SERVICING OPTIONS FOR AFRICAN LOW-COST HOUSING

A thesis submitted to the Faculty of Graduate Studies and Research of McGill University, Montreal, in partial fulfillment of the requirement for the degree of Master of Architecture.

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ABSTRACT

The growth of urban centers continues to outstrip the ability to supply dwellings and urban services in many African cities which have limited financial resources. It is becoming increasingly harder for the urban poor to acquire an affordable dwelling which is a basic necessity. To put housing within the reach of these people it is essential to develop ways of reducing the investments by lowering the standards of services. The present thesis examines such a possibility and outlines specific options for Lusaka, Zambia.

RÉSUMÉ

L'expansion constante des centres urbains continue de l'emporter sur la capacité de fournir des logements et des services urbains dans beaucoup de villes africaines dont les ressources financières sont limitées. Il devient de plus en plus difficile pour les mal nantis de la ville d'obtenir des logements abordables, bien qu'il s'agisse d'un besoin fondamental. Pour mettre l'habitation à la portée de ces gens, il importe d'élaborer des moyens de réduire les mises de fonds en réduisant les normes visant les services. La présente thèse cherche à étudier ces possibilités et à ébaucher des choix particuliers à Lusaka, au Zambie.

ACKNOWLEDGEMENTS

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CONTENTS

PREFACE

Preface

The provision of adequate housing for the growing number of urban poor, at a price they can afford, is a formidable task for concerned authorities. Housing for the poor is usually costly in relation to their incomes and therefore it is extremely difficult to make enough provision for housing.

The provision of a plot on a parcel of land which is serviced with related infrastructure, normally referred to as Site and Services programmes, is one step in the direction of such efforts. However, it has proven difficult to meet the set targets with available financial resources.

Inappropriate servicing standards are a major cost item for such programmes forming the principal barrier in achieving goals. Public authorities can minimize the costs by providing affordable standards of services at the initial stage. The present study examines the possibility of lowering the initial standards of services for Site and Services projects and identifies workable options for long-term upgrading.

This study does not propose to reduce the standards of services to be provided. Rather it examines and outlines a method of reducing initial investments by lowering the servicing standards at the initial stage while maintaining the possibility of upgrading them at a later date without precluding any of the previous works. Hence, different servicing options may at first incorporate a low level of service which permits subsequent upgrading.

Options discussed in the study are not to be considered as alternative solutions since all options allow future upgrading without loss or damage to present installations. For example, if a standpipe is initially installed with several taps to supply water to a group of families, but allows for future upgrading to a greater number of individual connections, initial costs are reduced. The main point to remember is that the minimum cost option should never preclude the possibility of future improvements towards conventional standards. Finally, it is not the purpose of this study to present a readymade proposal for implementation. For different sites, different options can be applied at different stages. The study demonstrates that the cost ratio between the lowest option and the conventional one for water supply may be as high as 5.1 : 1 . There is clearly the possibility of considerable savings in the initial development costs of the Site and Services projects.

The study is organized into three chapters. The first chapter examines African low-cost housing. The second chapter reviews the state of the art of services and identifies practical options in general. In the third and the last chapter these options are translated on a prototype layout in the specific case of Lusaka, Zambia, based on about 20 months' work experience during 1974 to 1976.

CHAPTER : 1 AFRICAN LOW-COST HOUSING

1.1 Low-cost Housing in Africa and Related Issues

One of the basic needs of every human being is to acquire a shelter for himself and for his family, be it a tree, a cave, a hut or a house. Shelter provides protection against the weather, a space for resting and sleeping and a place to react to physical, material and psychological surroundings.

It is becoming increasingly difficult, particularly in urban centers, to acquire a shelter which can satisfy even minimum requirements with available financial resources. Countries in the African continent are no exception to this phenomenon. Urbanization and low-cost housing are two closely related topics which demand a closer study.

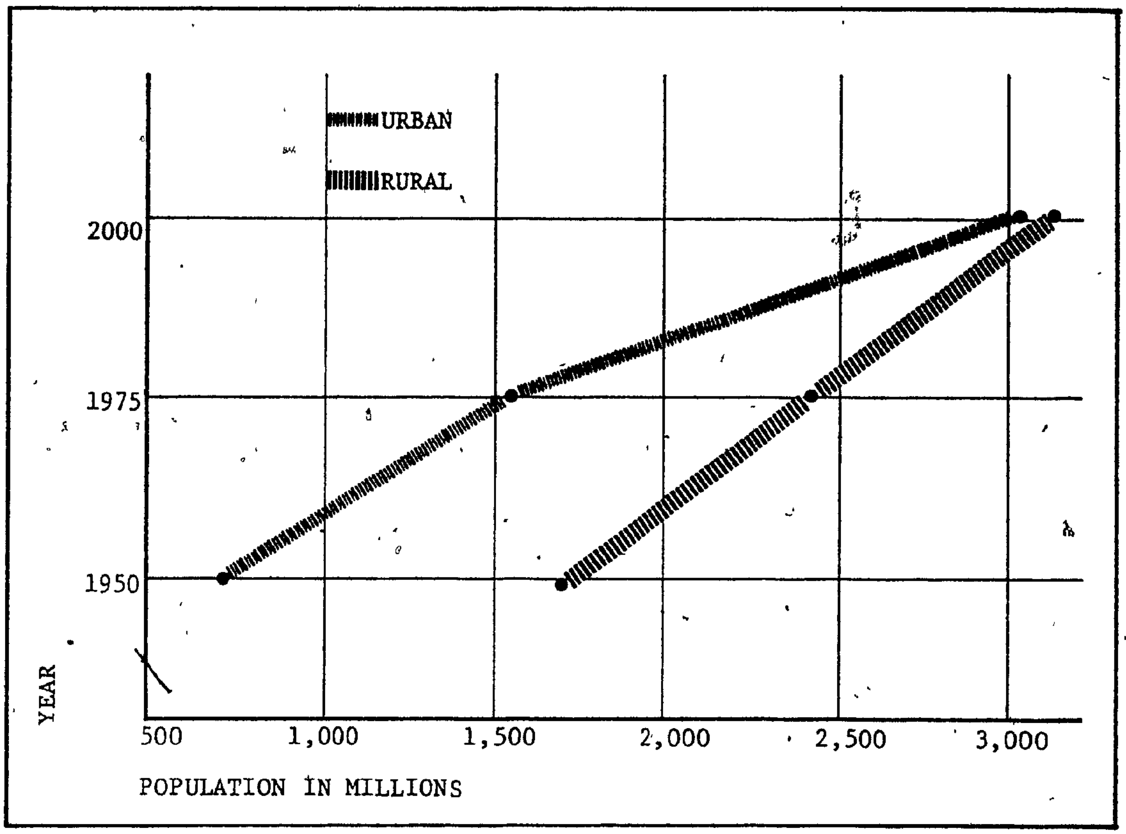
Urbanization in Africa

In sub-saharan Africa, urban growth and economic development are essentially twentieth century phenomena. The traditional form of settlement was the shifting village or hamlet which was mainly rural in character. The settlements that can by any definition be classified as urban places were settlements inhabited by chiefs who attracted some craft specialists around them; but such settlements can hardly be defined as urban by any internationally set criteria. Furthermore, with the advent of colonial rule, such settlements declined in status.[1] Most of the present urban centers in Africa are essentially the product of colonial rule and therefore urbanization in sub-saharan Africa was largely a response to the needs of colonial economic policy. Today African urbanization takes place within a variety of political frameworks and the diverse accompaniment of problems demand attention.

Africa was a late starter in the urbanizing process and remains the least urbanized of all the continents. Consequently Africa has the highest rate of urban growth in the world. Urban and rural population estimates of the world and Africa are presented in illustrations 1 and 2 respectively. Estimates indicate that urban growth represented in percent increase between 1900 and 1950 was 629 for Africa, 444 for Asia and 254 for the world at large.[2] However, the annual rate of urban growth in Africa between 1850 and 1950 was only around 3.9 percent compared with 2.6 percent for the world as a whole.[3] One of the reasons for this urban growth can be attributed to the migration of people from rural to urban centers for a variety of reasons. The rural to urban migration trend comprised about 51 percent of the increase in the total urban population in Africa for the period between 1970 and 1975.[4] Although migration is clearly a factor in Africa's urbanization process, it poses a different problem from that of the 1930's and 1940's when the urban population was necessary to supply the labour needs of industry.

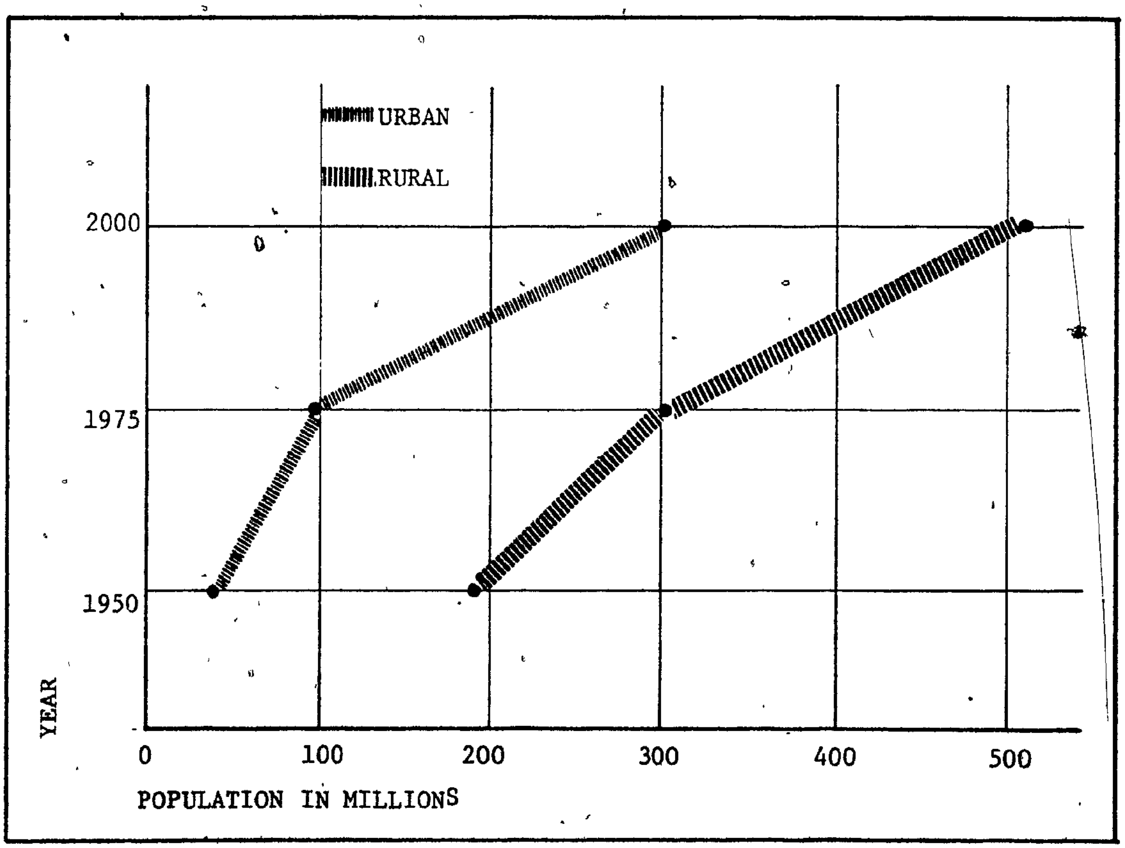
In the last twenty years, the population of most urban centers in Africa more than doubled, and in some cases tripled. For example, the urban population of Zambia grew approximately 21 times faster than the rural, and around 4 times faster than the national population between 1963 and 1974.[5] However, the difference in these growth rates is largely the result of migration from villages to urban centers. For example, 77.1 percent of Lusaka's growth could be attributed to migration for the years 1968-1969.[6]

The direct effect of this population increase in the urban centers was felt in the housing sector. Traditional methods of providing housing did not cope with the demand. The provision of housing is complex and requires heavy investments in infrastructure for related services.



URBAN AND RURAL POPULATION : WORLD [7]

Illustration # 1



URBAN AND RURAL POPULATION : AFRICA [8]

Illustration # 2

Housing Requirements

A continuous increase in the supply of housing stock is needed to cope with the increasing urban population. Failure on the part of concerned authorities to provide an ample supply of housing results in innovative solutions by people themselves. One such solution is the squatter settlement which is a feature common to all urban centers not only in Africa but throughout the developing world. In order to increase the supply of housing continuously, it is imperative that the concerned authorities have accurate estimates of housing requirements, adequate financial resources, technical capabilities and appropriate strategies.

It is estimated that the urban population during the period between 1960 and 1975 was around 76 million or 19.3 percent of the total population of Africa.[9] The total urban housing requirements for the same period are estimated to have been 11.4 million dwellings. Little is known about how well goals in urban housing were met for the period between 1960 and 1975, but it is calculated that from 8 to 10 dwellings per 1,000 inhabitants were needed to be constructed to meet the requirements. Fifteen of the 66 cities in Africa, with populations between 100,000 and 500,000 for which information was available, have a very high percentage of squatter populations ranging from 48 to 90 percent of the total population.[10] It is obvious from the high percentage of squatter populations that the housing requirements have not been adequately met.

Revised urban population projections suggest that by the year 2000 the urban population of Africa will be 301 million.[11] Accordingly the total estimated urban housing requirements will be approximately 50 million dwellings. To meet such a requirement with available financial resources, a gigatic effort will be needed. In order to achieve such an objective, it will be useful to examine briefly how efforts have been made to meet the total housing requirements chiefly by providing low-cost housing.

Low-cost Housing and The Serviced Sites Approach

The need to provide housing for the urban poor has long been recognized by governments in developing countries which are especially aware of the importance of housing to urban and national economies. The housing sector plays an important role in social welfare, thus a positive housing policy makes a substantial contribution to economic development and social welfare. Despite the importance of the housing sector, the housing conditions in many cities remain a major problem.

A decreasing proportion of the urban population has benefited from the efforts of urban housing authorities. Therefore a growing proportion of these urban populations have developed housing solutions in the squatter settlements which are outside the jurisdiction of the authorities responsible for meeting housing needs. The most common function of the squatter settlements has been to provide housing for the lowest income groups of the urban population. Squatter settlements provide shelter to the urban poor who need an inexpensive residence in or near the city.

Housing policies for the urban poor have typically stressed the public supply of fully serviced 'standard' housing units. The construction costs of such 'standard' housing units result in very high rental or financing costs that are much beyond the means of the majority of the urban population. The only way to make such policies operative is through subsidies but such subsidies do not allow replication of projects. Furthermore, the economies of developing countries cannot afford to provide subsidies.

The policy makers realized that urban growth continued to outstrip the public sector's ability to supply housing units. This understanding caused most countries in Africa to abandon complete reliance on conventional public housing methods in favour of the exploration of self-help approaches to urban shelter. The provision of serviced sites is one such approach.

The provision of serviced sites, widely known as the Site and Services programme, satisfies needs at many levels in that it stimulates maximum private involvement in shelter development with minimum public expenditure. For most developing countries this approach provides the only realistic method of substantially alleviating housing shortages. The Site and Services approach is discussed in more detail in the following section.

1.2 Site and Services Provision

The inefficient use of available resources is evident in existing patterns of urban development. This problem is well illustrated in the pattern of squatter settlements. More often than not, sites of squatter settlements prove both expensive and difficult to supply with necessary services: water supply, sewers and roads. Evidently, supplying services at a later date is more costly than directing the pattern of development through planning.

The alternatives as far as housing is concerned are two: (1) to provide complete dwellings to a few beneficiaries and (2) to provide utilities and services to a much larger sector of the urban population. In the latter case, the concerned authorities redirect their efforts in order to provide utilities and services on urbanized parcels of land. Such provisions are currently referred to as Site and Services programmes.

The construction of dwelling units which do not call for special skills or tools can be undertaken by individuals to suit their economic situation as is the case in many squatter settlements. The provision of services to a community demands more technical resources and more collective effort. Therefore, the construction of services will always be institutional.

Other Similar Concepts

The inception of the Site and Services concept can be traced to the dissatisfaction of the concerned authorities with the performance of their housing schemes in dealing with slum clearance, resettlement housing or low-cost housing. Housing policy makers were forced to rethink issues because their policies incurred financial problems and failed to achieve goals. One important concept that emerged from this reassessment was that a substantial part of low-income population can (and do) house themselves, without direct control or assistance from the government. The planners also realized that this construction could be directed relatively quickly, and controlled through legal ownership of land with the installation of urban utilities and services. The development of these two important ideas defines the basis for the present Site and Services concept. Tipple cites a very good example to illustrate that a site with a few urban services encourages people to construct their own permanent dwellings.

> "The extent of the demand for housing is indicated by a recent occurance in Kitwe (Zambia). 'Charlie West', a small contractors' settlement of 19 dwellings close to the official housing area, was provided with water at three standpipes by the council. Households in a nearby settlement, 'Kabulanda', were encouraged to move and resettle at Charlie West. A few households from elsewhere joined in the resettlement and, as the word spread, more flocked to the area from adjacent council low-cost housing. Political party officials 'allocated plots' and shopkeepers established businesses. The resultant settlement, four months after the first resettlement, numbered 1,800 dwellings under construction and was aptly renamed 'Ipusukilo' (meaning 'refuge'). The generally high quality of house construction indicates that the people feel secure and with subsequent upgrading, the area could form a useful addition to the official urban housing stock. This spontaneous grassroots movement added more dwellings to the housing stock of Kitwe than the city council had planned between 1971 and 1974."[12]

The example described above bears great similarity to the description of Sites and Services projects. By providing water pipes and allocating plots, the city council and the political party officials joined together to provide serviced urban land to a low-income section of the population.

Similar concepts have been presented or discussed and have even been implemented in some cases in different parts of the world. Although the details of each application vary slightly and are distinctive, they all bear a striking similarity to that of the Site and Services approach. The term "basic sites" is linked with the concept of Site and Services since provision is made for basic services only. Tipple has proposed a concept of planned informality.[13] It is so described because a square area large enough for 25 plots allows the group to grow informally, like existing squatter settlements, but each square is part of a gridiron pattern division which ensures economy in laying future services. Similarly the concept of urban villages also promotes informal growth, while retaining control to ensure the easy supply of services at a later date.

Meaning of Site and Services Projects

Site and Services projects are aimed at stimulating maximum private involvement in dwelling development using minimum public expenditure. Public expenditure and public action are directed to the goal of removing constraints for people who have demonstrated an ability and willingness to house themselves. Public expenditure and action provide land, infrastructure and in some cases building materials or financial loans to purchase such materials as are required for the construction of a dwelling. Serviced urbanized land is normally sold, or leased at long terms, to individuals or occasionally to groups. The construction of the actual dwelling is left to the individual. This opens the possibility of organizing self-help or mutual self-help or retaining small contractors such as brick layers, carpenters and artisans to build part or all of the dwelling unit.

In simple terms, Site and Services projects can be described as the development of land that is levelled and provided with access roads, drainage, water supply, sewers and electricity and sold or leased to the prospective resident who builds his own dwelling. The essential services of water supply, access roads, sewers and electricity together with street lighting may vary in degree and depend on the standards acceptable to the community. The site location for such a project is of critical importance in relation to its distance from places of employment and the main business district of the city. A Site and Services project is graphically explained in illustration no. 3.

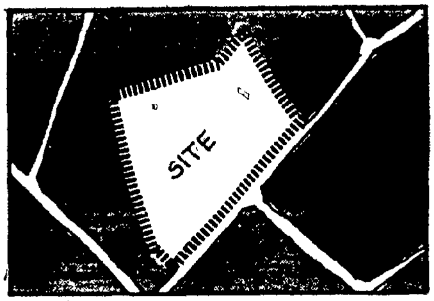
Since the development of a cohesive community cannot rely on the construction of housing alone, social amenities, communal services and the generation of employment should be considered in the eventual project. These services usually include schools, police posts, health centers, community halls, refuse collection service, markets and fire protection service.

In summary Site and Services projects are balanced programmes based on self-help and progressive improvement and, in this way, they are geared to the development of low-income communities.

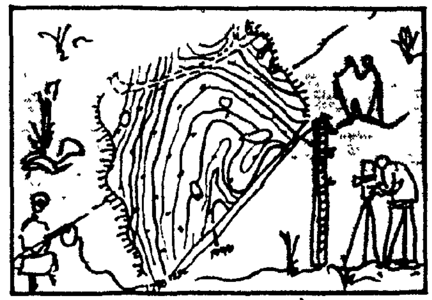
Standards of Services

Since Site and Services projects are designed to provide housing for low-income families, the development costs for such projects must be within economic limits. There are several factors which directly affect the costs of the final development. One of these factors is the degree to which services are provided. A higher level of services demands higher repayments and thus is cost prohibitive for low-income families.

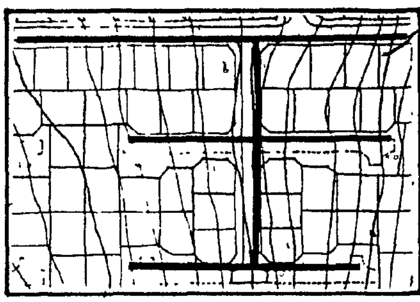
The highest standards of services may be fixed by the maximum affordable



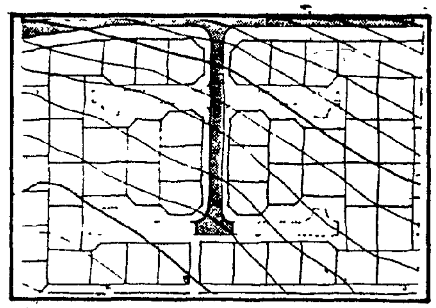
A PARCEL OF LAND



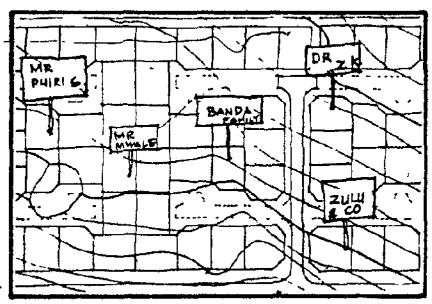
TOPOGRAPHICAL SURVEY



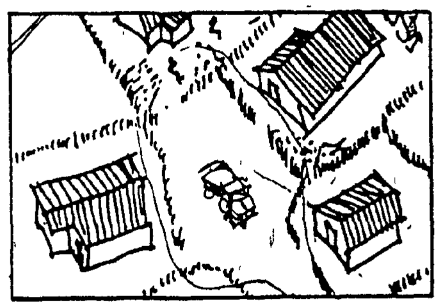
INSTALLATION OF SERVICES



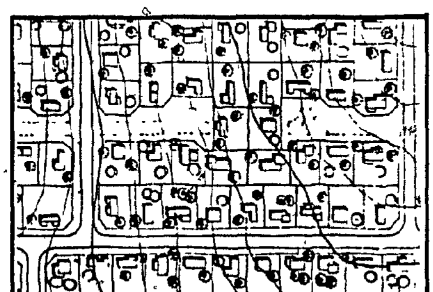
PREPARING ROADS



ALLOCATION OF PLOTS



INDIVIDUALS START CONSTRUCTION



A COMPLETED PROJECT

SITE AND SERVICES PROJECT

Illustration #3

costs and by the repayment requirements which can justifiably be borne by the target income level. Bearing in mind the factors affecting the absolute standards, most of the plots may have the following services in varying degrees:

1. Road access facilitating access to the place of employment either by foot or by public or private transport.
2. Water : either communal or individual supply.
3. Sanitation : pit latrines, sewered aquaprivies, cesspools, septic tanks or conventional sewer facilities.
4. Storm drainage : either by natural slopes with necessary culverts or by conventional storm drains.
5. Electricity and street lighting : minimum security street lighting and access for individual electrical connection if desired by the resident.

It is to be noted that only infrastructural services are dealt with at this point. Social services are equally important, but detailed discussion of these lies outside the scope of this thesis.

Earlier attempts at Site and Services projects were aimed at reaching not far below the median level of family incomes. Hence, they were comparable to conventional public housing schemes. These projects have since been refined and aimed at urban families with much lower income levels. However, they still do not reach the poorest 20 percent or so of the urban population.[14]

Evidence in Zambia has indicated that the fully serviced plots, or those serviced at the regular standards (see Appendix : A), cost more than the budget allows, and more than the prospective residents can afford. The available financial outlay itself prohibits the use of such standards if the planned number of plots are to be provided. As a result, the National Housing Authority of Zambia reported that the second national development plan (1972-1976) could attain only about 40 percent of the planned target for the provision of serviced sites indicating that the main reason is the shortage of funds.[15] Evidence in Zambia shows that the levels set for the services normally cost more than the available finances allowed. In this case, since the financial outlay was constant and known, it would have been useful to correspondingly revise the level of services to be provided to match it. The levels of services to be provided or the services themselves could have been checked. It is apparent that such revisions did not take place and hence it was impossible to achieve the target. Another important factor in reducing cost is the optimization of the layout. Caminos and Goethert have prepared a thorough study of services and summarized their findings:

> "The conclusions that can be derived from them (studies on infrastructure) are not new, but they provide an element of credibility since they are substantiated by numbers. Some conclusions are:
>
> d) Two approaches to minimize costs are: 1) To lower the level of services, which is a policy decision. 2) To optimize the layout for required level, which is a design decision."[16]

For a case in Zambia, Martin concludes from his studies that the serviced plots were too expensive for 32 percent of the population.[17] This undoubtedly excluded a significant portion of the urban poor. Thus a still cheaper solution is required.

In conclusion, it can be said that the Site and Services concept has potential for expansion provided that the standards of services are viewed more critically.

Role of Services

Essential services such as access roads, water, sanitation and electricity constitute a major portion of expenses representing 40 to 60 percent of the total costs where this total includes land, servicing, plot development, design and supervision costs. The higher standards of services will result in higher development cost, but with limited available financial resources, only a very small sector of the target population can benefit. The intention of minimizing the initial investments can best be accomplished by lowering the standards of services initially, and permitting progressive improvements to match the economic situation. Thus lowering the standards of services at the initial stage means postponing, not changing the standards.

By providing affordable standards of services at the initial stage, public authorities can allocate any extra capital to other programmes while reducing the costs related to the upgrading of services. Hopefully, in the meantime, continuous upgrading of the sites rather than their instant but costly development will take place.

There is a need to examine how to lower the standards of services at the initial stage of Site and Services projects. The following chapter examines this possibility and identifies practical options applicable to these services.

CHAPTER : 2 SERVICING OPTIONS

2.1 General

The role of services in Site and Services projects has been discussed in the preceeding chapter. It was noted that lowering the standard of services provided will substantially reduce development costs.

In many African countries attempts to provide serviced plots have been partially successful in allowing the urban poor to build their own dwellings. Many international agencies have provided financial aid and technical help to countries in Africa. In the 1970's, the World Bank alone undertook more than 30 such urban development projects in the developing world.[18] In the last seven years, basic urbanization projects costing some US $ 1.3 billion have been processed with benefits expected to go to over 10 million people.[19]

Between 20 to 58 percent of low-income families are still unable to afford any sort of official accomodation.[20] To put housing within the reach of these people it is essential to develop ways of reducing costs within an affordable range. The idea of reducing standards of public housing needs to be applied to Site and Services projects themselves. The servicing standards ought to be reduced to an affordable level.

This chapter examines affordable standards of services. These affordable standards of services are called options. The options discussed in this chapter are identified by the author and are based on the experience gained in Lusaka, Zambia and use the methodology developed by the World Bank. The options elaborated are best suited for the chosen example, but not necessarily the only options.

The options discussed in this chapter do not contain any dollar costs. They are presented in the third chapter with a prototype layout. However, the options are grouped in three general cost categories : (1) Minimum cost (2) Intermediate cost and (3) Conventional or standard cost.

2.2 Servicing Options

The conveniences of urban life depend on related social,political and economic systems, on land and shelter and also on a complex system of service networks. Some networks (water supply, sewers, storm drainage or gas supply) are buried in the ground, some networks (refuse collection, police stations, schools, health centers and markets) are laid on the ground and other networks (electricity, telephones or street lighting) are suspended in the air.

The levels of these services provided to a particular community depend on that community's capacity to pay their costs and on financial resources and on technical know-how available. Some communities can afford to have all services while others cannot afford any of them. Site and Services projects require the provision of all of these services to a varying degree. Their cost determine the level of services which these communities can install. The prospective beneficiaries of such projects are low-income families with very small means.

The following services are normally provided in the Site and Services projects:

1. Water Supply:

   Most existing Site and Services projects provide for a piped water supply connection to individual plot. Some projects have tried to provide communal water supply (i.e. a group of plots share a public standpipe).

2. Sanitation:

   Water borne sanitation facilities are appreciated but the costs are prohibitive in many cases. Hence, septic tanks or in some cases simple pit latrines with or without soak pits are provided.

3. Roads and Storm Drainage:

A tarmac road to individual plots is preferred but again the expenses are so prohibitive that quite often only the main road with access to important urban areas is surfaced with tarmac. In most cases, storm drainage is provided by open drains following the natural slope of the site with culverts where required.

4. Electricity and Street Lighting:

Provision is made to have individual electrical connections and security lighting on the streets at a rate of 2 to 5 lamp posts per hectare or at intersections only.

These four services constitute a large portion, usually around 50 percent, of the total project costs. However, there is greater opportunity to reduce the costs of these four services than any other components of Site and Services projects. The total project cost also includes site preparation cost, land cost, plot development cost, design and supervision cost and contigency cost of between 10 to 12 percent.[21]

An analysis of completed Site and Services projects indicates that the cost of supplying water according to conventional standards represents on the average 20 to 30 percent of the total on-site infrastructure costs.[22] The cost of providing a water borne sewer system on the average represents 40 to 50 percent of the total on-site infrastructure costs. In order to provide surface storm drains and tarmac roads the average cost amounts to about 30 to 40 percent of the total on-site infrastructural costs. It is especially important to bear in mind that the economically optimum layout of roads can play a very important role in the cost factor. To provide street lighting at the rate of 2 to 5 lamp posts per hectare, the cost on the average represents between 10 to 15 percent of the total on-site infrastructure costs.

At this point a distinction is made between servicing standards and servicing options. The aim of servicing standards is to supply the service at a certain standard irrespective of the costs. The aim of servicing options is to minimize the initial investment that is required to provide services. This must allow future improvements without repeating or destroying existing installations. Thus the servicing options imply a postponement of the installation of services at an acceptable standard and do not mean that the servicing standards are irrevocably lowered. The concept of servicing options also recognizes the potential for incremental improvement through an efficient use of available resources.

2.3 Water supply Options

Water for drinking, cooking, washing and hygienic purposes is an essential element of a healthy and productive life. Most squatter settlements place a high priority on securing a regular supply of safe and potable water. Any new Site and Services projects must have access to adequate water supply.

Water supply requirements can be met by many available methods such as by means of securing a connection to an existing water supply network, water wells or delivery of water either by truck, animal or human transport. Distribution from the available water main is of great relevance to the on-site infrastructure works, as this is the normal practice found in most cases. To have water wells one must make sure that the underground water will yield enough water to meet daily needs. Sometimes water is drawn from lakes or rivers but other sources of water supply are not too common.

The quantity and quality of water to be supplied are the principal cost determinants for the on-site water supply system. The quantity of water used largely depends on the standard of living, level of charges, traditional and local conditions and on the kind of water supply that is available. An investigation made in East Africa by White, Bradely and White suggests that low-income families use an average of 30 liters of water per capita per day when the water supply is piped within the plot.[23] The usage decreases to 15 liters per capita per day when the family carries water from a distant source. Illustration no.4 indicates the daily use of water for different places.

PER CAPITA RESIDENTIAL WATER USE IN SELECTED AREAS

Country	Place	Estimated Daily Use per Capita in liters	Source	Year
Urban multiple taps or mixed use				
Developing nations	Several hundred	11-930	Dietrich and Henderson 1963, p 28	
Costa Rica	2 metered cities	264-388	Wielers, Zobel, and Henderson 1959	1958
	7 unmetered cities	215		1959
	34 flat rate cities	444		
Ghana[a]	Accra High grade housing	675	Tahal 1966	1965
	Medium grade housing	165		
	Low grade housing	34		
	Substandard housing	27		
	Tema High grade	342		
	Medium grade	265		
	Low grade	108		
Greece		144	Panastasiou 1967	1965
India	Kalyani	113	Lee 1968	1964
	New Delhi	136		
Japan[b]	Osaka	520	Japan 1967	1966
	Yokohama	395		
	Tokyo	348		1966
	Kobe	328		1966
	Kyoto	317		1966
Kenya	Nairobi	90	City council report	1968
South Africa	Cape Town	144-53	Cluver n d., p 29	c 1953
	Johannesburg	158	Morris 1967	1965
	Queenstown	225		
	Pretoria	239		
	Durban	243		
Taiwan	Urban pop 50,000	245	Fung 1967	
Tanzania	Dar es Salaam (all supplies)	81	Tanganyika Ministry of Communications, Power, and Works 1964	1962
	Dodoma	86		
	Moshi	202		
Turkey	Greater Istanbul	108	Noyan and Senogullari 1967	1965
Uganda	Kampala	72-338	Scaff 1964 p 180	
	All municipal supplies	202	Uganda Protectorate 1960/61	
UK	Bradford	544	Skeat 1961, p 56	1958
	Tees Valley	126	ibid	1958
	Birmingham	99	ibid., p 69	1958
	Glasgow	212	ibid	1959
	Liverpool	126	ibid	1958
	London	162	ibid	1959
US	All cities	227	U S Senate 1961 7	1960
	Towson, Md rental	190	Johns Hopkins Report 1 2-16	1959-62
	Residence value, $14 000	194		
	Residence value $19,000	214		
	Residence value $37,000	247		
Uruguay	Montevideo	176	Castagnino 1966	1964
	Punta del Este	447		
	All other towns	130-270		
Zambia	Mazabuka	27	G Marais 1966 personal communication	
	Lusaka Suburban African	13-50		
Single taps				
Guatemala	Single automatic tap systems	60	Ans 1967	1966
Paraguay	Asuncion pilot area single taps	28-49	Borjesson and Bobeda 1964 p 858	1964
Pakistan	Comilla pilot area single automatic taps	16	East Pakistan Water and Sewer Authority 1968	1968
Urban standpipes				
India	Calcutta standpipe or pump	30	Lee 1958	1964
Turkey	Greater Istanbul	15	Noyan and Senogullari 1967	1965
Uganda	Kampala	14	Scaff 1964 p 32	
Venezuela		15	Dieterich and Henderson 1963, p 28	
Rural Connected				
Republic of China	Rural area (with water systems)	50	Fung 1967	
West Germany	Rural systems	83	Schickhardt 1967	
Not connected				
Bolivia	Seven villages	10	Teller 1969	1968
Kenya	Zaina	7	Fenwick	
Nigeria	Anchau District	23-27	Nash 1948	1948
Sudan	Kordofan	9-16	FAO Land and Water Survey 1967, p 238	1967
Tanzania	26 villages in 10 districts	5-26	Warner 1969	1968

[a]Estimates of household use for accra were based on metered observations at six standpipes and five households for two months. Tema 282 housing units were studied for two weeks

[b]Includes industrial uses

'Illustration #4

The level of water supply will determine the cost of infrastructure. The normal standard is to have connection to each plot. The diameter of pipes to be laid for reticulation is also a major cost factor. The quantity of water to be supplied will determine the diameter of pipe which in turn affects the cost. The greater the diameter of the pipe, the greater the cost will be. A larger water supply requires a larger pipe diameter. The choice of material for the pipe is another factor to be considered. On the average, water supply cost represents 20 to 30 percent of the total on-site infrastructure costs.[24] Illustration no.5 indicates the comparable costs for water supply for different Site and Services projects.

Keeping in mind the cost factor, the prospective resident's ability to repay and the convenience of the utility, the following water supply options have been developed.

Water Supply Option: Minimum Cost

The minimum cost option assumes a communal source of water supply, which is a standpipe with the required number of tap outlets (this option assumes that the connection to an urban water supply network is available). An alternative is a well with an overhead reservoir, suitable pumping facilities and outlets through a standpipe (this option assumes that a connection to the urban water supply network is not available). Illustration no. 6 graphically represents both of these options. Minimum cost level has been achieved through the reduction in reticulation network. Pipes laid would carry ultimate design quantities to reach conventional or acceptable standard. The standpipe should be located so that the maximum walking distance form the farthest dwelling is 200 meters.

ON–SITE INFRASTRUCTURE COSTS PER PLOT: WATER SUPPLY (1974) 26

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$
NICARAGUA	2,750	110	Individual connection, 65 1pd	80 0
SENEGAL	11,900	150	Communal standpipe, 1 per 100 Hsehlds	10 4
	2,100	150	Individual connection	49.5
	1,600	200	Communal standpipe, 1 per 100 Hsehlds	13 5
INDONESIA	12,866	80	Individual connection	33.8
	4,425	140	Individual connection	57 4
	23 600	110	Communal standpipe, 1 per 6 plots	30.0
JAMAICA	785	94	Individual connection	88.9
	785	94	Individual connection	88.9
	785	94	Individual connection	88 3
BOTSWANA	1,100	375	Communal standpipe, 1 per 20-25 plots	34.0
	305	375	Communal standpipe, 1 per 150m radius	38 0
	–	–	Individual connection	105 0
	–	–	Individual connection	106.0
ZAMBIA	7,600	210	Communal standpipe, 1 per 25 Hsehlds	51.5
	1,200	324	Communal standpipe; 1 per 4 Hsehlds	168 5
	1,200	324	Individual connection	171 0
	1,084	324	Individual connection	127.7
	868	324	Individual connection	96 6
	1,977	165	Individual connection	52.2
	114	324	Communal standpipe, 1 per 2 3 plots	53.8
	858	324	Individual connection	57.8
	858	370	Communal standpipe, 1 per 37 plots	37.1
	717	370	Communal standpipe, 1 per 20 plots	53 6
	307	370	Individual connection	53.9
	278	370	Individual connection	60 4
	100	370	Individual connection	45.1
INDIA	1,000	70	Individual connection, 200 lpd	156 0
EL SALVADOR	5,100	60	Individual connection	n.a
	2,900	120	Individual connection	n.a
	508	60	Individual connection	32.6
	235	60	n.a.	
	62	66	n.a.	
TANZANIA	5,370	265	Individual connection, 150 1pd	69.2
	5,370	265	Communal standpipe, 1 per 10 plots	55 9
	5,370	265	Communal standpipe, 1 per 50 plots	24 5
	12,100	260	Communal standpipe 1 per 50 plots	39 9
	2,300	260	Communal standpipe, 1 per 50 plots	47 5
	2,000	230	Communal standpipe, 1 per 50 plots	44.8
	8,050	260	Communal standpipe, 1 per 50 plots	39 5
KENYA	500	126	Individual connection	57 1
	375	126	Individual connection	28 6
	104	126	Communal standpipe 1 per 20 plots	14 3
	723	167	Individual connection	54 0
	100	326	Individual connection	34 1
	110	188	Individual connection	57 0
	42	296	Individual connection	35 0
	94	242	Individual connection	42 6
	4,200	120	Individual connection	48 0
COLOMBIA	3 500	80	Individual connection	107 5
	3,500	80	Individual connection	107 5
	2,800	140	n.a.	
	475	140	Individual connection	n.a
	757	140	Communal standpipe	n.a
CHILE	–	170	Individual connection	169 0
ECUADOR	9 280	120	Communal standpipe	n.a
KOREA	507	116	Individual connection	n.a
	145	165	Individual connection	n.a
	73	248	Individual connection	n.a

% OF TOTAL URBANIZATION COST OF ON–SITE INFRASTRUCTURE

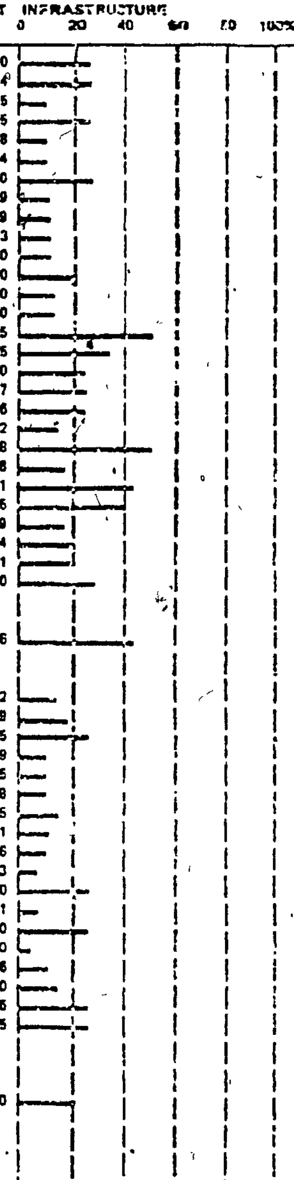
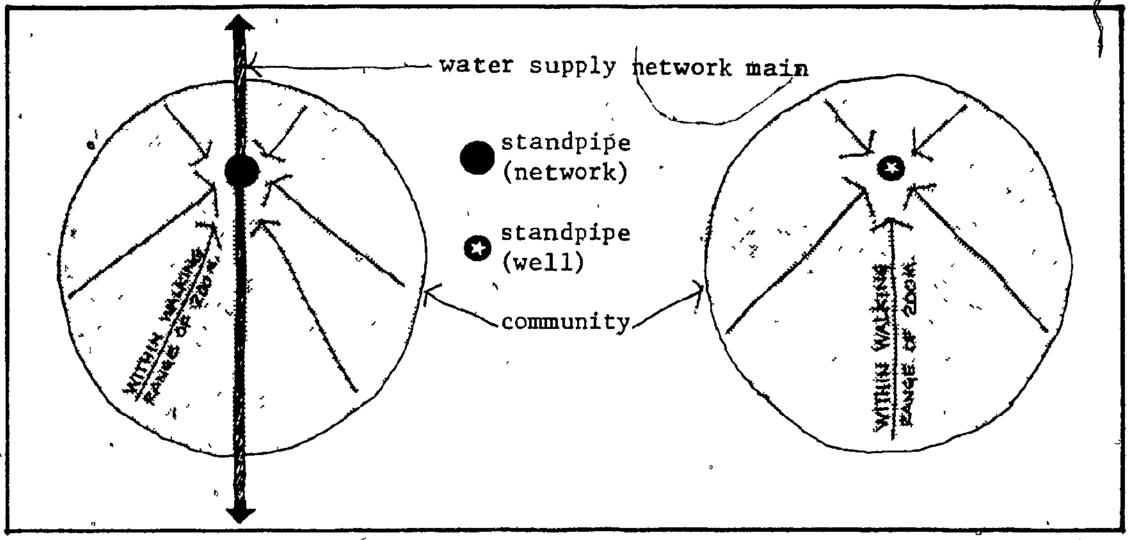


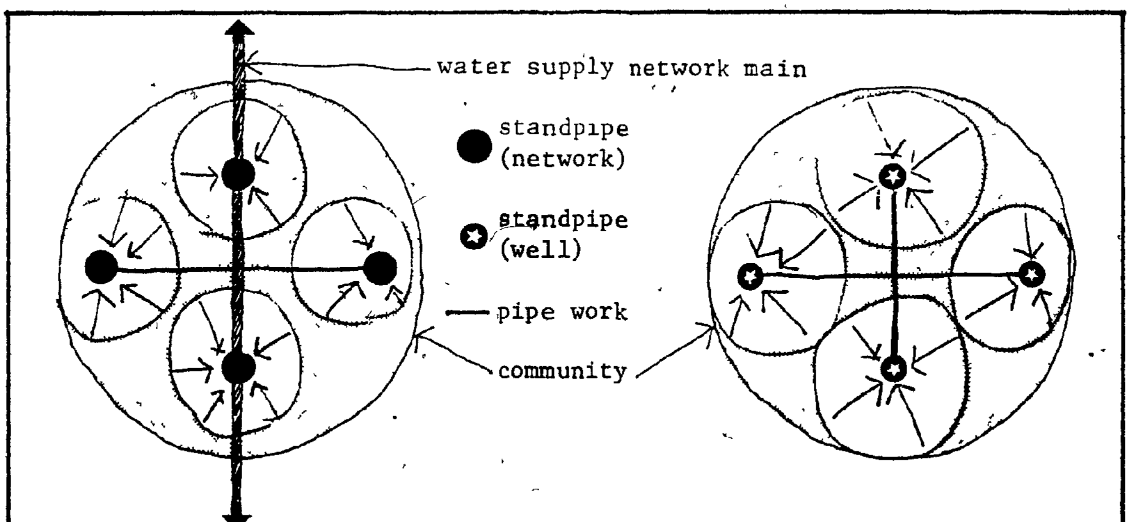
Illustration #5



WATER SUPPLY OPTION : MINIMUM COST Illustration #6

Water Supply Option: Intermediate Cost

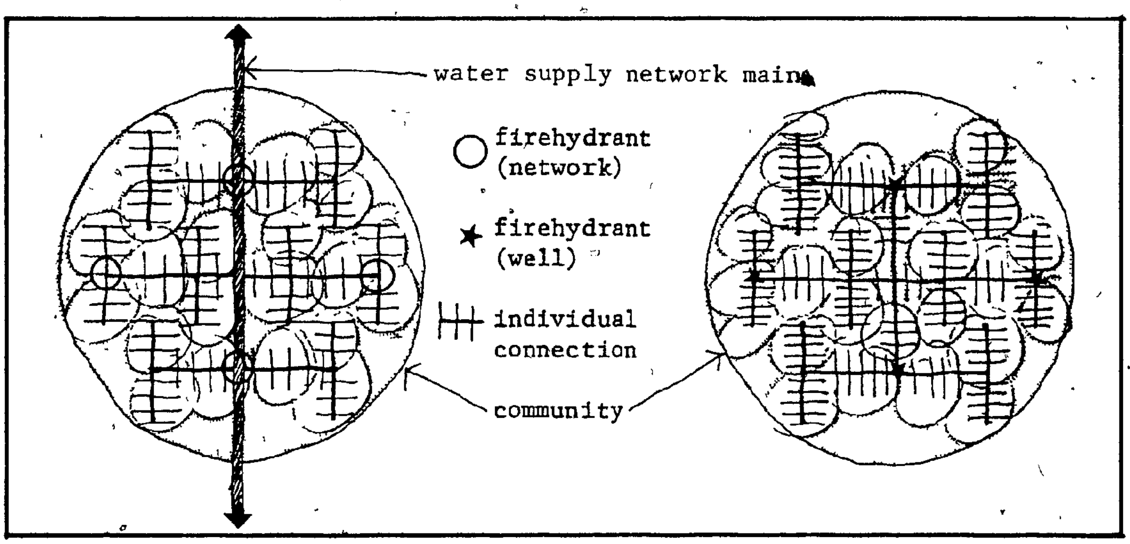
This option is based on a communal water supply system but the number of families sharing a standpipe is reduced. Since a greater number of standpipes are provided walking distances are reduced thus greatly increasing their convenience. The required pipe work is extended. There can be more than one stage of incremental progress at this level. Illustration no.7 graphically explains this option.



WATER SUPPLY OPTION : INTERMEDIATE COST Illustration # 7

Water Supply Option: Conventional or Standard Cost

This option conforms to the conventional standard of water supply where individual pipe connections are provided for each plot. Previously laid pipes contribute to this option. To achieve this stage only additional work is required without redundancies. Existing standpipes are converted into public firehydrants.



WATER SUPPLY OPTION : CONVENTIONAL

Illustration # 8

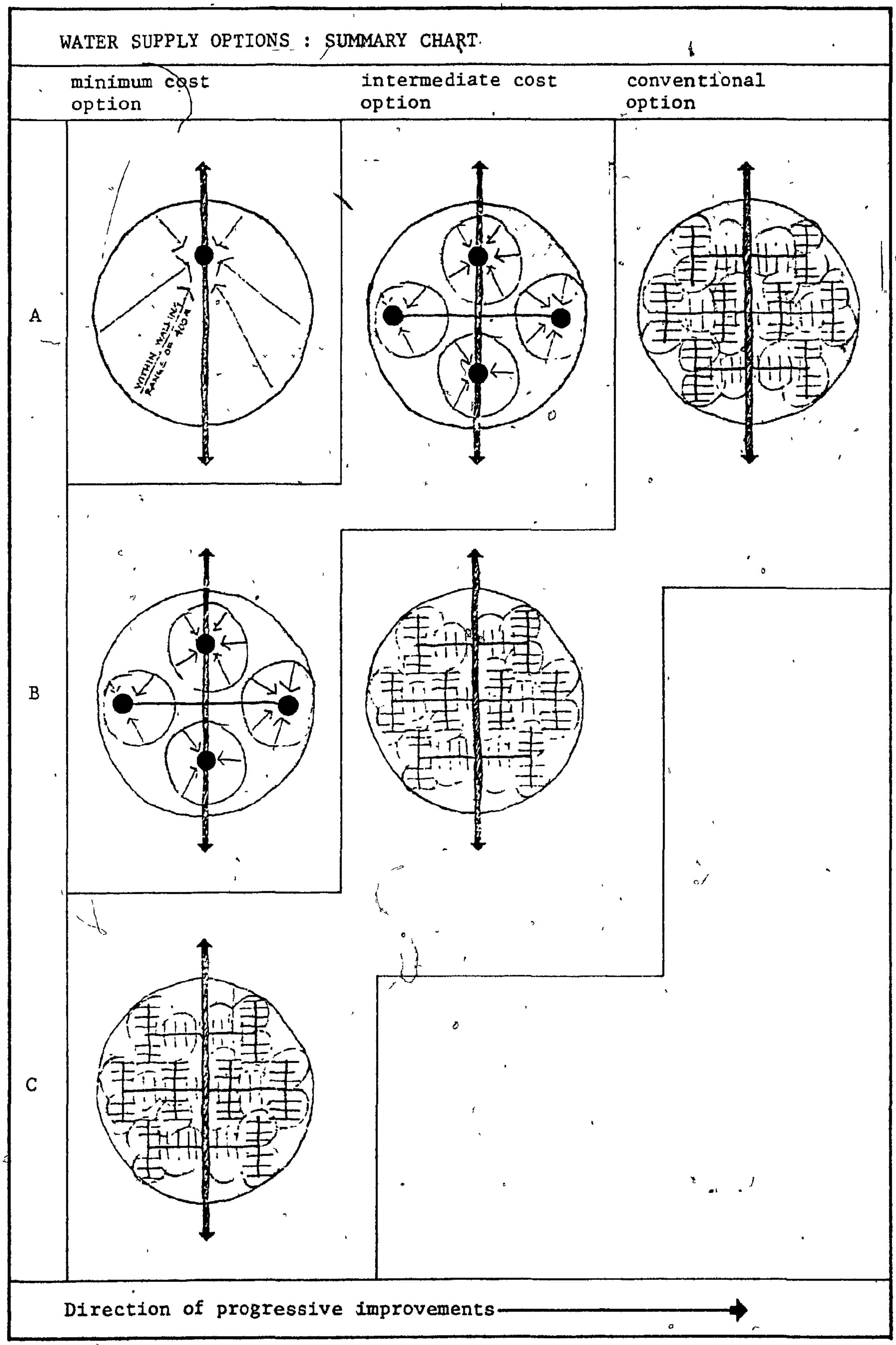


Illustration # 9

2.4 Sanitation Options

Proper sanitation facilities are very important for the maintainance of public health. Poor sanitation facilities are one of the prime causes of the spread of diseases like hookworm, diarrhea, enteritis, cholera and typhoid. Therefore, the objective of sanitation options is to efficiently and hygienically dispose of human waste in such a way that waste disposal does not pollute or spread diseases and does not contaminate drinking water resources. It must also be done at a price the user can afford.

Sanitation requirements can be met by one of many systems that are known today, such as : by means of a connection to an existing network of sewers or developing a new system of sewers or using one of the on-site systems for the disposal of human waste. The method chosen will depend not only on available financial resources but also on the availability of water and porous ground conditions. Conventional sewers are more costly than any of the on-site systems described later. The infrastructure costs of sewers represent on the average 40 to 50 percent of the total on-site infrastructure costs.[27] Illustration no.10 indicates the comparable costs for sanitation systems in different Sites and Services projects. Communal facilities for sanitation are difficult to maintain and highly unpopular. Experts on the subject are opposed to the provision of such facilities except in unavoidable circumstances.[28]

In order to minimize initial investments, the incremental progress approach is to be followed eventually leading to conventional standard of sewers. However, a recent study concluded that a sewer system is not likely to be the most cost effective solution of human waste disposal for most situations

ON–SITE INFRASTRUCTURE COSTS PER PLOT: SEWERAGE (1974)[29]

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON–SITE INFRASTRUCTURE 0 20 40 60 80 100%
NICARAGUA	2 750	110	Individual connection, waterborne	100.0	
SENEGAL	11,900	150	Self-dug pit latrine on each plot	10.6	
	2,100	150	Individual connection septic tank	391 0	
	1 600	200	Self-dug pit latrine on each plot	17.2	
INDONESIA	12,866	80	Individual connection, waterborne	150 4	
	4,425	140	Individual connection, waterborne	263 2	
	23,600	110	Self-dug pit latrine on each plot	–	
JAMAICA	785	94	Individual connection, waterborne	153 6	
	795	94	Individual connection, waterborne	153 6	
	785	94	Individual connection, waterborne	153 6	
BOTSWANA	1,100	375	Individual aqua privy units	182 0	
	305	375	Individual aqua privy units	92 0	
	–	–	Individual connection waterborne	511.0	
	–	–	Individual connection waterborne	504 0	
ZAMBIA	7,600	210	Self-dug pit latrine on each plot	–	
	1,200	324	Self-dug pit latrine on each plot	–	
	1,200	324	Individual connection waterborne	334 0	
	1 084	324	Individual Connection waterborne	234 4	
	868	324	Individual Connection waterborne	157 4	
	1,977	165	Individual Connection waterborne	223 6	
	114	324	Self-dug pit latrine on each plot	–	
	858	324	Individual connection, waterborne	153.9	
	858	370	Self-dug pit latrine on each plot	–	
	717	370	Self-dug pit latrine on each plot	–	
	307	370	Individual connection waterborne	159 2	
	278	370	Individual connection waterborne	94.2	
	100	370	Individual connection waterborne	111 2	
INDIA	1,000	70	Individual connection waterborne	227.5	
EL SALVADOR	5,100	60	Individual connection waterborne	n.a	
	2,400	120	Individual connection, waterborne	n.a	
	508	60	Individual connection, waterborne	31 1	
	235	60	n.a		
	62	66	n.a		
TANZANIA	5,370	265	Individual connection waterborne	171 4	
	5,370	265	Improved pit latrine on each plot	98 9	
	5 370	265	Communal pit latrine	14 3	
	12,100	260	Individual aqua privy units	119 0	
	2 300	260	Individual aqua privy units	130 9	
	2 000	280	Individual aqua privy units	137.2	
	8 050	260	Individual aqua privy units	59 5	
KENYA	500	126	Individual connection waterborne	147 9	
	375	126	Individual connection waterborne	114 3	
	104	126	Communal waterborne 6 per 20 plots	57 1	
	723	157	Individual connection waterborne	71 0	
	100	326	Individual connection septic tank	180 0	
	110	188	Individual connection waterborne	143 0	
	42	298	Individual connection waterborne	84 0	
	94	242	Individual connection oxidation pond	260 6	
	4 200	120	Individual connection waterborne	113 4	
COLUMBIA	3,500	80	Individual connection waterborne	118 9	
	3 500	80	Individual connection waterborne	118 9	
	7 800	140	n.a		
	475	140	n.a		
	757	140	n.a		
CHILE	–	170	Individual connection waterborne	140 0	
ECUADOR	9 220	120	Individual pit latrine	n.a	
KOREA	507	116	Individual connection waterborne	n.a	
	145	165	Individual connection waterborne	n.a	
	73	248	Individual connection waterborne	n.a	

Illustration #10

in developing countries.[30] This system is the effective solution in high density, westernized cities.

Several methods are used to classify waste disposal systems, but the most useful for Site and Services projects is to differentiate between on-site or household systems and off-site or community systems. On-site systems do not require organizational actions while off-site systems normally do. Illustration no. 11 indicates the comparative costs of each system. On-site technologies have been classified into the following five categories.[31]

1. Pit latrines
2. Pour-flush toilets
3. Composting toilets
4. Aquaprivies
5. Septic tanks

1. Pit latrines

Pit latrines have three components: a pit, which is covered with a squatting plate or a seat and a superstructure. There are a few improved versions of the pit latrine which provide a vent pipe to prevent flies and odour. Sometimes the superstructure is displaced from the pit. Liquid wastes infiltrate the ground while solids accumulate in the pit and partially decompose over time. The pit is discarded or emptied when it is full. The pit is usually 3-7 meters deep and one meter across. Pit volume may be calculated at the rate of 0.06 m^3 per person per year. Thus it may take 6-7 years for a pit for a family of five to become non-usable.

