Annex 4

Review of Relevant Studies and Projects

4 Review of Relevant Studies and Projects

4.1 Review of Relevant Studies

Several studies and reports related to SWM for DSM have been produced over the years although very few have been implemented. This section reviews only the major studies and reports relevant to this Study.

a. DSM Master Plan, Chp 5 on SWM, Marshall, Macklin and Monaghan Ltd., October 1979

The Dar es Salaam Master Plan, prepared in 1979, was designed to serve the city for over 20 years and hence is still valid. It includes a general plan for SWM and describes the situation of SWM in 1979 as follows:

- The City Health Department operated the refuse collection and disposal system.
- Tabata dump was in use, but dumping tended to be in a haphazard manner.
- Refuse was collected from all residential, institutional and commercial areas with adequate access for trucks.
- Industries disposed of their own waste and were able to use Tabata dump site.
- The collection fleet consisted of 14 compactor ($15m^3$) and 10 side loader ($11m^3$) trucks but in April 1978 less than half of these were operational.
- Residential refuse was stored outside homes in standard bins (approximately $0.1m^3$).
- Much more refuse was generated than collected. It was estimated that approximately 100 t/d of refuse was collected by Municipal authorities.
- Estimated waste generation rates for squatter residential areas were 0.17 kg/cap/d; other residential areas: 0.33 kg/cap/d.
- Domestic refuse was generally high in organic matter; the density being in the range of 250-300 kg/m^3.
- A site at Kimara had been surveyed for use as a dump and the land acquired by compensation but its use was postponed due to objections lodged by residents.

The master plan recommended sanitary landfill operation as the main disposal method until at least 1999 and also recommended two levels of service: a) roadside collection from small bins for residential, commercial and institutional areas; b) collection of bulk bins located in central areas, sites and services and squatter areas, market areas and at some small industries. The use of a medium size truck type loader, modified with a landfill blade and capable of spreading, carrying and compacting wastes, was proposed for use at the landfill.

It was stated that an economical balance needs to be achieved between the number of disposal sites and the refuse haulage distance. A maximum distance of 20 km was recommended. Projected generation rates for refuse up to 1999 were presented together with a 5 year and 10 year programme. The development of 5 new landfill sites at Mbezi, Kimara, Pugu Station, Mbagala and Kigamboni was proposed.

b. Master Plan on SWM for Dar es Salaam, Haskoning and M-Konsult, 1989

This study, which was conducted as a joint venture between Haskoning, (Royal Dutch Consulting Engineers and Architects), and M-Konsult Ltd, (Consulting Engineers from Tanzania) for the Ministry of Water was very comprehensive. 5 months was spent on site surveys including a waste generation amount survey, time and motion survey, and another 5 months on formulation of the master plan valid until 2009. The study concluded that the waste amount generation rate was 0.377 kg/cap.day and the total waste generation amount was 1,140 t/d in 1988.

Their proposed master plan consisted of three stages:

Stage 1 (1989-91) would be mainly used to upgrade and strengthen institutional, financial and legal aspects of SWM; 3 pilot projects would be carried out - two to trial new equipment and techniques: (a tractor trailer system based on locally produced vehicles and a container truck system already owned by the DCC but operated differently, with a number of containers on a revolving basis); the third to promote self-disposal techniques. A cost recovery system would be introduced to finance the collection system. Targets were set for DCC to collect 28% of the waste generated and private contractors 5%.

Stage 2 (1992-99) would be used to consolidate the improved managerial and institutional setting. Capital expenditure would be necessary for expansion of collection equipment and replacement of existing equipment. The tractor/trailer system was stated to be the most appropriate system financially and economically if the collection range is less than 8-10 km. Revenue collection was to be from direct charges and joint billing with sewerage, water and property tax. In 1999, it was predicted 2,475 t/d of SW will be produced. The target was for 33% to be collected by DCC; 6% by private contractors.

Stage 3 (1999-2009) would be used to further decentralise the SWM service to keep pace with the expanding city. The Tabata dump site would be closed and a new dump site away from the city centre would be opened. New equipment would have to be phased in to allow for longer haulage times. It was estimated that in 2009, 4,880 t/d of SW would be produced. The target was for 42% to be collected by DCC; 5% by private contractors.

The masterplan stated that capital costs should be met by grants while local revenue collection would cover the costs of operation. A joint billing system with the sewerage and water charge was proposed as a source of finance for the refuse collection service.

Although this report was produced with much effort and the contents of the Master Plan were reasonable, the proposed projects have not been implemented. However, a few proposals of this study, such as strengthening the institutional and financial system, seem to still be valid.

c. Sustainable Cities Programme, Report on SWM, Manus Coffey for SDP, 1992

This report contains an overview on SWM, diagnosis of the existing technical system, SWM computer programme and computer studies for a financial plan including calculation of refuse collection charges and costs. Much effort was spent on understanding the existing situation and formulating improvement proposals for

immediate action. It did not include a comprehensive master plan nor any technical surveys, and generally, it uses the technical data in Haskoning's report.

This report is useful to help understand the history and conditions of SWM, especially the institutional and organisational setups and problems for the immediate period prior to 1992. The situation described seems to be largely unchanged since then.

The proposals for action included setting up a separate "Emergency Clean-up" team; sanitary landfill operation at Vingunguti; preventive maintenance programme, refurbishing of existing vehicles and privatisation. Of these, only the privatisation proposal has been implemented.

d. Environmental Survey, Proposed Sanitary Landfill, Kinzudi 'B', SDP, S. Mgana, 1992

The objective of this study was to assemble field data for a proposed landfill site at Kinzudi 'B' which is located about 18 km north of the city centre along Bagamoyo Road. This site has an area of 18.5 hectares and a capacity of about 5.5 million m^3.

It focused only on technical and environmental aspects of the proposed site. Financial and social aspects were not discussed. It was concluded, on the basis of soil, hydrological and land use surveys of the site and neighbourhood conducted, that this was an excellent site and environmental impact would be minimal.

It was proposed that the City Council should act immediately to utilise this site as a landfill for the nearby areas. However, the final part of this report stated that access development and waste transport costs from the city centre would be enormous.

e. Takagas Biogas for Tanzania, Pre-investment Study, UDSM, Carl Bro et al., 1993

This study was financed through the UN system in response to a request from the Ministry of Energy and Minerals and was conducted by Carl Bro (Danish Institute of Technology), Biowaste and UDSM. Few field surveys were conducted and generally existing data was used to examine the feasibility of the biogas project. It was concluded that it would be economically feasible to construct a biogas plant in DSM.

However, this report is more a proposal than an objective study and the feasibility of the project is questionable based on the given data. The estimated investment cost is 3.991 million USD, and the annual operation cost is 169,000 USD while the income is 414,350 USD. Thus the annual profit is 245,350 USD. According to this data, to recover the capital investment cost would take 16.3 years without applying a discount rate. However, if a discount rate of 5% is applied, the capital investment costs cannot be returned within a reasonable time. Since the Vingunguti disposal site is expected to be used for a maximum of 5 more years, the risks of this project seem to be high. However, it may be said to be economically feasible if environmental benefits, such as reduction of CH_4 emission, are taken into account.

f. Vingunguti Landfill Study, Dar es Salaam Tanzania, COWIconsult for Habitat, 1994

Preliminary surveys including geological, hydrological and water quality surveys using 26 boreholes were conducted by S. Mgana of the Ardhi Institute. This study was subsequently conducted in Denmark using the survey data and included calculation of

the leachate generation amount; the minimum cost abatement measure for protecting the environment; preliminary design of stormwater drainage, leachate control and gas ventilation systems and other basic infrastructure for the site. Appropriate site management procedures were also presented.

This study did not find any water pollution caused by leachate from the disposal site. However, it did mention the possibility of ground water flowing from the subsoil into a solid waste deposit situated in the valley as filling proceeds. The calculated leachate generation amount of 41 mm/yr should be reviewed because the water balance (sheet 18 in Annex 3 of the Study) seems to be based on a few assumptions, such as provision of daily soil cover, which are not true. Hence, this figure for leachate generation should be used with care.

Recommendations were made for the establishment of landfill sections, covering of existing wastes, the use of final cover and the use of a cut-off ditch, interceptor trench, gas ventilation pipes at top of the landfill and gas collection wells for gas control and handling. As alternative solutions, a final cover with clay liner or final cover with synthetic liner; a bottom liner of clay with a drainage system or bottom liner of synthetic material with a drainage system; and an evaporation pond with recirculation system were proposed. However, as the amount of solid waste deposited has increased significantly since then, most of the proposed measures can now not be implemented.

4.2 Relevant Projects

a. Sustainable Dar es Salaam Project

The Sustainable Dar es Salaam Project (SDP) which is being executed by UNCHS (Habitat) and funded by UNDP is part of the Global Sustainable Cities Programme (SCP) launched by UNCHS in 1990 which provides municipal authorities and their partners in community sectors with an improved environmental planning and management capacity.

SDP was launched in 1992 with an aim of strengthening the City Council's capacity to plan and manage the growth and development of the city in partnership with other public sector parties. SDP is supporting DCC to address the following priority environmental issues.

- Improving solid waste management;
- Upgrading unserviced settlements;
- Servicing city expansion;
- Managing surface waters and liquid wastes;
- Air quality management and urban transportation;
- Managing open spaces, recreational areas, hazard lands, green belts and urban agriculture potential;
- Managing the economy and integrating petty trading;
- Coordinating city centre renewal;
- Managing coastal resources.

This work is being undertaken in partnership with central government, ministries, utility parastatals, the private sector and non-government/community based organisations; who nominated representatives to be members of cross-sectoral, multi-institutional

working groups established to address key components of each environmental issue. A total of about 150 people from these different bodies are members of 30 working groups.

The improvement of SWM was given a high priority. The SWM working group is currently targeting the following four strategies and smaller working groups have been established for each issue.

- Privatising the city centre collection operation;
- Better management of disposal sites;
- Expanding the collection system through greater community participation;
- Encouraging waste recycling.

Each small group consists of around 10 members from relevant public sector and private sector organisations. The main task of each group is to identify the existing problems and to make proposals for their solution which are submitted to DCC. SDP is also directly assisting community based refuse collection activities, community composting and some other projects.

