

**The United Republic of Tanzania
Ministry of Works, Transport and Communications
Tanzania National Roads Agency**

**SUPPLEMENTAL STUDY FOR
IMPLEMENTATION OF ARUSHA-HOLILI
ROAD IMPROVEMENT PROJECT
IN THE UNITED REPUBLIC OF TANZANIA**

**FINAL REPORT
(Executive Summary)**

July 2016

JAPAN INTERNATIONAL COOPERATION AGENCY

**International Development Center of Japan Inc.
Oriental Consultants Global Co., Ltd.**

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16-005

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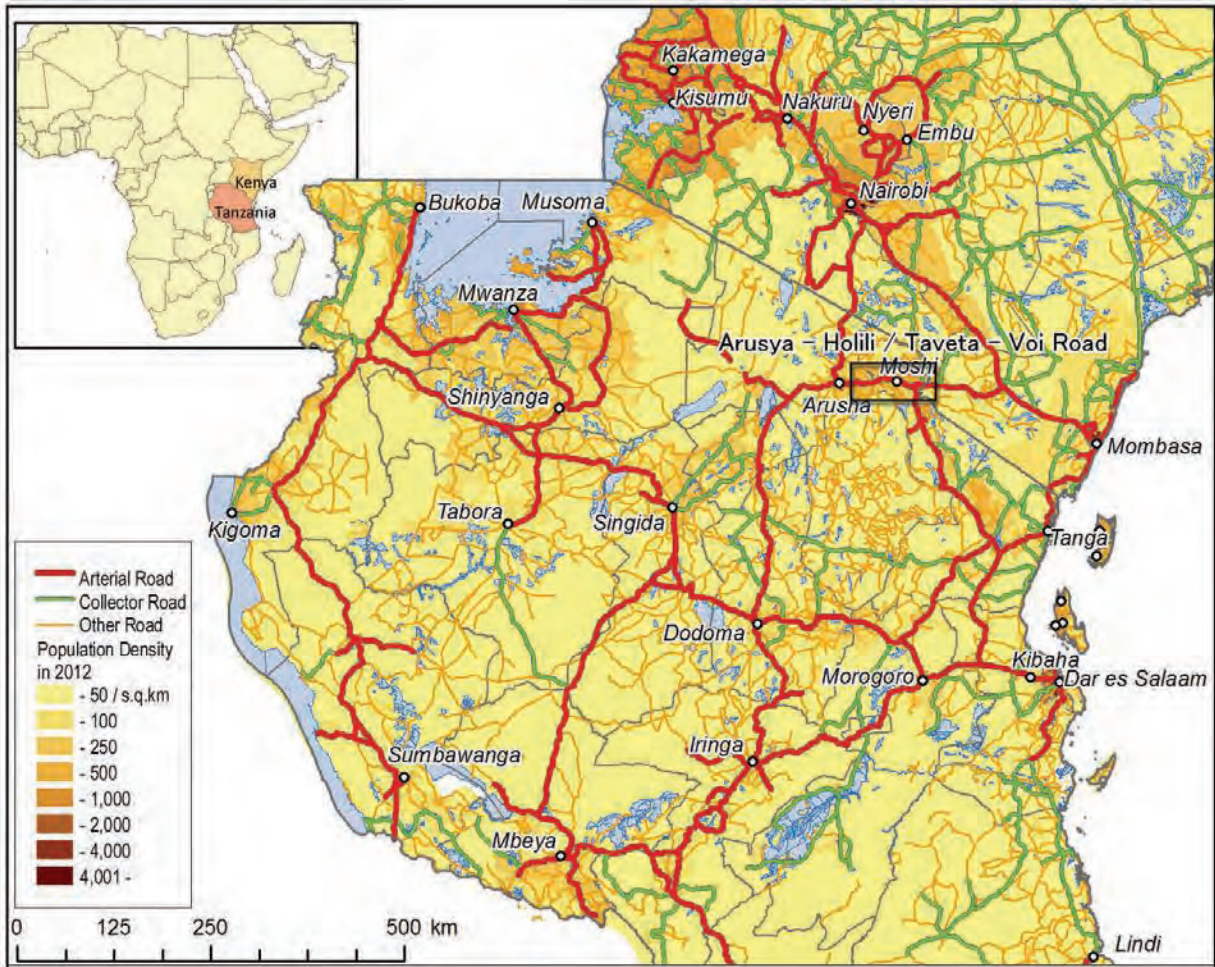
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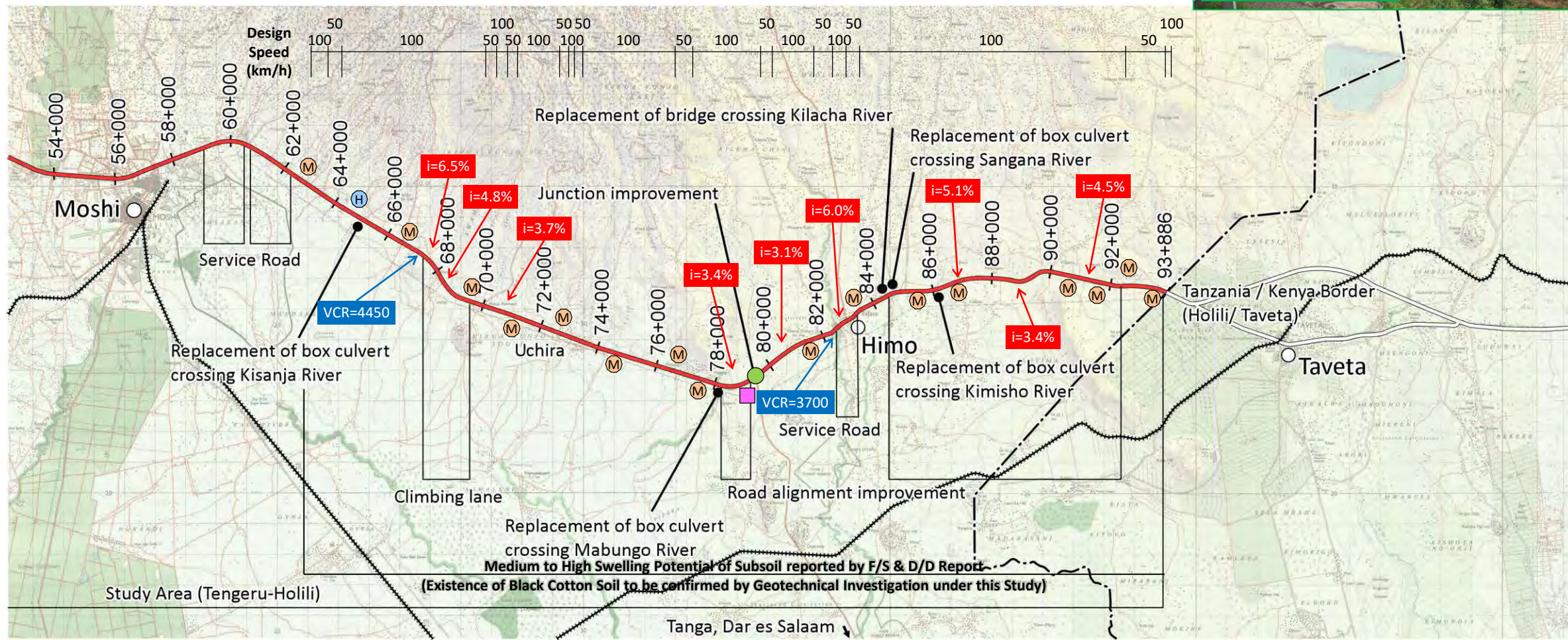
The following exchange rate is applied to the Study
1 USD = 2,192.1 TZS=109.9 JPY
(Exchange rate as of May 2016)



Note: A route map (shown in the middle and bottom), referred to from EAC (2011), shows Usa River and Holili section (93.9km) and the project also includes Tengeru and Usa River section (8.2km) and Kilimanjaro International Airport access road (5.7km).

Project Location Map

Supplemental Study for Implementation of Arusha-Holili Road Improvement Project Schematic Route Plan proposed by F/S



- LEGEND**
- Njia Panda Weigh Station
 - Roundabouts to be improved
 - Other Major Intersections to be improved
 - i=4.5% Vertical Grades not complying Geometric Design Standard in Tanzania
 - VCR=5000 Crest Vertical Curve Radius not complying Geometric Design Standard in Tanzania
 - H Swelling Potential (High)
 - M Swelling Potential (Medium)
- Source: F/S & D/D Report

Comparison of Geometric Design Standards for Vertical Alignment (Design Speed 100 km/h)

		Tanzania	Japan	AASHTO
Stopping Sight Distance	m	205	160	185
Max. Grade	-	3%	3% (6% in special exception case)	Flat: 3% Rolling: 4% Mountain: 6%
Min. Vertical Curve Radius	Crest	m 10,500	6,500 (preferable over 10,000)	5,200
	Sag	m 5,100	3,000 (preferable over 4,500)	4,500

Supplemental Study for Implementation of Arusha-Holili Road Improvement Project
in the United Republic of Tanzania

Final Report (Executive Summary)

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Schematic Route Plan proposed by F/S

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Abbreviation

AADT	Annual Average Daily Traffic	IUCN	International Union for Conservation of Nature and Natural Resources
AASHTO	American Association of State Highway and Transportation Officials	JICA	Japan International Cooperation Agency
AC	Asphalt Concrete	KIA	Kilimanjaro International Airport
AfDB	African Development Bank	kN	Kilo Newton
AHP	Analytical Hierarchy Process	LC	Local Currency
BH	Borehole	LGAs	Local Government Agencies
BOD	Biochemical Oxygen Demand	LOS	Level of Service
BOQ	Bill of Quantity	LRFD	Load and Resistance Factor Design
BS	British Standards	MDG	Medium Development Goals
CBR	California Bearing Ratio	MGV	Medium Goods Vehicles
CIF	Cost, Insurance and Freight	MOF	Ministry of Finance
CO	Carbon Oxide	MOWTC	Ministry of Work, Transport and Communication
COD	Chemical Oxygen Demand	MP	Master Plan
COI	Corridor of Impact	MPa	Mega Pascal
CSIR	Council for Scientific and Industrial Research	MR	Resilient Modulus
D/D	Detailed Engineering Design	NA	Normal Traffic Loading
dBA	Decibel	NACP	National HIV/AIDS Control Program
DBM	Dense Bituminous Macadam	NB	Abnormal Traffic Loading
DO	Dissolved Oxygen	NEMC	National Environment Management Council
DRC	Democratic Republic of Congo	NEP	National Environment Policy
DTM	Dense Tar Macadam	NGO	Non-Governmental Organization
EAC	East African Community	NOx	Nitrogen Oxides
EF	Equivalent Factors	NPRS	National Poverty Reduction Strategy
EIA	Environmental Impact Assessment	NPV	Net Present Value
EIRR	Economic Internal Rate of Return	O&M	Operation and Maintenance
EMA	Environmental Management Act	OD	Origin and Destination
EMP	Environmental Management Program	ODA	Official Development Assistance
ESAL	Estimation of Design Traffic Loading	PAH	Project Affected Household
ESIA	Environmental and Social Impact Assessment	PAPs	Project Affected Persons
F/S	Feasibility Study	PC	Prestressed Concrete
FC	Foreign Currency	PCU	Passenger Car Unit
FOB	Free On Board	PM	Particular Matter
GCA	Game Controlled Area	PO-RALG	President's Office Regional Administration and Local Government
GDP	Gross Domestic Product	PPP	Public-Private Partnership
GL	Ground Level	PSI	Present Serviceability Index
GOT	Government of Tanzania	R/A	Roundabout
GPS	Global Positioning System	RAP	Resettlement Action Plan
GRDP	Gross Regional Domestic Product	RMR	Rock Mass Rating
HCM	Highway Capacity Manual	RoW	Right of Way
HDM	Highway Development and Management Tool	RQD	Rock Quality Designation
HGV	Heavy Goods Vehicles	SADC	Southern African Development Community
HQ	Head Quarter	SCF	Standard Conversion Factor
HRA	Hot Rolled Asphalt	SD	Deformed Bars
HWL	High Water Level	SMU	Social Management Unit
IEE	Initial Environmental Evaluation	SN	Structural Number
IR	Income Restoration	SPT	Standard Penetration Test
IRI	International Roughness Index	TACAIDS	Tanzania Commission for AIDS
Formalization Program			