Pit latrines are recommonded for low and medium density areas (up to 300

Summary of Total Annual Costs per Household 32
(1978$)

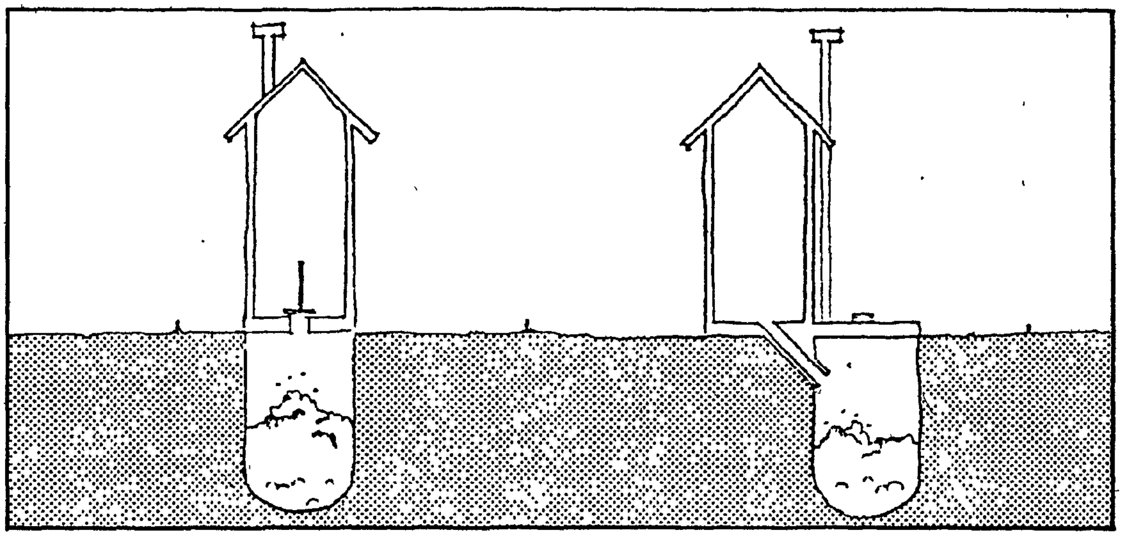
	Number of Observations	Mean	Median	Highest	Lowest
Low Cost					
Pour flush toilet	3	18.7	22.9	23.3	10.1
Pit latrine	7	28.5	26.0	56.2	7.6
Communal septic tank /1	3	34.0	39.0	48.0	15.0
Vacuum truck cartage	5	37.5	32.2	53.8	25.7
Low Cost septic tanks	3	51.6	45.0	74.5	35.4
Composting toilet	3	55.0	56.2	74.6	34.3
Bucket cartage /1	5	64.9	50.3	116.5	23.1
Medium Cost					
Sewered aquaprivy /1	3	159.2	161.4	191.3	124.8
Aquaprivy	2	168.0	168.0	248.2	87.7
Japanese vacuum truck cartage	4	187.7	193.4	210.4	171.8
High Cost					
Septic tanks	4	369.2	370.0	390.3	306.0
Sewerage	8	400.3	362.1	641.3	142.2

/1 To account for large differences in the number of users, per capita costs were used and scaled up by the cross-country average of 6 persons per household.

Illustration #11

persons per hectare). It is customary to have 3-5 meters distance from the house to the latrine. If nearby ground water is used for drinking, the pit should be around 30 meters away from the source, depending on the soil conditions. The construction of the pit latrine depends chiefly on the porosity of the ground.

Pit latrines as a system of sanitation are the least expensive, the easiest to construct, and provide the best opportunity for upgrading to pour-flush toilets.



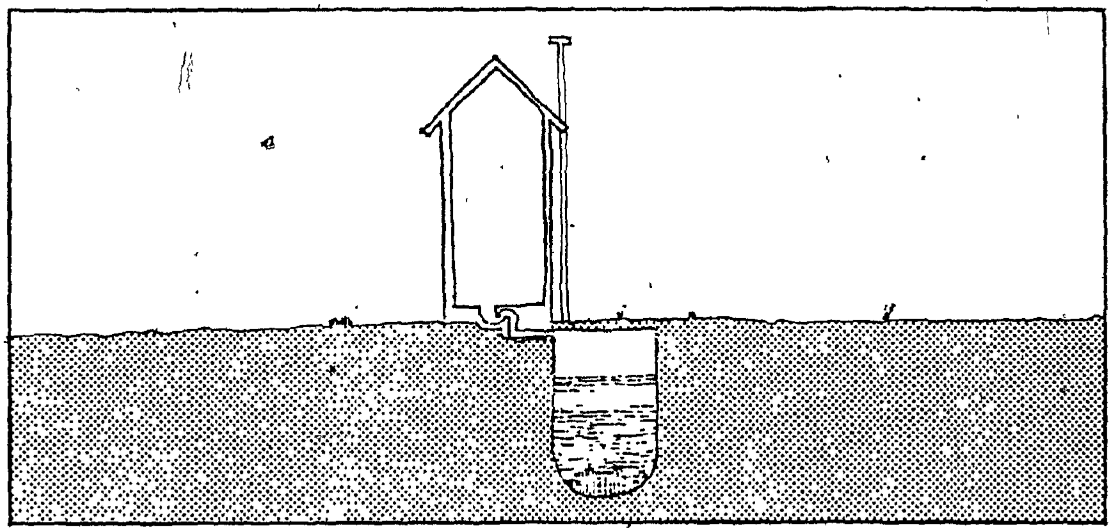
PIT LATERINES

Illustration #12

2. Pour-flush toilets

A modified version of the pit latrine with displaced pit and a water seal which prevents flies and odour, is the pour-flush toilet. Many varieties of pour-flush fixtures are available in plastic, ceramic or concrete. About a litre of water is added to the bowl after every use.

Three to six liters of water per day is required for a pour-flush toilet. This system depends on sufficient soil porosity for infiltration, and like the pit latrine it is recommended for low density settlements. Pour-flush toilets allow indoor location of the toilet, as they can be connected to an offset pit outside and have potential for upgrading to an aquaprivy.

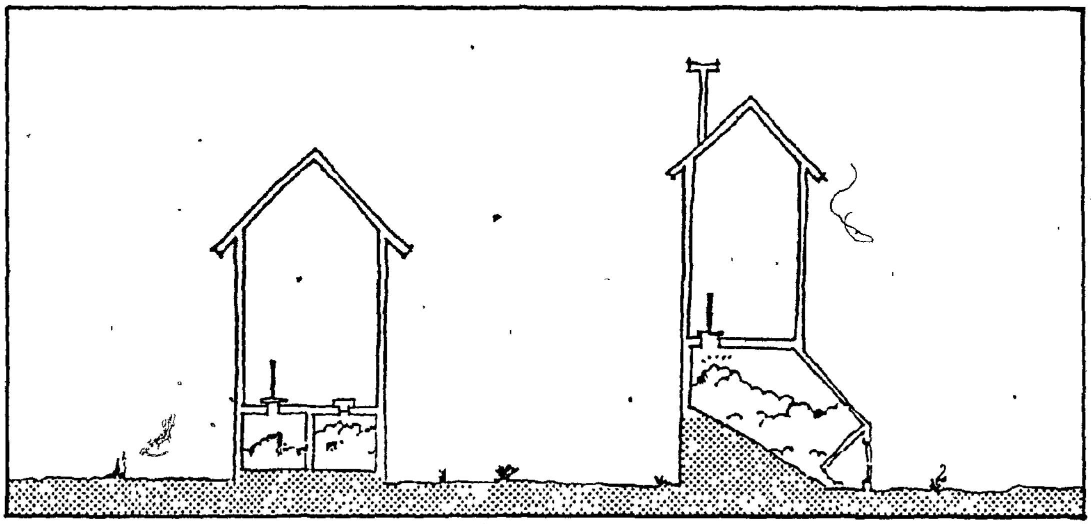


POUR-FLUSH TOILETS Illustration #13

3. Composting toilets

Similar to pit latrines, composting toilets have a compartment for composting where excreta undergoes aerobic or anaerobic biological decomposition. They are either continuous or batch type, which use one or two compartments respectively. Carbon containing organic materials is added to promote composting. More recent and sophisticated continuous type composting toilets, developed in Sweden, have one sloped compartment.

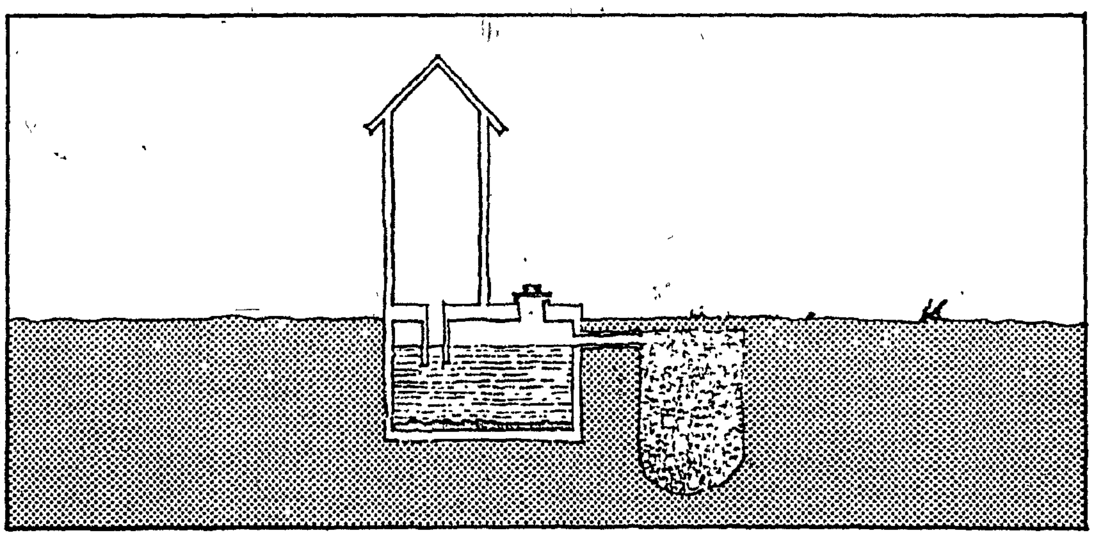
This system requires ~~the~~ periodic removal of humus which can be recyled as fertilizer. The separation of urine in certain types of toilets helps to speed up the decomposition process.



COMPOSTING TOILETS Illustration # 14

4. Aquaprivies

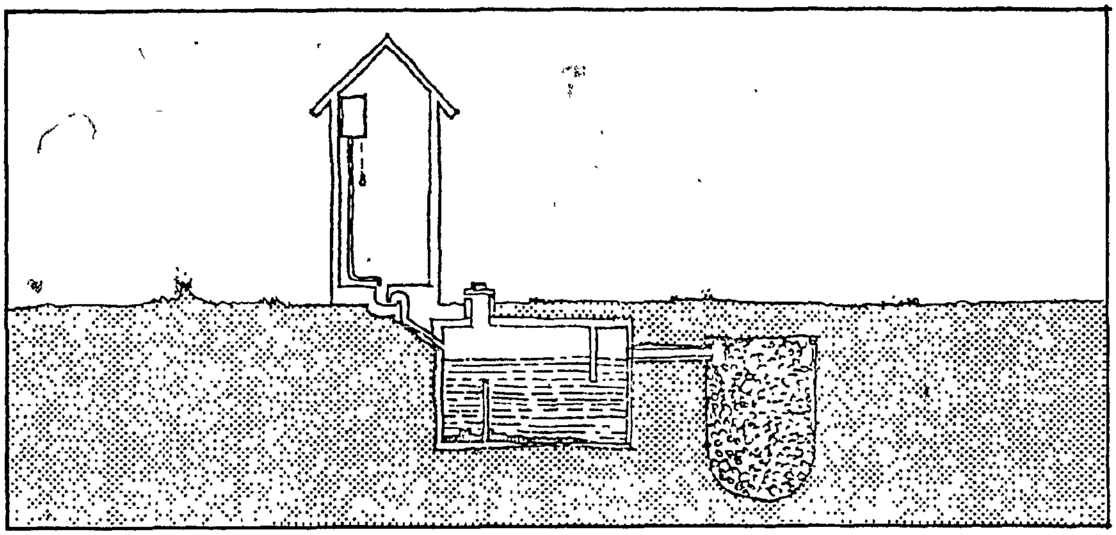
The aquaprivy has a small tank resembling a septic tank with an adjacent soak pit. The water seal contains a drop pipe that is submerged in the water in the tank. The seal prevents odour and inhibits insects from breeding. The tank requires desludging periodically (every 2-3 years). Aquaprivies have the same limitations as pit latrines with respect to soil porosity. Aquaprivies permit eventual connection to a small diameter sewer.



ACQUAPRIVY Illustration #15

5. Septic tanks

The septic tank consists of a small chamber, buried underground which receives both excreta and sullage (waste-water). The tank is connected to a soak pit or infiltration field. Flush toilets are connected to a septic tank and provide all the convenience of a sewer system except that the tank needs to be desludged periodically. This system is not necessarily cheaper than a conventional sewer system.



SEPTIC TANK Illustration #16

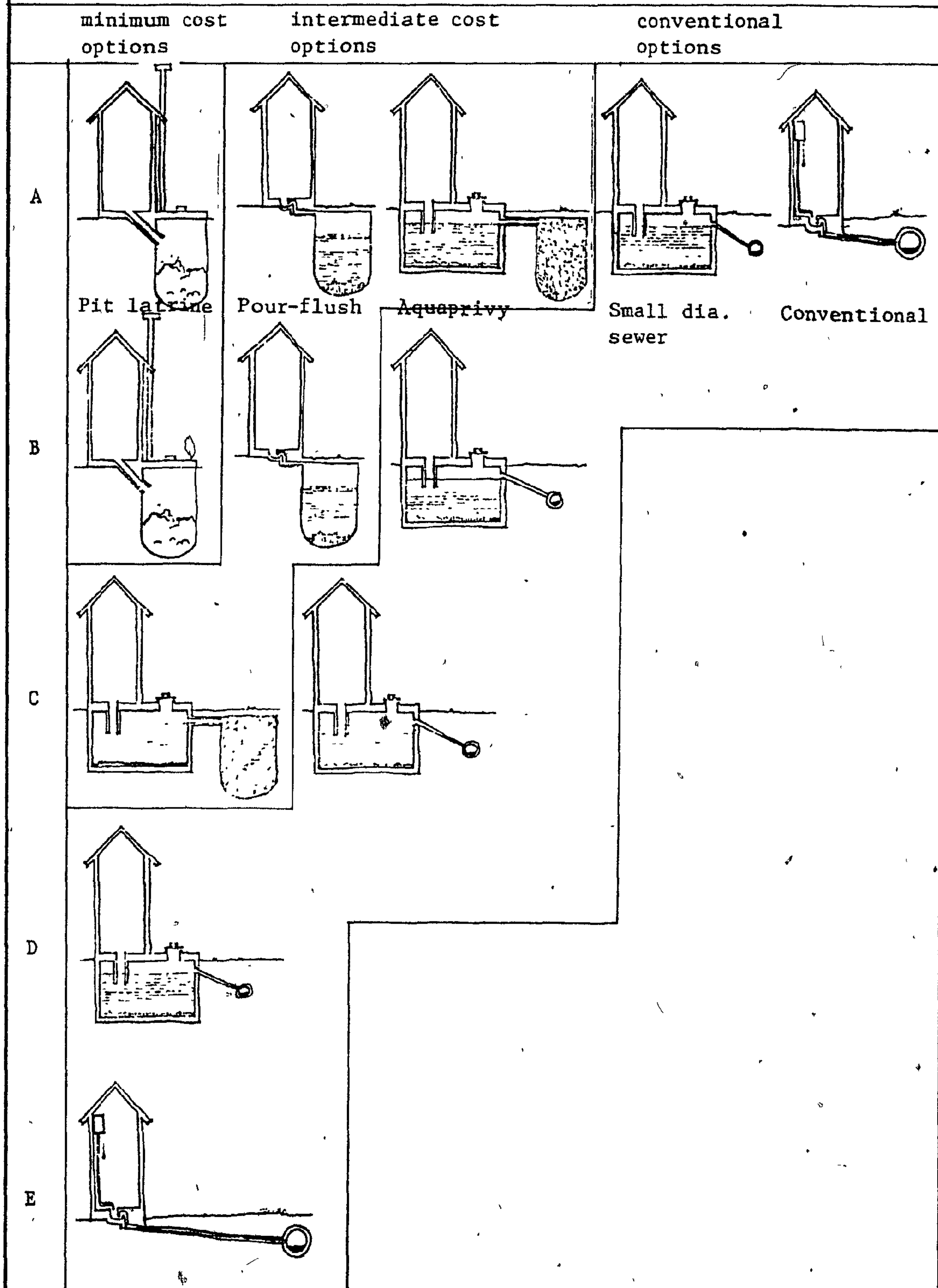
Possible Options

The economic options that are evolved from the technologies outlined are important in that they allow progressive improvement. The upgrading sequence of sanitation options closely follows the sequence of water supply options. The selected sequence described is developed for the Zambian context but is applicable to similar situations elsewhere. The same sanitation sequence is examined on a prototype layout in the following chapter. Illustration no.17 graphically explains the sequence.

Where water is not immediately available the choice of the sanitation system is limited to the one that uses a minimum of water. This is clearly the pit latrine. Once water is more available, the same pit latrine can be upgraded to the pour-flush toilet. As the water supply becomes abundant, the pour-flush toilet will require a connected soak pit because water will be used in greater quantities. The same pour-flush toilet can later be converted into an aquaprivy which allows connection to a sewer system. The link to soak pit must be disconnected before it is connected to a sewer system. The diameter of the pipe required for a sewer is small and can be laid on flatter gradients than the conventional sewer systems, and thus a big saving can be effectuated on the sewer network. However, the pit will require periodical desludging. At this stage the convenience level is comparable to that of conventional sewer systems.

Sometimes, the ground conditions do not favour pour-flush toilets with soak pits. Under such circumstances, the pits should be desludged periodically and the waste should be carted away possibly by a vacuum truck. This option is not considered here since most areas in Africa have favourable ground conditions.

SANITATION OPTIONS : SUMMARY CHART



Direction of progressive improvements →

Illustration #17

2.5 Roads and Storm Drainage Options

Daily movement involving commuting to places of employment, education and recreation may require extended journeys. Site and Services projects should make provisions for pedestrian and vehicular movements within the site and should link up with urban roads. It is also essential to provide for storm drainage so that rain water does not flood the roads and impede travel.

Roads in Site and Services projects can be tarmac with underground storm drains or passable tracks with storm drains which follow the natural slope of the ground. The roadway may or may not function in all seasons depending on the method of surfacing. The quality of road surface, the length of road (a function of the layout) and the kind of storm drains installed considerably influence the costs. The most expensive road surface is tarmac with a base course; the least expensive, is simply a levelling of the ground which entails the removal of any obstacles from its path. Roads and storm drainage cost represents on the average 30 to 40 percent of the total on-site infrastructure costs.[33] Illustration no.18 indicates the comparable costs of roads and surface drainage for different Site and Services projects. Illustration no.19 depicts various possible solutions for roads and storm drainage.

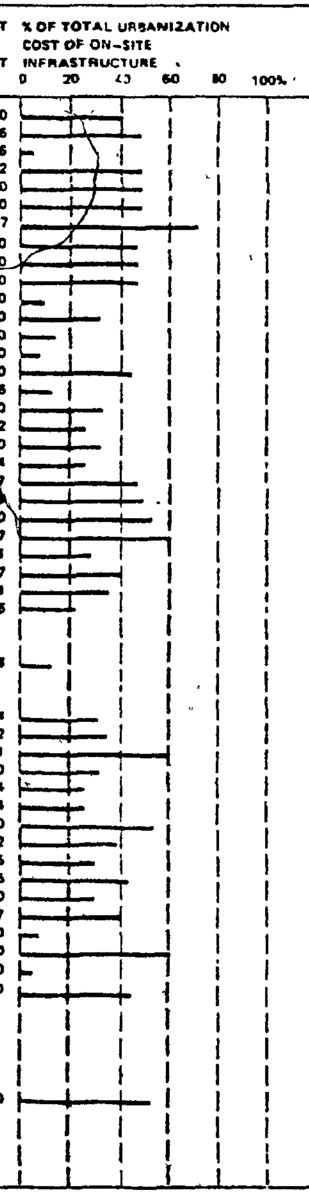
The following possible road and storm drainage options have been developed, in view of the costs, the prospective resident's ability to repay and the convenience of the utility.

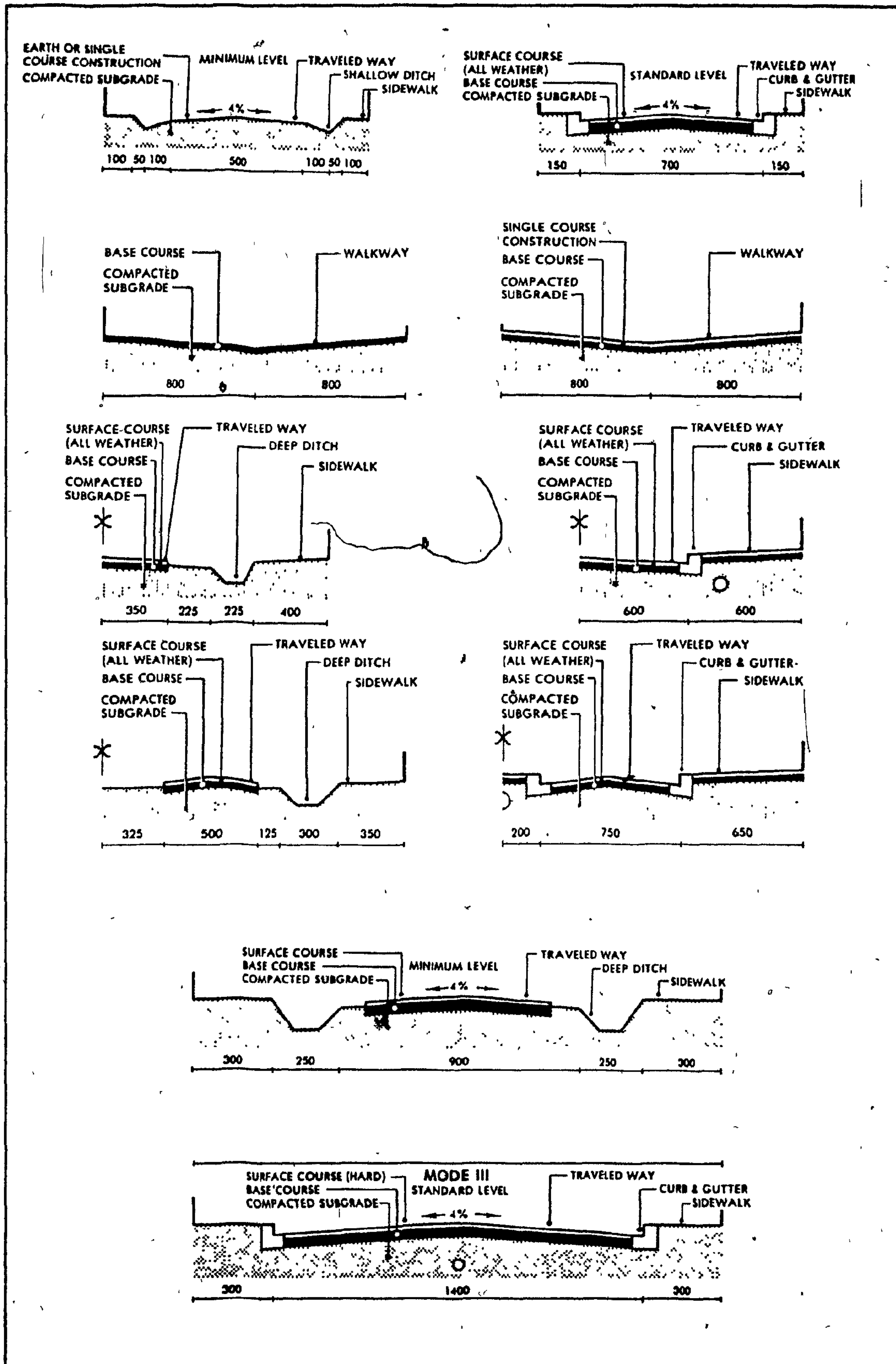
Roads and Storm Drainage Option: Minimum Cost

The minimum cost option assumes that, in the early stages of a Site and

ON-SITE INFRASTRUCTURE COSTS PER PLOT: ROADS & SURFACE DRAINAGE (1974)

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$
NICARAGUA	2,750	110	Main roads bitumenized Piped drainage	135 0
SENEGAL	11 900	150	Main roads bitumenized, No drainage	20 6
	2,100	150	Main roads bitumenized No drainage	20.6
	1,600	200	Main roads bitumenized No drainage	30.2
INDONESIA	12,866	80	Surfaced roads, Stormwater drainage	164.0
	4,425	140	Surfaced roads, Stormwater drainage	287.0
	23,600	110	Surfaced roads, earth ditches	81.7
JAMAICA	785	94	Surfaced roads, open channel drainage	196 0
	785	94	Surfaced roads, open channel drainage	196.0
	785	94	Surfaced roads open channel drainage	196 0
BOTSWANA	1,100	375	Main roads gravel, Open 'V' channels	35 0
	305	375	All roads earth formed, Open channels	64 0
	–	–	Main roads bitumenized, Piped drainage	142 0
	–	–	All roads gravel, Open channels	77 0
ZAMBIA	7 600	210	Main roads bitumenized Drainage	42.0
	1,200	324	Main roads bitumenized Drainage	48 6
	1,200	324	Main roads bitumenized, Drainage	273 0
	1,084	324	All roads gravel, Drainage	126.2
	868	324	All roads gravel, Drainage	133 0
	1,977	165	All roads gravel, Drainage	85.4
	114	324	Some surfaced roads	44 7
	858	324	Some surfaced roads	89.3
	858	370	Some surfaced roads	47.0
	717	370	Some surfaced roads	79.7
	307	370	Some surfaced roads	79 1
	278	370	Some surfaced roads	91 7
	100	370	Some surfaced roads	80 1
INDIA	1,000	70	All roads gravel, Drainage	117 6
EL SALVADOR	5,100	60	All roads earth (compacted), Drainage	n.a
	2,400	120	All roads earth (compacted), Drainage	n.a
	508	80	All roads earth Drainage	10.8
	235	60	Surfaced roads, Drainage	n.a.
	62	66	Surfaced roads Drainage	n.a
TANZANIA	5,370	265	Main roads bitumenized, Earth ditches	131 4
	5,370	265	Main roads bitumenized, Earth ditches	103.2
	5,370	265	Main roads gravel, Earth ditches	56 1
	12,100	260	Surfaced roads Piped drainage	124.0
	2,300	260	Surfaced roads, Piped drainage	103 4
	2,000	280	Surfaced roads, Piped drainage	91 4
	8,050	260	Surfaced roads, Drainage	127 0
KENYA	600	126	Main roads bitumenized Piped drainage	157.2
	375	126	Main roads bitumenized Drainage	71 5
	104	126	Main roads bitumenized Drainage	71 5
	723	167	Main roads bitumenized Drainage	54 0
	100	326	Main roads bitumenized, Drainage	146 7
	110	188	Main roads bitumenized Open channels	21 0
	42	298	Surfaced roads Piped drainage	340 0
	94	242	All roads earth, No drainage	15 0
	4 200	120	Surfaced roads Drainage	129 0
COLOMBIA	3,500	80	n.a	
	3,500	80	n.a	
	2,800	140	n.a	
	475	140	n.a	
	757	140	n.a	
CHILE	–	170	Surfaced roads, Drainage	428 0
ECUADOR	9 280	120	n.a	
KOREA	507	116	Surfaced roads Drainage	n.a
	145	166	Surfaced roads, Drainage	n.a
	73	248	Surfaced roads, Drainage	n.a

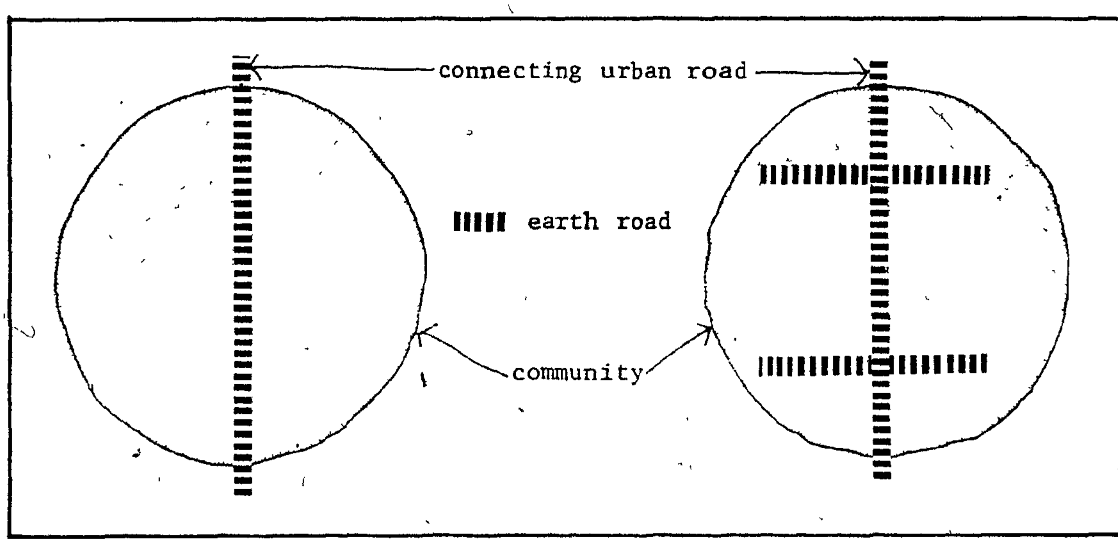




STREET SECTIONS

Illustration #19

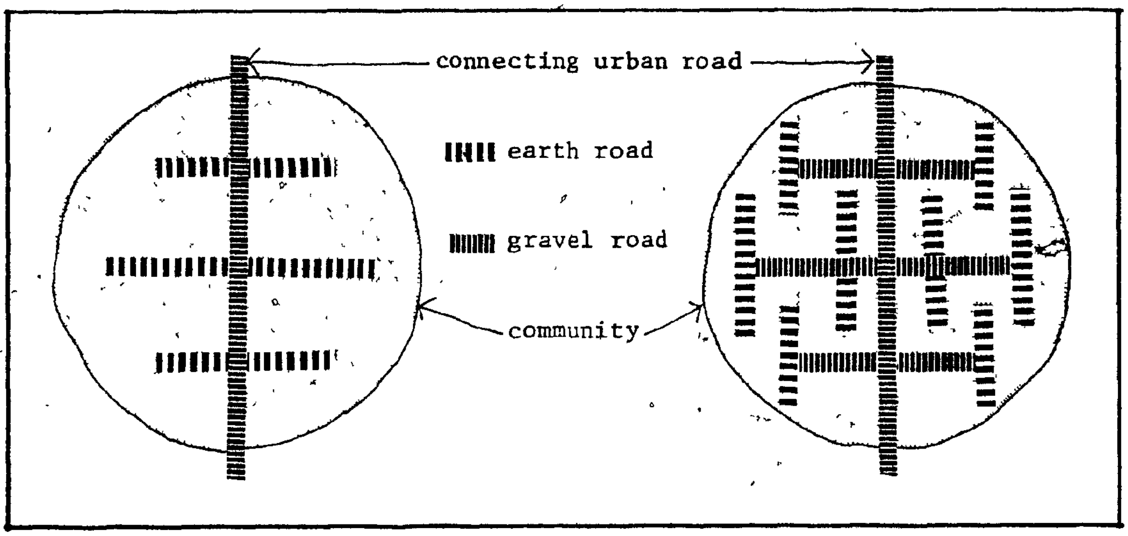
Services project, it is sufficient to provide a road which connects the site with the urban road network. In the beginning, the road surface can simply be levelled and the storm drains can take the form of ditches on the sides of the road which follow the natural slope of the ground. This option has plenty of scope for communal self-help thereby additionally defraying costs. The minimum cost option may have more than one stage of incremental progress. The minimum cost is achieved through a lowering of the quality of the road surface, through a lowering of the standard of storm drainage and through reducing the length of the road surface. All of these offer possibilities for subsequent improvement without any loss or damage of initial work. The option is explained graphically in Illustration no.20.



ROADS AND STORM DRAINAGE OPTION: MINIMUM COST   Illustration #20

<u>Roads and Storm Drainage Option: Intermediate Cost</u>

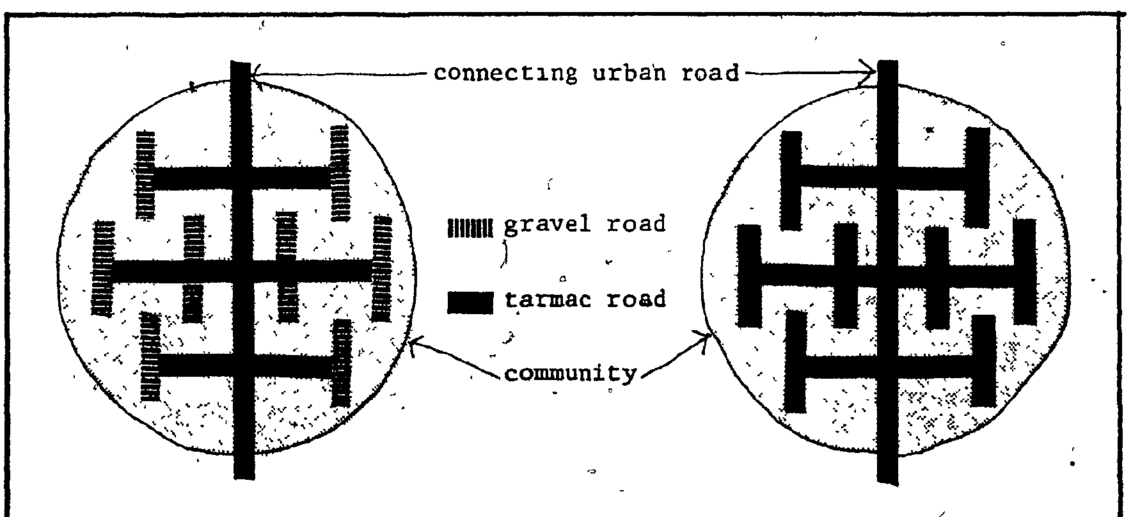
This option is based on the same principles as the previous option except that the main road is upgraded. This road is surfaced with an appropriate thickness of gravel base and provided with storm water ditches with culverts at junctions or at intersections. This upgrading permits the passage of traffic during all kinds of weather. At the same time secondary roads can be levelled. There can be more than one stage of incremental progress at this level. Illustration no. 21 explains this option graphically.



ROADS AND STORM DRAINAGE OPTION: INTERMEDIATE COST Illustration #21

Roads and Storm Drainage Option: Conventional

This option conforms to the conventional Zambian standards for road and storm drainage by laying a tarmac surface on a previously prepared gravel sub-base providing road access to individual plots. To reach this stage only additional work is required without redundancies of previous work. For storm drainage, more culverts are added or pipes laid in existing ditches. These pipes are then covered. Walkways can be built and trees can be planted over the storm drain ditches constituting a future stage.



ROADS AND STORM DRAINAGE OPTION: CONVENTIONAL Illustration #22

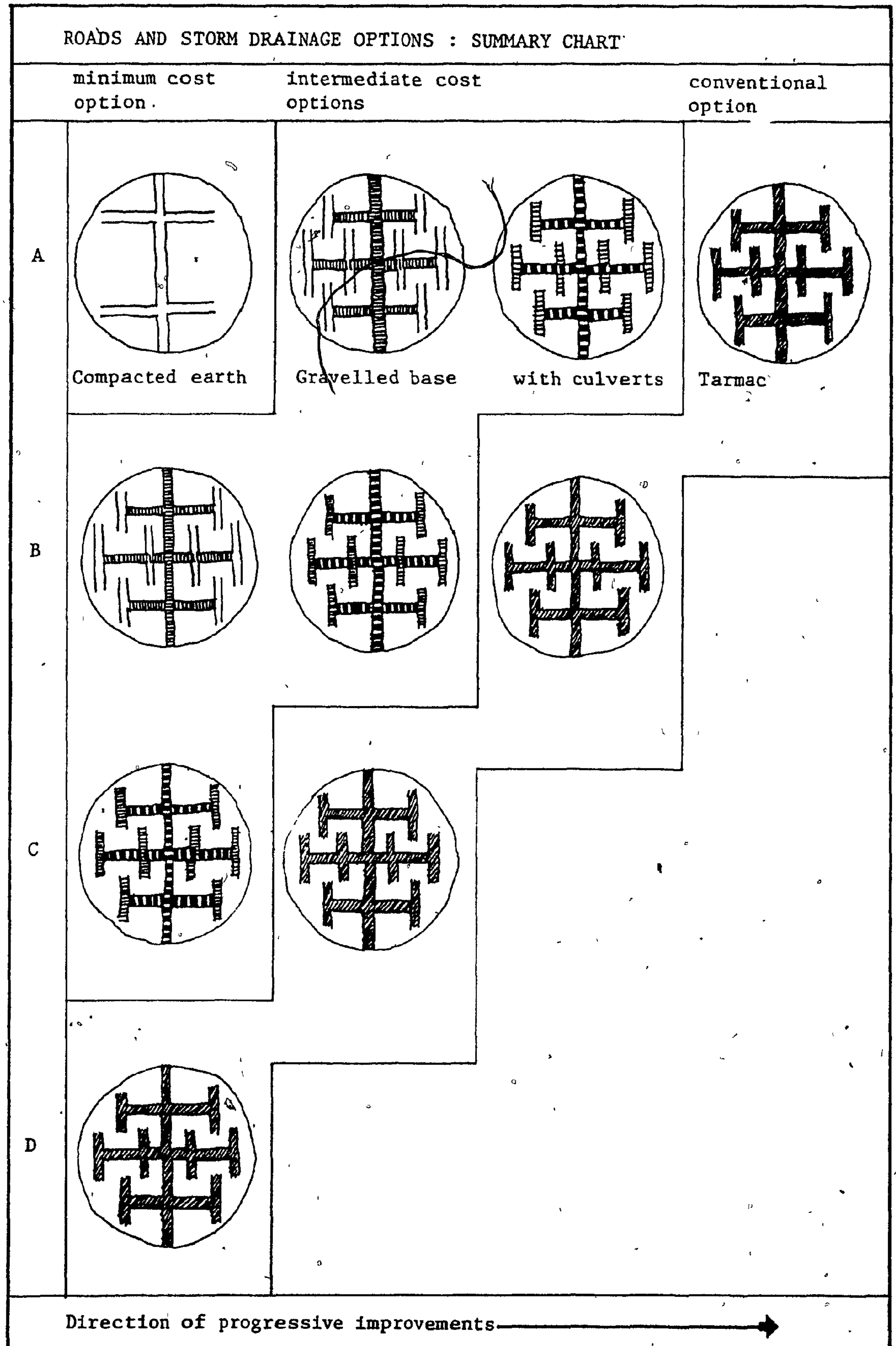


Illustration #23

2.6 Electricity and Street Lighting Options

Given a choice, most families will choose to have an electrical connection to their homes. Moreover, street lighting is desired by the residents of a community for security, convenience in night travel and for the extension of activities to the evening hours. It is desirable to connect electricity to private dwellings and to install street lights in Site and Services projects. The demand for private connections is determined by the individual's priorities verses his ability to pay, functions which vary considerably.

Electricity and street lighting requirements can be met by linking up to an existing electrical network or by using generators for producing electricity specifically for the site. Solar power may be feasible in the future but at present it is cost prohibitive and electrical generation by any other means has not been documented for Site and Services projects. The generation of electricity on-site requires the largest capital layout. Electrical services normally consist of an aerial distribution network, service drops and meters.

The use of less expensive fixtures and poles can produce some savings in street lighting cost, but do not reduce investment significantly. The costs of electrical and street lighting installations represent on the average 10 to 15 percent of the total on-site infrastructure costs.[36] Illustration no.24 compares the costs of electricity and street lighting in different Sites and Services projects.

There is not much scope in decreasing the cost of electrical installations. The installation of electrical lines to each dwelling takes up most of the

37

ON–SITE INFRASTRUCTURE COSTS PER PLOT: STREET LIGHTING & ELECTRICITY (1974)

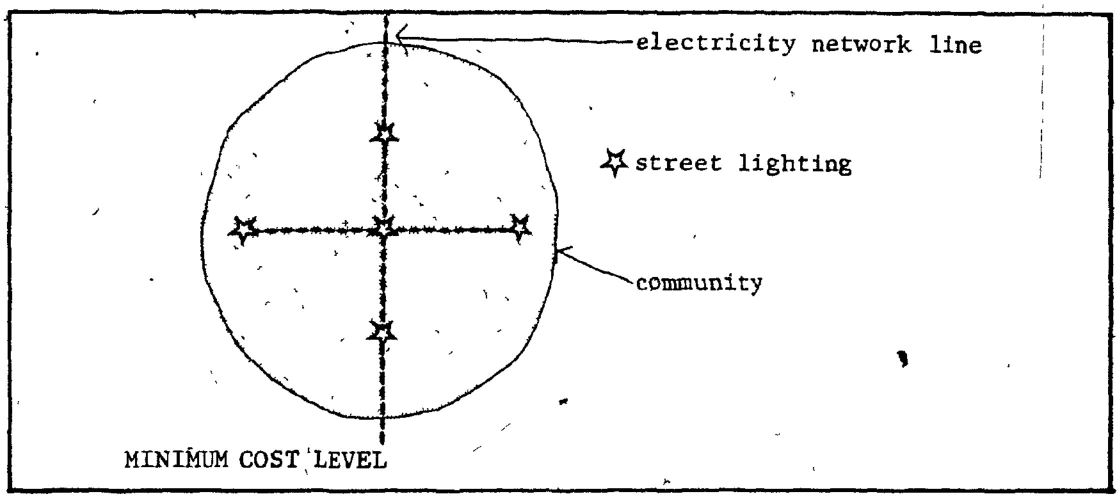
COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON-SITE INFRASTRUCTURE 0 20 40 60 80 100%
NICARAGUA	2,750	110	Street lighting, Individual electricity	28 0	
SENEGAL	11 900	150	Street lighting	n.a	
	2,100	150	None; Power company to provide		
	1,600	200	None		
INDONESIA	12,866	80	None		
	4,425	140	None		
	23,600	110	None		
JAMAICA	785	94	Street lighting Individual electricity		
	785	94	Street lighting Individual electricity		
	785	94	Street lighting; Individual electricity		
BOTSWANA	1,100	375	Street lighting	29 4	
	305	375	None		
	–	–	Street lighting, Individual provision	99 0	
	–	–	Street lighting, Individual provision	98 0	
ZAMBIA	7,600	210	Security lighting, 2 per Ha	9 7	
	1,200	324	Security lighting, 2 per Ha	48 6	
	1,200	324	Security lighting, 5 per Ha	45 0	
	1,084	274	None		
	868	324	None		
	1,977	165	None		
	114	324	None		
	858	324	None		
	856	370	None		
	717	370	None		
	307	370	None		
	276	370	None		
	100	370	None		
INDIA	1,000	70	Street lighting, Low tension lines	63 1	
EL SALVADOR	6 100	60	Street lighting at 50m spacing	n.a	
	2 400	120	Street lighting, 50m spacing	n.a	
	508	60	To be provided later		
	235	60	n.a		
	62	66	n.a		
TANZANIA	5,370	265	Security lighting Individual provision	51 0	
	5,370	265	Security lighting	21 9	
	5 370	265	None		
	12 100	260	Street lighting Individual provision	102 3	
	2,300	240	Street lighting Individual provision	117 3	
	2,000	280	Street lighting Individual provision	113 9	
	8,050	260	Street lighting along main roads	18 0	
KENYA	500	126	Street lighting Individual electricity	57 1	
	375	126	Security lighting	28 6	
	104	126	Security lighting	28 6	
	723	167	Security lighting	4 0	
	100	326	Street lighting	22 3	
	110	188	None		
	42	298	Street lighting, Individual provision	130 2	
	54	242	None		
	4 200	120	Security lighting	14 0	
COLOMBIA	3 500	80	Street lighting, Individual provision	126 1	
	3,500	80	Street lighting, Individual provision	125 1	
	2 800	140	Street lighting Individual provision	n.a	
	475	140	Street lighting Individual provision	n.a	
	757	140	Street lighting Individual provision	n.a	
CHILE	–	170	Street lighting Individual electricity	79 0	
ECUADOR	9,280	120	None		
KOREA	107	116	Security lighting	n.a	
	145	165	Security lighting	n.a.	
	78	248	Security lighting	n.a	

Illustration #24

investment. However, other options are neither possible nor practical. Possibly, the installation of street lighting services can be phased out. Two options have been developed and are described in the following text.

Electricity and Street Lighting Options: Minimum Cost

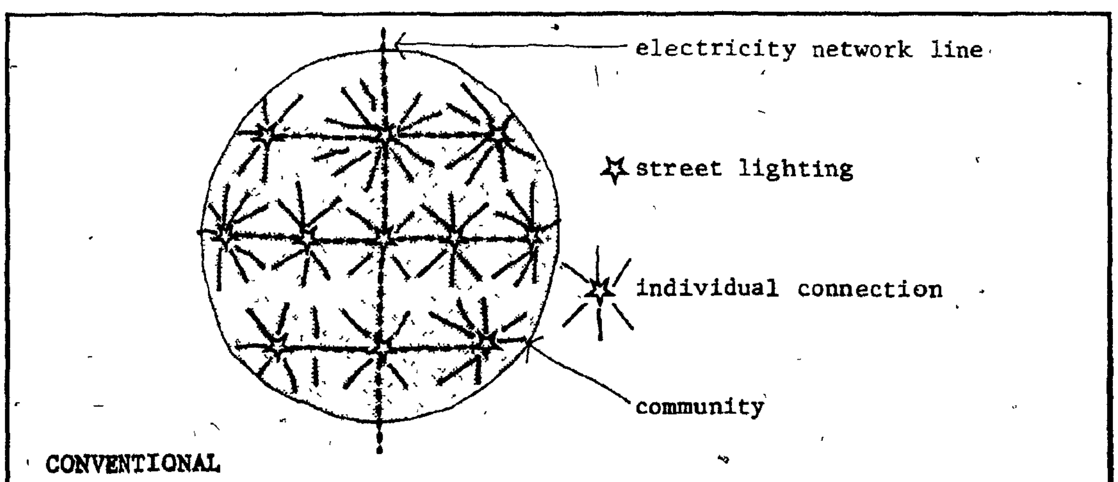
The minimum cost option provides for street lighting at intersections only. The option is explained in Illustration no.25.



ELECTRICITY AND STREET LIGHTING OPTION Illustration #25

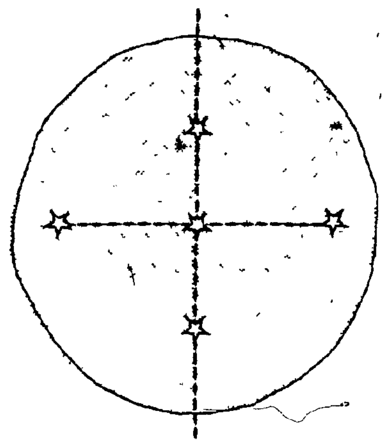
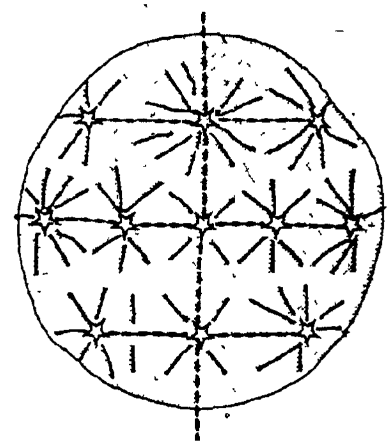
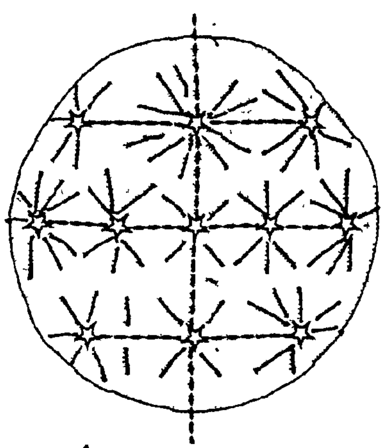
Electricity and Street Lighting Option: Conventional

Street lighting at all required locations is installed. Individual connections of a conventional standard are provided for each plot. Individual connections may also be provided at the minimum cost level to those who desire them. This option is graphically explained in Illustration no.26



ELECTRICITY AND STREET LIGHTING OPTION Illustration #26

ELECTRICITY AND STREET LIGHTING OPTIONS : SUMMARY CHART

	minimum cost option	conventional level
A		
B		

DIRECTION OF PROGRESSIVE IMPROVEMENTS →

Illustration #27

CHAPTER : 3 SPECIFIC OPTIONS FOR LUSAKA

3.1 Background : Lusaka, Zambia

In this third and final chapter, several options are presented for a prototypical layout which has been developed specifically for Lusaka, Zambia. It may be useful at this point to present some background information on Lusaka. Later in this chapter the process of choosing the right kind of option will be explained through a list of the most likely combinations of these options. This selection process will in turn indicate what the affordable standards of services for Site and Services projects are.

Some 70 years ago, Lusaka was a village of the Lenje tribe, one of Zambia's numerous tribes, and it consisted of only 6-8 huts. It was known by the name of its headman, Lusaaka. Until October 24,1964, Zambia was part of the Central African Federation, a protectorate of the United Kingdom. The federation consisted of present-day Malawi, Zambia and Zimbabwe. In 1910, a railway serving the Kabwe mines (then Broken Hill) from Salisbury, Zimbabwe (then Rhodesia) passed 0.8 km. away from the village of Lusaaka.

The formation of the Lusaka Township and Village Management Board was announced in 1913 with a boundary of 0.8 km. on either side of the railway. White settlers began to trickle in and by 1914, Lusaka had a half a dozen stores along one of six gridiron patterned streets. However, during the First World War, much of the male population left Lusaka and development ceased. Later, the government chose Lusaka as the new capital of what was Northern Rhodesia in 1934 because of its central location, its established communication links and its ample water resources under dolomite rocks.

Lusaka's population continued to grow and in 1954 numbered about 155,000. In 1978 the population was estimated to be close to 520,000.[38] Today, greater Lusaka, the capital city of Zambia, covers some 360 sq.km. with an average gross population density of 14.5 persons per hectare, while the country's average gross population density is around 0.07 persons per hectare (7 persons per sq.km.). The housing sector did not cope with this population increse and half of Lusaka's population was living in informal settlements in 1973. There were about 34 such settlements, some of which were as big as a neighbourhood. For example 'Mwaziona' settlement had a total population in excess of 45,000.[39]

Housing in Lusaka

Prior to independence in 1964, the housing problem in Zambia was less significant than it is today because the movement of native Zambians to urban centers was controlled by regulations based on race. Local urban authorities or private employers provided accommodation for their employees. Since most native Zambians were employed and were provided with rental accomodation by their employers, housing was very closely related to employment. Housing shortages grew as the newly self employed had to find their own accommodation. Under these circumstances, people built their houses wherever they could, regardless of the difficulties of servicing and of commuting. Prior to independence, building contractors allowed their employees to build temporary huts on construction sites; groups of such huts were referred to as 'compounds'. As these compounds grew, the huts became more permanent dwellings. Many new settlements also grew on the fringes of urban centers. The new housing act passed in October 1974, recognizes the legal existence of these settlements. Some of them have since been upgraded and provided with services.

There are basically five different kinds of residential areas in Lusaka. These areas evolved during Lusaka's early development around 1930. Strict principles of racial segregation, controlled movement of native Zambians and the practice of connecting housing with employment have imparted a distinctive character to these residential areas. At the time of independence, most of the housing stock was rented and very few dwellings were owner occupied.

The residential areas of Lusaka can be identified with the five categories listed below.[40]

1. Upper Income Housing
2. Military Housing
3. Council Housing
4. Site and Services Housing
5. Informal Housing

1. Upper Income Housing

This type of housing developed around the Ridgeway capital buildings. This area is well serviced with social, educational and recreational facilities. Individual dwellings are of good quality with well finished exteriors and interiors. They have running water, sewers, electricity and good roads. Since independence, this type of housing is declining in proportion to the total housing stock, and in 1974 it provided housing for only 19 percent of the population.

2. Military Housing

This type of housing consists of police camps and armed forces quarters and is located to the immediate south west of the Ridgeway capital complex.

Before independence, the proportion of this type of housing was greater but it is relatively insignificant today. In fact, in 1974, there were only 986 units for police housing and approximately 900 units for the armed forces.

3. Council Housing (Owned by the Lusaka City Council)

This type of housing is quite widespread. The practice of connecting housing with employment gave rise to this type of residential development. The Lusaka City Council built rental units for their employees. The units are of good quality but lack in social, educational and recreational facilities. At one time, this type of housing was the most dominant housing category. In 1974, it provided housing to some 25 percent of the population.

4. Site and Services Housing

This type of housing increased in popularity after independence. Usually the dweller builds his own unit with or without any technical assistance and with or without a financial loan. The plot is serviced with piped water, sanitary facilities, road access and street lighting. Most dwellings are of good quality but lack social amenities. In addition, some areas lack an effective public transport system. This type of residential development provided housing accommodation for approximately 12 percent of the population in 1974.

5. Informal Housing

This type of residential development consists mainly of informal settlements. With the expansion of the Lusaka city limits, informal settlements are part of the city but are not subject to demolition due to the legislation passed in 1974 which recognized such settlements. The quality of these dwellings is constantly improving. Most of the dwellings have changed from pole and doga construction to concrete block walls and galvanized iron or asbestos sheet roofing. The gross density is quite high when compared with other types of residential areas. Although they lack in social, educational and recreational facilities, social life is flourishing. These areas also lack proper road access, water supply and sanitation facilities. In 1973 this type of residential area provided housing for about half the total population of Lusaka.

Services : Water Supply

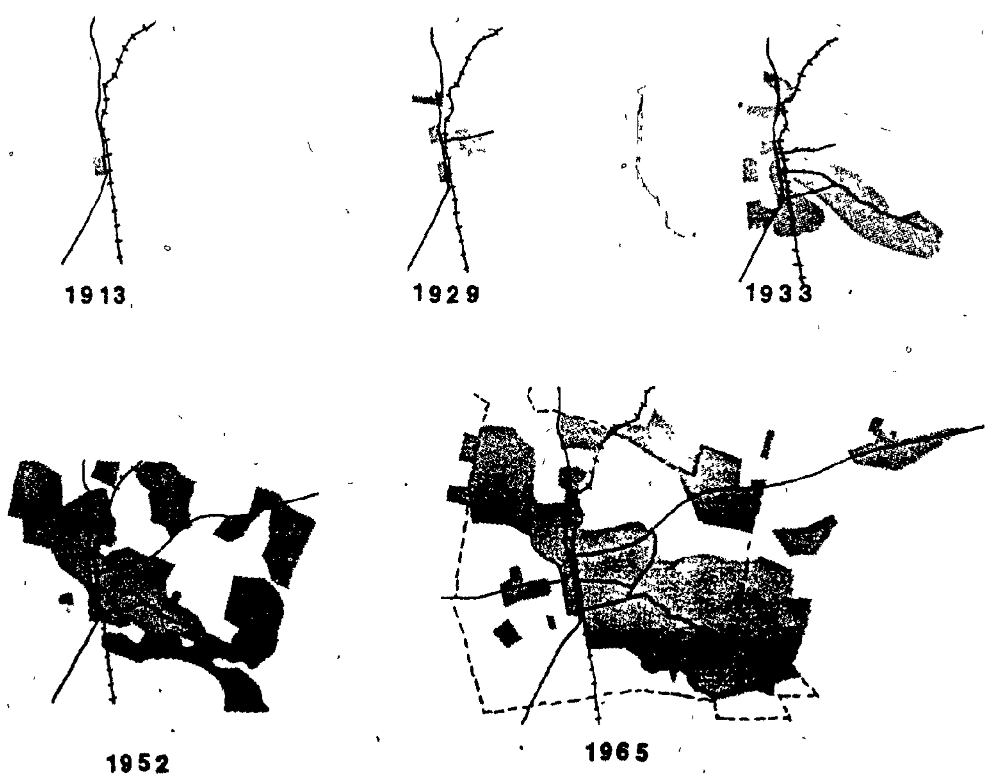
Lusaka has had a piped water supply system since 1954. Water is supplied by boreholes and taped from a nearby river, the Kafue. The water is supplied after treatment and meets international health standards thus making it potable straight from the tap. Households which have access to a communal water tap within a ten minute walk or which have their own water supply are considered to have water supply facilities. In 1957, about 82 percent of the total housing stock had such facilities while it decreased to 64 percent by 1973. A recent programme to upgrade informal settlements is likely to improve this situation.

