16.4 Unit Rates

16.4.1 Unit Prices of Materials, Labor and Equipment

(1) Materials

Construction materials to be imported are as follows:

- Materials to be imported from Japan:
  Reinforcement bar, explosives, structural steel, steel forms, wire mesh for gabion, traffic signal system and street lighting system
- Materials to be imported from other countries:
  Asphalt bitumen

The unit prices of these materials were estimated on the basis of CIF at Dar es Salaam and they include the inland transportation between Dar es Salaam Harbor and construction site. Table 16.1 shows the unit prices of the materials.

(2) Labor

The unit prices of labor were estimated on the basis of average daily wages applied for workers employed by international contractors at the current road construction projects in Dar es Salaam. The daily wages include an allowance for overtime.

Table 16.2 shows the average daily wage by labor classification.

(3) Equipment

The unit prices of equipment were developed using FOB price at the shipping port of foreign country (tentatively, FOB price at Tokyo Port in Japan was used). The purchasing prices of the equipment, which are used for calculating depreciation cost of equipment, are the prevailing prices in Japan as of July 1994.

The foreign currency portion of unit prices includes the depreciation cost, spare parts and consumable items cost, while the local portion includes the mechanical cost for repairs and administration expenses.

The unit prices for plant operation cost are presented in Table 16.3.

Table 16.1 Unit Cost of Major Construction Materials

Unit: Tsh.

Materials	Unit	Unit Cost
Cement	ton	60,950
Reinforcement*	ton	254,400
Fuel (Diesel)	lit	360
Petroleum (Gasoline)	lit	280
Lubricant	lit	2,000
Grease	kg	1,800
Asphalt bitumen 80/100*	ton	238,500
Bitumen emulusion MC30*	ton	307,400
Timber	m3	105,600
Plywood*	m2	6,630
Steel Plate Girder	ton	170,000
Strucutral steel*	ton	281,000
Gabion wire mesh*	kg	530
Base agggregate (selected)	m3	16,500
Hard rock (stone), ex-Quarry	m3	10,890
Grating bar, 400x700x55*	no.	69,960
Chatter bar, oneside*	no.	24,910
Traffic sign board*	no.	56,710
Concrete pipe, D450	no.	20,600
Sodding	m2	5,170
Steel circular form, D700*	m2	72,200
Metal form, 200x1500*	pc	14,310
Steel pile, D500-D800*	ton	604,200

*: Imported local

Table 16.2 Unit Cost of Labor (Wage Rate)

Unit: Tsh.

Description	Unit	Wage Rate
Foreman	Man-Day	2800
Skilled laborer	Man-Day	1700
Unskilled laborer	Man-Day	1400
Operator, light	Man-Day	2200
Operator, heavy	Man-Day	2400
Assistant operator	Man-Day	1700
Driver, dumptruck	Man-Day	2000
Driver, vehicle	Man-Day	1900
Electrician	Man-Day	2100
Mechanic	Man-Day	2300
Carpenter	Man-Day	1800
Concrete worker	Man-Day	1800
Reinforcement worker	Man-Day	2000
Masonry worker	Man-Day	1800
Pavement worker	Man-Day	1800
Welder	Man-Day	1700
Rigger	Man-Day	1700

Table 16.3 Unit Cost of Major Equipment

Unit: Tsh.

Description	Unit	Unit Cost
Bulldozer, 3-ton	hr	12,230
Bulldozer, 15-ton	hr	35,530
Bulldozer, 21-ton	hr	55,330
Backhoe, 0.6m3	hr	28,030
Tractor shovel, 2.1 m3, crawler	hr	59,840
Tractor shovel, 2.1 m3, wheeled	hr	30,540
Dumptruck, 11-ton	hr	17,770
Dumptruck, 4-ton	hr	8,290
Truck, 4-ton, with crane 2-ton	hr	11,240
Truck, 4-ton	hr	9,950
Truck crane, 20-ton	hr	33,890
Road sprinkler, 5.5-ton	hr	15,390
Motor grader, 3.1-m	hr	23,940
Macadam roller, 10-ton	hr	15,390
Tire roller, 8-20 ton	hr	16,990
Vibratating roller, 2.8-ton	hr	12,440
Asphalt finisher, 2.4-4.5m	hr	30,490
Asphalt plant, 30-ton	hr	113,000
Portable concrete plant, 0.5m3	hr	54,000
Portable crushing plant, 60 t/h	hr	458,200
Porable crushing plant, 30 t/h	hr	308,100
Truck mixer, 1.7m3	hr	13,990
Cement Stabilizer 1.7m	hr	126,930

16.4.2 Unit Costs of Major Work Items

The unit costs of equipment, materials and labor were calculated for each work item based on the construction schedule and method, local conditions, availability of local products, combination and workability of equipment, quantities of equipment, materials and labor to be used. The contractor's overhead and profit were also included in the unit costs.

Table 16.4 shows the unit costs of the major work items.

16.5 Work Quantities

Work quantities were calculated on the basis of preliminary design. A summary of the major types of work is shown in Table 16.5. Calculation of detailed quantities is presented in Appendix 16.1.

16.6 Estimated Construction Costs

The construction cost was estimated for each Project road using the July 1994 price as shown in Table 16.6. The detailed construction cost estimated by road or section is presented in Appendix 16.2.

16.7 House/Building Compensation Costs

Table 16.7 shows the estimated costs for compensation of houses/buildings and replacement of public utilities (i.e. in the local currency component). In Tanzania, private ownership of land is not allowed and thus all the land belongs to the government.

16.8 Summary of the Project Costs

Table 16.8 shows the Project costs by package including construction cost, compensation cost for houses/buildings, physical contingency and price contingency as well as the engineering costs for the detailed design and construction supervision. A summary of the Project cost by currency component is presented in Table 16.9.

Table 16.4 Unit Cost for Major Work Items

Unit : Tsh.

Description	Unit	Foreign Currency Portion	Local Currency Portion	TOTAL
1. Earthwork				
Clearing and stripping (t=70cm)	m2	1,290	70	1,360
Removal of existing pavement material (t=70cm)	m3	5,500	290	5,790
Excavation (common)	m3	4,260	220	4,480
Embankment (common)	m3	5,680	300	5,980
Sodding	m2	1,850	210	2,060
2. Strucutral work				
Concrete block wall, concrete class C, 180kg	m2	3,460	3,460	6,920
Box culvert, concrete class B, 240kg	m3	262,970	87,660	350,630
Reinforced retaining walls, concrete class A, 240kg	m3	244,190	81,400	325,590
Gravity wall, concrete class C	m3	79,690	79,690	159,380
RC hollow slab, consrete class -A	m2	522,150	174,050	696,200
Pier and Abutment, concrete class-A	m3	139,560	46,520	186,080
Steel Plate Girder,	ton	5,071,100	266,900	5,338,000
Cast in place pile (D=1,000)	m	43,240	14,410	57,650
Concrete pile (D= 450)	m	32,130	1,690	33,820
Improvement of foundation	m3	16,050	1,780	17,830
3. Drainage work				
Pipe culvert, D300	m	30,250	30,250	60,500
Pipe culvert, D600 (Type A)	m	70,120	70,120	140,240
Pipe culvert, D600 (Type B)	m	34,700	34,700	69,400
Pipe culvert, D1000	m	112,380	112,380	224,760
L-side ditch	m	13,400	13,400	26,800
U-shaped drain ditch (0.3 x 0.3m)	m	31,230	25,550	56,780
U-shaped drain ditch (0.4 x 0.5m)	m	37,520	30,690	68,210
U-shaped drain ditch (1.0 x 1.0m)	m	43,800	35,840	79,640
Side drain with stone pitching	m	10,260	8,390	18,650
Catch pit	no.	140,620	46,870	187,490
Manhole	no.	122,170	122,170	244,340
4. Pavement work				
Improved subgrade (t=1.0m)	m3	13,410	1,490	14,900
Subbase course, CBR 30%	m3	22,400	2,490	24,890
Base course, selected materials, CBR 80	m3	18,780	18,780	37,560
Base course, cement stabilized, UCS 30kg/m2	m3	22,510	2,500	25,010
Asphalt concrete Type 1 (BC t=5cm, SC t=5cm)	m2	12,350	1,370	13,720
Asphalt concrete Type 2 (BC t=10cm, SC t=5cm)	m2	18,400	2,040	20,440
Sidewalk, base course(t=10cm), asphalt surface(t=3cm)	m2	8,150	1,440	9,590
Kerb stone	m	7,250	3,900	11,150
Overlay (t=100mm)	m2	13,670	1,520	15,190
5. Miscellaneous work				
Road lighting	no.	2,692,760	299,200	2,991,960
Traffic signals	no.	2,923,680	324,850	3,248,530
Lane marking 15cm	m	390	40	430
Information signs	no.	38,320	25,540	63,860
Shelters at bus stops	no.	1,523,800	169,310	1,693,110
Bus station (Type A)	no.	117,145,000	45,357,000	162,502,000
Bus station (Type B)	no.	14,777,000	6,038,000	20,815,000
6. Other work				
Construction approach road with gravel	m2	12,280	3,070	15,350
Construction and Removal of temporary road with gravel	m2	12,280	3,070	15,350
Relocation of water mains; D 150mm - D 300mm	m	22,580	1,190	23,770
Relocation of electric lines	m	6,180	330	6,510
Relocation of telephone lines	m	5,550	290	5,840
Disposal of aboundand ships in the harbor	ton	132,170	14,690	146,860
Embankment of Existing Railway Line (TRC)	Sum	177,490,000	19,721,000	197,211,000

