UNOPS

Feeder Road Construction in Support of Trade and Market Development in South Sudan

Atlas # 88050

Feasibility Study Report (Final)

Date:

15th June 2015

A project of:

ZEAT BEAD Feeder Roads Program

Funded by:

European Union

Executive Summary

Poor and inadequate rural infrastructure and rudimentary markets with limited access hinder the agricultural development and food security in South Sudan. As identified in the South Sudan Development Plan (SSDP), rural infrastructure development is a vital action to address chronic food insecurity, improve livelihoods and stimulate development. On this ground, the European Union in consultation with the government has committed to support the Greater Bahr el Ghazal (GBG) Zone in its effort to realize agricultural development, leading to the establishment of the 'Zonal Effort for Agricultural Transformation: Bahr el Ghazal Effort for Agricultural Development' (ZEAT BEAD). As part of this program, a rural feeder roads construction and maintenance project is considered in four out of the ten States. The project is aimed at increasing the rural small farm holders' food production and sustainable livelihood through market connection, rise in production and trade development. The four target States for the selection of prioritized feeder roads are Lakes , Western Bahr el Ghazal (WBG), Warrap and Northern Bahr el Ghazal (NBG) States in the Greater Bahr el Ghazal (GBG) Region.

In this regard, the EU and UNOPS have signed a contribution agreement for the implementation of the project entitled ZEAT BEAD "Feeder Road Construction in support of Trade and Market development in South Sudan". This project is in line with the EU's strategic objectives, in addition to other programmes and the assessed needs of stakeholders. The project will focus on the construction and maintenance of approximately 120km of feeder roads in target States. The project will also incorporate the implementation of a maintenance and capacity building program with the State Ministries of Physical Infrastructure and local contractors, as well as community engagement and labour intensive support activities.

The objective of the project is to improve rural livelihoods by providing sustainable access to agricultural markets using appropriately engineered infrastructural approaches. As part of the implementation process, UNOPS has undertaken a feasibility study and a social and environmental impact assessment for the prioritized routes as proposed by the respective State Ministries of Physical Infrastructure and Ministries of Agriculture. This process has allowed for appropriate road section selection for construction along the priority routes, in line with the planned project length of roads; the process will also be relevant to the ZEAT BEAD and SORUDEV feeder road programs by linking agricultural areas to markets.

As part of the Feasibility Study process, a team of engineers, topographic surveyor, social scientist, transport economist and environmentalist were deployed to the feeder roads' site from 6th to 26th March 2015 to undertake detailed field assessment on the identified roads. The objectives of this visit include:

- To evaluate the terrain along the existing road & the route corridor;
- To assess the sub-grade soil, climate and geology along the route;
- To understand the Environmental Impact of the project in the road corridor;
- To have an overall impression of the availability of construction materials;
- To appreciate the importance of the project in relation to economy & social affairs;
- To assess the travel demand potential for the project roads and establish a baseline of current level of demand through traffic surveys;

- To assess the current state of socio-economic factors in the project vicinity and establishes current baselines.
- To establish first hand information in relation with the preliminary construction cost estimate.
- To collect relevant information in relation with the maintenance capacity and level of commitment in the states ministry of physical infrastructures.

Accordingly, the team has undertaken a detailed assessment on the project roads on the following key areas and provided baseline studies, recommendations and likely scenarios for the way forward. These key areas are discussed briefly hereunder.

Preliminary Engineering Survey, Design and Engineering Cost Estimate

Though the existing roads are unclassified tracks which can rarely be accessed during rainy season, they are the only means of access to the communities residing along the project road corridors. A GPS tracking unit was used to investigate the alignment of the roads and preliminary geometric design was made for each of them. The design was based on the SSRA Low Volume Roads Design Manual which selected a design standard based on traffic projection on the road throughout its design life. Accordingly, based on the current traffic counts made and expected generated traffic in relation with the agricultural potential of the studied roads, the Average Annual Daily Traffic (AADT) was established and projected into 15-years of design life. It was found that Aluakluak – Mapourdit – Aguran (LAKES) and Gok Machar – Mayom Angok roads (NBEG) would require a DC-4 Standard road (7.5m carriageway) whereas the remaining two roads of Kangi – Bar Urud (WBeG) and Achol Pagong – Ayien market (WARRAP) were found to require a DC-3 Standard road (7.0m carriageway). The corresponding cost for each of the identified roads was estimated for the DC-3 standard ranging between ***USD 168,800 to USD 171,200*** per km while for the DC-4 option the costs range between ***USD 188,700 to USD 213,100*** per km.

Socio-economic Impact Assessment

The road investment's impact on socio-economic development is wide scale though difficult to quantify in monetary terms. The project's positive impact is anticipated in the long-run to extend from the local community to the State and the country at large. The optimal impact is realized when the road network operates at full capacity. Optimization of the project's benefits is governed by the prerequisite of the provision of socio-economic infrastructure, alongside volume of road traffic, access to motorized transport means, affordability and willingness of the target beneficiaries. A set of affirmative actions are thus a pre-condition to ensuring substantial socio-economic benefit and impact of the project to the rural community.

Economic Evaluation

Based on the results of the economic evaluation supported by the sensitivity analysis, the investment for the improvement of the four feeder roads to Gravel Wearing Course (GWC) standard has been observed to be economically viable. The Economic Internal Rate of Return (EIRR) value is above 12% for all projects, which is higher than the cut-off point for similar projects in other developing countries, including Republic of South Sudan (ROSS). The sensitivity analysis does, however, show that in the worst-case scenario, i.e. increase in cost by15% and decrease in benefit by 15%, the EIRRs are less than 12% for some cases, which is below the cut-off point. As such, risk management measures need to be put in place to control cost over-runs during implementation.

Improvement of the project road as proposed, to DC-3 and DC-4 GWC standard road, would impact positively upon the transportation costs, which include Vehicle Operating Cost (VOC) savings, travel time savings to road users, better riding quality and maintenance costs savings for the road agency, i.e. MTRB and State DRBs. The investment in the project road would also impact positively on the overall socio-economic development of the project influence area
Based on the study, to cater for future traffic and ensure an economically justifiable investment, it is, therefore, recommended that the *Aluakluak – Mapourdit – Aguran* and *Gok Machar – Mayom Angok* roads be constructed to roads of Class DC-4 standard with gravel wearing course pavement, having a carriageway width of 6m and a 0.75m wide shoulder, for a total roadway width of 7.5m. Furthermore, the *Achol Pagong – Ayien* and *Kangi – Bar Urud* roads should be constructed to a road of Class DC-3 standard with gravel wearing course pavement, having a carriageway width of 5.5m and a 0.75m wide shoulder for a total roadway width of 7.0m. In terms of technology choice, the proposed intervention could be better implemented using machine intensive technology with great emphasis on maximum utilization of labor for the roadworks.

Environmental Impact Assessment
The construction of the feeder roads is likely to provide important development and access opportunities to the residents of the local area. However, this development is likely to have significant impact on the overall natural environment and as such strategic measures need to be incorporated into the design to mitigate the adverse impact.

It is advised that efforts be made to ensure the identification of the most opportune locations for the acquisition of embankment construction material. Furthermore, it is advised that efforts be made to transform borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of the borrow pit and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat, clearing must be kept to a minimum; this should be considered in the design of the road corridor and the subsequent planning of the construction works. It is also important to avoid the removal of, or to consider the establishment of or compensation for, the removal of any vegetation that is a food source. Due to the dispersive and fine particle characteristics of the predominant soils in the project areas it is advisable to re-vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss.

During the construction period access to water may be limited. To mitigate the effect, early identification of a viable water sources is recommended. Alternatively, a new water source could be constructed in order to reduce the impact on water collection opportunities for the local population. It is prudent also to plan sourcing of naturally available materials for construction in such a way that it will not compete for key resources, such as water, with the local community

Road Selection
The final selection of the road sections considered for further project development is based on the multi selection criterion listed hereunder. These are:

- Existing or potential agricultural activities;
- Connection to market collection areas;
- Proximity to existing components of the ZEAT BEAD and SORUDEV Programs;
- Existing social services and facilities;
- Population densities;
- Community participation;

- Construction costs and feasibility;
- Security situation of the project area

The roads which have been selected and proposed for final project development, along with project extent and estimated preliminary project cost, are depicted hereunder.

No.	STATE	SELECTED ROAD	LENGTH (km)	Cost (USD)
1	**LAKES**	Aluakluak - Mapourdit - Aguran	26.6	4,490,000
2	**WARRAP**	Achol Pagong – Ayien Market	27.5	5,860,000
3	**WBeG**	Kangi – Bar Urud	29.2	5,510,000
4	**NBeG**	Gok Machar - Mayom Angok	34.7	6,020,000
TOTAL			**118**	**21,880,000**

Maintenance Concept

The field mission has verified that for Lakes and NBeG States, the States Ministry of Physical Infrastructure have reasonable capacity and commitment to support the envisaged routine maintenance activity after completion of the feeder roads construction. However, the following key challenges will limit the adequate utilization of this capacity for the maintenance of feeder roads:

- Lack of funding/budget to support the planning, management and operations of road maintenance activity;
- Limited capacity of road technicians in construction and maintenance of rural roads;
- Insecurity in the States, particularly Lakes

With regards to WBeG and Warrap States, the State Ministries of Physical Infrastructure have limited capacity in terms of technical knowhow, resource availability and budget to carry out road maintenance activities. Besides, the commitment and enthusiasm to embark on this task is minimal.

Broadly, the following shortfalls are considered as an impediment for road maintenance activities in WBeG and Warrap States:

- Lack of funding/budget;
- Lack of technical knowhow and commitment on labor based road maintenance activities;
- Poor institutional framework to cater for road maintenance planning and operation.

As such, the involvement of UNOPS is expected to be greater during the maintenance stage of the roads, particularly for these last two states as compared to the former.

During the implementation period UNOPS will work with the state authorities and key stakeholders to determine and agree an appropriate approach for post construction maintenance of the feeder roads by the state MoPI and/or community maintenance groups. UNOPS advocates for public

private partnerships (PPP) between the government and local community based organizations for the envisaged road maintenance.

Locations of Agricultural Products Collection Points

The key objective of the feeder roads under this programme is to provide year-round access for small holder farmers in the project influence area so that the farmers can easily transport their agricultural products to the nearby markets and collection points that in turn motivates for more production. The feasibility study team identified possible locations in each State for establishment of collection points for agricultural produce inorder to better facilitate the distribution of produce. Two options were considered; firstly the opportune location for produce to be consolidated for local makets and secondly the optimum location for produce to be consolidated for distrubtion to larger regional markets. The team made the following key considerations to select appropriate collection points:

- Collection Point for Servicing Local Markets:
  - Evidence of existing community market activity
  - Central location to service local community
  - Location will have reasonable accessibility for majority of the local community
- Distribution to Regional Market
  - as much as possible avoid use of the feeder roads by trucks and trailers;
  - availability of nearby establishments;
  - Connectivity to main trunk roads and potential markets options.

In this regard the following locations are identified as appropriate for establishment of agricultural products storage and packing facilities

State	Location	Description
Lakes	Mapourdit (community local produce collection centre)	Well established rural market assembly with numerous transactions. Location has social and economic services Market is a central location to local community and the proposed feeder road development will provide adequate accessibility.
	Aluakluak (Regional collection centre)	Market can easily be accessed to the bigger markets in Rumbek, Yirol and Movolo.
WBeG	Kangi (Regional collection centre)	Is along the main Wau – Aweil road and a new road is being constructed to connect to Kuajok. The market can be supplied with produce from as far as Kayango and Bar Urud and it has a well established rural market.
	Basilia (community local produce collection centre)	Is along the main Wau – Raja main road and a key market centre connects to Kayango through a reasonably good earth road

State	Location	Description
WBeG	Kayango (community local produce collection centre)	Kayango market is at median location from both sides of the Kayango-to-Riyal- Basilia and Kayango-Bar Urud-Kangi routes that joins the Wau-Raja and Wau-Aweil road respectively. It is a well-established rural market assembly with many transactions
Warrap	Ayien Market (community local produce collection centre)	Ayien Market is well established and services communities beyond the scope of the proposed road development, providing greater distribution opportunities.
	Regional Market: Achol Pagong	Is along the newly constructed Mayom Tiotin to Gogrial East and will serve all the area from Ayen, Makauc. It also connects to the main Kuajok Wunrok road that can access bigger markets.
NBG	(community local produce collection centre and regional centre)Gok Machar	It is near to the main trunk road that connects Aweil Town to the border with Sudan. This market is the most active in the region of the proposed feeder road and services communities from a wider area then the proposed development providing an opportunity for greater local distribution.

List of Acronyms

EU	European Union
DFID	UK Department for International Development
NBeG	Northern Bahr el Ghazal State
WBeG	Western Bahr el Ghazal State
RSS	Republic of South Sudan
SMoPI	State Ministry of Physical Infrastructure
SSLVR	South Sudan Low Volume Roads
SSLVRDM	South Sudan Low Volume Roads Draft Manual
SSRF	South Sudan Recovery Fund
ToR	Terms of Reference
UNOPS	United Nations Office for Project Services
WBG	Western Bahr el Ghazal State
WFP	World Food Programme
GBG	Greater Bahr el Ghazal
MTRB	Ministry of Transport, Roads and Bridge
RoSS	Republic of South Sudan
SORUDEV	South Sudan Rural Development
SSLVR	South Sudan Low Volume Roads
UNOPS	United Nations Office for Project Services
SSRF	South Sudan Recovery Fund
SSDP	South Sudan development Plan
WFP	World Food Programme
ZEAT	Zonal Effort for Agricultural Transformation
BEAD	Bahr el Ghazal Effort for Agricultural Development

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1 Introduction

1.1 Project Description

EU and UNOPS have signed a contribution agreement for the implementation of the project entitled ZEAT BEAD "Feeder Road Construction in support of Trade and Market development in South Sudan", in line with the strategic objectives of EU's SORUDEV and ZEAT BEAD's Program. The key activities in this project include the construction of feeder roads, capacity building of the State Ministries of Physical Infrastructure and local contractors; community engagement and labour intensive support activities including a maintenance program, in the Great Bahr el Ghazal Region.

As part of the preliminary implementation of this project, UNOPS has carried out a feasibility study of the previously prioritised roads in order to advise on road selection and proposed concept for the capacity building and maintenance component. This report details the method, findings and recommendations of the feasibility study.

1.2 Aims of Assessment

The overall objective of the assessment is to carry out a feasibility study of the prioritised feeder roads in terms of economic and technical evaluation, to carry out an environmental and social impact assessment (ESIA), and to come up with a revised recommended list of priority road sections in each state that can be achieved under this programme.

The assessment requires:

- Carrying out a formal ESIA assessment as per Annex A.
- Conducting all necessary studies to support the recommendations in relation with the prioritised roads based on technical recommendations and predicted costs, and the above ESIA findings;
- Identifying the best means to maintain the roads, based on local government and local community participation, utilising current or proposed resources;
- Conducting stakeholder consultation meetings at the project sites and preparing brief reports of the proceedings that will be part of the feasibility study report;
- Assessing the suitability/potential of engaging local CBOs during the road construction/maintenance phases.

1.3 Report Deliverables

As a result of the feasibility study, including the findings, analysis and results of existing data reviews and field investigations, the following report includes:

- Preliminary engineering survey and route selection;
- Environmental Impact Assessment;
- Traffic analysis and projection;
- Socio-economic Impact Assessment;
- Preliminary Engineering Design and cost estimation;
- Economic Evaluation;
- Road selection recommendations;
- Maintenance concept recommendation.

1.4 Structure of the Feasibility Study Report (FSR)

1.4.1 Preliminary Considerations

This section provides a brief overview of the project background and history, including a brief overview of the preliminary road assessment. This section further outlines the project scope, objectives, and constraints and identified stakeholders.

1.4.2 Methodology

Section 3 provides a brief methodology for process of data collection, analysis and collation in order to achieve the deliverable of the service.

1.4.3 Lakes State (Findings & Recommendations)

1.4.4 Warrap State ((Findings & Recommendations)

1.4.5 Western Bahr El Gazal State (WBEG) (Findings & Recommendations)

1.4.6 Northern Bahr El ghazal State (NBEG) (Findings & Recommendations)

1.4.7 Conclusions & Recommendations

2 Preliminary Considerations

Socio-economic indicators in South Sudan are poor. 51% of the population (55% in rural areas and 24% in urban areas) lives below the poverty line (NBS, 2010). The livelihoods of about 95% of the country's population are dependent upon farming, herding and fishery (FAO, 2014). Indeed, rural farmers account for an estimated83% of the population (5th SPHC, 2008). The majority of small farmers rely on rain fed subsistent agriculture. Agricultural production and food production are limited by the erratic rainfall, and a number of other factorssuch as lack of capacity and agricultural knowledge. More than a third of the population faces food insecurity.

Poor and inadequate rural infrastructure and rudimentary markets with limited access hinder the agricultural development and food security. As identified in the South Sudan Development Plan (SSDP), rural infrastructure development is vital to address chronic food insecurity, improve livelihoods and stimulate development. On this ground, the European Union, in consultation with the Government of South Sudan, has committed to support the Greater Bahr el Ghazal (GBG) Zone in its effort to realize agricultural development and its' Zonal Effort for Agricultural Transformation. The support proposal came up with Bahr el Ghazal Effort for Agricultural Development (ZEAT BEAD) program establishment. As part of the program, a rural feeder roads construction and maintenance project is considered in four of the ten States. The project is aimed at increasing the rural small farm holders' food security and sustainable livelihoods through market connection, rise in production and trade development. In this regard, EU and UNOPS have signed an agreement of contribution for the project implementation. The four target states for the selection of prioritized feeder roads are Lake State, Western Bahr el-Ghazal State, Warrap State and Northern Bahr el-Ghazal State.

2.1 Project History and Background

Some of the worst social indicators are found in South Sudan. At least 80 per cent of the population is income-poor. More than one third of the population is food insecure. The country's economy is constrained by the sheer absence of roads and by the fact that any existing roads are in very poor state. South Sudan's fragmented transport infrastructure network has impeded agricultural producers in remote areas from effectively connecting to market centers.

The South Sudan Development Plan (SSDP) sets out national priorities to achieve inclusive and sustainable development. A component of the SSDP's Economic Development pillar is the achievement of rural transformation to improve livelihoods and expand employment opportunities. As identified in the SSDP, a key ingredient for rural transformation is the extension, upgrading and maintenance of feeder roads. Sustainable feeder roads can improve livelihoods, reduce poverty and improve security.

In this regard and in full consultation with the Government, the EU proposed to support the Greater Bahr el Ghazal (GBG) Zone in its effort to achieve agricultural development, and the 'Zonal Effort for Agricultural Transformation: Bahr el Ghazal Effort for Agricultural Development' (ZEAT BEAD, or ZB) program was created. One of the components of this program is to build roads to increase marketing volumes and increase access to productive areas.

In this connection, the EU and UNOPS have signed a contribution agreement for the implementation of the action entitled ZEATBEAD "Feeder Road Construction in support of Trade and Market development in South Sudan", in line with the strategic objective of the EU's program and other complimentary existing and envisaged programs, as well as the assessed needs of stakeholders. The key activities in this action also include Capacity Building within the State Ministries of Physical Infrastructure and local contractors, alongside community engagement and labour intensive support activities.

The action will focus on the construction and maintenance of approximately 120km of feeder roads in Greater Bahr el Ghazal States (Northern & Western Bahr el Ghazal, Warrap and Lakes States), incorporating the implementation of a maintenance and capacity building program. The objective is to improve rural livelihoods by providing sustainable access to agricultural markets using appropriately engineered infrastructure approaches. As part of the implementation process UNOPS will undertake a feasibility study and a social and environmental impact assessment for the priority routes proposed by the respective States Ministry of Physical Infrastructure and Ministries of Agriculture. This process will allow for appropriate road section selection for construction along the priority routes that will fit with the planned project length of roads and be relevant to the ZEAT BEAD and/or SORUDEV feeder road programs by linking agricultural areas to markets.

The initial prioritised lists of routes that will be further re-assessed in the feasibility study are reported inbelow. These were determined following extensive consultations in the 4 states by UNOPS assessment teams

Table 1: Initially Prioritized list of routes by UNOPS

Particular	Width (m)	Total Length (Km)	Rank
Warrap State			
Akop - Marial Lou – Romic	6	60.2	1
Warrap - Aliek - Majak Juer	6	74.6	2
Mayom Tiotin - Achol Pagong - Makuac - Ayien	6	39	3

Western Bahr el Ghazal			
Kangi - Bar Urud - Kayango - Basillia	6	73.15	1
Kuajina – Nyinakok	6	29.4	2
Bazia – Namatina	6	32	3
Northern Bahr el Ghazal			
Wanyjok - Rum Aker	6	79	1
Gok Machar - Jor Beauc	6	73	2
Matuic - Kiir Ajowak	6	74	3
Lakes State			
Aluakluak to Mapourdit	6	24	1

2.2 Project Objectives

The Overall Objective of the SORUDEV / ZEAT BEAD Program is to contribute to improved food security and income of the population of the Republic of South Sudan. The project's purpose is defined as ''Improved Food Security and Income for Rural Smallholders".

The specific objective of the ZEAT BEAD feeder road project to be implemented by UNOPS is to increase rural livelihood, trade and marketing volume by providing sustainable access to agricultural markets using appropriately engineered infrastructure.

The strategy to address the poor connection between agriculture production areas and markets is to construct approximately 120km of feeder roads and to build the capacity of the state government and local contractors to plan and conduct road maintenance and rehabilitation of feeder roads to ensure sustainable access to markets. The roads will be maintained during the life of the project and the capacity of the state government, private sector and communities developed to allow future sustainable maintenance.

3 Methodology

This section provides a description of how the Feasibility study was carried out by the UNOPS Team deployed for the assignment.

3.1 Preliminary Engineering Survey and Route Selection

The preliminary engineering survey and route selection has been conducted based on a desk review of the preliminary assessment report conducted by UNOPS in March 2014, baseline surveys prepared by SORUDEV/ZEAT BEAD implementing partners in the corresponding states and in consultation with SORUDEV/ZEAT BEAD implementing partners and relevant government authorities.

The objectives of conducting the site visit for the project include:

- To see the availability and conditions of benchmarks and to consider the same in our work program as well as financial proposal;
- To assess the need for clearing for the revision of surveying works;
- To evaluate the terrain along the existing road and the route corridor;
- To assess the sub-grade soil, climate and geology along the route;
- To inspect the crossing sites so as to compare the actual site conditions with the designed drainage structures;
- To understand the environmental impact of the project in the road corridor;

- To assess the available facilities in nearby town/villages for the surveying and design review team during the Contractor's mobilization period and during the supervision phase for the permanent works;
- To have an overall impression of the availability of construction materials;
- To appreciate the importance of the project in relation to economy and social affairs.

3.2 Physical Environment and Environmental Assessment

The EIA has been conducted in accordance with UNOPS Organizational Directive No. 40 - Sustainable Infrastructure Practice Group: Environmental Management Policy, UNOPS Environment Management System Handbook Version 1.2 and DFID Overseas Road Note 5 – A guide to road project appraisal.

3.2.1 Baseline Evaluation

The assessments have involved baseline evaluation assembled by the collection of data on the valued ecosystem components (VEC). This has been achieved through a combination of techniques including a desk review of existing information, collection of data from physical site investigations and through the direct consultation with field experts, government and non-government organization and local community groups. The sources of data are as follow:

- Topographic maps;
- Aerial photographs;
- Scientific and technical reports;
- Existing environmental impact assessment documents;
- Technical, social, demographic and economic information from local, regional, and national government;
- Professional and non-governmental research organizations, and development agencies;
- Consultation with local residents and professionals.

3.2.2 Impact Prediction Assessment and Mitigation

Impact prediction and assessment involved considering the baseline environment in the light of the expected changes associated with the project. The prediction and assessment has been carried out to provide an input to the technical and economic component of the assessment. The key areas of potential environmental impact and the respective assessment methods are further detailed below:

- Water resources – this involved identifying the location of ground and surface water bodies, catchments and drainage basins and seasonal floodplains through topographic maps, site visits and consultations. Furthermore, assessments of water sources use, capacity and environmental impacts were conducted.
- Soil and geology – entailed the use of site visits, satellite imaging, geological maps and survey to ascertain the geological conditions and gradients.
- Local air pollution – due to the lack of existing relevant data and specialized equipment a very rudimentary assessment was conducted based on observations from a site visit, existing population data, traffic analysis and seasonal climatic conditions.
- Landscape, natural resources and waste – this involved the use of site visits, satellite imaging, topographic maps, survey and consultation, to ascertain the location of available construction material and evaluation the current status of vegetation.
- Biodiversity – although biodiversity is a very important aspect of environmental impact analysis, due to the lack of available information and specialist knowledge only a very rudimentary assessment was conducted based on observations from site visits, climatic data and topographic maps.

- Cultural heritage – consultation, site inspection and topographic maps. This element was found to have little impact on each of the sites.
- Noise and vibration

3.3 Travel Demand Establishment and Projection

The survey of the existing transport pattern is useful in calibrating transport demands, forecasts and prediction of possible modal shift. The transport survey is based on the following key parameters:

- Existing transport pattern;
- Available transport facilities, vehicles and service;
- Accessibility problem and latent demand for mobility.

The survey has further investigated available transport means, travel distances, travel time and cost involved, nature and level of traffic and other factors. Moreover, the purpose of the trip is determined considering socio-economic, food security and transit needs. The survey was implemented through traffic surveys and origin-destination surveys as described below.

3.3.1 Traffic Survey

Manual traffic count surveys at appropriate locations in the project influence area were carried out. Comparison of traffic growth considered in the study and the actual number from the new counts is made to arrive at a conclusion on possible traffic growth over the design period. Vehicle traffic surveys were conducted on the project road that forms part of the route. Where the new road follows the alignment of existing paths, trials and tracks, then surveys were undertaken to determine all movements of pedestrians, animals, animal carts and vehicles.

Traffic counts were conducted for seven days of 12 hours. The consultant used standard traffic count format to conduct the counts. The vehicles were classified into the following categories by adopting international practice as indicated below:

I. Motorized Vehicles

a) Motorcycles (including tri-cycles);
b) Cars (including taxis);
c) Utilities (also termed L/Rover);
d) Small Bus (<12 seats);
e) Medium Bus (>12 and <27 seats)
f) Large buses (>27 seats);
g) Small trucks (2-axle);
h) Medium trucks (2-axle);
i) Heavy trucks (3-axle);
j) Truck –trailers (or Articulated);and
k) Others (e.g. Tractors and construction specialized equipment).

II. Non-Motorized Vehicles were also counted during survey duration, divided into four categories:

a) Bicycles;
b) Pedestrians;
c) Animal drawn carts;and
d) Other NMTs (typically pack animals).

Non-motorized vehicles use the roads due to the relative absence of motorized vehicle in the interior areas away from the road. Rural people bring their produce to market centers over

distances of the order of 10km or more using non-motorized modes of transport. Such non-motorized modes have the potential for being converted into motorized modes in future in view of improvement of the project road.

The traffic count results were compared with the previous study's counts, if any, and South Sudan Roads Authority's historic counts, whenever available, and will be used to update previous estimates of Average Annual Daily Traffic (AADT) along various sections of the road.

In addition to the traffic count, a travel time survey along the project road is undertaken. The proposed method is to dispatch vehicles on the project road at various times of the day and then record travel time at various sections.

3.3.2 Seasonal Adjustment Factor

In order to estimate AADT, the Average Daily Traffic (ADT) was adjusted by seasonal factor. The seasonal adjustment factor is required because the volume and composition of traffic using the road varies during different seasons.

When traffic count is undertaken in high, medium and low business seasons, AADT, which is the required output from the survey, is calculated simply by adding ADT at each season and dividing by three. However, traffic count on the project road can only be conducted in high, medium or low business seasons. Therefore, ADT that was obtained from one season count should be adjusted by a factor developed for this purposes. Past historical data is utilized in the estimation of AADT when available or indexed ADTs used to estimate the Seasonal Correction Factor (SCF) as appropriate.

3.3.3 Non-Motorized Traffic Survey

During traffic surveying it is important to consider non-motorized traffic in addition to motorized traffic since it will benefit from construction of the project. The benefit to non-motorized traffic is quantified and included in the benefit streams of the project. Therefore, the volume and composition of non-motorized traffic currently using the project road was surveyed for 7 days during 12-hours of daytime where pedestrians, pack animals, animal drawn carts and motor cycles were recorded.

3.3.4 Origin-Destination Survey

The traffic count is supplemented by programmed origin/destination (O-D) surveys involving road-side interviews with vehicle operators. The O-D surveys did provide detailed information about the characteristic of the traffic moving on the motorable sections of the road. Such information as origin, destination, age, vehicle utilization, pay-load, gross vehicle weight etc. for both passenger and freight vehicles were obtained from the 2-days O-D survey fro each of the project roads.

3.3.5 Traffic Forecasts

Based on the traffic count that will be conducted and historic traffic data collected, the traffic is forecasted over the design period. The traffic forecast included:

- Normal traffic using the road;
- Diverted traffic from alternative routes due to the project road;
- Diverted traffic to alternative routes due to various options;
- Generated/induced traffic due to improved road conditions.

Market, community and facility surveys will be conducted to understand the communities' future plan in use of the upgraded road. The study had surveyed aspects such as:

- Population and settlement;
- Economic centers and markets;
- Industries;
- Employment opportunities;
- Businesses;
- Institutions;
- Public facility.

The traffic forecast is made based on national and regional GDP growth patterns and price elasticity of transport demand as well as economic activities, past trends, growth in vehicular population and fuel consumption.

3.4 Socio-Economic Assessment

The rural road investment impact on the target rural community socio-economic development is based on qualitative and quantitative techniques of data collection. The data originated from both secondary and primary sources.

3.4.1 Secondary Data Collection Method

The secondary data and information of substantial reliability, consistency and validity has been extracted from credible sources of the relevant and up-dated socio-economic baseline survey report of the target project areas. The desk study also reviewed all reliable socio-economic data/information from the proposed rural road project documents, policy principles and objective guidelines of the EU and other potential stakeholders, project government institutions (Local administration, State Ministries of Agriculture and Forestry, Animal Resources and Fishery, Commerce and Industry, Rural Development and Cooperatives and State Ministries of Physical Infrastructure), development partners operating on the ground, Food Security and Livelihood Cluster bulletins and other dependable sources.

3.4.2 Primary Data Collection Method

The study manipulated both qualitative and quantitative socio-economic data using the appropriate approach from reliable primary sources. The primary data and information of considerable importance are locally applicable and time-bound.

- **Field Assessment Visit:** Field visits were made to the prioritized areas for the selection of the rural road construction and maintenance project. In the field, the focus was on qualitative data and information given the time limitation and impracticality of gaining accurate quantitative data at the community level. During the field mission, data and information was accessed by the Field Team.
- **Local Key Informant Semi-Structured Interview:** Government and development partners' officers at the grassroots level (Boma and Payam) were interviewed by semi-open questionnaire to acquire relevant socio-economic data on development activities. Results were analyzed and compiled for interpretation of impacts.
- **Focal Person Semi-Structured Interview:** community chiefs, group leaders (women, youth and elder) and other community based organisation (CBO) representatives (farmers' group/association) were contacted to assess the realistic socio-economic situation, development challenges, opportunities and potential livelihood strategies.
- **Structure Household Interview Questionnaire:** Households were interviewed using random and purposive sampling techniques. However, the time constraint limited the number of the households interviewed.

- **Analysis and Evaluation Techniques**: Appropriate and relevant techniques such as cost-benefit, Road Economic Modelling and other appraisal tools were used to analyse and evaluate the socio-economic impact of road investment whenever applicable.

3.5 Preliminary Engineering Design and Cost Estimation

Preliminary design is an essential component to determine the physical feasibility of construction and forms the basis for a cost estimation of the proposed construction component of the project. In order to gain firsthand information of the project and appreciate the various issues needed for the study of the road, a Consultants' Team had visited the project area from 5th March 2015 to 26th March 2015. During the site visit, the team used the following maps and simple hand tools:

- Hand held Garmin GPS to have fairly accurate chainage and position;
- Measuring tape;
- Digital camera.

The site visit was conducted as a slow drive-over survey; frequent stops at sites of structures, pavement damages, challenging terrain, problem soil areas, severe right of way (ROW) obstructions, construction materials sources and at other locations that were deemed necessary to get firsthand information of the projects. In addition, the visiting team had discussions with the local people and state and county authorities on various issues pertaining to drainage structures, construction materials, available facilities and environmental issues. They also investigated right of way issues at Town/Village Sections. The site visit covered the following:

- Visual inspection of terrain, existing road geometry and pavement condition;
- Visual assessment of sub-grade soil and existing problem areas;
- Visual observation of sight distance, curve radii, vertical gradient;
- Measurement of road widths;
- Measurements using hand-held GPS;
- Visual inspection of construction materials sources;
- Assessment of facilities available that can impact the works;
- Assessment of drainage structures, existing and new locations;
- Right of way issues;
- Environmental issues that may be impacted by the works
- Traffic using the present facility;
- General information about the area that will have an impact on the construction of the road.

3.5.1 Topographic Survey

A preliminary topographic survey was carried out to mark track points in order to establish the existing route and alignment and pick coordinates of waypoints for all major features along the road. The features to be included are existing villages, culverts, bridges and the like. Where no substantial road exists and only tracks are available, the surveyor captured details of the existing alignment and proposed new alignments that will have straight stretches in order to avoid meanders so as to minimize the length of the road. Such new alignment is expected to be as close to the existing alignment as possible in order to not significantly alter the profile.

For locations with major drainage features a detailed longitudinal and cross-sectional survey was conducted in order to aid the design of appropriate drainage structures.

The topographic survey captured the existing embankment (if any) and picked out areas that have been deformed, marshy areas, low-lying ground and areas that require embankment upgrade. It also captured details of existing gravel wearing course (if any) for the purposes of thickness upgrade or complete gravelling or re-gravelling. The surveyor picked all existing and potential borrow pit locations.

The surveyor did plot the existing and proposed alignments based on the information collected from the field as well as all existing villages, boreholes and drainage structures. The surveyor also plotted all locations where new drainage structures will be required.

3.5.2 Preliminary Design

An inventory of all existing drainage structures and their condition was made by the surveyor. The inventory comprised the following:

- Location of the structures and chainages;
- Sizes and materials that make up the structures e.g. concrete or steel pipe culverts;
- Assessment of general condition and structural integrity of the structures including the flow direction and geometric alignment.

The team also recorded the nature of the terrain, materials, adjacent land use and vegetation. The team documented the terrain encountered along the road as well as types of soils forming the sub-grade of the road through visual assessment. The vegetation along the road as well as any settlements and land use were also captured. In areas where the road passes through existing villages, the alignment will have to be carefully determined in order to lead to the minimum displacements. Special features like schools and other social amenities along the road were covered in the survey as well. Based on data collected in the field and secondary sources of data, a preliminary geometric design was made to improve the existing geometry of the roads. The preliminary design is yet to be validated during Detail Engineering Design phase when hydrological and geotechnical investigation of the project route will be incorporated and the final route of the road will be decided.

3.5.3 Preliminary Cost Estimates

The engineers used the proposed route to determine the actual length of the road. They had assessed the height of existing embankment and determine if it is adequate or requires additional fill material as well as the gravel-wearing course. Where no embankment existed, the engineers determined the appropriate height of new embankments, working out volumes of fill and gravel-wearing course materials as well as the haulage distances.

The engineering team collected information on existing contractors and machinery rates that were used to compute the cost of constructing the roads. They also determined the number, size and locations of drainage structures based on the profile of the proposed road though this needs to be validated during detail engineering design. In addition, the engineering team determined the number and location of road furniture based on the geometric survey of the road. The engineering team produced the following deliverables:

- Location drawing showing the existing and proposed road alignments (two options each) as well as all existing and proposed drainage structures;
- Detailed longitudinal profile and cross section of all major drainage structures;
- Quantity of work expected and cost estimates for the road works;
- Cross sectional details of the embankment.

3.6 Economic Evaluation

The main tasks that formed the economic evaluation are discussed hereunder.

3.6.1 The Identification of the Base and Project Case

An economic assessment of the road project includes identification of at least two different cases or scenarios involving one ‘base’ or ‘without investment’ case and at least one ‘project’ or ‘with investment’ case. In the ‘with investment case’, alternative scenarios were examined, including design standards, and alternate designs (in case of new construction). The estimates of benefits shall include dis-benefits during the construction period. Benefits of the proposed investments should include the direct impact on all users of the facility (including motorized and non-

motorized modes, pedestrians) and indirect impact on the community and business establishments served by the road.

The World Bank's Roads Economic Decision Model (RED model) is used as the principal tool for the core economic evaluation process.

3.6.2 The Planning Time Horizon

Appropriate planning time horizon was determined using suitable forecasting methods. In general, the period over which a road project is evaluated should reflect the assumed functional life of the road. A period of 15 years is used for the economic analysis.

3.6.3 Resource Cost

The estimated resource cost of the project is used to assess the net contribution that the investment will make to the national economy. The opportunity cost will be used as a measure of resource cost rather than market price. Costs and prices were adjusted to ensure that they are all measured in the same unit and they represent real resource costs to the country as a whole. The information on conversion factors to derive economic prices from market prices was collected from available documentation or derived when data availability allows it.

3.6.4 Investment Cost

Investment costs of alternative design options considered were estimated, section by section, comparing it with detail investment cost estimates obtained using a bill of quantity approach together with estimates of unit rates for different components of work.

3.6.5 Maintenance Costs

Maintenance costs for the different options were obtained from the ROSS Road Authority's data bank, UNOPS operated maintenance projects and from rates of local contractor's. The maintenance cost estimation shall be for all the alternative design options considered for the project. As such, maintenance costs in USD/km for Routine and Periodic maintenance were estimated and incorporated in the Economic appraisal model.

3.6.6 Traffic Benefits

The benefits from the savings in vehicle operating costs and passenger time as well as benefits from changes in road maintenance costs due to the improvement of the project were estimated. This was done through forecast of both normal and generated traffic under a "with investment" and "without investment" (or more probably a "do minimum") case. This analysis is executed using a road planning model RED Model.

3.6.7 Change in Road Condition

The road deterioration sub-model of RED predicts annual changes in road roughness that will occur over time; given specified initial road conditions, maintenance and capital works intervention and traffic development. The VOC sub-model of RED predicts changes in vehicle operating costs and time costs that will occur as a result of changes in road roughness and associated vehicle speeds. It also provides a discounted cash flow analysis of the annual stream of works costs, vehicle operating costs and time costs and any other specified cost streams, over the specified evaluation period. It then compares these cost streams in the 'with' and 'without' project cases to yield standard measures of net project worth such as NPV (Net Present Value) and EIRR (Economic Internal Rate of Return).

3.6.8 Vehicle Operating Cost (VOC)

Appropriate estimation and calibration of VOC is crucial to the evaluation process. The calibration process covered estimation of vehicle life and utilization, vehicle maintenance parameters, fuel consumption and vehicle speed functions. Information from sample of vehicle operators, transport associations and repair shop is used as source evidence.

3.6.9 Discounting

In calculating the required decision criteria (NPV, IRR, NPV/C, First Year Rate of Return and Switching Values) the different economic values of costs and benefits over the analysis period were taken into account. Based on these results, the different scenarios will be ranked and recommendations will be made to the client regarding the preferred alternative.

3.6.10 Economic Development

The economic benefits for each identified option were expressed in terms of:

- Savings in vehicle operating costs;
- Savings in maintenance expenditure;
- Residual value of the road's structures at the end of the evaluation period;
- Other factors such as employment generation, accident reduction, time saving, etc that bare of demonstrable benefit within the economy;
- Assessing the improvement in food security due to better transport condition, in term of improved access and cost of food aid distribution.

Detailed economic analysis is carried out to quantify the costs and benefits associated with the project.

3.6.11 Social Benefits

Where the levels of economic activity are low, improved accessibility may have a significant effect on poverty reduction, agricultural production and the long-term development of local communities through the improved access to the provision of services. Such benefits can't be easily analyzed through conventional economic analysis. A statement of the likely 'social benefits' of the proposed road investment were, therefore, included.

3.6.12 Sensitivity and Risk Analysis

In order to test the robustness of the results a sensitivity analysis was carried out. Sensitivity analysis on the following variables is deemed important and was tested:

- The cost of construction activities;
- Level of development of benefits;
- Traffic growth.

As such, the major areas of uncertainty were identified and the sensitivity of the final measures of the project worth variations in the main variables was studied.

3.7 Road Selection

The Team has adopted Multi-Criterion Analysis (MCA) to prioritize road sections and identified key criterion required for this purpose. It was decided the key requirements for a road section to be considered for further project development exercise must fulfill the following criterion:

- Existing or potential agricultural activities;
- Connection to Market collection areas;
- Proximity to existing components of the ZEAT BEAD and SORUDEV Programs and complementarily with the overall program objectives;
- Existing Social services and Facilities;
- Population Densities;
- Community Participation;
- Construction Costs and Feasibility;
- Security of Transport Operators.

As such, these criteria were put under the MCA Approach to determine the rank of the sections under comparison by weighting them against the selection criterion adopted. As can be seen the weighting of the ranks was either 0, 1 or 2 with 1 & 2 differentiating which of the two sections was observed to have a higher ranking. The main effort for road selection was to subjectively compare which end of the road offers better satisfaction of the program objectives as there are only two ends to be compared for each identified road project.

S/N	Criteria	Maximum points	Weight	Total Points
1	Connection of Farms to Markets	10	2	20
2	Socio Economic Factors	10	2	20
3	SORUDEV / ZEAT BEAD Partners	10	2	20
4	Construction Feasibility	10	2	20
5	Sustainability	10	2	20
	Total Maximum Score			**100.00**

The Five Major Criteria were sub-divided into further sub-criteria for objective measurement of available options as outlined hereunder.

Table 2: Multi-Criterion Analysis Criterion for Selection of Road Section

S/n	Criteria	Total Scores	Weight
1	**Connection of Farms to Markets**		
1.1	Number of farms located along the road section	2	
1.2	Number of market centres located along the section	2	
1.3	Extent of land suitable for farming (potentially)	2	
1.4	Estimated population residing within the project corridor	2	
1.5	Existence of agricultural activities in the region that will further develop with the road construction.	2	
		10	2
		20	
2	**Socio Economic Factors**		
2.1	Existence of social services such as schools, medical assistance, religious institutions, etc. that the road will provide better access to.	2	
2.2	Stability and security level	2	
2.2	Road connection to higher population densities creating opportunities for local population	2	
2.4	Level of motorized and non-motorized traffic operating on existing road	2	
2.5	Presence of Payam and Boma Administration offices	2	
		10	2
		20	
3	**SORUDEV / ZEAT BEAD Partners**		
3.1	Activities of SORUDEV / ZEAT BEAD Partners are currently being conducted in the region.	10	
		10	**2**
		20	

4	**Construction Feasibility**		
4.1	Estimated cost of construction	2	
4.2	Requirement for a major bridge structure (bridge span)	2	
4.3	Availability of construction material (borrow pits, quarry, sand, water)	2	
4.4	Likelihood construction operation will be affected due to instability in the area	1	
4.5	Availability of skilled labor to be engaged in construction activity	1	
4.6	Possible hydrological, geo-technical or subgrade material problems	2	
		10	2
		20	
5	**Sustainability**		
5.1	Community and Government is motivated to participate in the construction and maintenance program.	4	
5.2	Development does not have significant adverse environmental impact (EIA)	4	
5.3	Number of affected persons and properties (PAPs) due to the construction of the road (SIA)	2	
		10	2
		20	

The scores of each road sections prioritized under the MCA are included under the respective States.

3.8 Maintenance Concept Overview

3.8.1 General

Road repair and maintenance is undertaken to keep the road in working condition by mitigating the dual effects of road surface deterioration and road material loss through long-term use of the road and environmental impact. The key objectives of road maintenance are:

- To keep the road service operational;
- To reduce the transportation cost and travel time;
- To minimize the chances of accident;
- To reduce the need for costlier and more complicated repair work;
- To ensure sustainable use of roads and preserve road assets;
- To prevent environmental loss;
- To give continuity to social and economic achievements/impacts.

One of the key causes for deterioration of road assets is lack of repair and maintenance activities. If the relevant repair and maintenance is neglected, cyclic growth of damage and collapse of roads takes place.

The prevalent climate, vehicle types, vehicular load and pressure, engineering design, quality of road construction and type of road surface (earth, gravel, asphalt sealed), determine the appropriate time, type of repair and maintenance, and required budget.

The following five types of repair and maintenance work are done on rural roads:

a. Routine Repair and Maintenance

Routine repair and maintenance covers petty repair and maintenance jobs on all roads to be carried out year-round. General types of repair and maintenance jobs to be carried out on a routine basis are especially done without prior estimation and assessment, and are of specific nature. Routine jobs that are carried out to keep the road in an appropriate shape and prevent its quality from deteriorating fall under this category. Such jobs, which

incur fixed costs, are normally executed by length persons through user committees or community organizations along the project road.

b. Recurrent Repair and Maintenance

This covers minor repairs and maintenance jobs that are carried out at different times of the year but are not covered by routine repair and maintenance fall under recurrent/occasional repair and maintenance. Those repair and maintenance jobs that are done recurrently (two or three times) in a year in order to protect the road from damage that has occurred, or could occur, due to the types and pressure of vehicles and rains are called recurrent/occasional repair and maintenance. Such activities require a skilled labor force. Such jobs should be identified and their cost estimates done before executing repair and maintenance.

c. Periodic Repair and Maintenance

This covers major repair and maintenance jobs that are to be done at an interval of a few years. Since routine and recurrent repair and maintenance cannot always maintain the road condition, those types of repair and maintenance jobs that call for relatively a lot of work fall under this category. Such repair and maintenance work is done once every three to five years on graveled roads, depending on the condition of the road. However, for some rural roads periodic repair and maintenance may become necessary every year, especially after the rainy period. Such jobs usually require skilled workforce. Scope of the deterioration and maintenance work should be identified through proper inventory of the roads and their cost estimates done before executing repair and maintenance.

d. Emergency Repair and Maintenance

Emergency repair and maintenance is done in situations when movement is stalled due to unexpected natural or accidental obstructions on the road. The category includes repair and maintenance that is carried out to immediately reopen the road to traffic, and manage the disturbed traffic. It also includes protecting the road from additional damage and loss when traffic movement comes to a standstill due to an obstruction or closure of the road for natural or unforeseen cases, and action in the face of danger of damage and loss to the road.

e. Preventive Repair and Maintenance

The repair and maintenance jobs that are carried out to protect the road from possible damage in the future and to extend the time interval for doing restoration work are known as preventive repair and maintenance. These jobs are determined by geological, geographical and environmental causes. As it is not possible to fix an appropriate time for executing this type of repair and maintenance, efforts should be made for carrying out such tasks as soon as it is deemed necessary as far as available resources allow.

The physical condition of roads is critical to any transport network. However, unless roads are adequately maintained, they inevitably deteriorate, leading to higher road user costs and longer travel times. Routine maintenance is often delayed due to various factors, such as lack of funds, insufficient technical knowledge or lack of political will. When simple routine maintenance is postponed for long periods, there is often a need for more extensive rehabilitation, which is much more costly.

3.8.2 Road Maintenance Capacity Overview

UNOPS feasibility study team travelled to Lakes, Western Bahr El Ghazal, Warrap and North Bahr El Ghazal States between 6th to 26th March and assessed the capacity and commitment of the local government and/ or road maintenance groups in each state and suitable approaches to road maintenance activities. The following maintenance approaches are considered vis-a-vis available capacity and ongoing road maintenance activities in each State.

- Maintenance by the state MoPI;
- Maintenance by community based organizations and/or groups;
- Maintenance by small scale contractors.

The Maintenance Capacity assessment of each State is reported accordingly.

4 Lakes State

4.1 Introduction

Lakes State is one of the four states selected for the implementation of the project entitled ZEAT BEAD "Feeder Road Construction in support of Trade and Market development in South Sudan", in line with the strategic objective of the EU's SORUDEV program. According to the SORUDEV's baseline survey, Lakes is one of the rural States in South Sudan with 91% of the population living in rural areas. Population of Lakes State as per the 2008 Population and Housing Census of the Republic of South Sudan (PHCSS, 2008) was 695,730 with 365,880 being males and 329,850 females. 49% of Lakes State population lived below the poverty line. 99% of Lakes State population depends on rain-fed agriculture. The FAO/WFP Crop and Food Security Assessment Mission anticipated a cereal deficit of up to 33,681 MT, representing 31% of cereal deficit. This scenario is a potential indicator of rising food insecurity and poor wellbeing of the local communities.

According to the 2008 PHCSS, the population of the eight counties covered by the study is estimated to be as follows: Rumbek North 43,410; Rumbek Central, 153,550; Cueibet 117,755; Wulu 40,550; Yirol East 67,402; Yirol West 103,190; Awerial 47,041 and Rumbek East 122,832. Yirol West County accounts for about 14.8% of the State's population. According to SORUDEV baseline survey, a majority of the households (64.6%) rated the level of food security as fair while 27% rated it as poor. This poor situation underscores the importance of the ZEAD BEAD feeder road intervention in order to address the high food insecurity, and improve market access and the livelihoods of rural communities.

The Aluakluak to Mapourdit feeder road is located in the Yirol West County of Lakes State and has been proposed for development under the EU SORUDEV / ZEAT BEAD program. The originally proposed route was a total length of 24km. In consultation with NPA, route alteration was advised to incorporate key agricultural areas and the Yirol County Commissioner requested that an assessment continue past Mapourdit to incorporate Aguran and finishing at Ngop. The final route and distance will be determined as part of this feasibility report. Section four of this report details the feasibility study of the feeder road giving findings and recommendations of final route selection and feasibility of construction. The key criteria the road is required to meet are as follows:

- Existing agriculture activities likely to benefit from infrastructure development is present in the immediate proximity of the road;
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities;
- Social services are currently established at various locations along the proposed road;
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups;
- Development does not have significant adverse environmental impact;
- Community and Government are motivated to participate in the construction and maintenance programs;
- Road connection of significant population densities;

- Construction is physically feasible and economically viable;
- Operators will not be affected by insecurity.

4.2 Preliminary Engineering Survey and Route Selection

The Aluakluak to Mapourdit feeder road was a late addition to the scope of proposed roads assigned to UNOPS as part of the ZEAT BEAD Feeder Road Project. Previously, the EU had engaged WFP to construct a number of feeder roads as part of the original SORUDEV program. In 2013, WFP conducted assessments of feeder roads in the Lakes State and in consultation with the EU and local government had selected the Aluakluak to Mapourdit route amongst a number of other roads to be constructed. Due to a lack of funding under the current agreement WFP was not able to carry out the works. As a result UNOPS was requested to incorporate this feeder road under the ZEAT BEAD feeder road project.

As no other roads had been proposed for construction in the Lakes State, pre-assessment selection process was not required. However consultation was conducted with NPA, WFP, EU, Lakes State MoA and the Feeder Roads Steering committee prior to proceeding with site visits. The implementing partners confirmed the road met the essential selection criteria being that:

- Existing agriculture activities likely to benefit from infrastructure development is present in the immediate proximity of the road;
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities;
- Social services are currently established at various locations along the proposed road;
- SORUDEV implementing partners have mobilized in this area and established agreements with the community groups;
- A predetermined route had been identified for verification through a site assessment;
- The route for assessment was based on information provided by WFP and NPA who advised the existing route currently being utilized and the locations of significant agricultural activities, established markets and social services. As such the Aluakluak to Mapourdit was deemed eligible for further analysis and verification as part on the feasibility study.

4.3 Physical Environment and Environmental Assessment

The environmental impact assessment of the Aluakluak to Mapourdit feeder road in Yirol County, Lakes State was carried out in accordance with the UNOPS Environmental Management System Handbook v 1.2 (https://www.unops.org/ApplyBO/File.aspx/11.%20RFP-KEOH-2014-002%20-%20Section%20V%20Annex%20G%20-%20EMS.pdf?AttachmentID=c21f27ea-0319-4879-a37a-e006cd46c115) and the DFID Overseas Road Note 5 – A guide to road project appraisal (http://www.transport-links.org/transport_links/filearea/publications/1_851_ORN_5_Final.pdf).

Physical site inspections were conducted between the 6th and 9th March 2015 in order to ascertain primary observational data. Efforts have been made to incorporate information from existing compiled environmental data, however it was found that the majority of reports discuss South Sudan as a whole rather than provide separate information for regions with information often being generic for some elements and not available in detail.
Field data on natural resources and ecosystem services are very scarce in South Sudan due to the long period of war, during which data collection stalled and existing data sources were also lost (USAID, 2007). Moreover, the focus of many studies and data sets were on northern Sudan.

The Government of the Republic of South Sudan is still working towards comprehensive Environmental Legislation with the initiation of a Draft Environment Protection Bill (2010) which is yet to be formally recognized, but has achieved the implementation of the Southern Sudan Land Act 2009 which has been adhered to in the assessment report.

The Interim National Constitution of Southern Sudan (ICSS) incorporates legal aspects for the protection and management of the environment and natural resources. Part three, article 44 of the Interim Constitution of South Sudan - The Environment 'stipulates that every person or community has the right to have a clean and healthy environment.' As part of this Constitution all levels of government in Southern Sudan are committed to sustainable development and ensure that the environment is protected for the benefit of present and future generations.

Draft Environment Policy (2010):
The draft environmental policy under section 4.3 Environmental Impact Assessment indicated that the Government of South Sudan will require systematic environmental impact assessment, audits, monitoring and evaluation to mitigate adverse impacts and enhance environmental benefits. As a policy guidance, the ESIA process is legally binding on all proposed projects and should occur right from the initial planning stages of the project.

The Draft Environmental Policy has the following objectives:

- Improve livelihoods of South Sudanese through sustainable management of the environment and utilization of natural resources;
- Build capacity of the government at all levels of governance and other stakeholders for better management of the environment;
- Integrate environmental considerations into the development policies, plans, and programs at the community, government and private sector levels; and
- Promote effective, widespread, and public participation in the conservation and management of the environment.

The main purpose of the Draft Environment Policy is to provide guidance and direction to all stakeholders.

4.3.1 Climate

The climate of Yirol West County is considered to be tropical and classified as *Aw* by the Koppen climate classification being Tropical wet and dry or savanna climate, having a pronounced dry season. The temperature averages 26.9 degrees Celsius with March being the warmest month at 28.8 degrees Celsius and the coolest month at 25.5 degrees Celsius in July. The annual average precipitation is 894mm; the driest month is December with no precipitation and the peak wet season is in August with an average of 160 mm (Climate Data, 2015).

4.3.2 Water resources

The Lakes State is adequately named in that the landscape significantly changes from dry dusty terrain during the dry season to vast areas of wetland during the peak of the wet season. With such a flat topography surface water drains slowly from the area leaving vast areas submerged for prolonged periods. In the location of the proposed road from Aluakluak to Mapourdit the area is slightly elevated on an iron stone plateau, however the area remains consistently flat. Should the road continue past the village of Aguran, the elevation gradually decreases until it reaches the flood plains of Yei River. The catchment area of the proposed feeder road from Aluakluak and including the section of road to the Village of Ngop drains into the Yei River which feeds into the Lakes Yirol and Yiboor. Ngop is a seasonal village that is located on the flood plains of the Yei River. The area is populated by cattle grazers who, according to the Yirol Commissioner, migrate to higher ground during the wet season.

As can be observed in the survey plan, there are a number of existing boreholes along the proposed route from Aluakluak to Aguran, however beyond this point few have been established making residences highly dependent on sourcing water directly from the Yei river. It was observed that the existing boreholes had been fit with hand pumps, however a number of pumps were no longer working and residents were using ropes and buckets to retrieve water. Consultation with the Director of Water at the MoPI revealed that the depth to artesian water reservoirs was between 35m to 42m depth below surface level.

The site first revealed two locations of seasonal pans between the route section of Aguran to Ngop. It would appear that during the wet season the local cattle grazers relocate from the Yei River flats to cattle camps located in close proximity to the seasonal pans.

As the site visit was conducted in the dry season, observations revealed that apart from boreholes, there are no reliable water sources for construction or agricultural purposes between Aluakluak until reaching the Yei River at Ngop.

4.3.3 Topography, Soil and Geology

Over the 36km of the assessed route there is little variance in elevation. From topographic mapping the elevation at Aluakluak is approximately 450m above sea level; this rises gradually over the 25km to a peak of 474m above sea level at Aguran, then decreases over the remaining 11km to the flood plains of Ngop reducing to an elevation of 445 m above sea level.

According to Harris (1958), Lakes State is classified as a combination of a medium to high rainfall woodland savannah. No soil testing was conducted as part of this assessment, however through onsite observation it was evident that the soil type is general a clayey loam with an underlying ironstone bedrock. Due to the presence of fine clays it is reasonable to assume that the soil would be somewhat dispersive in nature.

4.3.4 Local Air Pollution

As the local area is predominantly populated by subsistent/barter farming it is reasonable to assume that majority of air pollution is attributed to smoke and dust particles. There is evidence of recent deforestation activities in the area contributing to increased exposed soils. Especially surrounding the established villages, there are large areas of barren ground and soil compaction impacting the soil structure. As previously mentioned, the physical assessment was conducted during the dry season; observations revealed that cultivation areas are left exposed after harvest and significant vegetation cover is not achieved until the commencement of the wet season.

Pedestrians and animals make up the greater proportion of the traffic.Motorcycles are present, and though cars are present towards the middle of the route usage is dependent on the road condition. Overall, it is evident that air pollution is higher during the dry season due to the presence of dust and this is typically the period when burning for clearing, brick and coal manufacturing is conducted.

4.3.5 Landscape, natural resources and waste

The high rainfall woodland savannah characteristic of South Sudan extends into most parts of the greater Bahr el Ghazal. Trees in this region are generally tall and broad leaved. Coarse tall tussocks of perennial grasses predominate and fires are hence usually fiercer than in the low rainfall woodland savannah. *The most important tree species are Khayyam senegalensis and Isoberlina doka. Other species are Parkia oliveri, Daniella oliveri, Afzelia africana, Terminalia mollis, Burkea africana and itellaria paradoxa. (MTRB, 2014)*

The site inspection commenced at Aluakluak and continued to Ngop finishing at the river. From Chainage 0.00km until chainage 28.4km there was negligible variance in the features of the area. The terrain was relatively flat with little change in elevation. Soils appeared to be clayey sandy loam, with an underlying ironstone / murram foundation. Depths to foundation are unknown,

however it is suspected to be less than 1m in most locations due to the stunted growth of vegetation. The vegetation was sparse in areas where population densities were higher and was of medium density outside of Bomas and Payams. There was a consistent observation of Mango, Lulu and Palm trees, other varieties such as Mahogany and Abeyie trees were in less abundance due to clearing and deforestation activities.

Beyond the chainage of 28.4km, the existing track had a decreasing gradient, with some flat areas, until reaching the river at chainage 35.7km. The soil conditions altered to black silty clayey loam and appear to have significant areas of water retention. It was obvious that during the wet season the existing track would be impassable.

Local knowledge indicated that during the dry season the water table could be as low as 7m depth from surface level and that during the wet season the water table was close to the natural ground level in some areas and in the floodplains land is often submerged.

Boreholes were located at regular intervals close to the existing track. Some pumps were no longer active and locals had resorted to drawing water by hauling buckets suspended on ropes. Generally the depths of boreholes were in the range of 35 to 38m depth from surface level.

Cattle-grazing is prominent in the region of the proposed project. During the dry season cattle are grazed on the flood plains near the river. During the wet season cattle are mustered to higher ground and confined to cattle camps or allowed to graze through the forested area. Cattle movement is likely to have significant impact on the condition of the road and drainage infrastructure especially in wet conditions.

There are some large more mature trees, however these are mostly mango and lulu trees being significant to the local population as a food source. The area has been significantly impacted by clearing for villages, deforestation for use as timber, firewood and charcoal, and cattle grazing. Large areas show signs of natural regeneration with the re-growth of trees indicating the nomadic grazing/farming techniques may still be practiced in this area. Fire seems to be a common practice for cultivation and land clearing techniques.

Agriculture and other commercial enterprises are not immediately evident. The NPA representative indicated that cultivation is occurring in the area, but most activity occurs during the wet season. Minor progress has been made on the ground by NPA at this stage as the majority of activity will occur during the wet season. At Mapourdit there is an established blacksmith, and an ox-plough production training school.

There is evidence of clay and mud brick manufacturing in the area. There are many shallow borrow pits that have been excavated to facilitate this activity, however no effort has been made to rehabilitate these borrow pits. The borrow pit locations are frequent and random leading to mud hollows, erosion and silted water runoff.

As indicated in plan drawing of this road, adequate borrow pits for Murram have been identified at km 7+500 RHS, being 1km from an entry point to the proposed works. The borrow pit is currently not in use, and no efforts have been made to stabilize the excavation area. This area is surrounded by medium density vegetation. Further extension of the borrow pit would necessitate additional clearing.

To ensure all weather access during the wet season a road embankment will need to be constructed to raise the finished road surface level above the anticipated residual water level. Preliminary investigations indicate that select material can be obtained in various locations in close proximity to the proposed route; however this requires further investigations and planning in the design phase.

4.3.6 Biodiversity

Due to a lack of available information it is difficult to establish an adequate baseline for the current state of biodiversity in the area. However generalized information and site observations have been used to establish the current bio-diversity status.

Lakes State is significantly defined by the seasonal fluctuations of water levels and marsh-lands. The region is a significant area for bird life and, despite the effects of the prolonged war, the area is still significant in the seasonal migration of birds and wildlife (WWI, 2007). It is important to take into account the impact a smaller road development in an already heavily populated region may have on the wider catchment.

As further explained in Section 4.6 (Socio-Economic Assessment), substantial population densities already exist in the region of the proposed road. As a result of the land occupation the immediate area has already sustained significant impact to the biodiversity. It can be assumed that the common activities practiced in this area, including burning under-scrub, deforesting, migrational cattle grazing, hunting, excavation for brick manufacturing and farming, have reduced the biodiversity in the immediate area and had a similar effect on the wider environment. The establishment of reliable vehicle impact is likely to further facilitate the reduction in biodiversity in the immediate area.

4.3.7 Cultural heritage

No significant sites of cultural heritage were observed or discovered for the immediate area of the proposed route; however, it is important that dialogue with the local community continues to ensure this element has been explored fully.

4.3.8 Noise and vibration

Due to the lack of available information and monitoring equipment only rudimentary observational assessments are possible. Considering the existing access limits, the velocity of mechanized transport and the lack of mechanized agricultural and manufacturing equipment, it is reasonable to assume that noise and vibration pollution is minimal. It can further be assumed that due to better accessibility during the dry season noise and vibration will be higher than the wet season.

4.3.9 Conclusion and recommendation

The construction of the Aluakluak - Mapourdit – Aguran road is likely to provide significant development and access opportunities to the residents of the local area. These developments include the promotion of cost-effective and efficient rural services access as improved health, education, social security, gender equity, innovative farming knowledge and skill, improved agricultural practices, market connectivity, productive assets, increased agricultural production, crop diversification, food security and nutrition, increasing employment, income, market and trade development. The feeder road project will enhance the poor rural community`s self-esteem, self-confidence, farmers association, economic empowerment, entrepreneurship and innovative skill development.

However this development is likely to have significant impact on the overall natural environment and as such strategic measures need to be incorporated in the design to mitigate the adverse impact.

It is advised that efforts are be made to ensure the identification of the most opportune locations for the acquisition embankment construction material. Furthermore it is advised that efforts be made to transform these borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of the borrow pit and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat, clearing must be kept to a minimum and is advisable that this is considered in the design of the road corridor and the subsequent planning of the construction works. It is important to avoid the removal of, or consider the establishment of or compensation for, the removal of any vegetation that is a food source. Due to the dispersive and fine particle characteristics and nature of soils it is advisable to re-

vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss.

During the construction period access to water may be limited. To mitigate the effects, early identification of a viable water source is recommended; alternatively, a new water source could be constructed in order to reduce the impact of water collection opportunities on the local population.

4.4 Travel Demand Establishment and Traffic Projection

The establishment of travel demand is carried out in strict compliance with the recommendations of Overseas Road Note 5 (ORN-5) for low-volume rural roads and in reference with the South Sudan Roads Authority Low Volume Roads Design Manuals.

4.4.1 Review of Available Traffic Data

Relevant traffic information available to the Project road is sought from the State Ministry of Physical Infrastructure and State Department of Roads and Bridges. It was, however, found out that the Ministry responsible for the management and administration of the feeder road under consideration is severely budget-constrained. As such, it was confirmed that the state does not keep records on traffic volumes, condition surveys or other relevant informationrequired for the planning and investment decisions. As such, information on historical data was sought from development partners and from central government Ministry of Transport, Roads and Bridges (MTRB).

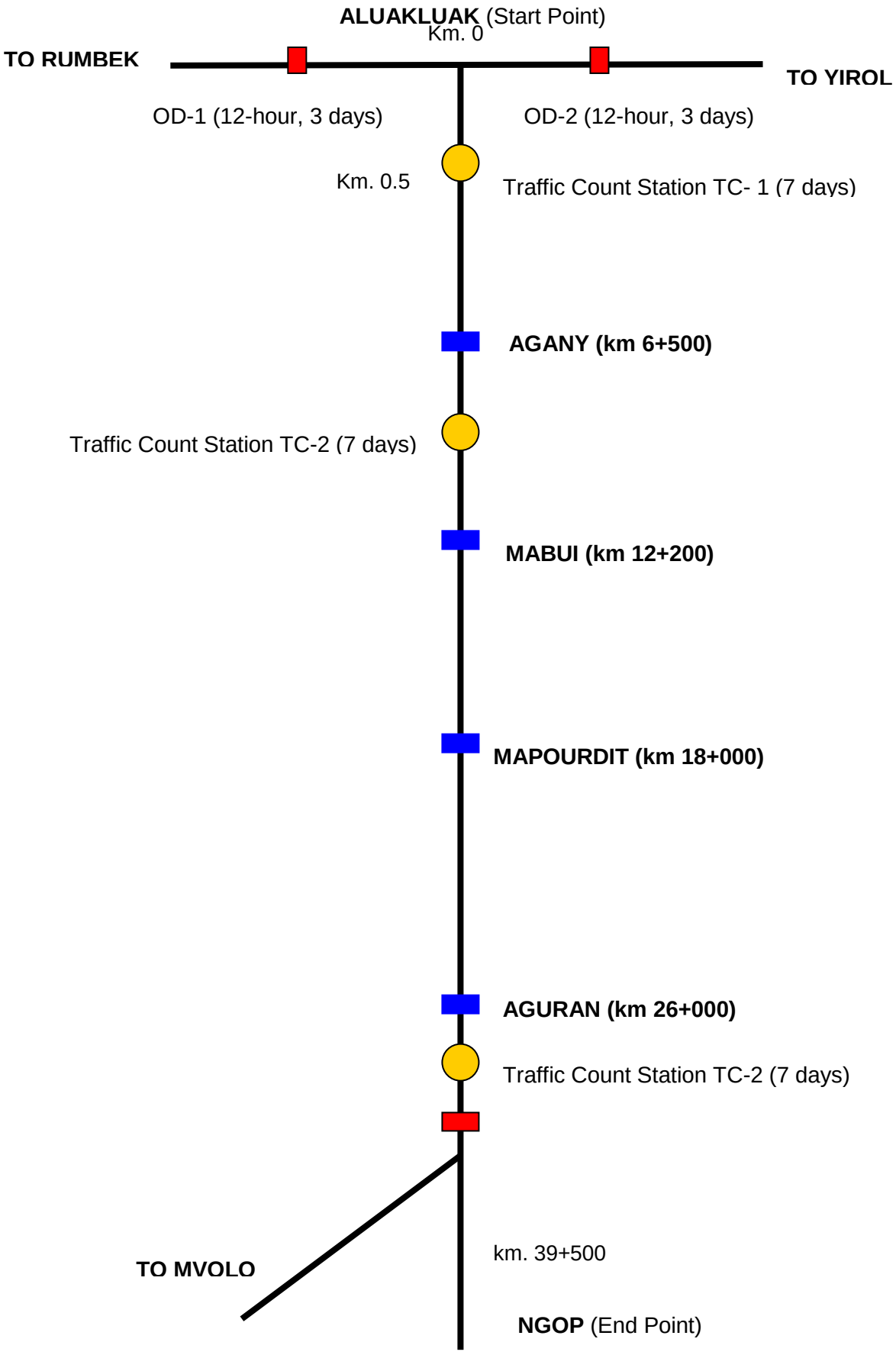
Traffic survey data relating to the project road, as collected and complied by SSRA, were obtained for 2010 for **Aluakluak – Mvolo** road; the project road is a section of the road section covered by the SSRA study. The referred study was undertaken by the Government of South Sudan, Ministry of Transport and Roads through an external consultant, AFRICON Ltd. (South Africa), named *Feasibility Study, Detail Design and Preparation of Bidding Documents for the Phased Rehabilitation of about 7,000km of Rural Roads in Southern Sudan (September 2010)*. The study has undertaken a brief study of traffic volumes on the subject road, indicated in **Table 4-1** below.

Table 4-1: Historical Traffic Count on Project Road (2010)

No	Road Section	State	Length (km)	Class	Traffic Count over Survey Period				ADT	
					Pedestrians	Bicycle	Light Vehicles	Heavy Vehicles	MT	NMT
1	Aluakluak - Mvolo	Western Equatoria	40	S	6	1	3	3	72	84
2	Aluakluak - Mvolo	Lakes	10	S	2	1	1	1	60	90
Weighted Averaged ADT			**50**	**S**	**5**	**1**	**3**	**3**	**70**	**85**

The available traffic data thus indicates that the project road has catered for as much as 70 vehicles and 85 NMTs when the surveys were made in early 2010. The indicated traffic demand at the time places the road at a DC-2 Standard as per the current Low Volume Roads Design Manual (June 2013) in use by the SSRA. This signifies the potential for growth in the project area, as long as no abnormal interruptions occur.

Figure 4-1: Locations of Traffic Surveys



4.4.2 Program for Traffic Surveys

In view of the available information and data requirements of the Project road, data-gapswere identified, and it was planned to conduct a series of traffic surveys. Keeping in mind the ToR requirements, a program of traffic surveys was formulated. Accordingly, the following traffic surveys were conducted in the project vicinity.

- Classified Traffic Volume Counts;
- Origin-Destination Surveys; and
- Travel Time Surveys.

Based on the reconnaissance survey and observation of the Project road and traffic movement pattern on it, five traffic survey locations were selected, as indicated on a line diagram **(Figure 4-1).**

4.4.3 Classified Traffic Volume Counts

Classified traffic volume counts at three locations were conducted between 09.03.2015 and 16.03.2015 of which the details and durations are given in **Table 4-2.**

Table 4-2: Classified Traffic Volume Counts: Survey Locations

Survey Station	Location	Duration	Survey Dates
TC-1: Aluakluak, outside the town limits in the direction towards Mapourdit (km 0+500)	Aluakluak	7 Days	09.03.15 – 15.03.15
TC-2: Agany, outside the town limits in the direction towards Mapourdit (km 7+000)	Agany	7 Days	09.03.15 – 15.03.15
TC-3: At Aguran, outside the town limits in the direction towards Ngop/Mvolo (km 21+000)	Aguran	7 Days	10.03.15 – 16.03.15

4.4.3.1 Daily Traffic Counts and Traffic Compositions

The daily traffic count data are summarized in **Table 4-3,** presenting the averaged traffic volume as well as composition as percent of total traffic for each survey station. The vehicle composition brings out an interesting feature that passenger vehicle: freight vehicles ratio are close to 3:1 for all stations where almost 3 quarters of all vehicles surveyed were actually passenger vehicles. The reason for this could be attributed to the well-populated project area and poor service delivery resulting from the poor transport infrastructure. This corresponds to the actual population distribution & assessment of basic services in the project area.

Table 4-3 Vehicle Category wise Traffic Volume at Survey Stations

Station 1: Aluakluak (TC-1)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
9th March 2015, Mon	12-Hr	286	208	223	151	65	133	78	77	32	**1,253**
10th March 2015, Tues	12-Hr	600	386	437	340	323	430	283	225	290	**3,314**
11th March 2015, Wed	12-Hr	524	402	374	243	195	204	124	68	52	**2,186**
12th March 2015, Thurs	12-Hr	462	424	271	120	137	122	97	53	28	**1,714**
13th March 2015, Fri	12-Hr	535	322	283	282	155	151	152	103	48	**2,031**
14th March 2015, Sat	12-Hr	491	275	337	130	75	43	21	10	7	**1,389**
15th March 2015, Sun	12-Hr	403	259	228	101	72	85	55	38	27	**1,268**
12-Hr Daily Average (ADT)		471.6	325.1	307.6	195.3	146.0	166.9	115.7	82.0	69.1	
Vehicle Composition		25%	17%	16%	10%	8%	9%	6%	4%	4%	
12-Hr Average Daily Traffic		**472**	**325**	**308**	**195**	**146**	**167**	**116**	**82**	**69**	**1879.3**

Station 2: Agany (TC-2)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
9th March 2015, Mon	12-Hr	106	114	107	80	45	90	54	33	25	**654.00**
10th March 2015, Tues	12-Hr	93	72	47	47	26	44	34	45	29	**437.00**
11th March 2015, Wed	12-Hr	522	398	403	279	197	346	239	113	44	**2,541.00**
12th March 2015, Thurs	12-Hr	103	73	50	39	21	11	1	0	0	**298.00**
13th March 2015, Fri	12-Hr	458	408	319	180	386	249	137	107	0	**2,244.00**
14th March 2015, Sat	12-Hr	596	511	444	327	237	277	179	73	0	**2,644.00**
15th March 2015, Sun	12-Hr	612	512	461	344	244	228	211	169	0	**2,781.00**
12-Hr Daily Average (ADT)		355.7	298.3	261.6	185.1	165.1	177.9	122.1	77.1	14.0	
Vehicle Composition		21%	18%	16%	11%	10%	11%	7%	5%	1%	
12-Hr Average Daily Traffic		**356**	**298**	**262**	**185**	**165**	**178**	**122**	**77**	**14**	**1,657**

Station 3: Mapourdit (TC-3)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
10th March 2015, Tues	12-Hr	5	20	14	4	0	26	2	0	0	**71.00**
11th March 2015, Wed	12-Hr	19	38	39	8	0	21	2	0	0	**127.00**
12th March 2015, Thirs	12-Hr	43	54	27	17	0	45	20	0	0	**206.00**
13th March 2015, Fri	12-Hr	70	49	32	45	0	60	33	0	0	**289.00**
14th March 2015, Sat	12-Hr	46	89	70	29	0	30	21	0	0	**285.00**
15th March 2015, Sun	12-Hr	63	67	35	23	0	43	12	0	0	**243.00**
16th March 2015, Mon	12-Hr	40	35	0	21	0	31	25	0	0	**152.00**
12-Hr Daily Average (ADT)		40.9	50.3	31.0	21.0	0.0	36.6	16.4	0.0	0.0	
Vehicle Composition		21%	26%	16%	11%	0%	19%	8%	0%	0%	
12-Hr Average Daily Traffic		**41**	**50**	**31**	**21**	**0**	**37**	**16**	**0**	**0**	**196**

4.4.3.2 Traffic Variation: Day & Night

The traffic counts were normally carried out for 12 hours (0700-1900 hr) each day. Hence, a 24-hour (0600-0600) count was not carried out in any of the survey stations to get information about the proportion of traffic plying during 1900 to 0600 hr. However, given the poor state of the feeder road under consideration, apparent security situation in the state, it is anticipated a 24-hr survey would not be feasible. As such, it was decided that the surveys would only be conducted for 12 hours during day-time. Therefore, the ratios of the 24-hr count/12-hr count (termed as **"night factor**") for each category of vehicle and for each survey station are taken as unity.