Services : Sanitation

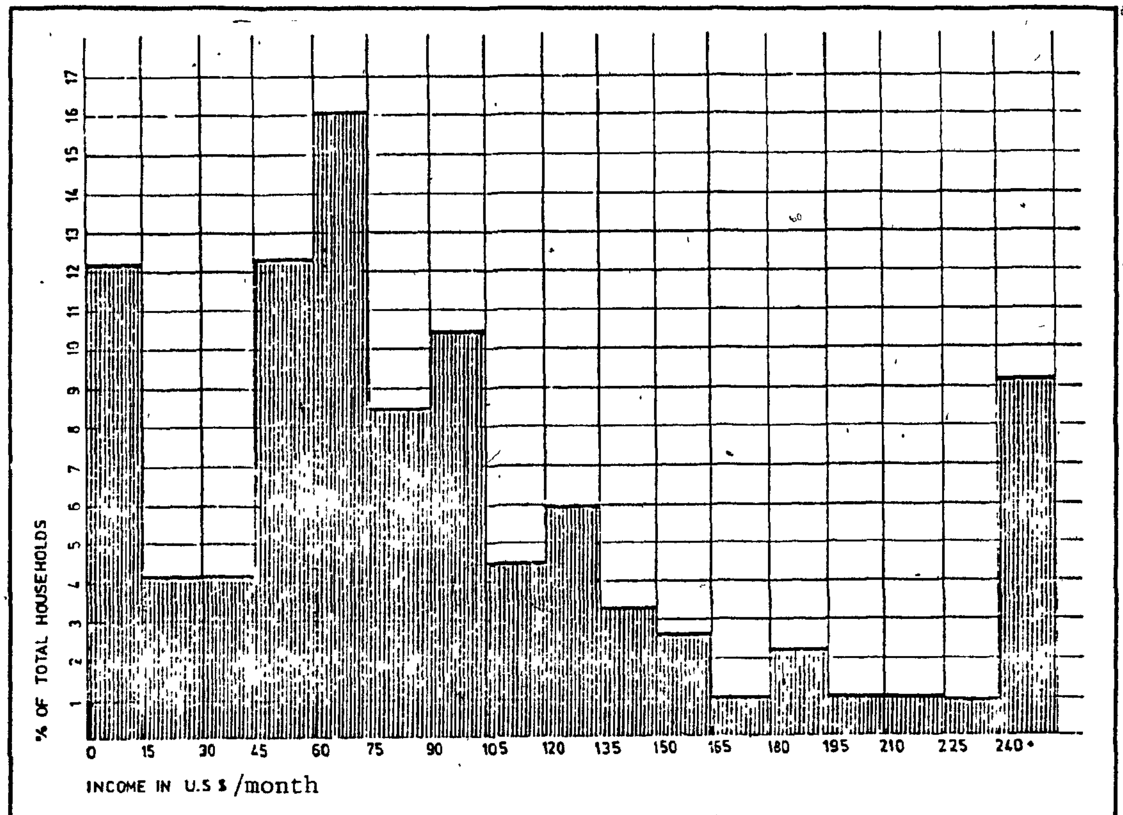
Part of Lusaka has a sewer system where the sewage is treated at five stabilization ponds and two sewage treatment plants. In 1976, 37 percent of the population had flush toilets, 54 percent of the population had pit latrines and three percent of the population used bucket latrines.[41] The remaining population had no access to any kind of organized sanitation system.

Location:	**Latitude : 15° 25' South**
	Longitude : 28° 19' East
	Mean Elevation above sea level : 1274 Meters
Landscape:	High plateau and water table goes down in winter Land consists of limestone and schist Parts of Lusaka are thickly wooded with indigenous trees
Temperatures:	**Seasons** Cool dry season (April to August): Mean : Max. 26°C Extreme : Max. 34°C Mean : Min. 10°C Extreme : Min. 04°C Hot dry season (August to November): Mean : Max. 31°C Extreme : Max. 38°C Mean : Min. 15°C Extreme : Min. 07°C Warm wet season (November to March): Mean : Max. 26°C Extreme : Max. 34°C Mean : Min. 17°C Extreme : Min. 12°C
Humidity:	Relative mean 62%
Wind:	Prevailing winds occur from the East at an average speed of 5.6 km/second or 3.5 miles/second during nine months of the year except January, February and July January : East-North-East February : East-North-East July : East-South-East
Population:	238,000 (1969 census) estimated close to 520,000 persons (1978 estimates)

LUSAKA : BASIC INFORMATION Illustration #28

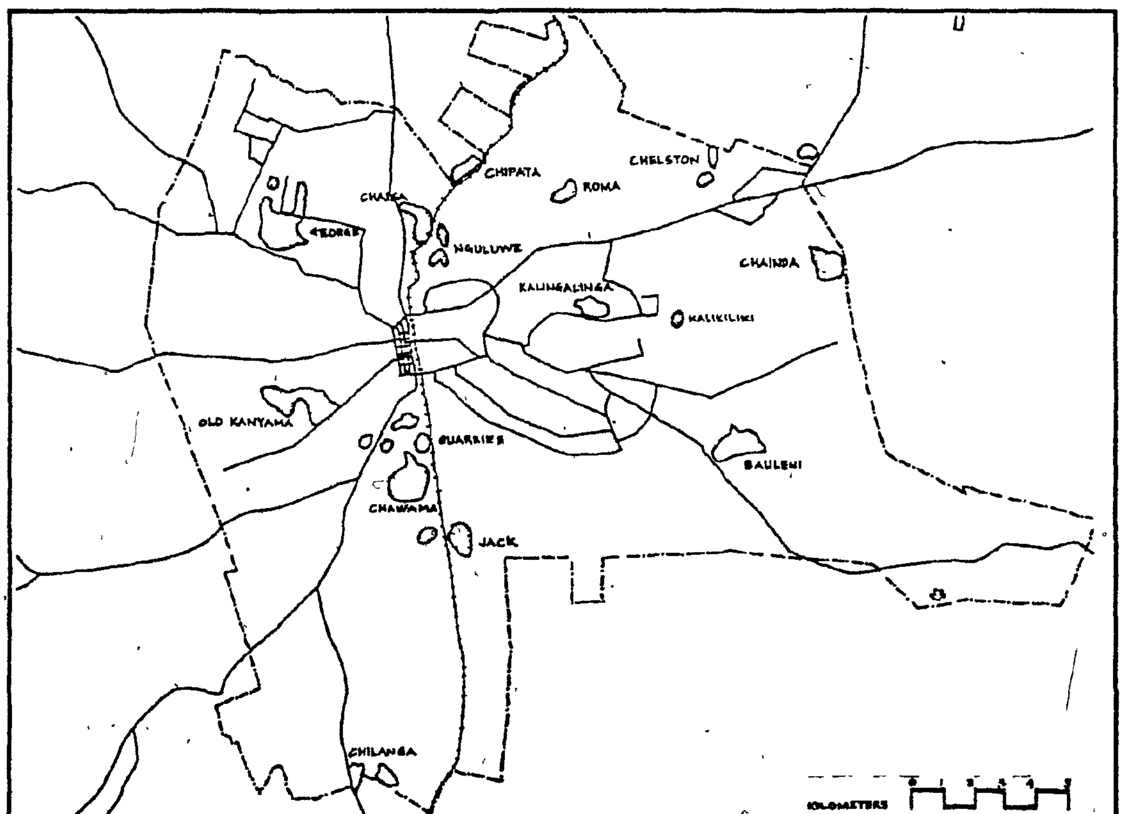


LUSAKA : STAGES OF GROWTH Illustration #29



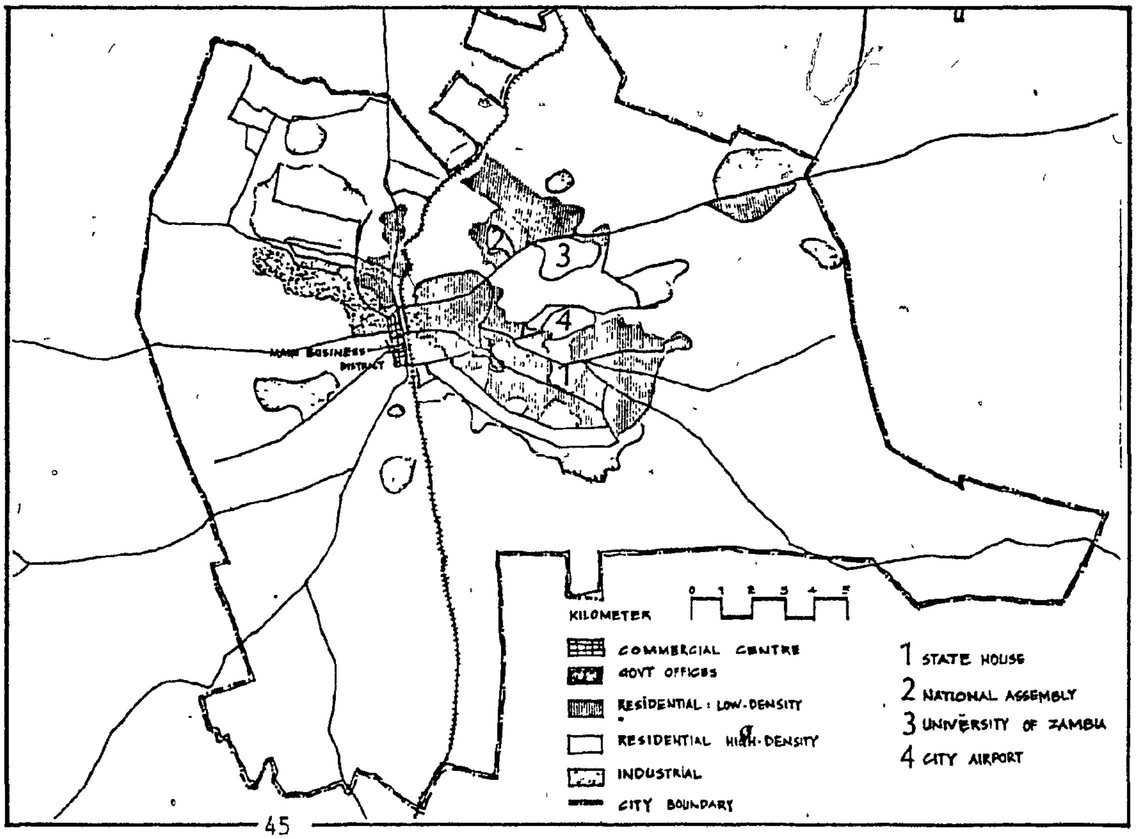
LUSAKA : INCOME DISTRIBUTION (1973)[43]

Illustration #30



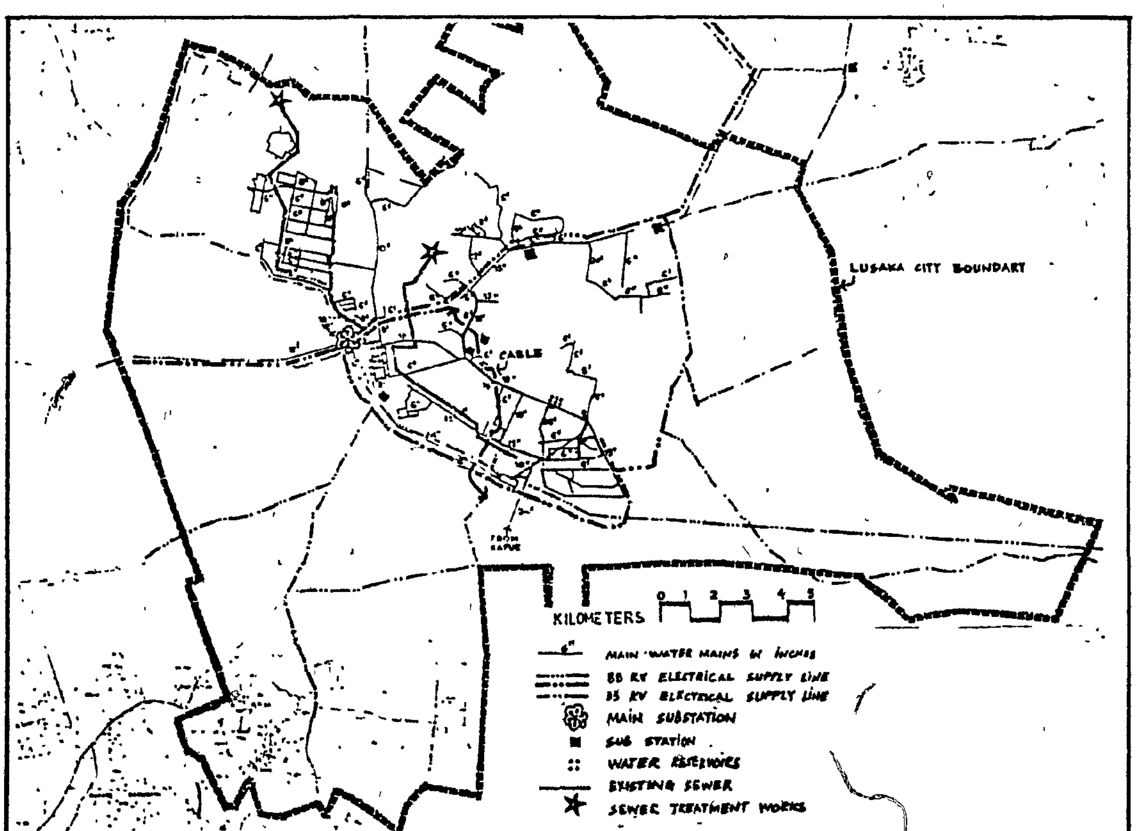
LUSAKA : INFORMAL HOUSING AREAS[44]

Illustration #31



LUSAKA : LAND USE[45]

Illustration #32



LUSAKA : EXISTING INFRASTRUCTURE[46]

Illustration #33

3.2 Servicing Options for Lusaka

Evidently it is extremely difficult to meet future housing requirements in Lusaka with available financial resources. To achieve the goal of providing shelter to a maximum number of people it is of utmost importance to provide serviced land on which people can build their own dwellings. It was noted in the previous chapter that even these projects fail to provide housing to many urban poor chiefly because of expensive and inappropriate servicing standards which result in unaffordable repayment requirements. Therefore, it is important to find out how the standards of services for Site and Services projects can be lowered thereby creating substantial savings.

In 1974, the average cost for plot in a Site and Services project in Lusaka was about US $ 823.[47] Presently, it is estimated that it would cost close to twice that amount or US $1,650 per plot to provide the standards of services. A reliable unit cost base for the year 1974 is available and has been used for cost computations throughout this work and for the illustrations of options. Illustration no.40 indicates such unit costs for Site and Services projects in Lusaka.

Servicing options are presented on a prototypical layout. This prototype has been developed on the basis of experience designing layouts for Site and Services projects in Lusaka. While developing the prototype, all applicable regulations which were exercised by the concerned ministry in Zambia have been followed with the exception of regulation 1.b. (see Appendix:A).

Basic data of a prototypical layout

Total area of land:	9.9968 hectare
Total no. of plots:	220
Gross density Plots/ hectare:	22
Average size of plot:	320 sq.m.
Roads and open spaces:	29.58 percent
Residential:	70.42 percent

The servicing options which have been assumed for Lusaka are listed below and are presented in the following pages. It should be noted that the preparation of the minimum cost option never precluded the possibility of future improvements leading towards more conventional standards.

1. Water supply options
2. Sanitation options
3. Roads and storm drainage options
4. Electricity and street lighting options.

SITE AND SERVICES SURVEY

Unit Costs & Standards[48]

SURVEY NO: 6- ZAMBIA
DATE: May 20, 1974

COMPONENT: DESCRIPTION/STANDARD	SPECIFICATION	UNIT	UNIT COST US$	COST/PLOT US$
1. LAND				
1a. Land Acquisition	n/a			
2. SITE PREPARATION	n/a			
3. PUBLIC UTILITIES				
3a. Water Supply				
Standpipes @ 1 per 25 plots	12 mm G.S. pipe	m	2.4	
in overspill areas;	19 mm " "	m	2.7	
Standpipes @ 1 per 4 plots	25 mm " "	m	3.6	
in basic plots;	75 mm A.C. Pipe	m	5.5	
Individual Connection of piped	100 mm " "	m	7.3	
water brought 10m inside of	150 mm " "	m	12.7	
plots for 'normal' plots.	200 mm " "	m	16.4	
Average consumption 150 lpd.	225 mm " "	m	18.2	
Allowance for schools, shops etc.,	(Laying included)			
30,000 litres per ha.	Fittings, etc. add			
	20% of total above.			
	Fire Hydrant	no.	168.0	
3b. Sewerage				
Pit latrines built by users in				
the overspill and 'basic' plots;				
Individual waterborne connection	100 mm Earthenware Pipe	m	13.7	
brought 3m inside of plot in the	150 mm " "	m	16.4	
'normal' plots.	225 mm " "	m	25.5	
Average flow 150 lpd.	300 mm A.C. pipe	m	36.4	
Allowance for schools, shops etc.,	375 mm Concrete pipe	m	41.9	
20,000 litres per ha.	Inspection Chamber	no.	84.0	
	Manhole	no.	238.0	
	Pumping Station I	no.	49,000	
	Pumping Station II	no.	98,000	
	Pumping Station III	no.	126,000	
3c. Surface Drainage				
open ditches	earth drains	n/a		
3d. Roads and Footways				
Overspill areas;	100 mm - 200 mm	m	10 -	
Gravelled 4m internal road	gravel thickness		20	
system, no direct access to	on 3m - 6m wide			
all plots; bitumenized 6m	roads (with 4-25m			
bus routes.	right of way)			
Site & Services Areas;	2-3.5m wide foot paths			
Gravelled 4m internal road				
system; direct access to all	tar	m^2	1.5	
plots. bitumenized 6m access roads.				

Illustration #34

1. Water supply options

The cost of supplying water depends on the degree of service installed. The principle to be adopted is a step-by-step upgrading of services, beginning with a low-cost, and therefore low-level, service and ultimately reaching a 'conventional' standard. This strategy assumes that a communal public standpipe is installed in the beginning which supplies water to a group of families who have to walk at maximum about 5-6 minutes to fetch water. Eventually, these standpipes are extended to connect to individual houses.

Four options have been developed on the assumption that an urban water main passes through the main street with sufficient water at a suitable pressure to supply the community.

I. Water supply option: I (Illustration no.35)

A public water standpipe is provided for every 110 families, each standpipe has 20 taps (one tap for every 5-6 families). The maximum walking distance is about 190 meters or 5-6 minutes based on an average walking speed of 4 km. / hour. This is the minimum cost level and costs US $26.61 per plot.

II. Water supply option: II (Illustration no.36)

A public water standpipe is provided for every 37 families, each standpipe has 6 taps (one tap for every 6 families). The maximum walking distance is about 70 meters or a 2-3 minute walk. It costs US $53.98 per plot.

III. Water supply option: III (Illustration no.37)

A public water standpipe is provided for every 9 families, each standpipe has four taps (one tap for every 2.5 families). Maximum walking distance is about a 1-2 minute walk. It costs US $104.45 per plot. Six firehydrants are also provided.

IV. Water supply option: IV (Illustration no.38)

Individual connections and six firehydrants are provided at an installation cost of US $135.52 per plot.

WATER SUPPLY OPTION : I

* Installation cost/plot : US $26.61

* Maximum walking distance : 5-6 minutes

200 mm Ø water main

stand pipe

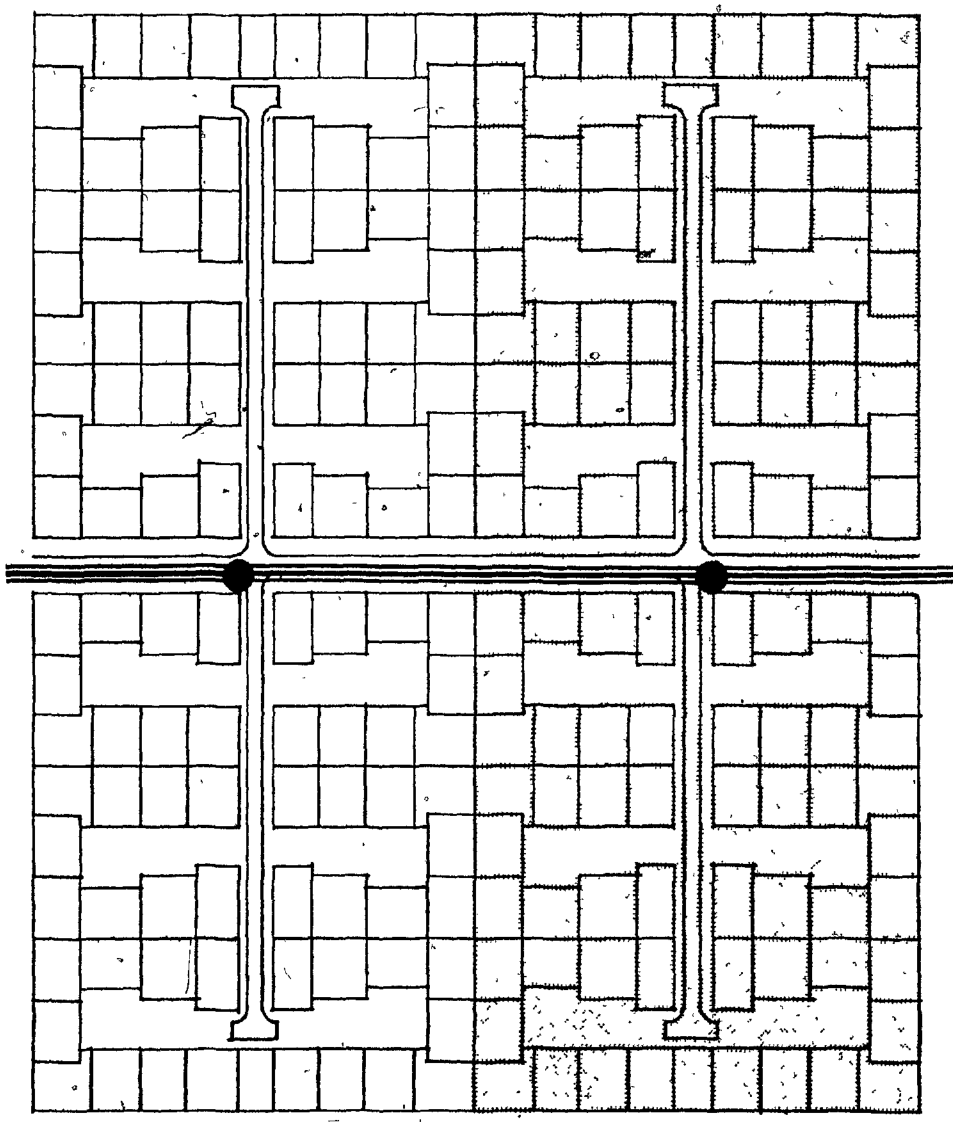


Illustration # 35

WATER SUPPLY OPTION : II

* Installation cost/plot : US $53.98

* Maximum walking distance: 2-3 minutes

200 mm Ø water main
150 mm Ø water pipe
stand pipe
existing stand pipe

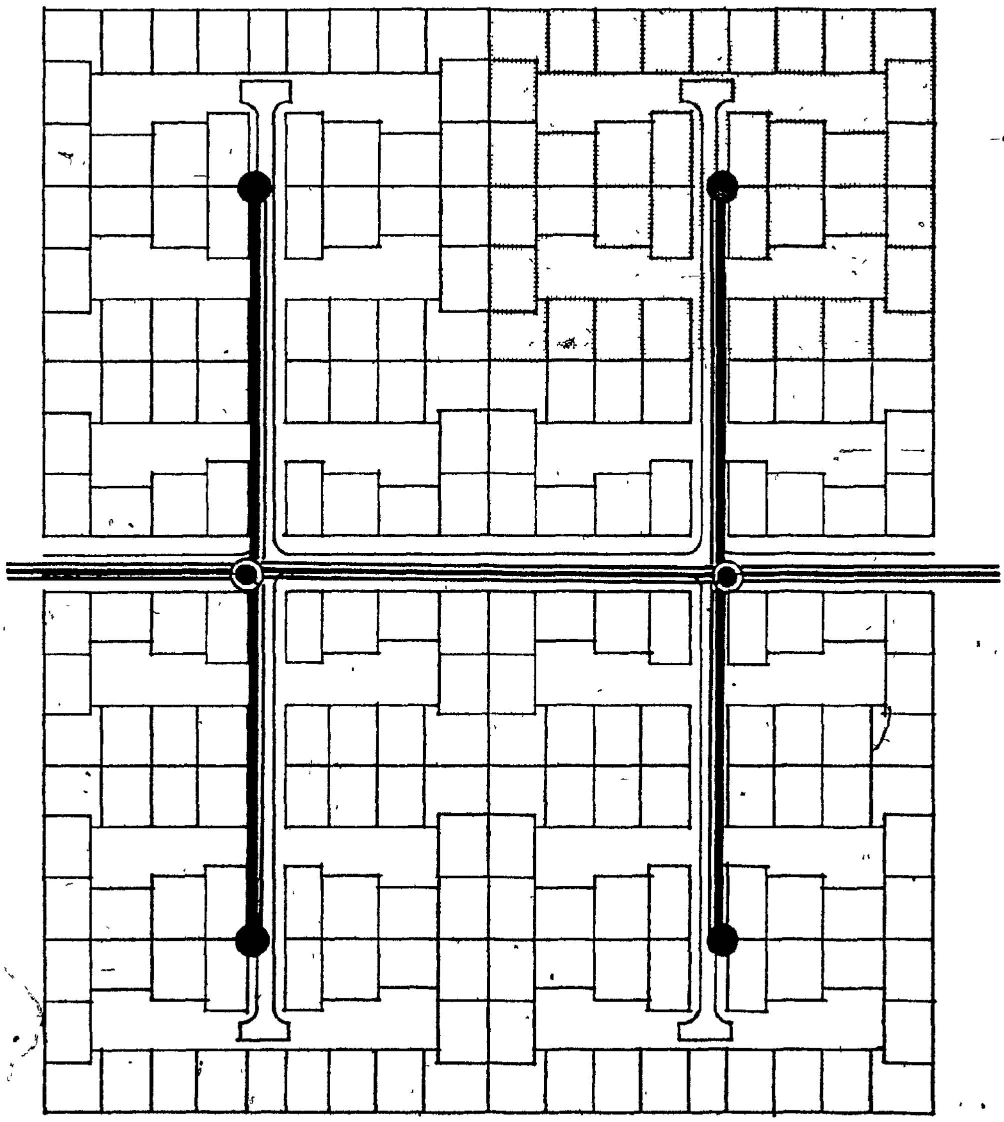


Illustration # 36

WATER SUPPLY OPTION : III

* Installation cost/plot : US $104.45

* Maximum walking distance: 1-2 minutes

200 mm Ø water main
150 mm Ø water pipe
75 mm Ø water pipe
stand pipe
fire hydrant

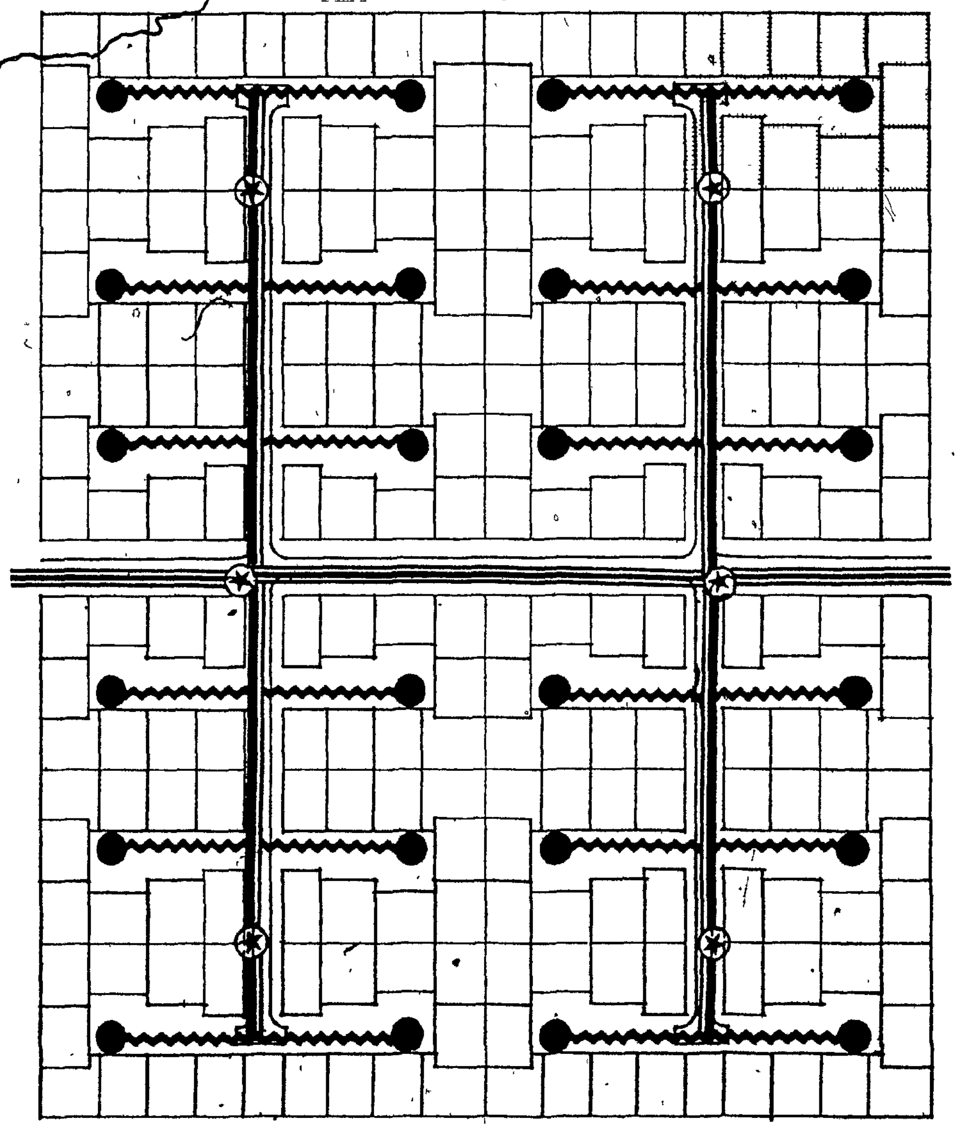
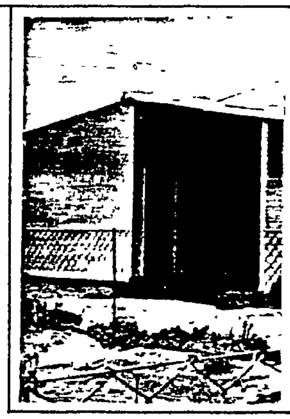


Illustration #37

WATER SUPPLY OPTION : IV

* Installation cost/plot : US $135.52



200 mm Ø water main
150 mm Ø water pipe
75 mm Ø water pipe
12 mm Ø individual connection
fire hydrant

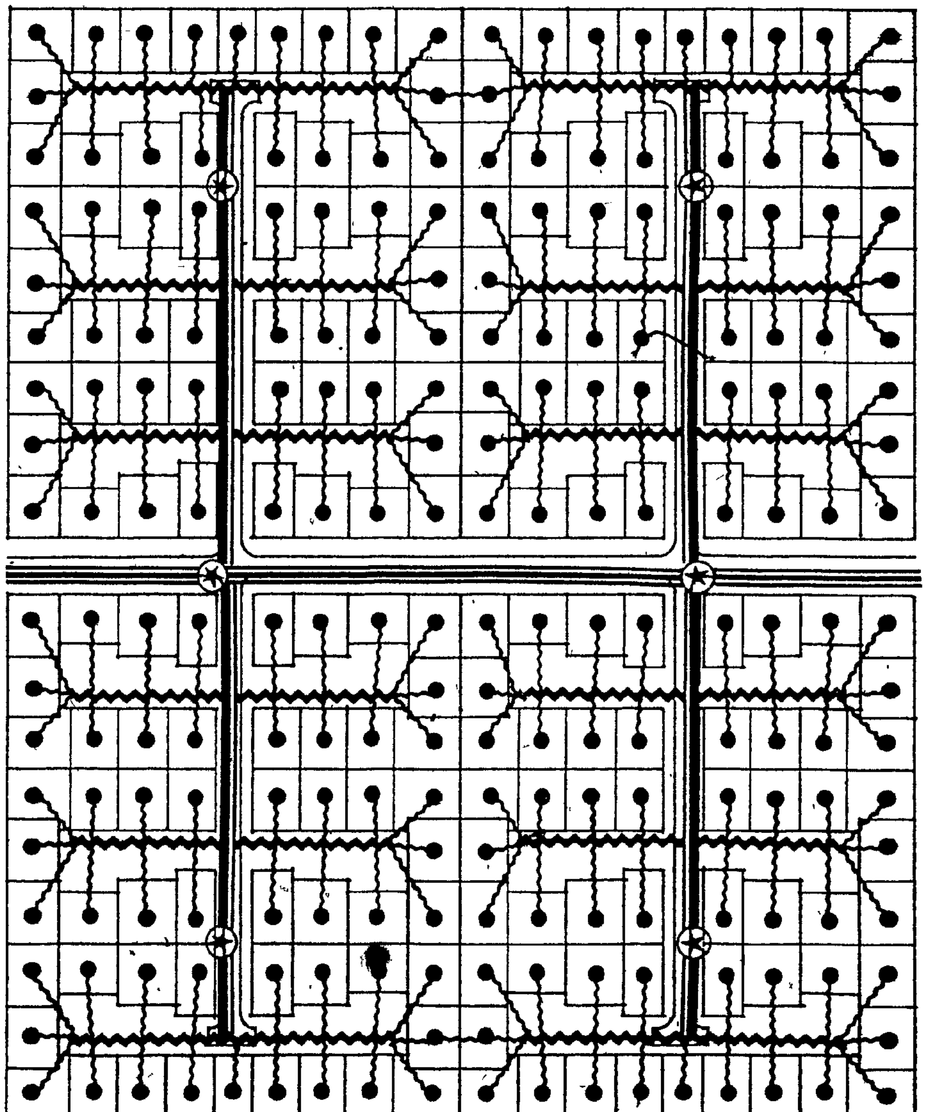


Illustration # 38

WATER SUPPLY OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A ......US $ 26.61
* Initial investment required for sequence B ......US $ 53.98
* Initial investment required for sequence C ......Us $104.45
* Initial investment required for sequence D ......US $135.52

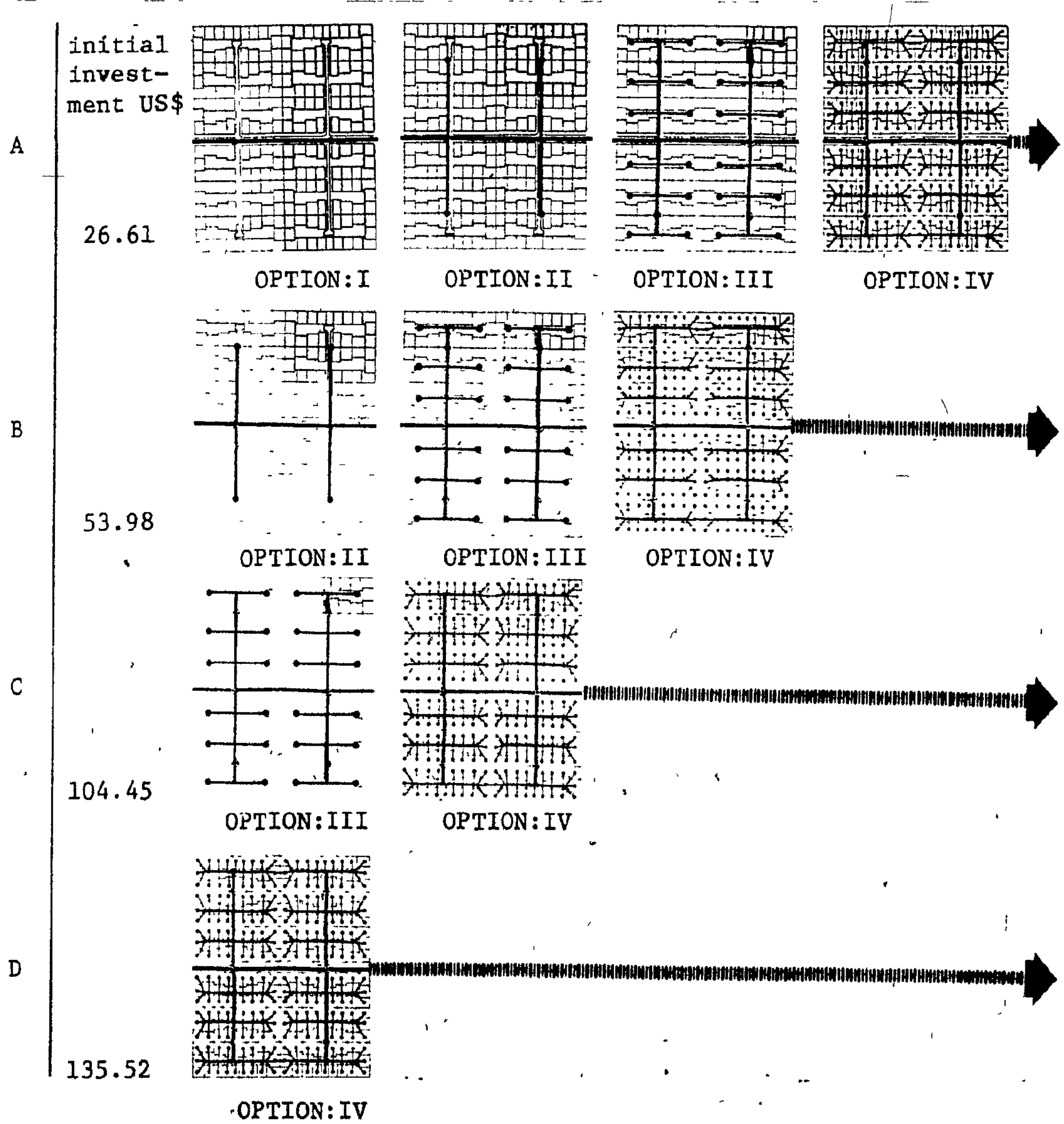


Illustration #39

2. Sanitation options

The cost of sanitation depends on the degree of service provided. In this case the minimum cost option is a pit latrine and the ultimate level of service is a sewer network.

Four options have been developed on the assumption that it is possible to connect to an urban sewer network through a main collector pipe with sufficient capacity to accept the additional flows from the community in question. The initial option assumes that the porosity conditions of the ground are favourable for pit latrines to function properly.

I. Sanitation option: I (Illustration no.40)

An improved pit latrine with a vent pipe equipped with a fly screen to prevent odour and flies is provided for each plot. This option assumes that the superstructure will be built by the residents and therefore the cost of the superstructure is discounted. The cost of the pit latrine is US $37.56 per plot (for cost calculations refer to Appendix : B).

II. Sanitation option: II (Illustration no.41)

Pit latrines are upgraded to become pour-flush toilets with soak pits (it is assumed that at this stage, there is more water available than at the previous stage). The cost of a pour-flush toilet is US $72.38 per plot. which includes the pit, pour-flush squatting fixture and the soak pit but excludes the cost of the superstructure (see Appendix:B).

III. Sanitation option: III (Illustration no.42)

The pour-flush toilets are upgraded to become aquaprivies by converting the pit into a holding tank which is connected to a soak pit. It is assumed that at this stage water is more freely available. The cost of the aquaprivy is US $97.50 per plot (see Appendix:B). The cost does not include the cost of the superstructure.

IV. Sanition option: IV (Illustration no.43)

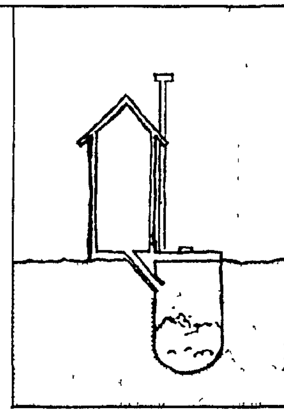
The aquaprivies are upgraded by connecting them to a sewer with a small diameter pipe as it can safely be assumed that sufficient water is available at this stage. The cost of the small diameter sewered aquaprivy is US $271.64 per plot.

At this stage aquaprivies function perfectly well and provide the same degree of convenience as do flush toilets, therefore, it is suggested that the Site and Services projects not provide for conventional flush toilet level. Although illustration no.44 shows the cost as US $347.81 per plot for conventional flush toilet sewers, these costs are for comparision only and serve to indicate the relative savings that can be made.

SANITATION OPTION : I

* Installation cost/plot : US $37.56

o . pit latrine



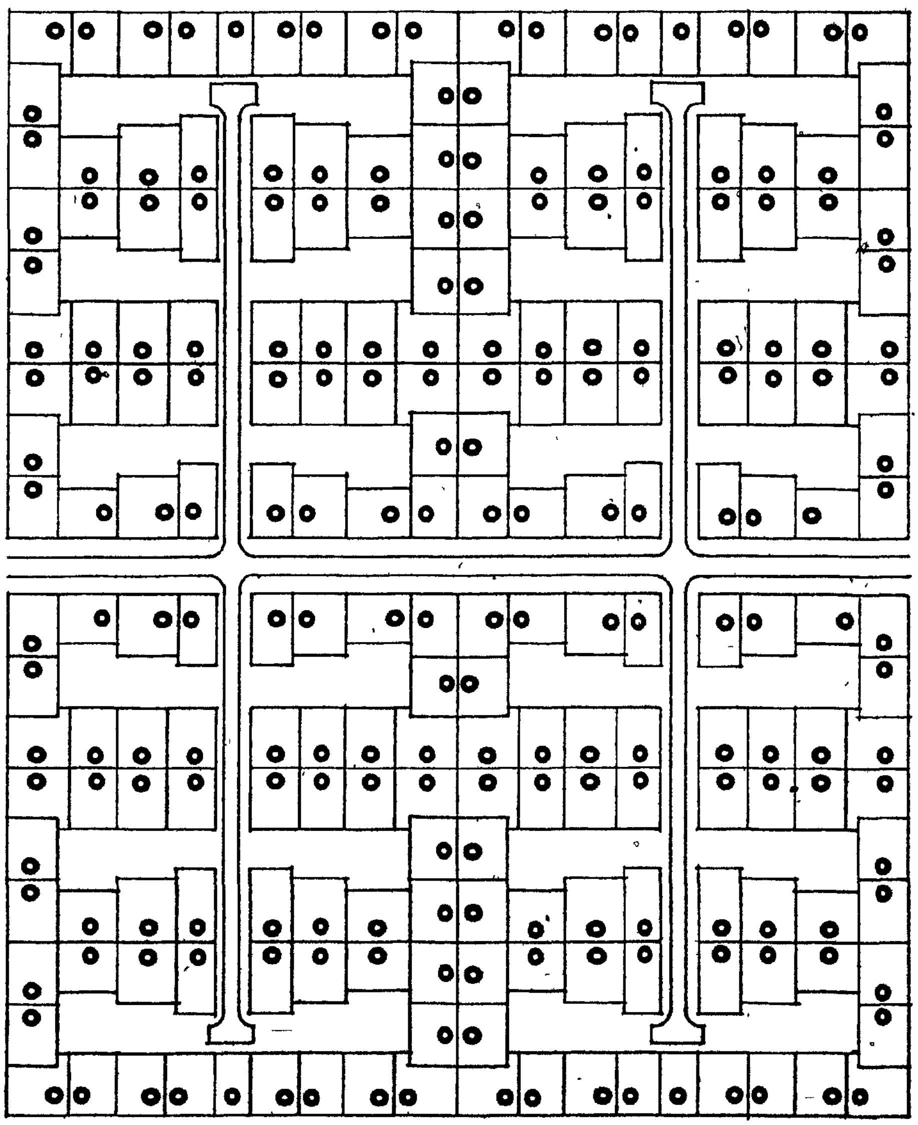
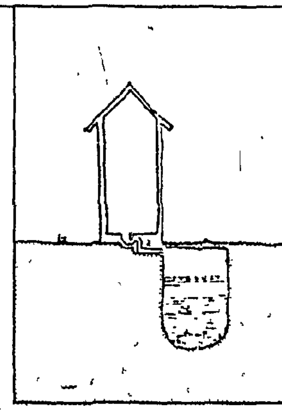


Illustration #40

SANITATION OPTION : II

* Installation cost/plot US $72.38

● Pour-flush toilet



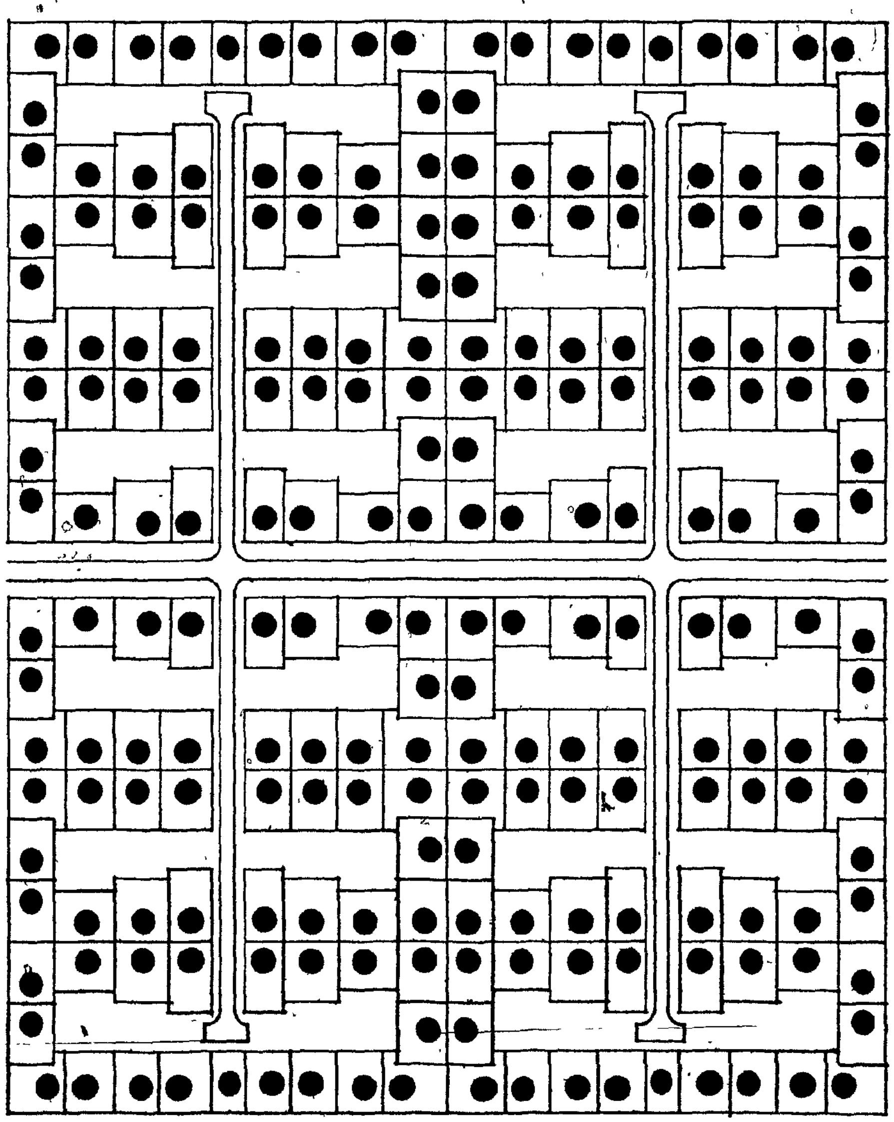
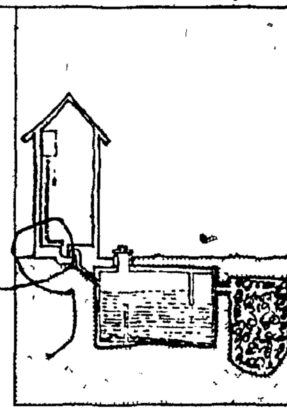


Illustration #41

SANITATION OPTION : III

* Installation cost/plot US $97.50



■ An aquaprivy

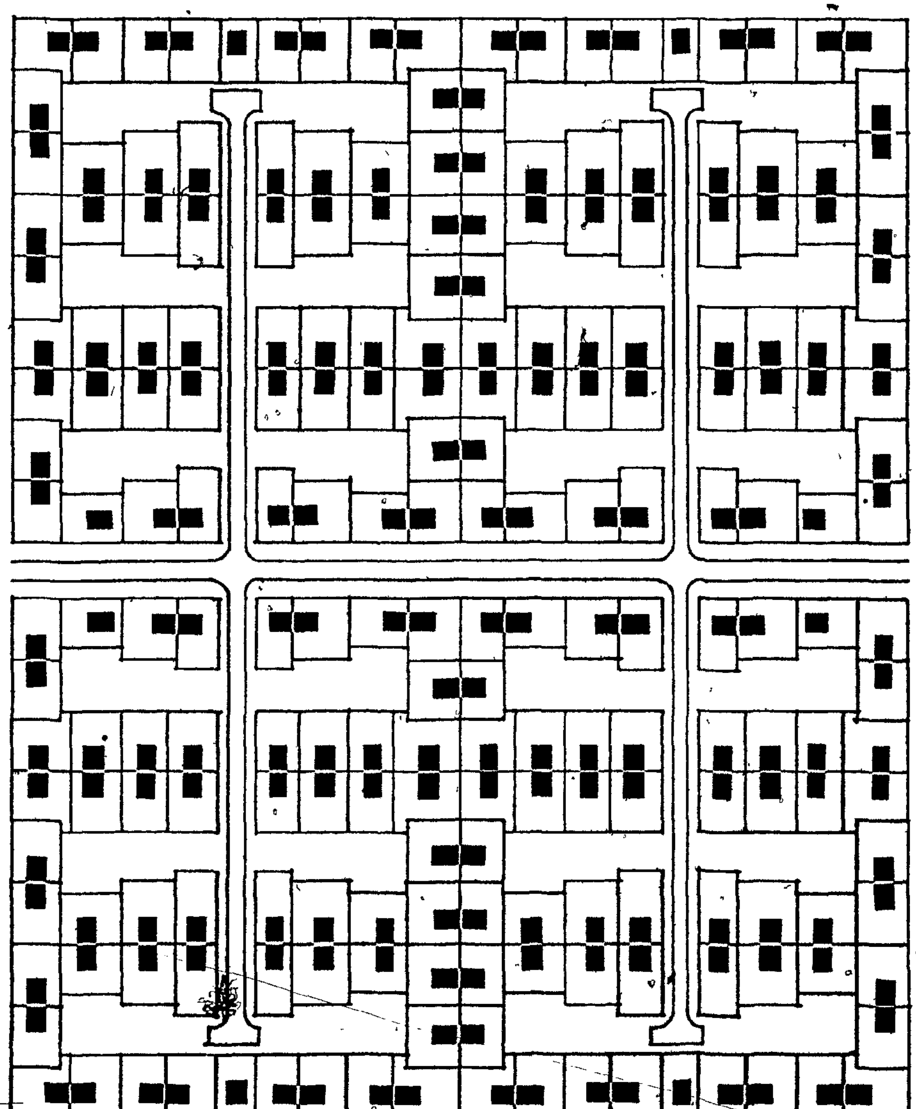
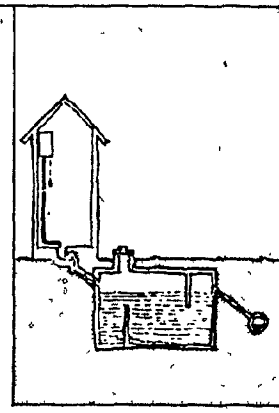


Illustration # 42

SANITATION OPTION : IV



* Installation cost/plot US $271.64

■■■	225 mm Ø collector pipe
▮▮▮▮▮	150 mm Ø sewer pipe
-----	100 mm Ø sewer pipe
□	manhole
■	small dia. sewered acquaprivy

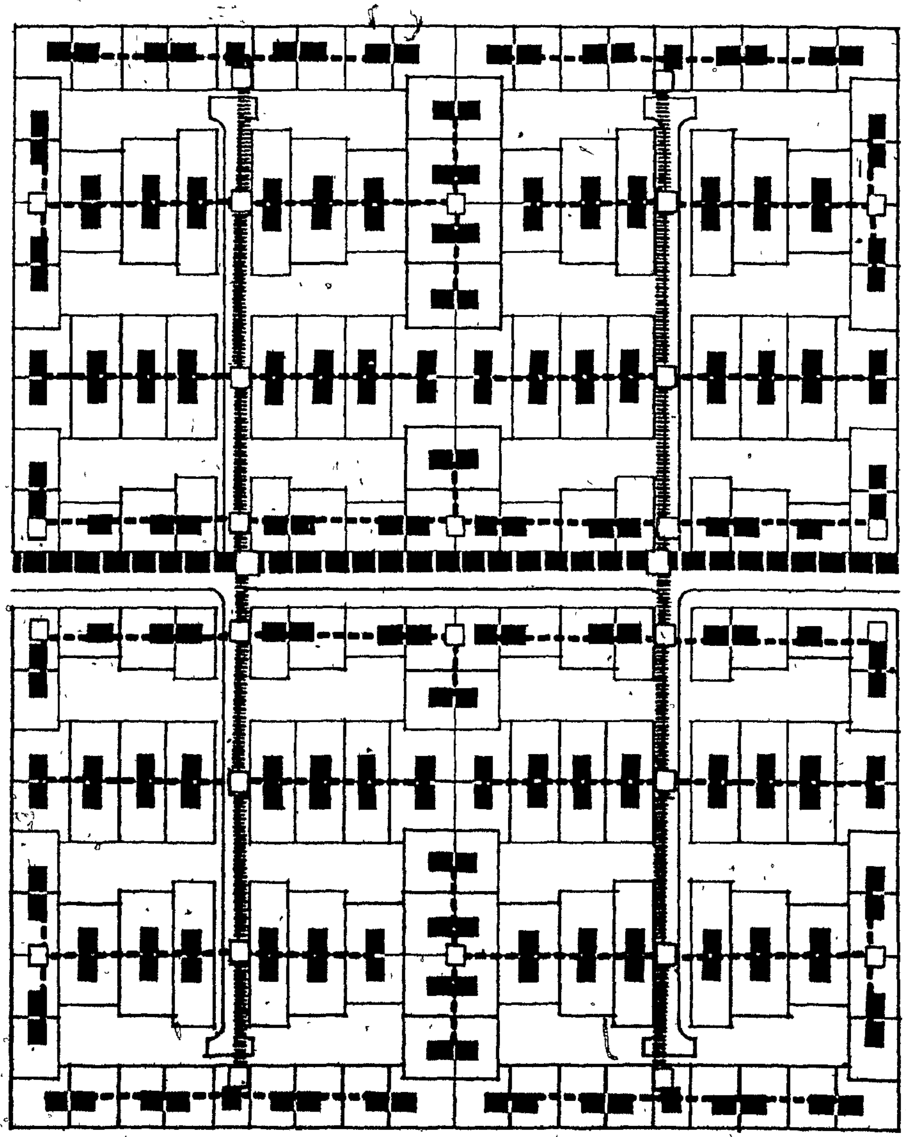
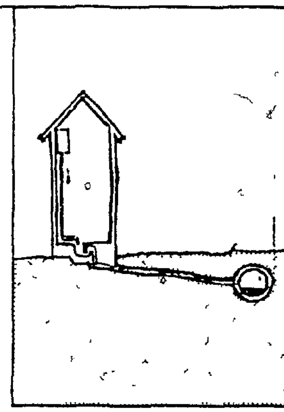


Illustration # 43

SANITATION OPTION : CONVENTIONAL

* Installation cost/plot US $347.81



300 mm Ø sewer main
225 mm Ø sewer pipe
150 mm Ø sewer pipe
manhole
flush toilet

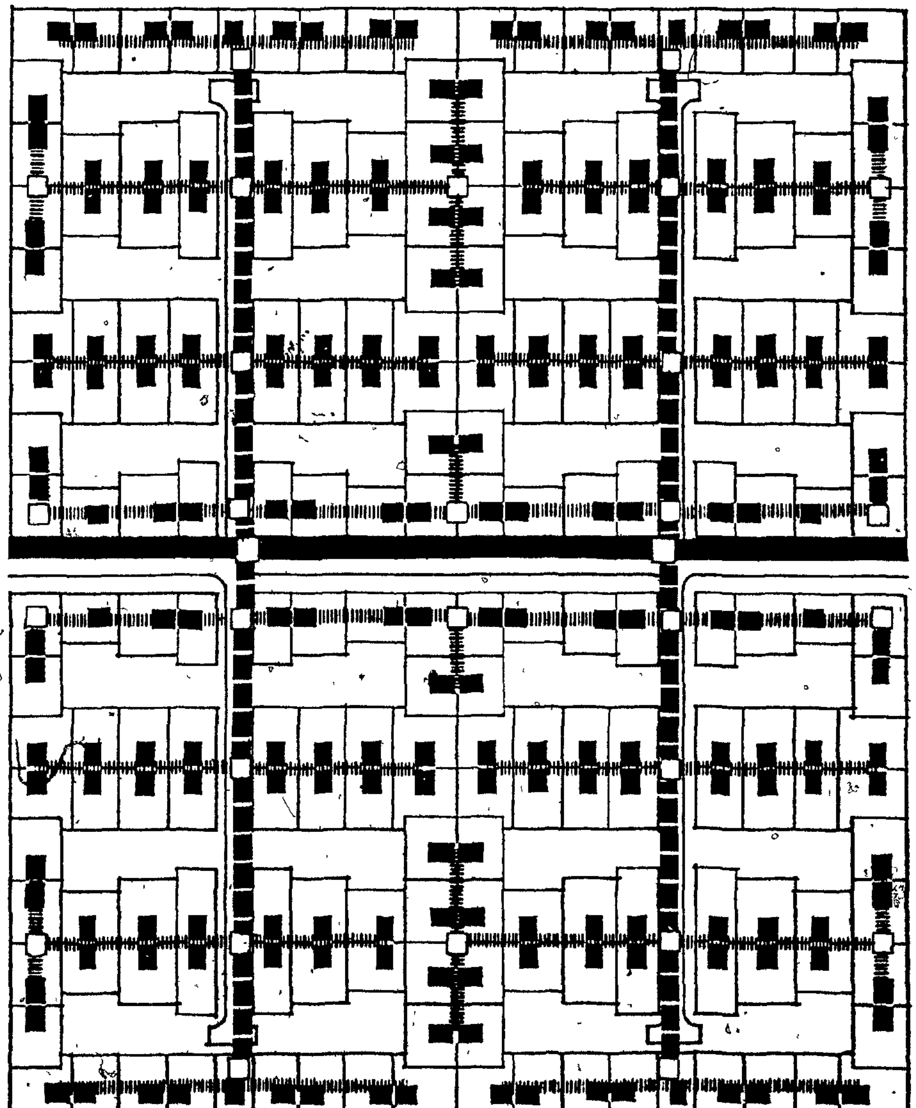


Illustration #44

SANITATION OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A.......US $ 37.50
* Initial investment required for sequence B.......US $ 75.00
* Initial investment required for sequence C.......US $ 97.50
* Initial investment required for sequence D.......US $271.64

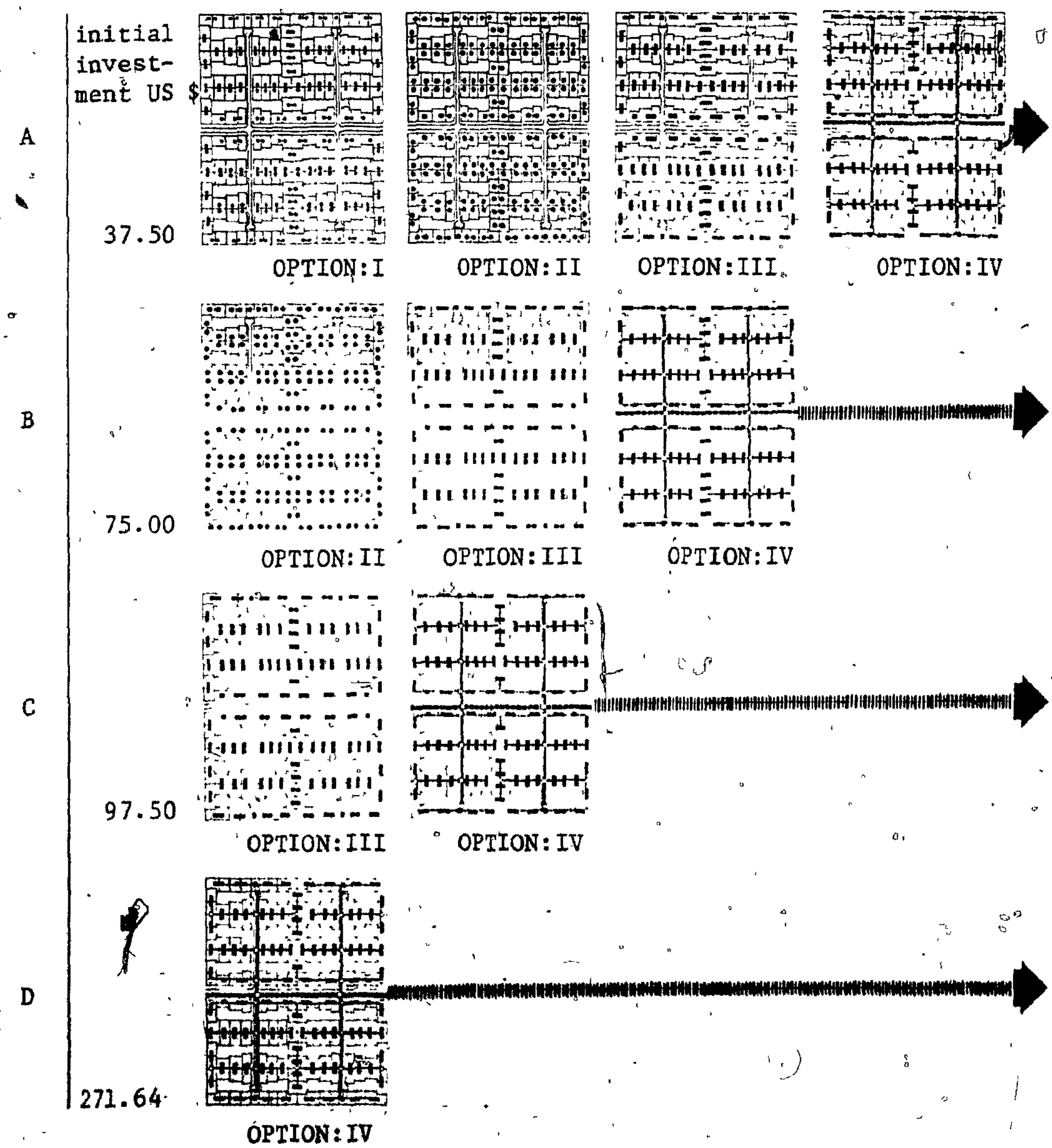


Illustration # 45

3. Roads and storm drainage options

The cost of surfacing roads depends on the quality provided. The principle of upgrading roads begins with a compacted earth surface which provides only seasonal service and is ultimately converted to a conventional tarmac surface. Initially, storm drains are open ditches on the sides of the prepared road surface following the natural slope of the ground for rain water disposal. Eventually, built up ditches which serve as storm drains are provided with concrete culverts where required.

