CHAPTER 9

PRE-FEASIBILITY STUDY ON REHABILITATION/RECONSTRUCTION OF RAILWAY BETWEEN LIMBE AND BORDER (MARKA)

Chapter 9 Pre-Feasibility Study on Rehabilitation/Reconstruction of Railway between Limbe and Border (Marka)

9.1 Justification of Rehabilitation and Reconstruction of Railway between Limbe and Border (Marka)

In the Master Plan study, rehabilitation and reconstruction of the railway between Limbe and Border (Marka) was selected as the second priority project in the medium- and long-term programme. The evaluation of the Master Plan showed several benefits, such as: reduction of transport cost by connecting to Beira Port; positive economic and social effects for people living along the railway line between Luchenza and Makhanga who lost the opportunity to sell agricultural products in big markets such as in Limbe and Bangula and to commute to school and receive better health care services; reduction of CO_2 emissions; and foreign currency savings by diesel consumption between trucks/trailers and locomotives. On the other hand, benefits in Mozambique were not considered because there was uncertainty about the intentions of the GoMZ for reconstruction of the railway section between *Vila Nova de Frontela* and *Dona Ana*, which is an essential part of the Branch Line of the Sena Railway connecting to the railway between Border (Marka) and Limbe in Malawi.

After submission of the Interim Report to the GoM, the Study Team held Technology Transfer Seminars in Lilongwe and Blantyre, as well as discussions with relevant authorities in Mozambique in early November 2011. In the Technology Transfer Seminars, responses from business, particularly companies involved in export-oriented products and transport business, were very positive about connecting the railway to Beira Port in order to reduce transport costs and raise the reliability of railway operation. During discussions with relevant authorities in Mozambique, their response toward revival of the Branch Line of the Sena Railway was also very positive, because of the increase of cargo handling capacity of Beira Port after the completion of dredging works of the main approach channel, and some shipping companies have already started to operate direct mail liner services between Beira Port and the Middle East and Asia.

With this background, the Study Team considers that carrying out the Pre-F/S for the rehabilitation and reconstruction of the railway between Limbe and Border (Marka) is justified.

9.2 Route Alignment Study

To establish the rehabilitation plan on the route alignment, the existing route alignment and right-of-way will not be changed except at the Chiromo washaway section.

9.2.1 Horizontal Alignment

As to the improvement of the horizontal alignment between Border and Limbe (see Figure

9-1), the alignment at the Chiromo washaway section will be changed to connect the existing alignment with the new railway bridge (see Figure 9-3). The minimum radius of curvature of the new alignment at Chiromo washaway section should be at least 300 m to secure an operation speed of 50 km/h.

9.2.2 Vertical Alignment

An outline of the vertical alignment between Border and Limbe is shown in Figure 9-2. The section between the border and Sankhulani is almost flat without small horizontal curves, however, the section from Sankhulani is a rising gradient of average 10‰ with continuous small curves.

As to the improvement of the vertical alignment between Border and Limbe, the vertical alignment at the Chiromo washaway section and the section subject to flooding will be changed (see Figure 9-4). The maximum gradient at these sections should be designed to be less than 16.7‰ according to the design standards of CEAR, but it is recommended to use less than 15.0‰ for the sections to allow a safety margin.

9.3 Basic Transportation Plan

9.3.1 Freight Train

(1) Outline of Train Operation

Freight trains will be operated on the section between Beira and Limbe via Border. However, operation between Beira and Limbe is not considered; it will be operated by CFM.

The maximum hauling weight per diesel locomotive is 1,000 tonnes; two diesel locomotives (DL) could haul up to 2,000 tonnes per train.

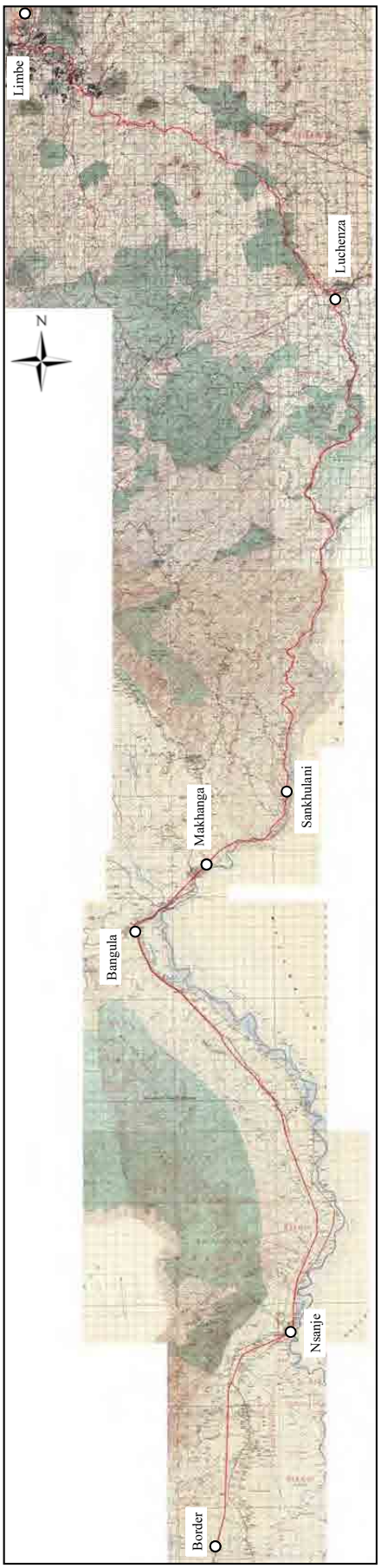
Table 9-1 Travel Time

Section	Required time = Operation time + Waiting time
Limbe–Luchenza	130 min = 120 min + 10min
Luchenza–Bangula	150 min = 140 min + 10min
Bangula–Nsanje	80 min = 70min + 10min
Nsanje–Border	50 min = 40 min + 10min

Source: Study Team

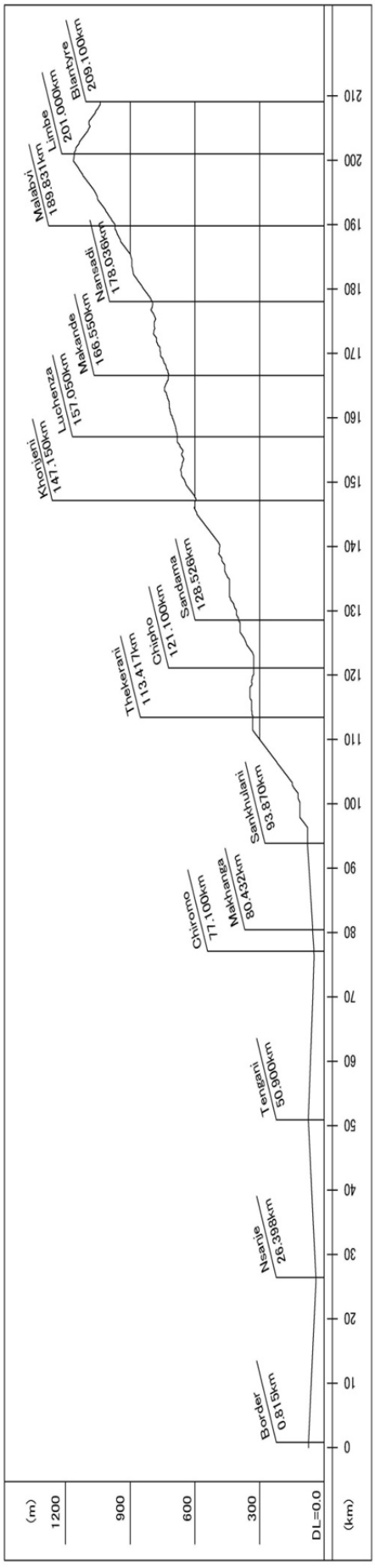
(2) Transportation Volume and Number of Trains

From the yearly cross sectional transportation volume of freight calculated based on the demand forecast, the daily average transportation volume is calculated and the number of trains required to transport the freight multiplied by the fluctuation rate due to variations with the season is determined. In the case of freight trains, as the type of freight differs between the up and down directions, cases of empty operation in one direction may happen frequently. Therefore, round-trip train operations are calculated.



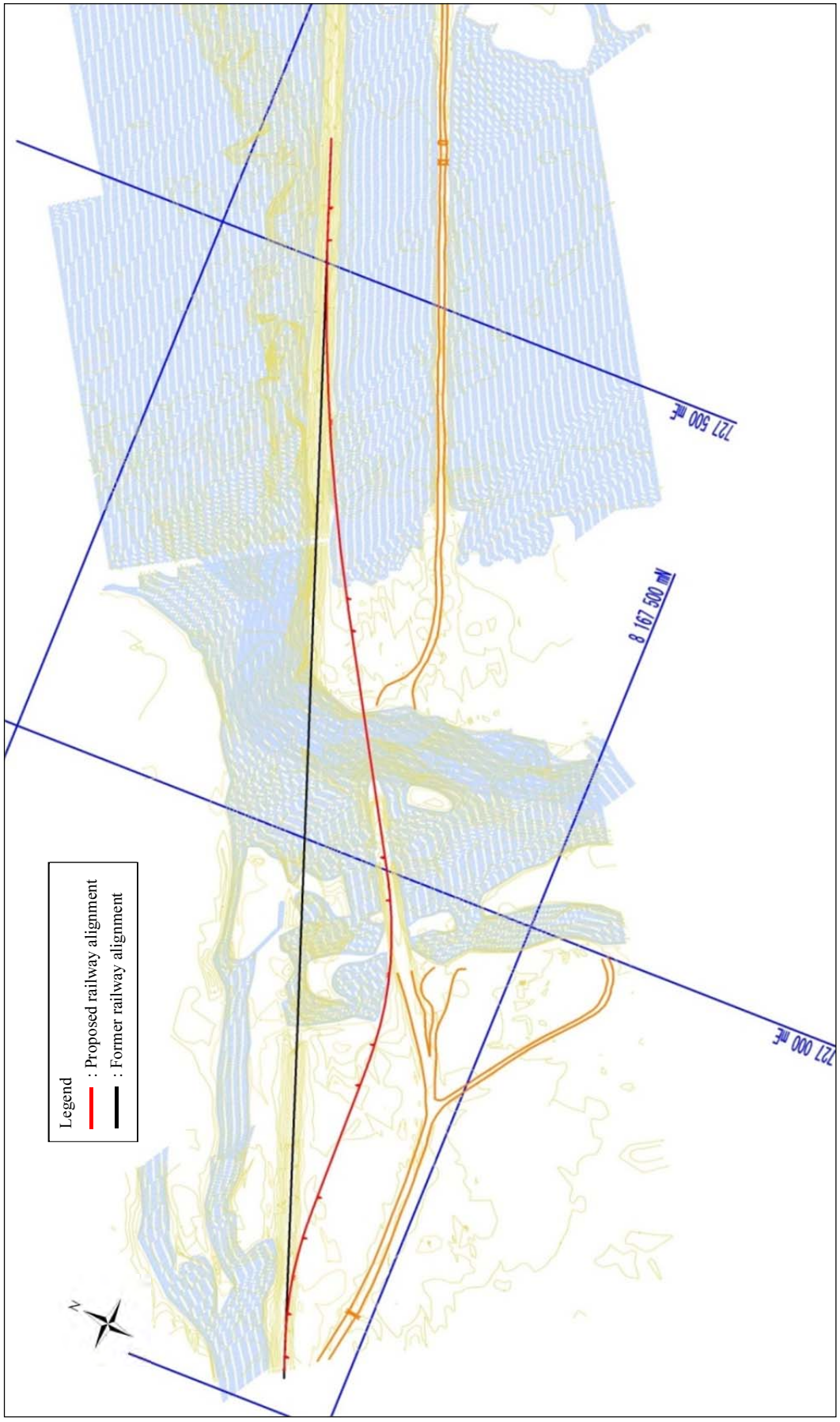
Source: Study Team

Figure 9-1 Horizontal Alignment between Border and Limbe



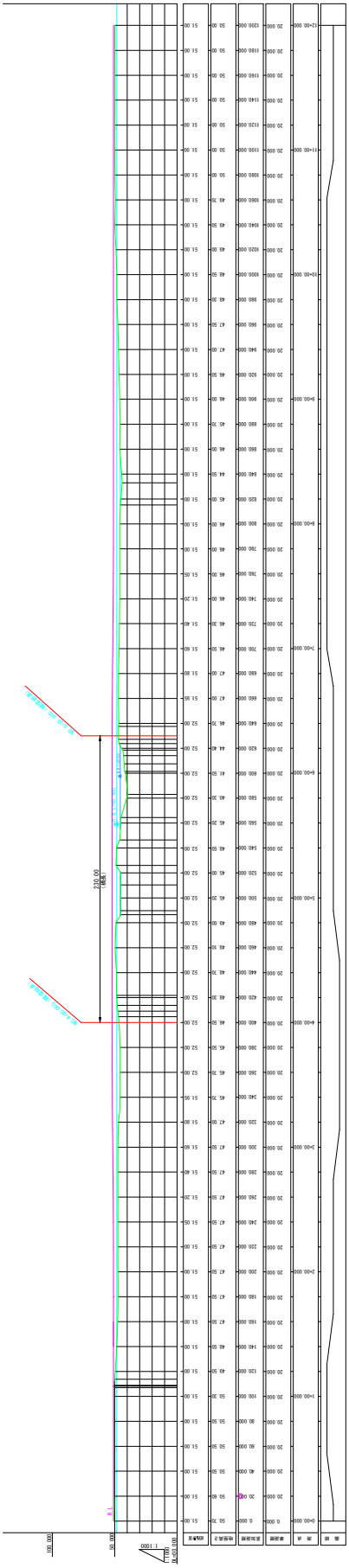
Source: Study Team

Figure 9-2 Vertical Alignment between Border and Limbe



Source: Study Team

Figure 9-3 Horizontal Alignment at Chiromo Washaway Section



Source: Study Team

Figure 9-4 Vertical Alignment at Chiromo Washaway Section

Table 9-2 Transportation Volume and Number of Train Operations

Type of Commodity	Freight Transport Volume (tonnes/day/direction)		Type of Rolling Stock	Number of Rolling Stock Required	
	2020	2030		2020	2030
General	686	1,682	DL	1	2
			Wagon	20	60
Fuel	297	1,093	DL	0	1
			Wagon	10	30
Ore	860	1,720	DL	1	2
			Wagon	30	60
Total	1,843	4,495	DL	2	5
			Wagon	60	150

Source: Study Team

(3) Number of Locomotives Required

The following conditions are assumed for calculating the train operation plan for the rehabilitated line. The scheduled speed of freight trains is assumed as 40 km/h judging from the actual scheduled speed of other existing lines. At the trunk stations where side tracks will be installed, a stopping time of 2 hours is assumed for changing the train formation, locomotives, drivers and crews at Border station.

Examples of train diagrams in the medium and long term for operating one train (1 up and down) are shown in Figures 9-5 and 9-6. The train operation routes and times are shown in Section 6.9.9.

The freight train diagram is based on every one hour and operation is carried out as required. Full-day operation of freight trains is assumed.

Table 9-3 Number of DLs to be Introduced

Type of Rolling Stock	Number of Rolling Stock to be Procured		
	2015	2020	2030
DL	1	0	1
Wagon	30	0	30
DL	0	0	1
Wagon	0	0	30
DL	0	1	1
Wagon	0	30	30
DL Total	1	1	3
Wagon Total	30	30	90

Source: Study Team

9.3.2 Passenger Trains

(1) Outline of Train Operation

As mentioned in Section 3.3.2, a passenger train runs only once a week between Limbe and Makhanga, Limbe and Bilila, Balaka and Nayuchi. These sections are in remote regions with no road traffic or where the roads are in poor condition. In addition, the passenger train is operated

only as a domestic service. For the convenience of residents along the line in the Study Area, at least two passenger trains should be operated weekly.

The passenger train will be operated on the section between Limbe and Bangula in the medium-term plan. Under the long-term plan, the section will be extended to Border (Marka).

(2) Transportation Volume and Number of Trains

As to the yearly passenger volume, it is not based on forecasted demand; the daily average transportation volume is assumed to be 1,000 passengers per day per direction, that is not based on the traffic demand forecast. The train formation is set as six passenger coaches as a standard intercity train, which can carry approximately 1,200 persons. The number of trains required to transport passengers is assumed to be one train, which makes round trips.

(3) Number of Locomotives Required

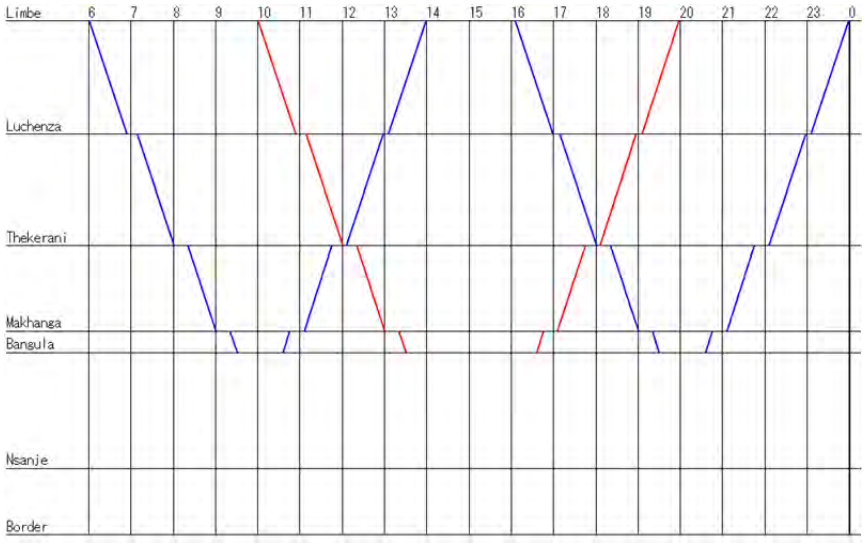
The following conditions are assumed for calculating the train operation plan for the rehabilitated line. The scheduled speed of the freight train is assumed to be 40 km/h judging from the actual scheduled speed of other existing lines. At the trunk stations where side tracks will be installed, a stopping time of 2 hours is assumed for changing the train formation, locomotives, drivers and crews at Border station.

Examples of train diagrams for the medium and long term for operating one train (1 up and down) are shown in Figures 9-5 and 9-6.

Table 9-4 Number of DLs and Coaches for Passenger Train

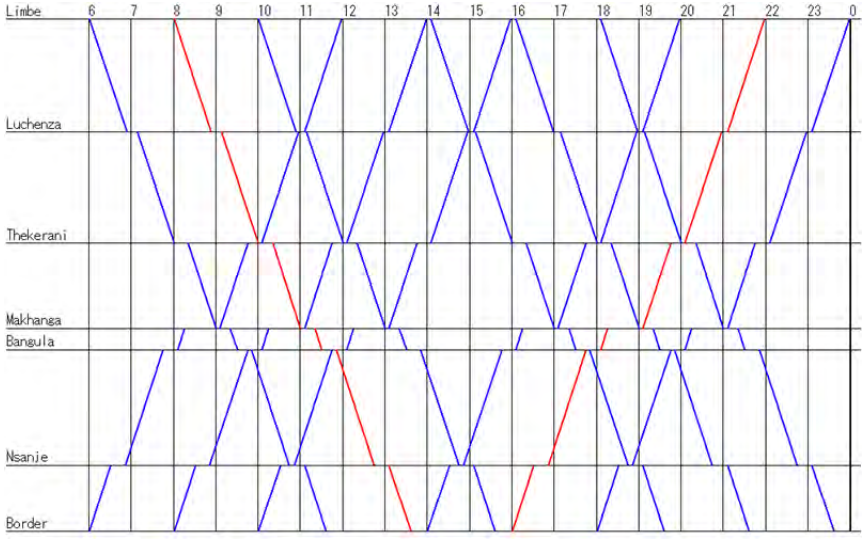
Type of Rolling Stock	Number of Rolling Stock Required			Number of Rolling Stock to be Procured		
	2015	2020	2030	2015	2020	2030
DL	1	1	1	0	1	0
Coach	6	6	6	0	6	0

Source: Study Team



Legend: Blue line – freight train, Red line – passenger train
Source: Study Team

Figure 9-5 Diagram of Train Operation in 2020



Legend: Blue line – freight train, Red line – passenger train
Source: Study Team

Figure 9-6 Diagram of Train Operation in 2030

9.4 Rehabilitation/Reconstruction Plan for Railway Infrastructure

Civil railway structures comprise a structure to support the train load directly, a structure to secure the passage for train operation by retaining external pressure, protective facilities to secure the safe operation of a train and various structures crossing over/under the track, etc. Upon establishing the rehabilitation/reconstruction plan, the construction work should be selected from repair, reinforcement, replacement and new construction after inspecting the soundness of the existing facilities. Effects on the environment should also be fully considered.

As for maintenance work, preventive maintenance has not been conducted sufficiently in Malawi. Therefore the inspection and maintenance system on the civil structures should be established to enhance the operational safety in consideration of the preventive maintenance scheme.

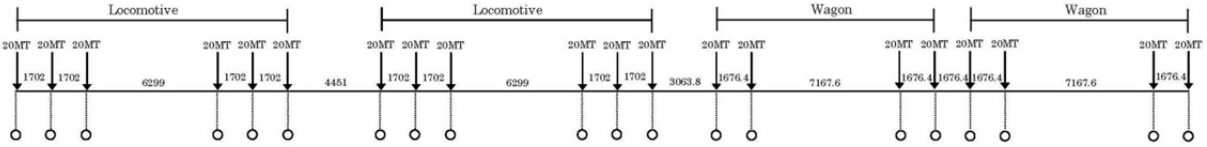
9.4.1 Design Standard

The objectives of defining the standards to be applied to the reconstruction of the railway are to ensure optimal operating conditions for safety and to keep low maintenance costs. The construction standards are summarised as follows:

Table 9-5 Construction Standards

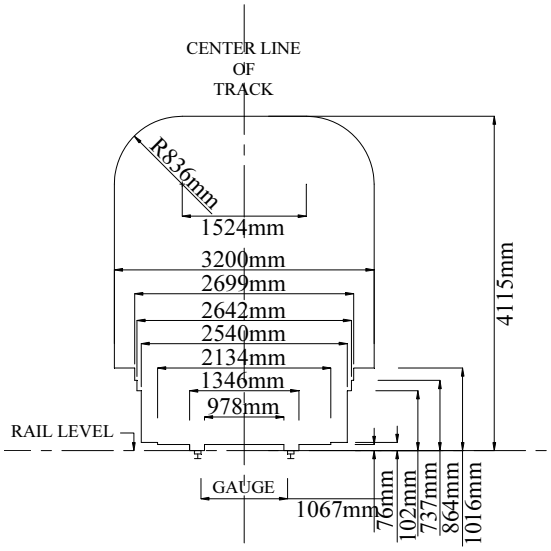
Track gauge	Standard	1,067 mm
	Curves with 242 m < R < 403 m	1,076 mm
	Curves with R ≤ 242 m	1,086 mm
	Maximum including side wear	1,092 mm
Curves	Minimum radius on existing lines	111 m
	Minimum radius on new running lines	244 m
	Transition curves	Parabolic
	Minimum cant	76 mm
	Maximum ramp gradient	1 in 480
Maximum gradients	Existing lines	1 in 44
	New lines (from year 1969 onwards)	1 in 60 compensated (= including curve resistance)
	Stations	1 in 400
Permissible axle load on permanent way and structures	Design load	13 tonnes
	Operated at	15 tonnes
	New line	20 tonnes
Track distance and clearance	Structure gauge	See below
	Track distance	≥4,572 mm
Speed	Maximum section speed	50 km/h
	Track distance	≥4,572 mm

Source: CEAR



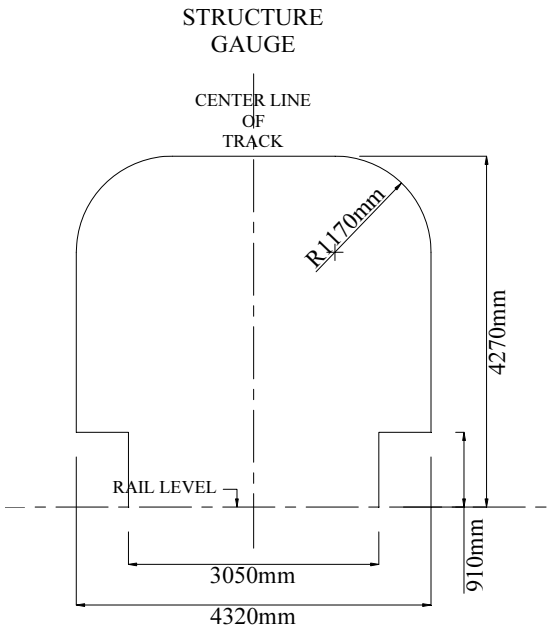
Source: CEAR

Figure 9-7 Design Train Load



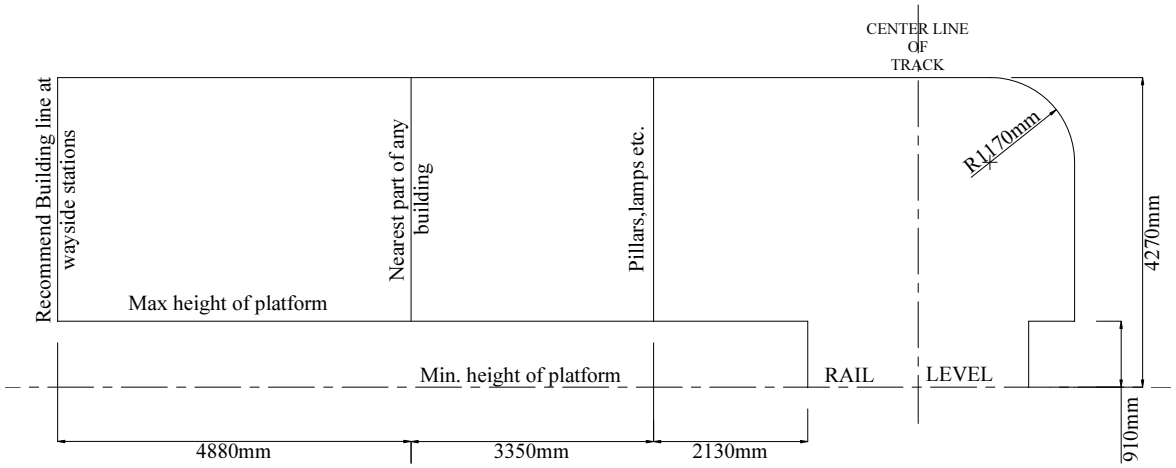
Source: CEAR

Figure 9-8 Vehicle Gauge at Typical Section



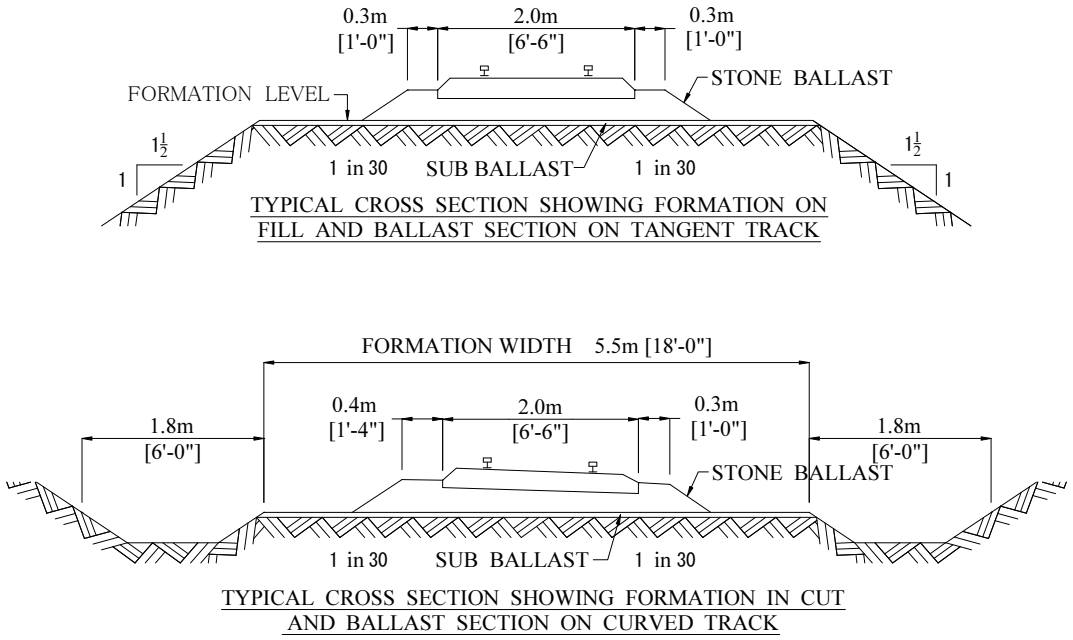
Source: CEAR

Figure 9-9 Structure Gauge at Typical Section



Source: CEAR

Figure 9-10 Structure Gauge at Station



Source: CEAR

Figure 9-11 Typical Cross-section

9.4.2 Earthworks

Earthworks can be carried out economically and easily in comparison with bridge structures and tunnel structures. It is therefore desirable to use earthworks wherever possible by studying the alignment of the route plan.

However, the earthworks should consider maintenance and prevention of problems such as shrinking of the roadbed, flowing out of the slope, collapse of the embankment due to heavy rainfall and landslide, and mud pumping. As rainfall is especially serious, it is necessary to construct auxiliary structures such as a drainage system and slope protection. Furthermore, the earthworks will continuously require maintenance even after completion of the construction work.

The embankment works will need imported fill, therefore some earth borrow pits are required alongside the line to minimize the cost of transporting fill material.

(1) Cuttings

There are no cutting sections between Border and Limbe. However, cut batter slopes of 1:1.5 should be applied with intermediate benches at 5.0-m intervals wherever required. For slopes with high seepage potential and unfavourable rock defects, some slips must be expected. Horizontal drilled drains will be necessary together with toe buttresses, slope reinforcement and in some cases mass concrete infill. Well drained slopes can be steepened to some extent, but the final height/angle relationship will depend on the orientation of defects and the kind of rocks.

(2) Fills

When embankments are reconstructed, fill embankment batter slopes of 1:1.5 with lift

benches at 5.0-m vertical intervals should be applied over firm foundation soil bases. Ground improvement measures will be required where the embankment runs over soft sub-soils such as will be encountered on low ground.

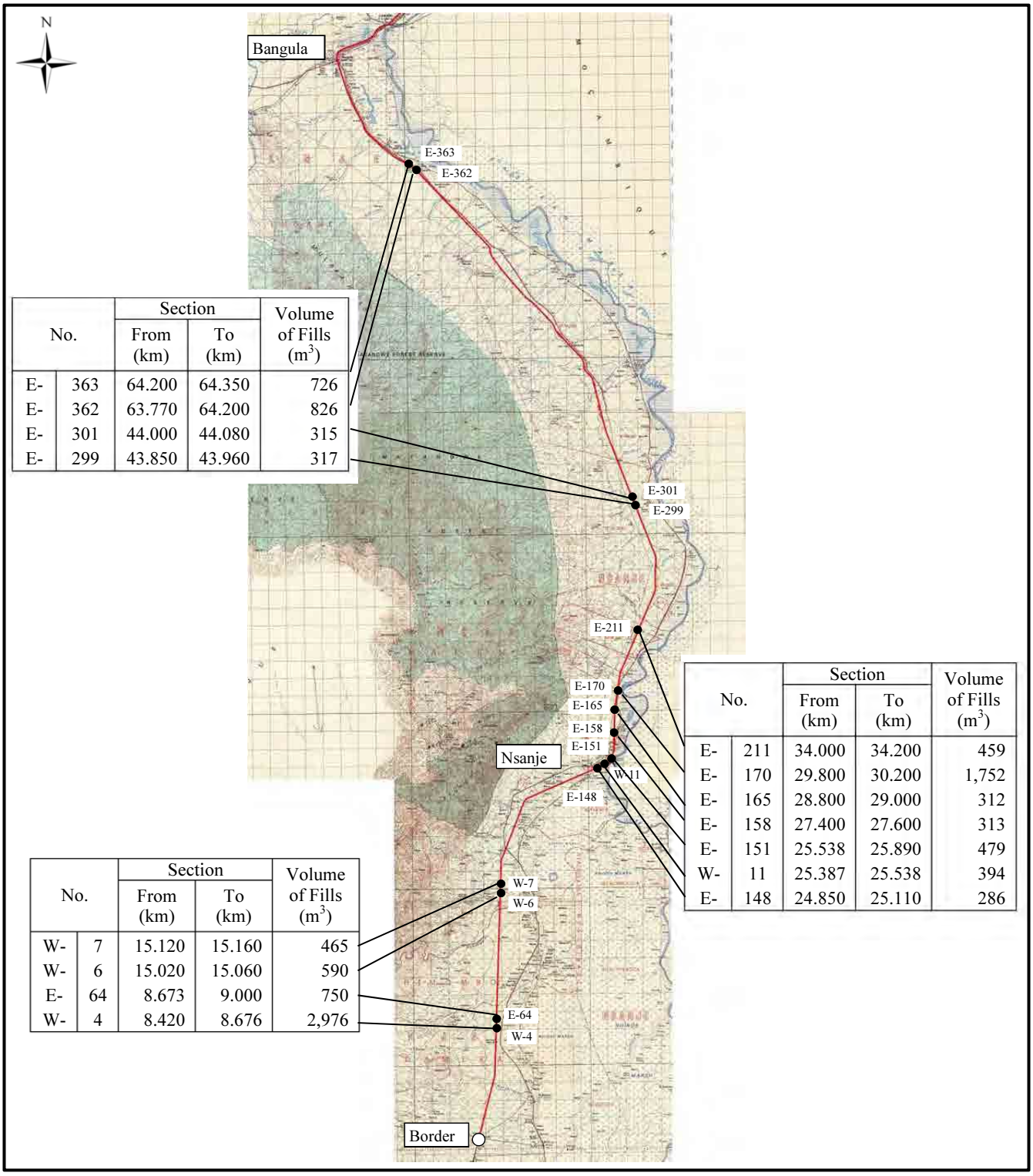
The embankments between Border and Limbe which should be rehabilitated or reconstructed are shown in Figure 9-12.

Those between Border and Bangula according to the inventory survey are summarised in Tables 9-6 and 9-7. The ground height of this section is less than 1.0 m. About 7.2% of the embankments on the section have some collapses to be repaired (shown as E-). They are counted as half the amount of required fills, and the washaway sections (shown as W-) are counted in all of the required fills.

Table 9-6 Fills between Border and Nsanje

No.		Section		Distance (m)	Ground Height (m)	Volume of Fills (m^3)	Remarks
		From (km)	To (km)				
-	15	2.020	2.040	20	0.65	42	Embankment collapse, surface failure type. Provide structure for 2.5 m opening.
E-	16	2.040	2.065	25	0.72	59	Embankment collapse, washaway type. Provide new bridge structure or 0.9 m pipe.
E-	21	2.300	2.305	5	0.70	11	Washaway, new structure required.
E-	38	5.300	5.380	80	0.60	154	Localized washaway i.e. just at a point.
E-	42	5.510	5.520	10	0.60	19	
E-	58	8.350	8.410	60	0.90	185	
W-	4	8.420	8.676	256	1.50	2,976	Embankment washed away.
E-	60	8.505	8.512	7	0.37	8	
E-	64	8.673	9.000	327	0.70	750	
W-	6	15.020	15.060	40	1.80	590	Embankment washed away.
W-	7	15.120	15.160	40	1.50	465	Embankment washed away.
E-	93	15.240	15.320	80	0.74	197	Embankment collapse, washaway type.
E-	94	15.320	15.350	30	0.80	80	Embankment collapse, surface failure.
E-	97	15.509	15.580	71	0.75	176	Embankment collapse, washaway type. New structure required.
E-	98	15.580	15.583	3	0.74	7	Embankment collapse, washaway type.
E-	102	16.400	16.404	4	0.42	5	Embankment collapse, surface failure type. New structure required for 4 m opening.
E-	148	24.850	25.110	260	0.36	286	
W-	9	25.290	25.360	70	0.41	177	Rail washed away.
W-	10	25.360	25.387	27	0.42	70	New road drain outlet trench excavation.
W-	11	25.387	25.538	151	0.42	394	Rail washed away.
E-	151	25.538	25.890	352	0.44	479	352 m of washaway near Nsanje International Port.
Total						7,132	

Source: Study Team



No.		Section From (km)	Section To (km)	Volume of Fills (m^3)
E-	363	64.200	64.350	726
E-	362	63.770	64.200	826
E-	301	44.000	44.080	315
E-	299	43.850	43.960	317

No.		Section From (km)	Section To (km)	Volume of Fills (m^3)
E-	211	34.000	34.200	459
E-	170	29.800	30.200	1,752
E-	165	28.800	29.000	312
E-	158	27.400	27.600	313
E-	151	25.538	25.890	479
W-	11	25.387	25.538	394
E-	148	24.850	25.110	286

No.		Section From (km)	Section To (km)	Volume of Fills (m^3)
W-	7	15.120	15.160	465
W-	6	15.020	15.060	590
E-	64	8.673	9.000	750
W-	4	8.420	8.676	2,976

Source: Study Team

Figure 9-12 Major Earthworks along the Railway Line

Table 9-7 Fills between Nsanje and Bangula

No.		Section From (km)	Section To (km)	Distance (m)	Ground Height (m)	Volume of Fills (m^3)	Remarks
E-	155	26.760	26.860	100	0.30	88	
E-	157	27.080	27.400	320	0.20	186	Embankment collapse.
E-	158	27.400	27.600	200	0.50	313	Embankment collapse.
E-	165	28.800	29.000	200	0.50	312	Embankment collapse.
E-	170	29.800	30.200	400	1.20	1,752	Embankment collapse.
E-	172	30.400	30.600	200	0.40	244	Embankment collapse.
E-	175	30.920	31.000	80	0.30	71	Embankment collapse.
E-	188	32.085	32.090	5	0.50	8	
E-	191	32.167	32.173	6	0.50	9	Embankment collapse and loss of sleepers.
E-	194	32.500	32.595	95	0.50	148	Embankment collapse.
E-	197	32.740	32.760	20	0.60	38	Embankment collapse, wash away. 2.5 m opening requiring new structure. Washaway induced by road culvert outlet.
E-	199	32.900	32.915	15	0.66	32	Embankment collapse, surface failure type.
E-	203	32.976	33.000	24	0.69	54	New structure required for 2 m opening.
E-	206	33.400	33.404	4	1.10	31	Embankment collapse, surface failure type.
E-	211	34.000	34.200	200	0.70	459	Loss of embankment encouraged by loss of sleepers.
E-	219	35.592	35.617	25	0.70	57	Embankment collapse, surface failure type. New structure for 2.5 m opening required.
E-	262	40.300	40.395	95	0.20	55	Embankment failure, washaway type.
E-	299	43.850	43.960	110	0.85	317	Embankment collapse, surface failure type and loss of sleepers noted as well.
E-	301	44.000	44.080	80	1.10	315	
E-	323	46.700	46.800	100	0.35	105	
E-	362	63.770	64.200	430	0.60	826	Embankment collapse.
E-	363	64.200	64.350	150	1.30	726	Sleepers removed; Embankment collapse 20 m.
Total						6,147	

Source: Study Team

In the section between Bangula and Makhanga, a new embankment should be constructed to connect the existing railway line to the Chiromo Railway Bridge as shown in Table 9-8. The average height of the embankment is 3.5 m on the Bangula side and 4.24 m on the Makhanga side.

In the section between Makhanga and Limbe, the inventory survey was not conducted except for the flooding area from km 86.7 to 80.0 which was surveyed by MoTPI. In the flooding area, an embankment with a height of 1 m should be constructed to avoid the track being submerged with muddy water. Regarding the collapse of embankments on the remaining section, it is assumed to be half of the rate found on the section between Nsanje and Makhanga. The fills are summarised in Tables 9-9 and 9-10.

Table 9-8 Fills between Bangula and Makhanga

No.		Section From (km)	Section To (km)	Distance (m)	Ground Height (m)	Volume of Fills (m^3)	Remarks
E-	380-1	73.284	73.670	386	2.50	11,221	New embankment connecting the existing alignment with Chiromo Bridge at the washaway section (Bangula side).
E-	380-2	73.900	74.352	452	3.52	19,708	New embankment connecting the existing alignment with Chiromo Bridge at the washaway section (Makhanga side).
E-	402	77.500	77.590	90	3.10	1,416	Embankment collapse, washaway type. Rail suspended.
E-	403	77.590	78.000	410	3.00	6,150	Embankment collapse by submerged water (erosion).
E-	404	78.000	78.065	65	3.40	1,171	
E-	405	78.065	78.068	3	3.40	54	
E-	408	78.710	78.750	40	3.10	629	Embankment collapse by submerged water (erosion).
E-	409	78.750	78.780	30	3.20	494	Embankment collapse by submerged water (erosion).
E-	410	78.780	78.850	70	3.20	1,154	Embankment collapse by submerged water (erosion).
E-	411	78.850	79.000	150	3.20	2,472	Embankment collapse by submerged water (erosion).
Total						44,470	

Source: Study Team

Table 9-9 Fills between Makhanga and Luchenza

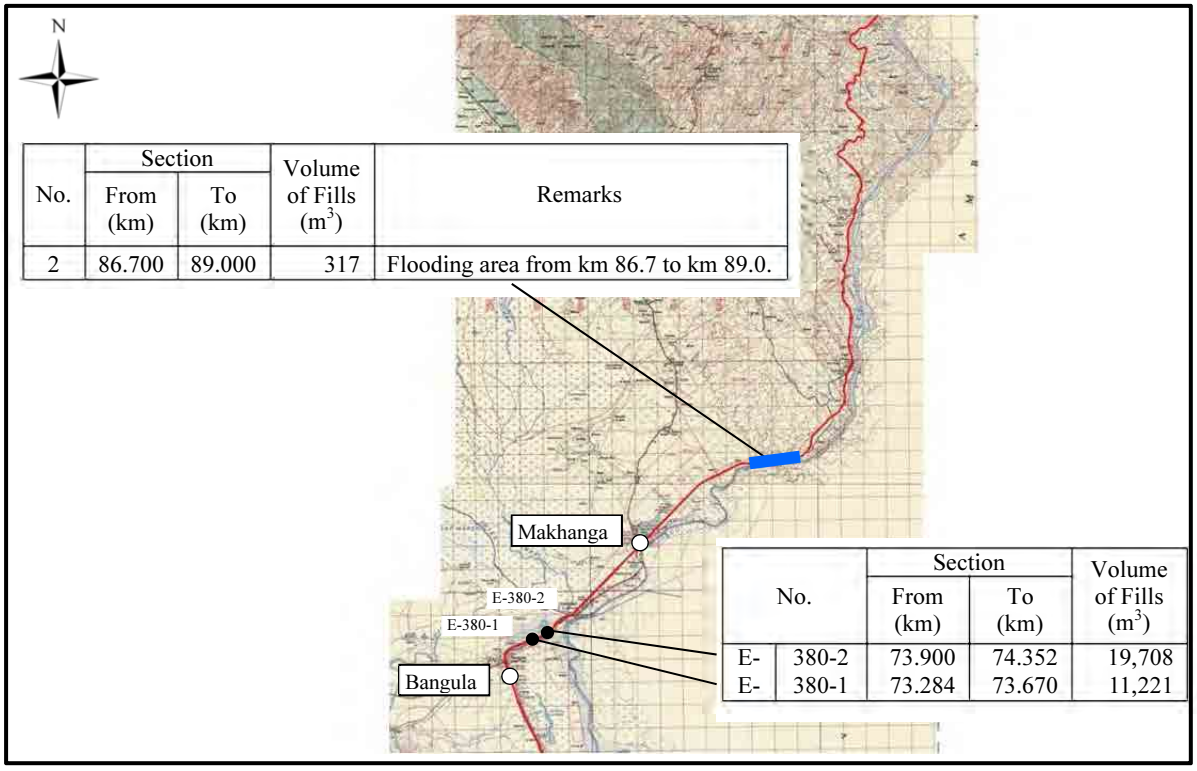
No.	Section From (km)	Section To (km)	Distance (m)	Ground Height (m)	Volume of Fills (m^3)	Remarks
1	80.400	86.700	6,300	n/a	851	Assumed 0.135 m^3 perm.
2	86.700	89.000	2,300	1.00	16,100	Flooding area from km 86.7 to km 89.0.
3	89.000	157.000	68,000	n/a	9,180	Assumed 0.135 m^3 perm.
Total					26,131	

Source: Study Team

Table 9-10 Fills between Luchenza and Limbe

No.	Section From (km)	Section To (km)	Distance (m)	Ground Height (m)	Volume of Fills (m^3)	Remarks
1	157.000	201.000	44,000	n.a.	5,940	Assumed 0.135 m^3 per m
Total					5,940	

Source: Study Team



No.	Section From (km)	Section To (km)	Volume of Fills (m^3)	Remarks
2	86.700	89.000	317	Flooding area from km 86.7 to km 89.0.

No.	Section From (km)	Section To (km)	Volume of Fills (m^3)
E-380-2	73.900	74.352	19,708
E-380-1	73.284	73.670	11,221

Source: Study Team

Figure 9-13 Fills and Flooding Area between Bangula and Luchenza

Flooding Area

Ruo River adjacent to the Track

Photos by MoTPI, May 2011

Photos 9-1 Flooding Area of Railway Line

(3) Culverts

The conditions of culverts between Border and Makhanga were surveyed by the inventory survey. Those between Makhanga and Limbe are assumed to be half of the rate that are judged to be poor on the section between Border and Makhanga.

(4) Revetment for Protection of Embankment along the New Shire River

In order to prevent scouring of the foot of the embankment from the discharge force of the New Shire River, it is planned to install revetments between the point where the New Shire

River starts to flow along the railway embankment and the Chiromo washaway section (length of 750 m) using the Type C revetment described in Section 7.2.3.

The earthworks are summarised in Table 9-11.

Table 9-11 Summary of Earthworks

Item	Unit	Border–Nsanje	Nsanje–Bangula	Bangula–Makhanga	Makhanga–Luchenza	Luchenza–Limbe	Total
Fills	m^3	7,132	6,147	44,470	26,131	5,940	89,819
Cuttings	m^3	0	0	0	0	0	0
Culverts	lot	1	2	2	10	25	40
Revetment (Riprap)	m^3	-	-	12,000	-	-	12,000

Source: Study Team

(5) Land Acquisition

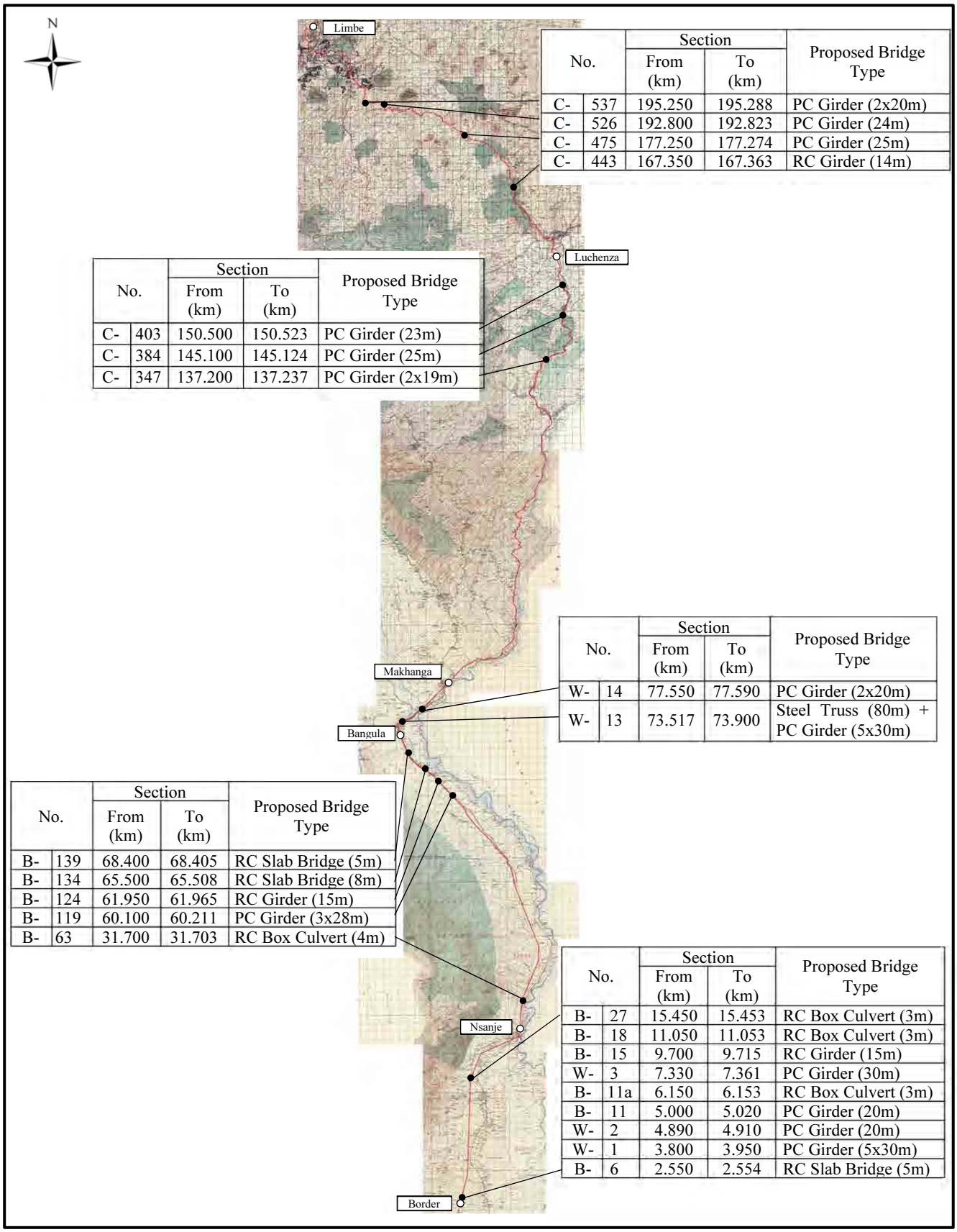
To connect the existing railway line to the new Chiromo Railway Bridge, a new embankment should be constructed on common land owned by the Government. The ROW required will be an area of around 12,700 m^2. In the remaining sections of the line, no land acquisition will be required.

