Ministry of Roads and Bridges
Republic of South Sudan

PREPARATORY SURVEY REPORT
ON
THE PROJECT
FOR CONSTRUCTION OF
NILE RIVER BRIDGE
IN THE
REPUBLIC OF SOUTH SUDAN

February 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Construction of Nile River Bridge in the Republic of South Sudan and organized a survey team headed by Dr. Shingo Gose of CTI Engineering International Co., Ltd. between October 2010 to February 2012.

The survey team held a series of discussions with the officials concerned of the Republic of South Sudan, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express our sincere appreciation to the officials concerned of the Republic of South Sudan for their close cooperation extended to the survey team.

February 2012

Kiyofumi KONISHI
Director, Economic Infrastructure
Development Department
Japan International Cooperation Agency

EXECUTIVE SUMMARY

① Country Overview

The Republic of South Sudan with vast floodplain areas is located in the arid zones in Africa with elevations ranging from 366m above sea level (Eastern Equatoria State) to 1,293m above sea level (south-eastern section of Central Equatoria and Jonglei States). The land area of South Sudan totals to 640,000km^2 with a population reaching 8.26 million people as of 2008.

The climate which is influenced by the effects of the seasonal monsoon, has rainy season from May until October with an average annual rainfall of 1,000mm and dry season with negligible rain. The lowest average daytime (night time) temperature is 32°C (20°C) in July while the highest average daytime (night time) temperature is 38°C (24°C) in February.

South Sudan has abundant agricultural land due to much rainfall and is endowed with rich natural resources including water and forest resources. In particular, it has huge oil reserves with $10 billion in oil revenue since 2005. On the other hand, the poverty level in South Sudan is 51% while the human happiness index is the lowest in the world.

According to South Sudan Government (August 2011), the GNI is $13 billion in 2010 with a per capita GNI of $1,546. Moreover, the economic growth rate is 4.2% (EIU 2009) with main items traded including crude oil exports, imports of machinery and equipment, industrial products, transportation equipment, and wheat flour. With the recent appreciation of the dollar, prices of commodities including food and oil have risen internationally with a year-on-year rate if increase of 57% since August 2010.

Considering the above conditions, the “South Sudan Development Plan 2011-2013” was formulated after the country’s independence last July 2011 focusing on “governance”, “economic development”, “social development and human development” and conflict prevention and security” as the four pillars of development. The policy objectives and priority programs were established for these pillars including “Governance” – administration and accountability, “Economic development” – infrastructure development, natural resources development and other important economic development, “Social Development and Human Development” – education and human capital, “Conflict Prevention and Security” – rule of law and security.

② Project Background and Outline

Since South Sudan is located inland and relies basically on the import of goods, ensuring a reliable international transport route has become a major issue and challenge towards the country’s reconstruction and development. Currently, there are two major economic international logistics distribution corridors linking the capital city of Juba: the southern route corridor which links to Mombasa (Kenya) - the Juba-Nimule-Kampala-Mombasa and the Juba-Yei-Kaya-Kampala-Mombasa routes, and the northern route corridor – Juba-Nile River-Khartoum-Sudan Port route. At present, the most efficient route towards the center of Juba

City is the Juba-Nimule road from Uganda which has to cross the Nile River through the Juba Bridge (a 2-lane divided bailey bridge). At present, Juba Bridge is the only bridge crossing the Nile River in South Sudan and the only access from Nimule to Juba proper but there are structural issues and problems in the bridge durability itself as proven by the superstructure collapse due to overloaded truck in 2006. In August 2010, due to some traffic accident a section of the truss panel was damaged (with members severed) making the downstream side of the bridge in critical condition. Even though recent repairs (January 2012) have been done in the damaged panels, large vehicles are required to travel slowly in the bridge for safety. Moreover, since this is the only existing bridge, heavy vehicles crossing the river tend to concentrate in this area contributing to the worsening traffic congestion in the city.

Under these circumstances, the construction of the new Nile River Bridge (about 1.5km upstream of the existing Juba Bridge) and the C-3 Circumferential road, following the "Juba Road Network Master Plan" (JICA, 2008.8~2009.6), is proposed to ease the burden of the existing bridge and alleviate the worsening traffic condition in Juba. This project is one of the priority projects of the Republic of South Sudan. In addition, the new Nile River Bridge is part of the C-3 Circumferential road which provides direct link to the Juba-Nimule and Juba-Yei-Kaya International roads thus directly connecting South Sudan to its neighboring countries in the south. With the construction of C-3, the new Nile River Bridge and access roads to the city, land development and land readjustment projects are expected in the surrounding areas, thus preventing unorganized urban sprawl in the vicinity. Since South Sudan's independence in July 2011, significant influx of returnees are expected as South Sudan gears for development with the C-3 Road and new Nile River Bridge supporting the pillars of infrastructure development.

Considering the above circumstances, the Republic of South Sudan requested the Government of Japan (GOJ) in December 2009 a grant aid to construct the new Nile River Bridge and its approach road. Under this request, the GOJ dispatched the preparatory survey team to South Sudan three times until October 2010 to undertake planning for this project.

This project, covering the construction of the new Nile River Bridge, is consistent with the "South Sudan Development Plan" (formulated after the independence) with the overall goal of development of a safe, efficient and sustainable road network, improvement of logistics in Juba and South Sudan, encouragement of economic growth, consolidation of peace and poverty reduction. Moreover, since the project connects South Sudan's International Route corridor to the neighboring countries, it also promotes and facilitates logistics in the country.

③ Summary of the Project Findings

The Japan International Cooperation Agency dispatched the Preliminary Survey Team three times in South Sudan to conduct site surveys and investigation related to the project. The three site surveys conducted are: - the First site survey from October 19 to November 17, 2010 (Preliminary Investigation), the Second site survey from December 10 to December 25, 2010 (Social Impact and Resettlement Plan Explanation) and the Third site survey from February 15

until March 31, 2011(Outline Design Study). After completion of the third site survey and the outline design in Japan, the draft final report was explained to the concerned authorities in South Sudan from October 15 to 30 2011. In addition, two follow-up surveys were conducted to monitor resettlement and compensation activities (December 13-26, 2011 and January 12-February 1, 2012).

The policies and principles for the planning and construction of the new Nile River Bridge, as presented in **Table 1**, is based on the results of the field surveys and consultations with the Government of the Republic of South Sudan.

Table 1 Project Digest

Bridge Name		New Nile River Bridge
Road Class		International Highway
Design Speed		60 km/hr
Design Live Load		HL-93 (AASHTO)
Bridge Length		560m
Bridge Span Length	Approach Bridge (Beg.)	5 @ 30.0m = 150m
	Main Bridge	4 @ 87.5 = 350m
	Approach Bridge (End)	2 @ 30.0m = 60m
Superstructure Type	Main Bridge	Steel Langer Arch Bridge
	Approach Bridge	Steel Plate I-Girder
Substructure Type	Main Bridge	Wall Type Pier
	Approach Bridge	Wall Type Pier, Inverted T-abutment
Foundation	Main Bridge	Steel Pipe Sheet Pile
	Approach Bridge	RC Cast-in-place Bored Pile (Piers, End Abutment) Spread Footing/Direct Bearing (Beg. Abutment)
Approach Road (1)	Beginning & End Abutments	50m each side (cement concrete pavement)

Based on the December 2009 grant aid request of the Republic of South Sudan for the construction of the new Nile River Bridge, the 3.665 km long approach road shall be constructed jointly by the Government of Japan and the Republic of South Sudan's with the Japan side providing the two-lane gravel road section (about 3.565km) used for construction access and the South Sudan side completing the rest of the pavement structure. In addition, the Japan side shall undertake the 50m long concrete pavement approach road from the each bridge abutment. The major scope of Japan's grant aid project is confirmed as follows:

- 560m, 2-lane bridge construction (with sidewalk on one side),
- 50m (from each abutment) concrete pavement approach road construction.

④ Project Implementation Schedule and Summary of Project Costs

The project duration for implementation includes 9.5 months for detailed design and 39.6 months for construction of the facilities.

The estimated project cost is about _____Yen (Japan side: _____Yen, South Sudan side: 0.838 Billion Yen (US$ 9.98 million).

⑤ Project Evaluation

With the implementation of the project, the Juba city arterial roads will be consolidated with South Sudan's international and interstate roads, as well as that of the neighboring countries, and will facilitate and ensure smooth and efficient logistics. As a result, this will encourage investment and improve logistics in South Sudan and Juba city, promote regional economic growth, support the consolidation of peace and contribute to poverty reduction. The project evaluation results enumerated below indicates that the project is suitable for grant aid cooperation:

- After independence, South Sudan's Development Plan (2011-2013) priority policy is to contribute to the formation of the arterial road network. Moreover, since this project is one of the President's 100 days plan after independence, it will contribute to building a strong trust relationship between our countries.
- In the capital city of Juba, the international highway routes will be safely linked by the bridge that will benefit the entire South Sudan which relies mainly on international logistics.
- This project will contribute to securing a stable international and domestic logistics and improvement of the lives of post-independent residents of Juba city and South Sudan.
- The new Nile Bridge, located in the peripheral section of Juba city and forms part of the outer ring road (C-3), will contribute to an orderly reconstruction and expansion of the city.
- This project will contribute to solve the gap between the east and west side of the Nile River including poor living condition, lack roads and infrastructure development and promote a balanced development in the eastern and western regions.
- This bridge will bypass the existing Juba Bridge and redistribute the flow of international logistics from Uganda and Kenya that directly goes to the city and will improve distribution efficiency and ease the traffic congestion in the city.
- The traffic speed to cross the Nile River will be increased from 20 km/hr on the existing Juba Bridge to 60 km/hr on the new Nile River Bridge. Moreover, the traffic capacity of the Nile River crossing will be doubled after construction of the new bridge.
- The impact to social environment, assuming proper implementation of resettlement compensation and land acquisition, has little negative impact.
- Using Japan's advanced technology in bridge construction, the implementation of this project through grant aid system offers no particular difficulty.
- This bridge, once constructed, requires minor maintenance works like cleaning, weed and accumulated sediment removal which can be done with the present budget and technical level of South Sudan.

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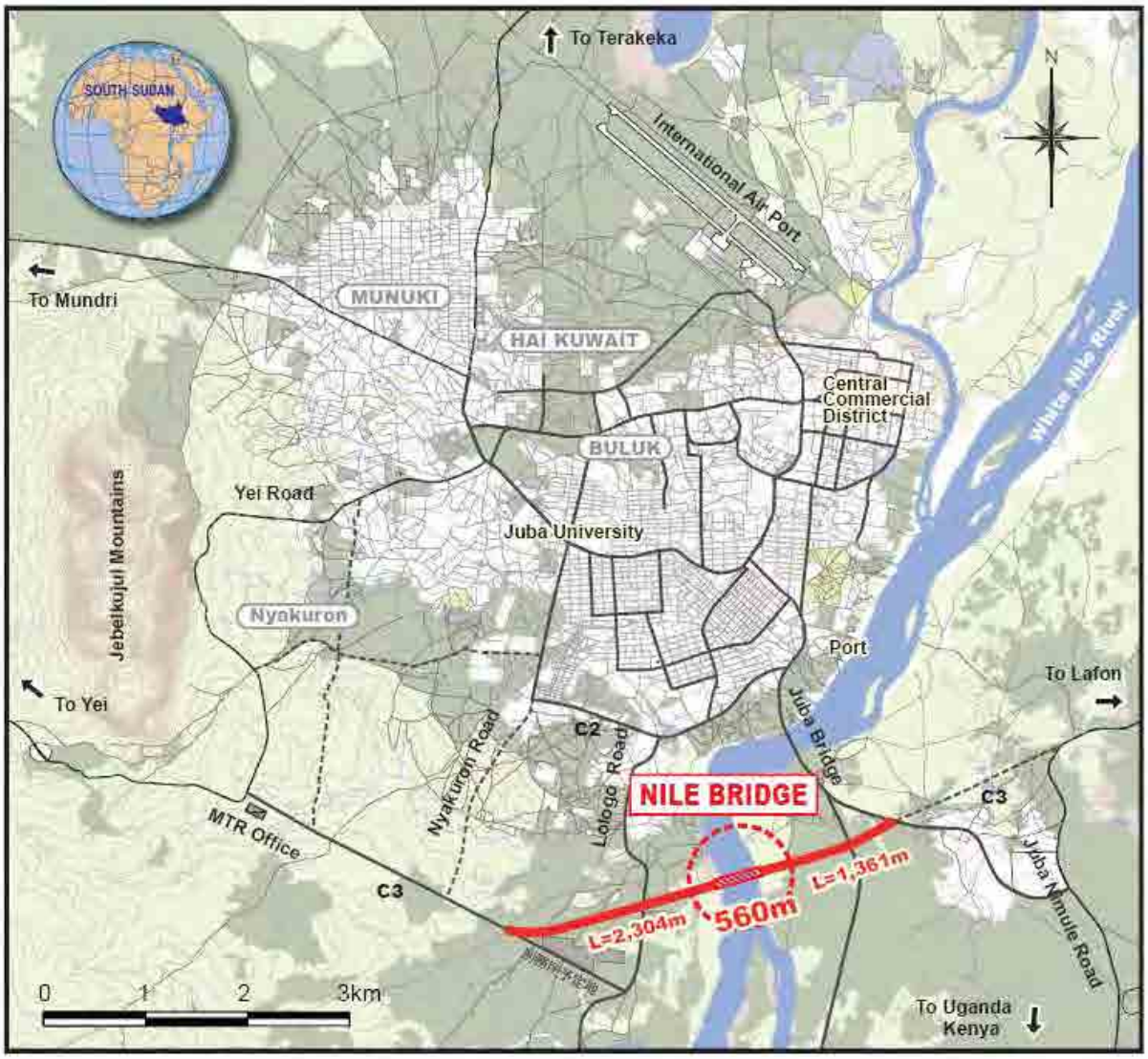


LEGEND

Road	Shrub
River	Plain
Pond	Grassland
Forest	Marsh

PROJECT SCOPE

Bridge : 560m (2- Lanes)

Approach Road : 2×50m
(Concrete Paved)

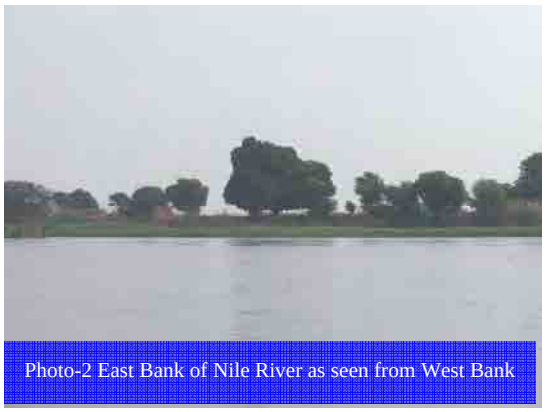
Project Location Map

Proposed New Nile River Bridge Rendering

	
View of the bridge from downstream of Nile River	View from west bank
	
View from east bank	View from deck of new Nile River Bridge

Photos

Photo-1 Downstream View of the New Nile River Bridge Alignment



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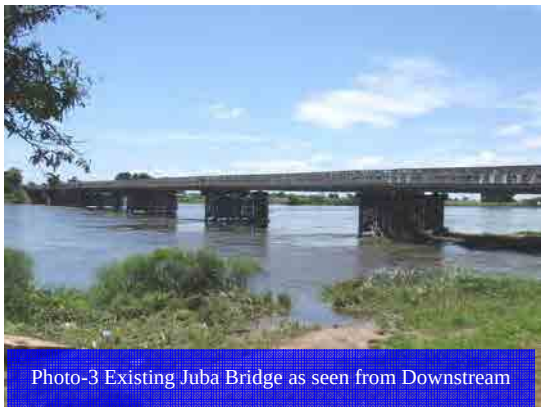

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Abbreviations

AASHTO	American Association of State Highway and Transportation Office
AH	Affected Households
ASTM	American Society for Testing and Materials
BDM	Bridge Design Manual
CD	Capacity Development
CES	Central Equatoria State
DBST	Double Bituminous Surface Treatment
DDM	Drainage Design Manual
EIA	Environmental Impact Assessment
EIE	Environmental Impact Evaluation
EIR	Environmental Impact Review
EIS	Environmental Impact Statement
E/N	Exchange of Notes
EU	European Union
G/A	Grant Agreement
GNI	Gross National Income
GoSS	Government of South Sudan
GOJ	Government of Japan
GRC	Grievance and Redressing Committee
HWL	High Water Level
IEE	Initial Environmental Examination
IDP	Internally Displaced Person
IMC	Inter-Ministry Committee
JICA	Japan International Cooperation Agency
JRA	Japan Road Association
MDTF	Multi Donor Trust Fund
MOE	Ministry of Environment
MOPI	Ministry of Physical Infrastructure
MOT	Ministry of Transport
M/P	Master Plan
MRB	Ministry of Roads and Bridges
MTR	Ministry of Transport and Roads
MOT	Ministry of Transport

OD	Origin-Destination
PAP	Project Affected Person
PC	Prestressed Concrete
RAP	Resettlement Action Plan
ROW	Right of Way
RSS	Republic of South Sudan
SATCC	Southern Africa Transport and Communications Commission
SCS	Social and Cultural Sector
SETIP	Sudan Emergency Transport and Infrastructure Project
SSP	South Sudan Pounds
TRRL	Transport and Road Research Laboratory
UNEP	United Nations Environmental Programme
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development
USGS	United States Geological Survey
VACRC	Value Assessment, Compensation and Resettlement Committee
V/C	Vehicle / Capacity
WB	World Bank

CHAPTER 1 Background of the Project

1-1 Background of the Grant Aid

Due to more than 20 years of civil war in Sudan, the development of the social and economic infrastructure in South Sudan especially in Juba city, which is the political and economic center, has been severely inhibited together with unresolved issues in the livelihood, settlement and socio-economic activities of the displaced people and demobilized soldier returnees. Under this condition and with the expected significant inflow of people after the independence in 2011, the development of economic infrastructure as well as social stability has become an urgent issue in South Sudan. In particular, there is an urgent need to develop the road infrastructure and ensure a smooth transport of goods from the neighboring countries.

In this regard, the construction of the C-3 road with the new Nile River Bridge (starting at 1km before the existing Juba Bridge) which is proposed to bypass the city center and redistribute through traffic as recommended in the "Juba Urban Road Network Master Plan" (JICA, 2008.8-2009.6), has become the single most important task of the South Sudan government. In addition, since the construction of the C-3 road together with the new Nile River Bridge connects with the Juba-Nimule road which functions as an international cargo road corridor, the project will promote land readjustment and redevelopment thus preventing disorganized urban sprawl in the area. After independence in July 2011, a significant inflow of returnees is anticipated in Juba city so that the construction of C-3 road together with the new Nile River Bridge is expected to be one of the main pillars of support for the reconstruction and development not only of Juba city but also of South Sudan as a whole.

Moreover, since public works such as the construction of C-3 road and improvement of access roads usually takes a long time to implement, this can generate employment opportunities for demobilized soldiers and returnees in the unskilled work level and thus contribute to stability and security.

On the other hand, although the efficient flow of logistics from the Juba-Nimule road to the city is facilitated by the existing Juba Bridge over the Nile River, there is great concern over the risk of future damage due to passage of large vehicles (similar to the accidents that happened previously) in this semi-permanent bridge which will affect the smooth flow of logistics. In addition, due to the rapid increase of large vehicles traversing this route towards the city, this has become one of factors causing serious traffic congestion in Juba.

Under these conditions, the South Sudan government requested for a grant aid for this project and the exchange of notes (E/N) signed in November 2009. In this regard, the preparatory survey was undertaken to confirm the scope of the project, the location of the bridge, the bridge configuration and type, the roads (including construction access road), the natural condition and social and environmental concerns. The new Nile River Bridge is proposed to facilitate the development and distribution of traffic in Juba, considering the on-going construction of the Juba-Nimule road and

minimizing the negative impacts in the natural and social environment of the area. In consultations with the authorities of South Sudan, the main scope of the Japan grant aid is confirmed as follows:

- 560m 2-lane bridge construction (with sidewalk on one side),
- 50m (from each abutment) concrete pavement approach road construction.

1-2 Natural Conditions

The Republic of South Sudan with vast floodplain areas is located in the arid zones in Africa with elevations ranging from 366m above sea level (Eastern Equatoria State) to 1,293m above sea level (south-eastern section of Central Equatoria and Jonglei States). Located at the western section of Juba city is the Jebel Kujur mountain (Elevation of 744m) which forms the boundary between the city and the surrounding areas. Juba is basically covered with the less productive reddish laterite soil (ferruginous soil) contrary to higher altitude areas with much rainfall and possible agriculture lands.

The climate, as influenced by the effects of the dry seasonal monsoon wind from the Arabian Peninsula, has negligible rain from January to March. However, when the monsoon wind coming from the Congo river reaches South Sudan, it brings along large amount of rain accompanied by thunderstorms. Normally, the rainy season begins in May and continues until October with an annual average rainfall of about 1,000 mm but it hardly rain during the period of dry season. The annual rainfall intensity of Central Equatoria State's southwest section ranges from 1,300mm to 1,600mm. The lowest average daytime (night time) temperature is 32°C (20°C) in July while the highest daytime (night time) temperature is 38°C (24°C) in February.

Based on the 10-year earthquake records compiled by the U.S. Geological Survey (USGS) from 1982 to 1992, the previous seismic activities are concentrated in the areas northeast of Juba city. Moreover, at least two major earthquakes occurred near Juba in May 1990 with magnitudes of 7.1 and 7.2 at a distance of 63 km and 67 km from Juba city, respectively.

(1) Results of Topographic and Geotechnical Survey

Topographic survey was conducted for about 4.5km long x 100m wide (2.4 km west approach road, 0.60 km bridge and 1.5 km east approach road) section of the proposed alignment, including the location and size of structures, trees, monuments, wells, graveyards, etc. (see **Figure 1-2-1**). The results of the topographic survey were utilized to study the basic alignment of the approach road and bridge in consideration of the environmental and social impact of the project. In addition, geotechnical investigations were undertaken in the project area. Six boreholes were drilled considering the locations of bridge piers to determine the underlying soil conditions and properties and confirm the level of bearing support of the foundation planned for the bridge structure (refer to **Figure 1-2-2**).

The terrain for the location of the roads and bridge is relatively flat on the eastern side of the Nile River and gently sloping towards the river by 1-2% at the western side. The western side of the river before the bank is a floodplain that normally is normally submerged during the rainy season. The bases of the banks on both sides of the river are grasslands with the western section utilized for agriculture. Erosion of the riverbank on the western side is observed resulting to sedimentation on the eastern side. Since there is no drainage facilities, earth road rutting and erosion of the soil in the existing road due to stormwater and vehicular traffic can be seen.

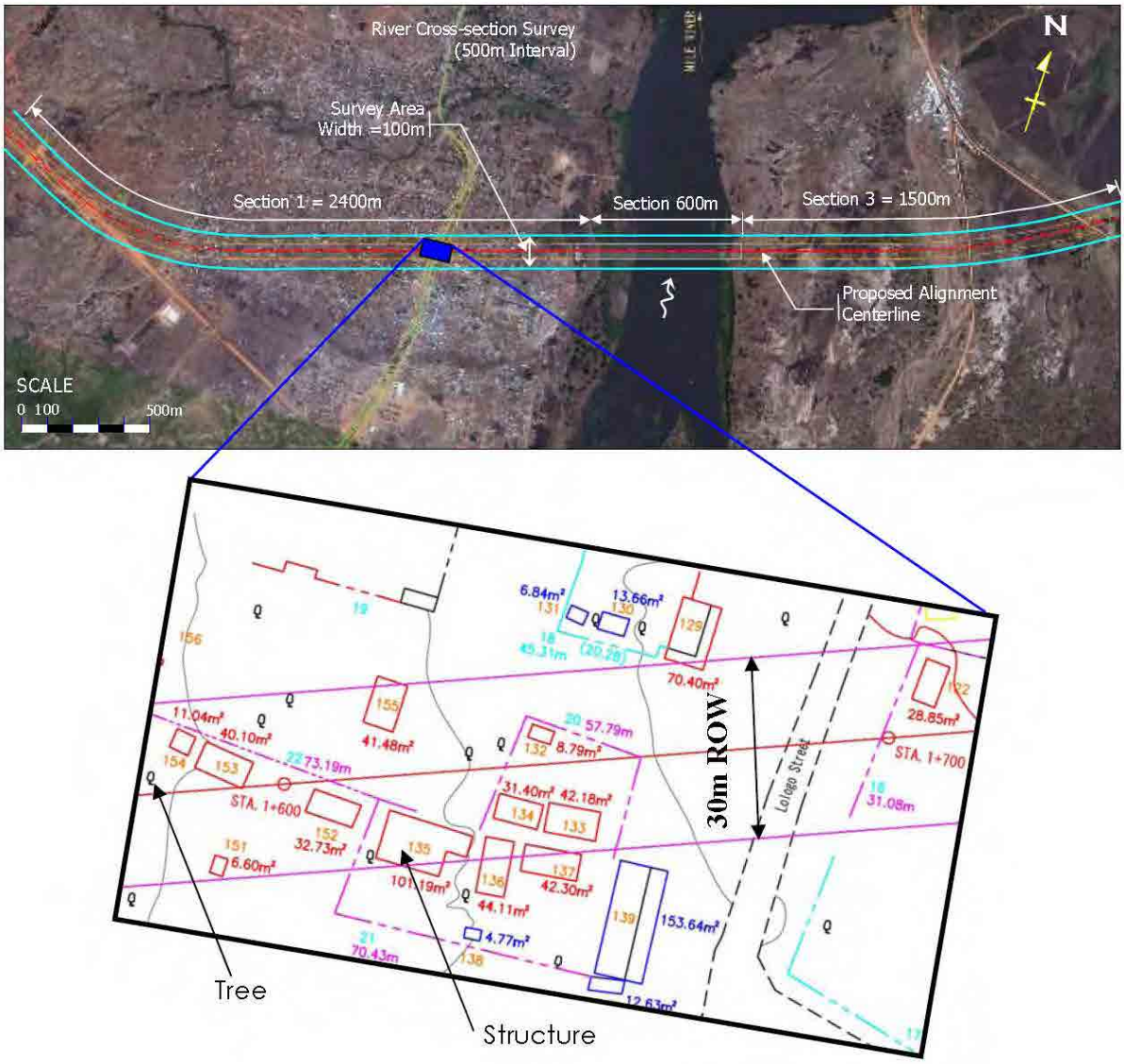


Figure 1-2-1 Location and Details of Topographic Survey

On both banks of the river, the underlying soil types in the upper sections are basically silty clay while sand deposits abound in the west floodplain. Rock layer starts at 4m depth on the west bank and 10m deep on the east bank. However, the soil type inside the river is basically sandy gravel until 5m deep, on average, and becomes granite bedrock below this level. In and around Juba city, shallow rock layers are found, including metamorphic rocks, gneiss and granitic gneiss,

amphibolite and schist. The results of the geotechnical investigation are shown in **Figure 1-2-2.** The aquifer layer “Um Rwaba” strata (Cenozoic strata) are shallow with groundwater level of 1.5 ~ 3.5m below the surface.

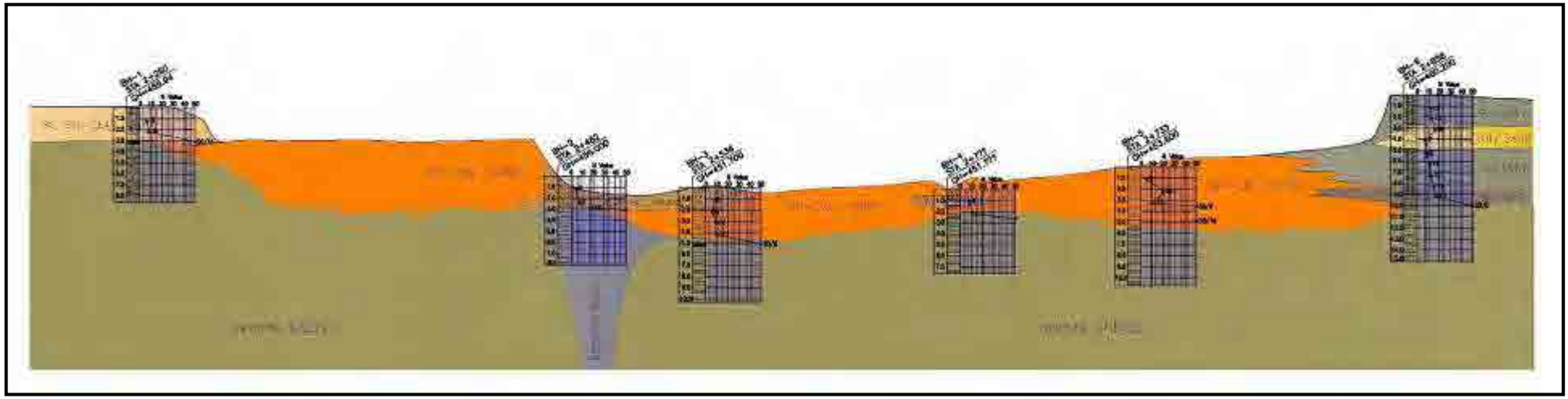


Figure 1-2-2 Soil Profile Results of Geotechnical Investigation

The results of geotechnical survey and boring for each location are presented in **Appendix 6** while the data on earthquake records is presented in **Appendix 7**. The results of the topographic survey (**Figure 1-2-1**), the types of trees, affected houses, etc. are utilized to analyze the environmental impact and in the basic design.

(2) Hydrological Survey Results

The river hydrological survey was conducted, as illustrated in **Figure 1-2-3**, to determine the design flood discharge, the design high water flood level and the changes in river flow regime due to bridge construction.

1) Data Collection

In order to plan for the bridge design discharge and high water flood level using the 100-year return flood (based on MTR requirements), it is necessary to determine the river conditions at the proposed location of the bridge and the characteristics of the upper river basin including catchment area, flow probability, longitudinal gradient and river cross-section profile.

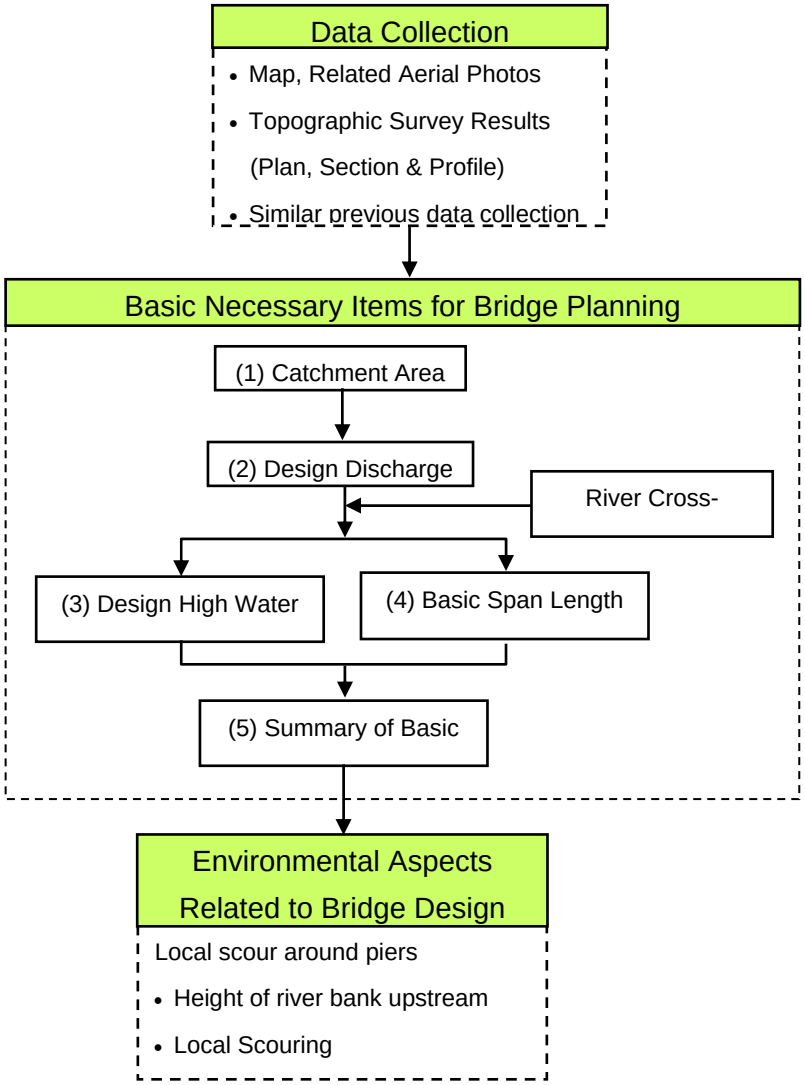


Figure 1-2-3 Flow of Hydrological Survey

A broad range of information, including plans to build dams and similar bridge types in Uganda, is necessary to be collected in the upstream side of the proposed bridge to set the design catchment area, rainfall characteristics and flow probability.

2) Basic Requirements for Bridge Planning

In order to set the design HWL (High Water Level), freeboard and minimum span length, it is necessary to undertake river cross-section survey and river profile survey which will be used to carry-out the hydraulic analysis at the proposed bridge site and used to plan the bridge configuration.

3) Effects of Bridge Construction to Surrounding Areas

The degree of impact on the surrounding areas of the proposed bridge site during construction, including local scour effect, changes in flow regime and bank erosion can be determined based on information from aerial photographs, interview of the people around the proposed bridge site, flood and hydrologic history of the area which will be helpful to determine the river flow discharge and water level during floods.

Figure 1-2-4 Nile River Basin

Source: National Water Resource Plan 2017, Ministry of Water Resource and Irrigation (2005)

4) Catchment Area for the Proposed Bridge Site

The Nile river, at 6,650 km is the longest river in the world, spans 11 countries in Africa and has 287 million km^2 of catchment area.

- The farthest upstream section of Nile is the Ruviroza river in Burundi that flows towards the Lake Victoria,
- Downstream of Lake Victoria is the Victoria Nile that flows to Sudan via the Lake Kyoga or the Lake Albert located 500 km downstream,
- At approximately 150 km from the border of South Sudan is the capital city of Juba, where the confluence of tributaries form at the Bahr el Ghazal, called the White Nile River.
- The White Nile River then merges with the Blue Nile River from Lake Tana in Ethiopia in the northern Sudan's capital of Khartoum and discharges towards Cairo, Egypt and the Mediterranean.

The river basin area of the proposed site for the bridge crossing in the Nile River is calculated to be 529,000 km^2, as shown in **Figure 1-2-4**.

During flood, runoff flows down through the spillway of the hydroelectric dam of Uganda and combines with the flow from Lake Albert towards the bridge site location. The upper river basin area in is presented in Appendix 8. The findings of the survey are reflected in the design high water level and the minimum span length.

1-3 Environmental and Social Consideration

1-3-1 Environmental Consideration Survey

The environmental and social survey was conducted in accordance with the JICA Environmental and Social Guidelines and the World Bank's Safeguard Policy on Environment (O.P.4.01) and Involuntary Resettlement (O.P.4.12).

(1) Environmental Baseline

The existing conditions of the project site, divided into east and west banks, are presented in **Table 1-3-1**.

Table 1-3-1 Characteristics of the Natural and Social Environment

Items	West Bank of Nile River	East Bank of Nile River
Topographic Features	The site is relatively flat with about 1% slope (20m/2000m). A stepped natural levee is formed with about 150m floodplain that is inundated every year.	This section is a plateau with elevation of 460m that used to be a section of the river and gets flooded every 50-100 years.
Land Use	The western side of the left bank is basically at a higher ground and used mainly as a residential area where house are scattered. Brick making is common at the river bank while small scale cash crop farming is done at the flood plain. Fishing activity is observed in the river to supplement daily living.	Basically an open land with few scattered houses. Similar to the west bank, the daily life activities include brick making, small scale farming and fishing to supplement daily living.
Roadside Housing Situation	The proposed alignment traverses a residential area with 3,600m^2 graveyard and 3 shallow hand-pump nearby. Majority of the houses are thatched roof with mud walls with few concrete and corrugated galvanized iron sheets. There is a 2-storey concrete house near Lologo road. About 80 households maybe affected by the road alignment.	There are about 1-2 houses (thatched roof with mud walls) that lies near the proposed alignment.
Other Important Issues on Natural and Social Environment	The community area has been a resettlement site for soldier returnees. These returnees do not have land titles and have low income of living. There are several useful trees that need to be cut in the area.	There are several useful trees that need to be cut in the area.

(2) Environmental and Social Institutional Structure

The environmental protection laws and policies in southern Sudan including the "Environmental Protection Bill, 2010" and the "Southern Sudan National Environmental Policy, January 2010" at the time of writing this report are merely draft and have not yet been approved by the Ministry of Justice. The environmental licensing process is illustrated in **Figure 1-3-1**. The EIA report was submitted to the Ministry of Environment (MOE) in mid-October and the Environmental License (Environmental Impact Assessment Clearance) was granted by MOE on November 3.

