Data 7

Supporting Data for the Environmental Impact Assessment

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1 Introduction

1.1 General

This Annex contains the measurement, survey and data collection works required, according to the technical specifications in the Terms of Reference (see Appendix 4) for the Environmental Impact Assessment (EIA) of the proposed sanitary landfill site at Kunduchi New MECCO quarry (referred to as the study).

These works were conducted as part of the "Study on the Solid Waste Management for Dar es Salaam (DSM) City in the United Republic of Tanzania". Specifically, they form part of the Feasibility Study of the first priority project identified in the Master Plan and are a follow-up to the Initial Environmental Examination (IEE), conducted by the JICA Study Team between June - September, 1996.

These works were conducted by the Department of Environmental Engineering of the University College of Lands and Architectural Studies (UCLAS) of DSM, from January - March 1997.

The study area of these works covers the Kunduchi New MECCO quarry site and its environs and the New Bagamoyo Road from the Kunduchi New MECCO quarry site to the intersection with the Sam Nujoma Road. The main survey sites were in the Kunduchi New MECCO quarry site and its environs as well as at one point along New Bagamoyo Road, 150 metres north of the intersection with Sam Nujoma Road.

1.2 Location and Background of the Study Area

The proposed landfill site is located along New Bagamoyo Road, approximately 19.3 km north of the city centre of DSM, near the village of Mtongani. The site comprises an area of approximately 30 ha. with an original ground elevation of 50 - 65 m above sea level. The land is owned by the government and is under the control of the Ministry of Energy and Minerals who has leased most of the mining rights to MECCO while some rights have also been leased to National Service, MALI Ltd., and TSSQ.

MECCO continues to operate a crushing plant on the site, although these activities are at a low level. This is because a substantial part of the site is already exhausted, having been excavated for coralline limestone down to bottom levels of 43 - 48 m above sea level. Some manual quarrying operations are also being conducted at various parts of the site by independent individuals.

1.3 Measurement, Survey and Data Collection Works

The measurement, survey and data collection works conducted in the study, according to the chronological order in which they are presented in this Annex, are as follows:

- Topographical survey and mapping of the whole area of Kunduchi New MECCO quarry site and its environs, covering an area of approximately 50 hectares.
- Geological survey of the quarry site and investigation of borrow soil sites.
- Hydrological survey.

- Water use survey.
- Water quality survey.
- Soil contamination survey.
- Traffic volume survey.
- Noise level survey.
- Vibration level survey.
- Air quality survey.
- Land use survey.
- Flora and fauna survey.
- Public health survey.
- Economic survey.
- Meteorological data.

1.4 Methodology and Approach

The methodologies and approaches used in the study include:

- Site investigations and surveys.
- Interviews.
- Laboratory analysis.
- Review of available literature.

Detailed information on the methodologies and approaches used is set out under respective study components.

2 Topographical Survey

The work carried out for the topographical survey, including the topographical survey map, is presented here while the topography itself is discussed in the final report.

The whole survey work was based on control points established on the site. Two base points were established using the resection method based on three trigonometric points visible from the site. The three trig points used were the Light House, TP10 (Radio Tanzania Dar es Salaam - RTD) and TP15 (Wazo Hill). The co-ordinates of these points are stated in terms of the UTM co-ordinate system in Table 2-1.

Table 2-1: Trigonometric points used in resection

	N(n)	E(n)	H(m)
Lighthouse	9249662.33	537150.67	-
TP 10	925965.44	519977.22	140.43
TP 15	9263378.31	518621.15	123.62

The topographical map is shown in Figure 2-1. The scale is 1:2000, contour interval is 1.0 m and measurements are in metric units, in accordance with the technical specifications. Existing terrain features such as houses, roads, drainage, river banks, wells, electricity, telephone poles and other less prominent features are also shown.

Processing of the data was carried out using "SDR Map" software which is compatible with the instrumentation used. The final output was through a plotter (in analogue form) and a DXF file (in digital form) and can be exchanged with other software (Autocad, Ilwis, ArcInfo etc.).

LEGEND

- Supply Roads (Temporary)
- 49 — Spot Height (with elevation)
- LP — Lamp Post
- Buildings
- Tree
- BH2 49.3 — Bore Hole (with elevation value)
- TP — Telephone Post
- EP — Electricity Supply Post
- 50 — Contour Line (VI = 1 m)

Title	Present Topographical Conditions and Location of Boreholes
Drawing No. Figure 2-1	The Study on The Solid Waste Management for Dar es Salaam City
Date July 1997	Japan International Cooperation Agency (JICA) Kokusai Kogyo Co., Ltd.

3 Geological Survey

3.1 Borehole Investigations

A total of twelve boreholes were drilled within the study area for the purpose of investigating the geological and hydrological conditions, particularly beneath the bottom of the proposed landfill site. Nine of these boreholes were drilled within the site and are indicated on Figure 2-1 (BH1, BH2, BH3, BH4, BH5, BH6, BH7, BH8 and BH10). These boreholes were surveyed as part of the topographical survey and their location co-ordinates, height (ground level at top of borehole) and drilled depth are set out in Table 3-2.

Table 3-2: Borehole locations

Description	Northing	Easting	Height (m a.m.s.l.)	Depth (m)
BH 1	9261146.700	521899.887	47.186	15.0
BH 2	9261090.286	522039.822	48.136	3.5
BH 3	9261119.925	521613.171	45.087	15.0
BH 4	9261367.910	521733.353	49.970	3.0
BH 5	9261340.859	521524.622	44.501	6.4
BH 6	9261310.530	521748.828	43.603	1.3
BH 7	9261312.217	521916.123	50.941	5.6
BH 8	9261469.734	521901.402	50.084	6.2
BH 10	9261395.949	521989.599	51.405	15.1

The remaining three boreholes (BH11, BH12 and BH13) were drilled to depths of 4.0, 5.5 and 9.2 m respectively outside of the landfill site but within the study area as explained further in section 4 where the hydrological results are presented.

The total depth of drilling was 90 metres; 71.3 metres within the proposed landfill site and 18.7 metres outside. The drilling depth of the boreholes varied, depending on the geological conditions for each particular borehole, as indicated in Table 3-2.

The soil characteristics of 18 samples taken from the drilled boreholes is presented in summary form in Table 3-5. The detailed soil characteristics (Atterberg limits and graphic borehole records) are found in Appendices 1 and 2 of this Annex.

3.2 Clay Borrow Sites

Three sites were investigated as possible borrow areas for clay which could be used for the construction of a bottom liner for the proposed landfill. These were:

- The surroundings of the proposed landfill site at Kunduchi.
- A site at Kinzudi, located approximately 10 km from the proposed landfill site.
- A site at Pugu located approximately 45 km from the proposed landfill site.

One of the most important factors to consider in selecting an appropriate type of clay for use in the construction of a clay bottom liner is that the clay should have a suitably low coefficient of permeability. Maximum permitted values of the coefficient of permeability

vary between countries. For example, the maximum values in Japan and Denmark are 10^{-7} and 10^{-10} m/s respectively while Tchobanoglous et al states a value of 10^{-8} m/s[1]. In this study, the very strict Danish standard is adopted. Ideally, the permeability should be measured in the field as the field value of the permeability coefficient is usually larger than the laboratory determined value, often by a factor of 2^2. In these investigations, all permeability determinations were made in the laboratory and hence the actual field permeability should be larger than the stated values.

3.2.1 The Surroundings of Kunduchi Landfill Site

Within the quarry site itself, patches of sandy clay were found at depths of 4 to 6 m in some of the boreholes drilled in this study. These clay formations were thin (0.5 m) and were found not to comprise a continuous series that could be utilised for the construction of a clay liner.

In the surroundings of the landfill site, clay was found in the valley west of the site and in a relatively small swampy area immediately south of the landfill site. These clay formations were found to be too small for utilisation for the construction of a clay liner. Furthermore, they are located on land that is used for agriculture.

Samples of clay were taken from the two boreholes (BH11 and BH12), 5 metres deep, drilled in the valley west of the site and were analysed in the laboratory. The complete results are set out in Table 3-5 while the main results are summarised in Table 3-1.

Table 3-1: Analysis of Clay from the Valley west of the proposed Landfill Site

Borehole	Clay content (%)	Permeability coefficient (m/s)	Natural moisture content (%)
11	17.5	2.0×10^{-10}	10.4
12	20.0	1.7×10^{-5}	14.4

3.2.2 The Site at Kinzudi

The site at Kinzudi was previously investigated by Kisarawe Brick Factory for the occurrence of clay that could be used for the manufacturing of bricks. Furthermore, geotechnical investigations have previously been carried out for the site to gather field data for its evaluation as a possible landfill site.

Two boreholes, 5 metres deep, were drilled on the site and samples from clay formations were analysed in the laboratory. The complete results are set out in Table 3-6 while the main results are summarised in Table 3-2 below. The permeability coefficients of both clay samples are not satisfactory, being larger than 10^{-10} m/s.

[1] "Integrated Solid Waste Management"; Tchobanoglous et al.; McGraw-Hill Inc.; 1993; pg 432
[2] "Foundation Analysis and Design"; J.E. Bowles; 5th edition; McGraw-hill Inc.; 1996; pg 53

Table 3-2: Analysis of clay from the Kinzudi site

Borehole	Clay content (%)	Permeability coefficient (m/s)	Natural moisture content (%)
TP 1	≈ 0%	3.3×10^{-9}	5.4
TP 2	12%	4.2×10^{-7}	6.1

3.2.3 The Site at Pugu

The site at Pugu is used by Kisarawe Brick Factory as a borrow pit for clay for the manufacture of bricks. Large formations of two types of clay are found in this area: red clay within the compound of Kisarawe Brick Factory (KBF) and bentonite (grey) clay found at Mwambisi (part of KBF). Samples of each type of clay were taken and analysed in the laboratory. The complete results are set out in Table 3-6 and summarised in Table 3-3.

Table 3-3: Analysis of clay from the Pugu site

Clay sample	Clay content (%)	Permeability coefficient (m/s)	Natural moisture content (%)
Red clay	12.5	2.5×10^{-6}	6.6
Bentonite (grey) clay	36.0	2.4×10^{-11}	9.2

Of the two clay samples, the permeability coefficient of the bentonite (grey) clay is satisfactory, being less than 10^{-10} m/s. When properly moistened the clay is highly plastic but is also expected to be very sensitive to traffic and compaction, especially vibration.

It was suggested that the bentonite clay could be used for the construction of a liner for the Kunduchi landfill. Therefore, further laboratory tests were undertaken to investigate the permeability of mixtures of the bentonite clay and sand excavated from the bottom of the New MECCO quarry. Four samples of mixed sand/bentonite clay were prepared as set out below:

- 25% bentonite clay and 75% sand (by weight).
- 40% bentonite clay and 60% sand (by weight).
- 60% bentonite clay and 40% sand (by weight).
- 75% bentonite clay and 25% sand (by weight).

The permeability of each sample was measured after remoulding the mixture using the maximum dry density and optimum moisture content, as determined by the Proctor Test. The permeability results are shown in Table 3-4.

Table 3-4: Coefficient of Permeability Results for Bentonite Clay/Sand Mixtures

Sample	Optimum moisture content (%)	Permeability coefficient (m/s)
25% bentonite clay	15.6	2.0×10^{-10}
40% bentonite clay	17.0	1.6×10^{-11}
60% bentonite clay	25.0	1.8×10^{-10}
75% bentonite clay	28.0	0.9×10^{-10}

The permeability coefficients of all bentonite clay/sand mixtures was found to be satisfactory, being less than or equal to 2×10^{-10} m/s. Thus a bentonite clay/sand mixture with clay content as low as 25% could possibly be used for the construction of a bottom liner.

Table 3-5: Summary of soil test results for New MECCO Quarry site at Kunduchi.

Depth (m)	LAB:	B/H	S/No.	LABORATORY SOIL DESCRIPTION	N.M.C.	Sieve Analysis					Atterberg Limits			Bulk density gm/m³	Specific Gravity	Permeability (m/s)
						Clay	Silt	Silt+Clay	Sand	Gravel	L.L. (%)	P.L. (%)	P.I. (%)			
1.25 - 3.46	924	1	6	Greyish Sandy SILT CLAY of high plasticity.	26.03	22.0	59.0		18.0	1.0	83.20	42.80	40.40	1.851	2.625	3.72×10^{-10}
7.16 - 12.50	936	1	18	Yellowish clayey silty SAND slightly plastic.	26.50	sample not enough		13.0	84.0	3.0	46.70	20.78	25.92	1.766	2.645	2.523×10^{-5}
14.7 - 15.04	940C	1	24	Yellowish grey silty sandy clay of medium plasticity.	12.65	16.0	29.0		53.0	2.0	53.40	24.62	28.78	1.780	2.645	1.463×10^{-7}
3.00 - 3.51	945	2	5	Yellow clayey silty SAND of medium plasticity.	9.95	9.0	17.0		71.0	3.0	48.1	23.85	24.25	1.808	2.60	1.692×10^{-5}
3.10 - 4.83	950	3	4	Grey sandy silty CLAY of medium to high plasticity	18.59	17.5	34.5		46.5	1.5	77.1	26.96	50.14	1.747	2.64	3.758×10^{-8}
9.44 - 10.94	953C	3	4	Grey with yellow sandy silty CLAY of medium plasticity.	10.62	4.0	37.0		57.5	1.5	45.80	20.79	25.01	1.776	2.64	1.926×10^{-9}
13.00 - 15.00	982	3	14	Whitish/Pinkish Grey clayey silty SAND of low to medium plasticity.	9.08	4.5	9.5		83.0	3.0	46.4	23.5	22.9	1.805	2.66	3.616×10^{-6}
2.95 - 3.07	957	4	6	White limestone rock	8.20	1.5	1.5		85.0	3.0	27.15	9.70	17.45	1.895	2.69	1.698×10^{-5}
2.58 - 2.77	964	5	4	Yellowish grey clayey silty SAND of low to medium plasticity.	14.47	12.0	26.0		58.0	4.0	39.60	17.76	21.84	1.678	2.53	2.35×10^{-6}
0.65 - 1.15	975	6	3	Yellow silty SAND of non plasticity with broken stone.	8.03	3.0	9.0		71.0	17.0	sample not enough			1.875	2.68	2.550×10^{-5}
2.90 - 3.06	985	7	6	Yellowish brown sandy silty CLAY of high plasticity.	31.72	31.5	19.5		46.0	3.0	sample not enough			1.707	2.62	2.041×10^{-11}
0.40 - 1.50	992	8	3	Yellowish grey clayey silty SAND of low to medium plasticity.	21.62	1.5	27.5		67.0	4.0	44.60	21.14	23.46	1.582	2.56	2.379×10^{-10}
1.50 - 6.20	996	8	7	Light grey/Grey clayey silty SAND of low to medium plasticity	10.36	3.0	18.0		76.0	3.0	37.1	15.70	21.40	1.730	2.60	1.051×10^{-5}
2.75 - 3.65	1002	10	4	Greyish Yellow sandy silty CLAY of medium to high plasticity	21.95	20.0	57.0		22.0	1.0	68.00	29.33	38.67	1.841	2.62	1.319×10^{-10}
7.40 - 9.18	1008	10	10	Grey clayey silty SAND of low plasticity.	15.53	10.0	21.5		67.5	1.0	54.40	28.29	26.11	1.726	2.66	3.5×10^{-9}
3.70 - 4.00	1014	11	5	Brownish silty clayey SAND of high plasticity.	10.39	17.5	11.5		70.0	1.0	52.90	21.49	31.41	1.621	2.58	1.997×10^{-10}
1.66 - 2.86	1021	12	4	Grey with yellow patches silty clayey SAND of medium plasticity.	14.34	20.0	13.0		66.0	1.0	45.20	15.87	29.33	1.870	2.58	1.694×10^{-6}
1.40 - 2.40	1028	13	4	Dark grey clayey silty SAND of high plasticity.	64.52	18.0	24.0		8.0	0.0	84.90	24.62	60.28	1.680	2.71	4.391×10^{-10}

