REPORT

ON

RAILWAY CONSTRUCTION PROJECT

IN TANZANIA

(ARUSHA - MUSOMA)

SEPTEMBER 1970

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

Preface

The Overseas Technical Cooperation Agency of Japan in line with the request of the East African Community had sent a team of eight experts, led by Dr. Matsutaro Fujii, President of Nippon Kotsu Gijutsu K.K., to Tanzania, Uganda and Kenya on the 25th of March, 1970 with a view to undertaking necessary field surveys of the proposed railway-line between Musoma and Arusha.

During about one month period, the team among other things carried out works to determine the most suitable location of the link between, and to prepare preliminary designs for the railway alignment, estimated cost and period of the construction.

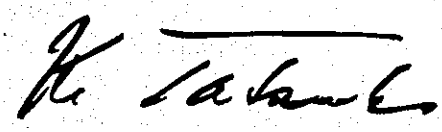
At the same time, it studied any improvements to the present Tanga-Arusha line, a plan for possible upgradings to Musoma and Tanga Ports, and also improvements to existing roads feeding traffic to the new railway-line.

This report is the outcome of the survey and study performed by the team mentioned above.

Nothing would be more gratified than it could contribute to further economic development of the countries involved, and thus to enhancement of mutual friendship between us.

Finally, I take this opportunity to express my hearty gratitude to the East African Community as well as the Governments of the related Three Countries for their kind cooperation and assistance extended to the team.

September 1970



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency
Japan

SUMMARY AND RECOMMENDATIONS

This report deals with the project for the new railway-line between Arusha and Musoma, improvements of existing Tanga-Arusha line as well as those of both ports - Tanga and Musoma and also roads construction or improvement which are supposed to be undertaken in relation with the new railway-line project.

In this regard, touching upon the perspectives of Tanzania in general, the report forecasts transportation volume on the project line by 1980.

The following are conclusions as a result of the study for the project:

1. New railway-line between Arusha and Musoma.
   Total length: 544.4 km
   Station facilities: at 19 places (including existing both terminals)
   Construction cost: £ 35.535 millions
   Construction period:
   Survey and design ——— 2 years
   Actual construction ——— 4 years
   Total ——— 6 years

2. Improvements of existing Tanga-Arusha railway-line.
   Improvement for increasing transportation capacity: £ 4.27 millions
   (Contents)
   Establishment of signal stations for increasing railway-line capacity: £ 0.36 millions
   Track strengthen: £ 3.46 millions
   Improvement of curvature: £ 0.20 millions
   Enlargement of effective length of station: £ 0.25 millions
   Improvement for operational safety: £0.1 millions
   Shortening of sections between existing Tanga-Arusha line: £0.28 millions
   Grand total: £ 4.65 millions
   Construction period: one year starting from urgent item

3. Roads construction and improvement in relation with new railway construction.
   New road construction of 55 km between Oldeani and Endulen: £ 0.26 millions
   Roads improvement of 30 km between Endulen and B144, and of 42 km between Ruhogo and Ikoma: £ 0.23 millions
   New feeder roads construction of 52 km: £ 0.24 millions
   Total: £ 0.73 millions
   Construction period: 6 months for improving main road, and 15 - 18 months for constructing new main road while remaining a few months for feeder roads construction.

4. Improvements of Tanga and Musoma Ports.

Tanga Port: two berths for the time being, costing £ 2.4 millions
(five more berths necessary in the future with a cost of £ 6.0 millions)

Musoma Port: No need for improvement at present.

5. Estimate of railway traffic volume

Assuming Tanzania's rate of gross products in future be same as that in 1963 - 1967, and the volume of railway traffic increased in proportion to the above rate, and also goods flown into the shortest route thoroughly, the transportation volume between Musoma and Tanga in 1980 is estimated to be 64,000 - 366,000 ton for the Up and 22,000 - 181,000 ton for the Down in the case that goods are not flown from Uganda alternatively, while 801,000 - 1,101,000 ton for the Up and 624,000 - 780,000 ton for the Down in the case that goods are flown from Uganda.

From the above, it seems far difficult to justify economically the new railway project, to be more specific, the revenue deemed to obtain from the new railway between Arusha and Musoma in 1980, that is, £ 4.924 millions per annum at the present fare rate, will not be enough to cover necessary costs such as depreciation cost for railway-line, rolling stock, etc. as well as capital interest, since the railway operation cost is computed to be £ 4.264 millions annually.

However, it is considered a mistake to stick too much to the present statistics on the ground that agricultural and industrial products in developing countries are expected to be remarkablly increased with a result of development of infrastructure such as railway, road, port & harbour, etc.

The new railway-line between Arusha and Musoma, once constructed, will provide Uganda with two links towards the Indian Ocean. On the other hand, it will play a role to ease the present rush of the Nairobi-Mombasa Railway and, in addition, relieve the congestion at Mombasa Port to a certain degree.

As for Tanzania, this line will produce an artery to high potential areas of both agriculture and industry alongside the railway-line and that the revenue from the existing Tanga-Arusha line is considered to be greatly raised at a little cost for the improvement, contributing to the prosperity of Tanzania in future.

Consequently, it is concluded that the entire three countries of the East African Community will derive a great deal of benefits from the new railway-line project, and thus an emphasis on the accomplishment of the project by all means is recommended.

In order to construct the new railway-line, detailed survey, investigation and design are required to conduct at the earliest possible date, following a final determination of the project. For this purpose, about two years of duration and a cost of £ 0.5 millions will be needed.

JAPANESE SURVEY TEAM FOR RAILWAY CONSTRUCTION PROJECT IN TANZANIA

Dr. Matsutaro Fujii (Head of the Team)
President
Nippon Kotsu Gijutsu K.K.
(Japan Transportation Consultants, Inc.)

Mr. Mitsuhiko Yokota (New Railway-line Planning)
General Manager
Sapporo Regional Office
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Deputy Director
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Ministry of Transport

Mr. Mitsuo Arai (New Railway-line Planning)
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Loop Line Division
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Japan Railway Construction Public Corporation

Mr. Yuichi Katayama (Improvement of Existing Railway-line and Economic Survey)
Assistant Director
Long Term Planning Office
Tohoku Region
Japanese National Railways

Mr. Michio Morihira (Planning of Port & Harbour)
Deputy Director
Construction Division
Bureau of Ports & Harbours
Ministry of Transport

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Japan Highway Public Corporation

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Development Survey Department
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PROGRAMME AND ITINERARY CARRIED OUT BY THE TEAM

I. Railways Group for New Railway-line
(Messrs. M. Fujii, M. Yokota, M. Arai and Y. Hirotani)

Mar. 25 (Wed)	Lv. Tokyo
26 (Thu)	Ar. Dar es Salaam
27 (Fri)	Programme meeting and orientation by Japanese Embassy
28 (Sat)	Visit: Ministry of Communications, Transport and Labour Exchanging views
	Data collection
29 (Sun)	Preparation for field survey
30 (Mon)	Lv. Dar es Salaam for Arusha by air
31 (Tue)	Visit: Headquaters of Communication & Research, East African Community Preliminary meeting
Apr. 1 (Wed)	Investigation of Arusha Station
2 (Thu)	Field survey of Ngorongoro area
3 (Fri)	Lv. Arusha for Manyara
	Field survey of northern part of Lake Eyasi area
4 (Sat)	Field survey of Manyara area and its vicinity
5 (Sun)	Free
6 (Mon)	Field survey (Manyara - Mto Wa Mbu - Engaruka & its vicinity)
7 (Tue)	Field survey (Manyara - Ngorongoro & its vicinity)
8 (Wed)	Field survey (Manyara - Ngorongoro - Seronera)
9 (Thu)	Field survey (Seronera - Naabi - Kakesyo & its vicinity)
10 (Fri)	Field survey (Seronera - Musoma)
	Inspection of Musoma Port
11 (Sat)	Lv. Musoma for Kampala
12 (Sun)	Inspection of Jinja Port
13 (Mon)	Visit: Ministry of Communications Courtesy call
	Lv. Entebbe for Nairobi by air
	Visit: Japanese Embassy — courtesy call and orientation
14 (Tue)	Visit: East African Railways Headquaters Exchanging views and data collection
15 (Wed)-	Lv. Nairobi for Moshi by air
17 (Fri)	Interim Report making
18 (Sat)	Visit: East African Community Headquaters Presentation of Interim Report

Apr. 19 (Sun)		Meeting with Minister for Communications, Government of Tanzania (Messrs. Fujii, Yokota, Sugita and Hirotani)
		Lv. Moshi for Dar es Salaam by air
	20 (Mon)	Visit: Ministry of Communications
		: Japanese Embassy
		Report on results of field survey
		Data collection
	21 (Tue)	Preparation for departure
	22 (Wed)	Lv. Dar es Salaam for Tokyo (Messrs. Yokota and Arai)
	23 (Thu)	Visit: President's Office
		Courtesy call on President of Tanzania (Messrs. Fujii and Hirotani)
	24 (Fri)	Lv. Dar es Salaam for Tokyo

II. Railways Groups for Existing Railway-line Improvement
(Messrs. T. Kikukawa and Y. Katayama)

Mar. 25 (Wed)-		Same as Group I's
Apr. 1 (Wed)		
	2 (Thu)-	Field survey between Arusha and Tanga Stations
	4 (Sat)	
	5 (Sun)-	Join with Group I
	11 (Sat)	
	12 (Sun)	Lv. Entebbe for Nairobi
	13 (Mon)	Visit: Japanese Embassy — courtesy call and orientation
	14 (Tue)-	Join with Group I
	22 (Tue)	

III. Port & Harbour Group (Mr. M. Morihira)

Mar. 25 (Wed)-		Same as Group I's
Apr. 1 (Wed)		
	2 (Thu)	Lv. Arusha for Tanga
	3 (Fri)-	Field survey tour of Tanga, Mombasa, Portbell and Entebbe Ports
	11 (Sat)	
	12 (Sun)-	Join with Group I
	19 (Sun)	
	20 (Mon)-	Inspection of Dar es Salaam Port
	21 (Tue)	
	22 (Wed)	Lv. Dar es Salaam for Tokyo

IV. Road Group (Mr. Y. Sugita)

Mar. 25 (Wed)-	Same as Group I's
Apr. 4 (Sat)	
5 (Sun)	Lv. Arusha for Dar es Salaam by air
6 (Mon)-	Field survey of Dar es Salaam/Mtwara Road Project
14 (Tue)	
15 (Wed)	Lv. Dar es Salaam for Arusha by car, investigating load conditions en route
16 (Thu)-	Join with Group I
22 (Wed)	

CONTENTS

CHAPTER I THE UNITED REPUBLIC OF TANZANIA

1-1 A short history of Tanzania

Tanzania, located in the central part of the continent of Africa facing the Indian Ocean, is formed by the main territory known as Tanganyika, and three islands, namely, Zanzibar, Pemba, and Mafia. Due to the geographical features of the country, the coastal area has maintained its diplomatic relations with various countries from olden days with the Indian Ocean as media, and particularly its trade with Arabia and India has been promoted rather extensively. The TANU Party (Tanganyika African National Union) was organized in 1954. Julius K. Nyerere, the leader of the party, was elected prime minister by an overwhelming majority at the general elections held in 1958 and 1960. On December 9, 1961, Tangayika declared its independence as an autonomous government within the Commonwealth, and the republican form of government was adopted in 1962 with Mr. Nyerere elected as the first president. In May, 1964, Zanzibar joined in a single republic, and the name of the republic was changed to the United Republic of Tanzania.

With the Arusha Declaration of February, 1967, the government enhanced the spirit of independence and self-support, and nationalized many main industries and all banks. Nationalization has been carried out quite smoothly. Tanzania, Kenya and Uganda have organized the East African Community, and are conducting joint operation of the railways, harbors, communications, tariff, and liberalization of the regional trade.

1-2 Topography of Tanzania

The scenery in Tanzania is widely varying with a large number of lakes lying sporadically on the highlands, and tall mountains rising majestically beyond the grassland. The vast central highland which occupies the greater part of the territory and the Savanna where the Masai tribes dwell in are the typical topographical features of the African continent. Though the topography is a long continuation of gentle rolling plains, rift valley scarpment formed by landslides and crustal movements lies before the rolling plains.

The topography of the hilly districts in Usambara, Pare, Ulunga, Ungura and Iringa districts consists of the uplifted block affected by the subsequent river erosion, and the hilly districts up to El. 2700 m in Ulugurus and up to El. 2100 m in other districts from important forests and arable land. In the western part of the territory, faulting and warping caused by block movement occurred in two zones running parallel to each other and formed rift valleys. These rift valleys are found at quite high elevations, and the lowest parts of the rift valleys form long and narrow lakes. Lake Tanganyika is the typical example, and its elevation at the water surface is El. 770 m while the water depth is 1420 m.

In the northern district which is the center of the territory, rift valley scarpment created by the active crustal movement has dammed up the shallow lake like Lake Manyara. Although there still are some active volcanoes like Oldony Lengai on the northern

side of Ngorongoro, most of the volcanoes in Tanzania are extinct valcanoes. Kilimanjaro of elevation close to El. 6000 m, Meru of El. 4500 m, and Hanang of El. 3400 m do have the crater, but all are extinct. The famous Ngorongoro used to have the elevation of 4500 m, but halfway up of the same subsided and changed to caldera.

The southern coast of Lake Nyasa and the highlands on the north-western end of the territory were formed by the uplifting of the earth crust in the course of formation of the rift valley by block movement. The formation of Lake Victoria is quite different from that of other lakes. This lake was formed as the result of gentle warping of earth crust of the highlands, and is very shallow when compared with rift lakes. The rivers in the north-western part of Tanzania flow into Lake Victoria, and later form the Nile river system. Water on the vast Malagarasi basin flows into Lake Tanganyika which later pours itself into the Atlantic Ocean. Other rivers flow into Lake Eyasi, Lake Manyara and other lowlands or flow into the Indian Ocean. Those rivers rising from Kilimanjaro and the highlands in the southern areas such as Uruguru all flow eastward and empty themselves into the Indian Ocean. The important rivers among these are Pangani, Wami, Ruvu, Rufiji and Ruvuma. With the exception of Pangani, all the rivers have swamps which contain water in the rainy season, and they form the delta on the estuary.

With the exception of the deltas of the rivers, the coast line of Tanzania has well developed coral reefs, and those low precipices on the coast line are the eroded coral reefs of ancient times. Main ports were formed at places where the low precipices on the coast line were affected by river erosion.

Zanzibar, Pemba and Mafia are the three main islands formed as the result of sinking of ground. The elevation of Zanzibar is approximately 90 meters above sea level. Development of coral reefs is conspicuous around the islands, and the islands have beautiful sandy beaches. The territory covers and area of 938,023 km^2 (of which Zanzibar occupies 2,644 km^2). Water surface area of lakes, swamps and rivers is 134,680 km^2. 40% of the entire territory or 362,082 km^2 is covered by forests (of which 125,689 km^2 are forest reserve). (See Fig. 1-1 General Map of Tanzania and Fig. 1-2 Geology of Tanzania)

1-3 Climate of Tanzania

The climate of Tanzania can roughly be classified into four types according to the zone. The territory can be divided into the coastal zone, central highland zone, lake zone, and the northern and southern highland zone. The coastal zone has the typical tropical climate of high temperatures and high humidity. Mean annual temperature is about 27°C. Mean annual rainfall is about 1,200 mm. Comparatively favorable season is from June to August when the humidity gets low. The zone at El. 1500 feet and slightly inland from the coastal zone has lower humidity, but the temperatures are higher. The central highland zone located at El. 2000 ft. – 4000 ft. above sea level has the typical Savanna climate in which the dry season and the wet season can be distinguished clearly. Mean annual tem-

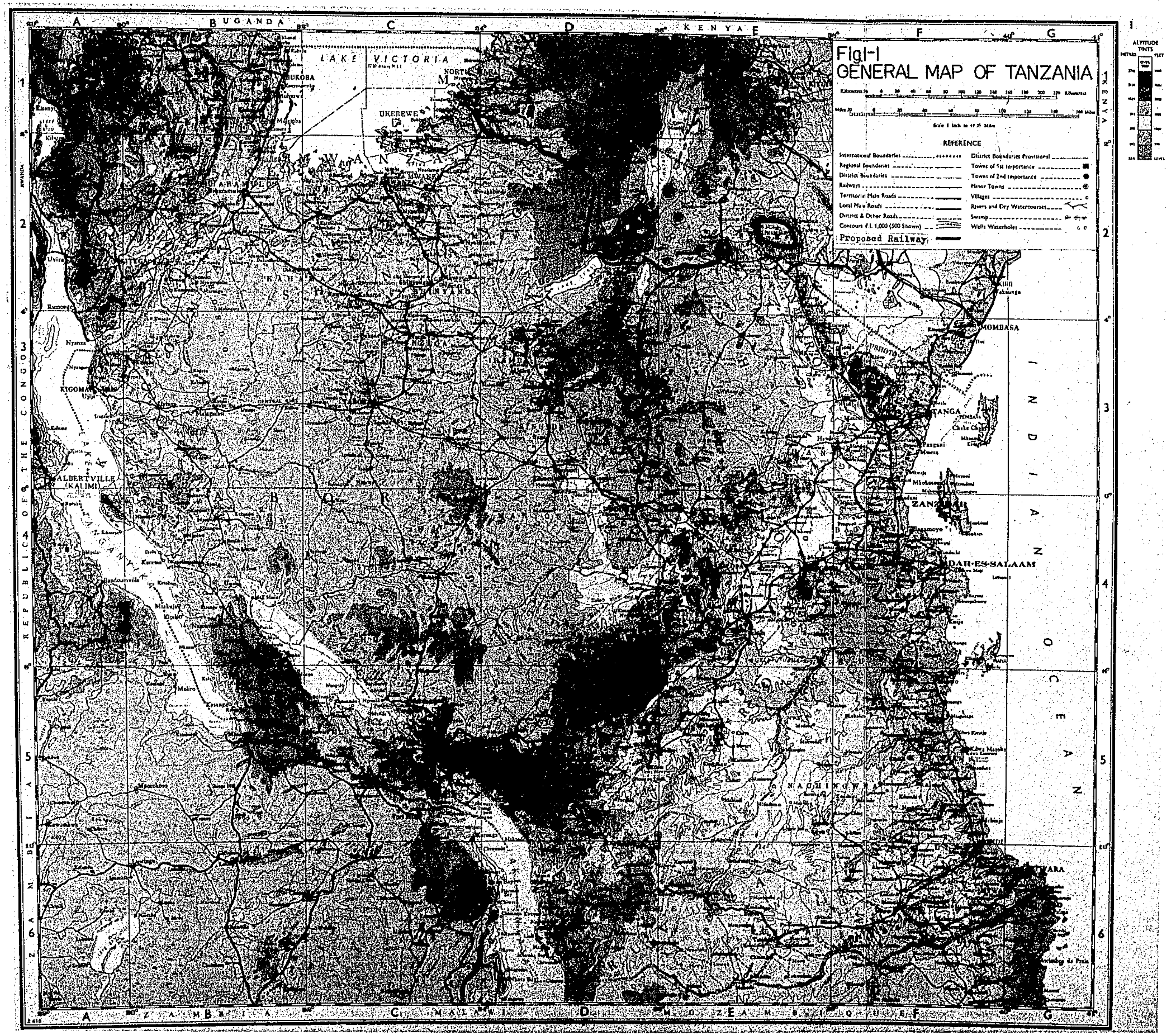
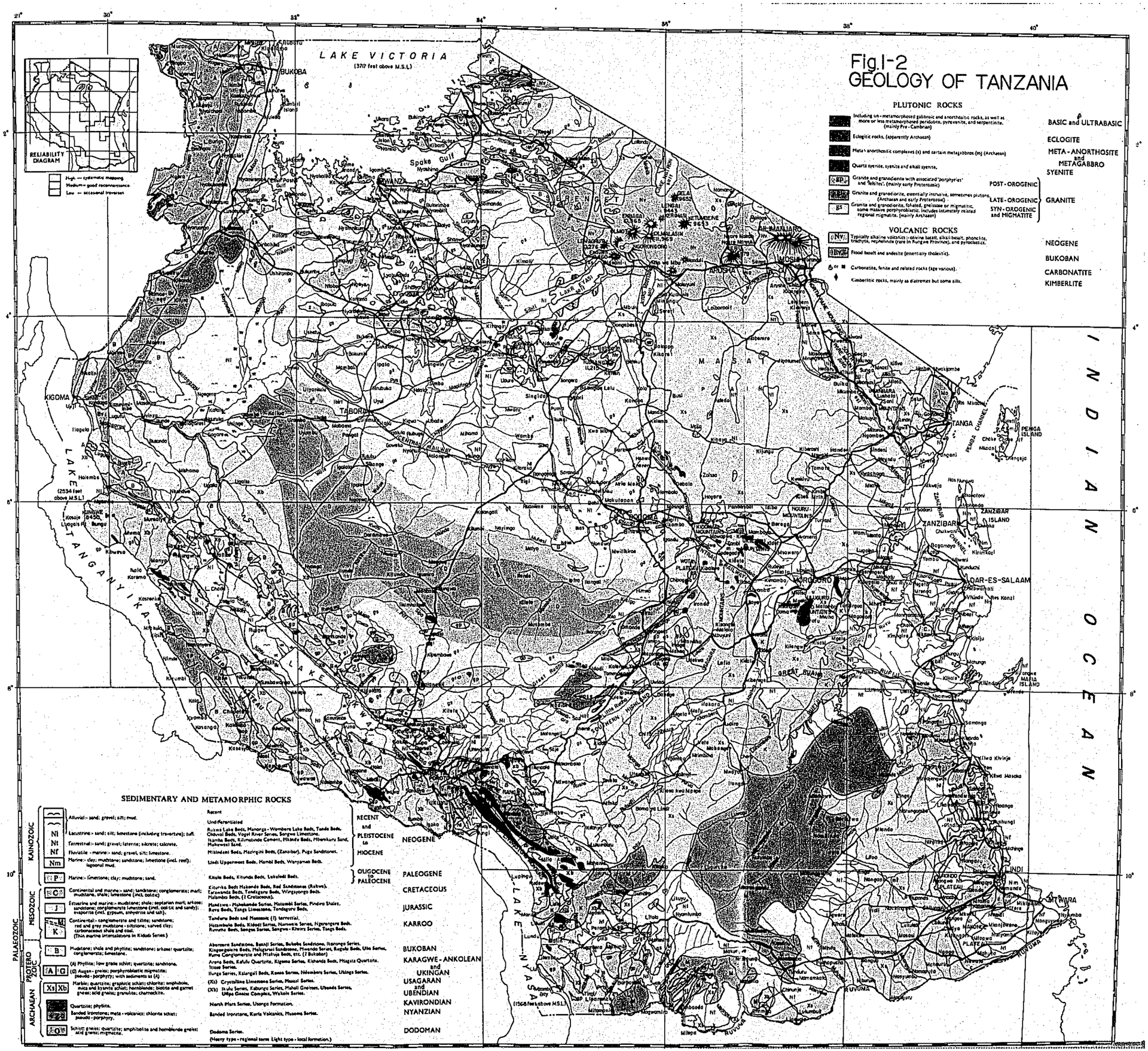


Fig.I-1
GENERAL MAP OF TANZANIA
REFERENCE
International Boundaries
Regional Boundaries
District Boundaries
Railways
Territorial Main Roads
Local Main Roads
District & Other Roads
Contours V.I. 1,000 (500 Shown)
Proposed Railway
District Boundaries Provisional
Towns of 1st Importance
Towns of 2nd Importance
Minor Towns
Villages
Rivers and Dry Watercourses
Swamp
Wells Waterholes
UGANDA
KENYA
LAKE VICTORIA
UKEREWE
MOMBASA
TANGA
ZANZIBAR
DAR-ES-SALAAM
KIGOMA
ALBERTVILLE (KALIMI)
INDIAN OCEAN
REPUBLIC OF THE CONGO
ZAMBIA
MALAWI
MOZAMBIQUE

Fig.I-2
GEOLOGY OF TANZANIA



PLUTONIC ROCKS

	Including un-metamorphosed gabbroic and anorthositic rocks, as well as more or less metamorphosed peridotite, pyroxenite, and serpentinite. (mainly Pre-Cambrian)	BASIC and ULTRABASIC
	Eclogitic rocks. (apparently Archaean)	ECLOGITE
	Meta-anorthositic complexes (s) and certain metagabbros (m) (Archaean)	META-ANORTHOSITE and METAGABBRO
	Quartz syenite, syenite and alkali syenite.	SYENITE
εPt	Granite and granodiorite with associated 'porphyries' and 'felsites'. (mainly early Proterozoic)	POST-OROGENIC GRANITE
εPt	Granite and granodiorite, essentially intrusive, sometimes plutonic. (Archaean and early Proterozoic)	LATE-OROGENIC GRANITE
gs	Granite and granodiorite, foliated, gneissose or migmatitic, some massive porphyroblastic. Includes intimately related regional migmatite. (mainly Archaean)	SYN-OROGENIC and MIGMATITE GRANITE

VOLCANIC ROCKS

Nv	Typically alkaline volcanics :- olivine basalt, alkali basalt, phonolite, trachyte, nephelinite (rare in Rungwe Province), and pyroclastics.	NEOGENE
Bv	Flood basalt and andesite (essentially tholeiitic).	BUKOBAN
c or ≋	Carbonatite, fenite and related rocks (age various).	CARBONATITE
♦	Kimberlitic rocks, mainly as diatremes but some sills.	KIMBERLITE

SEDIMENTARY AND METAMORPHIC ROCKS

KAINOZOIC	Alluvial :- sand; gravel; silt; mud.	Recent	RECENT and PLEISTOCENE to MIOCENE — NEOGENE
	Ni Lacustrine :- sand; silt; limestone (including travertine); tuff.	Undifferentiated	
	Nt Terrestrial :- sand; gravel; laterite; calcrete; calcrete.	Rukwa Lake Beds, Manonga - Wembere Lake Beds, Tunde Beds, Olduvai Beds, Vogel River Series, Songwe Limestone.	
	Nf Fluviatile - marine :- sand; gravel, silt; limestone.	Njamba Beds, Kilimalinde Cement, Mkindo Beds, Mbemkuru Sand, Mahewesi Sand.	
	Nm Marine :- clay; mudstone; sandstone; limestone (incl. reef); lagoonal mud.	Mitindani Beds, Mazingira Beds, (Zanzibar). Pugu Sandstones.	
		Lindi Upper-most Beds, Mambi Beds, Wanyamas Beds.	
MESOZOIC	P Marine :- limestone; clay; mudstone; sand.	Kisuke Beds, Kitunda Beds, Lukuledi Beds.	OLIGOCENE PALEOCENE — PALEOGENE
	C Continental and marine :- sand; sandstone; conglomerate; marl; mudstone, shale; limestone (incl. oolitic)	Kitumbo Beds Makonde Beds, Red Sandstones (Rukwa). Turamondo Beds, Tendaguru Beds, Wangayango Beds. Malumbo Beds, (? Cretaceous).	CRETACEOUS
	J Estuarine and marine :- mudstone; shale; septarian marl; arkose; sandstone; conglomerate limestone (incl. oolitic and sandy); evaporite (incl. gypsum, anhydrite and salt).	Mandawa - Mahokondo Series, Matumbi Series, Pindiro Shales. Ruvu Beds, Tanga Limestone, Tendaguru Beds.	JURASSIC
	M K Continental :- conglomerate and tillite; sandstone; red and grey mudstone - siltstone; varved clay; carbonaceous shale and coal. (Thin marine intercalations in Kidodi Series.)	Tanduru Beds and Manonga (?) terrestrial. Mazumbai Beds, Kidodi Series, Mariwa'a Series, Ngorongoro Beds. Ruhuhu Beds, Songea Series, Songwe - Kiwira Series, Tonya Beds.	KARROO
PROTEROZOIC	B Mudstone; shale and phyllite; sandstone; arkose; quartzite; conglomerate; limestone.	Abercorn Sandstone, Bunji Series, Bukoba Sandstone, Itororgo Series. Kingongeiro Beds, Pelagyazi Sandstone, Mtuwala Series, Bagula Beds. Uha Series, Ruvu Conglomerate and Mtakuja Beds, etc. (? Bukoban)	BUKOBAN
	A Phyllite; low grade schist; quartzite; sandstone.	Arusha Beds, Kafulu Quartzite, Kigoma Series, Kishanda Beds, Mugata Quartzite. Itasa Series.	KARAGWE - ANKOLEAN and UKINGAN
	G (G) Augen - gneiss; porphyroblastic migmatite; pseudo - porphyry; with sediments as (A)	Ilunga Series, Kalangali Beds, Konse Series, Ndembera Series, Usinga Series.	
ARCHAEAN	Xs Xb Marble; quartzite; graphitic schist; chlorite; amphibolite, mica and kyanite schist; hornblende; biotite and garnet gneiss; acid gneiss; granulite; charnockite.	(Xs) Crystalline Limestone Series, Masasi Series.	USAGARAN and UBENDIAN
		(Xb) Itulu Series, Kaburagu Series, Mahali Gneisses, Ubende Series, Uliga Gneiss Complex, Wakole Series.	
	Quartzite; phyllite.	North Mara Series, Usonga Formation.	KAVIRONDIAN
	Banded Ironstone; meta - volcanics; chlorite schist; pseudo - porphyry.	Banded Ironstone, Kuria Volcanics, Musoma Series.	NYANZIAN
	Schist; gneiss; quartzite; amphibolite and hornblende gneiss; acid gneiss; migmatite.	Dodoma Series. (Nzega type - regional term Light type - local formation.)	DODOMAN

perature is about 17°C. and the mean annual rainfall is 600–800 mm. Temperature difference between daytime and night-time is quite large. As the lake zone at El. 3000 ft. –4000 ft. is close to the tropical forests of Congo, high temperatures and high humidity prevail. The southern and northern highland zone located at El. 5000 ft.—10,000 ft. has excellent climate, and there are summer resorts on the foot of Mt. Kilimanjaro and Mt. Meru and the area around Mbeya. (See Fig. 1-4 Mean Annual Rainfall)

1-4 Population of Tanzania

According to the 1967 census, the total population was 12,230,000 of which 98% were Africans. Most of the people belong to the Bantu tribe, but there are 120 tribes altogether. Tribal names in the order of the dwelling place beginning with north and moving toward south are as follows:-

Sukuma, Zinza, Sumbwa, Chagga, Nkalinsi, Ha, Nyamwezi, Iraow, Iramba, Nyaturu, Masai, Pare, Sambaa, Digo, Bonde, Tongwe, Bende, Konongo, Kimbu, Gogo, Zigua, Doe, Usagara, Zaramo, Luguru, Primbwe, Fipa, Bungu, Nyiha, Sangu, Uhehe, Mbunga, Bena, Pogoro, Ngindo, Ngoni, and etc.

Of the above, Sukuma tribe is the largest, holding 12% of the total. Population of Tanzania classified by region and district is as given below. Population density is 13.5 persons to one km^2. (See Fig. 1-5 Population Density)

Swahili is the language used in all official business, and English is generally used as a commercial language. Being influenced by the Arabs, there are more Mohammedans in this country comprising 31% of the total population. 17% of the population are Christians, and others are animists.

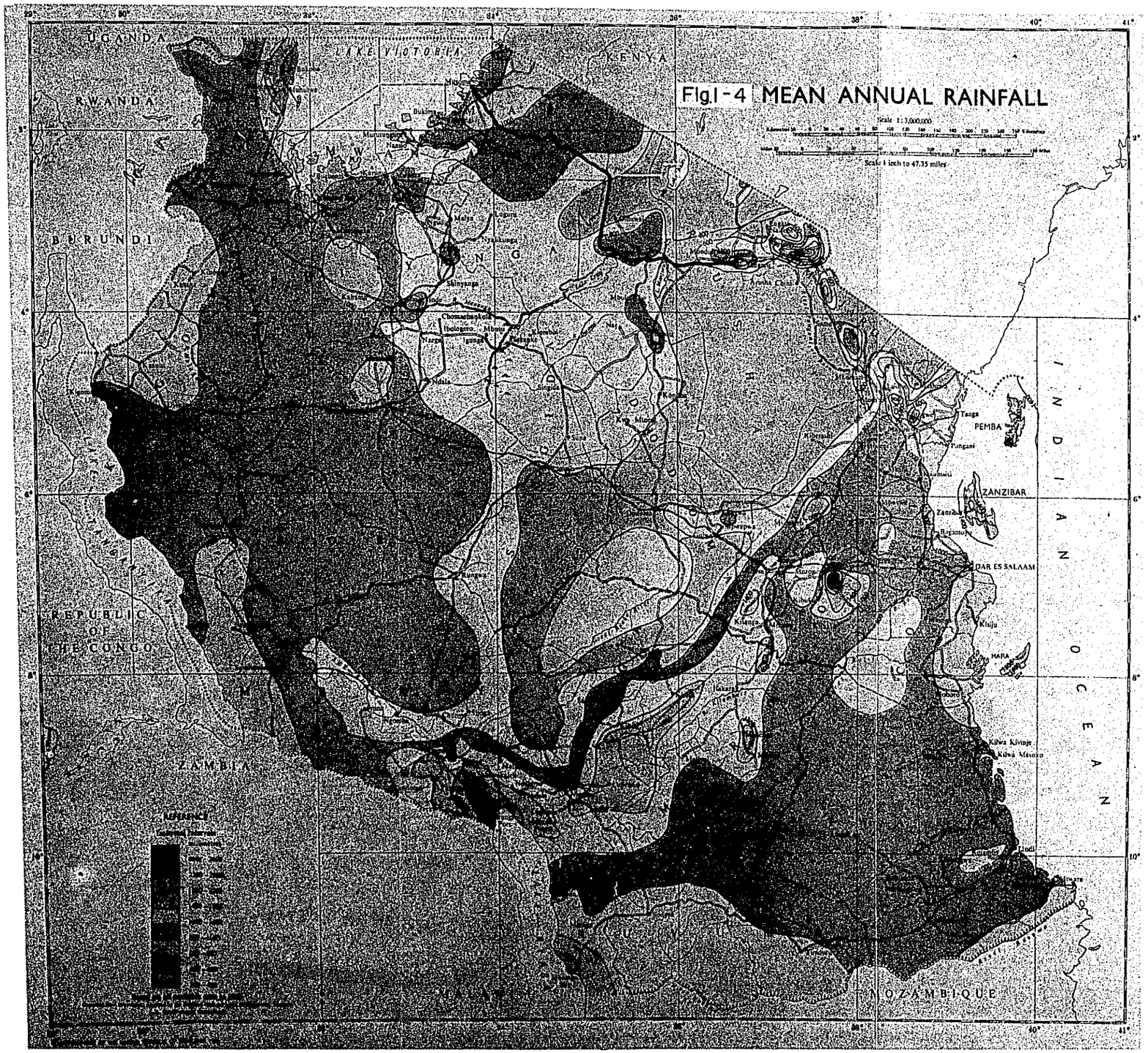


Fig.I - 4 MEAN ANNUAL RAINFALL
Scale 1 : 3,000,000
Scale 1 inch to 47.35 miles
UGANDA
LAKE VICTORIA
KENYA
RWANDA
BURUNDI
TANZANIA
REPUBLIC OF THE CONGO
ZAMBIA
MALAWI
MOZAMBIQUE
INDIAN OCEAN
PEMBA
ZANZIBAR
DAR ES SALAAM
MAFIA
Kilwa Kivinje
Kilwa Masoko
Tanga
Pangani
Kisiju
Lindi
Mtwara

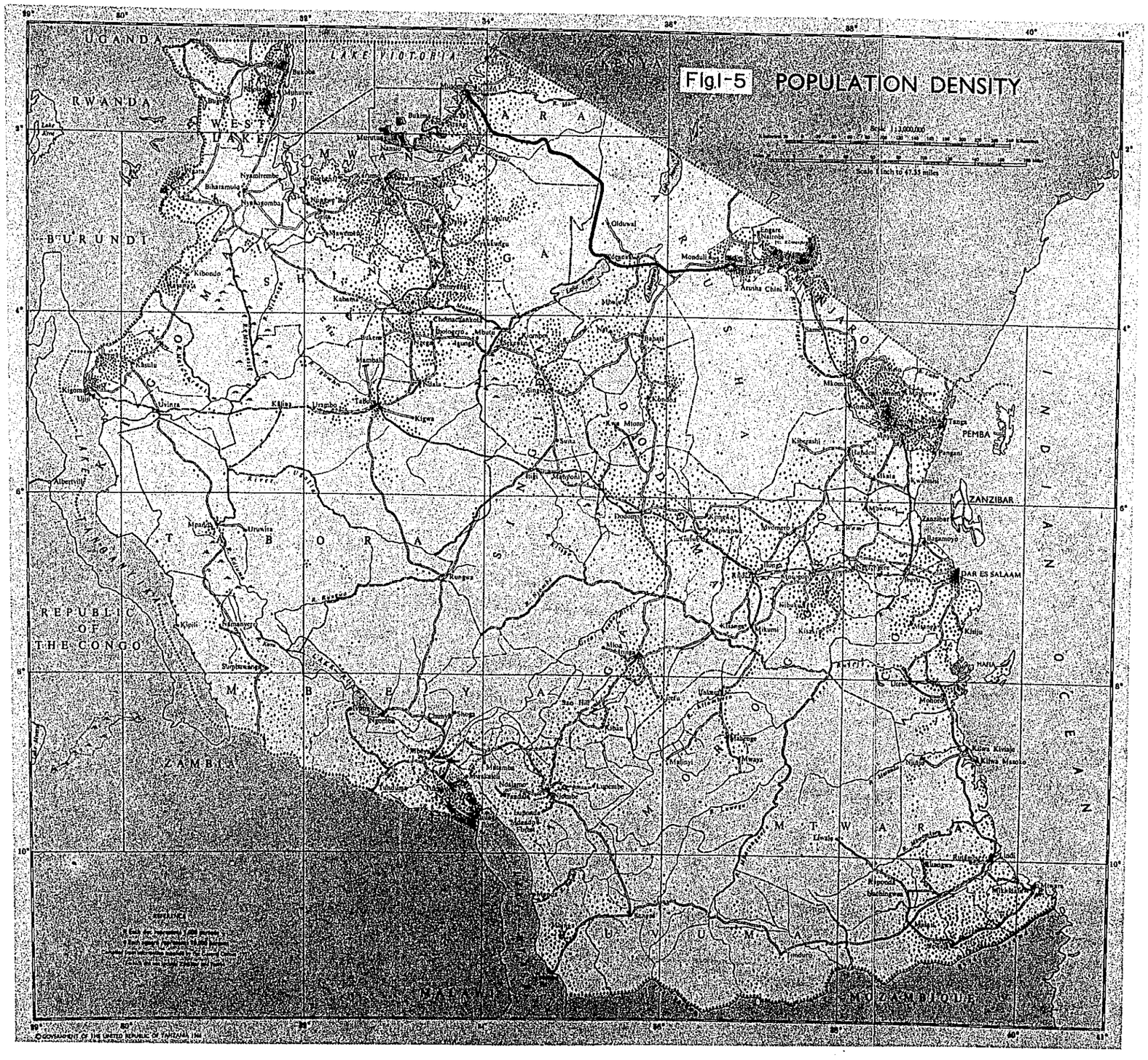


Fig1-5 POPULATION DENSITY
UGANDA
RWANDA
BURUNDI
REPUBLIC OF THE CONGO
ZAMBIA
MALAWI
MOZAMBIQUE
KENYA
TANZANIA
LAKE VICTORIA
LAKE TANGANYIKA
LAKE MALAWI
WEST LAKE
PEMBA
ZANZIBAR
DAR ES SALAAM
Scale 1 inch to 47.35 miles

Fig. 1-5 Population Density

REGION AND DISTRICT		POPULATION (In thousands)	DENSITY PER SQUARE KILOMETRE
ARUSHA			
Arusha		214.2	71.9
Masai		106.9	1.7
Mbulu		289.3	18.0
	Total	610.4	7.4
COAST			
Bagamoyo		117.6	11.9
Dar es Salaam (Mizizima)		348.4	446.7
Kisarawe		180.5	19.4
Mafia		16.8	32.2
Rufiji		121.0	9.1
	Total	784.3	23.1
DODOMA			
Dodoma		320.9	19.4
Kondoa		212.2	16.1
Mpwapwa		176.2	15.3
	Total	709.3	17.2
IRINGA			
Iringa		252.6	8.8
Mufindi		118.5	16.6
Njombe		318.8	15.1
	Total	689.9	12.1
KIGOMA			
Kasulu		207.6	22.3
Kibondo		136.9	8.5
Kogoma		128.9	11.1
	Total	473.4	12.8
KILIMANJARO			
Kilimanjaro		503.0	94.7
Pare		149.7	18.9
	Total	652.7	49.4
MARA			
Musoma		355.6	19.9
North Mara		188.5	48.5
	Total	544.1	25.0
MBEYA			
Chunya		53.6	2.0
Mbeya		192.7	10.4
Mbozi		147.5	15.4
Rungwa		360.0	69.5
Ufipa		215.5	9.5
	Total	969.3	11.6

REGION AND DISTRICT		POPULATION (In thousands)	DESNITY PER SQUARE KILOMETER
MOROGORO			
Kilosa		193.7	13.6
Morogoro		316.4	16.4
Ulanga		174.9	4.4
	Total	685.0	9.4
MTWARA			
Kilwa		98.0	7.1
Lindi		241.4	25.5
Masasi		213.7	23.9
Mtwara		134.7	35.8
Nachingwea		80.5	1.9
Newala		272.8	68.0
	Total	1,041.1	12.6
MWANZA			
Geita		371.4	40.9
Kwimba		305.5	50.2
Mwanza		268.9	69.1
Ukevewe		109.3	170.7
	Total	1,055.1	53.6
RUVUMA			
Mbinga		144.0	17.1
Songea		151.4	4.4
Tunduru		97.6	11.1
	Total	393.0	6.4
SHINYANGA			
Kahama		147.7	7.4
Maswa		430.9	20.2
Shinyanga		320.9	34.0
	Total	899.5	17.7
SINGIDA			
Iramba		184.0	23.3
Manyoni		80.2	2.8
Singida		193.8	15.1
	Total	458.0	9.3
TABORA			
Mpanda		60.8	1.3
Nzega		302.0	22.0
Tabora		200.1	3.2
	Total	562.9	6.3

REGION AND DISTRICT	POPULATION (In thousands)	DENSITY PER SQUARE KILOMETER
TANGA		
Handeni	133.3	10.0
Korogwa	140.3	37.3
Lushoto	210.5	60.1
Pangani	28.4	20.0
Tanga	258.6	52.6
Total	771.1	28.8
WEST LAKE		
Biharamulo	81.9	7.5
Bukoba	382.7	47.6
Kavagwe	97.2	14.5
Ngara	96.3	33.8
Total	658.1	23.1
GRAND TOTAL (MAINLAND)	11,957.2	13.5

1-5-1 General Description

Tanzania's economy depends largely on limited kinds of agricultural products such as coffee, cotton, Sisal hemp, oil seeds, etc., and is influenced by the fluctuation in the international market prices of these products. Agricultural production holds 50 to 60% of the GNP, but the annual growth rate of the agricultural sector has dropped relatively. On the contrary, mining and manufacturing industry have shown a conspicuous growth. The percentage of mining and manufacturing industry to GNP in 1967 was about 8.2%, but mining recorded the growth rate of 48.2% and the manufacturing industry 300% in a period of seven years from 1960 to 1967. GNP of recent years classified by industry is as shown below.