SDP is currently having a major influence on DCC policy making, including for SWM.

b. Channel Diversion Project at the Vingunguti Disposal Site

A diversion channel for the Msimbazi River was constructed at the Vingunguti disposal site in 1995 with financial assistance from the Danish Government. This diversion channel now forms the border between the disposal site and the northern side. The southern slope of the diversion channel is protected with a gabion mattress which helps to prevent scouring.

c. Vingunguti-Mtambani Urban Horticulture and Composting

Composting activity is being carried out by local community based organisations in some areas with financial assistance from Habitat. About five groups of around 10 members per group are involved in this. The groups are collecting organic wastes from certain places for composting and the compost produced is used for group horticultural activities. Technical advice is provided by Dr. Rubindamayugi of UDSM. This project was initiated in 1992 and compost production began in January 1995.

One such group is located at Vingunguti-Mtambani. Composting bins of approximately 50 m^2 were constructed here in 1995. During planning, transportation costs were estimated to be low due to the site's proximity to Vingunguti disposal site. However, in reality, SDP provided transport by truck free of charge. The compost is used for horticulture purposes, supplementing chicken manure fertiliser, which is in short supply. Ms. Mtani, who is in charge of this activity, suggested that the viability of composting depends on the production cost and hence only a community based composting operation may be feasible.

Annex 5

Time and Motion Survey

5 Time and Motion Survey

5.1 Outline of the Survey

a. Objectives of the Survey

Solid waste collection involves intensive work and its cost occupies a large portion of the total cost of SWM. Therefore, the following measures should be taken to improve the refuse collection efficiency:

- Maximum use of the truck capacity
- Maximum use of legal working hours

It is necessary to understand precisely the present condition of solid waste and find its problems in order to prepare an improvement plan. This was carried out with such objective.

b. Contents of the Survey

The survey includes;

- bearing of time, distance and weight on collection and haulage.
- type of dustbin and container used
- working efficiency of collection workers
- collection routes
- level of user cooperation in waste collection activities
- service level
- maintenance and condition of equipment

5.2 Method of the Survey

a. Survey Samples

The refuse collection services are being provided by DCC and private contractors in the city. The Multinet Africa is only contractor which has the capacity to be taken into account in the present refuse collection system. Therefore, to conduct the time and motion survey on trucks of DCC and Multinet was decided.

b. Schedule of the Survey

The time and motion survey were conducted ten times in total as follows.

Date	Operator	Type of Waste Collected
31 Jul. 96	DCC	Residential
31 Jul. 96	DCC	Residential
2 Aug. 96	DCC	Market, Residential
3 Aug. 96	DCC	Market
6 Aug. 96	Multinet	Residential, Hotel, Hospital
7 Aug. 96	Multinet	Residential
8 Aug. 96	Multinet	Residential
8 Aug. 96	Multinet	Residential, Hotel, Hospital, Office
11 Aug. 96	DCC	Market
13 Aug. 96	DCC	Market

c. Time Recording

The following times were recorded with a watch.

- departure time from the vehicle depot
- arrival and departure times from each point on the collection route
- arrival and departure times from disposal site
- arrival time at the vehicle depot

The time consumed in each cycle was calculated.

d. Distance

The following distances in kilometres were recorded using the odometre of a vehicle.

- Initial indicator in kilometres at the time of departure from the vehicle depot
- distance in kilometres at the time of arrival at each station
- distance in kilometres at the time of arrival at the disposal site
- distance in kilometres at the time of arrival at the vehicle depot

e. Mapping

The following information was marked on the map.

- collection route
- collection points
- direction of truck depot
- direction of disposal site
- serial number of the collection points

Time and Motion Survey Data 1/10

Date	:31st July,1996
Type of waste collected	:Residential solid wastes
Collection Area	:Jangwani
DCC or Multinet	:D.C.C.
Crew	:2 drivers
Type of collection vehicle	:ISUZU TURBO SM1232
Loading capacity(ton)	:8ton
Year of vehicle manufacture	:1987
Working hours	:09:03 to 17:30 (8hr.27min.)
Number of Trips	:3 trips
Travel distance	:90.5km
Number of collection points	:3 points

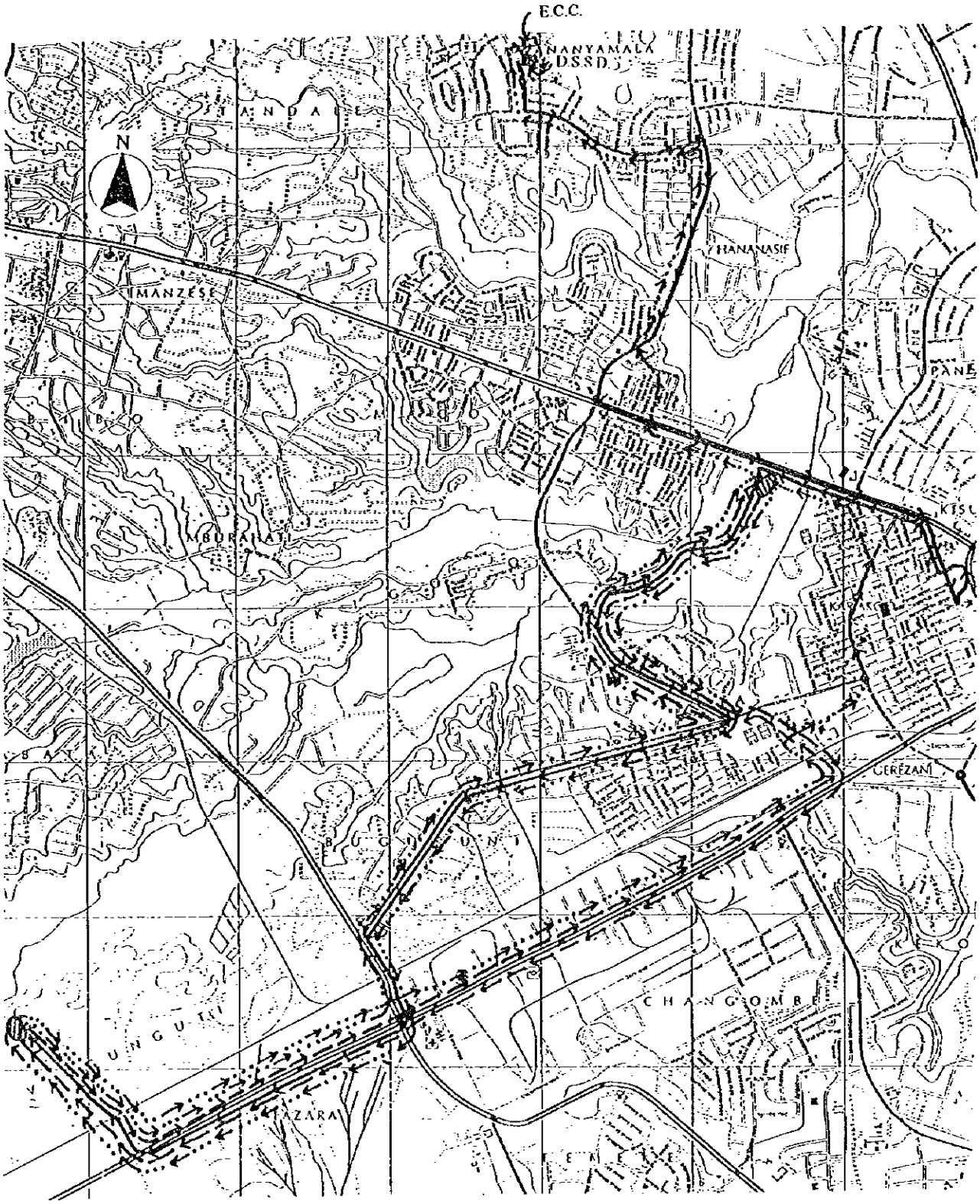
Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
1	09:03-09:17	14	6	Depot to collection area (1st trip)	-	-
	09:17-09:48	31	-	Waiting to load waste	-	Jangwani
	09:48-09:54	6	-	Loading waste by wheel loader	1	Jangwani
	09:54-10:22	28	12	Collection area to disposal site	-	-
	10:22-10:23	1	-	Unloading waste	-	Vingunguti
2	10:23-10:48	25	11.6	Disposal site to collection area (2nd trip)	-	-
	10:48-10:53	5	-	Waiting to load waste	-	Jangwani
	10:53-11:00	7	-	Loading waste by wheel loader	1	Jangwani
	11:00-11:27	27	11.4	Collection area to disposal site	-	-
	11:27-11:28	1	-	Unloading waste	-	Vingunguti
3	11:28-11:55	27	12	Disposal site to collection area (3rd trip)	-	-
	11:55-13:55	120	-	Wheel loader repairing	-	Mwananyamala
	13:55-14:20	25	-	Waiting to load waste	-	Jangwani
	14:20-14:25	5	-	Loading waste by wheel loader	1	Jangwani
	14:25-14:52	27	11	Collection area to disposal site	-	-
	14:52-14:53	1	-	Unloading waste	-	Vingunguti
-	14:53-15:17	24	13	Disposal site to collection area	-	-
	15:17-15:25	8	-	Waiting to load waste	-	Jangwani
	15:25-15:48	18	4.5	Collection area to garage	-	-
	15:48-16:18	35	-	Wheel loader repairing(but it was not repaired)	-	Mwananyamala
	16:48-16:38	20	4.5	Garage to collection area for providing information	-	Jangwani
	16:38-17:30	52	4.5	Collection area to depot	-	Mwananyamala

