+290.911
R=700 L=175.099
EC 4-0 STA.1+466.009
R=∞ L=82.341
MAULA WALL
UNITED GENERAL INSURANCE COMPANY LTD
PUMA
CROWN HOTEL
Paul Kagame Road
Sunbird Lilongwe Hotel
LEGEND
: CONSTRUCTION PLAN
: POWER LINE
: TELEPHONE LINE
: INTERNET CABLE
: POWER LINE& INTERNET CABLE
: TREE
: UTILITY POLE
: STREET LIGHT
: SECURITY LIGHTING
: SIGNBOARD(SB)
: SIGNBOARD(TRAFFIC SIGN)
: TRAFFIC SIGNAL
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY
JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL
THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE
TITLE :
LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.1+200 - 1+500)
Drawing No. UG-01
SCALE S=1/1000
DATE

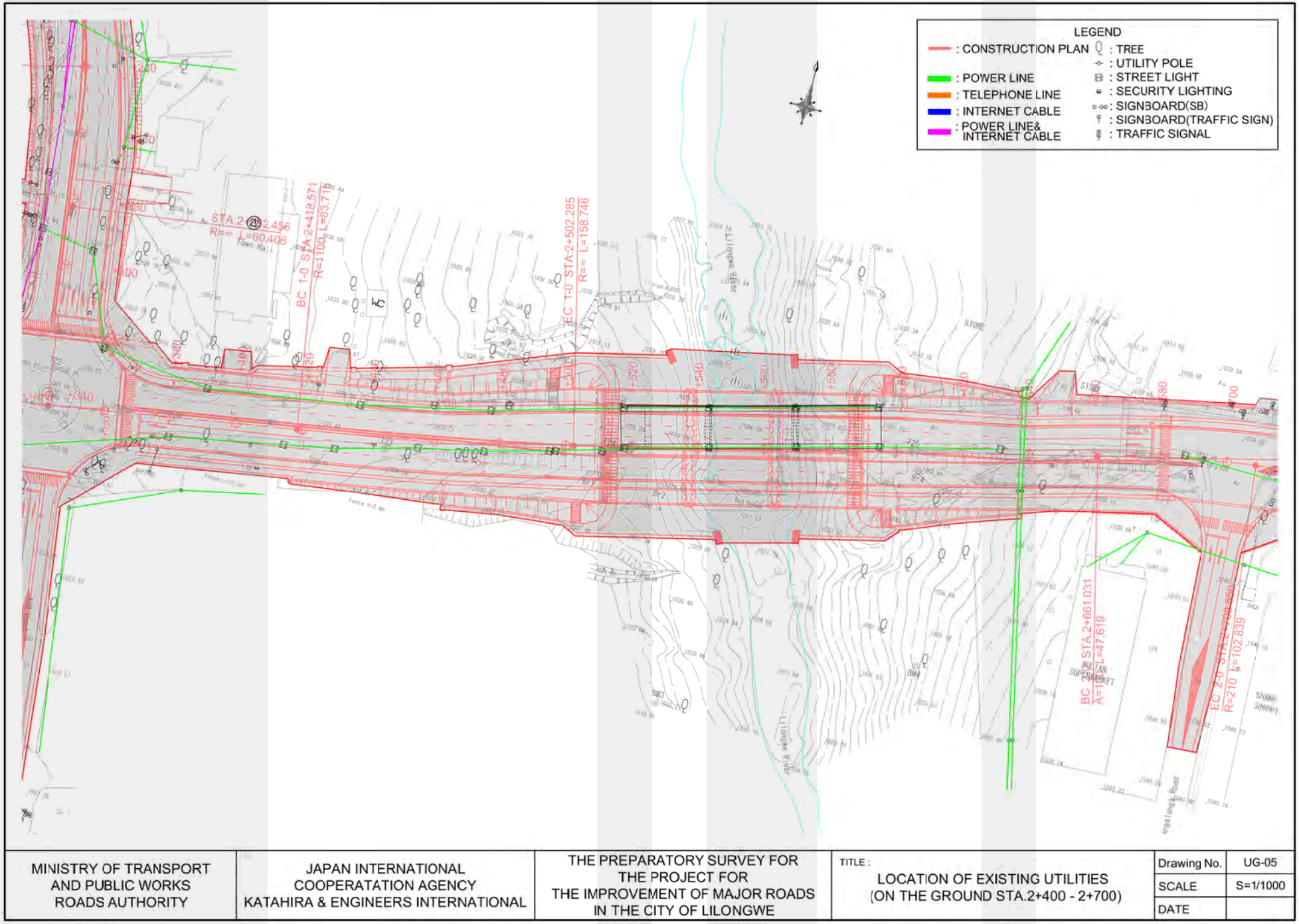


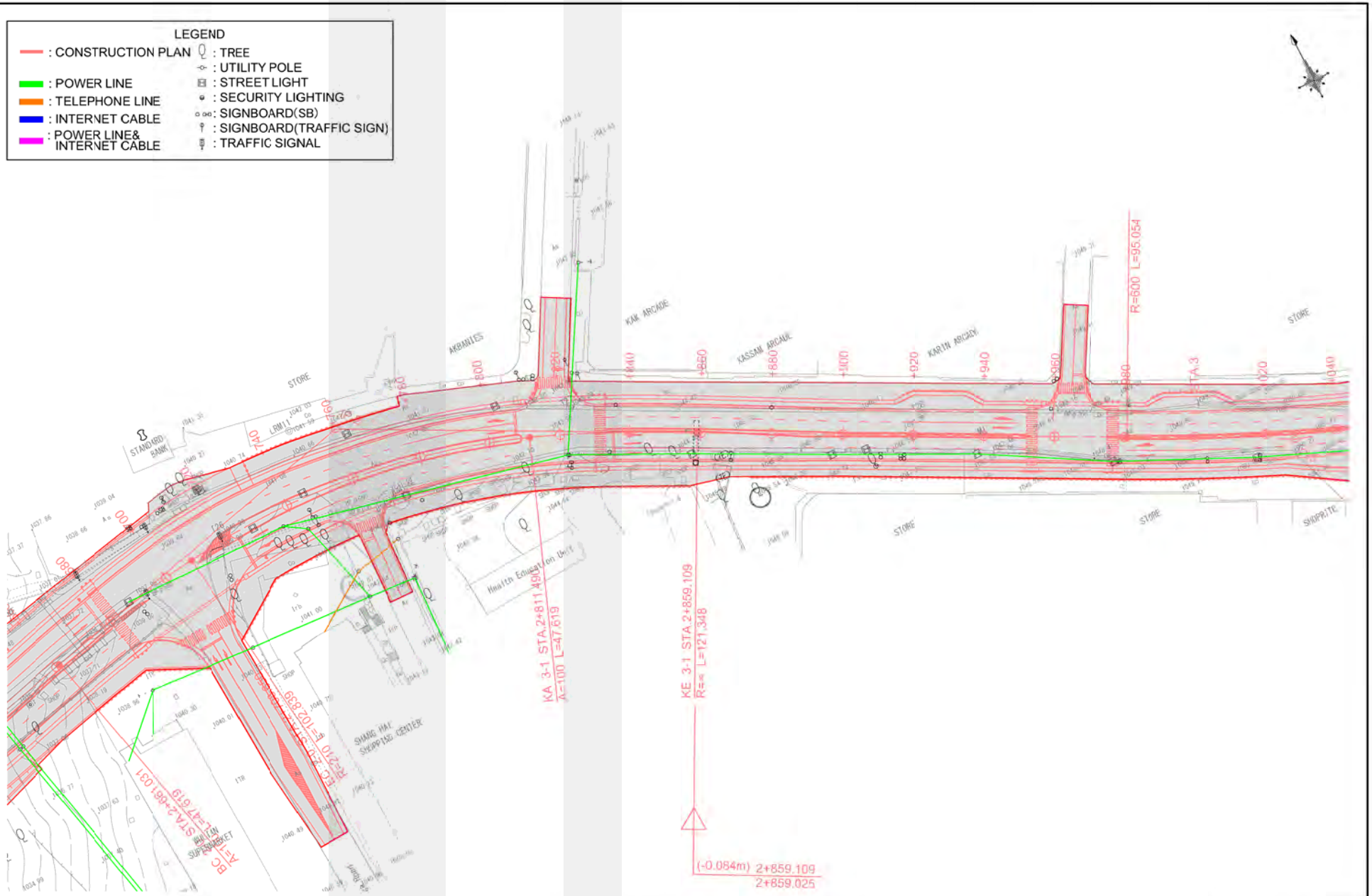
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.1+500 -1+800)	Drawing No.	UG-02
				SCALE	S=1/1000
				DATE	


LEGEND
: CONSTRUCTION PLAN
: POWER LINE
: TELEPHONE LINE
: INTERNET CABLE
: POWER LINE& INTERNET CABLE
: TREE
: UTILITY POLE
: STREET LIGHT
: SECURITY LIGHTING
: SIGNBOARD(SB)
: SIGNBOARD(TRAFFIC SIGN)
: TRAFFIC SIGNAL
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY
JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL
THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE
TITLE :
LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.1+800 - 2+100)
Drawing No. UG-03
SCALE S=1/1000
DATE

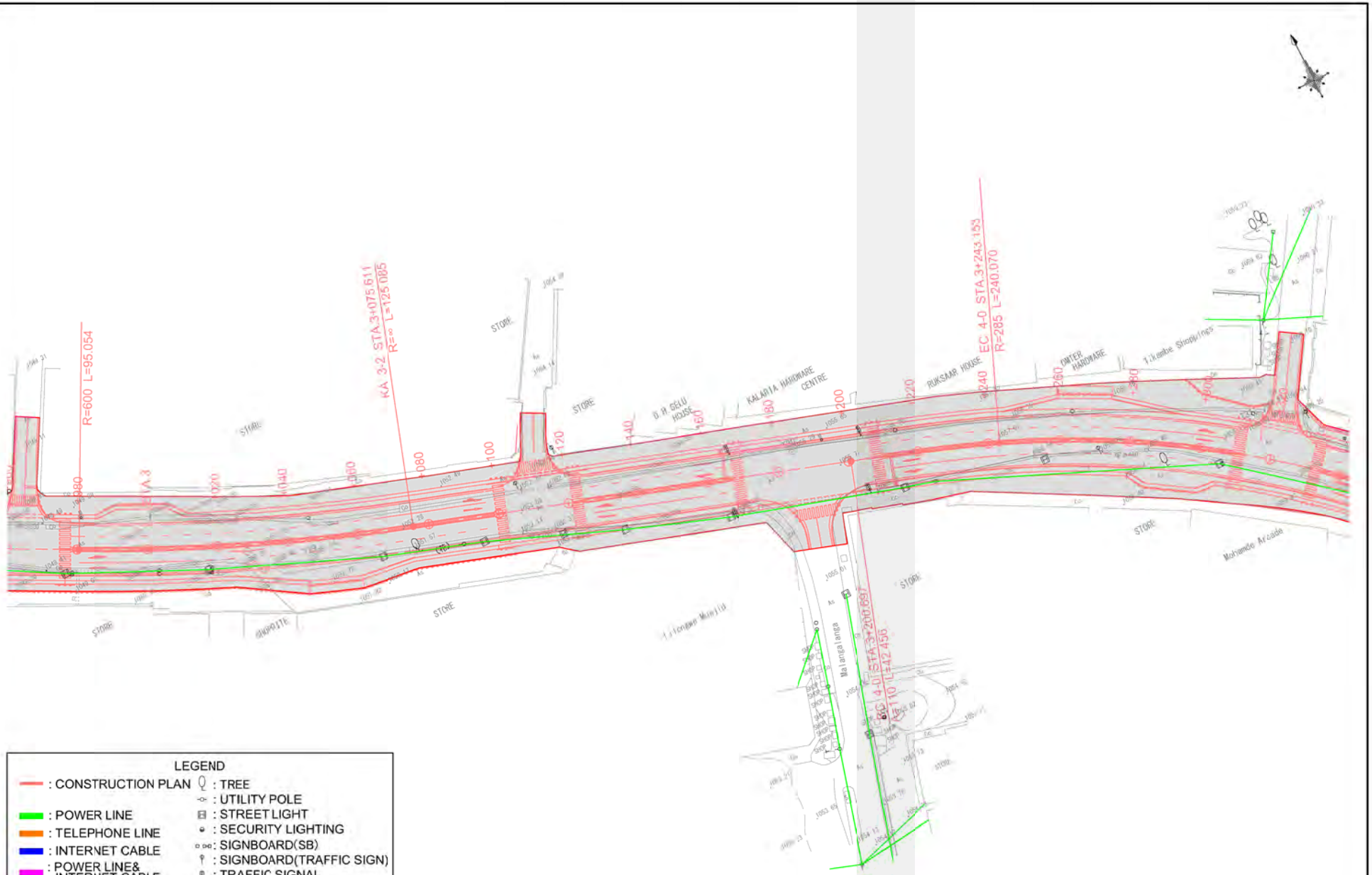


MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.2+100 - 2+400)	Drawing No.	UG-04
				SCALE	S=1/1000
				DATE	