Table 3-6: Summary of soil test results from proposed borrow areas

Depth (m)	LAB:	B/H	S/No.	LABORATORY SOIL DESCRIPTION	N.M.C.	Sieve Analysis					Atterberg Limits			Bulk density gm/m³	Specific Gravity	Permeability (cm/sec)	Compaction parameter	
						Clay	Silt	Silt+ Clay	Sand	Gravel	L.L. (%)	D.L. (%)	P.I. (%)				MDD gm/m³	OMC (%)
	1032	Mwambisi Brick Factory (Pugu)		Grey sandy clayey SILT of high plasticity (bentonite clay).	19.61	27.5	55.5		17.0	0.0	84.5	39.48	45.02	1.860	2.743	7.485×10^{-11}		
	1034			Grey sandy clayey SILT of high plasticity.	9.24	36.0	51.0		13.0	0.0	91.60	37.23	54.37	1.890	2.695	2.357×10^{-11}	1.455	28.50
	10.33	Kisarawe Brick Factory (Pugu)		Red clayey silty SAND of medium plasticity.	6.57	12.5	20.5		66.0	1.0	34.00	18.39	15.61	1.660	2.668	2.539×10^{-6}		
	1035			Red clayey silty SAND of medium plasticity.													1.910	13.69
3.00 - 4.00	1037 TP 1	Kinzudi site		Yellow grey clayey silty SAND of medium plasticity.	5.36	0.2	26.8		71.0	2.0	46.30	20.80	25.50	1.820	2.60	3.257×10^{-9}	1.740	19.50
1.00 - 1.25	1036 TP 2			Grey with Red patches clayey silty SAND of medium plasticity.	6.11	12.0	13.0		73.0	2.0	49.0	20.0	29.2	2.075	2.66	4.205×10^{-7}	1.820	15.5

4 Hydrological Survey

The hydrological survey was divided into two parts:

- groundwater sources within the study area including downgradient of the proposed disposal site to the sea.
- all surface waters within the catchment area of the disposal site

All measurements were taken during the survey period: January - March, 1997, corresponding to the dry season. It should be noted that this year has been drier than normal due to the failure of the short rains in November - December 1996.

4.1 Groundwater

The groundwater table level was investigated using the nine boreholes (BH1 - BH8 and BH10) drilled for the geological survey within the disposal site (see Figure 2-1), and three boreholes, located outside of the landfill site but within the study area (see Figure 4-1). Two of these (BH12 and BH11) were drilled in the valley, approximately 450 and 750 metres west respectively of the western boundary of the landfill site while the third (BH13) was drilled near the salt pans located approximately 1,400 metres to the east of the site's eastern boundary, near the Indian Ocean. In describing the groundwater conditions within the study area, reference is made to Figure 4-2 which is a cross-section of the area through the landfill site to the Indian Ocean.

Within the quarry site, no water was struck in any of the nine boreholes drilled during the survey period (January - March). Three of these boreholes (BH1, BH3 and BH10) were drilled to a depth of 15 m equivalent to 30, 32 and 36 metres a.m.s.l respectively (to the nearest metre). 29.72 metres a.m.s.l. was the greatest depth reached by any of these boreholes. Hence, it can be assumed that the groundwater table below the quarry site is located below 30 metres a.m.s.l. in the dry season.

In the valley to the west of the site, BH11 struck groundwater at an elevation of 44.5 metres a.m.s.l (4.0 m below the ground surface). There are some other dug wells within this valley with water levels at 0.3 - 1.5 m below the surface. These wells contain non-saline water, even during the dry season. The geology of this valley is characterised by shallow patches of sand on top of clay (see borehole log diagrams for BH11 and BH12). The infiltration of water through permeable ground is halted by these clay lenses and hence localised areas within the valley, such as these, have their own perched water table.

East of New Bagamoyo Road and from the bottom of the Old MECCO quarries, the terrain falls relatively steeply to a level of approximately 10 metres a.m.s.l. where two saline water springs are found. From these springs, an approximately 2 km wide swampy area, populated by mangroves, slopes gently towards the Indian Ocean. Within the swampy area, salt pans have been constructed north-east and south-east of the landfill site. The salt pan owners stated that the bottom of these pans never reach the groundwater, which must be true as otherwise the pans could not be used for the production of salt. The drilling of BH13 confirmed this as saline groundwater was struck at 0.6 metres a.m.s.l., 2.4 m below the ground level and approximately 1 m below the bottom of the deepest salt pans.

The groundwater potential of the coastal region was studied as part of the 1979 Water Master Plan[3]. Generally, the groundwater is saline. Close to the coast, saltwater intrusion occurs. However, sometimes even far inland, water has been encountered exhibiting excessive chloride concentrations. A number of explanations have been suggested for this including chloride being released by host minerals, chloride being present as a result of previous sea water inundation.

Data was obtained from the Ministry of Water on existing boreholes within the Kunduchi area which were established more than 20 years ago before the expansion of the existing piped water supply and is presented in Table 4-1. At present, most of these boreholes are not in use; primarily due to salt water intrusion but also because of vandalism. For example, borehole No. 9/61 was constructed in 1961 near the existing army barracks on the bank of the Tegeta River (~1.5 km downstream of the proposed landfill site) and was used by Kunduchi prison. After not being used for a long time, the borehole was vandalised by removing the pumps and associated structures.

On the basis of these results and observations, the primary groundwater is saline, located at lower than 30 metres a.m.s.l. under the bottom of the New MECCO quarry and flows in the direction towards the Indian Ocean. As Figure 4-2 shows, it is expected that the groundwater level below the landfill site is at approximately 20 metres a.m.s.l.

Table 4-1: Inventory of existing boreholes within the Kunduchi area

1. Borehole No. 94/76 Yield of well: Depth water struck: Lithology (depth in m below ground level):	Village, District: Goba (Kinondoni District), Kinondoni Total depth: 59.15 m sands, clays
2. Borehole No. 237/74: Yield of well: 2,000 gph; LPM 151.7 Depth water struck: 15.73 m Lithology (depth in m below ground level):	Village, District: Kunduchi, Kinondoni Total depth 50.3 m 0 - 0.75 dark brown silty sand; 0.76 - 11.28 brown to light brown clay-bound sand; 11.89 - 22.87 white decomposed sandy coal in a matrix of silty clay; 22.87 - 41.16 white fine and coarse sand with coral fragments; 41.16 - 50.3 yellow - brown coarse sand.
3. Borehole No. 9/61 Yield: 1,100 gph/82 LPM Depth water struck: not recorded Lithology: Impure sandy clays with two horizons of pure quartz. Sand - quaternary alluvials.	Village, District: Kunduchi Prisons, Kinondoni Total depth: not recorded
4. Borehole No.: 5/42 Yield: 500 gph/37.8 LPM Depth water struck: not recorded Lithology (depth in m below ground level):	Village; District: Kunduchi Estate, Kinondoni Total depth: 36.3 m Pliocene-Pleistocene sands, clays, chalk
5. Borehole No. 4/59 Yield: 1,080 gph (81.9 LPM) Depth water struck: not recorded Lithology: not recorded	Village District: Kunduchi Sisal estate, Kinondoni Total depth: 30.5 m
6. Borehole no.: 5/59 Yield: 800 gph (60.6 LPM) Depth water struck: not recorded Lithology: not recorded	Village, District: Kunduchi Sisal Estate, Kinondoni Total depth: 32.6 m
7. Borehole No.: 9/59 Yield: 4,000 gph (303.3 LPM) Depth water struck: 13.1 m. Lithology (depth in m below ground level):	Village, District: Kunduchi Sisal Estate Kinondoni Total depth: not recorded. Marine clays, sands and gravel - Tertiary

[3] "Coast/Dar es Salaam Regions Water Master Plan"; CBA Engineering Ltd.; Canada, 1979

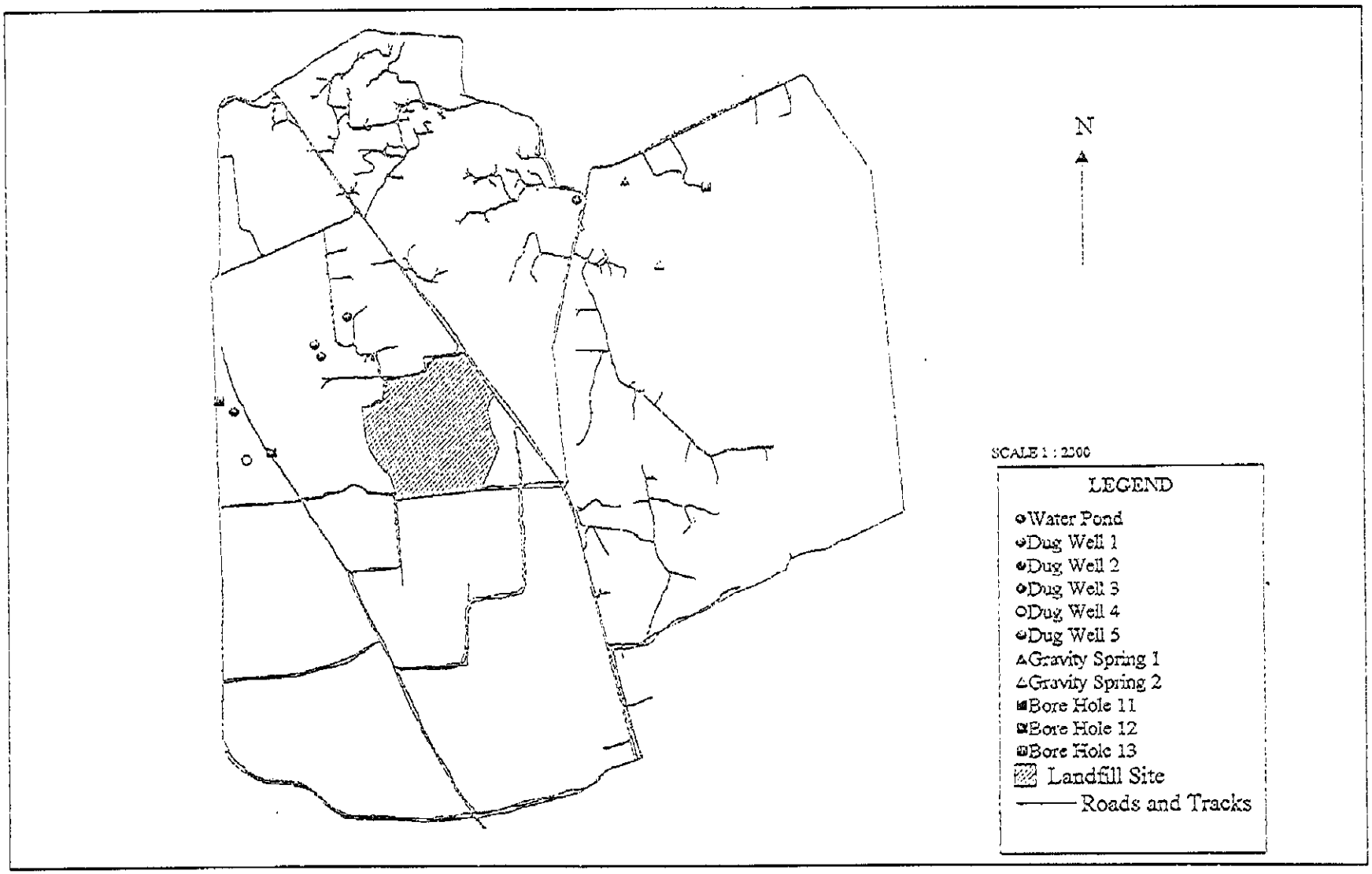

Figure 4-1: Water Sampling Points within the Study Area at Kunduchi

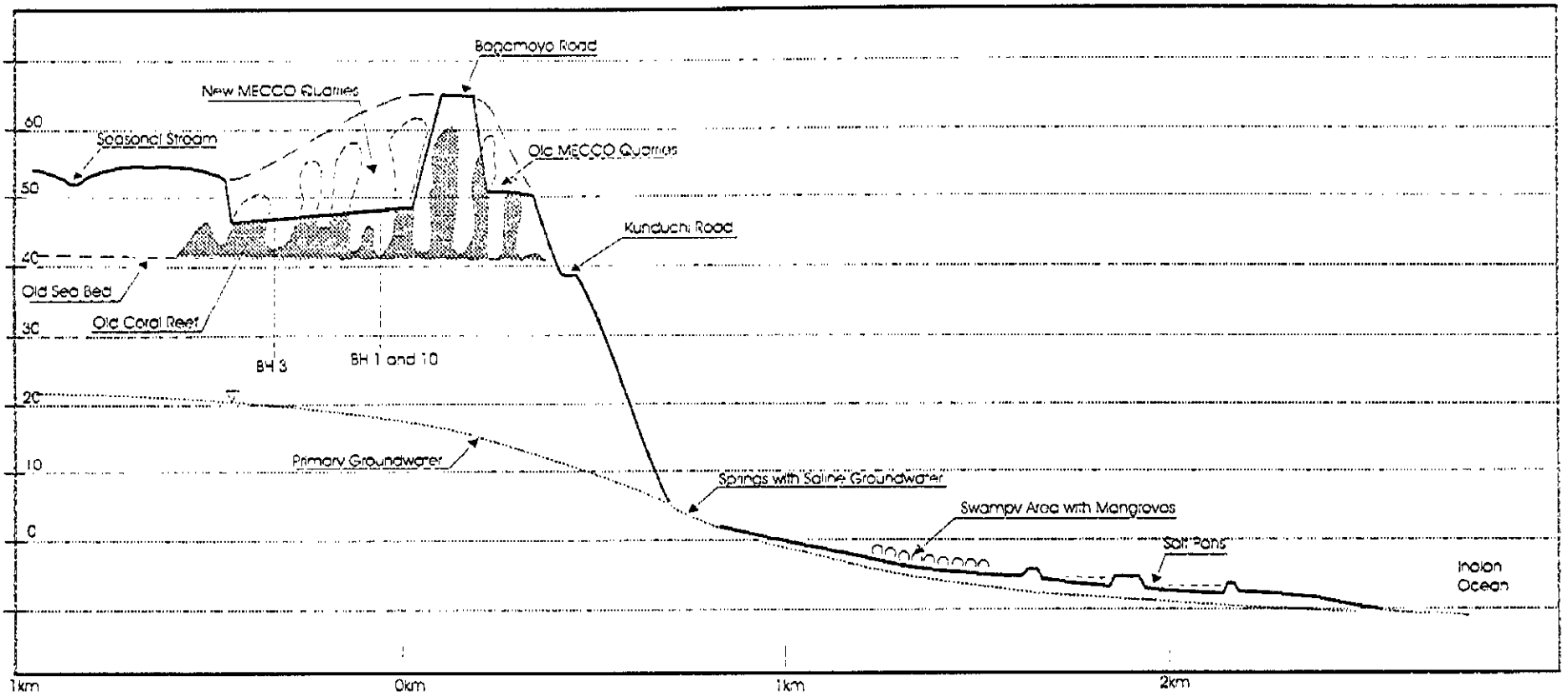

Figure 4-2: Cross - Section of the Area through the Landfill to the Indian Ocean

4.2 Surface Water

The surface water conditions within the study area are summarised below. Reference is made to Figure 4-3 which shows the water catchment areas around the proposed landfill site and surface water sources

There are only seasonal surface water sources around the proposed disposal site at Kunduchi. The major surface water source is Tegeta River to the north of the study area which flows into the Indian Ocean about 2 km north-east of the site. This river is a physical boundary of the Kunduchi/Salasala/Mtongani and Tegeta areas and is formed by tributaries from the adjacent catchment areas. During the entire three month survey period, the river and its tributaries were all dry. Hence, it was not possible to measure surface water flowrates during this time. Neither was it possible to use historical data for this purpose, as no discharge data was available from the Water Department (Hydrology section) as this river is not under a long-term monitoring programme. However, it is known that the lower reaches of this river experiences floods during heavy rains.

