No.

Dar es Salaam City Council

The United Republic of Tanzania

Dar es Salaam

Transport Policy and System Development

Master Plan

Pre-Feasibility Study Report

Vol. II　Tazara Intersection Improvement Project

June 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

PACIFIC CONSULTANTS INTERNATIONAL

CONSTRUCTION PROJECT CONSULTANTS

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Chapter 1 Project Orientation

Master Plan study has identified Tazara Intersection as being a priority location and selected as one of the Pre Feasibility Study project by the stakeholder meeting. Located in the southwestern part of the city, Tazara Intersection accommodates two major trunk roads (Nyerere Road and Nelson Mandela Road), each of which carry considerable traffic volume (**Figure 1.1.1**).

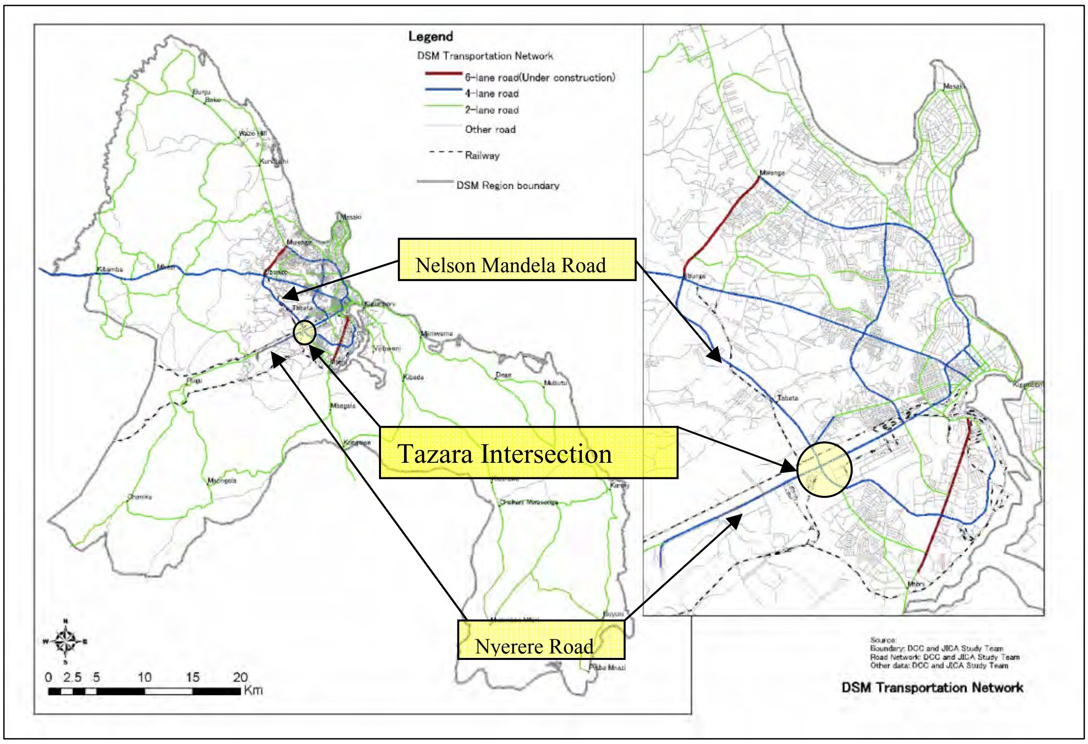
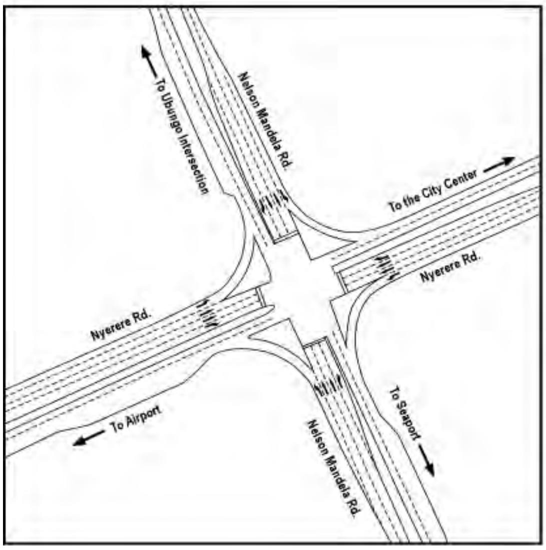


Figure 1.1.1 Location of Traza Intersection

Both facilities feature four-lane cross-sections, with right-turn bays provided on all approaches. Left-turn slip-ramps exist in all four quadrants. Intersection control is via a traffic signal based on a 120 second cycle or, during peak demand periods, intermittent police intervention (**Figure 1.1.2**).



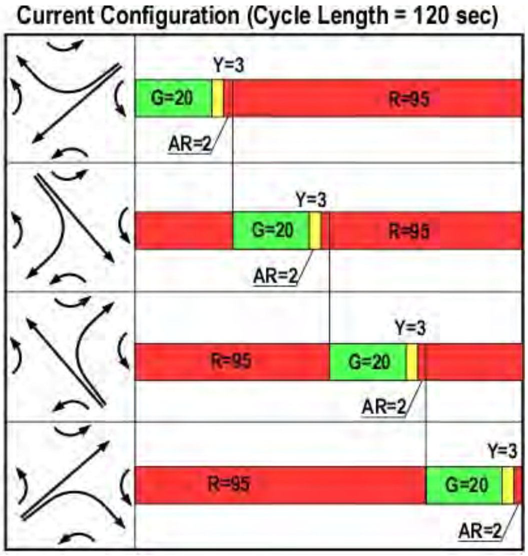


Figure 1.1.2 Current Layout and Signal Control at Tazara Intersection

(1) Road Function

The roads crossing at Tazara Intersection fulfill a variety of functions:

- Nyerere International Airport lies west of the junction; Nyerere Road is the only major road providing direct access to the airport. While the actual traffic volume to/from the airport is, vis-à-vis the daily metropolitan demand, modest, Nyerere Road is the gateway to Tanzania for many foreign visitors and dignitaries. The massive current congestion at Tazara Intersection is not conducive to forming an "initial positive image".
- Nyerere Road is flanked almost continuously by industrial activities and various companies between approximately the airport and Rashidi Kawawa Road. Thus, in addition to serving as a gateway road to central Dar es Salaam, Nyerere Road also accommodates considerable activity by light (2 or 3 axle) and heavy (more that 3 axle) commercial vehicles.
- The importance of the Nelson Mandela Road corridor to seaport cargo movement is pronounced. The *Cargo Transport Survey* conducted by the JICA Study Team during June, 2007, queried drivers at the Dar Es Salaam seaport as to a number of indicators including routing preferences: 43 percent (the largest subgroup) indicated that the preferred route of travel to/from the port is along Nelson Mandela Road. It is of further interest to note that the mix of commercial vehicles servicing the seaport consists of near 80 percent having more than three axles (that is, articulated vehicles).
- Tazara rail station is located south of the intersection; however, use is intermittent.
- Residential activity intensifies north and south of the intersection; in particular the Tabata development located to the north along Nelson Mandela Road.

Tazara Intersection is one of the few locations in Dar es Salaam where major, multi-lane traffic arteries intersect.

The characteristics of two trunk roads, which cross at the Tazara intersection, are summarized in **Table 1.1.1**.

Table 1.1.1 Salient Feature of Intersecting Roads at Tazara Intersection

Name of Road	Description	Total length with in Dar es Salaam	Effective width for one direction	Traffic volume counts in June 2007*	Average width of reserved right of way
Nyerere Road	Nyerere road is the only access road to the Dar es Salaam International Airport, connecting the city center and the airport. Along this road many industrial activities are observed. There are two important intersections on this road, namely the intersection with Nelson Mandela road and another is with Kawawa road.	10.6 km	7.0 m (3.5m x 2) Dual carriage way	28,249	45 m / 60 m
Nelson Mandela Road	Nelson Mandela road is a four-lane dual carriageway road, constructed in 1970's by German assistance. Together with the Morogoro road, this road provides access to the Dar es Salaam port. Accordingly percentage of commercial vehicles (heavy vehicles) is very high, exceeding 50% of the total traffic volume.	15.6 km	7.5m	23,887	60 m

* Showing 14 hours traffic count conducted by JICA study team

(2) Existing Land Use

The characteristic of land use at the surrounding area of the intersections is summarized as follows;

1) Tazara station

The Tazara railway station built in 1970s is adjacent to the intersection in the south. Current station activities are relatively small due to less railway operation.

2) Industrial area

In parallel to the expansion of Dar es Salaam, the light industry area has been formed along the Nyerere Road starting from Tabata, Nyerere to the Airport. This industrial area spreads around 100m from the centerline of Nyerere Road. Around the Tazara intersection, various industrial-purpose buildings have been built such as factories and transform station. There are few residential houses around the project site.

3) Tabata residential area

Between Ubungo and Tazara intersection, Tabata T intersection exists. This is the only mouth to Tabata residential area, which is recently developed, so that the congestion is common in peak hours.

4) Crossing the TRC railway and Uhuru Intersection

Nelson Mandela Road crosses TRC railway and Uhuru Street. The railway intersects at 350m north-west from the Tazara intersection. Currently there is no train operation; however, there is a possibility that rehabilitation of the railway be planned by the Government.

(3) Social Economic Condition

The Tazara intersection is administratively located at Ilala Municipality, Buguuni ward and Malapa sub-ward. According to 2002 Census, administration unit at Tazara intersection is summarized as below.

Table 1.1.2 Administration Unit related to Tazara Intersection

Administration Unit		Population	Area (ha)
Municipality	Ilala	637,600	38,300
Word	Buguruni	67,000	372
Sub-word	Malapa	26,000	98

(4) Programmed and Anticipated Improvements

Several projects have been proposed and committed which directly impact Tazara Intersection.

- Nelson Mandela Road is being improved, largely within existing alignments. The extent is from vicinity of the seaport to Morogoro Road, or approximately 16 kilometers. The existing multi-lane cross-section will be retained, but considerable enhancements of road surface, drainage and traffic control expected. The project is being sponsored by the European Commission. Completion is expected within approximately two years. Current plans at Tazara Intersection call for implementation of a high-order signal system; however, the Study Team is of the opinion that this may represent only a near to mid-term solution, and that growing traffic volumes will likely overwhelm any at-grade betterment in due course.

  Productive discussions have already been held between representatives of TANROADS, the European Commission, the Study Team and other interested stakeholders. There is growing consensus that there may well be justification for revising the current improvement project by including a flyover at Tazara Intersection.

- The issue of truck routes is becoming increasingly relevant already within the current context. The *Cargo Transport Survey*, as well as other analyses described in the previous Chapter 3 of Technical Report 2, confirmed the importance of Nelson Mandela Road and Nyerere Road as a noted choices as corridor of heavy vehicle travel. Each has important implications for cargo movement by heavy commercial vehicles. Based on these preferences, as well as reviews conducted within the framework of the Master Plan, an "immediate action" truck route was developed which includes a circumferential link (the Nelson Mandela Road belt) with radial connectors along main corridors of heavy vehicle activity: to certainly include Nyerere Road and Tazara Intersection.

The truck route network also represents an initial step towards an "inner ring road" circumnavigating the central area of Dar es Salaam. This argues that, should more advanced solutions emerge such as grade separations, that the direction of the separations be structured along the Nelson Mandela Road belt; that is, in support of circumferential routing and the truck route. The alignment of any flyovers along the belt in a consistent circumferential direction will also preclude "congestion transfer" (that is, speed and capacity benefits gained at a flyover will become liabilities at the next signalized junction encountered). The circumferential flyover alignment is also preferred to radial-direction flyovers in that the latter approach simply encourages more to/from CBD traffic; this will increasingly, and considerably, burden the numerous traffic signals located within the core area.

- The BRT bus network, to include both the on-going implementation of the Phase I system, as well as further build-out proposed by the JICA Study Team is discussed in detail beginning Chapter 10 of Technical Report 2. There are two essential considerations: location of BRT busways, consisting of dual median-sited BRT lanes plus stations; and, supporting routes outside of the busway. In the latter case, this includes regular sized buses operating in mixed traffic; thus, from a road operations point of view, do not represent a critical issue. However, the actual location of busways is of considerable interest as these directly impact, both in physical and operational terms, functioning of intersections and road segments.

The staged busway locations are noted in **Figure 5.3.6** of Technical Report 2. It is noted that the Nyerere Road BRT system is proposed in the second phase; that is, immediately following implementation of the currently committed Phase I (Morogoro Road) system. The Nyerere Road system will, in the opinion of the Study Team, be realized approximately year 2011.

As mentioned above, the European Union (EU) has committed to support the road rehabilitation project along Nelson Mandela Road. Though the tender for the works was held in early 2005, all proposals exceeded the engineering cost estimate. Accordingly, re-tendering was called in early 2007. As of now, the contractor has been nominated for the implementation. The outline of this project is summarized in **Table 1.1.3**.

Table 1.1.3 Nelson Mandela Rehabilitation Project

Item	Description
Project road length	15.6km
Time to fix the contractor	By September 2007
Expected opening date for the Works	Early January 2008
Execution Period	Main works 24months
Project Budget (Consultant, Contractor)	Euro 32Million

Source: TANROADS

Chapter 2　Project Options

2.1 Project Options

The subsection 5.3 of Technical Report 2 discusses potential project options; namely, (a) the existing situation; and, (b) a generalized grade separation concept with a flyover along the Nelson Mandela Road axis. Using the VISSIM micro simulation, some of the findings for each project option are summarized below.