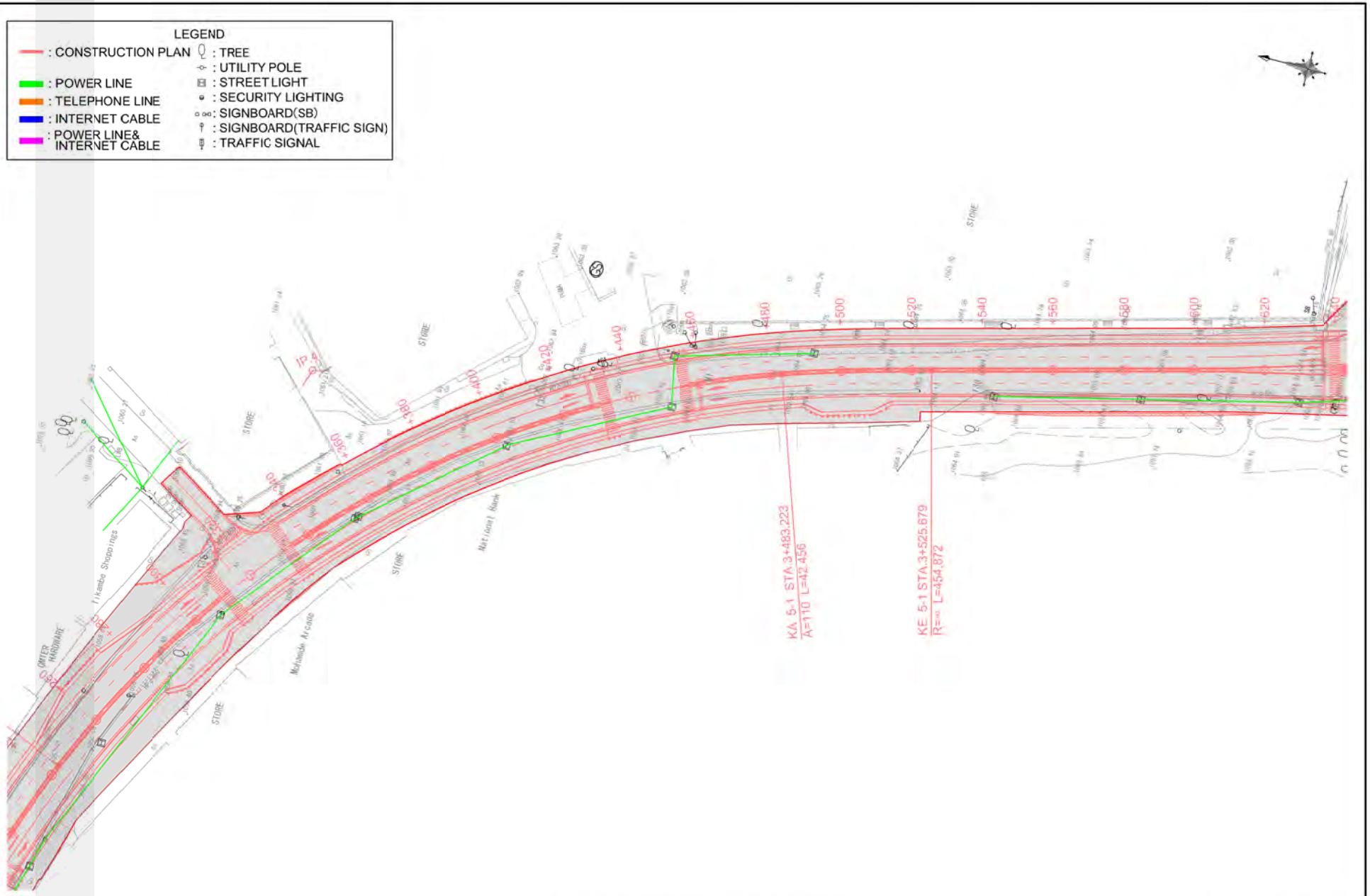

LEGEND
: CONSTRUCTION PLAN
: POWER LINE
: TELEPHONE LINE
: INTERNET CABLE
: POWER LINE& INTERNET CABLE
: TREE
: UTILITY POLE
: STREET LIGHT
: SECURITY LIGHTING
: SIGNBOARD(SB)
: SIGNBOARD(TRAFFIC SIGN)
: TRAFFIC SIGNAL
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY
JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL
THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE
TITLE :
LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.2+400 - 2+700)
Drawing No. UG-05
SCALE S=1/1000
DATE



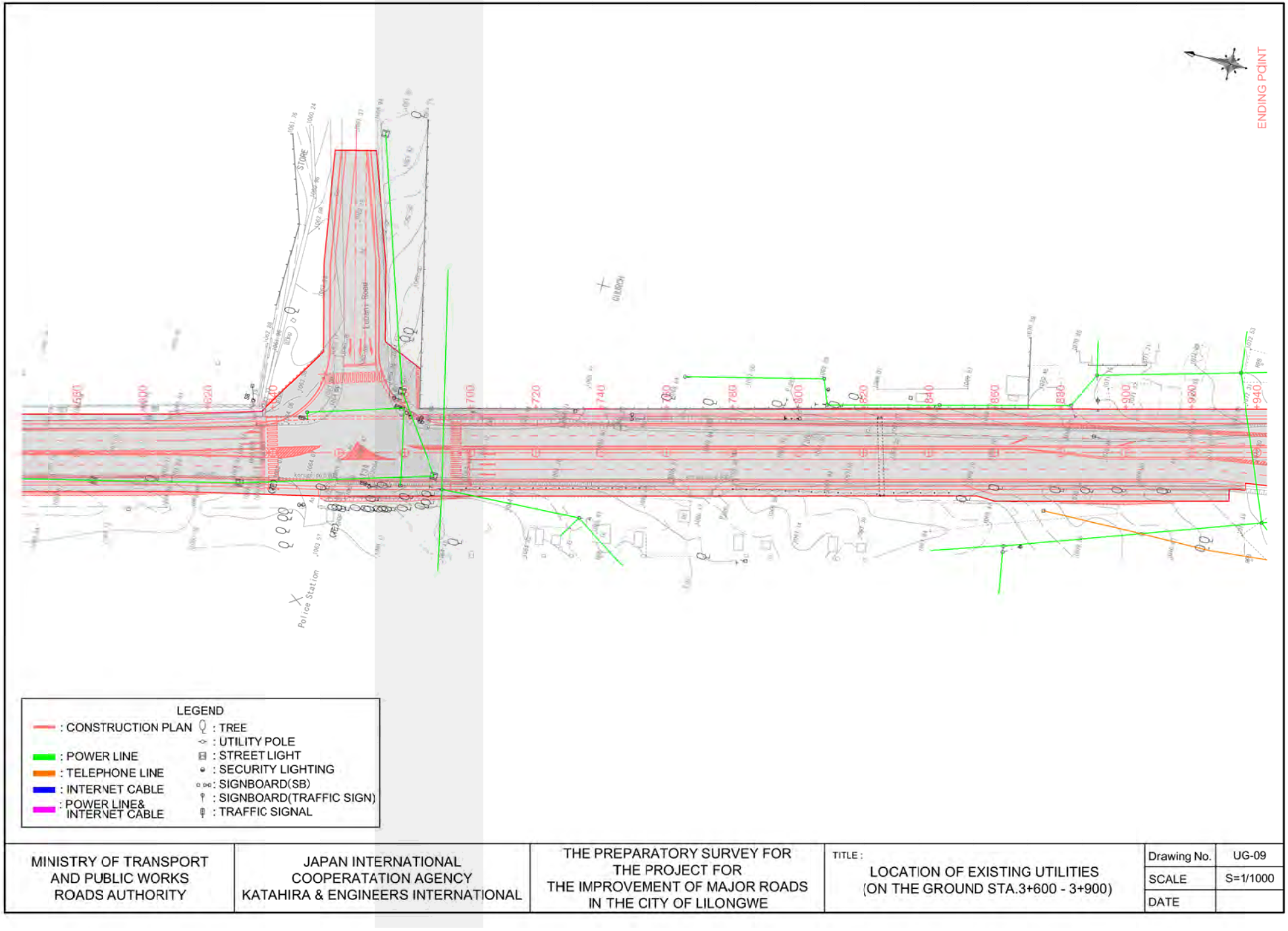
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.2+700 - 3+000)	Drawing No.	UG-06
				SCALE	S=1/1000
				DATE	



