CHAPTER 13

ENVIRONMENTAL IMPACT ASSESSMENT

13. ENVIRONMENTAL IMPACT ASSESSMENT

13.1 Initial Environmental Impact Assessment

An Initial Environmental Assessment was carried out prior to a full Environmental Impact Assessment. The scope of the Initial Environmental Assessment included familiarisation of the road network in Kampala and consultation with various stakeholders, particularly government staff with environmental and land use remits. An attempt was made to understand the nature of future economic and environmental change in Kampala and the ability of government institutions to plan, direct and control future natural resource development in the city.

The Study Team identified the following major environmental considerations to be studied in the Initial Environmental Assessment as a result of a primary process of scoping, screening and ranking of environmental impacts:

- Possibility of Demolition, Relocation and Resettlement
- Noise and Vibration Pollution
- Air Pollution
- Flood-Prone Areas, Siltation of Water Courses and Erosion
- Utilisation of Quarries and Borrow Pits
- Flora and Fauna
- Pedestrian-Cyclists and Motorist Conflict

The following road sections comprised the network initially identified for rehabilitation in Kampala, based on MOWTC and JICA objectives:

1.	Queens Way/Masaka Road	8.3 km
2.	Katwe Road	1.6 km
3.	Lubiri Ring Road	3.8 km
4.	Gaba Road	11.0 km
5.	Port Bell Road	6.7 km
6.	Natete Road	4.0 km
7.	Hoima Road	8.5 km
8.	Jinja Road	6.9 km
9.	Jinja Road	1.8 km
10.	Bombo Road	5.1 km
11.	Gayaza Road	5.9 km
12.	Lugogo By-pass	2.4 km
13.	Kira Road	8.0 km
14.	Sentema Road	5.2 km

15.	Jinja-Kampala-Bombo Road	3.7 km
16.	Butikiro-Kisenyi Road	2.1 km
17.	Musajja-Alumbwa Road	0.5 km
18.	Mwanga Road	0.6 km
19.	Mengo-Kisenyi Road	0.7 km
20.	Motebi Road	0.4 km
21.	Lubiri Ring-Queens Way Road	0.3 km
22.	Lubiri Ring-Masaka Road	0.2 km
23.	Entebbe Road	3.0 km
24.	Ring Road	11.5 km
	Sub-total	102.2 km

Current literature was reviewed and interviews were carried out with officials from Ministry of Works and Transport Communication (MOWTC), Kampala City Council (KCC), National Environmental Management Authority (NEMA), FRI (Forrestry Research Institute), National Tree Seed Centre (NTSC), Ministry of Lands, Housing and Physical Planning (MLHPP) and Ugandan Traffic Police.

13.2 Environmental Studies and the Institutional Framework in Uganda

(1) General

Construction of major roads is among the projects listed in the National Environmental Statute, 1995, Schedule 3 which require an Environmental Impact Assessment (EIA).

The National Environmental Management Agency (NEMA) is the authority responsible for the management of the environment and operates within the Statute and under the Ministry of Natural Resources.

Of direct relevance to road construction and rehabilitation are air, noise, vibration and water effluent quality standards and to date, only draft standards relating to these pollutants are available in Uganda.

Other legislation of importance to this study includes The Kampala Development Plan (1994-2004), The Town and Country Planning Act of 1964, the Land Acquisition Act of 1965, and the Road Safety and Traffic Act (amended in 1991).

The maintenance and sustainability of environmental integrity of the Kampala ecosystem is also of interest to the Water Development Department (WDD) of the Ministry of Natural Resources, the National Water and Sewerage Corporation (NWSC) and the Lake Victoria Environment Management Project (LVEMP). The latter, an East African regional body has the function of co-ordinating environmental management within the Lake's catchment area.

(2) Past Environmental Studies on Road Projects in Kampala/Uganda

Since the formation of NEMA in 1995, there are few complete EIA's on road projects in Uganda and none on Kampala. The available studies include:

- Road Maintenance Capacity Building: Environmental Review by Parkman - O'Sullivan & Graham, November 1996.
- Studies for the Rehabilitation and Improvement of PTA Sponsored Roads - Katunguru-Kasese-Fort Portal Road, Kasese-Kilembe Link and For Portal-Bundibugyo Road, Sabbour Associates, January 1996.
- Environmental Impact Assessment of the Mubende-Fort Portal Road, Carl Bro, 1993.
- Environmental Impact Assessment of the Karuma-Pakwach-Arua Road, Associated Consulting Engineers, February 1996.
- A Comparative Feasibility Study between the Northern and Southern By-passes for Kampala, Sir Alexander Gibb & Partners, January 1997.

13.3 Environmental Impact Assessment and the High Priority Roads and Junctions

The aim of the proposed project is to ease current levels of traffic congestion (vehicle, cycle and pedestrian) and take into account, future levels of traffic forecast for Kampala.

Kampala City is currently experiencing one of the fastest rates of growth in its history with a corresponding growth in vehicle numbers. It has been estimated that the increase in vehicles in recent year is approximately 10% and that of the 100,000 vehicles registered in Uganda, over 60,000 mainly operate in Kampala. Therefore the development and maintenance of relevant infrastructure in the City is of paramount importance.

At the same time it is equally important that due attention be given to environmental considerations pertinent to the proposed Project. EIA has focused on the high priority junctions and roads listed below:

Junctions

Natete Junction
Makerere Junction
Kibuye Junction
Port Bell/Jinja Road Junction
Wandegaya Junction
Jinja Road Junction

Roads

Natete Road
Gaba Road
Port Bell Road
Gayaza Road
Hoima Road

The European Council EIA Directive 85/337/EC of 27 June 1985 applies the term "Environmental Impact Assessment" to the identification, description and assessment of direct and indirect effects of a project on: human beings, fauna and flora, soil, water, air climate and the landscape; the interaction of these factors; and on material assets and cultural heritage.

The following environmental issues were analyzed in detail with regard to the high priority projects:

- possibility of demolition, relocation and resettlement
- noise and vibration
- dust and air pollution
- flood-prone areas, siltation of waterways and erosion
- use of quarries and borrow-pits
- flora
- pedestrians, cyclists and motorists

Table 13.1 Environmental Description of High Priority Projects

Junction or Road	Social and Economic Environment	Physical and Natural Environment	Environmental Concern
Natete Junction	- next to one of the 3 busiest markets in Kampala. - area of intense commercial activity. - encroachment of businesses onto roadside taxi park	- drainage channel passes underneath the road. - roundabout at base of slope. - disintegrated road - no greenery	- pedestrian-cycle-vehicle conflict - chronic congestion. - dust, air & noise pollution - blocked drains
Makerere Junction	- area of commercial activity (timber sale, furniture sale, car washing & shops)	- Mulago Green Park next to Bombo road - no flora in roundabout centre, but a number of trees in area - drainage underneath road	- blocked drains - exacerbated by car washing (associated hydrocarbon pollution) - dust & air pollution
Kibuye Junction	- area of commercial activity - railway crossing with two bridge (Makindye & Entebbe road) crossings	- trees and shrub beds in roundabout centre. - flora along railway embankment and ball field	- dust, air and odour (from rubbish) pollution
Port Bell/Jinja Road Junction	- area of less intense commercial activity (abuts onto Nakawa University, Nakasero market and a fuel station)	- area rich in flora with trees, bananas, crops (maize, cassava, potatoes) and mixed grasses	- dust & air pollution from Nakasero market - blocked drains with associated odour
Wandegeya Junction	- area of intense commercial activity. - focal point for Makerere University students - taxi park - police flats	- religious/cultural site of Wandegeya Mosque - landscaped area surrounding mosque and some other large trees	- noise, dust & air pollution affecting mosque - building encroachment onto road reserve
Jinja Junction	- industrial & commercial area	- next to Centenary Green Park through which Kitante channel passes	- flooding - dust, air & noise pollution
Natete Road	- commercial at both ends of the road with a residential zone in the middle and many schools	- highly disintegrated road. - topographically many lows and highs - wetland zone	- poor drainage - dust & air pollution
Gaba Road	port access route commercial & residential area	- crosses Kansanga wetland	- poor drainage - dust, air & noise pollution
Port Bell Road	- port access route with mixed residential, commercial & institutional area. - For the last 1.4 km industrial zone	- low lying area, skirts Kansanga wetland - tree planting along road in places	- poor drainage - water pollution from industrial area into Lake Victoria - dust & air pollution - water hyacinth dumping on road reserve
Gayaza Road	- sparsely commercial & residential (least densely populated road) area	- low lying, intermittent wetland	- poor drainage - some exposed drinking wells along road
Hoima Road	- commercial area at start and low density residential at end	- crosses Lubigi wetland - tree lined road along sections.	- poor drainage

From Table 13.1 and general observations, there are a number of patterns and trends which are emerging or continuing in Kampala.

Junctions in Kampala often act as a focal point for commercial activity. An example is the Natete roundabout which is surrounded by a market, taxi park and numerous shops and businesses. These activities directly contribute to the congestion at the junction. Planning authorities would do well to encourage future development away from the junctions.

The main arterial roads connecting different parts of the City, such as the high priority roads, attract a high level of development on both sides of the road. In places, particularly congested areas, development is taking place extremely close to the road reserve and in some instances in the road reserve. When development takes the form of multiple storied buildings, the options for future road expansion are extremely limited. Added to this, the effects of noise and air pollution on communities living so close to the road, though not well documented in Uganda are expected to be quite detrimental.

Encroachment of the Kampala wetlands (Kansanga, Nakivubo and Lubigi) continues. This is due to the growth of low income residential areas such as Kitintale in the Nakivubo wetland off the Port Bell Road. This development inhibits the natural capacity of the wetlands to drain the City. Drainage difficulties attract a host of other problems including water pollution and water transmitted diseases. Distinct regulation and zonation of the wetland areas should be a future priority.

Existing drainage channels are often disintegrated and/or are blocked by both silt and refuse. The disposal of refuse, particularly used plastic, is increasing at a high rate. Furthermore, many of the drains, particularly the ones in the industrial area off Port Bell Road, contain untreated industrial wastewater. There is an urgent need for drainage channel maintenance and co-ordinated solid waste disposal. Lastly there is a new trend of indiscriminate dumping of the water hyacinth from the town of Port Bell onto the road reserve of Port Bell Road.

There are a number of green parks and green belt areas with a rich and unique bird life in the City. These areas are adjacent to roads and should be conserved and further promoted. Examples include the Mulago Park off Bombo/Gayaza Road and Centenary Park at the Jinja roundabout.

13.3.1 Possibility of Demolition, Relocation and Resettlement

(1) Land Tenure/Ownership

Generally, the roads in the City centre have little or no road reserve, while those in the periphery often have a road reserve, usually undeveloped. The land tenure system in Kampala is complex and has a profound effect on the development of the City and implications with regard to compensation. In 1995, the Uganda Constitution reverted all land rights to the owners. There are now four main land tenure systems in Uganda:

- Mailo land
- Freehold land
- Leasehold land
- Customary tenure

Mailo land: Under the Uganda Agreement of 1900, a total of 9,003 square miles of land in Buganda were shared out among the Protectorate Government, the Kabaka, chiefs and notables. Under mailo land tenure, land title is issued in perpetuity.

Freehold land: Freehold tenure in Kampala is limited to a number of churches and schools which had established a presence by 1900. Under freehold tenure, a Certificate of Title is issued and the interest in land likewise carries on for 199 years. Normally, no conditions are attached to what amounts to the granting of land to such institutions.

Leasehold land: Public land in Kampala is allocated to the City by the Uganda Land Commission (ULC), which also leases out land directly to certain agencies (e.g. National Housing and Construction Corporation, at Ntinda). The KCC is in turn responsible for leasing land to suitable applicants for development on a leasehold basis. Formal land transfers are regulated and governed by the Urban Authorities Act (1965) and the Land Reform Decree (1975). Mailo land-owners may also grant leases to various types of developers. Public and private leases typically run for either 49 or 99 years.

Customary tenure: Customary tenure is the oldest form of land tenure and can supersede all other forms of land tenure depending on the particular situation, including, above all, the length of residency of the occupant. Those who hold land under this system are not subject to annual ground rent or observance of development conditions.

Approximately 45% of the land tenure in Kampala is mailo land tenure.

(2) Compensation

Compensation is the responsibility of the Government of Uganda. It is paid to property owners, but not to tenants or for services or business opportunities lost.

Table 13.2 lists some recent examples of compensation value payments for crops and semi-permanent structures in the line of proposed roads undertaken by KCC. In recent times, there have been no new roads constructed in Kampala District. Roads have only been rehabilitated and generally not widened.

Table 13.2 Past Cases of Compensation by Road

Road Location	Contractor	Date	Compensation For	Compensation Value	No of people relocated
Nalukolongo Ring Road	KCC	21.12.95	crops & semi-permanent structures	4,525,460/-	16 (customary tenure)
Nalukolongo Ring Road	KCC	N.A	N.A	6,560,941/-	N.A
Plot No 6, Wankulukuko Road at Nalukolongo	KCC	25.05.94	crops	2,149,828/-	14 (customary tenure)
Plot No 8, Naguru Close	KCC	N.A	crops & semi-permanent structures	1,150,760/-	N.A
Access to Kitezi Dump Site	KCC	12.06.95	crops & semi-permanent structures	4,810,705	14 (customary tenure)

Note: N.A - Data Not Available

In the past, a valuation was made and people were moved with the promise of forthcoming compensation, which in some instances took years or is still pending. Since 1995, according to the Constitution, compensation payment has to be prompt, and must take place before acquisition of the land. The responsibility for setting compensation rates now lies with the Kampala District Land Board, following decentralisation of land control in February/March 1997.

KCC states that highways have a 10 m designated road reserve from the center line while all other roads have a 5 m reserve on either side of the road. However, according to the Ministry of Lands, Housing and Physical Planning (MLHPP), these road reserves must be gazetted in order to be legally binding.

MOWTC states that no road reserves have been gazetted to date in Kampala District. For example, Entebbe Road which is currently being rehabilitated was not a gazetted road, and individuals who have built within the road reserve are theoretically entitled to compensation (MLHPP). This may have serious implications for road rehabilitation in Kampala.

In conclusion, compensation for land, structures/buildings and crops, trees etc. may fall into two categories:

- Property within a road reserve which was never gazetted and therefore, theoretically, the owners are entitled to compensation.

- Property outside a road reserve, but within a zone of proposed widening for a road; thus owners are entitled to compensation.

(3) Demolition, Relocation and Resettlement Survey

Topographical maps at a scale of 1:2,500 were used (1993, USD.6 Series) in combination with ground surveying. It was generally found that the number of buildings along most roads had increased dramatically in number since 1993. In some instances it was estimated that they had increased by approximately 30-40%.

The survey work at bottleneck junctions and along roads was planned so that environmental and engineering considerations could be investigated simultaneously. The present situation of building/housing location was investigated and described by project and this information was used as a prerequisite for junction/road design. As a consequence, it was proved that the projects involve no demolition and relocation of building/housing with the adoption of junction and road designs which aim at minimization of environmental damage.

One of the over riding principles behind the highway engineering design was that the minimum of demolition should be planned. Instead, the road design or width was frequently changed along the length of the road in order to accommodate buildings and trees, in particular well established buildings and indigenous trees. In extreme instances this resulted in a narrow to non-existent pedestrian/cycle way or buffer zone.

13.3.2 Noise and Vibration Pollution

(1) Noise and Vibration Survey

The surveys were carried out on the 25, 26, and 28 February and on 4 and 5 March 1997. A Rion sound level meter, model NA-24 was used for the noise measurements while a Rion vibration level meter, model VM-51 was used for the vibration measurements. The following types of survey were carried out:

(a) A noise source survey
(b) A road traffic survey of noise 1 m from the edge of the road and at a building fronting the road.
(c) A road traffic vibration survey 1 m from the edge of the road
(d) A construction machinery noise survey
(e) A construction machinery vibration survey

(a) Vehicle Noise Source Survey

The first survey to be carried out was a survey to determine the source of noise from vehicles along roads in Kampala. Two types of vehicles were tested; a 1600 cc saloon car and a 2,800 cc mini bus. Maximum noise levels were measured at four different points, 2 m, 5 m, 7.5 m and 15 m, perpendicular to the edge of a paved road with the vehicle travelling at 40 km/hr and then 60 km/hr. Maximum noise levels were measured and a minimum of three readings was taken for every point.

(b) Road Traffic Noise Survey

The road traffic noise surveys was carried out at five locations on Masaka Road, Gaba Road, Port Bell Road, Bombo Road and Jinja Road. The locations chosen corresponded to the traffic survey points in principle to match the result with the number and type of traffic volume. Instantaneous noise levels for each location was measured a total of six times each day at 07:00, 08:00, 10:00, 14:00, 18:00 and 20:00 and measurements were taken from positions 1m from the paved roadside surface and 1 m from a residential dwelling fronting the road. Noise levels were recorded every 15 seconds for 2 minutes to give a total of eight readings.

(c) Road Traffic Vibration Survey

Vibration measurements were recorded at the same locations on the same days as the noise level measurements for each of the five roads: Measurements for each location were taken 1m away from the paved roadside surface and six times every day at 07:00, 08:00, 10:00, 14:00, 18:00 and 20:00. At each site a total of 8 instantaneous measurements were taken consecutively every 15 seconds. As the readings were well below the recommended levels outlined by the Japanese Standard it was deemed unnecessary to take measurements at buildings fronting the roadside.

(d) Construction Machinery Noise Survey

Noise survey measurements were taken of typical construction machinery (Wheel Loader CAT 950F) at 1 m, 5 m, 10 m, 15 m, 20 m and 30 m perpendicularly from where the construction machinery was being operated on the Entebbe Road. Maximum noise levels were recorded a minimum of three times for every point.

(e) Construction Machinery Vibration Survey

For the construction machinery survey, two different types of rollers were tested for vibration along the Entebbe Road Rollers were chosen for the survey as they known to produce more vibration than other types of construction machinery. Instantaneous vibration levels were recorded at 3.5 m or 5 m, 10 m, 20 m and 30 m distances perpendicular to the direction of movement of the rollers.

(2) Results of Noise and Vibration Surveys

(a) Vehicle Noise Source SurveyResults

From Figure 13.1 it can be seen that noise levels decrease with distance as expected and that the minibus with the larger engine produces higher noise levels than the saloon car. Noise levels for a saloon car travelling at 40 km/hr measured 2 m away from the vehicle averaged 72.3 dB (A) and measured 15 m away from the vehicle averaged 68.2 dB (A). At 60 km/hr measured 2 m away from the vehicle gave an average of 74.4 dB (A) and measured 15 m away from the vehicle gave an average of 66.2 dB (A).