(1) Existing Condition

- The initial simulation relates to current conditions; that is, four phase signal cycle, existing intersection layouts, and observed traffic volumes (**Figure 2.1.1**).

Figure 2.1.1　Queue Build-up along Nyerere Road Approaches Simulation of Existing Peak Period Condition

- The volume to capacity review (refer previous section) has already determined that existing PM peak hour conditions are saturated bordering on operational breakdown. The main intent of the VISSIM simulation is to quantify the operational conditions within the intersection as a “beginning point”; that is, benchmark parameters against which the operational conditions of other intersection layouts may be compared.

- The simulation confirms that, over a three hour PM peak period (1600-1900) some 12,900 vehicles pass through the intersection. These travel a total distance of near 29,500 kilometers for an average model boundary condition of 2.3 km per vehicle. The average travel time for passing through the modeled precinct is 3.4 minutes, to include 0.7 minute of delay. The average network speed (that is, for all movements on all approaches through and within the intersection area) was some 42 kilometers per hour.

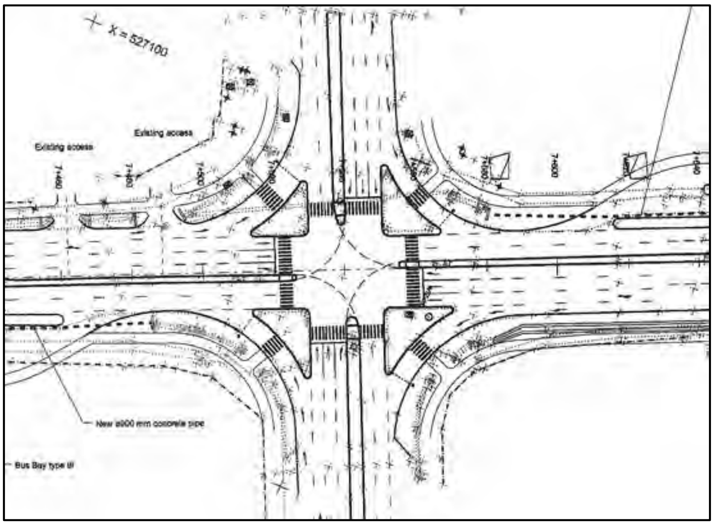
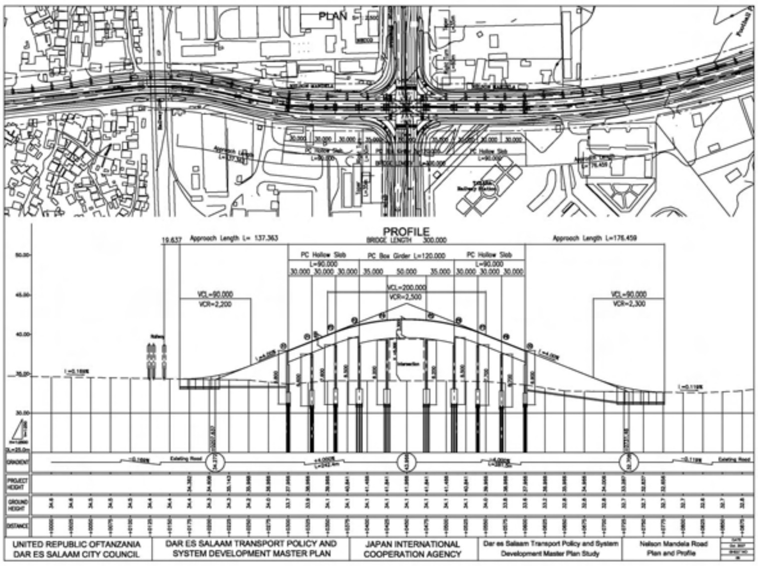
(2) Flyover Case

- The second simulation integrates a flyover facility along the Nelson Mandela Road axis (**Figure 2.1.2**).

Figure 2.1.2 Flyover Provided for Nelson Mandela Road
Simulation of Existing Peak Period Condition

- The flyover would carry “through” Nelson Mandela Road traffic in both directions; right and left turn maneuvers would continue to be carried out at-grade. Likewise, for Nyerere Road, all movements would take place at-grade, including the ultimate Phase 2 BRT. Given the removal of north-south through movements, and the requisite reallocation of signal time, considerable reserve cycle time would now be available for allocation to other movements. However, while overall intersection operations are likely to be improved at this particular junction, the solution may in fact catalyze "congestion transfer". This again reinforces the importance of viewing Nelson Mandela Road on a corridor basis, and providing systematic flyovers aligned along the Mandela belt. For example, the Ubungo Intersection discussion is consistent in that regard (refer subsection 5.2 of Technical Report 2).

- Findings of the micro-simulation confirm considerable benefits. While the average vehicle distance traveled through the modeled area remains identical to the existing case (2.3 kilometers), average travel time has reduced by some 12 percent to 3.0 minutes per vehicle, average simulation speed has increased by roughly 10 percent to near 46 km/hr, and average delay per vehicle has decreased dramatically by some 40 percent to 0.4 minutes per vehicle

Current at-grade Solution • Inclusion of service roads for additional capacity and land use access. • Layout largely follows current geometric conditions. • Installation of state-of-the-art signal system. • Enhanced markings, signage, channelization, controls and geometrics. • All traffic activity at grade. • Reconstruction needed for implementation of BRT along Nyerere Road.	
Potential Flyover Solution • Compatible with concept embodied in at-grade solution • North-south traffic along Nelson Mandela Road via flyover. All other traffic activity at grade. • Enhanced markings, signage, channelization, controls and geometrics. • Installation of state-of-the-art signal system. • Optimum positioning of right-turn lanes under flyover to minimize space. • Compatible with provision of future BRT along Nyerere Rd	

Source: JICA Study Team

Figure 2.1.3 Overview of Current At-grade and Flyover Solutions at Tazara Intersection

The subsection 5.3 of Technical Report 2, from the viewpoints of the traffic flow and its optimization, has confirmed the desirability of implementing a Nelson Mandela Road flyover at Nyerere Road. From the consultation with relevant stakeholders, the Study Team also suggested that the proposed Tazara Intersection flyover solution be subjected to further pre-feasibility reviews, due to the following reasons.

2.2 Design Alternatives

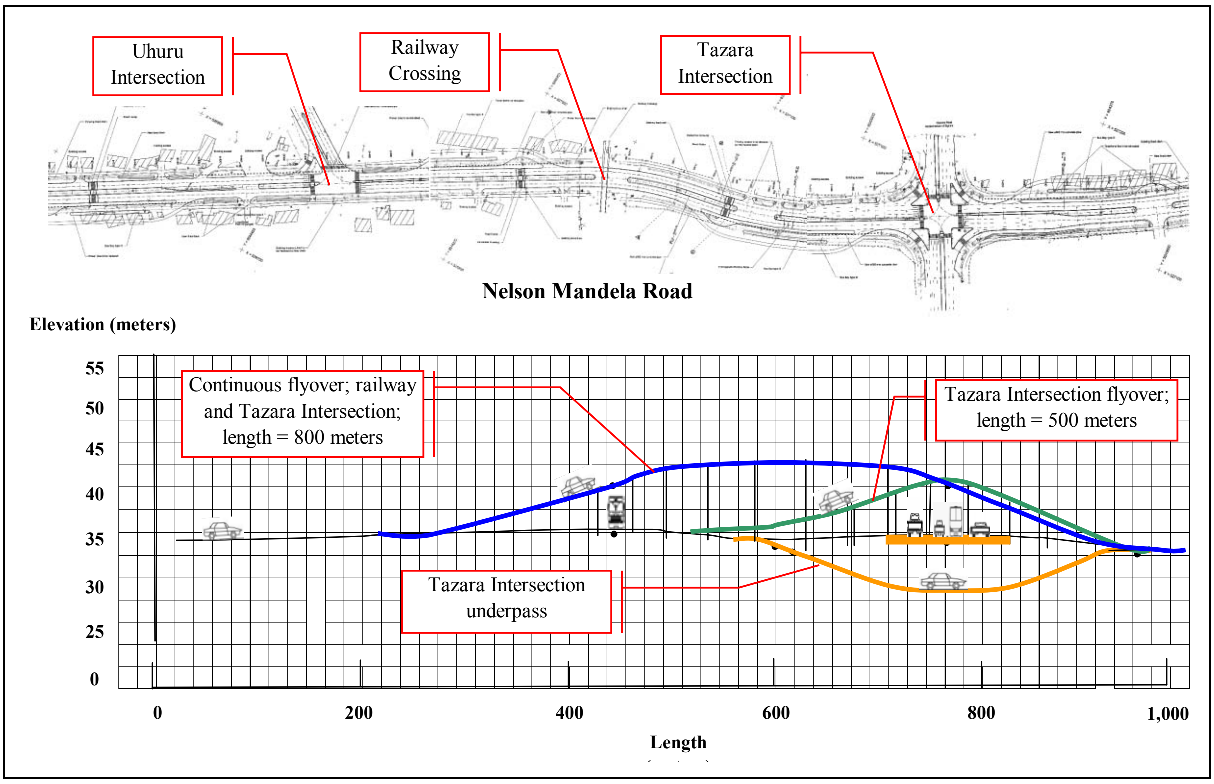
(1) Alternatives of Grade Separation

The physical crossing of Nyerere Road can take several forms; three core choices would exist at initial inspection (**Figure 2.2.1** and **Table 2.2.1**). These are:

- A continuous flyover of about 800 meters length spanning both Tazara Intersection and the nearby railway tracks. The benefits of such a structure are obvious in that traffic operations will, to certain degrees, no longer be impacted by rail operation. That is, through north-south traffic on Nelson Mandela Road; all turning movements would still occur at grade. However, at present, rail service is very intermittent and does not appear to present a major obstacle to traffic flow other than periodic inconvenience. However, in the longer term future, a BRT line has been proposed in the Tabata rail corridor and certain efficiencies for BRT would be undeniable. The main deterrent to a dual overbridging function is cost: the flyover is not only longer, but also higher, than other variants: costs are likely to escalate considerably.
- An overbridging of Tazara Intersection proper via a 500 meter flyover. The previous simulation ("flyover case") is based on such a configuration. As noted, considerable benefits already accrue to motorists with this type of flyover.
- An underpass of Tazara Intersection. While certain aesthetic benefits are undeniable (no flyover structure), three factors speak against this approach: rather high cost; a likely need for considerable relocation of public utilities; and, a need for mechanical pumping during the rainy season.

Accordingly, it is the opinion of the JICA Study Team the most appropriate course of action at this location is construction of an approximately 500 meter flyover bridging Tazara Intersection proper.

Previous discussions with stakeholders confirm the desirability of this solution.



Source: JICA Study Team

Figure 2.2.1 Potential Alternative Configurations Nelson Mandela Road Crossing of Nyerere Road

Table 2.2.1 Comparison of Grade Separation Alternatives

Items	Continuous 800m Flyover	Tazara Intersection Flyover	Underpass
Cost	Considerably large	Relatively small	Large
Maintenance	Easy	Easy	Frequently needed
Construction Period	Long	Short	Relatively short
Construction Method	Relatively simple	Simple	Complex
Landscape	Not good	Relatively good	good
Evaluation in Total		Recommended	

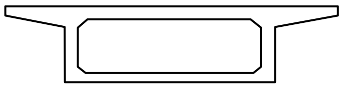
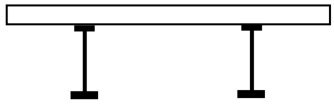
(2) Superstructure Type

In order to secure required space of the at grade intersection under the flyover, 50 m of span length is required. **Table2.2.2** shows the comparison of two types of superstructure, namely (i) PC box girder and (ii) Steel I girder as generally selected superstructure types for 50 m span length.

As the result of comparison, PC box girder is selected considering cost efficiency, easy maintenance, good aesthetic view and procurement of construction material.

PC hollow slab is selected for the approach portion (span length: 35m) from the viewpoints of reasonable cost, short construction period, easy maintenance and good aesthetic view.

Table 2.2.2 Type of Superstructure

Type of Superstructure	PC box girder	Steel I girder
Image		
Cost	Cheaper than Steel I girder	Very High
Construction Period	Long construction period on site	Short construction period on site
Maintenance	Easy maintenance	High maintenance cost is required
Aesthetic	Good aesthetic view	Poor aesthetic view
Construction in Tanzania	Major materials can be procured in Tanzania.	Steel I girder must be imported.
Evaluation	**Recommended**	

Chapter 3 Traffic Study

3.1 Existing Condition

3.1.1 Intersections Sufficiency

An insight regarding facility traffic demand can be gleaned from findings of the Master Plan traffic survey program during which traffic counts, stratified by hour, direction and vehicle type, were collected for 14 or 24 hours at some 30 sites throughout the study area[1]. Year 2007 volume information is therefore available along Nyerere Road about 500 meters west of Tazara Intersection, Nelson Mandela Road some two kilometers north of Tazara Intersection, and peak period turning movement counts at Tazara Intersection proper.

- The Nyerere Road traffic count monitored a total of 28,200 vehicles (total both directions of travel) over a 14 hour weekday period. Of that total, 15,000 (53 percent) were cars and pick ups; 7,200 (26 percent) dala dala's, 3,500 trucks (12 percent), 900 (three percent) other buses, and 1,600 (six percent) other vehicles. Highest hourly volume was observed during the hour beginning 1700, when some 2,500 two-directional vehicles passed the count station (**Figure 3.1.1**).

