

SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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RESEARCH TO ACHIEVE BACHELOR DEGREE OF SCENCES IN
ARCHITECTURE FROM SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

REPORT TITLE:

LOW-COST HOUSING

(AN APPROACH TO MODERN DESIGN)

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Abstract:

This project aims to provide the context of re-compensation to those in the East Nile state, mainly in Marabe'a Al Shereef and Al Kiryab areas, who lost their houses in the floods that has occurred during the period of August / September 2013. But specifically this project is analyzing the concept of 'Affordable / Low-cost Housing Development in Sudan.

The main key initiatives and other strategies worth applauding and which require immediate government intervention and civil society involvement to accelerate housing supply are to be highlighted. The goal of the proposed project is to improve the quality and quantity of affordable housing units for those with a limited income, mainly those who lost their houses in the floods in Sudan in order to boost economic growth and reduce poverty by providing suitable and sustainable housing units for better settlement in both rural and urban areas of Sudan. This affordable housing project's vision is to create an economically easily accessible affordable housing project that will act as a model of sustainable development addressing issues of population's economic status , environmental quality while meeting needs of economically fragile group of the community .

This project targets the economically weak group, some with stable jobs and some without. These groups will be offered opportunities to repay montages upon acquisition of the structure.

The structures will be energy efficient with natural ventilation , lighting and water recycling services in place. Modern building technologies will be used alongside durable zero carbon emission building materials in this project.

Dedication:

I dedicate this humble project to the low-income people of my country and i ask god for there be more of these kinds of projects for these people , providing them with the most simplest rights of life which is a home containing them.

Acknowledgments :

I would first like to thank god for the blessing of knowledge. I present my thanks and gratitude to my supervisor Dr. Sleem Alzain for all the help he has given me, the dean Dr. Awaad Saad for sharing the knowledge and experience he has on my project, all the teachers, my parents, family relatives and dear friends for their constant help and support.

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CHAPTER 1

Introduction

- Project summary
- Project description
- Project objectives
- Housing in Sudan
- Housing problems in Sudan
- Population charts
- Housing state
- Water demand
- Electricity demand

1. Project summary:

1.1 Introduction:

The world population today is very much connected by the rapidly developing communication and information technology. New images, products, inventions and new discoveries are influencing the life of every human being, even those in developing parts of the world. This raises the ambitions and expectations of people and governments of the developing countries for a better life. As a result, modern life in modern cities becomes an aspiration (Larsson, 1990). But , with the limited economic resources , high rate of birth, rapid urbanization, immigration and migration, the result of total collapse of almost all the newly adapted systems (Madibo,1989). People in developing countries find themselves in a situation where neither the new systems of physical and urban planning, services or social facilities are functioning, nor are the traditional systems maintained to serve as they used to be. At the same time, while the developing countries are working towards modernization, the developed countries are introducing many traditional ways of doing things. For instance, in the areas of collecting, processing and recycling used materials, and the use of passive heating and cooling. Motivations for the adaptations of traditional solutions include the energy crisis and the concern for environmentally-friendly approaches. Using the traditional solutions does not necessary mean that we should copy the old solutions. And essential step is first to analyze and understand the traditional solutions before developing and applying them.

In architecture, tendencies to revive and study traditional heritage has brought traditional architecture to the centre of attention. These writings covered areas of human settlements, panning and housing , social network and extended family, the compound, the household, traditional building materials and techniques , traditional dwellings and its modernization. Nevertheless , very little is written about how the layout of the dwellings is affected by culture, specifically social factors.

Over 41,000 people were affected by the floods that has hit the east Nile locality, over 5,000 houses were completely destroyed and over 2,000 were partially damaged. These people currently live in temporary shelters provided by various charity groups, and have no homes to go back to. Moreover the country's total population is expected to increase to about 3,000,000 by 2033. Attracted to the growing economic opportunities, people from the rural areas are moving to the city, creating a large demand for affordable housing.

The housing demand and housing supply levels arising from the falling levels of public funding, insufficient incomes and the sheer scale of population growth and the huge rates of urbanization aggravates the matter. Countrywide, the job market and levels of earning is alarming.

The project proposal attempts to address the above mentioned issues through modalities destined to improve supply and access to housing to improve socio-economic urban life.

1.2 Project description:

The aim of this project is to provide affordable housing for low income earners, specifically those affected by floods at the east Nile locality, Khartoum state.

A huge discrepancy between housing demand and supply levels arising from the falling levels of public funding, insufficient incomes, the sheer scale of population growth and the huge rates of urbanization has obliged the seeking of innovative ways to attempt to address such demanding issues.

1.3 Objectives of the project:

The main objective of the project is to design low cost/affordable housing to accommodate families of 6-7.

1.3.1 Specific objectives:

- *Provide different modes of residential housing.*
- *Provide residential housing built by sustainable , low cost and local building materials.*
- *Provide home to a large number of people affected by the floods.*
- *Infra-structure serviceability.*
- *Benefit the country by providing a poverty reduction strategy and social economic development.*

1.4 Housing in Sudan :

House in the Arabic language is synonymous to Manzel and Bayt. Manzel refers to a house as a constructed shelter, housing one or a number of families. Bayt has an additional meaning to shelter, and refers to the family living in it.