Changes in GNP (Unit: Million sh.)

	1960–62 Mean annual	1966	1967	1968
Gross National Product	3,920	5,462	5,650	5,869
Depreciation	194	304	347	373
Net National Product	3,736	5,158	5,303	5,496
Indirect tax	70	137	120	63
National Income	3,666	5,021	5,183	5,433

(Source) *The Annual Economic Survey, 1969/70*

(Note) *Figures for 1968 are provisional figures*

GNP Classified by Industry (Unit: £1,000)

	1960	1966	1967	1968
Agriculture	112,809	145,950	147,200	146,700
Mining	5,194	7,150	7,700	5,550
Manufacturing ind.	5,469	13,550	15,700	18,850
Architecture	4,565	8,550	10,750	11,050
Public enterprises	1,231	2,400	2,550	3,000
Commerce	20,931	38,300	39,050	42,650
Housing	8,026	13,350	15,200	15,100
Transportation	8,734	12,300	14,000	14,900
Service	18,094	31,200	32,450	35,650
TOTAL	185,053	272,750	284,600	293,450

(Source) *The Annual Economic Survey, 1969/70*

1-5-2 Agriculture

Tanzania has the largest territory among the three East African states, but its cultivated land is 78,000 km^2 or less than 10% of the entire land. Cultivated land for cash crops comprises 5 or 6%, and Sisal hemp is grown on 70% of the cultivated land. Sisal hemp is grown and processed mainly in the coastal area facing the Indian Ocean. The main use of Sisal hemp is as raw material for making ropes, but the demand for Sisal hemp is decreasing with the appearance of the synthetic fibers on the market. As for coffee, the Arabian variety is grown on the foot of Mt. Meru and Mt. Kilimanjaro in the northern area, and lobster variety is grown on the west coast of Victoria Lake. Cotton is another important export item next to Sisal hemp, and production is increasing every year. Most of the cotton is produced in Mwanza district along Victoria Lake. Other agricultural products are pyrethrum, tobacco, tea and peanut, but the production of cashew nut increased rapidly in recent years. Agriculture of this country having vast plains and blessed with high temperatures is most promising, and the future prosperity of this country can certainly be expected if the study of crops suitable for the climate and natural features is made, and irrigation and drainage systems improved. (See Fig. 1-3 Potential Land Use)

1-5-3 Cattle Breeding

In this country blessed with rich grazing land, cattle breeding, along with agriculture, is one of the most promising industries. Cattle breeding mainly of cattle is being carried out in the western district. In the central highlands near Arusha, Masai tribe is grazing extensively the hump cattle.
Annual milk production is approximately 40 million gallons, but the African consumption is small, only about 20% of the production.

1-5-4 Mining

As the topography of the territory is intricate and diversified, Tanzania seems to have rich mineral resources. Development of mineral resources was started in earnest since 1940, but prospecting has never been carried out to any satisfactory extent. Diamond was found in 1940, and its output comprises 60% of the total amount of mining products produced in this country. Gold is the next important mineral product, and gold deposits lie scattered in each district.
Presence of coal, iron ore, tin ore, mica, etc. has been confirmed, and development of such resources is now being promoted. (See Fig. 1-2 Geology of Tanzania)

1-5-5 Forestry

Timberland extends over an area of 359,200 km^2, which is 40% of the entire land in the territory. Forest reserve comprises 125,700 km^2 of the abovementioned timberland. Total timber output in 1967 was 127,500 m^3 of which about 75%

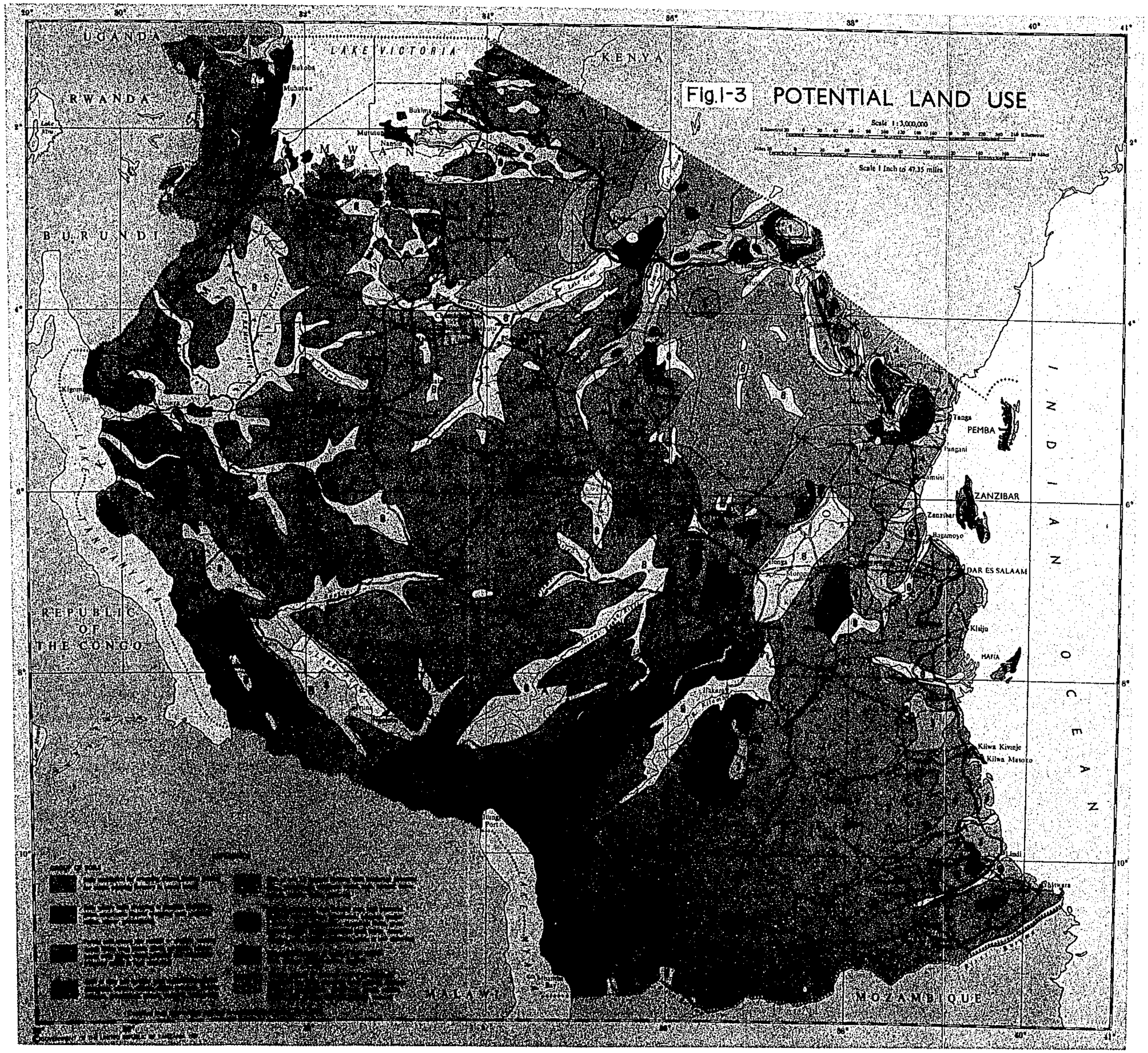


Fig.1-3 POTENTIAL LAND USE
UGANDA
LAKE VICTORIA
KENYA
RWANDA
BURUNDI
Tanga
PEMBA
ZANZIBAR
DAR ES SALAAM
MAFIA
Kilwa Kivinje
Kilwa Masoko
REPUBLIC OF THE CONGO
MALAWI
MOZAMBIQUE
INDIAN OCEAN

consisted of broad-leaved trees. Coupled with the improvement of roads, etc., the future growth of this industry can be expected.

1-5-6 Manufacturing industry

Main industrial areas are Dar es Salaam Arusha, Tanga, Mwanza, etc., and the number of factories was about 6,200 in 1968. Main businesses are tobacco, cannery, brewery, flour mill, oil refinery, metal container, soap, textile and textile goods, medical supplies, plastics, plywood, wooden and metal furnitures, transistor radio, dry battery, tires and tubes, steel rolling, and fertilizer. The manufacturing industries were started with the enforcement of the government's policy of industrialization after this country became independent, and they are still in the stage of light industry and will be further developed hereafter keeping pace with the progress of the education of the youths.

1-5-7 Sight-seeing

Many tourists from all parts of the world are now beginning to visit Tanzania which has rich sightseeing places such as Mt. Kilimanjaro, the highest mountain in Africa, natural zoos at six places including those in Ngorongoro Caldera and Serengeti, Lake Victoria, Lake Tanganyika, etc. The future of the tourist industry is most promising if roads, airports, railways and other transport facilities should be improved, and also hotels, lodges and other sightseeing facilities be provided.

1-6 Trade

Tanzania's foreign trade, with the exclusion of the inter-regional trade of the three East African states, is in black figure, but the tendency is that the margin of this black figure is being narrowed down as the result of continual excess of imports over exports in the inter-regional trade with Kenya and Uganda. The scale of trade since 1965 has been expanded both for export and import. However, the export of Sisal hemp, the major export item of Tanzania, was affected adversely by the long spell of dry weather and the introduction of synthetic substitutes for hemp on the market. On the contrary, the export of coffee and cotton recorded a remarkably rapid growth.

1-6-1 Export

The export continued to increase since 1965. The main items of export are the Sisal hemp, cotton, coffee, and diamond. These four items comprise 60 to 70% of the total amount of export. Sisal hemp showed a big decrease, but the increased export of coffee and cotton has well covered this unfavorable situation. The amount of export since 1965 classified by item and destination is as given below.

Export Classified by Item of Export

(Unit: £1,000)

	1965	1966	1967	1968
Meat and meat products	1,921	2,868	2,406	2,169
Cashew nut	4,125	5,001	4,611	5,082
Pulses	689	581	685	766
Coffee	8,588	15,136	11,939	13,254
Tea	1,511	2,255	2,159	2,243
Feed for animals	1,599	1,741	1,732	1,642
Tobacco leaves	483	805	1,678	1,979
Hides	1,517	2,145	1,450	1,575
Peanut	601	340	356	273
Caster oil plant	383	644	651	404
Sesame oil	673	605	580	498
Sunflower	289	260	162	171
Timber	610	543	433	438
Cotton	12,212	17,497	12,568	14,144
Sisal hemp	14,279	11,734	10,046	7,935
Wattle resin	454	479	481	2
Pyrethrum extract	1,038	1,442	1,460	888
Beeswax	231	205	286	161
Diamond	7,114	9,000	11,147	6,772
Gold	1,140	706	233	240
Total amount	62,778	79,106	77,678	79,270

(Source) *Annual Trade Report of Tanganyika, Uganda and Kenya (Each year's edition)*

Table 40 Export Classified by Country of Destination

(Unit: £1,000)

	1965	1966	1967	1968
Britain	18,963	22,949	23,520	19,299
West Germany	4,818	5,583	4,068	3,672
United States of America	3,801	6,133	3,900	4,672
Holland	2,922	2,998	3,209	3,902
India	4,779	5,806	5,169	5,752
Japan	1,674	4,780	3,352	5,541
Hong Kong	5,080	6,946	5,563	6,305
Belgium	2,173	2,243	2,058	1,416
China	4,313	3,392	2,757	2,744
Italy	1,132	1,641	2,130	1,765
Others	-	-	-	-
Total	62,778	79,106	77,678	79,270

(Source) Annual Trade Report of Tanganyika, Uganda and Kenya

1-6-2 Import

The import increased remarkably in recent years. A 35% increase was recorded in the period of 1965–1968. Raw materials, animal fats and vegetable oil, chemical products, machines, transport machines and textile were the main items of import. These items comprised 60% of the total import.

Imports since 1965 classified by item and country are as shown below.

Import Classified by Item of Import

(Unit: £1,000)

	1965	1966	1967	1968
Condensed milk	1,000	1,123	1,554	959
Medical suplies	1,010	1,120	1,006	1,422
Fertilizers	526	79	583	692
Tires and tubes	923	1,017	1,490	1,889
Paper and paper goods	953	1,043	1,114	1,304
Cotton goods	525	26	47	67
Cotton cloths	3,402	5,013	2,642	4,549
Synthetic fibers	1,236	1,089	668	1,235
Hemp bags	813	1,067	791	223
Non-Metal mineral products	561	35	497	813
Steel sheets	1,153	1,003	1,178	1,041
Pipe joints	960	87	4,011	951
Metal and metal goods	4,339	3,052	4,268	4,312
Tractors	767	59	872	1,203
General machinery	5,095	6,046	8,215	7,917
Electrical machinery	2,260	2,042	3,053	4,139
Passenger cars	1,183	1,074	1,304	1,591
Buses and trucks	3,001	4,072	4,217	5,625
Electrical apparatus	1,899	2,041	4,628	4,371
Clothings	998	959	714	1,483
Total Amount	50,017	64,251	65,026	76,584

(Source) Annual Trade Report of Tanganyika, Uganda and Kenya

Table 40 Import Classified by the Country

(Unit: £1,000)

	1965	1966	1967	1968
Britain	16,242	20,042	18,756	21,188
West Germany	4,137	5,499	4,215	5,396
U.S.A.	2,824	3,897	4,939	4,209
Holland	2,145	2,707	2,662	3,859
India	3,424	3,334	2,012	2,709
Japan	4,633	4,164	3,311	6,556
Hong Kong	837	1,614	1,228	2,152
Belgium	564	577	619	841
China	1,745	3,706	3,101	4,314
Italy	4,017	3,106	6,934	5,188
Others	9,479	15,607	17,249	20,172
Total	50,047	64,251	65,026	76,584

(Source) Annual Trade Report of Tanganyika, Uganda and Kenya

CHAPTER II ESTIMATION OF RAILWAY TRAFFIC VOLUME

2-1 Method of estimation of traffic volume

The probable traffic volume of the proposed Tanga–Arusha–Musoma railway line for 1967 was estimated according to the various statistics kept by the East African Railways Corporation, on the assumption that the proposed new railway-line between Arusha and Musoma was opened to traffic already in the end of 1966, moreover both passengers and freight took the shortest route, and also that a part of freight used to be transported by the existing Mombasa–Uganda alignment via Nairobi was switched to the proposed new Tanga–Uganda alignment via Lake Victoria.

Based on the changes in the output of the products classified by item which took place in Tanzania during the period of 1963–1967, the output of each item in 1980 was estimated by using the method of least squares. Assuming that the traffic volume would proportionate to the output of the products, traffic volume of the Tanga–Arusha–Musoma railway in 1980 was estimated.

Although this method of estimation was not perfect, it was used just for setting up an outlook since no other method was applicable.

In a developing country like Tanzania, it might be rather accurate to forecast the future volume of products by item and then look into the trend of traffic demand by appraising potentials of development in various industries such agriculture, manufacturing and mining industries in the country as well as perspectives of them in the future.

However, due to lack of sufficient data, limited time for the survey, etc., the above method was not adopted this time.

2-2 Freight Traffic Volume

The estimated annual volume of freight traffic of each section of the Tanga-Arusha railway-line in 1967 is as given below and in Fig. 2-2. The details are as given in Table 2-1.

Section			Freight passing through Up	Down	(1000 tons) Total
Tanga	–	Mruaji	118	55	173
Mruaji	–	Korogwe	184	91	275
Korogwe	–	Mombo	167	75	242
Mombo	–	Same	164	74	238
Same	–	Kahe	142	67	209
Kahe	–	Moshi	140	64	204
Moshi	–	Arusha	59	30	89

Note: *Up* – *Freight for Indian Ocean bound*
Down – *Freight for inland bound from Indian Ocean*

Assuming that the proposed new railway-line between Arusha and Musoma had already been completed by the end of 1966, the additional volume of freight which should have been transported between Tanga and Arusha, and between Arusha and Musoma in 1967 could be estimated as follows. The figures have been calculated for the shortest distance between the destinations. The details are as given in Table 2-2.

Section			Tonnage of Freight Passing Through (1000 tons)		
			Up	Down	Total
Tanga	–	Mruaji	-	-	-
Mruaji	–	Korogwe	5	10	15
Korogwe	–	Mombo	5	10	15
Mombo	–	Same	5	10	15
Same	–	Kahe	5	10	15
Kahe	–	Moshi	25	11	36
Moshi	–	Arusha	25	12	37
Arusha	–	Musoma	25	13	38

Assuming that the proposed railway-line between Arusha and Musoma had been completed by the end of 1966, the volume of freight traffic which could have been switched to transportation between Tanga and Uganda via Lake Victoria in 1967 with the aim of relieving the freight traffic congestion at Port Mombasa in Kenya is as shown below.

Item	Volume of freight traffic (1000 tons)		
	Up	Down	Total
Wheat	-	8	8
Pulses	4	-	4
Coffee, tea	223	-	223
Cotton	71	-	71
Salt & rock salt	-	26	26
Fertilizer, etc.	-	19	19
Oil	-	273	273
Iron & steel, metals & machinery	-	60	60
Others	6	14	20
Total	304	400	704

Putting together all have been mentioned before, and on the assumption that the proposed Arusha–Musona railway-line had been completed in 1966, the total volume of freight traffic of the sections of the proposed Plans (both up and down ways) in 1967 has been estimated as follows. The details are as given in Table 2-3-1 and Table 2-3-2.

Section			Total Freight Traffic Volume (Up and down ways) (1000 tons)	
			Plan A	Plan B
Tanga	–	Mruaji	173	781
Mruaji	–	Korogwe	290	994
Korogwe	–	Mombo	257	961
Mombo	–	Same	253	957
Same	–	Kahe	221	925
Kahe	–	Moshi	232	936
Moshi	–	Arusha	125	829
Arusha	–	Musoma	37	741

Note: *Plan A gives the freight traffic volume when freight has been transported by taking the shortest distance route between the places of departure and destination. Plan B gives the freight traffic volume under Plan A plus the freight traffic volume which can be switched to Tanga--Uganda alignment from the existing Mombasa–Uganda alignment.*

On the basis of the numerical values mentioned above, the 1980 freight traffic volume was estimated.

The estimated output of each item of the products of Tanzania for the period of 1963–1967, and the estimated 1980 output obtained by using the method of least squares were given under Table 2-4. The estimated freight traffic volume for 1980 on the assumption that the freight traffic volume would increase in proportion to the numerical value of the output of the products is as shown in Fig. 2-3 and Tables 2-5-1 and 2-5-2. These can be summarized as follows:-

Section			Total freight traffic volume (Up and down ways) (1000 tons)	
			Plan A	Plan B
Tanga	–	Mruaji	303	1,669
Mruaji	–	Korogwe	547	1,881
Korogwe	–	Mombo	470	1,812
Mombo	–	Same	470	1,816
Same	–	Kahe	415	1,751
Kahe	–	Moshi	460	1,796
Moshi	–	Arusha	227	1,564
Arusha	–	Musoma	86	1,425

2-3 Passenger traffic

At present, the average annual passenger traffic volume of the East African Railways Corporation is 810 persons/operating km, but the growth of passenger traffic volume to an annual average of 3,800 persons/operating km. can be expected since there are world famous tourist resorts along the proposed railway line such as Kilimanjaro, Lake

Manyara, Ngorongoro, Serengeti, etc.

2-4 Transportation capacity

The transportation capacity required to meet the 1980 traffic volume mentioned above is as shown in Tables 2-6-1 and 2-6-2. Assuming that the project of modernization of the motive power now being promoted by the East African Railways Corporation would be completed by 1976 as scheduled, it was decided to use Class 90 Diesel electric locomotive for both up and down ways between Tanga and Musoma, the traction power of which is 1000 tons for the freight train and 750 tons for the passenger-freight train.

Main features of the Class 90 Diesel electric locomotive are as follows:-

Type	90
Gauge	1,000 mm
Axle arrangement	ICo - ICo
Length over coupling faces	16,948 mm
Dry weight	95.9 tons
Weight in working order	101.425 tons
Maximum axle load	13.475 tons
Engine:	
Output	1,840 HP
Rotation	850 rpm.
Power transmission	Electrical
Max. running speed	72km/hour
Capacity of fuel tank	36,000 liters

Fig. 2-1 Map of East African Railways Corporation

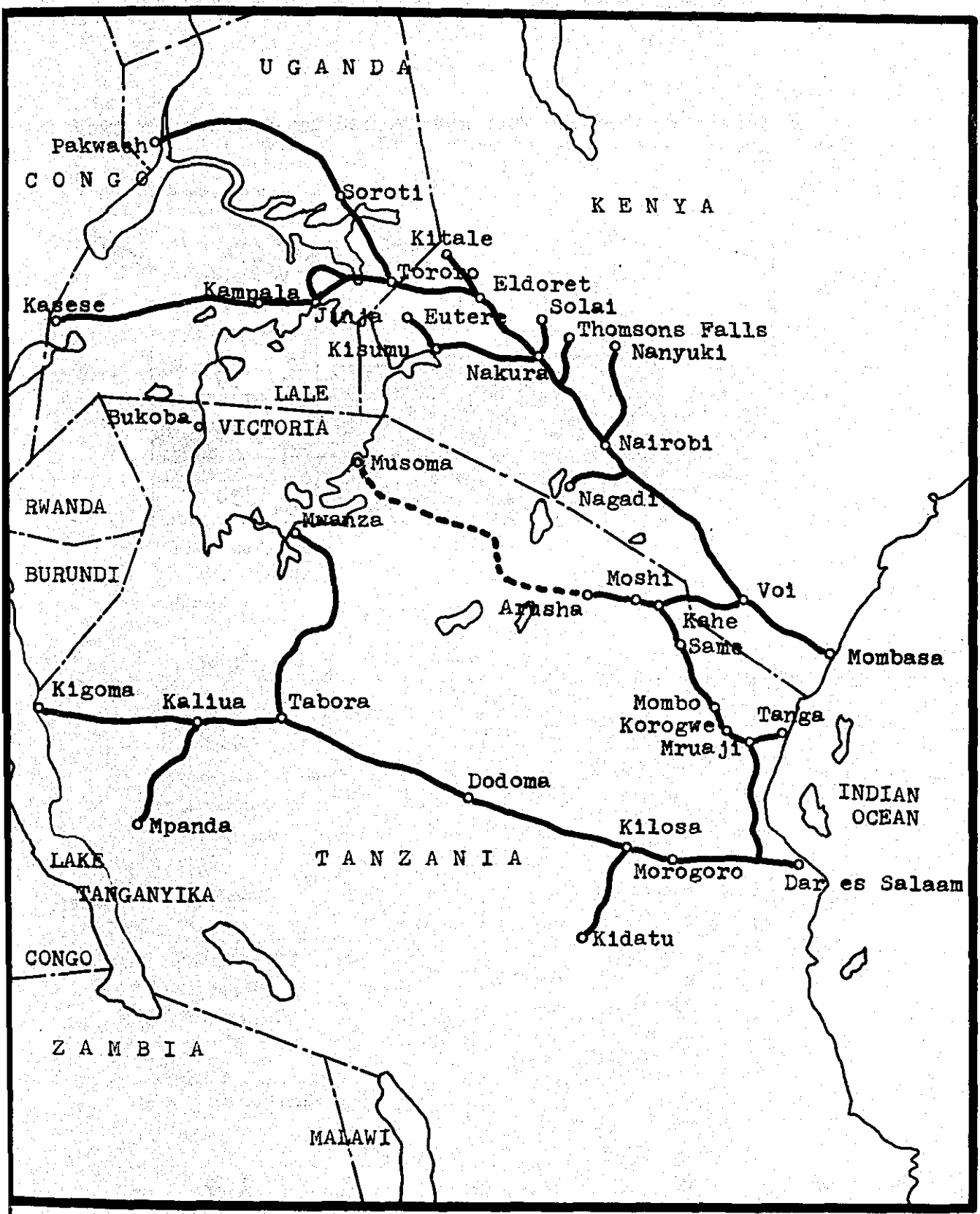


Fig.2-2 Net Goods Tonnages Carred by Section in 1967

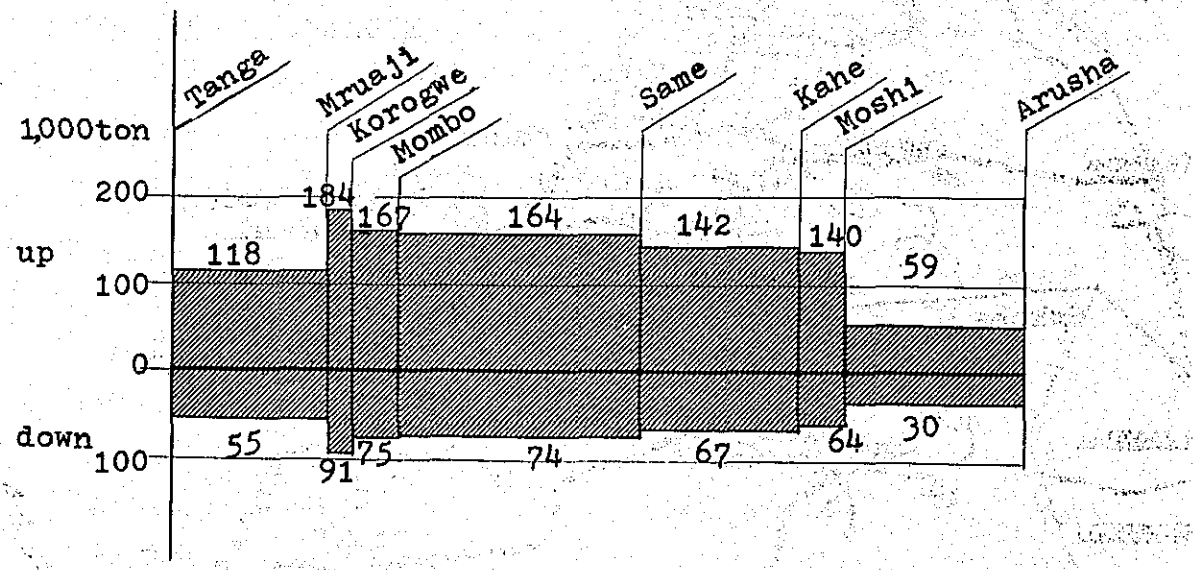


Table 2-1 ESTIMATED NET FREIGHT TONNAGE CARRIED BY EACH SECTION IN 1967

(Thousand tons)

Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha
Up (For Indian Ocean Bound)	Maize, maize meal & flower		26	45	45	45	45	45	17
	Wheat & wheat flower		12	2	2	2	2	2	3
	Cereals, etc.		2	2	2	2	2	2	2
	Beans & peas		13	17	17	17	17	22	22
	Fruits & vegitables		-	4	4	4	4	4	-
	Sugar		16	42	42	47	32	-	-
	Coffee & tea		28	32	32	32	32	58	11
	Fertilizers		1	1	1	1	1	1	2
	Woods		13	26	10	4	4	4	-
	Feeding stuff		2	8	9	7	-	-	-
	Cement		3	-	-	-	-	-	-
	Iron & steel, metals and machinery		-	1	1	1	1	-	-
	Others		2	4	2	2	2	2	2
	Total		118	184	167	164	142	140	59
Down (For Inland Bound)	Maize, maize meal & flower		2	2	2	2	2	2	-
	Wheat & wheat flower		10	3	3	3	3	3	3
	Cereals, etc.		-	13	13	13	13	7	1
	Beans & peas		-	2	2	2	2	-	1
	Sugar		-	-	-	-	-	12	12
	Fertilizers		-	3	3	3	3	3	1
	Woods		15	5	5	6	6	1	1
	Salt & rock salt		8	5	5	5	5	5	-
	Feeding stuff		12	12	8	16	16	14	6
	Sand & stone		10	10	10	-	-	-	-
	Cement		8	18	18	18	11	11	1
	Iron & steel, metals and machinery		-	4	4	4	4	4	4
	Others		-	2	2	2	2	2	-
	Total		55	91	75	74	67	64	30
Grand Total			173	275	242	238	209	204	89

Table 2-2 NET FREIGHT TONNAGE TO BE INCREASED UPON COMPLETION OF ARUSHA–MUSOMA RAILWAY LINE, IN 1967

(Thousand tons)

Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha	Musoma
Up (For Indian Ocean bound)	Maize, maize meal & flower	-	2	2	2	2	2	2	2
	Rice	-	3	3	3	3	3	3	3
	Cereals, etc.	-	-	-	-	-	12	12	12
	Feeding stuff	-	-	-	-	-	7	7	7
	Cotton	-	-	-	-	-	1	1	1
	Total	-	5	5	5	5	25	25	25
Down (For inland bound)	Wheat & wheat flower	-	-	-	-	-	-	-	1
	Sugar	-	-	-	-	-	1	1	1
	Beer	-	4	4	4	4	4	5	5
	Salt & rock salt	-	1	1	1	1	1	1	1
	Cement	-	5	5	5	5	5	5	5
	Total	-	10	10	10	10	11	12	13
Grand Total		-	15	15	15	15	36	37	38

Table 2-3-1 NET FREIGHT TONNAGE TO BE CARRIED BY EACH SECTION IN 1967 ON THE ASSUMPTION THAT THE NEW RAILWAY LINE BETWEEN ARUSHA AND MUSOMA HAD ALREADY BEEN COMPLETED *(SHORT-CUT TRANSPORTATION ROUTE ONLY)*

(Thousand tons)

Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha	Musoma
Up (For Indian Ocean bound)	Maize, maize meal & flower		26	47	47	47	47	47	19	2
	Rice		-	3	3	3	3	3	3	3
	Wheat & wheat flower		12	2	2	2	2	2	3	-
	Cereals, etc.		2	2	2	2	2	14	14	12
	Beans & peas		13	17	17	17	17	22	22	-
	Fruits & vegitables		-	4	4	4	4	4	-	-
	Sugar		16	42	42	47	32	-	-	-
	Coffee & tea		28	32	32	32	32	58	11	-
	Fertilizers		1	1	1	1	1	1	2	-
	Woods		13	26	10	4	4	4	-	-
	Feeding stuff		2	8	9	7	-	7	7	7
	Cement		3	-	-	-	-	-	-	-
	Iron & steel, metals and machinery		-	1	1	1	1	-	-	-
	Others		2	4	2	2	2	2	2	-
	Total		118	189	172	169	147	157	83	24
Down (For inland bound)	Maize, maize meal & flower		2	2	2	2	2	2	-	-
	Wheat & wheat flower		-	10	3	3	3	3	3	1
	Cereals, etc.		-	13	13	13	13	7	1	-
	Beans & peas		-	2	2	2	2	-	1	-
	Sugar		-	-	-	-	-	13	13	1
	Beer		-	4	4	4	4	4	5	5
	Fertilizers		-	3	3	3	3	3	1	-
	Woods		15	5	5	6	6	1	1	-
	Salt & rock salt		8	6	6	6	6	6	1	1
	Feeding stuff		12	12	8	16	16	14	6	-
	Sand & stone		10	10	10	-	-	-	-	-
	Cement		8	23	23	23	16	16	6	5
	Iron & steel, metals and machinery		-	6	4	4	4	4	4	-
	Others		-	2	2	2	2	2	-	-
	Total		55	101	85	84	77	75	42	13
Grand Total			173	290	257	253	221	232	125	37

Table 2-3-2 NET FREIGHT TONNAGE TO BE CARRIED BY EACH SECTION IN 1967 ON THE ASSUMPTION THAT NEW RAILWAY LINE BETWEEN ARUSHA AND MUSOMA HAD ALREADY BEEN COMPLETED (IN ADDITION TO THE SHORT-CUT TRANSPORTATION ROUTE, THE TONNAGE CONSIDERED TO BE SWITCHED TO TANGA–UGANDA ROUTE FROM MOMBASA–UGANDA ROUTE)

(Thousand tons)

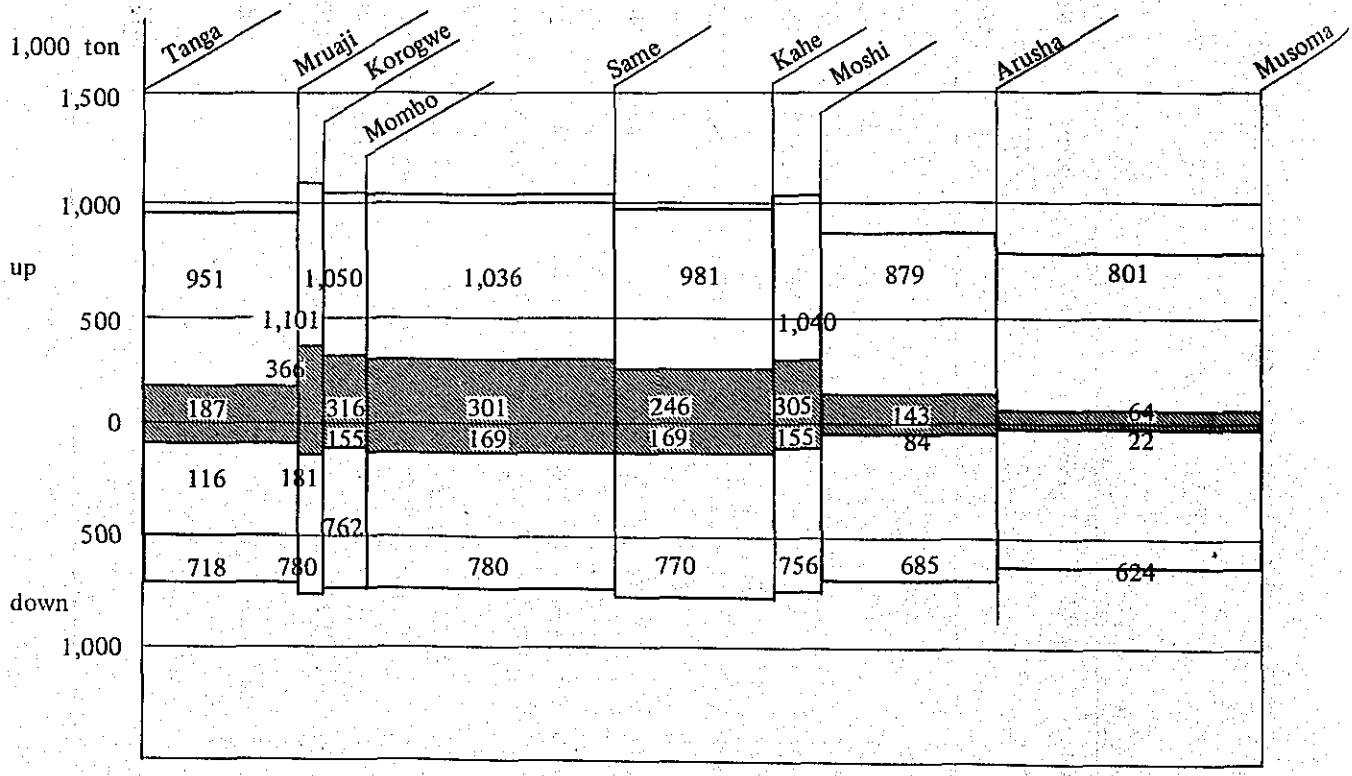
Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha	Musoma
Up (For Indian Ocean bound)	Maize, maize meal & flower	26	47	47	47	47	47	19	2	
	Rice	-	3	3	3	3	3	3	3	
	Wheat & wheat flower	12	2	2	2	2	2	3	-	
	Cereals, etc.	2	2	2	2	2	14	14	12	
	Beans & peas	17	21	21	21	21	26	26	4	
	Fruits & vegetables	-	4	4	4	4	4	-	-	
	Sugar	16	42	42	47	32	-	-	-	
	Coffee & tea	251	255	255	255	255	281	234	223	
	Cotton	71	71	71	71	71	71	71	71	
	Fertilizers	1	1	1	1	1	1	2	-	
	Woods	13	26	10	4	4	4	-	-	
	Feeding stuff	2	8	9	7	-	7	7	7	
	Cement	3	-	-	-	-	-	-	-	
	Iron & steel, metals and machinery	-	1	1	1	1	-	-	-	
	Others	8	10	8	8	8	8	8	6	
	Total	422	493	476	473	451	461	387	328	
Down (For inland bound)	Maize, maize meal & flower	2	2	2	2	2	2	-	-	
	Wheat & wheat flower	8	18	11	11	11	11	11	9	
	Cereals, etc.	-	13	13	13	13	7	1	-	
	Beans & peas	-	2	2	2	2	-	1	-	
	Sugar	-	-	-	-	-	13	13	1	
	Beer	-	4	4	4	4	4	5	5	
	Fertilizers	19	22	22	22	22	22	20	19	
	Woods	15	5	5	6	6	1	1	-	
	Salt & rock salt	34	32	32	32	32	32	27	27	
	Feeding stuff	12	12	8	16	16	14	6	-	
	Sand & stone	10	10	10	-	-	-	-	-	
	Oil	273	273	273	273	273	273	273	273	
	Cement	8	23	23	23	16	16	6	5	
	Iron & steel, metals and machinery	60	64	64	64	64	64	64	60	
	Others	14	16	16	16	16	16	14	14	
	Total	455	501	485	484	477	475	442	413	
Grand Total		781	994	961	957	925	936	829	741	

Table 2-4 TRANSITION OF PRODUCTS, ETC. IN TANZANIA

(Thousand tons)

Item	1963	1964	1965	1966	1967 (A)	1980 Estimated (B)	Rate (A/B) %	Remarks
Maize, maize meal & flower	109	80	70	108	104	119	114	Purchasing volume by N.A.P.B.
Rice	-	37	20	37	30	22	73	– Ditto –
Wheat & wheat flower	13	22	28	4	23	23	100	Producting & importing volume
Cereals, etc.	30	104	131	117	2,060	6,678	324	Producting volume
Beans & peas	37	48	30	37	38	25	66	– Ditto –
Fruits & vegetables	149	197	151	154	121	141	117	– Ditto –
Sugar	49	60	66	70	71	152	214	– Ditto –
Coffee & tea	33	38	39	58	46	113	246	– Ditto –
Feeding stuff	2	2	5	6	8	25	313	Exporting volume from Dar es Salaam
Beer	4,010	4,810	4,830	6,050	6,290	1,390	221	Consumption volume
Woods ($1,000\ ft^3$)	-	9,330	10,228	15,412	16,312	50,726	311	Producting volume
Salt & rock salt	33	32	38	36	32	34	106	– Ditto –
Cotton	87,000	103,000	123,000	151,000	127,000	310,200	244	– Ditto –
Oil	30,120	30,670	30,150	35,040	36,430	57,984	159	Consumption volume
Cement	19,730	15,110	17,720	18,000	22,890	32,505	142	– Ditto –
Iron & steel, metals and machinery	-	2,990	2,970	2,820	3,150	3,460	110	Importing volume
Fertilizers							205	There is no specific figure, so the average of above mentioned rate only is given.
Others							205	

Fig.2-3 Net goods tonnages to be carried by section in 1980



Tonnage to be carried by short cut transportation route only.

Tonnage to be replaced by Tanga-Uganda route from Mombasa-Uganda route, in addition to the short cut transportation route.

Table 2-5-1 NET FREIGHT TONNAGE TO BE CARRIED BY EACH SECTION IN 1980
(SHORT-CUT TRANSPORTATION ROUTE ONLY)

(Thousand tons)

Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha	Musoma
Up (For Indian Ocena bound)	Maize, maize meal & flower		30	54	54	54	54	54	22	2
	Rice		-	2	2	2	2	2	2	2
	Wheat & wheat flower		12	2	2	2	2	2	3	-
	Cereals, etc.		6	6	6	6	6	45	45	39
	Beans & peas		9	11	11	11	11	15	15	-
	Fruits & vegetables		-	5	5	5	5	5	-	-
	Sugar		34	90	90	101	68	-	-	-
	Coffee & tea		69	79	79	79	79	143	27	-
	Fertilizers		2	2	2	2	2	2	4	-
	Woods		40	81	31	12	12	12	-	-
	Feeding stuff		6	25	28	22	-	21	21	21
	Cement		4	-	-	-	-	-	-	-
	Iron & steel, metals and machinery		-	1	1	1	1	-	-	-
	Others		4	8	4	4	4	4	4	-
	Total		187	366	315	301	246	305	143	64
Down (For inland bound)	Maize, maize meal & flower		2	2	2	2	2	2	-	-
	Wheat & wheat flower		-	10	3	3	3	3	3	1
	Cereals, etc.		-	42	42	42	42	23	3	-
	Beans & peas		-	1	1	1	1	-	1	-
	Sugar		-	-	-	-	-	28	28	2
	Beer		-	9	9	9	9	9	11	11
	Fertilizers		-	6	6	6	6	6	2	-
	Woods		47	16	16	19	19	3	3	-
	Salt & rock salt		8	6	6	6	6	6	1	1
	Feeding stuff		38	38	25	50	50	44	19	-
	Sand & stone		10	10	10	-	-	-	-	-
	Cement		11	33	33	33	23	23	9	7
	Iron & steel, metals nad machinery		-	4	4	4	4	4	4	-
	Others		-	4	4	4	4	4	-	-
	Total		116	181	155	169	169	155	84	22
Grand Total			303	547	470	470	415	460	227	86

Table 2-5-2 NET FREIGHT TONNAGE TO BE CARRIED BY EACH SECTION IN 1980 (IN ADDITION TO THAT OF THE SHORT-CUT TRANSPORTATION ROUTE, THE TONNAGE CONSIDERED TO BE SWITCHED TO TANGA–UGANDA ROUTE FROM MOMBASA–UGANDA ROUTE IS ADDED)

(Thousand tons)

Up or Down	Item	Tanga	Mruaji	Korogwe	Mombo	Same	Kahe	Moshi	Arusha	Musoma
Up (For Indian Ocean bound)	Maize, maize meal & flower	30	54	54	54	54	54	22	2	
	Rice	-	2	2	2	2	2	2	2	
	Wheat & wheat flower	12	2	2	2	2	2	3	-	
	Cereals, etc.	6	6	6	6	6	45	45	39	
	Beans & peas	11	14	14	14	14	17	17	3	
	Fruits & vegetables	-	5	5	5	5	5	-	-	
	Sugar	34	90	90	101	68	-	-	-	
	Coffee & tea	617	627	627	627	627	691	576	549	
	Cotton	173	173	173	173	173	173	173	173	
	Fertilizers	2	2	2	2	2	2	4	-	
	Woods	40	81	31	12	12	12	-	-	
	Feeding stuff	6	25	28	22	-	21	21	21	
	Cement	4	-	-	-	-	-	-	-	
	Iron & steel, metals and machinery	-	1	1	1	1	-	-	-	
	Others	16	20	16	16	16	16	16	12	
	Total	951	1,101	1,050	1,036	981	1,040	879	801	
Down (For inland bound)	Maize, maize meal & flower	2	2	2	2	2	2	-	-	
	Wheat & wheat flower	6	13	8	8	8	8	8	7	
	Cereals, etc.	-	42	42	42	42	23	3	-	
	Beans & peas	-	1	1	1	1	-	1	-	
	Sugar	-	-	-	-	-	28	28	2	
	Beer	-	9	9	9	9	9	11	11	
	Fertilizers	39	45	45	45	45	45	41	39	
	Woods	47	16	16	19	19	3	3	-	
	Salt & rock salt	36	34	34	34	34	34	29	29	
	Feeding stuff	38	38	25	50	50	44	19	-	
	Sand & stone	10	10	10	-	-	-	-	-	
	Oil	434	434	434	434	434	434	434	434	
	Cement	11	33	33	33	23	23	9	7	
	Iron & steel, metals and machinery	66	70	70	70	70	70	70	66	
	Others	29	33	33	33	33	33	29	29	
	Total	718	780	762	780	770	756	685	624	
Grand Total		1,669	1,881	1,812	1,816	1,751	1,796	1,564	1,425	

Table 2-6-1 NUMBER OF TRAINS REQUIRED TO BE SCHEDULED AND THE FREIGHT TRANSPORTATION CAPACITY TO MEET THE 1980 TRAFFIC VOLUME (SHORT-CUT TRANSPORTATION ROUTE ONLY)

Item				Tanga	Mruaji	Morogwe	Kahe	Moshi	Arusha	Musoma
Number of trains scheduled to be operated per day (Both way)	Mixed train	Average number of passenger coaches to each train		3	3	3	3	2	2
		Daily operating		2	2	2	2	-	-
		Operating Specified days	Sun	2	2	-	4	2	2
			Mon	2	2	-	-	-	-
			Tue	-	-	-	-	-	-
			Wed	2	4	4	4	2	2
			Thu	2	2	-	-	-	-
			Fri	2	4	2	2	-	-
			Sat	2	2	-	-	-	-
			Total	12	16	6	10	4	4
	Goods train	Daily operating		2	6	6	6	-	-
		Operating specified days	Sun	-	-	-	-	-	-
			Mon	-	-	-	-	2	2
			Tue	2	2	2	-	2	2
			Wed	-	-	-	-	-	-
			Thu	2	2	2	-	2	2
			Fri	-	-	-	-	2	2
			Sat	2	2	-	-	2	2
			Total	6	6	4	-	10	10
Annual freight transportation capacity (Thousand tons)	Mixed train			178	206	140	164	28	28
	Goods train			220	528	528	462	264	11
	Total			398	734	668	626	352	138
Estimated net traffic volume in 1980 (Thousand tons)				303	547	470	460	227	86

Remarks

Annual freight transportation capacity is calculated according to the following formula:-

$$W = \frac{365\ N\ w1\ (e2 - e1)\ (C - nw3)}{w1 + w2}$$

Where;

- W : Annual freight transportation capacity (tons).
- w1 : Average net freight tonnage carried per wagon unit (11 tons, actually obtained by East African Railways is introduced).
- w2 : Average tare weight per wagon unit (20 tons).
- w3 : Average weight in working order per passenger coach (40 tons).
- C : Traction capacity per train by Class 90 Diesel-electric locomotive (750 tons for passenger-freight train and 1,000 tons for freight train).
- e1 : Rate of seasonal fluctuation (20%).
- e2 : Wagon hauling coefficiency (80%).
- N : Average number of trains scheduled to be operated per day.
- n : Average number of passenger coaches to each train.

