No.

IMPLEMENTATION REVIEW STUDY REPORT
ON
THE PROJECT
FOR
IMPROVEMENT OF TRUNK ROADS
IN
KAMPALA, PHASE-II
IN
THE REPUBLIC OF UGANDA

OCTOBER 2002

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.
JAPAN ENGINEERING CONSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Uganda, the Government of Japan decided to conduct a implementation review study on the Project for Improvement of Trunk Roads in Kampala, Phase-II and entrusted the study to the Japan International Cooperation Agency (JICA).

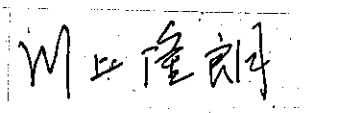
JICA sent to Uganda a study team from March 30 to May 13, 2002.

The team held discussions with the officials concerned of the Government of Uganda, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Uganda from July 21 to July 31 and from August 11 to September 1, 2002 in order to discuss a draft basic design and as this result, the present report was finalized.

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

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

October, 2002



Takao Kawakami
President
Japan International Cooperation Agency

October, 2002

LETTER OF TRANSMITTAL

We are pleased to submit to you the implementation review study report on the Project for Improvement of Trunk Roads in Kampala, Phase-II in the Republic of Uganda.

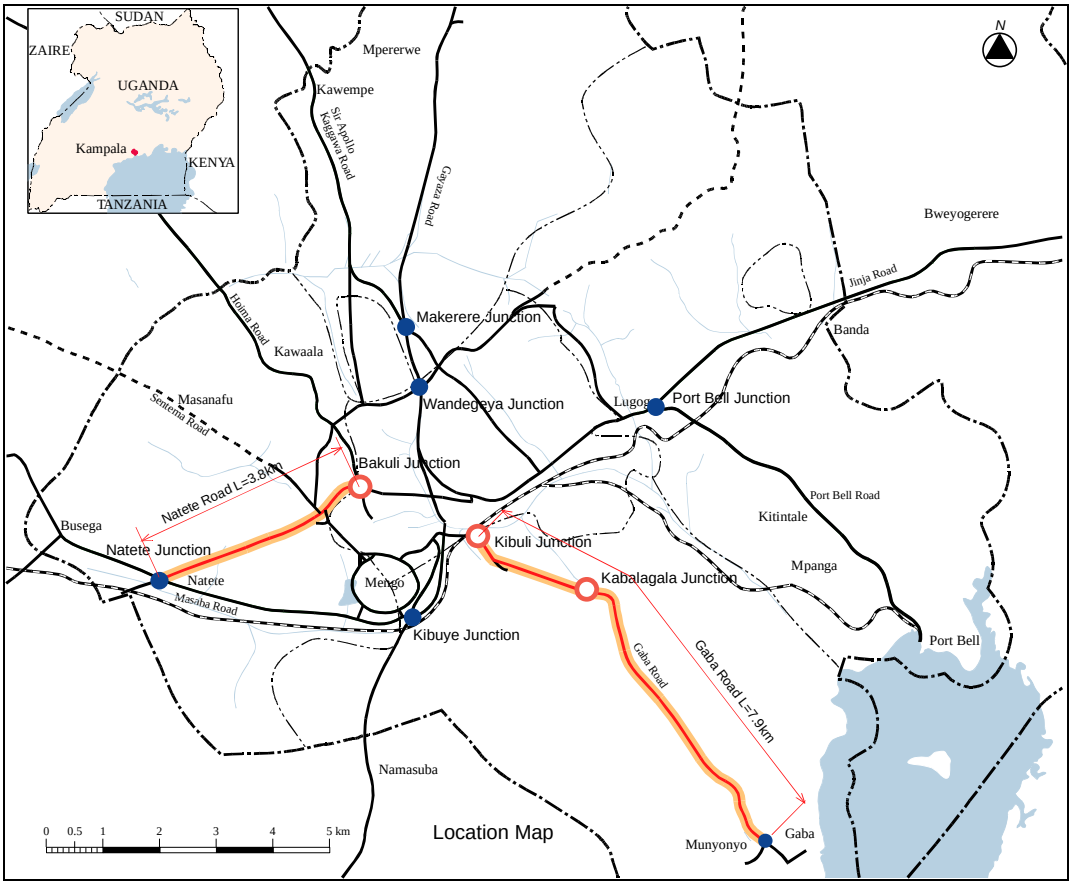
This study was conducted by the joint venture between Nippon Koei Co., Ltd. and Japan Engineering Consultants Co., Ltd., under a contract to JICA, during the period from March, 2002 to November, 2002. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Uganda and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

K. Matsuda

Katsuyoshi Matsuda
Project Manager
The Implementation Review Study Team on
the Project for Improvement of Trunk Roads
in Kampala
in the Republic of Uganda
The joint venture between
Nippon Koei Co., Ltd.
and Japan Engineering Consultants Co., Ltd.



The Basic Design Study on the Project for
Improvement of Trunk Roads in Kampala, Phase II

Location Map

[Present Condition]

■NATETE Road
NO.1+280

PERESPECTIVE

SUMMARY

The Republic of Uganda, located on the equator in the East Africa, is a land locked country and has a total area of about 236,000 km^2. The majority of land is mostly fertile and potentially available for crop and livestock production.

As the city of Kampala is located at a high elevation of 1,000m and on the shore of Lake Victoria, the city enjoys a mild climate with 22 °C annual average temperature. There are two rainy seasons in Uganda. The rainy seasons in Kampala area are from March to May and from September to November. The city of Kampala has total area of 238 km^2 and the city center is surrounded by 7 gentle hills. There are some swamps in the low area which provide a form of flood control in rainy seasons but sometimes causes stagnation of natural water flow into Lake Victoria.

The national economy of Uganda achieved constant growth in the 10 years period after the independence in 1962, but during the period of internal turmoil of 1971- 79, the economy of the nation was greatly devastated. The national economy of Uganda is steadily recovering and stabilized since president Museveni took office in 1986. The government has set a target of developing an independent, integrated, and self-sustaining economy. The government is now undertaking structural adjustment policy with the assistance from the World Bank and IMF aiming at promotion of national economic activities and creation of free and competitive international market conditions. The economy of the nation had shown negative growth in 1997 temporally due to the drought which hit the nation, where the production of coffee that is the main export item of the nation was greatly affected. However since 1998, the nation's economy has steadily growing with the recovery of agriculture and promotion of the manufacturing industry. The GDP growth rate in 2000 was maintained at 5% and the inflation rate in the same year was contained at 5%, Per capita income in 1998, according to the World Bank statistics was US$ 310.

The Public Investment Plan (PIP) is Uganda's sector investment program that is a three year rolling plan updated annually as part of the budget process. The plan aims at formulating of investment plan to achieve the following development targets for the nation:

- Promote economic growth and reduce domestic poverty,
- Sustain macro economic stability, and
- Improve effectiveness/ and efficiency of government services.

In the above context, the Government of Uganda placed highest priority on the development of road sector. In the Ten Year Road Sector Development Program prepared by the Ministry

of Works, Housing and Communications (MOWHC) in 1996, the Government of Uganda set forth the following development targets:

- Provide road maintenance sufficient to protect the road investment,
- Rehabilitate the main road network, with priority given to heavily traveled links,
- Upgrade sections as required to meet traffic demand and reduce accidents,
- Establish effective program administration through organizational structure, appropriate financing, sound traffic management and polices supportive of market needs, and
- Promote the domestic construction industry.

To attain the above targets, road development in the city of Kampala, where two-thirds the nation's traffic is concentrated and the traffic situation is most chaotic and serious, is urgent.

The requested project of the improvement of Natete and Gaba Roads, is the road development projects in the city of Kampala, in line with the concept of 10 Year Road Development Programme of Uganda. With this context, the project was designed on the basis of Ugandan Design Standard with the following design principles:

- To introduce an optimal number of lanes and carriageway width on the basis of estimated future traffic volume,
- To streamline urban traffic flow through the enhancement of traffic capacities of bottle neck intersections, that are located on the project roads,
- To introduce traffic safety facilities, including side walks, bas bays and traffic signs so as to minimize traffic accidents on the project roads,
- To provide road drainage facilities to cope with the inundation of waters onto the carriageways and sidewalks, and for the prevention of deterioration of road conditions,
- To introduce economical pavement design taking the residual values of existing pavement into account,
- To prepare practical and financially viable plans, especially, minimization of affected buildings to be relocated and demolished with the optimal road alignment design so as to reduce the financial burden of the Ugandan Government,
- To reduce the construction cost with the introduction of cost effective methods of construction including subletting of suitable works to Ugandan contractors, and
- To foster and strengthen the road maintenance facilities of the Ugandan Government.

The scope of works, initially requested by the Ugandan Government in 1997, was modified with the discussion between two governments, considering the changes in the road situation since then. The pavement works of Gaba Road was removed from the scope of the works because the resurfacing of the pavement was done by Ugandan side in 2001 on the occasion

of an international conference held at Munyonyo, neighboring town of Gaba. In addition, the project length of Gaba Road was reduced from original 9.1km to 7.9km taking the small volume of traffic on the 1.2km section between Munyonyo junction to Gaba town into account.

The description of the project is shown below:

Item	Description
Length of Roads	Natete Road, 3.8km Gaba Road 7.9km
Number of Lanes and Lane Width	3.0m for one lanes except the main lanes at Bakuli junction of Natete Road and Kibuli and Kabalagala junctions on Gaba Roads which are 3.0m.
Design Speed	40km/h
Longitudinal Slope	Proposed Maximum Slope 7.5%
Shoulder Width	0.5m
Sidewalk Design	Flat type sidewalk with 1.5m-2.25m width except adjacent to areas of major junctions is adopted. Pavement by DBST is adopted.
Pavement Design	Two of the Pavement types are introduced for Natete Road: Type 1: Surface course + Base course, and Type 2: Surface course + Base Course + Subbase course Surface course is of Asphalt Concrete with 7.5cm thickness
Drainage Design	The types of drainage are determined on the basis of estimated Design Flood and surrounding road conditions The type and kind of the drainage to be adopted are as the follow: 1.Open drainage with concrete, 2. Open drainage with earth, 3. U shaped drainage, 4.L-shaped drain, 5. LU shaped drain, 6. Shallow open drain
Intersection Design	Bakuli junction(4,200m^2)and Kibuli junction (5,000 m^2) shall be model into signalized ones with specified turning lanes, pedestrian signals and walls between carriage way and sidewalks. Kabalagala junction shall be improveed as non-signaled junction with specified turning lanes, pedestrian signals and walls between carriage way and sidewalks.
Access Road	Pavement of adjacent areas of access roads (2.0m length) for Natete Road
Traffic Safety Facilities	- Bas bays with 3.0m x 40.0m (10 locations at Natete Road and 19 at Gaba Road) - Traffic signs and road markings at critical sections of traffic accidents - Parking spaces with non-pavement shall be placed at two of the congested areas shops/restaurants along Gaba Road.

The implementation period of the Project is estimated to be 18 months including the period for pre-construction activities and the term of project implementation is divided into two phases: Term1 (Natete Road), 8.5 months and Term 2 (Gaba Road), 6.5 months. The cost to be borne by the Ugandan side is estimated to be about 543 million Japanese Yen.

With the completion of the Project, traffic flows in urban area of Kampala City shall be streamlined as the result of the enhanced traffic capacity thereon. Especially, queuing delays at the junction shall be greatly relieved that shall produce a great amount of vehicle operation cost savings and travel time cost savings, these effect shall result in the increase of the traffic.

According to the estimation, the numbers of vehicles per day in 2004 and 2009 are estimated to be12,500 and 15,700 in total, respectively. These are about increases of about 14% and 43% over present traffic volume of 11,000 vehicles per day.

Besides the above, the improved road condition with complete drainage systems and pavement condition shall contribute to the reduction of annual maintenance cost greatly.

The Project will produce many other indirect effects both in tangible and intangible forms. Those include, among other things, the following:

- Promotion of Socio-economic Activities
  It is expected that the improved road traffic condition by the Project will promote the efficiency of urban activities through such effects as reducing of commuting time and realized better accessibility to market areas and business center.

- Reduction of Traffic Accidents
  Segregated pedestrian ways and signaled road crossings will contribute to the enhancement of safety consciousness of the citizen and to the reduction of traffic accidents as the result.

- Improvement of Public Transport Operation
  With the introduction of bus bays and designation of bus stop areas nearby the junctions, the operation of public transport will be greatly improved.

The direct beneficiary population from this project is estimated to be about 1.2 million. This is equivalent to the estimated total population of Kampala City.

LIST OF FIGURES AND TABLES

ABBREVIATIONS

AASHTO	American association of State Highway and Transport Official
A/P	Authorization of Pay
BS	British Standard
CBR	California Bearing Ratio
DANIDA	Danish International Development Agency
DBST	Double Bituminous Surface Treatment
DCP	Dynamic Cone Penetration
E/N	Exchange of Notes
EU	European Union
F/S	Feasibility Study
GOU	Government of Uganda
IDA	International Development Association
JICA	Japan International Cooperation Agency
KCC	Kampala City Council
KN	Kilo Newton
KUTIP	Kampala Urban Transport Improvement Project
MOF	Ministry of Finance
MOWHC	Ministry of Works, Housing and Communications
M/P	Master Plan
NCRP	Nakivubo Channel Rehabilitation Project
PCU	Passenger Car Unit
PIP	Public Investment Plan
PRSP	Poverty Reduction Strategy Paper
PSI	Present Serviceability Index
UEB	Uganda Electric Board
UPS	Uninterruptible Power System

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BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Kampala City as the capital city of Uganda plays a dominant role in the nation's economy. The population of the city, according to the recent census conducted in 1991 was about 774 thousands and annual population growth rate during 1981-91 was estimated at 4.9%. According to Kampala Urban Study prepared by Kampala City Council in 1994, total population of the city in 2000 was expected to reach 1.2 million. This high growth of population entails a great amount of urban infrastructure including roads.

Historically, the urban area of the city has developed along Jinja-Masaka roads, East-West corridor of the city, then developed along the 6 radial roads including Gaba road, one of the project roads of this Study.

Most of the urban facilities such as government buildings, business offices and commercial facilities are located in the city center while residential area is shifting outskirts of the city in rather haphazard manner. This type of urban formation is causing a great amount of traffic flow between the city center and suburban residential areas, especially during the peak hours of traffic.

Road traffic in the city is characterised by mixture of traffic, where varieties of vehicles and pedestrians are mixed up on narrow carriageways. Especially, traffic congestion at intersections and at nearby market centres are severe, where intrusion of pedestrians onto the carriageways, on-off loading of public transport at carriage ways and roadside parking are commonly seen. This chaotic traffic situation is extremely lowering the traffic capacity of roads and their safety levels.

The project aims at improvement of Natete and Gaba Roads, which are two of the most important urban arterial roads in the city of Kampala and road conditions are deteriorated with chaotic traffic situation thereon. It is expected that the improved roads shall produce great amounts of socio-economic impacts to the city, as well as direct benefits to road users including vehicle operation cost saving and travel time saving.

Chapter 2

CONTENTS OF THE PROJECT

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2.1 BASIC CONCEPT OF THE PROJECT

The Feasibility Study of Improvement of Trunk Road at Kampala Urban Interface Section, which was a Master Plan and Feasibility Study for the road development in the city of Kampala, was conducted in line with the concept of the Ten Year Road Sector Development Programme, 1996/97-2005/6.

The necessity of improvement of Natete and Gaba Roads, which are two of the most functional urban trunk roads in the city of Kampala, was first proposed in the study and the following road development components were introduced:

Road Section (Natete Rd.)	:	One of the most important urban arterial road connecting Trans-African Highway and Hoima Road, traversing suburban area of western Kampala city. Pavement condition is severely deteriorated, which entails road surface improvement by reconstruction method. Road alignment has been designed so as to minimize removal of existing buildings and additional land acquisition.
Road Section (Gaba Rd.)	:	One of the most important urban arterial roads connecting the city center with the residential area that is rapidly developing recently. Pavement was deteriorated but it was overlaid by Ugandan government in 2001 on the section from Kibuli Junction, starting point of the road, to Munyonyo Junction (7.9km).
Bakuli Junction (Natete Rd.)	:	Located at the beginning point of Natete Road. Traffic congestion level in the peak hour of traffic is as high as 85%. Existing right-angle intersection shall be improved into signalised one, which will contribute to the increasing of intersection capacity as well as streamlining the traffic flow and promotion of traffic safety.
Kiburi Junction (Gaba Rd.)	:	Located at the beginning point of Gaba Road. The junction is over saturation level (93%) in the peak hours of traffic. Existing T-shaped intersection shall be improved into signalised one, which will contribute to the increasing of intersection capacity level as well as streamlining of the traffic flow and enhancement of traffic safety.
Kabalagala Junction (Gaba Rd.)	:	Located in the middle of Gaba Road. Traffic congestion level is far below the capacity. However, intrusion of pedestrians onto the carriageway is commonly seen as many shops, restaurants and business facilities are densely located nearby area. Provision of side walks,

pedestrian crossings and fences between carriageway and side walk is quite necessary for promoting the traffic safety.

Drainage Facilities : Optimum roadside drainage system shall be installed at proper locations to prevent pavement deterioration of the project roads. In addition, measures to reduce drain water speed shall be introduced at critical sections.

Side Walks : Traffic accident rate in Kampala is very high compared to other cities of the world. Especially, fatal accidents of pedestrians which occur during the road crossing and intrusion onto the carriageway due to lack of proper crossing points and insufficient sidewalks. Brick fence shall be installed in between carriageways and sidewalks in the vicinity of junctions, schools and public buildings. Traffic sign shall be provided nearby junctions and critical points of traffic so as to enhance the traffic safety level.

2.2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2.2.1 Design Policy

The design policy of the roads is described as follows:

- to introduce road alignment within the right-of-ways (Natete Rd. 25m, Gaba Rd. 30m), so as to minimise additional land acquisition,
- to provide sufficient and minimum width of carriage ways and pedestrian ways taking the original alignment of the existing roads into consideration,
- to provide traffic safety facilities in between carriage ways and pedestrian ways,
- to provide roadside drainage with sufficient and minimum capacities to prevent intrusion of rainwater and underground water beneath the road foundation,
- to provide sufficient and optimal pavement treatment to cope with future traffic, after examinations of existing road pavement conditions,
- to apply construction method which minimises the construction cost through utilisation of local material & equipment, technology and labours,
- to conduct intersection design to secure road safety as well as traffic efficiencies, and
- to introduce bus parking bays at suitable location in conjunction with land use pattern at nearby the project roads.

2.2.2 Basic Plan

(1) Basic Plan

1) Road Design Standard

The designing of the project roads is carried out on the basis of Ugandan Road Design Standard in principle. With regard to some of the items which are not clearly stipulated in the Ugandan manuals, British Standard, AASHTO, and Japanese Standard are adopted. The road design manuals adopted in the study are as follows:

Geotechnical Design Standard	:	Road Design Manual (MOWHC, Nov.1994)
	:	A Policy on Geometric Design of Highways and Street

	:	Explanation and Application of Cabinet Order for Road Structure (Japan Road Association)
Pavement Design Standard	:	Road Design Manual (MOWHC, Nov.1994)
	:	Asphalt Overlays for Highway and Street Rehabilitation
	:	Asphalt Pavement Manual (Revised Edition), (Japan Road Association)
Road Earth Work Design Standard	:	Road Earth Work Manual (Japan Road Association)
Road Drainage Design Standard	:	Road Design Manual (MOWHC, Nov. 1994)
	:	Drainage Manual (Japan Road Association)

2) Road Classification

Natete Road

Natete Road starts from Bakuli, runs towards south-east and goes through the suburban areas of Narimembe, Rubaga and Wakaliga and ends at the Natete Junction on Masaka Road. The total length of the road section is 3.8km. Natete Road is classified into Category A of national road in Ugandan road classification.

Category A: Principal Arterial (Primary Roads)

- Connection between the national road system and neighbouring countries.
- Linkage between districts, local centres of population and development areas with the principal arterial system.

Gaba Road

Gaba Road starts at the Nsambya-Kibuli Junction and follows a southerly direction, through the towns and built up areas of Kabalagala, Kansanga and ends at Gaba on the shores of Lake Victoria. Gaba Road is classified into Category B of national road in Ugandan Road classification.

Category B: Minor Arterial (Secondary Roads)

- Connection between local and population centres.
- Linkage between districts, local centres of population and development areas with the principal arterial system.

Table 2.1 Road Classification in Uganda

	Category A	Category B
Classification	Principal Arterial system (Primary Roads)	Minor Arterial System (Secondary Roads)
Criteria for Road Classification	- Connection between the natural road system and those of neighbouring countries - Linkage between districts, local centres of population and development areas with the principal arterial system.	- Connection between local and population centres. - Linkage between districts, local centres of population and development areas with the principal arterial system.
Number of Required Lanes	One lane one direction	One lane one direction
Carriageway Width	3.5 m x 2 = 7.0 m	3.5 m x 2 = 7.0 m

3) Design Speed

According to the Road Design Manual, design speed for the categories A and B roads is stipulated as 80-110km/h. But this speed level is interpreted as that on the suburban sections of the arterial roads.

The design speed of the project roads, as they are urban arterial roads in densely populated areas, is to be reduced for safety and environment reasons. In this regards, the design speed of the captioned roads is set at 50km/h except for the sections of sharp gradient where the design speed is set at 40km/h.

The relation between design speed and other design factors such as minimum curve radius, maximum gradient lane number and so on that are stipulated in the Japanese Road Design Manual are shown in Table 2.2.

Table 2.2 Relation between Design Speed and Geometrical Standard

	40km/hr	50km/hr	60km/hr
Min. Radius (m)	50-60	80-100	120-150
Min. Curve Length	70	80	100
Super-elevation	6%		
Radius of Vertical Curve (Crest)	700	1200	2000
Ditto (Sag)	700	1000	1500
Width of Traffic Lane	3.0-2.75	3.25-3.0	
Left Shoulder Width (Class 2-2)	1.25-1.75		
Ditto (Class 4-1)	0.5		

Source: Japan Road Structure Ordinance

4) Geometric Design

Road alignment has been designed within the existing right-of-ways in principle. Larger radius of curvature shall be adopted to increase road capacities and to enhance traffic safety level. Most of the road sections of Natete and Gaba Roads are consisted of straight ones except for some sections of curve that require in depth study as described in Table 2.3, But it can be concluded there is no serious problems of land constraints along the sections.

Table 2.3 Sharp Curve Sections

	Radius	Curve Length	Remarks
Natete Road			
STA0+313-0+486	200m	150m	No problems
STA0+890-1+026	800m	130m	ditto
Gaba Road			
STA0+318-0+462	350m	150m	ditto
STA 2+686-2+755	90m	64m	Take note
STA 6+904-6+980	120m	76m	No problems

5) Vertical alignment

As Kampala City is located of at the altitude of 1200m and located on the hilly area, vertical road alignment has many ups and downs. The project roads have many high gradient sections as shown in Fig. 2.1 and 2.2 and some of the high gradient sections have to be improved for mainly traffic safety reasons. However, due to densely located buildings along the road sides and difficulty of further land acquisition, minimum level of improvement works on the existing vertical alignment is provided instead of drastic changes of them.

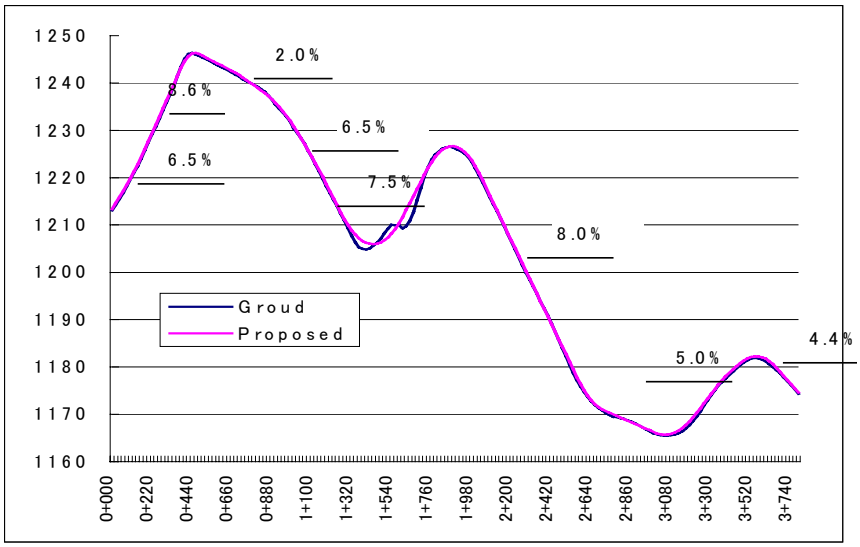


Figure 2.1 Longitudinal Cross Section of Natete Road (% shows gradients)

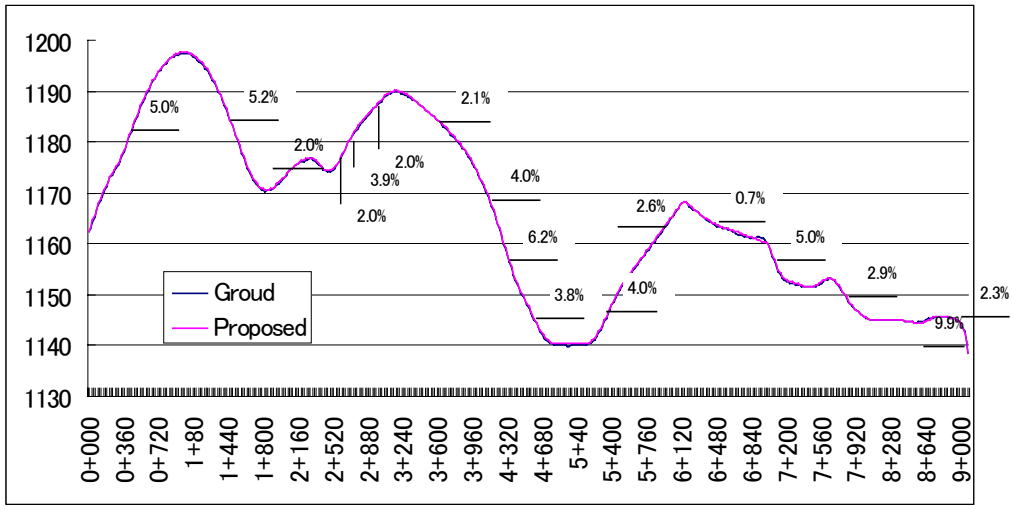


Figure 2.2 Longitudinal Cross Section of Gaba Road

There exist 2 high gradient sections along Natete Road and one along Gaba Road. It is proved that these sections are free from inundation of water during the rainy season by the hydrologic analysis of this study. However, in terms of accelerated vehicle speed to be realised with the completion of the improvement works may result in increase in traffic accident. In this connection, it is important to provide road safety measures so as to reduce the driving speeds by such measures as humps, traffic signs and road marking at proper places of high gradient sections.

6) Carriageway Width

Carriage way width of the captioned roads is determined on the basis of the required traffic capacities by lane width that are prescribed in Japanese Road Standard as shown in Table 2.4.