Within the quarry pits on site, virtually all of the surface runoff is trapped, thus creating large water pools in the pits during the rainy season.

Stormwater runoff from the areas outside the site on the north and west sides is drained off to the valley west of the site, where the approximate level at the bottom of the valley is 45 m. The valley contains a stream which is dry throughout most of the year. However, during the rainy season, the stream connects to Tegeta River as described above.

The areas outside the site on the south-east and eastern sides drain towards Mtongani village and into the swampy area near the salt pans.

Directly south of the site, there is a very shallow, seasonal water pond, which is only present during the rainy season, collecting and storing stromwater runoff from catchment areas to the south of the site, which subsequently evaporates on the cessation of the rains. No survey map for the area immediately south of the site is available and hence it is not possible to determine the size of this pond's catchment area, nor is there any historical data on the variation in water volume of this lake. However, during flood events, water flows via an overflow channel from this pond to the New MECCO quarry.

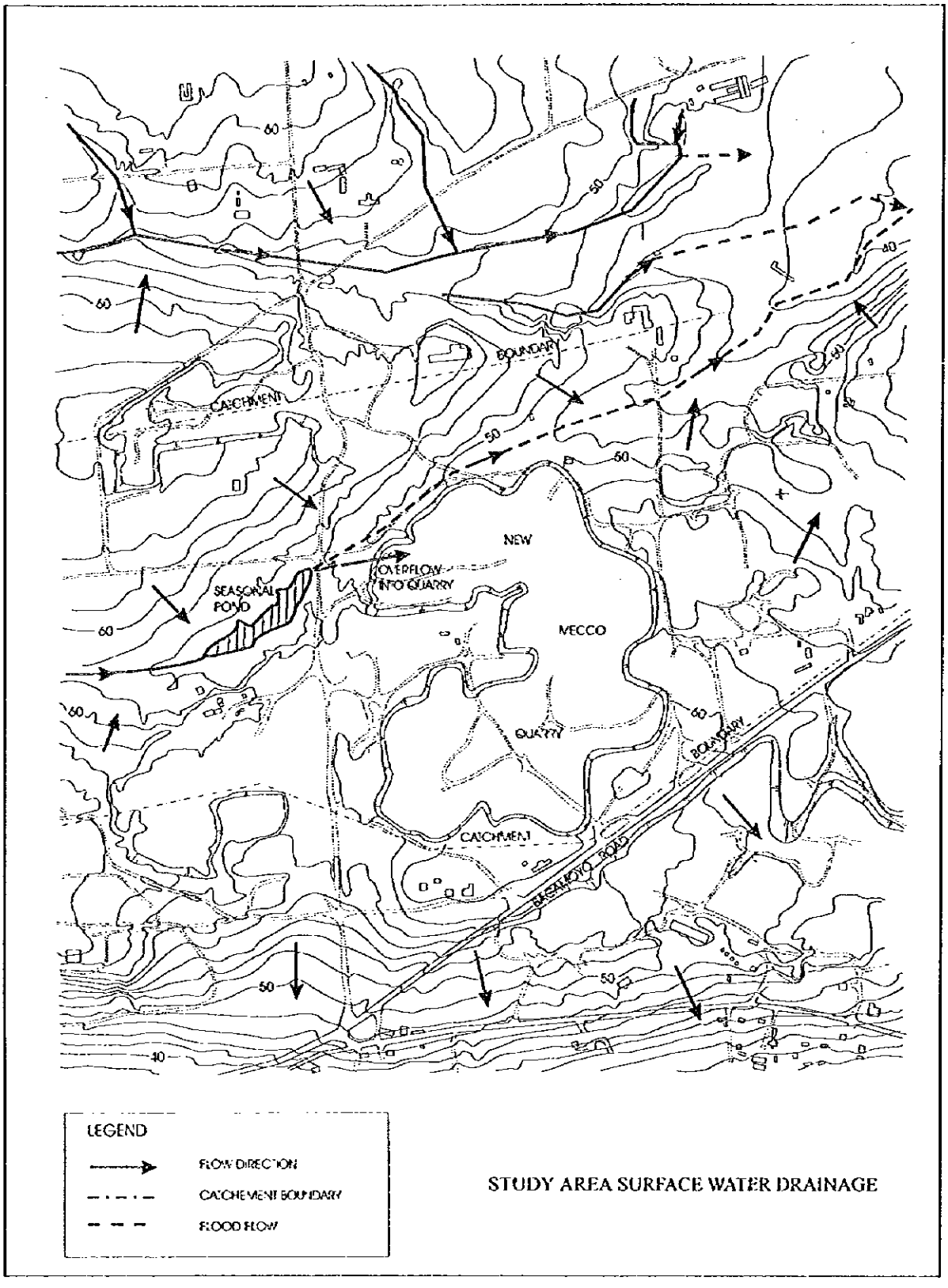

Figure 4-3: The Surface Water Conditions within the Study Area at Kunduchi

5 Water Use Survey

Investigations were made to determine water use from surface water and groundwater sources within the study area (Figure 4-1).

5.1 Regular Water Supply

The main water pipeline from Lower Ruvu Water Treatment Plant passes through the valley to the west of the landfill site. This pipeline provide piped water to people living along the pipeline, including residents around the landfill site and villages situated between New Bagamoyo Road and the Indian ocean, downstream of the landfill site. This is the primary source of water for all people living in these areas and the supply is generally reliable.

5.2 Surface Water Use

All rivers within the study area are seasonal. Tegeta River, the most prominent river is used as an alternative water source during water shortages/cuts. The water taken from this river is used for laundry, bathing and other domestic purposes excluding drinking.

5.3 Groundwater Use

The groundwater survey covered a total area of more than 2 sq. km. The groundwater provides an important alternative water source during water shortages/cuts. Several wells (mainly traditional) were identified inside the study area, the details of which are presented in Table 5-1.

Table 5-1: Water Use Survey

Date	Water source	Location	Water Level relative to ground level	Water use
23/1/97	Water pond	E 519529.03 N 9269728.8	1.0 m	A dug pit used for fish culture, of area 20 m x 15 m and 2.0 deep. The water is also used for small scale irrigation and as a source of drinking water for livestock. The pool is recharged by groundwater.
23/1/97	Dug well 1	E 518456.62 N 9269528.50	0.3 m	Water used for cooking and laundry.
	Dug well 2	E 518484.38 N 9269472.10	1.5 m	The well provides drinking water. The water is clear. The well is not protected. During piped water supply interruptions, the well is the only dependable source of water for the surrounding residents as far as Boko (about 1500 people per day served during water cuts).
23/1/97	Dug well 3	E 518152.43 N 9269200.1	0.3 m	The second source of water during water cuts. The water is turbid (milky).
28/1/97	Dug well 4	E 518164.54 N 9269087.0 (in Tanesco's premises on the Tegeta river bank)	1.0 m	The water is turbid. The pool is 1.5 m x 4 m and about 1.0 deep. The pool is recharged by groundwater.
29/1/97	Dug well 5	At the junction of Tegeta river and Bahari Beach Hotel Road.	0.3 m	A dug well in the Tegeta river bed. The well provides water during acute shortages of water. The well is seasonal.
4/2/97	Gravity spring	Mtongani near the road to Kunduchi Beach Hotel	Surface	Not used for drinking. Also used as a source of water for construction activities. The water is saline.
4/2/97	Gravity spring	Mtongani near the salt pan.	Surface	Used for domestic purposes except drinking. The water is saline

Note: Water quality results from these water sources are presented in section 6.0.

6 Water Quality Survey

A Water quality survey was carried out in the study area in conjunction with the Hydrological and Water use surveys as set out below.

6.1 Sampling

Water samples were taken from selected points, set out in Table 6-1, located as shown in Figure 4-1. Sampling was conducted from these points at approximately fortnightly intervals three times over a three month period.

Table 6-1: Sampling Points

Water source	Sampling point	Nature of sampling point
groundwater	BH11	borehole in farm in valley to west of landfill site
	BH13	borehole at salt pans to east of landfill site
surface water	SP/1	gravity spring 1
	SP/2	gravity spring 2
	Pond	water pond in farm
groundwater	DW/1	dug well in farm (not for domestic use)
	DW/2	dug well in farm (used for domestic purposes)
	DW/3	dug well in farm
	DW/4	dug well in TANESCO premises on banks of Tegeta river

6.2 Analysis

"Standard Methods for the Examination of Water and Wastewater", 17th Edition (1989), published by the American Public Health Association (APHA), American Water Works Association and the Water Pollution & Control Federation of USA was used for most of the water quality analysis.

Ambient air temperature, water temperature and the water quality parameters analysed are set out in Table 6-2 together with the methods used for measuring these parameters. The weather conditions were also recorded during sampling. Water quality analysis results are set out in Table 6-3 - Table 6-5.

Table 6-2: Water Quality Analysis - Parameters and Methods

No.	Parameter	Measurement Method
1	Ambient Temperature	Mercury filled Celsius thermometer
2	Water Temperature	Mercury filled Celsius thermometer
3	Colour	Spectrophotometric Method
4	Turbidity	Nephelometric Method
5	pH	Electrometric Method
6	Dry matter (Filterable matter)	Whatman Filtration Method
7	Electrical Conductivity (EC)	Self Contained Conductivity Instrument (Laboratory) Method
8	Dissolved Oxygen (DO)	Electrode-probe Method
9	Chemical Oxygen Demand (COD)	Closed Reflux, Calorimetric Method
10	Biochemical Oxygen Demand (BOD)	5-day BOD test at $20^{O}C$ (Manometric Method)
11	Suspended Solids (SS)	Total Suspended Solids dried at 103 - 105^{O} C (Method)
12	Faecal Coliforms (FC)	Membrane Filter Procedure
13	Total Nitrogen (T-N)	Digestion and Nesslerization Method
14	Ammonia (NH_4^+)	Nessler Method
15	Sodium (Na^+)	not stated
16	Calcium (Ca^{2+})	EDTA Method
17	Iron (Fe)	Atomic Absorption Spectrophotometer Method
18	Chloride (Cl^-)	Argentometric Method
19	Sulphate (SO_4^{2-})	Turbidimetric Method
20	Chromium (Cr^{6+})	Atomic Absorption Spectrophotometric Method
21	Cadmium (Cd)	Atomic Absorption Spectrophotometric Method
22	Lead (Pb)	Atomic Absorption Spectrophotometric Method
23	Arsenic (As)	Atomic Absorption Spectrophotometric Method

Table 6-3: Water Analysis Results (I)

Sampling Date: 14 February 1997

PARAMETER	UNITS	SAMPLING POINTS								
		BH13	BH11	SP/1	SP/2	POND	DW/1	DW/2	DW/3	DW/4
Air Temperature	^{0}C	32	32	32	32	32	32	32	32	32
Water temperature	^{0}C	29	29	29	29	29	29	29	29	29
Weather		Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny
Colour		35420.00	3540.00	7.00	14.00	14.00	44.00	29.00	141.00	560.00
Turbidity	NTU	12390.00	2550.00	3.00	6.00	64.00	16.00	6.00	60.00	182.00
pH		5.49	5.93	8.34	9.31	8.49	7.20	5.28	7.99	7.45
Filterable solids (Dry matter)	mg /l	2354.1	433.5	0.42	1.67	1.61	1.37	0.74	2.11	1.33
EC	mS/cm	140.00	0.48	10.1	10.00	0.668	0.194	0.205	0.48	0.299
DO	mg/l	4.12	5.66	6.76	5.89	4.43	6.45	6.35	6.53	5.82
COD	mg/l	945.00	95.00	187.00	175.00	73.00	151.00	41.00	128.00	151.00
BOD	mg/l	633.00	59.00	130.9	120.00	49.00	99.00	29.00	84.00	97.00
SS	mg/l	31523.00	1887.00	2.3	4.9	55.68	13.98	4.9	46.70	140.05
FC	count/ 100ml	430	60	660	330	990	1200	110	82	2600
T-N	mg/l	164.00	84.75	1.51	1.43	2.98	2.28	8.65	2.22	1.51
NH_4^+	mg/l	24.24	36.00	1.36	0.27	0.35	0.55	0.43	0.32	0.96
Na^+	mg/l	2187.50	81.80	1597.50	1605.00	30.80	32.30	28.70	38.80	26.10
Ca^{2+}	mg/l	457.30	1.33	775.22	399.12	109.00	387.20	43.12	279.13	345.11
Fe	mg/l	100.1	27.3	0.05	0.00	0.53	0.34	0.63	0.27	1.66
Cl^-	mg/l	8370.00	280.00	5730.00	5320.00	75.00	53.00	64.00	216.00	87.00
SO_4^{2-}	mg/l	7200.00	68.00	2517.50	1960.00	21.50	35.20	37.60	35.20	22.00
Cr^{6+}	mg/l	0.025	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cd	mg/l	0.06	0.02	0.04	0.02	0.01	0.02	0.01	0.01	0.02
Pb	mg/l	0.22	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
As	mg/l	0.34	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003