A house in the Sudanese context is a place for both the nuclear family and the extended family. It is a place for receiving guests and entertaining them , guests visiting for short times, and also those coming from other towns and villages for longer periods. A guest room is almost a must in every house. When the house is small , the male guests stay in the Dewan or in one of the rooms in the male sections, whilst the female guest stay in the family section.

1.4.1 Housing in the official Sudanese documents (Khartoum Province 1992:5) is defined at 3 levels:

1- At the first level, it is the dwelling which is occupied by a nuclear family or an extended family household. The dwelling is a secured place where this group of people practice a vital part of their daily activities ,ex, relaxing, eating, bringing up their children etc.

2- At the second level, it is the group of neighboring families which have some common aspects such as social, Intellectual, cultural and economical. These similarities make the lives of the neighboring families similar to that of the extended families which was the prevailing way of living in Sudan.

3- At the third level, it is the village or city. As the household members and other members of the community have the same costumes, traditions, and ways of life. And they also share the public services and facilities, the relation between the inhabitants is very strong.

In this document (Khartoum Province 1992) the housing authorities are contradicting themselves by defining the dwelling in the first point as a place for housing a nuclear family or an extended family household and in the second point assumed the disappearance of the extended family household.

1.4.2 Housing problems in Sudan:

○ *The housing problem that is represented as the great lack of houses and basic services in Africa is considered the most critical around the world.*

○ *Poverty, inappropriate housing on the basis of structure, health. Economy and social factors, fallout and health hazard, environmental pollution, increased crime rates , incorrect planning, decreased funding, inappropriate life.*

○ *The increase in building materials especially those imported from outside the country is one of the main reasons to the housing problems in the urban parts of Sudan. In addition to that, the buildings founded by glass, concrete founded all over the city does not provide human comfort , in a country as hot as Sudan .*

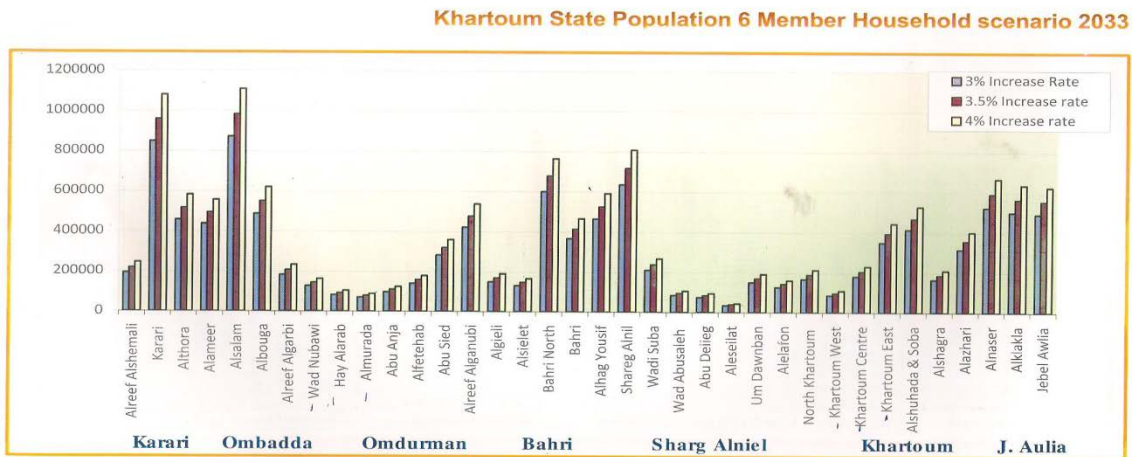
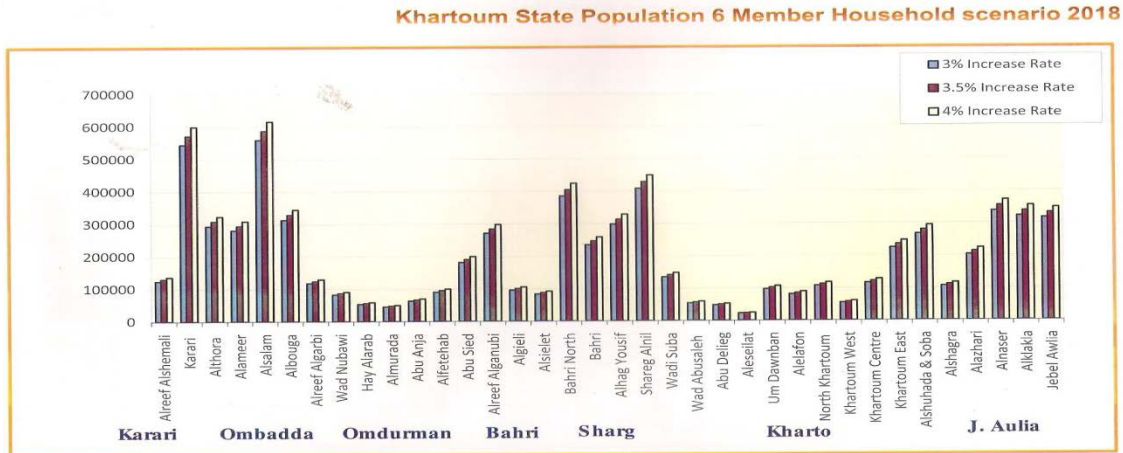
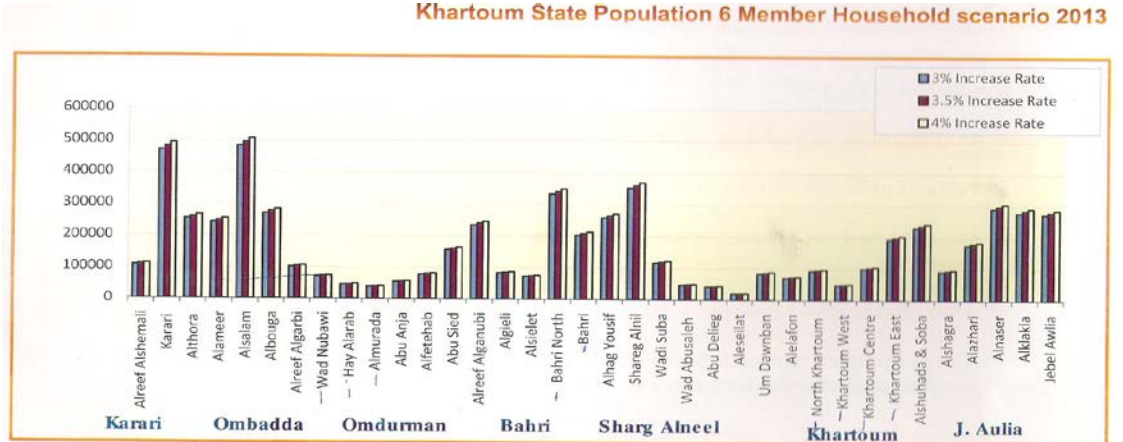
○ *Also . the use of traditional and local materials such as mud . straw. Wood etc. that 80% of the Sudanese population build with doesn't accomplish building strength and health and ecological safety.*