Figure 13.1 Results of Vehicle Noise Source Survey

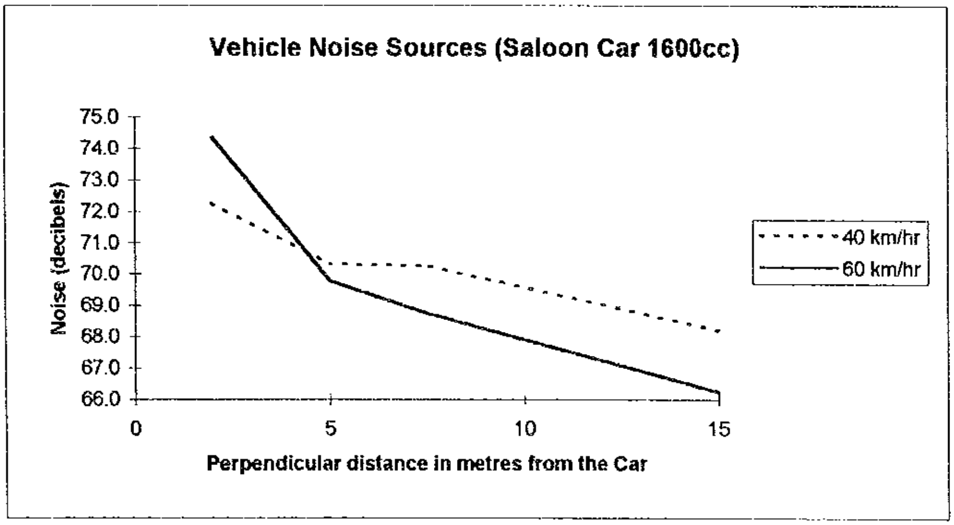
Maximum Noise Levels

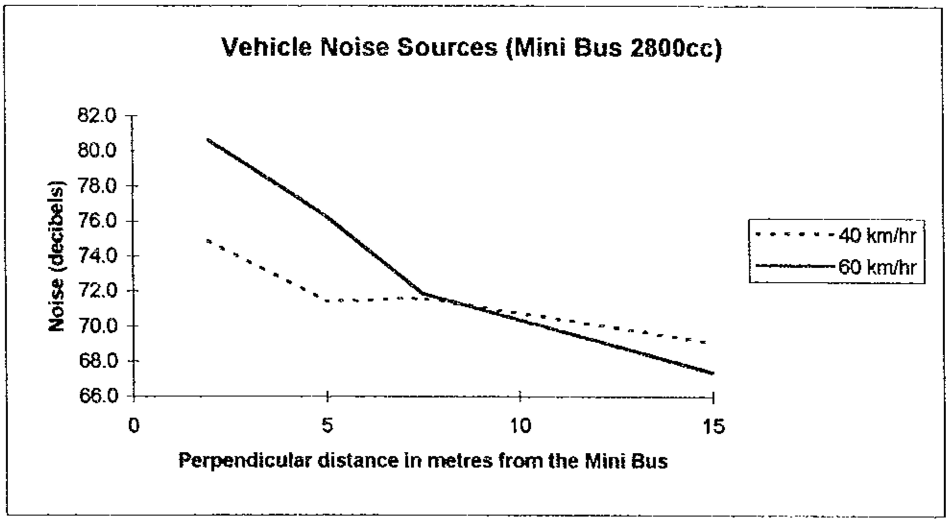
40 km/hr

Saloon Car 1600 cc					Mini Bus			
Metres	Readings				Readings			
from rd	1	2	3	Average	1	2	3	Average
2	72.2	72.6	72	72.3	75	75.1	74.6	74.9
5	70.4	70.3	70.2	70.3	71.1	71.7	71.4	71.4
7.5	70.3	70.7	69.8	70.3	71.6	71.3	71.9	71.6
15	67.9	67.8	68.9	68.2	68	69.1	70.1	69.1

60 km/hr

Saloon Car 1600 cc					Mini Bus			
Metres	Readings				Readings			
from rd	1	2	3	Average	1	2	3	Average
2	74.2	74.4	74.5	74.4	82.2	80.5	79.2	80.6
5	69.1	69.2	71	69.8	76.2	76.4	76.2	76.3
7.5	68.3	69	68.9	68.7	72	71.8	71.7	71.8
15	66.6	66.4	65.7	66.2	66.9	67.9	67.3	67.4





Interestingly enough, the results do not indicate that noise levels at 40 km/hr uniformly decrease with distance and are proportionally lower than at 60 km/hr. A possible explanation for this anomaly is that the sensitivity of the noise level meter was insufficient to detect differences over the relatively short distances measured.

Noise levels for a mini bus travelling at 40 km/hr measured 2m away from the vehicle averaged 74.9 dB (A) and measured 15 m away from the vehicle averaged 69.1 dB (A). At 60 km/hr measured 2 m away from the vehicle the average was 80.6 km/hr and measured 15 m away from the vehicle the average was 67.4 km/hr. The difference in noise level over 13 m is 5.8 dB (A) at 40 km/hr and is 13.2 dB (A) at 60 km/hr. As expected the noise levels for the mini bus are higher than for the saloon car by about 1 to 6 dB (A). Again the results do not indicate that noise levels at 40 km/hr uniformly decrease with distance and are proportionally lower than at 60 km/hr.

(b) Road Traffic Noise Survey Results

Figure 13.2 illustrates the noise levels recorded 1 m from different roads in Kampala. The results of the Road Traffic Noise Survey showed that the mean value (L50) for noise levels ranged from 63.1 dB (A) to 78 dB (A) 1m from the edge of the paved road along the five roads measured. Noise levels along Jinja Road yielded the highest values for all time periods, except for the one high on Bombo Road and values were recorded between 70.3 dB (A) and 73.9 dB (A). These high levels were attributed to the large number of heavy vehicles along this road in comparison to the other roads. In contrast the lowest noise level was recorded along Gaba Road at 63.1 dB (A).

From Figure 13.3 it can be seen that the noise levels at the buildings along some of the Kampala roads exceed the recommended Uganda Standard for Noise Levels of 60 dB (A) for day time hours (6:00 am to 10:00 pm). The highest noise level recorded was 72.8 dB (A) on Bombo Road and the lowest noise level recorded was 50.7 dB (A) on Masaka Road and occurred between 10:00-11:00 am and not at night as expected.

Figure 13.2 Noise Measurements Taking 1M from the Roadside

8 Instantaneous Noise Level Measurements Every 15s

	Time	1	2	3	4	5	6	7	8	Average
Masaka RSI	7-8 am	65.6	77	68.2	55.9	73.2	61.3	66.9	61.2	66.2
	8-9 am	71.1	61.1	77.4	74.9	75.7	74.6	67.6	74.9	72.2
	10-11 am	78.7	72.5	76.9	69.9	65.8	69.9	62.4	59.1	69.4
	2-3 pm	74.2	60.4	63.2	56.1	72.6	84.8	56.1	75.5	67.9
	6-7 pm	78.3	65	63.1	55.8	61.6	68.8	63	58.3	64.2
	8-9 pm	73.2	73.4	73.2	59.2	69.5	69.5	73.7	69.9	70.2
Gaba RSI	7-8 am	63.3	62.2	67.5	71.2	56.6	59.8	56.7	73.8	63.9
	8-9 am	60.4	72.9	64.9	57.5	66.4	66.4	72.5	71.8	66.6
	10-11 am	65.8	69.1	72.7	54.8	71.9	64	69.8	61	66.1
	2-3 pm	61.7	65.2	66.9	56.3	54.2	66.5	66.1	68.1	63.1
	6-7 pm	63.5	66.7	69.2	80.6	73.5	73.6	69.2	71.9	71.0
	8-9 pm	71.5	69.7	67.7	68.1	70.3	64.3	57.5	58.8	66.0
Port Bell RSI	7-8 am	85.3	92.2	84.3	86.9	57.2	72.4	72.3	73.3	78.0
	8-9 am	68	75.5	58.8	58.3	59.3	65.8	56.2	68.3	63.8
	10-11 am	67	63.5	68	69.2	54.5	64.1	72.5	74.8	66.7
	2-3 pm	62.9	69.7	57.1	66.3	62.3	60.9	82	67.3	66.1
	6-7 pm	70.2	57.4	72.9	74.1	67.6	56.4	55.9	77.6	66.5
	8-9 pm	57.8	69.7	70.4	68.8	66.9	57.2	67	60	64.7
Bombo RSI	7-8 am	60.4	72.7	76.4	71.2	69.9	61.8	65.6	75.6	69.2
	8-9 am	72.8	80.2	66.7	66.7	67.5	52	65.1	63.6	66.8
	10-11 am	72.1	73.1	60.6	57.9	66	74	74.2	68.2	68.3
	2-3 pm	77	63.2	62.9	69.4	80.8	77.1	76.8	66.6	71.7
	6-7 pm	74.8	75.7	61.6	72	62.5	71.4	74.2	78.5	71.3
	8-9 pm	63.7	61.1	63.7	73.8	68.6	70.1	63.5	59.2	65.5
Jinja RSI	7-8 am	76.5	77.4	72.8	73.9	62.9	67	68.2	74.4	71.6
	8-9 am	70	69.2	78.9	77	76.1	74.3	68.3	74.9	73.6
	10-11 am	79.1	61.9	77.9	70.1	60.1	77	71.4	64.7	70.3
	2-3 pm	72.1	70.8	76.8	71.3	74.7	73.7	69.2	71	72.5
	6-7 pm	76.9	73.2	73	68.2	71.4	77.8	74.1	76.5	73.9
	8-9 pm	74.4	72.3	77.6	69.2	66.2	73.6	75.1	69.8	72.3

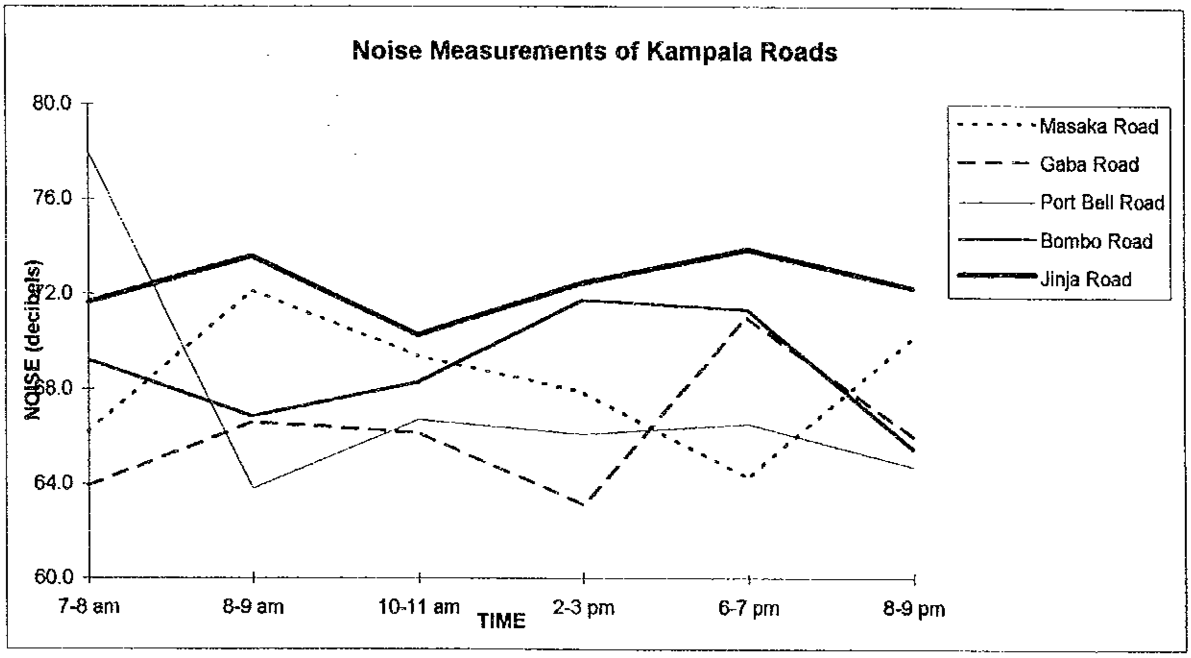
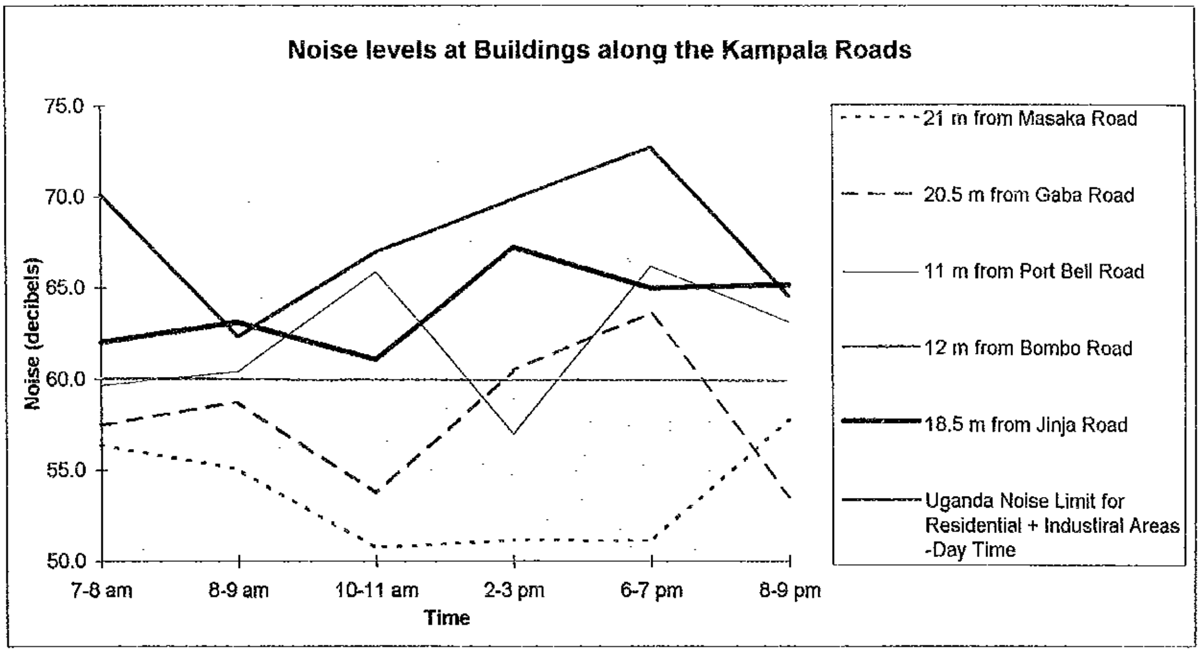


Figure 13.3 Noise Measurements Taken at a Building Fronting the Road

8 Instantaneous Noise Level Measurements Every 15s

	Time	1	2	3	4	5	6	7	8	Average
Masaka RSI	7-8 am	48	66	57.7	56.7	63.3	57.1	51.3	50.9	56.4
21m fr Road	8-9 am	57.7	51.5	58.3	50.2	55.6	61.6	51	54.3	55.0
	10-11 am	43.9	40.8	60.8	49.2	50.8	53.2	49.4	57.8	50.7
	2-3 pm	42.2	54	54.8	42.2	42.3	54.9	58.1	60.7	51.2
	6-7 pm	57.1	59.7	46.2	46.3	46.5	55.4	54.7	42.9	51.1
	8-9 pm	48.1	63.4	52.8	57.1	68.7	61	57.2	54	57.8
Gaba RSI	7-8 am	56.2	60.9	52	57.6	56.5	54.8	62	59.6	57.5
20.5 m fr Road	8-9 am	64.2	58.5	59	59.8	61.7	52.8	55.3	58.3	58.7
	10-11 am	55.9	57.1	58.9	48.1	52.4	48	57.4	52.1	53.7
	2-3 pm	66.1	57.4	58.4	63.4	57.5	61.2	61.2	58.6	60.5
	6-7 pm	65.5	64	66.4	66.7	62.6	66.9	59.2	57.4	63.6
	8-9 pm	56.9	56	49.2	54.8	61.1	51.2	48.4	50.9	53.6
Port Bell RSI	7-8 am	59.1	64.8	53.9	50.8	60.6	62.2	62.8	63	59.7
11 m fr Road	8-9 am	59.8	67.8	64.4	61.3	53.9	51.4	61	63.4	60.4
	10-11 am	65.4	65.1	66.3	64.2	62.2	58.1	73.7	72.1	65.9
	2-3 pm	54.9	65.9	65.4	62.9	51.6	48.1	48.1	58.7	57.0
	6-7 pm	66.8	65.4	65	66.9	66	66.6	67.1	65.7	66.2
	8-9 pm	62	60.1	64	62.5	61.9	68	63	63.5	63.1
Bombo RSI	7-8 am	67.1	67.1	83.5	70.9	59.9	72.6	73.7	66.3	70.1
12 m fr Road	8-9 am	61.4	60	63.9	63.8	61.5	62.5	58.8	66.5	62.3
	10-11 am	68.3	51.1	73.3	68.5	68.2	67.8	67.7	70.8	67.0
	2-3 pm	70.3	68	71.3	72.7	66.3	72.6	61.3	76.5	69.9
	6-7 pm	72.9	67.3	66.7	74.2	74.5	77.8	76.5	72.1	72.8
	8-9 pm	74.8	61.2	57.7	64.3	60.7	67.6	70	60	64.5
Jinja RSI	7-8 am	62.7	61.9	66.2	61	64	55.7	64	60.5	62.0
18.5 m fr Road	8-9 am	62.4	67.2	63	67	60.2	63.1	59	62.7	63.1
	10-11 am	62.7	54.9	59.7	63.9	64.8	62.9	57.3	62.4	61.1
	2-3 pm	72.6	70.7	64.6	64	74.6	64.5	63.6	63.4	67.3
	6-7 pm	68	60.5	67.8	62.7	65.5	61.3	65.5	68.6	65.0
	8-9 pm	64	61.1	62.3	65.9	75.7	65.9	64.2	62.4	65.2



Since the noise levels for the buildings along both the Jinja and Bombo Roads exceeded the recommended Draft Uganda standard all of the time, it was decided to compare the results using the Japanese and USA standards for noise levels.

Table 13.3 Compliance to Draft Uganda and Japanese Noise Standards

Different Noise Level Standards
Uganda Noise Level Standards Noise levels should not exceed 45 dBA during the day time (6:00 am - 10:00 pm) for buildings such as Hospitals etc. Noise levels should not exceed 50 dBA during the day time (6:00 am to 10:00 pm) for residential buildings. Noise levels should not exceed 55 dBA during the day time (6:00 am to 10:00 pm) for mixed residential and other buildings. Noise levels should not exceed 60 dBA during the day time (6:00 am to 10:00 pm) for residential + industrial + small scale commercial buildings. Noise levels should not exceed 70 dBA during the day time (6:00 am to 10:00 pm) for industrial buildings.
Japanese Noise Level Standards Noise levels are unacceptable if they exceed 55 - 60 dBA during the day time and 45 - 50 dBA during the night time for areas which are used mainly for residential purposes. Noise levels are unacceptable if they exceed 65 dBA during the day time and 55 - 60 dBA during the night time for areas which are used for residential purposes and which are also used for commercial and industrial purposes.
US Department of Transport Noise Level Standards Noise levels are unacceptable if they exceed 95 dBA for more than eight hour in 24 hours. Noise levels are unacceptable if they exceed 110 dBA for more than 30 minutes in 24 hours.

Key

Noise level exceeds given standard.

From Table 13.3 it can be seen that the buildings on Bombo and Jinja roads experience noise levels above the acceptable limits given by the standards for Uganda, Japan and the USA.

(c) Road Traffic Vibration Survey

The results of the Road Traffic Vibration Survey shows that the vibration levels ranged from 27.0 dB to 38.0 dB for all locations and time periods measured. Classification by location reveals that the highest vibration levels ranging between 31.4 dB and 38.0 dB were recorded along Gaba Road. Except for the Gaba Road, the other four roads experience similar vibration levels. The unusual consistent high for Gaba Road is attributed to a less stable road structure and underlying foundation rather than a difference in the type or volume of traffic. Uganda does not specify vibration level limits at roadsides. However the Japanese Vibration Regulation Law stipulates that vibration levels should not exceed 70 dB for residential areas during the day time (08:00 to 19:00). Therefore, the levels are well below the Japanese Standard. Figure 13.4 illustrates the results from the road traffic vibration survey.

(d) Construction Machinery Noise Survey

Maximum noise levels varied from 96 dBA to 76.8 dBA over 1 to 30 m away from the wheel loader, implying a decrease of some 30 dBA over a distance of 30 m. Again the Draft Uganda Noise Guidelines do not specify noise levels for construction machinery, while the Japanese Noise Regulation Law stipulates that noise levels should be below 85 dB (A) along the boundary of the site. The exact definition of "boundary" is somewhat vague and if it is assumed to be the edge of the road reserve which in this case is approximately 10 m, the noise levels of the construction machinery fell on or just below the limit as shown in Fig. 13.5.

(e) Construction Machinery Vibration Survey

Figure 4 illustrates the results of the construction machinery vibration survey. The results from the survey show that vibration levels varied from 90.0 dB to 50.3 dB over a distance of 26.5m for the Dynapac Roller and from 82.4 dB to 60.5 dB over a distance of 25m for the Bomag Roller. The vibration levels produced by both rollers mimic one another as would be expected. As Uganda does not yet have a guidelines for vibration level limits, the Japanese Vibration Regulation Law has been used which states that vibration levels should not exceed 75 dB as shown in Fig. 13.6.