Table 6-4: Water Analysis Results (II)

Sampling Date: 28 February 1997

PARAMETER	UNITS	SAMPLING POINTS								
		BH13	BH11	SP/1	SP/2	POND	DW/1	DW/2	DW/3	DW/4
Air Temperature	^{0}C	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4
Water temperature	^{0}C	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6
Weather		Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny
Colour	Hazen	35000.00	3530.00	5.00	12.00	12.00	34.00	20.00	101.00	540.00
Turbidity	NTU	12000.00	2500.00	1.00	4.00	60.00	8.00	10.00	23.00	184.00
pH		9.1	6.93	8.24	9.11	8.49	5.69	6.70	8.79	7.45
Filterable solids (Dry matter)	mg /l	2300.1	423.5	0.37	1.67	1.60	1.37	0.77	2.52	1.30
E.C.	mS/cm	134.00	0.68	9.10	9.5	0.479	0.190	0.198	0.55	0.367
D.O.	mg/l	4.82	5.83	6.89	6.89	5.89	6.47	6.65	6.77	6.82
COD	mg/l	935.00	99.00	178.00	171.00	76.00	158.00	48.00	133.00	158.00
BOD	mg/l	629.00	57.00	122.7	119.00	51.00	100.00	30.00	87.00	99.00
SS	mg/l	31413.00	1867.00	2.2	3.3	55.68	12.76	5.3	47.70	154.05
FC	count/ 100ml	410	71	668	344	993	1250	140	80	2600
T-N	mg/l	144.00	83.65	1.44	1.44	3.2	2.74	8.85	2.52	1.88
NH_4^+	mg/l	21.14	34.00	1.33	0.26	0.45	0.56	0.44	0.34	1.16
Na^+	mg/l	2144.30	80.44	1587.00	1603.00	31.60	32.88	28.70	39.70	27.14
Ca^{2+}	mg/l	447.30	1.33	305.22	390.22	111.00	388.00	43.00	266.11	347.11
Fe	mg/l	90.1	26.3	0.05	0.00	0.53	0.37	0.55	0.30	2.11
Cl^-	mg/l	8260.00	277.00	5640.00	5310.00	78.00	61.00	68.10	218.00	89.00
SO_4^{2-}	mg/l	7100.00	66.00	2516.10	1870.00	22.70	37.33	36.970	34.10	23.00
Cr^{6+}	mg/l	0.026	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cd	mg/l	0.05	0.02	0.06	0.05	0.02	0.02	0.01	0.01	0.02
Pb	mg/l	0.21	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
As	mg/l	0.33	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003

Table 6-5: Water Analysis Results (III)

Sampling Date: 14 March 1997

PARAMETER	UNITS	SAMPLING POINTS								
		BH13	BH11	SP/1	SP/2	POND	DW/1	DW/2	DW/3	DW/4
Air Temperature	°C	32	31	31	31	31	31	31	31	31
Water temperature	°C	29	29	29	29	29	29	29	29	29
Weather		Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny
Colour	Hazen	34420.00	3440.00	6.00	13.00	13.00	43.00	27.00	140.00	550.00
Turbidity	NTU	12210.00	2320.00	2.00	5.00	54.00	13.00	5.00	50.00	176.00
pH		6.57	6.64	8.44	9.56	8.67	7.82	6.11	8.43	7.66
Filterable solids (Dry matter)	mg /l	2404.1	441.5	0.51	1.54	1.59	1.43	0.73	2.8	1.23
EC	mS/cm	146.00	0.52	10.21	10.33	0.717	0.213	0.214	0.51	0.301
DO	mg/l	4.00	5.42	6.34	5.91	4.32	6.34	6.22	6.32	5.44
COD	mg/l	932.00	93.00	172.00	161.00	72.00	141.00	40.00	126.00	150.00
BOD	mg/l	622.00	56.00	127.6	126.00	51.00	98.00	31.30	85.32	96.00
SS	mg/l	31523.00	1887.00	2.3	4.9	55.68	13.98	4.9	46.70	144.55
FC	count/ 100 ml	560	100	760	420	1010	1600	230	100	2800
T-N	mg/l	177.00	92.12	2.15	1.98	3.13	2.34	8.88	2.76	1.79
NH_4^+	mg/l	22.13	33.00	1.12	0.27	0.37	0.43	0.41	0.29	1.21
Na^+	mg/l	2189.50	82.80	1649.50	1689.00	39.90	35.70	29.60	40.00	31.21
Ca^{2+}	mg/l	455.30	1.21	760.22	312.12	121.00	374.20	48.32	256.13	366.11
Fe	mg/l	99.19	30.23	0.15	0.01	0.59	0.47	0.71	0.32	1.71
Cl^-	mg/l	8360.00	278.00	5710.00	5310.00	67.00	59.00	66.00	226.00	89.0
SO_4^{2-}	mg/l	7120.00	78.00	2521.70	1980.00	23.10	37.10	37.60	35.00	23.20
Cr^{6+}	mg/l	0.025	<0.003	<	<0.003	<	<0.003	<	<0.003	<
Cd	mg/l	0.05	0.02	0.03	0.02	0.01	0.02	0.01		0.02
Pb	mg/l	0.22	<0.03	<	<0.03	<	<0.03	<	<0.03	<0.03
As	mg/l	0.34	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003

7 Soil Contamination Survey

7.1 Introduction

The objective of this survey was to determine baseline data for soil contamination within the study area and particularly near the proposed disposal site.

Two samples were taken from two sampling points; one being from the Old MECCO quarry, the other from the new MECCO quarry. Samples were analysed in the laboratory using the Atomic Absorption Spectrophotometer (AAS) Model 2380 P. Clmer.

7.2 Methodology and Results

About 5 g (accurately weighed) air dried finely ground sample was placed in an Erlenmeyer flask. 20 ml of extracting solution (0.05M HCL + 0.05M H_2SO_4) was added and placed in a mechanical shaker for 15 minutes. The sample was then filtered through Whatman No. 42 filter paper into a 50 ml flask with extracting solution. Concentrations of the elements of interest (i.e. Cd, Pb, Cr, Cu, Zn, Fe, and Mn) were determined using Atomic Absorption Spectrophotometer (AAS) model 2380 P.Elmer. All working standards were prepared using the extracting solution.

The results are presented in Table 7-1.

Table 7-1: Soil contamination results

Parameter	Units	Cd	Pb	Cr	Cu	Zn	Fe	Mn
OMQ	mg/l	0.215	0.9	<0.003	0.65	<0.002	1.36	0.23
NMQ	mg/l	0.16	1.1	<0.003	0.5	<0.002	0.910	0.365
Detection limit	mg/l	0.001	0.03	0.003	0.002	0.002	0.004	0.002

Note: OMQ = Old MECCO quarry; NMQ = New MECCO quarry

8 Traffic Volume Survey

8.1 Introduction

The traffic volume survey was conducted at two stations on New Bagamoyo Road in accordance with the Terms of Reference as shown in Figure 8-1. Station A1 was located about 150 metres north of the junction with Sam Nujoma Road and station A2 about 300 metres south of the proposed landfill site. The traffic volume survey was carried out for 3 days at each station from 21 - 23 January 1997 at station A1 and from 28 - 30 January at station A2.

8.2 Objective

The objective of this survey was to determine the current number of vehicles passing along New Bagamoyo Road during the normal working day at the two locations. This assessment was necessary as the location of the proposed disposal site is such that all the vehicles transporting waste from the city to the proposed disposal site have to pass along this road. Only the survey data is presented here while detailed data analysis is presented in the final report.

8.3 Methodology

The number of vehicles passing along the road at each of the two stations was counted and recorded on field forms as indicated in the survey result tables which follow. The survey was conducted manually with each station having two enumerators each counting vehicles going in different directions. Traffic was divided into three categories; namely, small vehicles (≤3.5 tons), large vehicles (>3.5 tons) and motor bikes. The number of vehicles in each category passing along the road were simultaneously counted and recorded hourly from 0600 hours to 1900 hours for three days at each of the two stations. In order to be able to compare the traffic volume with the noise levels, vehicle recording in each category was done separately for the first 10 minutes of each hour and also for the remaining 50 minutes of every hour as indicated in the tables which follow.

8.4 Results

The results are presented in the tables and figures that follow in this section where SV = small vehicle, LV = large vehicle and MC = motorcycle.

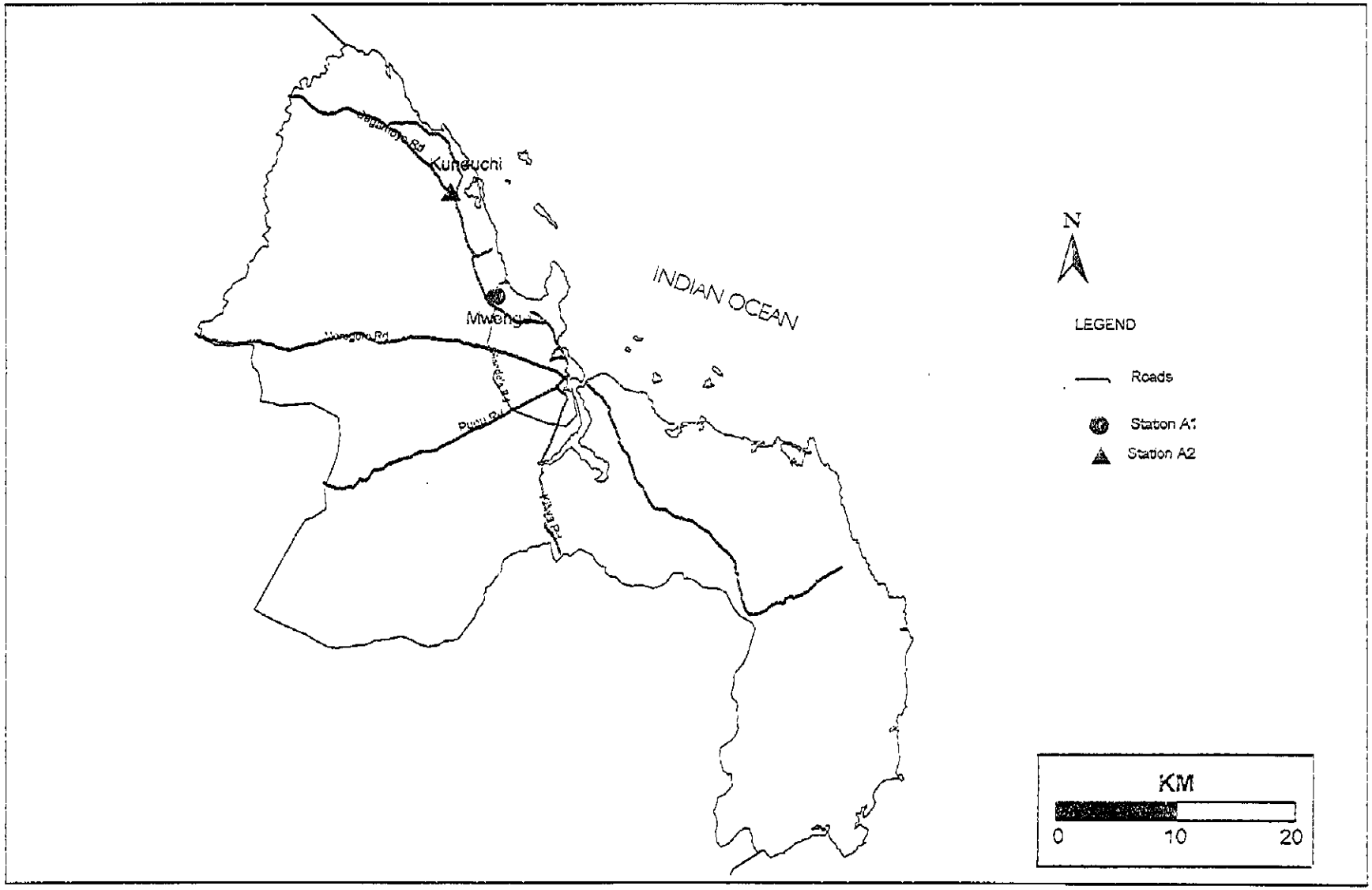

Figure 8-1: Location of Survey Stations on New Bagamoyo Road

Table 8-1: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 21 January, 1997

TIME		FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
		SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 -	6.00 - 6.10	15	4	0	19	11	8	1	20	26	12	1	39
7.00	6.10 - 7.00	159	26	5	190	271	39	4	314	430	65	9	504
7.00 -	7.00 - 7.10	35	14	1	50	73	5	2	80	108	19	3	130
8.00	7.10 - 8.00	250	84	9	343	283	19	12	314	533	103	21	657
8.00 -	8.00 - 8.10	61	25	2	88	67	6	1	74	128	31	3	162
9.00	8.10 - 9.00	215	58	4	277	309	51	12	372	524	109	16	649
9.00 -	9.00 - 9.10	77	9	3	89	63	14	5	82	140	23	8	171
10.00	9.10 - 10.00	196	83	5	284	250	44	3	297	446	127	8	581
10.00 -	10.00 - 10.10	38	6	1	45	52	7	2	61	90	13	3	106
11.00	10.10 - 11.00	254	70	9	333	226	55	10	291	480	125	19	624
11.00 -	11.00 - 11.10	47	15	1	63	38	10	2	50	85	25	3	113
12.00	11.10 - 12.00	194	79	3	276	238	55	7	300	432	134	10	576
12.00 -	12.00 - 12.10	54	19	0	73	48	12	1	61	102	31	1	134
13.00	12.10 - 13.00	225	65	10	300	235	49	7	291	460	114	17	591
13.00 -	13.00 - 13.10	42	13	0	55	45	15	1	61	87	28	1	116
14.00	13.10 - 14.00	179	62	8	249	70	186	7	263	365	132	15	512
14.00 -	14.00 - 14.10	59	17	0	76	28	19	1	48	87	36	1	124
15.00	14.10 - 15.00	240	60	9	309	250	47	9	306	490	107	18	615
15.00 -	15.00 - 15.10	58	10	0	68	53	17	1	71	111	27	1	139
16.00	15.10 - 16.00	231	66	6	303	222	81	4	307	453	147	10	610
16.00 -	16.00 - 16.10	57	12	1	70	41	15	0	56	98	27	1	126
17.00	16.10 - 17.00	311	55	9	375	235	74	5	314	546	129	14	689
17.00 -	17.00 - 17.10	49	7	2	58	47	14	0	61	96	21	2	119
18.00	17.10 - 18.00	294	49	10	353	241	58	5	304	535	107	15	657
18.00 -	18.00 - 18.10	56	3	2	61	53	10	1	64	109	13	3	125
19.00	18.10 - 19.00	313	24	7	344	227	48	3	278	540	72	10	622