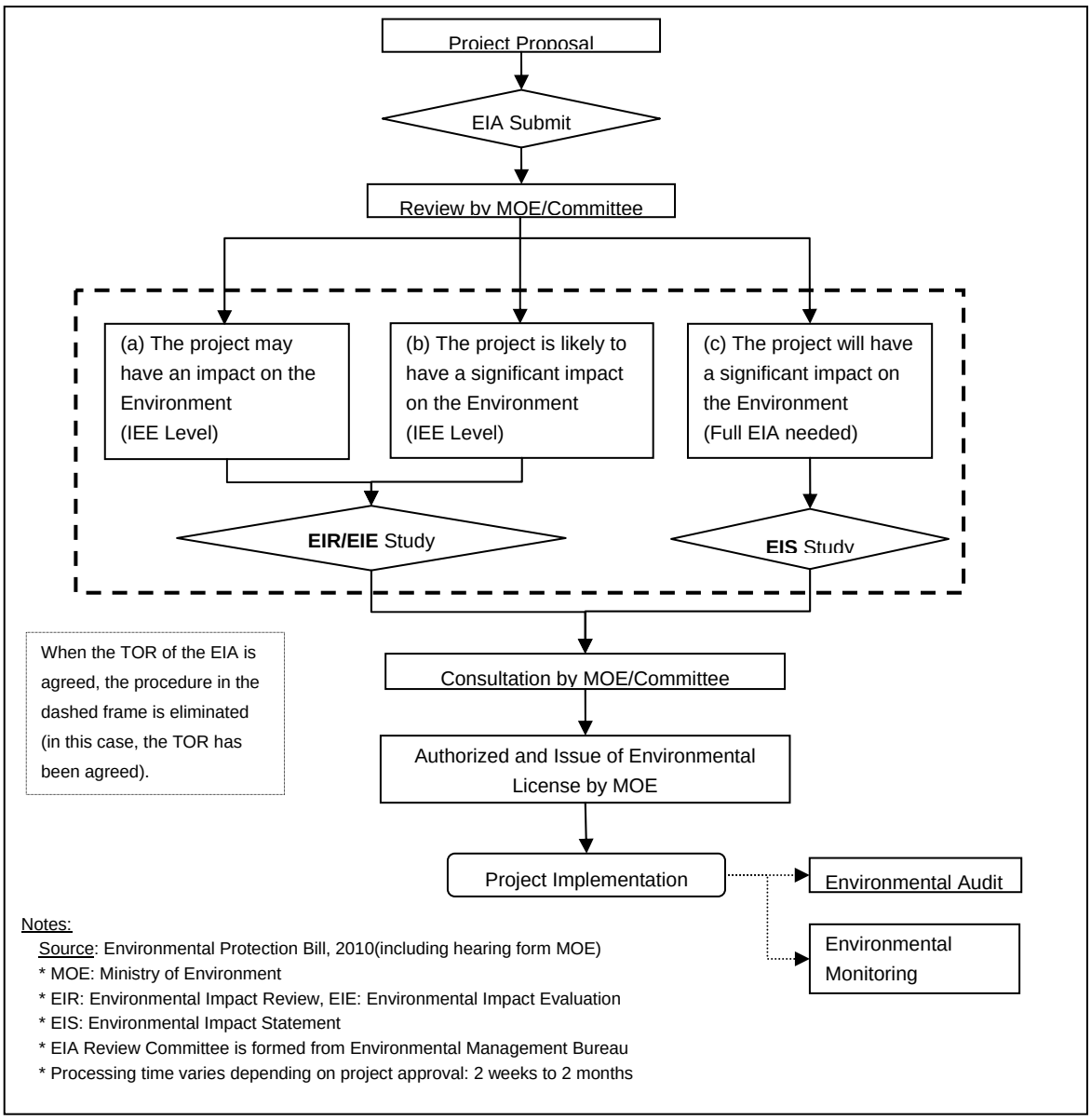


Figure 1-3-1 Environmental Protection Bill 2010 Environmental Approval Procedure

The Ministry of Environment (MOE) and the Ministry of Roads and Bridges (MRB) have an environmental management section. **Figure 1-3-2** shows the organizational structure of MOE. However, there is only one staff in MRB.

Under the Presidential Decree No.27 (dated August 26, 2011) of the Republic of South Sudan, the Ministry of Roads Transport (MTR) is divided into the Ministry of Roads and Bridges (MRB) and the Ministry of Transportation (MOT). Both Ministries started their official functions by virtue of the Presidential Decree No.29 (dated August 31, 2011).

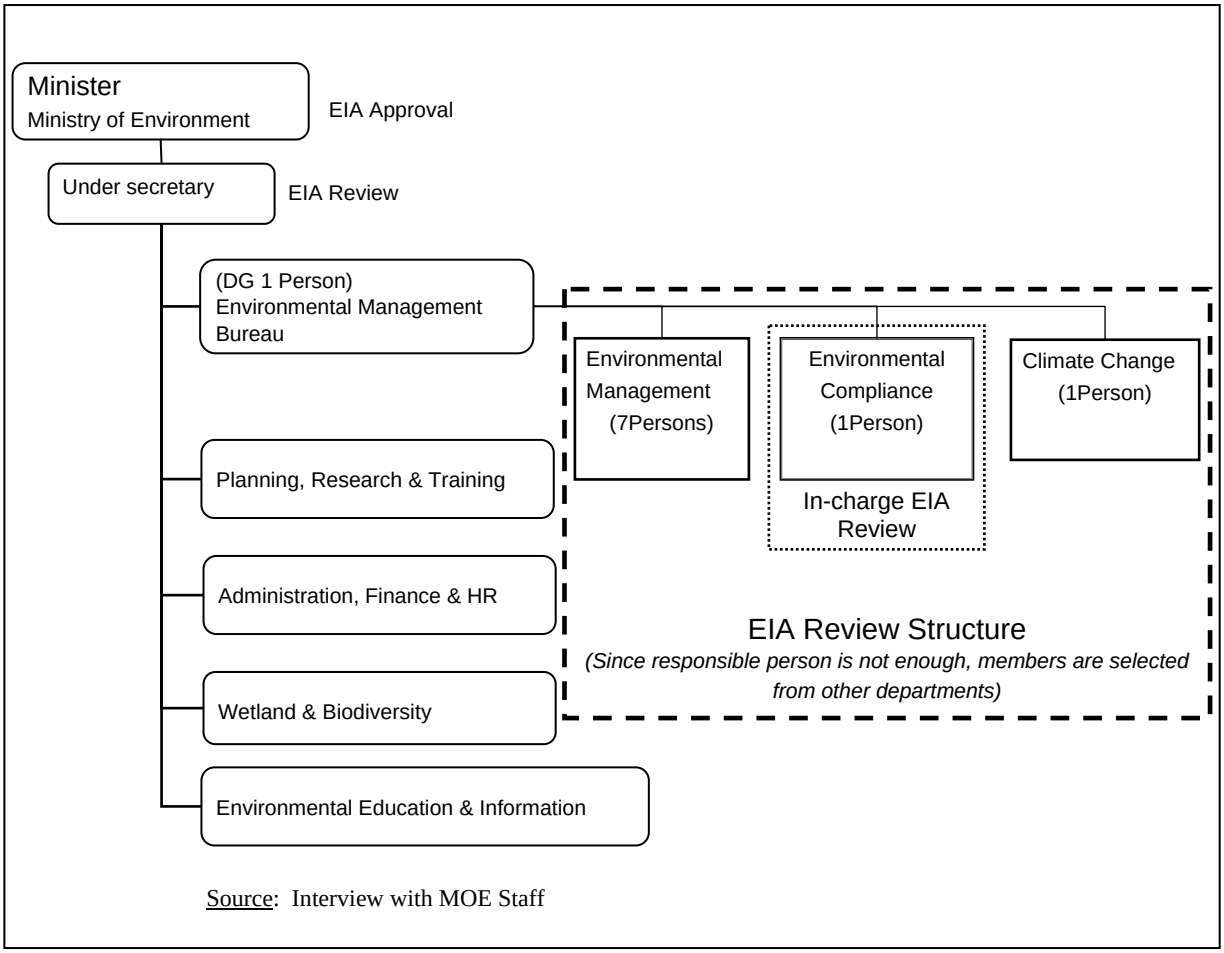


Figure 1-3-2 Ministry of Environment Organization Chart

(3) Comparison of Alternative Alignment

From the environmental and social considerations point of view, eight alternative alignment options (including without project option) as shown in **Figure 2-2-3 (1) & (2)** were considered. The results of comparative study for these options are shown in **Table 1-3-2**. The total number of affected households shown in the table was obtained during the first site survey. Alternatives 1, 2A and 2B were considered based on the number of affected households. Alternatives 1 and 3,4,5,6 were compared based on the impact to natural environment and pollution caused by the length of alignment and the total resettlement. The economic effects are predicted based on shorter travel time and close proximity to the city. As a result, the cheapest construction cost alternative with the lowest impact among the alternatives is selected.

Table 1-3-2 Results of Alignment Comparative Study

Alternative	Result	Social and Natural Environmental Impacts			Effects of the project	
		Social Environment	Natural Environment	Pollution	Construction Cost	Economical Effect
Without Project	×	・Since there are many unpaved road it is difficult to support movement of goods and people which hinders local/regional development of economy. ・Difficult to support transport to hospital during an emergency. ・With the present condition of the existing bridge, serious accident can happen again especially with the increase in traffic volume.	・None	・None	-	-
Alternative 1 L = 4,300m	○	・Resettlement necessary (60 houses/30m ROW). ・Economic effect is expected due to logistics improvement (1). ・Improvement of access to social services (2). ・Opportunity of employment is increased (3).	・A large quantity of cutting tree and embankment is needed (1). ・Some effects to livestock and ecosystem (2).	・Air pollution, water contamination and noise will occur during construction	○	○
Alternative 2A L = 4,426m	○	・Resettlement larger than Alt 1 will occur (85 houses/30 ROW). ・Same as (1) (2) (3) above.	・Same as (1) (2) above	・Same as above	○	○
Alternative 2B L =,466m	△	・Resettlement larger than Alt 1 will occur (115 houses/30 ROW). ・Same as (1) (2) (3) above.	・Same as (1) (2) above	・Same as above	○	○
Alternative 3 L = 5,142m	△	・Resettlement larger than Alt 1 will occur (69 houses/30 ROW). ・Same as (1) (2) (3) above.	・ (1) and (2) above effect longer and bigger than Alt 1.	・Same as above	△	○
Alternative 4 L = 5,348m	△	・Resettlement larger than Alt 1 will occur (70 houses/30 ROW). ・Land acquisition cost is low. ・Same as (3) above.	・(1) and (2) above effect longer and bigger than Alt 1.	・Same as above (pollution area will be wilder than Alt 1)	△	△
Alternative 5 L = 5,616m	×	・Resettlement smaller than Alt 1 will occur(40 houses/30 ROW) ・Land acquisition cost is low. ・Same as above (3).	・(1) above larger than Alt 1. (2) above larger than Alt 1, especially at hydraulic situation and ecosystem.	・Same as above (pollution area is longer than Alt 1)	×	×
Alternative 6 L = 4,027m	△	・Resettlement will occur (58 houses/30m ROW). ・Same as (1) (2) (3) above.	・(1) and (2) above have large effect, especially to improve geological condition of mud.	・Same as above	×	○

Note : ○ : Superior △ : Acceptable × : Not Acceptable - : Not Applicable

(4) Environmental Impact

1) Analysis of Environmental Impact

Scoping was undertaken for the social and natural environment considering the positive and negative impacts to the environment and the results analyzed to determine if the impact are significant or relatively small (see **Table 1-3-3**). As a result, there is serious negative impact for involuntary resettlement (Category A) while other items have relatively small negative impact (Category B or less). The natural environment considerations will be discussed in what follows while the social environment considerations will be discussed in the next section.

Table 1-3-3 Results of Scoping

Item		Legend: -A: Serious negative impact -B: Relatively small negative impact +A: Significant positive impact +B: Relatively small positive impact D: Negligible or minor impact	Rating			
			Overall	**Site Clearance**	**During Construction**	**Operation**
Social Environment	1	Involuntary resettlement	-A	-A*	D	D
	2	Local economies, such as employment, livelihood, etc.	-B	-B	+B	+B
	3	Land use and utilization of local resources	-B	-B	-B	+A
	4	Social institutions such as social infrastructure and local decision-making institutions	-B	-B	-B	+B
	5	Existing social infrastructures and services	-B	-B	-B	+B
	6	Poor, indigenous, or ethnic people	-A to -B	-B	-B	+B
	7	Misdistribution of benefits and damages	-B	-B	-B	+B
	8	Cultural Heritage	-B	-B	-B	D
	9	Local conflicts of interest	-B	-B	D	+B
	10	Usage of water and water right	-B	-B	-B	+B
	11	Accident	-B	D	-B	-B
	12	Sanitation	-B	-B	-B	D
	13	Infectious diseases such as HIV/AIDS	-B	D	-B	-B
	14	Gender	-B	-B	-B	-B
	15	Children's Right	-B	-B	-B	-B
Natural Environment	16	Topography and Geology	-B	D	-B	D
	17	Soil Erosion	-B	D	-B	-B
	18	Groundwater	-B	-B	-B	-B
	19	Hydraulic Situation	-B	D	-B	-B
	20	Costal Zone	D	D	D	D
	21	Fauna, Flora and Biodiversity	-B	-B	-B	-B
	22	Meteorology	-B	D	D	-B
	23	Landscape	-B	D	-B	-B
	24	Global Warming	-B	-B	-B	-B

Item		Legend: -A: Serious negative impact -B: Relatively small negative impact +A: Significant positive impact +B: Relatively small positive impact D: Negligible or minor impact	Rating			
			Overall	**Site Clearance**	**During Construction**	**Operation**
Pollution	25	Air Pollution	-A to -B	D	-B	+B
	26	Water Contamination	-B	D	-B	D
	27	Soil pollution	-B	D	-B	D
	28	Waste	-B	D	-B	D
	29	Noise and vibration	-B	D	-B	+B
	30	Ground Subsidence	-B	D	-B	-B
	31	Odor	-B	D	-B	-B
	32	Bottom Sediment	-B	D	-B	D

* 80 families (80 x 4 members = 320 persons) or more are to be displaced by the project, which exceeds the 200 persons as per para. 17(a), OP4.12 Involuntary Resettlement, World Bank.

In addition, the impact of environmental baseline surveys listed in **Table 1-3-4** was analyzed. The following describes the overview of the results of the analysis:

- Involuntary Resettlement

  Most of the residents indicated that they are in favor of new Nile River Bridge project and shows willingness to the transfer under the appropriate compensation. The policy on compensation unit price will be determined in consultation with the residents.

- Local Economy Including Employment and Livelihood

  At present, there are few local employment opportunities on site. However, employment opportunities for laborers, skilled worker and business opportunities for material suppliers will increase at the start of construction. Farmers, construction workers, brick production workers and fishermen are likely to be affected by this project.

- Land Use and Utilization of Local Resources

  The current land use classification includes residential areas, agricultural areas, cemetery and mobile brick production.

- Social institutions such as social infrastructure and local decision-making institutions

  The impact of construction to public institutions is minimal, with minor relocation of police tent office. Social institutions in the west bank includes community office, churches, nursery/primary school, vocational training school, clinic and police camp.

- Existing social infrastructures and services

  There are water borehole pumps (only in the west side) near the constructions site but the effect is almost negligible. Aside from the water pumps, there is no other infrastructure except the unplanned roads in very poor condition on the west side (no access road in the east side).

- Poor, indigenous, or ethnic people

  Aside from the Bari tribe (indigenous tribe in the area), other tribes settled informally in the area including Dinka, Kuku, Madi, Acholi, etc. after the war. Vulnerable people like widows, blinds and the poor and landless people exist. Their opinions will have to be considered.

- Misdistribution of benefits and damages

  While land title holders affected by the project will be compensated and those around the project area will be compensated, non-title holders may suffer and have to be removed at any moment.

- Cultural Heritage

  There is no cultural heritage on site.

- Local conflicts of interest

  Land disputes arise from the community-owned land and land title holders and non-title holders (squatters) who settled informally in the site.

- Usage of water and water right

  Although water is obtained from well pumps, river, water lorries (selling water) but the project will not affect such.

- Accident

  Although the existing roads in the area are in poor to very poor condition and without street lighting, accidents during construction can be avoid through proper safety planning.

- Sanitation

  Sanitation levels in all the areas are quite poor and a significant portion of households indicated that they did not have a basic pit latrine. Many households have constructed shallow pit latrines on plot perimeters that tend to overflow during heavy rain onto public pathways, a clear public health hazard. Garbage are left everywhere. With additional 500 workers during construction, it is necessary to prevent the health and sanitation from getting worse.

- Infectious diseases such as HIV/AIDS

  HIV prevalence rate in Juba County is more than 20%

- Gender

  Large salary gap exists between men and women.

- Children's Right

  Child labor and child soldier has been an issue in South Sudan. Child labor is prevalent with most young children doing menial jobs and house chores instead of going to school.

- Topography and Geology

  There is no problem with topography (which is relatively flat with mild slope) and geology (with shallow rock strata).

- Soil Erosion

  Although ground erosion and bank erosion are visible in some areas, it does not present a serious problem. Local scouring may occur in the river bed at pier locations but will not present a problem on the bridge. The road embankment section behind the abutment and the section in front of the abutment shall be protected from erosion.

- Groundwater

  The project has no particular effect on the groundwater.

- Hydraulic Situation

  The bridge construction will have little impact to the river flow discharge.

- Costal Zone

  There is no coastal area on site.

- Fauna, Flora and Biodiversity

  According to MOFA and UNEP, there is no protected species on the proposed site.

- Meteorology

  There is no impact.

- Landscape

  Interview results and opinions of local residents indicated no negative impact on the landscape.

- Global Warming

  Since the project will improve the traffic speed in the area, the emitted greenhouse gas effect will decrease.

- Air Pollution

  Since traffic will be dispersed after project completion pollution caused by vehicle emission will decrease. Exhaust and dust generated by construction equipment may cause temporary pollution effects during construction.

- Water Contamination

  There is a possibility of muddy water and liquid waste being generated during construction.

- Soil pollution

  Soil maybe contaminated due to oil leaks from construction equipment.

- Waste

  Wastes generated during construction may have high impact possibility.

- Noise and vibration

  Noise and vibration generated by construction equipments may have some impact.

- Ground Subsidence

  The project has no particular impact.

- Odor

  There is possibility of unwanted odor and gas smell from waste generated during construction.

- Bottom Sediment

  There may be minor contamination due to oil leaks from construction equipment.

Table 1-3-4 Results of Environmental Baseline Survey

Item			Evaluation Indicator	Data Difference between Dry and Rainy Season	Result of the Third Field Survey (Feb.-Mar., Dry Season)
Social Environment	1	Involuntary resettlement	Legal system (resettlement system, property), assets (such as house or land), occupation, income, constitution of family, relationship with the neighbors	No	30m width of land acquisition causes approximately 80 houses resettlement, though most of them (approximately 50 houses) can be set back along the road and all the houses can be resettled within 100m along the road, therefore their life environment will not change radically. Most of the residents agree with the project and they are cooperative to resettle with proper compensation. Compensation policy and unit price will be decided after public meeting and the result will be written in RAP. As a result, making proper resettlement plan and implementation of compensation can mitigate the effect.
	2	Local economy, such as employment, livelihood, etc.	Occupation of the neighbors, average income, unemployment rate	No	Most popular occupations are soldier (19%) and policeman (14%). Average income is SSP750 (=$300) only per month. Therefore, the income per one family member nearly drops on the line of $1 per day which is the absolutely poverty line. Four households replied as fishermen. They catch catfish, carp and Nile perch etc at up and down streams of Nile River since there is no fishery right set. Apparently, they are not full time fishermen and have labor work depending on the season.
	3	Land use and utilization of local resources	Distribution of livelihood	No	Land uses and local resources are classified as: - Residential area for the most portion of west bank and along river of east bank - Agricultural land in the flooded swamp (activity is limited to February to April only)) on the west bank and in non-flooded area on the east bank - Brick manufacturing along the river side of both banks - Mango plantation along the riverside - Group cemetery for unidentified war-dead on the west bank
	4	Social institutions such as social infrastructure and local decision-making institutions	Situation of school, hospital, religious facility, rural government, or residential organization	No	There are several institutions on the west bank but there no institution at all on the east bank. Social institutions on the west bank include: - Community office - Churches - Nursery/primary schools - Vocational training school - Clinic - Refugee camp - Police In addition some portion of river side is used as - Laundry - Bathing - Water taking
	5	Existing social infrastructures and services	Satisfaction to infrastructure or social service	No	They feel satisfied to infrastructure or social services. On the other hand, existing social infrastructure, bus operation, is possible to be affected during construction period. However, it can be mitigated thru traffic control during construction.

Item			Evaluation Indicator	Data Difference between Dry and Rainy Season	Result of the Third Field Survey (Feb.-Mar., Dry Season)
	6	Poor, indigenous, or ethnic people	Income, satisfaction to life environment, support from NGO or government	No	The indigenous people of the area are the Bari people. Settlers within Lologo and Gumbo area include soldiers and their families of other tribes. In addition there is an area which is predominantly Lopit people who came to Juba from Eastern Equatoria in the 1960s as a result of famine and subsequently moved to Lologo. There is also an area predominantly of Dinka who have lived in Juba since the 1960s and who had cattle camps nearby. A large number of Equatorian tribes have settled over the years for a variety of reasons, including for employment and availability of land relatively close to Juba. In 1992, many people left the area due to the heavy fighting around Juba. Some returned soon after hostilities ended, whilst others remained in the town until the signing of the CPA. Community leaders and members have stated the population has increased dramatically since the signing of the CPA.
	7	Misdistribution of benefits and damages	Residents' acknowledgement of misdistribution of benefits and damages	No	Other ethnic tribe than indigenous tribe who occupy community land are not provided with land titles, are thus suffering for unstable condition and afraid to be kicked out any day.
	8	Cultural Heritage	Not dictated	No	There is no cultural heritage at the site.
	9	Local conflicts of interest	Residents' acknowledgement of local conflict of interest	No	Based on the results of interviews to the 80 number of affected households during census, only 16% replied there is no conflict in the site.
	10	Usage of Water and Water Right	Usage of water from well, river and water lorry	No	Water is obtained from: - River (free) - Water lorry (5SSP/200 liter) - Pumping well (1SSP/4 liter) - Pet bottle (0.5SSP/1 liter) Quality of river water is very low and has to be chlorinated before use. Ordinary households obtain one drum can of water per day. There are three wells in the site.
	11	Accident	Number of the accident per year	No	Making number of the accidents minimum through managing properly during construction and operation of the bridge.
	12	Sanitation	Morbidity and countermeasures	No	Sanitation levels in all the areas are quite poor and a significant portion of households indicated that they did not have a basic pit latrine. Many households have constructed shallow pit latrines on plot perimeters that tend to overflow during heavy rain onto public pathways, a clear public health hazard.
	13	Infectious diseases such as HIV/AIDS	Number of HIV infection and countermeasures	No	The prevalent rate in the site is unknown, however due to the inflow of returned soldier the rate can be higher, since the soldiers after CPA 2005 came out of the jungle and were paid much to spend on alcohol and sex with prostitutes, exposed to with high risks to be transmitted of HIV.
	14	Gender		No	Female in South Sudan faces the issues of: - Patrilineal society with limited roles and rights - Early marriage due to poverty (dowry) and conflict (fear of death) - Polygamy (based on economic conditions)
	15	Children's right		No	The children's labor at the site are as follows: - Young school boys were involved in money creating activities such as shoe shine business where they walk

<table>
<tr><th colspan="3">Item</th><th>Evaluation Indicator</th><th>Data Difference between Dry and Rainy Season</th><th>Result of the Third Field Survey
(Feb.-Mar., Dry Season)</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>around with brushes and shoe polish looking for any ready customer.
- Others are involved in daily family chores such as looking for younger siblings within the family and drawing water from the borehole.
- The Black Market for foreign currency exchange has several young boys who deal in money exchange.

The condition of children soldiers in South Sudan are as follows:
Although the recruitment or use of children under the age of 18 in armed conflict is contrary to international law and contrary to Sudan’s CPA 2005, many children were conscripted or some times abducted by fighting forces. Since 2001. An estimated 20,000 children from the SPLA have been disarmed, demobilized and returned to their families with UNICEF supports. However it is still estimated that more than 2,000 children are in SPLA presently.</td></tr>
<tr><td rowspan="5">Natural Environment</td><td>16</td><td>Topography and Geology</td><td>Situation of topography and geology</td><td>No</td><td>The terrain within Lologo area (west bank of the River Nile), is relatively flat but gradually sloping towards the river. The elevation ranges approximately +460m to +480m above sea level. Elevation of river bottom is EL+450m. The terrain within Gumbo area has the same characteristics but there are a few rock outcrops near the Juba-Nimule road junction, where the project road will commence.
Project area and its surrounding areas can be tectonically and geologically divided into two zones that consist of the alluvial deposits and the Undifferentiated Basement Complex. The alluvial deposit, un-conformably overlying the Undifferentiated Basement Complex, is extensively distributed in the area. The undifferentiated basement complex consists of metamorphic and intrusive rocks of various grades of metamorphism.</td></tr>
<tr><td>17</td><td>Soil Erosion</td><td>Surface erosion, river bank erosion</td><td>Yes</td><td>Erosion on the ground surface by rain water, due to absence of proper drainage system, is never significant. The erosion by the river is progressing on the west bank while sedimentation is occurring on the east bank based on the discussion with site observation and discussion with authorities.</td></tr>
<tr><td>18</td><td>Groundwater</td><td>Level of groundwater, aquifer</td><td>Yes</td><td>Existing well data were collected from Rural Water and Sanitation Department, MWRI. According to these data, a total of 439 wells are listed consisting of 417 wells in Juba Payam and 22 wells in Rajaf Payam</td></tr>
<tr><td>19</td><td>Hydraulic Situation</td><td>Depth, amount, flood situation</td><td>Yes</td><td>Hydraulic situation was studied and Table 19-1 indicates the summary of parameters of Nile River.
Table 19-1 Hydraulic parameters of Nile River
<table>
<tr><td rowspan="1">River bed</td><td>Material</td><td>Well-graded sand</td></tr>
<tr><td></td><td>Elevation m</td><td>451.0</td></tr>
<tr><td rowspan="3">Flow in dry season</td><td>Water level m</td><td>455.65</td></tr>
<tr><td>Volume m^3/s</td><td>1,300</td></tr>
<tr><td>Velocity m/s</td><td>1.2</td></tr>
<tr><td rowspan="3">Flow in rainy season</td><td>Water level m</td><td>456.65</td></tr>
<tr><td>Volume m^3/s</td><td>1,900</td></tr>
<tr><td>Velocity m/s</td><td>1.2</td></tr>
</table>
During rainy season, water level rises 1m higher than dry season.</td></tr>
<tr><td>20</td><td>Costal Zone</td><td>Not dictated</td><td>Yes</td><td>There is no coastal zone around Juba.</td></tr>
</table>

Item			Evaluation Indicator	Data Difference between Dry and Rainy Season	Result of the Third Field Survey (Feb.-Mar., Dry Season)
	21	Fauna, Flora and Biodiversity	Distribution of fauna and flora	Yes	The aquatic environments along River Nile, water and wetlands, which also forms part of the project area, serve as habitat for interrelated and interacting populations of plants and just a few animals. However, at the proposed project area, Lologo and Gumbo do not support any wildlife due to the existing human settlements and lack of wildlife habitats. Red listed fauna stay in the protected area about tens of kilometers upstream of the site around Ethiopian border. Residents saw crocodiles but they are the common species of Nile Crocodile. In the river, cat fish and other common mud fishes are available.
	22	Meteorology	Yearly meteorology data in Juba city	Yes	<u>Temperature</u> Juba is basically a hot area where average minimum monthly temperature (based on the 1998 to 2004 statistics) ranges from 20 to 24, whereas the average maximum monthly for the same period are in the range 30 to 38. <u>Rainfall</u> Rainfall data for Juba Town is available for the period of 1996 to 2009 but excludes 2001. Features of rainfall are as flows; - Annual rainfall. Rainfall records for the last 10 years for Juba Town, mean annual rainfall averages 1,096.1 mm. The wettest year 1996 with 1,340mm while 2000 was the driest year when only 884mm was recorded. - Seasonal rainfall: Annual rainfall is delivered in one long wet season lasting 7 months from April to December. Each of the 7 months of the wet season receives on averages above 100mm of rainfall. April and October are the wettest months receiving on average 154.2 and 145mm of rainfall respectively. November to march is the dry season when rainfall on average is below 50mm.
	23	Landscape	Acknowledgement of landscape	No	The present landscape of the site on the west bank is sparse built-up residential area on the reddish soil (Laterite[1]). On the east bank, it is similar to west bank with some bushes and shrubs but almost without residential house
	24	Global Warming	Forecasted amount of CO2 emission	No	Due to the traffic congestion caused by the increase of the number of vehicle and deterioration of the traffic network, emitted amount of greenhouse gas is considered as increasing year by year.
Pollution	25	Air Pollution	SPM, CO, NOx, SOx	Yes	Actual monitoring for air pollution was not implemented since the traffic at the site is almost zero and there can be no air pollution produced, in addition to the fact there is no factory which emit air pollutant. Instead, to estimate the baseline conditions for air pollution, we took the data[2] obtained in Juba downtown near Juba Port, 4 km north to the project site since no data was available at the project site. Juba downtown is more congested with vehicles and the air pollution can be considered to be worse than the project site where there is almost no traffic. The average air pollution concentrations are less than the environmental standards set even in this traffic congested town. Therefore, the air pollution in the less congested project site can be estimated as not worse than in downtown.

[1] Laterites are typical soil types, rich in iron and aluminium, found in tropical region, rusty-red coloured due to oxidization. They are developed by weathering of parent rock underneath.
[2] JICA, EIA Report for Juba River Port Expansion Project, 2010

Item			Evaluation Indicator	Data Difference between Dry and Rainy Season	Result of the Third Field Survey (Feb.-Mar., Dry Season)
	26	Water Contamination	pH, electric conductivity, turbidity	Yes	Existing data about the qualities of Nile River water and groundwater were collected from the same EIA Report for Juba Port Expansion and others references[3], and studied while samples of river water at the location of the proposed bridge and groundwater at Lologo Village were taken and tested. The following are noted: - The quality of river water can be classified B-D, based on the concentrations of SS and Coliform which specifies: - Bathing is not applicable - Sophisticated treatment is required as drinking water - Muddy water fishing may be only applicable For direct drinking water from river water: - In the view of *human health*, coliform and E-coliform which were 1,100 and 210 MNP/100mL respectively, shouldn't be detected. Concentrations of Cyanide, Mercury, Lead, Cadmium, Arsenic, Nitrate and Nitrite were within the standards. - In the view of *monitoring requirement*, concentration of Nickel was beyond the standard. - In the view of *acceptable water quality*, concentrations of Copper, Iron, Magnesium and Phenol exceeded the standards. Colour and Turbidity also were not accepted. - In the view of *comfortable drinking water standard*, concentration of Aluminium exceeded the standard. Turbidity was not accepted as well For direct drinking water from ground water: - In the view of accepted water quality, turbidity sometimes is beyond the standard..
	27	Soil Pollution	Pollution of heavy metal from natural environment, oil leaking accident in the past	No	According to the hearing from village head, there was no soil contaminating activities such as fuel storage or dumping of harmful material at the project site which was done so far, therefore we presumed no monitoring is necessary. Soil contamination monitoring will be implemented before construction to confirm if any soil be polluted.
	28	Waste	Type of the litter	No	There are many domestic waste including pet bottles that are scattered all over the site. They are some times collected in the open holes anywhere and incinerated.
	29	Noise and Vibration	Noise level, vibration level	No	Similarly as the case of air pollution, no noise pollution was considered as no serious, since no traffic or factory is there at the site. The existing data in downtown is taken as baseline data. As it say, no serious noise or vibration is suffered in general as would beyond allowable limits compared in the case with Japanese standards. For the time being the data are to be utilized as baseline data for future prediction of noise and vibration caused by the project in the safety side estimation. Finally based on the monitoring before construction, noise and vibration are estimated at right location and the mitigation measures, if necessary, shall be planned.
	30	Ground Subsidence	Damage of ground subsidence	No	The ground at the site is covered with well compacted sand or stiff clays, immediately underlain by rock within several meters bellow ground surface and no long term consolidation settlement can be caused

[3] Water analysis report provided from JICA Technical Assistant Team

Item			Evaluation Indicator	Data Difference between Dry and Rainy Season	Result of the Third Field Survey (Feb.-Mar., Dry Season)
	31	Odor	Type of odor and emission source	No	Stinging smell can be expected while they incinerate kitchen waste near the house.
	32	Bottom Sediment	Bottom pollution of organic-rich sediment, bottom pollution of natural matter	No	Bottom sediments are well-graded sand or gravels without very muddy material which may contain organic residue or heavy metal elements easy to adhere to very small soil particles.

* Although there is no impact predicted for some items, still some measures/ monitoring are proposed for the purpose to reconfirm that the environment is not affected, observation of natural phenomenon/disaster or to be further improved as routine procedure.

Table 1-3-5 Summary of Environmental Impacts, Mitigation Measures and Monitoring Plan

Item		Negative impact predicted	Mitigation measures proposed* (Mitigation)	(Monitoring)	**Cost for monitoring plan	Cost borne by	Responsible Ministry	Responsible Directorate
1	Involuntary resettlement	See RAP, different volume			$150,000	MRB	MoPI	Directorate of Housing and Directorate of Land
2	Local economies, such as employment, livelihood, etc.	Moderate: Tentative/permanent loss of working places for farmer, fisherman, brick bakery etc	Priority employment during construction if requested (RAP)	External monitoring to ensure the proper implementation of resettlement activities	-	-	MoPI	Central Equatoria Rajaf Payam
3	Land use and utilization of local resources	Moderate: Loss of productive land	Provision of alternative land or cash compensation by market prices (RAP)	-	-	-	MoPI	Directorate of Housing and Directorate of Land
4	Social institutions such as social infrastructure and local decision-making institutions	Negligible: Only police station affected but easy to move (tent)	Provision of alternative land (RAP)	-	-	-	MoPI	Directorate of Housing and Directorate of Land
5	Existing social infrastructures and services	Negligible:	Not required	-	-	-	MoPI	Directorate of Housing and Directorate of Land
6	Poor, indigenous, or ethnic people	Moderate to severe: Loss of shelter, livelihood and life	Provision of alternative land and priority employment during construction (RAP)	External monitoring to ensure the proper implementation of resettlement activities	-	-	MoPI	Central Equatoria State – Rajaf Payam
7	Misdistribution of benefits and damages	Moderate: No project benefit (ex. economic development) may be provided for informal residents	Provision of land cheaply to landless and job training (RAP)	External monitoring to ensure the proper implementation of resettlement activities	-	-		
8	Cultural Heritage	No cultural heritage	Not required	-	-	-	Ministry of Culture	Directorate of Culture
9	Local conflicts of interest	Moderate: Possible land dispute by encroaching by displaced people	Strictly prohibit not encroach (RAP)	External monitoring to ensure the proper implementation of resettlement activities	-	-	MoPI	Directorate of Housing and Directorate of Land
10	Usage of Water and Water Right	Negligible	Not required	Water is sampled from river or wells dug inside construction camps.	-	-	Ministry of Water Resources and Irrigation	Directorate of Water Management

Item		Negative impact predicted	Mitigation measures proposed* (Mitigation)	(Monitoring)	**Cost for monitoring plan	Cost borne by	Responsible Ministry	Responsible Directorate
11	Accident	Moderate: Possible increase of accident while construction and after operation	Preparation for possible dangerous works and provision of emergency response system as Health Management Plan (HMP) and prevention of traffic accidents as in Traffic Management Plan (TMP) Provision of fences at camps and construction site injury of residents	Traffic safety and construction safety are monitored and reported monthly.	-		Ministry of Interior	Directorate of Traffic Control
12	Sanitation	Moderate: Possible increase of hygiene problem	Provision of enough clean water and sanitary facilities at the site and camp (HMP)	Inspection if sanitation is properly controlled as per HMP	$20,000	Contractor	Ministry of Health	Directorate of Sanitation
13	Infectious diseases such as HIV/AIDS	Moderate: Possible increase of infected people	Campaign of awareness and provision of preventive goods to workers an adjacent community (HMP)	Inspection if campaigns are properly implemented			Ministry of Health	Directorate of HIV/STI
14	Gender	Moderate: Salary discrimination between genders	Prohibit salary discrimination between genders	Check payment records of contractor to workers regularly	-	-	Ministry of Gender, Child and Social Welfare	Directorate of Gender
15	Children's right	Moderate: Possible increase of children's labor	Prohibition of children's labor	Patrol if child is working at the site	-	-	Ministry of Gender, Child and Social Welfare	Directorate of Child Rights
16	Topography and Geology	Negligible: change of landscape at the borrow pits but acceptable	Not required	-	-	-	Ministry of Petroleum and Mining	Directorate of Geology
17	Soil Erosion	Negligible: Estimated erosion on river bed is not serious (<1m) while the west bank is now being eroded by its nature but no impact is predicted which is caused by the project due to proper disposition of piers	Not required	Monthly inspected and reported, since, as a natural phenomenon, soil erosion can be caused regardless of the project	-	-	Ministry of Environment and Ministry of Water Resources and Irrigation	

Item		Negative impact predicted	Mitigation measures proposed* (Mitigation)	(Monitoring)	**Cost for monitoring plan	Cost borne by	Responsible Ministry	Responsible Directorate
18	Groundwater	Negligible: construction work as would affect groundwater such as pumping or grouting	Not required	Monitoring of groundwater qualities monthly since, as a natural phenomenon, groundwater level can be changed regardless of the project Groundwater level is monitored using the well in the camp.	-	-	Ministry of Water Resource and Irrigation	Directorate of Water Management
19	Hydraulic Situation	Negligible: Water level arises 1cm by the bridge	Not required	-	-	-	Ministry of Water Resource and Irrigation	Directorate of Hydrology
20	Costal Zone	No coastal zone	Not required	-	-	-	Ministry of Water Resource and Irrigation	Directorate of water Management
21	Fauna, Flora and Biodiversity	Negligible: The ecosystem at the site is common species and is widely distributed and loss of small area does by the project not affect the total ecosystem there.	Not required	-	-	-	Ministry of Environment and Ministry of Agriculture	Directorate of Wetlands and Biodiversity
22	Meteorology	Negligible	Not required	-	-	-	Ministry of Transport	Directorate of Civil Aviation
23	Landscape	Negligible: no resident thinks landscape will deteriorated by the project.	Re-vegetation of side slopes of earth embankment and bank at abut by lawn/ tree to improve the landscape quality.	Monitoring of grass/ tree planting activities and the growth	-	-	Ministry of Environment and Ministry of Housing	Directorate of Wetlands and Biodiversity in Ministry of Environment
24	Global Warming	Improved: emitted CO2 when project implemented is helved of without project	Minimize the consumption of fuel during construction (EMP)	-	-	-	Ministry of Environment	Directorate of Environment Management
25	Air Pollution	Moderate to severe at the site since there had been no vehicles. Improved by the project until 2015,but worsen in 2025 in	- Prohibit open burning - Idling stop - Fitting exhausted gas control devices - Spraying water on the earth road regularly	Measurement of NO2, SPM, CO, SO2 before(wet and dry seasons), during (wet and dry seasons)and after construction (wet and dry seasons) for roadside	$300,000	Contractor	Ministry of Environment	Directorate of Environment Management

Item		Negative impact predicted	Mitigation measures proposed* (Mitigation)	(Monitoring)	**Cost for monitoring plan	Cost borne by	Responsible Ministry	Responsible Directorate
		Juba. Allowable during construction.	(EMP)	and behind the road(back ground) at the site and existing Nile Bridge road respectively together with traffic volume counting Frequency: 4 locations (Juba and Nile Bridges and their back grounds) x 2 days x 6 seasons (3 years) during construction and 2 season (2 years)after construction Monitoring of SO2 may be continued after 2018 based on the concentrations and damages to human and vegetation observed before 2018.				
				Regular inspection of exhausted gases from equipments every month by gas detector.	$10,000	Contractor		
26	Water Contamination	May be moderate: Muddy water generated during earthwork, although impact by pier construction work is negligible Oil leakage from vessels for construction	Proper treatment of muddy water liquid waste before discharged (EPM)	Measurement of DO (dissolved oxygen), Ec (Electric Resistivity), NTU (Turbidity) Frequency: before (2 seasons), during (every month) and after (2 seasons for 2 years) construction at upstream and downstream to the proposed bridge.	$5,000 (equipment cost only)	Contractor	Ministry of Environment	Directorate of Environment Management
				Patrol ensuring no dumping material/muddy water into the river	-	-	Ministry of Environment	Directorate of Environment Management
27	Soil pollution	Moderate: leakage of fuel	Proper prevention of fuel leakage (EMP)	Inspection of equipment and fuel tank	-	-	Ministry of Environment	Directorate of Environment Management

Item		Negative impact predicted	Mitigation measures proposed* (Mitigation)	(Monitoring)	**Cost for monitoring plan	Cost borne by	Responsible Ministry	Responsible Directorate
28	Waste	Moderate: Generation of non-organic construction waste and organic domestic waste from camp	Proper treatment of construction waste/domestic waste from camp (EMP) including waste deduction/recycling planning Insoluble treatment for hazardous substance containing waste	Supervising and monitoring to ensure all wastes are properly handled	-	-	Ministry of Environment and Ministry of Housing	Directorate of Environment Management in Ministry of Environment and Directorate of Water and Sanitation in the Ministry of Housing
29	Noise and vibration	Improved to moderate: By the project from unacceptable range to allowable range while operation until 2015 and worsen in 2025. Allowable during construction.	Minimization of noise and vibration during construction (EMP)	Measurement of noise and vibration levels before (2 season), during (2 season x 3 years) and after construction (2 season x 2 years) for roadside and behind the road(back ground) at the site and existing Nile Bridge road respectively together with traffic volume counting (4 locations x 1day x 12 times)	$360,000	Contractor	Ministry of Environment	Directorate of Environment Management
				Regular inspection of equipment and monitoring of NOx and CO by detector	-	-		
30	Ground Subsidence	Not caused	Not required	-	-	-	Ministry of Environment	Directorate of Environment management
31	Oder	Moderate: from exhausted from equipment/lorry but not serious	Minimization of generation of offensive order during construction n	Patrol ensuring no open burning of waste	-	-	Ministry of Environment	Directorate of Environment Management
32	Bottom Sediment	Moderate: by dumping of waste/used oil into river but avoidable	Control of waste (EMP)	Patrol ensuring no dumping in the river	-	-	Ministry of Environment	Directorate of Environment Management

Notes:

* Although there is no impact predicted here for some items, still some measures/ monitoring are proposed for the purpose to reconfirm that the environment is not affected, observation of natural phenomenon/disaster or to be further improved as routine procedure.