9.4.3 Bridge Rehabilitation and Reconstruction Plans

(1) Bridges to be Rehabilitated or Reconstructed

The bridges between Border and Limbe which should be rehabilitated or reconstructed are shown in Figure 9-14; the proposed bridge types are summarised in Tables 9-12 to 9-16. The bridges between Border and Makhanga to be rehabilitated or reconstructed were decided based on the inventory survey conducted in November 2010. Those between Makhanga and Limbe were decided by visual check conducted in October 2011. The deteriorated bridges found this section are characterized by the configuration of a long span in between a shorter span with more than two piers.

The bridge rehabilitation and reconstruction works are summarised in Table 9-17.



No.		Section From (km)	Section To (km)	Proposed Bridge Type
C-	537	195.250	195.288	PC Girder (2x20m)
C-	526	192.800	192.823	PC Girder (24m)
C-	475	177.250	177.274	PC Girder (25m)
C-	443	167.350	167.363	RC Girder (14m)

No.		Section From (km)	Section To (km)	Proposed Bridge Type
C-	403	150.500	150.523	PC Girder (23m)
C-	384	145.100	145.124	PC Girder (25m)
C-	347	137.200	137.237	PC Girder (2x19m)

No.		Section From (km)	Section To (km)	Proposed Bridge Type
W-	14	77.550	77.590	PC Girder (2x20m)
W-	13	73.517	73.900	Steel Truss (80m) + PC Girder (5x30m)

No.		Section From (km)	Section To (km)	Proposed Bridge Type
B-	139	68.400	68.405	RC Slab Bridge (5m)
B-	134	65.500	65.508	RC Slab Bridge (8m)
B-	124	61.950	61.965	RC Girder (15m)
B-	119	60.100	60.211	PC Girder (3x28m)
B-	63	31.700	31.703	RC Box Culvert (4m)

No.		Section From (km)	Section To (km)	Proposed Bridge Type
B-	27	15.450	15.453	RC Box Culvert (3m)
B-	18	11.050	11.053	RC Box Culvert (3m)
B-	15	9.700	9.715	RC Girder (15m)
W-	3	7.330	7.361	PC Girder (30m)
B-	11a	6.150	6.153	RC Box Culvert (3m)
B-	11	5.000	5.020	PC Girder (20m)
W-	2	4.890	4.910	PC Girder (20m)
W-	1	3.800	3.950	PC Girder (5x30m)
B-	6	2.550	2.554	RC Slab Bridge (5m)

Source: Study Team

Figure 9-14 Bridges to be Rehabilitated or Reconstructed

Table 9-12 Bridges between Border and Nsanje

No.		Section		Original Structure Type	Size	Proposed Bridge Type	Remarks
		From (km)	To (km)				
B-	6	2.550	2.554	Bridge	1 × 4.450 m span	RC Slab Bridge (5 m)	Structure cracked
W-	1	3.800	3.950	Embankment		PC Girder (5 × 30 m)	River changed course
W-	2	4.890	4.910	Embankment		PC Girder (20 m)	Embankment, railway line and 2-span bridge washed away
B-	11	5.000	5.020	Bridge	Not measurable i.e. structure washed away	PC Girder (20 m)	Structure washed away. 20 m opening requires new structure
B-	11a	6.150	6.153	Bridge	1 × 2.500 m span	RC Slab Bridge (3 m)	No abutment walls
W-	3	7.330	7.361	Embankment		PC Girder (30 m)	Bridge and approach embankment washed away
B-	15	9.700	9.715	Bridge	Not measurable i.e. structure washed away	RC Girder (15 m)	Both abutments collapsed. New 15m opening bridge required
B-	18	11.050	11.053	Bridge	1 × 2.700 m span	RC Slab Bridge (3 m)	Had walls knocked off
B-	27	15.450	15.453	Bridge	1 × 2.550 m span	RC Slab Bridge (3 m)	Cracked

Source: Study Team

Table 9-13 Bridges between Nsanje and Bangula

No.		Section		Original Structure Type	Size	Proposed Bridge Type	Remarks
		From (km)	To (km)				
B-	63	31.700	31.703	Bridge	1 × 3.400 m span	RC Box Culvert (4 m)	
B-	119	60.100	60.211	Bridge	4 × 18.450 m spans	PC Girder (3 × 28 m)	
B-	124	61.950	61.965	Bridge	2 × 7.350 m spans	RC Girder (15 m)	Pier sunk
B-	134	65.500	65.508	Bridge	1 × 7.600 m span	RC Slab Bridge (8 m)	
B-	139	68.400	68.405	Bridge	1 × 4.500 m span	RC Slab Bridge (5 m)	

Source: Study Team

Table 9-14 Bridges between Bangula and Makhanga

No.		Section From (km)	Section To (km)	Original Structure Type	Size	Proposed Bridge Type	Remarks
W-	13	73.517	73.900	Embankment		Steel Truss (80 m) + PC Girder (5 × 30 m)	Embankment height taken on the edge. Distance measured from end of rail (Makhanga side) and end of rail (Bangula side)
W-	14	77.550	77.590	Embankment		PC Girder (2 × 20 m)	Between Makhanga Station and Chiromo Station

Source: Study Team

Table 9-15 Bridges between Makhanga and Luchenza

No.		Section From (km)	Section To (km)	Original Structure Type	Size	Proposed Bridge Type	Remarks
C-	347	137.200	137.237	Bridge	4 × 9.144 m spans	Plate Girder (2 × 19 m)	
C-	384	145.100	145.124	Bridge	2 × 6.096 m spans 1 × 12.192 m span	PC Girder (25 m)	A long span in between shorter spans
C-	403	150.500	150.523	Bridge	2 × 4.600 m spans 1 × 13.500m span	PC Girder (23 m)	A long span in between shorter spans

Source: Study Team

Table 9-16 Bridges between Luchenza and Limbe

No.		Section From (km)	Section To (km)	Original Structure Type	Size	Proposed Bridge Type	Remarks
C-	443	167.350	167.363	Bridge	2 × 3.660 m spans 1 × 6.096 m span	RC Girder (14 m)	A long span in between shorter spans
C-	475	177.250	177.274	Bridge	2 × 6.096 m spans 1 × 12.192 m span	PC Girder (25 m)	A long span in between shorter spans
C-	526	192.800	192.823	Bridge	2 × 4.420 m spans 1 × 14.410 m span	PC Girder (24 m)	A long span in between shorter spans
C-	537	195.250	195.288	Bridge	4 × 7.010 m spans 1 × 10.360 m span	PC Girder (2 × 20 m)	A long span in between shorter spans

Source: Study Team

Table 9-17 Summary of Bridge Works

Type	unit	Border–Nsanje	Nsanje–Bangula	Bangula–Makhanga	Makhanga–Luchenza	Luchenza–Limbe	Total
Steel Truss Bridge	m	0.0	0.0	80.0	0.0	0.0	80.0
PC Bridge (20 to 30 m)	m	220.0	75.0	190.0	48.0	89.0	622.0
RC Bridge (10 to 20 m)	m	15.0	15.0	0.0	38.0	14.0	82.0
RC Slab Bridge (5 to 10 m)	m	5.0	13.0	0.0	0.0	0.0	18.0
RC Box Culvert (less 5 m)	m	9.0	4.0	0.0	0.0	0.0	13.0

Source: Study Team

(2) Structure Type

There are many kinds of bridge structures and construction methods. The following three types of bridge structure are planned in the Study, with reference to the existing structure types.

a) Spans over 30 m

The bridge at the Chiromo washaway section, the Chiromo Railway Bridge, which requires a span length of over 80 m. In this case, a superstructure span length of 80 m is required. Details of the study of Chiromo Railway Bridge are described in Section (3) below.

b) Spans between 10 m and 30 m.

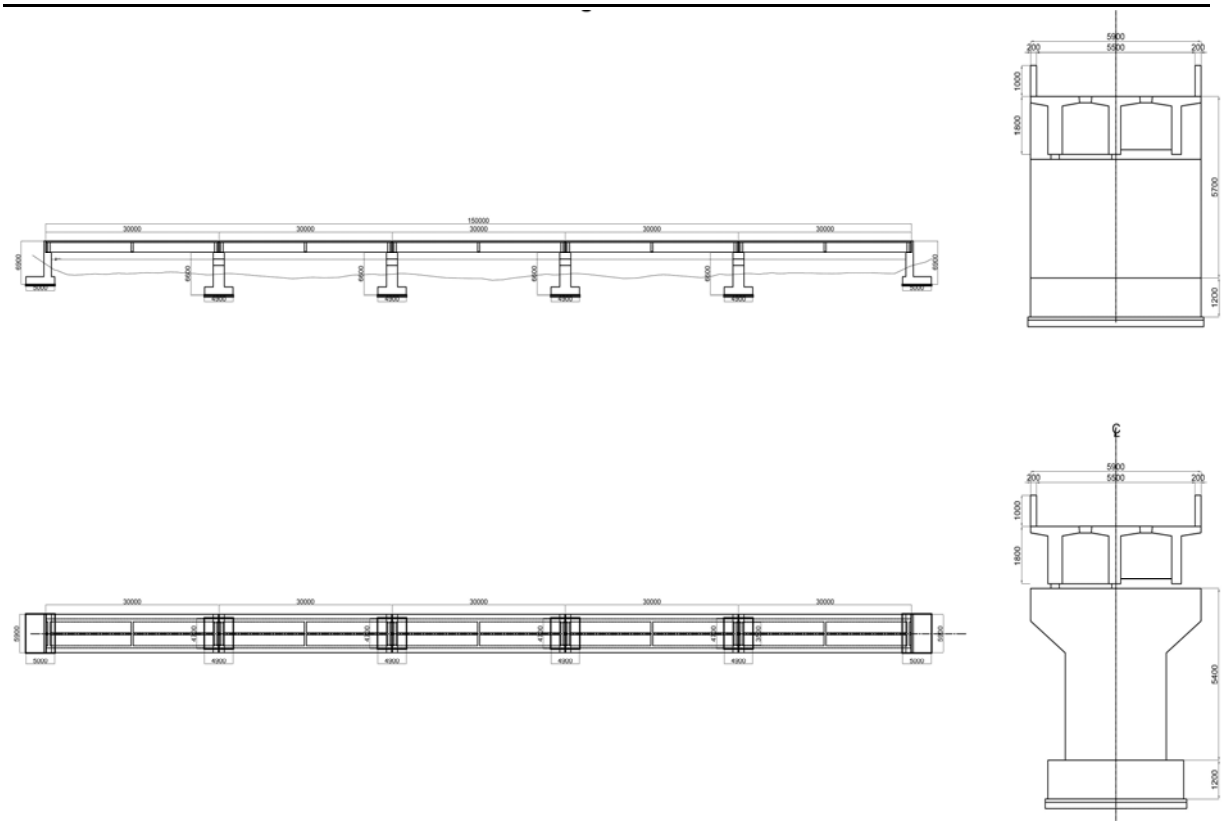
Bridges for crossing a road, river, or washaway, with a pier height of 5–10 m and span length between columns of less than 30 m. These are mainly used for the section between Border and Bangula.

- Foundation: Spread foundation
- Abutment, Column: Reinforced concrete structure
- Superstructure: Pre-stressed concrete (PC) or reinforced concrete (RC)

Regarding the structure of the foundation, a pile foundation (pre-cast concrete piling, in-situ concrete piling and steel pipe piling methods) should be considered at places with soft ground. Piers are used for a reinforced concrete structure because they are economical; there are many examples in Malawi.

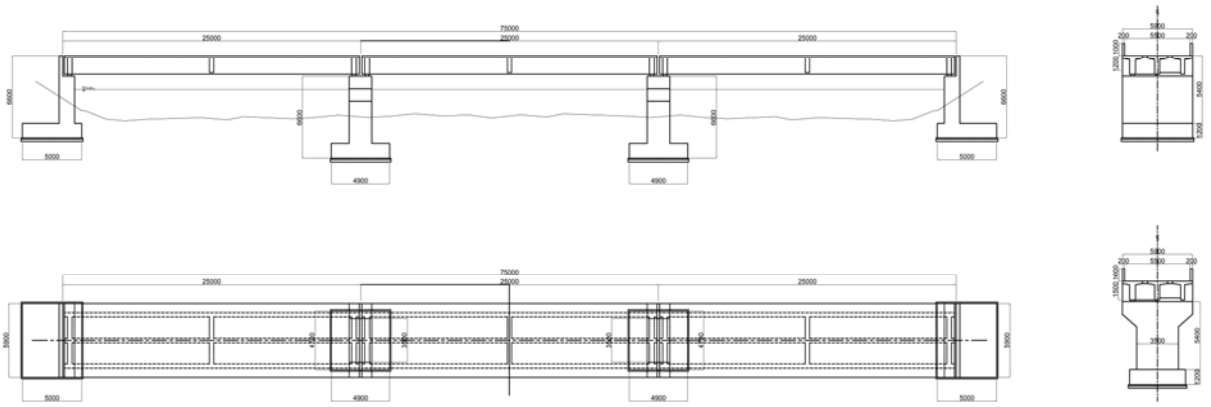
Regarding the superstructure, if the span length is over 20 m, a PC bridge is most suitable. There are many types of pre-stressed concrete bridges, such as I-shaped beam, hollow slab beam, box beam and through beam. The results of this study showed that the PC I-shaped beam type is suitable, considering the construction cost.

Schematic views are shown in Figures 9-15 to 9-18.



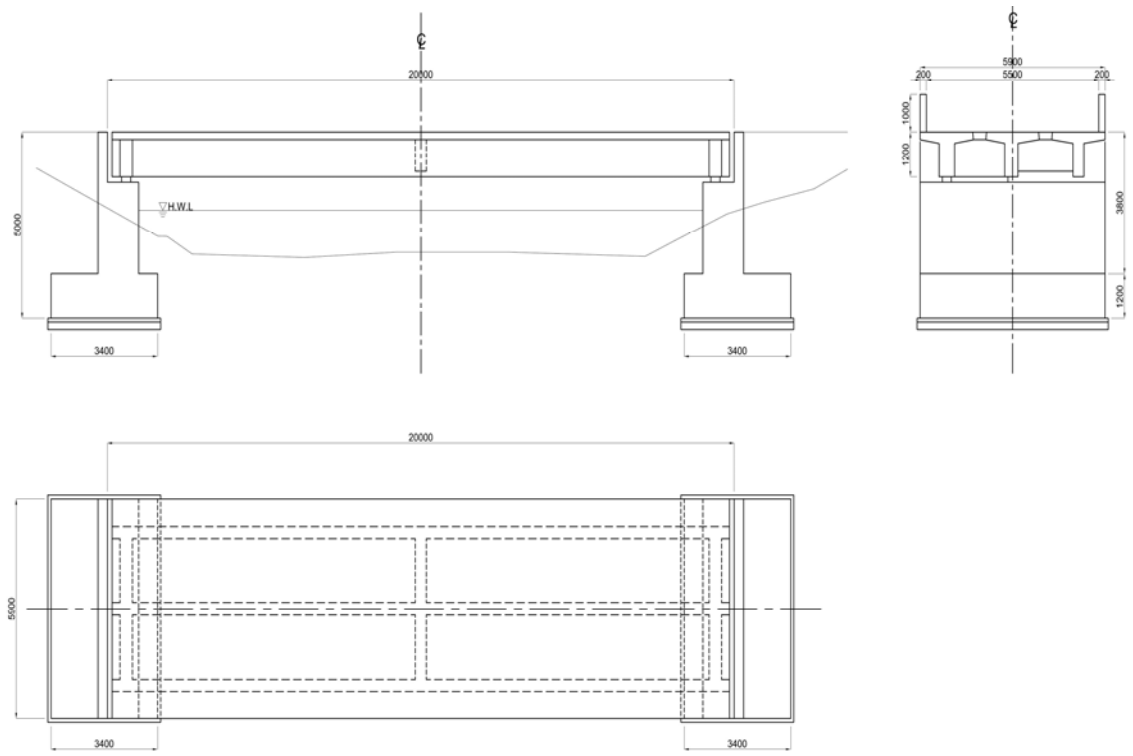
Source: Study Team

Figure 9-15 Schematic View of 5-span PC Bridge



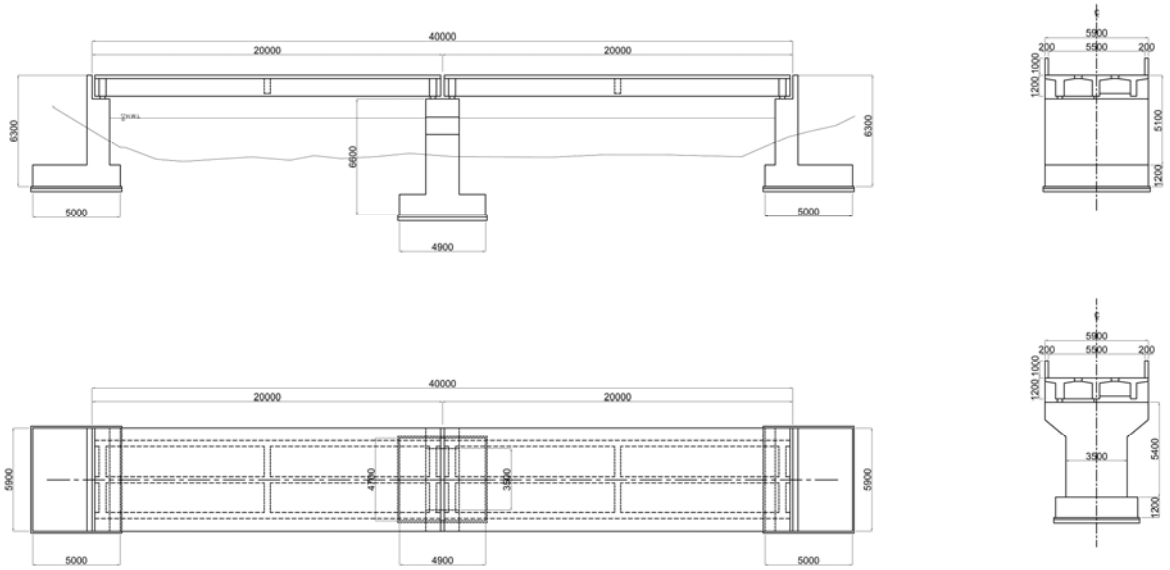
Source: Study Team

Figure 9-16 Schematic View of 3-span PC Bridge



Source: Study Team

Figure 9-17 Schematic View of 1-span PC Bridge



Source: Study Team

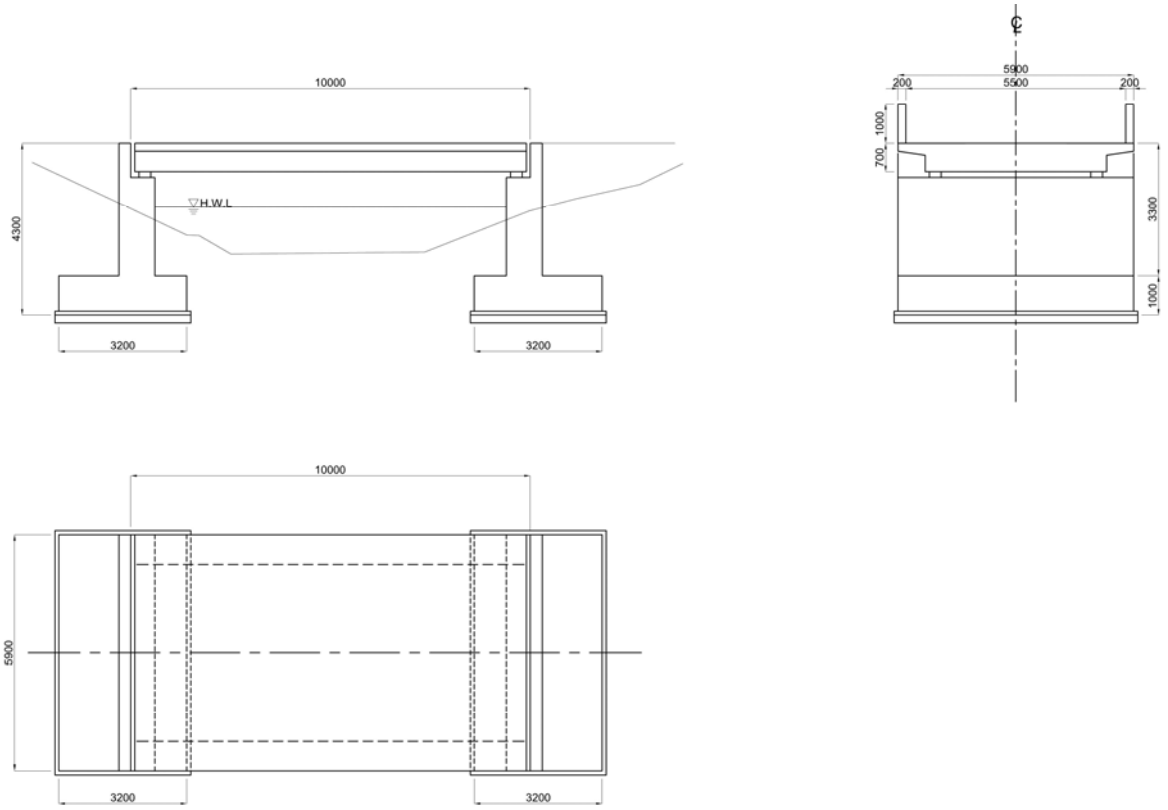
Figure 9-18 Schematic View of 2-span RC Bridge

c) Span between 5m and 10m

The bridge at the section between Makhanga and Limbe where the deteriorated steel bridge should be replaced without stopping train operation.

- Foundation: Spread foundation
- Abutment, Column: Reinforced concrete structure
- Superstructure: RC slab bridge

The foundation and column are the same as noted in the previous section 1). With plate girder or steel beam bridges, simple beams and partial members can be transported and assembled on site easily and safely. Steel beams are more economical and feasible than pre-stressed concrete beams at the site to minimize the period of train suspension. Schematic view is shown in Figure 9-19.



Source: Study Team

Figure 9-19 Schematic View of RC Slab Bridge

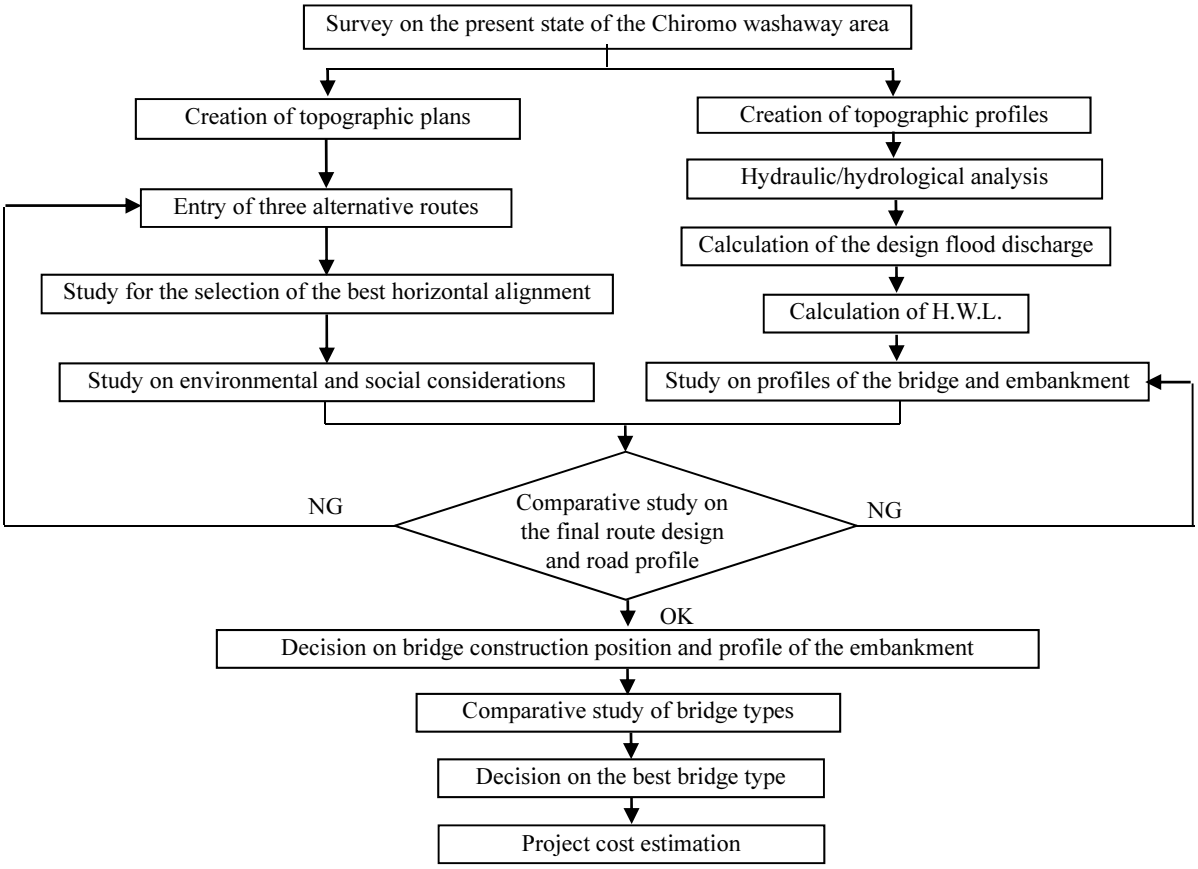
d) Span less 5m

The RC box culvert is used for original bridges with a span of less 5m.

(3) Chirmo Railway Bridge

a) Workflow of the Outline Study

In the outline study, studies required for the construction of a railway bridge in the area of the Chiromo washaway area, including a field survey of the area and studies on the selection of a bridge construction position, railway alignment, establishment of the scale and type of bridge shall be implemented to select the appropriate bridge type. After selecting the bridge type, the project cost shall be estimated. Figure 9-20 shows the workflow of the outline study.



Source: Study Team

Figure 9-20 Workflow of the Outline Study

b) Present State of the Bridge Construction Position

1) Section between Bangula and Shire River

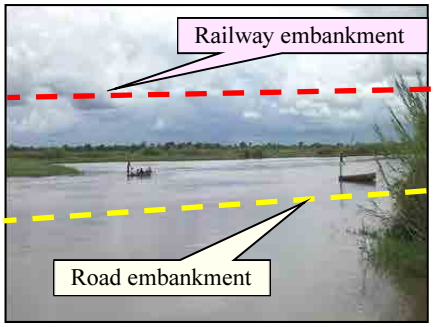
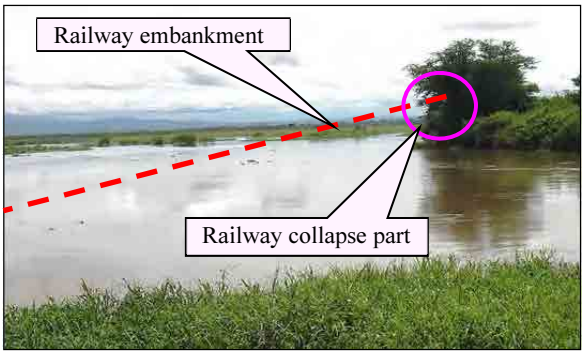
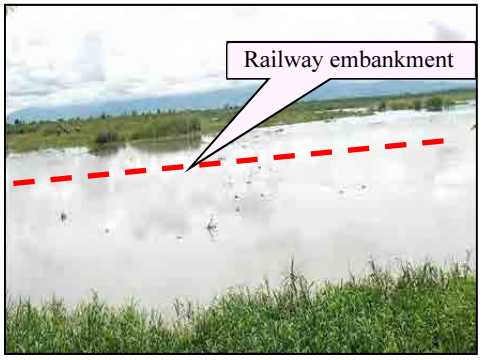
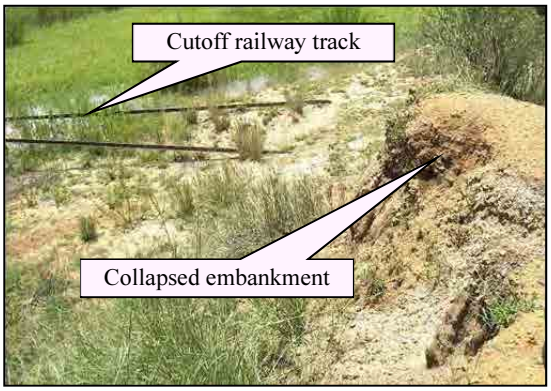
Before the large-scale flood in 1997, it is considered that the water which overflowed from the riverbank upstream of the Shire River stagnated in the swamp area on the north side of the railway embankment constructed in the section between Bangula and the Shire River. In addition, there was a road embankment on the south side of the railway embankment, which was a protected by the railway embankment until it was hit by the flood.

2) Makhanga Side

The railway embankment functioned as a riverbank which dammed the water making it stagnate in the swamp area. As the amount of water overflowing from upstream of the Shire River increased and gradually weakened the slope of the embankment. Usually if a slope of an embankment is at risk of inundation, revetment work is carried out. However, it seems that such

a situation was not anticipated before the embankment was constructed for rail installation.

It is considered that the large-scale flood of 1997 hit the embankment which had been weakened by the water overflowing from the Shire River, and washed it away.

<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Chiromo Washaway Area</td><td>Railway Embankment and
Location of Railway Track Collapse</td></tr>
<tr><td>  </td><td> 
</td></tr>
<tr><td>Collapsed Railway</td><td>Area of Washed Away Railway Embankment</td></tr>
<tr><td> 
</td><td>  </td></tr>
<tr><td>Damage to Embankment</td><td>Cut-off and Abandoned Railway Track and Embankment</td></tr>
</table>

Photos by the Study Team, November 2010

Photos 9-2 Present Situation of Railway Embankment at Chiromo Washaway Section

3) Bangula Side

A larger section of the embankment was washed away on the Bangula side compared to that on the Makhanga side. Approximately 260 m of the 360 m long section that was washed away is on the Bangula side. A possible cause of this difference in damage is that the Bangula side possibly had more stagnant water than the Makhanga side, since the water overflowing from

upstream of the Shire River flowed from the Makhanga side to the Bangula side of the embankment area.

c) Study on Bridge Construction Position and Embankment

The best bridge construction position shall be selected from the three alternatives mentioned below using the results of a comparative study on bridge construction position and embankment. In the comparison, the three alternatives shall be analysed comprehensively, with bridge length, cost performance, alignment of embankment, impact on the embankments of the New Shire River, flood control measures, land acquisition, construction efficiency and impact on the natural and social environments taken into full consideration, and the best alternative shall be identified from the results of the analysis.

1) Alternative 1 (Construct a bridge on the alignment of the existing embankment)

A section longer than 360 m of the railway embankment was washed away on the Bangula side. This alternative is to construct a bridge on the alignment of the washaway embankment. Since the bridge is to cross a deep section of the New Shire River the bridge will be significantly affected by flood, a survey is to be conducted to study and confirm the condition of the river.

2) Alternative 2 (Use the existing road embankment)

This alternative is to construct a bridge on the existing road embankment on the Bangula side. Although this alternative requires a bridge with a long span length to cross the New Shire River, it allows flexibility in the selection of spans as part of the construction work can be implemented on land since it is to be implemented on the existing road embankment. However, since the position of the bridge will be away from the alignment of the existing embankment, this alternative requires the construction of a new embankment to connect the new bridge to the remaining embankment.

3) Alternative 3 (Construct a bridge adjacent to the alignment of the new road)

This alternative is to construct a railway bridge adjacent to the planned Chiromo Road Bridge. Since piers can only be constructed on the islands, this alternative requires the construction of a bridge with long spans. Since the bridge position will be further away from the existing alignment of the embankment compared to that of Alternative 2, this alternative requires the construction of a new long embankment to connect the bridge to the remaining embankment.

Table 9-18 shows result of comparing the three alternatives mentioned above on the basis of the results of field reconnaissance and a topographical survey.

d) Comparative Study of Bridge Types

Three bridge types shall be compared for construction at a provisional position selected as the best in above. While steel bridge structures are used in most cases of railway bridge construction, concrete bridges can be a potent candidate depending on the span lengths because of the versatility and low cost of the material. Thus, a concrete bridge shall be considered as the candidate structure. The scale of a bridge, bridge length and span length shall be decided based on the results of the hydrological survey and analysis of the survey results, and in consideration of the bridge width, the railway track shall be at least 4,572 mm apart, and the structure gauge

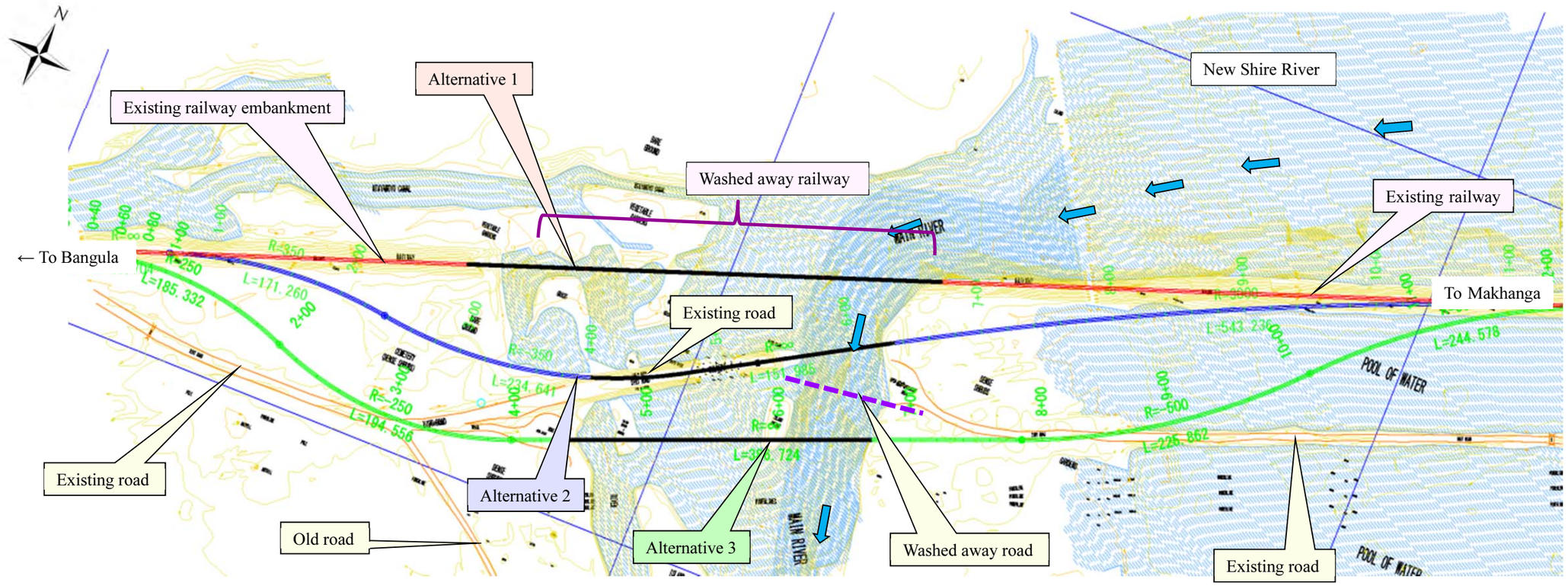
shall be as shown in Figure 9-9.

The following three alternative bridge types shall be compared:

- Alternative 1: Steel 8-span plate girder bridge
- Alternative 2: Steel 3-span continuous truss bridge
- Alternative 3: Steel simple truss bridge + PC 5-span connected post-tensioned T-girder bridge

Table 9-19 shows the results of the comparative analysis of the three alternatives mentioned above. Figure 9-21 shows the general drawing of the entire bridge of Alternative 3 which was selected as the best bridge type.

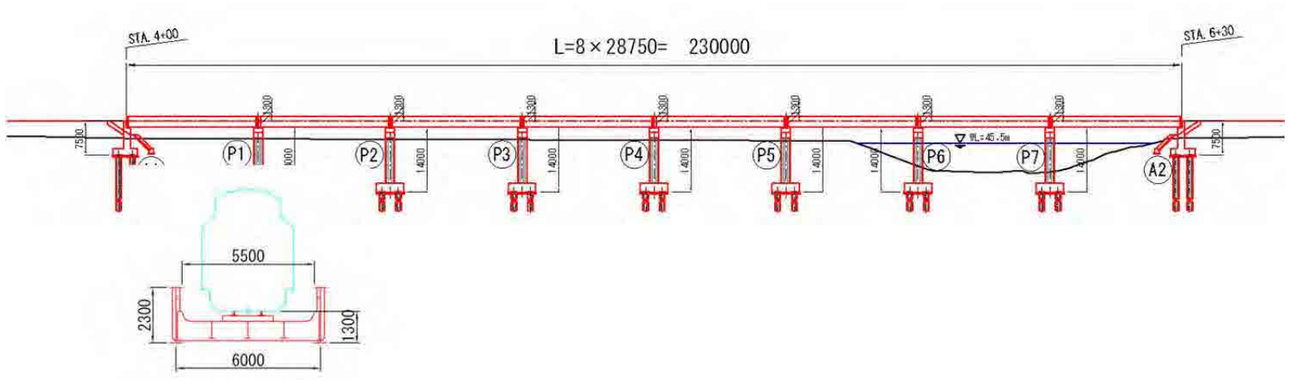
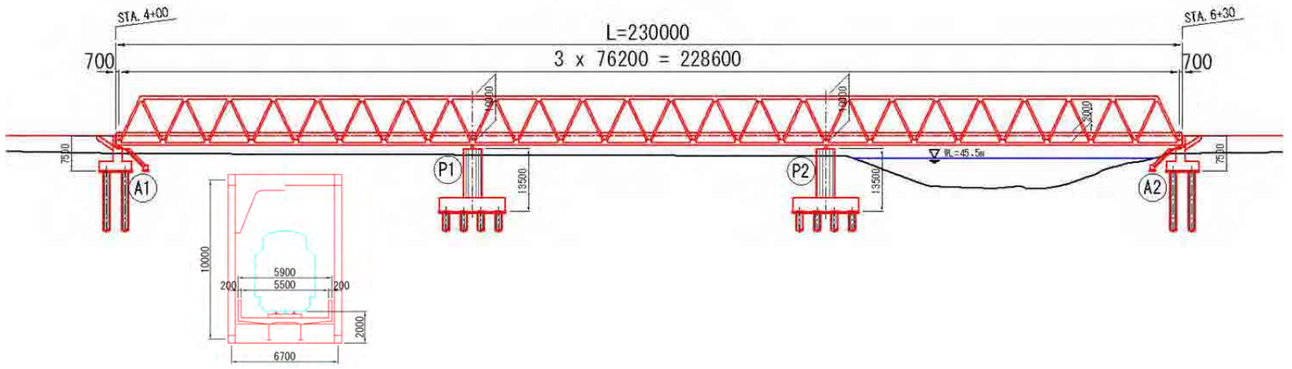
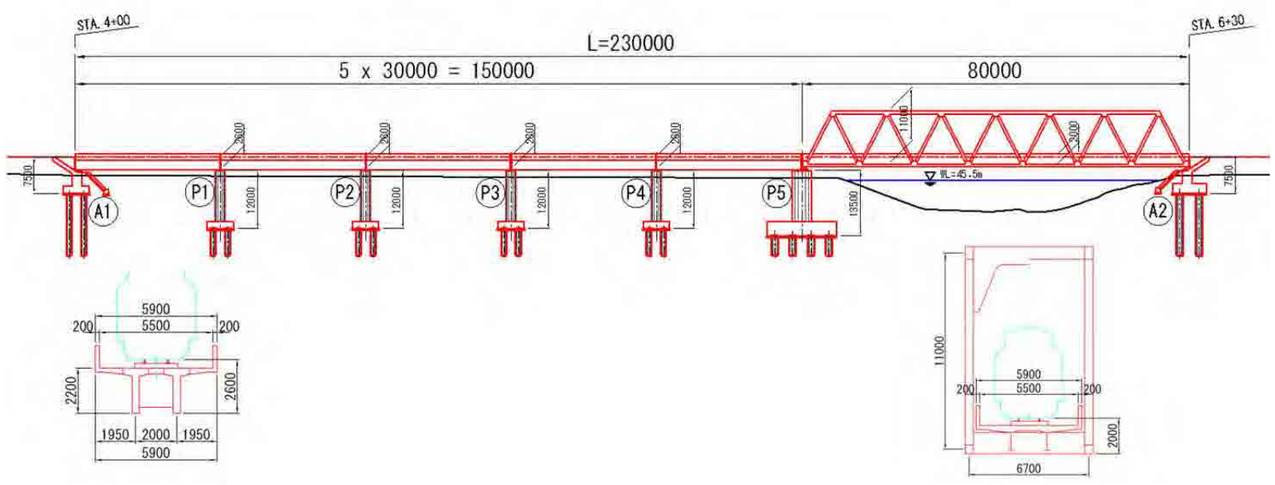
Table 9-18 Comparison of Bridge Construction Position Alternatives



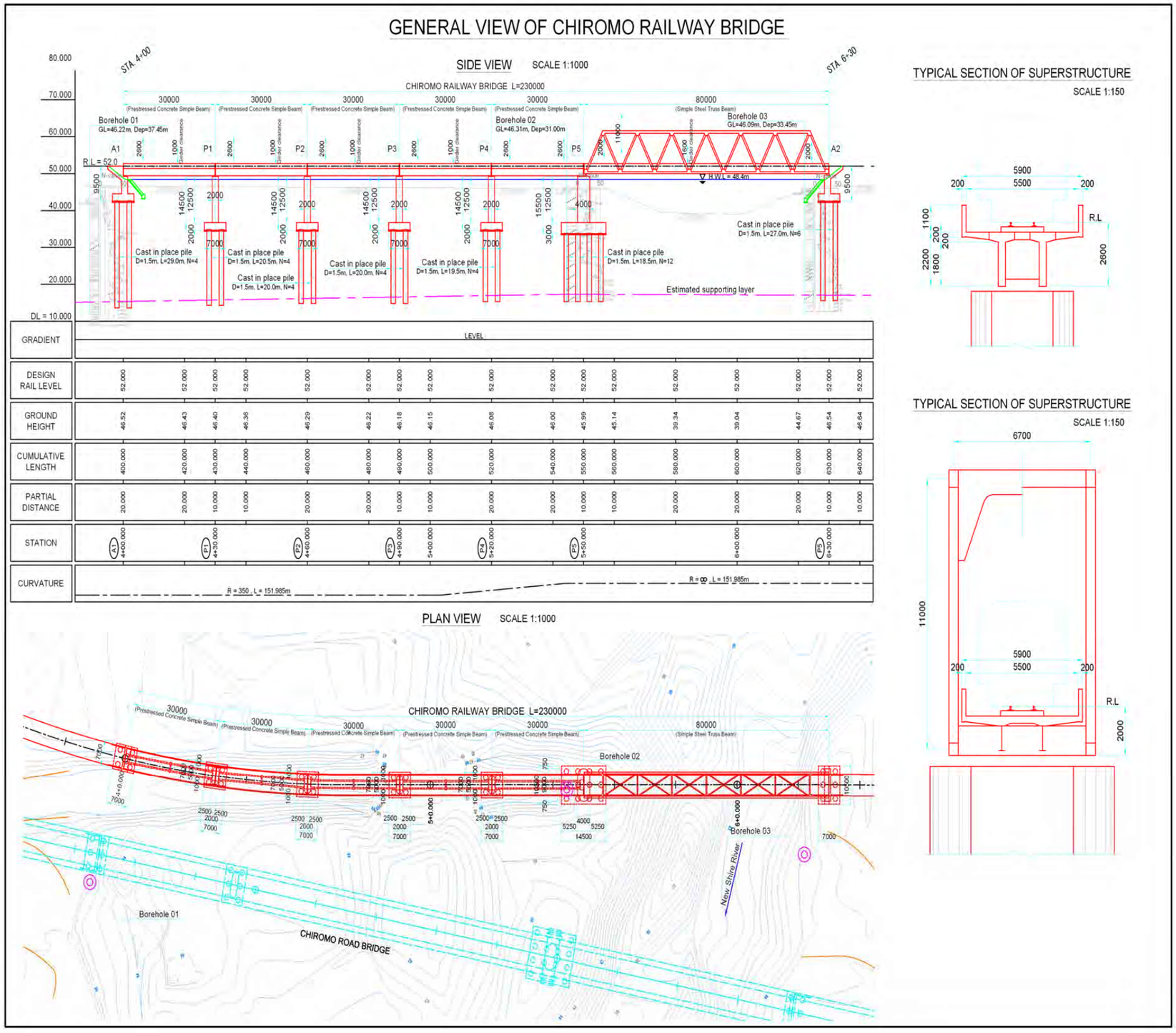
Alternative		Alternative 1 (existing alignment position)	Alternative 2 (using the existing road embankment)	Alternative 3 (Matching the new road alignment)
Overview of alternative		• The existing railway alignment position will be followed.	• The route will pass on the existing road embankment on the Bangula side.	• The route will match the new road alignment.
Evaluation of alternative	Alignment of access road	• The existing alignment is straight and the best horizontal alignment.	• An S-curve will be needed to shift the route to the existing road embankment position.	• Two S-curves will be needed because the route will be significantly shifted from the existing railway position, resulting in the worst horizontal alignment.
	Characteristics of new bridge	• 4-span continuous steel truss bridge: 4@90.0 m=360.0 m.	• Simple steel truss bridge: 80.0 m. • 5-span PC post-tensioned bridge: 5@30.0 m=150.0 m.	• 3-span continuous steel truss bridge: 3@76.667 m=230.0 m.
	Impact of the new Shire River on access road	• The existing railway embankment is in a condition to receive a significant impact from a flood of the new Shire River.	• The existing road embankment on the Bangula side is in a condition to receive direct impact from flooding of the New Shire River.	• There will be little impact from a flood of the new Shire River because of the existing road embankment on the Bangula side and the railway embankment on the Makhanga side.
	Flood control measure	• Large-scale bank protection will be required for the existing railway embankment on the Makhanga side.	• Bank protection will be needed if the existing road embankment is to be retained.	• Bank protection will be needed for the approach to the existing railway embankment.
	Environmental and social considerations	• Due to illegal huts on the railway site, there will be problems such as resettlement and demolition of the huts. • Since the route is on the existing railway alignment, no land acquisition will be necessary.	• Problems such as resettlement and building removal will not occur as there are no hut on this alignment. • Land acquisition will be needed for the approach to the existing road embankment.	• Same as left. • Land acquisition will be needed for the approach to the existing railway embankment, resulting in the largest expropriation area.
	Target work (Ratio of costs)	• Bridgework, approach embankment work for 510 m, bank protection work (3.33).	• Bridgework, approach embankment work for 450 m, bank protection work (1.00).	• Bridgework, approach embankment work for 540 m, bank protection work (1.64).
	Overall evaluation	• Straight with the best horizontal alignment. • Significant impact from flooding of the New Shire River. The highest construction costs because of a large-scale bridge and bank protection work. ✕	• The best horizontal alignment because the new alignment is approximately straight. • Some impact from flooding of the New Shire River but not as significant as Alternative 1. • The lowest construction costs because of a small-scale bridge and bank protection work. ○	• The worst horizontal alignment because of the two S-curves. • Difficulty of construction in a practical manner due to overlapping with the road alignment. • Much higher construction costs than Alternative 2 because of the high construction costs for the bridge and approach embankment. ✕