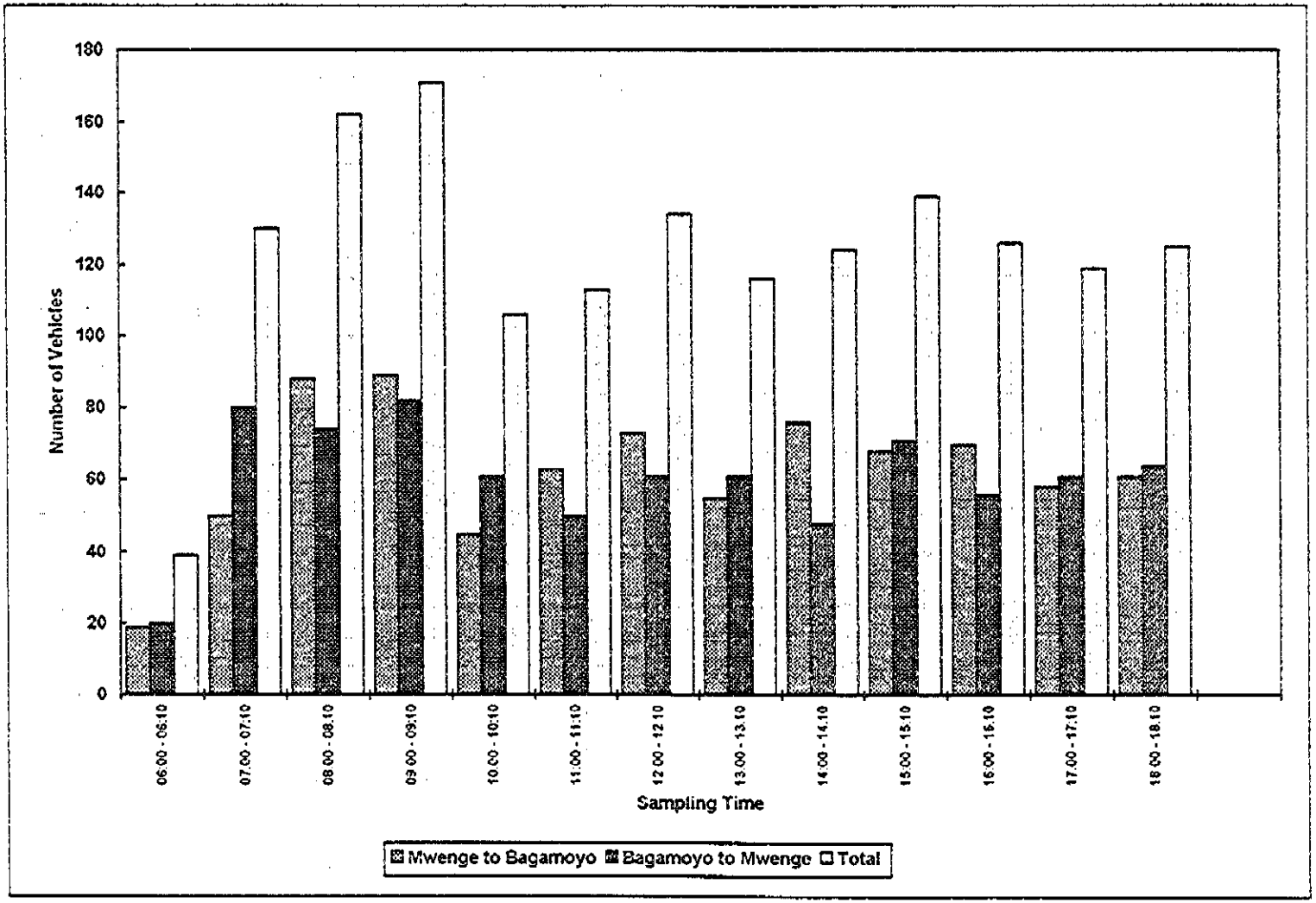

Figure 8-2: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 21 January, 1997

Table 8-2: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 21 January, 1997

TIME	FROM MWENGE TO BAGAMOYO	FROM BAGAMOYO TO MWENGE	TOTAL
6.00 - 7.00	209	334	**543**
7.00 - 8.00	393	394	**787**
8.00 - 9.00	365	446	**811**
9.00 - 10.00	373	379	**752**
10.00 - 11.00	378	352	**730**
11.00 - 12.00	339	350	**689**
12.00 - 13.00	373	352	**725**
13.00 - 14.00	304	324	**628**
14.00 - 15.00	385	354	**739**
15.00 - 16.00	371	378	**749**
16.00 - 17.00	445	370	**815**
17.00 - 18.00	411	365	**776**
18.00 - 19.00	405	342	**747**

Table 8-3: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 21 January, 1997

TIME	FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 - 7.00	174	30	5	**209**	282	47	5	**334**	456	77	10	**543**
7.00 - 8.00	285	98	10	**393**	356	24	14	**394**	641	122	24	**787**
8.00 - 9.00	276	83	6	**365**	376	57	13	**446**	652	140	19	**811**
9.00 - 10.00	273	92	8	**373**	313	58	8	**379**	586	150	16	**752**
10.00 - 11.00	292	76	10	**378**	278	62	12	**352**	570	138	22	**730**
11.00 - 12.00	241	94	4	**339**	276	65	9	**350**	517	159	13	**689**
12.00 - 13.00	279	84	10	**373**	373	283	61	**352**	562	145	18	**725**
13.00 - 14.00	221	75	8	**304**	115	201	8	**324**	452	160	16	**628**
14.00 - 15.00	299	77	9	**385**	278	66	10	**354**	577	143	19	**739**
15.00 - 16.00	289	76	6	**371**	275	98	5	**378**	564	174	11	**749**
16.00 - 17.00	368	67	10	**445**	276	89	5	**370**	644	156	15	**815**
17.00 - 18.00	343	56	12	**411**	288	72	5	**365**	631	128	17	**776**
18.00 - 19.00	369	27	9	**405**	280	58	4	**342**	649	85	13	**747**

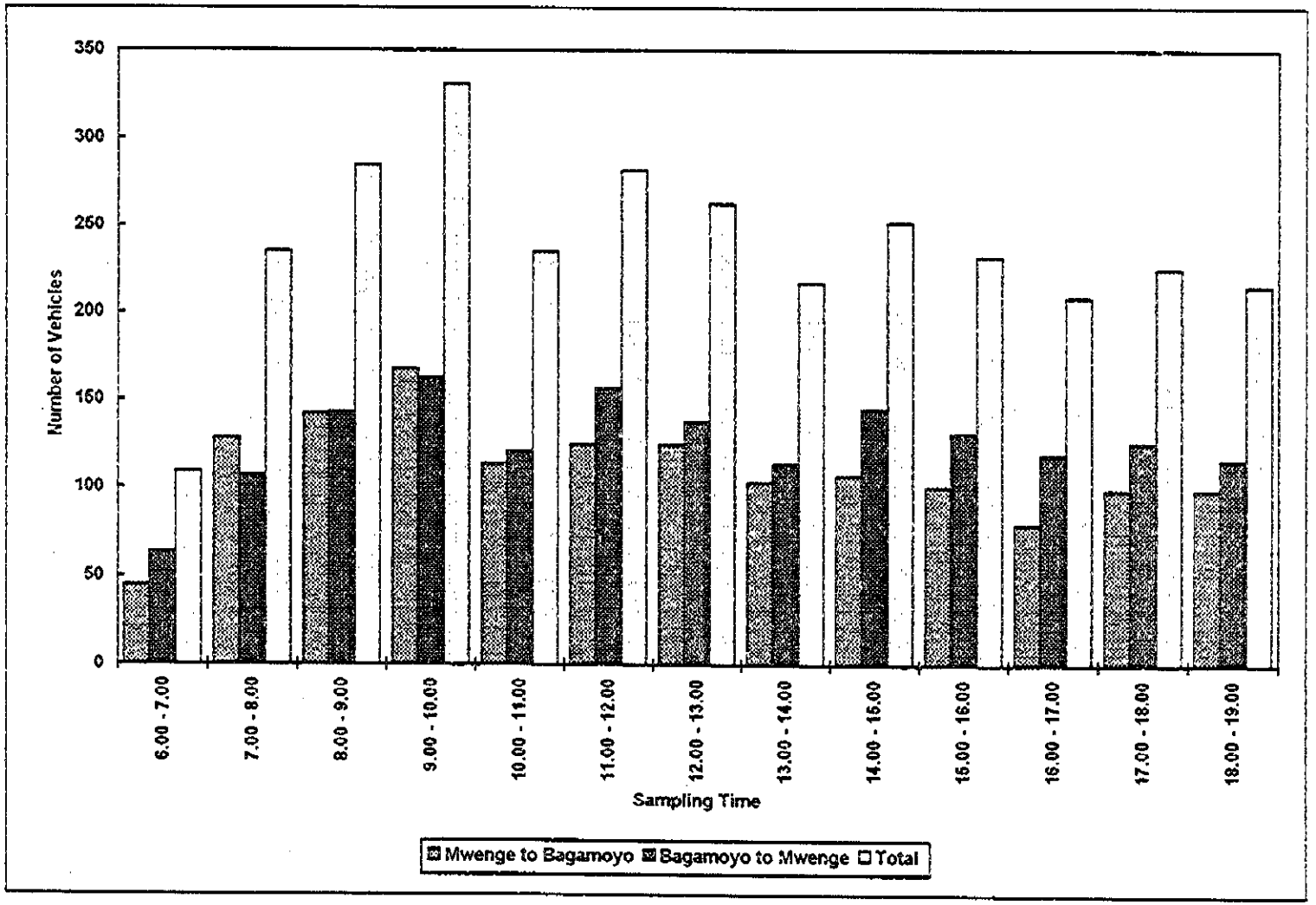

Figure 8-3: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 21 January, 1997

Table 8-4: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 22 January, 1997

TIME		FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
		SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 -	6.00 - 6.10	18	3	0	21	14	6	0	20	32	9	0	41
7.00	6.10 - 7.00	149	30	8	187	253	46	6	305	402	76	14	492
7.00 -	7.00 - 7.10	35	8	1	44	73	3	2	78	108	11	3	122
8.00	7.10 - 8.00	277	90	7	374	313	20	9	342	590	110	16	716
8.00 -	8.00 - 8.10	58	14	3	75	62	3	2	67	120	17	5	142
9.00	8.10 - 9.00	237	57	4	298	340	51	15	406	577	108	19	704
9.00 -	9.00 -9.10	52	8	2	62	44	12	2	58	96	20	4	120
10.00	9.10 - 10.00	179	69	5	253	227	37	2	266	406	106	7	519
10.00 -	10.00 - 10.10	50	6	0	56	48	11	0	59	98	17	0	115
11.00	10.10 -11.00	212	79	3	294	178	55	4	237	390	134	7	531
11.00 -	11.00 - 11.10	37	11	2	50	38	14	0	52	75	25	2	102
12.00	11.10 - 12.00	238	90	8	336	216	49	9	274	454	139	17	610
12.00 -	12.00 - 12.10	57	12	1	70	36	13	1	50	93	25	2	120
13.00	12.10 - 13.00	257	75	5	337	214	60	7	281	471	135	12	618
13.00 -	13.00 - 13.10	49	15	1	65	37	8	1	46	86	23	2	111
14.00	13.10 - 14.00	266	73	3	342	247	51	4	302	513	124	7	644
14.00 -	14.00 - 14.10	45	10	1	56	36	12	2	50	81	22	3	106
15.00	14.10 - 15.00	345	97	15	457	297	61	6	364	642	158	21	821
15.00 -	15.00 - 15.10	61	10	2	73	46	18	0	64	107	28	2	137
16.00	15.10 - 16.00	245	54	10	309	230	59	5	294	475	113	15	603
16.00 -	16.00 - 16.10	60	9	0	69	39	24	0	63	99	33	0	132
17.00	16.10 - 17.00	406	95	19	520	229	73	9	311	635	168	28	831
17.00 -	17.00- 17.10	41	5	0	46	37	10	0	47	78	15	0	93
18.00	17.10 -18.00	327	32	9	368	260	48	7	315	587	80	16	683
18.00 -	18.00 - 18.10	56	10	2	68	55	13	3	71	111	23	5	139
19.00	18.10 - 19.00	380	71	12	463	260	45	5	310	640	116	17	773

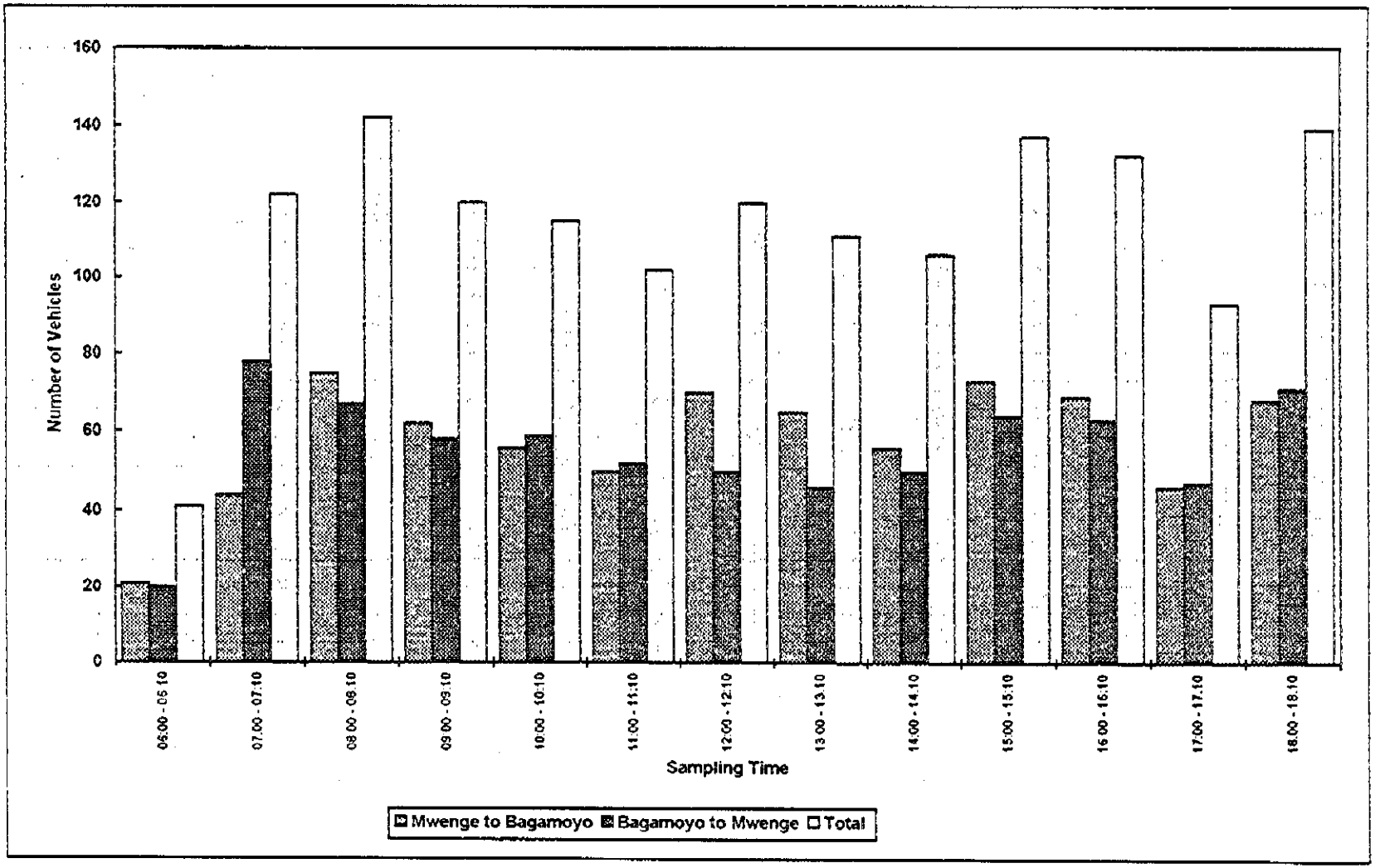

Figure 8-4: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 22 January, 1997