4.4.3.3 Average Daily Traffic (ADT) for Road Sections

The 12-hour traffic count data shown in Table 4-3 have been adjusted by the application of unit night factors indicated above and treated as equivalent 24-hour count data. The adjusted daily traffic count data are presented in **Table 4-4** and further averaged to derive the ADT (average daily traffic) for each survey station.

The project road has been divided into three sections, traffic distribution wise, from Aluakluak to Agany (6.5km), Agany to Mapourdit (11.5km) and finally from Mapourdit to Ngop (20.5km). The traffic count from each of the count stations is meant to be assigned to the section of the road that is represents. However, as can be seen from the survey data, the stations Aluakluak and Agany has produced unrealistic and highly exaggerated results. As such, it was decided to adopt the count obtained at Mapourdit station (TC-3) for all sections of the road, as it offers realistic figures and is conveniently located at almost at the center of the road at km 21+000 on the about 40km road which is under investigation.

Taking into account the ADTs derived for the three survey locations, the ADTs are assigned to the three road sections are shown in **Table 4-4.**

Table 4-4: ADT assigned to Project Road Sections

Section of the Road	Length (km)	Normal 12-Hr Motorized Traffic Count 2015									Total	Traffic Count Year
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T		
Aluakluak - Agany (0+000 to 6+500)	6.5	41	50	31	21	0	37	16	0	0	**196**	**Mar-15**
Agany – Mapourdit (6+500 to 18+000)	11.5	41	50	31	21	0	37	16	0	0	**196**	**Mar-15**
Mapurdit – Aguragne - Ngop (18+000 to 38+500)	20.5	41	50	31	21	0	37	16	0	0	**196**	**Mar-15**
Aluakluak - Ngop (0+000 to 38+500)	**38.5**	**41**	**50**	**31**	**21**	**0**	**37**	**16**	**0**	**0**	**196**	**Mar-15**

4.4.4 Origin-Destination Surveys

In order to establish the movement pattern on the Project Road, roadside interviews with vehicle drivers/crew were conducted at two traffic survey locations for three days each, to ascertain the origins and destinations of the vehicles using the adjacent road, their trip lengths (distance traveled), trip purpose, occupancy and the commodity flow pattern. The surveys had been carried out on a working day and weekend for 12-hours from 0700 to 1900 hrs. The enumerators were deployed with sufficient training to conduct the surveys. Police help was obtained to ensure smooth flow of traffic and stoppage of the selected vehicles. The OD survey stations are described in **Table 4-5**.

Table 4-5: Origin-Destination Survey: Survey Locations

Survey Station	Location	Duration	Survey Duration
OD-1: At Aluakluak, outside town limits in the direction towards Rumbek (km 0+000)	Aluakluak	3 Days	12.03.15 – 14.03.15
OD-2: At Aluakluak, outside town limits in the direction towards Yirol (km 0+000)	Aluakluak	3 Days	12.03.15 – 14.03.15
OD-3: Aguran, outside town limits in the direction towards Ngop/Mvolo (km 21+000)	Aguran	3 Days	12.03.15 – 14.03.15
OD-4: Aguran, outside town limits in the direction from Ngop/Mvolo (km 21+000)	Aguran	3 Days	12.03.15 – 14.03.15

Location-wise numbers of vehicles interviewed are given in **Table 4-6.**Out of the 189 vehicles interviewed, about 37 motorcycles and 2 specialized motorized vehicles were excluded from the table for the purpose of clarity.

Table 4-6: Number of Vehicles Intercepted in the O-D Survey

Location	Car*	L/Rover	S/Bus	L/Bus	S/Truck	M/Truck	H/Truck	T &T	Total
TOTAL	**9**	**76**	**21**	**1**	**14**	**19**	**9**	**1**	**150**

*Motor-cycles and specialized vehicles interviewed during the surveys is excluded

The intercepted vehicles were classified by vehicle plates and purpose of trip. In the former category, Table 4-7A shows that while business and trading vehicles by far dominated vehicle movement at about 44% of intercepted trips, these were followed by government vehicles at 23.2% and personal vehicles at 16%. Incidence of driving vehicles without any plate number is observed as high as 6.5%.

Table 4-7A: Vehicle Plate Category

Plate Code	Code	Frequency	%
No Plate	0	12	6.5%
Taxi	1	5	2.7%
Personal Automobile	2	30	16.2%
Trading Vehicle	3	81	43.8%
Administration/Local Government	4	23	12.4%
National Government	5	20	10.8%
Other Country/UN	6	14	7.6%
Others	7	0	0.0%
TOTAL		**185**	**100%**

Table 4-7B: Trip Purpose Category

Trip Purpose	Code	Frequency	%
No Response	0	24	15.5%
From/To Work	1	16	10.3%
Employment	2	12	7.7%
Personal	3	30	19.4%
Education	4	4	2.6%
Medical	5	10	6.5%
Social	6	13	8.4%
Vacation	7	6	3.9%
Ceremony (Wedding, Funeral)	8	9	5.8%
Others	9	31	20.0%
TOTAL		**155**	**100%**

The OD survey has also captured the response of drivers regarding trip purposes **(Table 4-7B)**. It was found that personal trips contributed most of the motorized travel around the project vicinity at 20% while work and employment trips intercepted account for 18% of trips and trips to social services (medicine, education) account 10% of trips. Social trips, vacation and attending ceremonies accounted for 18.1% of trips. The incidence of no response to the interview is exceptionally high at about 16% of all vehicles intercepted by the OD survey.

4.4.4.1 Commodity Movement

For analyzing the commodity movement on the Project road, major commodities being transported on roads within the Project Area of Influence were identified. For carrying out the above exercise, data were collected through the formats used in the O-D survey at the four locations. For the purpose of data analysis, these commodities were grouped and assigned numeric codes, as given in **Table 4-8**.

Table 4-8: Commodity Category

Code	Group	Possible Commodity Type
0	Empty	Unloaded
1	Agricultural product	Wheat, oil seed, *sorghum*, barely
2	Livestock	Ox, goat, camel
3	Fuel wood or charcoal	Charcoal, etc
4	Water	Water (tanker)
5	Processed food or drinks	Vegetables, fish, meat, milk and milk products, soda, bottled water, etc.
6	Machinery, equipment	Machinery and transport equipment
7	Logs or lumber	Wood, timber, etc
8	Construction materials, cement	HCB, brick, cement, steel, aluminum, etc
9	Petrol, diesel, kerosene, gas	Flammable hydrocarbons
10	Chemicals or fertilizes	Mineral fuels, lubricants and related material
11	Medicines and pharmaceuticals	
12	Miscellaneous household goods	House-hold items, finished products, soap, salt, sugar, pulses, spices etc.
13	Other or unknown	Other items

During the O-D surveys, a variety of commodities – bulk and mixed cargo, was observed moving on the project road. The O-D information collected was classified according to the commodity category (Table 4-8) and the percentage distribution of commodity is given in **Table 4-9.**

Table 4-9: Distribution of Commodity on the Project Road (%)

Commodity Type	%
Empty	7.9%
Agricultural Product	23.7%
Livestock	0.0%
Fuel-wood or Charcoal	5.3%
Water	0.0%
Processed Food or drinks	26.3%
Construction machinery/equipment	13.2%
Logs or lumber	0.0%
Construction Materials, cement, rebar	10.5%
Petrol, Diesel, Kerosene, gas	2.6%
Chemicals or Fertilizers	0.0%
Pharmaceutical Items, Medicine	2.6%
Miscellaneous Household goods	0.0%
Others/Unknown	7.9%
TOTAL	**100%**

It may be noted that incidence of empty hauling was observed to be low at about 8%. As such, most of the vehicles that were intercepted by the survey were loaded trucks. Of the loaded goods vehicles, 26.3% carried processed food items and drinks, followed by agricultural products which constitute about 23.7% of the total commodity movement. The construction sector has then contributed the bulk of commodities being transported in the vicinity of the project road with construction equipment at 13.2% and inputs required for construction such as cement and

reinforcement steel at 10.5%. On the lower end of commodity movements, fuel wood/charcoal contributed 5% of freight trips followed by petrol, diesel, kerosene and medicines at 2.6% each. In general, it is noted that the project vicinity contributes to the national freight movement through agricultural items collected from farms existing along the project road to relevant markets elsewhere.

Alongside the commodity flow survey, data on the carrying capacity of trucks was collected and the payload carriedby truckers were recorded. For the purpose of analysis, the trucks have been categorized as shown in **Table 4-10** with their respective percentage distribution.

Table 4-10: Percentage Distribution of Commodity Flow from the O-D survey

Vehicle Utilization	Code	Frequency	%
Empty	0	4	8.2%
1/4 Full	1	4	8.2%
Half Full	2	8	16.3%
3/4 Full	3	4	8.2%
Fully Loaded	4	15	30.6%
Over-loaded	5	14	28.6%
TOTAL		**49**	**100%**

Based on the survey, 8.2% of the trucks are empty loaded and almost 24.5% of total intercepted trucks are half orquarter loaded. On the project road, it has been observed that a considerable amount of trucks are substantially to fully loaded which accounts to 38.8% of the total intercepted trucks, while the extent of over-loading was observed as high as 28.6%.

4.4.4.2 Trip Frequency on the Project Road

The frequency of making similar trips by drivers was collected from the drivers and analyzed. We note that high proportion of the intercepted vehicles actually make similar trips frequently as shown in **Table 4-11**.

Table 4-11: Trip Frequency Distribution from the O-D survey

Trip Frequency	Code	Frequency	%
Most Frequent	7	68	75%
	3	40	
	2	30	
Frequent	1	12	7%
Occasional	0.5	24	18%
	0.25	10	
TOTAL		**184**	**100%**

Most frequent trips, made from once a week to daily, account for 3 quarters of all vehicles interviewed by the OD survey. This makes the trip characteristics observed from this particular survey a dependable replica of actual movement pattern of drivers in the future. These are followed by occasional trips that are made at most once a month accounting for 18% of trips and those that fall in-between at 7% respectively.

4.4.4.3 Traffic Flow Pattern

The Rumbek and Yirol, followed by Juba, Aluakluak and Mapourdit are the major generating and attracting centers of traffic on the Project Road (**Table 4-12**). As the distance between Origin and Destination towns increase, the traffic flow on the Project road decreases.

Table 4-12: Traffic Attraction Centroids from the O-D survey

Location	Origin	Destination	SUM	RANK
Rumbek	54	33	87	1
Yirol	40	31	71	2
Mapourdit	11	22	33	5
Juba	24	25	49	3
Tonj	2	4	6	9
Aluakluak	12	31	43	4
Akot	6	0	6	9
Wau	4	2	6	9
Awerial	1	3	4	13
Mvolo	7	4	11	7
Ngop	7	11	18	6
Maridi	3	0	3	17
Yambio	3	0	3	17
Yei	4	0	4	13
Agany	0	5	5	12
Warrap	0	4	4	13
Aweil	0	4	4	13
Anuol	2	6	8	8
TOTAL	**180**	**185**	**365**	

Based on the major origin and destination points on the project road, the OD Matrix is established and shown under **Table 4-13A and Table 4-13B**.

Table 4-13A: Origin Destination Matrix based on OD Survey

O/D	Rubmek	Yirol	Juba	Aluakluak	Mapourdit	Ngop	Mvolo	Anuol	Wau	Akot	OTH	Sum
Rumbek	0	24	19	8	2	4	0	0	0	0	2	**59**
Yirol	20	0	0	15	2	2	3	0	0	0	0	**42**
Juba	15	1	0	1	6	0	0	0	0	0	2	**25**
Aluakluak	2	1	0	2	2	5		1	0	0	0	**13**
Mapourdit	2	1	0	0	0	1	5	1	0	0	0	**10**
Ngop	0	1	0	2	4	0	0	0	0	0	0	**7**
Mvolo	0	4	0	0	10	0	0	0	0	0	0	**14**
Anuol	1	0	0	0	1	0	0	0	0	0	0	**2**
Wau	0	0	1	0	0	0	0	0	0	0	0	**1**
Akot	0	2	1	1	1	0	0	0	0	0	0	**5**
OTH	3	1	3	1	2	0	0	0	0	0	0	**10**
Sum	**40**	**35**	**24**	**30**	**30**	**12**	**8**	**2**	**0**	**0**	**4**	**188**

Table 4-13B: Origin Destination Matrix based on OD Survey

O/D	1	2	3	4	5	6	7	8	9	10	OTH	Sum
1	0	24	19	8	2	4	0	0	0	0	2	**57**
2	20	0	0	15	2	2	3	0	0	0	0	**42**
3	15	1	0	1	6	0	0	0	0	0	2	**25**
4	2	1	0	2	2	5		1	0	0	0	**13**
5	2	1	0	0	0	1	5	1	0	0	0	**10**
6	0	1	0	2	4	0	0	0	0	0	0	**7**
7	0	4	0	0	10	0	0	0	0	0	0	**14**
8	1	0	0	0	1	0	0	0	0	0	0	**2**
9	0	0	1	0	0	0	0	0	0	0	0	**1**
10	0	2	1	1	1	0	0	0	0	0	0	**5**
OTH	3	1	3	1	2	0	0	0	0	0	0	**10**
Sum	**40**	**35**	**24**	**30**	**30**	**12**	**8**	**2**	**0**	**0**	**4**	**186**

Of all the trips that have originated from Rumbek, though 3 quarters of the trips were headed to either Yirol or Juba, the remaining quarter of trips headed to the project vicinity, namely Aluakluak, Mapurdit and Ngop. Again, of all trips that originated from Yirol, though 48% were headed to Rumbek, the remaining 52% of trips were headed to either Aluakluak, Mapourdit, Ngop or Mvolo. Significant number of journeys starting from Juba did end in Rumbek, however about 30% were headed to Aluakluak and Mapourdit. Of all vehicles intercepted by the survey, more than two third of the tripseither started or ended in either of Rubmek, Yirol, Juba, Aluakluak or Mvolo. This shows the significance of the project road control points, particularly Aluakluak and Mapourdit in the overall travel pattern at the national level.

4.4.5 Seasonal Variation in Traffic Flow

The road section-wise ADTs shown in **Table 4-7** relate to the time of the year when the traffic surveys are carried out, over periods of 3 to 7 days in March 2015. The Project road traffic, however, is susceptible to seasonal variations, particularly those caused by the seasonality of the climate and agricultural activities in the project area.

The best historical data for assessing the seasonal variations of traffic flow along the project road would be counts made by SSRA during the different cycles of the year, particularly focusing on the dry period (December to March) and wet season (April to November) with two thirds of the time being a rainy period. As the traffic surveys were made during the dry period (High season), factors are required to be used to correct the seasonality of traffic along the project road, particularly in lieu of the wet season (Low-traffic volume season). In the absence of historical data maintained with the SSRA, it was decided to assume proportion of traffic during high, low and medium seasons in relation to the annual average values as depicted under **Table 4-14**.

Table 4-14: Seasonal Correction Factor (SCF)

Season	Indexed ADT	SCF
Low	0.25	3.80
Medium	1	0.95
High	1.6	0.59
Average	**0.950**	

The use of the SCF meant that the ADT calculated from the traffic count surveys shall be adjusted for seasonality of traffic on project road relating to low, medium and high seasons.

4.4.6 Non-Motorized Traffic Survey

Non-Motorized transport modes in use in the project area comprise principally pack animals and walking. Other intermediate non-motorized modes, mainly bicycles, do play an important role; both offer scope for reducing travel costs through faster travel time or increased loading capacity with relatively small capital outlays. Road improvement is likely to reduce costs of operation and encourage adoption of these modes at least in suitable terrain. Hence, to scrutinize the, on-motorized traffic at the vicinity of the project area, data has been collected. The non-motorized traffic count has been conducted alongside with the motorized traffic count, .i.e. the traffic survey stations as well as the period of the traffic count are similar to that of the motorized traffic count. The Non –motorized traffic data for the four stations are depicted as shown below from **Table 4-15**.

Table 4-15: Non-Motorized Traffic Survey Results

Station 1: Aluakluak

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
9th March 2015, Mon	12-Hr	485	543	570	49	7	**1,654**
10th March 2015, Tues	12-Hr	510	557	601	12	0	**1,680**
11th March 2015, Wed	12-Hr	518	491	635	15	3	**1,662**
12th March 2015, Thurs	12-Hr	535	856	890	13	0	**2,294**
13th March 2015, Fri	12-Hr	644	768	822	22	0	**2,256**
14th March 2015, Sat	12-Hr	537	739	747	23	0	**2,046**
15th March 2015, Sun	12-Hr	488	761	806	30	0	**2,085**
12-Hr Weekly Average (ADT)		531.0	673.6	724.4	23.4	1.4	
24-Hr Average Weekly Daily Traffic		**531**	**674**	**724**	**23**	**1**	**1953.9**
		0.25	0.2	0.15	0.7	0	**PCU**
		133	135	109	16	0	**Cars**

Station 2: Agany

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
9th March 2015, Mon	12-Hr	246	1023	1083	130	65	**2,547.00**
10th March 2015, Tues	12-Hr	158	135	197	15	0	**505.00**
11th March 2015, Wed	12-Hr	407	384	872	10	16	**1,689.00**
12th March 2015, Thurs	12-Hr	215	545	580	141	0	**1,481.00**
13th March 2015, Fri	12-Hr	474	460	468	153	4	**1,559.00**
14th March 2015, Sat	12-Hr	520	567	600	210	0	**1,897.00**
15th March 2015, Sun	12-Hr	572	576	641	201	0	**1,990.00**
12-Hr Weekly Average (ADT)		370.3	527.1	634.4	122.9	12.1	
24-Hr Average Weekly Daily Traffic		**370**	**527**	**634**	**123**	**12**	**1,667**
		0.25	0.2	0.15	0.7	0	**PCU**
		93	105	95	86	0	**Cars**

Station 3: Mapourdit

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
10th March 2015, Tues	12-Hr	96	144	143	0	0	**383.00**
11th March 2015, Wed	12-Hr	206	263	134	0	0	**603.00**
12th March 2015, Thirs	12-Hr	187	186	180	0	0	**553.00**
13th March 2015, Fri	12-Hr	264	242	181	0	0	**687.00**
14th March 2015, Sat	12-Hr	232	279	221	0	0	**732.00**
15th March 2015, Sun	12-Hr	229	232	157	0	0	**618.00**
16th March 2015, Mon	12-Hr	257					**257.00**
12-Hr Weekly Average (ADT)		202.3	224.3	169.3	0.0	0.0	
24-Hr Average Weekly Daily Traffic		**202**	**224**	**169**	**0**	**0**	**596**
		0.25	0.2	0.15	0.7	0	**PCU**
		51	45	25	0	0	**Cars**

As shown from above tables, it is observed that the dominating non-motorized forms of traffic are pedestrians and pack animals at all stations. At proximity of larger villages such as Aluakluak and Agany, considerable amount of dwellers used bicycles for day-to-day activities for local movements. It has been noticed that the intensity of handcarts is also high in the vicinity of

villages. The non-motorized traffic flow has been converted to motorized vehicles to estimate the traffic volume on the project road by using appropriate Passenger-Car Equivalent (PCE) factors from the **Low Volume Road Design Manual (2013)**.

4.4.7 Establishment of AADTs

Based on the analysis of traffic seasonality indicated above and also applying judgment, the road section-wise AADTs so derived are shown in **Table 4-15.**

The components of traffic considered for design and economic analysis of project road are normal, generated and diverted traffic. So it is necessary to distinguish between the following traffic:

Current/Normal Traffic: This represents the existing traffic that would use the improved road when it is opened to traffic.

Diverted Traffic: This represents the traffic attracted to the improved road or lost to alternative routes when the improvements are completed.

Induced Traffic: This represents the increase in traffic as a result of the increased demand for transport, if any, induced by the improvement of the road. This is part of the Generated Traffic under establishment of AADT.

Development Traffic: This represents the increase in traffic, if any, that may arise from improvements on adjacent land over and above the development which would have taken place had the new or improved road not been constructed. This is part of the Generated Traffic under establishment of AADT.

4.4.7.1 Normal Traffic

This represents the traffic which would in any event occur if no improvement is made. The base year for traffic projection is 2015, on which traffic surveys and baseline data have been based. The normal traffic has been projected for 2 years (2015-2017), based on short-term traffic growth rate of 1%.Accordingly, the summarized AADT based on traffic count made by the Consultant and considering the adopted growth rate on the project road, the opening year normal traffic for the year 2017 is shown **Table 4-16**.

Table 4-16: Normal Traffic

Section of the Road	Length (km)	Normal AADT 2017									Total	Traffic Forecast Year (2-Yrs)
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T		
Seasonal Correction Factor		**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**		
Aluakluak - Agany (0+000 to 6+500)	6.5	21	26	16	11	3	19	8	4	2	**109**	**Mar-17**
Agany – Mapourdit (6+500 to 18+000)	11.5	21	26	16	11	3	19	8	4	2	**109**	**Mar-17**
Mapurdit – Aguragne - Ngop (18+000 to 38+500)	20.5	21	26	16	11	3	19	8	4	2	**109**	**Mar-17**
Aluakluak - Ngop (0+000 to 38+500)	**38.5**	**21**	**26**	**16**	**11**	**3**	**19**	**8**	**4**	**2**	**109**	**Mar-17**

The SCF adopted for the project is 0.5 with an effort to arrive at reasonable demand levels. The NMT count has been used to estimate the number of passenger and freight vehicles. The values obtained were added to the motorized traffic obtained from survey into bus and truck traffic. The sum of MT and NMT gives the Normal Traffic for the project.

4.4.7.2 Generated Traffic

Generated traffic is the traffic that results from economic, social and environmental development of the Project area. Generated traffic is expected to emerge as soon as the road is upgraded and open to traffic. Two categories of traffic change may be generated by road construction. First there may be modal shift in which low cost movements are replaced by higher cost movements

due to the change in mode and the quantity of trips. Secondly, additional trips may be undertaken solely as a result of better accessible road, thereby reducing trip cost i.e. lower VOCs and travel time. This phenomenon takes place in ROSS, as demand for the transportation increases as its cost decreases, which yields savings to the road users.

Currently, agricultural activities and passenger mobility are low due to the bad condition of the existing road. Thus generated traffic is the induced traffic which will use the road following road construction or improvement that would not occur without the project road. These changes may lead to new or increased economic activity or higher volumes of consumption or marketed products, or increased frequency or new patterns of personal trip making, leading to increased passenger traffic. It is obvious that there will be an increase in agricultural product in the project area, the nearby project areas and the country at large, given that this road is highly influenced by the import and export activity of the county, the road being the alternative import export corridor. The construction of the road will have a positive impact in increasing the income of the surrounding farmers and thereby will result in more demand of industrial commodities by farmers because of augmented income. Thus, it can be concluded that generated traffic will be significant since the existing road cannot handle additional requirements of the different vehicles as a result of the economic activity in the long-term period of the project life. In this regard, experience shows that estimated generated traffic generally varies between 15% and 30% of the normal traffic. As such, a Generated Traffic Factor of 20% is adopted and shown in **Table 4-17**.

Table 4-17: Generated Traffic

Section of the Road	Length (km)	Generated AADT 2017									Total	Traffic Forecast Year (7-Yrs)
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T		
Aluakluak - Agany (0+000 to 6+500)	6.5	4	5	3	2	1	4	2	1	0	**22**	**Mar-17**
Agany – Mapourdit (6+500 to 18+000)	11.5	4	5	3	2	1	4	2	1	0	**22**	**Mar-17**
Mapurdit – Aguragne - Ngop (18+000 to 38+500)	20.5	4	5	3	2	1	4	2	1	0	**22**	**Mar-17**
Aluakluak - Ngop (0+000 to 38+500)	**38.5**	**4**	**5**	**3**	**2**	**1**	**4**	**2**	**1**	**0**	22	**Mar-17**

4.4.7.3 Diverted Traffic

Diverted traffic represents traffic that diverts to the project road from alternative roads, while at the same time keeping the same origin and destination as before. As clearly indicated under the TOR for the study, the aim of the project is to implement about 30km of feeder road.During the analysis of Origins and Destinations using O/D Matrix, it was noted that the project road may be a possible alternative to travel from Rumbek or Yirol to say, Mvolo. However, as the project road will not be constructed from Aluakluak to Mvolo, traffic diversion will not be possible. As such, diverted traffic is excluded from this study.

4.4.7.4 Opening Year AADT

The resulting summary of AADT establishment is shown hereunder in Table 4-18.

Table 4-18: Opening Year AADT

Total AADT 2017 By SECTION

Section of the Road	Length (km)	AADT 2017									Total	Traffic Forecast Year (7-Yrs)
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T		
Aluakluak - Agany (0+000 to 6+500)	6.5	25	31	19	13	4	22	10	4	2	**130**	**Mar-17**
Agany – Mapourdit (6+500 to 18+000)	11.5	25	31	19	13	4	22	10	4	2	**130**	**Mar-17**
Mapurdit – Aguragne - Ngop (18+000 to 38+500)	20.5	25	31	19	13	4	22	10	4	2	**130**	**Mar-17**
Aluakluak - Ngop (0+000 to 38+500)	**38.5**	**25**	**31**	**19**	**13**	**4**	**22**	**10**	**4**	**2**	130	**Mar-17**

Total AADT 2017 By WHOLE PROJECT

Type of Traffic	Car	Utility	S. Bus	L. Bus	M. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM
Normal Traffic	21	26	16	11	3	19	8	4	2	109
Generated Traffic	4	5	3	2	1	4	2	1	0	22
Diverted Traffic	0	0	0	0	0	0	0	0	0	0
Recommended AADT	**25**	**31**	**19**	**13**	**4**	**22**	**10**	**4**	**2**	**130**

4.4.8 Project Schedule

The analysis period for the project has been considered as 20 years starting after the completion of the improvement, and opening the Project Road to traffic. In this context, the Project Schedule is envisaged as described in **Table 4-18**.

Table 4-18: Proposed Project Implementation Schedule

Activity	Period
Feasibility Study	March. 2015
Detailed engineering and bid document preparation	Sept. 2015
Bidding and contractor selection	Sept. 2015 – Dec. 2015
Implementation (1.5 year)	Jan. 2016 – Jun. 2017
Opening to traffic after implementation	July 2017
Traffic service period (20 years)	2017 - 2037

4.4.9 Traffic Projection

The projection of traffic based on the realistic economic growth scenario is shown hereunder in Table 4-19.

Table 4-19: Traffic Projection on Project Road

Demand estimation for upgrading to Feeder Roads Standard

Traffic Projection on Aluakluak - Agany - Mapourdit - Aguragne - Ngop Road (Realistic Situation)

Counter	Year	Projected ADT										LVRD Design Standard
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM	
0	2017	**25**	**31**	**19**	**13**	**4**	**22**	**10**	**4**	**2**	**130**	DC-3
1	2018	27	33	20	14	4	23	10	4	3	**137**	DC-3
2	2019	28	35	21	14	4	24	11	5	3	**145**	DC-3
3	2020	30	37	23	15	4	25	11	5	3	**152**	DC-4
4	2021	32	39	24	16	4	26	12	5	3	**161**	DC-4
5	2022	**33**	**41**	**25**	**17**	**4**	**27**	**12**	**5**	**3**	**169**	DC-4
6	2023	35	44	27	18	5	28	13	5	3	**178**	DC-4
7	2024	38	46	29	19	5	29	13	6	3	**188**	DC-4
8	2025	40	49	30	20	5	31	14	6	3	**198**	DC-4
9	2026	36	44	27	18	5	29	13	6	3	**180**	DC-4
10	2027	**37**	**46**	**28**	**19**	**5**	**30**	**13**	**6**	**3**	**187**	DC-4
11	2028	38	47	29	20	5	31	14	6	3	**194**	DC-4
12	2029	40	49	30	21	5	32	14	6	3	**201**	DC-4
13	2030	42	51	32	21	5	33	15	6	4	**208**	DC-4
14	2031	43	53	33	22	5	30	13	6	3	**208**	DC-4
15	2032	**45**	**55**	**34**	**23**	**5**	**30**	**13**	**6**	**3**	**215**	DC-4
16	2033	47	58	36	24	5	31	14	6	3	**223**	DC-4
17	2034	49	60	37	25	5	31	14	6	3	**230**	DC-4
18	2035	51	62	38	26	5	32	14	6	3	**238**	DC-4
19	2036	53	65	40	27	5	33	14	6	4	**247**	DC-4
20	**2037**	**55**	**67**	**42**	**28**	**5**	**33**	**15**	**6**	**4**	**255**	DC-4

Growth Rates

Realistic Scenario

2015 - 2025	**6.0%**	**6.0%**	**6.0%**	**6.0%**	**4.0%**	**4.0%**	**3.90%**	**3.90%**	**3.9%**
2026 - 2030	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**3.0%**	**3.0%**	**2.9%**	**2.9%**	**2.9%**
2031 - 2035	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**
2036 - 2040	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**

This section of the report has established that the project road under investigation caters for a significant level of travel demand resulting from the agricultural activities on-going in the vicinity. The AADT at project opening (at 2017) will increase upto 215 (by 2032) after 15-years of service and to 255 (by 2037) after 20 years of service. Even with relatively flat growth rates adopted for

the project, ranging between 2% to 6% for different vehicle types, the project road has still managed to fall within the boundary of a DC-4 standard according to the South Sudan Roads Authority, Low Volume Roads Design Manual (Sept. 2013).

There is a concern with the quality of data obtained from the traffic count stations; particularly, it is felt that the reported results are much more exaggerated than what was briefly observed during the field mission and what was expected in the context of other feeder roads in the South Sudan. As such, it is felt that a stage construction approach would be more feasible during implementation. As such, it is suggested to adopt DC-2 standard during the estimation of costs during this Feasibility Study. However, the traffic results obtained are suggested to be validated during detail design by the external Engineering Design Consultant, by conducting classified manual traffic survey at the selected locations and projecting the traffic levels into the design period for final adoption of appropriate design standard for the feeder road under investigation.

4.5 Socio-Economic Assessment

4.5.1 Socio-economic Assessment Objective

As per the Project TOR, the overall objective of the socio-economic impact assessment (SEIA) is to identify and analyze the potential impact of the proposed feeder road construction activity and recommend initiatives, realize sustainable development opportunities as well as to mitigate the negative impacts. The core objective is to justify the selection of the prioritized road based on feasibility of the extent and nature of the socio-economic impact of the investment involved.

4.5.2 Review of the Project Areas: Lake State, Yirol West County

This section highlights the general administrative, geographical and socio-economic characteristics of the feeder road project`s catchment areas, Yirol West County, the road section areas Aluakluak – Mapourdit -Aguran at Lakes State.

4.5.2.1 Catchment Areas and Administrative Structure

The proposed rural road project influence areas fall under the local administration of the West Yirol County, Lake State, and South Sudan. The project section links two Payams, namely Aluakluak and part of Nguam Payam/Mapourdit Boma. There are a sheer number of villages adjacent to and at certain distance from the proposed road section.

4.5.2.2 Socio-economic characteristics

The target communities under the proposed road project’s influence areas have homogeneous socio-economic characteristics.

4.5.2.2.1 Social Characteristics

The communities under the project influence area are dispersedly settled into clusters of villages along the proposed road-side, and some at a certain distance of about ½- 1 hour walk on average. The socio-economic team could not find any statistical information at the Payam or Boma level that can be used as benchmarks for comparisons. According to a local Boma chief, each village cluster has an estimated average of 20-30 households. The only statistical data the team could access isthe SORUDEV State level baseline survey, which is assumed to equally apply at Boma or village level. Accordingly, the average household size is 7.2 persons. The total population is composed of 49.6% male and 50.8% female.

According to the baseline study, a majority of household members (79.6%) were nuclear family members, 20% extended family members and 0.4% workers or non-relatives living within the same homestead.

Based on Key Informant Interviews (KII) and Focus Group Interviews (FGI) the local community under consideration has poor and inadequate access to rural service and infrastructure. The Boma level primary school and health facilities are poor in quality and scope of service.

According to information from the local health officer, women and children are the most vulnerable group to disease. The most common diseases are malaria, typhoid, skin disease and headache. There exist one catholic mission run hospital and a secondary school in Mapourdit Boma, Nguam Payam, which serve the communities in the project influence area. The hospital services extend to the various Bomas, Payam and county under the jurisdiction of Lake State, and admit outpatients and referral from Western Equatoria State and Warrap State. As indicated in **Table 4.5-1**, the communities have to cover an average of 17.6km and 8.65km distance to access the Mapourdit hospital and secondary school services respectively.

Both school-boys and girls are assumed to have equal opportunities to education. The SORUDEV baseline report indicates that 39% of those of school going age have access to education. However, education studies have found that distance to school and the opportunity cost of enrolling a child to school are negatively correlated with child (particularly girls) school enrolment rates. According to the local education inspector, early girl child marriage, the distance covered and household labor-burden on girls negatively affects female access to education.

The largest segment of the local people has no social assets of great significance such as bicycle, animal-drawn cart, radio, motorbike, donkey, radio and telephone. Footing is the leading means of transport, readily followed by bicycle-ride and motorbike.

4.5.2.2.2 Food Security and Livelihood

Agriculture is predominantly the major means of livelihood for the target communities. According South Sudan Infrastructure Action Plan study (IAP) by AfDB (2013) 87% of Lakes State households primarily rely on agriculture and livestock. Based on the SORUDEV baseline survey, traditional crop production and pastoralism support 75.8% and 14.9% of the households respectively. Most households do not access basic productive assets such as ox-ploughs, extension services, improved seed, fertilizer and pesticides. Sorghum, finger millet, groundnuts and simsim account for the most important staple crop production. The crop farming is at subsistence level due toa number of agricultural constraints, lack of rural transport infrastructure being among the major challenges.

According to the SORUDEV baseline survey, 64.6% of households are fairly food secure. A few households (4.4%) base their livelihood on employment, and 2.9% generate means of living from small businesses. 0.4% of the households subsist on fishing, 0.4% on casual labor and 1% on relief/remittances.

4.5.3 Key Findings of the Socio-economic Assessment (SEIA)

The impact assessment studies how poor rural transport infrastructure seriously affects the rural households' poverty, agricultural production and food security. The study conducts descriptive analysis on how the rural road investment intervention promotes food security, builds resilience and improves the local livelihoods.

4.5.3.1 Poor Rural Road as Key Driver of Rural Food Insecurity

99% of the rural people under road project influence rely on rain fed subsistence agriculture (AfDB/IAP, 2013). The SORUDEV baseline survey reports that the majority (64.6%) of households are fairly food secure, and 27% poorly secure. 38.8% of the households engage in crop sale as their primary income generating activity while 34.2% of them on livestock sales. The

heavy reliance on the precarious nature of rainfall, manual labor with rudimentary farm tools and other potential constraints entail high risk of crop failure. This phenomenon, coupled with poor rural infrastructure, worsens rural food insecurity, resilience and livelihoods. The lack of road infrastructure drives rural poverty in direct and indirect dimensions:

Poor transport access to basic services
Rural service and infrastructures are extremely poor and inadequate in the project vicinity. The subsequent rural remoteness in spatial, physical and social terms are translated into high cost of travel, time and distance covered to access basic services, perpetuating rural poverty. The local people perceive poverty in terms of the distance covered to reach the basic social services.

Table 4.5-1: Access to Basic Services: DistanceCovered to Basic Service: Per person/trip

S.r	Basic Service access	Code	Unit	Average Distance (km)	Number of Trips	Total Avg.Distance (km)	% of Average totaldistance covered
1	Boma Head Quarter	BHQ	Km	1.625	2	3.25	6%
2	Payam Head Quarter	PHQ	Km	7.3	2	14.6	28%
3	Primary Health Care	PHCU	Km	0	2	0	0%
4	Health Center	HC	Km	3.6	2	7.2	14%
5	Mapourdit Hospital	MPHSL	Km	8.8	2	17.6	34%
6	Water Supply point	WSP	Km	0	2	0	0%
7	Primary School	PSCL	Km	0	2	0	0%
8	Secondary School	SSCL	Km	4.325	2	8.65	17%
	Average total			**25.65**		**51.3**	**100%**

Table 4.5-1 shows that the target community travel the farthest **average** distance **(17.6km)** to access Mapourdit hospital, followed by Payam head quarter **(14.6km),** secondary school service in Mapourdit (8.65km), health center (3.25km) and Boma head quarter(3.25km)**.** The drinking water, primary health and education services are at the shortest distance, less than 1km or at homestead (0km). Potable water supply points are available almost at a settlement cluster level, while primary health care and education access are witnessed at every Boma level. The social services have inadequate scope and quality of service delivery, and provide services to widely scattered population at the project influence areas.

Education: various social studies showed that illiteracy, measured by the population age 15 with no education, is more prominent in regions where the distance to primary schools is more than 2kmfrom homesteads. The studies have found that distance to school and the opportunity cost of enrolling a child to school all correlate negatively with child (particularly girls) school enrolment rates. In this regard, the SORUDEV baseline reports of 39% of school going age children accessing education, and a 66.9% level of illiteracy at the project influence area can be potential indicators. Table-1 shows that the distance to secondary school is **14.6 times** greater than to primary school. This scenario is more complicated when the post-primary child grows between 14 to 15 years old, since age of going secondary school also corresponds tothe critical age of joining the farm labor force. The child's enhanced opportunity cost of attending secondary school impairs the chance of child education, which ultimately impedes the development of human resource capacity. It is worth noting that the child post-education contributes to entrepreneurship

skill development such as better crop husbandry, agro processing technique and marketing skill. The low level of post-primary education, therefore, confines rural households into food insecurity and a poverty cycle.

Health service is crucial for households and community stability. The most disease vulnerable groups are women and children, which constitute for about **80%** of the farm Labor (AfDB/IAP, 2013). Access to health service is more important at the time of agricultural season, when the occurrence of diseases is critical. Poor access and quality of health delivery coupled with disease seasonality adversely impact active farm labor availability and productivity, i.e. women are the most disease -prone group. As noted in Table-1 above, the distance to the hospital is 17.6 times greater than to the primary health care. This situation reflects the high demand of effort, time and cost of hospital travel. The following **Table 4.5-2** depicts the time spent to access the social services.

Table 4.5-2 Access: Average Time Spent Per person-Footing

S.r	Basic Service access	Acr	Unit	Average per capita time spent	% of Per head daytime working	% of average total time
1	Boma head Quarter	BHQ	hrs	2.16	27%	7%
2	Payam head Quarter	PHQ	hrs	4.48	56%	14%
3	Primary Health Care	PHCU	hrs	3.2	40%	10%
4	Health Center	HC	hrs	2.48	31%	8%
5	Mapourdit hospital	MPHSL	hrs	8	100%	25%
6	Water Supply point	WSP	hrs	1.2	15%	4%
7	Primary School	PSCL	hrs	2	25%	6%
8	Secondary School	SSCL	hrs	8	100%	25%
	Average Total			**31.52**	**394%**	**100%**
	Average Total			**3.94**		

Source: Annex 2

In **Table 4.5-2**, it can be noted that the local people walk for 4 to 8 hours to access hospital and secondary school services. The longest hours to the hospital involves high cost of transport and energy to the community, in particular for the most disease susceptible group. What is more, the longer the distance to health services, the higher the likelihood of households resorting to alternative, poor quality health services, and dropping out post-primary education.

Persistent diseases generate spill-over to social and economic costs, in particular among women. The SORUDEV baseline survey found that 26.2% of farm labor shortage is due to human disease, thus representing as key constraint for increasing cultivated land area and production. This scenario is indicative of the fact that poor rural road infrastructure adversely affects households' food security.

The majority of households have neither non-motorized nor motorized transport service access. Walking to long distances to access services is painstaking. A few local motorbike owners provide transport to the local community. As depicted in table-3, access to basic services costs are high. Indeed, a two-way trip to the hospital costs SSP 38.5, while a round-trip to the secondary school SSP 18.5, to primary health care SSP 6 and to the Boma head quarter SSP

5.5. Given the fact that 49% of the community at the project influence area lives below the poverty line (5th SPHC, 2008), the transport tariff rate can be classified as extremely high. The low quality of rural services leads to shortage of healthy and productive human resources, which in turn engulfs the community into poverty and food insecurity.

Table 4.5-3: Passenger transport cost/motor bike to basic services

Basic Service access	Acr	Unit	Average Cost /T/head	Number of Trips	Total Aver cost	% of average total cost
Boma head Quarter	BHQ	trip	2.75	2	5.5	6%
Payam head Quarter	PHQ	trip	9.25	2	18.5	19%
Primary Health Care	PHCU	trip	3	2	6	6%
Health Center	HC	trip	6.25	2	12.5	13%
Mapourdit hospital	MPHSL	trip	19.25	2	38.5	39%
Water Supply point	WSP	trip	0	2	0	0%
Primary School	PSCL	trip	0	2	0	0%
Secondary School	SSCL	trip	9.25	2	18.5	19%
Average total			**49.75**		**99.5**	**100%**

Domestic Social Security is a major issue contributing to 25.9% of the key challenges to crop production and marketing in the area (SORUDEV BLS, 2014). Rampant inter-communal violence is evident. Opportunities for peace-building interventions and the promotion of social harmony and stability at the community level are hindered by inadequate transport infrastructure, in particular the rural road network.

According to the baseline survey conducted, the lack of transport infrastructure is one of the major challenges (25.8%) to rural food security and development in the proposed road project areas.

Poor market and Productive Sector Access

Access to markets and the productive sector is key to enhancing rural farmers' income, food security and poverty alleviation. The lack of transport infrastructure is automatically translated into huge transaction costs of production and marketing for the rural community. Small farmers experience subsistence production levels. Households are badly in need of basic productive assets such as seeds, farm tools, extension service, micro-credit fertilizers and pesticides at the onset of every farming season (May-August). Extreme transport costs to markets directly undermine households' livelihood activities and food security.

Small farm holders' own crop produce meets only an average four months (September-February) of the household's cereal food consumption needs. As such, rural households heavily rely on market supply for ¾ of their food crop consumption needs during critical hunger periods (March-July). First-hand information acquired from the target farmers in the field shows that market recourse is quite limited. Potential market options vary seasonally and spatially. The Juba market place, national central market, is the most important/First Option destination for agricultural outputs, inputs and basic consumer goods. The poor transport and road infrastructure considerably restrict small-holder households' connection to the Juba central market. During the rainy period, the main Juba-Yirol trunk and the Aluakluak-Mapourdit feeder road routes are impassable. The blockage of primary market routes denies communities accessibility to basic food consumption needs and economic services at time of critical demand. The interplay of the market drives up transport costs of market travel, commodities purchase and freight.

Table 4.5-4 reflects passenger travel and freight transport costs. The below-stated transport costs consider only travel costs from the target village to the Aluaklauk trunk road junction point. Since the transport transaction along the main trunk road is beyond the scope of this rural road project. The figure in the table indicates that the cost of passenger travel to the first-option market has surged up by three-digits **(104%)** in the rainy season, and freight cost has similarly increased at more than double rate **(148%).** The Munduri market is the second option during the rainy season as the Aluakluak - Mapourdit surface road is apparently in a good enough state to access. Passenger and good transport costs have shown equal rise by 37%.

Table 4.5-3: Average Transport Cost to Market Option: Passenger and Good(50Kg), in SSP

S.r	Season	Market Option-1 motorbike		Market Option 2 motorbike	
		Passenger	Good	Passenger	Good
1	Dry	27	35	30	40
2	Rainy	55	75	40	50
	Total	**82**	**110**	**70**	**90**
	Average	**41**	**55**	**35**	**45**
%	**increase**	**104%**	**148%**	**37%**	**37%**

Source: Local Boma chiefs and business owners' data from field

Table 4.5-4: Staple food crop/Sorghum/ Purchase Market Price/Kg

S.r	Season	Unit	Option-1	Option 2
			Sorghum	Sorghum
1	Dry	1Kg	2.25	2.8
2	Rainy	1Kg	3.2	5
	Total		**5.45**	**7.8**
	Average		**2.725**	**3.9**
			0.95	2.2
%	**increase**		**4%**	**8%**

Source: Local Boma chiefs and business owners' data from field

The combination of high market food dependence and heavy rainfall generates high risk of food insecurity, vulnerability and poor livelihoods. During dry season, staple food, cereal and sorghum prices usually reduce by approximately 4% and 8% at first and second option markets respectively (refer to table-4). As can be seen in table 4.5-4 during the rain season prices significantly increases. At the first market option, the rapid food price rise seriously reduces poor households' food purchase power by 30%, from 44 kg to 31 kg of sorghum; at the second market option, the food purchase power drops by 18.2%, from 36 kg to 20 kg of sorghum. The project influence area recorded serious levelsof acute malnutrition (GAM: 10%), below WHO's emergency thresholds (GAM>15%). This can be attributed to reduced food consumption and other factors such as disease, poor dietary intake, feeding practice and poor health service delivery. The SORUDEV baseline survey indicates that 54.5% of households take two meals, 22.8% one meal and 20.5% three meals a day. These looming socio-economic conditions are potential indicators of the realities of poor rural road networks as a primary driving force of rural food insecurity, poverty and low livelihood status.

4.5.3.2 Poor Rural Road as Key Driver of Low Rural Livelihood Status

According to the SORUDEV baseline survey, the key food security coping mechanisms for the households are 40.1% livestock sales and 13.5% personal asset sales. Feeder road access to the market is poor during the critical food insecurity periods in parallel with the heavy rainfall season. The assets selling prices also dramatically decline at the peak lean season (June-July) due to increasing market supply of the smallholders commodities to buy their household cereal food consumption needs. **Table 4.5-5** indicates that goat sale prices decrease by 29% and 40% in market option 1 and option 2 respectively during the rainy period.

Table 4.5-5: Goat Market Sale Price

S.r	Season	Unit	Market Option-1			Market Option-2		
			Dry	Rainy	% Price decrease	Dry	Rainy	% Price decrease
1	Goat	Head	350	250	**29%**	250	150	40%

Source: Local Boma Chief and FGI

This situation drops the goat to sorghum Term of Trade (TOT) and puts poor households in disadvantaged positions in terms of the amount of sorghum they can get by selling a goat. It implies that the small farm holder's goat to sorghum term will drop from 156 kg to 89 kg of sorghum for a goat sold in peak hunger season.

Poor roads, shortage of transport means, long distances to market and lack of market information respectively constitute 12.6%, 25.8%, 20.9%, and 15.9% of the key agricultural marketing challenges facing the small-scale farmers.

4.5.4 Socio economic Impact of the Rural Road Investment

Empirical models revealed that rural services, infrastructure and agricultural productivity have strong positive correlation with increases in food crop(s) production, household level food availability and livelihoods. The study will discuss the effect that each category of improved rural road infrastructure and services has on rural agricultural productivity, incomes and food security.

4.5.4.1 Connectivity Role of the Road Network

Rural feeder road condition and scope of connectivity have a direct impact on smallholder farmers' social services, market access, economic opportunities and trade objectives.The proposed access road shall play a critical role in high profile inter- and intra-connectivity at the community level. The road construction bears great potential of linking:

- A number of villages to their respective Boma/smallest administrative units;
- Bomas to their respective Payam head quarter/Aluakluak;
- Bomas to central basic social services access areas(Mapourdit Boma/Ngom Payam)
- Villages to the Rumbek-Yirol-Juba main road at Aluak-Luak junction, including connections to potential marketplaces further afield.

The target households will be well connected to the potential markets. See Table 4.5-6 for the route of connectivity to the primary market options.

Table 4.5- 6: Connectivity to Potential Market Options: Road Project Influence Areas

S.r	Target Village	Market Option-1				Market Options-2			
		Dry Season		Rainy season		Dry Season		Rainy Season	
		Road Route	Distance (Km)	Road Route	Distance (Km)	Route	Distance (Km)	Route	Distance (Km)
1	Aluakluak	1	NA	2	NA	NA	NA	NA	NA
2	Agany	3	5.7	4	30.7	NA	NA	NA	NA
3	Mabui	3	5.7	5	119.5	7	+18.5	5	119.5
4	Mapourdit	6	19	5	119.5	7	+18.5	5	119.5

Source: Local Boma chiefs and FGI

Note: the numbers under the road route column in table 4.5-6 denotes as below:

1. Juba - Yirol-Aluakluak
2. Mundri – Mvolo – Mapourdit -Aluakluak
3. Juba - Aluakluak-Agany
4. Mundri - Mvolo-Mapourdit-Agany
5. Mundri - Mvolo-Mapourdit
6. Juba - Mvolo-Mapourdit
7. Juba – Yirol – Aluakluak-Mapourdit

Table 4.5-7: Comparison of Market access time: Before and After Project

S.r	Target Village	Market Access (Time in hours)		% Time Saving
		Before	After	
1	Aluakluak	3	0.4	-60%
2	Agany	2	0.36	-64%
3	Mabui	0.45	0.11	-89%
4	Mapourdit	0.15	0.07	-93%
	Average			-77%

Source: Local Boma chiefs, March 2015

The feeder road connectivity is expected to drop access time to the potential market by an average of 77%. This is a good indication of the high advantage of reducing the cost of transportation, purchasing farm input, producing and gaining better rural services which collectively enhance rural food security, income and livelihoods.

There exists no established baseline information on the use of social services. Based on general consensus, it is believed that the closer the service center, the more rural farmers will make use of it.

Based on the study findings the connectivity is expected to meet significant rural service impacts, which can be expressed later in quantifiable indicators. The lack of established benchmark, time series data and sufficient socio-economic data make the pre-projection difficult.

S.r	Key Impact Indicators
1	Increase in number of feeder road users- local people
2	Increase in volume of non-motorized and motorized-traffic
3	Increase in number and frequency of people access to market
4	Number and frequency of public transport travel
5	Volume of agricultural output and inputs transported to and from
6	Number of community awareness raising activities and capacity building training conducted
7	Number of local administration and community meeting
8	Volume of agricultural produce at market collection centers
9	Volume of consumer goods traded to and from the areas
10	Number of new business establishment at the areas
11	Number of new employment opportunities

The high degree of road investment driven linkages will create, develop and foster substantial momentum of social interaction, social security, safety, inclusiveness, unity, integrity, collaboration, communication, equal and balanced distribution of resources and opportunities. The impetus indispensably supports strengthening of local leadership and organization, economic empowerment of small farmers, better access to market and institutional support, sharing and dissemination of marketing knowledge, skill and information. The transformation process promotes increasing agricultural production, innovative entrepreneurship, rural poverty alleviation, food security and sustainable livelihood development.

4.5.4.2 Social and Gender Development

Education and health services are important for enhancing the quality and hence productivity of human capital. The investment on road infrastructure is the local need-tailored response to address the alarming social and gender issues in the proposed project area. Lifeline services, already limited in scope, are barely accessible by local communities due to the lack of transport facilities. Attempts to reach central services entail huge costs, time and effort for the local communities. A responsive rural feeder road network is a core solution to life-threatening social and gender concern.

4.5.4.3 Social Analysis

The rural feeder road project is expected to play a critical role in improving the social development of target communities. The travel-time saving and short distance covered represent the key direct social impacts. The construction of the feeder road is anticipated to dramatically decrease access time to basic social services. After the project, the target communities' average access time to rural services is expected to fall by 93%, assuming the former Sudan 45km /hour speed limit for public transport moving on rural rough road network is maintained.

Table 5: Comparative Time-spent before and after project

S.r	***Basic Service access***	***Acr***	***Unit***	***Average Distance***	***Before Project Av time spent/trip***	***After Project-Car Expected Av time spent/trip***	**% Decrease in Time-spent**
1	*Boma head Quarter*	*BHQ*	*hrs*	*1.6*	*2.16*	*0.03*	-97%
2	*Payam head Quarter*	*PHQ*	*hrs*	*7.3*	*4.48*	*0.16*	-84%
3	*Primary Health Care*	*PHCU*	*hrs*	*0*	*3.2*	*0*	-100%
4	*Health Center*	*HC*	*hrs*	*3.6*	*2.48*	*0.08*	-92%
5	*Mapourdit hospital*	*MPHSL*	*hrs*	*8.83*	*8*	*0.2*	-80%
6	*Water Supply point*	*WSP*	*hrs*	*0*	*1.2*	*0*	-100%
7	*Primary School*	*PSCL*	*hrs*	*0*	*2*	*0*	-100%
8	*Secondary School*	*SSCL*	*hrs*	*4.325*	*8*	*0.1*	-90%
	Average Total			***25.655***	***31.52***	***0.57***	**93%**

Source: Consultant aggregation from KII and FGI

4.5.4.4 Gender Analysis

The time factor is among the major challenges for girl-child education in the area. The girl-child is culturally overburdened with household activities. The length of time taken to reach school has automatically resulted in girl school denial or drastic dropouts. Shorter travel times to school encourage significant school-age girl enrolment.

Rural road investment is vital mechanism of promoting gender equality and development. Indeed, the girl child's education is a dynamic tool for positive attitudinal and behavioral change on the local socio-cultural context, encouraging sustainable community development. The post-primary female student drop out is expected to be less than the school's reported rate of 30% at Mapourdit Secondary school.

4.5.4.5 Food Security and Livelihood Analysis

The rural road network intervention significantly contributes to poverty reduction, food security, community resilience, peace building and sustainable livelihood development. The project's benefits are widely felt in direct, indirect, induced and generated dimensions.

4.5.4.5.1 Food Security and Livelihoods

Part of Northern Bahr el Ghazal, Warrap, Unity and Lake States lie on the Western Flood Plains' agro-ecological zone, which is identified as the most important livelihood zone in terms of cropland distribution at the national level. The zone represents 34.2% of the national cropland and 24.2% of the national cropland mixed with grass and tree. This zone records the highest ratio of cropland over total land (Diao et al. 2012).The road project area is thus part of the country's most important livelihood zones. **75.8%** of households primarily rely on traditional crop farming. In spite of the vast potential agricultural land, smallholders cultivate only small farmland. Households' average cropland holdings is limited to 2- 3 feddans.

Among other factors, the SORUDEV baseline report has shown that the shortage of labor is a critical challenge (**22.9%)**. Family members (women and children) are the potential source of manpower for expansion of cropland cultivation. As indicated in Table 5 above, 93% of the average time–saving gained from improved transport access is anticipated to be productively invested on increasing farmland plantation and production, assuming no seasonal opportunity cost of marginal rural labor is forgone elsewhere in the economy. This is expected to ensure households' food self-sufficiency, which currently stands only at 56.6% of the consumption needs (SORUDEV BLS, 2014). This indicates that household crop production will increase by **43.4%.**

The feeder road construction project is also expected to reduce passenger ticket price by an average of 84%. The effect is anticipated to positively influence small farmers' accessibility and mobility to potential market places and productive activities.

Table 4.5-6: Comparative Transport-cost Before and after project, in SSP

S.r	Basic Service access	Acr	Unit	Average Cost Before Project	Expected Cost After Project	Expected Decrease Passenger Av. Transport cost
1	Boma head Quarter	BHQ	trip	5.5	1.92	92%
2	Payam head Quarter	PHQ	trip	18.5	8.76	97.4
3	Primary Health Care	PHCU	trip	6	1.2	20%
4	Health Center	HC	trip	12.5	4.32	65%
5	Mapourdit hospital	MPHSL	trip	38.5	11	71%
6	Water Supply point	WSP	trip	0	0	0
7	Primary School	PSCL	trip	0	0	0

8	Secondary School	SSCL	trip	18.5	5	78%
	Total			**99.5**	**32.2**	
	Average Travel cost			**12.4375**	**4.025**	**84%**

Table 4.5-7: Comparison of Staple Crop Production: Before and After Feeder Road Operation

Cultivated Crops	Av.Farm use(ha)		Av yield [ha/HH/ton]	Average total Production		% increase
	Before Project	After Project		Before PROJECT	After PROJECT	estimated Pxn
Groundnuts	0.83	0.97	0.104	0.08632	0.10088	**0.17**
Sorghum	1.11	1.3	0.168	0.18648	0.2184	**0.17**
Maize	0.4	0.46	0.31	0.124	0.1426	**0.15**
Finger Millet	0.61	0.71	0.31	0.1891	0.2201	**0.16**
Total	**2.95**	**3.44**		**0.49958**	**0.5811**	**0.16**

Source: Estimated based on local Boma Chief and Farmers Information

The construction and maintenance of the rural feeder road is expected to increase smallholder farmers' staple crops production volume. As shown in Table 4.5-7, sorghum and groundnuts harvest, which are the most predominant staple food crops, are anticipated to rise by 17% each in the first year of the intended rural feeder road use/operation. Meanwhile, finger millet and maize are predicted to increase by 16% and 15% respectively after the start of the road. This promising increase in production can be attributed to the road connectivity ensuring better access to markets, combined with improved seed variety, cheaper farm tools and implements, extension support, innovative farming knowledge and skills, marketing information, agribusiness and trade development initiatives. The combined impact is expected to increase farmers' income, food security, nutrition and sustainable livelihoods.

4.5.4.5.2 Market Access and Livelihood

Access to the potential market destination stimulates small farmer productivity and income from increased volume of agricultural product sales. The market access creates its own supply, empowering the small farm holders economically, building self-esteem and innovation.

Table 4.5-8: Summary of Staple Crop Net Production Surplus (tons)-Five Years Projection

Cultivated Crops	Five year Projection Staple Crop Surplus Production Summary (Y1-Y5)-ton					Total Surplus Production	Post Harvest Loss (20%)	Net Surplus (ton)
	Y1	Y2	Y3	Y4	Y5			
Finger millet	526	570	718	617	643	3074	614.751	2459
Sorghum	1203	935	1865	1013	1055	6071	1214.142	4857
Maize	766	770	1051	835	869	4292	858.317	3433
Groundnuts	1213	1134	1680	1228	1279	6533	1306.691	5227
Total	3707	3409	5314	3694	3845	19970	3993.902	15976

Source: Aggregated Projection by Study Team

The above production projection is based on logical assumptions that the project influence areas lay on the most agricultural potential agro ecological zone of South Sudan, achievements of the strategic objectives of better access to extension, improved farming practices (animal traction) and farmers organization project under SORUDEV program, the feeder road induced anticipated opportunities and the general principles of supply creates its own demand.

Table 4.5-9: Cost of Farm Production: After the Project

Cultivated Crops	Av Farm use(ha)	Production cost per hectare	Total cost of production, in SSP	Av yield farm cultivated	Unit cost estimate of production(Qt)
Groundnuts	0.97	1575	1528	0.10	15144.2
Sorghum	1.3	1575	2048	0.22	9375.0
Maize	0.46	1575	725	0.14	5080.6
Finger M	0.71	1575	1118	0.22	5080.6
Total Cost	**3.44**	**6300**	**5418**	**0.68**	**34680.5**

Source: Estimation by Study Team

Table 4.5-10: Small farm holders' Projected Net Income (5Years): After Rural Feeder Road Operation

Cultivated Crops	Net Surplus(ton)	Average Sales (SSP)	Total Cost (SSP)	Total (SSP)	Net Income (SSP)
Fingermillet	2,459	19	46,721	66586.54	-19,865
Sorghum	4,857	21	101,988	41220.24	60,768
Maize	3,433	19	65,232	22338.71	42,893
Groundnuts	5,227	62	324,059	22338.71	301,721
Total	15,976		538,001	152,484	385,516

Source: Estimation by Study Team

The net income projection is calculated based on the crop prices prevailing at the first option market. The improved feeder road infrastructure is expected to step down high farm operation costs, gain economies of scales and encourage farmer organizations and collective marketing. As noted in Table 4.5-11, small farmers face a mild loss of finger millet sale (SSP 19,865) in the first five years of operation. This can be related to the fact that finger millet accounts for the lowest cropping pattern. The farmers are predicted to have gained a net income of SSP 385, 516 in the first five years of operations. There however seems to be a low margin of net profit in monetary terms, at least in the short-term. The short-term impact is low with great opportunities for development. In the short-term, low knowledge, skill and experience of farm management, market information, network, negotiation power and group organization are a major concern. However, the farmers' lessons-learned on market engagement are a worthwhile implicit benefit.

4.5.4.5.3 Institutional arrangement

The road project design and implementation frameworks meet the necessary institutional requirements. Rural food security and livelihood support initiatives rest at the forefront of the EU Aid program. The program pre-condition requiring alignment with host government's prioritized development policies, needs and plan of action are well met.

The government of the Republic of South Sudan (RoSS), endorsing the food and agriculture policy framework (2011-2016) and National Agriculture and Livestock policy, identified Food and

Agriculture development as one of the six top spending priorities in South Sudan's 2011-2013 Development Plan. These government policies and strategies are supportive of the EU's ZEAT BEAD programs.

The EU support terms also consider the broad coordination, consultation and communication requirements with potential stakeholders at all levels. Relevant actors, such as the State Ministry of Agriculture and Forestry, State Ministry of Physical Infrastructure, NPA -NGOS (operating on ground in particular), local county commissioner, Payam inspectors, Boma chiefs and community representatives at the grass-root level have been engaged in a practical, dynamic and interactive approach, throughout the proposed rural road project planning.

The road project's objectives comply with the strategic development policy and key partners' priorities. The EU's rural road construction at the proposed project areas is aligned with the EU's ZEAT BEAD program objectives of strengthening smallholder food security and livelihood.

The project design and implementation documents are produced as part of a professional ethics based logical and integrated approach.

4.5.4.5.4 Stakeholders Analysis

The project's key stakeholders are assessed to ensure successful design and implementation capacity**.**

4.5.4.5.4.1 Project Lead Body

United Nation for Project Services (UNOPS) is the lead UN agency on sustainable infrastructure development. UNOPS' vast experience in South Sudan coupled with high quality expertise in project management principles and practices ensures client-oriented, sustainable, logical and integrated project end-result.

4.5.4.5.4.2 Local Administration

The local administration has expressed commitment to support the project. The local commissioner, Payam inspectors and Boma chiefs shall take bold initiatives to coordinate, contribute and provide security throughout the project phase.

4.5.4.5.4.3 Relevant line Ministries

The State of Ministry of Agriculture and Forestry provides institutional support to farmers. In collaboration with potential development partners, the Ministry is involved in strengthening the smallholders' innovative labor-based farming techniques, introducing new seed varieties, and offering extension and marketing support by assigning extension workers at the county and Payam level. Increasing the numbers and building the capacity of extension workers is important to broaden and sustain the scope of service.

The State Ministry of Physical Infrastructure has no regular annual capital budget allocated for feeder road construction and maintenance, neither from the State nor National government. The Ministry's construction machinery and equipment are very limited and in a state of disrepair. The Ministry has a few qualified technical staff engaged in road and housing construction supervision. Furthermore infrastructure planning and design expertise is lacking. Building technical know-how is a major challenge.

4.5.4.5.4.4 Grass- root Community engagement

The local communities are homogenous in nature. They have strong culture of organization and leadership based on democratic process. The local chief, elders, youth, women and faith-based groups have responsibility and power of influence over community interests. Local development activities are practiced through community-based resources organized by the local leadership. Help-group farming, collective farming, community school and health construction/maintenance, access road pavement and periodic maintenance are witnessed. Yet the capacity remains limited in scope and work quality. Currently, the community-based groups are in charge of the Rural Blacksmith Center established by Norwegian People's Aid under the South Sudan Rural Development Programme (SORUDEV). The community-owned and run center provided local need-oriented ox-ploughing training, extension services, ox-plough blacksmith making and quality seed variety provision at fair prices.

4.5.4.5.4.5 Other Implementing Partners

The NPA is an existing implementing partner operating on the ground. NPA has an operational office in Rumbek and a Field office in Yirol. The partner has contributed to strengthening smallholders' animal traction and extension service under the South Sudan Rural Development Program (SORUDEV). The local community established groups have taken over the responsibility of control, managing and operating the facility. **NPA** is an international NGO that has built capacity of, and has experience working with, rural communities in Lakes State; this is particularly true with regards to implementing community based livelihood and food security projects.

4.5.4.5.4.6 Sustainability

The project design incorporates appropriate strategies encouraging community consultation, and active and full participation of local communities throughout the project cycle. The local communities' resources contribution to the project is a vital tool of building community-based sense of ownership and responsibility to sustain the project objective.

- At the project inception period, the target community should be committed to engage in consultation, identify community needs and priorities, and achieve clear understanding and willingness to accept the project implementation framework. In addition, the target community should ensure access to the road route, land for project camp, disclaimer of cost of compensation on settlement affected by the project implementation, and provide security and local construction materials.
- The implementation stage should facilitate the use of labour-intensive techniques to ensure local community involvement in the construction process. The approach not only creates local employment opportunities but also plays a great role in building a sense of local ownership and responsibility.
- The local community lacks material, tools, financial and technical resources to engage in sustainable maintenance of the road. Strong coordination, communication and collaboration strategies are required to strengthen the local community's capacity. The local authorities, in cooperation with line-ministries and other potential stakeholders, need to provide technical, material and institutional capacity building aligned with the local community resource mobilization and fund-raising.
- The proposed rural road project design includes a technical capacity building component on community based rural feeder road maintenance training to ensure sustainability.

4.5.4 Impact Monitoring and Evaluation Framework

The project monitoring and evaluation framework is a key mechanism for tracking the project's objectives' progress and achievement in enhancing the target smallholder rural farmers'

productivity, income, food security and sustainable livelihood. Based on the assessment key findings and project area-specific baseline data, the expected project impact monitoring and evaluation metrics are proposed.

1. Food Security Impact Indicators

S.r	Food Security Impact Indicator	Expected Impact Result
1	Cultivated farm area per household	Greater than 0.97 hectare
2	Staple crop-sorghum yield/ha	Greater than 0.7MT or 680 kg
3	Small farmers own food crop harvest stay	More than four months
4	Food secure number of HHs	More than 8.4% of the HHs
5	Fair food secure number of HHs	More than 64% of the HHs
6	Poor food secure number of HHs	Less than 27% of the HHs
7	Number of HHs taking two meal a day	More than 54.5%
8	Number of HHs taking one meal a day	Less than 22.8%
9	Number of HHs taking three meal a day	More than 20.5%
10	Number of HHs living on food relief	Less than 1%
11	Sorghum purchase price	Increase by less 4% in Juba market

2. Rural Marketing Indicator

S.r	Rural Marketing Impact Indicator	Expected Impact Result
1	Number of HHs selling crop at nearby market	Greater than 73%
2	Number of HHs selling crop at farm gate	Less than 25%
3	Number of HHs selling crop at central market	More than 2%
4	Farmer`s time taken to reach local market in State	Less than 2 hours
5	Number of farmers lacking market information	Less than 56%
6	Number of farmers accessing information	More than 44%
7	Number of farmers accessing information by market visit	More than 42.9%
8	Number of farmers selling through traders/brokers	Less than 26.7%

3. Rural Income Impact Indicator

S.r	Rural income Impact Indicator	Expected Impact Result
1	Number of HHs depending on labor income	Greater than 4.4%
2	Number of HHs spending/week	More than SSP 365
3	Average per capita consumption/month	More than SSP 203
4	HHs crop sales income per annum	Greater than SSP 1,543
5	HHs crop sale volume/at market collection center	More than 16.6% of HH harvest
6	Number of HHs selling part of their produce	More than 30.7 %
7	Goat to sorghum TOT	Greater than 156 Kg
8	HHs purchase power per SSP 100-sorghum	Greater than 44 kg
9	Number of HHs having mobile or other telephone	Greater than 23.2%
10	Number of HHs having vernacular radio station	Greater than 7.2%
11	Save travel time to access rural services	By 93%
12	Save passenger ticket cost	By 84%

4. Rural Agriculture Production Impact Indicator

S.r	Rural Agriculture Impact Indicator	Expected Impact Result
1	Number of HHs with shortage of farm labor	Less than 22.9%
2	Number of HHs with labor shortage- due to human disease	Less than 26.2%
3	Number of HHs with lack of farm tools and equipment	Less than 26.1%
4	Number of HHs facing animal threat to farming	Less than 8.6%
5	Number of HHs lacking farmland fencing	Less than 7.1%
6	Number of HHs with subsistent crop production satisfaction	Less 4 %
7	Number of HHs facing poverty to farm	Less 4.3%

4.5.5 Conclusion

Based on the assessment key findings, rural services and infrastructure development have a strong correlation with increasing rural agricultural productivity, income, food security and sustainable development. The rural feeder road construction and maintenance project is therefore well aligned with the EU's ZEAT BEAD and SORUDEV program objective of strengthening the smallholder farmers' production, employment and income through creation of market access and trade development. The proposed project is expected to reduce the farmers' transaction cost of producing and marketing their products by 84%. The project provides an anticipated major (93%) time-saving to rural services access such as health, school, market centers and productive sectors. The cumulative positive effect improves the rural community service access and quality, which significantly contributes to healthy and productive farm labor availability, improved pre-harvest and post-harvest crop management, better market information, use of improved farming techniques (ox-plough), improved seed, reduced cost of farm inputs, encouraging output prices, labor intensive agro-processing and microcredit facilities.

Therefore, the proposed rural feeder road construction is socially and economically viable in terms of combating rural poverty, enhancing agricultural productivity, income, nutrition and employment on inclusive and sustainable manner.

4.5.6 Recommendation

Based on the assessment findings Aluakluak is recommended as a commercially viable agricultural produce collection centre for distrubtion to regional market centres. It is a well-established rural market assembly with voluminous transactions, uniting people from the dispersed villages in the project influence area and outside the target counties (Western Equatoria State- Mundri) and is located along the main Juba – Yirol – Rumbek road.

Mapourdit village would be the ideal collection point to service local communities. The villages have an established market, a number of social and economic services and about 30-40 established retail shops.

Better provision of rural services is essential elements of attracting rural agribusiness, creating new rural market opportunities and growth. The increasing market expansion raises the demand and supply of private-led motorized transport services, which improve the rural income, employment and development.

4.6 Preliminary Engineering Design and Cost Estimation

4.6.1 Introduction

The Aluakluak - Mapourdit road was selected by the donor in Lakes State; the road is in Yirol West County and runs between Aluakluak and Mapourdit Payams – see Map 1 on project area. The route assessment was carried out on the 7th March 2015 jointly between the UNOPS team and representatives from the State Ministries of Physical Infrastructure and that of Agriculture and Forestry Resources. The objective of the mission was to:

- Assess the current condition of the road and come up with recommendations on the horizontal alignment of the road, height of embankment, gravel wearing course and the drainage requirements and prepare a cost estimate.
- Assess the sub-grade and geology of the materials along the road.
- Assess the environmental impact of the project.
- Assess the availability of construction materials along the route.

4.6.2 Methodology of the assessment

In order to gain first hand information of the project and appreciate the various issues needed for the study of the road, the team visited the project area on March 07, 2015.
During the site visit, the following maps and simple equipment and tools were used:

- Motor vehicle odometer;
- Hand held GPS to map way points;
- Measuring tape;
- Digital camera.

The assessment was conducted by driving along the existing track and stopping at sites where there were problematic terrain, problem soil areas, and construction materials sources and at other locations deemed necessary to gain firsthand information.

In addition, the team held discussions with local communities on various issues pertaining to the proposed project.

The existing route is just a track that has been used over time and meanders without any defined geometry through thickets and various villages. The assessment began by setting the vehicle odometers at zero in order to determine the length of the road as well as to pick distances to different villages and other important features. Table 4.6-1 below shows the distances (chainages) to the villages measured from the starting point.

Table 4.6-1 – Inventory of villages and important features

No.	Chainage	Village/feature
1.	0+000	Aluakluak junction with the Rumbek – Yirol road
2.	6+600	Agany Payam office
3.	12+800	Mabui Ox-plough center
4..	18+700	Mapourdit Catholic Church
6.	26+600	Aguran Village
7.	36+500	Ngop Village

GPS coordinates of all villages and important features were recorded as tabulated on Table 4.6-2 below and a horizontal profile plotted to show the alignment of the existing track. A design alignment was then developed from the existing track.

Table 4.6-2: GPS Coordinates for villages along the road

No.	Village/feature	Latitude	Longitude	Elevation	Remarks
1	ALUAKLUAK	6.474	30.099	428.836	CH0+000
2	AGANY MARKET	6.440	30.058	449.877	CH6+600
3	MABUI OX-PLOUGH CENTRE	6.390	30.060	467.933	CH12+800
4	MAPOURDIT MARKET	6.346	30.074	471.215	CH18+700
5	SWAMPY AREA	6.314	30.104	483.297	CH24+700
6	AGURAN VILLAGE	6.296	30.113	482.711	CH26+600
7	JUNCTION TO MVOLO	6.295	30.114	482.894	CH27+100
8	NGOP VILLAGE	6.267	30.164	458.597	CH36+500
9	YEI RIVER	6.265	30.176	459.889	RIVER BANK

4.6.3 Geometric Alignment

The existing route follows a track that has been used over time and meanders through the thickets and woodland. Two proposals for geometric design have been made as follows:

- A route that follows the existing track closely but connects many straight sections and takes into account horizontal curves as provided for in the South Sudan Low Volume Roads Design Manual (Sept, 2013). This alignment follows closely the existing track and hence it still has numerous curves, however, the terrain it follows is expected to be more or less similar profile as the existing track.
- A route that connects key control points/villages directly but deviates from the existing track hence could have a much different profile. This alignment has the advantage of being shorter, having better geometry and as such improving the safety and comfort in driving. However, the route has to be surveyed further as it runs further away from the existing alignment and could have a completely different profile and could be traversing private property that may require elements of compensation.

4.6.4 Existing Terrain

The general terrain along the route is flat and rises from Aluakluak to Aguran (gradient of about 0.2%) and then drops between Aguran and Ngop (gradient of about 0.28%) where the gradient slopes towards River Yei at Ngop village. The soils are generally sandy clay at Aluakluak to Mapourdit with clay soils characterizing the section between Aguran and Ngop. Given the flat nature of the terrain it is susceptible to flooding during the rainy season.

Fig. 4.6-1: Swamp at CH24+700

	
Existing road at CH 7+500	Typical vegetation along the Aluakluak – Mapourdit road.

4.6.5 Area of influence and land use

The area of influence extends from Rumbek, which is the State Headquarters, to Mvolo to the South and Yirol to the East. The major activities are small-scale agriculture, mainly for subsistence consumption and livestock keeping.

4.6.6 Population, settlements and town centers

The majority of the population is clustered around the main centers, mainly Aluakluak, Agany, Mapourdit, Aguran and Ngop. However, there are some scattered settlements along the road mainly between Aluakluak-Agany-Mapourdit-Aguran. The section between Aguran and Ngop is very sparsely populated. The main trading centers are Aluakluak, Agany, Mapourdit, Aguran and Ngop.

Fig. 4.6-2: Market at Agany village

4.6.7 Sub-grade, geology and materials availability

The general sub-grade from Aluakluak to Aguran is comprised of sandy clay and between Aguran and Ngop it turns into expansive black cotton soils. There was no detailed soil investigation carried out but from visual inspection the material available along the road section between Aluakluak to Aguran is good for embankment fill construction. However, detailed soil investigation will need to be carried out during the design stage to ascertain the CBR values of the available materials and their suitability for road construction.

There is an established gravel (murram) borrow pit approximately 6km west of Agany village that has been used for road construction. Two more locations were identified where there is potential for gravel materials availability. Further investigation needs to be carried out to establish the quality and amount of usable material available in all the three borrow pits. Table 4.6-3 below shows the GPS locations for the existing and potential borrow pits.

Table 4.6-3 GPS locations for existing and potential borrow pits

No.	Borrow Pit	Latitude	Longitude	Elevation
1	Existing borrow pit			
2	Potential borrow pit 1	6.317	30.099	482.880
3	Potential borrow pit 2	6.311	30.106	484.30.

Fig. 4.6-3: Existing borrow pit at Agany

4.6.8 Drainage structures

There are no existing drainage structures along the existing track, and while the general terrain is flat with a minimal gradient (0.28%) there is a swamp at CH24+700 and the gradient from Aguran towards Ngop drops more sharply (0.28%) than that from Aluakluak to Aguran. There are no hydrologic reports on the project area and the topographic maps available do not show any locations with waterways except for River Yei at Ngop. For that reason a provision will be made for the purposes of cost estimation for 900mm diameter steel pipe culverts for every 250m length along the road. Further hydrological studies will need to be carried out to establish the hydrology of the project area and determine the actual drainage requirement.