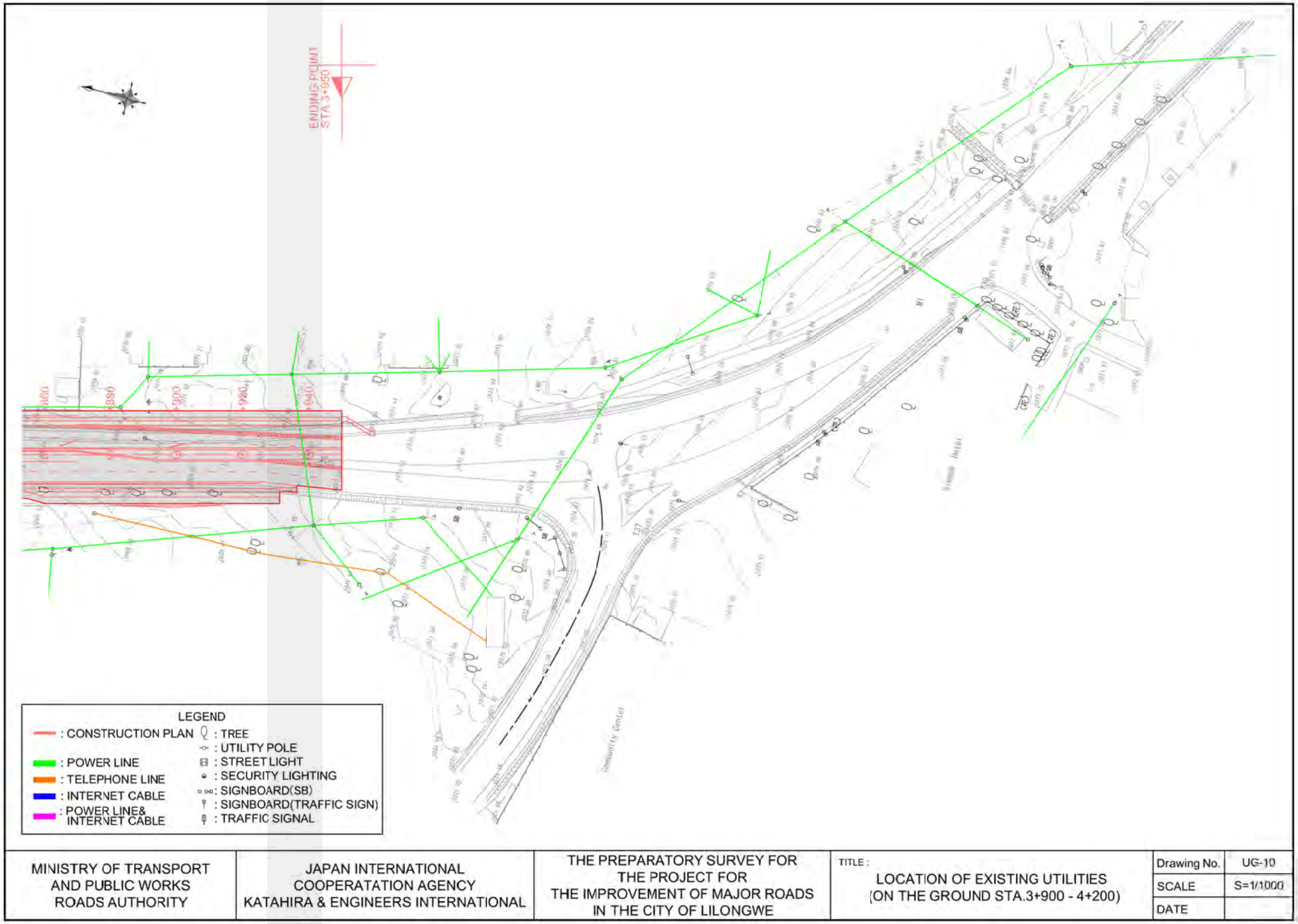
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.3+000 - 3+300)	Drawing No.	UG-07
				SCALE	S=1/1000
				DATE	



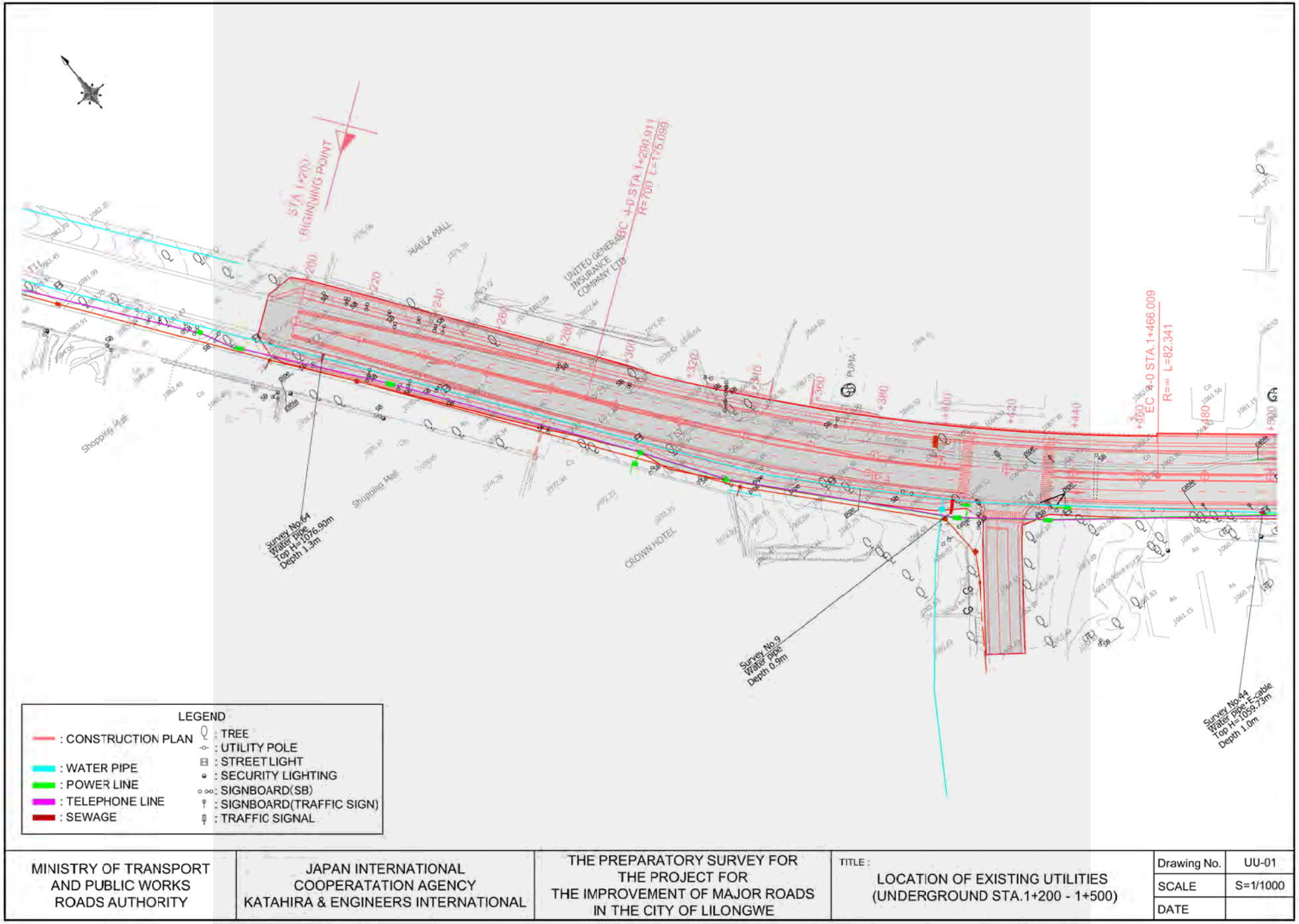
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.3+300 - 3+600)	Drawing No.	UG-08
				SCALE	S=1/1000
				DATE	



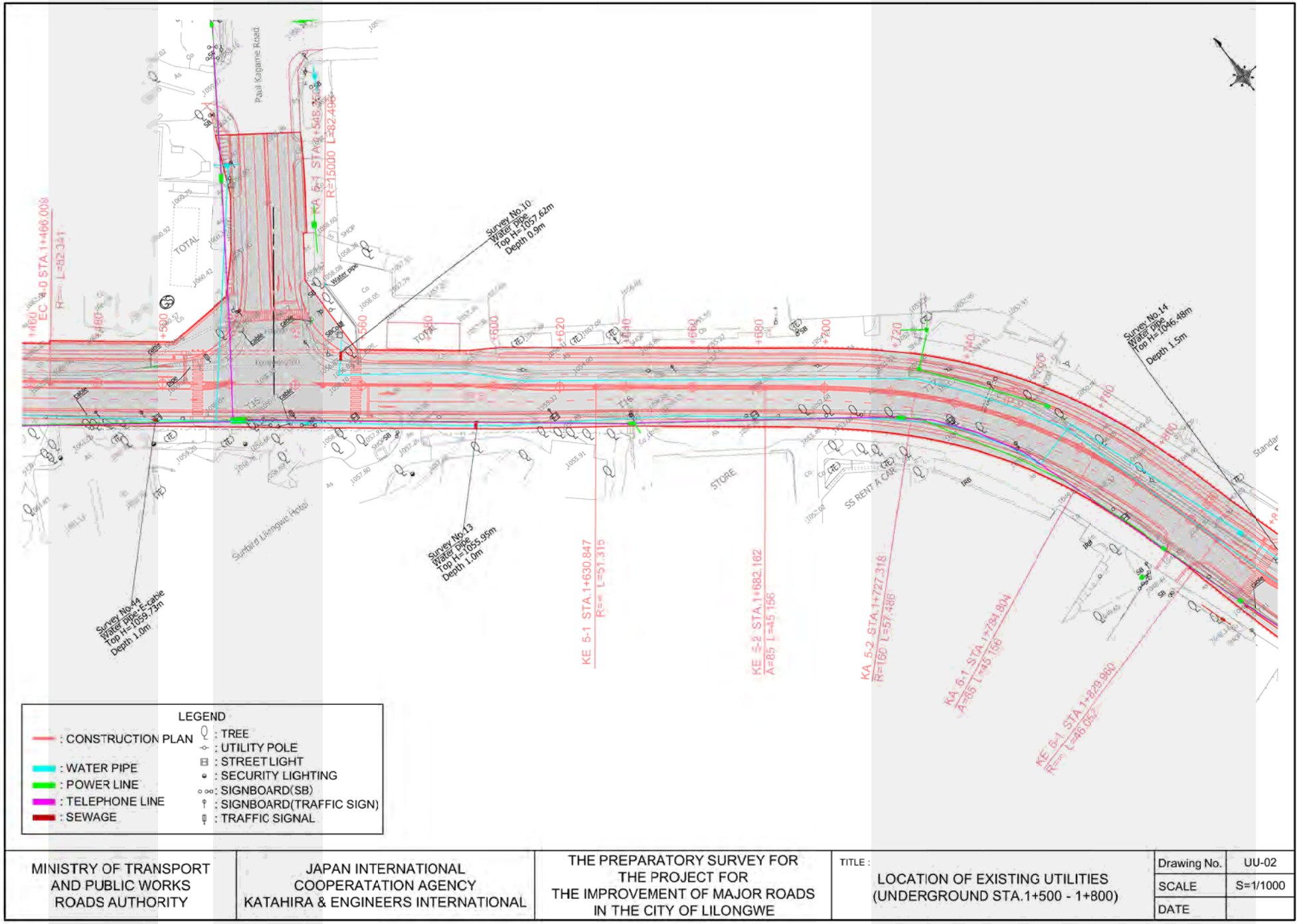
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.3+600 - 3+900)	Drawing No.	UG-09
				SCALE	S=1/1000
				DATE	