Legend	
⟶	1st collection route
⇢	2nd collection route
⋯→	3rd collection route

Time and Motion Survey Data 2/10

Date :31st July,1996
Type of waste collected :Residential solid wastes
Collection Area :Jangwani
DCC or Multinet :D.C.C.
Crew :4 persons(1 vehicle driver, 1 wheel loader driver, 2 collectors)
Type of collection vehicle :JIEFANG TIPPER TRUCK
Loading capacity(ton) :6 ton
Year of vehicle manufacture :1987
Working hours :09:04 to 17:30 (8hr.26min.)
Number of Trips :3 trips
Travel distance :89.6km
Number of collection points :3 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	09:04-09:08	4	-	Fuelling (40 litre)	-	D.C.C.D.
	09:08-09:24	16	5.3	Depot to collection area	-	
	09:24-09:39	15	-	Picking up two collectors	-	Jangwani
	09:39-09:50	11	2.3	Collection area to collectors office	-	-
	09:50-10:05	15	-	Finding three more collectors. But all assigned were sick	-	Anatagro
1	10:05-10:12	7	2.6	Collectors office to collection area (1st trip)	-	-
	10:12-10:20	8	-	Waste collection work	1	Jangwani
	10:20-10:46	26	11	Collection area to disposal site	-	-
	10:46-10:47	1	-	Unloading waste	-	Vingunguti
2	10:47-11:23	36	11.9	Disposal site to collection area(2nd trip)	-	Jangwani
	11:23-14:00	157	-	Wheel loader repairing	-	Jangwani-
	14:00-14:04	4	-	Waste collection work	1	Jangwani
	14:04-14:35	31	12.3	Collection area to disposal site	-	-
	14:35-14:36	1	-	Unloading waste	-	Vingunguti
3	14:36-15:05	29	10.8	Disposal site to collection area (3rd trip)	1	-
	15:05-15:12	7	-	Waste collection work	-	Jangwani
	15:32-15:44	32	10.9	Collection area to Disposal site	-	-
	15:44-15:48	4	-	Unloading Waste	-	Vingunguti
-	15:48-16:20	32	11.5	Disposal site to collection area	-	-
	16:20-16:45	25	-	Wheel loader repairing	-	Jangwani
	16:45-17:30	45	11	Collection area to Depot (D.C.C.D.)	-	-

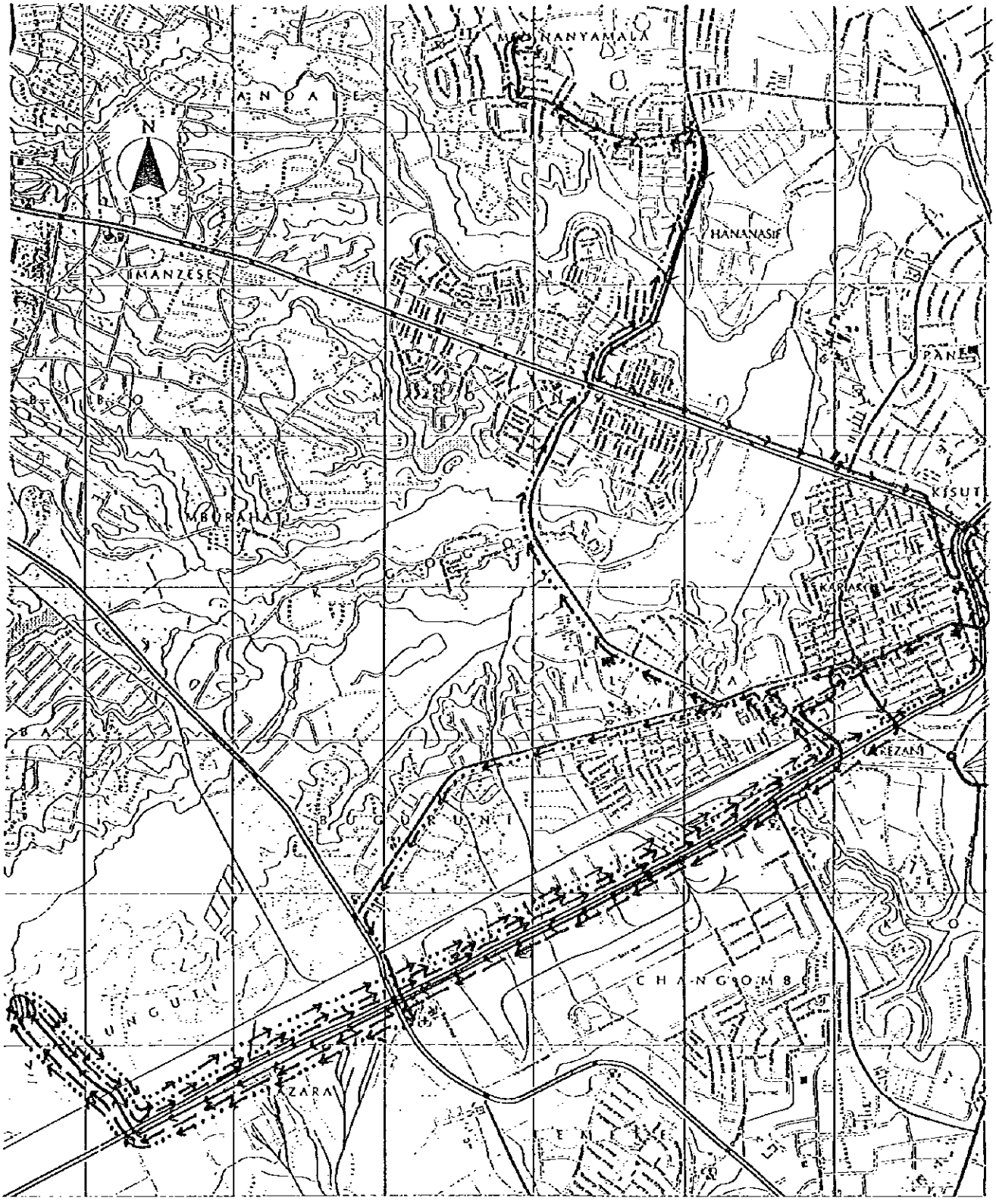


Legend	
⟶	1st collection route
- - ⟶	2nd collection route
··· ⟶	3rd collection route

Data of Time and Motion Survey 3/10

Date :2nd August, 1996
Type of waste collected :Market Waste and Residential solid wastes
Collection Area :Ilala
DCC or Multinet :D.C.C.
Crew :13 persons(1 vehicle driver, 1 supervisor,11collectors)
Type of collection vehicle :JIEFANG TIPPER TRUCK
Loading capacity(ton) :6 ton
Year of vehicle manufacture :1987
Working hours :08:03 to 18:05 (10hr.02min.)
Number of Trips :3 trips
Travel distance :72.6km
Number of collection points :6

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	08:03-09:31	88	-	Repairing	-	D.C.C.D.
	09:31-09:36	5	0.5	Depot to fuel station	-	-
	09:36-09:45	9	-	Fuelling (60 litre)	-	D.C.C.D.
	09:45-10:05	20	7.3	Fuel station to collectors office	-	-
	10:05-10:15	10	-	Picking up collectors	-	Anatagro
1	10:15-10:20	5	0.7	Collectors office to collection area(1st trip)	-	-
	10:20-11:37	77	2.1	Waste collection work	3	Kisutu Market
	11:37-12:00	23	8.5	Collection area to disposal site	-	-
	12:00-12:03	3	-	Unloading waste	-	Vingungnti
2	12:03-12:30	27	9.6	Disposal site to collection area(2nd trip)	-	-
	12:30-13:40	70	-	Waste collection work	1	Kamata area
	13:40-14:01	21	7.6	Collection area to disposal site	-	-
	14:01-14:08	7	-	Unloading waste	-	Vingunguti
3	14:08-14:37	29	9.5	Disposal site to collectors office(3rd trip)	-	-
	14:37-14:45	8	-	Picking up the 3rd shift collectors	-	Anatogro-
	14:45-15:00	15	2.4	Collectors office to collection area	-	-
	15:00-16:45	105	0.3	Waste collection work	2	Shaurimayo
	16:45-17:15	30	8.8	Collection area to Disposal site	-	-
	17:15-17:20	5	-	Unloading Waste	-	Vingunguti
-	17:20-18:05	45	15.3	Disposal site to the office(D.C.C.D.)	-	-