4.6.9 Design framework

The traffic surveys conducted indicated that the AADT for this section of the road is 130v/day and hence places this road on class DC4 according to the South Sudan low volume roads design manual guidelines hence a carriageway of 6.0m has been recommended and 0.75m wide shoulders making the embankment to be a total of 7.5m and 20m wide bush clearing for right of way.

Given that the terrain is flat and susceptible to flooding an embankment height of 600mm (on average) has been recommended; however, in some few cases where there are depressions the embankment height will be varied between 600-900mm. Detailed design of the vertical alignemnt that will determine the finished road level will be carried out during the detailed design stage.

Side ditches on flat terrains have not proved very helpful as they tend to pond water on the sides of the road rather than draining it to lower grounds. In this case only the section between Aguran and Ngop would be considered for side ditches.

4.6.10 Costing

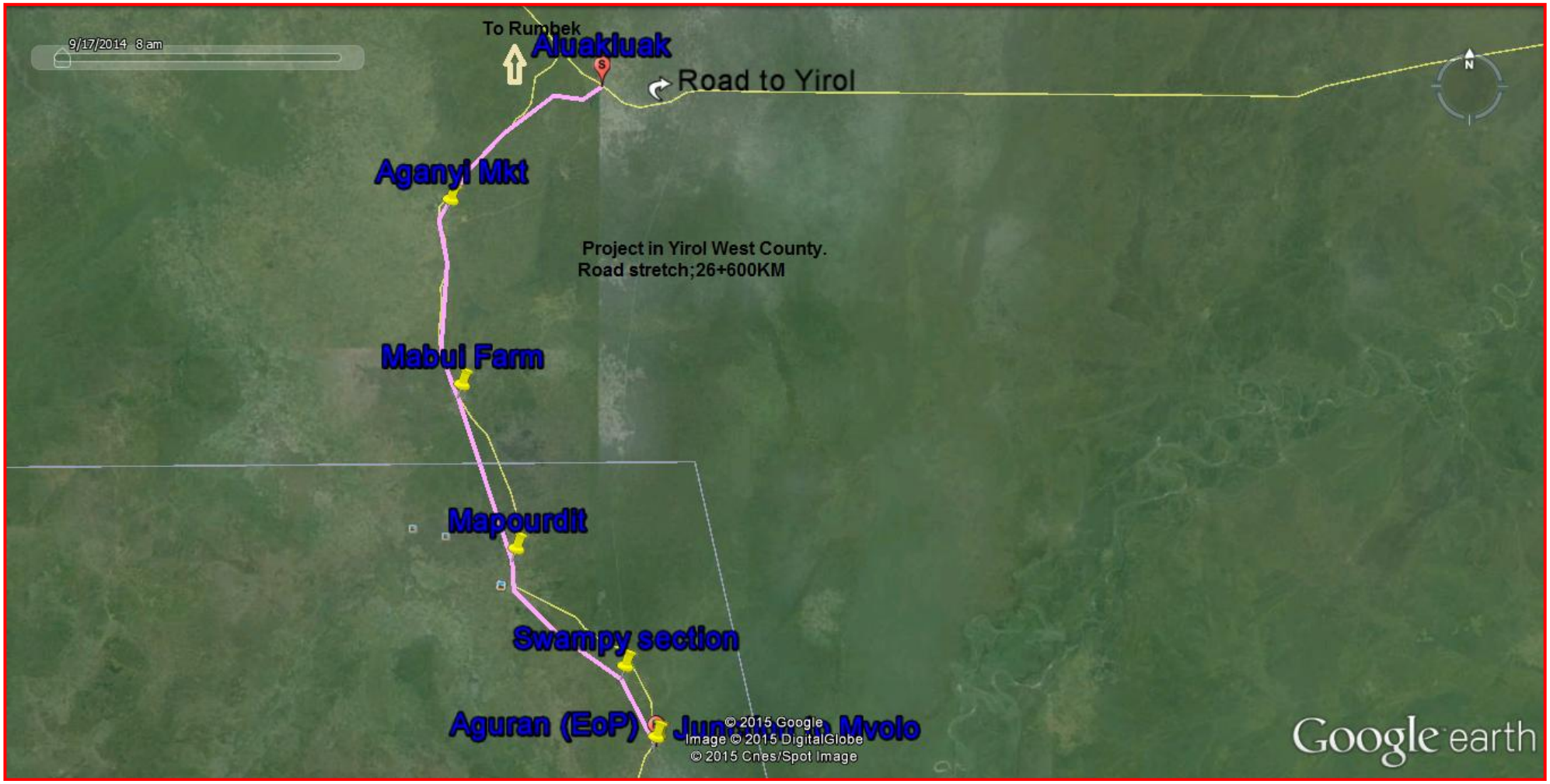
The proposed embankment will be raised using the insitu materials available on the sides of the road and it is envisaged that at least three borrow pits will be established along the 30km stretch of the road to make the maximum haulage distance to not more than 5km. A gravel borrow pit exists about 6km from Agany village and it is envisaged that this is the borrow pit that will be used to source the gravel wearing course. Two more potential borrow pits were identified and once detailed investigations are carried out to ascertain the quality and quantity of materials available in the potential borrow pits they will be considered for materials extraction for the gravel wearing course.

Due to lack of contractors currently operating in the State, the daily rental rates of machinery were obtained from the State Ministry of Physical Infrastructure and compared to the long-term agreements that UNOPS had for the same area and there was minimal difference hence adopted.

The summary of the estimated costs involved for the 26.7Km Alukluak-Mapourdit-Aguran is as follows:

Summary	Bill Group	Amount in USD
Bill 1	General	640,000.00
Bill 2	Site Clearance	231,506.45
Bill 3	Drainage	1,512,707.32
Bill 4	Earthworks	1,486,631.10
Bill 5	Gravel Wearing Course	200,000.00
Bill 6	Ancillary	134,150.00
Bill 7	Day-works	30,000.00
SUB TOTAL		***4,234,994.87***
Contingency (6%)		254,099.69
Sub total		*4,489,094.56*

MAP 1 - THE PROJECT ROAD MAP – ALUAKLUAK TO AGURAN



4.7 Economic Evaluation

4.7.1 Results of Economic Evaluation

The economic evaluation of the project road has been carried out using the RED Model. The Economic Internal Rates of Return (EIRRs) for the project have been derived by comparing 'with improvement' and 'without improvement' project options. The Net Present Values (NPVs) have been calculated at 12% discount rate. The results of the economic evaluation are summarized in **Table 4.7-1,** and the details of the results showing benefits and costs including the RED Model outputs are included in **Annex 3C.**

Table 4.7-1: Summary of Results of Economic Evaluation

Sl. No.	OPTION	EIRR (%)	NPV (USD million)	NPV/C	FYRR/C (%)
1	DC-2 Standard	N/A	-2.754	-0.94	0.12
2	DC-3 Standard	11	-0.255	-0.08	0.23
3	DC-4 Standard	14	0.323	0.09	0.25
Project Road (DC-4 With GWC Surfacing)		**13**	**14**	**0.323**	**0.09**

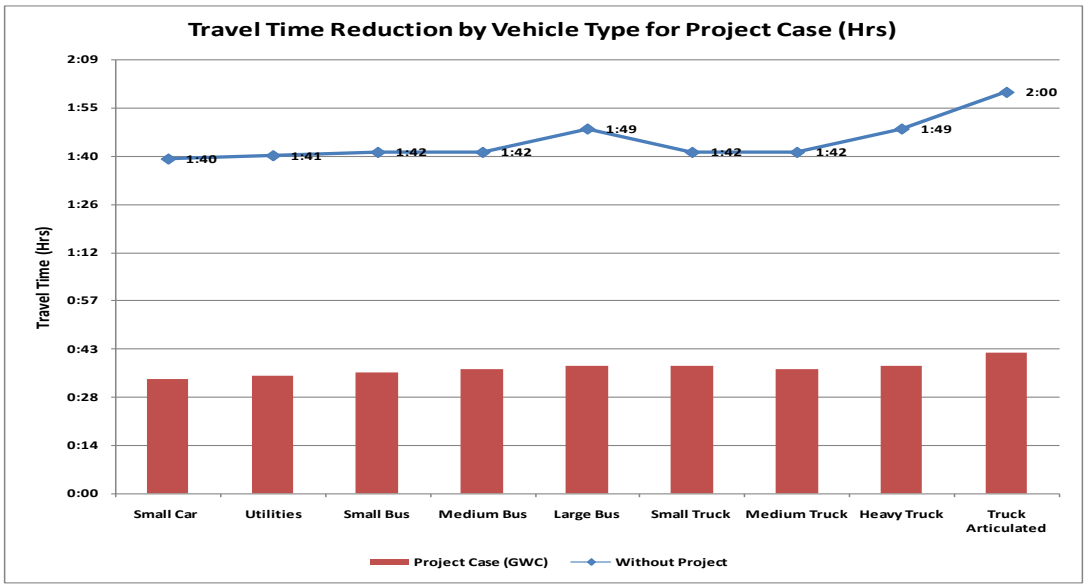
The improvement option is economically viable as the values of EIRRs for all sections of the road and the Project road are above the cut-off point of 12% set by the World Bank for the appraisal of infrastructural projects in developing countries.

A comparison of travel times was made to understand the effect of the project case in relation to the travel times being experienced by travelers as a result of poor access infrastructure available to the society. **Table 4.7-2** depicts the figures extracted from the RED Model while **Chart 4.7-1** has compared the results graphically.

Table 4.7-2: Travel Time Comparison between Without Project and With Project Scenario

Project Alternatives	Dry Season		Wet Season		Car	Four-Wheel	Bus	Bus	Bus	Truck	Truck	Truck	Truck
	Length (km)	Roughness (IRI)	Length (km)	Roughness (IRI)	Small	Drive	Small	Medium	Large	Light	Medium	Heavy	Articulated
	Traffic Composition (%)				19%	24%	15%	10%	3%	17%	8%	3%	2%
Without Project	**44**	**24**	**36.5**	**25**	**1:40**	**1:41**	**1:42**	**1:42**	**1:49**	**1:42**	**1:42**	**1:49**	**2:00**
Project **ALT-1: GWC**	36.5	10	36.5	10	0:34	0:35	0:36	0:37	0:38	0:38	0:37	0:38	0:42
	Travel Time Saving (HR)				**1:06**	**1:06**	**1:06**	**1:05**	**1:11**	**1:04**	**1:05**	**1:11**	**1:18**

Chart 4.7-1 Travel Time Reduction by Vehicle Type



The results indicate that travel times will decrease substantially with the Project Case for all vehicle categories. Every vehicle category has enjoyed a travel time saving of more than 1 hour; the largest coming from Truck Trailers. It is understood that the current state of the tracks does not allow such vehicles to be operated on them, however, under a hypothetical scenario where they could, then, the big trucks are the ones likely to suffer due to bad condition of the road. We note that almost all vehicles were able to make the trip in slightly less than 40 minutes under the project case.

4.7.2 Sensitivity Analysis

Investments in rural road projects, like any other investment, involve risks and uncertainties such as cost overrun, time overrun, traffic development, level of benefit realization, etc. The effect of these uncertainties has been evaluated under a Sensitivity Analysis, which involves recalculating the project economic evaluation results for different values of major variables. The traffic level (directly related to the benefits) and the project improvement cost are the two basic parameters, influencing the viability of the project. The Sensitivity Analysis has been carried out by varying the traffic and the improvement cost and reworking the costs and benefits analysis using RED Model for the following scenarios:

- Scenario-I Increase in cost by15% and base benefits;
- Scenario-II Base costs and decrease in benefit by 15%; and
- Scenario-III Increase in cost by15% and decrease in benefit by 15%.

The results of the Sensitivity Analysis are presented in **Table 4.7-3** incorporating the changes in variables Project Costs and Benefits. The details of the analysis, thus, obtained are given in **Annex 3C**.

Table 4.7-3: Results of Sensitivity Analysis

Sl. No.	Options		Base Case	Cost +15% (A)	Benefit – 15% (B)	A & B
1	**DC-2 Standard**	**EIRR**(%)	**N/A**	N/A	N/A	**N/A**
		NPV (mill.USD)	**-2.754**	-3.623	-3.210	**-4.079**
2	**DC-3 Standard**	**EIRR**(%)	**11**	6	5	**0**
		NPV (mill.USD)	**-0.255**	-1.250	-1.212	**-2.207**
3	**DC-4 Standard**	**EIRR**(%)	**14**	9	8	**3**
		NPV (mill.USD)	**0.323**	-0.751	-0.799	**-1.873**

4.7.3 Conclusions and Recommendations

Based on the results of economic evaluation and supported with the Sensitivity Analysis, the investment for the improvement of **Aluakluak – Mapourdit – Aguran** road to the DC-4 standard Feeder Road with GWC pavement has been observed to be economically viable. As such, the road may be upgraded to *DC-4 with 6m carriageway width and 0.75m shoulders each side, i.e.7.5m total width*.

The value of the EIRR is 14% for the project road, which is slightly higher than the cut-off point of 12% for similar projects in ROSS.

The Sensitivity Analysis shows that for all tested cases including the worst-case i.e. increase in cost by15% and decrease in benefit by 15%, the EIRRs are below the cut-off point. The risks identified should be mitigated during implementation, i.e. project cost should not be allowed to increase more than projected at the time of the feasibility study.

Improvement of the Project road as proposed, to Gravel Wearing Course standard, would impact positively upon the transportation costs, which include VOC savings, travel time savings to road users, better riding quality and maintenance costs savings for the road agency, i.e. South Sudan Roads Authority and State DRB. The investment in the project road would also impact positively on the overall socio-economic development of the project influence area, Lakes State, in particular.

4.8 Recommendations

4.8.1 Road Selection

The two options compared are Aluakluak-Mapourdit and the Aluakluak – Mapourdit – Aguran Sections. The section from **Aluakluak – Mapourdit – Aguran** (26.6km) is recommended for further project development and eventual implementation.

The MCA results that justified the selection are shown below.

LAKES STATE					
MULTI-CRITERIA ANALYSIS				SECTION	
S/n	Criteria	Total scores	Weight	1.1 Aluakluak - Aguran	1.2 Mapourdit - Ngop
1	**Connection of Farms to Markets**				
1.1	Number of farms located along the road section	2		2	1
1.2	Number of market centers located along the section	2		2	1
1.3	Extent of land suitable for farming (potentially)	2		2	2
1.4	Estimated population residing within the project corridor	2		2	1
1.5	Existence of agricultural activities in the region that will further develop with the road construction.	2		2	2
		10	2	**10**	**7**
		20		**20**	**14**
2	**Socio Economic Factors**				
2.1	Existence of social services such as schools, medical assistance, religious institutions, etc. that the road will provide better access.	2		1	2
2.2	Stability and security level	2		2	2
2.2	Road connection to higher population densities creating opportunities for local population	2		2	2
2.4	Level of motorized and non-motorized traffic operating on existing road	2		1	1
2.5	Presence of Payam and Boma Administration offices	2		2	2
		10	2	**6**	**9**
		20		**12**	**18**
3	**SORUDEV / ZEAT BEAD Partners**				
3.1	Activities of SORUDEV / ZEAT BEAD Partners are currently being Conducted in the region.	10		10	8
		10	**2**	**10**	**8**
		20		**20**	**16**

4	**Construction Feasibility**				
4.1	Estimated cost of construction	2		2	0
4.2	Requirement for a major bridge structure (bridge span)	2		1	1
4.3	Availability of Construction material (borrow pits, quarry, sand, water)	2		2	2
4.4	Likelihood construction operation will be affected due to instability in the area	1		2	2
4.5	Availability of skilled labour to be engaged in construction activity	1		2	1
4.6	Possible hydrological, geo-technical or subgrade material problems	2		2	1
		10	2	11	7
		20		**22**	**14**
5	**Sustainability**				
5.1	Community and Government is motivated to participate in the construction and maintenace program.	4		**4**	**4**
5.2	Development does not have significant adverse environmnetal impact (EIA)	4		**4**	**2**
5.3	Number of affected persons and properties (PAPs) due to the construction of the road (SIA)	2		2	2
		10	2	10	8
		20		**20**	**16**
	Total score/40			**47**	**39**
	Total score/100	**100.00**		**94.00**	**78.00**
	Priority Ranking			***1***	***2***

4.8.2 Maintenance Capacity Assessment

The feasibility study team conducted thorough consultation with relevant state government bodies and carried out site visits. The team assessed that the state MoPI has reasonable capacity in terms of availability of equipment and skilled workforce. However, it was evident that machinery breakdown and lack of funds is a major challenge hindering the road maintenance activities despite availability of capacity in terms of technical know-how and equipment. The recurrent inter communal clashes have also resulted insecure working environment in the state. Notwithstanding this, the State MoPI executes emergency maintenance activities through limited support from the state government.

4.8.2.1 Available Resources

The following resources are available in the state MoPI that could be engaged on road construction /maintenance activities

4.8.2.2 Road Construction/Maintenance Equipment

Equipment	Quantity	Condition
Motor Grader	2	1-breakdown,1-working
Excavator	2	1-brekdown,1-working

Wheel Loader	2	2-breakdown,0-working
Tipper trucks	4	2-breakdown, 2-working
Pedestrian Roller	1	1-working

Relatively new motor grader lies outside the MoPI offices due to lack of maintenance

One of the broken down front wheel loaders

Broken down tipper trucks

Broken down jeep for supervision

The team had learnt also that the State does not have an equipment maintenance workshop and barely has required maintenance tools and spare parts; this is hampering the State capacity to carry out routine and preventive maintenance of the available fleet of road building equipment.

4.8.2.3 Manpower

Staff	Quantity
Civil Engineer	1
Road Supervisors	1
Road Forman	1
Machine Operators	4
Tipper Trucks Driver	4
Mechanics	2
Pedestrian Roller	1

The State ministry is keen to adopt a labor based road maintenance approach as it is difficult to get adequate and consistent budget allocation from the national government for management and operation of road maintenance tasks using machine intensive methods, which is relatively a costly

exercise. In addition, the team learnt that GIZ IS initiated capacity building trainings on labor based road maintenance activities before the political crisis occurred in South Sudan in 2013; however, this program is no longer operational and GIZ did not return back after the crisis. UNOPS is trying to reach GIZ to understand the scope of the said training and if there were any identified maintenance groups (CBOs or small scale contractors) who benefited from the training and operations. UNOPS is keen to continue with whatever capacity was created by GIZ in relation tofeeder roads construction and/or maintenance programs.

4.8.2.4 Key Findings

The state Ministry of Physical Infrastructure has reasonable capacity and commitment to support the envisaged maintenance activity. However, the following key challenges are broadly considered as impediments for the state to adequately utilize the available capacity:

- Lack of funding/budget to support the planning, management and operations of road maintenance activity;
- Limited capacity of road technicians in construction and maintenance of rural roads;
- Insecurity in the state.

4.8.2.5 Recommendations

The following recommendations are made as shown hereunder:

- Considering the tangible commitment witnessed from the state MoPI, UNOPS is keen to adequately engage the state MoPI during the construction and maintenance period of the Aluakluak-Mapourdit-Aguran road. However, to ascertain continuity of the maintenance activity after completion of the action, the MoPI needs substantial budgetary support and capacity building/skills gap training on planning, management and operations of road maintenance activity.
- In view of previous experience in the State, labor-based maintenance methods are found to be acceptable by the State and feasible subject to improvement of the security situation in the area; the recent inter-communal clashes and cattle raiding created a sense of instability for the road-side community who are key to the labor-based road maintenance activities.
- UNOPS will liaise with GIZ to gather relevant information with respect to the program that was implemented in the State in relation with feeder roads.
- UNOPS will share the information gathered during this feasibility study and produce a comprehensive maintenance strategy in consultation with the state MoPI and key stakeholders on the ground.
- The planned procurement of intermediate road construction/maintenance equipment (mostly tractor drawn equipment) and tools will be evaluated against provision of support for maintenance and running of the available equipment at the state's disposal. This will be scrutinized and incorporated in the maintenance strategy.
- UNOPS advocates for public-private partnership (PPP) for follow up maintenmnace of the feeder roads by the State ministry of physical infrastructure after completion of the action.

5 Warrap State

5.1 Introduction

Warrap State is one of the four states selected for the implementation of the project entitled ZEAT BEAD "Feeder Road Construction in support of Trade and Market development in South Sudan"in line with the strategic objective of the EU's SORUDEV program.

According to the South Sudan National Bureau of Statistics (NBS), Warrap State is one of the most rural States in South Sudan with 91% of the population living in rural areas. 16% of the adult population is literate. 64% of the population lives below the poverty line. 87% of households

depend on crop farming or animal husbandry as their primary source of livelihood. 52% of the population has access to improved sources of drinking water.

The Achol Pagong to Ayen feeder road is located in the Gogrial West county of Warrap State and has been proposed for development under the EU SORUDEV / ZEAT-BEAD program. The originally proposed route was a total length of 39km and included a 13km section from Mayom Tiotin to Achol Pagong. However, consultation with SMoPI revealed that this section was already under construction. In consultation with NRC, SMoPI, SMoA and the Gogrial West commissioner, an alternate route was proposed to incorporate Majok Village and further extension from Ayien Market, through the village of Jong Lual to Panlieth Market. The total route for assessment was 40km.

The final route and route distance will be determined as part of this feasibility report. Section 5 of this report details the feasibility study of the feeder road giving findings and recommendations of final route selection and feasibility of construction. The key criteria the road is required to meet are as follows:

- Existing agriculture activities likely to benefit from infrastructure development was present in the immediate proximity of the road;
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities;
- Social services are currently established at various locations along the proposed road;
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups;
- Development does not have significant adverse environmental impact;
- Community and Government are motivated to participate in the construction and maintenance programs;
- Road connection of significant population densities;
- Construction is physically feasible and economically viable;
- Operators will not be affected by insecurity.

5.2 Preliminary Engineering Survey and Route Selection

In March 2014, UNOPS presented a Preliminary Assessment report for proposed Feeder development under the EU ZEAT BEAD project. For the state of Warrap, three roads were proposed as the top priority for development: Akop to Romic, Warrap to Majak Juer and Mayom Tiotin to Ayien, as detailed in table 5.1. There was minimal difference between the roads in relation to feasibility and all roads meet the selection criteria, however this assessment revealed that the Mayom Tiotin to Ayen was the lowest cost per kilometer to construct. Furthermore, an additional requirement of the ZEAT BEAD project necessitated that existing SORUDEV/ZEAT BEAD implementing partners is currently active in the area of the proposed feeder road development.

In consultation with NRC, WFP, EU, Warrap State MoA and the Feeder Roads Steering committee prior to proceeding to site visits, it was revealed that the Mayom to Ayen Feeder road was the only proposed route were existing implementing partners were present. The implementing partners confirmed the road met the essential selection criteria being that:

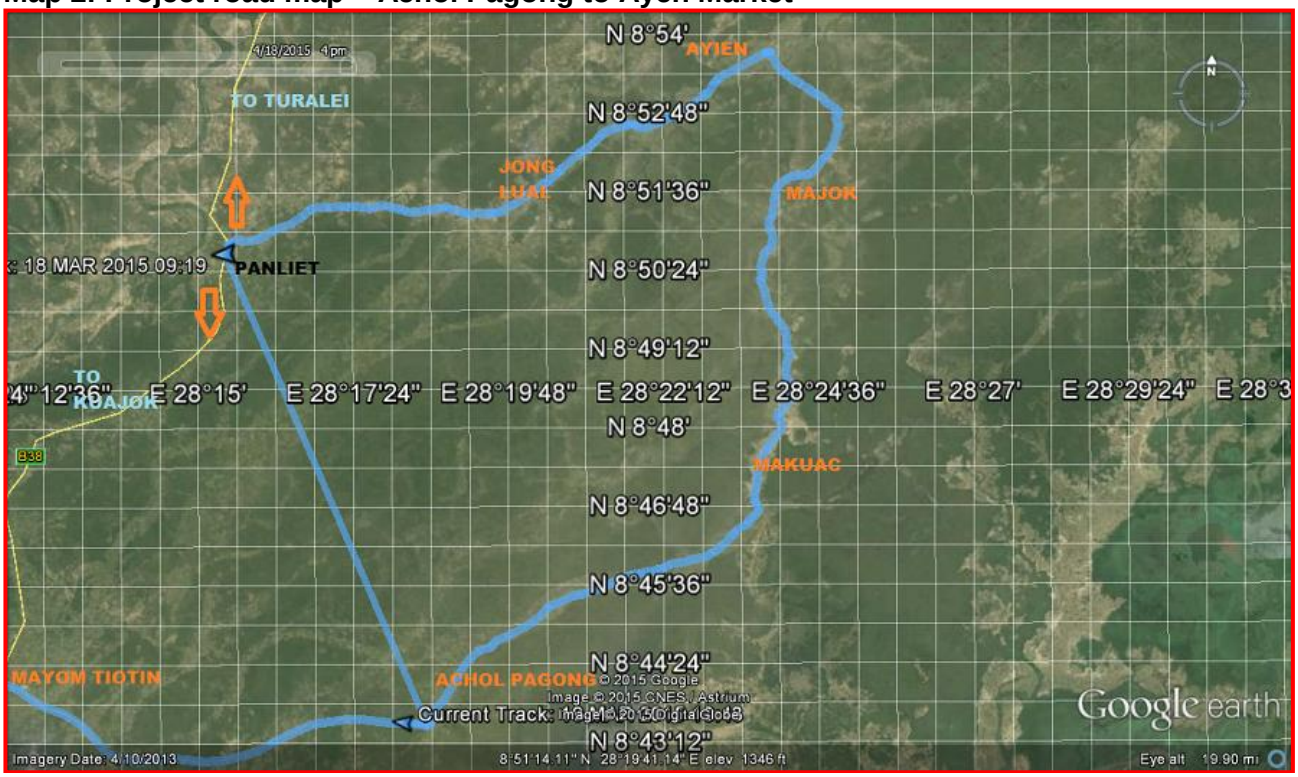
- Existing agriculture activities likely to benefit from infrastructure development was present in the immediate proximity of the road.
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities.
- Social services are currently established at various locations along the proposed road.
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups.
- A predetermined route had been identified for verification through a site assessment.

The route for assessment was based on information provided by NRC, SMoA and SMoPI who advised the existing route currently being utilized and the locations of significant agricultural activities, established markets and social services. As such the Achol Pagong to Ayien feeder road was deemed eligible for further analysis and verification as part on the feasibility study.

Table 5.2: Initially Identified Roads for WARRAP State

Road	Width (m)	Total Length (Km)
Akop - Marial Lou - Romic	6.00	60.20
Warrap - Aliek - Majak Juer	6.00	74.60
Mayom Tiotin - Achol Pagong - Makuac - Ayien	6.00	39.00

Map 2: Project road map – Achol Pagong to Ayen Market



5.3 Physical Environment and Environmental Assessment

The environmental impact assessment of the **Achol Pagong to Ayen** feeder road in Gogrial West County, Warrap state was carried out in accordance with the UNOPS Environmental Management System Handbook v 1.2 (https://www.unops.org/ApplyBO/File.aspx/11.%20RFP-KEOH-2014-002%20-%20Section%20V%20Annex%20G%20-%20EMS.pdf?AttachmentID=c21f27ea-0319-4879-a37a-e006cd46c115) and the DFID Overseas Road Note 5 – A guide to road project appraisal (http://www.transportlinks.org/transport_links/filearea/publications/1_851_ORN_5_Final.pdf).

Physical site inspections were conducted between the 17th and 19th March 2015 in order to ascertain primary observational data. Efforts have been made to incorporate information from existing compiled environmental data; however, it was found that the majority of reports discusses

South Sudan as a whole rather than provide separate information for regions with information often being generic for some elements and not available in detail.

Field data on natural resources and ecosystem services are very scarce in South Sudan due to the long period of war, during which data collection stalled and existing data sources were also lost (USAID, 2007). Moreover, the focus of many studies and data sets were on northern Sudan.

The Republic of South Sudan Government is still working towards comprehensive Environmental Legislation with the initiation of a Draft Environment Protection Bill (2010) which is yet to be formally recognized, but has achieved the implementation of the Southern Sudan Land Act 2009 which has been adhered to in the assessment report.

The Interim National Constitution of Southern Sudan (ICSS) incorporates legal aspects for the protection and management of the environment and natural resources. Part three, article 44 of the Interim Constitution of Southern Sudan - The Environment 'stipulates that every person or community has the right to have a clean and healthy environment.' As part of this Constitution all levels of government in Southern Sudan are committed to sustainable development and insurance that the environment is protected for the benefit of present and future generations.

Draft Environment Policy (2010):
The draft environmental policy under section 4.3 Environmental Impact Assessment indicated that the Government of South Sudan will require a systematic environmental impact assessment, audits, monitoring and evaluation to mitigate adverse impacts and enhance environmental benefits. As policy guidance, the ESIA process is legally binding on all proposed projects and should occur right from the initial planning stages of the project.

The Draft Environmental Policy has the following objectives:

- Improve livelihoods of South Sudanese through sustainable management of the environment and utilization of natural resources;
- Build capacity of the government at all levels of governance and other stakeholders for better management of the environment;
- Integrate environmental considerations into the development policies, plans, and programs at the community, government and private sector levels; and
- Promote effective, widespread, and public participation in the conservation and management of the environment.

The main purpose of the Draft Environment Policy is to provide guidance and direction to all stakeholders.

5.3.1 Climate

The climate in the Gogrial West County is considered to be tropical and classified as Aw by the Koppen climate classification (Tropical wet and dry or savanna climate), having a pronounced dry season. The temperature averages 27.6 degrees Celsius with April being the warmest month at 30.6 degrees Celsius and August the coolest month at 26.0 degrees Celsius. The annual average precipitation is 922mm, with the driest month being in January with no precipitation and the peak wet season August with an average of 208 mm.

5.3.2 Water resources

Warrap state is characterized by the presences of swamps that are seasonal due to the extensive fluctuation in precipitation creating a distinctive dry and wet season for the region. During the months of November to March the landscape becomes a dry dusty terrain. The landscape is transformed during April to October with the onset of the rainy season, with a peak in August of over 200mm average monthly rainfall. Across the entire state of Warrap there is little variance in elevation. With such a flat topography, surface water drains slowly from the area leaving vast

areas submerged for prolonged periods creating seasonal swamps and a number of year round swamps.

In the location of the proposed feeder road from Achol Pagong to Ayien, the area is consistent with the Warrap state topography with little variance in elevation and obvious signs of seasonal swamps. Although the road is not directly adjacent to a major water source, the area drains into the Loll River and the Pongo River Catchment, which eventually contributes to the Bahr el Ghazal River Catchment.

As can be observed in the survey plan annexure 5 there are some existing boreholes along the proposed route; however, these are few and extensively far between for the majority of the road. It was observed that the existing boreholes had been fitted with hand pumps, but a number of pumps were no longer working and residents were using ropes and buckets to retrieve water. Consultation with the SMoA revealed that the depth to artesian water reservoirs was between 38m to 42m depth below surface level.

The site inspections revealed a pan located at chainages 20.0km, 32.0km, 34.0km, 39.0km and 53.0km that could potentially turn into a watercourse during the peak of the wet season. The pan at chainage 34.0km had retained water despite the dry conditions and a number of native birds were observed at this location. At the location of each pan, a significantly sized village is located in close proximity. There were significant distances between the clusters of huts, and generally the population was quite spread out. Signs of water logging were evident from the landscape. Often, there were sections where multiple tracks had been formed for passing during the wet season. Consultation with local residents revealed that in vast sections the water would remain for weeks at a time at depth of around 100 up to 400mm in the lowest points.

As the site visit was conducted in the dry season, observations revealed that apart from boreholes, there are no reliable water sources for construction or agricultural purposes. The natural surface water is used for human consumption, livestock, brick manufacturing and a small amount of cultivation.

Concerns would be for the quality of surface water due to the combined human and livestock use and also the lack soil stabilization during the dry season. Waste and sanitation are not regulated in this area which would affectthe quality of water.

5.3.3 Topography, Soil and geology

Over the 40km of the assessed route there is little variance in elevation. From topographic mapping the elevation was not available for the exact location of the road, however no significant gradient changes were observed or recorded with the GPS survey.

According to Harris (1958) Warrap State is classified as a combination of a medium to high rainfall woodland savannah. No soil testing was conducted as part of this assessment, however through onsite observation and comparison to existing data it is evident that the soil type is in general a sandy clayey loam.The bedrock is documented to be volcanic material in this area (Harris 1958), however bedrock is located meters below the surface level giving little constitution to the soil structure.

5.3.4 Local air pollution

As the local area is predominately populated by subsistence/barter farming it is reasonable to assume that a majority of air pollution is attributed to smoke and dust particulates. There is evidence of recent deforesting activity in the area contributing to increased exposed soils. Especially surrounding the established villages, there are large areas of barren ground and soil compaction impacting the soil structure. As previously mentioned, the physical assessment was conducted during the dry season; however, observations revealed that cultivation areas are left

exposed after harvest and significant vegetation cover is not achieved until the commencement of the wet season.

Pedestrians and animals make up the greater proportion of the traffic. Motorcycles are present, and though cars are present towards the middle of the route usage is dependent on the road condition. Overall it is evident that air pollution is higher during the dry season due to the presence of dust and this is typically the period when burning for clearing, brick and coal manufacturing is conducted.

5.3.5 Landscape, natural resources and waste

The high rainfall woodland savannah characteristic of South Sudan extends into most parts of the greater Bahr el Ghazal. Trees in this region are generally tall and broad leaved. Coarse tall tussocks of perennial grasses predominate and fires are hence usually fiercer than in the low rainfall woodland savannah. *The most important tree species are Khayyam senegalensis and Isoberlina doka. Other species are Parkia oliveri, Daniella oliveri, Afzelia africana, Terminalia mollis, Burkea africana and itellaria paradoxa. (MTRB, 2014)*

Despite the received information that a section of the original route was already under construction, the site inspection commenced at Mayom Tiotin through to Achol Pagong in order to confirm the reports and ascertain the condition of construction. The site inspection then continued to Makuac to Majok coming to Ayien Market Village which was the original intended end point. On the request of the SMoA and on the advice of NRC the inspection continued from Ayien to Jong Lual finishing at Panlieth Market. From Chainage 0.00km until chainage 13.3km the road had been constructed to the finished embankment level with locally acquired select material creating an embankment height of about 800mm above natural surface level. To this end no efforts have been made to consolidate clearing debris, which has been pushed directly into the bush adjacent to the clearing. Borrow pits for the earth fill embankment are in close proximity to the road with no obvious design for how the areas of pits were selected varying in depths and widths. At this stage no work has commenced to rehabilitate the borrow pits or surrounding disturbed areas and sides have not yet been benched or battered to an acceptable grade.

The commencement of the newly selected route started at chainage 13.300km, perpendicular to the newly formed road. There are a few small shops that would require relocating for construction, or an alternate commencement location would need to be selected. For the entire route there was negligible variance in the features of the area. The terrain was relatively flat with little change in elevation. Soils appeared to be sandy clayey sandy loam with a significant depth to bedrock. Depth to foundation is unknown, but it is suspected to be more than 1m in most locations.There was a presence of large trees and the evidence of lack of soil structure during the wet season. In the observed swamp areas, the soil was black clayey loam and sedimentary material. It was obvious that, due to the soil conditions, during the wet season the existing track would be impassable.

A school and the market village of Makuac was located at chainage 26km. A substantial construction is in process for the new school in this area. The Majok was the next significant village located at chainage 34km where a small amount of local cultivated and gathered goods were being sold. Ayen market center was located at chainage 40.5km. In this area the high level water mark could be observed on some buildings at around 200 to 300mm. Further consultation with the locals indicated that flood water levels during the wet season could be up to 300mm in depth.

The vegetation was sparse in areas where population densities were higher and was of medium density outside of Bomas and Payams. There was a consistent observation of Lulu and Palm trees, other varieties such as Mahogany and Abeyie trees were in less abundance due to clearing and deforestation activities. Large trees were present, but vegetation was stunted on the low lying swamp areas. Where clearing had occurred there were vast areas of established native grasses. In the low-lying, seasonal wet areas, reads and water grasses were observed. At chainage 36km a

plantation of Laluk trees were present which the locals use as a food source. Again at chainage 40km a plantation of Palms was observed, which is also a local food source.

As previously mentioned, upon advice from NRC and the SMoA, the site inspection continued from Ayien market through Jong Lual and through to Panlieth. There was a slight change in elevation through this terrain with a small increase in gradient between Ayien to Jong Lual. More agricultural activity was observed in this area.

Through discussions with the contractors completing the current road works from Mayom Tiotin and the Director of Road SMoPI, it was made clear that the most reliable source of murram for construction of roads was located 80km away close to the Warrap capital of Kuajok. However, further discussions with a contractor working for MTRB revealed that another borrow pit had been identified 46km from the commencement of the proposed road. A significant amount of select material will be required to construct embankments to raise the road above the flood levels. This would involve a substantial proportion of clearing to expose the material sources.

5.3.6 Biodiversity

Due to a lack of available information it is difficult to establish an adequate baseline for the current state of biodiversity in the area. However, generalized information and site observations have been used to establish the current bio-diversity status.
Warrap State is significantly defined by the seasonal fluctuations of water levels and marshlands. The region is a significant area for bird life and, despite the effect of the prolonged war, the area is still important in the seasonal migration of birds and wildlife (WWI, 2007). It is important to take into account the impact a smaller road development in an already heavily populated region may have on the wider catchment.

As further explained in Section 5.4 (Socio-Economic Assessment), substantial population densities already exist in the region of the proposed road. As a result of the land occupation the immediate area has already sustained significant impact to the biodiversity. It can be assumed that with the common activities practiced in this area, including burning under-scrub, deforesting, migrational cattle grazing, hunting, excavation for brick manufacturing and recently the introduction of cultivation, has reduced the biodiversity in the immediate area and contributed a similar effect wider environment. The establishment of reliable vehicle impact is likely to further facilitate the reduction in biodiversity in the immediate area.

5.3.7 Cultural heritage

No significant sites of cultural heritage were observed or discovered for the immediate area of the proposed route; however, it is important that dialogue with the local community continues to ensure this element has been explored fully.

5.3.8 Noise and vibration

Due to the lack of available information and monitoring equipment, only rudimentary observational assessments are possible. Considering that the existing access limits the velocity of mechanized transport and that mechanized agricultural and manufacturing equipment are lacking, it is reasonable to assume that noise and vibration pollution is minimal. It can further be assumed that due to better accessibility during the dry season, noise and vibration will be higher than in the wet season.

5.3.9 Conclusion

The construction of the Achol Pagong to Ayien Market feeder road is likely to provide important development and access opportunities to the residents of the local area. However, this development is likely to have significant impact on the overall natural environment and as such strategic measures need to be incorporated in the design to mitigate the adverse impact.

It is advised that efforts be made to ensure the identification of the most opportune locations for the acquisition of embankment construction material. Furthermore, it is advised that efforts are made to transform these borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of the borrow pit and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat, clearing must be kept to a minimum; this should be considered in the design of the road corridor and the subsequent planning of the construction works. It is also important to avoid the removal of, or to consider the establishment of or compensation for, the removal of any vegetation that is a food source. Due to the dispersive and fine particle characteristics of soils it is advisable to re-vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss.

During the construction period access to water may be limited. To mitigate the effect early identification of a viable water source is recommended. Alternatively, a new water source could be constructed, in order to reduce the impact of water collection opportunities to the local population.

5.4 Travel Demand Establishment and Projection

The establishment of travel demand is carried out in strict compliance with the recommendations of Overseas Road Note 5 (ORN-5) for low-volume rural roads and in reference with the South Sudan Roads Authority Low Volume Roads Design Manuals.

5.4.1 Review of Available Traffic Data

Relevant traffic information available to the project road is sought from the State Ministry of Physical Infrastructure and State Department of Roads and Bridges. It was however found that the Ministry responsible for the management and administration of the feeder road under consideration is severely budget-constrained. As such, it was confirmed that the state does not keep records on traffic volumes, condition surveys, etc. which are required for the planning of investment decisions. As such, available data on historical data was sought from development partners and from central government Ministry of Transport, Roads and Bridges. All approached sources failed to avail any historical traffic data for the road.

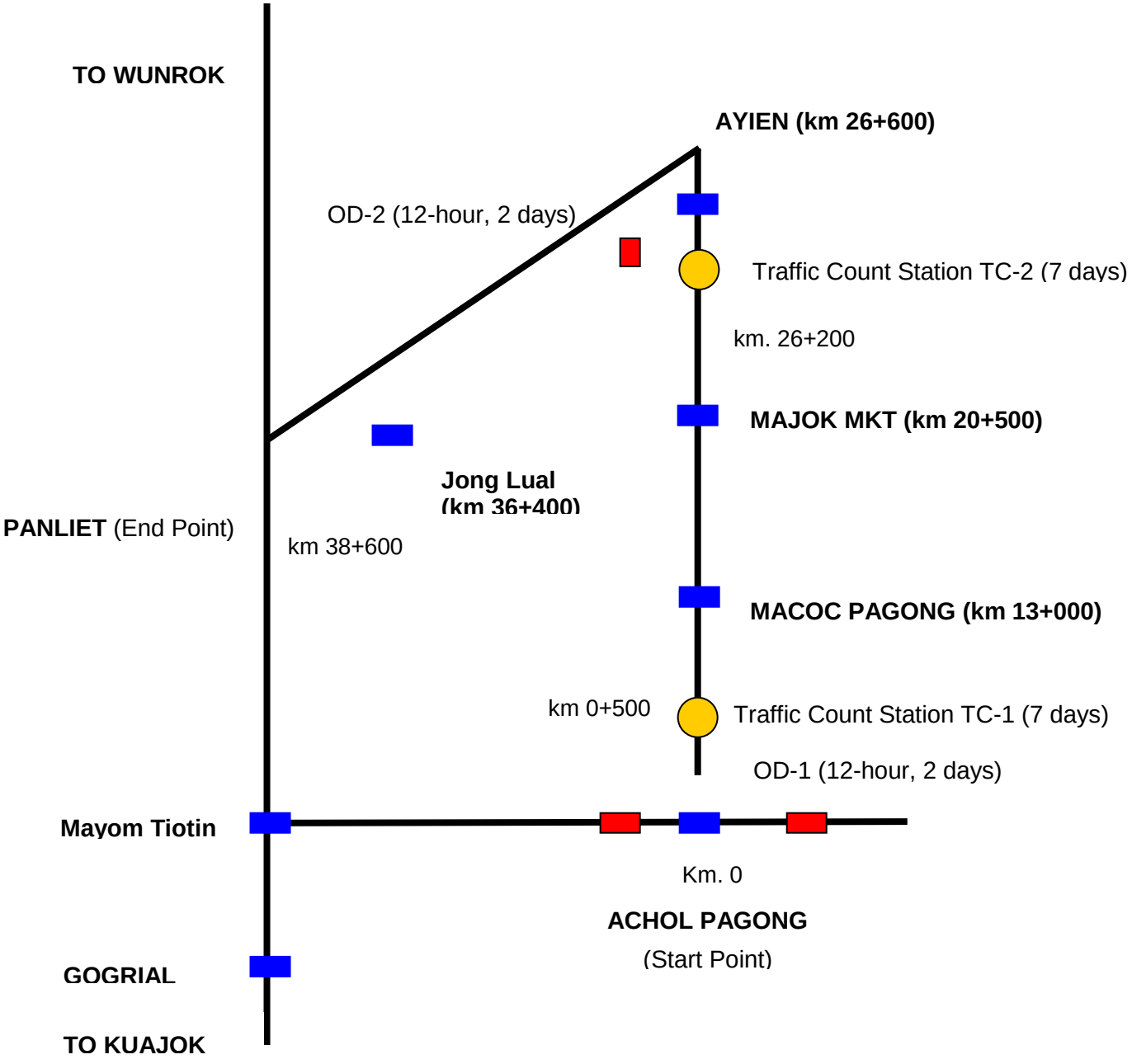
5.4.2 Program for Traffic Surveys

In view of the available information and data requirements of the project road, the data-gaps were identified, and it was planned to conduct a series of traffic surveys. Keeping in mind the ToR requirements, a program of traffic surveys was formulated; accordingly, the following traffic surveys were conducted in the project vicinity.

- Classified Traffic Volume Counts;
- Origin-Destination Surveys; and
- Travel Time Surveys.

Based on the reconnaissance survey and observation of the project road and traffic movement pattern on it, five traffic survey locations were selected, as indicated on a line diagram **(Figure 5.4-1).**

Figure 5.4-1: Locations of Traffic Surveys



5.4.3 Classified Traffic Volume Counts

Classified traffic volume counts at three locations were conducted between 19.03.2015 and 25.03.2015 of which the details and durations are given in Table 5.4-2.

Table 5.4-2: Classified Traffic Volume Counts: Survey Locations

Survey Station	Location	Duration	Survey Dates
TC-1: Achol Pagong, outside the town limits in the direction towards Ayien (km 0+500)	Achol Pagong	7 Days	19.03.15 – 25.03.15
TC-2: Ayien, outside the town limits in the direction towards Achol Pagong (km 39+500)	Ayien	7 Days	19.03.15 – 25.03.15

5.4.3.1 Daily Traffic Counts and Traffic Compositions

The daily traffic count data is summarized in Table 5.4-3, presenting the averaged traffic volume as well as composition as percent of total traffic for each survey station. The vehicle composition interestingly reveals that passenger vehicle: freight vehicles ratio is close to 1:1 for all Achol Pagong but 9:1 for Ayien Market. The reason for this could be attributed to the well-populated project area in Ayien Market area and poor service delivery resulting from the poor transport infrastructure. This corresponds to the actual population distribution & assessment of basic services in the project area.

Table 5.4-3 Vehicle Category wise Traffic Volume at Survey Stations

Station 1: Achol Pagong (TC-1)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
19th March 2015, Thurs	12-Hr	0	12	0	2	0	4	1	0	0	**19**
20th March 2015, Fri	12-Hr	0	22	0	0	0	0	6	17	0	**45**
21st March 2015, Sat	12-Hr	0	113	0	0	0	0	91	76	0	**280**
22nd March 2015, Sun	12-Hr	0	99	0	0	0	80	0	27	0	**206**
23rd March 2015, Mon	12-Hr	0	55	0	0	0	15	3	2	0	**75**
24th March 2015, Tues	12-Hr	0	7	0	2	0	4	0	0	0	**13**
25th March 2015, Wed	12-Hr	0	58	0	0	0	0	14	0	0	**72**
	12-Hr Daily Average (ADT)	0.0	52.3	0.0	0.6	0.0	14.7	16.4	17.4	0.0	
	Vehicle Composition	0%	52%	0%	1%	0%	15%	16%	17%	0%	
12-Hr Average Daily Traffic		**0**	**52**	**0**	**1**	**0**	**15**	**16**	**17**	**0**	**101.4**
						52%				48%	

Station 2: Ayien (TC-2)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
19th March 2015, Thurs	12-Hr	11	22	0	2	0	6	0	0	0	**41**
20th March 2015, Fri	12-Hr	40	41	0	0	0	5	0	0	0	**86**
21st March 2015, Sat	12-Hr	2	5	0	0	0	1	0	0	0	**8**
22nd March 2015, Sun	12-Hr	3	10	0	0	0	2	0	0	0	**15**
23rd March 2015, Mon	12-Hr	4	9	0	0	0	3	0	0	0	**16**
24th March 2015, Tues	12-Hr	0	7	0	2	0	4	0	0	0	**13**
25th March 2015, Wed	12-Hr	29	13	0	0	0	4	0	0	0	**46**
	12-Hr Daily Average (ADT)	12.7	15.3	0.0	0.6	0.0	3.6	0.0	0.0	0.0	
	Vehicle Composition	40%	48%	0%	2%	0%	11%	0%	0%	0%	
12-Hr Average Daily Traffic		**13**	**15**	**0**	**1**	**0**	**4**	**0**	**0**	**0**	**32**
						89%				11%	

5.4.3.2 Traffic Variation: Day & Night

The traffic counts were normally carried out for 12 hours (0700-1900 hr) each day. Hence, a 24-hour (0600-0600) count was not carried out in any of the survey stations to get information about the proportion of traffic plying during 1900 to 0600 hr. However, given the poor state of the feeder road under consideration and apparent security situation in the state, it is anticipated that a 24-hr survey would not be feasible. As such, it was decided that the surveys would only be conducted for 12 hours during day-time. Therefore, the ratios of the 24-hr count/12-hr count (termed as **"night factor**") for each category of vehicle and for each survey station are taken as unity.

5.4.3.3 Average Daily Traffic (ADT) for Road Sections

The 12-hour traffic count data shown in Table 5.4-3 have been adjusted by the application of unit night factors indicated above and treated as equivalent 24-hour count data. The adjusted daily traffic count data are presented in **Table 5.4-4** and further averaged to derive the ADT (average daily traffic) for each survey station.

The project road has been divided into three sections, traffic distribution wise, from Achol Pagong to Macoc Pagong (13.0km), Macoc Pagong to Ayien (26.6km) and finally from Ayien to Jong Lual (38.6km). The traffic count from each of the count stations is meant to be assigned to the section of the road that it represents.

Taking into account the ADTs derived for the three survey locations, the ADTs are assigned to the three road sections are shown in **Table 5.4-4.**

Table 5.4-5: ADT assigned to Project Road Sections

Section of the Road	Length (km)	Normal 24-Hr Traffic Count Forecast 2017 (Opening Year)									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Achol Pagong - Macoc Pagong (0+000 to 13+000)	13	0	53	0	1	3	15	17	26	5	**120**
Macoc Pagong – Ayien (13+000 to 26+600)	13.6	6	34	0	1	2	9	8	16	4	**81**
Ayien - Adjong Lual (26+600 to 38+600)	12	13	16	0	1	1	4	0	5	3	**42**
Achol Pagong - Macoc Pagong - Ayien - Panliet (0+000 to 38+600)	**38.6**	**6**	**35**	**0**	**1**	**2**	**9**	**9**	**16**	**4**	**83**

5.4.4 Origin-Destination Surveys

In order to establish the movement pattern on the project road, roadside interviews with vehicle drivers/crew were conducted at two traffic survey locations for three days each, to ascertain the origins and destinations of the vehicles using the adjacent road, their trip lengths (distance traveled), trip purpose, occupancy and the commodity flow pattern. The surveys had been carried out on a working day and weekend for 12-hours from 0700 to 1900 hrs. The enumerators were deployed with sufficient training to conduct the surveys. Police help was obtained to ensure smooth flow of traffic and stoppage of the selected vehicles. The OD survey stations are described in **Table 5.4-5**.

Table 5.4-5: Origin-Destination Survey: Survey Locations

Survey Station	Location	Duration	Survey Duration
OD-1: At Achol Pagong, outside town limits in the direction towards Ayien (km 0+400)	Achol Pagong	2 Days	21.03.15 and 25.03.15
OD-2: At Achol Pagong, outside town limits in the direction towards Achol Pagong (km 0+400)	Achol Pagong	2 Days	21.03.15 and 25.03.15
OD-3: At Ayien, outside town limits in the direction towards Ayien (km 27+000)	Ayien	2 Days	21.03.15 and 25.03.15
OD-4: At Ayien, outside town limits in the direction towards Jong Lual (km 27+000)	Ayien	2 Days	21.03.15 and 25.03.15

Numbers of vehicles interviewed by location are given in **Table 5.4-6.** Out of the 57 motorized vehicles interviewed, about 28 motorcycles were excluded from the table for the purpose of clarity.

Table 5.4-6: Number of Vehicles Intercepted in the O-D Survey

Location	Car*	L/Rover	S/Bus	L/Bus	S/Truck	M/Truck	H/Truck	T &T	Total
TOTAL	**0**	**16**	**0**	**0**	**5**	**3**	**5**	**0**	**29**

*Motor-cycles and specialized vehicles interviewed during the surveys is excluded

The intercepted vehicles were classified by vehicle plates and purpose of trip. In the former category, **Table 5.4-7A** shows that while business and trading vehicles by far dominated vehicle movement at about 33.3% of intercepted trips, these were followed by vehicles at 28.1%. While government vehicles and taxis each attribute for 8.8% of the trips, UN/NGO vehicles have accounted for 10.5% of trips on the project road. Incidence of driving vehicles without any plate number is observed at 1.8% which is particularly low compared to other states.

Table 5.4-7A: Vehicle Plate Category

Plate Code	Code	Frequency	%
No Plate	0	1	1.8%
Taxi	1	5	8.8%
Personal Automobile	2	16	28.1%
Trading Vehicle	3	19	33.3%
Administration/Local Government	4	3	5.3%
National Government	5	2	3.5%
Other Country/UN	6	6	10.5%
Others	7	5	8.8%
TOTAL		**57**	**100%**

Table 5.4-7B: Trip Purpose Category

Trip Purpose	Code	Frequency	%
No Response	0	0	0.0%
From/To Work	1	17	37.8%
Employment	2	11	24.4%
Personal	3	11	24.4%
Education	4	3	6.7%
Medical	5	0	0.0%
Social	6	3	6.7%
Vacation	7	0	0.0%
Ceremony (Wedding, Funeral)	8	0	0.0%
Others	9	0	0.0%
TOTAL		**45**	**100%**

The OD survey has also captured the response of drivers regarding trip purposes **(Table 5.4-7B)**. It was found out that work and employment trips contributed most of the motorized travel around project vicinity at 62.2% while personal trips intercepted account for 24.4% of trips and trips to social services (education) account 13.3% of trips. Social (medical) trips, vacation and attending ceremony accounted for none of the trips. The incidence of no response to the interview is exceptionally low at 0% of all vehicles intercepted by the OD survey.

5.4.4.1 Commodity Movement

To analyze commodity movement on the project road, major commodities being transported on roads within the project area of influence were identified. To carry out this exercise, data was collected through the formats used in the O-D survey at the four locations. For the purpose of data analysis, these commodities were grouped and assigned numeric codes, as given in **Table 5.4-8**.

Table 5.4-8: Commodity Category

Code	Group	Possible Commodity Type
0	Empty	Unloaded
1	Agricultural product	Wheat, oil seed, *sorghum*, barely
2	Livestock	Ox, goat, camel
3	Fuel wood or charcoal	Charcoal, etc
4	Water	Water (tanker)
5	Processed food or drinks	Vegetables, fish, meat, milk and milk products, soda, bottled water, etc.
6	Machinery, equipment	Machinery and transport equipment
7	Logs or lumber	Wood, timber, etc.
8	Construction materials, cement	HCB, brick, cement, steel, aluminum, etc.
9	Petrol, diesel, kerosene, gas	Flammable hydrocarbons
10	Chemicals or fertilizes	Mineral fuels, lubricants and related material
11	Medicines and pharmaceuticals	
12	Miscellaneous household goods	House-hold items, finished products, soap, salt, sugar, pulses, spices etc.
13	Other or unknown	Other items

During the O-D surveys, a variety of commodities – bulk and mixed cargo, were observed moving on the project road. The O-D information collected was classified according to the commodity category (Table 5.4-8) and the percentage distribution of commodity is given in **Table 5.4-9.**

Table 5.4-9: Distribution of Commodity on the Project Road (%)

Commodity Type	%
Empty	9.1%
Agricultural Product	18.2%
Livestock	9.1%
Fuel-wood or Charcoal	36.4%
Water	0.0%
Processed Food or drinks	0.0%
Construction machinery/equipment	0.0%
Logs or lumber	9.1%
Construction Materials, cement, rebar	0.0%
Petrol, Diesel, Kerosene, gas	18.2%
Chemicals or Fertilizers	0.0%
Pharmaceutical Items, Medicine	0.0%
Miscellaneous Household goods	0.0%
Others/Unknown	0.0%
TOTAL	**100%**

It may be noted that the incidence of empty hauling was observed to be high, accounting for 9.1% of truck trips. Of the loaded goods vehicles, 36.4% was accounted by fuel-wood/charcoal followed by agricultural products and petroleum products at 18.2% each of the total commodity movement. Livestock and logs shared the remaining share of trips equally at 9.1%. Peculiarly enough, the construction sector has not contributed any trips of commodities being transported in the vicinity of the project road. In general, it is noted that the project vicinity contributes to the national freight

movement through agricultural items collected from farms existing along the project road to relevant markets elsewhere.

Alongside the commodity flow survey, data on the carrying capacity of trucks was collected and the payload carried by truckers was recorded. For the purpose of analysis, the trucks have been categorized as shown in **Table 5.4-10** with their respective percentage distribution.

Table 5.4-10: Percentage Distribution of Commodity Flow from the O-D survey

Vehicle Utilization	Code	Frequency	%
Empty	0	1	10.0%
1/4 Full	1	2	20.0%
Half Full	2	0	0.0%
3/4 Full	3	4	40.0%
Fully Loaded	4	2	20.0%
Over-loaded	5	1	10.0%
TOTAL		**10**	**100%**

Based on the survey, 10% of the trucks are empty loaded and 20% of total intercepted trucks are quarter loaded. On the project road, it has been observed that a considerable amount of trucks are substantially to fully loaded which accounts to60% of the total intercepted trucks, while the extent of over-loading was observed at 10%.

5.4.4.2 Trip Frequency on the Project Road

The frequency of similar trips by drivers was collected from the drivers and analyzed. We note that high proportion of the intercepted vehicles actually make similar trips frequently as shown in **Table 5.4-11**.

Table 5.4-11: Trip Frequency Distribution from the O-D survey

Trip Frequency	Code	Frequency	%
Most Frequent	7	15	67%
	3	6	
	2	11	
Frequent	1	16	33%
Occasional	0.5	0	0%
	0.25	0	
TOTAL		**48**	**100%**

'Most frequent trips', made from once in a week to daily, account for two-third of all vehicles interviewed by the OD survey. This makes the trip characteristics observed from this particular survey a dependable replica of actual movement pattern of drivers in the future. These are followed by frequent trips that are made at most once a month accounting for the last third of trips. There were no occasional trips intercepted by the survey.

5.4.4.3 **Traffic Flow Pattern**

Ajogo, followed by Achol Pagong, Ayien and MayomTiotin are the major generating and attracting centers of traffic on the Project Road (**Table 5.4-12**). As the distance between Origin and Destination towns increase, the traffic flow on the Project road decreases.

Table 5.4-12: Traffic Attraction Centroids from the O-D survey

Location	Origin	Destination	SUM	RANK
Achol Pagong	8	7	15	2
Ayien	2	12	14	3
Ajogo	2	15	17	1
Kwajok	7	0	7	6
Mayom Tiotin	6	5	11	4
Wunrok	3	1	4	8
Panliet	0	4	4	8
Turalei	8	1	9	5
Mangolpuk	5	0	5	7
Warrap	2	0	2	12
Aweil	2	0	2	12
Wau	2	0	2	12
Makual	0	1	1	18
Macoc	0	2	2	12
Gogrial	3	0	3	11
Alek	2	0	2	12
Mongol	0	2	2	12
Magol	0	4	4	8
TOTAL	**52**	**54**	**106**	

Based on the major origin and destination points on the project road, the OD Matrix is established and shown under **Table 5.4-13A and Table 5.4-13B**.

Table 5.4-13A: Origin Destination Matrix based on OD Survey

O/D	Ajogo	Achol	Ayien	Mayom	Turalei	Kwajok	Mangolpuk	Panliet	Wurrok	Magol	OTH	Sum
Ajogo	0	0	0	1	0	0	0	1	0	0	0	**2**
Achol	4	0	0	4	0	0	0	0	0	0	0	**8**
Ayien	0	0	0	0	1	0	0	1	0	0	0	**2**
Mayom	3	3	0	0	0	0	0	0	0	0	0	**6**
Turalei	0	1	6	0	0	0	1	0	0	0	0	**8**
Kwajok	4	1	3	0	0	0	0	0	0	1	1	**10**
Mangolpuk	0	0	0	0	0	0	0	3	2	0	0	**5**
Panliet	0	0	0	0	0	0	0	0	0	0	0	**0**
Wurrok	2	1	4	0	0	0	0	0	0	0	0	**7**
Magol	0	0	0	0	0	0	0	0	0	0	0	**0**
OTH	2	1	1	0	0	0	0	0	0	5	0	**9**
Sum	**15**	**7**	**14**	**5**	**1**	**0**	**1**	**5**	**2**	**6**	**1**	**57**

Table 5.4-13B: Origin Destination Matrix based on OD Survey

O/D	1	2	3	4	5	6	7	8	9	10	OTH	Sum
1	0	0	0	1	0	0	0	1	0	0	0	**2**
2	4	0	0	4	0	0	0	0	0	0	0	**8**
3	0	0	0	0	1	0	0	1	0	0	0	**2**
4	3	3	0	0	0	0	0	0	0	0	0	**6**
5	0	1	6	0	0	0	1	0	0	0	0	**8**
6	4	1	3	0	0	0	0	0	0	1	1	**10**
7	0	0	0	0	0	0	0	3	2	0	0	**5**
8	0	0	0	0	0	0	0	0	0	0	0	**0**
9	2	1	4	0	0	0	0	0	0	0	0	**7**
10	0	0	0	0	0	0	0	0	0	0	0	**0**
OTH	2	1	1	0	0	0	0	0	0	5	0	**9**
Sum	**15**	**7**	**14**	**5**	**1**	**0**	**1**	**5**	**2**	**6**	**1**	**57**

Of all the trips that were destined to Ajogo, half originated from Achol Pagong. Again, of all trips that were destined to Achol Pagong, half originated from Mayom Tiotin. Of all vehicles intercepted by the survey, more than half were originated from or ended in either Ajogo, Achol Pagong or Kwajok. This shows the significance of the project road control points, particularly Achol Pagong and Ayien in the overall travel pattern at the national level.

5.4.5 Seasonal Variation in Traffic Flow

The road section-wise ADTs shown in **Table 5.4-7** relate to the time of the year when the traffic surveys are carried out, over a period of 7 days in March 2015. The project road traffic, however, is susceptible to seasonal variations, particularly those caused by the seasonality of the climate and agricultural activities in the project area.

The best historical data for assessing the seasonal variations of traffic flow along the project road would be counts made by SSRA during the different cycles of the year, particularly focusing on the dry period (December to March) and wet season (April to November). As the traffic surveys were made during the dry period (high season), factors are required to be used to correct the seasonality of traffic along the project road, particularly for the wet season (lowtraffic volume season). In the absence of historical data maintained with the SSRA, it was decided to assume proportions of traffic during high, low and medium seasons in relation to the annual average values as depicted under **Table 5.4-14**.

Table 5.4-14: Seasonal Correction Factor (SCF)

Season	Indexed ADT	SCF
Low	0.5	1.87
Medium	1	0.93
High	1.3	0.72
Average	**0.933**	

The use of the SCF meant that the ADT calculated from the traffic count surveys shall be adjusted for seasonality of traffic on project road relating to low, medium and high seasons.

5.4.6 Non-Motorized Traffic Survey

Non-motorized transport modes in use in the project area comprise principally of pack animals and walking, although other intermediate non-motorized modes such as bicycles do play an important role. Both offer scope for reducing travel costs through faster travel time or increased loading capacity with relatively small capital outlays. Road improvement is likely to reduce costs of operation and encourage adoption of these modes at least in suitable terrain. Hence, to scrutinize the non-motorized traffic at the vicinity of the project area, data has been collected. The non-motorized traffic count has been conducted alongside with the motorized traffic count, .i.e. the traffic survey stations as well as the period of the traffic count are similar to that of the motorized traffic count. The non-motorized traffic data for the four stations are depicted in **Table 5.4-15**.

Table 5.4-15: Non-Motorized Traffic Survey Results

Station 1: Achol Pagong (TC-1)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
19th March 2015, Thurs	12-Hr	33	81	126	5	0	**245**
20th March 2015, Fri	12-Hr	38	64	171	0	0	**273**
21st March 2015, Sat	12-Hr	184	379	702	58	0	**1,323**
22nd March 2015, Sun	12-Hr	235	336	508	67	0	**1,146**
23rd March 2015, Mon	12-Hr	185	642	949	15	0	**1,791**
24th March 2015, Tues	12-Hr	215	673	807	0	0	**1,695**
25th March 2015, Wed	12-Hr	189	722	927	0	0	**1,838**
12-Hr Weekly Average (ADT)		154.1	413.9	598.6	20.7	0.0	
24-Hr Average Weekly Daily Traffic		**154**	**414**	**599**	**21**	**0**	**1,187.29**
		0.25	0.2	0.15	0.7	0	**PCU**
		39	83	90	15	0	**Cars**

80% passenger	180	3	L. Bus
20% freight	45	8	H. Truck
		5	TT

Station 2: Ayien (TC-2)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
19th March 2015, Thurs	12-Hr	63	131	301	0	0	**495**
20th March 2015, Fri	12-Hr	74	234	427	0	0	**735**
21st March 2015, Sat	12-Hr	29	86	205	0	0	**320**
22nd March 2015, Sun	12-Hr	26	102	170	0	0	**298**
23rd March 2015, Mon	12-Hr	37	55	98	0	0	**190**
24th March 2015, Tues	12-Hr	38	48	116	0	0	**202**
25th March 2015, Wed	12-Hr	69	154	283	0	0	**506**
12-Hr Weekly Average (ADT)		48.0	115.7	228.6	0.0	0.0	
24-Hr Average Weekly Daily Traffic		**48**	**116**	**229**	**0**	**0**	**392**
		0.25	0.2	0.15	0.7	0	**PCU**
		12	23	34	0	0	**Cars**

60% passenger	42	1	L. Bus
40% freight	28	5	H. Truck
		3	TT

As shown from above tables, it is observed that the dominating non-motorized forms of traffic are pedestrians and pack animals at all stations. At proximity of larger villages such as Acol Pagong, considerable amount of dwellers used bicycles for day-to-day activities for local movements. It has been noticed that the intensity of handcarts is also high at vicinity of villages. The non-motorized traffic flow has been converted to Motorized vehicles to estimate the traffic volume on the project road by using appropriate Passenger-Car Equivalent (PCE) factors from the **Low Volume Road Design Manual (2013)**.

5.4.7 Establishment of AADTs

Based on the analysis of traffic seasonality indicated above and also applying judgment, the road section-wise AADTs so derived are shown in **Table 5.4-15.** The components of traffic considered for design and economic analysis of project road are normal, generated and diverted traffic. So it is necessary to distinguish between the following traffic:

Current/Normal Traffic: This represents the existing traffic that would use the improved road when it is opened to traffic.

Diverted Traffic: This represents the traffic attracted to the improved road or lost to alternative routes when the improvements are completed.

Induced Traffic: This represents the increase in traffic as a result of the increased demand for transport, if any, induced by the improvement of the road. This is part of the Generated Traffic under establishment of AADT.

Development Traffic: This represents the increase in traffic, if any, that may arise from improvements on adjacent land over and above the development which would have taken place had the new or improved road not been constructed. This is part of the Generated Traffic under establishment of AADT.

5.4.7.1 Normal Traffic

This represents the traffic, which would in any event occur if no improvement is made. The base year for traffic projection is 2015, on which traffic surveys and baseline data have been based. The normal traffic has been projected for 2 years (2015-2017), based on short-term traffic growth rate of 1%.Accordingly, the summarized AADT based on traffic count made by the Consultant and considering the adopted growth rate on the project road, the opening year normal traffic for the year 2017 is shown **Table 5.4-16**.

Table 5.4-16: Normal Traffic

Section of the Road	Length (km)	Normal AADT 2017									Total	Traffic Forecast Year (2-Yrs)
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T		
Seasonal Correction Factor		**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**		
Achol Pagong - Macoc Pagong (0+000 to 13+000)	13	0	40	0	0	2	11	13	19	4	**90**	**Mar-17**
Macoc Pagong – Ayien (13+000 to 26+600)	13.6	5	26	0	0	2	7	6	12	3	**61**	**Mar-17**
Ayien - Adjong Lual (26+600 to 38+600)	12	10	12	0	0	1	3	0	4	2	**31**	**Mar-17**
Achol Pagong - Macoc Pagong - Ayien - Panliet (0+000 to 38+600)	**38.6**	**5**	**26**	**0**	**0**	**2**	**7**	**6**	**12**	**3**	**61**	**Mar-17**

The SCF adopted for the project is 0.75 with an effort to arrive at reasonable demand levels. The NMT count has been used to estimate the number of passenger and freight vehicles. The values obtained were added to the motorized traffic obtained from survey into bus and truck traffic. The sum of MT and NMT gives the Normal Traffic for the project.

5.4.7.2 Generated Traffic

Generated traffic is the traffic that results from economic, social and environmental development of the project area. Generated traffic is expected to emerge as soon as the road is upgraded and open to traffic. Two categories of traffic change may be generated by road construction. First there may be a modal shift in which low cost movements are replaced by higher cost movements, reflecting a the change in the mode rather than the quantity of trips. Secondly, additional trips may be undertaken solely as a result of better accessible roads, thereby reducing in trip cost i.e. lower VOCs and travel time. This phenomenon takes place in ROSS, as demand for the transportation increases as its cost decreases, which yields savings to the road users.

Currently, agricultural activities and passenger mobility are low due to the bad condition of the existing road. Thus, generated traffic is the induced traffic which will use the road following road construction or improvement that would not occur without the project road. These changes may lead to new or increased economic activity or higher volumes of consumption or marketed products, or increased frequency or new patterns of personal trip making, leading to increased passenger traffic. It is obvious that there will be an increase in agricultural product in the project

area, the nearby project areas and the country at large, given that this road is highly influenced by the import and export activity of the county, the road being the alternative import export corridor. The construction of the road will have a positive impact in increasing the income of the surrounding farmers and thereby will result in more demand of industrial commodities by farmers because of augmented income. Thus, it can be concluded that generated traffic will be significant since the existing road cannot handle additional requirement of the different vehicles as a result of the economic activity in the long-term period of the project life. In this regard, experience shows that estimated generated traffic generally varies between 15 % and 30% of the normal traffic.

However, it is noted that this approach will only under-estimate the true potential of the project area in agricultural production and population growth. As such, the population growth and agricultural production forecast is studied for the project to characterize likely scenario of passenger and freight. The analysis to calculated generated traffic is made and the same is depicted hereunder.

The relevant county for the project in Warrap State is Gogrial West County. The agricultural surplus for the project catchment area (taken from **Section 5.5**) is depicted hereunder; **Table 5.4-17A**has served as the basis to estimate truck traffic.

Table 5.4-17A: Generated Freight Traffic from Agricultural Surplus & Population Forecast

Cultivated Crops	Five Years Projection on Staple Crop Production in the targeted areas (tons)														
	Y1 (2017)			Y2 (2018)			Y3 (2019)			Y4 (2020)			Y5 (2021)		
	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus
Cowpeas	77.99	18.20	59.80	81.19	18.54	62.65	84.50	19.30	65.21	87.95	20.08	67.87	91.52	20.90	70.62
Sorghum	557.80	127.39	430.41	580.62	132.60	448.02	604.35	138.02	466.33	628.99	143.65	485.34	654.52	149.48	505.04
Maize	155.99	30.53	125.46	162.37	37.07	125.30	169.01	38.59	130.42	175.90	40.16	135.73	183.04	41.79	141.24
Groundnuts	311.98	61.28	250.70	324.74	74.42	250.32	338.02	77.46	260.55	351.79	80.62	271.17	366.07	83.89	282.18
TOTAL (ton)	**1103.8**	**237.4**	**866.4**	**1148.9**	**262.6**	**886.3**	**1195.9**	**273.4**	**922.5**	**1244.6**	**284.5**	**960.1**	**1295.1**	**296.1**	**999.1**
Small Truck		15%	37		15%	38		15%	40		15%	41		15%	43
Medium Truck		20%	23		20%	24		20%	25		20%	26		20%	27
Heavy Truck		30%	22		30%	22		30%	23		30%	24		30%	25
TT		35%	15		35%	16		35%	16		35%	17		35%	17
Total return trips		**100%**	**97**		**100%**	**99**		**100%**	**103**		**100%**	**108**		**100%**	**112**

Average HH No		1,857		Small Bus	20%	43
Average Size of HH		7		Medium Bus	35%	34
Total Population		12,999		Large Bus	45%	19
Active Population	0.2	2,599.8	**Total Passenger Traffic (2017)**		**100%**	**97**

It was assumed that the trucks will divide the freight in the ratio 15:20:30:35while the buses will divide the passengers estimated to be worthy of travelling in the ratio 20:35:45 as shown in the table above. It was assumed that the generated traffic in respect to cars and utilities will be only 20% of the normal traffic for the respective vehicle types. Finally, **Table 5.4-17B** summarizes the total generated traffic that covers the potential of the project influence area by considering population growth and agricultural surplus from the farms in the vicinity of the project. A considerable amount of the demand comes from the generated traffic for the feeder roads under consideration. In order to avoid over-estimation of the generated traffic resulting, only 50% of the estimated demand is considered as viable generated demand, owing to data limitations in forecast.

Table 5.4-17B: Generated Traffic

Section of the Road	Length (km)	Generated AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Achol Pagong - Macoc Pagong (0+000 to 13+000)	13	0	8	22	17	10	19	12	11	8	**105**
Macoc Pagong – Ayien (13+000 to 26+600)	13.6	1	5	22	17	10	19	12	11	8	**103**
Ayien - Jong Lual - Panliet (26+600 to 38+600)	12	2	2	22	17	10	19	12	11	8	**101**
Achol Pagong - Macoc Pagong - Ayien - Panliet (0+000 to 38+600)	**38.6**	**1**	**5**	**22**	**17**	**10**	**19**	**12**	**11**	**8**	**103**

5.4.7.3 Diverted Traffic

Diverted traffic represents traffic that diverts to the project road from alternative roads, while at the same time, keeping the same origin and destination as before. As clearly indicated under the TOR

for the study, the aim of the project is to implement about 30km of feeder road. During the analysis of Origins and Destinations using O/D Matrix, it was noted that the project road may be a possible alternative to travel from Achol Pagong to Panlieth. However, as travelling from Achol Pagong to Panlieth through the project road will be at least twice in length via Mayom Tiotin than via Ayien, traffic diversion will not be possible. As such, diverted traffic is excluded from this study.

5.4.7.4 Opening Year AADT

The resulting summary of AADT establishment is shown hereunder in Table 5.4-18.

Table 5.4-18: Opening Year AADT

Total AADT 2017 By SECTION

Section of the Road	Length (km)	AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Achol Pagong - Macoc Pagong (0+000 to 13+000)	13	0	48	22	17	12	30	24	30	11	**195**
Macoc Pagong – Ayien (13+000 to 26+600)	13.6	6	31	22	17	11	26	18	22	11	**164**
Ayien - Jong Lual - Panliet (26+600 to 38+600)	12	12	14	22	17	11	21	12	15	10	**133**
Achol Pagong - Macoc Pagong - Ayien - Panliet (0+000 to 38+600)	**38.6**	**6**	**31**	**22**	**17**	**11**	**26**	**18**	**23**	**11**	**164**

Total AADT 2017 By WHOLE PROJECT

Type of Traffic	Car	Utility	S. Bus	L. Bus	M. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM
Normal Traffic	5	26	0	0	2	7	6	12	3	61
Generated Traffic	1	5	22	17	10	19	12	11	8	103
Diverted Traffic	0	0	0	0	0	0	0	0	0	0
Recommended AADT	**6**	**31**	**22**	**17**	**11**	**26**	**18**	**23**	**11**	**164**

5.4.8 Project Schedule

The analysis period for the project has been considered as 20 years starting after the completion of the improvement, and opening the Project Road to traffic. In this context, the project schedule is envisaged as described in **Table 5.4-18**.

Table 5.4-18: Proposed Project Implementation Schedule

Activity	Period
Feasibility Study	March. 2015
Detailed engineering and bid document preparation	Sept. 2015
Bidding and contractor selection	Sept. 2015 – Dec. 2015
Implementation (1.5 year)	Jan. 2016 – Jun. 2017
Opening to traffic after implementation	July 2017
Traffic service period (20 years)	2017 - 2037

5.4.9 Traffic Projection

The growth scenario of the travel demand based on realistic assumptions is used fortraffic projection. The projection of traffic based on the realistic economic growth scenario is shown hereunder.