Table 8-5: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 22 January, 1997

TIME	FROM MWENGE TO BAGAMOYO	FROM BAGAMOYO TO MWENGE	TOTAL
6.00 - 7.00	208	325	**533**
7.00 - 8.00	418	420	**838**
8.00 - 9.00	373	473	**846**
9.00 - 10.00	315	324	**639**
10.00 - 11.00	350	296	**646**
11.00 - 12.00	386	326	**712**
12.00 - 13.00	407	331	**738**
13.00 - 14.00	407	348	**755**
14.00 - 15.00	513	414	**927**
15.00 - 16.00	382	358	**740**
16.00 - 17.00	589	374	**963**
17.00 - 18.00	414	362	**776**
18.00 - 19.00	531	381	**912**

Table 8-6: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 22 January, 1997

TIME	FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 - 7.00	167	33	8	**208**	267	52	6	**325**	434	85	14	**533**
7.00 - 8.00	312	98	8	**418**	386	23	11	**420**	698	121	19	**838**
8.00 - 9.00	295	71	7	**373**	402	54	17	**473**	697	125	24	**846**
9.00 - 10.00	231	77	7	**315**	271	49	4	**324**	502	126	11	**639**
10.00 - 11.00	262	85	3	**350**	226	66	4	**296**	488	151	7	**646**
11.00 - 12.00	275	101	10	**386**	254	63	9	**326**	529	164	19	**712**
12.00 - 13.00	314	87	6	**407**	250	73	8	**331**	564	160	14	**738**
13.00 - 14.00	315	88	4	**407**	284	59	5	**348**	599	147	9	**755**
14.00 - 15.00	390	107	16	**513**	333	73	8	**414**	723	180	24	**927**
15.00 - 16.00	306	64	12	**382**	276	77	5	**358**	582	141	17	**740**
16.00 - 17.00	466	104	19	**589**	268	97	9	**374**	734	201	28	**963**
17.00 - 18.00	368	37	9	**414**	297	58	7	**362**	665	95	16	**776**
18.00 - 19.00	436	81	14	**531**	315	58	8	**381**	751	139	22	**912**

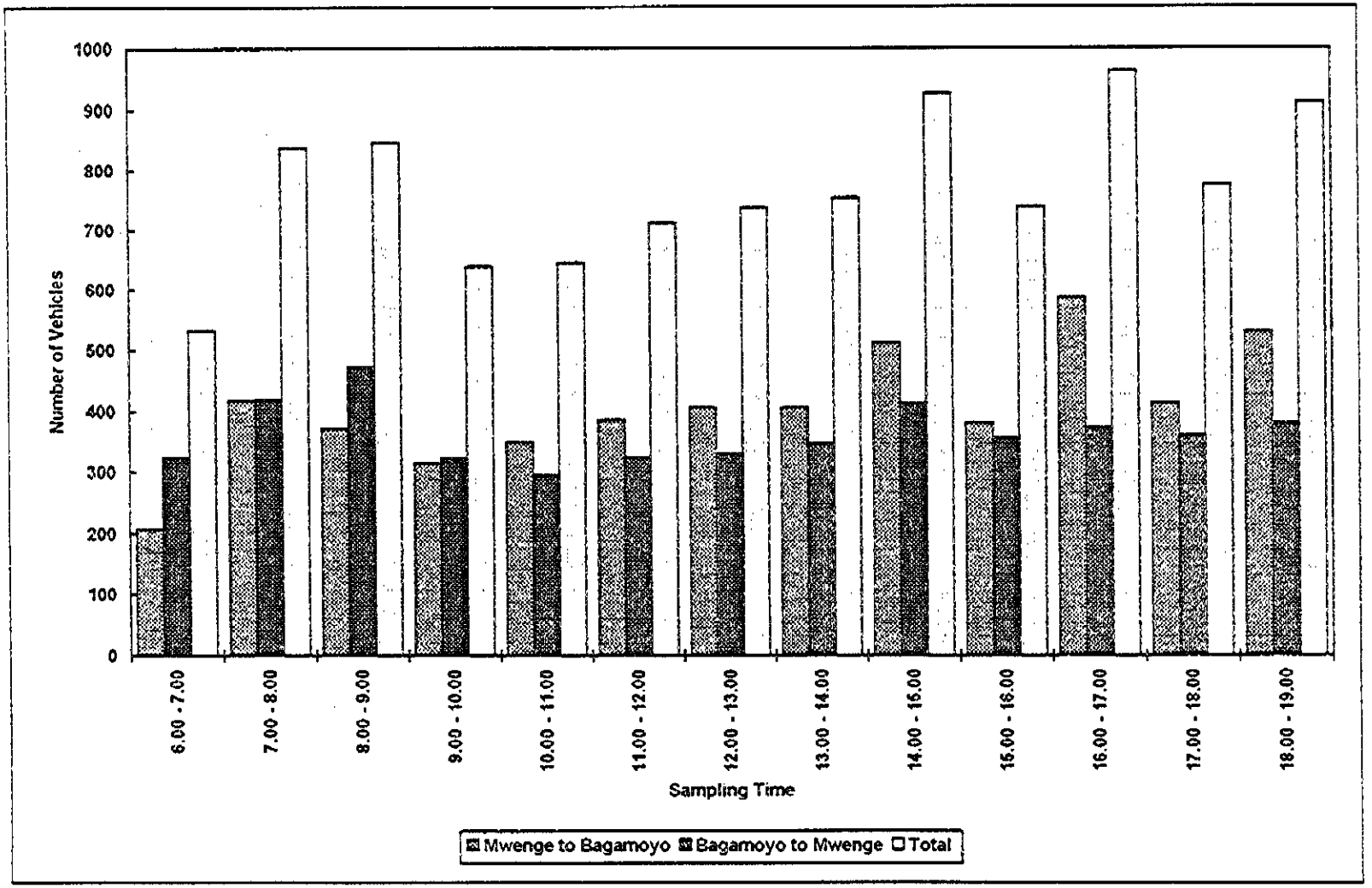

Figure 8-5: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 22 January, 1997

Table 8-7: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 23 January, 1997

TIME		FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
		SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 -	6.00 - 6.10	20	5	0	**25**	15	10	1	**26**	35	15	1	**51**
7.00	6.10 - 7.00	140	24	7	**171**	239	35	5	**279**	379	59	12	**450**
7.00 -	7.00 - 7.10	41	12	1	**54**	86	4	1	**91**	127	16	2	**145**
8.00	7.10 - 8.00	291	98	6	**395**	328	21	8	**357**	619	119	14	**752**
8.00 -	8.00 - 8.10	72	21	3	**96**	77	5	2	**84**	149	26	5	**180**
9.00	8.10 - 9.00	217	58	4	**279**	305	51	14	**370**	522	109	18	**649**
9.00 -	9.00 - 9.10	62	5	2	**69**	52	8	3	**63**	114	13	5	**132**
10.00	9.10 - 10.00	202	94	6	**302**	258	51	3	**312**	460	145	9	**614**
10.00 -	10.00 - 10.10	44	7	1	**52**	60	7	4	**71**	104	14	5	**123**
11.00	10.10 - 11.00	250	60	13	**323**	223	46	13	**282**	473	106	26	**605**
11.00 -	11.00 - 11.10	55	12	1	**68**	45	8	1	**54**	100	20	2	**122**
12.00	11.10 - 12.00	197	76	4	**277**	240	52	9	**301**	437	128	13	**578**
12.00 -	12.00 - 12.10	60	13	1	**74**	53	9	2	**64**	113	22	3	**138**
13.00	12.10 - 13.00	225	88	14	**327**	237	66	10	**313**	462	154	24	**640**
13.00 -	13.00 - 13.10	51	11	1	**63**	54	12	2	**68**	105	23	3	**131**
14.00	13.10 - 14.00	229	49	7	**285**	236	56	6	**298**	465	105	13	**583**
14.00 -	14.00 - 14.10	45	13	1	**59**	43	15	0	**58**	88	28	1	**117**
15.00	14.10 - 15.00	219	81	5	**305**	229	63	5	**297**	448	144	10	**602**
15.00 -	15.00 - 15.10	48	6	2	**56**	45	10	1	**56**	93	16	3	**112**
16.00	15.10 - 16.00	231	53	5	**289**	225	64	4	**293**	456	117	9	**582**
16.00 -	16.00 - 16.10	53	7	2	**62**	38	9	0	**47**	91	16	2	**109**
17.00	16.10 - 17.00	310	50	4	**364**	213	67	2	**282**	523	117	6	**646**
17.00 -	17.00 - 17.10	51	8	1	**60**	49	13	0	**62**	100	21	1	**122**
18.00	17.10 - 18.00	301	31	6	**338**	244	37	3	**284**	545	68	9	**622**
18.00 -	18.00 - 18.10	62	3	2	**67**	59	10	1	**70**	121	13	3	**137**
19.00	18.10 - 19.00	331	20	11	**362**	241	39	5	**285**	572	59	16	**647**

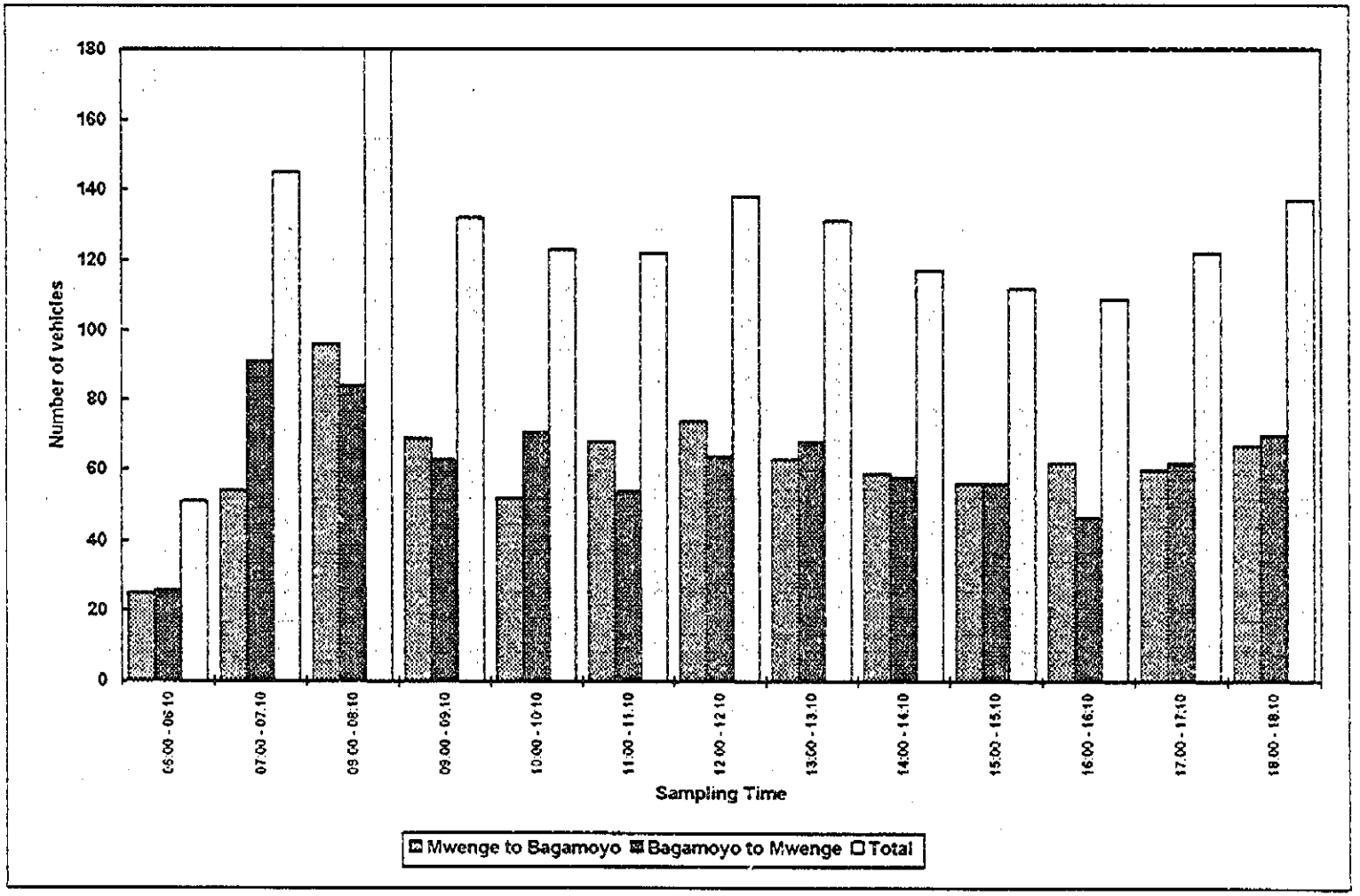

Figure 8-6: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 23 January, 1997

Table 8-8: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 23 January, 1997

TIME	FROM MWENGE TO BAGAMOYO	FROM BAGAMOYO TO MWENGE	TOTAL
6.00 - 7.00	196	305	501
7.00 - 8.00	449	448	897
8.00 - 9.00	375	454	829
9.00 - 10.00	371	375	746
10.00 - 11.00	375	353	728
11.00 - 12.00	345	355	700
12.00 - 13.00	401	377	778
13.00 - 14.00	348	366	714
14.00 - 15.00	364	355	719
15.00 - 16.00	345	349	694
16.00 - 17.00	426	329	755
17.00 - 18.00	398	346	744
18.00 - 19.00	429	355	784