Table 2.4 Traffic Capacity by Lane Width

Lane Width	3.5m	3.25m	3.0m	2.75m
Traffic Capacity per hours (pcu)	2,083	1,958	1,833	1,708

Source: Japan Road Association "Road Traffic Capacity"

As to the carriageway width of Natete Road, 3.0m width along the whole section is adopted taking the forecasted average traffic volume of 1752 pcu in 2012 into consideration. Whilst 3.0m of carriageway width is adopted for Gaba Road for the reason that the 3.0m wide newly overlaid carriageway in 2001 remains almost intact.

According to the Ugandan Road Design Manual, required carriageway width for class A and B arterial roads is 3.5m as mentioned (1) of this section. The

reduced carriageway width to 3.0m is justified by the following characteristics of the roads:

- The captioned roads are classified as urban arterial road as most of the sections passes in densely developed urban area where the vehicle speed has to be limited,
- Shares of large vehicles on the project roads are small, as compared to that on inter regional trunk road such as Masaka and Jinja Roads,
- Land acquisition for additional lane width is very difficult due to high land acquisition and compensation cost, and
- Wider carriageway shall result in high project cost.

7) Shoulder width

Shoulder width of 0.5m for whole of the section of Natete Road shall be introduced taking the difficulties of additional land acquisition, limited budgets and cost into account. The required shoulder width of category A and B of the arterial roads outside of urban areas in Uganda is stipulated to be 2.0m in principle by the Ugandan Road Design Manual, but narrower shoulders can cope with traffic in urban areas where vehicle speeds are lowered. The shoulder shall be paved with asphalt concrete to protect soil erosion onto the carriage ways as well.

8) Sidewalks

Sidewalks with width of 1.5m - 2.25m are provided along either one side or both sides of the roads taking the roadside conditions and number of pedestrians into consideration. The sidewalks shall be paved with DBST.

9) Cross Fall

The cross fall of 2.0% shall be applied on the basis of Japanese Road Standard.

10) Conclusion

Design standards stipulated by relevant design manuals are described by element of road engineering as shown in Table 2.5.

Table 2.5 Comparison of Geometrical Standards

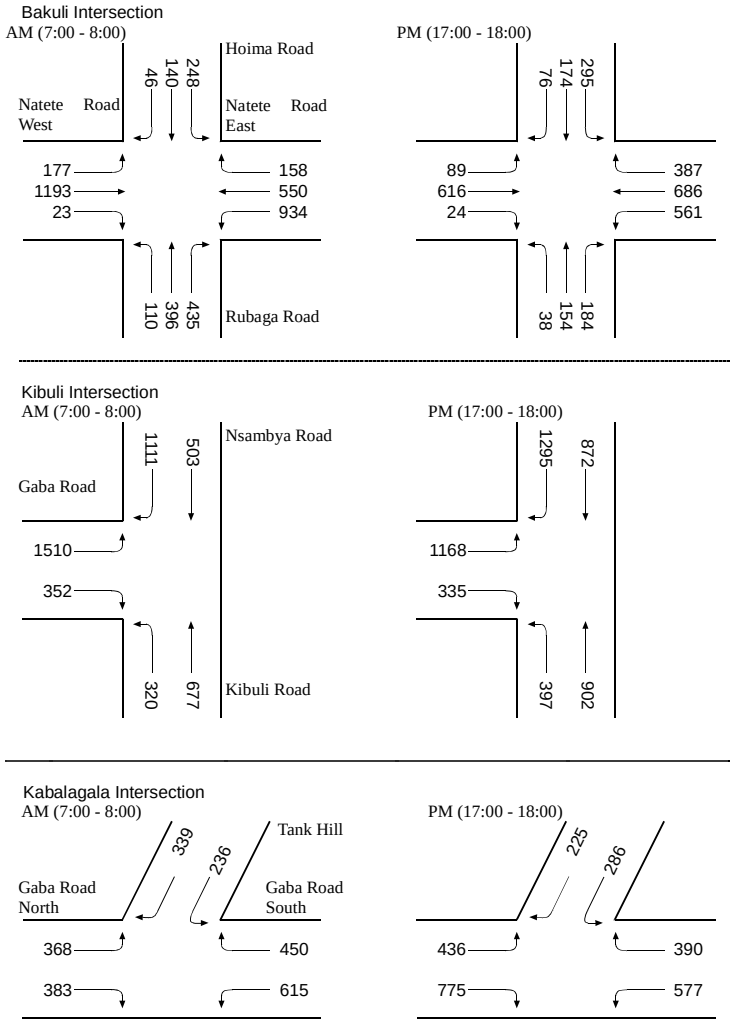
Element	Japan Road Structure Ordinance	AASHTO	Ugandan Standard	Applied Standard for this Project
Class of Road	Class 4-1	Urban Arterial	Category A	Urban Road
Design Speed	60km/hr	30~60 mph	80~110km/hr	40~50km/hr
Min. Radius	150m	-	125m	150m
Max. Radius	5.0%	5.0~11.0%	4.0~6.0%	10.0%
Min. Transition Curve Length	50.0m		-	50.0m
Cross Fall	2.0%	1.5~3.0%	2.5%	2.0%
Max. Composite Grading	10.5%		7.0%	10.5%
Lane Number	2 lanes	2 lanes	2 lanes	2 lanes
Lane Width	3.25m	10~12 ft.	3.5m	3.0m

(2) Intersection Design

1) Intersection Analysis

Intersections are designed on the basis of turning movements at the critical junctions and physical conditions of intersections. The Japanese Intersection Design Manual has been adopted for the designing. Turning lanes and enough length of storage shall be provided to enhance the capacities, along with mount up structured sidewalks and pedestrian crossings shall be introduced in the vicinity of the intersections, to prevent roads crossing of pedestrians.

The intersections to be improved are Bakuli Junction, located at the beginning point of Natete Road, Kibuli Junction located at the northern end of Gaba, and Kabaragara Junction located at the middle of Gaba Road. Among the above three junctions, Bakuli and Kibuli Junctions have to be improved into signalled intersections as the capacities of these junctions are almost getting saturated. The results of intersection analysis are shown in Table 2.6 and 2.7 and the data used for the analysis is shown in Fig. 2.3 and 2.4.



Unit: Vehicles/hr.

Figure 2.3 Turning Movement at Peak Hours of Traffic

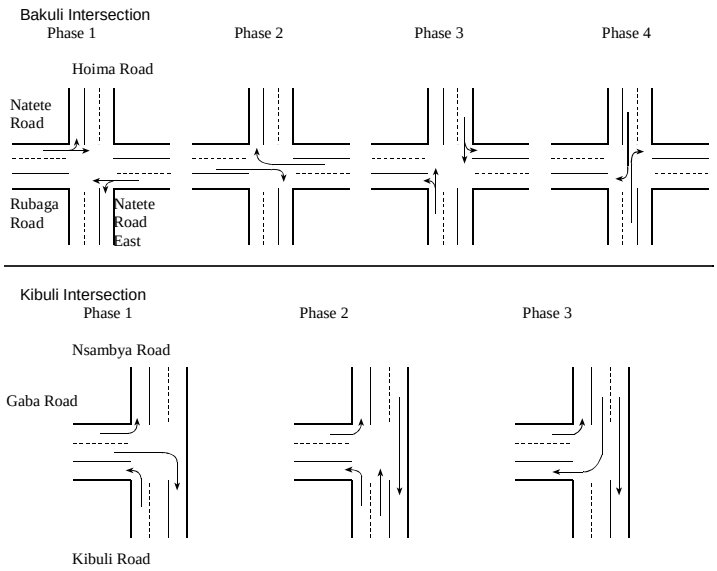


Figure 2.4 Proposed Signal Phases at Bakuli and Kibuli Intersections

Table 2.6 Result of Intersection Analysis - Bakuli Intersection

Saturation Degree	AM (7:00-8:00)		75.6%
	PM (15:00-16:00)		69.2%
Optimum Cycle Time	AM (7:00-8:00)		82.9 sec.
	PM (17:00-18:00)		63.9 sec.
Duration of Green Time	Pattern	AM	PM
	Phase 1	30.9 sec.	17.6 sec.
	Phase 2	7.0 sec.	8.5 sec.
	Phase 3	13.9 sec.	10.8 sec.
	Phase 4	11.1 sec.	7.0 sec.

Table 2.7 Result of Intersection Analysis - Kibuli Intersection

Saturation Degree	AM (7:00-8:00)		72.5%
	PM (17:00-18:00)		80.4%
Optimum Cycle Time	AM (7:00-8:00)		54.7 sec.
	PM (17:00-18:00)		65.4 sec.
Duration of Green Time	Pattern	AM	PM
	Phase 1	7.0 sec.	7.0 sec.
	Phase 2	12.3 sec.	17.4 sec.
	Phase 3	20.5 sec.	26.0 sec.

2) Intersection Design

a) Bakuli Junction

Taking the land constraint of the junction into consideration, the improvement works of the junction shall be undertaken utilising the existing right-of-way as possible as it can. Right turn lane with width of 3.0m shall be introduced for each arms of access road in addition to straight/left lanes with width of 3.5m. 30.0m long storage shall be installed for each arm to streamline the traffic, Sidewalks with width of 3.0m with brick fence shall be introduced so as to prevent the intrusion of pedestrians onto the carriage ways in the vicinities of intersection. Storage length was determined on the basis of the result of intersection analysis where the minimum length of 30m was given according to the Japanese Standard. Traffic saturation level according to the traffic survey in April 2002 was about 85% in the morning peak hour.

b) Kibuli Junction

As being located in the proximity of railway, the queuing control on the arm of Mukwano Road (west) is critical factor for the designing. Furthermore, additional land acquisition to expand the intersection is inevitable at the arm of Mukwano Road to reduce long queuing that

occurs in the evening peak hours. Right turn lane with width of 3.0m shall be introduced at the entrance from Kibuli and Mukwano Roads to streamline the traffic flow. Left turn lane with width of 3.5m at the entrance from Gaba Road and left turn lane with width of 3.0m at Gaba Road shall be introduced to enhance the handling capacity of traffic in the morning peak hours. The results of intersection analysis suggest the necessity of 80m long storage at Mukuwano Road, 40.0m at Kibuli Road and 80.0m at Gaba Road, respectively. Storage length was determined on the basis of the result of intersection analysis where the minimum length of 30m was given according to the Japanese Standard. Traffic saturation level according to the traffic survey in April 2002 was as hign as 93% in the evening peak hour.

Table 2.8 Design Dimensions of Signal Junction

Name of Junction	Lane width		Storage length			
	Straight and left turn lane	Right turn lane				
Bakuli			Hoima Road	Natete Road east	Rubaga Road	Natete Road west
	3.5m	3.0m	30.0m	30.0m	30.0m	30.0m
Kibuli			Mukwano Road east	Gaba Road	Mukwano Road west	-
	3.5m	3.0m	40.0m	30.0m	80.0m	-

c) Kabalagala Junction

The junction is under saturation level and there is no urgent necessity of enhancing the junction capacity. The major problem of this junction is the mixture of traffic among pedestrians and vehicles that entails improvement of sidewalks segregated from the carriageway and designation of road crossings at proper locations. The minimum of 30 m long storage length was given according to Japanese Standard.

(3) Ancillary Design

1) Bus Bay and Road Crossing Facilities

Bus bays of 3.0m width shall be installed at proper locations with appropriate intervals so as to induce orderly operation of public transport along the project roads as shown in Table 2.9. Road crossing points shall be introduced at the points that are located nearby the schools and congested shopping areas.

Table 2.9 Location for Installation of Bus Bay

Location			Width	Effective length	Transition area	Gradient
Natete Road	Direction from Bakuli to Natete	0+100~0+160	3.0m	12.5m	5.0m×2	6.47~8.60%
		0+670~0+680	3.0m	12.5m	5.0m×2	2.72%
		1+480~1+540	3.0m	12.5m	5.0m×2	7.50%
		1+880~1+940	3.0m	12.5m	5.0m×2	8.00%
		3+420~3+480	3.0m	12.5m	5.0m×2	3.28%
	Direction from Natete to Bakuli	0+110~0+170	3.0m	12.5m	5.0m×2	6.47~8.60%
		0+740~0+800	3.0m	12.5m	5.0m×2	2.72%
		1+430~1+480	3.0m	12.5m	5.0m×2	7.49~7.50%
		1+960~2+020	3.0m	12.5m	5.0m×2	8.00%
		3+420~3+480	3.0m	12.5m	5.0m×2	3.28%
Gaba Road	Direction from Kibuli to Gaba	0+340~0+400	3.0m	12.5m	5.0m×2	5.00%
		0+870~0+930	3.0m	12.5m	5.0m×2	2.10%
		1+880~1+940	3.0m	12.5m	5.0m×2	2.00%
		2+340~2+400	3.0m	12.5m	5.0m×2	0.70~2.00%
		3+080~3+140	3.0m	12.5m	5.0m×2	0.61~2.00%
		4+190~4+250	3.0m	12.5m	5.0m×2	6.20%
		5+300~5+360	3.0m	12.5m	5.0m×2	4.00%
		6+020~6+080	3.0m	12.5m	5.0m×2	2.60%
		7+020~7+080	3.0m	12.5m	5.0m×2	5.00%
		7+810~7+870	3.0m	12.5m	5.0m×2	2.90%
	Direction from Gaba to Kibuli	0+240~0+300	3.0m	12.5m	5.0m×2	3.50%
		0+930~0+990	3.0m	12.5m	5.0m×2	1.90~2.10%
		1+820~1+880	3.0m	12.5m	5.0m×2	2.00%
		3+020~3+080	3.0m	12.5m	5.0m×2	2.00%
		4+250~4+300	3.0m	12.5m	5.0m×2	6.20%
		5+230~5+290	3.0m	12.5m	5.0m×2	4.00%
		5+970~6+030	3.0m	12.5m	5.0m×2	2.60%
		7+840~7+900	3.0m	12.5m	5.0m×2	2.90%

2) Traffic Sign

Traffic signs are installed at critical sections of the roads to promote traffic safety. As to the standard of signs to be adopted, that of International Standard shall be adopted. The type and conditions of places where the signs are to be installed are shown in Table 2.10.

Table 2.10 Location for Installation of Traffic Sign

Classification of traffic sign		Installation point
Warning sign	Sharp turn ahead	Radius of curvature < 100m and curve angle > 45º
	Steep gradient ahead	Steep gradient > 6%
	Carriageway width narrow	Reducing
	Pedestrian crossing ahead	Road crossing points except signal junction
	School	Near by school
Regulatory sign	Stop	Exit point of access road
	Do not enter	Exit point of one-way road
	Do not pass	Steep gradient section
	Parking prohibition	Near by shopping area
	Standing and parking prohibition	Entrance lanes at intersections
	Direction designated lane	Direction designated lane
Instruction sign	Pedestrian crossing	Road crossing points except signal junction
	Bus stop	Bus bay points
	Roadside parking place	Roadside parking place

Table 2.11 Installation Method of Traffic Sign

Item	Specification	Remarks
Strut type	Single strut type	-
Installation method	Roadside system	To be posted 50cm away from road edges in principle
Height	2.0m above the ground	-
Assignment	In row parallel to carriageway	
Assignment order	In conformity to the traffic sign code	-

3) Road Marking

Road marking shall be introduced on the critical sections of road traffic. The type of marking and location of the places to be placed are shown in Table2.12.

Table 2.12 Location for Installation of Road Marking

Classification of road marking		Installation point
Road marking (Instruction marking)	Center line	Overall section (except do not pass section)
	Lane line	Plural lanes section at intersection
	Channelizing strip	Changing points the number of lane at intersection
	Stop line	Entrance lanes at intersection or exit point of access road
	Pedestrian crossing	Pedestrian crossing
Road marking (regulatory marking)	Do not pass	-Steep gradient > 6%-Steep gradient section-Radius of curvature < 100m and curve angle > 45º
	Passing division	Plural lanes section at intersection
Section marking	Road edge marking	Overall section(except bus bay and roadside parking place)
	Changing carriageway width	Changing points of carriageway width
	Roadside parking place	Bus bay and Roadside parking place

4) Roadside Parking Spaces

Roadside parking spaces with 3.0m wide shall be introduced at Kansanga trade center and Half London areas along Gaba Road. The spaces shall not be paved.

(4) Pavement Design

1) Selection of Pavement type

In general, the pavement type is classified into two types: flexible (asphalt) type and rigid type (concrete). With a comparison study of advantage and disadvantage of them, flexible (asphalt) type of pavement was selected taking the supply conditions of the material and equipment and climate conditions into account.

2) Pavement Design

a) Design Policy

There are many kinds of methods of Pavement design, AASHTO, British Standard and Japanese Standard and so on. AASHTO is accepted as the most popular international methods and this study will follow this method in principle.

AASHTO design methods for asphalt pavement are conducted following the procedures as described in Fig. 2.5.

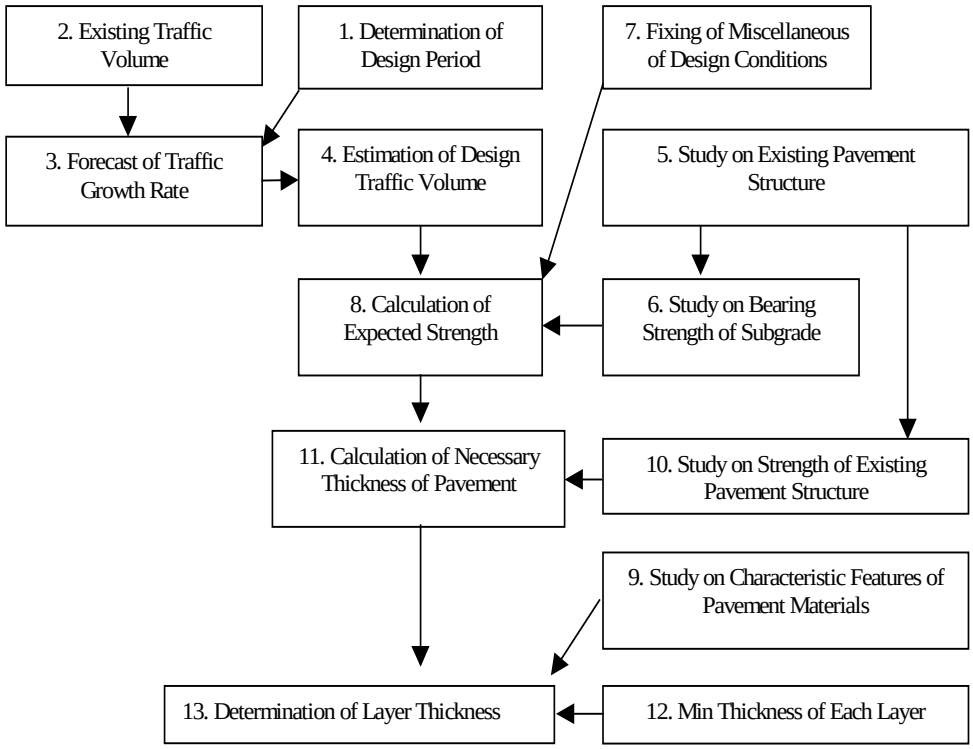


Figure 2.5 Asphalt Pavement Design Procedure by AASHTO

Necessary strength of the pavement, termed Structural Number (SN), is calculated by the following formula;

$$\log_{10} W_{18} = Z_R * S_0 + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\frac{\Delta PSI}{(4.2-1.5)}}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

where,

- W18: passing number of equivalent single axle load of 18 kip (=8t) during the design period.
- ZR: coefficient number for reliability = －1.037
  (corresponding to Reliable Probability: R=85%. 80~99% is for urban roads)
- So: Overall Standard Deviation=0.45 (normally 0.45 is applied for flexible pavement)
- MR: Resilient Modulus
- ΔPSI: Loss of Performance Serviceability Index

(Ref.：initial value: Po=4.2, terminal value: Pt=2.5 Loss=Po-Pt=1.7)

One of he characteristic feature of AASHTO is introduction of PSI

(Present Serviceability Index), and the values shown in Table2.13 are used in general.

Table 2.13 Value of PSI

	PSI	
Maximum	5.0	
Initial index P0	4.5	(Rigid Pavement)(Flexible Pavement)
	4.2	
Terminal index Pt	3.0	Bench mark index for Overlay. It will be selected from three index shown in left as the execution time for overlay works
	2.5	
	2.0	
Minimum	0	

Acceptable values of terminal service index Pt are interpreted as described in Table2.14.

Table 2.14 Terminal Present Serviceability Index(PSI)

Terminal Performance Service Index P_t	Percentage of the users who recognize that road surface is unacceptable for drivers.
3.0	12%
2.5	55%
2.0	85%

Terminal Present Serviceability Index of Pt=2.5 is adopted for this study.

b) Deign Period

In this study, the design period is fixed at 10 years, taking urban arterial nature of the project roads and self-maintenance works by Ugandan side after the opening into consideration.

c) Estimation of Number of Axle Load

The number of axle load is calculated on the basis of the results of traffic survey conducted in May 2001, number of axles by vehicle type and EAL factors. Future growth rate of the traffic is assumed to be 6.0% up to 2007 and 3.0 % thereafter.

Table 2.15 Traffic Volume at the Project Roads

Unit: Vehicles/day

	Passenger car	Mini bus	Bus	Pickup car	Truck 2axle	Truck 3axle~ (single)	Truck 3axle~ (articulate)	Total
Natate N1(O.5KM)	4,373	4,013	220	850	182	23	13	9,674
Natate N2 (3.5KM)	1,236	2,271	82	348	255	11	8	4,211
Gaba G1 (1.1KM)	8,083	4,647	5	1,621	447	73	5	14,881
Gaba G2 (2.7KM)	7,705	4,507	3	1,845	507	44	3	14,614
Gaba G3 (5.9KM)	4,031	2,631	14	1,007	298	97	13	8,091
Gaba G4 (3.5KM)	696	1,792	16	298	166	1	0	2,969

Design traffic volume is expressed in terms of 18 kip equivalent axle load (EAL), where 18kip＝18x453.59kg=8.16t as shown in Table 2.17.

Table 2.16 Conversion Factors for 18 kip EAL

	Passenger car	Mini bus	Bus	Pickup car	Truck 2axle	Truck 3axle~ (single)	Truck 3axle~ (articulate)
Gross weight (t)	1.5	3.0	15.0	3.0	12.0	20.0	20.0
Axle number	2	2	1+2	1+2	2	1+2	1+2
Front Axle Load (t)	0.5	1.0	3.0	1.0	4.0	4.0	4.0
Rear Axle Load (t)	1.0	2.0	6.0	2.0	8.0	8.0	8.0
EAL Factor Front	0.0000	0.0002	0.0198	0.0002	0.0625	0.0625	0.0625
EAL Factor Rear1	0.0002	0.0039	0.3164	0.0039	1.0000	1.0000	1.0000
EAL Factor Rear2			0.3164			1.0000	1.0000
EAL Factor Total	0.0003	0.0042	0.6526	0.0042	1.0625	2.0625	2.0625

(EAL Factor = (Axle load/8t)4

From the above, axles by survey point are estimated as shown in Table 2.17.

Table 2.17 Estimated Axle Load

	passenger car	mini bus	bus	pickup car	truck 2axle	truck 3axle~ (single)	truck 3axle~ (articulate)	Total of 8t axle load
Natate N1	207	3,040	26,201	644	35,291	8,657	4,893	78,933
Natate N2	59	1,720	9,766	264	49,446	4,140	3,011	68,406
Gaba G1	383	3,520	595	1,228	86,676	27,478	1,882	121,762
Gaba G2	365	3,414	357	1,397	98,310	16,562	1,129	121,535
Gaba G3	191	1,993	1,667	763	57,784	36,511	4,893	103,803
Gaba G4	33	1,357	1,906	226	32,188	376	0	36,086

Table 2.18 Forecasted Yearly 18 kips Axle Numbers at Project Roads

	Natate N1	Natate N2	Gaba G1	Gaba G2	Gaba G3	Gaba G4
2002	78,933	68,406	121,762	121,535	103,803	36,086
2003	83,669	72,510	129,067	128,827	110,031	38,252
2004	88,690	76,861	136,811	136,557	116,633	40,547
2005	94,011	81,473	145,020	144,750	123,630	42,979
2006	99,652	86,361	153,721	153,435	131,048	45,558
2007	105,631	91,543	162,944	162,641	138,911	48,292
2008	108,800	94,289	167,833	167,520	143,079	49,741
2009	112,064	97,118	172,868	172,546	147,371	51,233
2010	115,426	100,031	178,054	177,722	151,792	52,770
2011	118,888	103,032	183,395	183,054	156,346	54,353
2012	122,455	106,123	188,897	188,546	161,036	55,983
2013	126,129	109,307	194,564	194,202	165,867	57,663
2014	129,913	112,586	200,401	200,028	170,843	59,393
2015			206,413	206,029	175,969	61,175

Assuming the opening years of Natete Road and Gaba Road in 2004 and 2005, respectively, the accumulated 18 kips EALs for 10 years after the opening are estimated as shown in Table2.19.

Table 2.19 Accumulated 18kips Axle Numbers for 10 years after Opening

Open~10Year	1,221,656	1,058,724	1,954,111	1,950,474	1,665,892	579,139
Rounded EAL	$1.2x10^6$	$1.0x10^6$	$2.0x10^6$	$1.9x10^6$	$1.7x10^6$	$0.6x10^6$

d) Existing Pavement Structure

Existing pavement structures are surveyed by DCP Tests of the project roads in 1998 and 2002. Average thickness of the existing pavement obtained by these tests is shown in Table2.20.

Table 2.20 Average Thickness of Existing Pavement

	Natete Rd.	Gaba Rd.	
Overlaid Surface	-	2.5cm	Done by MOWHC in 2001
Surface	5cm	5cm	
Base course	16cm	16cm	
Sub-base course	19cm	25cm	

e) Evaluation of Bearing Strength of Sub-grade (design CBR)

For the design of pavement structure it is principle to use the Soaked CBR (soaked in water 4 days) of sub-grade. In this context, the Site CBRs obtained by the DCP test conducted in April 2000 have to be converted into Soaked CBRs. For this procedure, it is inevitable to define the relationship between Site CBRs and Soaked CBRs. The relation is established by regression analysis on the basis of typical samples from the both tests as shown in Fig. 2.6.

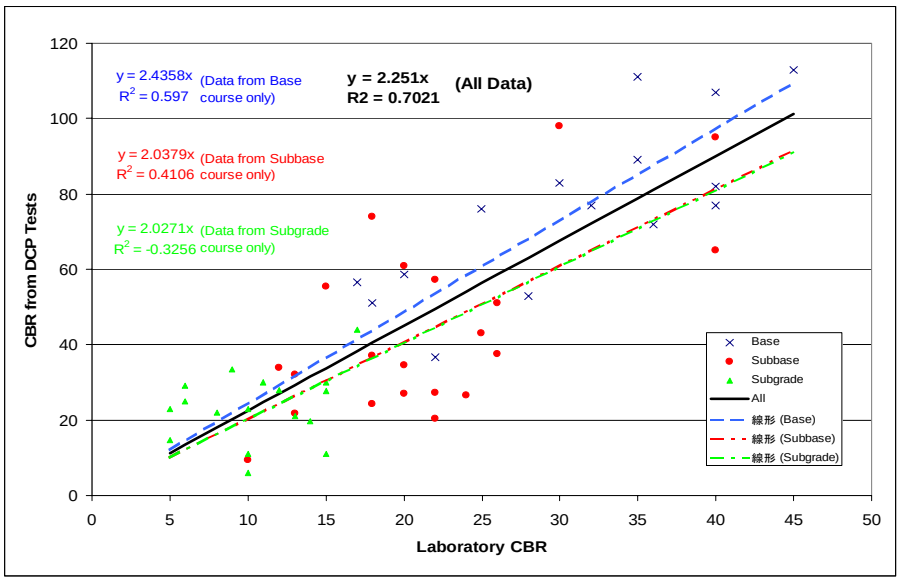


Figure 2.6 Relation between Site CBRs from DCP and Soaked CBRs.