Table 2-6-2 NUMBER OF TRAINS REQUIRED TO BE SCHEDULED AND FREIGHT TRANSPORTATION CAPACITY IN 1980 (IN ADDITION TO THAT OF THE SHORT-CUT TRANSPORTATION ROUTE, THE TONNAGE CONSIDERED TO BE SWITCHED TO TANGA–UGANDA ROUTE FROM MOMBASA–UGANDA ROUTE IS ADDED)

Item				Tange	Mruaji	Korogwe	Kahe	Moshi	Arusha	Musoma
		Average number of passenger coaches to each train		3	3	3	3	2	2
		Daily operation		2	2	2	2	-	-
			Sun	2	2	-	4	2	2
			Mon	2	2	-	-	-	-
	Mixed train		Tue	-	-	-	-	-	-
		Operating specified	Wed	2	4	4	4	2	2
			Thu	2	2	-	-	-	-
			Fri	2	4	2	2	-	-
			Sat	2	2	-	-	-	-
			Total	12	16	6	10	4	4
		Daily operating		22	26	26	26	22	20
			Sun	-	-	-	-	-	-
			Mon	-	-	-	-	-	-
			Tue	2	-	-	-	2	2
	Goods train		Wed	-	-	-	-	-	-
		Operating specified	Thu	2	-	-	-	2	2
			Fri	-	-	-	-	-	-
			Sat	-	-	-	-	2	2
			Total	4	-	-	-	6	6
Annual goods transportation capacity (Thousand tons)	Mixed train			178	206	140	164	28	28
	Goods train			1,738	2,002	2,002	2,002	1,760	1,606
	Total			1,916	2,208	2,142	2,166	1,788	1,634
Estimated net traffic volume in 1980 (Thousand tons)				1,669	1,881	1,816	1,796	1,564	1,425

Annual freight transportation capacity is calculated according to the following formula :-

$$W = \frac{365\,N\,w1\,(e2 - e1)\,(C - nw3)}{w1 + w2}$$

Where;

W : Annual freight transportation capacity (tons).

w1 : Average net freight tonnage carried per wagon unit (11 tons, actually obtained by East African Railways is introduced).

w2 : Average tare weight per wagon unit (20 tons).

w3 : Average weight in working order per passenger coach (40 tons).

C : Traction power per train by Class 90 Diesel-electric locomotive (750 tons for passenger-freight train and 1,000 tons for freight train)

e1 : Rate of seasonal fluctuation (20%)

e2 : Wagon hauling coefficiency (80%).

N : Average number of trains scheduled to be operated per day.

n : Average number of passenger coaches to each train.

CHAPTER III PLAN OF CONSTRUCTION OF NEW RAILWAY-LINE BETWEEN ARUSHA AND MUSOMA

3-1 Outline of Arusha-Musoma Alignment

3-1-1 Topography

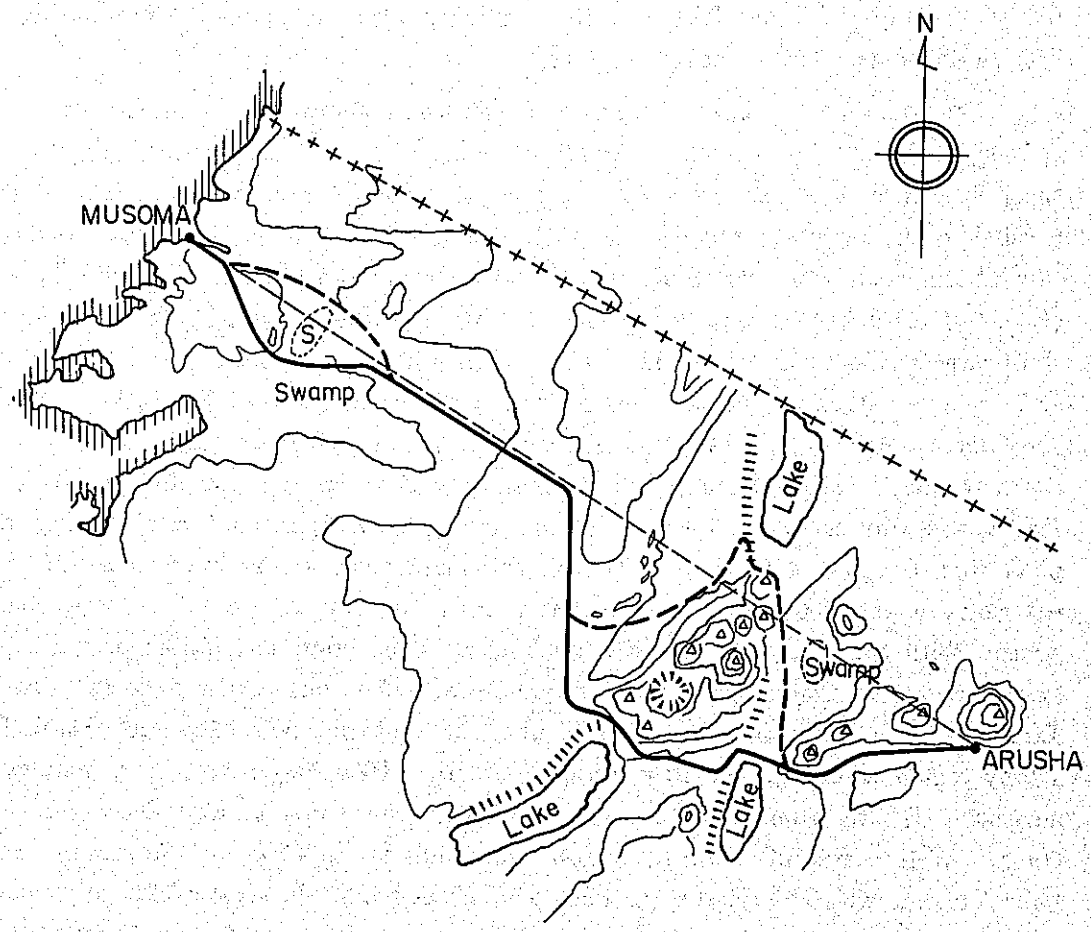
Arusha is situated at the point about 330 km northwest (length of railway-line is 437 km) of Tanga Port near the boundary with Kenya on the Indian Ocean. The elevation is 1,350 m above sea level.

Musoma on the Lake Victoria is at the point about 385 km northwest of Arusha in straight line distance. And the elevation is 1,120 m above sea level. From the point close to Arusha runs the Great North Road (A 104) westward almost in parallel to the proposed railway-line. Mt. Monduli (El. 2660 m) is on the northern side of this road while Mt. Burko (El. 2160 m) is on the western side. Mt. Losimingur (El. 2170 m) is to the west of Mt. Burko. Mt. Ngorongoro (El. 2280 m) having the sixth largest caldera in the world (19 km x 16 km or 304 sq. km) is at the point 130 km from Arusha. Around this mountain are 9 volcanoes of El. 3000 m class. The Gregory Rift Valley (elevation difference is about 270 m on the west wall) runs north to south passing through the abovementioned volcanoes. To the west of this Rift Valley runs from north to south and grazing Lake Eyasi another rift valley far older than Gregory Rift Valley. The elevation difference on the north wall of this rift valley is about 640 m. In these rift valleys are many salt lakes and large marshy zones. With the exception of the comparatively deep gorge at Oldupai near Lake Lagaja, Serengeti Plains form vast level grassland, and is one of the national parks of Tanzania. The elevation is about 1680 m. The western side of Serengeti Plains forms a hilly region where the elevation drops gradually. Near Mageta is a large marshy zone measuring 35 km from north to south and 10 km from east to west at El. 1200 m. On the western side of this marshy zone lies a hill at El. 1500 m. Musoma is on the Lake Victoria which is on the northern foot of this hill. In view of the aforementioned topography, the route will run along the Great North Road on the southern foot of Mr. Monduli, Mt. Burko and Mt. Losimigur, then take a detour either north or south to avoid Ngorongoro mountains and enter Serengeti Plains, go up north, then change the direction to northwest to follow the straight line joining the two terminals, then again take a detour north or south to avoid the large swampy zone near Mugeta and reach Musoma. See Fig. 3-1 Explanatory Map of Routes.

3-1-2 Geology

The bed rock consists mainly of metamorphic sedimentary rock of Archaean era, Neogene volcanic rocks and granite, and lacustrine deposits of Cainozoic era are found on the northern shore of Lake Manyara and near Nata. As to the surface layer,

Fig. 3 – 1 Explanatory Map for Routs



Proposed line

Comparative line

either the bed rock is exposed or reddish brown soil characteristic of the tropical zone or calcimorphic volcanic soil have piled up to a thickness of one to 2 meters. As there are no large rivers at points where the route passes through, no much river deposits are found. It does not seem necessary to take the problem of weak soil into consideration. (See Fig. 1-2 Geology of Tanzania)

3-1-3 Rainfall

Districts on the foot of the mountains located south of Arusha are the districts having much rainfall. Hilly districts of Musoma and mountainous districts of Ngorongoro come next.

Arusha	1800 mm/year
Western districts of Ngorongoro	600
Southern foot of Ngorongoro	1000
Southern part of Serengeti Plains	600
Northern part of Serengeti Plains	800
Around Ikoma	1000
Hilly districts around Musoma	1400
Musoma	800

(See Fig. 1-4 Mean Annual Rainfall)

According to the data kept at Arusha and Musoma, April is the month having the most rainfall comprising 20 to 30% of the annual rainfall. The total of the rainfall in March and May reaches 30% of the annual rainfall.

3-1-4 Population

Due to the aforementioned topography, the population is very small compared with that of the entire territory of Tanzania. With the exception of the southern foot of Mt. Ngorongoro and the districts west of Ikoma, the population is almost nil. (See Fig. 1-5 Population Density)

Region and District	Population (in thousands)	Density (Persons per km^2)
Arusha		
Arusha	214.2	71.9
Masai	106.9	1.7
Mbulu	289.3	18.0
Mara		
Musoma	355.6	19.9
Grand Total (Mainland)	11,957.2	13.5

The following table shows the distance covered by the new railway-line (Arusha–Musoma) in each district.

District	Arusha	Masai	Mbulu	Musoma	Total
Distance to be covered by the new railway-line	19 km	210 km	91 km	224 km	544 km
Comparative line	19 km	316 km	—	226 km	561 km

3-2 Standards of the new Arusha–Musoma Railway Line

3-2-1 Gauge

In consideration of the through service with the East African Railway (particularly between Tanga and Arusha), 1-meter gauge is adopted. However, the structure shall be such that modification is possible in case of unification of pan-African railway gauge to 1067 mm. (See Fig. 3-2 Cross Section of Tunnel, Structure and Loading Gauge)

3-2-2 Maximum Grade

The maximum grade of the existing sections of the railway-line between Tanga and Arusha has the grade of 1.5% as a standard. However, as there are some sections in which the grade is 2.0%, and so the maximum grade of the proposed new railway-line shall be 1.5% on the premise that those sections having the grade over 1.5% in existing lines will be improved. The maximum grade of 2.0% was not considered also for the following reasons.

(1) Most of the districts except the central mountainous district are comparatively level.

(2) Concerning the central mountainous district, west wall of Gregory Rift Valley and the foot of Oldeani, comparison was made between 1.5% grade and 2.0% grade, but no substantial difference was found in the construction cost.

3-2-3 Minimum Radius of Curve

The minimum radius of the main line of the East African Railway is 216 m (curvature = $8^{\circ}.0$) while the standard minimum radius adopted is 300 m (curvature = $5^{\circ}.8$).

3-2-4 Earthwork Standard

Earthwork standard of the proposed new railway-line is as given in Fig. 3-3. (See Fig. 3-3 Earthwork standard)

Fig. 3 – 2 Cross Section of Tunnel Structure and Loading Gauge

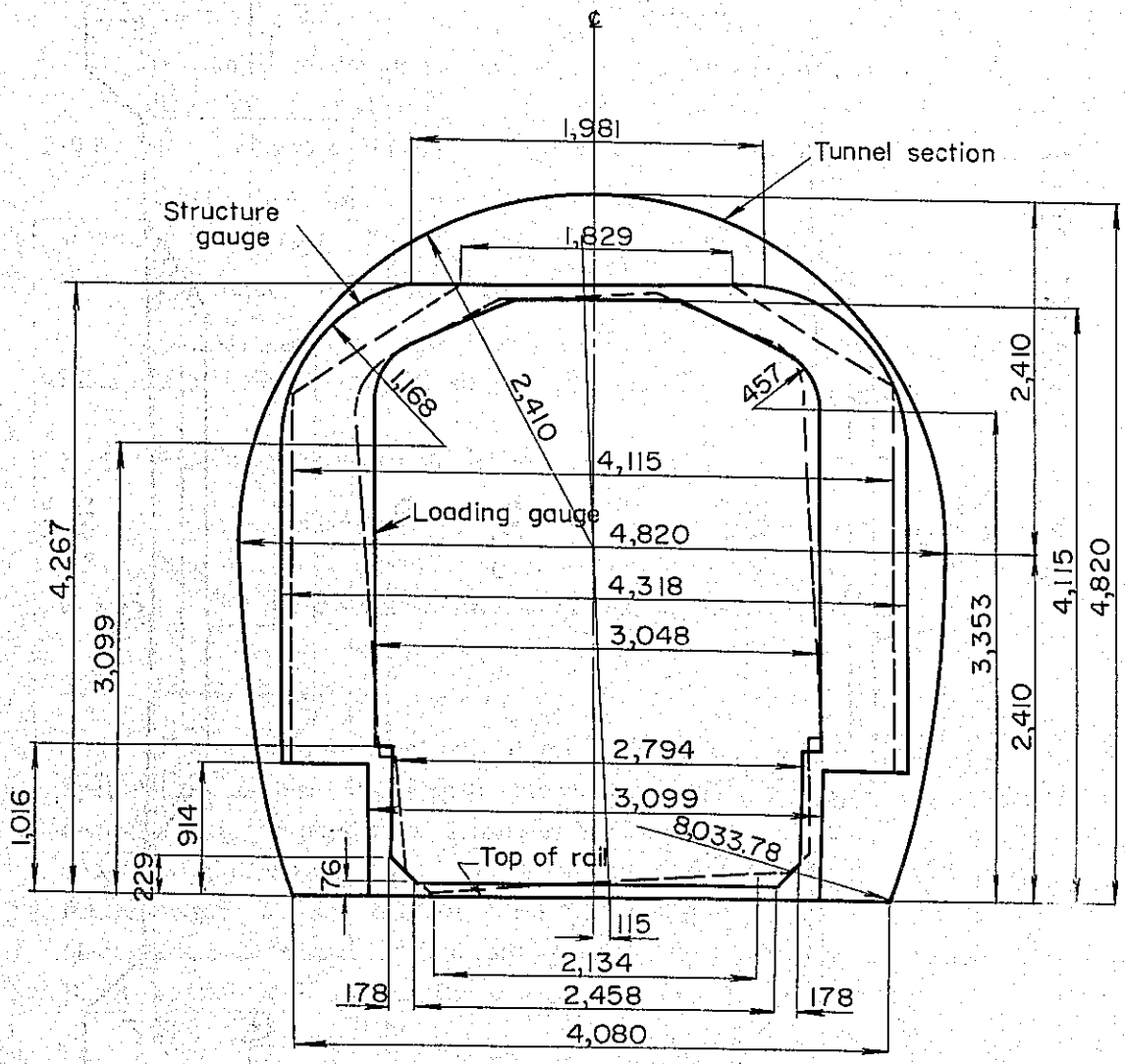
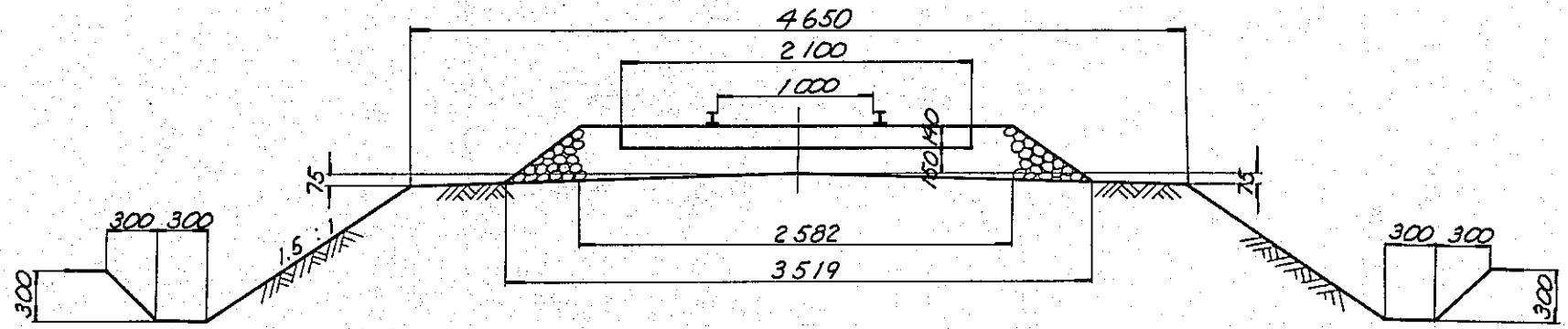
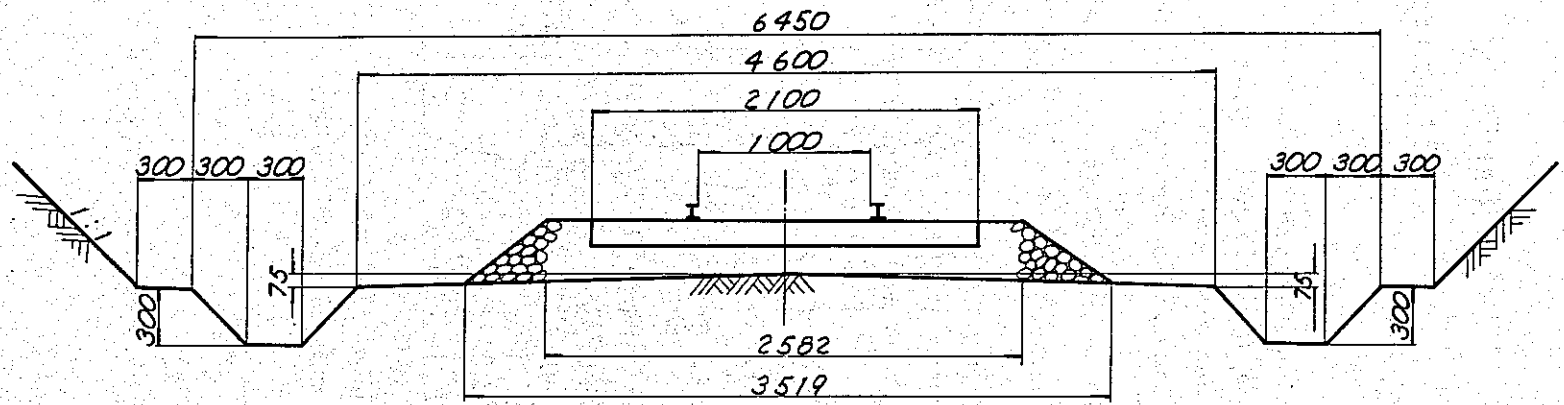


Fig. 3-3 Earthwork Standard

FILL Unit: mm



CUT



3-2-5 Structure of Track

The total length of the railway-line in three East African countries, for which the rails were renewed during the period of 1965–1966, is as shown below, classified by the weight of rail used.

35 kg/m	3.2 km
30 kg/m	90.1 km
40 kg/m	12.8 km
47 kg/m	16.0 km

According to the above records, 30 kg/m rail is presently being used most. In consideration of levelling up of the future standards, 40 kg/m rail is to be used in this project. However, the rails for the side tracks shall be the 30 kg/m rail.

Steel will be used as sleepers since this is customary in this country, but it would be necessary to study the use of P.S. concrete sleepers also.

The number of sleepers shall be 34 sleepers/25 m.

As river gravel is rather scarce, crushed stone will be used as ballast. The thickness of ballast under the sleepers shall be 15 cm thick.

3-2-6 Fundamental Policy for the Selection of the Route

Careful consideration was given when selecting the route of the proposed new railway line so that it would pass through cultivated and inhabited districts as much as possible and the districts in which the existing highways are close by.

3-2-7 Railway Stations

The distance between one station and another has been decided at about 30 km. Special consideration was given to choose the location of the station in cultivated district where the population density is high, and also the distance between stations could be reduced to about 15 km in case the traffic volume should increase in the future. Again, a turnout at the point 82.5 km from Arusha and located west of Lake Manyara was considered in expectation of the construction of a new railway-line in Babati district or Singida district.

Maps obtained were of 1/50,000, 1/250,000 and 1/500,000 scales, but the 1/500,000 scale map with indistinct contours was the only map showing the south-western part of Mt. Oldeani and the Serengeti Plains to the north of Lake Eyasi, which made it difficult to choose the accurate route between the south-western foot of Mt. Oldeani and Oldupai Gorge.

Out of those maps presented by the Government of Tanzania and those which were available, the following maps were used.

Kind of Map			Hight Between Contours	Remarks
1/3,000,000 scale			1000 ft	
1/2,000,000 scale (Road Map of E.Africa)			Non	
1/500,000 scale	Lake Province Series 3		500 ft	
1/500,000 scale	Lake Province Series 4		500 ft	
1/500,000 scale	Musoma SA 362		500 ft	Approx.
1/500,000 scale	Kisumu SA 363		500 ft	Approx.
1/500,000 scale	Ngorongoro SA 366		500 ft	Approx.
1/500,000 scale	Arusha SA 374		500 ft	Approx.
1/50,000 scale		4-4	50 ft	
		*12-2		(*Published but not available)
		12-4		
		13-1		
		13-2		
		39-2		
		39-4		
		40-1		
		40-3		
		52-2		
		53-1		
		53-2		
		53-3		
		53-4		
		54-1		
		54-3		
		54-4		
		55-3		
		70-1		
1/2,500 scale	Musoma	1-5	5 ft	

Fig. 3-4 Index of 1/50,000 Scale Map

3-3-1 Arusha–The Foot of Eluanata

This section of the railway-line runs almost parallel to the Great North Road (A104), and the area along this section is thinly populated with the exception of Arusha and the foot of Mt. Eluanata. The Masai tribe is pasturing in the Savanna zone. However, the lay of the land is even, and the construction work would be easy.

Picture 1

3-3-2 The Foot of Mt. Eluanata–East Gate of Serengeti National Park

This section of the railway-line runs parallel to the main local road (B142) and reaches Mto Wa Mbu on the foot of Gregory Rift Scarpment. It then climbs up south-south-westward the west wall of Gregory Rift Valley, runs westward on the foot of Mt. Ngorongoro and Mt. Oldeani, passes through the western foot of Mt. Oldeani and the southern foot and the western foot of Mt. Makarut, and then enters the Serengeti Plain and reaches the East Gate of Seregenti National Park. Topographically, this is a rugged section, and erosional valleys have developed particularly on the west wall of Gregory Rift Valley, west foot of Mt. Oldeani, south foot of Mt. Makarut and Oldupai Gorge, and many bridges and tunnels have to be constructed. This will involve a large amount of construction cost. The southern foot of Mt. Ngorongoro and Mt. Oldeani is a prosperous zone where the land is fertile and inhabitants are many.

The route of a comparative railway-line will run north-ward along the foot of Mt. Eluanata and further on the foot of west wall of Gregory Rift Valley, pass through the mountain side of the active volcano Mt. Lengai, then climb up the Gregory Rift Valley in the direction of north-north-east, then make a turn, run through the northern foot of Mt. Empakaai south-westward, then pass through the southern foot of Mt. Kiti and Mt. Longoijio and enter Serengeti Plain and reach the East Gate. The mountain side of Mt. Lengai is impassable due to the recent volcanic activity. The west wall of Gregory Rift Valley has a particularly steep slope which make it difficult to pass. The low area on the eastern side of the Rift Valley has many seasonal swamps. Other part of the section will be in the Savanna or the sand dune districts where the construction work would be easy but the density of population is very low. Those pasturing Masai tribes are the only inhabitants. The construction cost is high compared with that of the former, and the route itself is inferior to the former one.

Pictures 2, 3, 4 and 5

3-3-3 East Gate of Serengeti National Park–Kilimafeza

With the exception of the area around Kilimafeza, this section is a vast grassland known as the kingdom of wildlife. As there are no inhabitants, the construction work would be easy if the route is to pass through this grassland. However, a part of this grassland west of Long. 35° 15' E. is a part of the National Park, and it has been decided to avoid this National Park as much as possible, and the route has been decided to pass through the Serengeti Plain and then cross the National Park

changing its direction to west at the northernmost point of the Serengeti Plain where it touches the east boundary of the National Park.

Pictures 6 and 7

3-3-4 Kilimafeza–Ikoma

This section of the railway-line runs westward on the northern side of the existing road. As this area is distant from the Savanna, more trees, cultivated land and inhabitants are seen as we get closer to Ikoma. The construction cost would be small, but there are small swamps located sporadically.

3-3-5 Ikoma–Musoma

This section of the railway-line runs westward and north-weatward on the southern side of the existing road, passes near Megata and Butiama and reaches Musoma. The topography is a gentle hilly zone from Ikoma to around Mageta, and the places where the route passes through are about El. 1200 m. On the northern side of Mageta lies a large swampy zone measuring about 35 km from north to south and 10 km from east to west. The western part of Mageta touches this large swampy zone, and from there a rugged hilly zone of El. 1400–1500 m continues to the point close to Musoma. Though the construction cost may be slightly higher, this route has been chosen since the area has good cultivated land and the population density is high. The alternative route is the one that runs northward or north-westward from Ikoma avoiding the swampy zone, passes through Simba Sorori on the northern tip of the swampy zone, then passes through northern foot of the hilly zone at about El. 1200 m, and then reaches Musoma. The number of inhabitants and the acreage of cultivated land are inferior to those of the former route. This route cannot be recommended because the total length of the railway-line will be large and the construction cost also will be large.

Picture 8

3-4 Railway Stations

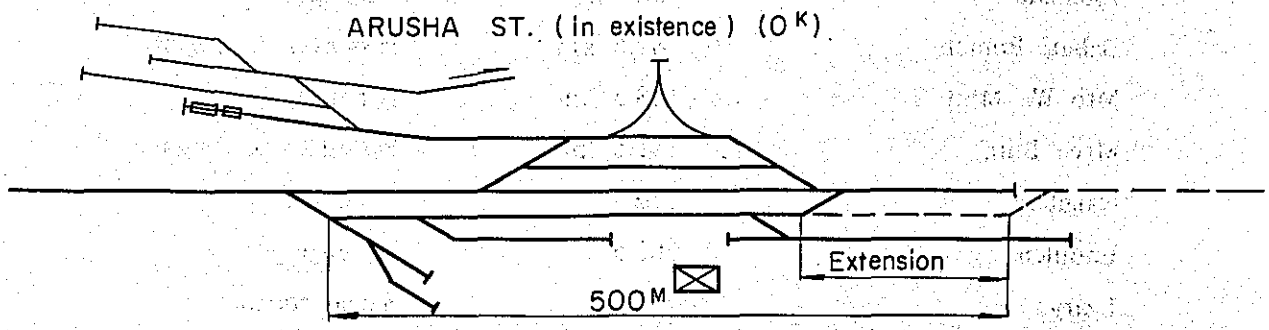
The distance between one station and another is 30 km as a rule, and the railway stations will be located by the side of the existing road as much as possible and also at places where the population is large.

This railway-line will have 16 railway stations and three signal stations, the names of which are as given in the following table.

Station	Distance from Terminal Station (Arusha)	Type
Arusha (Existing)	0	Passenger & freight
Ardai	30 km	Passenger
Eluanata	58 km	Passenger
Babati Branch	82.5 km	Passenger & freight
Mto Wa Mbu	108.5 km	Passenger
Mzee Bura	142.5 km	Passenger & freight
Naigibo	176	Passenger
Endulen	205.5	Passenger
Lgarya	237	Signal station
Serengeti	275	Passenger
Nyamagati	310	Signal station
Nyabogati	340	Signal station
Ruhogo	370.5	Passenger
Ikoma	403	Passenger & freight
Nata	438	Passenger
Ikizu	475	Passenger & freight
Butiama	511	Passenger & freight
Musoma	542	Passenger & freight
Port Musoma (existing)	544.4	Passenger & freight

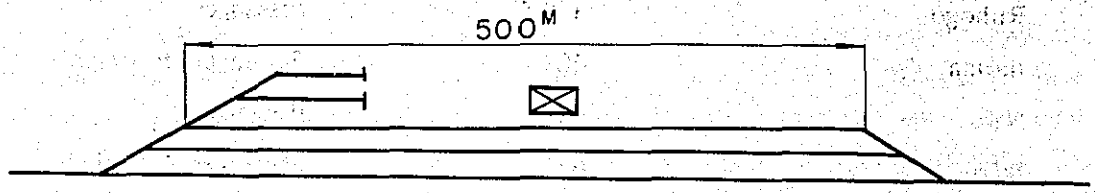
Fig. 3-5 shows the track layout diagrams of the railway stations.

Fig. 3 - 5 Track Layout Diagram of Stations

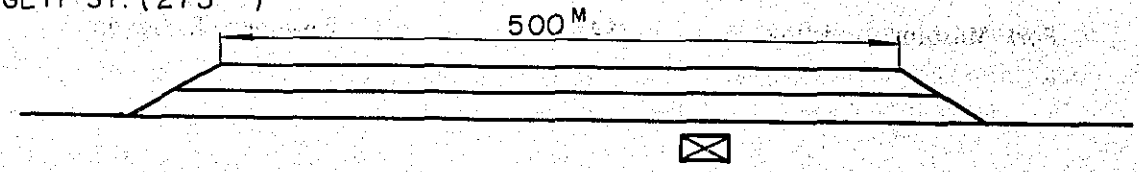


BABATI BRANCHI ST. (82.5 K)
MZEE BUBA ST. (142.5 K)
BUTIMA ST. (511 K)

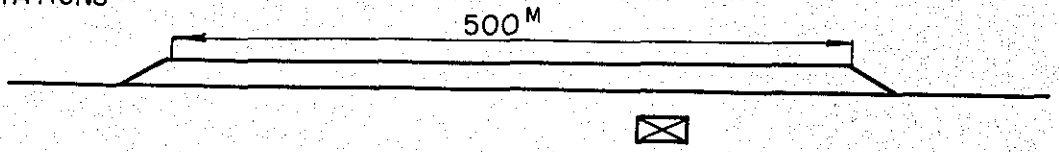
IKOMA ST. (403 K)
IKIZU ST. (475 K)



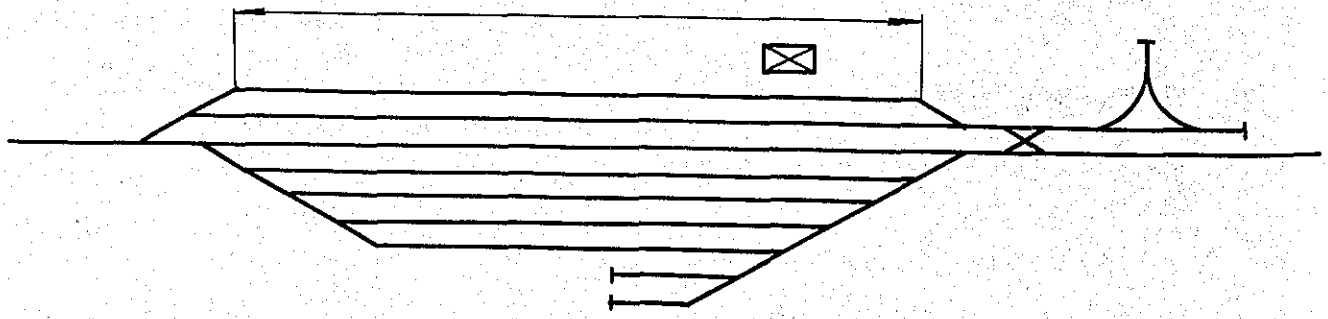
SEREUGETI ST. (275 K)



OTHER STATIONS



MUSOMA ST. (542 K)



3-5 Height of Roadbed; Countermeasures Against Swamps

Although it has been decided that the railway-line will go round the large swampy zones, the following countermeasures have been worked out concerning such small swamps which the proposed new railway-line may have to pass through.

* As Road B142 on the northern side of Lake Manyara is subject to inundation at many places in the wet season, this railway will be equipped with large drains on both sides, and the roadbed will be raised by 2 meters above the present ground level by filling-up.
* As the road on Serengeti Plain is also subject to inundation in the wet season, it has been decided to install large drains on both sides and raise the road-bed by at least 50 cm by filling-up.
* For other small swamps which are inundated in the wet season, it has been decided to install small-scaled drainage for protecting the railway-line.

3-6 Conclusion on the Proposed New Arusha–Musoma Railway Line

The summary of the decided route of the railway-line is as shown on

Fig. 3-6 Plan for Arusha . . . . . Musoma,
Fig. 3-7 Profile for Arusha . . . . . Musoma,
Fig. 3-8 Profile for Comparative Route 89 km . . .295 km and
Fig. 3-9 Profile for Comparative Route 411 km. . . 546 km, respectively.

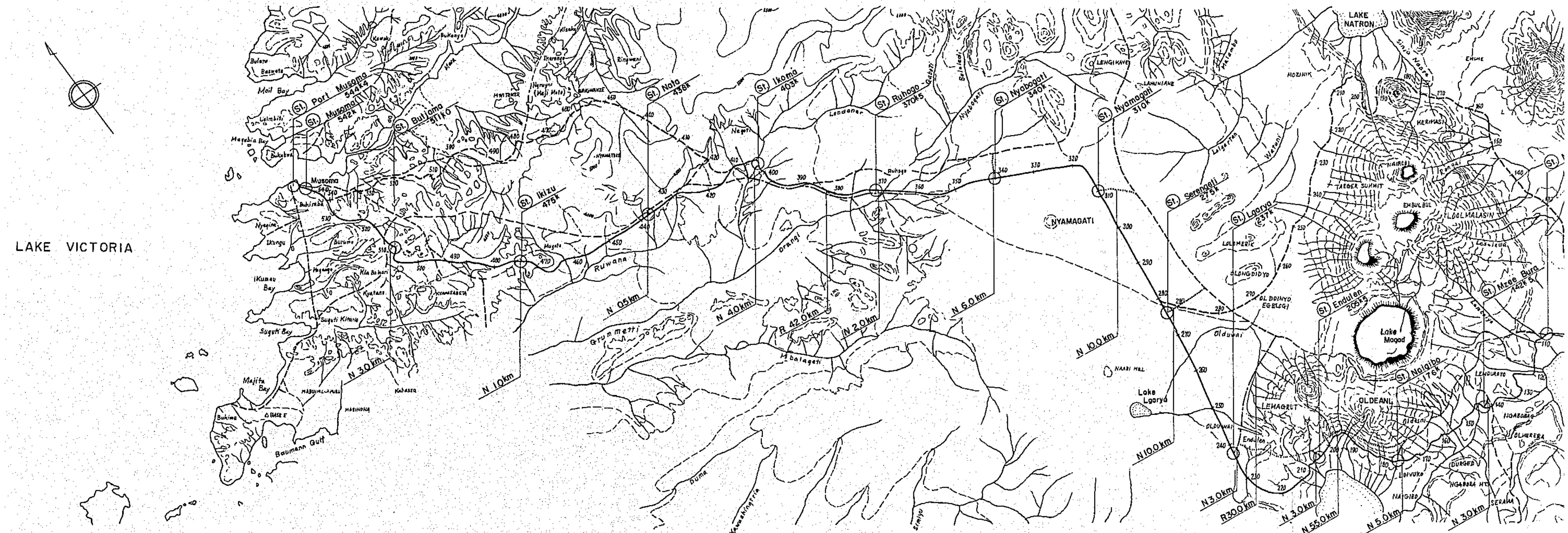
3-6-1 Summary of the Proposed Route

Total distance covered by the route 544.4 km

Name of Section	Proposed Route	Comparative Route
Arusha–The foot of Mt. Eluanata	89 km	-
The foot of Mt. Eluanata–Serengeti Gate	191 km	206 km
Serengeti Gate–Kilimafeza	90 km	-
Kilimafeza–Ikoma	40 km	-
Ikoma–Port Musoma	134.4 km	136.8 km
TOTAL	544.4 km	561.8 km

3-6-2 Total Construction Cost

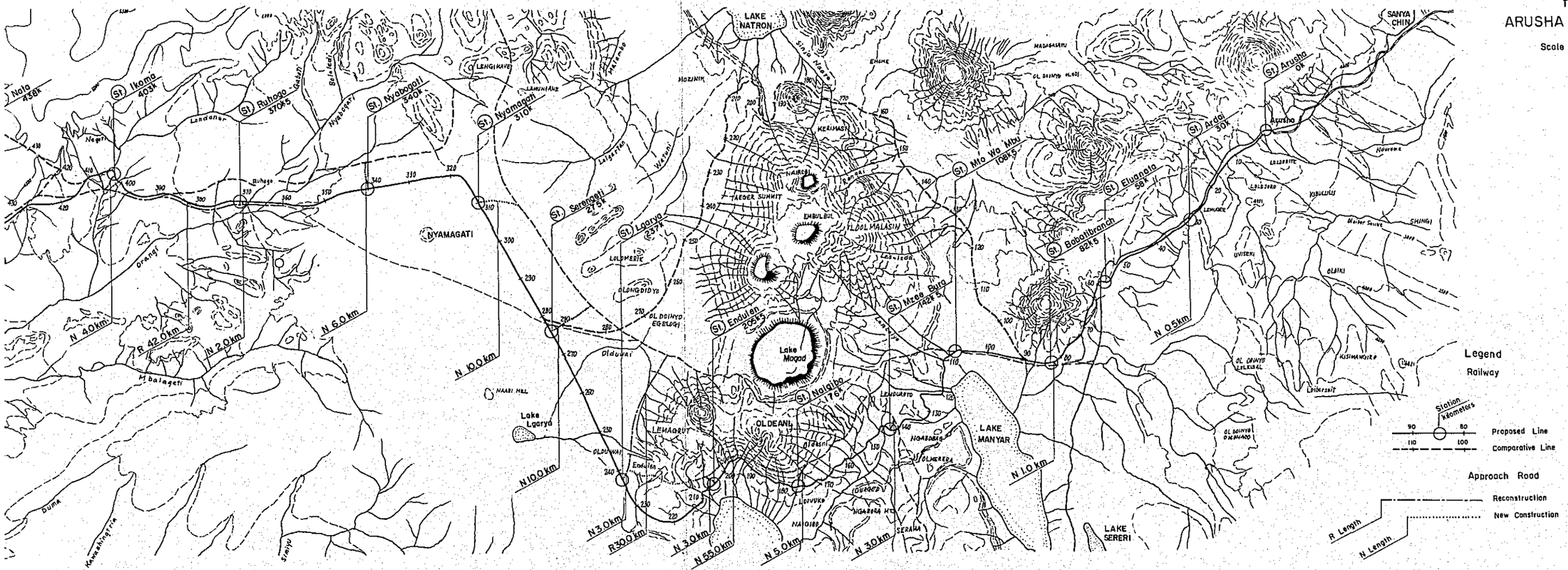
The total construction cost including the cost of surveys and investigations is £35,535,000.-, and the details are as given in Table 3-1.