TANROADs Tanzania National Roads Agency
TAWIRI Tanzania Wildlife Research Institute
TDS Total Dissolved Solids
TLC Traffic Load Classes
ToR Terms of Reference
TPBP Tanzania`s Property and Business
TSS Total Suspended Solids
TZS Tanzania Shilling
UAV Unmanned Aerial Vehicle
UCS Unconfined Compressive Strength
UTM Universal Transverse Mercator
VAT Value Added Tax
VEF Vehicle Equivalent Factors
VHGV Very Heavy Goods Vehicles
VOC Vehicle Operating Cost
WHO World Health Organization
WHO-GPA World Health Organization
Global Program on AIDS
WWF World Wide Fund for Nature

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CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Arusha – Holili/ Taveta – Voi Road is an international truck road that stretches from Arusha, the second largest city in Tanzania, to Voi, a city along the Northern Corridor, through Holili/ Taveta, the border to Kenya. The Arusha – Holili/ Taveta – Voi Road, when improved, will function as an alternative route to the Northern Corridor, connecting Mombasa to Nairobi as well as neighbouring inland countries. This will increase the use of the said corridor hence increasing capacity for international freight/passenger traffic. Currently, the unpaved road section between Taveta and Voi is under improvement and which contributes to providing a freight transport route connecting Mombasa Port, Tanzania and its neighbouring inland countries through Holili/ Taveta. In this regard, improvement of the Arusha – Holili road section is essential.

The Feasibility Study and Detailed Engineering Design of the Multinational Arusha – Holili/ Taveta – Voi Road (F/S or F/S report and D/D or D/D report) was carried out in 2011 by the East African Community (EAC). Following the said study, the road section between Mwatate and Voi (23.5 km) in Kenya is being improved by the Kenyan Government. The road sections between Mwatate and Taveta (91.1 km) in Kenya, Sakina and Tengeru (14.1 km) and Arusha Bypass (42.4 km) are currently under implementation with financial assistance from the African Development Bank (AfDB).

Japan International Cooperation Agency (JICA) is currently considering improvement of the remaining Tengeru - Holili section (102.1 km) and access road to Kilimanjaro International Airport (5.7 km) as a loan project. This would follow the project approval process, to fulfil the requirements set by JICA's manuals and guidelines. Therefore, the Study aims at confirming the feasibility of the road improvement project between Tengeru and Holili and access road to Kilimanjaro International Airport.

1.2 Objectives and Contents of the Study

The objective of the Study is to confirm viability of road improvement between Arusha (Tengeru) and Holili and the access road to Kilimanjaro International Airport, as stated above through revision works on F/S and D/D of the Multinational Arusha – Holili/ Taveta – Voi Road as well as conducting supplementary studies to fulfil requirements set to meet JICA financial support.

(1) Study Area

The area of the Study covers Tanzania and neighbouring countries, which include Kenya, for the traffic study and proposed road alignment between Tengeru (Arusha Region) and Holili (Kilimanjaro Region) and access road to Kilimanjaro International Airport for the preliminary engineering and environment study.

(2) Target Year

The Study tests the feasibility of the Project with the target year of 2035.

(3) Executive and Implementing Agencies

Ministry of Works, Transport and Communications, TANROADS (HQ, Arusha Region and Kilimanjaro Region)

CHAPTER 2 PROJECT RATIONAL

(1) Road Network and Condition

The road network in Tanzania, totalling to 86,574 km (as of 2014), is classified into five road classes, namely, Trunk Roads, Regional Roads, District Roads, Feeder Roads and Urban Roads, by road administrator. Trunk Roads and Regional Roads are managed by TANROADS and other local roads are managed by Local Government Agencies (LGAs).

The trunk road network has been the investment priority and, as a result, 54% of Trunk Roads have been upgraded to bitumen standard and 74% of these paved Trunk Roads are in good condition as of 2014. In contrast to Trunk Roads, 95% of Regional Roads are still left unpaved and only 28% of these unpaved Regional Roads have been evaluated to be in good condition.

(2) Road Demand – Registered Vehicle

The number of registered vehicles by type between 2010 and 2014 has shown a rapid growth in the number of motorcycles and which reached around 860,000 by 2014, followed by light passenger vehicles which reached around 460,000 by the same period. The number of heavy vehicles and buses also shows a rapid increase at around 10% – 20% per annum and increased to 210,000 and 511,000 vehicles in 2014, respectively.

(3) Road Administration

TANROADS was set up in July 2000 as a semi-autonomous agency under the Ministry of Works, Transport and Communications. It manages around 34,000 km of Trunk and Regional Roads, with 697 staff comprising of 492 technical skilled staff and 205 supporting staff (as of March, 2011).

This agency, headed by a Chief Executive, has six functional Directorates namely: Maintenance, Development, Planning, Procurement, Projects and Management Services. There are 21 regions managed by Regional Managers. The Regional Managers and heads of Legal and Internal Audit Units report directly to the Chief Executive.

(4) Road Financing

The source of funds for road improvement and maintenance of the Trunk Roads and Regional Roads are (i) Roads Fund, (ii) GOT (MOWTC) and Donor Funding. The financial performance of TANROADS illustrates its budgets/expenses to be nearly 1,000 billion TZS in recent years for road maintenance (by Roads Fund) and road improvement (by GOT and Donor Funding).

(5) Road Maintenance

Maintenance performed by TANROADS between 2011/12 and 2013/14 implies that kilometre wise, majority of maintenance works are routine maintenance, followed by periodic maintenance and spot improvement works. Monetary wise, most of the maintenance funds are spent on periodic maintenance, followed by routine maintenance and spot improvement works.

In 2011/12, TANROADS implemented nearly 100% of planned maintenance works, however, the percentage of actual maintenance against planned maintenance works is dropping and 60% of planned maintenance works have been completed in 2013/14.

(6) Road Maintenance Needs

The Roads Fund Board, TANROADS and PO-RALG prepared 5-year investment plan, projecting future maintenance needs and revenue to be collected. The Roads Fund expects to collect increasing amounts of funds, mainly those from the fuel levy, which has an average growth rate of

13% per annum and will collect 1,340 billion TZS in 2018/19. TANROADS and PO-RALG estimate the future maintenance needs and which reach 1,430 billion TZS in the same year. Although maintenance needs, including backlog rehabilitation, exceed the amount of funds collected, the gap between revenue and future needs is expected to become marginal every year.

CHAPTER 3 REVIEW OF PREVIOUS F/S

The Study, through the preliminary review of previous F/S report, identified technical issues in the traffic survey and demand forecast, road and bridge design, and project evaluation, explored in the F/S report.

(1) Traffic Survey and Demand Forecast

(1) In previous F/S, improvement of several roundabouts along the project road was proposed. However, a traffic survey to validate the proposed design of those roundabouts was not carried out.

(2) A single future traffic demand growth rate was applied to the entire study area and encompassed all types of vehicles. It was assumed that the growth rate of heavy vehicles such as trucks and trailers in Arusha and Kilimanjaro would be different because of the disparity in population density and economic activities. Therefore, this assumption in the accuracy of future demand forecast in previous F/S report in the middle and long term may not be reliable.

(3) Diversion of traffic induced by the proposed road improvement project from Dar es Salaam to Mombasa Seaports was estimated through road accessibility to those two seaports. Dwell time and other factors that influence route choice of sea-borne cargo were not considered. Furthermore, induced traffic demand generated by the existing large-scale development plan along the project road was not accounted for in the demand forecast.

(2) Road Design

(1) Setting of the design speed is unsubstantiated; the design speed changes from 100 km/h to 50 km/h frequently within a short section, which deviates from the actual traveling speed and is therefore not desirable in terms of safety.

(2) There are multiple sections whose (vertical) grades do not comply with the design standard of Tanzania and that have steep grades without climbing lanes, which may cause accidents due to speed drop and when overtaking/bypassing heavy vehicles.

(3) For the vertical alignment near the Kikafu Bridge the grades of the approach section are proposed to be in the range of 3.5% to 4.5% so as to limit the bridge length to about 100 meters. Considering major accidents in the past, it is recommended to set flatter grades at/near the proposed Kikafu Bridge and to take appropriate measures to cope with design-related issues.

(3) Bridge Design

(1) For applicable standards and design conditions, the Study confirms approach of concerned authorities with revisions, made to meet the standards set in 2011.

(2) The bridge type and structural data were uniformly established according to the bridge size, and the priority among them, however the rationale for decision of the bridge type are unclear. Accordingly, the Study Team performs the technical verification (selection of the bridge type, etc.) to prove suitability to meet the requirements set by JICA's guidelines and manuals.

(3) Issues and subjects in terms of the design and construction plans are identified; for example, the reference data necessary for appraisal of the JICA loan project is insufficient, including those for the project process, review of the construction method for estimation of the work costs and for

project schedules. The Study undertakes a supplementary study and survey as follows to deal with these technical issues.

(4) Project Evaluation

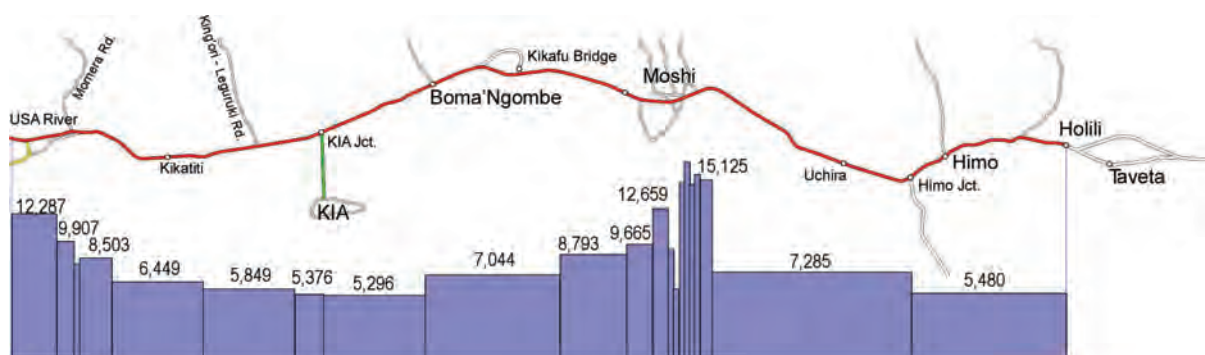
(1) The Vehicle Operating Cost (VOC) saving and travel time reduction due to the implementation of the Project were calculated and indicated as quantitative effects as a result of the Project. However, the accuracy of future demand forecast in previous F/S report in the middle and long term may not be reliable as described above.

(2) In the previous F/S report, qualitative effects derived from the Project are not estimated, apart from its input in economic analysis on the Project. The Study carries out economic analysis and project evaluation, following the JICA's guidelines.

CHAPTER 4 TRAFFIC DEMAND FORECAST

4.1 Summary Result of Traffic Survey

To update the existing traffic volume data at road section and junction, a traffic count survey was performed in October 2015. Traffic survey consists of (i) traffic count survey at road sections, and (ii) traffic count survey at junctions and roundabouts. The following figure summarizes the result of the traffic survey and current traffic ranging from 5,300 to 15,100 PCUs was accounted for along the project road. More traffic was observed at the road section between Tengeru and Usa and Moshi Town.



unit: PCU/day

Source: JICA Study Team

Note: motorcycles are not included.