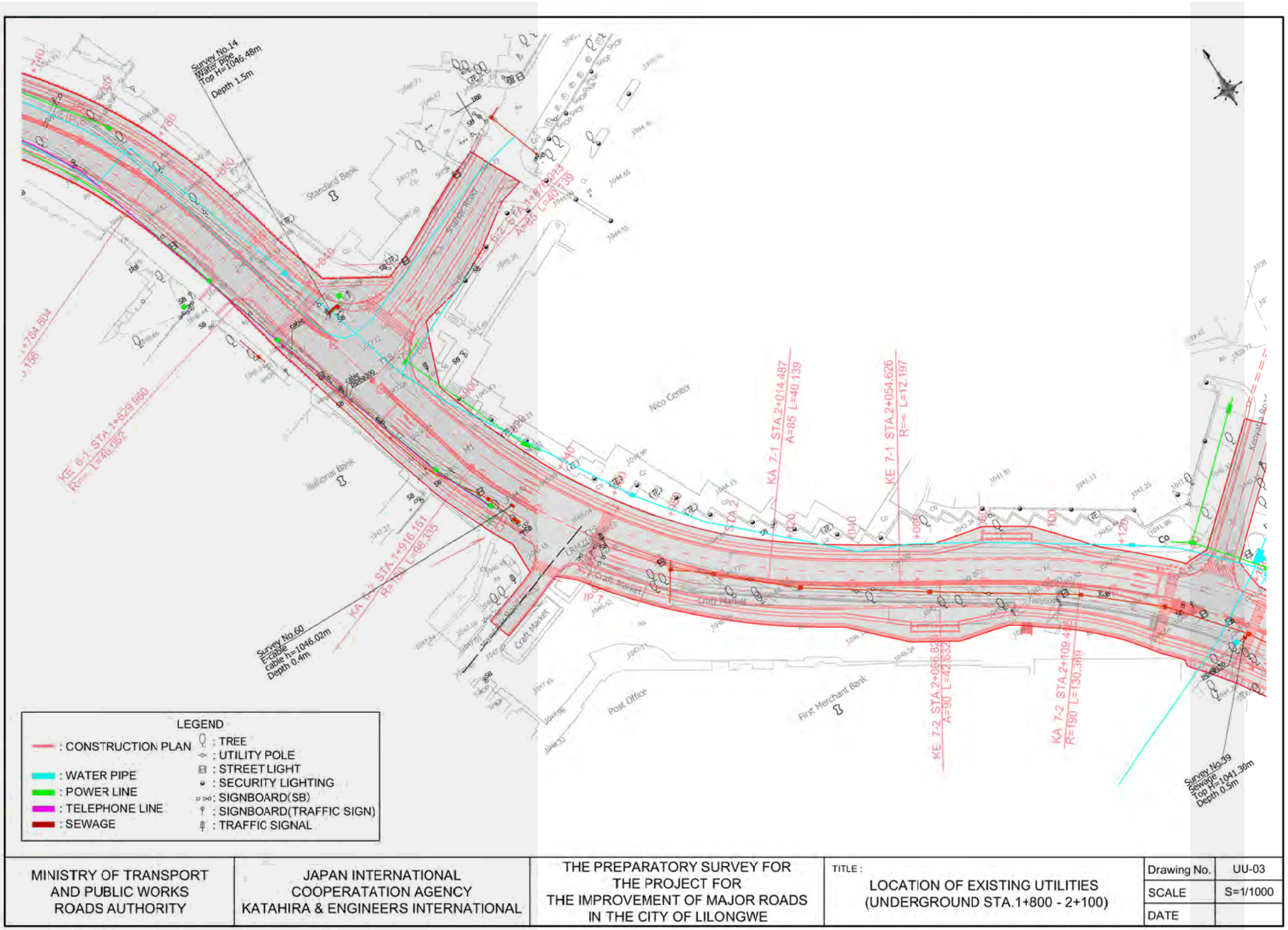
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (ON THE GROUND STA.3+900 - 4+200)	Drawing No.	UG-10
				SCALE	S=1/1000
				DATE	



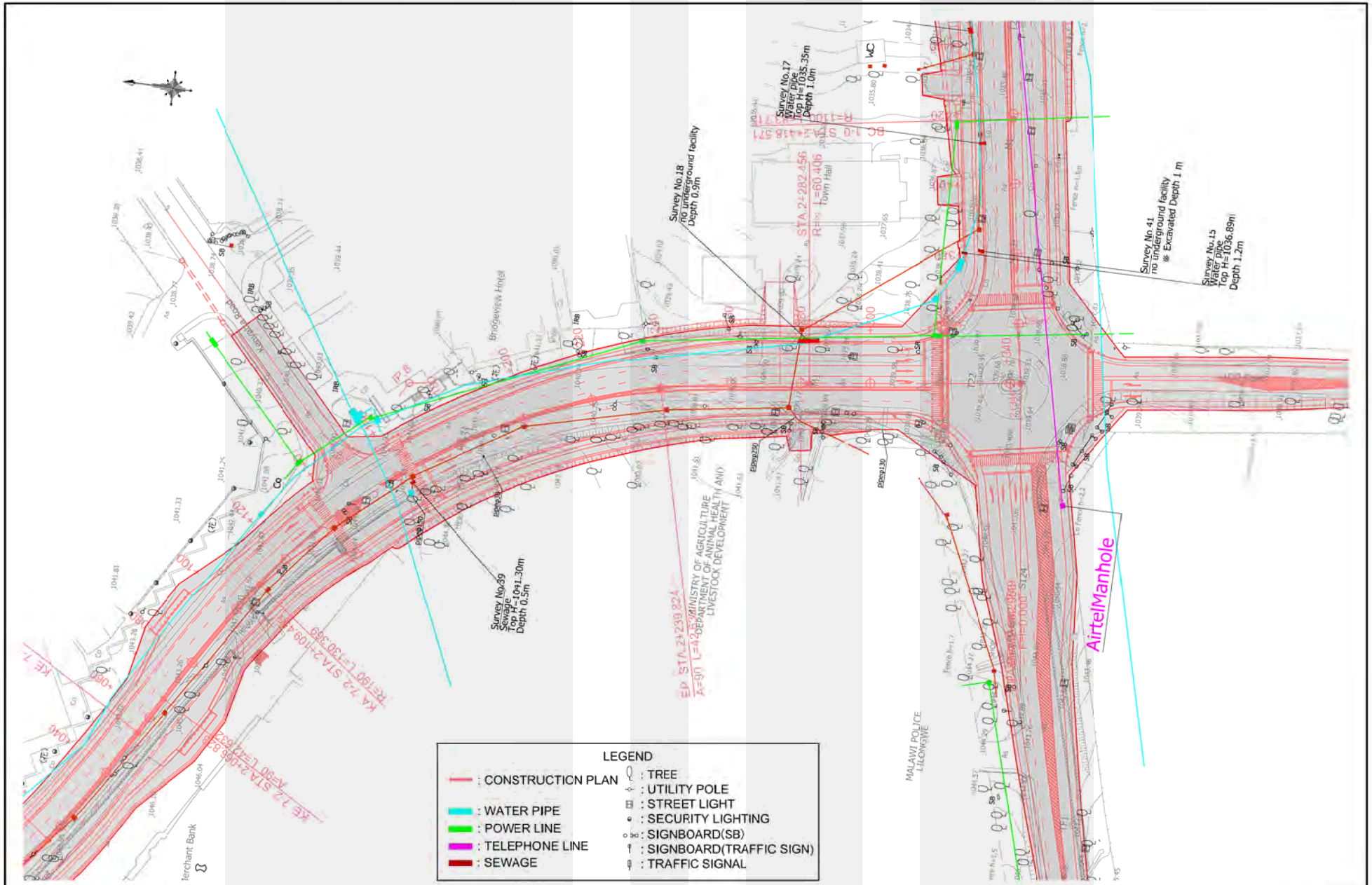
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.1+200 - 1+500)	Drawing No. UU-01 SCALE S=1/1000 DATE



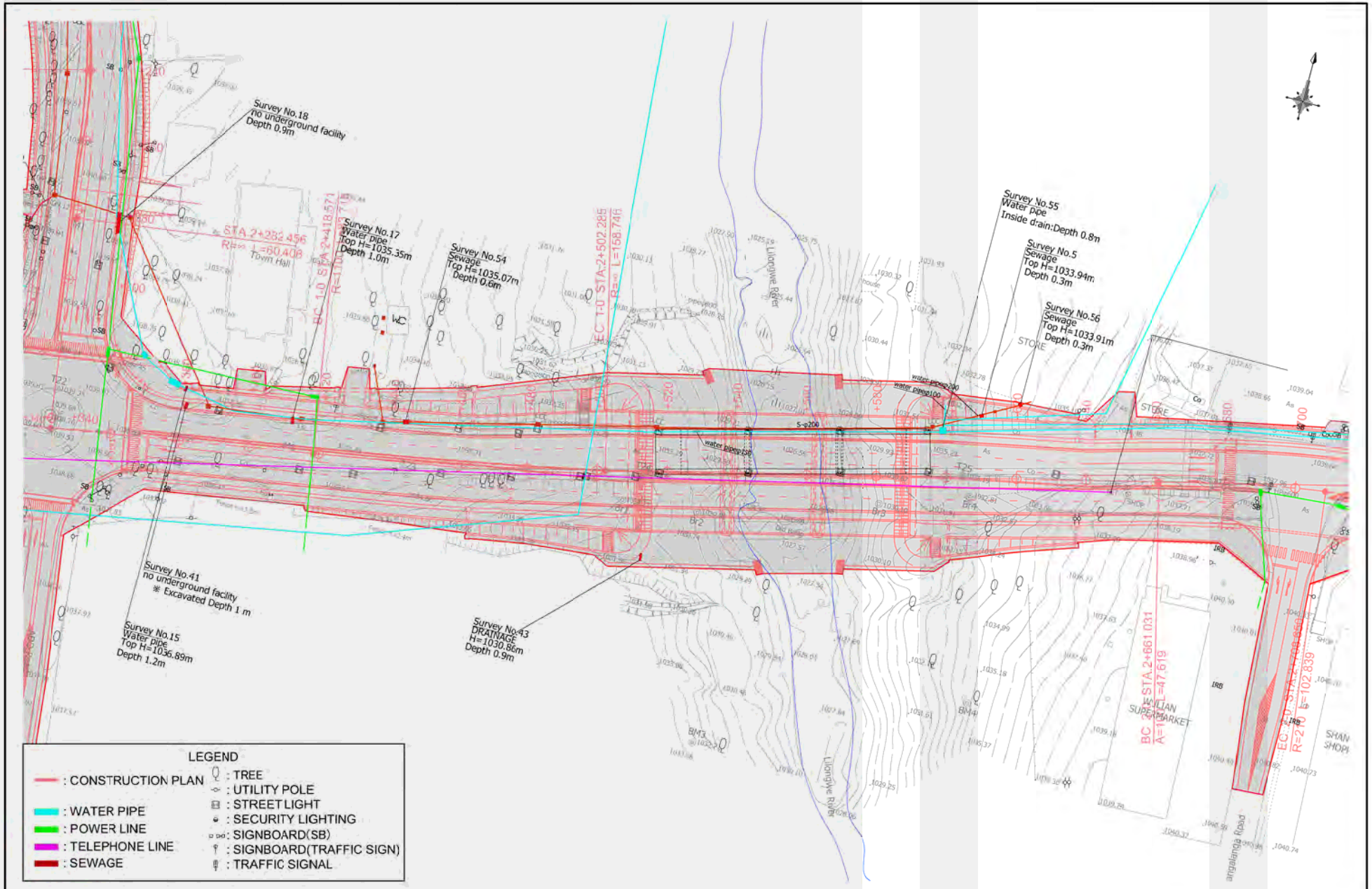
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.1+500 - 1+800)	Drawing No. UU-02 SCALE S=1/1000 DATE