○ *The traditional suburban houses, even if it fits its natural environment doesn't fulfill the stability, health and engineering terms, can easily be affected by fire and floods and can easily collapse.*

○ *Blocks founded from mud and dried by the sun's heat. Even though economic and acts as a heat insulator cannot withstand heavy rains and floods .*

1.5 Sudan's populations and household members:

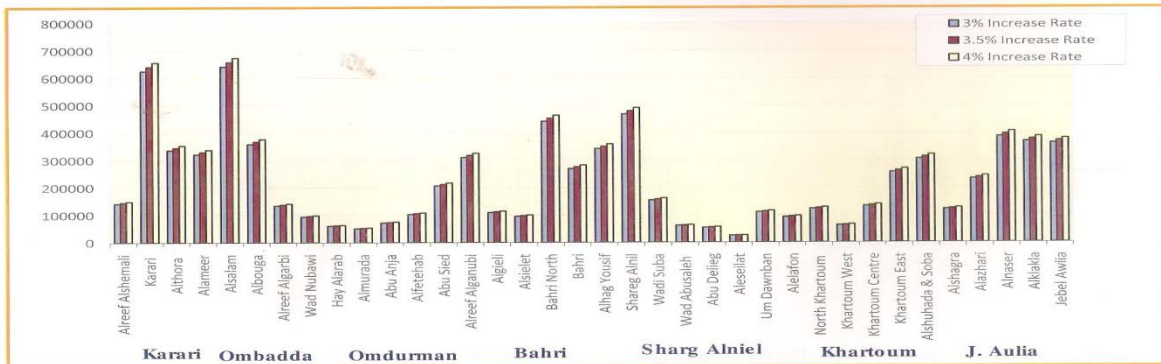
Charts showing the changes in the 6 members household:



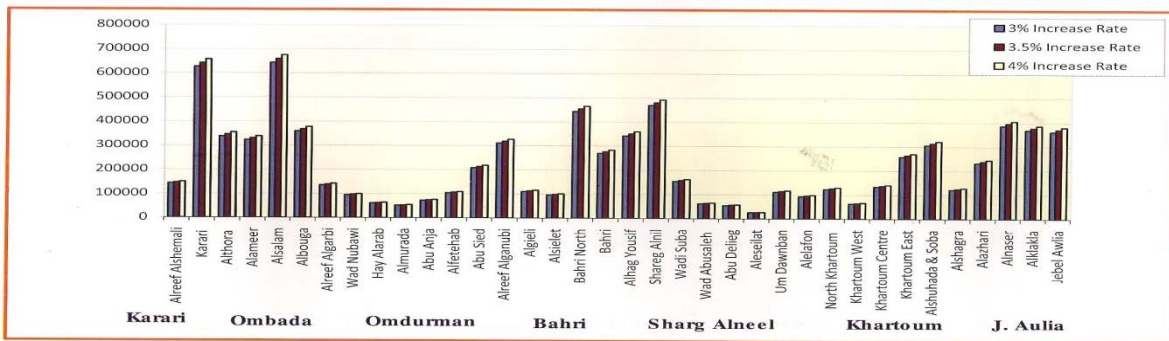
As observed there is a slow increase in population in the next few years, followed by a great increase in population during the following 20 years.