Source: Study Team

Table 9-19 Comparison of Bridge Types

Bridge type		Characteristics
Alternative 1: Steel 8-span plate girder bridge 	Structural features	・A common plate girder bridge that has been adopted for many past constructions. ・Being a simple type, this bridge type is inferior in earthquake resistance.
	Construction efficiency	・The New Shire River is five to nine meters deep, making it very difficult to construct bridge piers in the river. ・Adopting an erection girder enables the superstructure to be constructed without influence from the river.
	Maintenance performance	・Being a steel bridge, maintenance such as recoating is needed.
	River characteristics	・Having bridge piers in the river, the bridge has the highest impact on the river. ・The reduction of river cross-section exceeds 6% (standard value: 5%).
	Cost performance	・Medium cost performance of the three alternatives. (Construction cost ratio: 1.08)
	Overall evaluation	・The construction of bridge piers in the river is very difficult due to the deep water. ・This bridge type should not be adopted due to the river cross-section reduction exceeding the standard value. ✕
Alternative 2: Steel 3-span continuous truss bridge 	Structural features	・A steel truss type is appropriate for long spans and has been adopted the most for past constructions. ・The continuous structure offers superior earthquake resistance.
	Construction efficiency	・Since the bridge has no piers in the river, they are easy to construct. ・Adopting the cantilever method enables the superstructure to be constructed without influence from the river.
	Maintenance performance	・Being a steel bridge, maintenance such as recoating is needed.
	River characteristics	・Having no pier in the river, it has no impact on the river.
	Cost performance	・Being a steel truss bridge, the cost performance is low. (Construction cost ratio: 1.37)
	Overall evaluation	・No bridge pier construction is needed in the river. ・The cost performance is the lowest. △
Alternative 3: Steel simple truss bridge + PC 5-span post-tensioned T-girder bridge 	Structural features	・A steel truss type is appropriate for long spans and is often used at the river-crossing point. ・A PC-girder bridge can be applied to the existing road embankment.
	Construction efficiency	・Adopting a cable suspended erection method enables the construction of the steel truss bridge section without influence from the river. ・Adoption of an erection girder or support enables the construction of the PC girder bridge section.
	Maintenance performance	・The truss bridge section is a steel bridge that needs recoating. ・The PC girder bridge section is a concrete bridge that does not need any maintenance.
	River characteristics	・Having no pier in the river, it has no impact on the river.
	Cost performance	・Although the cost for the steel truss bridge section is high, the cost for the PC girder bridge section is the lowest. The overall construction cost is the lowest of the three alternatives (Construction cost ratio: 1.00).
	Overall evaluation	・For the river-crossing point the truss type is used which is appropriate for long spans and does not need any construction in the river. ・The best cost performance. ・The most desirable alternative in overall evaluation. ○

Source: Study Team



Source: Study Team

Figure 9-21 General Drawing of Chiromo Railway Bridge

(4) Rehabilitation Plan for the Existing Kamuzu Truss Bridge

The present condition of the existing Kamuzu Truss Bridge (see Figure 9-22) was visually inspected by the Study Team and the result is explained in Section 3.1.5. Basically, there is no major damage on both substructure and superstructure. However, no maintenance work has been carried out for a long time and there is minor damage as described below.

a) Corrosion on the Surface of Truss Structure

After suspension of train operations from Makhanga onward, no maintenance work, including repainting truss structure was made by CEAR. As a result, there is rust on the whole structure, which may cause corrosion of metal beams. In order to prevent the corrosion of metal beams, it is necessary to repaint the whole truss structure as early as possible, because vehicular traffic will use the Kamuzu Truss Bridge for the time being until construction of the New Shire Bridge begins under the project for reconstruction of the S151 road between Makhanga and Bangula described in Chapter 8.

b) Corrosion on the Open Grating Floor

The open grating floor was installed in the 1970s to allow passage of vehicles on the Kamuzu Truss Bridge, which was used exclusively by trains. There is also rust on the metal of the open grating floor. In order to prevent corrosion of this floor, anti-corrosion paint must be applied.

c) Impassable Sidewalk

A sidewalk is attached on the downstream side of Kamuzu Truss Bridge by a simple structure consisting of a metal plate with a bituminous surface. However, some parts of this metal plate have dropped off and this sidewalk is impassable at present. Therefore, pedestrians and bicycles crossing the Shire River are forced to use the open grating floor of the main span; however there is almost no traffic at present. In order to prevent traffic accidents as well as smooth passage of vehicles on the main span after construction of the Chiromo Road Bridge and improvement of road section between Makhanga and Bangula proposed for completion by 2015, it is necessary to separate pedestrians and bicycle traffic from other vehicle traffic on the Kamuzu Truss Bridge. Therefore, all the metal flooring is planned for replacement by the open grating floor to minimize the static load on the simple sidewalk structure.

d) Rehabilitation Cost

Preliminary cost for rehabilitation of Kamuzu Truss Bridge is estimated as follows:

- Repainting of truss structure and open grating floor: US$ 560,000
  (including installation of scaffoldings for painting works)
- Installation of open grating floor for the side walk: US$ 256,000

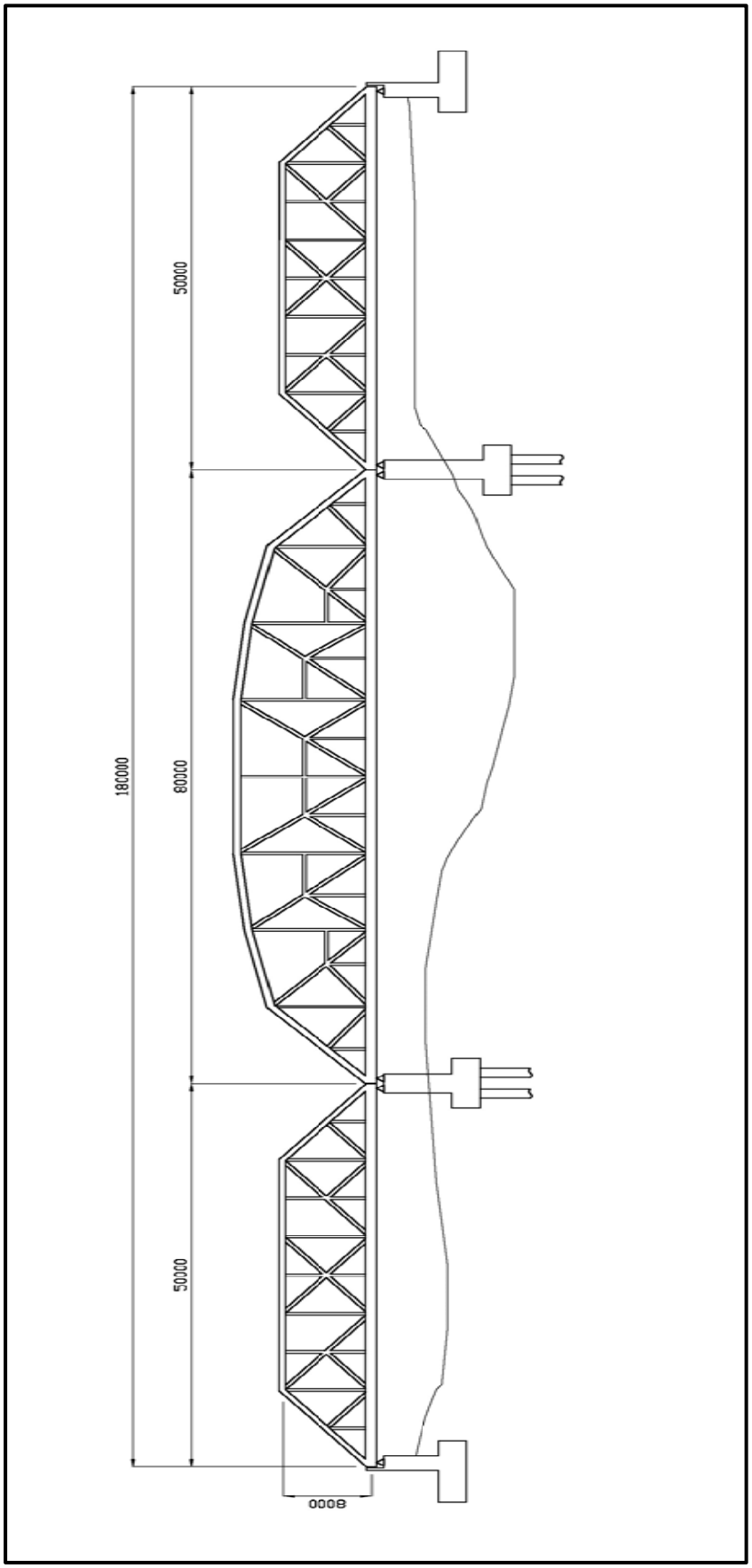


Figure 9-22 General View of the Existing Kamuzu Truss Bridge

Source: Study Team

e) Inspection and Maintenance

The Kamuzu Truss Bridge is old yet is still in sound condition because no train or vehicle traffic has passed since the major flood at Chiromo. This means that there was no live load to fatigue the metal truss and concrete substructure. After completion of the S151 reconstruction and the railway reconstruction mentioned in this report, frequent passage of both trains and vehicles is expected. Therefore, routine inspection and maintenance, as well as periodic maintenance are deemed necessary. Items of routine inspection/maintenance and periodic maintenance are as follows:

- Routine inspection/maintenance
- Condition and corrosion of members of truss structure, open grating floor and sidewalk
- Condition of metal shoes
- Condition of abutments and piers
- Emergency repair of damaged part
- Periodic maintenance
- Repainting of members of truss structure and sidewalk

f) Reconstruction of Kamuzu Truss Bridge

To consider the life span of the Kamuzu Truss Bridge, it will be necessary for MoTPI to consider the construction of a new railway bridge parallel to the existing bridge after 2030 to accommodate increasing railway traffic when freight trains will operate between Limbe and Beira Port.

9.4.4 Track Rehabilitation and Reconstruction Plans

The track is composed of rails, sleepers, fastenings, ballast, roadbed, etc. The criteria for the track should be defined according to the annual passing tonnage and maximum operating speed of the line. Previous improvement works conducted in Japan, which adopts the same narrow gauge, will be a good example for rehabilitating the track in Malawi.

(1) Gauge

The track gauge is 1,067 mm, the same as the present one, measured at 14 mm below the top of the rails. The curves on the main line are a minimum of 244 m radius and it is unlikely that the track gauge will require widening on the curves to improve the passage of locomotives.

(2) Track Alignment

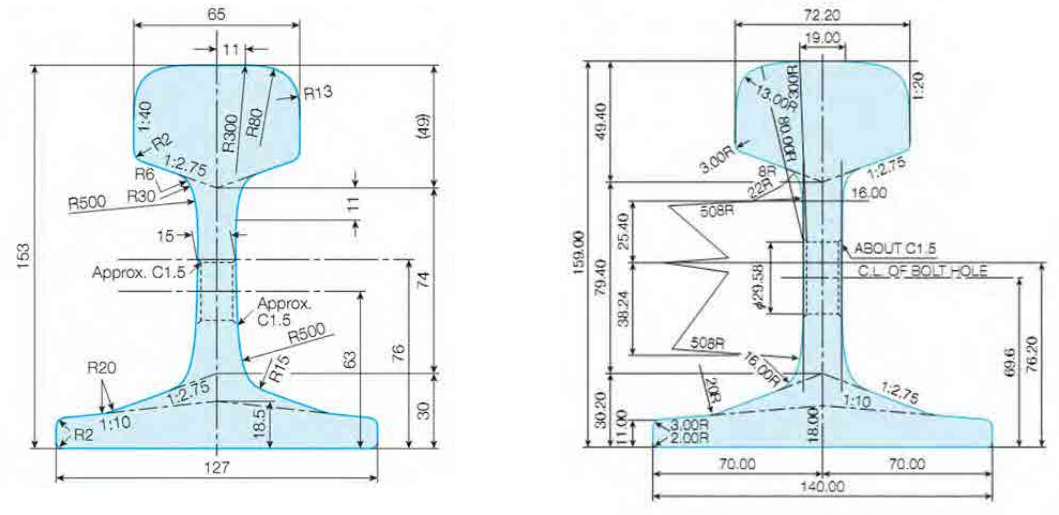
The track alignment will be designed based on the track design standards of MoTPI. The design should be based on a design speed of 60 km/h and operation speed of 50 km/h on the narrow gauge track, which will be suitable for freight and passenger services.

(3) Rails and Sleepers

The rails are laid on resilient supports attached to PC sleepers and continuously welded with expansion joints. The rails will be a 50 kg/m type such as JIS 50N[15] or UIC54[16] rails. There are

[15] JIS: Japanese Industrial Standard
[16] UIS: International Union of Railways

two types of sleeper: mono-block type PC and two-block type RC sleepers. The former is recommended for the narrow gauge track, because it is more stable for the track than the latter.



JIS50N **UIC54**

Source: Nippon Steel Corporation

Figure 9-23 Cross-section of Rails (JIS50N and UIC54)

The Japanese Railway Standard recommends the rail type by line class as shown in Tables 9-20 and 9-21. However, 40 kg rail is now seldom used to construct a new line other than depots, and so the market price of 40 kg rail is higher than that of 50 kg rail. Therefore, it is recommended to use 50kg rail for rehabilitation of the line in terms of cost, mechanical stiffness and durability.

As to the number of sleepers per 25 m rail, 39 sleepers should be provided per 25 m rail considering an axle load of 20 tonnes, as shown in Figure 9-24.

Table 9-20 Recommended Rail Type

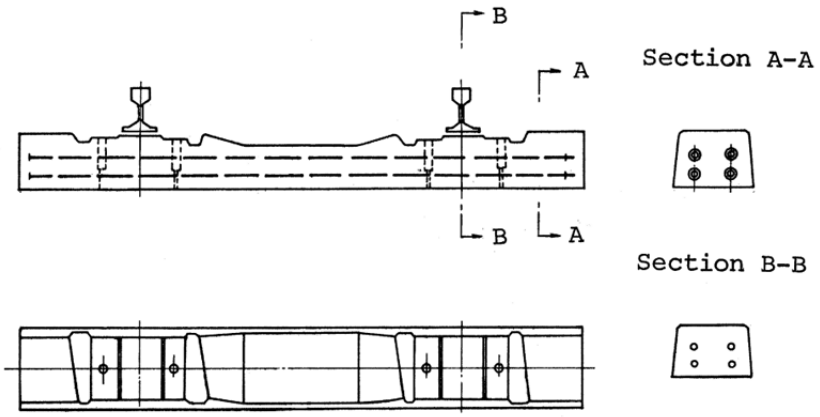
Line Class	Recommended Rail Type (kg/m)
High-speed railway line (Shinkansen) or trunk line with heavy traffic in metropolitan area	JIS 60 kg
Trunk Line	JIS 50N (50 kg)
Local Line	JIS 40N (40 kg)

Source: Nippon Steel Corporation

Table 9-21 Market Price of Rail

Rail Type	Market Price (US$ per 25 m)
JIS 50N (50 kg rail)	1,840
JIS 40N (40 kg rail)	1,890

Source: Market Price as of August 2011

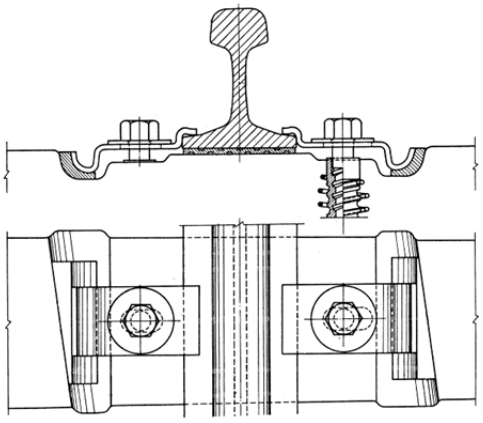


Source: Study Team

Figure 9-24 PC Sleeper

(4) Fastening System

The fastening system for PC sleepers should adopt a double elastic fastening with a resilient pad which fixes the rail on the sleeper from the top. A maintenance-free clip-type fastening (PANDROL) can be applied.



Source: Study Team

Figure 9-25 Double Elastic Fastening System

Source: Study Team

Figure 9-26 Fastening System (Double Elastic Fastening and Clip-type Fastening)

(5) Ballast

Ballast with a nominal depth of 300 mm is to be laid on the track bed to support the sleepers and rails. The depth is based on the use of an appropriate ballast material and a well-compacted sub-ballast formation.

The sub-ballast formation slopes so that rain water drains to both sides of the alignment. A cross-fall of 1:30 will provide satisfactory drainage under heavy rainfall and will minimize the risk of erosion of the surface of the foundation.

(6) Roadbed

The critical matters for the roadbed are mud pumping, roadbed settlement, slope collapse, etc. The countermeasures for mud pumping are: a) increment of ballast pressure, b) improvement of drainage, c) roadbed substitution method, and d) roadbed covering method. As settlement of the roadbed is caused by soft ground, proper countermeasures should be taken considering the importance of the line. Slope collapse should be prevented by vegetation, covering with concrete blocks, etc.

(7) Track Works

Track works by section are summarised in Table 9-22.

Table 9-22 Outline of Track Works

Item	Unit	Border–Nsanje	Nsanje–Bangula	Bangula–Makhanga	Makhanga–Luchenza	Luchenza–Limbe	Total
Track Length (Main line)	km	25.6	45.4	8.7	76.6	44.0	200.3
Track Length (Loops)	km	1.5	1.0	1.9	1.0	1.1	6.5
Total Track Length	km	27.1	46.4	10.6	77.6	45.1	206.8
Rail (Main line)	tonne	2,600	4,600	900	7,700	4,400	20,200
Rail (Loops)	tonne	200	100	200	100	100	700
Total Rail	tonne	2,800	4,700	1,100	7,800	4,500	20,900
PC Sleeper	Set	42,300	72,400	16,500	121,100	70,400	322,700
Fastening	Set	84,600	144,800	33,000	242,200	140,800	645,400
Turnouts	Set	7	4	8	4	9	32
Ballast	m^3	36,200	62,100	14,200	103,800	60,300	276,600

Source: Study Team

9.4.5 Rehabilitation Plans for Stations and Station Facilities

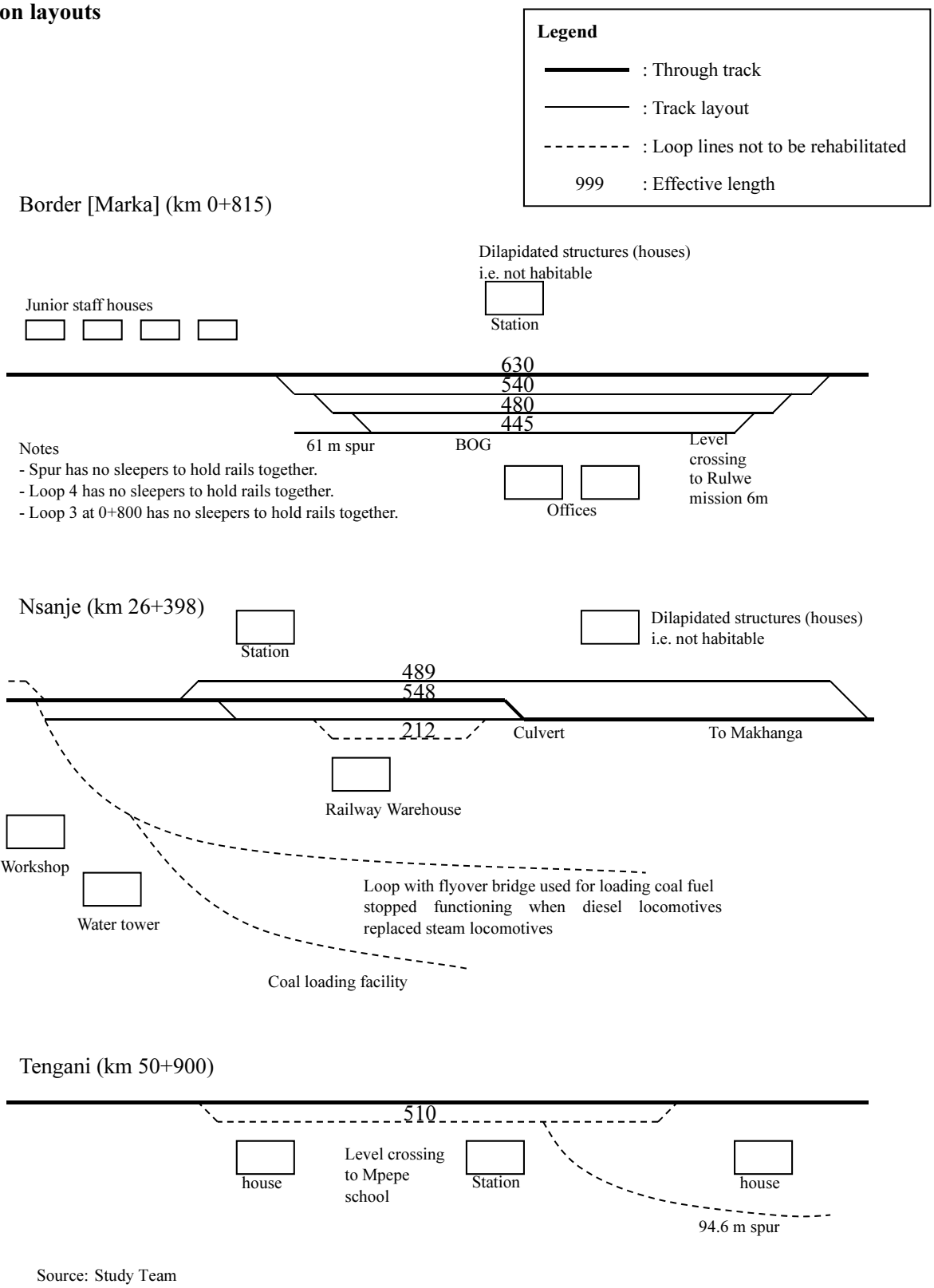
(1) Stations

Stations along the railway line directly connecting between Border and Limbe are arranged at 3.3-km to 25.6-km intervals (average 13.3 km) at present.

According to the train operation plan based on forecasted demand for the year 2030, three trains will be needed per day for one way. Accordingly, some stations should be interchange points with loop lines. Therefore, the existing loop lines at intermediate stations other than interchange points are not rehabilitated or removed.

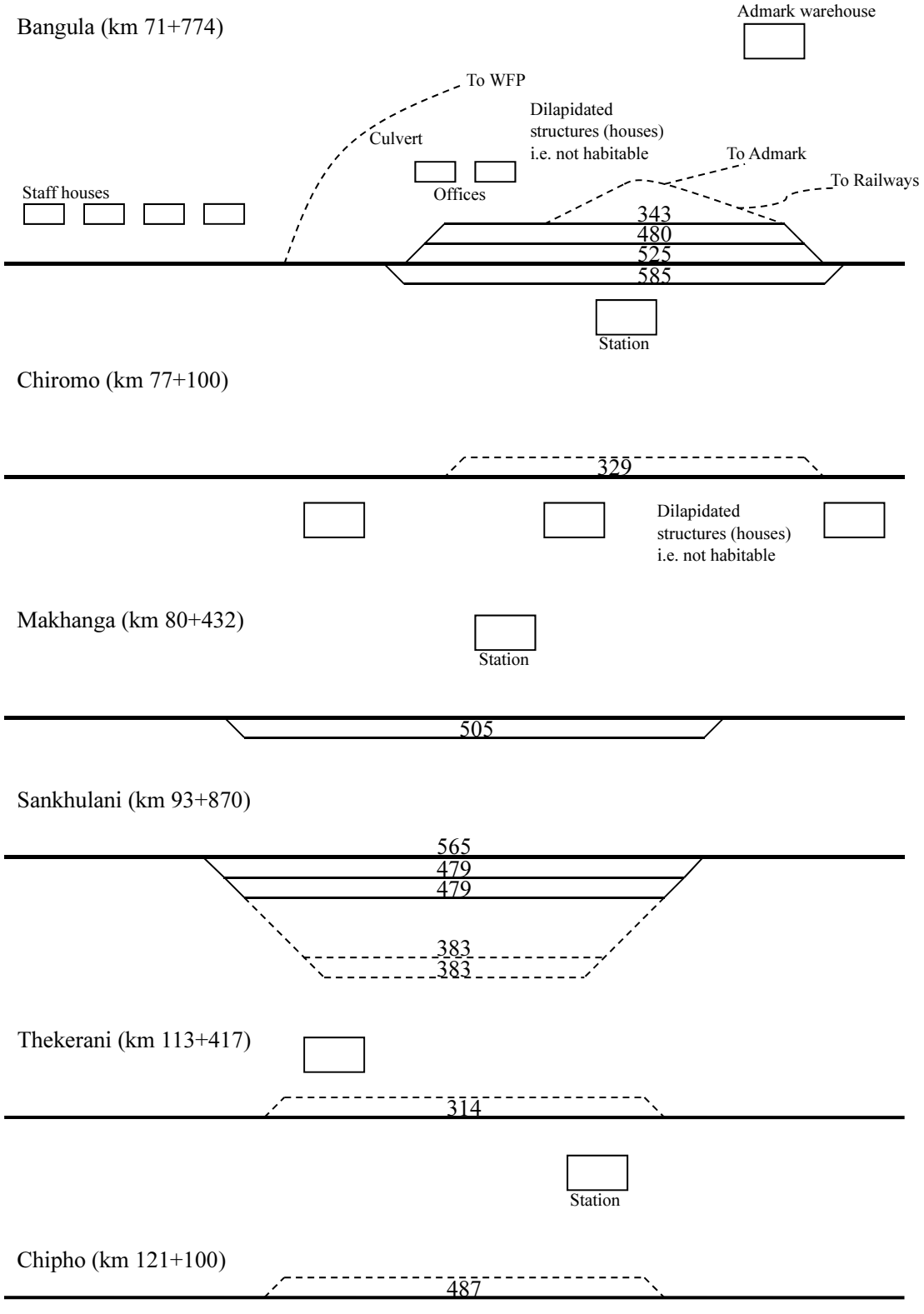
Schematic diagrams of the track layout of each station are shown in Figures 9-27 to 9-29.

Station layouts



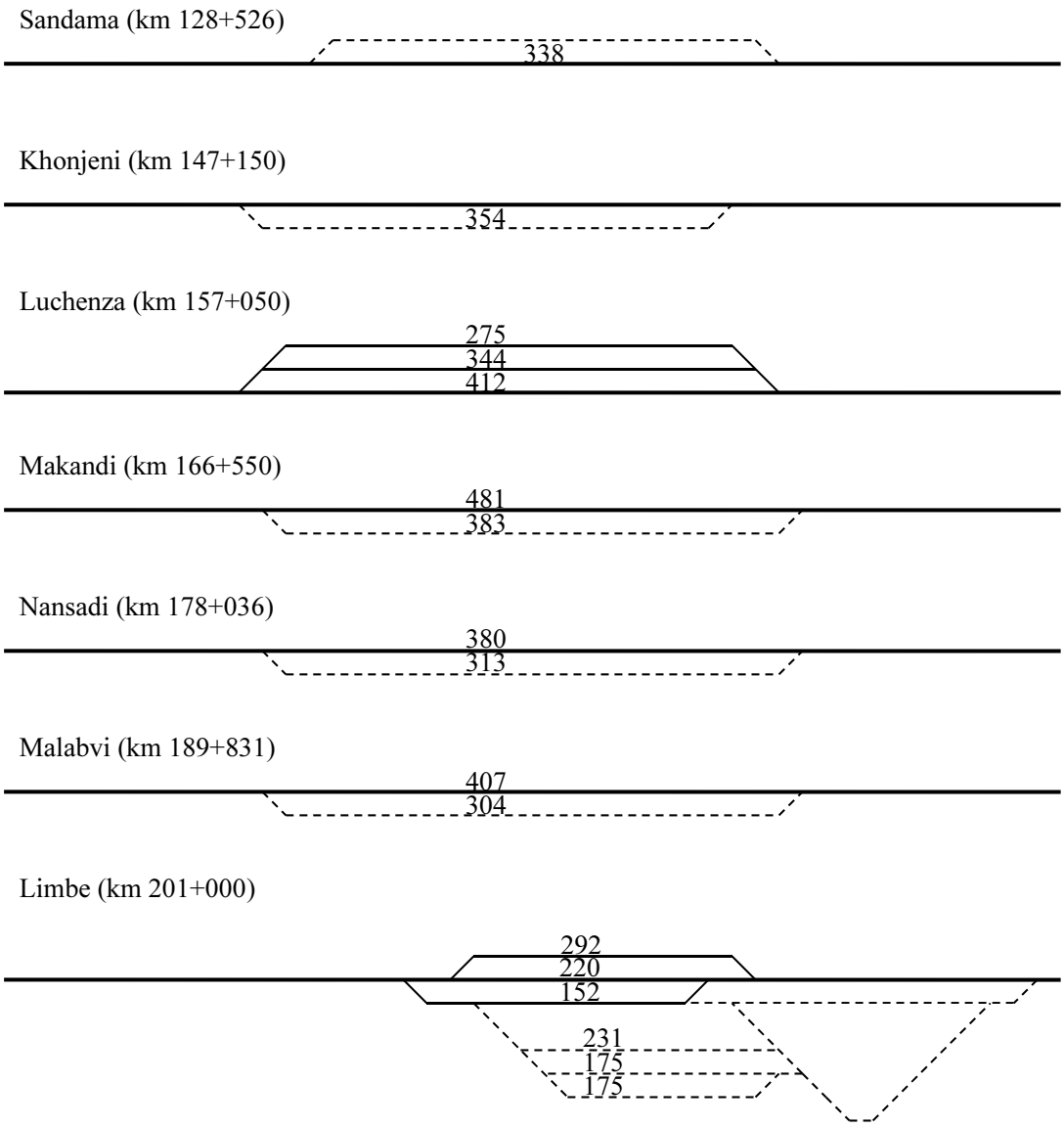
Source: Study Team

Figure 9-27 Station Layouts from Border to Tengani



Source: Study Team

Figure 9-28 Station Layouts from Bangula to Chipho



Source: Study Team

Figure 9-29 Station Layouts from Sandama to Limbe

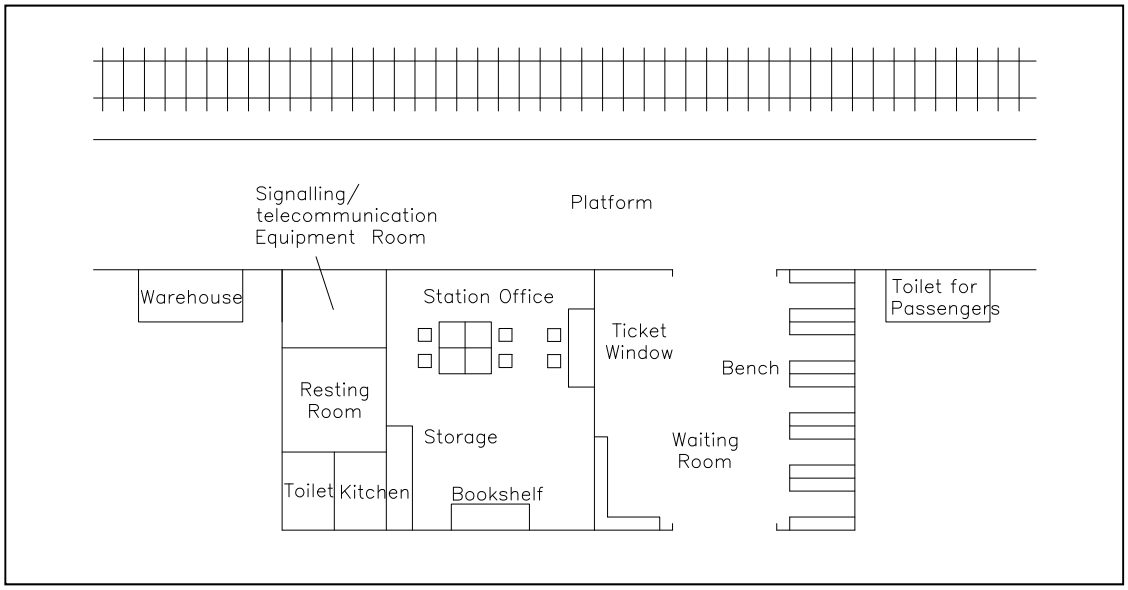
(2) Station Facilities

In the stations handling passengers, station facilities should be installed in the station building as shown in Table 9-23. The layout of typical station facilities is shown in Figure 9-30.

Table 9-23 Station Facilities

Facilities	Description
1) Station office	A station office is installed near the entrance for station staff to work, take a rest or for standby persons.
2) Signalling and telecommunication equipment room	A signalling/telecommunication equipment room is installed. The room contains electrical equipment, signalling/telecommunication equipment, etc.
3) Ticket window	Tickets are sold at ticket offices by station staff. The space of the ticket window to be constructed will be sufficient to install a ticket vending machine (TVM) in future.
4) Passenger information system (PIS) and public address system (PA)	In future, a passenger information system (PIS) and public address system (PA) should be installed for passenger convenience.
5) Waiting room	A waiting room is installed for passengers. In future, air conditioners should be installed in the station office and waiting room.
6) Warehouse	A warehouse is installed adjacent to the station building to keep materials for station business and emergency supplies.
7) Toilet	At each station, toilets should be installed adjacent to the station building.

Source: Study Team



Source: Study Team

Figure 9-30 Layouts of Station Facilities

9.4.6 Reconstruction Plan for Level Crossings

(1) Existing Level Crossings

The major level crossings between the border and Limbe are shown in Photo 9-3. Railways in Malawi have no safety equipment at level crossings, although signs such as “Give a Way” or “Stop” are placed on the roadside at some level crossings.

Level Crossing at Nsanje

Level Crossing at Bangula

Level Crossing at Makhanga

Level Crossing at Luchenza

Level Crossing at Limbe

Photos by Study Team, November 2010 and June 2011

Photos 9-3 Existing Level Crossings

(2) Classification of Level Crossings

The level crossings are categorized into four types according to safety equipment. Type 1 is a level crossing with automatic barrier, Type 2 is a level crossing with manual barrier, Type 3 is a level crossing with alarm, and Type 4 is a level crossing without safety equipment. The four types of level crossing are explained in Table 9-24.

Table 9-24 Classification of Level Crossings

Classification		Description
Type 1	Level crossing with automatic barrier	Blocks the road traffic automatically when trains pass through the crossing.
Type 2	Level crossing with manual barrier	Blocks the road traffic by a security guard when train pass through the crossing.
Type 3	Level crossing with alarm	Sounds an alarm for road traffic automatically when trains pass through the crossing.
Type 4	Level crossing without safety equipment	Has no safety equipment.

Source: Study Team

(3) Types of Barrier

In Type 1 and 2 level crossings, the types of barrier are categorized as follows. A rope is stretched across the road when traffic is relatively low. A bascule barrier is used when the road is less than 6 m wide, and a sliding door is used when it is more than 6 m wide. For roads with high traffic volume, a hung gate is used which is raised to a high position so as not to disturb the traffic when trains are not passing through the crossing.

Table 9-25 Types of Barrier

No.	Type	Description
1	Rope stretching	Blocks the road traffic with a rope by a guard man for a crossing with light road traffic.
2	Bascule barrier	Blocks the road traffic with a bascule barrier automatically or by a guard man.
3	Sliding door	Blocks the road traffic with a sliding door by a guard man at a crossing with heavy road traffic.
4	Hung gate	Blocks the road traffic with a hung gate automatically or by a guard man at a crossing with heavy road traffic.

Source: Study Team

(4) Recommendations on Rehabilitation of Level Crossings

The frequency of train operation will become high after rehabilitation of the railway. Therefore, level crossings also need rehabilitation. The rehabilitation points are as follows.

a) Installation of Precast Crossing Plate

At some level crossings, the crossing part is paved in the same way as the road. It is difficult to conduct the track maintenance work. Therefore, the removable precast crossing plate as shown in Figure 9-32 and Photo 9-4 must be installed to enable track maintenance.

b) Improvement of the crossing angle

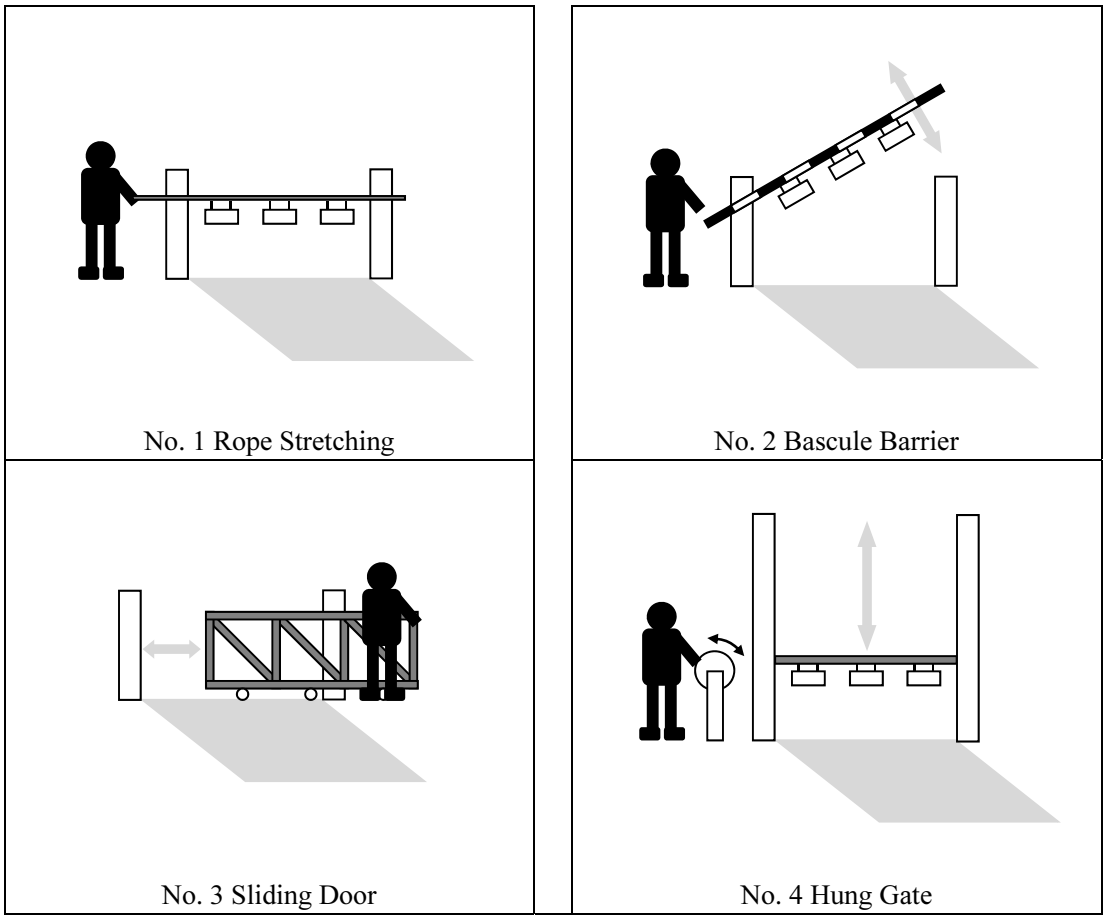
The crossing angle between a road and a railway should be greater than 45° to minimize the problem of oblique crossing.

c) Installation of Signs

Signs which indicate the level crossings should be installed.

d) Installation of barriers

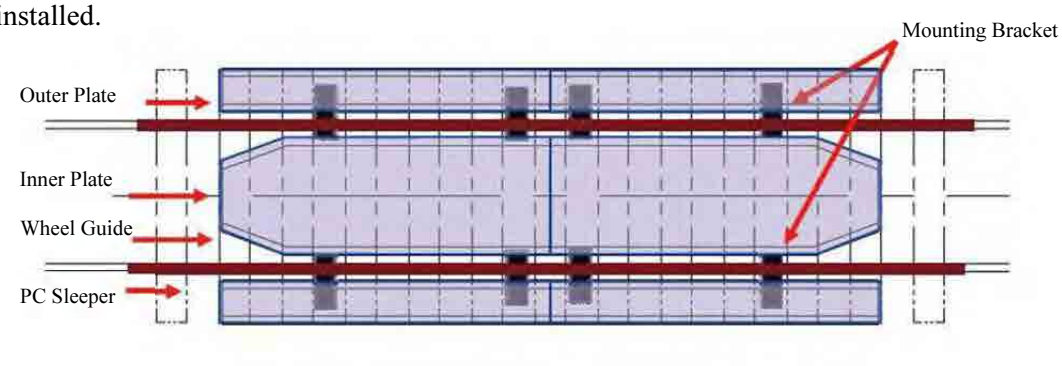
There are manned level crossings at the six major locations of Nsanje, Bangula, Makhanga, Luchenze and Limbe. The type of barrier might be Type 2 or 3 depending on the road width.



Source: Study Team

Figure 9-31 Types of Barrier

If the volume of road traffic at the crossing greatly increases in future, a flyover should be installed.



Source: Railway Technical Research Institute (RTRI) in Japan

Figure 9-32 Precast Crossing Plate

Source: Railway Technical Research Institute (RTRI) in Japan

Photo 9-4 Example of Crossing with Precast Crossing Plate

9.5 Signalling and Telecommunication System Installation Plans

The current signalling and telecommunication system is not working at all. A new signalling and telecommunication system should be planned for the line.

The concept of the proposed signalling and telecommunication system is described below.

9.5.1 Signalling System

The signalling system will ensure the safety and efficient control of train operations. The system will include the following devices and facilities for signalling and train control in a pattern designed to meet the requirements of long-distance freight transportation.

The signalling system will consist of a combination of signals, interlocking devices, electric switch machines and track circuits. The electronic logic and interlocking devices will be installed in the signalling of each station.

(1) Signals

As the signals are to be installed on the ground, the following types are assumed:

a) Fixed type signal

The fixed type signal is a simple metallic panel installed on a concrete pole and used for indicating stop, speed and special danger.

b) Signals

Coloured light signals will be used to indicate the running condition or whether the section ahead is clear to train drivers and will consist of green, yellow and red for each signal unit. The signals will be categorized as follows:

- Home signal: will be installed at the entrance of each station to instruct approaching trains whether they can enter the station or not.
- Starting signal: will be installed at the departure tracks of each station to give permission for outgoing trains to depart from the station.

- Repeating signal: will be installed where home signals are not easily visible, will repeat the home signals on the main signals.
- Shunting signal: will be installed to give permission for shunting operation in the stations where the shunting will be performed, and will include route indicators to show a train operation destination to the train driver.

(2) Electronic Interlocking Device

Signals and electrical turnout switches will be installed to ensure safe and efficient operations for leaving, arriving and shunting of trains in the stations. To provide overall control of the equipment, the electronic interlocking device will be installed to perform electrical interlocking between signals. The electronic interlocking devices are operated by microcomputer.

(3) Track Circuit

Track circuits will be provided to detect track sections occupied by trains in each station only. Considering the train operation plan in Section 9.2, sections between stations will form one block system without a continuous track circuit, and a token-less block instrument system will be installed outside of the signals to check trains in and out.

(4) Automatic train protection (ATP)

ATP will be provided inside the station to compensate for errors by train drivers. The ATP will automatically make a warning sign to the train driver when the train is approaching a red light and then if the driver does not apply brake, the train will be automatically stopped by the ATP system.

(5) Operation Control Centre (OCC)

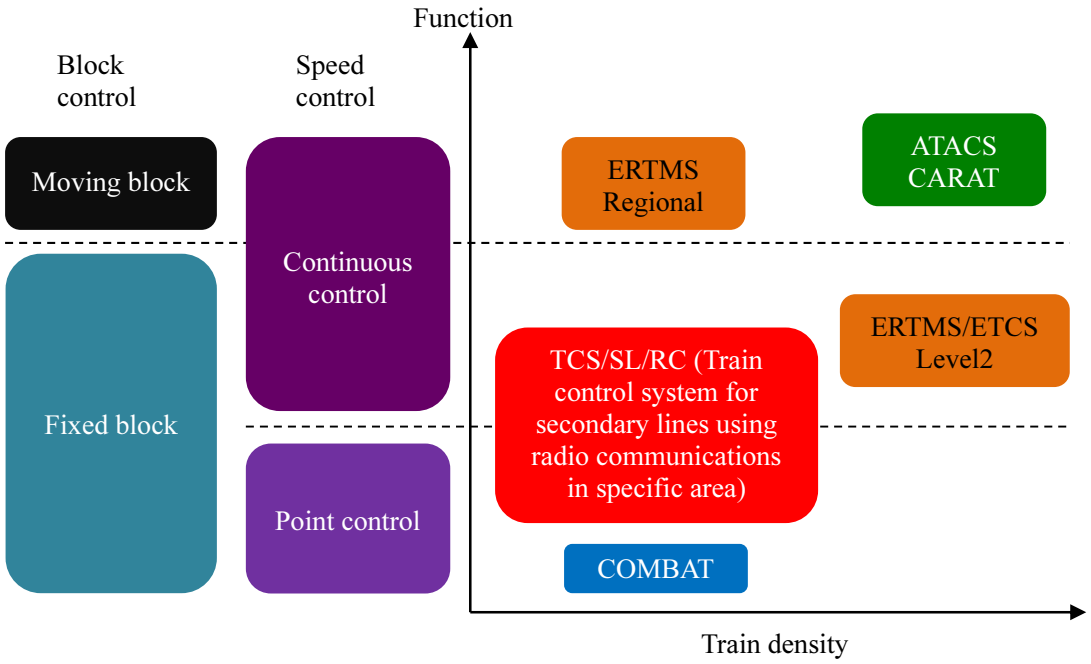
The OCC will be installed at Limbe station which is almost the mid point of the mainline in Malawi, and will be fitted with control and indication panels. The control panel will be used to operate the turnout switch machines in each station, and will be fitted with telecommunications equipment including train dispatching telephone and train radio. The indication panel will schematically display the operating conditions and faults of signalling devices and train locations between stations.

(6) Proposed Signalling System

The relationship between traffic density and required functions is shown in Figure 9-33. On the Sena railway, there are not many trains and the traffic density is low. In addition, the train operation control does not require advanced technology. The "Train Control System for Secondary Lines using Radio Communications in Specific Area (TCS/SL/RC)" developed by the Railway Technical Research Institute (RTRI) of Japan for intermittent and continuous control would be suitable for the line. The system configuration charts of the wayside and on-board equipment are shown in Figures 9-34 and 9-35, respectively.

The block system based on electronic tokens called COMBAT (Computer and Microwave Balise Aided Train control system) has been used for secondary lines since the 1980s in Japan, and has contributed to efficient administration. However, an alternative advanced system needs

to be developed because spare parts are no longer available. Therefore, a new train control system applying the 2.4-GHz band radio has been developed, which does not require a license. Replacement of the whole system is not required and system migration is simple, because conventional equipment is used wherever possible. Simultaneously, it is easy to introduce additional functions and to solve the problems of the conventional system.

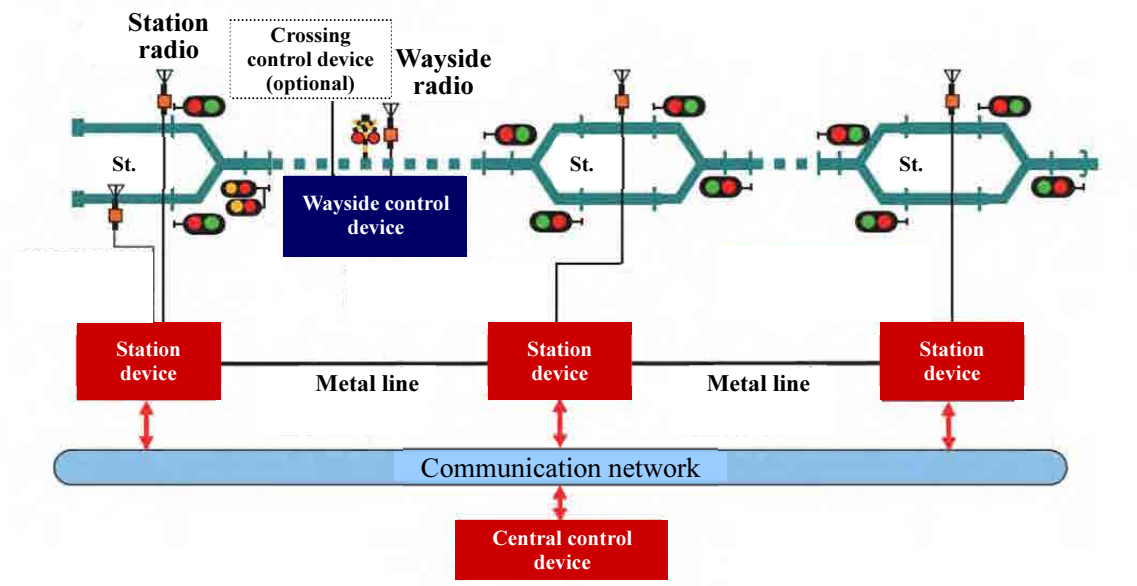


Source: Railway Technical Research Institute in Japan

Note:

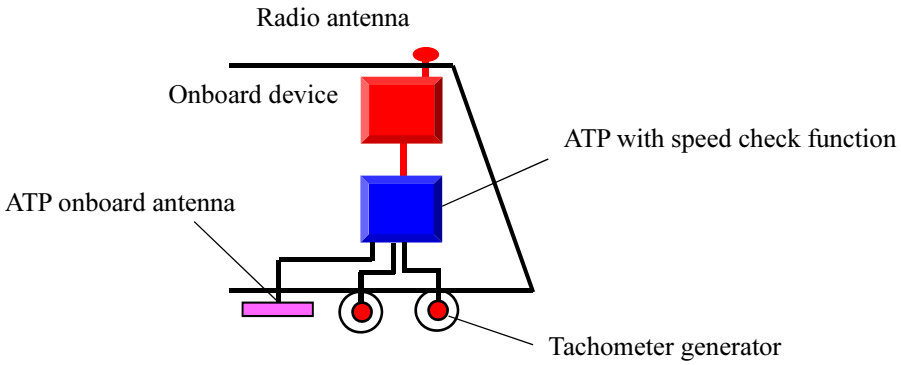
- COMBAT (Computer and Microwave Balise Aided Train control system):
  COMBAT is a computer and microwave Balise (composed of onboard transmitter and wayside train detector) aided train control system which can detect trains without contact. It provides high safety and reliable train operation with low cost on low-density lines.
- ERTMS Regional (European Rail Traffic Management System-Regional):
  The basic aim of the ERTMS REGIONAL concept is to enable cost-saving solutions for signalling on regional and local lines when renewing or introducing signalling equipment on such lines.
- ATACS CARAT (Advanced Train Administration and Communications System, Computer and Radio Aided Train control system):
  ATACS CARAT is being developed to reduce the amount of equipment and permit on-board detection of train locations without using track circuits.
- ERTMS/ETCS Level 2 (European Rail Traffic Management System/European Train Control System):
  ERTMS is a signalling and traffic management system developed with the backing of the European Union. The objective of ERTMS is to allow interoperability across international borders without the problem of having incompatible signalling systems on either side. ETCS is the train control element of ERTMS.