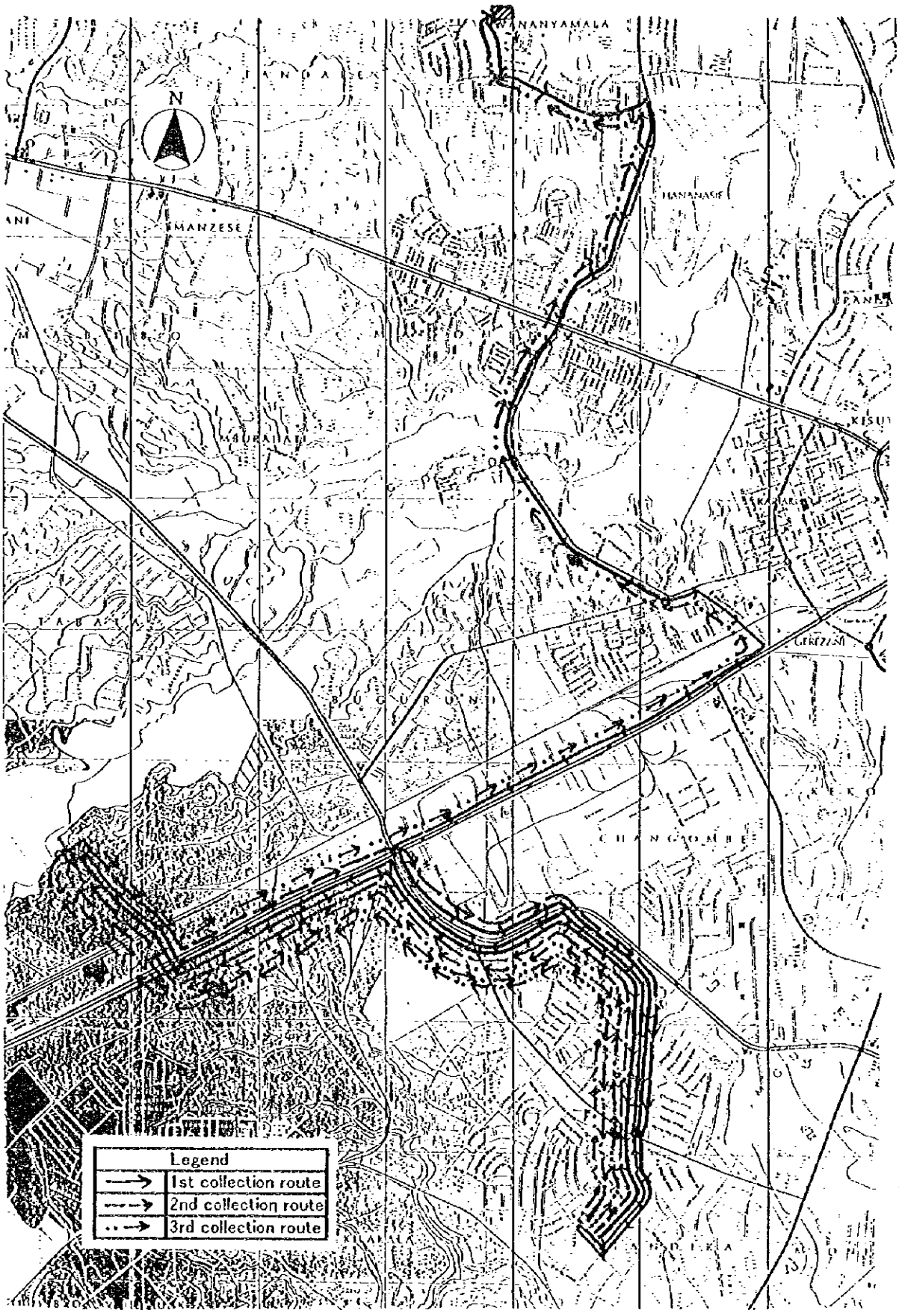


Legend	
⟶	1st collection route
⟶	2nd collection route
⟶	3rd collection route

Time and Motion Survey Data 4/10

Date	:3rd August, 1996
Type of waste collected	:Market waste
Collection Area	:Tandika market
DCC or Multinet	:D.C.C.
Crew	:1 person(1 vehicle driver)
Type of collection vehicle	:ISUZU TURBO SM1232
Loading capacity(ton)	:8ton
Year of vehicle manufacture	:1987
Working hours	:08:20 to 18:00 (09hr.40min.)
Number of Trips	:3 trips
Travel distance	:95.3km
Number of collection points	:4 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	08:20-08:23	3	0.6	Depot to fuel station	-	D.C.C.D.
	08:23-08:44	21	-	Fuelling	-	D.C.C.D.
	08:44-09:32	48	-	Waiting for permission	-	D.C.C.D.
1	09:32-10:10	38	14	Depot to collection area(1st trip)	-	-
	10:10-10:50	40	-	Waiting to load waste	-	Tandika
	10:50-10:58	8	-	Loading waste by wheel loader	1	Tandika
	10:58-11:20	22	10	Collection area to disposal site	-	-
	11:20-11:21	1	-	Unloading waste	-	Vingungnti
2	11:21-11:43	22	9	Disposal site to collection area(2nd trip)	-	-
	11:43-13:25	102	18.4	Waiting to load waste and loading waste by wheel loader	2	Tandika
	13:25-13:47	22	8.6	Collection area to disposal site	-	-
	13:47-13:48	1	-	Unloading waste	-	Vingunguti
3	13:48-14:08	20	9.6	Disposal site to collectors office(3rd trip)	-	-
	14:08-14:28	20	-	Waiting to load waste	-	Tandika
	14:28-14:33	5	-	Loading waste by wheel loader	1	Tandika
	14:33-14:53	20	9.4	Collection area to disposal site	-	-
3	14:53-14:54	1	-	Unloading waste	-	Vingunguti
-	14:54-15:06	12	-	Driver talking with his friend	-	Vingunguti
	15:06-15:25	19	0.5	Lunch time	-	Vingunguti
	15:25-16:07	42	15.2	Disposal site to the office	-	-
	16:07-18:00	113	-	Waiting for another assignment	-	D.C.C.D.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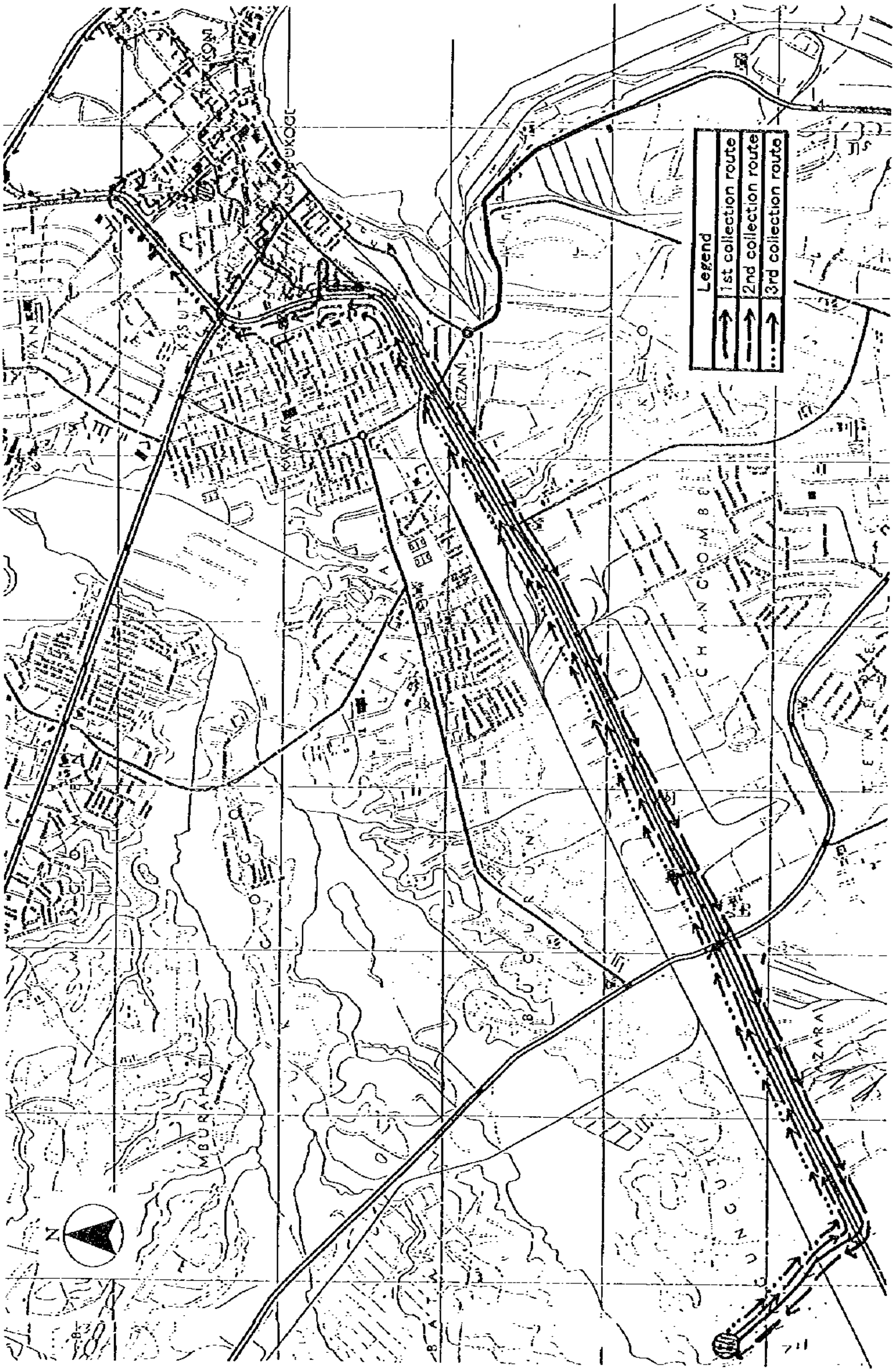
Legend
1st collection route
2nd collection route
3rd collection route

Time and Motion Survey Data 5/10

Date	:6th August, 1996
Type of waste collected	:Hospital Waste, Residential solid wastes, Hotel wastes
Collection Area	:City centre
DCC or Multinet	:Multinet, Africa Ltd.
Crew	:6 persons(1 vehicle driver, 5 collectors)
Type of collection vehicle	:JIEFANG TIPPER TRUCK
Loading capacity(ton)	:6ton
Year of f vehicle manufacture	:1987
Working hours	:07:30 to 17:32 (10hr.02min.)
Number of Trips	:3 trips
Travel distance	:47 km
Number of collection points	:20 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	07:30-08:04	34	-	Meeting(Assignment of daily work)	-	Anatogro
1	08:04-08:10	6	0.4	Office to collection area (1st trip)	-	-
	08:10-09:53	103	1.7	Waste collection work	8	Uhuru street
	09:53-10:20	27	8.4	Collection area to disposal site	-	-
	10:20-10:22	2	-	Unloading waste	-	Vingunguti
-	10:22-10:45	23	1.3	Breakfast	-	Vingunguti
	10:45-11:10	25	8.1	Disposal site to fuel station	-	-
	11:10-11:15	5	-	Fuelling (20liter)	-	B.P.
2	11:15-11:20	5	1	Fuel station to collection area(2nd trip)	-	-
	11:20-14:38	198	14.4	Waste collection work	11	Happy snake restaurant
	14:38-15:03	25	0.5	Collection area to disposal site	-	-
	15:03-15:05	2	-	Unloading waste	-	Vingunguti
-	15:05-15:50	45	0.8	Lunch	-	Vingunguti
	15:50-16:00	10	3	Disposal site to Depot	-	-
	16:00-16:15	15	-	Meeting with mechanics	-	Nyerere road
-	16:15-16:24	9	4.8	Depot to office	-	-
	16:24-16:27	3	-	Reporting to supervisor	-	Anatogro
3	16:27-16:36	9	1.5	Office to collection area(3rd trip)	-	
	16:36-17:19	43	-	Loading waste	1	Sheraton Hotel
	15:19-17:32	13	1.1	Disposal site to the office	-	-