Design CBRs by section are estimated deducting Standard Deviation Values from the averages for each section. The results are shown in Table2.21 and 2.22.

Table 2.21 Design CBRs by Section of Natete Road

Section	0+000~1+000	1+000~1+750	1+750~2+550	2+550~3+700
Design CBR	4.0%	5.0%	4.0%	4.0%

Table 2.22 Design CBRs by Section of Gaba Road

Section	0+000~ 1 +950	1+950~ 2+800	2+800~ 3+850	3+850~ 5+500	5+500~ 6+750	6+750~ 7+450	7+450~ 8+550	8+550~ 9+150
CBR	6.0%	5.0%	10%	5.0%	8.0%	6.0%	10%	6.0%

f) Estimation of Required Structural Number (SN)

SNs are estimated using the relation between SN and design CBR by magnitude of EAL. The relation between SNs and design CBRs by magnitude of EAL is defined as shown in Fig.2.7. The results are shown in Table 2.23.

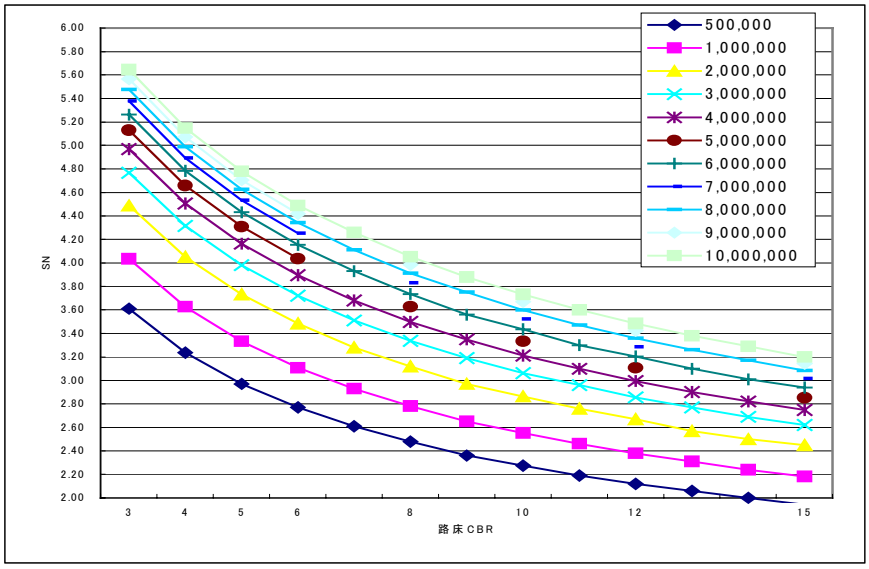


Figure 2.7 Relation between SNs and CBRs by Magnitude of EAL

Table 2.23 Required SNs by Section

	CBR	EASL (10years)	EASL* (20years)	Traffic survey points	SN (10years)	SN (20years)*
Natete Road						
0-1.0KM	4	1200000	2700000	0+500	3.73	4.24
1.0-1.75KM	5	1100000	2550000		3.38	3.87
1.75-2.5KM	4	1000000	2400000		3.62	4.16
2.5-3.7KM	4	1000000	2400000	3+500	3.62	4.16
Gaba Road						
0-1.95	6	2000000	4400000	1+100	3.48	3.95
1.95-2.8	5	2000000	4400000	2+700	3.73	4.22
2.8-3.85	10	1900000	4100000		2.83	3.19
3.85-5.5	5	1800000	3900000		3.66	4.11
5.5-6.75	8	1700000	3700000	5+900	3.03	3.23
6.75-7.45	6	1100000	2500000		3.15	3.15
7.45-8.55	10	600000	1300000	8+000	2.34	2.66
8.55-9.15	6	500000	1000000		2.76	3.1

g) Characteristics of Base Course Materials

Resilient Coefficient: (MR) and Layer Coefficient: (A) for sub-grade, base course and surface are assumed as shown in Table2.24.

Table 2.24 Resilient Coefficient: (MR) Layer Coefficient: (A) by Layer of Pavement

	Sub-grade	Sub-base Course	Base Course	Surface (As. Con)
Material Spec.		Modified CBR=30% or more PI=6.0% or less	Modified CBR=80% or more PI=4.0% or less	Hot mixture
Resilient Modules (MR)	CBR x 1,500	1,500 (CBR x 500)	28,000 (CBR x 350)	300,000
Layer coefficient		A_3 0.08	A_2 0.14	A_1 0.42

In the meanwhile, pavement materials of existing road are getting deteriorated with the passage of daily traffic and with the weather. The remained layer coefficients are estimated to be around 80% of the original ones as shown in Table 2.25.

Table 2.25 Layer Coefficient of Existing Pavement Material

	Sub-grade	Sub-base Course a_3	Base Course a_2	Surface (Asphalt Concrete) a_1
Original		0.08	0.14	0.42
Remaining ratio		80%	80%	80%
Layer coefficient		0.06	0.11	0.34

h) Comparison of existing Pavement strength and desirable strength

The pavement thickness shown in Table 2.20 is converted into "inch" applying Layer Coefficient shown in Table 2.25. The average SNs obtained by the procedure are shown in Table 2.26.

Table 2.26 Remaining Sn of Pavement at the Project Roads

	a	Natete Road	SN	Gaba Road	SN
Existing Overlay	0.38	-	-	2.5c m=1	0.38
Surface	0.34	5cm=2	0.68	5cm=2	0.68
Base Course	0.11	16cm=6.3	0.69	16cm=6.3	0.69
Sub-base Course	0.06	19cm=7.5	0.45	25cm=10	0.60
Total			1.82		2.35

*The layer coefficient of the existing overlay is assumed to be 90 % of new one.

From the above, required SNs and Desirable Overlay Thickness by asphalt concrete are estimated as shown in Table 2.27.

Table 2.27 Required SNs (Table 2.24) and Desirable Overlay Thickness by Asphalt Concrete

	EASL (10 years)	Required S_N (10Years)	Existing S_N	Shortage of S_N	Converted necessary thickness to asphalt concrete (inch)
Natete section					
0-1.0KM	1,200,000	3.73	1.82	1.91	4.5
1.0-1.75KM	1,100,000	3.38	1.82	1.56	3.7
1.75-3.7KM	1,000,000	3.62	1.82	1.80	4.3
Gaba section					
0-1.95	2,000,000	3.48	2.35	1.13	2.7
1.95-2.8	2,000,000	3.73		1.38	3.3
2.8-3.85	1,900,000	2.83		0.48	1.1
3.85-5.5	1,800,000	3.66		1.31	3.1
5.5-6.75	1,700,000	3.03		0.68	1.6
6.75-7.45	1,100,000	3.15		0.80	1.9
7.45-8.55	600,000	2.34		-0.01	0.0
8.55-9.15	500,000	2.76		0.41	1.0

* Layer coefficient of new overlay surface is 0.42

As the conclusion, reconstruction of Natete Road pavement is judged urgent whilst the overlay of Gaba Road is not necessary for the time being as the results of the above design calculation suggest.

i) Structural Design of Overlay

- Natete Road

The first conceivable method of overlay of this road is to do it with asphalt concrete over the existing pavement with the thickness shown in Table 2.27. However, this method has two disadvantages: One is the terribly deteriorated condition of the existing pavement at some sections of the road, and the other is that overlay with 4~5inch (10cm~13cm) thickness is not economical. As such, the second method that removes the exiting surface and reconstructs the base course and surface course is recommended. In this case, the problems of "slipping of surface" are avoidable. The calculated results of necessary thickness by this method is shown in Table 2.29 along with the estimated existing SN_s shown in Table 2.28 that are necessary for this calculation.

Table 2.28 Existing SNs (inch) of Natete Road

	Existing Road	Pavement after improvement	Layer Coefficient	SN
New surface		x	0.42	
New base course		y	0.12	
Existing surface	5cm	(remove)		-
Existing base course	16cm	16cm=6.3inch	0.11	0.69
Existing sub-base course	19cm	19cm=7.5inch	0.06	0.45
Total				1.14

Table 2.29 Additional Thickness of Pavement of Natete Road by Section (inch)

Section	EASL (10year)	Necessary S_N (10year)	Existing S_N	Shortage of S_N	Surface 0.42	base course 0.14
0-1.0KM	1,200,000	3.73	1.14	2.59	3	10
1.0-1.75KM	1,100,000	3.38	1.14	2.24	3	7
1.75-3.7KM	1,000,000	3.62	1.14	2.48	3	9

- Gaba Road

Additional overlay on the surface of Gaba Road, that was conducted by the Uganda Government in 2001, is judged to be not

necessary in terms of relatively well preserved road surface condition observed in the last PSI survey as far as the near future is concerned. The calculated results of the design thickness, that are shown in Table 2.31 suggest this fact.

Table 2.30 Existing SNs (inch) of Gaba Road

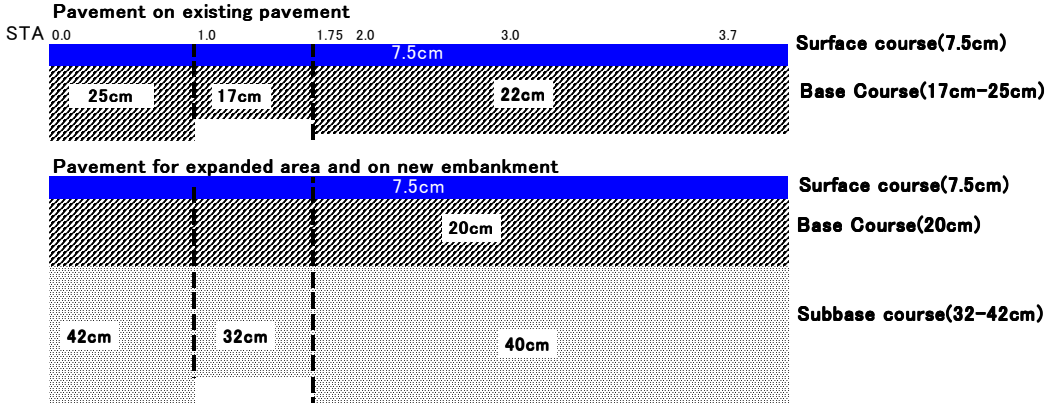
	Gaba Road Pavement	Thickness by inch	Layer Coefficient	SN
Future overlay		x	0.42	
Existing Overlay	2.5cm	1.0 inch	0.37	0.37
Existing Surface	5cm	2.0 inch	0.32	0.64
Base course	16cm	6.3 inch	0.10	0.63
Sub-base course	25cm	10 inch	0.06	0.60
Total				2.24

Table 2.31 Calculated Overlay thickness of Gaba Road, section by section

Gaba section	EASL (10year)	Required SN (10year)	Shortage of SN	New overlay 0.42
0-1.95	2,000,000	3.48	1.24	3 inch
1.95-2.8	2,000,000	3.73	1.49	3.5 inch
2.8-3.85	1,900,000	2.84	0.60	1.5 inch
3.85-5.5	1,800,000	3.67	1.43	3.4 inch
5.5-6.75	1,700,000	3.04	0.80	2.0 inch
6.75-7.45	1,100,000	3.16	0.92	2.0 inch
7.45-8.55	600,000	2.34	0.10	-
8.55-9.15	500,000	2.77	0.53	1.0 inch

j) Conclusion

The pavement structure of Natete Road is proposed as sown in Fig 2.80. (Unit: longitudinal direction by kilo meters and vertical direction by cm)



(The upper is one that on the existing pavement, and the lower for new expansion or embankment areas)

Figure 2.8 Longitudinal Cross Section of the Pavement of Natete Road

On the other hand, improvement of pavement at Gaba Road is concluded not necessary as the pavement which was done by MOWHC in 2001 preserves satisfactory condition.

(5) Drainage Design

1) Applicable design standard

Road Design Manual in Uganda is used principally and Road Design Manual in Japan is used supplementary in accordance with the cases of analysis:

- Road Design Manual Ministry of Works, Transport and Communications Nov. 1994
- Drainage Design Manual (Japan Road Association)

2) Determination of Return Period of Flood for Drainage Design

The return periods for the designing of the drainage facilities of the project roads are determined through the comparison analysis among the standards, that are stipulated in available design manuals and that are used in the related projects, including Nakivuvo Channel Rehabilitation Project (NCRP) by Kampala City Council in 2001 as shown in Table 2.32.

Table 2.32 Comparison of Return Period

	JICA Basic design (2000)	Ugandan Standard	Japanese Standard	Kampala Drainage Master Plan	Adopted Value for this design
Roadside Drainage	3 year	—	3 year	—	3 year
Crossing Culvert	10 year	20 to 25 year (Bridge)	5 to 10 year	10 year (outlet)	10 year

As the results, the following assumption on the return period are introduced for this study:

Roadside Drainage : Return Period 3 year
Road Crossing Culvert : Return Period 10 year

3) Catchment Area

The catchment area of waters which flow onto the project roads are topographically determined on the basis of collection waters at swamps and the demarcation of river basin of the project roads including their nearby streets as described in Fig.2.9.

4) Estimation of Design Flood

a) Design Flood Volume

Design flood volume is estimated adopting the following Rational Formula:

$$Q=1/3.6 * C * I * A$$

Where

Q: Food Peak at Catchment Exits（m^3/sec）
C: Runoff Coefficient (Ref, Table2.33)
I: Average Rainfall Intensity over the whole of the Catchment Area (mm/h)
A: Catchment Area (km^2)

The specific values of the coefficients are determined as described below:

b) Runoff Coefficients

0.8 for the road surfaces and 0.3 for adjoining areas are introduced as the average of detailed soil conditions in the East Africa is as shown in Table 2.33. Almost all adjoining areas of the project roads are of hilly areas with rich flora and scattered houses.

Table 2.33 Runoff Coefficients

Land use		Runoff coefficient	Adopted value
Road surface	Paved	0.70~0.95	0.80
	Unpaved	0.30~0.70	
Shoulder, Slope	Fine grained soil	0.40~0.65	
	Coarse grained soil	0.10~0.30	
	Hard rock	0.70~0.85	
	Soft rock	0.50~0.75	
Sandy Lawns	Flat 0~2%	0.05~0.10	
	Steep2~7%	0.10~0.15	
	Steep more than7%	0.15~0.20	
Clayey Lawns	Flat 0~2%	0.13~0.17	
	Steep2~7%	0.18~0.22	
	Steep more than7%	0.25~0.35	
Roofs		0.75~0.95	0.30
Dispersed area		0.20~0.40	
Grassland, Park		0.10~0.25	
Soft to moderate mountain		0.20~0.45	
Steep for mountain		0.40~0.60	
Lakes, swamps etc		0.70~0.80	
Vegetation		0.10~0.30	

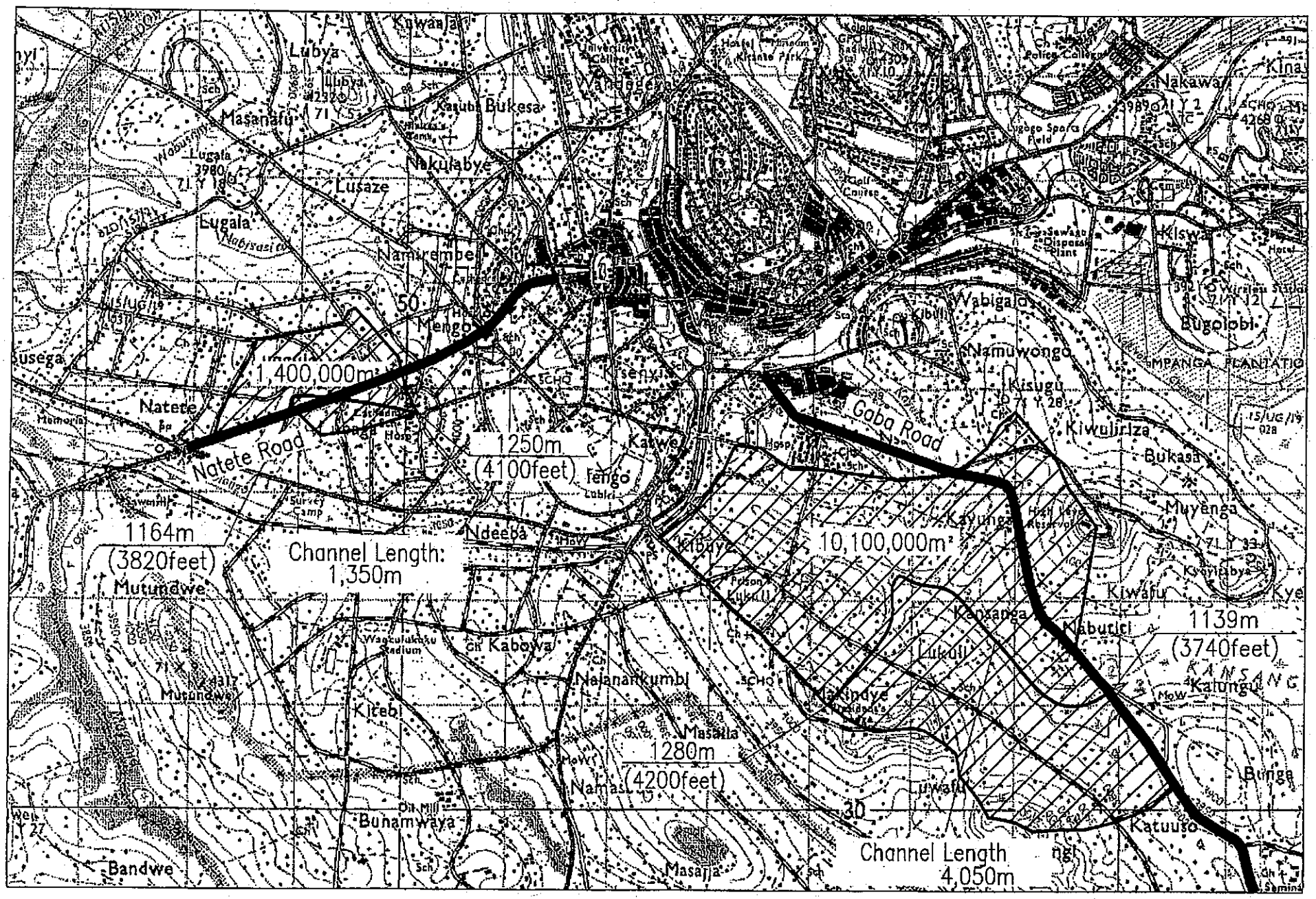


Figure 2.9 Catchment Area of the Project Roads S = 1/50,000

c) Rainfall Intensities

Rainfall intensities, usually defined in the relation with the reaching time of waters from the farthest places in catchment areas, are estimated adopting the Kerby Formula. It is usually known empirically that the rainfall intensity is 15-30 minutes in mountainous area, 3-5 minutes at cut slopes and 5 minutes in urban areas in general. The structure of the Kerby Formula is described as below:

$$T_1 = 1.445 * \left[\frac{N * L}{\sqrt{S}} \right]^{0.467} = 30mn$$

Where

T_1: Rainfall Intensities (Min,)
N: Kerby Coefficient of Roughness, which is 0.3
L: Length of Catchment Areas (m)
H: Average Difference in Height within Catchment Areas (m)
S: Gradient, H/L

The Kerby Formula is not applicable in the cases that the value of T1 is larger than 120 minutes or less than 10minutes because the degrees of errors go beyond the limit of allowance. As such, minimum of 10 minutes of T1 is assumed for the analysis of road surfaces.

Short period Rainfall Intensities are estimated with the application of the following formula:

$$R_t = \frac{R_d}{24} * \left(\frac{24}{T_c} \right)^{\frac{2}{3}}$$

Where

R_t: Rainfall Intensity (mm/hr)
Rd: Probable Daily Rainfall (mm/day)
Tc: Time of concentration, roadside drain, 10minutes (0.17hour, Storm water from outside of roads, 30minutes (0.5hour)

d) Discharge Volume of Catchment Areas

Discharged volumes from road surfaces and their adjacent areas are calculated and the results are filed in computer disk.

5) Determination of Type of Drainage

Appropriate type of drainage is determined taking the location of drainage to be placed into consideration as described in Table 2.34. Figure 2.10 illustrates typical drainage pattern.

Table 2.34 Determination of Drainage Types

Type of Drainage	Advantage	Disadvantage	Location to be installed
Open Drainage (Concrete, Trapezoid shape)	- Easy maintenance	- Covers are necessary in front of the houses and shops. - Difficult to apply in the areas with narrow spaces.	- Areas with enough spaces - Not desirable in residential areas
Open Drainage (Earth, Trapezoid shape)	- Easy construction	- Routine maintenance is necessary to secure the flow capacity.	- Swamp area
U shaped Drain	- Suitable for the areas with enough road width		- Area where spaces are limited
L-side ditch	- Suitable for the areas with enough road width		- Nearby intersections
LU shaped Drain	- Convenient at the access to private houses.		- Residential area- Nearby Intersections
Shallow open drain	- Easy cross over by pedestrians and the vehicles.	- Flow capacity is small.	- Roads crossing sections

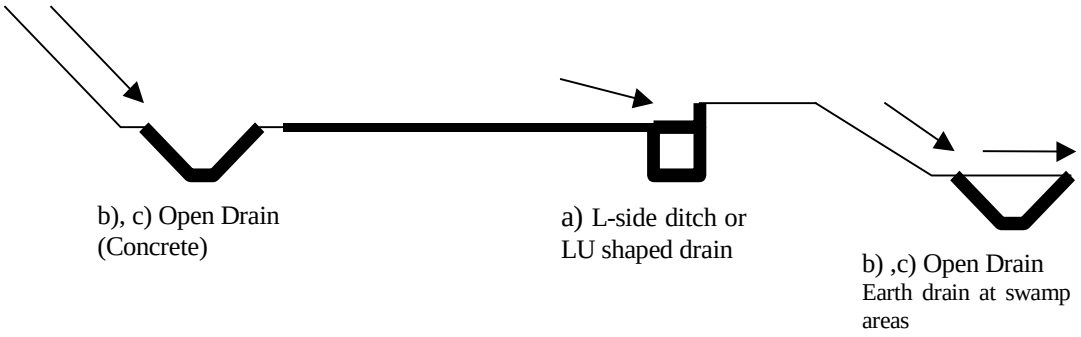


Figure 2.10 Typical Drainage

- L-side ditch / LU shaped drain

  L-side ditch / LU shaped drain be installed between sidewalks and carriage ways.

- Trapezoid open drainage

  Trapezoid open drainage is to be installed at the sections without sidewalks.

  This drainage type is made of concrete basically. At the swamp areas, earth open drain is to be installed for cost reduction purposes.

- Stepping open drainage

  Stepping open drainage is to be installed at the sections of steep gradient to reduce the Velocity of flow waters.

6) Determination of Cross Section Area of Drainage

Flowing capacities for each drain facility are determined by the following formulas:

$$Q=A * V$$

Where

A: Channel Cross-sectional Area (m^2)
V: Flow Velocity (m/sec), which is defined by the Maning Formula:

$$V=1/n * R^{2/3} * i^{1/2}$$

Where

N Maning's Roughness Coefficient ($sec/m^{1/3}$)
R: Hydraulic Radius (m)=A/P
P: Perimeter (m)
I: Channel Gradient

The data necessary for the above calculation are being filed in computer disk.

7) Results of Drainage Design

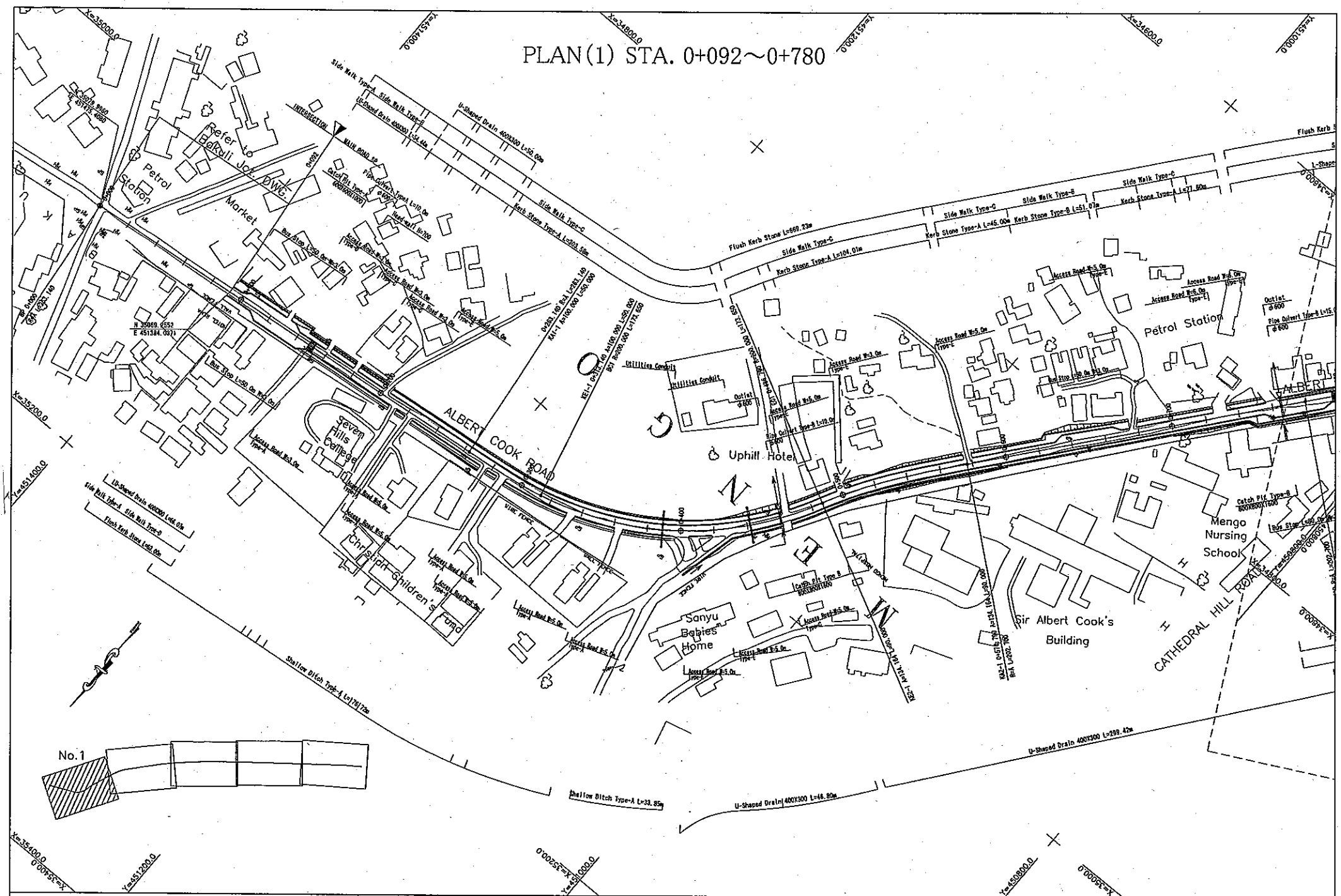
The Results of drainage design are shown in Appendices 6.