Figure 1 AADT in 2015 Based on Traffic Survey (PCU/day)

4.2 Summary Result of Demand Forecast

(1) Methodology of Traffic Demand Forecast

The traffic demand for the Arusha-Holili Road is forecasted by traffic assignment of current and forecasted future vehicular trips with the origin and destination (OD) assigned to the road network. Current vehicular OD is estimated based on existing traffic surveys conducted by relevant empirical studies and traffic information provided by TANROADS and traffic survey performed in the October 2015 Study. Future OD is forecasted by GDP/GRDP growth rate by traffic zone and elasticity of traffic volume to GDP/GRDP growth.

Table 1 Traffic Demand Elasticity to GDP/GRDP Growth

	Passenger Cars	Buses	Trucks/Trailers
Elasticity of Traffic Demand to GDP/GRDP	1.493	1.042	0.903

Source: JICA Study Team

(2) Result of Demand Forecast

The results of traffic demand forecast along the project road is tabulated by the road network link with the target years of 2025 and 2035. The traffic volume along the project road is projected to increase at around 6% to 7% per annum between 2015 and 2035. A large number of traffic is projected at/near Usa River and Moshi Town where the projected traffic demand exceeds 20,000 PCU/day in 2025 and 40,000 PCU/day in 2035¹.

Table 2 Future Traffic Demand by Section (both direction, PCU/day)

Survey Station	2015	Est. 2025	2015 – 2025 Growth Rate (p.a.)	Est. 2035	2025 – 2035 Growth Rate (p.a.)
Section A	12,287	24,000	6.9%	45,800	6.7%
Usa River (West of Momera Jct.)	9,907	19,200	6.8%	36,400	6.6%
Usa River (East of Momera Jct.)	8,951	17,200	6.7%	32,200	6.5%
Section B	8,503	16,400	6.8%	30,800	6.5%
Section C	6,449	12,500	6.8%	23,500	6.5%
Section D	5,849	11,400	6.9%	21,700	6.6%
KIA Junction (West of KIA)	5,376	10,400	6.8%	19,600	6.5%
KIA Junction (East of KIA)	5,296	10,400	7.0%	20,000	6.8%
Section E	7,044	13,600	6.8%	25,600	6.5%
Sasini Center (West of Jct)	8,793	16,900	6.8%	31,700	6.5%
Sasini Center (East of Jct)	9,665	18,600	6.8%	35,000	6.5%
Sekou Toure Way R/A (West)	12,659	24,400	6.8%	46,000	6.5%
Sekou Toure Way R/A (East)	9,229	18,400	7.1%	35,600	6.8%
Moshi R/A (West of R/A)	5,845	12,200	7.6%	24,200	7.1%
Moshi R/A (East of R/A)	14,860	28,200	6.6%	52,300	6.4%
Moshi Town West (West)	16,648	32,700	7.0%	62,800	6.7%
Moshi Town West (East)	14,740	28,700	6.9%	54,700	6.7%
Moshi Town East (West)	15,584	30,400	6.9%	58,200	6.7%
Moshi Town East (East)	15,125	29,400	6.9%	56,100	6.7%
Himo Jct (West)	7,285	13,400	6.3%	24,000	6.0%
Himo Jct (East)	5,480	9,800	6.0%	16,800	5.5%
Mwika Jct (West)	2,306	4,500	6.9%	8,400	6.4%
Mwika Jct (East)	1,685	3,300	7.0%	6,100	6.3%

Note1: The above figures exclude motorcycle.

Note2: Traffic demand of KIA access road is estimated at 2,648 PCU (2015), 5,200 PCU (2025) and 9,900 PCU (2035).

Source: JICA Study Team

The following figures compare the 2025 projected traffic volume by section and indicates two forecasts (F/S and the Study) provide similar traffic volume in most road sections, whereas the larger traffic volume is projected in/around Moshi in the Study.

¹ Conversion Rate of Passenger Car Unit applied to F/S is also applied to this Study: Motorcycle (0.5), Passenger Cars (1.0), Small Buses (1.3), Large Bus (1.6), 2 Axles Truck (1.5), 3+ Axles Truck (1.8), Trailer (2.2).

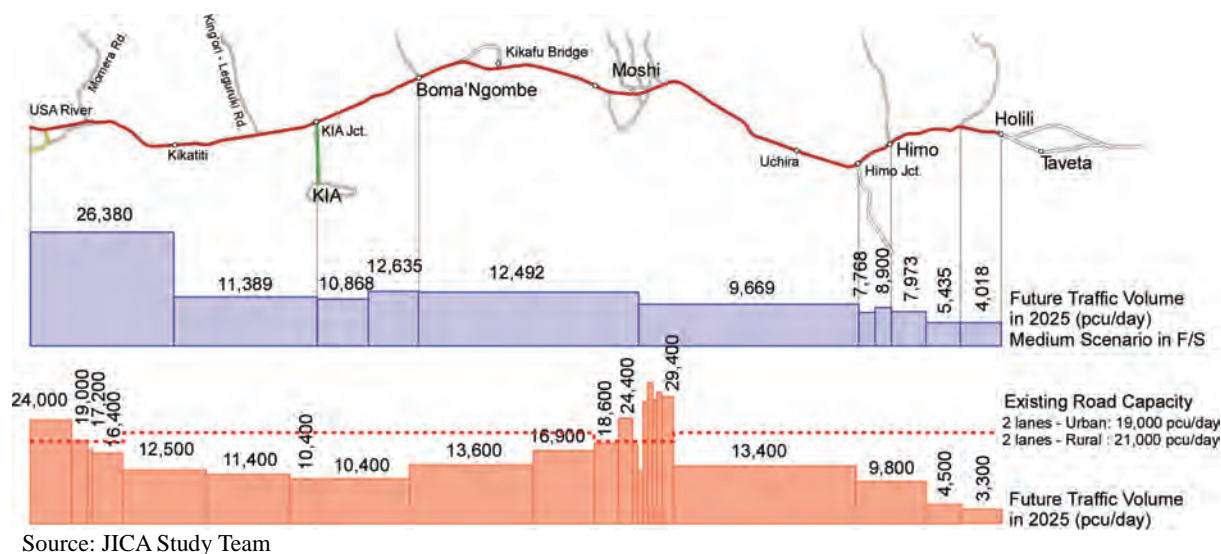


Figure 2 Future Traffic Demand in 2025 (PCU/day)

CHAPTER 5 STUDY OF ALTERNATIVE ROAD AND BRIDGE PLAN

5.1 Study on Alternative Road Design

(1) Design Standard

The Study concedes that reviewing the design shall be carried out according to the Tanzanian Standard, and the STACC Standard shall also be supplementary referred to.

(2) Design Speed

All standards/manuals referred to recommend the application of a design speed of 120kph for international trunk roads. Considering the nature of improvement, 100kph is considered to be reasonably applicable since the geometrical requirements of design speed of 120kph calls large land acquisitions and compensations which is not in line with the improvement strategy.

(3) Road Classification

There are two kinds of classification for road networks in Tanzanian. As for the functional classification, the project road is classified as a Trunk Road and as for the design classification, the project road is evidently categorized into 'A' of functional class (among A to E) and 'DC1' of design class (among DC1 to DC8), considering traffic characteristics of the project road.

(4) Geometrical Design

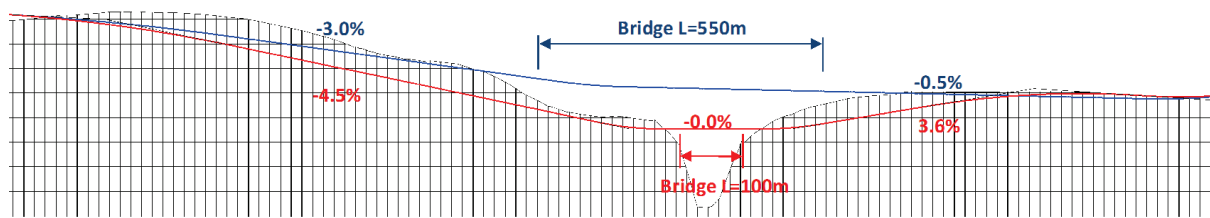
1) Horizontal Alignment

The horizontal alignment design shall follow the existing parameters as much as possible. Minor adjustments in the geometrical design at the dual carriageway section is needed as explained. The Study finds no reasonable amendment needed on the alignment design at this stage.

2) Vertical Alignment

For the existing alignment section, the geometrical design shall follow the existing geometrical parameters as much as possible. Minor adjustments will be needed so as to satisfy required sight distance (i.e. K value) as required in the applied design speed.

For the Kikafu Bridge and its approach road section, an alternative study is conducted on the vertical alignments of 3%-A and 4.5%-B in order to confirm viability. The design speed of 100kph requires a maximum of 3% of gradient in vertical alignment designing which may call the cost implication as it requires a longer span bridge. On the other hand, the steeper gradient (i.e. 4.5% in this alternative study) requires a relatively shorter span bridge which gives smaller impact on the project budget. The Study recommends to improve the vertical alignment around the Kikafu Bridge and to apply a maximum gradient of 3%, considering the impact of the traffic and risk in occurrence of traffic accidents.



Note: Above figure shows road section between 41.4 km and 43.4 km.

Source: JICA Study Team

Figure 3 Alternative Study on Vertical Alignment at New Kikafu Bridge

(5) Cross Section Design and Pavement Design

1) Pavement Design Life

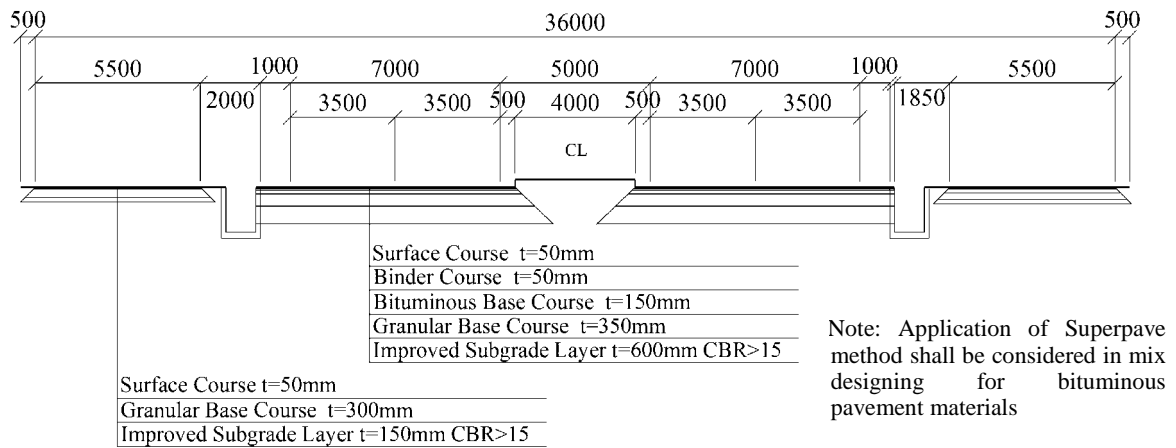
The Study recommends maintaining the design life of 20 years as F/S and D/D applied.

2) Traffic Factor

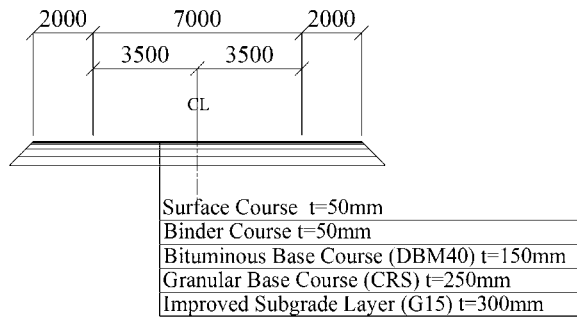
Applying the traffic factor, data and formulae, the design traffic loadings (ESAL) are obtained: 5.0×10^6 (Holili-Himo Section), 79.4×10^6 (Himo-Moshi Section), 77.7 to 81.8×10^6 (Moshi-Usa Section) and 98.7×10^6 (Usa-Tengeru Section).

