6.4.6 Traffic Volume

A traffic volume survey was conducted for two 3 day periods from 6am - 7pm at two survey stations on New Bagamoyo Road (see Figure 6-8). Station A1 was located about 150 metres north of the junction with Sam Nujoma Road at Mwenge; station A2 about 300 m south of the proposed landfill site.

At each station, traffic travelling out of the city (Mwenge to Bagamoyo) and into the city (Bagamoyo to Mwenge) was recorded separately and then summed to get the total number of vehicles passing each station. Traffic was divided into three categories: small vehicles (3.5 tonnes or less), large vehicles (over 3.5 tonnes) and motorcycles and counted and recorded hourly. The data is summarised in Appendix 1 and the results are displayed graphically in Figure 6-9 - Figure 6-10. The complete data is presented in section 8 of the Annex.

6.4.6.1 Traffic Volume and Flows

The road is in reasonable condition with ample shoulders and few potholes, thus facilitating traffic flows (Plate 4.11).

For each station, traffic flows are relatively uniform throughout the day and there was no significant variation in the volume of traffic travelling in either direction.

The average total number of vehicles passing stations A1 and A2 over the 13 hour measurement period was 9,700 and 2,980 respectively, equivalent to average hourly flows of 750 and 230 respectively. The traffic density at station A1 is 3.3 times greater than that at station A2. This is to be expected as most of the vehicles passing station A1 begin or terminate their journeys in the Mbezi area, which is located between the two survey stations.

At station A1, peak total traffic flows were recorded between 7am - 9am, 4pm - 5pm and 6pm - 7pm. At station A2, peak traffic flows were recorded between 8am-10am and 3pm - 5pm. Peak flows were in the range of 820-845 and 250-275 vehicles at stations A1 and A2 respectively.

The average composition of the traffic passing station A1 is 18% large vehicles, 80% small vehicles and 2% motorbikes. Corresponding results for station A2 are 30% large vehicles, 68% small vehicles and 2% motorcycles.

Plate 4.11: New Bagamoyo Road at survey station A1, about 150 m north of the junction with Sam Nujoma Road at Mwenge. This photo shows the typical condition of this road.

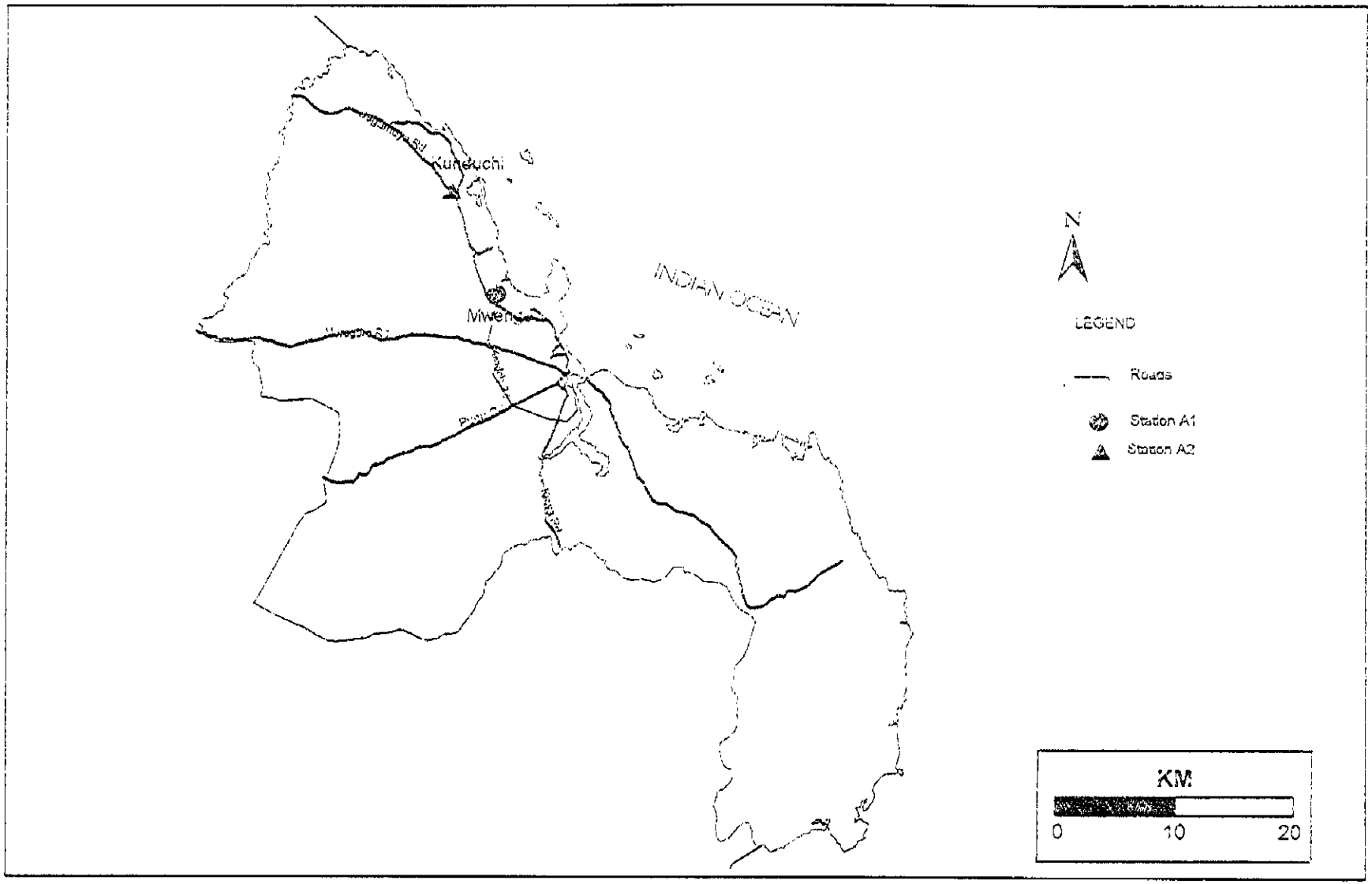
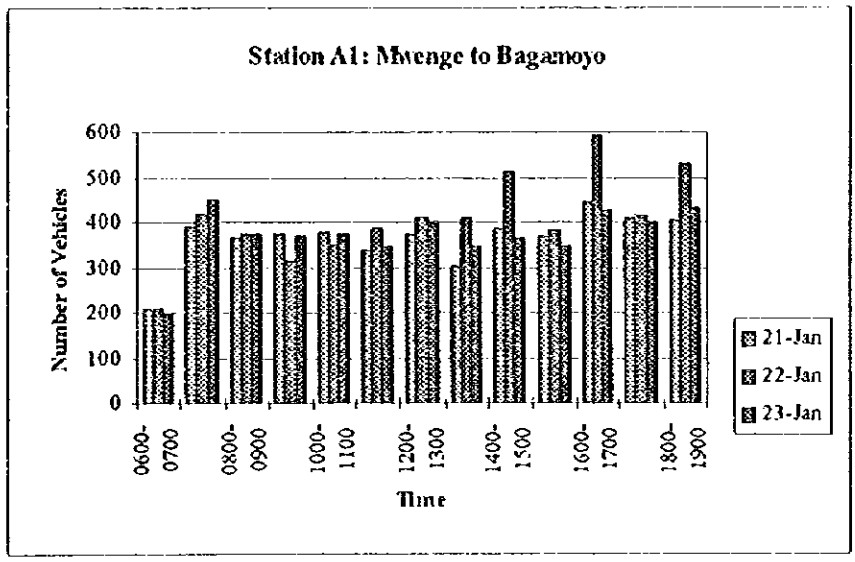
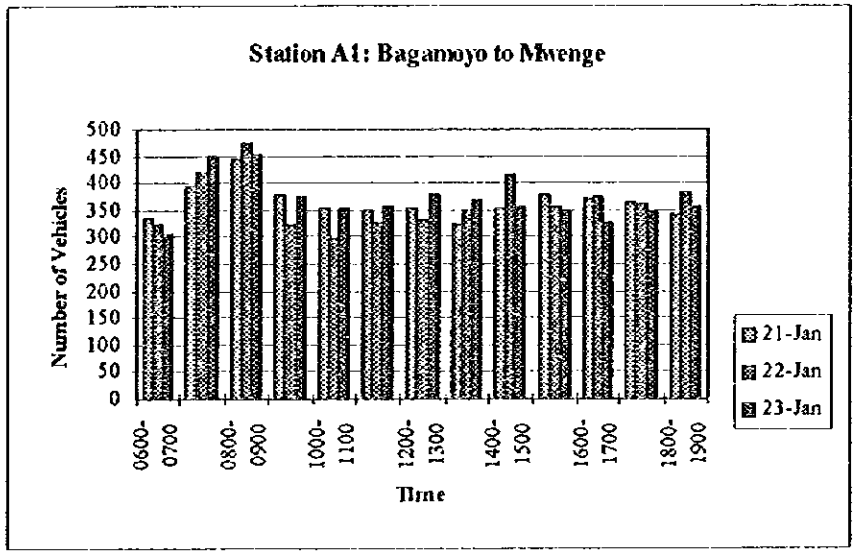


Figure 6-7: Location of Survey Stations along New Bagamoyo Road





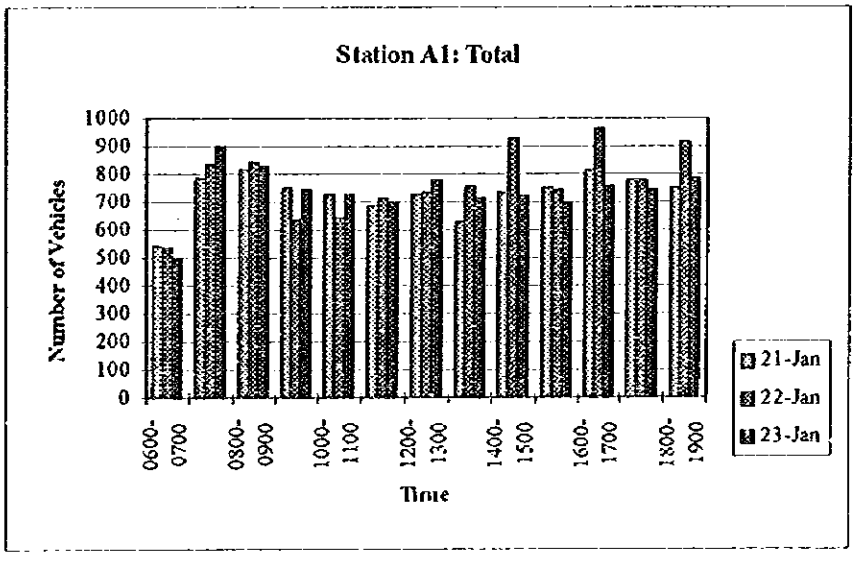
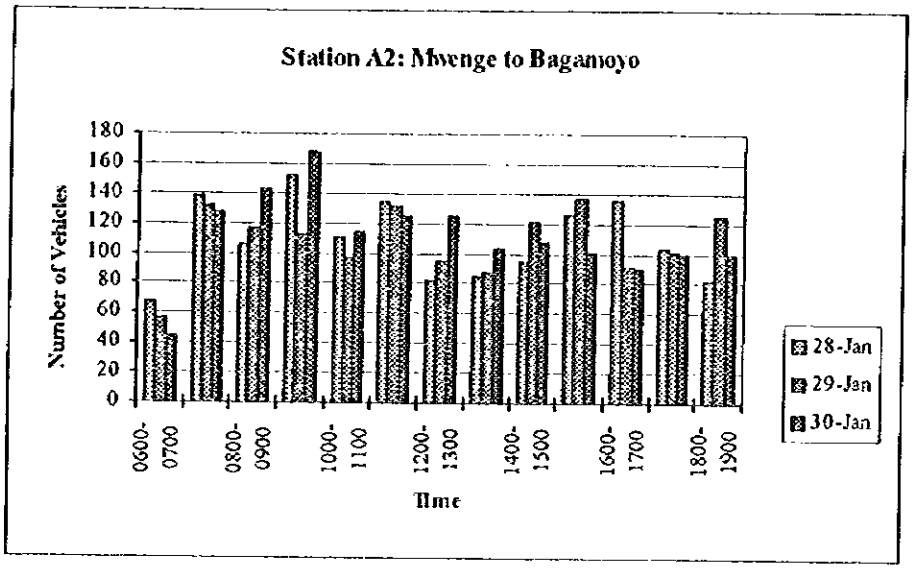
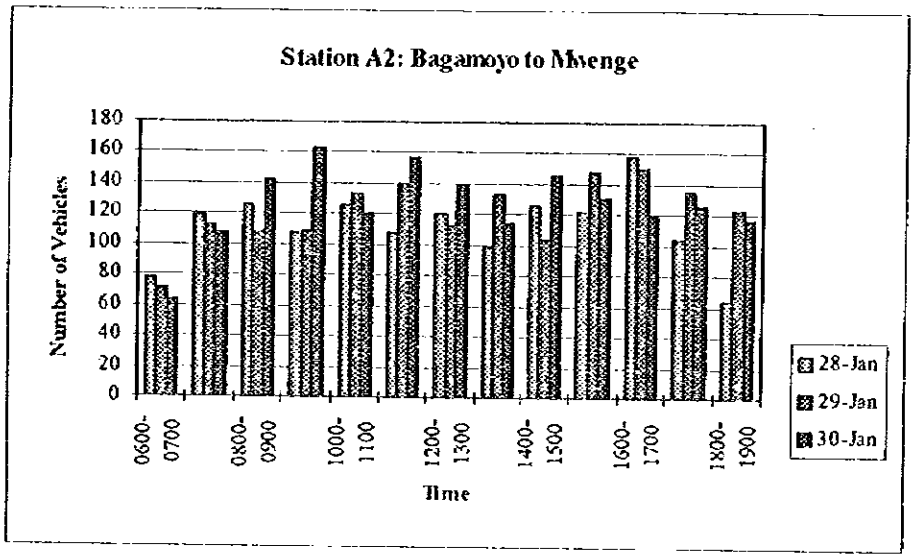


Figure 6-8: Traffic Survey Results at Station A1: 21-23 January 1997





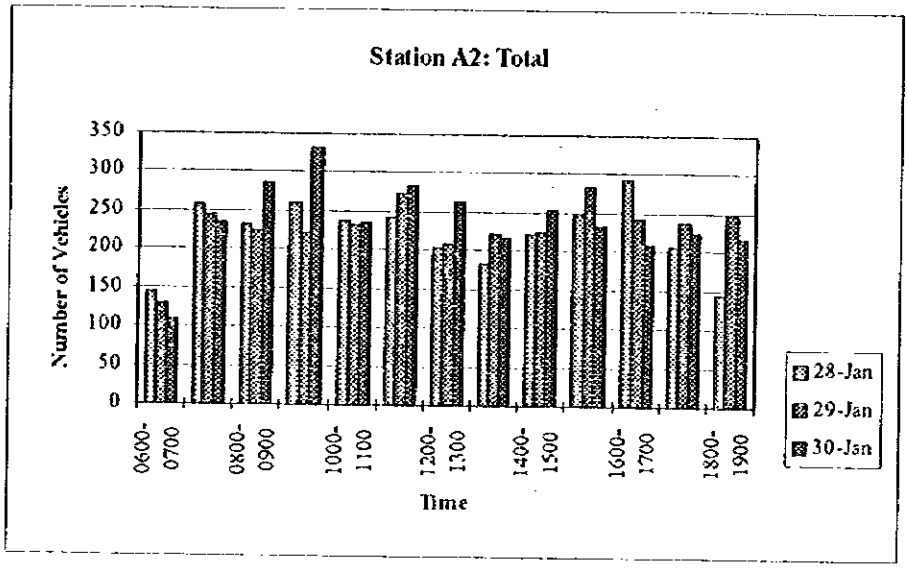


Figure 6-9: Traffic Survey Results at Station A2: 28-30 January, 1997

6.4.6.2 Comparison of Traffic Volumes with Road Carrying Capacity

New Bagamoyo Road is a two lane, single carriageway road running northwards from Morocco Road (Rashidi Kawawa Road) and has a design carrying capacity of 10,000 vehicles per 12 hours[7]. In order to compare traffic volumes with the road carrying capacity, it is necessary to express traffic volumes in terms of the equivalent number of small vehicles and on a 12 hour basis. This is done as follows:

- The number of large vehicles and motorcycles was converted to equivalent numbers of small vehicles (Table 6-6) using standard Japanese conversion factors of 2 and 0.5 respectively, giving a total of 11,350 and 3,840 vehicles per 13 hours at stations A1 and A2 respectively.

Table 6-6: Calculation of Equivalent Number of Small Vehicles

Station A1

Type of Vehicle	Composition (%)	Number of Vehicles per 13 hours	Conversion factor	Equivalent number of small vehicles per 13 hours
Large vehicle	18	1,746	2	3,492
Small vehicle	80	7,760	1	7,760
motorcycles	2	194	0.5	97
Total	100	9,700	1.17	11,349

Station A2

Type of Vehicle	Composition (%)	Number of Vehicles per 13 hours	Conversion factor	Equivalent number of small vehicles per 13 hours
Large vehicle	30	894	2	1,788
Small vehicle	68	2,026	1	2,026
motorcycles	2	60	0.5	30
Total	100	2,980	1.29	3,844

- The data was converted to a 12 hour basis (on a pro rata basis) to give traffic volumes of 10,480 and 3,545 per 12 hour period at stations A1 and A2 respectively.

The traffic volume at station A1 (10,480 per 12 hours) shows that the road carrying capacity already exceeds its design capacity at this location by 4.8%. At station A2, traffic volume (3,545 per 12 hours) is only 35% of the road carrying capacity.