Charts showing the changes in the 8 members household:

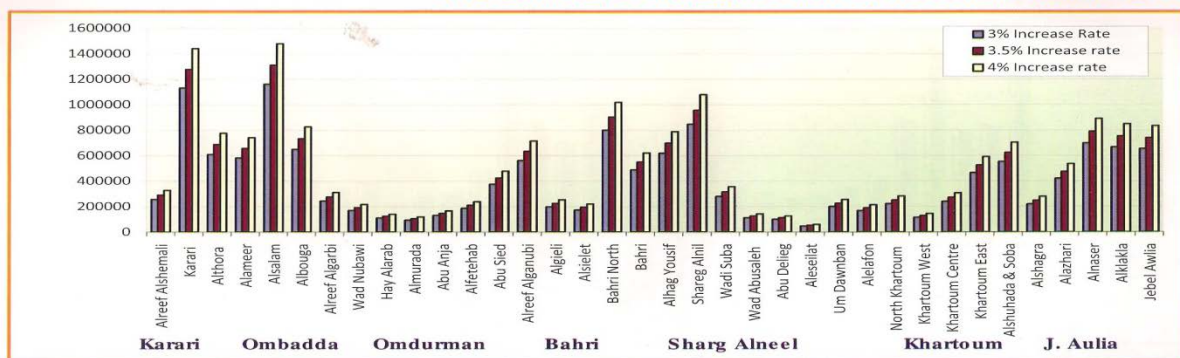
Khartoum State Population 8 Member Household scenario 2013



Khartoum State Population 8 Member Household scenario 2018



Khartoum State Population 8 Member Household scenario 2033



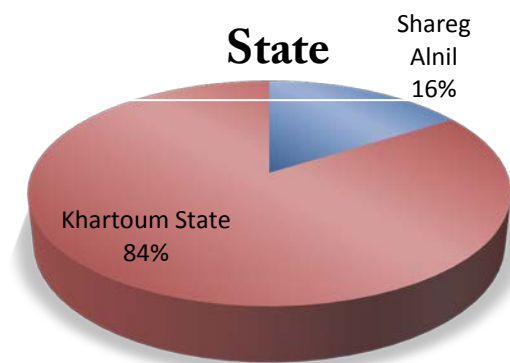
As observed there is a slow increase in population in the next few years, with that going at a steady rate for the next

1.5.1 Population charts:

1.5.1.1 Characteristics and growth:

The number of people of shareg alnil locality were found to be 868147(statistical study 2008) and they represented 16% of the total Khartoum state population, whose total population accounted 5274321 individuals., with a natural growth by 2.44%

Population of Sharg Alnil locality to Khartoum

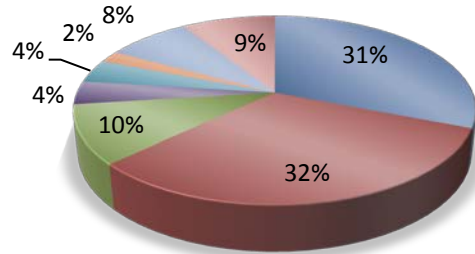


POPULATION OF THE DIFFERENT UNITS OF THE LOCALITY:

<i>Unit</i>	<i>Population</i>	<i>Percentage %</i>
<i>Alhag Yousif</i>	256,666	30.6
<i>Shareg Alnil</i>	280,546	32.3
<i>Wadi Suba</i>	89,596	10.3
<i>Wad Abusaleh</i>	33,920	3.9
<i>Abu Delieg</i>	33,903	3.9
<i>Aleseilat</i>	20,721	2.4
<i>Um Dawnban</i>	70,720	8.2
<i>Alelafon</i>	73,075	8.2
<i>Total population</i>	868,147	100

Population of the different units in the locality

- Alhag Yousif
- Shareg Anil
- Wadi Suba
- Wad Abusaleh
- Abu Delieg
- Aleseilat
- Um Dawnban
- Alelafon

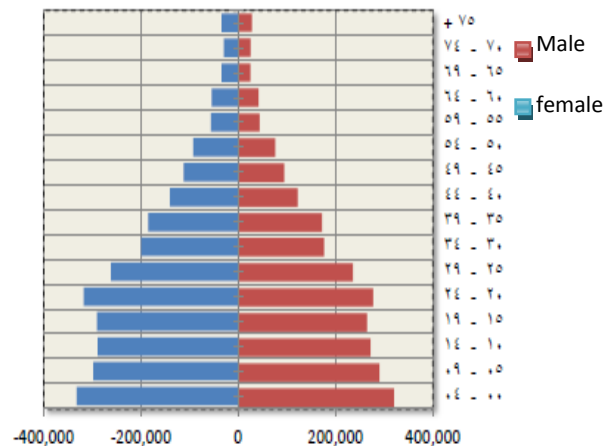
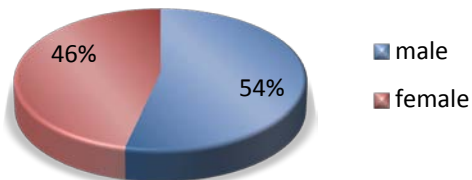


**Gender formation of the locality:*

** Age formation of Khartoum state:*

Gender Formation

Age distribution of males and females



The male population of the locality is 451436 , representing 52% of the population , whereas the female population is 416711, representing 48%.

The increase in the job opportunities for the males in the area in accordance resulted in the male populations increase, and as noticed the pyramid widens as we go down.

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Distribution of different age groups.