(6) Pavement Design Improvement Study

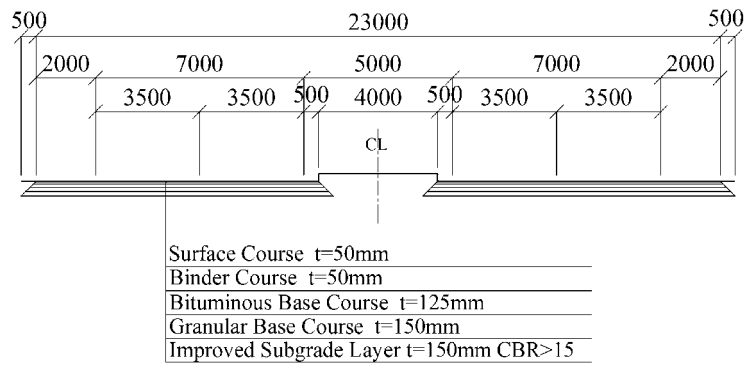
There were some observations that pavement structure failures have occurred on the road sections where the stabilized base/subbase course have been applied. Against the backdrop of the pavement failure cases and its ongoing analysis by JICA, the Study recommends not to apply stabilization in construction of the base/subbase course. In addition, following the EAC guideline, the Study also recommends the Superpave mix design method shall be designed to replace existing Hveem and Marshall methods. Consequently, the pavement improvement design is prepared as shown in the following figures.



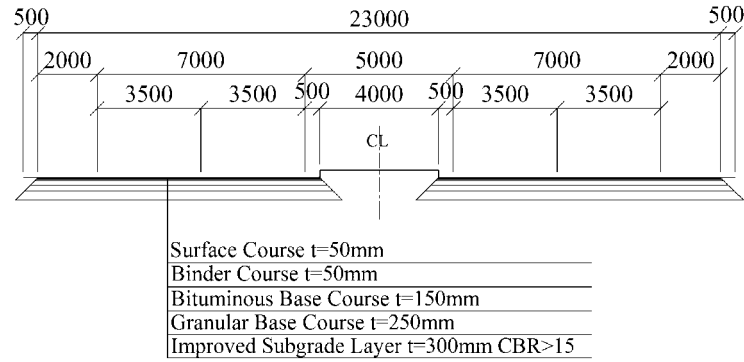
Tengeru-Usa (Dual Carriageway)



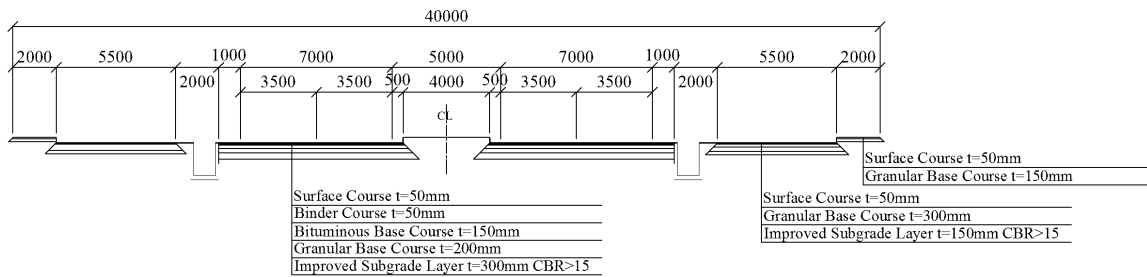
Usa -Moshi (Single Carriageway)



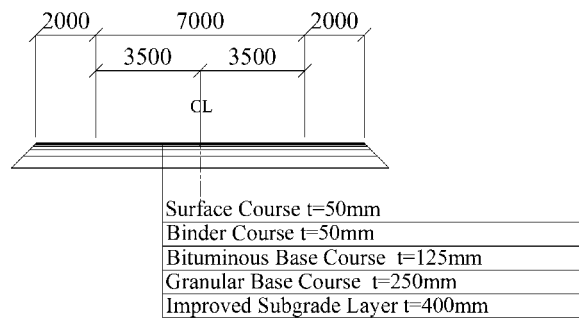
Kikafu (Dual Carriageway)



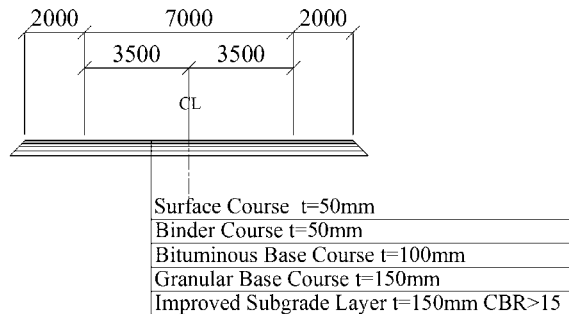
Moshi Town (Dual Carriageway, without Service Road and Footpath)



Moshi Town (Dual Carriageway, with Service Road and Footpath)



Moshi-Himo (Single Carriageway)



Himo-Holili (Single Carriageway)

Source: JICA Study Team

Figure 4 Cross Section and Pavement Design

5.2 Study on Alternative Bridge Type

(1) Comparative Study of Preferable Bridge Type

At the initial stage of the Study on alternative bridge type, the Study sets design configurations, reviewing the previous F/S and D/D and site visits by the Study Team. The following design configurations are set for the selection of an alternative bridge type:

- Bridge length: Around 550m
- Both bridge ends are determined abutments from a reasonable height of abutments ($H < 8m$).
- Skew angle of bridge: 54 degrees
- Pier arrangements in the river are technically considered subject to disturbance of water current if the skew angle is less than 60 degrees
- Min. span length more than 130m

Given the above design configuration, the feasible superstructure types were studied with reference to Japanese practices. Both the different structure types of concrete and steel girders provide the applicable range of span length for each bridge type respectively.

Among these feasible types of bridges, a comparative study was conducted as shown in the following table and the following types of bridge were selected as preferable alternatives for the detailed comparative study shown in the same table.

[Concrete bridge]

- **Alt.-1 PC Continuous Box Girder Bridge**
- **Alt.-2 PC Rigid Frame (Ramen) Continuous Box Girder Bridge**
- **Alt.-3 Extradosed Bridge**
- **Alt.-4 PC Cable Stayed Bridge**

[Steel bridge]

- **Alt.-5 Steel Continuous Box Girder (Steel Slab) Bridge**
- **Alt.-6 Continuous Steel Truss Bridge**
- **Alt.-7- Steel Arch Bridge**

The detailed comparative study in the following tables resulted in the following types of bridges obtaining the highest scores of AHP among the options.

[Concrete bridge]

- **Alt.-3 Extradosed Bridge**

[Steel bridge]

- **Alt.-7- Steel Arch Bridge**

On December 11, 2015, a tripartite meeting was held involving TANROADS, JICA and the Study Team and confirmed PC Extradosed Bridge as the optimum bridge type agreed, considering maintainability, workability during construction and landscape.

Table 3 Comparative Study for Possible Candidates Bridges for New Kikafu Bridge (Concrete Bridge)

Side View		Cross Section	Criteria	Assessment	Score ^{*2,3}			
Alt-1	5 span continuous PC box girder bridge+ PC box girder bridge	<p>Construction Period: 3.0 years</p>	Cost (Mil. USD) ^{*1}	Super.	17.3 (12.1)	Most reasonable cost due to general type of bridge and abundant practices in EAC member countries however implicated potential cost increase for foundation and substructure works.	A	B (0.65)
<p>This bridge structurally performs a high maintainability in connecting PC box girders by minimizing expansion joints of the superstructure. Launching girders from the piers located in the river slope is presumed a difficult construction concerning the excavation of hard rock (assumed 50-100MN/m²) on the steep slope (40-45 degree).</p>				Sub.	8.7 (6.1)			
			Temp.	7.8 (5.5)				
			Total	33.8 (23.6)				
			Structure	<ul style="list-style-type: none"> Economic span length ranging between 60m and 110 m Efficient girder erection by cantilever method using form traveler crossing over deep valley safely High durability and maintainability for pre-stressed concrete girder 		B		
		Workability	<ul style="list-style-type: none"> Applying cantilever erection over the river assumed while applying all stage method at on land viaduct Potential risk for the pier construction to be located on the steep slope of the river that be difficult to haul materials and equipment for the excavation. 		C			
Maintainability	Free maintenance by using PC		A					
Landscape	Fair aesthetic view due to general type of bridge		B					
Alt-2	3 span PC continuous rigid frame PC box girder bridge +PC box girder bridge	<p>2.9 years</p>	Cost (Mil. USD) ^{*1}	Super.	19.3 (13.5)	Most reasonable cost due to general type of bridge and abundant practices in EAC member countries.	A	C (0.50)
<p>This bridge performs a high durability and maintainability eliminating bearing shoes at launching piers and saving maintenance cost in connecting girders. Unbalanced structure in combination between long span and low piers might be impossible to form rigid frame system.</p>				Sub.	7.7 (5.4)			
			Temp.	8.1 (5.7)				
			Total	35.2 (24.6)				
			Structure	<ul style="list-style-type: none"> Economic range of span length between 40m and 130 m. Efficient girder erection by cantilever method using form traveler crossing over deep valley safely A span 130m with low pier (assumed less than 20m height) standing on spread foundation be structurally difficult to form a rigid frame system (ramen) 		C		
		Workability	<ul style="list-style-type: none"> A similar work sequence with Alt.1 assumed using cantilever erection over the river and all staging method on land section. A potential risk for requiring shortening of middle span and rearrangement of configuration if rigid frame system cannot be workable 		C			
Maintainability	<ul style="list-style-type: none"> Free maintenance by using PC. Rigid frame between girder and piers without the bearing shoe for saving maintenance cost 		A					
Landscape	Fair aesthetic view due to low piers		C					

Note1: Cost indicates construction costs of 4 lane bridge and cost in (parenthesis) indicates that of 2 lane bridge. Note2: Above score indicates A (Reasonable or superior), B (Fair or tolerable), C (Unreasonable or inferior). Note3: The score is calculated by multiplying weight of each evaluation factor, estimated by AHP questionnaire survey, and average of ranking of evaluation factors (A=1.0, B=0.5, C=0.0). The higher the score, the better the performance of the bridge type.

Source: JICA Study Team

Table 4 Comparative Study for Possible Candidates Bridges for New Kikafu Bridge (Concrete Bridge)