Table 16.5 Summary of Construction Quantities

Description	Unit	Package 1; Widening of Arterial Roads in the City Center						The Middle Ring Road					Radial Trunk Roads				Grand Total
		Ohio Road	Kivukoni Front	Sokoine Drive	Gerezani Street	Bandari Road	Total	Morocco Road	New Kigogo Road	Chang'ombe Road	Missing Link	Total	New Baga-moyo Road	Uhuru Road	Kilwa Road	Total	
1. Earthwork																	
Clearing and stripping (t=70cm)	m2					0	0	36,000	30,000	0	0	66,000	107,500		9,000	116,500	182,500
Removal of existing pavement material (t=70cm)	m3					0	0	2,400	1,250	1,000	0	4,650	3,483		1,300	4,783	9,433
Excavation (common)	m3	3,500	930	1,386	4,500	7,900	18,216	29,260	21,270	21,500	2,361	74,391	35,005	14,700	30,371	80,076	172,683
Embankment (common)	m3		23,000	6,250	3,900	33,300	66,450	29,000	27,000	7,737	12,230	75,967	79,700	3,000	27,500	110,200	252,617
Sodding	m2					6,505	6,505	740	1,100	0	3,047	4,887	31,375		20,561	51,936	63,328
2. Strucutral work																	
Concrete block wall, concrete class C, 180kg	m2		4,500	0	0	0	4,500	8,100	15,340	0	0	23,440			2,500	2,500	30,440
Box culvert, concrete class B, 240kg	m3					300	300	463	1,526	0	0	1,989	600	130	250	980	3,269
Reinforced retaining walls, concrete class A, 240kg	m3			597	430		1,027					0				0	1,027
Gravity wall, concrete class C	m3			410			410					0				0	410
RC hollow slab, consrete class -A	m2					723	723					0				0	723
Pier and Abutment, concrete class-A	m3					2,564	2,564					0				0	2,564
Steel Plate Girder	ton																
Cast in place pile (D=1,000)	m					1,140	1,140					0				0	1,140
Concrete pile (D=450)	m																
Improvement of foundation	m3						0	1,460				1,460				0	1,460
3. Drainage work																	
Pipe culvert, D300	m					116	116	289	190	416	47	942		360	34	394	1,452
Pipe culvert, D600 (Type A)	m	60	160	60			280					0	380		228	608	888
Pipe culvert, D600 (Type B)	m						0	1,550	200			1,750	439	60	150	649	2,399
Pipe culvert, D1000	m		120				120	150	200	30		380	36		48	84	584
L-side ditch	m	1,995	770	1,070	2,770	2,370	8,975					0	3,180	1,890	470	5,540	14,515
U-shaped drain ditch (0.3 x 0.3m)	m		840			380	1,220					0				0	1,220
U-shaped drain ditch (0.4 x 0.5m)	m					1,740	1,740	7,090	5,460	5,530	1,450	19,530		5,480	1,220	6,700	27,970
U-shaped drain ditch (1.0 x 1.0m)	m						0	200	400			600				0	600
Side drain with stone pitching	m						0	880	1,200			2,080	8,930		5,995	14,925	17,005
Catch pit	no.	100	47	54	139	208	548	355	274	277	73	979	160	386	85	631	2,158
Manhole	no.	6	4	6		4	20	14	14	2	14	44	178	4	80	262	326
4. Pavement work																	
Improved subgrade (t=1.0m)	m3						0	4,810	4,140	3,555	1,125	13,630	7,270	2,444	5,143	14,857	28,487
Subbase course, CBR 30%	m3	2,550	337	774	1,683	5,023	10,367	16,835	12,040	9,166	3,938	41,979	21,810	9,776	15,429	47,015	99,361
Base course, selected materials, CBR 80	m3						0					0				0	0
Base course, cement stabilized, UCS 30kg/m2	m3	1,020	135	553	1,122	3,588	6,418	12,025	10,350	8,888	2,813	34,076	14,540	7,332	12,857	34,729	75,223
Asphalt concrete Type 1 (BC t=5cm, SC t=5cm)	m2	10,200	1,346		5,610		17,156		41,400	35,550	11,250	88,200	72,700		51,430	124,130	229,486
Asphalt concrete Type 2 (BC t=10cm, SC t=5cm)	m2			2,210		14,350	16,560	48,100				48,100		24,440		24,440	89,100
Sidewalk, base course(t=10cm), asphalt surface(t=3cm)	m2	4,490	4,160	2,360	7,100	10,750	28,860	35,800	27,600	13,950	3,750	81,100	41,760	16,000	31,150	88,910	198,870
Extension of Sidewalk up to the Fish Market	m2		6,720				6,720					0				0	6,720
Kerb stone	m	2,100	1,740	1,180	2,840	4,200	12,060	7,160	5,520	5,580	1,500	19,760	8,600	10,500	6,230	25,330	57,150
Overlay (t=100mm)	m2	9,450	3,664	4,860	12,780	15,050	45,804	5,600		9,450		15,050	4,500	28,080	7,000	39,580	100,434
5. Miscellaneous work																	
Road lighting	no.	16	16	28	12	44	116	72	56	56	16	200	86	64	62	212	528
Traffic signals	no.	3	3	12	3	3	24	14	4	9		27	12	8	4	24	75
Lane marking 15cm	m	4,900	2,100	2,750	6,630	10,030	26,410	16,710	12,880	13,020	3,500	46,110	20,070	17,200	14,540	51,810	124,330
Information signs	no.	16	16	28	12	3	75	14	4	9	2	29	12	8	4	24	128
Shelters at bus stops	no.				2	2	4	8	4	2		14	8	1	7	16	34
Bus station (Type A)	no.						0	1			0	1	1	1	1	3	4
Bus station (Type B)	no.		2				2	3	2	2		7				0	9
6. Other work																	
Construction approach road with gravel	m2	210	0	110	560	860	1,740	2,260	1,730	1,250	140	5,380	3,300	1,370	3,110	7,780	14,900
Construction and Removal of temporary road with gravel	m2						0	12,530	9,660			22,190	15,050		10,900	25,950	48,140
Relocation of water mains; D 150mm - D 300mm	m	1,125	300	590	600	1,200	3,815	3,580	2,760	1,400		7,740	8,600	3,120	6,230	17,950	29,505
Relocation of electric lines	m	1,375		590	1,420	1,380	4,765	5,030	1,550	2,790		9,370	4,500	3,120	3,165	10,785	24,920
Relocation of telephone lines	m	1,125	25	890	1,700	1,300	5,040	2,200	1,000	1,300		4,500	4,400		3,315	7,715	17,255
Disposal of abondand ships in the harbor	ton		500				500					0				0	500
Embankment of Existing Railway Line (TRC)	Sum						0				1	1				0	1

Table 16.6 Summary of Construction Cost

Description	Package 1; Widening of Arterial Roads in the City Center						Package 2; The Middle Ring Road					Package 3; Radial Trunk Roads				Grand Total
	Ohio Road	Kivukoni Front	Sokoine Drive	Gerezani Street	Bandari Road	Total	Morocco Road	New Kigogo Road	Chang'ombe Road	Missing Link	Total	New Baga-moyo Road	Uhuru Road	Kilwa Road	Total	
1. Earthwork																
Clearing and stripping (t=70cm)		0			0	0	48,960,000	40,800,000			89,760,000	146,200,000		12,240,000	158,440,000	248,200,000
Removal of existing pavement material (t=70cm)		0			0	0	13,896,000	7,237,500	5,790,000		26,923,500	20,166,570		7,527,000	27,693,570	54,617,070
Excavation (common)	15,680,000	4,166,400	6,209,280	20,160,000	35,392,000	81,607,680	131,084,800	95,289,600	96,320,000	10,577,280	333,271,680	156,822,400	65,856,000	136,062,080	358,740,480	773,619,840
Embankment (common)		137,540,000	37,375,000	23,322,000	199,134,000	397,371,000	173,420,000	161,460,000	46,267,260	73,135,400	454,282,660	476,606,000	17,940,000	164,450,000	658,996,000	1,510,649,660
Sodding					13,400,300	13,400,300	1,524,400	2,266,000		6,276,820	10,067,220	64,632,500		42,355,660	106,988,160	130,455,680
2. Strucutral work																
Concrete block wall, concrete class C, 180kg		31,140,000			0	31,140,000	56,052,000	106,152,800			162,204,800			17,300,000	17,300,000	210,644,800
Box culvert, concrete class B, 240kg					105,189,000	105,189,000	162,341,690	535,061,380			697,403,070	210,378,000	45,581,900	87,657,500	343,617,400	1,146,209,470
Reinforced retaining walls, concrete class A, 240kg			194,377,230	140,003,700	0	334,380,930					0				0	334,380,930
Gravity wall, concrete class C			65,345,800		0	65,345,800					0				0	65,345,800
RC hollow slab, consrete class -A					503,352,600	503,352,600					0				0	503,352,600
Pier and Abutment, concrete class-A					548,362,680	548,362,680					0				0	548,362,680
Steel Plate Girder																
Cast in place pile (D=1,000)					65,721,000	65,721,000					0				0	65,721,000
Concrete pile (D= 450)																
Improvement of foundation					0	0	26,031,800				26,031,800				0	26,031,800
3. Drainage work																
Pipe culvert, D300					7,018,000	7,018,000	17,484,500	11,495,000	25,168,000	2,843,500	56,991,000		21,780,000	2,057,000	23,837,000	87,846,000
Pipe culvert, D600 (Type A)	8,414,400	22,438,400	8,414,400		0	39,267,200					0	53,291,200	0	31,974,720	85,265,920	124,533,120
Pipe culvert, D600 (Type B)					0	0	107,570,000	13,880,000			121,450,000	30,466,600	4,164,000	10,410,000	45,040,600	166,490,600
Pipe culvert, D1000		26,971,200			0	26,971,200	33,714,000	44,952,000	6,742,800		85,408,800	8,091,360		10,788,480	18,879,840	131,259,840
L-side ditch	53,466,000	20,636,000	28,676,000	74,236,000	63,516,000	240,530,000					0	85,224,000	50,652,000	12,596,000	148,472,000	389,002,000
U-shaped drain ditch (0.3 x 0.3m)		47,695,200			21,576,400	69,271,600					0				0	69,271,600
U-shaped drain ditch (0.4 x 0.5m)					118,685,400	118,685,400	483,608,900	372,426,600	377,201,300	98,904,500	1,332,141,300		373,790,800	83,216,200	457,007,000	1,907,833,700
U-shaped drain ditch (1.0 x 1.0m)					0	0	15,928,000	31,856,000			47,784,000				0	47,784,000
Side drain with stone pitching					0	0	16,412,000	22,380,000			38,792,000	166,544,500		111,806,750	278,351,250	317,143,250
Catch pit	18,749,000	8,812,030	10,124,460	26,061,110	38,997,920	102,744,520	66,558,950	51,372,260	51,934,730	13,686,770	183,552,710	29,998,400	72,371,140	15,936,650	118,306,190	404,603,420
Manhole	1,466,040	977,360	1,466,040		977,360	4,886,800	3,420,760	3,420,760	488,680	3,420,760	10,750,960	43,492,520	977,360	19,547,200	64,017,080	79,654,840
4. Pavement work																
Improved subgrade (t=1.0m)					0	0	71,669,000	61,686,000	52,969,500	16,762,500	203,087,000	108,323,000	36,415,600	76,630,700	221,369,300	424,456,300
Subbase course, CBR 30%	63,469,500	8,387,930	19,264,860	41,889,870	125,022,470	258,034,630	419,023,150	299,675,600	228,141,740	98,016,820	1,044,857,310	542,850,900	243,324,640	384,027,810	1,170,203,350	2,473,095,290
Base course, selected materials, CBR 80					0	0					0				0	0
Base course, cement stabilized, UCS 30kg/m2	25,510,200	3,376,350	13,830,530	28,061,220	89,735,880	160,514,180	300,745,250	258,853,500	222,288,880	70,353,130	852,240,760	363,645,400	183,373,320	321,553,570	868,572,290	1,881,327,230
Asphalt concrete Type 1 (BC t=5cm, SC t=5cm)	139,944,000	18,467,120		76,969,200		235,380,320		568,008,000	487,746,000	154,350,000	1,210,104,000	997,444,000		705,619,600	1,703,063,600	3,148,547,920
Asphalt concrete Type 2 (BC t=10cm, SC t=5cm)			45,172,400		293,314,000	338,486,400	983,164,000				983,164,000		499,553,600		499,553,600	1,821,204,000
Sidewalk, base course(t=10cm), asphalt surface(t=3cm)	43,059,100	39,894,400	22,632,400	68,089,000	103,092,500	276,767,400	343,322,000	264,684,000	133,780,500	35,962,500	777,749,000	400,478,400	153,440,000	298,728,500	852,646,900	1,907,163,300
Sidewalk, Extension up the Fish Market		64,444,800				64,444,800					0				0	64,444,800
Kerb stone	23,415,000	19,401,000	13,157,000	31,666,000	46,830,000	134,469,000	79,834,000	61,548,000	62,217,000	16,725,000	220,324,000	95,890,000	117,075,000	69,464,500	282,429,500	637,222,500
Overlay (t=100mm)	143,545,500	55,656,160	73,823,400	194,128,200	228,609,500	695,762,760	85,064,000		143,545,500		228,609,500	68,355,000	426,535,200	106,330,000	601,220,200	1,525,592,460
5. Miscellaneous work																
Road lighting	47,871,360	47,871,360	83,774,880	35,903,520	131,646,240	347,067,360	215,421,120	167,549,760	167,549,760	47,871,360	598,392,000	257,308,560	191,485,440	185,501,520	634,295,520	1,579,754,880
Traffic signals	9,745,590	9,745,590	38,982,360	9,745,590	9,745,590	77,964,720	45,479,420	12,994,120	29,236,770		87,710,310	38,982,360	25,988,240	12,994,120	77,964,720	243,639,750
Lane marking 15cm	2,107,000	903,000	1,182,500	2,850,900	4,312,900	11,356,300	7,185,300	5,538,400	5,598,600	1,505,000	19,827,300	8,630,100	7,396,000	6,252,200	22,278,300	53,461,900
Information signs	1,021,760	1,021,760	1,788,080	766,320	191,580	4,789,500	894,040	255,440	574,740	127,720	1,851,940	766,320	510,880	255,440	1,532,640	8,174,080
Shelters at bus stops				3,386,220	3,386,220	6,772,440	13,544,880	6,772,440	3,386,220		23,703,540	13,544,880	1,693,110	11,851,770	27,089,760	57,565,740
Bus station (Type A)					0	0	162,502,000				162,502,000	162,502,000	162,502,000	162,502,000	487,506,000	650,008,000
Bus station (Type B)		41,630,000			0	41,630,000	62,445,000	41,630,000	41,630,000		145,705,000				0	187,335,000
6. Other work																
Construction approach road with gravel	3,223,500		1,688,500	8,596,000	13,201,000	26,709,000	34,691,000	26,555,500	19,187,500	2,149,000	82,583,000	50,655,000	21,029,500	47,738,500	119,423,000	228,715,000
Construction and Removal of temporary road with gravel						0	192,335,500	148,281,000			340,616,500	231,017,500		167,315,000	398,332,500	738,949,000
Relocation of water mains; D 150mm - D 300mm	26,741,250	7,131,000	14,024,300	14,262,000	28,524,000	90,682,550	85,096,600	65,605,200	33,278,000		183,979,800	204,422,000	74,162,400	148,087,100	426,671,500	701,333,850
Relocation of electric lines	8,951,250		3,840,900	9,244,200	8,983,800	31,020,150	32,745,300	10,090,500	18,162,900		60,998,700	29,295,000	20,311,200	20,604,150	70,210,350	162,229,200
Relocation of telephone lines	6,570,000	146,000	5,197,600	9,928,000	7,592,000	29,433,600	12,848,000	5,840,000	7,592,000		26,280,000	25,696,000		19,359,600	45,055,600	100,769,200
Disposal of aboundand ships in the harbor		73,430,000				73,430,000					0				0	73,430,000
Embankment of Existing Railway Line (TRC)						0				197,211,000	197,211,000				0	197,211,000
Total	642,950,450	691,883,060	690,347,920	819,269,050	2,815,510,340	5,659,960,820	4,506,017,360	3,505,617,360	2,266,798,380	849,879,060	11,128,312,160	5,091,720,470	2,817,909,330	3,510,741,320	11,420,371,120	28,208,644,100