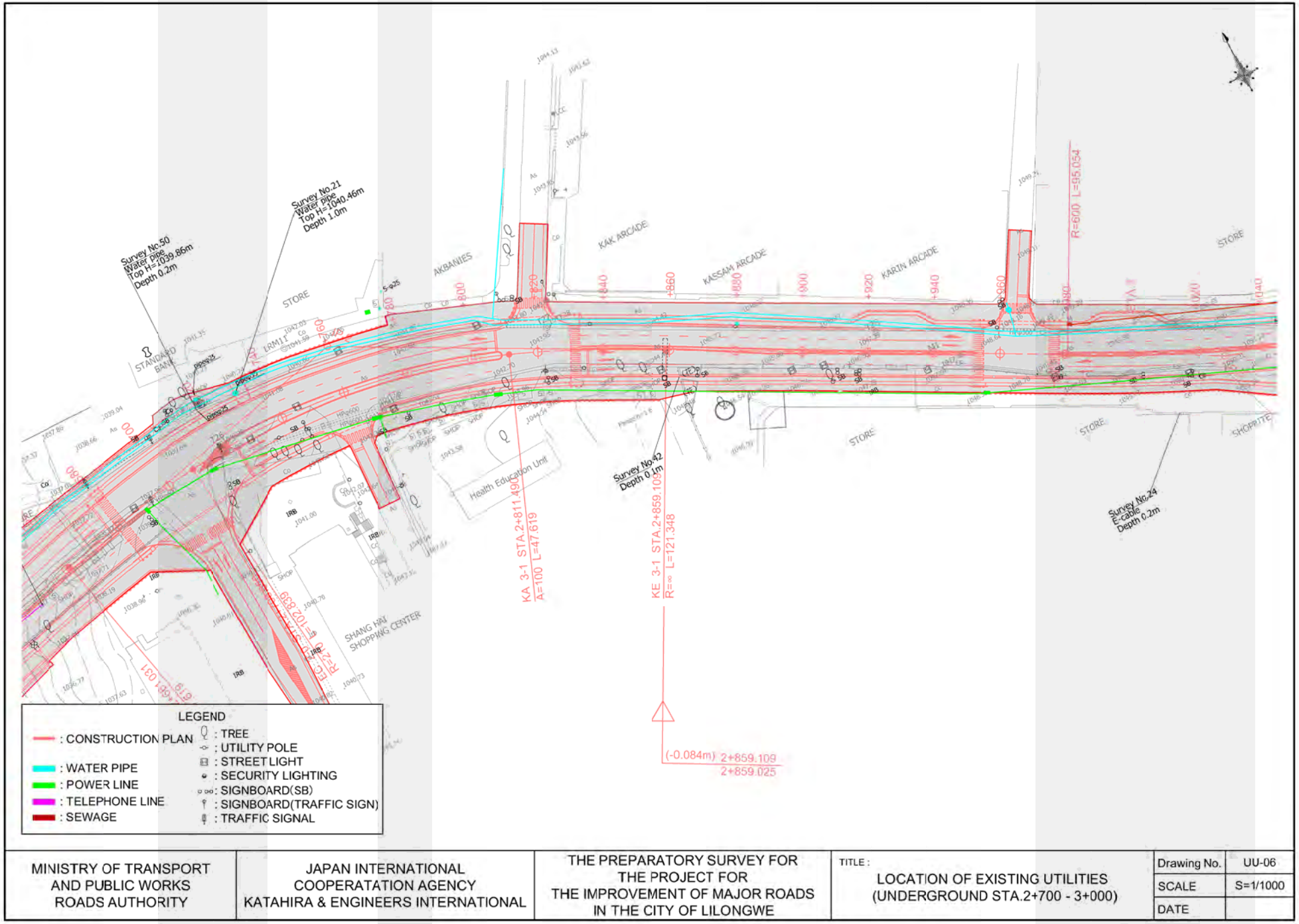
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.1+800 - 2+100)	Drawing No.	UU-03
				SCALE	S=1/1000
				DATE	



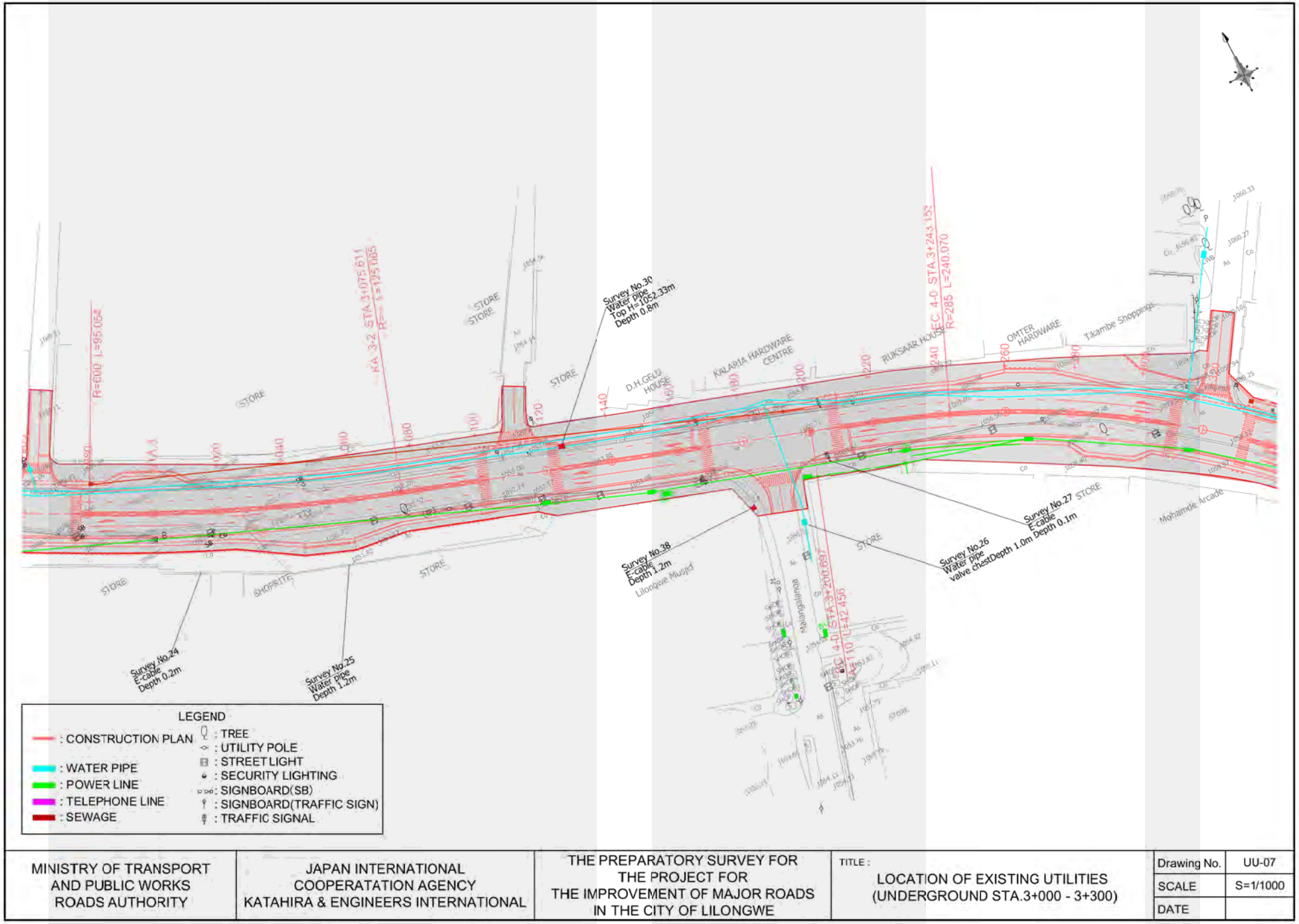
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.2+100 - 2+400)	Drawing No. UU-04 SCALE S=1/1000 DATE



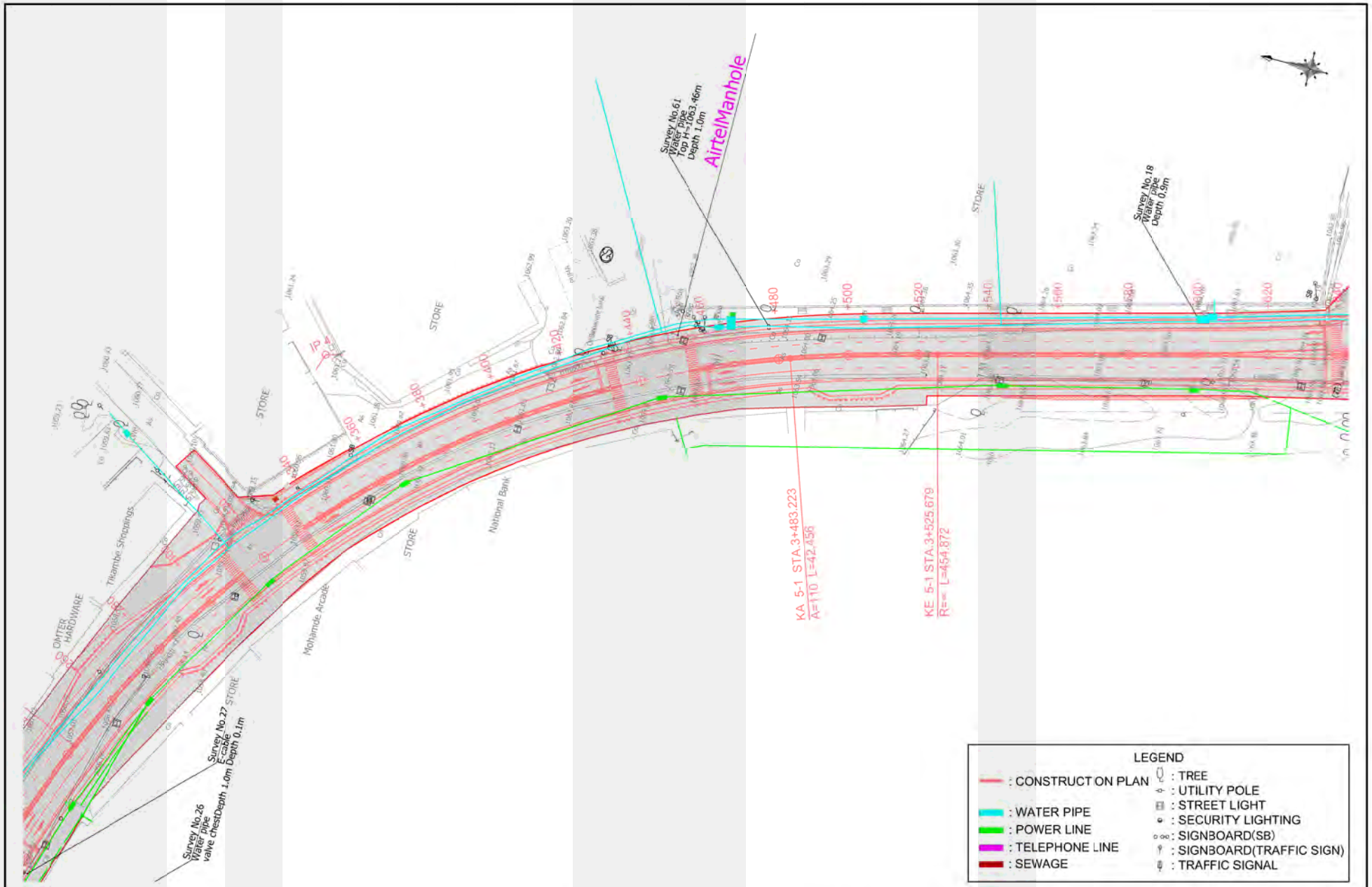
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.2+400 - 2+700)	Drawing No.	UU-05
				SCALE	S=1/1000
				DATE	