Five options have been developed on the assumption that the main street will be a public transportation route with light commercial traffic.

I. Roads and storm drainage option: I (Illustration no.46)

Only the main road surface is prepared with a gravel base to provide public transport route facilities. Two additional roads are prepared with compacted earth surfaces. Open storm drain ditches are prepared along both sides of the roads and culverts are prepared at two intersections. The cost is US $37.56 per plot.

II. Roads and storm drainage option: II (Illustration no.47)

The main road surface is prepared with tarmac, and storm drain ditches along this road are built up together with culverts at two intersections. Two additional road surfaces are prepared with a gravel base, and storm drain ditches are prepared along these roads. The cost is US $72.38 per plot.

III. Roads and storm drainage option: III (Illustration no.48)

The main road and two additional roads are prepared with a tarmac surafce. Storm drains are built up along these roads and culverts are prepared at two intersections. All extensions in the clusters are finished with compacted earth surfaces thus providing direct road access to each plot. The cost is US $130.47 per plot.

IV. Roads and storm drainage option: IV (Illustration no.49)

All road extensions in the clusters are prepared with a gravel base and accompanying storm drain ditches are provided with culverts at all intersections and junctions. The cost is US $174.98 per plot.

V. Road and storm drainage option: V (Illustration no.50)

All road surfaces are prepared with tarmac with built up storm drain ditches and necessary culverts of conventional standards. The cost is US $222.11 per plot.

ROADS AND STORM DRAINAGE OPTION : I

* Installation cost/plot : US $ 37.56

gravelled base surface
with culverts

compacted earth
with formed ditches

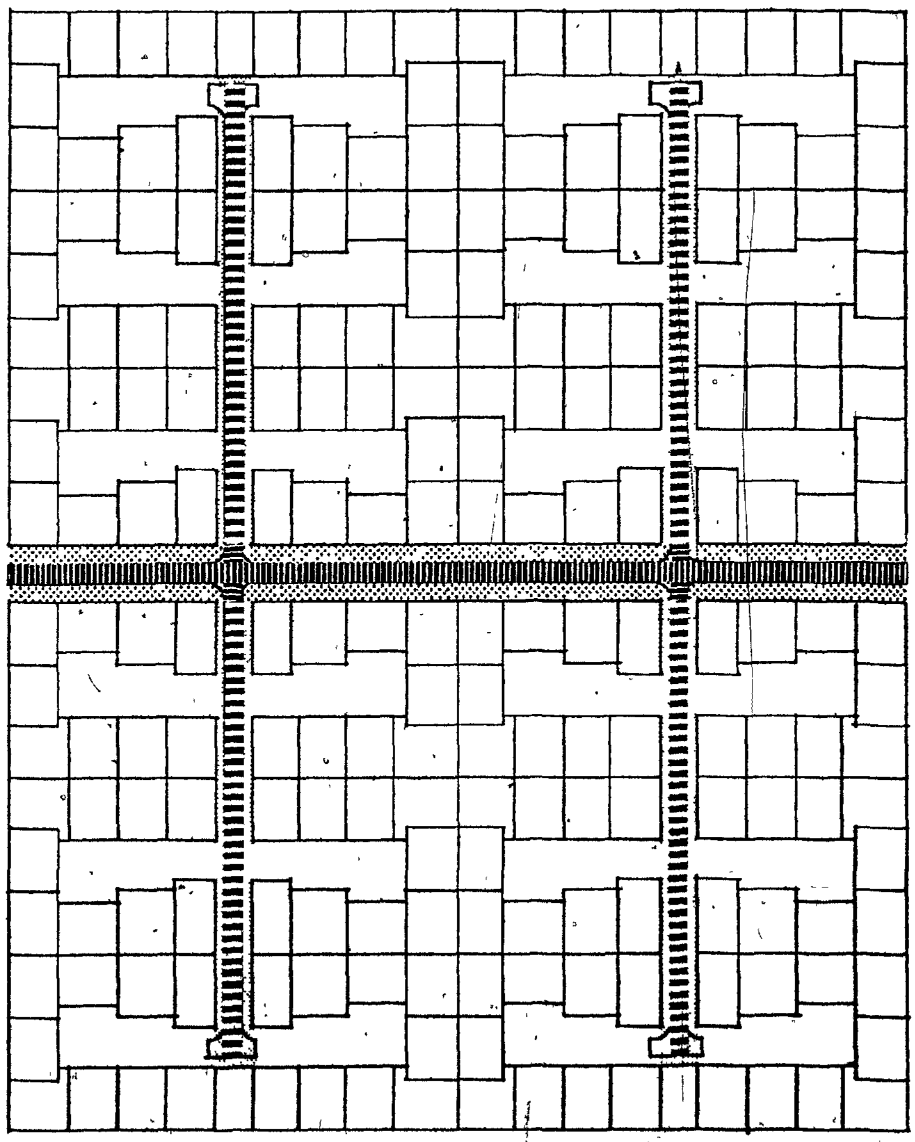


Illustration #46

ROADS AND STORM DRAINAGE OPTION : II

* Installation cost/plot : US $ 72.38

tarmac surface
with built up ditches and culverts

gravelled base surface
with culverts

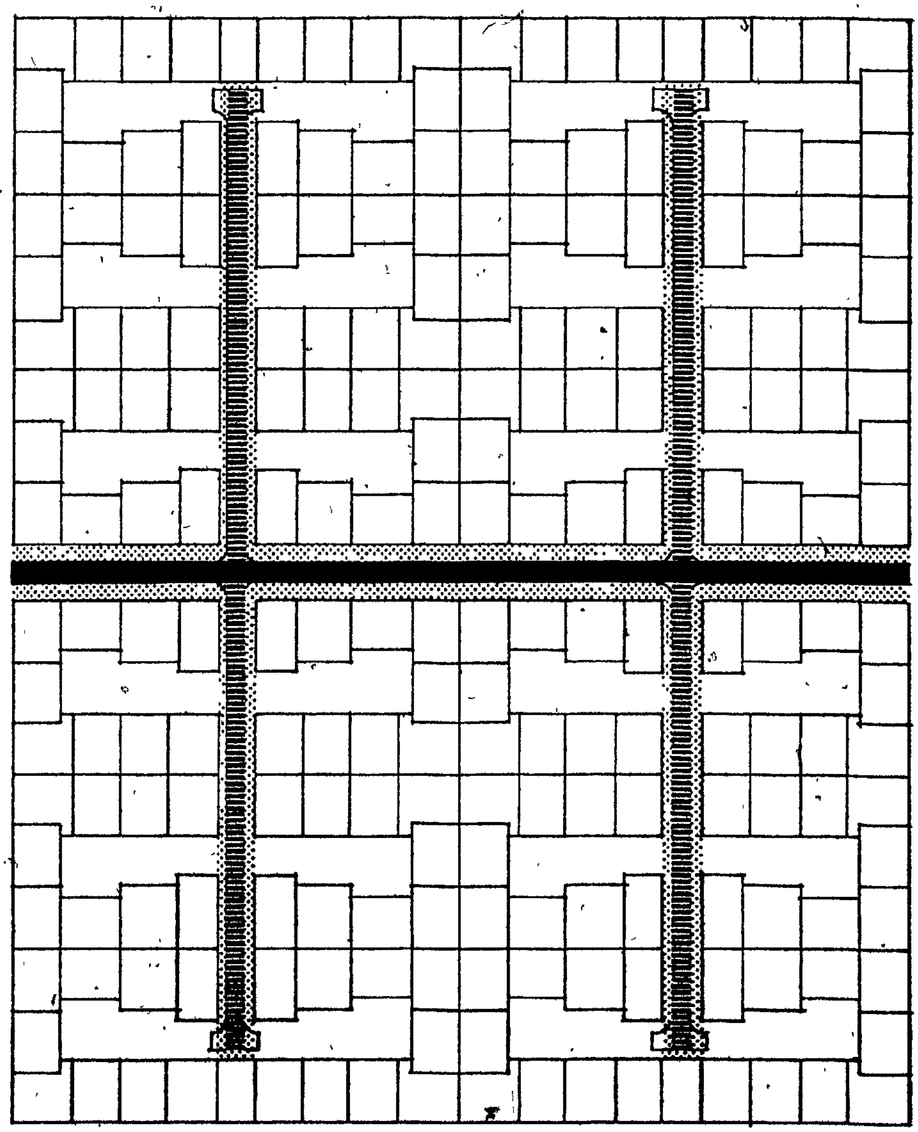


Illustration #47

ROADS AND STORM DRAINAGE OPTION : III

* Installation cost/plot US $130.47

tarmac surface
with built up ditches and culverts

compacted earth
with formed ditches

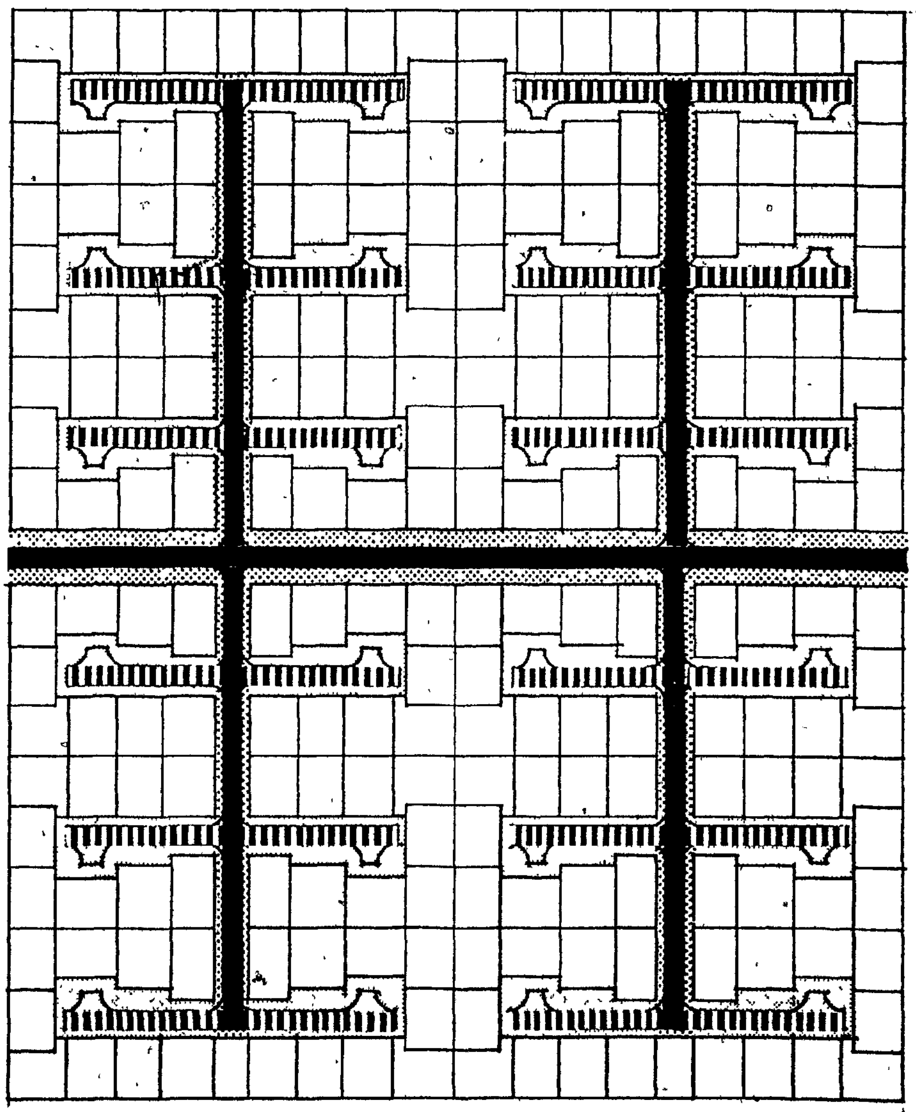


Illustration #48

ROADS AND STORM DRAINAGE OPTION : IV

* Installation cost/plot US $ 174.98

tarmac surface
with built up ditches and culverts

gravelled base surface
with culverts

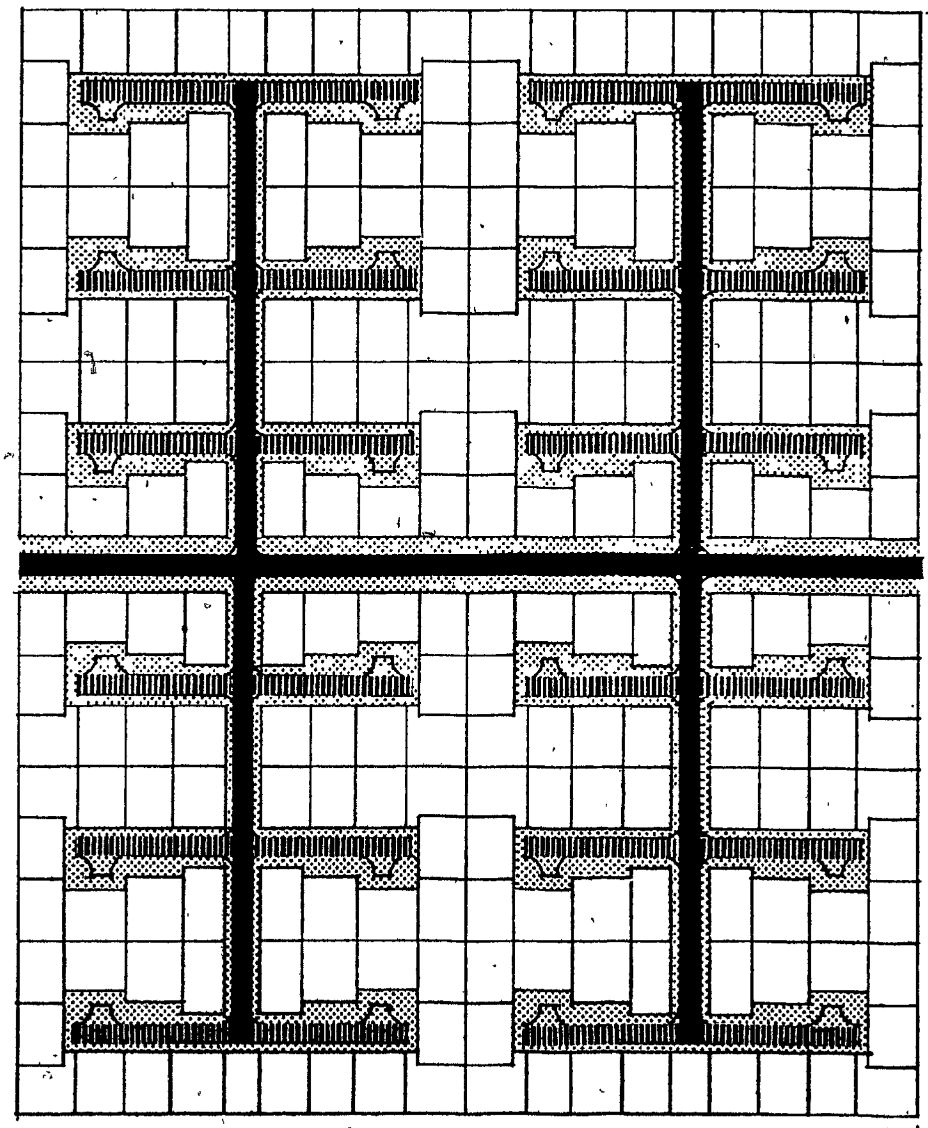


Illustration #49

ROADS AND STORM DRAINAGE OPTION : V

* Installation cost/plot US $ 222.11

tarmac surface
with built up ditches and culverts

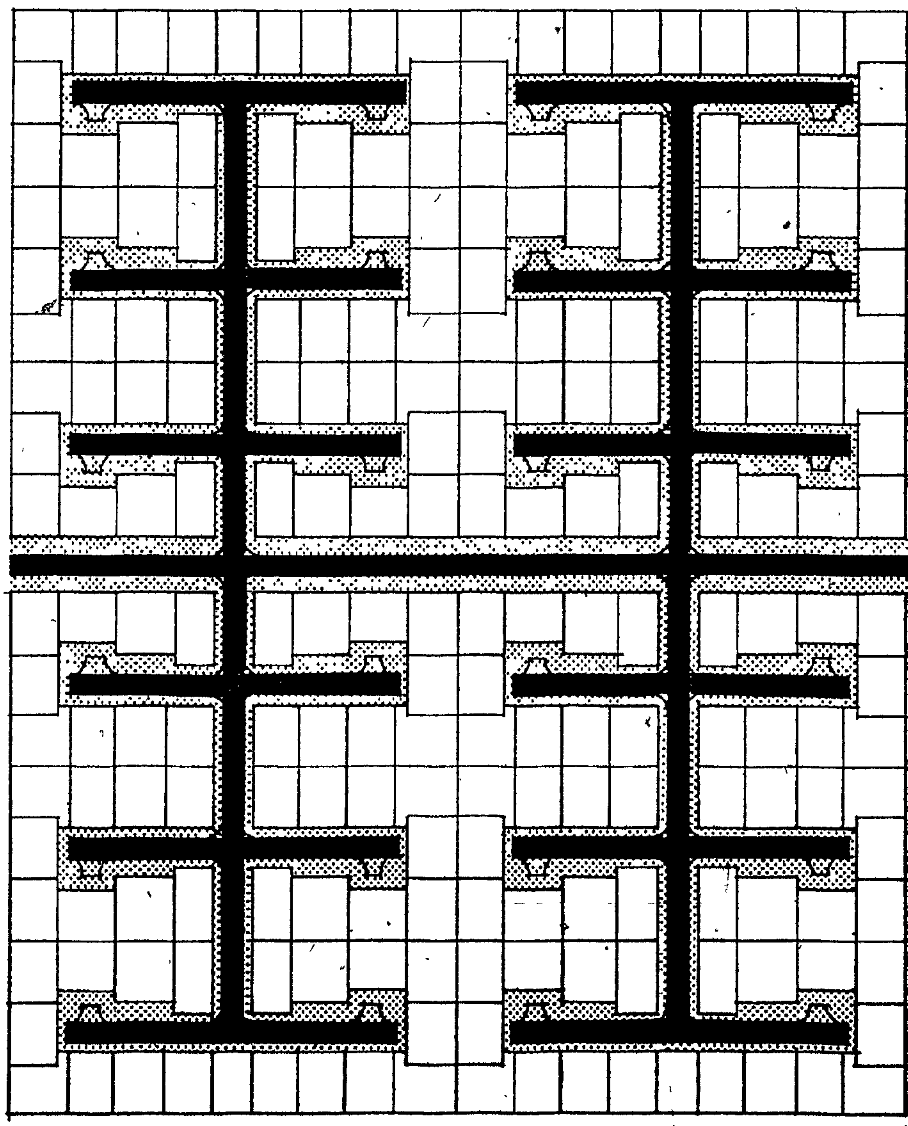
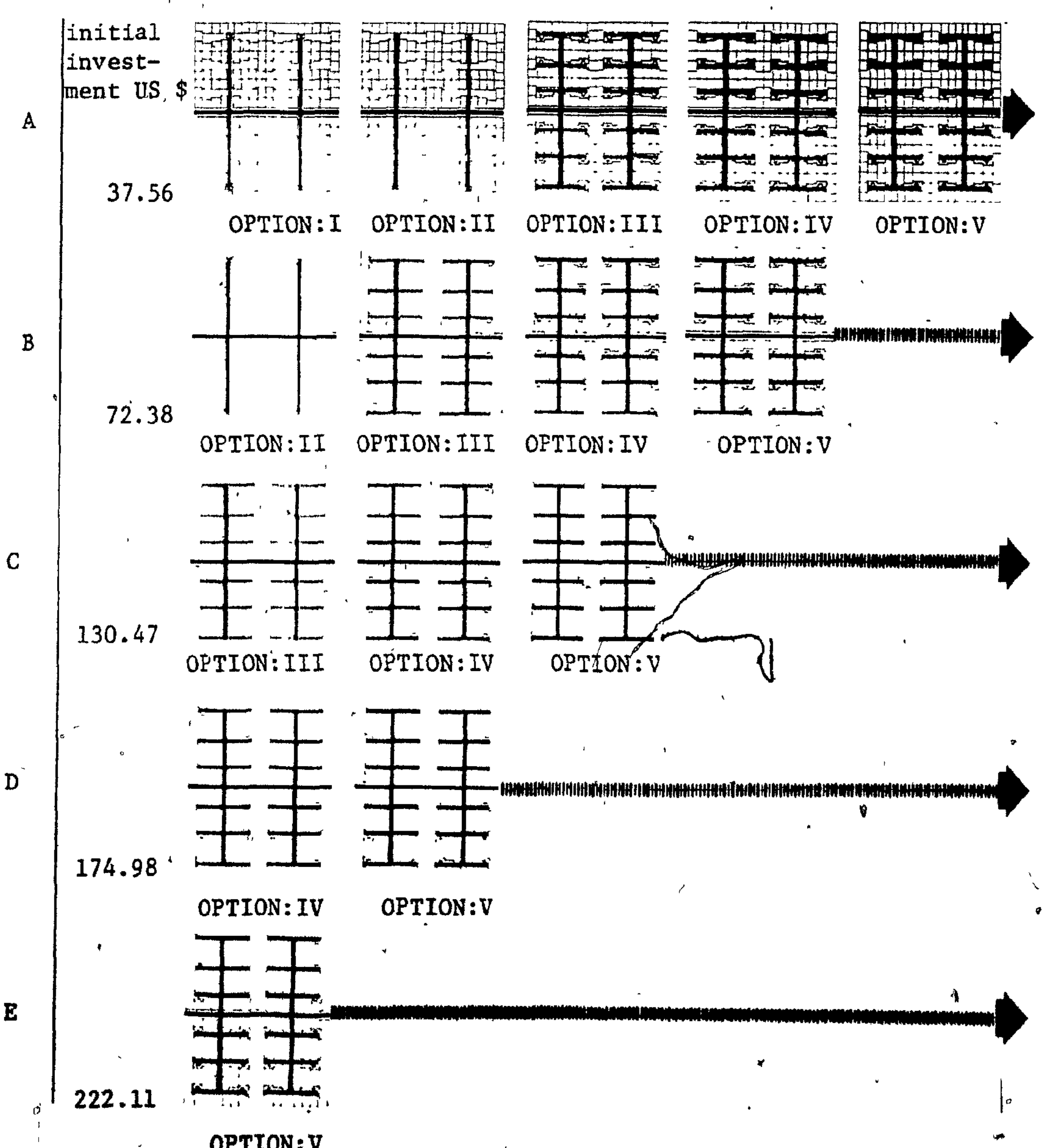


Illustration #50

ROADS AND STORM DRAINAGE OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A ......US $ 37.56
* Initial investment required for sequence B ......US $ 72.38
* Initial investment required for sequence C ......US $130.47
* Initial investment required for sequence D ......US $174.98
* Initial investment required for sequence E ......US $222.11



4. Electricity and street lighting options

The cost of electricity and street lighting installations is a function of the degree of service provided. Electricity and street lighting options can eventually be upgraded to complete electrical services. Initially, street lighting is provided only at intersections for security, and eventually street lighting of conventional standard is provided at all required points.

Only two options are developed for street lighting and no options are developed for electrical connections to houses. It is possible to provide house connections to those who desire it from the beginning.

I. Electricity and street lighting option: I (Illustration no.52)

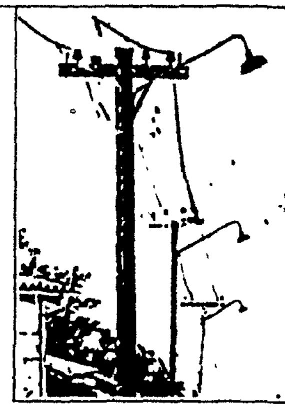
Street lighting at all intersections is provided. The cost is US $39.34 per plot.

II. Electricity and street lighting option: II (Illustration no.53)

Street lighting is provided at all required points. At this stage all connections to houses should also be finished. The cost is US $44.80 per plot.

ELECTRICITY AND STREET LIGHTING OPTION : I

* Installation cost/plot US $ 39.34



electric distribution line

street light

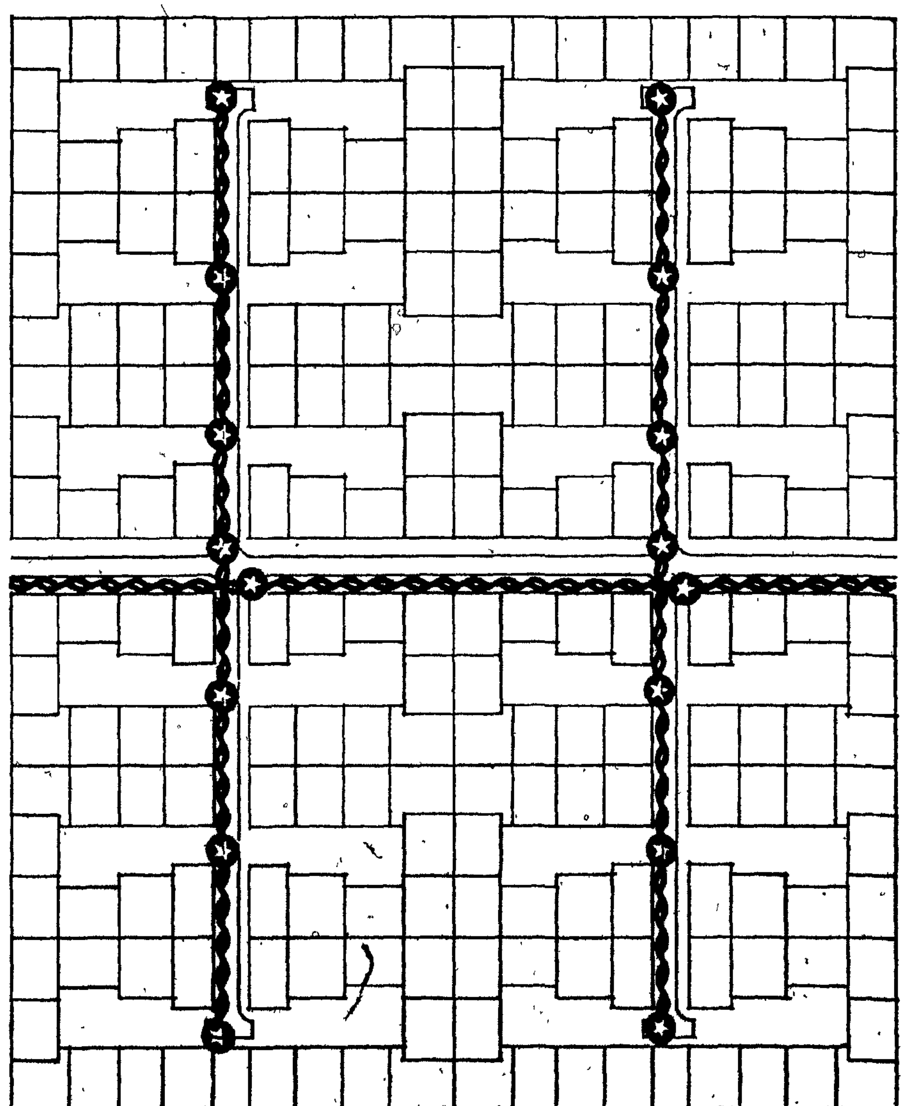


Illustration #52

ELECTRICITY AND STREET LIGHTING OPTION : II

* Installation cost/plot US $ 44.80

electric distribution line

street light

individual connection

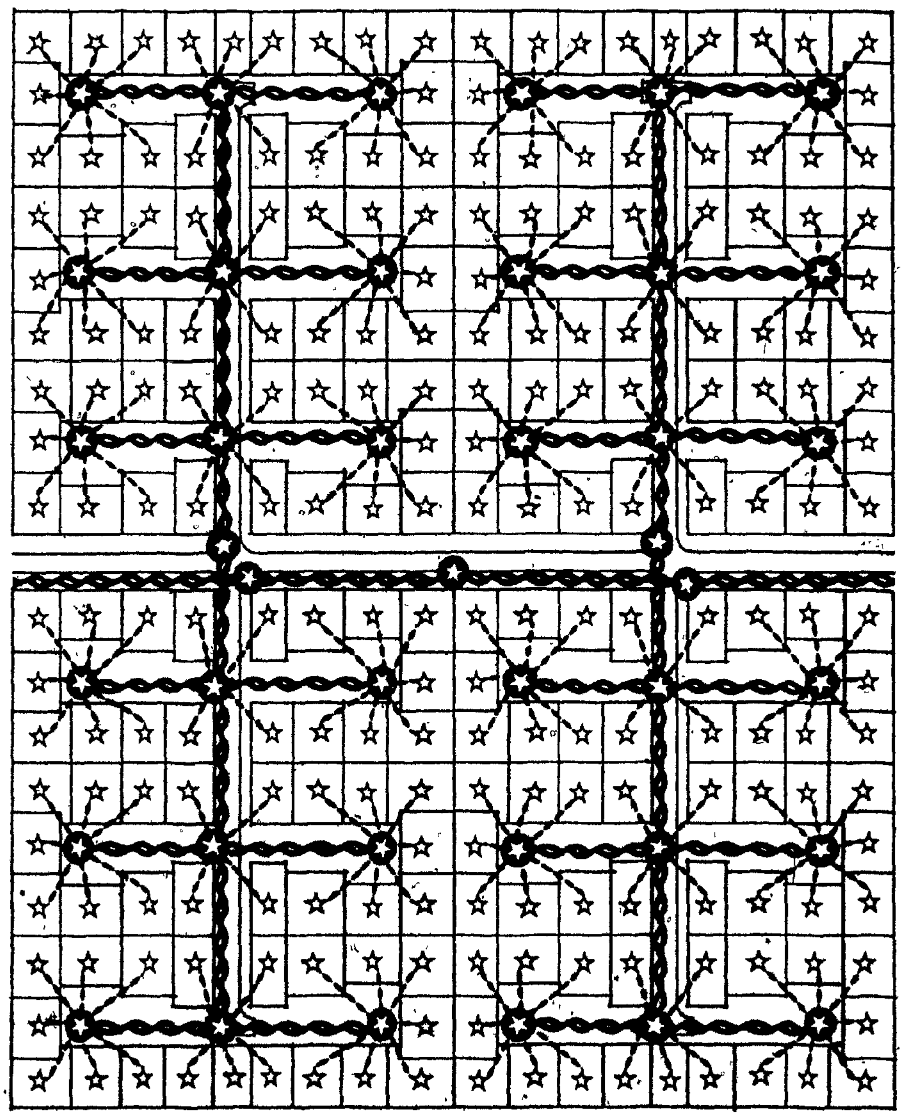


Illustration #53

SERVICING OPTIONS FOR AFRICAN LOW-COST HOUSING

A thesis submitted to the Faculty of Graduate Studies and Research of McGill University, Montreal, in partial fulfillment of the requirement for the degree of Master of Architecture.

Mahendra Shah

April, 1980

ABSTRACT

The growth of urban centers continues to outstrip the ability to supply dwellings and urban services in many African cities which have limited financial resources. It is becoming increasingly harder for the urban poor to acquire an affordable dwelling which is a basic necessity. To put housing within the reach of these people it is essential to develop ways of reducing the investments by lowering the standards of services. The present thesis examines such a possibility and outlines specific options for Lusaka, Zambia.

RÉSUMÉ

L'expansion constante des centres urbains continue de l'emporter sur la capacité de fournir des logements et des services urbains dans beaucoup de villes africaines dont les ressources financières sont limitées. Il devient de plus en plus difficile pour les mal nantis de la ville d'obtenir des logements abordables, bien qu'il s'agisse d'un besoin fondamental. Pour mettre l'habitation à la portée de ces gens, il importe d'élaborer des moyens de réduire les mises de fonds en réduisant les normes visant les services. La présente thèse cherche à étudier ces possibilités et à ébaucher des choix particuliers à Lusaka, au Zambie.

ACKNOWLEDGEMENTS

Many individuals were both helpful and encouraging in the development of this thesis. The author is especially grateful to Professor Witold Rybczynski for his keen interest and guidance and to Miss Maureen Anderson for her assistance with regard to administrative matters.

Deep gratitude is expressed to the staff of the National Housing Authority, Lusaka with whom the author gained invaluable work experience and to the staff of the World Bank, Washington DC who willingly provided information.

The help of Mr. Mark Sedgwick and Miss Andrea Hajdo is acknowledged for reading manuscript and for making useful suggestions.

CONTENTS

PREFACE

Preface

The provision of adequate housing for the growing number of urban poor, at a price they can afford, is a formidable task for concerned authorities. Housing for the poor is usually costly in relation to their incomes and therefore it is extremely difficult to make enough provision for housing.

The provision of a plot on a parcel of land which is serviced with related infrastructure, normally referred to as Site and Services programmes, is one step in the direction of such efforts. However, it has proven difficult to meet the set targets with available financial resources.

Inappropriate servicing standards are a major cost item for such programmes forming the principal barrier in achieving goals. Public authorities can minimize the costs by providing affordable standards of services at the initial stage. The present study examines the possibility of lowering the initial standards of services for Site and Services projects and identifies workable options for long-term upgrading.

This study does not propose to reduce the standards of services to be provided. Rather it examines and outlines a method of reducing initial investments by lowering the servicing standards at the initial stage while maintaining the possibility of upgrading them at a later date without precluding any of the previous works. Hence, different servicing options may at first incorporate a low level of service which permits subsequent upgrading.

Options discussed in the study are not to be considered as alternative solutions since all options allow future upgrading without loss or damage to present installations. For example, if a standpipe is initially installed with several taps to supply water to a group of families, but allows for future upgrading to a greater number of individual connections, initial costs are reduced. The main point to remember is that the minimum cost option should never preclude the possibility of future improvements towards conventional standards. Finally, it is not the purpose of this study to present a readymade proposal for implementation. For different sites, different options can be applied at different stages. The study demonstrates that the cost ratio between the lowest option and the conventional one for water supply may be as high as 5.1 : 1 . There is clearly the possibility of considerable savings in the initial development costs of the Site and Services projects.

The study is organized into three chapters. The first chapter examines African low-cost housing. The second chapter reviews the state of the art of services and identifies practical options in general. In the third and the last chapter these options are translated on a prototype layout in the specific case of Lusaka, Zambia, based on about 20 months' work experience during 1974 to 1976.

CHAPTER : 1   AFRICAN LOW-COST HOUSING

1.1 Low-cost Housing in Africa and Related Issues

One of the basic needs of every human being is to acquire a shelter for himself and for his family, be it a tree, a cave, a hut or a house. Shelter provides protection against the weather, a space for resting and sleeping and a place to react to physical, material and psychological surroundings.

It is becoming increasingly difficult, particularly in urban centers, to acquire a shelter which can satisfy even minimum requirements with available financial resources. Countries in the African continent are no exception to this phenomenon. Urbanization and low-cost housing are two closely related topics which demand a closer study.

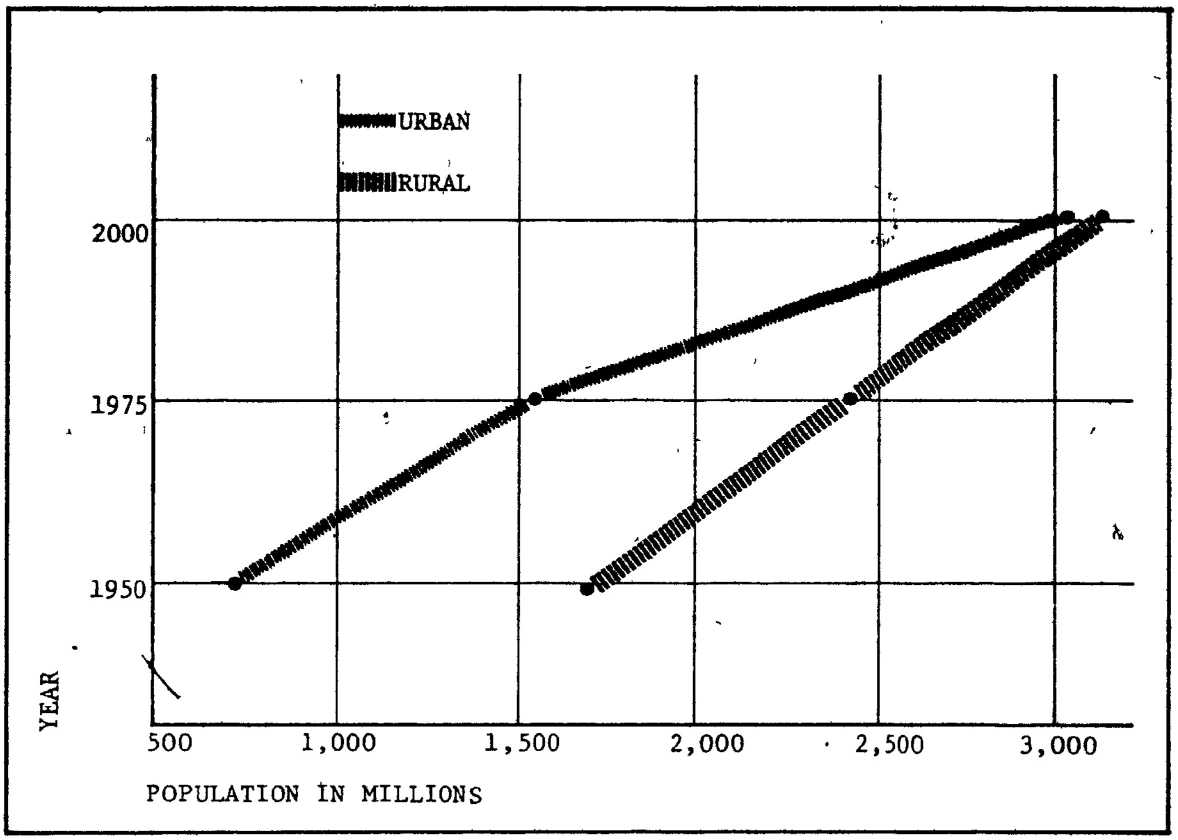
Urbanization in Africa

In sub-saharan Africa, urban growth and economic development are essentially twentieth century phenomena. The traditional form of settlement was the shifting village or hamlet which was mainly rural in character. The settlements that can by any definition be classified as urban places were settlements inhabited by chiefs who attracted some craft specialists around them; but such settlements can hardly be defined as urban by any internationally set criteria. Furthermore, with the advent of colonial rule, such settlements declined in status.[1] Most of the present urban centers in Africa are essentially the product of colonial rule and therefore urbanization in sub-saharan Africa was largely a response to the needs of colonial economic policy. Today African urbanization takes place within a variety of political frameworks and the diverse accompaniment of problems demand attention.

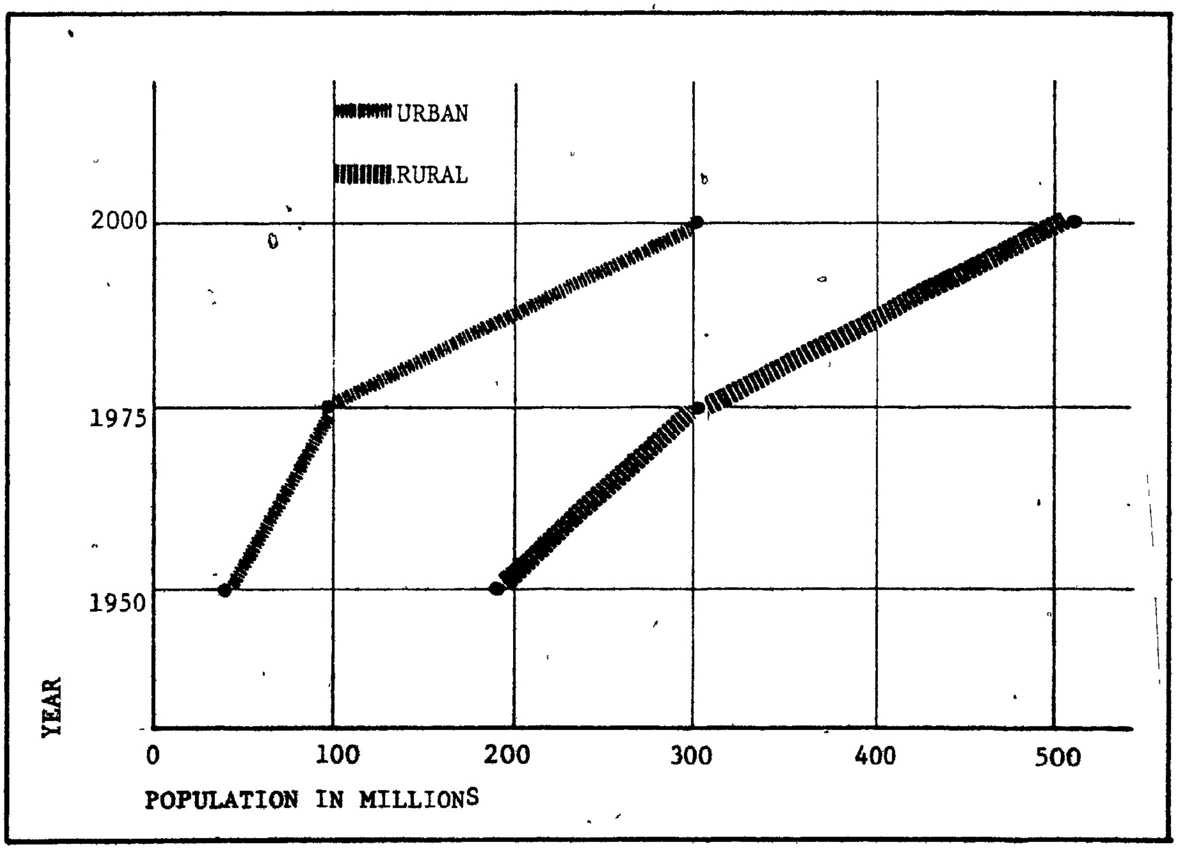
Africa was a late starter in the urbanizing process and remains the least urbanized of all the continents. Consequently Africa has the highest rate of urban growth in the world. Urban and rural population estimates of the world and Africa are presented in illustrations 1 and 2 respectively. Estimates indicate that urban growth represented in percent increase between 1900 and 1950 was 629 for Africa, 444 for Asia and 254 for the world at large.[2] However, the annual rate of urban growth in Africa between 1850 and 1950 was only around 3.9 percent compared with 2.6 percent for the world as a whole.[3] One of the reasons for this urban growth can be attributed to the migration of people from rural to urban centers for a variety of reasons. The rural to urban migration trend comprised about 51 percent of the increase in the total urban population in Africa for the period between 1970 and 1975.[4] Although migration is clearly a factor in Africa's urbanization process, it poses a different problem from that of the 1930's and 1940's when the urban population was necessary to supply the labour needs of industry.

In the last twenty years, the population of most urban centers in Africa more than doubled, and in some cases tripled. For example, the urban population of Zambia grew approximately 21 times faster than the rural, and around 4 times faster than the national population between 1963 and 1974.[5] However, the difference in these growth rates is largely the result of migration from villages to urban centers. For example, 77.1 percent of Lusaka's growth could be attributed to migration for the years 1968-1969.[6]

The direct effect of this population increase in the urban centers was felt in the housing sector. Traditional methods of providing housing did not cope with the demand. The provision of housing is complex and requires heavy investments in infrastructure for related services.



URBAN AND RURAL POPULATION : WORLD [7] Illustration # 1



URBAN AND RURAL POPULATION : AFRICA [8] Illustration # 2

Housing Requirements

A continuous increase in the supply of housing stock is needed to cope with the increasing urban population. Failure on the part of concerned authorities to provide an ample supply of housing results in innovative solutions by people themselves. One such solution is the squatter settlement which is a feature common to all urban centers not only in Africa but throughout the developing world. In order to increase the supply of housing continuously, it is imperative that the concerned authorities have accurate estimates of housing requirements, adequate financial resources, technical capabilities and appropriate strategies.

It is estimated that the urban population during the period between 1960 and 1975 was around 76 million or 19.3 percent of the total population of Africa.[9] The total urban housing requirements for the same period are estimated to have been 11.4 million dwellings. Little is known about how well goals in urban housing were met for the period between 1960 and 1975, but it is calculated that from 8 to 10 dwellings per 1,000 inhabitants were needed to be constructed to meet the requirements. Fifteen of the 66 cities in Africa, with populations between 100,000 and 500,000 for which information was available, have a very high percentage of squatter populations ranging from 48 to 90 percent of the total population.[10] It is obvious from the high percentage of squatter populations that the housing requirements have not been adequately met.

Revised urban population projections suggest that by the year 2000 the urban population of Africa will be 301 million.[11] Accordingly the total estimated urban housing requirements will be approximately 50 million dwellings. To meet such a requirement with available financial resources, a gigatic effort will be needed. In order to achieve such an objective, it will be useful to examine briefly how efforts have been made to meet the total housing requirements chiefly by providing low-cost housing.

Low-cost Housing and The Serviced Sites Approach

The need to provide housing for the urban poor has long been recognized by governments in developing countries which are especially aware of the importance of housing to urban and national economies. The housing sector plays an important role in social welfare, thus a positive housing policy makes a substantial contribution to economic development and social welfare. Despite the importance of the housing sector, the housing conditions in many cities remain a major problem.

A decreasing proportion of the urban population has benefited from the efforts of urban housing authorities. Therefore a growing proportion of these urban populations have developed housing solutions in the squatter settlements which are outside the jurisdiction of the authorities responsible for meeting housing needs. The most common function of the squatter settlements has been to provide housing for the lowest income groups of the urban population. Squatter settlements provide shelter to the urban poor who need an inexpensive residence in or near the city.

Housing policies for the urban poor have typically stressed the public supply of fully serviced 'standard' housing units. The construction costs of such 'standard' housing units result in very high rental or financing costs that are much beyond the means of the majority of the urban population. The only way to make such policies operative is through subsidies but such subsidies do not allow replication of projects. Furthermore, the economies of developing countries cannot afford to provide subsidies.

The policy makers realized that urban growth continued to outstrip the public sector's ability to supply housing units. This understanding caused most countries in Africa to abandon complete reliance on conventional public housing methods in favour of the exploration of self-help approaches to urban shelter. The provision of serviced sites is one such approach.

The provision of serviced sites, widely known as the Site and Services programme, satisfies needs at many levels in that it stimulates maximum private involvement in shelter development with minimum public expenditure. For most developing countries this approach provides the only realistic method of substantially alleviating housing shortages. The Site and Services approach is discussed in more detail in the following section.

1.2 Site and Services Provision

The inefficient use of available resources is evident in existing patterns of urban development. This problem is well illustrated in the pattern of squatter settlements. More often than not, sites of squatter settlements prove both expensive and difficult to supply with necessary services: water supply, sewers and roads. Evidently, supplying services at a later date is more costly than directing the pattern of development through planning.

The alternatives as far as housing is concerned are two: (1) to provide complete dwellings to a few beneficiaries and (2) to provide utilities and services to a much larger sector of the urban population. In the latter case, the concerned authorities redirect their efforts in order to provide utilities and services on urbanized parcels of land. Such provisions are currently referred to as Site and Services programmes.

The construction of dwelling units which do not call for special skills or tools can be undertaken by individuals to suit their economic situation as is the case in many squatter settlements. The provision of services to a community demands more technical resources and more collective effort. Therefore, the construction of services will always be institutional.

Other Similar Concepts

The inception of the Site and Services concept can be traced to the dissatisfaction of the concerned authorities with the performance of their housing schemes in dealing with slum clearance, resettlement housing or low-cost housing. Housing policy makers were forced to rethink issues because their policies incurred financial problems and failed to achieve goals. One important concept that emerged from this reassessment was that a substantial part of low-income population can (and do) house themselves, without direct control or assistance from the government. The planners also realized that this construction could be directed relatively quickly, and controlled through legal ownership of land with the installation of urban utilities and services. The development of these two important ideas defines the basis for the present Site and Services concept. Tipple cites a very good example to illustrate that a site with a few urban services encourages people to construct their own permanent dwellings.

> "The extent of the demand for housing is indicated by a recent occurance in Kitwe (Zambia). 'Charlie West', a small contractors' settlement of 19 dwellings close to the official housing area, was provided with water at three standpipes by the council. Households in a nearby settlement, 'Kabulanda', were encouraged to move and resettle at Charlie West. A few households from elsewhere joined in the resettlement and, as the word spread, more flocked to the area from adjacent council low-cost housing. Political party officials 'allocated plots' and shopkeepers established businesses. The resultant settlement, four months after the first resettlement, numbered 1,800 dwellings under construction and was aptly renamed 'Ipusukilo' (meaning 'refuge'). The generally high quality of house construction indicates that the people feel secure and with subsequent upgrading, the area could form a useful addition to the official urban housing stock. This spontaneous grassroots movement added more dwellings to the housing stock of Kitwe than the city council had planned between 1971 and 1974."[12]

The example described above bears great similarity to the description of Sites and Services projects. By providing water pipes and allocating plots, the city council and the political party officials joined together to provide serviced urban land to a low-income section of the population.

Similar concepts have been presented or discussed and have even been implemented in some cases in different parts of the world. Although the details of each application vary slightly and are distinctive, they all bear a striking similarity to that of the Site and Services approach. The term "basic sites" is linked with the concept of Site and Services since provision is made for basic services only. Tipple has proposed a concept of planned informality.[13] It is so described because a square area large enough for 25 plots allows the group to grow informally, like existing squatter settlements, but each square is part of a gridiron pattern division which ensures economy in laying future services. Similarly the concept of urban villages also promotes informal growth, while retaining control to ensure the easy supply of services at a later date.