Table 16.7 Land and House Acquisition Cost

Unit: Ths. million

Description	Unit	Unit Price	Package 1: Arterial Roads in the City Center												Package 2: The Middle Ring Road									
			Ohio Street		Kivukoni Front		Sokoine Drive		Gerezani Street		Bandari Road		Total		Morocco Road		New Kigogo Road		Missing Link		Chang'ombe Road		Total	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost
(1) Commercial Building																								
Concrete, 3 or more storyied	no.	7.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, 2-storyied	no.	4.25	0	0.00	0	0.00	0	0.00	0	0.00	1	4.25	1	4.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, flat	no.	2.00	0	0.00	0	0.00	1	2.00	0	0.00	0	0.00	1	2.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wooden	no.	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Kiosk	no.	0.20	1	0.20	7	1.40	0	0.00	0	0.00	7	1.40	15	3.00	30	6.00	14	2.80	0	0.00	11	2.20	55	11.00
(2) Factory																							0	
Concrete, 3 or more storyied	no.	7.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, 2 storyied	no.	4.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, flat	no.	2.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
(2) Residential Building							0																	
Concrete, 2 storyied	no.	5.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, flat	no.	2.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	64	128.00	59	118.00	10	20.00	0	0.00	133	266.00
Wooden	no.	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Small house	no.	0.20	0	0.00	0	0.00	0	0.00	2	0.40	5	1.00	7	1.40	85	17.00	48	9.60	0	0.00	11	2.20	144	28.80
TOTAL			1	0.20	7	1.40	1	2.00	2	0.40	13	6.65	24	10.65	179	151.00	121	130.40	10	20.00	22	4.40	332	305.80

Unit: Ths. million

Description	Unit	Unit Price	Package 3: Radial Trunk Roads								Ground Total	
			:w Bagamoyo Rc		Uhuru Road		Kilwa Road		Total			
			No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost
(1) Commercial Building												
Concrete, 3 or more storyied	no.	7.00	0	0.00	2	14.00	0	0.00	2	14.00	2	14.00
Concrete, 2-storyied	no.	4.25	0	0.00	0	0.00	0	0.00	0	0.00	1	4.25
Concrete, flat	no.	2.00	0	0.00	0	0.00	2	4.00	2	4.00	3	6.00
Wooden	no.	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Kiosk	no.	0.20	67	13.40	42	8.40	17	3.40	126	25.20	196	39.20
(2) Factory				0.00		0.00		0.00			0	0.00
Concrete, 3 or more storyied	no.	7.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, 2 storyied	no.	4.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Concrete, flat	no.	2.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
(2) Residential Building				0.00		0.00		0.00			0	0.00
Concrete, 2 storyied	no.	5.00	0	0.00	0	0.00	1	5.00	1	5.00	1	5.00
Concrete, flat	no.	2.00	0	0.00	22	44.00	33	66.00	55	110.00	188	376.00
Wooden	no.	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Small house	no.	0.20	6	1.20	9	1.80	20	4.00	35	7.00	186	37.20
TOTAL			73	14.60	75	68.20	73	82.40	221	165.20	577	481.65

Table 16.8 Summary of Project Cost by Package

Description	Unit	Unit Rate (Tsh)	Package 1 Arterial Roads in the City Quantities	Package 1 Arterial Roads in the City Amount (Tsh)	Package 2 The Middle Ring Roads Quantities	Package 2 The Middle Ring Roads Amount (Tsh)	Package 3 Radiual Trunk Roads Quantities	Package 3 Radiual Trunk Roads Amount (Tsh)	Total Quantities	Total Amount (Tsh)
A. Construction Cost										
1. Earthwork										
Clearing and stripping (t=70cm)	m2	1,360	0	0	66,000	89,760,000	116,500	158,440,000	182,500	248,200,000
Removal of existing pavement material (t=70cm)	m3	5,790	0	0	4,650	26,923,500	4,783	27,693,570	9,433	54,617,070
Excavation (common)	m3	4,480	18,216	81,607,680	74,391	333,271,680	80,076	358,740,480	172,683	773,619,840
Embankment (common)	m3	5,980	66,450	397,371,000	75,967	454,282,660	110,200	658,996,000	252,617	1,510,649,660
Sodding	m2	2,060	6,505	13,400,300	4,887	10,067,220	51,936	106,988,160	63,328	130,455,680
				492,378,980		914,305,060		1,310,858,210		2,717,542,250
2. Strucutral work										
Concrete block wall, concrete class C, 180kg	m2	6,920	4,500	31,140,000	23,440	162,204,800	2,500	17,300,000	30,440	210,644,800
Box culvert, concrete class B, 240kg	m3	350,630	300	105,189,000	1,989	697,403,070	980	343,617,400	3,269	1,146,209,470
Reinforced retaining walls, concrete class A, 240kg	m3	325,590	1,027	334,380,930	0	0	0	0	1,027	334,380,930
Gravity wall, concrete class C	m3	159,380	410	65,345,800	0	0	0	0	410	65,345,800
RC hollow slab, consrete class -A	m2	696,200	723	503,352,600	0	0	0	0	723	503,352,600
Pier and Abutment, concrete class-A	m3	213,870	2,564	548,362,680	0	0	0	0	2,564	548,362,680
Steel Plate Girder	ton	7,288,000	0	0	0	0	0	0	0	0
Cast in place pile (D=1,000)	m	57,650	1,140	65,721,000	0	0	0	0	1,140	65,721,000
Improvement of foundation	m3	17,830	0	0	1,460	26,031,800	0	0	1,460	26,031,800
				1,653,492,010		885,639,670		360,917,400		2,900,049,080
3. Drainage work										
Pipe culvert, D300	m	60,500	116	7,018,000	942	56,991,000	394	23,837,000	1,452	87,846,000
Pipe culvert, D600 (Type A)	m	140,240	280	39,267,200	0	0	608	85,265,920	888	124,533,120
Pipe culvert, D600 (Type B)	m	69,400	0	0	1,750	121,450,000	649	45,040,600	2,399	166,490,600
Pipe culvert, D1000	m	224,760	120	26,971,200	380	85,408,800	84	18,879,840	584	131,259,840
L-side ditch	m	26,800	8,975	240,530,000	0	0	5,540	148,472,000	14,515	389,002,000
U-shaped drain ditch (0.3 x 0.3m)	m	56,780	1,220	69,271,600	0	0	0	0	1,220	69,271,600
U-shaped drain ditch (0.4 x 0.5m)	m	68,210	1,740	118,685,400	19,530	1,332,141,300	6,700	457,007,000	27,970	1,907,833,700
U-shaped drain ditch (1.0 x 1.0m)	m	79,640	0	0	600	47,784,000	0	0	600	47,784,000
Side drain with stone pitching	m	18,650	0	0	2,080	38,792,000	14,925	278,351,250	17,005	317,143,250
Catch pit	no.	187,490	548	102,744,520	979	183,552,710	631	118,306,190	2,158	404,603,420
Manhole	no.	244,340	20	4,886,800	44	10,750,960	262	64,017,080	326	79,654,840
				609,374,720		1,876,870,770		1,239,176,880		3,725,422,370
4. Pavement work										
Improved subgrade (t=1.0m)	m3	14,900	0	0	13,630	203,087,000	14,857	221,369,300	28,487	424,456,300
Subbase course, CBR 30%	m3	24,890	10,367	258,034,630	41,979	1,044,857,310	47,015	1,170,203,350	99,361	2,473,095,290
Base course, selected materials, CBR 80	m3	37,560	0	0	0	0	0	0	0	0
Base course, cement stabilized, UCS 30kg/m2	m3	25,010	6,418	160,514,180	34,076	852,240,760	34,729	868,572,290	75,223	1,881,327,230
Asphalt concrete Type 1 (BC t=5cm, SC t=5cm)	m2	13,720	17,156	235,380,320	88,200	1,210,104,000	124,130	1,703,063,600	229,486	3,148,547,920
Asphalt concrete Type 2 (BC t=10cm, SC t=5cm)	m2	20,440	16,560	338,486,400	48,100	983,164,000	24,440	499,553,600	89,100	1,821,204,000
Sidewalk, base course(t=10cm), asphalt surface(t=3cm)	m2	9,590	28,860	276,767,400	81,100	777,749,000	88,910	852,646,900	198,870	1,907,163,300
Sidewalk, Extension up to the Fish Market	m2	9,590	6,720	64,444,800	0	0	0	0	6,720	64,444,800
Kerb stone	m	11,150	12,060	134,469,000	19,760	220,324,000	25,330	282,429,500	57,150	637,222,500
Overlay (t=100mm)	m2	15,190	45,804	695,762,760	15,050	228,609,500	39,580	601,220,200	100,434	1,525,592,460
				2,163,859,490		5,520,135,570		6,199,058,740		13,883,053,800
5. Miscellaneous work										
Road lighting	no.	2,991,960	116	347,067,360	200	598,392,000	212	634,295,520	528	1,579,754,880
Traffic signals	no.	3,248,530	24	77,964,720	27	87,710,310	24	77,964,720	75	243,639,750
Lane marking 15cm	m	430	26,410	11,356,300	46,110	19,827,300	51,810	22,278,300	124,330	53,461,900
Information signs	no.	63,860	75	4,789,500	29	1,851,940	24	1,532,640	128	8,174,080
Shelters at bus stops	no.	1,693,110	4	6,772,440	14	23,703,540	16	27,089,760	34	57,565,740
Bus station (Type A)	no.	162,502,000	0	0	1	162,502,000	3	487,506,000	4	650,008,000
Bus station (Type B)	no.	20,815,000	2	41,630,000	7	145,705,000	0	0	9	187,335,000
				489,580,320		1,039,692,090		1,250,666,940		2,779,939,350
6. Other works										
Construction approach road with gravel	m2	15,350	1,740	26,709,000	5,380	82,583,000	7,780	119,423,000	14,900	228,715,000
Construction and Removal of temporary road with grav	m2	15,350	0	0	22,190	340,616,500	25,950	398,332,500	48,140	738,949,000
Relocation of water mains; D 150mm - D 300mm	m	23,770	3,815	90,682,550	7,740	183,979,800	17,950	426,671,500	29,505	701,333,850
Relocation of electric lines	m	6,510	4,765	31,020,150	9,370	60,998,700	10,785	70,210,350	24,920	162,229,200
Relocation of telephone lines	m	5,840	5,040	29,433,600	4,500	26,280,000	7,715	45,055,600	17,255	100,769,200
Disposal of aboundand ships in the harbor	ton	146,860	500	73,430,000	0	0	0	0	500	73,430,000
Embankment of Existing Railway Line (TRC)	Sum	197,211,000	0	0	1	197,211,000	0	0	1	197,211,000
				251,275,300		891,669,000		1,059,692,950		2,202,637,250
Total (A)				5,659,960,820		11,128,312,160		11,420,371,120		28,208,644,100
B. Contingency										
Price Escalation (5%of the construction cost)				282,998,000		556,416,000		571,019,000		1,410,432,000
Physical Escalation (5% of the construction cost)				282,998,000		556,416,000		571,019,000		1,410,432,000
Total (B)				565,996,000		1,112,832,000		1,142,038,000		2,820,864,000
C. Consultancy Services										
Detailed Design (4% of the construction cost)				226,398,000		445,132,000		456,815,000		1,128,346,000
Supervision Services(6% of the construction cost)				339,598,000		667,699,000		685,222,000		1,692,519,000
Total (C)				565,996,000		1,112,831,000		1,142,037,000		2,820,865,000
Total of the Project Cost (A+B+C)				6,791,952,820		13,353,975,160		13,704,446,120		33,850,373,100
D. Administration Cost of Tanzanian Government										
Compensation for Land and Buildings				10,650,000		305,800,000		165,200,000		481,650,000
Operation Cost of Government Project Office (1% of the construction cost)				56,600,000		111,283,000		114,204,000		282,087,000
Total (D)				67,250,000		417,083,000		279,404,000		763,737,000
Grand Total (A+B+C+D)				6,859,202,820		13,771,058,160		13,983,850,120		34,614,110,100