Figure 9-33 Train Control System using radio communications



Source: Railway Technical Research Institute in Japan

Figure 9-34 Outline of Wayside Equipment



Source: Railway Technical Research Institute in Japan

Figure 9-35 Outline of Onboard Equipment

(7) Outline of Onboard Equipment

As the line is connected to a part within Malawi of the Nacala railway line at Nkaya which will be upgraded and an extension line constructed, the connection with the existing line should be considered when designing the signalling system.

No interlocking device has been installed yet at Nkaya station, and the block is secured by dispatch telephone with adjoining stations, therefore an interlocking device should be installed in this station when the extension line is completed.

Though the signalling system for the extension line between Moatize and Nacala has not been announced yet, it is important and essential to secure safe and efficient train operation between the existing line and the extension line. The compatibility and integration of signalling should be considered at the basic design stage for the rehabilitation.

9.5.2 Telecommunication System

(1) Outline

In general, a railway telecommunication network is installed along the railway line. The network is composed of general stations with few transactions and junctions/terminals with many transactions.

To meet these requirements, the railway telecommunication network consists of a combination of transmission network deployed along the rail line using voice cables, multiplex carrier, radio systems, or other forms of transmission media, which are suitable for transmission between terminals, and voice/data exchange equipment, data processing equipment, etc.

Another feature of railway communication is that it requires a higher degree of real-time communication and communication accuracy than common carriers as telephone companies in Malawi, because it handles the operation of trains, rolling stock allocation and freight movement. For this reason, dedicated transmission lines or direct transmission lines should be installed on the whole line. The radio communication system between the OCC and trains will be another requirement unique to the railway operation.

(2) Proposed Telecommunication System

a) Backbone System

A fibre-optic communication system with redundancy, expandability and high cost-performance should be installed along the whole route as a backbone communication system.

A Network Management System (NMS) will be installed at the OCC and highly reliable dedicated circuits will be provided not only for communication sub-systems but also for the OCC.

b) PABX System

The automatic telephone system is composed of a Private Automatic Branch Exchange (PABX) and telephones, which will be installed to allow general communications between the offices and stations for operation and administration of the railway.

The PABX equipment will be installed in the equipment room in the buildings at Limbe, Luchenza, Bangula, Nsanje and Border stations, and will be able to communicate with common carriers.

c) Dispatching Telephone System

The dispatching telephone system will be installed to send essential control information for train operation. Using the dispatching circuits, the dispatching telephone system will connect a dispatch console to be installed in the OCC and individual telephone sets to be installed in every station and the maintenance depot. Also, a recording facility will be mounted on the dispatch consoles to record voice communications on this system.

d) Train Radio System

The train radio system provides a communication link between the OCC and the trains

running on the line for the purpose of regulating train operations on a daily basis. In an emergency, the system is used to provide quick and reliable communication for taking suitable countermeasures. Possible technologies for the train radio are a dedicated UHF/VHF band or GSM-R (Global System for Mobile communications - Railway).

The train radio system offers individual calls, group calls, and general telephone calls from the OCC. The system also enables each train to communicate with nearby stations, if necessary.

By employing the GPS system and a map system, train locations could easily be detected.

e) Clock System

The clock system will be a maintenance-free type with self-adjusting function based on a GPS receiver.

9.6 Rolling Stock and Maintenance Depot/Workshop

9.6.1 Rolling Stock

In the railway in Malawi, only 4 out of 10 DLs are operated on the whole route at present. When the section between Border and Limbe is reopened, additional DLs, freight wagons and passenger coaches will be required.

In the Study, it is assumed that DLs have similar or superior characteristics to the ones currently in operation (Bombardier MX615). However, the Bombardier MX615 is not available today.

(1) Required number of diesel locomotives, freight wagons and passenger coaches

The required number of DLs, wagons and coaches has been calculated in Section 6.6.6. They are summarised in Table 9-26.

Table 9-26 Required Number of Rolling Stock

Year	2015	2020	2030
DL	2	3	6
Freight Wagon	30	60	150
Passenger Coach	6	6	6
Total	38	69	162

Source: Study Team

(2) Diesel Locomotive

The choice of rolling stock for the section would be determined to meet the overall traffic requirements for present and future at maximum efficiency and minimum overall cost to the system. Considering this and the train load of the section, DF200 diesel locomotives, which are currently operated on the freight lines in Japan, will be a candidate locomotive for the section. The DF200 does not require a delta track for pendulum operation at turn-back stations, because it has a driver's cabs at each end of the car. Its induction motors with Variable Voltage Variable Frequency (VVVF) control system can realize high acceleration, high speed, and large torque, which resulted in saving labour for maintenance and diesel fuel. On the other hand, the GE Dash 9-40BBW proposed for Nacala line cannot fit the section, because the dimensions of the

car and the axle load exceed the current vehicle gauge and axle load respectively.

Note: The type DF200 is a diesel electric locomotive equipped with diesel generators and developed for use on the main line of the Japan Freight Railway Company, to solve the insufficient output power of the former Type DD51 diesel hydraulic locomotive. It has six drive shafts and adopts induction motors with VVVF control system to realize high acceleration, high speed, and large torque, which resulted in a quick-response generator brake system. The adoption of induction motors has saved labour for maintenance and diesel fuel.

Source: Kawasaki Heavy Industries, Ltd.

Photo 9-5 DF200 Diesel Electric Locomotive

Table 9-27 Comparison of Diesel Locomotive

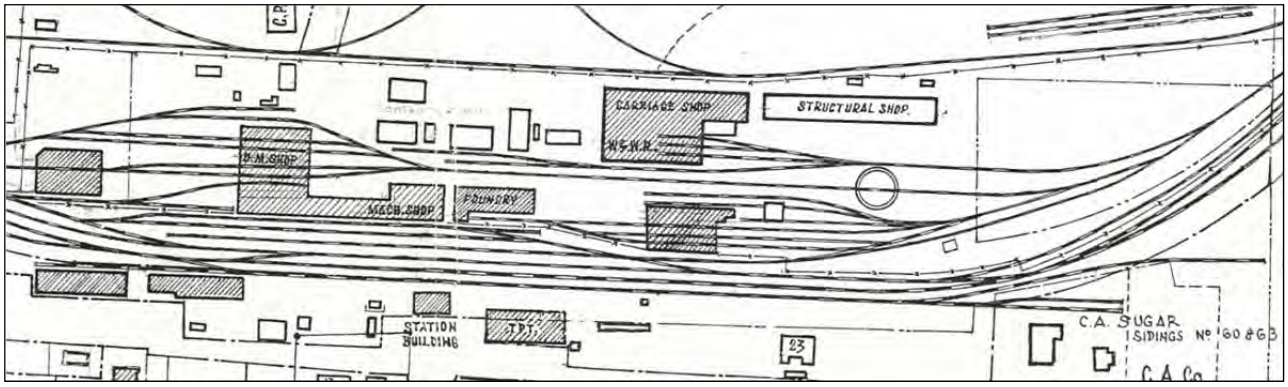
Item	Specifications	
	DF200	GE Dash 9-40BBW
Maximum Operating Speed	110 km/h	80 km/h
Traction Control System	VVVF Inverter Control	Electric AC/DC
Adhesive Mass	96 tonnes	160 tonnes
Rated Output	1,700 HP	3,990 HP
Output of Traction Motor	320 KW x 6=1,920 KW	n.a.
Dimensions	19,600 x 2,805 x 4,078 mm	23,076 x 3,340 x 4,900 mm
Axle Arrangement	BoBoBo	BoBoBoBo
Gauge	1,067 mm	1,067 mm

Source: Kawasaki Heavy Industries, Ltd., GE

9.6.2 Maintenance Depot/Workshop

The depot is used not only for repair, maintenance and storage but also as the base for the operator. The current depot/workshop is located at Limbe as shown in Figure 9-36 and it should be improved and extended according the following matters:

- To accommodate future demand
- To manage equipment and operators effectively
- To easily obtain the land for expansion



Source: CEAR

Figure 9-36 Layout of Depot/Workshop at Limbe

9.6.3 Main Facilities of Depot

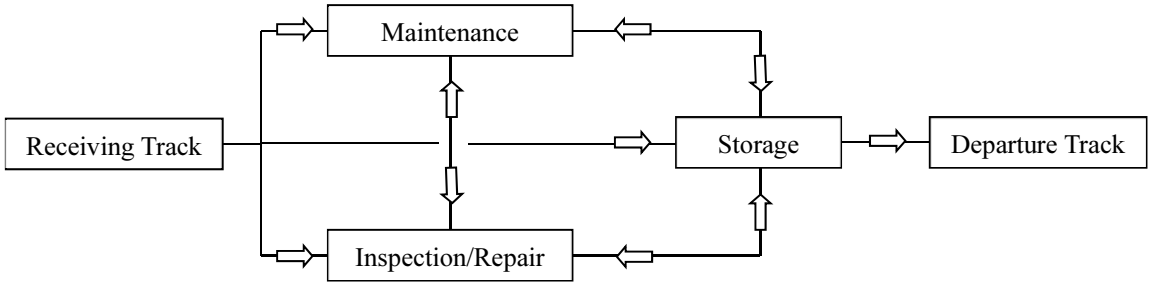
Systematic arrangement of facilities and equipment at the depot is important so as to carry out the works effectively and smoothly. First, the total plan of the facility arrangement should be determined based on the scope and type of works and second, a detail arrangement is determined according to the content of each work. Facilities required at the depot are as follows:

- Car storage track
- Car maintenance track
- Car repair and maintenance facilities
- Facilities for the drivers and staff
- Management office

The size of the depot should be determined based on the number of cars and area required for inspections. It is also affected by the number of trains, train sets and train diagrams. The depot at Limbe has a workshop facility in order to carry out general and important-part inspections, casual repair and renewal repair.

The design of the size and facility plan for the depot should be based on the final number of cars and initial purchase, and the arrangement of equipment is based on minimum requirements at re-opening time.

The basic flow of inspection and maintenance at the depot is shown in Figure 9-37.



Source: Study Team

Figure 9-37 Basic Flow of Inspection /Maintenance at Depot

9.6.4 Main Facilities of Workshop

The main facilities of the workshop should be arranged in order to carry out the works effectively and safely. In the workshop, there are many facilities or inspection and repair and the arrangement of each facility shall take into account functionality and safety. The sufficient space shall be considered around the factory building to mitigate the effect of noise and dust.

The following shops should be located in the workshop.

- Carbody jack-up/Repair Shop
- Carbody Panel Shop
- Bogie Shop
- Wheelset Shop
- Bearing Shop
- Engine Shop
- Generator/Motor Shop
- Electric Shop
- Coupler Shop
- Spring Shop
- Air Valve Shop
- Mechanical Shop
- Iron Shop
- Engine Test Shop
- Traverser

9.6.5 Inspection and Maintenance at Depot

(1) Inspection Procedure

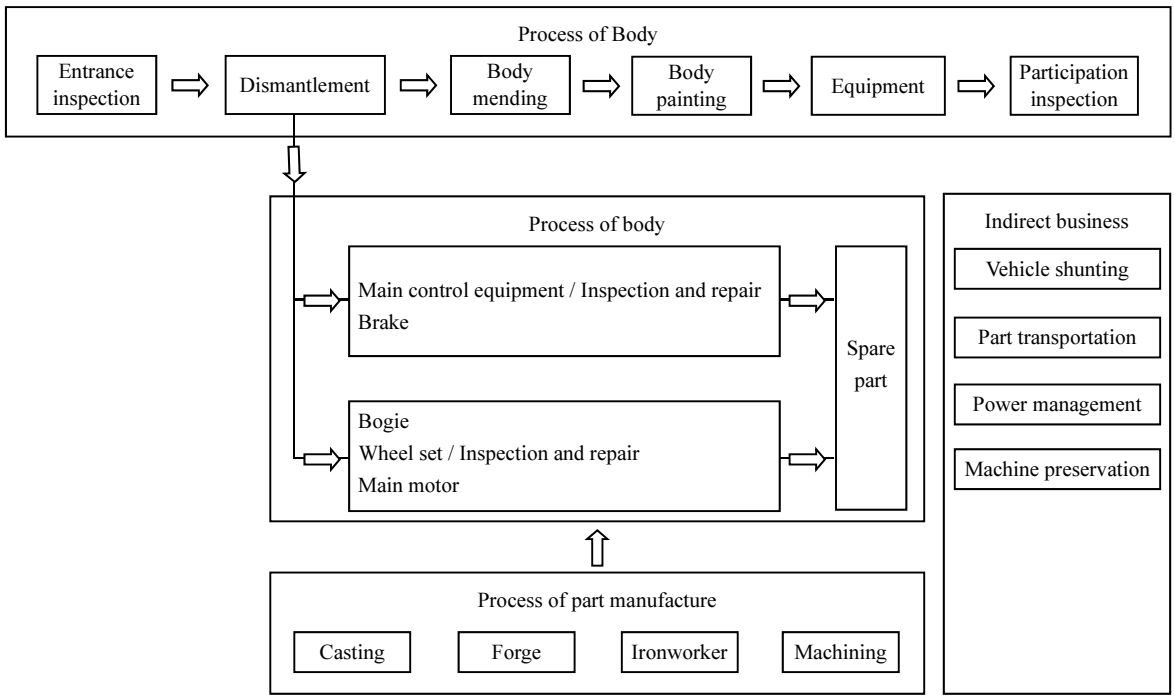
The flow of car inspection works at the workshop is shown in Figure 9-38. The car inspection works are divided into many types and these are carried out in parallel and concurrently.

(2) Classification of Inspection

The diesel locomotive consists of complicated parts and equipment. The maintenance and replacement of parts are regularly required. Therefore, periodical inspections such as daily inspection, regular inspection, important-parts inspection, general inspection and casual repair are very important for each part and piece of equipment. These inspections, dismantling inspection and large scale repair are carried out at the workshop. Each inspection is described as follows:

a) Daily Inspection

The daily Inspection is carried out in order to check the function of a car before daily operation. The condition and function are checked visually from the outside when the train is set.



Source: Study Team

Figure 9-38 Car Inspection Flow at Factory

2) Regular Inspection

The regular inspection is carried out periodically for main parts under the setting condition or after dismantling the part. It should be conducted after an interval of 30 days or an operation of 30,000 train-km.

3) Important-parts Inspection

The important- parts inspection is carried out only for those parts which are important for operation such as the brake system, traction motor, etc. It should be conducted after an interval of 4 years or an operation of 500,000 train-km.

4) General Inspection

The general inspection is carried out in detail by dismantling all parts and equipment. It should be conducted after an interval of 8 years.

5) Casual Inspection

The casual inspection is carried out after casual repair, for the first operation of a new car and as required.

9.7 Preliminary Cost Estimate

An estimate of the cost of rehabilitating/reconstructing the railway at least cost has been prepared to enable a decision to be made. However, before making a decision on the actual investment, a detailed feasibility study including a geotechnical investigation and development of the preliminary design should be conducted.

9.7.1 Basic Policy for Rehabilitation and Reconstruction of the Railway

This plan is prepared as mentioned below based on the actual conditions.

- Construction/reconstruction of bridges and reconstruction of railway lines on the unused section (between Border and Makhanga) will be carried out within the railway ROW.
- Bridges on the section between Makhanga and Limbe, where a weekly passenger train is operated, will be reconstructed as parallel bridges with existing bridges. Rehabilitation work on the existing railway line of this section will be carried out five days a week, when a train does not operate, and will complete the section.
- For constructing the Chiromo Railway Bridge and new embankment for approach sections, the GoM will acquire necessary land.
- The construction method shall be applied to avoid the influence of flood in the rainy season.
- The construction of foundation and substructure for bridges shall be done in the dry season in principle.
- The access to rehabilitation and reconstruction sites will be made from major stations, where an access road exists.
- A temporary road parallel to the railway track will be constructed for locations where no obstruction exists.
- A temporary bridge will be used during the construction of the Chiromo Railway Bridge during the construction period, in order to transport equipment, material and the workforce to the other side of the river.
- The procurement period for the material is not steady in Malawi, therefore a leeway for the start of certain work will be necessary.
- The fill material shall be obtained as close as possible to the site from a quarry.

9.7.2 Unit Costs and Quantities

The unit costs applied in the study are based on the following:

- Various unit cost data provided by CEAR through MoTPI
- Construction costs of ongoing and previous highway and road bridge construction projects by RA
- Adjusted international rates specific to railway equipment
- Consultant's past experience with similar projects elsewhere

To derive the quantities of each component of the project, Section 9.3 describes the earthworks, bridge works, etc. which have been included in the cost estimate.

The quantities have been prepared for the following items:

- Earth works
- Bridge
- Track
- Station

- Level Crossing
- Signal & Telecommunication System
- Rolling stock (Diesel Locomotive, Freight Wagon, Passenger Coach)
- Land Acquisition Cost
- Engineering Cost
- Contingency

The engineering cost is the cost for the detailed design and construction supervision, and is assumed to be 10% of the total construction cost.

Meanwhile, the contingency is an integral part of the expected total project cost and normally is necessary for all project items involving significant expenditures. For this study, it is assumed to be 10% of the total construction cost as a physical contingency.

9.7.3 Estimation of Project Cost

The estimation of construction cost is calculated based on the condition mentioned below. The construction cost includes 10％ contingency and does not include tax in Malawi.

(1) Bridge

Based on the consideration of construction site and structures for Chiromo Railway Bridge and other small scale bridges, those costs are calculated with comparison to similar construction projects abroad. An truss bridge is applied for the Chiromo Railway Bridge.

(2) Railway Rehabilitation and Reconstruction

Cost estimation for earthworks and concrete works is calculated based on the previous contract data in Malawi in consideration of the escalation of construction costs. Cost estimation for the bridges are calculated with comparison to similar construction projects carried out by RA and abroad.

(3) Others

The present situation to accomplish the project due to the shortage of fuel, cement and steel material is clearly difficult due to the delay of two Japanese grand aid road and bridge projects which are still on going. If such difficult conditions could not be solved, the project cannot be completed within the budget and in this situation the start of the project could be put into jeopady. The project costs are summarised in Table 9-28.

9.7.4 Construction Plan and Procurement Conditions

(1) Construction of Bridge

a) Concrete Bridge

The Chiromo Railway Bridge and other bridges for construction and reconstruction are steel truss, PC girder and RC girder bridges. In Malawi, it is impossible to procure the necessary equipment and material for construction of steel truss bridges and PC girder bridges, so those shall be imported from other countries. For the bridge substructures, pile or direct foundations

can be considered and the procurement conditions will be the same as for the superstructure of the bridges. For RC girder bridges, only the reinforcement bars will need to be imported from other countries. Fabrication and procurement of Steel trusses shall be made abroad including the launching equipment.

Table 9-28 Summary of Preliminary Cost Estimate

Unit: US$ million

Section / Route Length / Item	Border–Nsanje 25.6 km	Nsanje–Bangula 45.4 km	Bangula–Makhanga 8.7 km	Makhanga–Luchenza 76.6 km	Luchenza–Limbe 44.0 km	Total 200.3 km
Earth Works	0.186	0.161	0.789	0.683	0.155	1.974
Bridge	10.232	4.480	17.550	3.911	4.407	40.579
Chiromo Railway Bridge	-	-	15.350	-	-	15.350
Other bridges	10.232	4.480	2.200	3.911	4.407	25.229
Track	13.243	21.764	5.674	36.028	21.486	98.195
Station	0.138	0.275	0.413	0.688	0.688	2.200
Level Crossing	0.000	0.125	0.250	0.000	0.250	0.625
Signal & Telecommunication System	0.651	1.205	1.070	2.533	7.126	12.585
Sub-Total	24.449	28.009	25.746	43.841	34.112	156.158
Rolling Stock	0.000	0.000	0.000	0.000	46.500	46.500
Diesel Locomotive	0.000	0.000	0.000	0.000	30.000	30.000
Freight Wagon	0.000	0.000	0.000	0.000	13.500	13.500
Passenger Coach	0.000	0.000	0.000	0.000	3.000	3.000
Engineering Cost (10%)	2.445	2.801	2.575	4.384	3.411	15.616
Contingency (10%)	2.445	2.801	2.575	4.384	3.411	15.616
Total	29.339	33.611	30.895	52.610	87.434	233.890
Average Cost per km excluding Rolling Stock	1.146	0.740	3.551	0.687	0.930	0.936

Source: Study Team

b) Concrete Work

The onsite temperature is high year-round. The maximum daytime temperature only drops below 30°C for two months. A small quantity of concrete could be cast early in the morning or at night. However in order to cast the huge concrete volume such as the footing of the substructure, concrete casting would need to continue during day and night, therefore the concrete temperature would need to be controlled by a cooling plant or ice maker plant.

c) Culvert Work

The Malawi concrete box type uses concrete pipe which is not a hume pipe, and corrugated metal pipes as a culvert structure. To prevent the corrosion of corrugated metal pipes, a bituminous coating is applied to the external surface during road construction between Chikwawa and Bangula. The Contractors do not recommend the use of corrugated metal pipes because of theft or vandalism which could cause the culvert to collapse. Therefore the use of a concrete culvert has been recommended.

d) Embankment Work

The selected material for fill shall be obtained as close as possible to the site and the work shall be carried out as much as possible in the dry season.

e) Track Rehabilitation and Reconstruction Work

Materials for track rehabilitation/reconstruction work will be procured abroad; e.g. rails and fasteners from RSA, and PC sleepers were obtained from either Zambia or RSA in the past. Aggregate can be procured in the existing quarry in Blantyre. The major contractors in Malawi do not have equipment for track rehabilitation or reconstruction works, so this equipment must be imported from abroad.

f) Construction Equipment

Major contractors in Malawi have sufficient equipment for use in earth works and bridge construction. However they do not have special equipment for track works. Special equipment shall be procured from abroad.

g) Temporary Yard

A temporary yard shall be established close to the bridge sites. In this case the land might off the main route, so approval must be obtained from the GoM in order to use it. The purpose of the temporary yard is;

- Site office
- Plant (Concrete)
- Accommodation for workers
- Park for equipment
- Deposit for material
- Work shop for reinforcement bar
- Work shop for form work

(2) Procurement Condition

a) Aggregate

The coarse aggregate used for concrete and ballast could be procured in the existing quarry in Blantyre. On the other hand the fine aggregate could be procured near the site. Currently one quarry is being used for the Chikwawa–Bangula road construction. According to the contractor, the amount of useful material might be limited.

b) Cement

The import volume of clinker is extremely decreased and production of cement in Malawi is being suspended. Procurement from Zambia or South Africa is presently insufficient, so some contractor are trying to import from another country.

c) Reinforcement Bar and Steel Material

The amount of steel produced in RSA decreased in 2008 and there is a problem of supply shortage, but it is expected that production by major steel companies will resume in early 2012. However, procurement shall be confirmed before the construction begins from RSA or Mozambique as well as from a third country.

d) Rails and Fasting

Just as for reinforcement bars, the procurement is not easy. Sometimes the procurement takes

several months. The procurement shall be confirmed before the construction begins from RSA as well as a third country.

e) Construction Equipment

Major contractors in Malawi have sufficient equipment for the road construction and they can be used for civil works for railway reconstruction. However they do not have special equipment for bridge construction. Therefore, special equipment shall be procured from abroad.

g) Labour

Some skilled labour could be procured in Lilongwe or Blantyre. Common labour could be procured near the site. However specialists for construction of the foundation or superstructure of the bridge, and reconstruction of track shall be from abroad.

h) Contractor in Malawi

There are more than 10 A-class contractors and they have equipment for road construction mainly and 25 ton truck cranes and concrete plant.

9.7.5 Supervision of Construction by a Consultant

(1) Supervision of Quality Control and Finished Dimension

The quality and finished dimension of each structure shall be kept based on the contract document. The works for the project are railway track, PC bridge, RC bridge, steel truss bridges, drainage, earthworks and miscellaneous structures. For the railway track and civil works, experienced engineers will be needed from other countries.

(2) Supervision of Progress of Works

Prior to starting the project the construction method, equipment, number of labourers shall be studied appropriately and then an adequate program shall be made to avoid any shortage and delay. In case of delay during the construction period, the consultant will order the contractor to modify the plan and the program immediately in order to recover the delay.

(3) Supervision of safety

Accidents on the construction site cause lots of problems and difficulty for the project. So the consultant and contractors shall take necessary measures to avoid any accidents. The contractor shall educate all the labourers in appropriate health and safety procedures.

In case of an emergency, a special organization shall be established prior to the commencement of the work and take the necessary action immediately if accident happens.

On the other hand, to protect the labourers, equipment and construction work from heavy rain and flood, the contractors shall have good knowledge of the weather information and/or forecasting and establish a safety system.

To avoid the traffic accidents and any trouble with third parties, a safety measure plan shall be considered. The plan shall include safety matter of the intersections with public roads, night time, over-loading of transport material, the material logistics and distribution of guards.

(4) Environmental Protection Measures

Mitigation measures against vibration, noise and water contamination shall be considered and controlled by the Consultant and Contractors which shall maintain coordination with local residents.

9.8 Establishment of Railway Maintenance Plan

The railway facilities which are to be rehabilitated or reconstructed should be maintained properly by limited human resources and utilized longer to provide safe and stable railway transport services. To achieve this, a reliable and efficient maintenance plan should be established. This chapter describes matters concerning railway maintenance, the latest technical efforts, and countermeasures to be taken by the railway operator.

9.8.1 Current Situation and Matters of Railway Maintenance

The maintenance of the railway facilities is characterized by the following:

- There are many old structures which have been used for more than 80 years.
- There are various types of structures such as bridges, piers, retaining walls, etc.
- There are many types of materials such as concrete, steel, brick, stone, etc.
- There is a large number of structures.

At present, these complicated facilities are maintained by very limited staff and budget. Due to the limited business scale and budget of the railway operator, the targets and methodologies of maintenance are not standardised. This situation will worsen considering the difficulty of passing on technologies and the shortage of railway engineers.

To overcome the situation, the railway operator should strive to acquire the following maintenance technologies:

- Maintenance technology for old types of structures
- Maintenance technology for various types of structures
- Maintenance technology for identifying deteriorated parts of structures
- Maintenance technology for maintaining large numbers of structures by a small number of staff
- Maintenance technology for consistently assessing the soundness of structures
- Methods for economical repair/reinforcement of structures

In addition, the operator should conduct research and development on mechanising the inspection and assessment of the soundness of structures, new sensing technologies, monitoring systems, materials for repair/reinforcement, and application of new railway technologies.

9.8.2 Maintenance System

The present maintenance system involves assessing the soundness of the structure by periodical inspection, identification of deteriorated or deformed parts, detailed inspection of

identified parts, and implementation of required measures (observation, repair, reinforcement). In Japan, the maintenance system is governed by a technical standard defining the maintenance method and cycle for railway facilities, which was enforced in February 2007 by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan. All railway operators conduct maintenance according to this system.

It is recommended that the railway operator in Malawi should establish a maintenance system by referring to the one in Japan and. considering the following:

- Verification of performance
- Applicability to related railway operators such as CDN
- Consistency for all types of structure
- Few major changes from the maintenance system during the Malawi railway era

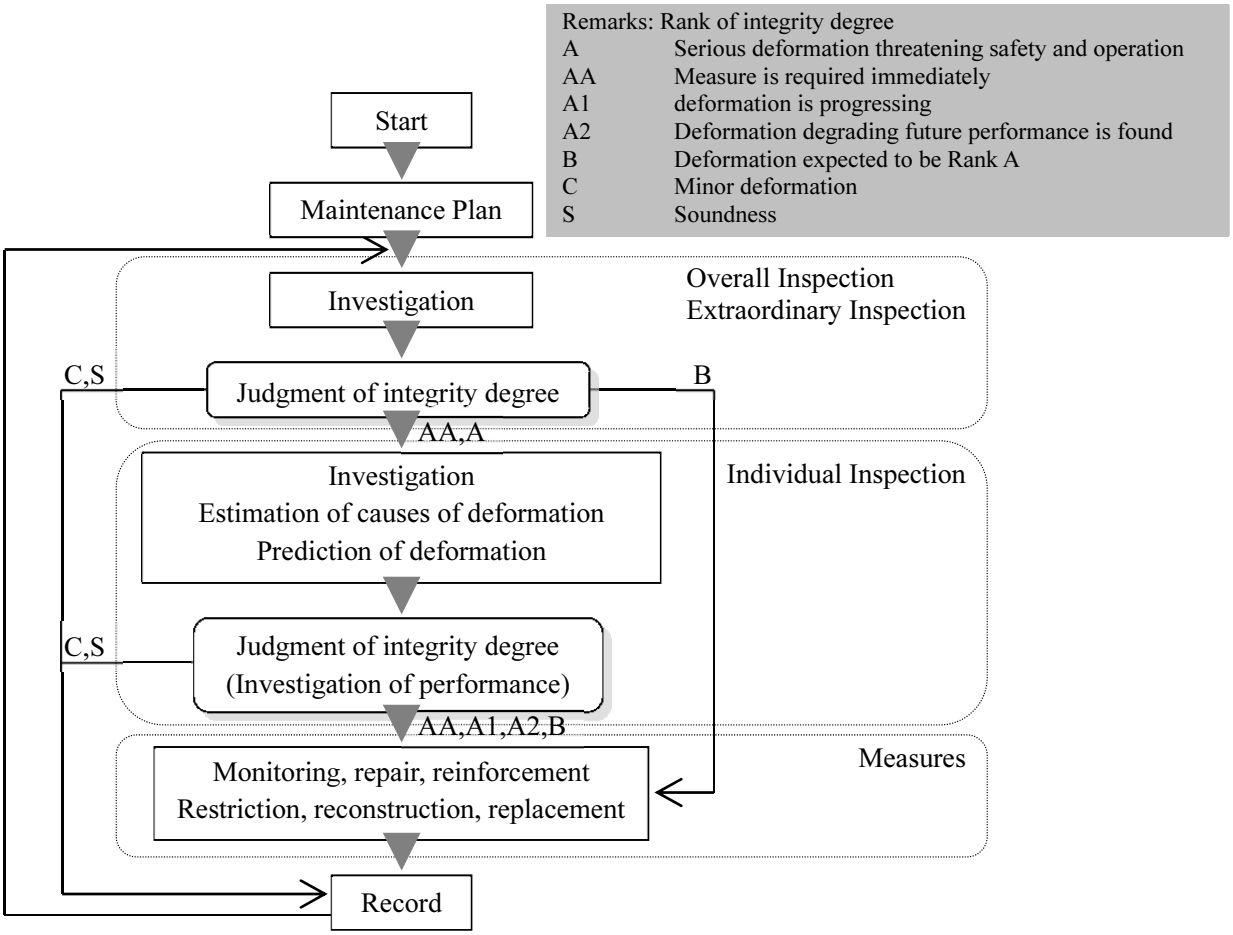
The contents of the maintenance system should be classified into concrete structures, steel structures, foundations, retaining walls and earth structures (fills and cuttings).

Each part should include general rules, maintenance standards, initial inspection, overall inspection, individual inspection, extraordinary inspection, measures, recording method, etc. as shown in Table 9-29 and Figure 9-39.

Table 9-29 Classification of Inspections on Railway Structures

Initial Inspection		Inspection cycle:	Before start of commercial operation
		Inspection method:	Detailed visual inspection
		Target structure:	New and reconstructed/replaced railway structure
Overall Inspection	General Overall Inspection	Inspection cycle:	Once/2 years
		Inspection method:	Visual inspection
		Target structure:	Railway structure
	Special Overall Inspection	Inspection cycle:	Once/10 years
		Inspection method:	Detailed visual inspection
		Target structure:	Railway structure
Individual Inspection		Inspection cycle:	As necessary
		Inspection method:	Inspection using measurement instrument
		Target structure:	A-ranked structure
Extraordinary Inspection		Inspection cycle:	As necessary
		Inspection method:	Visual inspection etc.
		Target structure:	Wayside environmental change caused by disaster such as earthquake, heavy rail, etc.

Source: East Japan Railway Company



Source: Railway Technical Research Institute (RTRI) in Japan

Figure 9-39 Typical Maintenance Procedure

9.9 Economic and Financial Analyses of Rehabilitation/Reconstruction of Railway between Limbe and Border (Marka)

9.9.1 Methodology of Economic Analysis

The objective of the economic analysis is to analyse and evaluate the viability of implementing this project from the viewpoint of the national economy. A comparative analysis of the costs and benefits both in the case of executing the project ("With project") and not executing the project ("Without project") is carried out. Economic Internal Rate of Return (EIRR), Benefit and Cost Ratio (B/C Ratio) and Economic Net Present Value (ENPV) are estimated as the evaluation indexes. The methodologies of these indexes are as follows.

(1) Economic Internal Rate of Return (EIRR)

The EIRR is the discount rate whereby total benefits and total costs calculated into the net present value become equal. The EIRR is evaluated in comparison with the opportunity cost of capital. In the analysis, the Social Discount Rate (SDR) of 12% is applied as the opportunity cost of capital. In Malawi, an SDR of 12% is widely applied in the analysis of infrastructure

projects conducted by international agencies.

(2) Benefit and Cost Ratio (B/C Ratio)

The B/C ratio is the ratio found from the net present value of the total benefit divided by the net present value of the total cost. The advantage of the project is evaluated from the value of this ratio, and if the ratio is higher than 1.00 under the designated discount rate, the project is considered to be socially and economically viable. The SDR used to evaluate the B/C ratio is normally decided by the opportunity cost in the country concerned. The same as EIRR, an SDR = 12% is used as the discount rate in the analysis.

(3) Economic Net Present Value (ENPV)

The ENPV is the total net benefit found from the difference between total benefit and total cost in net present value. The advantage of the project is evaluated from the amount of ENPV. The ENPV is discounted by the SDR=12%.

9.9.2 Premises

In this study, the economic analysis is carried out based on the following premises.

(1) Period of the Analysis

The period of the analysis is set at 33 years including the construction (investment) period from 2017, and 30 years of operation from 2020 to 2049.

(2) Exchange Rate

The exchange rate is assumed to be US$1.00 = MWK165.00 = JPY78.60 as the monthly average of November 2011. All costs are given in US$.

(3) Economic Price

All figures are based on constant prices in 2011. The economic prices are calculated excluding transferable items such as various taxes, customs duty and subsidies etc., from the viewpoint of the national economy. In order to translate market price into economic price, Standard Conversion Factor (SCF) as 0.85 is applied in the economic analysis referring previous studies in Malawi.

(4) Inflation

Since it is difficult to estimate the inflation rate during the overall period of the project, it is not considered in the analysis.

(5) Residual Value

The residual value in the last year (2049) of the analysis is counted as a negative investment cost. The residual value is calculated based on the life cycle of the facilities stated below.

(6) Life Cycle of Facilities

The following durations are assumed for the life cycle of the facilities, based on previous studies.

Table 9-30 Life Cycle of Facilities

Item	Duration
Bridge (new)	100 years
Bridge (rehabilitated)	50 years
Track	40 years
Signal and telecommunication	25 years
Diesel locomotive	35 years
Freight wagon, passenger coach	50 years

Source: Study Team

(7) Shadow Prices

Shadow pricing in project appraisal is often recommended as a means of correcting for economic distortions. However, for the same reason described in Section 8.8.2, it is not used in this analysis.

(8) Cases of the Analysis

In the analysis, costs and benefits are defined as the difference between the cases of "With project" and "Without project". The cases are summarised as follows.

- "With project" means implement the project case, and the proposed railway rehabilitation/ reconstruction between Limbe and Border (Marka) is expected to be conducted fully.
- "Without project" is the case that the proposed project is not implemented.

9.9.3 Results of Economic Analysis

(1) Project Costs

Project costs consist of investment costs and operation and maintenance (O&M) costs. All costs are shown in economic price.

a) Investment Costs

The investment cost of "With project" is summarised in Table 9-31. An engineering cost of 10.0% and contingency of 10.0% are added to the total investment cost.

Table 9-31 Investment Costs of "With Project" (in economic price)

(Unit: US$ million)

Project	2017	2018	2019	2027	2028	2029	Total
Rehabilitation of Limbe–Luchenza	2.00	19.51	7.48	-	-	-	29.00
Rehabilitation of Luchenza–Makhanga	1.91	27.57	7.79	-	-	-	37.27
Reconstruction of Makhanga–Bangula	6.64	7.91	7.33	-	-	-	21.88
Reconstruction of Bangula–Nsanje	-	-	-	2.04	15.37	6.40	23.81
Reconstruction of Nsanje–Border	-	-	-	1.86	14.03	4.90	20.78
Procurement of Rolling Stock	-	9.88	9.88	-	9.88	9.88	39.53
Engineering Cost (10%)	1.06	5.50	2.26	0.39	2.94	1.13	13.27
Contingency (10%)	1.06	5.50	2.26	0.39	2.94	1.13	13.27
Total	12.66	75.88	37.00	4.68	45.15	23.44	198.81

Source: Study Team

b) Operation and Maintenance (O&M) Costs

Annual O&M costs of the project are estimated from the differences in freight tonne-km and unit cost of O&M. From CEAR's financial statements, the unit cost of O&M is calculated at

US$0.03/tonne-km as a variable cost. The annual fixed cost is estimated from the length of the rehabilitated railway section at a unit cost of US$4,200/km. Furthermore, the cost of maintaining the railway bridge once every 10 years after completion is added.

(2) Project Benefits

The quantified benefits of Vehicle Operating Cost (VOC) savings and Transport Time Cost (TTC) savings are estimated in the analysis. The benefits and measures are summarised in Table 9-32.

Table 9-32 Project Benefits

Benefit		Measure
VOC saving	Freight by railway	("With project" - "Without project" (tonne-km)) x (unit VOC of railway)
	Freight by road	("With project" - "Without project" (tonne-km)) x (unit VOC of road)
	Passenger transport by car and bus	("With project" - "Without project" (vehicle-km)) x (unit VOC of car and bus)
TTC saving	Freight by railway	("With project" - "Without project" (tonne-hour)) x (unit time value)
	Freight by road	("With project" - "Without project" (tonne-hour)) x (unit time value)
	Passenger transport by car and bus	("With project" - "Without project" (passenger-hour)) x (unit time value)

Source: Study Team

a) VOC Savings

The VOC savings are calculated by taking the difference in tonne-km between "With project" and "Without project". The unit VOC for railways was estimated to be US$0.07/tonne-km from CEAR's financial statements. The unit VOC for roads was estimated to be US$0.10/tonne-km from the average freight transport cost. The unit VOCs for cars and buses are US$0.30/km and US$0.56/km, respectively.

b) TTC Savings

To calculate the TTC savings for road and railway, the unit time value of freight was estimated to be US$0.03/tonne-km from the average freight value and hourly lending rate. The unit time value of passengers is US$0.09/hour.

(3) Results of Economic Evaluation

The results of the economic evaluation based on the above conditions are summarised in Table 9-33. Detail cash flow of economic cost and benefit is shown in Table 9-34.

Table 9-33 Results of Economic Analysis

(Social discount rate = 12.0%)

Total Investment Cost (in economic price) (US$ million)	Economic Internal Rate of Return (EIRR)	Benefit and Cost Ratio (B/C Ratio)	Economic Net Present Value (ENPV) (US$ million)
198.81	17.40 %	1.53	72.43

Source: Study Team

Table 9-34 Cash Flow of Economic Cost and Benefit

(Unit: US$ million)

Seq. No.	Year	Project Costs			Project Benefits					Net Economic Benefits
		Investment	O&M	Total	VOC		TTC		Total	
					Freight	Passenger	Freight	Passenger		
-3	2017	12.66	0.00	12.66	0.00	0.00	0.00	0.00	0.00	-12.66
-2	2018	75.88	0.00	75.88	0.00	0.00	0.00	0.00	0.00	-75.88
-1	2019	37.00	0.00	37.00	0.00	0.00	0.00	0.00	0.00	-37.00
1	2020	0.00	2.28	2.28	13.51	0.32	0.17	0.06	14.06	11.78
2	2021	0.00	2.36	2.36	14.24	0.62	0.18	1.02	16.06	13.70
3	2022	0.00	2.44	2.44	15.01	0.92	0.19	1.98	18.10	15.66
4	2023	0.00	2.53	2.53	15.82	1.22	0.20	2.94	20.18	17.65
5	2024	0.00	2.62	2.62	16.67	1.53	0.21	3.90	22.31	19.68
6	2025	0.00	4.08	4.08	30.39	1.83	0.17	4.85	37.25	33.16
7	2026	0.00	4.26	4.26	32.03	2.13	0.18	5.81	40.16	35.90
8	2027	4.68	4.44	9.12	33.76	2.43	0.19	6.77	43.16	34.04
9	2028	45.15	4.64	49.79	35.59	2.73	0.20	7.73	46.25	-3.54
10	2029	23.44	4.84	28.28	37.51	3.03	0.22	8.69	49.45	21.16
11	2030	0.00	6.18	6.18	37.31	3.33	0.26	9.65	50.55	44.37
12	2031	0.00	4.93	4.93	38.32	3.42	0.26	9.91	51.91	46.99
13	2032	0.00	5.04	5.04	39.35	3.52	0.27	10.18	53.32	48.28
14	2033	0.00	5.15	5.15	40.41	3.61	0.28	10.45	54.76	49.60
15	2034	0.00	5.27	5.27	41.51	3.71	0.29	10.73	56.23	50.96
16	2035	0.00	5.39	5.39	42.63	3.81	0.29	11.02	57.75	52.36
17	2036	0.00	5.51	5.51	43.78	3.91	0.30	11.32	59.31	53.80
18	2037	0.00	5.64	5.64	44.96	4.02	0.31	11.63	60.91	55.28
19	2038	0.00	5.77	5.77	46.17	4.13	0.32	11.94	62.56	56.79
20	2039	0.00	5.90	5.90	47.42	4.24	0.33	12.26	64.25	58.35
21	2040	0.00	8.14	8.14	48.70	4.35	0.34	12.59	65.98	57.84
22	2041	0.00	6.18	6.18	50.02	4.47	0.34	12.93	67.76	61.59
23	2042	0.00	6.32	6.32	51.37	4.59	0.35	13.28	69.59	63.27
24	2043	0.00	6.47	6.47	52.75	4.72	0.36	13.64	71.47	65.00
25	2044	0.00	6.62	6.62	54.18	4.84	0.37	14.01	73.40	66.78
26	2045	0.00	6.78	6.78	55.64	4.97	0.38	14.39	75.38	68.61
27	2046	0.00	6.94	6.94	57.14	5.11	0.39	14.78	77.42	70.48
28	2047	0.00	7.10	7.10	58.69	5.25	0.40	15.17	79.51	72.41
29	2048	0.00	7.27	7.27	60.27	5.39	0.42	15.58	81.66	74.39
30	2049	-65.39	7.44	-57.94	61.90	5.53	0.43	16.00	83.86	141.80

Source: Study Team

(4) Sensitivity Analysis

Table 9-35 shows the results of the sensitivity analysis by changing cost and benefit.

Table 9-35 Results of Sensitivity Study of Economic Analysis

Benefit \ Cost	-10%	-5%	0%	+5%	+10%
+10%	18.92%	18.84%	18.77%	18.69%	18.62%
+5%	18.25%	18.17%	18.09%	18.02%	17.94%
0%	17.56%	17.48%	17.40%	17.32%	17.25%
-5%	16.85%	16.77%	16.69%	16.61%	16.53%
-10%	16.13%	16.04%	15.96%	15.88%	15.80%

Source: Study Team

As a result, even in the case of +10% increase in the costs and -10% decrease in the benefits, the value of EIRR exceeds the 12% of social discount rate. It is therefore this project considered to be economically viable from the viewpoint of the national economy.

9.9.4 Methodology of Financial Analysis

The objective of the financial analysis is to evaluate the financial adequacy of the project and management soundness by the operation body. Financial Internal Rate of Return (FIRR) and Financial Net Present Value (FNPV) are used as evaluation indexes. The methodologies of these indexes are as follows.

(1) Financial Internal Rate of Return (FIRR)

The FIRR is the discount rate whereby the totals of revenue and expenditure (investment cost and O&M cost) converted into the net present value become equal. The FIRR is evaluated in comparison with the Financial Opportunity Cost of Capital (FOCC). In the analysis, the Weighted Average Cost of Capital (WACC) serves as a proxy for the FOCC.

(2) Financial Net Present Value (FNPV)

The FNPV is the total net benefit calculated from the net present value of total revenue and total expenditure.

9.9.5 Premises

The financial analysis is carried out based on the following premises.

(1) Period of the Analysis

The period of the analysis is set at 33 years including the construction (investment) period from 2017, and 30 years of operation from 2020 to 2049.

(2) Exchange Rate

The exchange rate is assumed to be US$1.00 = MWK165.00 = JPY78.60 as the monthly average of November 2011. All costs are given in US$.

(3) Financial Price

All figures are based on constant prices in 2011. The price for domestic products is the market price including various taxes, and for imported products is the CIF price with import duty, inland transportation cost and other fees. According Articles 4000.445 (a) of the “Customs and Excise Act”, customs duty, excise duty and VAT are zero (0%) on goods under an agreement between the Governments. Therefore, relevant materials and equipment of the project are considered without including those duties.

(4) Inflation

Since it is difficult to estimate the inflation rate during the overall period of the project, it is not considered in the analysis.

(5) Residual Value

The residual value in the last year (2049) of the analysis is counted as a negative investment

cost. The residual value is calculated based on the life cycle of facilities stated in Table 13-30.

9.9.6 Results of Financial Analysis

(1) Financing Plan

Expected financing sources and terms are shown in Table 9-36. Financing terms are determined based on the OECD arrangement and/or conditions for each project, and detailed conditions such as interest rate and payment terms are considered by financing institutions at the financing stage.

Table 9-36 Financing Sources and Terms

Financing Source	Terms of Financing	
Development Partners	Financing form:	International Financial Institutions
	Coverage:	By negotiation
	Interest rate:	1.80% (reference value of International Financial Institutions) (6-month LIBOR 0.75% + fixed spread 1.05%)
	Payment terms:	Equal payment of principal Up to 30 years including grace period
Domestic Loans	Financing form:	Commercial banks in Malawi
	Coverage:	By negotiation
	Interest rate:	13.00% (bank rate) 17.75% (minimum lending rate) (reference values of December 2011 from Reserve Bank of Malawi)
	Payment terms:	Equal payment of principal By negotiation
Private Funds	Source:	Own fund
	Coverage:	Generally 10 to 20% of project cost
Government Funds	Source:	The central government of Malawi
	Coverage:	Generally 10 to 20% of project cost

Source: Study Team

The Weighted Average Cost of Capital (WACC) is assumed based on the combination of the above financial sources. Table 9-37 shows the proposed financial plan and WACC of each case.

Table 9-37 Proposed Financing Plan

Case	WACC	Financial Source		
Case 1	11.05%	Private Funds 15.0%	Domestic Loans 85.0%	---
Case 2	7.74%	Private Funds 10.5%	Domestic Loans 59.5%	Government Funds 30.0%
Case 3	1.53%	Development Partners 85.0%	Government Funds 15.0%	---

Source: Study Team

(2) Expenditure

The expenditure is composed of the investment cost and O&M cost as shown in Tables 9-38 and 9-39

Table 9-38 Investment Costs

(Unit: US$ million)

Project	2017	2018	2019	2027	2028	2029	Total
Rehabilitation of Limbe–Luchenza	2.36	22.96	8.80	-	-	-	34.11
Rehabilitation of Luchenza–Makhanga	2.25	32.43	9.16	-	-	-	43.84
Reconstruction of Makhanga–Bangula	7.81	9.31	8.63	-	-	-	25.75
Reconstruction of Bangula–Nsanje	-	-	-	2.40	18.08	7.53	28.01
Reconstruction of Nsanje–Border	-	-	-	2.19	16.50	5.76	24.45
Procurement of Rolling stock	-	11.63	11.63	-	11.63	11.63	46.50
Engineering Cost (10%)	1.24	6.47	2.66	0.46	3.46	1.33	15.62
Contingency (10%)	1.24	6.47	2.66	0.46	3.46	1.33	15.62
Total	14.90	89.27	43.53	5.50	53.12	27.58	233.89

Source: Study Team

Table 9-39 Annual O&M Cost

(Unit: US$ million)

Year	Variable Cost	Fixed Cost	Bridge Maintenance Cost	Total
2020	0.84	1.10	0.00	1.95
2030		5.86	1.37	8.07
2040		9.91	1.92	12.68

Source: Study Team

(3) Revenue

Annual fare revenue consists of fare revenue and non-fare revenue. According to CEAR's financial statements, non-fare revenue is estimated around 5% of fare revenue. The annual revenue is summarised in Table 9-40.

Table 9-40 Annual Revenue

(Unit: US$ million)

Year	Fare Revenue	Non-fare Revenue	Total
2020	2.47	0.12	2.59
2030	13.09	0.65	13.74
2040	22.15	1.11	23.26

Source: Study Team

(4) Results of Financial Evaluation

The results of financial analysis based on the above conditions are shown in Tables 9-41 and 9-42, respectively. As a result, the FIRR is found to be 2.05% and is considered financially viable compared with 1.53% of WACC.