6.4.6.3 New Bagamoyo Road Development Plans[8]

According to short term development plans, New Bagamoyo Road will be widened from two to four lanes from Morocco Road to Sam Nujoma Road, a distance of 4.4 km. Construction is scheduled for 1998-99 although funds have yet to be secured for this work.

Long term development plans (2000 - 2010) provide for further widening of 12.6 km of New Bagamoyo Road from Sam Nujoma Road to Wazo Hill, north of the proposed landfill site.

[7] Ministry of Works, Tanzania
[8] "The Study on Dar es Salaam, Road Development Plans, Final Report"; JICA; March 1995

6.4.6.4 Projected Traffic Volumes

Future traffic volumes were calculated using the survey data, expressed in terms of equivalent number of vehicles per 12 hours, and assuming that the growth rate in the number of vehicles in DSM remains constant at 6.3%[9]. These projected traffic volumes are shown in Table 6-7 for the years 2000 - 2005. The year 2000 is when operation of the new landfill at Kunduchi is scheduled to begin, while 2005 is the target year for the Master Plan.

Table 6-7: Projected Traffic Volumes at Stations A1 and A2

Year	Traffic Projection (number of vehicles per 12 hours)	
	Station A1	Station A2
1997	10,480	3,545
2000	12,590	4,260
2001	13,380	4,530
2002	14,220	4,810
2003	15,120	5,110
2004	16,070	5,440
2005	17,085	5,780

By 2005, the projected traffic volume at station A1 will be 17,085 per 12 hours or 71% greater than the road carrying capacity, which may lead to serious congestion problems along this section of the road. In contrast, the projected traffic volume at station A2 will be 5,780 per 12 hours or 58% of the road carrying capacity and no congestion problems should be experienced along this section of the road.

Hence, it is important for the long term road development plans to be approved and implemented as soon as practicable after 2000. Sections of New Bagamoyo Road between Sam Nujoma Road and Wazo Hill where the road carrying capacity will be exceeded should be identified and upgraded first.

Development of Tegeta as a residential area may also increase the traffic volume on New Bagamoyo Road.

6.4.7 Noise and Vibration

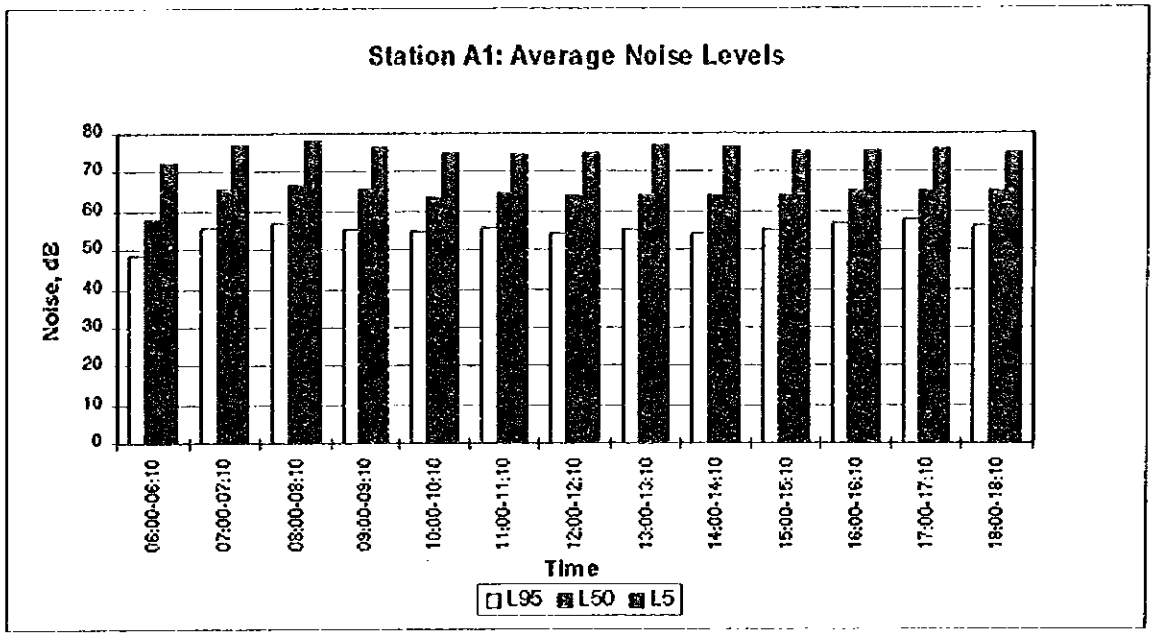
Noise and vibration surveys were conducted at the same time and at the same survey stations, A1 and A2, as the traffic volume survey. At each survey station, noise and vibration measurements were made at one second intervals using appropriate meters for the first ten minutes of each hour from 0600 -1900. Average readings were recorded at the end of this period. Details of survey sites, measurement methods and the complete results are presented in sections 9 and 10 of the Data 7.

At each station, there was no significant variation in the noise and vibration results for different dates. Hence, 3 day average noise and vibration values were calculated for each time interval and these are plotted in Figure 6-11 - Figure 6-12 respectively.

The principal land uses near survey stations A1 and A2 are high density unplanned residential/commercial/industrial and residential/agricultural/commercial/light industrial

[9] "The Study on Dar es Salaam, Road Development Plans, Final Report"; JICA, March 1995

respectively. Hence, measured values are compared with the appropriate Japanese standards for mixed residential/commercial/industrial areas below.



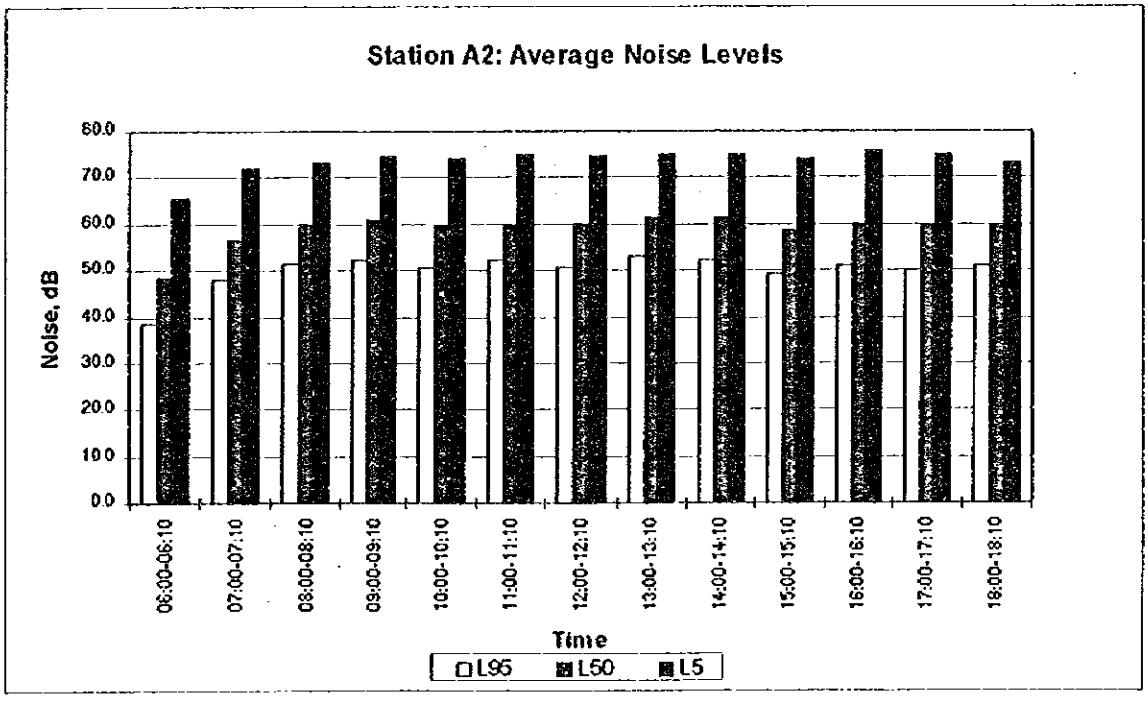
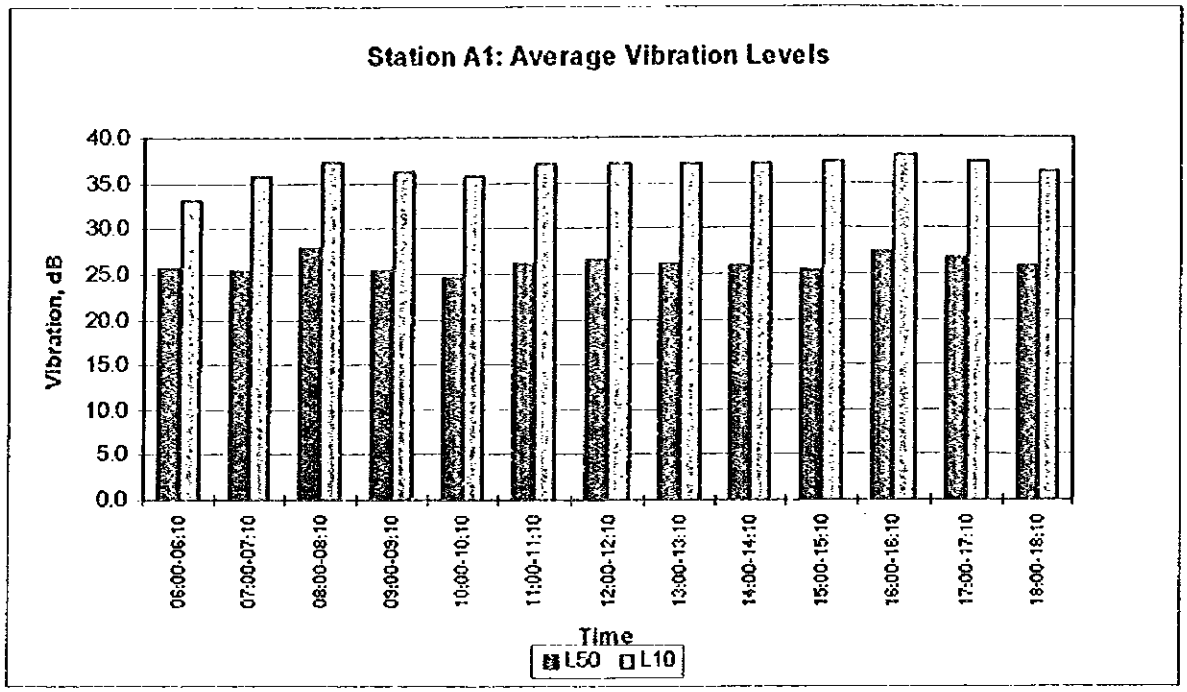


Figure 6-10: Average Noise Levels



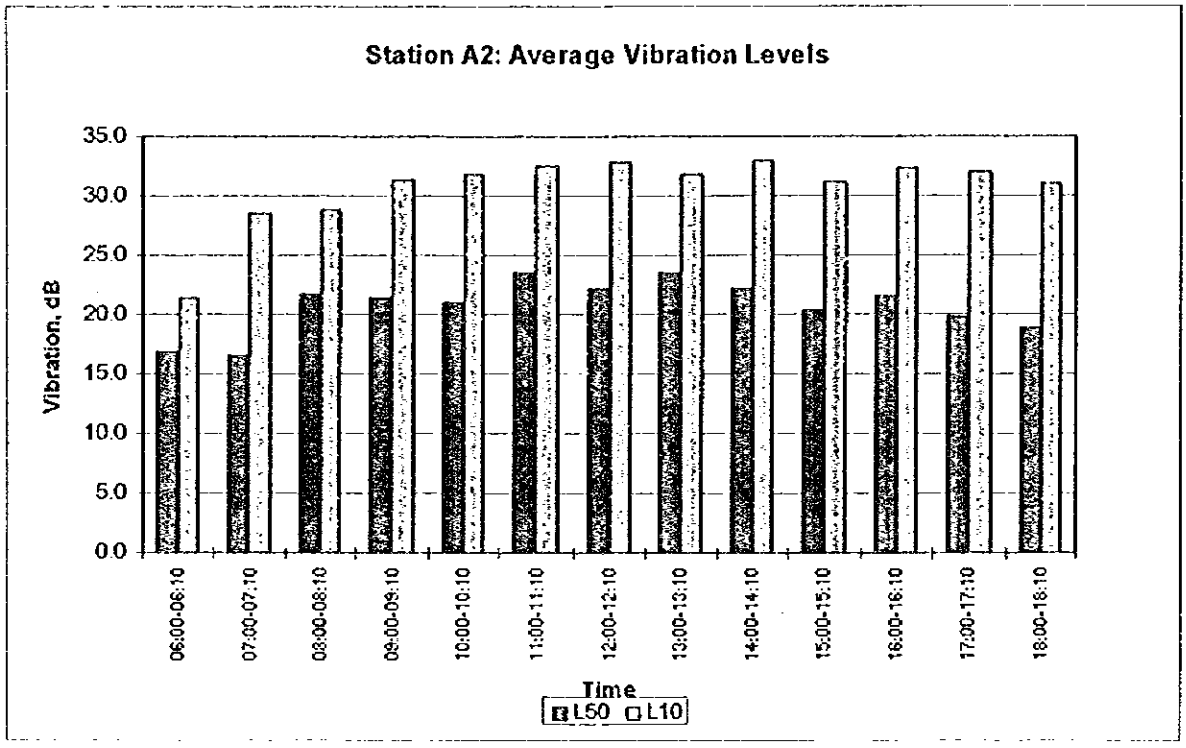


Figure 6-11: Average Vibration Levels

6.4.7.1 Noise levels

The maximum, minimum and overall average L_{95}, L_{50} and L_5 noise values are shown in Table 6-8 for stations A1 and A2.

Table 6-8: Maximum, Minimum and Overall Average Noise Levels

Station	Noise Level	Minimum (dB)	Maximum (dB)	Average (dB)
A1	L_{95}	47.4	58.5	55.2
	L_{50}	58.4	68.4	64.2
	L_5	70.6	81.8	75.6
A2	L_{95}	36.0	55.0	50.0
	L_{50}	46.2	63.6	58.8
	L_5	60.9	78.2	73.5

Note: Japanese L_{50} standard is 65 dB for mixed residential/commercial/industrial areas during the daytime

Average daily values did not vary significantly during the measurement period for each index (i.e. L_{95}, L_{50} and L_5).

L_{95} measures the noise level which is exceeded for 95% of the measurement period and is used as an indicator of background noise. The average L_{95} values for stations A1 and A2 were 55.2 and 50.0 dB respectively.

L_{50} measures the level of noise which is exceeded for 50% of the measurement period. Average L_{50} values for stations A1 and A2 were 64.2 and 58.8 dB respectively. Both these values are slightly less than the corresponding Japanese standard of 65 dB although the former value is very close to the standard.

L_5 measures the level of noise which is exceeded for 5% of the measurement period and may be used as an indicator of the upper limit of fluctuating noise such as that from road traffic. Average L_5 values for stations A1 and A2 were 75.6 and 73.5 dB respectively. These noise levels do not reflect the significant difference in average daily traffic volume between the two survey stations (746 and 229 vehicles/hour at stations A1 and A2 respectively) as might be expected. However, this apparent discrepancy can be explained by the fact that the percentage of large vehicles observed at station A2 was much higher than at A1 (30% compared with 18%). Furthermore, many of the large vehicles passing station A2 were observed to be earth-moving equipment and very large goods vehicles, whose movements are largely confined to the Kunduchi and Tegeta areas.

6.4.7.2 Vibration levels

The maximum, minimum and overall average L_{50} and L_{10} vibration values are shown in Table 6-9 for stations A1 and A2.

Table 6-9: Maximum, Minimum and Overall Average Vibration Levels

Station	Noise Level	Minimum (dB)	Maximum (dB)	Average (dB)
A1	L_{50}	23.2	29.5	26.1
	L_{10}	32.0	39.2	36.6
A2	L_{50}	15.0	25.0	20.7
	L_{10}	19.8	34.9	30.7

Note: Japanese L_{50} standard is 70 dB for mixed residential/commercial/industrial areas during the daytime

Average daily values did not vary significantly during the measurement period for each index (i.e. L_{50} and L_{10}).

L_{50} measures the level of vibration which is exceeded for 50% of the measurement period. Average L_{50} values for stations A1 and A2 were 26.1 and 20.7 dB respectively. Both these values are significantly less than the corresponding Japanese standard of 70 dB.

L_{10} measures the level of vibration which is exceeded for 10% of the measurement period and may be used as an indicator of the upper limit of fluctuating vibration such as that from road traffic. Average L_{10} values for stations A1 and A2 were 36.6 and 30.7 dB respectively. These noise levels only differ by 20% and do not reflect the significant difference of 225% in average daily traffic volume between the two survey stations for reasons explained in section 4.7.1.

The vibration levels were measured at a distance of one metre from the edge of the road. As walkways and areas further away from the road are not paved, the vibrations experienced by residents and passersby will be significantly less than the measured values due to heavy damping.

6.4.8 Air Quality

This survey was also conducted at survey stations, A1 and A2, along New Bagamoyo Road and at the proposed disposal site. For stations A1 and A2, measurements were made over a three day period at the same time as for the traffic volume, noise and vibration surveys. The following gas concentrations were measured: carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3), together with temperature, humidity, wind direction and speed. At the disposal site, dust fall-out was also measured. Details of the survey stations, methodologies and the complete results are presented in the Data 7(section 11).

Concentrations of these gases were measured using gas sampling tubes and as such represent instantaneous rather than average values for each sampling period. In the absence of Tanzania air quality standards, the air quality survey results are compared with the appropriate Japanese standards. Carbon monoxide, nitrogen oxides, sulphur dioxide and ammonia were monitored in order to obtain baseline data for the concentrations of these gases.