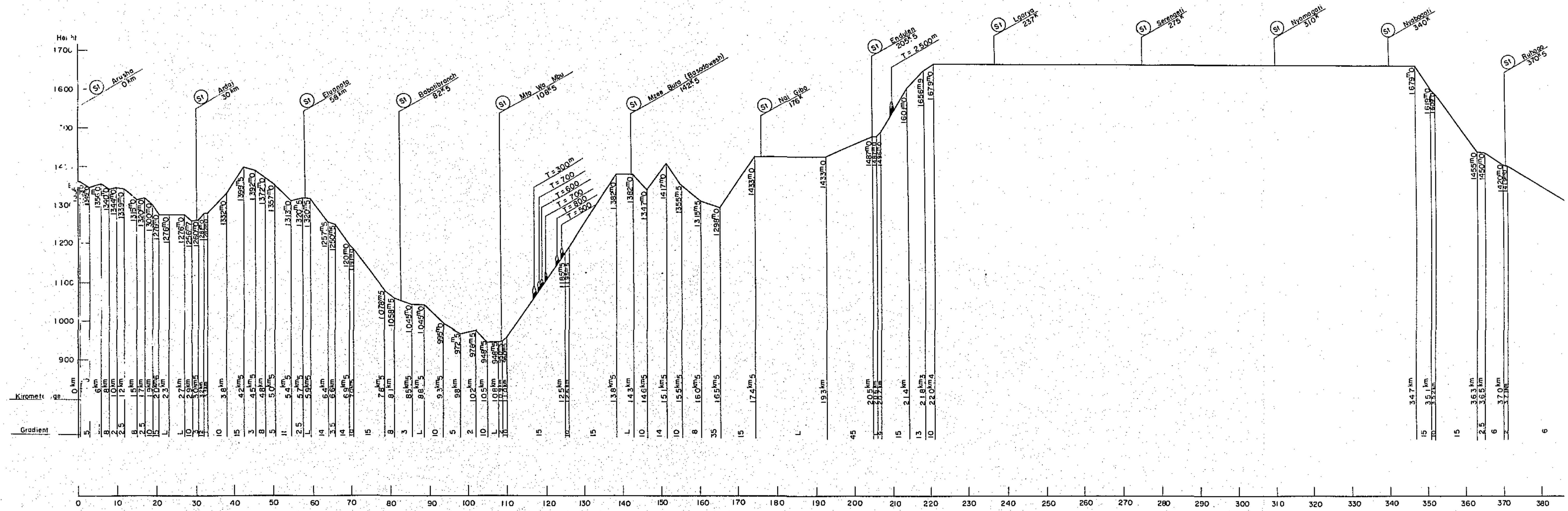


LAKE VICTORIA
LAKE NATRON
St. Port Musoma 544k4
St. Musoma 542k
St. Butiama 511k6
St. Ikizu 475k
St. Nata 438k
St. Ikoma 403k
St. Ruhogo 370k5
St. Nyabogati 340k
St. Nyamagati 310k
St. Serengeti 275k
St. Lgarya 237k
St. Endulen 209k5
St. Naigibo 176k
St. Mzee Bura 142k5
Musoma
Majita Bay
Baumann Gulf
Suguti Bay
Ruwana
Grummetti
Orangi
Mbalageti
NYAMAGATI
Olduvai
Lake Lgarya
Lake Magad
OLDEANI
LEMAGRUT
N 30km
N 10km
N 05km
N 40km
R 42.0km
N 20km
N 6.0km
N 10.0km
N 10.0km
N 3.0km
R 30.0km
N 3.0km
N 55.0km
N 5.0km
N 30km

Fig. 3-6 PLAN
for
ARUSHA - MUSOMA

Scale : 1:500,000





Arusha 0 km
Ardai 30 km
Mto Wa Mbu 108k5
Mzee Bura (Basodowesh) 142k5
Nai Gibo 176k
Endulen 205k5
T = 2500m
Serengeti 275k
Gradient

Fig. 3-7 PROFILE

Scale : Horizontal 1/500,000
Vertical 1/ 50,000

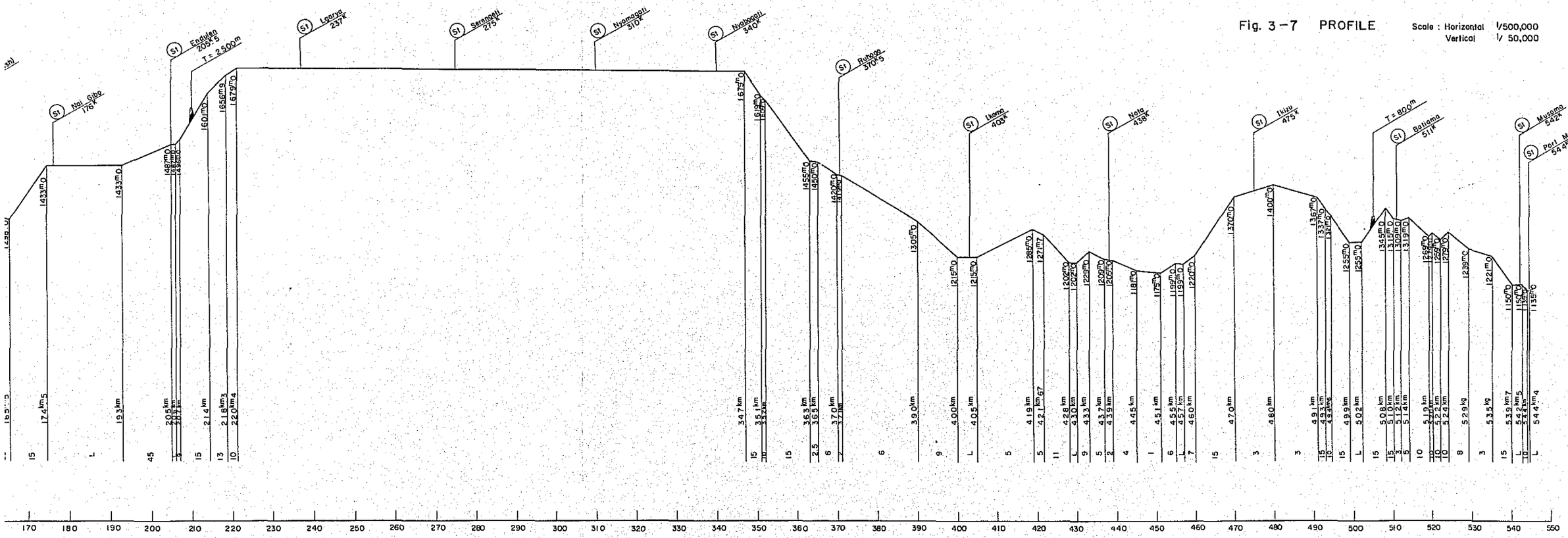


Fig. 3-9 COMPARATIVE ROUTE (411km ~ 546km4)

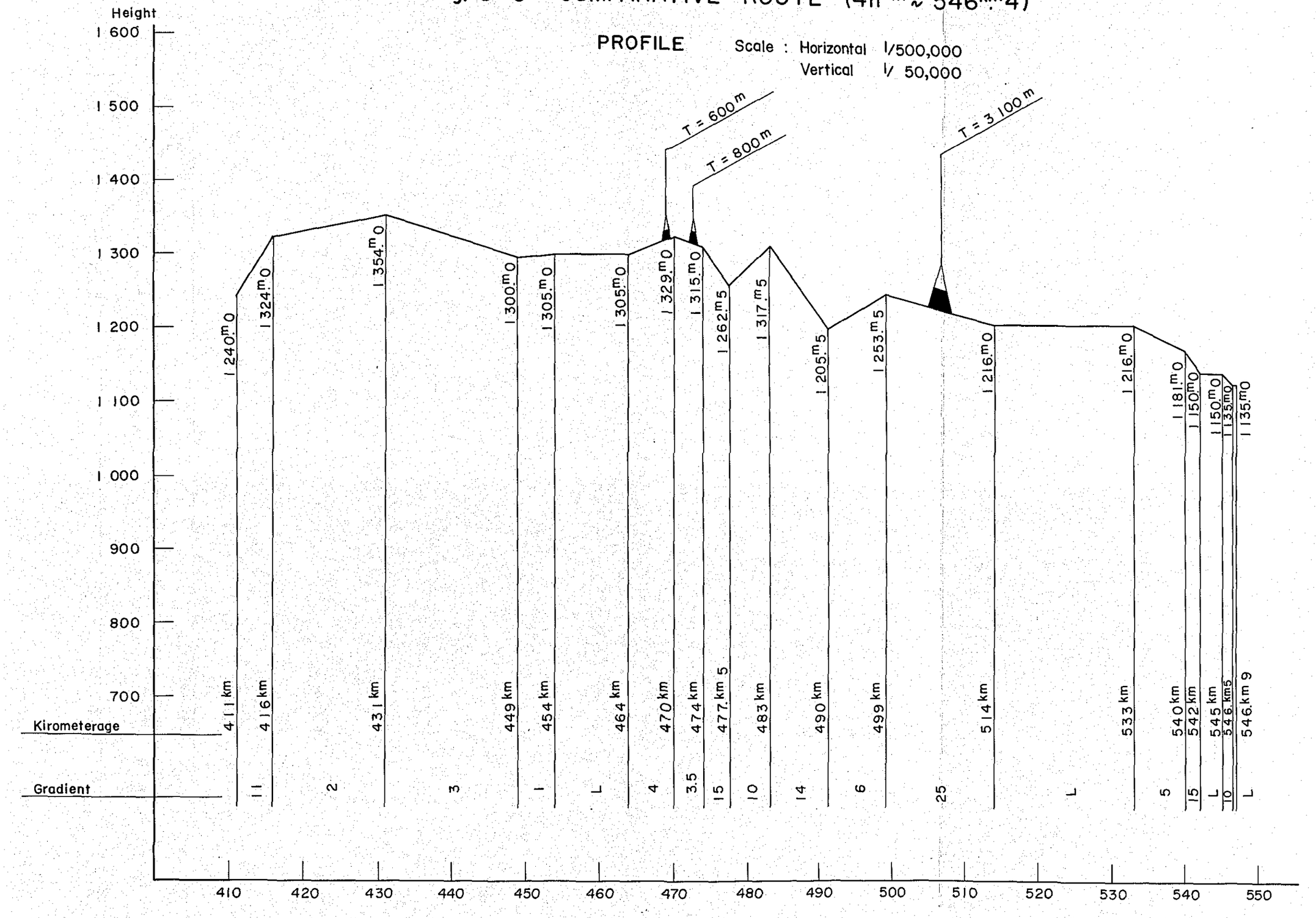


Fig. 3-8 COMPARATIVE ROUTE (89km ~ 295km)

PROFILE Scale : Horizontal 1/500,000
Vertical 1/ 50,000

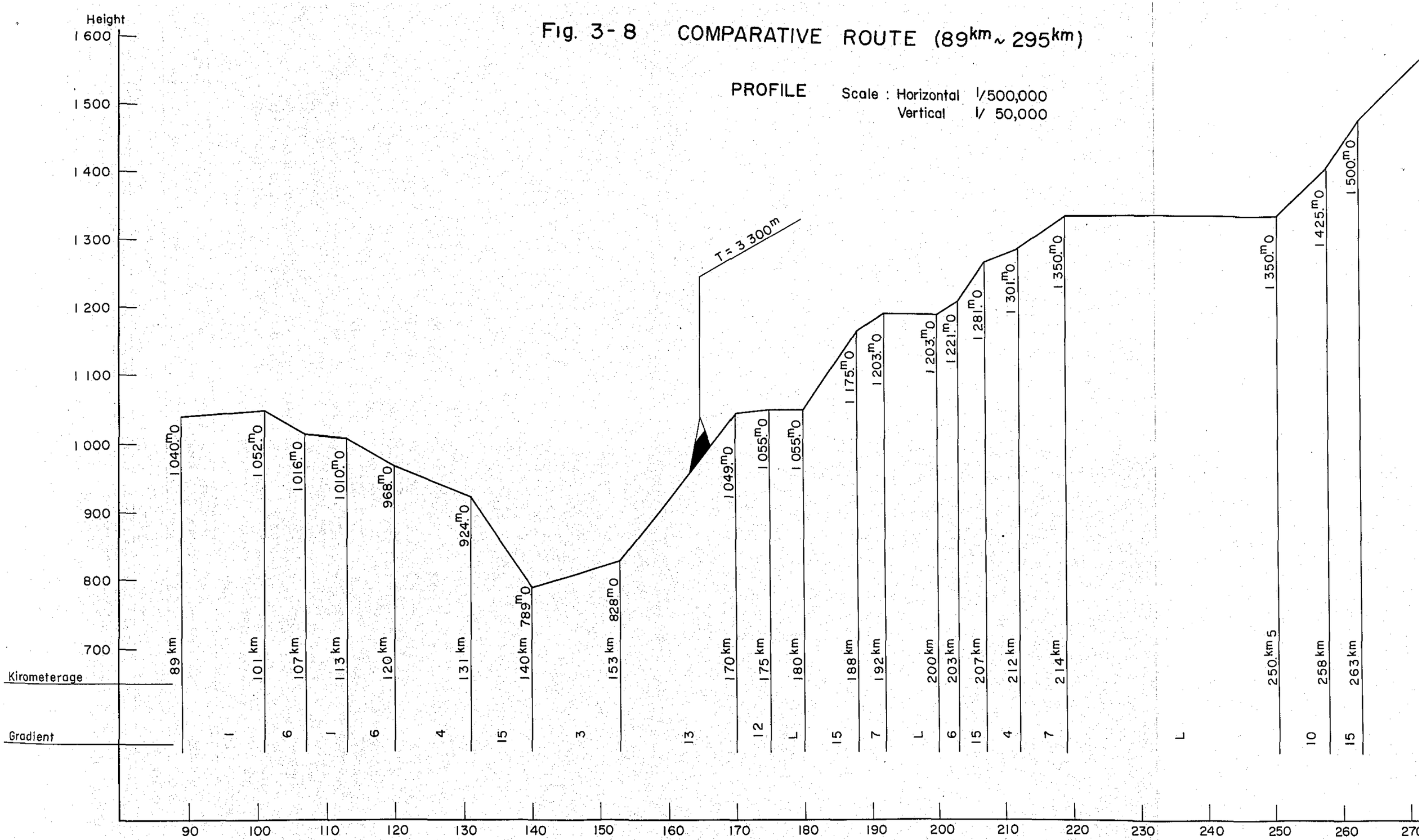


Fig. 3-8 COMPARATIVE ROUTE (89km ~ 295km)

PROFILE Scale : Horizontal 1/500,000
Vertical 1/ 50,000

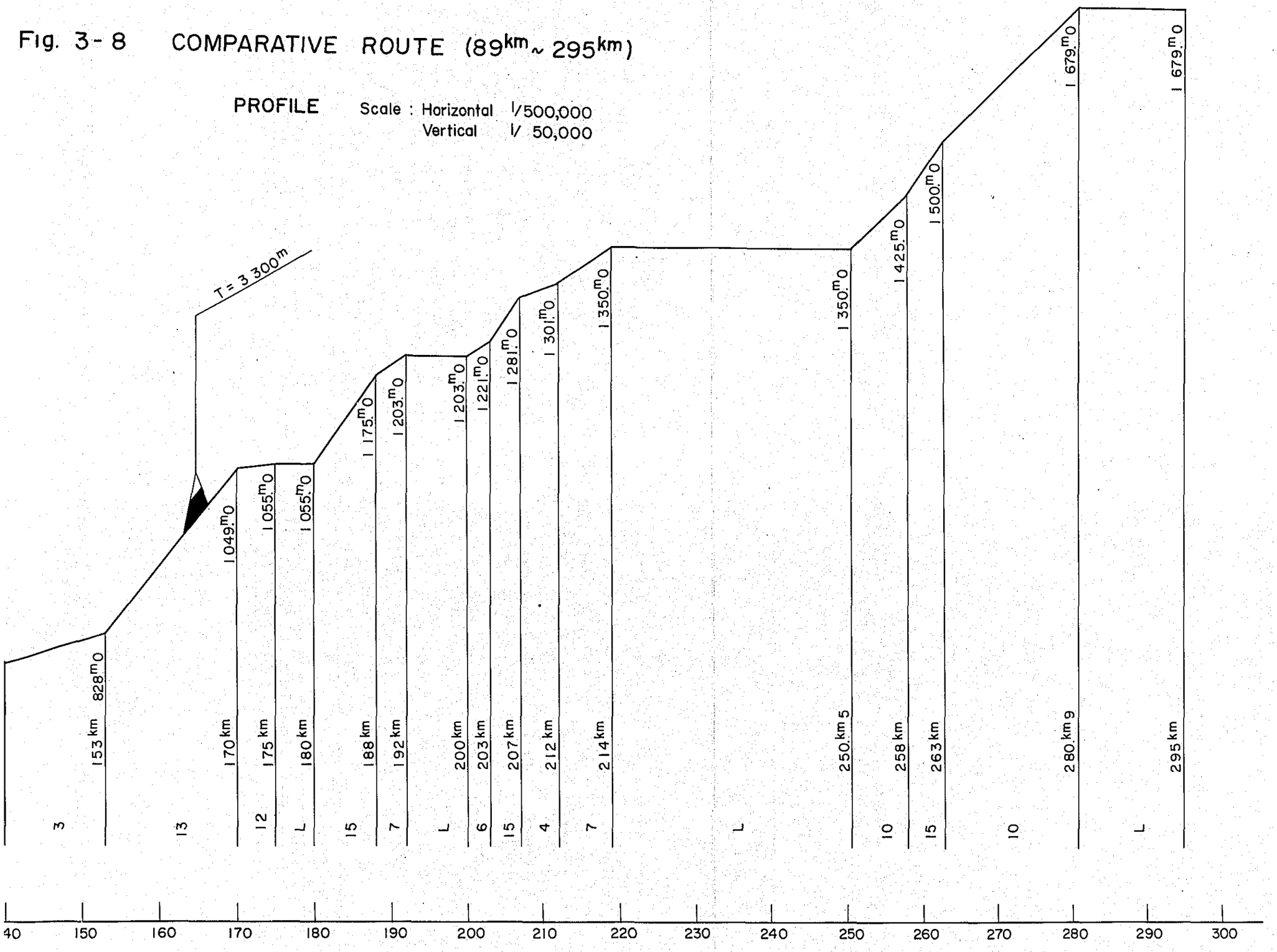


Table 3-1 Construction Cost of the Proposed New Railway Line
(Arusha–Musoma)

		Proposed New Railway Line									Comparative Line			
Kilometerage		0 km–89 km		89 km–280 km		280 km–410 km		410 km–544 km		Total	89 km–295 km		410 km–546.4 km	
Route Length		89 km		191 km		130 km		134 km		544.4 km	206 km		136.4 km	
		A		B		C		D			B'		D'	
Description	Unit	Amount	Estimate £'000	Amount	Estimate £'000	Amount	Estimate £'000	Amount	Estimate £'000	Amount	Estimate £'000	Amount	Estimate £'000	Amount	Estimate £'000
Roadbed			2,388		11,248		3,752		6,347		23,735		15,937		10,329
Cut	'000 m³	1,560	780	3,410	1,705	1,160	580	920	460	7,050	3,525	3,460	1,730	2,630	1,315
Fill	do	2,720	1,048	7,400	3,018	3,560	1,548	3,110	1,371	16,790	6,985	7,690	3,153	8,020	3,484
		(57)		(58)		(7)		(17)		(139)		(39)		(13)	
Bridge	m	570	171	1,530	834	180	114	390	182	2,670	1,301	20,260	6,198	280	84
				(7)				(1)		(8)		(1)		(3)	
Tunnel	do			6,000	1,800			800	240	6,800	2,040	3,300	990	4,500	1,350
Retaing wall	'000 m²	60	300	730	3,650	256	1,280	792	3,960	1,838	9,190	732	3,660	792	3,960
Drainage	set		89		191		130		134		544		206		136
Disaster prevent	do				50		100				150				
Track	km	98	1,469	210	3,152	143	2,145	147	2,211	598	8,977	227	3,399	150	2,251
Station facilities	lot	4	20	6	30	4	20	5	25	19	95	6	30	5	25
Signal & safety devices	do	4	20	6	30	4	20	5	25	19	95	6	30	5	25
Others			312		1,157		475		689		2,633		1,552		1,010
Sub-total			4,209		15,617		6,412		9,297		35,535		20,948		13,640
Total through B' or D'											35,535		40,866		39,878

3-6-3 Term Required for the Construction of the New Railway Line

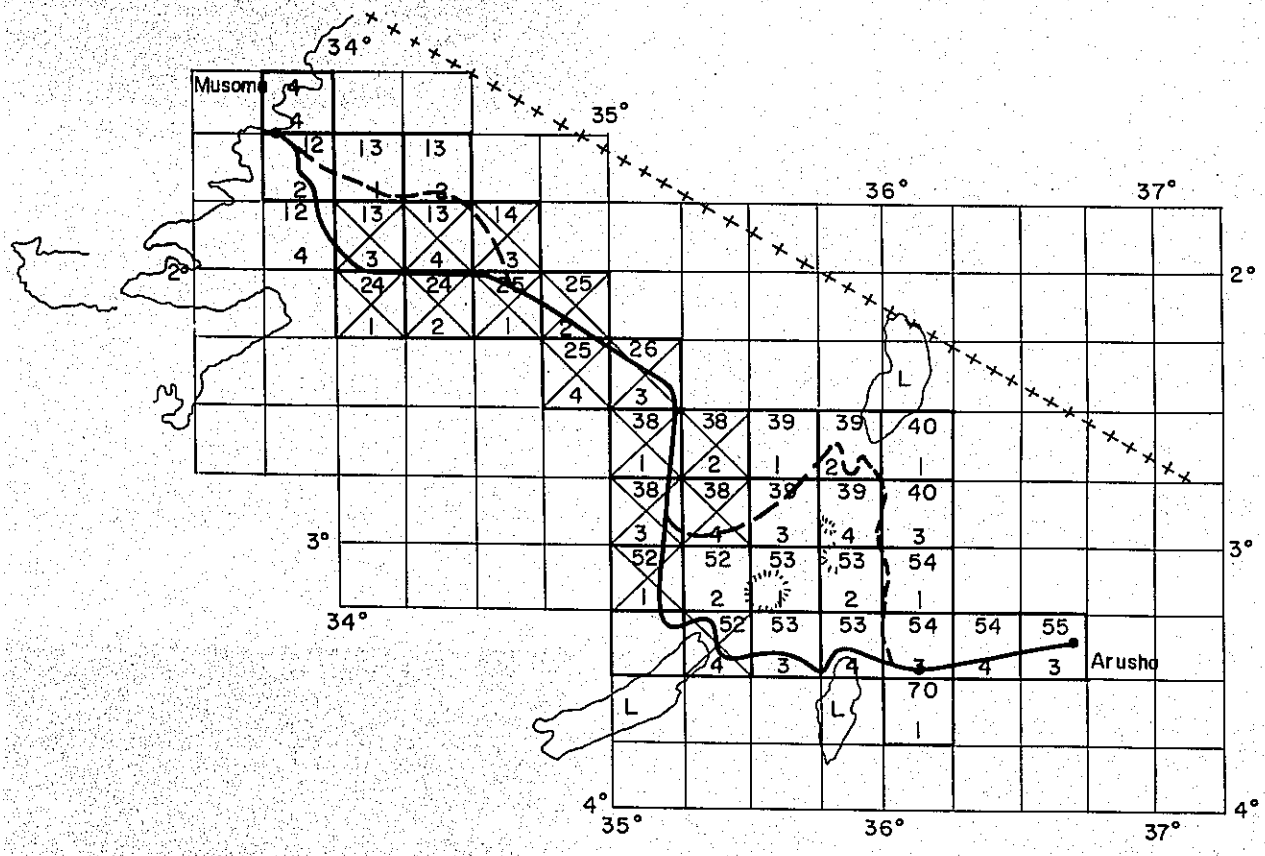
Survey and design of structures and facilities of the new railway	2 years
Actual construction of the new railway-line	4 years
Total	6 years

3-6-4 Preparation of Maps

Maps necessary for the field survey to be conducted in the future are as mentioned below, classified into three categories, namely, (1) Maps which are absolutely necessary, (2) Maps which can reduce the time and cost of survey if prepared, and (3) Maps necessary when the comparative route of the railway line has to be studied further. (See Fig. 3-4)

Maps of 1/50,000 scale	(1)	(2)	(3)
	52-1	13-3	13-4
	52-3	24-1	14-3
	52-4	24-2	38-2
		25-1	38-4
		25-2	39-1
		25-4	39-3
		26-3	
		38-1	
		38-3	
Total	3 maps	9 maps	6 maps

Fig. 3 - 4 Map 1/50,000 Index



REFERENCE

No. / No. in use

No. / No. to be equipped Completely hereafter

Picture 1. Arusha Station

Picture 2. The foot of Mt. Oldeani

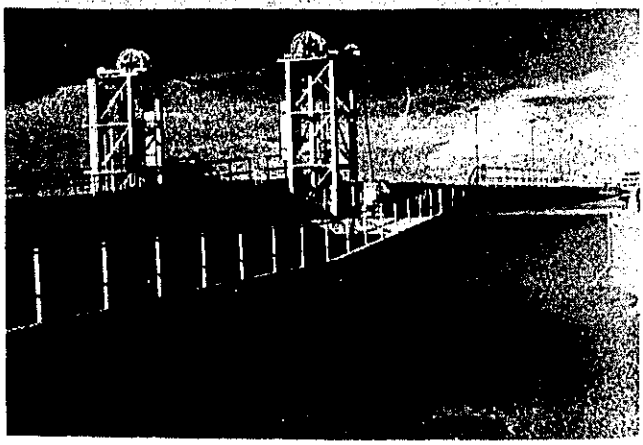
Picture 3. Gregory Rift Valley

Picture 4. Ngorongoro Cardera

Picture 5. Mt. Lengai

Picture 6. Serengeti Plain

Picture 7. Serenera Safari Camp.



Picture 8. Musoma

CHAPTER IV PLAN OF IMPROVEMENT OF THE EXISTING LINE

4-1 Outline

The year of construction of the railway lines, names of the railway lines, and the summary of line gauges of the East African Railway Corporation are as shown in Fig. 4-1.

In short, the East African Railway comprises the following railway lines, the total length of railway was approximately 7,000 km as of the end of 1968 fiscal year.

Main Line	Mombasa (sea port in Kenya)–Nairobi (capital)–Jinja (a port on Lake Victoria in Uganda)–Kasese
Tanzania Central Line	Dar es Salaam Port (sea port in Tanzania)–Tabora–Kigoma
Mwanza Branch Line	Tabora–Mwanza (port on Lake Victoria)
Tanga Line	Tanga (port in Tanzania)–Moshi (chief production center of agricultural products)
Arusha Branch Line	Moshi–Arusha

The outline of the annual traffic density in 1968 fiscal year of each of the railway lines mentioned above is as given in Fig. 4-2.

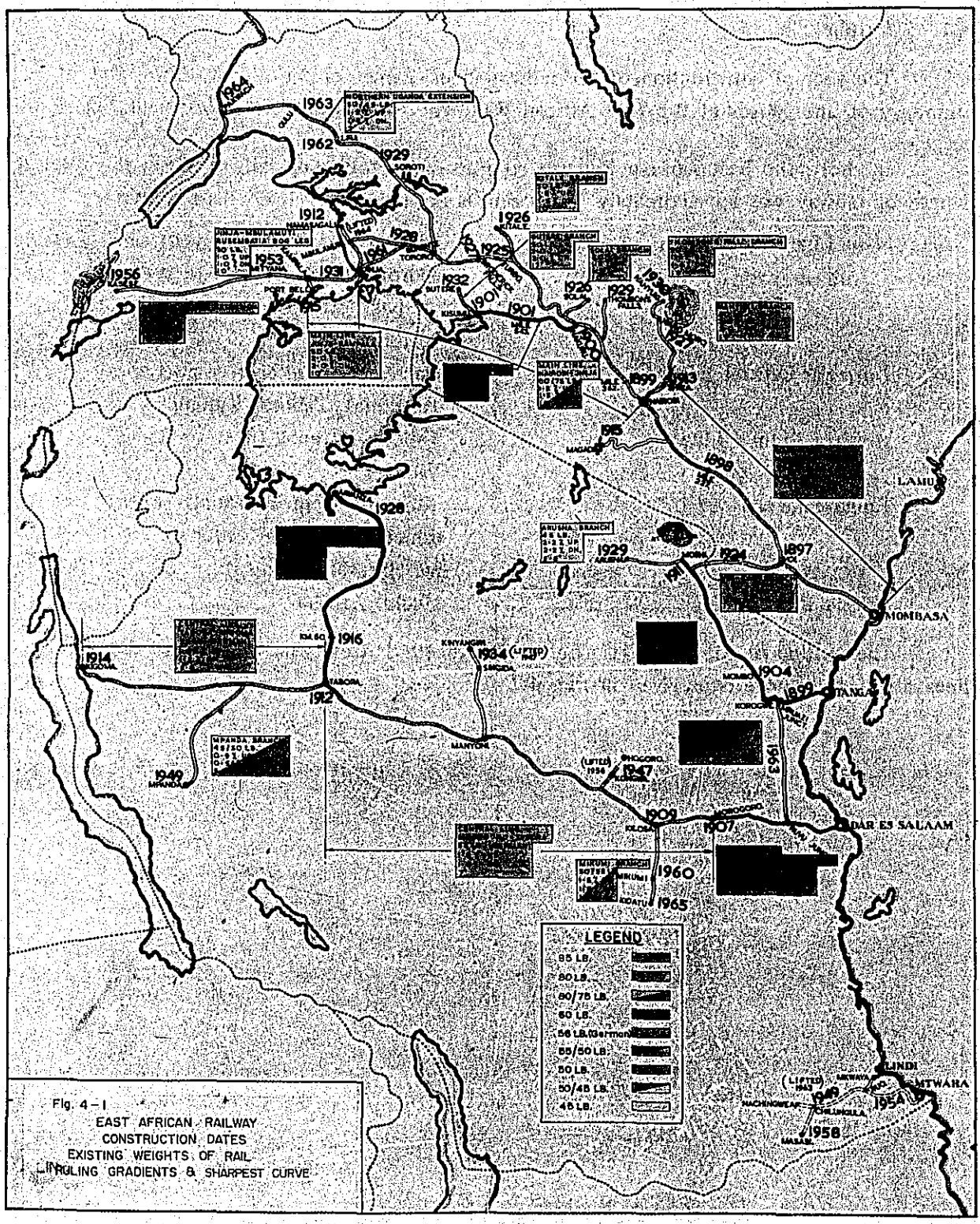
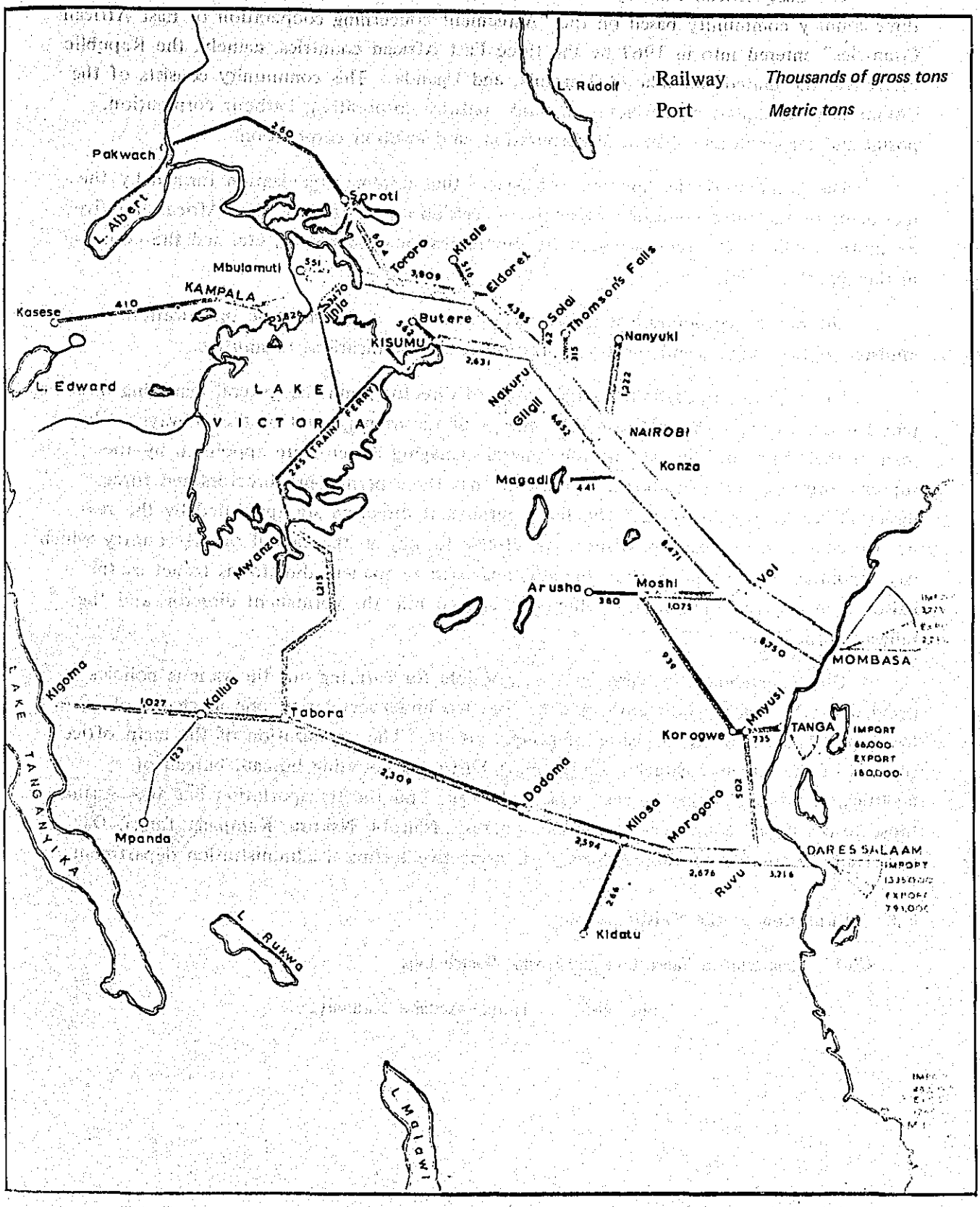


Fig. 4 – 1
EAST AFRICAN RAILWAY
CONSTRUCTION DATES
EXISTING WEIGHTS OF RAIL
& RULING GRADIENTS & SHARPEST CURVE

Fig. 4-2 TRAFFIC DENSITY 1968



4-2 Organization of the Railway

The East African Railway Corporation is one of the service organizations of the three-country community based on the "Agreement concerning cooperation of East African Countries" entered into in 1967 by the three East African countries, namely, the Republic of Kenya, the united Republic of Tanzania, and Uganda. This community consists of the Community Headquarters, development bank, railway corporation, harbour corporation, postal and telegraph and telephone corporation, and aviation corporation.

The Community Headquarters consists of the supreme organization formed by the presidents of the three countries, assembly of legislation, Minister of East Africa, and five committees such as the transportation & communications committee, etc. and the common market court of justice.

The railway corporation is under the supervision of the supreme organization, Minister of East Africa, and the transportation & communications committee.

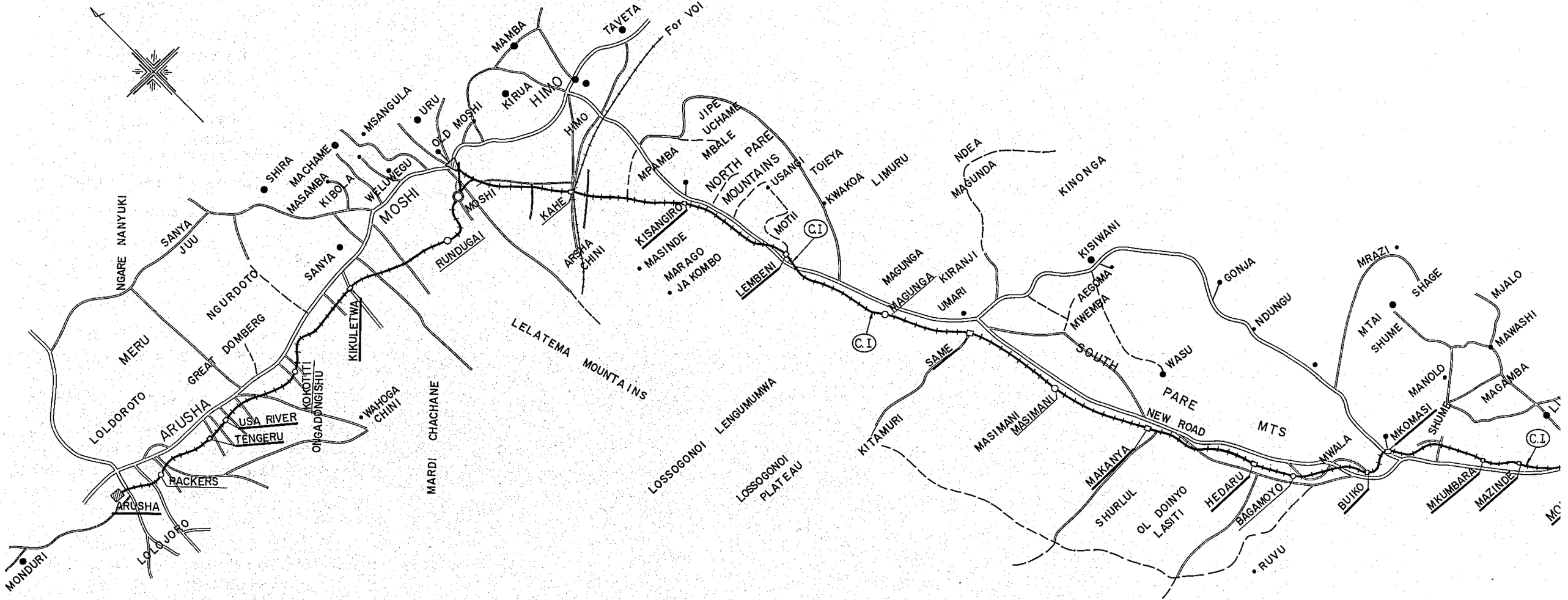
The railway corporation has the board of directors, and the general managing director (corresponds to the president) who take charge of the management of the railways. Chairman of the board of directors and the general managing director are appointed by the supreme organization. The board of directors has three permanent directors and three directors besides the chairman. The three permanent directors are appointed by the respective countries, and each permanent director is to stay in the capital of the country which has appointed him the permanent director, and each permanent director is to act as the liaison man between the country, which has elected him the permanent director, and the railway corporation.

The general managing director is responsible for carrying out the various policies decided by the board of directors, and he has two under-secretaries, one in charge of techniques and the other in charge of general affairs. The organization of the main office consists of the bureaus, namely, the planning bureau, accounting bureau, bureau of facilities, facilities planning bureau, vehicles bureau, and the transportation bureau. Again, those towns in the country-side such as Mombasa, Nairobi, Nakuru, Kampala, Tanga, Dar es Salaam Dodoma, and Tabora, have their respective technical administration department.

4-3 Condition of the Existing Line

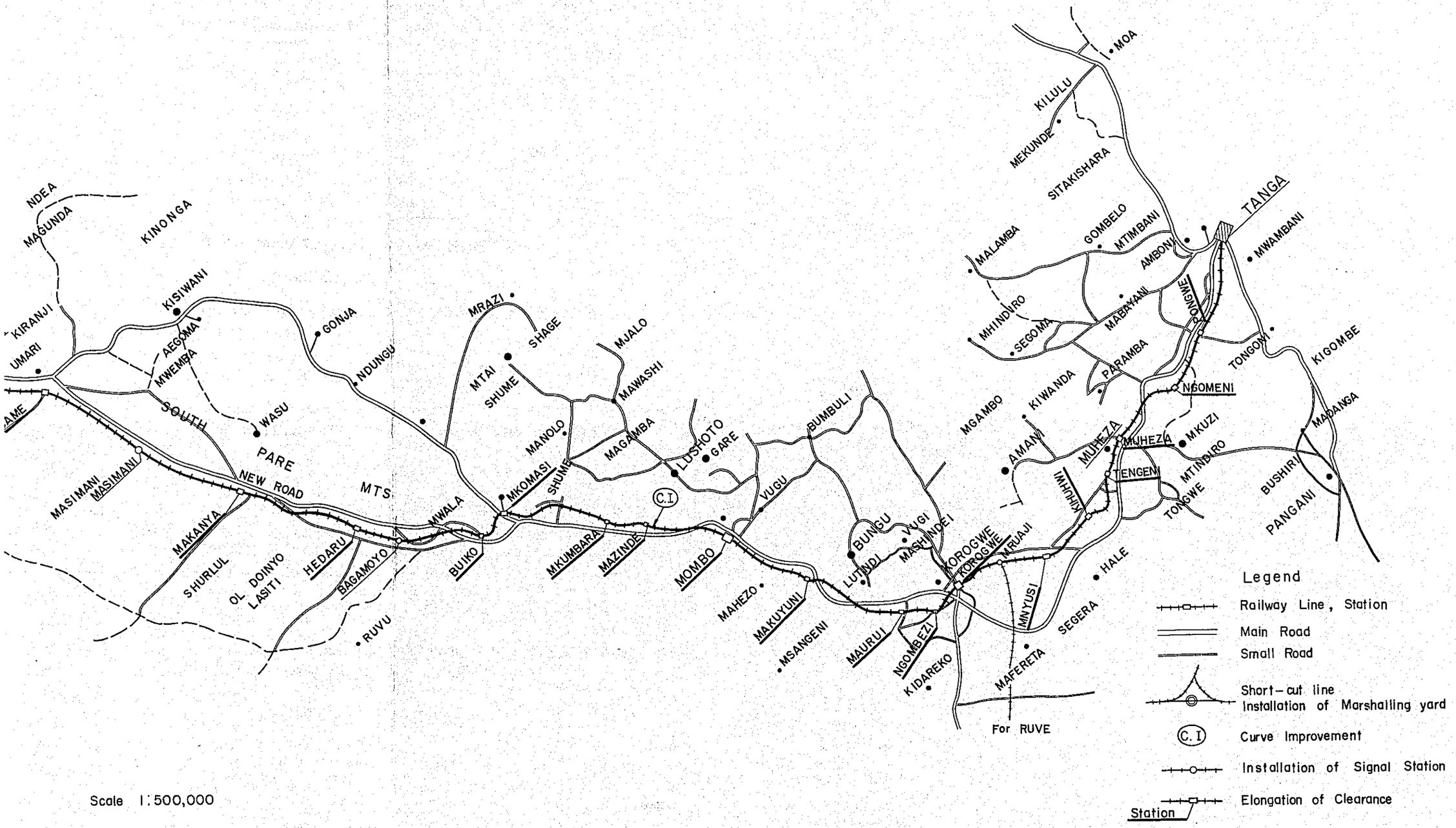
4-3-1 Alignment of Tanga Line and Arusha Branch Line

Fig. 4-3 Tanga–Arusha Railway.



Scale 1:500,000

Fig. 4-3
TANGA-ARUSHA RAILWAY



Legend

- Railway Line, Station
- Main Road
- Small Road
- Short-cut line
  Installation of Marshalling yard
- (C.I) Curve Improvement
- Installation of Signal Station
- Elongation of Clearance
  Station

Scale 1:500,000

The rough plan of Tanga Line and Arusha Branch Line which forms the trunks of the new railway project between Arusha and Musoma is as shown in Fig. 4-3. At Kahe on Tanga Line is the Kahe Branch which is connected with the Main Line, and there is a link branch at Mruazi which is connected with the Tanzania Central Line. Again, the ruling grade of Tanga Line and Arusha Branch Line is as shown in the following table.

Portion			%
Tanga	–	Korogwe	1.5
Korogwe	–	Mombo	1.8
Mombo	–	Mkomasi	1.66
Mkomasi	–	Buiko	2.0
Buiko	–	Moshi	1.66
Moshi	–	Arusha	2.2

4-3-2 The Standard of Tanga Line and Arusha Branch Line

4-3-2-1 Width of formation level

The width of formation level is 4.572 mm at the banking portion and 5.182 mm at the cutting portion.