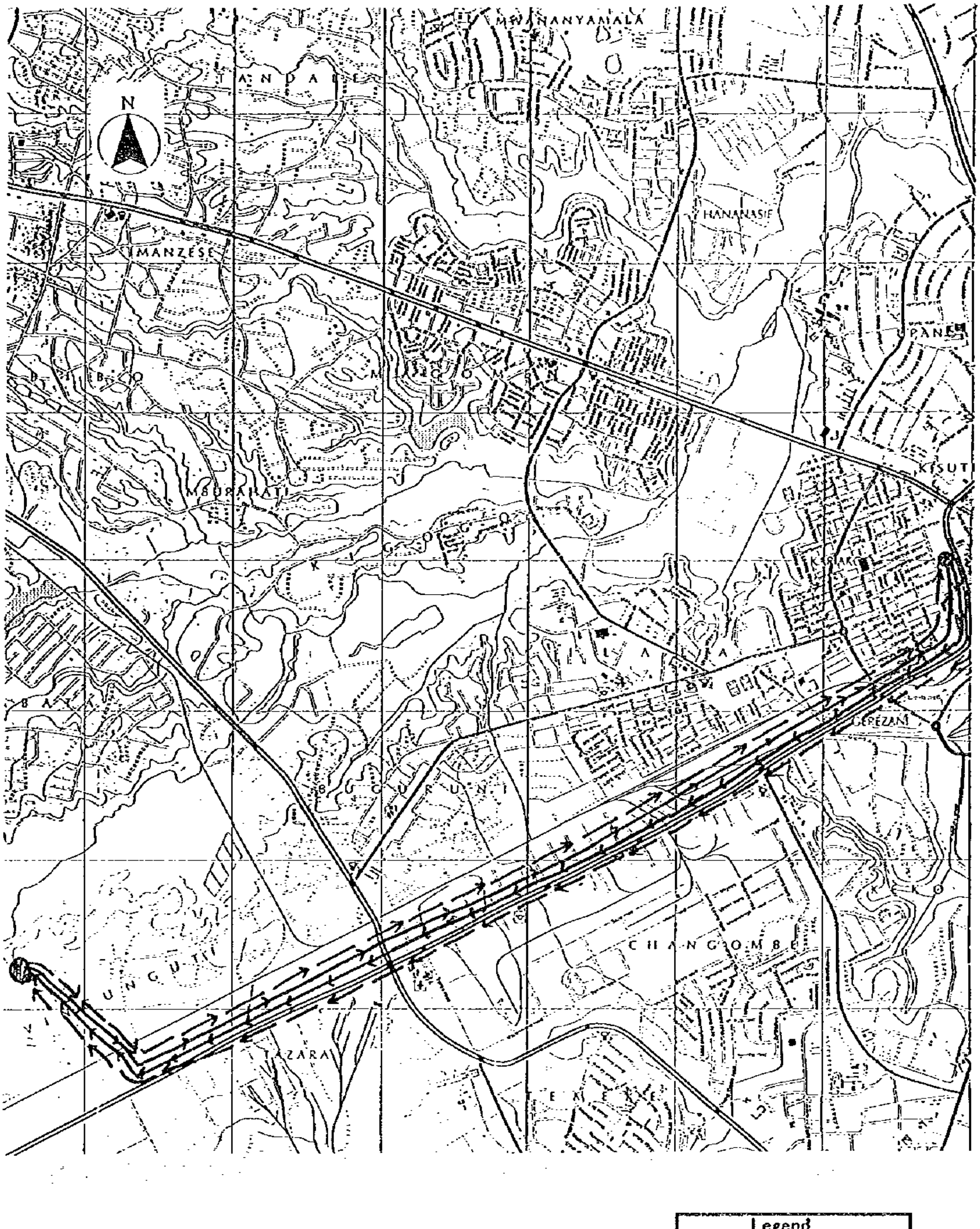

Legend
1st collection route
2nd collection route
3rd collection route
N

Time and Motion Survey Data 6/10

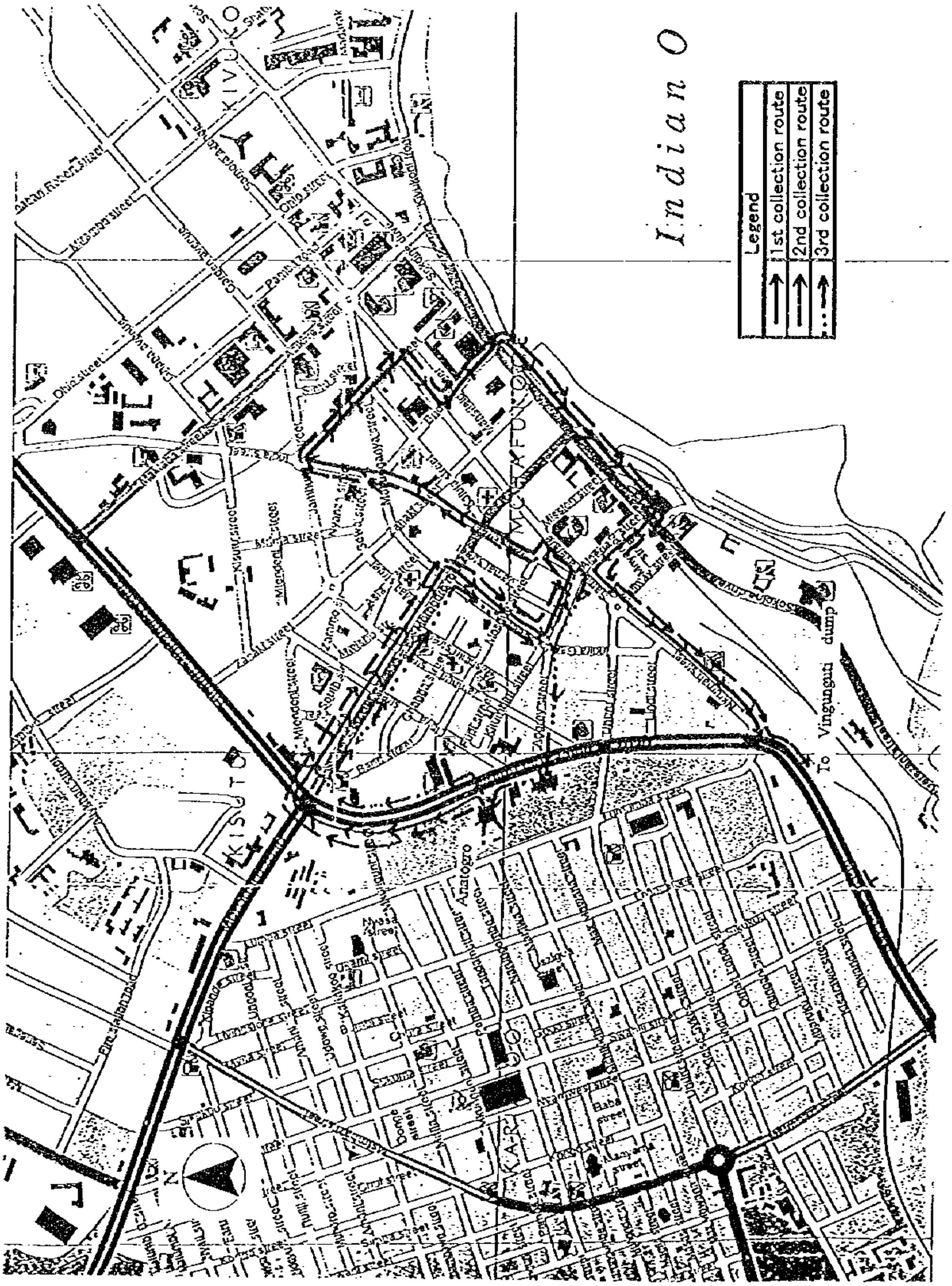
Date :7th August, 1996
Type of waste collected :Residential solid wastes
Collection Area :City centre
DCC or Multinet :Multinet, Africa Ltd.
Crew :5 persons(1 vehicle driver, 4 collectors)
Type of collection vehicle :JIEFANG TIPER TRUCK
Loading capacity(ton) :6ton
Year of vehicle manufacture :1987
Working hours :07:10 to 19:10 (12hr.00min.)
Number of Trips :3 trips
Travel Distance :71.5 km
Number of collection points :19 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	07:10-07:13	3	0.4	Depot to fuel station	-	-
	07:13-07:17	4	-	Fuelling	-	Band St.
1	07:17-07:20	3	0.8	Fuel station to collection area(1st trip)	-	-
	07:20-09:56	156	2.85	Waste collection work	9	Samora amenue algeria St.
	09:56-10:22	26	7.95	Collection area to disposal site	-	-
	10:22-10:24	2	-	Giving tins to scavengers	-	Vingunguti
	10:24-10:27	3	1.2	To disposal site	-	-
	10:27-10:28	1	-	Unloading waste	-	Vingunguti
-	10:28-10:50	22	0.55	Breakfast	-	Vingunguti
2	10:50-11:04	14	6.6	Disposal site to collection area(2nd trip)	-	-
	11:04-13:10	126	1.55	Waste collection work	7	Nyerere road
	13:10-13:43	33	8.8	Collection area to disposal site	-	-
	13:43-13:45	2	-	Giving recycled tools to scavengers	-	Vingunguti
	13:45-13:46	1	0.8	To disposal site	-	-
	13:46-13:47	1	-	Unloading waste	-	Vingunguti
-	13:47-13:51	4	-	Selling sorted waste materials	-	Vingunguti-
	13:51-14:15	24	0.3	Lunch	-	Vingunguti
-	14:15-14:30	15	7.7	Disposal site to the office	-	-

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
	14:30-14:40	10	-	Waiting for another route	-	Anatogro
3	14:40-14:45	5	1.2	Office to collection area(3rd trip)	-	-
	14:45-16:00	75	0.9	Waste collection work	3	DSM Supermarket
	16:00-16:28	28	8.9	Collection area to disposal site	-	-
	16:28-16:29	1	-	Unloading waste	-	Vingunguti
-	16:29-16:43	14	0.2	Signing	-	Vingunguti
	16:43-17:47	64	19.2	Disposal site to the office	-	-
	17:47-17:55	8	-	Waiting for collectors	-	Anatogro
	17:55-17:56	1	0.6	Office to collection area	-	-
	17:56-18:27	31	-	Traffic accident	-	Morogoro road
	18:27-18:47	20	1	Return to the office	-	-
	16:47-19:10	23	-	Waiting for collectors	-	Anatogro