Side View		Cross Section	Criteria	Assessment	Score ^{*2,3}										
Alt-3	3 span continuous PC extradosed bridge+ PC box girder bridge		Cost (Mil. USD) ^{*1}	<table border="1"> <tr> <td>Super.</td> <td>26.9 (18.8)</td> <td rowspan="4">Tolerable cost to realize a suitable longer span PC bridge however implicated comparatively longer construction period</td> </tr> <tr> <td>Sub.</td> <td>10.8 (7.5)</td> </tr> <tr> <td>Temp.</td> <td>11.3 (7.9)</td> </tr> <tr> <td>Total</td> <td>49.0 (34.2)</td> </tr> </table>	Super.	26.9 (18.8)	Tolerable cost to realize a suitable longer span PC bridge however implicated comparatively longer construction period	Sub.	10.8 (7.5)	Temp.	11.3 (7.9)	Total	49.0 (34.2)	B	
Super.	26.9 (18.8)		Tolerable cost to realize a suitable longer span PC bridge however implicated comparatively longer construction period												
Sub.	10.8 (7.5)														
Temp.	11.3 (7.9)														
Total	49.0 (34.2)														
			<p>This bridge provides a longer span bridge which can reduce the number of piers in anticipated the rock excavation at foundation works and provides high maintainability minimizing expansion joint of superstructure. The aesthetic view of this bridge is one of the best candidates harmonizes with the scenery of the site.</p>	Structure	<ul style="list-style-type: none"> - Economic span length around 150m. - Efficiently arranging outer cables from tower to enable longer span length with using box girder. - High durability and maintainability for pre-stressed concrete girder 	A									
<p>This bridge provides a longer span bridge which can reduce the number of piers in anticipated the rock excavation at foundation works and provides high maintainability minimizing expansion joint of superstructure. The aesthetic view of this bridge is one of the best candidates harmonizes with the scenery of the site.</p>		Workability		<ul style="list-style-type: none"> - Similar cantilever erection like Alt 1 and 2 assumed in addition to tower construction 	A										
		Maintainability		<ul style="list-style-type: none"> - Free maintenance by using PC (if using maintenance free outer cable). 	A										
		Landscape		<ul style="list-style-type: none"> - Superior aesthetic view in combination with twin towers of bridge 	A										
Alt-4	2 span continuous PC cable stayed bridge+ PC box girder bridge			Cost (Mil. USD) ^{*1}	<table border="1"> <tr> <td>Super.</td> <td>27.6 (19.3)</td> <td rowspan="4">Slightly higher cost to meet the site condition of Kikafu over 160m span length by single pylon cable stayed bridge.</td> </tr> <tr> <td>Sub.</td> <td>11.0 (7.7)</td> </tr> <tr> <td>Temp.</td> <td>11.6 (8.1)</td> </tr> <tr> <td>Total</td> <td>50.2 (35.1)</td> </tr> </table>	Super.	27.6 (19.3)	Slightly higher cost to meet the site condition of Kikafu over 160m span length by single pylon cable stayed bridge.	Sub.	11.0 (7.7)	Temp.	11.6 (8.1)	Total	50.2 (35.1)	B
Super.	27.6 (19.3)			Slightly higher cost to meet the site condition of Kikafu over 160m span length by single pylon cable stayed bridge.											
Sub.	11.0 (7.7)														
Temp.	11.6 (8.1)														
Total	50.2 (35.1)														
			<p>This bridge has two lateral stay-cables plane that are anchored at the edge of the transverse ribs of box girder, fixed at a main pylon. Unsymmetrical stay-cables give an unique impact to the aesthetic view in the background of Mt. Kilimanjaro.</p>	Structure	<ul style="list-style-type: none"> - Economic span length around 200m longer than that of Alt.3. - Depth of box girder can be reduced efficiently but critical structural behaviour by wind force 	B									
		Workability		<ul style="list-style-type: none"> - More difficult cantilever erection than Alt 1, 2 and 3 assumed in addition to high pylon construction - Potential risk with the construction of high pylon, cantilever work and large spread footing - Longer construction period assumed for high pylon construction than other PC bridges 	B										
		Maintainability		<ul style="list-style-type: none"> - Need maintenance of stayed cable be required higher technique - Need operational control for the traffic during strong wind 	B										
		Landscape		<ul style="list-style-type: none"> - Good aesthetic view in combination with high pylon of bridge might harm the view of Mt Kilimanjaro 	A										

Note1: Cost indicates construction costs of 4 lane bridge and cost in (parenthesis) indicates that of 2 lane bridge. Note2: Above score indicates A (Reasonable or superior), B (Fair or tolerable), C (Unreasonable or inferior). Note3: The score is calculated by multiplying weight of each evaluation factor, estimated by AHP questionnaire survey, and average of ranking of evaluation factors (A=1.0, B=0.5, C=0.0). The higher the score, the better the performance of the bridge type.

Source: JICA Study Team

Table 5 Comparative Study for Possible Candidates Bridges for New Kikafu Bridge (Steel Bridge)

Side View		Cross Section	Criteria	Assessment	Score ^{*2,3}									
Alt-5	3 span continuous steel box girder bridge (steel slab) + Steel I girder bridge	<p style="text-align: center;">2.8 years</p>	Cost (Mil. USD) ^{*1}	<table border="1"> <tr> <td>Super.</td> <td>31.0 (21.7)</td> </tr> <tr> <td>Sub.</td> <td>12.4 (8.7)</td> </tr> <tr> <td>Temp.</td> <td>13.0 (9.1)</td> </tr> <tr> <td>Total</td> <td>56.5 (39.5)</td> </tr> </table>	Super.	31.0 (21.7)	Sub.	12.4 (8.7)	Temp.	13.0 (9.1)	Total	56.5 (39.5)	Comparatively higher cost among the alternatives in spite of the shortest construction time.	C
Super.	31.0 (21.7)													
Sub.	12.4 (8.7)													
Temp.	13.0 (9.1)													
Total	56.5 (39.5)													
Structure	<ul style="list-style-type: none"> - Appx. 20% of self-weight lighter than concrete girder to efficiently save cost by downsizing of substructure and foundation. - Possible saving time for slab works eliminating the steps for form works and concrete casting by using steel slab 	A												
This bridge shortens the construction time by prefabricating the girders at factory in advance. Using weathering steel also saves maintenance cost however a rusty color of girder may harm the aesthetic view of bridge.			Workability	<ul style="list-style-type: none"> - Possibly applying launching erection by using temporary nose girder crossing over the river while applying TC bent supporting the girder on land section. - Difficult to locate the temporary bent on steep slope during the erection of girder over the river 	B									
			Maintainability	<ul style="list-style-type: none"> - Recommend to apply weathering steel for saving maintenance routine - Require higher technical capacity for the maintenance of pavement on the steel slab 	C									
			Landscape	Non symbolic view due to general type of bridge	C									
Alt-6	Simple steel tied arch bridge+ Steel I girder bridge	<p style="text-align: center;">2.7 years</p>	Cost (Mil. USD) ^{*1}	<table border="1"> <tr> <td>Super.</td> <td>27.1 (18.9)</td> </tr> <tr> <td>Sub.</td> <td>10.8 (7.6)</td> </tr> <tr> <td>Temp.</td> <td>11.4 (8.0)</td> </tr> <tr> <td>Total</td> <td>49.3 (34.5)</td> </tr> </table>	Super.	27.1 (18.9)	Sub.	10.8 (7.6)	Temp.	11.4 (8.0)	Total	49.3 (34.5)	Tolerable cost to realize a suitable longer span bridge with a good aesthetic view	B
Super.	27.1 (18.9)													
Sub.	10.8 (7.6)													
Temp.	11.4 (8.0)													
Total	49.3 (34.5)													
Structure	<ul style="list-style-type: none"> - Tide arch bridge incorporates a tie between two opposite ends of the arch. The tie is capable of withstanding the horizontal thrust forces which is normally exerted by the abutments of an arch bridge. - Vertical members and hanger cable tiding between Arch rib and bottom chord separates the type of arch called as "Lohse" using vertical member and "Nielsen" using oblique cables. 	A												
This bridge shortens the construction time similarly with Alt.1. The aesthetic view is one of the best candidates however using weathering steel may harm the aesthetic view of bridge with the rusty color although saving maintenance cost.			Workability	<ul style="list-style-type: none"> - Assumed that cable erection method would be applied to erect the arch rib crossing over the Kikafu River. - Need skilled workers to control the erection of members from cables 	B									
			Maintainability	Recommend to apply weathering steel for saving maintenance routine	A									
			Landscape	Superior aesthetic view with combination of arch however harming with color of bridge if weathering steel is applied.	A									

Note1: Cost indicates construction costs of 4 lane bridge and cost in (parenthesis) indicates that of 2 lane bridge. Note2: Above score indicates A (Reasonable or superior), B (Fair or tolerable), C (Unreasonable or inferior). Note3: The score is calculated by multiplying weight of each evaluation factor, estimated by AHP questionnaire survey, and average of ranking of evaluation factors (A=1.0, B=0.5, C=0.0). The higher the score, the better the performance of the bridge type.

Source: JICA Study Team

Table 6 Comparative Study for Possible Candidates Bridges for New Kikafu Bridge (Steel Bridge)

Side View		Cross Section	Criteria	Assessment	Score ^{*2,3}									
Alt-7	Simple steel warren truss bridge + Steel I girder bridge		Cost (Mil. USD) ^{*1}	<table border="1"> <tr> <td>Super.</td> <td>22.9 (16.0)</td> <td rowspan="4">Tolerable cost however implicates potential cost increase for foundation and substructure works.</td> </tr> <tr> <td>Sub.</td> <td>9.2 (6.4)</td> </tr> <tr> <td>Temp.</td> <td>9.6 (6.7)</td> </tr> <tr> <td>Total</td> <td>41.7 (29.2)</td> </tr> </table>	Super.	22.9 (16.0)	Tolerable cost however implicates potential cost increase for foundation and substructure works.	Sub.	9.2 (6.4)	Temp.	9.6 (6.7)	Total	41.7 (29.2)	B
Super.	22.9 (16.0)		Tolerable cost however implicates potential cost increase for foundation and substructure works.											
Sub.	9.2 (6.4)													
Temp.	9.6 (6.7)													
Total	41.7 (29.2)													
		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">2.8 years</div>	Structure	<ul style="list-style-type: none"> - A truss girder associates with an isosceles triangle steel frame provides light self-weight to enable downsizing of the foundation and substructure. - Also, rationalized truss girder associates with ratis frame using shaped steel provide more self- weight down. 	A									
<p>This bridge shortens the construction time similarly with other steel bridges however requires construction of piers on the river slope that is presumed a difficult construction concerning the excavation of hard rock (50-100MN/m²) on the steep slope (40 -45degree).</p>			Workability	<ul style="list-style-type: none"> - Assumed that launching erection method would be applied for crossing the Kikafu River while stage erection using TC bent support can be generally applied. - Potential risk for the pier construction to be located on the steep slope of the river that be difficult to haul materials and equipment for the excavation. 	C									
			Maintainability	Recommend to apply weathering steel for saving maintenance routine and use PC slab to increase durability	A									
			Landscape	No good with unbalanced structure due to high truss and low piers	C									
					C (0.52)									

Note1: Cost indicates construction costs of 4 lane bridge and cost in (parenthesis) indicates that of 2 lane bridge. Note2: Above score indicates A (Reasonable or superior), B (Fair or tolerable), C (Unreasonable or inferior). Note3: The score is calculated by multiplying weight of each evaluation factor, estimated by AHP questionnaire survey, and average of ranking of evaluation factors (A=1.0, B=0.5, C=0.0). The higher the score, the better the performance of the bridge type.

Source: JICA Study Team

(2) Optional Superstructure by Dualling Configuration

There are several types of composite PC girders that have been invented in Japan and other countries. Unique composite structures, such as using corrugated steel panel and steel pipe truss, etc. in the web of a PC girder, could be applied to Kikafu Bridge. However, these are suitable when the cost of the foundation and substructure can be effectively minimized by reducing the self-weight of the superstructure. The area around Kikafu Bridge requires only seismic design for a common earthquake force (Level-1) and the bridge has normal spread foundation. As a practical aspect, the conventional PC box girder would be suitable for the Kikafu Bridge taking into account the site condition and other factors given in the comparative studies.

For the dualling configuration, the integrated four lanes section (Alt-A) would be suitable for dualling configuration at the economic factor (minimum initial cost) however the dual separate two lane section (Alt-B) would be desirable considering the traffic safety factor.

Table 7 Optional Superstructure with Dualling Configuration for New Kikafu Bridge

Opt.	Structure	Section xLane	Cost (Mil. USD)	Economic	Structure	Workability	Maintainability	Traffic safety	Land-scape	Assessment
Alt-1A	PC Box	1x4	49.0	A+ (0.20)	A (0.11)	B (0.08)	A+ (0.14)	B (0.19)	A (0.08)	A- (0.80)
Alt-1B		2x2	58.9	B- (0.10)	A+ (0.12)	A (0.12)	A (0.12)	A (0.29)	B (0.05)	A- (0.80)
Alt-2A	Corrugated. Steel	1x4	51.0	A (0.18)	B+ (0.08)	B+ (0.09)	C+ (0.05)	B (0.19)	A (0.08)	B (0.68)
Alt-2B		2x2	60.9	B- (0.10)	A (0.11)	A+ (0.13)	C (0.04)	A (0.29)	B (0.05)	B+ (0.72)
Alt-3A	Composite Truss	1x4	53.0	A- (0.16)	B+ (0.08)	B+ (0.09)	C+ (0.05)	B (0.19)	A (0.08)	B (0.66)
Alt-3B		2x2	63.3	C+ (0.08)	A (0.11)	A+ (0.13)	C (0.04)	A (0.29)	B (0.05)	B+ (0.70)

Source: JICA Study Team

On 23rd May, 2016, a tripartite meeting was held involving TANROADS, JICA and Study Team and confirmed PC box and integrated four lanes (Alt-1A) as an optimum superstructure type agreed, considering maintainability and initial investment cost.