Table 8-9: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road

Date: 23 January, 1997

TIME	FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 - 7.00	160	29	7	196	254	45	6	305	414	74	13	501
7.00 - 8.00	332	110	7	449	414	25	9	448	746	135	16	897
8.00 - 9.00	289	79	7	375	382	56	16	454	671	135	23	829
9.00 - 10.00	264	99	8	371	310	59	6	375	574	158	14	746
10.00 - 11.00	294	67	14	375	283	53	17	353	577	120	31	728
11.00 - 12.00	252	88	5	345	285	60	10	355	537	148	15	700
12.00 - 13.00	285	101	15	401	290	75	12	377	575	176	27	778
13.00 - 14.00	280	60	8	348	290	68	8	366	570	128	16	714
14.00 - 15.00	264	94	6	364	272	78	5	355	536	172	11	719
15.00 - 16.00	279	59	6	345	270	74	5	349	549	133	12	694
16.00 - 17.00	363	57	6	426	251	76	2	329	614	133	8	755
17.00 - 18.00	352	37	7	398	293	50	3	346	645	89	10	744
18.00 - 19.00	393	23	13	429	300	49	6	355	693	72	19	784

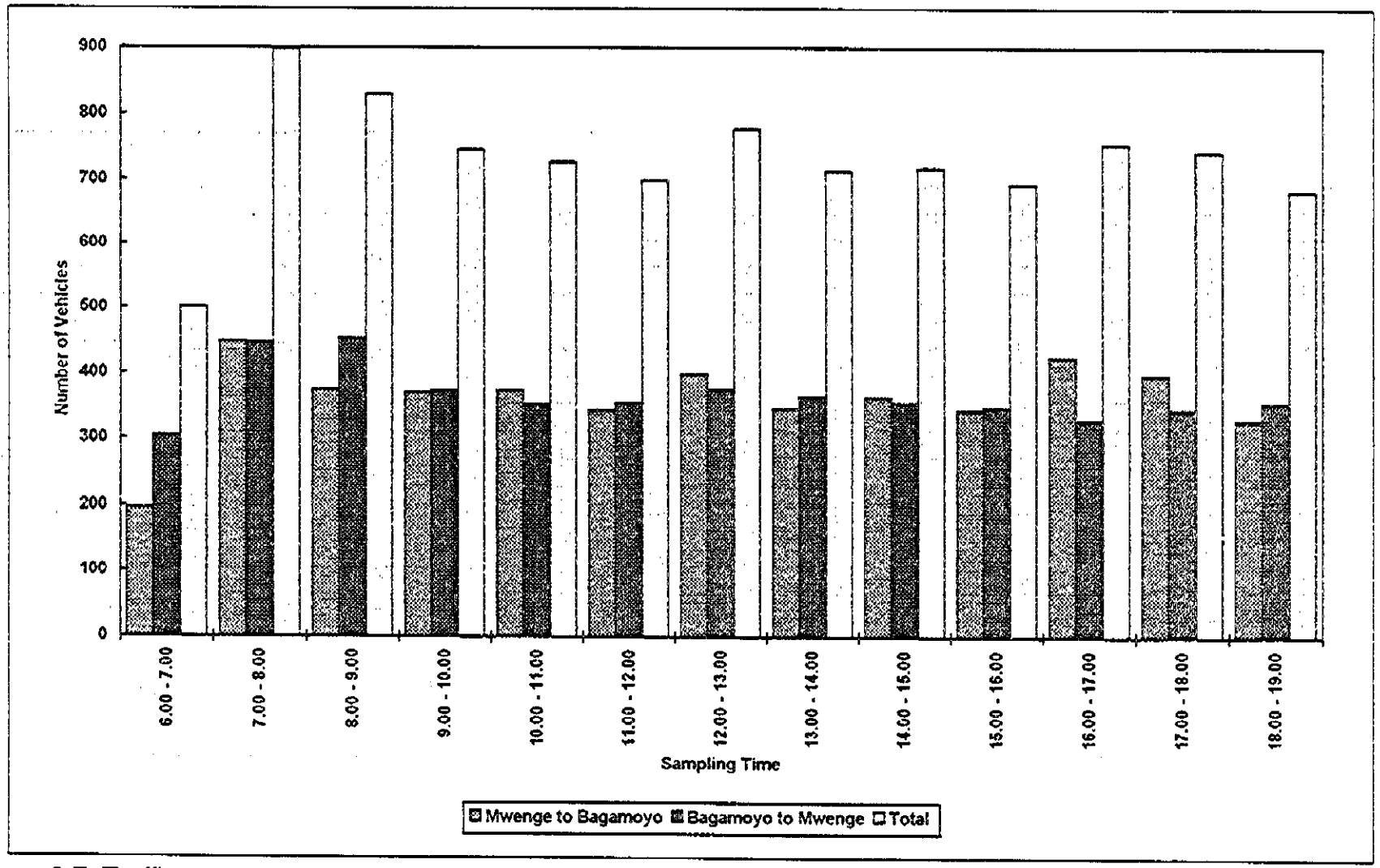

Figure 8-7: Traffic survey results for station A1: New Bagamoyo Road, 150 m north of the intersection with Sam Nujoma Road: 23 January, 1997

Table 8-10: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side

Date: 28 January, 1997

TIME		FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
		SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 -	6.00 - 6.10	6	1	0	**7**	5	0	0	**5**	11	1	0	**12**
7.00	6.10 - 7.00	48	9	3	**60**	64	5	4	**73**	112	14	7	**133**
7.00 -	7.00 - 7.10	14	4	0	**18**	12	1	1	**14**	26	5	1	**32**
8.00	7.10 - 8.00	91	26	4	**121**	80	23	2	**105**	171	49	6	**226**
8.00 -	8.00 - 8.10	17	3	1	**21**	20	3	0	**23**	37	6	1	**44**
9.00	8.10 - 9.00	67	17	1	**85**	85	15	2	**102**	152	32	3	**187**
9.00 -	9.00 - 9.10	17	6	0	**23**	11	3	0	**14**	28	9	0	**37**
10.00	9.10 - 10.00	87	41	1	**129**	69	23	1	**93**	156	64	2	**222**
10.00 -	10.00 - 10.10	13	6	0	**19**	21	2	0	**23**	34	8	0	**42**
11.00	10.10 -11.00	57	34	0	**91**	64	38	1	**103**	121	72	1	**194**
11.00 -	11.00 - 11.10	13	5	1	**19**	11	6	0	**17**	24	11	1	**36**
12.00	11.10 - 12.00	75	41	0	**116**	51	40	0	**91**	126	81	0	**207**
12.00 -	12.00 - 12.10	23	15	0	**38**	17	5	0	**22**	40	20	0	**60**
13.00	12.10 - 13.00	27	15	2	**44**	70	25	4	**99**	97	40	6	**143**
13.00 -	13.00 - 13.10	7	3	1	**11**	14	4	0	**18**	21	7	1	**29**
14.00	13.10 - 14.00	50	22	1	**73**	58	21	2	**81**	108	43	3	**154**
14.00 -	14.00 - 14.10	14	7	1	**22**	14	10	0	**24**	28	17	1	**46**
15.00	14.10 - 15.00	50	22	1	**73**	70	31	1	**102**	120	53	2	**175**
15.00 -	15.00 - 15.10	17	10	0	**27**	15	4	0	**19**	32	14	0	**46**
16.00	15.10 - 16.00	61	36	2	**99**	62	41	0	**103**	123	77	2	**202**
16.00 -	16.00 - 16.10	20	11	2	**33**	12	6	0	**18**	32	17	2	**51**
17.00	16.10 - 17.00	69	32	2	**103**	87	46	7	**140**	156	78	9	**243**
17.00 -	17.00- 17.10	14	5	0	**19**	13	2	0	**15**	27	7	0	**34**
18.00	17.10 - 18.00	73	12	0	**85**	67	21	0	**88**	140	33	0	**173**
18.00 -	18.00 - 18.10	16	4	1	**21**	15	4	0	**19**	31	8	1	**40**
19.00	18.10 - 19.00	40	20	1	**61**	36	8	0	**44**	76	28	1	**105**

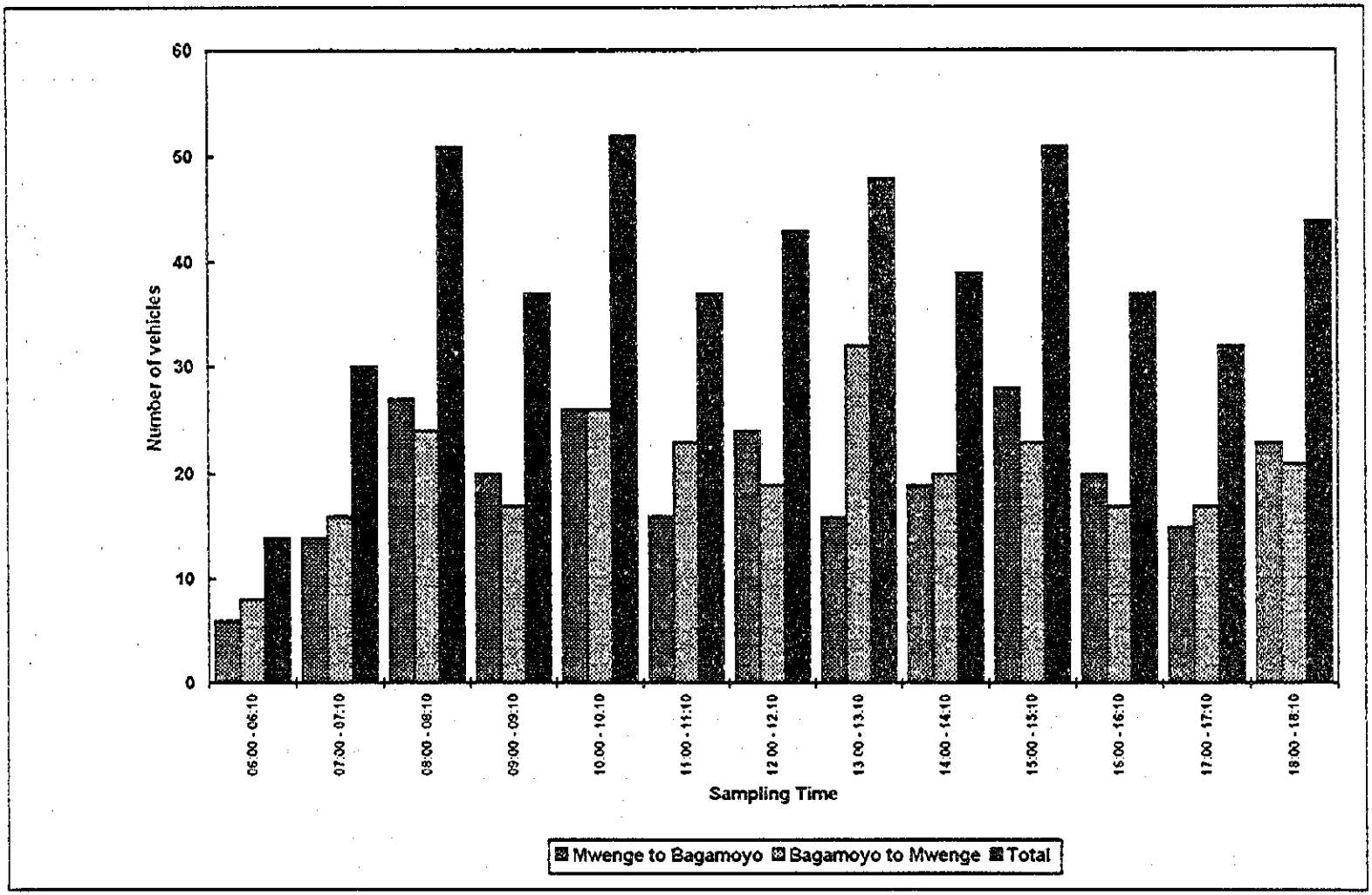

Figure 8-6: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side: 28 January, 1997

Table 8-11: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side

Date: 28 January, 1997

TIME	FROM MWENGE TO BAGAMOYO	FROM BAGAMOYO TO MWENGE	TOTAL
6.00 - 7.00	67	78	145
7.00 - 8.00	139	119	258
8.00 - 9.00	106	125	231
9.00 - 10.00	152	107	259
10.00 - 11.00	110	126	236
11.00 - 12.00	135	108	243
12.00 - 13.00	82	121	203
13.00 - 14.00	84	99	183
14.00 - 15.00	95	126	221
15.00 - 16.00	126	122	248
16.00 - 17.00	136	158	294
17.00 - 18.00	104	103	207
18.00 - 19.00	82	63	145

Table 8-12: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side

Date: 28 January, 1997

TIME	FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 - 7.00	54	10	3	67	69	5	4	78	123	15	7	145
7.00 - 8.00	105	30	4	139	92	24	3	119	197	54	7	258
8.00 - 9.00	84	20	2	106	105	18	2	125	189	38	4	231
9.00 - 10.00	104	47	1	152	80	26	1	107	184	73	2	259
10.00 - 11.00	70	40	0	110	85	40	1	126	155	80	1	236
11.00 - 12.00	88	46	1	135	62	46	0	108	150	92	1	243
12.00 - 13.00	50	30	2	82	87	30	4	121	137	60	6	203
13.00 - 14.00	57	25	2	84	72	25	2	99	129	50	4	183
14.00 - 15.00	64	29	2	95	84	41	1	126	148	70	3	221
15.00 - 16.00	78	46	2	136	77	45	0	122	155	91	2	248
16.00 - 17.00	89	43	4	136	99	52	7	158	188	95	11	294
17.00 - 18.00	87	17	0	104	80	23	0	103	167	40	0	207
18.00 - 19.00	56	24	2	82	51	12	0	63	107	36	2	145