Figure 13.4 Vibration Measurements Taken 1M from the Roadside

		8 Instantaneous Vibration Level Measurements Every 15s								
	Time	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Average**
Masaka Road	7-8 am	38.5	25.4	28.3	32.4	27.7	40.8	30.8	39.4	32.9
	8-9 am	31.2	26.0	34.6	25.2	32.2	32.4	32.3	28.0	30.2
	10-11 am	37.0	37.9	28.8	31.4	33.5	28.8	25.3	32.3	31.9
	2-3 pm	33.6	28.6	36.2	25.7	33.2	40.6	34.0	27.4	32.4
	6-7 pm	28.6	31.5	29.3	25.2	30.6	36.2	25.4	44.9	31.5
	8-9 pm	31.5	26.3	25.1	33.5	31.6	26.6	31.0	25.7	28.9
Gaba Road	7-8 am	42.9	29.2	26.4	33.3		38.7	28.2	36.3	33.6
	8-9 am	36.7	30.6	38.6	33.8	40.7	29.4	30.6	28.4	33.6
	10-11 am	43.5	25.4	34.5	35.4	37.6	28.8	37.8	37.7	35.1
	2-3 pm	31.1	39.6	37.6	32.4	33.1		48.4	25.6	35.4
	6-7 pm	47	33.1	35.6	41.2	37.6	34.3	37.8	37	38.0
	8-9 pm	27.4	28.9	33.7	32.4	31.1	34.8	33.4	29.8	31.4
Port Bell Road	7-8 am	30.5	26.1	38.4	34.2	25.4	28.2	36.9	27.2	30.9
	8-9 am	27.9	28.5	40	36.2	35.2	29.9	28.2	26.8	31.6
	10-11 am	40.4	29	30	30.6		26.2	34.4	30	31.5
	2-3 pm	30.2	31.6	25.4	35.3	31.6	36.6	25	25.2	30.1
	6-7 pm	32.8	26.6	27.1	36.5	25.9	32.8	36.9	26.2	30.6
	8-9 pm	36.9	32.2	29.6	28.4		40	30.2	32.3	32.8
Bombo Road	7-8 am	36.8	29	30.9	29.6	25.8	33.1	30.9	33.8	31.2
	8-9 am	29.1	26	30.4	27.2	26.2	27.4	29.2	28.2	28.0
	10-11 am	33.4	31.3	30.6	28.7	31.2	32.6	34.9	36.4	32.4
	2-3 pm	26.2		25.5	25.1	30.6	26	40.8	33.4	29.7
	6-7 pm	31.1	28	27.4	25.6	28.2	32.4	34.4	28	29.4
	8-9 pm	34.5	27.4	27.2	30.3	25.5	25.2	31.6	30.9	29.1
Jinja Road	7-8 am	33.5	36.7	30.7	32.5	26.1	28.2	26.1	29.3	30.4
	8-9 am	26.3	29.2	25.3	25.3	28	25.2	28.4	28.6	27.0
	10-11 am	26.4	32.1	26.6	27.1	27		31.1	40.3	30.1
	2-3 pm	25.8	28.2	34.6	25.9		28.3	42.3	32.5	31.1
	6-7 pm	32.8	37.1	29.3	36.8	31.5	25.2	29.3	28.5	31.3
	8-9 pm	26.4		25		27	26.4	31.2	26.8	27.1

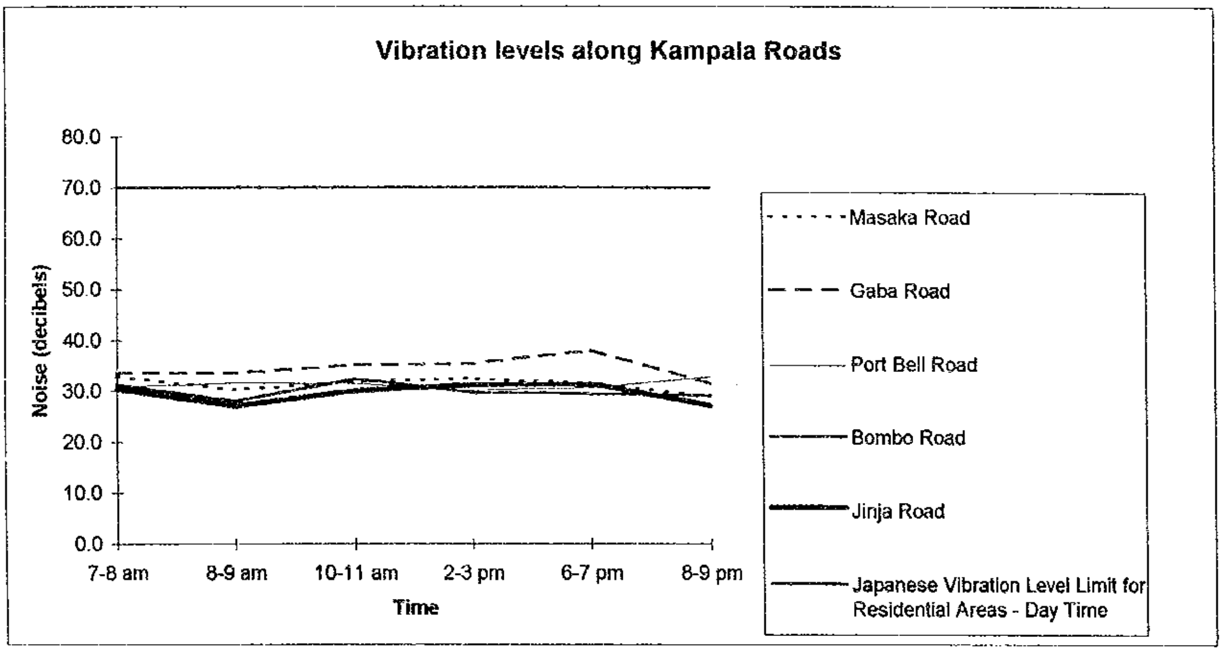


Figure 13.5 Noise Levels of Construction Machinery

Wheel Loader (CAT 950F)
Maximum Noise Levels Measured
Distance from the Wheel Loader

Metres from rd	Readings 1	2	3	Average
1	94.5	96.5	96.9	96.0
5	89.8	91.6	91	90.8
10	86.2	85.5	86.8	86.2
20	80.6	81.6	80	80.7
30	76.3	77	77	76.8

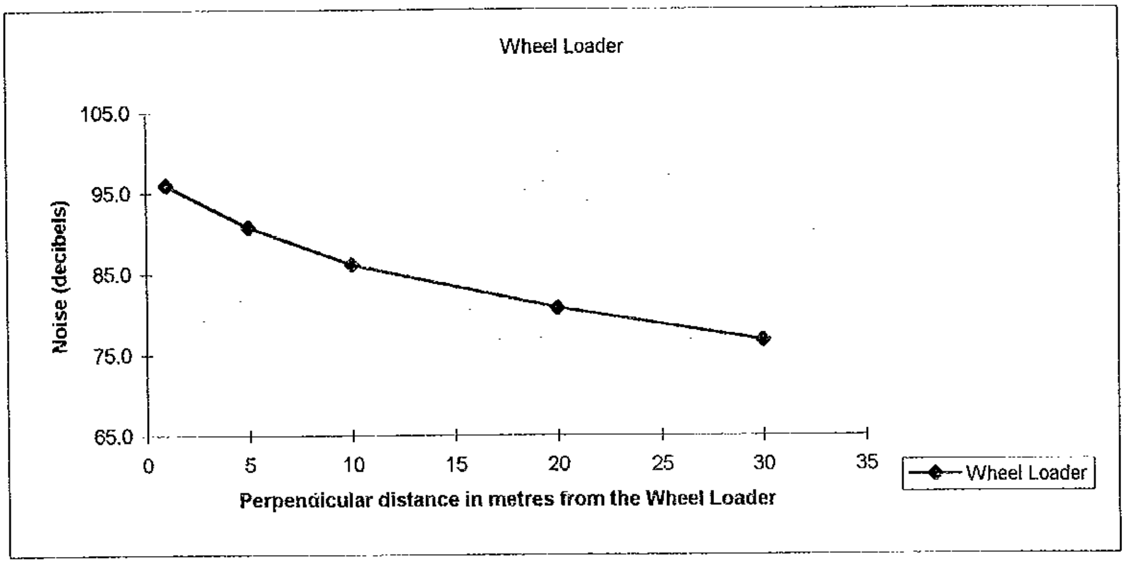


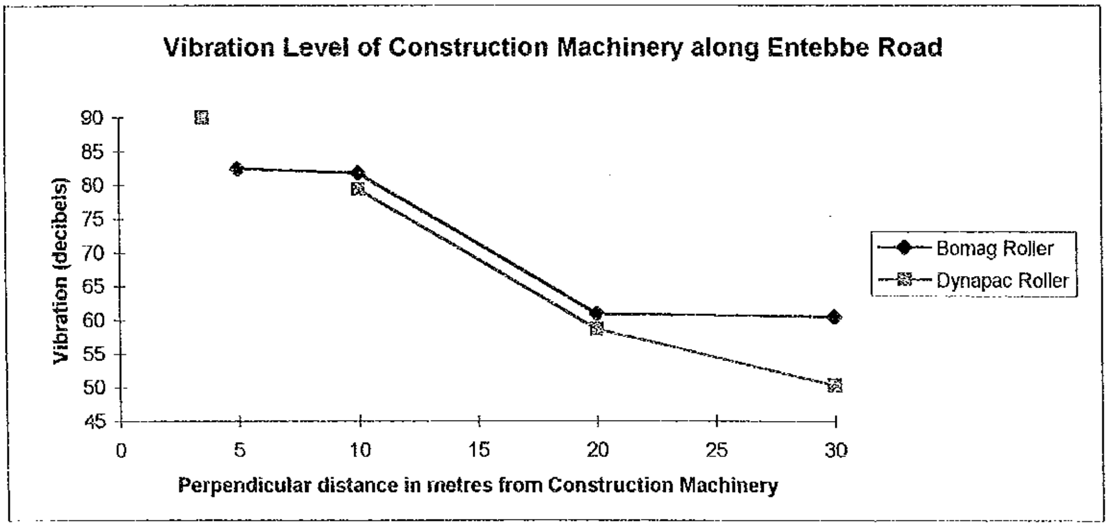
Figure 13.6 Vibration Levels of Construction Machinery

Bomag Roller
Instantaneous Vibration Levels Measured
Distance from the Bomag Roller

Metres from rd	Readings 1	2	3	Average
5	82	82.4	82.7	82.4
10	81.8	81.9	81.6	81.8
20	61.6	61.2	59.8	60.9
30	60.5	61.7	59.3	60.5

Dynapac Roller
Instantaneous Vibration Levels Measured
Distance from the Dynapac Roller

Metres from rd	Readings 1	2	3	Average
3.5	88.4	90.2	91.3	90.0
10	79.4	79.5	79.2	79.4
20	58	58.6	59.1	58.6
30	50	49.7	51.2	50.3



(3) Conclusions

1) The noise source survey indicates that the larger the vehicle engine the greater the noise level as would be expected. However, the results also indicate that the noise level is not directly proportional to the speed the vehicle is travelling at. From a planning perspective these results support the classification of different areas into zones such as residential zones which do not allow the movement of large vehicles through the area, either at all, or during designated time periods, such as at night. Other recommendations include an information campaign on the insidious nature of noise pollution and ways to prevent it.

2) The road traffic noise survey clearly shows that some roads are subject to levels of noise above recommended limits. It is therefore suggested that future construction of residential buildings along all roads in Kampala, but the Jinja and Bombo Roads in particular, should be discouraged within a 20-40m corridor on either side of the road.

3) Vibration is not a problem in Kampala. This is supported by the fact that the City mainly rests on Precambrian basement rocks comprised of granitoid gneisses and granites and has extensive wetlands which are likely to absorb most of the vibration.

4) Noise levels emanating from construction machinery borders on acceptable recommended limits. The use of construction machinery in general and Wheel Loaders (CAT 950F) in particular is intermittent and usually for short time periods of time during the construction phase. Therefore, recommendations include warning communities prior to their use, particularly if there are likely to be computers and other sensitive equipment in the area. Construction should be prevented at night and periodic tests on construction equipment used by different contractors, should be carried out particularly if there are complaints.

5) Vibration levels of construction machinery also borders on the acceptable recommended limits. Therefore, the recommendations are the same as those mentioned in point 4 above.

13.3.3 Air Pollution

(1) Air Pollution Survey

(a) Automobile Exhaust Gas Survey

Exhaust gas emissions from a total of 30 vehicles were measured using the detector tube method. This study was spread over 2 days (12 and 24 June 1997). Vehicles were measured opposite the vehicle inspection unit at Naguru.

The vehicle sample population was determined considering vehicle composition by the traffic survey. As a result, 10 saloon cars, 8 mini-buses, 4 large 4WD vehicles, 5 pick-ups, 1 small lorry and two large lorries were measured. Of these 30 vehicles, 10 were diesel as it was estimated at the time of the survey that approximately 30% of the vehicles in Kampala operate on diesel.

All vehicle engines were run for a period of 10 minutes prior to measuring the exhaust gases, in order to ensure that the engines were operating under uniform conditions. A standard 100 ml gas pump was used in combination with a hot probe as the detetector tubes should not be used directly with substances above 40°C. Tests were carried out while the vehicle was idling and at 2,000 to 2,500 rpm which was taken to be equivalent to 40 km/hr. Each vehicle's exhaust emissions took approximately 20 minutes to half an hour to measure.

The exhaust gases tested for, were Carbon monoxide, Sulphur dioxide, Nitrogen oxides and Ozone. All 30 vehicles were tested for Carbon monoxide, Sulphur dioxide and Nitrogen oxides, while only 15 vehicles were tested for Ozone, the reason for this being that the former three gases are traditionally considered to be the more important air pollutants.

(b) Dust Survey

The six junctions and the five roads identified for the high priority project were visually assessed for dust pollution and ranked against one another.

(2) Results and Discussion of Dust and Air Pollution Survey

(a) Automobile Exhaust Gas Survey

Carbon Monoxide (CO)

From Fig. 13.7, it can be observed that all petrol vehicles tested, except two emitted > 2,000 ppm Carbon monoxide either when idling or at the equivalent of 40 km/hr. 2,000 ppm is the maximum detectable range for any tubes manufactured to measure Carbon monoxide. This indicates that the majority of petrol vehicles in Kampala are emitting more than 2,000 ppm of Carbon monoxide.

Diesel vehicles were found to emit between 150 - 900 ppm during idling and between 300 - 1000 ppm at 40 km/hr. As would be expected, on average, more Carbon monoxide is emitted at the higher speed.

The results clearly indicate that petrol vehicles emit substantially more Carbon monoxide than diesel vehicles.

Nitrogen Oxide (NO) and Nitrogen Dioxide(NO_2)

Fig. 13.8 illustrates the results from both the Nitrogen Oxide and Nitrogen Dioxide survey. Levels for Nitrogen oxide are generally higher at 40 km/hr compared to idling conditions for petrol vehicles. Values range from 0 - 150 ppm during idling and between 0 - 200 ppm at 40 km/hr. Levels for Nitrogen Dioxide are consistently low, at, or less than or equal to 2.5 ppm for all petrol vehicles measured except one.

Sulphur Dioxide (SO_2)

From Fig. 13.9, it can be observed that the values for Sulphur dioxide for diesel vehicles do not change appreciably from vehicles idling to the equivalent of 40 km/hr. The average value was calculated to be 45 ppm (10 - 70 ppm).

For petrol vehicles, Sulphur dioxide values were found to be consistently lower during idling (many around 0 - 5 ppm) than for diesel vehicles and the results are mixed at 40 km/hr with some vehicles having substantially higher amounts of Sulphur dioxide and others little above 0 ppm.

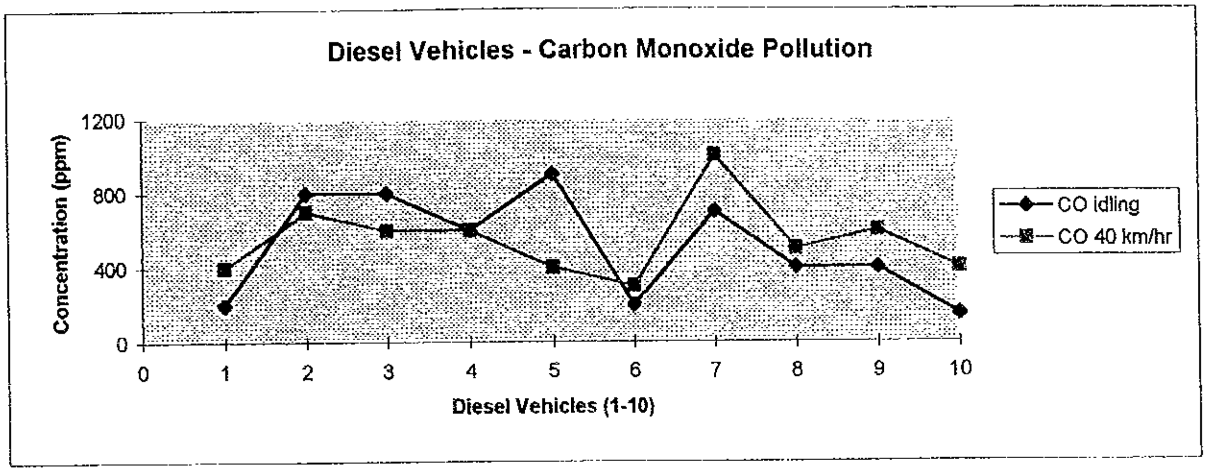
Table 13.4 Results from Automobile Exhaust Emissions

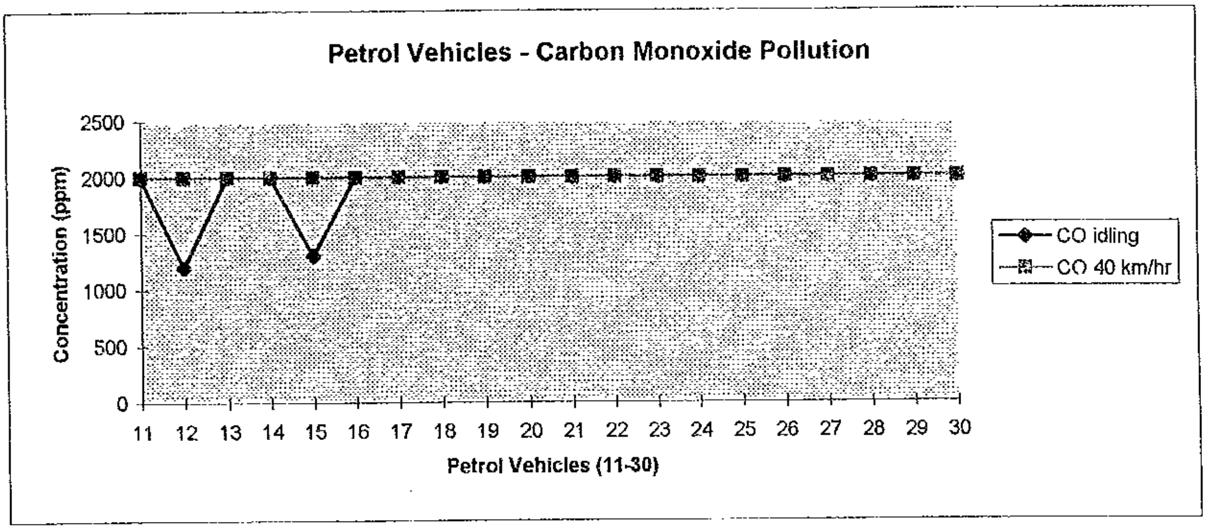
AUTOMOBILE EXHAUSTS
EXHAUST GAS CONCENTRATION (ppm)

		Idling					40 km/hr				
Vehicle Type	**Model Year**	**CO**	**NO**	**NO2**	**SO2**	**O3**	**CO**	**NO**	**NO2**	**SO2**	**O3**
Sedan and Hatchback	1992	2000	40	0	5	10	2000	15	0	5	60
	1989	2000	60	0	0	0	2000	200	0	0	0
	1988	2000	70	0	0	0	200	70	0	0	0
	1990	2000	30	0	50		2000	20	0	75	
	1988	2000	50	0	50		2000	50	0	150	
	1987	2000	100	0	50		2000	150	0	125	
	1988	2000	80	0	50		2000	200	0	200	
	1985	2000	150	0	0		2000	70	0	<5	
	1975	2000	0	0	0		2000	0	0	<5	
	1988	2000	150	0	50		2000	70	0	100	
	1988	2000	70	0	0		2000	150	0	<5	
Sedan 4WD	1987	2000	50	0	50		2000	70	0	300	
Range R 4WD	1975	2000	10	0	0		2000	50	0	10	
Nissan-P 4WD	1994	400	50	70	60	200	600	50	100	70	200
Pajero 4WD	1988	800	100	100	60		600	70	70	60	
Pick-up (0.5-1T)	1990	200	15	200	40	140	300	100	30	40	200
	1985	2000	30	5	5	30	2000	60	0	10	30
	1989	1300	70	0	0	0	2000	80	0	5	50
	1989	2000	100	15	5	70	2000	100	20	5	50
	1986	2000	15	0	0	0	2000	140	0	5	0
Mini-bus (14 seater)	1985	200	70	50	50		400	40	100	50	
	1988	700	50	100	65	200	1000	40	55	60	200
	1988	400	100	50	60	200	500	100	100	60	200
	1985	2000	30	0	0	10	2000	100	0	5	40
	1983	1200	30	5	10	110	2000	150	0	10	20
	1988	2000	40	0	50		2000	150	0	200	
Lg. Mini-bus (18 seater)	1981	800	50	50	25		700	100	50	25	
Lorry-3T	1988	900	50	20	50	140	400	50	75	40	
Lorry-15T	1994	600	70	18	20		600	50	10	30	
Lorry-20T	1984	150	40	0	10	200	400	25	20	20	200

where: CO = Carbon Monoxide
NO = Nitrogen Oxide
NO2= Nitrogen Dioxide
SO2 = Sulphur Dioxide
O3 = Ozone