Combustion exhaust gases from transportation sources are a major source of CO and NO_x emissions as well as volatile organic compounds (VOCs) and to a lesser extent, sulphur oxides (SO_x). Particulate matter (PM) is also created during combustion and includes small solids or liquid droplets (0.01 - 100 micrometers). In the USA in 1991, transportation sources were the primary anthropogenic source of CO (>70%) and also contributed about 38%, 30% and 21% of the NO_x, VOC and PM emissions respectively while their contribution to SO_x emissions was small (3-4%) as fuels in the USA are highly refined with sulphur largely being removed[10]. The burning of solid/fossil fuels accounts for over 80% of anthropogenic SO_2 emissions, especially from fuel combustion in stationary sources (power/heating) and industrial processes[11].

[10] "The Civil Engineering Handbook"; CRC Press Inc.; USA; 1995; pg 2436
[11] " Environmental Engineering"; Peavy et al; McGraw Hill, Inc.; 1986; pp 453-454

Ammonia is not normally measured in ambient air quality surveys but was included in this case to generate baseline data as ammonia is a typical constituent of landfill gas (0.1 - 1.0 vol. %[12]). Methane was not monitored as no methane gas detector tube was available.

6.4.8.1 Roadside Air Quality

The baseline air quality data obtained from the survey conducted at two points along New Bagamoyo Road and at the disposal site are summarised in Table 6-10. The average concentration results are presented in Figure 6-12 - Figure 6-14.

Table 6-10: Baseline Air Quality Data

Gas	Concentration	Station A1	Station A2	Standard
Carbon Monoxide	average	3.3	1.87	10
	maximum	5.0	4.0	20
Nitrogen Oxides	average	0.04	0.01	0.06
	maximum	0.08	0.06	---
Sulphur Dioxide	average	0.06	0.09 (0.05)	0.04
	maximum	0.16	0.31 (0.13)	0.10
Traffic Volume	Equiv. No. of small vehicles/ 12 hr	10,480	3,545	

Note: 1. Ammonia was not detected at any time at each of the survey points.
2. Dust was also measured at the disposal site but the levels of dust recorded were insignificant.
3. The numbers in brackets for SO_2 are adjusted values as explained in the text.

Average carbon monoxide (CO) concentrations at stations A1 and A2 were 3.3 and 1.87 ppm respectively while the corresponding highest recorded concentrations were 5.0 and 4.0 ppm. All of these values are within the Japanese standards which specify that the average concentration per 24 hour period must be less than 10 ppm while the maximum concentration per 8 hour period must be less than 20 ppm.

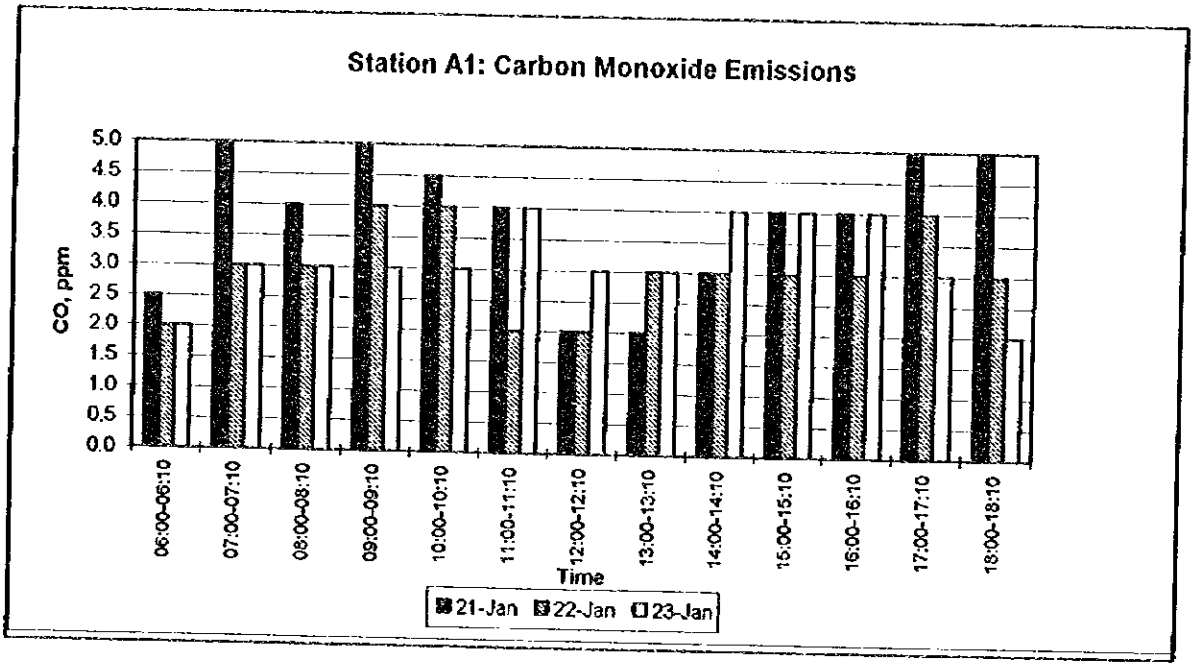
For both stations, there was no clear correlation between CO concentration with time and traffic volume. This could partially be attributed to the open nature of the stations and relatively strong winds which facilitated dispersion of gases. However qualitatively, the average traffic volume (in terms of small vehicles) at station A1 is 3.0 times greater than that at station A2 and clearly, this has contributed to the CO concentrations being 1.8 times higher at station A1 than at A2.

Average nitrogen oxide concentrations at stations A1 and A2 were 0.04 and 0.01 ppm respectively while the corresponding highest recorded concentrations were 0.08 and 0.06 ppm. This can primarily be attributed to the significantly higher traffic volumes recorded at station A1 relative to station A2.. The average values are within the Japanese standards which specify that the average concentration per hour period must be less than 0.06 ppm. Inspection of Figure 6-13 shows that the nitrogen oxides concentration only reached 0.08 ppm on three occasions at survey station A1 between 1300-1600 and hence it is possible that the average hourly concentration will exceed the Japanese standard of 0.06 ppm during this time at station A1. This figure also shows that NO_x concentrations are lowest before 7 am and after 6 pm.

Average sulphur dioxide concentrations at stations A1 and A2 were 0.06 and 0.09 ppm respectively while the corresponding highest recorded concentrations were 0.16 and 0.31 ppm. These values are greater than the Japanese standards which states that the

[12] "Integrated Solid Waste Management"; Tchobanoglous et al; Mcgraw Hill Inc.; 1993; pg 382

average concentration per 24 hour period must be less than 0.04 ppm while the maximum concentration per 8 hour period must be less than 0.1 ppm.



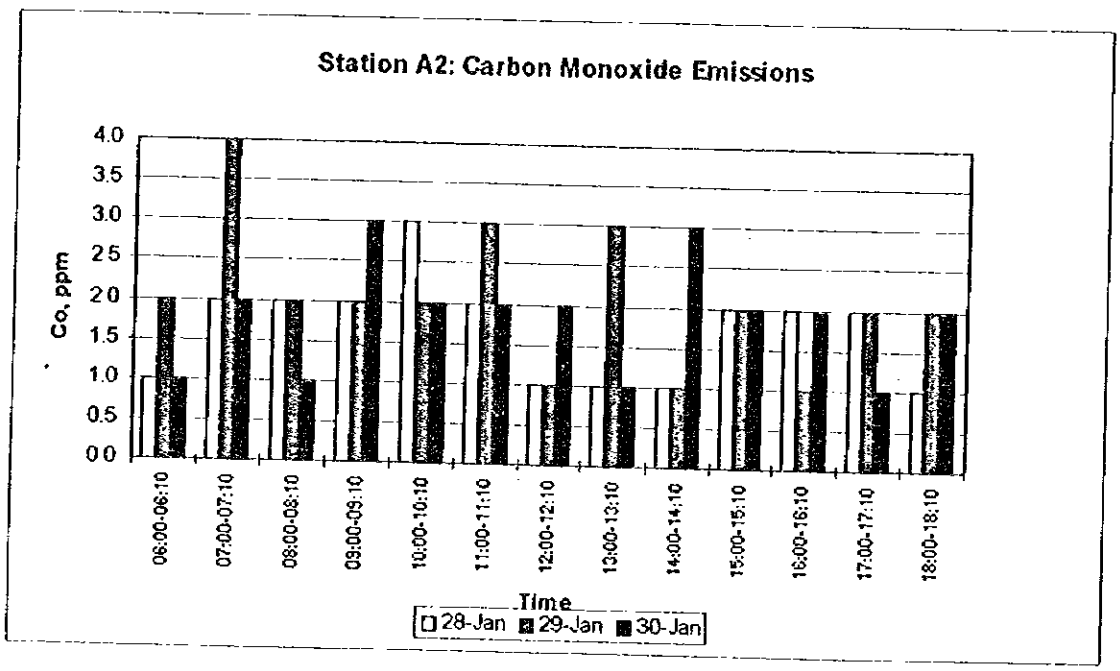
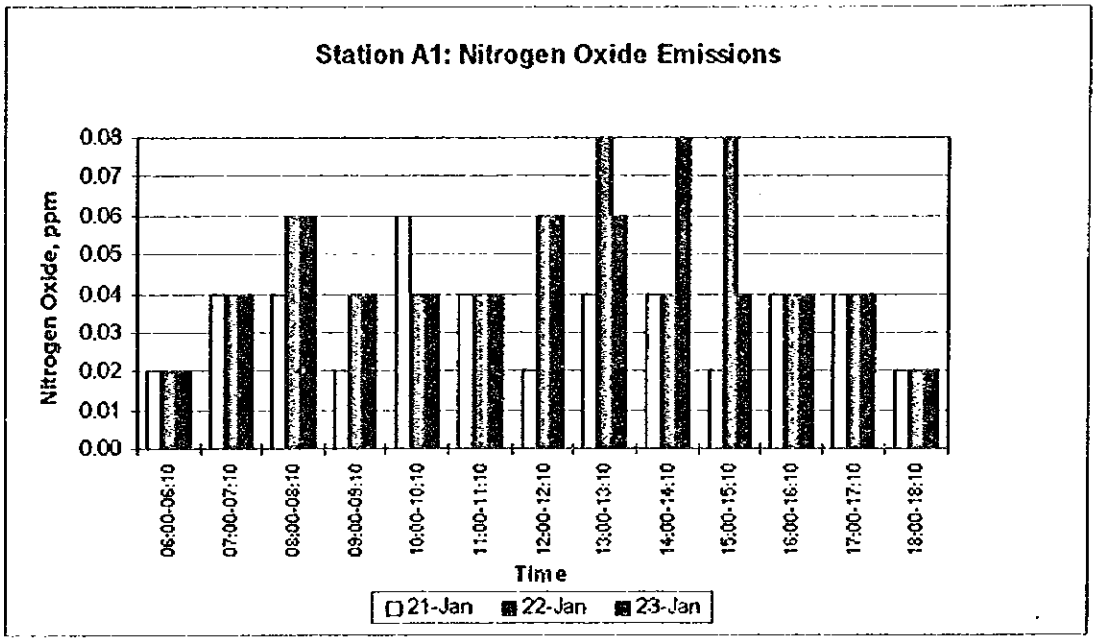


Figure 6-12: Carbon Monoxide Levels



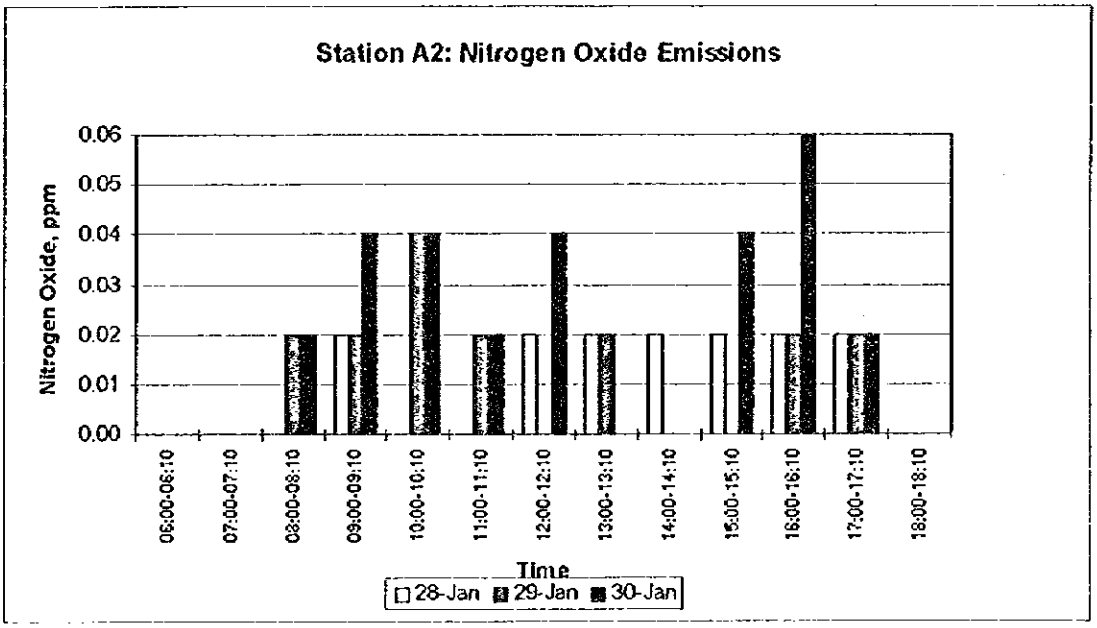
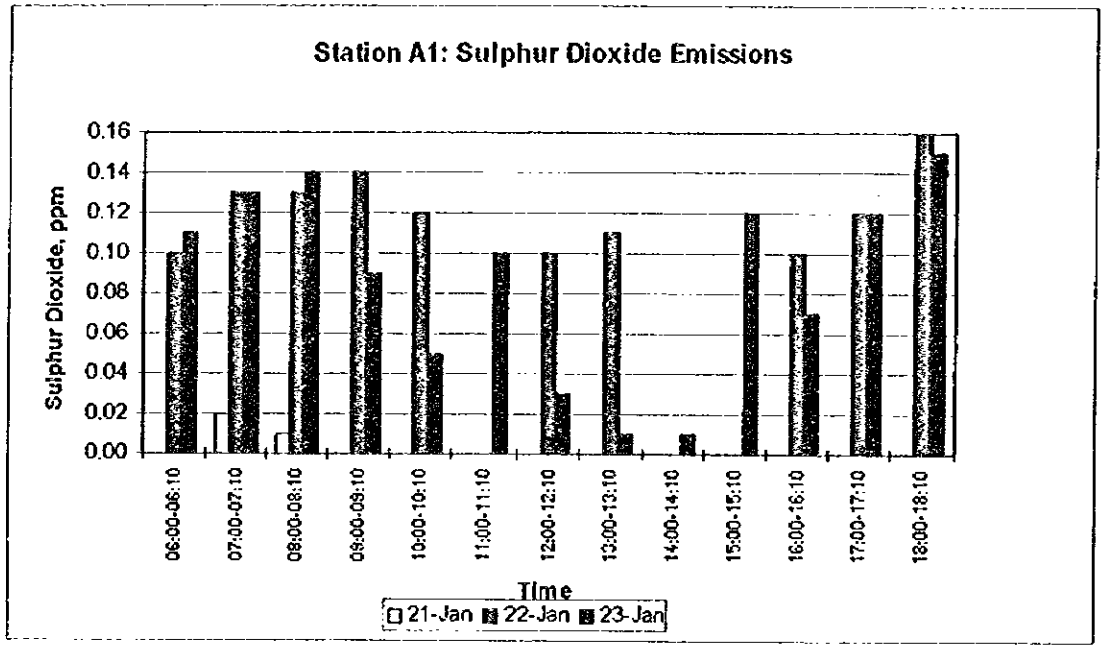


Figure 6-13: Nitrogen Oxide Levels



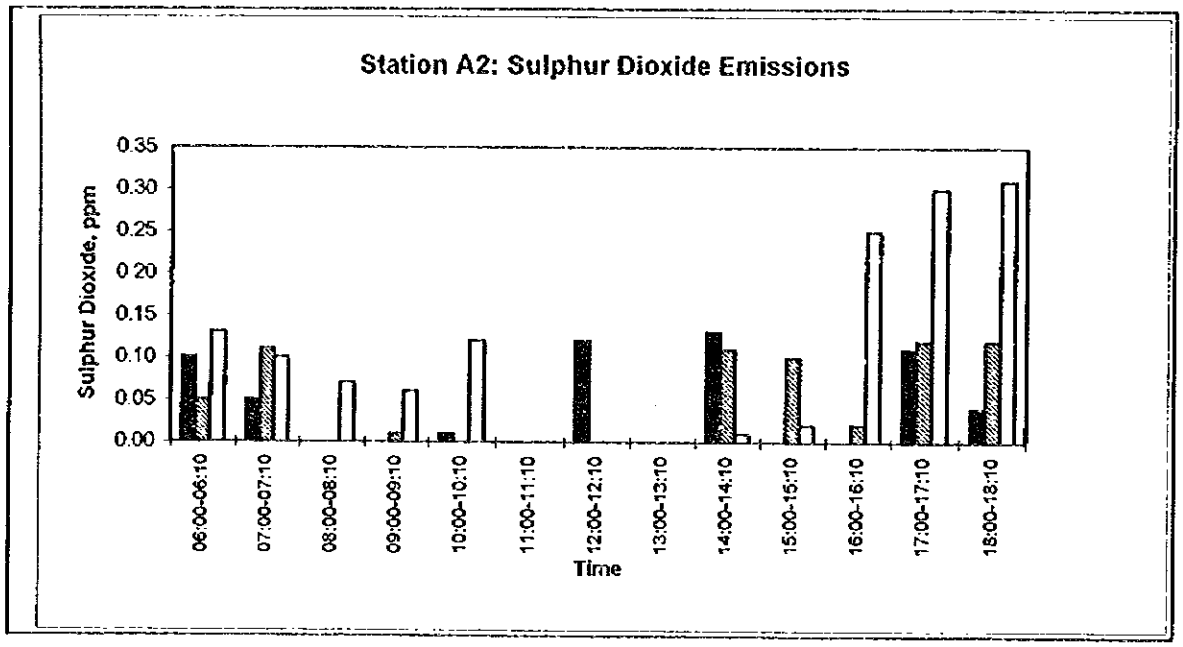


Figure 6-14: Sulphur Dioxide Levels

With carbon monoxide and nitrogen oxides, corresponding average concentrations were virtually always higher at station A1 compared with A2. However, the converse was true for sulphur dioxide and this is primarily due to the unusually high sulphur dioxide readings of 0.25 - 0.31 ppm recorded on January 30 at survey station A2 from 1600-1900. Sulphur dioxide emissions primarily come from the combustion of solid and fossil fuels as explained above, although automotive fuels used in Tanzania may have a higher sulphur content than in western countries. Nevertheless, it is expected that the contribution of transportation sources to total sulphur dioxide emissions is about 5-7%.