			عولها		Total
			شلا	روكذ	
تظلا قيرمغا	0-4	Count	56	64	120
		% of Total	5.6%	6.4%	12.0%
	9 - 5	Count	68	67	135
		% of Total	6.8%	6.7%	13.5%
	14-10	Count	66	61	127
		% of Total	6.6%	6.1%	12.7%
	19-15	Count	63	57	120
		% of Total	6.3%	5.7%	12.0%
	24-20	Count	60	51	111
		% of Total	6.0%	5.1%	11.1%
	29 - 25	Count	47	46	93
		% of Total	4.7%	4.6%	9.3%
	34 -30	Count	39	29	68
		% of Total	3.9%	2.9%	6.8%
	39 -35	Count	34	29	63
		% of Total	3.4%	2.9%	6.3%
	44-40	Count	21	17	38
		% of Total	2.1%	1.7%	3.8%
	49-45	Count	19	17	36
		% of Total	1.9%	1.7%	3.6%
	54-50	Count	14	12	26
		% of Total	1.4%	1.2%	2.6%
	59-55	Count	9	8	17
		% of Total	.9%	.8%	1.7%
	64 60	Count	9	7	16
		% of Total	.9%	.7%	1.6%
	69-65	Count	6	5	11
		% of Total	.6%	.5%	1.1%
	75- 70	Count	5	4	9
		% of Total	.5%	.4%	.9%
	75 قيف لمب	Count	6	5	11
		% of Total	.6%	.5%	1.1%
	Total	Count	522	479	1001
		% of Total	52.1%	47.9%	100.0%

The following chart shows the populations distribution based on the different age groups.

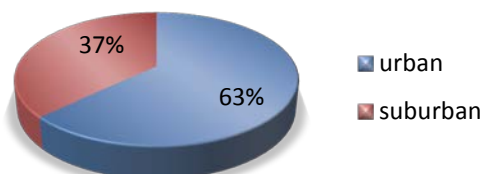
As noticed in the chart, the kids of age 5-9 are the largest numbers in the locality.

And the chart shows a healthy growth, large number of children, and a few number of old people, and a good percentage of the productive age groups.

1.5.1.2 Urban and suburban distribution:

People living in the urban parts are 546,212 , representing 63% and those in the suburban parts are 321,935 , representing 37% of the locality population.

urban and suburban distribution



*** Population review and density:**

The current population density in the locality is 119.8 individual in every km², and accounting the increase by 2.44, is expected to increase to 1416654 by 2022, and then the increase is expected to decrease to 2.33 i the years 2023 to 2037, unless the immigration rates increased.

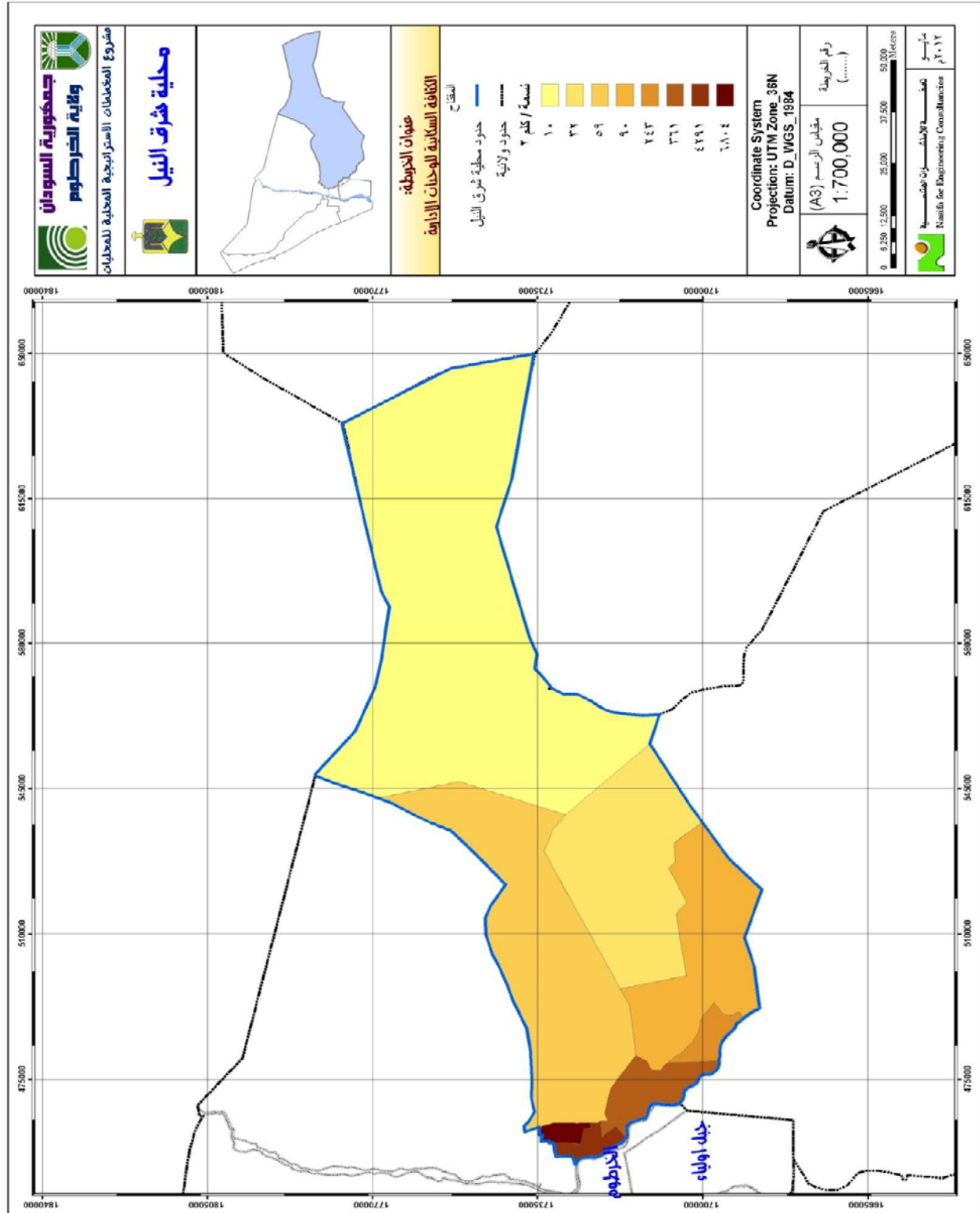
Year	Population	Density (individuals/ km²)	Classifica tion
2012	956030	119.8	Low
2017	1032492	135.2	Low
2022	1216654	152.5	Low
2027	1365155	171.1	Low
2032	1531322	192	Low
2037	1312343	215.4	Low