Table 5.4-19: Traffic Projection on Project Road

Demand estimation for upgrading to Feeder Roads Standard

Traffic Projection on Achol Pagong - Macoc Pagong - Ayien - Jong Lual - Panleit Road (Realistic Situation)

Counter	Year	Projected ADT										LVRD Design Standard
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM	
0	2017	**6**	**31**	**22**	**17**	**11**	**26**	**18**	**23**	**11**	**164**	DC-4
1	2018	6	33	23	18	12	27	19	24	11	**172**	DC-4
2	2019	6	35	24	19	12	28	19	24	12	**181**	DC-4
3	2020	7	37	26	21	13	29	20	25	12	**190**	DC-4
4	2021	7	40	27	22	13	30	21	26	12	**199**	DC-4
5	2022	8	42	29	23	14	31	22	27	13	**209**	DC-4
6	2023	8	45	31	25	14	32	23	29	13	**219**	DC-4
7	2024	9	47	33	26	15	34	24	30	14	**230**	DC-4
8	2025	9	50	35	28	15	35	24	31	14	**242**	DC-4
9	2026	8	45	31	25	15	33	23	29	14	**223**	DC-4
10	2027	8	47	32	26	15	34	24	30	14	**231**	DC-4
11	2028	9	48	33	27	16	36	25	31	15	**239**	DC-4
12	2029	9	50	35	28	16	37	25	32	15	**247**	DC-4
13	2030	9	52	36	29	17	38	26	33	15	**255**	DC-4
14	2031	10	54	38	30	15	34	23	30	14	**247**	DC-4
15	2032	10	57	39	31	15	35	24	30	14	**255**	DC-4
16	2033	11	59	41	32	16	35	24	31	14	**263**	DC-4
17	2034	11	61	42	34	16	36	25	31	15	**271**	DC-4
18	2035	12	64	44	35	16	37	25	32	15	**279**	DC-4
19	2036	12	66	46	36	16	37	26	32	15	**288**	DC-4
20	**2037**	**12**	**69**	**47**	**38**	**17**	**38**	**26**	**33**	**16**	**296**	DC-4

Growth Rates

Realistic Scenario

Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T
2015 - 2025	**6.0%**	**6.0%**	**6.0%**	**6.0%**	**4.0%**	**4.0%**	**3.90%**	**3.90%**	**3.9%**
2026 - 2030	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**3.0%**	**3.0%**	**2.9%**	**2.9%**	**2.9%**
2031 - 2035	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**
2036 - 2040	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**

This section of the report has established that the project road under investigation caters for a significant level of travel demand resulting from planned and on-going agricultural activities in the vicinity. The AADT at project opening (at 2017) which amounts 164 vpd (by 2017), after 15-years of service becomes 296 (by 2032). Even at a relatively flat growth rates adopted for the project ranging between 2% to 6% for different vehicle types, the project road has still managed to fall within the boundary of a DC-4 standard according to the South Sudan Roads Authority, Low Volume Roads Design Manual (Sept. 2013). As such, the DC-4 design standard has been adopted for Preliminary Engineering Design during the Feasibility Study. However, the traffic results obtained are suggested to be validated during detail design by the external Engineering Design Consultant, by conducting classified manual traffic survey at the selected locations and projecting the traffic levels into the design period for final adoption of appropriate design standard for the feeder road under investigation.

5.5 Socio-Economic Assessment

5.5.1 Socio-economic Assessment Objective

As per the Project TOR, the overall objective of the socio-economic impact assessment (SEIA) is to identify and analyze the potential impact of the proposed feeder road construction activity and recommend initiatives, realize sustainable development opportunities as well as to mitigate the negative impacts. The core objective is to justify the selection of the prioritized road based on feasibility of the extent and nature of the socio-economic impact of the investment involved.

5.5.2 Review of the Project Areas: Warrap State, Gogrial West County

This section highlights the general administrative, geographical and socio-economic characteristics of the feeder road project's catchment areas, Gogrial West County, the road section areas **Achol Pagong-Ayen/Panliet** at Warrap State.

5.5.2.1 Catchment Areas and Administrative Structure

The proposed rural road project impact areas fall under the local administration of the Gogrial West County, Warrap State, and South Sudan. The project section links two Payams, namely Mayom Pagong of Gogrial West County and part of Ayen Boma, Turalei Payam of Twic County. The proposed road shall connect village markets that include; MayomTiotin, Achol Pagong, Det, Makuach, Majok, Ayien and other villages adjacent to and at certain distance from the proposed road section.

5.5.2.2 Socio-economic characteristics

The target communities under the proposed road project's influence areas have homogeneous socio-economic characteristics.

A. Social Characteristics

The communities in the project influence area are closely settled into clusters of villages along the proposed road side, and some at certain distance of about ½- 1 hour walk on average. The socio-economic team could not find any statistical information at the Payam or Boma level that can be used as benchmarks for comparisons. According the local Boma chief, each village cluster has an estimate average of 40-60 households. The only statistical data the team could access is the SORUDEV State level baseline survey which is assumed to equally apply at Boma or village level. Accordingly, the average household size is 7.2 persons. The total population is composed of 49.6% male and 50.8% female.

Based on Key Informant Interviews (KII) and Focus Group Interviews (FGI), the local community under consideration has poor and inadequate access to rural services and infrastructure. The Boma level primary school and health facilities are poor in quality and scope of services.

According to the local health officer, women and children under five are the most vulnerable group to diseases. The common diseases are malaria, typhoid, skin diseasea and diarrhea. There exist only three PHCUs and four primary schools that are unreachable during the rainy season. As indicated in Table-1, the communities have to cover an average of **13km, 11km** and **15km** distance to access the Mayom Pagong, Ayienand Panlieth health and school services respectively.

Although both boys and girls are assumed to have equal opportunities to education, girls remain marginalized due to cultural practices, household domestic work and road condition. In addition, education studies have found that distance to school and the opportunity cost of enrolling a child to school are negatively correlated with child (particularly girls) school enrolment rates. According to the local education inspector, early girl child marriage, the distance covered and household labor-burden on girls negatively affect the female access to education.

The largest segment of the local people has no social assets of great significance such as bicycle, animal-drawn cart, motor bike, donkey, radio and telephone. Footing is the leading means of transport, readily followed by bicycle-ride and motorbike among in few individuals.

B. Food Security and Livelihood

Agriculture is the major livelihood for target communities. According to an African Development Bank (ADB) study (2013), 84.1% of Warrap State households primarily rely on agriculture and livestock. Based on the SORUDEV baseline survey, traditional crop production supports 73.5% of households, although most households do not access basic productive assets such as ox-ploughs, extension services, improved seeds, fertilizers and pesticides. Sorghum, groundnuts and sesame are the most important staple crop production. Crop farming is at subsistence level due a numberof agricultural constraints; lack of rural transport infrastructure remain a major challenge.

5.5.3 Key Findings of the Socio-economic Assessment (SEIA)

The impact assessment studies showed how poor rural transport infrastructure seriously affects rural households' poverty, agricultural production and food security. The study conducts descriptive analysis on how rural road investment promotes food security, build resilience and improve the local livelihoods.

5.5.3.1 Poor Rural Road as Key Driver of Rural Food Insecurity

87%of the rural people on the sphere of the road project influence rely on rain fed subsistent agriculture (AfDB/IAP, 2013). The heavy reliance on the precarious nature of rainfall, manual labor with rudimentary farm tools and other potential constraints entail high risk of crop failure. This phenomenon coupled with poor rural infrastructure, worsens rural food insecurity, vulnerability and livelihoods. The lack of road infrastructure drives rural poverty on direct and indirect dimensions, as described below.

Poor transport access to basic services

Rural service and infrastructures are extremely poor and inadequate in the project vicinity. The subsequent rural remoteness in spatial, physical and social terms is translated into high transaction costs of travel, time and distance covered to access basic services, perpetuating rural poverty. Local people perceive poverty in terms of the distance covered to reach the basic social services.

Table 5.5-1: Access: Distance Covered to Basic Service : Per person/trip

S.r	Basic Service access	Acr	Unit	Average distance /T	Number of Trips	Total Aver Distance	% of average total distance covered
1	Boma head Quarter	BHQ	Km	3	2	6	11%
2	Payam head Quarter	PHQ	Km	4.5	2	9	16%
3	Primary Health Care	PHCU	Km	0	2	0	0%
4	Health Center	HC	Km	10	2	20	36%
5	Kuajok hospital	MPHSL	Km	0	2	0	0%
6	Water Supply point	WSP	Km	0	2	0	0%
7	Primary School	PSCL	Km	0	2	20	0%
8	Secondary School	SSCL	Km	10	2	20	36%
	Average total			**27.5**		**55**	**100%**

Table 5.5-1 shows that the target communities travel the longest **average** distance **(20km)** to access health centers, primary and secondary school, followed by Payam head quarter **(9km).** Drinking water, primary health and education services are at the shortest distance, less than 1kmor at homestead (0km). Potable water supply points are mostly available at a settlement cluster level while primary health care and education access are witnessed in every Boma level. The social services have inadequate scope and quality of service delivery, and provide services to widely scattered population in the project influence areas.

With regards to **education**, various social studies showed that illiteracy, measured by the population age 15 with no education, is more prominent in regions where the distance to primary school is more than 2kmfrom homesteads. Studies have found that distance to school and the opportunity cost of enrolling a child into school all correlate negatively with child (particularly girls) school enrolment rates.Table-1 shows that the distance to primary school is quite far, at an estimated 20km from homesteads. This scenario is more complicated when the post-primary child grows between 14 to 15 years old, since the age of going secondary school corresponds to the

critical age for joining the farm child labor force. Children's enhanced opportunity cost of attending secondary school impairs the chance of child education, which ultimately impedes the development of human resource capacity. It is worth noting that the child post-education contributes to entrepreneurship skill development such as better crop husbandry, agro processing technique and marketing skill. The low level of post-primary education, therefore, confines rural households into food insecurity and a poverty cycle.

Health services are crucial for household and community stability. The most disease vulnerable groups are women and children, which constitute about 80% of the farm Labor (AfDB/IAP, 2013). Access to health services is more important at the time of agricultural season, at a time when the occurrence of the diseases is critical. Poor access and quality of health delivery, coupled with disease seasonality, adversely impact the active farm labor availability and productivity, with women being the most disease-prone group. As noted in Table-1 above, the distance to the health services is 20km. This situation reflects the high demand of effort, time and cost for hospital travel. Table 5.5-2 depicts the time spent to access the social services.

Table 5.5-2 Access: Average Time Spent Per person-Footing

S.r	Basic Service access	Acr	Unit	Average per capita time spent	% of Per head daytime working	% of average total cost
1	Boma head Quarter	BHQ	hrs	1	13%	16%
2	Payam head Quarter	PHQ	hrs	1.3	16%	21%
3	Primary Health Care	PHCU	hrs	2	25%	24%
4	Health Center	HC	hrs	2	25%	32%
5	Kuajok hospital	MPHSL	hrs	0	0%	0%
6	Water Supply point	WSP	hrs	0	0%	0%
7	Primary School	PSCL	hrs	0	0%	0%
8	Secondary School	SSCL	hrs	2	25%	32%
	Average Total			**6.3**	**79%**	**100%**
	Average Total			**0.7875**		

Source: Aggregated from Local Boma Chief and FGI

In Table 5.5-2, it can be noted that the local people spend 32% of their daytime working hours to access health and education facilities. Primary schools and Payam headquarters access claim 24% and 21% of daytime working hours respectively. The long journey to the hospital involves high cost of transport and energy to the community, in particular the most disease susceptible group (women, the elderly and children under five). What is more, the longer the distance to the services, the more likely households are to resort to alternative, poor quality health services and drop out of school.

Social and economic costs rise with persistent disease cases, in particular among women. Farm labor shortages due to human disease are a key impediment to increasing cultivated land area and production. This scenario is indicative of the fact that the poor rural road infrastructure adversely affects the households' food security.

The majority of households have neither non-motorized nor motorized transport. Walking long distances to access services is difficult. A few local motorbike owners provide transport to the local community. As depicted in Table 5.5-3, the costs of access to the basic services are very high, with access to the secondary school costing SSP 18.5, primary health care SSP 6 and Boma headquarter SSP 5.5. Given the fact that 64% of the community in the project influence area lives

below the poverty line (5th SPHC, 2008), transport costs can be classified as extremely high. The low quality of rural services leads to shortage of healthy and productive human resources, which in turn engulfs the community into poverty and a food insecurity trap.

Table 5.5-3: Passenger transport cost/motor bike to basic services

Basic Service access	Acr	Unit	Average cost /T/head	Number of Trips	Total Aver cost	% of average total cost
Boma head Quarter	BHQ	trip	2.75	2	5.5	6%
Payam head Quarter	PHQ	trip	9.25	2	18.5	19%
Primary Health Care	PHCU	trip	3	2	6	6%
Health Center	HC	trip	6.25	2	12.5	13%
Kuajok hospital	PHSL	trip	NA	NA	NA	NA
Water Suppy point	WSP	trip	0	2	0	0%
Primary School	PSCL	trip	0	2	0	0%
Secondary School	SSCL	trip	9.25	2	18.5	19%
Average total			**49.75**		**99.5**	**100%**

Source: Aggregated from Local Boma Chief

Poor market and productive sector access

Access to markets and the productive sector is key to enhancing rural farmers' income, food security and poverty alleviation. The lack of transport infrastructure is automatically translated into increased transaction costs of producing and marketing for the rural community. Households are badly in need of the basic farm inputs such as seeds, farm tools, extension service, micro-credit facilities fertilizers and pesticides at the onset of every farming season (May-August). The high transport costs to the market directly undermine the livelihood activities and food security of the households.

Small-holder farmers own crop produce meets only on average four months (September-February) of the household cereal food consumption needs. As such, rural households heavily rely on market supply for ¾ of their food crop consumption needs at the critical hunger periods (March-July). First-hand information acquired from target farmers in the field shows that market recourse is quite limited. The potential market options vary seasonally and spatially.

Juba, the national central market, is the most important/First Option destination for agricultural output, inputs and basic consumer goods. The poor transport and road infrastructure considerably restrict smallholder household connection to the Juba central market. During the rainy period, the main Kuajok - Wunrok trunk and Mayom Pagong - Ayien/Panlieth feeder road routes are impassable. The blockage of the primary market routes denies the communities access to basic food consumption needs and economic services at time of critical demand. The interplay of market forces drives up the transport cost of market travel, commodities purchase and freight.

Table 5.5-4reflects passenger travel and freight transport cost. The below-stated transport costs consider only travel costs from the target village to the Kuajok - Wunrok trunk road junction point since the transport transaction along the main trunk road is beyond the scope of this rural road project. The figures in the table indicate that the cost of passenger travel to first-option market increases by 85% in the rainy season, and freight cost similarly shoot up by 85.7%.

Table 5.5-3: Average Transport Cost to Market Option: Passenger and Good(50Kg), in SSP

S.r	Season	Market Option-1		Market Option 2	
		motorbike		motorbike	
		Passenger	Good	Passenger	Good
1	Dry	27	35	30	40
2	Rainy	50	65	40	50
	Total	**77**	**110**	**70**	**90**
	Average	**38.5**	**55**	**35**	**45**
%	**increase**	**85%**	**85.7%**	**37%**	**37%**

Source: Local Boma chiefs and business owners' data from field

Table 5.5-4: Staple food crop/Sorghum/ Purchase Market Price/Kg

S.r	Season	Unit	**Option-1**	**Option 2**
			Sorghum	**Sorghum**
1	Dry	1Kg	2.25	2.75
2	Rainy	1Kg	2.95	4.8
	Total		**5.2**	**7.55**
	Average		**2.6**	**3.76**
%	**increase**		**31%**	**75%**

Source: Local Boma chiefs and business owners' data from field

The coincidence of market food dependence with heavy rainfall holds high risk of food insecurity, vulnerability and poor livelihoods. During the dry season, staple food, cereal and sorghum prices usually plummet by an estimated 31% and 75 % at first and second option market respectively (refer to table-4). At the first market option, the rapid food price rise seriously reduces the poor households' food purchase power by 23.7%, from 44.44 Kg to 33.9 Kg of sorghum. Meanwhile, at the second option market, the food purchase power drops by 42.7%, from 36.36 Kg to 20.83Kg of sorghum. These looming socio-economic conditions are potential indicators of the realities of poor rural road networks as a primary driving force of rural food insecurity, poverty and low livelihood status.

5.5.3.2 Poor Rural Road as Key Driver of Low Rural Livelihood Status

Feeder road access to markets is poor during the critical food insecurity period in parallel with the heavy rainfall season. The assets selling prices also dramatically decline at the peak lean season (June-July) due to increasing market supply of the smallholders commodities and lack of demand due to food insecurity. Table 5 indicates that the goat sale price decrease by 29% and 40% in market option 1 and option 2 respectively during the rainy period.

Table 5.5-5: Goat Market Sale Price

S.r	Season	Unit	Market Option-1			Market Option-2		
			Dry	Rainy	% Price decrease	Dry	Rainy	% Price decrease
1	Goat	Head	295	235	**20.3%**	255	145	43.14%

This situation drops the goat to sorghum Term of Trade (TOT) and puts poor households in a disadvantaged position in terms of the amount of sorghum they can get by selling a goat. It implies that small farm holders' goat to sorghum term will drop from 131 Kg to 80Kg of sorghum for a goat sold in peak hunger season.

5.5.4 Socio economic Impact of the Rural Road Investment

Empirical models revealed that rural services, infrastructure and agricultural productivity have strong positive correlation with increases in food crop(s) production, address household level food availability and improve livelihood in a more direct manner. The study will discuss the effect that each category of improved rural road infrastructure and services have on rural agricultural productivity, incomes and food security.

5.5.4.1 Connectivity Role of the Road Network

The rural feeder road condition and scope of connectivity have direct relationships with smallholder farmers' social services, market access, economic opportunities and trade objectives.The proposed access road shall play a critical role in high profile inter and intra-connectivity at the community level. The road construction bears great potential of linking:

- A number of villages to their respective Boma/smallest administrative unit.
- Bomas to respective Payams headquarters.
- Bomas to central basic social services (Kuajok, State capital).
- Villages to Achol Pagong – Ayien, to main road at Panlieth junction and potential market places further afield.

Table 5.5-6: Connectivity to Potential Market Options: Road Project Influence Areas

S.r	Target Village	Market Option-1				Market Options-2			
		Dry Season		Rainy season		Dry Season		Rainy Season	
		Road Route	Distance(Km)	Road Route	Distance(Km)	Route	Distance	Route	Distance
1	Mayom	Ma-Ach	10km	Achol-Mak-Ayien-Panlieth	29km	NA	NA	NA	NA
2	Achol	Ach-Mayo	10km	Achol-Mak-Ayien-Panlieth	29km	NA	NA	NA	NA
3	Makuac	Ma-Ach-Ma	5.5km	Achol-Mak-Ayien-Panlieth	29km	NA	NA	NA	NA
4	Ayiel	Ayien-Panlieth	13.5km	Achol-Mak-Ayien-Panlieth	29km	NA	NA	NA	NA

Source: Local Boma chiefs and FGI

Table 5.5-7: Comparison of Market access time: Before and After Project

S.r	Target Village	Market Access(Time in hours)		% Time Saving
		Before	After	
1	Mayom	3	0.55	-82.0%
2	Achol	2	0.15	-93.0%
3	Makuac	6	0.55	90.0%
4	Ayien	7	1.55	-78.0%
	Average			-41%

Source: Local Boma chiefs, March 2015

Feeder road connectivity is expected to drop access time to the potential market by an average of 41%. This is a good indication of the high advantage of reducing the cost of transporting, purchasing farm input, producing and gaining better rural services which collectively enhance rural food security, income and livelihood.

There exists no established baseline information on the use of the social services. Based on general consensus, it is believed that the closer the service center, the more rural farmers will make use of the road. Based on the study findings, the connectivity is expected to have significant rural service impacts, which can be expressed later in quantifiable indicators. The lack of established benchmarks, time series data and sufficient socio-economic data make the pre-projection difficult.

S.r	Key Impact Indicators
1	Increase in number of the feeder road users- local people
2	Increase in volume of non-motorized and motorized-traffic
3	Increase in number and frequency of people access to market
4	Number and frequency of public transport travel
5	Volume of agricultural output and inputs transported to and from
6	Number of community awareness raising activities and capacity building training conducted
7	Number of local administration and community meeting
8	Volume of agricultural produce at market collection centers
9	Volume of consumer goods traded to and from the areas
10	Number of new business establishment at the areas
11	Number of new employment opportunities

The high degree of road investment driven linkages will create, develop and foster substantial momentum for social interaction, social security, safety, inclusiveness, unity, integrity, collaboration, communication, equal and balanced distribution of resources and opportunities. The impetus indispensably supports strengthening of local leadership and organization, economic empowerment of small farmers, better access to market and institutional support, sharing and dissemination of marketing knowledge, skill and information. The transformation process promotes increasing agricultural production, innovative entrepreneurship, rural poverty alleviation, food security and sustainable livelihood development.

5.5.4.2 Social and Gender Development

Education and health services are important for enhancing the quality and hence productivity of human capital. The investment in road infrastructure is thus the local need-tailored response to address the alarming social and gender issue, at the proposed project area. Lifeline services, already limited in scope are barely accessible by local communities due to lack of transport facilities. Attempted access to central services entails increased cost, time and effort for local communities. A responsive rural feeder road network is a core solution to life threatening social and gender concerns.

5.5.4.3 Social Analysis

The rural feeder road project is expected to play a critical role in improving the social development of the target communities. The travel-time savings represent the key direct social impact. The construction of the feeder road is anticipated to dramatically reduce the time spent accessing basic social services. After the project, the target communities' average access time to rural service is expected to fall by 44%, assuming the former Sudan 45km /hour speed limit for public transport moving on rural rough road network is maintained.

Table 5.5-8: Comparative Time-spent before and after project

				Average	Before Project	After Project-Car	% Decrease
S.r	Basic Service access	Acr	Unit	Distance	Av time spent	Av time spent	in Time-spent
1	Boma head Quarter	BHQ	hrs	2	0.54	0.044	-96%
2	Payam head Quarter	PHQ	hrs	4	0.54	0.089	-91%

3	Primary Health Care	PHCU	hrs	5	0.55	0.111	0%
4	Health Center	HC	hrs	5	0.55	0.111	-89%
5	Kuajok hospital	MPHSL	hrs	0	0	0.000	0%
6	Water Supply point	WSP	hrs	0	0	0.000	0%
7	Primary School	PSCL	hrs	0	0	0.000	0%
8	Secondary School	SSCL	hrs	12	2	0.267	-73%
	Average Total			**28**	**4.18**	**0.62**	**-44%**

Source: Consultant aggregation from KII and FGI

5.5.4.4 Gender Analysis

Time factor is among the major challenges to girl child education in the area. The girl child is culturally overburdened with household activities. The longtime taken to reach school has automatically resulted in girl school denial or drastic dropouts. Shorter travel times needed to get to school encourage significant school age girl enrolment. Poor roads also mean higher risks to the safety and security of girls going to school and once roads are improved that risk is significantly reduced and girls retention at school increased.

The rural road investment is a vital mechanism of promoting gender equality and development. Since girl child education is a dynamic tool for positive attitudinal and behavioral change in the local socio-cultural context, generating sustainable community development. The female primary pupils drop out is expected to be less the current reported rate at Ayien primary school of 40%.

5.5.4.5 Food Security and Livelihood Analysis

The rural road network intervention significant contributes to poverty reduction, food security, community resilience building and sustainable livelihood development. The project's benefits are wide felt in direct, indirect, induced and generated dimensions.

A. Food Security

Part of Northern Bahr el Ghazal, Warrap, Unity and Lakes State lay on the Western Flood Plains agro-ecological zone, which is identified as the most important livelihood zone in terms of cropland distribution at national level. The zone provides 34.2% of national cropland and 24.2% of national cropland mixed with grass and tree (Diao et al. 2012). This zone records the highest ratio of cropland over total land[1].The road project area, territorially part of Warrap State, is thus among the most important livelihood zone.

87% of households primarily rely on traditional crop farming or animal rearing. In spite of the vast potential agriculture land, smallholders cultivate only small farmland. The household's average cropland holdings is limited to 1- 6 feddans.

Family members (women and children) are one potential source of manpower for expansion of cropland cultivation. As indicated in Table 5.5-8 above, 44% of average time–saving gained from improved transport access is anticipated to be productively invested on increasing farmland plantation and production, assuming no seasonal opportunity cost of marginal rural labor is forgone elsewhere in the economy. This is expected to realize the households' food self-sufficiency and drive development.

The feeder road construction project is also expected to reduce passenger ticket prices by an average of 20%. The effect is anticipated to positively influence small farmer's accessibility and mobility to the potential market place and productive activities.

Table 5.5-9: Comparative Transport-cost Before and after project, in SSP

Basic Service access	Acr	Unit	Average Cost Before Project	Expected Cost After Project	Expected Decrease Passe Av. Transport cost
Boma head Quarter	BHQ	trip	1.95	1.21	21%
Payam head Quarter	PHQ	trip	3.66	1.29	97.4
Primary Health Care	PHCU	trip	0	0	0%
Health Center	HC	trip	5.88	3.68	65%
Kuajok hospital	MPHSL	trip	0	0	0%
Water Supply point	WSP	trip	0	0	0
Primary School	PSCL	trip	0	2.16	0
Secondary School	SSCL	trip	3.45	5	78%
Total			**14.94**	**13.34**	
Average Travel cost			**1.8675**	**1.6675**	**20%**

Table 5.5-10: Comparison of Staple Crop Production: Before and After Feeder Road Operation

Cultivated Crops	Av. Farm use(ha)		Av yield /ha/HH/ton	Average total Production		% increase estimated Production
	Before Project	After Project		Before Project	After Project	
Cowpeas	0.83	0.84	0.104	0.08632	0.08736	0.012
Sorghum	1.11	1.26	0.168	0.18648	0.21168	0.14
Maize	0.4	0.84	0.31	0.124	0.2604	1.1
Groundnuts	0.61	1.68	0.31	0.1891	0.5208	1.75
	2.95	4.62		0.49958	0.99288	75%

Source: Consultant Estimate based on local Boma Chief and Farmers

The construction and maintenance of the rural feeder road is expected to increase smallholder farmers' staple crops production volume. As shown in Table 5.5-10, sorghum and groundnuts harvest, which are the most predominant staple food crops, are anticipated to rise by 0.14 and 1.75 points respectively, at the initial year of the intended rural feeder road use/ operation, while cowpeas and maize are predicted to increase by 0.012 and 1.1 points respectively after the start of the road. This promising increase in production can be attributed to the road connectivity enabling better access to market, alongside improved seed variety, cheap farm tools and implements, extension support, innovative farming knowledge and skills, marketing information, agribusiness and trade development initiatives. The combined impact is expected to increase the farmers' income, food security, nutrition and sustainable livelihood. The improved road access is expected to boost the aggregated farm harvest by 75% on average.

B. Market Access and Livelihood

Access to the potential market destination stimulates small farmer productivity and income from increased volume of agricultural product sales. The market access creates its own supply, empowers small farm holders economically, and builds self-esteem and innovation.

Table 5.5-10 : Summary of Staple Crop Net Production Surplus (tons)-Five Years projection

Cultivated Crops	Five year Projection Staple Crop Surplus Production Summary (Y1-Y5)-ton					Total Surplus Production	Post Harvest Loss(20%)	Net Surplus (ton)
	Y1	Y2	Y3	Y4	Y5			
Cowpeas	60	63	65	68	71	326	65.228	261
Sorghum	430	141	147	153	159	1032	206.31	825
Maize	125	125	130	136	141	658	131.63	527
Groundnuts	251	250	261	271	282	1315	262.99	1052
Total	866	580	603	628	653	3331	666.15	2665

Source: Aggregated projection by Field Team

The above production projection is based on logical assumptions that the project influence area lies on the highest agricultural potential agro-ecological zone of South Sudan. Successful achievements of the Norwegian Refugee Council (NRC) in implementing project's strategic objectives including; better access to extension, improved farming practices (animal traction), farmer organizations and market connection funded under SORUDEV program. The feeder road induced anticipated opportunities and the general principles of supply creates its own demand.

Table 5.5-11: Cost of Farm Production: After the Project

Cultivated Crops	Av Farm use(ha)	production cost per hectare	Total cost of production , in SSP	Av yield farm cultivated(ton)	Unit cost estimate of production(ton)
Cowpeas	0.84	1575	1323	0.05	26460.0
Sorghum	1.26	1575	1985	0.1125	17640.0
Maize	0.84	1575	1323	0.1	13230.0
Groundnuts	1.68	1575	2646	0.1	26460.0
Total	4.62	6300	7277	0.36	83790.0

Source: Estimation by Field Team

Table 5.5-12: Small farm holders' Projected Net Income (5Years): After Rural Feeder Road Operation

Cultivated Crops	Net Surplus (ton)	Average Sell Price (ton),SSP	Total Sales	Total Cost	Net Income
Cowpeas	261	19	4,957	3718.005	1,239
Sorghum	825	21	17,330	12997.57	4,333
Maize	527	19	10,004	7502.906	2,501
Groundnuts	1,052	62	65,220	26460	38,760
Total	15,976		97,512	50,678	46,833

Source: Consultant estimation

The net income projection is calculated based on the crop prices prevailing at the first option market access. The improved feeder road infrastructure is expected to reduce the high farm operation cost and encourage economies of scale, farmers' organizations and collective marketing. As noted in table-13, groundnut is the highest income generating cash crop (83%) with an average return of SSP 38,760 in the first five years of operation. The farmers have gained a net income of SSP 46,833 in the first five years of operations. The level of net profit has a low margin in monetary terms at least for the short-run. The short-term impact is low with great opportunities for development. In the short-term, low knowledge, skill and experience of farm management,

market information, network, negotiation power and group organization are major concerns. However, farmers' lessons learned on market engagement are worthwhile implicit benefits.

C. Institutional Arrangement

The road project design and implementation frameworks meet the necessary institutional requirements. Rural food security and livelihood support initiatives rest at the forefront of the EU Aid program.

The program preconditions requiring the alignment with host government's prioritized development policies, needs and plan of action are well met.

The government of the Republic of South Sudan (RoSS) endorsing the food and agriculture policy framework (2011-2016) and National Agriculture and Livestock policy, identified Food and Agriculture development as one of the six top spending priorities in South Sudan's 2011-2013 Development Plan. These government policies and strategies are supportive of the EU's ZEAT and BEAD programs.

The EU support terms also consider the broad coordination, consultation and communication requirements with potential stakeholders at all levels. Relevant actors, such as the State Ministry of Agriculture and Forestry, State Ministry of Physical Infrastructure, NRC -NGOs (operating on ground in particular), local county commissioner, Payam inspectors, Boma chiefs and community representatives at the grass-root level have been engaged in a practical, dynamic and interactive approach, throughout the proposed rural road project planning.

The road project objectives comply with the strategic development policy and priorities of the key partners. The EU's rural road construction at the proposed project areas is aligned with the EU's ZEAT and BEAD programs objectives of strengthening smallholder food security and livelihoods.

The project design and implementation documents are produced as part of a professional ethics based logical and integrated approach.

D. Stakeholders Analysis

The project key stakeholders are assessed to ensure the successful design and implementation capacity.

Project Lead Body

United Nation for Project Services (UNOPS) is the lead UN agency on sustainable infrastructure development. UNOPS' vast experience in South Sudan coupled with high quality expertise in project management principles and practices ensures client-oriented, sustainable, logical and integrated project end-result.

Local Administration

The local administration has expressed commitment to support the project. The local commissioner, Payam inspectors and Boma chiefs shall take bold initiatives to coordinate, contribute and provide security throughout the project phase.

Relevant line Ministries

The State of Ministry of Agriculture and Forestry provides institutional support to farmers. In collaboration with potential development partners, the Ministry is involved in strengthening the smallholders' innovative labor-based farming techniques, introducing new seed varieties, and offering extension and marketing support by assigning extension agents at the county and Payam level. Increasing the numbers and building the capacity of extension agents is important to broaden and sustain the scope of service.

The State Ministry of Physical Infrastructure has no annual capital budget allocated for feeder road construction and maintenance, neither from the State nor National government. The Ministry's construction machinery and equipment are very limited and in a state of disrepair. The Ministry has limited technical staff engaged in road and housing construction supervision. What is more, infrastructure planning and design expertise is inadequate. Building technical know-how is a major challenge.

Grass- root Community engagement
The local communities are homogenous in nature. They have a strong culture of organization and leadership based on democratic process. The local chief, elders, youth, women and faith-based groups have responsibility and power of influence over community interest. Local development activities are practiced through community-based resources organized by local leadership. Help-group farming, collective farming, community school and health construction/maintenance, access road pavement and periodic maintenance are witnessed. Yet the capacity remains limited in scope and work quality.

Other Implementing Partner
The NRC is the implementing partner operating on the ground. NRC has the extension workers in charge at Bomas level under Mayom Pagong Payam and Field office in Alek. The partner is implementing a food security project in the area through organizing farmers into groups, and ensuring they are trained and supported with seeds and tools. NRC is an international NGO that has built the capacity of, and has experience working with, rural communities in Warrap State, in particular implementing community based livelihood and food security projects.

E. Sustainability

The project design incorporates appropriate strategies encouraging community consultation, and active and full participation of local communities throughout the project cycle. The local communities' resources contribution to the project is a vital tool of building community-based sense of ownership and responsibility to sustain the project objective.

- At the project inception period, the target community should be committed to engage in consultation, identify community needs and priorities, and achieve clear understanding and willingness to accept the project implementation framework. In addition, the target community should ensure access to the road route, land for project camp, disclaimer of cost of compensation on settlement affected by the project implementation, and provide security and local construction materials.
- The implementation stage should facilitate the use of labour-intensive techniques to ensure local community involvement in the construction process. The approach not only creates local employment opportunities but also plays a great role in building a sense of local ownership and responsibility.
- The local community lacks material, financial and technical resources to engage in sustainable maintenance of the road. Strong coordination, communication and collaboration strategies are required to strengthen the local community's capacity. The local authorities, in cooperation with line-ministries and other potential stakeholders, need to provide technical, material and institutional capacity building aligned with the local community resource mobilization and fund-raising.
- The proposed rural road project design includes a technical capacity building component on community based rural feeder road maintenance training to ensure sustainability.

5.5.5 Impact Monitoring and Evaluation Framework

The project monitoring and evaluation framework is a key mechanism for tracking the project objective progress and achievement in enhancing target smallholder rural farmers' productivity, income, food security and sustainable livelihoods. Based on the assessment's key findings and project area-specific baseline data, the expected project impact monitoring and evaluation metrics are proposed.

Food Security Impact Indicators

S.r	Food Security Impact Indicator	Expected Impact Result
1	Sorghum market price in rain season, first market	Decrease by more than 31%
2	Sorghum market price in rain season, second market	Decrease by more than 75%
3	Poor HHs staple crop purchase power in rainy period, 1st market	Increase by more than 23.7%
4	Poor HHs staple crop purchase power in rainy period, 2nd market	Increase by more than 42.7%
5	Basic social access time	Decrease by more than 44%

Rural Marketing Indicator

S.r	Rural Marketing Impact Indicator	Expected Impact Result
1	Average cost of passenger ticket	Decrease by more than 20%
2	Average freight cost in rainy season (market)	Decrease by more than 85%
3	Market access time	Decrease by more than 41%
4	Goat selling price in first market option	Increase by more than 29%
5	Goat selling price in second market option	Increase by more than 40%
8	Number of farmers selling through traders/brokers	Less than 20%

Rural Income Impact Indicator

S.r	Rural income Impact Indicator	Expected Impact Result
1	Goat to sorghum TOT	Greater than 131 Kg
2	Average total small farmers net income	More than SSP 46,833

4.5.4.3 Rural Agriculture Production Impact Indicator

S.r	Rural Agriculture Impact Indicator	Expected Impact Result
1	Average crop yield	Increase by more than 75%
2	Average net crop surplus	More than 2,665 tons

5.5.6 Conclusion

Based on the assessment's key findings, rural services and infrastructure development have a strong co-relation with increasing rural agricultural productivity, income, food security and sustainable development. The rural feeder road construction and maintenance project is therefore well aligned with the EU's SORUDEV program objective of strengthening smallholder farmers' production, employment and income through creation of market access and trade development. The proposed project is expected to reduce the farmers' transaction cost of production (by 21%) and marketing (by 41%).. The project anticipates major (44%) time-savings in access to rural services such as health, school, market centers and productive sectors. The cumulative positive effect improves the rural community service access and quality, which significantly contributes to healthy and productive farm labor availability, improved pre-harvest and post-harvest crop management, better market information, use of improved farming techniques (ox-plough), improved seed, reduced farm input, encouraging output prices, labor intensive agro-processing and micro-credit facilities. Therefore, the proposed rural feeder road construction is socially and economically viable in terms of combating the rural poverty, enhancing agricultural productivity, income, food security, nutrition, agri-business and trade development on inclusive and sustainable manner.

5.5.7 Recommendation

Based on the assessment findings Achol Pagong market is recommended as commercially viable collection centre for distribution to regional markets. It is a well-situated rural market assembly with potential for increased transactions, uniting people from dispersed villages in the project influence areas, and outside the target counties. Achol Pagong have farming populations that usually supply Panlieth, Wunrok, Mayom and State capital Kuajok markets with agriculture products. Achol Pagong is also located on the main Mayom Tiotin road leading to Gogrial East that is currently under construction with funding from MTRB, this road will also link Achol Pagong to Gogrial East.

For servicing and agricultural distribution to the immediate local community the most optunistic collection point is Ayien market. Ayien has an established market place, has a number of established social services and is centrally located with reasonable access to the majority of the local communities.

The better provision of rural services is an essential element of attracting rural agri-business, creating new rural market opportunities and growth. The increasing market expansion raises the demand and supply of private-led motorized transport services, which improves rural income, employment and development.

The MCA that informed the choice of the section to be developed is shown below:

WARRAP STATE				**Feeder Roads**	
				Road section	
S/n	**Criteria**	**Total scores**	**Weight**	1.1 **Achol Pagong - Ayien**	1.2 **Mjok - Ayien - Jong Lual**
1	**Connection of Farms to Markets**				
1.1	Number of farms located along the road section	2		2	1
1.2	Number of market centers located along the section	2		2	1
1.3	Extent of land suitable for farming (potentially)	2		2	2
1.4	Estimated population residing within the project corridor	2		2	2
1.5	Existence of agricultural activities in the region that will further develop with the road construction.	2		2	1
		10	2	**10**	**7**
		20		**20**	**14**
2	**Socio Economic Factors**				
2.1	Existence of social services such as schools, medical assistance, religious institutions, etc. that the road will provide better access.	2		2	1
2.2	Stability and security level	2		2	2
2.2	Road connection to higher population densities creating opportunities for local population	2		2	0
2.4	Level of motorized and non-motorized traffic operating on existing road	2		2	1
2.5	Presence of Payam and Boma Administration offices	2		1	1
		10	2	**9**	**5**
		20		**18**	**10**

3	**SORUDEV / ZEAT BEAD Partners**				
3.1	Activities of SORUDEV / ZEAT BEAD Partners are currently being Conducted in the region.	10		10	10
		10	**2**	**10**	**10**
		20		**20**	**20**
4	**Construction Feasibility**				
4.1	Estimated cost of construction	2		2	2
4.2	Requirement for a major bridge structure (bridge span)	2		1	1
4.3	Availability of Construction material (borrow pits, quarry, sand, water)	2		1	1
4.4	Likelihood construction operation will be affected due to instability in the area	1		1	1
4.5	Availability of skilled labour to be engaged in construction activity	1		2	2
4.6	Possible hydrological, geo-technical or subgrade material problems	2		1	1
		10	2	8	8
		20		**16**	**16**
5	**Sustainability**				
5.1	Community and Government is motivated to participate in the construction and maintenace program.	4		**2**	**2**
5.2	Development does not have significant adverse environmnetal impact (EIA)	4		**4**	**4**
5.3	Number of affected persons and properties (PAPs) due to the construction of the road (SIA)	2		2	2
		10	2	**8**	**8**
		20		**16**	**16**
	Total score/40			**45**	**38**
	Total score/100	**100.00**		**90.00**	**76.00**
	Priority Ranking			***1***	***2***

5.6 Preliminary Engineering Design And Cost Estimation

5.6.1 Introduction

The Mayom Tiotin – Ayien market road was one of the three roads prioritized by the State authorities through a consultative process. The selection was done through a desk review and following a set selection criteria. As part of the feasibility study the route assessment was carried out on the 17th March 2015 jointly between the UNOPS team and representatives from the State Ministries of Physical Infrastructure. The objective of the mission was to:

- Assess the current condition of the road and come up with recommendations on the horizontal alignment of the road, height of embankment, gravel wearing course and the drainage requirements and prepare a cost estimate.
- Assess the sub-grade and geology of the materials along the road.
- Assess the environmental impact of the project.
- Assess the availability of construction materials along the route.

5.6.2 Methodology of the assessment

In order to gain firsthand information of the project and appreciate the various issues needed for the study of the road, the team carried out the site visit and used the following equipment and tools to get the information required:

- Motor vehicle odometer;
- Hand held GPS to map way points;
- Measuring tape;
- Digital camera.

The assessment was conducted by driving from Mayom Tiotin all the way to Panlieth and stopping at points of special interest e.g. problematic terrain, problem soil areas, construction materials sources and at other locations deemed necessary to gain firsthand information.

In addition, the team held discussions with the local communities on various issues pertaining to proposed project.

The first 13km from Mayom Tiotin to Achol Pagong is already being worked on by a private contractor contracted by the National Ministry of Transport, Roads and Bridges (MTRB); this section was excluded from further study as it is under construction. The team commenced the assessment from Achol Pagong and the route followed is just a track that has been used over time and meanders without any defined geometry through the thickets and various villages. The assessment began by setting the vehicle odometers at zero in order to determine the length of the road as well as to pick distances to different villages and other important features. Table 5.6-1 below shows the distances (chainages) to the villages measured from the starting point.

Fig. 5.6-1: A section of the track between Achol Pagong and Ayien market

Table 5.6-1: Inventory of villages and important features

No.	Chainage	Village/feature
1.	0+000	Achol Pagong
2.	13+300	New school at Makuac
3.	20+900	Majok village
4..	27+500	Ayien market
6.	43+000	Panliet

GPS coordinates of all villages and important features were recorded as tabulated on Table 5.6- 2 below and a horizontal profile plotted to show the alignment of the existing track. A design alignment was then developed from the existing track as shown on Map 2.

Table 5.6-2: GPS Coordinates for villages along the road.

No.	Village/feature	Latitude	Longitude	Elevation
1	Achol Pagong	8.726	28.310	417.733
2	Makuac	8.794	28.397	419.698
3	Majok market	8.854	28.398	421.842
4	Ayien market	8.895	28.398	419.507
5	Jong Lual village	8.856	28.310	414.221
6	Panlieth	8.847	28.258	416.180

5.6.3 Geometric design

The existing route follows a track that has been used over time and meanders through the thickets and woodland. Two proposals for geometric design have been proposed as follows:

- A route that follows the existing track closely but connects many straight sections and takes into account horizontal curves as provided for in the South Sudan Low Volume Roads Design Manual (Sept, 2013). This alignment follows closely the existing track and hence still has numerous curves. However, the terrain it follows is expected to be more or less similar profile as the existing track.
- A route that connects key control points/villages directly, but deviates from the existing track hence could have a much different profile. This alignment has the advantage of being shorter, having better geometry and as such improving the safety and comfort in driving. However, the route has to be surveyed further as it runs further away from the existing alignment and could have a completely different profile and could be traversing private property that may require elements of compensation.

5.6.4 Existing terrain

The existing terrain undulates along the entire section with gradients ranging between 0.2 - 0.3%. The soils are generally sandy clay and patches of clay and black cotton soil. Given the flat nature of the terrain, and according to information gathered from local population, the area floods during the rainy season.

Fig. 5.6-2: Swamp at CH24+700Section of the road between Ayien market and Panliet

5.6.5 Area of influence and land use

The area of influence extends from Kuajok, which is the State capital for Warrap State, to Wunrok to the north-west. The road starts at Mayom Tiotin, which is on the main trunk road connecting Kuajok to Wunrok and Turalei on the border between Sudan and South Sudan. The main economic activities are livestock keeping and small-holder crop farming mainly targeting domestic consumption. Crops produced are mainly sorghum, millet and ground nuts.

5.6.6 Population, settlements and town centers

Majority of the population is clustered around the main centers, specifically Achol Pagong, Makuac, Majok, Ayien, Jong Lual and Panlieth. The biggest markets are in Ayien and Panlieth, although there are scattered settlements along the route.

Fig. 5.6-3: Livestock keeping on the way

5.6.7 Sub-grade, geology and materials availability

The sub-grade is comprised of sandy clays and sections with clays and on flood ponds patches of black cotton soils were noted. Based on visual inspection, there is a reasonably acceptable quality of construction material especially for embankment filling. Further investigation needs to be carried out to determine the strength of the available materials and suitability for use in embankment fillings.

The only known gravel (murram) pit is in Kuajok approximately 82km from Mayom Tiotin. From discussions with the company building the road from Mayom Tiotin to Gogrial East, there was an indication of a potential gravel site nearer to Mayom. However, no details of the exact location or photos were made available to verify that potential. Further investigation needs to be carried out on the existing borrow pit as well as follow-ups to verify claims of the existence of a potential borrow pit that could significantly reduce the haulage distances and the cost of construction.

5.6.8 Drainage structures

There are no existing drainage structures along the existing track and, while the general terrain is flat with a minimal gradient (0.2 – 0.3%), there are several swamps along the way that are subject to ponding during the rainy season. For that reason, a provision has been made for the purposes of cost estimation for 900mm diameter steel pipe culverts for every 250m length along the road. Further hydrological studies will need to be carried out to establish the hydrology of the project area and determine the actual drainage requirements.

5.6.9 Design framework

The economic evaluation conducted on this road (refer to economic evaluation chapter below) places this road DC4 according to the South Sudan low volume roads design manual guidelines. As such, a carriageway of 6.0m has been recommended with 0.75m wide shoulders making the embankment a total of 7.5m, with 20m wide bush clearing for right of way.

Given that the terrain is flat and susceptible to flooding, an embankment height of 600mm (on average) has been recommended, however, in some few cases where there are depressions the embankment height will be varied between 600-900mm.

5.6.10 Preliminary Costing

The proposed embankment will be raised using materials available on the sides of the road and it is envisaged that at least four borrow pits will be established along the 43km stretch of the road to make the maximum haulage distance to no more than 5km. A gravel borrow pit exists about 82km from Mayom Tiotin village and it is envisaged that this is the borrow pit that will be used to source the gravel wearing course. Potential borrow pits were mentioned and once detailed investigations are carried out to ascertain the location, quality and quantity of materials available in the potential borrow pit it will be considered for materials extraction for the gravel wearing course.

There was one construction company operating in the State and discussions were held on their resource availability and costs of construction machinery. However, by the time of writing this report, the company had not shared its rates of hire for equipment; as such,the rates used in the cost build up is what UNOPS has in its long term agreements for supply of equipment in the area.

Table 5.6-4: Summary of the estimated costs: Achol Pagong – Ayien Market 27.5KM

Summary	Bill Group	Amount in USD
Bill 1	General	640,000.00
Bill 2	Site Clearance	181,600.00
Bill 3	Drainage	996,919.93
Bill 4	Earthworks	1,237,730.45
Bill 5	Gravel Wearing Course	2,313,878.85
Bill 6	Ancillary	126,500.00
Bill 7	Day-works	30,000.00
SUB TOTAL		***5,526,629.23***
Contingency (6%)		331,597.75
	Sub total	*5,858,226.99*

COST/km ***200,968.34***

5.7 Economic Evaluation

5.7.1 Results of Economic Evaluation

The economic evaluation of the project road has been carried out using the RED Model. The Economic Internal Rates of Return (EIRR) for the project have been derived by comparing 'with improvement' and 'without improvement' project options. The Net Present Values (NPVs) have been calculated at 12% discount rate. The results of the economic evaluation are summarized in **Table 5.7-1,** and the details of the results showing benefits and costs including the RED Model outputs are included in **Annex 3C.**

Table 5.7-1: Summary of Results of Economic Evaluation

Sl. No.	**Option**	**EIRR** (%)	**NPV** (USD million)	**NPV/C**	**FYRR/C** (%)
1	DC-2 Standard	22	3.377	0.62	0.26
2	DC-3 Standard	20	2.913	0.49	0.24
3	DC-4 Standard	18	2.174	0.34	0.23
Selected Option (DC-3 With GWC Surfacing)		**20**	**2.913**	**0.49**	**0.24**

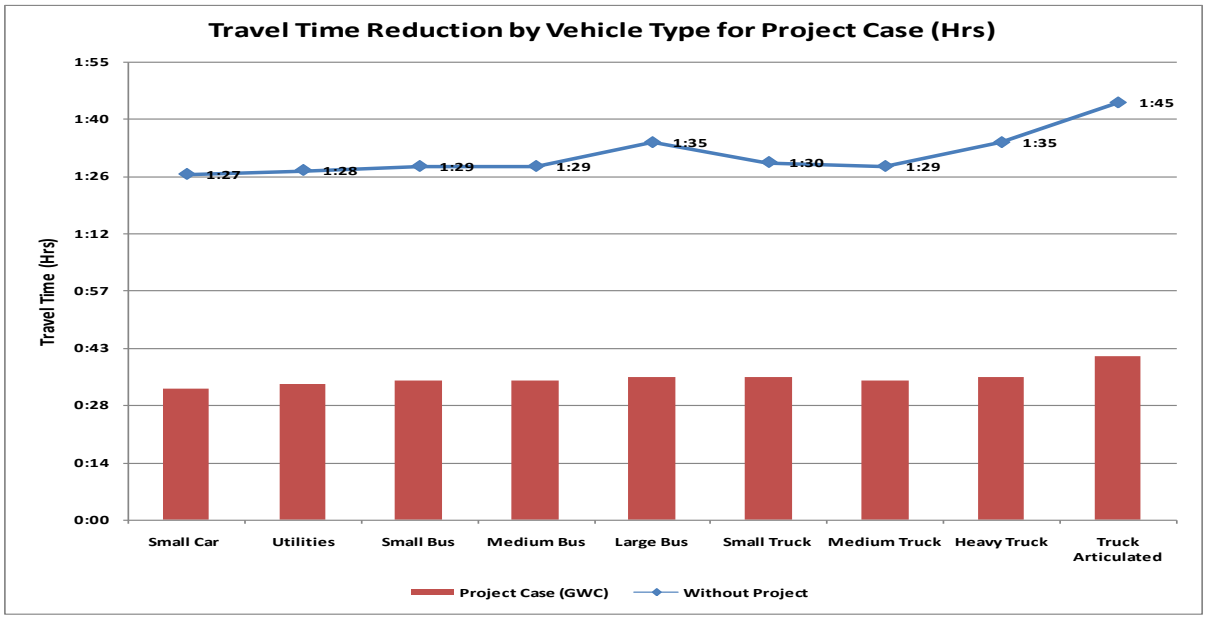
The improvement option is economically viable as the values of EIRRs for all sections of the road and the project road are above the cut-off point of 12% set by the World Bank for the appraisal of infrastructural projects in developing countries.

A comparison of travel times was made to understand the effect of the project case in relation to the travel times being experienced by travelers as a result of poor access infrastructure available to the society. **Table 5.7-2** depicts the figures extracted from the RED Model while **Chart 5.7-2** has compared the results graphically.

Table 5.7-2: Travel Time Comparison between Without Project and With Project Scenario

Project Alternatives	Dry Season		Wet Season		Car	Four-Wheel	Bus	Bus	Bus	Truck	Truck	Truck	Truck
	Length (km)	Roughness (IRI)	Length (km)	Roughness (IRI)	Small	Drive	Small	Medium	Large	Light	Medium	Heavy	Articulated
	Traffic Composition (%)				3%	19%	13%	11%	7%	16%	11%	14%	6%
Without Project	**38.6**	**24**	**38.6**	**25**	**1:27**	**1:28**	**1:29**	**1:29**	**1:35**	**1:30**	**1:29**	**1:35**	**1:45**
Project **ALT-1: GWC**	32	10	32	12	0:33	0:34	0:35	0:35	0:36	0:36	0:35	0:36	0:41
	Travel Time Saving (HR)				**0:54**	**0:54**	**0:54**	**0:54**	**0:59**	**0:54**	**0:54**	**0:59**	**1:04**

Chart 5.7-1 Travel Time Reduction by Vehicle Type



The results indicate that travel times will decrease substantially with the Project Case for all vehicle categories. Every vehicle category has enjoyed a travel time saving of about 1 hour, the largest coming from Truck Trailers. It is understood that the current state of the tracks does not allow such vehicles to operate on them; however, under a hypothetical scenario where they could, the big trucks are the ones likely to suffer due to bad condition of the road. We note that almost all vehicles were able to make the trip in slightly less than 40 minutes under the project case.

5.7.2 Sensitivity Analysis

Investments in rural road projects, like any other investment, involve risks and uncertainties such as cost overrun, time overrun, traffic development and level of benefit realization. The effect of these uncertainties has been evaluated under Sensitivity Analysis, which involves recalculating the project economic evaluation results for different values of major variables. The traffic level (directly related to the benefits) and the project improvement cost are the two basic parameters influencing the viability of the project. The Sensitivity Analysis has been carried out by varying the traffic and the improvement cost and reworking the costs and benefits analysis using RED Model for the following scenarios:

- Scenario-I Increase in cost by15% and base benefits;
- Scenario-II Base costs and decrease in benefit by 15%; and

- Scenario-III Increase in cost by15% and decrease in benefit by 15%.

The results of the Sensitivity Analysis are presented in **Table 5.7-3** incorporating the changes in variables Project Costs and Benefits. The details of the analysis thus obtained are given in **Annex 3C.**

Table 5.7-3: Results of Sensitivity Analysis

Sl. No.	Options		Base Case	Cost +15% (A)	Benefit – 15% (B)	A & B
1	**DC-2 Standard**	**EIRR**(%)	**22**	18	17	**13**
		NPV (mill.USD)	**3.377**	2.115	1.608	**0.346**
2	**DC-3 Standard**	**EIRR**(%)	**15**	14	13	**12**
		NPV (mill.USD)	**2.913**	1.581	1.144	**-0.187**
3	**DC-4 Standard**	**EIRR**(%)	**18**	14	13	**9**
		NPV (mill.USD)	**2.174**	0.731	0.405	**-1.038**

5.7.3 Conclusions and Recommendations

Based on the results of economic evaluation and supported with the Sensitivity Analysis, the investment for the improvement of **Achol Pagong – Ayien market** road to an engineered standard Feeder Road with GWC pavement has been observed economically viable. From the options considered DC-3 standard offered viable benefits in base case as well as under sensitivity testing. As such, the road may be upgraded to *DC-3 with 5.5m carriageway width and 0.75m shoulder each side, i.e. 7.0m total width*.

The value of the EIRR is 15% for the DC-3 Project road, which is higher than the cut-off point of 12% for similar projects in ROSS.

The Sensitivity Analysis shows that for all tested cases, including the worst-case scenario i.e. increase in cost by15% and decrease in benefit by 15%, the EIRRs are below the cut-off point. The risks identified should be mitigated during implementation, i.e. project cost should not be allowed to increase than projected at the time of the feasibility study.

Improvement of the project road as proposed, to Gravel Wearing Course standard, would impact positively the transportation costs, which include VOC savings, travel time savings to road users, better riding quality and maintenance costs savings for the road agency, i.e. South Sudan Roads Authority. The investment in the project road would also impact positively on the overall socio-economic development of the project influence area, Warrap State, in particular.

5.8 Recommendations

5.8.1 Road Selection

The two sections which were compared were Achol Pagong – Ayien and Majok – Ayien – Jong Lual - Panliet. According to the MCA analysis, the section ***Achol Pagong – Ayien market*** about 27.5km in length, is identified to be considered for further project development and eventual implementation. Annex 1 depicts the MCA Framework adopted for road selection.

5.8.2 Maintenance Capacity Assessment

The feasibility study team noticed that the Warrap State MoPI owns a fleet of intermediate road construction/maintenance equipment mostly tractor drawn equipment. The equipment was

procured and supplied by UNOPS in 2012 as part of a capacity building program of the state MoPI under the construction of Warrap-Musharar road. However, the team noticed that the equipment have never been used due to the reported lack of budget to cover running costs and inadequate training on the use of the equipment.

Apparently, a number of road construction companies are operating in the state and the construction activities are supported by the national government and European Union through World Food Program. The state government has no capacity and maintenance unit to carry out routine road maintenance activities but has had experience engaging maintenance contractors to maintain rural roads. Budget constraint is mentioned as a key impediment for road maintenance activities.

5.8.2.1 Road Construction/Maintenance Equipment

Below is some of the equipment supplied by UNOPS and parked idle in Kuajok in the state MoPI premises due to lack of budget for operational expenses from the State.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Tractor drawn grader parked outside the MoPI offices in Kuajok</td><td>Tractor drawn tipper</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Compacting roller</td><td>Tractor drawn excavator</td></tr>
</table>

The State Ministry of Physical Infrastructure, Directorate of Roads and Bridges, has four Engineers and eight road technicians to support road construction/maintenance activities.

The state MoPI is keen to adapt community-based road maintenance concept but needs appropriate capacity building training.

It is noted that NRC (Norwegian Refugee Council) who is implementing the smallholder component under SORUDEV program has established farmer groups along the first 13km of Mayom Tiotin-Achol Pagong-Makuac-Ayien road (39km). Apparently, this segment of the road is being rehabilitated through funding from the national government.

The population density along the last segment of the road-Achol Pagong-Makuac-Ayien (27.5km) is very sparse and there are no establishments or infrastructure support services along the road. This will make labor based maintenance methods less viable.

5.8.2.2 Key Findings

The State ministry of physical infrastructure has more construction contractors operating in the State as compared with the other States. This is considered as a good opportunity to the State to second ministry staff to the projects so that the staff will get on the job training on various aspects of road construction, quality control and contract administration activities.

Generally, the State ministry of physical infrastructure listed the following bottlenecks to activating a maintenance unit and carrying out required road maintenance activities:

- Lack of funding/budget;
- Inadequate training of staff on the operation and maintenance of the available intermediate road maintenance equipment;
- Lack of technical know-how and experience on labor based road maintenance activities;
- Sparse population density along Achol-Pagong-Makuac-Ayien and no basic amenities:

5.8.2.3 Recommendations

- The state MoPI has already acquired some of the relevant intermediary road maintenance/construction equipment but needs budgetary and technical support to make use of the equipment.
- UNOPS shall introduce a labor-based road maintenance concept and provide on the job training.
- UNOPS will sign a memorandum of understanding with the state MoPI to seek reasonable commitment in the project area to get required support, access to the project site and also highlight envisaged responsibilities and supports. This will also include maintenance responsibilities and ownership of the road assets and procurement of necessary tools or equipment.
- UNOPS will engage NGOs working in the area under ZEAT BEAD and SORUDEV programs to sensitize the road-side community and establish road maintenance groups such as farmer groups, youth groups etc.
- UNOPS will populate the information gathered during this feasibility study with a follow up mission in the State and produce a comprehensive and robust road maintenance strategic document in consultation with the State and national road infrastructure offices and key stakeholders on the ground.
- UNOPS advocates PPP for follow up maintenmnace of the feeder roads by the state ministry of physical infrastructure after completion of the action.

6 Western Bahr el Ghazal State

6.1 Introduction

Western Bahr el-Ghazal (WBG) is one of the four states selected for the implementation of the project entitled ZEAT BEAD "Feeder Road Construction in support of Trade and Market development in South Sudan" in line with the strategic objective of the EU's SORUDEV program. According to SORUDEV baseline survey, WBG is one of the most rural States in South Sudan with 57% of the population living in rural areas (NBHS, 2010). Population of WBG State as per the 2008 Population and Housing Census (PHCSS, 2008) was 333,431. 43% of WBG State's population lived below the poverty line. According NBHS 2010, 64% of WBG State population depends on rain fed agriculture and animal husbandry.

The Basilia to Kangi feeder road is located in the Wau and Jur River Counties of WBG State and has been proposed for development under the EU SORUDEV / ZEAT BEAD program. The originally proposed route was a total length of 73km of which a section of 30km needed to be selected for construction. In consultation with HARD, SMoPI, SMoA and the Wau and Jur River County commissioners, the most suitable route alignment was identified as passing through Basilia, Kayango, Bar Urud and Kangi.

The final route and route distance will be determined as part of this feasibility report. Section five of this report details the feasibility study of the feeder road giving findings and recommendations of final route selection and feasibility of construction. The key criteria the road is required to meet is as follows:

- Existing agriculture activities likely to benefit from infrastructure development are present in the immediate proximity of the road.
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities.
- Social services are currently established at various locations along the proposed road.
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups.
- Development does not have significant adverse environmental impact.
- Community and Government are motivated to participate in the construction and maintenance programs.
- Road connection of significant population densities.
- Construction is physically feasible and economically viable.
- Operators will not be affected by insecurity.

6.2 Preliminary Engineering Survey and Route Selection

In March 2014, UNOPS presented a Preliminary Assessment report for proposed feeder development under the EU ZEAT BEAD project. For the State of WBeG, three roads were proposed as the top priority for development; Basilia to Kangi, Kuajina to Nyinakok and Bazi to Namatina.The preliminary assessment revealed that the Bazi to Namatina route was a mostly abandoned area and as such did not meet the selection criteria.

The Basilia to Kangi route offered the lowest cost per kilometer to construct, a higher density of population and agricultural activity present in the area. Furthermore, an additional requirement of the ZEAT BEAD project necessitated that existing SORUDEV/ZEAT BEAD implementing partners be currently active in the area of the proposed feeder road development.

In consultation with HARD, WFP, EU, WBG State MoA and the Feeder Roads Steering committee prior to proceeding with site visits, it was revealed that the Basilia to Kangi Feeder road was the only

proposed route where existing implementing partners were present. The implementing partners confirmed the road met the essential selection criteria being that:

- Existing agriculture activities likely to benefit from infrastructure development are present in the immediate proximity of the road.
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities.
- Social services are currently established at various locations along the proposed road.
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups.
- A predetermined route had been identified for verification through a site assessment.

The route for assessment was based on information provided by HARD, SMoA and SMoPI who advised the existing route currently being utilized and the locations of significant agricultural activities, established markets and social services.

Map 3 - Project road map – Kangi to Bar Urud

6.3 Physical Environment and Environmental Assessment

The environmental impact assessment of the Basilia to Kangi feeder road in Wau and Jur River Counties, WBG state was carried out in accordance with the UNOPS Environmental Management System Handbook v 1.2 (https://www.unops.org/ApplyBO/File.aspx/11.%20RFP-KEOH-2014-002%20-%20Section%20V%20Annex%20G%20-%20EMS.pdf?AttachmentID=c21f27ea-0319-4879-a37a-e006cd46c115) and the DFID Overseas Road Note 5 – A guide to road project appraisal (http://www.transport-links.org/transport_links/filearea/publications/1_851_ORN_5_Final.pdf).

Physical site inspections were conducted between the 11th and 13th March 2015 in order to ascertain primary observational data. Efforts have been made to incorporate information from existing compiled environmental data. However, it was found that the majority of reports discuss South Sudan as a whole rather than provide separate information for regions, with information often being generic for some elements and not available in sufficient detail.

Field data on natural resources and ecosystem services are very scarce in South Sudan due to the long period of war, during which data collection stalled andexisting data sources were also lost (USAID, 2007). Moreover, the focus of many studies and data sets were on northern Sudan.

The Republic of South Sudan Government is still working towards comprehensive Environmental Legislation with the initiation of a Draft Environment Protection Bill (2010) which is yet to be formally recognized, but has achieved the implementation of the Southern Sudan Land Act 2009 which has been adhered to in the assessment report.

*The Interim National Constitution of Southern Sudan(ICSS)*incorporates legal aspects for the protection and management of the environment and natural resources. Part three, article 44 of the Interim Constitution of Southern Sudan - The Environment 'stipulates that every person or community has the right to have a clean and healthy environment.' As part of this Constitution all levels of government in Southern Sudan are committed to sustainable development and insurance that the environment is protected for the benefit of present and future generations.

Draft Environment Policy (2010):
The draft environmental policy under section 4.3 Environmental Impact Assessment indicated that the Government of South Sudan will require a systematic environmental impact assessment, audits, monitoring and evaluation to mitigate adverse impacts and enhance environmental benefits. As a policy guidance, the ESIA process is legally binding on all proposed projects and should occur right from the initial planning stages of the project.

The Draft Environmental Policy has the following objectives:

- Improve livelihoods of South Sudanese through sustainable management of the environment and utilization of natural resources;
- Build capacity of the government at all levels of governance and other stakeholders for better management of the environment;
- Integrate environmental considerations into the development policies, plans, and programs at the community, government and private sector levels; and
- Promote effective, widespread, and public participation in the conservation and management of the environment.

The main purpose of the Draft Environment Policy is to provide guidance and direction to all stakeholders.

6.3.1 Climate

The climate in the Jur River and Wau Counties is considered to be tropical and classified as Aw by the Koppen climate classification (tropical wet and dry or savanna climate), having a pronounced dry season. The temperature averages 27.6 degrees Celsius, with April being the warmest month at 30.1 degrees Celsius and August the coolest month at 25.8 degrees Celsius. The annual average precipitation is 1092mm, with the driest month being December with no precipitation and the peak wet season August with an average of 214 mm (Climate Data, 2015).

6.3.2 Water resources

WBeG State is characterized as a high rainfall woodland savannah. It is an area of swamps and ironstone plateaus. Swamps are mostly seasonal due to the extensive fluctuation in precipitation, creating a distinctive dry and wet season for the region. During the months of November to March, the landscape becomes a dry dusty terrain. The landscape is transformed during April to October with the onset of the rain season with a peak in August of over 200mm average monthly rainfall. Across the entire state of WBeG there is little variance in elevation leading to prolonged water retention in some areas.

In the location of the proposed feeder road from Basilia to Kangi feeder road is wedged between the Jur River and Pongo River catchments and sections of the road will contribute to both catchments. The road itself skirts a seasonal swamp, so that much of the surface water will remain until evaporated during the dry season.

As can be observed in the survey plan, there are existing boreholes along the proposed route. However, these are few and at extensive distances from the road. It was observed that the existing boreholes had been fitted with hand pumps, but a number of pumps were no longer working and residents were using ropes and buckets to fetch water. Consultation with the SMoA revealed that the depth to artesian water reservoirs was between 42m to 54m depth below surface level.

As the site visit was conducted in the dry season, observations revealed that apart from boreholes, there are no reliable water sources for construction or agricultural purposes. The natural surface water is used for human consumption, livestock, brick manufacturing and a small amount of cultivation.

Concerns would be for the quality of surface water due to the combined human and livestock use and also the lack soil stabilization during the dry season. Waste and sanitation are not regulated in this area, which would contribute to the quality of water.

6.3.3 Topography, Soil and geology

Over the 73km of the assessed route there is little variance in elevation. Topographic mapping detailing the elevation was not available for the exact location of the road, but no significant gradient changes were observed or recorded with the GPS survey.
According to Harris (1958), WBeG State is classified as a combination of a medium to high rainfall woodland savannah cauterised by Ironstone Plateaus. No soil testing was conducted as part of this assessment; however, through onsite observation and comparison to existing data, it is evident that the soil type is generally rich red topsoil and clayey loam soils. In some places, black cotton soil was present, with an underlying ironstone plateau that is close to the surface in some places (Harris 1958).

6.3.4 Local air pollution

As the local area is predominantly populated by subsistent/barter farming, it is reasonable to assume that majority of air pollution is attributed to smoke and dust particulates. Burning of bushes as a means to clear vegetation either for planting or to allow the sprowting of new grass for livestock keeping communities is a seasonal event that causes significant amounts of smoke and air pollution. There is evidence of recent deforesting activity in the area contributing to increased exposed soils. Especially surrounding the established villages, there are large areas of barren ground and soil compaction impacting the soil structure. As previously mentioned, the physical assessment was conducted during the dry season, observations revealing that cultivation areas are left exposed after harvest and significant vegetation cover is not achieved until the commencement of the wet season.

Pedestrians and animals make up the greater proportion of the traffic. Motorcycles are present, and though cars are present towards the middle of the route usage is dependent on the road condition. Overall it is evident that air pollution is higher during the dry season due to the presence of dust and this is typically the period when burning for clearing, brick and coal manufacturing is conducted.

6.3.5 Landscape, natural resources and waste

The high rainfall woodland savannah characteristic of South Sudan extends into most parts of the greater Bahr el Ghazal. Trees in this region are generally tall and broad leaved. Coarse tall tussocks of perennial grasses predominate and fires are hence usually fiercer than in the low rainfall woodland savannah. *The most important tree species are Khayyam senegalensis and Isoberlina doka. Other species are Parkia oliveri, Daniella oliveri, Afzelia africana, Terminalia mollis, Burkea africana and itellaria paradoxa. (MTRB, 2014).*

The assessment of the proposed Basilia to Kangi feeder road commenced at Basilia market at chainage 0.00km. At this location there was an active market and the proposed route wound through the established huts and businesses. Some large fruit bearing trees, such as mango trees, are located very close to the road and would need to be removed for construction.

The village quickly disperses and the vegetation becomes more dense forest, with the soils appearing to be highly fertile red topsoil. The landscape continues to shift between forest areas, with some large trees, to open savannah grasslands, which is a source of roof thatching material.

For the entire route there is negligible variance in the features of the area. The terrain is relatively flat with little change in elevation. Soils appear to be clayey red topsoil, with black cotton soils evident in some areas. The area has an underlying ironstone plateau. Depth to foundations are unknown, however it is suspected to be less than 1m in most locations except where there were the presence of large trees and the evidence of lack of soil structure during the wet season. In some areas, murram is found at the surface. In the observed swamp areas, the soil is black clayey loam and sedimentary material. It is obvious that, due to the soil conditions, during the wet season the existing track would be impassable in some sections.

Although there is little overall variance in the elevation, the area is characterized by undulations and swamps in the wet season. This was particularly noticeable at chainage 11.4km that was characterized by black cotton soil. Also located at this chainage is a Teak Plantation for commercial use.

From Chainage 6km to 20km there is a slight decreasing gradient that steepened in some sections. At chainage 20.7km, a sizeable water source is located that would become a flowing creek. A manmade causeway has been created at this location which acts as a bridge during the wet season; the Kayango market is located on 200m from this point on higher ground.

The terrain continues on a slightly decreasing gradient until flattening out at chainage 27.5km where a season swamp is located. Black cotton soil is present in the area and it is covered by water grasses and reeds. At chainage 35km a large cattle camp is located and man managed beehives are present. Murram is present at the ground surface in many sections from chainage 35km to 42km.

From chainage 41km, the turn-off to the Kayango Market, the track was less distinct and the population less dense. Black cotton soil is more evident in the area from chainage 42km to 58km and a creek crossing is located at chainage 46km and again at chainage 53km. In this area, the vegetation is more scrub-like and there is a higher density of water grasses and reeds, leading to the assumption that this area is a seasonal swamp.

At chainage 60km, the population density was higher, though the majority of residents are scattered throughout the terrain and well back from the proposed feeder road route. A health care centre is established at chainage 62km. However, the area still seems to be a seasonal swamp. At chainage 67km, Palm, Lulu and Mango plantations are present; the area was slightly elevated and appears to be less affected by seasonal flooding. Chainage 71km is the location of Kangi market; there is also a church, school, well point and a mobile service tower.

Discussions with the local population revealed that in some areas the water could remain at a depth of up to 500mm for prolonged periods. As such there will be sections of the road that will require a road embankment to be constructed to raise the road above the water level. Adequate embankment material appears are available in close proximity to the road, however, this will require the clearing and stripping of large areas of trees and native vegetation. It is imperative to select a route minimising the quantity of material to avoid unnecessary impact on the natural environment.

The site assessment revealed that murram is available in the immediate proximity of the proposed construction. However, testing of the material will have to be done in order to ensure adequate quality of material for construction. As very few boreholes are present in the immediate area, the excavation

of construction material could provide an opportunity to create water detention basins to subsidise the use of bore water during the dry season especially for livestock consumption.

6.3.6 Biodiversity

Due to a lack of available information it is difficult to establish an adequate baseline for the current state of biodiversity in the area. However, generalized information and site observations have been used to establish the current bio-diversity status.

WBeG State is significantly defined by the seasonal fluctuations of water levels and marshlands. The region is a significant area for bird life and, despite the effects of the prolonged war the area is still important in the seasonal migration of birds and wildlife (WWI, 2007). It is important to take into account the impact a smaller road development in an already heavily populated region may have on the wider catchment.

As further explained in Section 6.5 (Socio-Economic Assessment), substantial population densities already exist in the region of the proposed road. As a result of the land occupation, the immediate area has already sustained significant impact to the biodiversity. It can be assumed that the common activities practiced in this area, including burning under-scrub, deforesting, migrational cattle grazing, hunting, excavation for brick manufacturing and recently the introduction of cultivation, have reduced the biodiversity in the immediate area and contributed a similar effect on the wider environment. The establishment of reliable vehicle impact is likely to further facilitate the reduction in biodiversity in the immediate area.

6.3.7 Cultural heritage

No significant sites of cultural heritage were observed or discovered in the immediate area of the proposed route, although it is important that dialogue with the local community continues to ensure this element has been explored fully.

6.3.8 Noise and vibration

Due to the lack of available information and monitoring equipment, only rudimentary observational assessments are possible. Considering the existing access limits the velocity of mechanized transport and the lack of mechanized agricultural and manufacturing equipment it is reasonable to assume that noise and vibration pollution is minimal. It can further be assumed that, due to better accessibility during the dry season, noise and vibration will be higher than in the wet season.

6.3.9 Conclusion

The construction of the Kangi-Bar Urud feeder road is likely to provide important development and access opportunities to the residents of the local area. However, this development is likely to have significant impact on the overall natural environment and as such strategic measures need to be incorporated in the design to mitigate the adverse impacts.

It is advised that efforts be made to ensure the identification of the most opportune locations for the acquisition of embankment construction material. Furthermore, it is advised that efforts be made to transform these borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of the borrow pits and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat, clearing must be kept to a minimum; this should be considered in the design of the road corridor and the subsequent planning of the construction works. It is also important to avoid the removal of, or to consider the establishment of or compensation for, any vegetation that is a food source. Due to the dispersive and fine particle characteristics of soils it is advisable to re-vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss. The section of road from Basilia to Kayango

would have less environmental impact as less of this route would require an elevated road embankment and that would reduce the construction material required and area of clearing.

During the construction period access to water may be limited. To mitigate the effect, early identification of a viable water source is recommended. Alternatively, a new water source could be constructed in order to reduce the impact on water collection opportunities for the local population.

6.4 Travel Demand Establishment and Projection

The establishment of travel demand is carried out in strict compliance with the recommendations of Overseas Road Note 5 (ORN-5) for low-volume rural roads and in reference with the South Sudan Roads Authority Low Volume Roads Design Manuals.

6.4.1 Review of Available Traffic Data

Relevant traffic information available to the project road is sought from the State Ministry of Physical Infrastructure and State Department of Roads and Bridges. It was however found that the Ministry responsible for the management and administration of the feeder road under consideration is severely budget-constrained. As such, it was confirmed that the state does not keep records on traffic volumes, condition surveys and other information which is required for the planning of investment decisions. As such, available data on historical data was sought from development partners and from central government Ministry of Transport, Roads and Bridges. All approached sources failed to avail any historical traffic data for the road.

6.4.2 Program for Traffic Surveys

In view of the available information and data requirements of the project road, the data-gaps were identified, and it was planned to conduct a series of traffic surveys. Keeping in view the TOR requirements, a program of traffic surveys was formulated. Accordingly, the following traffic surveys were conducted in the project vicinity:

- Classified Traffic Volume Counts;
- Origin-Destination Surveys; and
- Travel Time Surveys.