4-3-2-2 Clearance between center line of track

Clearance between center and center of tracks is 4.267 mm at the straight portion, and is enlarged at the curve accordingly with the radius of curvature.

4-3-2-3 Rail

The rail is flat-bottomed one, and the standard length is 9.14 mm – 12.19 m. Rail used on Tanga Line is 29.8 kg/m while rail used on Arusha Branch Line is 22.5 kg/m. These rails were used rails when first layed, and those changed recently were those used rails brought from the Main Line.

4-3-2-4 Sleeper

Steel sleeper is being used. However, wooden sleeper is being used at frog of railway switch of turnout of the Main Line.

Picture 4-1

Timber produced in this country is soft and is not suitable for sleeper. Both wooden and steel sleepers are being imported.

4-3-2-5 Ballast

All Ballasts are of crushed stone of uniform large grain size, and not suitable for tamping. Mixture of soil or weeds cannot be seen except at places near the railway crossing. Ballast of Arusha Branch Line is laterite. Ballast is thin, weeds are growing, and drainage condition is not very good.

Picture 4-2

4-3-2-6 Rail Joint

Rail joint is the suspended joint of four-hole type joint plate method.

4-3-3 Track Maintenance

Track maintenance personnel per 1 km of the Main Line including side line counted as one-third is 1.5 persons. There are the moving work party and the stationary work party. The working range for one stationary work party which consists of 6 – 8 persons is 10 – 12 km. Maintenance work is being carried out according to the plan made by the assistant master based on the patrol. Working equipments are crowbar, hammer, fork, hoe, etc., and mechanization of tie tamper has not been carried out. This is because the workers have received no training for using the tie tamper.

The assistant master makes a patrol by the train or motor car.

As derailment occurs quite often on the Main Line, several trains carrying equipment for restoration of derailment are being held at the train inspection yard.

The causes of derailment are mainly the collapse of formation level and the irreguralities of alignment of rails.

4-4 Operating Speed and Frequency of Tanga Line and Arusha Branch Line

The maximum speed between stations on the Tanga Line is 48 km/H between Tanga and Maurui, 56 km/H between Maurui and Mkomasi, 48 km/H between Mkomasi and Buiko,

56 km/H between Buiko and Lembeni, 48 km/H between Lembeni and Kisangiro. and 56 km/H between Kisangiro and Moshi. On Arusha Branch Line, the maximum speed is 40 km/H for the entire line between Moshi and Arusha.

The operating frequency at the most crowded section, which is between Kahe junction and Moshi, is 11 roundtrips/day. Next is 9 roundtrips/day between Mruazi junction and Korogwe. The operating frequency is the lowest between Tanga and Mruaji junction on the Tanga Line, which is 5 roundtrips/day. On Arusha Branch Line, the frequency is 2 roundtrips/day at the most.

4-5 Others

4-5-1 Structure gauge and loading gauge

Structure gauge and loading gauge of the East African Railway are as shown in Fig. 4-4. Although the track gauge is 1 m, they are considerably large. The maximum width of a freight car is 2.59 m.

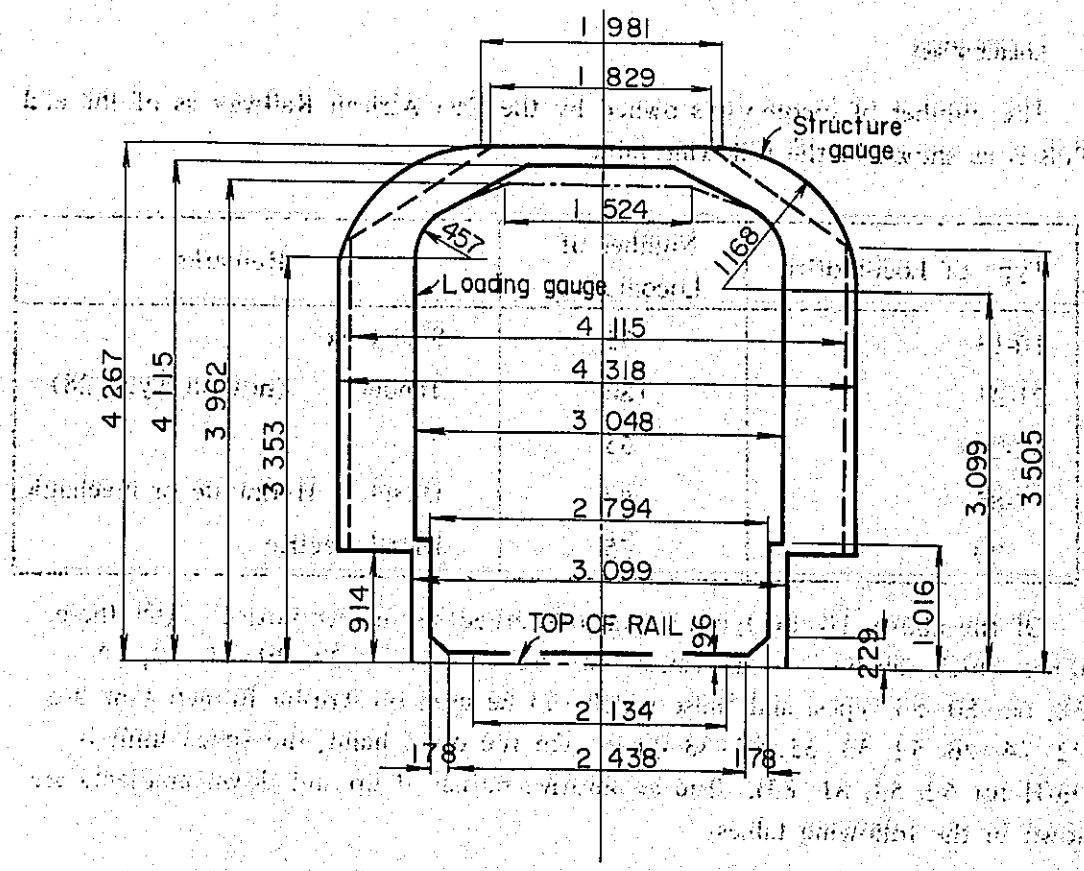
4-5-2 Locomotives

The number of locomotives owned by the East African Railway as of the end of 1968 is as shown in the following table.

Type of Locomotive	Number of Locomotives	Remarks
10-13	55	Side tank
21-31	186	Tender (not on Type 28)
52-60	55	
79-85	67	Diesel Hydraulic or mechanic
90	55	Diesel electric

Of the above, 10–60 types are all oil-burned steam locomotives. (Of these, the types which can be used on Tanga Line are 10–12, 21–27, 29–31, 52, 53, 55–58, 60, 80–85 types, and those which can be used on Arusha Branch Line are 10, 22–24, 26, 52, 53, 55, 80–83 types. On the other hand, the speed limit is 32 km/H for 52, 53, 81–83). The locomotive ratings at up and down gradients are as shown in the following tables.

Fig. 4－4 Structure and Loading Gauge



Rising Gradient Ruling Grade	Type of Train		
	Mail & Passenger	Freight-Passenger	Freight
0 – 1.18%	650 tons	960 tons	1280 tons
1.19 – 1.5	650	900	1200
1.6 – 2.0	650	720	960
2.1 – 2.5	570	570	760
2.6 – 3.0	490	490	600
3.1 – 3.5	425	425	500

Falling Gradient	Type of Locomotive				
	10, 11, 12	21–27	13, 79, 83–85	29–31	G90
0 – 1.5	600 tons	800 t	1000 tons	1100 t	1280 t
1.6 – 2.5	450	600	750	900	1000
2.6 – 3.0	300	400	600	600	600
3.1 – 3.5	200	300	500	500	500

The East African Railway considers type 90 (specifications are: 1840 HP, maximum speed 72 km/H, gross weight 97.5 tons, length 15.545 m) most reliable, and it is scheduled that all locomotives on the Main Line will be changed to Type 90 by 1976.

4-5-3 Passenger carriage and freight car

The number of passenger carriages is as shown in the following table (as of the end of 1968).

Type of Carriage	Number of Carriages
Dining car and buffect car	29
1st Class carriage	38
2nd Class carriage	76
3rd Class carriage or 2-3 class carriage	199
Patrol carriage	125
Parcel and main carriage	254
Car for conductor	182

The number of freight cars is as shown in the following table (As of the end of 1968)

Type of Freight Car	Number of Freight Cars
Boxcar	6,032
Closed car	122
Stock car	525
Gondola car	2,775
Tank car	1,082
Others	810

A large–sized freight car measures 12.5 m (l) x 2.44 m (w) x 2.75 m (h).

4-5-4 Factories

Car factories are at Nairobi and Dar es Salaam. The link between Kahe and Voi was constructed in 1963 mainly for the purpose of concentrating the repair of the rolling stock upon Nairobi. The present number of employees is about 3,000 in Nairobi factory and 800 in Dar es Salaam factory. The plan of the Nairobi factory is as shown in Fig. 4-5, and this factory is equipped with all facilities necessary for the inspection of locomotives and all other types of the rolling stock. This Nairobi factory has the capacity of repairing 180 locomotives, 500 passenger carriages, and 3,800 freight cars a year. Recurrence of inspection is 2–3 years for the locomotive, 2 years for the passenger carriage, and 4 years for the freight car.

4-5-5 Total number of employees

The total number of employees of the East African Railway including harbour employees (until October 1969 the railway and the harbour were under the same corporation) as of the end of 1968 was 45,060.

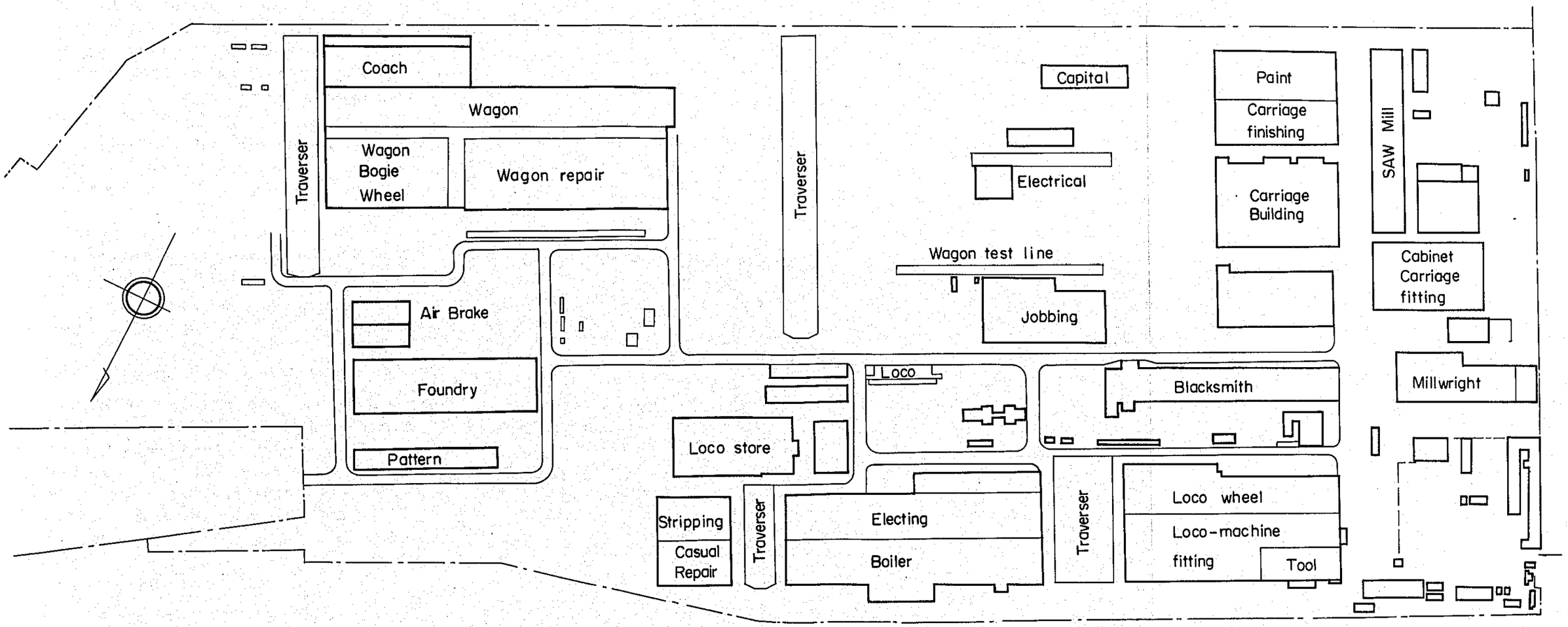
4-5-6 Casualties of railway accidents

Casualties of railway accidents in 1968 were as follows:-

3 passengers killed due to their carelessness
5 persons killed on the crossing of road
19 persons injured on the crossing of road
49 persons killed stepping into the roadway
20 persons injured on stepping into the roadway
6 persons killed due to other reasons
5 persons injured for other reasons
7 employees killed while on work
16 employees injured while on work

4-6 Improvement of the Existing Lines

Fig. 4-5 Nairobi - Workshop



4-6-1 Improvement for increasing transport capacity

To cope with the situation under which the volume of transportation will increase largely following the economic development of Tanzania and Uganda and the opening of the new railway-line between Arusha and Musoma, it is necessary to increase the transport capacity of the Tanga Line and the Arusha Branch Line. For this purpose, the following improvement is advisable.

4-6-1-1 Establishment of signal stations for increasing roadway capacity

For the purpose of making the most effective use of the roadway of the single track section, it is necessary to establish railway stations or signal stations at equal intervals calculating the distance by time. In order to increase the number of trains to increase the transport capacity, the time distance based on the equal intervals should be reduced. In order to operate the number of trains required to be operated on the Tanga Line and the Arusha Branch Line, it is necessary that the distance between stations should be within approximately 15 km.

Therefore, a signal station should be established at the point 187 km from Tanga on the Buiko–Hedoru section of the Tanga Line where the interval between stations is 24 km. Similarly, a signal station should be established at the points 234 km and 269 km from Tanga respectively for Makanya – Same section and Same – Lembeni section where the interval between stations is 33.6 km and 36 km respectively. Again, it is necessary to establish the signal station at the points 45 km and 76.8 km respectively from Moshi on the Arusha Branch Line. The cost of such improvement is £ 0.36 million.

As the signal stations to be established newly are necessary only for the exchange of train, the spring point type is recommended.

4-6-1-2 Speed-up for increasing the roadway capacity

When increasing the roadway capacity, it is possible to shorten the time distance by increasing the speed of the trains besides reducing the intervals between the exchange stations mentioned before. Even if the signal stations mentioned under 4-6-1-1 are established, there still will be many sections where the interval between stations will be more than 19 km, and it would be necessary to raise the operating speed on such sections to reduce the operating time. For this purpose, expansion of the radius of curvature and reinforcement of track would be necessary.

4-6-1-2-1 Reinforcement of track

As the ballast of the track covering a distance of about 85 km between Moshi and Arusha on the Arusha Branch Line consists of laterite and not crushed stone ballast and the rails used are the 22.5 kg/m type, track burdening is small, and the locomotives are limited to several types having light axle weight. Naturally,

the maximum speed is limited to 40 km/H. To cope with the heavy load in future it is necessary to change the rails to 40 kg/m rails, and make the ballast of crushed stone having over 15 cm thick.

In this case, section of the rail will be different from that of the rail now being used, and so the steel sleeper will have to be changed at the same time.

As regards the Tanga Line, used rail has been used on the entire line when it was constructed. Fatigue of rail is excessive and deformation of rail has occurred, and it would be very difficult to correct the irregularity of track. It is advisable to change rails on the entire line, and it is particularly necessary to change the rails to the 40 kg/m type to speed-up the trains for increased transport capacity on those sections, where the interval between stations is comparatively large. Those sections are Mnyusi–Korogwe (14.4 km), Maurai–Makuyuni (16 km), Makuyuni–Mombo (11.2 km), Mukumbara–Mkomasi (19 km), and Hedaru–Moshi (14.7 km). The cost of improvement is £ 3.46 million.

4-6-1-2-2 Curve improvement of railway

To increase the transport capacity by speed-up, curves subject to speed limit at places where the block section is long must be improved. For example, sharp curves of over 8° such as Curve Nos. 35, 82, 83 and 84 must be improved in such a way that the radius of curvature will be over 300 m. The cost of this improvement will be £ 0.2 million.

4-6-1-2-3 The enlarging of the effective length of railway station for increased train unit

To increase the transit capacity, it is necessary to increase the number of cars making up a train. At present, the longest effective length of the railway line at stations etc. on Tanga Line is 427 m. This will be shorter than the necessary length of a train after the construction of the new railway-line, and it should be improved so that the effective length of railway-line will be over 500 m. The cost of this improvement is £ 0.25 million.

Of course it is necessary that the effective length of railway-line at the signal station to be established according to 4-6-1-1 should be improved so that it will be over 500 m.

4-6-2 Improvement for maintenance of safety

4-6-2-1 Locking device

Locking device on Tanga Line is the tablet block system, but it is the ticket clearance system on Arusha Branch Line. It is necessary to improve the system for better maintenance of safety to cope with the situation, under which trains will be operated more frequently. Locking device at each station between Moshi and Arusha should be changed to the tablet block system.

4-6-2-2 Interlocking of signal and railway switch

At present the railway switch is being locked by hand after switching. Again, the signal can be handled separately. In the future signal and railway switch will have to be handled more and more when trains are operated more frequently, and it is necessary to prevent mishandling to secure safety of way through interlocking of signal and railway switch.

4-6-2-3 Installation of the departure signal

At present only the yard signal is being installed at the stations, but it is necessary to install the departure signal for securing the safety of way and lock the railway switch ahead of the train.

4-6-2-4 Side line outside of station

There are many side lines installed outside of the station leading to factories, but as these side lines limit the train capacity of the entire line and are dangerous on the phase of safety, it is advisable to abandon as much as possible those which are not necessary. For those side lines which are absolutely necessary and cannot be abolished, the location of such side lines should be changed to a station. If such side lines have to be maintained, railway switch possible for tablet locking should be installed to secure safety of way.

4-6-2-5 Maintenance of formation level

In a part of the cutting portion, there are some parts where the formation level has been eroded by rain water and the ballast is thicker than 60 cm to cover the deficit. This makes the maintenance of track very difficult.

Therefore, it is necessary to widen and reinforce the side ditch of the cutting portion for maintenance of formation level. The cost of construction for improved safety mentioned under 4-6-2 is about £ 0.1 million.

4-6-3 Short connection between Tanga Line and Arusha Branch Line

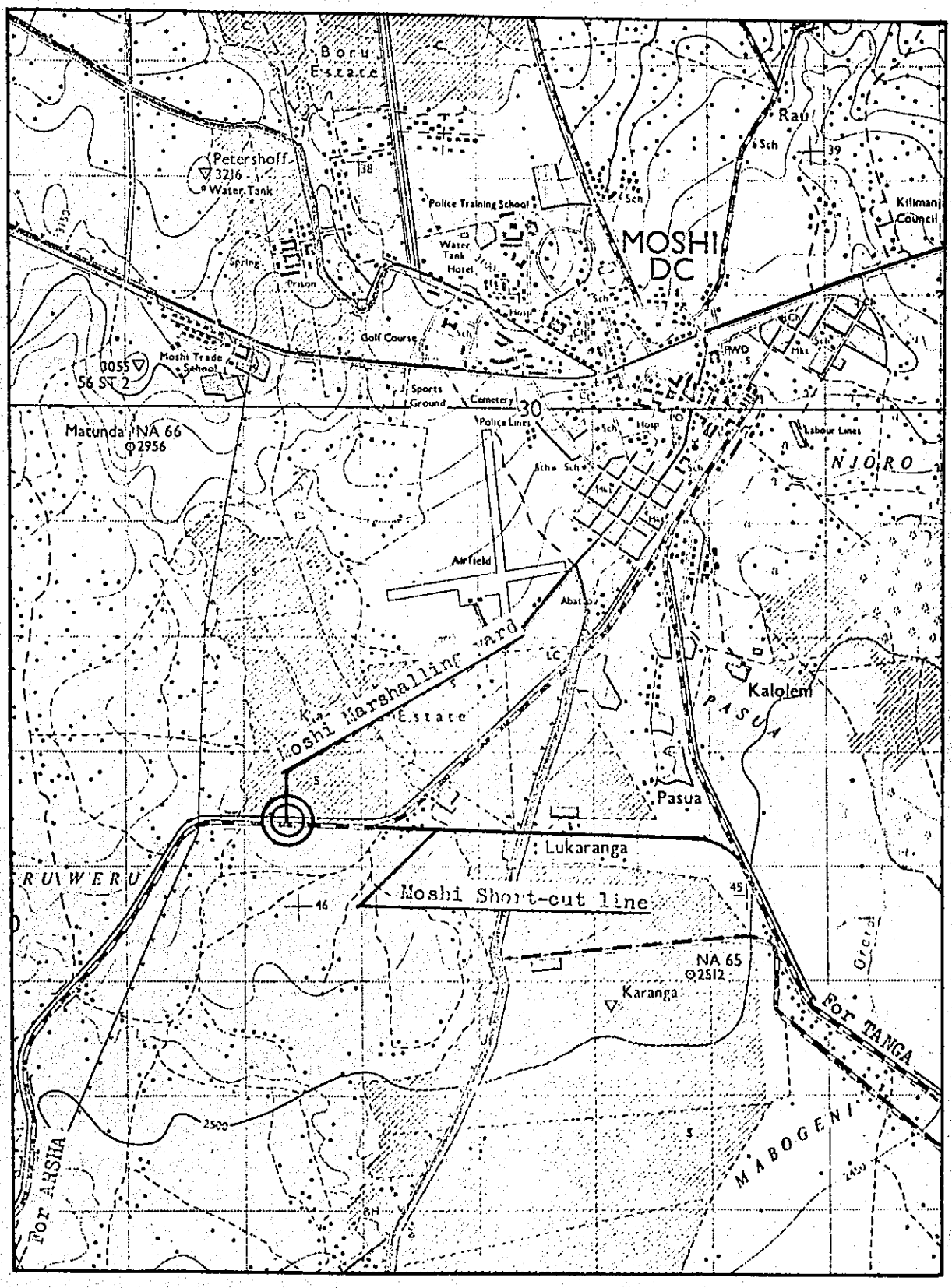
Moshi station, which is the terminal station of the Tanga Line, is the traffic origin of the Arusha Branch Line.

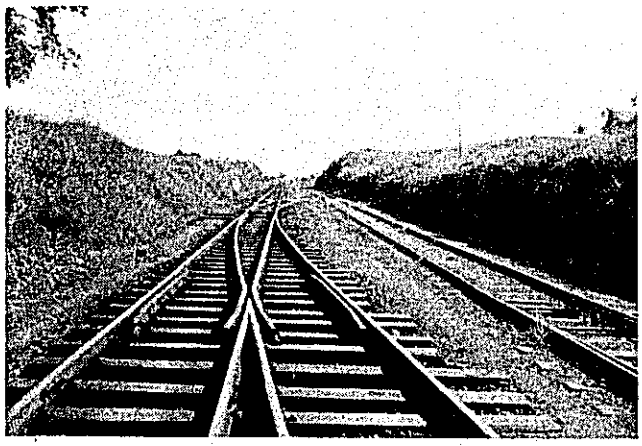
However, the train has to be switched back at Moshi station. Again, Moshi station does not have much cargo hoist equipment, and this causes stagnation of freight cars and makes the handling of trains difficult. As Moshi station is located on a sloped place, and the southern side forms a banking with retaining wall, measuring 10 m high, expansion of this station is impossible. Naturally, a short connecting line between Tanga Line and the Arusha Branch Line should be constructed with a marshalling yard nearby. It is necessary to allow Moshi station to handle only its own cargo and reduce the number of passing trains. The cost of this improvement is £ 0.28 million.

As explained above, various improvement works can be completed in a period of about one year since it is not necessary to construct any special structures. However, the reinforcement of track mentioned under 4-6-1-2-1 is necessary for the sake of safety. Again, as those clauses under 4-6-2 are important for safety, it is advisable to commence these improvement works as soon as possible.

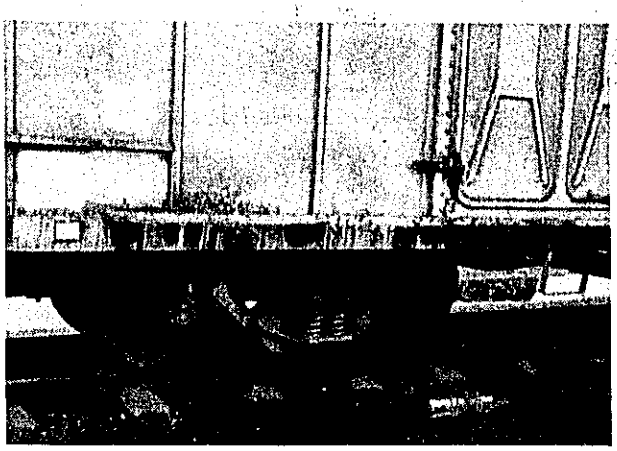
Fig. 4-6 Short-cut Line and Marshalling yard

scale 1: 50,000

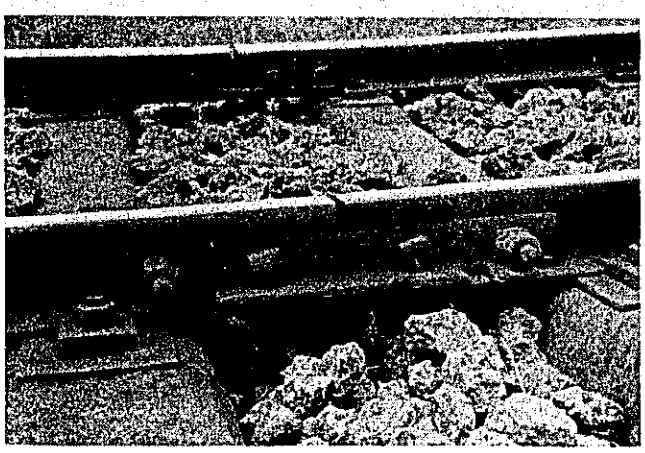




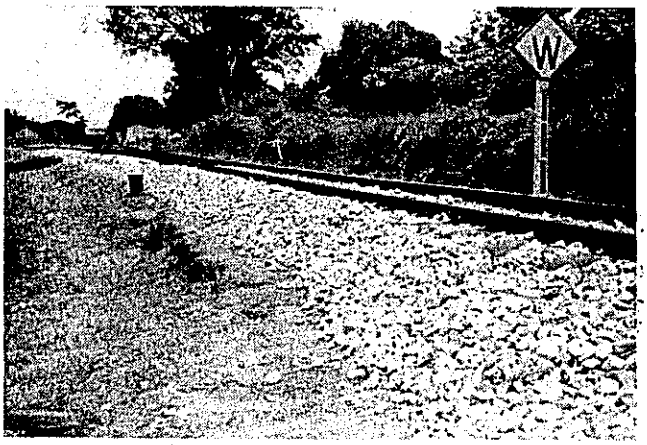
Picture 4-1. Tournout and sleeper



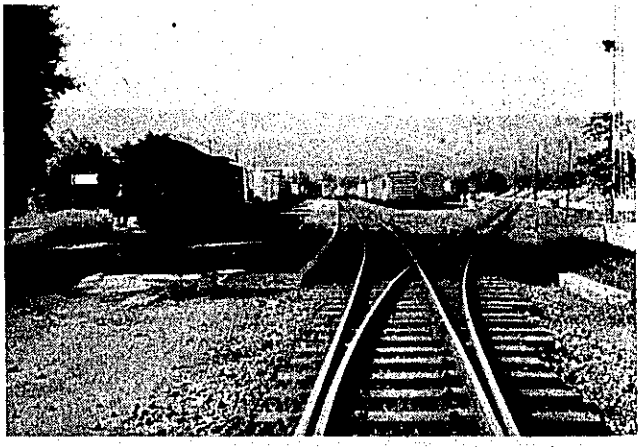
Picture 4-2. Track of Arusha branch and track of wagon



Picture 4-3. Ballast and joints of rails



Picture 4-4. Eroded road bed



Picture 4-5. Layouts of tracks and wagons at the Moshi Station

CHAPTER V IMPROVEMENT AND NEW CONSTRUCTION OF ROADS IN RELATION WITH NEW RAILWAY CONSTRUCTION PROJECT

5-1 New railway route and existing roads

The proposed new railway route starts from Arusha, runs south of Great North Road A104 almost in parallel with the proposed Arusha–Babati railway route and crosses A104 about 20km north-east of Makuyni. The route parallels north of Local Main Road B142 for about 10km long and branches to two alternative routes in order to climb up gradually the steep Gregory Rift Valleys.

The northern route skirts along the southern hills of Mt. Losimingur toward north direction, approaches to Lake Natron and turns west around Mt. Lengai. The southern route parallels north of Local Main Road B142 down to Mto Wa Mbu in north-west direction, but it turns west to avoid steep longitudinal gradient. It weaves the way around the southern gather skirts of Mt. Oldeani and Mr. Lemagrut, and reaches Endulen after passing through several tunnels. These two alternative routes join again at the east edge of Serengeti National Park.

From Endulen to Nyamagati, the route runs straight to north direction, and turns to north-west direction toward the west end terminal of Musoma along the existing secondary on feeder roads. Again, two alternative routes are considered to be taken between Ikoma and Musoma.

The existing roads between Arusha and Musoma are well maintained by means of motor-grader trimming and crushed stone spreading, while the bitumen paved section is only 90km from Arusha to Makuyuni, and no difficulty was found to insure general traffic even in rainly season except a short section between Ruhogo and Ikoma where the road embankment was low and washed by seasonal water.

The road planning in relation with the new railway construction is summarized as follows:

(1) To secure all-weather construction haul roads for the transportation of construction materials and equipment.

(2) To construct and maintain proper feeder roads to the new railway stations, for fuel or water supply for passenger traffic, and for gathering or distributing on-rail commodities.

5-2 Construction haul roads

5-2-1 New construction

New road construction will be required between Oldeani and Endulen along the southern slopes of Mt. Oldeani and Mt. Lemagrut for about 55km length with

engineered gravel surface. A number of bridges and box culverts as well as concrete or corrugated metel pipe culverts should be included in the project to cope with the steep and complicated topographic condition.

Because of the mountainous terrain, the following design standard will be applicable:

Design Speed (km/hr.)	60
Minimum Radius of Curvature (m)	120
Maximum Gradient (%)	8
Length of Maximum Gradient (m)	120
Road Width (m)	6
Shoulder Width (m)	0.9 (Cut)
	1.2 (Fill)

The cost of new road construction will be approximately £260,000.

5-2-2 Improvement

Considerable improvement work is necessary to maintain a safe and smooth traffic in rainy season especially for two sections – one is between Endulen–B144 and the other is between Ruhogo–Ikoma. The total length will be about 72 km. Addition of surplus embankment on the existing road. engineered gravel surfacing, and installation of adequate drainage facilities are the major items of improvement work.

The total improvement cost will be approximately £230,000.

5-3 Feeder roads to new railway stations

The number of railway stations in the project is a total of 19 including both terminals of Arusha and Musoma. The individual length of feeder roads from the existing or planned roads to the stations is as summarized in Table 4-1.

The total length of feeder roads will be approximately 52km and the construction cost will be approximately £240,000.

Table 4-1 Feeder roads to railway Stations

	STATION	CUMULATIVE DISTANCE (km)	LENGTH OF FEEDER ROAD (km)	CONSTRUCTION HAUL ROAD
1	ARUSHA	0	0	
2	ARDAI	30.0	0.5	
3	ELUANATA	58.0	0	
4	BABATI BRANCH	82.5	1.0	
5	MTO WA MBU	108.5	0	
6	MZEE BURA	142.5	3.0	
7	NAIGIBO	176.5	5.0	CONSTRUCTION Oldeani–Endulen 55.0 km
8	ENDULEN (EYASI)	205.5	3.0	
9	LGARYA (ENDULEN)	237.0	3.0	IMPROVEMENT Endulen–B144 30 km
10	SERENGETI (LGARYA)	275.0	10.0	
11	NYAMAGATI (SERENGETI)	310.0	10.0	
12	NYABOGATI	340.0	6.0	
13	RUHOGO	370.5	2.0	IMPROVEMENT 42 km
14	IKOMA	403.0	4.0	
15	NATA	438.0	0.5	
16	IKIZU	475.0	1.0	
17	BUTIAMA	511.0	3.0	
18	MUSOMA	542.0	0	
19	MUSOMA PORT	544.4	0	
TOTAL			52.0 km	CONSTRUCTION 55km IMPROVEMENT 72km

5-4 Total cost and construction period

All of the new construction and improvement of roads for the project are planned with an assumption of engineered gravel surfacing of two lane road. The total cost for road planning in relation with the new railway project is approximately £730,000.

About 6 months will be sufficient for the construction period of new feeder roads to the railway stations, as the in dividual length is short and the topographic conditions are favorable. About the same period will be necessary for the improvement of existing roads which are expected to be construction haul roads.

However, some difficulties are anticipated in the construction of new road between Oldeani and Endulen, as the topographic condition will not allow a continuous grading work operation. Moreover a considerable number of bridges and box culverts are also required to cross frequent steep valleys along the skirts of Mt. Oldeani and Mt. Lemagrut.

A total of 15 to 18 months is assumed for the construction period. As briefly mentioned in the interim report, this new road construction has a close relation with the proposed Mwanza–Arusha Highway Project. Therefore, depending upon the timing schedule of commencing the work, such new road construction might become unnecessary in near future.

No recommendation is given in this paper for the improvement of existing roads around the both terminals of Arusha and Musoma to be used for gathering and distributing on-rail commodities, because the total number of registered motor vehicles in the country is as few as 70,000 to 80,000, most of which are passenger cars, and the reasonable design criteria for the improvement of paved road could not be established for the small truck traffic volume. If the bituminous surfacing is laid on the firm and sound base, subbase and subgrade, the serviceable life will be at least 3 to 5 years with proper maintenance work when the daily traffic volume of heavy traffic is less than 300.

CHAPTER VI IMPROVEMENT PLAN OF PORT OF TANGA AND PORT OF MUSOMA

6-1 Outline of the Survey

This is a report of the basic survey conducted for studying the improvement plan of Port of Tanga facing the Idian Ocean and Port of Musoma on the shore of Lake Victoria in East Africa, in relation with the project of a new railway-line between Musoma and Arusha. In connection with this survey, on-the-spot investigation of the Ports of Dar es Sallam, Mombasa, Jinja, Bell and Entebe was carried out. The four ports for international trade in the three East African countries (Tanzania, Kenya, and Uganda) facing the Indian Ocean are Port of Mombasa in Kenya, Port of Dar es Sallam, Port of Tanga and Port of Mutwara in Tanzania. Among them except Port of Mutwara all have railway facilities connecting them with the hinterland. Port of Mombasa is directly connected with the shores of Lake Victoria, and Port of Tanga with the shores of Lake Victoria and Lake Tanganyika.

There is a railway running from Port of Mombasa toward inland, which passes through Nairobi, capital city of Kenya, Port of Kisumu on the shore of Lake Victoria, Port of Jinja in Uganda, and Kampala, capital city of Uganda, to reach Kasese. Its branch line passes through Tororo to reach the northern part of Lake Albert. The Central Railway of Tanzania is being operated between Port of Dar es Sallam and Kigoma on the shore of Lake Tanganyika via Tobora. This railway has a branch line running from Tabora to Port of Mwanza, the main port on the shore of Lake Victoria.

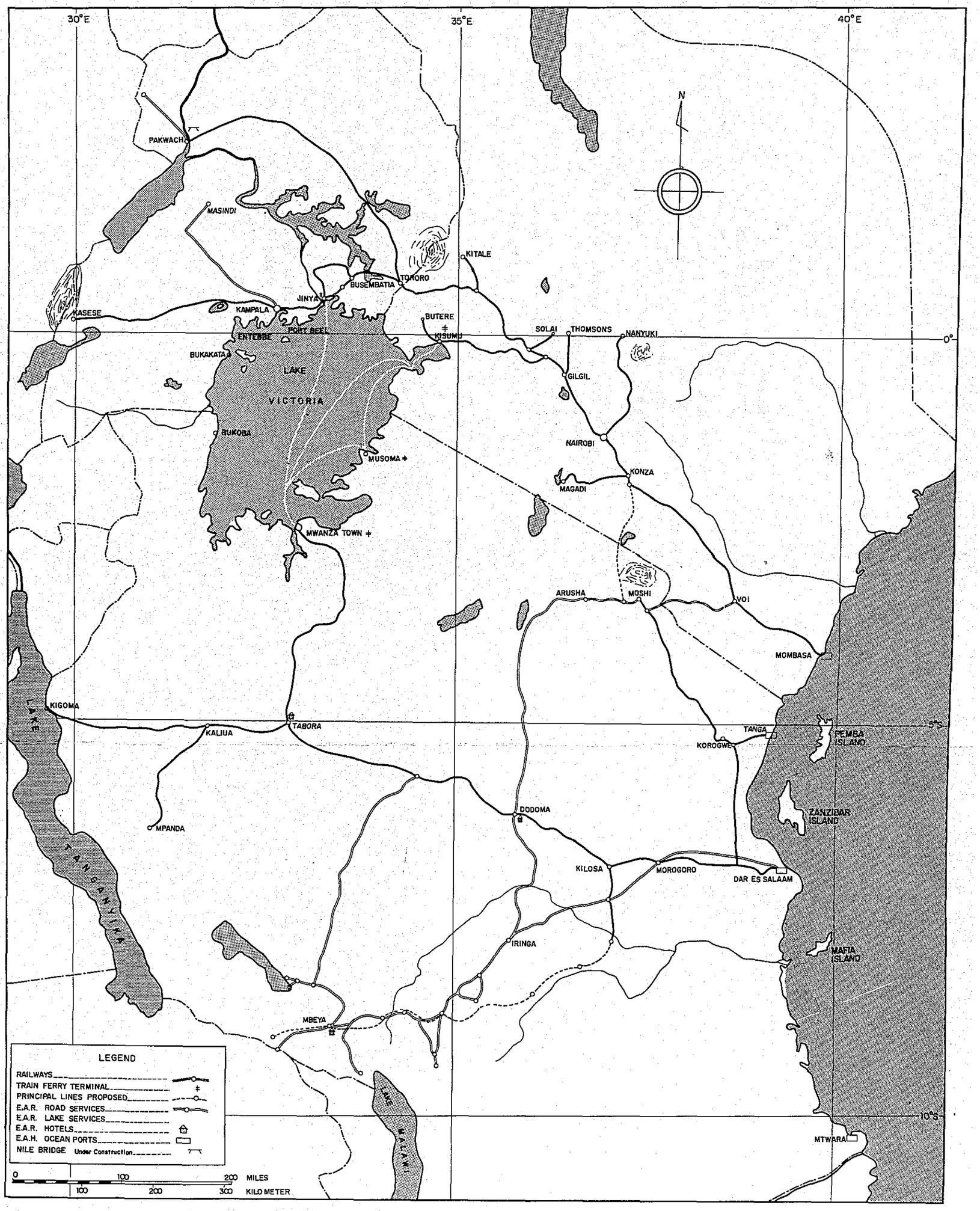
Freights, which are mostly agricultural produce from the inland area of Kenya and Tanzania as well as from Uganda, Rwanda and Burundi, are concentratedly transported by these railways to Port of Mombasa and Port of Dar es Sallam. Therefore, these two ports are now confront with the congestion of ships at anchor.

The Railway of Port of Tanga, which is located midway between Mombasa and Dar es Sallam, runs from Tanga to Arusha via Moshi, and from Kahe and passes through Voi connecting Port of Tanga with Kenya and Uganda. This port is also connected with Dar es Sallam by the branch line of the railway running between Korogwe and Ruvu.

When conducting the basic survey concerning the improvement plan of Port of Tanga and Port of Musoma, emphasis was placed on the following matters:

(1) Gathering the available data on the natural conditions such as the land and marine meteorological conditions.
(2) Investigating into the existing port facilities.
(3) Investigating into the condition of port services.
(4) Investigating into the economy of the hinterland of the ports.

Fig 6-1-1


30°E
35°E
40°E
N
PAKWACH
MASINDI
KITALE
TORORO
BUSEMBATIA
JINJA
KAMPALA
KASESE
BUTERE
KISUMU
ENTEBBE
PORT BELL
SOLAI
THOMSONS
NANYUKI
0°
BUKAKATA
LAKE
VICTORIA
GILGIL
BUKOBA
NAIROBI
MUSOMA
KONZA
MAGADI
MWANZA TOWN
ARUSHA
MOSHI
VOI
MOMBASA
KIGOMA
TABORA
KALIUA
TANGA
KOROGWE
PEMBA ISLAND
5°S
DODOMA
MPANDA
ZANZIBAR ISLAND
KILOSA
MOROGORO
DAR ES SALAAM
IRINGA
MAFIA ISLAND
MBEYA
MTWARA
10°S
LEGEND
RAILWAYS
TRAIN FERRY TERMINAL
PRINCIPAL LINES PROPOSED
E.A.R. ROAD SERVICES
E.A.R. LAKE SERVICES
E.A.R. HOTELS
E.A.H. OCEAN PORTS
NILE BRIDGE Under Construction
0
100
200 MILES
100
200
300 KILO METER

6-2 Present Condition of Port of Tanga

6-2-1 Natural conditions

6-2-1-1 Topography of the area around Port of Tanga
(See Fig. 6-2-1)

The hinterland to the south of Port of Tanga forms a fertile tableland at El 50 ft above sea level and on it the town of Tanga is being built. Two small rivers, Mutojiji River and Mutomrunu River, flow into the western part of Port of Tanga. No technical survey was conducted, but certain amount of sediment carried by the two rivers into the port in the rainy season has been observed. On the northern side and about 2,100 ft away from the Port is located the Tanga Island which checks the sediment flow into the Port. The northern side of Port of Tanga is a swamp area, and there is no road passing through it.

The entrance to Port of Tanga is on its east side, and there are well developed coral reefs inside. Two large tropical coral reefs, Nyule and Nyama, are in the sea about 10 km east of the Port. They submerge at high tide. However, the water inside Tanga Bay is very deep, and the water depth of the natural channel is -30 ft in minimum and -150 ft in maximum. There is no continental shelf facing the Indian Ocean and the offing east of the coral reefs is much deeper.

So, the ships at anchor at the designated places naturally face no problem of draught.

6-2-1-2 Meteorological conditions

At Port of Tanga, the northeast monsoon prevails from December to February, and the Southeast monsoon from March to November.

(1) Temperature and humidity

The temperature of Tanga District, as shown in Table 6-2-1, ranges between 20°C and 35°C not very high if the location of the district near the Equator is taken into consideration. The humidity ranges between 65% and 85%.