Figure 13.7 Carbon Monoxide Pollution





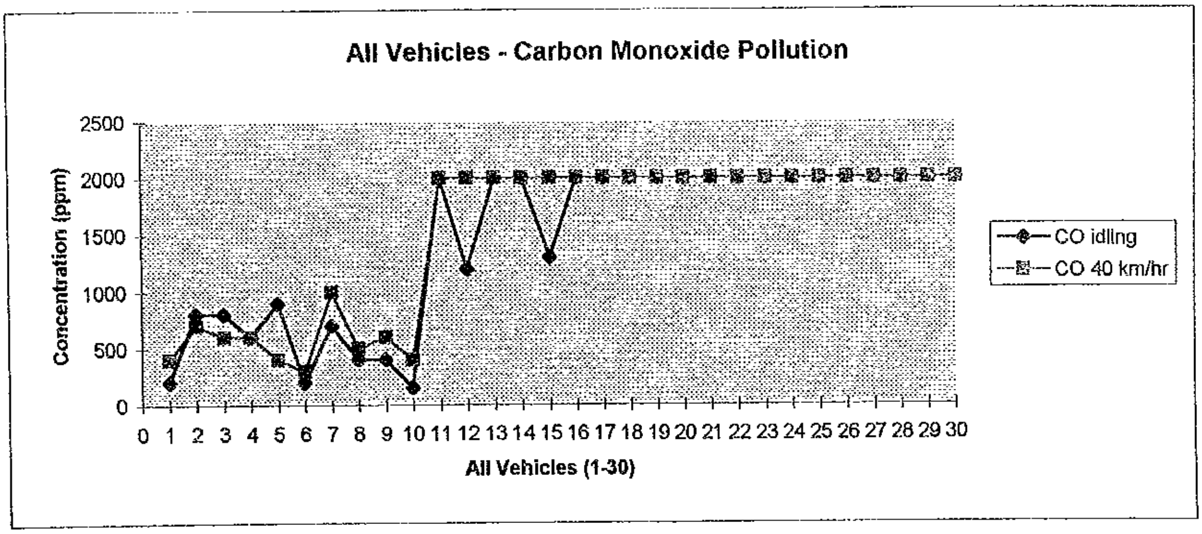
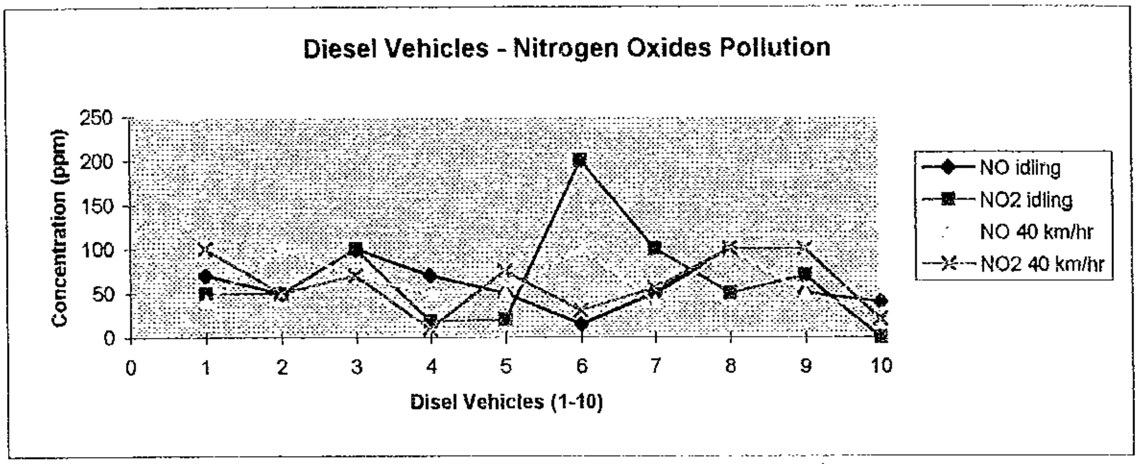
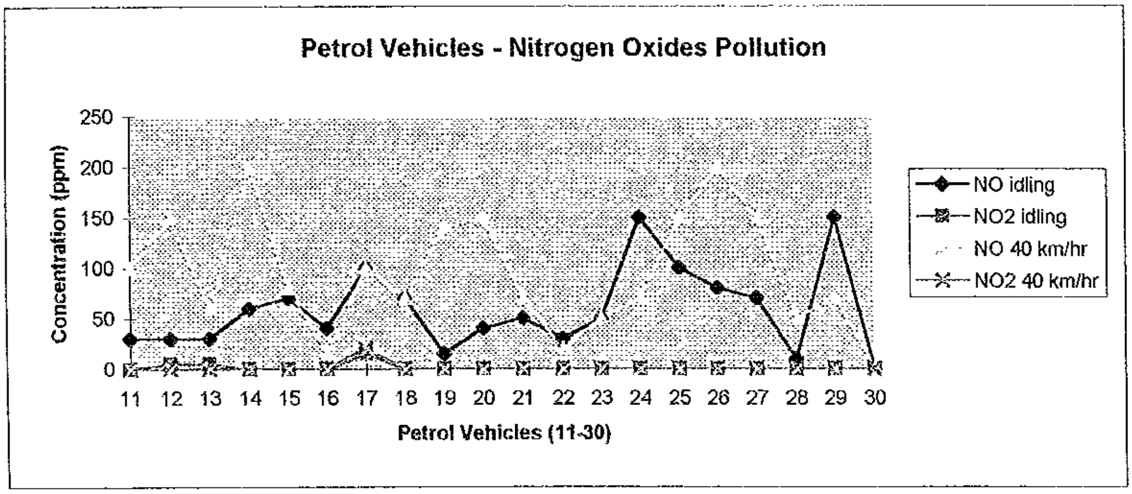


Figure 13.8 Nitrogen Oxides Pollution





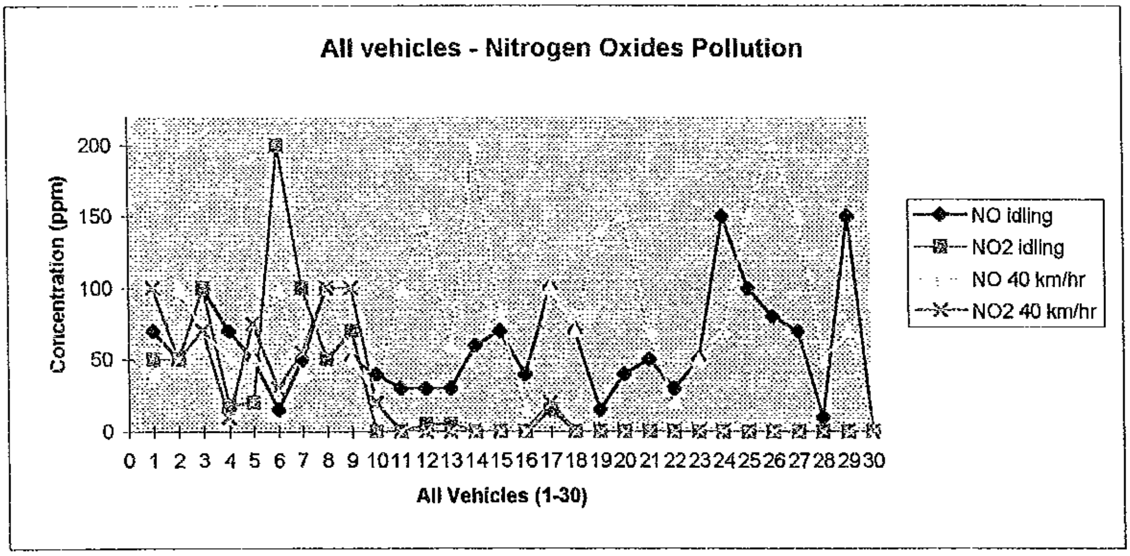
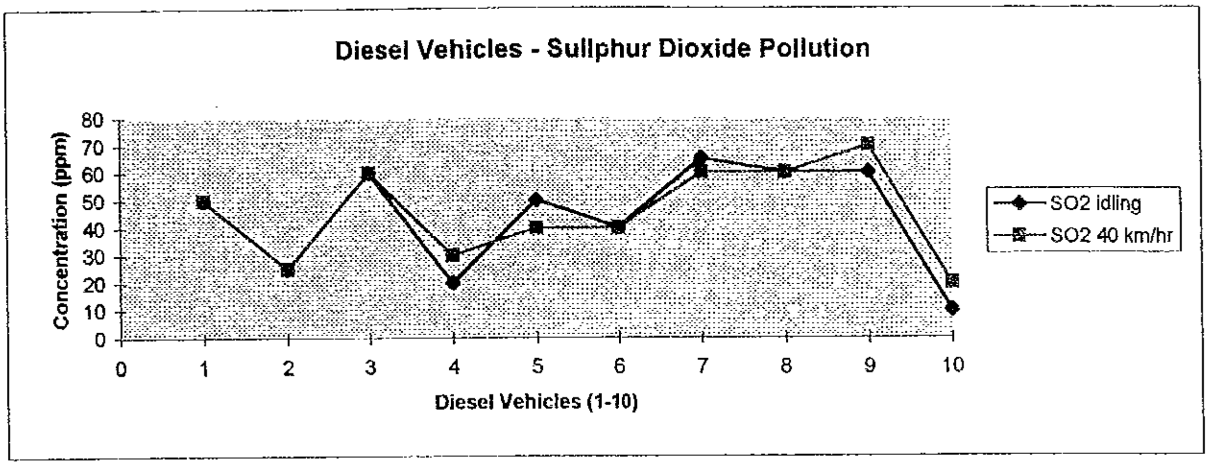
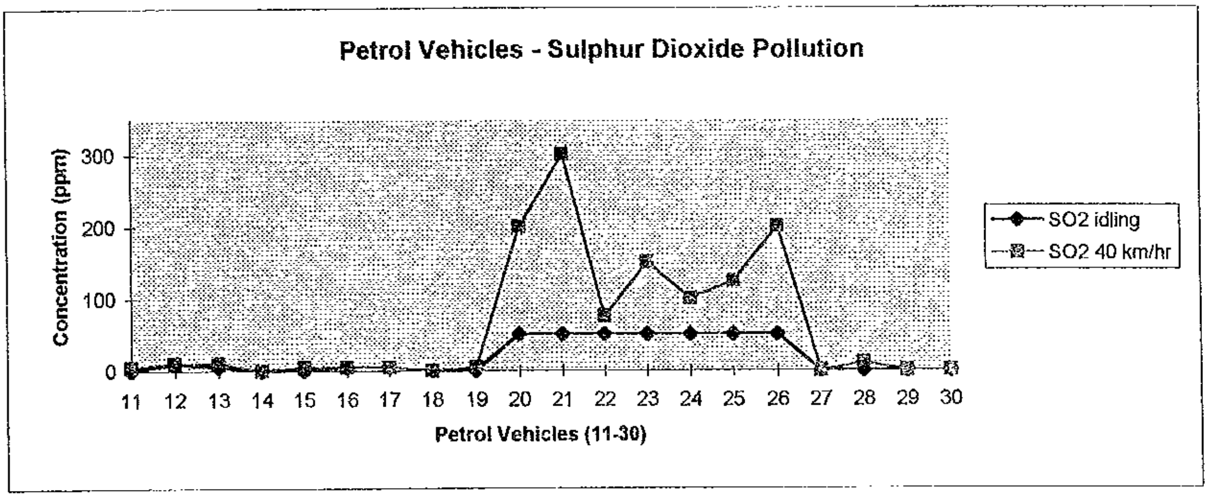
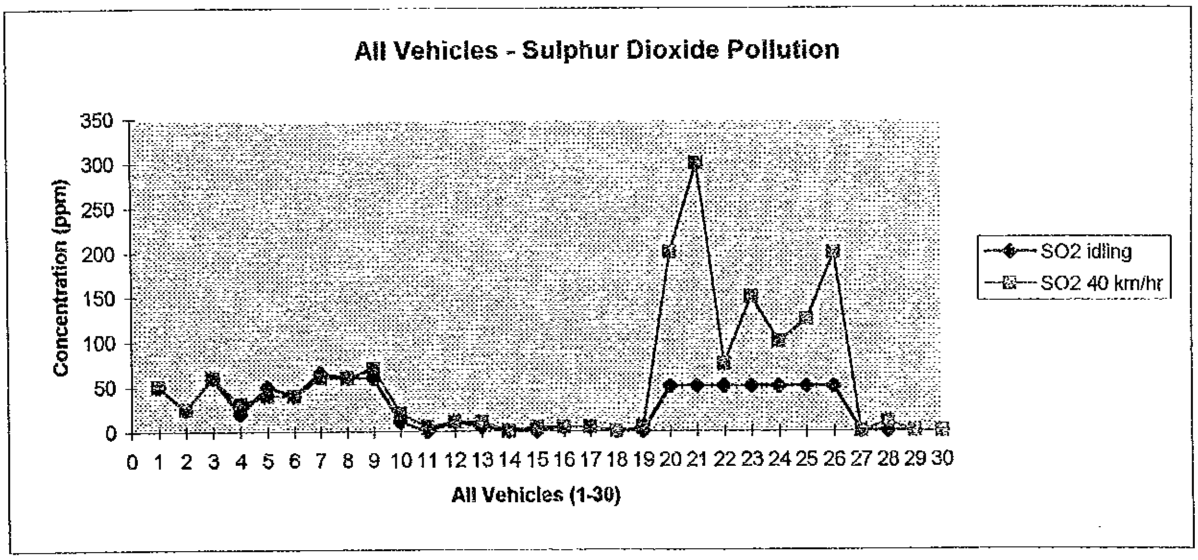


Figure 13.9 Sulphur Dioxide Pollution







Ozone (O_3)

From Fig. 13.10, there does not appear to be a distinct relationship between the emission of Ozone and petrol vehicles.

From the five diesel vehicles measured, two emitted 140 ppm while the other three emitted > 200 ppm (the upper detection limit) Ozone during idling. All five vehicles emitted > 200 ppm (the maximum detection limit) at 40 km/hr. Clearly diesel vehicles emit substantially more Ozone than petrol vehicles.

(b) Dust Survey

A purely visual assessment was carried out of the dust levels on the high priority junctions and roads as shown in the table below.

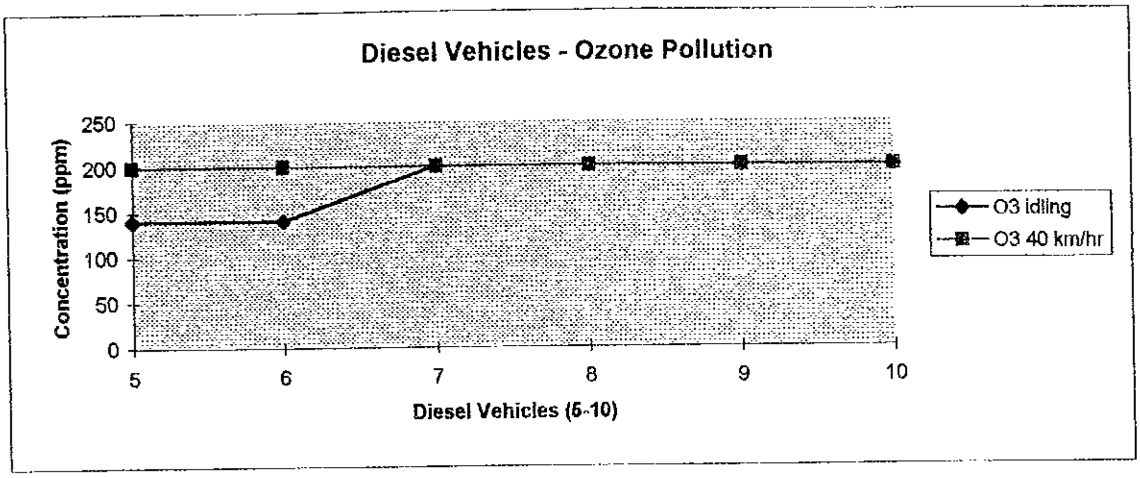
Table 13.5 Visual Assessment of Dust Levels at the Six Junctions and Along the Five Priority Roads

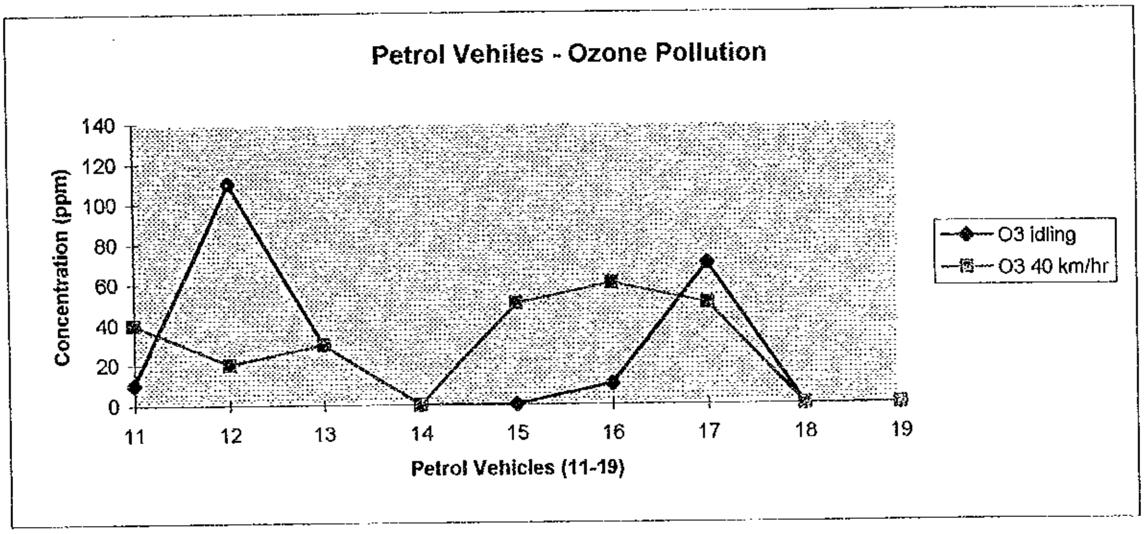
	High level of dust	Medium level of dust	Low level of dust
Junctions	Natete	Wandegeya Makerere Kibuye	Port Bell Jinja
Roads	Natete	Port Bell Hoima Gayaza Gaba	

(3) Air Pollution Standards

There are two types of standards which are relevant to the project are available. The first type are the environmental quality standards for ambient air while the second type are emission standards for motor vehicles as shown below:

Figure 13.10 Ozone Pollution





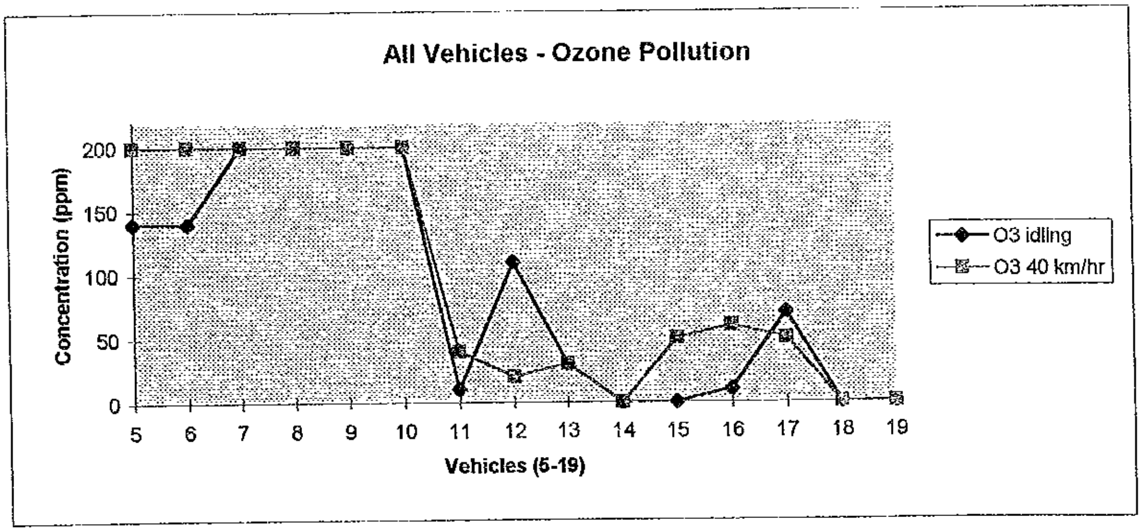


Table 13.6 Environmental Quality Standards for Ambient Air

Standards for Ambient Air	Sulphur dioxide	Carbon monoxide	Suspended particulate matter	Photo-chemical oxidant-Ozone	Nitrogen dioxide
Draft Ugandan, January 1997	24 hr average < 0.15 ppm	8 hr average < 9 ppm	24 hr average < 0.3 mg/m^3	Hourly value < 1 ppm	24 hr average < 0.05-1 ppm
Japanese Standards, 1996	Daily average (1hr) < 0.04 ppm One hour < 0.1 ppm	Daily average (1hr) < 10 ppm 8 hr average < 20 ppm	Daily average (1hr) < 0.1 mg/m3 One hour < 0.2 mg/m3	Hourly value < 0.06 ppm	* Daily average (1hr) < 0.04-0.06 ppm

* The environmental quality standard mentioned shall NOT apply to exclusive industrial districts, roads or other regions where the general public do not usually live.