**All the cost for mitigation/monitoring is included in the construction costs.

(5) Environmental Monitoring

The environmental monitoring system is schematically shown in **Figure 1-3-3** while **Table 1-3-5** presents the summary of environmental impacts, mitigation measures and monitoring plan. In addition, the monitoring form and environmental checklist are shown in **Table 1-3-6** and **Table 1-3-7** respectively.

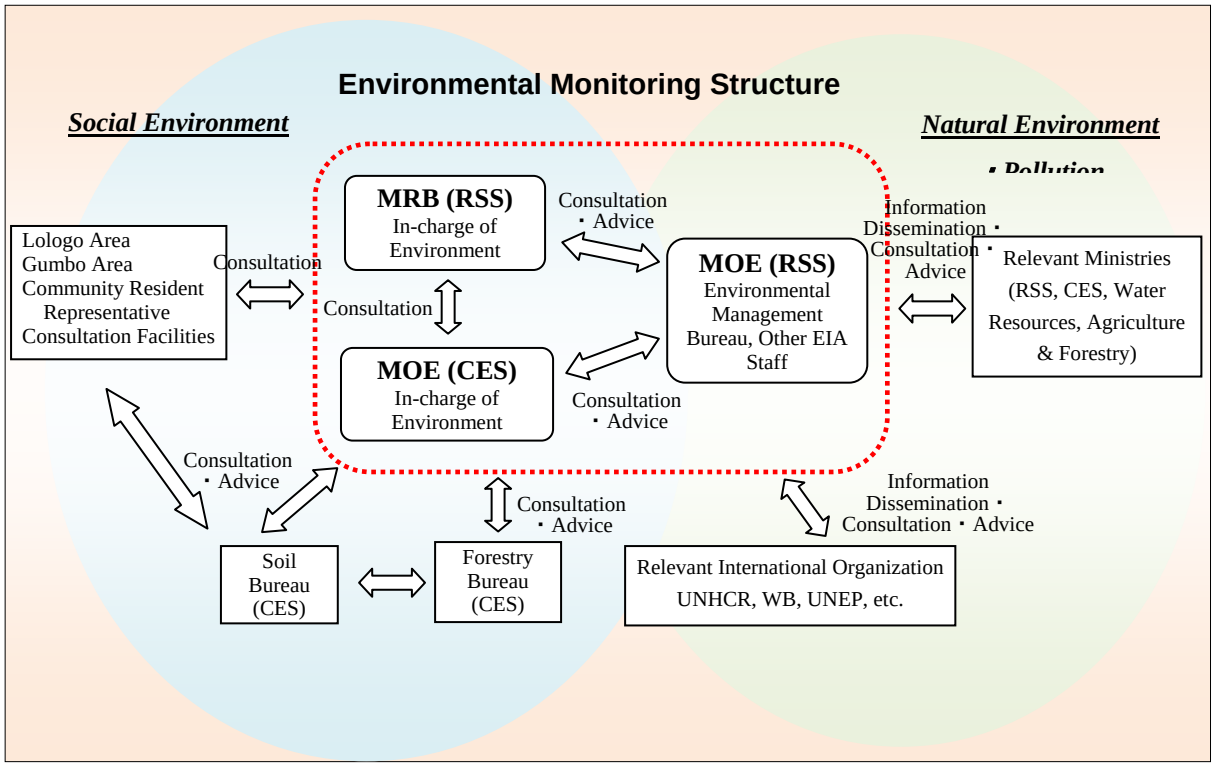


Figure 1-3-3 Social and Environmental Monitoring System

Table 1-3-6 Monitoring Form

1. Permission and Public Meeting

Items	Contents
The proponent will obtain the permission of river water sampling	Date of approval
Public meeting	Date, participants, subject, opinion

2. Pollutions

－Ambient air pollution around the site, 2 times per year between 2012-2018

Item	Unit	Nile Bridge Road		Juba Bridge Road		Tentative Standards
		Beside road *	200m Behind Road	Beside Road *	200m Behind Road	
Sulfur Dioxides SO_2	$\mu g/m^3$					WHO 20-125 (daily) 500 (10min)
Nitrogen dioxides NO_2	$\mu g/m^3$					WHO 40 (yearly) 200 (hourly)

Item	Unit	Nile Bridge Road		Juba Bridge Road		Tentative Standards
		Beside road *	200m Behind Road	Beside Road *	200m Behind Road	
Carbon monoxide CO	μg/m^3					Japan 2000 (8hours)
Suspended Particulate Matter SPM	μg/m^3					Japan 100 (daily) 200 (hourly)
Dust	μg/m^3					Japan 600
Noise	dB					Japan 70 (Daytime) 65 (Night time)
Vibration	dB					Japan 70 (Daytime) 65 (Night time)
Traffic Volume	No./ hour					-

*: Boundary between private and public/road areas

For sensitive areas (school, hospital and church), the limits shall be 60dB in daytime and 55 dB in nighttime for noise and vibration respectively.

－Maintenance of equipment by exhausted gas detector during construction

Item	Equipment 1	Equipment 2		Standards
NOx				
CO				

－Dust suppression plan during construction

Item	Confirmation	Standards
Accesses		Spray of water 5 times daily in dry season
Stock piles		Water spray/covering with
Earth transport lorries		Covering with tarpaulin and prohibiting overloading

－Water quality (environmental water around the site during construction)

Item		Unit	200m downstream from Nile Bridge	200m upstream of Nile Bridge	Well at the site	Standards
Hand held type - simple monitoring every month during construction	pH	-				6.5-8.5
	Turbidity	NTU				<5 NTU
	Electric Conductivity (EC)	μS/cm				<2000 (Environmental Protection Agency, USA)
	Dissolved Oxygen DO	mg/L				>2 (Japan)
Sampling and laboratory analysis 1-2 times before and during construction, and 2 years after construction	SS	mg/m^3				<50 or <100 (Japan)
	Coliform	group/100mL				Not detected
	Oil	mg/L				0.5mg/L (Japan)

－Control of muddy water/excavated river bed material during construction

Item	Situation
Installation of sediment ponds/tanks	
Approximate volumes of liquids brought in ponds/tank	
Sedimentation control	

－Waste management during construction

Item	Situation
Date of collection, types of waste (solid/liquid), volume/weight, etc.	

－Vegetation of the embankment slope during construction

Item	Situation
Date of seeding, area, growth condition	
Area covered	

3. Health and Safety During Construction

Item	Situation
Records of safety/health activities, accident reports	
Record of clinic activities and number of patients	

4. Social Environment

－Involuntary Resettlement

Item	Situation
Sample interviews about resettlement activities implemented (census, asset inventory, contract, payment, relocation site preparation, private assets transportation) per every three months in 2012. 4 times in total for 2012.	

－Life and Livelihood Levels

Item	Situation
Sample interviews about occupation, income, education and integration with surrounding communities in 1 time in 2013 and 2014 respectively	

Table 1-3-7 Environmental Check Lists for Roads

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1. Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) Y	(a) Preparing and to be submitted on October to MOE (b) - (c) - (d) Waste is dumped at authorized site. Soils/rocks are to be bought from licensed developer. As for river water sampling, the proponent will get necessary approval.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) More than 5 times of public meetings and door to door interviews of 200 households were implemented from 2010 and project consent was obtained. (b) The proponent agreed with requests from illegal residents for the provision of cheap land, house compensation and transportation of private effects although such compensations are not specified in the law.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) The site is the area where development is most urgently required and, within that area, the most socially and economically feasible route has been chosen.
2. Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) Y (b) N	(a) Although air pollution complies with the international standards in 2015, it may not in 2025. Before 2025, the urban road network will be improved and traffic congestion will be relieved with less emission. (b) No industrial area in Juba that can affect air quality
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a) Y (b) N (c) Y	(a) There is no cut portion. Fill near the river is protected from erosion, Muddy water is once pooled in sediment ponds/tank before discharged to the river. (b) Groundwater can be contaminated by inflow of muddy water through outcropped rock, into the ground. However there is no well at the out crop area. (c) Liquid waste from workers camp is dumped at the official dumping site.
	(3) Wastes	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in	(a) Y	(a) Solid waste generated from the workers, camp will be properly dumped at the official dumping site

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		accordance with the country's regulations?		
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle traffic comply with the country's standards?	(a) Y	(a) It could become greater than standard during construction in the area facing the road. Monitoring will be implemented and noise prevention barrier will be installed if necessary.
3. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) -
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (nonnative invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) N (d) N (e) N (f) N	(a) - (b) - (c) - (d) - (e) - (f) -
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a) -
	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) Based on the results of boring, the ground is confirmed to be generally firm. Soil slope failure will not occur since the excavation will be made with proper slope angles and depths. (b) Excavation in the river will be done surrounded be steel pipe pile walls. (c) The slope of pier excavation on land will be protected.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4. Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	Replies to questions (a) through (j) are detailed in RAP. The following outlines the replies: (a) The route is chosen with least number of households to be moved so far it is technically and economically feasible. (b) It will be explained when the compensation policies have been finalized. (c) Value Assessment, Compensation and Resettlement Committee (VACRC) is established and census, assets survey, market price survey will be implemented. (d) Payment is scheduled before relocation. (e) They are indicated in the entitlement matrix. (f) Food and medical care cost (1 month income) is provided for vulnerable group. (g) Presently one household is reluctant for relocation, but persuasion is continued. (h) New committees will be established and the proponent will secure enough budget for compensation. (i) Both internal and external monitoring will be implemented (j) Grievance committee will include the chief/representative of the affected tribe.
	(2) Living and Livelihood	(a) Where roads are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any possibility that roads will impede the movement	(a) Y (b) Y (c) Y (d) Y (e) N (f) Y	(a) Shop keeper who loses shop is provided with shop loss allowance. Farmers, who lost farm are provided alternative farm lands or replacement cost. (b) Residents who may lose their job are employed at the construction site with priority. (c) Provision of safety goods and prevention campaigns are planned. (d) Special care will be taken at intersections with new access and existing route, sign boards will be installed and design will consider improving visibility in the area. (e) The traffic volume is several cars only per minute, until 2015, which does not cause much disruption to cross the road. After that, other roads will be developed and the road traffic will not be drastically increase. (f) Due to the presence of overhead bridge, some of the farmland will be under the shadow and such area is will be fully compensated.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		of inhabitants? (f) Is there any possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?		
4. Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) Y	(a) -
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) Slope of embankment will be covered with grass/sodding to create a green landscape
	(5) Ethnic Minorities and Indigenous People	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous people? (b) Are all of the rights of ethnic minorities and indigenous people in relation to land and resources respected?	(a) Y (b) Y	(a) Integration of host community and relocated community is planned. (b) For the integration promotion, wells are provided not to affect the present use of wells by host community.
	(6) Working Environment	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project do not violate the safety of other individuals involved or the local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Compliance with the law is the first priority policy in EMP. (b) Health and safety for employees and residents are planned properly and secured. (c) Safety education, including how to use safety equipment and how to behave in emergency case, are to be implemented (d) Security guard will be chosen after his background is sufficiently checked.
5. Others	(1) Impacts During Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) Y (b) N (c) N	(a) Monthly meeting will be held to monitor the complaints about construction. Based on the meeting, mitigation measures are taken when necessary. (b) Impact to ecosystem is negligible and, for improvement of landscape, the vegetation on the embankment slope is promoted (c) Impact can be considered to be mitigated and public meeting is continued.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) N (d) Y	(a) The contractor implements monitoring under the supervision of the proponent. (b) Scheduled before, during and after construction for air pollution, noise and vibration, water pollution and social conditions of affected people as indicated in the monitoring plan of EIA. (c) Only one specialist is available but without any equipment. However proponent is going to request enough budget to fulfill the requirement of JICA Environmental and Social Considerations Guidelines as much possible. (d) Every month the monitoring report is submitted to JICA
6. Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) N (b) N	(a) No forest at the site. (b) -
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	Prediction of emission of CO2 was implemented for year 2015 and 2025 respectively and the results indicated that the emission amounts will be halved by the implementation of the project in 2015 and 2025 respectively

1) Regarding the term “Country's Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.
3) - : Not Applicable/Not Relevant.

1-3-2 Social Consideration Survey

The social environment survey was conducted in accordance with the policies and guidelines of JICA and the World Bank Safeguard Policy OP.4.12 “Involuntary Resettlement”. The results of the survey are discussed in what follows.

(1) Socio-economic Survey of Residents Around the Proposed Route

A socioeconomic survey was implemented to about 200 households in the Lologo community on the west bank and Gumbo Community on the east bank (see **Table 1-3-8**). As a result, the land at the proposed site is originally a community land of the Bari tribe, but thru the demarcation by the government and the occupation by the returnees (soldiers/IDPs), the ancestral land area became narrower. Moreover, due to the influx of returned soldiers and other tribal group, the ratio of the Bari households dropped down to 30% of total households in the community. In addition, the land titles of other 70 % households of non Bari occupants are not confirmed. Residents are, on average, doe not reach Grade 6 (Primary School) education level and stay in simple thatch roofed and mud walled houses. The average number of one household is as high as 9 members or more. There is no public electricity or pipeline water network and residents get water from either well, river or water tank lorry. Next to Malaria, water borne diseases are prevailing.

The planned route is at sufficient distance from important social facilities such as churches, schools, clinics and wells/hand pumps. However, the route passes through an unknown cemetery and relocation of police tents are necessary. **Figure 1-3-4** shows the land use and local resources utilization while **Figure 1-3-5** shows the locations of social and public services and daily activities in the area.

Table 1-3-8 Outline of Socioeconomic Features of Residents on East and West Banks

Item	Description
1. Constitutions of Land Tribes	The whole land area on both banks of the river used to be a community land of Bari. However, at present, the west side of Lologo Street is a private land demarcated by the government and river bank is privatized, while the east side is still community land. 70% of the residents at west side is not Bari, therefore many other tribes live in the site. Returned soldiers occupy 25% of the householders.
2. Family	85% of interviewed households are led by male. They are 41 years old on average and most are only primary school graduates while 28% replied they had no education at all. The average family members are 8.5, 4 of them go to school while 3 of them go to work.
3. Occupation and Income	On the west bank, primary occupations are soldiers/police while secondary is business. The income/salary range is SSP 500-800 per month with SSP 750 as the average. Fisherman's income is very cheap at only SSP 150 while engineer's income is high at SSP 1,000. On the east bank, half of the residents are farmers.
4. Types of House	Most of the residential houses are of mud-walled and corrugated galvanized iron roofed houses with floor areas less than $30m^2$(5mX6m). There is earth floor. Shops are usually of corrugated galvanized iron sheets.
5. Household Effect	Since there is no power source, they do not have electronic devices except battery-operated radio and mobile phones. Every houses uses neem as medicine.
6. Water	Water is obtained from well, river or delivered by lorry (pumping up from river). They have chlorine disinfection for intake. The well water cost is SSP 1 for 4 liters while lorry water is SSP 5 for 200 liters. Many families consume 200 liters per day.
7. Origin of Residents	65% answered they are original residents, whose ancestors had been lived in same place and most of them are Bari. 28% are returned soldiers, most of them returned after CPA was concluded in 2005. All the residents of east side answered they are original residents. Bari people can be called the original residents, on the other hand, however, the others are assumed as inflows.
8. Land Title	Land occupation is defined as having land title for private land, or having approval of occupation from the head of their own community for community land. Community land must not sell or rent to the other tribes. 70% of the households responded that they own the land, 40% of which mentioned that they inherit the land from the ancestors. However, considering that only half (of the 40%) belong to Bari tribe in the community only 20% could inherit the land and since the rest are non-Bari people they could not have inherited the land or borrow it from the community. Therefore, the percentage of the households that could own the land or allowed to stay formally is more or less 50%.
9. Satisfaction to Social Service/Infrastructure	They are happy with present social services and infrastructures.
10. Social Welfare	One householder received social welfare (cash).
11. Neighbors	Most replied they go well with their neighbors
12. Commuting	Commuters travel about 5-10km everyday. Most of them think about commuting fee is expensive.
13. Perception About the Project	97% agree with the Project and ready for relocation. They believe there will be working opportunities, development of the village and improvement of traffic situation, but 40% are also concerned about water and air pollution and 90% are concerned about resettlement.
14. Gender Issues	Many householders have several wives therefore the average numbers of family member is nine. 85% of household are men but the gap of payment between man and woman is not much high except police.
15. Children's Right	Young people voluntarily teach reading, writing and math to children less than 10 years old under the tree in the community. Children's role is important by bringing water and bricks.

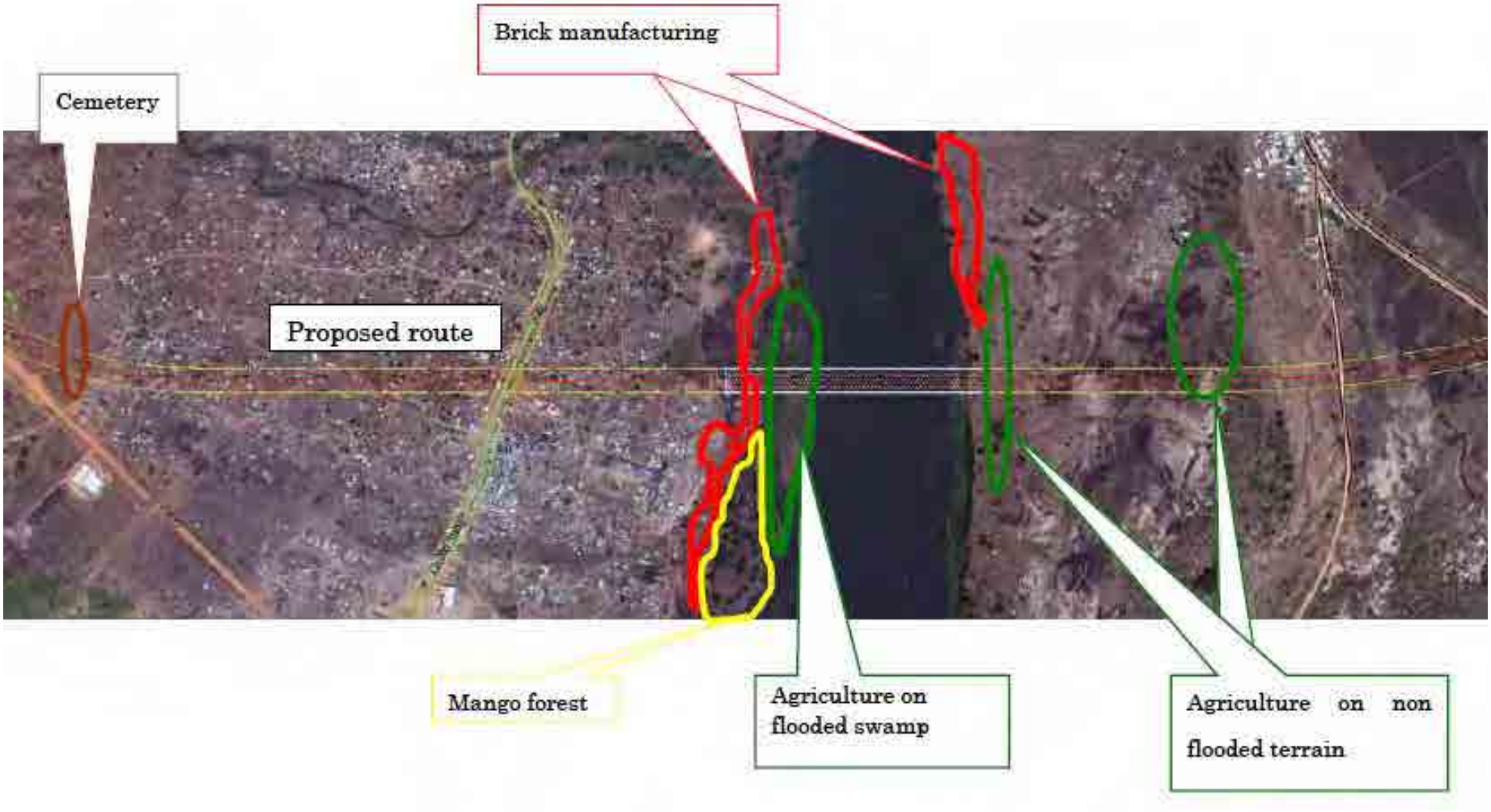


Figure 1-3-4 Land Use and Local Resources Utilization

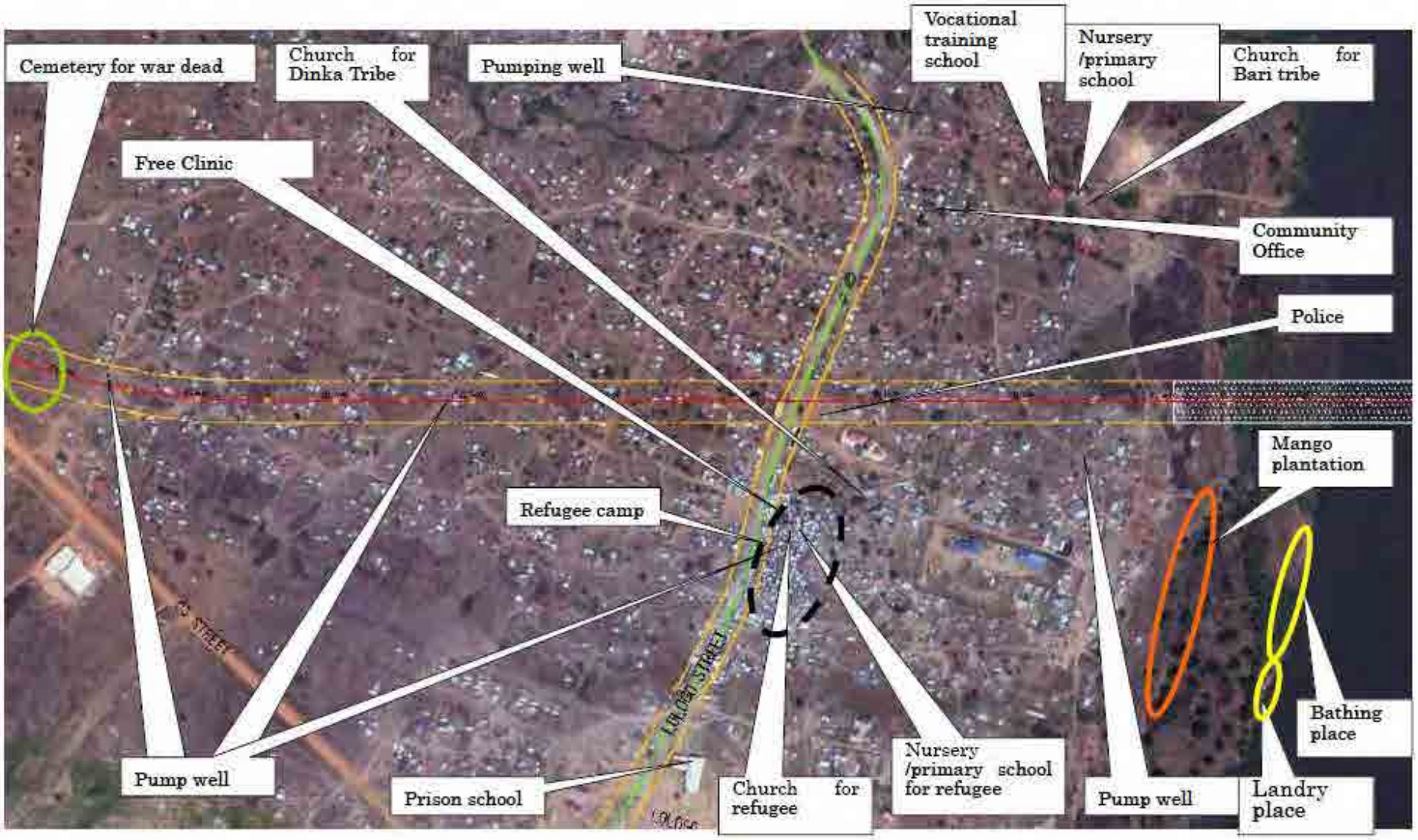


Figure 1-3-5 Location of Social/Public Services and Daily Activities

(2) Census of Residents within the 30m ROW

There are about 80 households affected by the project during the survey, 79 of which are accounted for in the west bank. The land title certificates were checked and about 80% of the householders could not confirm their deed of ownership, as shown in **Table 1-3-9** below.

Table 1-3-9 Status of Land Titles of Project Affected Household

Items		
Location: Rajaf Payam, Juba		
Land Type: Residential/Agricultural/Open Land		
No. of affected households (AH) excluding police station		80 (100%)
Formal land title holder*	With document confirmed	16(20%)
Quasi-formal land title holder*	Verbally approved by community head	3 (4%)
Title not confirmed**	Document could not be presented, including empty houses	27 (34%)
	Informal Settlers	34 (42%)
Police station		1
House head with age >60 years old		1
House head widowed		4
House head disabled		1
Tenant		14
Shop/stall		6
Empty house/plot/unoccupied/demolished		7
Absent at the time of interview		7

Note: * With Legal Rights ** Without Legal Rights

Table 1-3-10 Opinion About Relocation (Affected Householders)

Request for Relocation	Response %	Reasons
Any place is OK	11	To follow government's decision; Cooperate with project
Nearby place	80	If moved far away, they are afraid to lose: - School, good neighbors - Lologo is comfortable to live - Satisfactory present life level
Want to move to Gumbo	4	- No money
Don't want to move	2	- Don't know any other place
No reply	3	- Absent during interview

(3) Asset Survey Results

Asset inventory was conducted within the 30m ROW which includes houses, fences, trees, farmland and cemetery. The affected assets include 150,000m^2 of land, 130 units of houses and sheds (4,000m^2 floor area), 200 trees and 12,000m^2 of farmland.

(4) Legal Issues

The land law in South Sudan may not be as effective when it comes to community involvement, compensation at market price, provision of land for the landless and compensation at government fixed price.

Table 1-3-11 Policy Gap

	Items	JICA Guidelines for Environmental and Social Considerations	Safeguard Policies – Operation Policy (OP) 4.12/OP Annex	Government of the Republic of Southern Sudan Law (Land Act 2009)	Gap	Response Policies in this Project (draft)
0.	General	Loss of livelihood and involuntary resettlement shall endeavor to avoid considering every possible way. If avoidance is not possible even after such a study is conducted to minimize the impact, effective measures shall be taken in order to compensate for losses agreements reached on the subject.	Section OP para.2 Involuntary resettlement is avoided wherever possible, and should be minimized through project design that considers a viable alternative if not all. If it is impossible to avoid relocation, a sustainable development programs to transfer the activities and invest sufficient resources allotted to allow residents to benefit from the project due to relocation. Meaningful consultation with residents in line with relocation. They should provide opportunities to participate in planning and conducting the relocation program for relocated residents. Section OP6 The Borrower will prepare a relocation plan.	Section 72 (1) Obligation to prepare a resettlement plan (2) IDP (internally-displaced people) to participate in formulating the RAP (3) IDP / people must be restored after the transfer or living condition increases.	Detail of RAP for project affected persons is not clearly indicated.. There is no policy about compensation/assis-tances for the involuntary resettlement.	Resettlement policy is established in this RAP
1.	Information, public participation and consultation	Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of involuntary resettlement plans and measures against the loss of their means of livelihood.	Section OP para.6 (a) 1) Information pertaining to the selection and transfer of rights 2 R) consultation recommended with the relocated residents. Section OP para.13 (a) The relocation, relocation communities, community planning and acceptance with the full consultation. Can participate in the execution.	Section 74 (1) land acquisition plan will be in consultation with individual communities	No Gap. Secure the implementation.	Public Consultation and small Group discussion conducted
2.	Compensation with replacement cost	Persons affected by the loss of livelihood and involuntary resettlement and adequate compensation must be given appropriate time by the project proponent	Section OP para.6 (a) 2) consulted on, offered choices among, and provided with technically and economically feasible resettlement alternatives; and 3) provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project. Section Annex10 Land acquisition price calculation method Annex A.11 Resettlement measures. A description of the	Section 75 (2) Compensation shall be provided after the agreed cash or substitutes. (3) If the relocation of the occupants of the land community to pay the agreed	(1) The reality is that there is a gap, which the government fixed price is set very low price than the market. (2) Unknown shop houses on farm	To follow Section 75 word to word. Cash compensation shall be given for the structures/houses of the affected persons while land shall be given in exchange for the loss land designated by the RSS. All trees shall be

	Items	JICA Guidelines for Environmental and Social Considerations	Safeguard Policies – Operation Policy (OP) 4.12/OP Annex	Government of the Republic of Southern Sudan Law (Land Act 2009)	Gap	Response Policies in this Project (draft)
			package of compensation and other resettlement measures that will assist each category of eligible displaced persons to the objectives of the policy (see OP4.12 para.6). In addition to being technically and economically feasible, the resettlement packages should be compatible with the cultural performance of the displaced persons, and prepared in consultation with them.	amount (taking into account market value compensation) Fruit Forest Act for compensation regardless of the type in Section 6.18 (papaya banana without compensation)	(3) animals banana and papaya are also compensated	compensated.
3	Livelihood and life levels	Project proponent must make efforts to enable people affected by the projects to improve their standard of living, income opportunities and production levels, or at least restore them to pre-project level. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing expenses necessary for relocation and the re-establishment of community at relocation site.	OP para.2 (c) Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever higher.	Not clear except IDP	Policy is not clear about livelihood and life levels	Provision of necessary compensations for both legal and illegal settlers shall be made to maintain the livelihood and life levels at least, together with other assistances.
4	Vulnerable group	Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to the decision-making processes within society.	OP para.8 To achieve the objectives of this policy, particular attention is paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, indigenous peoples, ethnic minorities, or other displaced persons who may not be protected through national land compensation legislation.	Section 87 An alternative land may be provided to unlawful land occupant when eviction is initiated.	Treatment of these vulnerable groups is not clear.	Allowance for vulnerable group is proposed.
5	Grievance redressing		Annex A.17 Grievance Procedure. Affordable and accessible	Section 75. Grievance due to land	The role of land committee in	The, Grievance Redressing Committee

	Items	JICA Guidelines for Environmental and Social Considerations	Safeguard Policies – Operation Policy (OP) 4.12/OP Annex	Government of the Republic of Southern Sudan Law (Land Act 2009)	Gap	Response Policies in this Project (draft)
			procedures for third-party settlement of disputes arising from resettlement: such grievance mechanisms should take into account the availability of judicial recourse and community and traditional dispute settlement mechanisms.	acquisition is filed to the land committee.	resettlement activities is not clear.	(GRC) easily accessible and fairy treated for all affected people is established
6	Monitoring	The internal monitoring by the project proponent and the external monitoring by the third party shall be implemented to review, modify and disclose the resettlement activities	Annex A.21 Monitoring and evaluation. Arrangements for monitoring of resettlement activities by the implementing agency, supplemented by independent monitors as considered appropriate by the Bank, to ensure complete and objective information: performance monitoring indicators to measure inputs, outputs, and outcomes for resettlement activities: involvement of the displaced persons in the monitoring process: evaluation of the impact of resettlement for a reasonable period after all resettlement and related development activities have been complete; using the results of resettlement monitoring to guide subsequent implementation.	Not specified	Necessity of internal and external monitoring is not clear.	Internal monitoring by the proponent under the Inter-Ministry Committee is to be established and external monitoring by a third party is to be organized by MRB and the results will be disclosed.
7	Relocation site		Annex A.13 Housing, infrastructure, and social services. Plans to provide (or to finance resettlers' provision of) housing, infrastructure (e.g., water supply, feeder roads), and social services (e.g., schools, health services): plans to ensure comparable services to host populations: any necessary site development, engineering, and architectural designs for these facilities.	Not specified	Provision of same quality relocation site is lacking	To maintain the life level, MRB will prepare the site for relocation with sufficient well/water source for the relocated families. Afterward, necessary infrastructure is provided.. In this view, the land plot is sold to illegal settlers with affordable price and payment system
8	Eligibility		Criteria for Eligibility. Displaced person may be classified in one of the following three groups: a. Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country) b. Those who do not have formal legal rights to	Compensation is made to those either (a) possessing with formal land title or (b) verbally approved by the communities to	Any compensation is not made to (c) who are not recognized either (a) title holder or (b) verbally approved.	Same compensation shall be made at least for their assets (houses, trees) except land that does not belong to them.

	Items	JICA Guidelines for Environmental and Social Considerations	Safeguard Policies – Operation Policy (OP) 4.12/OP Annex	Government of the Republic of Southern Sudan Law (Land Act 2009)	Gap	Response Policies in this Project (draft)
			land at the time the census begins but have a claim to such land or assets-provided that such claims are recognized under the laws of the country or becomes recognized through process identified in the resettlement plan (see Annex A, para.7(f)); and c. Theses who have no recognizable legal right or claim to the land they are occupying.	occupy that land		

Resettlement Implementation Organization

An Inter-Ministry Committee for the Nile River Bridge project was formed under the leadership of the MRB with sub-committees on Value Assessment, Compensation and Resettlement Committee (VACRC), Redress and Grievance Committee and Internal Monitoring Committee established with members from different Ministries, Community, Tribes, etc.

(5) Method of Compensation Support

Compensation, depending on the legal rights of the project affected persons (PAP), shall be paid in terms of monetary compensation or equivalent alternatives (see **Table 1-3-12**). The assistance for the PAPs shall follow JICA's guideline on maintaining or making better the level of existing living condition at the pre-project stage.

Table 1-3-12 Entitlement Matrix

Item		Legal residents(1)	Illegal residents	Responsible Agency
Land	Residential land	Provision of alternative land at nearby place in community. (<300 Lots)	* Cash compensation for cost of affected structures(2) * Identify relocation site for squatters with an affordable payment system(3) * Option to be included in the UN Habitat Program for resettling squatters(4).	MRB/ MOPI /Payam
	Agricultural land	Replacement cost compensation or provision of alternative land		
Assets	House	Replacement cost compensation (SSP 250/m^2 for mud house and 500/m^2 for galvanized house)		MRB/ MOPI
	Fence			
	Tree	SSP 500 (Neem) – 30,000 (Mango) /tree, (200 trees of Neem mostly)		
	Crop	SSP 1.4/m^2 x 2 seasons/year x 2 years, (12,500m^2)		
Other Losses and Assistance	Disturbance allowance during relocation	2 months income (SSP 750/mo x 2 = 1,500), (80 HH)		MRB
	Business loss for shops during relocation (Shops)	2 months income (SSP 1,200/mo = 2,400), (6 Shops)		MRB
	Transportation of private effects	Provide means of transportation (vehicle/manpower), (80 HH)		MOPI/ MRB
	Employment Opportunity for PAPs	Prioritized employment at the construction site as unskilled worker with provision of on-job training as skilled workers.		MRB
	Assistance for Tenants	Assistance for compensation equivalent to 3 months' advanced rental fee (SSP 600/mo), (14 HH)		MRB
	Additional Assistance to vulnerable group (house heads of either widow, >60 years old or handicapped)	Provision of food and medical support for 1 month (SSP 750) (14 persons)		MRB

Remarks:

(1) Numbers of affected households shall be finalized by census done by MOPI/Payam and the compensation rates also may be revised later after formation of the Inter-Ministry Committee.

(2) The cash compensation amount will be finalized by the Inter-Ministry Committee to cover reasonable costs of the affected structure.

(3) The MOPI/Rajaf Payam will identify a relocation site with a price and payment system to be agreed upon with the Inter-Ministry Committee. E.g. at Tokiman West Relocation Site, the squatters will pay the SSP 700 for acquiring the lots at SSP 35 for 20 months.