Table 9-41 Results of Financial Analysis

Financial Internal Rate of Return (FIRR)	Weighted Average Cost of Capital (WACC)	Financial Net Present Value (FNPV)
2.05 %	1.53 %	US$ 22.70 million

Source: Study Team

Table 9-42 Cash Flow of Financial Cost and Revenue

Unit: million US$

Seq. No.	Year	Investment Cost	O&M Cost	Total Cost	Net Revenue	Annual Revenue
-3	2017	14.90	0.00	14.90	-14.90	0.00
-2	2018	89.27	0.00	89.27	-89.27	0.00
-1	2019	43.53	0.00	43.53	-43.53	0.00
1	2020	0.00	1.95	1.95	0.64	2.59
2	2021	0.00	2.01	2.01	0.72	2.73
3	2022	0.00	2.07	2.07	0.81	2.88
4	2023	0.00	2.14	2.14	0.90	3.04
5	2024	0.00	2.21	2.21	0.99	3.20
6	2025	0.00	3.75	3.75	3.08	6.83
7	2026	0.00	3.91	3.91	3.29	7.20
8	2027	5.50	4.08	9.58	-1.99	7.59
9	2028	53.12	4.25	57.37	-49.38	8.00
10	2029	27.58	4.44	32.01	-23.58	8.43
11	2030	0.00	8.07	8.07	5.67	13.74
12	2031	0.00	7.02	7.02	7.47	14.49
13	2032	0.00	7.35	7.35	7.92	15.27
14	2033	0.00	7.70	7.70	8.39	16.09
15	2034	0.00	8.07	8.07	8.89	16.96
16	2035	0.00	8.46	8.46	9.42	17.88
17	2036	0.00	8.87	8.87	9.97	18.84
18	2037	0.00	9.31	9.31	10.55	19.86
19	2038	0.00	9.76	9.76	11.17	20.93
20	2039	0.00	10.24	10.24	11.82	22.06
21	2040	0.00	12.68	12.68	10.58	23.26
22	2041	0.00	11.29	11.29	13.22	24.51
23	2042	0.00	11.85	11.85	13.98	25.83
24	2043	0.00	12.45	12.45	14.78	27.23
25	2044	0.00	13.07	13.07	15.63	28.70
26	2045	0.00	13.73	13.73	16.52	30.25
27	2046	0.00	14.43	14.43	17.45	31.88
28	2047	0.00	15.16	15.16	18.44	33.60
29	2048	0.00	15.94	15.94	19.48	35.42
30	2049	-76.93	16.75	-60.18	97.51	37.33
Total		156.96	253.01	409.97	116.67	526.64

Source: Study Team

(5) Sensitivity analysis

Table 9-43 shows the results of the sensitivity analysis. The FIRR in the case of expenditure increase of 10% and revenue decrease of –10% is 0.28%, which does not satisfy the WACC (1.53%). This result means the sensitivity to variation of revenue and expenditure. It is recommended that proper management should be carried out at the construction stage and in the operation scheme.

Table 9-43 Results of Sensitivity Study of Financial Analysis

Expenditure / Revenue	-10%	-5%	0%	+5%	+10%
+10%	3.78%	3.29%	2.83%	2.39%	1.96%
+5%	3.40%	2.91%	2.45%	2.00%	1.57%
0%	3.00%	2.52%	2.05%	1.60%	1.16%
-5%	2.59%	2.10%	1.63%	1.17%	0.73%
-10%	2.16%	1.66%	1.19%	0.72%	0.28%

Source: Study Team

9.10 Implementation Programme for Rehabilitation/Reconstruction of Railway between Limbe and Border (Marka)

The rehabilitation/reconstruction of the railway requires the involvement of various engineers for transport planning, earthworks, bridges, tracks, signalling, telecommunications, rolling stock and other areas of expertise. Close coordination among them will be required to ensure the work is done effectively. A detailed implementation programme should be drawn up in advance at the detailed design stage.

According to past experience in similar railway projects, the following periods should be allowed for each task. The project should also be divided into two phases, the mid-term project and the long-term project, as described in the Master Plan.

- Feasibility Study: 12 months
- Decision on Investment: 3 months
- Selection of Engineering Consultant: 3 months
- Detailed Design: 12 months
- Selection of Contractor: 3 months
- Execution of Project: 72 months (36 months for each project)
- Commissioning: 12 months (6 months for each project)
- Start of Service: after completion of rehabilitation/reconstruction work

Of these tasks, the selection of a contractor is very important to ensure the success of the project, because the contractor plays a key role in the project. Therefore, a good contractor with a solid track record in railway projects should be selected.

The implementation schedule for the whole project, mid-term project and long-term project with type of construction work are shown in Tables 9-44, 9-45 and 9-46, respectively.

Table 9-44 Construction Schedule (Whole Project)

Task	Year	2014				2015				2016				2017				2018				2019				2020		2026		2027				2028				2029				2030			
	Duration (month)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Feasibility Study	12																																											
Decision on Investment	3																																											
Selection of Engineering Consultant	3																																										
Detailed Design	12																																										
Selection of Contractor	6																																										
- Medium-term Project	3																																										
- Long-term Project	3																																										
Execution of Project	72																									Start of Service																	
- Medium-term Project	36																																										
- Long-term Project	36																																					Start of Service						

Source: Study Team

Table 9-45 Construction Schedule (Medium-term Project)

Section	Task	Year	2017				2018				2019				2020	
		Duration (month)	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Limbe - Luchenza	Earth Works	12														
	Bridge	15														
	Track	15														
	Station	6														
	Level Crossing	3														
Luchenza - Makhanga	Earth Works	12														
	Bridge	15														
	Track	15														
	Station	6														
	Level Crossing	3														
Makhanga - Bangula	Earth Works	12														
	Bridge	15														
	Track	15														
	Station	6														
	Level Crossing	3														
Limbe - Bangula	Signal & Telecommunication System	12														
	Rolling Stock	12														
	Commissioning	6														
	Start of Service														▼	

Source: Study Team

Table 9-46 Construction Schedule (Long-term Project)

Section	Task	Year	2027				2028				2029				2030	
		Duration (month)	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Bangula - Nsanje	Earth Works	12														
	Bridge	24														
	Track	3														
	Station	6														
	Level Crossing	3														
Nsanje - Border	Earth Works	12														
	Bridge	15														
	Track	15														
	Station	6														
	Level Crossing	3														
Bangula - Border	Signal & Telecommunication System	12														
	Rolling Stock	12														
	Commissioning	6														
	Start of Service														▼	

Source: Study Team

9.10 Overall Evaluation of Rehabilitation and Reconstruction of Railway between Limbe and Border (Marka)

Overall evaluation of the railway rehabilitation/reconstruction project is summarised as follows:

(1) Expected Economic Benefits of the Project

The rehabilitation and improvement of the railway between Limbe and Border would provide several benefits on the national and local economy, such as reduction of import/export transport cost by shifting trucks to the railway, positive economic and social benefits for residents along the railway line between Luchenza and Makhanga, who lost their opportunity to sell agricultural products in a big market, such as in Limbe and Bangula, the ability to commute to school, better health care services, reduction of CO_2 emissions, and foreign currency saving by diesel consumption between trucks/trailers and locomotives.

(2) Design Standard

The design standard used in the Study is based on the current one. The aim of this application is to minimize the cost for the rehabilitation/reconstruction by reusing the existing structures which are still partially usable. The revision of the design standard, particularly axle loads, should be carefully considered at the basic design stage taking into account the future freight demand. The biggest matter to increase the axle load is a replacement of Kamuzu Truss Bridge which will incur a high cost and long construction period.

(3) Earth Works

The main earth works to build new embankment are planned at Chiromo washaway. The current embankment which is about 80 years old would not have enough soil bearing capacity due to inadequate compaction work during its construction. Therefore, the compaction work for the new embankment should be carefully executed.

(4) Bridge Rehabilitation and Reconstruction

The Chiromo Railway Bridge over New Shire River is planned as a steel truss bridge from a viewpoint of vertical alignment and easiness of the construction. Other small bridges are planned as RC or PC bridges which are popular these days. The maintenance of tracks on them is easy.

(5) Track

The rails for the section are 30kg rails. It is recommended to upgrade to heavy rails, i.e. 50 kg rails with PC sleepers which would achieve stable operation, track durability and the reduction of noise.

(6) Signalling

The current signalling/communication system is not working at all. A new system should be implemented on the line. Considering the train operation plan in Section 9.2, the section between stations will form one block system without a continuous track circuit, and a token-less

block instrument system should be installed outside of the signals to check the trains in and out. Regarding compatibility with the signalling system of Nacala Railway where Vale is planning to construct a new line and rehabilitate the existing line, it is important and inevitable to secure mutual compatibility.

Similarly, CEAR does not have any dedicated telecommunication system other than mobile phones which do not cover the whole line. To overcome this situation, a new railway telecommunication network is to be established by the combination of a transmission network deployed along the rail line using voice cables, multiplex carriers, radio systems, or other forms of transmission media, that are suitable for transmission between terminals, and voice/data exchange equipment, data processing equipment, etc.

(7) Rolling Stock

At present, only 4 out of 10 diesel locomotives (DL) can be made available. It is necessary to introduce new diesel locomotives. However, the Bombardier MX615 is not currently available. New locomotives with similar specifications should be procured. The Japanese DF200 type diesel locomotive would be a candidate diesel locomotive.

(8) Establishment of Railway Maintenance Plan

After rehabilitation or reconstruction of the section, the railway facilities should be maintained properly by limited human resources and utilized longer to provide safe and stable railway transport service. To achieve this, a reliable and efficient maintenance plan should be established.

(9) Economic and Financial Analysis

In the economic analysis, all the values of the evaluation index are in good standard and this project is considered to be economically feasible from the viewpoint of the national economy. The results of the financial analysis also indicate that the project will be feasible. To implement the project, a management plan including actual finance arrangement and financial plan must be established in future. It is inevitable to arrange governmental subsidies for the infrastructure portion of the project.

(10) IEE Results

According to the scoping results of the project, executing the project will generate various positive impacts particularly for the local economy and social lives of local residents along the railway line. On the other hand, negative effects under the environment and social consideration are very limited. Mitigation measures for these limited negative impacts should be studied in detail when the horizontal alignment of the road for improvement will be more concrete under the feasibility study stage.

CHAPTER 10

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Chapter 10 Environmental and Social Considerations

10.1 National Environmental Framework and Legal Requirements

10.1.1 National Environmental Framework

The Constitution of Malawi 1995 provides a basis for the sustainable development of natural resources and improved living conditions for people in Malawi. Section 13 (d) of the Constitution states that the environment should be managed in order to i) prevent degradation of the environment; ii) provide a healthy living and working environment, iii) accord full recognition to the rights of future generations by means of environmental protection and iv) conserve and enhance the biological diversity of Malawi. In line with this, the GoM launched MGDS in 2006, which is to achieve "strong and sustainable economic growth, building a healthy and educated human resource base, and protecting and empowering the vulnerable". The strategy for sustained economic growth described in MGDS recognises that sustainable use of natural resources contributes to many of the goals in MGDS.

The World Summit on Sustainable Development held in Johannesburg in 2002, ten years after the 1992 Earth Summit, called upon governments to develop "National Strategies for Sustainable Development". In line with the commitments made at the World Summit, the GoM prepared the "National Strategy for Sustainable Development" in 2004, which became the basis for Malawi's "Sustainable Development Framework for Action". There are nine thematic areas of the Johannesburg Plan of Implementation. In the thematic area of "Poverty Reduction", for instance, poverty is to be reduced, among others, by transport and public works through:

- Building basic rural infrastructure, diversifying the economy and improving transportation and access to markets to support sustainable agricultural and rural development
- Implementing transport strategies for sustainable development, reflecting specific regional, national and local conditions, to improve the affordability, efficiency and convenience of transportation as well as urban air quality and health and to reduce greenhouse gas emissions.

The National Environmental Action Plan (NEAP) was also drawn up in 2002 with the bottom-up involvement of all 27 district assemblies and the participation of all local communities. The main purpose of NEAP is to integrate the strategies and measures for environmental protection and management into plans and programmes for the social and economic development of Malawi. The GoM launched the Malawi Decentralised Governance Programme in 1998 and appointed Environmental District officers in all 27 districts. In compliance with the Environmental Management Act 1996 (EMA), the district officers are to produce District State of Environment Reports and Environmental Action Plans. In response to NEAP, the National Biodiversity Strategy and Action Plan was prepared to provide a strategic framework for action for the conservation and sustainable use of biodiversity by the year 2020.

10.1.2 Legal and Policy Framework

The legal and policy framework for environmental and social considerations in the transport sector is summarised in Table 10-1. The details of the Environmental Impact Assessment (EIA) process, land acquisition and resettlement process, and protected areas in the project area are discussed in the following sections.

Table 10-1 Legal and Policy Framework in Malawi (1/2)

Law/Policies	Description
EIA Process	
Environmental Management Policy, 1996, Revised in 2004	The policy highlights the areas of high priority for the promotion of sustainable social and economic development. The policy also provides that an Environmental Mitigation and Management Plan shall be required for all activities.
Environmental Management Act, 1996	Sections 24-26 legislate the EIA Process and administration of EIA (Director of Environmental Affairs Department (EAD), Technical Committee on the Environment (TCE), and National Council for the Environment (NCE)).
Guidelines for Environmental Impact Assessment, 1997	Guideline of the EIA process including: 1) screening process and project brief, 2)scoping process and 3) undertaking the EIA study.
Land Acquisition/ Resettlement	
Land Act Cap 57:01, 1965	The policy defines 1) government land, 2) public land, 3) private land, and 4) customary land. The policy provides that a landholder is entitled to compensation if the owner's property happens to be acquired by the Government for public use. For customary land, compensation shall be based on the open market value of the land and all permanent improvements on the land. The policy states that developing activities in fragile ecosystems like wetlands will only be permitted after the appropriate authority has conducted an environmental impact assessment study.
Land Act Cap 57:01, 1965	The Act gives the Minister power to acquire customary land needed for a public purpose. The Act also provides that any person who suffers from loss, damage, or disturbance to his/her land shall be compensated (Section 28). There is a section to regulate unlawful use or occupation of any land.
Land Acquisition Act Cap. 58:04	The Act provides the procedure for land acquisition including: 1) notifying the person from whom to acquire the land, 2) paying compensation, 3) assessing fair compensation, and 4) transferring the land. No compensation shall exceed the current market value of the land.
Town and Country Planning Act Cap. 23:01	The Act under Part VIII gives power to the Minister to acquire any land, either compulsorily or by agreement, paying such compensation as agreed and determined in accordance with law in the interest of the implementation of any plan. Any acquisition of land and any payment of compensation under this Act shall be in accordance with the Land Acquisition Act.
Public Roads Act, Cap. 69:02	The Act provides that the Minister may declare road reserves. Within a road reserve, no compensation is required if the land is designated as a public road. The owner or occupier of land in a road reserve is entitled to compensation. The compensation for customary land is assessed after consultation with the Chief of the area.
Railway Act, Cap. 69:03, 1907	The Act gives the Minister power to acquire land for the purpose of a railway. The owner of land is entitled to compensation for any damage caused by the exercise. Compensation is agreed with the owner.
Protected Areas	
National Fisheries and Aquaculture Policy, 2001	The policy is to maximise the sustainable yield from the national waters of Lake Malawi, Malombe, Chilwa, Chiuta, the Shire River and so on. The policy also promotes sustainable utilisation of fish resources in the riverine and adjacent floodplains and wetlands to maintain biodiversity.
Water Resources Act Cap. 72:03, 1969	This regulates the pollution of public water and granting of water rights. Declaration of controlled area.

Table 10-1 Legal and Policy Framework in Malawi (2/2)

Law/Policies	Description
National Water Policy, 2005	The guiding principles include the 'Polluter-Pays' principle controlling the pollution of water resources, and the principle that water allocations shall consider ecosystem integrity and biodiversity.
The Forestry Act, 1997	The Act gives the Minister power to declare any public land not already reserved for another public purpose to be a forest reserve (22). The Act also gives the power to any village headman, with advice of the Director of Forestry, to demarcate on unallocated customary land a village forest area which shall be protected and managed in the prescribed manner (30).
National Forest Policy of Malawi, 1996	The policy guides the sustainable use of forest resources for improving the quality of life in the country. The policy mentions the limitation of the Forestry Act (1942) in providing a mechanism for managing trees and forests on customary land and the lack of clarification of the rights of individuals and communities to own, manage and utilize indigenous trees growing on such land.
National Parks and Wildlife Act, 2004	The Act declares protected areas of public land to be known as national parks, wildlife reserves or nature sanctuaries. The Act also gives the Minister power to declare any area of land or water to be a national park or wildlife reserve (28 (1)).
National Wildlife Policy, 2000	The policy ensures that the Department of National Parks and Wildlife has the responsibility to take into account the environmental impact assessment procedures when proposals, plans or projects that are likely to have adverse impacts on wildlife are formulated. There is a section on the conservation of wetland, which states that wetlands "have high biodiversity and are of international importance especially for migrating birds".
Monuments and Relics Arrangement of Sections Cap. 29:01	The Act gives the Minister power to declare a monument or group of monuments or any relic or collection of relics to be a protected monument or a protected group of monuments or to be a protected relic or a protected collection of relics.
Health and Safety	
Code of Practice for Occupational Safety, Health and Welfare in the Main Road Sector, 2010 (2nd draft)	This code of practice is to ensure the highest possible standards of occupational safety, health and welfare at all levels within RA.
Occupational Safety, Health and Welfare Act Cap. 55:07, 2003	The Act provides for the registration of workplace and duties of employers with respect to working environment.
Road Traffic Regulations, 2000	The Regulations provide conditions for the use of vehicles and safety.
National Gender Policy, 2000	This policy provides a guiding principle for equal employment opportunities and benefits for women, men, girls and boys.
Worker's Compensation Act, 2000	The Act provides legislation for compensation for injuries suffered or diseases contracted by workers.
Employment Act Cap. 55:01	The Act provides legislation for employment contracts, anti-discrimination, and equal remuneration for work of equal value.
Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS)	
National HIV/AIDS Policy, 2003	The policy provides technical and administrative guidelines for the design, implementation and management of HIV/AIDS interventions, programmes and activities. It provides guidance on measures to prevent HIV/AIDS, protection of vulnerable people, and responses to HIV/AIDS in the workplace.
HIV and Aids Mainstreaming Guidelines for the Public, Private and Civil Society Organisations, 2007	The guideline provides a step by step approach to the HIV/AIDS Mainstreaming Process for Public, Private, and Civil Society Organisations.
Roads Authority HIV/AIDS Policy	This policy provides employees and employers with sufficient updated information on HIV/AIDS and promotes effective measures for managing HIV/AIDS.

Source: Study Team

10.2 EIA Process

The Environmental Management Act (1996) Section 24 stipulates that development projects should be screened to establish major environmental and social considerations which may need to be addressed before the commencement of project activities. Outlined below are legal requirements and the process used to screen environmental and social impacts, in line with the Malawi EIA process.

The EIA process is managed by EAD in the Ministry of Natural Resources, Energy, and Environment (MoNREE). The implementation of EIA is guided by the National Environmental Policy 1996, which was revised in 2004, and legislated by the EMA in 1996. Figure 10-1 shows the EIA process in Malawi.

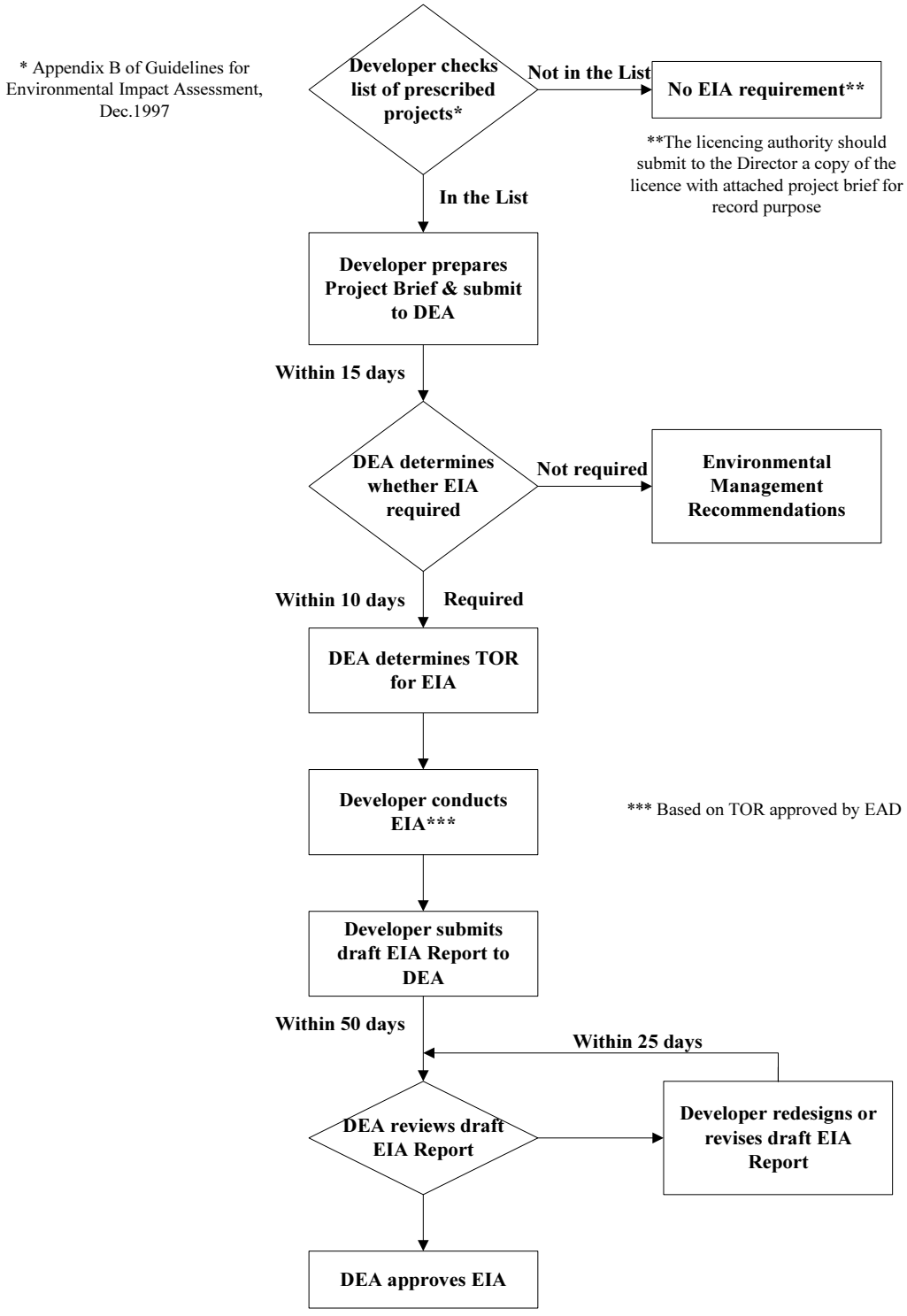
The first stage in the EIA is a screening process; a licensing authority determines if the EIA is required. There are two categories of prescribed projects: 1) List A, those projects for which an EIA is mandatory and 2) List B, those for which an EIA may be required. Table 10-2 lists the prescribed projects relevant to this study. If the project is a prescribed project, then a project brief must be submitted to the EAD, but if not, then no further action is required. Together with advice from TCE, the director of EAD determines whether or not an EIA is required. If the prescribed project is exempt from an EIA, no further compliance is required and the Director issues a certificate along with any recommendations for environmental management activities. If the screening criteria are not satisfied, an EIA must be undertaken.

The second stage is a scoping process in which the principal issues in the EIA are prepared by the developer and approved by the Director. The scoping discussions between the developer and EAD are undertaken to ensure that all potentially significant impacts are included in the study.

After the preparation of TORs in the EIA, the developer then conducts an EIA. When the draft EIA has been completed and submitted to the director of the EAD, a review process is undertaken with assistance from the TCE. The EIA report is to be made available to the public for consultation and a public hearing is mandatory under the EMA. The TCE then submits a recommendation to the National Council for the Environment for approval. If the EIA report is approved, the EAD issues a certificate to the developer. If some redesigns are required to eliminate or reduce adverse impacts, the EIA report must be redone and resubmitted for the revised project. Depending on the complexity of projects, it takes around two weeks for a review by the TCE and around two weeks for a review by the National Council.

In Malawi, it is also mandatory to submit an Environmental Management and Monitoring Plan together with the EIA report.

In addition to this EIA process, RA has prepared a guideline for environmental and social management in the road sector. This guideline follows the EIA process described in the Guidelines for Environmental Impact Assessment 1997. It also describes proposed mitigation measures associated with road development projects.



Source: Modified by JICA Study Team based on Guidelines for Environmental Impact Assessment (EAD, 1997)

Figure 10-1 EIA Approval Process

Table 10-2 List of Selected Prescribed Projects

List A – List of projects for which an EIA is mandatory		
A4 Infrastructure Projects		
	A4.5	Construction of new highways and feeder roads or expansion of existing highways and feeder roads
	A4.8	Construction of new, or expansions to, existing railway lines
A13 Projects in proximity to or which have the potential to affect:		
	A13.1	areas of unique historical, cultural, scientific or geographical significance or which have received some kind of world heritage designation
	A13.2	national parks, game reserves and protected areas
	A13.3	Wetlands
	A13.4	water bodies
	A13.5	flood zones
	A13.6	major sources of drinking water, including communal wells
	A13.7	cemeteries or ancestral shrines
	A13.8	residential, school and hospital areas, as designed in local planning documents
List B – List of projects for which an EIA may be required		
B5 Infrastructure		
	B5.2	major roads and highways
	B5.3	major railway lines
B.13 Areas protected under legislation		
	B13.1	Forest reserves, game reserves
	B13.2	National parks
	B13.3	Monuments and declared historical sites
B14 Areas containing rare or endangered flora and fauna		
B15 Areas containing unique or outstanding scenery		
B16 Tribal habitats		
		Cemeteries
		Ancestral shrines

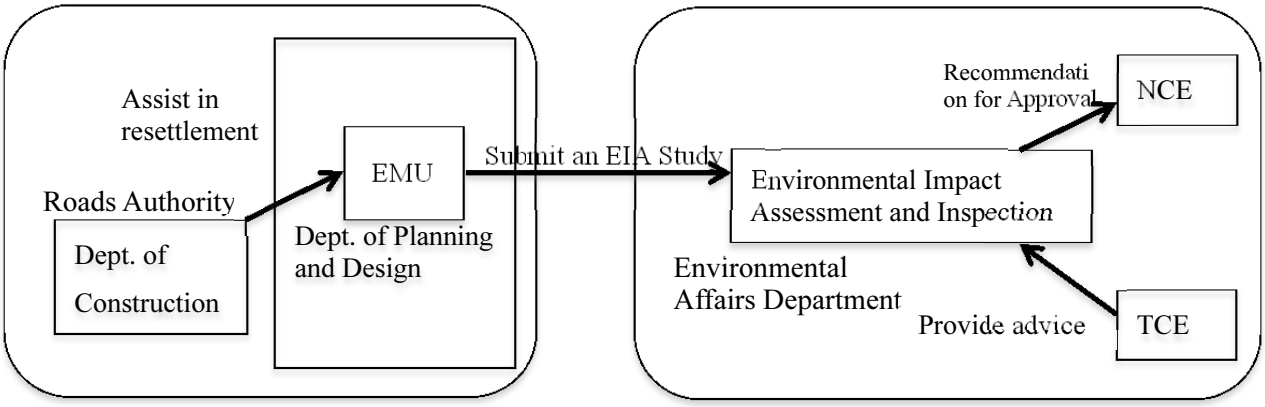
Source: Guidelines for Environmental Impact Assessment, 1997, EAD

In the railway sector, there is no guideline for environmental and social management. However, the Railways Act 1907 provides the general legal framework applicable to environment and social consideration in railway projects. The Act provides regulations for railway safety and the process of land acquisition.

The EMA 1996 was revised in 2007 to provide a legal framework for the establishment of EPA, but the revised EMA has not been submitted to, or approved by, the Parliament. EPA will be the principal agency for environmental protection, and will coordinate, monitor and supervise all activities relating to the environment, including the EIA process. The proposed EMA bill requires a registration of persons who conduct the environmental impact assessments.

EAD in MoNREE is responsible for conducting the EIA process. The EIA process is guided by the Technical Committee on the Environment. EAD assigns an environmental officer in each district. In the case of road projects, the Environmental Management Unit (EMU) in RA, under MoTPI, is in charge of conducting the EIA process and there is only one officer assigned in this unit. When resettlement is required in a road project, EMU coordinates the resettlement process with the Department of Construction. Environmental monitoring is implemented by EMU and assisted by EAD under MoNREE. Figure 10-2 illustrates the institutional structure of the EIA process in the road sector.

In the case of railway projects, RD in MoTPI is responsible for the EIA process. There are only two staff in RD at the time of writing this report. Since there is no environmental officer in this division, the EIA process in railway projects is to be jointly handled by RD and EAD under MoNREE. The GoM signed a Concession Agreement with CEAR in 1998, and there is a Director of Engineering and Safety in CEAR in charge of environmental and social management.



Source: Study Team

Figure 10-2 Institutional Structure of the EIA Process in the Road Sector

10.3 Process of Land Acquisition

10.3.1 Categories of Land in Malawi

Malawi has a total area of 118,484 m^2 (11.8 million hectares), of which 9.4 million hectares are land. The Land Act 1965 defines three categories of land in Malawi, namely, 1) public land, which is occupied, used or acquired by the GoM and any other land, not being customary land or private land; 2) private land, which is owned, held or occupied under a freehold title, or a leasehold title; and 3) customary land, which is held, occupied or used under customary law, but does not include any public land. With due consideration of the land problems related to land acquisition in the past, the Malawi National Land Policy 2002 introduced a new land category of government land. The new land categories under this Malawi National Land Policy 2002 are as follows:

- **Government Land,** which is acquired and privately owned by The GoM and dedicated to a specified national use or made available for private use at the discretion of the GoM (e.g., government buildings, schools, hospitals)
- **Public Land**, which is held in trust and managed by GoM or TA openly used or accessible to the public at large (e.g., national parks, forest reserves). This type of public land includes 1) the public land vested in the GoM as a result of uncertain ownership, abandonment and land that is unusable for one reason or another, and 2) the community's public land under a TA, which includes all land within the boundaries of the TA not allocated exclusively to any

group, individual or family such as *dambos* (permanent wetland) and dry-season communal grazing areas.

- **Private Land**, which is exclusively owned, held or occupied under 1) freehold tenure, and 2) customary land allocated exclusively to a clearly defined community, corporation, institution, clan, family or individual, known as customary estate. A leasehold estate can be created out of Government land or any private land including customary estates.
- **Customary Land**, which is all land falling within the jurisdiction of a recognised Traditional Authority, which has been granted to a person or group and used under customary land. The policy provides customary land with secure tenure by recognising such customary allocations officially as a customary estate. The property rights contained in a customary estate are private usufructuary rights in perpetuity.

A Special Law Commission on the Review of Land Related Laws was empanelled in 2003 to review land related laws. The Special Law Commission recommends, pursuant to Section 133 (b) of the Constitution, that Government land shall be defined as land acquired and privately owned by the GoM and public land shall be vested in the Republic, not the President as written in the Land Act 1965.

Customary land accounts for around 66% of all land in Malawi, followed by public land (21%) and private land (13%) (State of Environment Report, 2002). The statistics compiled by MoAFS (2010) show that more than 76% of land in the Southern Region of Malawi used by agricultural smallholders is customary land (Table 10-3). Apart from Chiradzulu District where freehold land accounts for a majority of land tenure, most parcels of smallholders hold customary land under the jurisdiction of Traditional Authority. Therefore, it is likely that land required for the purpose of new construction or rehabilitation of transport projects in the Study Area may fall under the category of customary land.

Table 10-3 Percentage Distribution of Parcels by Type of Land

(Unit: %)

Area	Customary Land	Leasehold	Freehold	Public
Malawi	77	2	19	1
Southern Region	76	2	20	2
Blantyre City	70	2	26	2
Blantyre Rural	72	1	25	2
Zomba Rural	75	3	20	2
Chiradzulu	38	1	60	1
Thyolo	70	1	28	1
Mulanje	71	4	24	1
Phalombe	91	1	8	0
Mwanza	69	1	28	2
Chikwawa	83	0	14	2
Nsanje	98	1	0	0

Source: NCAL 2006/07, 2010

Note: A parcel of land is a piece of land that has been allocated to a member of a household, whether used for farming or not. It includes grazing land, woodlot, orchard, and land where the household has built its dwelling unit. Areas of parcels and plots were measured using GPS equipment.

10.3.2 Policy and Legal Regulations on Land Acquisition

The principles and process of land acquisition for the purpose of development projects are provided by the Constitution, Land Act 1965, Land Acquisition Act, Public Roads Act 1971, Town and Country Planning Act 1988, Malawi National Land Policy 2002, Forestry Act 1997, Local Government Act 1998, and Railway Act 1907.

Sections 28 (2) and 44 (4) of the Constitution provide the guiding principles of land acquisition in Malawi, stating that "no person shall be arbitrarily deprived of property" and "expropriation of property shall be permissible only when done for public utility and only when there has been adequate notification and appropriate compensation, provided that there shall always be a right to appeal to a court of law".

Section 28 under the Land Act recognises the need for compensation to individuals who suffer any disturbance, loss or damage as shall be reasonable. Meanwhile, the Land Acquisition Act provides the procedure for land acquisition, including: 1) notifying the person from whom land is to be acquired, 2) paying compensation, 3) assessing fair compensation, and 4) transferring land. Section 6 (1) under this Act provides for the possession of land by the GoM after expiration of the period specified in the notice given by the Minister. A revision to this section was recommended by the Special Law Commission to insert a provision that the land should only be yielded up after compensation has been paid.

The Malawi National Land Policy was formulated in 2002 after reviews of land issues in Malawi. It highlights that any private land (including customary land) acquired for the benefit of national development shall be valued and compensated based on the open market value (commercial rate) paid to the owner for both the land and improvement. The open market value is defined as "the best price at which the sale of an interest in property might reasonably be expected to have been completed unconditionally for cash consideration on the day of valuation". A reasonable period of valuation is ensured for the agreement of price and terms and for the completion of the sale by this policy. The policy refutes the notion that customary land has no value because "land has value as a scarce resource and has other physical and intrinsic attributes that also contribute to its economic and social value".

The Public Roads Act provides more comprehensive land acquisition procedures for the road sector. The Act gives the Minister power to declare the width of road reserves to be 60 m for a main road, 36 m for a secondary road and a district road, and 18 m for branch roads and estate roads outside land declared under the Town and Country Planning Act. Part II under this Act provides the procedure for compensating for use of a road project. For customary land, the amount of compensation is assessed after consultation with the Chief of the area and based on the loss suffered by the claimant. For private land, the amount of compensation is based on the loss or damage suffered by the claimant, which is valued at the valuation date and the market value of the land is taken into consideration (Section 44-46). If the market value has increased due to any improvement by the claimant in interest within two years before the valuation date,

such increase is disregarded. The Special Law Commission recommended amending Section 44 (2) to assess the amount of compensation for customary land in the same way as private land (open market value). There is a section which regulates the procedure for claims for compensation in which the claim should be made in writing to the highway authority liable to pay such compensation. Since the literacy rate in Southern Malawi is around 62% (Population and Housing Census 2008), careful consideration should be given to those who cannot write a claims letter for compensation.

The Railway Act 1907 provides the Minister power to acquire land for the purpose of a railway. Section 10 ensures that the owner of land is entitled to compensation for any damage caused by the exercise and this compensation shall be agreed by the owner. The Concession Agreement between the GoM and CEAR includes a section on land acquisition, in which CEAR may ask the Minister to implement the procedures for the acquisition of land by the GoM.

The Forestry Act 1997 provides for the licensing of forest land and utilization of forest produce on customary land, public land, forest reserves and protected areas (Section 45).

JICA Guidelines for Environmental and Social Considerations 2004 require that people who are required to resettle involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents in a timely manner. The recommended measures for this compensation include the provision of land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities in the new area. The basic principle for involuntary resettlement in the guidelines is to avoid involuntary resettlement wherever possible by exploring all viable alternatives.

To apply the guidelines to the legal context of Malawi, the following resettlement framework is considered:

- Involuntary resettlement should be avoided wherever possible by exploring all viable alternatives.
- The study cites Section 28 (2) and 44 (4) of the Constitution as the basic principles for the process of land acquisition.
- In the Study, the open market value outlined in the Malawi National Land Policy will be a benchmark to assess private and customary land required for the benefit of development.
- Compensation should be paid by the GoM before the land is yielded up, as recommended by the Special Law Commission.
- An appropriate grievance mechanism should be established to ensure the proposed project is launched smoothly.

10.3.3 Current Land Acquisition and Resettlement Process

Table 10-4 illustrates the land acquisition process in a previous project in the road sector,

financed by AfDB. The Resettlement Policy Framework for the Malawi Power System Project, financed by Millennium Challenge Corporation, provides more detailed resettlement procedures. For instance, the valuation of tree crops and perennial crops shall be based on the market price, i.e., the current government schedule for valuing crops and trees (e.g., forest tree rates for 2010 and crop prices for September 2010), while residential dwellings are valued on the basis of the cost of constructing a new replacement structure, which includes the market price of required construction materials and labour, the cost of sanitation facilities, and the cost of access to water supply.

The Study Team undertook a field investigation in Nsanje and Thyolo districts from November to December 2011 to understand the current land acquisition and resettlement process in the project area. It was found that, although not explicitly stated, the Local Government Act 1998 provides certain power to district assemblies to conduct the land acquisition and resettlement process at the district level. According to Nsanje District Assembly, the first step of resettlement is to conduct an assessment (or a census of Project Affected Persons (PAPs) and affected assets). The assessment is normally carried out by a Land Officer of the District Assembly and a Regional Officer for Land and Evaluation, in consultation with TAs.

Table 10-4 Land Acquisition Process in the Road Project between Zomba and Blantyre (M3)

Process	Description
Identification	For customary land, the Ministry of Land consults with the TA to identify land and persons for compensation. For private land, the Ministry confirms the correct registered owners of the land from the Land Registry.
Notification	The Ministry notifies the public in widely circulated daily newspapers of its intention to acquire the land.
Entitlement	Displaced persons who encroach on the project area after the cut-off date (date of commencement of the census of PAPs within the project area) are not entitled to compensation.
Compensation	For the loss of land for property owners including those covered by customary land, the full replacement value is provided.
Illegal occupants	For squatters who have no legal right or claim to the land they are occupying, compensation for loss of shelter is provided at cull replacement value for structures and relocation to a resettlement site, with payment of site rent.
Grievance	A complaints and grievances mechanism was proposed.

Source: Proposed Rehabilitation of the Zomba-Blantyre (M3) Road: Environmental and Social Impact Assessment Report: Abbreviated Resettlement Action Plan, 2008

The assessment is based on the market price, whose value shall be determined in consultation with a District Commissioner, TAs, and the Road Authority, in case of a road project. The District Commissioner declares the date of this assessment as a cut-off date. The assets for compensation normally include lands (including agricultural land), houses, forests, and other assets. After the assessment, consultation with PAPs is carried out, in which many local people are usually involved in order to ensure transparency in the consultation process and incorporate their views and opinions (Nsanje District Assembly). Regarding compensation for houses, the developer normally provides a residential dwelling equivalent to, or better than, the previous

one, while agricultural land is usually compensated in cash.

Trees are also compensated if a community owns/uses it, which requires the assessment and consultation process, as in the case of houses. Customary forest is often used as a woodlot for energy use and other means of livelihoods of local people. A Village Natural Resource Management Committee (VNRM) is established in each village, which manages a free access forest for the community. The acquisition of forest under the management of VNRM requires consultation with TAs. Trees owned by individuals required consultation with, and compensation for, individual owners. A forestry officer in the District Assembly is in charge of the assessment of trees. Compensation for trees is normally done in cash, or by replanting trees in case of felling.

The ROW of secondary road is 18m×18m while the ROW of the railway between Limbe and Border (Marka) is 15m×15m. However, there is much agricultural land extending to the ROW of the railway between Limbe and Sandama and some vendors occupy the ROW of the road near Makhanga Market. According to Thyolo District Assembly, since the land within the ROW of railways is normally located within the boundary of customary land, local people think that the land within ROW is not utilised, in particular where trains pass once a week, and thus occupy ROW for agriculture and business purpose. In other words, local people do not know the boundary between railway/road reserves and customary land. The occupied land and buildings in ROW are illegal, but in some cases, these occupations are recognized locally as customary occupation. According to RA, houses that have occupied ROW for more than 5 years are entitled to receive compensation.

10.3.4 Resettlement Policy Framework

JICA Guidelines for Environmental and Social Considerations April, 2010 (hereafter referred to as "JICA Environmental Guidelines" require that people who are required to resettle involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents in a timely manner. To apply the guidelines to the legal and customary context of Malawi, the following resettlement framework is considered:

- Involuntary resettlement should be avoided wherever possible by exploring all viable alternatives.
- Where resettlement is unavoidable, the resettlement process should be planned and conducted as a sustainable development programme, enabling those displaced by the project to share in its benefit.
- The study cites Section 28 (2) and 44 (4) of the Constitution as the basic principles for the process of land acquisition.
- In the Study, the open market value outlined in the Malawi National Land Policy will be a benchmark to assess private and customary land required for the benefit of development.

The valuation shall be based on the market price of building a new replacement structure equivalent to, or better than, the previous one for residential dwellings and business structure, and the current government schedule for trees and crops. Compensation for trees shall be done either in cash or by replanting trees in case of felling.

- As in the case of Nsanje District, valuations shall be assessed by the District Assembly, in consultation with community/TAs, executing agents, and financial providers.
- PAPs shall be (a) those who have the formal legal right to land (including customary and traditional rights recognized under the law of Malawi), (b) those who do not have formal legal rights to land at the time when the assessment begins but have a claim to such land or assets (for instance, those who reside in ROW for more than 5 years), (c) those who have no recognized legal right or claim to the land they are occupying.
- Full replacement cost must be provided wherever possible for those who need to be resettled involuntarily and those whose means of livelihoods will be hindered or lost (for PAPs of 6. (a) and (b) above). Measures to achieve this include: i) providing land and money for losses of residential dwelling and business structure, ii) supporting means for an alternative sustainable livelihood for those whose income sources or means of livelihood will be lost, and iii) providing the expenses necessary for the relocation of agricultural crops and forest resources. For squatters who have no legal and customary right or claim to the land they occupy, resettlement assistance to relocate to a resettlement site can be provided, if they occupied the area prior to a cut-off date established by the local government.
- Appropriate consultation with stakeholders and PAPs needs to be conducted in the following stages:
  - Consultation with stakeholders during the Pre-F/S stage: consultation with District Assembly, Working Group Meetings, Consultation with stakeholders in Lilongwe and Blantyre
  - Consultation with PAPs during the F/S stage: during the assessment (census), public hearings
  - Consultation with PAPs during the implementation and post-resettlement monitoring

  Consultation with PAPs includes the dissemination and gazetting of alignment information, which is required under the law of Malawi, the assessment of affected people/assets, and public hearing on resettlement plans and mitigation measures. As many people as possible should be involved in the consultation in order to ensure transparency in the resettlement process and to incorporate the views and opinions of local people.
- Compensation should be paid by the GoM before the land is yielded up, as recommended by the Special Law Commission.
- An appropriate grievance mechanism should be established to ensure the proposed project is launched smoothly.

10.4 Strategic Environmental Assessment (SEA) for Master Plan

10.4.1 SEA Methodology

This study applies the Initial Environmental Examination (IEE) level study for the Master Plan and the IEE level for the pre-Environmental Impact Assessment for priority projects, which will be selected by the Master Plan. The IEE level study means, "an analysis of alternative plans, a prediction and assessment of environmental impacts, and a preparation of mitigation measures and monitoring plans based on easily available information including existing data and simple field surveys" ("JICA Environmental Guidelines"). At the Master Plan stage, a methodology of Strategic Environmental Assessment (SEA) is normally required to assess environmental and social impacts from an early stage, according to the "JICA Environmental Guidelines". The SEA is an assessment that is implemented at the policy, planning, and programme levels and uses a range of "analytical and participatory approaches that aim to integrate environmental considerations into policies, plans and programmes and evaluate the inter-linkages with economic and social considerations" (Organization for Economic Co-operation and Development (OECD), Applying Strategic Environmental Assessment, 2006). In this study, the proposed nine options, including the zero option, are regarded as regional transport programmes, and each programme will be evaluated based on the analytical tools of the SEA. The following approaches are considered at the Master Plan stage:

(1) Screening of Proposed Projects

The screening process is carried out by using the Malawi EIA process and the SEA methodology. After screening by the EAD guidelines, the proposed projects are briefly checked to assess whether they are in line with the objectives of the proposed development programme and if there are clear economic, social, and environmental benefits. The objectives of the development of the Sena Corridor are to facilitate sustainable economic growth and poverty reduction in the Study Area by improving the inadequate transport network, and to promote regional development in Southern Africa. The SEA mainly focuses on the first objective of the Sena Corridor Development in the Study Area15.

(2) Scoping and SEA for the Master Plan for the Sena Corridor

After the selection of candidate projects by the screening process, the Study applied the SEA methodology to evaluate qualitatively the environmental, social, and economic impacts of the regional transport development programme for the Sena Corridor. The main analytical tools of the SEA used in this study include:

- Assessment of cumulative environmental, economic, and social impacts at the programme level (including zero option)
- Consideration of alternatives
- Participatory approaches to bring in relevant stakeholders

[15] The contribution to regional development in Southern Africa is assessed by other evaluation criteria.

- Identification of measures to enhance opportunities and mitigate adverse impacts

After identifying a priority programme for the Sena Corridor, the Pre-Environmental Impact Assessment will be undertaken for priority project(s) at the IEE level. The IEE for priority projects requires public participation from the Project Affected Persons (PAPs) during the scoping process, according to the Environmental Management Act 1997. To encourage public participation, a public hearing will be held to convey information about the IEE study and gather comments and opinions from the public. The participants may consist of representatives from relevant government agencies, donors, NGOs, representatives of communities affected, and traditional chiefs. Both English and the local language (Chichewa) will be used and the gender balance to represent affected communities will be considered. The presentation will be conducted by Malawian counterparts with assistance from Japanese experts as part of the capacity development programme.

The proposed projects for the IEE at the Master Plan stage are shown in Table 10-5. The proposed projects in Mozambique are excluded from the IEE level study because this study only applies Malawi's EIA process.

Table 10-5 Proposed Projects for the SEA in the Master Plan

Transport Mode	Route	Section	Length (km)	Width (m)	Designed Width (m)
Road	S152	Upgrading of Thabwa–Seven (Scenario 2)	59.1	5 to 6	10
	S151	Reconstruction of Makhanga–Bangula (Scenario 2)	8.7	4 to 5	10
	M1	Upgrading of Blantyre–Thabwa (Climbing Lane)	36.9	9.7	+3
	Operated/ Not Operated	**Section**	**Length (km)**	**Vertical Gradient**	**ROW (m)**
Railway	Operated	Rehabilitation of Limbe–Luchenza (Scenario 2)	44.0	Steep	15
	Operated	Rehabilitation of Luchenza–Makhanga (Scenario 2)	76.6	Steep	15
	Not operated	Reconstruction of Makhanga–Bangula (Scenario 2)	8.7	Flat	15
	Not operated	Reconstruction of Bangula–Nsanje (Scenario 2)	45.3	Flat	15
	Not operated	Reconstruction of Nsanje–Border (Marka) (Scenario 3)	26.4	Flat	15

Source: Study Team.

10.4.2 Environmental and Social Impacts in the Project Area

The main negative anticipated environmental and social impacts found in the Study relate to air pollution, water pollution, noise, biodiversity, soil erosion and topography, hydrology, and resettlement. There are also positive impacts expected from the proposed transport projects in terms of local economy, social infrastructure and social services.

(1) Air Pollution

Air quality is not measured or monitored in Malawi. There is no environmental standard to regulate air pollution in the transport sector. However, the number of motorized vehicles has been sharply increasing as evidenced by congested roads in the major cities in Malawi. According to the State of Environment Report 2002, air pollution occurs countrywide in both urban and rural areas in Malawi. In particular, diesel vehicles are poorly maintained and make a

significant contribution to the levels of air pollution in urban areas. The major pollutants to roadside air quality by motorized vehicle emissions are dust, gaseous emissions (nitrogen oxides (NOx), sulphur dioxide (SO_2), hydrocarbons (HC), and carbon monoxide (CO)) and particulates.

However, the traffic volume in the project area is relatively low compared to other regions in Malawi: traffic volumes of motorised vehicles on M1 (Bangula) and S151 (Seven) in 2006 were 216 veh./day and 37 veh./day, respectively. The average speed of vehicles on unpaved roads in the project area was about 32-40 km/h. In the proposed projects, the roads in the project area are designed for an average speed of 70 km/h, which will result in more efficient combustion of fossil fuels than at present. Some dust will be produced during construction, but no significant adverse impacts are expected since most of the construction work will be done in open agricultural/vegetation areas in dispersed settlements. The dust may be more intense during the dry season in Malawi. It is possible to reduce dust generation to some extent by using manpower for construction and sealing highly-used earth roads by water application.