Fig 6-2-1 Tanga Bay

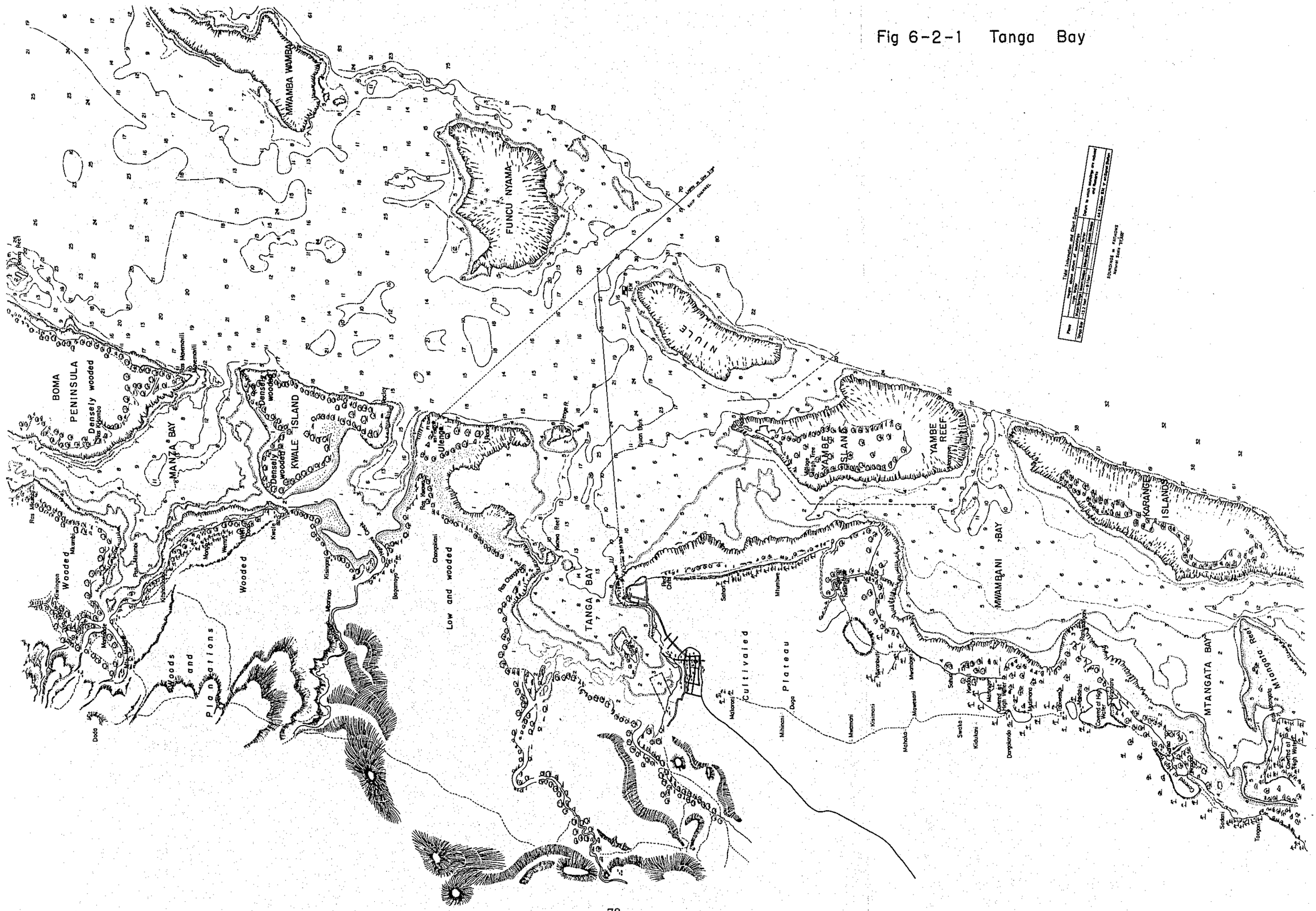


Table 6-2-1 Temperature & Humidity of Tanga District

(Record of 14 Years)

	Temperature				Humidity	
	Highest Daily Mean	Lowest Daily Mean	Highest Monthly Mean	Lowest Monthly Mean	0900	1500
Jan	32°C	24°C	34°C	21°C	76	67
Feb	33	24	34	22	77	66
Mar	33	24	34	22	79	65
Apr	31	23	33	22	85	73
May	29	22	31	21	85	71
Jun	29	21	31	19	83	68
Jul	28	20	30	19	84	69
Aug	28	20	30	18	85	69
Sep	29	20	30	18	82	67
Oct	30	21	31	19	81	67
Nov	31	23	33	21	81	69
Dec	32	23	33	22	77	69
Mean	30	22	35*	17**	81	68

Remarks: * *Highest annual mean*

** *Lowest annual mean*

(2) Wind

The record of wind of Tanga District is based on the observation made at Tanga Ariport. Table 6-2-2 shows record of 17 years in total from 1920 to 1963 observed at a point about 105 ft above the sea level.

Twice a day at 9:00 a.m. and 3:00 p.m., the recording wind force is made employing the Beaufort wind scale. On the average, the wind force at 3:00 p.m. is around 3, and the typhoon-class wind force of 8 has been recorded in only 4 days during the 17 years. The wind force of 8 in the Beaufort wind scale converted to wind velocity is about 17m/sec to 21m/sec.

Table 6-2-2 Wind of Tanga District

(Record of 17 years)

Month	Direction 0900 %									Direction 1500 %									Velocity		No. of Days Velocity above 8
	N	NE	E	SE	S	SW	W	NW	Calm	N	NE	E	SE	S	SW	W	NW	Calm	0900	1500	
Jan	28	39	10	8	2	0	0	8	5	11	50	23	11	3	1	0	1	0	1.8	3.6	1
Feb	25	36	12	4	3	2	1	11	6	10	41	28	10	2	0	0	1	0	1.5	3.4	
Mar	9	19	8	13	15	8	5	10	13	6	25	21	26	13	6	0	1	2	1.3	2.9	0
Apr	1	3	2	20	46	16	3	1	8	0	2	4	37	41	12	2	0	2	1.4	2.5	0
May	1	0	0	19	15	22	1	0	6	0	0	0	29	53	15	0	0	3	1.6	2.5	0
Jun	0	0	0	19	45	30	2	0	4	0	0	0	34	51	14	1	0	0	1.5	3.1	0
Jul	0	0	0	21	46	25	6	0	2	0	0	0	37	44	16	1	0	0	1.6	2.8	0
Aug	0	0	0	29	46	19	2	0	4	0	0	0	42	42	14	1	0	1	1.5	2.6	0
Sep	0	0	2	39	40	15	2	0	2	0	0	2	54	36	8	0	0	0	1.4	2.8	1
Oct	0	0	3	45	33	9	2	3	5	0	2	8	53	32	5	0	0	0	1.4	3.3	1
Nov	3	8	9	42	20	6	2	3	7	1	11	16	51	17	4	0	0	0	1.4	3.0	
Dec	20	32	15	45	5	3	1	5	4	4	33	32	24	4	1	0	2	0	1.8	3.6	1
Mean	7	11	4	23	29	13	3	4	6	3	14	11	34	28	8	0	1	1	1.5	3.0	

(3) Rainfall

Table 6-2-3 is a summary record of rainfall in Tanga District observed at Tanga Airport of 14 years from 1920 to 1963. The mean annual rainfall of Tanga District is 1,364 mm, the average monthly rainfall in the heavy rainy season (April to June) is around 270 mm, and the average monthly rainfall in light rainy season (October to November) is from 120 mm to 160 mm.

Table 6-2-3 Rainfall in Tanga District

Month	Mean Rainfall	No. of Days Having Over 0.25mm of Rainfall per Day
Jan	29 mm	6
Feb	39	5
Mar	111	10
Apr	279	18
May	264	15
June	63	9
Jul	71	10
Aug	77	12
Sep	84	11
Oct	116	13
Nov	160	13
Dec	70	10
Total	1,360	131

6-2-1-3 Tides

Table 6-2-4 shows the tidal range at Tange District from the 1970 record of the East African Harbour Corporation (EAHC). HWL shows the value of + 11.8 ft + 5.1 ft, and LWL + 4.3 ft – 1.6 ft. The HHWL is + 11.8 ft which occurs in March, April and October while the LLWL is - 1.6 ft which occurs in February, March, June and September. The largest tidal range is 13.4 ft in March, and the lowest is 1.0 ft in January and February. The daily average of the year is MHWL = + 8.7 ft and MLWL = + 1.5 ft. Thus, the tidal range at Port of Tanga is quite large. Putting together the above values, the following ones are derived.

HHML = +11.8 ft

MHWL = + 8.7 ft

MLWL = + 1.5 ft

LLWL = – 1.6 ft

The above tides have been calculated using the values of those at Port of Dar es Sallam as the standard because the tides of Port of Tanga are exactly the same, and there are no facilities at Port of Tanga to make observations.

Table 6-2-4 Tidal Range at Tanga District

Month	HWL		LWL	
	HWL Max	HWL Min	LWL Max	LWL Min
Jan	11.3 ft	5.8 ft	– 1.1 ft	3.4 ft
Feb	11.5	5.1	– 1.6	4.1
Mar	11.8	5.3	– 1.6	4.3
Apr	11.8	5.5	– 1.1	4.1
May	11.1	6.3	– 0.4	3.6
Jun	10.7	6.6	– 0.4	3.0
July	11.0	5.8	– 1.1	3.2
Aug	11.2	5.2	– 1.6	3.7
Sep	11.7	5.2	– 1.6	4.0
Oct	11.8	5.7	– 1.2	3.9
Nov	11.3	6.6	– 0.6	3.6
Dec	10.5	6.2	– 0.6	3.3

6-2-1-4 Waves

There is no facilities in Tanga Bay for making wave observation. According to the engineers and pilots, the highest wave they have witnessed inside Port of Tanga so far has been less than 4 ft, and there never was an occasion in which the ships anchoring inside Port of Tanga or those ships entering and leaving the port were affected by waves. This is convincing since Nyama and Nyule coral reefs are playing a role of breakwater. According to the engineers of the East African Railway Corporation (EARC) in Nairobi, waves as high as 30 ft are seen in the monsoon seasons outside Port of Tanga. This also is convincing since the records of observations made at Tanga Airport during the past ten years show four days having the wind scale cover 8. The waves can reach the maximum height of 21 to 24 ft when the wind scale is 8. Pemba Island is located 50 miles east of Port of Tanga, and this island shelters the entrance of Tanga Bay. As there are no shelters on the northeast and southeast directions. Waves may attack the bay from these directions in the monsoon season. However, as Port of Tanga is located in the heart of Tanga Bay, so it is generally quiet. It could be said that this port is quite safe from waves.

6-2-2 Existing port facilities

6-2-2-1 Channels and contour facilities.

At present, there are no artificial channel and breakwater in Port of Tanga. The water depth of the natural channel, which runs between the Nyama coral reef and the Nyule coral reef into Port of Tanga, is more than -30 ft. As the waves and tidal current in the bay are not violent, it seems that there is no necessity of dredging the natural channel under the present condition.

Fig. 6-2-1 shows the natural channel and the water depth of Tanga Bay. To enter Port of Tanga, ships have to follow this channel from the northeast direction advancing according to the sign at Ulenge for a guide. The northern end of the coral reef to the starboard is marked with a beacon of checkered pattern. After passing the Nyule coral reef, the ships follow the leading mark at Raskzon and change the direction to portside to enter the port. To guide the large-sized ships to the designated anchorage inside Tanga Bay, a pilot gets on the ship somewhere near the Ulenge beacon.

6-2-2-2 Anchorage

Fig. 6-2-2 shows the anchorage in Port of Tanga. There are seven anchorages in the inner harbor for lage-sized ships. These anchorages can accommodate large ships of 700 ft in length and 21 to 31 ft of draught. In the outer harbor, there are five anchorages for ships of the draught larger than 31 ft. As the seabed of anchorage is clay, the anchor works well.

6-2-2-3 Moorings

Fig. 6-2-2 shows the layout of Port of Tanga. There is no berth for the mooring of a large-sized ship, and so cargo is picked up by lighters. There are one steel sheet pile type wharf for lighter 670 ft in length and another wharf for lighter 580 ft in length having three jetties. And the west end is a jetty for shows, and at the east basin for small ships. The water depth in front of such wharf at LWL is -8 ft. There is a machine repair shop at the west end of the port where barges, cranes, etc. are repaired. In this shop there is a slip for barges. These facilities are distributed parallel to the coastline on the northern front of the Town of Tanga. All structures were constructed before Tanzania became independent, and the facilities are being maintained and repaired throughout the year. Improvement work for the fender of the wharf for lighter was carried out recently.

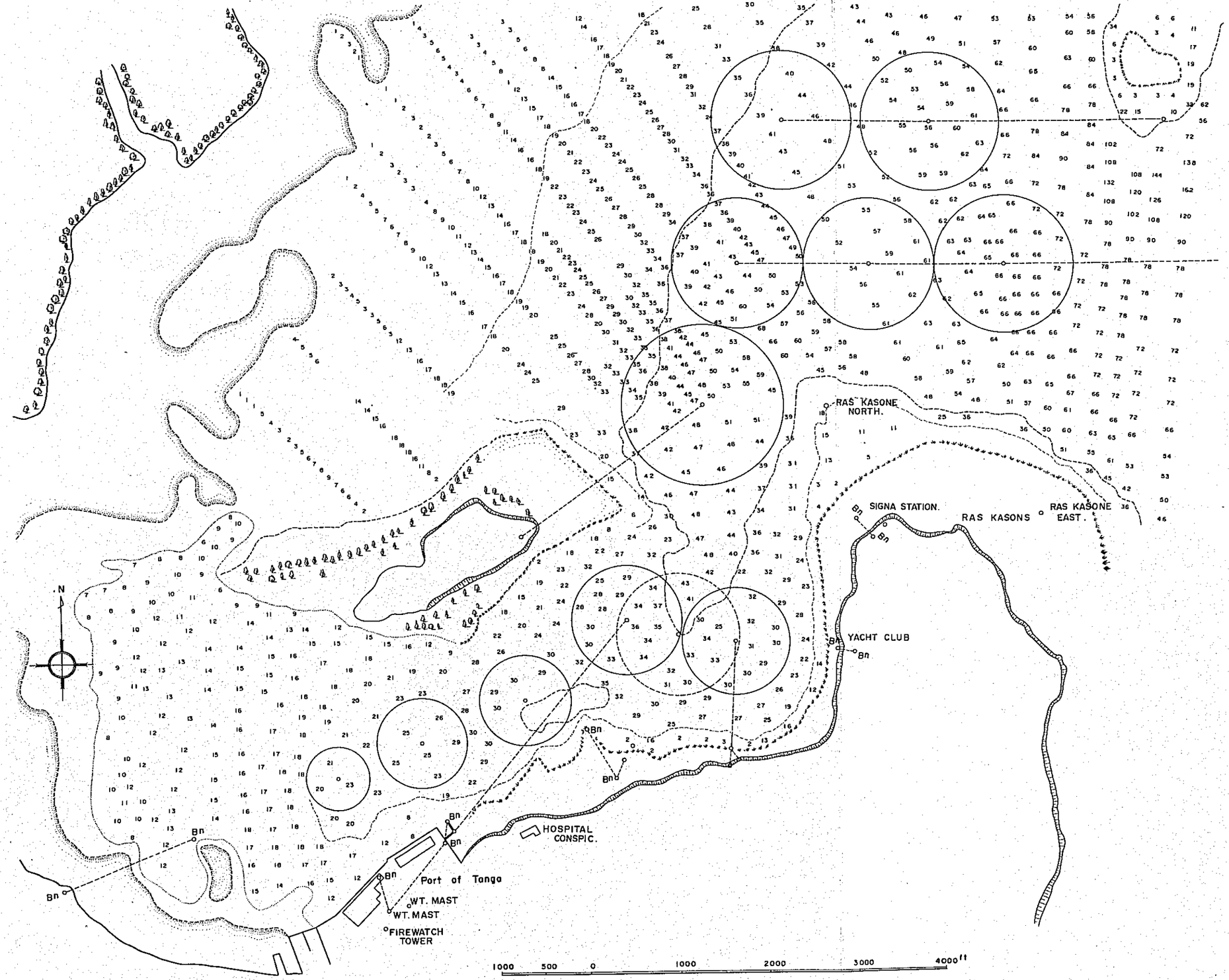
6-2-2-4 Facilities for loading and unloading

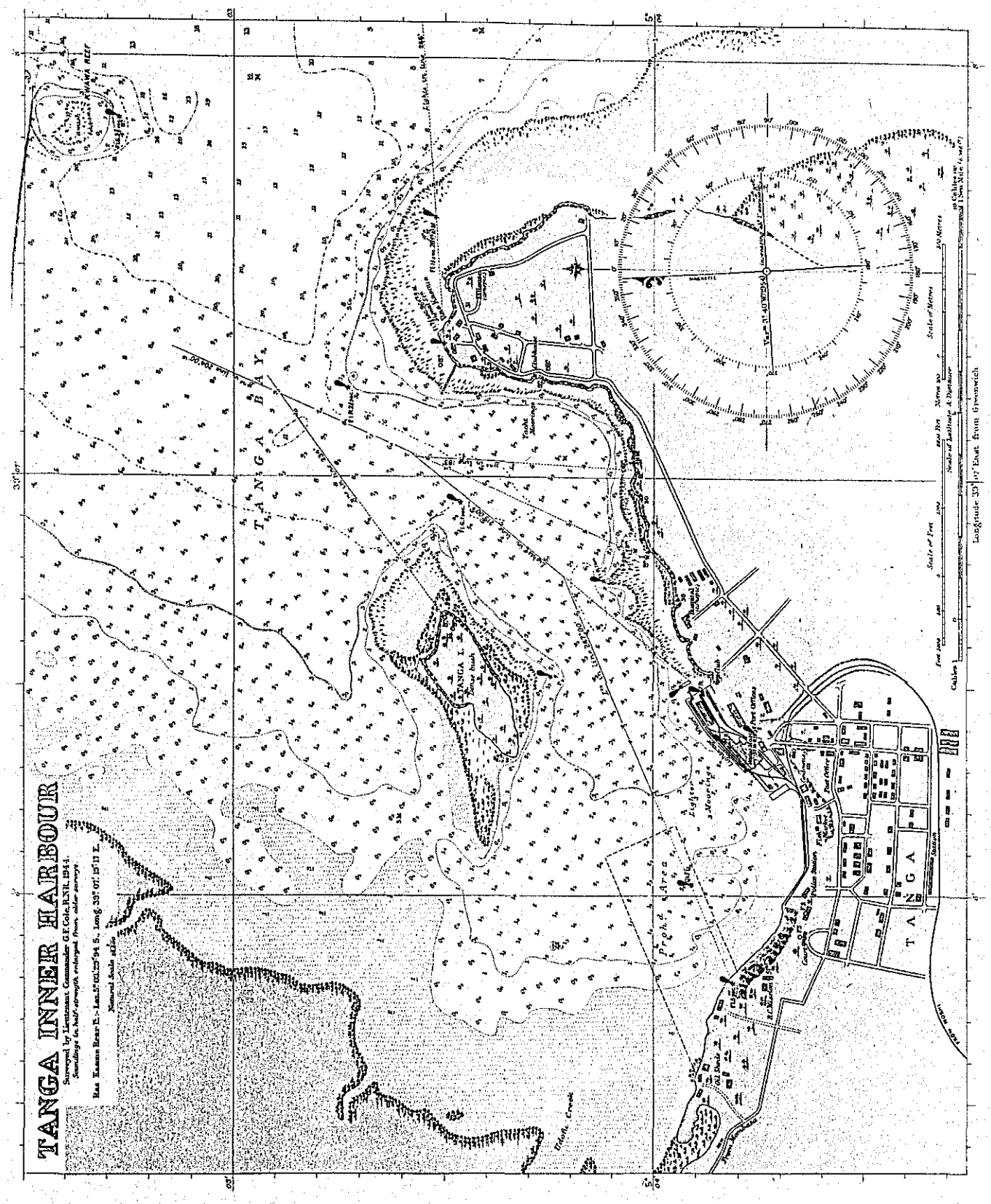
Loading and unloading operations of goods at Port of Tanga are being undertaken by the East African Cargo Handling Ltd. This company owns 37 barges and four tugboats. The total tonnage of barges is 7,080 tons, and the largest barge has the capacity of 250 tons. On the apron and the jetties of the lighter's wharf are cranes, and the 670 ft long lighter's wharf has one 20-ton fixed type electric gantry crane and five 5-ton travelling gantry cranes. Three jetties are equipped with fixed type gantry cranes, two are 3-ton crane and one is a 5-ton crane. The port also has other cargo handling machines as mentioned blow:

Machine	Capacity	No. of Machine
Forklift 40	3,920 lbs	12
Forklift (diesel)		4
Scammell Horse		9
Scammell Trailer		30
Tractor		30
Electric King Hoist		1
Hand Operated Pallet Truck	4,480 lbs	1
RSJ L30A	3,000 lbs	1
ITD TLS6	4,480 lbs	1
Pallet		1,800

The time for cargo handling are 15 hours a day, and workers operate in two shifts. The working hours of one shift is 7 1/2 hours.

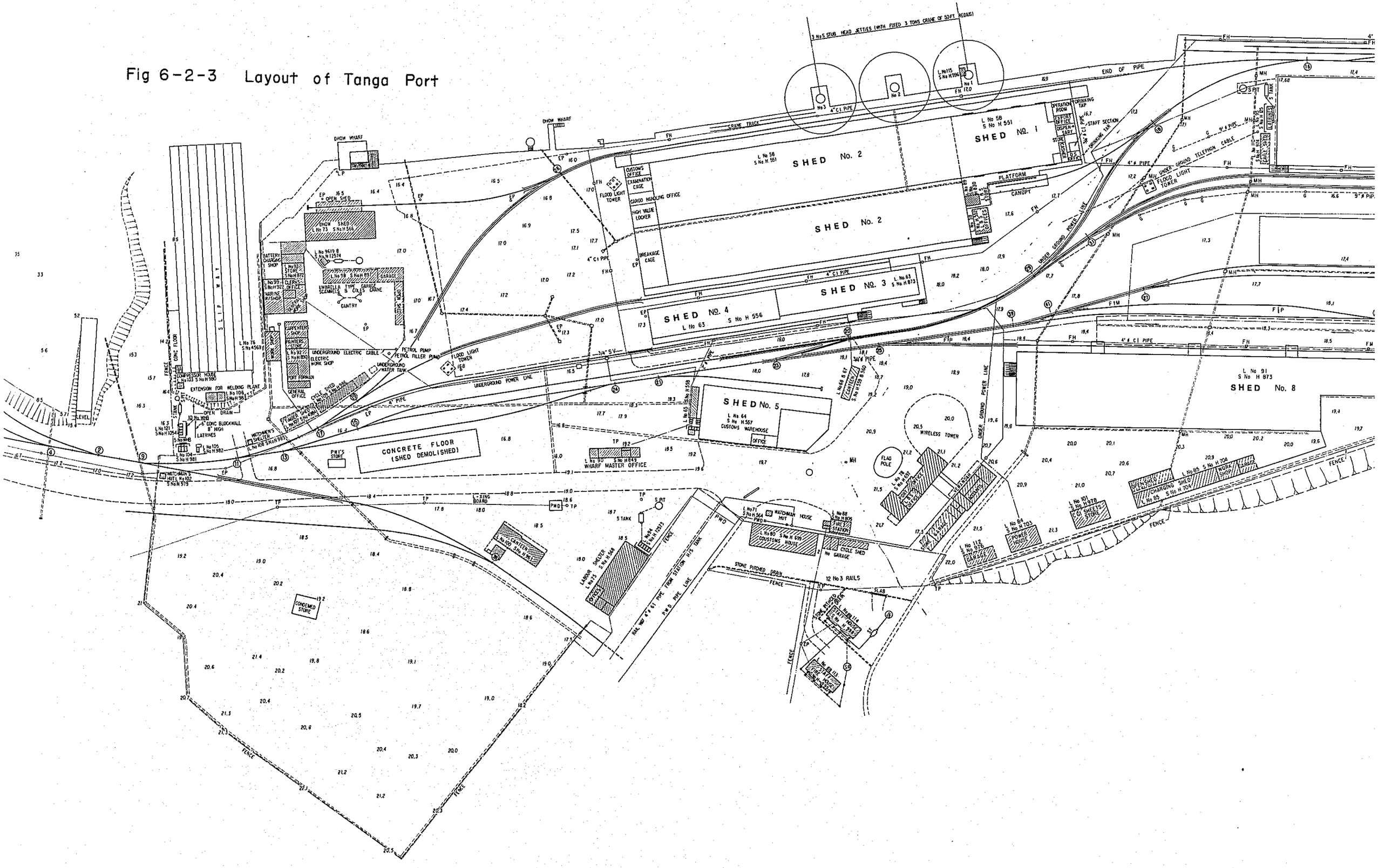
Fig 6-2-2 Anchorage of Tang Port

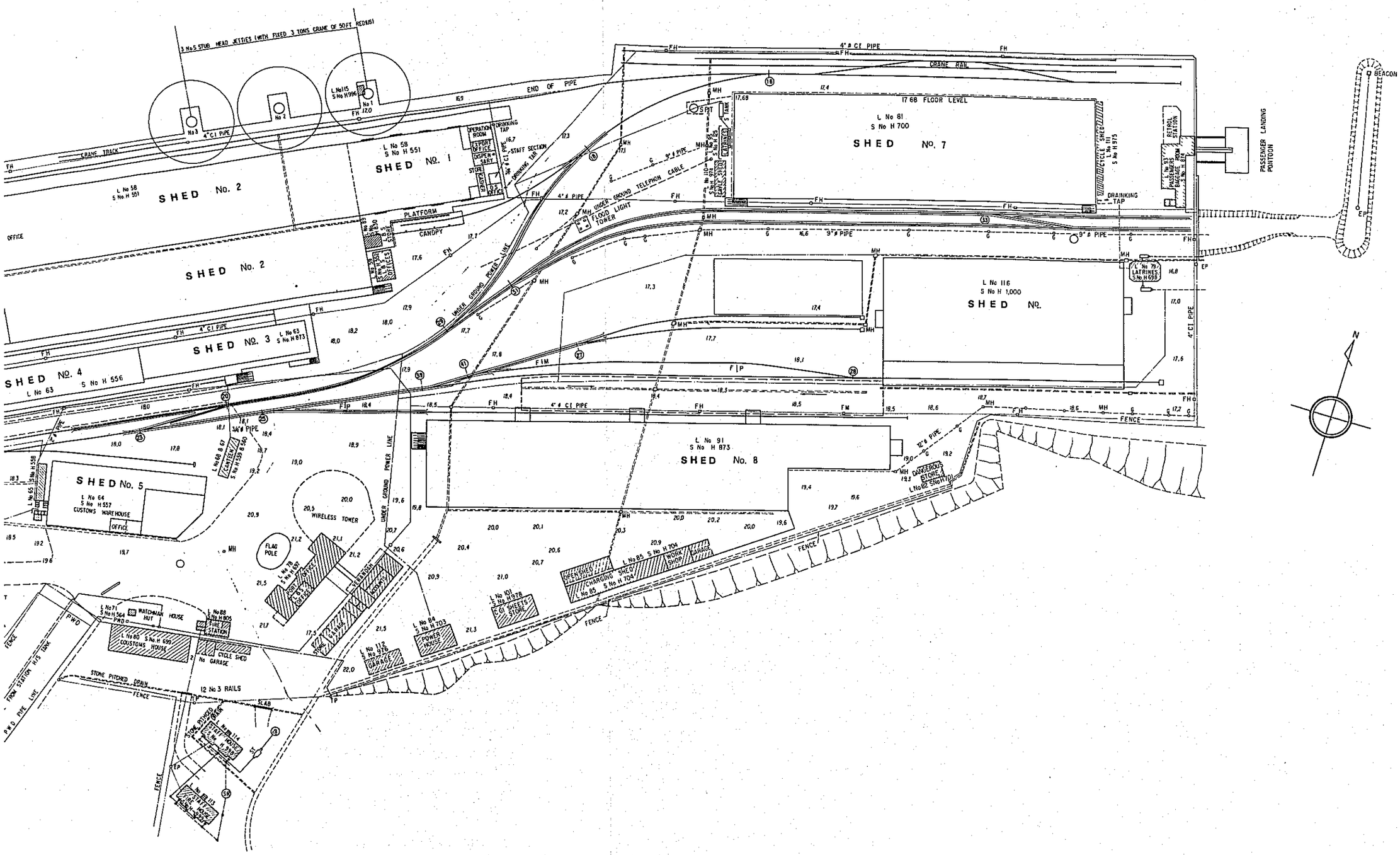




Tanga Inner Harboar

Fig 6-2-3 Layout of Tanga Port




3 No 5 STUB HEAD JETTIES (WITH FIXED 3 TONS CRANE OF 50 FT RADIUS)
CRANE TRACK
SHED No. 2
SHED No. 1
SHED No. 3
SHED No. 4
SHED No. 5
SHED No. 7
SHED No. 8
SHED No.
END OF PIPE
4" CI PIPE
CRANE RAIL
17.68 FLOOR LEVEL
PLATFORM
CANOPY
OFFICE
STAFF SECTION
DRINKING TAP
OPERATION ROOM
SPORT OFFICE
DISPENSARY
STORE
DOCK OFFICE
MH UNDER GROUND TELEPHONE CABLE
MH UNDER GROUND POWER LINE
FLOOD LIGHT TOWER
DRAINKING TAP
PASSENGER LANDING PONTOON
BEACON
PETROL STATION
CYCLE SHED
LATRINES
CANTEEN
CUSTOMS WAREHOUSE
OFFICE
WIRELESS TOWER
FLAG POLE
WATCHMAN HUT
HOUSE
FIRE STATION
CUSTOMS HOUSE
CYCLE SHED
GARAGE
STONE PITCHED DRAIN
12 No 3 RAILS
SLAB
DRIFT HOUSE
FENCE
P.W.D.
P.W.D. PIPE LINE
FROM STATION H/S TANK
DANGEROUS STORE
CHARGOND SHED
OPEN SHED
WORK SHOP
GARAGE
POWER HOUSE
SWEETS STORE
N

6-2-2-5 Wharf facilities

As facilities for storage and warehousing, there are ten sheds. One shed is for the dhows. These facilities occupy a total area of approximately 240,000 sq ft. One warehouse has an area of 2,340 sq ft. The space of each shed is large compared with the volume of cargo handled. There was not a shed stocked to full capacity. The open storage yard has a total area of 1,650,000 sq ft. There is no special storage such as timber basin, coal storage yard or storage for dangerous articles.

A single track port railway runs between Tanga Station and Port of Tanga. The width of the road running from the Town of Tanga to the port is about 6 m, which is rather narrow.

6-2-2-6 Other facilities

As the inside of Tanga Bay is dotted with coral reefs, beacon and light-beacon are being installed at 9 places as the facilities for navigational aid. Ships entering port of Tanga have to pass between Nyule coral reef and Nyama coral reef, but they have to be very cautious as a strong tidal current drift toward northeast around here. (The current velocity is reportedly 2 to 4 knots.) As regards the facility for repairing ships, there is a machine repair shop in Tanga Bay. In the compound of this repair shop, there is a slipway type repairing station which was initially constructed for the purpose of repairing the barges up to the 250-ton class. There are no facilities for the supply of fuel oil or fresh water.

6-2-3 Condition of utilization of harbors

6-2-3-1 Number of ships entering the port

The number and the total tonnage of the ships which entered port of Tanga are as shown in Table 6-2-5. The number of ships increased during the period from 1956 to 1959, but gradually decreased since 1960, and finally dropped below the level of 500 in 1969. The total tonnage decreased continuously in the past five years. The average total tonnage of the ships entering the port showed no substantial change, being 3,400 tons in 1961 and 3,710 tons in 1969. Table 6-2-6 shows the number of ships which entered port of Tanga in January 1970 classified by gross tonnage. The number of ships which entered the Port in that month was 41, and most of them were of the 1,000 to 10,000 tonnage.

Table 6-2-7 shows the number of days for the ships at anchor in the port for loading and unloading of cargo in the period of 5 years from 1965 to 1969. The peak of days was in 1966 and then dropped to 12 days in 1967.

Table 6-2-8 shows the rate of utilization of the berths for barges. The highest rate recorded was 53.7% of 1966, but it dropped since 1967 till 1969 to 39.5%.

The main causes were the decrease in production of Sisal, the major export item Port of Tanga District and the decrease in the population of the Tanga District.

Table 6-2-5 Number of Ships Entering Port of Tanga

Year	No. of Ships	Total Tonnage (NRT)	Total Tonnage (NRT) / No. of Ships
1956	611	1,839,399	3,010
1957	569	1,664,909	2,930
1958	721	1,877,400	2,610
1959	727	2,097,498	2,885
1960	658	2,131,664	3,235
1961	635	2,156,737	3,400
1962	545	1,820,004	3,340
1963	589	2,085,718	3,540
1964	571	2,112,566	3,690
1965	526	1,934,654	3,680
1966	524	1,946,072	3,715
1967	541	1,963,582	3,630
1968	518	1,905,687	3,675
1969	497	1,843,319	3,710

Table 6-2-6 Number of Ships Entering Port of Tanga Classified by Tonnage (January 1970)

Tonnage	No. of Ships
Less than 1,000 GT	6
1,000 10,000 GT	34
More than 10,000 GT	1

Table 6-2-7 Number of Days Delay to Deep-Sea Dry Cargo Ships Awaiting Working at Port of Tanga

Year / Month	1965	1966	1967	1968	1969
Jan	6	18.5	1	4	4
Feb	12	15.5	0.5	2	2.5
Mar	4.5	1.5	0.5	-	3
Apr	6.5	19	1	2.5	3
May	0.5	9.5	0.5	1	2
Jun	0.5	10	1.5	5	-
July	3	5.5	-	0.5	-
Aug	1	2.5	1.5	-	2
Sep	1	0.5	1	1	-
Oct	2	2	-	6.5	-
Nov	9	4	0.5	1.5	1.5
Dec	10.5	2.5	4	1.5	1
Total	56.5	91	12	24.5	19

Table 6-2-8 Rate of Utilization of Berths at Port of Tanga

(Unit: %)

Year / Month	1965	1966	1967	1968	1969
Jan	34.0	53.7	28.8	27.3	51.4
Feb	31.6	42.1	25.5	46.0	30.6
Mar	30.0	50.9	25.6	43.3	44.2
Apr	37.4	57.6	24.3	49.0	28.7
May	29.3	72.3	21.6	26.4	32.3
Jun	26.9	90.3	22.6	46.0	28.7
July	29.5	58.4	21.6	36.7	24.9
Aug	21.9	28.8	25.4	32.0	33.7
Sep	21.7	22.6	30.0	27.3	28.2
Oct	24.6	23.0	36.6	35.8	40.0
Nov	30.7	24.7	37.3	37.0	33.0
Dec	43.1	35.9	36.3	38.0	35.5
Average	30.1	53.7	32.2	42.2	39.5

6-2-3-2 Volume of cargo handled at port

The transition of the volume of cargo handled at Port of Tanga in the period of 11 years from 1959 to 1969 is as shown in Table 6-2-9. The volume of cargo handled increased slightly during this period. The total is approximately 200,000 tons, out of which 80% are cargoes for export. Tables 6-2-10-(1) and (2) show the volumes of cargo for import and export classified by items. The major item exported from Port of Tanga is Sisal. Besides Sisal, there are maize and coffee. The main items of import are petroleum, fertilizer, cement, rail and sleepers. The number of passengers at Port of Tanga, as shown in Table 6-2-11, has shown a rapid decrease since 1965.

Table 6-2-9 Volume of Cargo Handled at Port of Tanga
(Unit: D/W Metric Ton)

Year	Import	Export	Total
1959	38,343	153,439	191,782
1960	28,235	156,798	185,033
1961	64,128	147,730	211,858
1962	42,805	161,203	204,008
1963	27,868	170,736	198,604
1964	26,627	184,776	211,403
1965	25,825	174,347	200,172
1966	42,886	172,209	215,095
1967	36,591	184,198	220,789
1968	43,464	178,647	222,111
1969	36,219	178,793	215,012

Table 6-2-10-(1) Main Items of Import at Port of Tanga
(Unit: D/W Metric Ton)

Item	1968	1969
Wheat	2,547	1,527
Salt	2,206	2,101
Fertilizer	5,395	7,185
Coffee	3,522	2,077
Steel	1,664	1,460
Canned food, milk	792	1,173
Butter	1,070	-
Automobile	256	225
Animal fat	2,430	3,477
Cement	5,671	-
Gasoline	6,965	-
Kerosene	4,170	-
Diesel oil	8,001	-
Rail, sleeper	4,371	1,903
Rice	303	-
Cloth	586	1,019
Caustic soda	879	980

Table 6-2-10-(2) Main Items of Export at Tanga of Port
(Unit: D/W Metric Ton)

Item	1968	1969
Sisal	124,241	123,987
Black tea	3,068	3,728
Coffee	6,502	7,354
Timber	2,667	2,024
Wooden floor blocks	5,608	8,114
Ground maize	6,356	5,536
Maize	11,702	7,366
Broad bean	4,433	3,375
Twine	5,044	5,982

Table 6-2-11 Number of Passengers at Port of Tanga

Year	Arriving	Leaving
1956	2,142	1,729
1957	2,415	2,483
1958	2,975	3,120
1959	3,220	3,157
1960	3,213	2,247
1961	1,897	2,399
1962	1,624	1,205
1963	1,522	378
1964	1,452	1,840
1965	807	456
1966	471	327
1967	577	506
1968	1,326	472

6-3 Present Condition of Other Ports

6-3-1 Port of Mombasa

Port of Mombasa is a good natural port located at Lat. 4° 04' S. and Long. 30° 40' East, which consists of the old Mombasa port and the Kilindini port, with the latter one making up the major main port of the whole port. Port of Mombasa, infact is a major port not only of Kenya but also of Uganda, the northern part of Tanzania and the eastern part of Congo. The old port on the eastern side of Mombasa Island, which stands the same as it was 1,000 years ago, is still serving actively as a trade

port linking East Africa with Arabian countries, Persia and India by the dhows. Taking the advantage of the northeast wind around the end of December and early January, the dhows sail into the old port, and by the southeast monsoon around April, they sail to Persia, India, etc. The channel depth at the entrance of the port is -39 ft, and it is being used by dhows, small ships and small-sized cement transport ships, etc. The maximum current velocity at the entrance is 3 knots.

The Kilindini port at the southwestern part of Mombasa Island has a total length of 7,690 ft, a quay of water depth of -30 to -33 ft on the front, 13 berths and oil berths of water depth of -44 ft and -32 ft respectively, a cargo space 1,350 ft in length and other facilities. A 65,000 DWT class tanker up to the length of 820 ft can be moored alongside Kipevu Oil Terminal which has the water depth of -44 ft on the front, while Shimanzi Oil Terminal having the water depth of -32 ft on the front has a quay capable to moor alongside at a tanker up to the length of 640 ft. All ships entering the port must be guided by the pilot. The effective width at the entrance of this port is about 900 ft. There are 12 berths in this port. As the seabed is of clay soil, the anchor works well. On the western side of the Kilindini port are mooring buoys for 5 large-sized ships 700 ft in length. To lie at anchor outside of the port is dangerous particularly in the southeast monsoon season because of the big surges and the strong coastal current. The channel was dredged in 1960 to allow entrance of large-sized ships with a draught of -45 ft and a length of 820 ft. This was done along with the construction of a quay (completed in 1963) for 65,000 DWT class oil tankers at Kipevu. HWL at the Kilindini port is +12.5 ft at spring tide, and +7.9 ft, at the neap tide while the maximum current according to this tide range is 2 knots.

As shown in Table 6-3-1, the volume of cargo (general cargo) handled at the ports has recorded an increase of approximately 25% in the past 10 years. Table 6-3-2 shows the volume of petroleum, cement and molasses handled in 1967 and 1968. The total amount of cargo handled in 1968 reached 5,528,000 DWT tons. Table 6-3-3 gives the volumes of main export and import. The main items of import at Port of Mombasa are crude oil, agricultural machinery, fertilizers, kerosene, etc., and the main items of export are bunker oil, maize, coffee, cement, etc.

The number of ships entering the ports has increased rapidly since 1967 as shown in Table 6-3-4, and the total tonnage increased, making the average tonnage of one ship increased to 3,800 tons. The number of passengers has decreased since 1965 as shown in Table 6-3-5. Table 6-3-6 shows the number of days in each month of 1968 that ships had to take awaiting available berths.