(4) UN Habitat Program includes following provisions:
- Technique, material and machine for construction of houses
- Microcredit

(6) Relocation Sites

There are four (4) candidates for relocation sites, as follows:

Table 1-3-13 Candidate Relocation Sites

Location	Affected Persons		In-charge	Distance from Ministry Compound (km)
	Legal	Illegal		
Inside Community	Accepted	Not Accepted	Payam	5
Jandoro Relocation Site	Accepted	Accepted	Payam	7
Tokiman West Relocation Site	Accepted	Accepted	MOPI	6
Derupi Relocation Site	Accepted	Accepted	MOPI	8

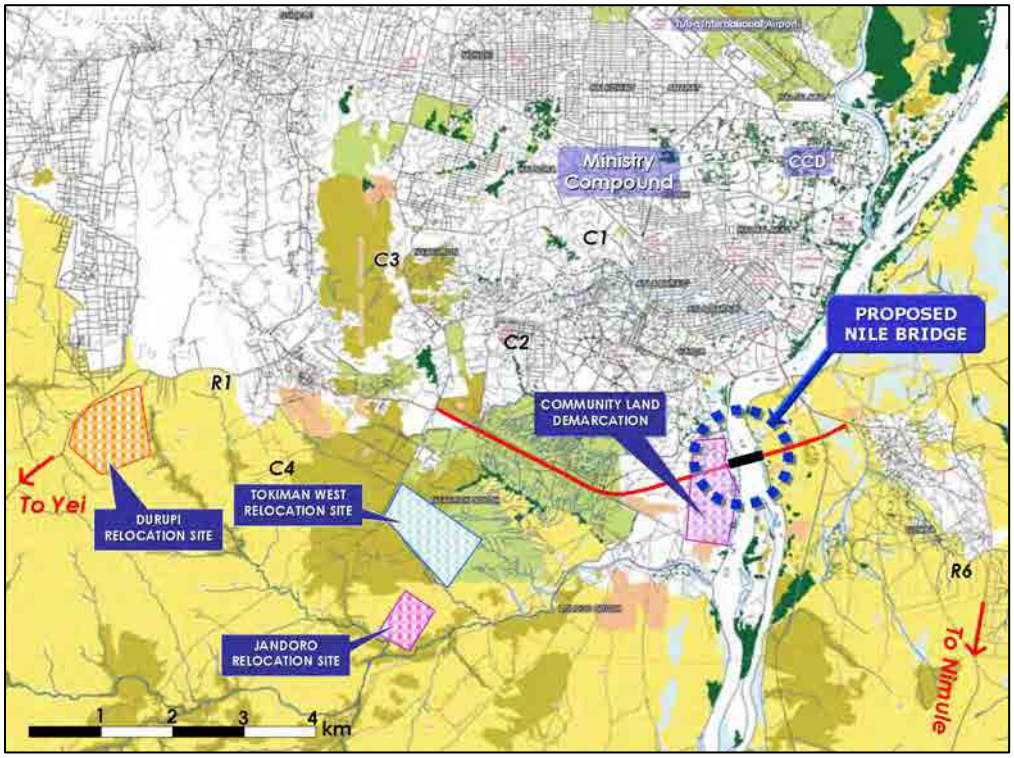


Figure 1-3-6 Possible Relocation Sites

The most probable relocation site is the Tokiman West Relocation Site as shown in **Figure 1-3-6** where MRB plans to supply wells and prepare the access roads. The existing road is typical of the earth roads found in the outskirts of Juba city which is expected to be improved during land readjustment (although access to the city is available and relocation can be done any time). Survey demarcations have been completed in this site.

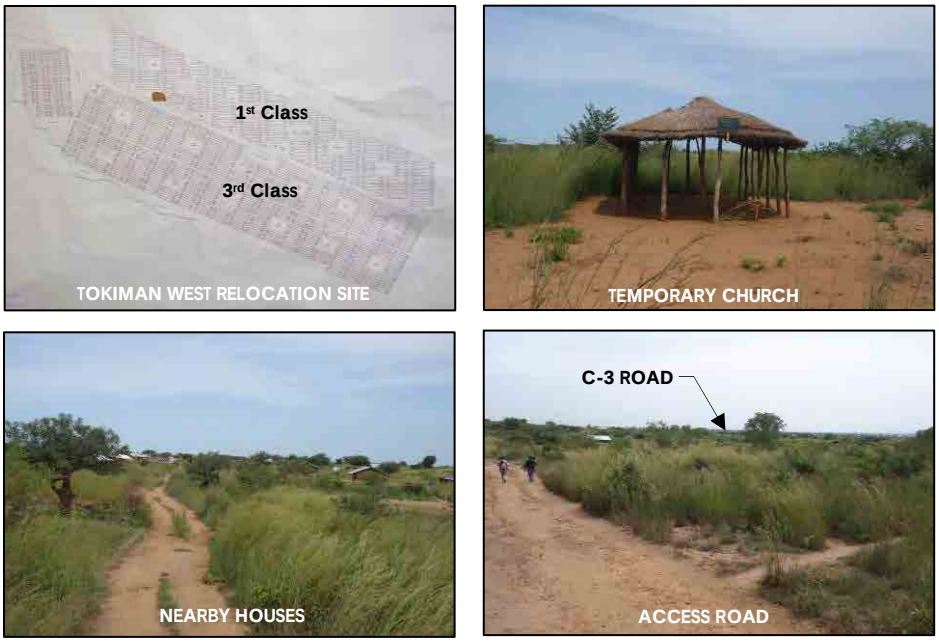


Photo 1-3-1 Tokiman West Relocation Site and Nearby Areas

(7) Community Participation

The scope of the project together with the relocation compensation policy were discussed during the community stakeholders meetings with opinions and requests from the affected persons reflected in the resettlement plan including relocation and transfer.

Table 1-3-14 Public Consultations

No.	Title	Content	Attendees	Date Conducted (Proposed)
1	The 1st Stakeholders Meeting	(e) Explanation of the project	MOPI, MOE, Rajaf Payam, UNHCR	11/9/2010
2	The 2nd Stakeholders Meeting	(f) Explanation of TOR for EIA and RAP	Payam, Paramount Chief, Community	15/12/2010
3	Group discussion (Site meeting)	(g) Compensation for farmland	Payam, Rajaf Farmers	24-25/2/2011
4	The 3rd Stakeholders Meeting	(h) Declaration of Cut-off-day	MOPI, MOE, Rajaf Payam, Community	27/2/2011
5	Joint Site Survey	(i) Site reconnaissance	MOPI, MOE, Rajaf Payam, Community	2-4/3/2011
6	The 4th Stakeholder Meeting	(j) Meeting especially for Gumbo PAPs	Community	17/3/2011
7	The 5th Stakeholders Meeting	(k) Explanation of progress of study	MOPI, MOE, Rajaf Payam	24/3/2011
8	Inter-Ministry Committee (IMC) Kick-off Meeting (see Appendix D)	(l) Organizing the IMC	MRB, MOPI, MOE, Land Commission, Gumbo Community Leader, Lologo Community, Juba County Commissioner, Rajaf Payam, Village Development Committee, JICA, UN Habitat, and Consultants (CTII, LBG,USAID)	15/09/2011
9	The 2nd IMC Meeting	(m) Explanation of draft EIA and RAP	MRB, MOPI, MOE	28/10/2011
10	The 3rd IMC Meeting	(n) Organizing Sub-committees of IMC	MRB, MOPI, MOE, Rajaf Payam, Village Development	15/11/2011

No.	Title	Content	Attendees	Date Conducted (Proposed)
			Committee, JICA, UN Habitat and Consultants (CTII)	
11	The 4th IMC Meeting	(o) Explanation of compensation payment (p) Explanation of resettlement policy	MRB,MOPI, Rajaf Payam, Communities, Consultants (CTII)	19/12/2011
12	The 5th IMC Meeting	(q) Explanation of compensation payment	MRB, MOPI, Rajaf Payam, Communities, Consultants (CTII)	22/12/2011
13	The 6th IMC meeting	(r) Explanation of compensation payment	MRB, MOPI, Rajaf Payam, Communities, Consultants (CTII)	10/1/2012
14	The 6th stakeholders meeting	(s) Explanation of resettlement policy and implementation schedule	MRB, MOPI, Rajaf Payam Communities Consultants (CTII)	21/1/2012
15	Group discussion	(t) For vulnerable group	MRB, MOPI, Consultants (CTII)	21/1/2012
16	The 7th IMC meeting	(u) Discussion on relocation site	MRB, MOPI, Rajaf Payam Communities Consultants (CTII)	25/1/12012
17	The 7th stakeholders meeting	(v) Explanation of compensation payment	MOPI, Rajaf Payam, Communities and Affected People	4/2/2012
18	-ditto-	(w) For compensation payment	-ditto-	(Feb 2012)
19	-ditto-	(x) For relocation of titled PAPs	-ditto-	(Feb2012)
20	-ditto-	(y) For relocation of non titled PAPs	-ditto-	(Feb 2012)
21	Group Discussion	(z) For vulnerable group	Small number	(Any time when concerns are raised)

(8) Grievance Mechanism

A Grievance Committee is established with residents from the community, the tribes and legal and illegal affected persons represented to ensure fair and unbiased ruling on complaints.

(9) Resettlement Cost and Budget

The unit costs of compensation is not yet finalized at this stage (the Inter-Ministry Sub-committee VACRC will finalize compensation) but the initial estimate of resettlement compensation amounts to SSP2.45 million, as detailed in **Table 1-3-15**. The government, thru MRB allocated a budget of SSP10 million that will cover the entire expenses of ROW acquisition, preparation and resettlement.

Table 1-3-15 Estimated Resettlement Costs

Pariculars	Unit price	Unit	Quantity	Unit	Subtotal, SSP
1. Land Area			*49,536*	m^2	*389,513*
West bank (Lologo)			*6,785*		*264,500*
Community Residential Land at East of Lologo St. (20mx20m)[a)]	700.0	SSP/lot	70	lots	49,000
Alternative for Demarcated Residential Land at West Side of Lologo St. (20mx20m)[a)]	700.0	SSP/lot	215	lots	150,500
Lologo Agricultural Land[b)]	10.0	SSP/m^2	6,500	m^2	65,000
East bank (Gumbo)			*42,751*		*125,013*
Community Residential Land (20mx20m)[a)]	700.0	SSP/lot	1	lot	700
Community Land Other than Agriculture[c)]	1.75	SSP/m^2	36,750	m^2	64,313
Gumbo Agricultural Land[b)]	10.0	SSP/m^2	6,000	m^2	60,000
2. Buildings (Formal and Informal Settlers)					*1,410,750*
Mud house	250	SSP/m^2	3,244	m^2	811,000
Galvanized house	500	SSP/m^2	39	m^2	19,500
Concrete house	2,000	SSP/m^2	258	m^2	516,000
Fence	50	SSP/m	1,285	m	64,250
3. Crops			*12,500*		*70,000*
West bank					
Lologo Agricultural Land (SSP1.4/season x 2 seasons x 2 years)	5.6	SSP/m2	6,500	m^2	36,400
East bank (Gumbo)					
Gumbo Agricultural Land (SSP1.4/season x 2 seasons x 2 years)	5.6	SSP/m2	6,000	m^2	33,600
4. Trees[d)]					*201,500*
Mango Trees	30,000	SSP/No	3	no	90,000
Banana	10,000	SSP/No	2	no	20,000
Other trees	500	SSP/No	183	no	91,500
5. Cemetery					*145,000*
Earth moving (Area = 60mx30m) x 2sites	37.5	SSP/m2	3,600	m^2	135,000
Ceremony	10,000.0	LS	1	LS	10,000
6. Disturbance Allowance					*120,000*
2 months income (SSP 750/mo)	1,500.0	SSP/HH	80	HH	120,000
7. Business loss					*14,400*
2 month income (SSP 1,200/mo)	2,400	SSP/Shop	6	Shop	14,400
8. Vulnerable allowance (aged, widowed, disabled, etc.)					*10,500*
1 month food and medical support (SSP 750/person)	750	SSP/Person	14	Person	10,500
9. Assistance to tenants					*8,400*
3 months advanced rental fee (SSP 200/mo)	600	SSP/HH	14	HH	8,400
10. Transportation of Private Effects					*80,000*
1 lot (SSP 1,000/HH)	1,000	SSP/HH	80	HH	80,000
Grand Total				*Total*	***2,450,063***

Notes:

[a)] The cost of land is based on the Tokiman West Relocation Site Cost managed by MOPI.

[b)] Agricultural land cost covers allotment of community land near the river with improvement for agricultural use (including foot pumps, with training on productive agriculture, etc.)

[c)] Cost covers only demarcation of replacement land.

[d)] Compensation for Trees are based on the price quotation of Ministry Forestry and Agriculture (CES).

[e)] Compensation for affected structures of informal settlers are included in Item 2 - Buildings.

(10) Implementation Schedule

The implementation schedule of resettlement activities is shown in **Table 1-3-16**.

Table 1-3-16 Implementation Schedule for Resettlement Activities

Activities	2011						2012								
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Implementing Agency															
1.RAP															
Submission of RAP Report to MOE			■ (Completed)												
MOE Approval of RAP Report				■ (Completed)											
2.Measures for Formal Settlers (Title Holders)															
Compensation Agreement						■	■	■							
Budget Approval								■							
Compensation Payment								■	■	■					
Confirmation of Relocation Site							■	■							
Completion of Resettlement (PAPs)												■			
3.Measures for Informal Settlers (Non-title Holders)															
Compensation Agreement						■	■	■							
Budget Approval								■							
Compensation Payment								■	■	■					
Preparation of Resettlement Site								■	■						
Resettlement Site IEE Preparation and Approval					■										
Training for House Construction								■	■						
Completion of Resettlement (PAPs)												■			
Construction of Houses									■	■	■				
Well Drilling											■				
4.Grievance Redressing					■	■	■	■	■	■	■	■	■		
5.Clearing of ROW												■			

As of October 2011, the following milestones were set by MRB:

- by the end of November 2011, to determine the compensation budget.
- by the end of December 2011, to determine the resettlement of relocated residents.
- by the end of January 2012, to start the compensation.
- by the end of June 2012, to complete the compensation and relocation.

(11) Monitoring

It will be necessary not only to monitor the on-going resettlement activities but also to monitor the recovery of livelihood of the affected persons after resettlement.

CHAPTER 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Project Goals and Objectives

The “South Sudan Development Plan 2011-2013” has four set of pillars focusing on “governance”, “economic development”, “social development and human development” and conflict prevention and security” as the four pillars of development. The policy objectives and priority programs were established for these pillars including “Governance” – administration and accountability, “Economic development” – infrastructure development, natural resources development and other important economic development, “Social Development and Human Development” – education and human capital, “Conflict Prevention and Security” – rule of law and security. Among these four pillars, the “economic development” and “conflict prevention and security” are related to this project.

The "Economic Development" pillar, with the goal of improving the living standards and poverty reduction through economic growth and sustainable development of a diversified private sector, has a priority policy to implement the development of the interstate highway network with asphalt paved road and to extend the distance of feeder roads by1,000 km. Moreover, the "Conflict Prevention and Security" has the policy objective of educing the risks of future crises and conflicts.

"Conflict prevention and security", on the other hand, has the policy objective of reducing risks of future crises and conflicts.

The overall goal of the project in anticipation of the above development plan is to develop a safe, efficient and sustainable road network in Juba City that supports and encourages the region’s economic growth, distribution of investments, consolidation of peace and reduction of poverty. Moreover, the project aims at providing a fix link over the Nile River which connects the Circumferential Road C-3 in Juba with South Sudan’s interstate and international highways thus promoting an efficient and smooth transport of goods and people.

2-1-2 Project Outline

In order to achieve the project objectives, a 560m reliable bridge is proposed to be built over the Nile River that has divided Juba into eastern and western sections. The new Nile River Bridge augments the traffic capacity of the existing Juba Bridge and forms a fix link in the circumferential road C-3 which promotes an optimal physical distribution and urban development in Juba. At present, the Juba-Nimule Road, linking South Sudan with Uganda and Kenya, is under construction on the western side of Juba under the support of the USAID and is expected to be completed in 2012. The new Nile River Bridge will directly connect this road to the center of Juba thus promoting a reliable transport of goods and people with the neighboring countries in the south. Moreover, with the completion of the new Nile Bridge, it is expected that the east-west and north-

south connections with neighboring countries including Ethiopia, Kenya, Uganda, Central African Republic and Congo will become smooth and more efficient.

The new Nile River Bridge construction covers a two-lane bridge and a 3.665km two-lane approach road to form part of the circumferential C-3 road connecting the Juba-Nimule Road and the Juba-Yei-Kaya Road. In partnership with the local government, who is responsible for the construction of the pavement structure of the approach road, the construction of the new Nile River Bridge will pave the way for the development of transport lifeline infrastructure in Southern Sudan.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Request from Recipient Country

Date of Request : December 2009
Amount Requested : Yen 70.4 billion
Content of Request : Construction of facility (new Nile Bridge: 560m, Construction Road: 3.9km)

2-2-1-2 Scope of Cooperation Project

(1) Project Scope

The Government of Japan decided to undertake the preparatory survey for this project based on the request of the Republic of South Sudan for a grant aid construct a new bridge over the Nile River 2009 .

The major scope of the project was confirmed during the preparatory survey including the location of the bridge, the roads alignment (construction road), bridge type and configuration, environmental assessment and existing natural conditions. In consultation with the South Sudan, the main content of the request for grant aid of Japan has been finally confirmed as follows:

- Construction of 560m two-lane bridge (with sidewalk on one side)
- Construction of 50m paved approach road on either side of the bridge

(2) Bridge Location and Construction Road Standard

The new Nile River bridge shall be built in order to facilitate the development and improve transport distribution in the city, considering the approach road connection point with the Juba-Nimule road that is currently under construction and bearing in mind to minimize the negative impact to natural and social environment. In addition, the 50m of the approach at the abutments shall have cement concrete pavement finish with the remainder of the approach road prepared as temporary construction road with gravel structure. The design speed shall be 60 km/hr.

(3) Bridge Length

The bridge length, measured as the distance between the abutments on both banks of the river, is decided based on the position of the abutments. The abutment position is decided considering the shape and stability of the river banks.

(4) Number of Traffic Lanes

The number of traffic lanes of the bridge is determined by considering the projected volume of traffic that passes through the new Nile Bridge. Based on the preliminary traffic demand projection, the new bridge requires four lanes after year 2025, but the present demand indicates the necessity of only a two-lane bridge. Since a similar 2-lane bridge will be constructed in the future to complete the 4-lane bridge, the sidewalk is provided only on one side of the bridge.

(5) Bridge Type

Since the width of the Nile River at the propose location of the bridge is about 400m ~ 500m, which is similar to the proposed bridge length, the bridge type and shape is then decided considering minimum construction cost and negative impact to environment. The following presents the basic configuration of the proposed bridge:

- Main Bridge Configuration
  - 4 Span Steel Tied Arch (Langer Arch) – 87.5m Spans
  - Steel Pipe Sheet Pile Foundation
- Approach Bridge Configuration
  - Steel I-Girder with Concrete Deck Bridge (30m Spans)
  - RC Bored Pile Foundation

2-2-1-3 Policy on Natural Condition

The design that reflects the existing natural conditions of the site is a very important factor that directly affects the safety and size of the structure. The following natural conditions are considered and reflected in the design as a policy:

- Weather conditions set the process and planning for construction implementation.
- Planning for bridge type selection and design and construction including location of abutments, piers and slope protection shall be based on the river discharge and river cross-section, river bed condition, site terrain and topography, maximum flood discharge and flood high water level, and environmental considerations.
- Planning for bridge foundation type selection and design and construction shall be based on the site topography and geological conditions, depth of bearing layer and estimated bearing capacity.
- Earthquake conditions shall be reflected in the type of substructure and the scale of foundations.

In determining the type and size of the bridge, the policies on the major planning items including river discharge, flood high water level, foundation bearing layer and seismic effect shall be as follows:

Policy on Planning the Design Discharge and High Water Level

- To comply with Sudan's standard for high water level with 100-year return period
- The proposed new Nile River Bridge is downstream of Uganda's Owen Dam where data on river discharge is accumulated. The basis of river discharge analysis in the upstream side of the proposed bridge site is taken at 40km downstream of the Owen Dam at Mbulamuti where discharge data has been accumulated for 37 years from 1957 to 2007. The proposed bridge site is part of the area with an annual rainfall between 1,000mm to 1,400mm and is similar in rainfall characteristics with the Owen Dam site. In this regard following such rainfall record, the maximum river discharge is calculated using the Gumbel Plot based on the annual maximum discharge.
- The design flood water level at the proposed bridge site is taken from the water height-discharge curve (H-Q Curve) developed on the basis of the river survey.
- The span length and freeboard height from the design flood level is decided based on the requirements of the "Japan Guidelines for River Control Facilities and Management". The minimum span length is calculated by L = 0.005Q (where L is the span length in m and Q is the river discharge in m^3/s) and the minimum freeboard taken from the table below, based on the Japanese Guidelines.

Design Discharge (m^3/s)	500 – 2,000	>2,000 – 5,000	>5,000 – 10,000	>10,000
Minimum Freeboard (m)	**1.0**	**1.2**	**1.5**	**2.0**

Source: Japan River Facility Construction Ordinance.

Policy on Determining the Bearing Layer

- The bridge foundation level shall be at soil strata with the standard penetration test N-values from 30 to 50 or more for granular soil (sand and gravel) and more than 20 for clay soil.
- For the case of sand and gravel layer, the foundation depth shall be carefully considered, including the structure size, due to the possibility of scouring at the pier footing (foundation layer is not simply decided by N-value of 30).

The rock strata supporting layer is expected to change significantly over the span of the bridge especially at relatively shallow layer (the rock strata shown in **Figure 2-2-1** is assumed based on the borehole data obtained during the geotechnical investigation). Considering such variation in the depth of the supporting rock strata, changes in the scope of work may occur (such as possibility of changes to pile foundation). The reasons for such changes are as follows:

- In the left bank flood overflow section, the area is presently being cultivated by farmers and borehole drilling could not be undertaken due to farmer's disagreement with the terms

of compensation during the drilling works.

- During construction, it is necessary to undertake confirmation boring to determine the rock strata or bearing layer and any changes in actual condition shall be reflected as a design change. In this case, it will be more effective to consider such risk compensation during the detailed design.
- Possible changes to pile foundation have the tendency to decrease the costs and such effect is small.

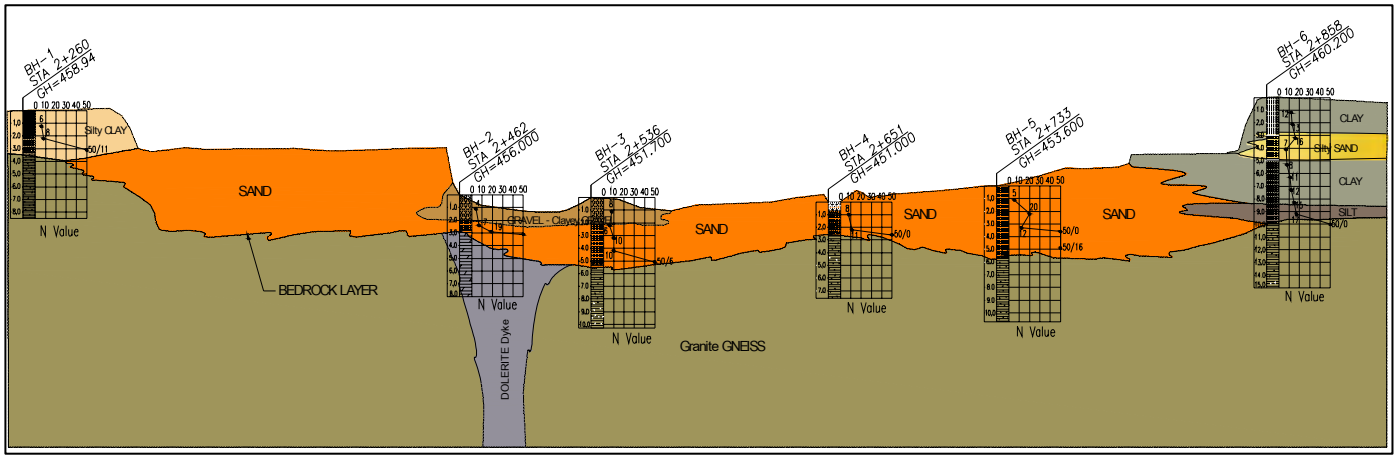


Figure 2-2-1 Borehole Logs

Seismic Force

- The available records of earthquake occurrences in and around Juba are compiled by the U.S. Geological Survey (USGS) which extends only for 10 years from 1982 to 1992. The record indicates at least two major earthquakes that occurred twice in May of 1990 with magnitudes of 7.1 and 7.2 and epicenters at 67km and 63km from Juba, respectively. The horizontal design seismic forces are based on these earthquakes.

2-2-1-4 Policy on Natural and Social Environment

This cooperation project is adjacent to agricultural land, planned and existing residential development areas and crossing a major river. Thus, preservation of the natural and social environment is a major consideration minimizing impact to residential areas, agricultural areas, the river and the natural environment. In this regard, the plans for design and construction carefully consider:

- Minimizing, as much as possible, the resettlement of affected persons in the residential areas.
- Minimizing pollution of river water quality during construction.
- Proper handling of construction waste.

2-2-1-5 Policy on Compliance with Design Standard

The design of roads and bridges basically complies with the requirements of the following design standards (Draft) of the Government of Southern Sudan:

- Geometric Design Manual, Ministry of Transport and Roads 2006
- Drainage Design Manual, Ministry of Transport and Roads 2006
- Bridge Design Manual, Ministry of Transport and Roads 2006

However, if the design provisions are inadequate in the above standards or there is a need for a more efficient and safer design, the following design standards will be referred to:

- Geometric Design of Highway and Streets, AASHTO 2004
- Bridge Design Specifications, AASHTO 2007
- Japan Road Association, JRA 2002
- Guidelines for River Control Facilities and Management, Japan 1998
- Design of Pavement Structure, AASHTO 1993

2-2-1-6 Policy on the Use of Local Supplier

According to the results of the field survey, most of the skilled labor, technicians and materials including cement and reinforcing steel, except for aggregates and fill materials, are not available locally and will have to be procured abroad. Likewise, companies that can undertake such large bridges are not available locally and will also need to be procured from Japan. Although road projects including earthworks, pavement construction, drainage and short bridges are being undertaken locally, there is no local experience in constructing Steel Langer Arch Bridge and piers in the Nile River. Moreover, since there is only one local company presently undertaking the road construction works in Juba, the possibility of using such company as a subcontractor to a Japanese company may be difficult. Therefore, the local participation in bridge construction shall be mainly the supply of local labor while the construction method and system shall be directly managed by the Japanese construction company.

2-2-1-7 Policy on Operation and Maintenance Capacity of Implementing Agency

After the completion of this Grant Aid project, the Ministry of Transport and Roads (MRB) will be the implementing agency for operation and maintenance of the facility. However, MRB's annual budget is mainly for road construction with a limited share for road maintenance. In addition to the low maintenance budget, MRB's capacity on prioritizing and implementing road maintenance works is likewise lacking. Currently, both the USAID and MDTF are providing assistance to road construction and road maintenance development in South Sudan (with the USAID undertaking the capacity development on road maintenance and the MDTF implementing road maintenance works). Since MRB's willingness to improve further their maintenance capacity is high, a technical cooperation project for road maintenance is requested to the Government of Japan. In this regard, and with the current issues on MRB's limited capacity for maintenance, structural configurations and considerations for bridges should minimize maintenance works.

2-2-1-8 Policy on Construction Method

By adopting the widely accepted construction method and techniques, internationally and in Japan, it is expected that a high-quality bridge will be built in this project. To attain such, the design drawings, construction specifications and standards for inspection and materials testing shall form part of the quality assurance program for this project. Moreover, in developing the construction plan, the safety of the construction workers and the local residents including the environmental concerns shall always be given emphasis during construction. Considering the bearing layer for the foundation, it is observed that shallow rock strata exist in the river. For the bridge to be stable under earthquake and flood, there is a need to ensure that the foundation is embedded in the rock layer. In this regard, a special method requiring an advanced foundation construction technology in Japan is needed to construct the bridge foundation on rock considering the high flow velocity in the river.

2-2-1-9 Policy on Selection of Bridge Type

After comprehensive evaluation of environmental impact, the selection of the most appropriate and applicable bridge type shall be based on practicability, maintenance and economy.

Road Function and River Discharge	: Bridge geometry based on road function; bridge layout which does not constrict river flow discharge
Structure Type and Construction Method	: Structural system that is easy to construct
Maintenance	: Structure that is easy and inexpensive to maintain
Economical	: Cost-effective structure with inexpensive initial investment, rehabilitation and maintenance
Social and Environmental Impact	: Impact on the residents along the road such as dust, noise and vibration should be minimized; design of bridge shall be in harmony with the natural landscape.

2-2-1-10 Policy During Construction

Rainy season starts around May until October. Annual rainfall in the site is about 1,000 mm. Between July to October, water of Nile river is rising and flooding the area. This event should be taken into consideration in the formulation of construction methodology.

2-2-2 Basic Plan (Construction Plan/Equipment Plan)

The basic plan is formulated and its flowchart is shown in **Figure 2-2-2-1** below.

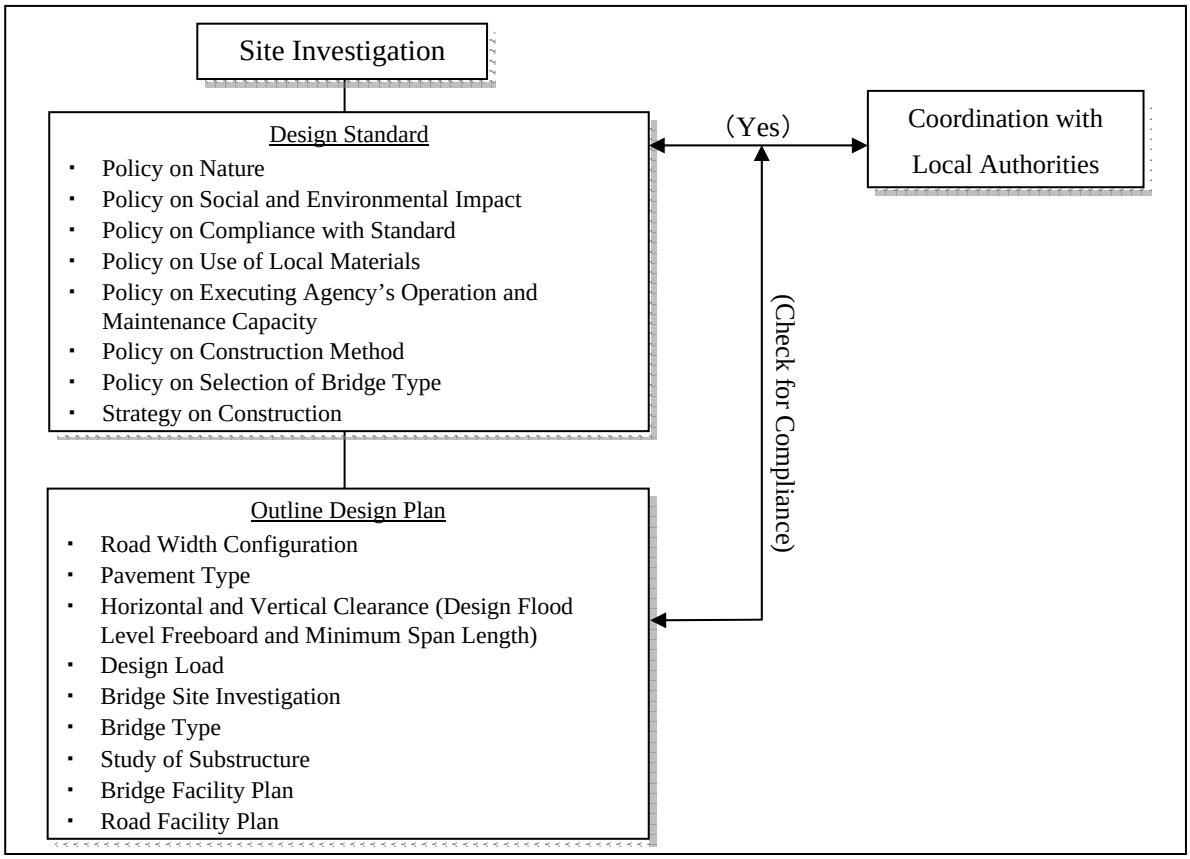


Figure 2-2-2 Flowchart of the Basic Plan

2-2-2-1 Overall Plan

Table 2-2-1 shows the scope of the project.

Table 2-2-1 Project Scope

The Project	Total length of road and bridge: 4.21 km
Bridge - Main Span - Side Span	Length: 560 m Langer Bridge: 4 Span x 87.5 m (350m), Steel pipe sheet and pile foundation Steel Bridge: 5 Span x 30 m (150m)、2 Span x 30 m (60m) Pile Foundation
Road (1)	Concrete Pavement: 100 m

2-2-2-2 Bridge Planning

(1) Selection of Bridge Location

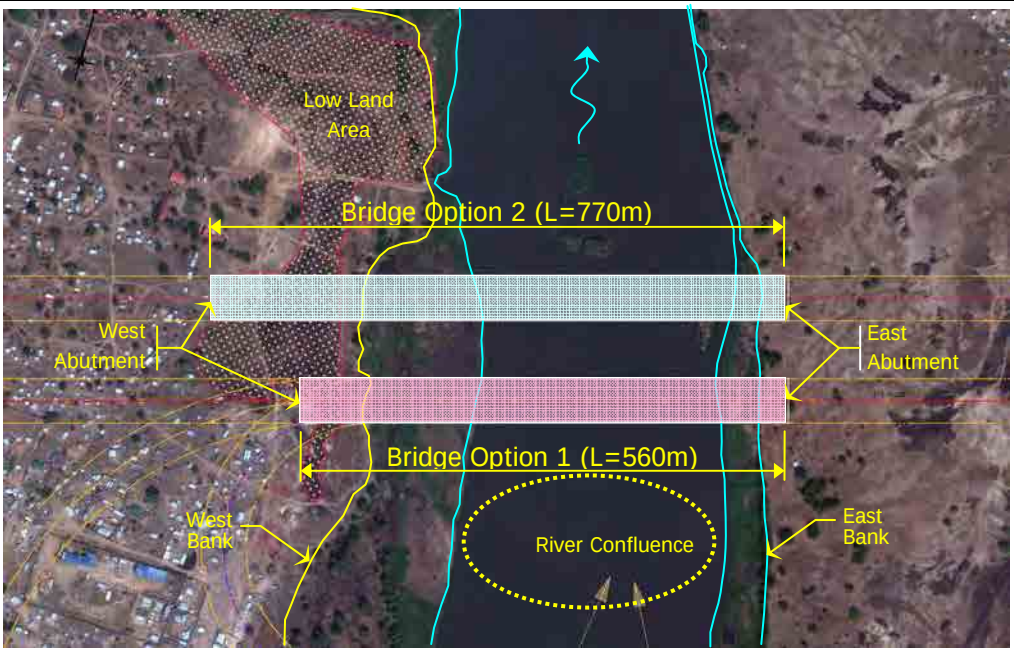
The JICA assisted study entitled "Juba Urban Transport Infrastructure and Capacity Development Study in the Southern Sudan" carried-out a comparative analysis on the proper location of the

bridge. This analysis was adopted in this study. The proposed bridge site is shown in **Table 2-2-2** and **Figure 2-2-3 (1) & (2)**, with a view of minimizing resettlement as much as possible. Aside from the comparative analysis carried-out earlier by the above mentioned study, further analysis was carried out to determine which location is best for the bridge. Option 1 is selected as location of the bridge for the following reasons.

- Option 2 – the length of the bridge is about 210 meters traversing a soft soil and wetland formed by the overflow of the water during rainy season. Construction cost is approximately 40% higher compared to Option 1.
- If Option 2 is selected, despite the increase in construction cost, there is no significant decrease in the number of houses affected.

Table 2-2-2 Selection of Bridge Location

Option / Description	OPTION 1 (Upstream Side)	OPTION 2 (Downstream Side)
Bridge Location	• Proposed site is 1.75km upstream of the existing Juba Bridge and 200m north of river confluence area. • Area is in the straight section of the river about 770m upstream before it meanders to the eastern side. • Two river banks exist – the 1st bank for the normal water level and the 2nd bank for the overflow section of the river.	• Proposed site is likewise upstream side of the existing bridge and 140m north of Alternative 1. • Area is in the straight section of the river about 610m upstream before it meanders to the eastern side. • Two river banks exist – the 1st bank for the normal water level and the 2nd bank for the overflow section of the river.
Abutment Location	• East abutment location is 10m after the 2nd east bank of the river. • West abutment is 12m after the 2nd west bank of the river.	• East abutment location is 10m after the 2nd east bank of the river. • West abutment is 200m after the 2nd west bank of the river to avoid the low land area in the western side.
Bridge Length	• Total length = 560m	• Total length = 770m
Evaluation/ Recommendation	**Recommended** (Shorter and cheaper to construct)	**Not Recommended** (Longer bridge length and more expensive due to low land area)



(2) Selection of Approach Road from C-3

As shown in **Figure 2-2-3 (1)**, Alternative 1 provides good connection between C-3 and the proposed bridge location (Option 1). The eastern approach road to Juba, as shown in the figure is nearly a straight line. The road intersect with a plan to Nimule and this is alignment is best in terms of less construction cost. The challenge is the liner approach of the west because of the number of several houses affected (**Figure 2-2-3 (2)**). Comparison of alternatives taking into account the impact of the number of houses affected and construction cost is shown in **Table 2-2-3**. Further, difficulties in land acquisition due to type of compensation depending on house sizes as well as number of affected houses are presented in **Table 2-2-3**.

Alternative 1 is recommended after comparing the different route alternatives in **Table 2-2-3** due to several reasons such as shortest length, cheap construction cost and less number of affected houses (ranked 3rd).

1. Alternative 3, 4 and 5, did not meet the required specification set by the masterplan for arterial road. These alignments are not recommended.
2. Alternative 1 has the lowest construction cost. Alternative 2A and 2B bend slightly to the south further increasing the number of affected houses.
3. It is easier to take land for right of way in cooperation with the local government in Alternative 1. Thus, government is expected to facilitate transfer of affected houses.
4. Alternative 5 has the lowest number of houses affected however construction cost is quite high due to the alignment which passes through the lower portion of river bank.
5. Comparing Alternative 4 to Alternative 1, it has more number of affected houses, poor road alignment (which may have negative impact on traffic flow), and has higher construction cost.
6. Alternative 6 as shown in the previous section is not recommended due to its high construction cost

The preferred route, ***Alternative 1***, is proposed to be 60m wide road in the future (current width of the road project 30m). Based on this route, a 100m wide corridor survey was conducted. The survey includes topographic survey which identifies position of house, size, trees, land use type, etc. Based on this survey, the 30m land needed for road's right of way is identified. The alignment is decided based on critical control points including the least number of affected house and water wells in the area.

Based on the above, the proposed alignment for the initial stage 30m-wide road is on the down stream side of the 60m proposed ROW corridor. The abutment positions are then based on the location of the river banks.