Possibly, the high sulphur dioxide concentrations may be due to airborne pollution carried to the survey station by the combination of westerly and northerly winds which occurred only on that afternoon from 1300-1600 (see Annex, section 11). One possible source of such airborne pollution is the Wazo Hill cement factory located about 4 km to the north-west of the site.

Hence, the high SO_2 concentrations of 0.25 - 0.31 ppm are considered to be abnormal and not related to traffic volumes. Omitting these data values for station A2 gives revised average and maximum SO_2 concentrations of 0.05 and 0.13 ppm respectively which are consistent with station A1 results and the data trends for CO and NO_x.

Ammonia was not detected at any time at either survey station. This is to be expected.

The wind speed and direction results, measured over a three day period in this survey are summarised in Table 6-11. This data is used as indicative of normal wind conditions in the absence of longer term data.

Table 6-11: Wind Speed and Direction

Wind Direction	Station A1			Station A2		
	Recorded frequency (%)	Average wind speed (m/s)	Range in wind speed (m/s)	Recorded frequency (%)	Average wind speed (m/s)	Range in wind speed (m/s)
North	0.0	---	---	15.4	1.8	0.4 - 3.0
North-east	38.5	1.0	0.3 - 2.2	38.5	2.0	1.0 - 3.4
North-west	17.9	1.6	1.2 - 2.0	41.0	2.5	1.6 - 3.6
West	0.0	---	---	5.1	2.7	2.6 - 2.8
South-east	43.6	1.9	0.7 - 3.2	0.0	---	---

At station A1, the prevailing winds were from the south-east (43.6%) and north-east (38.5%) while north-west winds were less common (17.9%). Based on these wind directions, airborne pollutants will be dispersed towards Lugalo barracks and the Mikocheni area.

At station A2, the prevailing winds were from the north-west (41.0%) and north-east (38.5%) while northerly winds were less common (15.4%). In this case, airborne pollutants will be dispersed towards the residential areas of Mbezi and Mbezi Beach.

6.4.8.2 Air Quality at proposed disposal site

No CO, NO_x, SO_2 and NH_3 could be detected using the gas detection tubes, meaning that the concentrations of these gases were below detection limits.

Similarly, the levels of dust recorded were insignificant. This latter result is somewhat surprising as quarrying activities are associated with dust production.

6.4.8.3 Discussion

The air quality at the survey stations is acceptable, with CO and NO_x concentrations being within acceptable levels, while SO_2 concentrations are above accepted levels.

However, projected traffic volumes are expected to increase significantly, which should result in increased gas concentrations, particularly for CO and NO_x.

6.4.9 Land Use

Present and future land use was investigated within an area of approximately a 1 km radius of the centre of the proposed disposal site.

6.4.9.1 Existing Land Use

Existing land use is shown in Figure 6-15 - Figure 6-17.

a. Mining Rights and Quarrying: western side of New Bagamoyo Road

The land allocated to mining activities on the western side of New Bagamoyo Road is owned by the Government and is under the control of the Ministry of Energy and Minerals, who has leased mining rights to various parties.

The landfill site comprises an area of 30 ha. Most of the mining rights for this area have been leased to Mwananchi Engineering Construction Company (MECCO) while some rights have also been leased to the National Service, MALI Ltd. and Tanzania Sand and Stone Quarries (TSSQ) (see Figure 6-15). The area leased to MECCO is known as the New MECCO quarry. MECCO continues to operate a crushing plant on site even though a significant proportion of the New MECCO quarry has already been exhausted.

Other mining rights have been granted to Konoike, TANGEM, Daffi Castro, and A. PEA for areas in the immediate vicinity but outside of the site (see Figure 6-16).

The main land uses within these areas is the excavation and crushing of aggregates. Other land use activities include associated offices and open workshops for heavy machinery. Some independent small scale miners and food vendors also operate within these areas, including at the New MECCO quarry. There are no residential buildings within or immediately outside of the site.

b. Residential/Farm Areas

The proposed landfill site is surrounded by subsistence farms and large residential properties to the north, west and the south. These areas are characterised by mixed farming. The main crops include bananas, palms, oranges, pawpaw, water melon and green vegetables. Poultry and livestock farming are also commonly practised in these areas. There are also some clusters of abandoned buildings on the western side of the site.

c. Residential

The major residential areas are found to the east and north-east of the proposed landfill site. These are built-up areas composed of both permanent and non-permanent structures. Mtongani village, which is largely an unplanned area, is the most prominent residential area close to the site.

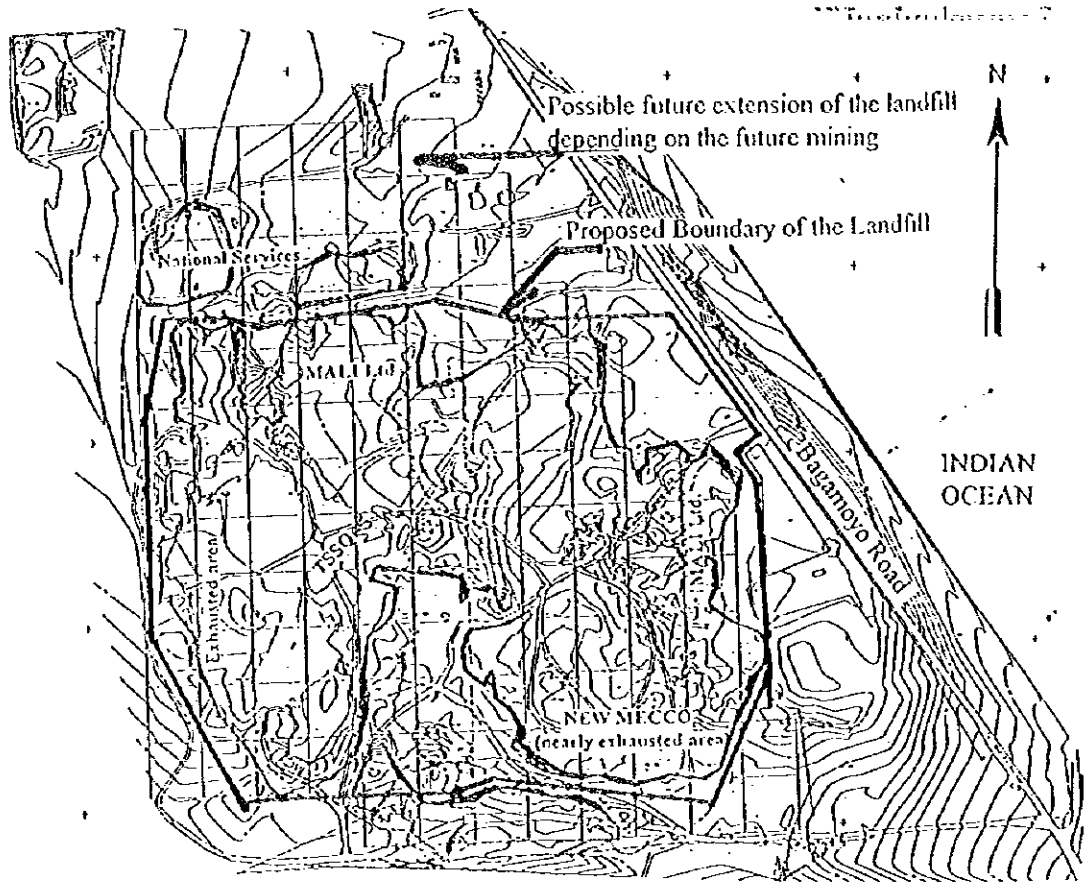


Figure 3.1: Mining Rights and Proposed Boundary of the Landfill.
(The mining rights shown by squares are held by: New Mecco, National Services, MALI Ltd., and TSSQ.

Figure 6-15: Mining Rights within and near to the Proposed Landfill Boundary

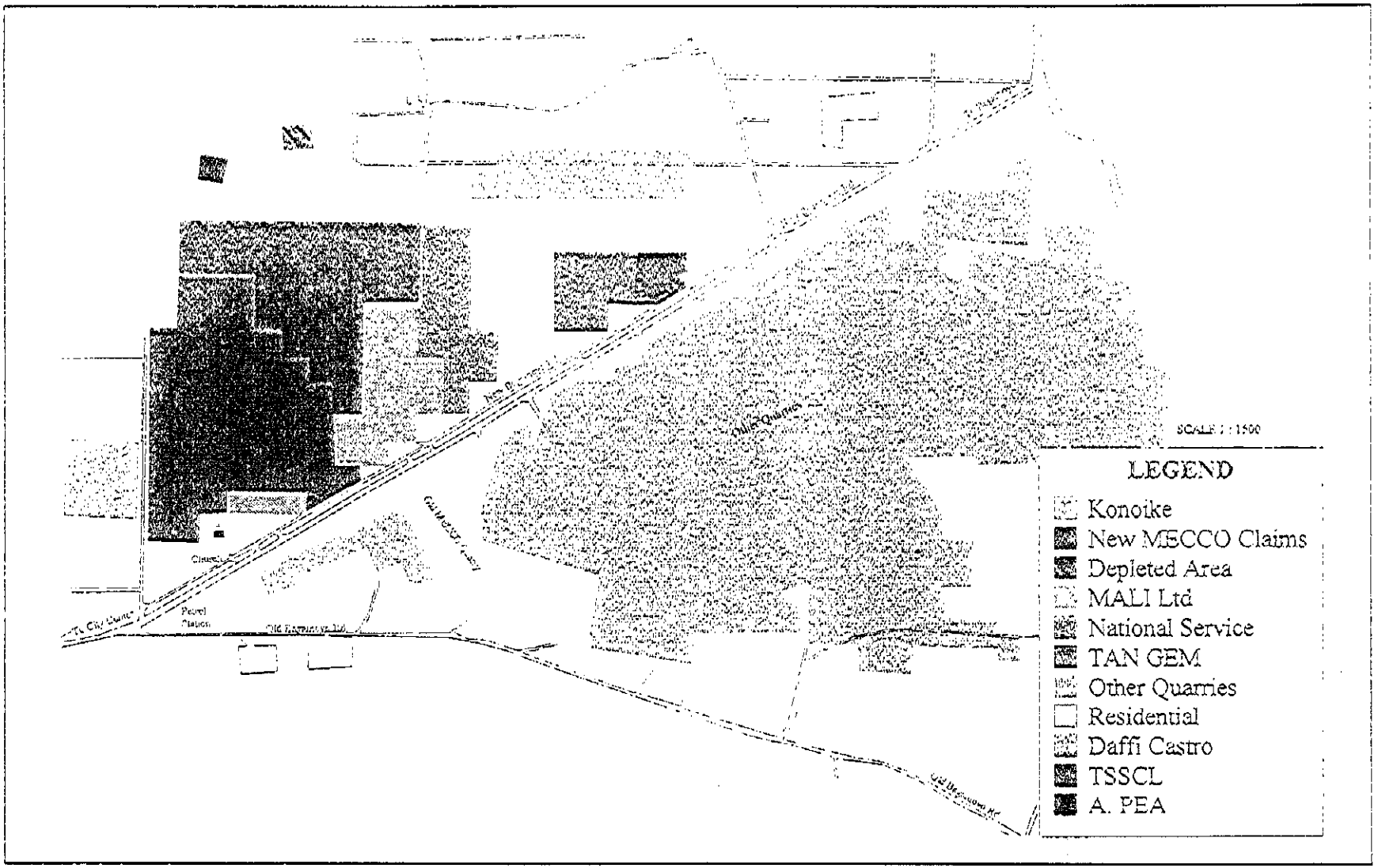


Figure 6-16: Mining Rights within the Study Area at Kunduchi

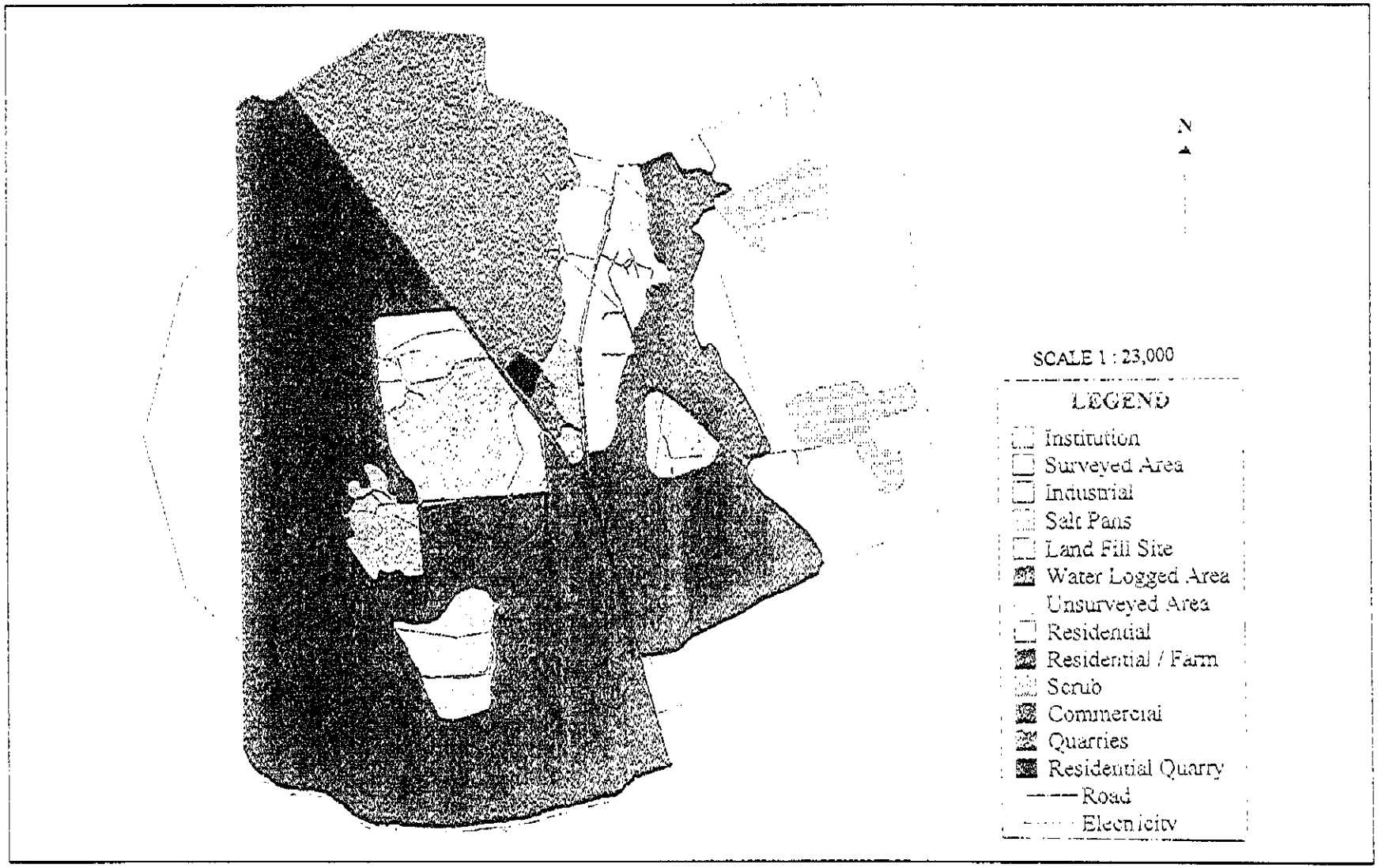


Figure 6-17: Present Land Use within the Study Area at Kunduchi

d. Other Quarries: eastern side of New Bagamoyo Road

On the eastern side of New Bagamoyo Road is the Old MECCO quarry site which is no longer operational as well as some other privately owned quarries, most of which are still working. These quarries cover a very large area. Some residential houses are already being built in the old quarries especially close to New Bagamoyo Road.

e. Commercial

Commercial activities are found at the junction of New Bagamoyo Road and Kunduchi Road. These include a petrol station, hotel and other small-scale activities.

f. Salt pans and water logged area

In the far eastern part of the study area, about 2.5 km from the site and near sea level, lies a water logged (swampy) area where salt pans are found. The salt pans are in operation and produce salt. Some saline water springs are also located in this area.

g. Scrub and Bushes

Scrub and bushes do exist in the study area, especially west of the proposed site. However, these are only found in small patches.

6.4.9.2 Infrastructure

The New Bagamoyo Road runs parallel to the north-eastern border of the site (see Figure 6-18). This is the main road link between the site and other parts of DSM city and it also links Dar es Salaam city with Bagamoyo town. To the north of the site, there is an earth track that links the northern part of Salasala, a settlement on the western side of the site, to New Bagamoyo Road. An important but ill-defined earth standard access road passes across the southern end of the site, in between quarry pits. This goes to another part of Salasala settlement, and is the only means of access to Salasala quarries which are an important source of building materials for the city.