Classification of densities:

- *1-100 individual/km² very low
- *101-1001 individual/km² low
- *1001-10001 individual/km² medium
- *10001-more individual/km² high

Population density of the different units:

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Classification of densities

1.6 Housing state in east Nile locality:

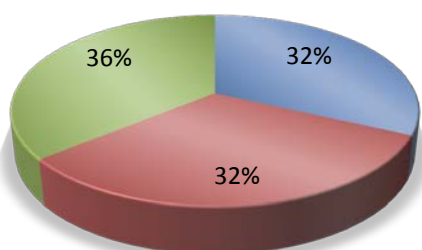
1.6.1 State of buildings:

Percentage of those in a good state =32.4%, those in a medium state =36%, bad state =31.6%

number	Unit	Good		Medium		Bad	
		number	%	Number	%	Number	%
1	Alhag Yousif	6223	8	1991	32	3734	60
2	Shareg Alnil	20596	40	18022	35	12873	25
3	Wadi Suba	-	-	950	25	2853	75
4	Wad Abusaleh	1251	20	2052	40	2052	40
5	Abu Delieg	14628	30	21942	45	12190	25
6	Aleseilat	2414	18	4292	32	6706	50
7	Um Dawnban	3245	25	4543	35	5192	40
8	Alelafon	313	5	1564	25	4378	70
Total		48670	31.6	55356	36	49978	32.4

State of buildings

■ good ■ medium ■ bad



A building in a bad state



A building in a good state



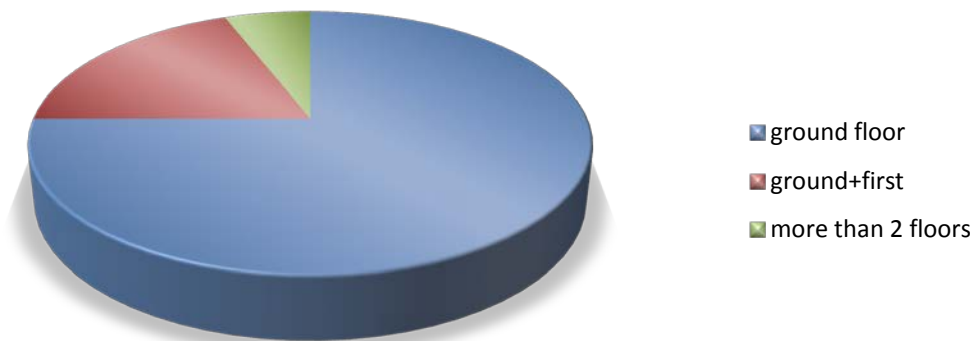
A building in a medium state

1.6.2 Height of different buildings:

Buildings with only a ground floor has a total percentage of 75%, those with two floors 19.1%, more than 2 floors 5.9%

number	Unit	Ground floor		Ground + first floor		More than 2 floor	
		number	%	Number	%	Number	%
1	Alhag Yousif	6223	100	-	-	-	-
2	Shareg Alnil	30895	60	15447	30	5149	10
3	Wadi Suba	3803	100	-	-	-	-
4	Wad Abusaleh	5943	95	313	5	-	-
5	Abu Delieg	34132	70	11215	23	3413	7
6	Aleseilat	13010	97	268	2	134	7
7	Um Dawnban	11682	90	1298	10	-	-
8	Alelafon	6255	100	-	-	-	-
Total		11943	75	28541	19.1	8696	5.9