Based on the reconnaissance survey and observation of the project road and traffic movement patterns, five traffic survey locations were selected, as indicated on a line diagram **(Figure 6.4-1).**

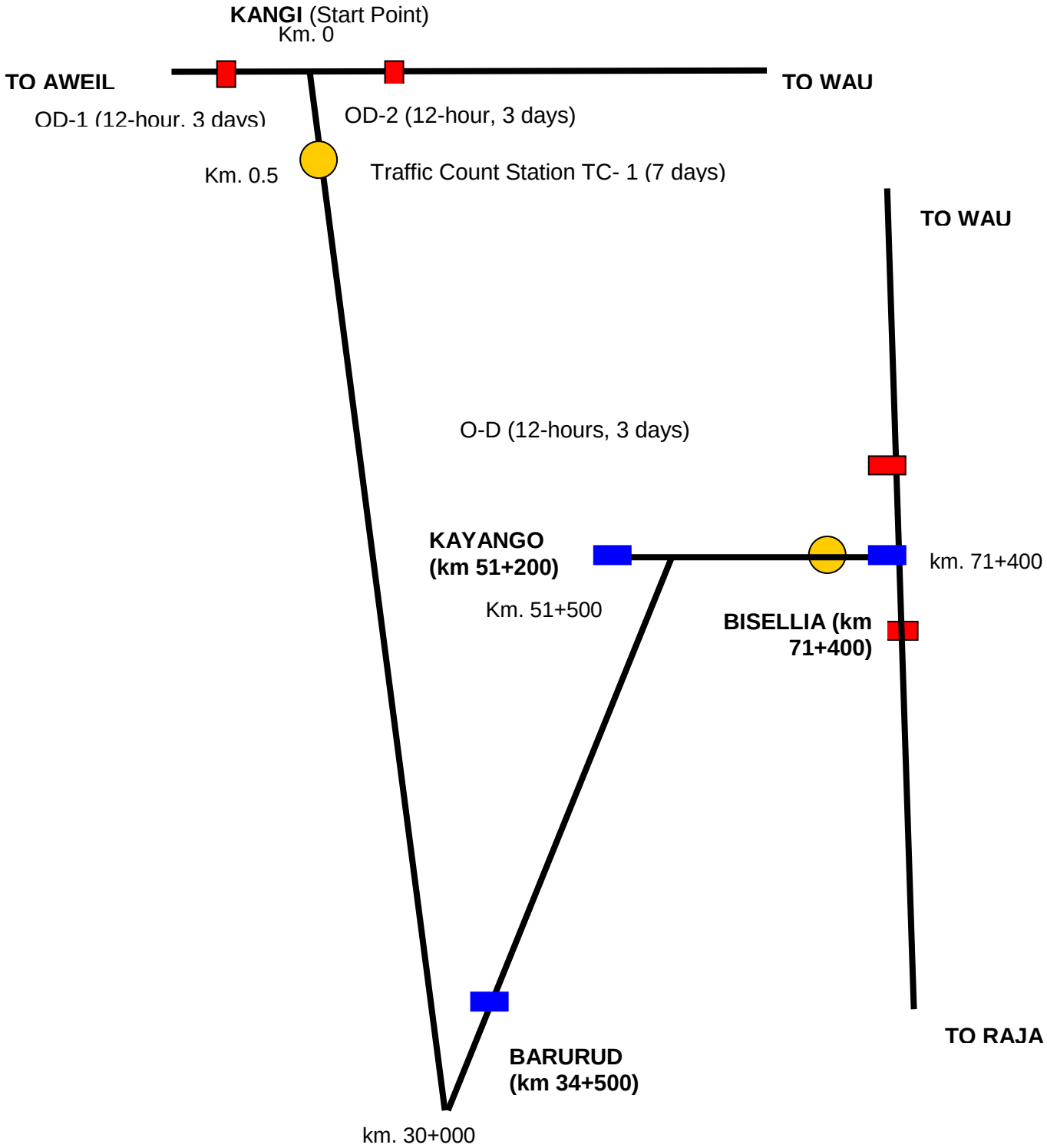


Figure 6.4-1: Locations of Traffic Surveys

6.4.3 Classified Traffic Volume Counts

Classified traffic volume counts at two locations were conducted between 16.03.2015 and 22.03.2015 of which the details and durations are given in **Table 6.4-2.**

Table 6.4-2: Classified Traffic Volume Counts: Survey Locations

Survey Station	Location	Duration	Survey Dates
TC-1: Kangi, outside the town limits in the direction towards Kayango (km 0+300)	Kangi	7 Days	16.03.15 – 22.03.15
TC-2:Bisellia, outside the town limits in the direction towards Bar Urud (km 7+000)	Basilia	7 Days	16.03.15 – 22.03.15

6.4.3.1 Daily Traffic Counts and Traffic Compositions

The daily traffic count data are summarized in **Table 6.4-3,** presenting the averaged traffic volume as well as composition as percent of total traffic for each survey station. The vehicle composition brings out an interesting feature that passenger vehicle: freight vehicles ratio are close to 3:1 for all stations where almost three quarters of all vehicles surveyed were actually passenger vehicles. The reason for this could be attributed to the well-populated project area and poor service delivery resulting from the poor transport infrastructure. This corresponds to the actual population distribution and assessment of basic services in the project area.

Table 6.4-3 Vehicle Category wise Traffic Volume at Survey Stations

Station 1: Kangi (TC-1)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
15th March 2015, Sun	12-Hr	49	36	0	0	0	0	0	0	0	**85**
16th March 2015, Mon	12-Hr	4	2	0	0	0	3	0	0	0	**9**
17th March 2015, Tues	12-Hr	17	18	0	0	0	0	0	0	0	**35**
18th March 2015, Wed	12-Hr	21	9	0	0	0	0	0	0	0	**30**
19th March 2015, Thurs	12-Hr	40	25	0	0	0	0	0	0	0	**65**
20th March 2015, Fri	12-Hr	21	17	0	0	0	0	0	0	0	**38**
21th March 2015, Sat	12-Hr	20	14	0	0	0	0	0	0	0	**34**
	12-Hr Daily Average (ADT)	24.6	17.3	0.0	0.0	0.0	0.4	0.0	0.0	0.0	
	Vehicle Composition	58%	41%	0%	0%	0%	1%	0%	0%	0%	
12-Hr Average Daily Traffic		**25**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**42.3**
						99%				1%	

Station 2: Bisellia (TC-2)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
15th March 2015, Sun	12-Hr	3	19	0	0	0	8	0	0	0	**30.00**
16th March 2015, Mon	12-Hr	12	0	0	11	0	8	0	0	0	**31.00**
17th March 2015, Tues	12-Hr	15	0	0	0	0	11	0	0	0	**26.00**
18th March 2015, Wed	12-Hr	14	0	0	5	0	5	0	0	0	**24.00**
19th March 2015, Thurs	12-Hr	0	20	0	0	0	0	0	17	0	**37.00**
20th March 2015, Fri	12-Hr	5	26	0	0	0	8	0	0	0	**39.00**
21th March 2015, Sat	12-Hr	36	37	0	23	0	31	0	0	0	**127.00**
	12-Hr Daily Average (ADT)	12.1	14.6	0.0	5.6	0.0	10.1	0.0	2.4	0.0	
	Vehicle Composition	27%	32%	0%	12%	0%	23%	0%	5%	0%	
12-Hr Average Daily Traffic		**12**	**15**	**0**	**6**	**0**	**10**	**0**	**2**	**0**	**45**
						72%				28%	

6.4.3.2 Traffic Variation: Day & Night

The traffic counts were normally carried out for 12 hours (0700-1900 hr) each day. A 24-hour (0600-0600) count was not carried out in any of the survey stations to get information about the proportion of traffic plying during 1900 to 0600 hr. Given the poor state of the feeder road under consideration and the apparent security situation in the state, it is anticipated that a 24-hr survey would not be feasible. As such, it was decided that the surveys would only be conducted for 12 hours during day-time. Therefore, the ratios of the 24-hr count/12-hr count (termed as **"night factor**") for each category of vehicle and for each survey station are taken as unity.

6.4.3.3 Average Daily Traffic (ADT) for Road Sections

The 12-hour traffic count data shown in Table 6-3 have been adjusted by the application of unit night factors indicated above and treated as equivalent 24-hour count data. The adjusted daily traffic count data are presented in **Table 6.4-4** and further averaged to derive the ADT (average daily traffic) for each survey station.

The project road has been divided into three sections, traffic distribution wise, from Kangi to Bartia (21km), Bartia through Bar Urud to Kayango (29km) and finally from Kayango to Basilia (20km). The traffic count from each of the count stations is assigned to the section of the road that it represents.

Taking into account the ADTs derived for the three sections by taking the closest station count and averaging for the middle section, the ADTs are assigned to the three road sections as shown in **Table 6.4-4.**

Table 6.4-4: ADT assigned to Project Road Sections

Section of the Road	Length (km)	Normal 24-Hr Traffic Count Forecast 2017 (Opening Year)									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Kangi - Bartia (0+000 to 21+000)	21	26	18	0	1	1	0	0	2	1	**49**
Bartia - Barurud - Kayango (21+000 to 50+000)	29	19	17	0	4	1	5	0	4	2	**52**
Kayango - Bisellia (50+000 to 70+000)	20	13	15	0	7	1	11	0	6	2	**54**
Kangi - Bisellia (0+000 to 70+000)	**70**	**19**	**17**	**0**	**4**	**1**	**5**	**0**	**4**	**2**	**53**

6.4.4 Origin-Destination Surveys

In order to establish the movement pattern on the project road, roadside interviews with vehicle drivers/crew were conducted at two traffic survey locations for three days each, to ascertain the origins and destinations of the vehicles using the adjacent road, their trip lengths (distance traveled), trip purpose, occupancy and the commodity flow pattern. The surveys had been carried out on a working day and weekend for 12-hours from 0700 to 1900 hrs. The enumerators were deployed with sufficient training to conduct the surveys. Police help was obtained to ensure smooth flow of traffic and stoppage of the selected vehicles. The OD survey stations are described in **Table 6.4-5**.

Table 6.4-5: Origin-Destination Survey: Survey Locations

Survey Station	Location	Duration	Survey Duration
OD-1: At Kangi, outside town limits in the direction towards Wau (km 0+000)	Kangi	3 Days	17.03.15 – 19.03.15
OD-2: At Kangi, outside town limits in the direction towards Aweil (km 0+000)	Kangi	3 Days	17.03.15 – 19.03.15
OD-3: Basilia, outside town limits in the direction towards Wau (km 70+000)	Basilia	3 Days	19.03.15 – 21.03.15
OD-4: Basilia, outside town limits in the direction towards Raja (km 70+000)	Basilia	3 Days	19.03.15 – 21.03.15

Location-wise, numbers of vehicles interviewed are given in **Table 6.4-6.**Out of the 216 vehicles interviewed, about 46 motorcycles and 4 specialized motorized vehicles were excluded from the table for the purpose of clarity.

Table 6.4-6: Number of Vehicles Intercepted in the O-D Survey

Location	Car*	L/Rover	S/Bus	L/Bus	S/Truck	M/Truck	H/Truck	T &T	Total
TOTAL	**13**	**38**	**14**	**20**	**17**	**12**	**20**	**32**	**150**

*Motor-cycles and specialized vehicles interviewed during the surveys is excluded

The intercepted vehicles were classified by vehicle plates and purpose of trip. In the former category, Table 6-7A shows that while business and trading vehicles by far dominated vehicle movement at about 31% of intercepted trips, these were followed by government vehicles at 28.3% and personal vehicles at less than 10%. Incidence of driving vehicles without any plate number is observed as high as 11%.

Table 6.4-7A: Vehicle Plate Category

Plate Code	Code	Frequency	%
No Plate	0	24	11.0%
Taxi	1	10	4.6%
Personal Automobile	2	21	9.6%
Trading Vehicle	3	67	30.6%
Administration/Local Government	4	16	7.3%
National Government	5	46	21.0%
Other Country/UN	6	23	10.5%
Others	7	12	5.5%
TOTAL		**219**	**100%**

Table 6.4-7B: Trip Purpose Category

Trip Purpose	Code	Frequency	%
No Response	0	13	12.6%
From/To Work	1	26	25.2%
Employment	2	14	13.6%
Personal	3	13	12.6%
Education	4	6	5.8%
Medical	5	7	6.8%
Social	6	9	8.7%
Vacation	7	0	0.0%
Ceremony (Wedding, Funeral)	8	5	4.9%
Others	9	10	9.7%
TOTAL		**103**	**100%**

The OD survey has also captured the response of drivers regarding trip purposes **(Table 6.4-7B)**. It was found out that work and employment trips contributed most of the motorized travel around the project vicinity at 38.8%, while personal trips account for 12.6% of trips and trips to social services (medicine, education) account for 15.5% of trips. Social trips, vacations and attending ceremonies accounted for 13.6% of trips. The incidence of non-response to the interview is high at about 12.6% of all vehicles intercepted by the OD survey.

6.4.4.1 Commodity Movement

To analyze commodity movement on the project road, major commodities being transported on the roads within the project area of influence were identified. To carry out the above exercise, data was collected through the formats used in the O-D survey at the four locations. For the purpose of data analysis, these commodities were grouped and assigned numeric codes, as given in **Table 6.4-8**.

Table 6.4-8: Commodity Category

Code	Group	Possible Commodity Type
0	Empty	Unloaded
1	Agricultural product	Wheat, oil seed, *sorghum*, barely, maize
2	Livestock	Ox, goat, camel
3	Fuel wood or charcoal	Charcoal, etc
4	Water	Water
5	Processed food or drinks	Vegetables, fish, meat, milk and milk products, soda, juice, etc.
6	Machinery, equipment	Machinery and transport equipment
7	Logs or lumber	Wood, timber, Logs, etc
8	Construction materials, cement	Cement, steel, finishing materials, etc
9	Petrol, diesel, kerosene, gas	Hydrocarbons (liquid or gas)
10	Chemicals or fertilizes	Mineral fuels, lubricants and related material
11	Medicines and pharmaceuticals	
12	Miscellaneous household goods	House-hold items, finished products, soap, salt, sugar, pulses, spices etc.
13	Other or unknown	Other items

During the O-D surveys, a variety of commodities such as bulk and mixed cargo was observed moving on the project road. The O-D information collected was classified according to the commodity category (Table 6.4-8) and the percentage distribution of commodity is given in **Table 6.4-9.**

Table 6.4-9: Distribution of Commodity on the Project Road (%)

Commodity Type	%
Empty	19.5%
Agricultural Product	31.2%
Livestock	1.3%
Fuel-wood or Charcoal	3.9%
Water	3.9%
Processed Food or drinks	6.5%
Construction machinery/equipment	2.6%
Logs or lumber	2.6%
Construction Materials, cement, rebar	1.3%
Petrol, Diesel, Kerosene, gas	3.9%
Chemicals or Fertilizers	0.0%
Pharmaceutical Items, Medicine	2.6%
Miscellaneous Household goods	7.8%
Others/Unknown	13.0%
TOTAL	**100%**

It may be noted that incidence of empty hauling washigh at about 20%. Of the loaded goods vehicles, 31.2% carried agricultural products, marking this sector as the most important source of traffic on the roads. The major items encountered were sorghum and onion. Processed foods contributed to 6.5% of trips, household goods 7.8%, fuel-wood/charcoal and water 4% each. On the lower end of commodity movements, livestock and construction materials contributed to 1.3% of freight trips each, and construction machinery, logs and medicinal items to 2.6% each. In general, it is noted that the project vicinity contributes to the national freight movement through agricultural items collected from farms along the project road to relevant markets elsewhere.

Alongside the commodity flow survey, data on the carrying capacity of trucks was collected and the payload carriedby truckers were recorded. For the purpose of analysis, the trucks have been categorized as shown in **Table 6.4-10** with their respective percentage distribution.

Table 6.4-10: Percentage Distribution of Commodity Flow from the O-D survey

Vehicle Utilization	Code	Frequency	%
Empty	0	16	20.8%
1/4 Full	1	2	2.6%
Half Full	2	8	10.4%
3/4 Full	3	8	10.4%
Fully Loaded	4	31	40.3%
Over-loaded	5	12	15.6%
TOTAL		**77**	**100%**

Based on the survey, 21% of the trucks are empty loaded and almost 13% of total intercepted trucks are half orquarter loaded. On the project road, it has been observed that a considerable amount of trucks are substantially to fully loaded, accountingfor50.7% of the total intercepted trucks, while the extent of over-loading was observed as high as 15.6%.

6.4.4.2 Trip Frequency on the Project Road

The frequency of making similar trips by drivers was collected from the drivers and analyzed. We note that a high proportion of intercepted vehicles actually make similar trips frequently, as shown in **Table 6.4-11**.

Table 6.4-11: Trip Frequency Distribution from the O-D survey

Trip Frequency	Code	Frequency	%
Most Frequent	7	58	42%
	3	12	
	2	17	
Frequent	1	93	45%
Occasional	0.5	0	13%
	0.25	28	
TOTAL		**208**	**100%**

Most frequent trips, made from once in a week to dailyaccount for 42% of all vehicles interviewed by the OD survey. This makes the trip characteristics observed from this particular survey a dependable replica of actual movement patterns of drivers in the future. These are followed by occasional trips

that are made at most once a month accounting for 13% of trips; those that fall in-between at 45% respectively.

6.4.4.3 Traffic Flow Pattern

Wau, Raja and Aweil, followed by the project control points, namely, Kangi, Bar Urud, Kayango and Basilia are the major generating and attracting centers of traffic on the Project road (**Table 6.4-12**). As the distance between Origin and Destination towns increase, the traffic flow on the Project road decreases.

Table 6.4-12: Traffic Attraction Centroids from the O-D survey

Location	Origin	Destination	SUM	RANK
Wau	100	82	182	1
Raja	12	19	31	3
Aweil	47	49	96	2
Kangi	6	13	19	5
Bar Urud	6	8	14	6
Kayango	4	5	9	9
Basilia	9	15	24	4
Kwajok	4	7	11	7
Rumbek	2	5	7	11
Ngomba	4	7	11	7
Khartoum	3	0	3	13
Juba	7	2	9	9
Khorghana	1	2	3	13
North S.	4	0	4	12
Uyu-fuku	1	1	2	16
Darfur	3	0	3	13
Mapel	1	0	1	17
TOTAL	**214**	**215**	**429**	

The OD Matrix is based on the major origin and destination points on the project road, as shown in **Table 6.4-13A and Table 6.4-13B**.

Table 6.4-13A: Origin Destination Matrix based on OD Survey

O/D	Wau	Aweil	Raja	Basilia	Kangi	BarUrud	Kwajok	Kayango	Juba	Rumbek	OTH	Sum
Wau	0	41	15	11	13	7	5	4	0	0	4	**100**
Aweil	47	0	2	0	0	0	1	0	0	2	0	**52**
Raja	12	2	0	1	0	0	0	1	0	2	0	**18**
Basilia	6	0	0	0	0	0	0	0	0	0	3	**9**
Kangi	5	0	0	0	0	1	0	0	0	0	0	**6**
Bar Urud	3	3	0	0	0	0	0	0	0	0	0	**6**
Kwajok	2	0	2	0	0	0	0	0	0	0	0	**4**
Kayango	3	0	0	1	0	0	0	0	0	0	0	**4**
Juba	0	3	4	0	0	0	0	0	0	0	0	**7**
Rumbek	0	0	1	1	0	0	0	0	0	0	0	**2**
OTH	5	0	1	1	0	0	1	0	2	2	0	**12**
Sum	**83**	**49**	**25**	**15**	**13**	**8**	**7**	**5**	**2**	**6**	**7**	**220**

Table 6.4-13B: Origin Destination Matrix based on OD Survey

O/D	1	2	3	4	5	6	7	8	9	10	OTH	Sum
1	0	41	15	11	13	7	5	4	0	0	4	**100**
2	47	0	2	0	0	0	1	0	0	2	0	**52**
3	12	2	0	1	0	0	0	1	0	2	0	**18**
4	6	0	0	0	0	0	0	0	0	0	3	**9**
5	5	0	0	0	0	1	0	0	0	0	0	**6**
6	3	3	0	0	0	0	0	0	0	0	0	**6**
7	2	0	2	0	0	0	0	0	0	0	0	**4**
8	3	0	0	1	0	0	0	0	0	0	0	**4**
9	0	3	4	0	0	0	0	0	0	0	0	**7**
10	0	0	1	1	0	0	0	0	0	0	0	**2**
OTH	5	0	1	1	0	0	1	0	2	2	0	**12**
Sum	**83**	**49**	**25**	**15**	**13**	**8**	**7**	**5**	**2**	**6**	**7**	**220**

Of all the trips that have originated from Wau, 54% of the trips were headed to Aweil/Kangi, the remaining 26% of the trips headed to Raja/Basilia. Again, of all trips that originated from Aweil, 90% were headed to Wau, while of all trips originated from Raga/Basilia, 67% of trips were headed to Wau. Of all vehicles intercepted by the survey, about 20% ended in the project control points while they were the origins for 11.1% of trips intercepted in the survey. This shows the significance of the project road control points, particularly Basilia and Kangi in the overall travel pattern at the national level, however, Wau remains to be the major traffic attractor and generator in the project context.

6.4.5 Seasonal Variation in Traffic Flow

ADTs shown in Table 6-7 relate to the time of the year when the traffic surveys are carried out, over periods of 3 to 7 days in March 2015. The project road traffic, however, is susceptible to seasonal variations, particularly those caused by the seasonality of the climate and agricultural activities in the project area.

The most ideal historical data for assessing the seasonal variations of traffic flow along the project road, would be counts made by SSRA during the different cycles of the year. This data would have particularly focus on the dry period (December to March and wet season (April to November) with two thirds of the time being a rainy period. As the traffic surveys were made during the dry period (high season), factors are required to be used to correct the seasonality of traffic along the project road, particularly in lieu of the wet season (lowtraffic volume season). In the absence of historical data maintained with the SSRA, it was decided to assume proportion of traffic during high, low and medium seasons in relation to the annual average values as depicted under **Table 6.4-14**.

Table 6.4-14: Seasonal Correction Factor (SCF)

Season	Indexed ADT	SCF
Low	0.5	1.87
Medium	1	0.93
High	1.3	0.72
Average	**0.933**	

The use of the SCF meant that the ADT calculated from the traffic count surveys shall be adjusted for seasonality of traffic on project road relating to low, medium and high seasons.

6.4.6 Non-Motorized Traffic Survey

Non-motorized transport modes in use in the project area comprise principally of pack animals and walking. Other intermediate non-motorized modes, mainly bicycles do play an important role; both enable the reduction of travel costs through faster travel time or increased loading capacity with relatively small capital outlays. Road improvement is likely to reduce costs of operation and encourage adoption of these modes at least in suitable terrain. Hence, data has been collected to assess the potential of Non-motorized traffic at the vicinity of the project area. The Non-motorized traffic count has been conducted alongside with the motorized traffic count, .i.e. the traffic survey stations as well as the period of the traffic count are similar to that of the motorized traffic count. The Non-motorized traffic data for the four stations are depicted as shown below in**Tables6.4-15**.

Table 6.4-15: Non-Motorized Traffic Survey Results

Station 1: Kangi (TC-1)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
15th March 2015, Sun	12-Hr	78	425	255	0	0	**758.00**
16th March 2015, Mon	12-Hr	29	290	318	0	0	**637.00**
17th March 2015, Tues	12-Hr	28	323	233	0	0	**584.00**
18th March 2015, Wed	12-Hr	34					**34.00**
19th March 2015, Thurs	12-Hr	53					**53.00**
20th March 2015, Fri	12-Hr	54	265	224	0	0	**543.00**
21th March 2015, Sat	12-Hr	46	97	27	0	0	**170.00**
12-Hr Weekly Average (ADT)		46.0	280.0	211.4	0.0	0.0	
24-Hr Average Weekly Daily Traffic		**46**	**280**	**211**	**0**	**0**	**537**
		0.25	0.2	0.15	0.7	0	**PCU**
		12	56	32	0	0	**Cars**

70% passenger	69	1	L. Bus
30% freight	30	5	H. Truck
		3	TT

Station 2: Bisellia (TC-2)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
15th March 2015, Sun	12-Hr	59					**59.00**
16th March 2015, Mon	12-Hr	57	86	127	0	49	**319.00**
17th March 2015, Tues	12-Hr	119	107	128	0	76	**430.00**
18th March 2015, Wed	12-Hr	72	128	138	0	131	**469.00**
19th March 2015, Thurs	12-Hr	148	96	95	0	97	**436.00**
20th March 2015, Fri	12-Hr	27	151	119	0	95	**392.00**
21th March 2015, Sat	12-Hr	111	155	154	0	94	**514.00**
12-Hr Weekly Average (ADT)		80.3	113.6	121.4	0.0	90.3	
24-Hr Average Weekly Daily Traffic		**80**	**114**	**121**	**0**	**90**	**406**
		0.25	0.2	0.15	0.7	0	**PCU**
		20	23	18	0	0	**Cars**

70% passenger	43	1.4	L. Bus
30% freight	18	3	H. Truck
		2	TT

As illustrated in the tables above, the Consultant observed that the dominating non – motorized forms of traffic are pedestrians and pack animals at all stations. At proximity of larger towns such as Basilia, Kayango and Kangi, considerable amount of dwellers used bicycles for day-to-day activities for local movements. It has been noticed that the intensity of handcarts is also high at vicinity of towns. The Non-motorized traffic flow has been converted to Motorized vehicles to estimate the traffic volume on the project road by using appropriate Passenger-Car Equivalent (PCE) factors from the **Low Volume Road Design Manual (2013)**.

6.4.7 Travel Time Survey

The moving car method was carried out on project road for appreciating the travel time. The results of survey are summarized in **Table 6.4-16.** This survey provides data for assessing running speed, journey speeds and congestion levels. Journey speed is the effective speed of a vehicle between two points. It is determined by the distance between two points divided by the total time taken by the vehicle to complete the journey, including all delays incurred en-route. Running speed is the average speed maintained by a vehicle over a given course while the vehicle is in motion. This speed is calculated as the length of course divided by running time.

Table 6.4-15: Speeds on the Project Road

Chainage (km)		Journey Time		Speed [kph]
Start	**End**	**Start**	**Finish**	
0	9.5	11:24	12:00	15.83
9.5	17.7	12:30	12:45	32.80
18	21	01:58	02:06	22.50
22.6	49.3	02:12	03:05	30.23
49.5	55	01:25	01:34	36.67
55	65.5	02:56	03:18	28.64
65.5	70	03:18	03:25	38.57
Average Speed (km/hr)				**29.32**

Table 6.4-15 indicates that average speeds are varying between 15km/h to 37km/h signifying the poor condition of the roads under consideration. The average travel speed from project start to end on the existing tracks is less than 30km/hr.

6.4.8 Establishment of AADTs

AADTs as shown in **Table 6.4-16** are derived based on the analysis of traffic seasonality as indicated above and also by applying judgment.

The components of traffic considered for design and economic analysis of project road are normal, generated and diverted traffic. So it is necessary to distinguish between the following traffic:

Current/Normal Traffic: This represents the existing traffic that would use the improved road when it is open to traffic.

Diverted Traffic: This represents the traffic attracted to the improved road or lost to alternative routes when the improvements are completed.

Induced Traffic: This represents the increase in traffic as a result of the increased demand for transport, if any, induced by the improvement of the road. This is part of the Generated Traffic under establishment of AADT.

Development Traffic: This represents the increase in traffic, if any, that may arise from improvements on adjacent land over and above the development which would have taken place had the new or improved road not been constructed. This is part of the Generated Traffic under establishment of AADT.

6.4.7.1 Normal Traffic

This represents the traffic, which would in any event occur if no improvement is made. The base year for traffic projection is 2015, on which traffic surveys and baseline data have been based. The normal traffic has been projected for 2 years (2015-2017), based on short-term traffic growth rate of 2%.Accordingly, as shown **Table 6.4-16,** thesummarized predicted AADT for the year of 2017 is based on traffic count made by the Field Team considering the adopted growth rate on the project road.

Table 6.4-16: Normal Traffic

Section of the Road	Length (km)	Normal AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Seasonal Correction Factor		**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	
Kangi - Bartia (0+000 to 21+000)	21	19	13	0	1	1	0	0	2	1	**37**
Bartia - Barurud - Kayango (21+000 to 50+000)	29	14	12	0	3	1	4	0	3	1	**39**
Kayango - Bisellia (50+000 to 70+000)	20	9	11	0	5	1	8	0	4	2	**40**
Kangi - Bisellia (0+000 to 70+000)	**70**	**14**	**12**	**0**	**3**	**1**	**4**	**0**	**3**	**1**	**39**

The SCF adopted for the project is 0.75 with an effort to arrive at reasonable demand levels. The NMT count has been used to estimate the number of passenger and freight vehicles. The values obtained were added to the motorized traffic information obtained from survey and divided into bus and truck traffic. The sum of MT and NMT gives the Normal Traffic for the project.

6.4.7.2 Generated Traffic

Generated traffic is the traffic that results from economic, social and environmental development of the project area. Generated traffic is expected to emerge as soon as the road is upgraded and open to traffic. Two categories of traffic change may be generated by road construction. First, there may be modal shifts in which low cost movements are replaced by higher cost movements. It is the change in mode rather than the quantity of trips. Secondly additional trips may be undertaken solely as a result of better accessible roads and thereby reduction in trip cost i.e. lower VOCs and travel time. This phenomenon takes place in ROSS, as demand for the transportation increases as its cost decreases, which yields savings to the road users.

Currently, agricultural activities and passenger mobility are low due to bad conditions of the existing road. Thus, generated traffic is the induced traffic, in which the road is used following road construction or improvement that would not occur without the project road. These changes may lead to new or increased economic activity or higher volumes of consumption or marketed products, or increased frequency or new patterns of personal trip making, leading to increased passenger traffic. It is obvious that there will be an increase in agricultural product of the project area and the nearby project areas and the country at large. This understanding is based on the idea that this road is highly influenced by the import and export activity of the county, the road being the alternative import-export corridor. The construction of the road will have a positive impact in increasing the income of the surrounding farmers and thereby will result in more demand of industrial commodities by farmers because of augmented income. Thus, it can be concluded that generated traffic will be significant since the existing road cannot handle additional requirement of the different vehicles as a result of the economic activity in the long term period of the project life. In this regard, experience shows that estimated generated traffic generally varies between 15 % – 30% of the normal traffic.

However, it is noted that this approach will only under-estimate the true potential of the project area in agricultural production and population growth. As such, the population growth and agricultural production forecast is studied for the project to characterize likely scenario of passenger and freight. The analysis to calculated generated traffic is made and the same is depicted hereunder.

The estimated agricultural surplus in the relevant county for the project in the WARRAP State is Gogrial West County. The agricultural surplus for the project catchment area (taken from **Section 6.5**) figures are depicted hereunder, **Table 6.4-17A**, which has served as the basis to estimate truck traffic.

Table 6.4-17A: Generated Freight Traffic from Agricultural Surplus & Population Forecast

Cultivated Crops	Five Years Projection on Staple Crop Production in the targeted areas (tons)														
	Y1 (2017)			Y2 (2018)			Y3 (2019)			Y4 (2020)			Y5 (2021)		
	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus	Production	Consumption	Surplus
Sesame	249.10	56.88	192.22	1889.54	61.63	1827.90	280.98	64.16	216.82	292.49	66.78	225.70	304.46	69.52	234.94
Sorghum	1781.52	406.87	1374.66	13513.57	440.89	13072.68	2009.51	458.93	1550.57	2091.81	477.73	1614.08	2177.42	497.28	1680.14
Maize	498.20	113.76	384.45	3779.08	123.27	3655.81	561.96	128.31	433.65	584.98	133.57	451.41	608.92	139.04	469.88
Groundnuts	996.41	228.34	768.06	7558.15	247.44	7310.71	1123.92	257.57	866.36	1169.95	268.11	901.84	1217.83	279.09	938.75
TOTAL (ton)	**3525.2**	**805.8**	**2719.4**	**26740.3**	**873.2**	**25867.1**	**3976.4**	**909.0**	**3067.4**	**4139.2**	**946.2**	**3193.0**	**4308.6**	**984.9**	**3323.7**
Small Truck		15%	117		15%	38		15%	40		15%	41		15%	43
Medium Truck		20%	73		20%	24		20%	25		20%	26		20%	27
Heavy Truck		30%	68		30%	22		30%	23		30%	24		30%	25
TT		35%	48		35%	16		35%	16		35%	17		35%	17
Total return trips		**100%**	**305**		**100%**	**99**		**100%**	**103**		**100%**	**108**		**100%**	**112**

Average HH No		500		Small Bus	20%	12
Average Size of HH		7		Medium Bus	35%	9
Total Population		3,500		Large Bus	45%	5
Active Population	0.2	700.0	**Total Passenger Traffic (2017)**		**100%**	**26**

It was assumed that the trucks will divide the freight in the ratio 15:20:30:35while the busses will divide the passengers in the ratio 20:35:45 as shown in the table above. It was assumed that the generated traffic, in respect of cars and utilities, will be only 20% of the normal traffic for the respective vehicle types. Finally, **Table 6.4-17B**, summarizes the total generated traffic that covers the potential of the project influence area by considering population growth and agricultural surplus from the farms in the vicinity of the project. Considerable amount of the demand comes from the generated traffic for the feeder roads under consideration. In order to avoid over-estimation of the generated traffic, only 50% of the estimated demand is considered as viable generated demand, owing to data limitations in forecast.

Table 6.4-17B: Generated Traffic

Section of the Road	Length (km)	Generated AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Kangi - Bartia (0+000 to 21+000)	21	4	3	6	5	3	58	36	34	24	**172**
Bartia - Barurud - Kayango (21+000 to 50+000)	29	3	2	6	5	3	58	36	34	24	**171**
Kayango - Bisellia (50+000 to 70+000)	20	2	2	6	5	3	58	36	34	24	**169**
Kangi - Bisellia (0+000 to 70+000)	**70**	**3**	**2**	**6**	**5**	**3**	**58**	**36**	**34**	**24**	**171**

6.4.7.3 Diverted Traffic

Diverted traffic represents traffic that diverts to the project road from alternative roads, while at the same time, keeping the same origin and destination as before. As clearly indicated under the TOR for the study, the aim of the project is to implement about 30km of feeder road either on the Basilia or Kangi side.During the analysis of origins and destinations using the O/D Matrix, it was noted that the project road may be a possible alternative to travel from Aweil to Raja or vice versa. However, as the project road will not be constructed from Kangi to Basilia, traffic diversion will not be possible. As such, diverted traffic is excluded from this study.

6.4.7.4 Opening Year AADT

The resulting summary of AADT is shown in Table 6-18.

Table 6.4-18: Opening Year AADT

Section of the Road	Length (km)	AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Kangi - Bartia (0+000 to 21+000)	21	23	16	6	5	3	59	36	36	25	**209**
Bartia - Barurud - Kayango (21+000 to 50+000)	29	17	15	6	7	3	62	36	37	25	**209**
Kayango - Bisellia (50+000 to 70+000)	20	11	14	6	10	3	66	36	38	25	**210**
Kangi - Bisellia (0+000 to 70+000)	**70**	**17**	**15**	**6**	**7**	**3**	**62**	**36**	**37**	**25**	**209**

Total AADT 2017 By WHOLE PROJECT

Type of Traffic	Car	Utility	S. Bus	L. Bus	M. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM
Normal Traffic	14	12	0	3	1	4	0	3	1	39
Generated Traffic	3	2	6	5	3	58	36	34	24	171
Diverted Traffic	0	0	0	0	0	0	0	0	0	0
Recommended AADT	**17**	**15**	**6**	**7**	**3**	**62**	**36**	**37**	**25**	**209**

6.4.9 Project Schedule

The analysis period for the project has been considered as 20 years starting after the completion of the improvement, and opening the project road to traffic. In this context, the Project Schedule is envisaged as described in **Table 6.4-18**.

Table 6.4-18: Proposed Project Implementation Schedule

Activity	Period
Feasibility Study	March. 2015
Detailed engineering and bid document preparation	Sept. 2015
Bidding and contractor selection	Sept. 2015 – Dec. 2015
Implementation (1.5 year)	Jan. 2016 – June. 2017
Opening to traffic after implementation	July 2017
Traffic service period (20 years)	2017 - 2037

6.4.10 Traffic Projection

The growth scenario of the travel demand based on realistic assumptions is used fortraffic projection. The projection of traffic based on the realistic economic growth scenario is shown below.

Table 6.4-19: Traffic Projection on Project Road

Demand estimation for upgrading to Feeder Roads Standard

Traffic Projection on Kangi - Barurud - Kayango - Bisellia Road (Realistic Situation)

Counter	Year	Projected ADT										LVRD Design Standard
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM	
0	2017	**17**	**15**	**6**	**7**	**3**	**62**	**36**	**37**	**25**	**209**	DC-4
1	2018	18	16	6	8	4	65	38	38	26	**219**	DC-4
2	2019	19	17	7	8	4	67	39	40	27	**228**	DC-4
3	2020	21	18	7	9	4	70	41	41	28	**238**	DC-4
4	2021	22	19	7	9	4	73	42	43	29	**249**	DC-4
5	2022	23	20	8	10	4	76	44	45	30	**260**	DC-4
6	2023	25	21	8	11	4	79	46	46	31	**271**	DC-4
7	2024	26	22	9	11	4	82	47	48	33	**283**	DC-4
8	2025	28	24	9	12	5	85	49	50	34	**296**	DC-4
9	2026	25	21	8	11	4	81	47	48	32	**277**	DC-4
10	2027	26	22	9	11	5	84	48	49	33	**286**	DC-4
11	2028	27	23	9	11	5	86	50	50	34	**295**	DC-4
12	2029	28	24	9	12	5	89	51	52	35	**305**	DC-4
13	2030	29	25	10	12	5	92	53	53	36	**315**	DC-4
14	2031	30	26	10	13	4	82	47	48	32	**293**	DC-4
15	2032	31	27	11	13	5	84	48	49	33	**301**	DC-4
16	2033	32	28	11	14	5	86	49	50	34	**308**	High Volume
17	2034	34	29	11	15	5	87	50	51	34	**316**	High Volume
18	2035	35	30	12	15	5	89	51	52	35	**324**	High Volume
19	2036	36	31	12	16	5	91	52	53	36	**332**	High Volume
20	**2037**	**38**	**33**	**13**	**16**	**5**	**93**	**53**	**54**	**36**	**340**	High Volume

Growth Rates

Realistic Scenario

Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T
2015 - 2025	**6.0%**	**6.0%**	**6.0%**	**6.0%**	**4.0%**	**4.0%**	**3.90%**	**3.90%**	**3.9%**
2026 - 2030	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**3.0%**	**3.0%**	**2.9%**	**2.9%**	**2.9%**
2031 - 2035	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**
2036 - 2040	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**

This section of the report has established that the project road under investigation caters for a significant level of travel demand resulting from the agricultural activities ongoing in the vicinity. The AADT at project opening (2017) may be as high as 209 vpd, which will increase to 301 vpd after 15years of service in 2032. Even at a relatively flat growth rates adopted for the project ranging between 2% to 6% for different vehicle types, the project road has still managed to fall within the boundary of a **DC-4 standard** according to the South Sudan Roads Authority, Low Volume Roads Design Manual (Sept. 2013).

6.5 Socio-Economic Assessment

As per the Project TOR, the overall objective of the socio-economic impact assessment (SEIA) is to identify and analyze the potential impact of the proposed feeder road construction activity and recommend initiatives, to realize sustainable development opportunities, as well as to mitigate the negative impacts. The core objective is to justify the selection of the prioritized roads based on feasibility of the extent and nature of the socio-economic impact of the investment involved.

6.5.1 General Overview of the Project Areas

Proposed Project - Kangi - Kayango - Basilia Road route: The section enlightens the general administrative, geographical and socio-economic characteristics of the project influence area - Wau and Jur-River County, Western Bahr-el Ghazal State.

6.5.2 Catchment Areas and Administrative Structure

The proposed rural road project catchment areas fall under the local administration of the Jur-River County and Wau County, Western Bahr-el Ghazal State, South Sudan. The project catchment areas consider the two Payams, namely Kangi of Jur-River County and Basilia Payam of Wau County.

The target communities under the proposed road project`s catchment areas have a homogeneous socio-economic characteristics.

6.5.3 Social Characteristics

These communities are dispersedly settled into clusters of villages along the proposed road side, withsome at distances of between ¾ to 1 hour walk. Based on the study field assessment village cluster, there is an estimated average of30 to 50households per village cluster.

The communities have formal access to primary social services of water, school, health care, and other community services at the respective Boma level. However, the problem of road accessibility, especially during the rainy season, and the lack of transport services constrains the social access and mobility constraints. On average the local communities reach the services at a range of forty-five minutes to one hour footing,one-way. There is a border Market of two Payams at Kayango Boma, which is 20km to Basilia and 46km to Kangi,Farmers from both Payams collectively sell and buy products in Kayango Market, Kangi Payam. This market is said to be the meeting center for both famers and traders from Payam of Kangi, Jur-River County and Basilia, Wau County.

Both school boys and girls are assumed to have equal opportunities to education. However, the distance covered and household labor-burden on girls limits the female access to education. The Government primary school, PHCU, located at Kayango and community initiated primary school and Government PHCU in Rian village are the only education and health services accessible to communities on the proposed road project sphere of influence. Hand pumps are only sources of clean affordable water to the communities, with the furthest household being ½ km away from the hand pump.

6.5.4 Economic Characteristics

Agriculture is predominantly the major means of livelihood for the target communities. Baseline survey at the area shows that 98% of the Western Bahr-el Ghazal State households rely on agriculture and livestock. Based on the recent HARD conducted Western Bahr-el Ghazal State baseline survey, crop farming stand at 98%, livestock support 19%, charcoal burning 29%, sale of thatching grass and petty cash business 11%, sales of fire woods 7%, and fishing 3% of the households respectively. Sorghum, finger millet, groundnuts, simsim, cassava and maize account for the most important staple crop production. Crop farming is at subsistence level due various agricultural constraints, with the most challenging being a lack of modern tools and rural transport infrastructure.

6.5.5 Key Findings of the Socio-economic Assessment (SEIA)

The impact assessment studies how poor rural transport infrastructure seriously affects arural households' poverty, agricultural production and food security. The study conducts descriptive analysis on how rural road investment intervention promotes food security, builds resilience and improves the local livelihoods.

6.5.5.1 Poor Rural Road as Key Driver of Rural Food Insecurity

89% of rural-based people in the sphere of the road project influence rely on rain fed subsistent agriculture (SORUDEV BLS, 2014). The majority (64.6%) of the household are considered to have fair food security, and 27% are considered to have poor food security. Further, 38.8% of the households engage in crop sale as their primary income generating activity while 34.2% of them engage in livestock sales[1]. The heavy reliance on the precarious nature of rainfall, manual labor with rudimentary farm tools and other potential constraints entail high risk of crop failure. This phenomenon coupled with poor rural infrastructure worsens the rural food insecurity, vulnerability, and livelihoods. The lack of the road infrastructure drives the constancy of rural poverty in bothdirect and indirect dimensions.

Poor transport access to basic services

Rural social services and infrastructures are extremely poor and inadequate at the project vicinity. The subsequent rural remoteness in spatial, physical, and social terms are translated into high transaction cost of travel, time and distance covered to access basic services, perpetuating rural poverty. Local people perceive poverty in terms of the distance covered to reach the basic social services.

Table 6.5-1: Access: DistanceCovered to Basic Service : Per person/trip

S.r	Basic Service access	Acr	Unit	Average distance /T	Number of Trips	Total Aver Distance	% of average total distance covered
1	Boma head Quarter	BHQ	Km	1.625	2	3.25	13%
2	Payam head Quarter	PHQ	Km	3.05	2	6.1	25%
3	Primary Health Care	PHCU	Km	0	2	0	0%
4	Health Center	HC	Km	4.9	2	9.8	39%
5	Wau hospital	WPHSL	Km	0	2	5.74	23%
6	Water Supply point	WSP	Km	0	2	0	0%
7	Primary School	PSCL	Km	0	2	0	0%
8	Secondary School	SSCL	Km	2.88	2	0	0%
	Average total			**12.445**		**24.89**	**100%**

Table 6.5-1 shows that the target communities travel the farthest average distance (9.8km)to access health centers, followed by Payamheadquarters(6.1km),by secondary school services (2.88km), and by Boma headquarters (3.25km)**.** The drinking water, primary health and education services are at the shortest distance, which is less than 1km or at homestead (0km). The potable water supply point is available at a settlement cluster level while primary health care and education access are witnessed in every Boma level. Social services have inadequate scope and quality of service delivery. The services are further challenged due to the needs of a widely scattered population inthe project influence areas.

Access to Education Services

Various social studies showed that illiteracy, measured by thepopulation age of 15 with no education, is more prominent in regions where the distance to primary school is more than 2km from homesteads. The studies have found that distance to school and the opportunity cost of enrolling a child to school all correlate negatively with child (particularly girls) school enrolment rates. In this regard, the SORUDEV baseline report of 39% of the school-going age group have access to education and 66.9% are illiterate at the project influence area can be potential indicators.

Table 6.5-1 shows that the distance to secondary school is 2.88km; This scenario is more complicated when the post-primary child reaches the certain age (14-15 years old) where he/she can go to secondary school or join the farm labor force. The child`s enhanced opportunity cost of attending secondary school impairs the chance of child education, which ultimately impedes the development of human resource capacity. It is worth noting that continued education contributes to entrepreneurship skill development, such as better crop husbandry, agro processing technique and marketing skill. The low level of post-primary education, therefore, maintains the rural households in food insecurity and a poverty cycle.

Access to Health Services

Health service is crucial for households and community stability. The most disease vulnerable groups are women and children, which constitute about 80% of the farm labor. Access to health service is more important at the time of agricultural season. It is the time when the occurrence of the diseases is critical. The poor access and quality of health delivery coupled with the disease seasonality adversely

impact the active farm labor availability and productivity, i.e. women, the most disease-prone group. As noted in Table-1 above the distance to the health center is 9.8km. This situation reflects the high demand of effort, time and cost of health access travel. The following table depicts the time spent to access the social services.

Table 6.5-2 Access: Average Time Spent Per person-Footing

S.r	Basic Service access	Acr	Unit	Average per capita time spent	% Per head daytime working	% of average total cost
1	Boma headquarter	BHQ	hrs	0.54	7%	14%
2	Payam headquarter	PHQ	hrs	1	13%	26%
3	Primary Health Care	PHCU	hrs	0	0%	0%
4	Health Center	HC	hrs	1.3	16%	34%
5	Wau Hospital	MPHSL	hrs	0	0%	0%
6	Water Supply point	WSP	hrs	0	0%	0%
7	Primary School	PSCL	hrs	0	0%	0%
8	Secondary School	SSCL	hrs	1	13%	26%
	Average Total			3.84	48%	100%
	Average Total			0.48		

Source: Annex 2

In Table 6.5-2, it can be noted that the local people spend the highest 34% at health centers, with 16% per head ofthe daytime working hours at health centers. The longest hours to the health facility involves high cost of transport and energy to the community, especially to the most disease susceptible group (women, elders and children). Moreover, the longer the distance to accessing servicesincreases the likelihood that households will resort to alternative, poorer quality health care and drop out of post-primary education.

The majority of the households have neither non-motorized nor motorized transport service access. Walking far distances to access services is painstaking. A few local motorbike owners provide transport to the local community. As shown in the table below, access to the basic services is costly accessing Basilia health center incurs the highest two-way ticket charge of SSP 11.76; Payam headquarters costs SSP 7.32, secondary school costs SSP 6.9, and Boma headquarters costs SSP 3.9.Given the fact that 43% of the community in the project influence area lives below the poverty line, the transport tariff rate should be classified as extremely high. The low quality of rural services leads to a shortage of healthy and productive human resources, which in, turn sustains the community's poverty and food insecurity trap.

Table 6.5-3: Average travel cost/Motor bike to Basic Service, in SSP

S.r	Basic Service access	Acr	Unit	Average cost /T/head	Number of Trips	Total Aver cost	% of average total cost
1	Boma headquarters	BHQ	trip	1.95	2	3.9	13%
2	Payam headquarters	PHQ	trip	3.66	2	7.32	24%
3	Primary Health Care	PHCU	trip	0	2	0	0%
4	Health Center	HC	trip	5.88	2	11.76	39%
5	Wau hospital	MPHSL	trip	0	2	0	0%
6	Water Suppy point	WSP	trip	0	2	0	0%

7	Primary School	PSCL	trip	0	2	0	0%
8	Secondary School	SSCL	trip	3.45	2	6.9	23%
	Total			**14.94**		**29.88**	**100%**
	Average			**1.8675**			

Source: Annex 3

Poor market and productive sector access

Access to market and productive sector is significant for enhancing the rural farmers' income, food security and poverty alleviation. The Lack of transport infrastructure to access is automatically translated into huge transaction cost of producing and marketing for the rural community.

The small farmers experience subsistence production level. The households are badly in need of the basic productive assets such as seeds, farm tools, extension services, and microcredit fertilizers and pesticides at onset of every farming season (May-August). The extreme transport cost to the market directly undermines the livelihood activities and food security of the household.

First-hand information acquired from the target farmers at the field shows that market recourse is quite limited. The potential market option varies seasonally and spatially. Wau town central State market and Basilia are the most important/First Option destination for agricultural output, inputs and basic consumer goods. The poor transport and road infrastructure considerably restrict the smallholder household connection to the Wau central market. During the rainy period, the main Kayango –Basilia feeder road routes are impassable. The blockage of the primary market routes denies the communities accessibility to basic food consumption needs and economic services at a time of critical demand. The interplay of the market forces drives up the transport cost of market travel, commodities purchases and freight.

Table 6.5-4 reflects the passenger travel and freight transport cost. The below-stated transport cost considers only travel cost from the target village to the Kayango-Basilia at Raja-Wau trunk road junction point. The transport transaction along the main trunk road is beyond the scope of this rural road project. The figure in the table indicates that passenger travel cost to first-option market has surged up by two- digits (56%) during the rainy period and freight cost increase at more than triple the rate (130%). The Kayango market is the second option during the rainy season, as Kayango is relatively accessible on foot. The passenger travel cost to the second option market has recorded a 29% rise on the rainy season, while the freight charge to the second option market experiences a drastic drop at both seasons. This fall in freight charge is merely attributed to the proximity of the Kayango market to the target community settlement.

Table 6.5-3: Average Transport Cost to Market Option: Passenger and Good(50Kg), in SSP

S.r	Season	Option-1		Option 2		% Increase/Decrease	
		motorbike		motorbike		Mkt 1 to Mkt2	
		Passenger	Good	Passenger	Good	Passenger	Good
1	Dry	20	40	25	20	25%	-50%
2	Rainy	35	75	45	35	29%	-53%
	Total	**55**	**115**	**70**	**55**		
	Average	**27.5**	**57.5**	**35**	**27.5**		
		15	35	20	15		
%	**increase**	**56%**	**130%**	**74%**	**56%**		

Source: Local Boma chiefs and business owners' data from field

Table 6.5-4: Staple food crop/Sorghum/ Purchase Market Price/Kg				
S.r	Season	Unit	Option-1	Option 2
			Sorghum	Sorghum
1	Dry	1Kg	1.7	1.5
2	Rainy	1Kg	2.5	2.3
	Total		**4.2**	**3.8**
	Average		**2.1**	**1.9**
			0.8	0.8
%	**increase**		**3%**	**3%**

Source: Local Boma chiefs and business owners' data from field

The intercept of high market food dependence with heavy rainfall seasons holds high risk of food insecurity, vulnerability and poor livelihood. During summer times, prices of the staple food cereals, sorghum, increases equally by estimate of 3% , at first and second option market respectively. At the first market option, the rapid food price rise drastically reduces the poor households' food purchase power by (assume SSP 100) 31%, from 58Kg to 40 Kg of sorghum. While at the second option market the food purchase power drops by 34%, from 67 Kg to 44Kg of sorghum.

Poor Rural Road as Key Driver of Low Rural Livelihood Status

The feeder road access to the potential demand market is poor during the critical food insecurity period in parallel with the heavy rainfall season. The asset selling prices also dramatically decline at the peak lean season (June-July) due to increasing market supply of smallholderhouseholds' cereal food consumption needs. Table 6.5-5 indicates that the goat sale price decrease by 24% and 36% in market option 1 and option 2 respectively, during the rainy period.

Table 6.5-5: Goat Market Sale Price

S.r	Season	Unit	Option-1			Option-2		
			Dry	Rainy	% Price fall	Dry	Rainy	% Price fall
1	Goat	Head	375	285	**-24%**	250	160	-36%

This situation drops the goat to sorghum Term of Trade (TOT) and puts the poor household in disadvantaged position in terms of the amount of sorghum they can get by selling a goat. It implies that the small farm holder`s goat to sorghum term will drop from 221 Kg to 150Kg of sorghum for a goat sold in peak hunger season.

6.5.6 Socio economic Impact of the Rural Road Investment

Empirical model revealed that rural services, infrastructure and agricultural productivity have strong positive co-relation with increases in food crop(s) production. Further, there is co-relation in terms of the household level of food availability and improvements of livelihoods. The study will discuss the effect that each category of improved rural road infrastructure and services has on rural agricultural productivity, incomes and food security.

A. Connectivity Role of the Road Network

The rural feeder road condition and scope of connectivity have direct relationship to meet the smallholder farmers' better social services, market access, improve farmers` economic opportunities and trade objectives.

The proposed access road shall play a critical role in high profile inter and intra connectivity at the community level. The road construction bears great potential in the linking of:-

- a number of villages to- respective Boma/smallest administrative unit
- the Boma to respective Payam headquarters/Basilia and Kangi
- Bomas to central basic social services access area BasiliaPayam HQ
- Villages to- Raja Wau main road at Raja - Wau trunk road junction. The road route induces in, within, and far beyond connection to potential marketplaces.

Table 6.5-6: Connectivity to Potential Market Options: Road Project Influence Areas

S.r	Target Village	Market Option-1				Market Options-2			
		Dry Season		Rainy season		Dry Season		Rainy Season	
		Road Route	Distance (Km)	Road Route	Distance (Km)	Route	Distance (Km)	Route	Distance (Km)
1	Basilia	B-R-Ki	NA	NA	NA	B-Wau	65	NA	NA
2	Riani	R-B	61	NA	NA	R-Ki	5	NA	NA
3	Kayango	Ki-R-B	66	NA	NA	Ki-R-B	66	NA	NA
4	Kangi	Ka-Wau	70	NA	NA	Ka-Ki	50	NA	NA

Source: Local Boma chiefs and FGI

Table 6.5-7: Comparison of Market access time: Before and After Project

S.r	Target Village	Market Access(Time in hours)		% Time Saving
		Before	After	
1	Basilia	5	1	-80.0%
2	Riani	1	0.15	-85.0%
3	Kayango	5	1	-80.0%
4	Kangi	4	1.3	-68.0%
	Average			-78%

Source: Local Boma chiefs

The feeder road connectivity is expected to drop access time to the potential market by an average of 78%. This is a good indication of the high advantage of reducing the cost of transporting, purchase farm input, producing and gain better rural services which collectively enhance the rural food security, income and livelihood.

There exists no established baseline information on the use of the social services. Based on general consensus, it is believed that the closer the service centers are, the more the rural farmers will make use of it. Based on the study findings the connectivity is expected to meet significant rural service impacts, which can be expressed later in quantifiable indicators. The lack of established benchmark, time series data and sufficient socio-economic characters make the pre-projection difficult.

S.r	Key Impact Indicators
1	Increase in number of the feeder road users- local people
2	Increase in volume of non-motorized and motorized-traffic
3	Increase in number and frequency of people access to market
4	Number and frequency of public transport travel

5	Volume of agricultural output and inputs transported to and from
6	Number of community awareness raising activities and capacity building training conducted
7	Number of local administration and community meeting
8	Volume of agricultural produce at market collection centers
9	Volume of consumer goods traded to and from the areas
10	Number of new business establishment at the areas
11	Number of new employment opportunities
12	Number of farmers group
13	Number of farmer`s group membership

The high degree of the road investment driven backward and forward linkages will create, develop and foster substantial momentum of social interaction, social security, safety, inclusiveness, unity, integrity, collaboration, communication, equal and balanced distribution of resources and opportunities. The impetus indispensably supports strengthening of the local leadership and organization, economic empowerment of the small farmers, better access to market and institutional support, share and dissemination of marketing knowledge, skill and information. The transformation process promotes increasing agricultural production, innovative entrepreneurship, rural poverty alleviation, food security and sustainable livelihood development.

B. Social and Gender Development

Education and health services are important for enhancing the quality and productivity of human capital. The investment on road infrastructure is then the local need-tailored response to address the alarming social and gender issue, at the proposed project area. The limited scope of the lifeline services is barely accessible by the local communities due to the lack of transport facilities. An attempt to the central services outreach entails huge cost, time and effort to the local communities. Substantial and effective rural feeder road networks are a core solution to life threatening social and gender concern.

C. Social Analysis

The rural feeder road project is expected to play a critical role in improving the social development of the target communities. The travel time saving and short distance covered represent the key direct social impact. The construction of the feeder road is anticipated to realize dramatic drop of the time spent to basic social services access. After the project the target communities` average access time to rural service is expected to fall by 46%, assuming former Sudan's 45km/hour speed limit for public transport moving on rural rough road network.

Table 6.5-8: Comparative Time-spent before and after project

S.r	Basic Service access	Acr	Unit	Average Distance	Before Project Avg time spent	After Project-Car Av time spent	% Decrease in Time-spent
1	Boma headquarters	BHQ	hrs	1.625	0.54	0.036	-96%
2	Payam headquarters	PHQ	hrs	3.05	1	0.068	-93%
3	Primary Health Care	PHCU	hrs	0	0	0	0%
4	Health Center	HC	hrs	4.9	1.3	0.11	-89%
5	Wau hospital	MPHSL	hrs	0	0	0	0%
6	Water Supply point	WSP	hrs	0	0	0	0%
7	Primary School	PSCL	hrs	2.875	0	0.064	0%
8	Secondary School	SSCL	hrs	0	1	0.1	-90%
	Average Total			**12.45**	**3.84**	**0.378**	**-46%**

Source: Consultant aggregation from KII and FGI

Table 6.5-9: Comparison of Staple Crop Production: Before and After Feeder Road Operation

Cultivated Crops	Av.Farm use(ha)		Av yield /ha/HH/ton	Average total Production		% increase estimated Pxn
	Before Project	After Project		Before PRJ	After PRJ	
Groundnuts	0.92	1.68	0.104	0.09568	0.17472	**-82%**
Sorghum	0.69	1.26	0.168	0.11592	0.21168	**-79%**
Maize	0.46	0.84	0.31	0.1426	0.2604	**-74%**
Sesame	0.46	0.84	0.31	0.1426	0.2604	**-74%**
Totals	2.53	4.62		0.40112	0.73248	**-77%**

The construction and maintenance of the rural feeder road is expected to increase the smallholder farmers` staple crops production volume. Sorghum and groundnuts harvest are the most predominant staple food crops. As shown in table-9, these crops are anticipated to rise by 79% and 82% respectively, at the initial year of the intended rural feeder road use/ operation. Concurrently, finger millet and maize are predicted to increase by 74% each after the start of the road. This promising increase in production can be attributed to the road connectivity driving better access to market. In turn, this access can improve seed variety; reduce the price of farm tools; improve innovative farming knowledge, skills, and support; and increase access to marketing information, agribusiness and trade development initiatives. The combined impact is expected to increase the farmers' income, food security, nutrition and sustainable livelihood.

D. Gender Analysis

Time factor is among the major challenge for girl child education at the area. The girl child is culturally overburdened with household activities. The lengthy period of time taken to reach school automatically results in girl school denial or drastic dropouts. In contrast, the shorter periods of time needed to reach school encourages a significant school age girl enrolment.

The rural road investment is a vital mechanism for promoting gender equality and development. Improving the education for girl children serves as a dynamic tool to promoting the positive attitude and behavioral change on the local socio-cultural context towards sustainable community development.

E. Food Security and Livelihood Analysis

The rural road network intervention has significant contribution in the poverty reduction, food security, community resilience peace building, and sustainable livelihood development. The project`s benefits are expansive with direct, indirect, induced and generated dimensions.

F. Food Security

According to the baseline survey, 98%of households primarily rely on traditional crop farming. In spite of the vast potential agriculture land the smallholder cultivates only small farmland. The household`s average cropland holdings is limited to 2- 3 feddans.

Family members (women and children) are the potential source of manpower for expansion of cropland cultivation. As indicated in Table 5, over 46% average time saving gained from improved transport access is anticipated to be productively invested on increasing farmland plantation and production. This percentage assumes no seasonal opportunity cost of marginal rural labor is forgone elsewhere in the economy. This is expected to realize the households` food self-sufficiency, where currently stands only at 56.6% of the consumption needs. The feeder road construction project is also expected to reduce the passenger ticket price by an average of 20%. The effect is anticipated to

positively influence the small farmers' accessibility and mobility to the potential market place and productive activities.

Table 6.5-10: Comparative Transport-cost Before and after project, in SSP

S.r	Basic Service access	Acr	Unit	Average Cost Before Project	Expected Cost Before Project	Expected Decrease Passe Av. Transport cost
1	Boma head Quarter	BHQ	trip	1.95	1.21	21%
2	Payam head Quarter	PHQ	trip	3.66	1.29	97.4
3	Primary Health Care	PHCU	trip	0	0	0%
4	Health Center	HC	trip	5.88	3.68	65%
5	Mapourdit hospital	MPHSL	trip	0	0	71%
6	Water Supply point	WSP	trip	0	0	0
7	Primary School	PSCL	trip	0	2.16	0
8	Secondary School	SSCL	trip	3.45	5	78%
	Total			**14.94**	**13.34**	
	Average Travel cost			**1.8675**	**1.6675**	**20%**

Source: Consultant Estimate based on local Boma Chief and Farmers

G. Market Access and Livelihood

Access to the potential market destination stimulates small farmer productivity and income from increased volume of agricultural product sales. The market access creates its own supply, empowers the small farm holders economically, and builds self-esteem and innovation.

Table 6.5-11 : Summary of Net Staple Crop Production Surplus (Ton)

Cultivated Crops	Five year Projection Staple Crop Surplus Production Summary (Y1-Y5)-ton					Total Surplus Production	Post Harvest Loss(20%)	Net Surplus (ton)
	Y1	Y2	Y3	Y4	Y5			
Sesame	192	62	217	226	235	931	186	745
Sorghum	434	441	489	509	530	2404	481	1923
Maize	384	123	434	451	470	1863	373	1490
Groundnuts	768	247	866	902	939	3722	744	2978
Total	1779	873	2006	2088	2174	8920	1784	7136

Source: Aggregated projection by Field Team

The above production projection is based on logical assumptions that the project influence areas has high potential for sustainable agriculture. Achieving the strategic objectives of the project shall provide better opportunity to improve farming practices (animal traction) and farmer cooperatives under the SORUDEV program.

Table 6.5-12: Cost of Farm Production: After the Project

Cultivated Crops	Av Farm use(ha)	production cost per hectare	Total cost of production in SSP	Av yield farm cultivated(ton)	Unit cost estimate of production(ton)
Groundnuts	0.84	1575	1323	0.05	26460.0
Sorghum	1.26	1575	1985	0.11	17640.0
Maize	0.84	1575	1323	0.10	13230.0
Finger M	1.68	1575	2646	0.10	26460.0
Total	4.62	6300	7277	0.36	83790.0

Source: Estimation by Field Team

Table 6.5-13: Small farm holders` Projected Net Income (5Years): After Rural Feeder Road Operation

Cultivated Crops	Net Surplus (ton)	Average Sell Price (ton),SSP	total Sales	Total Cost	Net Income
Sesame	745	19	14,156	66586.54	-52,430
Sorghum	1,923	21	40,384	41220.24	-836
Maize	1,490	19	28,312	22338.71	5,974
Groundnuts	2,978	62	184,633	22338.71	162,294
Total	7,136		267,485	152,484	115,001

Source: Estimation by Field Team

The net income projection is calculated based on the crop prices prevailing at the first option market access. The improved feeder road infrastructure is expected to reduce operation costs and facilitate the growth of economies of scale, farmer organizations and collective marketing. As noted in table-13, the small farmers face a loss in sesame sale (SSP 52,430) in the first year of operation. This loss can be related to the fact that simsim accounts for the smallest cropping pattern thus have lower returns on outlay. The farmers have gained a net income of SSP 115,001 in the first years of operations. The level of net profit is low in monetary terms at least for the short-run; however, there is great opportunity for development in the long-run. At the short-period – low knowledge, skill and experience of farm management, market information, network, negotiation power and group organization are a major concern. Even so, the farmers` learnt lessons on market engagement are a worthwhile implicit benefit.

6.5.4.5.3 Institutional arrangement

The road project design and implementation frameworks meet the necessary institutional requirements. Rural food security and livelihood support initiatives rest on the forefront of the EU Aid program.The program precondition requiring the alignment with host government`s prioritized development policies, needs and plan of action are well met.

The government of South Sudan (GOSS), endorsing the food and agriculture policy framework (2011-2016) and National Agriculture and Livestock policy, identified Food and Agriculture development as one of the six top spending priorities in South Sudan's 2011-2013 Development Plan. These government policies and strategies are supportive of the EU's ZEAT and BEAD programs.

The EU support terms also considered the broad coordination, consultation and communication requirements with potential stakeholders at all levels. The State Ministry of Agriculture and Forestry, State Ministry of Physical Infrastructure, NPA -NGOS (operating on ground in particular), local county commissioner, Payam inspectors, Boma chiefs and community representatives at the grass-root level

have been engaged to ensure a practical, dynamic and interactive approach throughout the proposed rural road project planning.

The road project objectives comply with the strategic development policy and priorities of the key partners. The EU`s rural road construction at the proposed project areas is aligned with the EU`s ZEAT and BEAD programs objectives of strengthening smallholder food security and livelihood.
The project design and implementation documents are produced on professional ethics based on a logical and integrated approach.

6.5.4.5.4 Stakeholders Analysis
The project key stakeholders are assessed to ensure the successful design and implementation capacity**.**

The project lead body
United Nation for Project Services (UNOPS) is the lead UN agency on sustainable infrastructure development. UNOPS' vast experience in South Sudan coupled with high quality expertise in project management principles and practices ensures client-oriented, sustainable, logical and integrated project end-result.

Local Administration
The local administration has expressed commitment on the project support. The County Commissioner, Payam inspectors and Boma chiefs shall take bold initiatives to coordinate, contribute and provide security throughout the project phase.

Relevant Line Ministries

The State Ministry of Agriculture and Forestry provides institutional support to farmers. In collaboration with potential development partners, the Ministry is involved in strengthening the smallholders' innovative labor-based farming techniques, introducing new seed varieties, and offering extension and marketing support by assigning extension agents at the county and Payam level. Increasing the numbers and building the capacity of extension workers is important to broaden and sustain the scope of service.

The State Ministry of Physical Infrastructure has no annual capital budget allocated for feeder road construction and maintenance, neither from the State nor National government. The Ministry's construction machinery and equipment are limited and some are in a state of disrepair. The Ministry has a few technical staff engaged in road and housing construction supervision. What is more, infrastructure planning and design expertise is inadequate. Building technical know-how is a major challenge.

Grassroots Community engagement
The local communities are homogenous in nature. They have a strong culture of organization and leadership based on democratic process. The local chief, elders, youth, women and faith-based groups have the responsibility and power of influence on the community interest. Local development activities are practiced through community-based resources organized by the local leadership. The help-group farming, collective farming, community school and health construction/maintenance, access road pavement and periodic maintenance are witnessed. Yet the capacity remains limited in scope and work quality.

Other Implementing Partners
The HARD is the implementing partner operating on the ground, it has a functional office in Wau HQ. The NGO has implemented strengthening the smallholders' agricultural extension service under the South Sudan Rural Development Programme (SORUDEV). **HARD** is the national NGO that has built capacity and experience in working with rural communities in WBeG State especially in implementing community based livelihood and food security projects.

Sustainability
The project design incorporates appropriate strategies encouraging community consultation, active and full participation of the local communities throughout the project cycle. The local communities' resources contribution to the project is a vital tool of building community-based sense of ownership and responsibility to sustain the project objective.

- At the project inception period, the target community should be committed to engaging in consultation, identifying the community's needs and priorities, clear understanding and showing a willingness to accept the project implementation framework. This will entail access to the road route, land for project camp, a disclaimer of cost of compensation on settlements affected by the project implementation and the provision of security and local construction material.
- The implementation stage should facilitate use of labor-intensive techniques to ensure local community involvement in the construction process. The approach not only creates local employment opportunities, but also plays a great role in building a sense of local ownership and responsibility.
- The local community lacks material, financial, and technical resource to engage on sustainable maintenance of the road. Strong coordination, communication and collaboration strategies are required to strengthen the local community capacity. The local authority in cooperation with line-ministries and other potential stakeholders need to provide technical, material and institutional capacity building aligned with the local community resource mobilization and fund-raising.
- The proposed rural road project design includes technical capacity building component on community based rural feeder road maintenance training to ensure sustainability.

6.5.4 Impact Monitoring and Evaluation Framework
The project monitoring and evaluation framework is a key mechanism for tracking the project objective progress and achievement in enhancing the target smallholder rural farmers` productivity, income, food security and sustainable livelihood. Based on the assessment key findings and project area-specific baseline data, the expected project impact monitoring and evaluation metrics are proposed as follows:

6.5.4.1 Food Security Impact Indicators
Rural Income Impact Indicator

S.r	Rural income Impact Indicator	Expected Impact Result
1	Number of HHs depending on employment income	Greater than 2%
2	Number of HHs living on petty	Greater than 11%
3	Number of HHs involved in fishing	Greater than 3%
4	HHs making livelihood on livestock	Less than 2%
5	Number of HHs selling part of their produce	Greater than 57%
6	Goat to sorghum TOT	Greater than 221kg
7	HHs purchase power per SSP 100-sorghum	Greater than 67 kg

Rural Agriculture Production Impact Indicator

S.r	Rural Agriculture Impact Indicator	Expected Impact Result
1	Number of HHs with shortage of farm labor	Less than 73%
2	Number of HHs lacking farm land	Less than 11%
3	Number of HHs with lack of farm tools and equipment	Less than 8%
4	Number of HHs facing land infertility	Less than 4%
5	Number of HHs facing insecurity	Less than 4%
6	Number of HHs owning Ox-plough	More than 7%
7	Number of farmers with ox-plough use know-how	More than 17%
7	Average farm size/HH	More than 8 feddans

8	Sorghum yield/feddan	More than 165 kg
9	Groundnut yield/feddan	More than 275 kg
10	Maize yield/feddan	More than 170 kg

6.5.5 Conclusion

Based on the assessment key findings the rural services and infrastructure development have strong cor-elations with increasing rural agricultural productivity, income, food security and sustainable development. The rural feeder road construction and maintenance project is therefore well-aligned with the EU`s SORUDEV program objective of strengthening the smallholder farmers production, employment and income through creation of market access and trade development. The proposed project is expected to reduce farmers' transaction costs of producing and marketing their products by 84%. The project anticipates a major time-saving, of 93%, in rural services access, such as with health services, school, market centers, and productive sectors. The cumulative positive effect improves the rural community service access and quality, which significantly contributes to a diverse variety of benefits: healthy and productive farm labor availability, improved pre-harvest and post-harvest crop management, better market information, innovative farming techniques(ox-plough), improved seed, reduced farm input, encouraging output prices, labor intensive agro-processing, and microcredit facilities.

Therefore, the proposed rural feeder road construction is socially and economically viable in terms of combating rural poverty. The project enhances agricultural productivity, income, nutrition and employment in an inclusive and sustainable manner.

6.5.6 Recommendation

Based on the assessment findings, Kangi market place in Jur River County is recommended as a commercially viable collection centre for regional distribution. Kangi is located along the main Wau – Aweil road that connects two State capitals and a new road is currently under construction that will connect Kangi to Kuajok which is yet another State capital. It has a well established rural market assembly with substantial transactions. The market serves as a place of convergence for people from dispersed villages around the project influence areas and other Payams from within and outside (WBG State). Kangi village has a number of social and economic services, such as health facilities, primary schools, rivers, nearby fishing activities, established businesses, and an established weekly market.. However, Kayango market would be an ideal community collection point for all farm produce as it is located mid-way between Basilia and Kangi and has a reasonably big market and draws produce from all the communities living along the road.

6.6 Preliminary Engineering Design and Cost Estimation

6.6.1 Introduction

The Kangi – Bar Urud – Kayango – Basilia road was selected out of a list of three roads prioritized by the State authorities during the consultative process. The selection process was through a desk review with the other partners in the ZEAT-BEAD program where the roads were subjected to selection criteria. The route assessment was carried jointly between the UNOPS team and representatives from the State Ministry of Physical Infrastructure. The objective of the mission was to:

- Assess the current condition of the road and develop recommendations on the horizontal alignment of the road, height of embankment, gravel wearing course, drainage requirements. These assessments and recommendations will then inform a cost estimate.
- Assess the sub-grade and geology of the materials along the road.
- Assess the environmental impact of the project.
- Assess the availability of construction materials along the route.

6.6.2 Methodology of the Assessment

In order to gain firsthand information of the project and appreciate the various issues needed for the study of the road, the team visited the project area on March 11, 2015.

The assessment was conducted by driving along the existing road and stopping at sites where there were problematic terrain and problem soil areas. Additionally, problematic areas as well as other locations were stopped at to assess the type of construction material used and to increase the volume of first-hand information.

The team began research by holding discussions with the Wau County Commissioner and later met with the Basilia Payam administrator and briefed them on the project scope and objectives. Later, the team proceeded for the road mission to assess the road.

The existing route between Basilia and Kayango is a defined track that appears to have been opened some years back and is used regularly both by vehicular and pedestrian traffic. It follows a relatively straight alignment with a few changes in direction. The track is about 3m wide and covers a length of 21.9km from Basilia to Kayango. The section between Kayango through Bar Urud to Basilia is a track that has been used over time but meanders without any defined geometry through the thickets, swamps and settlement areas. The assessment began by setting the vehicle odometers at zero in order to determine the length of the road as well as to pick distances to different villages and other important features. Table 6.6-1 below shows the distances (chainages) to the villages measured from the starting point.

Table 6.6-1 – Inventory of villages and important features

No.	Chainage	Village/feature
1.	0+000	Basilia
2.	21+900	Kayango Market
3.	40+200	Bar Urud Junction
4..	48+300	Bar Tiet
6.	62+200	PHCC
7.	69+600	Kangi Market

GPS coordinates of all villages and important features were recorded as tabulated on Table 6.6-2 below and a horizontal profile plotted to show the alignment of the existing track. A design alignment was then developed from the existing track as shown on Map 2.

Table 6.6-2: GPS Coordinates for villages along the road.

No.	**Village/feature**	**Latitude**	**Longitude**	**Elevation**
1	Basilia	7.758	27.679	452.968
2	Box culvert location at CH50+000	7.946	27.665	448.506
3	Kayango Market	7.948	27.624	464.840
4	Box culvert location at Ch17+700	7.960	27.573	458.355
5	Ajugo village	8.074	27.623	493.752
6	Kangi Market	8.148	27.661	493.365

6.6.3 Geometric Alignment

The existing route between Basilia and Kayango is relatively straight and requires very minor improvements on the horizontal alignment. The proposed alignment follows the existing alignment very closely and hence considered to be adequate. The sections between Kayango through Bar Urud to Kangi market follows a track that has been used over time and meanders through the thickets,

swamps and woodland. Two proposals for geometric design have been proposed for the Kayango – Bar Urud – Kangi road as follows:

- A route that follows the existing track closely but connects many straight sections and takes into account horizontal curves as provided for in the South Sudan Low Volume Roads Design Manual (Sept, 2013). This alignment follows closely the existing track and hence it still has numerous curves; however, the terrain it follows is expected to be more or less similar in profile of the existing track.