Along New Bagamoyo Road, to the northeast of the site, there is a power supply line of 11 kV which is not easily discernible. To the southwest, there is a radio transmitter belonging to Radio Tanzania Dar es Salaam (RTD) and a telephone transmitter belonging to the Tanzania Telephone Company Ltd (TTCL).

6.4.9.3 Significant Sites

Within and around the site, there are no protected areas, no places of historical or cultural significance nor any areas used for recreational purposes. The site also has no religious significance although there is an Anglican church, located along New Bagamoyo Road to the southeast of the landfill site.

6.4.9.4 Zoning of Existing Land Use

Table 6-12 breaks down the main land uses into three zones within 0 - 0.25 km, 0.25 - 0.50 km and 0.50 - 1.00 km radius of the centre of the proposed landfill site (see Figure 6-18). Within the first zone (up to 0.25 km), the main land uses are quarries (75.9%) followed by residential/farm (20.6%). In the second zone (0.25 - 0.50 km), the main land uses are residential/farm (70.9%) followed by quarries (13.9%). In the last zone

(0.50 - 1.0 km), the main land uses are residential/farm (72.3%) followed by quarries (14.2%).

Table 6-12: Zoning of main land use categories according to distance from the centre of the proposed landfill site.

Land Use Category	Distance from centre of landfill site	0 to 0.25 km	0.25 to 0.50 km	0.50 to 1.00 km	Total
Quarries	Area (ha)	56.00	31.00	47.00	134
	Row (%)	41.8	23.1	35.1	100
	Column (%)	75.9	13.9	14.2	
Scrub land	Area (ha)	2.50	10.10	0.00	12.60
	Row (%)	19.8	80.2	0.0	100
	Column (%)	3.3	4.5	0.0	
Residential/Farm	Area (ha)	15.20	157.50	239.10	411.80
	Row (%)	3.7	38.2	58.1	100
	Column (%)	20.6	70.9	72.3	
Residential	Area (ha)	0.00	18.00	21.30	39.30
	Row (%)	0.0	45.8	54.2	100
	Column (%)	0.0	8.1	6.4	
Institutional	Area (ha)	0.00	0.00	8.40	8.40
	Row (%)	0.0	0.0	100.0	100
	Column (%)	0.0	0.0	2.5	
Commercial	Area (ha)	0.00	0.84	0.00	0.84
	Row (%)	0.0	100.0	0.0	100
	Column (%)	0.0	0.4	0.0	
Industrial	Area (ha)	0.00	4.5	0.00	4.50
	Row (%)	0.0	100.0	0.0	100
	Column (%)	0.0	2.0	0.0	
Water logged	Area (ha)	0.00	0.00	14.90	14.10
	Row (%)	0.0	0.0	100.0	100
	Column (%)	0.0	0.0	4.5	
Total Area		73.70	221.94	330.70	626.34
Total Column (%)		100	100	100	100

6.4.9.5 Future Land Use

There are three main future land uses proposed for the study area (see Figure 6-19) as summarised below:

1. Quarrying use: all areas presently used for quarrying activities are still allocated for quarrying use.
2. Residential use: all areas east of the landfill site, starting with Mtongani village and including the police quarters and water logged areas are zoned as residential areas. Similarly, all areas west and north-west of the site (i.e. all areas between the valley and Bagamoyo Road) are earmarked for residential use.
3. Industrial use: all areas south of the landfill site, beginning from the transmitter location are zoned for industrial use.

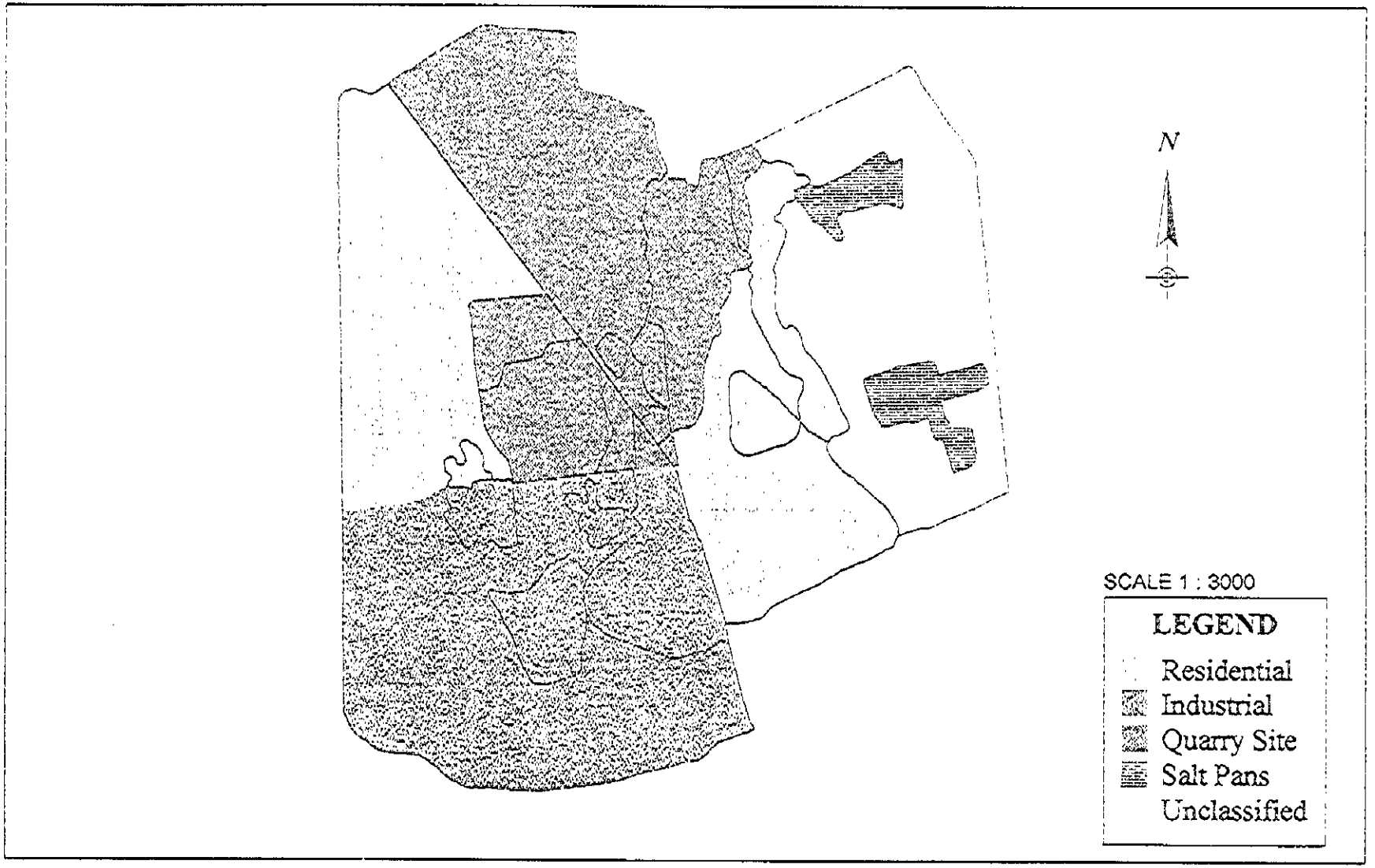


Figure 6-18: Future Land Use within the Study Area at Kunduchi

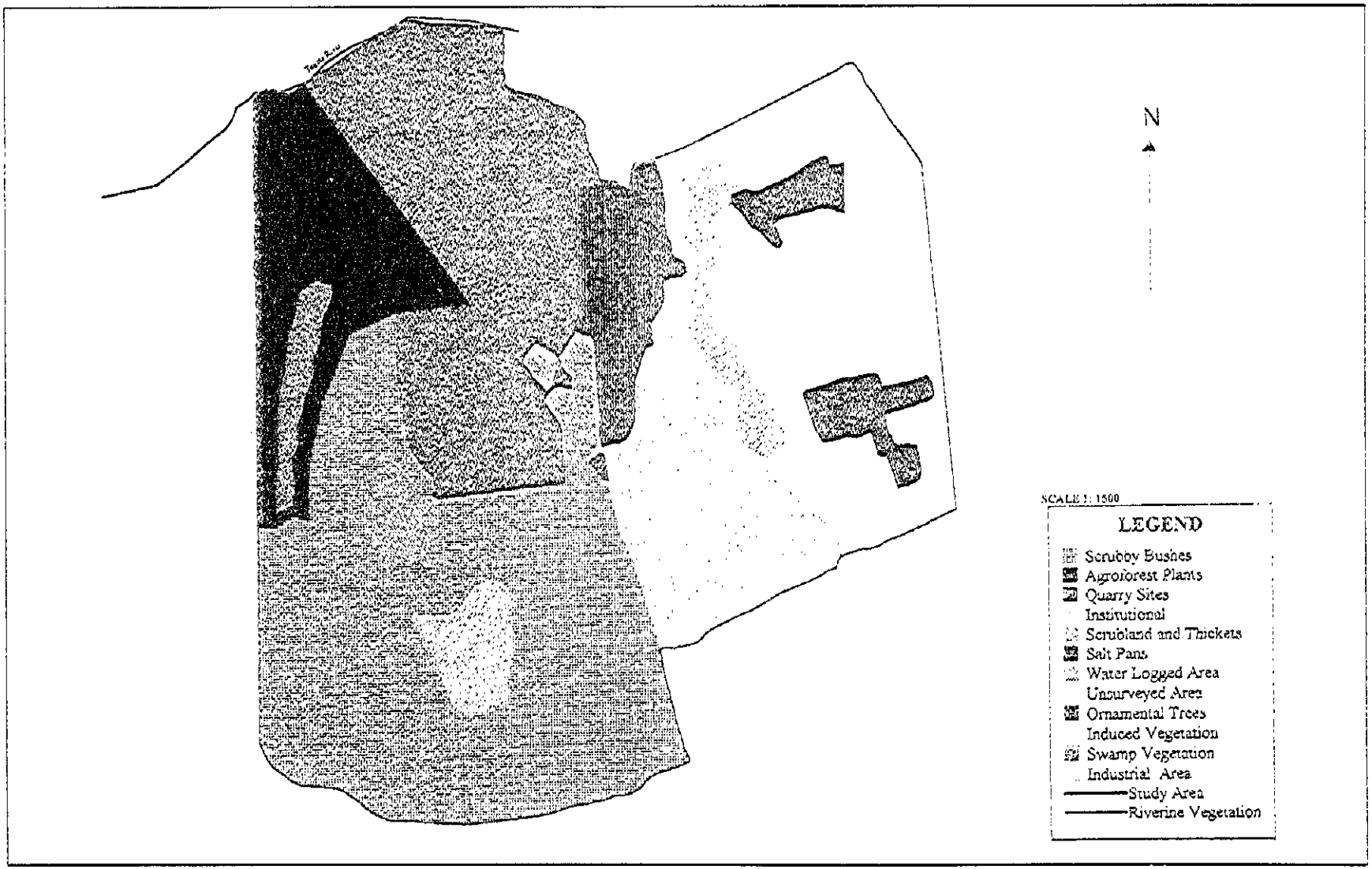


Figure 6-19: Existing Distribution of Vegetation within the Study Area at Kunduchi

6.4.10 Flora and Fauna

The flora and fauna survey covered an areas within approximately a 1 km radius of the centre of the proposed disposal site. Details of the methodology and results are presented in the Data 7.

6.4.10.1Flora

The original vegetation of the study area was virtually eliminated when all the land from the Kunduchi quarries westwards was turned into a sisal estate. Only relics of fragmented pockets of shrubs and bushes or thickets remain.

The present existing vegetation distribution at the proposed landfill site and its environs is shown in Figure 6-20 and described below:

The operating quarry pits are completely devoid of any vegetation cover while the vegetation in abandoned old quarry pits consists primarily of scattered pioneer weed species. The hill tops and quarry verges are mainly covered with scrubby bushes of *Dichrostachys cinerea*.

Scrubland and thickets cover most of the hill and hill slopes on either side of New Bagamoyo Road. The trees and shrubs which cover most of the areas on the eastern side of the New MECCO quarry (Mtongani village) include *mangifera indica, anacardium occidentale and carpodiptera africana.*

Riveline vegetation occurs along Tegeta River and swamp vegetation is found within the valley to the west of the proposed landfill site.

Induced vegetation, a result of land use development, is found in the western valley of the Tegeta River system and is characterised by a landscape which is a mosaic of agricultural crops, agroforesty plants and orchards of *cocos, mangifera* and *anacardium species.*

Induced vegetation is also found on the eastern side of New Bagamoyo road at Kilongawima, within the boundaries of Mtongani and Mbezi villages and about 700 m from the landfill site, which is now under housing development. Each housing plot is surrounded by a garden of annual crops like *carica papaya* (pawpaw), *albelmoschus esculentus* (okra), *lycopersicon esculentum* (tomato), *musa* sp. (banana plants), *cocos* (coconut) and a variety of induced weeds.

Mangroves are located about 1.5 km east of the proposed disposal site within a waterlogged area; the main species being *avicennia marina* and *ceriops tagal.*

6.4.10.2Fauna

Ants are by far the most dominant taxon in the Kunduchi ecosystem, both in terms of frequency of occurrence and relative abundance.

The farm areas to the north-west of the proposed landfill site, especially in dry (unirrigated) farms, are mainly colonised by ants, beetles and spiders. In the wetlands near the farms and in adjacent areas, viable populations of tilapia and catfish and a host of unidentified water insects were observed.

Many shrews (mammals), amphibians (*bufo regularis*) and millipedes were located in the farms located in the south-eastern parts of the study area (Kilongawima village), compared to the other areas surveyed. This is undoubtedly attributable to the moist conditions resulting from the manual watering of crops in this area. The area is also rich in birds, especially the common balbul (*psychonotus barbatus*).

In most of the dry areas to the north-east of the proposed landfill site (Tegeta area), ants, grasshopper, crickets and spiders were the most abundant animal taxa.

The operating, abandoned quarry pits and adjacent habitats were found to be the poorest in terms of the variety and density of animal colonisation, with only aphids and termites being found to occur abundantly. The bird population was also very low and not very diverse in nature.

6.4.10.3Existing International Conventions on Flora and Fauna

Reference is also made to section 6.2 where existing acts and policies relating to environmental management in Tanzania are discussed.

a. IUCN Red List of Threatened Animals

In terms of conservation status, none of the broad categories of animals that have been observed within the study area appears in the IUCN Red List of Threatened Animals but that alone is no reason for complacency for three basic reasons:

1. The survey was carried out in a short time of about 10 days. There are still many species within the area whose presence would be detected through further surveys.
2. The baseline studies from which the status of animals is determined have not yet been carried out.
3. Identification of animals, to the species level with the exception of birds, was not attempted because of the limited time at the disposal of the investigators.

b. Convention on Biological Diversity

Tanzania is a party to the Convention on Biological Diversity (Rio de Janeiro, 1992), the objectives of which are stated in section 6.2.4. It is obvious that quarrying at Kunduchi is degrading the immediate and surrounding environments, especially as no efforts are made to restore areas on the completion of quarrying. Obviously, the loss of good habitats translates into a loss of biodiversity. The proposed landfill will be constructed on exhausted quarrying areas and landfilling will restore the original topography. Once landfilling is completed, in order to live up to the expectations of this Convention, the grassing and planting of the capped landfill should be carried out as proposed in the conceptual landfill design (see section 6.3).

6.4.11 Public Health

The proposed landfill is situated in Kunduchi ward which is a rural part of Kinondoni district. Kinondoni district is the most populated district in DSM with an estimated population of 948,420 in 1996[13]. Kunduchi ward has a total area of 53.6 sq.km. and

[13] Source: "The Study on Solid Waste Management for Dar es Salaam City in The United Republic of Tanzania"; JICA, 1996

estimated 1996 population of 38,785, equivalent to a population density of 724 persons/sq.km.

In this survey, data was collected from the nearest dispensary to the disposal site at Kunduchi Mtongani and for Kinondoni district. The complete data is found in section 14 of the Annex and summarised here.

The occurrence and incidence of diseases amongst residents in the Kunduchi Mtongani area is shown in Figure 6-20. The three most common diseases are malaria (58.3%), sexually transmitted diseases (STDs) (10.4%), and wounds (9.7%).

This data was compared with that for Kinondoni district in Table 6-13. The percentage of malaria cases is similar in both cases. The Kunduchi Mtongani data shows a much higher occurrence of wounds which may be attributed to injuries sustained by people working in the nearby quarries of New MECCO and other companies.

Apart from the cases of STDs and wounds reported at the dispensary nearest to the proposed disposal site, most of the prevalent diseases in Kinondoni district and DSM region are water related.