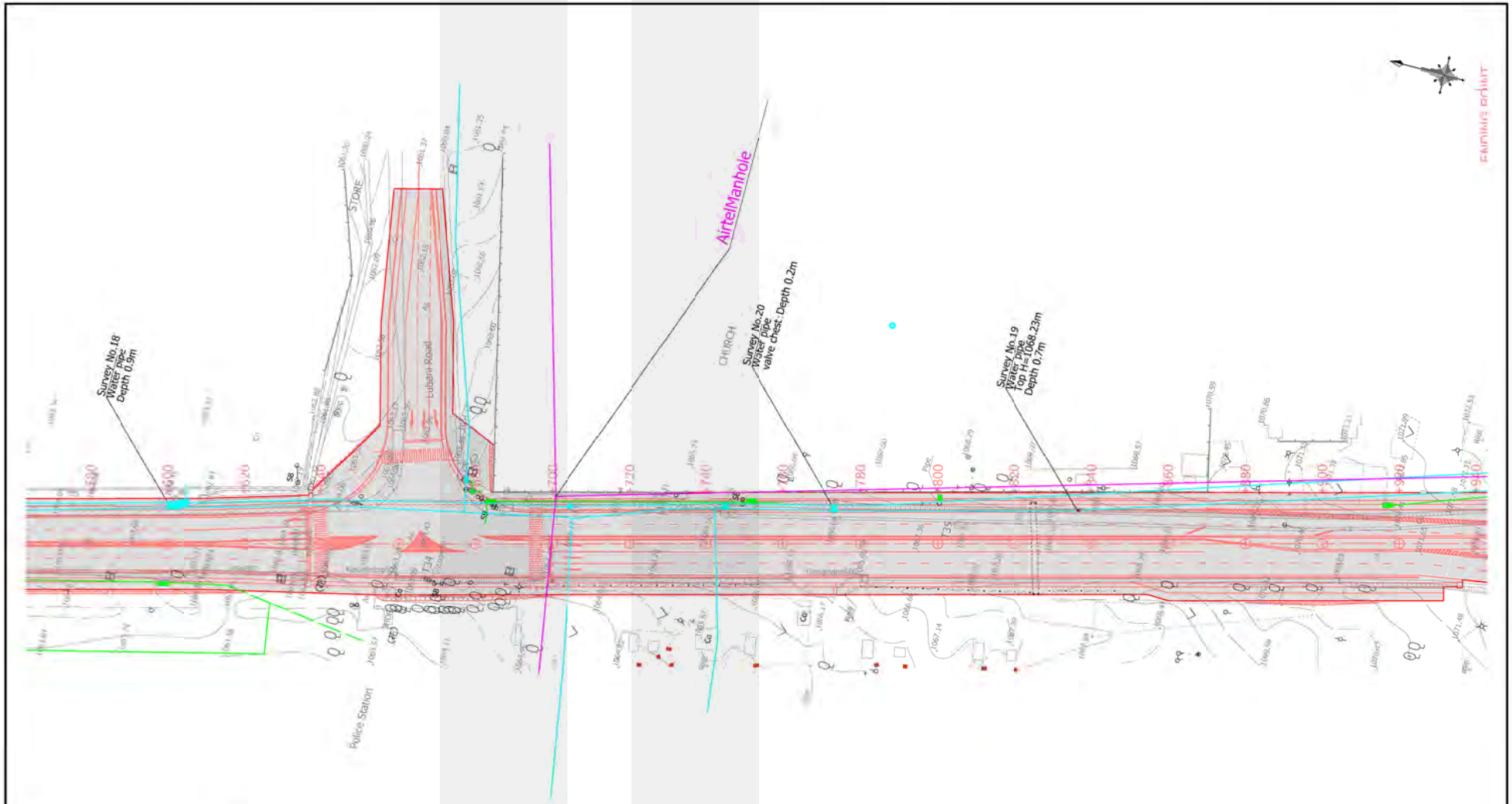
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.2+700 - 3+000)	Drawing No.	UU-06
				SCALE	S=1/1000
				DATE	



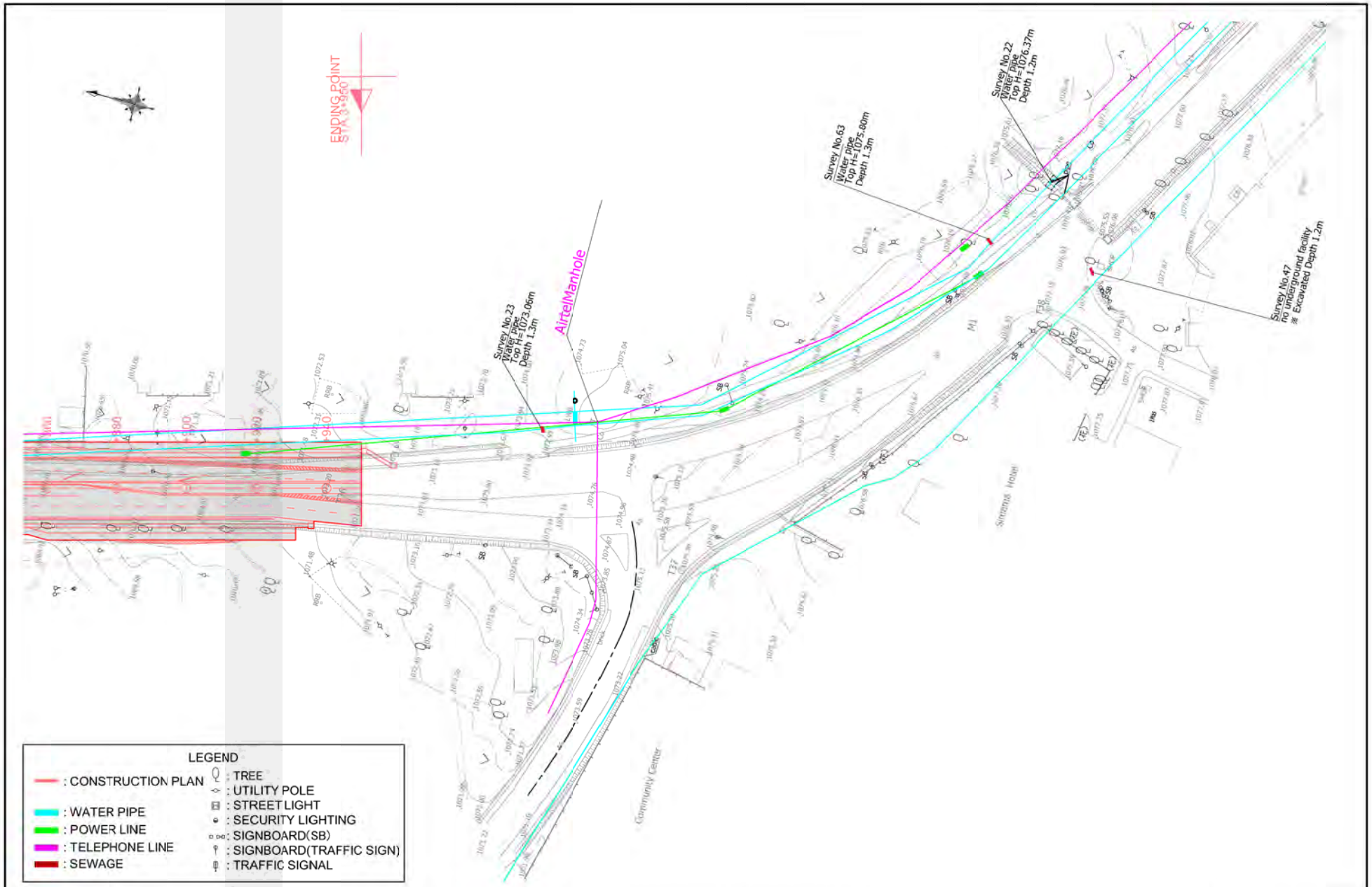
MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.3+000 - 3+300)	Drawing No.	UU-07
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.3+300 - 3+500)	Drawing No.	UU-08
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.3+600 - 3+900)	Drawing No.	UU-09
				SCALE	S=1/1000
				DATE	



MINISTRY OF TRANSPORT AND PUBLIC WORKS ROADS AUTHORITY	JAPAN INTERNATIONAL COOPERATATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY FOR THE PROJECT FOR THE IMPROVEMENT OF MAJOR ROADS IN THE CITY OF LILONGWE	TITLE : LOCATION OF EXISTING UTILITIES (UNDERGROUND STA.3+900 - 4+200)	Drawing No.	UU-10
				SCALE	S=1/1000
				DATE	

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The basic policy for project implementation is presented as follows:

- The governments of Japan and Malawi first conclude the exchange of notes concerning a grant aid scheme for the project, and accordingly the project will be implemented in accordance with Japan's grant aid scheme.
- The MoTPW and the Roads Authority (RA) are responsible for project implementation.
- When it comes to consulting services such as a detailed design and the assistance for tendering and construction supervision, a Japanese consulting firm will make a contract with the RA and undertake the required assignments accordingly.
- A Japanese pre-qualified tenderer who has been awarded the contract by the RA will undertake the project.

The basic construction policy is presented as follows:

- Construction materials and manpower for the project shall be procured in Malawi at the lowest price. If they cannot be procured locally, they will be procured from Japan or a third country which secures the required quality and provides them at the lowest price.
- The construction method and schedule shall correspond to local meteorological, topographical, and geological conditions as well as any natural conditions affecting road and bridge construction works.
- A common construction method which does not require specific machinery or technology shall be adopted if possible.
- Appropriate construction method and management standards shall be adopted, and accordingly a contractor's site management entity and a consultant's construction supervision entity shall be arranged in compliance with them.
- Safety of construction workers and third parties shall be thoroughly secured during construction. In particular, education or training programs shall be implemented concerning environmental considerations and AID/HIV.
- The followings will be implemented for environmental protection:
  - Precautionary measures shall be taken to prevent water pollution in the existing gutters or rivers due to construction and the ensuing sediment runoff in the flooding period.
  - Asphalt plants, concrete plants, borrow pits, and quarry sites will be procured by suppliers who consider or are considering measures to reduce environmental impacts.
  - Construction wastes shall be appropriately discarded at a disposal area designated by the Government of Malawi.

2-2-4-2 Cautions for Implementation

As far as the construction plan and method are concerned, the first priority shall be given to safety of third parties and those engaged in construction. In addition, the construction plan and method shall be determined in a way to mitigate environmental impacts on road users and roadside residents.

Cautions Concerning Present Road Conditions

The project road is an important trunk road that runs through the center of Lilongwe City and has caused traffic congestion especially in the morning and evening, greatly hampering civic life such as a commute to the workplace, a school, and a hospital.

Therefore, it is critical to set up a construction plan which can secure safety and traffic of road users and mitigate environmental impacts on roadside residents.

Cautions Concerning Present Roadside Facilities

The project is designed to maintain the urban road, which serves as an important community road for Lilongwe citizens and a main arterial road. Concerning construction, securing safe traffic should be prioritized, and the complete road shutdown should be avoided during construction. Also, it is necessary to carry out construction while sufficiently considering environmental impacts on residents.

Cautions Concerning Bridge Replacement

For reconstruction of the Lilongwe River Bridge, a temporary bridge will be installed upstream of the existing bridge after securing detour roads for vehicles and pedestrians.

As a result of comparative examination, the location of a temporary bridge was determined to be that of Proposal 4 as shown in Table 2-2-12 in terms of constructability because the suggested alignment is excellent and has some distance from the main bridge.

Since the Old Market and shops are densely located in the vicinity, it is crucial to come up with a construction plan which can secure safety and convenience of pedestrians and mitigate environmental impacts during construction.