US$ 1.0 = ¥100 = Tsh.520 (As of July, 1994)

Table 16.9 Summary of Project Costs

Unit : Tsh. 1,000

No.	Description	Amount		
		Foreign Portion	Local Portion	Total
A.	**Construction Cost**			
P-1	Arterial Roads in the City Center			
	Ohio Street	544,797	98,153	642,950
	Kivukoni Front	552,949	138,934	691,883
	Sokoine Drive	547,291	143,057	690,348
	Gerezani Street	674,197	145,072	819,269
	Bandari Road	2,262,798	552,712	2,815,510
	Total (1)	4,582,032	1,077,928	5,659,960
P-2	The Middle Ring Road			
	Morocco Road	3,677,255	828,762	4,506,017
	New Kigogo Road	2,811,120	694,498	3,505,618
	Missing Link	723,691	126,188	849,879
	Chang'ombe Road	1,865,656	401,143	2,266,799
	Total (2)	9,077,722	2,050,591	11,128,313
P-3	Radial Trunk Road			
	New Bagamoyo Road	4,351,302	740,418	5,091,720
	Uhuru Road	2,297,362	520,547	2,817,909
	Kilwa Road	2,976,528	534,214	3,510,742
	Total (3)	9,625,192	1,795,179	11,420,371
	Total (1) + (2) + (3)	**23,284,900**	**4,923,700**	**28,208,600**
B.	**Engineering Cost**			
	Detaied Design & Superviision	2,328,500	492,400	2,820,900
	(10% of Const. cost)			
C.	**Contingency for Price Escalation**			
	and Physical Change	2,328,500	492,400	2,820,900
	(10% of Const. cost)			
D.	**Government Administration Cost**			
	House Acquisition Cost	-	481,600	481,600
	Admi. Cost (1% of Const. cost)	-	282,100	282,100
	Grand Total (A)+(B)+(C)+(D)	**27,941,900**	**6,672,200**	**34,614,100**

Exchange Rate: US$ 1.0 = Tsh. 530.0 = ¥ 100.0 (as of July, 1994)

16.9 Maintenance Cost

Road maintenance costs, which are required after completion of the Project, are divided into two categories as follows:

- Routine maintenance
- Periodic maintenance

The required cost for each type of maintenance work are estimated as shown below:

16.9.1 Routine Maintenance Cost

Routine maintenance consist of the following three categories:

- Operation cost : Costs for electricity for street lighting, signal operation, etc.
- Cleaning cost : Costs for cleaning the road surface, drainage facilities, traffic sign boards, traffic devices, etc.
- Repairing cost : Costs for pavement repair, overlays, painting of road markings and safety devices, repair of traffic control facilities, etc.

According to the data in connection with the road maintenance for Dar es Salaam Region, the average annual maintenance cost spent by the City Council of Dar es Salaam in the past few years is roughly estimated at Tsh. 350,000 per km for a 2-lane road. After widening to a 4-lane road, it is estimated that the cost will increase by about 50 % to Tsh. 525,000 per km for a 4-lane road.

The total maintenance cost for the Project roads having a total length of 28 km is calculated as shown below:

Annual maintenance cost required for the Project in the first year is;
Ths. 525,000 km/4-lane x 28 km = Tsh. 14,700,000

16.9.2 Periodic Maintenance Cost

Pavement design is usually made covering a period of five 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 (5 cm of asphalt concrete) is planned to be done at five years intervals assuming that the project will be completed in 2000. Two times of overlay will be done in 2005 and in 2010. The required cost of the overlay for a 4-lane road is estimated as follows:

Periodic maintenance cost =

Tsh. 9,100/m2 x 2(dual lane) x 7.5 m (pavement width) x
2/3 (deterioration rate) x 28 km (project length) = Tsh 2,548,000,000

16.9.3 Economic Maintenance Cost

The maintenance cost in terms of economic cost (which is used for the economic evaluation of the Project) shall exclude tax and duties, which is equivalent to 90 % of the above maintenance costs as follows:

Economic maintenance cost.
- Routine maintenance: 90% of annual routine maintenance cost.
- Periodic maintenance: Tsh 2,548,000,000 x 0.9 = Tsh 2,293,000,000.

16.10 Maintenance System and Operation

16.10.1 General

The detailed discussion on the road maintenance issue is not a main target or out of scope of this Study; however, the Study team has discussed the road maintenance operation being undertaken by MWCT and DCC to achieve or establish more effective maintenance system in Dar es Salaam.

The manual of "Road Maintenance Management System (RMMS)" was prepared by the former Ministry of Works, which became effective on the 1st July, 1991. The RMMS was introduced to maintain uniform national standards, procedures and work methods as well as to produce guideline

priorities for regional maintenance work programs. Since the establishment of effective management system is essential for road maintenance, the RMMS should be fully implemented as soon as possible.

Recently, two major road rehabilitation and maintenance projects have been and are being implemented in Dar es Salaam as follows:

(a) Dar es Salaam Region Periodic Maintenance and Emergency Road Repair Program (Under Integrated Road Projects I)
- Financed by World Bank
- Construction Period: March 1992 - January 1994
- Proposed Roads

Old Bagamoyo Road	8.0 km
New Bagamoyo Road(North)	13.4 km
Mpakani Road	6.3 km
Shekilango Road	3.8 km
Kilwa Road	8.5 km
Kongowe/Mjimwema Road	17.5 km
Pugu-Chanika Mbagala Road	46.8 km
Kivukoni Pembamnazi Road	56.7 km
Total	161.0 km

(b) Dar es Salaam Road Rehabilitation and Improvement Project (DRIMP)
- Financed by Japanese Government
- Construction Period: December 1991 - March 1996
- Proposed Roads

Phase 1; Roads in Central Area	20.0 km
Phase 2; Upanga/New Bagamoyo Road	9.8 km
Phase 3; Morogoro Road (Morocco-Mpakani)	5.7 km
Phase 4; Kariakoo/Chang'ombe Roads	30.0 km
Total	65.5 km

After improvement of the above project roads, almost 100% of the trunk roads (144 km) and 1/5 - 1/4 of regional roads including major city roads in Dar es Salaam will be improved. However, there are still many regional, district and feeder roads that are still in bad conditions due to long time lack of proper and timely maintenance.

The following are the comments and recommendations in connection with the road maintenance works being undertaken by MWCT and DCC in Dar es Salaam Region.

16.10.2 Technical Issues on Maintenance Work

(1) Special Care for Roadside Drainage Structure

Main cause of pavement deterioration is due to generally an increase of traffic volume with large-sized vehicles. However, in case of Dar es Salaam, inadequate maintenance, especially on drainage facilities, is mainly caused by pavement deterioration.

The roadside drainage system in urban and sub-urban areas are mostly served by lined channel and underground piped system; however, these systems are not working well due to small capacity of structures as well as inadequate drainage maintenance.

Dar es Salaam City is sandy throughout seasons due to the nature of soil and geology. Blocking of gratings by soil, in addition to the sedimentation in the drainage structure, have frequently brought about flooding along the roadside which have caused serious difficulties for passage of vehicles and pedestrians during the rainy season. Such flooding had also shortened the pavement life greatly.

These problems can be solved if a routine maintenance including following works, is undertaken properly and timely:

(a) Cleaning the blocking of gratings and sedimentation in the roadside drainage structures
(b) Removing the sand heaped on the road and sidewalk
(c) Dredging the mud in channel

The above works are labor-intensive routine maintenance which may not require large amount of cost, so that it is advised for the agencies concerned to give a priority on the above routine maintenance and allocate sufficient budget required for these works.

(2) Improvement of Storm Drainage System

With current rapid increase of population in Dar es Salaam, the urban area is expanding outside Mandela Road and spreading in rather uncontrolled and disorderly manner. The road development master plan was also established to promote well-ordered development for the above frontage.

As discussed in the Drainage Design, Chapter 15, improvement and maintenance of storm drainage system is serious problem which needs to solve. These improvement measures, however, should be implemented incorporating the development plan of other sectors, especially road sector, to minimize the investment as well as the environmental effects.

It is, therefore, recommended to carry out the master plan study for rehabilitation and emergency maintenance for storm drainage system as soon as possible and prepare the concrete implementation program for improvement taking into account the related development plan and investment program.

(3) Destruction of Pavement by Private Works

Approx. 20 km of major roads in Central Area were rehabilitated and improved under the improvement project of DRIMP, Phase 1 in 1991- 1992.

However, some of the pavements of these roads are already damaged in several places by installation of water supply and sewerage pipes incidental to the construction of building alongside the road. These destruction should be repaired soon after completion of the building work; however, they are usually left for a long time without any emergency repair which results in expansion of pavement deterioration as well as cause of serious traffic accidents.

Improvement of emergency repairing system for such type of destruction should be established as soon as possible with penalty system being applied for a person responsible for repairs.

16.10.3 Maintenance Management System

(1) Jurisdiction of MWCT and DCC on Maintenance Work

Trunk Road Maintenance (TRM) under the Ministry of Works, Communications and Transport is an agency responsible for conducting road maintenance for trunk and regional roads in Dar es Salaam Region, while Road Maintenance Division in Dar es Salaam City Council (DCC) has responsibility for district and local roads, according to the "DRAFT ROAD MANUAL" prepared by former MCW (present MWCT) in 1989 .

However, actual classification for maintenance responsibility does not seem distinct and has a lack of uniformity or consistency. The road classification (trunk road, regional road, etc.) has not been applied to the road network system in Dar es Salaam strictly in accordance with the Manual as stated in the Section 4.3, Chapter 4.

The classification of road network system as well as the jurisdiction of maintenance responsibility should be clarified taking into account the urban road or city roads in Dar es Salaam Region, which may need for establishing an efficient road maintenance management system (RMMS) in the City.

(2) Development of DRIMP Office as On-the-Job Training Center

The maintenance units of DCC have been improved under the "Dar es Salaam Road Improvement and Maintenance Project (DRIMP)" since 1991 with a financial assistance of Japanese Government. New main depot was established as the DRIMP Office in Ilala Garden near the junction of Uhuru/New Kigogo Road and maintenance equipment has been procured under this program.

The DRIMP Office is responsible for maintaining the district and city roads, except for trunk and regional roads under jurisdiction of MWCT. At present, the office has surplus capacity in excess of routine maintenance requirements, but it is not sufficient for heavy maintenance work such as rehabilitation and reconstruction unless office capacity is strengthened by procurement of additional equipment and labor.

In the meantime, maintenance contract has been introduced in line with the MWCT's policy for the use of private sector to maximize the efficiency of maintenance work in terms of cost, quality and progress. A UNDP/USAID/IDA funded project was started late in 1991 to train labor-based contractors and develop appropriate contract procedures covering routine and periodic maintenance and rehabilitation.

The full extent of contract maintenance, however, may be long and need sufficient transition time due to lack of resources and maintenance experience of local contractors. Technology transfer to the local contractor is required.