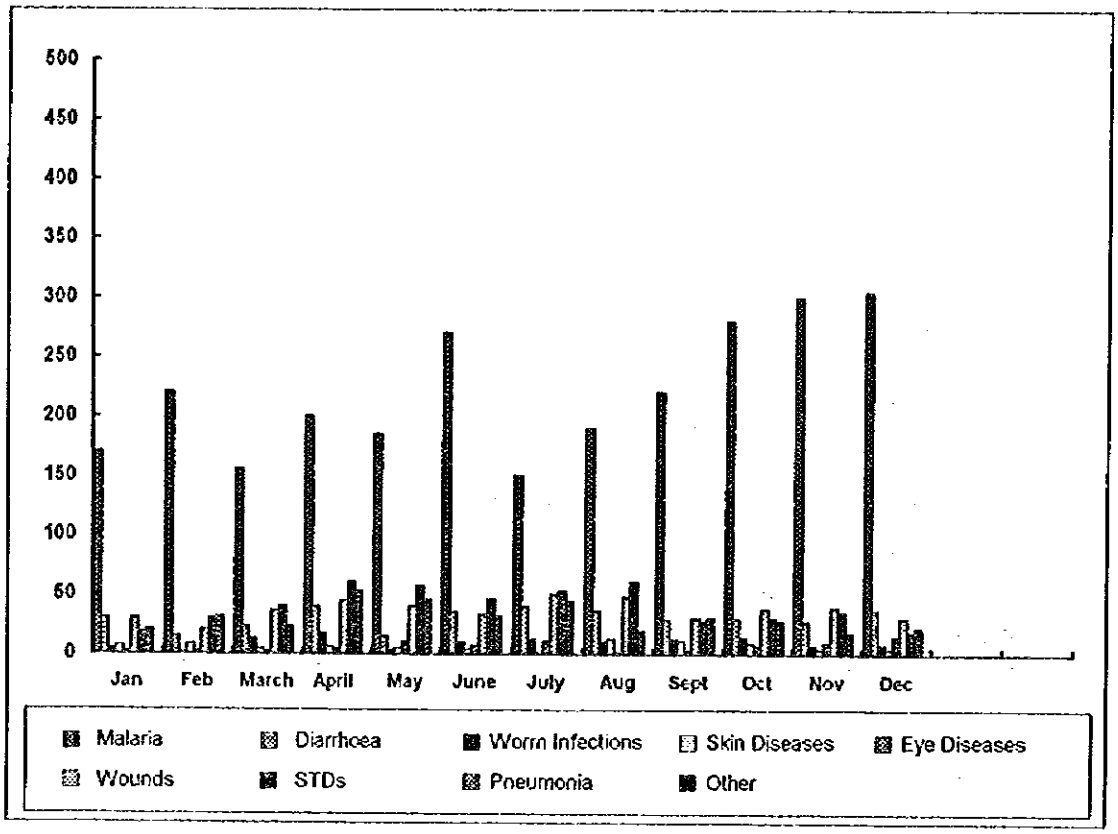


Figure 6-20: Reported cases at Kunduchi Mtongani dispensary in 1996

Table 6-13: Comparison of Occurrence of some commonly reported Diseases (% basis) between Kunduchi Mtongani dispensary and Kinondoni district

Type of Disease	Kunduchi Mtongani Dispensary (1996)	Kinondoni District (1995)
Malaria	58.3	63.0
Diarrhoea	7.9	20.2
Worm Infections	2.4	na
Skin Diseases	1.6	11.2
Eye Diseases	1.6	5.6
Wounds	9.7	na
STDs	10.4	na
Pneumonia	8.1	na
Total	100	100

Note:1. na means data not available (missing)

6.4.12 Economic Survey

6.4.12.1General

The economic survey was conducted for the purpose of assessing the economic impacts of the development of the proposed landfill site at the existing New MECCO quarry (Kunduchi). The major objectives were:

1. to determine the status and scale of mining operations within the boundaries of the proposed landfill site.
2. to determine the number of individual workers whose work will be affected by the landfill site and the type and scale of the economic activities they are engaged in.
3. to assess the impact on the recycling system of shifting the proposed site from Vingunguti to the Kunduchi site.

a. Status and Scale of activities within the Proposed Landfill Site and its Environs

The main economic activity in and around the proposed landfill performed by companies and private individuals is the extraction of coralline limestone and other aggregate for construction purposes. In addition to the mining activities, food vendors supply meals to the miners.

The proposed landfill site comprises an area of 30 ha. Most of the mining rights for this area have been leased to MECCO while some rights have been leased to the National Service, MALI Ltd. and TSSQ (Figure 6-15). The area leased to MECCO is known as the New MECCO quarry. MECCO continues to operate a crushing plant on site even though a significant proportion of the coralline limestone of the New MECCO quarry has been exhausted. In the immediate vicinity, but outside the proposed landfill site, other mining rights have been granted to Konoike, TANGEM, Daffi Castro, and A PEA (Figure 6-16).

Production data received from the mining companies willing to provide information indicates that companies excavate between 1,200 and 15,000 tonnes of stone per month

resulting in monthly incomes between Tsh 2,000,000 and 4,000,000. A further indication to economic activity is the amount of tax paid annually (see Table 6-14).

Table 6-14: Annual Tax of Mining Companies

Company	Tax (Tsh/year)
TANGEM	840,000
National Service	120,000
MALI	390,000
New MECCO claim	540,000
Daffi Castro	450,000
A. PEA	30,000
Konoike Construction	820,000
TSSQ	3,000,000
Total	**6,190,000**

A questionnaire was conducted on 69 (21% of the total of 326) small scale miners. Results showed that one third are women, and that 74% of the miners are aged between 21 and 40, most of the miners (68%) have been engaged in the work for between 1 and 9 years - the majority opting for the business because it was the only reliable means of income generation available to them.

Of the interviewees, 94% said they rely totally on mining as a means of income generation, while the remaining 6% carry out additional activities such as small scale farming and petty trading. Income generation results (Table 6-15) show that two thirds of small scale miners earn between Tsh 20,000 and 40,000.

Table 6-15: Income generation of small scale miners

Income per month Tsh	No. of small scale miners
20,000 - 30,000	23
31,000 - 40,000	23
41,000 - 50,000	8
51,000 - 100,000	15
Total	**69**

A site survey of the New MECCO Quarry and its environs revealed that there are 26 food vending stalls providing food to the miners and drivers. Twelve(12) food vendors were surveyed and it was found that for 11 of them selling food was their sole means of income. Incomes range from 20,000 to 50,000 Tsh per month.

b. Waste Recycling and Scavenging Activities at Vingunguti Disposal Site

Solid waste recycling in DSM has been identified to be taking place at 5 points of the waste stream at generation, discharge, collection, illegal dumps, and the Vingunguti final disposal site. The closure of the current disposal site and shifting of waste disposal operations to the proposed new landfill will affect current recycling and scavenging activities, as well as the middlemen who purchase the recyclable waste and the end users.

Of the 294 scavengers that were recorded visiting the disposal site during the 7 day survey, 94 scavengers came only once. The attendance survey taken in the morning, afternoon and evening showed that at any one time during the day, on average, 45 scavengers were present at the site.

A survey of 30 Vingunguti scavengers indicated that most of the scavengers were aged from 20 to 39 years old and that 60% had been scavenging for 6 to 12 years. 90% of interviewed scavengers work 8 - 12 hours daily (average 10 hours) and the monthly income of the majority (60%) of the scavengers is between Tsh 6,000 and 10,000 (average Tsh 11,500).

Assuming that each scavenger spends 8 hours at the site and 2 hours selling their items it was calculated that there is the equivalent of 67 "full-time" scavengers, which multiplied by the average monthly income gives a total of Tsh. 770,500 from scavenging activities at Vingunguti disposal site.

Items collected by the scavengers have been categorised into four(4) groups (Table 6-16) according to the number of scavengers collecting them.

Table 6-16: Categories of Salvaged Items

Category	Number of Scavengers	Items Collected
Very High	140 - 200	cans/tins, paper
High	80 - 110	glass bottles , plastic bottles, sacks, other metals
Medium	30 - 50	food leftovers, cereals, wire, mesh, wooden materials
Low	20 - 0	other glass, plastic sheets, sawdust, textiles, tyres

Scavengers usually sell their materials to middlemen. Eleven(11) Vingunguti middlemen were surveyed and it was found that their monthly income is on average Tsh 27,300. Their major source of recyclable items is the Vingunguti disposal site and most of the middlemen sell the recyclable items directly to industries.

The amount of waste recycled from the Vingunguti disposal site was estimated using three methods: 1) Scavenger Interview Survey (SIS); 2) Middleman Interview Survey (MIS); 3) Scavenger Waste Amount Survey (SWAS). The average quantity for each item is calculated and summed (see Table 6-17) to get the total recycled amount of 2.1 tonnes/day.

Table 6-17: Estimated Recycled Amounts of Different Items

kg/day

Item	bo	ct	fo	hu	me	pa	pl	pt	sa	ty	wo	other	total
SIS	87	132	—	200	162	1256	62	6	126	15	147	—	2193
MIS	—	120	83	—	433	1765	(4)	—	(9)	—	117	41	2572
SWAS	76	165	5	75	136	233	36	34	17	7	260	29	1073
Avg.	**82**	**139**	**44**	**138**	**244**	**1086**	**49**	**20**	**72**	**11**	**175**	**35**	**2095**

Notes: 1. Numbers in brackets are excluded from average calculations.
2. bo =glass bottles; ct = cans/tins; fo = food leftovers; hu = cereals/rice hulls; me = other metal; pa = paper; pl = plastic; pt = paint; sa = sacks; ty = tyres; wo = wood.

It was concluded that the SWAS results are a more reliable guide in determining the total income from scavenging activities. Using unit costs shown in Table 15-10 in the Annex and the SWAS data it was calculated that a total income of Tsh 1,050,000 a month is generated from scavenging activities at Vingunguti.

Combining this result with that previously calculated based on the number of "full-time" scavengers, and income of between Tsh 770,500 and 1,050,000 is generated each month through scavenging activities.

c. End Uses and Users

The main end users of different recycled waste items depends on the types of waste recycled. Some of the items (e.g. broken glass, metals, paper etc.) need to be reprocessed before they can be reused. Table 6-18 summarises the main uses and user of different types of recycled items.

Table 6-18: Uses and major users of recycled waste items in DSM

Item	End Use	User
broken glass	-reprocessed into bottles/jars -cemented to the tops of walls for security	-industries (broken bottles) -bricklayers/construction companies
metal (cans and tins, etc.)	-reprocessed into billets, ingots, etc. -household and other items -toys and decorations -cans/tins used for pot plants	-industries -individuals, micro industries -individuals -residents
cereals/hulls	-animal feed	-livestock owners
drums (50 gal)	-water barrels -property boundary markers -storage and transportation of goods	-individuals -individuals, hospitals, schools, etc. -shops, traders, etc.
food leftovers	-recooked and eaten -animal feed	-scavengers -livestock owners
glass bottles	-reused	-individual, shops, petty traders, markets, soft drink, beer manufacturers
paper (sheets, boxes, etc.)	-reprocessed into paper products -paper bags -wrapping goods -printing bus tickets	-industries -markets, petty traders, micro-industries -markets, petty traders -micro-industries
paint	-remixed and sold as new paint	-individuals
plastic bottles	-reuse -toys, decorations	-individuals, markets, traders, shops, etc. -individuals
plastic sheets	-covering, roofing, wall materials	-individuals, markets, petty traders
sacks	-covering, roofing, wall materials -reused	-individuals, markets, petty traders -individuals, charcoal vendors
sawdust	-bedding for animals	-livestock owners
textiles	-bushes, sandals, bicycle brakes -property boundary markers	-micro-industries -individuals, offices, etc.
wire mesh	-mosquito netting, etc.	-individuals
wood	-fire wood -carpentry/construction	-individuals, canteens -individuals, tradesmen

6.5 Environmental Impact Assessment

In this section an assessment is made of the nature and magnitude of both positive and negative environmental impacts for the proposed disposal site at New MECCO quarry in Kunduchi. The assessment is conducted for the 16 environmental items selected as a result of the Initial Environmental Examination conducted by the JICA Study Team in Sept. - Nov. 1996, and is based on the existing environmental conditions described in section 6.3.

For each item, the statement in italics describes the nature of the environmental item and the assessment for each item is broken down into three parts, corresponding to different stages of the landfill's life: namely. **construction, operation** and **aftercare**.

The results of this assessment are summarised in Table 6-28 at the end of this chapter.

6.5.1 Social Environment

6.5.1.1 Economic Activities

Loss of bases for economic activities (e.g. land) and effects on these activities due to shifting of the disposal site from Vingunguti to New MECCO quarry in 2000.

a. Construction

It is estimated that over 80% of the coralline limestone has already been removed from the proposed landfill site. The remaining limestone exists mainly (approximately 15%) in the area proposed for the location of section 3, while section 2 has small deposits (approximately 5%), and section 1A and 1B have none (see Figure 6-22).

Table 6-19: Landfill Construction and Operation Schedule

Section	Year of Construction	Projected Period of Operation
1A	1999	2000 - 2002
1B	1999	2003 - 2004
2	2004	2005 - 2007
3	2007	2008 - 2010

Table 6-19 shows the year of construction and projected operational period for each section. Ideally, quarrying activities will continue in other sections of the quarry so that by the time construction is due to begin in sections 2 and 3, the coralline limestone should be exhausted. Hence, the construction of the proposed landfill will have no negative economic impact on the companies, small scale miners, and food vendors currently working in the study area.

Moreover, it is estimated that section 1A and 1B of the proposed landfill will take 9 months to construct and employ up to 50 workers (labourers, drivers, equipment operators, supervisors, etc.), thus increasing economic activity in the area; particularly the business of food vendors. The construction of sections 2 and 3 will follow at intervals after the completion of section 1, continuing to provide increased work for local businesses.

Based on the above, the construction of the proposed landfill will be economically beneficial.

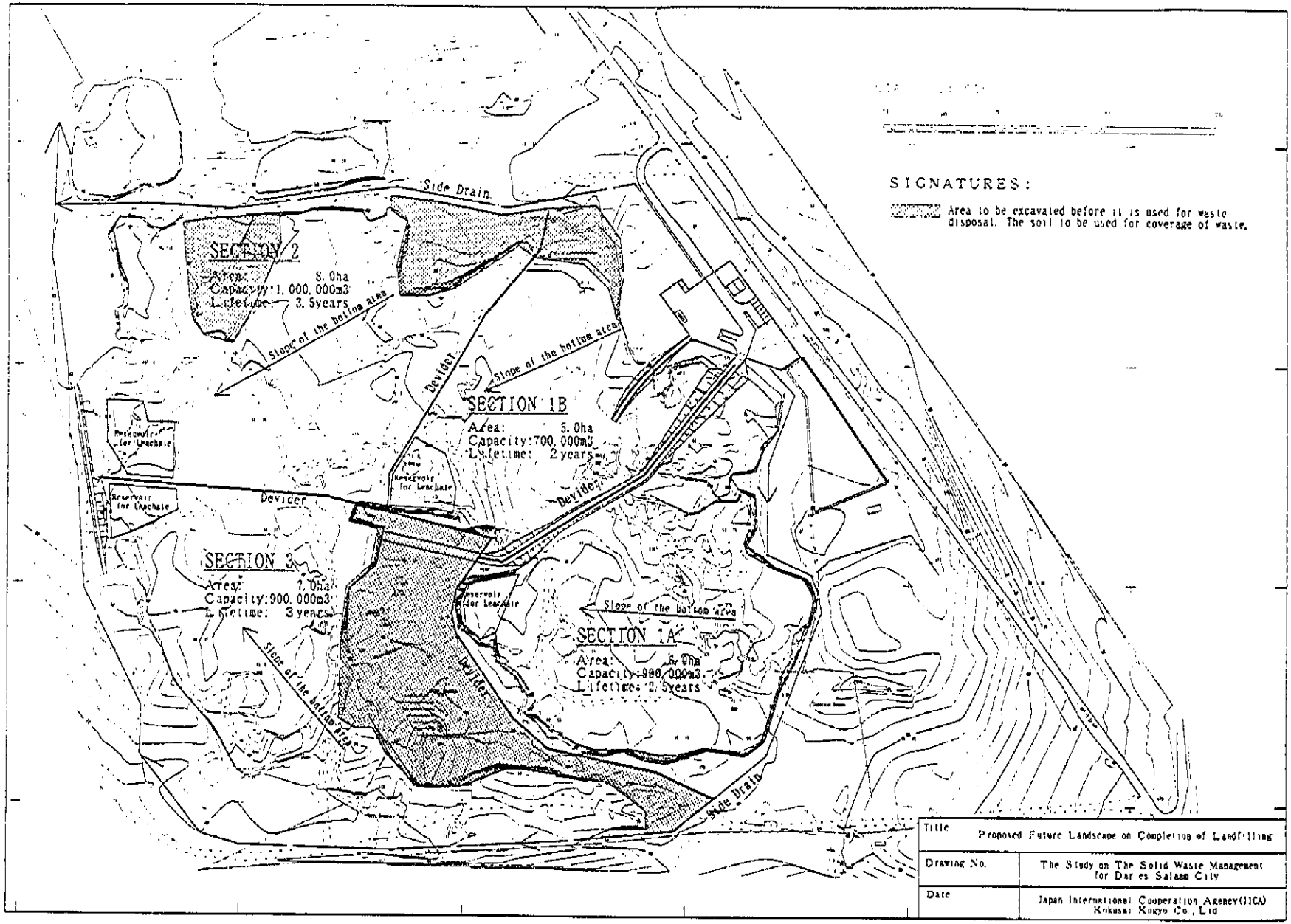


Figure 6-22: Proposed Future Landscape on Completion of landfilling

b. Operation

On opening the new landfill at Kunduchi in the year 2000, operation of the Vingunguti disposal site will be halted. Presently the Vingunguti site provides an economic benefit for people whom scavenge reusable items from the disposal site, the middlemen who buy and distribute these items, and the end users. Because scavenging will not be allowed in the new Kunduchi landfill, the closure of the Vingunguti disposal site will result in a loss of income for these groups.

The total number of scavengers visiting the site at least once over a seven day survey period was 294. However, the number of scavengers that rely on scavenging as a sole means of income is significantly lower, being less than 50. Regular scavengers spend an average of 8 -12 hours per day on scavenging related activities, and earn an average of Tsh 11,500 per month. The total income generated by scavengers was estimated to be between Tsh 770,500 and 1,050,000 per month.

Middlemen operating in the vicinity of the Vingunguti disposal site earn on average Tsh 27,500 per month. The total number of middlemen working in this area was difficult to estimate as many middlemen are involved in other activities. Hence the total income could not be confirmed; however, it is expected that it will correlate with the total income derived from scavenging.