Railway is an environment friendly means of transport in terms of air pollution. For the section between Limbe and Makhanga, diesel locomotives are currently utilised for passenger trains, which run once a week. Diesel engines emit combustion products such as NOx and particulate matter (PM). In the designed railway projects, passenger trains will run daily between Limbe and Nsanje (or Border Station (Marka)). Freight trains from Bangula to Limbe are expected to resume operation after the rehabilitation of this section, and the trucks that are currently used to carry sugar from Illovo may be replaced by freight trains, for instance. Although there may be increased air pollutants emitted by locomotive engines, this increase may be partially, offset by the change of transport mode from minibus/truck to railway.

(2) Water Pollution

As shown in Section 2.4.3, three major rivers, namely, the Shire River, Ruo River, and Mwanza River flow into the project area. In addition, two wetlands, Elephant Marsh and Ndinde Marsh, extend along the Shire River Basin in this region. The GoM launched the Greenbelt Irrigation initiative to transform the lakeshore, the Shire Valley and other valleys in the 17 major catchment basins into a planted green belt. Many river basins and wetlands are under pressure from human activity, which may cause a deterioration in water quality. The Shire Valley and rivers that flow into Lake Chilwa accumulate soil loads, which could change the channel configuration and increase the risk of flooding. Agricultural and industrial wastes are the main causes of degradation of water quality.

Groundwater is also an important source of water for the rural population in this region: there were 14,074 wells in the Southern Region in 2006. Groundwater resources are thought to be diminishing, especially with the ever-increasing number of wells being dug (State of Environment Report 2002). In the Lower Shire Valley, groundwater holes tend to have high levels of salt, causing boreholes to be abandoned.

In the transport projects, diesel fuels and other fuel products will be transported and used throughout the worksite. In addition, solid and liquid wastes generated by the construction work will be of particular concern where the projects involve crossing rivers and wetlands. If proper management is not ensured, waste oils could contaminate groundwater and affect the health of the surrounding population. This potential negative impact can be mitigated by proper siting of work camps to avoid sensitive areas such as water catchments, and by locating the stockyard for all construction materials far from rivers, wetlands and drinking water source. According to the Environmental and Social Management Guidelines in the Road Sector, it is recommended to stockpile waste materials 15 km away from water resources.

(3) Noise and Vibration

Noise associated with road projects has four main sources: a) vehicle noise; b) friction between vehicles and road surface; c) driver behaviour; and d) construction and maintenance work. On the other hand, noise/vibration associated with railway development is generated from three main sources: a) rolling noise between wheel and rail during normal movement and braking; b) aerodynamic noise generated by the train pushing air; and 3) engine noise.

The proposed projects do not pass populous cities except Limbe, but people living close to the roads and railways could be disturbed. To mitigate the potential noise and vibration during the rehabilitation period, working hours can be set from morning to evening to avoid disturbing the people. Noise barriers can also be used to reduce noise levels in residential areas.

(4) Protected Areas and Biodiversity

Malawi is endowed with unique and diverse flora and fauna, with over 800 species of fish and 651 species of birds. The GoM has designated protected areas as a measure to conserve and protect the unique ecosystem and species. The total protected area covers approximately 180,000 ha or 20% of the total land area (National Biodiversity Strategy and Action Plan 2006). There are three categories of protected area:

i) Game Reserves, which are protected by the National Park and Wildlife Act 2004 and the Forestry Act 1997
ii) National Parks, which are protected by the National Park and Wildlife Act 2004 and guided by the National Wildlife Policy 2000
iii) Forestry Reserves, which are protected by the Forestry Act 1997 and guided by the National Forestry Policy of Malawi 1996

The National Park and Wildlife Act 2004 gives the Minister power to declare any area of land or water to be a national park or wildlife reserve (28 (1)). An environmental impact assessment on wildlife species or community must be conducted with a public hearing, which includes an account of the species, communities, and habitats affected, and a statement of whether rare, endangered or endemic species are or may be affected (23 (1), 25 (1)).

The National Wildlife Policy 2000 ensures that the Department of National Parks and Wildlife is responsible for taking into account the environmental impact assessment procedures

when proposals, plans or projects are formulated that are likely to have adverse impacts on wildlife. The guiding principles state that infrastructure development in national parks and wildlife reserves shall be undertaken according to the guidelines for such activities. The policy also requires that road construction, maintenance, and traffic do not inflict damage on wildlife resources. There is a section on the conservation of wetlands, which states that wetlands "have high biodiversity and are of international importance especially for migrating birds".

The area of forests and woodlands in Malawi is estimated at 3,237,000 ha, accounting for about 34% of the total land area (Food and Agriculture Organization (FAO), 2010). The Forestry Act 1997 gives the Minister power to declare any public land not already reserved for another public purpose to be a forest reserve (22). The Act also gives the power to any village headman, with advice from the Director of Forestry, to demarcate on unallocated customary land a village forest area, which shall be protected and managed in the prescribed manner (30). The National Forestry Policy provides guidelines on the sustainable use of forest resources to improve the quality of life in the country. The Policy mentions the limitation of the Forestry Act (1997) in providing a mechanism for managing trees and forests on customary land and the lack of clarification of the rights of individuals and communities to own, manage and utilise indigenous trees growing on such land.

In the project area, there are three national parks and game reserves: 1) Lengwe National Park, 2) Majete Wildlife, and 3) Mwabvi Wildlife Reserve. There is a Ramsar protected lake, Lake Chilwa. Figure 7-3 shows the locations of the protected areas along the Lower Shire River.

The Lengwe National Park, for instance, was established to conserve the northernmost population of Nyala antelope in its range in Southern Africa. The number of Nyala was found to be in the low hundreds by the Wildlife Society of Malawi in 1999. Rare, endangered, and endemic mammal species in this park were listed as follows: *Rhynchocyon cirnei-shirensis* (a subspecies of chequered elephant shrew endemic to Malawi), *Cercopithecus albogularis* (Nchima monkey), *Tragelaphus angasi* (Nyala), *Neotragus moschatus* (a particular subspecies of Livingston's Suni, which occurs in Lengwe and has a very restricted range) and *Hippotragus niger* (Sable antelope, the Lengwe population may be a subspecies restricted to Malawi and eastern Zambia). For birds, *Apalis ruddi caniviridis* (a subspecies of Rudd's Apalis), *Francolinus sephaena zambesia* (a subspecies of Crested Francolin) and *Nectarinia veroxii* (the Grey Sunbird, confined to Lengwe within Malawi) are regarded as important species within the park.

The current park plan for the Lengwe National Park includes two separate systems of zoning, namely: 1) the delineation of compartments for ecological management based on the landscape classification and, 2) the designation of zones for public use and development according to a set of established categories. The park plan specifies five categories of zone to separate public use zones from development zones within the park. The zoning categories include: 1) special areas (relatively small sites designated to protect unique, unusual or otherwise important biotic,

abiotic or cultural features), 2) wilderness areas (relatively large tracts of undisturbed land intended for aesthetic recreational experience and conservation of biological diversity), 3) semi-wilderness area (relatively undisturbed but accessible land designated primarily for public use, 4) resource use zones (areas where controlled consumptive use of wild resources is permitted, 5) utility areas (sites for management and visitor purposes).

In general, the faster access to the National Park brought by transport development projects poses a serious risk of escalated poaching activities, solid wastes from tourists, and pressure for wildlife resources. Although the current National Parks seem to be effectively managed by the zoning process, further reviews of the park management plan and conservation measures may be necessary when a transport development project is planned.

There are currently 23 gazetted forest reserves in the project area (Table 10-6).

Table 10-6 Gazetted Forest Reserves as of June 2010

Forest Name	District	Area (km^2 Registered)	Area (ha)	Year Gazetted
Mulanje Mountain	Mulanje	552.09	55,209	1927
Sambani	Mulanje	1.29	129	1948
Thuchila	Mulanje	24.34	2,434	1925
Masatwe hills	Mwanza	73.88	7,388	
Michiru mountain	Mwanza	14.48	1,448	
Mkanya hills	Mwanza	3.16	316	
Mindi hills	Mwanza	6.88	688	
Nankhwazi hills	Mwanza	1	100	
Neno escarpment	Mwanza	68.44	6,844	
Nkula/Tedzani	Mwanza	30.92	3,092	
Phirilanjoka	Mwanza	2.76	276	
Thambani	Mwanza	106.7	10,670	1927
Tsamba	Mwanza	32.4	3,240	1928
Twiti mountain	Mwanza	10.32	1,032	
Zaka hills	Mwanza	0.56	56	
Matandwe	Nsanje	262.05	26,205	1931
Amalika	Thyolo	5.2	520	1974
Kalulu hills	Thyolo/Nsanje	28.23	2,823	1958
Lichenya	Thyolo	1.29	129	1948
Masambanjati	Thyolo	0.92	92	1914
Masenjere	Thyolo	1.01	101	1930
Thyolo	Thyolo	13.21	1,321	1924
Thyolomwani	Thyolo	9.32	932	1930

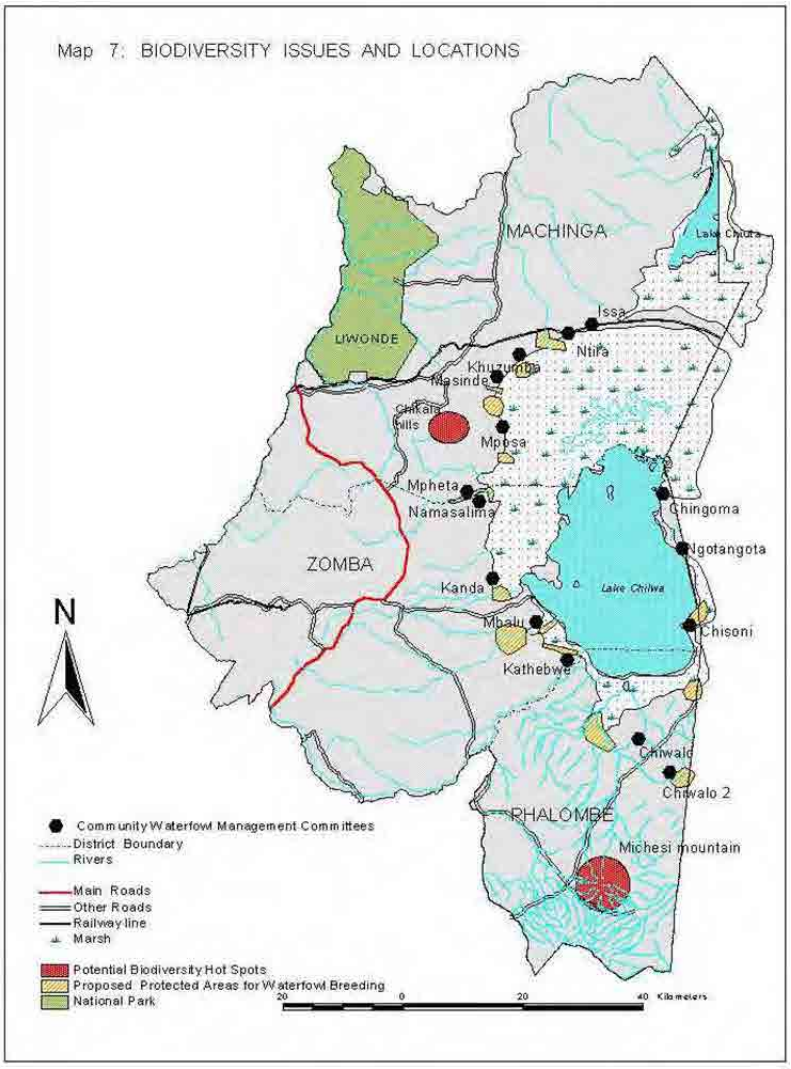
Source: Malawi State of Environment and Outlook 2010

However, the actual forest areas in forest reserves have decreased due to encroachment, illegal cutting and charcoal production. For instance, Thyolo Mountain has suffered significant encroachment, resulting in the total elimination of forest cover by 2004 from 1,321 ha in 1996 (State of Environment Report in Thyolo District). The protected forest reserves comprise mostly Miombo species such as Mbawa (*Khaya anthothica*), Mlombwa (*Pterocarpus angolensis*), Tsamba (*Brachystegia species*), Masuku (*Uapaca kikiana*) and Mwanga (*Pericopsis angolensis*).

The section between Chikwawa and Mwanza (S136) passes through 106.7 km^2 of the Thambani Forest Reserve. The improved access to commercial sites in Chikwawa may cause deforestation and a threat to the forest ecosystem of the Thambani Forest Reserve. To mitigate this adverse impact from the road development project, ROW can be minimized for the road section through the Reserve. The clearance of trees along the road should be carried out in an environmentally friendly way, i.e., by cutting instead of bulldozing, and without using chemical and fertilizer. Further investigation on the ecosystem in the Thambani Forest Reserve may be required before undertaking the road project in this section.

Wetlands are not protected areas under Malawian law. Most of the wetland areas are under customary land tenure and accessed openly, except at Lake Chilwa, which is protected by the Convention on Wetlands, internationally known as the Ramsar Convention.

Lake Chilwa has a wide water catchment area, comprising Phalombe District, most of Zomba District, and 43% of Machinga District (Figure 10-3). The lake and wetland contain water most of the time, but the water has completely dried up three times in the last 100 years. Lake Chilwa has up to 164 species of birds, of which 41 species are Palearctic migrant species that migrate from Europe through the Rift Valley. The Shire River flows through an area of swamp called Elephant Marsh. The marsh is bound on the east by the Thyolo escarpment and on the immediate west by the alluvial floodplain of the river. This marsh was around 150 square miles in area and about 10 miles wide, as shown in Figure 10-4.

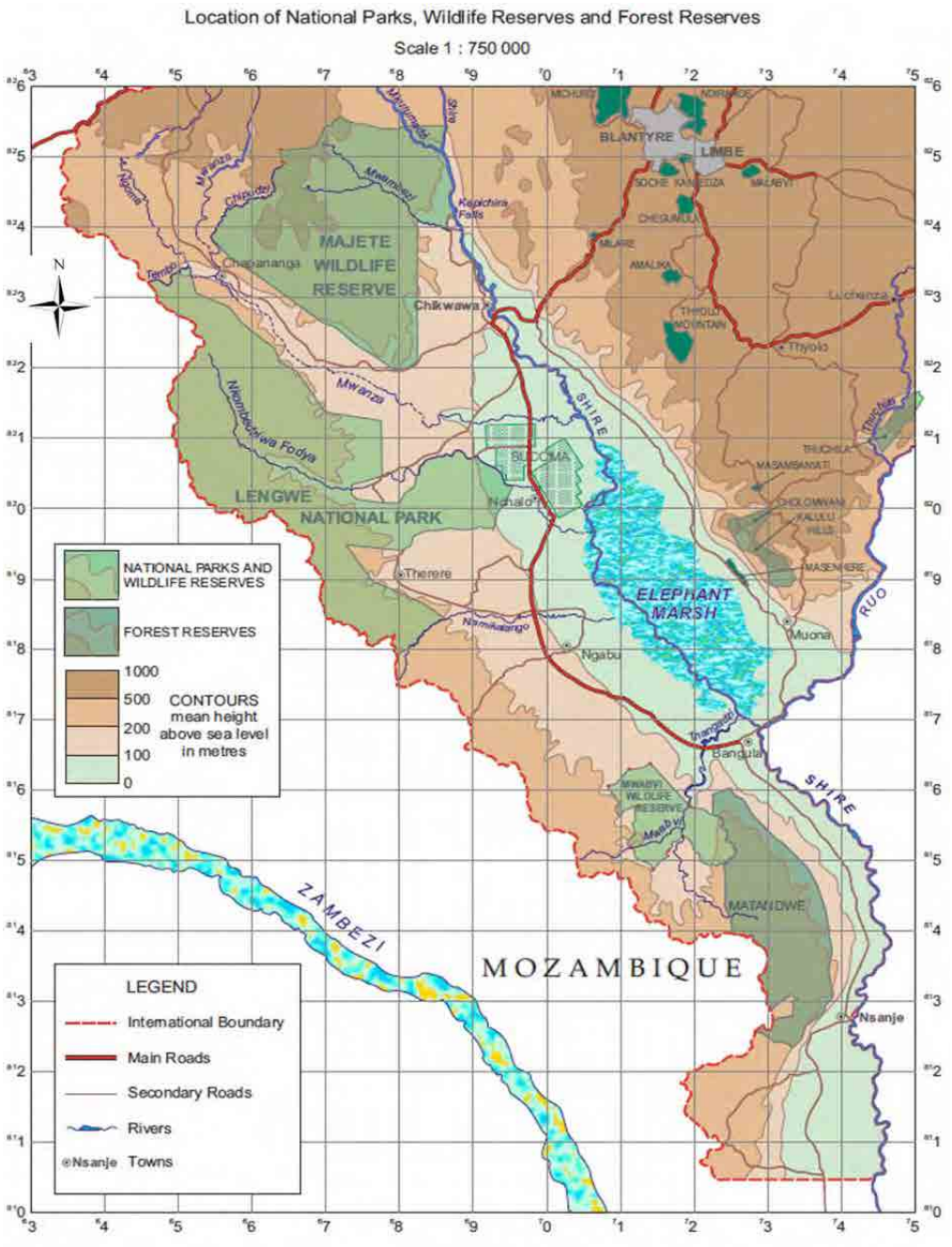


Source: Lake Chilwa Wetland Management Plan, 2001

Figure 10-3 Biodiversity and Hot Spots

Following the flooding of the Shire River in 1997, the marsh area became larger. Elephant Marsh is not a protected area by law in Malawi and some farmers have cultivated this area

openly. However, the wetland plays an important role in biodiversity as a bird sanctuary and as a destination for migrant birds (a draft "Malawi State of Environment and Outlook 2010" and interviews with the Department of National Parks and Wildlife in Lengwe National Park). Ninety-eight bird species were recorded in an inventory survey of birds in Elephant Marsh done by the Cambridge Expedition to Malawi July-August 1991. The Palearctic birds, which are migrant birds from the Palearctic region including Europe, North Africa and all of Asia except its southern region, come from Europe to Elephant Marsh through the Rift Valley during the European winter.



Source: Department of National Parks and Wildlife

Figure 10-4 Lower Shire Valley Conservation Areas

In addition, some inter-African migrant birds were recorded in Elephant Marsh as shown in Table 10-7. A more recent inventory survey was conducted in August 2008 on the lower side of the Kamuzu Truss Bridge (Chiromo) and found one species of inter-African migrant bird and several resident birds. Birdlife International listed 32 bird species occurring in Malawi as Globally Threatened Species (Red List Category).

Table 10-7 Examples of Migratory Bird Species from Elephant Marsh

Species Name	Scientific Name	Status
Little Bittern	*Ciconia Ciconia*	Palearctic migrant
Ruff	*Philomachus pugnax*	Palearctic migrant
Greenshank	*Tringa nebularia*	Palearctic migrant
African Skimmer	*Rynchops flavirostris*	Inter-African migrant
Mascarene Martin	*Phedina borbonia*	Malagasy migrant

Source: Data adapted from a bird checklist by Cambridge Expedition to Malawi July-August 1991;
Perspectives on wild birds in Malawi in relation to avian bird flu, by W. O. Mgoola

The National Parks and Wildlife Act (2004) provides a classification of protected species, some of which are also classified as game species for the purpose of hunting. Based on the inventory surveys in 1991 and 2008 in Elephant Marsh and a book detailing the 650 bird species in Malawi, the Study Team compiled a list of Red Listed species that may exist in Elephant Marsh in Table 10-8. Although Elephant Marsh is not a protected area, its biodiversity and importance as a destination for migrant birds need to be taken into consideration when undertaking a development project in this area (interview with the Department of National Parks and Wildlife). For instance, a developer may need to take measures to reduce the negative effects on biodiversity in terms of noise, water pollution, and air pollution, as discussed above. Other possible mitigation measures to protect biodiversity in this area are to minimize water crossing and reclamation, design a narrower ROW, and minimize the felling of trees in which birds nest.

Table 10-8 Possible Existence of Red Listed and Protected Species in Elephant Marsh

English Name	Scientific Name	Red List	Status	Description in "The Birds of Malawi" (2006)	Elephant Marsh (1991)	Kamuzu Truss Bridge (2008)
Madagascar Squacco Heron	*Ardeola idea*	EN	Non breeding visitor from Madagascar	The earliest photographed on 18 April 2002 in Elephant Marsh		
Long-crested Eagle*	*Lophaetus occipitalis*		Resident	Widespread species	Recorded	
African Skimmer	*Rynchops flavirostris*	NT	Moved from the Shire River to the lake shore	Most regularly seen on the Shire River.	Recorded	Recorded
Spotted Eagle Owl*	*Bubo africanus*		Resident	The most common and widely spread	Recorded	
Lilac-breasted Roller*	*Coracias caudatus*		Mainly resident	Widespread and fairly common	Recorded	

Sources: The Birds of Malawi, Françoise Dowsett-Lemaire and Robert J. Dowsett (2006); Data obtained from the Department of National Parks and Wildlife.
Notes: EN=Endangered, NT=Near Threatened. * means a protected species by law in Malawi.

The number of hippo has fallen significantly since the peak of 234 counted in 1998 in the Lower Shire (Hippo and Crocodile Counts in the Lower Shire, 1998). The Crocodile and Hippo Census in the Shire River in 2009 estimated the number of hippo in the Lower Shire River at 38, a drastic decline from the 1998 level (Table 10-9). The conflicts between wildlife and humans, increasing cultivation in the Shire River, and poaching are the main reasons for the decline of hippo in Elephant Marsh. Some 754 crocodiles were recorded in 1998, but due to conflicts with human activities and hunting, the number had decreased to 464 by 2008. There used to be some 800 elephants in Elephant Marsh when Livingstone travelled through this area, but it is thought that the elephants moved either to the Majete Wildlife Research or dispersed to Mozambique along the Ruo River. No elephant has been recorded in this area in recent times.

The improved accessibility around the marsh might lead to increased poaching activities and encroachment. As the marsh is not only rich in biodiversity but also a source of human livelihood, an appropriate wetland management plan, as illustrated in the case of Lake Chilwa, is desired.

Table 10-9 Hippo and Crocodile Counts in the Lower Shire River

Area	Hippo			Crocodile		
	Sightings	Density (Animal/km)	Population Estimate	Sightings	Density (Animal/km)	Population Estimate
Chikwawa–Illovo	16	0.76	25	98	4.7	150
Illovo–Chiromo	2	0.03	13	29	0.6	234
Chiromo–Nsanje	0	0	0	63	1.5	80
Total	18	0.26	38	190	2.27	464

Source: Hippo and Crocodile Counts in the Shire River, National Parks and Wildlife Research Unit, 2009

(5) Topography and Soil

According to the topographical categories described in Section 2.1.1, the project areas in the Study are mainly in the topographical categories of 1) the Rift Valley Escarpment (two railway sections and S136 and M1 road sections) and 2) the Rift Valley Plains (3 railway sections and 3 road sections). The Rift Valley Escarpment is characterised by a series of stepped faults and hills. The soils in the East African Rift Valley are mainly Lithosols, which are shallow stony soils associated with steep slopes, while the Rift Valley Plains are mainly characterised by alluvial soils. The average annual rainfall in the escarpment area ranges from 800 mm to 1,700 mm, suggesting that large volumes of water flow overland from the surrounding areas. The steep slope of the Rift Valley Escarpment in some road sections of S136 and climbing lane, and railway sections of Limbe–Luchenza and Luchenza–Makhanga, together with the large volume of rainfall during the rainy season have the potential to cause slope failure, landslides, rock fall, washaway and soil erosion (see Photos 10-1 to 10-3).

For the section between Limbe and Makhanga, several landslides and slope failures along the hilly areas of the railway have occurred during the rainy season, imposing an additional burden on the railway company to carry out emergency repairs of slope failures and landslides (see Table 10-10 and Photo 10-3). Deforestation in this region has accelerated the occurrence of

landslides and slope failures, and there is now an urgent need to stabilize the slopes along the railway line.

In the proposed railway rehabilitation projects, the risk of landslides and slope failures will be minimized by replanting vegetation and trees on cleared areas and slopes, using slope retaining techniques, improving the drainage system, and conducting a community education programme to protect slope vegetation along the railway line.

Photo 10-1 M1 Section for Climbing Lane

Photo 10-2 Section between Sandama and Thekerani

Photo 10-3 Sand flew on Railway Track Caused by Slope Failure at Hilly Area

Photo by Study Team, June 2011.

Table 10-10 Occurrence of Landslides and Slope Failure between Limbe and Makhanga

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2008	3	4	0	0	0	0	0	0	0	0	1	4	12
2009	2	4	0	0	0	0	0	0	0	0	0	1	7
2010	1	1	0	0	0	0	0	0	0	0	0	2	4
2011	2	1	6	0	0	-	-	-	-	-	-	-	9

Source: CEAR

(6) Hydrology

As shown in Section 2.4.3, the roads and railways in this study are within the drainage area of the Lower Shire Valley and cross several rivers/streams. The section between Makhanga–Bangula passes through the Shire River and Elephant Marsh, while S152 receives regular torrential rains from the escarpment, which occasionally cause inundations on the road and

disrupt transport. Roads and railways that intersect river/streams generally have the potential to modify the natural flow of overland surface water by increasing the water flow in the roadside drains. To prevent severe impacts on the hydrological environment, water crossings should be minimized. Other mitigation measures include providing of relief culverts, and techniques for reducing water speed such as riprap, settling basins, and infiltration ditches.

(7) Resettlement

The proposed road and railway projects follow the existing alignments, except for the disconnection section at Chiromo on S151. The population density in the project area varies by district from 92.3 persons/km^2 in Chikwawa to 342.5 persons/km^2 in Thyolo, as shown in Table 2-19 and Figure 2-19.

a) Upgrading of S152 between Thabwa and Seven

The current width of S152 is around 6 m and the additional land required for upgrading work is around 9-10 m in width or 0.6 km^2 (10 m×59.1 km). Most houses on this road are located outside of ROW, but this area is a populous area of Thyolo. Photo 10-4 shows the houses along the S152 road. On the other hand, there are some agricultural fields illegally occupying ROW in this section. These illegally extended agricultural fields result from the shortage of available arable land and increasing population in this region. The illegally occupied fields need to be relocated for the upgrading.

Photo 10-4 Houses along S152

Photo by Study Team in November 2010

b) Upgrading M1 (Blantyre-Thabwa Section: Climbing Lane)

The lands required for constructing climbing lanes are in the hilly area and generally away from human settlements and human activities. However, a few charcoal vendors along the road may need to be relocated. One charcoal vendor was found along the proposed climbing lane during the field visit, but this structure is temporarily built and can be relocated to the nearest roadside. The impact of resettlement along this section is thus expected be negligible.

c) Reconstruction of S151 between Makhanga and Bangula

The section of Makhanga–Bangula (S151) passes the market and town of Makhanga, and a few vendors and houses may need to be relocated during the reconstruction. A boat association was established in the disconnected area in Chiromo in 1998 and the members rely on ferry operations for their livelihoods. The boat association comprises 52 members and the fare is 100 MWK per adult. There are several bicycle taxis operating between the east riverbank of the disconnection and Kamuzu Truss Bridge. If the disconnected area is reconstructed, the project developer needs to consult the boat association, bicycle taxi operators, and surrounding vendors as to alternative means of sustaining their livelihoods.

d) Rehabilitation of Railway between Limbe and Luchenza

A 15 m ROW is secured for the railway line between Limbe and Nsanje. Along the railway line between Limbe and Luchenza, several houses are located near the railway line and will need to be relocated during the upgrading, particularly near Limbe.

e) Rehabilitation of Railway between Luchenza and Makhanga

There are few houses along the railway line between Luchenza and Makhanga, and no significant negative impact of resettlement is anticipated in this section. However, a lot of agricultural fields have extended to ROW of the railway line between Luchenza and Makhanga. Photo 10-5 shows a banana field close to the railway line. The agricultural fields that currently illegally occupy ROW need to be relocated during the upgrading work. There are also some vendors selling agricultural products and clothes near Thekerani Station (Photo 10-7), but this market is temporarily created and there is no vendor's association to form social institutions at this market. When the stakeholder meeting is held to discuss resettlement issues, careful consideration should be taken for those vendors who do not form a social institution and thus are more vulnerable during consultations.

f) Reconstruction of Railway between Makhanga and Bangula

The railway line between Makhanga and Bangula is not operated currently. At Makhanga and Bangula Stations, vendors have illegally built small buildings along the railway line, but these are temporarily constructed. The vendors need to be relocated for the reconstruction of the railway line, which will have a negative affect during the reconstruction, but will benefit their business by the increased number of customers at the Stations after the reconstruction. A similar impact of the road project in this section is predicted concerning the resettlement of boat associations, bicycle taxi operators, and vendors at the disconnection in Chiromo.

g) Reconstruction of Railway between Bangula and Nsanje

For the section between Bangula and Nsanje, there is one maize field close to the railway line, which was identified by the railway inventory survey (Photo 10-8). There are some houses between the railway line and the road near Bangula, but not expected to have a significant impact since the M1 road adjacent to the railway can be used to transport construction materials and there is no need to construct a temporary road for the reconstruction

h) Reconstruction of Railway between Nsanje and Border (Marka).

There are some illegal occupations by villagers between Nsanje and Border (Marka) (Photo 10-9). According to the consultant who conducted the inventory survey, some settlements near the railway line were seen near the Border Station (Marka).

Photo 10-5 Banana Field Close to Railway Line

Photo 10-6 Market near Makhanga Crossing

Photo 10-7 Market at Thekerani Station

Photo 10-8 Maize field between Bangula and Nsanje

Photo 10-9 Illegal Occupation between Nsanje and Border (Marka)

Photos by Study Team in November 2010 and June 2011

(8) Socio-Economy

The average poverty headcount (percentage of people below the poverty line) in the Study Area is 61.1%, 9 points higher than the national average of 52.4%. The lowest levels of annual household expenditure are found in Thyolo District (MWK69,195.6) and Phalombe District (MWK70,530.4). The unemployment rate is highest in the urban areas such as Blantyre City (21.3%) and Zomba Municipality (15.9%), although some rural areas have unemployment rates of more than 10% (Blantyre Rural, Thyolo). The deterioration of the livelihoods of people in Chiromo and along the railway line between Luchenza and Makhanga is described in details in Chapter 2.

The Study Team undertook a brief field survey on in February 2011 and June 2011 to research the social and economic impacts of Chiromo washaway in 1997 and along the railway line between Thekerani and Luchenza. The objectives of this survey were to understand the level of poverty in terms of infrastructure and other socio-economic issues. The methodology for this survey was based on key informant interviews due to the limited time at the site. The interviews for the impact of the washaway were conducted with a local person residing near Kamuzu Truss Bridge and local people near the Thekerani and Sandama stations. The interview for local infrastructure was conducted with a head teacher at Makhanga Primary School. The results of this survey are as follows:

a) Impact of Chiromo Washaway

- Before the washaway, there was a lot of traffic using the road with more than 50 cars, around 100 bicycles, 5-6 trucks, and 2 buses each day. There were two bus routes: a) Blantyre–East Bank (S152 via Chikwawa)–Nsanje and b) Blantyre–Thyolo–Nsanje. In addition to passenger traffic, trucks and trains used to carry cash crops such as cotton and tea, and food crops such as bananas and oranges from Thekerani in Thyolo District.
- After the washaway, life became very difficult. For instance, to go to Nsanje, it costs MWK 100 by boat and a bicycle taxi costs MWK70, placing a significant burden on living expenditure.
- Since the washaway, railway freight arrives only once a week, and as a result, food supplies have fallen significantly. Food such as bananas and oranges is not produced in this area, so the people depend on rail transport from Thekerani in Thyolo District for their livelihoods.
- School access became difficult after the washaway. In the past, people use to go to the primary school at Makhanga by train, but now there is no train to commute to school, and life has become very difficult. Access to a hospital is not difficult since there is a hospital located nearby.

b) Impact of Chiromo Washaway at Thekerani and Sanaama Stations

- The livelihoods of people near Thekerani Station became worse after the washaway; in particular, transporting agricultural products such as banana, cassava, and orange from this area became very difficult. In the past, there were two passenger trains and one freight train

every day between Nsanje and Blantyre, but there is now only one mixed train a week. The train fares to Makhanga, Luchenza and Limbe are MWK200, 200 and 300, respectively. The railway is much cheaper than minibus[16], but due to the lack of availability of trains, some people travel by bicycle. There are schools and hospitals near Thekerani, but there is no well, energy, or cell phone coverage.

- After the major washaway, the living conditions of people near Sandama Station worsened due to the decrease of income sources. For instance, one businessman in Sandama used to transport charcoal, lemon and banana to Limbe and brought fishes and food groceries from Limbe, but he could not work as a businessman after the washaway and was forced to change job from businessman to ticket collector at the station. In the past, he used to go to school or hospital (3 km away from Sandama) by train, but must now go on foot. A mixed train come to Sandama once a week, but is often too crowded to get on board.

c) Local Infrastructure between Makhanga and Chiromo

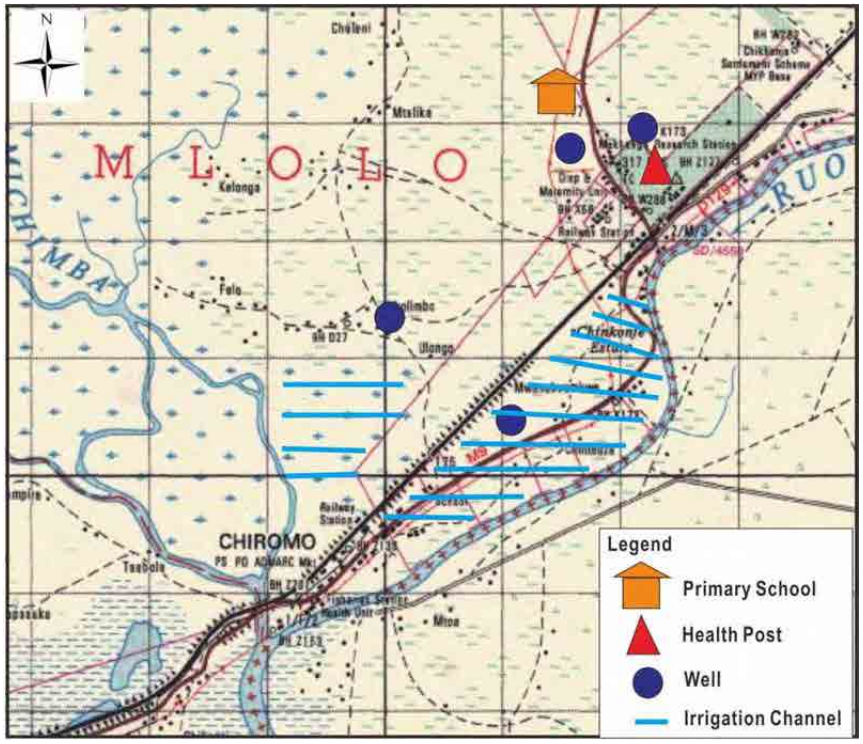
A mapping exercise was used to identify the location of local infrastructure and protected areas in Makhanga and Nsanje. The map drawn during the interview with the head teacher at Makhanga is shown in Figure 10-5. The results of the mapping exercise were as follows:

- There is now only one school in this area (Makhanga Primary School). There used to be a primary school in Chiromo but it was closed.
- A health post is located near the Makhanga Research Station.
- There are four wells in this area, located at a) the primary school, b) the Makhanga Research Station, c) Mwanabvumbwe village, and d) Mkolimbo village. Water near the Ruo River contains a lot of salt and therefore some boreholes are not used.
- There is no cemetery or protected area such as a forest reserve along the railway line and the road.
- There are some irrigated areas along the Ruo River. The Kalonga Irrigation Programme has been implemented near Elephant Marsh.
- There are no job opportunities except for governmental institutions such as the school. There are no factories.
- There is a market along the railway line.
- The water level rises to the railway line two or three times a year, normally between January and March. No cars can use the road when there is a flood, and occasionally water covers the railway line.

The above interviews revealed that the washaway in 1997 had a significant impact on the local economy and social services in Chiromo and along the railway line. Due to the disconnection, local people living in the eastern side of the washaway section need to spend MWK100 to go to Nsanje to sell their products. Agricultural products from Thekerani, on which the local people living in the eastern side of the washaway section are heavily dependent,

[16] The minibus fare costs MWK700 between Limbe and Luchenza,

became very limited after the washaway. Since there is no road nearby, local people along the railway line could not sell their agricultural products as occasionally as before, thus reducing their sources of income.



Source: Study Team

Figure 10-5 Mapping between Makhanga and Chiromo

Photos by Study Team in February 2011

Photos 10-10 A Boatman Carrying Passengers on the Washaway Section

Improving in these sections will significantly improve the livelihoods of the local population, particularly the poor, and revitalize the local economy through improved access to agricultural products, schools, and hospitals. The mapping exercise indicates the existence of an irrigation scheme and four bore holes in Chiromo, which need to be taken into consideration when considering the realignment of the road and railway line.

(9) Cultural Heritage

Section 29 of the Monuments and Relics Arrangement of Sections provides that new development projects must carry out rescue archaeology of a monument or relic if an important cultural heritage is located in the project area. “Rescue archaeology” means the removal of cultural heritage to another location. The site survey is normally carried out by the Department of Antiquity and the cost of the site survey is borne by the developer.

In the case of rehabilitation of existing transport projects, a site survey should be implemented in advance, and an additional site survey is normally not required (interview with the Department of Antiquity). If a transport project is to construct a new road/railway or to increase the width of a road/railway, a site survey is required. The districts of Chikwawa, Thyolo, and Nsanje have some archaeological and cultural sites. A list of archaeological sites in these districts was acquired by the Study Ream and the Khulubvi Rain Shrine is located near the railway line near Nsanje.

10.4.3 Screening of Proposed Projects using the EAD Guidelines and the SEA Methodology

As described in Section 10.1, a proposed project needs to be screened according to a list for prescribed projects. If the project is under List A, an EIA is mandatory and the developer needs to prepare a project brief. If the project is under List B, an EIA may be required and the developer needs to prepare a project brief. Table 10-11 shows the necessity of submitting a project brief to the EAD. The EAD will evaluate the project brief and determine whether an EIA is required.

All proposed projects are expected to contribute to the objectives of the Sena Corridor to facilitate sustainable economic growth and alleviate poverty in the Study Area. Since all projects are under List B, less significant environmental and social impact is expected. The detailed economic, social, and environmental impacts of the proposed projects will be analysed in the next scoping process.

Table 10-11 Screening of Proposed Projects

Project	List A Category	List B Category	Project Brief is Required
Reconstruction of S151 between Makhanga and Bangula	No	B 5.2, B 14	X
Upgrading of S152 between Thabwa and Seven)	No	B 5.2	X
Upgrading of M1 between Blantyre and Thabwa (Climbing Lane)	No	B 5.2	X
Rehabilitation of Railway between Limbe and Luchenza	No	B 5.3	X
Rehabilitation of Railway between Luchenza and Makhanga	No	B 5.3, B14	X
Reconstruction of Railway between Makhanga and Bangula	No	B 5.3	X
Reconstruction of Railway between Bangula and Nsanje	No	B 5.3	X
Reconstruction of Railway between Nsanje and Border (Marka)	No	B 5.3	X

Source: Study Team

10.4.4 Scoping of Proposed Projects for the Master Plan

A scoping checklist for each proposed project is provided in the following tables, which is

based on the analysis of Section 10.5. Both negative and positive impacts are evaluated in a scoping matrix. The non-project option is also evaluated to compare the impact of the proposed project.

Table 10-12 Reconstruction of S151 between Makhanga and Bangula

Impacts			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local economy such as employment and livelihood, etc.	B+	B+	A
	3	Land use and utilisation of local resources	C	C	D
	4	Social institutions such as social infrastructure and local decision-making institutions	B	B	D
	5	Existing social infrastructure and services	C	A+	A
	6	The poor, indigenous and ethnic people	D	A+	A
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflicts of interest	C	C	D
	10	Water usage or water rights	C	C	D
	11	Sanitation	C	D	D
	12a	Hazards (risks)	B	B+	B
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	B	C	D
	14	Soil erosion	B	B+	A
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	B	B	B
	19	Meteorology	D	D	D
	20	Landscape	B	C	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	D	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	D	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	A+	B

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-13 Upgrading of M1 between Blantyre and Thabwa (Climbing Lane)

		Impact	Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local economy such as employment and livelihood, etc.	B+	D	D
	3	Land use and utilisation of local resources	C	C	D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	D	D	D
	6	The poor, indigenous and ethnic people	D	D	D
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflicts of interest	D	D	D
	10	Water usage or water rights	C	C	D
	11	Sanitation	C	D	D
	12a	Hazards (risks)	D	D	D
	12b	Infectious diseases such as HIV/AIDS	C	C	D
Natural Environment	13	Topography and geographical features	B	B	C
	14	Soil erosion	B	C	B
	15	Groundwater	D	D	D
	16	Hydrological situation	D	D	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	C	D	D
	19	Meteorology	D	D	D
	20	Landscape	B	B	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	D	D
	26	Noise and vibration	B	D	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	D	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	B+	D

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-14 Upgrading of S152 between Thabwa and Seven

Impact			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	A	A	D
	2	Local economy such as employment and livelihood, etc.	B+	B+	B
	3	Land use and utilisation of local resources	B	B	D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	C	B+	B
	6	The poor, indigenous and ethnic people	D	B+	D
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflicts of interest	D	D	D
	10	Water usage or water rights	C	C	D
	11	Sanitation	C	D	D
	12a	Hazards (risks)	B	B+	B
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	D	D	D
	14	Soil erosion	B	B+	B
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	B	B	B
	19	Meteorology	D	D	D
	20	Landscape	D	D	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	D	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive Odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	C	D

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-15 Rehabilitation of Railway between Limbe–Luchenza

Impact			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local economy such as employment and livelihood, etc.	B+	B+	D
	3	Land use and utilisation of local resources	C	C	D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	B	B+	B
	6	The poor, indigenous and ethnic people	D	B+	B
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflicts of interest	D	D	D
	10	Water usage or water rights	C	C	C
	11	Sanitation	C	D	D
	12a	Hazards (risks)	D	D	D
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	D	D	D
	14	Soil erosion	B	B+	B
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	C	C	D
	19	Meteorology	D	D	D
	20	Landscape	D	D	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B+	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	C	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	B+	B

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-16 Rehabilitation of Railway between Luchenza and Makhanga

Impact			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local Economy such as employment and livelihood, etc.	B+	A+	A
	3	Land use and utilisation of local resources	B	B	D
	4	Social Institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	B	A+	A
	6	The poor, indigenous and ethnic people	D	A+	A
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflict of interest	D	D	D
	10	Water usage or water rights	C	C	D
	11	Sanitation	C	D	D
	12a	Hazards (Risk)	B	B+	B
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	B	B+	A
	14	Soil erosion	B	B+	B
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	B	B	D
	19	Meteorology	D	D	D
	20	Landscape	B	B	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B+	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	C	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	B+	B

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-17 Reconstruction of Railway between Makhanga and Bangula

Impact			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local Economy such as employment and livelihood, etc.	B+	B+	A
	3	Land use and utilisation of local resources	C	C	D
	4	Social Institutions such as social infrastructure and local decision-making institutions	B	B	D
	5	Existing social infrastructure and services	C	A+	A
	6	The poor, indigenous and ethnic people	D	A+	A
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	D	D	D
	9	Local conflict of interest	C	C	D
	10	Water usage or water rights	B	B	D
	11	Sanitation	C	D	D
	12a	Hazards (Risk)	B	B+	B
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	B	C	D
	14	Soil erosion	B	B+	A
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, fauna and biodiversity	B	B	B
	19	Meteorology	D	D	D
	20	Landscape	C	C	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B+	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	C	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	A+	B

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-18 Reconstruction of Railway between Bangula and Nsanje

		Impact	Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local economy such as employment and livelihood, etc.	B+	B+	D
	3	Land use and utilisation of local resources	C	C	D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	B	B+	D
	6	The poor, indigenous and ethnic people	D	B+	B
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	D	D	D
	9	Local conflict of interest	D	D	D
	10	Water usage or water rights	C	C	C
	11	Sanitation	C	D	D
	12a	Hazards (risks)	D	D	D
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	D	D	D
	14	Soil erosion	B	B+	A
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, Fauna and biodiversity	C	C	D
	19	Meteorology	D	D	D
	20	Landscape	D	D	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B+	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	C	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive Odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	B	D

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

Table 10-19 Reconstruction of Railway between Nsanje and Border (Marka)

Impact			Construction Phase	Operation Phase	Non-project
Social Environment	1	Resettlement/land acquisition	B	B	D
	2	Local economy such as employment and livelihood, etc.	B+	B+	B
	3	Land use and utilisation of local resources	C	C	D
	4	Social Institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructure and services	B	B+	D
	6	The poor, indigenous and ethnic people	D	B+	B
	7	Misdistribution of benefit and damage	D	D	D
	8	Cultural heritage	C	C	D
	9	Local conflicts of interest	D	D	D
	10	Water usage or water rights	C	C	D
	11	Sanitation	C	D	D
	12a	Hazards (risks)	B	B+	B
	12b	Infectious diseases such as HIV/AIDS	B	B	B
Natural Environment	13	Topography and geographical features	D	D	D
	14	Soil erosion	B	B+	A
	15	Groundwater	C	C	D
	16	Hydrological situation	B	B	D
	17	Coastal zone	D	D	D
	18	Flora, Fauna and biodiversity	C	C	D
	19	Meteorology	D	D	D
	20	Landscape	D	D	D
	21	Global warming	D	D	D
Pollution	22	Air pollution	B	B+	D
	23	Water pollution	B	D	D
	24	Soil contamination	B	C	D
	25	Waste	B	C	D
	26	Noise and vibration	B	B	D
	27	Ground subsidence	C	C	D
	28	Offensive odour	B	C	D
	29	Bottom sediment	B	D	D
	30	Accidents	B	B	D

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicate a positive impact

Source: Study Team

10.4.5 SEA for the Master Plan

Based on the results of the scoping matrix for the proposed projects of nine transport network alternatives, the Study attempts to evaluate the three alternative transport network options for the Master Plan on the development of the Sena Corridor, using the SEA methodology at the IEE level. The option of no investment on the Sena Corridor (zero-option) is also evaluated for comparison. As explained in Section 10.4.1, the SEA methodology integrates environmental considerations into economic and social aspects and the study evaluates each project in terms of economic, social and environmental aspects. The results of each alternative are then cumulative at the programme level in order to compare the three alternatives of the Master Plan for Development of the Sena Corridor from the SEA perspective.

Table 10-20 shows the local economic impact, social impact, and environmental impact of the three alternatives. The overall cumulative results for the Sena Corridor's Master Plan are summarised in Table 10-21. These shows that Alt. 1 (Scenario 3: connection to Beira by road and railway) and Alt. 3 (Scenario 3: connection to Beira by road and connecting to Nsaje by railway) have the relatively positive impacts. Both cases will improve the disconnection at Chiromo washaway, which will benefit the local population in terms of access to agricultural products, schools and health posts. Although the boat association, bicycle operators and vendors at the disconnection site will lose their sources of income by the upgrading and the appropriate compensation for affected people is needed, the project will significantly improve the livelihoods of poor people, who currently suffer from expensive transport costs due to the disconnection. The overall impact on the local economy by connecting at Chiromo washaway is anticipated to be positive. The population living between Luchenza and Makhanga, where there is no road nearby and the train service is currently not sufficient to meet the demands along the railway line, are expected to benefit significantly from the improved mobility by the rehabilitation of the railway. Improved transport at the disconnection will help reduce the number of accidents by boats. The rehabilitation of the railway line is expected to change the transport mode from truck/car to railway, which will reduce total air pollutants emissions. The current landslides, slope failure, and soil erosion that occur along the railway line are expected to be improved by the stabilisation of slopes and soil while the occurrence of floods and overflow of water on the road are expected to be minimized.

On the other hand, the zero option is expected to deteriorate the local economy due to the limited availability of transport, especially at the disconnection at Chiromo washaway, and will cause a significant negative social impact in terms of boat accidents at Chiromo washaway and the soial transport services to schools and health posts.