Fig 6-3-1 Mombasa Port

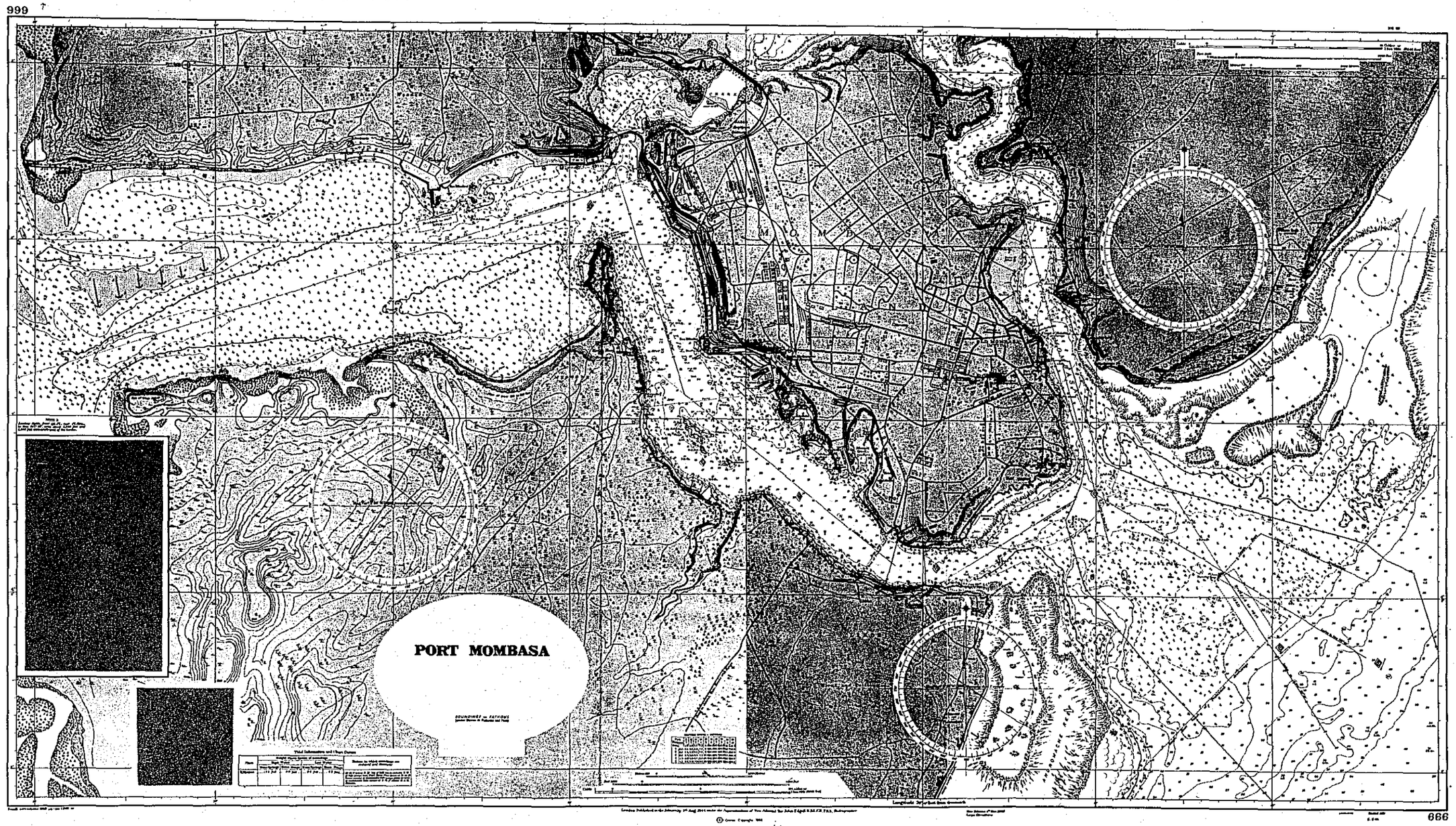


Table 6-3-1 Volume of General Dry Cargo Handled at Port of Mombasa
(Petroleum not Included)

(Unit: D/W Metric Ton)

Year	Import	Export	Total
1959	605,927	880,142	1,486,069
1960	635,380	902,894	1,538,274
1961	714,527	893,857	1,608,384
1962	734,970	923,860	1,658,830
1963	673,761	1,069,039	1,742,800
1964	677,082	917,532	1,594,614
1965	958,350	868,920	1,827,270
1966	1,140,712	990,813	2,131,525
1967	838,277	1,055,259	1,893,536
1968	941,154	1,202,681	2,143,835
1969	885,558	1,131,156	2,016,714

Table 6-3-2 Volume of Petroleum, Cement and Molasses Handled at Port of Mombasa

(Unit: D/W Metric Ton)

	1967	1968
Petroleum (imported)	2,194,163	2,346,364
Petroleum (exported)	878,145	791,649
Cement (imported)	173,786	203,257
Molasses (imported)	43,185	43,236

Table 6-3-3 Volumes of Cargo Imported and Exported Handled at Port of Mombasa in 1968 Classified by Item

(Unit: D/W Metric Ton)

Import Commodity		Export Commodity	
Fuel (in bulk)	67,369	Beans, peas and pulses	19,443
Petroleum (in bulk)	52,334	Cashew nuts	7,360
Kerosene	74,247	Castor beans	4,685
Crude oil (in bulk)	2,144,997	Cement (in bulk)	203,257
Carton Goods	53,530	Cement (packaged)	59,300
Lub. Oil (in bulk)	40,306	Coffee beans	255,722
Liquid gas (in bulk)	12,074	Cotton (raw)	88,756
Carton piece goods	10,569	Maize	263,304
Gunnies	13,977	Maize, meal	
Motor vehicles and	22,507	and flour	32,542
tractors		Sisal	65,084
Motor vehicle spares		Wattle extract	21,457
and batteries	11,058	Domestic products	37,456
Motor vehicle tyres		Goods manufactured	
and tubes	19,361	in foreign country	28,521
Agricultural		Magadi soda	108,426
machinery	8,177	Oils	7,806
Iron ware	162,645	Blister copper	12,319
Salt	58,777	Oil lub. fuel (in c/s or drums)	13,989
Fertilizers (in bags)	93,260	Tea	95,769
Fertilizers (in bulk)	7,977	Fruit (canned)	5,769
Sugar	27,902	Bunker coal	256,690
Lub. oil (in c/s and drums)	17,321	Bunker oils	534,958
Rice	5,516	Molasses	43,936
Railway materials	22,143	Bran	10,947
Rails and sleepers	16,369	Hides (dry and salted)	5,038
Pipes and fittings	20,383	Meat (tinned)	4,494
Malt	12,868	Seeds sesame	5,197
		Seeds (others)	4,679
		Scrap (bales and drums)	4,628

Table 6-3-4 Number of Ships Entering Port of Mombasa

Year	No. of Ships	NRT	Average Tonnage of Ship
1956	1,233	3,839,606	3,110
1957	1,279	3,822,224	2,990
1958	1,155	3,884,505	3,360
1959	1,270	4,110,695	3,240
1960	1,330	4,469,754	3,360
1961	1,357	4,676,796	3,450
1962	1,453	4,640,733	3,190
1963	1,491	5,034,856	3,370
1964	1,548	5,383,640	3,410
1965	1,533	5,152,013	3,360
1966	1,506	5,289,088	3,510
1967	1,963	7,538,940	3,840
1968	2,114	7,988,329	3,720

Table 6-3-5 Passengers at Port of Mombasa

Year	Arriving	Leaving	Visa (Total)
1956	35,020	31,211	66,231
1957	36,240	35,494	71,734
1958	38,345	37,907	76,252
1959	41,157	39,164	80,321
1960	37,559	45,847	83,533
1961	35,421	45,864	81,345
1962	34,847	42,779	77,653
1963	34,840	39,697	74,177
1964	26,038	44,486	70,534
1965	28,730	33,915	62,645
1966	25,917	25,873	51,790
1967	22,897	21,222	44,119
1968	16,459	22,238	38,697

Table 6-3-6 Number of Days Delay to Deep-Sea Dry Cargo Ships Awaiting Working

Month	No. of Ships	No. of Days
Jan	95	54½
Feb	82	24
Mar	101	125½
Apr	87	38½
May	86	227
Jun	95	343½
July	84	41
Aug	92	60½
Sep	82	13½
Oct	92	42½
Nov	87	78½
Dec	90	131
Total	1,073	1,180

The number of waiting days per ship in 1968 was 1.1 days, and the number of days required by one ship for cargo handling was 3.97 days. The volume of cargo handled per berth on the average was 143,723 DWT in 1967, and 166,249 DWT in 1968. The volume of cargo handled by each crane in the cargo space was 16,616 DWT in 1967 and 21,265 DWT in 1968. The main cargo handling machines used are the followings:-

Electric Level Luffing Crane	10-ton	3	Units
"	7-ton	12	"
"	5-ton	15	"
"	3-ton	12	"
"	20-ton/7-ton	1	Unit
Electric Level Luffing Fixed Crane	5-ton	1	"
"	3-ton	5	Units
"	2-ton	2	"
Mobile Crane	15-ton	1	Unit
"	6-ton	15	Units
Floating Steam Crane	60-ton	1	Unit
Overhead Belt Conveyor		2	Units
Scammell (Horses)		33	"
Scammell (Trailers)		80	"
Forklift Trucks		149	"
Platform Trucks		34	"
Pallets		22,634	"
Pallet Trucks		2	"
Tin Plate Machine		3	"

6-3-2 Port of Dar es Salaam

Port of Dar es Salaam is also a good natural port situated at Lt. 6° 50' South and Long. 39° 17' E. Dar es Salaam is the capital of Tanzania having a population of approximately 270,000. (See Fig. 6-3-3)

The port is under the control of the East African Harbour Corporation, and all cargo handling is being carried out by the East African Cargo Handling Services, Ltd. Of the 3 berths on the quay, one is used exclusively for handling cargoes owned by Congo, Rwanda and Urundi, and this berth is under the control of the African Agency Maritime International. Dar es Salaam is the terminal of the Central Railway, and as already mentioned before, it is connected with Lake Tanganyika, Lake Victoria, Kenya and Uganda.

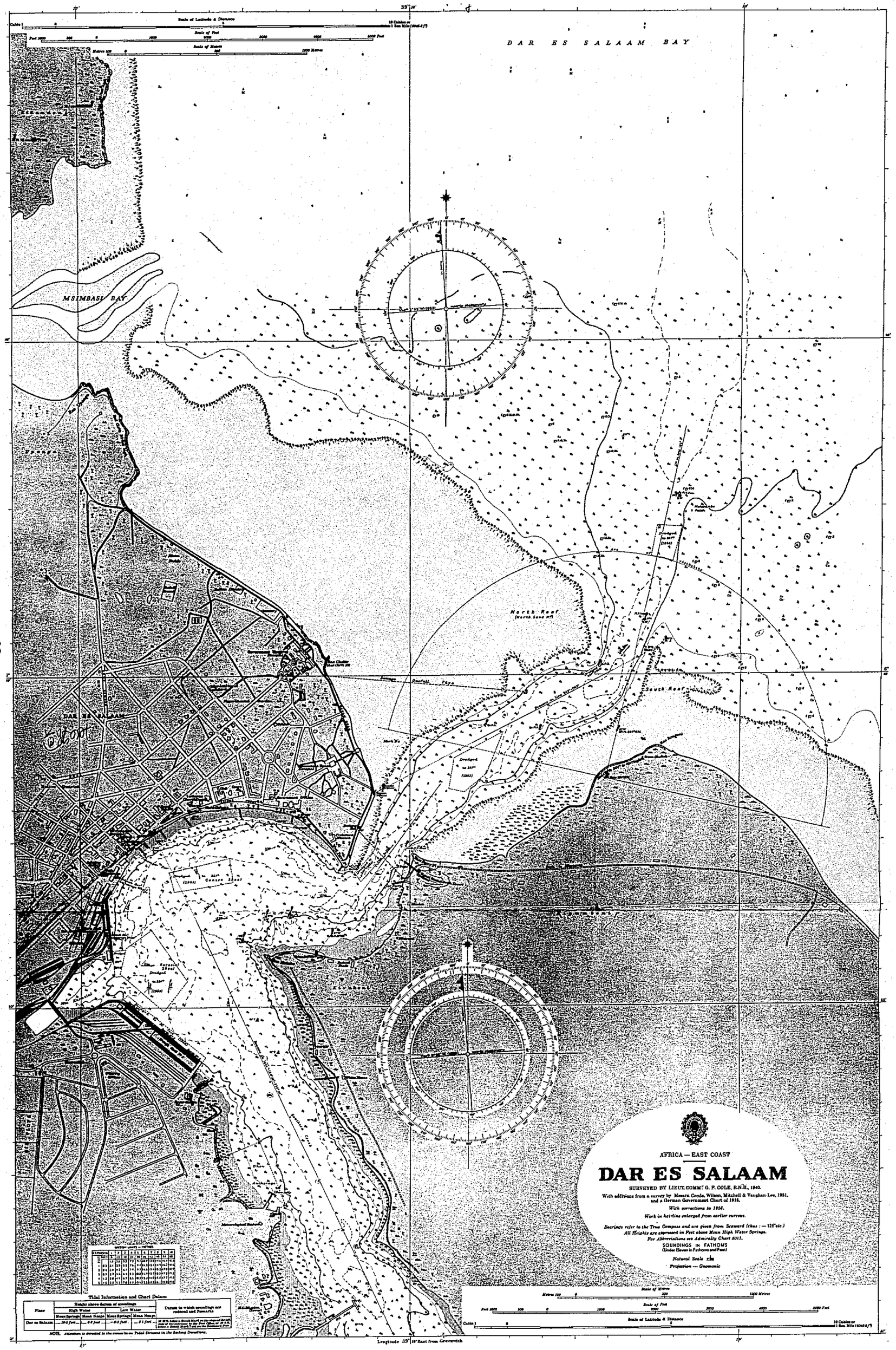
The tides of this port are exactly the same as those of Port of Tanga (See the paragraph on Port of Tanga), and the tidal range is quite large. As shown in Fig. 6-3-2, the coral reefs develop on both sides of the entrance to the port. The total length of the waterway at the entrance is 1.25 miles, and the effective width of waterway having water depth of more than -21.6 ft is 420 ft. Therefore, a very strong current is generated at spring tide, and the maximum current is 3.5 knots. Due to such topographic condition and the current, ships capable to gain entrance to the port are limited to those of the maximum length of 600 ft. Ships sometimes cannot enter the port in the monsoon season because of strong winds and current, but cargo handling in the inner port is not hindered by them.

There are nine moorages in the inner port where large-sized ships within 350 ft 600 ft in length and having draught of 23～30 ft can be moored. There are two moorages in the inner port exclusively for coastal trade ships. The waterway in the inner port where the ships having draught up to 30 ft can navigate is 1.75 miles long, and the effective width of the waterway with water depth larger than -21.6 ft is 1,000 ft. On the western side of the inner port is an oil berth where a large tanker of 575 ft in length and having a draught of 32 ft can be moored alongside.

There are 3 berths on the quay where the water depth is -30 ft, and the total length of the berths is 1,824 ft. The coastal trade ships with a draught less than 16 ft can be moored alongside the cargo space, the total length of which is 1,929 ft. On the quay where the water depth is -30 ft are 15 cranes, 9 of which are of the 5-ton type and 6 the 7-ton type.

The area of the shed at No.1 Berth is 126,000 sq ft. The sheds of No.2 and No.3 berths are connected, and their total area is of 145,879 sq ft. These sheds are now being expanded. Behind them are the supplementary sheds having a total area of 112,500 sq ft. The open freight storage for bulky cargo has a total area of 357,770 sq ft, two 10-ton cranes and three 5-ton cranes.

Fig 6-3-2 Dar es Salaam Port



There are 9 land cranes on the cargo space, 7 of which are 3-ton cranes, one 5-ton crane and another 20-ton crane. The total area of the sheds is 155,997 sq ft, and the open freight storage has two 4-ton cranes and forty 30-ton cranes. A quay having 3 berths is now under construction at this port.

There are also 60 barges, 6 tugboats and other land cargo handling machines such as the 7 shunting tractors, 38 Scammell horses, 130 Scammell trailers and 8 Nutfield tractors.

Table 6-3-7 shows the volume of general dry cargo handled at this port. The volume has increased rapidly since 1966 to almost double in a period of five years. Table 6-3-8 shows the volume of cargo handled in 1968 of the major import and export items classified by item. The main import items are crude oil, fuel gas, diesel oil, kerosene, cement, automobiles, steel and steel goods. The main export items are copper, cotton, coffee beans, Sisal and maize from Zambia and Congo.

Table 6-3-7 General Dry Cargo at Port of Dar es Sallam

(Unit: D/W Metric Ton)

Year	Import	Export	Total
1959	222,447	311,397	533,844
1960	249,752	363,286	613,038
1961	261,951	277,795	539,746
1962	295,291	276,194	571,485
1963	233,328	288,384	521,712
1964	182,762	316,587	499,349
1965	241,589	316,263	557,852
1966	316,520	416,599	733,119
1967	394,943	555,093	950,036
1968	381,875	591,498	973,373
1969	434,970	623,845	1,058,815

Table 6-3-8 Volume of Cargo Handled at Port of Dar es Salaam

(Unit: D/W Metric Ton)

Import Commodity	(E/W)	Export Commodity	(D/W)
Fuel oil & diesel oil (in bulk)	151,482	Beans, peas & pulses	1,071
Petroleum (in bulk)	65,007	Cashew nuts	19,574
Crude oil (in bulk)	684,749	Cassava	1,264
Bitumen	8,229	Castor seeds	6,174
Wines & spirits	13,564	Cement bagged	10,580
Condensed & preserved milk	9,837	Coffee	22,415
Carton goods	10,037	Copper (Congo)	43,170
Cotton piece good	13,564	Copper (Zambia)	229,485
Galvanized/cast iron sheets	7,113	Copra	1,222
Motor vehicles, tractors & trailers	29,864	Cotton & cotton lint	38,072
Motor vehicle spares	8,717	Cotton seeds	770
Motor vehicle tyres & tubes	8,200	Fruit (canned)	4
Wheat & wheat flour	17,067	Grain (wheat & GNOE)	31
Iron & iron works	21,557	Ground nuts	3,258
Sugar	13,003	Hides & skins	7,907
Salt	2,863	Kapok	247
Cement (in bulk)	59,237	Meat (canned)	3,467
Fertilizers	19,694	Oil seed cake	1,136
Lub. oil & grease (in cases & drums)	6,655	Pyrethrum	-
Railway materials	10,631	Scrap metal (in bales or drums)	903
Pipes & fittings	10,532	Sisal	60,296
Paper & paper bags	8,976	Tea	5,245
Machinery spares	19,628	Timber	981
Soap, soap flakes & detergents	5,746	Tobacco	2,512
Zambia cargo (Tonnage included in the above)		Wattle extract	8,875
Motor vehicles, tractors & trailers	4,280	Twine	7,539
Cotton piece goods	7,256	Maize	13,127
Sodium hydrosythric	7,437	Maize meal & flour	4,954
Fertilizers	100	Oil lubricating & fuel (in cases or drums)	1,022
General cargoes	57,919		

Table 6-3-9 Number of Ships and Passengers Entering Port of Dar es Salaam

	Ships			Passengers		
	No.	NRT	NRT/NO.	DIS	EMB	TOTAL
1956	911	2,782,845	3,060	20,403	18,849	39,252
1957	939	2,786,191	2,970	20,295	18,512	38,807
1958	1,203	3,226,176	2,680	26,149	21,548	47,697
1959	1,237	3,322,566	2,690	21,398	16,771	38,169
1960	1,163	3,616,075	3,100	23,750	19,858	43,608
1961	1,095	3,626,880	3,310	19,058	17,871	36,929
1962	1,007	3,501,489	3,270	16,958	16,039	32,997
1963	1,050	3,666,326	3,490	14,455	14,029	28,484
1964	1,030	3,068,151	3,500	16,659	17,530	34,189
1965	1,032	3,513,749	3,460	15,984	17,245	33,229
1966	1,012	3,624,015	3,580	17,948	18,320	36,268
1967	1,011	3,801,918	3,760	17,281	19,202	36,483
1968	1,033	3,635,060	3,520	17,537	15,603	33,140

Table 6-3-10 shows the number of days the ships have to wait at the offings of Port of Dar es Salaam before entering the port. Recently, it appears that ships may to wait for more than two weeks. The average waiting days of a ship is 0.29 days and the average number of days required for cargo handling by each ship is 2.43 days. The rate of utilization of berths was 96.6% in 1967 and 98% in 1968. Berths are being utilized almost fully. The volume of cargo handled at each berth on the quay in 1968 was 184,767 D/W metric tons, and the volume of cargo handled by each crane on the cargo space was 52,384 D/W metric tons.

Table 6-3-10 Number of Ships and Waiting Days

Month	No. of Ships	Waiting Days
Jan	69	24½
Feb	61	7
Mar	68	4½
Apr	62	19½
May	67	9
Jun	69	11
July	67	9½
Aug	66	15½
Sep	74	8½
Oct	69	13
Nov	68	40½
Dec	75	76
Total	815	238½

The volume of petroleum handled is as shown below. The import of crude oil was 790,217 D/W metric tons in 1967, and 899,839 D/W metric tons in 1968. The volume of oil exported was 178,417 D/W metric tons in 1967, and 208,107 D/W metric tons in 1968. Therefore, the total volume of petroleum products handled in 1968 was approximately 1,100,000 D/W metric tons.

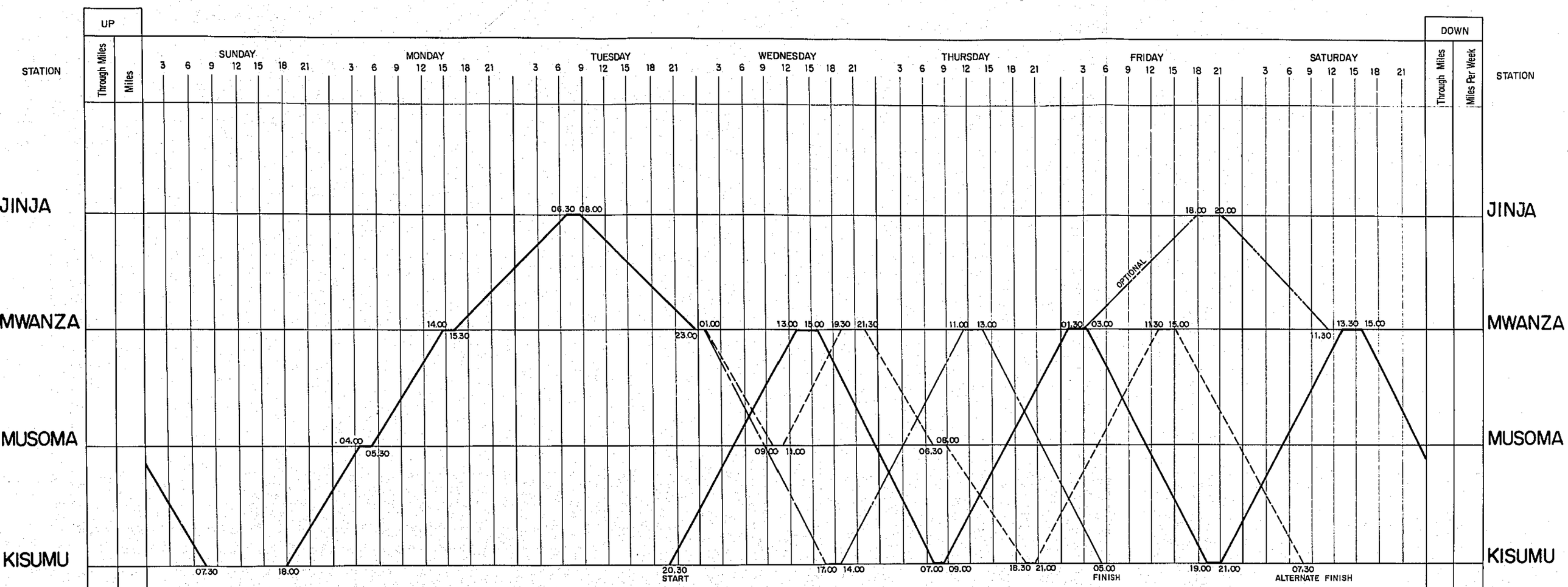
Due to the economic growth attained by Tanzania in recent years and her increased foreign trade as a consequence of such economic growth, the volume of cargoes transported from the inland areas of Congo and Zambia has increased tremendously in recent years. Since such a situation has given rise to the problems of traffic congestion and freight congestion at the port, it is now necessary that the harbor facilities of Port of Dar es Salaam should be improved urgently to cope with the situation. At present Nos. 4, 5 and 6 berths are under construction to be connected with No. 3 Berth on the western side of the inner port for completion soon.

6-3-3 Ports along the shore of Lake Victoria

Lake Victoria is the second largest lake in the world. It is situated in the continent about 600 km from the Indian Ocean. The coastal line of Lake Victoria is shared by Tanzania, Kenya and Uganda. The main ports along the coastal line are Port of Mwanza, Port of Musoma and Port of Bukoba in Tanzania, Port of Kisumu in Kenya, Port of Jinja, Port Bell, Port of Entebe and Port of Bukakata in Uganda. The construction of regular port facilities of these coastal ports was commenced about ten years ago. Among these ports, Port of Entebe is a small one having only one pier. The level of the water surface of Lake Victoria is approximately 3,720 ft above the mean sea water level. Wagon ferries and passenger boats like "Victoria" are being used for the transport of cargoes and passengers among the coastal ports. At present there are two wagon ferries, named "Umoja" and "Uhuru". Port of Kisumu, Port of Mwanza, Port of Jinja and Port of Musoma are the four which have the pier for the ferries. The first three have the railway to connect the respective ports with the hinterland. Port of Musoma does not have the connected line but several side lines inside the port. The East African Railway Corporation is now planning to construct a wagon ferry station at Port of Bukoba, and the field survey is now being conducted at the site 14 miles south of Port of Bukoba. The management of the ports on the shore of Lake Victoria is under the control of the East African Railway Corporation.

At present ferry services are being provided as follows: 5.5 roundtrips per week between Kisumu and Mwanza; 1 roundtrip per week between Mwanza and Jinja; 2 roundtrips per week between Mwanza and Musoma; and 1 roundtrip between Musoma and Kisumu. However, the schedule is sometimes changed to 4.5 roundtrips per week between Kisumu and Mwanza, and 2 roundtrips between Mwanza and Jinja, depending upon the volume of cargoes at the ports to be transported. Fig. 6-3-3 is the diagram showing the abovementioned ferry services.

Fig 6-3-3 Wagon Ferry Diagram



ONE VESSEL COMMENCES THE SERVICE EVERY THURSDAY AT 2030 HRS AND FOLLOWS THE SOLID LINE UNTIL 2300 HRS ON THE FOLLOWING TUESDAY SHE THEN OPERATES EITHER THE RED OR BLACK DOTTED LINES DEPENDING UPON TRAFFIC UNTIL EITHER 0500 ON FRIDAY OR 0730 ON SATURDAY. IF THE TRAFFIC SITUATION REQUIRES THE OPTIONAL TRIP BETWEEN MZA/JJS MAY BE OPERATED ON FRIDAY OR ANY OTHER CONVENIENT PERIOD.

AFTER OPERATING THE SCHEDULE FROM TUESDAY THROUGH TO THE FOLLOWING FRIDAY OR SATURDAY, THE VESSEL WILL REST UNTIL THE FOLLOWING TUESDAY ie 4 DAYS

STARTING DATES.

	UMOJA				UHURU			
THURSDAY	1st	JAN.	11th	AUG.	THURSDAY	8th	JAN.	21st	JULY
	15th	"	25th	"		22nd	"	4th	AUG.
	29th	"	8th	SEPT.		5th	FEB.	18th	"
	12th	FEB.	22nd	"		DOCKING		1st	SEPT.
	26th	"	6th	OCT.		14th	MAR (2days)	15th	"
	DOCKING		20th	"		19th	"	29th	"
11th to 18th APR. (Special)			3rd	NOV.		2nd	APR.	13th	OCT.
TUESDAY	21st	APR.	17th	"		16th	"	27th	"
	5th	MAY	1st	DEC.	TUESDAY	28th	"	10th	NOV.
	19th	"	15th	"		12th	MAY	24th	"
	2nd	JUNE	29th	"		26th	"	8th	DEC.
	16th	"				9th	JUNE	22nd	"
	30th	"				23rd	"		
	14th	JULY				7th	JULY		
	28th	"							

Table 6-3-11 shows the HWL max. and LWL min. of each year from 1960 to March 1970 obtained from the records at Port of Entebe. The water level of Lake Victoria rose rapidly (by about 1.5 meters) since the heavy rain fall in 1960, and the water level has not fallen ever since. Because of this, the construction work for raising the piers is being carried out at Port of Kisumu and Port of Mwanza. Due to this rise of the water level, Port of Bukakata has been completely submerged and could be used ever since.

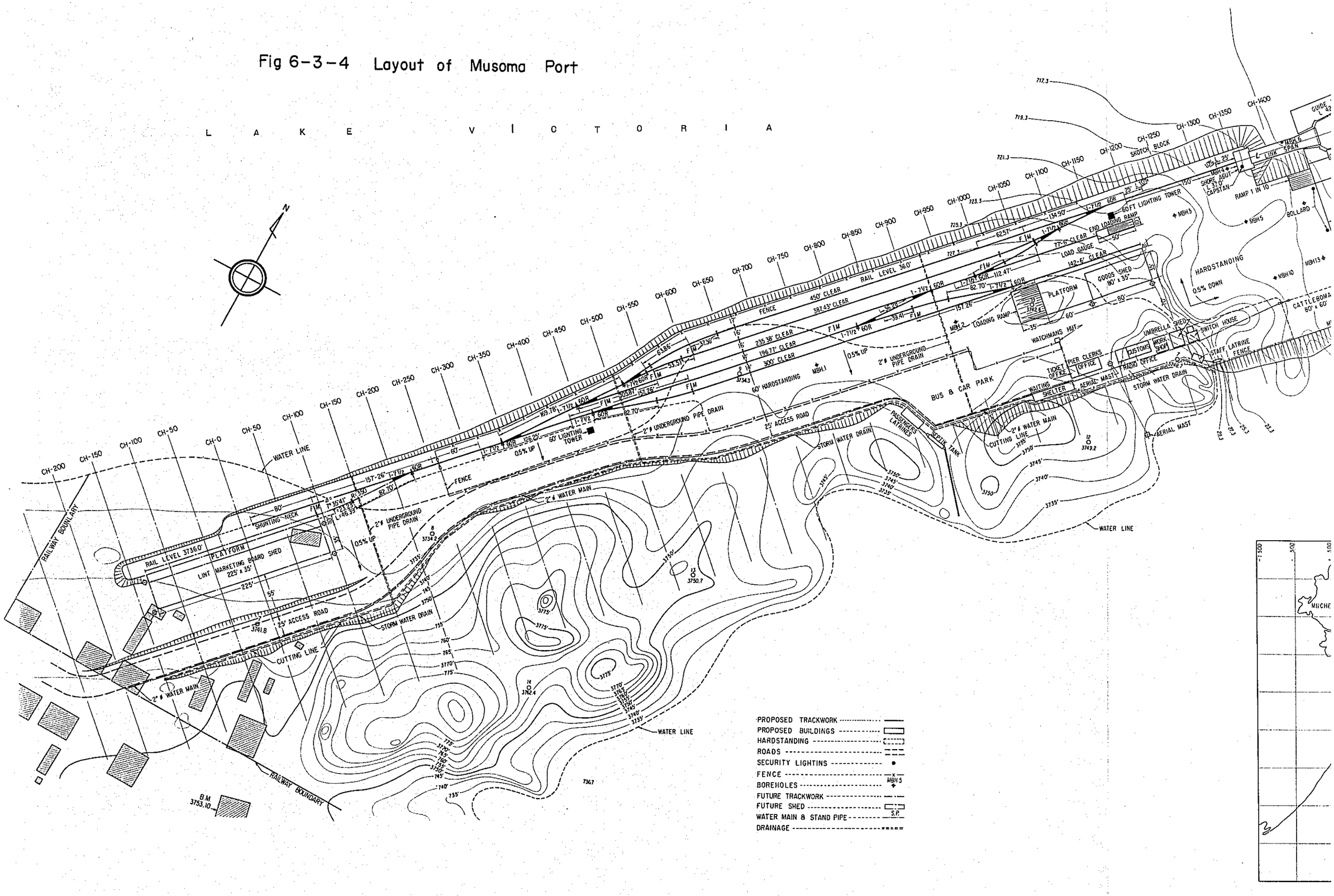
Table 6-3-11 Water Level of Lake Victoria

(Unit: Meter)

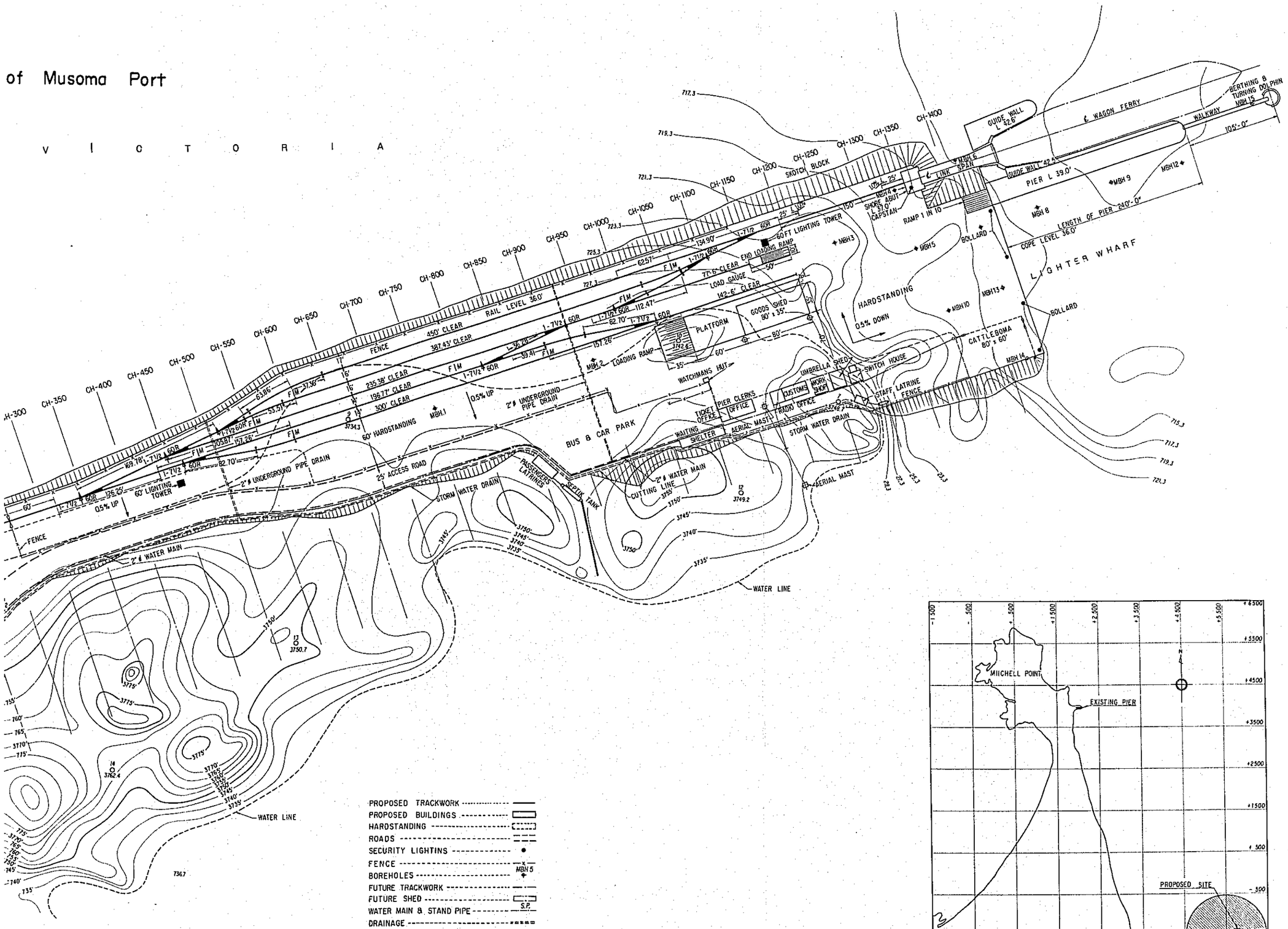
Year	HWL max.	LWL min.	Mean
1960	10.80	10.36	10.58
1961	11.44	10.27	10.86
1962	12.01	11.44	11.76
1963	12.53	11.86	12.20
1964	12.85	11.85	12.35
1965	12.40	11.78	12.09
1966	12.33	11.83	12.08
1967	11.90	11.54	11.72
1968	12.32	11.67	12.00
1969	12.44	11.84	12.14
1970	-	-	

The volume of cargoes handled at the coastal ports of Lake Victoria was 202,107 G/W metric tons in 1967, and 263,151 G/W metric tons in 1968. The number of passengers transported was approximately 320,000 persons in 1967 and about 365,000 persons in 1968. Since Port of Musoma began to provide perfect services from around the end of 1968, the abovementioned data are rather too old in view of the present condition. In 1968, Port of Kisumu handled 111,200 G/W metric tons, and Port of Mwanza 137,500 G/W metric tons. Of these, cargoes transported by ferries comprised 84,120 tons handled at Port of Kisumu, and 99,500 tons at Port of Mwanza. At Port of Jinja, 30,000 tons of cargo was transported by wagon ferry alone, and 37,000 tons in 1969. No data for Port of Musoma have been obtained, but it is supposed that this port is handling the same volume of cargoes as that handled at Port of Jinja by judgment of the frequency of the ferry services provided and the volume of cargoes handled at other ports. Fig. 6-3-4 gives the plan of Port of Musoma. Plans of other ports are given in the supplement of this report.

Fig 6-3-4 Layout of Musoma Port



of Musoma Port



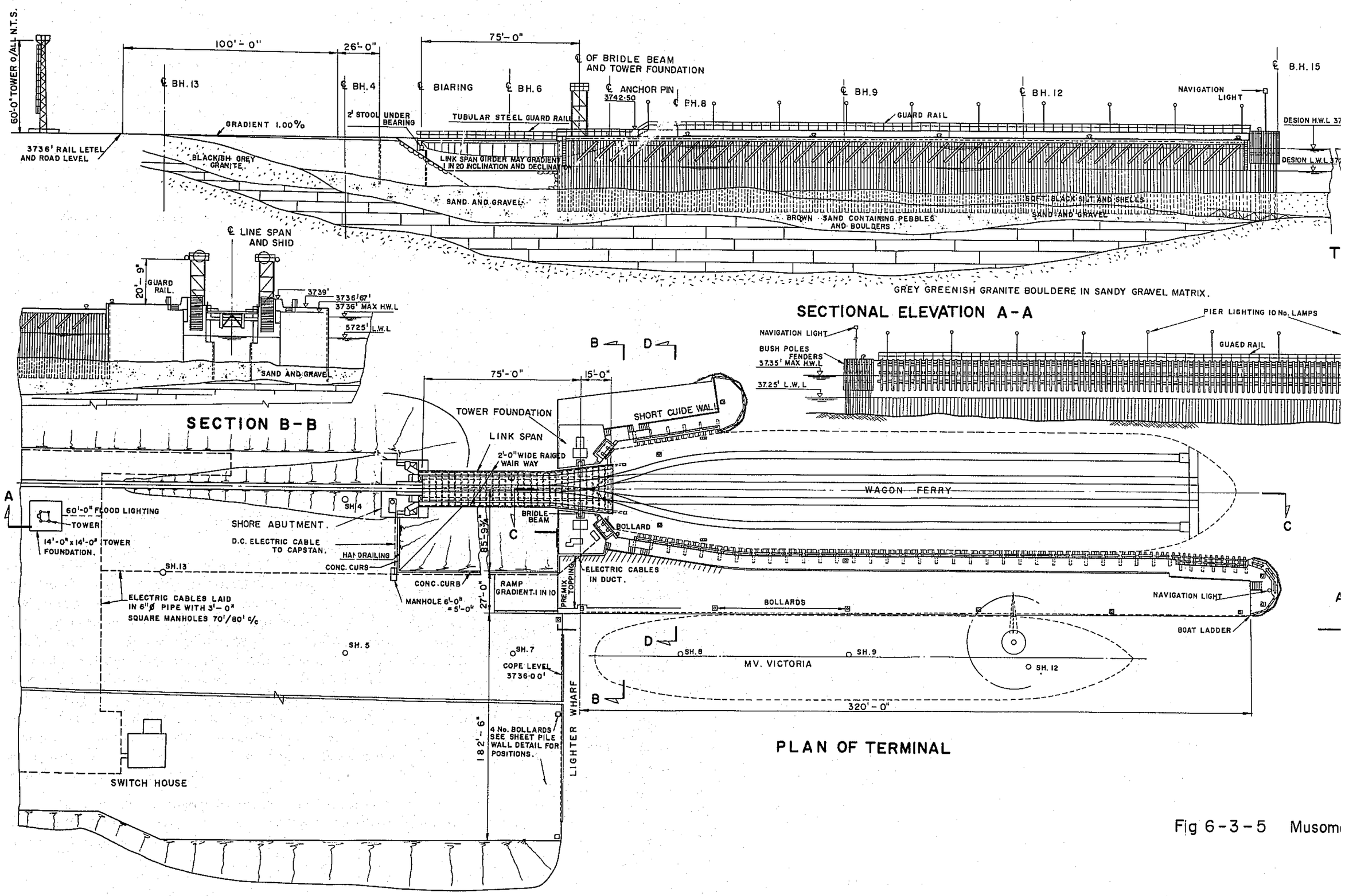


Fig 6-3-5 Musom

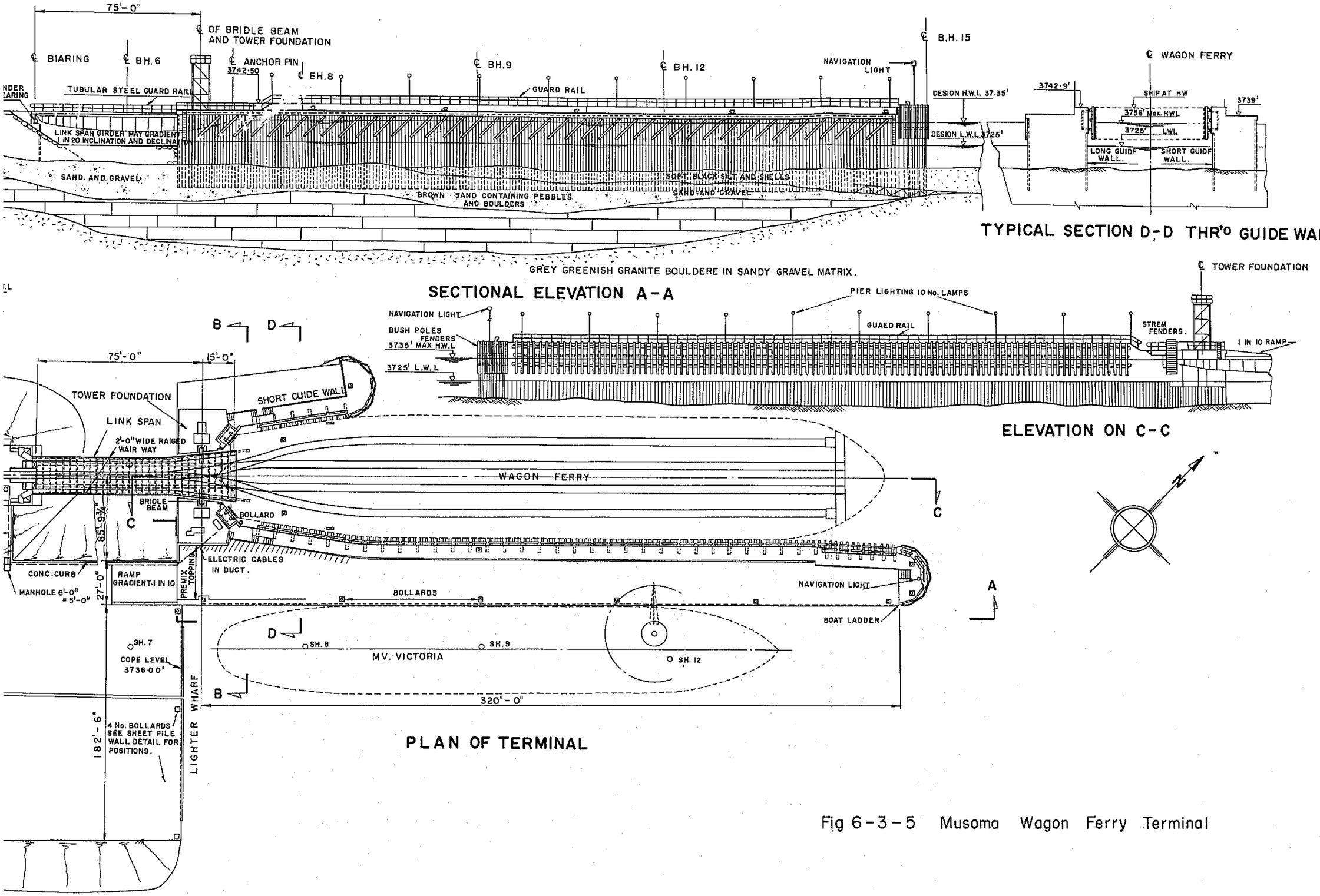


Fig 6-3-5 Musoma Wagon Ferry Terminal

6-4 Problems Relative to the Present Condition

The foreign trade ports of the three East African countries are four, and among them, Port of Mombasa in Kenya and Port of Dar es Salaam in Tanzania have deep water berths and railways connecting them to the hinterland. Figures 6-4-1 and 6-4-2 show the traffic density (railway and port) in the three East African countries in 1968 and 1969 respectively. Cargoes are concentrated on these two ports, and nearly 70% and 30% are concentrated on Port of Mombasa and Port of Dar es Salaam respectively.