2.2.3 Basic Design Drawings

On the basis of above scheme and the design criteria, following drawings are prepared as shown below:

- Plans
- Typical Cross Section
- Structural Design

PLAN(1) STA. 0+092～0+780



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE I : NATETE ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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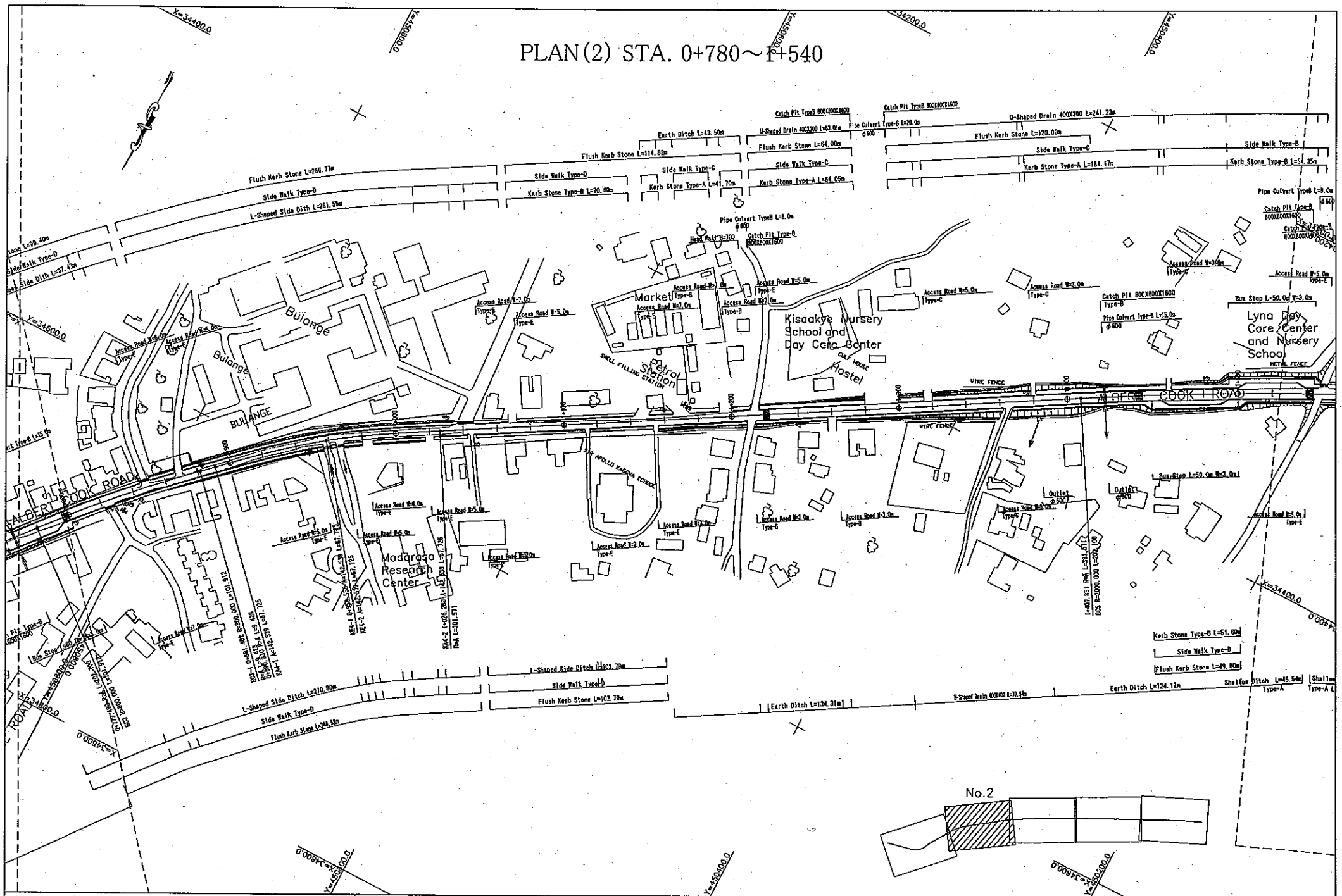
PLAN(2) STA. 0+780～1+540



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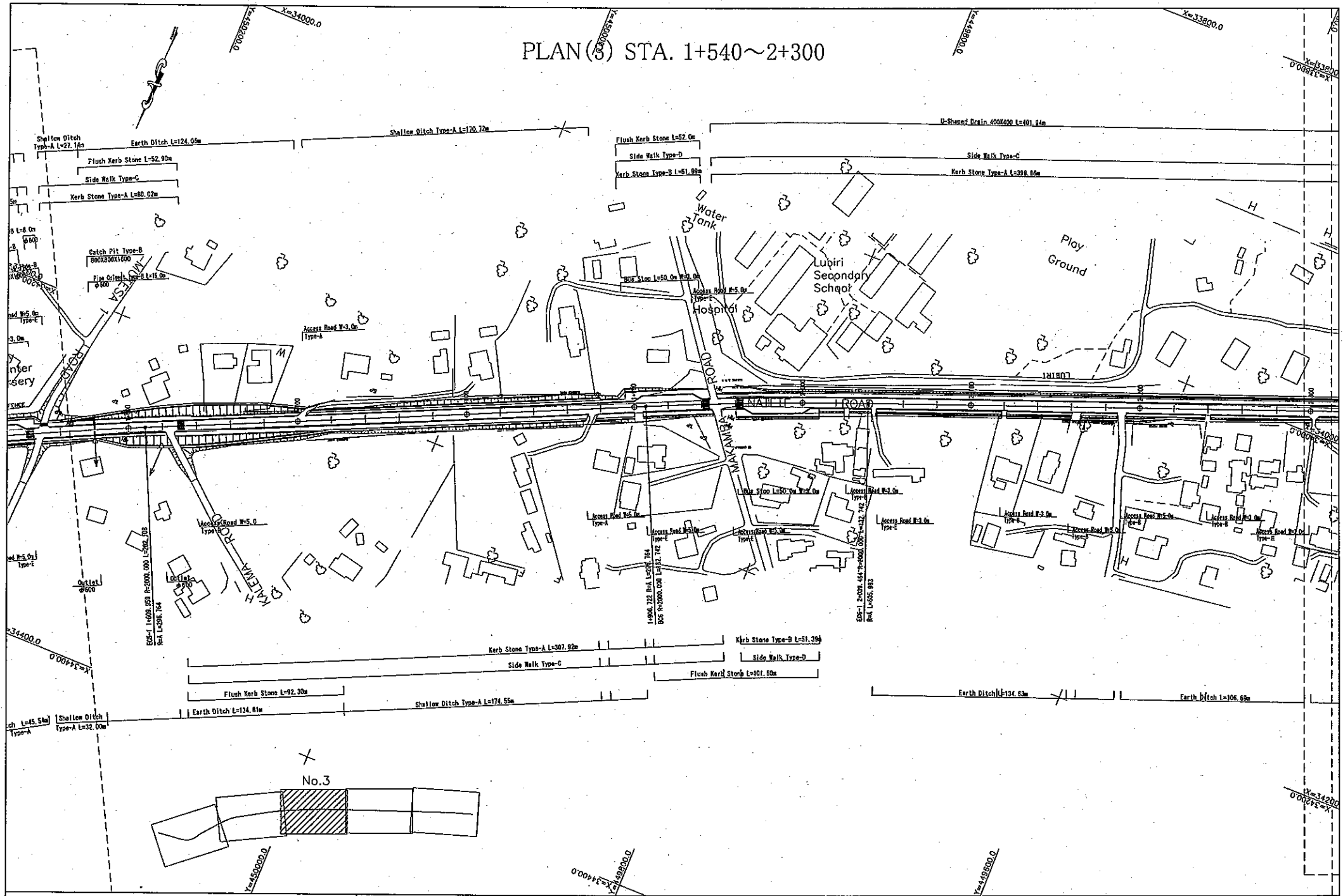
PLAN(3) STA. 1+540～2+300



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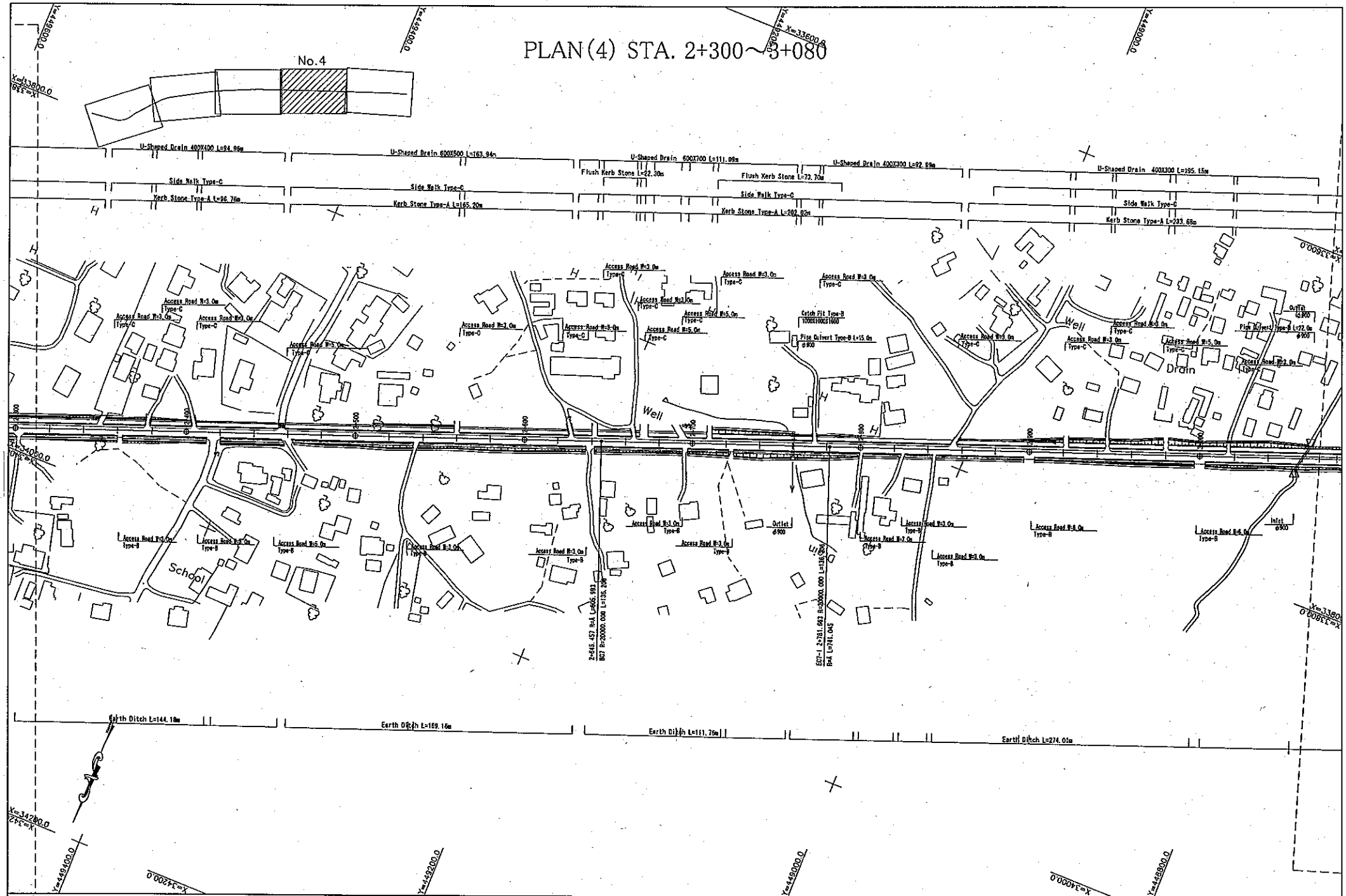
PLAN (4) STA. 2+300～3+080



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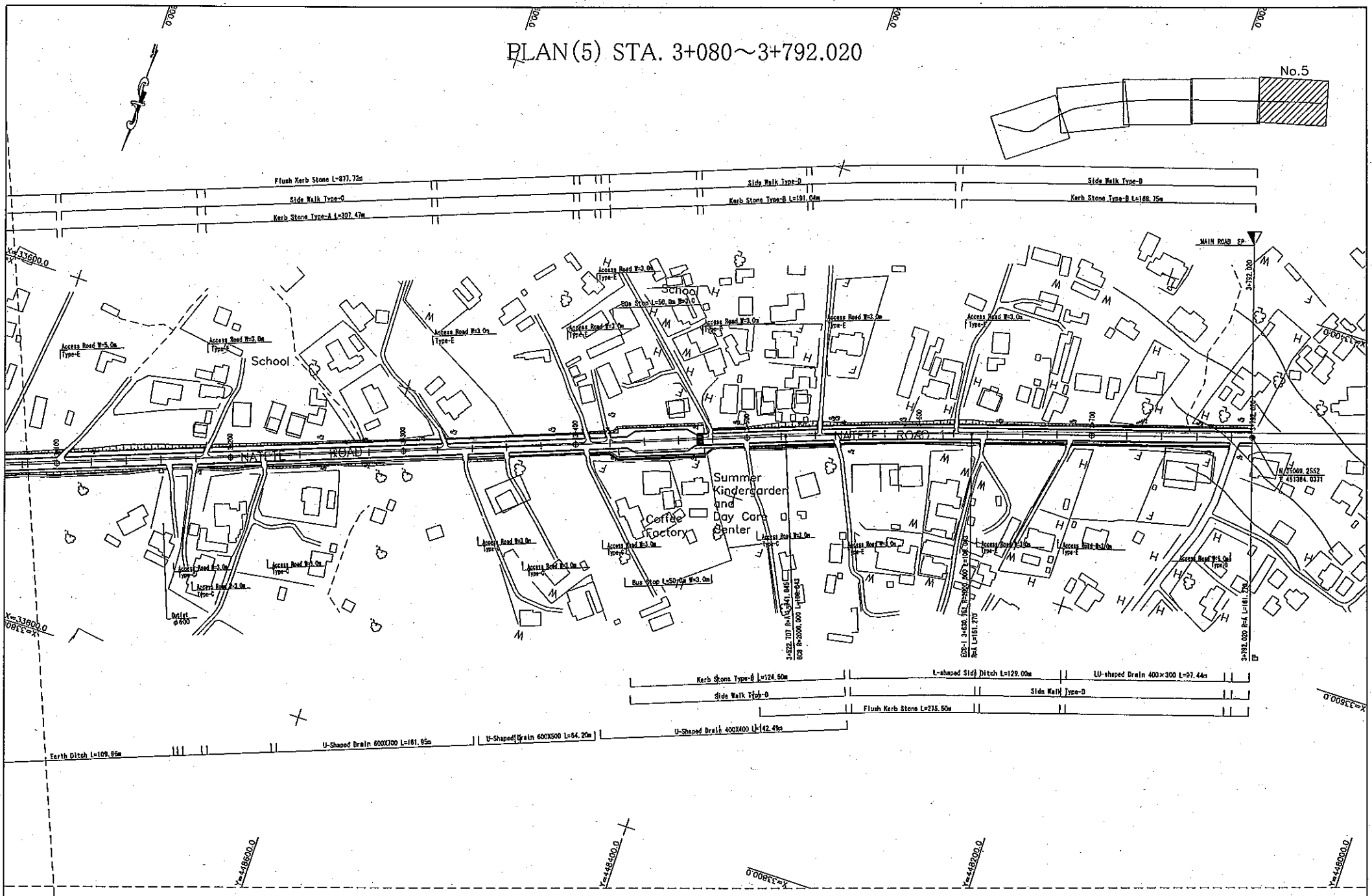
PLAN(5) STA. 3+080～3+792.020



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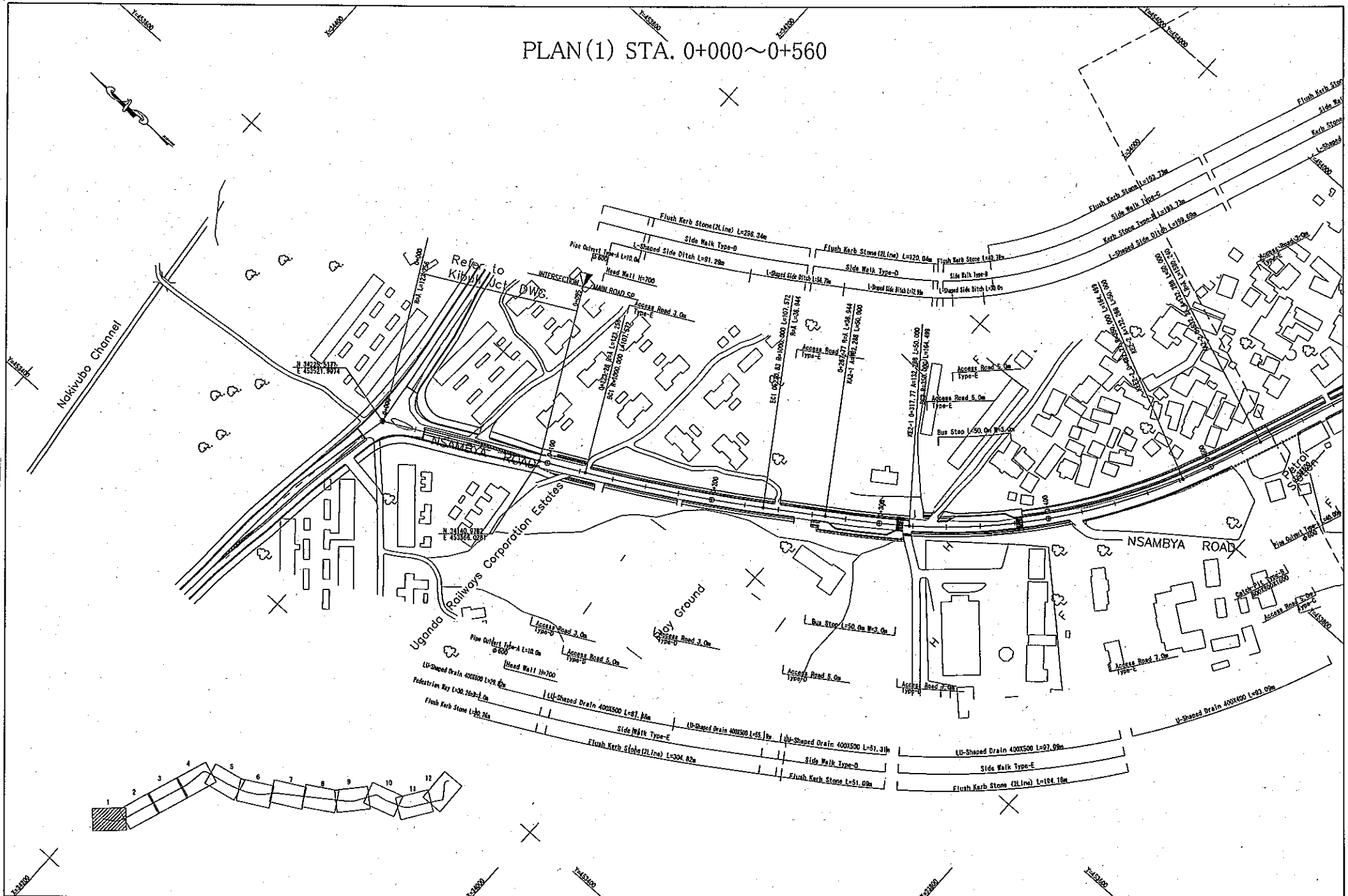
PLAN (1) STA. 0+000～0+560



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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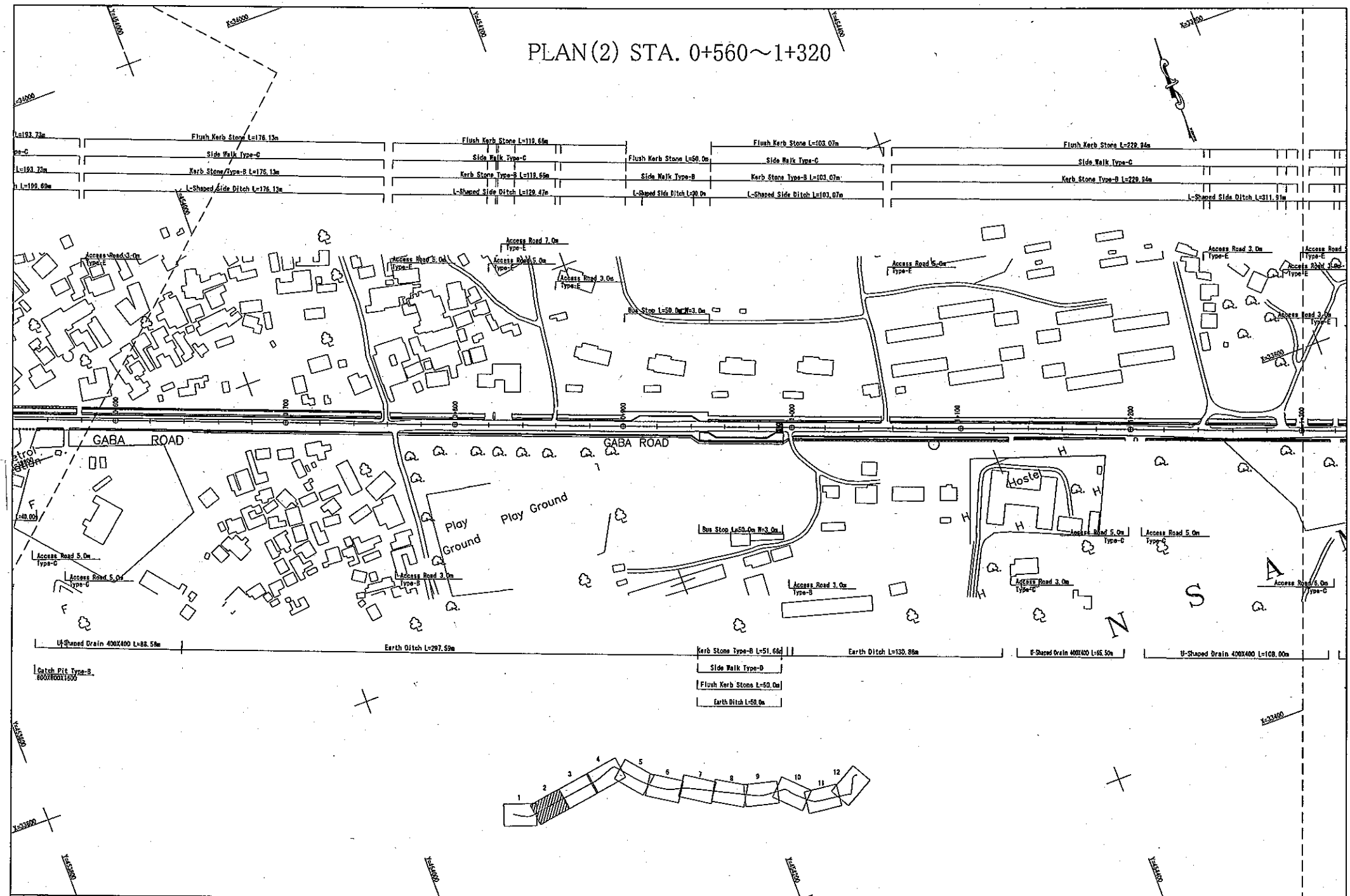
PLAN(2) STA. 0+560～1+320



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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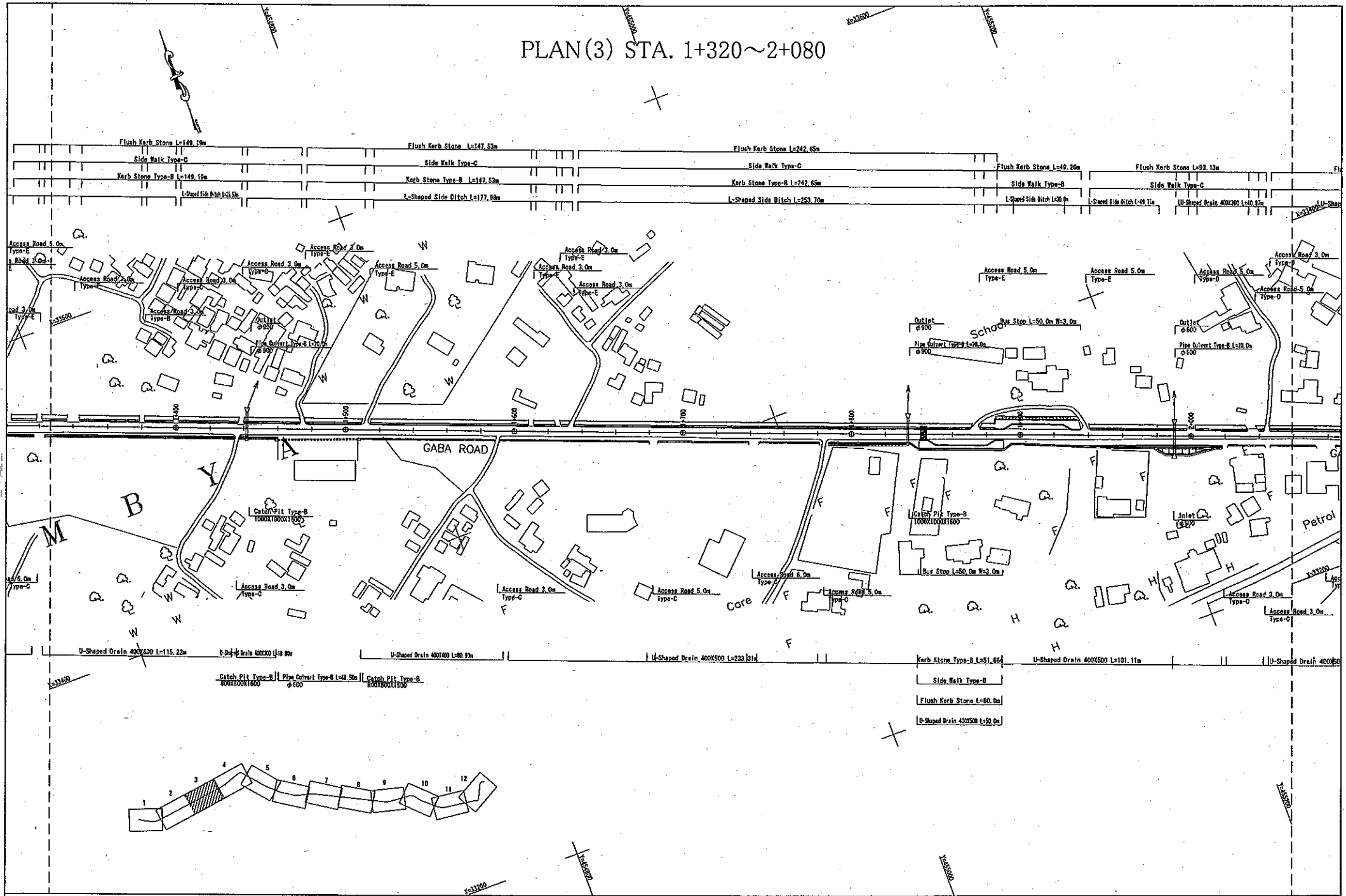
PLAN(3) STA. 1+320～2+080