Table 13.7 Emission Standards for Motor Vehicles

Pollutant	Standard ($g\ km^{-1}$)				Standard (g/kWh)	
	Light-duty petrol-powered		Light-duty diesel-powered		Heavy-duty diesel-powered	
	Draft Ugandan Standards	Japanese Standards	Draft Ugandan Standards	Japanese Standards	Draft Ugandan Standards	Japanese Standards
Particulate matter	-	-	0.06	0.2 (1995)	0.15	0.7 (1996)
Carbon Monoxide	2.1	2.1 (1991)	2.63	2.1 (1995)	4.5	7.4 (1996)
Nitrogen oxides	0.6	0.5 (1993)	0.38	0.5 (1993)	7.0	5.0-6.0 (1996)
Lead	-	-	-	-	-	-
Hydro-carbons	0.3	0.25 (1993)	-	0.4 (1991)	1.23	2.9 (1996)
VOCs	-	-	0.19	-	-	-
Smoke (opacity not to exceed)	Ringlemann scale No.2 or 40%	-	Ringlemann scale No.2 or 40%	-	-	-

1) VOCs Volatile Organic Carbons

g/kWh gramme per kilowatt-hour

gkm-¹ gramme per kilometre

2) Where light-duty vehicles include cars, vans and light trucks (less than 3.5 metric tonnes) and heavy-duty vehicles include goods vehicles, buses (exceeding 3.5 metric tonnes) and trains.

(4) Projected Air Pollution by 2005

By the year 2005, traffic volumes are forecast to have increased by around 75%. While this increase will affect all the roads in Kampala, the impact will be particularly felt at junctions. Table 13.8 illustrates the queuing delay between the existing junction design for the year 2005 and the new design for the high priority junctions.

In general, if there are vehicle time savings from the proposed new junction designs, it also follows that there will be savings in terms of pollution emissions. Table 13.8 quantifies the time saving and the corresponding Carbon monoxide saving in grammes per cubic metre. Nevertheless, it must be remembered that how this pollution is dispersed is currently impossible to quantify due to the behaviour of air at and around junctions.

Table 13.8 The Existing and New Designs for the High Priority Junctions and the Corresponding Time and Carbon Monoxide Savings.

Junction Name	Average Concentration of Carbon monoxide (g/m3) *	Existing Design Queue Delay (min)	New Design Queue Delay (min)	Time savings per hour (min)	Concentration (g/m3) x Time Savings per hour
Natete					
(am)	1800	9871	4346	5525	6.0×10^{8}
(pm)		5200	2253	2947	3.2×10^{8}
Makerere					
(am)	1800	171550	28015	143535	2.6×10^{8}
(pm)		60735	13755	46980	8.5×10^{7}
Kibuye					
(am)	1800	521983	75314	446669	4.8×10^{10}
(pm)		658637	133217	525420	5.7×10^{10}
Port Bell					
(am)	1800	231360	27983	203377	2.2×10^{10}
(pm)		196320	14197	182123	2.0×10^{10}
Wandegeya					
(am)	1800	800925	306244	494681	5.3×10^{10}
(pm)		495120	296344	198776	2.1×10^{10}
Jinja					
(am)	1800	1268658	688795	579861	6.3×10^{10}
(pm)		1299087	534145	764922	8.3×10^{10}

* the average concentration of Carbon monoxide pollution was calculated by assuming a ratio of 66% petrol vehicles to 33% diesel vehicles and averaging the results from the emission survey during idling.

(5) Conclusions

a) Air pollution is a growing problem in Kampala City. The results from the air pollution survey demonstrated that Carbon monoxide levels at road sides, often where people live, are close to, or exceed both the Draft Uganda Standards and the Japanese Standards for Carbon monoxide.

b) The results from the vehicles emissions testing illustrated that medium to large scale petrol vehicles emit double or more the recommended level of Carbon monoxide when compared with the Draft Uganda or Japanese Standards for vehicle emissions. Further research is required to determine whether the fuel used in Uganda is responsible for these relatively high levels of Carbon monoxide or whether the maintenance of vehicles is the key issue, or a combination of both.

c) Lastly a monitoring programme to establish a data series on air pollution levels should be established at some key locations in Kampala.

13.3.4 Flood-prone Areas, Siltation of Water Courses & Erosion

(1) General

Kampala is located on the watershed between the Lake Victoria down-warped basin and the more gentle slope to Lake Kyoga in the north. The effective watershed is formed by a ridge of resistant rocks trending to the north-east which is highly weathered and rarely exposed, but remnants of the underlying geology gives rise to the laterite-capped hills running from Lubya in the west, through Makerere, Mulago, Bukoto, Naguru and Banda in the east. A corresponding series of hills (Rubaga, Namirembe, Kampala, Nakasero, Kololo and Kireka) runs in a south-easterly direction. Between these two series of hills, the headwaters of the two systems inter-digitate (Pallister, 1959). The difference between hill top and valley bottom in Kampala is 60 to 100m leaving little level land for development.

(a) Flood-Prone Areas

Flood-prone areas can be sub-divided into two categories:

- natural flood-prone areas which correspond to wetland areas
- man-made flood-prone areas - often low lying areas with blocked or inadequate drainage channels

Fig. 13.11 illustrates the major wetlands of Kampala District and the main roads which cross them, while Table 13.9 summarises the flood-prone road sections.

(b) Siltation and Contamination of Water Courses

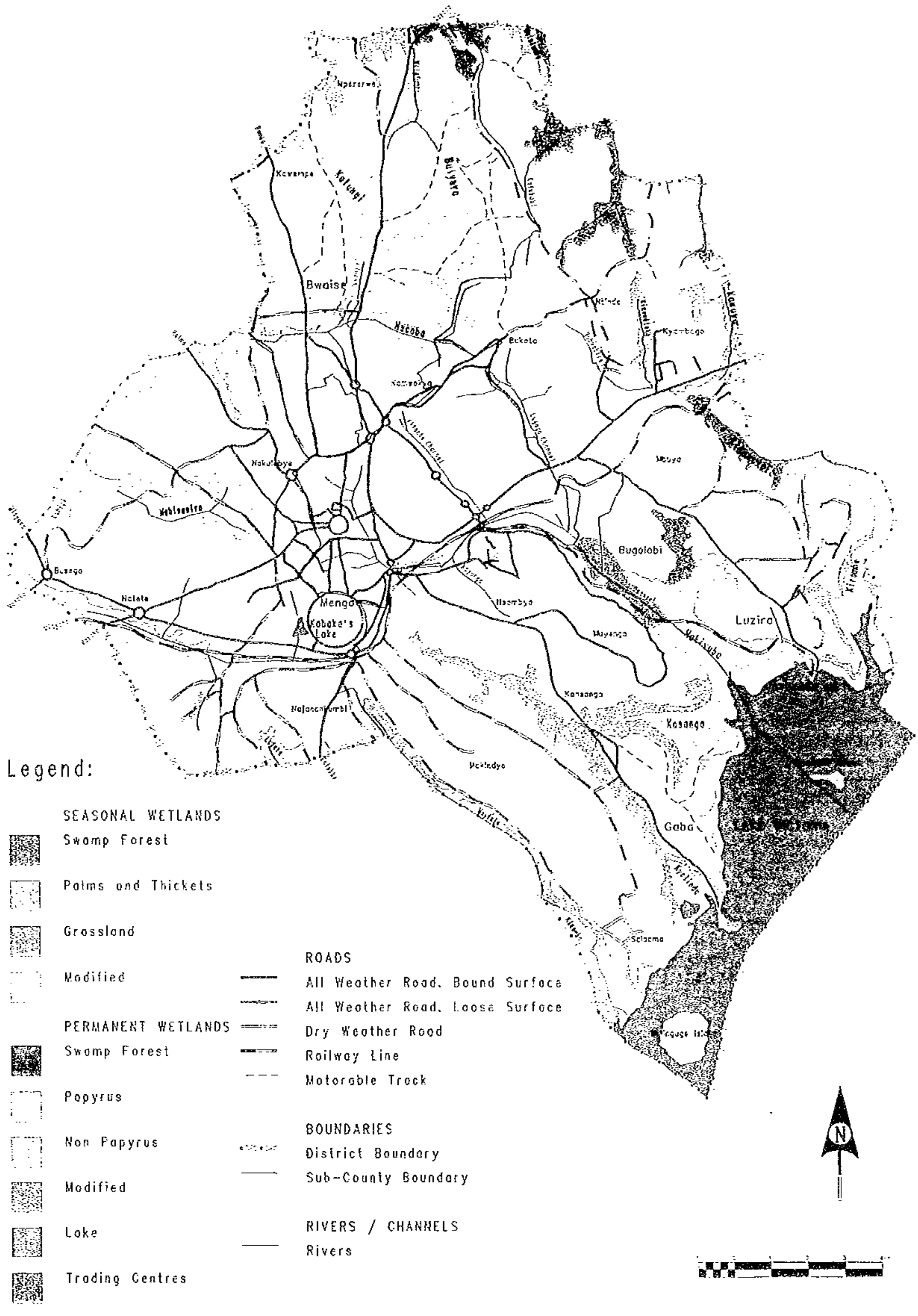
There are very few free flowing water courses or drainage channels in the City. Most water courses and drainage channels are heavily polluted and silted, or blocked, often with refuse.

Drainage, or the lack of, is probably the single largest cause of the disintegration of roads in Kampala. All the roads in the study have inadequate drainage.

A water quality study on the nutrient and pollutant loading of the northern region of Lake Victoria indicates that the water quality of the lake is deteriorating and that all channels draining into Lake Victoria are polluted.

Table 13.9 Flood - Prone Areas

Natural Flood -Prone Areas				
Road Name	From (Km)	To (Km)	Difference (m)	Remarks
Gaba Road	4.8	5.3	500	The Gaba Road crosses the Kansanga Wetland and then runs parallel for a distance of 5.7 Km to the Kansanga-Kietinda Wetland until the shores of Lake Victoria
Hoima Road	3.3	3.6	300	Runs parallel and crosses the Lubigi Swamp
Man made Flood-Prone Areas.				
Road Name	From (Km)	To (Km)	Difference (m)	Remarks
Natete Road				Floods occur in patches on Natete Road between where Mutesa Road intersects Natete Road as far as the junction with Sentema Road
Gayaza Road	2.5	2.8	300	Flooding occurs where the Nsoba/Bwaise Channel crosses the road



THE FEASIBILITY STUDY OF IMPROVEMENT OF TRUNK ROAD AT KAMPALA URBAN INTERFACE

Figure 13.11 Kampala District Wetlands

(c) Erosion

All roads in Kampala suffer from erosion along the margins, especially those in hilly terrain. This is particularly noticeable where earth roads feed into the main bituminous road. After an incidence of rainfall, the lateritic soil collects at the entry point on the bituminous road. This results in disintegration of the road which is further exacerbated by vehicles deliberately trying to avoid the earth patches on the road, which in turn is a traffic hazard.

Fig. 13.12 illustrates the problem. Erosion occurs on all bituminous roads in Kampala.

13.3.5 Flora and Fauna

(1) General

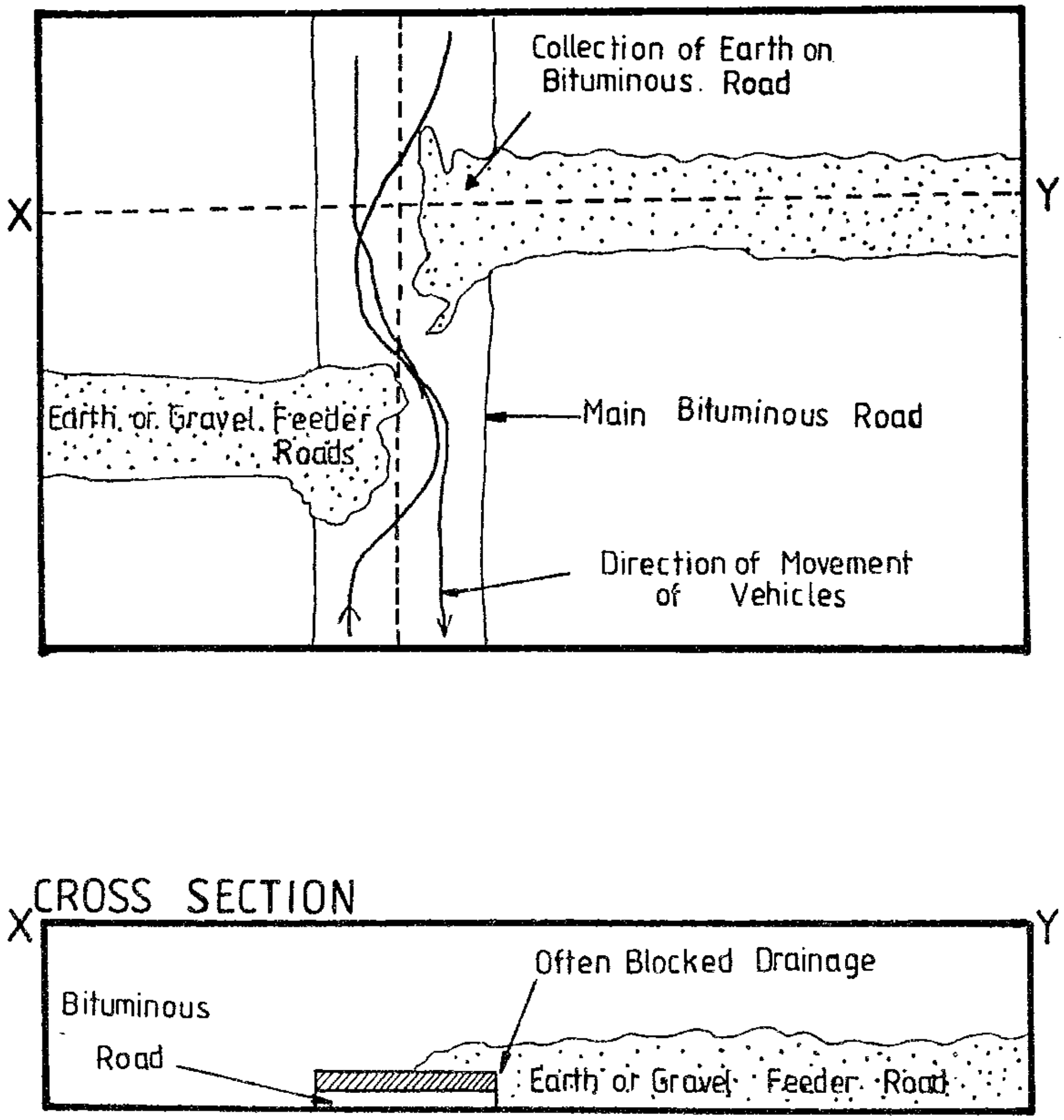
The number of trees to be removed has been minimised due as a result of the simultaneous engineering and environmental survey that was carried out as described in 13.3.1. Trees found along roadsides in Kampala can be divided into indigenous and exotic species. Generally, exotic species have been planted, usually by KCC.

The criteria for trees planted in the city by KCC incorporate aesthetic attributes, slow growth, shade and species that do not damage the road. To a certain extent tree growth can be managed by pruning. The two main problems encountered with tree planting programmes in Kampala are the heavy congestion of people in the city and grazing animals; both of which destroy young trees. Indigenous trees are not planted by KCC mainly because they grow too large and cannot be managed.

Furthermore, two of the roads considered in this study cross important wetlands in Kampala. While wetlands and swamps in Kampala remain to be investigated in detail, they are known to be of considerable biological value.

13.4 Mitigation Measures

Many of the potentially significant adverse impacts identified in the EIA are concerned with the construction phase of the project and hence relate to the activities of the engineering contractors. Mitigative measures are therefore, best achieved through the incorporation of suitable clauses in the construction contract documents, which are enforced.



THE FEASIBILITY STUDY OF
IMPROVEMENT OF TRUNK ROAD
AT KAMPALA URBAN INTERFACE

Figure 13.12 Erosion of Main Roads Caused by Earth Feeder Roads

Most of the other mitigative measures recommended relate to changes in policy.

13.4.1 Mitigation for Noise and Vibration

1) During road construction, the use of construction vehicles and machinery should be limited or prohibited at night, particularly in residential areas.

2) All vehicles and construction machinery should be maintained in accordance with the original manufacturer's specifications and manuals and in such a manner to minimise noise and vibrations.

3) There should be an education campaign to reduce the current high usage rate of vehicle horns in Kampala. Appropriate educational mediums may include newspapers, television and radio broadcasts.

4) Again vehicles should be tested for noise and vibration pollution, particularly large vehicles such as buses and all types of trucks, as part of the routine annual licence tests.

5) A study should be undertaken to identify suitable noise absorber species of plants that are also suitable for growing at road sides. The emphasis should be on indigenous tree and shrub species and the research could be undertaken at Makerere University.

13.4.2 Mitigation for Air Pollution

Dust

1) During the construction, dust pollution levels can be particularly high and water bowsers should be used regularly to reduce dust levels. More care should be taken at the junctions and roundabouts than the roads owing to the high density of development surrounding them.

Air Pollution

2) During construction, all asphalt plants and construction machinery should be operated and maintained in accordance with the original manufacturer's specifications and manuals and in such a manner to minimise emissions of hydrocarbons, particulates and other air pollution. Again more care should be taken at the junctions and roundabouts than along the roads owing to the high density of development.

3) Annual inspection of vehicle emissions should be introduced into Uganda. In addition, educational campaigns on the regular maintenance of vehicles should be introduced using newspapers, television and radio broadcasts.

4) Consideration should be given to prohibiting/reducing the importation of fuel inefficient vehicles and providing additional incentives (tax relief) for the importation of fuel efficient vehicles into Uganda.

5) In terms of fuel specifications, negotiations should be undertaken with the Kenya Petroleum Refineries and a time frame established for the phasing in of de-leaded petrol and diesel with low levels of sulphur. Once introduced, the use of catalytic converters and emission control devices on vehicles should be considered.

6) In terms of urban planning, consideration should be given to regulating the movement of heavy commercial vehicles such as lorries through residential areas.

13.4.3 Mitigation for Flood-Prone Areas, Siltation of Water Courses and Erosion

Drainage, or the lack of, is one of the largest environmental problems plaguing the roads in Kampala and a number of solutions are proposed to rectify this problem:

1) Existing drainage channels should be un-blocked and cleared of silt/refuse and overgrown vegetation. For example it is noted that the drainage channels running through market areas are often blocked. The reason for this is likely to be a combination of factors that may include an inadequate size of channel, poor refuse collection/disposal and lack of information on the importance of un-blocked drains. Therefore, solving the problem must include a combination of strategies ranging from engineering solutions such as the widening of channels, to encouraging better refuse disposal and simple educational information campaigns.