CHAPTER 6 CONSTRUCTION AND IMPLEMENTATION PLAN

(1) Construction Package (Contract Package)

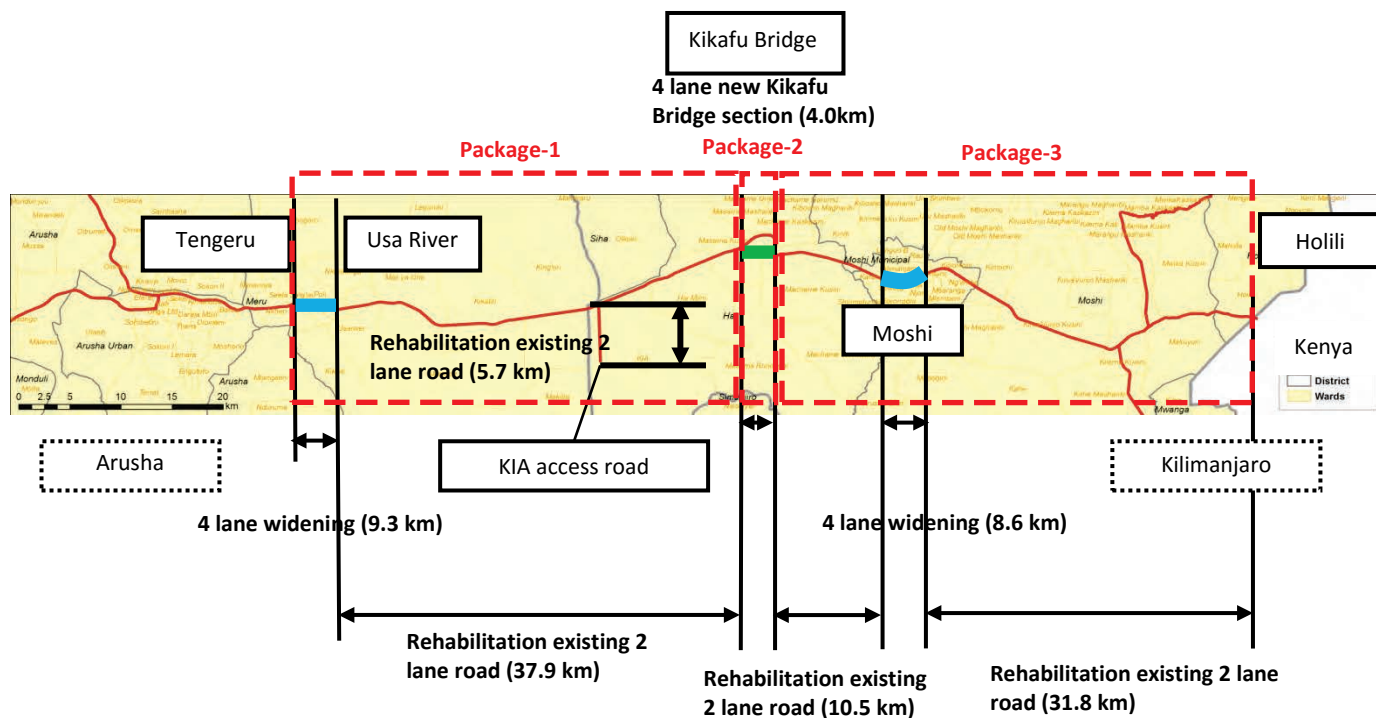
The Project includes widening and rehabilitation of road sections, totaling to 107.9 km (including 4 lane widening 21.9 km) and 560m long Kikafu Bridge. Rehabilitation of existing road, especially widening the section through the urban area, requires diversion of main traffic, to ensure safety. A 560m long PC Extradosed Kikafu Bridge itself requires a complex construction method. Considering the manageable size of the Project, the following four packages are proposed.

Package-1: 47.2km Tengeru - West Kikafu and 5.7km KIA Access Road

Package-2: 4.0km West Kikafu –East Kikafu including 560m Kikafu Bridge, and Roadside Station

Package-3: 50.9km East Kikafu- Holili

Package-4: Safety measure at vicinity of existing Kikafu Bridge



Source: JICA Study Team

Figure 5 Proposed Construction Package of the Project

(2) Implementation Schedule

The implementation plan for the Project is proposed based on the assumptions listed in the following table. Assuming the loan agreement is made in October, 2016, the Project is completed and open to the traffic between mid-2021 (Package 1 and 3) and end-2021 (Package 2).

Table 8 Basic Assumptions for Implementation Schedule

Item	Assumption
Loan Agreement	October, 2016
Procurement of D/D Consultant	9 months
Detailed Design	9 months for package 1 and 3 12 months for package 2 and 4
Tender Assistance	12 months
Civil Works	33 months for package 1 and 3 36 months for package 2 6 months for package 4
Land Acquisition	Completed before construction

Source: JICA Study Team

CHAPTER 7 ENVIRONMENTAL AND SOCIAL STUDIES

7.1 Review of ESIA Report

(1) Status of ESIA and RAP

According to AfDB categorization, the Project is classified as Category 1, which requires a full Environmental and Social Impact Assessment. Tanzanian Environmental Impact Assessment and Audit (2005) regulations also classifies the Project as a Type A, which requires a full Environmental Impact Assessment. Environmental License of this Project was approved by NEMC on 30th September 2014.

According to Article 35, Part VII of this Act, where there are design changes after the environmental certificate is issued, the project owner shall apply for further approval for these design changes, using the Form 5.

Form 5 of the Project was prepared and submitted to NEMC by TANROADS on 16th May, 2016, and its review by NEMC is on-going. Basically, the Project is planned to be conducted within RoW =45 m road space, already declared by TANROADS, so that there is no significant design change except the bridge design of Kikafu (bridge span was extended from 100m, originally set in F/S and D/D to 560m, proposed by JICA Study Team).

(2) Review of ESIA and RAP

A comprehensive review of ESIA, EMP and RAP was conducted, based on JICA Guideline for the Social and Environmental Considerations (published in 2004, revised in 2010). Typical remarks, obtained from this review, are summarized in the following section. Basically, contents of ESIA, EMP and RAP are thorough and no big gap was recognized based on JICA.

From this review, it is found that ESIA and EMP are comprehensive, but the following field data and/or information are not incorporated.

- a) Existing traffic accidents
- b) Existing ambient air quality
- c) Existing levels of noise and vibrations
- d) Domestic water quality
- e) Secondary data obtained from the village government were not reliable as data collected is not updated frequently particularly those concerning demography, livestock and agricultural production trend.

Regarding vibration, no environmental standard is available in Tanzania. So, it is recommended to carry out relevant on-site field surveys such as roadside air quality, noise and water quality analysis in order to improve contents of ESIA and EMP.

7.2 Environmental Surveys and Preliminary Studies

(1) Supplemental Environmental and Social Consideration Study

Based on the preliminary environmental scoping results, summarized in the tables below review results of ESIA, EMP and RAP and findings from technical site visits, a draft ToR for the supplemental environmental and social study was developed. Basically, this ToR development is carried out abiding by IEE/EIA Law and/or relevant environmental regulations of Tanzania and the JICA Guideline. The table below summarizes major tasks of the additional field study

required for the proposed road improvement project.

Table 9 Major Tasks of Supplemental Environmental and Social Consideration Study

Major Tasks to be conducted	
1	Roadside Air Quality and Noise Survey
2	Water Quality Survey
3	Preliminary Biological Environmental Study
4	Review and Updating of Past RAP study
5	Socio-Economic Study for newly identified PAPs
6	Preparation of Entitlement Matrix
7	Public consultation (and/or community meeting for Land Take)
8	Support TANROADS for Preparation of Form # 5 regarding the Updating of Road Improvement

Source: JICA Study Team

(2) Major Field Survey Results

a) Roadside Air Quality Survey

The roadside air quality, measured at 5 points, showed several peaks, corresponding to morning, noon and evening traffic peak modes, but below 0.1 mg/m³. These were below both the ambient air quality standard of Tanzania and WHO guideline values. Accordingly, the current roadside air quality condition between Tengeru and Holili is in good condition.

b) Roadside Noise Survey

The roadside noise, measured at 5 points, showed several peaks, corresponding to morning, noon and evening traffic peak modes and sometimes reach more than 70 dBA. In addition, the noise measured at 5 points during off-peak hours also exceeded more than 40-50 dBA. Based on the noise standards, adopted in Tanzania, maximum permissible noise levels at residential and mixed residential areas are 50 and 55 dBA during day time and 35 and 45 dBA during night time, respectively.

The table below summarizes the L_d (daytime-averaged Leq) and L_n (night time-averaged Leq), calculated based on the noise survey results.

Table 10 Summary of L_d and L_n

Survey Point	L _d (6:00 am – 10:00 pm)	L _n (10:00 pm – 6:00 am)
Tengeru	67.7	51.5
B-Ng'ombe	68.8	55.2
Moshi	75.4	51.8
Himo	75.5	49.6
Holili	62.4	44.8

Source: JICA Study Team

As summarized in the above table, roadside noise conditions at all five survey points were not in good status, so the future roadside noise condition would be worsened if the local traffic volume increases during both construction and operation phases. Thus, it would be wise to prepare several mitigation measures such as the roadside vegetation and others would be applicable for the local conditions.

c) Water Quality Survey

Most measured water quality parameters were below the water quality standards of river water, adopted in Tanzania. Thus, the river water quality measured in the Study at all six sampling points (i.e., Kikafu and Wona Rivers) was in good condition.

Laboratory results of sub-surface water quality showed that pH values of the entire samples were to some extent lower than those of surface water, compared to the water quality condition of surface water. In addition, all BOD, COD and Coli-form values were considerably low.

d) Preliminary Biological Environmental Study

There was no any existing wildlife corridor for large animals across the study area of the Project.

e) Review and Updating of Past RAP studies

Eight (8) PAPs were located within the existing RoW=45m of the proposed road improvement project. The COI (Corridor of Impact) method was applied to the Project, so that, no land-take nor demolition of those identified PAPs' structures would occur within the COI.

Within the ROW=60m of the proposed two bypass roads of Kikafu (4.0km) and Himo-Holili (bypass section is 5.0km in total) sections, land take (approximately 54ha) and its compensation to 157 PAHs (119 PAHs in Kikafu section and 38 PAHs in Himo-Holili section) will be required².

7.3 Environmental Scoping and Impact Assessment

The table below summarizes the environmental scoping and impact assessment results of the proposed road improvement project.

Table 11 Environmental Scoping and Impact Assessment

Environmental Factor	Scoping		Impact Assessment		Comments	
	Pre-Construction Construction	Operation	Pre-Construction Construction	Operation		
Socio-Cultural Env						
1	Involuntary Resettlement	B/D	D	B/D	D	TANROADS has already started relevant land-take negotiation for the entire road improvement project (RoW = 45 m) and partial road improvement between Arusha and Tengeru is on-going. However, several PAPS still exist between Tengeru and Holili within RoW = 45 m. Besides, land-take negotiations for the new bypass sections (Kikafu and Himo-Holili, RoW = 60 m) have not been initiated yet (valuation of the new bypass road sections have been completed by TANROADS). Further land-take negotiation is required for the implementation of the proposed road improvement project between Tengeru and Holili.
2	Local Job Market and Economy	B/B	D	B/B	D	As mentioned earlier, further land-take negotiation is required. If some land owners request for land-for-land basis process and/or relocation, it is essential to prepare the compensation of physical relocation as well as recovery of livelihood. During the construction period, there may be some negative impacts on the local economy, due to the temporally worsened local traffic condition.
3	Land use and Utilization of Local Resources	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on the land use and utilization of local resource.
4	Social Institutions	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on social institutions.
5	Existing social infrastructures and services	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on existing social infrastructure and services.
6	The poor and Indigenous ethnic groups	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on the poor and indigenous ethnic groups.
7	Misdistribution of benefits and damage	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on distribution of benefits and damage.