Meaning of Site and Services Projects

Site and Services projects are aimed at stimulating maximum private involvement in dwelling development using minimum public expenditure. Public expenditure and public action are directed to the goal of removing constraints for people who have demonstrated an ability and willingness to house themselves. Public expenditure and action provide land, infrastructure and in some cases building materials or financial loans to purchase such materials as are required for the construction of a dwelling. Serviced urbanized land is normally sold, or leased at long terms, to individuals or occasionally to groups. The construction of the actual dwelling is left to the individual. This opens the possibility of organizing self-help or mutual self-help or retaining small contractors such as brick layers, carpenters and artisans to build part or all of the dwelling unit.

In simple terms, Site and Services projects can be described as the development of land that is levelled and provided with access roads, drainage, water supply, sewers and electricity and sold or leased to the prospective resident who builds his own dwelling. The essential services of water supply, access roads, sewers and electricity together with street lighting may vary in degree and depend on the standards acceptable to the community. The site location for such a project is of critical importance in relation to its distance from places of employment and the main business district of the city. A Site and Services project is graphically explained in illustration no. 3.

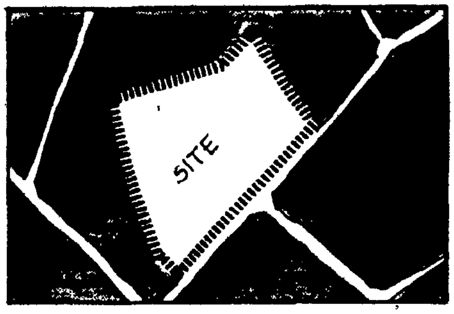
Since the development of a cohesive community cannot rely on the construction of housing alone, social amenities, communal services and the generation of employment should be considered in the eventual project. These services usually include schools, police posts, health centers, community halls, refuse collection service, markets and fire protection service.

In summary Site and Services projects are balanced programmes based on self-help and progressive improvement and, in this way, they are geared to the development of low-income communities.

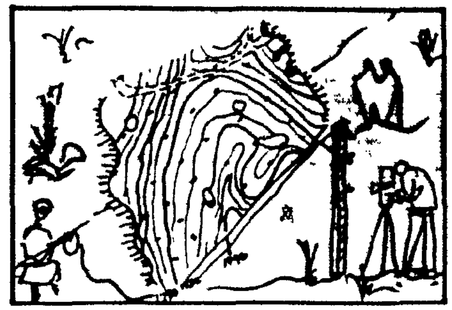
Standards of Services

Since Site and Services projects are designed to provide housing for low-income families, the development costs for such projects must be within economic limits. There are several factors which directly affect the costs of the final development. One of these factors is the degree to which services are provided. A higher level of services demands higher repayments and thus is cost prohibitive for low-income families.

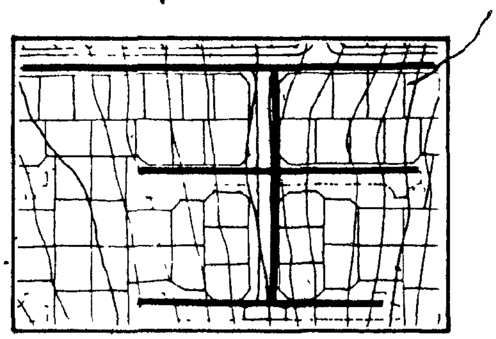
The highest standards of services may be fixed by the maximum affordable



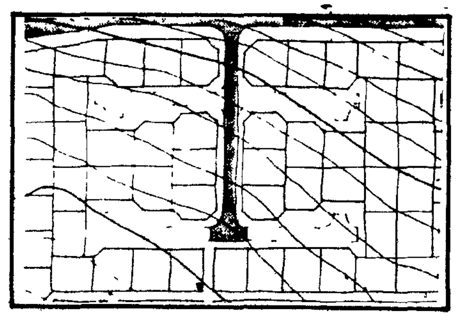
A PARCEL OF LAND



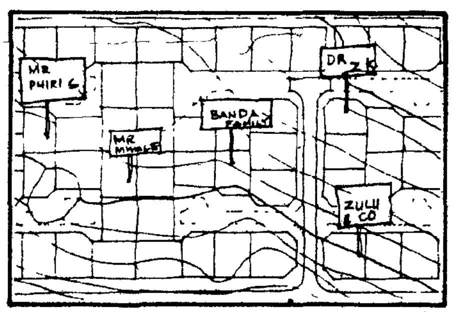
TOPOGRAPHICAL SURVEY



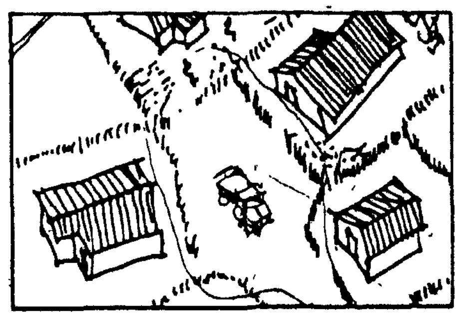
INSTALLATION OF SERVICES



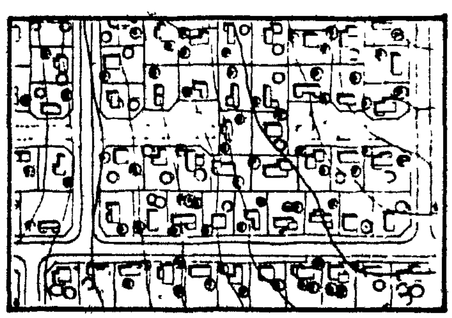
PREPARING ROADS



ALLOCATION OF PLOTS



INDIVIDUALS START CONSTRUCTION



A COMPLETED PROJECT

SITE AND SERVICES PROJECT

Illustration # 3

costs and by the repayment requirements which can justifiably be borne by the target income level. Bearing in mind the factors affecting the absolute standards, most of the plots may have the following services in varying degrees:

1. Road access facilitating access to the place of employment either by foot or by public or private transport.
2. Water : either communal or individual supply.
3. Sanitation : pit latrines, sewered aquaprivies, cesspools, septic tanks or conventional sewer facilities.
4. Storm drainage : either by natural slopes with necessary culverts or by conventional storm drains.
5. Electricity and street lighting : minimum security street lighting and access for individual electrical connection if desired by the resident.

It is to be noted that only infrastructural services are dealt with at this point. Social services are equally important, but detailed discussion of these lies outside the scope of this thesis.

Earlier attempts at Site and Services projects were aimed at reaching not far below the median level of family incomes. Hence, they were comparable to conventional public housing schemes. These projects have since been refined and aimed at urban families with much lower income levels. However, they still do not reach the poorest 20 percent or so of the urban population.[14]

Evidence in Zambia has indicated that the fully serviced plots, or those serviced at the regular standards (see Appendix : A), cost more than the budget allows, and more than the prospective residents can afford. The available financial outlay itself prohibits the use of such standards if the planned number of plots are to be provided. As a result, the National Housing Authority of Zambia reported that the second national development plan (1972-1976) could attain only about 40 percent of the planned target for the provision of serviced sites indicating that the main reason is the shortage of funds.[15] Evidence in Zambia shows that the levels set for the services normally cost more than the available finances allowed. In this case, since the financial outlay was constant and known, it would have been useful to correspondingly revise the level of services to be provided to match it. The levels of services to be provided or the services themselves could have been checked. It is apparent that such revisions did not take place and hence it was impossible to achieve the target. Another important factor in reducing cost is the optimization of the layout. Caminos and Goethert have prepared a thorough study of services and summarized their findings:

> "The conclusions that can be derived from them (studies on infrastructure) are not new, but they provide an element of credibility since they are substantiated by numbers. Some conclusions are:
>
> d) Two approaches to minimize costs are: 1) To lower the level of services, which is a policy decision. 2) To optimize the layout for required level, which is a design decision."[16]

For a case in Zambia, Martin concludes from his studies that the serviced plots were too expensive for 32 percent of the population.[17] This undoubtedly excluded a significant portion of the urban poor. Thus a still cheaper solution is required.

In conclusion, it can be said that the Site and Services concept has potential for expansion provided that the standards of services are viewed more critically.

Role of Services

Essential services such as access roads, water, sanitation and electricity constitute a major portion of expenses representing 40 to 60 percent of the total costs where this total includes land, servicing, plot development, design and supervision costs. The higher standards of services will result in higher development cost, but with limited available financial resources, only a very small sector of the target population can benefit. The intention of minimizing the initial investments can best be accomplished by lowering the standards of services initially, and permitting progressive improvements to match the economic situation. Thus lowering the standards of services at the initial stage means postponing, not changing the standards.

By providing affordable standards of services at the initial stage, public authorities can allocate any extra capital to other programmes while reducing the costs related to the upgrading of services. Hopefully, in the meantime, continuous upgrading of the sites rather than their instant but costly development will take place.

There is a need to examine how to lower the standards of services at the initial stage of Site and Services projects. The following chapter examines this possibility and identifies practical options applicable to these services.

CHAPTER : 2 SERVICING OPTIONS

2.1 General

The role of services in Site and Services projects has been discussed in the preceeding chapter. It was noted that lowering the standard of services provided will substantially reduce development costs.

In many African countries attempts to provide serviced plots have been partially successful in allowing the urban poor to build their own dwellings. Many international agencies have provided financial aid and technical help to countries in Africa. In the 1970's, the World Bank alone undertook more than 30 such urban development projects in the developing world.[18] In the last seven years, basic urbanization projects costing some US $ 1.3 billion have been processed with benefits expected to go to over 10 million people.[19]

Between 20 to 58 percent of low-income families are still unable to afford any sort of official accomodation.[20] To put housing within the reach of these people it is essential to develop ways of reducing costs within an affordable range. The idea of reducing standards of public housing needs to be applied to Site and Services projects themselves. The servicing standards ought to be reduced to an affordable level.

This chapter examines affordable standards of services. These affordable standards of services are called options. The options discussed in this chapter are identified by the author and are based on the experience gained in Lusaka, Zambia and use the methodology developed by the World Bank. The options elaborated are best suited for the chosen example, but not necessarily the only options.

The options discussed in this chapter do not contain any dollar costs. They are presented in the third chapter with a prototype layout. However, the options are grouped in three general cost categories : (1) Minimum cost (2) Intermediate cost and (3) Conventional or standard cost.

2.2 Servicing Options

The conveniences of urban life depend on related social,political and economic systems, on land and shelter and also on a complex system of service networks. Some networks (water supply, sewers, storm drainage or gas supply) are buried in the ground, some networks (refuse collection, police stations, schools, health centers and markets) are laid on the ground and other networks (electricity, telephones or street lighting) are suspended in the air.

The levels of these services provided to a particular community depend on that community's capacity to pay their costs and on financial resources and on technical know-how available. Some communities can afford to have all services while others cannot afford any of them. Site and Services projects require the provision of all of these services to a varying degree. Their cost determine the level of services which these communities can install. The prospective beneficiaries of such projects are low-income families with very small means.

The following services are normally provided in the Site and Services projects:

1. Water Supply:

   Most existing Site and Services projects provide for a piped water supply connection to individual plot. Some projects have tried to provide communal water supply (i.e. a group of plots share a public standpipe).

2. Sanitation:

   Water borne sanitation facilities are appreciated but the costs are prohibitive in many cases. Hence, septic tanks or in some cases simple pit latrines with or without soak pits are provided.

3. Roads and Storm Drainage:

A tarmac road to individual plots is preferred but again the expenses are so prohibitive that quite often only the main road with access to important urban areas is surfaced with tarmac. In most cases, storm drainage is provided by open drains following the natural slope of the site with culverts where required.

4. Electricity and Street Lighting:

Provision is made to have individual electrical connections and security lighting on the streets at a rate of 2 to 5 lamp posts per hectare or at intersections only.

These four services constitute a large portion, usually around 50 percent, of the total project costs. However, there is greater opportunity to reduce the costs of these four services than any other components of Site and Services projects. The total project cost also includes site preparation cost, land cost, plot development cost, design and supervision cost and contigency cost of between 10 to 12 percent.[21]

An analysis of completed Site and Services projects indicates that the cost of supplying water according to conventional standards represents on the average 20 to 30 percent of the total on-site infrastructure costs.[22] The cost of providing a water borne sewer system on the average represents 40 to 50 percent of the total on-site infrastructure costs. In order to provide surface storm drains and tarmac roads the average cost amounts to about 30 to 40 percent of the total on-site infrastructural costs. It is especially important to bear in mind that the economically optimum layout of roads can play a very important role in the cost factor. To provide street lighting at the rate of 2 to 5 lamp posts per hectare, the cost on the average represents between 10 to 15 percent of the total on-site infrastructure costs.

At this point a distinction is made between servicing standards and servicing options. The aim of servicing standards is to supply the service at a certain standard irrespective of the costs. The aim of servicing options is to minimize the initial investment that is required to provide services. This must allow future improvements without repeating or destroying existing installations. Thus the servicing options imply a postponement of the installation of services at an acceptable standard and do not mean that the servicing standards are irrevocably lowered. The concept of servicing options also recognizes the potential for incremental improvement through an efficient use of available resources.

2.3 Water supply Options

Water for drinking, cooking, washing and hygienic purposes is an essential element of a healthy and productive life. Most squatter settlements place a high priority on securing a regular supply of safe and potable water. Any new Site and Services projects must have access to adequate water supply.

Water supply requirements can be met by many available methods such as by means of securing a connection to an existing water supply network, water wells or delivery of water either by truck, animal or human transport. Distribution from the available water main is of great relevance to the on-site infrastructure works, as this is the normal practice found in most cases. To have water wells one must make sure that the underground water will yield enough water to meet daily needs. Sometimes water is drawn from lakes or rivers but other sources of water supply are not too common.

The quantity and quality of water to be supplied are the principal cost determinants for the on-site water supply system. The quantity of water used largely depends on the standard of living, level of charges, traditional and local conditions and on the kind of water supply that is available. An investigation made in East Africa by White, Bradely and White suggests that low-income families use an average of 30 liters of water per capita per day when the water supply is piped within the plot.[23] The usage decreases to 15 liters per capita per day when the family carries water from a distant source. Illustration no.4 indicates the daily use of water for different places.

PER CAPITA RESIDENTIAL WATER USE IN SELECTED AREAS 25

Country	Place	Estimated Daily Use per Capita in liters	Source	Year
Urban multiple taps or mixed use				
Developing nations	Several hundred	11-930	Dietench and Henderson 1963, p 28	
Costa Rica	2 metered cities	284-386	Wielers, Zobel, and Henderson 1959	1958
	7 unmetered cities	215		1959
	34 flat rate cities	444		
Ghana[a]	Accra High grade housing	675	Tahal 1966	1965
	Medium grade housing	165		
	Low grade housing	34		
	Substandard housing	27		
	Tema High grade	342		
	Medium grade	265		
	Low grade	108		
Greece		144	Panasiasiou 1967	1965
India	Kalyani	113	Lee 1968	1964
	New Delhi	136		
Japan[b]	Osaka	520	Japan 1967	1966
	Yokohama	395		
	Tokyo	348		1966
	Kobe	328		1966
	Kyoto	317		1966
Kenya	Nairobi	90	City council report	1968
South Africa	Cape Town	144 53	Cluver n d., p 29	c 1953
	Johannesburg	158	Morris 1967	1965
	Queenstown	225		
	Pretoria	239		
	Durban	243		
Taiwan	Urban pop 50 000	245	Fung 1967	
Tanzania	Dar es Salaam (all supplies)	81	Tanganyika Ministry of Communications Power, and Works 1964	1962
	Dodoma	86		
	Moshi	202		
Turkey	Greater Istanbul	108	Noyan and Senogullari 1967	1965
Uganda	Kampala	72-338	Scaff 1964 p 180	
	All municipal supplies	202	Uganda Protectorate 1960/61	
U K	Bradford	544	Skeat 1961 p 56	1958
	Tees Valley	126	ibid	1958
	Birmingham	99	ibid., p 59	1958
	Glasgow	212	ibid	1959
	Liverpool	126	ibid	1958
	London	162	ibid	1959
U S	All cities	227	U S Senate 1961 7	1960
	Towson, Md rental	190	Johns Hopkins Report 1 2-16	1959-62
	Residence value $14 000	194		
	Residence value, $19,000	214		
	Residence value $37 000	247		
Uruguay	Montevideo	176	Castagnino 1966	1964
	Punta del Este	447		
	All other towns	130-270		
Zambia	Mazabuka	27	G Marais 1966 personal communication	
	Lusaka, Suburban African	13-50		
Single taps				
Guatemala	Single automatic tap systems	60	Ans 1967	1966
Paraguay	Asuncion pilot area single taps	26-49	Borjesson and Bobeda 1964 p 858	1964
Pakistan	Comilla pilot area single automatic taps	16	East Pakistan Water and Sewer Authority 1968	1968
Urban standpipes				
India	Calcutta standpipe or pump	30	Lee 1968	1964
Turkey	Greater Istanbul	16	Noyan and Senogullari 1967	1965
Uganda	Kampala	14	Scaff 1964 p 32	
Venezuela		15	Dieterich and Henderson 1963, p 28	
Rural Connected				
Republic of China	Rural area (with water systems)	50	Fung 1967	
West Germany	Rural systems	83	Schickhardt 1967	
Not connected				
Bolivia	Seven villages	10	Teller 1969	1968
Kenya	Zaina	7	Fenwick	
Nigeria	Anchau District	23 27	Nash 1948	1948
Sudan	Kordofan	9-18	FAO Land and Water Survey 1967, p 238	1967
Tanzania	26 villages in 10 districts	5 26	Warner 1969	1969

[a]Estimates of household use for accra were based on metered observations at six standpipes and five households for two months. Tema 282 housing units were studied for two weeks

[b]Includes industrial uses

Illustration #4

The level of water supply will determine the cost of infrastructure. The normal standard is to have connection to each plot. The diameter of pipes to be laid for reticulation is also a major cost factor. The quantity of water to be supplied will determine the diameter of pipe which in turn affects the cost. The greater the diameter of the pipe, the greater the cost will be. A larger water supply requires a larger pipe diameter. The choice of material for the pipe is another factor to be considered. On the average, water supply cost represents 20 to 30 percent of the total on-site infrastructure costs.[24] Illustration no.5 indicates the comparable costs for water supply for different Site and Services projects.

Keeping in mind the cost factor, the prospective resident's ability to repay and the convenience of the utility, the following water supply options have been developed.

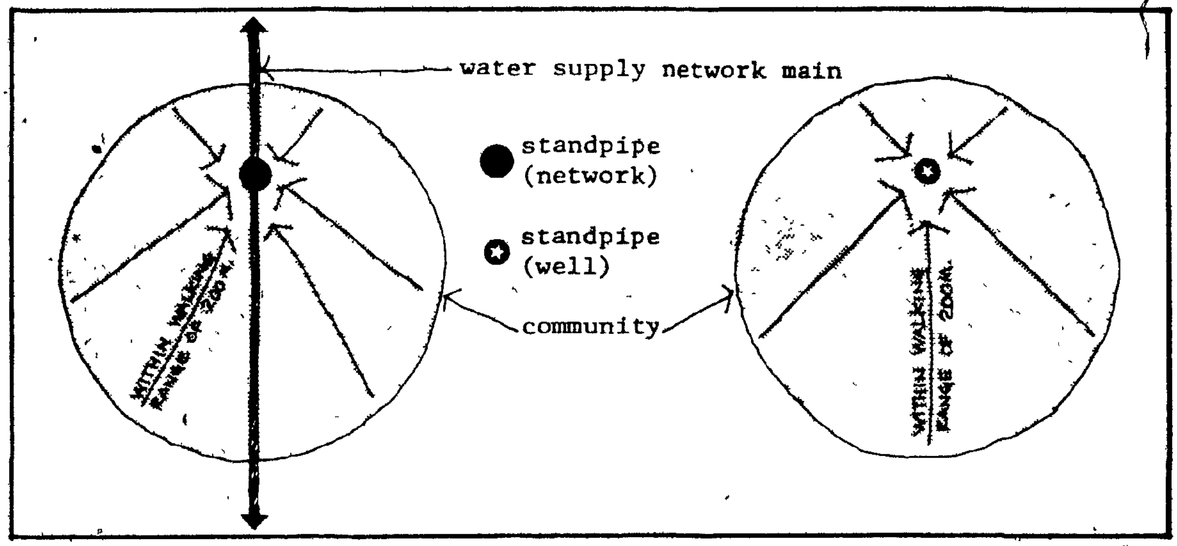
Water Supply Option: Minimum Cost

The minimum cost option assumes a communal source of water supply, which is a standpipe with the required number of tap outlets (this option assumes that the connection to an urban water supply network is available). An alternative is a well with an overhead reservoir, suitable pumping facilities and outlets through a standpipe (this option assumes that a connection to the urban water supply network is not available). Illustration no. 6 graphically represents both of these options. Minimum cost level has been achieved through the reduction in reticulation network. Pipes laid would carry ultimate design quantities to reach conventional or acceptable standard. The standpipe should be located so that the maximum walking distance form the farthest dwelling is 200 meters.

ON–SITE INFRASTRUCTURE COSTS PER PLOT: WATER SUPPLY (1974)[26]

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON–SITE INFRASTRUCTURE 0 20 40 60 80 100%
NICARAGUA	2,750	110	Individual connection, 65 1pd	80 0	
SENEGAL	11,900	150	Communal standpipe, 1 per 100 Hsehlds	10 4	
	2,100	150	Individual connection	49.5	
	1,800	200	Communal standpipe 1 per 100 Hsehlds	13 5	
INDONESIA	12,866	80	Individual connection	33 8	
	4 425	140	Individual connection	57 4	
	23 600	110	Communal standpipe, 1 per 6 plots	30.0	
JAMAICA	785	94	Individual connection	88.9	
	785	94	Individual connection	88.9	
	785	94	Individual connection	88 3	
BOTSWANA	1,100	375	Communal standpipe, 1 per 20-25 plots	34.0	
	305	375	Communal standpipe 1 per 150m radius	38 0	
	–	–	Individual connection	108 0	
	–	–	Individual connection	106.0	
ZAMBIA	7,800	210	Communal standpipe, 1 per 25 Hsehlds	51.5	
	1,200	324	Communal standpipe, 1 per 4 Hsehlds	168 5	
	1,200	324	Individual connection	171 0	
	1,084	324	Individual connection	127.7	
	868	324	Individual connection	96.6	
	1,977	165	Individual connection	82.2	
	114	324	Communal standpipe, 1 per 2 3 plots	53.8	
	858	324	Individual connection	57.8	
	858	370	Communal standpipe, 1 per 37 plots	37 1	
	717	370	Communal standpipe 1 per 20 plots	53 6	
	307	370	Individual connection	53.9	
	278	370	Individual connection	60 4	
	100	370	Individual connection	45 1	
INDIA	1,000	70	Individual connection 200 1pd	156.0	
EL SALVADOR	5,100	60	Individual connection	n.a	
	2,900	120	Individual connection	n.a	
	506	60	Individual connection	32.6	
	235	60	n.a.		
	62	66	n.a		
TANZANIA	5,370	265	Individual connection 150 1pd	69 2	
	5,370	266	Communal standpipe 1 per 10 plots	55 9	
	5,370	265	Communal standpipe 1 per 50 plots	24 5	
	12,100	260	Communal standpipe 1 per 50 plots	38 9	
	2,300	260	Communal standpipe 1 per 60 plots	47 5	
	2,000	230	Communal standpipe 1 per 50 plots	44.8	
	8,050	260	Communal standpipe 1 per 50 plots	39 5	
KENYA	500	126	Individual connection	67 1	
	375	126	Individual connection	28 6	
	104	126	Communal standpipe 1 per 20 plots	14.3	
	723	167	Individual connection	54 0	
	100	326	Individual connection	34 1	
	110	188	Individual connection	67 0	
	42	296	Individual connection	36 0	
	94	242	Individual connection	42 6	
	4,200	120	Individual connection	48 0	
COLOMBIA	3 500	80	Individual connection	107 6	
	3,500	80	Individual connection	107 5	
	2,800	140	n.a		
	475	140	Individual connection	n.a	
	757	140	Communal standpipe	n.a	
CHILE	–	170	Individual connection	169 0	
ECUADOR	9 280	120	Communal standpipe	n.a	
KOREA	507	116	Individual connection	n.a.	
	145	165	Individual connection	n.a	
	73	248	Individual connection	n.a.	

Illustration #5

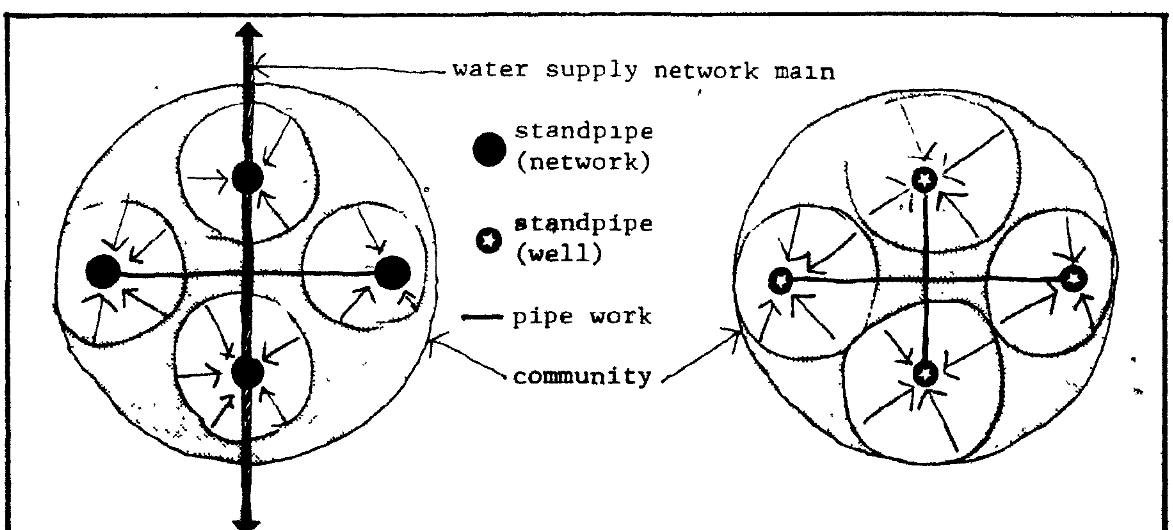


WATER SUPPLY OPTION : MINIMUM COST

Illustration #6

Water Supply Option: Intermediate Cost

This option is based on a communal water supply system but the number of families sharing a standpipe is reduced. Since a greater number of standpipes are provided walking distances are reduced thus greatly increasing their convenience. The required pipe work is extended. There can be more than one stage of incremental progress at this level. Illustration no.7 graphically explains this option.

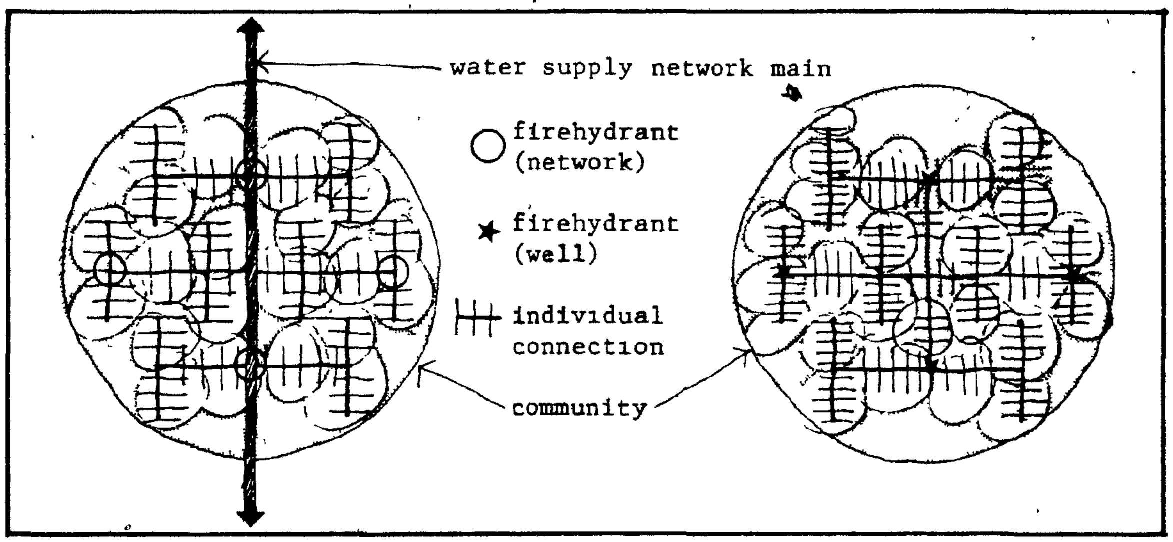


WATER SUPPLY OPTION : INTERMEDIATE COST

Illustration # 7

Water Supply Option: Conventional or Standard Cost

This option conforms to the conventional standard of water supply where individual pipe connections are provided for each plot. Previously laid pipes contribute to this option. To achieve this stage only additional work is required without redundancies. Existing standpipes are converted into public firehydrants.



WATER SUPPLY OPTION : CONVENTIONAL

Illustration # 8

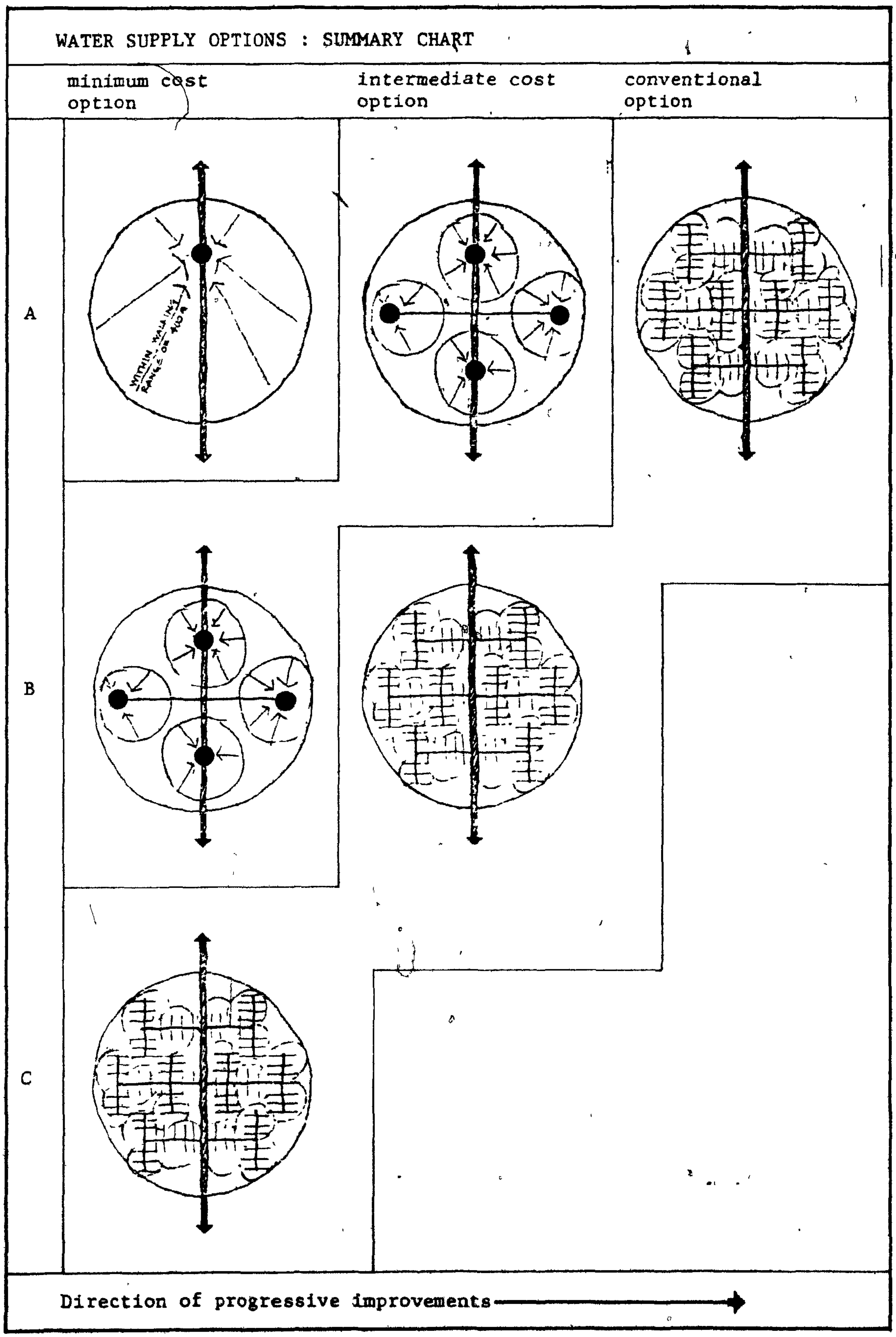


Illustration # 9

2.4 Sanitation Options.

Proper sanitation facilities are very important for the maintainance of public health. Poor sanitation facilities are one of the prime causes of the spread of diseases like hookworm, diarrhea, enteritis, cholera and typhoid. Therefore, the objective of sanitation options is to efficiently and hygienically dispose of human waste in such a way that waste disposal does not pollute or spread diseases and does not contaminate drinking water resources. It must also be done at a price the user can afford.

Sanitation requirements can be met by one of many systems that are known today, such as : by means of a connection to an existing network of sewers or developing a new system of sewers or using one of the on-site systems for the disposal of human waste. The method chosen will depend not only on available financial resources but also on the availability of water and porous ground conditions. Conventional sewers are more costly than any of the on-site systems described later. The infrastructure costs of sewers represent on the average 40 to 50 percent of the total on-site infrastructure costs.[27] Illustration no.10 indicates the comparable costs for sanitation systems in different Sites and Services projects. Communal facilities for sanitation are difficult to maintain and highly unpopular. Experts on the subject are opposed to the provision of such facilities except in unavoidable circumstances.[28]

In order to minimize initial investments, the incremental progress approach is to be followed eventually leading to conventional standard of sewers. However, a recent study concluded that a sewer system is not likely to be the most cost effective solution of human waste disposal for most situations

ON–SITE INFRASTRUCTURE COSTS PER PLOT: SEWERAGE (1974)[29]

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON–SITE INFRASTRUCTURE (0 20 40 60 80 100%)
NICARAGUA	2 750	110	Individual connection waterborne	100 0	
SENEGAL	11,900	150	Self-dug pit latrine on each plot	10 6	
	2,100	150	Individual connection septic tank	391 0	
	1 600	200	Self-dug pit latrine on each plot	17 2	
INDONESIA	12,886	80	Individual connection waterborne	150 4	
	4,425	140	Individual connection waterborne	263 2	
	23,600	110	Self-dug pit latrine on each plot	–	
JAMAICA	785	94	Individual connection waterborne	153 6	
	795	94	Individual connection waterborne	153 6	
	785	94	Individual connection waterborne	153 6	
BOTSWANA	1,100	375	Individual aqua privy units	182 0	
	305	375	Individual aqua privy units	92 0	
	–	–	Individual connection waterborne	511 0	
	–	–	Individual connection waterborne	504 0	
ZAMBIA	7 600	210	Self-dug pit latrine on each plot	–	
	1,200	324	Self-dug pit latrine on each plot	–	
	1 200	324	Individual connection waterborne	234 0	
	1 084	324	Individual Connection waterborne	234 4	
	868	324	Individual Connection waterborne	157 4	
	1,977	185	Individual Connection waterborne	223 6	
	114	324	Self-dug pit latrine on each plot	–	
	858	324	Individual connection waterborne	153.9	
	858	370	Self-dug pit latrine on each plot	–	
	717	370	Self-dug pit latrine on each plot	–	
	307	370	Individual connection waterborne	159 2	
	278	370	Individual connection waterborne	94 2	
	100	370	Individual connection waterborne	111 2	
INDIA	1,000	70	Individual connection waterborne	227 5	
EL SALVADOR	5 100	60	Individual connection waterborne	n.a	
	2,400	120	Individual connection waterborne	n.a	
	506	80	Individual connection waterborne	31 1	
	235	80	n.a		
	62	66	n.a		
TANZANIA	5 370	265	Individual connection waterborne	171 4	
	5,370	265	Improved pit latrine on each plot	98 9	
	5,370	265	Communal pit latrine	14 3	
	12 100	260	Individual aqua privy units	119 0	
	2,300	260	Individual aqua privy units	130 9	
	3 000	280	Individual aqua privy units	137 2	
	8 050	260	Individual aqua privy units	59 5	
KENYA	500	126	Individual connection waterborne	142 9	
	376	126	Individual connection waterborne	114 3	
	104	126	Communal waterborne 6 per 20 plots	57 1	
	723	167	Individual connection waterborne	71 0	
	100	326	Individual connection septic tank	180 0	
	110	188	Individual connection waterborne	141 0	
	42	298	Individual connection waterborne	84 0	
	94	242	Individual connection oxidation pond	280 6	
	4 200	120	Individual connection waterborne	113 4	
COLUMBIA	3,500	80	Individual connection waterborne	118 9	
	3,500	80	Individual connection waterborne	118 9	
	2 800	140	n.a		
	475	140	n.a		
	757	140	n.a		
CHILE	–	170	Individual connection waterborne	140 0	
ECUADOR	9 220	120	Individual pit latrine	n.a	
KOREA	507	118	Individual connection waterborne	n.a	
	145	165	Individual connection waterborne	n.a	
	73	248	Individual connection waterborne	n.a	

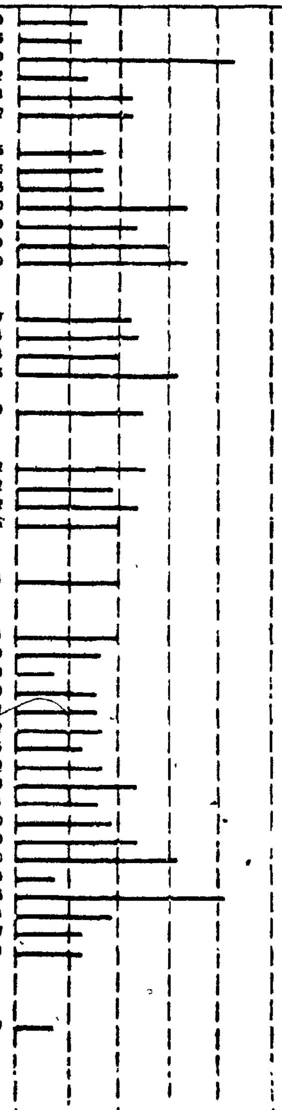


Illustration #10

in developing countries.[30] This system is the effective solution in high density, westernized cities.

Several methods are used to classify waste disposal systems, but the most useful for Site and Services projects is to differentiate between on-site or household systems and off-site or community systems. On-site systems do not require organizational actions while off-site systems normally do. Illustration no. 11 indicates the comparative costs of each system. On-site technologies have been classified into the following five categories.[31]

1. Pit latrines
2. Pour-flush toilets
3. Composting toilets
4. Aquaprivies
5. Septic tanks

1. Pit latrines

Pit latrines have three components: a pit, which is covered with a squatting plate or a seat and a superstructure. There are a few improved versions of the pit latrine which provide a vent pipe to prevent flies and odour. Sometimes the superstructure is displaced from the pit. Liquid wastes infiltrate the ground while solids accumulate in the pit and partially decompose over time. The pit is discarded or emptied when it is full. The pit is usually 3-7 meters deep and one meter across. Pit volume may be calculated at the rate of 0.06 m^3 per person per year. Thus it may take 6-7 years for a pit for a family of five to become non-usable.

Pit latrines are recommonded for low and medium density areas (up to 300

Summary of Total Annual Costs per Household 32
(1978$)

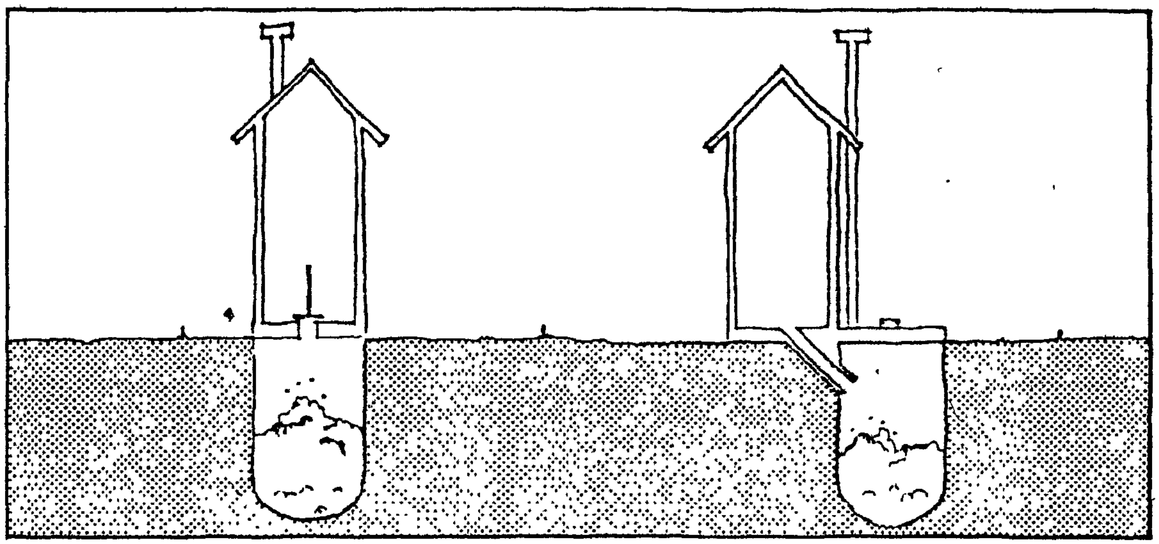
	Number of Observations	Mean	Median	Highest	Lowest
Low Cost					
Pour flush toilet	3	18.7	22.9	23.3	10.1
Pit latrine	7	28.5	26.0	56.2	7.6
Communal septic tank /1	3	34.0	39.0	48.0	15.0
Vacuum truck cartage	5	37.5	32.2	53.8	25.7
Low Cost septic tanks	3	51.6	45.0	74.5	35.4
Composting toilet	3	55.0	56.2	74.6	34.3
Bucket cartage /1	5	64.9	50.3	116.5	23.1
Medium Cost					
Sewered aquaprivy /1	3	159.2	161.4	191.3	124.8
Aquaprivy	2	168.0	168.0	248.2	87.7
Japanese vacuum truck cartage	4	187.7	193.4	210.4	171.8
High Cost					
Septic tanks	4	369.2	370.0	390.3	306.0
Sewerage	8	400.3	362.1	641.3	142.2

/1 To account for large differences in the number of users, per capita costs were used and scaled up by the cross-country average of 6 persons per household.

Illustration #11

persons per hectare). It is customary to have 3-5 meters distance from the house to the latrine. If nearby ground water is used for drinking, the pit should be around 30 meters away from the source, depending on the soil conditions. The construction of the pit latrine depends chiefly on the porosity of the ground.

Pit latrines as a system of sanitation are the least expensive, the easiest to construct, and provide the best opportunity for upgrading to pour-flush toilets.

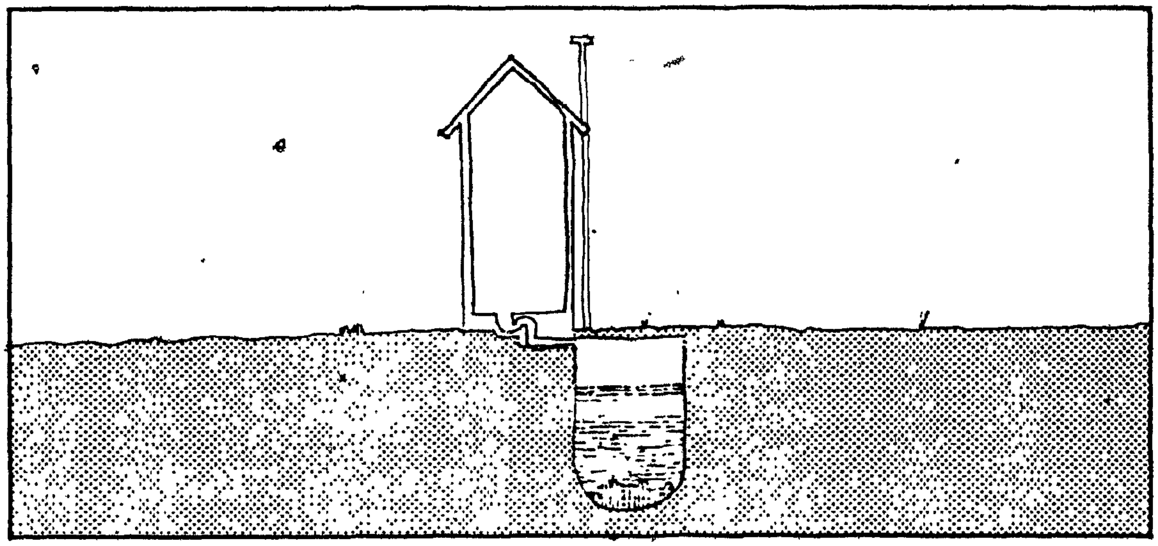


PIT LATERINES Illustration #12

2. Pour-flush toilets

A modified version of the pit latrine with displaced pit and a water seal which prevents flies and odour, is the pour-flush toilet. Many varieties of pour-flush fixtures are available in plastic, ceramic or concrete. About a litre of water is added to the bowl after every use.

Three to six liters of water per day is required for a pour-flush toilet. This system depends on sufficient soil porosity for infiltration, and like the pit latrine it is recommonded for low density settlements. Pour-flush toilets allow indoor location of the toilet, as they can be connected to an offset pit outside and have potential for upgrading to an aquaprivy.

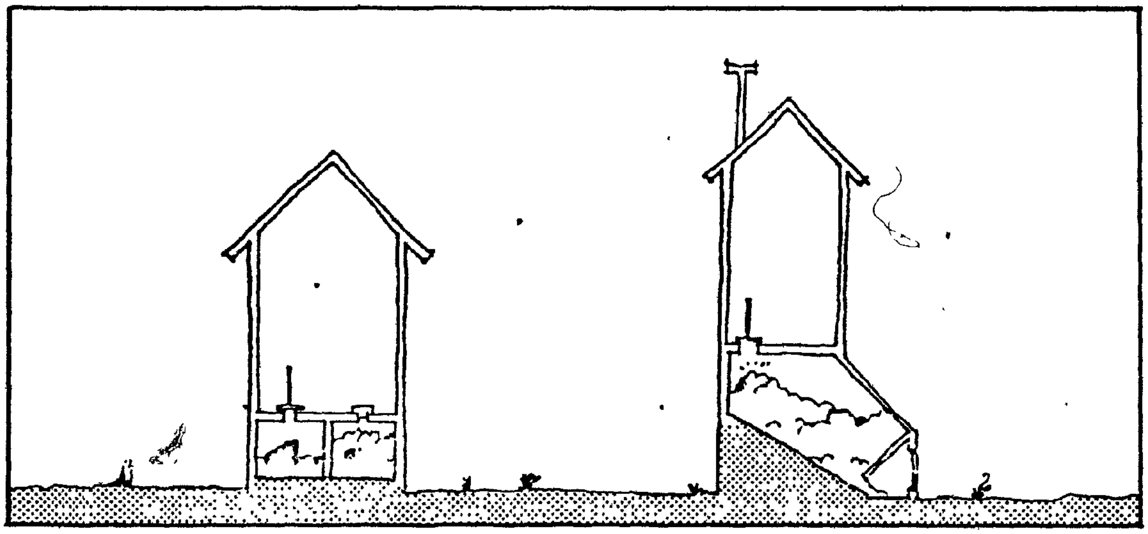


POUR-FLUSH TOILETS Illustration #13

3. Composting toilets

Similar to pit latrines, composting toilets have a compartment for composting where excreta undergoes aerobic or anaerobic biological decomposition. They are either continuous or batch type, which use one or two compartments respectively. Carbon containing organic materials is added to promote composting. More recent and sophisticated continuous type composting toilets, developed in Sweden, have one sloped compartment.

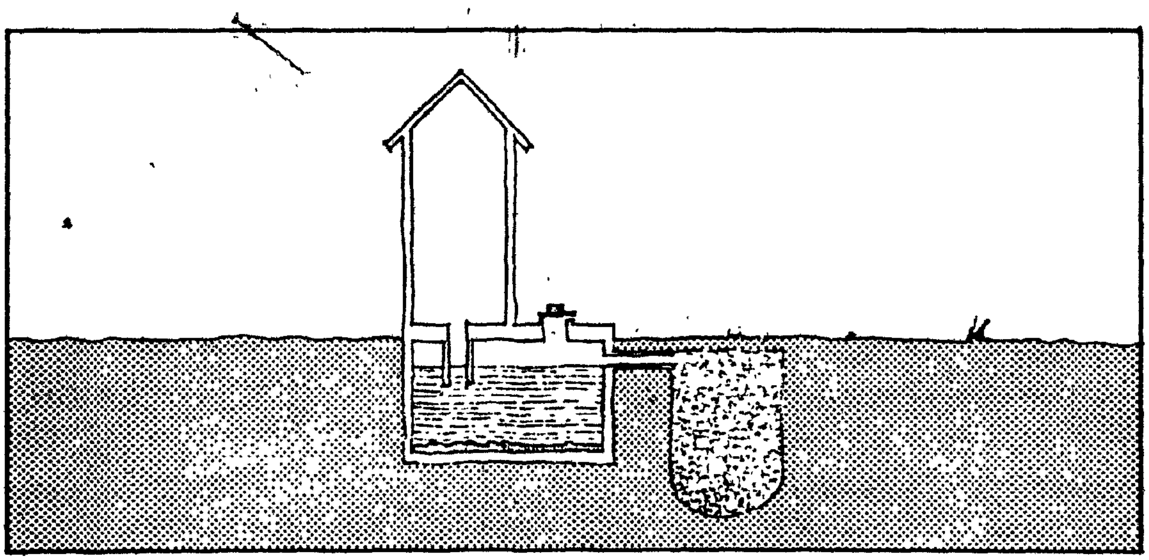
This system requires the periodic removal of humus which can be recyled as fertilizer. The separation of urine in certain types of toilets helps to speed up the decomposition process.



COMPOSTING TOILETS Illustration # 14

4. Aquaprivies

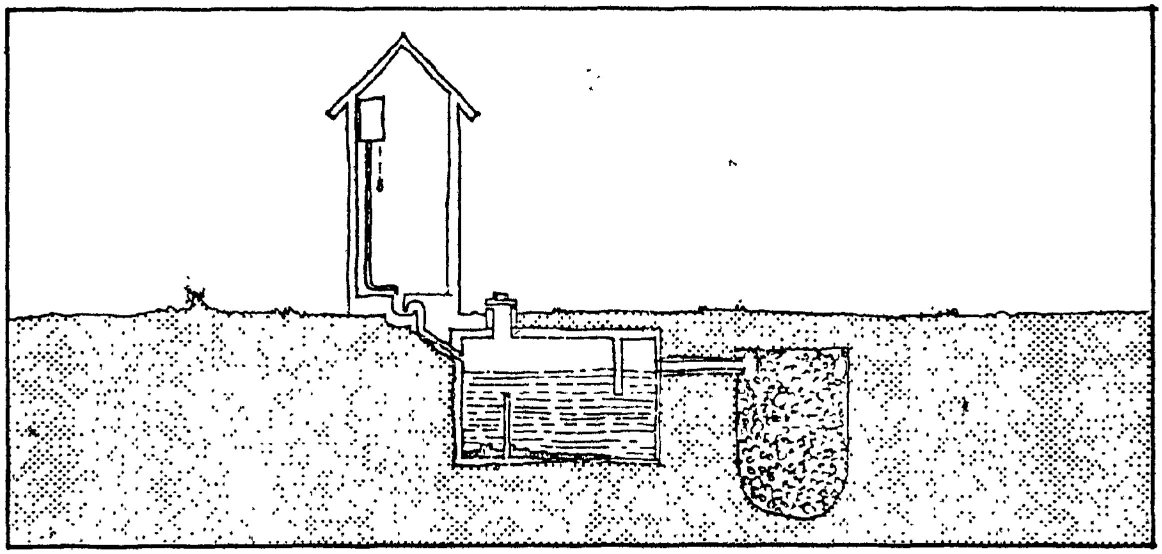
The aquaprivy has a small tank resembling a septic tank with an adjacent soak pit. The water seal contains a drop pipe that is submerged in the water in the tank. The seal prevents odour and inhibits insects from breeding. The tank requires desludging periodically (every 2-3 years). Aquaprivies have the same limitations as pit latrines with respect to soil porosity. Aquaprivies permit eventual connection to a small diameter sewer.



ACQUAPRIVY Illustration #15

5. Septic tanks

The septic tank consists of a small chamber, buried underground which receives both excreta and sullage (waste-water). The tank is connected to a soak pit or infiltration field. Flush toilets are connected to a septic tank and provide all the convenience of a sewer system except that the tank needs to be desludged periodically. This system is not necessarily cheaper than a conventional sewer system.



SEPTIC TANK Illustration #16

Possible Options

The economic options that are evolved from the technologies outlined are important in that they allow progressive improvement. The upgrading sequence of sanitation options closely follows the sequence of water supply options. The selected sequence described is developed for the Zambian context but is applicable to similar situations elsewhere. The same sanitation sequence is examined on a prototype layout in the following chapter. Illustration no.17 graphically explains the sequence.

Where water is not immediately available the choice of the sanitation system is limited to the one that uses a minimum of water. This is clearly the pit latrine. Once water is more available, the same pit latrine can be upgraded to the pour-flush toilet. As the water supply becomes abundant, the pour-flush toilet will require a connected soak pit because water will be used in greater quantities. The same pour-flush toilet can later be converted into an aquaprivy which allows connection to a sewer system. The link to soak pit must be disconnected before it is connected to a sewer system. The diameter of the pipe required for a sewer is small and can be laid on flatter gradients than the conventional sewer systems, and thus a big saving can be effectuated on the sewer network. However, the pit will require periodical desludging. At this stage the convenience level is comparable to that of conventional sewer systems.

Sometimes, the ground conditions do not favour pour-flush toilets with soak pits. Under such circumstances, the pits should be desludged periodically and the waste should be carted away possibly by a vacuum truck. This option is not considered here since most areas in Africa have favourable ground conditions.

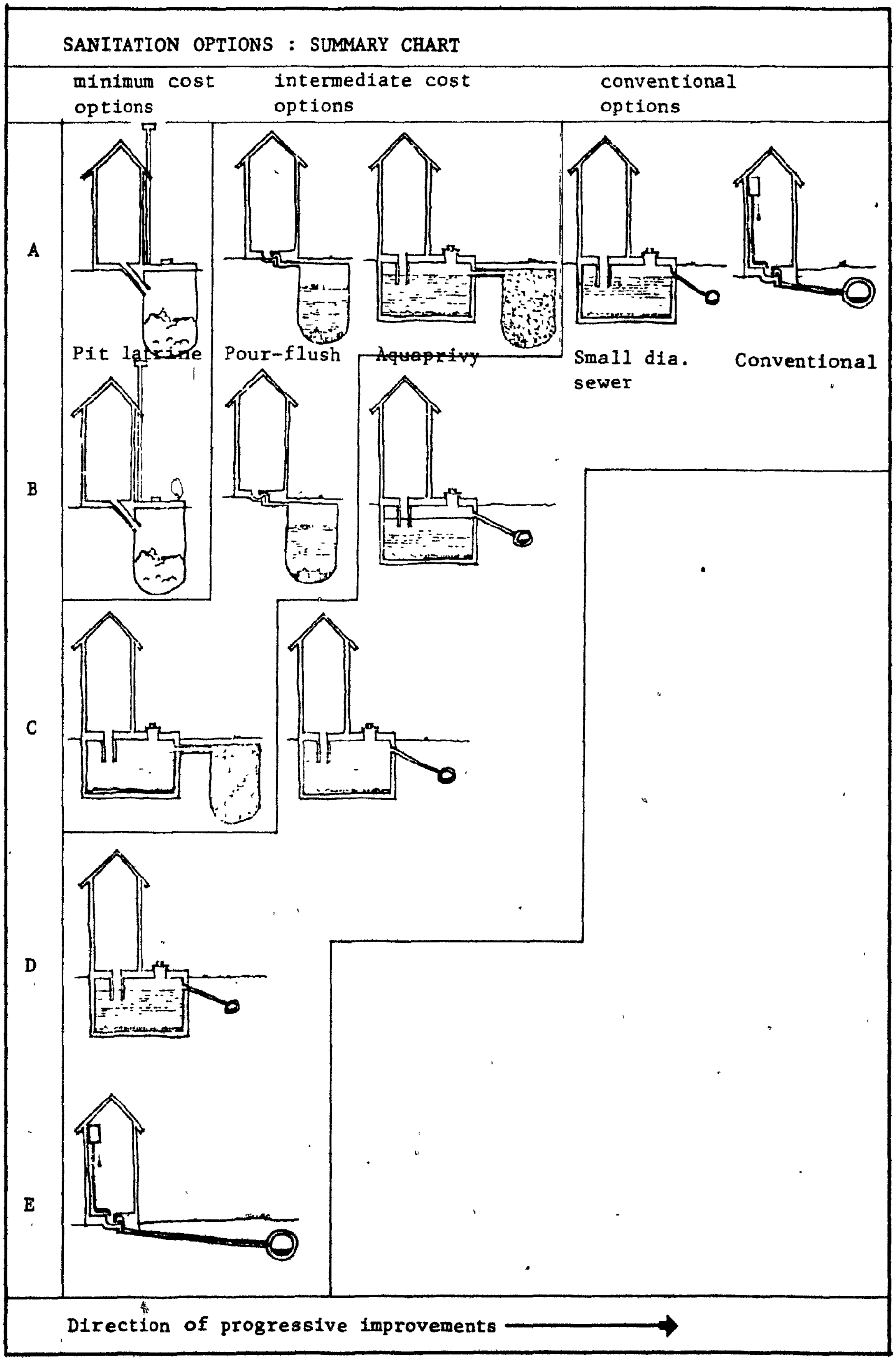


Illustration #17

2.5 Roads and Storm Drainage Options

Daily movement involving commuting to places of employment, education and recreation may require extended journeys. Site and Services projects should make provisions for pedestrian and vehicular movements within the site and should link up with urban roads. It is also essential to provide for storm drainage so that rain water does not flood the roads and impede travel.