It was estimated that 2.1 tonnes of solid waste a day is recycled from the Vingunguti disposal site. Micro-industries, large industries and individuals benefit from the recycling of solid waste in various ways. Boxes are reprocessed into craft paper, glass bottles are reused by soft drink manufacturers, tins are made into kerosene lamps, cereals are used as livestock fodder, paint is remixed and sold, car tyres are made into sandals, wood is used as fuel, etc. Although the Vingunguti landfill is not the sole source of recyclable materials, as significant quantities of recyclable materials are also collected at discharge, collection and illegal dumping points, it is a major one and its closure will severely interrupt the flow of recycled goods.

It is concluded that the operation of the Kunduchi landfill and the resulting closure of the Vingunguti landfill will result in the loss of income and livelihood to scavengers, middlemen, and the reduction in the amount of recycled materials on the market.

However, the need for such materials will remain and any shortage will increase prices paid by end users. With the promotion of recycling and waste separation activities in DSM proposed in the SWM Master Plan for DSM and the ingenuity of Tanzanians other opportunities for recycling waste materials, at locations other than the final disposal site at Kunduchi, will arise (see section 6.6.1.1).

Moreover, the operation of the Kunduchi landfill site will bring many more people into the area. In addition to the 17 permanent staff, 100 drivers and another 500 collection workers will enter the landfill 2 to 3 times per day to empty their refuse trucks. Food vendors will receive an increase in business by providing food to the hungry workers.

Under the SWM Master Plan, new landfill sites are to open in the districts of Temeke and Ilala in the year 2003. It is assumed that some staff of the Kunduchi landfill will be needed to get them up and running, thus providing a good chance for promotion.

Overall, there will be a high negative economic impact with the closure of the Vingunguti disposal site, with scavengers, middlemen, and end users being adversely

affected. Further the amount of waste recycling is expected to fall until alternative methods can be developed.

c. Aftercare

After the completion of section 1A; operation will begin in section 1B; once 1B is complete, in section 2; and once 2 is complete in section 3 (see Table 6-19). In total, this is expected to take 11 years, during which time the staff of the Kunduchi landfill site will have gained much experience in the day to day operation of a sanitary landfill.

When the Kunduchi landfill site is finally completed it is expected that another landfill site will be constructed to replace it. All workers associated with the Kunduchi landfill (refuse vehicle workers, landfill staff, etc.) will presumably be offered employment at the new landfill. It is probable that the future site will be within the same general locality as this area has several potential sites that could be developed in the future. Food vendors, previously providing food to workers at the Kunduchi landfill, may shift their activities to the new site, depending upon its proximity to Kunduchi, or seek other means of income generation. Thus, they may experience a low negative economic impact.

The recommended future land use for the completed landfill is for agricultural or recreational purposes. In the former case, the landfill may provide a source of agricultural land for local people while in the latter case, it may provide limited employment opportunities. Both uses will result in a small positive economic impact.

Taking these different factors into consideration, the overall economic impact during the aftercare stage is concluded to have a low positive economic impact.

6.5.1.2 Traffic and Public Facilities

Impact on traffic conditions (e.g. road carrying capacity, increased congestion, increased accidents) and public facilities such as schools, hospitals, etc. near the proposed disposal site and along New Bagamoyo Road from the Sam Nujoma intersection to the disposal site.

a. Traffic Conditions

aa. Construction

Construction activities will be largely confined to the site and will mainly involve small numbers of earthmoving machines/equipment, dump trucks, rollers, asphalt finishers and a few light vehicles. Some dump trucks will bring materials to the site, mainly for the construction of the access road and reception area. These activities will have a negligible negative impact on traffic conditions.

ab. Operation

aba. At the Landfill Site

Within the landfill site, two bulldozers, an excavator, two tip trucks and water tanker will operate. These vehicles will have a negligible impact on traffic conditions.

abb. Refuse Collection Vehicles

The impact of refuse collection vehicles on traffic volumes and flows along New Bagamoyo Road from the Sam Nujoma intersection to the proposed disposal site was assessed by comparing projected volumes of normal traffic (see section 6.4.6.4) with planned refuse collection vehicle volumes (see section 6.3.3) at the two survey stations, A1 and A2, on an annual basis from 2000 - 2005. The results are shown in Table 6-20 and Table 6-21 respectively. Traffic volumes were expressed as "equivalent numbers of small vehicles per 12 hours" (see section 6.4.6.4).

Table 6-20: Comparison of Refuse Vehicle and Normal Traffic Volumes at Station A1

Year	Normal Traffic Projection	Refuse Collection Vehicles Volume		Total Vehicles	% of refuse vehicles to total traffic
	(small vehicles/12 h)	No.	(small vehicles/12 h)	(small vehicles/12 h)	
1997	10,480	---	---	10,480	0.0
2000	12,590	652	1,304	13,894	9.4
2001	13,380	826	1,652	15,032	11.0
2002	14,220	1,016	2,032	16,252	12.5
2003	15,120	392	784	15,904	4.9
2004	16,070	474	948	17,018	5.6
2005	17,085	560	1,120	18,205	6.2

Note: 1. The refuse collection vehicle data in section 3.3 is in terms of units/day. Each unit will pass along New Bagamoyo Road twice (i.e. to and from the disposal site). Hence the number of vehicle units must be multiplied by 2 to get refuse vehicle volumes.
2. To express the number of refuse collection vehicles in terms of small vehicles, the conversion factor is 2.

Table 6-21: Comparison of Refuse Vehicle and Normal Traffic Volumes at Station A2

Year	Normal Traffic Projection	Refuse Collection Vehicles		Total Vehicles	% of refuse vehicles to total traffic
	(small vehicles/12 h)	No.	(small vehicles/12 h)	(small vehicles/12 h)	
1997	3,545	---	---	3,545	0.0
2000	4,260	652	1,304	5,564	23.4
2001	4,530	826	1,652	6,182	26.7
2002	4,810	1,016	2,032	6,842	29.7
2003	5,110	392	784	5,894	13.3
2004	5,440	474	948	6,388	14.8
2005	5,780	560	1,120	6,900	16.2

Note: see notes in Table 6-20.

New Bagamoyo Road is a two lane, single carriageway road running northwards from Morocco Road and has a design carrying capacity of 10,000 vehicles per 12 hours[14]. Provided funding can be secured, it is planned to widen this road from two to four lanes in two stages[15]:

- 4.4 km from Morocco Road to Sam Nujoma Road. Construction is scheduled for 1998-99 (short term plans).
- 12.6 km from Sam Nujoma Road to Wazo Hill, north of the proposed disposal site between 2000 -2010 (long term plans).

At station A1, Table 6-20 shows that the current traffic volume of 10,480 vehicles per 12 hours already exceeds the road carrying capacity. By 2005, the projected traffic

[14] Ministry of Works, Tanzania
[15] "The Study on Dar es Salaam, Road Development plans, Final Report"; JICA; March 1995

volume will be 17,085 per 12 hours, 71% greater than the design capacity. This basic analysis suggests that serious traffic congestion problems will result along this section of New Bagamoyo Road. However, experience shows that roads can often handle traffic volumes significantly greater than their design carrying capacities without serious congestion. A more detailed analysis would be required to assess the true magnitude of this problem but this is beyond the scope of this study. Nevertheless, it is considered important that long term road development plans are approved and implemented as soon as possible to minimise this problem.

Refuse collection vehicles will further increase traffic volumes along this section of New Bagamoyo Road but the volume of refuse collection vehicles constitutes 4.9% - 12.5% of total traffic volume. Hence, there will be a moderate negative impact of refuse collection vehicles on traffic conditions. However, it should be noted that if road development plans do not go ahead, the traffic congestion which could possibly result will reduce refuse collection vehicle efficiency.

At station A2, Table 6-21 shows that the contribution of refuse collection vehicles to total traffic is more significant, reaching a maximum of 29.7% of the total traffic in 2002. However, the total projected traffic volumes do not exceed the road design carrying capacity at any time, reaching only 69.0% of the design capacity in 2005. Hence, the negative impact of refuse collection vehicles on traffic conditions at this point is low.

The increased traffic volumes due to refuse collection vehicles are expected to have a low negative impact on the incidence of traffic accidents along New Bagamoyo Road. A potential accident trouble spot will be the entrance/exit to the landfill site, where the number of refuse collection vehicles entering and leaving the site during the period 2000 - 2005 ranges from 16 - 42 per hour. The likelihood of accidents at this point may be reduced by appropriate design of the entrance/exit and other mitigation measures (see section 6.6.1.2).

ac. Aftercare

During the aftercare stage, refuse collection vehicles will no longer be travelling to and from this disposal site along New Bagamoyo Road. There will be a moderate positive impact on traffic conditions.

b. Public Facilities

There are very few public facilities located within a 1.5 km radius of the disposal site and along New Bagamoyo Road between the disposal site and Sam Nujoma Road. Presently, the nearest public facilities to the landfill site are a small dispensary, school and mosque located at Mtongani, approximately 1,200 m from the site.

From now until 2005, the target year for the Master Plan, some degree of residential, commercial and industrial development in the vicinity of the site will occur. The land to the north, east and west is proposed for residential development and the area to the south is set aside for industrial development. No significant developments of public facilities are expected near to the site nor along New Bagamoyo Road, north of Sam Nujoma Road. Furthermore, a buffer zone of at least 50 m will be maintained around the site.

Hence, the disposal site and the movement of refuse collection vehicles along New Bagamoyo Road, north of Sam Nujoma Road will not have any adverse impacts on public facilities during the construction, operation and aftercare stages.

6.5.1.3 Public Health

Deterioration of public health and sanitary conditions in the area around the landfill site due to refuse disposal and increase in pathogens.

a. Construction

During construction, it is expected that significant amounts of dust will be produced, which will primarily affect site workers, possibly causing eye and respiratory diseases. The resulting negative impact on their health is considered to be low, especially as workers should be provided with adequate protective equipment (e.g. face masks) and good construction practices should be followed (e.g. use of water sprays).

Reference to health statistical data obtained from Mtongani Dispensary shows that the present incidence of eye diseases and pneumonia amongst local residents is 1.6% and 8.1% of all reported diseases. This situation is not expected to be aggravated by dust from the landfill site during construction as very few residential buildings are located within 250 m of the site boundary and the prevailing winds are from the north while the nearest residential settlement is to the north-east and future land use plans allocate areas to the north, east and west for residential development.

b. Operation

The overall negative impact on public health within the landfill and its surrounding areas during operation is considered to be low.

b.1 Water Contamination

Leachate from the disposal site will permeate directly through the ground and contaminate the groundwater from the disposal site to the Indian Ocean. However, the groundwater is saline and badly polluted between the disposal site and the ocean and is not used as a source of water for human consumption. The groundwater flows under the bottom of the salt pans, located in the gently sloping area downgradient of the landfill site, and hence will not affect the production of salt for human consumption. On entering the Ocean, the leachate that migrates to the sea will be diluted massively by seawater and hence its impact will be reduced. Hence, the impact of leachate on public health by contaminating the groundwater and seawater is considered to be very low.

Clean runoff from the surroundings will be diverted from the disposal area in order to restrict the generation of leachate and to prevent the contamination of surface water sources within the vicinity of the site, thus preventing any negative impact on public health due to surface water contamination.

b.2 Deterioration in Air Quality

During operation of the landfill, there will be an increase in air pollution levels, attributable to emissions of landfill gases, smoke, fumes and dust from the disposal site and refuse collection vehicles. The assessment of these types of air pollution (see section 5.3.1) concluded that the main source of air pollution is exhaust emissions from refuse collection vehicles which will make a significant contribution to NO_x and SO_2 emissions

from all vehicles travelling along New Bagamoyo Road, north of Sam Nujoma Road. NO_x concentrations may approach levels leading to an increased incidence of respiratory diseases. However, this prediction should be treated with caution and the resulting negative impact on public health is expected to be low.

Site workers may be exposed to significant amounts of dust, especially during the dry season. The resulting negative impact on their health is considered to be low and can be minimised by providing workers with adequate protective equipment (e.g. face masks) and through taking dust suppression control measures (e.g. water sprays, controlling on-site vehicle movements).

b.3 Increased Incidence of Disease

Landfills attract a wide range of pathogens, vectors and vermin and hence can potentially increase the incidence of diseases in surrounding areas. Poor refuse disposal will encourage fly breeding and may thus promote the transmission of faecal-oral infections (e.g. hepatitis A, amoebic dysentery, giardiasis). Mosquitoes can also breed in standing water in refuse heaps, spreading malaria. It can also promote diseases associated with rats (e.g. plague, salmonellosis, endemic typhus).

According to health statistical data from the Mtongani dispensary, 61.5% of diseases are water-related (malaria, skin and eye diseases), 10.3% excreta-related (diarrhoea[16], worms), 8.1% are airborne infections (pneumonia), 10.4% are sexually transmitted diseases and 9.7% wounds. This data shows that malaria and diarrhoea, two diseases that can be related to refuse, are common diseases amongst the local population. There is an absence in the cases of rat associated diseases although some complaints have been received from the public concerning the occurrence of rats in the nearby settlement at Mtongani. Nearby residents may be affected by increased numbers of rats, especially if it is taken into account that rats can travel up to about 1.5 km per night in search of food.

The impact of refuse-related infections on public health can be minimised by following standard sanitary landfilling practices, including operating with a relatively small tipping front, compacting the waste, applying daily soil cover and eliminating standing water. Pesticides may also be used as a secondary means of control if required. These measures should control the populations of flies, mosquitoes, rats and other vectors and ensure that the associated negative impact on public health is low.

Furthermore, the prohibition of the general public from the site, including scavengers, will limit the spread of diseases and help to protect public health.

b.4 Accidents

It is predicted that during the period 2000 - 2005 refuse collection vehicles will constitute 4.9 - 12.5% and 13.3 - 29.7% of total traffic at stations A1 (near Mwenge) and A2 (near the disposal site) respectively. Hence, there will be an increased possibility of traffic accidents along New Bagamoyo Road due to refuse collection vehicles increasing the total traffic volume. This will result in a low negative impact on public health.

[16] diarrhoea has been included under excreta-related diseases here but many cases of diarrhoea are also water related.

c. Aftercare

During this stage, all the refuse will have been covered with a final soil cover and the land will be rehabilitated. However, leachate and landfill gases will continue to be produced, albeit in diminishing quantities and strength. As explained above, the effect of leachate and landfill gases on public health is not considered to be significant and hence the impact on public health during the aftercare stage will be low.

6.5.1.4 Waste

Generation of construction waste and debris at the disposal site.

a. Construction

Construction works include clearing of the site; construction of the reception area, access road and buildings; excavation of the bottom area and embankments and construction of drainage systems. The existing New MECCO quarry office buildings will need to be demolished and there will be some scrap materials resulting from abandoned quarrying equipment, tools and construction facilities as well as broken bricks, blocks and other discarded building materials. Waste, in this context, refers to all these construction and demolition wastes and debris originating from the landfill site.

Demolition of existing office buildings will produce waste and debris in the form of timber, bricks, blocks, roofing sheets as well as rubble. Reusable components will have a ready market as building materials, while the remainder may be stockpiled and subsequently disposed of in the landfill.

Construction of the reception area facilities will necessitate the removal of top soil of about 0.3 m depth over the entire area. In the case of buildings and the enclosing brick wall, deeper trench excavations of at least 0.7 m depth and 0.7 m width will be required for the foundations. The removed top soil will most likely be utilised for landscaping of the reception area itself upon completion of construction work. The soil excavated from foundation trenches may partly be used as backfill material and the remainder may be used for landscaping. In view of the above, waste arising from construction of reception area facilities will most likely have no impact.

The landfill site has been divided into four sections (1A, 1B, 2 and 3) with construction of each section scheduled for 1999 (1A and 1B), 2004 (2) and 2007 (3). In sections 2 and 3, major excavations (quarrying works) are required before these areas will be used for waste disposal. Ideally, these excavations will be carried out on a similar basis as now (i.e. by mining companies and small scale miners concerned) with the coralline limestone being crushed and sold for use as a building material while the excavated soil will be utilised within operational sections of the landfill for the coverage of waste but this will depend upon arrangements between the DCC and mining operators concerned. Assuming this will happen, all wastes from these excavation works (excavated coralline limestone and soil) will be utilised (sold or reused) as described above.

Construction of the access road to the landfill will produce waste in terms of scraped and excavated soil which can be utilised within the landfill (e.g. for covering material).

On completion of the construction works, there may be used containers, discarded building materials, discarded asphalt, surplus road embankment filling materials, most of

which can be disposed of within the landfill and as such, their impact is not anticipated to be significant.

The overall impact is concluded to be a low positive impact as much of the waste/debris produced will be utilised within the landfill during construction and operation, thus minimising the amount of filling and cover materials to be imported to the site.

b. Operation

As described in section (a), construction wastes/debris will be utilised for cover materials as much as possible during operation of the landfill, thus producing a low positive impact.

c. Aftercare

On completion of landfilling, restoration and rehabilitation of the land will be carried out. Any construction wastes still remaining at the site as well as operational wastes (e.g. broken down vehicles and equipment) shall be removed during redevelopment of the land on the landfill site. Furthermore, it is assumed that the on-site buildings and other facilities at the reception area will be converted to other uses rather than being demolished. Hence, the aftercare process will ensure that the long term impact of construction wastes is negligible.