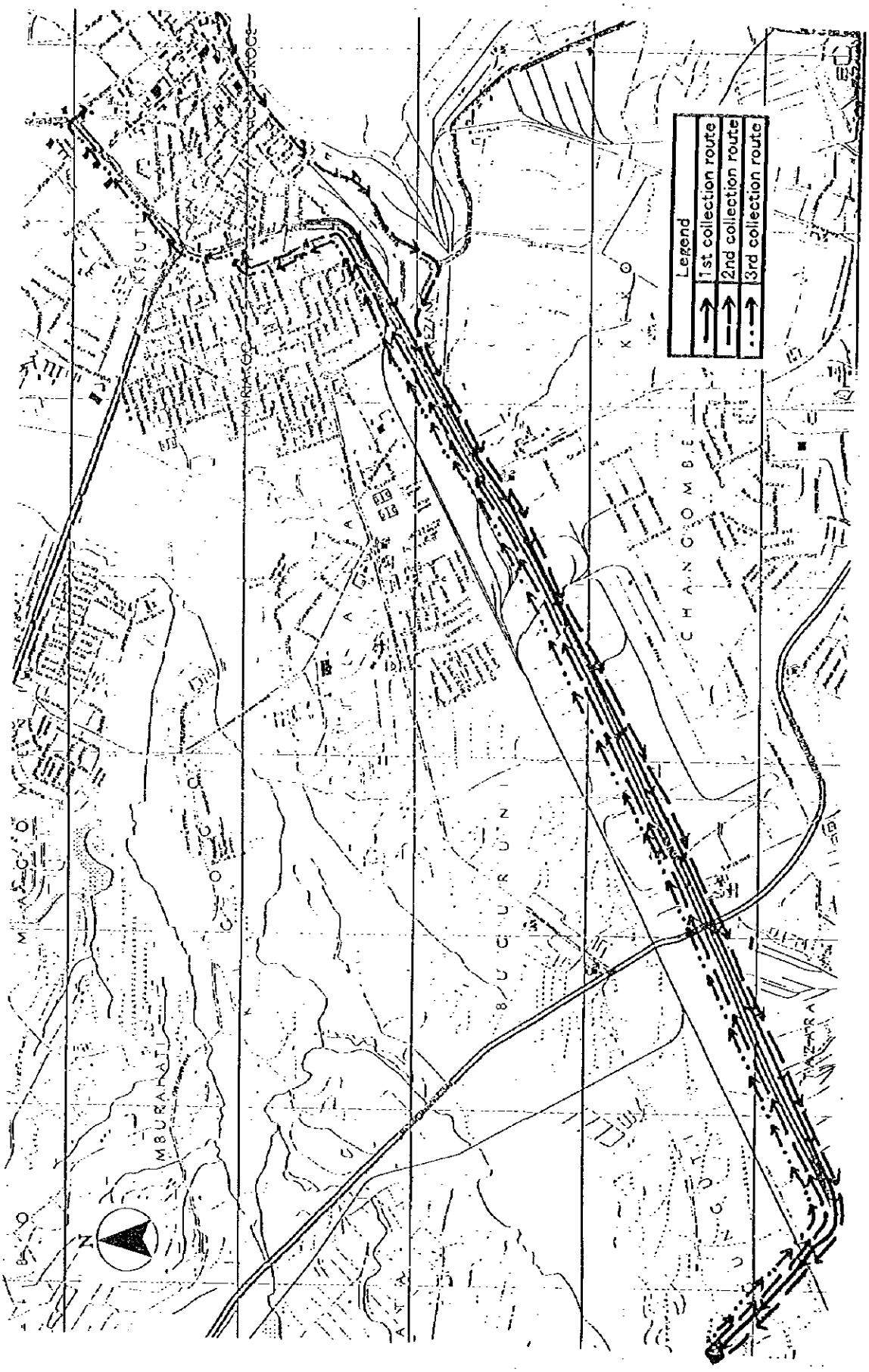
Legend	
——→	1st collection route
- - -→	2nd collection route

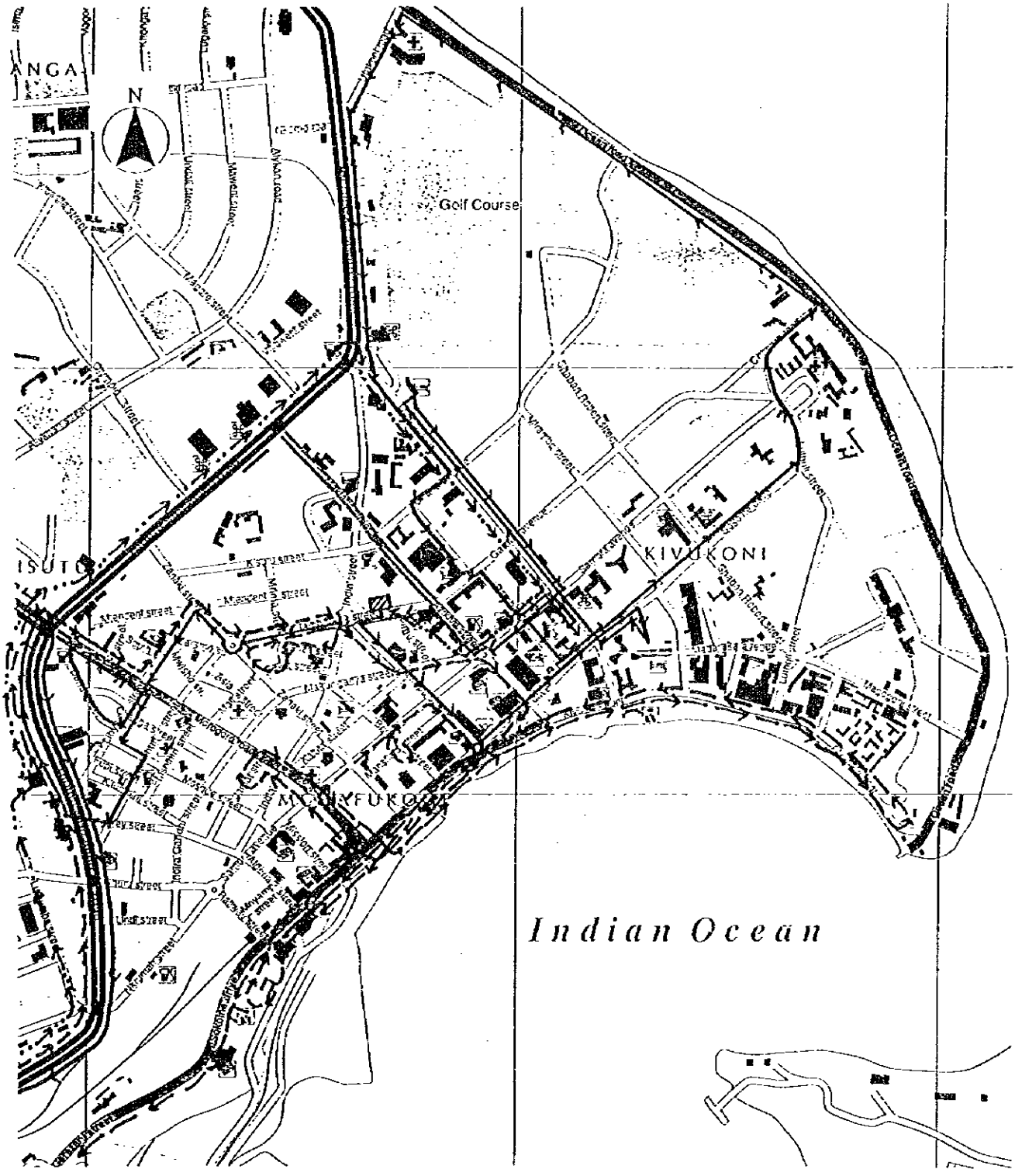

Indian O
Legend
1st collection route
2nd collection route
3rd collection route
To Vingunguti dump

Time and Motion Survey Data 7/10

Date	:8th August, 1996
Type of waste collected	:Hotel waste, Hospital waste, Office waste, Residential solid wastes
Collection Area	:City centre
DDC or Multinet	:Multinet, Africa Ltd.
Crew	:6 persons(1 vehicle driver, 5collectors)
Type of collection vehicle	:JIEFANG TIPPER TRUCK
Loading capacity(ton)	:6ton
Year of vehicle manufacture	:1987
Working hours	:06:28 to 18:07 (12hr.21min.)
Number of Trips	:3 trips
Travel distance	: 59.8km
Number of collection points	: 30 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
1	06:28-06:38	10	-	Depot to collection area(1st trip)	-	-
	06:38-11:22	284	10.8	Waste collection work	13	Kilimanjaro
	11:22-11:31	9	0.7	Collection area to the office	-	-
	11:31-11:38	7	-	Short meeting	-	-
	11:38-11:42	4	0.7	Office to fuel station	-	-
	11:42-11:46	4	-	Fuelling (20liters)	-	-
	11:46-12:05	19	8.3	Fuel station to disposal site	-	-
	12:05-12:10	5	-	Unloading waste	-	Vingunguti
-	12:10-12:28	18	0.3	Lunch	-	Vingunguti
	12:28-12:42	14	7.7	Disposal site to the office	-	-
	12:42-12:55	13	-	Short meeting	-	Anatogro
2	12:55-12:57	2	0.5	Office to collection area(2nd trip)	-	-
	12:57-16:28	211	7.3	Waste collection work	16	Mtendeni tea road
	16:28-16:46	18	10.9	Collection area to disposal site	-	-
	16:46-16:47	1	-	Unloading waste	-	Vingunguti
-	16:47-16:52	5	0.9	Disposal site to Kijimei	-	-
-	16:52-17:12	20	-	Selling scavenged things	-	Vingunguti
	17:12-17:28	16	7.8	Disposal site to the office	-	-
	17:28-17:30	2	-	Writing a report of the work	-	Anatogro
3	17:30-17:36	6	1.7	Office to collection area(3rd trip)	-	-
	17:36-18:02	26	-	Waste collection work	1	Sheraton Hotel
	18:02-18:07	5	2.2	Collection area to depot	-	-


Legend
1st collection route
2nd collection route
3rd collection route
CHANGOMBE
MBURAHATI
N