² A RAP-related study (valuation of assets) for two bypass sections was conducted by TANROADS in 2012. Its Valuation Report is currently being examined by the Ministry of Finance.

Environmental Factor		Scoping		Impact Assessment		Comments
		Pre-Construction Construction	Operation	Pre-Construction Construction	Operation	
8	Cultural Heritage	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on the cultural heritage.
9	Local Conflict of interests	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on local conflict of interests.
10	Water use/or water rights	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on water use/rights.
11	Sanitation	D/B	C	D/B	B	Some topographic changes are expected to occur during both construction and operation phases. As a result, risk of occurrence of local inundation due to the temporal worsening of local run-off conditions and resultant outbreak of waterborne or insect-borne diseases such as dengue will increase to some extents.
12	Infectious Disease (e.g., HIV.AIDS)	D/B	C	D/B	B	As mentioned earlier, risk of outbreak of waterborne or insect-borne diseases such as dengue or malaria will increase.
Bio-Physical Env						
13	Topography	D/B	B	D/B	B	Due to earthworks, some topographic changes are expected to occur during the construction phase.
14	Groundwater	D/B	D	D/B	D	Temporal water quality degradation during construction period may occur.
15	Soil Erosion	D/B	B	D/B	B	Due to earthworks, the risk of local soil erosion and/or landslide will increase, in particular, at river crossing points during both construction and operation phases.
16	Hydrology	D/B	B	D/B	B	Due to earthworks, the risk of disruption of local run-off water will increase.
17	Coastal ecosystem	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on coastal ecosystem.
18	Flora/Fauna and biodiversity	D/B	D	D/B	D	Several local riverine ecosystems occur at tributaries (e.g., Kikafu and Wona Rivers) crossing the proposed road alignment. Both riverbank strips (60m away from the water front of high water level) of all perennial rivers crossing project the alignment is categorized as water resource protected areas (EMA 2004). (Note that an environment approval is not required as a condition of project implementation.
19	Meteorology	D/B	C	D/B	B	Due to some changes of local topographic and hydrological conditions, mentioned above, the risk of local meteorological change will increase.
20	Landscape	D/C	C	D/B	B	Due to some topographic changes caused by earthwork, impacts on local visual resources are expected to occur.
21	Global warming	D/B	C	D/B	B	Temporal increase of regional CO2 emission, due to the temporal increase of local traffic volume and usage of certain amount of mortar is expected to occur during the construction phase.
Pollution						
22	Air Quality	D/B	B	D/B	B	Baseline roadside air quality conditions are in good condition (see Section 7.5 for more detailed descriptions of the field roadside noise study). Temporal degradation of roadside air quality condition due to the temporal increase of local traffic volumes is expected to occur.
23	Water Quality	D/B	C	D/B	B	Baseline water quality conditions of several rivers crossing the project alignment (e.g., Kikafu and Wona Rivers) are in good condition (see Section 7.5 for more detailed descriptions of the

Environmental Factor	Scoping		Impact Assessment		Comments	
	Pre-Construction Construction	Operation	Pre-Construction Construction	Operation		
					field roadside noise study). Risk of temporal water quality degradation of nearby tributaries and/or wells will increase during the construction phase. Risk of water quality degradation due to soil erosion from unprotected slopes, created by the road construction work, will be increased during operation phase.	
24	Soil Contamination	D/B	B	D/B	B	Risk of soil contamination due to accidental spill of chemicals will increase during both construction and operation phases.
25	Waste	D/B	B	D/B	B	Certain amounts of construction waste is expected to occur. Amount of soil dumping is to be minimized by optimized earthwork balance.
26	Noise/Vibration	B/B	B	B/B	B	Baseline roadside noise conditions are not in good condition (see Section 7.5 for more detailed descriptions of the field roadside noise study). Temporal degradation of roadside noise/vibration condition due to the temporal increase of local traffic volumes is expected to occur.
27	Ground subsidence	D/D	D	D/D	D	During both construction and operation period, there may be less significant impact on ground subsidence.
28	Obnoxious smell	D/B	C	D/B	B	Risk of obnoxious smell (e.g., compost smell) due to the occurrence of unexpected local inundation and/or degraded run-off will increase during both construction and operation phases.
29	Sediment/Benthos	D/B	B	D/B	B	Due to the increased risk of soil erosion at all river crossing points, mentioned above, the risk of sediment and resultant water quality degradation at downstream side of all tributaries crossing the proposed road alignment will increase.
30	Accidents	D/B	C	D/B	B	Risk of traffic accident and worsened local traffic jam due to the temporal increase of local traffic volume, mentioned earlier, will increase. Similarly, risk of traffic accident and worsened local traffic jam due to the increase of local traffic volume, will be increased during operation phase.

Note A: significant, B: major, C: unknown, D: less significant

Source: JICA Study Team

The table below summarizes the fundamental directions of environmental issues, evaluated as “A” and/or “B” within the preliminary environmental scoping and impact assessment results of the proposed road improvement projects.

Table 12 Summary of Environmental Management Directions

	Environmental Issue	Mitigation/Management Policies
1	Involuntary Resettlement	TANROADS has already started relevant land-take negotiations for the entire road improvement project (RoW = 45 m) and partial road improvement between Arusha and Tengeru is on-going. However, several PAPS still exist between Tengeru and Holili within RoW = 45 m. However, due to the implementation of the COI (Corridor of Impact) policy, no demolition nor resettlement for those PAPS will occur. Besides, the land-take process for new bypass sections (Kikafu and Himo-Holili) have not yet been completed (valuation of the new bypass road sections has been completed and its final reports were prepared by TANROADS in July 2012). Currently, contents of those valuation reports are examined by Ministry of Finance (MoF). After its approval by the MoF, TANROADS plan to initiate the actual land-take negotiation process with each land owner (as of May 2016).
2	Local Job Market and Economy	Comprehensive compensation scheme covering recovery of livelihood shall be developed.

	Environmental Issue	Mitigation/Management Policies
11	Sanitation	<ul style="list-style-type: none"> - To develop monitoring systems, in particular, an intensive daily field inspection system during the rainy season, in order to find out the occurrence of local inundation at an early stage. - A local field drainage system shall be well-designed in order not to avoid long-term inundation. An anti-mosquito outbreak EMP shall be developed. - To develop periodic medical seminars for construction workers for disease prevention.
12	Infectious Disease (e.g., HIV.AIDS)	
13	Topography	
14	Groundwater	<ul style="list-style-type: none"> - Environment-friendly facility designs and/or layout shall be developed. In particular, special attention shall be paid to the local drainage system as well as vegetation system in order to minimize the impact of local hydrological balance changes.
15	Soil Erosion	
16	Hydrology	<ul style="list-style-type: none"> - To include a description of the practices to be employed to ensure that the quality of the runoff leaving the construction site is compliant with water quality standards - To implement appropriate facilities such as sedimentation ponds in drainages and glass plantation areas at early construction phases in order to deal with any soil from land preparation works - To implement sediment control structures to be regularly monitored and maintained throughout construction phases
18	Flora/fauna and biodiversity	
19	Meteorology	
22	Air Quality	<ul style="list-style-type: none"> - To establish periodic roadside air quality monitoring program (e.g., PM2.5, PM10, NOx, CO) during both construction and operation phases. - To describe practices, the contractor will follow to minimize phase air quality impacts during both construction and operation phases. This generally would include commitments with respect to equipment maintenance, equipment operating procedures, dust control and so on.
23	Water Quality	<ul style="list-style-type: none"> - To implement methods in order to avoid contaminating local drainages and ponds with waste and wastewater which may be mixed with concrete and other chemicals. - To establish periodic water quality monitoring programs (e.g., DO, BOD, COD, pH and others) during both construction and operation phases.
25	Waste	<ul style="list-style-type: none"> - To determine how to deal with liquid and solid waste generated from construction works, such as burning, land filling, off-site disposal, recycling and so on - To implement methods to minimize areas to be disturbed by accumulating waste - To determine how to handle sewage, refuse and other liquid and solid waste will be handled at construction sites.
26	Noise•Vibration	<ul style="list-style-type: none"> - To implement appropriate manners for minimizing noise generated throughout construction phases, such as of determining operating hours and any possible abate measurement. - To notify possibilities of generating noise and making some disturbances around the project area, especially residential areas. - To establish periodic roadside noise/vibration monitoring program (e.g., Leq and L10) during both construction and operation phases.
28	Obnoxious Smell	<ul style="list-style-type: none"> - To implement appropriate waste management systems during both construction and operation phases
30	Accidents	<ul style="list-style-type: none"> - To address how the contractor will handle, safely store and utilize hazardous materials. - To address how waste from hazardous materials usage will be disposed off in an environmentally safe manner. - To address common preventive action and procedures against any event of accidents on site to be determined by the contractor prior to the construction phase. - To implement programs for all the workers of instructing how to handle fuel, lubricating oil, hydraulic fluids and any other hazardous chemicals. - To list equipment to be used on site by construction workers in emergency cases. - To implement worker health, safety and environment training programs, safety precautions and procedures which all the construction workers are required to take prior to their construction works.

Source: JICA Study Team

7.4 Revision of EMP and RAP

Based on the proposed road improvement plan between Tengeru and Holili, revising of the environmental management program (EMP) as well as monitoring plan, for the pre-construction, construction and operation phases, were prepared. The EMP revision is conducted based on EPA, summarized in the ESIA Report. Total amount of the budget needed to implement the revised

environmental management program and relevant environmental monitoring plan is estimated at TZS 2,079,176,000 and annually TZS 213,600,000, respectively.

RAP was revised based on the RAP related study and review of the Valuation Report, and recommendations were made in the revised RAP, noting that during the detailed design stage, a supplemental socio-economic survey should be conducted to the land owners within RoW of 60m for the new bypass sections, who would be required for compensation. Based on the survey result, RAP should be reviewed and revised, and these land owners should be compensated following the revised RAP. There is a high possibility that tenants and/or seasonal employees of land owners might lose means of livelihood temporarily or permanently due to land take by the Project. Thus, the revised RAP also recommended that RAP should be reviewed and revised when tenants and/or seasonal employees of land owners are found and mitigation measures should be prepared and taken in order to restore their livelihoods during the course of the Project.

7.5 Public Involvement

(1) Introduction

A series of sensitization meetings for this proposed road improvement project were initiated between June 20th, 2016 and June 25th, 2016. Basically, these meetings consist of the following two types: (i) meetings at District Level with participants from the general community not invited, and (ii) meetings at Ward Level with participants from the general community invited. In each meeting, “COI (Corridor of Impact)” method, applied to the Project, was well explained to all participants, and all of them understood that no demolition of houses, buildings nor structures but several land takes for the new bypass construction would occur within the road space along the proposed alignment.

Table 13 Outline of Sensitization Meetings

	District/Ward	Date & Time	No of Participants
1	Rombo District (DED)	June 20, 2016, Started at 11:00	26
2	Himo Ward	June 20, 2016, Started at 14:35	64
3	Makuyuni, Ward	June 21, 2016, Started at 15:00	70
4	Masama Kusini and Kwa Sadala Villages	June 22, 2016, Started at 10:00	76
5	Hai District	June 22, 2016, Started at 11:00	25
6	Moshi Rural District	June 22, 2016, Started at 15:00	25
7	Arumeru District	June 24, 2016, Started at 09:30	26
8	King'ori Ward	June 24, 2016, Started at 14:40	56
9	Nashoni, Kikatiti and Sakila Chini Villages	June 24, 2016, Started at 17:00	82
10	Maji ya Chai Ward	June 25, 2016, Started at 10:00	50
11	USA River (Mji Mwema, Ngarasero, USA Madukani & Magaridishu Hamlets)	June 25, 2016, Started at 13:00	21
12	Makumira Center, Poli Ward, Ndatu Village	June 25, 2016, Started at 14:40	49

Source: JICA Study Team

(2) Overall Comments from Participants

In general, all participants welcomed the proposed road improvement project and expected its construction to start since most of them were the closest beneficiaries of the proposed project.