6.5.1.5 Hazards/Risks

Increase in natural disasters (e.g. landslides) and man-made hazards (e.g. landfill gas explosions, refuse fires) due to the disposal site.

a. Construction

The natural environment of the area around the site has already been profoundly altered by the development of quarrying operations in this area. No natural disaster has occurred within this area during the lifetime of the new MECCO quarry (> 15 years). Even though explosives have been used by some parties involved in quarrying activities, these have not caused any landslides or other major accidents. This suggests that there is a low probability of natural disasters occurring in this area and that the ground structure (i.e. soil and rock formations) is relatively stable. The planned construction works are relatively small in scale compared with the man-made alterations of the natural environment which have already occurred and are not expected to increase the probability of natural disasters.

There are some sections (2 and 3) of the site, where major excavation works will be carried out before these areas are used for landfilling. Conventional machinery will be used for this work rather than explosives, thus minimising the hazards associated with the use of explosives.

The operation of construction equipment and plant such as bulldozers, loaders, dump trucks and excavators introduces the risk of accidents to construction workers which may cause injury or loss of life. There is also a risk of accidents to site workers involved in manual construction activities. Workers' health issues have already been dealt with in section 6.5.1.3. The provision of proper safety equipment to workers, proper construction practices, safety procedures and supervision of construction activities will minimise the risk of accidents and the overall negative impact is low.

Furthermore, the landfill site itself will be fenced and access to the site will be restricted. This policy will prevent the general public, including scavengers, from entering the site and being exposed to hazards/risks.

The possibility of flooding is very small.

b. Operation

b.1 At the Landfill Site

Access to the landfill site will be restricted to approved personnel only. Thus, the general public, including scavengers, will not be allowed entry to the disposal site. This will prevent these people from being exposed to the hazards and risks described below.

The adoption of the policy to prohibit the disposal of hazardous, toxic, radioactive and liquid wastes at the new landfill will help to prevent locally produced or imported chemicals for industrial and agricultural use and other types of hazardous wastes finding their way into the disposal site and subsequently into the groundwater or surface waters, causing direct harm to humans and other organisms or indirect harm through the food chains.

However, there will still be other dangerous objects within the waste accepted for disposal (broken glass, rusty tins, spoiled food) which pose a small risk of injury to site and refuse vehicle workers. This risk can be minimised by equipping them with proper clothing and handling equipment (e.g. gloves, boots).

At Vingunguti disposal site, the refuse is not covered with soil. The outbreak of refuse fires is a common problem there, especially during the dry season. Refuse fires will pose a similar risk at the new disposal site, but this risk will be minimised by following proper sanitary landfill practices.

Another operational hazard concerns the occurrence of landfill gas explosions. Uncontrolled migration of gas from the landfill may also result in self-ignited fires and damaged vegetation. The proposed landfill design provides for the ventilation of landfill gases in a controlled manner to the atmosphere, thus minimising this impact. This is also necessary for safety reasons, due to the possible proximity of residential buildings to the site in the future.

There is a small risk of traffic accidents associated with the movement of landfill equipment and refuse collection vehicles within the disposal site, which can be minimised by controlling vehicle movements within the site. This is not expected to be a problem, as there will be 6-8 site vehicles and an average of 16 - 42 refuse collection vehicles per hour arriving at the landfill.

The likelihood of flooding is very small.

The overall negative impact is considered to be low, provided proper sanitary landfill practices are implemented (see section 6.6.1.5).

b.2 Refuse Vehicles

The increased traffic volumes along New Bagamoyo Road, north of Sam Nujoma Road, from the year 2000 due to the passage of refuse collection vehicles may lead to a slight increase in traffic accidents along this section of the road (~9.6 km in length) (see section 6.5.1.2).

c. Aftercare

On closure of the landfill site, further decomposition of waste within the landfill will occur, which may result in subsidence of the land over the disposal site. The impact of subsidence will depend on how soon and for what purpose(s) the landfill is put to use after closure. No significant negative impact is expected.

During the aftercare period, the migration of landfill gas continues to occur and hence there is still a risk of consequent fires and explosions. However, no significant impacts are expected provided the gas ventilation facilities are inspected and maintained regularly.

6.5.2 Natural Environment

6.5.2.1 Topography and Geology

Changes of valuable topography and geology due to excavation, construction and/or filling works at the disposal site.

a. Construction

It is planned to developed the four sections of the landfill sequentially, on completion of quarrying in each section. During construction of each section, minor excavation works will be required and the impact on topography and geology of the site will therefore be insignificant.

b. Operation

The topography of the site has already been profoundly altered due to quarrying activities. Refuse filling will restore the original topography and create a hilly landform that is compatible with the surroundings. Hence, there will be a moderate positive impact on the topography of the site.

Sanitary landfill operation requires covering the deposited waste daily with soil. In the conceptual landfill design, daily soil coverage is assumed to take up 12% of the landfill volume, equivalent to 420,000 m^3 over the 11 year period from 2000 - 2010 or about 730 m^3/week. Sources of soil cover are expected to be from the nearby environs. Ideally, excavated soil from quarrying works that will continue in sections 2 and 3 of the landfill prior to their development and other quarries in the vicinity will be utilised as cover material. Hence, cover soil should not be taken from virgin areas, in which case the negative impact will be low.

c. Aftercare

On completion of landfilling, a waste hill of maximum height 72 m a.m.s.l. will have been created, the quarry pits will have been reclaimed and the topography of the site restored to near its original state prior to the commencement of quarrying activities, this being a high positive impact.

However, the specific geology of the disposal site will have changed from its original composition, where coralline limestone was predominant, to a mixture of compacted waste and soil. This is a low negative impact.

6.5.2.2 Groundwater

Changes in groundwater level due to infiltration of leachate and run-off from the disposal site.

It must be stressed that the present infiltration situation in the existing quarries is not a natural or ideal one. In the vicinity of the New MECCO quarry there is approximately 150 hectares of open quarry pits. These pits trap virtually all stormwater runoff creating large ponds during the rainy season. The bare permeable soil within the landfill and the hot conditions result in the water either quickly permeating into the soil or evaporating (see Table 6-22).

Further, porous soils predominate in the region resulting in high infiltration rates. The proposed landfill site is small (30 ha) in comparison to the total recharge area and thus any reduction or increase in groundwater infiltration is thought to have only a slight effect on existing groundwater flows.

a. Construction

There will be little to no change in groundwater level due to the construction activities. The site has no grass cover to remove and there will be only a slight change to the topography.

b. Operation

The landfill conceptual design divides the landfill into four sections, each of which is filled before filling of a new section begins, thus minimising the total landfill area with waste open for direct penetration of rain water. Hence, the generation of leachate is kept at a minimum.

Figure 6-23 provides a forecast of groundwater infiltration at various stages of the Kunduchi landfill's life. This forecast was based on the water balance data presented in Table 6-22, the areas and years of operation of different landfill sections.

Table 6-22: Water Balance

	Before mm/year	Operation mm/year	After mm/year
Annual Rainfall	1150	1150	1150
Evaporation	500	700	900
Runoff	0	0	200
Absorbed in waste	0	100	0
Infiltration	650	350	50

From Figure 6-23 it can be seen that throughout the life of the landfill the rate of infiltration will decrease. This is due to the operational and capped sections of the landfill being less permeable to rainfall and thus subject to greater evaporation than the open quarry pits.

Capped sections will also generate runoff which will be diverted away from the disposal area, restricting the generation of leachate, by a system of drains and will subsequently evaporate or infiltrate. Infiltration outside the landfill site will offset to a degree the reduction inside the landfill site.

The overall impact of this decrease in groundwater infiltration will be low.

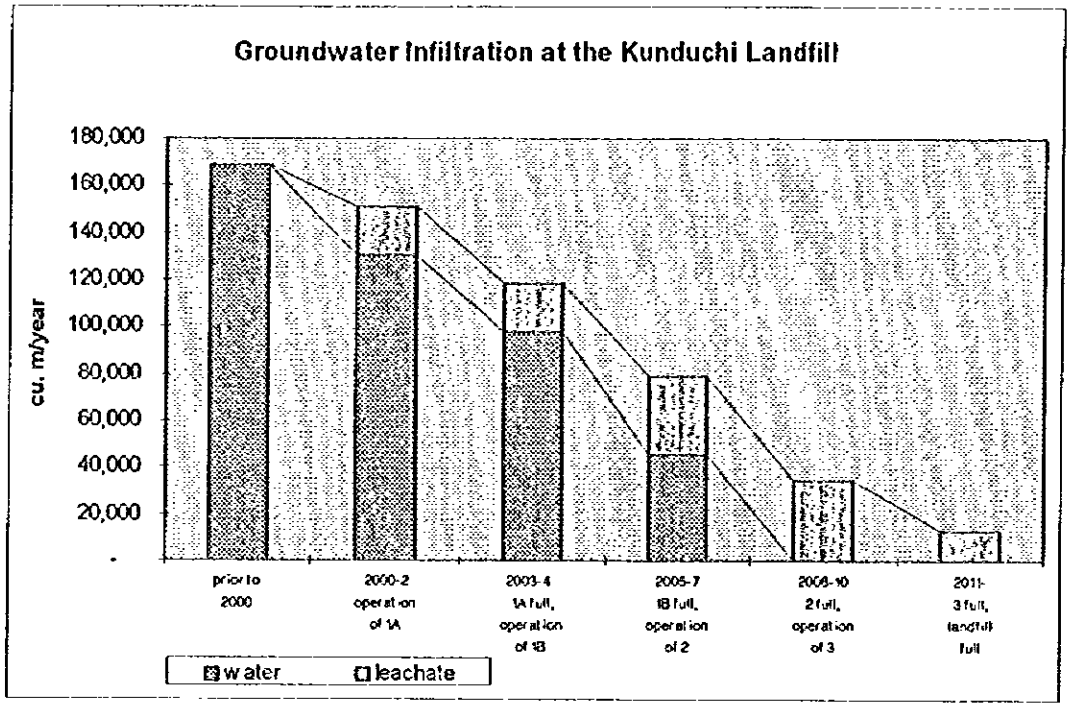


Figure 6-23: Groundwater Infiltration at the Kunduchi Landfill

c. Aftercare

After the completion of the landfill the amount of groundwater infiltration will remain roughly constant as shown in the above figure and will be less than before landfilling began. The only variations will be due to seasonal rainfall. However, no significant changes in groundwater are expected and the overall negative impact is low.

6.5.2.3 Hydrological Situation

Change in surface water bodies (e.g. river discharge and riverbed conditions) due to inflow of runoff and the disposal site.

Stormwater runoff from the areas outside the site drains off away from the site and either evaporates or infiltrates into the ground (see section 6.4.2.2), although during the rainy season some surface water may flow into the Tegeta River. Furthermore, during flood events, water may flow via an overflow channel from the seasonal pond directly south of the site into the New MECCO quarry.

Due to the high rate of infiltration and evaporation only those open drains within very close proximity to the proposed site were examined.

a. Construction

As most of the construction works are to be carried out within the quarry nearby streams will not be affected. Runoff will be diverted from the landfill site and an embankment will be constructed to prevent water overflowing into the New MECCO quarry from the seasonal pond to the south of the site during flood events.

b. Operation and After care

Unpolluted runoff will be diverted from the landfill site during operation and will flow into nearby waterways and ponds. The amount will gradually increase over the life of the landfill. However, as the site is on top of a hill runoff will be diverted into different catchments and thus, the increase in flows will be small. Furthermore, the landfill conceptual design plan proposes that the site, including buffer zone, be well vegetated with trees and grasses thus further reducing runoff.

Possible impacts of increased runoff include a benefit to flora and fauna of the area while the possibility of increased flooding is small. Thus, the overall impact is considered to be negligible.

6.5.2.4 Flora and Fauna

Changes in flora and fauna leading to obstruction of breeding, extinction of species, etc. due to the disposal site.

a. Construction

Construction works will have a negligible negative impact on fauna and flora since these have already been severely depleted by quarrying activities. There is virtually no vegetation cover on the site which has led to a low population of birds and other wildlife in the area.

The expected landscaping of the disposal site and the surrounding areas during construction will facilitate the establishment of new plant species and associated animal species, thus resulting in a low positive impact.

b. Operation

Refuse disposal sites often promote growth in the population of vectors and vermin, such as flies, mosquitoes, cockroaches and rats, which can have a negative impact on surrounding ecosystems. However, it is proposed to operate the disposal site as a sanitary landfill which will minimise this problem. Furthermore, pesticides and other vector control measures may be used if required basis. Hence, the impact of vectors and vermin associated with the landfill on flora and fauna should be negligible.

The site's proximity to the sea may attract seagulls to the landfill in large numbers, affecting local bird life to a small extent. However, if this does occur, mitigation measures, described in section 6.6.2.4, will minimise this impact.

Noise from landfill equipment (e.g. bulldozers) and refuse collection vehicles and landfill gas, dust and fumes will have a negligible impact on flora and fauna within the vicinity of the proposed landfill site due to its current severely depleted state.

The permeation of leachate into the groundwater and subsequently into the Indian Ocean may affect the mangroves, found near the salt pans at Kunduchi, between the disposal site and the ocean. Mangroves are highly specialised plants which grow in saline environments but have the usual requirements for fresh water and nutrients. They are able to withstand a wide range of environmental stresses and reduce pollution of near-shore coastal waters by trapping and/or absorbing pollutants. For example, the groundwater in the vicinity of the salt pans is badly polluted but the mangroves are healthy. Similarly, the mangroves of Msimbazi River (DSM), which are composed of an

almost pure stand of *A. marina*, are healthy despite this river being highly polluted by industrial, hospital and domestic wastes. As the leachate will not significantly aggravate groundwater pollution in this area (see section 6.5.3.2) it is expected that the impact on the mangroves will be very low.

Leachate which migrates to the Ocean will be massively diluted by seawater, thus minimising the pollution effect on near-shore coastal ecosystems.

Stormwater runoff from the landfill, if not properly managed could carry pollutants to neighbouring wetlands and seasonal streams and this may affect the freshwater ecosystems, mainly due to increased nutrient levels. However, as only clean runoff will be allowed to drain from the site and as the freshwater ecosystems and most of the wetlands are far away from the proposed landfill, the negative impact on the existing flora and fauna will be negligible.

Landfill gases will be ventilated in a controlled manner and should not cause harm to flora and fauna within the vicinity of the landfill.

Capping and restoration of completed sections of the landfill will have a moderate positive impact on fauna and flora as these processes will lead to the establishment of suitable habitats which will favour plant colonisers as well as the emergence of new plant species from existing seed banks. These plants will form associations with emerging fauna, thereby altering local ecosystems. Moreover, induced weeds in the landfill and its verges will bring out competition, especially for resources (food, nutrients, etc.), leading to niche differentiation and thus increased ecosystem diversity.

c. Aftercare

The main impacts on flora and fauna during the aftercare stage will be due to land management (landscaping, grassing, planting and maintenance), leachate discharge and landfill gas emissions, and are similar in nature to the impacts during operation, described above. However, leachate and landfill gases will be produced in smaller quantities and be weaker in composition. Land management will have a significant beneficial impact, while leachate discharge and landfill gas emissions are expected to have a negligible, negative impact.

6.5.2.5 Landscape/Aesthetics

Changes in topography and vegetation due to construction and operation of the landfill site; deterioration in environmental aesthetics.

The original landscape and site aesthetics have already been profoundly destroyed by quarrying operations in the area. The site is predominantly derelict land, has little vegetation cover and quarry site machinery and buildings also contribute to its low aesthetic quality. The site also has no historical, cultural or religious significance, no recreational role and is of little commercial value.

a. Construction

The main construction activities which will impact on the landscape and site aesthetics are:

- site clearing which will affect very small areas on the fringes of the site and hence has no significant impact.

- construction of access road and tracks which is likely to encroach on unspoilt land and have a small negative impact.
- construction of buildings and the reception area and peripheral fencing, which are considered to have a minor positive impact on landscape/aesthetics due to the present disfigured landscape and low aesthetic quality.

Landscaping measures, associated with the construction of the landfill site, will definitely have a highly beneficial impact on the landscape quality and site's visual amenity for many reasons, including the addition of plant cover, increased compatibility with surrounding areas and reducing the impact of the peripheral fencing.

Monitoring boreholes, to be drilled east of New Bagamoyo Road, will most likely intrude upon the landscape of their sites. However, owing to their small number (only two), their location and small structure, they are envisaged to have no significant visual impact.

Overall, construction activities are considered to have a small positive impact on landscape/aesthetics.

b. Operation

b.1 At the Landfill Site

The landfill site has been divided into four sections, each of which will be developed and utilised in sequential stages. The design concept is to create a "waste hill", of maximum height 13 - 16 m above the surrounding area at a distance of 250 m from New Bagamoyo Road. Within each landfill section, most landfilling operations will be hidden from view until the refuse height approaches and then exceeds the original ground level of 50 - 65 m a.m.s.l. Thus, mounds of waste will only be visible from outside during the final stages of filling in each section and the resulting interference with the landscape and visual amenity of the site will be minor, especially as there are very few residential buildings within a 250 m radius of the site. Similarly, the movement of landfill site equipment (two bulldozers, excavator, two dump trucks, water tanker) and refuse collection vehicles within the site will only be visible during the final stages of filling in each section, meaning the consequent negative visual impact will be low.

As the landfill will be filled sequentially in stages, this will give the site a skewed landscape and visual quality. This will be especially significant during the initial stages of filling in each section and before the completion of filling in section 1B as both sections 1A and 1B face New Bagamoyo Road (see Figure 6-22) from where the visual impact is most likely to be felt.

Runoff control measures in the form of interception and diversion channels will have a minor visual impact as they will interrupt the topography of the site and cause a visual intrusion. However, this impact will be small as they are placed below the ground and only in certain areas of the site. Ventilation pipes from the landfill gas control system will be visible all around the site. However, such pipes are small in size and relatively small in number. They will have a small negative impact on the landscape and it's visual amenity, especially before vegetation is well established.

The above negative impacts are temporary and outweighed by the permanent high positive impact on the landscape and aesthetics that will result from the capping and