Roads in Site and Services projects can be tarmac with underground storm drains or passable tracks with storm drains which follow the natural slope of the ground. The roadway may or may not function in all seasons depending on the method of surfacing. The quality of road surface, the length of road (a function of the layout) and the kind of storm drains installed considerably influence the costs. The most expensive road surface is tarmac with a base course; the least expensive, is simply a levelling of the ground which entails the removal of any obstacles from its path. Roads and storm drainage cost represents on the average 30 to 40 percent of the total on-site infrastructure costs.[33] Illustration no.18 indicates the comparable costs of roads and surface drainage for different Site and Services projects. Illustration no.19 depicts various possible solutions for roads and storm drainage.

The following possible road and storm drainage options have been developed, in view of the costs, the prospective resident's ability to repay and the convenience of the utility.

Roads and Storm Drainage Option: Minimum Cost

The minimum cost option assumes that, in the early stages of a Site and

34

ON–SITE INFRASTRUCTURE COSTS PER PLOT: ROADS & SURFACE DRAINAGE (1974)

COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON-SITE INFRASTRUCTURE 0 20 40 60 80 100%
NICARAGUA	2 750	110	Main roads bitumenized Piped drainage	135 0	
SENEGAL	11 900	150	Main roads bitumenized No drainage	20 6	
	2 100	150	Main roads bitumenized No drainage	20 6	
	1 600	200	Main roads bitumenized No drainage	30 2	
INDONESIA	12 866	80	Surfaced roads Stormwater drainage	164.0	
	4,425	140	Surfaced roads Stormwater drainage	287.0	
	23,600	110	Surfaced roads earth ditches	81 7	
JAMAICA	785	94	Surfaced roads open channel drainage	196 0	
	785	94	Surfaced roads open channel drainage	196.0	
	785	94	Surfaced roads open channel drainage	196 0	
BOTSWANA	1 100	375	Main roads gravel Open 'V' channels	35 0	
	305	375	All roads earth formed Open channels	64 0	
	–	–	Main roads bitumenized Piped drainage	142 0	
	–	–	All roads gravel, Open channels	77 0	
ZAMBIA	7,600	210	Main roads bitumenized Drainage	42 0	
	1,200	324	Main roads bitumenized Drainage	48 6	
	1,200	324	Main roads bitumenized Drainage	273 0	
	1 084	324	All roads gravel, Drainage	126.2	
	868	324	All roads gravel Drainage	133 0	
	1,977	165	All roads gravel, Drainage	85.4	
	114	324	Some surfaced roads	44 7	
	858	324	Some surfaced roads	[illegible]	
	858	370	Some surfaced roads	47.0	
	717	370	Some surfaced roads	79 7	
	307	370	Some surfaced roads	79 1	
	278	370	Some surfaced roads	91 7	
	100	370	Some surfaced roads	80 1	
INDIA	1,000	70	All roads gravel, Drainage	117 6	
EL SALVADOR	5,100	80	All roads earth (compacted); Drainage	n.a	
	2 400	120	All roads earth (compacted) Drainage	n.a	
	508	80	All roads earth Drainage	10.8	
	236	60	Surfaced roads Drainage	n.a	
	62	66	Surfaced roads Drainage	n.a	
TANZANIA	5,370	265	Main roads bitumenized, Earth ditches	131 4	
	5,370	265	Main roads bitumenized Earth ditches	103 2	
	5,370	266	Main roads gravel Earth ditches	58 1	
	12,100	260	Surfaced roads, Piped drainage	124.0	
	2,300	260	Surfaced roads Piped drainage	103 4	
	2,000	280	Surfaced roads Piped drainage	91 4	
	6,050	260	Surfaced roads, Drainage	127.0	
KENYA	900	126	Main roads bitumenized Piped drainage	157.2	
	375	126	Main roads bitumenized Drainage	71 5	
	104	126	Main roads bitumenized Drainage	71 5	
	723	167	Main roads bitumenized Drainage	54 0	
	100	326	Main roads bitumenized Drainage	146 7	
	110	188	Main roads bitumenized Open channels	21 0	
	42	298	Surfaced roads Piped drainage	340 0	
	94	242	All roads earth No drainage	15 0	
	4 200	120	Surfaced roads Drainage	129 0	
COLOMBIA	3 500	80	n.a		
	3,500	80	n.a		
	2,800	140	n.a		
	475	140	n.a		
	757	140	n.a		
CHILE	–	170	Surfaced roads, Drainage	428 0	
ECUADOR	6 280	120	n.a		
KOREA	507	116	Surfaced roads Drainage	n.a	
	145	186	Surfaced roads, Drainage	n.a	
	73	248	Surfaced roads, Drainage	n.a	

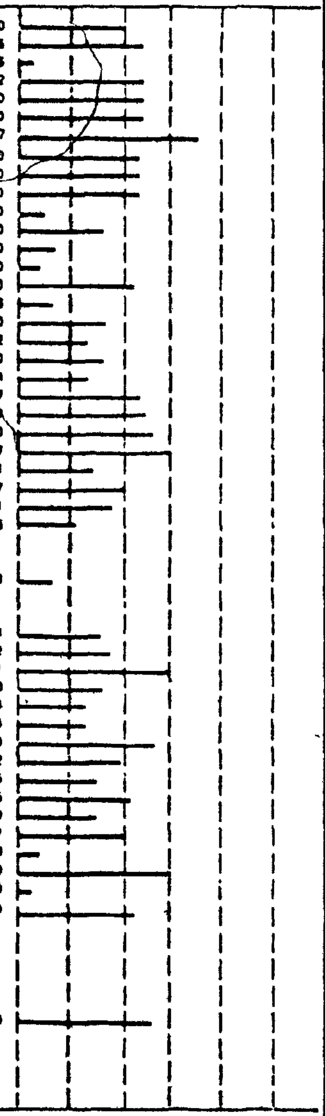
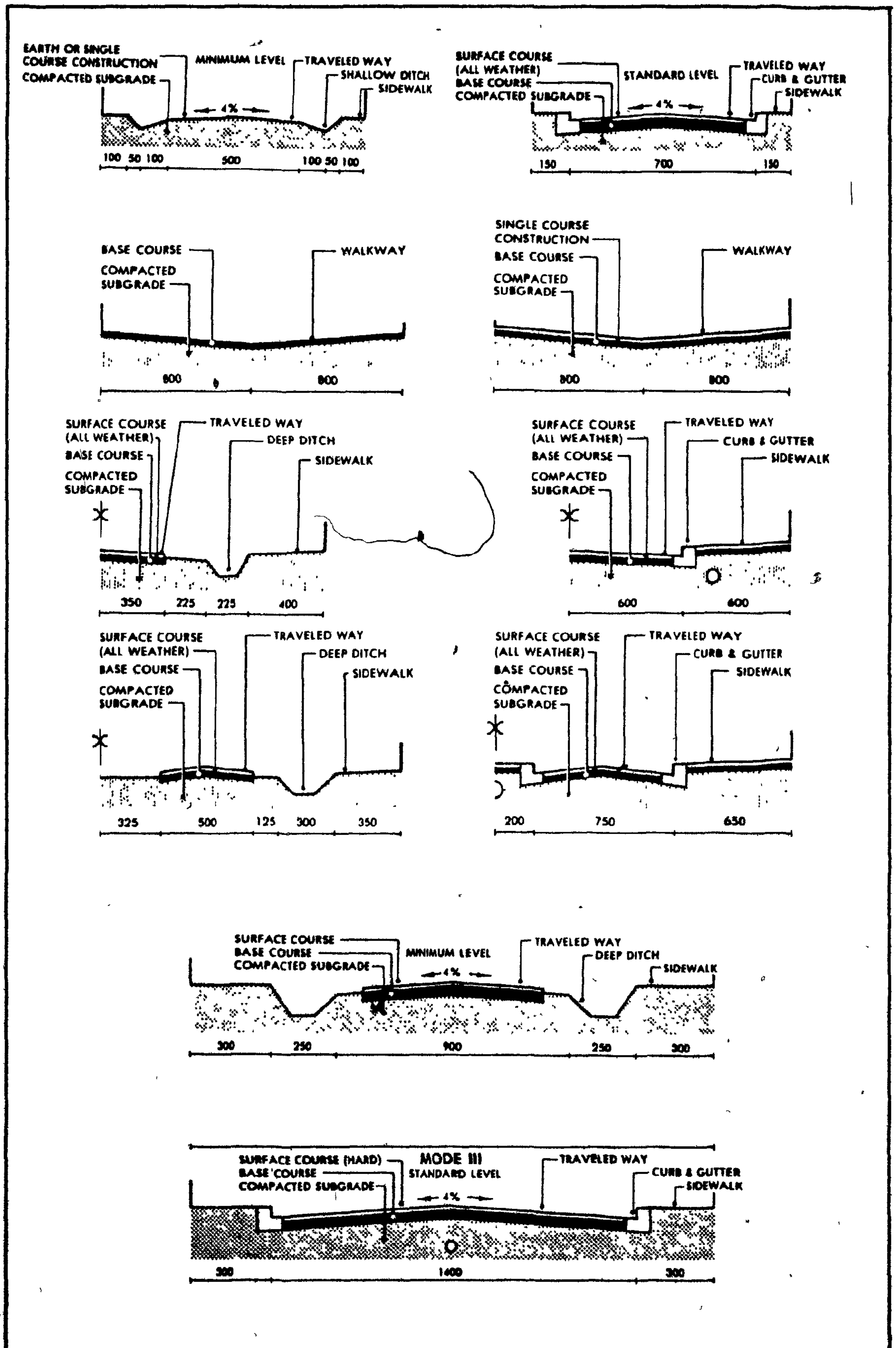


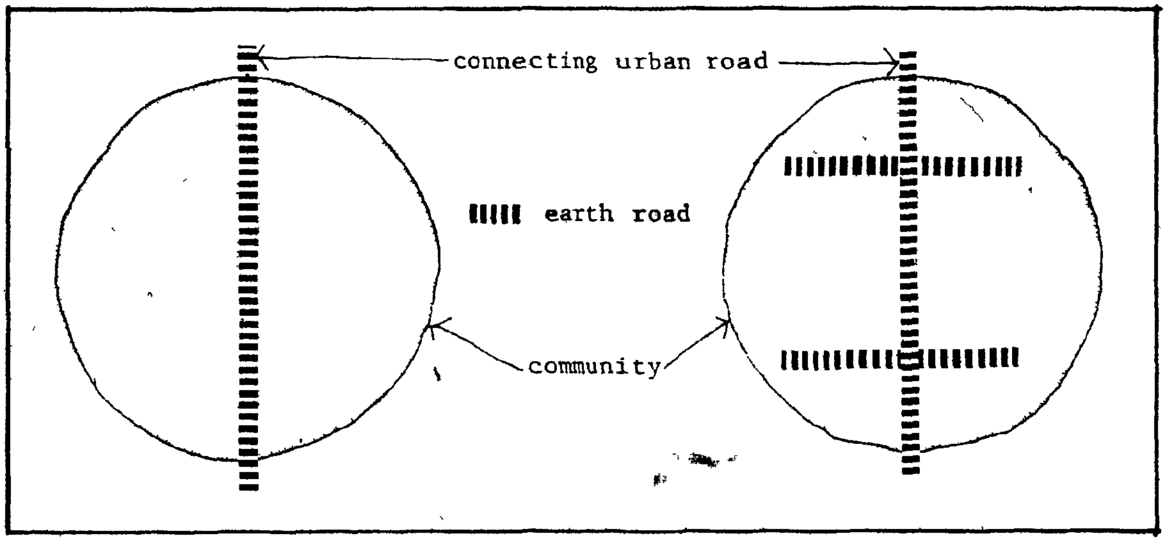
Illustration # 18



STREET SECTIONS

Illustration #19

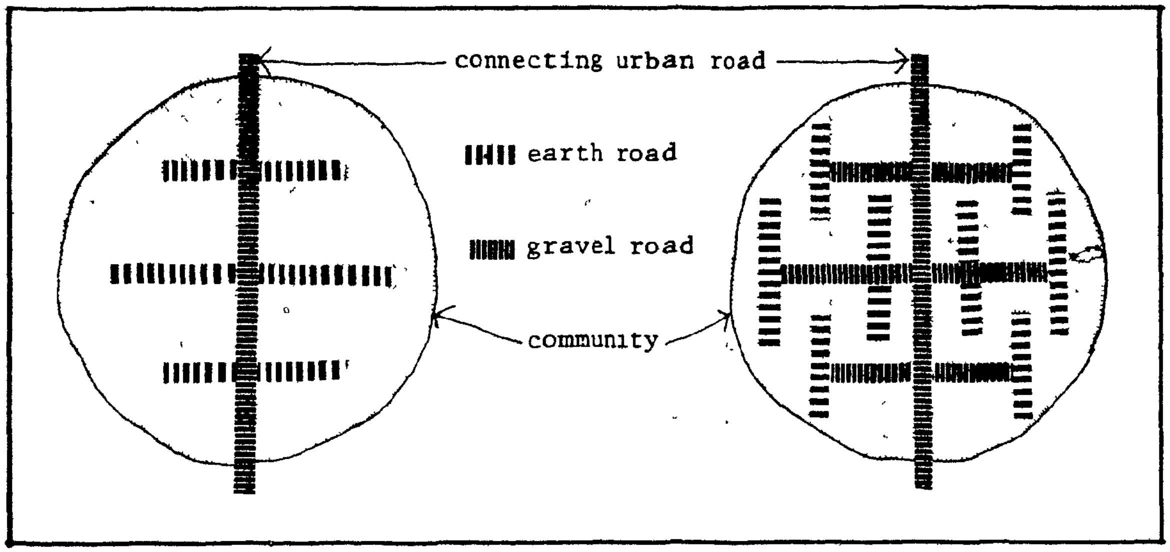
Services project, it is sufficient to provide a road which connects the site with the urban road network. In the beginning, the road surface can simply be levelled and the storm drains can take the form of ditches on the sides of the road which follow the natural slope of the ground. This option has plenty of scope for communal self-help thereby additionally defraying costs. The minimum cost option may have more than one stage of incremental progress. The minimum cost is achieved through a lowering of the quality of the road surface, through a lowering of the standard of storm drainage and through reducing the length of the road surface. All of these offer possibilities for subsequent improvement without any loss or damage of initial work. The option is explained graphically in Illustration no.20.



ROADS AND STORM DRAINAGE OPTION: MINIMUM COST Illustration #20

Roads and Storm Drainage Option: Intermediate Cost

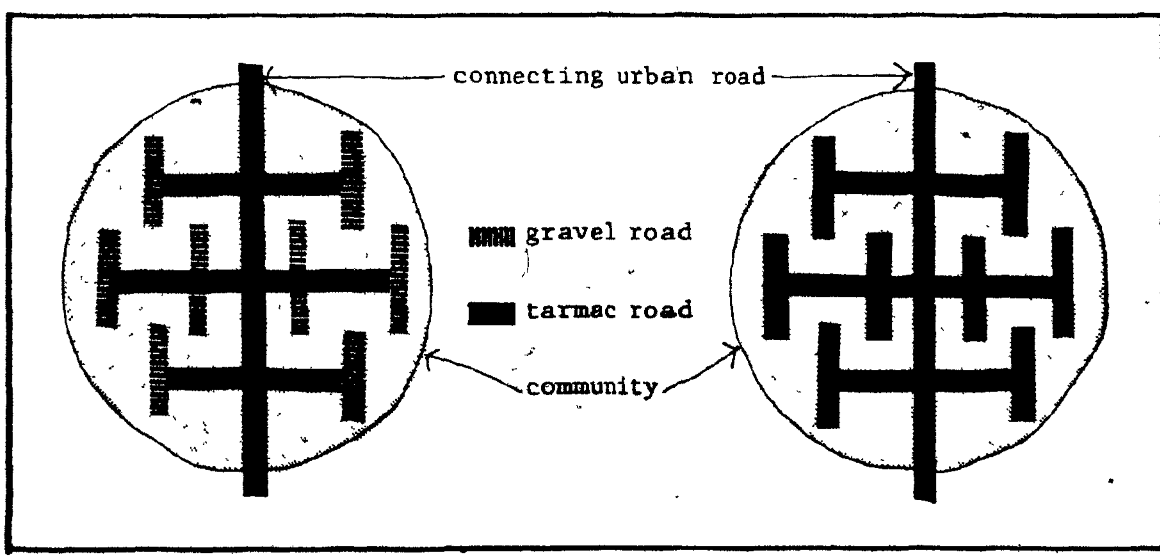
This option is based on the same principles as the previous option except that the main road is upgraded. This road is surfaced with an appropriate thickness of gravel base and provided with storm water ditches with culverts at junctions or at intersections. This upgrading permits the passage of traffic during all kinds of weather. At the same time secondary roads can be levelled. There can be more than one stage of incremental progress at this level. Illustration no. 21 explains this option graphically.



ROADS AND STORM DRAINAGE OPTION: INTERMEDIATE COST Illustration #21

Roads and Storm Drainage Option: Conventional

This option conforms to the conventional Zambian standards for road and storm drainage by laying a tarmac surface on a previously prepared gravel sub-base providing road access to individual plots. To reach this stage only additional work is required without redundancies of previous work. For storm drainage, more culverts are added or pipes laid in existing ditches. These pipes are then covered. Walkways can be built and trees can be planted over the storm drain ditches constituting a future stage.



ROADS AND STORM DRAINAGE OPTION: CONVENTIONAL **Illustration #22**

ROADS AND STORM DRAINAGE OPTIONS : SUMMARY CHART

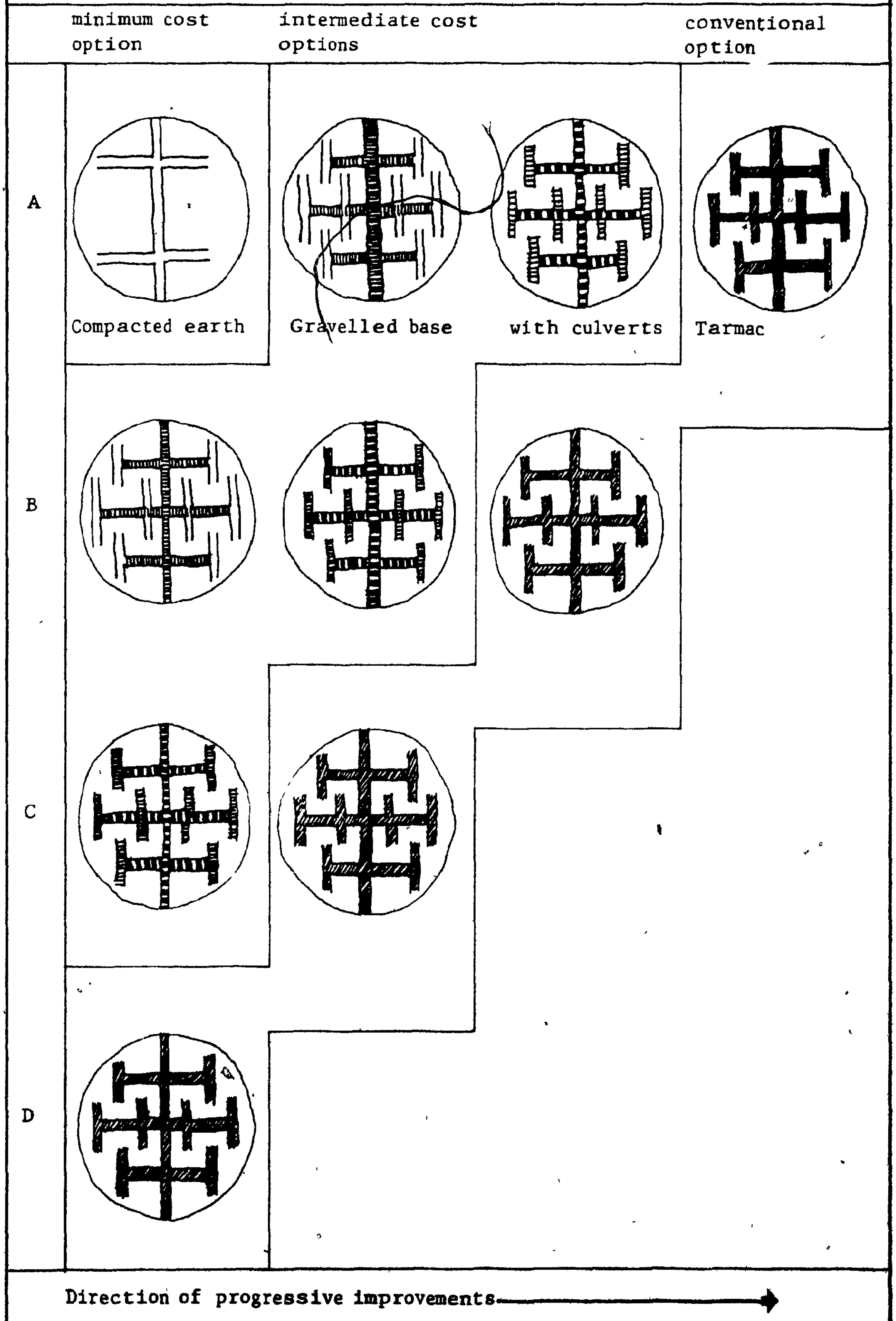


Illustration #23

2.6 Electricity and Street Lighting Options

Given a choice, most families will choose to have an electrical connection to their homes. Moreover, street lighting is desired by the residents of a community for security, convenience in night travel and for the extension of activities to the evening hours. It is desirable to connect electricity to private dwellings and to install street lights in Site and Services projects. The demand for private connections is determined by the individual's priorities verses his ability to pay, functions which vary considerably.

Electricity and street lighting requirements can be met by linking up to an existing electrical network or by using generators for producing electricity specifically for the site. Solar power may be feasible in the future but at present it is cost prohibitive and electrical generation by any other means has not been documented for Site and Services projects. The generation of electricity on-site requires the largest capital layout. Electrical services normally consist of an aerial distribution network, service drops and meters.

The use of less expensive fixtures and poles can produce some savings in street lighting cost, but do not reduce investment significantly. The costs of electrical and street lighting installations represent on the average 10 to 15 percent of the total on-site infrastructure costs.[36] Illustration no.24 compares the costs of electricity and street lighting in different Sites and Services projects.

There is not much scope in decreasing the cost of electrical installations. The installation of electrical lines to each dwelling takes up most of the

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ON-SITE INFRASTRUCTURE COSTS PER PLOT: STREET LIGHTING & ELECTRICITY (1974)

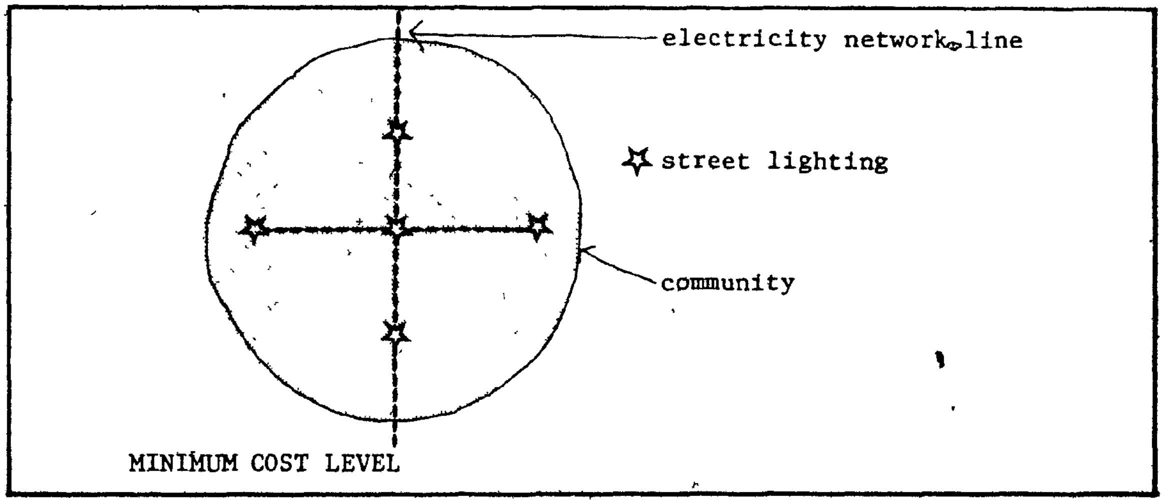
COUNTRY	NO OF PLOTS (COST BASE)	PLOT SIZE SQ.M	LEVEL OF SERVICE	COST PER PLOT US$	% OF TOTAL URBANIZATION COST OF ON-SITE INFRASTRUCTURE 0 20 40 60 80 100%
NICARAGUA	2,750	110	Street lighting, Individual electricity	28 0	
SENEGAL	11 900	150	Street lighting	n.a	
	2,100	150	None, Power company to provide		
	1,600	200	None		
INDONESIA	12,866	80	None		
	4,425	140	None		
	23 800	110	None		
JAMAICA	785	94	Street lighting Individual electricity		
	785	94	Street lighting Individual electricity		
	785	94	Street lighting, Individual electricity		
BOTSWANA	1,100	375	Street lighting	29 4	
	305	375	None		
	–	–	Street lighting Individual provision	99 0	
	–	–	Street lighting Individual provision	98 0	
ZAMBIA	7,600	210	Security lighting 2 per Ha	9 7	
	1,200	324	Security lighting 2 per Ha	48 6	
	1,200	324	Security lighting 5 per Ha	45 0	
	1,084	274	None		
	868	324	None		
	1,977	165	None		
	114	324	None		
	868	324	None		
	856	370	None		
	717	370	None		
	307	370	None		
	276	370	None		
	100	370	None		
INDIA	1,000	70	Street lighting, Low tension lines	63 1	
EL SALVADOR	5 100	60	Street lighting at 50m spacing	n.a	
	2 400	120	Street lighting, 50m spacing	n.a	
	508	60	To be provided later		
	235	80	n.a		
	62	66	n.a		
TANZANIA	5,370	265	Security lighting, Individual provision	51 0	
	5,370	265	Security lighting	21 9	
	5 370	265	None		
	12 100	260	Street lighting Individual provision	102 3	
	2 300	240	Street lighting Individual provision	117 3	
	2 000	280	Street lighting Individual provision	113 9	
	8,050	260	Street lighting along main roads	18 0	
KENYA	500	126	Street lighting Individual electricity	57 1	
	375	126	Security lighting	26 6	
	104	126	Security lighting	26 6	
	723	167	Security lighting	4 0	
	100	326	Street lighting	22 3	
	110	188	None		
	42	298	Street lighting, Individual provision	130 2	
	54	242	None		
	4,200	120	Security lighting	14 0	
COLOMBIA	3,500	80	Street lighting, Individual provision	126 1	
	3,500	80	Street lighting, Individual provision	125 1	
	2 800	140	Street lighting Individual provision	n.a	
	475	140	Street lighting Individual provision	n.a	
	757	140	Street lighting Individual provision	n.a	
CHILE	–	170	Street lighting Individual electricity	79 0	
ECUADOR	9,280	120	None		
KOREA	107	116	Security lighting	n.a	
	145	165	Security lighting	n.a	
	78	248	Security lighting	n.a	

Illustration #24

investment. However, other options are neither possible nor practical. Possibly, the installation of street lighting services can be phased out. Two options have been developed and are described in the following text.

Electricity and Street Lighting Options: Minimum Cost

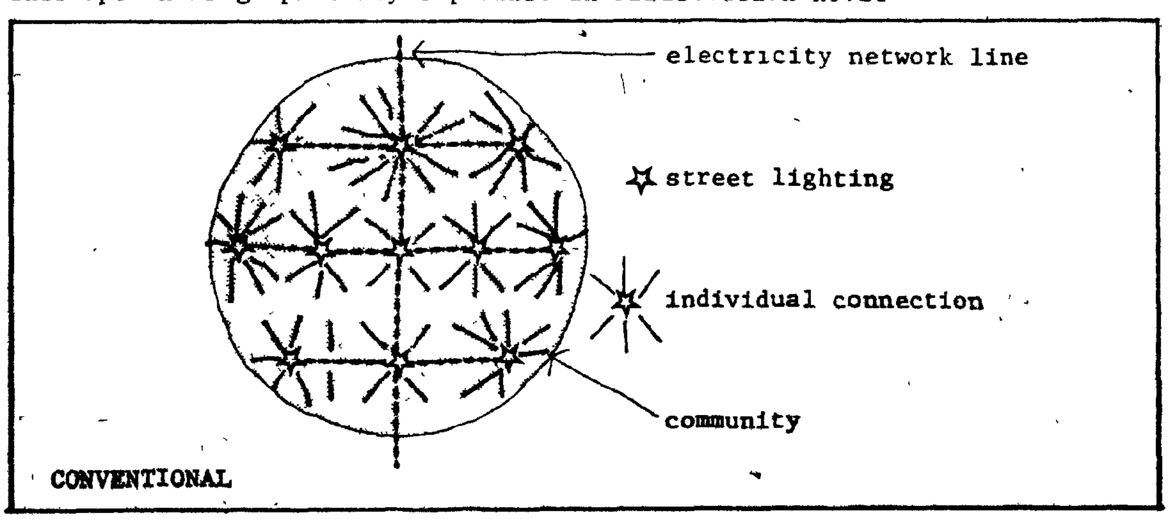
The minimum cost option provides for street lighting at intersections only. The option is explained in Illustration no.25.



ELECTRICITY AND STREET LIGHTING OPTION Illustration #25

Electricity and Street Lighting Option: Conventional

Street lighting at all required locations is installed. Individual connections of a conventional standard are provided for each plot. Individual connections may also be provided at the minimum cost level to those who desire them. This option is graphically explained in Illustration no.26



ELECTRICITY AND STREET LIGHTING OPTION Illustration #26

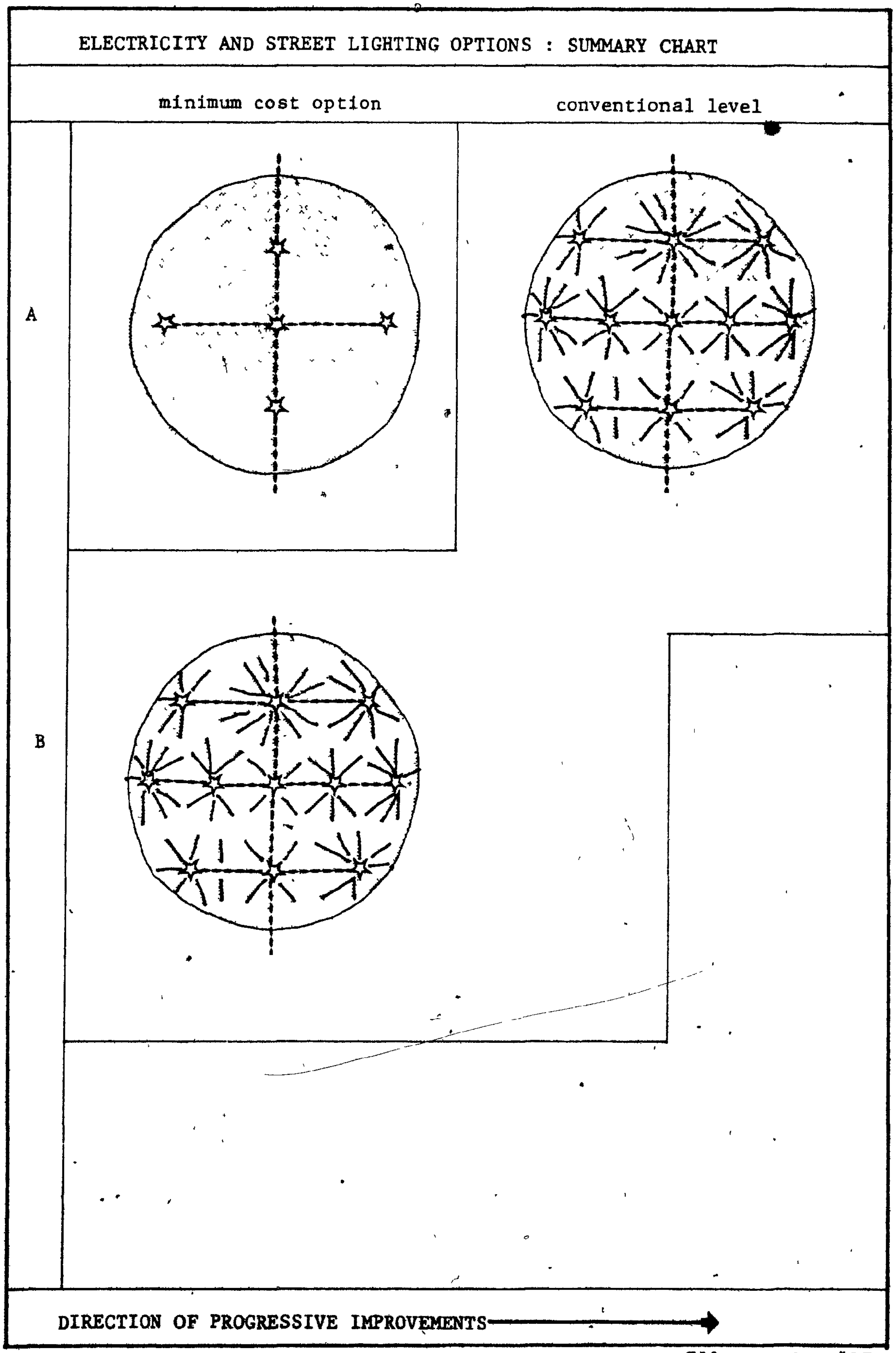


Illustration #27

CHAPTER : 3 SPECIFIC OPTIONS FOR LUSAKA

3.1 Background : Lusaka, Zambia

In this third and final chapter, several options are presented for a prototypical layout which has been developed specifically for Lusaka, Zambia. It may be useful at this point to present some background information on Lusaka. Later in this chapter the process of choosing the right kind of option will be explained through a list of the most likely combinations of these options. This selection process will in turn indicate what the affordable standards of services for Site and Services projects are.

Some 70 years ago, Lusaka was a village of the Lenje tribe, one of Zambia's numerous tribes, and it consisted of only 6-8 huts. It was known by the name of its headman, Lusaaka. Until October 24,1964, Zambia was part of the Central African Federation, a protectorate of the United Kingdom. The federation consisted of present-day Malawi, Zambia and Zimbabwe. In 1910, a railway serving the Kabwe mines (then Broken Hill) from Salisbury, Zimbabwe (then Rhodesia) passed 0.8 km. away from the village of Lusaaka.

The formation of the Lusaka Township and Village Management Board was announced in 1913 with a boundary of 0.8 km. on either side of the railway. White settlers began to trickle in and by 1914, Lusaka had a half a dozen stores along one of six gridiron patterned streets. However, during the First World War, much of the male population left Lusaka and development ceased. Later, the government chose Lusaka as the new capital of what was Northern Rhodesia in 1934 because of its central location, its established communication links and its ample water resources under dolomite rocks.

Lusaka's population continued to grow and in 1954 numbered about 155,000. In 1978 the population was estimated to be close to 520,000.[38] Today, greater Lusaka, the capital city of Zambia, covers some 360 sq.km. with an average gross population density of 14.5 persons per hectare, while the country's average gross population density is around 0.07 persons per hectare (7 persons per sq.km.). The housing sector did not cope with this population increse and half of Lusaka's population was living in informal settlements in 1973. There were about 34 such settlements, some of which were as big as a neighbourhood. For example 'Mwaziona' settlement had a total population in excess of 45,000.[39]

Housing in Lusaka

Prior to independence in 1964, the housing problem in Zambia was less significant than it is today because the movement of native Zambians to urban centers was controlled by regulations based on race. Local urban authorities or private employers provided accommodation for their employees. Since most native Zambians were employed and were provided with rental accomodation by their employers, housing was very closely related to employment. Housing shortages grew as the newly self employed had to find their own accommodation. Under these circumstances, people built their houses wherever they could, regardless of the difficulties of servicing and of commuting. Prior to independence, building contractors allowed their employees to build temporary huts on construction sites; groups of such huts were referred to as 'compounds'. As these compounds grew, the huts became more permanent dwellings. Many new settlements also grew on the fringes of urban centers. The new housing act passed in October 1974, recognizes the legal existence of these settlements. Some of them have since been upgraded and provided with services.

There are basically five different kinds of residential areas in Lusaka. These areas evolved during Lusaka's early development around 1930. Strict principles of racial segregation, controlled movement of native Zambians and the practice of connecting housing with employment have imparted a distinctive character to these residential areas. At the time of independence, most of the housing stock was rented and very few dwellings were owner occupied.

The residential areas of Lusaka can be identified with the five categories listed below.[40]

1. Upper Income Housing
2. Military Housing
3. Council Housing
4. Site and Services Housing
5. Informal Housing

1. Upper Income Housing

This type of housing developed around the Ridgeway capital buildings. This area is well serviced with social, educational and recreational facilities. Individual dwellings are of good quality with well finished exteriors and interiors. They have running water, sewers, electricity and good roads. Since independence, this type of housing is declining in proportion to the total housing stock, and in 1974 it provided housing for only 19 percent of the population.

2. Military Housing

This type of housing consists of police camps and armed forces quarters and is located to the immediate south west of the Ridgeway capital complex.

Before independence, the proportion of this type of housing was greater but it is relatively insignificant today. In fact, in 1974, there were only 986 units for police housing and approximately 900 units for the armed forces.

3. Council Housing (Owned by the Lusaka City Council)

This type of housing is quite widespread. The practice of connecting housing with employment gave rise to this type of residential development. The Lusaka City Council built rental units for their employees. The units are of good quality but lack in social, educational and recreational facilities. At one time, this type of housing was the most dominant housing category. In 1974, it provided housing to some 25 percent of the population.

4. Site and Services Housing

This type of housing increased in popularity after independence. Usually the dweller builds his own unit with or without any technical assistance and with or without a financial loan. The plot is serviced with piped water, sanitary facilities, road access and street lighting. Most dwellings are of good quality but lack social amenities. In addition, some areas lack an effective public transport system. This type of residential development provided housing accommodation for approximately 12 percent of the population in 1974.

5. Informal Housing

This type of residential development consists mainly of informal settlements. With the expansion of the Lusaka city limits, informal settlements are part of the city but are not subject to demolition due to the legislation passed in 1974 which recognized such settlements. The quality of these dwellings is constantly improving. Most of the dwellings have changed from pole and doga construction to concrete block walls and galvanized iron or asbestos sheet roofing. The gross density is quite high when compared with other types of residential areas. Although they lack in social, educational and recreational facilities, social life is flourishing. These areas also lack proper road access, water supply and sanitation facilities. In 1973 this type of residential area provided housing for about half the total population of Lusaka.

Services : Water Supply

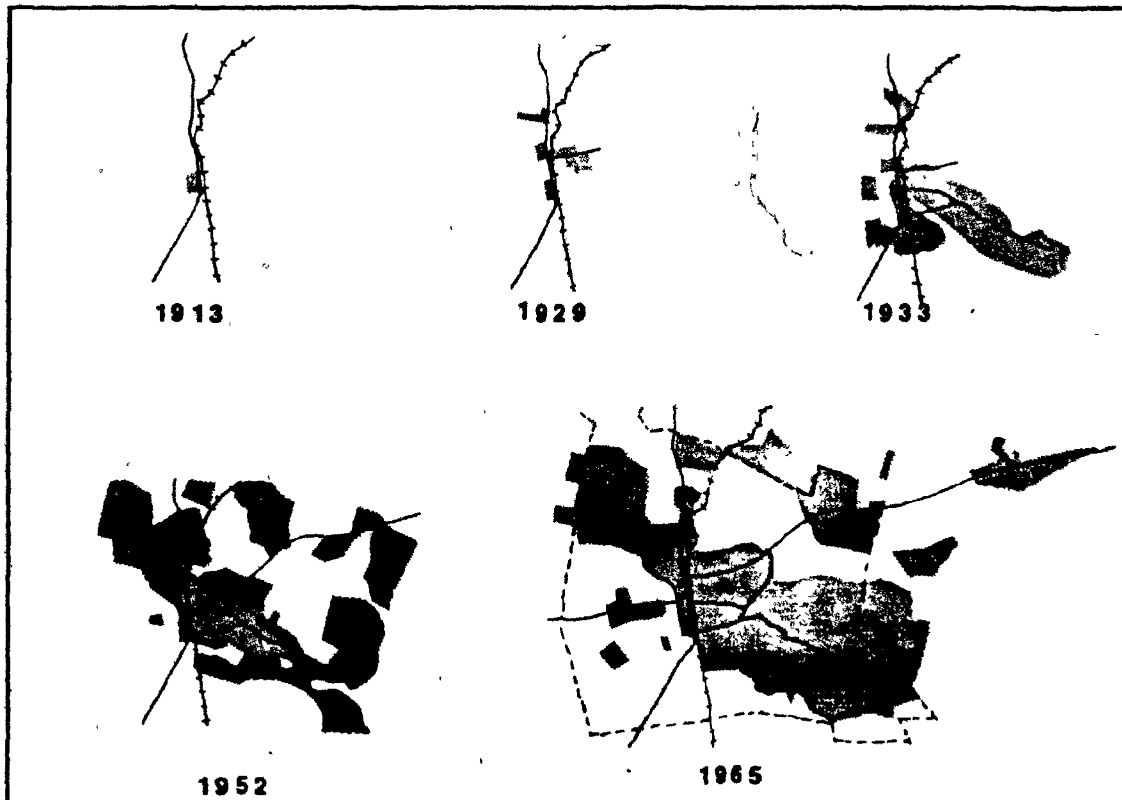
Lusaka has had a piped water supply system since 1954. Water is supplied by boreholes and taped from a nearby river, the Kafue. The water is supplied after treatment and meets international health standards thus making it potable straight from the tap. Households which have access to a communal water tap within a ten minute walk or which have their own water supply are considered to have water supply facilities. In 1957, about 82 percent of the total housing stock had such facilities while it decreased to 64 percent by 1973. A recent programme to upgrade informal settlements is likely to improve this situation.

Services : Sanitation

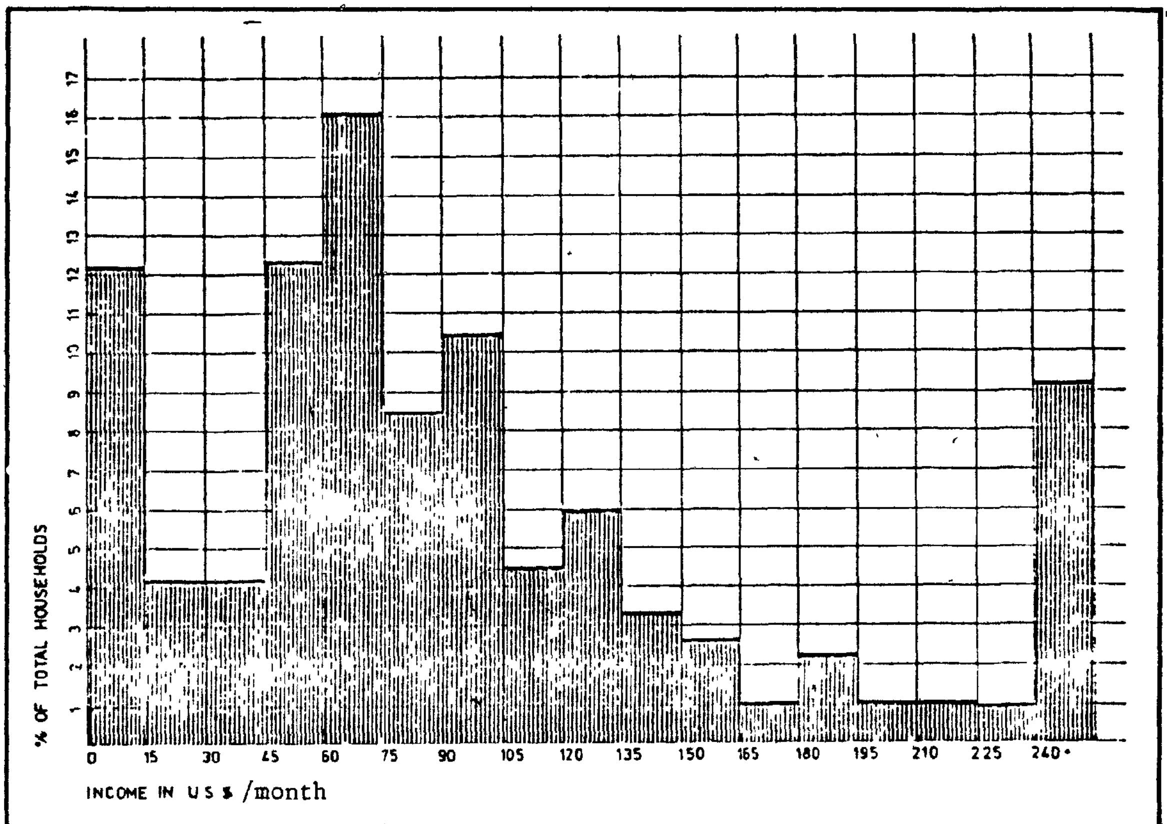
Part of Lusaka has a sewer system where the sewage is treated at five stabilization ponds and two sewage treatment plants. In 1976, 37 percent of the population had flush toilets, 54 percent of the population had pit latrines and three percent of the population used bucket latrines.[41] The remaining population had no access to any kind of organized sanitation system.

Location:	Latitude	: 15° 25' South
	Longitude	: 28° 19' East
	Mean Elevation above sea level	: 1274 Meters
Landscape:	High plateau and water table goes down in winter Land consists of limestone and schist Parts of Lusaka are thickly wooded with indigenous trees	
Temperatures:	Seasons Cool dry season (April to August):	
	Mean : Max. 26°C	Extreme : Max. 34°C
	Mean : Min. 10°C	Extreme : Min. 04°C
	Hot dry season (August to November):	
	Mean : Max. 31°C	Extreme : Max. 38°C
	Mean : Min. 15°C	Extreme : Min. 07°C
	Warm wet season (November to March):	
	Mean : Max. 26°C	Extreme : Max. 34°C
	Mean : Min. 17°C	Extreme : Min. 12°C
Humidity:	Relative mean 62%	
Wind:	Prevailing winds occur from the East at an average speed of 5.6 km/second or 3.5 miles/second during nine months of the year except January, February and July	
	January : East-North-East February : East-North-East July : East-South-East	
Population:	238,000 (1969 census) estimated close to 320,000 persons (1978 estimates)	

LUSAKA : BASIC INFORMATION Illustration #28

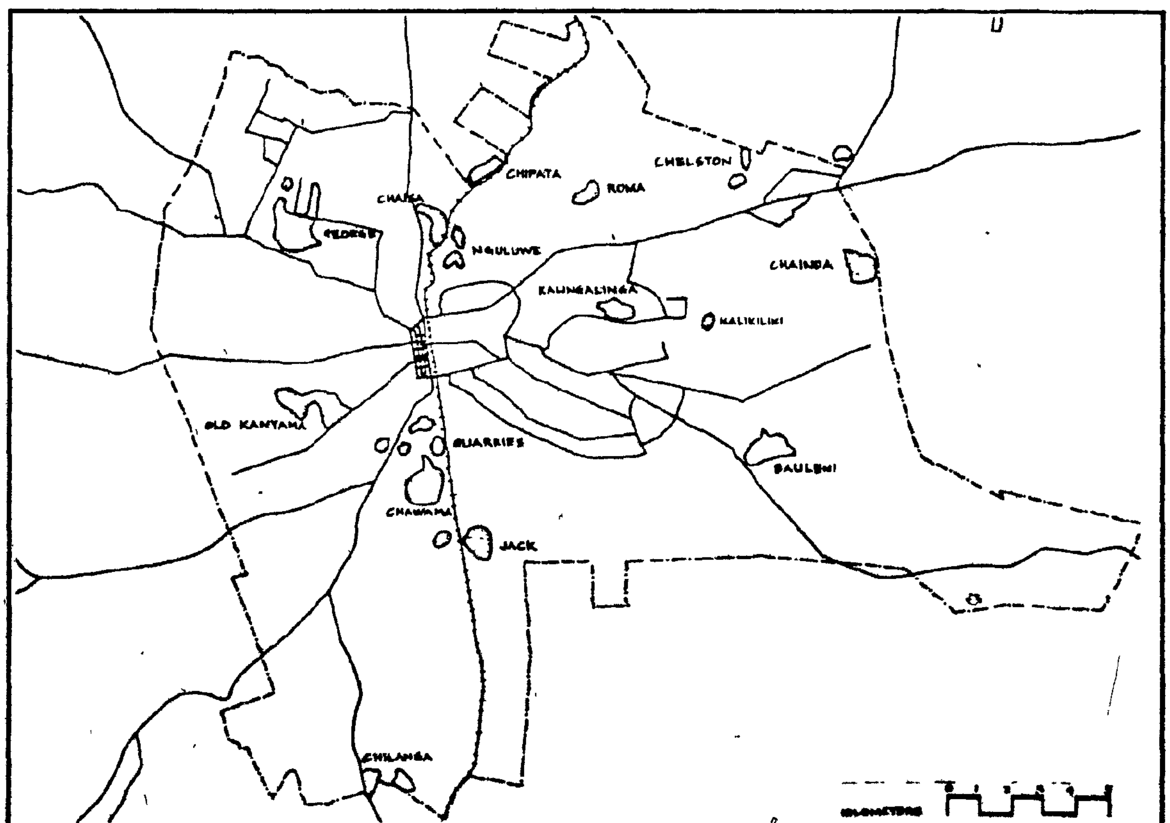


LUSAKA : STAGES OF GROWTH[42] Illustration #29



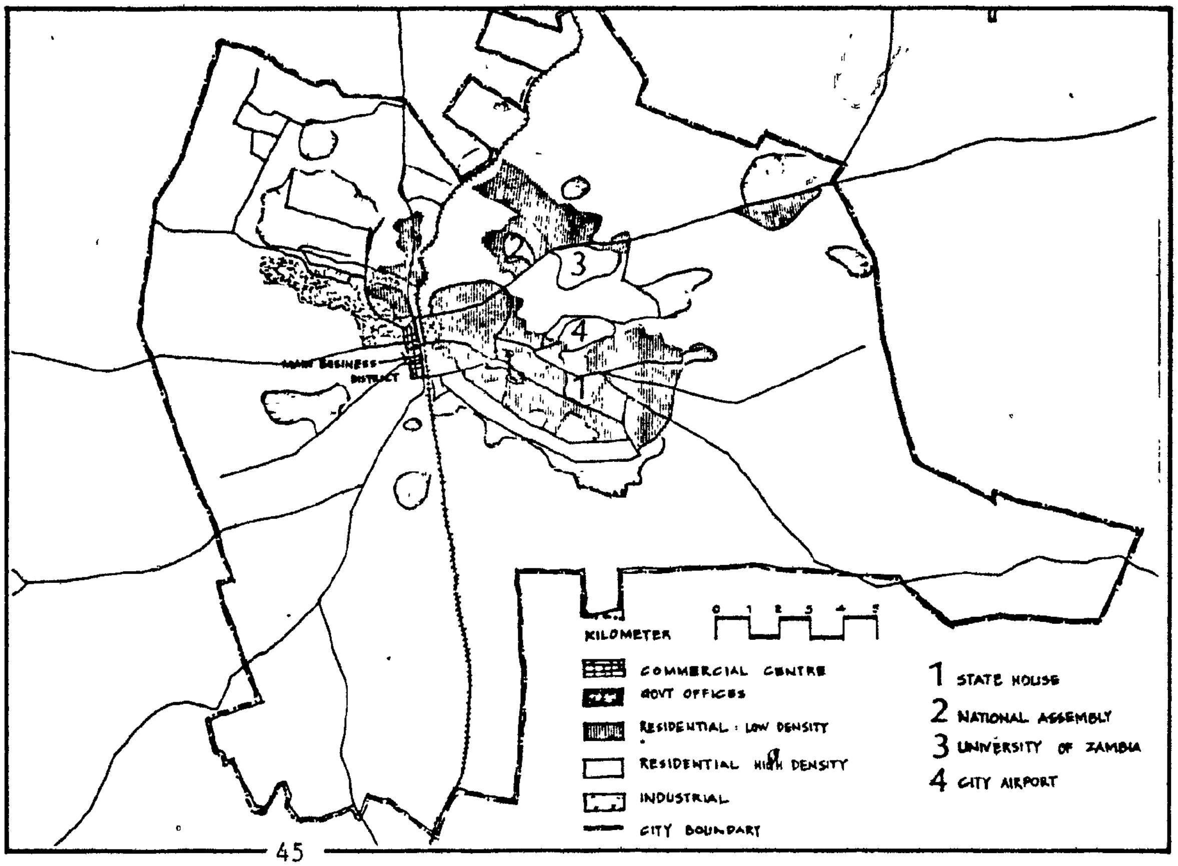
LUSAKA : INCOME DISTRIBUTION (1973)[43]

Illustration #30



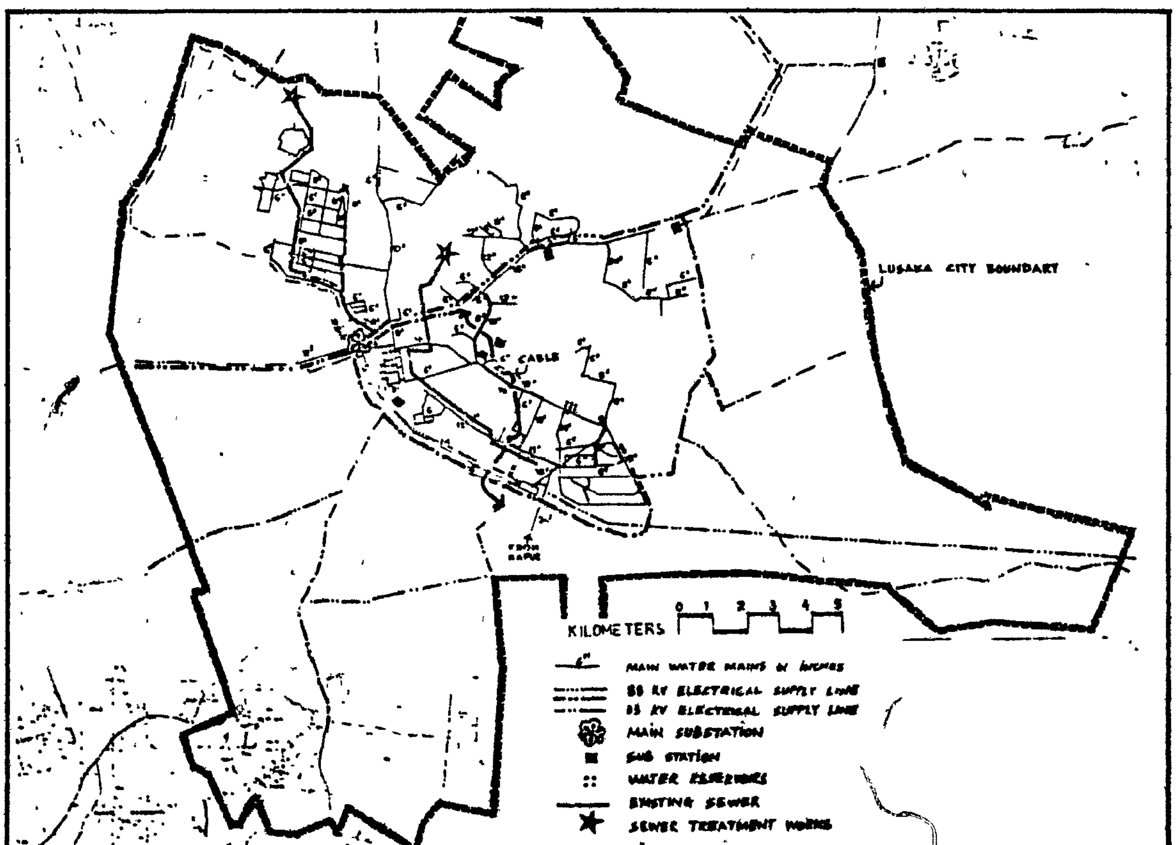
LUSAKA : INFORMAL HOUSING AREAS[44]

Illustration #31



LUSAKA : LAND USE[45]

Illustration #32



LUSAKA : EXISTING INFRASTRUCTURE[46]

Illustration #33

3.2 Servicing Options for Lusaka

Evidently it is extremely difficult to meet future housing requirements in Lusaka with available financial resources. To achieve the goal of providing shelter to a maximum number of people it is of utmost importance to provide serviced land on which people can build their own dwellings. It was noted in the previous chapter that even these projects fail to provide housing to many urban poor chiefly because of expensive and inappropriate servicing standards which result in unaffordable repayment requirements. Therefore, it is important to find out how the standards of services for Site and Services projects can be lowered thereby creating substantial savings.