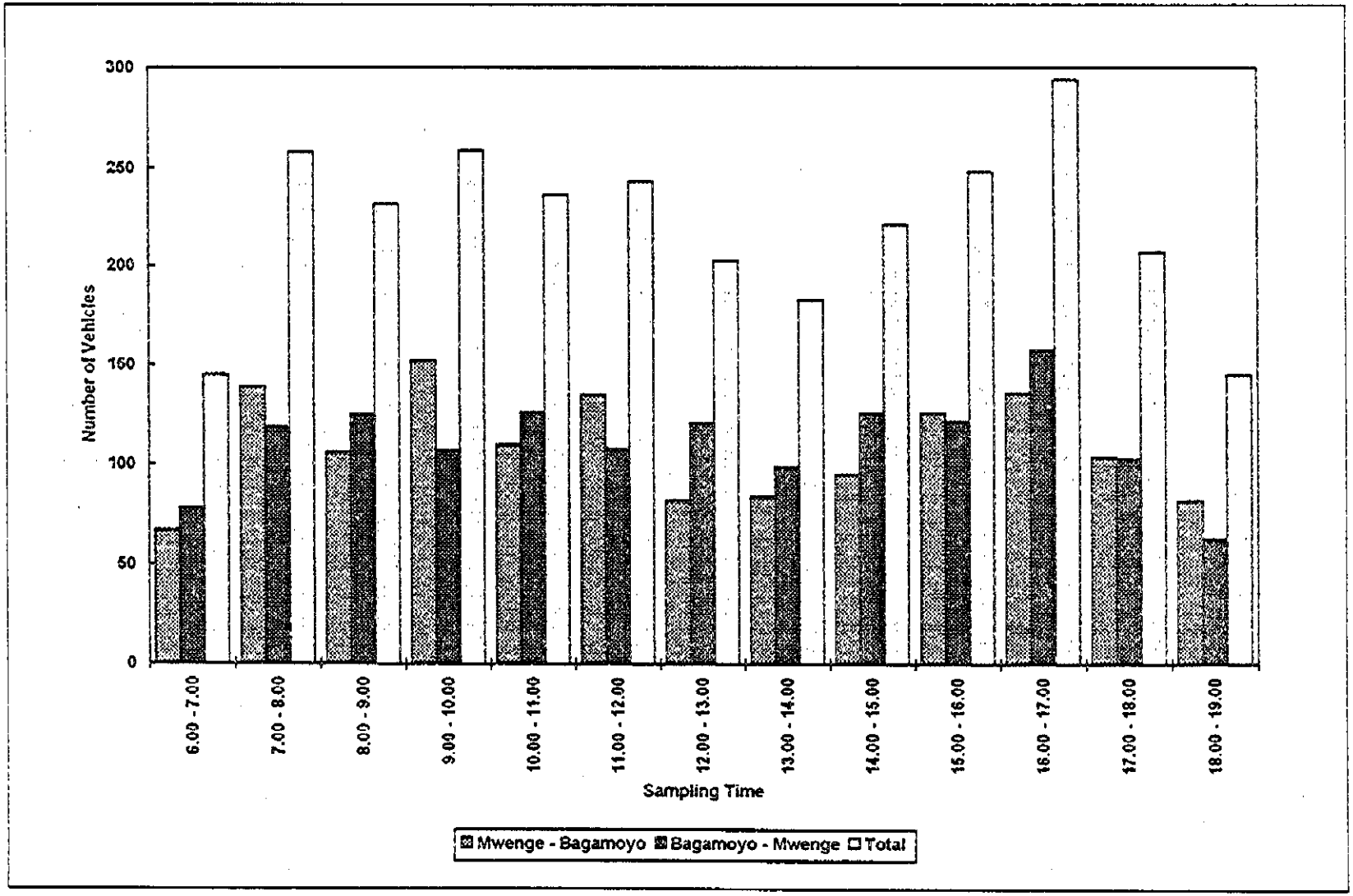

Figure 8-9: Traffic survey results for station A2: New Bagamoyo Road, near to the disposal site on the south-east side: 28 January, 1997

Table 8-13: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side

Date: 29 January, 1997

TIME		FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
		SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 -	6.00 - 6.10	2	4	0	6	6	2	0	8	8	6	0	14
7.00	6.10 - 7.00	42	8	1	51	48	13	2	63	90	21	3	114
7.00 -	7.00 - 7.10	10	4	0	14	15	0	1	16	25	4	1	30
8.00	7.10 - 8.00	80	35	3	118	73	22	2	97	153	57	5	215
8.00 -	8.00 - 8.10	21	6	0	27	20	4	0	24	41	10	0	51
9.00	8.10 - 9.00	62	28	0	90	71	12	0	83	133	40	0	173
9.00 -	9.00 - 9.10	14	6	0	20	15	2	0	17	29	8	0	37
10.00	9.10 - 10.00	59	34	0	93	64	27	1	92	123	61	1	185
10.00 -	10.00 - 10.10	19	6	1	26	13	13	0	26	32	19	1	52
11.00	10.10 - 11.00	48	22	1	71	59	46	3	108	107	68	4	179
11.00 -	11.00 - 11.10	10	4	0	14	15	7	1	23	25	11	1	37
12.00	11.10 - 12.00	64	51	3	118	66	47	4	117	130	98	7	235
12.00 -	12.00 - 12.10	15	9	0	24	12	6	1	19	27	15	1	43
13.00	12.10 - 13.00	42	26	3	71	61	31	2	94	103	57	5	165
13.00 -	13.00 - 13.10	10	6	0	16	17	15	0	32	27	21	0	48
14.00	13.10 - 14.00	42	29	0	71	67	34	1	102	109	63	1	173
14.00 -	14.00 - 14.10	13	6	0	19	12	8	0	20	25	14	0	39
15.00	14.10 - 15.00	62	39	1	102	50	33	0	83	112	72	1	185
15.00 -	15.00 - 15.10	17	10	1	28	13	10	0	23	30	20	1	51
16.00	15.10 - 16.00	65	44	0	109	74	47	3	124	139	91	3	233
16.00 -	16.00 - 16.10	9	10	1	20	12	5	0	17	21	15	1	37
17.00	16.10 - 17.00	51	17	3	71	86	43	4	133	137	60	7	204
17.00 -	17.00 - 17.10	12	2	1	15	13	4	0	17	25	6	1	32
18.00	17.10 - 18.00	70	15	1	86	92	23	3	118	162	38	4	204
18.00 -	18.00 - 18.10	18	4	1	23	17	3	1	21	35	7	2	44
19.00	18.10 - 19.00	86	15	1	102	86	15	1	102	172	30	2	204

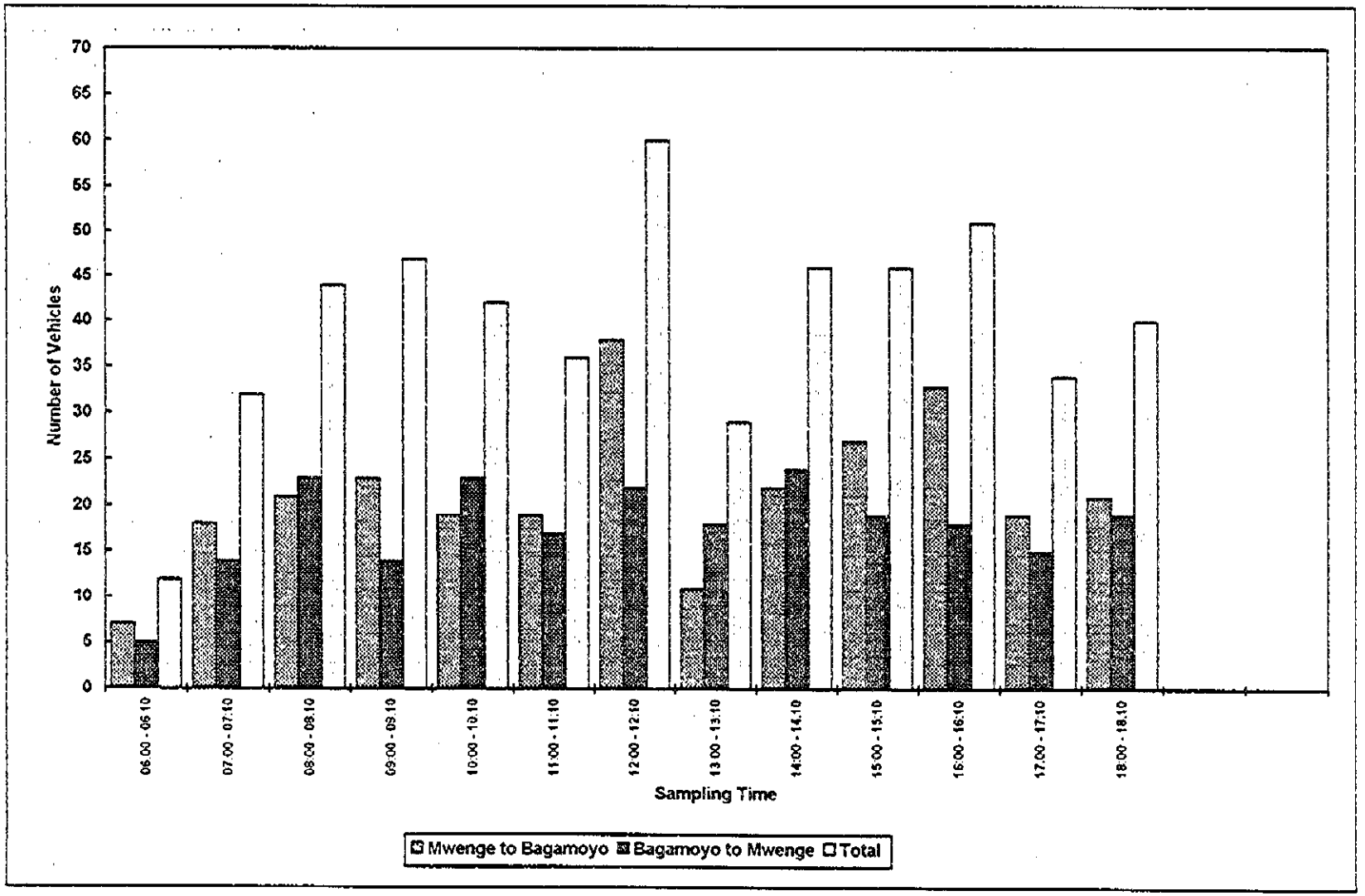

Figure 8-10: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side: 29 January, 1997

Table 8-14: Traffic survey results for station A2: New Bagamoyo Road, near to the disposal site on the south-east side

Date: 29 January, 1997

TIME	FROM MWENGE TO BAGAMOYO	FROM BAGAMOYO TO MWENGE	TOTAL
6.00 - 7.00	57	71	128
7.00 - 8.00	132	113	245
8.00 - 9.00	117	107	224
9.00 - 10.00	113	109	222
10.00 - 11.00	97	134	231
11.00 - 12.00	132	140	272
12.00 - 13.00	95	113	208
13.00 - 14.00	87	134	221
14.00 - 15.00	121	103	224
15.00 - 16.00	137	147	284
16.00 - 17.00	91	150	241
17.00 - 18.00	101	135	236
18.00 - 19.00	125	123	248

Table 8-15: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side

Date: 29 January, 1997

TIME	FROM MWENGE TO BAGAMOYO				FROM BAGAMOYO TO MWENGE				TOTAL			
	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL	SV	LV	MC	TOTAL
6.00 - 7.00	44	12	2	57	54	15	2	71	98	27	3	128
7.00 - 8.00	90	39	3	132	88	22	3	113	178	61	6	245
8.00 - 9.00	83	34	0	117	91	16	0	107	174	50	0	224
9.00 - 10.00	73	40	0	113	79	29	1	109	152	69	1	222
10.00 - 11.00	67	28	2	97	72	59	3	134	139	87	5	231
11.00 - 12.00	74	55	3	132	81	54	5	140	155	109	8	272
12.00 - 13.00	57	35	3	95	73	37	3	113	130	72	6	208
13.00 - 14.00	52	35	0	87	84	49	1	134	136	84	1	221
14.00 - 15.00	75	45	1	121	62	41	0	103	137	86	1	224
15.00 - 16.00	82	54	1	137	87	57	3	147	169	111	4	284
16.00 - 17.00	60	27	2	91	98	48	4	150	158	75	8	241
17.00 - 18.00	82	17	2	101	105	27	3	135	187	44	5	236
18.00 - 19.00	104	19	2	125	103	18	2	123	207	37	4	248

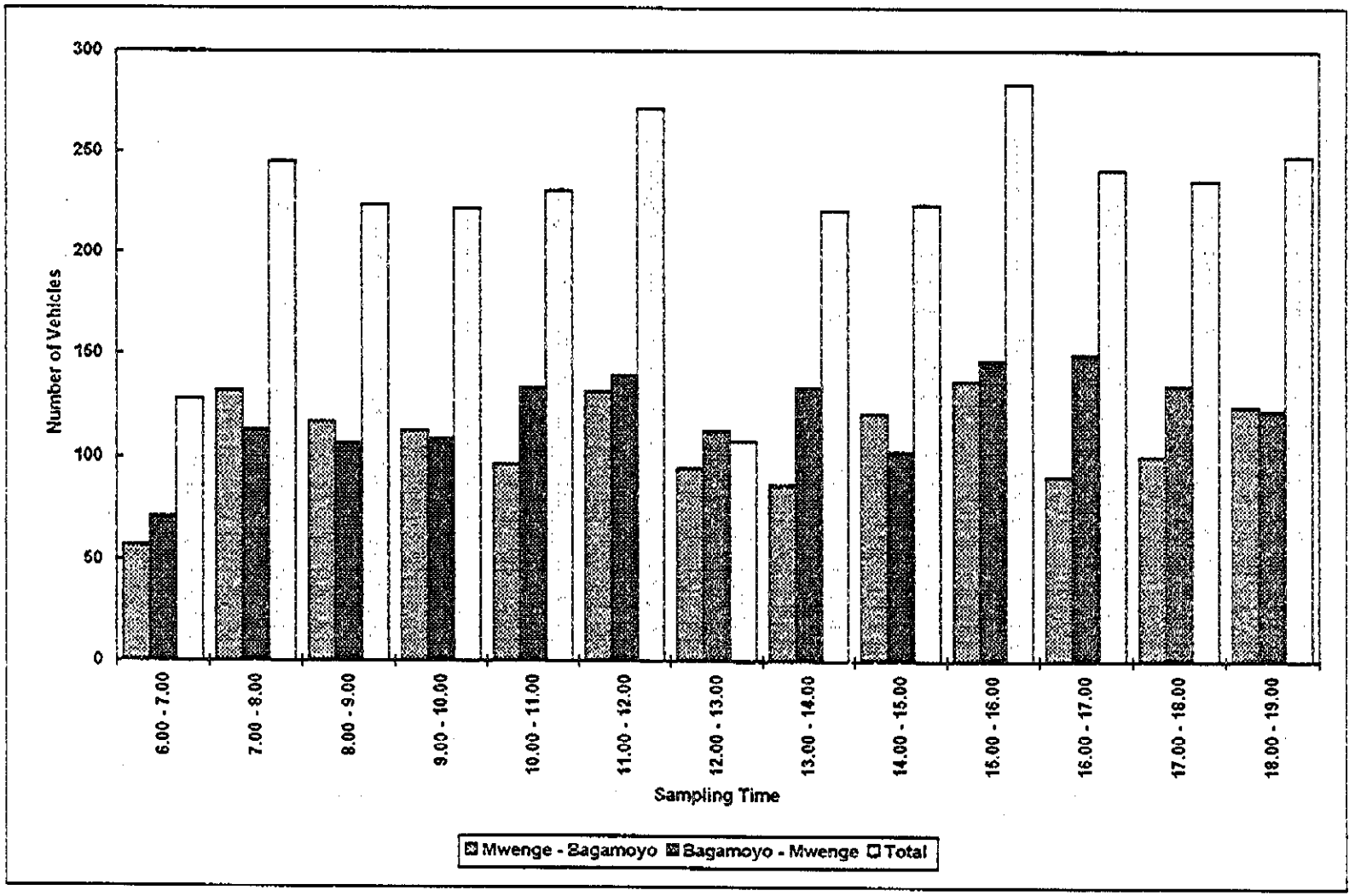

Figure 8-11: Traffic survey results for station A2: New Bagamoyo Road, near to the proposed disposal site on the south-east side: 29 January, 1997