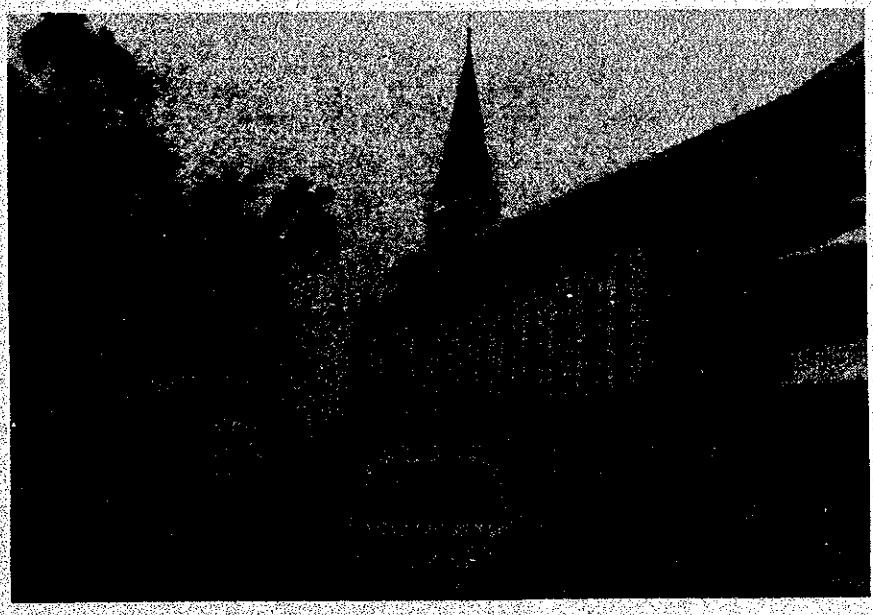
The Study Team recommends to develop the DRIMP Office as a road maintenance training center for urban roads with a target of on-the-job training for the staff of MWCT, DCC and private contractors, which will meet the above requirements to the MWCT's policy for encouraging the maintenance by contract.

The DRIMP Office has already been provided with a minimum facilities for periodic and routine maintenance, so that additional equipment and facilities required for the on-the-job training could be minimized as shown below.

Additional facilities required for DRIMP Office;
- Training room with computer facilities
- Workshop with instruments
- Store room for materials

Training is essential for improving the performance of the maintenance personnel at all level so that the procedures and standards of the RMMS must be fully understood and effectively executed.

CHAPTER 17 ENVIRONMENTAL IMPACT ASSESSMENT



CHAPTER 17 ENVIRONMENTAL IMPACT ASSESSMENT

17.1 General

In any kind of development project, it is imperative to harmonize the planned work with environmental issues. With a view to preventing harmful effects, an environmental impact assessment provides the tool to examine the present conditions and to determine the possible impact a project may have, as well as to establish mitigation measures. This system of assessment is now playing an important role with the increased global concern about environmental issues.

In this chapter, the environmental impact assessment has been conducted in respect of the proposed High-Priority Project packages in road development that were selected in the Master Plan. It is based on the results of initial environmental examination outlined in Chapter 5. Possible environmental impacts derived from project implementation were estimated and evaluated, and mitigation measures have been proposed as recommendations to reduce harmful effects.

The assessment in this Study covers the following aspects:

- Flood hazards
- Resettlement of residents
- Air pollution
- Noise and vibration

Flora and fauna are excluded in the assessment because of the non-existent of rare species in and around the routes of the proposed High-Priority Project packages.

17.2 Description of High-priority Projects

(1) Executing Agency

- Ministry of Works Communications, and Transport (MWCT)

(2) Characteristics of Projects

- Type of Project: Upgrading (Rehabilitation of function for trunk road)
- Characteristics of Road: trunk road/urban area/plain area

(3) Target year: 2000

(4) Length/Width/Lanes/Daily Traffic Volumes;

1. Package 1: Arterial Roads in the City Center

Road	Length (km)	Width (m)	No. of Lanes	Traffic Volume
Ohio	1.05	20 to 22	4	26,345
Sokoine	1.10	20 to 22	4	32,979
Gerezani	1.42	20 to 25	4	35,541
Bandari	2.15	20 to 25	4	30,874
Seaside promenade (Kivukoni)	0.56	20 + 8 (promenade)	4	-

2. Package 2: Middle Ring Road and Missing Link

Road	Length (km)	Width (m)	No. of Lanes	Traffic Volume
Morocco	3.58	30 to 50	4	41,675
New Kigogo	2.76	30 to 50	4	26,130
Chang'ombe	2.79	25	4	26,037
Missing Link	0.75	25	4	-

3. Package 3: Radial Trunk Roads

Road	Length (km)	Width (m)	No. of Lanes	Traffic Volume
New Bangamoyo	4.30	30 to 50	4	11,413
Uhuru	4.85	20 to 25	4	31,821
Kilwa	3.12	30 to 50	4	24,891

17.3 Site Condition

17.3.1 General Conditions

Table 17.1 summarizes the socio-economic, physical and natural aspects of the environment as well as the present condition of pollution along the priority roads. Site condition is, in general, as follows:

- Expanding residential area in the low lands with increasing possibility of flood hazard occurrences

  The Sinza River runs across Morocco Rd. while both the Ubungo River and Msimbazi River cross New Kigogo Rd. In recent years, a number of houses have been built in the low lands along these rivers; however these areas are flooded when it rains heavily. If the basins of the rivers are further developed as residential areas, the scale of flooding would increase with hazards occurring more frequently.

- Decreasing safety margin for flood control due to the accumulated earth, sand and garbage in the rivers and drainage channels

  Haphazard expansion of residential areas and farmland has caused soil erosion leading to more accumulation of earth and sand in the rivers and drainage channels and the raising-up of river bed which blocks the smooth flow of water. In addition, garbage and solid wastes are thrown into the rivers and channels, lowering flow capacity of the stream and causing the water flow to stagnate. Also, stagnant water causes sanitary problems such as the growth of mosquitoes.

  Incomplete provision of street inlets and sewage works, broken installations and insufficient maintenance causes overflow of water and flooding in roads.

- Roadside environment with rich geenery

  Areas along the priority roads, except for one part (in the downtown area along Uhuru Rd.), creates a nice roadside environment with rich greenery, where roadside trees together with trees in private yards create a green belt. Symbolic tall trees are located along the road, giving individual features of roads and place of relaxation for the residents.

- Air pollution due to the dust generated by vehicles

  On roads with an umpaued or damaged surface, dust is flung up as automobiles pass by thus causing deterioration of clean air conditions. This is because earth and sand from flooding has accumulated on the roads.

Table 17.1 Outline of Environment along the Proposed Roads

Type of road	Social and economical environment	Physical and natural environment	Public nuisance
A. Widening Arterial Road in City Center	[Ohio Rd.] •Many governmental and commercial facilities, and hotels are located here. [Kivkoni Front] •Small shops line the coastal area. [Sokoine Drive] •Many public and commercial facilities, and the train station is located here. [Gerezani Rd.] •Residences as well as public facilities are located here. [Bandari Rd.] •Many factories and warehouses as well as commercial facilities are located here.	[Ohio Rd.] •Rich in the greenery of trees of private houses and roadside trees. [Kivkoni Front] •Trees are lined along the coast, presenting a beautiful vista. [Sokoine Drive] •Historical and cultural buildings are located here. •Trees are planted from place to place along the coast. [Gerezani Rd.] •Full of trees of private houses, presenting an environment of rich greenery. Some trees are very symbolic. [Bandari Rd.] •Little greenery.	•The traffic volume of this road is generally heavy, resulting in severe traffic backup. For this reason, it cannot be said that the current situation of air and sound environments of the area are favorable.
B. Widening of Middle Ring Roads and Constriction of Missing Link	[Morocco Rd.] •Many residences are located here, but religious institution, elementary school, hospital, and garden are also located here. Shopping center is located here near the crossing with Kirodoni Rd. Residential area has extended into the low land of the river. [New Kigogo Rd.] •Elementary school, hospital, and religious institution are located here in addition to residences. •More and more houses have been built in the low land of the river for these years, causing a problem in the safe flood control. [Missing Link] •Public cemetery and stadium are located here in addition to residences. Railway crosses the road. [Chang'ombe Rd.] •A number of factories are located here near the crossing with Pugu Rd. •Many residences are located here, and so are college, school, and job training school.	[Morocco Rd.] •The Sinza River crosses under the road, and a wet land lies on the riverbed. [New Kigogo Rd.] •The Both Ubungo River and Msimbazi River cross the road, and the riverbed forms wet land (Ubungo) or is utilized as farmland (Msimbazi). [Missing Link] •Coconut palms are seen from place to place. [Chang ombe Rd.] •Factory area has few greens, but more greens can be seen near the crossing with Kilwa Rd. Some trees are symbolic.	•Heavy dust is flung up when motor vehicles run on the road where the surface is badly damaged (Chang ombe Rd.), and it worsens the atmospheric environment.
C. Widening of Trunk Roads	[New Bagamoyo Rd.] •Most of the area is occupied by residences, but educational facilities such as college and institute are also located here. Small shops are line the crossing with Mpakani Rd. [Uhuru Rd.] •A number of commercial facilities stand closely together in the central city area starting from the crossing with New Kigogo Rd. Many small shops are also located here. Outside this area are residences, hospital, market, and public cemetery. [Kilwa Rd.] •Most of the area is occupied by residences, but secondary school and public station are also located here. Railway runs parallel with the road.	[New Bagamoyo Rd.] •Rich in greenery because there are many private houses with lots full of trees. Road is very wide, providing comfortable space. •The Kijitonyama River crosses under the road. [Uhuru Rd.] •Central city area has very little greenery, but more greenery can be seen beyond the crossing with New Kigogo Rd. [Kilwa Rd.] •Roadside trees stand on both sides of the road near the starting point, and some symbolic trees can be seen.	•Surface is badly damaged on Uhuru Rd. and accordingly dust is flung up when motor vehicles pass over it. It worsens the atmospheric environment of the roadside area. Serious traffic congestion is caused near the crossing of Uhuru Rd. and Msimbazi Rd. Flung-up dust and exhaust gases from motor vehicles have worsened the roadside environment.

17.3.2 Survey of Buildings along the Roads

(1) Purpose

Condition of existing buildings along the planned roads of the priority project have been surveyed. The purpose of this survey is to prepare basic data necessary for estimating and assessing the impact of necessary resettlement of residents derived from the priority project.

(2) Method

In the survey, the road development plan was referred to and the locations where the roads are to be widened (consequently requiring high probability of resettlement) were identified with 200 buildings in the area being selected. For those 200 selected buildings, an on-site survey of the structure, material, age, and related items were surveyed. At the same time, an interview survey to the residents was conducted to find out number of family members, employment status, years of residence, and so forth.

(3) Survey Results

Table 17.2 shows results of the survey. Condition of the buildings and socio-economic conditions of residents along the priority roads are outlined as follows:

- Land use

  Land along the roads such as Ohio Street and Sokoine Drive in the City Center is mainly a business district with both commercial and public facilities. Land along the Middle Ring Road such as Morocco Rd. and New Kigogo Rd. is mostly residential with some commercial areas.

- Number of residents per building and length of residency

  Number of residents per building in the residential area varies by building type. As many as 180 people live in some collective houses. The length of residency also varies widely from less than a year up to 39 years, but those having from 20 to 30 years of residency is the largest accounting of approximately 30%.

- Structures and ages of buildings

  Most of the building structures are of block or brick, accounting for 50%. Next is of reinforced concrete or of concrete structures, accounting for 29%.

- Land ownership

  Most of the legal title of the properties of the buildings in this survey are owned by public organizations such as the National Housing Corporation, Home Affairs Ministry and DSM City Council. Privately-owned lands are relatively few.