- A route that connects key control points/villages directly but deviates from the existing track could have a much different profile. This alignment has the advantage of being shorter, having better geometry and, as such, improves the safety and comfort in driving. However, the route has to be surveyed further as it is removed from the existing alignment and could have a completely different configuration. Additionally, the route may go through private property whichmay require elements of compensation.

6.6.4 Existing terrain

The general terrain along the route is flat and undulates between Basilia to Kayango and the same is for the section between Kayango and Kangi. The soils are generally sandy clay and patches of rocky sections in between.

Fig. 6.6-1: Terrain between Kayango and Kangi

6.6.5 Area of influence and land use

The area of influence extends from Basilia, on the main Wau – Raja road, to Kangi, which is on the Wau – Aweil road. WFP is now constructing a road that will link Kangi to Kuajok which is the Warrap State Headquarters. The major activities are small-holder crop farming mainly producing sorghum, millet, cassava and ground nuts as well as livestock keeping.

Fig. 6.6-2: Some of the livestock kept by communities along the road&Cassava farm near Kayango

6.6.6 Population, settlements and town centers

Majority of the population is clustered around the main centers in Basilia, Kayango, Bar Urud and Kangi. However, there are settlements along the road between Basilia and Kayango. The section between Kayango and Kangi is very sparsely populated or the population lives far away from the road. The main trading centers are Basilia, Kayango, Bar Urud and Kangi.

The fact that there is a near established road between Basilia and Kayango is perhaps the reason why there is a consistent settlement along this section. Differently, between Kayango and Kangi, there is not much of settlement along the track. The local authorities; however, said that there are populations living in isolated settlements further away from the track. It can be deduced that the presence of a road could create a pull factor to have more people living along the road.

Fig. 6.6-4 Market at Basilia

6.6.7 Sub-grade, geology and materials availability

The general sub-grade from Basilia to Kayango is comprised of rocky surface and sandy clay as one approach Kayango. These surfaces then turn into sections of a mixture of expansive clay rocky surfaces. There was no detailed soil investigation carried out, but from visual inspection, the material available is good for sub-base construction as well as gravel wearing course. However, detailed soil investigation will need to be carried out to ascertain the CBR values of the available materials and

their suitability for road construction. The table 6.6-3 shows the GPS locations for the potential borrow pits.

Table 6.6-3: GPS locations for potential borrow pits

No.	Borrow Pit	Latitude	Longitude	Elevation
1	Potential borrow pit 1	7.954	27.513	501.294
2	Potential borrow pit 2	7.998	27.530	482.728
3	Potential borrow pit 3	8.016	27.546	488.109

Fig. 6.6-5: A source of coarse aggregates in Wau County&Fig. 6.6-6: A section of the road between Basilia and Kayango

6.6.8 Drainage structures

There are no existing drainage structures along the existing track and while the general terrain is flat with a minimal gradient (0.28%) between Basilia and Kayango. However, there are a number of swamps between Kayango and Kangi, where much of the road passes through marshland. There are two major seasonal streams: one at CH17+700 and the other one at CH50+000. From visual inspection and study of the longitudinal and cross-sectional profiles, the two streams will require a 2-cell and 3-cell box culverts respectively. There are no hydrologic reports on the project area and the topographic maps available show that the area between Basilia and Kangi is include a number of swamps. For that reason in addition to the two concrete box culverts mentioned above, a provision has been made for the purposes of cost estimation for 900mm diameter steel pipe culverts for every 250m length along the road. Further, hydrological studies will need to be carried out to establish the hydrology of the project area and determine the actual drainage requirement.

Fig. 6.6-7: A section through the seasonal stream at CH50+000 where the local community has used local resources to create some temporary crossing

6.6.9 Design framework

The traffic surveys conducted indicated that the ADT for this section of the road places this road at DC3 standard according to the South Sudan low volume roads design manual guidelines. In this way, a carriageway of 5.5.m with a 0.75m wide shoulder has been recommended, making the embankment to be a total of 7.0m and 20m wide.

Given that the terrain is flat and susceptible to flooding, an embankment height of 600mm (on average) has been recommended. However, in some few cases, where there are depressions, the embankment height will be varied between 600-900mm.

Side ditches on flat terrains have not proved very helpful as they tend to pond water on the sides of the road rather than draining it to lower grounds. In this case the section between Basilia and Kayango would be recommended to have side ditches as it has a definite slope over short sections. However, in the section between Kayango and Kangi, only embankment-raising would been deemed necessary.

6.6.10 Costing

The costing of the project has been broken into two distinct sections: 1) Basilia – Kayango section and 2) Bar Urud – Kangi section in order to meet the thresholds placed by the project budget. The proposed embankments will be raised using materials available on the sides of the road. It is envisaged that at least three borrow pits will be established along the two sections of the road to make the maximum haulage distance to not more than 5km. From the visual inspections, there is presence of good quality gravel along the road on both sections. However, further investigations needs to be carried out to establish the quality and volume of the available gravel and suitability for road construction work.

There is only one South Sudanese contractor that was seen to be working in the State (i.e. Payi Road and Bridges who are building the Kangi – Kuajok section of the road for WFP). Payi was contacted for the provision of rates for machinery and materials. These rates were compared with rates for similar machinery under the UNOPS LTAs and informed with reasonable estimates for the construction works.

Table 6.6-4: The summary of the estimated costs: Kangi – Bar Urud - 29.2KM

Summary	Bill Group	Amount in USD
Bill 1	General	640,000.00
Bill 2	Site Clearance	187,108.00
Bill 3	Drainage	1,466,607.43
Bill 4	Earthworks	1,414,318.83
Bill 5	Gravel Wearing Course	1,330,372.76
Bill 6	Ancillary	131,750.00
Bill 7	Dayworks	30,000.00
SUB TOTAL		***5,200,157.02***
Contingency (6%)		312,009.42
Sub total		*5,512,166.44*

6.7 Economic Evaluation

6.7.1 Results of Economic Evaluation

The economic evaluation of the Project road has been carried out using the RED Model. The Economic Internal Rate of Return (EIRR) for the project has been derived by comparing with improvement and without improvement project options. The Net Present Values (NPVs) have been calculated at a 12% discount rate. The results of the economic evaluation are summarized in **Table 6.7-1,** and the details of the results showing benefits and costs including the RED Model outputs are included in **Annex 3C.**

Table 6.7-1: Summary of Results of Economic Evaluation

Sl. No.	OPTIONS	EIRR (%)	NPV (USD million)	NPV/C	FYRR/C (%)
1	DC-2 Standard	23	6.594	0.71	0.3
2	rd	22	5.939	0.60	0.28
3	DC-4 Standard	20	5.427	0.52	0.27
Selected Option (DC-3 With GWC Surfacing)		**22**	**5.939**	**0.60**	**0.28**

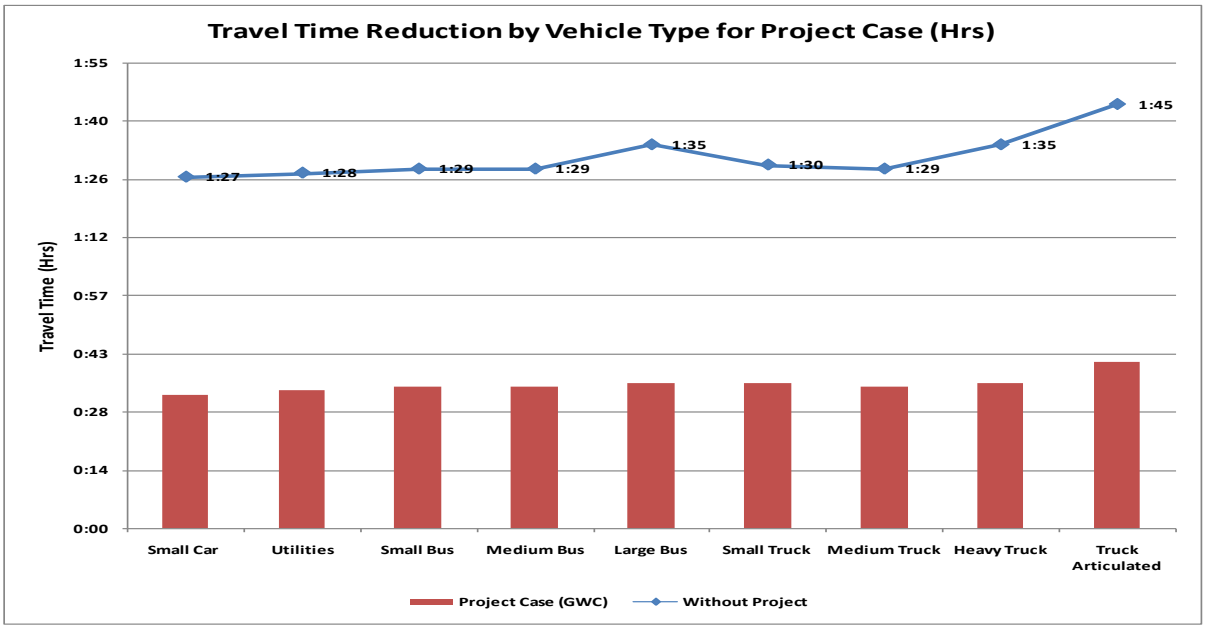
The improvement option is economically viable as the values of EIRRs for all sections of the road and the Project road are above the cut-off point of 12% as set by the World Bank for the appraisal of infrastructural projects in developing countries.

A comparison of travel times was made to understand the effect of the project case. These comparisons are determined in relation to the travel times being experienced by travelers as a result of poor access to infrastructure available to the society. **Table 6.7-2** depicts the figures extracted from the RED Model while **Chart 6.7-1** has compared the results graphically.

Table 6.7-2: Travel Time Comparison between Without Project and With Project Scenario

Project Alternatives	Dry Season		Wet Season		Car	Four-Wheel	Bus	Bus	Bus	Truck	Truck	Truck	Truck
	Length (km)	Roughness (IRI)	Length (km)	Roughness (IRI)	Small	Drive	Small	Medium	Large	Light	Medium	Heavy	Articulated
	Traffic Composition (%)				3%	19%	13%	11%	7%	16%	11%	14%	6%
Without Project	**38.6**	**24**	**38.6**	**25**	**1:27**	**1:28**	**1:29**	**1:29**	**1:35**	**1:30**	**1:29**	**1:35**	**1:45**
Project **ALT-1: GWC**	32	10	32	12	0:33	0:34	0:35	0:35	0:36	0:36	0:35	0:36	0:41
	Travel Time Saving (HR)				**0:54**	**0:54**	**0:54**	**0:54**	**0:59**	**0:54**	**0:54**	**0:59**	**1:04**

Chart 6.7-1 Travel Time Reduction by Vehicle Type



The results indicate that travel times will decrease substantially with the project case for all vehicle categories. Every vehicle category has enjoyed a travel time saving of about 1 hr; the largest coming from truck trailers. It is understood that the current state of the tracks does not allow such vehicles to be operated on them. Under a hypothetical scenario in which truck trailers could use the road, the larger trucks are more likely to suffer due to bad condition of the road than other types of vehicles. We note that almost all vehicles were able to make the trip in slightly less than 40 minutes under the project case.

6.7.2 Sensitivity Analysis

Investments in rural road projects, like any other investment, involves risks and uncertainties such as cost overrun, time overrun, traffic development, levels of benefit realization, etc. The effect of these uncertainties has been evaluated under Sensitivity Analysis, which involves recalculating the project economic evaluation results for different values of major variables. The traffic level (directly related to the benefits) and the project improvement cost are the two basic parameters, which influence the viability of the project. The Sensitivity Analysis has been carried out by varying the traffic and the improvement cost and reworking the costs and benefits analysis using RED Model for the following scenarios:

- Scenario-I: Increase in cost by15% and base benefits;
- Scenario-II: Base costs and decrease in benefit by 15%; and
- Scenario-III: Increase in cost by15% and decrease in benefit by 15%.

The results of the Sensitivity Analysis are presented in **Table 6.7-3** incorporating the changes in variables Project Costs and Benefits. The details of the analysis, thus, obtained are given in **Annex 3C**.

Table 6.7-3: Results of Sensitivity Analysis

Sl. No.	Options		Base Case	Cost +15% (A)	Benefit – 15% (B)	A & B
1	**DC-2 Standard**	**EIRR**(%)	**23**	18	18	**13**
		NPV (mill.USD)	**6.594**	4.165	3.176	**0.747**
2	**DC-3 Standard**	**EIRR**(%)	**22**	17	16	**12**
		NPV (mill.USD)	**5.939**	3.412	2.521	**-0.006**
3	**DC-4 Standard**	**EIRR**(%)	**20**	16	15	**11**
		NPV (mill.USD)	**5.427**	2.823	2,009	**-0.595**

6.7.3 Conclusions and Recommendations

Based on the results of the economic evaluation and supported with the Sensitivity Analysis, the investment for the improvement of Kangi – Bar Urud road an engineered standard feeder road with GWCpavement has been observed as being the most economically viable. From the options considered, DC-3 standard offered the most benefits in the base case as well as under sensitivity testing. As such, the road may be upgraded to *DC-3 with a5.5m carriageway width and a 0.75m shoulder on each side, i.e. 7.0m total width*.

The value of the EIRR is 18% for the project road, which is higher than the cut-off point of 12% for similar projects in RoSS.

The Sensitivity Analysis shows that for all tested cases including the worst-case, i.e. increase in cost by15% and decrease in benefit by 15%, the EIRRs are below the cut-off point posing that the risks identified should be mitigated during implementation, i.e. project cost should not be allowed to increase than projected at the time of the feasibility study.

Improvement of the project road as proposed, to Gravel Wearing Course standard, would impact positively the transportation costs. These impacts include the improvement of VOC savings, travel time savings to road users, better riding quality and savings in maintenance costs for the road agency (i.e. South Sudan Roads Authority). The investment in the project road would also impact positively on the overall socio-economic development of the project influence area, Lakes State in particular.

6.8 Recommendations

6.8.1 Road Selection

The two sections that were compared were Kangi – Bar Urud (29.2km) and Basilia – Kayango (21km) under this project from Kangi to Basilia (71km). The MCA has identified that the section from ***Kangi to Bar Urud (29.2km)*** shall be considered for further project development and eventual construction. The MCA that informed the decision to select this section is shown below.

WESTERN BAHR EL-GHAZAL STATE				Road section	
S/n	Criteria	Total scores	Weight	1.1 Kangi - Bar urud	1.2 Kayango - Basillia
1	**Connection of Farms to Markets**				
1.1	Number of farms located along the road section	2		1	2
1.2	Number of market centers located along the section	2		2	2
1.3	Extent of land suitable for farming (potentially)	2		2	1
1.4	Estimated population residing within the project corridor	2		1	2
1.5	Existence of agricultural activities in the region that will further develop with the road construction.	2		1	1
		10	2	**7**	**8**
		20		**14**	**16**
2	**Socio Economic Factors**				
2.1	Existence of social services such as schools, medical assistance, religious institutions, etc. that the road will provide better access.	2		2	2
2.2	Stability and security level	2		2	2
2.2	Road connection to higher population densities creating opportunities for local population	2		2	2
2.4	Level of motorized and non-motorized traffic operating on existing road	2		1	1
2.5	Presence of Payam and Boma Administration offices	2		2	2
		10	2	**7**	**7**
		20		**14**	**14**
3	**SORUDEV / ZEAT BEAD Partners**				
3.1	Activities of SORUDEV / ZEAT BEAD Partners are currently being Conducted in the region.	10		10	7
		10	**2**	**10**	**7**
		20		**20**	**14**
4	**Construction Feasibility**				
4.1	Estimated cost of construction	2		2	2
4.2	Requirement for a major bridge structure (bridge span)	2		1	0
4.3	Availability of Construction material (borrow pits, quarry, sand, water)	2		2	2
4.4	Likelihood construction operation will be affected due to instability in the area	1		2	2
4.5	Availability of skilled labour to be engaged in construction activity	1		1	2
4.6	Possible hydrological, geo-technical or subgrade material problems	2		2	2
		10	2	10	10
		20		**20**	**20**

5	**Sustainability**				
5.1	Community and Government is motivated to participate in the construction and maintenace program.	4		**4**	**3**
5.2	Development does not have significant adverse environmnetal impact (EIA)	4		**3**	**3**
5.3	Number of affected persons and properties (PAPs) due to the construction of the road (SIA)	2		2	2
		10	2	9	8
		20		**18**	**16**
	Total score/40			**43**	**40**
	Total score/100	**100.00**		**86.00**	**80.00**
	Priority Ranking			***1***	***2***

6.8.2 Maintenance Capacity Assessment

In accordance with the consultation and site visits carried out, the WBeG Ministry of Physical Infrastructure has one set of road construction/maintenance equipment which are all in working order. However, due to lack of budget allocated for road maintenance works, the equipment are not deployed on routine maintenance activities. The following equipment are reported to be available; however, the feasibility study team was not able to see and verify the available equipment.

6.8.2.1 Road Construction/Maintenance Equipment

Equipment	Quantity	Condition
Motor Grader	1	Serviceable
Excavator	1	serviceable
Smooth Roller	1	Serviceable
Tipper trucks	2	Serviceable

6.8.2.2 Manpower

Staff	Quantity
Mechanical Engineer	1
Plant Operators	1
Civil Engineers	Under recruitment

The team learned that the State Ministry does not have prior experience on community based road maintenance activities. However, there are established farmer groups who are being supported by an INGO (WATAP) to carry out routine maintenance of the Basilia - Rian rural road; the farmer groups receive provision of seeds and agricultural tools after maintenance. These groups could easily be trained and engaged for community based road maintenance activities. Furthermore, HARD (NGO) has also mobilized farmer groups under the SORUDEV program to form voluntary savings and loaning (VSL) scheme in Basilia, Kayango and Kangi areas which, if supported, could participate in the road construction and maintenance.

The technical know-how and capacity for planning and operations of maintenance activities are limited. Accordingly, the State is keen to receive any capacity building training and provision of required tools and equipment. As it stands now, the experience on road maintenance activities in the

state is minimal and the commitment is low. UNOPS will consider intensive capacity building training and community sensitization to introduce labor-based road maintenance activities using community-based organizations. Considering the prevailing budget constraints to fund maintenance activities and due to that fact that the available machinery requires large budget for operation and maintenance, UNOPS proposes the use of intermediate road building/maintenance equipment and tools for road maintenance activities.

6.8.2.3 Key Findings

The state Ministry of Physical Infrastructure has limited capacity in terms of technical know-how, resource availability, and budget to carry out road maintenance activities. Further, the commitment and enthusiasm to embark on this task as compared to the other States is low.. Overall, the following shortfalls are considered as an impediment for road maintenance activities in the state:

- Lack of funding/budget
- Lack of technical knowhow and commitment on labor based road maintenance activities
- Poor institutional framework to cater for road maintenance

6.8.2.4 Recommendations

- Considerable engagement and brainstorming of the State MoPI-Director of Roads & Bridges personnel is required to increase motivation and introduce appropriate road maintenance approaches.
- UNOPS will provide capacity building training on various aspects of road maintenance planning, operations, and maintenance such as
    - Planning, organizational and funding arrangements
    - Maintenance tasks
    - Defect identification
    - Planning & resource assignment
    - Maintenance methods
    - Traffic controls &safety

- UNOPS will engage INGOs working in the area under ZEAT BEAD and SORUDEV programmes to sensitize the roadside community and establish road maintenance groups.
- UNOPS will populate the information gathered during this feasibility study with a follow up mission in the State and produce a comprehensive and robust road maintenance strategic document in consultation with the State, national road infrastructure offices and key stakeholders on the ground.
- The principle of using intermediate level equipment has been deemed as feasible and cost effective in the State, in view of limited budget for operation and running of fleet of machineries. However, detailed evaluation of the amount, type and specification of equipment will be developed as maintenance requirements become established. The intermediate equipment approach would be balanced against the broader advantages of labor-based methodologies.
- UNOPS advocates PPP for follow up maintenmnace of the feeder roads by the state ministry of physical infrastructure after completion of the action.

7 Northern Bahr el Ghazal State

7.1 Introduction

Northern Bahr el-Ghazal is one of the four states selected for the implementation of the project entitled ZEAT BEAD, “Feeder Road Construction in support of Trade and Market development in South Sudan,”in line with the strategic objective of the EU’s SORUDEV programme. According to the NBS, 92% of Northern Bahr el-Ghazal population lives in rural areas. 76% of the population lives below the poverty line.80% depend on crop farming and animal husbandry. 21% of the adult population is literate. 66% of the population has access to improved sources of drinking water. This poor situation underscores ZEAD-BEAD feeder road intervention in effort to address the high food insecurity, improve market access and improve the livelihoods of the rural communities.

The Gok Machar to Jorbioc feeder road is located in the Aweil North County of Northern Bahr el Ghazal (NBeG) State and has been proposed for development under the EU SORUDEV / ZEAT BEAD program. The originally proposed route was a total length of 73km of which a section of 30km needs to be selected for construction. In consultation with CONCERN, SMoPI, SMoA and the Aweil North County Commissioner the most suitable route alignment was identified running parallel to the Loll River.

The final route and route distance will be determined as part of this feasibility report. Section five of this report details the feasibility study of the feeder road giving findings and recommendations of final route selection and feasibility of construction. The key criterion the road is required to meet is as follows;

- Existing agriculture activities likely to benefit from infrastructure development was present in the immediate proximity of the road.
- Local active markets are currently established in the area in reasonable proximity to agricultural activities.
- Social services are currently established at various locations along the proposed road.
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups.
- Development does not have significant adverse environmental impact.
- Community and Government are motivated to participate in the construction and maintenance programs.
- Road connection of significant population densities.
- Construction is physically feasible and economically viable.
- Operators will not be affected by insecurity.

7.2 Preliminary Engineering Survey and Route Selection

In March 2014 UNOPS presented a Preliminary Assessment report for proposed Feeder development under the EU ZEAT BEAD project. For the state of NBeG, three roads were proposed as the top priority for development; Wanyjok to Rum Aker, Gok Machar to Jor Beauc, and Matuic to Kiir Ajowak, as detailed in Table 7.1.The preliminary assessment revealed that there was little difference between the roads in relation to feasibility and all roads meet the selection criteria. An additional requirement of the ZEAT BEAD project necessitated that existing SORUDEV/ZEAT BEAD implementing partners be currently active in the area of the proposed feeder road development.

In consultation with Concern Worldwide, WFP, EU, NBeG State MoA and the Feeder Roads Steering committee prior to proceeding with site visits, it was revealed that the Gok Machar to Jor Beauc Feeder road was the only proposed route were existing implementing partners were present. The implementing partners confirmed the road met the essential selection criteria being that;

- Existing agriculture activities likely to benefit from infrastructure development was present in the immediate proximity of the road.
- Local active markets are currently established in the area in reasonable proximity to the agricultural activities.
- Social services are currently established at various locations along the proposed road.
- SORUDEV / ZEAT BEAD implementing partners have mobilized in this area and established agreements with the community groups.
- A predetermined route had been identified for verification through a site assessment.

The route for assessment was based on information provided by Concern, SMoA and SMoPI who advised the existing route currently being utilized and the locations of significant agricultural activities, established markets and social services. As such, the Gok Machar to Jor Beauc feeder road was deemed eligible for further analysis and verification as part on the feasibility study.

Table 7.1: Initially prioritized Roads by UNOPS for NBEG State

Northern Bahr el Ghazal	Width	Length (km)
Wanyjok - Rum Aker	6.00	79.00
Gok Machar - Jorbioc	6.00	73.00
Matuic - Kiir Ajowak	6.00	74.00

7.3 Physical Environment and Environmental Assessment

The environmental impact assessment of the Gok Machar to Jor Beauc feeder road in North Aweil County, NBeG state was carried out in accordance with the UNOPS Environmental Management System Handbook v 1.2 (https://www.unops.org/ApplyBO/File.aspx/11.%20RFP-KEOH-2014-002%20-%20Section%20V%20Annex%20G%20-%20EMS.pdf?AttachmentID=c21f27ea-0319-4879-a37a-e006cd46c115) and the DFID Overseas Road Note 5 – A guide to road project appraisal (http://www.transport-links.org/transport_links/filearea/publications/1_851_ORN_5_Final.pdf).

Physical site inspections were conducted between the 21st and 26th March 2015 in order to ascertain primary observational data. Efforts have been made to incorporate information from existing complied environmental data; however, it was found that the majority of reports discusses South Sudan as a whole rather than provide separate information for regions with information often being generic for some elements and not available in detail.
Field data on natural resources and ecosystem services are very scarce in South Sudan due to the long period of war, during which data collection stalled and existing data sources were also lost (USAID, 2007). Moreover, the focus of many studies and data sets were on northern Sudan.

The Government of the Republic of South Sudan is still working towards a comprehensive Environmental Legislation with the initiation of a Draft Environment Protection Bill (2010) which is yet to be formally recognized. Still, the government has achieved the implementation of the Southern Sudan Land Act 2009, *which has been adhered to in the assessment report.*

The Interim National Constitution of Southern Sudan (ICSS) incorporates legal aspects for the protection and management of the environment and natural resources. Part three, article 44 of the Interim Constitution of Southern Sudan - The Environment stipulates that every person or community has the right to have a clean and healthy environment. As part of this Constitution, all levels of the government in Southern Sudan are committed to sustainable development and the assurance that the environment is protected for the benefit of present and future generations.

Draft Environment Policy (2010):
The draft environmental policy under section 4.3 Environmental Impact Assessment indicated that the Government of South Sudan will require a systematic environmental impact assessment, audits and

monitoring and evaluation to mitigate adverse impacts and enhance environmental benefits. As a policy guidance, 1) the ESIA process is legally binding on all proposed projects; 2) Develop capacity to monitor the state of the environment in South Sudan; 3) Ensure that ESIA guidelines for all sectors are developed; and 4) Ensure stakeholder participation during the ESIA process right from the initial planning stages of the project.

The Draft Environmental Policy has the following objectives:

- Improve livelihoods of South Sudanese through sustainable management of the environment and utilization of natural resources;
- Build capacity of the government at all levels of governance and other stakeholders for better management of the environment;
- Integrate environmental considerations into the development policies, plans, and programs at the community, government and private sector levels; and
- Promote effective, widespread, and public participation in the conservation and management of the environment.

The main purpose of the Draft Environment Policy is to provide guidance and direction to all stakeholders.

7.3.1 Climate

The climate in the Aweil North County is considered to be tropical and classified as Aw by the Koppen climate classification, which implies tropical wet and dry or savanna climate (*Aw*) by having a pronounced dry season. The temperature averages 27.4 degrees Celsius with April being the warmest month at 30.8 degrees Celsius and the coolest month at 25.4 degrees Celsius in December. The annual average precipitation 858 mm with the driest month in January with no precipitation and the peak wet season in August with an average of 209mm (Climate Data, 2015).

7.3.2 Water resources

NBG state is characterized as a medium rainfall woodland savannah. It is an area of floodplains and ironstone plateaus. The floodplains are seasonally flooded due to the extensive fluctuation in precipitation creating a distinctive dry and wet season for the region. During the months of November to March, the landscape becomes a dry dusty terrain. The landscape is transformed during April to October with the onset of the rain season, with a peak in August of over 200mm average monthly rainfall.

In the location of the proposed feeder road from Gok Machar to Jor Beauc feeder runs parallel to the Loll River. This area makes up part of the greater Bahr el Ghazal catchment. According to the local authorities, despite the close proximity to the river and low elevation, flooding rarely occurs in the area of the proposed feeder road. This statement could be further verified by the presence of well-established villages that bore no signs of previous flooding. Most of the flooding in this area occurs on the south side of the river in the Aweil West County.

As can be observed in the Plan Drawings, boreholes are located at frequent intervals along the proposed route. It was observed that the existing boreholes had been fit with hand pumps and the majority seemed to be in good working order. Consultation with the SMoA and SMoPI revealed that the depth to artesian water reservoirs significantly varied between a 50m to 70m depth below surface level.

As the site visit was conducted in the dry season, observations revealed that apart from boreholes, there are no reliable water sources for construction or agricultural purposes. The natural surface water is used for human consumption, livestock, brick manufacturing and a small amount of cultivation.

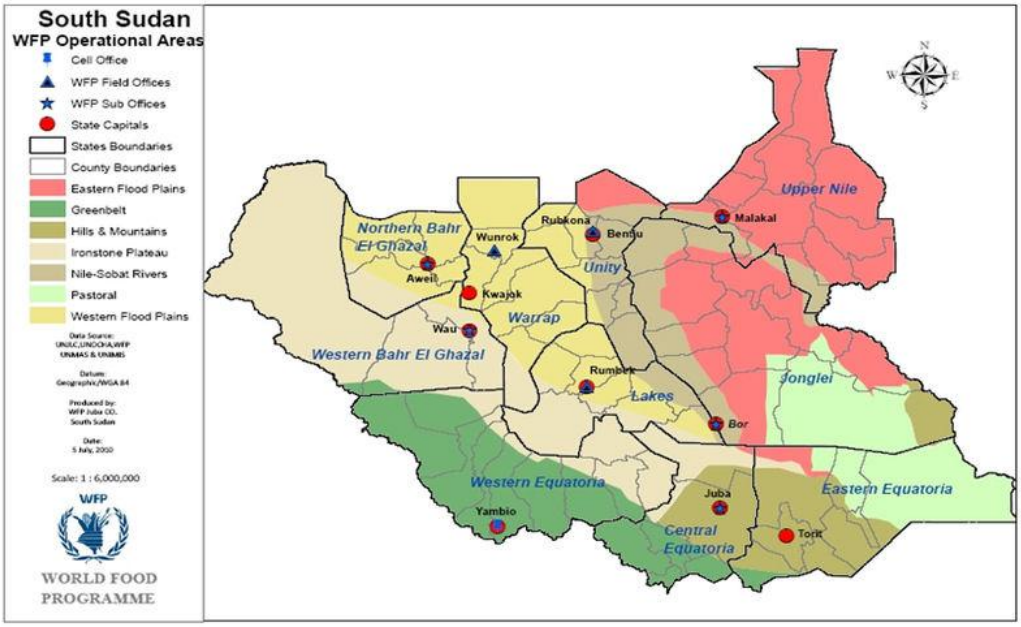
Concerns would be for the quality of surface water due to the combined human and livestock use and also, the lack of soil stabilization during the dry season. Waste and sanitation is not regulated in this area, which would contribute to the poor quality of water.

7.3.3 Topography, Soil and geology

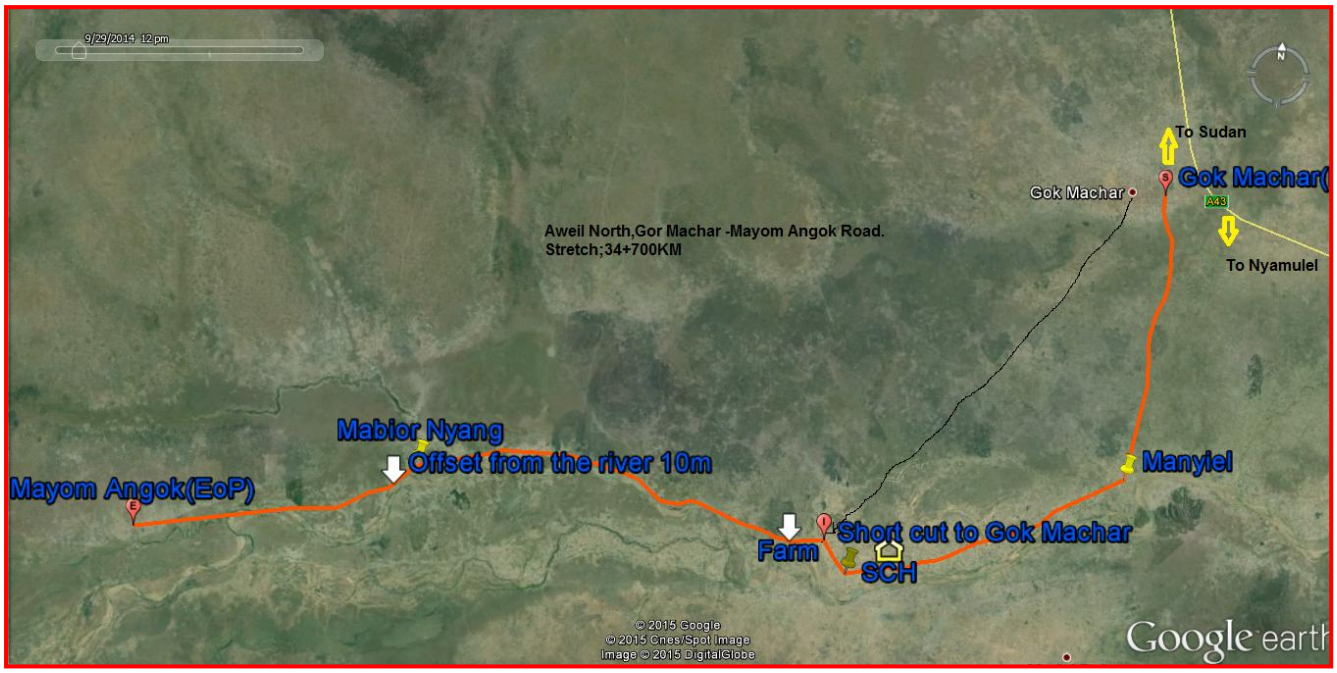
There is little variance in the elevation over the 73km of the assessed route. Topographic mapping detailing the elevation was not available for the exact location of the road; however, no significant gradient changes were observed or recorded with the GPS survey.

According to Harris (1958), the NBeG State is classified as a medium rainfall woodland savannah characterised by Ironstone Plateaus in the south and flood plain in the north as can be observed by the conditions WFP Operation Map ion Figure 7.1. No soil testing was conducted as part of this assessment; however, through onsite observation and comparison to existing data, it is evident that the soil type is generally loamy sandy soils. Some areas have a higher clay content, undelayed by an Ironstone plateau close to Gok Machar (Harris 1958).

Figure 7.3-1 WFP Operational Map



Map 4: Project road – Gok Machar to Mayom Angok



7.3.4 Local air pollution

As the local area is predominately populated by subsistent / barter farming, it is reasonable to assume that majority of air pollution is attributed to smoke and dust particulates. There is evidence of recent deforesting activity in the area contributing to increased exposed soils. Especially surrounding the established villages, there are large areas of baron ground and soil compaction impacting the soil structure. As previously mentioned, the physical assessment was conducted during the dry season. The observations revealed that cultivation areas are left exposed after harvest and significant vegetation cover is not achieved until the commencement of the wet season.

Although pedestrians and animals make up a large proportion of the traffic, current access has been enhanced by the implementation of Food For Assets program which has involve local residents working on the road. On the site visit, it became evident that this route is being used by trucks as a backroad access trade route for merchandise from Sudan. Motorcycles and some cars are also present, although usage would be dependent on the seasonal road condition. Overall, it is evident that air pollution is higher during the dry season due to the presence of dust, and this is typically the period when burning for clearing, brick and coal manufacturing is conducted.

7.3.5 Landscape, natural resources and waste

The medium rainfall woodland savannah characteristic of South Sudan extends into most parts of the greater Bahr el Ghazal. Trees in this region are generally tall and broad leaved. Coarse tall tussocks of perennial grasses predominate and fires are hence usually fiercer than in the low rainfall woodland savannah. *The most important tree species are Khayyam senegalensis and Isoberlina doka. Other species are Parkia oliveri, Daniella oliveri, Afzelia africana, Terminalia mollis, Burkea africana and itellaria paradoxa. (MTRB, 2014).*

The assessment of the proposed Gok Machar to Jor Beauc feeder road commenced at Gok Machar market being chainage 0km. At this location there was an active market and the proposed route wound through the established huts and businesses. Some large fruit bearing trees, such as large palms, were located very close to the road and would need to be removed for construction.

A murram deposit is located close to Gok Machar, but no other murram was noted along the route, however, this should be further investigated. At chainage 7km locals had been quarrying river stone for small quantity commercial use. It was also observed that there was a good reserve of sand with adequate quality for concrete construction products. In order to safe guard against future flood events, it would be prudent to form a low road embankment. Embankments could allow the opportunity to form water detention basins for use during the dry season and for crop irrigation.

The villages quickly dispersed beyond the Gok Machar village and the vegetation became denser forest, with the soils appearing to be mostly loamy sand soil with some areas having more clay or sediment content. The area near Gok Machar is underplayed by an ironstone plateau; however, this changed to an alluvial floodplain closer to the river. The landscape continued to shift between forest areas, with some large trees, to open savannah grasslands. There naturally occurring materials serve as a source of roof thatching material.

For the entire route there was negligible variance in the features of the area. The terrain was relatively flat with little change in elevation. Depth to foundations are unknown; however, it is suspect to be less than 1m in most locations except where there were large trees and the evidence of lack of soil structure during the wet season. In some areas, murram was found at the surface. In the observed low-lying areas, the soil was black clayey loam and sedimentary material. It was obvious that, due to the soil conditions, during the wet season, the existing track would be impassable in some sections.

For the chainages of 0.00km to 36.0km the population density was quite consistent with evidence of a lot of current agricultural activity. Large community vegetable gardens were observed at regular intervals, as were grain crops. Local and nomadic tribes used this area to graze cattle, goats and sheep. Grass for thatching was harvested in the area and brick manufacturing was also evident. There are recent signs of deforestation in some areas, mostly past chainage 43km. Well established social services are situated at regular intervals along this section of the route. The services include health clinics, schools, community halls, and churches. According to CONCERN and SMoPI, the construction of some of the community buildings have been funded and built by the local community. The population beyond chainage 36km becomes more scattered; there is greater distances between population clusters, less social services and, at in some sections, the route is less obvious. A recently established military training area had been constructed at chainage 45km, however the local authorities indicated that these camps are temporary and have a tendency of frequently relocating as part of their training.

Along the route, where the road was closer to the river, a number of sections of erosion were observed, most frequently in areas of creeks that fed into the river. Further development in this area could enhance the effects of the water erosion by creating a greater water shedding effect. During the design phase, specific considerations of adequate drainage structures and erosion mitigation measure need to be proposed. During the construction period, temporary soil stabilization and erosion control measures need to be implemented.

7.3.6 Biodiversity

Due to a lack of available information it is difficult to establish an adequate baseline for the current state of biodiversity in the area. However, generalized information and site observations have been used to establish the current bio-diversity status.

NBeG State is defined by the seasonal fluctuations of water levels and floodplains. The region is a significant area for bird life and, despite the effects of the prolonged war the area is still important in the seasonal migration of birds and wildlife (WWI, 2007). It is important to take into account the impact of the development of a smaller road in a heavily populated region may have on the wider catchment.

As further explained in Section 7.5 (Socio-Economic Assessment), substantial population densities already exist in the region of the proposed road. As a result of the land occupation, the immediate

area has already sustained significant impact to the biodiversity. It can be assumed that with the common activities currently practiced in this area negative impact on biodiversity has already occurred through; burning under-scrub, deforesting, migrational cattle grazing, hunting, excavation for brick manufacturing. Further, the recent introduction of cultivation has reduced the biodiversity in the immediate area and contributed a similar effect wider environment. The establishment of reliable vehicle impact is likely to further facilitate the reduction in biodiversity in the immediate area.

7.3.7 Cultural heritage

No significant sites of cultural heritage were observed or discovered for the immediate area of the proposed route however, it is important that dialogue with the local community continues to ensure this element has been explored fully.

7.3.8 Noise and vibration

Due to the lack of available information and monitoring equipment, only rudimentary observational assessments are possible. Considering the existing access limits with the velocity of mechanized transport and the lack of mechanized agricultural and manufacturing equipment, it is reasonable to assume that noise and vibration pollution is minimal. It can further be assumed that due to better accessibility during the dry season, noise and vibration will currently be higher than it is in the wet season.

7.3.9 Conclusion

The construction of the Gok Machar to Jor Beauc feeder road is likely to provide important development and access opportunities to the residents of the local area. However, this development is likely to have significant impact on the overall natural environment and as such strategic measures need to be incorporated in the design to mitigate the adverse impact.
It is advised that efforts are be made to ensure the identification of the most opportune locations for the acquisition of embankment construction material. Furthermore, it is advised that efforts are made to transform these borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of the borrow pit and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat clearing is required to be kept to a minimum.It is advisable that this requirement is considered in the design of the road corridor and the subsequent planning of the construction works. An important element to note is to avoid the removal of or consider the establishment of or compensation for the removal of any vegetation that is a food source. Due to the dispersive and fine particle characteristics of soils, it is advisable to re-vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss.

During the construction period access to water may be limited. To mitigate this negative impact, early identification of a viable water source is recommended or, alternatively initiation of a new water source construction, in order to reduce the impact of water collection opportunities onthe local population.

7.4 Travel Demand Establishment and Traffic Projection

7.4.1 Program for Traffic Surveys

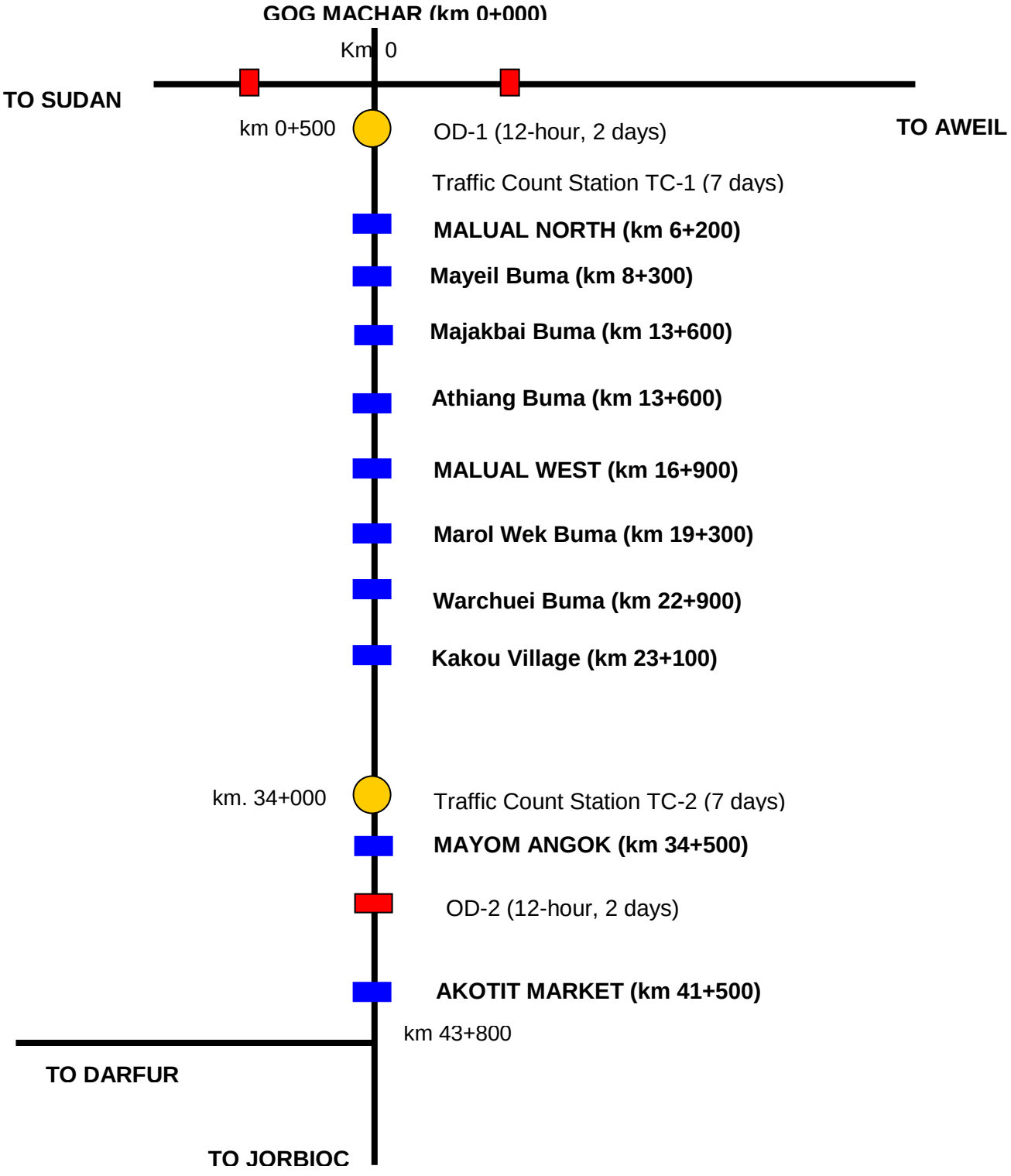
In view of the available information and data requirements of the project road, the data-gapswere identified, and a series of traffic surveys were conducted. Keeping in view of the ToR requirements, a program of traffic surveys was formulated and accordingly, the following traffic surveys were conducted in the project vicinity.

- Classified Traffic Volume Counts;

- Origin-Destination Surveys; and
- Travel Time Surveys.

Based on the reconnaissance survey and observation of the project road and traffic movement pattern on the road, five traffic survey locations were selected, as indicated on a line diagram **(Figure 7.4-1).**

Figure 7.4-1: Locations of Traffic Surveys



7.4.3 Classified Traffic Volume Counts

Classified traffic volume counts at three locations were conducted between 24.03.2015 and 30.03.2015 of which the details and durations are given in **Table 7.4-2.**

Table 7.4-2: Classified Traffic Volume Counts: Survey Locations

Survey Station	Location	Duration	Survey Dates
TC-1: Gog Machar, outside the town limits in the direction towards Mayom Angok (km 0+200)	Gog Machar	7 Days	24.03.15 – 30.03.15
TC-2: Mayom Angok, outside the town limits in the direction towards Gog Machar (km 35+000)	Mayom Angok	7 Days	24.03.15 – 30.03.15

7.4.3.1 Daily Traffic Counts and Traffic Compositions

The daily traffic count data are summarized in **Table 7.4-3,** presenting the averaged traffic volume as well as composition as percent of total traffic for each survey station. The vehicle composition brings out an interesting feature that passenger vehicle to: freight vehicles ratio are close to 1:1 for Mayom Angok Station. The reason for this ratio could be attributed to the well populated project area in Mayom Angok Market area and service delivery despite the poor transport infrastructure. This corresponds to the actual population distribution and assessment of basic services in the project area.

Table 7.4-3 Vehicle Category wise Traffic Volume at Survey Stations

Station 1: Gog Machar (TC-1)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
24th March 2015, Thurs	12-Hr										-
25th March 2015, Fri	12-Hr										-
26 March 2015, Sat	12-Hr										-
27 March 2015, Sun	12-Hr										-
28 March 2015, Mon	12-Hr										-
29 March 2015, Tues	12-Hr										-
30th March 2015, Wed	12-Hr										-
12-Hr Daily Average (ADT)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
Vehicle Composition		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
12-Hr Average Daily Traffic		**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
						#DIV/0!				#DIV/0!	

Station 2: Mayom Angok (TC-2)

Date of Survey	Count Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	Truck Trailer	Sum
24th March 2015, Thurs	12-Hr	1	0	0	0	0	0	8	6	0	**15**
25th March 2015, Fri	12-Hr	9	0	0	1	0	0	9	0	0	**19**
26 March 2015, Sat	12-Hr	68	0	0	67	35	5	17	103	0	**295**
27 March 2015, Sun	12-Hr	115	0	0	23	25	5	30	45	14	**257**
28 March 2015, Mon	12-Hr	55	0	14	10	16	5	23	23	0	**146**
29 March 2015, Tues	12-Hr	83	0	0	16	21	290	78	157	0	**645**
30th March 2015, Wed	12-Hr	164	0	0	0	50	20	65	57	24	**380**
12-Hr Daily Average (ADT)		70.7	0.0	2.0	16.7	21.0	46.4	32.9	55.9	5.4	
Vehicle Composition		28%	0%	1%	7%	8%	18%	13%	22%	2%	
12-Hr Average Daily Traffic		**71**	**0**	**2**	**17**	**21**	**46**	**33**	**56**	**5**	**251**
						44%				56%	

7.4.3.2 Traffic Variation: Day & Night

The traffic counts were normally carried out for 12 hours (0700-1900 hr) each day. Hence, a 24-hour (0600-0600) count was not carried out in any of the survey stations to get information about the proportion of traffic during 1900 to 0600 hr. However, given the poor state of the feeder road under consideration and the security situation in the state, it is anticipated that the need to carry out 24-hr survey would not be feasible. As such, it was decided that the surveys would only be conducted for

12 hours during the daytime. Therefore, the ratios of the 24-hr count/12-hr count (termed as “night factor”) for each category of vehicle and for each survey station are taken as one.

7.4.3.3 Average Daily Traffic (ADT) for Road Sections

The 12-hour traffic count data shown in Table 7-3 have been adjusted by the application of unit night factors indicated above and treated as equivalent 24-hour count data. The adjusted daily traffic count data are presented in Table 7.4-4 and further averaged to derive the ADT (average daily traffic) for each survey station.

The project road has been divided into three sections by the traffic distribution data: 1) from Gok Machar – Majakbai (13.6km), 2) Majak Bai to km 25+500 (11.9km), 3), Mayom Angok– Darfur Jn.km 25+500 (18.3km). The traffic count from each of the count stations is meant to be assigned to the section of the road that it represents.

Taking into account the ADTs derived for the three survey locations, the ADTs are assigned to the three road sections are shown in Table 7.4-4**.**

Table 7.4-4: ADT assigned to Project Road Sections

Section of the Road	Length (km)	Normal 24-Hr Traffic Count Forecast 2017 (Opening Year)									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Gok Machar - Majak Bai (0+000 to 13+600)	13.6	72	0	2	17	24	47	34	62	9	**267**
Majak Bai – km 25+500 (13+600 to 25+500)	11.9	72	0	2	17	24	47	34	62	9	**267**
Km 25+500 - Mayom Angok - Darfur Jn (25+500 to 43+800)	18.3	72	0	2	17	24	47	34	62	9	**267**
Gok Machar - Mayom Angok - Darfur Jn (0+000 to 43+800)	**43.8**	**72**	**0**	**2**	**17**	**24**	**47**	**34**	**62**	**9**	**268**

7.4.4 Origin-Destination Surveys

In order to establish the movement pattern on the project road, roadside interviews with vehicle drivers/crew were conducted at two traffic survey locations for three days each. The interviews ascertained the origins and destinations of the vehicles using the adjacent road, thetrip lengths (distance traveled), trip purpose, occupancy, and the commodity flow pattern. The surveys had been carried out on a working day and weekend for 12-hours from 0700 to 1900 hrs. The enumerators were deployed with sufficient training to conduct the surveys. Police help was obtained to ensure smooth flow of traffic and stoppage of the selected vehicles. The OD survey stations are described in Table 7.4-5.

Table 7.4-5: Origin-Destination Survey: Survey Locations

Survey Station	Location	Duration	Survey Duration
OD-1: At Gok Machar, outside town limits in the direction towards Aweil (km 0+400)	Gok Machar	2 Days	21.03.15 and 25.03.15
OD-2: At Gok Machar, outside town limits in the direction towards Sudan (km 0+400)	Gok Machar	2 Days	21.03.15 and 25.03.15
OD-3: At Mayom Angok, outside town limits in the direction towards Darfur Jn (km 35+000)	Mayom Angok	2 Days	21.03.15 and 25.03.15
OD-4: At Mayom Angok, outside town limits in the direction from Darfur Jn (km 35+000)	Mayom Angok	2 Days	21.03.15 and 25.03.15

Location-specific numbers of vehicles interviewed are given in Table 7.4-6.Out of the 105 vehicles interviewed, about 32 motorcycles and 2 construction plants were excluded from the table for the purpose of clarity.

Table 7.4-6: Number of Vehicles Intercepted in the O-D Survey

Location	Car*	L/Rover	S/Bus	L/Bus	S/Truck	M/Truck	H/Truck	T &T	Total
TOTAL	0	11	2	9	18	10	19	4	**73**

*Motor-cycles and specialized vehicles interviewed during the surveys is excluded

The intercepted vehicles were classified by vehicle plates and the purpose of the trip. In the former category, **Table 7.4-7A** shows that while business and trading vehicles by far dominated vehicle movement at about 47.6% of intercepted trips, these were followed by personal vehicles at 17.1%. While government vehicles attribute for 10% of the trips, UN/NGO vehicles have accounted for only2% of trips on the project road. Incidence of driving vehicles without any plate number was observed frequently at 20%, which is particularly high as compared to other states.

Table 7.4-7A: Vehicle Plate Category

Plate Code	Code	Frequency	%
No Plate	0	21	20.0%
Taxi	1	0	0.0%
Personal Automobile	2	18	17.1%
Trading Vehicle	3	50	47.6%
Administration/Local Government	4	9	8.6%
National Government	5	1	1.0%
Other Country/UN	6	2	1.9%
Others	7	4	3.8%
TOTAL		**105**	**100%**

Table 7.4-7B: Trip Purpose Category

Trip Purpose	Code	Frequency	%
No Response	0	2	7.4%
From/To Work	1	5	18.5%
Employment	2	12	44.4%
Personal	3	3	11.1%
Education	4	0	0.0%
Medical	5	3	11.1%
Social	6	0	0.0%
Vacation	7	2	7.4%
Ceremony (Wedding, Funeral)	8	0	0.0%
Others	9	0	0.0%
TOTAL		**27**	**100%**

The OD survey has also captured the response of drivers regarding trip purposes **(Table 7.4-7B)**. It was found out that work and employment trips contributed most to the purpose of the motorized travel around the project vicinity at 62.9%, while personal trips accounted for 11.1% of trips and trips to social services (medical) accounted 11.1% of trips. Social, educational and attending ceremony accounted for none of the trips. 7.4% of trips were made for vacation purposes. The incidence of no response to the interview is at 7.4% of all vehicles intercepted by the OD survey.

7.4.4.1 Commodity Movement

During the O-D surveys, a variety of commodities – bulk and mixed cargo, was observed moving on the project road. The O-D information collected was classified according to the commodity category (Table 5-8) and the percentage distribution of commodity is given in **Table 7.4-9.**

Table 7.4-9: Distribution of Commodity on the Project Road (%)

Commodity Type	%
Empty	36.5%
Agricultural Product	11.5%
Livestock	1.9%
Fuel-wood or Charcoal	0.0%
Water	5.8%
Processed Food or drinks	30.8%
Construction machinery/equipment	0.0%
Logs or lumber	3.8%
Construction Materials, cement, rebar	1.9%
Petrol, Diesel, Kerosene, gas	3.8%
Chemicals or Fertilizers	0.0%
Pharmaceutical Items, Medicine	0.0%
Miscellaneous Household goods	3.8%
Others/Unknown	0.0%
TOTAL	**100%**

It may be noted that incidence of empty hauling were observed frequently accounting for 36.5% of truck trips.Of loaded goods vehicles, 30.8% were for processed food/drinks followed by agricultural products at 11.5%, and water transport at 5.8%. Logging, hydrocarbons, and household items each contributed 3.8% of intercepted trips. Peculiar enough, the construction sector has not contributed to any trips of commodities being transported in the vicinity of the project road. In general, it is noted that the project vicinity contributes to the national freight movement through agricultural items collected from farms existing along the project road to relevant markets elsewhere. Further, the project road forms a major import corridor for processed food/drink items to be sold in the local markets.

Alongside the commodity flow survey, data on the carrying capacity of trucks was collected and the payload carried by truckers was recorded. For the purpose of analysis, the trucks have been categorized as shown in **Table 7.4-10** with their respective percentage distribution.

Table7.4-10: Percentage Distribution of Commodity Flow from the O-D survey

Vehicle Utilization	Code	Frequency	%
Empty	0	21	37.5%
1/4 Full	1	4	7.1%
Half Full	2	6	10.7%
3/4 Full	3	4	7.1%
Fully Loaded	4	12	21.4%
Over-loaded	5	9	16.1%
TOTAL		**56**	**100%**

Based on the survey, 37.5% of the trucks are empty while 7% of total intercepted trucks are a quarter loaded. On the project road, it has been observed that a considerable amount of trucks are substantially to fully loaded which accounts for 39% of the total intercepted trucks while the extent of over-loading was observed at 16%.

7.4.4.2 Trip Frequency on the Project Road

The frequency of making similar trips by drivers was collected from the drivers and analyzed. We note that high proportion of the intercepted vehicles actually make similar trips frequently as shown in **Table 7.4-11**.

Table7.4-11: Trip Frequency Distribution from the O-D survey

Trip Frequency	Code	Frequency	%
Most Frequent	7	0	10%
	3	4	
	2	5	
Frequent	1	82	87%
Occasional	0.5	0	3%
	0.25	3	
TOTAL		**94**	**100%**

Most frequent and frequent trips made from once a week to daily account for 97% of all vehicles interviewed by the OD survey. This makes the trip characteristics observed from this particular survey a dependable replica of actual movement pattern of drivers in the future. There were limited occasional trips intercepted by the survey.

7.4.4.3 Traffic Flow Pattern

Then, followed by Mayom, Gok Machar and Wau are the major generating and attracting centers of traffic on the project road (**Table 7.4-12**). As the distance between the Origin and Destination towns increase, the traffic flow on the project road decreases.

Table7.4-12: Traffic Attraction Centroids from the O-D survey

Location	Origin	Destination	SUM	RANK
Gok Machar	15	7	22	3
Akwaktiit	4	11	15	6
Nyamulell	2	2	4	13
Dhen	21	5	26	1
Mayom	8	17	25	2
Khartoum	12	2	14	7
Juba	1	4	5	11
Pardose	2	3	5	11
Nyala	11	7	18	5
Marial	3	3	6	10
Aweil	7	6	13	8
Wau	5	14	19	4
Ariath	0	3	3	15
Wanyjok	1	6	7	9

Joukon	4	0	4	13
Pirkou	0	1	1	17
Makuc	3	0	3	15
TOTAL	**99**	**91**	**190**	

Based on the major origin and destination points on the project road, the OD Matrix is established and shown under **Table 7.4-13A and Table 7.4-13B**.

Table 7.4-13A: Origin Destination Matrix based on OD Survey

O/D	Dhen	Mayom	Gok Machar	Wau	Nyala	Akuakiit	Khartoum	Aweil	Wanyjok	Marial	OTH	Sum
Dhen	0	0	8	1	0	0	0	5	3	1	3	**21**
Mayom	0	0	0	0	0	6	0	0	0	0	2	**8**
Gok Machar	4	4	0	0	1	4	0	0	0	0	3	**16**
Wau	0	0	0	0	3	0	1	0	0	0	1	**5**
Nyala	0	0	0	4	0	0	0	3	3	0	1	**11**
Akwaktiit	0	3	1	0	0	0	0	0	0	0	0	**4**
Khartoum	0	0	0	8	0	0	0	4	0	0	0	**12**
Aweil	1	1	0	0	3	0	1	0	0	0	3	**9**
Wanyjok	0	0	0	0	0	0	0	0	0	0	1	**1**
Marial	0	1	0	0	0	1	0	0	0	0	0	**2**
OTH	0	8	1	1	1	0	0	0	0	2	3	**16**
Sum	**5**	**17**	**10**	**14**	**8**	**11**	**2**	**12**	**6**	**3**	**17**	**105**

Table 7.4-13B: Origin Destination Matrix based on OD Survey

O/D	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**OTH**	**Sum**
1	0	0	8	1	0	0	0	5	3	1	3	**21**
2	0	0	0	0	0	6	0	0	0	0	2	**8**
3	4	4	0	0	1	4	0	0	0	0	3	**16**
4	0	0	0	0	3	0	1	0	0	0	1	**5**
5	0	0	0	4	0	0	0	3	3	0	1	**11**
6	0	3	1	0	0	0	0	0	0	0	0	**4**
7	0	0	0	8	0	0	0	4	0	0	0	**12**
8	1	1	0	0	3	0	1	0	0	0	3	**9**
9	0	0	0	0	0	0	0	0	0	0	1	**1**
10	0	1	0	0	0	1	0	0	0	0	0	**2**
OTH	0	8	1	1	1	0	0	0	0	2	3	**16**
Sum	**5**	**17**	**10**	**14**	**8**	**11**	**2**	**12**	**6**	**3**	**17**	**105**

Of all vehicles intercepted by the survey, more than 63% were originated from or ended in either of Dhen, Mayom, Gok Machar, Wau, Nyala and Akwaktiit. This shows the significance of the project road control points, particularly Gok Machar in the overall travel pattern at the national level. Of all the trips that started the journey at Gok Machar, 75% were headed to Dhen, Mayom or Akwaktiit. Of all the trips that were made to Gok Machar, 80% were from Dhen.

7.4.5 Seasonal Variation in Traffic Flow

ADTs shown in **Table 7.4-7** relate to the time of the year when the traffic surveys are carried out, over a period of 7 days in March 2015. The project road traffic; however, is susceptible to seasonal variations, particularly those caused by the seasonality of the climate and agricultural activities in the project area.

The most ideal historical data for assessing the seasonal variations of traffic flow along the project road would be counts made by SSRA during the different cycles of the year. This data should have particular focus on the dry period (December to March) and wet season (April to November) with two thirds of the time being a rainy period. As the traffic surveys were made during the dry period (High season), different factors are required to be used to correct the seasonality of traffic along the project road, particularly in lieu of the wet season (Low- traffic volume season). In the absence of historical data maintained with the SSRA, it was decided to assume proportion of traffic during high, low and medium seasons in relation to the annual average values as depicted under **Table 7.4-14**.

Table 7.4-14: Seasonal Correction Factor (SCF)

Season	Indexed ADT	SCF
Low	0.5	1.87
Medium	1	0.93
High	1.3	0.72
Average	**0.933**	

The use of the SCF meant that the ADT calculated from the traffic count surveys shall be adjusted for seasonality of traffic on the project road relating to low, medium and high seasons.

7.4.6 Non-Motorized Traffic Survey

Non-motorized transport modes in use in the project area comprise principally of pack animals and walking. Other intermediate non-motorized modes, mainly bicycles do play an important role; both enable the reduction of travel costs through faster travel time or increased loading capacity with relatively small capital outlays. Road improvement is likely to reduce costs of operation and encourage adoption of these modes at least in suitable terrain. Hence, data has been collected to assess the potential of Non-motorized traffic at the vicinity of the project area. The Non-motorized traffic count has been conducted alongside with the motorized traffic count, .i.e. the traffic survey stations as well as the period of the traffic count are similar to that of the motorized traffic count. The Non-motorized traffic data for the four stations are depicted as shown below in**Table7.4-15**.

As shown in the**Tables7.4-15**, it is observed that the dominating non–motorized forms of traffic are pedestrians and pack animals at all stations. At the proximity of larger villages such as Gok Machar, considerable amounts of inhabitants used bicycles for day-to-day activities for local movements. It has been noticed that the intensity of handcarts is also high at vicinity of villages. The Non-motorized traffic flow has been converted to Motorized vehicles to estimate the traffic volume on the project road by using appropriate Passenger-Car Equivalent (PCE) factors from the **Low Volume Road Design Manual (2013)**.

Table 7.4-15: Non-Motorized Traffic Survey Results

Station 1: Gog Machar (TC-1)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
24th March 2015, Thurs	12-Hr		470	545	340	0	**1,355**
25th March 2015, Fri	12-Hr		945	980	1040	0	**2,965**
26 March 2015, Sat	12-Hr		810	820	736	0	**2,366**
27 March 2015, Sun	12-Hr		831	1686	845	0	**3,362**
28 March 2015, Mon	12-Hr		777	755	721	0	**2,253**
29 March 2015, Tues	12-Hr		830	910	835	0	**2,575**
30th March 2015, Wed	12-Hr		820	840	815	0	**2,475**
12-Hr Weekly Average (ADT)		#DIV/0!	783.3	933.7	761.7	0.0	
24-Hr Average Weekly Daily Traffic		**#DIV/0!**	**783**	**934**	**762**	**0**	**#DIV/0!**
		0.25	0.2	0.15	0.7	0	**PCU**
		#DIV/0!	157	140	533	0	**Cars**

80% passenger	#DIV/0!	#DIV/0!	L. Bus
20% freight	#DIV/0!	#DIV/0!	H. Truck
		#DIV/0!	TT

Station 2: Mayom Angok (TC-2)

Date of Survey	Count Period	Motorcycles	Bicycles	Pedestrians	Carts	Others	Sum
24th March 2015, Thurs	12-Hr	36	218	575	3	0	**832**
25th March 2015, Fri	12-Hr	16	1152	1335	310	339	**3,152**
26 March 2015, Sat	12-Hr	115	324	523	6	0	**968**
27 March 2015, Sun	12-Hr	214	705	944	71	435	**2,369**
28 March 2015, Mon	12-Hr	223	779	1206	760	677	**3,645**
29 March 2015, Tues	12-Hr	155	633	1305	612	508	**3,213**
30th March 2015, Wed	12-Hr	163	710	1293	750	545	**3,461**
12-Hr Weekly Average (ADT)		131.7	645.9	1025.9	358.9	357.7	
24-Hr Average Weekly Daily Traffic		**132**	**646**	**1026**	**359**	**358**	**2,520**
		0.25	0.2	0.15	0.7	0	**PCU**
		33	129	154	251	0	**Cars**

60% passenger	190	3	L. Bus
40% freight	126	5	H. Truck
		3	TT

7.4.10 Establishment of AADTs

AADTs, as shown in **Table 7.4-15,** are derived based on the analysis of traffic seasonality, as indicated above, and through applying judgment**.** The components of traffic considered for design and economic analysis of project road are normal, generated and diverted traffic. Consequently, it is necessary to distinguish between the following traffic:

Current/Normal Traffic: This represents the existing traffic that would use the improved road when it is open to traffic.

Diverted Traffic: This represents the traffic attracted to the improved road or lost to alternative routes when the improvements are completed.

Induced Traffic: This represents the increase in traffic as a result of the increased demand for transport, if any, induced by the improvement of the road. This is part of the Generated Traffic under establishment of AADT.

Development Traffic: This represents the increase in traffic, if any, that may arise from improvements on adjacent land over and above the development which would have taken place had the new or improved road not been constructed. This is part of the Generated Traffic under establishment of AADT.

7.4.10.1 Normal Traffic

This represents the traffic, which would in any event occur if no improvement is made. The base year for traffic projection is 2015, on which traffic surveys and baseline data have been based. The normal traffic has been projected for 2 years (2015-2017), based on short-term traffic growth rate of 1%.Accordingly, as shown **Table 7.4-16,** the summarized predicted AADT for the year of 2017 is based on traffic count made by the Field Team considering the adopted growth rate on the project road.

Table 7.4-16: Normal Traffic

Section of the Road	Length (km)	Normal AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Seasonal Correction Factor		**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	**0.750**	
Gok Machar - Majak Bai (0+000 to 13+600)	13.6	54	0	2	13	18	36	25	47	6	**200**
Majak Bai – km 25+500 (13+600 to 25+500)	11.9	54	0	2	13	18	36	25	47	6	**200**
Km 25+500 - Mayom Angok - Darfur Jn (25+500 to 43+800)	18.3	54	0	2	13	18	36	25	47	6	**200**
Gok Machar - Mayom Angok - Darfur Jn (0+000 to 43+800)	**43.8**	**54**	**0**	**2**	**13**	**18**	**36**	**25**	**47**	**6**	**200**

The SCF adopted for the project is 0.75 with an effort to arrive at reasonable demand levels. The NMT count has been used to estimate the number of passenger and freight vehicles. The values obtained were added to the motorized traffic obtained from the survey into bus and truck traffic. The sum of MT and NMT gives the Normal Traffic for the project.

7.4.10.2 Generated Traffic

Generated traffic is the traffic that results from economic, social and environmental development of the project area. Generated traffic is expected to emerge as soon as the road is upgraded and open to traffic. Two categories of traffic change may be generated by road construction. First, there may be modal shifts in which low cost movements are replaced by higher cost movements. It is the change in mode rather than the quantity of trips. Secondly additional trips may be undertaken solely as a result of better accessible roads and thereby reduction in trip cost i.e. lower VOCs and travel time. This phenomenon takes place in ROSS, as demand for the transportation increases as its cost decreases, which yields savings to the road users.

Currently, agricultural activities and passenger mobility are low due to bad condition of the existing road. Thus, generated traffic is the induced traffic, which will use the road following road construction or improvement that would not occur without the project road. These changes may lead to new or increased economic activity or higher volumes of consumption or marketed products, or stimulate an increased frequency or new patterns of personal trip making, leading to increased passenger traffic. It is obvious that there will be an increase in agricultural product in the project area and the nearby project areas and the country at large. This increase follows the understanding that the road is highly influenced by the import and export activity of the county and serves as an alternative import-export corridor. The construction of the road will have a positive impact in increasing the income of the surrounding farmers, and thereby, will result in more demand of industrial commodities by farmers because of augmented income. Thus, it can be concluded that generated traffic will be significant since the existing road cannot handle additional requirements of the different vehicles as a result of the economic activity in the long-term period of the project life. In this regard, experience shows that estimated generated traffic generally varies between 15 % – 30% of the normal traffic. We use 20% for this road project.

Table 7.4-17B: Generated Traffic

Section of the Road	Length (km)	Generated AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Gok Machar - Majak Bai (0+000 to 13+600)	13.6	11	0	0	3	4	7	5	9	1	**40**
Majak Bai – km 25+500 (13+600 to 25+500)	11.9	11	0	0	3	4	7	5	9	1	**40**
Km 25+500 - Mayom Angok - Darfur Jn (25+500 to 43+800)	18.3	11	0	0	3	4	7	5	9	1	**40**
Gok Machar - Mayom Angok - Darfur Jn (0+000 to 43+800)	**43.8**	**11**	**0**	**0**	**3**	**4**	**7**	**5**	**9**	**1**	**40**

7.4.10.3 Diverted Traffic

Diverted traffic represents traffic that diverts to the project road from alternative roads, while at the same time, keeping the same origin and destination as before. During the analysis of Origins and Destinations using O/D Matrix, it was noted that the project road may not be a possible alternative to travel from Aweil to Sudan and traffic diversion will not be possible. As such, diverted traffic is excluded from this study.

7.4.10.4 Opening Year AADT

The resulting summary of AADT establishment is shown hereunder in Table 7.4-18.

Table 7.4-18: Opening Year AADT

Total AADT 2017 By SECTION

Section of the Road	Length (km)	AADT 2017									Total
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	
Gok Machar - Majak Bai (0+000 to 13+600)	13.6	65	0	2	15	22	43	30	56	8	**241**
Majak Bai – km 25+500 (13+600 to 25+500)	11.9	65	0	2	15	22	43	30	56	8	**241**
Km 25+500 - Mayom Angok - Darfur Jn (25+500 to 43+800)	18.3	65	0	2	15	22	43	30	56	8	**241**
Gok Machar - Mayom Angok - Darfur Jn (0+000 to 43+800)	**43.8**	**65**	**0**	**2**	**15**	**22**	**43**	**30**	**56**	**8**	**241**

Total AADT 2017 By WHOLE PROJECT

Type of Traffic	Car	Utility	S. Bus	L. Bus	M. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM
Normal Traffic	54	0	2	13	18	36	25	47	6	200
Generated Traffic	11	0	0	3	4	7	5	9	1	40
Diverted Traffic	0	0	0	0	0	0	0	0	0	0
Recommended AADT	**65**	**0**	**2**	**15**	**22**	**43**	**30**	**56**	**8**	**241**

7.4.11 Project Schedule

The analysis period for the project has been considered as 20 years starting after the completion of the improvement, and opening the project road to traffic. In this context, the project schedule is envisaged as described in **Table 7.4-18**.

Table 7.4-18: Proposed Project Implementation Schedule

Activity	Period
Feasibility Study	March. 2015
Detailed engineering and bid document preparation	Sept. 2015
Bidding and contractor selection	Sept. 2015 – Dec. 2015
Implementation (1.5 year)	Jan. 2016 – Jun. 2017
Opening to traffic after implementation	July 2017
Traffic service period (20 years)	2017 - 2037

7.4.12 Traffic Projection

The growth scenario of the travel demand, based on realistic assumptions,is used forthe traffic projection. The projection of traffic based on the realistic economic growth scenario is shown hereunder.

Table 7.4-19: Traffic Projection on Project Road

Demand estimation for upgrading to Feeder Roads Standard

Traffic Projection on Gok Machar - Mayom Angok - Darfur Jn. Road (Realistic Situation)

Counter	Year	Projected ADT										LVRD Design Standard
		Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T	SUM	
0	2017	**65**	**0**	**2**	**15**	**22**	**43**	**30**	**56**	**8**	**241**	DC-4
1	2018	69	0	2	16	23	44	31	58	8	**252**	DC-4
2	2019	73	0	2	17	24	46	33	60	8	**263**	DC-4
3	2020	77	0	2	18	25	48	34	63	9	**276**	DC-4
4	2021	82	0	2	19	26	50	35	65	9	**289**	DC-4
5	2022	87	0	2	21	27	52	37	68	9	**302**	DC-4
6	2023	92	0	3	22	28	54	38	70	10	**316**	High-Volume
7	2024	98	0	3	23	29	56	39	73	10	**331**	High-Volume
8	2025	103	0	3	24	30	58	41	76	11	**347**	High-Volume
9	2026	92	0	3	22	29	56	39	72	10	**323**	High-Volume
10	2027	96	0	3	23	30	57	40	74	10	**333**	High-Volume
11	2028	100	0	3	24	31	59	41	77	11	**344**	High-Volume
12	2029	104	0	3	25	31	61	43	79	11	**356**	High-Volume
13	2030	108	0	3	26	32	63	44	81	11	**368**	High-Volume
14	2031	112	0	3	27	29	56	39	73	10	**350**	High-Volume
15	2032	117	0	3	28	30	57	40	74	10	**359**	High-Volume
16	2033	122	0	3	29	30	59	41	76	10	**369**	High-Volume
17	2034	126	0	4	30	31	60	42	77	11	**380**	High-Volume
18	2035	132	0	4	31	31	61	42	78	11	**390**	High-Volume
19	2036	137	0	4	32	32	62	43	80	11	**401**	High-Volume
20	**2037**	**142**	**0**	**4**	**34**	**33**	**63**	**44**	**81**	**11**	**413**	High-Volume

Growth Rates

Realistic Scenario

Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T
2015 - 2025	**6.0%**	**6.0%**	**6.0%**	**6.0%**	**4.0%**	**4.0%**	**3.90%**	**3.90%**	**3.9%**
2026 - 2030	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**3.0%**	**3.0%**	**2.9%**	**2.9%**	**2.9%**
2031 - 2035	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**
2036 - 2040	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**

This section of the report has established that the project road under investigation has a significant level of travel demand resulting from the agricultural activities planned and on-going in the vicinity. The AADT at project opening (at 2017), which amounts to 264 vpd (by 2017), after 15-years of service becomes 359vpd (by 2032). Even at relatively flat growth rates adopted for the project ranging between 2% to 6% for different vehicle types, the project road has still managed to fall within the boundary of a DC-4 standard according to the South Sudan Roads Authority, Low Volume Roads Design Manual (Sept. 2013). However, the road will quickly need to be upgraded into a high-volume road as can be seen the projection. As such, the DC-4 design standard has been adopted for Preliminary Engineering Design during the Feasibility Study. However, the traffic results obtained are suggested to be validated during detail design by the external Engineering Design Consultant, by conducting s classified manual traffic survey at the selected locations and projecting the traffic levels into the design period for final adoption of an appropriate design standard for the feeder road under investigation.

7.5 Socio-economic Assessment

7.5.1 Socio-economic Assessment Objective

As per the Project TOR, the overall objective of the socio-economic impact assessment (SEIA) is to identify and analyze the potential impact of the proposed feeder road construction activity and recommend initiatives, realize sustainable development opportunities as well as to mitigate the negative impacts. The core objective is to justify the selection of the prioritized road-based on feasibility of the extent and nature of the socio-economic impact of the investment involved.

7.5.2 Review of the Project Areas: Northern Bahr el Ghazal State, Aweil North County

This section highlights the general administrative, geographical and socio-economic characteristics of the feeder road project`s catchment areas of Aweil North County, where the road section is Gok Machar – Mayom Angok – Jorbioc.