2) Existing drainage channels should be re-examined to assess whether they are of an adequate depth and width, particularly bearing in mind that building activities are likely to continue for the next decade at the current high rate in and around the city. As much of this building activity is not strictly regulated by the authorities, it is likely that the road drainage provided may be the only properly constructed drainage in a given area. Therefore, the capacity of the drains should be re-examined with this factor in mind, particularly in low income

residential and commercial areas such as Kitintale on the Port Bell Road and Bwaise on the Bombo Road.

3) There should be adequate drainage channels on either side of the road sections leading up to the wetlands and adequate culverts allowing for cross flow in the road sections that actually cross the wetlands, for example Gaba Road.

4) There are a number of stretches on existing roads, for example parts of Natete Road that clearly require the installation of new drainage channels. In the past drainage channels may not have been necessary due to the high proportion of vegetation cover. However, over the last decade construction activities have increased dramatically and the vegetation cover has diminished substantially leading to increased run-off and soil erosion.

5) Where necessary lined drainage channels should be installed, such as along parts of Natete Road.

6) Earth roads feeding into the main paved roads cause erosion. The inclination of these earth roads should be assessed and changed if possible for some distance prior to joining the main road and consideration should be given to paving these earth roads at the junctions. In addition the drainage channels of these earth roads should also be assessed for some distance prior to joining the main road.

7) Provision of adequate drainage channels combined with the correct camber of road and shoulder protection of the roads is inevitable.

8) Exposed slopes on either side of the road should be vegetated with indigenous grasses.

13.4.4 Flora

1) A tree planting programme should be implemented where ever possible on all rehabilitated roads. Consideration should be given to involving the communities living along the road via an incentive based programme. The principal behind such a programme is that people are given a number of indigenous tree seedlings to plant along the road.

2) Extra care should be taken during the construction phase with roads that pass through the wetlands to minimise oil and other spills.

13.4.5 Pedestrians, Cyclists and Motorists

It should be ensured that pedestrian footpaths are continuous where ever possible at all junctions and along all roads. In order to prevent the inordinately high number of traffic accidents in Kampala and pedestrian accidents in particular, the following has been recommended and incorporated into the road designs:

1) Pedestrian crossing facilities such as pelican crossings and rehabilitating existing zebra crossings at strategic locations. This is particularly important as there is an extremely high number of schools along most of the arterial roads of Kampala.

2) Installing and rehabilitating street lighting.

3) Installing guard rails at junctions.

4) Rehabilitating existing bus stops and the construction of new ones where necessary.

5) Roads should be clearly marked and appropriate speed limits and other signs posted on traffic boards. The legal/administrative/institutional measures recommended include:

   - A review and update of the traffic regulation code.
   - Introduction of a penalty system in the cases when the traffic law is violated.
   - Introduction of a parking code.
   - Regulation of heavy vehicle movement through the urban streets.
   - Introduction of a regular car inspection system.

13.5 Conclusions and Recommendations

As a result of including environmental considerations from the outset of the study the impacts of the proposed project have been significantly reduced. If due attention is paid to the mitigative measures proposed, the overall impact of rehabilitating the high priority roads and junctions both in socio-economic and bio-physical terms will be positive. Some of the positive results made to environmental concerns include:

1) Simultaneous environmental and engineering surveys were undertaken at all junctions and roads. This resulted in aversion of demolition and the conservation of vegetation.

2) The inclusion of "formal" pedestrian lanes into the road design.

3) The inclusion of "formal" buffer zones for trees and shrubs into the road design.

The detailed noise and vibration survey and air pollution survey led to a number of conclusions which have significant implications for future planning in Kampala:

4) Vibration pollution is not a problem in Kampala, except during the use of construction equipment.

5) Noise pollution is a problem along certain roads in Kampala and respect for the road reserve must be legally enforced in the future. This will protect many low income residents who build their houses at the edge of, or within a road reserve and are un-informed about the insidious nature of noise pollution. In addition, areas should be zoned and heavy commercial vehicles should not be allowed to pass through residential areas.

6) Air pollution, specifically Carbon monoxide pollution, is a growing problem in Kampala. The junction designs have gone a long way to easing congestion and resulting in time savings, which in turn reduces the amount of air pollution around these heavily developed junctions.

CHAPTER 14

IMPLEMENTATION PLAN

14. IMPLEMENTATION PLAN

14.1 Executing Agency

The Development Department, Ministry of works, Transport and Communications (MOWTC) is the government agency responsible for the execution of the Project.

14.2 Project Components and Construction Package

The high priority projects selected in the Master Plan Study consist of two (2) categories of projects; namely, (1) Improvement of bottleneck junctions and (2) Improvement of road sections. These projects have been classified into construction packages as shown below (Ref. 12.1.2 (3)):

Package-I	:	Mainly consists of bottleneck junction improvement projects. Junctions included in this package are Natete, Makerere, Kibuye, Port Bell/Jinja Road, and Wandegeya.
Package-II	:	The simultaneous improvement of two road sections, i.e. Natete Road and Gaba Road. Combination of two contrasted road sections; Natete Road, an urban short cut route with a short length of 3.8 km, and Gaba Road, a radiating trunk road with a length of 9.1 km. Both need urgent improvement works.
Package-III	:	Improvement of Port Bell Road, a typical intra-regional trunk road in the area, within an industrial zone with a length of 4.8 km.
Package-IV	:	Improvement of Gayaza Road. A section of the national trunk road connecting to the northern part of the nation with a length of 4.6 km.
Package-V	:	Improvement of Hoima Road and Jinja Junction. A combination section of national trunk road with a length of 8.5 km located in the urban periphery and a junction located in the city centre.

14.3 Description of Projects

Description of projects by construction package is shown in Table 14.1.

Table 14.1 Project Description

Package	Project Components	Present Issues	Content of Improvement Work	Traffic (1997) (A.M. Peak Hour)	Area of the Project Site (sq. m)
I	Natete Junction	- Queuing - Intrusion of pedestrians	- Signalized junction - Turning lanes - Pedestrian crossing	3,902 (A.M. Peak Hour)	9,000 sq. m
	Makerere Junction	- Queuing - Traffic accident	- Signalized junction - Turning lanes - Pedestrian crossing	5,565 (A.M. Peak Hour)	6,300 sq. m
	Kibuye Junction	- Queuing - Pavement deterioration	- Improvement of geometry - Safety facilities	5,618 (A.M. Peak Hour)	8,200 sq. m
	Port Bell/ Jinja Road Junction	- Queuing - Traffic accident	- Improvement of geometry - Safety facilities - Pedestrian crossing	7,793 (A.M. Peak Hour)	5,800 sq. m
	Wandegeya Junction	- Queuing - Traffic accident - Instruction of pedestrian	- Signalized junction - Turning lanes - Safety facilities - Pedestrian crossing	8,679 (A.M. Peak Hour)	13,000 sq. m
II	Natete Road	- Narrow carriageway - Pavement deterioration - Poor drainage system - Lack of sidewalk	- Improvement of pavement - Widening of carriageway - Raising of carriageway (2 points) - Installation of sidewalks	8,500 ADT	3.8 km
	Gaba Road	- Narrow carriageway - Pavement deterioration - Poor drainage system	- Improvement of pavement - Widening of carriageway - Raising of carriageway (1 point) - Installation of sidewalks	11,600 ADT	9.1 km
III	Port Bell Road	- Pavement deterioration - Poor drainage system - Lack of sidewalk	- Improvement of pavement - Widening of carriageway - Installation of sidewalks	7,800 ADT	4.8 km
IV	Gayaza Road	- Narrow carriageway - Pavement deterioration - Poor drainage system - Lack of sidewalk	- Improvement of pavement - Widening of carriageway - Installation of sidewalks	15,700 ADT	4.6 km
V	Hoima Road	- Narrow carriageway - Pavement deterioration - Poor drainage system - Lack of sidewalk	- Improvement of pavement - Widening of carriageway - Raising of carriageway (1 point) - Installation of sidewalks	9,900 ADT	8.5 km
	Jinja Junction	- Queuing - Pavement deterioration - Traffic accident	- Improvement of geometry - Turning lanes - Safety facilities	9,802 (A.M. Peak Hour)	10,000 sq. m

14.4 Construction Period by Project Component

The construction period for each project was estimated taking into consideration the work volume, location and site condition as described below:

(1) Bottleneck Junction Improvement Projects

The construction period for five (5) of the bottleneck junctions consisting of Natete Junction, Makerere Junction, Kibuye Junction, Port Bell/Jinja Road Junction, and Wandegeya Junction is estimated to be twelve (12) months under a simultaneous implementation method.

Jinja Road Junction will be improved independently from other five (5) junctions after the completion of Nakivuvo Channel Dredging Project financed by EU. The construction period for Jinja Road Junction is estimated to be six (6) months.

(2) Road Section Improvement Projects

- Natete Road Improvement Project

  Due to the relatively small work volume and the short length, the construction period for the road is estimated to be ten (10) months.

- Port Bell Road Improvement Project

  Construction period for the road is estimated to be twelve (12) months.

- Gaba Road Improvement Project

  Due to the large work volume and the large length of the section (9.1 km), construction period for the road is estimated to be fourteen (14) months.

- Hoima Road Improvement Project

  Due to the large work volume and the large length of the section, construction period for the road is estimated to be fourteen (14) months.

- Gayaza Road Improvement Project

  The construction period for the road is estimated to be twelve (12) months.

14.5 Implementation Schedule by Construction Package

The implementation schedule was prepared taking the following factors into consideration:

- Construction schedule of individual projects,
- Size of the construction cost of individual projects,
- Size of improvement effect brought about by the implementation of the individual project (= urgency), and
- Relation with related development schemes.

The recommended implementation schedule is presented in Fig. 14.1.

14.6 Investment Program

14.6.1 Investment Program for Short-term Development Plan

The investment program for the short-term development by construction package of high priority projects was prepared on the basis of an implementation schedule as shown in Table 14.2.

14.6.2 Investment Schedule and Program for Long-term Development Plan

The implementation schedule for the long-term development plan was prepared as shown in Table 14.3. The corresponding investment schedule was prepared as shown in Table 14.4 based on estimated costs of individual projects, where the estimation was done by applying the unit cost (per km, per square meter) obtained during the estimation of short-term projects.

Fig. 14.1 Proposed Implementation Schedule by Construction Package

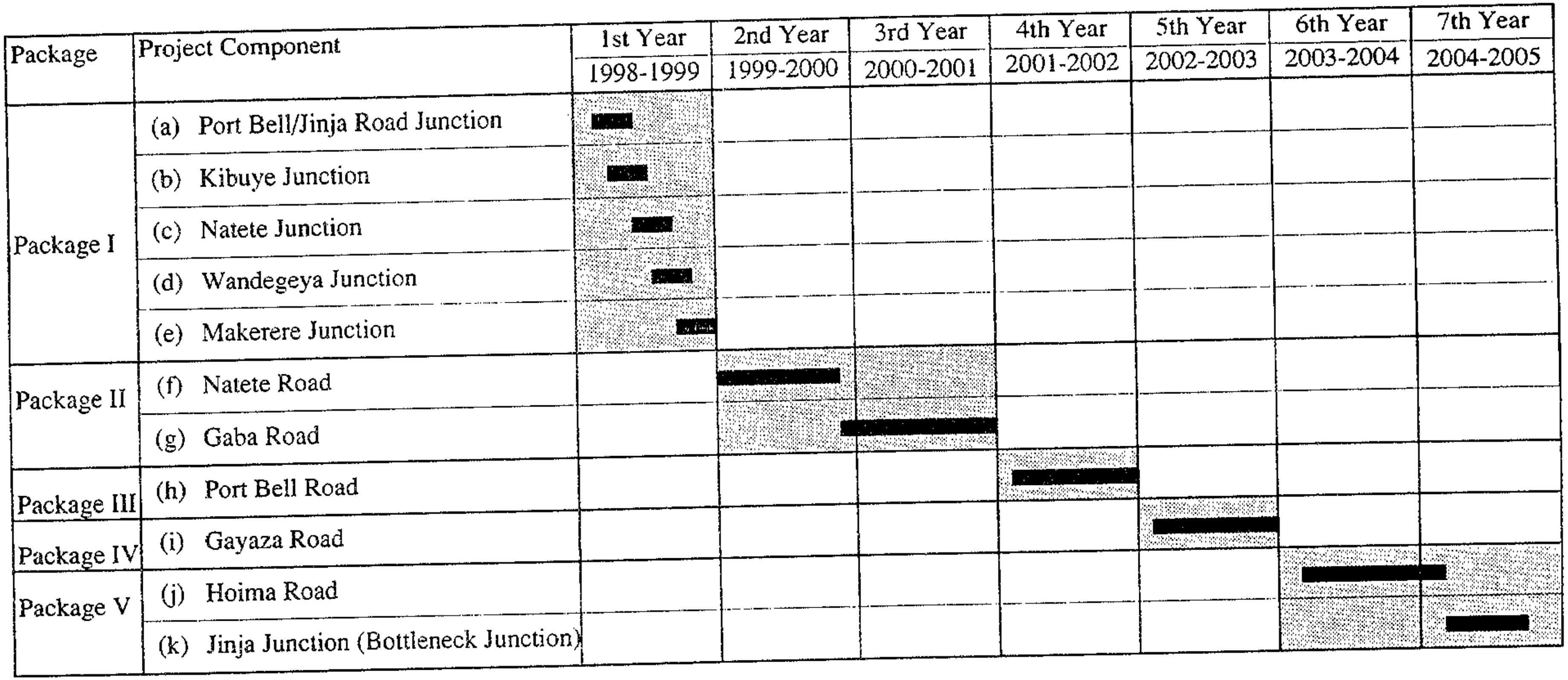


Table 14.2 Proposed Cost Disbursement Schedule by Construction Package

Unit: Ushs. million
(Unit: Yen, million)

Package	Project Component	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
		1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Package I	(a) Port Bell/Jinja Road Junction							
	(b) Kibuye Junction							
	(c) Natete Junction	5,132.8 (594.9)						
	(d) Wandegeya Junction							
	(e) Makerere Junction							
Package II	(f) Natete Road		14,952.5 (1,733.0)					
	(g) Gaba Road							
Package III	(h) Port Bell Road				5,522.1 (640.0)			
Package IV	(i) Gayaza Road					5,561.0 (644.5)		
Package V	(j) Hoima Road						11,540.7 (1,337.6)	
	(k) Jinja Junction							

Table 14.3 Proposed Implementation Schedule by Road Development (Long-term)

Proposed Projects to be Implemented in the Long-term Plan		2006 - 2010	2011 - 2015
[Improvement of Bottleneck]			
Junction	Clock Tower Roundabout	XXX	
Flood Area:	Sentema Road Carriageway Raising	XX	
	Bomba Road Carriageway Raising	XX	
	Jinja Road (A) Carriageway Raising	XX	
	Jinja Road (B) Carriageway Raising	XX	
[Reinforcement of Linehaul]			
Regional	Sentema Road	XXX	
Artery:	Kira Road	XXX	
	Jinja-Kampala -Bomba Road	XXX	
	Butikiro-Kisenyi Road	XXX	
	Musaja-Alumbwa Road	XXX	
	Muwanga Road	XXX	
	Mengo-Kisenyi Road	XXX	
[Reinforcement of Linehaul]			
Inter-regional			
Artery:	Masaka Road	XXX	
	Bomba Road	XXX	
	Jinja Road	XXX	
	Entebbe Road	XXX	
[Strengthening of Road Network]			
Circular:	Inner Ring Road	XX	
	Katwe Lubiri Ring Road		XXX
	Middle Ring Road (Kampala Bypass)		XXXXX
Access:	Katwe Road		XXX
	Motebi Road		XX
	Lubiri Ring-Queens way		XX
	Lubiri Ring-Masaka Road		XX

Table 14.4 Proposed Investment Schedule by Road Development (Long-term)

Unit: Ushs. million

Proposed Projects to be Implemented in the Long-term Plan		2005 - 2009		2010 - 2015	
		Investment Schedule			
		Pro. Cost	Land Acq.	Pro. Cost	Land Acq.
[Improvement of Bottleneck]					
Junction	Clock Tower Roundabout	1,107.1			
Flood Area:	Sentema Road Carriageway Raising	(1,141.9)			
	Bomba Road Carriageway Raising	(464.6)			
	Jinja Road (A) Carriageway Raising	(468.9)			
	Jinja Road (B) Carriageway Raising	(433.3)			
[Reinforcement of Linehaul]					
Regional	Sentema Road	4,927.8	(10.0)		
Artery:	Kira Road	10,462.8	(10.0)		
	Jinja-Kampala -Bomba Road	1,878.0			
	Butikiro-Kisenyi Road	1,476.1			
	Musaja-Alumbwa Road	370.1			
	Muwanga Road	444.1			
	Mengo-Kisenyi Road	518.1			
[Reinforcement of Linehaul]					
Inter-regional					
Artery:	Masaka Road	11,502.9			
	Bomba Road	6,637.3			
	Jinja Road	8,085.5			
	Entebbe Road	4,214.8			
[Strengthening of Road Network]					
Circular:	Inner Ring Road	9,111.1	(15.0)		
	Katwe Lubiri Ring Road			2,948.2	(23.0)
	Middle Ring Road (Kampala Bypass)			* –	–
Access:	Katwe Road			803.1	
	Motebi Road			296.1	
	Lubiri Ring-Queens way			222.0	
	Lubiri Ring-Masaka Road			148.0	
	Subtotal	60,735.7	(35.0)	4,417.4	(23.0)
Total		Project Cost 65,153.2		Land Acq. Cost (58.0)	

* Committed by EU

CHAPTER 15

PROJECT EVALUATION

15. PROJECT EVALUATION

15.1 General

15.1.1 Introduction

The project evaluation has been undertaken within the framework of the conventional economic evaluation in which a cost-benefit analysis has been applied. Estimated project costs and project benefits are compared, to appraise the viability of project implementation from the viewpoint of the national economy.

The project costs include capital investment costs as well as maintenance costs over the appraisal period. The project benefits are mainly road users' benefits arising principally from the savings of vehicle operating costs and passengers' time costs. It should be borne in mind that the project benefits cover only quantifiable ones; however, the quantification of road users' benefits occupies a major part of work in the procedures of the economic evaluation.

All costs and benefits have been derived as cost/benefit streams over the appraisal period. The evaluation results are expressed in terms of evaluation indicators calculated with the cost/benefit streams. The viability of project implementation can be judged by the comparison of indicator values with certain criterion. In this regard, the substance of the economic evaluation consists of the calculation of evaluation indicators; namely,-

- Benefit-Cost Ratio (B/C)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)

The robustness of the conclusions reached from the economic evaluation has been tested in the sensitivity analysis. Assuming possible cost/benefit alteration, corresponding IRR figures are calculated and the soundness of project implementation is judged in comparison with the same criterion as above.

Several socio-economic impacts have not been included in the economic evaluation because of the nature of project benefit quantification. These include the promotion of urban development and accelerating economic development including the multiplier effect of the project investment in the regional economy. In the section succeeding the economic evaluation, such socio-economic impacts have been provisionally delineated.

In the last section of this chapter, financial aspects of project implementation have been analyzed by referring to the MOWTC Budget.and the First Road Sector Project under the "10-year Road Sector Development Programme".

15.1.2 Procedures and Preposition in the Economic Evaluation

The economic evaluation begins with the estimation of yearly economic project costs and benefits. Economic project costs are obtained from the financial project costs by deducting transfer components in the national economy. Project benefits are quantified principally from the savings of travel cost and time under several assumptions; details of such quantification processes are placed in Section 15.3. Transfer elements in the national economy are excluded in the benefit estimation as well. Market distortion connected to the use of "shadow price" has not been accounted for in Uganda; therefore, the wage data have been used without adjustment as inputs to the road users' benefits.

Cost/benefit streams over the appraisal period are the source of the evaluation indicator calculation. The cost stream is prepared by allocating the yearly amount of project investment to meet the disbursement schedule in addition to the maintenance cost stream. In calculating the benefit stream, an appropriate annual increase in the rate of benefits shall be settled.

The next step is the calculation of present values of project costs and benefits, for the purpose of analyzing the project's net economic benefit. The yearly amount of cost/benefits shall be discounted to the present values of 1997 (as a base year). A discount rate having been applied is 12% per annum, which was confirmed in the discussions with MOWTC to be used for public sector investment appraisal.