Table 17.2 Result of Survey on Buildings along the Proposed Roads

Classification	Name of Road	Type of Land Use							Areas (m^2)		Population Data				Structure Data						
											Population		Length of Residency		Type of Structure					Age of Structure	
		R	C	B	I	P	A	O	Range	Ave	Range	Ave	Range	Ave	RC/ Concrete	Block/ Brick	Mud Thatch/ Earthen Brick	Bamboo/ Wood	Others	Range	Ave
A	Ohio Street	0	0	0	0	2	0	0	108 to 370	239					1	0	0	0	1	25	25
Arterial	Kivukoni Front	0	1	1	0	1	0	0	4.4 to 70	37					3	0	0	0	0	2 to 44	23
Road in	Sokoine Drive	2	0	2	0	0	0	0	135 to 500	283	9 to 10	9.5	2 to 4	3	0	2	0	0	2	19 to 50	36
City Center	Bandari Road	0	1	1	0	0	0	1	70 to 700	382					2	1	0	0	0	4 to 5	4.7
	Gerezani Road	0	0	1	0	0	0	0							0	1	0	0	0	20	20
B	Morocco Road	18	9	0	0	0	0	4			3 to 95	20.3	2 to 39	19	1	18	7	0	5	< 1 to 40	<18.2
Middle Ring	New Kigogo Road	20	3	0	0	2	0	0			1 to 42	12.4	2 to 39	15	1	22	0	0	0	2 to 54	32.3
Road and	Chang' ombe Road	20	7	4	5	3	0	1	6 to 1100	165	6 to 180	41.2	8 to 24	18	10	25	0	4	1	2 to 54	24.4
Missing Link	Missing Link	9	0	0	0	0	0	1	108 to 375	219	10 to 40	30.0	2 to 25	14	0	7	1	1	1	16 to 50	32.3
C	New Bgamoyo Road	0	10	0	0	0	0	0							0	5	0	6	2	1 to 4	2.05
Trunk Road	Uhuru Road	36	11	3	0	0	0	0			3 to 23	10.2	< 1 to 30	12	39	3	7	0	0	4 to 5	28.4
	Kilwa Road	12	9	0	0	0	0	0	9 to 420	112	7 to 18	11.7	2 to 12	12	1	17	0	2	1	1 to 5	13.8
	Total	117	51	12	5	8	0	7							58	101	15	13	13		

R: Residential Use
C: Commercial Retail
B: Business Office
I: Industrial Use
P: Public or Government Use
A: Agricultural Use
O: Others
Population: Inhabitants Only

17.4 Environmental Impact Estimation and Assessment

17.4.1 Flood Hazard

(1) General

With the road development with pavement, ground surface not permeating water will increase. It is foreseen that the increased peak rainwater flow will affect the safety margin concerning the capacities of the affected rivers and channels. For this reason, the increase in the amount of discharged rainwater (drainage from the roads) and also the change in the level of rivers and channels into which this rainwater drains have been estimated

(2) Estimation of Flood Discharge

As already discussed in Chapter 5, flooding on roads has been observed in many places in Dar es Salaam due to incomplete rainwater drainage (including street drains) and the insufficient maintenance of them. From the viewpoint of the observed overflow and local flooding in the vicinity of the priority roads, the possible impact of the project implementation was also studied as outlined below.

- Estimated Impacts
  - Impact of increased drainage with the new road development on the flood control safety margin of the affected rivers and channels
  - Impact of the road development on the places where overflow on roads or local flooding is currently observed
- Estimation Area (See Fig. 17.1)

  The priority roads, areas along them, and the following four rivers— in the basins, the above mentioned areas are included:
  - Kijitonyama River
  - Sinza River
  - Ubungo River
  - Msimbazi River

In addition to these four rivers, there is a waterway 5 (Fig. 17.1) with a relatively large catchment area that will affect Chang'ombe and Kilwa Roads. Since the data of total catchment and flow capacity is lacking, flood flow volume in this waterway could not be estimated. However, the condition of the waterway during rainfall has been evaluated by field reconnaissance, and the safety level will be evaluated.

- Estimation Method

The "Rational Model" (see Appendix 17.2 (1)) was used to calculate the discharged volume of rainwater from the basin and from road surface during rainy weather.

- Estimation Conditions

The discharge coefficient of the roads used in the "Rational Model" is set at 0.9 based on the value specified by The American Society of Civil Engineering (see Appendix 17.2 (2)).

The rainfall intensity of 153.6 mm/hr was used based on a 50-year probability from the past rainfall data collected by the weather stations in Dar es Salaam.

Area of each river basin and the priority road are shown in Table below.

Table 17.3 Road Area in each Basin

Name of River	Basin Area	Road Surface Area		Remarks
		Current	Planned	
Kijitonyama	3.9 km^2	22,000 m^2	137,500 m^2	New Bagamoyo Rd.
Sinza	24.75	24,480	120,400	Morocco Rd.
Ubungo	34.2	8,960	43,700	New Kigogo Rd.
Msimbazi	240.0	44,800	192,150	New Kigogo Rd. Missing Link Uhuru Rd.
Others	—	109,520	479,910	
Total	—	209,760	973,660	

Note: Others: Ohio, Sokoine, Kivukoni, Gerezani, Bandari, Chang'ombe, Kilwa, etc.

Figure 17.1 Rivers for Assessment of Flood Hazard

1 Kijitonyomo
2 Sinzo
3 Msimbazi
4 Ubungo
5 Waterway

The estimated flood discharges of the Kijitonyama River, Sinza River, Msimbazi River, and Ubungo River which were already calculated in Chapter 14 based on the rainfall of 50-year probability are shown below.

Table 17.4 Estimated Flood Discharge of Rivers

Name of river	Area of Road (A)	Discharge Coefficient (f)	Rainfall Intensity (r)	Flood Discharge
Kijitonyama	3.9 km^2	0.5	59.568 mm/hr	32.3 m^3/sec
Sinza	24.75	0.5	18.940	65.1
Ubungo	34.2	0.5	15.501	73.6
Msimbazi	240.0	0.5	11.441	381.4

Note: Discharge Coefficient: 0.5 Small Brooks in Flat Area

(3) Estimation of Increased Drainage and Flood Discharge

a. Impact of increased drainage from road surface on the safety margin concerning the capacities of the affected rivers and channels

- Drainage from road surface during rainy weather

Table 17.5 shows the estimated drain volume from the surface of each road in rainy weather. The data indicates that the largest increase of drainage is 4.44 m^3/sec from New Bagamoyo Rd. (No. 2). The next largest is 3.68 m^3/sec from Morocco Rd. (No. 1), and the third 3.54 m^3/sec from Kilwa Rd. (No. 2)

- Flood discharge from rivers during rainy weather

Taking into account the additional drainage from the surface of the planned roads, the increased flood discharge from each river during rainy weather is shown in Table 17.6.

Table 17.5 Estimated Drainage from the Surface of each Road during Rainy Weather

Classification	Location	Drainage from Road Surface m^3/sec		(B) - (A) m^3/sec	Drainage into
		Existing road (A)	Planned road (B)		
Package 1 Arterial Roads in the City Center	Ohio	0.3072	0.8448	0.5376	Sea Via storm water
	Sokoine	0.3164	0.9062	0.5898	ditto
	Kivukoni	0.1229	0.5952	0.4723	ditto
	Gerezani (1)	0.3072	0.9600	0.6528	ditto
	Gerezani (2)	0.1229	0.3840	0.2611	ditto (via Pugu Rd)
	Bandari (1)	0.2765	0.8640	0.5875	ditto
	Bandari (2)	0.3840	1.2000	0.8160	ditto
	Sub-total	(1.8371)	(5.7542)	(3.9171)	
Package 2 Middle Ring Road and the Missing Link	Morocco (1)	0.9400	4.6234	3.6834	Sinza river
	Morocco (2)	0.1536	0.7680	0.6144	Chato street
	New Kigogo (1)	0.3441	1.6781	1.3340	Ubungo river
	New Kigogo (2)	0.5161	2.5651	2.0490	Msimbazi River
	Missing link (1)	0	0.6048	0.6048	Msimbazi River
	Missing link (2)	0	0.1056	0.1056	Sea via stormwater
	Chang' ombe (1)	0.2304	1.6800	1.4496	ditto
	Chang' ombe (2)	0.3226	1.0080	0.6854	Riverbed
	Sub-total	(2.5068)	(13.0330)	(10.5262)	
Package 3 Trunk Roads	New Bagamoyo (1)	0.4762	2.6688	2.1926	Chato street
	New Bagamoyo (2)	0.8448	5.2800	4.4352	Kijitonyama river
	Uhuru (1)	0.2703	0.9124	0.6421	Sea via stormwater
	Uhuru (2)	0.5591	1.7472	1.1881	Msimbazi river
	Uhuru (3)	0.6451	2.4614	1.8163	Msimbazi river
	Kilwa (1)	0.1536	1.2288	1.0752	Sea via stormwater
	Kilwa (2)	0.7619	4.3027	3.5408	Riverbed
	Sub-total	(3.7110)	(18.6013)	(14.8903)	
TOTAL		8.0549	37.3885	29.3336	

Table 17.6 Estimated Increased Flood Discharge from each River and Channel during Rainy Weather

Name of River	Basin Area	Flood Discharge (A)	Additional Drainage from Road Surface (B)	(A) + (B)	Remarks
Kijitonyama	km^2 3.9	m^3/sec 32.3	m^3/sec 4.44 (12.1)	m^3/sec 36.74	New Bagamoyo Rd.
Sinza	24.75	65.1	3.68 (5.4)	68.78	Morocco Rd.
Ubungo	34.20	73.6	1.33 (1.8)	74.93	New Kigogo Rd.
Msimbazi	240.00	381.4	5.66 (1.5)	387.06	New Kigogo Rd. Missing Link Uhuru g Rd.

Note: Figures in parentheses are the percentages of drainage from road surfaces to total flood discharges.

b. Impact of the road development on areas where overflow on roads or local flooding is currently observed

The places where overflow on roads or local flooding is currently observed in Dar es Salaam were determined in the initial environmental examination (see Figure 5.1). In estimating and assessing the possible impact of the priority roads, the following two point should be taken into consideration.

First, overflow on roads will be reduced when surface conditions are improved and drainage devices are installed. The present overflow on roads is caused by the damaged surface and incomplete drainage structures (for example on Uhuru, Chang'ombe, Kilwa and Bandari Rd.). This overflow on roads will be eliminated after surfaces are improved and suitable drainage devices are provided. However, it is imperative that the roads and structures must be properly maintained after being constructed.

Secondly, the flowing capacity of rivers is insufficient if the flowing volume during flood-time is considered, thus leading to frequent occurrence of floods. If drainage from the road surface increases due to improvement, it is foreseen that the flowing volume in the Kijitonyama River (the basin of which includes New Bagamoyo Rd.), might increase and consequently the flood near the crossing of Old Bagamoyo Rd. would be more serious. This is because earth and sand washed out from the basin as well as thrown-away garbage and solid waste would be accumulated, causing reduction of flow capacity of the rivers.

(4) Assessment

1) Environmental Preservation Target

The environmental preservation target in terms of flood hazard shall be established as follows:

"The road development should not accelerate the flood hazard in areas along the road or downstream, and the living environment of the residents along the road and downstream should not be damaged."

2) Results of Assessment

- Impact of increased drainage from the road surface

An assessment on the safety margin concerning the capacities of the affected rivers and drainage channels has been made by comparing the expected flood discharge after the road improvement (as shown in Table 17.6) to the present flow capacity as shown in Table 17.7.

Table 17.7 Flood Discharge and Flow Capacity of Rivers

Name of river	Total flood discharge	Flowing capacity	Judgment
Kijitonyama	m^2/sec 36.74	m^3/sec 27.5	Expansion measure is required.
Sinza	68.78	69.3	"
Ubungo	74.93	196.6	No improvement measure is required.
Msimbazi	387.06	422.0	"
Waterway (Gerezani Rd.)	Data not available		Improvement measure might be required.

Note: The estimation of flow capacity of rivers and channels is concluded in Chapter 14.

As shown in Table 17.7, the flood discharge will become sufficiently lower than the flowing capacity in the Ubungo River and the Mismbazi River. It is to say, the safety margin concerning the capacities of each river and channel could be well maintained and consequently the environmental preservation target be achieved.

In the Kijitonyama River, where the flood discharge exceeds the flow capacity by 9.4 m^3/sec, it is necessary to increase the flow capacity by river improvement work such as widening the river bed and protecting the river banks. Moreover, although the flow capacity of Sinza River is slightly

greater than the flow volume during flood-time, the flow capacity of the culvert under Morocco Road has been greatly reduced due to accumulated garbage and silt thus causing problems during flooding period. Therefore, the replacement or renovation of this culvert should be considered to increase its flow capacity.