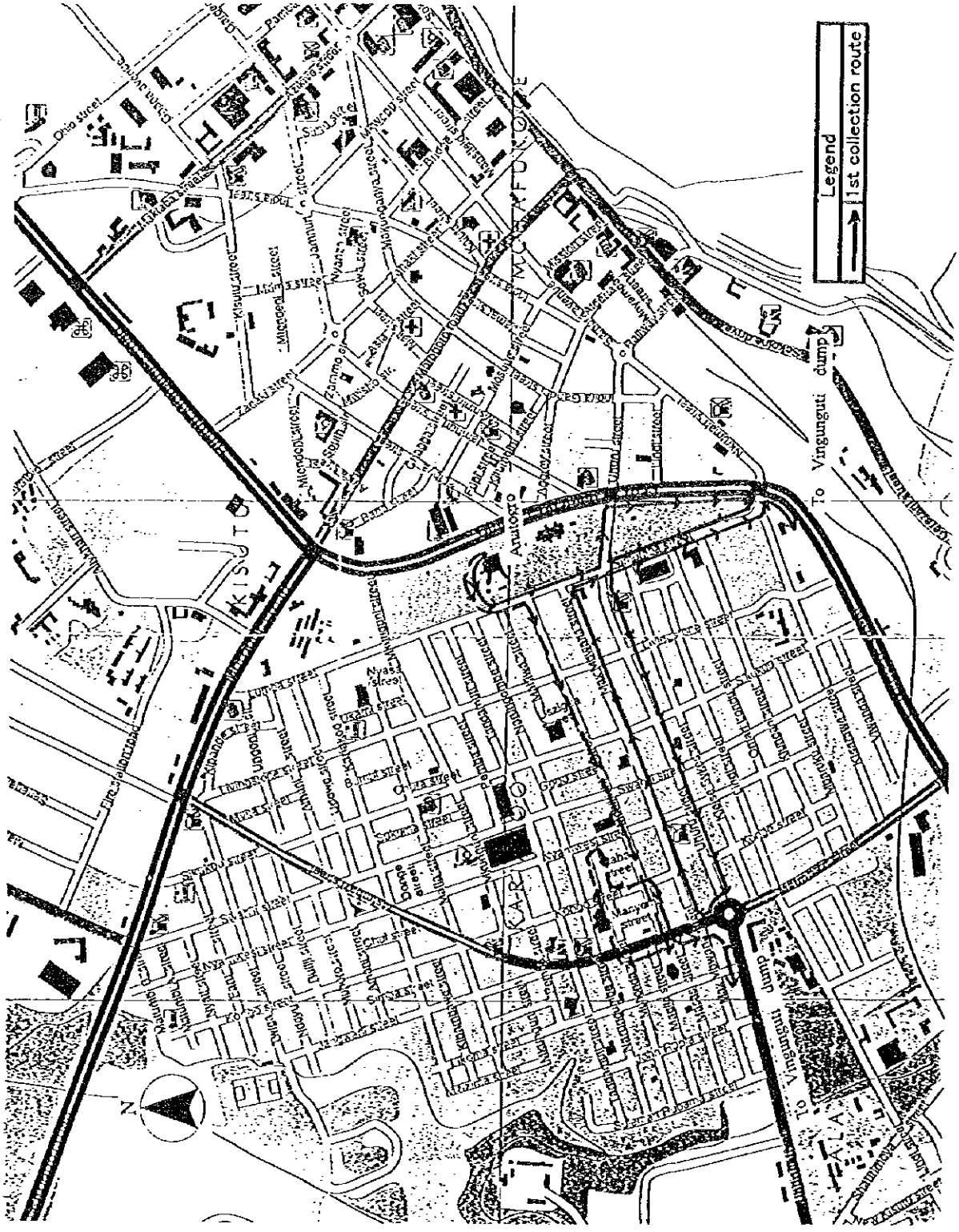
Legend	
——→	1st collection route
—·→	2nd collection route
···→	3rd collection route

Time and Motion Survey Data 8/10

Date :8th August, 1996
Type of waste collected :Residential solid wastes
Collection Area :Kariakoo A&B
DCC or Multinet :Multinet, Africa Ltd.
Crew :5 persons(1 vehicle driver, 4collectors)
Type of collection vehicle :JIEFANG TIPPER TRUCK
Loading capacity(ton) :6ton
Year of vehicle manufacture :1987
Working hours :07:10 to 15:45 (8hr.35min.)
Number of Trips :2 trips
Travel distance : 46.7km
Number of collection points : 24 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
1	07:10-07:18	8	0.7	Depot to collection area(1st trip)	-	-
	07:18-10:27	189	3.8	Waste collection work	14	Anatogro
	10:27-10:50	23	10.03	Collection area to disposal site	-	-
	10:50-10.51	1	-	Unloading waste	-	Vingunguti
2	10:51-11:20	29	11.27	Disposal site to collection area(2nd trip)	-	-
	11:20-14:00	160	1.2	Waste collection work	10	Lumumba St.
	14:00-14:35	35	10	Collection area to disposal site	-	-
	14:35-14:45	10	-	Giving sorted materials to scavengers	-	Vingunguti
	14:45-14:47	2	0.3	To disposal site	-	Vingunguti
	14:47-14:48	1	-	Unloading waste	-	Vingunguti
-	12:48-14:52	4	0.2	Selling waste materials	-	Vingunguti
	14:52-15:20	28	-	Lunch time	-	Vingunguti
	15:20-15:45	25	9.2	Disposal site to the office	-	-

Legend	
⟶	1st collection route
⇢	2nd collection route

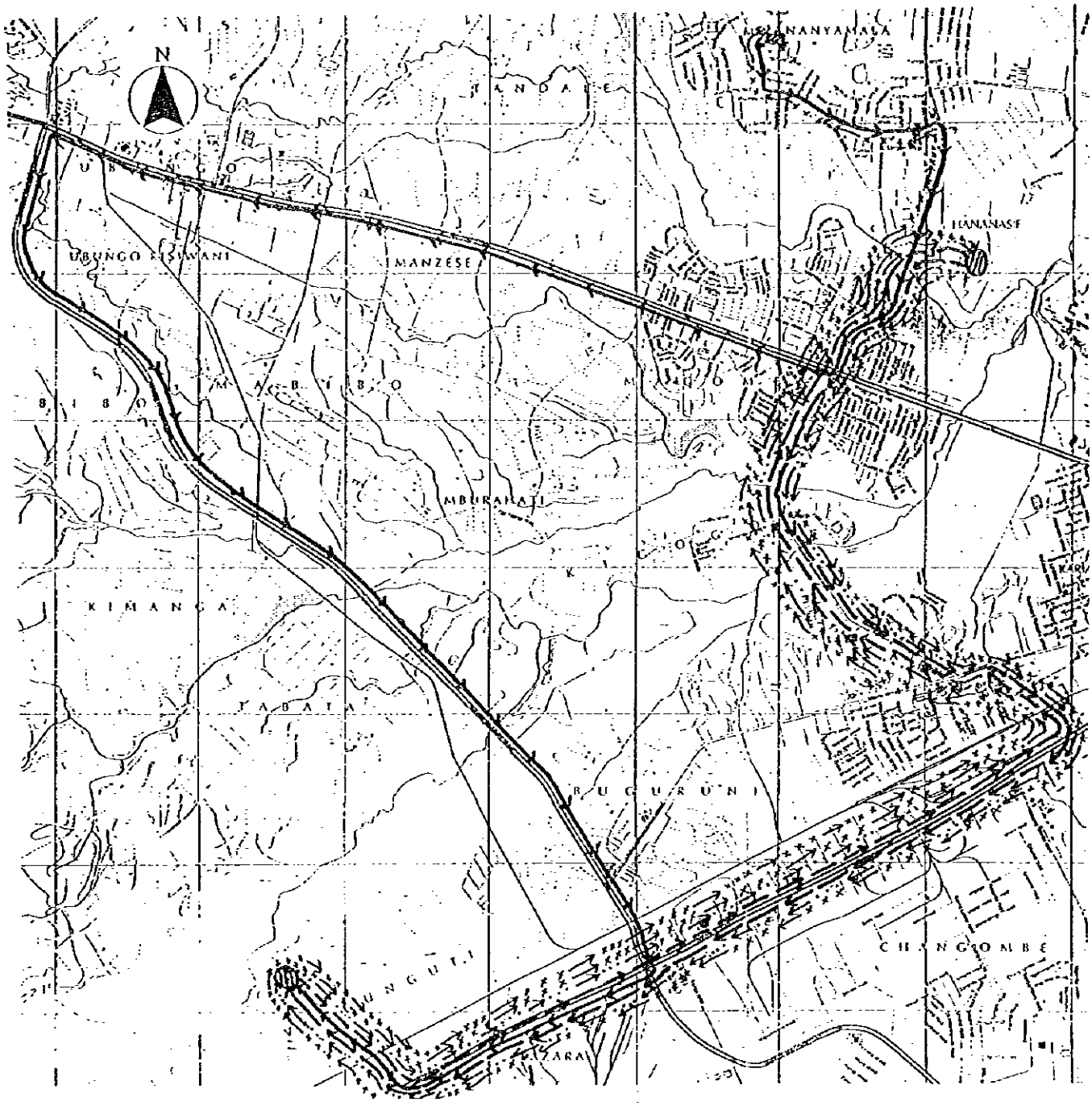

Legend
1st collection route
To Vingunguti dump
To Vingunguti dump
N

Time and Motion Survey Data 9/10

Date	:13th August, 1996
Type of waste collected	:Market wastes
Collection Area	:TANDALE Market & KINONDONI Market
DCC or Multinet	:DCC
Crew	:3 persons(1 vehicle driver, 1 wheel loader driver, 1 supervisor)
Type of collection vehicle	:JIEFANG TIPPER TRUCK
Loading capacity(ton)	:6ton
Year of vehicle manufacture	:1987
Working hours	:08:56 to 18:21 (9hr.25min.)
Number of Trips	:5 trips
Travel distance	: 122km
Number of collection points	: 5 points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	08:56-09:05	9	-	Fuelling(60liter)	-	D.S.S.D.
	09:05-09:10	5	0.5	Fuel station to the office		D.C.C.D.
	09:10-09:37	27	-	Repairing	-	D.C.C.D.
1	09:37-10:00	23	8.6	Office to collection area(1st trip)	-	-
	10:00-10:32	32	-	Waiting wheel loader	-	Tandale
	10:32-10:34	2	0.2	To collection area	-	-
	10:34-11:39	65	-	Waiting to load waste	-	Tandale
	11:39-11:55	16	-	Loading waste by wheel loader	1	Tandale
2	11:55-11:56	1	0.3	To the other collection area(2nd trip)	-	-
	11:56-12:17	21	-	Waiting to load waste	-	Tandale
	12:17-12:20	3	-	Loading waste by wheel loader	1	Tandale
	12:20-13:04	44	15.7	Collection area to disposal site	-	-
	13:04-13:05	1	-	Unloading	-	Vingunguti
3	13:05-13:50	45	13.5	Disposal site to collection area(3rd trip)	-	-
	13:50-13:56	6	-	Waiting to load waste	-	Kinanduni
	13:56-14:07	11	-	Loading waste by wheel loader	1	Kinanduni
	14:07-14:39	32	13.7	Collection area to disposal site	-	-
	14:39-14:45	6	-	Unloading waste	-	Vingunguti
4	14:45-15:15	30	13.5	Disposal site to collection area(4th trip)	-	-
	15:15-15:22	7	-	Loading waste by wheel loader	1	Kinonduni