Due to the abovementioned circumstances, the rate of utilization of the quay at Port of Mombasa rose to 94.3% in 1968 in comparson with 82.8% of the preceding year. The volume of cargoes handled at each berth increased from 144,000 tons of the preceding year to 166,000 tons in 1968. The rate of utilization of the quay at Port of Dar es Salaam increased from 96.6% to 98%. The volume of cargoes handled at each berth also increased from 181,000 tons to 185,000 tons. Although new data for the years after 1969 should be used, the recent field survey conducted has revealed that both ports are very crowded, particularly in Port of Dar es Salaam which has only three deep water berths, more than 10 ships appeared to have to wait in the offings until the berths are available. It is even said that some of these large-sized ships have to stay in the offings for more than ten days. To cope with the aggravating situation, a quay with 3 berths and a quay with 2 berths are now under construction at Port of Dar es Salaam and Port of Mombasa respectively. Both ports have the plan of constructing 2 container berths each in the near future.

As mentioned before, these ports are good natural ports, but the entrances of them are narrow and the water surfaces inside are not very large. Particularly, the water basin inside Dar es Salaam Port is small, and so it cannot be expected to expand the water surface inside it to a large extent.

With the growth of the world economy, the economy of the three East African countries has kept on growing smoothly ever since their independence, and along this trend their foreign trade is also expanding steadily. The volume of cargoes handled at the four ports for international trading in 1968 was approximately 8,000,000 tons, an increase of 550,000 tons over that of the preceding year. Fig. 6-4-3 shows the volume of cargoes handled at the four ports of the East African countries. Both the exports and the imports increased to almost double in a period of 6 years from 1962 to 1968. In view of the fact that most of the cargoes, both export and import, are being handled at Port of Mombasa and Port of Dar es Sallam as well as that the possibility of the future expansion of these two ports is limited, it would be necessary to consider the improvement of Port of Tanga as an alternate or a complimentary port of them separated from the construction of the railway between Arusha and Musoma.

According to the projects by the national Development Corporation of Tanzania, the top priority is given to Dar es Salaam, then Arusha, Moshi and Tanga areas. This is as shown in Fig. 6-4-4.

Fig 6-4-1 Traffic Density in 1968

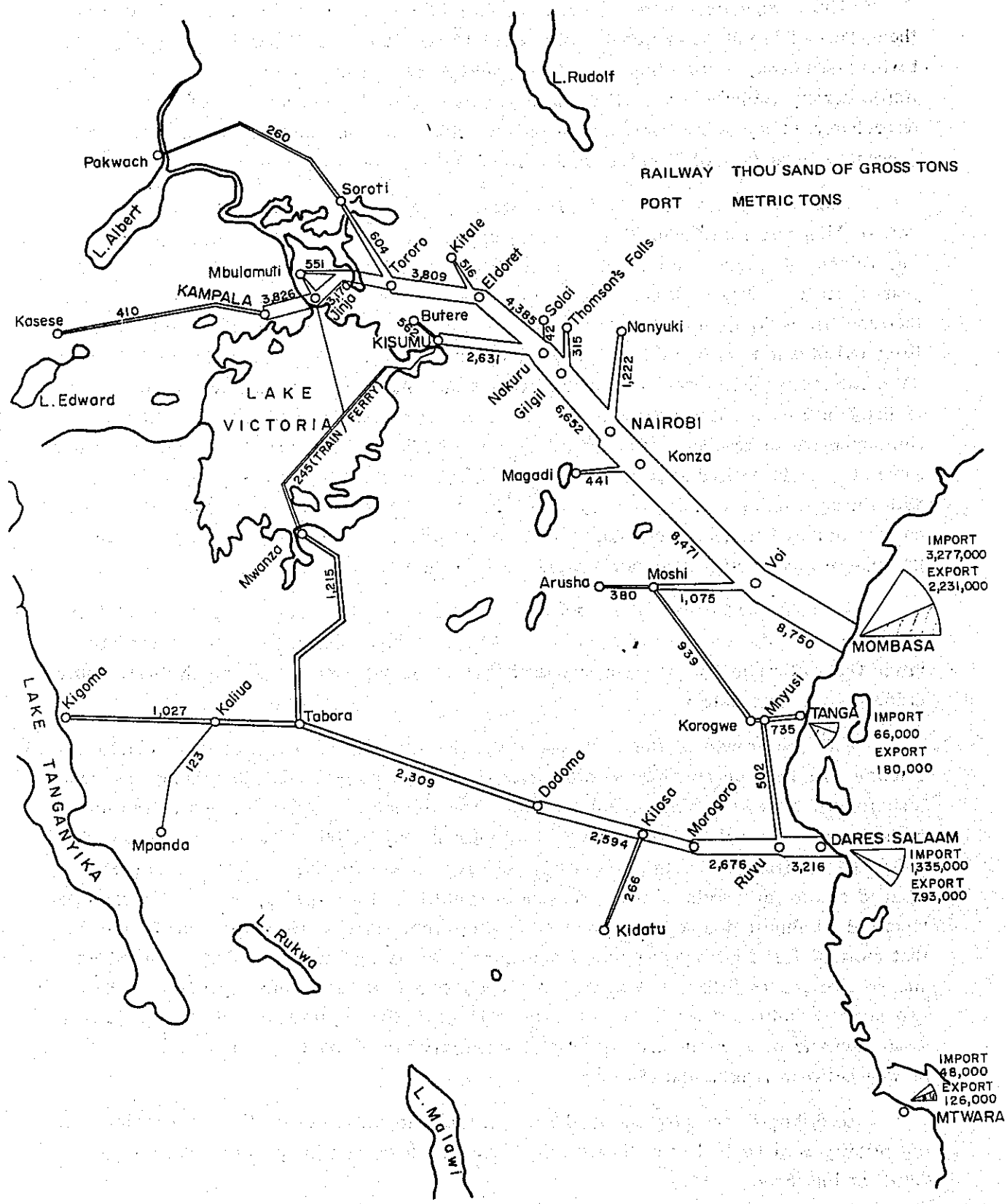


Fig 6-4-2 Traffic Density in 1969

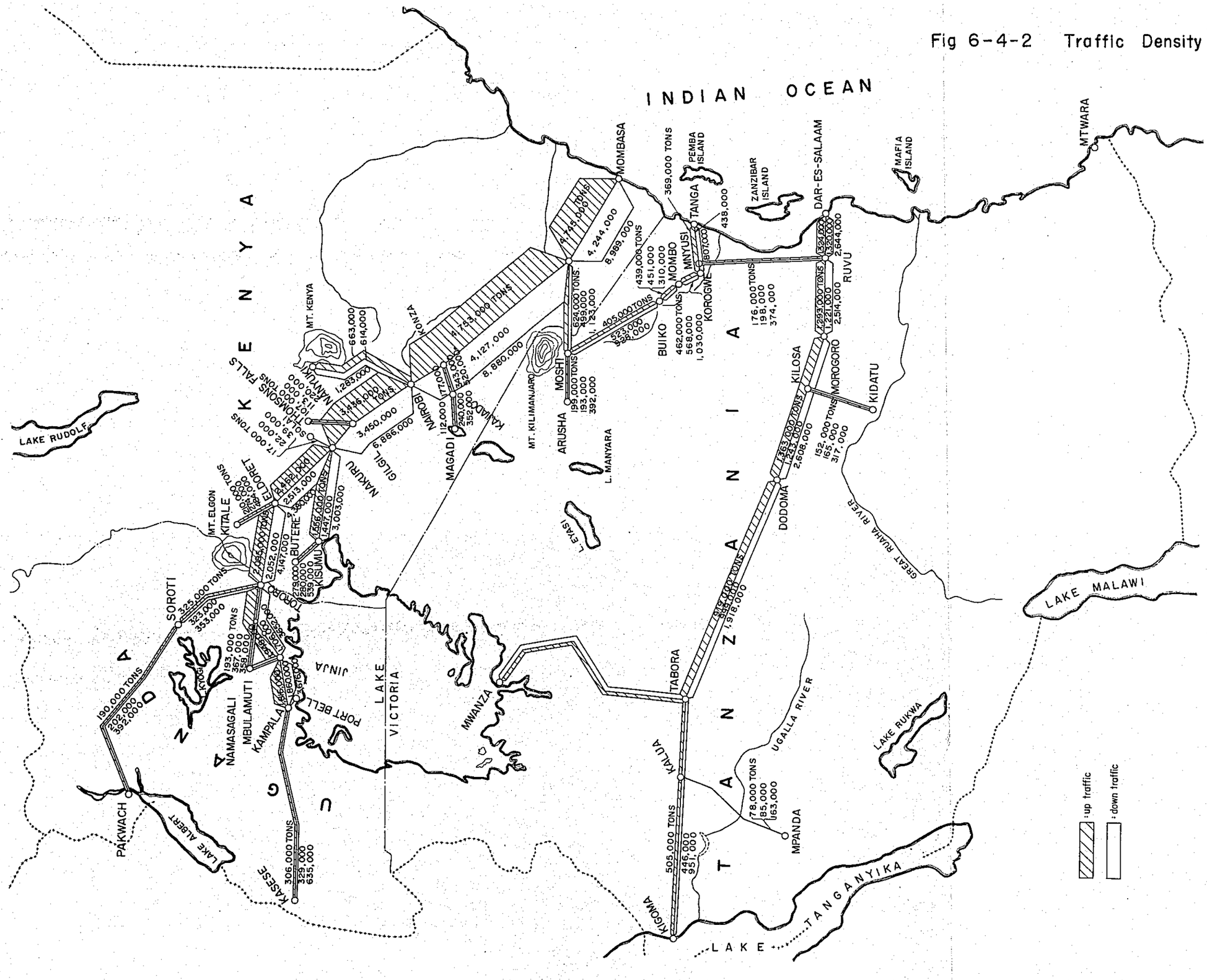
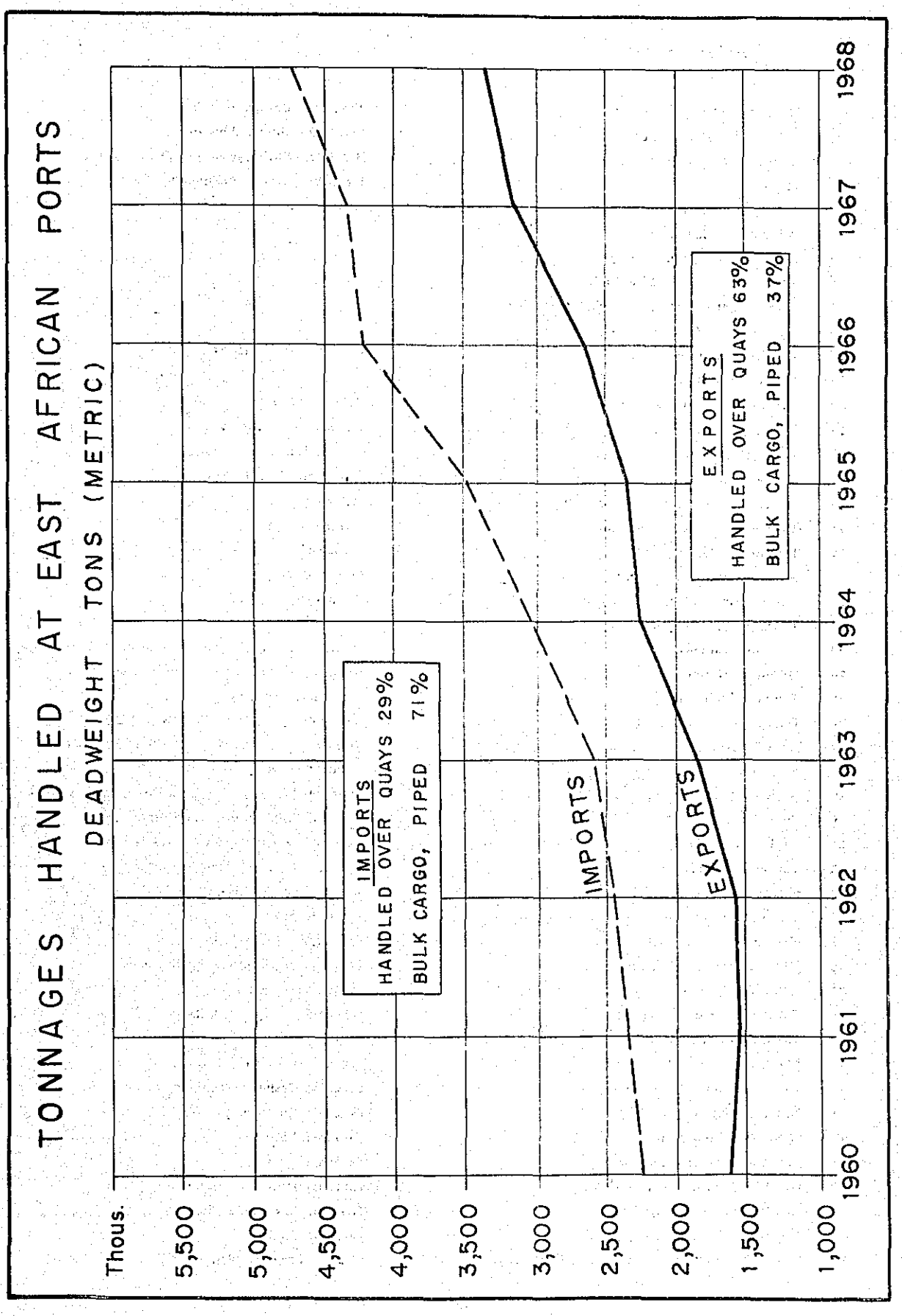


Fig 6-4-3


TONNAGES HANDLED AT EAST AFRICAN PORTS
DEADWEIGHT TONS (METRIC)
Thous.
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
1960
1961
1962
1963
1964
1965
1966
1967
1968
IMPORTS
HANDLED OVER QUAYS 29%
BULK CARGO, PIPED 71%
EXPORTS
HANDLED OVER QUAYS 63%
BULK CARGO, PIPED 37%

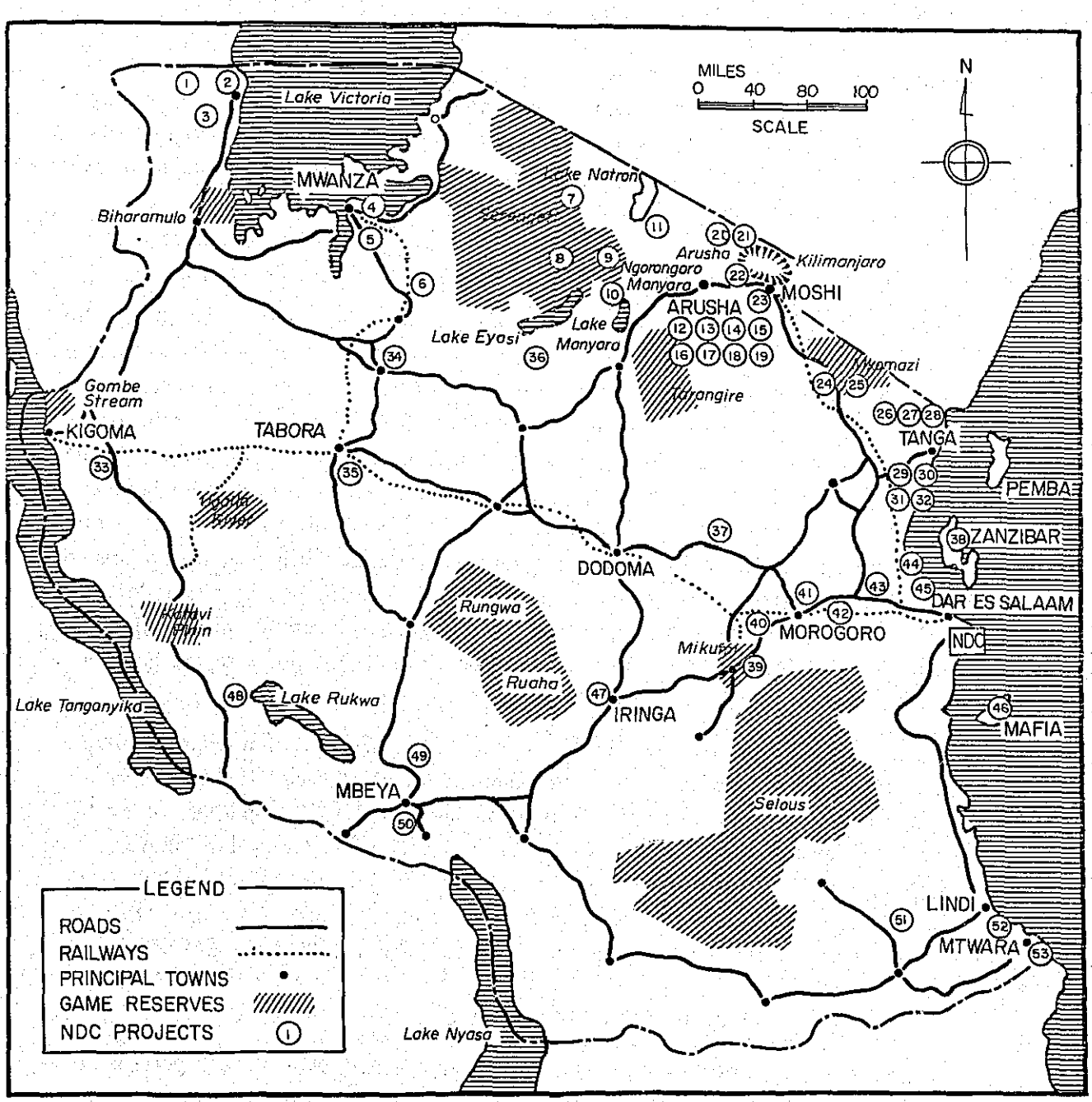
throughout Tanzania

1 N.A.C.O.–Kitengule Ranch
2 *Tanganyika Instant Coffee*
3 Bukoba Tea Company
4 Mwanza Hotel
5 Mwanza Textiles
6 Williamson Diamonds
7 S.S.L.–Lobo Wildlife Lodge
8 S.S.L.–Seronera Wildlife Lodge
9 S.S.L.–Ngorongoro Crater Wildlife Lodge
10 S.S.L.–Lake Manyara Hotel
11 T.M.C.–Bentonite Mine
12 Arusha Plantations
13 General Tyre East Africa
14 Kilimanjaro Breweries
15 *Tanganyika Extract*
16 Northern Dairies
17 *Tanganyika Meerschaum Corp. (T.M.C.)*
18 Tanzania Gemstone Industries
19 Tanzania Wildlife Safaris
20 N.A.C.O.–West Kilimanjaro Ranch
21 T.M.C.–Sinya Meerschaum Mine
22 Tanzania Bag Corporation
23 Tanzania Tanneries
24 Mkomazi Mining
25 Tembo Chipboards
26 Dindira Tea Estates
27 Ralli Estates
28 Kwamtili Cocoa Estates
29 National Steel Rolling Mill
30 *Sikh Sawmills*
31 Sisal Pulp Project
32 Tanzania Fertiliser
33 Nyanza Salt Mines
34 Kahama, Nzega, Igembasabo Co-operative Union
35 Tabora Msitu Products
36 N.A.C.O.–Basotu Wheat Scheme
37 N.A.C.O.–Kongwa Ranch
38 Furuha ya Visiwani Hotels
39 Mikumi Wildlife Lodge
40 N.A.C.O.–Mkata Ranch
41 Tanzania Tobacco Processing
42 N.A.C.O.–Ngerengere Ranch
43 *N.A.C.O.–Ruvu Ranch*
44 Tanzania Portland Cement
45 N.A.H.–Kunduchi Beach Hotel
46 N.A.H.–Mafia Fishing Lodge
47 Tanzania Diamond Cutting
48 N.A.C.O.–Sumbawanga Ranch and Abbatoir
49 N.A.C.O.–Usanga Ranch
50 *N.A.C.O.–Mbeya Abbatoir*
51 N.A.C.O.–Nachingwea Ranch
52 Lime Products Development
53 Mtwara Cashew

in Dar es Salaam

B.A.T. Tanzania
Blanket Manufacturers
Coastal Dairies
Friendship Textile Mill
Hallmark Hotels
Hilton Hotel
Industrial Promotion Services
I.P.S. Building
Kilimanjaro Hotels
Metal Box
Mwananchi Engineering & Contracting
Mwananchi Tractor & Vehicle Assemblers
Mwananchi Trading
National Agricultural Co. (N.A.C.O.)
National Co-operative & Development Bank
National Printing
National Property Development & Management
National Small Industries Corporation
New Africa Hotels, Ltd. (N.A.H.)
N.A.H.–The New Africa Hotel
Serengeti Safari Lodges (S.S.L.)
Sisi Enterprisers
Tanganyika Creameries
Tanganyika Development Finance
Tanganyika Packers
Tanganyika Tegry (Plastics)
Tanita
Tanzania Breweries
Tanzania Cashew Machines
Tanzania Elimu Supplies
Tanzania Film
Tanzania Finance
Tanzania Hotels Investments
Tanzania Publishing House
Tanzania Shoe
Ubungo Farm Implements

Fig 6-4-4 Project by N.D.C.



Upon materialization of the plan of construction of the railway between Arusha and Musoma, Port of Bukoba will emerge as the fifth port for inland waterways of the East African countries having the facilities of wagon ferry. This will further activate the coastal transportation of Lake Victoria, and will countribute much to the overall development of the Kilimanjaro area, as well as the development of Tanga, Moshi and Arusha areas including the industrial development of the Tanga area. At such time, the improvement of Port of Tanga as the main gate of the abovementioned hinterlands for the transport of products and consumer goods will become necessary.

The main causes which checked the growth in the volume of cargoes handled at Port of Tanga in the past 10 years could be mentioned as follows. The lack of the quay to accommodate large-sized ships, the decline of the Sisal production due to introduction of synthetic fibers, the closure of Sisal estates due to poor export and the subsequent decrease in the population of the Tanga area.

6-5 Plan of Improvement of Port of Tanga and Port of Musoma

It goes without saying that the plan of improvement of ports should be formed by keeping close relations with the economic activities and projects. However, as the economic turnover of the developing countries like the three East African countries is bewildering, it is difficult to make an accurate forecast of their economic development in a long term. This applies particularly to Port of Tanga, which though has not shown any growth in the volume of cargoes handled for the past ten years, has the sign of growing into a large cargo handling center in the future when the construction of the new railway will be materialized, the development of the Kilimanjaro area be promoted as well as the industrial development of Tanga, Moshi and Arusha areas be carried out. The same could be said about Port of Musoma, the improvement plan of which should be formed upon careful consideration of the influence of the new railway to be constructed and in combination with the improvement plan of other coastal ports of Lake Victoria.

As the survey of the ports conducted was an elementary one, it was not possible to make an economic forecast for the establishment of a port project. However, it is emphasized here that an economic survey should be carried out for the purpose of establishing the improvement plan of both ports of Tanga and Musoma taking the followings into consideration: Foreign trade, domestic trade, economic program of the three East African countries, regional development projects and the plan, of marine transportation on Lake Victoria at the time when the project of a new railway should have materialized.

6-5-1 Basic planning of the improvement of both ports

This article contains the outline of the improvement plan of both ports made in consideration of the transport volume of the new railway in 1980 as described in Chapter 2.

The viewpoints of the survey team and the conclusion of the survey report may be summarized as follows: Assuming that the new Arusha–Musoma railway had already been completed in 1967 and also taking into consideration the anticipated growth of domestic production of Tanzania as well as the growth of the transport volume which is expected to keep pace with the growth of domestic production, the volume of cargoes transported via regular routes, which would be handled at Tanga Station and Musoma Station in 1980, has been estimated at 303,000 tons and 86,000 tons respectively. It has been estimated that these figures will be increased to 1,669,000 tons and 1,425,000 tons respectively if the volume of cargoes transported correlatively between Mombasa and Uganda in addition to those transport via regular rutes, will be alteratively transported correlatively between Tanga and Uganda. The volume of cargoes handled at both stations of Tanga and Musoma may not be the same as those handled at Port of Tanga and Port of Musoma, judging by the direct relations between cargoes handled at the stations and ports of Tanga and Musoma the present facilities of both ports need not be improved in case of the cargo transport via the regular route. In case that the correlative cargo transport between Mombasa and Uganda is switched to that between Tanga and Uganda, it will become necessary for both ports to improve their facilities on a large scale.

6-5-2 The plan of improvement of port of Tanga

Fig. 6-5-1 shows the improvement plan formed on the assumption that the volume of cargoes handled at Port of Tanga has amounted to 1,669,000 tons per annum. Taking for granted that the existing freight space is capable of handling approximately 300,000 tons annually, 7 berths of the 10,000-ton class will be required to handle the aforementioned volume of cargoes. It may be noted that it is not necessary to construct all 7 berths at once but one by one at stages when the project of construction of a new railway is materialized. 2 berths of 10,000-ton quay will have to be constructed in view of the fact that Port of Tanga does not have deep water berths as well as that the arising trend that the cargoes will be concentrated on Port of Tanga in the near future subsequent to the industrial development of the Tanga, Arusha and Moshi areas. Moreover it would help relieve the traffic congestion at Port of Dar es Salaam and Port of Mombasa. It is estimated that the regular volume of cargoes handled at the 10,000-ton quay is 200,000 tons. Although it is necessary to plan for increased efficiency of cargo handling per berth at the ports of the developing countries, the greatly important is to limit the volume of cargoes for each berth to 100,000 tons or 120,000 tons and to increase the number of berths so that it will contribute to the reduction of transport cost by cutting down the waiting time of the ships in the offings. For this reason, the construction of 2 berths of 10,000-tons quay has been contemplated. The initial investment may be a big one according to this concept, but when we take a long-range view, the benefit from using the port most efficiently will be tremendous. The site for constructing 2 berths is shown by the portion marked with broad lines in Fig. 6-5-1, and it would be

most natural to utilize the coastline on the eastern side of the existing freight space. As there is a precipice of El 50 ft in the hinterland adjacent to the site, the soil of this precipice can be used for reclaiming land on which the seaside railway, roads, warehouses, sheds, open storage space and other port facilities are constructed. Fig. 6-5-1 gives the ground plans of 7 berths. The construction cost for land reclamation, dredging, quay, overland crane, sheds, seaside railway, etc. is approximately £8.4 million while that for the 2 berths for immediated need is approximately £2.4 million, Fig. 6-5-2 shows the standard cross section of a quay as a specimen.

6-5-3 The plan of improvement of port of Musoma

As already stated before, there are two ferries in service on Lake Victoria. One has the capacity of transporting 42 freight cars. Assuming that about 10 tons of cargo is loaded on a car, one ferry boat can transport 420 tons. If there is one ferry service each week, about 43,000 tons of cargo can be transported annually by making round-trips. In order to handle 1,425,000 tons of cargo at Port of Musoma each year, it is necessary to increase the ferry services to five times a day. To do this, 20 ferry boats and ferry stations will be required. Without excepting, it is again necessary that the plan of improvement of Port of Musoma should keep good balance with the plan of improvement of other ports on Lake Victoria. For this purpose, a general survey concerning marine transportation will become necessary in consideration of its relations with the plan of marine transportation of Lake Victoria. Consequently, it will be more than sufficient to carry out a feasibility study for the improvement of Port of Musoma in the future. Though no improvement is required under the present circumstances.

The above is an outline of the plan of improvement of Port of Tanga and Port of Musoma. It points out the urgency in the construction of 2 berths of 10,000-tons quay at Port of Tanga.

Supplement: Plans of Port of Entebe, Port of Bell and Port of Musoma Port on Lake Victoria.

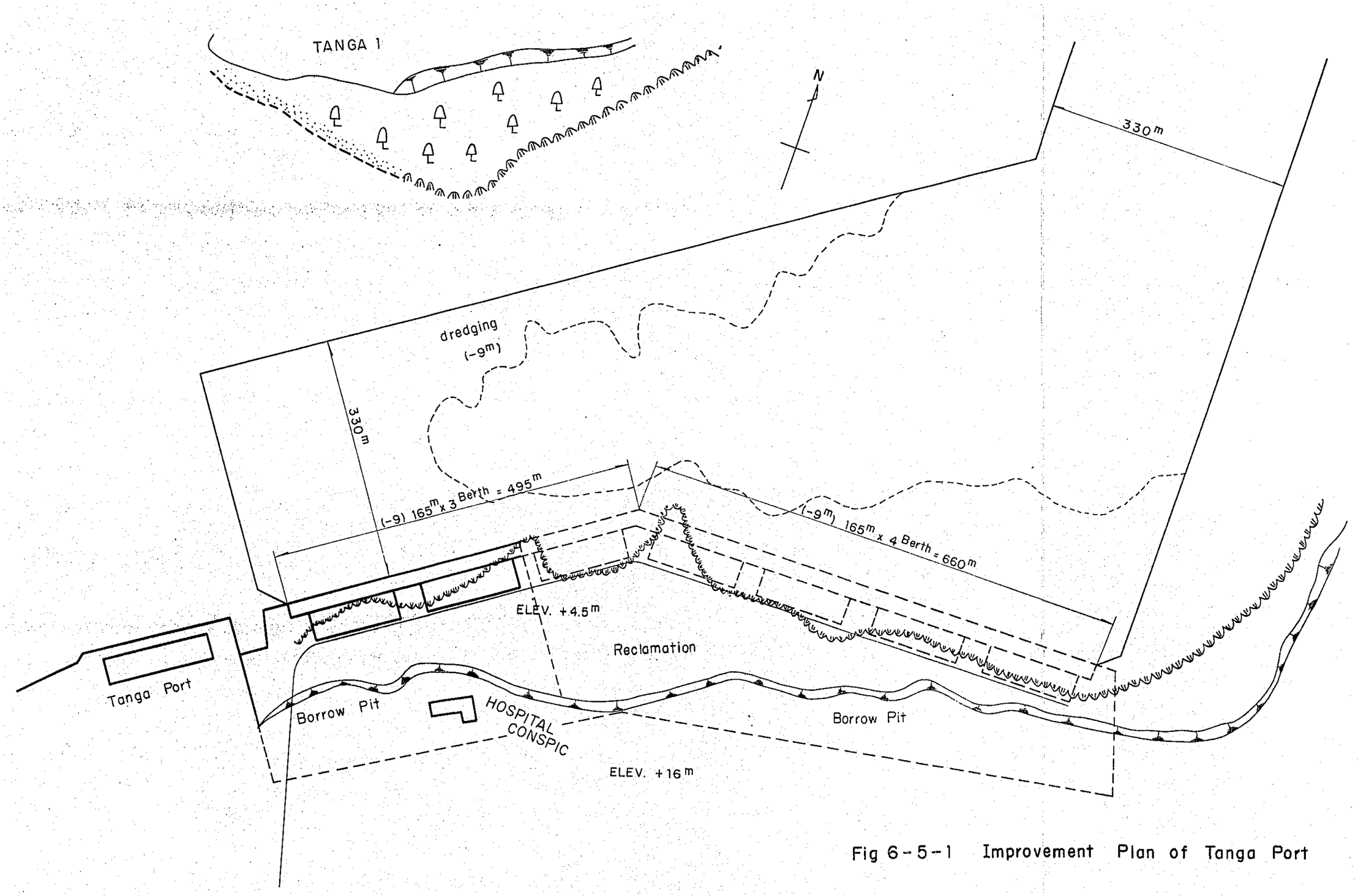
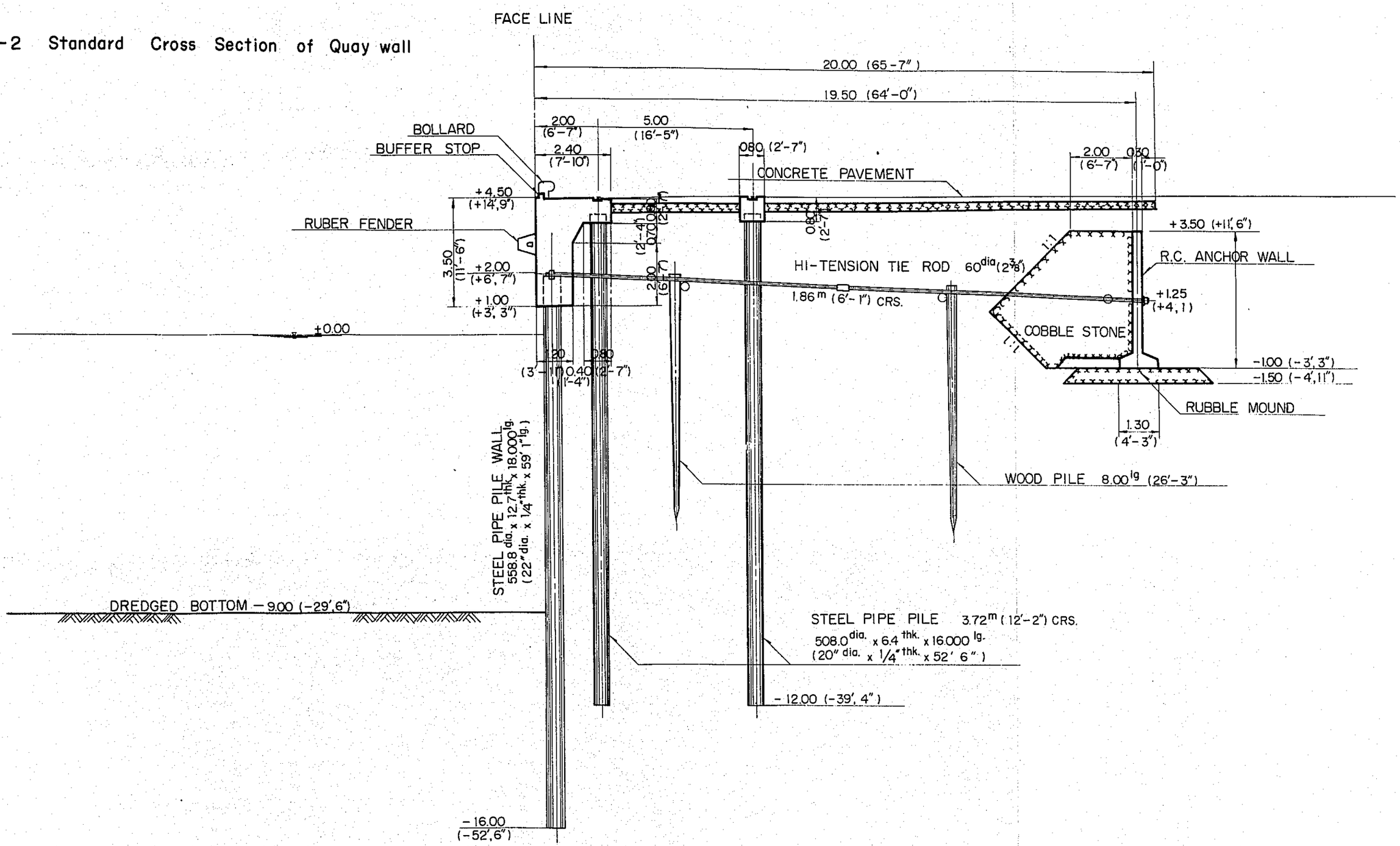


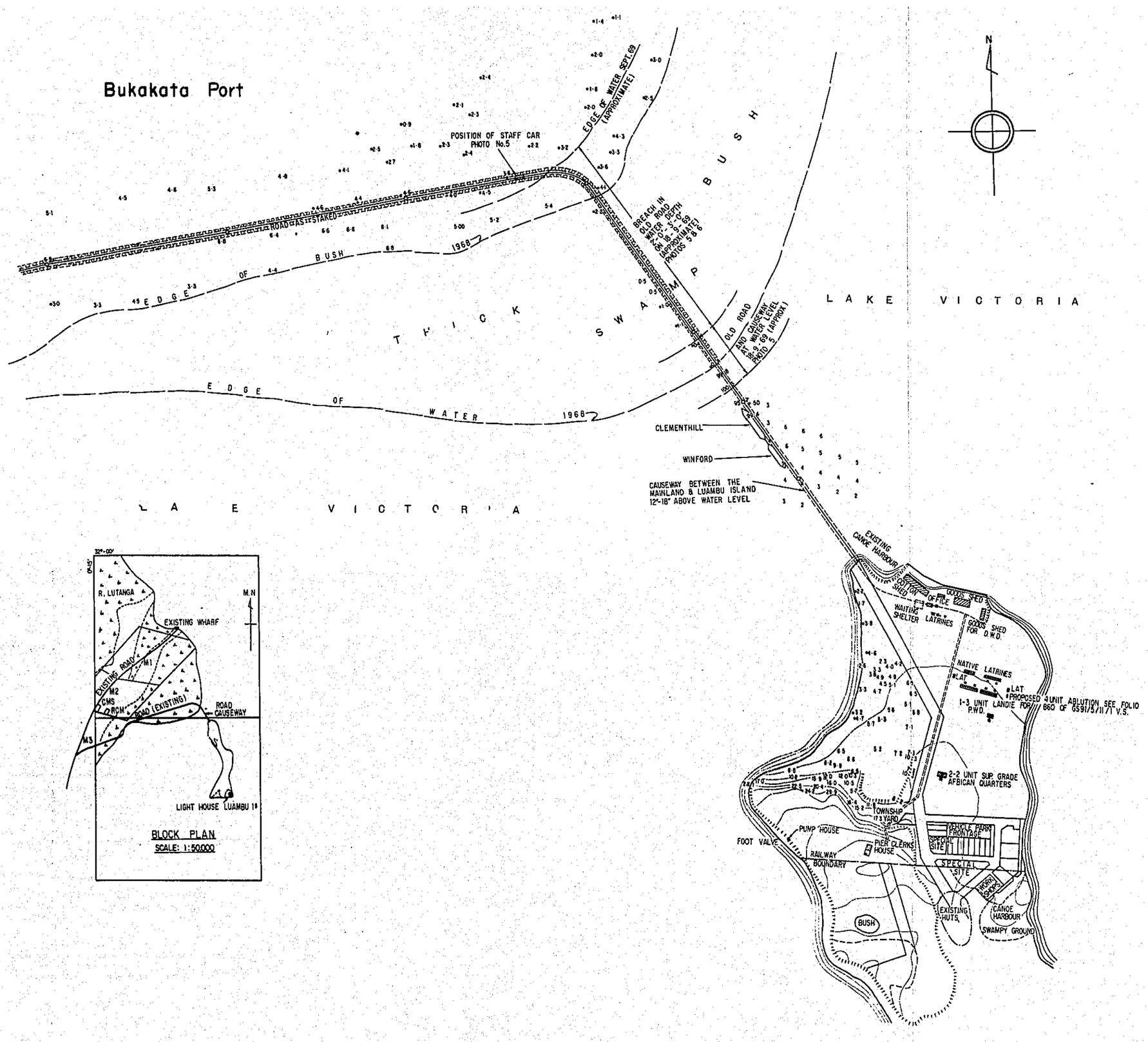
Fig 6-5-1 Improvement Plan of Tanga Port

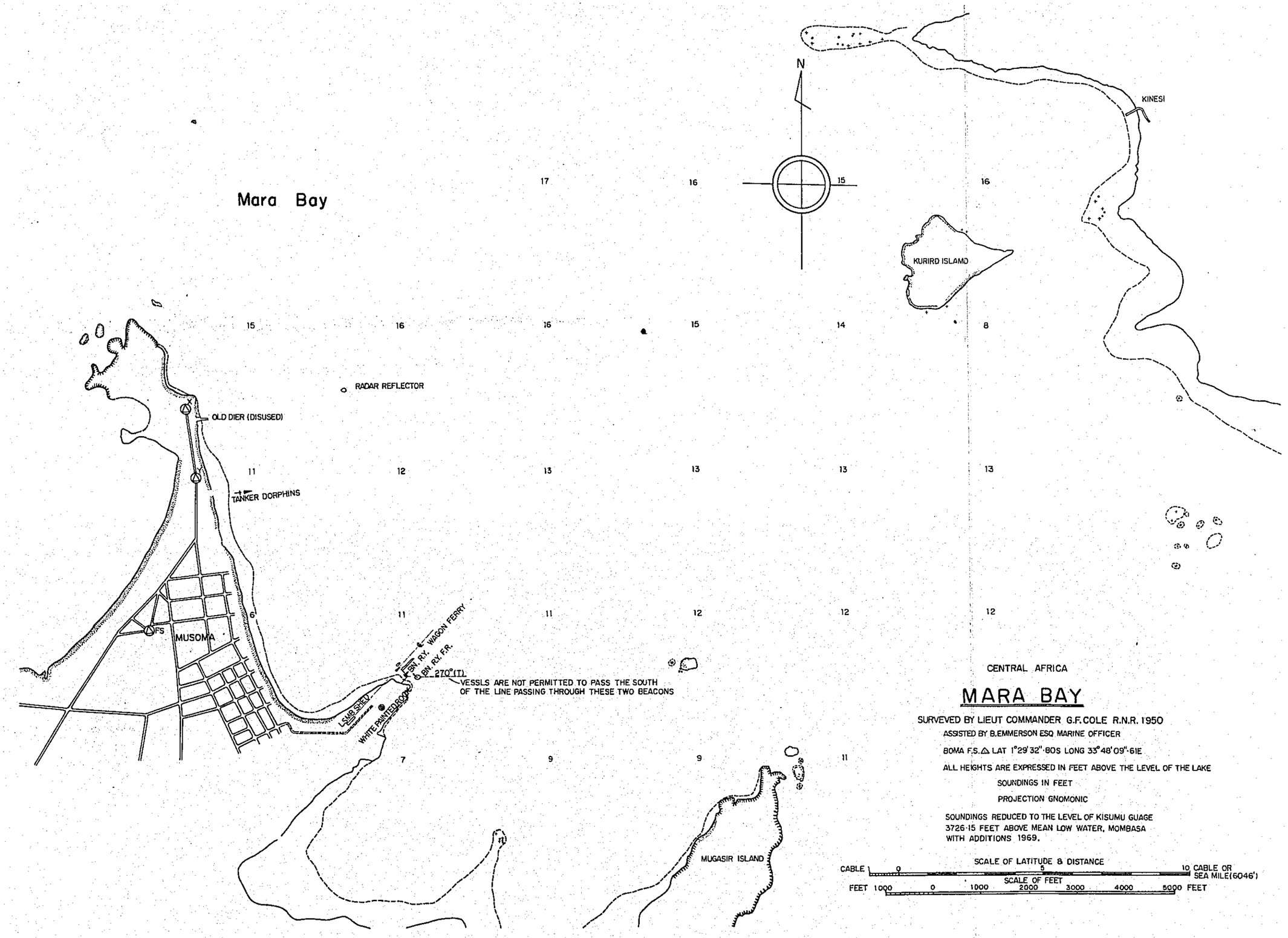
Fig 6-5-2 Standard Cross Section of Quay wall



SECTION OF WHARF

Bukakata Port





CENTRAL AFRICA

MARA BAY

SURVEVED BY LIEUT COMMANDER G.F.COLE R.N.R. 1950

ASSISTED BY B.EMMERSON ESQ MARINE OFFICER

BOMA F.S. △ LAT 1°29'32"·80S LONG 33°48'09"·61E

ALL HEIGHTS ARE EXPRESSED IN FEET ABOVE THE LEVEL OF THE LAKE

SOUNDINGS IN FEET

PROJECTION GNOMONIC

SOUNDINGS REDUCED TO THE LEVEL OF KISUMU GUAGE
3726·15 FEET ABOVE MEAN LOW WATER, MOMBASA
WITH ADDITIONS 1969.

SCALE OF LATITUDE & DISTANCE

CABLE 0 5 10 CABLE OR SEA MILE(6046')

SCALE OF FEET

FEET 1000 0 1000 2000 3000 4000 5000 FEET

Jinja Wagon Ferry Terminal