7.5.2.1 Catchment Areas and Administrative Structure

The proposed rural road project impact areas fall under the local administration of the Aweil North County, NBG State, and South Sudan. The project section links two Payams, namely Malual North and Malual West with Jor Beauc Payams. The proposed road shall connect village markets that include Warchuei village, Manyiel Boma, Majakbai Buma, Athiang Boma, Marol Wek Boma, Warthou Village, Warchuei Boma, Kakou village, Mayom Angok market, Akotit Market and other villages adjacent to and at certain distance from the proposed road section.

7.5.2.2 Socio-economic characteristics

The target communities under the proposed road project`s influence areas have a homogeneous socio-economic characteristics.

7.5.2.2.1 Social Characteristics

The communities at the project influence area are closely settled into clusters of villages along the proposed roadside, and some at certain distance of about a 30 minute to 1 hour walk on average. The socio-economic team could not find any statistical information at the Payam or Boma level that can be used as benchmarks for comparisons. According the local Boma chief, each village cluster has an estimate average of 40-60 households. The only statistical data the team could access is only the SORUDEV State level baseline survey and it is assumed to equally apply at Boma or village level. Accordingly, the average household size is 7.2 persons. The total population is composed of 49.6% male and 50.8% female.

Based on Key Informant Interviews (KII) and Focus Group Interviews (FDI), the local community under the consideration has poor and inadequate access to rural service and infrastructure. The Boma level primary school and health facilities are poor in quality and access to services.

According to information from the local health officer, women and children under five are the most vulnerable to diseases. The common maladies are malaria, typhoid, skin disease and diarrhea. There exist only three PHCU and four primary schools that remain unreachable during the rainy season. As indicated in Table-7.5-1, the community members travel an average of 8.3km, 4.1km and 4.1km to access the health, school & administrative services respectively.

Although both boys and girls are assumed to have equal opportunities to education, girls remain marginalized due to culture and household domestic work. In addition, education studies have found that distance to school and the opportunity cost of enrolling a child in school are negatively correlated with child (particularly girls) school enrolment rates. According to the local education inspector, early

girl child marriage, travel distance, and household labor-burden on girls negatively affect the female access to education.

The largest segment of the local people has no means of transport such as bicycles, animal-drawn cart, motorbikes or donkeys. Footing is the main mean of transport, followed by bicycles and motorbikes, as observed by some individuals.

7.5.2.2.2 Food Security and Livelihood

Agriculture is predominantly the major mean of livelihood for the target communities. According to the South Sudan Infrastructure Action Plan (IAP) study, AfDB (2013), 84.1% of the NBeG State households primarily rely on agriculture and livestock. Based on the SORUDEV baseline survey, traditional crop production supports 73.5% of the population, although most households do not possess basic productive assets such as the ox-plough, extension services, improved seed, fertilizer and pesticides. Sorghum, groundnuts and sesame are the most important staple crop production. Crop farming is at subsistence levels, where the lack of rural transport infrastructure is a major hindrance to further production.

80% of the households rely on crop farming and animal-raising as the primary means of livelihood. Sale of part of their crop harvest, livestock, fire wood, wood charcoal, wild fruits, thatch leaves, grass mats, petty trade and other related activities are major sources of income.

7.5.3 Key Findings of the Socio-economic Assessment (SEIA)

The impact assessment studies how poor rural transport infrastructure affects the rural households' poverty, agricultural production and food security. The study conducts descriptive analysis on how the rural road investment intervention promotes food security, builds resilience, and improves the local livelihoods.

7.5.3.1 Poor Rural Road as Key Driver of Rural Food Insecurity

99% of the rural people on the sphere of the road project influence rely on rain fed subsistent agriculture. Other potential constraints for the high risk of crop failure include the heavy reliance on the precarious nature of rainfall, manual labor with rudimentary farm tools. These occurrences coupled with poor rural infrastructure worsen the rural communities' food insecurity and livelihoods. The lack of the road infrastructure drives rural poverty indirect and indirect dimensions:-

Poor transport access to basic services

Rural services and infrastructures are extremely poor and inadequate at the project vicinity. The subsequent remoteness in spatial, physical, and social terms is translated into high transaction costs in travel, time, and distance, perpetuating rural poverty. The local people perceive poverty in terms of the distance covered to reach the basic social services needed.

Table 7.5-1: Access: Distance Covered to Basic Service : Per person/trip

S.r	Basic Service access	Code	Unit	Average distance /T	Number of Trips	Total Aver Distance	% of average total distance covered
1	Boma headquarters	BHQ	Km	0	2	0	0%
2	Payam headquarters	PHQ	Km	2.05	2	4.1	25%
3	Primary Health Care	PHCU	Km	4.125	2	8.25	50%
4	Health Center	HC	Km	0	2	0	0%

5	Aweil hospital	MPHSL	Km	0	2	0	0%
6	Water Supply point	WSP	Km	0	2	0	0%
7	Primary School	PSCL	Km	0	2	0	0%
8	Secondary School	SSCL	Km	2.05	2	4.1	25%
	Average total			**8.225**		**16.45**	**100%**

Table 7.5-1 shows that the target communities travel the longest average distance (4.125km) to access health care followed by the secondary school and Payam headquarters (2.05km). The drinking water, primary health and education services are at the shortest distance, less than 1km or at homestead (0km). The potable water supply point is available almost at a settlement cluster level, while primary health care and education access are observed in every Boma level. The social services have inadequate scope and quality of service delivery; this is worsened because service provisions are distributed to widely scattered population at the project influence areas.

Regarding education, various social studies showed that illiteracy, measured by the population age 15 with no education, is more prominent in regions where the distance to primary school is more than 2 kilometres from homesteads. The studies have found that distance to school and the opportunity cost of enrolling a child to school all correlate negatively with child (particularly girls) school enrolment rates. In this regard, Table 7.5-1 shows that the distance to secondary school is 2.05km times farther than primary school. This scenario is more complicated when the post-primary child becomes the age for secondary school, between 14 to 15 years old, but could also join the farm labor force. The child`s enhanced opportunity cost of attending secondary school impairs the chance of child education, which ultimately impedes the development of human resource capacity. It is worth noting that further education of the child post-education contributes to entrepreneurship skill development such as better crop husbandry, agro processing technique and marketing skills. The low level of post-primary education, therefore, engulfs the rural households in food insecurity and a poverty cycle.

Health services are crucial for households and community stability. The most disease vulnerable groups are women and children, which constitute for about 80% of the farm Labor (AfDB/IAP, 2013). Access to health service is more important at the time of agricultural season. It is the time when the occurrence of the diseases is at its highest. The poor access and quality of health delivery coupled with the disease seasonality adversely impacts the farm labor availability and productivity, i.e. women, the most disease-prone group. As noted in Table-1 above the distance to the primary health care is about 2 times greater than secondary school. This situation reflects the high demand of effort, time and cost of hospital travel. The following Table 7.5-2 depicts the time spent to access the social services.

Table 7.5-2: Average Per person Time Spent to Basic Service

S.r	Basic Service access	Acr	Unit	Average per capita time spent	% of Per head daytime working	% of average total cost
1	Boma headquarters	BHQ	hrs	0	0%	0%
2	Payam headquarters	PHQ	hrs	0.3	4%	19%
3	Primary Health Care	PHCU	hrs	1	13%	63%
4	Health Center	HC	hrs	0	0%	0%
5	Aweil Hospital	HSL	hrs	0	0%	0%
6	Water Supply point	WSP	hrs	0	0%	0%
7	Primary School	PSCL	hrs	0	0%	0%

8	Secondary School	SSCL	hrs	0.3	4%	19%
	Average Total			1.6	20%	100%
	Average Total			0.2		

In Table 7.5-2, it can be noted that local people walk about (63%) of the daytime working hours to access primary health care and 19% of the time to secondary school. The longest hours to the primary health service involves high cost of transport and energy to the community, the most disease susceptible groups (women, elders and children under five) in particular. Moreover, what`s more, the longer the distance to the services access the more likelihood households resort to alternative poor health services and leave education.

The majority of the households have neither non-motorized nor motorized transport to access services. Walking to far distances to access services is meticulous. A few local motorbike owners provide transport to the local community. As depicted in table-3, access to the basic services costs are very high: access to the primary health care registers the highest two-way trip at SSP 30, secondary school costs SSP 10, and Payam head quarter costs SSP20. Given the fact that 76% of the community at the project influence lives below the poverty line (5th SPHC, 2008), the transport tariff rate can be classified as extremely high. The low quality of rural services leads to shortages of healthy and productive human resources, who in turn perpetuates poverty and food insecurity trap.

Table 7.5-3: Passenger transport cost/motor bike to basic services

S.r	Basic Service access	Acr	Unit	Average cost /T/head	Number of Trips	Total Aver cost	% of average total cost
1	Boma headquarters	BHQ	trip	0	2	0	0%
2	Payam headquarters	PHQ	trip	10	2	20	33%
3	Primary Health Care	PHCU	trip	15	2	30	50%
4	Health Center	HC	trip	0	2	0	0%
5	Aweil Hospital	HSL	trip	0	2	0	0%
6	Water Supply point	WSP	trip	0	2	0	0%
7	Primary School	PSCL	trip	0	2	0	0%
8	Secondary School	SSCL	trip	5	2	10	17%
	Total			30		60	100%
	Average			3.75			

Social security is a key challenge to crop production and marketing in the area. An intervention to build peace, harmony and stability at the community level is hindered by inadequate transport infrastructure, especially the rural access road network.

According to the baseline, the lack of transport infrastructure is among the potential challenges (48.5%) torural food security and development at the proposed road project areas.

Poor market and productive sector access

Access to the market and productive sector is important to enhance the rural farmers' income, food security and poverty alleviation. The lack of transport infrastructure amounts to increased transaction costs for producing and marketing among the rural community.

The small farmers experience subsistent production levels. The households are badly in need of the basic productive assets such as seeds, farm tools, extension service, microcredit fertilizers and

pesticides at onset of every farming season (May-August). The extreme transport cost to the market directly undermines the livelihood activities and food security of the household.

The small farm holders` grow crops that produce food enough for an average of only four months (September-February) of the household cereal food consumption needs. This means that the rural households heavily rely on market supply for ¾ of their food crop consumption needs at the critical hunger periods (May-August). First-hand information acquired from the target farmer shows that market recourse is quite limited. The potential market options vary seasonally and spatially. The Aweil market place, state central market, is the most important/First Option/ destination for agricultural output, inputs and basic consumer goods. The poor transport and road infrastructure considerably restrict the smallholder household connection to the Aweil central market. During the rainy period, the main Mayom Angok - Majok Bai - Manyiel, which join Gok Machar- Aweil trunk road, is inaccessible. The blockage of the primary market routes denies the communities accessibility to basic food consumption needs and economic services at time of critical demand. The interplay of the market forces drives up the transport cost of market travel, commodities purchase, and freight.

Table-7.5.3 reflects the passenger travel and freight transport cost. The below-stated transport cost considers only travel cost from the target village to the Gok Machar – Aweil trunk road junction point. The transport transaction along the main trunk road is beyond the scope of this rural road project. The figure in the table indicates that the cost of passenger travel to first-option market has surged up by 56%in the rainy season, and freight cost similarly increase at 17%.

Table 7.5-4: Average Transport Cost to Market Option: Passenger and Good(50Kg), in SSP

S.r	Season	Option-1 motorbike		Option 2 motorbike		% Increase/Decrease Mkt 1 to Mkt2	
		Passenger	Good	Passenger	Good	Passenger	Good
1	Dry	15	10	8	7	-47%	-30%
2	Rainy	45	30	20	25	-56%	-17%
	Total	60	40	28	32		
	Average	30	20	14	16		
		30	20	12	18		
%	increase	111%	74%	44%	67%		

Source: Local Boma chiefs and business owners' data from field

Table 7.5-5: Staple food crop/Sorghum/ Purchase Market Price/Kg

S.r	Season	Unit	Option-1 Sorghum	Option 2 Sorghum
1	Dry	1Kg	2.5	1.7
2	Rainy	1Kg	3	3.2
	Total		5.5	4.9
	Average		2.75	2.45
			0.5	1.5
%	increase		2%	6%

Source: Local Boma chiefs and business owners' data from field

The intercept of high market food dependence with heavy rainfall season holds high risk of food insecurity, vulnerability, and poor livelihood.At summer times,prices of the staple food cereal, sorghum, usually plummets by estimates of 2% and 6%, in the first and second option market respectively (refer to table-5). At the first market option, the rapid food price rise seriously reduces the poor households' food purchase power by 16.7%, from 40Kgto 33Kg of sorghum. While at the second option, the food purchase power drops by 47.5%, from 58 Kg to 31 Kg of sorghum. The SORUDEV baseline survey indicates 80% of the households take two meals, 15% one meal, and 5% three meals a day. These looming socio-economic conditions are potential indicators of the reality of poor rural road network as a primary driving force of rural food insecurity, poverty, and low livelihood status.

7.5.3.2 Poor Rural Road as Key Driver of Low Rural Livelihood Status

According the SORUDEV baseline survey, the key food security coping mechanism for the households are 20% livestock sales and 7.5% personal asset sales. The feeder road access to the potential demand market is poor during the critical food insecurity period, which is with the heavy rainfall season. The assets selling prices also dramatically decline at the peak lean season (June-July) due to increasing market supply of the smallholders commodities to buy their household cereal food consumption needs. Table 5 indicates that goat sale prices decrease during the rainy period by 29% and 40% in market option 1 and option 2 respectively.

Table 7.5-5: Goat Market Sale Price

S.r	Season	Unit	Option-1			Option-2		
			Dry	Rainy	% Price fall	Dry	Rainy	% Price fall
1	Goat	Head	350	250	-29%	270	180	-33%

This situation drops the goat to sorghum Term of Trade (TOT) and puts the poor household in a disadvantaged position in terms of the amount of sorghum they can get by selling a goat. It implies that the small farm holder`s goat to sorghum term will drop from 140 Kg to 83Kg of sorghum per goat sold in peak hunger season.

7.5.4 Socio economic Impact of the Rural Road Investment

The empirical model revealed that rural services, infrastructure and agricultural productivity have strong positive correlations with increases in food crop(s) production, addresses household level food availability and improves livelihood in a more direct manner. The study will discuss the effect that each category of improved rural road infrastructure and services has on rural agricultural productivity, incomes, and food security.

7.5.4.1 Connectivity Role of the Road Network

The rural feeder road condition and scope of connectivity have a direct relationship to the improvement of the smallholder farmers' social services and market access, economic opportunities and trade objectives.

The proposed access road shall play a critical role in high profile inter and intra connectivity at the community level. The road construction bears great potential of linking of:-

- A number of villages-to- respective Boma/smallest administrative unit
- The Boma-to-respective Payams head quarter.

- Bomas-to-central basic social services access, state capital
- Villages-to- Mayom Angok-Manyiel to main road at Gok-Machar. The road route induces in with and far beyond connection to potential marketplaces.

Table 7.5-6: Connectivity to Potential Market Options: Road Project Influence Areas

S.r	Target Village	Market Option-1				Market Options-2			
		Dry Season		Rainy season		Dry Season		Rainy Season	
		Road Route	Distance (Km)	Road Route	Distance (Km)	Route	Distance	Route	Distance
1	Gok-Machar	Gok-trunk-Aw	NA		NA	NA	NA	NA	NA
2	Manieyel	Man-Gok	8.5			NA	NA	NA	NA
3	Majok	Maj-Ma-G							
4	Malual	Mal-Ma-G							

Table 7.5-7: Comparison of Market access time: Before and After Project

S.r	Target Village	Market Access(Time in hours)		% Time Saving
		Before	After	
1	Manyiel	0.45	0.15	-67.0%
2	Majak Bai	2	0.3	-85.0%
3	Mayom Angok	4	1	-75.0%
	Average			-57%

Source: Local Boma chiefs, March 2015

The feeder road connectivity is expected to decrease access time to the potential market by an average of 57%. This decrease is a good indication of the high advantage of reducing the cost of transportation, purchase farm input and production. Further, there is potential to improve rural services which collectively enhance the rural food security, income and livelihood.

There exists no established baseline information on the use of social services. Based on general consensus, it is believed that the closer the service centers, the more the rural farmers will make use of it. Based on the study findings, the connectivity is expected to meet significant rural service impacts, which can be expressed later in quantifiable indicators. The lack of established benchmarks, time series data, and sufficient socio-economic characters make the pre-projection difficult.

S.r	Key Impact Indicators
1	Increase in number of the feeder road users- local people
2	Increase in volume of non-motorized and motorized-traffic
3	Increase in number and frequency of people access to market
4	Number and frequency of public transport travel
5	Volume of agricultural output and inputs transported to and from
6	Number of community awareness raising activities and capacity building training conducted
7	Number of local administration and community meeting
8	Volume of agricultural produce at market collection centers

9	Volume of consumer goods traded to and from the areas
10	Number of new business establishment at the areas
11	Number of new employment opportunities

Sustainable accessibility will develop and foster substantial momentum of social interaction, social security, capacity for collaboration, equal and balanced distribution of resources and opportunities. The project supports the strengthening of the local leadership and organization and economic empowerment of the small farmers. Additionally, the project supports the enhancement of access to the market and institutional support as well as increases the ability to disseminate marketing knowledge, skill and information. This process promotes agricultural production, innovative entrepreneurship, rural poverty alleviation, food security, and sustainable livelihood development.

7.5.4.2 Social and Gender Development

Education and health services are important for enhancing the quality and productivity of human capital. The investment on road infrastructure serves as the local need-tailored response to address the alarming social and gender issue, at the proposed project area. Limited lifeline services are barely accessible by the local communities due to the lack of transport facilities. An attempt to the central services outreach entails huge cost, time, and effort to the local communities. A responsive rural feeder road network is a core solution to life threatening social and gender issues.

7.5.4.3 Social Analysis

The rural feeder road project is expected to play a critical role improving the social development of the target communities. The travel-time saving and short distance covered represent the key direct social impact. The construction of the feeder road is anticipated to realize a dramatic decrease inthe time spent on travel to access basic social services access. After the project the target communities` average access time to rural service is expected to fall by 35%, assuming former travel 45 Km /hour speed limit for public transport moving on rural rough road network).

Table 7.5-8: Comparative Time-spent before and after project

S.r	Basic Service access	Acr	Unit	Average Distance	Before ProjectAv time spent	After Project-CarAv time spent	% Decreasein Time-spent
1	Boma head Quarter	BHQ	hrs	0	0	0	0%
2	Payam head Quarter	PHQ	hrs	2.05	0.3	0.046	-95%
3	Primary Health Care	PHCU	hrs	4.125	1	0.092	-91%
4	Health Center	HC	hrs	0	0	0	0%
5	Aweilhospital	MPHSL	hrs	0	0	0	0%
6	Water Supply point	WSP	hrs	0	0	0	0%
7	Primary School	PSCL	hrs	0	0	0	0%
8	Secondary School	SSCL	hrs	2.05	0.3	0.046	-95%
	Average Total			8.225	1.6	0.184	-35%

Source: Consultant aggregation from KII and FGI

7.5.4.4 Gender Analysis

Time is among the major challenges for girl child education at the area. The girl child is culturally overburdened with household activities. The lengthy amount of time taken to reach school has automatically resulted in the denial ofschool to girls and high dropout rates. A shorter travel time to get school encourages a significant amount of school age girl enrolment.

The rural road investment is a vital mechanism for promoting gender equality and development. Improving the education for girl children serves as a dynamic tool promoting the positive attitudinal and behavioral change on the local socio-cultural context towards sustainable community development.

7.5.4.5 Food Security and Livelihood Analysis

The rural road network intervention has significant contribution topoverty reduction, food security, community resilience building, and sustainable livelihood development. The project`s benefits are direct, indirect, induced, and generated dimensions.

7.5.4.5.1 Food Security

Part of Northern Bahr el Ghazal, Warrap, Unity and Lake State lay on the Western Flood Plains agro-ecological zone, which is identified as the most important livelihood zone, in terms of cropland distribution at national level. The zone provides 34.2% of national cropland and 24.2% of national cropland mixed with grass and tree. This zone records the highest ratio of cropland over total land[1].

The road project area, as the territorial part of NBeG State is among the most important livelihood zone. The areas have largest portion of cropland over total land.63.1% of the households primarily rely on traditional crop farming. In spite of the vast potential agriculture land the smallholder cultivates only small areas of approximately 1- 6feddans.

Among other, the shortage of labor being 25% is critical challenging factor. Family members (women and children) are the potential source of manpower for the expansion of cropland cultivation. As indicated in Table 7.5-5 above there is a 93% average time–savinggained from improved transport access. The additional time can be invested on increasing farmland developmentand production, assuming no seasonal opportunity cost of marginal rural labor is forgone elsewhere in the economy. This extra time is expected to realize the households` food self-sufficiency, where currently stands only at 56.6% of the consumption needs. This indicates that the household crop production will increase by 43.4%.

The feeder road construction project is also expected to reduce the passenger ticket price by an average of 44%. The effect is anticipated to positively influence the small farmer's accessibility and mobility to the potential market place and with other productive activities.

Table 7.5-9: Comparative Transport-cost Before and after project, in SSP

S.r	Basic Service access	Acr	Unit	Average Cost Before Project	Expected Cost After Project	Expected Decrease Passe Av. Transport cost
1	Boma head Quarter	BHQ	trip	0	0	0%
2	Payam head Quarter	PHQ	trip	10	3	-70%
3	Primary Health Care	PHCU	trip	15	5	-67%
4	Health Center	HC	trip	0	0	0%
5	Aweil hospital	MPHSL	trip	0	0	0%
6	Water Suppy point	WSP	trip	0	0	0

7	Primary School	PSCL	trip	0	0	0
8	Secondary School	SSCL	trip	5	3	-40%
	total			30	11	
	Average Travel cost			3.75	1.375	20%

Table 7.5-10: Comparison of Staple Crop Production: Before and After Feeder Road Operation

Cultivated Crops	Av.Farm use(ha)		Av yield /ha/HH/ton	Average total Production		% increase estimated Pxn
	Before Project	After Project		Before PRJ	After PRJ	
Groundnuts	0.83	0.84	0.104	0.08632	0.08736	0.91
Sorghum	1.11	1.26	0.168	0.18648	0.21168	0.79
Maize	0.4	0.84	0.31	0.124	0.2604	0.74
Finger M	0.61	0.85	0.31	0.1891	0.2635	0.74
	2.95	3.79		0.49958	0.73558	0.80

Source: Consultant Estimate based on local Boma Chief and Farmers

The construction and maintenance of the rural feeder road is expected to increase the smallholder farmers` staple crops production volume. As shown in table -10, sorghum and groundnuts harvest, which are the most predominant staple food crops are anticipated to rise by 79% and 91% respectively, at the initial year of the intended rural feeder road use/ operation. Finger millet and maize are predicted to increase by 74% each after the start of the road. This promising increase in production can be attributed to the road connectivity which drivesbetter access to the market. In doing so, there will be improved seed variety, cheap farm tool and implement, extension support, innovative farming knowledge and skill, marketing information, as well as agribusiness and trade development initiatives. The combined impact is expected to increase the farmers' income, food security, nutrition and sustainable livelihood.

7.5.4.5.2 Market Access and Livelihood

Access to the potential market destination stimulates small farmer productivity and income by increasing the volume of agricultural product sales. Additionally, having market access can empower the small farm holders economically and, build self-esteem and innovation.

Table 7.5-10 : Summary of Staple Crop Net Production Surplus (tons)-Five Years Projection

Cultivated Crops	Five year Projection Staple Crop Surplus Production Summary (Y1-Y5)-ton					Total Surplus Production	Post Harvest Loss(20%	Net Surplus (ton)
	Y1	Y2	Y3	Y4	Y5			
Cowpeas	841	876	1139	949	988	4793	958.5014	3834
Sorghum	1292	1345	3030	1458	1517	8642	1728.496	6914
Maize	1249	1196	1701	1296	1349	6791	1358.243	5433
Groundnuts	1851	1718	2704	1862	1939	10074	2014.839	8059
Total	5234	5135	8574	5565	5793	30300	6060.079	24240

Source: Consultant`s aggregated projection

The above production projection is based on logical assumptions that the project influence areas has high potential for sustainable agriculture. Achieving the strategic objectives of the projectshall provide

better opportunity toimprove farming practices (animal traction) and farmercooperatives under the SORUDEV program.

Table 7.5-12: Cost of Farm Production: After the Project

Cultivated Crops	Av Farm use(ha)	production cost per hectare	Total cost of production , in SSP	Av yield farm cultivated(ton)	Unit cost estimate of production(ton)
Groundnuts	0.84	1575	1323	0.104	12721.2
Sorghum	1.26	1575	1985	0.168	11812.5
Maize	0.84	1575	1323	0.31	4267.7
Finger M	0.85	1575	1339	0.31	4318.5

Source: Consultant estimation

Table 7.5-13: Small farm holders` Projected Net Income (5Years): After Rural Feeder Road Operation

Cultivated Crops	Net Surplus(ton(	Average Sell Price (ton),SSP	total Sales	Total Cost	Net Income
Finger millet	3,834	19	72,846	58276.88	14,569
Sorghum	6,914	21	145,194	116154.9	29,039
Maize	5,433	19	103,226	82581.16	20,645
Groundnuts	8,059	62	499,680	399744	99,936
Total	24,240		820,946	656,757	164,189

Source: Consultant estimation

The net income projection is calculated based on the crop prices prevailing at the first option market access. The improved feeder road infrastructure is expected to decrease farming operational costs, facilitateeconomies of scaleand enable the formation of farmercooperatives and collective marketing. As noted in table-13, the small farmers earn (SSP 14,569) in the first year of operation. This can be related to the fact that finger millet account for thesmallest crop. The farmers have gained a net income of SSP 164, 189 in the first years of operations. The level of net profit is low in monetary terms at least for the short-run; however, there is great opportunityfor development in the long-run. In theshort term – low knowledge, skill, and experience of farm management, market information, network, negotiation power and group organization are major concern. Even so, the farmers` learnt lessons on market engagement are worthwhile implicit benefit.

7.5.4.5.3 Institutional arrangement

The road project design and implementation frameworks meet the necessary institutional requirements. Rural food security and livelihood support initiatives rest on the forefront of the EU Aid program.

The program precondition requiring the alignment with host government`s prioritized development policies, needs and plan of action are met.

The government of South Sudan (GOSS), endorsing the food and agriculture policy framework (2011-2016) and National Agriculture and Livestock policy, identified Food and Agriculture development as one of the six top spending priorities in South Sudan's 2011-2013 Development Plan. These government policies and strategies are supportive of the EU's ZEAT and BEAD programs.

The EU support terms also consider the broad coordination, consultation and communication requirements with potential stakeholders at all levels. Then concerned State Ministry of Agriculture and Forestry, State Ministry of Physical Infrastructure, Concern Worldwide-NGOS (operating on ground in particular), local county commissioner, Payam inspectors, Boma chiefs and community representatives at the grass-root level have been engaged on practical, dynamic and interactive approach, throughout the proposed rural road project planning.

The road project objectives comply with the strategic development policy and priorities of the key partners. The EU`s rural road construction at the proposed project areas is aligned with the EU`s ZEAT and BEAD programs objectives of strengthening smallholder food security and livelihood.

The project design and implementation documents are produced on professional ethics based on logical and integrated approaches.

7.5.4.5.4 Stakeholders Analysis

The project key stakeholders are assessed to ensure the successful design and implementation capacity.

Project Lead Body

United Nation for Project Services (UNOPS) is the lead UN agency on sustainable infrastructure development. UNOPS' vast experience in South Sudan coupled with high quality expertise in project management principles and practices ensures client-oriented, sustainable, logical and integrated project end result.

Local Administration

The local administration has expressed commitment on the project support. The County Commissioner, Payam inspectors, and Boma chiefs shall take bold initiatives to coordinate, contribute and provide security throughout the project phase.

Relevant line Ministries

The State of Ministry of Agriculture and Forestry provides institutional support to farmers. In collaboration with potential development partners, the Ministry is involved in strengthening the smallholders' innovative labor-based farming techniques, introducing new seed varieties, and offering extension and marketing support by assigning extension workers at the County and Payam level. Increasing the numbers and building the capacity of extension agents is important to broaden and sustain the scope of service.

The State Ministry of Physical Infrastructure has no annual capital budget allocated for feeder road construction and maintenance, neither from the State nor National government. The Ministry's construction machinery and equipment are very limited and in a state of disrepair. The Ministry has limited technical staff engaged in road and housing construction supervision. What is more, infrastructure planning and design expertise is inadequate. Building technical know-how is a major challenge.

Grassroots community engagement

The local communities are homogenous in nature. They have a strong culture of organization and leadership based on democratic processes. The local chief, elders, youth, women and faith-based groups have the responsibility and power of influence on the community interest. Local development activities are practiced through community-based resources organized by the local leadership. Activities and community groups such as self-help-group farming, collective farming, community school and health construction/maintenance, access road pavement work and periodic maintenance are commonly practiced in this area. Yet the capacity remains limited in scope and work quality.

Other Implementing Partners

The Concern Worldwide (NGO) is the implementing partner operating on the ground. Concern Worldwide has the extension workers that have responsibility in all Bomas and villages that are along the project proposed route and have Field office in Nyamlel.The partner is implementing food security project in the area by organizing farmers into groups, training them on ox-plough farming methods and supporting with seeds and tools. Concern Worldwide is an international NGO and has an established capacity and experience in working with rural communities in Northern Bahr el-Ghazal State, especially in implementing community based livelihood and food security projects.

Sustainability

The project design incorporates appropriate strategies that encourage community consultation and active and full participation of the local communities throughout the project cycle. The local communities' resources contribution to the project is a vital tool forbuilding a community sense of ownership and responsibility to sustain the project objective.

- At the project inception period, the target community should be committed to engaging in consultation, identifying the community's needs and priorities, and defining understanding and willingness in the project implementation framework. Additionally, the target community should be made aware of and willing to provide access to the road route, land for project camp, a disclaimer of cost of compensation on settlement affected by the project implementation, and in the provision of security and local construction materials.
- The implementation stage should facilitate use of labour-intensive techniques to ensure local community involvement in the construction process. The approach not only creates local employment opportunities, but also play great role in building sense of local ownership and responsibility.
- The local community lacks material, financial and technical resources to engage on sustainable maintenance of the road. Strong coordination, communication, and collaboration of strategies are required to strengthen the local community capacity. The local authority in cooperation with line-ministries and other potential stakeholders need to provide technical, material, and institutional capacity building aligned with local community resource mobilization and fund-raising abilities.
- The proposed rural road project design incorporates a technical capacity building component on the community based rural feeder road maintenance training to ensure sustainability.

7.5.4 ImpactMonitoring and Evaluation Framework

The project monitoring and evaluation framework is a key mechanism for tracking the project's objective progress and achievements in enhancing the target smallholder rural farmers` productivity, income, food security, and sustainable livelihood. Based on the assessment key findings and project area-specific baseline data, the expected project impact monitoring and evaluation metrics are proposed.

Food Security Impact Indicators

S.r	Food Security Impact Indicator	Expected Impact Result
1	Cultivated farm area per household	Greater than 0.6 hectare
2	Staple crop-sorghum yield/ha	Greater than 0.7MT or 520.2 kg
3	Small farmers own food crop harvest stay	More than four months
4	Food secure number of HHs	More than 22% of the HHs
5	Fair food secure number of HHs	More than 25% of the HHs
6	Poor food secure number of HHs	Less than 78% of the HHs
7	Number of HHs taking two meal a day	More than 80%

8	Number of HHs taking one meal a day	Less than 15%
9	Number of HHs taking three meal a day	More than 5%
10	Number of HHs living on food relief	Less than 1%
11	Sorghum purchase price	Increase by less 4% in Aweil market

Rural Marketing Indicators

S.r	Rural Marketing Impact Indicator	Expected Impact Result
1	Number of HHs selling crop at nearby market	Greater than 90%
2	Number of HHs selling crop at farm gate	Less than 5%
3	Number of HHs selling crop at central market	More than 1%
4	Farmer`s time taken to reach local market in State	Less than 2 hours
5	Number of farmers lacking market information	More than 74%
6	Number of farmers accessing information	Less than 9.6%
7	Number of farmers accessing information by market visit	More than 60%
8	Number of farmers selling through traders/brokers	Less than 5%

Rural Income Impact Indicators

S.r	Rural income Impact Indicator	Expected Impact Result
1	Number of HHs depending on labor income	Greater than 47%
2	Number of HHs spending/week	More than SSP 338
3	Average per capita consumption/month	More than SSP 203
4	HHs crop sales income per annum	Greater than SSP 1,543
5	HHs crop sale volume/at market collection center	More than 47% of HH harvest
6	Number of HHs selling part of their produce	More than 46.5%
7	Goat to sorghum TOT	Greater than 97 Kg
8	HHs purchase power per SSP 100-sorghum	Greater than 27 kg
9	Number of HHs having mobile or other telephone	Greater than 60%
10	Number of HHs having vernacular radio station	Greater than 9.2%
11	Save travel time to access rural services	By 85%
12	Save passenger ticket cost	By 58%

Rural Agriculture Production Impact Indicators

S.r	Rural Agriculture Impact Indicator	Expected Impact Result
1	Number of HHs with shortage of farm labor	Less than 48%
2	Number of HHs with labor shortage- due to human disease	Less than 12.5%
3	Number of HHs with lack of farm tools and equipment	Less than 39.6%
4	Number of HHs facing animal threat to farming	Less than 8.6%
5	Number of HHs lacking farmland fencing	Less than 99%
6	Number of HHs with subsistent crop production satisfaction	Less 5 %
7	Number of HHs facing poverty to farm	Less 2.3%

7.5.5 Conclusion

Based on the assessment key findings, the rural services and infrastructure development have a strong correlation with increasing rural agricultural productivity, income, food security, and sustainable development. The rural feeder road construction and maintenance project is therefore, well-aligned with the EU`s SORUDEV program objective of strengthening the smallholder farmers production, employment, and income through the creation of market access and trade development. The proposed project is expected to reduce the farmers' transaction costs of producing and marketing their products by 84%. The project anticipates a major (93%) time-saving to rural access to services such as health, school, market centers and the productive sectors. The cumulative positive effect improves the rural community service access and quality, which significantly contributes to healthy and productive farm labor availability. Moreover, additional benefits are as follows: improved pre-harvest and post-harvest crop management, better market information, use of innovative farming techniques (ox-plough), improved seed variety, reduced farm input, encouraging output prices, labor intensive agro-processing and microcredit facilities.

Therefore, the proposed rural feeder road construction is socially and economically viable in terms of combating rural poverty, enhancing agricultural productivity, income, nutrition and employment in an inclusive and sustainable manner.

7.5.6 Recommendations

Based on the assessment findings, Gok Machar market in the Aweil North County is recommended as a commercially viable collection center for both local and regional distribution. This center is a well-established rural market being a common meeting point for numerous villages within the projects influence area and from outside the target counties. Mayom Angok, Majak Bai, and Manyiel village have dense farming populations that are currently supplying Gok-Machar and futher distribution from Gok Machar to Nyamlen and state capital Aweil markets is already established.

NORTHERN BAHR EL-GHAZAL				**Road section**	
S/n	**Criteria**	**Total scores**	**Weight**	1.1 **Gok Machar - Mayom Angok**	1.2 **Akwaktiit - Jorbioc**
1	**Connection of Farms to Markets**				
1.1	Number of farms located along the road section	2		2	0
1.2	Number of market centers located along the section	2		2	1
1.3	Extent of land suitable for farming (potentially)	2		2	1
1.4	Estimated population residing within the project corridor	2		2	0
1.5	Existence of agricultural activities in the region that will further develop with the road construction.	2		2	1
		10	2	**10**	**3**
		20		**20**	**6**

2	**Socio Economic Factors**				
2.1	Existence of social services such as schools, medical assistance, religious institutions, etc. that the road will provide better access.	2		2	1
2.2	Stability and security level	2		2	1
2.2	Road connection to higher population densities creating opportunities for local population	2		2	1
2.4	Level of motorized and non-motorized traffic operating on existing road	2		1	1
2.5	Presence of Payam and Boma Administration offices	2		2	1
		10	2	**9**	**5**
		20		**18**	**10**
3	**SORUDEV / ZEAT BEAD Partners**				
3.1	Activities of SORUDEV / ZEAT BEAD Partners are currently being Conducted in the region.	10		10	5
		10	**2**	**10**	**5**
		20		**20**	**10**
4	**Construction Feasibility**				
4.1	Estimated cost of construction	2		2	2
4.2	Requirement for a major bridge structure (bridge span)	2		1	1
4.3	Availability of Construction material (borrow pits, quarry, sand, water)	2		2	2
4.4	Likelihood construction operation will be affected due to instability in the area	1		2	0
4.5	Availability of skilled labour to be engaged in construction activity	1		2	1
4.6	Possible hydrological, geo-technical or subgrade material problems	2		1	1
		10	2	10	7
		20		**20**	**14**
5	**Sustainability**				
5.1	Community and Government is motivated to participate in the construction and maintenace program.	4		**4**	**4**
5.2	Development does not have significant adverse environmnetal impact (EIA)	4		**3**	**3**
5.3	Number of affected persons and properties (PAPs) due to the construction of the road (SIA)	2		2	2
		10	2	9	9
		20		**18**	**18**
	Total score/40			**48**	**29**
	Total score/100	**100.00**		**96.00**	**58.00**
	Priority Ranking			***1***	***2***

7.6 Preliminary Engineering Design and Cost Estimation

7.6.1 Introduction

The Gok Machar – Jorbioc road was among the three roads identified as high priority for Northern Bahr-el-Ghazal (NBeG) State, the final selection was done through a desk review involving other ZEAT-BEAD partners through a selection criterion. The route assessment was carried out on the 21st March 2015 jointly between the UNOPS team and representatives from the State Ministries of Physical Infrastructure. The objective of the mission was to:

- Assess the current condition of the road and develop recommendations on the horizontal alignment of the road, height of embankment, gravel wearing course, and the drainage requirements; prepare a cost estimate.
- Assess the sub-grade and geology of the materials along the road.
- Assess the environmental impact of the project.
- Assess the availability of construction materials along the route.

7.6.2 Methodology of the assessment

In order to gain firsthand information of the project and appreciate the various issues needed for the study of the road, site visits were conducted and the following maps and simple equipment and tools were used:

- Motor vehicle odometer
- Hand held GPS to map way points;
- Measuring tape;
- Digital camera

The assessment was conducted by driving along the existing track and stopping at sites where there were problematic terrain, problem soil areas and sources for construction materials. Other locations were also observed if deemed necessary to gain firsthand information.

In addition, the team held discussions with the local authorities and communities on various issues pertaining to proposed project.

The existing route is a track that follows the course of River Kiir; this track has been used over time and meanders through various villages. The assessment began by setting the vehicle odometers at zero in Gok Machar in order to determine the length of the road. The method also allows the measurement of a variety of distances from specific important locations or villages. Table 7.6-1 below shows the distances (chainages) to the villages measured from the starting point.

Table 7.6-1 – Inventory of villages and important features

No.	Chainage	Village/feature	Remarks
1.	**0+000**	**Gok Machar**	
2.	6+000	PAN NYOR	
3.	7+600	MANYIEL	AGGREGATE PRODUCTION
4.	8+400		COMMUNITY SCHOOL + PHCU
5.	10+400	PANYANG	CHURCH + BOREHOLE
6.	12+200	NYENEKEN	BOREHOLE
7.	14+300	AKWAKTIIT	BOREHOLE
8.	15+200		WATER CHANNEL
9.	16+200		WATER CHANNEL
10.	16+500	MAJANG BAI	
11.	16+800		BOREHOLE
12.	18+400		VEGETABLE FARM ON LHS

13	19+500	KOL NG'AP	BOREHOLE
14.	23+300		WATER CHANNEL
15.	23+600		WATER CHANNEL
16.	24+100	NYINAMETH	BOREHOLE + CHURCH
17.	25+700		BOREHOLE
18.	28+000		WATER CHANNEL
19.	28+900	MABIOR NYANG	CHURCH
20.	29+600		WATER CHANNEL
21.	34+700	MAYOM NGOK	
22.	36+300		SCHOOL
23.	36+700		MARKET
24.	39+400		BOREHOLE
25.	41+400	KUAN KIT	BOREHOLE (Junction to Darfur)
26.	44+800		BOREHOLE
27.	46+000	MUONY	
28.	53+300	KUAN RIAR	
29.	54+400		SEASONAL STREAM
30.	57+600	GUALLANG	BOREHOLE
31.	62+400		BOREHOLE
32	68+600		SEASONAL STREAM
33.	71+200	MAKOL TIIT	BOREHOLE
34.	72+500		WATER CHANNEL
35	74+500	JORBIOC	CHURCH
36	74+900		PAYAM OFFICE

GPS coordinates of all villages and important features were recorded as tabulated on Table 7.6-2 below and a horizontal profile plotted to show the alignment of the existing track. A design alignment was then developed from the existing track.

Table 7.6-2: GPS Coordinates for key villages along the road.

No.	Village/feature	Latitude	Longitude	Elevation
1	Gok Machar	9.216	26.867	453.68
2	Majang Bai	9.118	26.795	454.39
3	Mabior Nyang	9.134	26.691	463.38
4	Kuan Kit	9.107	26.585	464.61

7.6.3 Geometric Alignment

As the existing route follows a track that has no defined geometry, two proposals for geometric design have been proposed as follows:

- A route that follows the existing track closely but connects many straight sections and takes into account horizontal curves as provided for in the South Sudan Low Volume Roads Design Manual (Sept, 2013). This alignment closely follows the existing track and hence, it has numerous curves. However, the terrain it follows is expected to be more or less of a similar profile to the existing track.

- A route that connects key control points/villages directly but deviates from the existing track. Due to the deviation, the route could have a much different profile. This alignment has the advantage of being shorter, having better geometry and as such, improves the safety and comfort of driving. However, the route has to be surveyed further as it runs away from the existing alignment and could have a completely different profile. Importantly, the route could be traversing private property which may require elements of compensation.

7.6.4 Existing terrain

The general terrain along the route is flat with an undulating profile; the gradient is between 0.2-0.25 per cent. The soils are generally sandy clay at Gok Machar with clay soils and a few pockets of rock formations characterizing the rest of the road. Given the fact that the route follows closely the course of the river, flooding during heavy rains poses a potential risk. However, the fact that the local communities have built some permanent structures along the way suggests that flooding has not been experienced for some time.

Fig. 7.6-1 section of the track between Mayom Ngok and Jor Beauc

7.6.5 Area of influence and land use

This road connects the main trunk road to the border with Sudan, and also connects with Eastern Darfur; its area of influence is large. During the site assessment visit, some trucks carrying goods from Eastern Darfur were seen to be using the road. From conversations with officials of the State Ministry of Physical Infrastructure, it was clear that this route is used frequently, especially during the dry season to transport goods from and to Eastern Darfur. The main activities are crop farming, livestock keeping, and fishing.

Fig. 7.6-2: One of trucks transporting goods from Eastern Darfur

7.6.6 Population, settlements and town centers

Between Gok Machar and Mayom Ngok, there are populations settled along the route. However, from Mayom Ngok to Jor Beauc, there are only scattered communities living in clusters of villages.

Fig. 7.6-3: Market at Mayom Ngok village

7.6.7 Sub-grade, geology and materials availability

The general sub-grade from Gok Machar to Jor Beauc is generally sandy clay and clay.There are pockets of gravel and rock; from visual inspection the materials were seen to be suitable for road construction. However, detailed soil investigation will need to be carried out to ascertain the strength of the available materials and their suitability for road construction.

There is a gravel borrow pit near Gok Machar that is largely used for the extraction of materials for the gravel wearing course. It was also noted that, along the road, there were pockets of gravel that needs to be further investigated to establish if the material is suitable for road construction.

Table 7.6-3: GPS locations for existing and potential borrow pits

Latitude	Longitude	Elevation	Remarks
9.003	26.409	480.93	Potential borrow pit

7.6.8 Drainage structures

There are no existing drainage structures along the existing track and the general terrain is flat with a minimal gradient. Along the route, a few channels of water were noted connecting to the river. This connection implies a need for drainage structures to be provided to facilitate the free flow of water to the river. A general provision has been made for the purposes of cost estimation for 900mm diameter steel pipe culverts for every 250m length along the road. Further hydrological studies will need to be carried out to establish the hydrology of the project area and to determine the actual drainage requirement.

7.6.9 Design framework

The traffic surveys conducted indicated that the ADT for this section of the road is 130v/day and places this road as DC4; according to the South Sudan low volume roads design manual guidelines. As such, the carriageway of 6.0m has been recommended with0.75m wide shoulders, making the embankment to be a total of 8m and 20m wide bush clearing for right of way.

Given that the terrain is flat and susceptible to flooding, an embankment height of 600mm (on average) has been recommended. However, in some few cases, where there are depressions, the embankment height will be varied between 600-900mm.

7.6.10 Costing

The proposed embankment will be raised using materials available on the sides of the road. It is recommended that at least three borrow pits be established along the stretch of the road to allow the maximum haulage distance to be no more than 5km. A gravel borrow pit exists near Gok Machar; it is recommended that this will be the borrow pit that will be used to source the gravel wearing course. There is a potential for more gravel borrow pits along the way. Once detailed investigations are carried out to ascertain the quality and quantity of materials available in the potential borrow pits, the pits will be considered for materials extraction for the gravel wearing course.

There are two main contractors operating in the State – Eyat and African Condai. However, the mission did not visit their sites; instead, the State Ministry of Physical Infrastructure followed up to obtain rates for machinery hire. These rates were compared against rates that UNOPS had earlier obtained under long term agreements to establish reasonable basis for costing.

Summary of Preliminary Construction Cost Estimate: Gok Machar - Mayom Angok

Summary	Bill Group	Amount in USD
Bill 1	General	640,000.00
Bill 2	Site Clearance	209,612.50
Bill 3	Drainage	1,293,813.11
Bill 4	Earthworks	1,924,237.45
Bill 5	Gravel Wearing Course	1,455,806.45
Bill 6	Ancillary	126,500.00
Bill 7	Day-works	30,000.00
SUB TOTAL		***5,679,969.51***
Contingency (6%)		340,798.17
	Sub total	*6,020,767.68*

7.7 Economic Evaluation

7.7.1 Results of Economic Evaluation

The economic evaluation of the Project road has been carried out using the RED Model. The Economic Internal Rate of Return (EIRR) for the project has been derived by comparing project options with improvement and without improvement. The Net Present Values (NPVs) have been calculated at a 12% discount rate. The results of the economic evaluation are summarized in **Table 7.7-1,** and the details of the results, showing benefits and costs including the RED Model outputs, are included in **Annex 3C.**

Table 7.7-1: Summary of Results of Economic Evaluation

Sl. No.	OPTIONS	EIRR (%)	NPV (USD million)	NPV/C	FYRR/C (%)
1	DC-2 Standard	43	7.677	2.21	0.56
2	DC-3 Standard	37	6.514	1.73	0.52
3	DC-4 Standard	33	5.715	1.43	0.49
Project Road (DC-4 With GWC Surfacing)		**33**	**5.715**	**1.43**	**0.49**

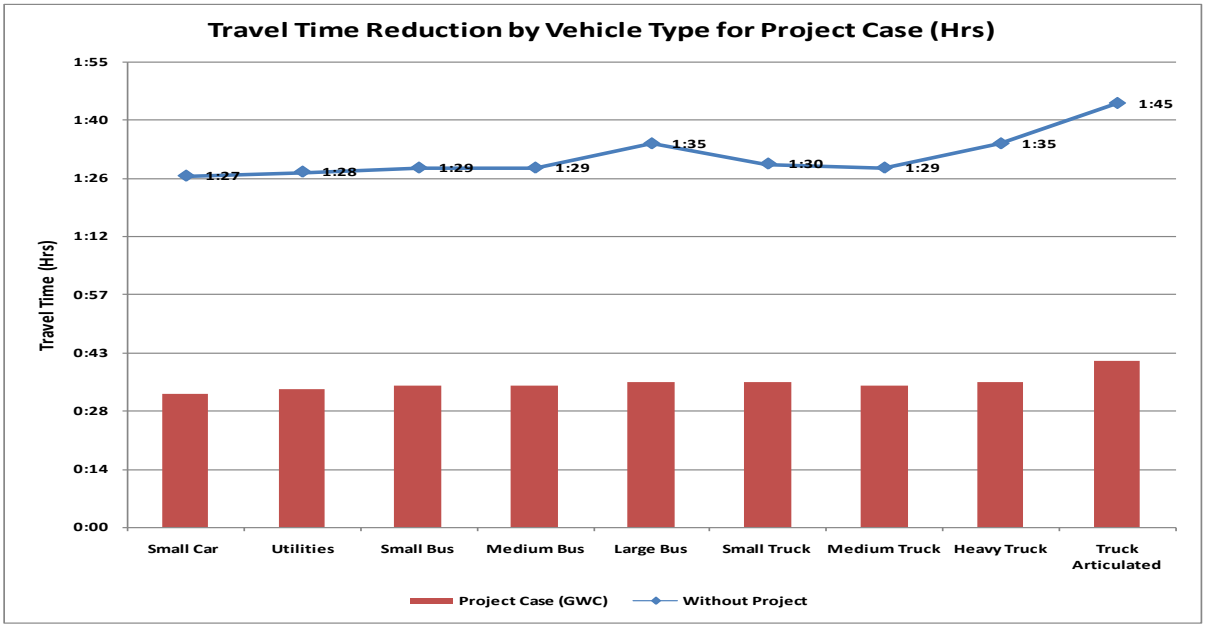
The improvement option is economically viable as the values of EIRRs for all sections of the road and the project road are above the cut-off point of 12% as set by the World Bank for the appraisal of infrastructural projects in developing countries.

A comparison of travel times was made to understand the effect of the project case in relation to the travel times being experienced by travelers as a result of poor access infrastructure available to the society. **Table 7.7-2** depicts the figures extracted from the RED Model while **Chart 7.7-2** has compared the results graphically.

Table 7.7-2: Travel Time Comparison between Without Project and With Project Scenario

Project Alternatives	Dry Season		Wet Season		Car	Four-Wheel	Bus	Bus	Bus	Truck	Truck	Truck	Truck
	Length (km)	Roughness (IRI)	Length (km)	Roughness (IRI)	Small	Drive	Small	Medium	Large	Light	Medium	Heavy	Articulated
	Traffic Composition (%)				3%	19%	13%	11%	7%	16%	11%	14%	6%
Without Project	**38.6**	**24**	**38.6**	**25**	**1:27**	**1:28**	**1:29**	**1:29**	**1:35**	**1:30**	**1:29**	**1:35**	**1:45**
Project **ALT-1: GWC**	32	10	32	12	0:33	0:34	0:35	0:35	0:36	0:36	0:35	0:36	0:41
	Travel Time Saving (HR)				**0:54**	**0:54**	**0:54**	**0:54**	**0:59**	**0:54**	**0:54**	**0:59**	**1:04**

Chart 7.7-1 Travel Time Reduction by Vehicle Type



The results indicate that travel times will decrease substantially with the project case for all vehicle categories. Every vehicle category has enjoyed a travel time saving of about 1 hr; the largest coming from truck trailers. It is understood that the current state of the tracks does not allow such vehicles to be operated on the tracks. Under a hypothetical scenario in which truck trailers could use the road, the larger trucks are more likely to suffer due to bad condition of the road than other types of vehicles. We note that almost all vehicles were able to make the trip in slightly less than 40 minutes under the project case.

7.7.2 Sensitivity Analysis

Investments in rural road projects, like any other investment, involves risks and uncertainties such as cost overrun, time overrun, traffic development, levels of benefit realization, etc. The effect of these uncertainties has been evaluated under Sensitivity Analysis, which involves recalculating the project economic evaluation results for different values of major variables. The traffic level (directly related to the benefits) and the project improvement cost are the two basic parameters, influencing the viability of the project. The Sensitivity Analysis has been carried out by varying the traffic and the improvement cost and reworking the costs and benefits analysis using RED Model for the following scenarios:

- Scenario-I: Increase in cost by15% and base benefits;
- Scenario-II: Base costs and decrease in benefit by 15%; and
- Scenario-III: Increase in cost by15% and decrease in benefit by 15%.

The results of the Sensitivity Analysis are presented in **Table 7.7-3** incorporating the changes in variables project costs and benefits. The details of the analysis are given in **Annex 3C**.

Table 7.7-3: Results of Sensitivity Analysis

Sl. No.	Options		Base Case	Cost +15% (A)	Benefit – 15% (B)	A & B
1	**DC-2 Standard**	**EIRR**(%)	**43**	35	34	**27**
		NPV (mill.USD)	**7.677**	6.435	5.284	**4.042**
2	**DC-3 Standard**	**EIRR**(%)	**37**	30	28	**22**
		NPV (mill.USD)	**6.514**	5.098	4.121	**2.705**
3	**DC-4 Standard**	**EIRR**(%)	**33**	26	25	**18**
		NPV (mill.USD)	**5.715**	4.179	3.322	**1.786**

7.7.3 Conclusions and Recommendations

Based on the results of economic evaluation and supported with the Sensitivity Analysis, the investment for the improvement of **Gok – Machar – Mayom Angok** (34.7km) road, an engineered standard Feeder Road with GWC pavement, has been determined to be economically viable. From the options considered, DC-4 standard offered viable benefits in the base case as well as under sensitivity testing. As such, the road may be upgraded to *DC-4 with 6.0m carriageway depth and 0.75m shoulder on each side, i.e. 7.5m total width*.

The value of the EIRR is 33% for the project road, which is higher than the cut-off point of 12% for similar projects in ROSS.

The Sensitivity Analysis shows that for all tested cases, including the worst-case (i.e. increase in cost by15% and decrease in benefit by 18%), the EIRRs are below the cut-off point. This implies that the risks identified should be mitigated during implementation, meaning that project cost should not be allowed to increase more than projected at the time of the feasibility study.

Improvements to the project road as proposed, to Gravel Wearing Course standard, would impact positively the transportation costs. These benefits include VOC savings, travel time savings to road users, better riding quality and maintenance costs savings for the road agency (i.e. South Sudan Roads Authority). The investment in the project road would also positively impact the overall socio-economic development of the project influence area – NBEG State, in particular.

7.8 Recommendations

7.8.1 Road Selection

The two road sections, which were compared, are the sections from Gok Machar – Mayom Angok and Darfur Junction – Jur Beauc. The MCA carried out depicts that Gok Machar – Mayom Angok (34.7km) shall be considered for further project development and eventual implementation.

7.8.2 Maintenance Capacity Assessment

The feasibility study showed that the Northern Bahr el Ghazal Ministry of Physical Infrastructure (MoPI), Directorate of Roads and Bridges is the most vibrant and adequately established entity as compared the other three States. The Directorate recently completed the grading of Aweil to Gok-Machar road, which has considerably reduced travel time and vehicle operating costs. The State Ministry of Agriculture also had a cooperative relationship with MoPI. This relationship extends support through the provision of road construction equipment that was procured for the Aweil Rice Farm Project through funding from the European Union.

The State ministry funds the road maintenance activities from revenues collected by charging road user. Yet, there is no clear institutional framework to levy the charges, collect, and administer the funds.

The team assessed that there was an established Community Based Organizations in the State who have been operating along the Gok Machar to Jor Beauc road supported by the World Food Programme through food for asset for work programme. However, the CBOs are not functional and the members are disbanded due to alleged mismanagement of funds by the CBO leaders.

The State Ministry of Physical Infrastructure has the following resources at its disposal.

7.8.2.1 Road Construction/Maintenance Equipment

Equipment	Quantity	Condition	Owned by
Motor Grader	1	Serviceable	MoPI
Wheel Loader	1	serviceable	MoPI
Tippers trucks	2	Serviceable	MoPI
Dozer	1	Serviceable	MoAg
Roller	1	Serviceable	MoAg

7.8.2.2 Manpower

Staff	Quantity	Remark
Civil Engineer	1	
Road Technicians	34	Trained on road maintenance activities
Machine Operators & Drivers	7	

7.8.2.3 Key Findings

The State Ministry of Physical Infrastructure (MoPI) has reasonable commitment and capacity to oversee road maintenance activities. The ministry welcomes any appropriate and tailored approach for road maintenance works and is keen to have capacity building trainings on labor based road maintenance methods. Appreciating the initiatives taken by the state to levy road user charges to upkeep the road assets; MoPI however, requires appropriate levels of structure and accountability to collect and manage funds.

The commitment and tangible actions exhibited in the state encourages active engagement of the state for the proposed feeder road construction project and follow up maintenance actions. However, this requires support on capacity building/skill gap training and an establishment of a dedicated maintenance unit under the directorate of roads and bridges based on thorough needs assessment and evaluation of the existing capacity.

- The feasibility study team noted that the population density along the first 36km of Gok Machar to Jor Beauc road is high and infrastructure supporting socio- economic activities of the roadside community (schools, markets and health centers) are available. This is considered as a key potential for labor based maintenance activities through engagement of the roadside community.

7.8.2.4 Recommendations

- UNOPS shall enhance the existing knowhow and experience in the State on labor based road maintenance concept through capacity building training and provision of tools and necessary intermediate road maintenance equipment.
- In view of availability of the roadside community along the first 36km of the Gok Machar-Beauc road and previous experience using community groups, labor based maintenance method is feasible in the project area.
- UNOPS, with the help of the implementing partners, local administration and traditional leaders, will organize the existing community groups who were trained and had experience working on labor based road maintenance activities. UNOPS, implementing partners and local authorities will engage them for road maintenance through performance-based routine maintenance or any appropriate engagement mechanism.
- The available road building/maintenance equipment in the State Ministry of Physical Infrastructure and Ministry of Agriculture could be of use for future maintenance activities of the feeder road subject to the allocation of funds to cover the operationals costs.
- UNOPS will sign a memorandum of understanding with the State MoPI to enhance collaboration, seek commitments and define responsibilities. This will include maintenance responsibilities, ownership of the road assets definitions and procurement of tools or equipment.
- UNOPS will engage INGOs working in the area under ZEAT BEAD and SORUDEV program to sensitize the roadside community and establish road maintenance groups such as farmer groups, youth groups etc.
- UNOPS will populate the information gathered during this feasibility study with a follow up mission(s) in the State and produce a comprehensive and robust road maintenance strategy document for the feeder road. This will be done in consultation with the State and national road infrastructure offices and key stakeholders on the ground.
- UNOPS will advocate for public-private partnership (PPP) for future maintenance of the feeder roads by the State MoPI

8 Conclusions and Recommendations

The following conclusions are made with respect to the feasibility study carried out for the feeder roads. The following describes the key findings, conclusions and recommendations against the key themes investigated, i.e. socio-economic impacts, travel demand assessment, engineering assessment and environmental impact assessment. Conclusions are further summarized below for easy reference.

8.1 Road Selection

The four roads for which feasibility study was carried out were chosen from each of the four States selected by the ZEAT BEAD Program. The road sections recommended for further project development are identified in Table 8.8-1 below. These roads were chosen based on the objectives of the ZEAT-BEAT and complimentary SORUDEV Programs and optimized to provide a reasonable even distribution of kilometers constructed for each State within the available budget. Once the final detail engineering design is complete and market prices are obtained, a review of the constructible kilometer will increase or decrease with revised scope based on the available project budget. The following are the roads that will meet program objectives: connect farmers to markets, maximize access to basic socio-economic facilities, are close to on-going SOURUDEV activities by development partners and meet the construction feasibility and sustainability criterion.

Table 8.8-1 –Recommended Road Sections

No.	State	Sections Compared	Length (Km)	Selected section	Cost Estimate (USD)
1	Lakes	Aluakluak - Mapourdit - Agruan	26.6	Aluakluak - Mapourdit – Aguran (26.6 km)	4,490,000
2		Aguran - Ngop	9.5		
3	Warrap	Achol Pagong - Ayien	27.5	Achol Pagong - Ayien (27.5 kms)	5,860,000
4		Ayien - Panliet	11.1		
5	WBG	Kayango – Bisellia	21	Kangi – Bar Urud (29.2 km)	5,510,000
6		Kangi – Bar Urud	29.2		
7	NBG	Gok Machar - Mayom Angok	34.7	Gok Machar - Mayom Angok (34.7 kms)	6,020,000
8		Mayom Angok –Jur Beauc	38.6		
	SUM			**118 kms**	**21,880,000**

*Remarks: A triple box culvert crossing required at Kayango Market entrance (5m x 2m) x 3 cells

The multi-criteria selection criterion adopted and the actual scores for each of the identified sections is included in Annex 1.

8.2 Engineering Assessment

Though the existing roads are unclassified tracks, they are the only means of access to the communities residing in the area. A GPS track was used to investigate the alignment of the roads and preliminary geometric design was made for each of them. The design was based on the SSRA Low Volume Roads Design Manual, selecting a design standard based on traffic projection on the road through its design life. Accordingly, based on the traffic counts made and the agricultural potential of the studied roads, the Average Annual Daily Traffic (AADT) was established and projected in 15 years of design life. It was found that Aluakluak – Mapourdit – Aguran (LAKES) and Gok Machar – Mayom Angok roads (NBEG) would require a DC-4 Standard road (7.5m carriageway) whereas the remaining two roads of Kangi – Bar Urud (WBEG) and Achol Pagong – Ayien (WARRAP) were found

to require a DC-3 Standard road (7.0m carriageway).

The corresponding cost for each of the identified roads was estimated for the DC-2, DC-3 and DC-4 options in order to compare and contrast them during economic evaluation. The costs estimated for each road, given terrain, land use and material availability were as follows:

Table 8.8-2 – Cost estimates based on Design Class of Road

No.	STATE	SECTION	Estimated Cost of Construction (USD/km) per design standard		
			DC-2	DC-3	DC-4
1	LAKES	ALUAKLUAK – MAPOURDIT - NGOP	118,457.41	133,081.59	159,210.33
2	WARRAP	ACHOL PAGONG - AYIEN MARKET	229,387.63	248,324.73	271,294.60
		AYIEN MARKET - PANLIETH	273,200.18	200,968.34	312,063.11
3	WBEG	BISELLIA - KAYANGO	181,471.73	191,606.76	198,867.74
		KANGI - BAR URUD	221,999.87	237,450.09	249,795.71
4	NBEG	GOK MACHAR - MAYOM ANGOK	127,499.37	138,605.39	163,687.88
	Average		**192,002.70**	**207,232.46**	**219,907.20**

These costs were used for economic evaluation of each of the identified road projects.

The road construction entails inevitable elements of environmental destruction. As much as roads are an important aspect of economic development, care must be taken to either minimize or mitigate aspects of environmental destruction. Below is a list of environmental issues identified and ways to mitigate them:

- Cutting down of trees during bush clearance: where possible,the cutting down of key indigenous trees of high environmental value will be avoided. The project should support an aspect of afforestation to compensate for the trees destroyed, especially where vegetation is a food source for the local community.
- Disturbance of topsoil stratum during bush clearance and road construction must be minimized and soil stabilization methods, such as mulching or re-vegetation, shall be established as soon as practicable.
- Effects of soil erosion as a result of the creation of road drainage must be mitigated through the construction of water retention and soil stabilization measures such as; re-vegetation, mulching, detention/retention basins and check dams.
- Blocking of natural water movement as a result of the road construction: drainage structure must be installed as per standard design specifications in order to facilitate the free movement of surface water.
- Negative impact to biodiversity can be mitigated through; minimizing clearing and area of construction, sustainable road construction and future road maintenance programs will ensure the impact of vehicle movement will be limited to the designated carriageway.

In addition, all borrow pits for fill and gravel materialsestablished for the purposes of the road construction will be rehabilitated by battering the sides of the pits and providing a reasonable slope to avoid the “cliff” effect. The borrow pits will then be converted into water catchment reservoirs for use by communities living along the road in a sustainable fashion. It is recommended that all rehabilitated borrow pits be fenced and a committee set up and trained on how to manage the borrow pits as water reservoirs.

8.3 Economic Viability

Based on the results of economic evaluation supported by the sensitivity analysis, the investment for the improvement of the four feeder roads to engineered all-weather standard has been observed to be economically viable and the investment is worthwhile.The EIRR values are above 12% for all projects, which is higher than the cut-off point for similar projects in developing countries including ROSS. The sensitivity analysis shows that in the worst-case scenario, i.e. increase in cost by15% and decrease in benefit by 15%, the EIRRs are less than 12% in some cases, which is below the cut-off point thus requiring necessary risk management measures to control cost over-runs during implementation.

Improvement of the project road as proposed, to DC-3 and DC-4 GWC standard road, would impact positively upon transportation costs, which include VOC savings, travel time savings to road users, better riding quality and maintenance costs savings for the road agency, i.e. MTRB and State DRBs. Investment in the project road would also impact positively upon the overall socio-economic development of the project influence area.

Investment in the identified feeder roads would enhance movement patterns and have a positive impact on the overall socio-economic development of the project area.

The main findings which emerged as a result of the conducted feasibility study are given below:

- Improvement of project roads would provide access to the counties, payams, bomas and villages between terminal points of the roads. The roads would also increase accessibility and mobility in the districts. They will in particular help the socio-economic and transportation development of villages located in the immediate project influence area.
- Improving the roads would be an important contribution the evolving road network in the area, providing high economic returns and a number of other unquantifiable benefits. Specifically, the Aluakluak – Mapourdit – Aguran and Gok Machar – Mayom Angok – Darfur Junction roads would offer an extra advantage for traffic that traverses between Rumbek/Yirol to Mvolo and Aweil to Darfur respectively.
- Existing traffic data anticipated agricultural surplus in the projects’ vicinity and expected growth rates indicate that there is sufficient traffic volume to recommend upgrading the roads to Gravel Wearing Course (GWC) standard.
- The works associated with the improvement of the roads would improve living conditions for the people in the corridor through creating job opportunities. The improved project roads will lead to considerable savings in vehicle operating costs, which are expected to be passed onto passengers and freight through the market mechanism of competition among transport operators.
- The feeder roadsare economically viable as the project analysis reports an Economic Internal Rate of Return (EIRR) higher than 12%, the qualifying cut of EIRR for infrastructural projects.

It is therefore recommended, based on the study, that **the *Aluakluak – Mapourdit – Aguran* and *Gok Machar – Mayom Angok*** roads be rehabilitated to a road of Class DC-4 standard with GWC

pavement,including a carriageway width of 6m and shoulder width of 0.75m for a total roadway width of 7.5m to cater to future traffic. Such an investment has been shown to be economically justifiable. Further, the ***Achol Pagong – Ayen Market*** **and** ***Kangi – Bar Urud*** **roads should** be rehabilitated to a road of Class DC-3 standard with GWC pavement, including a carriageway width of 5.5m and shoulder width of 0.75m for a total roadway width of 7.0m to cater for the future traffic. This investment would also be economically justifiable. In terms of technology choice, the proposed intervention would be best implemented using machine intensive technology with great emphasis on maximum utilization of labor for roadworks.

8.4 Economic & Social Development Aspects

8.4.1 Economic Development Aspects

Adequate accessibility is a pre-condition for any socio-economic development process, as it provides linkage between people and resources, generates new economic opportunities and helps in poverty alleviation. More specifically, improvement in transport infrastructure, inter alia, efficiently and economically facilitates the marketing of agricultural products to consumption centers, opens up new trade and employment opportunities and also facilitates the provision of agricultural accessories/ items and consumption items to the villages. Equally important is the improved access to social welfare and public services and closer economic and social interaction among communities living apart from each other.

The potential of the study areas formed substantial part of the travel demand forecasted for all projects. According to the SSRA Design Manuals, all four roads considered would lie above a DC-3 Standard Road. DC-3 roads have a 5.5m carriageway with 0.75m shoulders on each side with a total carriageway with of 7.0m. The roads' AADT economically justifies all the roads where a positive NPV and an IRR greater than 12% was obtained. Under sensitivity testing, however, some of the roads (e.g. Lakes) did not pass the combined case of increase in construction and maintenance costs and decrease in forecasted traffic volume. As such, caution may be required to ensure construction costs are not highly exaggerated during the execution of the projects, in comparison to those estimated during the feasibility study.

Agricultural activity in the project area is mostly dependent on rain, implying occasional crop failure risk. To provide support to agriculture in the project area, the European Union has plans for the development of agricultural activity including schemes of animal traction supported by development partners and NGOs in the project area. The resultant boost in agricultural production will also get support from improvements in the proposed transport infrastructure.

8.4.2 Social Benefits

The role of transport in rural development is vital to promote rural productivity and is an essential social amenity. The social benefits of upgrading the project roads in the influence area, impacting more than **0.15 million** people residing in the area of the projects (as per 2008 Census), will include the following:

I. Social Services

- Provision of improved social services (education, health, etc.) induced by reduction in transport tariff for the delivery of services and supplies by the provider;
- Improved provision of development aid, relief supplies and social services provided by voluntary organizations (charitable organizations, NGOs, etc.);
- Improvement in the social marketing of important topical initiatives such as HIV/AIDS, maternal health, family planning, etc.;
- Provision of goods and services at relatively cheaper prices, and increased product choices;
- Improved marketing services for agricultural inputs and produces; and
- Better access to secondary schools and higher educational institutions.

II. Employment

- Creation of numerous local employment opportunities during the civil works phase of the project road improvement activities (unskilled and semi-skilled manpower);
- Multiplier effect due to civil construction activities in the project area, with the generation of additional economic activities which would further enhance employment opportunities;
- Employment related to transport operation activities at bus/truck terminals given the expected increase in traffic volume during the project appraisal period;
- Employment arising out of intensive commercial farming (sorghum, sesame, etc.) and related agro-processing activities within the Yirol West area induced by reduced transportation cost; and
- Increased involvement of local communities in non-traditional income generating occupations for additional income generation, supported by updated and improved knowledge resulting in positive mindsets.

III. Safety & Security

- The security level of the project area would be highly improved due to increased accessibility for police forces;
- Incidence of conflict will decrease as more people are engaged in productive sectors such as trading, agriculture, transport operation, etc.

8.5 Socio-Economic Impacts

The road investment's impact on socio-economic development is wide-scope though difficult to quantify in monetary terms. In the long term, the project's positive impact is anticipated to extend from the local community to the State and the country at large. The optimal impact is realized when the road network operates at full capacity. Optimization of project benefits isdependent on the provision of socio-economic infrastructure, volume of road traffic, access to motorized transport means, willingness and affordability of the target beneficiaries. A set of affirmative actions are thus necessary to maximize socio-economic benefit and impact of the project on rural communities:

1. Coordinated and integrated government efforts at all levels to build the capacity of target communities in organization and leadership to secure efficient utilization of the road facilities pre- and post- project implementation.
2. Advocacy and promotion of activities are necessary before project implementation to sensitize communities and stakeholders.This aims atasserting the commitment of concerned government authorities(policy-makers, State Ministry of Local Government, Ministry of Physical Infrastructure, Ministry of Road Transport and Ministry of Agriculture, Rural Development and Cooperative), County commissioners, Payam executives, local Chiefs and grass-root community representatives to formulate strategic policies, directives and regulatory frameworks that encourage private sector-led motorized transport service delivery through the proposed feeder road route.
3. The construction of rural feeder roadsentails socially sensitive issues demanding special attention. The project implementation process raises serious social issues including the displacement of villagers' housing units, transect settlements, agricultural farm areas, animal camps and other rural services. Mitigating potential social costs and securing project sustainability requires adequate consultative planning, communication, coordination, integration and partnership development among all key stakeholders. Clearly defined project objectives, project management structure, authorities, roles and responsibilities of stakeholders constitute key element of consideration.
4. Establish market collection centres that promote efficient and effective marketing and trading of small farmers' agricultural commodities. Market collection facilities need be located at strategically commercial hubs. Better provision of rural services is essential to attract rural agribusiness, creating new rural market opportunities and growth. Market expansion raises the

demand and supply of private sector-led motorized transport services, which improves the rural income, employment and development. Regional market collection centres are recommended at Aluakluak in Lakes State, Kangi in WBeG, Achol Pagong in Warrap and Gok Machar in NBeG. Community level produce collection points are also recommended at Mapourdit in Lakes State, Kayango in WBeG State and Ayen in Warrap State. The community level collection centres are expected to be closer to the communities and centre that farmers can deliver produce on foot or by bicycle or ox-carts before the produce is moved to the regional collection centres.

5. Building the institutional, material, financial and technical capacity of communities and local government on community-based rural road maintenance project planning and operation are vital to ensure project sustainability.
6. The government, in consultation, communication and coordination with local communities, should where necessary undertake village collectivization and resettlement programs at suitable settlement locations along the feeder road.
7. The local government, concerned State line-ministries, grass-roots and potential stakeholders operating at the ground level should have active participation and involvement through a transparent approach. The concerned stakeholders should show strong commitment and resource contribution throughout out the project's lifecycle.
8. Enact administrative rules and regulations that favour farm operation. The aim is to stimulate agricultural production through forms of tax and duties exemption of small farmers, market intermediaries and transport agents involved in the production and marketing of primary and value-added farm products.
9. Promote rural development intervention through a diverse livelihood approach. Development interventionssuch as cash-for-work programs or small-ruminant animals and poultry distributionsare a strategic tool in improving rural families' food security, building resilience, enhancing nutrition, poverty alleviation and sustainable development.
10. Coordinate and integrate partnerships to establish an efficient state food security board with far-reaching operational presence at the rural grass-root level. Fully-fledged technical, financial, logistical and managerial capacity building is essential. The board shall be in charge of developing and managing the state food security program through direct involvement in the agricultural market including purchase, transport and storage of small-scale farmers' produces at attractive farm gate prices.

8.6 Environmental Impact Assessment

Construction of the feeder roads is likely to provide important development and access opportunities to residents of the local area. However, this development is likely to have a significant impact on the overall natural environment. As such, strategic measures need to be incorporated into the design to mitigate the adverse impacts.

It is advised that efforts be made to ensure the identification of the most opportune locations for the acquisition of embankment construction material. Furthermore, it is advised that efforts be made to transform these borrow pits into detention basins for use during the dry season. The acquisition of murram should consider the current and future uses of borrow pits and incorporate a plan for adequate rehabilitation to stabilize the area and ensure the safety of people and animals while also allowing for future usage.

In order to reduce the exposure of soils and impact on the natural habitat, clearing is required to be kept to a minimum. This should be considered in the design of the road corridor and the subsequent planning of the construction works. It is important to avoid the removal of, or consider the establishment of or compensation for, the removal of any vegetation that is a food source. In addition, due to the dispersive and fine particle characteristics of soils, it is advisable to re-vegetate or provide temporary stabilization measures until natural vegetation can occur in order to prevent soil loss.

During the construction period, access to water may be limited. To mitigate the effect, early identification of a viable water source is recommended. Alternatively, a new water source could be constructed in order to reduce the impact of water collection opportunities to the local population.

8.7 Maintenance Concept

The field mission has verified that for Lakes and NBeG States, the state Ministry of Physical Infrastructure has reasonable capacity and commitment to support the envisaged maintenance activity. However, the following key challenges are broadly considered as impediments for the state to adequately utilize this available capacity for the maintenance of feeder roads:

- Lack of funding/budget to support the planning, management and operations of road maintenance activity;
- Limited capacity of road technicians in construction and maintenance of rural roads;
- Insecurity in the state.

With regards to WBeG and Warrap States, the States Ministries of Physical Infrastructure have limited capacity in terms of technical knowhow, resource availability and budget to carry out road maintenance activities. Besides, the commitment and enthusiasm to embark on this task is minimal.

Broadly, the following shortfalls are considered an impediment for road maintenance activities in the state:

- Lack of funding/budget;
- Lack of technical knowhow and commitment on labor based road maintenance activities;
- Poor institutional framework to cater for road maintenance.

As such, UNOPS' involvement is expected to be greater during the maintenance stage of the roads, particularly for these last two States.