Table 10-20 SEA Results for Master Plan on the Development of the Sena Corridor

Project	Alternative				Local Economic Impact		Social Impact		Environmental Impact	
	Zero Option	Alt. 1	Alt. 2	Alt. 3						
Zero Option	X				D	Since the local population suffers from the limited availability of transport, especially due to the disconnection at Chiromo, the non-project option is expected to deteriorate the local economy.	D	The non-project option will cause significant negative impact in terms of boat accidents at Chiromo, and the social transport services in terms of access to agricultural products, schools, and health posts remain limited in the region.	C	No negative impact on biodiversity and forest resources is expected, but the current landslides, slope failure floods, and overflow of water on the roads and railways will remain.
S151 Makhanga–Bangula (8.7 km)		X		X	A	Since the local population currently suffers from the disconnection at Chiromo, the improved access to agricultural products and improved mobility will significantly benefit the local population, including the poor who suffer from expensive transport costs due to the disconnection.	B	Some negative impact of resettlement of households and boat associations is expected. Improved transport will help reduce the number of boat accident. Local people will benefit from the improved transport services in terms of access to agricultural products, schools, health posts, and so on.	C	The project passes the wetland and the Shire River, which may affect biodiversity and the hydrological situation. Soil erosion is expected to be improved by the project. The occurrence of floods and overflow of water on the road are expected to be minimized.
M1 Blantyre–Thabwa Climbing Lane (5.0km)		X	X	X	C	Some employment opportunities for local people are expected, but in general, no negative or positive impact on the local economy is expected.	C	The lands acquired for constructing climbing lane are in the hilly area and largely away from human settlements. Therefore, the impact of resettlement and social services is negligible.	C	Although some negative changes of geographical features are expected, the project does not pass through an ecologically sensitive area and its impact on the environment is expected to be negligible.
S152 Thabwa–Seven (59.1 km)		X	X	X	B	The local population is expected to benefit from the improved access to agricultural products and improved mobility.	C	Some negative impact of resettlement of households is expected. Since this is a populous area, the extent of resettlement could be significant. The local population will benefit from the improved transport services in terms of access to agricultural products, schools, health posts, and so on.	C	Since the project passes near the sensitive area of forest reserves and wetland, cutting trees and vegetation during the upgrading work could cause further stress and deterioration of biodiversity and forests. The soil erosion and overflow of water on the road are expected to be minimised.
Railway Limbe–Luchenza (44 km)		X	X	X	B	The local population is expected to benefit from the improved access to agricultural products and improved mobility.	B	Some negative impact of resettlement is expected. The local population will benefit from the improved transport services in terms of access to agricultural products, schools, health posts, and so on.	B	The railway line does not pass through an ecologically sensitive area. Air pollution will be reduced by the change of transport mode from truck/car to railway.
Railway Luchenza–Makhanga (76.6 km)		X	X	X	A	Since there is no road nearby and the train service is currently not sufficient to meet the demands along the railway line, the local population is expected to benefit significantly from the improved access to agricultural products and improved mobility. Due to the limited access to transport, the poverty rate is high in this area and the project will benefit all strata of the local population, including the poor, to provide less expensive transport.	B	Some impact of resettlement of households, agricultural fields, and vendors along the railway line is expected. The improved track and bridge will help reduce the number of derailment accidents and engine troubles. Local people will benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.	B	The current landslides, slope failure, and soil erosion along the railway line are expected to be improved by the stabilisation of slopes and soils. Air pollution will be reduced by the change of transport mode from truck/car to railway. The occurrence of floods and overflow of water on the railway are expected to be minimized.
Railway Makhanga–Bangula (8.7km)		X	X	X	A	Since the local population currently suffer from the disconnection at Chiromo, the improved access to agricultural products and improved mobility will benefit the local population, including the poor who suffer from expensive transport costs due to the disconnection.	B	Some impact of resettlement of households and boat associations is expected. Improved transport will help reduce the number of boat accidents. Local people will benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.	B	The project passes the wetland and the Shire River, which may affect biodiversity and the hydrological situation. Soil erosion is expected to be improved by the project. Air pollution will be reduced by the change of transport mode from truck/car to railway. The occurrence of floods and overflow of water on the road are expected to be minimised.
Railway Bangula–Nsanje (45.3 km)		X	X	X	B	The local population is expected to benefit from the improved access to agricultural products and improved mobility.	B	Some illegally occupied agricultural fields and vendors need to be resettled. Local people will benefit from the improved transport services in terms of access to agricultural products, schools, health posts, and so on.	B	The project does not pass through an ecologically sensitive area. Air pollution will be reduced by the change of transport mode from truck/car to railway.
Railway Nsanje–Border (Marka) (26.4 km)		X	X		B	The local population is expected to benefit from the improved access to agricultural products and improved mobility.	B	Some negative impact of resettlement of houses, agricultural fields, and vendors is expected. Local people will benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.	B	The project does not pass through an ecologically sensitive area. Air pollution will be reduced by the change of transport mode from truck/car to railway.

Notes: A = A significant positive impact is expected, B = Some positive impact is expected, C = Some negative/negligible impact is expected, D = Significant negative impact is expected.
Source: Study Team

Table 10-21 Overall Results of SEA

Item	Zero-option	Alt.1	Alt.2	Alt.3
Local Economic Impact	D	A	B	A
Social Impact	D	B	B	B
Environmental Impact	C	B	B	B

Notes: A = A significant positive impact is expected, B = Some positive impact is expected, C = Some negative/negligible impact is expected, D = Significant negative impact is expected
Source: Study Team

10.4.6 Recommendations for Mitigation Measures of the Master Plan

Based on the results of scoping checklists, several measures are recommended to minimize adverse impacts from the proposed Master Plan.

(1) Air Pollution

a) Utilization of Environment-friendly Mode of Transport

The increase in air pollutant emission from motor vehicles can be offset by the change of transport mode from truck/car to railway. The proposed rehabilitation of railways would significantly reduce the amount of air pollution in the project area. In general, one diesel locomotive can replace the amount of air pollutants generated from 20–30 trucks, which would reduce the overall amount of air pollution in Malawi.

b) Design to Minimise Air Pollution from Motor Vehicles

The average speed of 60–70 km/h is considered to be the most efficient in combusting fossil fuels of motor vehicles. The roads in the proposed projects are designed to be operated at the average speed of 70 km/h, which will improve the efficiency of fossil fuel combustion. To promote the efficient use of fossil fuels, the road alignment can be designed to avoid traffic congestion, sharp curves, and steep grades, which would cause acceleration and deceleration.

c) Minimization of Dust by Appropriate Instructions to Contractors

The dust produced during the construction phase can be minimized by providing appropriate instructions to contractors, such as spraying water on provisional earth road.

(2) Water Pollution

a) Proper Siting of Work Camp and Stockyard

The potential water pollution can be mitigated by proper siting of work camps, that is, by avoiding sensitive areas such as water catchments, and by locating the stockyard for all construction materials far from rivers, wetlands and drinking water intake. The recommended siting from the Environmental and Social Management Guidelines in the Road Sector is to stockpile waste materials 15 km away from water resources. This is possible in the proposed projects.

(3) Mitigation Measures for Biodiversity in Wetlands

a) Environmentally Friendly Construction Work in Wetlands

The biodiversity in Elephant Marsh will be taken into consideration in the Master Plan, in particular, the avoidance of water pollution and preservation of trees used by nesting birds will

be considered as much as possible. It is also recommended to minimize water crossing and reclamation work in wetlands in order to preserve the biodiversity of the aquatic ecosystem.

(4) Resettlement

a) Minimization of Resettlement and Avoiding Disturbance to the Local Community

The negative impact from resettlement can be minimized by an analysis of alternatives and a better understanding of local productive resources, sacred sites, and burial grounds of the local population. Local mobility and local economic activities should be carefully considered to avoid major changes in community interaction. The Department of Land and Evaluation in the Ministry of Land should be involved from an early stage to avoid delays in the resettlement process.

b) Undertaking Public Consultation with PAPs

At the stage of F/S, public consultation with the PAPs should be held to disseminate information on the proposed projects.

10.5 IEE for the Pre-Feasibility Study

10.5.1 IEE Methodology

The Study Team has conducted an IEE of the pre-Environmental Impact Assessment for the proposed priority projects. The IEE is a preliminary analysis of alternative plans, a prediction and assessment of environmental impacts, and preparation of mitigation measures and a monitoring plan on the basis of existing data and simple field surveys ("JICA Environmental Guidelines").

The proposed priority projects selected by the Master Plan are 1) Reconstruction of the S151 Road between Makhanga and Bangula, and 2) Rehabilitation/Reconstruction of the Railway between Limbe and Border (Marka). This survey follows the standard methodology of IEE, but due to the limited information on socio-economic data and flood damage in the project area, a field investigation was carried out for the section between Makhanga and Bangula. This includes a questionnaire survey of PAPs, data collection on agriculture and land use in the project area, and consultation with district governments.

In addition, the IEE for priority projects requires consultation with stakeholders during the scoping process, according to the Environmental Management Act 1997 and "JICA Environmental Guidelines". A stakeholder meetings were held to encourage relevant stakeholders to understand the project needs, the project design and adverse impacts on the environment and society, and to participate in the analysis of alternatives and mitigation measures at an early stage of the proposed projects. Table 10-22 shows an outline and the main features of the proposed projects for the IEE in the Pre-F/S.

Table 10-22 Outlines of Priority Projects for the IEE in the Pre-F/S

Project	Outline of Projects	Main Features
Reconstruction of S151 Road between Makhanga and Bangula	1) Reconstruction of road between Makhanga and Bangula 2) Construction of the Chiromo Road Bridge 3) Construction of the New Shire Bridge	• Length: 9.5 km • Existing width: 4-5 m • Design width: 9.7 m • Required width for construction: 23 m
Rehabilitation and Reconstruction of Railway between Limbe and Border	1) Construction of the Chiromo Railway Bridge 2) Rehabilitation of the Kamuzu Truss Bridge 3) Rehabilitation of railway line between Limbe and Makhanga 4) Reconstruction of railway line between Makhanga and Border	• Length: 201 km ✓ Limbe–Luchenza: 44.0 km, ✓ Luchenza–Makhanga: 76.6 km, ✓ Makhanga–Bangula: 8.7 km, ✓ Bangula–Nsanje: 45.3 km, ✓ Nsanje–Border (Marka): 26.4 km • ROW: 30 m (15 m each side)

Source: Study Team

10.5.2 Socio-Economic Survey

Due to the limited existing documents and data on the socio-economic situation and flood damage in the project area, the survey carried out a field investigation in the project area between Makhanga and Bangula. The proposed projects require an analysis of alternative routes (road project) and mitigation measures for PAPs, especially for the loss of income of the boat association and vendors after the Chiromo washaway is connected (both road and railway projects). Therefore, a questionnaire survey was undertaken to assess the impact on the livelihoods of people affected, and their willingness to find alternative sources of income, and to analyse possible mitigation measures for PAPs. This questionnaire survey focused on specific groups and was not statistically representative, since the sample size was limited due to the study schedule. However, the survey collected some useful information to understand the socio-economic situation and flood damage, which is not well known from existing documents and data. The detailed findings of the field investigation are provided in Appendix 5. Table 10-23 describes the major findings of the survey.

10.5.3 IEE Results

Based on the analysis of environmental and social impacts, the Study evaluates the proposed projects in the scoping matrix and describes the major impacts on each project section.

10.5.3 IEE Results for Reconstruction of the S151 Road between Makhanga and Bangula

(1) Scoping Matrix

Table 10-24 shows the scoping matrix for the reconstruction of the S151 road between Makhanga and Bangula (9.5 km).

Table 10-23 Major Findings of Socio-Economic Survey

Survey Item	Major Findings
Boat association	• Around 68 members are registered in the boat association. • There are two occupations, i.e., boat owners and oarsmen. Both have another occupation such as farming or fishing. • Boat owners are entitled to work for 5–8 days per month in shifts, while oarsmen normally work 3 days a week. • Boat fares are MWK100 for business people, and MWK10 and MWK50 for farmers and agricultural crops respectively. • The surveyed boat owners earn around MWK1,000/day (about MWK116,000/year) while oarsmen earn MWK400–800/day (about MWK86,400/year). • Their preferred future occupations if the Chiromo washaway is connected are to do another business (boat owners) or to continue their current other occupation such as farming or fishing (oarsmen).
Bicycle taxi association	• There are about 200 members in the bicycle taxi association at the disconnection. • The surveyed pedaler works every day and earns MWK1,000 per day. • The fare is MWK50 for one journey and MWK850 for a ride from Bangula to hospital in Mission. • The surveyed pedaler wishes to continue his occupation as a bicycle taxi pedaler if the Chiromo washaway is connected.
Agricultural production and land use in Makhanga	• Of the area of Makhanga EPA (36,082 ha), 8,494 ha are cultivated. Uncultivated arable land totals about 13,000 ha. • Major food crops are maize, sorghum, and sweet potato while major cash crops are cotton, pigeon peas, and cow peas. • Most residential areas are located in the upland above the railway line and near the Makhanga Market. Most agricultural lands are located near the Ruo River and the marsh area. • The price of cotton rose from MWK35/kg last year to MWK200/kg this year. The estimated annual income from cotton for the surveyed samples is MWK72,000–140,000, which is equivalent to or more than the average income of boat owners and oarsmen. • There are the Chiromo 1 irrigation scheme (19 ha), Chiromo 2 irrigation scheme (8 ha) and Chitsukwa irrigation scheme near the project area. Pumping engines and treadle pumping pedals are used to pump up water from the Ruo River and marsh through the canal, and wells. As a result, farmers can produce two harvests of maize during the dry season, which has significantly improved the food security and livelihoods of participating farmers. The GoM plans to expand cotton cultivation and irrigation schemes under the Green Belt Initiative. • Before the Chiromo washaway in 1997, 3 out of 10 farmers used to transport their crops by train. • In Makhanga, most farmers cannot transport their crops during the rainy season and are forced to use boats to transport their crops.
Fishermen	• The number of fish in the Shire River has decreased by around 50% from 10 years ago. • There are no fish farm around the project area. • One fisherman earns MWK6,000/month while another earns MWK4,500/day.
Flood damage	• The most significant floods in the Chiromo area occurred in 1976, 1989, 1997, and 2009, which indicates that major floods have returned almost every 10 years. • In 1997, the house near Chiromo Station was totally destroyed mainly by backwater from the Shire River, with inundation to a depth of about 2 m. • On the other hand, houses around Makhanga were usually damaged by floods from the Ruo River. • People in the Makhanga and Chiromo area need to use a boat during the rainy season to transport agricultural crops and to buy groceries from the Makhanga market. A farmer near the former Chiromo Station used a rented boat to take his children to the Makhanga primary school when flooding occurred, which continued for one week. • Farmers near Chiromo Station often evacuated to the railway platform and built a temporary hut there. • Flood water usually did not reach the level of the railway line, but in 1989 and 1997, water overflowed the railway line and local people had to evacuate to Bangula.
Limbe-Luchenza railway line	• Several markets are formed in Namiango, 4.8km from Limbe Station, where access to roads is limited. • Many farmers cultivate land within the ROW of the railway. • Some livestock such as cows and goats, and small animals were found during the site survey.

Source: Study Team

Table 10-24 Scoping Matrix for Reconstruction of S151 Road between Makhanga and Bangula (1/2)

Impact			Construction Phase	Operation Phase	Non-project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- Due to the realignment and upgrading of the road, the resettlement of some houses and shops in Makhanga is expected. - Some land acquisition is expected due to the change of alignment. Proper mitigation measures need to be taken.
	2	Local economy such as employment and livelihood, etc.	B+	B+	A	- The local population is expected to benefit significantly from the improved access to agricultural products and improved mobility. - Employment opportunities for local people are expected to be created during the reconstruction. - Members of the boat association and vendors at the Chiromo washaway section will lose their sources of income, and the incomes of members of the bicycle taxi association may decrease due to construction of the Chiromo Road Bridge. - Appropriate compensation for affected people is needed. The overall impact is anticipated to be positive.
	3	Land use and utilisation of local resources	B	B	D	- Land acquisition will be necessary for some plots of farmers' land which will be affected by the new alignment of the reconstructed S151 at Makhanga and both sides of the Chiromo washaway and the New Shire Bridge. - In addition, land will need to be rented during construction for temporary construction yard(s). - Water pumped up from shallow wells has the potential to be affected by the reconstruction works. - In order to identify the impact of the project, detailed observation will be required during the F/S stage.
	4	Social institutions such as social infrastructure and local decision-making institutions	B	C	D	- The boat association and bicycle taxi association will be affected by the reconstruction.
	5	Existing social infrastructure and services	B	A+	A	- The local population will significantly benefit from the improved transport services in terms of access to agricultural products, schools, and health posts. - During the construction work, detour routes will be provided.
	6	The poor, indigenous and ethnic people	D	A+	A	- The project will benefit all strata of the local population, including the poor. The poverty rate is high in the project area, partly due to the disconnection at the Chiromo washaway.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	D	D	D	- No important cultural sites have been identified near the project area.
	9	Local conflicts of interest	B	C	D	- Boat oarsmen and bicycle taxi pedalers could be adversely affected by the upgrading while most other people will benefit. - It is necessary to appropriately compensate the disadvantaged groups to avoid local conflict.
	10	Water usage or water rights	C	C	D	- Some farmers using irrigation could be affected by realignment of the road. - Appropriate consideration for the shallow wells can prevent adverse effects.
	11	Sanitation	C	D	D	- Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.
	12a	Hazards (risks)	B	B	B	- There is serious erosion on the right-side bank of the Ruo River near Makhanga and this could have a negative impact if it is decided to improve the existing road alignment, which passes only 30 m from the river bank. - Planned road reconstruction on the existing alignment with an embankment of 1.1 m to 2.0 m embankment near Makhanga may provide protection against flood water from the Ruo River for residences north of the existing road, while also preventing water from flooding the central part of Makhanga. This is a combination of positive and negative impacts. - Construction of the Chiromo Road Bridge is planned and the location of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway. - It will be a difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- Construction workers could increase the prevalence of HIV and other infectious diseases, if proper preventive measures are not taken.

Table 10-24 Scoping Matrix for Reconstruction of S151 Road between Makhanga and Bangula (2/2)

Natural Environment	13	Topography and geographical features	B	C	D	- Construction of embankments with a height of 1.1 m to 4.0 m will modify existing geographical features in the project area.
	14	Soil erosion	B	B+	A	- Further soil erosion is anticipated at construction sites of the Chiromo Road Bridge and the New Shire Bridge due to excavation of the river bank and river bed, unless proper revetment works are carried out for the excavated river bed and abutments/piers of the newly constructed bridges.
	15	Groundwater	C	C	D	- Construction of embankments may have adverse effects on groundwater. - Appropriate consideration for existing water sources (shallow wells) can prevent adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Construction of the Chiromo Road Bridge is planned and the locations of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway unless this road embankment is demolished. - It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	B	B	B	- The planned alignment of S151 will pass through the outer edge of Elephant Marsh, which is not a protected area by law in Malawi.
	19	Meteorology	D	D	D	- There is no activity that might affect meteorology.
	20	Landscape	B	C	D	- Construction of the Chiromo Road Bridge and the New Shire Bridge could change the landscape.
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.
Pollution	22	Air pollution	B	B	D	- In the proposed projects, the roads in the project area are designed for an average speed of 70 km/h, which will result in more efficient combustion of fossil fuels than at present. - Some dust will be produced during construction and some adverse impacts are expected in the residential area at Makhanga, but other places will suffer no significant impact since most of the construction work will be done in open agricultural/vegetation areas amid dispersed settlements.
	23	Water pollution	B	D	D	- There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, particularly due to excavation of river beds and banks for constructing the foundations of bridges and demolition of the road embankment on the Bangula side, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow. - Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the construction, accidental leakage of fuel/oil is anticipated to cause soil contamination.
	25	Waste	B	D	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road sides and slopes, and food waste from construction workers.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration.
	27	Ground subsidence	C	C	D	- There is no extraction of groundwater which might lead to ground subsidence.
	28	Offensive odour	B	D	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment.
	29	Bottom sediment	B	D	D	- The construction work could generate dust from construction materials and excavation work.
	30	Accidents	B	B A+	B	- During the construction process, there will be more heavy traffic, which may increase the risk of traffic accidents. - During the operational phase of the project, the higher speed and increase amount of traffic may hinder the movement of farmers and livestock, and the risk of traffic accidents may increase. - There have been boat accidents at the disconnection site every year and some people have died in such accidents. Improved transport at the Chiromo washaway will help reduce the number of boat accidents significantly in this area.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicates a positive impact

Source: Study Team

(2) Major Impacts

a) Major Impact on the Social Environment

The Chiromo washaway in 1997 had a significant impact on transport infrastructure and social services in the project area. Due to the disconnection, local people living in the project area need to spend at least an extra money of at least MWK 100 on the boat crossing to sell agricultural crops, to go to hospital, and so on. The proposed road project will significantly benefit the local population by improving transport services and hence access to agricultural products, schools, and health posts.

The members of the boat association are expected to be affected by the proposed project. Their sources of income will diminish after the construction of the Chiromo Road Bridge, since people will then be able to cross the Chiromo washaway without having to pay to oarsmen. Bicycle taxi pedalers may continue their business after the Chiromo washaway section is connected, but their income may decrease due to the improvement of transport access: for instance, local people will be able to transport agricultural crops by vehicle, their own bicycle or on foot between Makhanga and Bangula. Vendors at the disconnection may also be affected by the construction of the Chiromo Road Bridge. Appropriate mitigation measures need to be taken.

b) Involuntary Resettlement and Land Acquisition

The proposed reconstruction of S151 between Makhanga and Bangula will change the alignment at the New Shire Bridge, the Chiromo Road Bridge, and in Makhanga. The area near the Chiromo Road Bridge and the Chiromo Railway Bridge is not a residential area. The area near the New Shire Bridge is not inhabited. There are several shops close to the road near the Makhanga Market. In the project area between the Makhanga Market and the Kamuzu Truss Bridge, there are 373 households and 1639 people within 300 m of the road and the railway.

The section of the existing S151 Makhanga–Bangula passes through the Makhanga Market and the town of Makhanga, and some vendors and houses may need to be resettled for the reconstruction of the road. There are about 20 shops with concrete brick structures within 10 m of the centre- line of the road at the Makhanga Market, which may need to be resettled if the existing road is selected for improvement. There are also about 10 shops in temporary structures shops selling some fruits and vegetables. There are some houses along other parts of the road in Makhanga, which may need to be resettled for the improvement works.

The ROW of S151 is determined as 18 m each side from the centre line of the road according to the Public Road Act.

c) Local Economy

The proposed project will affect member of the boat association and vendors near the Chiromo washaway who will lose their sources of income, as well as members of the bicycle taxi association whose income may decrease, after the construction of the Chiromo Road Bridge. However, the local population is expected to benefit significantly from the improved access to agricultural product and social services, and improved mobility. Employment opportunities for

local people are expected to be created during the reconstruction works. The local population will also benefits from improved transport access for agricultural crops during the rainy season, and some people may no longer need to borrow a boat to transport agricultural crops.

Reconstruction of the S151 road may reduce the income of some vendor, whose shops are relocated.

d) Land Use and Utilisation of Local Resources

Land acquisition will be necessary for some plots of farmer's land which will be affected by the new alignment of the reconstructed S151 at Makhanga and both sides of the Chiromo washaway and the New Shire Bridge. In addition, land will need to be rented during construction for temporary construction yard(s). These will be negative impacts caused by the project.

Water pumped up from shallow wells has the potential to be affected by the reconstruction works. In order to identity the impact of the project, detailed observation will be required during the F/S stage.

e) Hazards

There is serious erosions on the right-side bank of the Ruo River near Makhanga and this could have a negative impact if it is decided to improve the existing road alignment, which passes only 30 m from the river bank.

Planned road reconstruction on the existing alignment with an embankment of 1.1 m to 2.0 m near Makhanga may provide protection against flood water from the Ruo River for residences north of the existing road, while also preventing water from flooding the central part of Makhanga. This is a combination of positive and negative impacts.

Construction of the Chiromo Road Bridge is planned in the Study and the locations of abutments and piers are planned so as to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway.

It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.

During the construction process, there will be more heavy traffic, which may increase the risk of traffic accidents. During the operational phase of the road and railway of the Project, the higher speed and increased volume of traffic may hinder the movement of farmers and livestock, and risk of traffic accidents may increase.

f) Forests Biodiversity and Social Condition

- It is expected that no forest cutting will be necessary for the Project.
- There are no historical and cultural heritages, including World Heritage Sites, along the selected roads.

- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

g) Flora, Fauna, and Biodiversity

As noted in Section 10.4, the proposed projects pass through the outer edge of a wetland called Elephant Marsh, which is not a protected area by law in Malawi. However, the wetland plays an important role in biodiversity as a bird sanctuary and as a destination for migrating birds, and its biodiversity and importance as a destination for migrating birds need to be taken into consideration when undertaking a road project in this area.

The Lower Shire Valley is a breeding site for crocodiles and hippos, as noted in Section 10.4. Improved accessibility around the marsh might lead to increased poaching activities and encroachment. As the marsh is not only rich in biodiversity but also a source of human livelihood, an appropriate wetland management plan, as illustrated in the case of Lake Chilwa, is desired.

h) Topography and Soil

Construction of road embankments with height of 1.1 m to 4.0 m will modify the existing geographical features in the project area.

i) Hydrology

Construction of the Chiromo Road Bridge is planned and the locations of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway unless this road embankment is demolished.

It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.

j) Air Pollution

The traffic volume in the project area is relatively low compared to other regions in Malawi: the volumes of motorised vehicles on the S151 (Seven) in 2006 was 37 veh./day. The average speed of vehicles on unpaved roads in the project area was about 32–40 km/h. In the proposed projects, the roads in the project area are designed for an average speed of 70 km/h, which will result in more efficient combustion of fossil fuels than at present.

Some dust will be produced during construction and some adverse impacts are expected in the residential areas of Makhanga, but other places will suffer no significant impact since most of the construction work will be done in open agricultural/vegetation areas amid dispersed settlements. The dust may be more intense during the dry season in the project area.

k) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, particularly due to excavation of river beds and banks for constructing the foundations of bridges and demolition of the road embankment

on the Bangula side, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

Groundwater is also an important source of water for the rural population in this region. In the Lower Shire Valley, groundwater tend to have high levels of salt, causing shallow wells to be abandoned. There are two shallow wells in the project area, and a detailed survey of the groundwater near the shallow wells is needed to prevent water pollution from construction work.

l) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.5.4 IEE Results for Rehabilitation of Railway between Limbe and Luchenza

(1) Scoping Matrix

Table 10-25 shows the scoping matrix for the rehabilitation of railway between Limbe and Luchenza (44.0 km).

Table 10-25 Scoping Matrix for Rehabilitation of Railway between Limbe and Luchenza (1/2)

Impact			Construction Phase	Operation Phase	Non-project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- Land acquisition will be necessary for some plots of farmers' land which will be affected by changing of the alignment for small bridges to be reconstructed. - Illegal farming activities within the railway ROW need to be stopped.
	2	Local economy such as employment and livelihood, etc.	B+	B+	D	- The local population is expected to benefit from the improved mobility. Employment opportunities for local people are expected to be created during the rehabilitation.
	3	Land use and utilisation of local resources	B	B	D	- Land will need to be rented during construction for temporary construction yard(s).
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	- There is no social association affected by the railway project.
	5	Existing social infrastructure and services	B	B+	B	- The local population will benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.
	6	Poor, indigenous and ethnic people	D	B+	B	- The rehabilitation will benefit all strata of the local population, including the poor.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	D	D	D	- No important cultural sites have been identified near the project area.
	9	Local conflicts of interest	D	D	D	- There is no significant local conflict caused by the rehabilitation project.
	10	Water usage or water rights	C	C	D	- Major damage to water usage by the local population is not anticipated, but it is necessary to confirm the water sources near the railway line.

Table 10-25 Scoping Matrix for Rehabilitation of Railway between Limbe and Luchenza (2/2)

	11	Sanitation	C	D	D	- The construction camp will adversely affect sanitation if proper measures are not taken.
	12a	Hazards (risks)	D	D	D	- Major hazards such as floods and washaways are not expected in this section.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- In general, the construction workers could increase the prevalence of HIV and other infectious diseases, if proper preventive measures are not taken.
Natural Environment	13	Topography and geographical features	D	D	D	- The project site is on hilly terrain and a major impact on geographical features is not expected.
	14	Soil erosion	B	B+	B	- Soil erosion due excavation and water flow diversion is expected during the rehabilitation work and proper mitigation measures are required to prevent it. The improved drainage system will minimise further soil erosion.
	15	Groundwater	C	C	D	- In-situ piling of the foundations of bridges for reconstruction will have adverse effects on groundwater. Appropriate consideration for the existing water sources (wells) can prevent adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Since the rehabilitation will be carried out over several rivers/ streams, some impacts on the hydrological situation are expected.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	D	D	D	- The railway line does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible.
	19	Meteorology	D	D	D	- There is no activity that may affect meteorology.
	20	Landscape	D	D	D	- The rehabilitation of the railway line follows the existing line, and a major change of landscape is not expected in this section.
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.
Pollution	22	Air pollution	B	B+	D	- Dust and other air pollutants are expected to be produced during the rehabilitation.
	23	Water pollution	B	D	D	- Accidental leakage of fuel/oil and discharge of sewage from the toilets and food courts of the construction camp into surrounding water flows may occur if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the rehabilitation, some chemical grouting is expected to cause soil contamination.
	25	Waste	B	C	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from railway sides and slopes, and food waste from construction workers. - The increase of passenger trains could increase waste at stations.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration. - Increased train operations could generate more noise and vibration along the railway line.
	27	Ground subsidence	D	D	D	- There is no extraction of groundwater that could lead to ground subsidence.
	28	Offensive odour	B	C	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment. - The operation of diesel locomotive will generate some offensive odour.
	29	Bottom sediment	B	D	D	- The rehabilitation work could generate dust from construction materials and excavation work, in particular near the river.
	30	Accidents	B	B	B	- After the completion of rehabilitation and reconstruction works, the number of trains will increase between Limbe and Luchenza. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at the three main level crossings with M2, M4 and a secondary paved road. - Accident involving pedestrians and bicycles along railway line are also anticipated.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicates a positive impact.

Source: Study Team

(2) Major Impacts

a) Involuntary Resettlement and Land Acquisition

There are several houses and latrines located near the railway line between Limbe and Luchenza, especially in the suburbs of Limbe. These houses may not need to be relocated. A cemetery near the Namiango Market may also not need to be relocated. Some shops in the Namiango Market are located within 10 m of the railway line, but may not need to be relocated. Agricultural fields currently occupying the railway ROW in this section need to be relocated. The ROW in the section between Limbe and Border is determined as 15 m each side from the centre line of the railway according to the MoTPI regulation.

b) Land Use and Utilisation of Local Resources

Land acquisition will be necessary for some plots of farmers' land which will be affected by changing the alignment for small bridges to be reconstructed. In addition, land will need to be rented during construction for temporary construction yard(s). These will be negative impacts caused by the Project.

c) Hazards

The rehabilitation and reconstruction of the railway between Limbe and Luchenza is planned mainly to follow the existing horizontal and vertical alignment. Hence, there is expected to be no major impact on flooding.

After the completion of the rehabilitation work, the number of trains will increase between Limbe and Luchanza. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at three level crossings with paved roads. This will be a potential negative impact.

d) Forests Biodiversity, and Social Condition

- The railway line between Limbe and Luchenza does not pass through an ecologically sensitive area and the impact on biodiversity is considered to be negligible.
- It is expected that no forest cutting will be necessary for the Project.
- There are no historical and cultural heritages, including World Heritage Sites, along the selected roads.
- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

e) Flora, Fauna, and Biodiversity

The railway line between Limbe and Luchenza does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. Most of the construction work will be done within the ROW.

f) Air Pollution

Railway is an environment-friendly means of transport in terms of air pollution. For the section between Limbe and Luchenza, diesel locomotives are currently used for passenger trains, which run once a week. Diesel locomotives emit combustion products such as NOx and

particulate matter (PM). In the planned railway projects, passenger trains will run daily between Limbe and Nsanje, some freight trains will run between Limbe and Border, and trucks that are currently used to carry sugar from Nchalo and cotton from Bangula will be replaced by freight trains. Although there may be an increase in air pollutants emitted by locomotives, this increase may be partially offset by the change of transport mode from minibus/truck to railway.

g) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

h) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.5.5 IEE Results for Rehabilitation of Railway between Luchenza and Makhanga

(1) Scoping Matrix

Table 10-26 shows the scoping matrix for the rehabilitation of railway between Luchenza and Makhanga (76.6 km).

Table 10-26 Scoping Matrix for Rehabilitation of Railway between Luchenza and Makhanga (1/2)

Impact			Construction Phase	Operation Phase	Non-project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- Land acquisition will be necessary for some plots of farmers' land which will be affected by changing the alignment for 2.3 km of the section between Makhanga and Sankhulani and small bridges to be reconstructed. - Illegal farming activities within the railway ROW need to be stopped.
	2	Local economy such as employment and livelihood, etc.	B+	A+	A	- Since there is no road nearby and the train service is currently not sufficient to meet demands along the railway line, the local population is expected to benefit significantly from the improved access to agricultural products and improved mobility. - Employment opportunities for local people are expected to be created during the rehabilitation.
	3	Land use and utilisation of local resources	B	B	D	- Land will need to be rented during construction for temporary construction yard(s).
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	- There is no social association affected by the railway project.
	5	Existing social infrastructure and services	B	A+	A	- The local population will significantly benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.

Table 10-26 Scoping Matrix for Rehabilitation of Railway, Luchenza–Makhanga Section (2/2)

Social Environment	6	Poor, indigenous and ethnic people	D	A+	A	- The rehabilitation will benefit all strata of the local population, including the poor. The poverty rate is high in the project area, partly due to the limited access to transport.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	D	D	D	- No important cultural sites have been identified near the project area.
	9	Local conflicts of interest	D	D	D	- There is no significant local conflict caused by the rehabilitation project.
	10	Water usage or water rights	C	C	D	- Major damage to water usage by the local population is not anticipated, but it is necessary to confirm the water sources near the railway line.
	11	Sanitation	C	D	D	- The construction camp will adversely affect sanitation if proper measures are not taken.
	12a	Hazards (risk)	B	B+	B	- The occurrence of floods and overflow of water on the railway are expected to be minimised by the improved drainage system.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- In general, construction workers could increase the prevalence of HIV and other infectious diseases if proper preventive measures are not taken.
Natural Environment	13	Topography and geographical features	B	B+	A	- The current landslides and slope failures that occur along the railway line will be improved by the stabilisation of slopes and soils. The rehabilitation work could change geographical features in the project area.
	14	Soil erosion	B	B+	B	- Soil erosion due to excavation and water flow diversion is expected during the rehabilitation work and proper mitigation measures are required to prevent it. Slope failures cause soil erosion at the moment, which can be improved by the better drainage system, and replanting vegetation and trees in cleared areas and on slopes.
	15	Groundwater	C	D	D	- In-situ piling of the foundations of bridges for reconstruction will have adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Since the rehabilitation will be carried out over several rivers/streams, some impacts on the hydrological situation are expected.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	B	B	D	- The railway line does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. However, cutting of trees and vegetation during the rehabilitation work may affect the forest resources in this area.
	19	Meteorology	D	D	D	- There is no activity that may affect meteorology.
	20	Landscape	B	B	D	- The rehabilitation of the railway line requires the cutting of hillside, which could change the landscape.
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.
Pollution	22	Air pollution	B	B+	D	- Dust and other air pollutants are expected to be produced during the rehabilitation.
	23	Water pollution	B	D	D	- Accidental leakage of fuel/oil and discharge of sewage from the toilets and food courts of the construction camp into surrounding water flows may occur if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the rehabilitation, some chemical grouting is expected to cause soil contamination.
	25	Waste	B	C	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from railway sides and slopes, and food waste from construction workers. - The increase of passenger trains could increase waste at stations.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration. - Increased train operations could generate more noise and vibration along the railway line.
	27	Ground subsidence	D	D	D	- There is no extraction of groundwater that could lead to ground subsidence.
	28	Offensive odour	B	C	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment. - The operation of diesel locomotives will generate some offensive odour.
	29	Bottom sediment	B	D	D	- The rehabilitation work could generate dust from construction materials and excavation work, in particular near the river.
	30	Accidents	B	B	B	- After the completion of rehabilitation and reconstruction works, the number of trains will increase between Luchenza and Makhanga. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian along the railway line or at a level crossing.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. * indicates a positive impact.

Source: Study Team

(2) Major Impacts

a) Major Impact on the Social Environment

Local residents along the railway line between Luchenza and Makhanga face serious problems as they have lost almost all opportunities to take agricultural products by train to sell at a major market, because the train runs only one a week or less since the disconnection of the railway line at the Chiromo washaway section.

b) Involuntary Resettlement and Land Acquisition

There are few houses along the railway line between Luchenza and Makhanga, and no significant negative impact of resettlement is anticipated in this section. However, many agricultural fields have extended to the ROW of the railway line between Luchenza and Sandama; those currently illegally occupy the ROW need to be relocated for the rehabilitation. There are also some vendors selling agricultural products and clothes near Thekerani Station, but this market is temporary and there is no vendors' association to form social institutions at this market.

c) Local Economy

For the section between Luchenza and Makhanga, the local population is expected to benefit significantly from the improved access to agricultural products and improved mobility by the proposed railway project, since there is no road nearby.

After the completion of rehabilitation and reconstruction of the railway between Limbe and Nsanje, or even Bangula, the local economy in Makhanga is expected to change dramatically, because Makhanga Station will become just one of the small station between Luchenza and Bangula, and most of the passengers from Limbe and Luchenza will continue their trip to Bangula or Nsanje, instead of using Makhanga Station as a transit point for their trip as at present. This is a very common situation all over the world when a bypass is constructed for either a railway or road, and indirect negative impacts for the local economy are unavoidable. To address this issue, a rural development plan will be necessary rather than mitigation measures in this project.

d) Land Use and Utilisation of Local Resources

Land acquisition will be necessary for some plots of farmers' land which will be affected by changing the alignment for 2.3 km of the section between Makhanga and Sankhulani and the small bridges to be reconstructed. In addition, land will need to be rented during construction for temporary construction yard(s). These will be negative impacts caused by the Project.

e) Hazards

The rehabilitation and reconstruction of the railway between Luchenza and Makhanga is planned mainly to follow the existing horizontal and vertical alignment. Hence, there is expected to be no major impact on flooding.

After the completion of the rehabilitation and reconstruction work, the number of trains will increase between Luchanza and Makhanga. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at level crossings. This will be a potential negative

impact.

f) Forests Biodiversity and Social Condition

- The railway line between Luchenza and Makhanga does not pass through an ecologically sensitive area and the impact on biodiversity is considered to be negligible.
- It is expected that no forest cutting will be necessary for the Project.
- There are no historical and cultural heritages, including World Heritage Sites, along the selected roads.
- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

g) Flora, Fauna and Biodiversity

The railway lines between Luchenza and Makhanga, does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. Most of the construction work will be done within the ROW.

h) Topography and Soil

In the proposed railway rehabilitation projects, the risk of landslides and slope failures between Luchenza and Makhanga will be minimized by replanting vegetation and trees on cleared areas and slopes, using slope retaining techniques, improving the drainage system, etc.

i) Air Pollution

Railway is an environment-friendly means of transport in terms of air pollution. For the section between Luchenza and Makhanga, diesel locomotives are currently used for passenger trains, which run once a week. Diesel locomotives emit combustion products such as NOx and particulate matter (PM). In the planned railway projects, passenger trains will run daily between Limbe and Nsanje, some freight trains will run between Limbe and Border, and trucks that are currently used to carry sugar from Nchalo and cotton from Bangula will be replaced by freight trains. Although there may be an increase in air pollutants emitted by locomotives, this increase may be partially offset by the change of transport mode from minibus/truck to railway.

j) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

k) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.5.6 IEE Results for Reconstruction of Railway between Makhanga and Bangula

(1) Scoping Matrix

Table 10-27 shows the scoping matrix for the reconstruction of railway between Makhanga and Bangula (8.7 km).

Table 10-27 Scoping Matrix for Reconstruction of Railway between Makhanga and Bangula (1/2)

	Impact		Construction Phase	Operation Phase	Non-Project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- Due to the reconstruction of the railway, the eviction of some vendors near Makhanga and Bangula Station is expected. - Some land acquisition is expected due to the change of alignment for construction of the Chiromo Railway Bridge.
	2	Local economy such as employment and livelihood, etc.	B+	B+	A	- The local population is expected to benefit significantly from the improved access to agricultural products and improved mobility. Employment opportunities for local people are expected to be created during the reconstruction. The overall impact is anticipated to be positive. - After the completion of rehabilitation and reconstruction of the railway between Limbe and Nsanje, or even Bangula, the local economy in Makhanga is expected to change dramatically, because Makhanga Station will become just one of the small stations between Luchenza and Bangula, and most of the passengers from Limbe and Luchenza will continue their trip to Bangula or Nsanje, instead of using Makhanga Station as a transit point for their trip as at present. This is a very common situation all over the world when bypass is constructed for either a railway or road, and indirect negative impacts for the local economy are unavoidable. To address this issue, a rural development plan will be necessary rather than mitigation measures in this project.
	3	Land use and utilisation of local resources	C	C	D	- Land will need to be rented during construction for temporary construction yard(s).
	4	Social institutions such as social infrastructure and local decision-making institutions	B	C	D	- The bicycle taxi association will be affected by the reconstruction of the railway line and resumption of operation of passenger trains to Bangula.
	5	Existing social infrastructure and services	D	A+	A	- The local population will benefit significantly from the improved transport services in terms of access to major markets, schools, and health posts.
	6	Poor, indigenous and ethnic people	D	A+	A	- The reconstruction will benefit all strata of the local population, including the poor. The poverty rate is high in the project area, partly due to the disconnection at Chiromo.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	D	D	D	- No important cultural sites have been identified near the project area.
	9	Local conflicts of interest	C	C	D	- Bicycle taxi pedalers may be disadvantaged by the reconstruction project while most other people will benefit. It is necessary to appropriately compensate the disadvantaged groups to avoid local conflict.
	10	Water usage or water rights	C	C	D	- Some farmers using irrigation could be affected by the reconstruction. Some fishermen could be affected by the construction of the Chiromo Railway Bridge.
	11	Sanitation	C	D	D	- The construction camp will adversely affect sanitation if proper measures are not taken.
	12a	Hazards (risks)	B	C	B	- Construction of the Chiromo Railway Bridge is planned and the location of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway. - It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- Construction workers could increase the prevalence of HIV and other infectious diseases, if proper preventive measures are not taken.

Table 10-27 Scoping Matrix for Reconstruction of Railway between Makhanga and Bangula (2/2)

Natural Environment	13	Topography and geographical features	B	C	D	- Construction of new embankments at the approach section of the Chiromo Railway Bridge will modify existing geographical features in the project area.
	14	Soil erosion	B	B+	A	- Further soil erosion is anticipated at construction sites of the Chiromo Railway Bridge due to excavation of the river bank and river bed, unless proper revetment works are carried out for the excavated river bed and abutments/piers of the newly constructed bridge.
	15	Groundwater	C	D	D	- Construction of a new embankment at the approach section of the Chiromo Railway Bridge may have adverse effects on groundwater. Appropriate consideration for existing water sources (shallow wells) can prevent adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Construction of the Chiromo Railway Bridge is planned and the locations of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway unless this road embankment is demolished. - It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River. This is a negative impact for land use for cultivation.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	B	B	B	- The existing railway alignment passes through the outer edge of Elephant Marsh, which is not a protected area by law in Malawi.
	19	Meteorology	D	D	D	- There is no activity that might affect meteorology.
	20	Landscape	C	C	D	- Construction of the Chiromo Railway Bridge could change the landscape..
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.
Pollution	22	Air pollution	B	B+	D	- Dust and other air pollutants are expected to be produced during the reconstruction. - The change of transport mode from truck/car to more environment-friendly railway will reduce total pollutant emissions.
	23	Water pollution	B	D	D	- There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, particularly due to excavation of river beds and banks for constructing the foundations of bridges and demolition of the road embankment on the Bangula side, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow. - Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the construction, accidental leakage of fuel/oil is anticipated to cause soil contamination.
	25	Waste	B	C	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from railway sides and slopes, and food waste from construction workers.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration. - Increased train operation could generate more noise and vibration along the railway line.
	27	Ground subsidence	C	C	D	- There is no extraction of groundwater which might lead to ground subsidence.
	28	Offensive odour	B	C	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment. - The operation of diesel locomotives will generate some offensive odour.
	29	Bottom sediment	B	D	D	- Reconstruction work could generate dust from construction materials and excavation work.
	30	Accidents	B	B	B	- During the construction process, there will be more heavy traffic, which may increase the risk of traffic accidents. - After the completion of rehabilitation and reconstruction works, trains will resume operation between Makhanga and Bangula. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at the one main level crossing with M1 and on the Kamuzu Truss Bridge (rail cum road bridge). - Accident involving pedestrians and bicycle along the railway line are also anticipated.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicates a positive impact.
Source: Study Team

(2) Major Impacts

a) Major Impact on the Social Environment

The improvement in railway services is expected to bring the same benefits for local people in the section between Makhanga and Bangula.

b) Involuntary Resettlement and Land Acquisition

The railway line between Makhanga and Bangula is not operating currently. At Makhanga and Bangula Stations, vendors have illegally built huts along the railway line, but these are temporary structures. The vendors need to be relocated for the reconstruction of the railway line, which will have a negative impact, but their business will benefit by the increased number of customers at stations after the reconstruction.

c) Local Economy

The railway project is expected to have the same impact on the local economy as the road project between Makhanga and Bangula.

d) Land Use and Utilisation of Local Resources

Land acquisition will be necessary for some plots of farmers' land which will be affected by changing the alignment for both sides of the Chiromo washaway. In addition, land will need to be rented during construction for temporary construction yard(s). These will be negative impacts caused by the Project.

e) Hazards

The rehabilitation and reconstruction of the railway between Makhanga and Bangula is planned mainly to follow the existing horizontal and vertical alignment. Hence, there is expected to be no major impact on flooding.

Construction of the Chiromo Railway Bridge is planned in the Study and the locations of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway.

After the completion of the rehabilitation and reconstruction work, operation of train will resume between Makhanga and Bangula. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at a level crossing and on the Kamuzu Truss Bridge. This will be a potential negative impact.

f) Forests Biodiversity, and Social Condition

- The railway line between Makhanga and Bangula does not pass through an ecologically sensitive area and the impact on biodiversity is considered to be negligible.
- It is expected that no forest cutting will be necessary for the Project.
- There are no historical and cultural heritages, including World Heritage Sites, along the selected roads.
- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

g) Flora, Fauna, and Biodiversity

The railway line between Makhanga and Bangula passes through the outer edge of Elephant Marsh and crosses the Shire River and the New Shire River, and is expected to have similar impact to the above road project.

h) Hydrology

Construction of the Chiromo Railway Bridge is planned and the locations of abutments and piers are planned so as not to disturb the present water flow. However, there is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway unless this road embankment is demolished.

i) Air Pollution

Railway is an environment-friendly means of transport in terms of air pollution. In the planned railway projects, passenger trains will run daily between Limbe and Nsanje, some freight trains will run between Limbe and Border, and trucks that are currently used to carry sugar from Nchalo and cotton from Bangula will be replaced by freight trains. Although there may be an increase in air pollutants emitted by locomotives, this increase may be partially offset by the change of transport mode from minibus/truck to railway.

j) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, particularly due to excavation of river beds and banks for constructing the foundations of bridges and demolition of the road embankment on the Bangula side, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

Groundwater is also an important source of water for the rural population in this region. In the Lower Shire Valley, groundwater tend to have high levels of salt, causing shallow wells to be abandoned. There are two shallow wells in the project area, and a detailed survey of the groundwater near the shallow wells is needed to prevent water pollution from construction work.

k) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.5.7 IEE Results for Reconstruction of Railway between Bangula and Nsanje

(1) Scoping Matrix

Table 10-28 shows the scoping matrix for the reconstruction of railway between Bangula and

Nsanje (45.3 km).

Table 10-28 Scoping Matrix for Reconstruction of Railway betwen Bangula and Nsanje (1/2)

Impact			Construction Phase	Operation Phase	Non-project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- A few illegally occupied agricultural fields and some illegally occupied huts of vendors need to be relocated. - Illegal farming activities within the railway ROW need to be stopped. - Since the adjacent road can be utilised to transport construction materials during the reconstruction, resettlement is not expected to have a significant impact.
	2	Local economy such as employment and livelihood, etc.	B+	B+	D	- The local population is expected to benefit from the improved access to agricultural products and improved mobility. - Employment opportunities for local people are expected to be created during the reconstruction.
	3	Land use and utilisation of local resources	C	C	D	- Land will need to be rented during construction for temporary construction yard(s).
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	- There is no social association affected by the railway project.
	5	Existing social infrastructure and services	B	B+	D	- The local population will benefit from the improved transport services in terms of access to agricultural products, schools, and health posts.
	6	Poor, indigenous and ethnic people	D	B+	B	- The reconstruction will benefit all strata of the local population, including the poor.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	C	C	D	- No important cultural sites have been identified near the project area.
	9	Local conflicts of interest	D	D	D	- There is no significant local conflict caused by the reconstruction project.
	10	Water usage or water rights	C	C	D	- Major damage to water usage by the local population is not anticipated, but it is necessary to confirm water sources near the railway line.
	11	Sanitation	C	D	D	- The construction camp will adversely affect sanitation if proper measures are not taken.
	12a	Hazards (risks)	D	D	D	- The occurrence of floods and overflow of water on the railway are expected to be minimised by the improved drainage system.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- In general, construction workers could increase the prevalence of HIV and other infectious diseases if proper preventive measures are not taken.
Natural Environment	13	Topography and geographical features	D	D	D	- The project site is on the flat plain in the Lower Shire Valley and a major impact on geographical features is not expected.
	14	Soil erosion	B	B+	A	- Soil erosion due to excavation is not anticipated because there are only wadis where reconstruction of bridges is planned. - Soil erosion of wadis only during rainy season will be minimised by the improved drainage system.
	15	Groundwater	C	C	D	- In-situ piling of the foundations of bridges for reconstruction will have adverse effects on groundwater. Appropriate consideration for existing water sources (wells) can prevent adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Since the reconstruction of bridges will be carried out over several wadis, some impacts on the hydrological situation are expected.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	C	C	D	- The railway line does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. However, cutting of trees and vegetation during the reconstruction work may affect the forest resources in this area.
	19	Meteorology	D	D	D	- There is no activity that may affect meteorology.
	20	Landscape	D	D	D	- The reconstruction of the railway line follows the existing line and a major change of landscape is not expected in this section.
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.