The total present values of project costs (C) and the total present values of project benefits (B) are then obtained by the summation. Using B and C, 3 key indicators for evaluation are calculated as follows:

- Benefit-Cost Ratio : B/C
- NPV : B - C
- IRR : Discount rate making B = C, or making B/C = 1 or NPV = 0

If B/C is higher than 1 or NPV is more than 0, the project benefits surpass the project costs, and as such the project implementation can be judged as economically feasible.

IRR is the discount rate giving a break-even point between cost/benefit streams. It shows how fast the investment amount can be recovered. If IRR is higher than the opportunity cost of capital, the contribution of project implementation is well justified to the national economy. The higher the IRR value the bigger the contribution to the economy.

The opportunity cost of capital is usually the same discount rate as applied in the present value calculation. As a consequence, criterion to screen IRR values has been set at 12% per annum. An IRR value higher than 12% justifies the project implementation to be economically feasible.

The project life, which shall be reflected in the project appraisal period, has been set at 15 years after the opening of the projects. Since construction will commence in different years, the opening and ending of project life might fall on different years according to project components. The project appraisal period has, however, been set to cover 15 years of project life regardless of the year of starting and completion.

15.1.3 Evaluation Cases

Already described in Chapter 14, the project investment schedule has been proposed as follows:

1st year - 1998	:	5 Bottleneck junctions improvement
2nd year - 1999	:	Natete Road improvement
3rd year - 2000	:	Gaba Road improvement
4th year - 2001	:	Port Bell Road improvement
5th year - 2002	:	Gayaza Road improvement
6th year - 2003	:	Hoima Road improvement
7th year - 2004	:	Jinja Roundabout improvement

Of these, in the 2nd/3rd year and 6th/7th year, the project components are close-connected and shall be regarded as two project packages. Also, it is convenient to consider the 1st year investment to be made towards a project package containing 5 junction improvements. Accordingly, the following naming is set forward:

Package-I	:	5 junction/roundabout improvements
Package-II	:	Natete and Gaba Roads improvement
Package-III	:	Port Bell Road improvement
Package-IV	:	Gayaza Road improvement
Package-V	:	Hoima Road and Jinja Roundabout improvements

Project components have, therefore, been fixed at five as follows:

1. Package-I : Investment to be made in 1998
2. Package-II : Investment to be made in 1999 and 2000
3. Package-III : Investment to be made in 2001
4. Package-IV : Investment to be made in 2002
5. Package-V : Investment to be made in 2003 and 2004

The economic evaluation has been conducted towards the individual project components. Additionally, one more case was added in the evaluation, which is to appraise the whole project implementation. All the project costs/benefits of project components are aggregated to prepare cost/benefit streams as a whole. Evaluation indicators have thus been calculated in 6 different cases.

In the economic evaluation, all values are indicated at constant 1997 prices. Price escalation, if any, has been deleted.

15.2 Estimation of Economic Project Cost

15.2.1 Capital Investment Cost

The capital investment costs have been prepared in Chapter 12, and the investment schedule in Chapter 14.

Economic investment costs have been obtained from the financial project costs taken from the former chapters, by multiplying with a conversion factor of 79%. Table 15.1 shows the obtained economic investment costs as well as the original financial investment costs.

The rationale of using a conversion factor of 79% is:

(1) Conversion of financial costs to economic costs can be done by the deduction of transfer elements such as import duty, excise duty, withholding tax and value added tax (VAT). Transfer elements do not represent the real use of resources.

(2) In Uganda, import duty and withholding tax are levied independently to the CIF-price, while VAT is levied to CIF-price plus import duty and withholding tax. The rate of import duty varies according to the commodity imposed; withholding tax and VAT are uniformly imposed: 4% and 17% respectively.

(3) In the "10-year Road Sector Development Programme", a conversion factor of 79% is applied for the mechanized procedures.

Table 15.1 Investment Cost for the Project

Unit: Million Ush.

Objective Area	Financial Cost	Economic Cost
I. Road :		
1.Natete	4,668.7	3,688.3
2.Gaba	10,283.8	8,124.2
3.Port Bell	5,522.1	4,362.5
4.Gayaza	5,561.0	4,393.2
5.Hoima	10,515.4	8,307.2
II. Junction/Roundabout :		
1.Natete	1,115.0	881.0
2.Makerere	893.5	705.9
3.Kibuye	868.4	686.0
4.Port Bell/Jinja	774.4	611.8
5.Wandegeya	1,481.4	1,170.3
6.Jinja	1,025.3	810.0

Remarks: (1): Economic Investment Cost = Financial Investment Cost x 0.79. (Based on deduction of transfer components: mainly, tax and duties, in the national economy).

(2): Investment schedule :

1st year (1998) :	Package-I: 5 junction/roundabout improvement(II.1 to II.5)
2nd and 3rd year (1999-2000):	Package-II: Natete and Gaba Roads (I.1 and I.2)
4th year (2001) :	Package-III: (I.3)
5th year (2002) :	Package-IV: (I.4)
6th and 7th year (2003-2004):	Package-V: Hoima Road and Jinja Roundabout (I.5 and II.6)

(4) Notwithstanding the rate of import duty, 79% is just equivalent to the net cost of withholding tax and VAT.

15.2.2 Maintenance Cost

The required amount of routine maintenance and periodic maintenance have been estimated in Chapter 12.

Economic maintenance costs have been obtained, in this case, by multiplying the conversion factor of 90%, due to labour intensive procedures. Table 15.2 shows thus obtained maintenance cost stream.

15.2.3 Cost Stream for the Economic Evaluation

Table 15.3 shows the economic cost stream in 6 different cases. Each yearly value is the sum of economic investment cost and economic maintenance cost.

15.3 Estimation of Project Benefits

15.3.1 Quantification of Project Benefits

Resources utilized in project implementation could otherwise be employed elsewhere. The project investment can be justified when the expected benefits exceed the project costs. In this regard, the measurement of project benefits profoundly influences the economic evaluation results. The quantification of project benefits thus has a significant meaning.

Initially, the Study Team assumed the following 4 categories of project benefits to be quantified; however:

(1) Vehicle Operating Cost (VOC) Savings

The costs of the operating vehicles on road (per km) will be reduced following road/junction improvements. This is brought about especially from better road surface condition allowing higher vehicle speed. Reduction of fuel consumption and vehicle maintenance costs are the major outcomes.

Saving of VOC is the most significant quantifiable project benefit. In Uganda at the MOWTC, currently in use is VOC sub-model of the Highway Design and Maintenance Standards Model - Version 3 (HDM-III) developed under the World Bank. However, noticing well-known shortcomings and the difficulty in preparing input data for HDM-III, the Study Team has taken steps in a standardized procedure to calculate VOC savings.

Table 15.2 Economic Maintenance Cost for the Project

Unit: Million Ush.

Year	Package-I	Package-II	Package-III	Package-Iv	Package-V
1998	-	-	-	-	-
1999	28.6	-	-	-	-
2000	28.6	20.5	-	-	-
2001	28.6	69.6	-	-	-
2002	28.6	69.6	25.9	-	-
2003	28.6	69.6	25.9	24.8	-
2004	28.6	69.6	25.9	24.8	45.9
2005	28.6	69.6	25.9	24.8	52.7
2006	28.6	69.6	25.9	24.8	52.7
2007	28.6	69.6	25.9	24.8	52.7
2008	28.6	69.6	25.9	24.8	52.7
2009	281.5	69.6	25.9	24.8	52.7
2010	28.6	251.3	25.9	24.8	52.7
2011	28.6	504.8	25.9	24.8	52.7
2012	28.6	69.6	255.4	24.8	52.7
2013	28.6	69.6	25.9	244.8	52.7
2014	-	69.6	25.9	24.8	459.2
2015	-	49.1	25.9	24.8	112.5
2016	-	-	25.9	24.8	52.7
2017	-	-	-	24.8	52.7
2018	-	-	-	-	52.7
2019	-	-	-	-	6.8
2020	-	-	-	-	-

Remarks: (1): Routine maintenance cost required every year for 15 years after the opening.
(2): Periodic maintenance cost required in the 11th year after the opening.
(3): Figures above are all economic costs. Conversion from financial maintenance costs have been made with the factor of 0.9, meaning that maintenance works are labour-intensive procedures and therefore 90% of financial value might be assumed as economic value.

Table 15.3 Cost Stream for the Project

Unit: Million Ush.

Year	Package-I	Package-II	Package-III	Package-IV	Package-V	Total
1998	4,055.0	-	-	-	-	4,055.0
1999	28.6	3,688.3	-	-	-	3,716.9
2000	28.6	8,144.7	-	-	-	8,173.3
2001	28.6	69.6	4,362.5	-	-	4,460.7
2002	28.6	69.6	25.9	4,393.2	-	4,517.3
2003	28.6	69.6	25.9	24.8	8,307.2	8,456.1
2004	28.6	69.6	25.9	24.8	855.9	1,004.8
2005	28.6	69.6	25.9	24.8	52.7	201.6
2006	28.6	69.6	25.9	24.8	52.7	201.6
2007	28.6	69.6	25.9	24.8	52.7	201.6
2008	28.6	69.6	25.9	24.8	52.7	201.6
2009	281.5	69.6	25.9	24.8	52.7	454.5
2010	28.6	251.3	25.9	24.8	52.7	383.3
2011	28.6	504.8	25.9	24.8	52.7	636.8
2012	28.6	69.6	255.4	24.8	52.7	431.1
2013	28.6	69.6	25.9	244.8	52.7	421.6
2014	-	69.6	25.9	24.8	459.2	579.5
2015	-	49.1	25.9	24.8	112.5	212.3
2016	-	-	25.9	24.8	52.7	103.4
2017	-	-	-	24.8	52.7	77.5
2018	-	-	-	-	52.7	52.7
2019	-	-	-	-	6.8	6.8
2020	-	-	-	-	-	-

(2) Time Cost (TC) Savings

Higher vehicle speed on the improved roads/junctions brings about the time savings accured to drivers and passengers. The time saved in travelling can be put to an alternative and productive use. Quantification of TC savings as a project benefit has been made by determining the time value in working-time for passengers. In the case of commercial vehicles such as minibus, bus and truck, TC savings for crew members have been excluded.

(3) Maintenance Cost Savings

High standard of improvement work along the roads or at junction/roundabouts will ensure reduction of future maintenance requirements and costs leading to the benefits. This is theoretically true; however, in the maintenance cost estimation in 12.9, the Study Team has assumed a unit cost higher than the current practices. There is no basis for the calculation of maintenance cost savings: therefore, the inclusion in the project benefit has been given up.

(4) Accident Cost Savings

Accident reduction is clearly an economic benefit. It can be quantified by savings of costs to the society; such as:

- Damage to vehicles
- Injury sustained by persons
- Loss of life

As substitutes, insurance cover and premium have been collected from interviews from the National Insurance Corporation. Afterwards, the Study Team decided against the inclusion of accident cost savings in the project benefit, in view of the lack of accident statistics along the project sites and difficulty of forecasting accident reduction effects.

Considering all of the above, VOC savings and TC savings remain the project benefits to be quantified. Both are the typical road users' benefits derived from the project.

15.3.2 Vehicle Operating Cost

(1) Composition and Vehicle Type

The vehicle operating cost (VOC) consist of 6 cost components; namely:-

fuel cost, engine oil cost, tyre/tube cost, repair/maintenance cost, crew cost, and overhead cost

In calculating the VOC, 6 vehicle types have been categorized:

- Motorcycle/Scooter
- Passenger Car/4WD
- Pick-up/Van
- Minibus (Matatu)
- Bus
- Heavy Goods Vehicle (Truck)

(2) Representative Vehicle and Basic Data

A representative vehicle (model) has been selected for each vehicle type, based primarily on the current market share and relevant availability of required data. Information was collected in interviews from car dealers, garages, tyre distributors, oil companies, bus/truck operators associations and government regulatory offices relating to tax imposition. Table 15.4 summarizes the basic data collected for the use in the VOC calculation.

(3) VOC in Standard Condition

Using the collected data, the amount of VOC component costs have been calculated. (Table 15.5).

VOC in standard condition is the aggregate of 6 VOC component costs. (Table 15.6).

(4) VOC in Response to Speed Level

VOC basic estimates have to be adjusted to different travelling speeds. VOC responding to a certain speed level is the aggregate of respective VOC component costs at the corresponding speed level. VOC component costs can individually be converted at the different speed levels.

Table 15.7 shows VOC in response to speed level, thus converted.

Table 15.4 Basic Data for VOC Calculation, Characterized by Vehicle Type

Item (Data)	Motorcycle /Scooter	Passenger Car/4WD	Pick-up /Van	Minibus (Matatu)	Bus	Heavy Goods Vehicle
1. Representative Vehicle - Model	YAMAHA DT-125	TOYOTA Corona	TOYOTA Hilux	TOYOTA Hiace	Layland/DAF FB	TATA
2. Vehicle Price (1000 Ush)						
-retail	2,900	18,000	34,000	31,000	63,000	51,000
-economic	2,174	12,407	26,666	21,367	49,400	39,991
3. Fuel Consumption						
(1) Fuel Type	Petrol	Petrol	Petrol	Diesel	Diesel	Diesel
(2) Cousuming Rate (l./1000km)	60	120	140	140	200	200
(3) Fuel Price (Ush/l.)						
-retail	1,140	1,140	1,140	1,000	1,000	1,000
-economic	855	855	855	750	750	750
4. Engine Oil						
(1) Consuming Rate (l./1000km)	0.5	1	1	1	4	4
(2) Oil Price (Ush/l.)						
-retail	2,100	2,100	2,100	1,975	1,975	1,975
-economic	1,574	1,574	1,574	1,481	1,481	1,481
5. Tyre/Tube Wear						
(1) No. of Tyres, including spare	2	5	5	5	7	7
(2) Set price (1000 Ush)						
-retail	18	70	85	85	300	300
-economic	13	52	64	64	225	225
(3) Average Tyre Life (km)	60,000	70,000	60,000	60,000	40,000	40,000
6. Monthly Repair/ Maintenance Cost (1000 Ush)	40	228	490	393	909	736
7. Crew and Its Monthly Wage (1000 Ush)	-	-	-	Driver:80 Conductor:40	Driver:90 Conducter:40 Turnboy:30	Driver:90 Turnboy:40
8. Vehicle Usage						
(1) Annual Running Distance (km)	30,000	20,000	40,000	40,000	94,000	67,000
(2) Use Limit (years)	7	9	10	10	10	10

Remarks: (1) : From interviews to car dealers, garages, tyre distributors, petroleum/oil companies, bus/truck operators associations, Customs & Excise Department and the Uganda Revenue Authority.

(2) : Economic price=Retail price less import duty (percentage varying according to the items imposed), withholding tax (4% uniformly) and VAT (17% uniformly)

Table 15.5 VOC Component Costs and Their Calculation

Item	Motorcycle /Scooter	Passenger Car/4WD	Pick-up /Van	Minibus (Matatu)	Bus	Heavy Goods Vehicle
I. Fuel Cost:						
Fuel Consumption Rate(Lt/1000km)	60	120	140	140	200	200
Economic Fuel Price (Ush/Lt)	855	855	855	750	750	750
(Ush/km)	51.3	102.6	119.7	105.0	150.0	150.0
II. Engine Oil Cost:						
Oil Consumption Rate(Lt/1000km)	0.5	1	1	1	4	4
Economic Oil Price (Ush/Lt)	1,574	1,574	1,574	1,481	1,481	1,481
(Ush/km)	0.8	1.6	1.6	1.5	5.9	5.9
III. Tyre and Tube Cost:						
Economic Tyre Price(1000 Ush)	13	52	64	64	225	225
Average Tyre Life (Km)	60,000	70,000	60,000	60,000	40,000	40,000
(Ush/km)	0.2	0.7	1.1	1.1	5.6	5.6
IV. Repair and Maintenance Cost:						
Annual Repair and Maintenance Cost (1000 Ush)	480	2,736	5,880	4,716	10,908	8,832
Annual Running Distance (km)	30,000	20,000	40,000	40,000	94,000	67,000
(Ush/km)	16.0	136.8	147.0	117.9	116.0	131.8
V. Crew Cost:						
No. of Crew	-	-	-	2	3	2
Annual Amount of Wage (1000 Ush)	-	-	-	1,440	1,920	1,560
Annual Running Distance (km)	30,000	20,000	40,000	40,000	94,000	67,000
(Ush/km)	-	-	-	36.0	20.4	23.3
VI. Overhead Cost:						
Economic Price of Vehicle (1000 Ush)	2,174	12,407	26,666	21,367	49,400	39,991
Overhead Cost Factor to be Multiplied (%)	-	-	-	6	7	7
Annual Amount of Overhead Cost (1000 Ush)	-	-	-	1,282	3,458	2,799
Annual Runnning Distance (km)	30,000	20,000	40,000	40,000	94,000	67,000
(Ush/km)	-	-	-	32.1	36.8	41.8

Table 15.6 VOC in Standard Condition

Unit:Ush/km

Component Cost	Motorcycle /Scooter	Passenger Car/4WD	Pick-up /Van	Minibus (Matatu)	Bus	Heavy Goods Vechicle
1. Fuel	51.3	102.6	119.7	105.0	150.0	150.0
2. Engine Oil	0.8	1.6	1.6	1.5	5.9	5.9
3. Tyre/Tube	0.2	0.7	1.1	1.1	5.6	5.6
4. Repair/ Maintenance	16.0	136.8	147.0	117.9	116.0	131.8
5. Crew	-	-	-	36.0	20.4	23.3
6. Overhead	-	-	-	32.1	36.8	41.8
Total (VOC)	68.3	241.7	269.4	293.6	334.7	358.4

Table 15.7 VOC in Response to Speed Level

Unit:Ush/km

Speed Level (km/hour)	Motorcycle /Scooter	Passenger Car/4WD	Pick-up /Van	Minibus (Matatu)	Bus	Heavy Goods Vechicle
0-10	74.5	261.0	433.7	468.3	614.9	748.6
10-15	67.3	241.7	364.8	407.0	527.0	615.1
15-20	65.2	230.3	327.6	354.4	467.3	545.2
20-25	63.6	224.2	295.9	320.2	424.4	492.2
25-30	61.1	224.2	261.2	287.6	385.1	445.3
30-35	60.0	214.6	244.4	269.7	359.9	417.7
35-40	58.0	203.2	231.1	252.9	350.1	395.9
40-45	58.0	205.0	223.5	246.9	341.1	379.7
45-50	59.0	208.4	220.4	245.3	337.8	370.0
50-55	59.0	210.2	214.8	245.8	334.7	362.1
55-60	60.5	214.6	214.3	245.8	334.7	359.1
60-65	62.6	221.6	216.8	246.9	340.1	358.4
65-70	64.7	227.7	224.0	248.6	345.8	360.3
70-75	67.3	241.7	226.0	249.6	354.5	366.3
75-80	70.4	247.0	238.8	261.0	369.7	371.4
Over 80	76.1	261.8	252.1	275.1	389.5	385.1

15.3.3 Passengers' Time Cost

Calculation of TC has been based on an "income approach" method. The basic data have been taken from "Uganda National Integrated Household Survey" conducted in March 1992 to March 1993. Average monthly household income (Ushs. 119,915) in Central Urban Region has been converted to per capita monthly income in 1997 by assuming a price increase rate of 7.3% per annum and an average number of employees per household of 1.2424. Working hours per month have been assumed to be 192, the time value in working-time was then obtained (Ushs. 666 per hour).

Passengers' time cost per vehicle has been calculated as shown in Table 15.8.

15.3.4 Project Benefits and Benefit Stream

The savings of VOC and TC form the project benefits.

Table 15.9 shows VOC savings in the year 2005.

Table 15.10 shows TC savings in the year 2005.

In the case of Package-I in which 5 junctions/roundabouts would be improved, VOC savings have not been calculated because of the uncertainty in setting up the difference of vehicle speed between "without" and "with" project cases.

Table 15.11 summarizes the project benefits in the year 2005.

An annual increase rate of project benefits has been assumed at 6.8% per annum during 1997 to 2005, and 6.4 percent per annum during 2005 to 2015. These growth rates coincide with the growth of forecast traffic volume in pcu/hour.

The annual project benefits throughout the project life of 15 years are tabulated in Table 15.12.