In 1974, the average cost for plot in a Site and Services project in Lusaka was about US $ 823.[47] Presently, it is estimated that it would cost close to twice that amount or US $1,650 per plot to provide the standards of services. A reliable unit cost base for the year 1974 is available and has been used for cost computations throughout this work and for the illustrations of options. Illustration no.40 indicates such unit costs for Site and Services projects in Lusaka.

Servicing options are presented on a prototypical layout. This prototype has been developed on the basis of experience designing layouts for Site and Services projects in Lusaka. While developing the prototype, all applicable regulations which were exercised by the concerned ministry in Zambia have been followed with the exception of regulation 1.b. (see Appendix:A).

Basic data of a prototypical layout

Total area of land:	9.9968 hectare
Total no. of plots:	220
Gross density Plots/ hectare:	22
Average size of plot:	320 sq.m.
Roads and open spaces:	29.58 percent
Residential:	70.42 percent

The servicing options which have been assumed for Lusaka are listed below and are presented in the following pages. It should be noted that the preparation of the minimum cost option never precluded the possibility of future improvements leading towards more conventional standards.

1. Water supply options
2. Sanitation options
3. Roads and storm drainage options
4. Electricity and street lighting options.

SITE AND SERVICES SURVEY

Unit Costs & Standards[48]

SURVEY NO: 6- ZAMBIA
DATE: May 20, 1974

COMPONENT: DESCRIPTION/STANDARD	SPECIFICATION	UNIT	UNIT COST US$	COST/PLOT US$
1. LAND				
1a. Land Acquisition	n/a			
2. SITE PREPARATION	n/a			
3. PUBLIC UTILITIES				
3a. Water Supply				
Standpipes @ 1 per 25 plots	12 mm G.S. pipe	m	2.4	
in overspill areas;	19 mm " "	m	2.7	
Standpipes @ 1 per 4 plots	25 mm " "	m	3.6	
in basic plots;	75 mm A.C. Pipe	m	5.5	
Individual Connection of piped	100 mm " "	m	7.3	
water brought 10m inside of	150 mm " "	m	12.7	
plots for 'normal' plots.	200 mm " "	m	16.4	
Average consumption 150 lpd.	225 mm " "	m	18.2	
Allowance for schools, shops etc.,	(Laying included)			
30,000 litres per ha.	Fittings, etc. add			
	20% of total above.			
	Fire Hydrant	no.	168.0	
3b. Sewerage				
Pit latrines built by users in				
the overspill and 'basic' plots;				
Individual waterborne connection	100 mm Earthenware Pipe	m	13.7	
brought 3m inside of plot in the	150 mm " "	m	16.4	
'normal' plots.	225 mm " "	m	25.5	
Average flow 150 lpd.	300 mm A.C. pipe	m	36.4	
Allowance for schools, shops etc.,	375 mm Concrete pipe	m	41.9	
20,000 litres per ha.	Inspection Chamber	no.	84.0	
	Manhole	no.	238.0	
	Pumping Station I	no.	49,000	
	Pumping Station II	no.	98,000	
	Pumping Station III	no.	126,000	
3c. Surface Drainage				
open ditches	earth drains	n/a		
3d. Roads and Footways				
Overspill areas;	100 mm - 200 mm	m	10 -	
Gravelled 4m internal road	gravel thickness		20	
system, no direct access to	on 3m - 6m wide			
all plots; bitumenized 6m	roads (with 4-25m			
bus routes.	right of way)			
Site & Services Areas:	2-3.5m wide foot paths			
Gravelled 4m internal road				
system; direct access to all	tar	m^2	1.5	
plots. bitumenized 6m access roads.				

Illustration #34

1. Water supply options

The cost of supplying water depends on the degree of service installed. The principle to be adopted is a step-by-step upgrading of services, beginning with a low-cost, and therefore low-level, service and ultimately reaching a 'conventional' standard. This strategy assumes that a communal public standpipe is installed in the beginning which supplies water to a group of families who have to walk at maximum about 5-6 minutes to fetch water. Eventually, these standpipes are extended to connect to individual houses.

Four options have been developed on the assumption that an urban water main passes through the main street with sufficient water at a suitable pressure to supply the community.

I. Water supply option: I (Illustration no.35)

A public water standpipe is provided for every 110 families, each standpipe has 20 taps (one tap for every 5-6 families). The maximum walking distance is about 190 meters or 5-6 minutes based on an average walking speed of 4 km. / hour. This is the minimum cost level and costs US $26.61 per plot.

II. Water supply option: II (Illustration no.36)

A public water standpipe is provided for every 37 families, each standpipe has 6 taps (one tap for every 6 families). The maximum walking distance is about 70 meters or a 2-3 minute walk. It costs US $53.98 per plot.

III. Water supply option: III (Illustration no.37)

A public water standpipe is provided for every 9 families, each standpipe has four taps (one tap for every 2.5 families). Maximum walking distance is about a 1-2 minute walk. It costs US $104.45 per plot. Six firehydrants are also provided.

IV. Water supply option: IV (Illustration no.38)

Individual connections and six firehydrants are provided at an installation cost of US $135.52 per plot.

WATER SUPPLY OPTION : I

* Installation cost/plot : US $26.61

* Maximum walking distance : 5-6 minutes

200 mm Ø water main

stand pipe

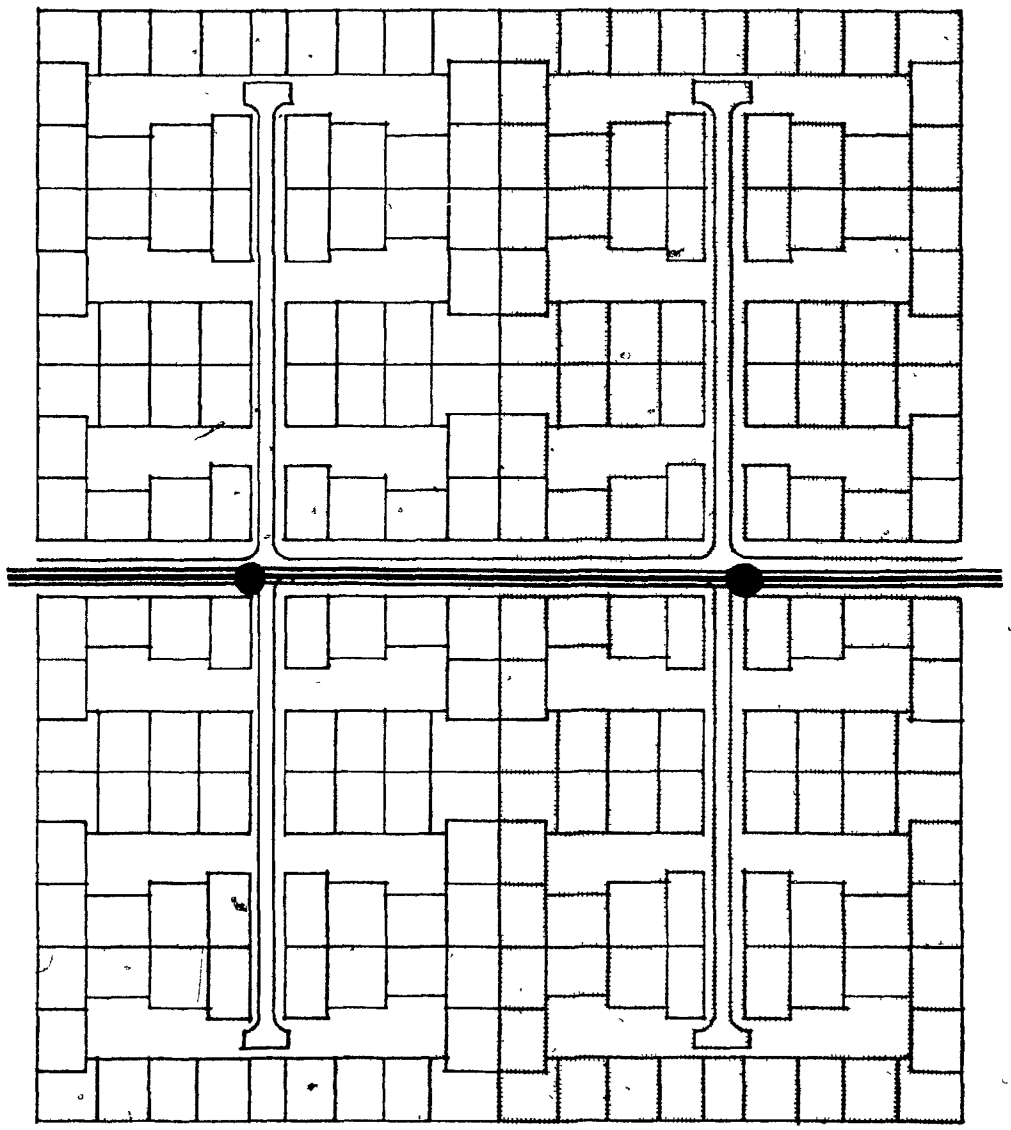


Illustration # 35

WATER SUPPLY OPTION : II

* Installation cost/plot : US $53.98

* Maximum walking distance: 2-3 minutes

200 mm Ø water main

150 mm Ø water pipe

stand pipe

existing stand pipe

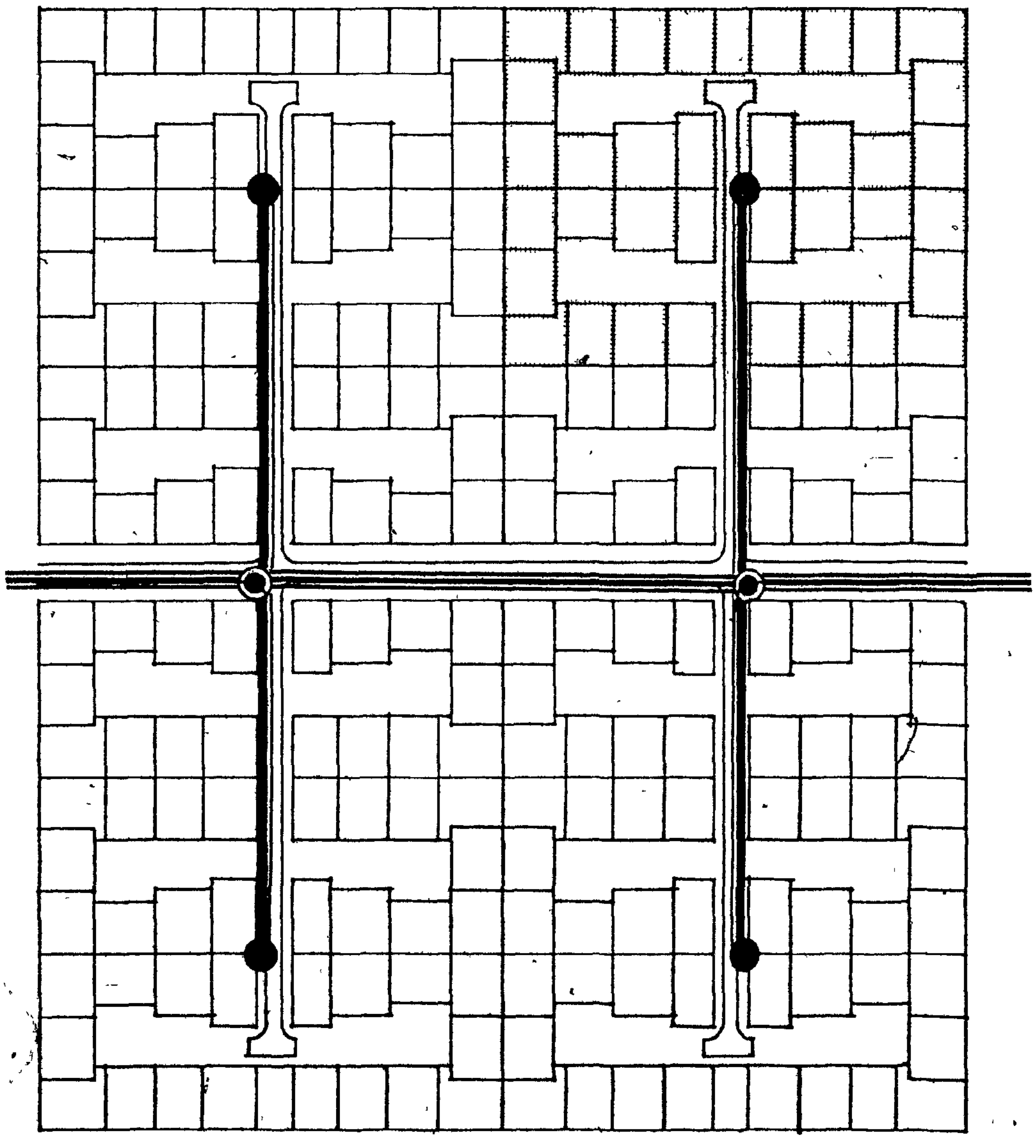


Illustration # 36

WATER SUPPLY OPTION : III

* Installation cost/plot : US $104.45

* Maximum walking distance: 1-2 minutes

200 mm Ø water main
150 mm Ø water pipe
75 mm Ø water pipe
stand pipe
fire hydrant

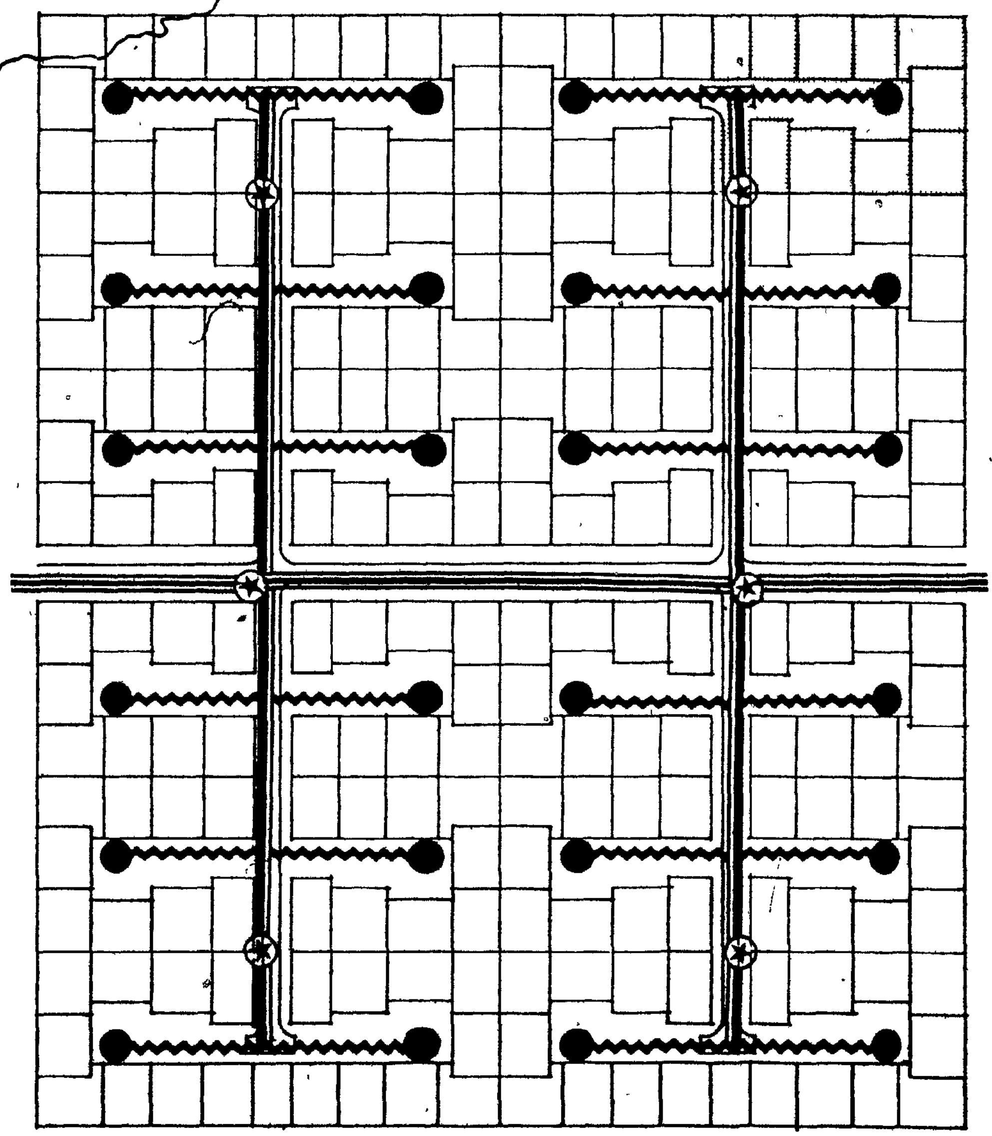
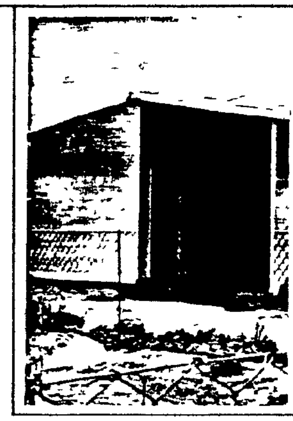


Illustration #37

WATER SUPPLY OPTION : IV

* Installation cost/plot : US $135.52



200 mm Ø water main
150 mm Ø water pipe
75 mm Ø water pipe
12 mm Ø individual connection
fire hydrant

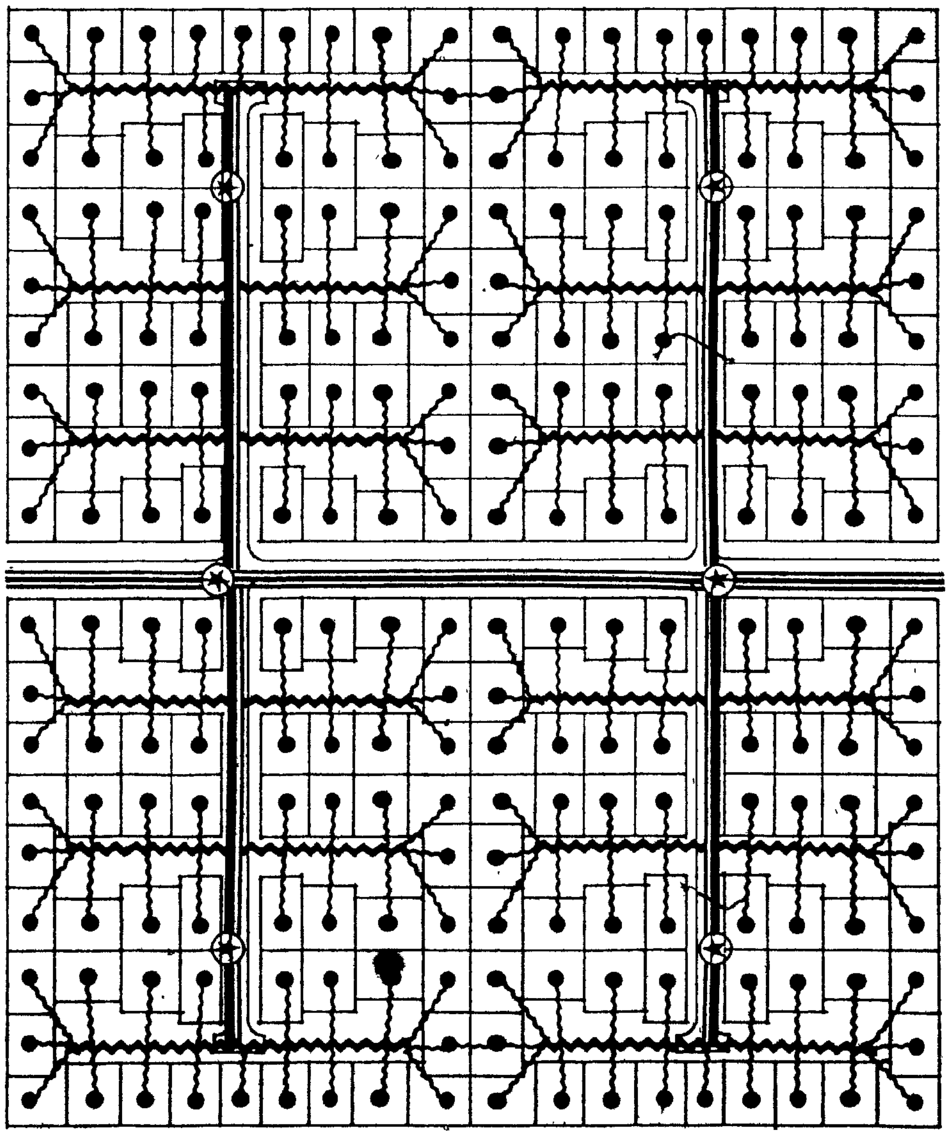


Illustration # 38

WATER SUPPLY OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A ......US $ 26.61
* Initial investment required for sequence B ......US $ 53.98
* Initial investment required for sequence C ......Us $104.45
* Initial investment required for sequence D ......US $135.52

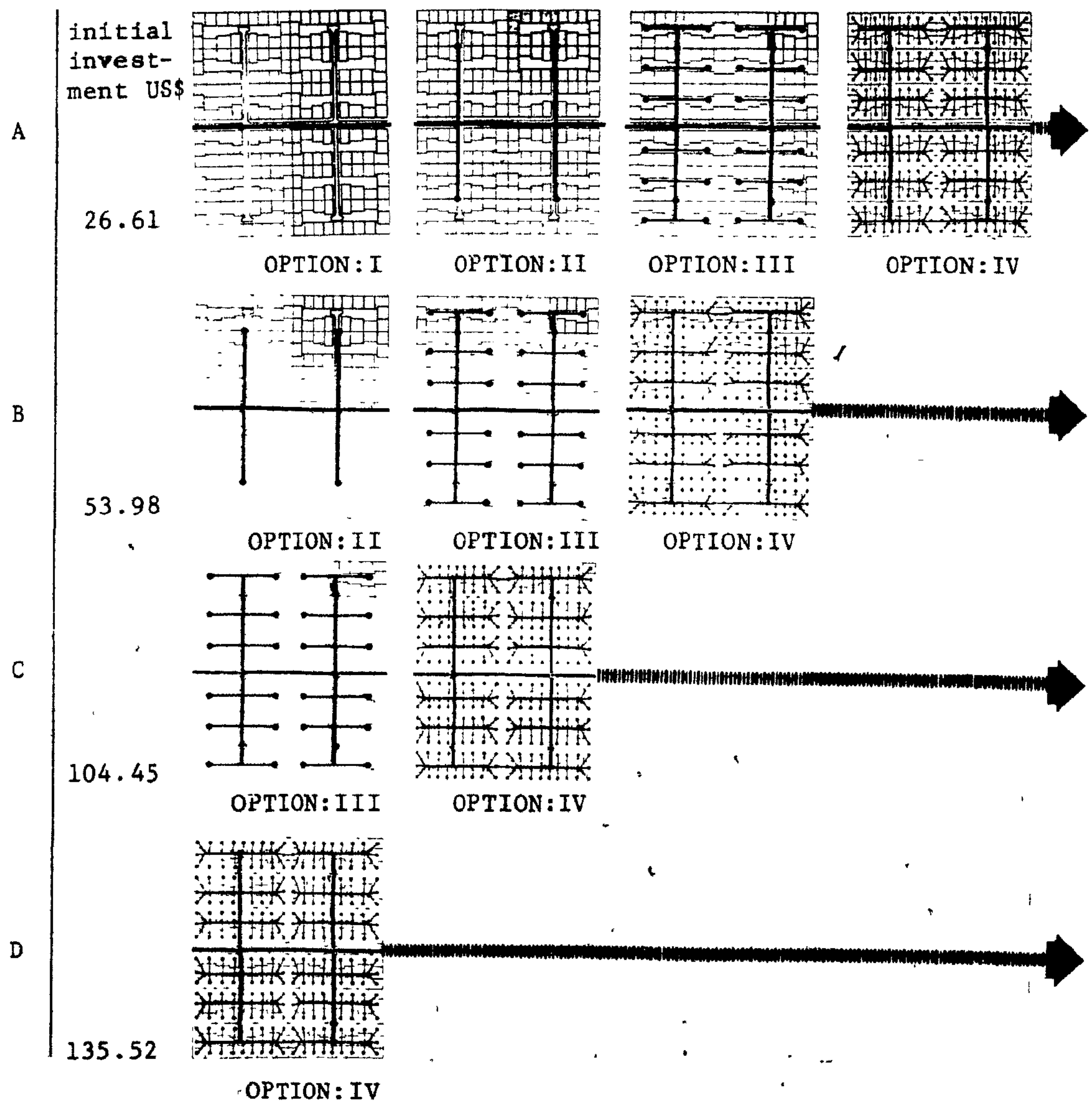


Illustration #39

2. Sanitation options

The cost of sanitation depends on the degree of service provided. In this case the minimum cost option is a pit latrine and the ultimate level of service is a sewer network.

Four options have been developed on the assumption that it is possible to connect to an urban sewer network through a main collector pipe with sufficient capacity to accept the additional flows from the community in question. The initial option assumes that the porosity conditions of the ground are favourable for pit latrines to function properly.

I. Sanitation option: I (Illustration no.40)

An improved pit latrine with a vent pipe equipped with a fly screen to prevent odour and flies is provided for each plot. This option assumes that the superstructure will be built by the residents and therefore the cost of the superstructure is discounted. The cost of the pit latrine is US $37.56 per plot (for cost calculations refer to Appendix : B).

II. Sanitation option: II (Illustration no.41)

Pit latrines are upgraded to become pour-flush toilets with soak pits (it is assumed that at this stage, there is more water available than at the previous stage). The cost of a pour-flush toilet is US $72.38 per plot. which includes the pit, pour-flush squatting fixture and the soak pit but excludes the cost of the superstructure (see Appendix:B).

III. Sanitation option: III (Illustration no.42)

The pour-flush toilets are upgraded to become aquaprivies by converting the pit into a holding tank which is connected to a soak pit. It is assumed that at this stage water is more freely available. The cost of the aquaprivy is US $97.50 per plot (see Appendix:B). The cost does not include the cost of the superstructure.

IV. Sanition option: IV (Illustration no.43)

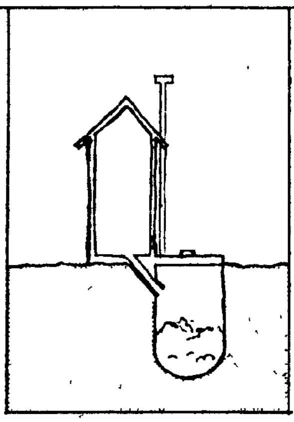
The aquaprivies are upgraded by connecting them to a sewer with a small diameter pipe as it can safely be assumed that sufficient water is available at this stage. The cost of the small diameter sewered aquaprivy is US $271.64 per plot.

At this stage aquaprivies function perfectly well and provide the same degree of convenience as do flush toilets, therefore, it is suggested that the Site and Services projects not provide for conventional flush toilet level. Although illustration no.44 shows the cost as US $347.81 per plot for conventional flush toilet sewers, these costs are for comparision only and serve to indicate the relative savings that can be made.

SANITATION OPTION : I

* Installation cost/plot : US $37.56

● pit latrine



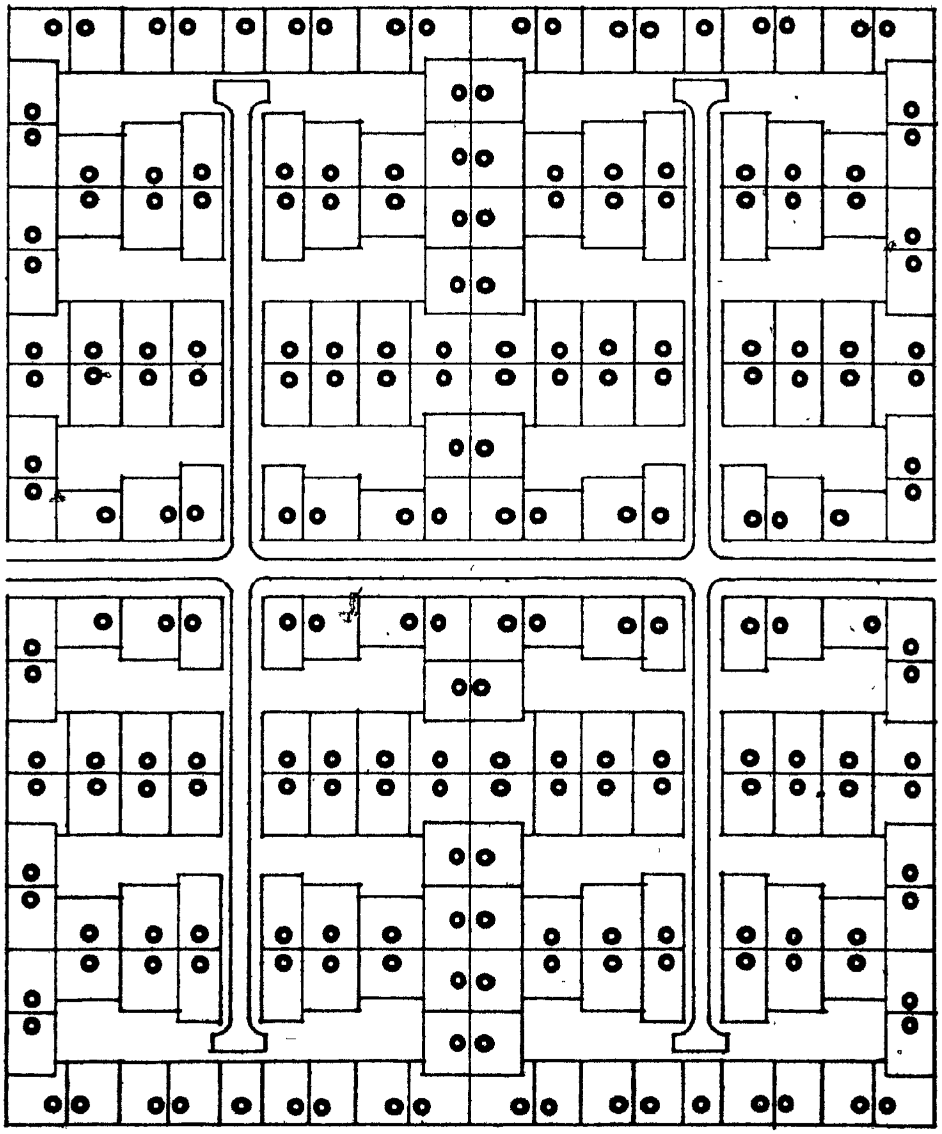
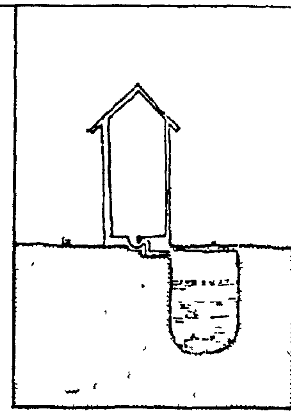


Illustration #40

SANITATION OPTION : II

* Installation cost/plot US $72.38

● Pour-flush toilet



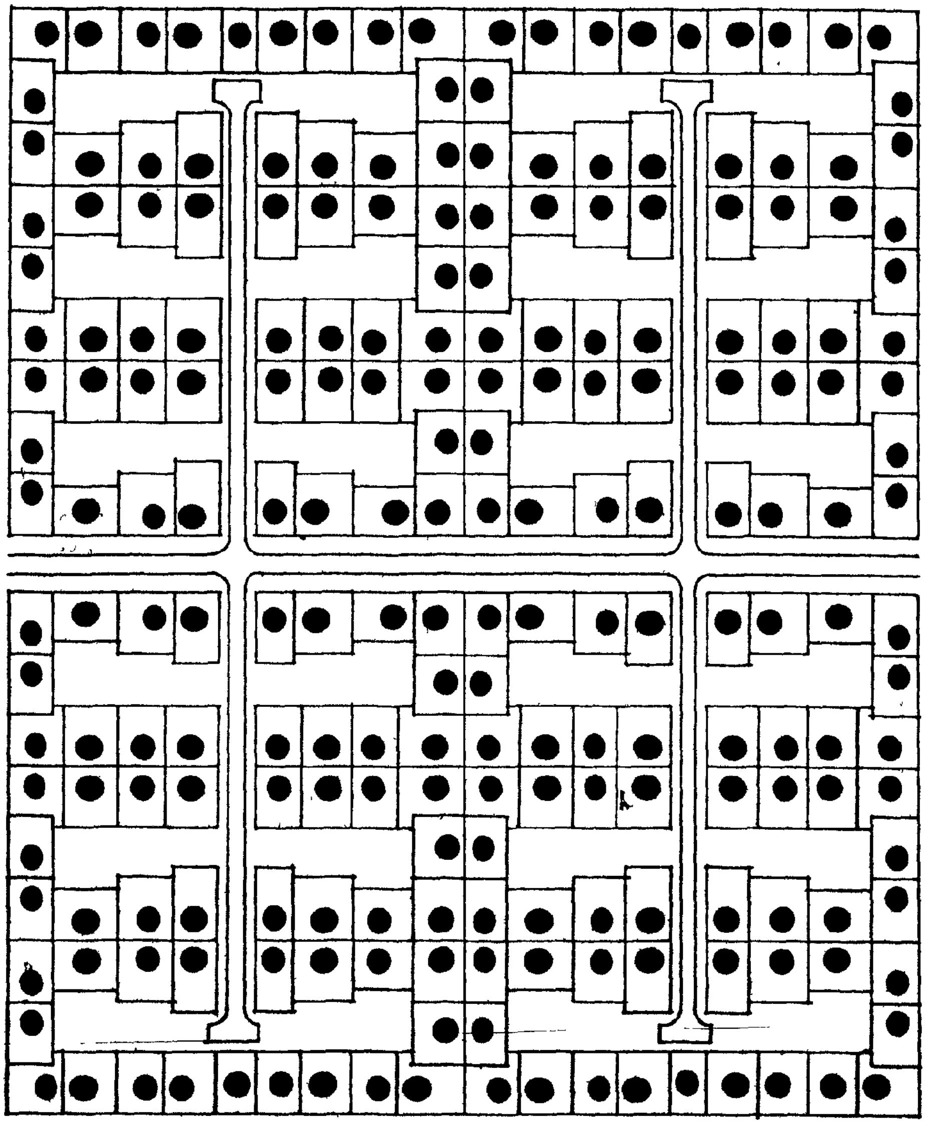
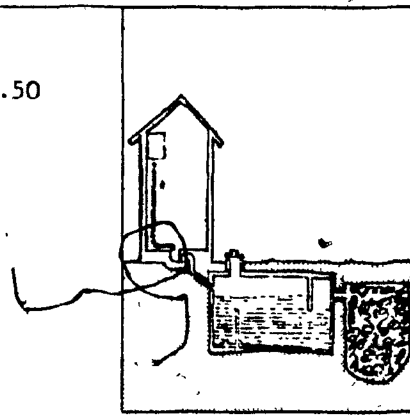


Illustration #41

SANITATION OPTION : III

* Installation cost/plot US $97.50

■ An aquaprivy



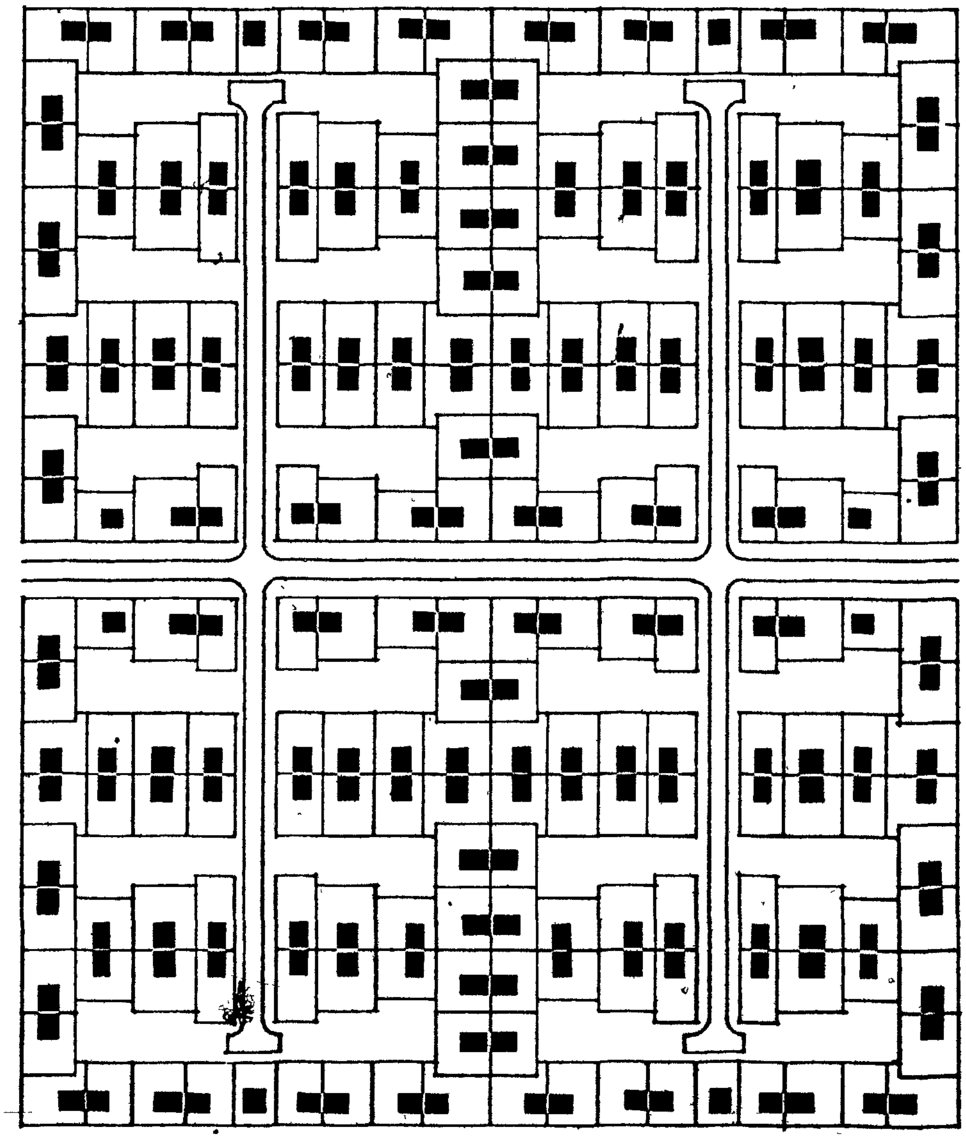
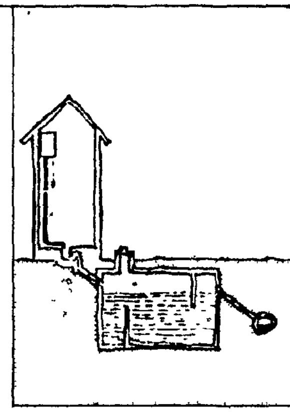


Illustration # 42

SANITATION OPTION : IV



* Installation cost/plot US $271.64

225 mm Ø collector pipe
150 mm Ø sewer pipe
100 mm Ø sewer pipe
manhole
small dia. sewered acquaprivy

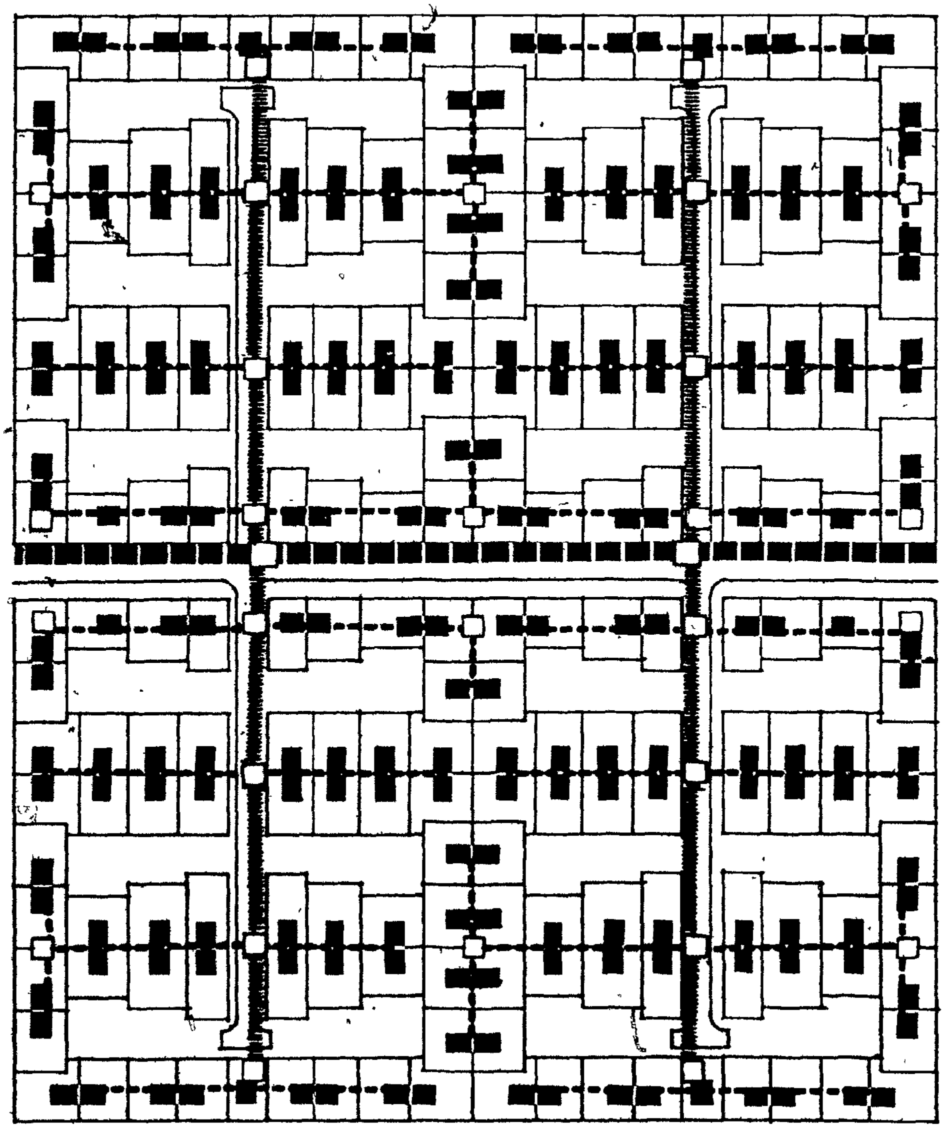
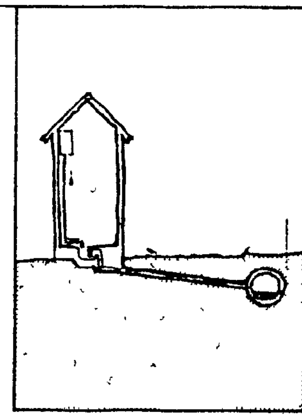


Illustration # 43

SANITATION OPTION : CONVENTIONAL

* Installation cost/plot US $347.81



- 300 mm Ø sewer main
- 225 mm Ø sewer pipe
- 150 mm Ø sewer pipe
- manhole
- flush toilet

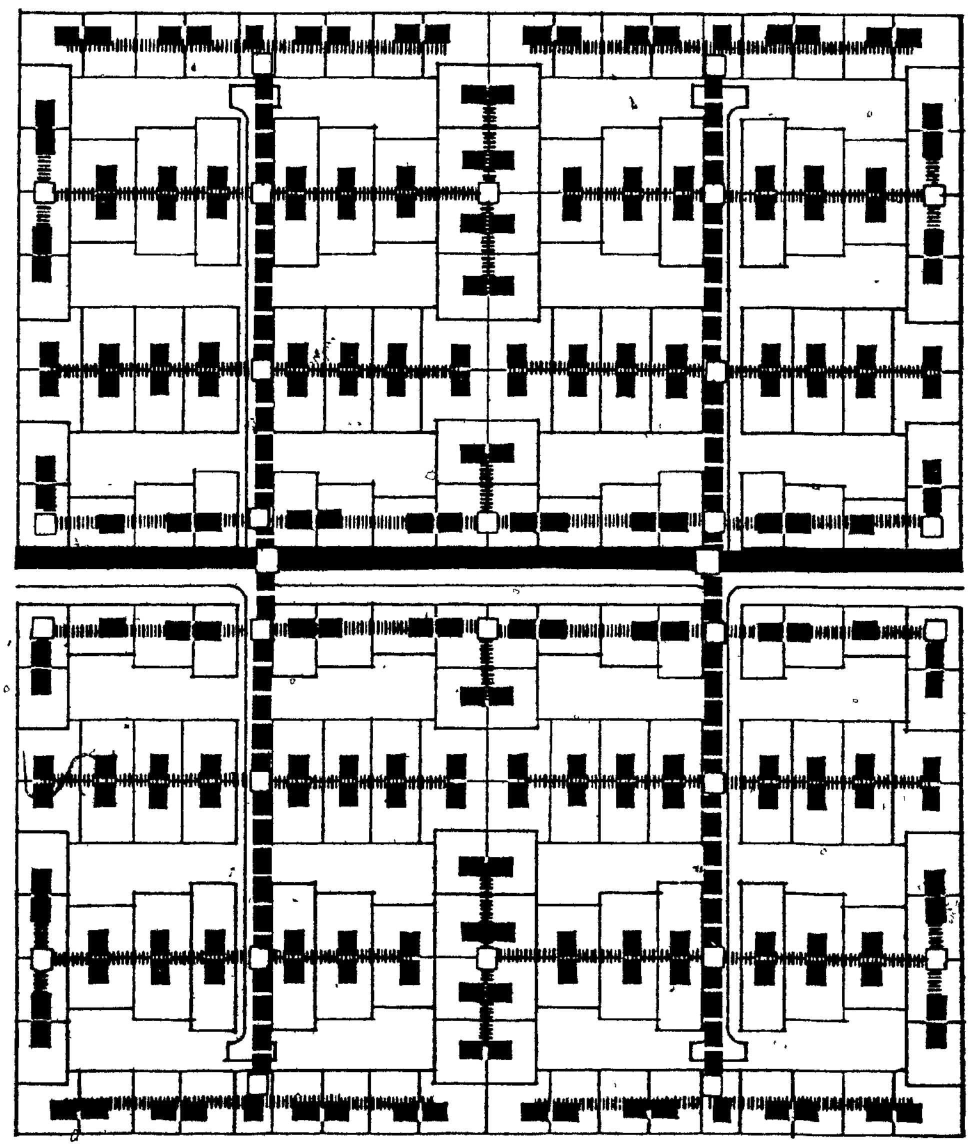


Illustration #44

SANITATION. OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A.......US $ 37.50
* Initial investment required for sequence B.......US $ 75.00
* Initial investment required for sequence C.......US $ 97.50
* Initial investment required for sequence D.......US $271.64

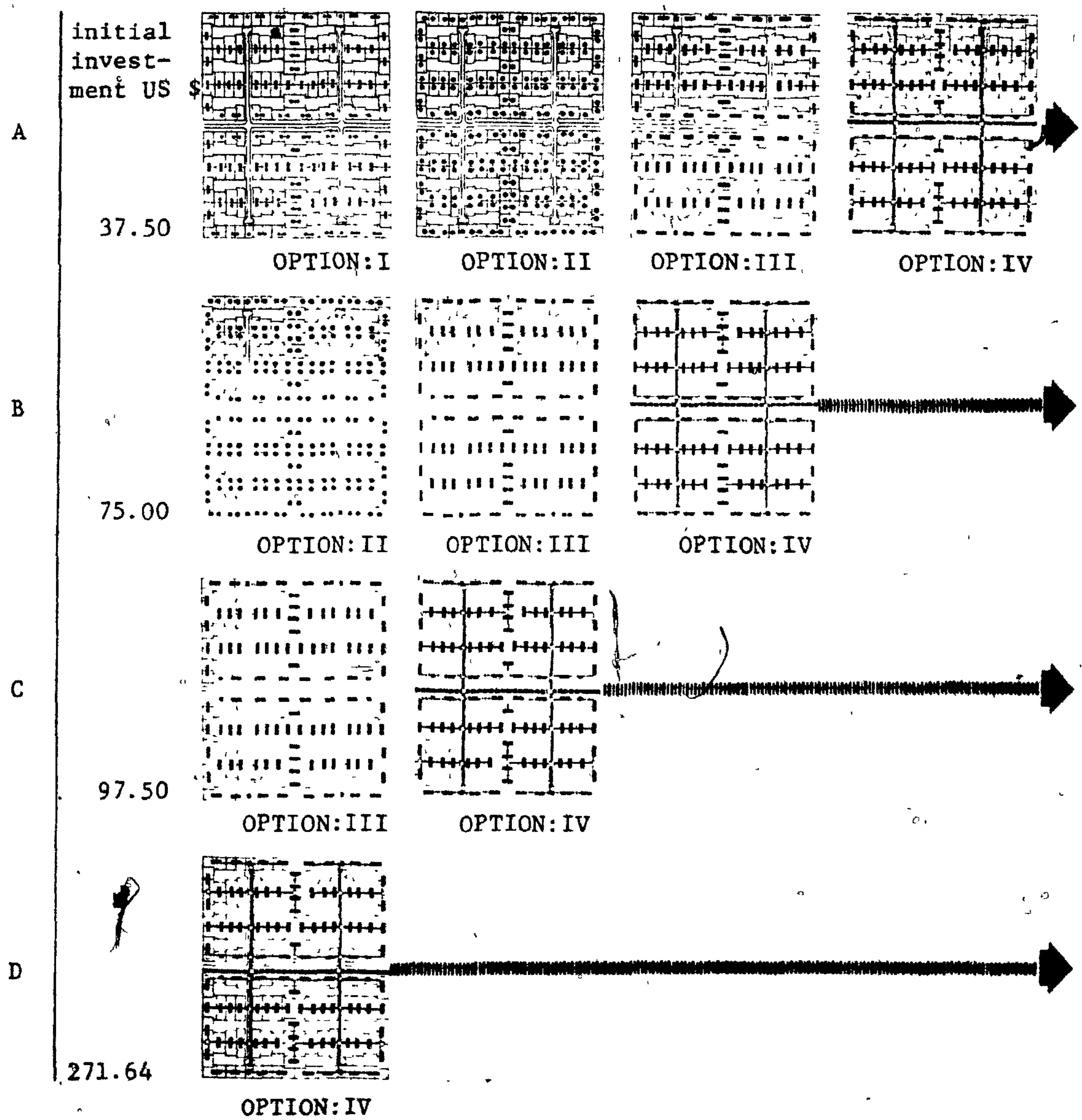


Illustration # 45

3. Roads and storm drainage options

The cost of surfacing roads depends on the quality provided. The principle of upgrading roads begins with a compacted earth surface which provides only seasonal service and is ultimately converted to a conventional tarmac surface. Initially, storm drains are open ditches on the sides of the prepared road surface following the natural slope of the ground for rain water disposal. Eventually, built up ditches which serve as storm drains are provided with concrete culverts where required.

Five options have been developed on the assumption that the main street will be a public transportation route with light commercial traffic.

I. Roads and storm drainage option: I (Illustration no.46)

Only the main road surface is prepared with a gravel base to provide public transport route facilities. Two additional roads are prepared with compacted earth surfaces. Open storm drain ditches are prepared along both sides of the roads and culverts are prepared at two intersections. The cost is US $37.56 per plot.

II. Roads and storm drainage option: II (Illustration no.47)

The main road surface is prepared with tarmac and storm drain ditches along this road are built up together with culverts at two intersections. Two additional road surfaces are prepared with a gravel base, and storm drain ditches are prepared along these roads. The cost is US $72.38 per plot.

III. Roads and storm drainage option: III (Illustration no.48)

The main road and two additional roads are prepared with a tarmac surafce. Storm drains are built up along these roads and culverts are prepared at two intersections. All extensions in the clusters are finished with compacted earth surfaces thus providing direct road access to each plot. The cost is US $130.47 per plot.

IV. Roads and storm drainage option: IV (Illustration no.49)

All road extensions in the clusters are prepared with a gravel base and accompanying storm drain ditches are provided with culverts at all intersections and junctions. The cost is US $174.98 per plot.

V. Road and storm drainage option: V (Illustration no.50)

All road surfaces are prepared with tarmac with built up storm drain ditches and necessary culverts of conventional standards. The cost is US $222.11 per plot.