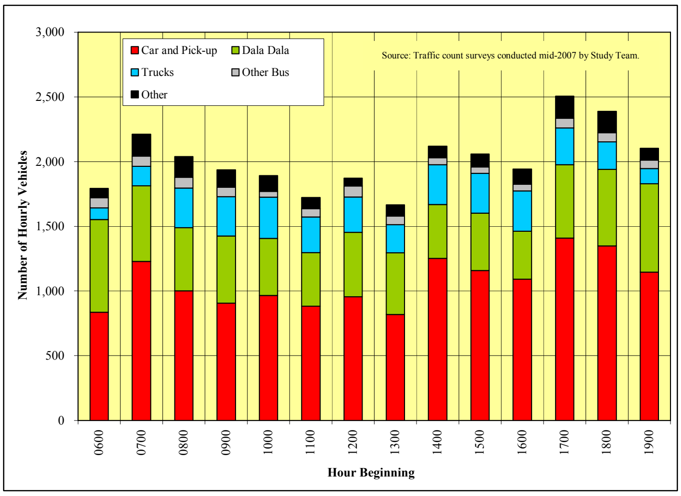


Figure 3.1.1 Hourly Traffic Volume
Nyerere Road West of Tazara Intersection

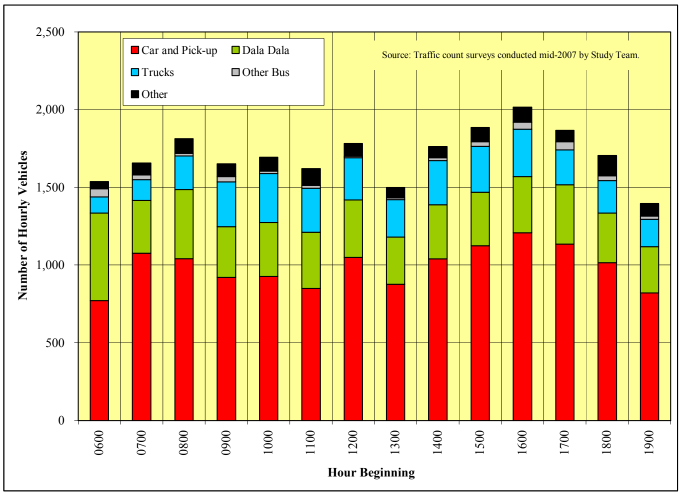
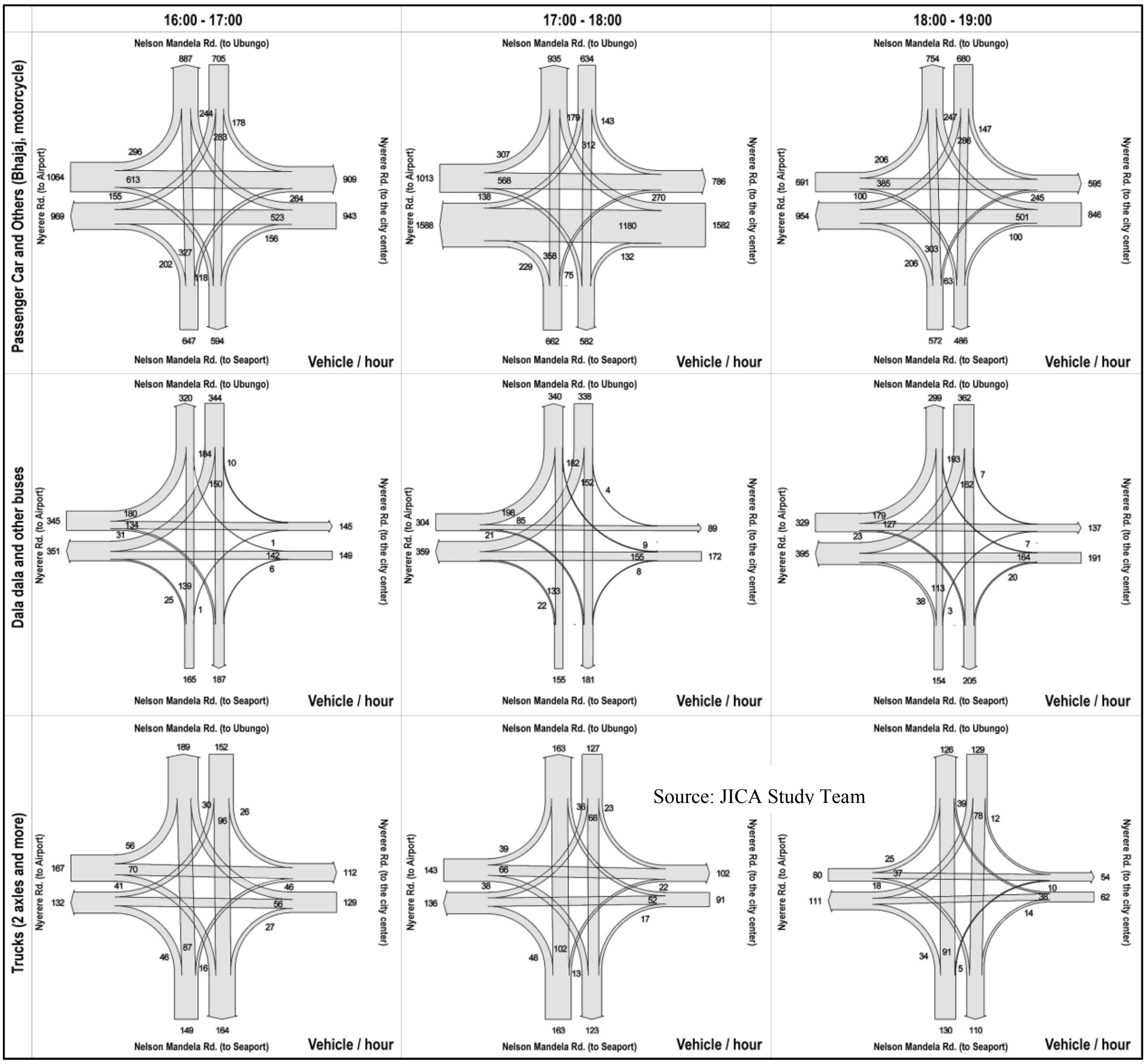


Figure 3.1.2 Hourly Traffic Volume
Nelson Mandela Road North of Tazara Intersection

[1] Refer *Technical Report Volume 6: Dar es Salaam Transport Policy and System Development Master Plan, op. cit. (Chapters 2 and 3)* for further discussion of traffic counting program and results.

- The Nelson Mandela Road traffic count monitored a total of 23,900 vehicles (total both directions of travel) over a 14 hour weekday period. Of that total, 13,900 (58 percent) were cars and pick ups; 5,100 (21 percent) dala dala's, 3,300 trucks (14 percent), 400 (two percent) other buses, and 1,200 (five percent) other vehicles. Highest hourly volume was observed during the hour beginning 1600, when some 2,000 two-directional vehicles passed the count station (**Figure 3.1.2**).



Source: JICA Study Team

Figure 3.1.3 Afternoon Peak Period Traffic Volume at Tazara Intersection

Both sets of traffic counts confirm that traffic demand is heavy during all hours of the weekday. While some peak period peaking does occur, off-peak hours continue to experience considerable traffic activity.

Turning movements during the critical afternoon peak period were reviewed by vehicle type, and on a clock hour basis (**Figure 3.1.3**). Several conclusions emerge:

- Passenger car demand is focused along Nyerere Road, particularly westbound during the hour beginning 1700 (a total of near 1,600 through cars). The main turning corridors of movement are Nyerere Road (west and east approaches) to/from Nelson Mandela Road (north approach).
- Dala dala activity mainly follows an axis linking Nyerere Road (west approach) and Nelson Mandela Road (north approach).
- Truck activity is noted on all approaches, with highest recorded volume being the north departure of Nelson Mandela Road. Truck turning volumes are also noted in all quadrants.

The Study Team utilized several approaches to evaluate the operations of the Tazara Intersection environment. These include a volume to capacity review as well as the application of VISSIM micro-simulation software.

The volume to capacity analysis relies on observed traffic movement volumes and thus represents a snapshot in time. Several conclusions emerge from this review[2] (**Table 3.1.1**):

Table 3.1.1 Tazara Intersection 2007 PM Peak Hour Sufficiency Analysis

Approach	1			2			3			4				
	Nelson Mandera			Nyerere Rd.			Nelson Mandela Rd.			Nyerere Rd.				
	From Ubungo Intersection			From City Center			From Uhasibu			From Airport				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
Basic value of saturation flow rate	1800	2000	1800	1800	2000	1800	1800	2000	1800	1800	2000	1800		
Number of lane	1	2	1	1	2	1	1	2	1	1	2	1		
Lane width (m)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
and adjustment factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Share of bus (%)	3.4%	33.8%	43.7%	3.9%	10.5%	3.0%	8.4%	24.7%	0.0%	39.0%	14.2%	11.4%		
and adjustment factor	0.99	0.94	0.92	0.99	0.98	0.99	0.98	0.95	1.00	0.93	0.97	0.98		
Share of truck (%)	12.1%	17.7%	8.2%	13.0%	3.7%	7.0%	17.5%	15.9%	12.2%	8.3%	10.3%	15.8%		
and adjustment factor	0.89	0.85	0.92	0.89	0.96	0.93	0.85	0.86	0.89	0.92	0.91	0.86		
Share of left turn (%)														
and adjustment factor														
Share of right turn (%)														
and adjustment factor														
Saturation flow ratio	1595	3184	1529	1581	3777	1672	1507	3289	1604	1541	3527	1520		
Total traffic volume (vehicle/hour)	174	464	389	154	1282	299	263	554	98	503	662	184		
- Passenger Cars	130	225	187	128	1100	269	195	329	86	265	500	134		
- Dala dala and buses	6	157	170	6	134	9	22	137	0	196	94	21		
- 2 axles Trucks	20	52	27	17	47	14	26	40	12	33	65	26		
- 3 and more axles	1	30	5	3	1	7	20	48	0	9	3	3		
- Others	23	85	16	12	56	3	31	30	6	74	46	12		
Flow ratio	0.109	0.146	0.254	0.097	0.339	0.179	0.175	0.168	0.061	0.326	0.188	0.121	λi	Σλ
Phase ratio phase1		0.146						0.168					0.168	0.941
phase2			0.254						0.061				0.254	
phase3					0.339						0.188		0.339	
phase4						0.179						0.121	0.179	
Required Green phase1		19						19						
phase2			28						28					
phase3					38						38			
phase4						20						20		
Current Cycle Length	120													
Capacity	1,595	504	357	1,581	1,196	279	1,507	521	374	1,541	1,117	253		
V/C	0.123	1.302	1.316	0.117	1.170	1.175	0.230	1.375	0.306	0.418	0.703	0.899		

Source: JICA Study Team

- Peak hour operations are very difficult to quantify given that manual control by traffic police is typically practiced. The volume to capacity review therefore approached the analysis from a slightly different perspective; that is, given observed traffic volumes, signal capabilities and geometric layout, might an optimum operations profile (in terms of intersection saturation) be possible?

[2] Approach and methodology per *Planning and Design of At-grade Intersections*, The Japan Society of Traffic Engineers, 2002.

- The peak afternoon peak hour (1645-1745 hours based on the highest four consecutive 15 minute count increments during the three hour peak period) catalyzes considerably more negative impact than the morning peak hour (0715-0815 hours). The PM peak hour is shown as achieving an unacceptable saturation rate of 0.94[3], one of the highest monitored in the study area.
- Thus, the afternoon peak hour is operating at critical levels with intersection saturation near unity. Particularly critical approaches include Nelson Mandela Road (southbound through and right; northbound through) as well as the westbound approach of Nyerere Road (through and right turn).

3.2 Travel Speed

Travel speed at Tazara intersection was also surveyed during a course of the traffic surveys conducted during the Master Plan Study. As the following figure illustrates, the average travel speed of vehicles passing Taraza intersection during the morning peak hours is recorded at 6km/h.