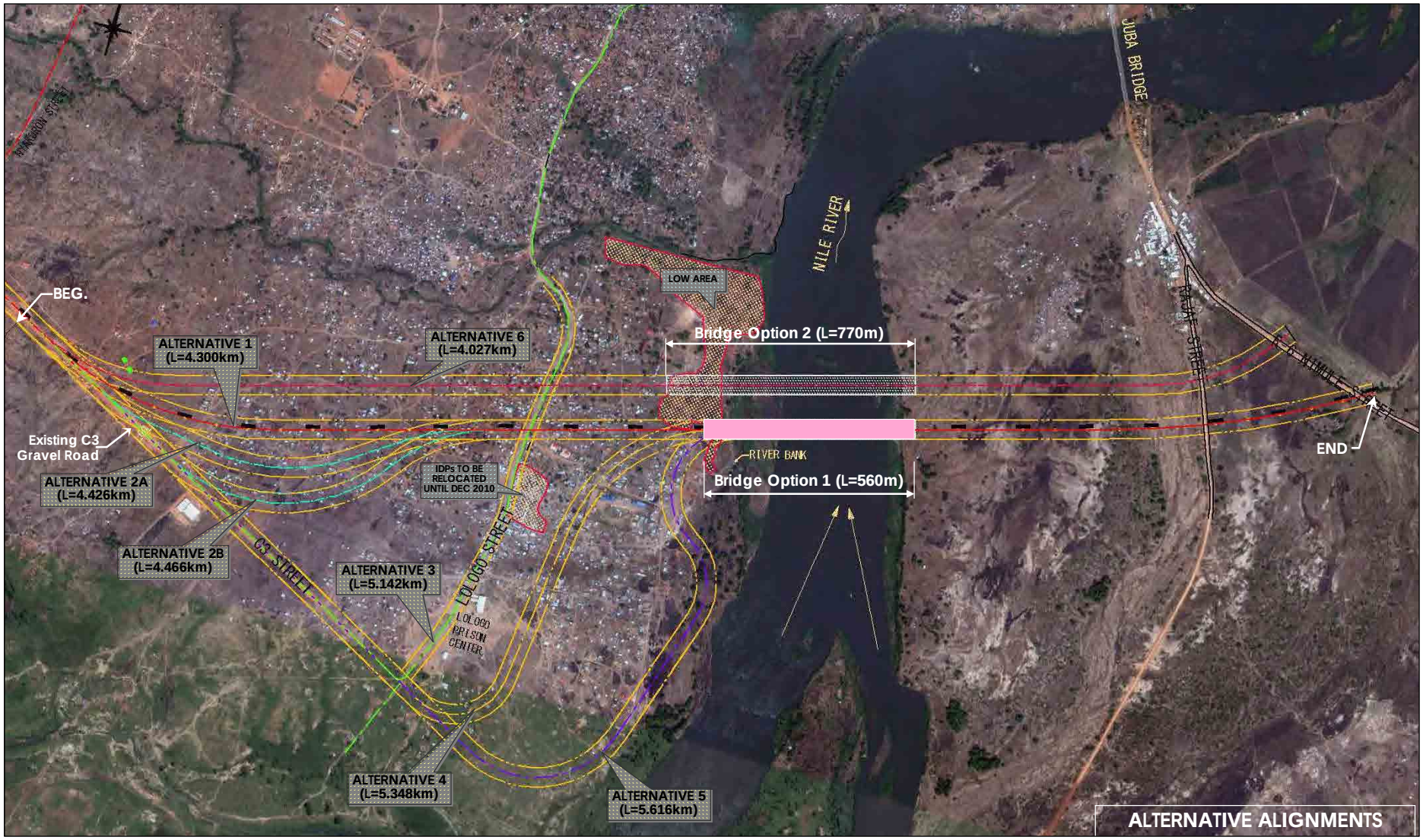


Figure 2-2-3 (1) Proposed Project Road Alternative Routes

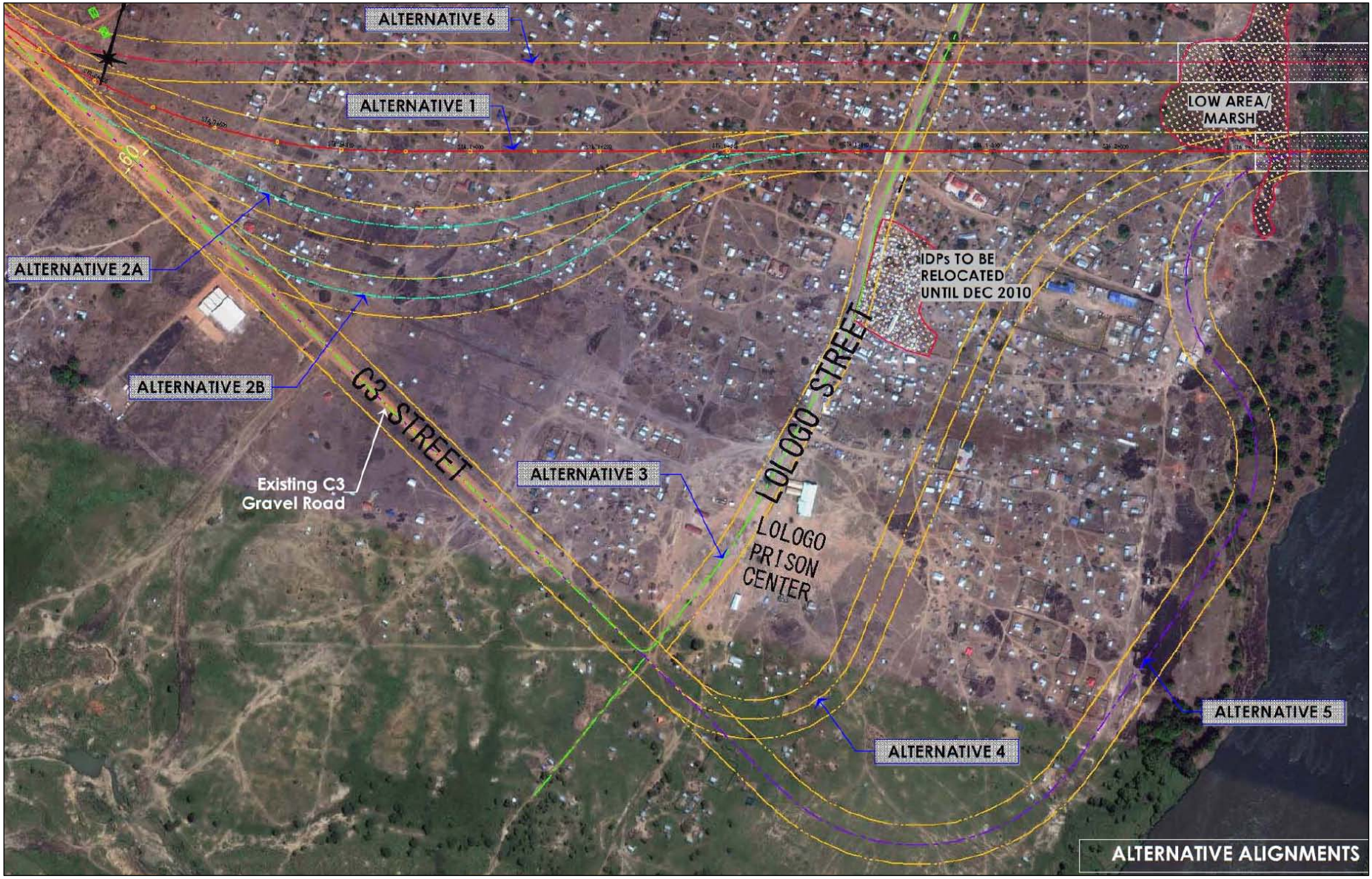


Figure 2-2-3 (2) Proposed Alternative Routes at Lologo Area on the West Bank

Table 2-2-3 Comparison of Alternative Routes

Items \ Alternative	Alternative 1	Alternative 2A	Alternative 2B	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Route Alignment Description	• Straight alignment joining the existing C3 section by a single curve. • Simplest alignment with best geometry for C3 road. ◎	• Beginning section is reverse curve with existing C3 • Joins Alternative 1 at Lologo Street. • Longer length than Alternative 1. ○	• South of Alternative 2A with similar geometry. • Longer length than Alternative 1 and 2A. ○	• Temporary use Lologo Street Alignment if ROW acquisition is initially difficult. • Final road alignment similar to Alternative 1 to be constructed later when ROW is available. • Requires box culvert. △	• East and running parallel to Lologo Street. • Curve is less than Alternatives 1 & 2. • Low geometric standard for arterial roads. • Requires box culvert. • Requires long embankment protection. ☒	• Utilizing maximum length of existing C3. • Alignment passes thru low and soft ground area. • Low geometric standard for arterial roads. • Require box culvert. • Requires long embankment protection. ☒	• North of Alternative 1 with similar geometry. • Requires ground improvement • Requires higher embankment and longer protection • Requires longer bridge. △
Total Length - Approach Road - Bridge	• **4,300 m** - 3,740m - 560m ◎	• **4,426 m** - 3,866m - 560m ○	• **4,466 m** - 3,906m - 560m ○	• **5,142 m** - 4,582m - 560m ☒	• **5,348 m** - 4,788m - 560m ☒	• **5,616 m** - 5,056m - 560m ☒	• **4,027 m** - 3,257m - 770m △
Social Impact/ Affected Houses for 30m ROW [*1)] *( ) – for 60m ROW	• **60** (142) ◎	• **85** (165) ○	• **115** (229) ○	• **69** (40m ROW) [*2)] △	• **70** (138) ☒	• **40** (68) ☒	• **58** (116) △
Total Estimated Cost - Bridge - Approach Road (AC) (Gravel Road Cost)	• **US$ 80.89 million** - US$ 67.44 million - US$13..45 million (US$ 8.83 million) ◎	• **US$ 83.48 million** - US$ 67.44 million - US$16.04 million (US$ 11.27 million) ○	• **US$ 83.59 million** - US$ 67.44 million - US$16.15 million (US$ 11.33 million) ○	• **US$ 85.48 million** - US$ 67.44 million - US$18.04 million (US$ 12.37 million) △	• **US$ 87.95 million** - US$ 67.44 million - US$ 20.51 million (US$ 14.57 million) △	• **US$ 93.67 million** - US$ 67.44 million - US$ 26.23 million (US$ 19.96 million) △	• **US$ 111.64 million** - US$ 95.61 million - US$ 16.03 million (US$ 11.92 million) ☒
Evaluation	**Recommended**	Alternative Option	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Note: [*1)] Initial 30m ROW for 1st Phase ROW Acquisition.

[*2)] Based on 40m ROW for Lologo Street (Used temporarily for C-3 Road).

LEGEND

◎ - Best Option ○ - Alternate Option △ - Acceptable Option ☒ - Not Acceptable

Table 2-2-4 House Classifications

Structure/House Types		Approx. Area (m^2)	Description
Big	B-1	85 – 225	Bricks or concrete blocks Walls; Preformed/Painted GI Roof
	B-2		Bamboo/wood pole finished with mud Walls; Preformed/Painted GI Roof
Medium	M-1	45 – 85	Bamboo/wood pole finished with mud Walls; Corrugated GI sheet Roof
	M-2		
Small	S-1	16 – 45	Bamboo/wood pole finished with mud Walls; Corrugated GI sheet Roof
	S-2		Mud hut with straw roof (Tukul)
Others	O-1	16 – 80	Wood pole with GI Sheet Walls; Corrugated GI sheet Roof
	O-2	12 – 16	Wood/bamboo frame with GI sheet Roof
	O-3	6 – 12	Wood/bamboo poles with PVC sheet Roof; Tents; Others

(3) Examination of Alternative Alignment within the Selected Route

The proposed new Nile River Bridge is located in C-3 Road which is envisioned to be finally a 4-lane divided highway (60 m wide ROW) and shall be constructed in stages. This project is the first stage which is a two-lane road (initially 30 m ROW) and built in parallel with the construction of the bridge. The number of houses initially affected will depend on the selected bridge location (downstream or upstream). In view of reducing the social impact of bridge construction, the elections of the proposed new Nile River Bridge location will take into account such parameter.

Upon considering the road alignment, the following points were noted:

- The scope of the corridor selected in the previous section is within the 50m north-south line from the center (100m total).
- As mentioned, in 2025, the road is planned to expand into a 4-lane road which would require 60m ROW. In this study, only 30m ROW is needed (for minimum house relocation at this stage) although the 60m ROW should be maintained for future expansion.
- The control point for road alignment takes into account the social impact and public facilities.
- The design speed is taken at 60km/hr
- The alignment considered avoiding construction obstacles including rock outcrops.
- The route alignment also considered avoiding, as much as possible, public facilities such as schools, hospitals, water wells and other facilities. A water pump and a police station (near Lologo road intersection) was confirmed on site, although the police station is a temporary facility that can be shifted at a nearby area.
- However, there is an unnamed cemetery at about 600m from the beginning section of the approach road which cannot be avoided and has to be relocated after consultation with the community.
- Moreover, the alignment considers conservation of rare tree species if found along the alignment (although only common trees are found on site).

Considering the above, two alternative routes in the north and south side (Alignment 1 & 2 in **Figure 2-2-4**) are proposed and compared. Although there is very little difference in natural environment impact and project costs of these alternatives, the social impact of the two alignments are notable.
Table 2-2-5 presents the results of comparison with Alignment 1 showing the least social impact and proposed to be the alignment for the new Nile River Bridge.

Table 2-2-5 Selection of Road Alignment (Width 30m)

Alternative	Road Length	Impact on the Residents		
		Number of Household*	Number of Affected Houses	Fence Length
Alignment-1 (Downstream)	4.306km	80	98	1,450m
Alignment-2 (Upstream)	4.317km	105	128	1,600m

*Based on existing households during the time of survey

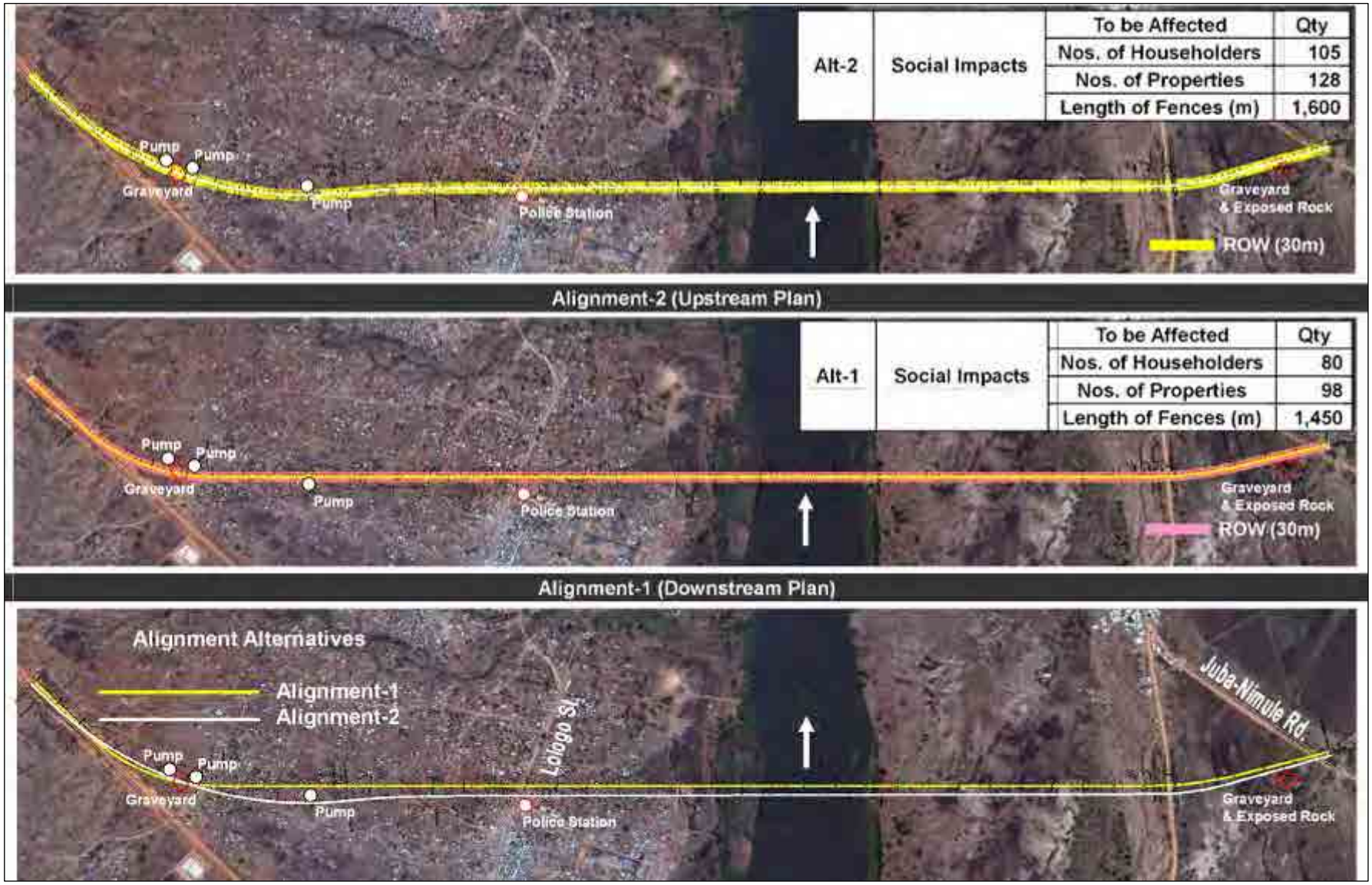


Figure 2-2-4 Alternative Alignments

(4) Selection of Length of Bridge (Abutment Position)

The length of bridge (abutment position) is determined by the following strategy.

- During flood high water level, position of abutment shall not hamper to the smooth flow of water
- To take into account the convenience of users during flooding
- To protect and minimize damage on the natural environment

In order to ensure smooth flow of water during flood high water level (in the natural river channels and in the flooded channel) it is necessary not to install the road embankment and bridge abutment to area which could disturb water flow. When installed in a highway embankment flood channel, results in sediment upstream of the flood channel, may cause some erosion and sedimentation of the flood channel further downstream. Therefore, the likely impact on the natural environment of farmland flood channel.

The left bank flood overflow section, the area is presently used by farmers to grow vegetables and also used for washing and fishing. The same is true with the right flood overflow section which served as farmland. Therefore it is necessary to conserve the natural environment to continue the usage of the land. For this reason, if structure is erected in the area, it necessary to take necessary measures to prevent damage of natural environment.

In this regard, the natural river cannel features including avoiding constriction of river flood discharge decided the location of the abutments. However, the slope protection in front of the abutment may encroach the flood plain section.

Based on the detailed field survey and topographic survey, it was determined that the possible length of the bridge is about 560m in total.

On the other hand, during the design flood (100 years return period) the mainstream channel carries the most of the river discharge (with 1.8m/s velocity), see **Figure 2-2-2-10**. The left bank overflow section, however, near the bank has a discharge velocity of only 0.3m/s without much impact on the river banks. On the other hand during the peak discharge, the flow velocity on the left bank may increase up to 1m/s which may require slope protection along the bank and in front of the abutment. Moreover, on the right bank the flow velocity at the design flood reaches to 1.2m/s requiring slope protection along the banks and in front of the abutment.

(5) Traffic Projection

Traffic project in the road network was conducted in 2010 by the JICA assisted study mentioned above.

Network conditions

Case 1 – Existing (Network 2011)

Case 2 - Existing + 2015 Network (Without Project)

Case 3- Existing + 2015 Network + 2015 Nile Project (With Project)

** Based on the Road Network of Master Plan (JICA Study)*

The OD used for each case assume that the new Nile River Bridge will be completed in year 2015.

Figure 2-2-5 illustrates the traffic count locations (①~⑫) in the road network. **Table 2-2-6** shows the results of the traffic volume based on future traffic demand models. In 2015 (at the time of completion of the new Nile River Bridge), the projected traffic volume at the point after the existing Juba bridge (location ③) is 15,000 vehicles, excluding two-wheeled vehicles. In year 2025, this traffic volume will increase to 30,000. The degree of congestion (V/C) ratio projected for each location in year 2025 is presented in **Table 2-2-7**.

Table 2-2-6 Projected Future Traffic Demand (Daily Traffic)

Vehicle Type	Year 2015	Year 2025
Truck	5,231	10,972
Bus	4,160	8,726
Passenger Car	5,383	11,290
Sub-total	14,775	30,989
2-Wheel Vehicle	3,503	7,347
Total	18,278	38,336

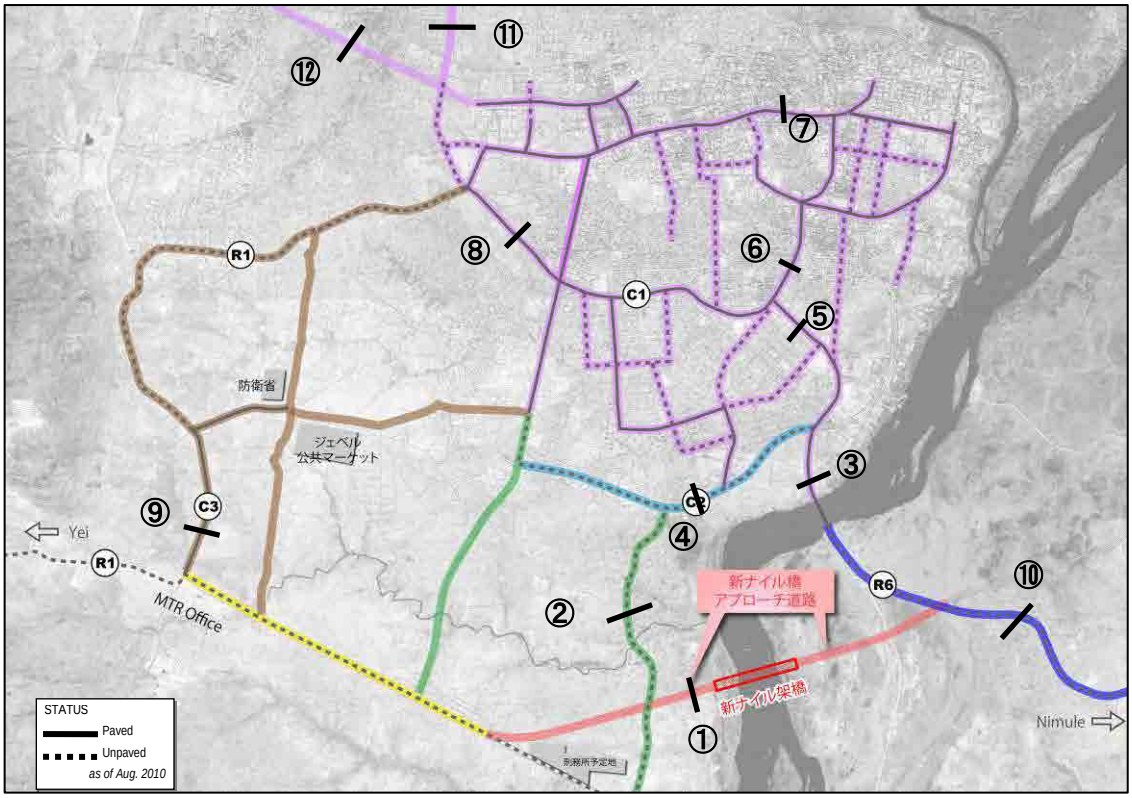


Figure 2-2-5 Road Network and Traffic Count Stations

(6) Necessity of Nile Bridge Construction

As shown in **Table 2-2-7**, considering the road network condition in year 2015, the degree of congestion near the existing Juba Bridge (Section ③) in 2015 is 0.9 (V/C). Unless a new bridge is constructed, even if the existing bridge is repaired, the degree of congestion in the vicinity of the existing bridge will still increase. However, if the new Nile River Bridge is constructed, the V/C ratio reduces to 0.38 which indicates a reduction of the degree of congestion by 52%. Therefore, in

order to reduce the degree of congestion in the area, it is necessary to construct the new Nile River Bridge.

(7) Road Standards and Road Width Configurations

1) Road Standards

The design standards at MRB such as road geometry, drainage design, bridge design was created in 2006 with the technical assistance from USAID. The road geometric and cross-section standards in the design manual is classified according to the road functional class. The new Nile River Bridge will be constructed as part of the circumferential road (C-3), which links Juba to the Ugandan border thru the Juba-Nimule road (international highway), is classified as a Class I or Trunk road from the road functional aspect. In year 2015, the projected traffic volume for the new Nile River Bridge is estimated at 14,610 pcu (passenger car units), as indicated in **Table 2-2-7** (location ①). For this reason, the design of the new Nile River Bridge and the approach roads will follow the requirements of road Class DS1.

Table 2-2-7 Comparison of Traffic per Section

断面	ケース	Motor-cycle	Car	Bus	Truck	Total	PCU/day	V/C
①	Case1	0	0	0	0	0	0	-
	Case2	0	0	0	0	0	0	-
	Case3	2,824	2,257	4,160	5,231	14,473	14,610	0.29
②	Case1	4,424	2,799	3,443	1,167	11,832	9,346	0.93
	Case2	3,770	2,389	2,930	1,195	10,283	8,241	0.82
	Case3	2,539	1,619	3,295	1,731	9,185	8,174	0.82
③	Case1	3,503	5,383	4,160	5,231	18,278	17,960	0.90
	Case2	3,503	5,383	4,160	5,231	18,278	17,960	0.90
	Case3	5,103	5,926	0	0	11,029	7,610	0.38
④	Case1	3,500	3,421	3,192	3,046	13,159	12,003	0.60
	Case2	4,709	4,156	3,965	3,723	16,554	14,853	0.74
	Case3	3,797	2,751	4,375	3,745	14,668	13,591	0.68
⑤	Case1	5,015	4,029	3,897	5,060	18,001	16,603	0.83
	Case2	4,597	4,038	3,928	4,970	17,532	16,380	0.82
	Case3	5,800	5,177	2,950	3,351	17,278	14,695	0.73
⑥	Case1	8,448	5,788	6,785	4,570	25,592	21,736	0.54
	Case2	9,018	6,084	7,033	4,815	26,950	22,808	0.57
	Case3	8,730	5,809	6,648	4,446	25,632	21,539	0.54
⑦	Case1	3,921	2,618	3,381	5,612	15,533	15,072	0.75
	Case2	3,803	2,542	3,291	5,664	15,300	14,937	0.75
	Case3	3,639	2,438	3,163	5,573	14,814	14,525	0.73
⑧	Case1	8,633	6,642	7,273	10,317	32,866	31,075	0.78
	Case2	9,097	7,022	7,693	10,320	34,132	32,035	0.80
	Case3	9,697	7,427	7,725	9,904	34,753	32,097	0.80
⑨	Case1	7,073	6,052	4,217	2,649	19,990	16,300	0.33
	Case2	6,930	6,084	3,955	2,373	19,343	15,641	0.31
	Case3	7,830	7,041	4,602	3,292	22,765	18,816	0.38
⑩	Case1	3,094	5,025	3,731	5,231	17,081	17,033	0.85
	Case2	3,094	5,025	3,731	5,231	17,081	17,033	0.85
	Case3	3,094	5,025	3,731	5,231	17,081	17,033	0.85
⑪	Case1	6,506	5,489	4,493	1,546	18,035	14,308	1.43
	Case2	6,900	6,105	5,393	3,399	21,797	18,519	0.93
	Case3	7,327	6,302	5,676	3,554	22,859	19,357	0.97
⑫	Case1	3,700	2,876	2,856	9,028	18,460	19,440	0.97
	Case2	3,652	2,850	2,821	8,614	17,936	18,791	0.94
	Case3	4,127	3,085	3,021	8,388	18,621	19,073	0.95

Table 2-2-8 Road Design Classification

Road Function	Design Class	Daily Traffic (PCU)	Road Width	Design Speed
Trunk Road	DS1	10,000-15,000	7.3m	50 km/hr (Urban Roads)
	DS2	5,000-10,000	2-Lanes	

2) Design Speed

Although the approach road is initially prepared as the construction access road, the geometric plan and design will consider the future road function and should satisfy the technical requirements considering the required design speed. The design speed is thus taken as the required for the corresponding road class.

The design speed of the approach road in the previous report (JICA M/P) is 50km/hr taking into account the standards of AASHTO. However in this study, the design speed will be 60km/hr which has very little significant impact on designs. To change from 50km/hr to 60km/hr, the road design will be ensured to satisfy the geometric design standard and the design speed requirements of the project.

3) Road Geometry

The design standard of the approach road which is classified as DS1 under MRB Design Manual will comply with the requirements of road with design speed of 60km/hr. Other design aspects will also be referred to other design guidelines (AASHTO, SATCC). **Table 2-2-7** shows the geometric standards as reference.

4) Bridge Cross-section

The cross-section configurations of the bridge are shown in **Figure 2-2-6**. MRB has requested the Study Team to adopt 3.6m wide two-lane carriageway and the sidewalk on one side assumes that a similar bridge will be constructed adjacent in the future. The reasons for not providing a mounted sidewalk are as follows:

- To provide space for bicycle users in order to ensure smooth traffic flow from the approach road and prevent accident,
- To provide consideration for people with handicap and disability the approach road and the bridge sidewalk should be in the same level.

The sidewalk or footbridge will be 2.5m wide which is narrower than the approach road which is 3.0m wide due to consideration of cost. In AASHTO, when the bridge length is more than 60m the deck section configuration is decided by economy.

Table 2-2-9 Geometric Design Criteria

Parameters	Unit	Applied	AASHTO	SATCC	MRB South Sudan DS1 (Urban, Peri Urban)	Remarks
Design Speed	Km/h	60	60	60	60	
Design Vehicle	M	Semi trailer combination large* W=2.6 L=16.7 H=4.1	WB-15 W=2.6 L=17, H=4.1	WB-15 (Semi-Trailer) W=2.5, L=17, H=4.1	DV4 Semi trailer combination large* W=2.6 L=16.7 H=4.1	
Lane Width	M	3.6	3.6	3.1~3.7 (3.4)	3.65	Less relationship to the design speed
Shoulder	M	3.0 (Combined Use)	1.2 (Combined Use)	1.5, 2.0,2.5 3.0[4]	Shoulder N/A; Parking Lane 3.5; Footway 2.5	
Min .R. of Horizontal Curve	M	150	Crossfall 4% 6% 8%: 150 135 125	Crossfall 6% 10%: 140 125	Crossfall 4% 8%: 150 125	
Min. Curve Length	M	Not Applicable	Not specified	300 (absolute 150)	5° or 300	
Min. R. of Curve for omitting Transition	M	500[5]	Not Specified	Not Specified	Transition curve is required to having design speed grater than 80km/hr	*5 R< (Design Speed)^3/432:Rounded
Stopping Sight Distance	M	85	85	80	85	
Max. Grade	%	6.0	7.0(Level)	6.0 (Flat)	3.0(Flat/Absolute)	
K-Value at Crest Point	-	180	195	-	180	Passing Sight Distance
K-Value at Sag Point	-	Not Applicable	Not Specified	-	180	Passing Sight Distance
K-Value at Crest Point	-	Not Applicable	11	16	18	Stopping Sight Distance
K-Value at Sag Point	-	18	18	16	18	Stopping Sight Distance
Pavement Crossfall	%	2.5	1.5~2[8] 2~6[9]	2.0-3.0	2.5	*8 :High Surface *9 Low Surface
Min. Height Clearance	M	5.1	4.3	5.1	5.1	
Right of Way	M	60(30)	More than Required Road Width	Not Specified	50-60	

Source: MRB Geometric Design Manual, AASHTO and SATCC.
*SATCC – Southern Africa Transport and Communications Commission

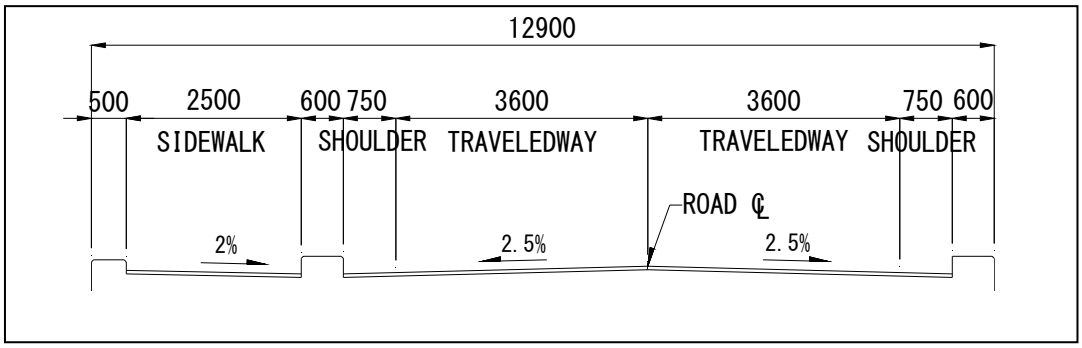


Figure 2-2-6 Cross-section Configuration of the Bridge

5) Approach Road Cross-section

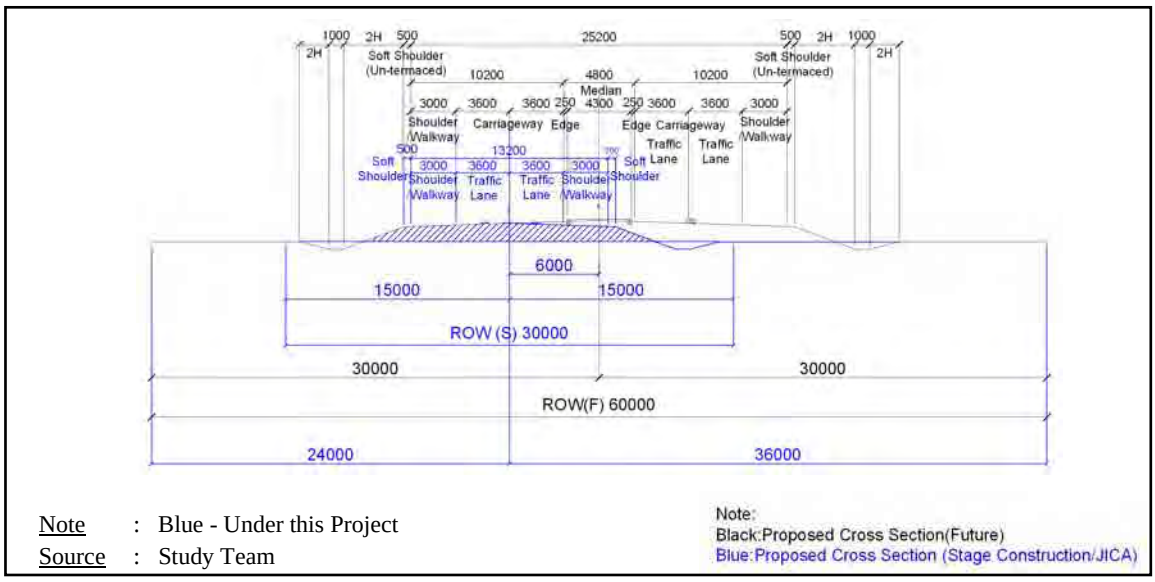
The C-3 Road is classified as urban road while the land use along the left bank of the Nile is considered as a residential area. Access control shall be considered and local traffic generated from the residential areas is allowed to get into the road at selected intersections. The design speed considered is 60km/hr.

The JICA M/P has proposed a standard cross section for different road classes. This standard was referred from cross section of urban road standard of AASHTO. The width of road lanes has been set at 3.6m.

The proposed width of road shoulder however is just 3.0m due to the following points:

- In Sub-Saharan Region of Africa, the main mode of public transportation is “matatu” (mini-bus like Toyota Hi-ace) and “boda boda” (motorcycle taxi) which are often seen in the streets of Juba. These public transportation modes become the major source of congestion due to the uncontrolled practice of loading/unloading of passengers at any part of the road.
- In this regard, a parking lane/shoulder is necessary to serve the public transport to minimize road traffic constriction which led to the development of a combined sidewalk and shoulder along the approach road.
- The typical road shoulder width in South Sudan is 2.5m and margin allowance becomes 3.0m.
- The design of the project road shall follow the recommendations of the JICA M/P.
- Based on traffic projection, the traffic volumes in 2025 require a 4-lane road and this project’s 2-lane road will serve as the initial stage road until capacity improvement is done in year 2025.

Figure 2-2-7 illustrate cross-section standard of the road project taking into account future expansion.



Note : Blue - Under this Project
Source : Study Team

Figure 2-2-7 Road Cross-section

This project covers the initial stage construction of a 2-lane road (based on the final stage symmetry) and considers the following points:

- The 2-lane road will be opened to traffic after construction of the road with additional pavement work by the local government. However, ten (10) years after the operation of the road, the necessity of expansion to 4-lane in 2025 shall be determined depending on the volume of traffic.
- During that period, the land development update plan can be carried out such as land re-adjustment and land use plan. The road is expected to provide convenient transportation and sidewalk should be provided on both sides to ensure safety of pedestrians.
- Although the road alignment is basically straight, the cross-slope of one lane should be adjusted during widening to avoid traffic safety issues. On the other hand, the bridge deck section has a reduced shoulder and a sidewalk on one side.
- The bridge, moreover, serves only through traffic and has no access from the road side. During capacity improvement to 4 lanes, a similar 2-lane bridge will be constructed next to this bridge with sidewalk on the opposite side.
- Sidewalk of the bridge is considered from the viewpoint of pedestrians' safety so that it is separated from the carriageway. The minimum standard to be adopted is 2.5m wide with a raised curb to separate vehicles and pedestrians.
- Since the likelihood of vehicles to stop in the bridge is low, provision narrow shoulders is considered in view of cost efficiency which is normally about 0.75m in Japan.

(8) Pavement Plan

In this project, a temporary approach road (construction access road) is provided as part of the bridge construction for the purpose of providing access to the construction site. The provision of asphalt pavement structure for this road (for better drivability and maintenance) will have to be completed by MRB, which is different from the purpose of this project. The temporary approach road is thus planned to be constructed by gravel. Since this road is gravel it can easily be damaged due to high intensity rainfall, so that maintenance is necessary including yearly gravel resurfacing, cleaning and repair of drainage.

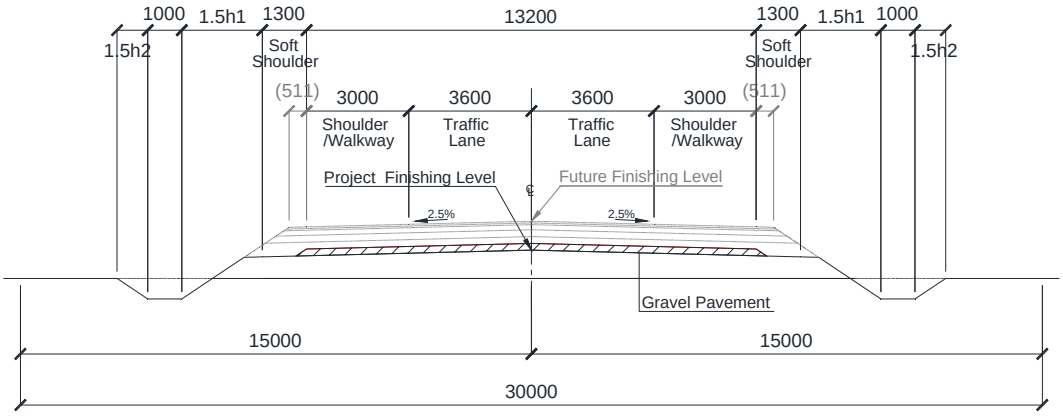


Figure 2-2-8 Construction Road Cross-section (Approach Road (2))

As shown in **Figure 2-2-9**, a 50m concrete paved road before and after the bridge will be constructed to provide smooth transition to the bridge (Approach Road (1)).