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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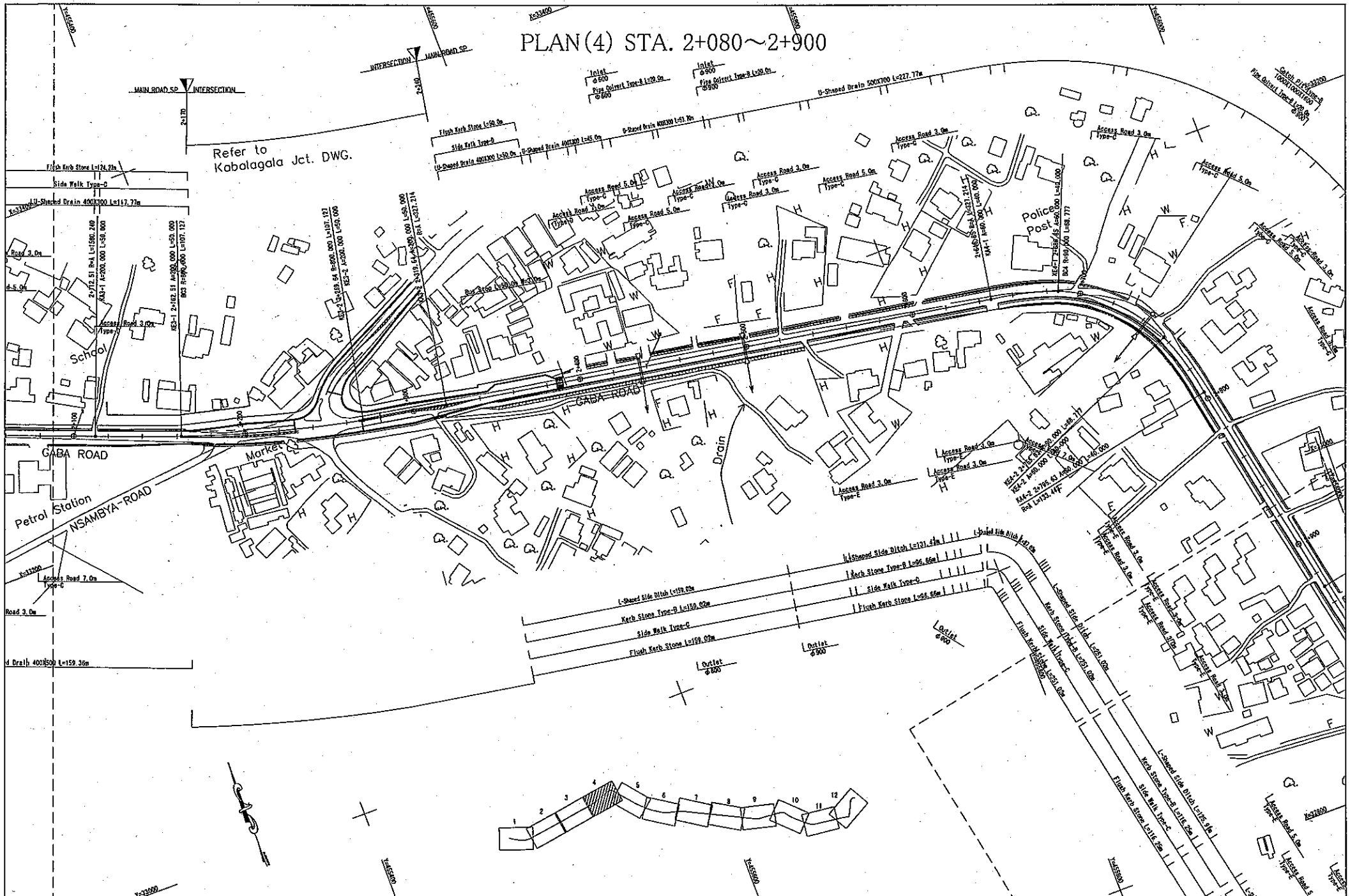
PLAN (4) STA. 2+080～2+900



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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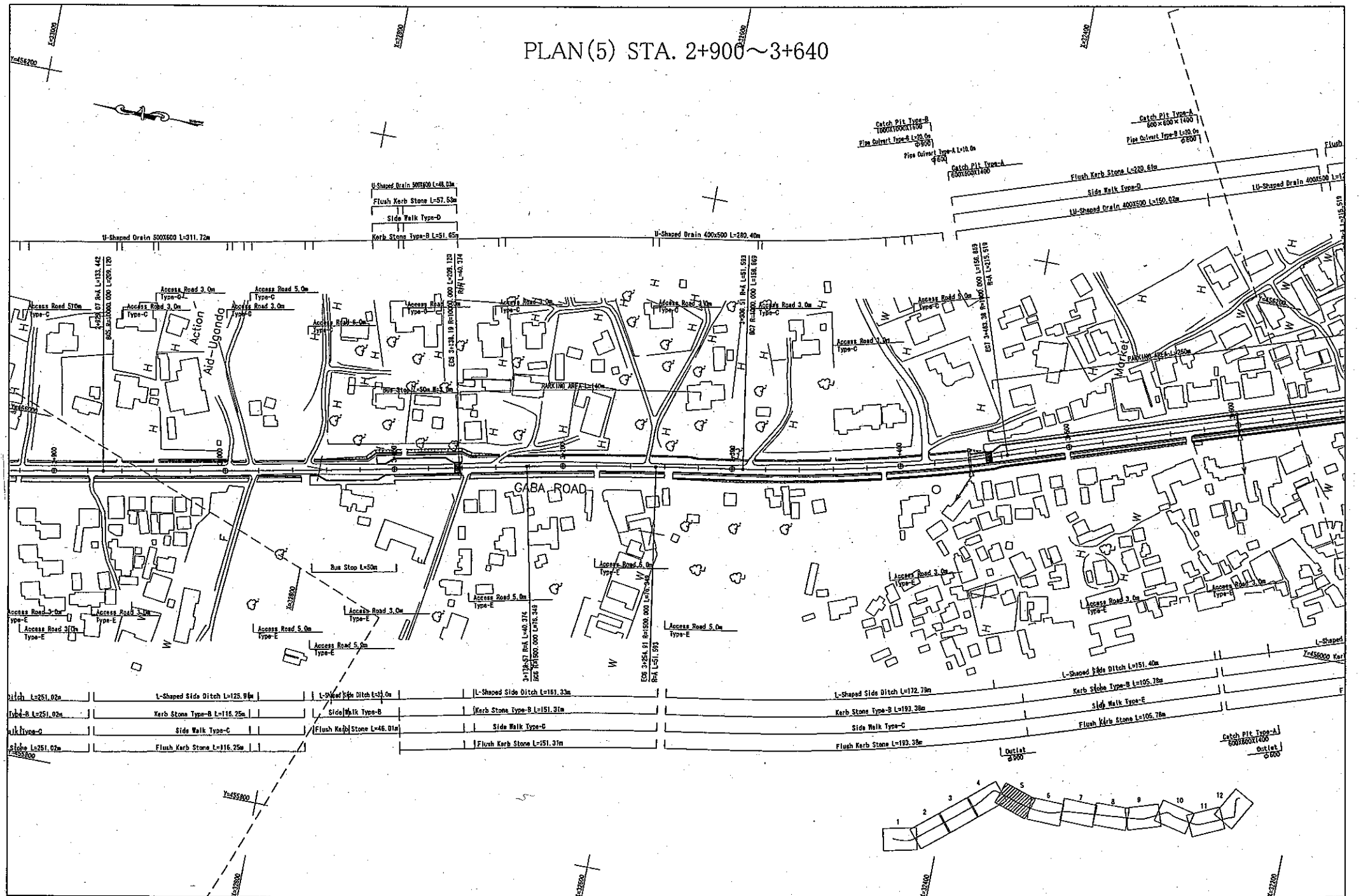
PLAN(5) STA. 2+900～3+640



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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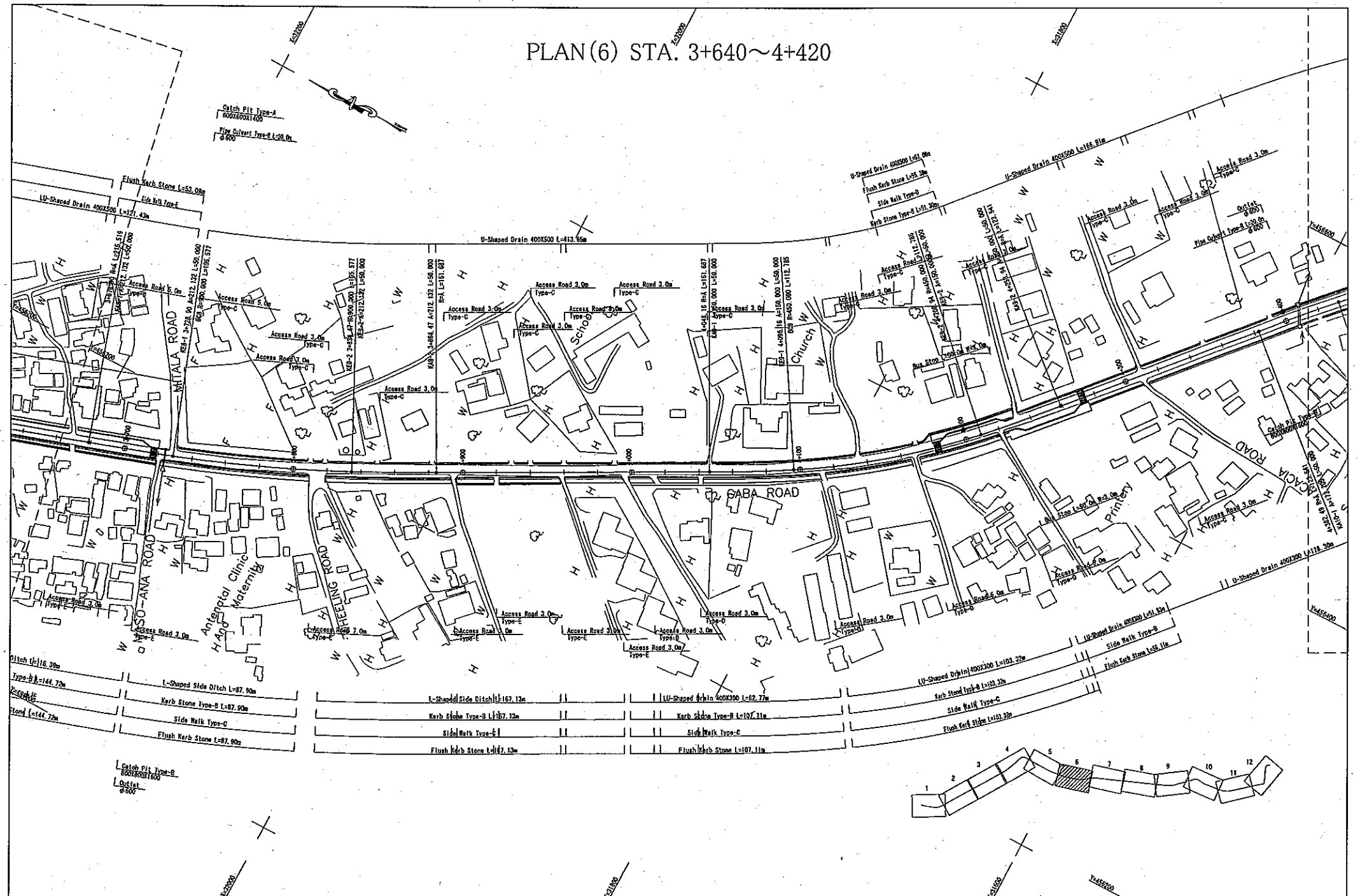
PLAN (6) STA. 3+640～4+420



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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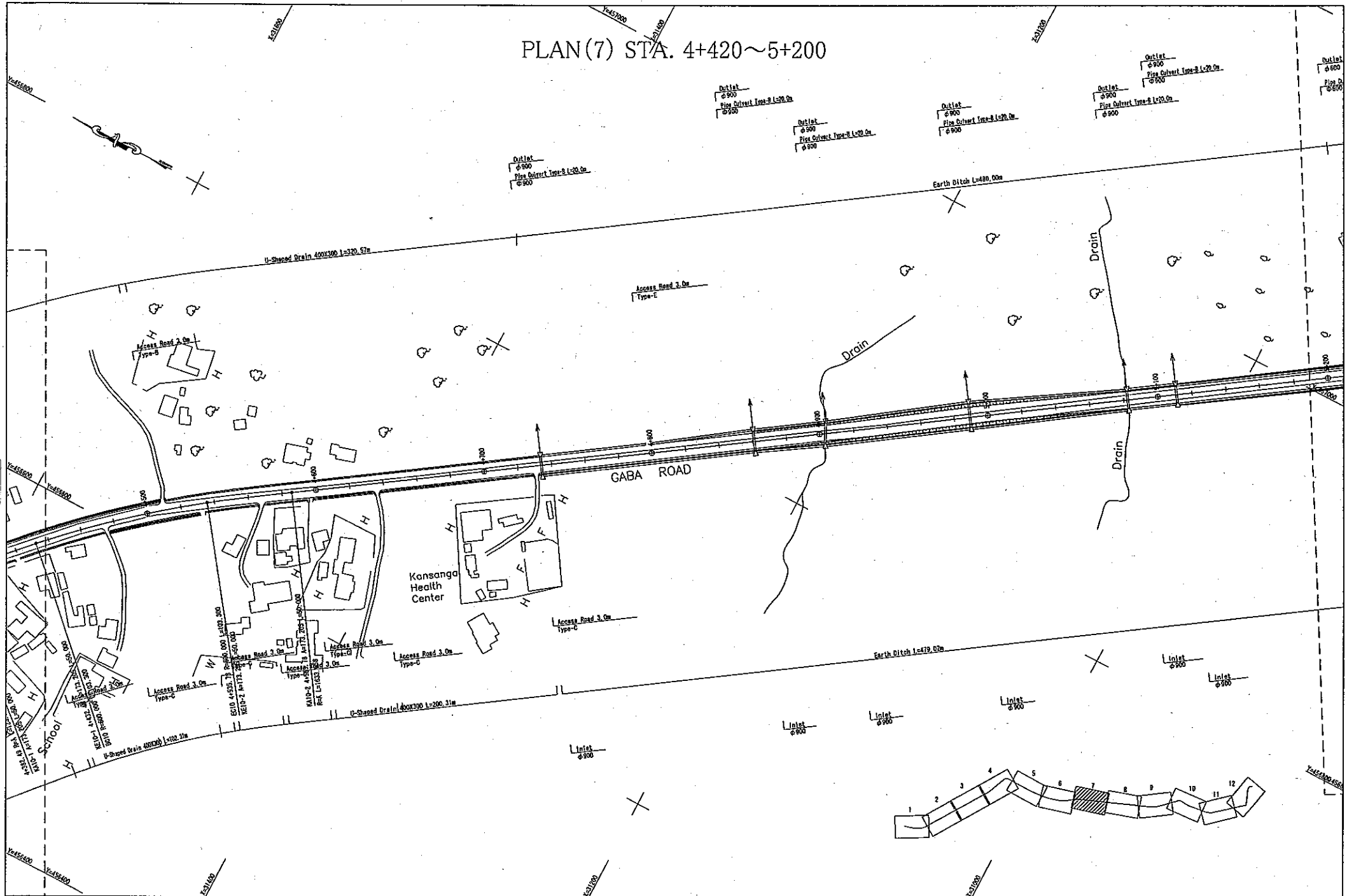
PLAN (7) STA. 4+420～5+200



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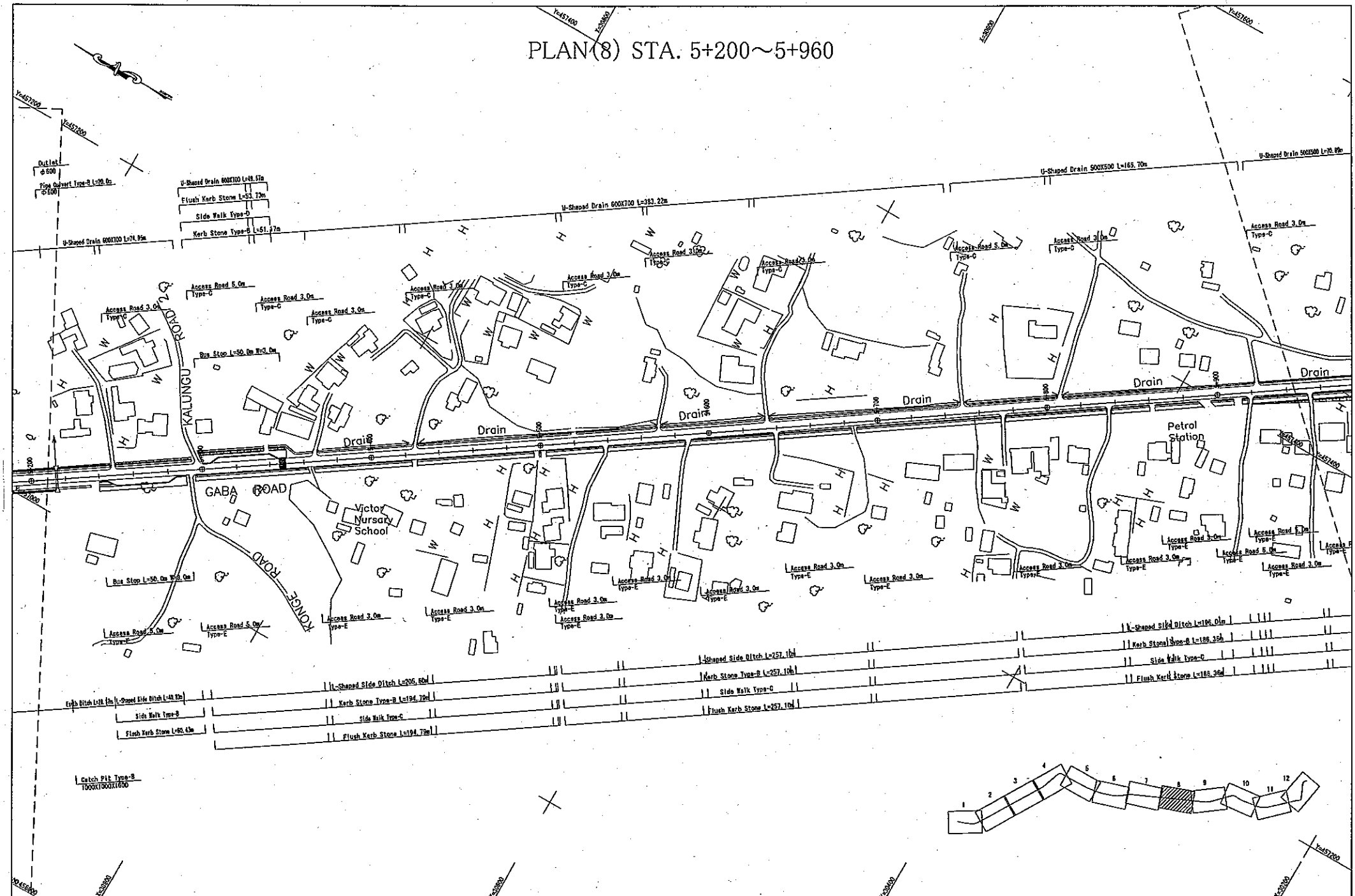
PLAN(8) STA. 5+200～5+960



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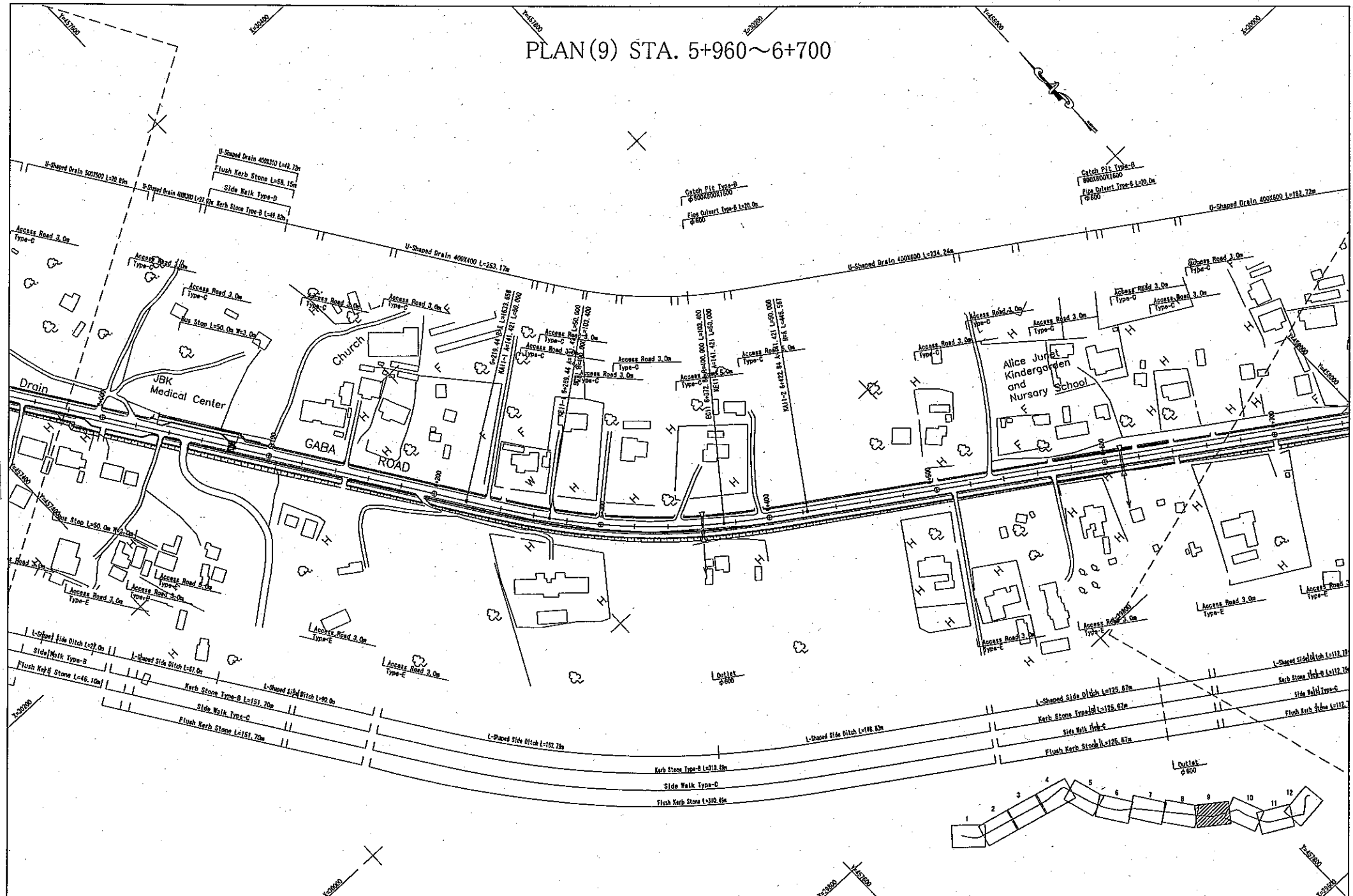
PLAN (9) STA. 5+960～6+700



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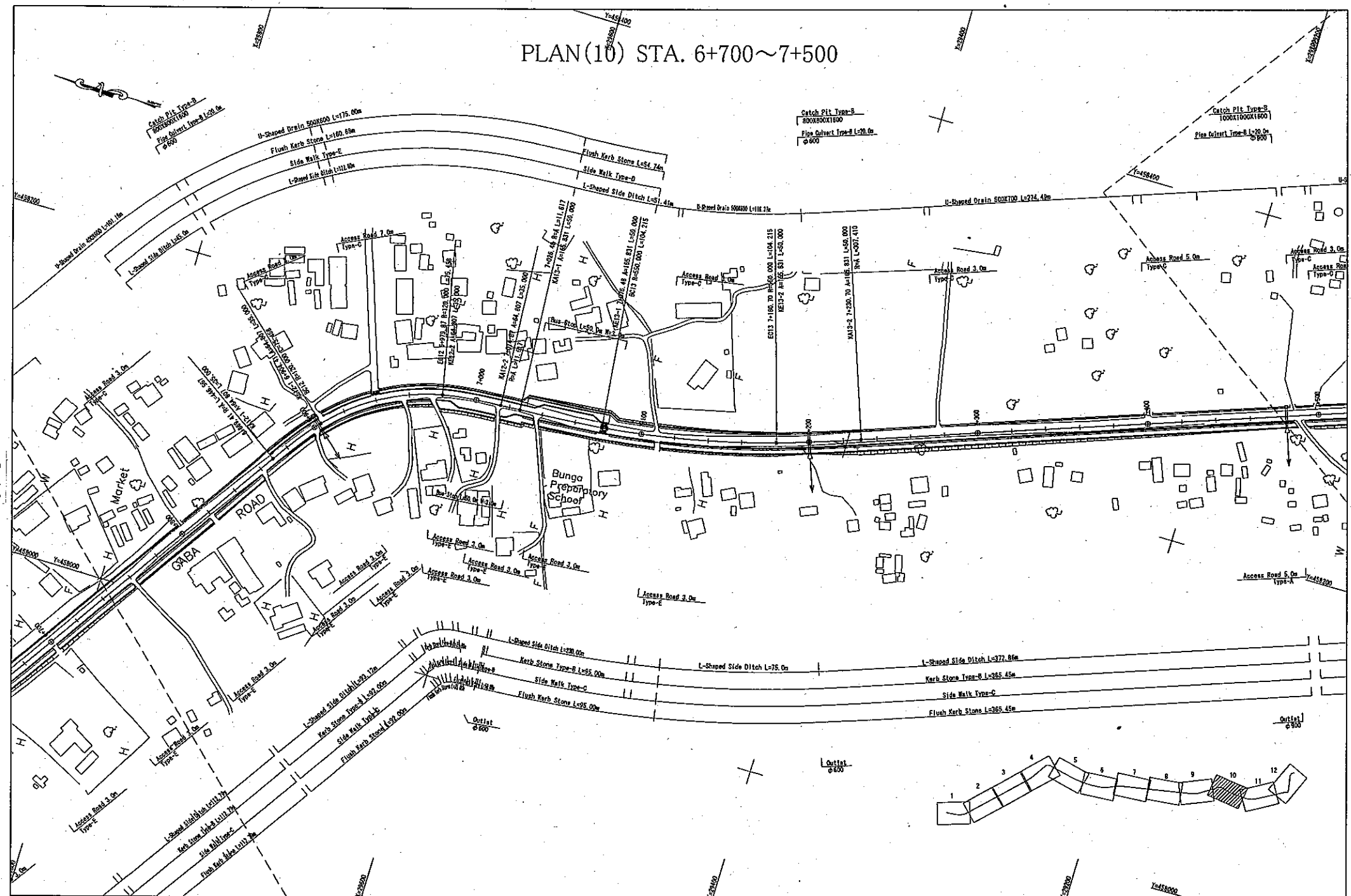
PLAN(10) STA. 6+700～7+500