Furthermore, the flow capacity of the waterway in the basin where Chang'ombe Rd., Kilwa Rd. and Gerezani Rd. are located is low particularly at the area near its crossing with Gerezani Rd. Since the area is located in a tidal zone, sea water flows back into the waterway at high tide thus a part of the area is flooded. However, as the land-use of the area will change in the future (for example, when the residential area expands into this area) a serious flood hazard may occur when a flood from heavy rains coincides with a high tide. It is therefore necessary to control the development of low lands near the river mouth, to guide the area towards suitable land-use and to provide funds for river rehabilitation to increase its flow capacity.

Along the above-mentioned waterway crossing the Kijitonyama River, Sinza River and Gerezani Rd., it is necessary to construct replacement or additional culverts to improve flow capacity of the waterway. This would ensure the flood control safety margin.

From the present condition of the rivers and of their basins in Dar es Salaam, it is very probable that the following issues will create serious social problems in terms of flood hazard. To avoid such problems, action should be taken to frame laws concerning river management and sewage control as well as improvement plans for these rivers and sewerage. Moreover, education of the residents should be promoted so that they can acquire awareness of the need for environmental conservation.

- Increased flood hazard resulting from the expansion of residential area into the areas prone to flooding.
- Reduced flood control safety margin caused by the decreased flow capacity of rivers due to accumulation of earth and soil from erosion.
- Reduced flood control safety margin caused by the decreased flow capacity of rivers due to garbage and solid waste.
- Collapse of river banks and accumulation of washed-out earth caused bay a lack of slope protection.

- Reduced capacity of the rainwater drainage systems due to insufficient maintenance.

- Impact of road development on places where overflow on roads or flooding is currently observed

After road surfaces are improved and rainwater drainage systems are installed, it is expected that road condition will be greatly improved in the flood-prone areas where water currently overflows on the roads due to damaged road surface and incomplete/clogged drainage structure.

Although it is anticipated that the flood-prone area will expand due to increased drainage from the new roads where the flow capacity of the river (at the crossing of Kijitonyama and Old Bagamoyo Rd.) is insufficient, the flood control safety margin could be assured by replacing or improving the culverts. Furthermore, it is necessary to improve the flow capacity of the river by carrying out periodic maintenance to remove accumulated earth, sand, trash and other form of waste. By taking these measures, it would be possible to limit the expansion of the flood-prone areas.

From all of these, it can be said that the possible impacts of priority roads on the areas suffering from overflow or flooding might include more favorable factors than adverse ones. It is therefore concluded that the environmental preservation target can be achieved.

17.4.2 Resettlement of Residents

(1) Estimation

1) General

The aim of the proposed project is to widen the trunk roads in Dar es Salaam which would eliminate traffic congestion and resulting in the smooth flow of urban traffic. Also, planting roadside trees and constructing overpasses would create a favorable urban environment.

On the other hand, construction and widening of the priority roads necessitate the resettlement of residents whose homes or commercial installations are built on the site of the planned roads. This of course will have economic, social and environmental impacts on these residents. In cases where the resettlement is inevitable, proper measures must be taken to minimize the impact on the affected residents.

The number of buildings and residents required to be relocated or resettled in the project implementation have been estimated and the various problems accompanying the resettlement were examined, pertaining to the following:

Coverage of the Estimation:

[Arterial Roads in the City Center]

- Ohio, Sokoine, Gerezani, and Bandar Roads
- Kivukoni Front

[Middle Ring Road]

- Morocco, New Kigogo, and Chang'ombe Roads
- Missing Link between New Kigogo Road and Chang'ombe Road

[Radial Trunk Roads]

- New Bagamoyo, Uhuru, and Kilwa Roads

2) Method of Estimation

The number of buildings to be included in the resettlement was calculated by checking the drawings of the Road Improvement Plan (plan alignment). Other

buildings were estimated according to results of site a survey and interview surveys with the residents living/working there.

3) Preconditions

a. Basic project policy

- Considerations for the road development plan

All priority roads are to be widened from two lanes to four lanes. As mentioned before, widening of the roads and subsequent tree planting would eliminate the traffic congestion, create more favorable urban environment and allow better traffic access for the residents in the roadside areas. Thus, several socio-economic benefits can be expected.

Even so, widening of the roads will necessitate resettlement of some residents in the roadside areas. Therefore, to reduce any adverse socio-economic impact an alignment plan has to be formulated to minimize the need for resettlement.

- Examining and executing an appropriate resettlement plan

An appropriate resettlement plan must take into account compensation for the affected persons, securing of places to move and considerations for the living environment at the place of resettlement (concerning relations with the existing residents at the resettled places, socio-economic conditions and surrounding infrastructure). This would help reduce adverse socio-economic impacts and preserve the living conditions of the residents to be moved. In doing so, the most possible type of arrangement with the residents to be moved shall be attained so that the resettlement plan could be carried out smoothly.

b. Present governmental policy

When resettlement of residents is necessitated for improvement of social and economic infrastructures in Tanzania, the present government policy in dealing with the residents to be moved is as follows:

- The property owner is eligible for compensation based only on the value of the property and not on the business, expense or service connections.

- Tenants who only occupy the property (i.e. non-owners) are not eligible for relocation nor compensation.

3) Results of Estimation

a. Type and number of buildings

Table 17.8 shows the type and number of buildings along each priority road which need to be removed. The table also shows the estimated cost for the resettlement.

The total number of buildings to be included in the resettlement is 577. The number of the buildings along each road is shown as follows: the largest is 179 along Morocco Rd. accounting for 31% of the total, the second is 121 along Kigogo Rd. (21%) and the third is 75 (13%) along Uhuru Rd. If classified by function, 196 kiosks or roadside stalls account for the greatest number (34%), next are residences at 189 (33%), and finally there are 186 small houses (32%). No factories will have to be removed.

b. Various problems concerning the resettlement

- Social and cultural effects

As a result of non-voluntary resettlement by the project implementation, it is possible that the present living standards of the residents in question may be reduced due to the level of the socio-economic infrastructure at the place of resettlement, or convenience of access to their places of work.

- Impact on economic activity and employment

In addition to residences, there are a number of commercial installations (including small roadside stalls and kiosks) located along the priority roads, some of which are to be moved. Most of the commercial installations located along the priority roads will be able to enjoy economic benefits because the traffic access would be improved and greater convenience would be brought about. Accordingly, economic activities will be enhanced. On the other hand, for some commercial installations to be moved, it is possible that the resettlement might bring adverse effects to their owners such as operational difficulty and less favorable business conditions as well as inconvenience to their employees such as longer commuting to the new working places.

Table 17.8 Number of Buildings and Residents to be included in Resettlement and Cost Required for Resettlement

Cost: Thousand Tsh.

	Name of Road	Residence		Commercial House or Office		Factory		Small House		Kiosk, timber stall		Total	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
A	Ohio Street	0	0	0	0	0	0	0	0	1	200	1	200
	Kivukoni Front	0	0	0	0	0	0	0	0	7	1,400	7	1,400
	Sokoine Drive	0	0	1	2,000	0	0	0	0	0	0	1	2,000
	Bandari Road	0	0	1	4,250	0	0	5	1,000	7	1,400	13	6,650
	Gerezani Road	0	0	0	0	0	0	2	400	0	0	2	400
B	Morocco Road	64	128,000	0	0	0	0	85	17,000	30	6,000	179	151,000
	New Kigogo Road	59	118,000	0	0	0	0	48	9,600	14	2,800	121	130,400
	Chang' ombe Road	0	0	0	0	0	0	11	2,200	11	2,200	22	4,400
	Missing Link	10	20,000	0	0	0	0	0	0	0	0	10	20,000
C	New Bagamoyo Road	0	0	0	0	0	0	6	1,200	67	13,400	73	14,600
	UhuruRoad	22	44,000	2	14,000	0	0	9	1,800	42	8,400	75	68,200
	Kilwa Road	1	5,000	2	4,000	0	0	20	4,000	17	3,400	73	82,400
Total		189	381,000	6	24,250	0	0	186	37,200	196	39,200	577	481,650

(2) Assessment

1) Environmental Preservation Target

The environmental preservation target in terms of the resettlement of the residents shall be set as follows:

"The standard of living of the residents who have to be resettled shall be assured and the social and cultural setting of the new settlement shall be the one to which the residents can easily adapt."

2) Results of Assessment

Traffic congestion will be eliminated and the urban environment will be improved as a result of widening the roads. Also, the traffic access will be improved for most residents and people engaged in commercial activities along the priority roads. Therefore, it can be said that socio-economic and environmental effects to be brought by the project implementation will be significant.

Along part of the roadside areas, however, widening the roads will undoubtedly necessitate the resettlement of the residents there. For this reason, an estimate was made of the number of buildings and residents to be moved according to the data included in the alignment plan of the priority roads. It is anticipated that the total number of buildings to be moved is 577.

Among the buildings to be moved, there are many which illegally occupy the land within the site of the priority roads, and they are not eligible for resettlement compensation. However, as already clarified in the survey to the residents to be moved, some of the long-term illegal occupants have lived there for 20 to 30 years. Therefore, these occupants should be deemed as having the right of residency and accordingly they would have to be allowed to receive compensation for the resettlement.

In addition, the following measures to be discussed in Section 17.5 should be taken. Through these measures, it would be possible to resolve the problems relating to the resettlement thereby doing much to maintain the standard of living of the residents to be moved and making sure that they can adapt to their new settlement site both socially and culturally.

- Early formation of an appropriate resettlement plan

- Reaching a consensus with the residents
- Considerations in the detailed plan to resettle the residents

17.4.3 Air Pollution

(1) Estimation

1) General

The traffic congestion is apparent in Dar es Salaam on a regular basis, hindering the smooth functioning of vehicles. Furthermore, in the areas along the roads where serious traffic congestion occurs, air quality is deteriorated by exhaust gases from vehicles. In view of the expected population increase, it is anticipated that the roadside environment will become much worse without proper improvement measures.

The proposed priority project will play an important role in eliminating traffic congestion and in restoring urban environment by improving air quality.

Since exhaust gases from motor vehicles will affect the air quality in residential areas, particularly in the areas along the trunk roads, concentration of pollutants in the atmosphere has been estimated and assessed. The probable impact of dust flung up by road construction and passing vehicles in the nearby areas along the priority roads has also been assessed.

- Estimated factors : Nitrogen dioxide (NO_2), Carbon monoxide (CO)
- Target year : the year 2000
- Roads and widths assumed for estimation:

A. Arterial Roads in the City Center
   - Ohio Street (20 m)
   - Gerezani Road (25 m)

B. Middle Ring Road and the Missing Link
   - Morocco Road (35 m)
   - Chang'ombe Road (25 m)

C. Radial Trunk Roads

- New Bagamoyo Road (30 m)
- Uhuru Road (25 m)
- Kilwa Road (35 m)

Components of road cross-sections are shown Appendix 17.3(1).

- Location:

Location is selected as shown in Figure 17.2, in view of land use of the areas along the High-Priority roads.