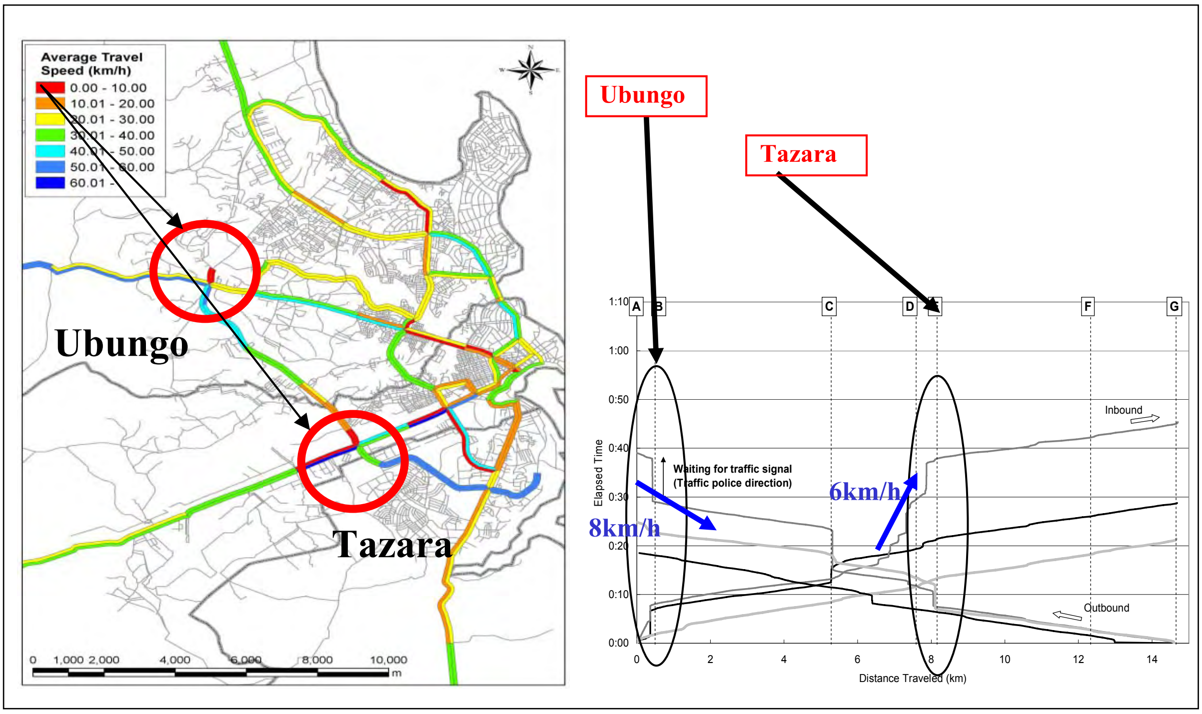
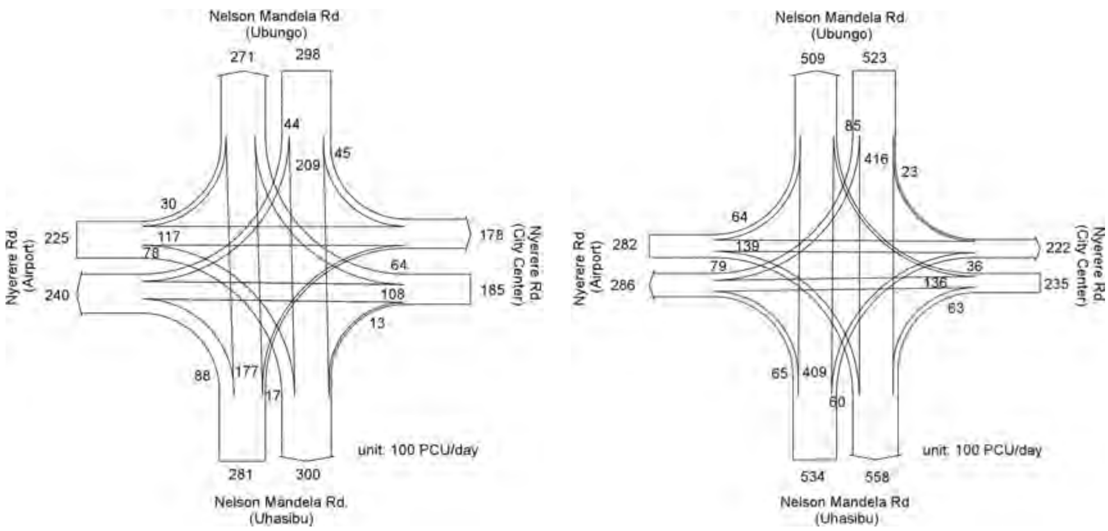


Figure 3.2.1 Average Travel Speed (AM Peak)

3 Guidelines suggest that a ratio of less than 0.85 implies acceptable intersection operation while a ratio of near unity indicates that the intersection is operating at full saturation and likely to experience unstable performance. A ratio in excess of 1.0, to say 1.4 approximately, implies intersection failure.

3.3 Future Traffic Demand

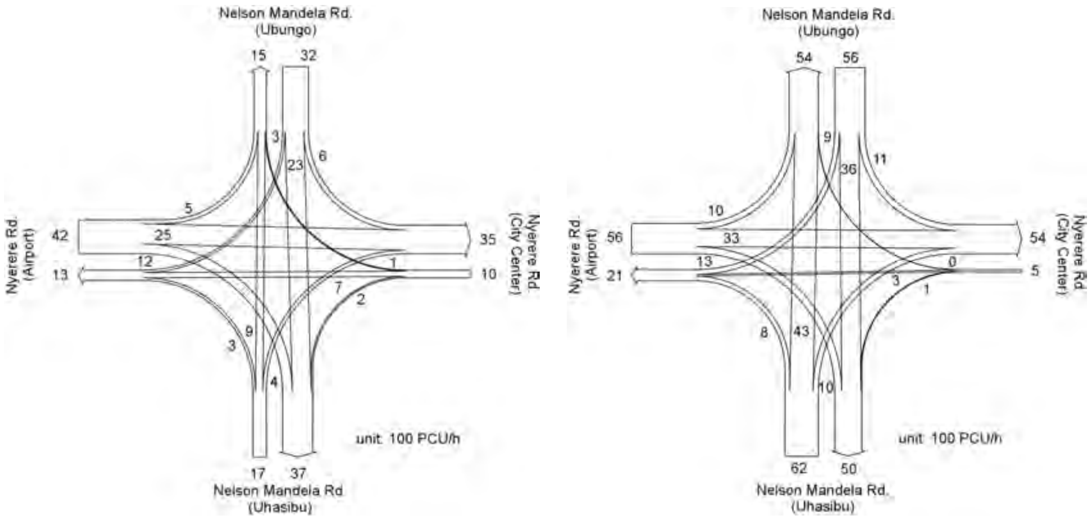
Traffic demand forecast has been prepared for the proposed master plan road network with UGB assumption for the two planning years: 2015 and 2030. Figure 3.3.1 shows the directional future daily traffic volume at Tazara intersection in 2015 and 2030. A traffic volume on Nyerere road is larger than Nelson Mandela road at present, while, in future, the traffic volume on Nelson Mandela road will be larger than that on Neyrere road due to the development in Kiganboni area. The traffic volume on Nelson Mandela road will reach at around 58,000 pcu per day in 2015 and 110,000 pcu per day in 2030, which requires at least 6-lane capacity by 2030.



Note: excluding BRT traffic volume

Figure 3.3.1 Directional Daily Traffic Demand at Tazara Intersection in 2015 (left) and 2030 (right)

Figure 3.3.2 shows the estimated AM peak 1 hour traffic demand at Tazara intersection in future. In order to develop morning peak-hour passenger car OD matrices, trips of home-to-work place and home-to-school purpose trips are extracted from the estimated daily OD matrix. The estimated peak-hour through-traffic volume on Nelson Mandela road at Tazara intersection is about 3,200 pcu per hour in 2015 and 7,900 pcu per hour in 2030, which requires at least 4-lane capacity for through-traffic.



Note: volumes include passenger car only

Figure 3.3.2 Directional AM Peak Traffic Demand at Tazara Intersection in 2015 (left) and 2030 (right)

A traffic signal system has been installed at Tazara intersection, but the system is used without fine tuning at present, while traffic polices are in charge of traffic control in the peak hours. In order to make a fair comparative analysis between the flyover option (with case) and at-grade option (without case), traffic signal timing should be optimized for by case.

Figure 3.3.3 shows the optimized signal phasing in the morning peak hour for the year 2007.

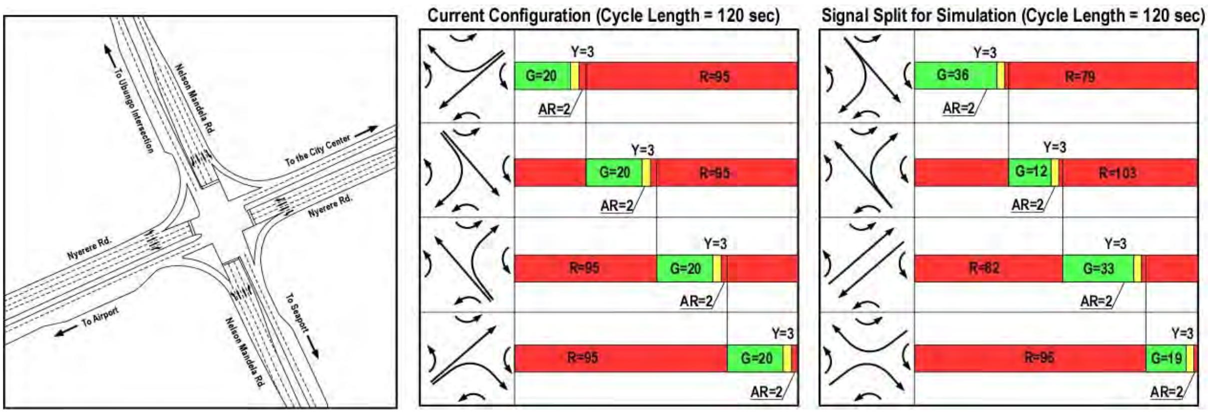


Figure 3.3.3 Current and Optimized Traffic Signal Configuration in 2007

Figure 3.3.4 shows the optimized signal timing of each case :

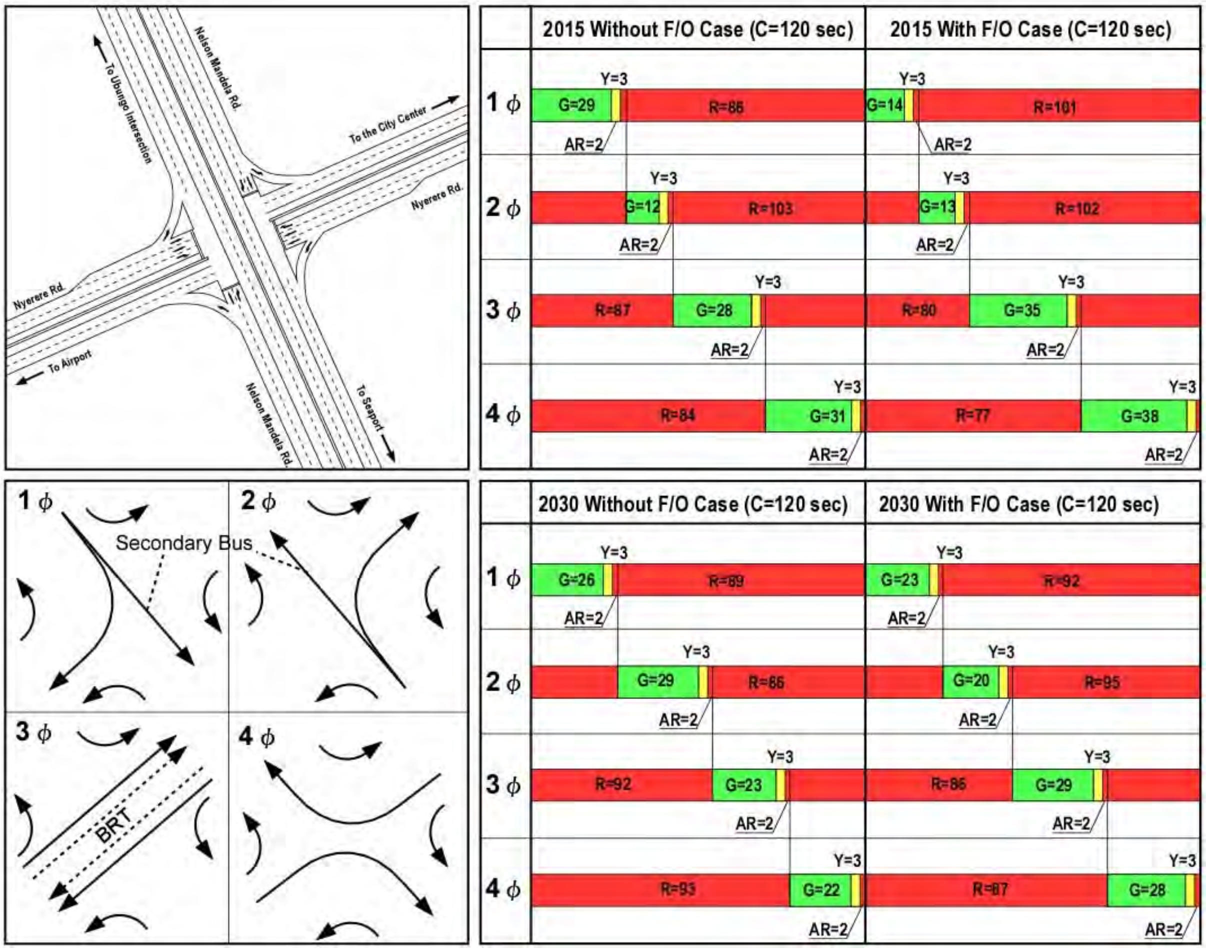


Figure 3.3.4 Current and Optimized Traffic Signal Configuration in 2007

Table 3.3.1 shows the results of microscopic simulation at Tazara intersection in the morning peak-hours (3 hours) in 2007. There are three cases presented in **Table 3.3.1**, namely 1) existing signal timing, 2) optimized signal timing, and 3) with flyover case. By optimizing the signal timing, the average travel speed within the simulated network will be improved from 33.0 km per hour to 42.2 km per hour. The total travel time on the simulated network will decrease from 908 hours during the morning peak-hours (3 hours) to 708 hours. A significant improvement is expected by optimizing the signal timing with the year 2007 traffic volume. While, there is no significant difference between the optimized signal timing case and the with flyover case with the year 2007 traffic volume, which indicates there is no need flyover at present (2007). It is actually recommended that immediate signal timing improvement should be made.