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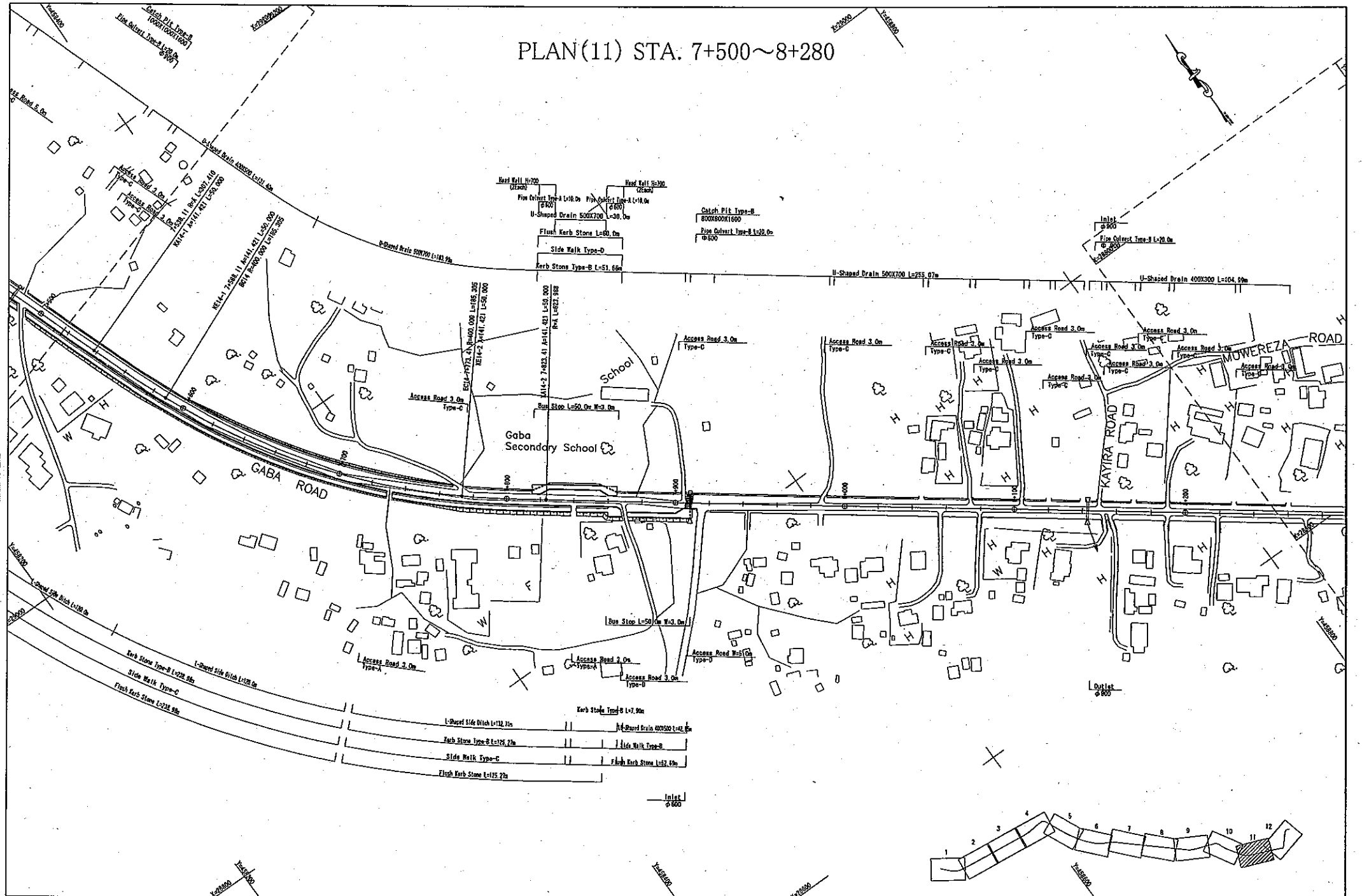
PLAN(11) STA. 7+500～8+280



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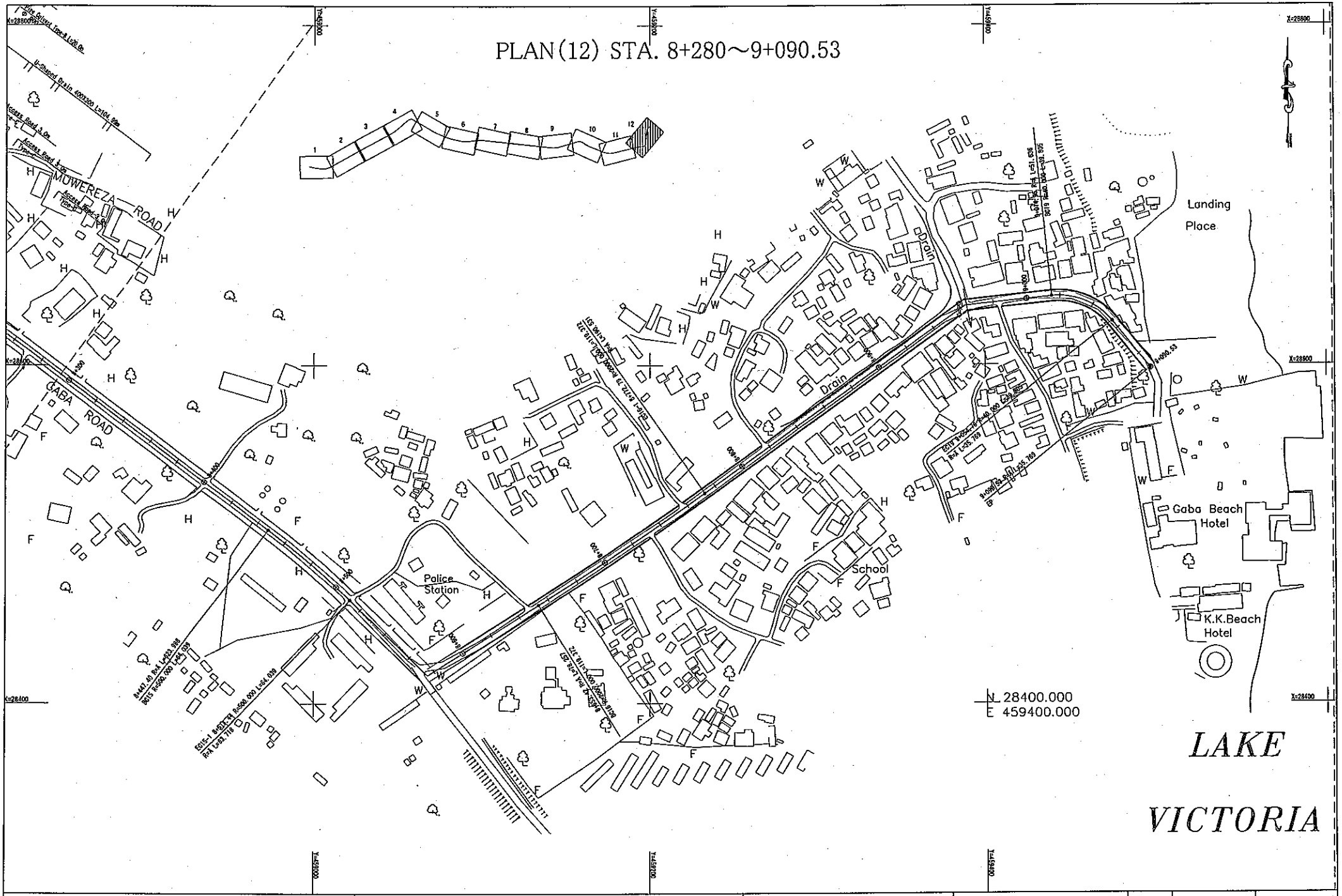
PLAN (12) STA. 8+280～9+090.53



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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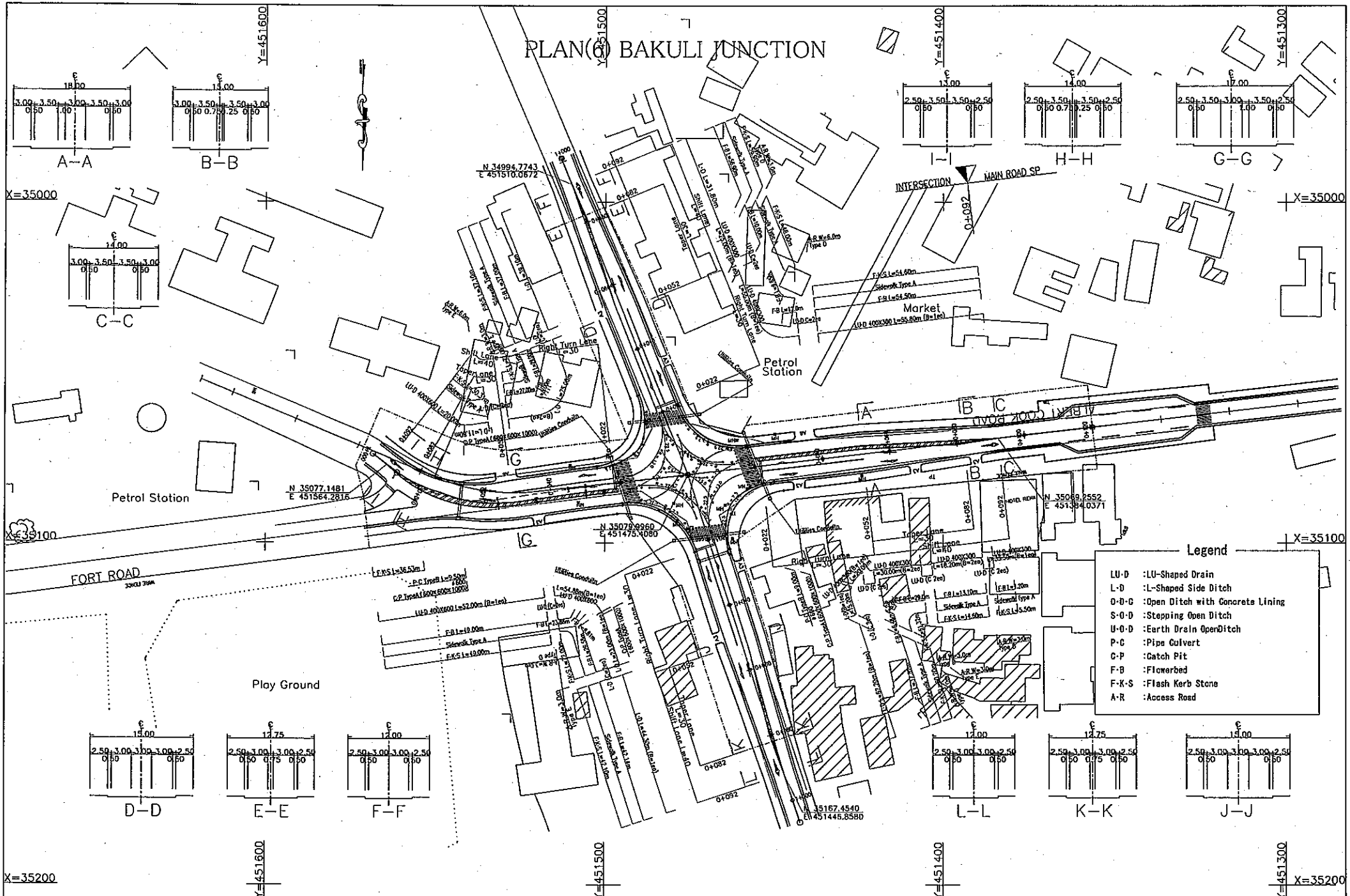

MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE I : NATETE ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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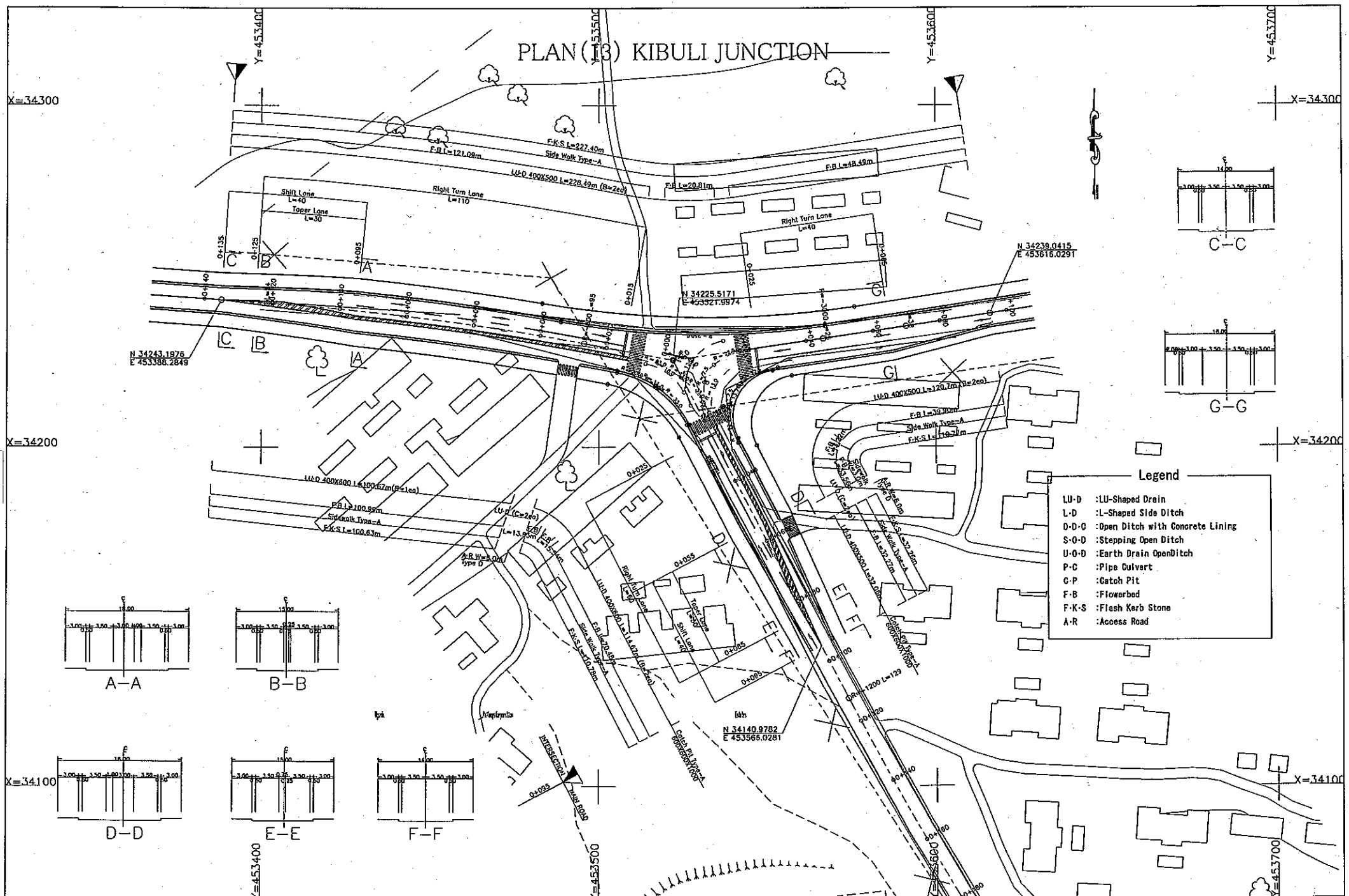
PLAN (13) KIBULI JUNCTION



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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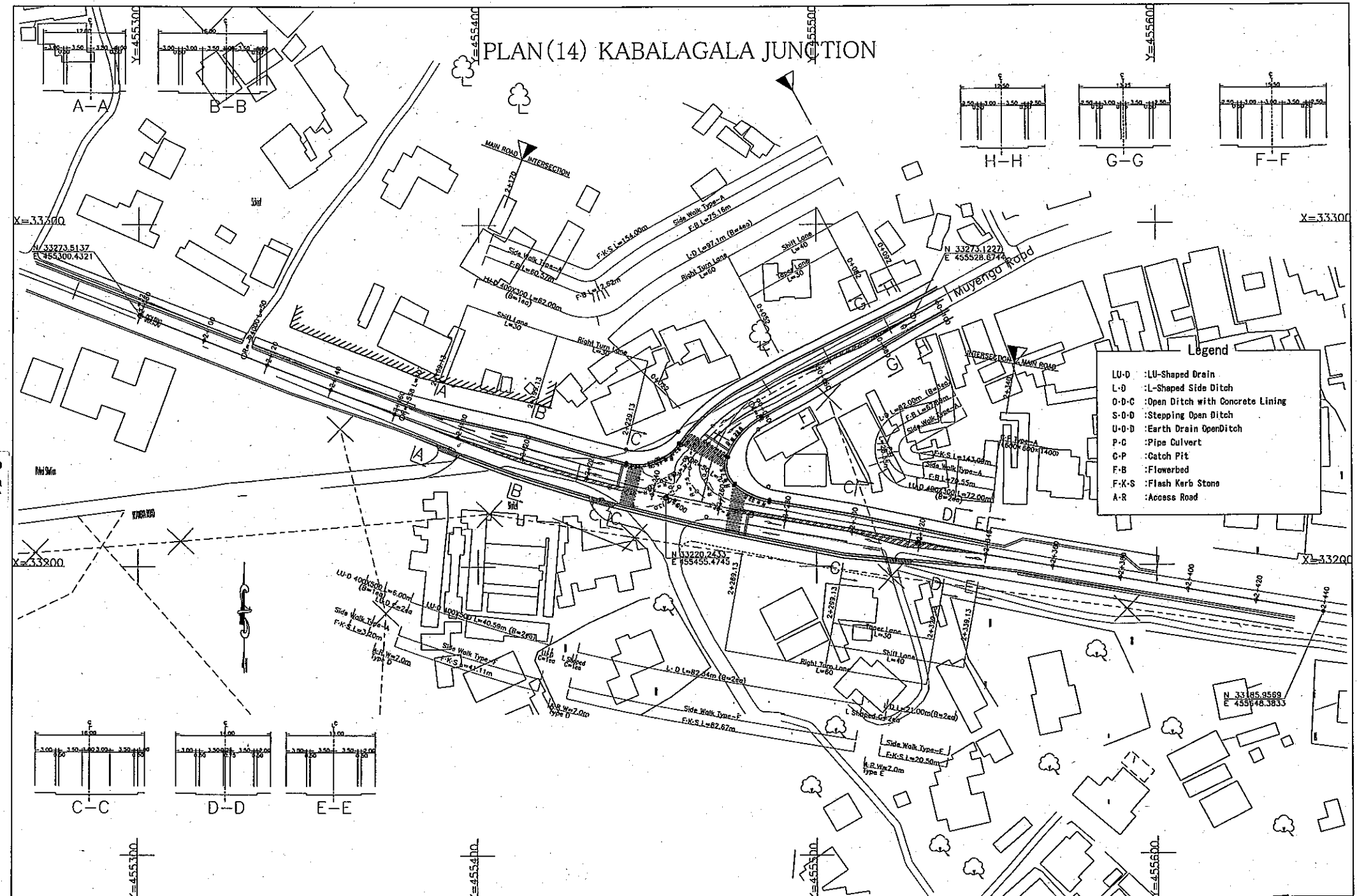

MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
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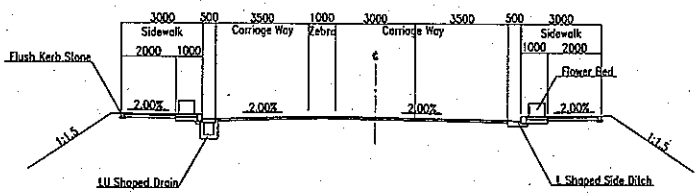
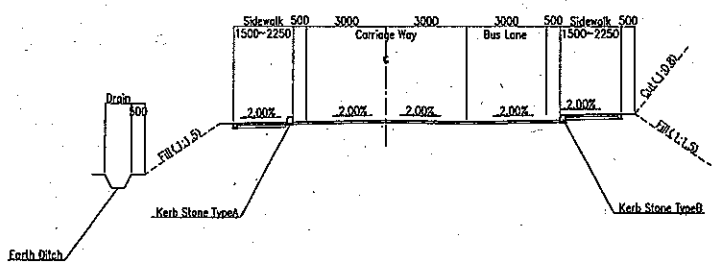
TYPICAL CROSS SECTION

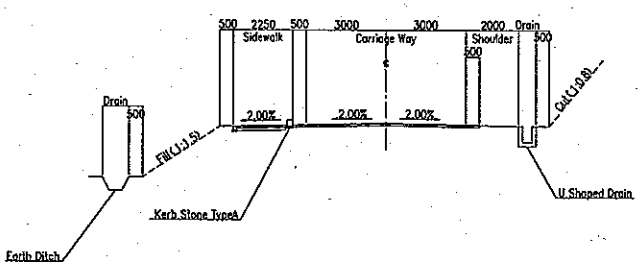
Type-A
(Intersection)



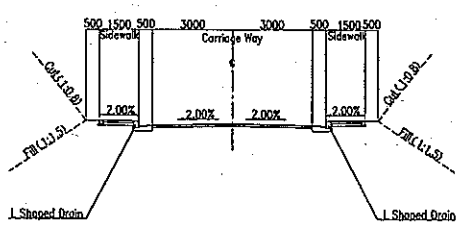
Type-D
(Bus Stop)



Type-B
(General)



Type-C
(Urban Area)

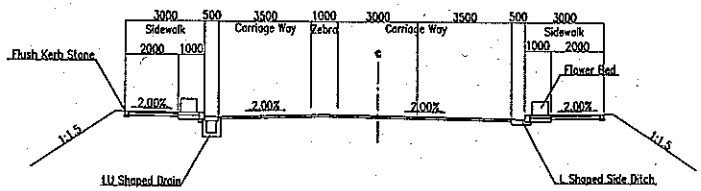


2-52

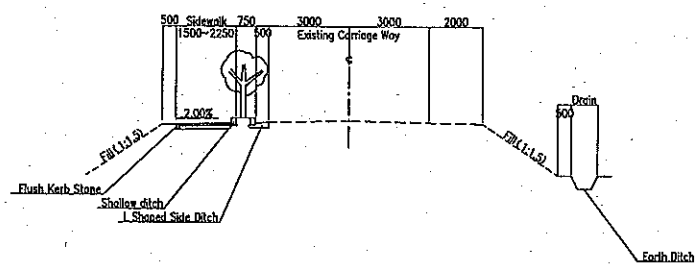
MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE 1 : NATETE ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
			TYPICAL CROSS SECTION	1:200	SEP 2002	D - 1

TYPICAL CROSS SECTION

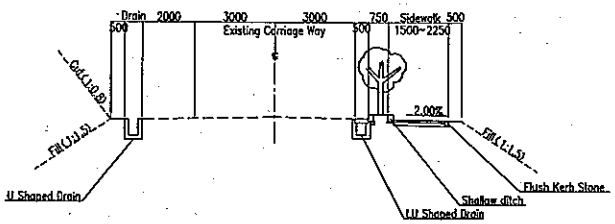
Type-A
(Intersection)



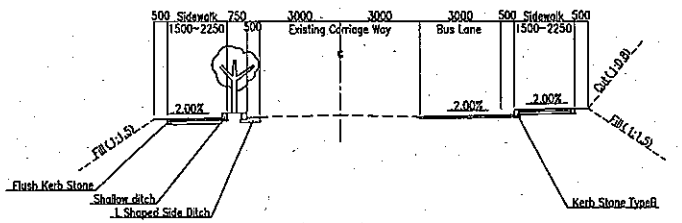
Type-B
(General 1)



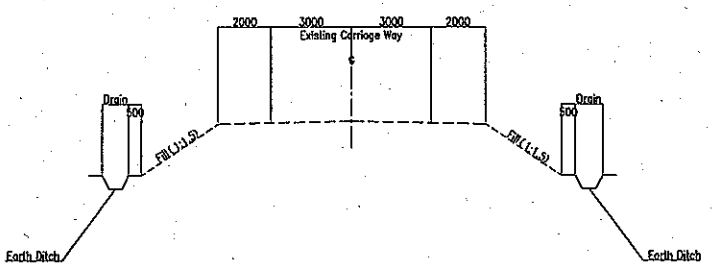
Type-C
(General 2)



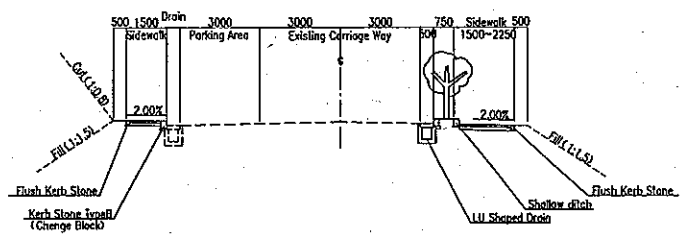
Type-D
(Urban Area・Bus Stop)



Type-E
(Swamp Area)



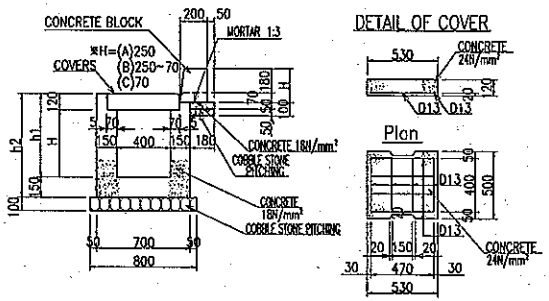
Type-F
(Kansanga Shopping Area)



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
			TYPICAL CROSS SECTION	1:200	SEP 2002	C - 1

DRAINAGE STRUCTURE (1)

LU-Shaped Drain
S=1:40



Dimension Table mm

CLASSIFICATION	Dimension		
	H	h1	h2
400 × 300	300	420	570
400 × 400	400	520	670
400 × 500	500	620	770
400 × 600	600	720	870

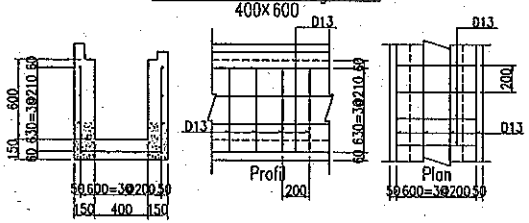
MATERIALS LIST (COVER) PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	24N/mm³	cu.m	0.031	
REINFORCEMENT BAR	D13	kg	3.463	
FORM		sq.m	0.247	

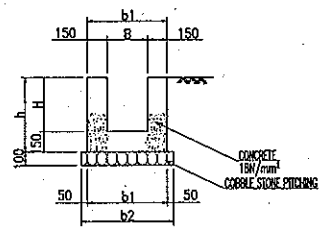
LU-SHAPED DRAIN MATERIALS LIST PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY				REMARKS
			H=300	H=400	H=500	H=600	
CONCRETE BLOCK	180 205 H250 L600	no.	166				TYPE A
CONCRETE	18N/mm²	cu.m	21.76	24.78	27.76	30.76	
BEDDING	COBBLE STONE PITCHING	sq.m	80.00				
REINFORCEMENT BAR	D13	kg	-	-	-	1920.35	
FORM		sq.m	204.00	244.00	284.00	324.00	
MORTAR	1:3	cu.m	0.21				BED MORTAR
COVER		no.	200				