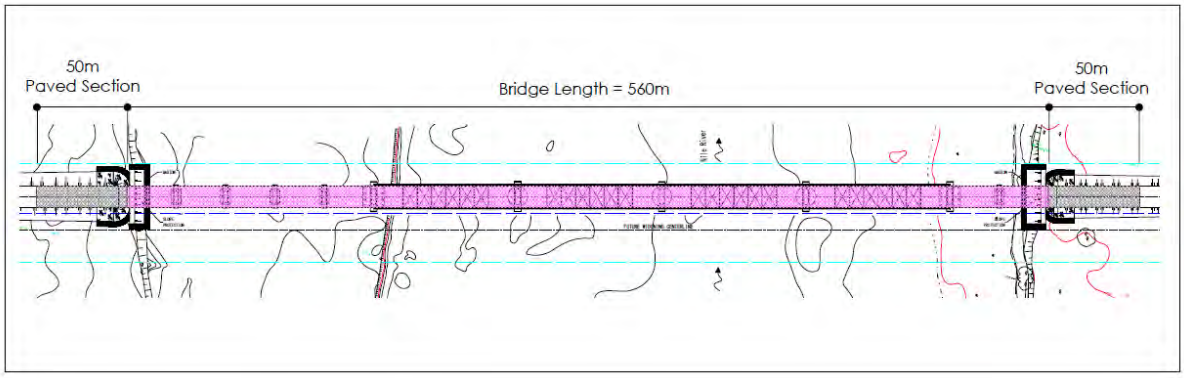


Figure 2-2-9 Location of Concrete Pavement Construction (Approach Road (1))

In this study, since axle load survey was not undertaken, the axle load used for the design of pavement is 8t based on the design value used for the Juba-Nadapal road and other road projects in Juba.

Table 2-2-10 Conversion Value by 8t Vehicle Weight

SN	Vehicle Type	Equivalent Factor
1	Bus	7.21
2	Medium Goods Vehicles	4.78
3	Heavy Goods Vehicles	10.40
4	Oil Tankers	13.35

Source: Juba-Nadapal Road Improvement Project Report

The initial performance period will be 20 years and the pavement structure is illustrated in **Figure 2-2-10**.

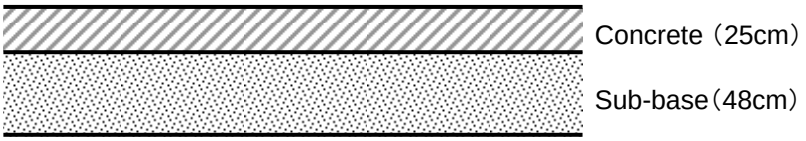


Figure 2-2-10 Pavement Structure of Approach Road (1)

(9) Planning for High Water Level and Minimum Span Length Design

1) Design Discharge

Since there is insufficient rainfall and river discharge data in South Sudan due to long civil war, the data accumulated at the downstream section of Lake Albert dam (more than 20 years record) which has a similar runoff characteristics with Juba Nile river will be referred to.

Based on the samples collected for a reasonable time, the volume of river discharge is estimated. This process took into account the traffic from major city of Jinya in Uganda that might utilize the new Nile bridge and also the discharge of Owen Dam.

The maximum annual river discharge at a location 40km downstream from Mbulamuti Dam is calculated based on 37 years record using the Gumbel plot, a conventional probability distribution method to calculate extreme value distribution. From the result of Mbulamuti point runoff characteristics, the flow at the proposed location of the bridge is calculated using a watershed area ratio shown in **Table 2-2-11** and illustrated in **Figure 2-2-11** In addition, the rainfall runoff characteristics at the proposed site can be regarded as similar since the annual rainfall of 1,000mm – 1,400mm is similar between the two points.

Table 2-2-11 Estimated Discharge at Proposed Bridge Site

Location	Bridge Site		Mbulamuti
Catchment Area (km^2)	529,000		265,727
Return Period (Years)	Calculated Discharge	Discharge (m^3/s)	Discharge Ratio
100	4,925	5,000	0.00931
50	4,586	4,600	0.00867
20	4,131	4,200	0.00781
10	3,782	3,800	0.00715
5	3,417	3,500	0.00646
3	3,126	3,200	0.00591
2	2,867	2,900	0.00542

2) Setting Design Flood Water Level

The calculation for flood/high water level and flood discharge is based on the river cross-section at the centerline of the alignment. The Manning formula is used to calculate the flow velocity and discharge using the cross-sectional area, hydraulic radius, roughness characteristic (N=0.030) and river bed slope of I=1/3,900 based on the river longitudinal survey.

As shown in **Figure 2-2-11**, for a design discharge of 5,000m^3/s the corresponding design high water level is EL. 459.22m which is rounded off to EL. 459.30m for design.

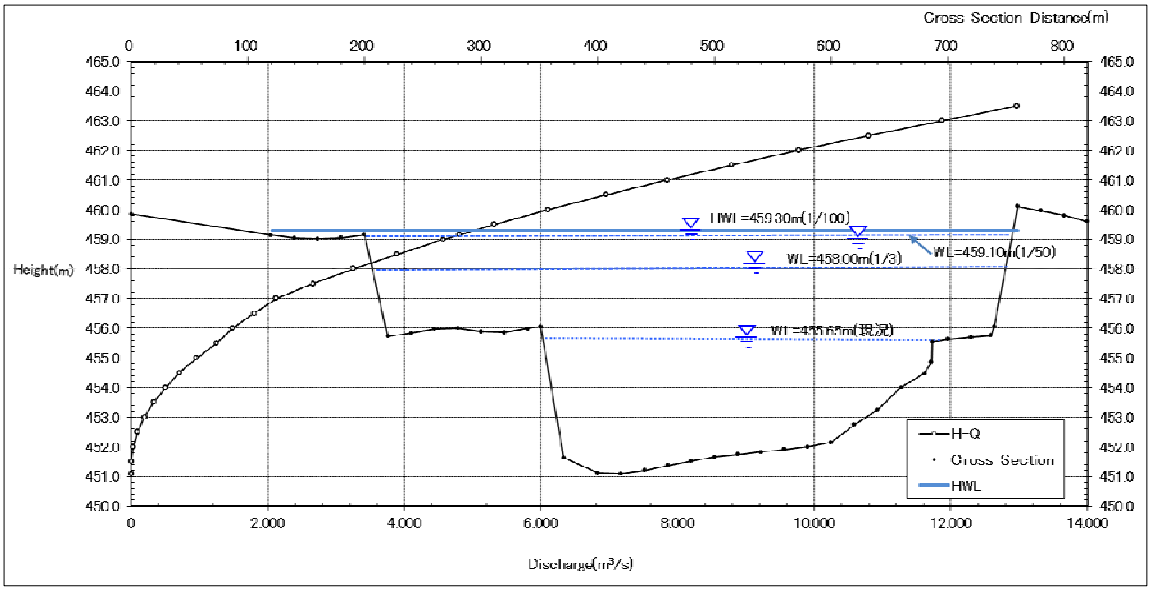


Figure 2-2-11 H-Q Curve (New Nile Bridge)

During the 50-year return flood, the overflow section at the left side of the river is almost full of water but does not go beyond the bank. The flood channel forms naturally together with the left and right overflow sections and flows continuously downstream as seen in **Figure 2-2-12**.

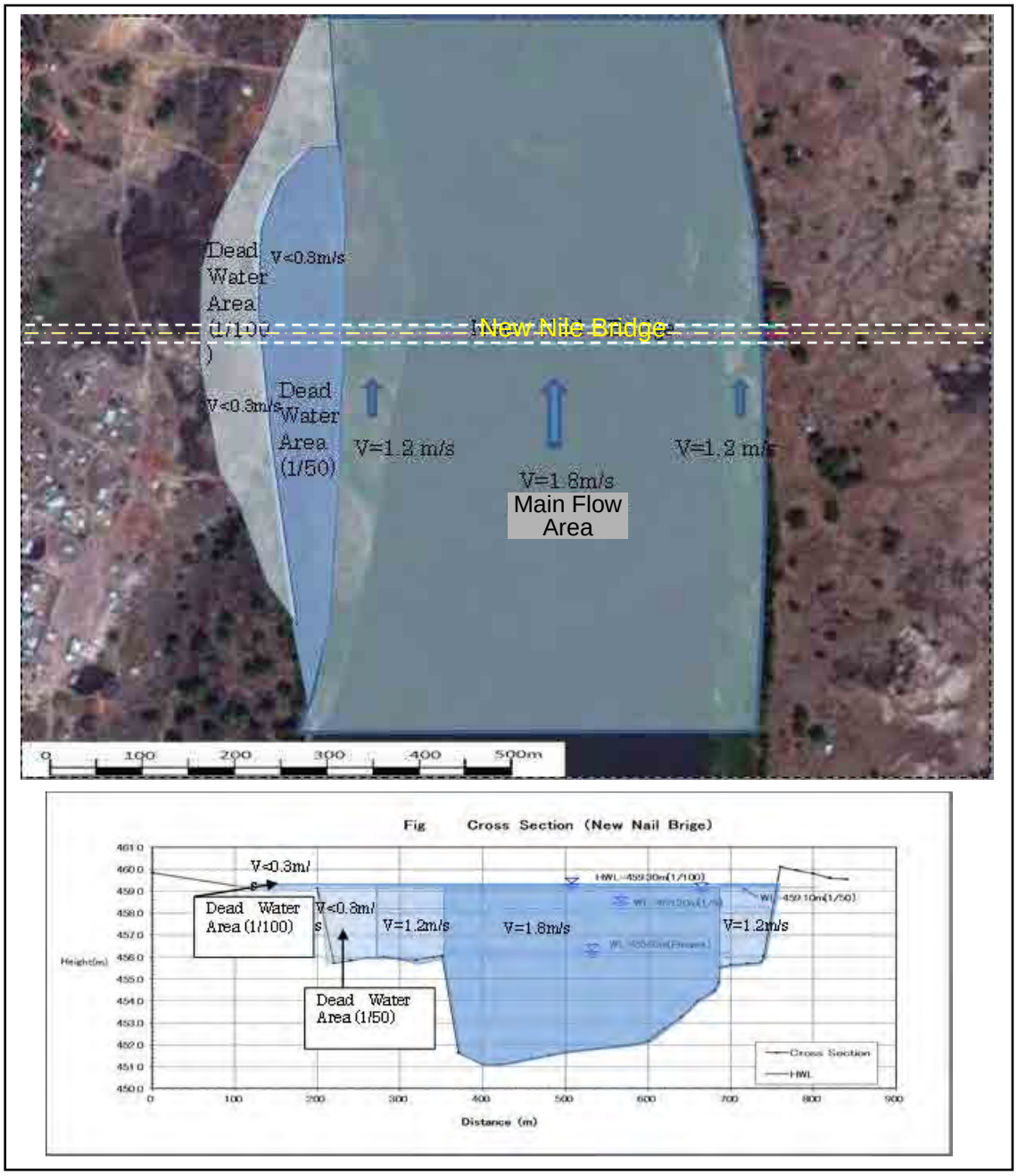


Figure 2-2-12 Estimated Flood Flow Condition

In other words, about half of the left bank flood channel is full with running water during floods. It can be assumed that the dead water area will not contribute to increase the flow of water. (Average velocity of the flood channel and the dominant part of the section is split into transverse sections, the results were estimated by calculating the flow etc.).

The flood water level for a 100-year return period is 0.2m-0.30m higher than the 50-year return period with slight overflow on the bank but with flow velocity of less than 0.30m/s.

3) Span Length and Vertical Clearance

The minimum span length value is calculated using the equation ***L = 20+0.005Q***, according to the Japan standards. Using a design flood discharge of Q = 5,000 m^3/s the minimum span length is determined to be 45m. Moreover, using the table below, the minimum vertical clearance (freeboard from bridge) is taken to be 1.5m.

Design Discharge (m^3/s)	500 < Q < 2,000	2,000 < Q < 5,000	5,000 < Q < 10,000	Q > 10,000
Vertical Clearance (m)	1.0	1.2	1.5	2.0

Source: Japan River Structure Ordinance

Using a discharge of Q = 5,000 m^3/s and a rectangular cross-section, the vertical clearance of the existing Juba Bridge (over Nile River) is calculated to be 1.0m. However, the Drainage "Design Manual, MRB 2006" requires that bridges with more than 50m in length should have a vertical clearance of 1.5m.

Moreover, under the construction of facilities for river management in Japan, the vertical clearance is decided depending on the design flow discharge and for Q=5,000 m^3/s (100-year flood flow design), the required clearance is 1.5m. As a result, the design for the new Nile Bridge will have a vertical clearance of 1.5m from the design flood water level.

To satisfy the criteria of bridge length and cross section, the bridge's configuration are the following (The overflow section flood channel flow rate is slower compared to the main channel segment and considering the span length and discharge criteria, the minimum span is 23m):

- Left bank flood channel section:
  Span Length 30m×5 span (150m) - Pier (2m wide, 10m long) × 5 locations
- Main channel section:
  Span Length 87.5m×4 span (350m) - Pier (3m wide, 10m long) × 3 locations
- Right bank flood channel section:
  Span Length 30m×2 span (60m) - Pier (2m wide, 10m long) × 2 locations

The presence of piers is found to have little influence in relation to the river cross section and the design discharge and flood level.

4) Environmental Impact Assessment of Bridge Construction

The effects of bridge construction on the river including the hydraulic pressures on the piers, water level on the upstream side, scour around the piers and bank erosion and scouring when the piers are too close to the river were investigated.

An overview of the structure and pier conditions is summarized below:

Channel Flow	Span Length	No. of Span	No. of Piers	Longitudinal Width	Transverse Length
Main Channel	87.5m	4	3	3m	10 m
Left bank flood section:	30m	5	5	2m	10 m
Right bank flood section:	30m	2	2	2m	10 m

It is normally considered that the above pier structures have little impact on the river.

a) Pier Effects on High Water Level

Analysis of flow around bridge piers have been proposed by D'Aubuisson and is used to calculate the increase in water depth (Δh) due to the presence of the bridge pier. It is found that the proposed piers in the river will slightly increase the water depth by Δh=0.01m (1cm) and presents no significant impact.

b) Maximum Scour Depth and Extent Around Piers

- **Maximum Scour Depth**

Traditionally, there are many expressions proposed to estimate the scour depth around the pier (Z) but most of which does not reflect the present issues and conditions at site. In this regard, the factors affecting the parameter Z is extracted from a dimensionless expression (Z/D) which is referred to the "Flood Control Issues on Piers", Civil Engineering Research Institute article published on November 1993.

Following the article, the maximum scour depth is estimated at Z = 0.90m.

- **Scour Range**

The extent of local scour around bridge piers depends on the angle of repose of saturated sand in the bed and the maximum scour depth. The 2-3m thick of sand cover above the river bedrock has an average diameter of 1mm and using the upper bound value, it is estimated that the angle of repose is $\theta = 27°$.

Therefore, the extent of scour (X) = maximum scour depth (Z)/tan θ = 1.8m is illustrated in **Figure 2-2-13**. It can be seen that the effect of pier on the river (local scour extent is only 1,8m around the piers), considering the span length of 87.5m, is negligible.

c) Impact on River Bank Erosion

According to the Japan River Management Facilities, bridge piers should not be constructed closer than 10m to prevent such impact as river bank erosion. In this project, the bridge main spans are 87.5m (main channel) while the approach spans are 30m on the left and right bank. In this regard, the effect of pier local scour on bank erosion is insignificant.

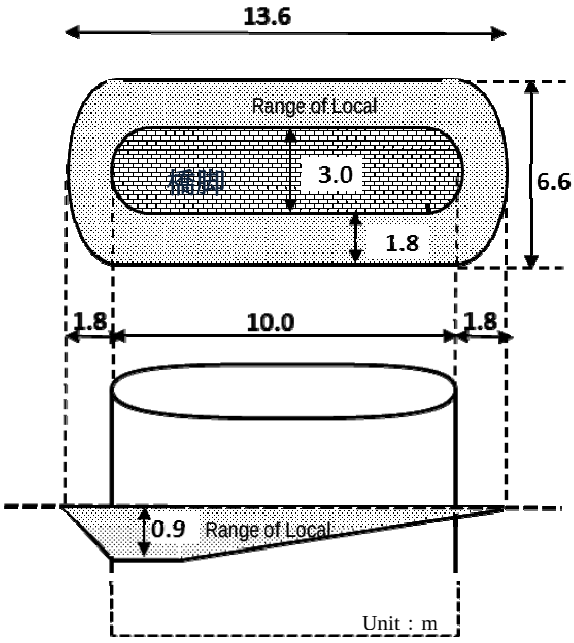


Figure 2-2-13 Maximum Scour Depth and Extent Around Pier

d) River Regime

The Owen hydroelectric dam has been constructed upstream of the Nile River in Uganda and another dam (Bujugari Dam) is under construction and expected to be completed in year 2012. The flood runoff released from these dams will pas through Lake Albert towards the proposed bridge site. Development plans in Uganda including construction of new hydroelectric dams will have significant impact on the downstream course of the river.

However, the actual and planned changes in dams and irrigation facilities upstream of the proposed bridge site are uncertain at the moment so that its impact on the flow regime near the proposed bridge site is also unknown. However, the river flow regime will be affected by the characteristics of the catchment area which is 530,000km^2 but the impact on the bridge will be concerned locally on the piers.

(10) Study of Bridge Type

1) Form of the Main Bridge Structure

The topographic results indicate that the length of the river's main channel is about 350m. The bridge type within the 350m main channel is selected based on the geological conditions as well as the hydraulic conditions. **Table 2-2-12** presents the design criteria for bridges. **Table 2-2-13** on the other hand, presents a comparative study focusing on the relative ratio of construction costs of three (3) prestressed concrete (PC) bridges and five (5) steel bridges. As a result, three (3) alternative types of bridge configurations (5-span continuous PC bridge, 4-span steel Langer bridge and 5-span steel box girder bridge) were selected as cost efficient facility.

Considering the steel Langer bridge, two alternative span lengths were considered – 4 spans at 87.5m and 5-spans at 70m spans. The overall bridge costs for these alternatives does not vary much

but construction with less piers in the river (87.5m span) offers less risk in construction and less impact on the river environment.

A comparative evaluation is conducted for the 3 alternative bridge types considering structural system and behavior, construction (method, costs, period and materials), hydraulic characteristics, and aesthetics and environment. The 4-Span Steel Langer bridge is evaluated as the most appropriate bridge type for the Nile main river channel with the following structural configurations:

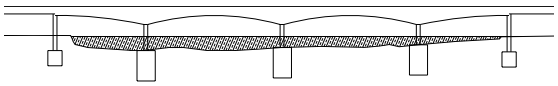
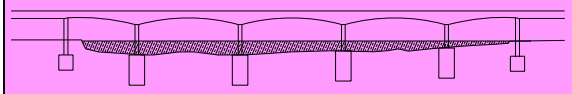
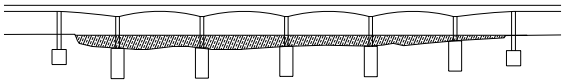
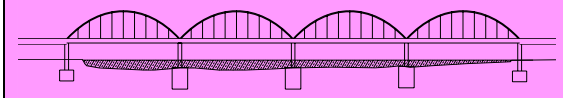
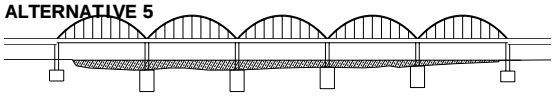
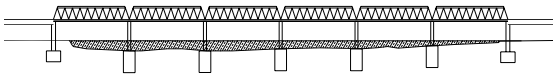
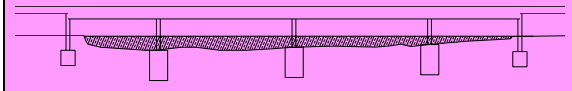
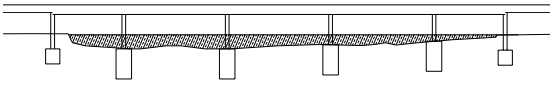
Main Span	: 4-Span Steel Langer Bridge	4@87.5m = 350m
Approach Span (West)	: 5 Span Steel I-Girder Bridge	5@30m = 150m
Approach Span (East)	: 2 Span Steel I-Girder Bridge	2@30m = 60m

Table 2-2-12 Bridge Design Criteria

Design Item \ Location			Main Bridge	Approach Bridge
1.0 General	Design Reference		• Bridge Design Manual, Ministry of Transport and Roads, GOSS, 2006 (MRB, RSS) • Geometric Design Manual, Ministry of Transport and Roads, GOSS, 2006 (MRB, RSS) • Drainage Design Manual, Ministry of Transport and Roads, GOSS, 2006(MRB, RSS) • AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010 • Specifications for Highway Bridges, Part I-V, Japan Road Association, 2002	
	Road/Bridge Class		• Interstate Trunk Road (DS1)/Primary Arterial	
	Bridge Section Length (m)		350	• 150 (West side) • 60 (East side)
	Span Configuration (m)		4@87.5	• 5@30 (West side) • 2@30 (East side)
	Design Speed (km/hr)		60	60
2.0 Geometry	Min. Horizontal Curve Radius (m)		150 (2.5%)	
	Max. Gradient (%)		6	
	Travel Lane Width (m)		3.6	
	Shoulder (m)		0.75 (Both Sides)	
	Sidewalk (m)		2.5 (One Side)	
	Pavement Crossfall (%)		1.5	
	Vertical Clearance on Roadway (m)		5.3 (GOSS/MRB BDM 2.4.5 for light structures)	
	Vertical Clearance on Design Flood Level (m)		1.5 (GOSS/MRB BDM, DDM)	
	Elevation of Design Flood Level (m)		EL. +459.30	
3.0 Design Load	Live Load		HL-93 (AASHTO)	HL-93 (AASHTO)
	Pedestrian Load (kPa)		4.0 (GOSS/MRB BDM 3.12)	4.0 (GOSS/MRB BDM 3.12)
	Flood Velocity (m/s)		1.8	1.2
	Base Wind Velocity, V_B (m/s)		45 (Open Country)	45 (Open Country)
	Peak Ground Acceleration Coefficient		0.2	0.2
	Temperature	T_{max} (°C)	50	50
		T_{min} (°C)	15	15
4.0 Materials	Concrete Strength	Footing/Pile Cap (MPa)	24	24
		Bored Piles (MPa)	30	30
		Pier/Abutment/Retaining Wall (MPa)	24	24
		Slab/Railing (MPa)	24	24
		Slope Protection (MPa)	21	21
		Lean Concrete (MPa)	16	16
	Reinforcing Bars	Yield Strength, f_y (MPa)	415 (ϕ16, ϕ20, ϕ25, ϕ32)	
		Yield Strength, f_y (MPa)	276 (ϕ10, ϕ12)	
	Structural Steel, f_y (MPa)		SM400, SM490, S10T	SM400, SM490, S10T
	Structural Steel (Piles), f_y (MPa)			
Others			GOS/MRB BDM, AASHTO	GOS/MRB BDM, AASHTO

*MRB, RSS – Ministry of Roads and Bridges, Republic of South Sudan

Table 2-2-13 Initial Screening for Main Span

Span Arrangement Alternatives	No. of Piers in River	Relative Cost	Remarks	Eval.
1. CONCRETE BRIDGE				
ALTERNATIVE 1  SPAN : 70+2@105+70 = 350M **4-SPAN CONTINUOUS PRESTRESSED CONC. BOX GIRDER**	3	Sub : 0.433 Super: 0.686 Total : 1.119	• Relative Construction Period: 1.175 • Girder depth : 6m – 3m • Least obstruction to river flow • Aesthetically pleasing • Less maintenance	△
ALTERNATIVE 2  SPAN : 55+3@80+55 = 350M **5-SPAN CONTINUOUS PRESTRESSED CONC. BOX GIRDER**	4	Sub : 0.489 Super: 0.601 Total : 1.090	• Relative Construction Period: 1.275 • Girder depth : 4.5m – 2.5m • Moderate obstruction to river flow • Aesthetically pleasing • Less maintenance	○
ALTERNATIVE 3  SPAN : 45+4@65+45 = 350M **6-SPAN CONTINUOUS PRESTRESSED CONC. BOX GIRDER**	5	Sub : 0.613 Super: 0.550 Total : 1.163	• Relative Construction Period: 1.375 • Girder depth : 3.75m – 2m • Greatest obstruction to river flow • Too many piers • Less maintenance	△
2. STEEL BRIDGE				
ALTERNATIVE 4  SPAN : 4@87.5 = 350M **4-SPAN STEEL TIED ARCH (LONGHER TYPE)**	3	Sub : 0.380 Super: 0.600 Total : 0.980	• Relative Construction Period: 0.90 • Girder depth : 2.0m • Least obstruction to river flow • Aesthetically pleasing • Requires repainting	◎
ALTERNATIVE 5  SPAN : 5@70 = 350M **5-SPAN STEEL TIED ARCH (LONGHER TYPE)***	4	Sub : 0.430 Super: 0.570 Total :**1.000**	• Relative Construction Period: 1.0 • Girder depth : 1.8m • Moderate obstruction to river flow • Aesthetically pleasing • Requires repainting	◎
ALTERNATIVE 6  SPAN : 6@58.33 = 350M **6-SPAN STEEL TRUSS**	5	Sub : 0.492 Super: 0.547 Total : 1.039	• Relative Construction Period: 1.15 • Girder depth : 1.5m • Greatest obstruction to river flow • Simple/Too many piers • Requires repainting	△
ALTERNATIVE 7  SPAN : 70+2@105+70 = 350M **4-SPAN STEEL CONTINUOUS BOX GIRDER**	3	Sub : 0.413 Super: 0.737 Total : 1.150	• Relative Construction Period: 0.90 • Girder depth : 4.0m • Least obstruction to river flow • Simple view • Requires repainting	△
ALTERNATIVE 8  SPAN : 55+3@80+55 = 350M **5-SPAN STEEL CONTINUOUS BOX GIRDER**	4	Sub : 0.467 Super: 0.659 Total : 1.126	• Relative Construction Period: 0.95 • Girder depth : 3.0m • Moderate obstruction to river flow • Simple view • Requires repainting	△

NOTE: *Relative Cost and Construction Period compared to Alternative 5 Bridge.

◎ – Recommended Option ○ – Alternate Option △ – Possible Option

Table 2-2-14 and **Table 2-2-15** presented the summary and detailed comprehensive comparison of different types of bridge. Based on this comparison, the Steel Langer Arch Bridge with four (4) spans is recommended.

Table 2-2-14 Comparative Summary of the Main Bridge Type

Alternative	Bridge Type	Construction Cost	Aesthetics/Scenery	Remarks
Alternative 1	Steel Langer Arch Bridge (4 Span)	1.0	○	Bridge aesthetics/ scenery depends on person, evaluation done in consultation with MRB.
Alternative 2	Steel Box-Girder Bridge (5 Span)	1.12	△	
Alternative 3	PC Box-Girder Bride(5 Span)	1.08	○	

However, if the bridge's length is about 80m, the PC Box-Girder might be advantageous but due to the following problems Alternative 1 is more advantageous in terms of construction cost:

- Quality and high cost of aggregate for PC concrete,
- Quality and high cost of rebar,
- Cement will be procured from South Africa or from Asia to ensure quality and becomes expensive (there are concerns that the poor quality of cement in neighboring countries may not guarantee the required strength and stability of PC concrete).
- Under the on-going bridge grant for peace building, more skills are necessary to handle concrete due to cement quality issues,
- There is relatively shallow bedrock in the riverbed which might require relatively expensive foundation work is PC Girder is used.

Compared to concrete bridge, steel bridge requires maintenance in a humid environment like Japan which needs application of paint to prevent rust for 20 years. However, the steel piers of the existing Juba Bridge (bailey bridge) have been exposed for almost 40 years but does not show any environmental problem. Moreover, it may be more economical to use weathering steel (corrosion resistant) for steel bridges. Concrete bridge, on the other hand, may deteriorate with time especially when cracks starts to appear but with proper maintenance steel bridges may be more durable than concrete bridges in any environment. It is also known that more historical bridges in the world are made of steel.

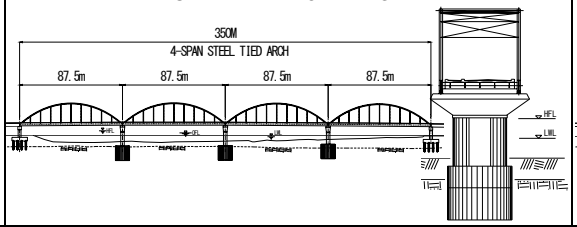
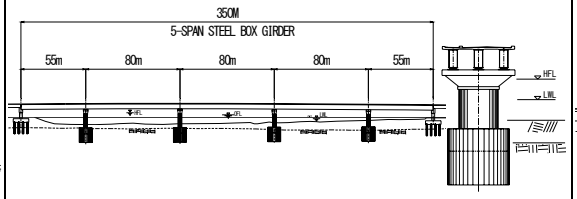
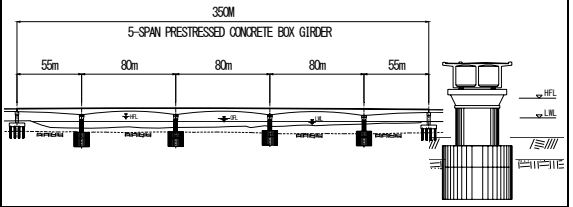
2) Form of the Approach Bridge Structure

The following bridge types are compared for the approach bridge section (see **Table 2-2-2-16**), assuming that the superstructure of the main channel is Steel Langer arch bridge:

- Precast PC girder bridge
- Steel I-Girder Bridge (Reinforced Concrete Deck Slab)
- Steel I-Girder Bridge (PC Slab Deck)

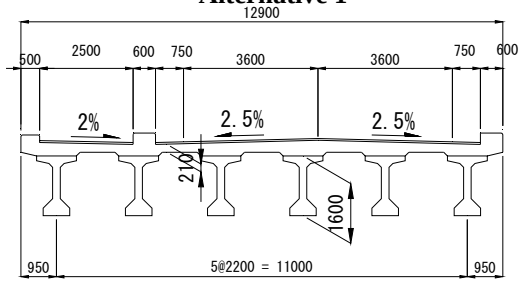
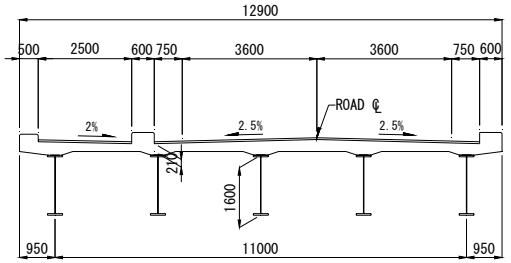
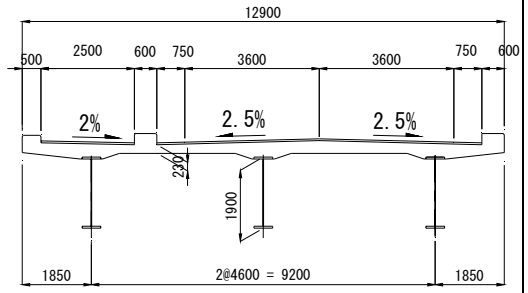
After comparing the structural integrity, workability, construction cost, construction period, aesthetics and environment, etc., it is recommended to use the steel I-girder bridge with concrete deck. Although steel I-girder bridge with precast prestressed deck is a little more economical, the difficulty of ensuring prestressed concrete quality overruled the advantage.

Table 2-2-15 Comparison of Main Bridge Span Alternatives for Nile River Bridge Crossing

		ALTERNATIVE 1 STEEL TIED ARCH BRIDGE	ALTERNATIVE 2 STEEL BOX GIRDER BRIDGE	ALTERNATIVE 3 PRESTRESSED CONCRETE BOX GIRDER BRIDGE
ALTERNATIVE LAYOUT (Main bridge basically covers the ordinary waterway at 350m wide)				
STRUCTURAL SYSTEM		• Superstructure consists of four-span steel tied arch (4@87.5m) with reinforced concrete slab and bearings at piers. • More flexible superstructure compared to Alternative 3. Serviceability in terms of deflection is less than Alternative 3 but better than Alternative 2. • Bottom chord depth is 2.0m which requires lowest deck profile among three alternatives. • Substructures are single column concrete wall piers on steel pipe pile caisson foundation embedded on rock base. • Steel members, bearings and expansion joints need routine inspection and maintenance. • Maintenance of steel members can be done by using long-lasting paint (20 years life) or corrosion resistant materials. ○	• Superstructure consists of five-span continuous steel steel box girder (55m+3@80m+55m) with reinforced concrete slab and bearings at piers. • More flexible superstructure compared to Alternatives 1 & 3. Least serviceability among three alternatives with higher deflection. • Girder depth is 3.2m which requires deck profile height in between Alternatives 1 & 3. • Substructures are single column concrete wall piers on steel pipe pile caisson foundation embedded on rock base. • Steel members, bearings and expansion joints need routine inspection and maintenance. • Maintenance of steel members can be done by using long-lasting paint (20 years life) or corrosion resistant materials. ○	• Superstructure consists of five-span continuous prestressed concrete box girder (55m+3@80m+55m) with bearings at piers. • More rigid than Alternatives 1 & 2. Serviceability is better with less deflection and better driving condition • Deeper girders (4.5m at piers and 2.25m at mid-span) which will need highest deck profile. • Substructures are single column concrete wall piers on steel pipe pile caisson foundation embedded on rock base. • Intermediate expansion joints are eliminated due to girder continuity. • Concrete basically requires minimal maintenance but bearings and expansion joints need routine inspection and maintenance. ◎
CONSTRUCTION	Method	• Temporary bridge/craneway is erected for substructure and superstructure construction. • Foundation is constructed by driving steel pipe piles to rock forming a caisson type foundation with cast-in-place concrete. Steel pipes are cut at top of footing upon completion of caisson. • Least number of piers (3 piers) offers least difficulty and safer in river construction. • Superstructure is fabricated elsewhere, transported into short sections and erected by crane and temporary bents/supports. • Erection of arch members requires higher level support/temporary works but with smaller members than Alternative 2 – easier to handle during erection. • Quality control is easier since members are fabricated in shop and assembled using high-tension bolts. ◎	• Temporary bridge/craneway is erected for substructure and superstructure construction. • Foundation is constructed by driving steel pipe piles to rock forming a caisson type foundation with cast-in-place concrete. Steel pipes are cut at top of footing upon completion of caisson. • Four piers on river require more construction efforts and difficulties than Alternative 1. • Superstructure is fabricated elsewhere, transported into short sections and erected by crane and temporary bents/supports. • Deeper structural members than Alternative 1 requires more handling and bigger equipment than Alternative1. • Quality control is easier since members are fabricated in shop and assembled using high-tension bolts. ○	• Temporary bridge/craneway is erected for access and substructure construction. • Foundation is constructed by driving steel pipe piles to rock forming a caisson type foundation with cast-in-place concrete. Steel pipes are cut at top of footing upon completion of caisson. • Four piers with bigger dimensions require more effort and difficulties than Alternatives 1 & 2. • Superstructure is erected by balanced cantilevering-out from the piers – special equipment and geometric control during construction is necessary. • Construction Reliability is difficult to assure and requires strict quality control during casting concrete due to quality of cement, aggregates, hot temperature and dry air. Difficult to control quality of prestressed concrete. △
	Cost	• Relative cost is 1.00, cheapest among three schemes. ◎	• Relative cost is 1.13, most expensive among three schemes. △	• Relative cost is 1.09, more expensive than Scheme 1. ○
	Period	• Relative duration is 1.00, shortest period among three schemes. ◎	• Relative duration is 1.06, intermediate period among three schemes. ○	• Relative duration is 1.28, longest period among three schemes. △
	Materials	• Steel pipe piles, steel arch sections and accessories are prefabricated in other countries and transported to site by sea and by land. • Steel member sizes are easier to transport than Alternative 2 due to smaller sizes. • Cement and reinforcing bars are imported from other countries. • Quality of steel members, fabrication and erection is easy to control. ◎	• Steel pipe piles and steel box girder sections and accessories are prefabricated in other countries and transported to site by sea and by land. • Steel members are more difficult to transport due to bigger sizes. • Cement and reinforcing bars are imported from other countries. • Quality of steel members, fabrication and erection is easy to control. ○	• Steel pipe piles and accessories are imported from other countries.. • Good quality cement, reinforcing bars and prestressing strands are imported from other countries which makes it more expensive than other schemes. • Difficult to obtain good aggregate sources for high strength concrete. • Difficult to assure concrete strength. △
RIVER HYDRAULICS		• The superstructure clears the high flood level (100yrs return) by 1.5m. • Lowest vertical profile requirements due to least girder depth. • Only three piers encroaches the river – least river flow and discharge obstruction among three alternatives. • Structure spans 87.5m which is sufficient for river discharge hydraulics – longest span among three alternatives. ◎	• The superstructure clears the high flood level (100yrs return) by 1.5m. • Moderate vertical profile requirements due to deeper girder depth than Alternative 1. • Four piers encroaching the river offer more obstruction to river flow and discharge. • Structure spans 80m which is sufficient for river discharge hydraulics – shorter span than Alternative 1 offers less opening. ○	• The superstructure clears the high flood level (100yrs return) by 1.5m. • Highest vertical profile requirements due to deepest girder depth. • Four piers encroaching the river offer more obstruction to river flow and discharge.. • Structure spans 80m which is sufficient for river discharge hydraulics – shorter span than Alternative 1 offers less opening. △
AESTHETIC & ENVIRONMENT		• Series of arches suits well with the view and environment. Can become a landmark and symbolic structure. • Better aesthetic impact can be achieved by choice of paint color to suit the area. • Construction method offers less impact to environment. • The use of long-life paint or corrosion resistant (anti-weathering) steel minimizes impact to environment due to painting works. ◎	• Constant girder depth offers monotonous view of the bridge. • Better aesthetic impact can be achieved by choice of paint color to suit the area. • Construction method offers less impact to environment. • The use of long-life paint or corrosion resistant (anti-weathering) steel minimizes impact to environment due to painting works. △	• Simple and elegant structure with varying girder depth. Less obstruction to river view. • Color of concrete is simple in view. • Construction method offers less impact to environment. • Minimal maintenance have less impact to environment. ○
EVALUATION		• RECOMMENDED (Cheapest structure with symbolic view; shortest period to construct; shallow girder depth requires lowest deck profile; least river encroachment.) ◎	• NOT RECOMMENDED (Most expensive structure with monotonous view; r than 3.2m depth steel box girders are difficult to transport and handle.) △	• ALTERNATE SCHEME (Reasonable structure cost with elegant view; more rigid, robust structure gives better serviceability; but construction reliability for Prestressed concrete may be difficult to assure due to quality of materials and hot and dry weather environment.) ○

Notes: ◎ – Excellent ○ – Good △ - Acceptable

Table 2-2-16 Superstructure Alternatives for Nile River Bridge Approach Span Considering Steel Tied Arch Main Bridge

	Alternative 1	Alternative 2	Alternative 3
SUBSTRUCTURE SCHEME	 **PRECAST/PRESTRESSED CONCRETE AASHTO GIRDERS**	 **STEEL I-GIDERS WITH CONCRETE DECK**	 **STEEL I-GIRDERS WITH PRESTRESSED DECK**
STRUCURAL CHARACTERISTICS	• Main structure is Precast and Prestressed Concrete AASHTO Girders made continuous under live load. • Deck slab is reinforced concrete cast-in-place made composite with girders to support negative moments under live load. • Expansion joints are minimized by making slabs continuous over supports. • Girders are supported on bearings at pier supports. • Requires less maintenance but needs regular inspection especially at prestress anchorage and girder joint connections. • Member strength is difficult to assure for prestressed and high strength concrete. • Not suitable for steel main bridge due difference in structural rigidity which causes damage to slab and expansion joints. • Presents serviceability issues due to difference in structural response and deflection with steel main bridge causing discomfort in driving and to pedestrians. △	• Main structure is Steel I-Girders which can be simply supported or continuous over supports. • Deck slab is reinforced concrete cast-in-place. • Expansion joints are minimized by making slabs continuous over supports. • Girders are supported on bearings at pier supports. • Maintenance of steel members can be done by using long-lasting paint (20 years life) or corrosion resistant materials. • Member strength reliability is better than Alternatives 1 & 3 since steel members are prefabricated on shop and erected in place by cranes. Easier to control quality of reinforced concrete deck. • Suitable for steel main bridge span with similar structural rigidity and response. ◎	• Main structure is Steel I-Girders continuous over supports – girder spacing is farther than Alternative 1. • Deck slab is precast and prestressed concrete. • Expansion joints are minimized by making slabs continuous over supports. • Girders are supported on bearings at pier supports. • Maintenance of steel members can be done by using long-lasting paint (20 years life) or corrosion resistant materials. • Member strength reliability is difficult to assure for prestressed and high strength concrete deck slab. • Suitable for steel main bridge span with similar structural rigidity and response. ○
CONSTRUCTION METHOD AND TEMPORARY WORKS	• Girders are precast and prestressed in fabrication yard (on-site) and erected by cranes – girder weight is heaviest among alternatives. • Concrete deck slab is cast-in-place with suspended formworks from the girders. • Quality of prestressed concrete girder is difficult to assure for materials and workmanship. △	• Steel I-Girders are prefabricated in shop and erected by cranes with temporary bents if continuous over piers – members are lighter than Alternatives 1 & 3. • Concrete deck slab is cast-in-place with suspended formworks from the girders. • Quality of girder is assured since it is fabricated in plant and erected in place using bolts. ◎	• Steel I-Girders are prefabricated in shop and erected by cranes with temporary bents – heavier than Alternative 2. • Prestressed slab are precast in fabrication yard and erected by cranes on girders. • Quality of prestressed concrete slab is difficult to assure for materials and workmanship. • Quality of steel girder is assured since it is fabricated in plant and erected in place using bolts. ○
CONSTRUCTION COST	• Cost Factor = 1.05 (Most expensive among three alternatives) △	• Cost Factor = 1.00 ○	• Cost Factor = 0.98 (Similar cost to Alternative 2) ◎
CONSTRUCTION PERIOD	• Similar construction period with Alternative 2. ○	• Similar construction period with Alternative 1. ○	• Fastest to construct among three alternatives since deck slab is precast. ◎
AESTHETIC AND ENVIRONMENT	• View is simple and similar to other alternatives. • Minimal impact to environment during construction. ○	• View is simple and similar to other alternatives. • Minimal impact to environment during construction. ○	• View is simple and similar to other alternatives. • Minimal impact to environment during construction. ○
EVALUATION	**APPLICABLE** (More expensive and difficult to assure precast concrete girder quality due to materials and environment; appropriate for prestressed concrete box girder main span.) △	**RECOMMENDED** (Cheap and fast to construct with quality assurance better than the other alternatives) ◎	**APPLICABLE** (Cheap and fast but difficult to assure precast concrete slab quality due to materials and hot and dry weather.) ○

Notes: ◎ – Excellent ○ – Good △ – Acceptable

(11) Substructure and Foundation Design

1) Main Span

Three types of substructures were considered for the bridge main span in the main channel (span range 80m-90m) – the spread footing using cofferdams, multiple piles (pile cap above water level) and steel pipe sheet pile foundation. The three alternatives were evaluated based on foundation characteristics, construction method, cost, construction period and impact to environment (see **Table 2-2-18**). The results of evaluation indicated that the steel pipe sheet pile foundation is recommended by virtue of cost and least impact to environment during construction.