Table 3.3.1 Results of Microscopic Simulation in 2007 (AM peak 3 hours)

	Existing Signal Timing	Optimized Signal Case (Base Case)	with Fly-Over Case
Number of vehicles assigned	12,872	12,895	12,879
Total Distance Traveled (km)	30,020	29,988	30,008
Total Travel Time (h)	908	708	700
Average Network Speed (km/h)	33.04	42.37	42.86
Total Network Delay (h)	339	136	131
Average Travel Distance (km)	2.33	2.33	2.33
Ave. Travel Time (min)	4.23	3.29	3.26
Ave. Delay (min)	1.58	0.63	0.61

Source: JICA Study Team

However the flyover along Nelson Mandela road is definitely needed in near future. **Table 3.3.2** shows the results of microscopic simulation for the year 2015 and 2030. As shown in **Table 3.3.2**, the demand in 2015 will reach at the ultimate capacity of the at-grade design (without case, about 16,000 vehicular trip demand in 3 hours); while, the flyover solution will be able to accommodate additional about 5,000 vehicular traffic demand in 3 hours.

Table 3.3.2 Results of Microscopic Simulation in Future (AM peak 3 hours)

	2015 without F/O	2015 with F/O	2030 without F/O	2030 with F/O
Number of vehicles assigned during the simulation period	15,752	19,961	15,952	21,190
Total Distance Traveled (km)	37,585	47,745	38,026	50,845
Total Travel Time (h)	2,670	2,385	2,604	2,252
Average Network Speed (km/h)	14.08	20.02	14.60	22.58
Total Network Delay (h)	1,954	1,480	1,880	1,288
Average Travel Distance (km)	2.39	2.39	2.38	2.40
Ave. Travel Time (min)	10.17	7.17	9.80	6.38
Ave. Delay (min)	7.44	4.45	7.07	3.65

Note: excluding BRT

Chapter 4 Natural Condition

4.1 Topographic Condition

Tazara intersection is located about 7 km inside from the shoreline and at altitude 32 m of a wide and flat land extending toward the inland. The place is categorized into a coastal plain and/or terrace, which came out on the ground due to the marine backward during late Pleistocene of the geological era.

4.2 Hydrological Condition

(1) Rainfall

Table 4.2.1 shows information about monthly rainfall. As shown in **Table 4.2.1**, there are clearly divided into dry and rainy season. June to October is dry and March to May is rainy season respectively, the season from November to February is called as semi rainy season.

Table 4.2.1 Monthly Rainfall in Dar es Salaam

Month	Rainfall (mm per month)	Rainy day (day per month)	Season Classification
Jan	81.8	7	Semi Rainy Season
Feb	59.4	5	Semi Rainy Season
Mar	130.4	12	Rainy
Apr	263.3	19	Rainy
May	178.9	13	Rainy
Jun	37.3	5	Dry
Jul	28.8	5	Dry
Aug	26.5	4	Dry
Sep	26.1	5	Dry
Oct	60.0	6	Dry
Nov	12.8	8	Semi Rainy Season
Dec	119.6	7	Semi Rainy Season

Source : Statistical Abstract 2002, Nation Bureau of Statistics (2003)

(2) Flood

The location of Tazara Intersection is on an extensive flat land and flood never happened.

4.3 Geotechnical Condition

Tazara intersection is located at about 15 km inland from the coastal line and its geological base is uplifted coral limestone of late Pleistocene of the geological era.

Geotechnical condition of the site is shown in **Table 4.3.1**.

Table 4.3.1 Geotechnical Condition at Tazara Intersection

Boring Location	Depth(m)	Soil Type	S.P.T N-Value	Hardness Stiffness	Recommendable Foundation
Nyerere Road Near Ilala	0 to14 14 to 20	Sand Sand gravel mix	5 to 15 50 more	Medium Very Stiff	End Bearing Pile 15 m

Source: Dar es Salaam Road Development Plan JICA, 1995

As shown in **Table 4.3.1**, subsoil in this site consists of 2 layers of medium stiff sand and very stiff sand. Accordingly the very stiff sand layer of below 14 m depth is regarded as a bearing layer for pile foundation.

4.4 Particular Condition

Surface drainage of the bridge is of concern at this site. Drain water from the flyover bridge should not be allowed to spill out into other road segments of lower level. This area is characterized by its shower-like rainfall, and therefore quick drain is very necessary. Drain volume in this bridge is estimated at 720 m^3 per hour on the condition of rainfall intensity of 40 mm per hour[i].

[i] Calculation formula: Road area (18,000m^2) x Rainfall per hour (0.04 mm) = Drain volume Per hour (720 m^3).

Chapter 5 Preliminary Design

5.1 Design Standards

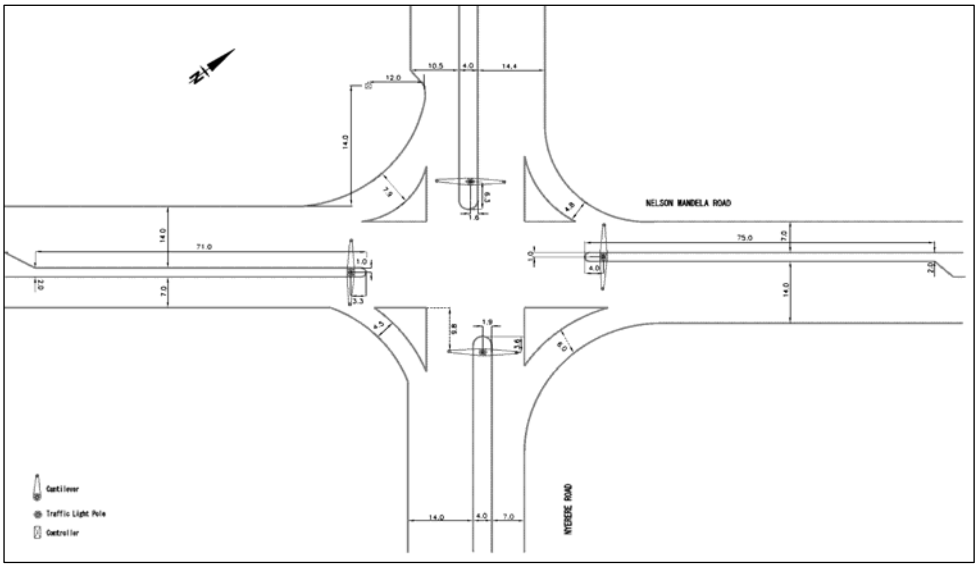
The following design standards are basically used for design of the grade separated intersection, and for reference, Japanese standards are also used.

- Standard Specification for Road Works, The United Republic of Tanzania, Ministry of Works, 2000
- Draft Code of Practice for the Geometric Design of Trunk Roads, The Southern African Transport and Communications Commission, 2001

5.2 Design Condition

The existing layout of Tazara intersection is shown in **Figure 5.2.1**.

Right-of-Way (RoW): RoW should be within 60 meters width, in which all the works should be completed.



Source: TANROADS

Figure 5.2.1 Sketch of Actual Taraza Intersection

Design Speed: 60 km per hour is employed as the design speed for the grade separation section, while 40 km per hour for the at grade section within the intersection.

5.3 Plan & Profile

As suggested in Chapter 2 of this report, a preliminary design for the short flyover option is prepared as shown in **Figure 5.3.1**. **Table 5.3.1** summarizes feature of the proposed flyover.

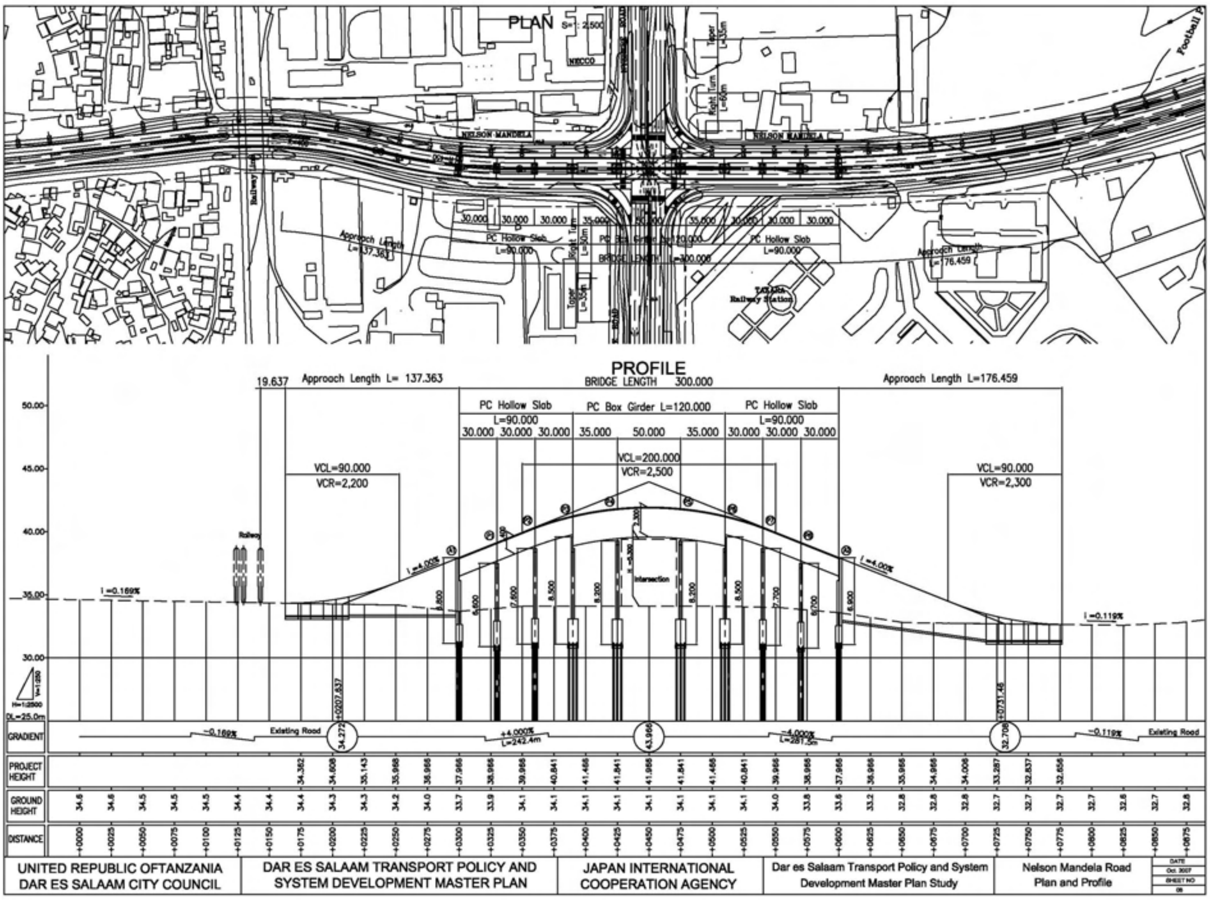


Figure 5.3.1 Plan and Profile

Table 5.3.1 Salient Feature of Taraza Flyover

Item	Description
Total length	613m
Bridge portion	300m
Approach portion	137m+176m
Type of bridge	PC box girder PC hollow slab
Girder height	2.3m for PC box girder 1.4m for PC hollow slab
Width of fly over	17.00m
Carriageway	7m+7m=14m
Median	1m
Shoulder	0.5m+0.5m=1.0m
Clearance	5.3m
Slope	4%
Span arrangement	9 spans (50m, 2@35m, 6@35m)
Type of foundation	Concrete pile foundation

5.4 Design of Structure and Pavement

As stated in “2.2 Design Alternatives”, PC box girder is employed for the road crossing section, while PC hollow slab is applied for the approach section. Detail of structure design is shown in **Figure 5.4.1**.