Reinforcement Arrangement
400X600



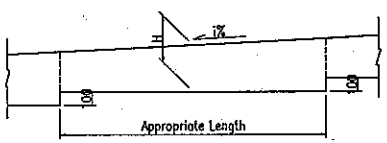
U-Shaped Drain
S=1:40



Dimension Table mm

CLASSIFICATION B x H	Dimension		
	h	b1	b2
400 × 300	450	700	800
400 × 400	550	700	800
400 × 500	650	700	800
400 × 600	750	700	800
500 × 500	650	800	900
500 × 600	750	800	900
500 × 700	850	800	900
600 × 500	650	900	1000
600 × 700	850	900	1000

When i% exceeds 3%
Profil



U-SHAPED DRAIN B=400 MATERIALS LIST PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY				REMARKS
			H=300	H=400	H=500	H=600	
CONCRETE	18N/mm²	cu.m	19.50	22.50	25.50	28.50	
BEDDING	COBBLE STONE PITCHING	sq.m	80.00				
FORM		sq.m	150.00	190.00	230.00	270.00	

U-SHAPED DRAIN B=500 MATERIALS LIST PER 100m

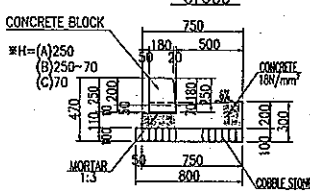
CLASSIFICATION	STANDARD	UNIT	QUANTITY				REMARKS
			H=500	H=600	H=700	-	
CONCRETE	18N/mm²	cu.m	27.00	30.00	33.00	-	
BEDDING	COBBLE STONE PITCHING	sq.m	90.00				
FORM		sq.m	230.00	270.00	310.00	-	

U-SHAPED DRAIN B=600 MATERIALS LIST PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY				REMARKS
			H=500	H=700	-	-	
CONCRETE	18N/mm²	cu.m	28.50	34.50	-	-	
BEDDING	COBBLE STONE PITCHING	sq.m	100.00				
FORM		sq.m	230.00	310.00	-	-	

L-Shaped Side Ditch
S=1:40

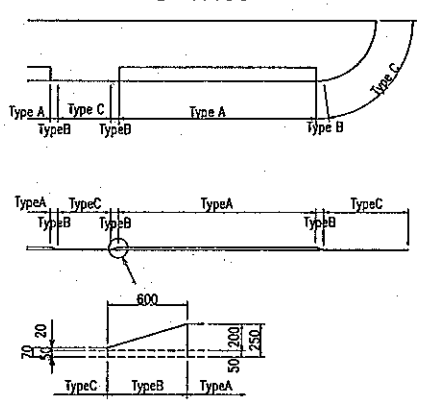
Cross



L-SHAPED SIDE DITCH MATERIALS LIST PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 H250 L600	no.	166	TYPE B
MORTAR	1:3	cu.m	0.21	BED MORTAR
CONCRETE	18N/mm²	"	11.95	
BEDDING	COBBLE STONE PITCHING	sq.m	80.00	
FORM		"	31.00	

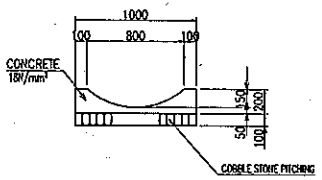
Arrangement Plan
S=1:400



MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
			DRAINAGE STRUCTURE (1)	EACH	SEP 2002	E - 1

DRAINAGE STRUCTURE (2)

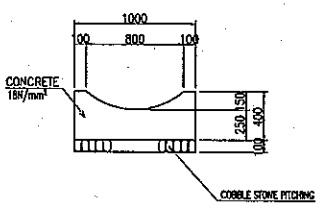
Shallow Ditch TypeA



MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	11.78	
BEDDING	COBBLE STONE PITCHING	sq.m	100.00	
FORM		"	40.00	

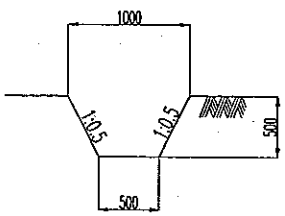
Shallow Ditch TypeB
(for Access Road Crossing)



MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	31.78	
BEDDING	COBBLE STONE PITCHING	sq.m	100.00	
FORM		"	80.00	

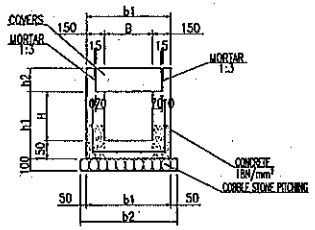
Earth Ditch



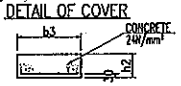
EXCAVATION QUANTITY — PER 100m

SIZE	UNIT	QUANTITY	REMARKS
1000×500×500	cu.m	150.00	

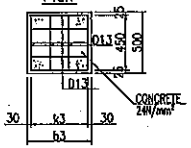
Covered U-Shaped Drain
(for Access Road Crossing)



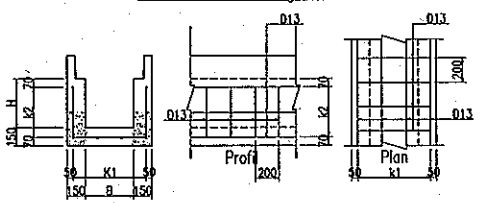
DETAIL OF COVER



Plan



Reinforcement Arrangement



Dimension Table — mm

CLASSIFICATION B x H	Dimension h1	h2	b1	b2	b3	k1	k2	k3
400 × 300	450	190	700	800	340	600=3@200	310=2@155	480=3@160
400 × 400	550	190	700	800	340	600=3@200	410=2@205	480=3@160
400 × 500	650	190	700	800	340	600=3@200	510=3@170	480=3@160
400 × 600	750	190	700	800	340	600=3@200	610=3@203	480=3@160
500 × 500	650	210	800	900	640	700=4@175	510=3@170	580=3@193
500 × 600	750	210	800	900	640	700=4@175	610=3@203	580=3@193
500 × 700	850	210	800	900	640	700=4@175	710=4@178	580=3@193
600 × 500	650	230	900	1000	740	800=4@200	510=3@170	680=4@170
600 × 700	850	230	900	1000	740	800=4@200	710=4@178	680=4@170

COVER MATERIALS LIST — PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY B=400	B=500	B=600	B=700	REMARKS
CONCRETE	24N/mm²	cu.m	0.051	0.067	0.085	0.101	
REINFORCEMENT BAR	D13	kg	4.179	4.877	5.822	6.619	
FORM		sq.m	0.385	0.479	0.570	0.643	

U-SHAPED DRAIN B=400 MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY H=300	H=400	H=500	H=600	REMARKS
CONCRETE	18N/mm²	cu.m	22.07	25.07	28.07	31.07	
BEDDING	COBBLE STONE PITCHING	sq.m	80.00				
REINFORCEMENT BAR	D13	kg	2202	2302	3198	3298	
FORM		sq.m	228.00	288.00	308.00	348.00	
MORTAR	1:3	cu.m	0.48				
COVER		no.	200				

U-SHAPED DRAIN B=500 MATERIALS LIST — PER 100m

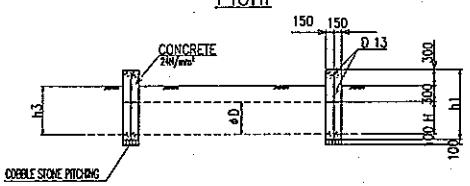
CLASSIFICATION	STANDARD	UNIT	QUANTITY H=500	H=600	H=700	–	REMARKS
CONCRETE	18N/mm²	cu.m	29.84	32.84	35.84	- -	
BEDDING	COBBLE STONE PITCHING	sq.m	90.00				
REINFORCEMENT BAR	D13	kg	3815	3945	5040	–	
FORM		sq.m	314.00	354.00	394.00	–	
MORTAR	1:3	cu.m	0.53				
COVER		no.	200				

U-SHAPED DRAIN B=600 MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY H=500	H=700	–	–	REMARKS
CONCRETE	18N/mm²	cu.m	31.81	37.81	–	–	
BEDDING	COBBLE STONE PITCHING	sq.m	100.00				
REINFORCEMENT BAR	D13	kg	3895	5090	–	–	
FORM		sq.m	322.00	402.00	–	–	
MORTAR	1:3	cu.m	0.56				
COVER		no.	200				

Head Wall
S=1:100

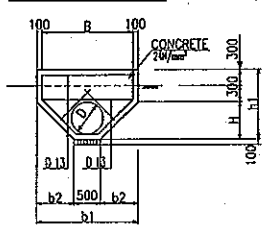
Plofil



Dimension Table — mm

CLASSIFICATION	Dimension h1	B	b1	b2	D
H=700	1300	1700	1900	700	600

Cross Section



MATERIALS LIST H=700 — PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	0.60	
REINFORCEMENT BAR	D13	kg	8.11	
BEDDING	COBBLE STONE PITCHING	sq.m	0.15	
FORM		"	5.48	

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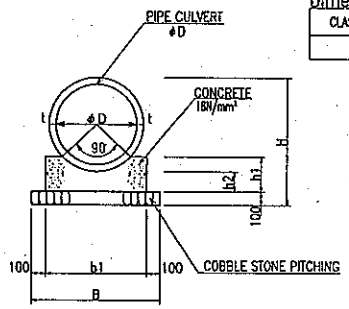
			DRAINAGE STRUCTURE (2)	1:40	SEP 2002	E - 2

DRAINAGE STRUCTURE (3)

Pipe Culvert TypeA

Cross Section



Dimension Table mm

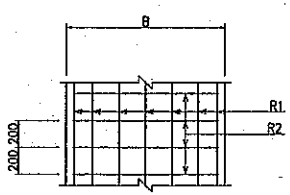
CLASSIFICATION	Dimension				
	B	b1	H	h1	h2
D600	950	750	950	260	150

MATERIALS LIST ϕ600 PER 100m

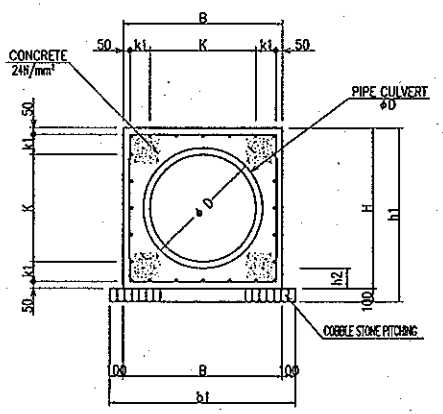
CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	15.63	
BEDDING	COBBLE STONE PITCHING	sq.m	95.00	
PIPE CULVERT	ϕ600	no.	41.00	
FORM		"	52.00	

Pipe Culvert TypeB

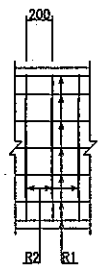
Plan



Cross Section



Plofil



Dimension Table mm

CLASSIFICATION ϕD	Dimension									
	t	B	b1	H	h1	h2	K	k1	R1	R2
ϕ600	50	1000	1200	1000	1100	150	600=3@200	150	D13	D13
ϕ900	75	1460	1660	1460	1560	200	1000=5@200	180	D16	D13
ϕ1000	82	1580	1780	1580	1680	200	1200=6@200	140	D16	D13

MATERIALS LIST ϕ600 PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	61.52	
BEDDING	COBBLE STONE PITCHING	sq.m	120.00	
PIPE CULVERT	ϕ600	nos.	41.00	
REINFORCEMENT BAR	D13	kg	4298.4	
FORM		sq.m	200.00	

MATERIALS LIST ϕ900 PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	126.57	
BEDDING	COBBLE STONE PITCHING	sq.m	166.00	
PIPE CULVERT	ϕ900	nos.	41.00	
REINFORCEMENT BAR	D13	kg	3223.8	
	D16	kg	4368.0	
FORM		sq.m	292.00	

MATERIALS LIST ϕ1000 PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	143.23	
BEDDING	COBBLE STONE PITCHING	sq.m	178.00	
PIPE CULVERT	ϕ1000	nos.	41.00	
REINFORCEMENT BAR	D13	kg	3462.6	
	D16	kg	4992.0	
FORM		sq.m	316.00	

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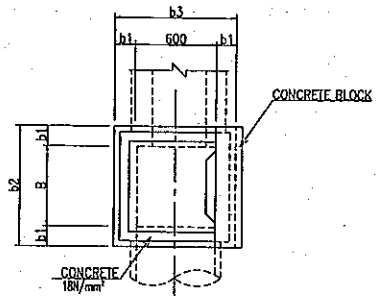
			DRAINAGE STRUCTURE (3)	1:40	SEP. 2002	E - 3

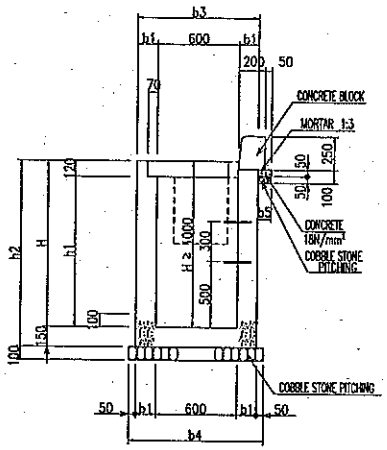
DRAINAGE STRUCTURE (4)

Catch Pit TypeA
S=1:40

Plan



Cross



Dimension Table mm

CLASSIFICATION 600×B×H	Dimension B	b1	b2	b3	b4	b5	H	h1	h2
600×600×1000	600	150	900	900	1000	100	1000	880	1150
600×600×1400	600	200	1000	1000	1100	50	1400	1280	1550
600×600×1600	600	200	1000	1000	1100	50	1600	1480	1750
600×800×1600	800	200	1200	1000	1100	50	1600	1480	1750
600×1000×1800	1000	200	1400	1000	1100	50	1800	1680	1950

MATERIALS LIST 600×600×1000 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×500	no.	1.50	
CONCRETE	18N/mm²	cu.m	0.56	
BEDDING	COBBLE STONE PITCHING	sq.m	1.00	
FORM		"	6.43	
MORTAR		cu.m	0.001	
COVER		no.	1	
STEP		no.	1	D16 1.25kg

MATERIALS LIST 600×800×1600 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×600	no.	2.00	
CONCRETE	18N/mm²	cu.m	1.20	
BEDDING	COBBLE STONE PITCHING	sq.m	1.43	
FORM		"	12.60	
MORTAR		cu.m	0.002	
COVER		no.	1	
STEP		no.	3	D16 3.74kg

MATERIALS LIST 600×600×1400 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×500	no.	1.67	
CONCRETE	18N/mm²	cu.m	1.02	
BEDDING	COBBLE STONE PITCHING	sq.m	1.21	
FORM		"	9.44	
MORTAR		cu.m	0.002	
COVER		no.	1	
STEP		no.	2	D16 2.50kg

MATERIALS LIST 600×1000×1800 PER EACH

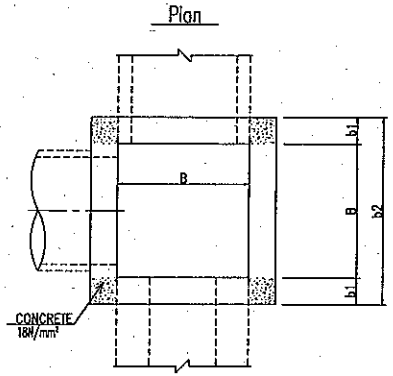
CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×600	no.	2.33	
CONCRETE	18N/mm²	cu.m	1.65	
BEDDING	COBBLE STONE PITCHING	sq.m	1.85	
FORM		"	15.60	
MORTAR		cu.m	0.002	
COVER		no.	1	
STEP		no.	4	D16 5.00kg

MATERIALS LIST 600×600×1600 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×500	no.	1.67	
CONCRETE	18N/mm²	cu.m	1.19	
BEDDING	COBBLE STONE PITCHING	sq.m	1.21	
FORM		"	10.80	
MORTAR		cu.m	0.002	
COVER		no.	1	
STEP		no.	2	D16 2.50kg

Catch Pit TypeB
S=1:40

Plan



Dimension Table mm

CLASSIFICATION BxBxH	Dimension B	b1	b2	b3	H	h1	h2
800×800×1600	800	200	1200	1200	1600	150	1750
1000×1000×1600	1000	200	1400	1400	1600	150	1750
1400×1400×1600	1400	200	1800	1800	1600	150	1750

MATERIALS LIST 800×800×1600 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	1.50	
BEDDING	COBBLE STONE PITCHING	sq.m	1.89	
FORM		"	14.00	
STEP		no.	3	

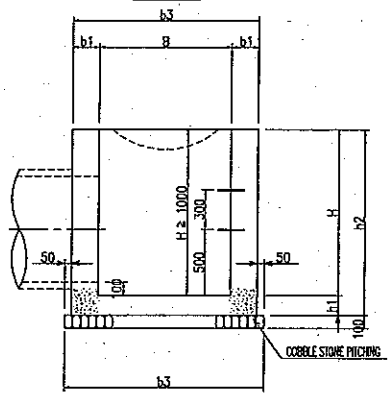
MATERIALS LIST 1000×1000×1600 PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	1.83	
BEDDING	COBBLE STONE PITCHING	sq.m	2.25	
FORM		"	16.80	
STEP		no.	3	

MATERIALS LIST 1400×1400×1600 PER EACH

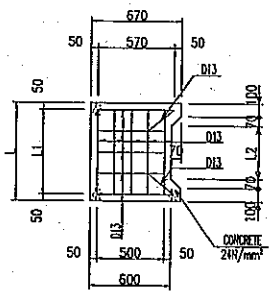
CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm²	cu.m	2.54	
BEDDING	COBBLE STONE PITCHING	sq.m	3.61	
FORM		"	22.40	
STEP		no.	3	

Cross



DETAIL OF COVER

Plan



Dimension Table mm

CLASSIFICATION 600×Bx–	Dimension L	L1	L2
600×600×–	740	640	400
600×800×–	940	840	600
600×1000×–	1140	940	800

MATERIALS LIST 600×600×– (COVER) PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	24N/mm²	cu.m	0.05	
REINFORCEMENT BAR	D13	kg	6.36	
FORM		sq.m	0.35	

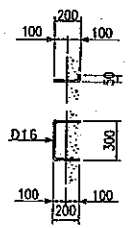
MATERIALS LIST 600×800×– (COVER) PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	24N/mm²	cu.m	0.07	
REINFORCEMENT BAR	D13	kg	7.40	
FORM		sq.m	0.39	

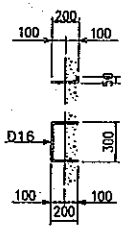
MATERIALS LIST 600×1000×– (COVER) PER EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	24N/mm²	cu.m	0.08	
REINFORCEMENT BAR	D13	kg	7.80	
FORM		sq.m	0.44	

Step
S=1:20



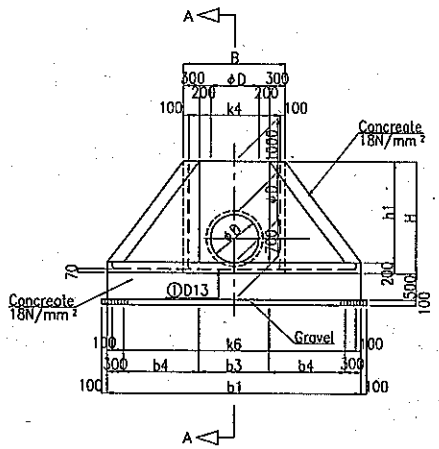
Step
S=1:20



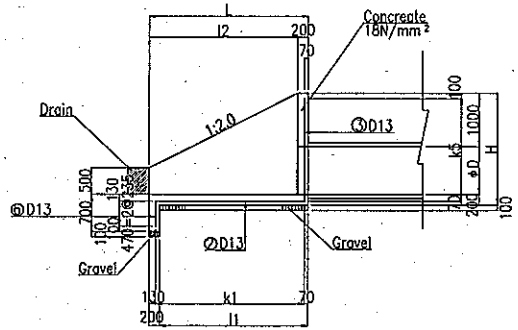
MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
			DRAINAGE STRUCTURE (4)	EACH	SEP 2002	D - 4

DRAINAGE STRUCTURE (5)

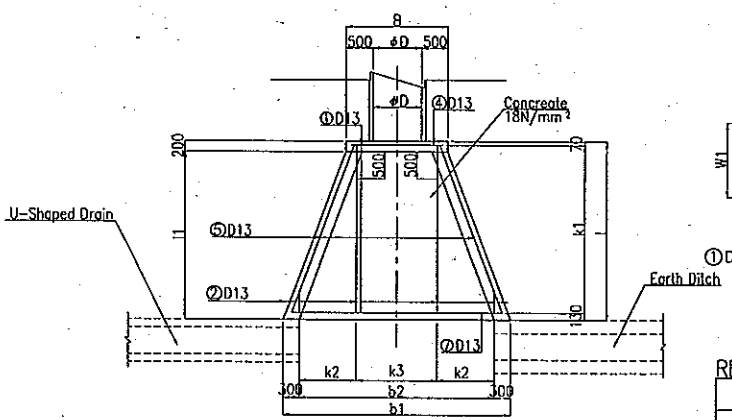
Inlet Outlet



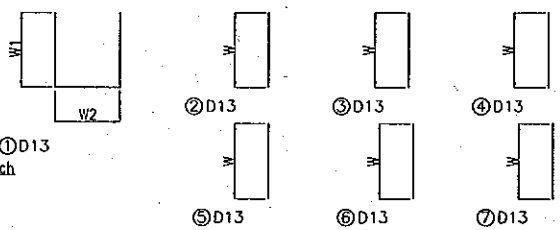
SECTION



SECTION A–A



PLAN



REINFORCEMENT BAR mm

MARK		Dimension φ600	Dimension φ900
1	W1	630~1630	630~1930
	W2	1400~3545	1900~4048
2	W	400~2460	400~3130
3	W	1630	1930
4	W	1400	1900
5	W	200~2460	200~3130
6	W	470	470
7	W	3545	4048

Dimension Table (1) mm

CLASSIFICATION φ D	Dimension B	b1	b2	b3	b4	H	h1	L	l1	l2
φ 600	1600	3745	3145	1000	1073	1800	1600	2660	2460	2460
φ 900	1900	4248	3648	1300	1174	2100	1900	3330	3130	3130

Dimension Table (2) mm

CLASSIFICATION φ D	Dimension k1	k2	k3	k4	k5	k6
φ 600	2460=12@205	1073=5@215	1000=5@200	1400=7@200	1630=8@204	3545=17@209
φ 900	3130=15@209	1174=5@235	1300=6@217	1900=9@211	1930=9@214	4048=20@202

MATERIALS LIST φ600 PER 1EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm2	cu.m	3.90	
REINFORCEMENT BAR	D13	kg	155	
BEDDING	GRAVEL	sq.m	7.86	
FORM		"	22.32	

MATERIALS LIST φ900 PER 1EACH

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE	18N/mm2	cu.m	5.50	
REINFORCEMENT BAR	D13	kg	217	
BEDDING	GRAVEL	sq.m	11.14	
FORM		"	30.20	

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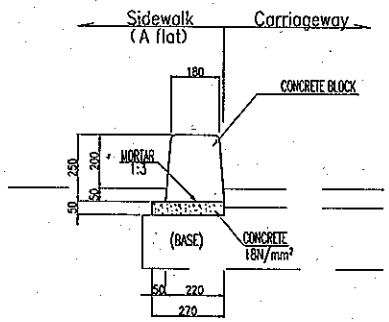
			DRAINAGE STRUCTURE (5)	1:100	SEP 2002	E-5

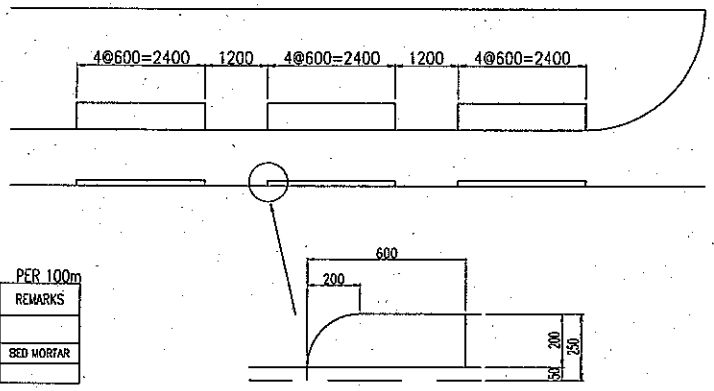
KERB STONE

Kerb Stone Type A
S=1:20

Cross Section



Arrangement Plan

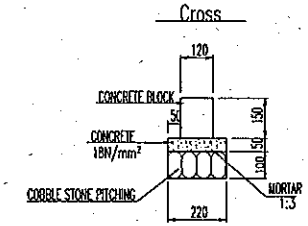


KERB STONE A MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 ×250×600	no.	112	
MORTAR	1:3	cu.m	0.15	BED MORTAR
CONCRETE	18N/mm²	"	0.91	

Flush Kerb Stone
S=1:20

Cross

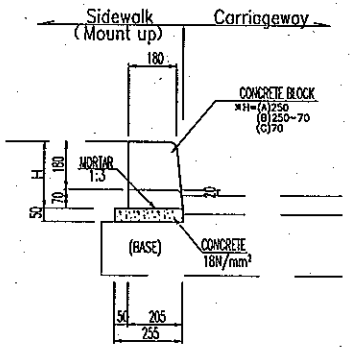


MATERIALS LIST — PER 100m

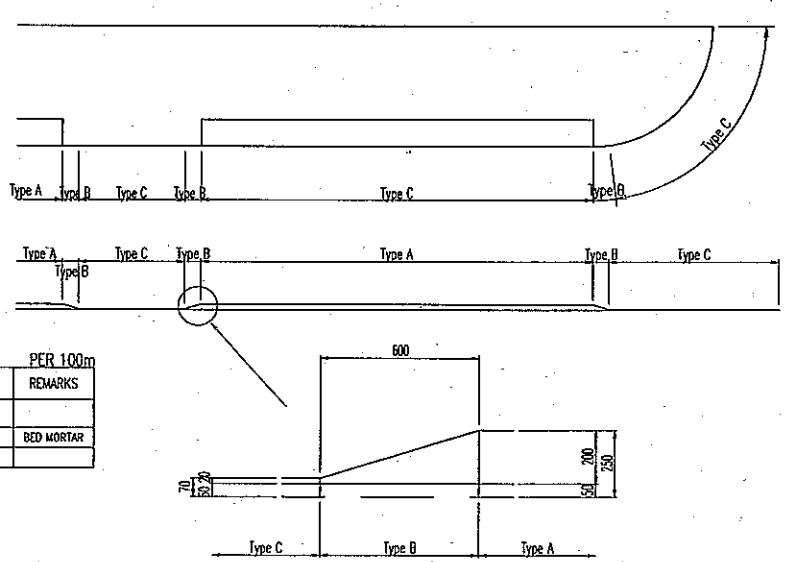
CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	150×120×600	no.	165	
MORTAR	1:3	cu.m	0.12	BED MORTAR
CONCRETE	18N/mm²	"	1.10	
BEDDING	COBBLE STONE PITCHING	sq.m	22.00	
FORM		"	10.00	