Figure 2-2-14 shows the basic sequence of steel pipe sheet pile construction. As described in **Table 2-2-17**, the steel pipe sheet pile foundation is to reduce the turbidity of water during construction to minimize the effects of sulfide after completion. This creates advantages to construction such as less impact on the quality of water flow.

Table 2-2-17 Basic Overview of the Steel Pipe Sheet Pile Construction

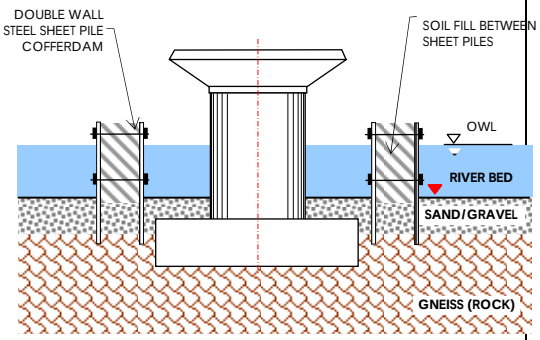
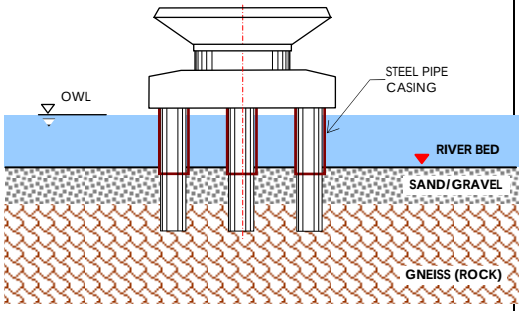
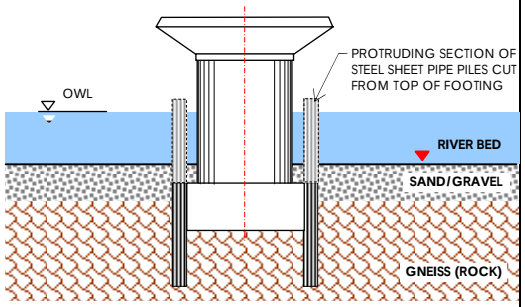
1. Rock Drilling for Steel Pipe Sheet Pile The casing tube is drilled to the rock layer by casing tube rotating method (Japanese construction method for pile foundation) and rock is excavated by percussion method. The steel pipe sheet pile is then inserted into position acting as a cofferdam for foundation construction.	**2. Setting of Steel Pipe Sheet Pile (Cofferdam)** The steel pipe sheet piles are then inserted and set into position with vertical guides and supports to ensure accurate position and proper interlock with adjacent piles. It is necessary to seal the sheet pipe pile joints with mortar seal to keep the cofferdam system watertight for construction of the foundation.
3. Draining Water from Inside the Cofferdam Once the steel pipe sheet pile cofferdam system is completed, water is drained from the inside. It is necessary to provide support inside to resist external forces from water flow pressure.	**4. Rock Excavation for Footing** In order to reach competent rock formation for the footing, rock excavation is undertaken. Rock excavation is done with backhoe inside the cofferdam and excavated materials disposed using clamshell and dump trucks.
5. Pier Footing, Column and Coping Construction After establishing the footing level, footing construction follows with reinforcement and concrete works. It is important to establish the proper connection of the footing with the steel pipe sheet piles. Construction of pier footing and coping then follows.	**6. Steel Pipe Sheet Pile Cutting** After completing the pier construction, the protruding section of the steel pipe sheet pile is cut from the inside. The steel pipe piles protect the divers from possible crocodile attacks in the river.
7. Steel Pipe Sheet Pile Removal The cut sections of the steel pipe sheet piles are then removed and stored in designated areas. This can still be utilized as cofferdam material for other foundation areas when necessary.	**8. Substructure Completion** The substructure is then completed. This foundation system is a common Japanese technology and highly reliable which can function as a temporary cofferdam for pier construction in the river.

2) Approach Span

Since the span length of the approach bridge is only 30m, the following foundation system were compared from the viewpoint of environmental impact: spread footing (direct foundation), concrete cast in place pile foundation and steel pipe pile foundation. The comparison of alternative foundation type is done based on foundation characteristics, construction method, cost, construction period and impact to environment (see **Table 2-2-19**). Direct bearing foundation is economical for excavation depth less than 5m but when the excavation depth is more than 5m, cast-in-place pile foundation is recommended. The following are the recommended foundation types for the bridge.

Main Span : Steel Sheet Pipe Pile Foundation
Approach Span : Concrete Cast-in-Place Pile Foundation

Table 2-2-18 Substructure Alternatives for Nile River Bridge Main Span

	Alternative 1	Alternative 2	Alternative 3
SUBSTRUCTURE SCHEME	 **SPREAD FOOTING**	 **MULTIPLE PILES AND PILE CAP**	 **STEEL PIPE SHEET PILE CAISSON**
CHARACTERISTICS	• Spread footing sits directly on rock layer. • Footing base can support large vertical and horizontal loads but requires large base. Largest dimension among 3 alternatives. • Stability is assured by large footing area. • Needs excavation in sand/gravel and rock layer to anchor base. • Cofferdam necessary to construct the pier and foundation which will be embedded to rock below scour level. ○	• Multiple rows of concrete pile bent is constructed to penetrate the rock layer with pile cap above water level. • Piles can support large vertical and horizontal loads by direct bearing to rock layer. • Stability is assured by compression and tension action of piles. • Rows of piles obstruct river flow and may cause debris accumulation during flood • Needs to drill in rock to anchor base with steel casing from river bed to contain concrete during construction. △	• Steel pipe sheet pile is used as temporary and permanent works for the caisson foundation. • Supports large vertical and horizontal loads by direct bearing and anchorage to rock. • Stability is assured by combination of steel pipe piles and concrete footing. • Least dimension among the three alternatives – minimal impact to river during and after construction. • Excavation and drilling on rock necessary for pipe piles and footing. ◎
CONSTRUCTION METHOD AND TEMPORARY WORKS	• Use of temporary bridge and working platform or crane on barge and embankment island or steel sheet pile cofferdam • River bed excavation (sand/gravel until rock layer) undertaken after removal of water inside cofferdam. • Large base area requires large amount of rock excavation. • Removal of temporary cofferdam necessary after completion of pier and foundation. △	• Use of temporary bridge and working platform or crane on barge construct cast-in-place piles. • Steel pile or steel casing driven to rock layer by casing tube rotating method – drilling to penetrate rock layer. • Steel casing necessary to remain at water section. • Pile cap constructed above ordinary water level to avoid concreting under water. ○	• Use of temporary bridge and working platform or crane on barge to drive steel pipe sheet piles. • Steel pipe sheet pile is driven to rock layer by casing tube rotating method and sealed to function as cofferdam. • Footing is connected to steel pipe sheet piles and functions as caisson foundation with piles embedded to rock. • Protruding section of pipe sheet piles cut after completion of pier and foundation. ◎
CONSTRUCTION COST	• Most expensive among three alternatives due to larger scale and bigger temporary works/cofferdam and difficulty in construction. Cost Factor = 1.20. △	• Similar cost to Alternative 3 due to pile requirements and suspended formworks for pile cap. Cost Factor = 1.00 ○	• Similar cost to Alternative 2 due to smaller scale and easier to construct. Cost Factor = 1.05 ◎
CONSTRUCTION PERIOD	• Longest period to construct among three alternatives. △	• Faster to construct than Alternative 1 but longer than Alternative 2. △	• Fastest to construct among three alternatives. ◎
IMPACT TO RIVER AND ENVIRONMENT	• Less obstruction to river after completion since footing is below river bed. • Construction presents greatest impact to environment due to temporary cofferdam obstructing river flow. △	• Multiple pile obstructs river flow with possible accumulation of debris on piles during flood. • Construction impact is less than Alternative 1. △	• Less obstruction to river after completion since foundation is below river bed. • Least impact to environment during construction. ◎
EVALUATION	**APPLICABLE BUT COSTLY AND DIFFICULT TO CONSTRUCT** △	**APPLICABLE BUT WITH MOST IMPACT TO RIVER AFTER COMPLETION** ○	**RECOMMENDED** (Cheap and fastest to construct with least environmental impact among three Alternatives) ◎

Notes: ◎ – Excellent ○ – Good △ - Acceptable

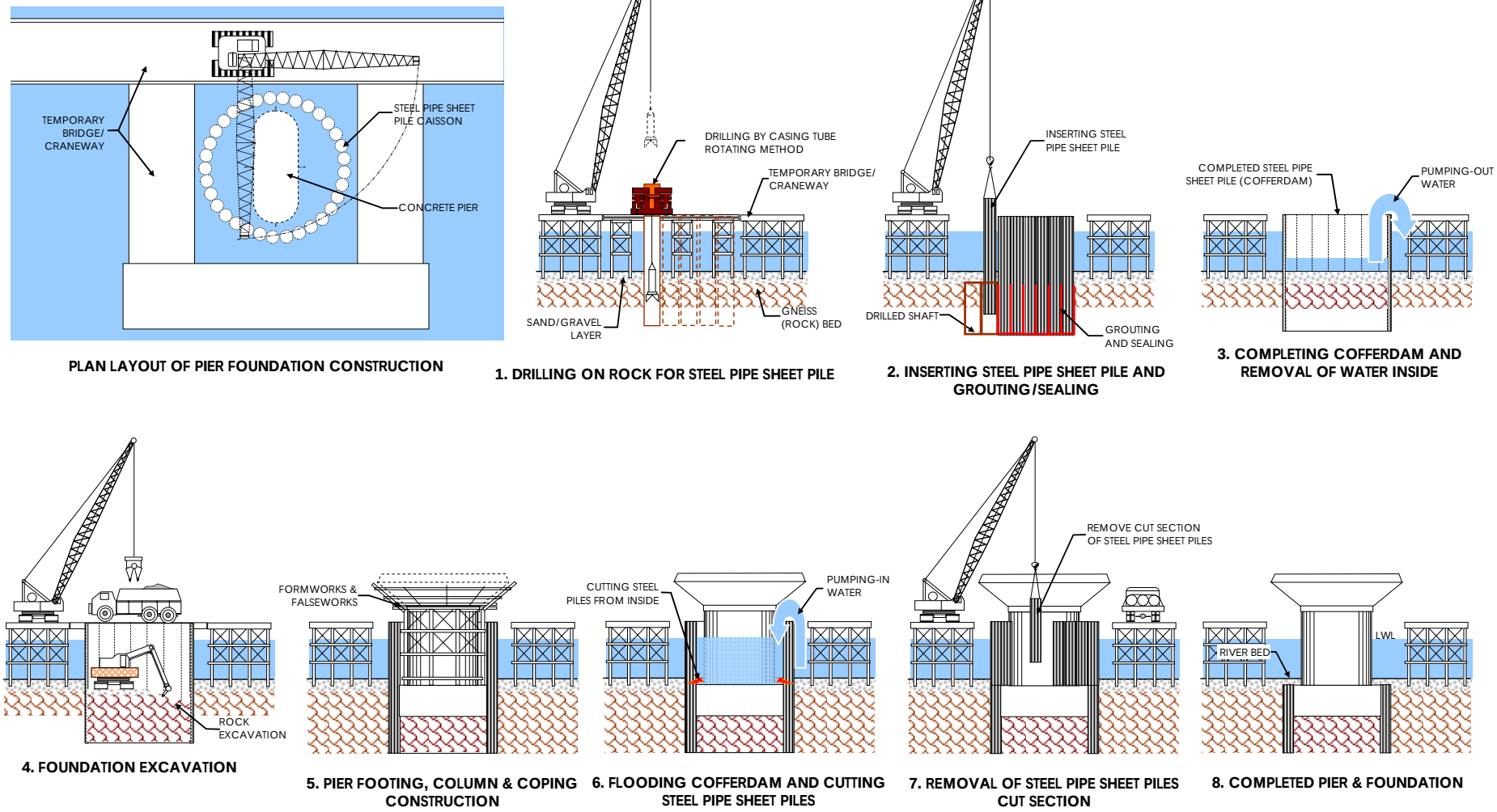
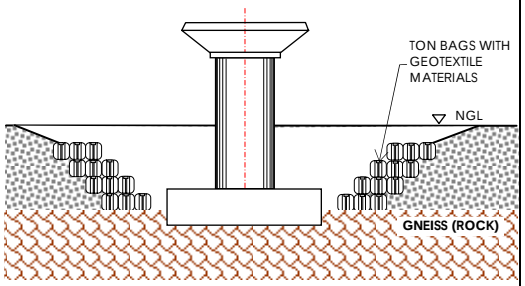
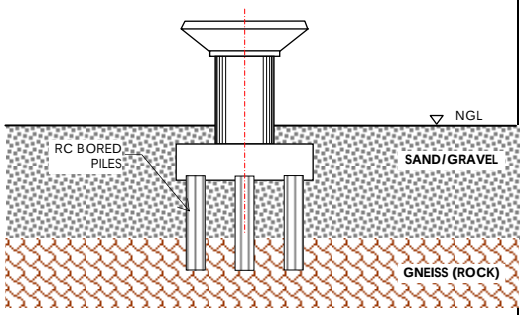
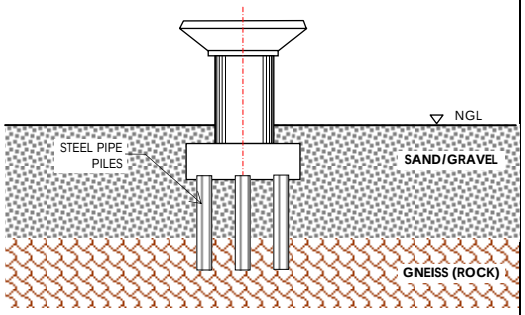


Figure 2-2-14 Steel Pipe Sheet Pile (Caisson) Foundation Construction Sequence

Table 2-2-19 Substructure Alternatives for Nile River Bridge Approach Span

	SHALLOW FOUNDATION	DEEP PILE FOUNDATION	
		Alternative 1	Alternative 2
SUBSTRUCTURE SCHEME	 SPREAD FOOTING	 CONCRETE BORED PILES (CAST-IN-PLACE)	 STEEL PIPE PILES
CHARACTERISTICS	• Applicable for footing depth until 5m depth. • Spread footing sits directly on rock layer. • Footing base can support large vertical and horizontal loads but requires large base. • Stability is assured by large footing area. • Requires large working area due to deep excavation in sand/gravel layer. Excavated area needs protection for stability using ton bags or cofferdams. • Footing needs to be anchored to rock layer requiring hard rock excavation. • Requires area for storing excavated materials. • Dewatering to footing depth necessary during construction.	• Multiple rows of concrete cast-in-place piles are constructed to penetrate the rock layer with pile cap constructed below natural ground. • Piles can support large vertical and horizontal loads by direct bearing to rock layer. • Stability is assured by compression and tension action of concrete piles. Side friction capacity mobilized is bigger than driven steel piles. • Pile is anchored to rock layer but lesser rock excavation than spread footing. • Bigger pile size Alternative 2. ◎	• Multiple rows of steel pipe piles are driven to penetrate the rock layer with pile cap constructed below natural ground. • Piles can support large vertical and horizontal loads by direct bearing to rock layer. • Stability is assured by compression and tension action of steel pipe piles. Side friction of piles is less than cast-in-place concrete piles. • Pile is anchored to rock layer but lesser rock excavation than spread footing. • Dewatering is minimal at pile cap level construction only. • Smaller pile size than Alternative 1. ○
CONSTRUCTION METHOD AND TEMPORARY WORKS	• Requires use of temporary access road for construction equipment. • Large and deep excavation area needs stabilization of excavation using ton bags or cofferdam. • Rock excavation requires concrete breaker. • Requires dewatering using wells and pumps during construction. • Concreting of footing requires concrete pump or crane and bucket.	• Requires use of temporary access road for construction equipment. • Driving steel casing and excavation to rock layer done by casing tube rotating method. • Reinforced concrete is cast in steel casing while steel casing is being lifted and removed. • Requires smaller working area than Alternative 2 due to lesser number of piles. • Dewatering is minimal at pile cap level construction only. ◎	• Requires use of temporary access road for construction equipment. • Steel pipe pile is driven to rock layer by casing tube rotating method. • Concrete is cast inside steel pipe. • Requires bigger working area than Alternative 1 due to more number of piles. • Dewatering is minimal at pile cap level construction only. ○
CONSTRUCTION COST	• Cheapest cost for shallow foundation.	• Cheaper than Alternative 2. Cost Factor = 1.00 ◎	• More expensive than Alternative 1. Cost Factor = 1.30 △
CONSTRUCTION PERIOD	• Shortest period for shallow foundation.	• 20% longer than Alternative 2. △	• Faster to construct than Alternative 1. ◎
IMPACT TO ENVIRONMENT	• Large earthworks (excavation and backfill) affect air quality in the area surrounding the site. • Proper disposal site should be identified for excavated materials.	• Minimal impact to environment. ◎	• Minimal impact to environment. ◎
EVALUATION	**APPLICABLE FOR SHALLOW FOUNDATION (D≦5M)**	**RECOMMENDED** (Cheaper, structurally more reliable and requires lesser working area) ◎	**ALTERNATIVE OPTION** ○

Notes: ◎ – Excellent ○ – Good △ - Acceptable

(12) Seismic Design

Occurrence of earthquakes in and around Juba for the past 10 years (1982-1992) has been recorded by the U.S. Geological Survey (USGS). Two major earthquakes took place in 1990 with magnitude of 7.1 and 7.2 with its epicenters 67km and 63km away from Juba City respectively. By applying the available earthquake record to the attenuation equation, the horizontal seismic coefficient for the design of the bridge is determined to be 0.2.

(13) Bridge Facilities Plan

1) Pavement Wearing Course

Wearing course is placed on top of the roadway and sidewalk pavements for added durability. The thickness of wearing course for both the roadway and sidewalk is 5cm.

2) Bridge Roadway Railing

Bridge railings are provided on both sides of the roadway to protect the pedestrians and prevent vehicle collisions with the bridge structure. The railing provided is Railing Type SB (Collision force, F = 58kN; Distributed railing load, P = 22kN/m). The railing material is basically aluminum with steel and cast iron replacement parts readily available when necessary. Corrosion prevention is attained through hot dip galvanization.

3) Sidewalk Railing

Sidewalk railing is also provided to ensure safety of the pedestrians. The shape and type used for sidewalk pedestrian railing shall be similar to the roadway railing for consistency.

4) Drainage

Bridge deck drainage is provided with 150mm diameter steel pipes at 7m~20m intervals at the ends of the road cross slopes. The discharge ends of the drainage pipes are extended below the soffit of girders to prevent superstructure member corrosion and dirt accumulating at the girders.

5) Support Bearing

The Langer arch bridge section (main span) is simply supported with movable and fixed steel bearings. On the other hand, the continuous steel I-girder bridge section (approach span) is provided with rubber elastic bearings. The types and forms of bearings for each pier are summarized in **Table 2-2-20**.

Table 2-2-20 Bearing Type and Bearing Condition

Item	A1	P1	P2	P3	P4	P5		P6		P7		P8		P9		P10	A2
Superstructure	5 Span Steel I-Girder						Langer Arch		Langer Arch		Langer Arch		Langer Arch		2 Span Steel I-Girder		
Bearing Type	Rubber	Rubber	Rubber	Rubber	Rubber	Rubber	BP	BP	BP	BP	BP	BP	BP	BP	Rubber	Rubber	Rubber
Bearing Condition	E	E	E	E	E	E	M	F	M	F	M	F	M	F	E	E	E
Reaction (t)	100	200	200	200	200	100	600	600	600	600	600	600	600	600	100	200	100
Quantity (pc)	5	5	5	5	5	5	2	2	2	2	2	2	2	2	5	5	5

6) Expansion Joint

Expansion joints are provided to allow movement of the superstructure due to certain internal and external forces and conditions (expansion and contraction), including temperature changes. Such expansion joint materials should be durable, easy to maintain and keep the deck joints watertight while maintaining a smooth driving surface. The steel finger type expansion joint is recommended which is consistent with the type of superstructure and economical for this bridge range of movement. The range of movements at the expansion piers are summarized in **Table 2-2-21**.

Table 2-2-21 Expansion Joint Movements

Item	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	A2
Superstructure Type	5 Span Steel I-Girder					Langer Arch	Langer Arch	Langer Arch	Langer Arch	2 Span Steel I-Girder		
Expansion Joint Type	Finger					Finger	Finger	Finger	Finger	Finger		Finger
Joint Gap (mm)	100					400	400	400	400	400		100
Joint Movement (mm)	32					70	40	40	40	13		13

7) Structure Fall-Down Prevention Device

If the bearings and the substructure keys/stoppers are destroyed during earthquakes and floods, fall down prevention devices are installed to prevent collapse of the bridge superstructure. PC cable fall down device is adopted for this bridge since it is economical, easy to maintain and practical to use. **Table 2-2-22** shows the type of fall down devise proposed for this bridge structure.

Table 2-2-22 Bridge Structure Fall-Down Device Schedule

Item	A1	P1	P2	P3	P4	P5		P6	P7	P8	P9		P10	A2
Superstructure Type	5 Span Steel I-Girder					Langer Arch	Langer Arch		Langer Arch		Langer Arch	2 Span Steel I-Girder		
Fall Down Device Type	PC					PC	PC	PC	PC	PC	PC	PC		PC
Reaction (t)	50					70	200	200	200	200	200	70		50
Quantity (pc)	8					5	8	8	8	8	8	5		8

8) Approach Slab

To prevent embankment subsidence at the back side of the abutment, a 5.0m reinforced concrete approach slab is provided.

9) Others

Bridge name plate will be installed at two locations at each end of the bridge. The bridge plate format will be embedded in granite. In addition, lighting equipment shall also be installed.

(14) Road Facilities Plan

1) Slope Protection

The road embankment slope is 1:1.5 with sodding provided on the slope.

2) Drainage Plan

Drainage facilities shall be planned based on the existing drainage system.

Amount of Rainfall

Rainfall intensity used to set the drainage design is difficult due to the absence of historical rainfall data over the past 20 years in Juba city.

Under the USAID Juba-Nimule road project, the drainage design is carried out using a 24-hr rainfall with equal probability as the TRRL 2-year rainfall and prorated the same for 10-year, 25-year and 50-year periods.

Projected Design Daily Rainfall Intensity Ratio

2yr Rainfall 24hrs (mm)	10 yr /2yr Ratio (Volume, mm)	25yr/2yr Ratio (Volume, mm)	50yr/2yr Ratio (Volume, mm)
50	1.64 (82)	1.97 (99)	2.24 (112)

Source: Hydraulic Memo for Juba Nimule Road Project

In drainage design, it is necessary to convert the daily rainfall to hourly rainfall intensity but the MRB Drainage Manual does not contain such provision and as such the following Monobe relationship is applied:

$$R_t = \frac{R_{24}}{24}\left[\frac{24}{t}\right]^{2/3}$$

Where: R_t : per hour rainfall intensity
R_{24} : daily rainfall
t : time flow (hr)

Using the above relationship, the rainfall intensity for each corresponding year is shown below:

Design Rainfall Intensity

2yr (mm/hr)	10 yr(mm/hr)	25yr(mm/hr)	50yr(mm/hr)
36	59	71	81

Source: Study Team

Planning for Scale of Drainage Structure

A review of the Drainage Design Manual by MRB presented in **Table 2-2-23** is carried out to determine the size of the drainage structure plan.

Table 2-2-23 Large Drainage Structure Plan

Structure Type	Geometric Design Standard			
	DS1/DS2	DS3/DS4	DS5/6/7	DS8/9/10
Gutters and Inlets*	10/5	2	2	-
Side Ditches	10	10	5	5
Ford/Low-Water Bridge	-	-	-	5
Culvert, pipe (see Note) Span<2m	25	10	5	5
Culvert, 2m<span <6m	50	25	10	10
Short Span Bridges 6m<span<15m	50	50	25	25
Medium Span Bridges 15m<span<50m	100	50	50	50
Long Span Bridges spans>50m	100	100	100	100
Check/Review Flood	200	200	100	100

Source: MRB Drainage Design Manual

Calculation of Run Off

MRB Drainage Design Manual introduces the two types of runoff calculation methods which are:

- **Rational Method (Rational Formula)**

Rational formula is suitable for calculating the peak discharge of a relatively small urban and rural areas - its scope is less than 50ha catchment area. However, this method might not be suitable if 30 minutes continuous rainfall occurs in the area.

- **SCS Synthetic Unit Hydrograph**

U.S. Soil Conservation Service has developed a synthetic unit hydrograph. This hydrograph is an evolution of observed level of water in many rural and urban areas. The SCS analysis takes into account the terrain and hydrological conditions.

The project road is located in urban areas and estimated to have less than 50ha catchment area. Rational expression is also used for drainage design in Japan due to its higher reliability. A Rational Expression which has proven reliability will also be used for road drainage design of this project.

Details of drainage design and calculations for the rational formula method are described in research prepared reports.

3) Embankment Design

The MRB Bridge Design Manual contains only design on embankment. In addition, as shown in **Table 2-2-24**, the slope is limited in relation to the embankment material.

Table 2-2-24 Maximum Slope and Embankment Material

Slope Material	Max. Slope H:V (angle)	Design Water Velocity (m/s)
Gravel (d_{50}≥70mm)	1.7:1(30°)	≤2m/s
Boulders(d_{50}≥300mm)	1.4:1(35°)	≤2m/s
Boulders(d_{50}≥300mm)	1.7:1(30°)	>2m/s

Source: MRB Bridge Design Manual

Concrete blocks will be utilized in order to prevent slope destabilization and erosion of embankment around the abutment. The concrete block will have a slope of 1:2 in accordance with Japan River Structures. In addition, gabion mattress will be employed at the base of the slopes.

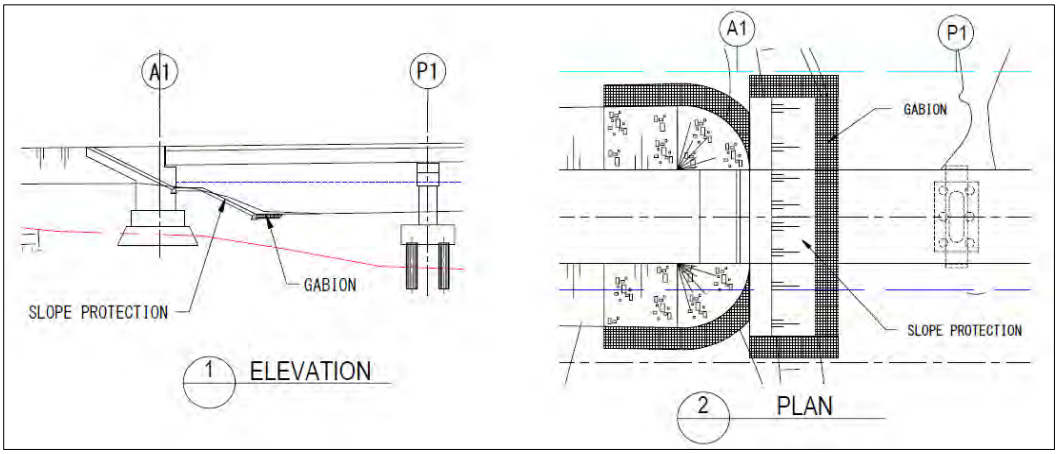


Figure 2-2-15 Protection Plan under the Abutment Cross-Section

The following points should be considered for rock revetment:

- Although the average discharge velocity of the overflow section near the left bank is only 0.30m/s, local flow generated by changes in high water runoff may cause erosion of the bank. On the other hand, the average velocity at the right bank is 1.2m/s which may cause erosion of the area. As a precaution, revetment works is required.
- The probability of high water level exceeding that of the 50-year or the 100-year return period will cause higher flow velocity rates near the bank. In this case, for high flow rates revetment works is necessary.
- At the base of the left bank, there is a small channel of about 3-5m wide and 1m depth. Moreover, during high water level flood, water receding from the top of the bank may cause scouring of the bank base. The base of this slope must therefore be stable and well protected.
- The upper section of the river banks are being used by the locals for brick production where clay materials are taken from the bank itself. Sufficient protection measures of the abutment and its slope must be considered after construction to prevent such activity from affecting the abutment structures.

4) Safety Facility/Utility

As a safety facility measure, pavement markings will be installed for this project.

There are no utilities affected by the project within the area.

2-2-3 Outline Design Drawings

The List of Outline Design Drawings is presented in **Table 2-2-25** while the drawings are attached as Appendix to this report.

Table 2-2-25 Outline Design Drawings

Item No.	Drawing Title	No. of Sheets	Drawing No.
1	LOCATION MAP	1	NB-01
2	PROJECT SITE DEVELOPMENT	1	NB-02
3	HORIZONTAL ALIGNMENT REFERENCE (1)~(3)	3	NB-03~05
4	GENERAL PLAN AND PROFILE (1)~(8)	8	NB-06~13
5	TYPICAL CROSS-SECTION OF APPROACH ROAD	1	NB-14
6	GENERAL VIEW OF THE BRIDGE	1	NB-15
7	SUPERSTRUCTURE LAYOUT AND TYPICAL SECTIONS (A1~P5)	1	NB-16
8	SUPERSTRUCTURE LAYOUTAND TYPICAL SECTIONS (P5~P9 LANGER ARCH)	1	NB-17
9	TYPICAL DETAILS OF SUPERSTRUCTURE FOR P5~P9 (LANGER ARCH)	1	NB-18
10	SUPERSTRUCTURE LAYOUT AND TYPICAL SECTIONS (P9~A2)	1	NB-19
11	ABUTMENT-A1 LAYOUT AND DIMENSIONS	1	NB-20
12	DIMENSION DETAILS FOR PIER-1~PIER-5	5	NB-21~25
13	DIMENSION DETAILS FOR PIER-6~PIER-8	3	NB-26~28
14	DIMENSION DETAILS FOR PIER-9~PIER-10	2	NB-29~30
15	ABUTMENT-A2 LAYOUT AND DIMENSIONS	1	NB-31
16	DRAINAGE DETAILS OF APPROACH ROAD (1)~(7)	7	NB-32~38
17	DRAWINGS FOR CONCRETE PAVEMENT CONSTRUCTION (1)~(2)	2	NB-39~40
18	ANCILLARY STRUCTURE(1)~(2)	2	NB-41~42
19	SLOPE PROTECTION LAYOUT AND DETAILS(1)~(2)	2	NB-43~44

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The basic points for implementation of the project are as follows:

- This project will be implemented under the Grant Aid Scheme of the Government of Japan (GOJ) in accordance with the Grant Agreement (G/A) and the Exchange of Notes (E/N) by the Republic of South Sudan (RSS) and the GOJ.

- The executing agency for the implementation of the project is the Ministry of Roads and Bridges (MRB) of the Republic of South Sudan.
- The consulting services including detailed design, tender-related works and construction supervision services, will be provided by a Japanese consulting firm in accordance with the consultancy contract that shall be executed with the Republic of South Sudan.
- The construction of bridge will be executed by a Japanese construction firm that shall be selected through pre-qualification and bidding, in accordance with the construction work contract that shall be executed between the said construction firm and the Republic of South Sudan.

The basic policies for the construction/procurement of this project are as follows:

- The equipment, materials and labor for construction shall be, as much as possible, procured locally. In cases where local procurement is not possible, they shall be procured either from a third country or from Japan where it is most economical insofar as the required quality and supply are secured.
- Construction method and the construction process shall be consistent with the local climate, topography, geology and natural conditions including the river characteristics.
- Appropriate and rational planning shall be carried out including construction method, machinery, equipment, skilled labor etc. Construction works which requires special technique or skilled labors will consider dispatch from Japan or outsourcing skilled labors from third countries. However, procurement of non-skilled labors should be sourced out from Southern Sudan and neighboring countries as much as possible.
- The contractor's site organization shall be planned to satisfy the established construction specifications and construction management standards set for this project. Likewise, the consultant's organization shall be based on such project management standards.
- To ensure safety during construction, appropriate traffic management plan including placement of construction and deployment of traffic personnel shall be considered.
- Environmental protection works shall be set up to reduce the negative impacts of construction activities including measures against river water contamination or sediment discharge into the river during excavation, proper management of borrow pits, proper disposal of construction waste at areas designated by the Republic of South Sudan, etc.
- If it is necessary to utilize river water during concrete works, the concrete batching plant location shall avoid flooded areas to minimize increase in river water turbidity during flood season. Moreover, the water wells built during the bridge construction shall be left for the use of the residents after the project.

2-2-4-2 Implementation Conditions

(1) Considerations on the Natural Conditions

The low water period in the project site occurs from November to June where the river channel during this period is 350m wide and about 3.0m deep. However, the high water period is from July to October where the river's overflow section gets flooded. Under this condition, the construction

plan for the whole year should consider the annual flood water level with temporary facilities designed not to inhibit the water flow during the flood season. Proper construction plan considering the variation in river water level (low and high water level season) will ensure smooth construction progress, safety and economy.

(2) Social and Environmental Consideration

The project involves construction of a new road to be carried out within the right-of-way provided by the government. However, the right bank and left bank of the river where the project site is located are both residential and crop production areas. Mitigation measures to minimize social and environmental impact around the construction site shall be considered during construction, e.g. water sprinkling to reduce dust particles during road construction, construction wastewater treatment, sediment control, soil stabilization and river water pollution and air pollution control during construction.

(3) Transportation Planning

The major items to be transported to designated areas at the construction site include ready-mix concrete, road base and sub-base materials and embankment materials. These will be carried until near the river banks during construction.

2-2-4-3 Scope of Works

The responsibilities to be borne by Japan and the Republic of South Sudan are summarized in **Table 2-2-26**.

Table 2-2-26 Responsibility of Each Government

Item	Content	Responsible		Remarks
		Japan	South Sudan	
Land acquisition (ROW) and house relocation	Land acquisition and house relocation		○	
Procurement	Procurement of materials and equipment	○		
	Custom clearance of materials and equipment		○	
Construction Preparation	Land acquisition necessary for construction		○	Project office, accommodation, equipment storage yard, workshop, etc.
	Preparation other than above	○		
Removal/relocation of obstruction to construction	Relocation of obstruction		○	Utility poles, power lines, water, telecommunications, and tree
Permission to use river water	Request for exemption/ permission from WWRMI		○	
Main Construction	Bridge construction; access road construction	○		Bridge, access road, embankment and slope protection construction
	Approach roads construction		○	Sub-base/base course construction; pavement construction

2-2-4-4 Consultant Supervision

Basically, the Japanese Consultant will enter into an agreement with the Republic of South Sudan to undertake the detailed design and construction supervision of the project.