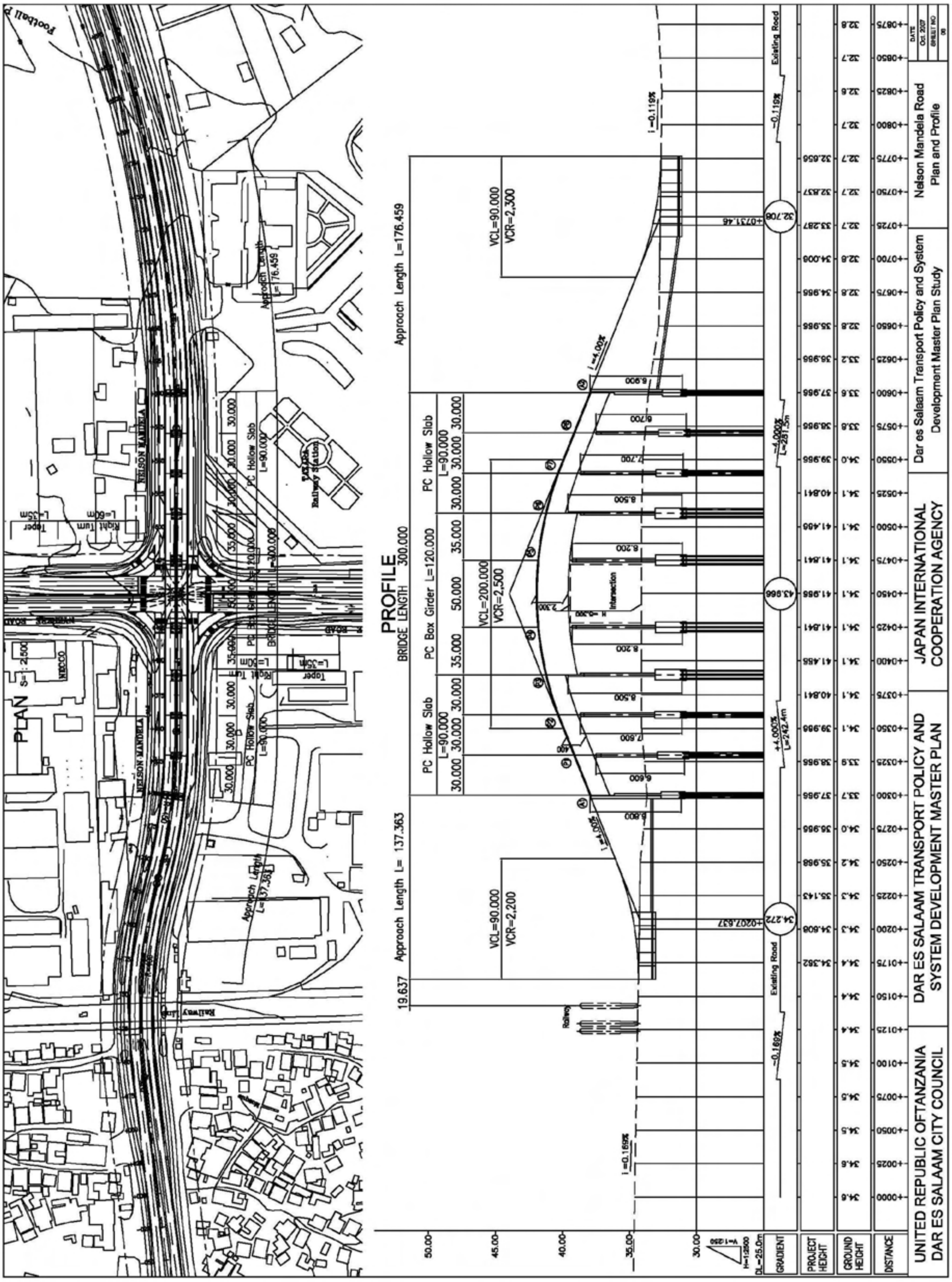


Figure 5.4.1 Detail of Structure Design

5.5 Pavement Design

The standard pavement structure in Tanzania is composed of asphalt concrete surface course, base course made of crushed stone for mechanical stabilization and sub-base course made of granular materials. The surface course and base of sidewalk is designed on the premise that no heavy vehicles pass there since the sidewalk is separated from the roadway. The pavement design shall ensure a design life of 15 years.

As per the Kilwa Road design, the pavement structure and specifications of roadway are as follows;

- Surface course: Asphalt concrete, 7 cm
- Base course: Crushed stone for mechanical stabilization, 20 cm
- Subbase course: Granular materials, 26 cm (locally available materials + cement stabilization)

As for the specifications of sidewalk are as bellows;

- Surface course: Double-layered asphalt with surface treatment (DBST)
- Base: Granular materials, 26 cm (locally available materials + cement stabilization)

Chapter 6 Construction Plan

6.1 General

This chapter presents a construction plan that is developed based on the preliminary design and several specific site conditions. To develop the plan (i) basic conditions such as workable day, construction materials, and temporary facilities, (ii) outline of the practical construction method, and (iii) construction period are examined.

This construction plan is used as a guide for the actual implementation plan development of the construction works and for the project cost estimate as well.

6.2 Basic Conditions

6.2.1 Workable day

The monthly rainfall of the Dar es Salaam City ranges from 26.1 mm to 263.3 mm (93.7 mm on average) and the annual rainfall is 1,124 mm, according to the rainfall data recorded in Statistical Abstract 2002, Nation Bureau of Statistics (2003) as mentioned in the preceding Chapter 4 Natural Condition. From this record, intensive rainfall is observed in the period between March and May with the total rainfall during this period accounting for about 55% of the annual rainfall.

Workable days for major construction works, comprising excavation works, embankment works, concrete works and pavement works are based on the daily rainfall. The suspended day due to rainfall is assumed to be the day having the rainfall of more than 10 mm/day in general. Thus, the workable day during the construction works in the Dar es Salaam City will not be much affected by rainfall except the rainy season between March and May.

6.2.2 Construction Materials

(1) Natural construction materials

As a result of the construction material survey, the construction materials used for the concrete structures, asphalt surface course, base and sub-base courses, and embankment can be obtained from the following materials sources:

Table 6.2.1 Natural Construction Material Sources

Materials	Name of Sources	Distance from the Tazara Intersection of Dar es Salaam (km)
Course Aggregate	Lugaba	150
Fine Aggregate	Mbagala	16
Coral Aggregate	Mjimwema	35
Laterite Soil for Embankment	Tuangoma	18

Source: JICA Study Team

At present the above materials are being utilized in the Kilwa road widening project.

(2) Asphalt materials

Almost all the asphalt materials are being imported from Saudi Arabia through domestic agents. Several suppliers are presently in business in Dar es Salaam City, therefore, such imported asphalt materials can be obtained from the domestic market.

(3) Cement

Cement is produced and distributed by four cement industrial companies in Tanzania. The TANGA Cement Industries Limited, located about 15 km north-west from the Kilwa road, has a production of 2,200 ton/day at full capacity. Meanwhile, the import of cement from abroad is presently limited by the Tanzanian government.

(4) Reinforcement bar

Although the reinforcement bar is being produced by six factories in Tanzania, such domestic products still have a problem on the quality control. Meanwhile, the reinforcement bar in good quality, imported from South Africa, Egypt, and Ukraine, is available in the domestic market. Selling price of the products imported is the same as the domestic products.

(5) Wood materials

Wood materials such as plywood and other timers can be obtained from the domestic market.

6.2.3 Temporary facilities

The temporary facilities for the construction works are consisted mainly of temporary buildings (i.e., contractor's office, camp, laboratory, and workshop), concrete batching plant, asphalt plant, and spoil bank. These temporary facilities can be located around the project site. The big parking area within the existing Tazara railway station is proposed as a candidate for the temporary yard.

6.3 Construction Method

The construction work is composed of the flyover bridge including approach portion and the improvement of intersection at grade. Each construction method is described hereinafter.

6.3.1 Flyover Bridge

The flyover bridge works consist of (i) construction of bridge portion with 300m length and 17 m width, and (ii) construction of approach portion with 313 m in both sides. The type of superstructure is PC box girder with 2.3 m girder height for road crossing portion and PC hollow slab with 1.4 m girder height for approach portion. Details of the design of flyover bridge are as shown in the preceding Chapter 5 Preliminary Design. The construction workflow is considered as follows:

1) Foundation piling works by cast-in-situ bored concrete pile
2) Construction works of abutments and piers including the retaining wall of approach portion
3) Embankment works within approach portion
4) Construction works of flyover bridge
5) Pavement works of road in approach portion and bridge portion

Among the above work items, flyover bridge needs to be constructed by mobilizing a skilled foreign worker/ supervisor due to the first construction works of PC box girder and PC hollow slab in Tanzania.

6.3.2 Improvement of Intersection at Grade

Major improvement work is the widening of the existing road at intersection. The construction workflow is developed in the following manner:

1) Site preparation works
2) Aggregate placement and compaction works for sub base course and base course
3) Asphalt concrete pavement works for surface course

Although the above improvement works can be conducted in parallel with the construction of flyover bridge, special attention needs to be given to the safety traffic management during the construction works.

6.4 Construction Period

The construction period is estimated taking into account the practical workflow of all the construction works. The critical path of the construction schedule is placed on the preparatory works and the construction of flyover bridge, since the improvement works of intersection at grade can be conducted in parallel with the construction of flyover bridge.

The preparatory works consist of (i) construction of the temporary buildings (i.e., contractor's office, camp, laboratory, and workshop) including water supply system, electric power supply system and telecommunication system, (ii) mobilization of the construction equipment, (iii) assembly/ installation of the concrete batching plant and asphalt plant, and (iv) order/ procurement of the imported materials. The required period for the preparatory works is estimated at three months.

The construction workflow of flyover bridge is as mentioned in the preceding Section 6.3.1. The required period for the flyover bridge is estimated at 21 months, in consideration of the actual construction schedules of similar projects.

As a result, the total construction period is estimated at 24 months (two years).

Chapter 7 Cost Estimates

7.1 General

This chapter describes the project cost estimate that is made based on the preliminary design and the construction plan. The project cost estimate is made by the unit cost estimate method in principal. The project cost consists of (i) construction cost, (ii) engineering services cost, (iii) contingency, and (iv) government administration cost including cost for house compensation and replacement of public utilities.

7.2 Basic Conditions and Assumptions

The basic conditions and assumptions of the cost estimate are as follows:

(1) The cost estimate is made in Tanzanian Shilling (Tshs) for both foreign and local currency components.

(2) The local currency component covers the costs of local labor and locally available materials such as aggregate, asphalt, cement, reinforcing bars, and fuel. The costs of imported materials, imported facilities and depreciation of construction equipment are allocated in the foreign currency component.

(3) The exchange rates as of the 2nd of October 2007 used in the cost estimate are as follows:
US$ 1.0 = Tshs 1,271.26 = Yen 116.74

(4) It has been assumed that the construction work will be undertaken by competent contractors selected through international competitive bidding (ICB).

(5) Each of the unit costs of major work items is estimated based on the cost data obtained from the Kilwa road project and other similar projects.

(6) No tax has been included in the cost estimate.

7.3 Cost Estimate Method

7.3.1 Preparatory Works

The cost for preparatory works consist mainly of (i) construction cost for the temporary buildings (i.e., contractor's office, camp, laboratory, and workshop) including water supply system, electric power system and telecommunication system, (ii) procurement cost for the furniture required for the temporary buildings, laboratory equipment, survey equipment, and (iii) transportation cost including packing for the construction equipment to be imported.

The cost for the temporary works is estimated at 7% of the total cost of the civil works.

7.3.2 Civil Works

The construction cost for each civil work is estimated by multiplying work quantity and unit cost in principal. The cost components of the breakdown of unit price comprise labor wage, material cost, equipment cost and contractor's indirect cost. Each cost component is explained as below.

(1) Labor wage

Labor wage is based on the basic daily wages in 8-hour per shift for each kind of labor. Each labor wage is shown at **Table 7.3.1**.

Table 7.3.1 Labor Wage

(Unit :Tshs)

Labor	Unit	Wage
Foreman	day	18,313
Skilled labor	day	9,572
Common labor	day	7,855
Unskilled labor	day	6,284
Operator for heavy equipment	day	17,326
Driver for light vehicle	day	16,496
Carpenter	day	14,588
Welder	day	20,199
Mechanic	day	20,951
Electrician	day	22,443

Remarks: Labor wages were based on the daily wages including social insurance, overtime, layoff allowance and retirement allowance.

(2) Material cost

As described in the preceding Section 6.2.2 Construction Materials, almost all the materials will be obtained from the domestic market. Each material cost is shown at **Table 7.3.2**.

Table 7.3.2 Material Cost

(Unit :Tshs)

Material	Unit	Unit Cost
Gasoline	liter	1,500
Diesel	liter	1,450
Portland cement	ton	213,013
Reinforcement bar	ton	1,070,531
Fine aggregate	m^3	22,443
Coarse aggregate	m^3	47,130
Cut back asphalt	ton	570,613
Straight asphalt	ton	532,572
Emulsified asphalt	liter	3,804
Plywood (thickness 4-22mm)	m^2	51,507
Timber	m^3	618,080
Wooden pile (φ8cm)	m	17,169
Wood	m^3	515,067

(3) Equipment cost

The equipment cost consists of depreciation cost, repair and maintenance cost, and annual administration cost. Almost all the equipment will be procured from abroad except for some locally available equipment. Therefore, the equipment costs on hourly or daily basis, which are calculated based on the authorized guideline prevailing in Japan, are applied in the cost estimate.

(4) Contractor's indirect cost

Overhead expenses and profits have been allocated to the unit costs of each work item. These expenses are estimated at 19% of the direct cost comprising labor wage, material cost and equipment cost.

(5) Unit cost of major work items

The unit cost of major civil works is estimated based on the cost data obtained from Kilawa road project and other similar projects. Each unit cost is shown at **Table 7.3.3**.

Table 7.3.3 Unit Cost of Major Work Items

Unit :Tshs

Work Items	Unit	Foreign Currency Portion	Local Currency Portion	Total
1. Earthwork				
Excavation,common	m3	8,686	2,171	10,857
Embankment, common	m3	13,018	3,254	16,272
2. Pavement work				
Carriageway	m2	9,323	52,829	62,152
(subbase course t=26cm, base course t=20cm, asphalt surface t=7cm)				
Shoulder	m2	3,829	21,698	25,527
(shoulder aggregate course t=26cm, DBST))				
Side walk, DBST	m2	2,054	11,637	13,691
(subbase course t=10cm, DBST)				
Median, sodding	m2	0	1,882	1,882
3. Concrete work				
Retaining wall, concrete structure	m3	77,153	308,611	385,764
4. Drainage work				
Cross drain, RC pipe, dia.= 900 mm	m	62,093	558,841	620,934
Culvert drain, RC box, 3.5 x 5.0 m	m	637,333	2,549,334	3,186,667
Ditch drain, V-shaped	m	7,595	68,351	75,945
5. Slope protection work				
Gabion mattress, h = 2.5 m	m	39,365	354,281	393,645
Retaining wall, concrete structure	m3	77,153	308,611	385,764
6. Bridge construction work				
Extradosed prestressing type	m2	4,905,030	2,102,156	7,007,185
PC box girder type	m2	2,291,447	982,049	3,273,495
PC T girder type/ hollow slab type	m2	1,570,642	673,132	2,243,774
7. Road facilities				
Bus stop, L = 500 m	no.	576,674	865,011	1,441,685
Road lighting	no.	2,242,341	1,207,414	3,449,755
Traffic signal	no.	7,012,398	779,155	7,791,553
Road information signs	no.	61,356	15,339	76,695
Lane marking, contineous line, 15 cm in width	m	66	1,256	1,322
Guard rail	m	0	426,686	426,686
Kerb stone	m	1,079	20,494	21,573

7.3.3 Engineering Services Cost

The cost for engineering service for detailed design and supervision is assumed to be 7% of the construction cost.