Table 10-28 Scoping Matrix for Reconstruction of Railway betwen Bangula and Nsanje (2/2)

Pollution	22	Air pollution	B	B+	D	- Dust and other air pollutants are expected to be produced during the reconstruction. - The change of transport mode from truck/car to railway is expected to reduce total pollutant emissions.
	23	Water pollution	B	D	D	- Accidental leakage of fuel/oil and discharge of sewage from the toilets and food courts of the construction camp into surrounding water flows may occur if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the reconstruction, some chemical grouting is expected to cause soil contamination.
	25	Waste	B	C	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from railway sides and slopes, and food waste from construction workers. - The increase of passenger trains could increase waste at stations.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration. - Increased train operation could generate more noise and vibration along the railway line.
	27	Ground subsidence	D	D	D	- There is no extraction of groundwater that could lead to ground subsidence.
	28	Offensive odour	B	C	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment. - The operation of diesel locomotives will generate some offensive odour.
	29	Bottom sediment	B	D	D	- Reconstruction work could generate dust from construction materials and excavation work, in particular near the river.
	30	Accidents	B	B	D	- During the construction process there will be more heavy traffic, which may increase the risk of traffic accidents. - After the completion of rehabilitation and reconstruction works, trains will resume operation between Bangula and Nsanje. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at the one main level crossings with M1.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicates a positive impact.

Source: Study Team

(2) Major Impacts

a) Involuntary Resettlement and Land Acquisition

For the section between Bangula and Nsanje, there is one maize field close to the railway line, which was identified by the railway inventory survey. There are some houses between the railway line and the road near Bangula, but these are not expected to suffer a significant impact since the M1 adjacent to the railway can be used to transport construction materials and there is no need to construct a temporary road for the reconstruction. Hence, neither resettlement nor land acquisition is expected.

b) Land Use and Utilisation of Local Resources

Land will need to be rented during construction for temporary construction yard(s). This will be negative impacts caused by the Project.

c) Hazards

The rehabilitation and reconstruction of the railway between Limbe and Border is planned mainly to follow the existing horizontal and vertical alignment. Hence, there is expected to be no major impact on flooding.

After the completion of the rehabilitation and reconstruction work, operation of train will

resume between Bangula and Nsanje. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at a level crossing with paved road. This will be a potential negative impact.

d) Forests Biodiversity, and Social Condition

- The railway line between Border and Limbe does not pass through an ecologically sensitive area and the impact on biodiversity is considered to be negligible.
- It is expected that no forest cutting will be necessary for the Project.
- There are no historical and cultural heritages, including World Heritage Sites, along the selected roads.
- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

e) Flora, Fauna, and Biodiversity

The railway line between Bangula and Nsanje does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. Most of the construction work will be done within the ROW.

f) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

g) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.5.8 IEE Results for Reconstruction of Railway between Nsanje and Border (Marka)

(1) Scoping Matrix

Table 10-29 shows the scoping matrix for the reconstruction of railway between Nsanje and Border (Marka) (26.4 km).

Table 10-29 Scoping Matrix for Reconstruction of Railway between Nsanje and Border (1/2)

Impact			Construction Phase	Operation Phase	Non-project	Outline
Social Environment	1	Resettlement/land acquisition	B	B	D	- A few illegally occupied huts of vendors need to be relocated. - Illegal farming activities within the railway ROW need to be stopped. - Since the adjacent road can be utilised to transport construction materials during the reconstruction, resettlement is not expected to have a significant impact.
	2	Local economy such as employment and livelihood, etc.	B+	B+	B	- Employment opportunities for local people are expected to be created during the reconstruction . - After completion of reconstruction work, employment opportunities for local people are also expected with the resumption of operation of Border Station as a transit station for trade with Mozambique.
	3	Land use and utilisation of local resources	C	C	D	- Land will need to be rented during construction for temporary construction yard(s).
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	- There is no social association affected by the railway project.
	5	Existing social infrastructure and services	B	B+	D	- No significant impact on the mobility of people is expected because only freight trains are planned to operate on this section.
	6	Poor, indigenous and ethnic people	D	B+	B	- The reconstruction will benefit all strata of the local population, including the poor.
	7	Misdistribution of benefit and damage	D	D	D	- Equal employment opportunities for the local population can avoid the misdistribution of benefit.
	8	Cultural heritage	C	C	D	- One cultural site has been identified near the project area. It is necessary to confirm the locations of cultural sites at the F/S stage.
	9	Local conflicts of interest	D	D	D	- There is no significant local conflict caused by the reconstruction project.
	10	Water usage or water rights	C	C	D	- Major damage to water usage by the local population is not anticipated, but it is necessary to confirm water sources near the railway line.
	11	Sanitation	C	D	D	- The construction camp will adversely affect sanitation if proper measures are not taken.
	12a	Hazards (risks)	B	B+	B	- The occurrence of floods and overflow of water on the railway are expected to be minimised by the improved drainage system.
	12b	Infectious diseases such as HIV/AIDS	B	B	B	- In general, construction workers could increase the prevalence of HIV and other infectious diseases if proper preventive measures are not taken.
Natural Environment	13	Topography and geographical features	D	D	D	- The project site is on the flat plain in the Lower Shire Valley and a major impact on geographical features is not expected.
	14	Soil erosion	B	B+	A	- Soil erosion due to excavation is not anticipated because there are only wadis where reconstruction of bridges is planned. - Soil erosion of wadis only during the rainy season will be minimised by the improved drainage system.
	15	Groundwater	C	C	D	- In-situ piling of the foundation of bridge for reconstruction will have adverse effects on groundwater. Appropriate consideration for existing water sources (shallow wells) can prevent adverse effects on groundwater.
	16	Hydrological situation	B	B	D	- Since the reconstruction of bridges will be carried out over several wadis, some impacts on the hydrological situation are expected.
	17	Coastal zone	D	D	D	- The project does not pass near the coast.
	18	Flora, fauna and biodiversity	C	C	D	- The railway line does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. - However, cutting of trees and vegetation during the reconstruction work may affect the forest resources in this area.
	19	Meteorology	D	D	D	- There is no activity that may affect meteorology.
	20	Landscape	D	D	D	- The reconstruction of the railway line follows the existing line and a major change of landscape is not expected in this section.
	21	Global warming	D	D	D	- Due to the volume of traffic in this area, the impact on global warming is expected to be negligible.

Table 10-29 Scoping Matrix for Reconstruction of Railway between Nsanje and Border (2/2)

Pollution	22	Air pollution	B	B+	D	- Dust and other air pollutants are expected to be produced during the reconstruction.
	23	Water pollution	B	D	D	- Accidental leakage of fuel/oil and discharge of sewage from the toilets and food courts of the construction camp into surrounding water flows may occur if appropriate measures are not taken.
	24	Soil contamination	B	C	D	- During the reconstruction, some chemical grouting is expected to cause soil contamination.
	25	Waste	B	C	D	- Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from railway sides and slopes, and food waste from construction workers.
	26	Noise and vibration	B	B	D	- Trucks and heavy equipment working along the road will be noisy and cause vibration. - Increased train operation could generate more noise and vibration along the railway line.
	27	Ground subsidence	D	D	D	- There is no extraction of groundwater that could lead to ground subsidence.
	28	Offensive odour	B	C	D	- Offensive odour is temporarily expected due to exhaust gas from construction vehicles and heavy equipment. - The operation of diesel locomotives will generate some offensive odour.
	29	Bottom sediment	B	D	D	- Reconstruction work could generate dust from construction materials and excavation work, in particular near the river.
	30	Accidents	B	B	D	- During the construction process there will be more heavy traffic, which may increase the risk of traffic accidents. - After the completion of reconstruction works, trains will resume operation between Nsanje and Border. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at one main level crossings with M1.

Note: A = A significant impact is expected, B = Some impact is expected, C = Extent of impact is unknown, D = No or negligible impact is expected. + indicates a positive impact

Source: Study Team

(2) Major Impacts

a) Involuntary Resettlement and Land Acquisition

There are some illegal occupations by villagers between Nsanje and Border (Marka). There are also some settlements near the railway line near the Border Station. Hence, some resettlement of illegal occupants is necessary. However, no land acquisition is required.

b) Land Use and Utilisation of Local Resources

Land will need to be rented during construction for temporary construction yard(s). This will be negative impacts caused by the Project.

c) Cultural Heritage

One cultural site has been identified near the project area.

d) Hazards

The rehabilitation and reconstruction of the railway between Nsanje and Border is planned mainly to follow the existing horizontal and vertical alignment. Hence, there is expected to be no major impact on flooding.

After the completion of the rehabilitation and reconstruction work, operation of train will resume between Nsanje and Border. This may increase the risk of accidents between a train and a vehicle, bicycle or pedestrian at a level crossing with paved road. This will be a potential negative impact.

g) Forests Biodiversity, and Social Condition

- The railway line between Border and Limbe does not pass through an ecologically sensitive area and the impact on biodiversity is considered to be negligible.
- It is expected that no forest cutting will be necessary for the Project.
- There are no indigenous people in Malawi. However, there are minority people living in the country since Malawi is a conglomerate state that consists of multi-ethnic groups and religious sects.

h) Flora, Fauna, and Biodiversity

The railway line between Nsanje and Border does not pass through an ecologically sensitive area and the impact on biodiversity is expected to be negligible. Most of the construction work will be done within the ROW.

i) Water Pollution

There are potential sources of pollution of surface and groundwater flows in the Project. These are: 1) runoff soil from the construction site, 2) surface soil erosion caused by rain water from the excavation site, 3) accidental leakage of fuel/oil and 4) structures, such as drains and bridges, connected to or placed in/under surface water flow.

Solid waste will be produced during the road improvement process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road side and slopes and food waste from construction workers.

Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows if appropriate measures are not taken.

j) Noise and Vibration

Trucks and heavy equipment working along the road will be noisy and cause vibration.

10.6 Analysis of Alternatives and Recommendations for Mitigation Measures

The Study Team proposed the preliminary design for the reconstruction of the S151 road between Makhanga and Bangula and rehabilitation and reconstruction of the railway between Limbe and Border (Marka). In order to avoid or alleviate the possible impacts of the Project, mitigation measures should be taken during the construction and operational phases of the Project. The expected negative impacts identified in the scoping matrices and possible mitigation measures are shown in Table 10-30. These mitigation measures should be discussed with stakeholders at public consultation meetings during the course of the F/S.

Table 10-30 Anticipated Negative Impacts and Proposed Mitigation Measures (1/2)

Environmental and Social Issue	Negative Impact	Possible Mitigation Measure(s)
Resettlement/land acquisition	Resettlement of houses and shops.	* Payment of appropriate amount of compensation according to the government regulation to those people affected. * Provision of similar type/size of house or shop at a nearby location to those people affected.
	Land acquisition.	* Acquisition of necessary plots of land according to the appropriate amount of land plots. * Provision of similar type/size of land plots to be able to continue farming of same crop(s).
	Resettlement of huts of vendors who are illegally occupying railway ROW.	* Payment of appropriate amount of compensation according to the government regulation to those people affected.
	Cessation of farming of land within railway ROW.	* Payment of appropriate amount of compensation according to the government regulation to those people affected.
Local economy such as employment and livelihood, etc.	Members of boat association will lose their source of income.	* Provision of job opportunities during construction of the Chiromo Road Bridge, Chiromo Railway Bridge and New Shire Bridge. * Mitigation measure to create a source of income will be prepared in the F/S.
	Income of members of bicycle taxi association may decrease.	* Provision of information on alternative job opportunities to those people affected.
Land use and utilisation of local resources	Land will need to be rented during construction for temporary construction yard(s).	* Payment of appropriate amount of renting charge according to the government regulation to those people affected.
	Water pumped up from shallow wells has the potential to be affected by the reconstruction works.	* Detailed analysis of shallow wells near the road alignment should be carried out during the F/S stage.
Water usage or water rights	Some farmers using irrigation could be affected by realignment of the road.	* Detailed analysis of shallow wells near the road alignment should be carried out during the F/S stage.
Sanitation	Sewage will be discharged from the toilets and food courts of the construction camp into surrounding water flows.	* Environmental management plan of a contractor to protect the environment.
Hazards (risks)	Serious erosions on the right-side bank of the Ruo River near Makhanga.	* Realignment of S151 to avoid effects of river bank erosion.
Infectious diseases such as HIV/AIDS	Construction workers could increase the prevalence of HIV/AIDS and other infectious diseases	* The contractor should instruct workers about the risks and preventive measures for HIV/AIDS and other infectious disease under the environmental management plan.
Soil erosion	Further soil erosion is anticipated at the construction sites of the Chiromo Road Bridge, Chiromo Railway Bridge and New Shire Bridge due to excavation of the river bank and river bed.	* Installation of appropriate protection measures for the abutments and piers of bridges, railway embankments and excavated river bed.
Groundwater	Construction of embankments may have adverse effects on groundwater.	* Detailed analysis of groundwater near the road alignment should be carried out during the F/S stage.

Table 10-30 Anticipated Negative Impacts and Proposed Mitigation Measures (2/2)

Environmental and Social Issue	Negative Impact	Possible Mitigation Measure(s)
Hydrological situation	There is a risk of frequent flooding due to a narrow river section caused by the existing road embankment on the Bangula side of the Chiromo washaway.	* Demolish the existing road embankment to widen the river cross-section.
	It will be difficult to drain flooded water on the land between the existing railway embankment and the planned road embankment from the Chiromo washaway section towards the Shire River.	* Provide culvert boxes with sufficient capacity on the road embankment to drain flooded water.
Water pollution	There are potential sources of pollution of surface and ground water flows mainly in the construction camp.	* Environmental management plan of a contractor to protect the environment.
Waste	Solid waste will be produced during the road and railway construction process, starting with surplus soil and rocks from the excavation work and also metallic parts, cut wood from road and railway side and slopes and food waste from construction workers.	* Dumping waste at appropriate places instructed by related District Councils. * Environmental management plan of a contractor to protect the environment.
Accidents	Risk of traffic accidents caused by heavy vehicles and heavy equipment for construction works.	* Installation of warning signs in populated areas. * Assignment of security staff in populated areas and near schools.
	Risk of traffic accidents after completion of reconstruction work.	* Installation of traffic safety devices (warning signs, sidewalks and pedestrian crossings, humps to reduce vehicle speed, etc.) in populated areas and near schools. * Traffic safety education at primary schools.
	Risk of accidents between a train and a vehicle, bicycle or pedestrian at a railway level crossing and on Kamuzu Truss Bridge.	* Installation of warning signs on approach section of road. * Installation of barriers at major level crossings. * Assignment of guard personnel at level crossings and Kamuzu Truss Bridge to control vehicle traffic. * Traffic safety education at primary schools.

Source: Study Team

10.7 Consultation with Stakeholders

The consultation with stakeholders aims to encourage stakeholders to understand the project needs, the project design, and the adverse impacts on the environment and society. In the Study, consultations with stakeholders were held according to the following schedule:

- April 2011: First Technology Transfer Seminar in Lilongwe and Blantyre
- October 2011: Second Technology Transfer Seminar in Lilongwe and Blantyre
- November and December 2011: Consultation with related District Councils
- January 2012: Third Technology Transfer Seminar in Lilongwe and Blantyre

Discussion memos at the technology transfer seminars are attached in Appendix 6.

Major items discussed in consultations with stakeholders are summarized in Table 10-31

Table 10-31 Major Items Discussed in Consultations with Stakeholders

Consultation	Major Items Explained	Items Discussed related to Environmental and Social Considerations
First Technology Transfer Seminar	Explanation of progress of study for preparation of the Master Plan	No specific discussions related to environmental and social considerations.
Second Technology Transfer Seminar	Explanation of outline of the Master Plan	Question: How to determine the compensation cost for resettlement? Response: The level of compensation will be determined based on standards defined by district and RA (RA). Question: Who is going to carry out the EIA? Response: During the F/S stage, an independent consultant employed by RA or MoTPI will carry out the EIA. (RA)
Consultation with Nsanje District Council and other related personnel (see Appendix 5)	Possible improvement plans for road and railway	* Process of resettlement and land acquisition in Nsanje District. * There are frequent flood damages in Makhanga and Chiromo. * Members of the boat association and vendors carrying out business near the boat landing point will lose their main source of income by construction of the Chiromo Road Bridge. * Members of the bicycle taxi association may be affected by construction of the Chiromo Road Bridge. * Vendors in the Makhanga Market should be resettled if the existing road alignment is improved. * There are irrigation system from shallow wells between Makhanga and the Chiromo.
Third Technology Transfer Seminar	Explanation of outline of the Master Plan and Pre-F/S	Comment: The EIA should be carried out at an early stage of the F/S because of the size of the project. Question: How much will the amount of compensation be? Response: There is no standard compensation amount. It is calculated based on the building and number of valuable trees, such as mango and banana trees. Comment: During the construction of projects, there were problems of increased prevalence of HIV/AIDS among the workers of a contractor. Mitigation measures should be noted in the report.

Source: Study Team

10.8 Environmental Management and Monitoring Plan

An Environmental Management and Monitoring Plan (EMMP) provides environmental standards for rehabilitation, operation, and routine maintenance of the proposed projects. As described in Section 10.2, the project developer needs to submit a project brief before implementation. The developer then may submit an EIA, if required. The results of the EIA should be incorporated in the EMMP, which is mandatory in Malawi. Tables 10-32 and 10-33 show the environmental management plan and the environmental monitoring plan for the proposed projects.

Table 10-32 Environmental Management Plan

Environmental and Social Impact	Mitigation Measures	Responsible Institutions	Time-framework
Involuntary resettlement	Payment of compensation for people affected by resettlement of houses and shops. Provision of similar type/size of house or shop at a nearby location.	Execution agency, District Council	Before construction work
	Land acquisition Provision of similar type/size of land plots to be able to continue farming of same crop(s).	Execution agency, District Council	Before construction work
	Payment of compensation for vendors affected by resettlement of huts occupying railway ROW.	Execution Agency, District Council	Before construction work
	Payment of compensation to farmers required to stop farming land within railway ROW.	Execution Agency, District Council	Before construction work
Loss of income sources	Payment of compensation according to the government regulation to those people affected (member of boat association and vendors doing business at the boat landing point of the Chiromo washaway section).	District Council, Execution Agency,	During construction of the Chiromo Road Bridge before completion
	Provision of information on alternative job opportunities to those people affected.	District Council,	During construction of the Chiromo Road Bridge before completion
	Provision of job opportunities for construction of the Chiromo Road Bridge, Chiromo Railway Bridge and New Shire Bridge with a boat.	Contractor	During construction of the Chiromo Road Bridge, Chiromo Railway Bridge and New Shire Bridge
Land use and utilisation of local resources	Renting of land for temporary construction yard(s) and detour route.	Contractor	During construction work
Water usage or water rights for groundwater	Detailed analysis of shallow wells near the road alignment.	Execution Agency, Consultant	During F/S stage
Soil erosion	Installation of appropriate protection measures for the abutments and piers of bridges, railway embankments and excavated river bed.	Execution Agency, Contractor	During construction work
Hydrological situation	Demolition of the existing road embankment to widen the river cross-section.	Execution Agency, Contractor	During construction work
	Provision of culvert boxes with sufficient capacity on the road embankment to drain flooded water.	Execution Agency, Contractor	During construction work
Water pollution	Environmental management plan to the protect environment.	Contractor	During construction work
Waste	Dumping of waste at appropriate places instructed by related District Councils. Environmental management plan of a contractor to protect the environment.	District Council Contractor	During construction work
Accident	Installation of warning signs and assignment of security staff in populated areas during construction.	Execution Agency, Contractor	During construction work
	Installation of traffic safety devices in populated area and near schools.	Execution Agency, Contractor	During construction work and operation period
	Installation of warning signs and barriers at major level crossings, and assignment of guard personnel at level crossings and Kamuzu Truss Bridge to control vehicle traffic.	Execution Agency, Contractor	During construction work and operation period
	Traffic safety education at primary schools	Execution Agency, Ministry of Education	During construction work and operation period

Source: Study Team

Table 10-33 Environmental Monitoring Plan

Project Phase	Monitoring Item	Parameters	Location	Frequency	Notes
Construction Phase	Surface water quality	pH, BOD, Suspended solids (SS), hydrocarbons	In surface waters downstream of construction activities	Once a month	Place to take samples to be defined in collaboration with the EDO concerned
	Liquid discharge from the construction site	pH, COD, BOD, SS	Downward of the exit of the construction site	Once a month	
	Solid waste	Waste from food, plastic, cardboard, metal products, etc.	In the temporary yard for construction work and road construction sites	Once a month	To control the implementation of PPM (Plan for Protective Measures) for those wastes
	Hazardous waste	Fuel, oils, solvents paints, used tyres, batteries, etc.	In the temporary yard for construction work and road construction sites	Once a month	To control the implementation of PPM for this type of waste
	Biodiversity	Pollution from work sites in and near water flows	The entire project area	Once every 3 months	To control the implementation of PPM
		Plantation of vegetation and trees where possible	The entire project area	Once every 3 months	
Operation Phase	Biodiversity	General flora conditions	In and near inhabited areas, near water flows, on slopes and forested area along roads	2 times a year	To control the implementation of PPM
	Increase of waste disposal	Amount of disposed domestic wastes, surface water quality (pH, BOD, SS)	Along the project road and railway, and water flow downstream of the road and railway	2 times a year	To control the implementation of PPM

Source: Study Team

10.9 Environmental Items to be Further Studied in the F/S

The following environmental items should be studied in detail in the F/S.

- Houses, huts and shops necessary to be resettled
- Land necessary to be acquired
- Illegally occupied ROW of railway by huts and farming
- Relation between shallow wells and road alignment
- Quarries and borrow pits for construction works
- Possible camp site(s) for construction

CHAPTER 11

INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION OF THE MASTER PLAN PROGRAMME

Chapter 11 Institutional Arrangements for Implementation of the Master Plan Programme

11.1 Institutional Arrangements for the Road Sub-sector

RA under MoTPI is currently responsible for the planning, design, construction and O&M of Main, Secondary and Tertiary roads, while district assemblies are responsible for budget allocation for improving other local roads. RA has implemented projects with general government budget, financial assistance from foreign development partners, and allocation from the Road Fund, which is funded by a fuel levy collected from sales of fuel in Malawi.

Improvement of most of the arterial roads in the Study Area is expected to be completed in the medium term (2020), and O&M works to secure the functions of road assets will become more important in the near future.

Therefore, the following programmes are considered to be desirable to maintain existing and newly improved road assets to secure their functions.

- Routine maintenance work such as cleaning ROW and small-scale repairs of pavement surface should be carried out according to the O&M programmes.
- Periodic maintenance works such as pavement repair or overlay works should be carried out according to the O&M programmes. The road database with the Highway Development and Maintenance Model 4 (HDM-4) is a suitable tool for identifying the priority of road sections for periodic maintenance, as RA has already introduced this model.
- Inspection and maintenance of drainage structures and bridges should be carried out annually to identify and repair/clean disorderly parts of structures.

The Road Fund is the most appropriate resource for these periodic and routine maintenance works, as the revenues of the Road Fund each year are reasonably stable. However, the Road Fund should not be allocated to development projects, in order to leave sufficient funding for O&M.

O&M of local roads can be performed as part of community development programmes as these roads cannot be improved as economically reliable projects.

11.2 Institutional Arrangements for the Railway Sub-sector

11.2.1 Institutional Arrangement

The institutional arrangements for the railway sub-sector have various functions and structures. The functions range from information-sharing and consensus-building to the planning and implementation of rehabilitation/reconstruction projects. Each function of an arrangement can be used to establish institutional arrangements as follows:

(1) Objectives

The main objectives of the institutional arrangements are:

- To utilize the Sena Corridor as an efficient, reliable and cost-effective corridor
- To establish an infrastructure rehabilitation plan to re-open the corridor
- To promote sustainable maintenance of the infrastructure of the line
- To implement the plan for the One-Stop Border Post (OSBP) system at the borders
- To cooperate with neighbouring countries with similar intentions

(2) Legal Instruments

The legal instruments for the institutional arrangements should define the objectives of the implementing authorities and the roles and responsibilities of the various parties. A review of the legal instruments for railway transport should include the following characteristics of the relevant legal instruments:

- They are international or written agreements between two or more nations or independent public law entities such as states or international organizations, intended to create rights and obligations between parties.
- They are governed by international law.
- They are designated as treaties, conventions, agreements, protocols, covenants, compacts, exchanges of notes, memoranda of understanding, agreed minutes, letters, etc.
- They can consider two ways, either bilateral or multilateral: bilateral treaties are contracts in which two parties balance their claims on a specific matter whereas multilateral treaties set rules of law to be observed by all parties to the treaty, in their joint or individual interest.
- A treaty is a contract and must be interpreted as such. Enforcement of its terms and conditions by a government agency is more than the implementation of domestic law provisions.

(3) Management of Arrangement

To maintain an arrangement, the followings are required:

- Monitoring the performance of train operation on the Sena Corridor
- Supporting the development and implementation of common/standard procedures and regulations
- Supporting capacity-development initiatives of key institutions engaged in transport operations (customs, clearing and forwarding agents, insurance companies, transport infrastructure management agencies, transport operators, etc.)
- Networking with international, regional, and local partners affiliated with transport corridor management

(4) Railway Freight Performance Indicators

The performance indicators should be monitored to improve and maintain train operations. The main indicators are based on time and cost, which can help in identifying those components on the corridor. The performance of rail freight transport can be improved by reducing the time and cost at specific points or sections on the line. In addition to these indicators, the turn-around time of locomotives and wagons is important to improve profitability.

The performance indicators are composed of:

- Transport time
- Transport cost
- Transport volume
- Turn-around time of locomotives and wagons including station stopping times for loading/unloading and transit times at border posts

(5) Options for Ownership and Operation of the Branch Line of the Sena Railway

At present, CEAR operates freight trains under a concession agreement with MoTPI that is somewhat vague regarding the rehabilitation of infrastructure.

In general, there are two options for the ownership and operation of railways which should be considered when the current concession agreement is revised:

- Option 1: Both ownership of rail infrastructure and the right to operate trains to be in the same agency; and
- Option 2: The ownership of rail infrastructure and the right to operate trains to be in two different agencies.

Each option has its advantages and disadvantages. In the context of options of ownership and operation of the railway, the following alternatives may be evaluated:

- The GoM rehabilitates the dilapidated railway facilities and operates the trains on its own by creating a central authority.
- The GoM rehabilitates the dilapidated railway facilities on its own, but gives the right to operate the trains to an independent operator on a revenue-sharing basis under a concession agreement for a fixed-period tenure. In this arrangement, the GoM retains ultimate ownership of either the physical assets or the right to supply, but grants operation rights to a concessionaire. The concessions include leasing, franchising and BOT arrangements.

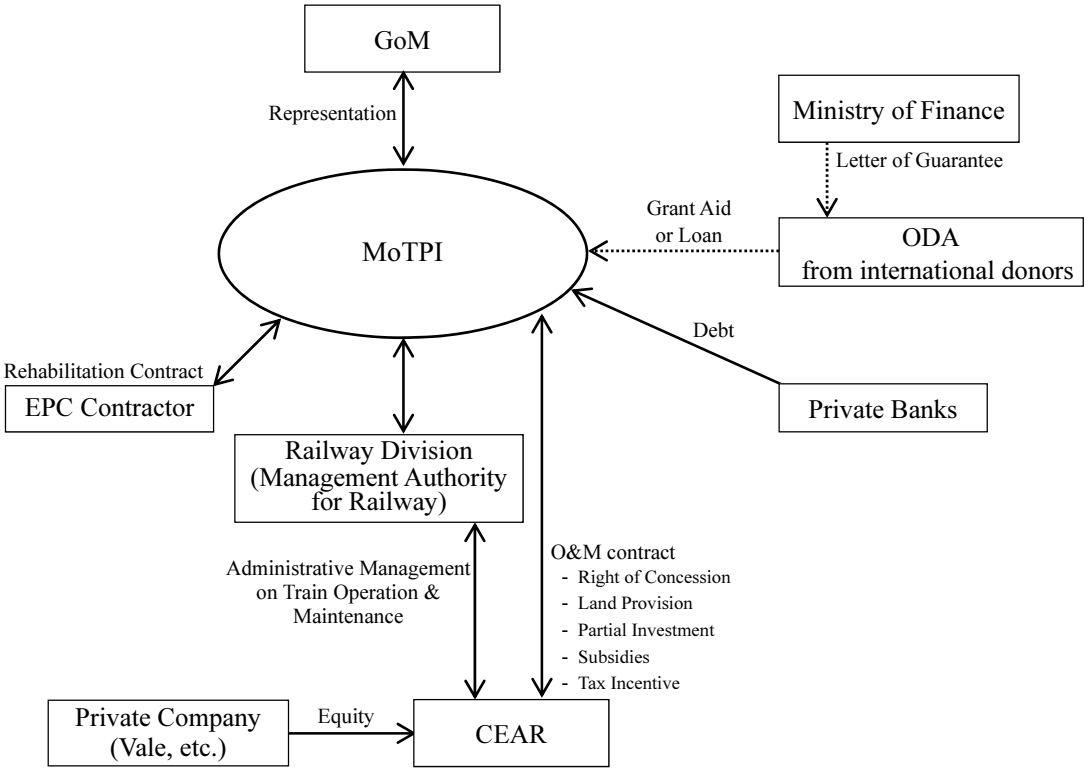
(6) Examination of Implementing Organization

MoTPI acts as an implementing organization of the rehabilitation project. It should exchange a revised concession contract with CEAR and implement financing, EPC (engineering, purchase, and construction), and O&M (operation and maintenance) of the Branch Line of the Sena Railway. The project implementation structure of the rehabilitation is shown in Figure 11-1.

11.2.2 Tariff Policy

To decide the freight tariff, a tariff policy is required. The tariff policy should be established based on a system of definite unified principles and priorities, rules and methods of the operator regarding rolling stock, freight cars handled, and transit by freight tariff.

The main objective of the tariff policy is to preserve the balance between the operating company and service consumers, for which the following matters should be considered:



Source: Study Team

Figure 11-1 Project Implementation Structure

- To value and make reasoned decisions regarding the tariffs
- To provide a stable situation and conditions for development of the operator
- To determine an acceptable standard of tariffs for services
- To follow economically sound investment policy
- To make long-term development plans and organize the development outlook based on long-term contracts

Regarding international freight traffic, the railway administrative bodies of Malawi, Mozambique and Zambia should establish a tariff policy for such traffic, based on the following principles:

- The tariff policy on international freight traffic should be agreed once a year.
- Each railway administrative body should have the right to raise and lower the tariff rates and additional charges for transportation in its territory.
- The railway administrative bodies should try to converge their tariffs in order to optimize the share of transport cost in setting prices and to increase the competitiveness of railway transport compared to other modes.
- A committee on the tariff policy should be established. The Terms of Reference of the committee should be drawn up by the railway administrative bodies.

- The railway administrative bodies should exchange lists of forwarding companies/agencies that have signed contracts for the coming year for payment for the international transportation of goods at rates based on the tariff policy.
- The committee should be responsible for monitoring the implementation of the tariff policy by the railway administrative bodies.

11.2.3 Revision of Concession Scheme

The current concession with CEAR will expire in 2019. According to the concession agreement, both parties should discuss revision or extension of the agreement 5 years before expiration of the contract. Therefore, the discussion will start within 3 years from now.

This clause describes general matters regarding the concession to assist the revision of the concession scheme.

(1) Characteristics of Railway Concessions

From a macroeconomic perspective, Malawi faces important structural changes to maintain sustained economic growth and improve living standards. It requires more transport services to import and export products. To provide stable transport services, operation and maintenance of the railway were shifted from public to private operation by CEAR as a concession. However, this concession has not worked well.

The “Review of Selected Railway Concessions in Sub-Saharan Africa” by the WB analyses the major characteristics of railway concessions in Sub-Saharan Africa as follows:

- There is no evidence of a clear link between tariffs and rail market share. Instead, a strong correlation exists between tariff levels and commodity value.
- The threat of the transport mode shifting from rail to road limits railway operators’ ability to charge excessive tariffs to their customers.
- Increasing the competitiveness of rail appears to benefit transport users first through lower road rather than rail transport costs.
- The profitability results achieved by private rail operators in terms of net income, net cash flow and return on equity do not suggest excessive profiteering.
- Concession contracts generally contain an array of clauses designed to protect rail users against excessive market/pricing power of rail operators. However, their enforceability remains questionable due to information asymmetry between concessionaires and regulators. Weak technical and financial capacity will limit the regulator’s enforcement ability.

(2) Forms of Private-Sector Participation

There are many forms of private-sector participation (PSP) as summarized in Table 11-1. The current concession with CEAR is one form of private-sector participation.

The forms of concession are summarized as follows:

- Operation management is conducted by the private sector.

- The funds for investment are subsidised by the GoM.
- The private sector is responsible for operations, fund raising and investment.
- The operating efficiency is greatly improved.
- The private sector can receive incentives.
- Private financial institutions are attracted.

Table 11-1 Forms of Private-Sector Participation

Form	Advantages and Disadvantages
Service Contracts	- Promotes competition during bidding for service contracts - Government's risk is relatively low - Contracts of short or long duration with easy retendering if contractor fails - Well tested easy-to-implement contractual terms - Potential starting point for PSP - Can increase focus on core business - Potential for efficiency gains in the area covered by the contract
Management Contracts	- Can improve service quality - Reduced risk for the GoM - Potential first step to concession contract - Potential for setting performance standards with incentives and penalties - Allows introduction of private-sector management skills - Limited commercial risk - Can revert to in-house management or contract may be retendered if problems arise - Potential to encourage competition in bidding
Lease	- Can increase efficiency of asset management and utilization - Reduced commercial risk for the GoM - Guaranteed collection of lease revenue - Management responsibility and commercial risk transferred to private sector - Incentives for contractor to minimize costs, provide reliable services and maximize revenue collection - Increased GoM revenue
Concession	- Private-sector management of operations - Relieves government of need to invest funds - Full responsibility for operations, capital raising and investment assumed by private sector - Encourages potentially large improvements in operating efficiency - Full private-sector incentives - Attractive to private financial institutions
BOT/BOOT/BTO	- Full responsibility for operations, fund raising and investment assumed by private sector - Potentially large improvements in operating efficiency of bulk assets - Attractive to private financial institutions - Mobilizes private finance for new investments - Addresses future funding shortfalls
Divestiture	- Full responsibility for operations, capital raising and investment assumed by private sector - Attractive to private financial institutions - Addresses any funding shortfall - Could be successful where there is a good track record of private-sector ownership - Mobilizes private finance for key investments

Source: Best Practices for Private Sector Investment in Railway, AfDB and WB

(3) Problems and Issues of Current Concession

The problems and issues in the current concession between MoTPI and CEAR are as summarized in Table 11-2. These matters should be considered in the course of discussing the concession revision work.

Table 11-2 Problems and Issues in the Current Concession

Problems and Issues	Description	Problems and Issues of Current Concession
Unprofitable passenger services for remote regions	The GoM should provide unprofitable passenger services for remote regions through the public service obligation (PSO).	CEAR operates a passenger train weekly by PSO, but it does not meet the demand and is not profitable for CEAR.
Insufficient rolling stock	Concessionaire is using old assets transferred from the public entity.	CEAR does not have enough funds to procure new rolling stock.
Restriction on revision of tariffs	Often prices do have to increase because the revision of tariffs is restricted by the concession agreement.	CEAR cannot set competitive tariffs against road transport without approval from the GoM.
Operation faces financial difficulty due to lower than expected income or other external factors	The GoM should be prepared to step in and assist, if the financial viability of the concessionaire is threatened due to reasons beyond the private company's control. As a general rule, however, the government should avoid assuming commercial risks.	CEAR is not profitable due to external factors such as frequent washaways. The GoM should be responsible for the maintenance of infrastructure.
Staff capability	The private company should select and hire capable staff from the public entity when it begins the concession.	CEAR faces insufficient staff capability. A staff training system should be established.
Investment needs are too large to be borne by one private company	The GoM should assist with financing for rehabilitation and maintenance.	The deteriorated infrastructure influences the freight operation by CEAR. The rehabilitation cost should be borne partially by the GoM.
Separation of regulator from the operator	Regulation and oversight must be kept as a public function with operations transferred to the private sector.	The GoM’s regulatory functions do not work well.
Separation of infrastructure from operations	For small railways with light traffic density, the preoccupation with infrastructure and operating units appears to be misplaced.	The large-scale repair of infrastructure is ambiguous in the concession agreement. The agreement should be reviewed.
Rail reform is a continuous process	The GoM needs to establish mechanisms to ensure proper industry governance and supervision, to review and approve challenging business plans, monitor achievements and take action to hold management accountable for performance.	The GoM is not managing the concessionaire.
Inconsistent GoM policy	The GoM must avoid changes in policy which are inconsistent with the previous policy under which PSP was implemented.	The GoM does not have any concrete policy for railway development.

Source: Study Team

CHAPTER 12

CAPACITY DEVELOPMENT PROGRAMME

Chapter 12 Capacity Development Programme

12.1 Capacity Development Programme in the Study

The Study consists of a comprehensive transport master plan covering the road, railway and inland waterway sub-sectors and a pre-F/S of selected priority projects in the Southern Region of Malawi and Mozambique. Personnel in the executing agency, MoTPI, and other related agencies have had limited experience of being involved in the preparation of transport master plans in the past and it was desirable for them to learn the process of formulating a transport master plan and understanding its contents for implementation in the near future.

The Study Team planned a capacity development programme in order to improve the skills of counterpart personnel in related agencies in preparing a transport master plan and conducting a pre-F/S of selected priority projects to improve the roads and railways in the Study Area.

Capacity development was planned to be carried out mainly through on-the-job (OJT) training while Japanese experts were carrying out their studies in Malawi. The main activities of the capacity development programme are as follows:

- Accompanying field surveys
- Discussion in the Working Group meetings
- Peer review of draft reports
- Preparation of materials for technology transfer seminars
- Presentation at technology transfer seminars

In addition to the capacity development in the Study, JICA selected one counterpart personnel for one of the Training and Dialogue Programmes entitled “National and Regional Development Policy” which was carried out in Japan and Malawi between August 2011 and January 2012 with the Core Phase conducted in Japan from September to October 2011. This programme was designed to give participating government officers lectures on practical planning methods and management capacity, so that they could plan national and regional development policies or schemes useful for regional development in their countries in an appropriate manner according to particular social situations.

Since the commencement of the Study in October 2010, the following capacity development activities have been performed with the active involvement of counterpart personnel to improve their skills.

- Accompanying Study Team members of respective fields to assist supervision of the road inventory survey, railway inventory survey, traffic survey, logistics survey and field observation for social and environmental considerations carried out by local consultants (November 2010 to February 2011)
- Discussion in the Working Group Meeting for road and railway planning, hydrological analyses, traffic demand forecasting, and environmental and social considerations (first

meeting on 2nd November 2010, second meeting on 25th November 2010, third meeting on 21st January 2011, fourth meeting on 9th June 2011, fifth meeting on 14th December 2011)

- Peer review of draft of the Progress Report, the Interim Report and the Draft Final Report by counterparts of road planning, road design, railway planning, and social and environmental considerations (March, September and December 2011)
- Preparation of materials for the first and second technology transfer seminars by counterparts of road planning and railway planning (March and October 2011)
- Presentation at the first technology transfer seminars by two counterpart personnel on the following contents (15th April 2011 at Lilongwe and 18th April 2011 at Blantyre):
  - Present situation of the road network in the Study Area (Counterpart of road planning)
  - From a perspective of railways (Counterpart of railway planning)
- Presentation at the second technology transfer seminars by three counterpart personnel on the following contents (26th October 2011 at Lilongwe and 28th October 2011 at Blantyre):
  - Development of the road network in the Study Area (Counterpart of road planning)
  - From a perspective of railways (Counterpart of railway planning)
  - Environmental and social considerations (Counterpart of environmental and social considerations)
- Presentation at the third technology transfer seminars by three counterpart personnel on the following contents (24th January 2012 at Lilongwe and 26th January 2012 at Blantyre):
  - Pre-F/S on Reconstruction of S151 Road between Makhanga and Bangula (Counterpart of road planning)
  - Pre-F/S on Rehabilitation/Reconstruction of the Railway between Limbe and Border (Marka) (Counterpart of railway planning)
  - Initial Environmental Evaluation of Projects for Pre-F/S (Counterpart of transport planning)

Table 12-1 shows the capacity development programme in the Study.

12.2 Evaluation of Capacity Development Programme in the Study

During the course of the Study from commencement up to the end of December 2011, the following counterpart personnel actively worked together with the Study Team to improve their ability to prepare the transport master plan and pre-F/S for both the road and railway projects, even though the number of personnel in the executing agencies is limited and they have their existing duties.

- Railway Planning: Controller of Rail Transport Services, MoTPI
- Transport Planning: Transport Economist of Planning Dept. MoTPI
- Road Planning: Civil engineer of Road Dept. MoTPI
- Economic Evaluation: Transport Specialist, RA
- Bridge Planning: Senior Engineer, RA

- Environmental and Social Considerations: Environmental Specialist, RA

These counterpart personnel have their own knowledge and experience in their own specialities. Even as part-time counterparts, their ability to prepare the transport master plan and pre-F/S for both the road and railway projects has definitely been improved, particularly the process of study carried out by JICA through OJT, such as transport network formulation based on basic concept of regional development potentials and transport redundancy point of view, and preparation/presentation in technology transfer seminars.

In order to secure the sustainability of capacity development in MoTPI and other agencies, it is recommended to assign one transport specialist (engineer) in MoTPI.

Table 12-1 Capacity Development Programme in the Study

Study Activity	2010		2011												2012	
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Traffic Demand Forecast																
Regional Development																
Bridge Study																
Environmental and Social Consideration																
Railway Study																
Economic and Financial Analyses																
Hydrological Study																
Road Planning Study																
Preparation for Seminar																
Working Group Meeting																

Source: Study Team

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

Chapter 13 Conclusions and Recommendations

13.1 Conclusions

Conclusions for the Master Plan of Development of the Sena Corridor and the Pre-F/S of projects selected in the Master Plan are as follows:

- The Basic Policy for development of the Sena Corridor is proposed in line with the national development policy for sustainable economic growth and poverty alleviation in three main areas: Southeastern Africa, Malawi and the Study Area.
- Based on the Basic Policy, development of the Sena Corridor is examined in terms of the international north-south axis, the domestic north-south axis and arterial transport networks in the study area, and then the targeted international transport corridor and arterial transport network in the study area are identified. The development of transport infrastructure in Mozambique is defined as an external factor and it is assumed that both the road and railway will be developed up to 2030.
- Master Plans for the road and railway sectors are proposed divided into three terms, i.e. short-term (2015), medium-term (2020) and long-term (2030), followed by the Development Concept and Strategy for both sectors. Among the three alternatives, the entire transport network including both the road and railway connecting to Beira Port is evaluated as the most desirable for the Master Plan in terms of economic evaluation (EIRR=17.1%), environmental impact and transportation.
- The proposed projects for the Master Plan in the Study, which consist of four road projects (M1, S151, S152 and D379) and three packages (railway line rehabilitation and reconstruction, procurement of rolling stock, and installation of signal and telecommunication system) of railway projects, are judged as technically and economically feasible. Hence, it is necessary to start preparing an investment programme for the Master Plan.
- The projects in the Master Plan will greatly contribute to sustainable economic growth, poverty alleviation and improvement of living conditions in the Study Area by improving access to rural growth centres from local communities, particularly from isolated communities with very limited access at present.
- These projects will also contribute to sustainable economic growth, improve the international competitiveness of export products, and strengthen the redundancy of the transport network in Malawi by improving access to ocean ports and international markets for exporting cash crops and importing fuel and fertilizer from a view point of Malawi.
- These projects will strengthen the international north-south axis in the region by creating an alternative international transport corridor to/from Beira Port from a view point of Southeastern Africa.

- The Selected road project for the Pre-F/S, i.e., ”Reconstruction of S151 Road between Makhanga and Bangula”, is judged as technically and economically feasible, based on the preliminary design for improvement of the road section between Makhnaga an Bangula, and construction of the Chiromo Road Bridge and the New Shire Bridge for the short term and medium term programme.
- The Selected railway project for the Pre-F/S, i.e., ”Rehabilitation and Reconstruction of the Railway between Limbe and Border (Marka)” is technically and economically feasible, based on the preliminary design of rehabilitation and reconstruction of railway line, including tracks and road bed, bridges, including the Chiromo Railway Bridge, installation of a signalling/telecommunication system, and procurement of rolling stock. Financial analysis results also indicate that the project will also be feasible.
- Results of IEE for both road and railway projects identified minimal negative environmental and social impact as a result of these projects.

13.2 Construction Method

(1) Construction Method

During the rainy season, the water level of rivers, including the Shire River and wadis, rises and causes flooding in some areas. Hence, it is recommended to avoid performing major earth works, pavement works and construction of bridge foundations during the rainy season.

(2) Rehabilitation of Railway Line

In rehabilitating the railway line between Limbe and Makhanga, it is necessary to secure provisional roads for rehabilitation works to transport equipment and materials. As a fact, it is not easy to construct a provisional road along the existing railway line due to the existence of many small rivers and very limited available land at certain sections. To solve this problem, it is recommended to improve some local roads connecting to villages along the railway line and to use them as provisional roads for rehabilitation of the railway line. This can also improve access to those isolated villages along the railway line.

For the rehabilitation works of the railway line, it is also recommended to install gangplanks in order to provide safe passage for pedestrians and cyclists who use the railway tracks as a path.

(3) Disposal of Construction Waste

In order to prevent pollution in rivers and lakes/ponds, mitigation measures should be strictly obeyed by contractors when disposing of construction waste located near water bodies. Therefore, either RA or CEAR should reserve land as disposal sites for construction waste and oblige contractors to transport waste to these sites.

13.3 Execution, Operation and Maintenance of the Project

13.3.1 Project Executing Agency

(1) Road Project

As Main, Secondary and Tertiary road improvements have been carried out by RA, they are the most appropriate agency to execute the Project. Since RA is a government agency, any intervention related to the Project will be done by MoTPI.

(2) Railway Project

The private concessionaire of railway operation is CEAR at present. They have a concession agreement with the GoM for the operation of trains and maintenance of track, but they have not carried out proper maintenance work due to financial difficulties. It is not clear whether there will be any investment from Vale.

Since most of the projects in the Master Plan are investment for infrastructures, the Railway Division of MoTPI should be the project executing agency. It is necessary to strengthen their function and manpower for executing projects, because the small number of staff in the division at present is not sufficient to control the many aspects of the projects.

13.3.2 Operation and Maintenance of the Projects

(1) Road Project

In order to carry out effective and adequate maintenance on the Project roads, the Study Team recommends that RA outsource O&M to private enterprises with resources from the Road Fund. The priority of periodic maintenance should be identified by using the road database system of RA.

(2) Railway Project

Under the present concession agreement, CEAR is supposed to carry out appropriate maintenance of railway track, but this is inadequate in practice because no government body has supervised CEAR's performance.

Therefore, it is strongly recommended to strengthen the authority of the Railway Division of MoTPI to supervise O&M by CEAR. It is also necessary to outsource maintenance of the railway tracks to ensure the work is done properly.

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13.4 Recommendations

Recommendations for the Master Plan of Development of the Sena Corridor and Pre-F/S of priority projects in the Master Plan are as follows:

(1) Recommendations for the Project Implementation

- The GoM will have to continue dialogs with counterparts in the GoMZ after the first dialogue in November 2011, since it is necessary to coordinate with the GoMZ for

implementing projects in the Master Plan. The main topics to be discussed are reconstruction of the branch line of the Sena Railway between *Villa Nova de Frontera* and *Dona Ana* and improvement of the secondary roads N300 and N322 between *Villa Nova de Frontera* and Caja via Mutarara.

- MoTPI can inform the outcome of the Master Plan as well as the Pre-F/S, particularly "Reconstruction of S151 Road between Makhanga and Bangula" and "Rehabilitation and Reconstruction of Railway between Limbe and Border (Marka)", to development partners for possible assistance with project implementation.
- MoTPI should carry out the F/S of priority projects identified as feasible under the Pre-F/S at an early stage. Also, MoTPI should carry out a full-scale EIA, including public consultations, during the course of the F/S for both the road and railway projects.
- MoTPI should allocate sufficient budget to the compensation for resettlement and land acquisition necessary for executing the projects based on the results of the F/S.

(2) Recommendations for the Institutional Arrangements

- RA can consider changing the classification of S151 to "Main Road" after the completion of upgrading to create complete arterial network in the Study Area.
- MoTPI needs to secure adequate budget for operation and maintenance of the road sub-sector to maximise the use of existing road assets, including M1 between Blantyre and Marka, S151 between Thyolo and Bangula, S152 between Thabwa and Seven, and S136 between Chikwawa and Muwanza.
- MoTPI needs to strengthen the organisation of the Railway Division (increase number of staff from two at present) in the and develop capacity of personnel (to train newly appointed or young staff to give them knowledge of railway management, operation and maintenance), and revise Railway Act to supervise and check the performance of CEAR.
- MoTPI will have to review the present concession with CEAR starting from 2014. The past performance of CEAR in management and operation of railway lines in Malawi will require carefully checking.