Cautions Concerning Meteorological Conditions

The annual rainfall in Lilongwe City amounts to about 800 mm. However, the rainfall exceeds 200 mm in the middle month of the rainy season between December and March, and thereby only a part of construction works can be implemented. In this regard, it is necessary to put a halt to construction works according to weather conditions, and the bridge pier construction should be completely suspended during the rainy season between December and February, when the water level of the Lilongwe River rises.

In addition, a construction plan or schedule with enough time will be examined in that it is difficult to carry out pavement construction on rainy days.

Safety Considerations for Roadside Residents and Construction Personnel

During construction, a temporary carriageway and sidewalk will be provided within the right-of-way to secure smooth traffic at critical road sections.

(i) Safety of Roadside Residents

- Clearly define the construction site and the construction-related area and prohibit entrance except the construction personnel;
- Take measures to prevent traffic accidents by implementing safety education for material handling vehicles; and
- Ensure proper traffic guidance during construction.

(ii) Safety of the Construction Personnel

- Displace a guard to prevent minor collisions when using heavy construction machinery.

(iii) Environmental Considerations

- Carry out appropriate disposal of demolished pavement and structures without placing a burden on the environment;
- Select borrow pits which give minimum impacts on the surroundings in consultation with the implementing entity;
- Avoid morning and night times when carrying out construction methods which cause vibration

and noise;

- Implement dust control measures by construction vehicles, e.g., spraying water; and
- Provide, publicize, and educate information on labor safety and sanitation, natural environmental protection, and public health including prevention measures against malaria, sex-related diseases, and AIDS/HIV to the construction personnel.

2-2-4-3 Scope of Construction Works

Undertakings of both governments of Japan and Malawi are listed in Table 2-2-14.

Table 2-2-14 Undertakings of the Two Governments

Items	Contents	Undertaken by		Remarks
		Japan	Malawi	
Procurement of Materials and Equipment	Procure and transport construction materials and equipment	○		
Preparatory Works	Acquire land and right-of-way		○	A site office, a stock yard, a work shop, and a plant yard
	Relocate encroached kiosks and other facilities		○	
	Secure borrow pits and dump sites		○	
	Secure waste disposal areas		○	
	Other preparatory works	○		
Relocation and Removal of Construction Obstacles	Relocate underground and aerial obstacles		○	
	Demolish existing footbridges		○	
	Demolish existing traffic lights		○	
	Demolish existing street lights		○	
	Demolish or relocate existing trees		○	
	Relocate existing water pipe and sewer pipes on the existing bridge	○		
	Install water pipes and sewer pipes on a new bridge	○		
	Connect water pipes and sewer pipes on a new bridge	○		
Main Works	Construct a road	○		
	Construct a bridge	○		
Ancillary Works	Install traffic signals	○		
	Install street lights	○		
	Install traffic safety facilities	○		

2-2-4-4 Construction Supervision Plan

A Japanese consultant will carry out a detailed design and assist implementing agencies in tendering and construction supervision based on a consulting service contract concluded with Government of Malawi.

(1) Detailed Design and Tender-Related Services

The consultant's main activities are as follows:

Detailed Design Services

The following detailed design services shall be carried out by the consultant:

- To confirm the contents of the project with implementing agencies in Malawi through initial consultation, a field study, and a detailed design;
- To review the detailed design and drawings wherever necessary;
- To review a procurement plan and a project cost estimate wherever necessary; and
- To assist the Malawi side with its relocation of the obstacles.

Tender Related Services

The following tender-related services shall be carried out by the consultant in the period from tender preparation to a construction contract.

Tender Related Services 1

- Prepare tender documents in parallel with detailed design services; and
- Obtain an approval on tender documents from the Government of Malawi.

Tender Related Services 2

- Announce a tender;
- Review pre-qualification of bidders
- Carry out tender procedures;
- Evaluate tender documents; and
- Facilitate contract conclusion.

(2) Construction Supervision Services

The following construction supervision services shall be carried out by the consultant based on a construction contract and a construction plan. Major items are as follows:

- Inspect and approve site surveys;
- Inspect and approve a construction plan;
- Control construction quality;
- Manage a construction schedule;
- Supervise construction outputs;
- Supervise safety issues; and
- Carry out final inspection and delivery.

For construction supervision, a permanent supervising engineer mainly in charge of bridge construction and an assistant supervising engineer mainly in charge of road construction will be displaced. In addition, a pavement specialist who supervise and guide the combination of asphalt compounds and supervise pavement construction will be displaced at the first half of pavement construction period. When it comes to construction, the consultant will consult and coordinate with a safety manager of the contractor to prevent any accidents at the construction site.

2-2-4-5 Quality Control Plan

Quality control plans for concrete works and earth and pavement works are shown in Table 2-2-15 and Table 2-2-16 respectively.

Table 2-2-15 Quality Control Plan for Concrete Works

Item	Test Item	Test Method (Specification)	Test Frequency
Cement	Physical property test	AASHTO M85	Once before a trail mix, once in every 500m^3 of concrete placing or when a raw material is changed.
Fine Aggregate	Physical property test	AASHTO M6	Once before a trail mix, once in every 500m^3 of concrete placing or when a supply spot is changed.
	Sieve analysis	AASHTO T27	Once a month
Course Aggregate	Physical property test	AASHTO M80	Once before a trail mix, once in every 500m^3 of concrete placing or when a supply spot is changed.
	Sieve analysis	AASHTO T27	Once a month
Water	Quality test	AASHTO T26	Once before a trail mix
Concrete	Slump test	AASHTO T119	Twice a day
	Air content test	AASHTO T121	Twice a day
	Compressive strength test	AASHTO T22	Six samples for each concrete placing. Six samples for every 75 m^3 of concrete placing in case of a large placing number for each time (Three samples for seven-day strength and three for 28-day strength).
	Temperature test	—	Twice a day
	Salinity test	—	Twice a day

Table 2-2-16 Quality Control Plan for Earth and Pavement Works

Item	Test Item	Test Method (Specification)	Frequency of Tests
Embankment	Field density test	AASHTO T191	For every 500 m^3
Subgrade and Base Course	Filed compaction test	AASHTO T180	Before a pilot construction, and when a construction material is changed.
	Modified CBR	AASHTO T193	Before a pilot construction, and when a construction material is changed.
	Field density test	AASHTO T191	Twice for every 1,000 m^2
Asphalt Concrete (Surface and Binder Course)	Sieve analysis of aggregates	AASHTO T27	Before a pilot construction, and when a construction material is changed.
	Abrasion test of aggregates	AASHTO T96	Before a pilot construction, and when a construction material is changed.
	Density test of asphalt mixture	AASHTO T166	Twice for every 1,000 m^2
	Temperature of asphalt mixture	-	Once for every truck

2-2-4-6 Procurement Plan

(1) Procurement Plan for Construction Materials

Most of construction materials that can be procured locally are imported from the neighboring countries including South Africa and are constantly supplied to the market. Native materials are rubbles, low-strength cement, and wood.

In particular, bridge equipment and machinery which require high quality and accuracy, e.g., PC strands, expansion joints, rubber bearings, erection girders, and steel frames for main beams are imported from Japan.

For street lights and traffic signals, it is easy to procure those with a commercial power system and advantageous for future maintenance and management and accordingly they will procured from South Africa.

Rubbers will be procured from quarry sites in operation around 25 km southeast of the project section of the M1 road in the vicinity of Nathenge.

The procurement plan for major construction materials is presented in Table 2-2-17.

Table 2-2-17 Procurement Plan for Major Construction Materials

Item	Procured from			Remarks
	Malawi	Japan	Third Country	
Cement	○		○	Procured from neighboring countries including South Africa
Cement Additives	○		○	－ ditto －
Straight Asphalts	○		○	－ ditto －
Asphalt Emulsion	○		○	－ ditto －
Crushed Stone and Sand (for concrete)	○			
Subgrade Materials	○			
Wooden Materials for Formworks	○			
Rebar: D9～D32	○		○	－ ditto －
H Steel Materials	○		○	－ ditto －
Concrete Products	○			Items limited (produced by a contractor)
PC Materials		○		
Expansion Joints		○		
Rubber Bearings		○		
Temporary Steel Materials for Main Beams	○	○		
Steel Frames for Main Beams		○		
Marking Paints	○		○	Procured from neighboring countries including South Africa
Road Signs	○		○	－ ditto －
Street Lights			○	Procured from neighboring countries including South Africa
Traffic Signals			○	－ ditto －
Plywood	○		○	Procured from neighboring countries including South Africa
Electric Welding Rods	○		○	－ ditto －
Oxygen and Acetylene	○		○	－ ditto －

(2) Procurement Plan for Construction Machinery

Steel wire jacks and erection girders for main beams will be procured from Japan because local procurement is extremely difficult.

Asphalt plants and concrete plants will be imported from Japan in order to ensure the quality and the supply of asphalt (especially high-strength asphalt) and concrete for the project.

Down-the-hole-hammers used to place abutment piles are imported from Japan.

The procurement policy for construction machinery is as shown in Table 2-2-18.

General types and models of construction machines which are owned by local contractors will be leased.

Table 2-2-18 Procurement Plan for Construction Machinery

Equipment	Size	Lease/ Purchase	Procured from			Transport Route
			Malawi	Japan	Third Country	
Backhoe	0.8 m^3	Lease	○			
Wheel Loader	2.4 m^3	Lease	○			
Dump Truck	10 t	Lease	○			
Truck Crane	20 t	Lease	○			
Crawler Crane	40 t	Lease	○			
Crawler Crane	80 t	Lease	○			
Trailer Truck	20 t	Lease	○			
Motor Grader	3.7 m	Lease	○			
Macadam Roller	10-12 t	Lease	○			
Tire Roller	8-20 t	Lease	○			
Vibration Roller	3-5 t	Lease	○			
Tamper	60-100 kg	Lease	○			
Asphalt Finisher	2.4-4.5 m	Lease	○			
Distributer	3,000 liters Self-propelled	Lease	○			
Water Spreading Truck	6,000 liters	Lease	○			
Concrete Mixer	0.5 m^3	Lease	○			
Concrete Plant	30 m^3/hr	Lease		○		Japan～ Tanzania～ Malawi
Asphalt Plant	30 t/hr	Lease		○		-ditto-
Down-the-hole Hammer	508-762 mm	Lease		○		-ditto-
Tension Jack and Pump	For 2200 KN (225 t) type	Lease		○		-ditto-
Erection Girder for Main Beams	For a precast T-beam	Lease		○		-ditto-

2-2-4-7 Initial Operation Instruction and Operation Instruction Plans

No particular initial operation instruction and operation instruction plans will be considered for the project.