7.3.4 Contingency

The contingency required for the project budgeting consists of (i) physical contingency to cover unforeseen changes of physical conditions and (ii) price contingency to compensate for future price escalation. The cost for the contingency is assumed to be 10% of the construction cost.

7.3.5 Government Administration Cost

The government administration cost consists of (i) the cost for house compensation and replacement of public utilities and (ii) administration cost of the project owner. Details of the cost for house compensation and replacement of public utilities is described in the Chapter 2 Environmental Study of the Technical Report Vol. 9. The administration cost of the project owner is estimated at 1% of the construction cost.

7.4 Total Project Cost

Total project cost is estimated at Tshs 19,514 million comprising foreign currency portion of Tshs 12,310 million and local currency portion of Tshs 7,204 million and is summarized below:

Table 7.4.1 Summary of Project Cost

Unit :Tshs

Work Items	Unit	Quantity	Unit Cost		Amount		
			F.C.	L.C.	F.C.	L.C.	Total
A. Construction Cost							
1) Bridge portion							
PC hollow slab type	m2	3,060	1,570,642	673,132	4,806,164,520	2,059,783,920	6,865,948,440
PC box girder type	m2	2,040	2,291,447	982,049	4,674,551,880	2,003,379,960	6,677,931,840
2) Approach portion							
Embankment	m3	8,496	13,018	3,254	110,597,530	27,649,383	138,246,913
Retaining wall	m3	819	77,153	308,611	63,188,144	252,752,573	315,940,717
Guardrail	m	626	0	426,686	0	267,105,436	267,105,436
Shoulder	m2	313	3,829	21,698	1,198,493	6,791,459	7,989,952
Carriageway	m2	4,382	9,323	52,829	40,852,510	231,497,555	272,350,065
Median	m2	313	0	1,882	0	589,066	589,066
3) Improvement of intersection at grade							
Carriageway	m2	14,633	9,323	52,829	136,420,533	773,049,684	909,470,217
Sub-total of 1), 2) and 3)					9,832,973,610	5,622,599,036	15,455,572,646
4) Preparatory works (7% of Sub-total)					688,308,153	393,581,933	1,081,890,085
Total Construction Cost					10,521,281,763	6,016,180,969	16,537,462,731
B. Engineering Services Cost							
Detailed design & Supervision (7% of A)					736,489,723	421,132,668	1,157,622,391
C. Contingency							
Price escalation & Physical change (10% of A)					1,052,128,176	601,618,097	1,653,746,273
D. Government Administration Cost							
Cost for house compensation and replacement of public utilities					0	0	0
Administration cost (1% of A)					0	165,374,627	165,374,627
Grand Total (A + B + C + D)					12,309,899,662	7,204,306,360	19,514,206,023

7.5 Maintenance Cost

The road maintenance work is divided into two categories, i.e., (i) routine maintenance work and (ii) periodic maintenance work. The costs required for each type of maintenance work are estimated as described hereinafter.

7.5.1 Routine Maintenance Cost

The routine maintenance consists of the following three categories:

(i) Operation cost : The costs for electricity for road lighting, signal operation, etc.
(ii) Cleaning cost : The costs for cleaning the road surface, drainage facilities, traffic sign boards, etc.
(iii) Repairing cost : The costs for pavement repair, overlays, painting of road markings and safety, etc.

The average annual maintenance cost spent by the TANROADS in the past years is roughly estimated at Tshs 3,784,000 per km for a 4-lane asphalt pavement road. Therefore, the total routine maintenance cost is estimated as follows:

0.613 km with 4-lanes for Flyover + 0.613 km with 4-lanes for Intersection at grade = 1.226 km x 3,784,000 Tshs/km = 4,639,184 Tshs

7.5.2 Periodic Maintenance Cost

The pavement design for the project is made covering a life period of 15 years after completion of the project so as to reasonably reduce the initial investment. This assumes that the periodic maintenance by overlay will be made at appropriate intervals to cope with the increased traffic volume.

In this study, an overlay with 7 cm of asphalt concrete is planned to conduct at 15 years intervals after completion of the project. The required cost of the overlay is estimated as follows:

29,000 Tshs/m^2 (unit cost of the overlay) x 24,441 m^2 (total pavement area) = 708,789,000 Tshs

Chapter 8 Implementation Plan

8.1 Executing Agency

TANROADS shall be responsible for the implementation of the construction works of this project. The required house/land compensation and replacement of public utilities should be conducted by TANROADS prior to the commencement of the construction works.

8.2 Implementation Schedule

The implementation schedule is made taking into account the following stages: (i) basic design/ detailed design stage, (ii) bidding and contract, and (iii) construction schedule. The period required for the basic design/ detailed design stage and the bidding and contract is estimated at 12 months, while the total construction period is estimated at 24 months as mentioned in the preceding Section 6.4 Construction Period.

As a result, the implementation schedule is made based on the assumption that the order to commence would be issued in January of the 2nd year. The proposed implementation schedule is summarized in **Figure 8.2.1**.

Work Item	Duration	1st Year	2nd Year	3rd Year	4th Year
	(month)	2009	2010	2011	2012
1) Basic Design/ Detailed Design Stage	9.0				
2) Bidding and Contract	3.0				
3) Preparatory Works	3.0		Order to Commence		
4) Flyover (Bridge length = 250 m, Approach length = 290 m, with 4 lanes)	21.0				
5) Improvement of intersection at grade (Widening of the existing road, total length = 470 m)	6.0				

Figure 8.2.1 Proposed Implementation Schedule

8.3 Annual Disbursement Schedule

The annual disbursement schedule is made in accordance with the project cost and the proposed implementation schedule as shown in **Table 8.3.1**.

Table 8.3.1 Annual Disbursement Schedule

Description	F.C. (million Tshs)					L.C. (million Tshs)				
	2,009	2,010	2,011	2,012	Total	2,009	2,010	2,011	2,012	Total
A. Construction Cost	0	5,261	5,261	0	10,521	0	3,008	3,008	0	6,016
B. Engineering Service Cost	368	184	184	0	736	211	105	105	0	421
C. Contingency	0	526	526	0	1,052	0	301	301	0	602
D. Government Administration Cost	0	0	0	0	0	55	55	55	0	165
Total	368	5,971	5,971	0	12,310	266	3,469	3,469	0	7,204

Chapter 9 Environmental Study

9.1 Introduction

Technical site inspection was carried out in July, October and November of 2007. Based on the reviews of current reports and major findings obtained from these technical site inspections, the initial environmental examination (IEE) of the selected pre-F/S project site was carried out, and potential environmental issues associated with the implementation of a selected pre-feasibility project are summarized. Basically, the examination is carried out in the following two scenarios: i.e., (i) Do - Nothing scenario, and (ii) Do - scenario. Under Do - scenario, possible negative environmental impacts to be caused during and/after improvement works are of concern.

9.2 Initial Environmental Examination

Tazara Intersection is situated at over an arid, flat costal lowland terrain, and Tazara Railway Station is located at nearby south-west corner of this intersection. This intersection is 4-legged, signalized one, and both Nelson Mandela and Nyerere Roads, crossing each other at this point, have a wide RoW of 60 meters, respectively. Land use of surrounding environment is classified as mixed commercial/industrial area. Current traffic volume passing through this intersection is huge and severe traffic congestions sometimes occur in morning and evening peak hours (refer to **Figure 9.2.1**). As shown in **Figure 9.2.2**, there are several bus stops around this intersection, consequently, group of passengers as well as street vendors gathers around this intersection. There are roadside vegetation along both Nelson Mandela and Nyerere Roads. Within this improvement project, a flyover with the total length of 600 meters is planned along Nelson Mandela Road. Its construction is to be carried out within the current road space of Nelson Mandela Road, so no expropriation or demolition of roadside house is expected. However, a temporal use of a wide land space for the set-up of the construction yard will be required, depending on the construction plan. Currently, partial road improvement work is going on along Nelson-Mandela Road and it is highly likely that this improvement work will be extended to this Tazara intersection in the future. The engineering design of this intersection improvement project shall be compatible with this long-term Nelson Mandela Road improvement project.

No major tributary exists in the vicinity of the project route. No important flora/fauna occurs. No illegal squatter areas exist around this site. No school, church but one hospital (refer to **Figure 9.2.3**) that would prefer calm environment exists. No historical and/or cultural sites exist. **Table 9.2.1** summarizes the preliminary environmental evaluation of the Tazara Intersection Improvement Project. It is noted that evaluation results "U" (unknown), such as examination results for the air quality, noise and vibration during the operation phase, indicates that these environmental conditions highly depend on future traffic demand forecast results, road structure, in particular, pavement conditions, and/or entire road design system, that are unknown at this moment (as of December 2007). Those evaluations may be possible only when those pending issues were solved.

Table 9.2.1 Initial Environmental Examination (Tazara Intersection Improvement)

Environmental Factor	Descriptions of Impact		Do nothing	Do project
1. Air quality	Increased roadside air pollution during;	Construction	B	B
		Operation	B	U
2. Water Quality	Risk of pollution to major tributaries.		D	D
3. Soil and sedimentation	Potential for soil erosion.		D	D
	Occurrence of new sedimentation at downstream side.		D	D
4. Waste Disposal	Generation of large amounts of construction wastes.		D	B
5. Noise/Vibration	Increased roadside noise and vibration during;	Construction	B	B
		Operation	B	U
6. Ground Subsidence	Potential of large-scale consolidation due to earthwork		D	D
7. Bad smell	Potential of newly creation of bad smell.		D	D
8. Topography and Geology	Partial road inundation due to poor drainage of road surface run-off water		C	D
	Disturbance of local drainage system	Construction	C	B
		Operation	C	D
9. River bed	Disturbance to river bed condition.		D	D
10. Fauna/flora	Destruction of roadside vegetation.		D	D
	Disturbance to surrounding habitats.		D	D
11. Water Resources	Disturbance to regional groundwater flow.		D	D
12. Accidents	Potential of increased traffic accidents.		C	D
	Temporal Traffic Jam during Construction.		B	A
13 .Global warming	Increased CO_2 emission.		U	U

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Table 9.2.1 Initial Environmental Examination (Tazara Intersection Improvement: continued)

Environmental Factor	Descriptions of Impact		Do nothing	Do project
14. Involuntary Resettlement	Temporal use of land space during construction (e.g., set-up of construction yard)		D	B
	Land expropriation due to construction		D	D
	Demolition of roadside houses.		D	D
	Demolition of illegal squatters' lots.		D	D
15. Local Economy	Possible impact on local employment and livelihood (e.g., street vendors)	Construction	D	B
		Operation	D	D
16. Land use and Utilization of local Resources	Conflict with current local land use plan		D	D
	Conflict with local development plans		D	D
	Establish engineering integrity with on-going Nelson-Mandela Road improvement work.		D	A
17. Social Institutions	Possible Impact on social infrastructure and local decision-making institutions		D	D
18. Existing social infrastructures and services	Conflict with current local transport (e.g., daradara bus) system	Construction	D	B
		Operation	D	D
	Conflict with current local energy/ communication/water supply system.		D	D
19. The poor, indigenous of ethnic group	Existence of ethnic minority around the site.		D	D
20. Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.		D	D
21. Local Conflict of interests	Conflicts between regional environmental conservation and development.		D	D
22. Gender	Risk of WID-related issues		D	D
23. Children's right	Risk of illegal child labors (e.g., street vender).		D	D
24. Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.		D	D
25. Infectious Disease	Risk of Dengue, Malaria and other Insect-borne diseases for construction workers.		D	B
	Risk of HIV/AIDS		D	C

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Note: Photo taken from CBD-side along Nyerere Road

Figure 9.2.1 Tazara Intersection

Note: Daladala bus heading for airport.

Figure 9.2.2 Bus stop around Tazara Intersection

Figure 9.2.3 Hospital located at Tazara Intersection

9.3 Summary of IEE

Based on the result of IEE of the selected pre-feasibility projects, possible environmental impacts, commonly identified for this intersection improvement project, are summarized in **Table 9.3.1**. It should be noted that most of identified negative impacts to be caused by this project are evaluated as either B or C. Also, most of B evaluations are related with construction activities, which implies that those negative impacts are temporal ones. **Table 9.3.2** summarizes further detailed descriptions of each potential negative impacts for both "Do - Nothing" and "Do - Project" scenarios, identified for the selected pre-F/S projects.