Table 15.8 Estimation of Passengers' Time Cost per Vehicle

Item (Data)	Motorcycle /Scooter	Passenger Car/4WD	Pick-up /Van	Minibus (Matatu)	Bus	Heavy Goods Vechicle
1. Number of Passengers, including Crew	1.3	2.3	2.7	10.7	37.7	2.8
2. Number of Crew and Its Classification	-	-	-	2 (Driver, Conductor)	3 (Driver, Conductor, Turnboy)	2 (Driver, Turnboy)
3. Working Time Proportion among the Passengers	0.15	0.35	0.35	0.25	0.25	1.0
4. Non-working Time Proportion among the Passengers	0.85	0.65	0.65	0.75	0.75	-
5. Passengers' Time Value in Working Time	: Ush. 666.0					
6. Passengers' Time Cost per Vehicle (Ush./hour)	129.9	536.1	629.4	1,448.6	5,777.6	532.8

Remarks: (1) : 1. : From the results of traffic survey conducted by the Study Team.
(2) : 2. : From intervews to bus and truck operator associations.
(3) : 3.&4. : Draft Final Report (Vol.4:Economic Analysis) of the "Comparative Feasibility Study Between Northern and Southern Bypass to Kampala City", Sir Alexander Gibb & Pertners Ltd., November 1996.
(4) : 5. : Study Team estimation, basic data taken from the "Uganda National Integrated Household Survey", Statistics Dept., March 1992 to March 1993.
(5) : 6. : Calculation using an equation of (1.-2.)×3.×5.
(6) : Crew cost is adjoined in the VOC calculation, and therefore excluded.
(7) : Time cost for the "private car" (combined, passenger car and pick-up/van) is assumed to be Ush 569.2 per vehicle, which has been obtained from the above figures multiplied by the composition of passenger car (64.5%) and pick-up/van (35.5%).

Table 15.9 VOC Savings, 2005

I. Annual VOC Savings by Road :

Unit : Million Ush.

Road Name	Annual VOC Savings per km	Distance to be Improved (km)	Annual VOC Savings
1. Natete Road	137.9	3.8	524.0
2. Gaba Road	162.5	9.1	1,478.8
3. Port Bell Ro:	122.0	4.8	585.6
4. Gayaza Roac	145.2	4.6	667.9
5. Hoima Road	115.6	8.5	982.6

Remarks: Annual VOC Savings = Annual VOC Savings per km x Distance.

II. Annual VOC Savings per km by Road :

Unit: ADT-Vehicle/day, VOCS-Million Ush./km•year

Road/Item	Motorcycl e	Car	Pick-up	Matatu	Bus	Truck	Total
1. Natete Road:							
(1) ADT	671	7,168	3,321	7,150	139	1,310	19,759
(2) VOCS	0.2	11.5	35.9	62.4	1.3	26.6	137.9
2. Gaba Road:							
(1) ADT	592	11,737	3,951	8,542	70	1,267	26,159
(2) VOCS	0.2	18.8	42.7	74.5	0.6	25.7	162.5
3. Port Bell Road:							
(1) ADT	566	7,199	3,207	6,742	73	794	18,581
(2) VOCS	0	11.6	34.6	58.8	0.7	16.1	122.0
4. Gayaza Road:							
(1) ADT	1,313	8,110	3,574	8,049	-	1,130	22,176
(2) VOCS	0.5	13.0	38.6	70.2	-	22.9	145.2
5. Hoima Road:							
(1) ADT	625	3,386	1,427	8,693	56	905	15,092
(2) VOCS	0.2	5.4	15.4	75.8	0.5	18.3	115.6

Remarks :

(1): ADT : Average daily traffic forecast for the year 2005 by the Study Team.

(2): VOCS : Vehicle operating cost savings per km calculated by vehicle type using the factors (VOCS Factors) below.

Motorcycl e	Car	Pick-up	Matatu	Bus	Truck
1.0	4.4	29.6	23.9	25.2	55.6

(3): VOCS Factor: Prepared under the notional assumptions on vehicle speed towards the VOC balance between "without project" and "with project" cases. Unit is Ush/km, since these factors are derived from Table 15.7: VOC in Response to Speed Level. When multiplied with the volume of traffic (ADT above), VOC savings per km (VOCS above) can be obtained.

Table 15.10 TC Savings, 2005

Unit: Daily Time Savings-hours, TC Savings-Million Ush.

Area/Item	Motorcycle	Private Car	Matatu	Bus	Truck	Total
I. Road:						
1. Natete						
(1) Daily Time Savings	8.3	130.5	88.9	1.7	16.3	245.7
(2) TC Savings	-	2.7	4.7	0.4	0.3	8.1
2. Gaba						
(1) Daily Time Savings	11.3	298.8	162.7	1.3	24.1	498.2
(2) TC Savings	-	6.2	8.6	0.3	0.5	15.6
3. Port Bell						
(1) Daily Time Savings	4.3	78.9	51.1	0.5	6.0	140.8
(2) TC Savings	-	1.7	2.7	0.1	0.1	4.6
4. Gayaza						
(1) Daily Time Savings	20.6	183.0	126.0	-	17.7	347.3
(2) TC Savings	0.1	3.8	6.7	-	0.3	10.9
5. Hoima						
(1) Daily Time Savings	33.9	261.7	472.7	3.0	49.2	820.5
(2) TC Savings	0.2	5.4	25.0	0.6	1.0	32.2
II. Junction/Roundabout:						
1. Natete						
(1) Daily Time Savings	-	84.5	76.7	1.0	9.4	171.6
(2) TC Savings	-	1.7	4.1	0.2	0.1	6.1
2. Makerere						
(1) Daily Time Savings	-	2250.4	1828.5	7.5	108.7	4195.1
(2) TC Savings	-	46.8	96.7	1.6	2.1	147.2
3. Kibuye						
(1) Daily Time Savings	-	4793.3	4359.2	9.3	386.2	9548.0
(2) TC Savings	-	99.6	230.5	2.0	7.5	339.6
4. Port Bell/Jinja						
(1) Daily Time Savings	-	2437.1	1265.6	6.6	179.3	3888.6
(2) TC Savings	-	50.6	66.9	1.4	3.5	122.4
5. Wandegeya						
(1) Daily Time Savings	-	6975.8	4191.7	15.5	216.8	11399.8
(2) TC Savings	-	144.9	221.6	3.3	4.2	374.0
6. Jinja						
(1) Daily Time Savings	-	9378.9	3293.8	16.3	615.3	13304.3
(2) TC Savings	-	194.9	174.2	3.4	12.0	384.5

Table 15.11 Economic Benefits in the Year 2005

Unit: Million Ush.

Description	Package-I	Package-II	Package-III	Package-IV	Package-V
1. VOC Savings	-	2,002.8	585.6	667.9	982.6
2. TC Savings	989.3	23.7	4.6	10.9	416.7
Total Benefits	989.3	2,026.5	590.2	678.8	1,399.3

Remarks :

(1) Package-I: Involves 5 junction/roundabout improvements; namely, Natete, Makerere, Kibuye Roundabout, Port Bell/Jinja Junction and Wandegeya Roundabout.
VOC savings have not been calculated because of the difficulty of setting up assumed vehicle speed between "without" and "with" projects for junction/ roundabout traffic. TC savings alone will suffice for the project benefits, which is supplemented by the fact that only one-tenth of the saved time has contributed to TC savings in the calculation.

(2) Package-II: Composed of Natete Road improvement and Gaba Road improvement, spanning 2 years in its implementation.

(3) Package-V: Hoima Road improvement (6th year) and Jinja Roundabout improvement (7th year). As in Package-I above, only TC savings are counted as project benefits for Jinja Roundabout improvement. TC savings are the aggregate of both those of Hoima Road and Jinja Roundabout.

(4) VOC Savings: Refer to Table 15.9.

(5) TC Savings: Refer to Table 15.10.

Table 15.12 Benefit Stream for the Project

Unit: Million Ush.

Year	Package-I	Package-II	Package-III	Package-IV	Package-V	Total
1998	-	-	-	-	-	-
1999	666.6	-	-	-	-	666.6
2000	712.0	382.9	-	-	-	1,094.9
2001	760.4	1,557.6	-	-	-	2,318.0
2002	812.1	1,663.5	484.5	-	-	2,960.1
2003	867.3	1,776.7	517.4	595.1	-	3,756.5
2004	926.3	1,897.5	552.6	635.6	950.2	4,962.2
2005	989.3	2,026.5	590.2	678.8	1,399.3	5,684.1
2006	1,052.6	2,156.2	628.0	722.2	1,488.9	6,047.9
2007	1,120.0	2,294.2	668.2	768.5	1,584.1	6,435.0
2008	1,191.7	2,441.0	710.9	817.6	1,685.5	6,846.7
2009	1,267.9	2,597.2	756.4	870.0	1,793.4	7,284.9
2010	1,349.1	2,763.5	804.8	925.7	1,908.2	7,751.3
2011	1,435.4	2,940.3	856.3	984.9	2,030.3	8,247.2
2012	1,527.3	3,128.5	911.2	1,047.9	2,160.2	8,775.1
2013	1,625.0	3,328.7	969.5	1,115.0	2,298.5	9,336.7
2014	-	3,541.8	1,035.1	1,186.4	2,445.6	8,208.9
2015	-	3,768.5	1,097.5	1,262.3	2,602.1	8,730.4
2016	-	-	1,167.8	1,343.1	2,768.7	5,279.6
2017	-	-	-	1,429.0	2,945.8	4,374.8
2018	-	-	-	-	3,134.4	3,134.4
2019	-	-	-	-	3,335.0	3,335.0
2020	-	-	-	-	-	-

15.4 Economic Evaluation

15.4.1 Evaluation Results and the Interpretations

The calculated evaluation indicators are tabulated in Table 15.13 below.

Table 15.13 Summary of Economic Evaluation Results

Evaluation Indicator	Package-I	Package-II	Package-III	Package-IV	Package-V	Whole Project
1. B/C	1.50	1.20	1.02	1.24	1.35	1.26
2. NPV (Million Ushs.)	1,936	1,819	52	633	1,675	6,116
3. IRR (%)	19.6	15.1	12.3	15.8	17.0	16.1

Remarks: B/C and NPV have been calculated at a discount rate of 12%.

In all, B/C is higher than 1, NPV is more than 0, and IRR is higher than 12%. The evaluation results indicate the project, not only the individual components but as a whole, is economically feasible.

Package-I containing 5 junction/roundabout improvements has the highest feasibility, followed by Package-V which is Hoima Road and Jinja Roundabout improvement. Package-II (Natete and Gaba Roads improvement) has the second biggest NPV but, if compared through B/C and IRR values, its feasibility shall be placed 4th next to Package-IV.

Package-III has the values of B/C and IRR just over the evaluation criteria; moreover, the obtained NPV is specifically low-valued. It can be said Package-III is marginally feasible. The reason for this low feasibility is the low level of future traffic forecast against the required costs for improvement.

The whole project implementation will have a favourable feasibility; B/C and IRR come after Package-V and it is obvious that NPV is the biggest because of the total sum of those of all project components. 16.1%, which is the IRR value of the whole project, shall be deemed as a benchmark of feasibility in this project implementation.

15.4.2 Sensitivity Analysis

A sensitivity analysis has been conducted to look through the appropriateness of procedures in the economic evaluation as well as to figure out the stability of the project implementation against the possible alteration of costs and benefits. Conceptual cost/benefit alteration has been assumed. IRR figures are calculated for all the combinations of the altered costs/benefits.

Table 15.14 lists the sensitivity test results.

Table 15.14 Sensitivity Test Results - IRR Values (Unit : %)

I. Package-I:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	19.6	21.5	23.6	26.2	29.3
+10%	17.8	19.6	21.6	22.2	27.0
±0	16.0	17.6	19.6	21.9	24.6
-10%	14.0	15.6	17.4	19.6	22.2
-20%	12.0	13.5	15.2	17.2	19.6

II. Package-II:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	15.1	16.7	18.5	20.7	23.2
+10%	13.6	15.1	16.8	18.9	21.3
±0	12.0	13.4	15.1	17.0	19.3
-10%	10.3	11.7	13.2	15.1	17.3
-20%	8.5	9.8	11.3	13.0	15.1

III. Package-III:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	12.3	13.8	15.5	17.5	19.9
+10%	10.9	12.3	13.9	15.9	18.1
±0	9.3	10.7	12.3	14.1	16.3
-10%	7.7	9.1	10.6	12.3	14.3
-20%	6.0	7.3	8.7	10.4	12.3

IV. Package-IV:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	15.8	17.5	19.4	21.7	24.4
+10%	14.2	15.8	17.6	19.8	22.4
±0	12.6	14.1	15.8	17.8	20.3
-10%	10.8	12.3	13.9	15.8	18.1
-20%	9.0	10.3	11.9	13.7	15.8

V. Package-V:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	17.0	18.7	20.5	22.8	25.4
+10%	15.5	17.0	18.8	20.9	23.4
±0	13.9	15.3	17.0	19.0	21.4
-10%	12.2	13.6	15.2	17.0	19.3
-20%	10.3	11.7	13.2	15.0	17.0

VI. Whole Project:

Benefit Alteration	Cost Alteration +20%	+10%	±0	-10%	-20%
+20%	16.1	17.7	19.6	21.9	24.6
+10%	14.5	16.1	17.9	20.0	22.6
±0	12.8	14.3	16.1	18.1	20.5
-10%	11.1	12.5	14.2	16.1	18.3
-20%	9.3	10.6	12.1	13.9	16.1

The evaluation procedures prove to be positive, since no extraordinary IRR figures appear in the sensitivity test results.

In respect of implementation stability, most IRR figures are above the 12% of screening criterion, meaning the project implementation is sound regardless of the probable cost/benefits alteration.

Except in Package-III, IRR figures lower than 12% appear with a benefit 20% down and 10% down and costs 20% up. However, these cases are not likely in view of:

- The cost increase of 20% is not considerable other than the design change to upgrade road functions.
- The benefit 20% down would only occur when the future traffic volume decreases by 20%. If the past trend of traffic growth is considered, this is not likely to happen.

Nevertheless, from these sensitivity test results, it is concluded that the viability of the project implementation has been proven as a whole.

15.5 Socio-economic Impact

Urban traffic in Kampala city is characterized by the high traffic concentration in the city centre along the 8 radial trunk roads. Traffic congestion is observed throughout the day in the city centre, which is especially severe during morning and evening peak hours. Traffic congestion generated within the city centre affects the traffic in the suburban arteries. It is expected to become worse, as the urbanization trend is producing a correspondingly rapid increase in traffic volume. A high rate of urbanization brings about the rapidly-growing suburban traffic in the radial trunk roads towards the city centre.

With the project implementation, major bottle-neck points (mostly junctions in the form of roundabouts) will be improved, regional/inter-regional linkage will be reinforced, and the trunk road network will be formed by adding circular/access routes. Traffic concentration in the city centre will be reduced and traffic congestion on the trunk road network will be eased with the provision of appropriate detour routes for the through-traffic. Urban traffic efficiency is expected to be improved in Kampala city and its environs. Inter-area traffic will be moving better between the respective trip ends, leading to reductions in travel time.

(1) Encouragement or Stimulation of Economic Activity

An efficient urban traffic ensures smooth distribution of goods and easy transportation of people. Agriculture produce can be more easily brought into the city for consumption and for processing. Commuter and shopping movement will become easier. Input (raw materials) - output (processed products) relationships will be vitalized among the different economic sectors, especially industry. Commercial activities and the services sector are other beneficiaries in the effective distribution of goods and people. As a result, the level of economic activities will rise in the different sectors. All types of private business are encouraged through the provision of the improved road infrastructure, even investment.

(2) Promotion of the Planned Urban (or Regional) Development

The Project will provide the basic framework to allow the urban transport network to meet the demands of the structure plan formulated under the "Kampala Urban Study, 1994". Intensified land use will be promoted within the current usage as well as for the planned expansion of the different land use proposals in the future. Inter-area linkage among the strategic population clusters with various land uses is also expected to become closer. Residential areas will be more closely connected to industrial areas, commercial centres and various service facilities. The potential suburban area might be encouraged towards new development associated with the planned location of sub-centres (Nakawa, Bwaise, Natete and Kibuye). Dispersion of city centre functions to these sub-centres and further to suburban areas will be realized by way of the improved corridors. Haphazard urban sprawl might be prevented by the construction of planned facilities with their different functions. The planned regional development will be accelerated in a more streamlined manner.

(3) Enhancement of Access to Essential Government Services

It is foreseen that the accessibility to public service facilities will be improved. These include hospitals (health), schools (education), water/sanitation, police stations (security), and other government offices. Public services will be improved for the potential beneficiaries in Kampala City. The incidence of poverty is highly connected to the lack of these facilities.

(4) Improvement of the Roadside Environment

Effects to the roadside environment will be:

- Decrease of air pollution in proportion to the decrease of travel distance, as traffic efficiency is improved,
- Improvement of road space by the provision of trees, lighting and other ancillary facilities and furnitures,
- Provision of safety measures for motorists, cyclists pedestrians and residents, and
- Alleviation of inundation in the surrounding flood-prone areas by the provision of roadside and/or crossing drainage systems.

(5) Negative Impact

Foreseeable negative socio-economic impacts include:

- Inflation due to the increased inflow of construction workers during the construction period and stimulated economic activities after the opening of project roads,
- Noise and vibration during the construction period,
- Dust caused by abandoned borrow pits and quarries, and
- Soil erosion on the embankment, cuts and slopes.

15.6 Financial Considerations

Financial aspects related to the project implementation have been analyzed, so as to assure the financing possibility as well as fund availability.

Table 15.15 summarizes the required investment amounts and their disbursement, indicated both in Ushs. and US$.

Table 15.15 Project Investment Cost and Disbursement

Year	In Ushs. Million	In US$ Million
1998	5,132.7	4.9
1999	4,668.7	4.5
2000	10,283.8	9.9
2001	5,522.1	5.3
2002	5,561.0	5.3
2003	10,515.4	10.1
2004	1,025.3	1.0
Total	42,709.0	41.0

Remarks: Exchange Rate: US$1 = Ushs. 1,042.52

Table 15.16 shows the MOWTC Budget in Fiscal Year (FY) 1994/95 through FY 1996/97. The Budget comprises Recurrent and Development accounts, of which closely related to the project is the latter; especially, Development Expenditure financed by donor funds.

Table 15.16 MOWTC Budget, 1994/95 to 1996/97

Unit: Ushs. Million

Fiscal Year	Recurrent Expenditure	Development Expenditure		
		Donor	Local	Total
FY 1994/95	10,652.3	46,142.3	11,462.0	57,604.3
FY 1995/96	8,649.7	43,597.3	12,738.9	56,336.2
FY 1996/97	8,272.8	45.8089 *	26,899.7	73,624.8

Remarks: (1) * : In US$ Million

(2) : All figures are the approved amount under MOF authorization

Source: MOWTC Budget Statement, 1994/95 to 1996/97

Table 15.17 gives the cost estimates for the First Road Sector Project that is the first phase of the "10-year Road Sector Development Programme". The MOWTC Budget shall be placed within the framework of the First Road Sector Project. Most important is a category of "Network Improvement" with donor assistance. A provisional financing plan has already been set up, in which donor funds will be disbursed to cover almost 83% of total requirements in the category.

Table 15.17 Estimated Costs for the First Road Sector Project

Unit: US$ Million

Project Category	GOU Fund	Donor Fund	Total
1. Maintenance and Rehabilitation	144.6	86.9	231.5
2. Improvement	34.5	571.8	606.3
3. Administration	3.3	62.8	66.1
Total	182.4	721.5	903.9

Remarks: (1) The First Road Sector Project is the 1st phase of the "10-year Road Sector Development Programme", covering the period July 1996 to June 2001.

(2) A provisional financing plan for the Project has already been established, in which US$776.8 million would be financed out of the total requirements estimated as above.

(3) In the financing plan, donor funds for "Improvement" will be disbursed:

FY 1996/97 : 37.4
FY 1997/98 : 83.9
FY 1998/99 : 107.1
FY 1999/00 : 111.0
FY 2000/01 : 112.8

, by which 83% of total requirements of donor funds in the category would be covered.

Source: "The First Road Sector Project-Progress Report (March 1997)", MOWTC.

If compared to MOWTC Development Expenditure (Donor) in FY 1996/97, the 1st-year (1998) investment cost of the project corresponds to 10.7%. In the next year (1999), the investment amount occupies less than 10% to the same amount in FY 1996/97.

The yearly amount of financial investment costs of the project will not surpass one-tenth of the scheduled disbursement of donor funds in the category of "Network Improvement" for the First Road Sector Project.

From these discussions, the annual amount of project investment cost has proved to correspond to at most 10% of the available or already scheduled fund resources. The financing of the project is therefore well justifiable in connection with the resource use as well as fund availability.