Kerb Stone Type B
S=1:20

Cross Section



Arrangement Plan



KERB STONE B MATERIALS LIST — PER 100m

CLASSIFICATION	STANDARD	UNIT	QUANTITY	REMARKS
CONCRETE BLOCK	180 205 ×250×600	no.	166	
MORTAR	1:3	cu.m	0.21	BED MORTAR
CONCRETE	18N/mm²	"	1.28	

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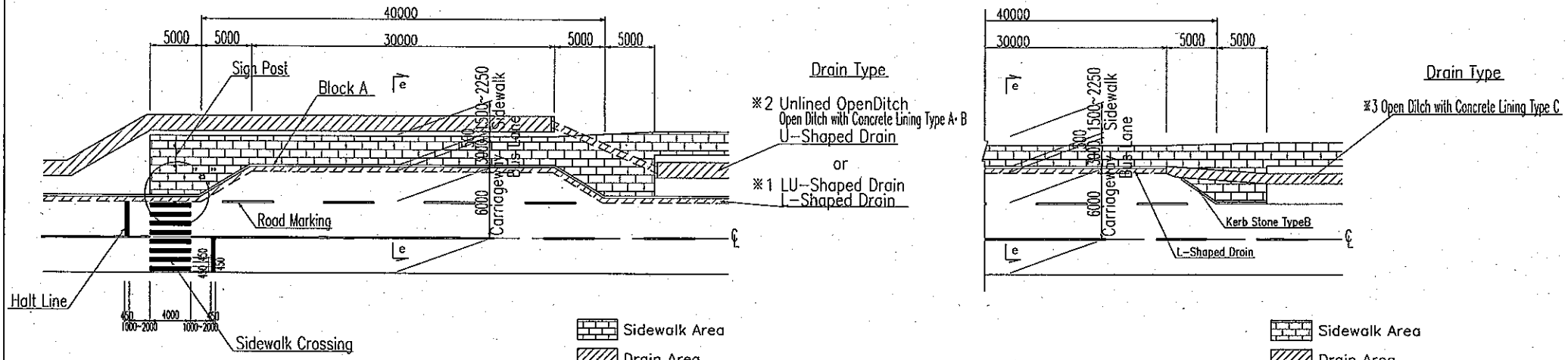
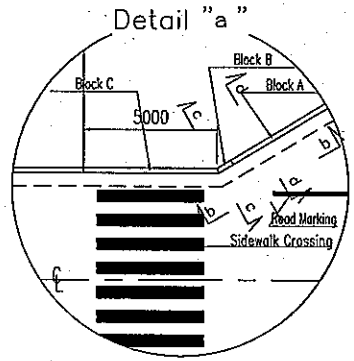
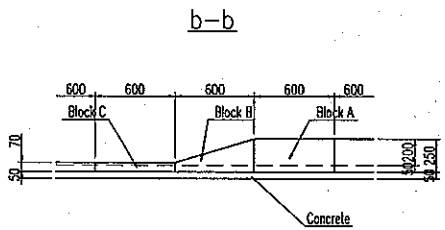
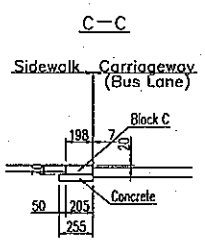
			KERB STONE	EACH	SEP 2002 / F - 1

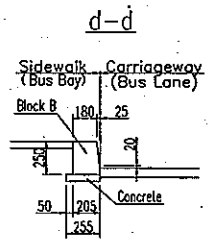
BUS STOP

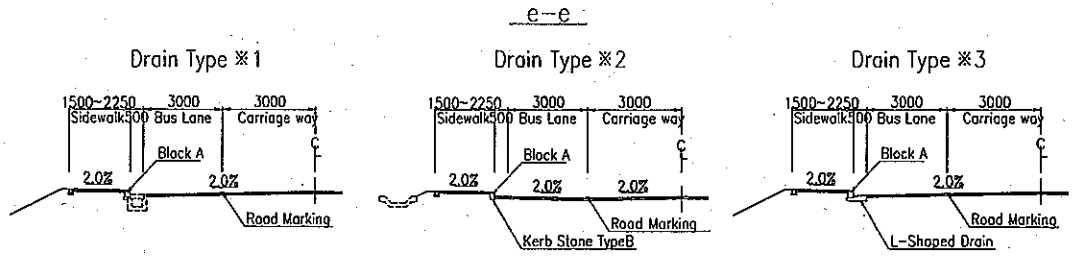












MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS THE REPUBLIC OF UGANDA	THE PROJECT FOR IMPROVEMENT OF TRUNK ROADS IN KAMPALA PHASE II : GABA ROAD	JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE	SCALE	DATE	SHEET NO.
			BUS STOP	1:200	SEP 2002	F - 3

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The implementation policies are introduced, taking into account that the project shall be implemented under the Japan's Grant Aid Scheme, as described below:

- to maximise the procurement of local labours, materials and equipment in Uganda so as to increase employment opportunities, to facilitate technology transfer and to provide positive impact to the local economy,
- to establish good communication between the Government of Uganda, the consultant and the contractor for the project implementation as smooth as possible,
- to prepare a practical construction plan taking into account the local rainfall pattern, period required for materials and equipment procurement, application of appropriate construction methods,
- to adopt construction methods which do not hamper smooth traffic flow, and
- to establish a coordinated maintenance organisation among agencies involved.

2.2.4.2 Implementation Condition

Special considerations for the project implementation are as follows:

1) Labour Law

   The contractor shall administer labours properly under adequate safety control and prevent conflict with local labours observing the prevailing government laws in Uganda.

2) Environmental Consideration

   The consultant shall be versed with Environmental Guideline of Uganda and related procedures for smooth implementation of the Project. The following measures are undertaken taking the environmental aspects of the Projects into consideration:

   - to minimize open shaped ditches so as to prevent inflow of soils and liters,
   - to pave the intersecting sections of access roads to prevent inflow of soils from the access roads onto the Project road,
   - to plant trees along the road sides to alleviate noise and air pollution levels,
   - to adopt hard-structured separators between carriage ways and sidewalks so as not to be demolished by accidents, and
   - to adopt construction measures that minimize inflow of contaminated water to nearby rivers and lakes.

3) Tight Security at Job Sites

Special security measures to be provided by the Ugandan sides is inevitable secure safety of project personnel and properties.

4) Religious and Local Restriction

Besides national and public holidays, there are many religious or local traditional holidays in Uganda. These holidays have to be taken into account in the estimation of the workable days.

5) Implementation Order

It is important to introduce an implementation order among sections of roads on the Project roads for smooth and efficient implementation. The location of borrow pits and quarries and transportation routes shall be key elements for the determination of the implementation order.

2.2.4.3 Scope of Works

The scope of works to be undertaken by the Japanese Government and by the Uganda Government respectively is as follows:

1) Works and Facilities to be provided by Japanese Government

- Earth work (Natete Road: 3.8km, Gaba Road: 7.9km),
- Drainage works,
- Pavement works,
- Installation of traffic safety facilities,
- Improvement of a camp yard,
- Security control,
- Transportation of materials and equipment from Japan and/or third countries, and
- Consulting services.

2) Works and Facilities to be provided by Ugandan Government

- Site clearance,
- Relocation of utilities,
- Drainage water management,
- Installation of utilities,
- Acquisition of borrows pits, camp yard and land clearance,
- Installation of power supply back up system during power failures.
- Installation of street lights,
- Banking arrangement with authorised foreign exchange bank in Japan,

- Issuance of visa, certificates necessary for the execution of the Project to consultant and contractor,
- To ensure tax exemption for consultant and contractor, and
- To protect the project sites and provision of security facilities.

2.2.4.4 Consultant Supervision

1) Schedule of the Consulting Services

The project shall be commenced with the signing of an Exchange of Notes (E/N) pertaining to the engineering services between two Governments. The contract for the service shall be concluded between MOWHC and the Japanese consultant who will provide the following engineering services within the limits of the Japan's Grant Aid:

a) Pre-construction Phase

After signing of an Exchange of Notes (E/N) pertaining to the engineering service for the constructions supervision and the construction, MOWHC shall select a Japanese contractor who will implement the project through an open tender. The consultant shall assist MOWHC to perform following tasks at this phase:

- Preparation of tender document,
- Bid announcement,
- Pre-qualification of contractors,
- Pre-bid conference and site inspection,
- Tender and tender evaluation, and
- Contract negotiation.

b) Construction Supervision Phase

The engineering services for construction supervision will begin with the issuance of a Notice to Proceed (N/P) to the Contractor by MOWHC.

The consultant shall perform his duties in accordance with criteria and standards applicable to the construction works and shall exercise the powers vested in him as the Engineer under the contract to supervise the field works by the contractor.

The consultant within his capacity as the Engineer shall directly report to

MOWHC about the filed activities and shall issue field memo or letters to the contractor regarding the various matters, including progress, quality, safety and payment of the Project.

2) Staffing

The required staff and their responsibilities at the pre-construction and construction stages are described below:

a) Pre-construction Stage

- Team Leader
  Responsible for all the aspects of consulting services during the pre-construction and construction stages.
- Tender Specialist
  Responsible for the preparation of tender document, bid announcement, pre-bid conference and site inspection, and tender and tender evaluation.
- Tender Assistance
  Responsible for the preparation of tender document, including review of drawings.

b) Construction Stage

The required staff and their responsibilities at the construction stages are described below:

- Team Leader
  Responsible for all the aspects of consulting services during the construction stages.
- Resident Engineer
  As the resident engineer for the Project, responsible for supervising the construction work.
- Electric Engineer
  Responsible for installation and adjustment of traffic signals and relevant electric works.

3) Construction Schedule

a) Preparation works

With the issuance of a Notice to Proceed, contractor shall commence the

preparation works. These include mobilization of construction materials and equipment, labor and opening of the base camp for construction. Especially, opening of the base camp at 6th road near Kibuli Junction of Gaba Road total area of about 5,000 square meters, is inevitable for the smooth and efficient implementation of the Project.

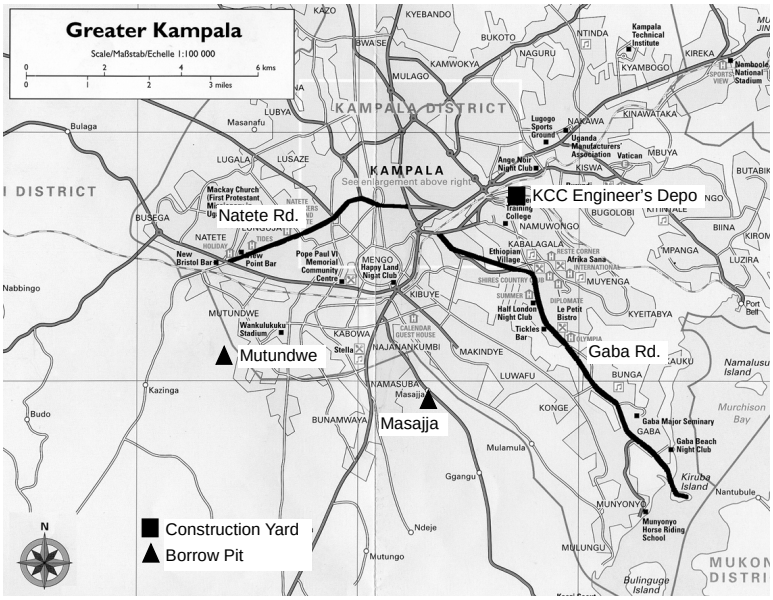


Figure 2.11 Location of Construction Yard

b) Provision of Utilities at the Project Sites

Provision of electricity, waters and other utilities necessary for the construct work has to be done prior to the commencement of the construction.

c) Construction Works

- Construction Management and Implementation Order

As the project roads are vital trunk roads in the city of Kampala, the construction works have be carried out without interrupting daily traffic. This will be done under well-designed method of traffic management system organized by the contractor and MOWHC in affiliation with KCC and traffic police to secure the safety of vehicles and pedestrians as well as that of project personnel.

The construction work shall begin with the widening work of carriageways. Followed by the overlay or reconstruction of

existing lanes without interrupting traffic flows as illustrated in Fig. 2.12.

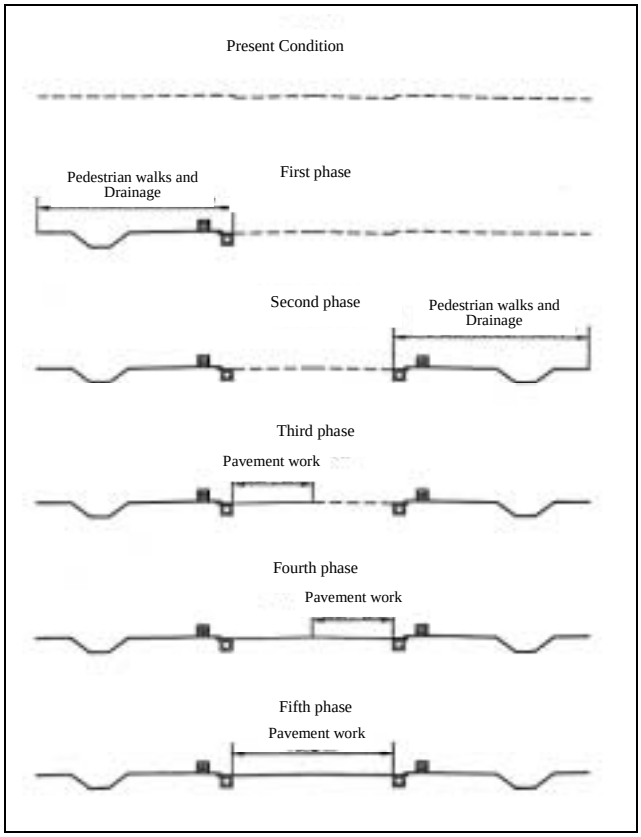


Figure 2.12 Construction Order

- Traffic Management during the Construction Work

The project roads are mostly 7.0m wide 2 lane roads which may require traffic management during the reconstruction of pavement and overlay works. These works shall be done under one side construction method without interrupting traffic for both directions. This methods requires traffic control by contractor with the assistance of traffic police.

2.2.4.5 Procurement Plan

1) Procurement of Construction Materials

Most of the construction materials to be used for the project are available in Kampala, with the exception of concrete admixture and special type of reinforcing bar and so on as described in Table 2.35.

Table 2.35 Procurement of Major Construction Materials

Item	Uganda	Japan	Third countries	Remarks
Asphalt	○			
Aggregate	○			
Ready Mixed Concrete	○			
Cement	○		○	
Concrete Admixture	○		○	
Re-bar	○			
Form	○			
Marking Paint	○			
Diesel	○			
Gasoline	○			
Traffic Signal		○		
Street Light & ancillaries	○		○	Out of Scope

2) Procurement of Construction Equipment

a) Asphalt Plant

Asphalt plants are held by Federici-Stirling Co., Ltd. and Spencon Co., Ltd. in Kampala City, of which only asphalt produced by Federici-Stirling Co., Ltd is available to purchase for the project. Production capacity of asphalt of Federici-Stirling Co., Ltd is about 300,000 tons/year and it is possible to acquire full amount of asphalt required for the project, that is estimated to be about 7,000 tons, from the company.

Table 2.36 Asphalt Plant

Company Name	Production Capacity	Location
Federici-Stirling	100ton/hr	30km East from Kampala City
Spencon Service Ltd	50ton/hr	25km West from Kampala City

b) Concrete

Concrete batching plants are held by Ayouboco Ltd., Spencon Ltd., and Cementers Ltd. In Kampala City, of which products from Ayouboco and Cementers are available to purchase for the project. The production capacities by each company, monthly amount of sales and relevant information are shown in Table 2.37.

Table 2.37 Concrete Batching Plant

Company Name	Production Capacity	Monthly Sales Volume	Location
Ayouboco Ltd.	$30m^3$/hr	2,000-3,000m^3	10km East from Kampala City
Cementers Ltd.	$60m^3$/hr	1,000m^3	7km North from Kampala City
Spencon service Ltd.	$30m^3$/hr	N/A	25km West from Kampala City

c) Traffic Signal

At present in total 7 of traffic signal junctions are operating in the city of Kampala, of which 3 junctions are using signals that were made in Japan, 3 made in India and 1 made in Germany. The three signalized junctions are that constructed under Japan's Grant Aid Scheme in the Phase 1 of this project in 2000.

The signals made in Japan are said to be superior to others in the following respects:

- Duration,
- Reliability,
- Easy maintenance, and
- Easy adjustment of signal phases.

On the other hand, Japanese signals are costly as compared with that of other manufactures in the world. With this regard, the signals to be installed are to be selected on the basis of a comparison analysis of cost-efficiency of signals. There is some possibility of introducing the signals from Singapore or other countries whose products have almost same function as that made in Japan but less prices.

d) Street Light

At present, about 2,800 street lights are functioning in the city of Kampala and those lights are mainly made in Uganda. Besides, Ugandan side has enough technical background in this field of electric work as demonstrated in the installation work at Kibuye junction in the First phase of the Project. With this regards, it is recommended that the work shall be undertaken under the responsibility of the Ugandan Government.

3) Procurement Plan of Construction Equipment

Most of the construction equipment required for the project are available at Ugandan contractors, although there is no equipment rental companies in Kampala.

The list of major construction equipment available in Uganda and their capacities are listed in Table 2.38.

Table 2.38 Procurement of Construction Equipment

Item	Spec.	Uganda	Japan	Third Countries
Bulldozer	15t	○		
Dump Truck	8.0t	○		
Backhoe	0.6 m^3	○		
Vibration Roller	3.0t～4.0t	○		
Load Roller	10.0t	○		
Motor Grader	3.1m	○		
Asphalt Spray	2,000 lit	○		
Concrete Mixer	3.0m^3	○		
Lane Maker	2.0lit/min	○		
Asphalt Finisher	2.5～5.0m	○		

2.2.4.6 Quality Control Plan

The designing of the Project was done according to the Ugandan Road Design Manual. However there is no specific Quality Control Manual in Uganda. For this reason, the quality control plan was formulated on the basis of the design concept as shown in Table 2.39.

2.2.4.7 Implementation Schedule

The tentative implementation schedule of the project is prepared taking into account the procedure of the Japanese Grant Aid Scheme. The project shall be implemented by phases:

First Phase: Natete road including Bakuli junction

Second Phase : Gaba road including Kibuli and Kabalagala junctions

Implementation periods of the above are 8.5 month for the First Phase and 6.5 months for the second as shown in Table 2.40.

The First phase shall begin with the signing the Exchange of Note for reconstruction activities, construction supervision and construction, the consultant contact will be concluded between Ugandan Government and a Japanese Consultant.

A Japanese Consultant will involve in the following services as the Engineer on behalf of the Government of Uganda.

- Pre-construction activities for the prequalification and tendering
- Construction supervision

Table 2.39 Quality Control Tests Plan

Item			Test Method	Frequency
Crushed Rock Base	Mixed Material		Liquid Limit, Liner Shrinkage	Every mixing
			Sieve Gradation	
			TFVsoaked & TFV dry	
			Aggregate Density	
			Maximum Dry Density	
	Paving		Field Density (Compaction)	Daily
Prim Coat	Material	Bitumen	Quality Certificate	
			Storage and Spraying Temperature	Every Truck
Asphalt Concrete	Material	Bitumen	Quality Certificate & Chemical Analysis	Every material
		Aggregate	Sieve Gradation	Every mixing
			Water Absorption	Every material
			TFVsoaked & TFV dry	
	Mix Requirements		Marshall Stability	Every mixing
			Marshall Flows	
			Air Voids	
			Voids in Mineral Aggregate : VMA	
			Indirect Tensile Strength	
			Immersion (Strength) Index	
			Bitumen Content	
	Paving		Max. Temperature of Asphalt at Mixing	If any
			Temperature for Compaction	Every truck
			Coring and Laboratory Tests	Daily
Concrete	Material	Cement	Quality Guarantee, Chemical & Physical Analysis	Every material
		Water	Chemical Analysis	Every material
		Admixture	Quality Guarantee, Chemical Analysis	Every material
		Fine	Bulk Specific Gravity Dry	Every material
		Aggregate	Sieve Gradation, Finesse Modulus	
			Clay and Friable Particles	
		Coarse	Bulk Specific Gravity Dry	Every material
		Aggregates	Flakiness Index	
			Sieve Gradation	
			Sodium Sulfate Soundness	
	Mixing Test		Compressive Strength at 7 days & 28 days	Every mixing
	Casting		Slump (Concrete)	Daily
			Concrete Temperature before Casting	Daily
	Strength		Compressive Strength at 7 days & 28 days	Daily or >50m^3
Re-bar	Material		Quality Certificate	Each lot

The period required for pre-construction activities will be a 3.0 month period. Almost same procedures and period of consultant services at the pre-stage of the second phase although this service shall be done in parallel with the construction work of phase 1.

There is about 1.5 overlapping period of construction period between the two phases for the prompt execution of the whole of the project.

A Japanese contractor to be selected by open tender according to the Japan's Grant Aid scheme shall undertake the construction in accordance with the work program and schedule of the project. The contractor is responsible for maintenance of the completed works until the final acceptance.

Table 2.40 Implementation Schedule (Draft)

Item \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Decision of Cabinet	▼							▼															
E/N		▼							▼														
Agreement of Consultant, Verification of Agreement			▼	▼					▼	▼													
Preparation of Tender Document				□							□												
Approval of Tender Document				▼								▼											
PQ & Approval of PQ				▼	▼							▼	▼										
Distribution of Tender Documents					▼								▼										
Tender Open						▼								▼									
Tender Evaluation & Approval						▼								▼									
Signing of Contract						▼								▼									
Verification of Contract							▼								▼								
Term 1 Construction of Natete Road (8.5M)								▬	▬	▬	▬	▬	▬	▬	▬	▬							
Term 2 Construction of Gaba Road (6.5 M)															▬	▬	▬	▬	▬	▬	▬		

2.3 OBLIGATION OF RECIPIENT COUNTRIES

The following necessary measures should be undertaken by the Ugandan Government that the Grant Aid by the Government of Japan is extended to the Project.

- To acquire the land and compensate for the affected buildings, relocation of utilities (electric and telephone cables, poles, water pipe and sewage), the land preparation work has to be finished before the implementation of the project (Natete Road: by May 2002, Gaba Road: by Nov. 2002),
- To conduct roadside drainage waters to the nearest outlets,
- To provide borrow pits, quarry sites temporal facilities (camp yard, office buildings and so on),
- To bear commission for the banking services based on the Banking arrangement,
- To ensure prompt unloading and tax exemption of customs clearance, and subsequent inland transportation,
- Ton ensure tax exemption for the Consultant and the Contractor engaged in the project, and
- To issue visas and other certificates necessary for the execution of the project to the consultant and contractors.

The budget required for the implementation of the project by phase and items of works to be borne by the Ugandan Government is estimated at 7.6 billion Ugandan shilling as shown in Appendices 5.

2.4 PROJECT OPERATION PLAN

(1) Operation and Maintenance Schedule

The operation and maintenance works will be carried out in accordance with the work schedule shown in Table 2.41.

Table 2.41 Operation and Maintenance Schedule

Item	Frequency	Content of works
Pavement surface	3 times per year	Repairing of ruts cracks and pot holes
Overlay	Every 10 years	Overlay
Drainage	2 times per year	Removal of deposit
Signal	2 times per year	Lump cleaning and Inspection of electric system
Road lighting	2 times per year	Lump cleaning and Inspection of electric system
Road Marking	1 time per year	Repainting

(2) Maintenance Cost

Based on the maintenance work plan proposed in this section, the periodical maintenance schedule and costs are estimated as shown in Table 2.42.

Table 2.42 Estimated Maintenance Cost

Item	Frequency	Estimate cost
Pavement surface	3 times per year	US$22,000（38.6 million Ushs.）
Overlay	Every 10 years	US$114,000（200 million Ushs.）
Drainage	2 times per year	US$15,000（25.7 million Ushs.）
Signal	2 times per year	US$15,000（25.7 million Ushs.）
Road lighting	2 times per year	US$15,000（25.7 million Ushs.）
Road Marking	1 time per year	US$7,000（12.9 million Ushs.）
Average maintenance cost per year	-	US$85,000（149 million Ushs.）

Annual maintenance cost to be required by MOWHC is estimated at 129 million Ushs. Besides, about 200 million Ushs. is requested for the overlay work that is scheduled to be carried out in every ten years. This means about 149 million Ushs. per annum in average is required for the maintenance of the project roads. This is about 0.2% of total maintenance cost of 2002/03 scheduled by the road investment plan by MOWHC, that is equivalent to about 76.2 billion Ushs. as shown in Table 2.43.

Table 2.43 Road Sector Development Programme

(Unit: Million US$)

FY	Ugandan Government		Donor	
	Maintenance	Development	Maintenance	Development
2001/02	38.23	12.13	12.13	60.39
2002/03	40.23	13.34	3.33	87.61
2003/04	42.32	14.68	3.25	108.31
2004/05	44.23	10.86	-	96.24
2005/06	46.23	10.86	-	95.86
2006/07	48.23	10.86	-	95.45
2007/08	50.23	10.86	-	95.22
2008/09	52.23	10.86	-	94.98
2009/10	54.23	10.86	-	94.73
2010/11	56.00	10.86	-	94.47
Total	472.16	116.17	18.71	923.27

Chapter 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 PROJECT EFFECT

(1) Direct Impacts and Effects

With the completion of the Project, traffic flows in urban area of Kampala City shall be streamlined as the result of enhanced traffic capacity thereon. Especially, queuing delays at the junction shall be greatly relieved that shall result in vehicle operation cost saving and travel time cost savings, Besides According to the estimation, the numbers of vehicles per day in 2004 and 2009 are estimated to be 12,500 and 15,700 in total, respectively. These are about 14% and 43% increase of present traffic volume that is 11,000 vehicles per day Besides the above, the improved road condition with complete drainage system and pavement condition shall contribute to the reduction of annual maintenance cost greatly.

(2) Indirect Impacts and Effects

The Project shall produce many other indirect effects both in tangible and intangible form. Those include, among other things, the following effects:

- Promotion of Socio-economic Activities

  It is expected that the improved road traffic condition by the Project will promote the efficiency of urban activities through such effects as reducing of commuting time and realized better accessibility to market areas and business centers.

- Reduction of Traffic Accidents

  Segregated pedestrian ways and signaled road crossings as well as streamlined intersection traffic flow will contribute to the reduction of traffic accidents nearby the junctions.

- Improvement of Public Transport Operation

  With the introduction of bus bays and designation of bus stop areas nearby the junctions, the operation of public transport will be greatly improved.

(3) Beneficiary Population

The direct beneficiary population from the Project is estimated to be about 1.2 million that is equivalent to the total population of Kampala City.

3.2 RECOMMENDATION

The project aims at improvement of traffic flow in Kampala City and shall produce great amount of benefit to road users and to the surrounding areas. The Project shall be implemented without delays owing to good security condition in Kampala and high executive/technical standards of the Ugandan Government. However, in order to maximize the benefit from the project throughout long period of project life, it is inevitable for the Ugandan side to undertake relevant road traffic policies by themselves. These include, among other things, the following:

- Execution of daily and periodic maintenance works,
- Promotion of traffic education and enforcement of traffic law, and
- Introduction of appropriate urban traffic management and administration system.

In addition, the above are recommended to be undertaken in coordinated manner with that of other ongoing and envisioned urban transport improvement projects in Kampala City.