(1) Major Works to be Undertaken

The major works to be carried out by the consultant during detailed design are as follows:

- Undertake consultations with concerned authorities of South Sudan; field surveys,
- Detailed design and drawings preparation
- Project cost estimate

The duration to carry out the detailed design work is about 5 months.

(2) Bidding Activities

The major tasks to be undertaken from bid announcement to construction agreement include:

- Preparation of bid documents (in parallel with detailed design).
- Bid announcement
- Pre-qualification of bidders
- Bidding
- Evaluation of bid documents
- Preparation of Contract Agreement

The duration of the bid-related activities is about 6.5 months.

(3) Construction Supervision

The Consultant will supervise the Contractor's planning and implementation of the construction contract. The major tasks under this stage include:

- Verification/Approval of related surveys and quantities
- Review/Approval construction plans
- Quality Control
- Process Control
- Work Output Control
- Safety Management
- Turnover Inspection and Acceptance

The duration of construction supervision is approximately 40 months.

The construction supervision team shall consists of: 1-Resident/Chief Engineer (Japanese), 1-Bridge Engineer/Superstructure (Japanese), 1-Safety Engineer (Local), 2-Site Inspectors (Local) and 1-Utility Personnel (Local). Moreover, the Chief Engineer may dispatch Inspector/s for turnover inspection during completion.

2-2-4-5 Quality Control Plan

The tasks to be carried out for quality control during the construction period are as follows:

- Concrete Works
- Reinforcing Bars and Formworks

- Earthwork
- Pavement Works
- Structural Shapes and Dimensions
- Steel Works (Materials and Erection)

Based on the above, the quality control items for Concrete works are presented in **Table 2-2-27** while the quality control items for pavement and earthworks are presented in **Table 2-2-28**.

Table 2-2-27 Concrete Quality Control Plan

Item	Test Items	Test Method (Specifications)	Test Frequency
Concrete	Cement Property/Physical Test	AASHTO M85	Once before trial mix and every once every 500m^3 batch of concrete; or once during production of cement (Mill sheet)
Aggregate	Property/Physical Test	AASHTO M6	Once before trial mix and every once every 500m^3 batch of concrete; and every change of source/quarry location (check supplier data)
	Property/Physical Test	AASHTO M80	Once before trial mix and every once every 500m^3 batch of concrete; and every change of source/quarry location (check supplier data)
	Sieve Analysis	AASHTO T27	Once a month
	Alkali-silica Reactive Test(Mortar Bar Method)	ASTM C1260	Once before trial mix and every change of source/quarry location (check supplier data)
	Mineral Composition Test	ASTM C295	Once before trial mix and every change of source/quarry location (check supplier data)
Water	Water Quality Test	AASHTO T26	Once before trial mix and when necessary
Admixture	Quality Test	ASTM C494	Once before trial mix and when necessary (Mill Sheet)
Concrete	Slump Test	AASHTO T119	Once every 75m^3 or per batch
	Air Content Test	AASHTO T121	Once every 75m^3 or per batch
	Compressive Strength Test	AASHTO T22	6 Samples per batch or 6 samples for every 75m^3 of concrete (3 samples each for 7-day strength and 28-day strength)
	Temperature	ASTM C1064	Once every 75m^3 or per batch

Table 2-2-28 Quality Management Plan for Earthwork and Pavement Work

Item	Test Items	Test Method (Specifications)	Test Frequency
Embankment	Density Test (Compaction)	AASHTO T191	Every 500m^2
Base course	Material Test (Sieve Analysis)	AASHTO T27	Once before placing and once every 1,500m^3 or change in source/quarry location.
	Material Test (CBR Test)	AASHTO T193	Once before placing and once every 1,500m^3 or change in source/quarry location.
	Dry Density Test (Compaction)	AASHTO T180	Once before placing and twice every 1,500m^3 or change in source/quarry location.
	Field Density Test (Compaction)	AASHTO T191	Every 500m^2

2-2-4-6 Procurement Plan

(1) Procurement of Major Construction Materials

The available construction materials can be procured in South Sudan are aggregate for concrete, fill material and small supply of fuel, oil and lubricants, while other materials will have to be procured from third countries and Japan. **Table 2-2-29** presents the major construction materials for procurement.

Table 2-2-29 Procurement of Major Construction Materials

Item		Procurement Area			Procurement Reason	Procurement Routes
Item Name	Description	Local (RSS)	Japan	Third Countries		
Materials for Structures						
Cement	50kg bag			Kenya	To assure quality and on-time delivery	
Reinforcing Bars	D6～D32		○		To assure quality and on-time delivery	
Aggregate for Concrete	3/4”～3/8”	○				Around the quarry routes
Aggregate for Concrete	Crushed stone dust, 2/8”	○				Around the quarry routes
Admixture				Kenya		
Rocks	350mm～500mm	○				Around the quarry routes
Rocks	250mm～500mm	○				Around the quarry routes
Steel pipe sheet pile	φ1,000mm, 12mm		○		Not available locally and in neighboring countries	
Tube steel pipe fittings	φ165.2mm, t=11mm		○		-Ditto-	
Rubber bearings	Fix Reaction 600t、Movable Reaction 600t; intermediate support, end support		○		To assure quality and on-time delivery	
Expansion Joint	Steel Finger Type		○		-Ditto-	
Fall Down Device	PC Cable Type、FT50,70,200TD		○		-Ditto-	
Bridge Railing			○		-Ditto-	
Steel Girder	Plate Girder, Steel Langer		○		-Ditto-	
Sub-base Course		○				Crushed stone mixed with the soil around the borrow pit site
Embankment Material	Good quality soil	○				Borrow pit site near
Guard Rail	H=700		○		To assure quality and on-time delivery	
Temporary Materials						
Fuels, oils and lubricants		○				Juba
Timber Formwork		○				Juba
Plywood Formwork				Kenya		
Temporary Steel	H Steel Beam, etc		○		To assure quality and on-time delivery	
Steel Sheet Pile	Type III, IV		○		-Ditto-	
Lining Plate/ Gusset Plate	1.0mx2.0mx0.208m		○		-Ditto-	
Temporary Roadbed	Gravel, Laterite	○				Around the quarry site, borrow pit
Steel Falsework	Steel Pipe Support		○		To assure quality and delivery	

(2) Procurement of Special Materials

Some special materials for this project such as steel girder material, bearings, expansion joints, steel pipe, steel sheet piles, etc. cannot be sourced out in South Sudan. These materials are appropriate to be sourced out from Japan for the following reasons:

Steel Girder (Steel Plate Girder, Langer Arch Material)

Steel production in South Sudan is dependent on imports. High quality steel is required to manufacture precision steel girder. In addition, it is essential to ensure reliability of delivery in procurement. Thus, it is appropriate to procure this material from Japan to ensure quality, and reliability of delivery.

Bearings, Expansion Joints and Bridge Fall Down Device

Bridge bearings transmit superstructure reactions to substructures, expansion joints provides mechanism for joint movements at girder ends due to temperature changes and protects the joints from vehicular traffic and bridge fall down devices prevents the superstructure from being unseated in the event of large horizontal excitation such as earthquakes. These bridge accessories are important parts of the bridge that significantly influence bridge durability. However, these accessories are basically not available in South Sudan and to ensure quality of materials and timely delivery, it is appropriate to procure such from Japan.

Steel Pipe Sheet Pile

Steel pipe sheet piles are basically used for foundation construction consisting of steel pipes and connection fittings to form a water tight cofferdam. For this project, the bridge foundation is formed by rigidly connecting the steel pipes with the concrete pile cap. There are many proven techniques unique to Japan bridge and foundation construction, including this foundation system, and these steel pipe sheet piles comes in a variety of diameter and wall thickness. To assure reliable supply, procurement of steel sheel pipe piles will be sourced from Japan.

Steel Sheet Pile

Basically, steel sheet piles are not available in South Sudan, so that by similar reason as above these materials will be procured from Japan since there is an adequate supply and inventory at present.

Steel for Temporary Works (Steel Plates, Pipe Supports, Falseworks, H-beams, etc.)

Steel materials used for temporary works (including steel plates, pipe supports, falseworks, H-beams, etc.) will likewise be procured form Japan.

(3) Construction Equipment

Although construction equipment and machineries (with few units of cranes and several earthmoving and paving equipment) are available in South Sudan, it is mostly owned and used by

local companies in on-going projects. Most of this heavy equipment are aging and maintained in-house by these companies and with insufficient number, equipment rental becomes risky. However, there are more equipment available for lease in Kenya and can be transported to Juba by low bed trailers. Special equipment and machineries, however, are planned to be procured from Japan.

Table 2-2-30 classifies and summarizes the necessary construction equipment for procurement for this project.

Table 2-2-30 Major Construction Equipment to be Procured (1/2)

Item		Rent/ Buy	Where to Procure			Reason for Procurement	Procurement Route
Equipment	Specification		Local	Japan	Other Country		
Backhoe	0.8m^3	Rent	○				Juba
	0.45 m^3	Rent	○				- Ditto -
Pay Loader	Heave 2.1m^3(2.4m^3)	Rent			Kenya		Land transport from Nairobi
Dump Truck	10t Cap.	Rent			Kenya		- Ditto -
Bulldozer	15t	Rent			Kenya		- Ditto -
	21t	Rent			Kenya		- Ditto -
Motor Grader	W=2.4m	Rent			Kenya		- Ditto -
Road Roller	10～12t	Rent			Kenya		- Ditto -
Tire Roller	8～20t	Rent	○				Juba
Vibrator Roller	0.8～1.1t (Hand Guide Type)	Lease		○		Assurance of procurement	Japan→Mombasa port→site
Truck-Mounted Crane	4.8～4.9t	Rent	○				Juba
	20～22t	Rent	○				- Ditto -
	25 t	Rent	○				- Ditto -
	50t	Rent	○				- Ditto -
Truck Mixer	4.4m^3	Rent			Kenya		Land transport from Nairobi
Rotary Drill (All Casing)	ϕ1,500mm class (Stationary, Engine Type))	Lease		○		Assurance of procurement	Japan→Mombasa port→site
Crawler Crane	50t	Rent	○				Juba
	90t	Lease		○		Assurance of procurement	Japan→Mombasa port→site
	100t	Lease		○		- Ditto -	- Ditto -
Hammer Grab	φ1,000mm	Lease		○		- Ditto -	- Ditto -
	φ1,500mm	Lease		○		- Ditto -	- Ditto -
Hammer Crown	<1200mm	Lease		○		- Ditto -	- Ditto -
	<2200mm	Lease		○		- Ditto -	- Ditto -
Clamshell Bucket	0.8m^3	Lease		○		- Ditto -	- Ditto -
Water Jet for Driven Pile	Engine Type, 325ℓ/min	Lease		○		- Ditto -	- Ditto -
Underwater Cutting	O.D. 1,000mm	Lease		○		- Ditto -	- Ditto -
Heavy Weight Breaker	Hydraulic Type 1,300kg class	Rent	○				Juba
Compressor	3.5-3.7m^3/min.	Rent	○				Juba
	5m^3/min.	Rent		○		Assurance of procurement	Japan→Mombasa port→site

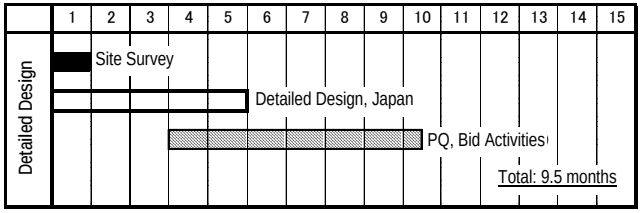
Table 2-2-30 Major Construction Equipment to be Procured (2/2)

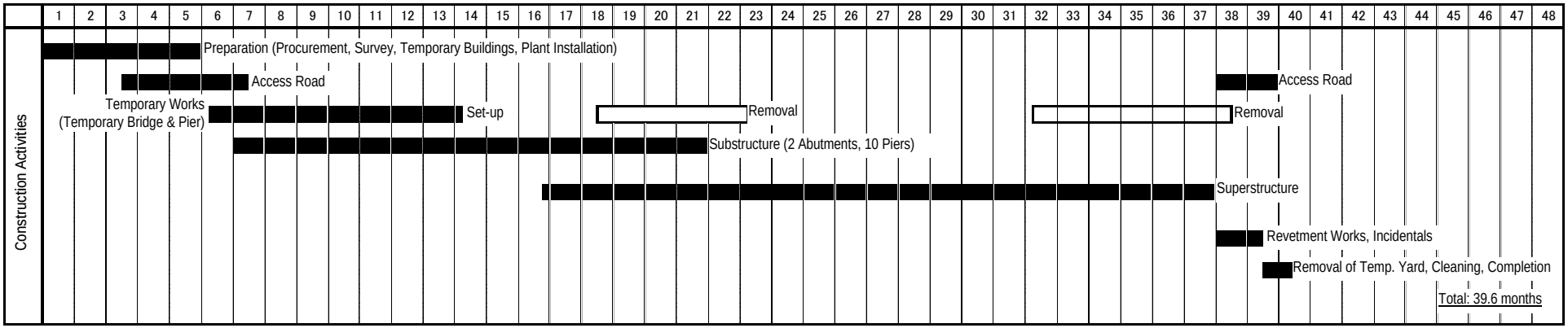
Item		Rent/ Buy	Where to procure			Reason	Procurement Route
Equipment	Specification		Local	Japan	Other Country		
Vibratory Hammer	60kw	Lease		○		Assurance of procurement	Japan→Mombasa→Site
Vibratory Hammer single	90kw	Lease		○		- Ditto -	- Ditto -
Chisel	1,500mm	Lease		○		- Ditto -	- Ditto -
Rebar Stud Equipment	2,000A	Lease		○		- Ditto -	- Ditto -
Diesel Generator	50KVA	Rent			Kenya		Land transport from Nairobi
	270/300KVA	Rent			Kenya		- Ditto -
	20/25KVA	Lease		○		Assurance of procurement	Japan→Mombasa→Site
	65/75KVA	Lease		○		- Ditto -	- Ditto -
	125/150KVA	Lease		○		- Ditto -	- Ditto -
Semi-automatic Welding Machine	500A	Lease		○		- Ditto -	- Ditto -
Electric Welding Machine	300A	Lease		○		- Ditto -	- Ditto -
Submersible Pump	φ100mm, 10m head	Rent	○		Kenya		Land transport from Nairobi
	φ150mm, 10m head	Rent	○		Kenya		- Ditto -
	φ100mm, 25m head	Lease		○		Assurance of procurement	Japan→Mombasa→Site
Submersible Pump	φ80mm, 30m head	Lease		○		- Ditto -	- Ditto -
Concrete Plant (Fully Automatic)	$30m^3/h$	Lease		○		- Ditto -	- Ditto -
Truck with Crane	10t, 2.9t cap.	Lease		○		Assurance of procurement	- Ditto -
Hand Winch	3t	Buy (Lease)		○		- Ditto -	- Ditto -
Gantry Crane (Endless Roller Type)	50t	Buy (Lease)		○		- Ditto -	- Ditto -
Trailer	20t	Rent	○				Juba
Trailer	30t	Rent	○				- Ditto -
Trailer	40t	Rent			Kenya		Land transport from Nairobi
Trailer	50t	Rent			Kenya		- Ditto -
Ultra High Pressure Pump	20MPa,35L/mim	Lease		○		Assurance of procurement	Japan→Mombasa→Site
Boring Machine	Hydraulic, 5.5kw	Lease		○		- Ditto -	- Ditto -
Ground Mixer	500L*1 2.2kw	Lease		○		- Ditto -	- Ditto -
Agitator	800～1000L 2.2kw	Lease		○		- Ditto -	- Ditto -
Flow meter	0～120L/min	Lease		○		- Ditto -	- Ditto -
Generator	250kVA	Lease		○		- Ditto -	- Ditto -
Concrete Breaker	20kg	Lease		○		- Ditto -	- Ditto -

2-2-4-7 Implementation Schedule

Table 2-2-31 presents the overall implementation schedule for detailed design and project construction for the New Nile River Bridge.

Table 2-2-31 Implementation Schedule of New Nile Bridge in South Sudan





2-3 Obligations of Recipient Country

To ensure smooth implementation of the project, the following are the obligations of the Republic of South Sudan:

- To provide information/documents necessary for the implementation of the project,
- To acquire and clear the land for project right-of-way and to relocation of affected houses,
- To secure yards for construction works, storage of materials, area for field office, fabrication yard,
- To secure area for borrow pit needed for construction and land for waste disposal,
- To construct the pavement and drainage facilities for the approach road (used as temporary construction access road) and maintain the same and the bridge after completion (refer to **Table 2-3-1**).

Table 2-3-1 Pavement and Drainage Obligation of South Sudan

Item	Distance (km)	Contents
Pavement	3.565	Sub-base, Base, AC Surface and Finish
Side Ditch	7.23	Concrete Gutter Finish for Earth Ditch

- To install power lines for project field office use,
- To open a bank account in Japan for the purpose of this project and bear the corresponding bank fees and other bank charges (such as advising commission and payment commission),
- To facilitate tax exemption for equipment to be brought for the use in the project and facilitate speedy customs clearance and inland transport,
- To facilitate tax exemption of Japanese engaged in this project and tax exemption of goods and services procured for this project,
- To facilitate the necessary legal documents for entry and stay to the Republic of South Sudan of the Japan Team engaged in this project,
- To issue permits/certificates required and necessary to implement this project (environmental approval, permit for road and bridge construction, permit for construction in the river, earthwork permits, traffic control during construction permits, etc.),
- To ensure proper use and maintenance of the bridge and the road after construction, etc.,
- To settle/solve potential problems with local people or any third party in connection with the execution of the project, and
- To bear all expenses required for the execution of the project other than those borne by the Grant Aid of Japan.

2-4 Project Operation Plan

2-4-1 Organization and Staffing for Operation and Maintenance

(1) Road Maintenance in South Sudan

The Ministry of Roads and Bridges (MRB, RSS) is in charge of arterial (Interstate/International) road management while the State government is responsible for the administration of urban and local roads. However, there is no clear distinction of responsibilities between MRB and the State with regards to Juba City roads and suburban roads. **Table 2-4-1** presents MRB's idea on the division of responsibilities in road management in the country.

Table 2-4-1 Division of Responsibilities on Road Maintenance (Draft)

Work Item	City/Local Road	City Arterial Road	Interstate/ International Arterial Road	Suburban Road
Maintenance	State	RSS/State	RSS	RSS/State
Rehabilitation	State	RSS/State	RSS	RSS/State
Improvement	State	RSS/State	RSS	RSS/State
New Construction	State	RSS/State	RSS	RSS/State

Notes: 1. Maintenance：Preserving the road function 2. Rehabilitation：Restoring the road to its original function
3. Improvement：Upgrading the condition and function of the road
*RSS : MRB, Republic of South Sudan *State : MOPI, CES

However, the State has a different opinion in the demarcation of road maintenance/ rehabilitation/improvement/construction works in Juba Urban Area as indicated below:

- Arterial Roads in Juba Urban Area : RSS
- Other Roads in Juba Urban Area : STATE

(2) Road Maintenance

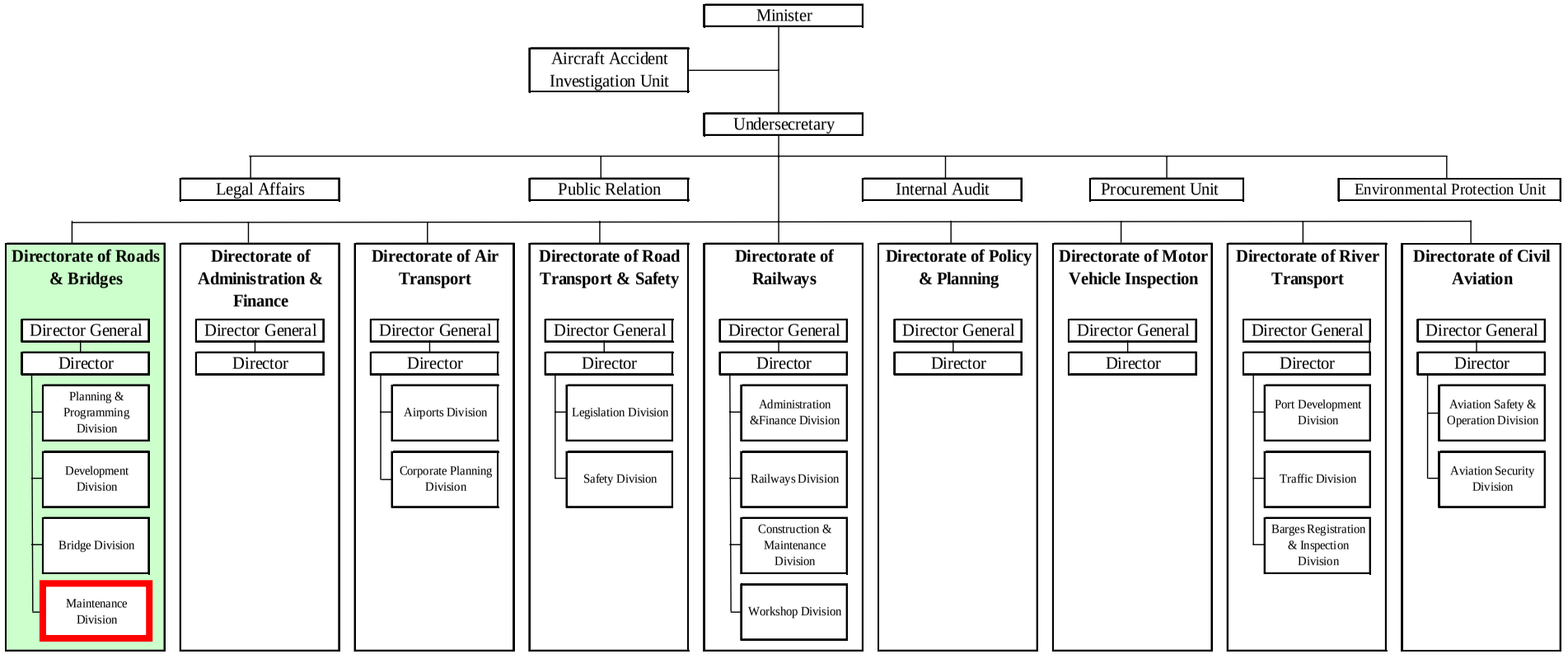
International roads and interstate roads have the function of linking South Sudan to surrounding countries like Uganda and Sudan. Thus maintenance of these roads to keep their purpose is of extreme importance and this function is tasked to the Ministry of Roads and Bridge, Republic of South Sudan (MRB, RSS). **Figure 2-4-1** shows the organization of the MRB.

The number of engineers tasked for planning and design of roads and bridges as well as road maintenance are shown in **Table 2-4-2.** However the Bureau of Roads and Bridges (BRB) are not very active in maintenance work and their activities are focused on road improvement project. Road rehabilitation and maintenance works are largely absent in the activities of engineers and they are mostly engaged in construction supervision and inspection of rehabilitation of road projects.

Table 2-4-2 Number of Staff and Division of Functions

Department/ In-charge	Task	No. of Staff
Planning Division	Highway planning and highway policy, budget preparation, environmental management	6
Road Development Division	Improvement of road design standards specification, design and construction management of the road	3
Bridge Division	Development of bridge design standards specification, design and construction management of bridges	2
Maintenance Division	Road inventory, equipment management, maintenance planning	5
	Total	18*

* Source: Director General and Bureau Director of Roads and Bridges



Note : Each division is headed by Deputy Director in principle.

Under the Presidential Decree No.27 (dated August 26, 2011) of the Republic of South Sudan, the Ministry of Roads Transport (MTR) is divided into the Ministry of Roads and Bridges (MRB) and the Ministry of Transportation (MOT). Both Ministries started their official functions by virtue of the Presidential Decree No.29 (dated August 31, 2011).

Figure 2-4-1 Organization Chart of MRB

2-4-2 Budget Status

Table 2-4-3 shows the budget of MRB in 2008 and 2009. It should be noted that road maintenance cost is not included in the budget shown in the table. The MRB has a budget of 30 Million Pound (US$ 12 million) for road maintenance in 2011.

Table 2-4-3 Budget of MRB

Unit: US $

Year	Staff Salary	Operating Costs	Capital Investment	Total
2008	861,758	4,310,744	224,017,314	229,189,816
2009	3,060,268	3,249,918	177,689,814	184,000,000

US$1=2.5SDG (1SDG=US$0.4)

2-4-3 Road and Bridge Maintenance Capacity

(1) Road and Bridge Maintenance Capacity

The Ministry of Roads and Bridges does not have yet a clear policy on road and bridge maintenance and has not done much on maintenance works for roads and bridges. Interview carried out with the MRB revealed budgeting for maintenance of arterial roads will start next year so that maintenance activities for these roads will be carried-out from next year. In addition, there is a plan to crack down on overloaded vehicles and to study establishing road fund to be used for road maintenance. In addition, the following are challenges at the MRB:

- Budget for road maintenance is not presently included in the MRB budget
- Difficulty in procurement of materials
- Others
  - Shortage of skilled workers
  - Lack of road information data
  - Inadequate road maintenance plan

(2) Equipment and Materials

The MRB possesses the following road equipment (in good working condition) which was procured in years 2007 and 2008:

Table 2-4-4 Equipment Owned by MRB

Equipment	Type	Year Manufactured	Capacity	Quantity	Operation status
Excavator	324D	2008	324HP	2	1
Loader Linkage	277B	2008	277HP	1	1
Motor Grader	160H	2008	160HP	2	1
Backhoe Loader		2008		1	1
Wheel Loader	966H	2008	966HP	2	1
Roller		2008		3	1
W-Shopmobile	4031	2007		1	1
Truck Actros	4031	2007	20T	5	1
Water Tank	MI3050	2007	18,000Lit	2	1

Note: Availability of equipment:
1 - good running condition, 2 - out of order, 3 - under repair

2-4-4 Contents of Operation and Maintenance

The necessary maintenance works are as follows:

- Periodic Inspections : regular inspections of bridges and roads
- Daily Maintenance : drainage, pavement, expansion joint device, shoulders, bridges, cleaning, etc.
- Repair : pavement, drainage facilities, bridge facility, railings, shoulder slope, fall down prevention device

Routine maintenance, repair of damaged facilities and maintenance will be performed by the entities in-charge.

2-4-5 Current Status of Road Operation and Maintenance

To realize full benefits of the project and its facilities, and to sustain its operation and keep it in good driving condition, it is important to improve its durability. The following needs should be noted:

- Inspect regularly to know the current condition of facility,
- Cleaning - especially drainage facilities, bearings, expansion device and its surroundings,
- To secure the necessary budget to maintain the facility.

The bridge to be constructed in this project is durable and strong against the environment in Juba and serious technical problems as well major repair is not expected to occur in the immediate future. Routine maintenance however is encouraged to promote durability of the bridge. With that in mind, it is important to allocate budget for operation and maintenance.

2-5 Project Cost Estimate

2-5-1 Initial Cost Estimate

The total initial project cost estimate necessary to implement the project amounts to Japan Yen __ which includes both the cost contributions of Japan and South Sudan and based on the conditions stated in Item 3 below. However, this amount does not represent a limit on the amount granted in the Exchange of Notes.

(1) Japan's Contribution

The table below indicates the costs borne by the Japan side.

Table 2-5-1 Approximate Cost Estimate of Japanese Contribution

Item			Project Cost (Million Yen)
Facility	Bridge Construction	Substructure Works	-
		Superstructure Works	-
		Incidental, Access Road Works	-
		Temporary Works, Others	-
		Indirect Costs, Others	-
Detailed Design and Construction Supervision			-
Total			-

(2) South Sudan's Contribution

Table 2-5-2 Approximate Project Cost Contribution of South Sudan

Item	**Amount (US$)**
• Bank Charges	146,551
• Land Acquisition and House Relocation	750,626
• Pavement and Drainage for Approach Road	9,085,010
Total	9,982,187

(3) Cost Estimation Condition

① Cost Estimate Date : March 2011

② Foreign Exchange Rate : US$ 1.00 ＝ 83.93 Yen
US$ 1.00 ＝ 2.44 SSP
Yen 1.00 ＝ 0.0313 SSP

③ Construction Period : Schedule of detailed design and construction supervision is shown in the schedule of implementation

④ Others : The project is carried out based on the Japanese Government's Grant Aid Scheme.

2-5-2 Operation and Maintenance Cost

The Ministry of Roads and Bridges (MRB) has an annual budget of SSP 480.48 million (US$ 192.19 million) in 2011. The annual maintenance cost of the New Nile River bridge is about US$ 6,881.91 per year, as shown in **Table 2-5-3** which represents 0.0035% of the total budget. In addition, the annual maintenance cost of the approach road is about US$ 16,669.23 which represents 0.0085% of the budget as shown in **Table 2-5-4**. Therefore, it is then necessary to allocate the amount in the budget in order to perform the operation and maintenance of the facility.

Table 2-5-3 Bridge Maintenance Cost

Maintenance Type	Frequency	Amount (US$)
Periodic Inspection	12 Times/Year (1day/ea)	2,538.76
Routine Maintenance	4 Times/Year (2days/ea)	2,307.84
Repair	1 Time/Year (4days/ea)	2,035.31
	Total	6,881.91

Details are shown in Table 2-5-5

Table 2-5-4 Roads Maintenance Cost

Maintenance Type	Frequency	Amount (US$)
Periodic Inspection	12 Times/Year (1day/ea)	2,538.76
Routine Maintenance	4 Times/Year (2days/ea)	2,307.84
Repair	1 Time/Year (4days/ea)	11,822.63
	Total	16,669.23

Details are shown in Table 2-5-6

Table 2-5-5 Bridge Major Maintenance Items and Annual Expenses

	Facility Name	Items to be Checked	Frequency	Number of Staff	Equipment to be Used	Required Quantity	Amount (US$)
Periodic Inspection	Pavements Drainage Main Body Revetment Bridge Facility	Crack、undulations, defects Siltation、obstacles, Damage, deformation, stains, abration, etc、 Failure Cracks, defects, detachment, Handrails damage	12 times/year (1 day per inspection)	2	Shovel, hammer, sickle, barricades, Pickup truck	24 man-days/year 12veh-days /year	670.24 1,868.52
						Sub-total	2,538.76
Routine Maintenance	Pavement Drainage Expansion Joint Bridge	Cleaning Sediment and obstacle removal, cleaning Sediment and obstacle removal, cleaning Cleaning	4 times/year (2 days per maintenance)	5	Shovels, barricades, mower, brooms, tools, Pickup truck	40 man-days/year 8 veh-days /year	929.44 1,378.40
						Sub-total	2,307.84
Repair	Pavements Drainage Main Body Bridge Facility Pavement Marking	Crack sealing, damage repair Repair of damages Repair of damages Repair of handrail damages, etc. Maintenance of road pavement marking	1 time/year (4 days per repair)	6	Plate compactors, Pickup truck, Concrete Lane Paint	24 man-days/year 4veh-days/ year 4veh-days /year 1.0m^3/year 15m/year	545.16 172.27 689.20 537.00 91.68
						Sub-total	2,035.31
						Total	**6,881.91**

Table 2-5-6 Approach Road Major Maintenance Items and Annual Expenses

	Facility Name	Items to be Checked	Frequency	Number of Staff	Equipment to be Used	Required Quantity	Amount (US$)
Periodic Inspection	Pavements Shoulder Slope Drainage	Cracks、undulations, defects, etc. Deformation, erosion, settlement, etc. Sediment, presence of obstacles	12 times/year (1 day per inspection)	2	Shovel, hammer, sickle, barricades, Pickup truck	24 man-days/year 12veh-days /year	670.24 1,868.52
						Sub-total	2,538.76
Routine Maintenance	Shoulder Slope	Grass cutting, cleaning	4 times/year (2 days per maintenance)	5	Shovels, barricades, mower, brooms, tools, Pickup truck	40 man-days/year 8 veh-days/year	929.44 1,378.40
						Sub-total	2,307.84
Repair	Pavement Shoulder Slope Road Ancillary	Crack sealing, defect repair, Repair of the damaged area Repair of the damaged area	1 time/year (4 days per repair)	6	 Plate compactors, Pickup truck, Asphalt Roadbed material Lane Paint	24 man-days/year 4veh-days/year 4veh-days /year 4m^3/year 35m^3/year 15m/year	545.16 172.27 689.20 537.00 1,415.47 10,416.00 275.05
						Sub-total	11,822.63
						Total	**16,669.23**

2-6 Other Relevant Issues

The following are other relevant issues related to project implementation:

- Undertaking of the recipient country's responsibility.
- Allocation of budget for compensation, resettlement site and relocation within Year 2011 Budget.
- Payment of compensation to affected persons starting from January 2012 and completion of affected persons' relocation in June 2012.
- Undertaking of the Environmental monitoring before, during and after construction based on the provided environmental monitoring form.

CHAPTER 3 Project Evaluation

3-1 Recommendations

3-1-1 Requirements for Project Implementation

The requirements for project implementation are as follows:

(1) Conditions Related to Environment

- The scale of impact within the 30m right-of-way width for the approach road includes 130 houses, 12,000 m^2 of agricultural land and 200 trees.
- The budget for compensation payment, prepared by the Value Assessment, Compensation and Resettlement Committee (VACRC) together by the community representatives last year, shall be appropriated and ensured.
- Using the estimated compensation unit costs, the compensation and land acquisition shall be completed by June of 2012, following JICA Environmental Guidelines and Procedures.

(2) Conditions Related to Construction

- The necessary permit regarding soil borrow pit and spoil dumping area shall be secured by MRB prior to start of project bidding.
- Authorization to use the required construction yards on both sides of the Nile River (3.5 hectares) shall be obtained by MRB prior to start of project bidding.
- The necessary permit to utilize the Nile River and obtain water from the river (Abstraction Permit) shall be secured by MRB.

3-1-2 External Conditions to Achieve the Overall Plan

(1) Prerequisite

After project completion, road maintenance is necessary not only to provide smooth flow of traffic but also to prolong the life of the structures and the approach road. Maintenance work includes daily or routine maintenance, removal of obstacles, cleaning, etc. Periodic inspection shall be carried-out and if damage is observed to structures and pavements essential repairs will be undertaken appropriately. Therefore, it is necessary to secure an annual maintenance budget to maintain and repair the facilities (Bridges: U.S.$6,882/year; Roads: U.S.$ 16,669/year). As noted in the earlier sections, the allocation of operation and maintenance budget in South Sudan is considered possible.

(2) External Conditions

The road projects related to the new Nile River Bridge project includes Juba road rehabilitation and interstate and international road projects. The "Juba Emergency Road Rehabilitation Project",

which started in 2006 after the civil war and aimed at rehabilitating 65 km of city roads, is about 90% complete as of March 2011.

Such projects, undertaken during the Government of South Sudan (GOSS) and currently being implemented under South Sudan funds, are to be continued beyond 65 km. However, the construction project has been suspended since the end of 2010, but the rehabilitation of C-2 ring road and improvement of C-3 access roads including Lologo and Nyakuron is planned to be completed by year 2015. Moreover, the construction of the 192-km Juba-Nimule road is scheduled for completion by 2012 while the detailed designs of the 245-km Juba-Yei road is completed under the assistance of the Multi-Donor Trust Fund (MDTF) and also the Juba-Nadapal road detailed design completed with both projects awaiting funding source for construction.

In addition, if this project will proceed as planned the connection of Juba city with the international highway thru the new Nile River Bridge will be seamless and the access to the city will improve and the effect of the project will be sufficient.

3-2 Project Evaluation

3-2-1 Validity

① The existing bridge linking eastern and western sections of Juba city across the river Nile is temporary with less durability but safety regulations have allowed passage of large heavy vehicles. The implementation of this bridge, on the other hand, will provide an east-west connection of Juba city with a safe and durable bridge that links the international highway corridors of South Sudan and will benefit the country in terms of smooth transport distribution.

② This project will the strengthen of the trunk road network (including the international transport highway routes), ensure stable logistics, and contribute to the urgent demand to improve the lives of the residents and provide stability at the post-independence era.

③ The routine maintenance of this bridge, including cleaning and sediment removal at the deck section can be done with the present technical and financial level in South Sudan.

④ After independence, the national development plan "South Sudan Development Plan" (2011-2013) targets four pillars of development with the "economic development" focusing on poverty reduction through sustainable development and improvement of living standards and with a diversified private sector led economic growth, the priority policy is to extend the feeder roads by a distance of 1,000km from the asphalt paved interstate highway network. This project contributes to this national development plan.

⑤ The project is not profitable.

⑥ Except for compensation and land acquisition, there is minimal negative environmental and social impact of the project.

⑦ This project will utilize Japan’s advance technology in bridge construction.

3-2-2 Effectiveness

(1) Quantitative Effect

(Travel Time Improvement)

① The travel speed to cross the Nile River using the existing Juba Bridge is limited to 20 km/hr but will be improved to 60 km/hr using the new Nile River Bridge.

(Traffic Capacity Improvement)

②The existing traffic capacity of the bridge crossing is 24,000 PCU/day (PCU: passenger car units), but this traffic capacity will double with the construction of the bridge at 48,000 PCU/day.

(Traffic Congestion Improvement)

③ Near the existing bridge (city side), the service level (the ratio V/C: traffic capacity (C) and the number of vehicles traveling (V) ratio) will drop from 0.9 to 0.38 after the completion of the new bridge thus relaxing the degree of congestion to about 52%.

(2) Qualitative Effect

(Congestion Mitigation and Logistics Efficiency and Stability)

① The international logistics route from Uganda and Kenya flows directly to Juba city through the existing bridge causing congestion within the city. But with the construction of the new Nile River Bridge, the distribution of logistics will be decentralized using the new bridge as an alternative distribution route resulting to more efficient distribution and a relief measure to traffic congestion.

② Since the new Nile River Bridge is a permanent bridge, this ensures the stable flow of domestic and international logistics in South Sudan from Juba to the northern regions (The concerns for the stability of domestic and international logistics due to the remaining years of durability of the existing bridge can be resolve through the construction of the new bridge.)

(Contribution to Orderly Reconstruction and Expansion of Juba City)

③ The new Nile River Bridge and its approach road, located and forming part of the C-3 circumferential road and the Juba city road network, will promote development and orderly expansion of Juba city thus contributing to the reconstruction of the city and prevents disorderly urban sprawl.

(Disparity Measures and Improvement of Relationship Between Divided Communities)

④ At present, there is a large gap in the living conditions between the east and west sides of the Nile River with much of the road infrastructure development of the city concentrated in the west. The construction of the new Nile River Bridge will physically connect the two east-west communities separated by the Nile River and promote, contribute and encourage a balanced

development in the area. Without the bridge, development of the community in the eastern side of the Nile River is very much delayed.

(Fostering Trust between Japan and South Sudan)

⑤ After independence, the South Sudan’s President's 100 days plan listed four infrastructure projects in which the construction of the new Nile River Bridge project has been mentioned as one of them. Implementation of this project will thus contribute to fostering trust between the two countries.