Table 9.3.1 Summary of Potential Negative Impacts

	Project Name	Potential Negative Impacts					
		Do Nothing			Do Project		
		A	B	C	A	B	C
3	Tazara Intersection	0	5	4	2	9	1

Note: The evaluation summary of **Option D** (total) = Bandari-Gerezani-Sokoine (**Op. D**) + Harbor Crossing (**Op. D**)

Table 9.3.2 Breakdown of Each Potential Impacts (Tazara Intersection)

	Environmental Factors	Remarks of Possible Impacts
1	Air Quality	1. Increased roadside air quality degradation before and/or during construction 2. Future roadside air quality degradation after construction.
2	Water Quality	Less significant.
3	Soil and Sedimentation	Less significant.
4	Waste Disposal	1. Preparation of excavated soil dump site. 2. Proper treatment of industrial wastes to be generated during construction period.
5	Noise/Vibration	1. Noise and vibration before and/or during construction period. 2. Future roadside noise and vibration after construction.
6	Subsidence	Less significant.
7	Bad Smell	Less significant.
8	Topography/ Geology	1. Disturbance of local drainage system.
9	River Bed	Less significant.
10	Flora/Fauna	Less significant
11	Water Resources	Less significant.
12	Accidents	1. Potential of increased traffic accidents before and/or during construction period.
13	Global Warming	Unknown, CO_2 emission loading may be reduced.

Table 9.3.2 Summary of Possible Impacts (Tazara Intersection, continued)

	Environmental Factor	Remarks of Possible Impact
14	Involuntary Resettlement	1. Temporal use of land space during construction (e.g., set-up of construction yard).
15	Local Economy	1. Possible impact on local employment and livelihood (e.g., street vendors)
16	Land use and Utilization of local Resources	1. Establish engineering integrity with on-going Nelson-Mandela Road improvement work.
17	Social Institutions	Less significant
18	Existing social infrastructures and services	1. Conflict with current local transport (e.g., daladala bus) system during construction.
19	Poor, indigenous of ethnic group	Less significant
20	Misdistribution of benefit and damage	Less significant
21	Local Conflict of interests	Less significant
22	Gender	Less significant
23	Children's right	Less significant
24	Cultural Heritage	Less significant.
25	Infectious Disease	1. Risk of Dengue, Malaria and other Insect-borne diseases for construction workers.

Chapter10 Project Evaluation

10.1 Introduction

Traffic congestion at Tazara Intersection has brought negative social and economic impact to the society of Dar es Salaam. By improving the intersection capacity, a significant benefit generation will be expected. In order to make it sure the economic benefit of the proposed flyover construction project, a conventional economic evaluation of the project, that is, benefit cost analysis is made by comparing the with and without cases.

Financial analysis appraises the project viability from the viewpoint of the project implementation body as an independent entity, calculating actual income figures as revenue and actual figures spent as cost; while, economic analysis uses discounted cash flow analysis for cost-benefit analysis of the project from the viewpoint of national economy.

10.2 Basic Assumption

1) “With Project” and “Without Project”

While “With Project” means the situation with the implementation of the proposed flyover construction at Tazara intersection, “Without Project” stands for the situation of no such investment. The quantified economic benefits, which would be realized from the implementation of the project, include time saving of travelers including car users, public transport users, and BRT operators are defined as the difference of the vehicle travel costs (vehicle operating costs and vehicle time costs) between “With Project” and “Without Project”.

2) Implementation schedule

The total period required for the basic design/ detailed design stage and the bidding and contract is estimated at 12 months, while the total construction period is estimated at 24 months. The study assumes that the basic design work starts in January 2009 and the bidding and contract process commence in January 2010. The detail of the implementation schedule is referred to Chapter 8, Implementation Plan.

3) Project life

The evaluation period is assumed to be 30 years after the completion; i.e. from 2012 to 2041.

4) Prices

The base year for prices is 2nd of October 2007 and exchange rates are set up as follows:

US$ 1.0 = Tshs 1,271.26 = Yen 116.74

5) Discount Rate

Discount rate is set at 12 %..

10.3 Traffic Demand Forecast

As described in Chapter 3, Traffic Study, traffic demand forecast in 2007, 2015 and 2030 at Tazara Intersection are made as a consequence of the traffic analysis with VISSIM soft ware. **Table 10.2.1** summarizes the daily forecast of traffic volume from 2007 to 2041. The figures between 2007 and 2015, 2015 and 2030, and after 2030 it is assumed there will be no more growth.

Table 10.2.1 Daily Traffic Volume Forecast at Tazara Intersection

(vehicle/day)

	Daily Volume	Passenger Cars	Dala dala and buses	2 axles Trucks	3 and more axles	Others
2007	35,955	23,644	6,886	1,661	670	3,095
2015	55,757	52,291	788	1,817	861	0
2030	59,190	55,183	465	2,411	1,131	0
2041	59,190	55,183	465	2,411	1,131	0

Source: JICA Study Team

10.4 Project Costs

1) Project Costs

The project costs in terms of financial prices are estimated in the process of cost estimates, Chapter 7. **Table 7.4.1** shows the project cost and the cost for the financial analysis, in which tax has been excluded.

2) Maintenance cost

Maintenance cost composed of routine maintenance cost and periodic maintenance cost and is calculated in the process of cost estimates, Chapter 7.

3) Estimation of Economic Project Costs

For the economic analysis, all project costs (in financial price) and benefits should be valued at their opportunity cost to the economy. International prices are taken to be the most appropriate measure of opportunity cost. Price distortion intentionally caused by imposition, limited opportunity, etc needs to be adjusted.

Major types of cost for shadow pricing corrections are foreign exchange, taxes, wages and interest and shadow pricing requires large quantities of data and analysis. For this reason, Standard Conversion Factor (SCF) is used as the compatible tool to convert financial prices to economic prices. SCF allows for the general distortion between international and domestic process that is caused by import duties, taxes, subsidies and other non-price distortions to the whole economy. SCF is an index, which converts domestic prices to border prices by adjustment of the distortion of domestic prices.

In the economic analysis, all the costs are classified into the items of trade goods, non-trade goods and transfer items. It is assumed that trade goods are equivalent to the foreign currency portion aggregation of non-trade goods stands for the local currency portion. Transfer item means the portion of taxes. Calculation of SCF and the details are described in 10.1.4 Shadow Pricing section of the Chapter 10 Master Plan Evaluation of the Final Report of the Dar es Salaam Transport Policy and System Development Master Plan.

3) Economic Cost of the Project

By adjusting shadow price factors economic cost of the project is calculated as shown in **Table 10.2.2**.

Table 10.2.2 Project Cost in Economic Price

Unit :Tshs million

Work Items	Financil Cost			Economic Cost		
	F.C.	L.C.	Total	F.C.	L.C.	Total
A. Construction Cost						
1) Bridge portion, PC hollow slab type	6,675	2,861	9,536	6,675	2,486	9,161
2) Approach portion						
Embankment	151	38	189	151	33	184
Retaining wall	101	403	503	101	350	451
Guardrail	0	247	247	0	215	215
Shoulder	1	6	7	1	5	7
Carriageway	38	214	252	38	186	224
Median	0	1	1	0	1	1
3) Improvement of intersection at grade						
Carriageway	42	236	278	42	205	247
Sub-total of 1), 2) and 3)	7,008	4,007	11,014	7,008	3,482	10,489
4) Preparatory works (7% of Sub-total)	491	280	771	491	244	734
Total Construction Cost	7,498	4,287	11,785	7,498	3,725	11,223
B. Engineering Services Cost						
Detailed design & Supervision (7% of A)	525	300	825	525	261	786
C. Contingency						
Price escalation & Physical change (10% of A)	750	429	1,179	750	373	1,122
D. Government Administration Cost						
House compensation / replacement of public utili	0	0	0	0	0	0
Administration cost (1% of A)	0	118	118	0	102	102
Grand Total (A + B + C + D)	8,773	5,134	13,906	8,773	4,461	13,234

Source: JICA Study Team

10.5 Project Benefits

1) Estimation of the benefits

The benefits that could be expected by the implementation of the project are identified as follows:

Savings to those road users who use the Tazara Intersection i.e. passenger cars, Dala dala & buses, 2 axles Trucks, 3 and more axles and others on roads because of increased speed and capacity on roads

- Personal travel time Saving

2) Savings

The quantified economic benefits of saving in vehicle operating costs and saving in vehicle time costs are defined as the difference of these costs when comparing the "With Project" and "Without Project"

10.6 Result of Economic Analysis

Based on the above assumptions, economic analysis is conduced with the results in **Table 10.2.3**.

Table 10.2.3 Results of Cost Benefit Analysis

Evaluation Indicator	Result
Net Present Value (NPV) (in Tshs million, discounted at 12%)	6,000
EIRR	18.7%
B/C (discounted at 12%)	2.23

Chapter11 Recommendations

11.1 General

The importance and necessity of this Tazara intersection capacity improvement project has been confirmed by the steering committee through in-depth discussions made in the steering committee meetings. This preliminary feasibility study report strongly supports the decision of the steering committee in a numerical manner. That is, the economic viability of this project has been confirmed by the conventional benefit cost analysis: the project EIRR will reach at 18.7% which is higher than the normal time preference in those developing countries including Tanzania. Accordingly it is strongly recommended to implement the project as soon as possible because a significant social and economic loss are being generated by this congested intersection.

11.2 Project Implementation Body

As indicated in Chapter 8 of this pre-FS report, TANROADS shall be responsible for the implementation of this project. Accordingly it is highly recommended to establish a special task force team for this project in TANROADS. Responsibility of the task force will not be limited to this Tazara intersection improvement. As suggested by the Master Plan, there are several important intersections in Dar es Sallam that requires grade separated solution to improve the capacity. The task force team shall be engaged in a series of the proposed intersection improvement projects.

11.3 Environmental Impact Assessment

This preliminary feasibility study summarizes possible environmental negative impacts caused by this construction work as IEE based on the site survey. From the local perspectives[1], it is mandatory to conduct a full-scale EIA study for any road sector related development projects. Therefore, the implementing agency of this project shall be required to conduct a full-scale EIA study during the preparatory stage of the project and monitor the environmental impacts during the implementation stage. A series of environmental survey and laboratory tests were conducted during the IEE exercise,

[1] EIA - related fact-finding meeting with Dr. Sosovelo, a senior research fellow of IRC, University of Dar Es Salaam, was held during the study period of the Master Plan Study in November 2007. He is the one of the advisory committee members for the draft preparation of Tanzanian EIA, SEIA and other relevant environmental codes.

and can be used as baseline data for a full-scale EIA. The EIA-related tasks of the implementing agencies and other stakeholders are itemized in the following table.

Table 11.1 Working Items of EIA Process for the Project

Major EIA Task \ Stakeholders	NEMC	MoID/TANROADs	Communities
1. Project Registration		X	
2. TOR Development for EIA Study	X	X	
3. Public Involvement (e.g., stakeholder meeting)		X	X
4. EIA-TOR Consultation with NEMC, Preparation of EIA- TOR (Final)	X	X	
5. EIA Study		X	
6. Preparation and submission of EIA (D/F) Report		X	
7. Review of submitted EIA (D/F) Report by NEMC, Revising if necessary.	X		
8. Revising submitted EIA (D/F) and Preparation of EIA Final Report		X	
9. Preparation of RAP and EMP		X	
10. Submission of EIA Final Report		X	
11. Public Involvement (e.g., stakeholder meeting)	X		X
12. Review of EIA Final Report by NEMC	X		
13. Notice of Official Environmental Approval	X	X	
14. Environmental Monitoring during construction phase		X	

11.4 Financial Arrangement

One of the obstacles for the immediate implementation of this project is financial arrangement. As indicated in Technical Report 4: Public Finance, the current road sector's budget is very much limited and accordingly very little budget has been allocated to new construction works. Besides, the investment to the urban road sector is much more limited in comparison with those to the national trunk roads. However, towards the world city objectives proposed in the Master Plan, a strategic budgeting approach should be established for the urban transport sector. Especially as the gateway city of Tanzania, that is, budget allocation to Dar es Salaam road system should be given priority.

Within the limited financial sources and current debt situation, it is hard to expect innovative and revolutionary financial solution. However, considering the importance and urgent necessity of the project it is recommended that financial plans analyzed in chapter 10 of the main report include new revenue generation scheme to be considered urgently. Followings are summary of the plans.

1) External Sources:

As a HIPC country, the government needs to plan closely with the relevant organizations for the additional debt on the project. Considering the amortization of the existing debt and future development, it is apparent that new debt, at least some roll over, is required. In other words, without new income sources, the debtor cannot suddenly stop all the scheduled annual debt. By balancing the reduction of the existing debt and new debt, the government might seek additional funding source for the project.

2) Road Funds:

As mentioned, increase in road tax revenue is still insufficient to fulfill all the required maintenance work. However, the government is still under consideration on how to use the increased revenue of the tax. There might be a possibility that some part of the revenue to use for the new project.

3) Improvement of Tax System

As described in Chapter 9, Financing Strategy and Plan of the Draft Final Report, Tanzanian tax system has a potential to develop, though it needs huge effort and time.

4) New Revenue Generation Scheme:

Some new possible schemes were introduced in chapter 9, Financing Strategy and Plan, in the Draft Final Report. It is up to the government decision which scheme to develop for the Tazara Project.

5) Grant aid

Since the preliminary feasibility study for the Tazara Intersection Improvement Project has been conducted, which indicates preferred design, the basic design and more accurate cost estimates can be prepared in a consequent basic design stage. It is recommended for GOT to try to receive grant aid for this intersection improvement. TANROADS can prepare the grant aid application with this preliminary study for further actions immediately.