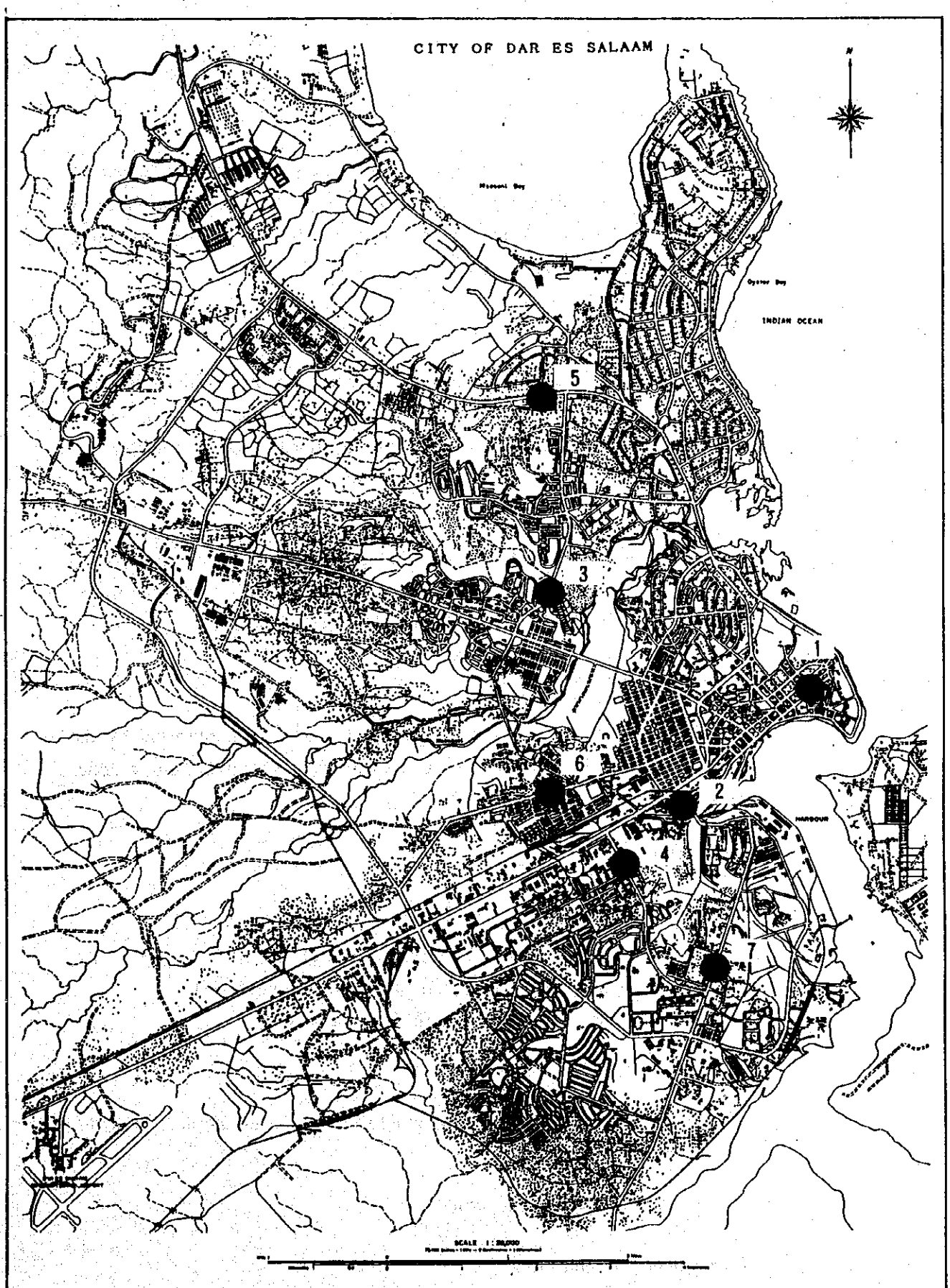


Figure 17.2 Location Subject to Estimation/Assessment on Air Pollution

1 Ohio Street
2 Gerezani Road
3 Morocco Road
4 Chang'ombe Road
5 New Bagamoyo Road
6 Uhuru Road
7 Kilwa Road

2) Method of Estimation

The annual mean concentration of air pollutants caused by automobile exhaust gases were estimated, using a diffusion equation, with the assumed height being as at 1.5 meter above the ground at the roadside. The calculation procedures are shown in Appendix 17.3(2), (3).

- Estimation equation

  A plume model equation was employed for windy conditions (in cases where the wind velocity exceeded 1 m/s) while a puff model equation was used for less windy conditions (in case where the wind velocity is below 1 m/s).

- Determination of diffusion width

  The diffusion width used for the calculation was determined in consideration of the stirring and mixing effects near to the road caused by passing motor vehicles, referring to Pasquill, Gifford and Turner's parameters.

- Estimated wind velocity

  Wind velocity at the height of the exhaust source was estimated by the following equation using the wind velocity data obtained from weather observation records:

  $$U = U_0 (H / H_0)^{\alpha}$$

  , where:

  U: Estimated wind velocity (m/s) at height H (m)
  U_0: Wind velocity (m/s) at the reference height H_0 (m)
  α: Exponent (0.2 for suburban area was used)

- Conversion from NO_X to NO_2

  The NO_X concentration was converted into a NO_2 concentration by applying the equation below.

  $$[NO_2] = 0.0801 [NO_X]^{0.701}$$

- Background concentration

  Because sufficient data at the site was not available to determine the background concentration, the measurement data of air pollution in Japan

were used. As such, the following concentration values for which the present status and future prospects of the urban activities in Dar es Salaam are set forth:

NO_2: 0.020 ppm, CO: 2.0 ppm (Note; ppm = part per million, ml/m^3)

- Traffic conditions (see Appendix 17.3(5))

  • Future daily traffic volume

  Daily traffic volume used in the estimation is as follows:

Table 17.9 Future Daily Traffic Volume

Type of road improvement	Name of road	Location No.	Future daily traffic volume (number/day)	
			Total	Large vehicles
A. Widening of Arterial Roads in City Center	Ohio	1	26,345	4,023
	Gerezani	2	35,541	8,706
B. Widening of Middle Ring Roads and Construction Missing Rink	Morocco	3	41,657	10,076
	Chang' ombe	4	26,037	7,927
C. Widening of Trunk Road from 2 to 4 Lane	New Bagamoyo	5	11,413	5,852
	Uhuru	6	31,821	10,399
	Kilwa	7	24,891	6,750

  • Coefficient of hourly variation and ratio of vehicle type mixture

  The coefficient of hourly variation and ratio of vehicle type mixture necessary for calculating the hourly traffic volume for the use in estimation was determined, according to the results of field survey conducted at Morocco Road

  • Average driving speed

  Design speed of each road was employed as mean driving speed.

  • Coefficient of exhaust gases

  Coefficient of exhaust gases indicated by the Road Bureau of the Ministry of Construction of Japan in 1986 was used.

- Determination of weather condition (see Appendix 17.3(6))

Weather conditions (wind velocity and direction) necessary for the

estimation of air pollution was determined according to the observation record of 1992 in Dar es Salaam.

3) Result of Estimation

a. Impact of vehicle exhaust gases on the atmosphere

Table 17.10 shows the estimated concentration of nitrogen dioxide at 1.5 meters above the roadside ground while Table 17.11 shows the estimated concentration of carbon monoxide.

Table 17.10 Estimated Concentration of Nitrogen Dioxide

Name of Road	Location No.	Nitrogen Dioxide Concentration (ppm)		
		Contributory Concentration	Background Concentration	Annual Mean
Ohio	1	0.00502	0.020	0.02502
Gerezani	2	0.00685		0.02685
Morocco	3	0.00635		0.02635
Chang' ombe	4	0.00571		0.02571
New Bagamoyo	5	0.00462		0.02462
Uhuru	6	0.00704		0.02704
Kilwa	7	0.00578		0.02578

Table 17.11 Estimated Concentration of Carbon Monoxide

Name of Road	Location No.	Carbon monoxide concentration (ppm)		
		Contributory Concentration	Background Concentration	Annual Mean
Ohio	1	0.05419	2.0	2.05419
Gerezani	2	0.06229		2.06229
Morocco	3	0.04605		2.04605
Chang' ombe	4	0.03517		2.03517
New Bagamoyo	5	0.01375		2.01375
Uhuru	6	0.04574		2.04574
Kilwa	7	0.02582		2.02581

b. Impact of dust caused by road construction and passing vehicles

In most cases, dust is flung into the air by vehicles when they run along the shoulders of unpaved roads. Also, during the construction stage, dust will be caused by construction equipment.

By the time the Project is completed, must of the road will have been paved, so it can be expected that dust caused by passing vehicles would decrease and the environment along the roads be improved. It is anticipated, however, that earth/sand carried by run-off discharge can still be deposited on the shoulders of the roads, depending upon weather conditions. It is therefore necessary to have the road maintenance activities include cleaning, as well as the further improvement of the sewerage.

(2) Assessment

1) Environmental Preservation Target

Environmental quality standards on air pollution have already been established in developed countries like Japan, the United States and Europe, as well as by international organizations such as WHO. With regard to nitrogen dioxide, the environmental quality standards specified by WHO have been adopted as the environmental preservation targets in this Study. For carbon monoxide, the Japanese environmental quality standards were used instead of WHO's, because the daily mean is not specified in the WHO standards. These are shown below.

Table 17.12 Environmental Preservation Target for Air Pollution

Pollutant	Target
Nitrogen dioxide	Daily mean of hourly concentration shall be less than 0.08 ppm.
Carbon monoxide	Daily mean of hourly concentration shall be less than 10 ppm.

2) Result of Assessment

In view of the estimated results based on the annual mean, the following equations were used to convert the annual mean into the annual 98% value of the daily mean (hereinafter called the daily mean).

Nitrogen dioxide (area along roads): $y = 1.48x + 0.0064$ (ppm)

Carbon monoxide (area along roads): $y = 1.49x + 0.544$ (ppm)

, where:

x: Annual mean
y: Annual 98% value of the daily mean (nitrogen dioxide)
y: 2% exceptional value of the daily mean (carbon monoxide)

Source: "Coefficient of exhaust, NOx conversion equation, and the estimation equation of the annual 98% value of the daily mean to be used for environmental impact assessment of road construction," Ministry of Construction, Japan (December 1987)

Note: The above equations represent the correlation between the yearly mean and the daily mean of the concentrations measured in Japan by the Bureau of Automobile Exhaust Gas Measurement, from 1983 to 1985.

Table 17.13 shows the daily mean concentrations of the air pollutants at the selected locations. Additionally, the Table also shows the estimated concentrations of the pollutants in the future for the case of "without project" in which the present road conditions are not improved.

Since the daily mean concentration of air pollutants in the case of "with project" for the project implementation, is below 0.05 ppm for nitrogen dioxide and below 4 ppm for carbon monoxide at all locations; both might meet the environmental preservation targets (NO_2: less than 0.08 ppm, CO: less than 10 ppm). Therefore, the impact of exhaust gases caused by passing motor vehicles on air quality would be minimal.

The estimated concentration of air pollutants in the case of "without project" shows fairly higher figures for nitrogen dioxide and carbon monoxide, if compared to those in the case of "with project". This is well justified by the fact that road development would play an important role in improving air quality along the roadside.

Air quality would be further improved in the near-by areas by the paving of roads which will prevent the dust being generated by passing vehicles. The impact of dust caused in the construction stage could be minimized by taking appropriate measures including water spraying.

It is concluded, from the above discussions, that the traffic conditions after the project implementation will, in general, little impact on the air quality along the roadside areas.

Table 17.13 Estimated Concentration of Air Pollutant (daily mean)

Name of road	Location No.	NO_2		CO	
		With project	Without project	With project	Without project
Ohio	1	0.04343ppm	0.06899ppm	3.60474ppm	3.73734ppm
Gerezani	2	0.04614	0.07586	3.61681	3.80172
Morocco	3	0.04540	0.08265	3.59261	3.86061
Chang' ombe	4	0.04445	0.06751	3.57640	3.71713
New Bagamoyo	5	0.04284	0.05435	3.54449	3.59859
Uhuru	6	0.04642	0.07336	3.59215	3.76969
Kilwa	7	0.04455	0.06939	3.56247	3.71412

According to the "Urban Air Pollution in Megacities of the World" (UNEP/WHO), air pollution caused by the nitrogen oxides in Los Angeles, Mexico City, Moscow and Sao Paulo is of a moderate level. (exceeding the WHO standards but less than that amount double) Pollution by nitrogen oxides are expected in Dar es Salaam in the near future due to the expansion as well as concentration of various urban activities.

In order to reduce the nitrogen oxides, it is proposed to take necessary action including regulating the exhaust gas concentrations of motor vehicles and introducing a compulsory periodic vehicle inspection system, because the present exhaust gas concentration from motor vehicles is very much higher than in advanced countries such as Japan, and also because the traffic volume of motor vehicles will increase even after the year 2000.

To preserve air quality, it would be necessary to establish legislations concerning environmental quality standards and regulation standards, as well as to form a long-term and comprehensive air quality preservation plan, and to conduct a survey on air pollution with immediate reference to the survey results.

Furthermore, an asphalt plant will be in use during construction stage. Appropriate measures must be taken at this plant to prevent the emission of airborne particles,as otherwise air pollution will be increased considerably. It is necessary, therefore, to install a particle filtration apparatus for the asphalt plant to protect air quality.