In order to provide future sustainable maintenance of the feeder roads it is recommend that training and capacity of the local CBO's are conducted and further investigations are made into a viable concept for COB's to be remunerated for maintenance work conducted beyond the project completion. In order to ensure this success it is vital that the States MoPI and MoA in conjunction with the local Counties establish a formal agreement of roles and responsibilities. This agreement should be State specific and established early in the project so that the SOURDEV/ ZEAT BEAD Partners are able to assist in relevant training and capacity building.

During the implementation period UNOPS will work with the state authorities and key stakeholders to determine and agree appropriate approach for post construction maintenance of the feeder roads by the state MoPI and/or community maintenance groups. UNOPS advocates PPP between the government and local community based organizations for the envisaged road maintenance.

Annex I Road Selection Criteria

Feeder Roads Section Assessment Score-sheet										
				Criteria						
				Connection of Farms to Markets	Socio Economic Factors	SORUDEV / ZEAT BEAD Partners	Construction Feasibility	Sustainability	Total score	Rank
			Maximum points	10	10	10	10	10		
			Weight	2	2	2	2	2		
			Total	**20**	**20**	**20**	**20**	**20**	**100**	
s/n	**Road Section**	**State**	**Classification**							
1.1	Achol Pagong - Ayien	Warrap	Feeder Road	10	9	10	8	8		
				20	**18**	**20**	**16**	**16**	**90**	**3**
1.2	Mjok - Ayien - Jong Lual	Warrap	Feeder Road	7	5	10	8	8		
				14	**10**	**20**	**16**	**16**	**76**	**7**
1.3	Warrap Town - Majak Juer	Warrap	Feeder	10	8	8	7		33	
				20	**16**	**16**	**14**		**66**	**9**
1.4	Akop - Romic	Warrap	Feeder	10	8	9	7		34	
				20	**16**	**18**	**14**		**68**	**8**
2.1	Alukluak - Aguran	Lakes	Feeder Road	10	6	10	11	10		
				20	**12**	**20**	**22**	**20**	**94**	**2**
2.2	Alukluak - Ngop	Lakes	Feeder Road	7	9	8	7	8		
				14	**18**	**16**	**14**	**16**	**78**	**6**
3.1	Gok Machar - Mayom Angok	NBG	Feeder Road	10	9	10	10	9		
				20	**18**	**20**	**20**	**18**	**96**	**1**
3.2	Akottit - Jor Beauc	NBG	Feeder Road	3	5	5	7	9		
				6	**10**	**10**	**14**	**18**	**58**	**8**
3.3	Matuic - Kiir Ajowak	NBG	Feeder	10	10	8	8		36	
				20	**20**	**16**	**16**		**72**	**3**
3.4	Wanyjok - Rum Akar	NBG	Feeder	10	10	6.5	8		34.5	
				20	**20**	**13**	**16**		**69**	**5**

4.1	Kangi - Barurud	WBG	Feeder Road	7	7	10	10	9		
				14	**14**	**20**	**20**	**18**	**86**	**4**
4.2	Kayango - Bisellia	WBG	Feeder Road	8	7	7	10	8		
				16	**14**	**14**	**20**	**16**	**80**	**5**

Annex II Origin Destination Survey Data

Annex III Economic Evaluation Data

Annex 3A: SHADOW PRICING VEHICLE OWNERSHIP COSTS

STANDARD Conversion Rate Calculation to Shadow Price Financial Value to Economic Value

Vehicle Type	CIF Kampala + 10% Freight & Insurance charge	Customs Duty	Excise Tax	Sales Tax	Profit Margin	Total
CAR	63.29%	5.06%	12.66%	12.15%	6.84%	100.00%
	1.00	-	-	-	0.90	
	0.63	-	-	-	0.06	**0.69**
Four Wheel Drive	63.29%	5.06%	12.66%	12.15%	6.84%	100.00%
	1.00	-	-	-	0.90	
	0.63	-	-	-	0.06	**0.69**
Small Bus (<12 seats)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00				0.90	
	0.68				0.07	**0.75**
Medium Bus (<27 passengers)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**
Large Bus (>27 passengers)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**
Small Truck (< 3.5 ton)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**
Medium Truck (3.5 to 7.5 ton)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**
Heavy Truck (7.5 to 12 ton)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**
T/T (>12 ton)	68.26%	5.46%	6.83%	12.08%	7.37%	100.00%
	1.00	-	-	-	0.90	
	0.68	-	-	-	0.07	**0.75**

Annex 3B: RED Economic Evaluation Input Data

1. Approach

The project road under evaluation involves improvement of an existing, narrow, poorly defined earth track to a wider unsealed engineered road with Gravel Wearing Course surface. The cost of the road improvement represents an investment which is expected to result in economic benefits. The benefits of road investment are essentially due to the difference in total transportation costs once proposed improvements having been undertaken (i.e. with project), compared to those incurred in case of status quo (i.e., without project). Economic evaluation takes into account all related costs and benefits to society. In case of a road project, the benefits accrue to the road users, in the from of vehicle operating cost savings and time savings, and also to the society in general, in the form of socio-economic development of the project road area, while improvement costs are primarily borne by the road agency.

Transportation costs over the period of analysis, for the “with project” option, consist of costs of improvement, costs of future facility maintenance (routine and periodic maintenance) and future road user costs, mainly vehicle operating costs and other time-related costs. For the “without project” option, the transportation costs will include the cost of maintenance of the existing facility, and road user costs incurred over the period of analysis. The combined road improvement and maintenance costs might be higher in the “with project” option, but this is expected to be more than offset by the lowering of the road user costs. In the economic evaluation, the total transportation costs during the project life (i.e. road improvement and maintenance costs and road user costs) will be compared for the “with project” and “without project” options.

The savings in transportation costs “with project” vis-à-vis “without project” are benefits to society from the investment for road improvement. Both the costs and benefits over the analysis period are discounted to the base year for comparison. The results of the economic analysis are expressed by the following standard measures to evaluate the economic viability of the project:

- Net Present Value (NPV);
- Economic Internal Rate of Return (EIRR);
- Net Present Value over Cost Ratio (NPV/C); and
- First Year of Return (FYRR).

The NPV is the sum of the discounted stream of project costs and benefits during the project life. A project with a positive NPV, taking into account the discount rate, is a measure of its economic viability. The EIRR represents the discount rate at which the NPV of the project would be equal to zero. Projects with EIRR above the cut-off point are treated as economically viable. The NPV/C criterion is used to rank projects where there is a budget constraint. The FYRR is used as a guide to the optimum timing of investment.

The Roads Economic Decision Model (RED), Version 3.2 has been used for carrying out the economic evaluation of the Feeder Road Projects. This is a widely used tool for economic evaluation of investments in low-volume rural roads.

2. Traffic Projection

2.1 General

In general, future travel is determined by the availability of fuel, growth in population, land use and other economic factors. Highway travel results from passenger demand and freight movements. Passenger travel on highways is mainly conducted by automobiles, station wagons, light, medium and large buses. Freight, meanwhile, is hauled by small, medium and heavy trucks.

Traffic forecasting is at best approximate. Traffic is generated as a result of the interaction of a number of contributory factors. Long-term forecasts of traffic must therefore be dependent on the forecasts of factors such as population, gross domestic product, vehicle ownership, agricultural

output, fuel consumption etc., at a national or regional level. Future patterns of change in these factors can be estimated with a limited degree of accuracy.Hence, the forecasting of future traffic levels cannot be precise.

Historical data was sought for the feeder roads under investigation from SSRA, State DRBs and development partners. However, past traffic count was obtained only for Aluakluak – Mapourdit – Mvolo road from SSRA earlier study. Short-term traffic growth rate could be estimated for the project road based on the study made by the SSRA, and the same is shown under **Table 1**.

Table 1: Traffic Growth Rates from Historical Data

Traffic Survey Time	Length (km)	Pedestrians	Bicycle	Light Vehicles	Heavy Vehicles
Count (2010)	40	70	16	36	34
Count (2015)	10	169	224	91	53
Annual Growth Rate (%)		**19.4%**	**70.4%**	**20.4%**	**9.5%**

2.2 Elasticity of Transport Demand

This method of long-term traffic forecasting incorporates analysis of some of the key socio-economic characteristics in the road influence area and their anticipated rates of change during the design period, these characteristics being taken as indicators for future traffic growth.Growth rates for normal traffic obtained from this approach take into account the following factors, which affect future traffic levels:

- The prospective growth in the economy;
- The estimated elasticity of demand for transport; and
- Changes in the structure of the vehicle fleet, if any.

It must be noted that growth in agriculture and manufacturing sectors affect the growth of freight vehicles, while growth in population and income level affect growth of passenger vehicles. This method thus incorporates the prospective growth envisaged in the state economy and the changes in transport demand elasticity over a period of time as the basic data input. Data on elasticity is not made available by the SSRA. As such, international practice was referred to and correlation made to reflect the South Sudanese situation.

2.3 National Gross Domestic Product

Available information on national GDP data is brief and limited. It was possible to obtain GDP data from the website of National Statistics Authority in the South Sudan for the period 2008 – 2013, along with population census data. This was used to compute GDP per capita for the time series data.

Table 2: GDP, Population and per Capita Income Development

Year	GDP at constant mkt price SSP Mn [a]	% Change	Population Mn [b]	% Change	GDP per Capita[c]	% Change
2008	26,896.00		8.473		3,174.32	
2009	28,252.00	5.0%	8.941	5.5%	3,159.83	-0.5%
2010	29,804.00	5.5%	9.415	5.3%	3,165.59	0.2%
2011	28,421.00	-4.6%	9.897	5.1%	2,871.68	-9.3%
2012	15,324.00	-46.1%	10.386	4.9%	1,475.45	-48.6%
2013	17,336.00	13.1%	10.882	4.8%	1,593.09	8.0%

Average rates of growth (%)	**2008 - 2013**	**-5.4%**		**5.1%**		**-10.0%**

Sources: [a] South Sudan National Bureau of Statistics 2014
[b] Population Census and Annual Abstract of Statistics

The outlook for the national GDP of ROSS for the future is slightly optimistic, but at risk given its dependence on oil incomes. The African Development Bank has outlined the **South Sudan Infrastructure Action Plan**. GDP at constant prices of 2010 were set for 2015 as -14.1% and for 2020 as +3.1% where the period 2011-2020 would have exhibited an annual increment of GDP at 0.7% rate per annum. This growth forecast is a high growth scenario and the same is used to set traffic growth rate scenarios under the following section.

2.4 Traffic Forecast Model

Empirical evidence reveals that traffic growth is not correlated to changes in major economic indicators of the immediate project influence area (PIA). In view of this, future traffic projections incorporate analysis of some of the key socio-economic characteristics and rates of change expected during the study period beyond the immediate PIA. This, however, requires assumptions concerning the elasticity of road transport demand with respect to changes in the overall economy, i.e., economic growth. As such, the method of elasticity is adopted to forecast future traffic by assessing elasticity of transport demand to estimate future traffic on the project road.

In specifying the forecast traffic growth rate for the projection of traffic stream using the road in the future, a simple model has been used that combines the effect of GDP and population growth on travel demand.Two models of the following forms were, therefore, applied:

$$\Delta T = e\,(\Delta GDP)$$

Where:

ΔT = the change in freight transport

ΔGDP = the change in GDP

e = the income elasticity for freight travel demand.

and

$$\Delta T = \Delta P + e\,(\Delta C)$$

Where:

ΔT = the change in passenger transport

ΔP = the change in population

ΔC = the change in per capita income

e = the income elasticity for passenger travel demand.

Based on the model relationship specified above, estimates of forecast traffic growth rates for passenger and freight vehicles categories (for three scenarios) are presented below corresponding to the forecast traffic growth periods.Accordingly, considering the GDP data and the foregoing analysis, the growth rates indicated in **Table 3**were eventually selected.

Table 3: Traffic Growth Scenario

Average Annual Traffic Growth Rate-Low Scenario [PESSIMISTIC FORECAST]

Forecast Period	National GDP (%)	Pop. Growth (%)	GDP Per Capita (%)	Elasticity		Average Annual Traffic Growth (%)	
				Passenger Veh.	Freight Veh.	PV	FV
2015-2025	2	3	1	1	1.3	4	2.6
2026-2040	2	2	0.5	1	1.3	2.5	2.6
				Average over Period		**3.25**	**2.6**

Average Annual Traffic Growth Rate-Medium Scenario [REALISTIC FORECAST]

Forecast Period	National GDP (%)	Pop. Growth (%)	GDP Per Capita (%)	Elasticity		Average Annual Traffic Growth (%)	
				Passenger Veh.	Freight Veh.	PV	FV
2015-2025	3	4	2	1	1.3	6	3.9
2026-2040	3	3	1	1	1.3	4	3.9
				Average over Period		**5.0**	**3.9**

Average Annual Traffic Growth Rate-High Scenario [OPTIMISTIC FORECAST]

Forecast Period	National GDP (%)	Pop. Growth (%)	GDP Per Capita (%)	Elasticity		Average Annual Traffic Growth (%)	
				Passenger Veh.	Freight Veh.	PV	FV
2015-2025	4	5	3	1	1.3	8	5.2
2026-2040	4	4	2	1	1.3	6	5.2
				Average over Period		**7.0**	**5.2**

PV - Passenger Vehicle **FV - Freight Vehicle**

The traffic forecasts under different pessimistic, realistic and optimistic scenarios with respect to the variables in the above model on annual and periodic basis are shown above. The growth scenario of travel demand based on realistic assumptions is used fortraffic projection. The projection of traffic based on realistic economic growth scenario is shown below.

3 Economic Parameters

3.1 Standard *Conversion Factors*

Market prices used as inputs for project road improvement costing reflect prices in financial terms, whereas economic costs represent the true cost of resource consumption of those inputs. For the purpose of economic analysis, financial costs have been converted into economic costs using standard conversion factors. These conversion factors are based on consideration of transfer payments and also on the identification of non-traded or intermediate goods. For example, taxes paid on goods and services are costs to domestic consumers. However, from the national economic view-point, taxes are transfer payments from the consumers to the government and not economic costs.

The ROSS Ministry of Finance and Economic Planning (MFEP) has not yet established a set of conversion factors to convert market prices into economic costs for ROSS projects. Therefore, conversion factors from other countries in the region and the SSRA Final Development Plan for 7000km Feeder Roads (September 2010) have been used in the economic evaluation for the project road.

3.2 RED *Model* Input

The basic input data modules of RED with values for various input parameters are described in the following sections.

3.2.1 *Road Network*

Network data includes information pertaining to the speed-flow pattern, climatic zone, existing geometry and condition of the project road and traffic levels. Input data for the model was obtained from available information and project surveys.

3.2.2 *Traffic Data*

Traffic volume and its composition in terms of AADT by vehicle type and annual traffic growth rates are key inputs for economic analysis. The derivation of base year AADTs (2017) and traffic growth rates have been discussed earlier (in Chapters 4.4) and these are abstracted in **Tables 3**.

Table 3: Traffic Growth Rates (% pa)

Period	Car	Utility	S. Bus	M. Bus	L. Bus	S. Truck	M. Truck	H. Truck	T/T
2015 - 2025	**6.0%**	**6.0%**	**6.0%**	**6.0%**	**4.0%**	**4.0%**	**3.90%**	**3.90%**	**3.9%**
2026 - 2030	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**3.0%**	**3.0%**	**2.9%**	**2.9%**	**2.9%**
2031 - 2035	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**
2036 - 2040	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**2.0%**	**2.0%**	**1.9%**	**1.9%**	**1.9%**

3.2.3 *Vehicle Fleet*

Vehicle fleet data provides the characteristics of the vehicles which will be operating on the project road. The data includes vehicle type, number of axles, passenger car space equivalency factor, equivalent standard axle loads, operating weight, average annual utilization in km, the economic costs of the vehicle, tyres, fuel, etc., trip characteristics, value of time for passengers and cargo. Details of vehicle fleet data are further dealt with below.

3.2.4 *Road Maintenance& Improvement*

Road maintenance and improvement data comprises specifications for maintenance and improvement standards that will be applied to different project road sections. Maintenance standards comprise periodic and routine maintenance. Improvement standards consist of widening, surfacing upgrading and reconstruction, including combinations thereof.

3.2.4.1 Maintenance Standard

Road maintenance activities to be carried out on gravel and paved roads are based on the practice followed by the SSRA, taking into account maintenance management planning in ROSS. Proposed maintenance standards for the base case and the project case followed in RED Analysis are summarized in **Table 4**.

Table 4: Maintenance Strategy

Option	Work Item	Intervention Criteria
Base Option (Earth Track Road)	No Maintenance Activity	N/A
Project Case (DC-2 Standard Gravel Wearing Course surfacing)	Grading	4 times a year
	Re-gravelling	Gravel Thickness < 50mm (Increase to 150mm). Every fourth year.
	Routine Maintenance	Every year

Data on prevailing maintenance costs was collected from the State Department of Roads & Bridges and UNOPS' database for periodic and routine maintenance activities, and further supplemented by the field assessments. These cost estimates were shadow-priced by the standard conversion factors to obtain economic costs. **Table 5** presents estimates of financial and economic costs of road maintenance and repair activities, which were used for the RED analysis.

Table 5: Estimates of Economic Road Maintenance Costs for Gravel Road

Activity	Unit	Financial Cost (USD/km)	SCF	Economic Cost (USD/km)	Intervention Criterion
Routine Maintenance	km	4,000.00	0.80	**3,200.00**	Every Year
PM-Except Re-gravelling	km	7,000.00	0.80	**5,600.00**	Every second year
PM-Re-gravelling	km	36,000.00	0.80	**28,800.00**	Every three years

Source: State Department of Roads & Bridges, UNOPS database and SSRA

3.2.4.2 Road Improvement Standards

Road improvement standards comprise widening and surface upgrading of existing narrow (4m wide) earth tracks into 6m or 7m wide carriageway of DC-3 or DC-4 road standard respectively with Gravel Wearing Course (150mm) pavement. The economic evaluation period considered is 15 years. The pavement will be maintained according to maintenance standards during the analysis period. **The improvement cost is estimated between USD 118,000.00 per km to USD 312,000 per km.**

The costs of improvement options and the maintenance standards are expressed at 2015 prices. The economic costs have been derived from financial costs by applying a conversion factor of 0.80. The project costs in financial terms for the improvement options are presented in **Table 6.**

Table 6: Construction Cost for Project Road (Financial)

No.	STATE	SECTION	Estimated Cost of Construction (USD/km) per design standard		
			DC-2	DC-3	DC-4
1	LAKES	ALUAK-LUAK - MAPOURDIT	118,457.41	133,081.59	140,970.40
2	WARRAP	ACHOL PAGONG - AYEN MARKET	229,387.63	248,324.73	271,294.60
3		AYEN MARKET - PANLIETH	273,200.18	294,237.42	312,063.11
4	WBEG	BISELLIA - KAYANGO	181,471.73	191,606.76	198,867.74
5		KANGI - BAR URUD	221,999.87	237,538.86	249,795.71
6	NBEG	GOK MACHAR - MAYOM ANGOK	127,499.37	138,605.39	146,451.66
Average (USD/km)			**192,002.70**	**207,232.46**	**219,907.20**

3.2.5 *Economic Analysis Parameters*

The following project implementation and investment schemes have been considered for the RED Model input data:

Analysis Period : 16 years (15 years after opening to traffic)
Construction Period : 1 year
Investment Schedule : 1st Year : 100%
2nd Year : 0%
3rd Year : 0%
} of the Project Cost
Discount Rate : 12%

3.2.6 *VehicleOperating* Costs (VOCs)

The major inputs required for estimating the VOCs are costs of vehicles, tyres, petrol, diesel and lubricants, crew, and maintenance labor and vehicle utilization level.

3.2.6.1 *Price of Vehicles*

Data on price of representative vehicles was collected by ROSS Ministry of Interior, Directorate of Customs Service. The same information could also be accessed via the South Sudan Customs Service (SSCS) website http://www.ss-cs.org/taxation-documents/. South Sudan's **Financial Bill (2014/15)** is utilized to estimate the applicable tax amount w.r.t each vehicle. Chapters 7 to 9 indicate the applicable tax regime on imported goods, including vehicles and items required for operation. The applicable categories of taxes for imported goods relevant to vehicles include sales tax, excise duty and customs duty.

Customs duty of 8% is payable for all transport vehicles and accessories except vehicle tyres which are taxed at 3%. In the case of excise duty, diesel and petroleum products are taxed at 5%, whereas buses and trucks are taxed at 10% and passenger vehicles at 20%. Sales taxes are set at 15% for all imported goods into the ROSS.

In converting the financial prices of vehicles into economic ones, the tax components were removed. However, the dealers' commission (or profit margin) was added, using the standard conversion factor, to arrive at the final economic costs of the vehicles. **Table 7** shows the applicable tax regime and **Table 8** shows financial prices and economic costs derived for each vehicle type.

Table 7: ROSS Tax Regime on Imported Vehicles

Vehicle Type	CIF Kampala (USD)	Customs Duty	Excise Tax	Sales Tax	Profit Margin	Representative Vehicle [2010 Model]
CAR	9,000.00	8.0%	20.0%	15.0%	10.0%	Mitsubishi Saloon
Four Wheel Drive	29,000.00	8.0%	20.0%	15.0%	10.0%	Toyota Land Cruiser
Small Bus (<12 passengers)	13,000.00	8.0%	10.0%	15.0%	10.0%	Toyota HIACE Minibus (14 seats)
Medium Bus (<27 passengers)	27,000.00	8.0%	10.0%	15.0%	10.0%	Toyota Coaster (28 seater)
Large Bus (>27 passengers)	60,000.00	8.0%	10.0%	15.0%	10.0%	ISUZU Bus (65 seats)
Small Truck (< 3.5 ton)	10,000.00	8.0%	10.0%	15.0%	10.0%	ISUZU Big Horn S
Medium Truck (3.5 to 7.5 ton)	39,000.00	8.0%	10.0%	15.0%	10.0%	
Heavy Truck (7.5 to 12 ton)	51,000.00	8.0%	10.0%	15.0%	10.0%	
T/T (>12 ton)	150,000.00	8.0%	10.0%	15.0%	10.0%	Scania semi-trailer

Source: South Sudan Customs Service (SSCS) Website http://www.ss-cs.org/taxation-documents/

Table 8: Estimates of Vehicle Prices: Financial and Economic

Vehicle Type	CIF Kampala + 10% Freight & Insurance charge	Customs Duty	Excise Tax	Sales Tax	Profit Margin	Total Financial Value (USD)	Conversion Factor	Total Economic Value (USD)
CAR	9,900.00	792.00	1,980.00	1,900.80	1,069.20	15,642.00	0.69	10,862.28
Four Wheel Drive	31,900.00	2,552.00	6,380.00	6,124.80	3,445.20	50,402.00	0.69	35,000.68
Small Bus (<12 passengers)	14,300.00	1,144.00	1,430.00	2,531.10	1,544.40	20,949.50	0.75	15,689.96
Medium Bus (<27 passengers)	29,700.00	2,376.00	2,970.00	5,256.90	3,207.60	43,510.50	0.75	32,586.84
Large Bus (>27 passengers)	66,000.00	5,280.00	6,600.00	11,682.00	7,128.00	96,690.00	0.75	72,415.20
Small Truck (< 3.5 ton)	11,000.00	880.00	1,100.00	1,947.00	1,188.00	16,115.00	0.75	12,069.20
Medium Truck (3.5 to 7.5 ton)	42,900.00	3,432.00	4,290.00	7,593.30	4,633.20	62,848.50	0.75	47,069.88
Heavy Truck (7.5 to 12 ton)	56,100.00	4,488.00	5,610.00	9,929.70	6,058.80	82,186.50	0.75	61,552.92
T/T (>12 ton)	165,000.00	13,200.00	16,500.00	29,205.00	17,820.00	241,725.00	0.75	181,038.00

Source: Calculated based on SSCS data

3.2.6.2 *Price of Tire, Fuel, Lubricants and Maintenance Cost*

The costs of vehicle operation were collected from available gas stations, distributers and maintenance workshops to estimate the financial cost of replacement and maintenance services. These were then shadow-priced by applying a conversion factor of 0.8 into economic prices for use in the RED Model.

Table 9: Estimates of Vehicle Operation Costs (Economic)

	Car Medium	Four-Wheel Drive	Bus Light	Bus Medium	Bus Heavy	Truck Light	Truck Medium	Truck Heavy	Truck Articulated
onomic Unit Costs									
w Vehicle Cost ($/vehicle)	10862	35001	15690	32587	72415	12069	47070	61553	181038
el Cost ($/liter for MT, $/MJ for NMT)	1.37	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
bricant Cost ($/liter)	3.43	3.43	3.43	3.43	3.43	3.43	3.43	6.86	6.86
w Tire Cost ($/tire)	68.57	148.57	68.57	148.57	176.00	148.57	285.71	411.43	411.43
intenance Labor Cost ($/hour)	2.50	2.50	2.50	3.00	3.50	2.50	3.00	4.00	4.00
ew Cost ($/hour)	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
erest Rate (%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00

3.2.7 Vehicle Fleet Data

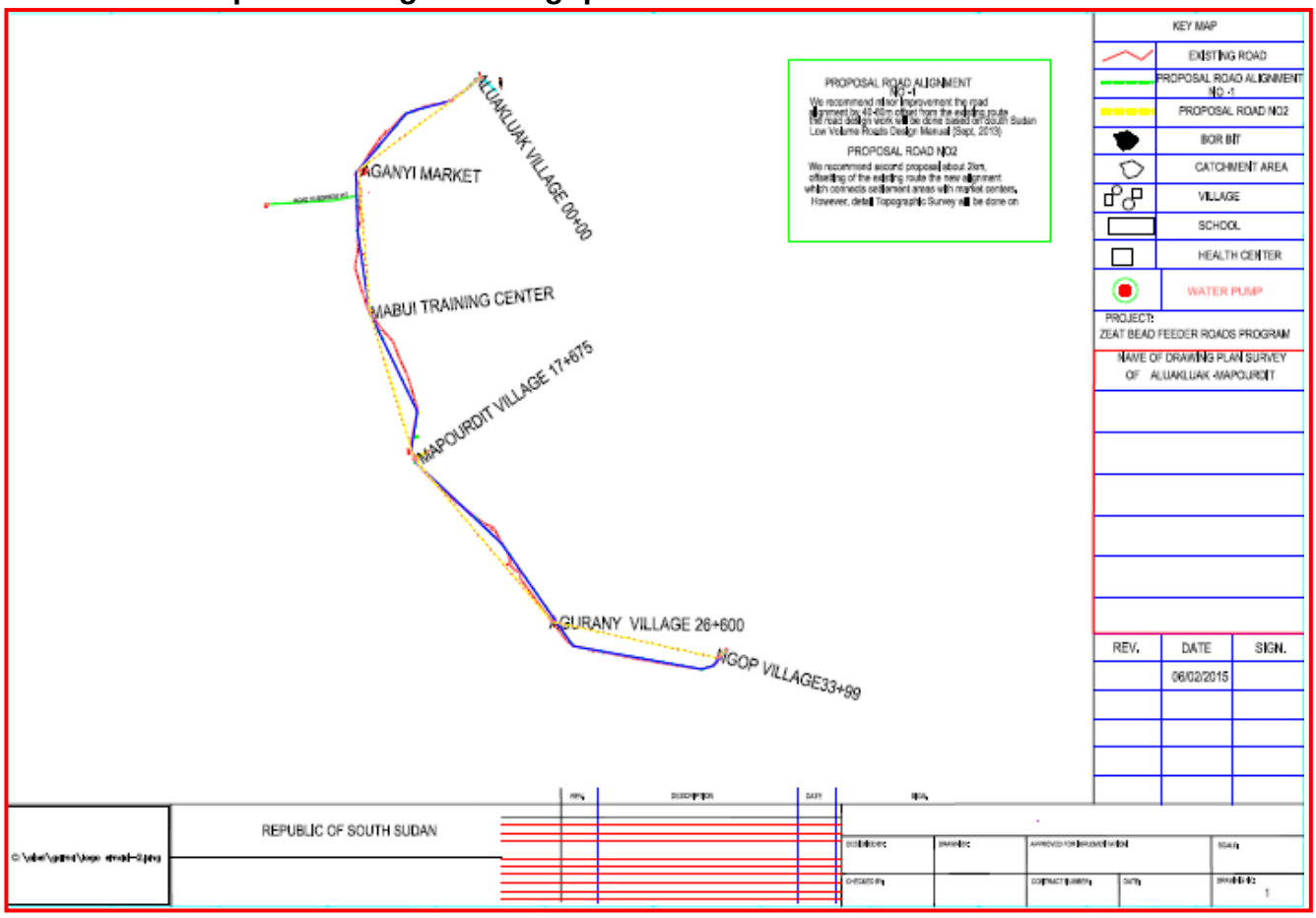
Based on market enquiries and other relevant information available, a set of vehicle characteristics data has been estimated for representative vehicles for use in RED analysis. These estimates are presented in **Table 10,** including the unit cost for inputs in economic terms of priced items.

Table 10: Vehicle Fleet Data (2015)

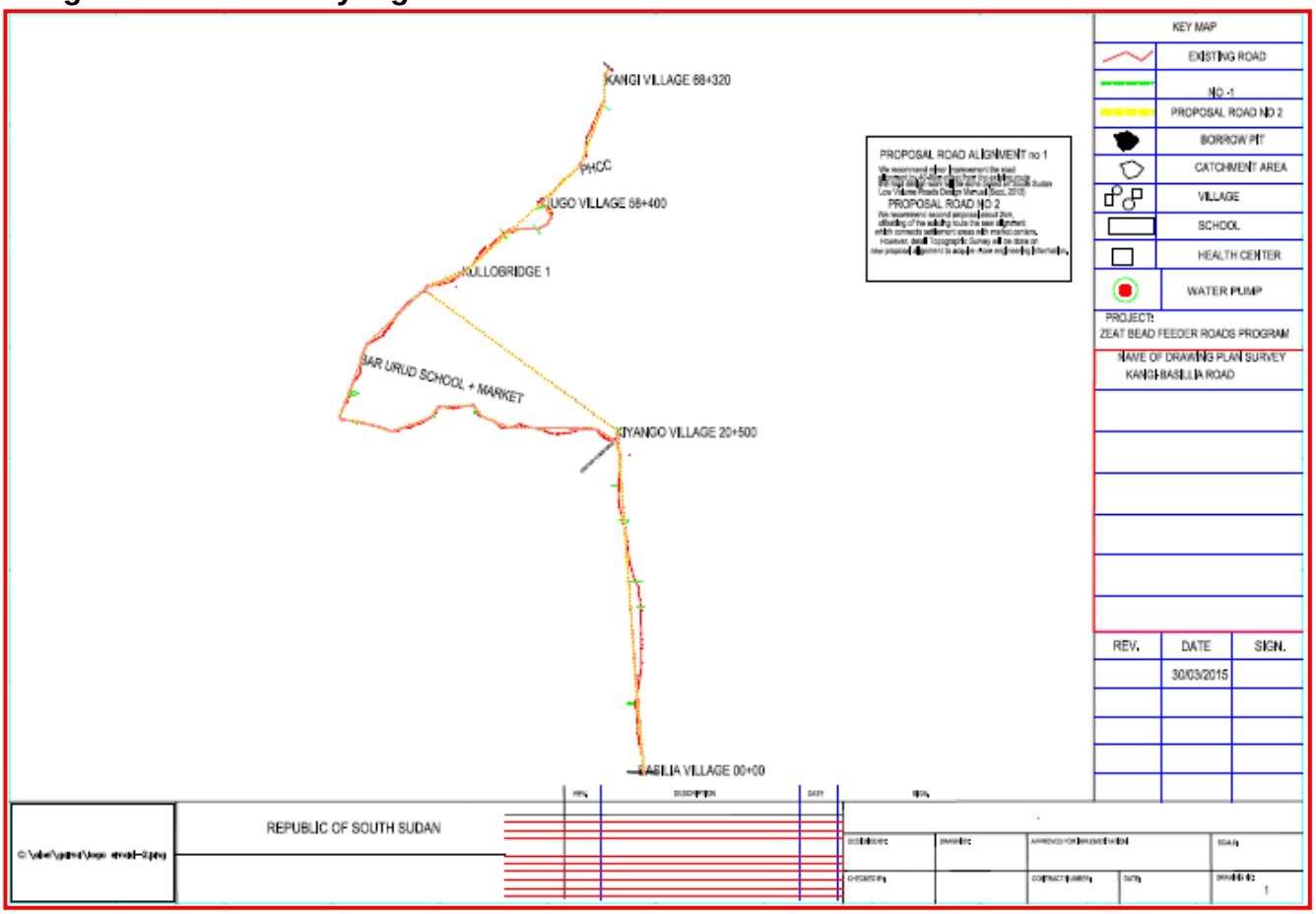
Characteristics	Vehicle Fleet Type								
	Car	4WD	S/Bus	M/Bus	L/Bus	S/Truck	M/Truck	H/Truck	T & T
Physical Characteristics									
Operating Weight (ton)	1.1	2.3	2.2		12	5.1	13	22	35
Axle per vehicle (No)	2	2	2	2	2	2	2	3	5
Tires per vehicles (No)	4	4	4	4	6	4	6	10	18
Tire Type	Radial	Radial	Radial	Radial	Radial	Radial	Radial	Radial	Radial
Passenger occupancy (no)	3	3	12	28	65	-	-	-	-
PCSE	1	1	2	2.5	3	2	3	3	4.5
Friehgt Carrying Capacity (ton)			0.35	0.5	0.75	3.5	7.5	12	20
Utilization									
Annual Run (km)	20,000	35,000	40,000	60,000	80,000	35,000	60,000	60,000	85,000
Annual Hours	600	1,250	1,300	2,000	2,000	1,200	1,500	1,500	2,000
Average service life (yrs)	10	15	10	15	15	10	15	15	15
Private Use (%)	85	20	15	0	0	0	0	0	0
Work Related (%)	15	80	85	100	100	100	100	100	100
Economic Unit Cost									
New vehicle price ('000USD)	10.862	35.001	15.690	32.587	72.415	12.069	47.070	61.553	181.038
Tire price (USD)	68.57	148.57	68.57	148.57	176.00	148.57	285.71	411.43	411.43
Retread cost (%)	15	15	15		15	15	15	15	15
Economic Vehicle Resource Costs									
Fuel (USD/Liter)	1.37	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Lub. Oil (USD/Liter)	3.43	3.43	3.43	3.43	3.43	3.43	3.43	6.86	6.86
Crew hour (USD)	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maintenance labor (USD/Hr)	2.50	2.50	2.50	3.00	3.50	2.50	3.00	4.00	4.00
Passenger working time cost (USD/hr)	1	1	0.5	0.5	0.5	0	0	0	0
Passenger non-working time cost (USD/hr)	0.5	0.5	0.25	0.25	0.25	0	0	0	0
Cargo time value (USD /Hr)	0	0	0	0	0	0.025	0.0375	0.05	0.05
Annual Interest rate (%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00

Annex IV Plan & Profile Drawings for Feeder Roads

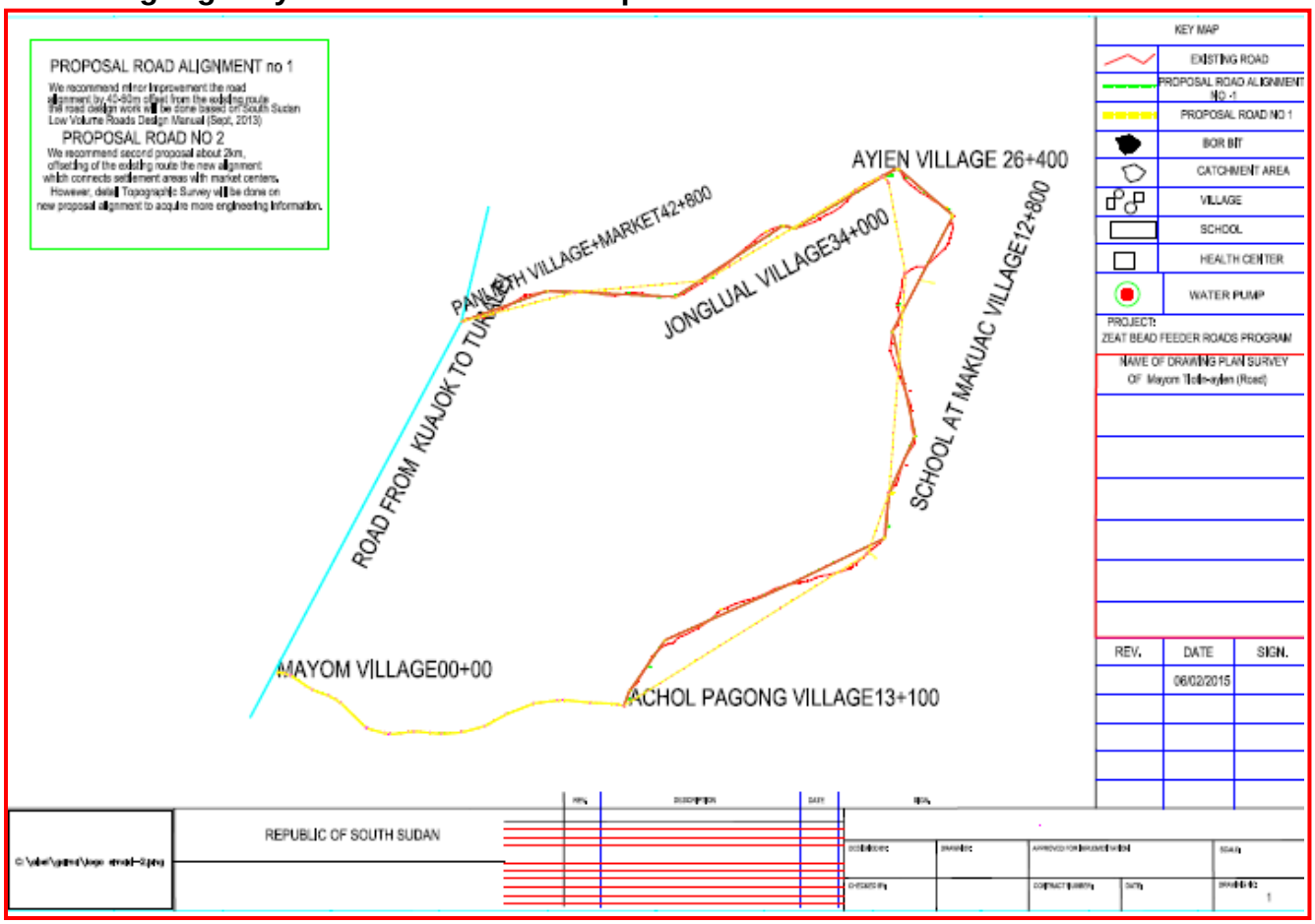
Aluakluak – Mapourdit – Aguran – Ngop section in Lakes State



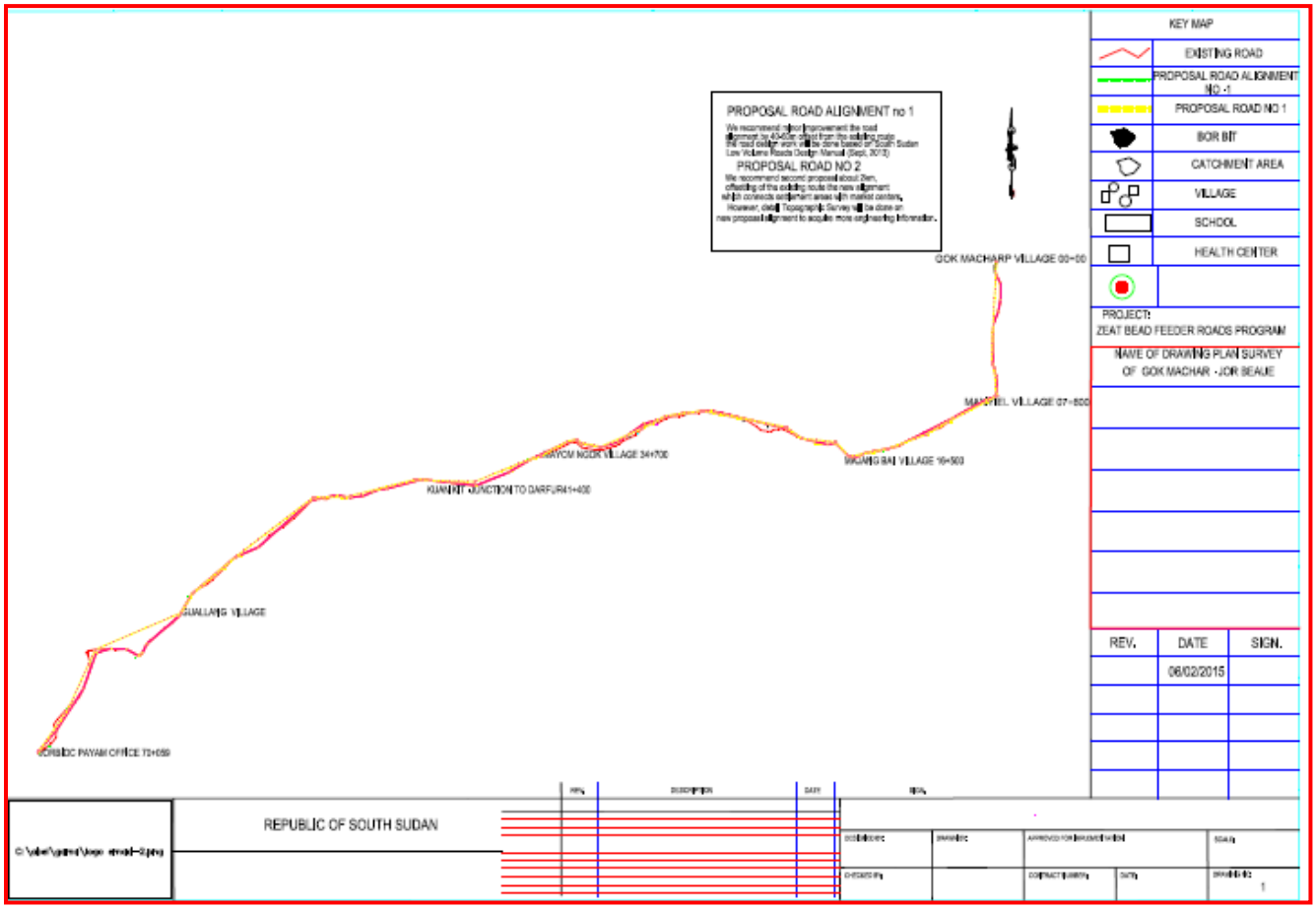
Kangi – Bar Urud – Kayango – Basilia section in WBeG State



Achol Pagong – Ayen – Panlieth in Warrap State



Gok Machar – Jorbioc in NBeG State



Annex V Engineering Cost Estimate BOQ

ANEEX V (A)

ENGINEER'S ESTIMATES FOR THE CONSTRUCTION OF ALUAK-LUAK – MAPOURDIT – AGURAN SECTION – 26.6KM IN LAKES STATE

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1	**GENERAL**				
	GENERAL REQUIREMENTS - SIGN BOARD				
1.1	Provision, erection, maintenance and removal of project sign board as indicated in the drawing or instructed by the Engineer.	No	1,500.00	2.00	3,000.00
2	**CONTRACTOR'S ESTABLISHMENT ON SITE**				
2.10	Mobilization, the contractor's general obligations for all charges in respect of the establishment of the contractor's camps, equipment ,personnel, accommodation and construction plant on the site, and also the financing costs, risks, legal and contractual obligations and general items of cost not covered elsewhere	L.S	100,000.00	1.00	100,000.00
2.20	Demobilization, satisfactory removal of site establishments of the contractor's organization, camps, equipment ,personnel, accommodation and construction plant and any financial obligation the Contractor entered on completion of the contract	L.S	50,000.00	1.00	50,000.00
2.30	Security arrangement for works and at camp site (20 nos guard , including accommodation, food and all other expenses, overheads and Contractor's profits etc.)	LS	36,000.00	1.00	36,000.00
3	**ACCOMMODATION, SERVICES, AND ATTENDANCE FOR THE EMPLOYER'S REPRESENTATIVE STAFF**				
3.1	Fencing as specified	L.S	30,000.00	1.00	30000.00
3.2	Office Building Complete as specified including furniture	L.S	60,000.00	1.00	60,000.00
3.3	Drilling of borehole and installation of submersible pump as specified	L.S	25,000.00	1.00	25,000.00
3.4	Fabrication and erection of a steel tower with 5,000 litre water tank as specified.	L.S	20,000.00	1.00	20,000.00
3.5	25 KVA generator complete with a generator shed as specified	L.S	35,000.00	1.00	35,000.00
3.6	Laboratory Building Complete as specified including furniture	L.S	15,000.00	1.00	15,000.00
3.7	Office Equipment as specified	L.S	15,000.00	1.00	15,000.00
3.8	Laboratory Equipment as specified	L.S	30,000.00	1.00	30,000.00
3.9	Services for the Offices and Laboratory	month	1,500.00	12.00	18000.00
3.10	Maintenance and Services for offices.	month	1,000.00	12.00	12,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
	Prefabricated Building, House Type, Complete, as specified, including all services, fixtures and equipment				
3.11	Type B prefab housing, four (4) rooms with self contained toilet and shower with floor area specified in the spec and/or drawing for the client's representatives	L.S	77,000.00	1.00	77,000.00
3.12	Services and maintenance for residential accommodation(s)	month	2,000.00	12.00	24,000.00
3.12	Operation and maintenance of the power and water systems including the provision of internet facility for the Engineer's Office, accommodation and laboratory as specified.	month	3,500.00	12.00	42,000.00
3.13	Provision of fuel and lubricants and the servicing, maintenance, and repair of two vehicles for the Employer's representative vehicle and his staff	month	4000	12.00	48,000.00
	TOTAL FOR BILL 1: GENERAL PROVISIONS				***640,000.00***
4	**SITE CLEARANCE**				
	CLEARING AND GRUBBING				
4.1	Bush clearing, ripping, top soil stripping and grubbing 20m wide road	ha	2,612.90	53.20	139,006.45
	Removal and grubbing of large trees and tree stumps				
4.2	Girth exceeding 1.0 m up to and including 2 m	No.	100.00	300.00	30,000.00
4.3	Girth exceeding 2 m up to and including 3 m	No.	150.00	250.00	37,500.00
4.4	Girth exceeding 3 m	No.	250.00	100.00	25,000.00
	TOTAL FOR BILL 2: SITE CLEARANCE				***231,506.45***
5	**DRAINAGE**				
	DRAINS				
	Excavation for open drains				
5.1	Excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches in ***suitable*** material of all class within any depth rates below the surface level, loading and hauling, and re-use in embankments incl. spreading, shaping and compaction to 95% of modified AASHTO density .	M^3	27.22	5,292.00	144,036.29
5.2	excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches within the following depth rates below the surface level in ***unsuitable*** or surplus material incl. loading, hauling, deposit/disposing, spreading, etc.	M^3	27.22	3,528.00	96,024.19

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
	Culverts and appurtenant structures				
5.3	Common/normal and intermediate excavation of trench within any depth rates below the surface level for foundation at new pipe culvert location or for replacement of existing culvert and for inlet and outlet structures incl. trimming/compaction of bottom of excavation, backfill with suitable material from the excavation and compaction, disposal of surplus and unsuitable material.	M^3	27.22	14.58	396.83
6	**STEEL PIPE CULVERTS**				
6.1	Supply and place 150mm thick class 25 concrete beds under steel culvert pipe	M^3	1,000.00	121.50	121,500.00
6.2	Provide and install 900 mm diameter and 2.7mm thick Corrugated Steel pipe complying with AASHTO 36 & 218 including jointing, inlet and outlet structures and all ancillary works	M	750.00	477.00	357,750.00
6.3	Ditto but 900mm diameter culverts	M	750.00	540.00	405,000.00
6.4	Ditto but 1200mm diameter culverts	M	1,450.00	100.00	145,000.00
6.5	Provide approved material for back fill at culvert locations	M^3			
	Pitching, Stonework, And Erosion Protection				
6.5	Provide and construct cement-mortared 1:4 fine pointed Class A stone masonry for cascades, inlet and outlet structures for CSP culverts, and where instructed including foundation and all ancillary works	M^3	1,200.00	202.50	243,000.00
TOTAL FOR BILL 3: DRAINAGE					***1,512,707.32***
7	**EARTHWORKS**				
	Fill material				
7.1	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified on embankments to raise the road profile	M^3	10.95	135,660.00	1,485,317.24
7.2	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified to level out hump created by installed culverts.	M^3	10.95	120.00	1,313.86
TOTAL FOR BILL 4: EARTHWORKS					***1,486,631.10***
	Gravel wearing course				
7.3	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified.	M^3	0.00	23,940.00	0.00
7.4	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified in the Specifications. For culverts and otherworks.	M^3	0.00	14.58	0.00
7.5	Rehabilitation of all earth fill and gravel borrow pits which shall including tapering of all sides to the required slope and shall include fencing with locally available material and barbed wire and gate so as to convert the borrow pits into water catchment sites(hafirs) for use by the local communities.	LS	50,000.00	4.00	200,000.00
TOTAL FOR BILL 5: GRAVEL WEARING COURSE					***200,000.00***

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
8	**ANCILLARY WORKS**				
	Gabions				
8.1	Delivery, assembly, installation and rock filling of Standard Sized Gabion Boxes, including the preparation of the foundation and surface for bedding, as per standard specifications or instruction from the Engineer.	M^3	250	400.00	100,000.00
9	**MARKERS AND KILOMETER POSTS**				
9.1	Provide and place standard double faced precast reinforced concrete kilometer posts with embossed kilometer numbers of up to 2 digits at 5km intervals on alternating road sides	No	150	6.00	900.00
10	**ROAD FURNITURE**				
	Road signs				
	Provide and erect where shown on Drawings and/or where instructed new galvanized steel plate road signs of high intensity grade reflective sheeting on standard single reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign post)				
10.1	Triangular type, 900mm equilateral	No	600	30.00	18,000.00
10.2	Circular type, 600mm diameter.	No	450	25.00	11,250.00
10.3	Provide and erect at town/village entry where shown on Drawings and/or where instructed new galvanized steel plate town/village name sign (rectangular 160mm high and in average 960mm wide according to the Standard Specifications 9402 to 9408) with town/village name in English, and 600mm diameter road sign of high intensity grade reflective sheeting on standard single reinforced concrete sign posts(alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	500	5.00	2,500.00
10.4	Provide and erect where instructed ***galvanized steel plate destination sign*** of high intensity grade reflective sheeting with symbols and letters/inscription English, as shown in the drawings and according to Standard Specifications 9402 to 9408) as instructed on standard reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	750	2.00	1,500.00
TOTAL FOR BILL 9: ANCILLARY WORKS					***134,150.00***
	TOTAL COST OF WORKS				***4,204,994.87***

ANNEX V (B)

ENGINEER'S ESTIMATE FOR THE CONSTRUCTION OF THE 34.7KM GOK MACHAR – MAYOM NGOK SECTION OF THE ROAD IN NORTHERN BAHR-EL-GHAZAL STATE

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1	**GENERAL**				
	GENERAL REQUIREMENTS - SIGN BOARD				
1.1	Provision, erection, maintenance and removal of project sign board as indicated in the drawing or instructed by the Engineer.	No	1,500.00	2.00	3,000.00
	CONTRACTOR'S ESTABLISHMENT ON SITE				
1.2	Mobilization, the contractor's general obligations for all charges in respect of the establishment of the contractor's camps, equipment ,personnel, accommodation and construction plant on the site, and also the financing costs, risks, legal and contractual obligations and general items of cost not covered elsewhere	L.S	100,000.00	1.00	100,000.00
1.3	Demobilization, satisfactory removal of site establishments of the contractor's organization, camps, equipment ,personnel, accommodation and construction plant and any financial obligation the Contractor entered on completion of the contract	L.S	50,000.00	1.00	50,000.00
1.4	Security arrangement for works and at camp site (20 nos guard , including accommodation, food and all other expenses, overheads and Contractor's profits etc.)	LS	36,000.00	1.00	36,000.00
	ACCOMMODATION, SERVICES, AND ATTENDANCE FOR THE EMPLOYER'S REPRESENTATIVE STAFF				
1.5	Fencing as specified	L.S	30,000.00	1.00	30000.00
1.6	Office Building Complete as specified including furniture	L.S	60,000.00	1.00	60,000.00
1.7	Drilling of borehole and installation of submersible pump as specified	L.S	25,000.00	1.00	25,000.00
1.8	Fabrication and erection of a steel tower with 5,000 litre water tank as specified.	L.S	20,000.00	1.00	20,000.00
1.9	25 KVA generator complete with a generator shed as specified	L.S	35,000.00	1.00	35,000.00
1.10	Laboratory Building Complete as specified including furniture	L.S	15,000.00	1.00	15,000.00
1.11	Office Equipment as specified	L.S	15,000.00	1.00	15,000.00
1.12	Laboratory Equipment as specified	L.S	30,000.00	1.00	30,000.00
1.13	Services for the Offices and Laboratory	month	1,500.00	12.00	18000.00
1.14	Maintenance and Services for offices.	month	1,000.00	12.00	12,000.00
	Prefabricated Building, House Type, Complete, as specified, including all services, fixtures and equipment				
1.15	Type B prefab housing, four (4) rooms with self contained toilet and shower with floor area specified in the spec and/or drawing for the client's representatives	L.S	77,000.00	1.00	77,000.00
1.16	Services and maintenance for residential accommodation(s)	month	2,000.00	12.00	24,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1.17	Operation and maintenance of the power and water systems including the provision of internet facility for the Engineer's Office, accommodation and laboratory as specified.	month	3,500.00	12.00	42,000.00
1.18	Provision of fuel and lubricants and the servicing, maintenance, and repair of two vehicles for the Employer's representative vehicle and his staff	month	4000	12.00	48,000.00
	TOTAL FOR BILL 1: GENERAL PROVISIONS				***640,000.00***
2	**SITE CLEARANCE**				
	CLEARING AND GRUBBING				
2.1	Bush clearing, ripping, top soil stripping and grubbing 20m wide road	ha	1,687.50	69.40	117,112.50
	Removal and grubbing of large trees and tree stumps				
2.2	Girth exceeding 1.0 m up to and including 2 m	No.	100.00	300.00	30,000.00
2.3	Girth exceeding 2 m up to and including 3 m	No.	150.00	250.00	37,500.00
2.4	Girth exceeding 3 m	No.	250.00	100.00	25,000.00
	TOTAL FOR BILL 2: SITE CLEARANCE				***209,612.50***
3	**DRAINAGE**				
	DRAINS				
	Excavation for open drains				
3.1	Excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches in ***suitable*** material of all class within any depth rates below the surface level, loading and hauling, and re-use in embankments incl. spreading, shaping and compaction to 95% of modified AASHTO density .	M^3	17.58	5,292.00	93,023.44
3.2	excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches within the following depth rates below the surface level in ***unsuitable*** or surplus material incl. loading, hauling, deposit/disposing, spreading, etc.	M^3	17.58	3,528.00	62,015.63
	Culverts and appurtenant structures				
3.3	Common/normal and intermediate excavation of trench within any depth rates below the surface level for foundation at new pipe culvert location or for replacement of existing culvert and for inlet and outlet structures incl. trimming/compaction of bottom of excavation, backfill with suitable material from the excavation and compaction, disposal of surplus and unsuitable material.	M^3	17.58	947.43	16,654.04
	STEEL PIPE CULVERTS				
3.4	Supply and place 150mm thick class 25 concrete beds under steel culvert pipe	M^3	1,000.00	157.91	157,905.00
3.5	Provide and install 600 mm diameter and 2.7mm thick Corrugated Steel pipe complying with AASHTO 36 & 218 including jointing, inlet and outlet structures and all ancillary works	M	750.00	Rate Only	
3.6	Ditto but 900mm diameter culverts	M	1,125.00	616.00	693,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
3.7	Ditto but 1200mm diameter culverts	M	135.00	209.00	28,215.00
3.8	Provide approved material for back fill at culvert locations	M^3			
	Pitching, Stonework, And Erosion Protection				
3.9	Provide and construct cement-mortared 1:4 fine pointed Class A stone masonry for cascades, inlet and outlet structures for CSP culverts, and where instructed including foundation and all ancillary works	M^3	1,200.00	202.50	243,000.00
TOTAL FOR BILL 3: DRAINAGE					***1,293,813.11***
4	**EARTHWORKS**				
	Fill material				
4.1	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified on embankments to raise the road profile	M^3	10.87	176,970.00	1,922,933.55
4.2	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified to level out hump created by installed culverts.	M^3	10.87	120.00	1,303.90
TOTAL FOR BILL 4: EARTHWORKS					***1,924,237.45***
5	**GRAVEL WEARING COURSE**				
5.1	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified.	M^3	28.91	39,037.50	1,128,419.99
5.2	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified in the Specifications. For culverts and otherworks.	M^3	28.91	947.43	27,386.46
5.3	Rehabilitation of all earth fill and gravel borrow pits which shall including tapering of all sides to the required slope and shall include fencing with locally available material and barbed wire and gate so as to convert the borrow pits into water catchment sites(hafirs) for use by the local communities.	LS	100,000.00	3.00	300,000.00
TOTAL FOR BILL 5: GRAVEL WEARING COURSE					***1,455,806.45***
6	**ANCILLARY WORKS**				
	Gabions				
6.1	Delivery, assembly, installation and rock filling of Standard Sized Gabion Boxes, including the preparation of the foundation and surface for bedding, as per standard specifications or instruction from the Engineer.	M^3	500	200.00	100,000.00
	ROAD FURNITURE				
	Road signs				
	Provide and erect where shown on Drawings and/or where instructed new galvanized steel plate road signs of high intensity grade reflective sheeting on standard single reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign post)				
6.2	Triangular type, 900mm equilateral	No	600	25.00	15,000.00
6.3	Circular type, 600mm diameter.	No	450	20.00	9,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
6.4	Provide and erect at town/village entry where shown on Drawings and/or where instructed new galvanized steel plate town/village name sign (rectangular 160mm high and in average 960mm wide according to the Standard Specifications 9402 to 9408) with town/village name in English, and 600mm diameter road sign of high intensity grade reflective sheeting on standard single reinforced concrete sign posts(alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	500	2.00	1,000.00
6.5	Provide and erect where instructed ***galvanized steel plate destination sign*** of high intensity grade reflective sheeting with symbols and letters/inscription English, as shown in the drawings and according to Standard Specifications 9402 to 9408) as instructed on standard reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	750	2.00	1,500.00
TOTAL FOR BILL 6: ANCILLARY WORKS					***126,500.00***
	TOTAL COST OF WORKS				***5,649,969.51***

ANNEX V (C)

ENGINEER'S ESTIMATES FOR THE CONSTRUCTION OF THE 27.5KM ACHOL PAGONG – AYEN MARKET ROAD IN WARRAP STATE

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1	**GENERAL**				
	GENERAL REQUIREMENTS - SIGN BOARD				
1.1	Provision, erection, maintenance and removal of project sign board as indicated in the drawing or instructed by the Engineer.	No	1,500.00	2.00	3,000.00
	CONTRACTOR'S ESTABLISHMENT ON SITE				
1.2	Mobilization, the contractor's general obligations for all charges in respect of the establishment of the contractor's camps, equipment ,personnel, accommodation and construction plant on the site, and also the financing costs, risks, legal and contractual obligations and general items of cost not covered elsewhere	L.S	100,000.00	1.00	100,000.00
1.3	Demobilization, satisfactory removal of site establishments of the contractor's organization, camps, equipment ,personnel, accommodation and construction plant and any financial obligation the Contractor entered on completion of the contract	L.S	50,000.00	1.00	50,000.00
1.4	Security arrangement for works and at camp site (20 nos guard , including accommodation, food and all other expenses, overheads and Contractor's profits etc.)	LS	36,000.00	1.00	36,000.00
	ACCOMMODATION, SERVICES, AND ATTENDANCE FOR THE EMPLOYER'S REPRESENTATIVE STAFF				
1.5	Fencing as specified	L.S	30,000.00	1.00	30000.00
1.6	Office Building Complete as specified including furniture	L.S	60,000.00	1.00	60,000.00
1.7	Drilling of borehole and installation of submersible pump as specified	L.S	25,000.00	1.00	25,000.00
1.8	Fabrication and erection of a steel tower with 5,000 litre water tank as specified.	L.S	20,000.00	1.00	20,000.00
1.9	25 KVA generator complete with a generator shed as specified	L.S	35,000.00	1.00	35,000.00
1.10	Laboratory Building Complete as specified including furniture	L.S	15,000.00	1.00	15,000.00
1.11	Office Equipment as specified	L.S	15,000.00	1.00	15,000.00
1.12	Laboratory Equipment as specified	L.S	30,000.00	1.00	30,000.00
1.13	Services for the Offices and Laboratory	month	1,500.00	12.00	18000.00
1.14	Maintenance and Services for offices.	month	1,000.00	12.00	12,000.00
	Prefabricated Building, House Type, Complete, as specified, including all services, fixtures and equipment				
1.15	Type B prefab housing, four (4) rooms with self contained toilet and shower with floor area specified in the spec and/or drawing for the client's representatives	L.S	77,000.00	1.00	77,000.00
1.16	Services and maintenance for residential accommodation(s)	month	2,000.00	12.00	24,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1.17	Operation and maintenance of the power and water systems including the provision of internet facility for the Engineer's Office, accommodation and laboratory as specified.	month	3,500.00	12.00	42,000.00
1.18	Provision of fuel and lubricants and the servicing, maintenance, and repair of two vehicles for the Employer's representative vehicle and his staff	month	4000	12.00	48,000.00
	TOTAL FOR BILL 1: GENERAL PROVISIONS				***640,000.00***
2	**SITE CLEARANCE**				
	CLEARING AND GRUBBING				
2.1	Bush clearing, ripping, top soil stripping and grubbing 20m wide road	ha	1,620.00	55.00	89,100.00
	Removal and grubbing of large trees and tree stumps				
2.2	Girth exceeding 1.0 m up to and including 2 m	No.	100.00	300.00	30,000.00
2.3	Girth exceeding 2 m up to and including 3 m	No.	150.00	250.00	37,500.00
2.4	Girth exceeding 3 m	No.	250.00	100.00	25,000.00
	TOTAL FOR BILL 2: SITE CLEARANCE				***181,600.00***
3	**DRAINAGE**				
	DRAINS				
	Excavation for open drains				
3.1	Excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches in ***suitable*** material of all class within any depth rates below the surface level, loading and hauling, and re-use in embankments incl. spreading, shaping and compaction to 95% of modified AASHTO density .	M^3	16.88	5,292.00	89,302.50
3.2	excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches within the following depth rates below the surface level in ***unsuitable*** or surplus material incl. loading, hauling, deposit/disposing, spreading, etc.	M^3	16.88	3,528.00	59,535.00
	Culverts and appurtenant structures				
3.3	Common/normal and intermediate excavation of trench within any depth rates below the surface level for foundation at new pipe culvert location or for replacement of existing culvert and for inlet and outlet structures incl. trimming/compaction of bottom of excavation, backfill with suitable material from the excavation and compaction, disposal of surplus and unsuitable material.	M^3	16.88	686.07	11,577.43
	STEEL PIPE CULVERTS				
3.4	Supply and place 150mm thick class 25 concrete beds under steel culvert pipe	M^3	1,000.00	114.35	114,345.00
3.5	Provide and install 600 mm diameter and 2.7mm thick Corrugated Steel pipe complying with AASHTO 36 & 218 including jointing, inlet and outlet structures and all ancillary works	M	750.00	Rate Only	
3.6	Ditto but 900mm diameter culverts	M	990.00	484.00	479,160.00
3.7	Ditto but 1200mm diameter culverts	M		121.00	0.00
3.8	Provide approved material for back fill at culvert locations	M^3			

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
	Pitching, Stonework, And Erosion Protection				
3.9	Provide and construct cement-mortared 1:4 fine pointed Class A stone masonry for cascades, inlet and outlet structures for CSP culverts, and where instructed including foundation and all ancillary works	M³	1,200.00	202.50	243,000.00
	TOTAL FOR BILL 3: DRAINAGE				***996,919.93***
4	**EARTHWORKS**				
	Fill material				
4.1	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified on embankments to raise the road profile	M³	10.71	115,500.00	1,236,445.83
4.2	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified to level out hump created by installed culverts.	M³	10.71	120.00	1,284.62
	TOTAL FOR BILL 4: EARTHWORKS				***1,237,730.45***
5	**GRAVEL WEARING COURSE**				
5.1	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified.	M³	86.16	22,687.50	1,954,766.70
5.2	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified in the Specifications. For culverts and otherworks.	M³	86.16	686.07	59,112.15
5.3	Rehabilitation of all earth fill and gravel borrow pits which shall including tapering of all sides to the required slope and shall include fencing with locally available material and barbed wire and gate so as to convert the borrow pits into water catchment sites(hafirs) for use by the local communities.	LS	100,000.00	3.00	300,000.00
	TOTAL FOR BILL 5: GRAVEL WEARING COURSE				***2,313,878.85***
6	**ANCILLARY WORKS**				
	Gabions				
6.1	Delivery, assembly, installation and rock filling of Standard Sized Gabion Boxes, including the preparation of the foundation and surface for bedding, as per standard specifications or instruction from the Engineer.	M³	500	200.00	100,000.00
	ROAD FURNITURE				
	Road signs				
	Provide and erect where shown on Drawings and/or where instructed new galvanized steel plate road signs of high intensity grade reflective sheeting on standard single reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign post)				

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
6.2	Triangular type, 900mm equilateral	No	600	25.00	15,000.00
6.3	Circular type, 600mm diameter.	No	450	20.00	9,000.00
6.4	Provide and erect at town/village entry where shown on Drawings and/or where instructed new galvanized steel plate town/village name sign (rectangular 160mm high and in average 960mm wide according to the Standard Specifications 9402 to 9408) with town/village name in English, and 600mm diameter road sign of high intensity grade reflective sheeting on standard single reinforced concrete sign posts(alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	500	2.00	1,000.00
6.5	Provide and erect where instructed ***galvanized steel plate destination sign*** of high intensity grade reflective sheeting with symbols and letters/inscription English, as shown in the drawings and according to Standard Specifications 9402 to 9408) as instructed on standard reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	750	2.00	1,500.00
TOTAL FOR BILL 6: ANCILLARY WORKS					***126,500.00***
	TOTAL COST OF WORKS				***5,496,629.23***

ANNEX V (D)
ENGINEER'S ESTIMATES FOR THE CONSTRUCTION OF THE 29.2KM KANGI – BAR URUD SECTION OF FEEDER ROAD IN WESTERN BAHR-EL-GHAZAL STATE

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
1	**GENERAL**				
	GENERAL REQUIREMENTS - SIGN BOARD				
1.1	Provision, erection, maintenance and removal of project sign board as indicated in the drawing or instructed by the Engineer.	No	1,500.00	2.00	3,000.00
	CONTRACTOR'S ESTABLISHMENT ON SITE				
1.2	Mobilization, the contractor's general obligations for all charges in respect of the establishment of the contractor's camps, equipment ,personnel, accommodation and construction plant on the site, and also the financing costs, risks, legal and contractual obligations and general items of cost not covered elsewhere	L.S	100,000.00	1.00	100,000.00
1.3	Demobilization, satisfactory removal of site establishments of the contractor's organization, camps, equipment ,personnel, accommodation and construction plant and any financial obligation the Contractor entered on completion of the contract	L.S	50,000.00	1.00	50,000.00
1.4	Security arrangement for works and at camp site (20 nos guard , including accommodation, food and all other expenses, overheads and Contractor's profits etc.)	LS	36,000.00	1.00	36,000.00
	ACCOMMODATION, SERVICES, AND ATTENDANCE FOR THE EMPLOYER'S REPRESENTATIVE STAFF				
1.5	Fencing as specified	L.S	30,000.00	1.00	30000.00
1.6	Office Building Complete as specified including furniture	L.S	60,000.00	1.00	60,000.00
1.7	Drilling of borehole and installation of submersible pump as specified	L.S	25,000.00	1.00	25,000.00
1.8	Fabrication and erection of a steel tower with 5,000 litre water tank as specified.	L.S	20,000.00	1.00	20,000.00
1.9	25 KVA generator complete with a generator shed as specified	L.S	35,000.00	1.00	35,000.00
1.10	Laboratory Building Complete as specified including furniture	L.S	15,000.00	1.00	15,000.00
1.11	Office Equipment as specified	L.S	15,000.00	1.00	15,000.00
1.12	Laboratory Equipment as specified	L.S	30,000.00	1.00	30,000.00
1.13	Services for the Offices and Laboratory	month	1,500.00	12.00	18000.00
1.14	Maintenance and Services for offices.	month	1,000.00	12.00	12,000.00
	Prefabricated Building, House Type, Complete, as specified, including all services, fixtures and equipment				
1.15	Type B prefab housing, four (4) rooms with self contained toilet and shower with floor area specified in the spec and/or drawing for the client's representatives	L.S	77,000.00	1.00	77,000.00
1.16	Services and maintenance for residential accommodation(s)	month	2,000.00	12.00	24,000.00
1.17	Operation and maintenance of the power and water systems including the provision of internet facility for the Engineer's Office, accommodation and laboratory as specified.	month	3,500.00	12.00	42,000.00
1.18	Provision of fuel and lubricants and the servicing, maintenance, and repair of two vehicles for the Employer's representative vehicle and his staff	month	4000	12.00	48,000.00
	TOTAL FOR BILL 1: GENERAL PROVISIONS				***640,000.00***

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
2	**SITE CLEARANCE**				
	CLEARING AND GRUBBING				
2.1	Bush clearing, ripping, top soil stripping and grubbing 20m wide road	ha	1,620.00	58.40	94,608.00
	Removal and grubbing of large trees and tree stumps				
2.2	Girth exceeding 1.0 m up to and including 2 m	No.	100.00	300.00	30,000.00
2.3	Girth exceeding 2 m up to and including 3 m	No.	150.00	250.00	37,500.00
2.4	Girth exceeding 3 m	No.	250.00	100.00	25,000.00
TOTAL FOR BILL 2: SITE CLEARANCE					***187,108.00***
3	**DRAINAGE**				
	DRAINS				
	Excavation for open drains				
3.1	Excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches in ***suitable*** material of all class within any depth rates below the surface level, loading and hauling, and re-use in embankments incl. spreading, shaping and compaction to 95% of modified AASHTO density .	M^3	16.88	5,292.00	89,302.50
3.2	excavation or shaping of open drains (intercepting ditches, turn-outs, culvert in-/outlet drains, etc.) others than road side ditches within the following depth rates below the surface level in ***unsuitable*** or surplus material incl. loading, hauling, deposit/disposing, spreading, etc.	M^3	16.88	3,528.00	59,535.00
	Culverts and appurtenant structures				
3.3	Common/normal and intermediate excavation of trench within any depth rates below the surface level for foundation at new pipe culvert location or for replacement of existing culvert and for inlet and outlet structures incl. trimming/compaction of bottom of excavation, backfill with suitable material from the excavation and compaction, disposal of surplus and unsuitable material.	M^3	16.88	748.44	12,629.93
	STEEL PIPE CULVERTS				
3.4	Supply and place 150mm thick class 25 concrete beds under steel culvert pipe	M^3	1,000.00	124.74	124,740.00
3.5	Provide and install 600 mm diameter and 2.7mm thick Corrugated Steel pipe complying with AASHTO 36 & 218 including jointing, inlet and outlet structures and all ancillary works	M	750.00	Rate Only	
3.6	Ditto but 900mm diameter culverts	M	750.00	528.00	396,000.00
3.7	Ditto but 1200mm diameter culverts	M	1,450.00	132.00	191,400.00
3.8	Provide approved material for back fill at culvert locations	M^3			
	Pitching, Stonework, And Erosion Protection				
3.9	Provide and construct cement-mortared 1:4 fine pointed Class A stone masonry for cascades, inlet and outlet structures for CSP culverts, and where instructed including foundation and all ancillary works	M^3	1,200.00	202.50	243,000.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
	CONCRETE BOX CULVERTS				
3.10	Reinforced concrete box culvert 2-cell internal dimensions of 5m wide by 2m high as shown on the drawings attached.	No.	350,000.00	1.00	350,000.00
	TOTAL FOR BILL 3: DRAINAGE				***1,466,607.43***
4	**EARTHWORKS**				
	Fill material				
4.1	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified on embankments to raise the road profile	M³	9.58	147,510.00	1,413,169.21
4.2	Embankment Fill of approved Borrow material, min CBR of 15%, with all lift and free haul within the project, all complete as specified to level out hump created by installed culverts.	M³	9.58	120.00	1,149.62
	TOTAL FOR BILL 4: EARTHWORKS				***1,414,318.83***
5	**GRAVEL WEARING COURSE**				
5.1	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified.	M³	32.16	31,290.00	1,006,302.54
5.2	Gravel Wearing Course of approved material, min CBR 30%, all complete, compacted to 98% of AASTHO modified density as specified in the Specifications. For culverts and otherworks.	M³	32.16	748.44	24,070.22
5.3	Rehabilitation of all earth fill and gravel borrow pits which shall including tapering of all sides to the required slope and shall include fencing with locally available material and barbed wire and gate so as to convert the borrow pits into water catchment sites(hafirs) for use by the local communities.	LS	100,000.00	3.00	300,000.00
	TOTAL FOR BILL 5: GRAVEL WEARING COURSE				***1,330,372.76***
6	**ANCILLARY WORKS**				
	Gabions				
6.1	Delivery, assembly, installation and rock filling of Standard Sized Gabion Boxes, including the preparation of the foundation and surface for bedding, as per standard specifications or instruction from the Engineer.	M³	500	200.00	100,000.00
	ROAD FURNITURE				
	Road signs				
	Provide and erect where shown on Drawings and/or where instructed new galvanized steel plate road signs of high intensity grade reflective sheeting on standard single reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign post)				
6.2	Triangular type, 900mm equilateral	No	600	30.00	18,000.00
6.3	Circular type, 600mm diameter.	No	450	25.00	11,250.00

Bill No.	ITEM DESCRIPTION	UNIT	RATE (USD)	QTY	AMOUNT (USD)
6.4	Provide and erect at town/village entry where shown on Drawings and/or where instructed new galvanized steel plate town/village name sign (rectangular 160mm high and in average 960mm wide according to the Standard Specifications 9402 to 9408) with town/village name in English, and 600mm diameter road sign of high intensity grade reflective sheeting on standard single reinforced concrete sign posts(alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	500	2.00	1,000.00
6.5	Provide and erect where instructed ***galvanized steel plate destination sign*** of high intensity grade reflective sheeting with symbols and letters/inscription English, as shown in the drawings and according to Standard Specifications 9402 to 9408) as instructed on standard reinforced concrete sign posts (alternatively hot dip galvanized steel pipe with internal diameter of 75mm can be used for the sign posts)	No	750	2.00	1,500.00
TOTAL FOR BILL 6: ANCILLARY WORKS					***131,750.00***
	TOTAL COST OF WORKS				***5,170,157.02***

REFERENCES

AfDB 2011, South Sudan Infrastructure Development Plan

DFID Overseas Road Note 5 – A guide to road project appraisal (2005)

GoSS, 2014/15, South Sudan Financial Bill (2014/15)

PIARC, 2006. *International road maintenance handbook. PIARC (World Road Association.*

SSRA 2010, South Sudan Roads Authority, Feeder Roads Development Program

SSRA 2013, South Sudan Roads Authority Low-Volume Roads Design Manual (Sept. 2013)

TRL, 2005, ORN-5 A Guide to Road Project Appraisal

TRL, ORN-32 Design of Flexible Pavements

TRL, 2003. *ORN 20. Management of rural road networks*. TRL Ltd, for DfID, UK.

TRL, 1985. *ORN2. Maintenance techniques for district engineers (2nd edition).*

UNOPS Environmental Management System Handbook v 1.2 (2014)

World Bank, 1994. *World Development Report, 1994 Infrastructure for development*. Report Number 24130.