2-2-4-8 Soft Component (Technical Assistance) Plan

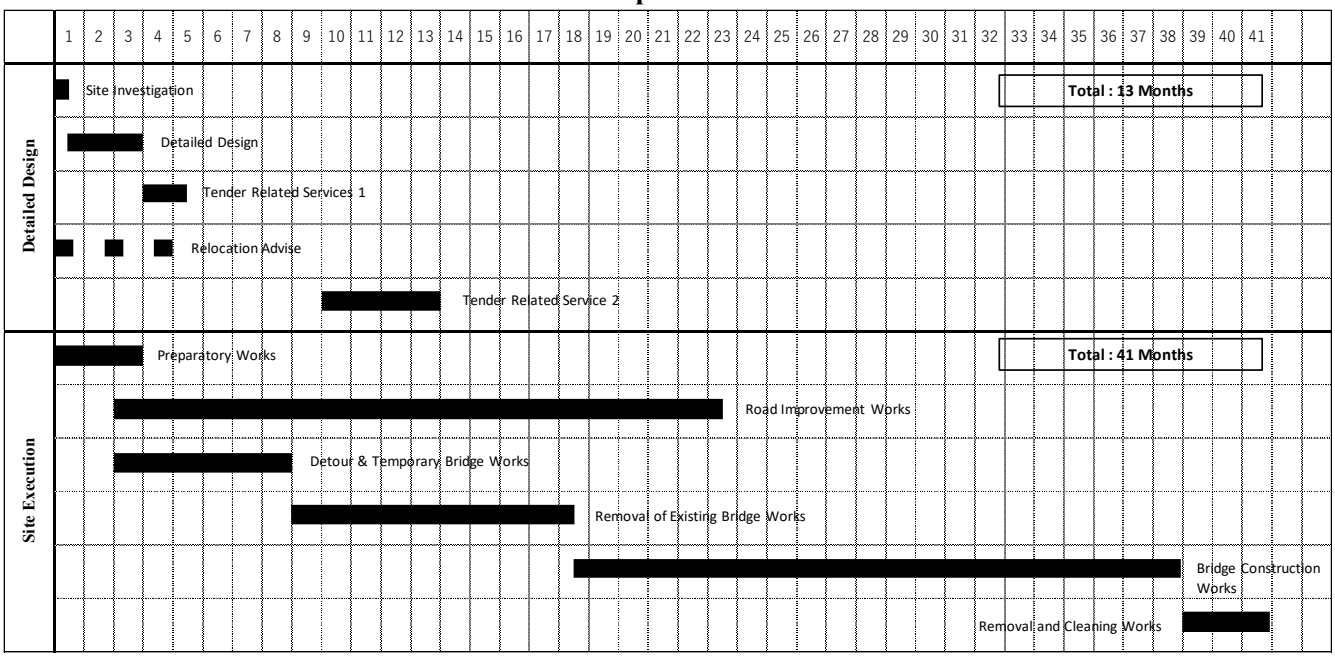
The project does not entail any soft component.

However, the relocation advisor from the consultant will assist the Malawi side in its relocation of the obstacles during the detailed design stage.

2-2-4-9 Implementation Schedule

An implementation schedule for a detailed design and project implementation is shown in Table 2-2-19.

Table 2-2-19 Implementation Schedule



2-2-4-10 Emergency Response Plan

Regarding the latest macroscopic and microscopic public security conditions, a broad range of detailed information shall be collected through various sources such as JICA's Malawi Office, Japanese embassy, the local police, newspapers, the Internet, and Malawian counterparts.

Japanese consultants and contractors will be necessarily enrolled for the Overseas Travel Registration, or "Tabi-Regi" of Japanese Ministry of Foreign Affairs, which is aimed at a quick response for emergencies. Furthermore, the emergency contact network will be established right after construction starts, thereby preparing for potential emergency situations.

The information on contact points in the following organizations shall be listed in the emergency contact network chart.

- **Malawi: Embassy of Japan in Malawi, JICA Malawi Office, the consultant, the contractor, and the implementing agency of Malawi**
- **Japan: Japanese Ministry of Foreign Affairs, JICA Headquarter, the consultant, and the contractor**

In addition, local hospitals which will accommodate patients transported in an emergency shall be specified, and insurance services which can provide emergency transport services on a 24/7 basis shall be fully utilized.

2-2-4-11 Safety Management Plan

In order to ensure construction safety, the contractor will formulate a safety management plan in accordance with JICA's ODA Construction Safety Management Guidance and implement safety management based on the plan after obtaining an approval from the client and the consultant.

Moreover, a safety specialist shall be assigned by the contractor in order to prevent accidents to not only the construction personnel but also third parties who are highly likely to access to the construction site due to it's location adjacent the existing road.

2-3 Obligations of the Recipient Country

The Government of Malawi shall undertake the following measures on condition that the grant aid by the Government of Japan is extended to the project:

- To provide data and information necessary for the project (including necessary measures for incidents occurred during construction);
- To secure the land necessary for project implementation such as the land for construction sites, stock yards, workshops, and field offices;
- To provide borrow pits, quarry sites, and waste disposal sites;
- To pay commissions to a Japan-based bank for its service which provides a bank account for the project;
- To provide tax exemption on material and equipment imports, streamline customs clearance on them, and expedite inland transportation;
- To provide tax exemption on purchase of goods and services necessary for the project, e.g., exemptions from value added tax, excise tax, and corporate tax;
- To take necessary legal actions to ensure that Japanese nationals who engage in the project and third country nationals recognized by the Government of Malawi can enter and stay in Malawi;
- To give all necessary permission for project implementation, e.g., environmental impact assessment (EIA) approval, construction permission, traffic control permission during construction, permission on the installation of detour roads, and earthwork permission;
- To remove or relocate all obstacles in the project road including electric poles and wires, telephone poles and cables, optical fiber cables, water pipes, sewer pipes, traffic signals, traffic signboards, a foot bridge, street lights and billboards (except for water/sewer pipes on the bridge);
- To secure the land required for the project before construction begins;
- To compensate project affected persons (PAPs) based on the abbreviated resettlement action plan (ARAP)
- To properly utilize, maintain, and manage the road after project completion;
- To coordinate in solving any project-related issues occurred with residents and/or third parties;
- To bear all the expenses other than those covered by Japanese grand aid among which the two governments agreed to divide up for project implementation;
- To secure safety at the construction site during construction;
- To conduct environmental/social and ARAP monitoring; and
- To establish, observe, and earnestly implement a reasonable schedule with regard to the above-mentioned obligations of the Government of Malawi.

2-4 Project Operation and Maintenance Plan

2-4-1 Organization for Road Operation, Maintenance, and Management

After project implementation, the Government of Malawi reviewed the project's road maintenance and management plan, the organizational structure, and the budget to verify whether road maintenance and management is appropriately implemented. The RA will serve as the implementing agency for road maintenance and management.

The RA is responsible for managing approximately 8,250 km of national roads throughout the country, while urban and district roads are managed by local governments. According to road condition surveys in 2011 and 2014, road conditions have been deteriorated. Limited budget allocation and a shortage of budget derived from a depreciation of the Malawian currency (MWK) indicate that appropriate road maintenance has not been carried out. In particular, regular maintenance and repair including pavement repair and replacement have not been implemented.

2-4-2 Road Maintenance and Management Plan

Required road maintenance works are presented as follows:

Regular Maintenance and Repair

Road : Routine inspection and cleaning of the road surface, drainage facilities, and road adjuncts
Routine inspection and grass cutting of road shoulders and slopes

Bridge : Routine inspection and cleaning of bridge structures and facilities

Irregular Maintenance and Repair

Road : Ceiling and patching cracked pavement, repainting road markings, and repairing any other damaged parts

Bridge : Repairing damaged parts of bridge, riverbank, and riverbed structures and partially repainting of bridge facilities including handrails

2-4-3 Cautions for the Current Road Maintenance and Management Works

To sufficiently realize and sustain project effects, it is important to keep maintaining good driving conditions and increase durability of road facilities by implementing adequate road maintenance and management. In particular, the following items should be noted:

- Check facilities regularly and document their status in a chronological order;
- Clean facilities especially drainage facilities and eliminate earth and sand and obstacles;
- Secure the required budget for maintenance and management; and
- Ensure that the results of the regular inspection are reflected on an appropriate maintenance and repair plan.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Costs Borne by the Government of Malawi

Total Cost	**: Approx.**	**350**	**million yen**
Land Acquisition and Relocation Compensation	: Approx.	202	million yen
Obstacles Relocation Cost	: Approx.	145	million yen
Bank Commission	: Approx.	3	million yen

(2) Conditions for the Cost Estimate

Time of Cost Estimate	: December 2017
Exchange Rate	: US$ 1 = ¥ 113.22
Construction Period	: As shown in the project implementation schedule
Other Conditions	: Cost estimate is implemented in accordance with Japan's grant aid scheme.

2-5-2 Operation and Maintenance Costs

The RA is in charge of regular inspection and routine maintenance of roads, drainage facilities, and bridges which will be improved thorough the project.

Annual frequency and costs required for the maintenance of roads, drainage facilities, and bridges are presented in Table 2-5-1 and Table 2-5-2.

Table 2-5-1 Bridge Maintenance Works and Costs

1. Regular Inspection (unit: US$)

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Pavement Drainage Road Marking Structure Ancillary Facilities	Crack, deformation, potholes, etc. Cleaning, removal of obstacles deformation stains, splitting Damaged areas, deformation, stains, splitting Bridge surface, abutment, pier Bridge surface, abutment, pier: Cracks, damaged and collapsed areas, etc. Damage of hanging facilities, handrail	12 times a year 1 day each time	2 persons	Scoop, hammer, sickle, barricade, pick-up Truck	24 man-day /year 12 vehicle-day/ year	10/day 155/day	240 1,860
					Total		2,100

2. Routine Maintenance and Management

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Cleaning Drainage Pavement Joint Shoulder Bridge Road Marking	 Cleaning, removal of obstacles Cleaning Cutting grass, cleaning Cleaning Cleaning	4 times a year 5 days each time	5 persons	Scoop, barricade, grass-cutter, broom, tools pick-up truck	100 man-day/year 20 vehicle-day/ year	10/day 155/day	1,000 3,100
					Total		4,100

3. Repair

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Structure Pavement Drainage Riverbank Bed Protection Bridge Ancillary Facilities	Repair of damages Crack sealing, patching potholes Repair of damages Repair of damages Partial repaint of handrail	2 times a year 7 days each time	6 persons	Patching Pick-up Truck	84 man-day/year 20.0m^2/year 14 vehicle-day/ year	10/day 17/m^2 155/day	840 340 2,170
					Total		3,350

Total Annual Bridge Maintenance Cost	9,550

Table 2-5-2 Road Maintenance Works and Costs

1. Regular Inspection (unit: US$)

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Pavement Shoulder/Slope Road Marking Drainage	Crack, deformation, potholes, etc. Rainwater erosion & collapse, etc. Injury, deformation, stain, splitting Damage and obstruction	12 times a year 1 day each time	2 persons	Scoop, hammer, sickle, barricade, pick-up truck	24 man-day/ year 12 vehicle-day/ year	10/day 155/day	240 1,860
					Total		2,100

2. Routine Maintenance and Management

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Cleaning Drainage Pavement Shoulder Road Marking	 Cleaning soil, obstacles Cleaning Cutting grass, cleaning Cleaning	4 times a year 5 days each time	5 persons	Scoop, hammer, sickle, barricade, pick-up truck (2 units)	100 man-day/ year 40 vehicle-day/ year	10/day 155/day	1,000 6,200
					Total		7,200

3. Repair

Facility	Repair Item	Frequency	Unit Price (per Year, per km)	Road Length
Pavement	Patching potholes	1 time/5 years	3,300	
Shoulder/Slope	Repairing damaged parts	1 time/5 years	120	
Drainage	Repairing damaged parts	1 time/5 years	2,040	2.75 km
Road attached Facilities	Repairing damaged parts	1 time/5 years	1,100	
Structure	Repairing damaged parts	1 time/5 years	1,600	
		Total	8,160	22,440

Total Annual Road Maintenance Cost	31,740
Grand Total	**41,290**