ROADS AND STORM DRAINAGE OPTION : I

* Installation cost/plot : US $ 37.56

gravelled base surface with culverts

compacted earth with formed ditches

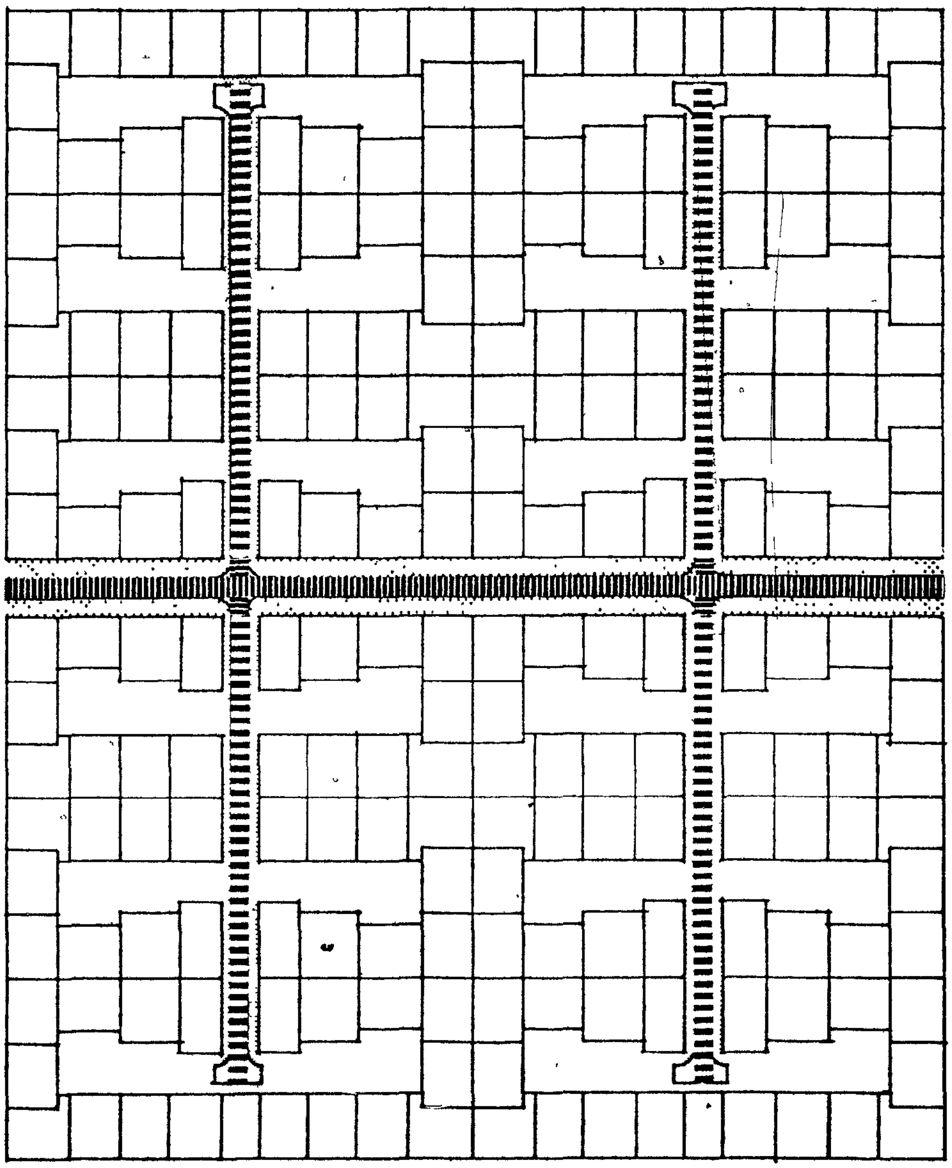


Illustration #46

ROADS AND STORM DRAINAGE OPTION : II

* Installation cost/plot : US $ 72.38

tarmac surface
with built up ditches and culverts

gravelled base surface
with culverts

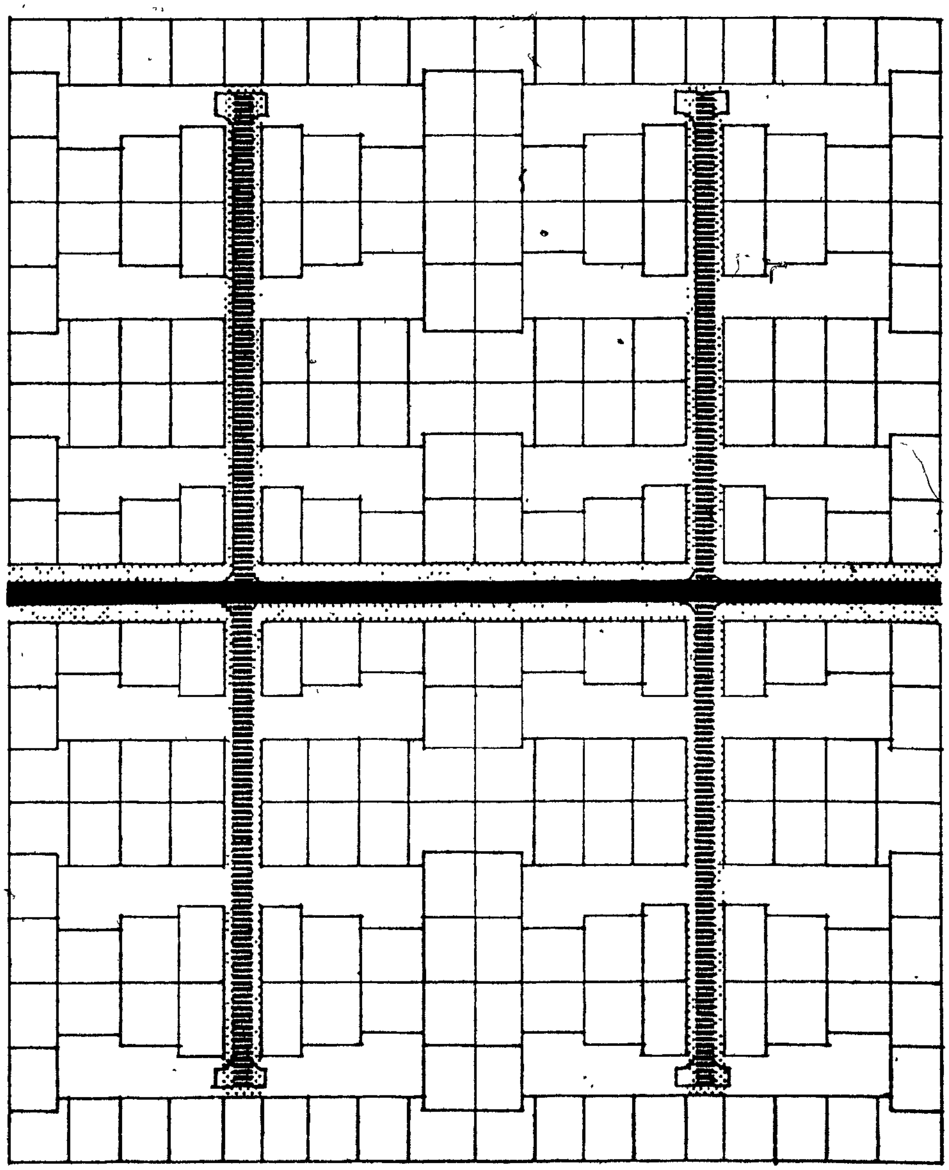


Illustration #47

ROADS AND STORM DRAINAGE OPTION : III

* Installation cost/plot US $130.47

tarmac surface
with built up ditches and culverts

compacted earth
with formed ditches

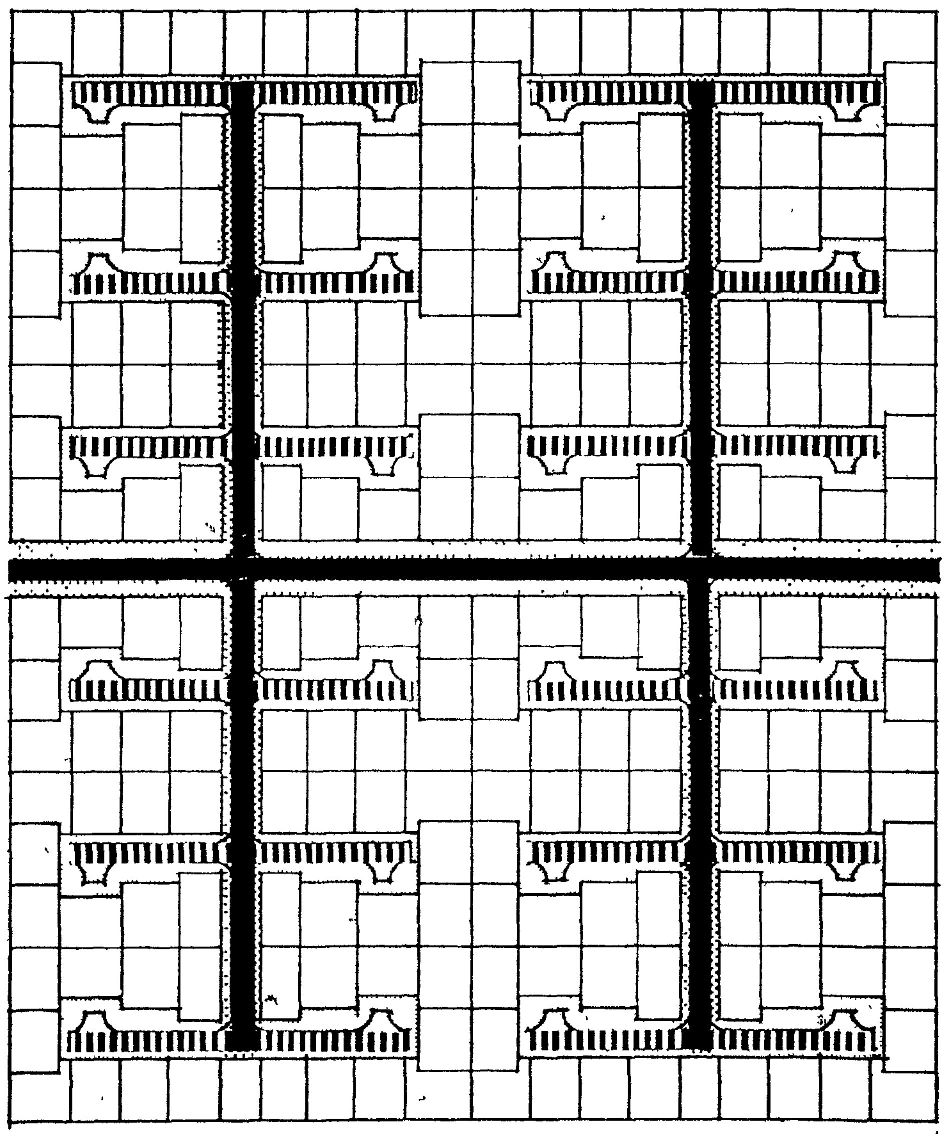


Illustration #48

ROADS AND STORM DRAINAGE OPTION : IV

* Installation cost/plot US $ 174.98

tarmac surface
with built up ditches and culverts

gravelled base surface
with culverts

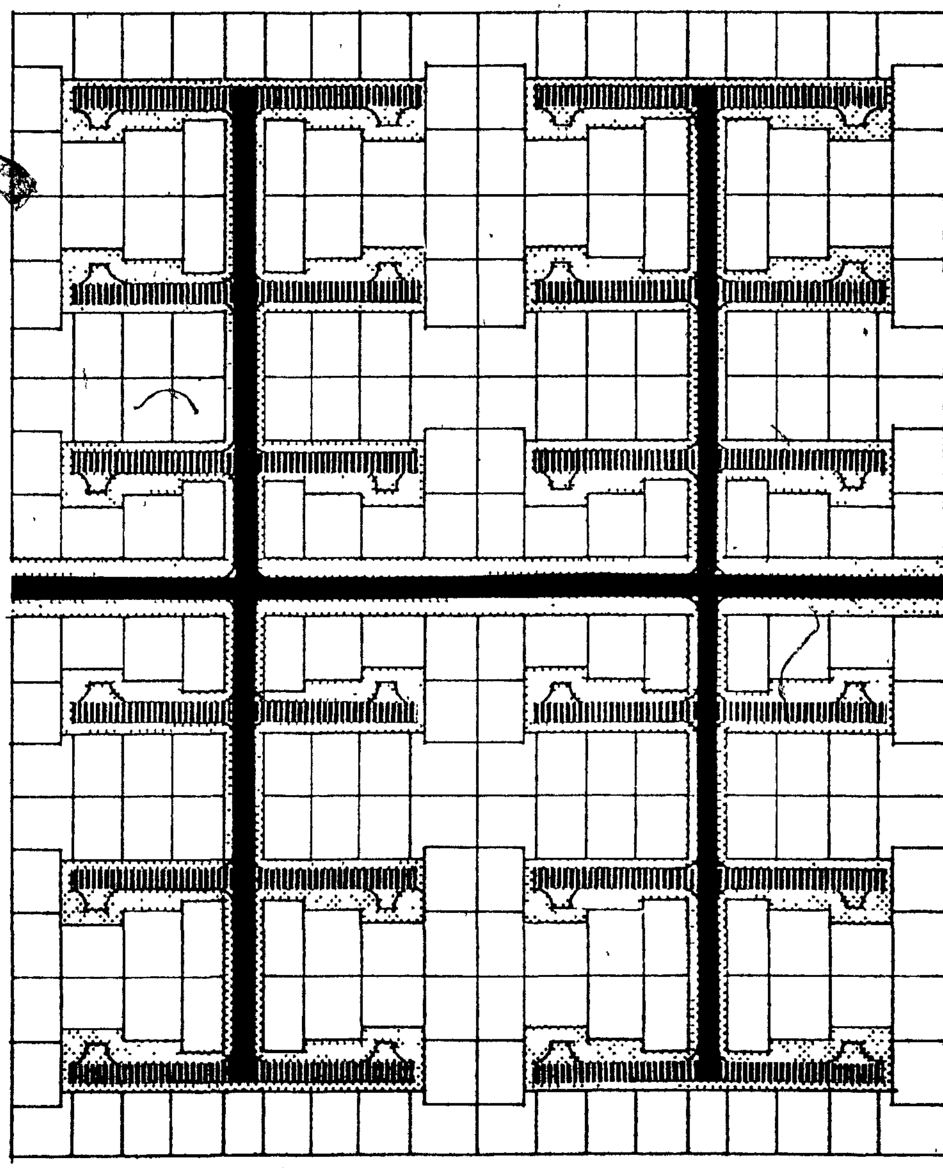


Illustration #49

ROADS AND STORM DRAINAGE OPTION : V

* Installation cost/plot US $ 222.11

tarmac surface
with built up ditches and culverts

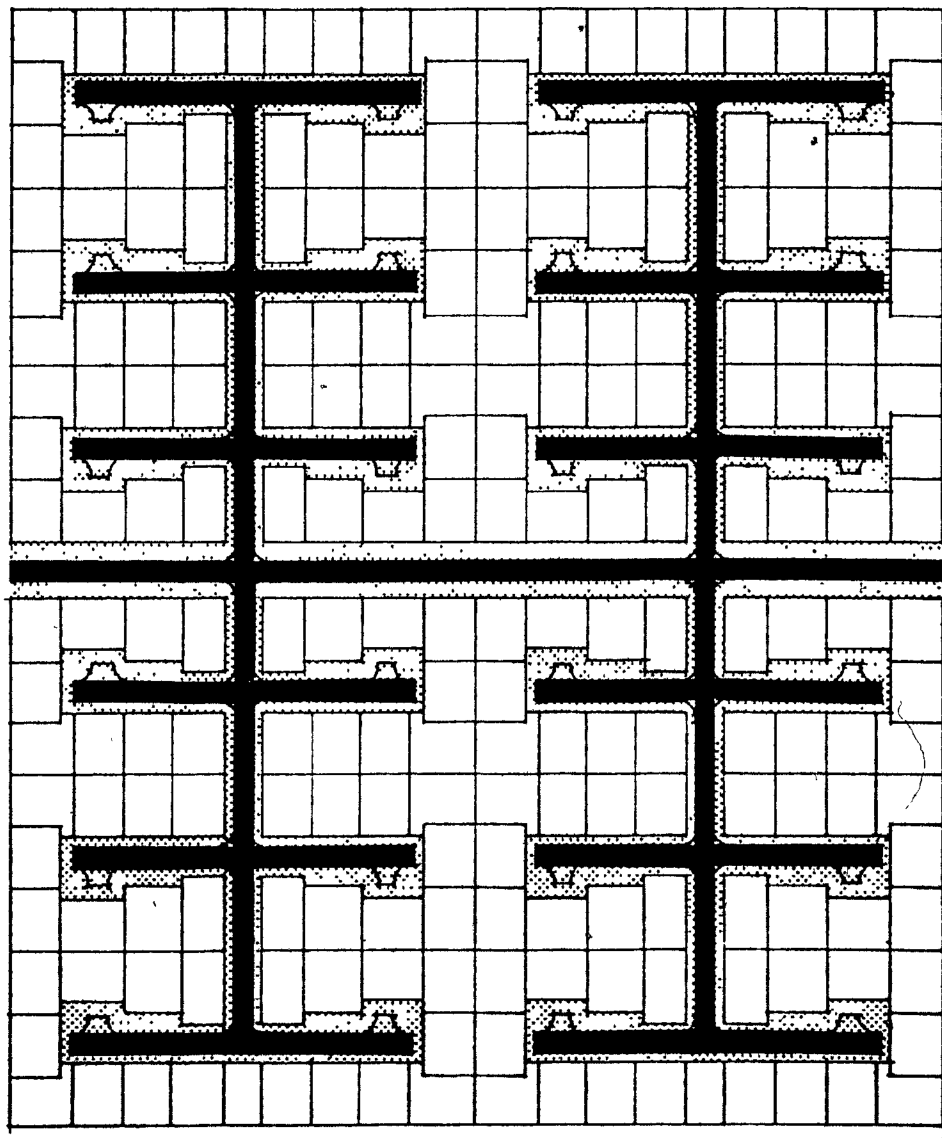


Illustration #50

ROADS AND STORM DRAINAGE OPTIONS : LUSAKA SUMMARY

* Initial investment required for sequence A ......US $ 37.56
* Initial investment required for sequence B ......US $ 72.38
* Initial investment required for sequence C ......US $130.47
* Initial investment required for sequence D ......US $174.98
* Initial investment required for sequence E ......US $222.11

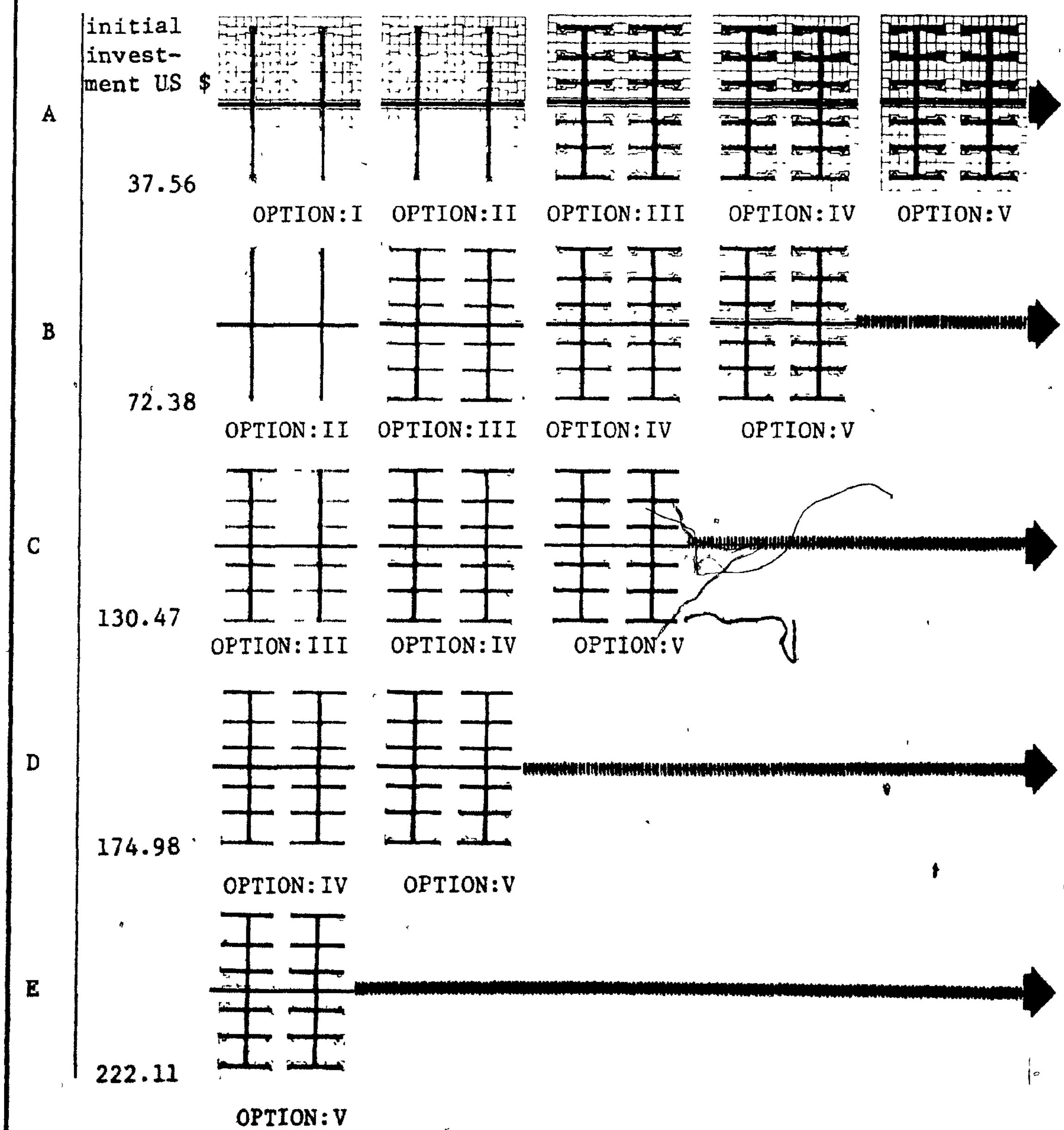


Illustration # 51

4. Electricity and street lighting options

The cost of electricity and street lighting installations is a function of the degree of service provided. Electricity and street lighting options can eventually be upgraded to complete electrical services. Initially, street lighting is provided only at intersections for security, and eventually street lighting of conventional standard is provided at all required points.

Only two options are developed for street lighting and no options are developed for electrical connections to houses. It is possible to provide house connections to those who desire it from the beginning.

I. Electricity and street lighting option: I (Illustration no.52)

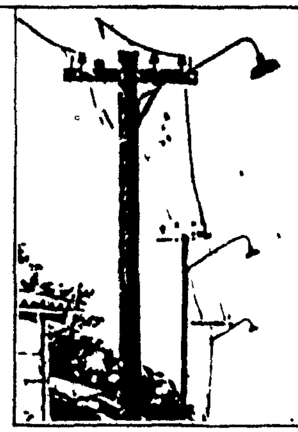
Street lighting at all intersections is provided. The cost is US $39.34 per plot.

II. Electricity and street lighting option: II (Illustration no.53)

Street lighting is provided at all required points. At this stage all connections to houses should also be finished. The cost is US $44.80 per plot.

ELECTRICITY AND STREET LIGHTING OPTION : I

* Installation cost/plot US $ 39.34



electric distribution line

street light

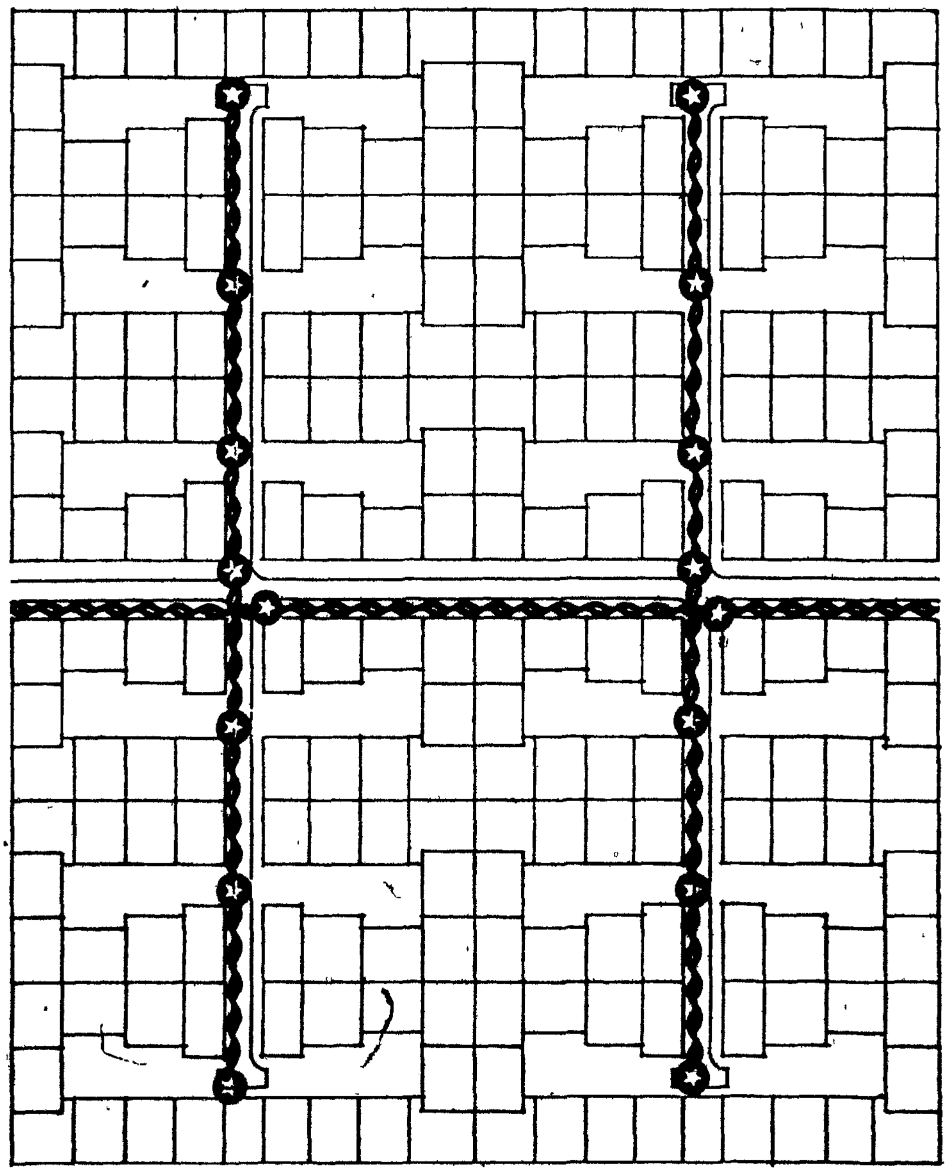


Illustration # 52

ELECTRICITY AND STREET LIGHTING OPTION : II

* Installation cost/plot US $ 44.80

electric distribution line
street light
individual connection

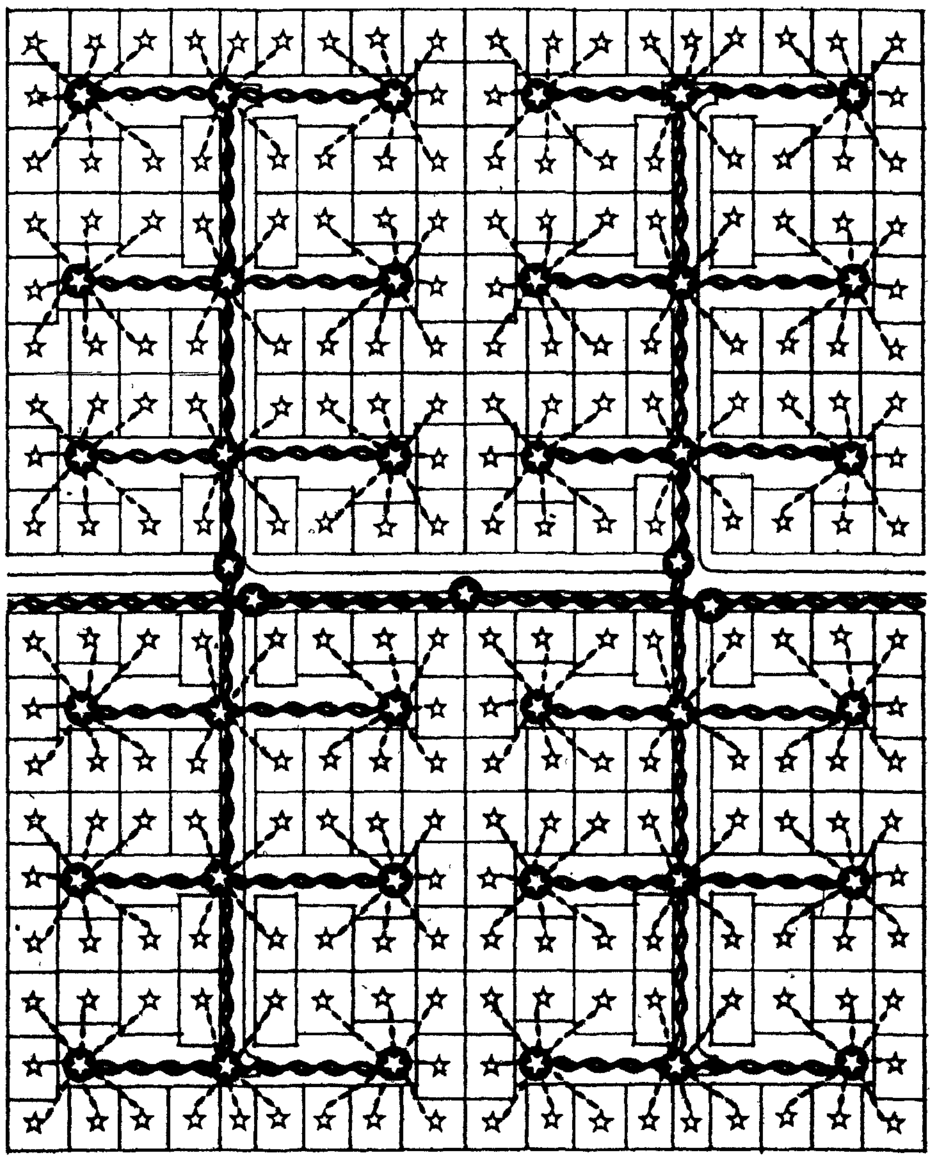


Illustration #53

3.3 Choosing Options : Synthesis

The options, including the cost in dollars, of water supply, sanitation, roads, storm drainage and electricity with street lighting have been identified and presented in the previous section. Each option of a given service represents a certain standard of servicing. At this stage, it becomes important to determine the combination of these options. In this section, the cost summary of all options has been presented in Illustration no. 55 as an aid in choosing the most suitable option from each service for a site in question.

The selection of an option from each service for a particular Site and Services project chiefly depends on available finances. It is possible to arrive at more than one choice by combining different options from different services. The options of four services offer several possible combinations. The final choice of a particular option from each service will certainly depend on the priority of the service level and the available finances.

In a Site and Services project one option of each service is required; therefore, it is important to find out which particular option best matches available finances. The task of choosing options is explained with the aid of Illustration no.54 and Illustration no.56.

Illustration no.54 shows possible combinations of options from each service, and Illustration no.56 lists all logically possible combinations of options together with the total cost of the combination.

Once a financial limit is established, it is possible to choose a suitable combination of options from the Illustrations presented.

The results of Illustration no.56 are indicated in a bar graph in Illustration no. 57 with income groups indicators. The graph indicates the affordable combinations of options for a particular income group and thus identifies affordable levels of services.

CHOICE POSSIBILITIES				
	Water Supply	Sanitation	Roads and Storn Drainage	Electricity and Street Lighting
Options	I	I	I	I
	II	II	II	II
	III	III	III	
	IV	IV	IV	
			V	

Illustration # 54

OPTIONS : FACTS AND FIGURES

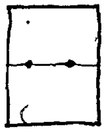
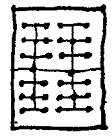
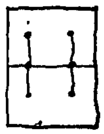
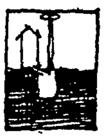
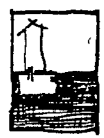
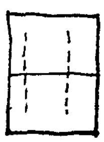
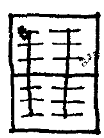
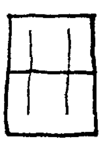
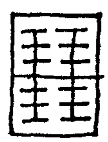
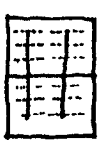
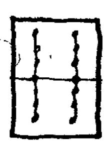
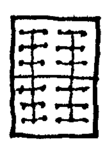
WATER SUPPLY		I COST/PLOT:US $26.61 * public water standpipe for every 110 families or 1 tap/5-6 families * 5-6 minutes walk		III COST/PLOT:US $104.45 * public water standpipe for every 9 families or 1 tap/2.5 families * 1-2 minutes walk
		II COST/PLOT:US $53.98 * public water standpipe for every 37 families or 1 tap/6 families * 2-3 minutes walk		IV COST/PLOT:US $135.52 * individual connection within plot * six firehydrants
SANITATION		I COST/PLOT:US $37.50 * pit latrine		III COST/PLOT:US $97.50 * aquaprivy
		II COST/PLOT:US $75.00 * pour-flush toilet		IV COST/PLOT:US $271.64 * small dia. sewer
ROADS AND STORM DRAINAGE		I COST/PLOT:US $37.56 * main road gravelled * secondary roads compacted earth		IV COST/PLOT:US $174.98 * main road and secondary roads tarmac * cluster extensions gravelled
		II COST/PLOT:US $72.38 * main road tarmac * secondary roads gravelled		V COST/PLOT:US $222.11 * all roads tarmac
		III COST/PLOT:US $130.47 * main road & secondary roads tarmac * cluster extensions compacted earth		
ELECTRICITY ST.LIGHTING		I COST/PLOT:US $39.34 * street lights at all intersections		II COST/PLOT:US $44.80 * street lights at all points

Illustration #55

POSSIBLE COMBINATIONS OF OPTIONS

	WATER SUPPLY	SANITATION	ROADS & STORM DRAINAGE	ELECTRICITY ST. LIGHTS	COST/PLOT US $
1	I	I	I	I	141.01
2	II	I	I	I	168.38
3	II	I	I	II	173.84
4	I	I	II	I	175.83
5	I	I	II	II	181.29
6	II	I	II	I	203.20
7	II	II	I	I	205.88
8	II	I	II	II	208.66
9	II	II	I	II	211.34
10	III	I	I	I	218.85
11	III	I	I	II	224.31
12	II	II	II	I	240.70
13	II	II	II	II	246.16
14	IV	I	I	I	249.92
15	III	I	II	I	253.67
16	IV	I	I	II	255.38
17	III	II	I	I	256.35
18	III	I	II	II	259.13
19	III	II	I	II	261.81
20	III	III	I	I	278.85
21	III	III	I	II	284.31
22	IV	I	II	I	284.74
23	IV	II	I	I	287.42
24	IV	I	II	II	290.20
25	III	II	II	I	291.17

Illustration #56

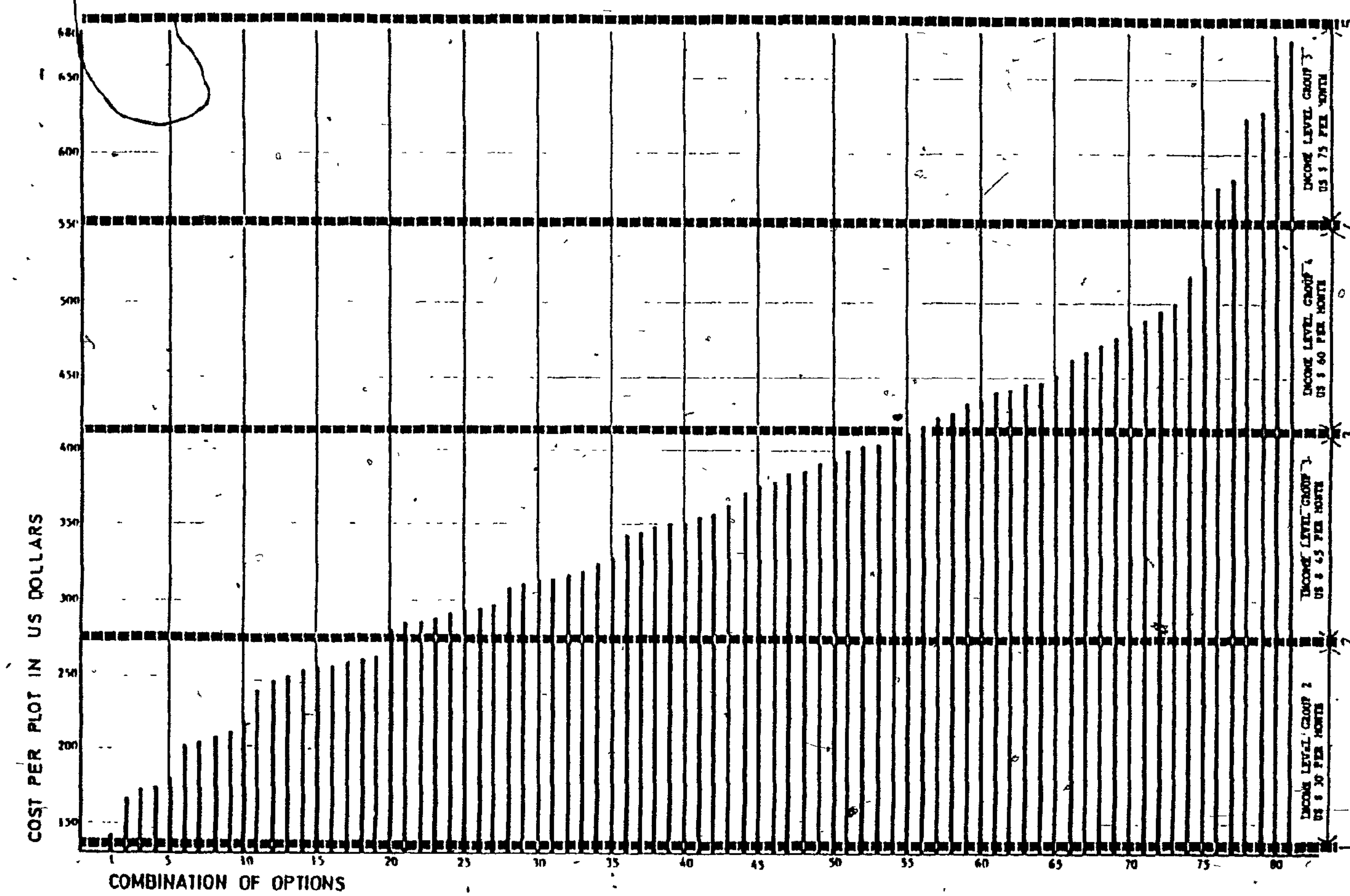
POSSIBLE COMBINATIONS OF OPTIONS (CONTINUED)					
	WATER SUPPLY	SANITATION	ROADS & STORM DRAINAGE	ELECTRICITY ST.LIGHTS	COST/PLOT US $
26	IV	II	I	II	292.88
27	III	II	II	II	296.63
28	IV	III	I	I	309.92
29	III	I	III	I	311.76
30	III	III	II	I	313.67
31	IV	III	I	II	315.38
32	III	I	III	II	317.22
33	III	III	II	II	319.13
34	IV	II	II	I	322.24
35	IV	II	II	II	327.70
36	IV	I	III	I	342.83
37	IV	III	II	I	344.74
38	IV	I	III	II	348.29
39	III	II	III	I	349.26
40	IV	III	II	II	350.20
41	III	II	III	II	354.72
42	III	I	IV	I	356.27
43	III	I	IV	II	361.73
44	III	III	III	I	371.76
45	III	III	III	II	377.22
46	IV	II	III	I	380.33
47	IV	II	III	II	385.79
48	IV	I	IV	I	387.34
49	IV	I	IV	II	392.80
50	III	II	IV	I	393.77
51	III	II	IV	II	399.23
52	IV	III	III	I	402.83
53	III	I	V	I	403.40

Illustration #56 (continued)

POSSIBLE COMBINATIONS OF OPTIONS (CONCLUDED)

	WATER SUPPLY	SANITATION	ROADS & STORM DRAINAGE	ELECTRICITY, ST. LIGHTS	COST/PLOT US $
54	IV	III	III	II	408.29
55	III	I	V	II	408.86
56	III	III	IV	I	416.27
57	III	III	IV	II	421.73
58	IV	II	IV	I	424.84
59	IV	II	IV	II	430.30
60	IV	I	V	I	434.47
61	IV	I	V	II	439.93
62	III	II	V	I	440.90
63	III	II	V	II	446.36
64	IV	III	IV	I	447.34
65	IV	III	IV	II	452.80
66	III	III	V	I	463.40
67	III	III	V	II	468.86
68	IV	II	V	I	471.97
69	IV	II	V	II	477.43
70	IV	IV	I	I	484.06
71	IV	IV	I	II	489.52
72	IV	III	V	I	494.47
73	IV	III	V	II	499.93
74	IV	IV	II	I	518.88
75	IV	IV	II	II	524.34
76	IV	IV	III	I	576.97
77	IV	IV	III	II	582.43
78	IV	IV	IV	I	621.48
79	IV	IV	IV	II	626.94
80	IV	IV	V	I	668.61
81	IV	IV	V	II	674.07

Illustration # 56 (concluded)



AFFORDABLE OPTIONS

Illustration # 57

It appears from this study that :

1. The income level group 1 (one) having US $ 15 per month income (for income groups refer Illustration no. 30, page 55) cannot even afford the most minimum level of services.
2. The income level group 5 having US $ 75 per month income can afford a conventional standard of services.
3. The graph also indicates affordable combinations of options for intermediate income groups.
4. The income level group 2 having US $ 30 per month income can afford combinations of options up to no.19; income level group 3 having US $ 45 per month income can afford combinations of options up to no.54 and income level group 4 having US $ 60 per month income can afford combinations of options up to no.75.
5. It may be possible to provide combination of options no.1 representing the most minimum level of services if the prospective residents' labour help is obtained.

APPENDICES

DESIGN AND ENGINEERING STANDARDS TO BE UTILISED IN THE PREPARATION OF THE SECOND AND SUBSEQUENT HOUSING PROGRAMMES OF THE SECOND NATIONAL DEVELOPMENT PLAN

Category	Standard Determined for Second and Subsequent Housing Programmes of Second National Development Plan
1. Residential	
a. Plot area	324 m^2.
b. Plot Dimension	12m. x 27m. Plots of these dimensions should form not less than 80% of the number of plots in any residential layout. Not more than 10% of the plots may be below 324m^2. and not more than 10% may be above 324m^2. subject to a minimum plot area of 300m^2. and a maximum plot area of 350m2
c. Building Line	Front Building Line 3m. Rear Building Line 3m. Side Building Line 1.5m.
d. Plot Coverage	40% maximum.
2. Pattern of Residential Layout	
a. Vehicular access to plots	All Plots to have a road frontage.
b. Double banking system	No double banking.
3. Educational facilities	
a. Pre-schools	
i. Age group of children attending	5 years to 7 years.
ii. Number of Children per school	100.
iii. Population served	2000.
iv. Plot area in hectares	0.5 ha in a convenient location. The existing conditions in respect of the location and establishment of pre-schools are to prevail pending the re-drafting of the Day Nurseries Act Cap. 541
b. Primary Schools	
i. Age group of children attending	7 years to 14 years.

2/....

ii. Number of streams	1	2	3	4
iii. Number of pupils	280	560	840	1120
iv. Population served	1500	3000	4500	6000

v. Plot area in hectares (Excluding teachers housing)

Number of Streams	Area
1	1.2 ha.
2	1.8 ha.
3	2.4 ha.
4	3.0 ha.

c. Day Secondary Schools

i. Number of Pupils — 1120.
ii. Population served — 20,000.
iii. Plot area in hectares — 5 ha.
Teachers housing to be provided outside the site and high cost plots to be provided within the residential area where the Day Secondary School is located.

d. Boarding Secondary Schools — The Ministry of Education is to be consulted in order to determine acceptable standards for these schools.

4. Health Facilities

a. Health Sub-centre

i. Population served — 10,000.
ii. Plot area in hectares — 0.1 ha.
Staff housing to be provided outside the site.

5. Commercial Facilities

a. Shops

i. Floor area per 1000 population — $250m^2$ - $500m^2$.
ii. Number of shops per 1000 population — 3.
iii. Distribution of shops — 2 shops in local sub-centre and 1 shop in neighbourhood centre.

b. Markets

i. Number of stalls per 1000 population — 15
10 stalls in local sub-centre and 5 stalls in neighbourhood centre.
ii. Area of stall — $25m^2$

3/.....

c. <u>Licenced Premises</u>

i. Bars and taverns	Determination of standard deferred pending clarification of Government policy in regard to the establishment of such a use.

d. <u>Petrol Filling Stations.</u>

i. Population served	20,000
ii. Plot area in hectares	0.1 ha, to 0.2 ha.

e. <u>Service Industry Small Workshops.</u>

i. Population served	1000
ii. Number of workshops	9
iii. Plot area in square metres	$50m^2$ to $100m^2$

<u>Large Workshops</u>

i. Population served	1000
ii. Number of workshops	3
iii. Plot area in square metres.	$400m^2$ - $500m^2$.

Both small and large workshops should be located on the periphery of the residential area to be served.

6. <u>Administrative Facilities</u>

a. Council Offices) b. Party Offices) c. Police Station) d. Police Post) e. Post Office)	i. Population served	20,000 to 30,000
	ii Plot area in hectares	1 ha. If a Police station is required in addition to a Police Post an additional I hectare is to be provided. Staff housing required in connection with the Police Station to be provided outside the site.

7. <u>Social Facilities</u>

a. <u>Community Hall</u>

i. Population served	10,000
ii. Plot area in hectares	0.15 ha. to 0.25 ha. The plot size may be increased to 0.3 ha. if additional sports facilities are to be provided within the plot.

b. Places of Worship

i. Population served	2000
ii. Plot area in hectares	0.1. ha.

c. Public Conveniences — Provision to be made for each sex both at the local sub-centres and the neighbourhood centre.

8. Recreational and Entertainment Facilities

a. Public Open Space Childrens Playground

i. Population served	1000
ii. Area to be provided in hectares	0.6 ha. Of this provision 0.1 ha. to be for "tot - lots"

Playing Fields

i. Population served	10,000
ii. Area to be provided in hectares	2 ha Within this provision a football pitch should be provided for every 5,000 persons.

Parks

i. Population served	1000
ii. Area to be provided in hectares	0.1 ha

9. Parking Spaces

a. Community Hall	1 per 10 seats
b. Health Sub-Centre*	1 per 5 beds plus 1 per staff member
c. Market	1 per 300m^2 floor area
d. Offices	1 to 2 per 100m^2 floor area depending on location of offices.
e. Places of Worship*	1 per 10 seats
f. Schools*	1 per classroom An adequate set down and pick up area should also be provided outside the school area.
g. Shops	3 per shop or 1 per 30m^2 retail sales area.
h. Licensed Premises* (Bars and taverns)	1 per 10m^2 floor area.

N.B. Users marked thus* will provide parking spaces to the determined standard within the plot boundaries. Sufficient area for such parking spaces has been allowed for in the standards set for the various uses.

10. Roads

Classification and Standards

a. Primary Distributor.

i. Design Speed	65 Kph.
ii. Number of Lanes	Dual 2 or 3 lane.
iii. Traffic capacity	6000 p.c.u per hour.
iv. Overallreserve	30m. to 40m.
v. Width of tarred/ gravel surface	12/15m. (for two lanes in each direction)
vi. Minimum gravel thickness	300mm.
vii. Plot access	Not permitted.
viii. Central reservation	4m. to 5m.

b. Main Distributor.

i. Design speed	60 Kph.
ii. Number of lanes	Single carriageway 2 lane or 4 lane.
iii. Traffic capacity	1500 p.c.u. per hour.
iv. Overall reserve	24m. for 2 lane 36m. for 4 lane.
v. Width of Tarred/ gravel surface	6m/6.5m. for 2 lanes.
vi. Minimum gravel thickness	200mm.
vii. Plot access	Not permitted.

c. Local Distributor.

i. Design speed	50 Kph.
ii. Number of lanes	Single carriageway 2 lanes.
iii. Traffic capacity	500 p.c.u. per hour.
iv. Overall reserve	20m.
v. Width tarred/gravel surface	6m.
vi. Minimum gravel thickness	200mm.
vii. Plot access	permitted.

d. Access Road and Cul-de-sac.

i. Design speed	30 Kph.
ii. Number of lanes	Single carriageway 2 lanes
iii. Traffic capacity	50 to 100 p.c.u. per hour
iv. Overall reserve	12m.
v. Width Tarred/gravel surface	6m.
vi. Minimum gravel thickness	150mm.
vii. Plot access	permitted.
viii. Cul-de-sac length	200m. maximum.

N.B. In all the above cases the carriageways are to be centrally located within the overall reserve.

e. Access Ways — It was determined that such means of access to plots was not acceptable and should not be utilised in the Second and subsequent Housing Programmes.

f. Segregated Pedestrian Ways

i. Overall width	3m minimum.
ii. Gravelled width	2m. minimum.
iii. Minimum gravel thickness	100mm.

g. Turning Space

i. Cul-de-sac "heads"	15m. x 18m. hammerhead.

h. Cross-fall or Camber

i. Tarred roads	1 in 40
ii. Gravel Roads	1 in 32 to 36 carriageway. 1 in 25 shoulders.

j. Curb Radius — 10m. minimum.

11. Storm Water Drainage

a. Method of drainage — Open channels,

b. Position of channels — Higher side of road.

c. Run off formula — $I = \frac{4572}{t + 30}$ where
I = intensity of rainfall in mm.
t = 5 minutes.

d. Side Drains

i. Maximum permitted depth of a side 'V' drain	200mm.
ii. Minimum gradient	1 in 200.
iii. Maximum gradient	Dependent on site conditions and channel treatment.

e. Velocity in Drains

i. Minimum velocity	1m per second.
ii. Maximum velocity	3m per second.

f. Trapezoidal Drains

i. Minimum base width	450mm.
ii. Minimum side slope	2 to 1.

g. Culverts

i. Minimum culvert diameter	300mm.
ii. Thickness of concrete bed and surround.	150mm.
iii. Height of head walls	200mm. minimum.
iv. Width of culvert	5m. with 4m. minimum width between head walls.

12. Water Supply Design Data.

a. Per capita average domestic consumption	1500 litres per plot per day subject to review in light of current studies.
b. Peak load factor	2.25.
c. Minimum pressure in distribution system	10m.
d. Maximum pressure in distribution system	30m. (This figure should be regarded as a guide rather than an absolute maximum.)

Pipes

a. Type of pipe in reticulation	Asbestos Cement pipes.
b. Type of pipe for house connection	Galvanised iron.
c. Minimum diameter of pipes in reticulation	75mm.
d. Minimum diameter of service connection.	
Low cost housing) Medium cost housing) High cost housing)	12mm.
e. Location of pipes	To be located in road reserve.

Ancillary Fittings

a. Water meters	Water meters to be provided to all plots.
b. Bulk meters	Bulk meters to be installed for each distribution district.
c. Fire Hydrants	To be at maximum intervals of 200m.
d. Air Valves	At all ridge points on trunk mains.
e. Sluice Valves	At the junction of main feeder and trunk mains.

8/.....

Sewerage.

Design Data.

a.	Rate of flow:	
	Low cost housing) Medium cost housing) High cost housing)	80% of water supply per plot.
b.	Allowance for schools	To be based on student population.
c.	Peak flow	4 x Dry Weather Flow.
d.	Minimum velocity	0.8m. per second.
e.	Maximum velocity	2.2m. per second.
f.	Minimum diameter of house connection	100mm.
g.	Minimum diameter of sewer.	150mm.
h.	Position of sewer	The sewer will be 2m. from the rear of the plot.

Pipes and Joints

a.	Pipe materials	Abestos cement, concrete or salt glazed pipes.
b.	Cover to sewer	1m. to 1.2m. under traffic loads
c.	Pipe bedding	Pipes below 450mm. diameter to have granular beds. All pipes above 450mm. diameter to be embedded in concrete.
d.	Joints	Flexible joints except where concrete surround is provided.

Manholes and Inspection Chambers

a.	Minimum depth of manhole	1m.
b.	Minimum depth of inspection chamber	500mm.
c.	Maximum spacing of manholes	90m. and at every change of direction and gradient.
d.	Location of inspection chambers	5m. inside rear of plots
e.	Maximum spacing of inspection chambers	1 inspection chamber in each plot.
f.	Construction of manhole.	Pre-cast concrete rings or brickwork.
g.	Manhole covers	Cast iron lids or pre-cast concrete.
h.	Location of manholes	2 metres inside rear plot boundary.

Minimum Gradient

a.	Lateral or house sewer	1 in 40.
b.	Terminal lengths	1 in 80.
c.	Normal lengths	1 in 100.

14. Engineering Specification — The Committee was of the opinion that it would be inappropriate to consider the document at this stage.

Appendix : B Calculations

Water Supply Options : Calculations

Option : I

Item	Quantity	Unit	Unit rate US $	Extended price US $
200 mm Ø pipe	296	meter	16.40	4,854.40
Tap outlets	40	no.	25.00	1,000.00
		Total..........US $		5,854.40

Total no. of plots : 220

cost/plot : 26.61 (US $)

Option : II

Item	Quantity	Unit	Unit rate US $	Extended price US $
200 mm Ø pipe	296	meter	16.40	4,854.40
150 mm Ø pipe	482	meter	12.70	6,121.40
Tap outlets	36	no.	25.00	900.00
		Total..........US $		11,875.80

Total no. of plots : 220

cost/plot : 53.98 (US $)

Option : III

Item	Quantity	Unit	Unit rate US $	Extended price US $
200 mm Ø pipe	296	meter	16.40	4,854.40
150 mm Ø pipe	582	meter	12.70	7,391.40
75 mm Ø pipe	1,332	meter	5.50	7,326.00
Firehydrants	6	no.	168.00	1.008.00
Tap outlets	96	no.	25.00	2,400.00

Total...........US $22,979.80

Total no. of plots : 220

cost/plot : 104.45 (US $)

Option : IV

Item	Quantity	Unit	Unit rate US $	Extended price US $
200 mm Ø pipe	296	meter	16.40	4,854.40
150 mm Ø pipe	582	meter	12.70	7,391.40
75 mm Ø pipe	1,332	meter	5.50	7,326.00
12 mm Ø pipe	3,848	meter	2.40	9,235.20
Firehydrants	6	no.	168.00	1,008.00

Total...........US $29,815.00

Total no. of plots : 220

cost/plot : 135.52 (US $)

Sanitation options : Calculations

Option : I

Item	Quantity	Unit	Unit rate US $	Extended price US $
Pit digging	5	cu.m.	3.50	17.50
squatting plate in concrete	1	no.	20.00	20.00
		Total..........US $		37.50

cost/plot : 37.50 (US $)

Option : II

Item	Quantity	Unit	Unit rate US $	Extended price US $
Pit digging	5	cu.m.	3.50	17.50
Pour-flush fixture	1	no.	40.00	40.00
Soak pit digging	1	no.	17.50	17.50
		Total..........US $		75.00

cost/plot : 75.00 (US $)

Option: III

Item	Quantity	Unit	Unit rate US $	Extended price US $
Holding tank	1	no.	40.00	40.00
Fixture	1	no.	40.00	40.00
Soak pit	1	no.	17.50	17.50
		Total..........US $		97.50

cost/plot : 97.50 (US $)

Option : IV

Item	Quantity	Unit	Unit rate US $	Extended price US $
225 mm Ø pipe	296	meter	25.50	7,548.00
150 mm Ø pipe	692	meter	16.40	11,348.80
100 mm Ø pipe	2,572	meter	13.70	35,236.40
Manholes	18	no.	238.00	4,284.00
Inspection chambers	16	no.	84.00	1,344.00
		Total..........US $		59,761.00

Total no. of plots ; 220

cost/plot : 271.64 (US $)

Conventional sewer

Item	Quantity	Unit	Unit rate US $	Extended price US $
375 mm Ø pipe	297	meter	41.90	12,402.40
225 mm Ø pipe	692	meter	25.50	17,646.00
150 mm Ø pipe	2,076	meter	16.40	34,046.40
100 mm Ø pipe	496	meter	13.70	6,795.20
Manholes	18	no.	238.00	4,284.00
Inspection chambers	16	no.	84.00	1,344.00
		Total..........US $		76,518.00

Total no, of plots : 220

cost/plot : 347.81 (US $)

Roads and Storm Drainage Options : Calculations

Option : I

Item	Quantity	Unit	Unit rate US $	Extended price US $
Compacted earth 6m. wide	588	meter	6.50	3,822.00
Gravel 150 mm tk. & 6m.	296	meter	15.00	4,440.00
		Total..........US $		8,262.00

Total no. of plots : 220

cost/plot ; 37.56 (US $)

Option : II

Item	Quantity	Unit	Unit rate US $	Extended price US $
Gravel 150 mm tk. 6 m. wide	588	meter	15.00	8,820.00
Tarmac 6 m. wide	296	meter	24.00	7,104.00
		Total..........US $		15,924.00

Total no. of plots : 220

cost/plot : 72.38 (US $)

Option : III

Item	Quantity	Unit	Unit rate US $	Extended price US $
Compacted 6m.wide	1,152	meter	6.50	7,488.00
Tarmac 6m. wide	884	meter	24.00	21,216.00
		Total..........US $28,704.00		

Total no. of plots : 220

cost/plot : 130.47 (US $)

Option : IV

Item	Quantity	Unit	Unit rate US $	Extended price US $
Gravel 150mm tk. 6m. wide	1,152	meter	15.00	17,280.00
Tarmac 6m. wide	884	meter	24.00	21,216.00
		Total..........US $ 38,496.00		

Total no. of plots : 22o

cost/plot : 174.98 (US $)

Option : v

Item	Quantity	Unit	Unit rate US $	Extended price US $
Tarmac 6m. wide	2,036	meter	24.00	48,864.00
		Total..........US $ 48,864.00		

Total no. of plots : 220

cost/plot : 222.11 (US $)

Electricity and Street Lighting Options : Calculations

Option : I

Item	Quantity	Unit	Unit rate US $	Extended price US $
Electrical connections	220	no.	35.84	7,884.80
Lamp posts	16	no.	48.08	769.28
		Total..........US $		8,654.08

Total no. of plots : 22o

cost/plot : 39.34 (US $)

Option: II

Item	Quantity	Unit	Unit rate US $	Extended price US $
Electrical connections	220	no.	35.84	7,884.80
Lamp posts	41	no.	48.08	1,971.28
		Total..........US $		9,856.08

Total no. of plots : 220

cost/plot : 44.80 (US $)

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