Source: JICA Study Team

Figure 7 Photo Record of Sensitization Meeting, held at Nashoni, Kikatiti and Sakila Chini Villages

CHAPTER 8 PRELIMINARY COST ESTIMATE

(1) Methodology and Condition of Cost Estimate

For cost estimation of the Project, the unit cost is prepared by work items, including general works, drainage works, road works and box culvert and bridge works. To calculate these unit costs, cost estimation in the previous F/S and D/D is referred to as a base cost. The conditions for preliminary cost estimation of the project road are summarized in the table below.

Table 14 Conditions for Cost Estimation

Item	Condition
Date of Estimate	May, 2016
Exchange Rate	1 USD = 2,192.1 TZS 1 USD =109.9 JPY
Price Escalation Rate	FC: 1.6% LC: 7.6%
Physical Contingency	Construction: 7.5% Consultant: 5%
VAT	18%

Source: JICA Study Team

(2) Result of Cost Estimate

The total construction cost of the Project is estimated, applying the unit cost of each work item and preliminary BOQs and detailed project cost estimates by section are tabulated. Given the above conditions, the total project cost was estimated at 549.6 million USD, with a construction cost of 320.9 million USD.

Table 15 Construction Cost Estimation by Package

Package	Construction Cost		
	FC USD ('000)	LC USD('000)	Total USD('000)
Package-1: 47.2km Tengeru - West Kikafu and 5.7km KIA Access Road	74,597	46,889	121,486
Package-2: 4.0km West Kikafu –East Kikafu including 560 m Kikafu Bridge, and Roadside Station	47,406	35,606	83,012
Package-3: 50.9km East Kikafu- Holili	71,728	42,563	114,290
Package-4: Safety measure at vicinity of existing Kikafu Bridge	720	1,352	2,073
Total	194,450	126,410	320,860

Source: JICA Study Team

CHAPTER 9 PRELIMINARY PROJECT EVALUATION

(1) Project Cost

Based on the preliminary project cost estimates and socio-economic benefits generated by the Project, economic feasibility of the project was tested through conventional economic analysis. Economic project cost is prepared each year, excluding price contingency and taxes, for economic analysis, based on preliminary cost estimation, the standard conversion factor and tentative project schedule.

(2) Project Benefit

As socio-economic benefits generated by the Project, followings are considered: (i) travel time saving by the project, (ii) reduction of travel distance by construction of new Kikafu Bridge, (iii) road user cost saving by road surface improvement.

(3) Results of Economic Evaluation

Based on the above assumptions, an economic analysis was conducted with the results shown in the following table. The EIRR is calculated at 23.1% and NPV is 455.6 million USD. As a result, the project is evaluated as economically viable.

Table 16 Results of Cost Benefit Analysis

EIRR	Net Present Value (million USD)	B/C
23.1%	455.6	3.10

Note: Discount rate applied is 12% p.a.

Source: JICA Study Team

CHAPTER 10 CONCLUSION AND RECOMMENDATION

10.1 Conclusion

The Study aims at confirming the feasibility of the road improvement project between Tengeru and Holili and the access road to Kilimanjaro International Airport, as well as conducting supplementary studies to fulfil requirements set to meet the JICA financial support criteria. As a result, during the course of reviews on previous F/S and traffic, environment and engineering analysis in the Study, the following points were concluded and with which both Tanzania and Japanese parties agreed in the course of consultative meetings during the Fact Finding and Pre-Appraisal Missions of the Project.

(a) Traffic Demand

Based on the traffic survey and comprehensive traffic demand forecast, the traffic volume along the project road is projected to increase at around 6% to 7% per annum between 2015 and 2035. A large number of traffic is projected between Tengeru and Usa and Moshi Town where the projected traffic demand exceeds 20,000 PCU/day in 2025 and 40,000 PCU/day in 2035.

(b) Dual Carriageway Sections

Both parties agreed that dual carriageway would be accommodated; (i) between Tengeru and Usa (9.3km), (ii) new Kikafu Bridge (4.0km), (iii) Moshi Town (8.6km), totalling to 21.9km, based on a multi criteria analysis considering investment cost, environment, commencement of the Project, and traffic demand forecast. The remaining sections should remain as a single carriage way until

traffic demand increases and level of service of the project road worsens to an unsatisfactory level.

(c) Bridge Type for New Kikafu Bridge

Two bridge types for the main span of the new Kikafu Bridge, namely Pre-stressed Concrete (PC) Extradosed Bridge and Steel Tied Arch Bridge, were selected as optimum bridge types through multi criteria analysis. During the Fact Finding Mission in December 2015, Tanzania side expressed their preference for the PC Extradosed Bridge mainly due to its maintenance free nature and both parties agreed that PC Extradosed Bridge is selected as an optimum bridge type for new Kikafu Bridge.

(d) Cross Sectional Option for New Kikafu Bridge

A parallel two-lane single bridge for new Kikafu Bridge was presented as a cross sectional option, demonstrating its advantages in terms of early opening to the traffic and traffic safety. Tanzania side expressed their preference for an integrated four-lane dual bridge due to its lower construction cost and both parties agreed that the integrated four-lane dual bridge be selected for the cross sectional option of new Kikafu Bridge.

(e) Superstructure Options for New Kikafu Bridge

PC upper and lower decks with a corrugated steel web and composite trussed web were presented as optional superstructures for the new Kikafu Bridge, demonstrating its advantages in terms of reduction in dead weight which contributes to a cost-saving foundation. Tanzania side expressed their preference for and both parties agreed to the standard PC box as an optimum superstructure for new Kikafu Bridge, due to inferior quality assurance of the joints of the concrete decks and steel web as well as higher technical capacity in maintenance of the steel required for the said optional superstructures.

(f) Pavement Design

Against the backdrop of pavement failure cases and its ongoing analysis by JICA, the Study recommends not to apply stabilization in construction of base/subbase course and apply granular materials, such as crushed fresh rock and crushed stones. The Superpave mix design method was proposed to replace existing Hveem and Marshall methods. The Superpave mix design ties asphalt binder and aggregate selection into the mix design process, and considers traffic and climate as well.

(g) Environmental Baseline Survey and Possible Environmental Impact

In the course of the Study, a series of environmental baseline surveys were conducted: (i) Roadside Air Quality Survey, (ii) Roadside Noise Survey, (iii) Water Quality Survey, (iv) Preliminary Biological Environmental Study and (v) Socio-Economic Study for potential PAPs. The results of baseline surveys and analysis on adverse impacts caused by the Project implies that, except noise, those environmental items are below both the ambient standard of Tanzania and WHO guideline values, and that the current environmental condition between Tengeru and Holili is in good or acceptable condition. Both parties agreed to monitoring parameters and standards for air quality, water quality, noise and vibration and, soil following the proposed Environmental Monitoring Plan in the Study.

(h) Right-of-Way (RoW) and PAPs

Both parties confirmed that for the purpose of implementation of the Project, a RoW of 60m is for two new bypasses (new Kikafu Bridge with its approach section and section between Himo and Holili) and RoW of 45m is for the existing road section from Tengeru to Kikafu and from Kikafu to Himo. Both parties confirmed that a Corridor of Impact (COI) would be applied to the Project in order to mitigate adverse impact on involuntary resettlement, accordingly, there is no involuntary resettlement within current RoW of 45m. Apart from RoW of 45m for existing road section, there are PAPs (mainly land owners) within RoW of 60m for the new bypass sections, who would be required for compensation.

(i) Project Implementation Plan

Considering the manageable size of the Project, the following four packages are proposed: Package-1: 47.2km Tengeru - West Kikafu and 5.7km KIA Access Road, Package-2: 4.0km West Kikafu –East Kikafu including 560 m Kikafu Bridge, and Roadside Station, Package-3: 50.9km East Kikafu- Holili and Package-4: Safety measure at vicinity of existing Kikafu Bridge.

An implementation plan was prepared under the following assumptions: 9 months for procurement of a detailed design consultant, another 9 months for the detailed design of Package 1 and 3 and 12 months for Package 2 and 4 plus 12 months for tender assistance and 33 months for civil works of Package 1 and 3 and 36 months for Package 2 and 6 months for package 4. Assuming a loan agreement is made in October, 2016, the Project would be completed and open to traffic between mid-2021 (Package 1 and 3) and end-2021 (Package 2).

(j) Project Cost Estimate

Given the following conditions: exchange rate (1 US dollar = 2,192.1 TZS), price escalation rate (FC: 1.6% and LC: 7.6%), physical contingency (construction: 7.5% and consultant: 5%) and VAT(18%), the total project cost was estimated at 549.6 million USD, including a construction cost of 320.9 million USD.

(k) Project Evaluation

Time saving and user cost saving were calculated as economic benefits derived from the Project and project cost was converted to economic costs and distributed annually according to the proposed implementation plan, and all benefits/costs were computed to on a spreadsheet for economic analysis. An economic analysis was conducted and the EIRR is calculated at 23.1% and NPV is 455.6 million USD. As a result, the Project was evaluated as economically viable.

10.2 Recommendation

In order to realize smooth implementation of the Project, there are several recommendations and requirements which need to be fulfilled during the detailed design and implementation stages. A few recommendations are summarized below.

(a) Pavement Design

Pavement design should be reviewed during the detailed design stage based on the latest traffic demand forecast as well as axle load investigation data. A Superpave and/or granular base course applied to the service road and footpath design could be excessive against the standards and that also needs to be reviewed during the detailed design stage. At the same time, availability of crushed fresh rock and crushed stones applied as base/subbase course material should also be confirmed during detailed design stage. Accordingly, further investigations with support from TANROADS laboratory engineers should be necessitated during the detailed design stage.

(b) Roadside Station

A Roadside Station was proposed to be part of the Project and which would be constructed beside the new Kikafu Bridge approach by converting a construction camp yard after of the new Kikafu Bridge. A detailed plan of effective operation and utilization of the Roadside Station should be developed during the detailed design and construction supervision stages.

(c) Overloading Control

During the Pre-Appraisal Mission, Tanzania side expressed their concerns on the issue of overloading control along the project road and both parties agreed that the issue of overloading be addressed and the existing weigh station should be replaced with a newly procured static weigh bridge with a weigh-in-motion system. This is to be installed around 2km west of Himo Junction. Specifications and design of the weigh station, including those of the static weigh bridge and weigh-in-motion system should be prepared during the detailed design stage.

(d) Land Acquisition for Roundabout/Roadside Station/Weigh Station

The Study recommends the installation of roundabouts at several junctions along the project road and these include junctions at KIA, Kikafu and Moshi Town. The Study also recommends to install a new weigh station near Himo Junction and develop a Roadside Station near new Kikafu Bridge. Further investigations should be carried out during the detailed design stage to determine the additional land (and its ownership) to be acquired for these planned roundabouts, Roadside Station and weigh station.

(e) Community Access Road

Community development should be promoted by providing local access roads connecting to the project road which benefits the local communities. In this context, both parties agreed that a certain amount of provisional sum should be secured for each package to provide better access between the project roads and community facilities, such as market, clinic, school, etc. and included as part of the Project in the detailed design stage.

(f) Environmental and Social Consideration

During the detailed design stage, a supplemental socio-economic survey should be conducted to the land owners within RoW of 60m for the new bypass sections, who would be required for compensation. Based on the survey result, RAP should be reviewed and revised, and these land owners should be compensated following the revised RAP.

There is a high possibility that tenants and/or seasonal employees of land owners might lose means of livelihood temporarily or permanently due to land take by the Project. RAP should be reviewed and revised when tenants and/or seasonal employees of land owners are found and mitigation measures should be prepared and taken in order to restore their livelihoods during the course of the Project.