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
	15:22-15:56	34	13.6	Collection area to disposal site	-	-
	15:56-16:00	4	-	Unloading waste	-	Vingunguti
5	16:00-16:31	31	13.5	Disposal site to collection area(5th trip)	-	-
	16:31-16:38	7	-	Waiting to load waste	-	Kinondunl
	16:38-16:45	7	-	Loading waste by wheel loader	1	Kinondunl
	16:45-17:18	33	13.7	Collection area to disposal site	-	-
	17:18-17:21	3	-	Unloading waste	-	Vingunguti
-	17:21-17:22	1	0.3	Disposal site to the office	-	-
	17:22-17:33	11	-	Meeting	-	Vingunguti
	17:33-18:21	48	14.9	Office to garage	-	-

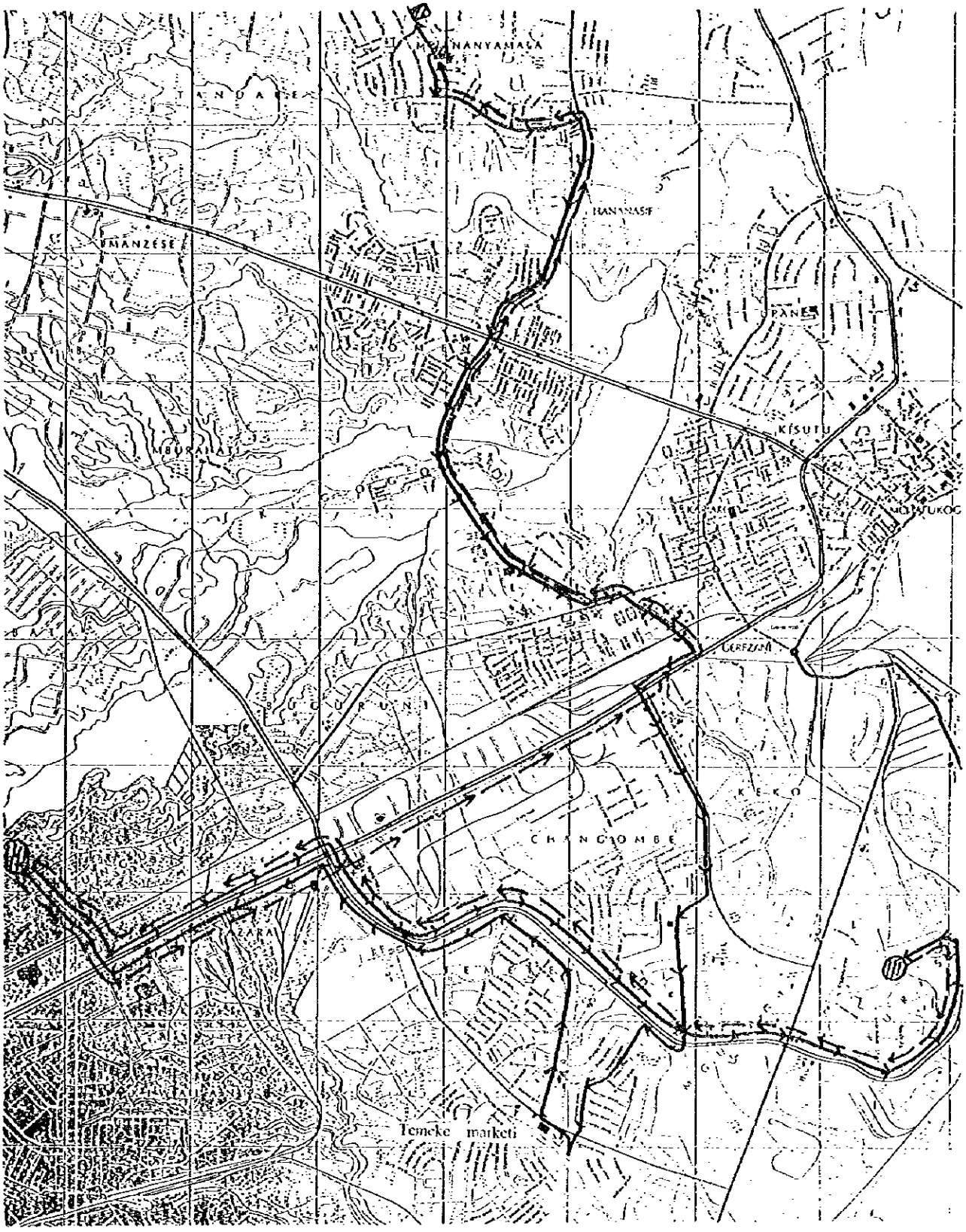


Legend	
——→	1st collection
– – →	2nd collection
· · · →	3rd collection
▸▸▸→	4th collection

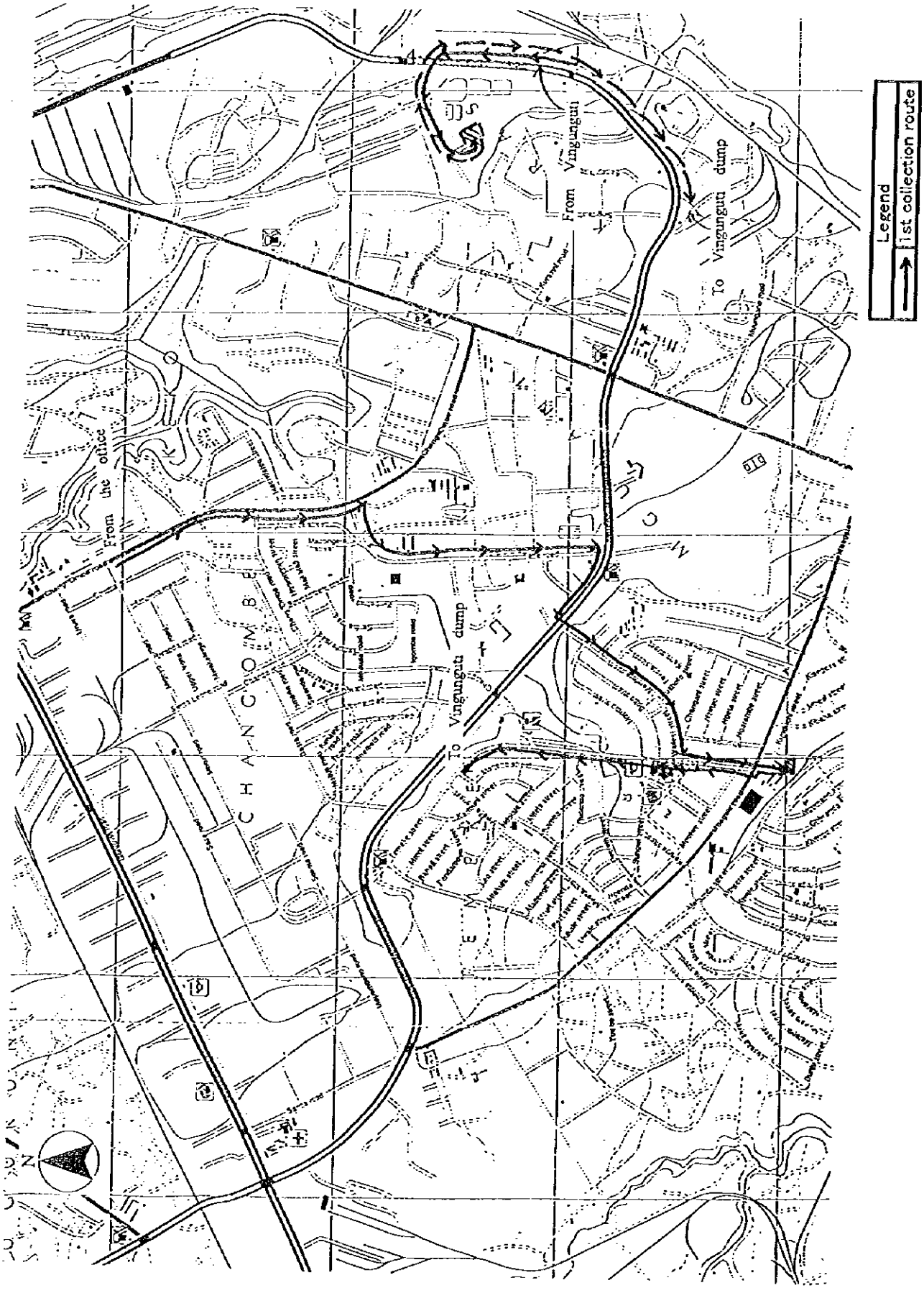
Time and Motion Survey Data 10/10

Date :13th August, 1996
Type of waste collected :Market wastes
Collection Area :Temeke Market & Kurasini Market
DCC or Multinet :DCC
Crew :1 person(1 vehicle driver)
Type of collection vehicle :ISUZU TURBO SM1232
Loading capacity(ton) :8ton
Year of vehicle manufacture :1987
Working hours :11:50 to 18:27 (6hr.37min.)
Number of Trips :2 trips
Travel distance :63.1km
Number of collection points : 2points

Trip No.	Time period	Actual time (min.)	Distance (km)	Activities collection, unloading, transporting, fuelling, meeting, repairing, lunch, etc.	Number of collection points	Location
-	11:50-11:51	1	0.4	Depot to fuel station	-	D.S.S.D.
	11:51-11:58	7	-	Fuelling	-	D.C.C.D.
1	11:58-12:25	27	12.7	Fuel station to collection area(1st trip)	-	-
	12:25-12:35	10	-	Waiting for collectors	-	Kibasira
	12:35-12:43	8	1.5	To collection area	-	-
	12:43-13:20	37	-	Waste collection work	1	Temeke
	13:20-13:40	20	8.4	Collection area to disposal site	-	-
	13:40-13:41	1	-	Unloading waste	-	Vingunguti
-	13:41-13:48	7	0.4	Disposal site to the office	-	-
	13:48-14:26	38	6.9	Waiting for collectors	-	Temeke
2	14:26-14:35	9	4.20	Office to collection area(2nd trip)	-	-
	14:35-15:45	70	-	Waste collection work	1	Kurasini Market
	15:45-16:10	25	11.7	Collection area to disposal site	-	-
	16:10-16:11	1	-	Unloading waste	-	Vingunguti
-	16:11-17:40	89	-	Selling and signing	-	Vingunguti
	17:40-18:27	47	16.9	Disposal site to the office	-	-



Legend	
→	1st collection route
→	2nd collection route


Legend
1st collection route
From Vingunguti
To Vingunguti dump
From the office
To Vingunguti dump
CHANCOMB
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