Building height

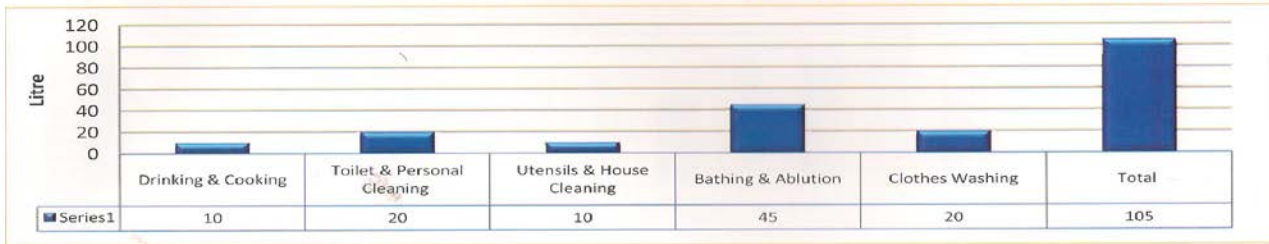


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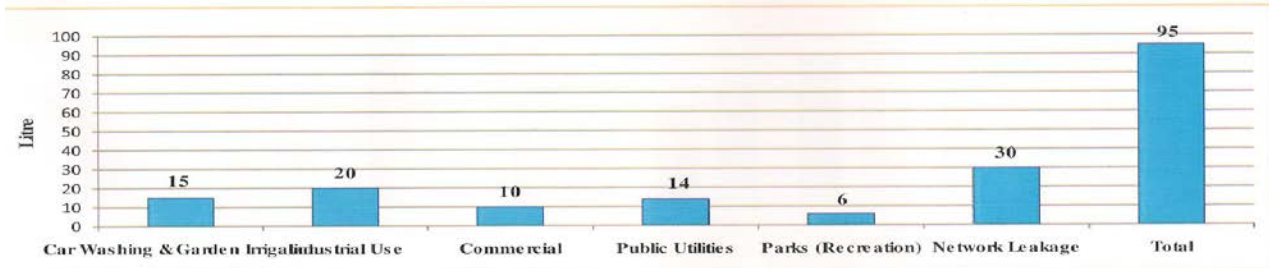
1.7 Water demand:

Charts showing the amounts of water used by a person for various activities, and the total supply required

Water Demand (Litres /Person/Day) Details

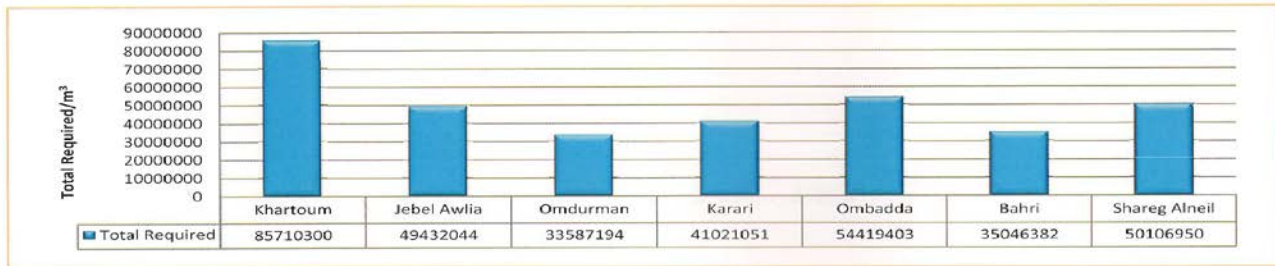


Water Other Usages (Litres /Person/Day)

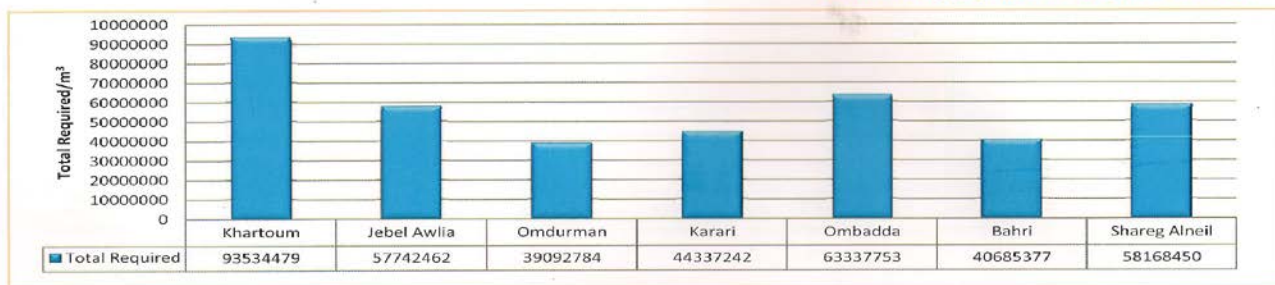


Total amounts of water required by the different localities:

Water Supply Total Required 2008

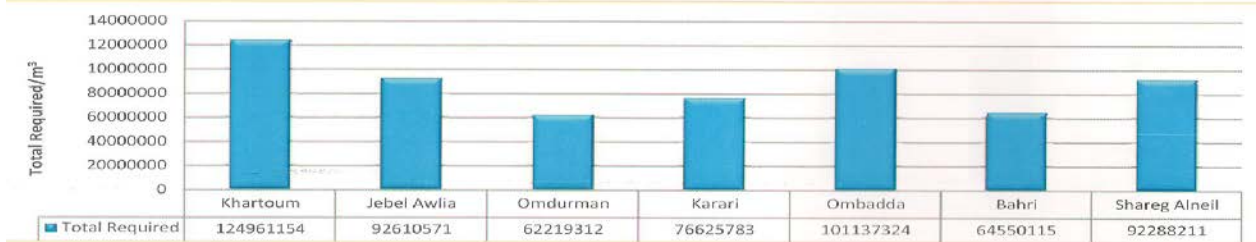


Water Supply Total Required 2013

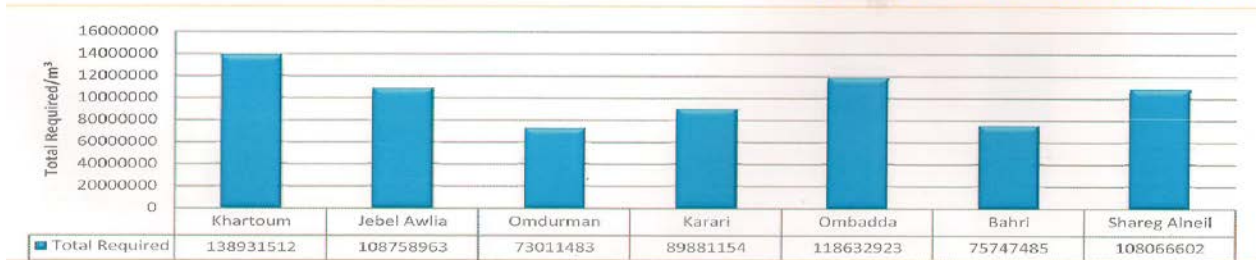


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Water Supply Total Required 2026



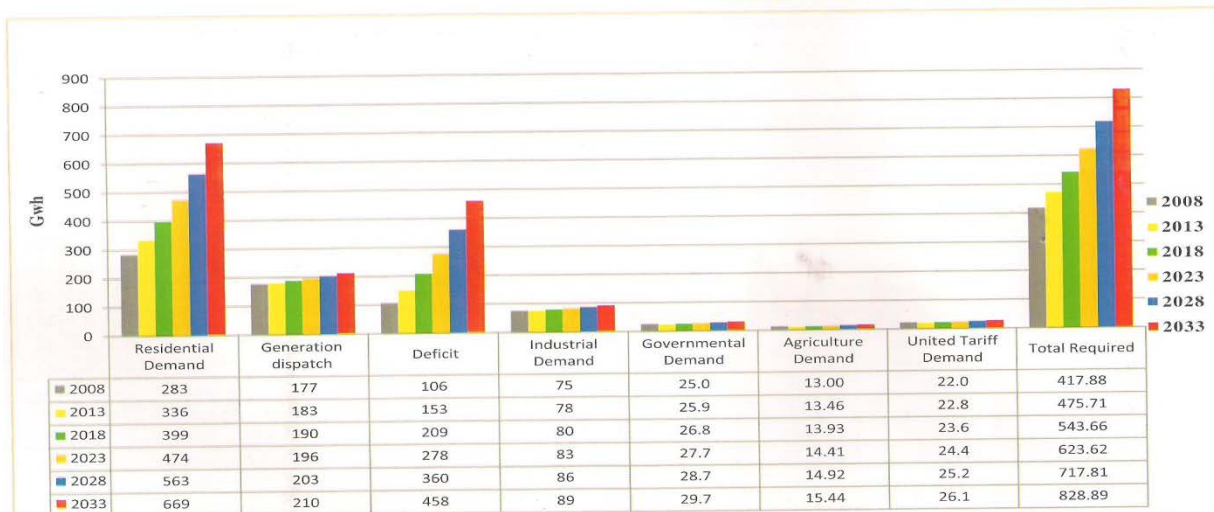
Water Supply Total Required 2033



The total amount of water required per person, knowing that shareg el neil has a total population of 868147, is 78 m3.

1.8 Electricity demand:

Shareg Alneil Locality – Electricity Services



The electricity demand keeps on increasing due to the increase in population, and in order to save energy alternate energy sources should be used , ex, solar panels.

CHAPTER 2

Literature review+
Similar ex. study

- Housing
- Affordable/ economic housing
- low-cost Housing
- Dwelling Unit
- Different types of households
- Residential development
- Neighbourhood

2.1 What is housing?

Buildings or structures that individuals and their families may live in that meet certain federal regulations. Different housing situations vary for individuals and may depend on age. Family and geographic location.

2.2 Affordable/ economic housing:

- *Generic term to cover any low cost housing (irrespective of tenure).*
- *Defined without reference to dwelling occupants but intended to meet affordability benchmarks*

2.3 LOW-COST Housing:

Low-cost housing in this study refers to the type of housing provided through the government housing programs for people. Earning within a specific wages range and working in the public sector in urban areas, the houses are designed on the basis of assumptions about standardized user requirements, the houses are also constructed and distributed by the department of low-cost housing in Khartoum, Sudan.

2.3.1 Dwelling Unit:

Used to describe the part of the traditional house which is occupied

by a simple family household or an extended family household.

2.3.1.1 Indoor Space:

A roofed space which is enclosed from all or some of its sides (room or veranda)

2.3.1.2 Outdoor Space:

As houses in Sudan usually have boundary walls, the space inside the boundaries of the individual house lot , which is neither roofed nor strictly enclosed , is an outdoor space "housh".

2.4 Different types of households:

The concept of "household" in the Sudanese context is difficult to define. The households are very much connected physically and socially especially in traditional areas. In the Sudanese context, defining "household" by associating it to variables like economy, cooking or eating together, also proved insufficient. There are cases where people in the same house cook separately but eat together or vise versa. For that reason the definition of "household" like the following are not useful in the case of Sudan:

"a separate unit off domestic economy consisting of all people who eat

together from the same pot. Dwell together in one part of the compound, and who contribute most of the time in kind labor service, and/or money to the household budget"

Category	Class
1/ Simple family household	a/ Married couples alone

	b/Married couples with child(ren)
	c/Widower or divorcee with child(ren)
	d/Widow or divorcee with child(ren)

2/Extended family household	a/Extended upwards
	b/Extended downwards
	c/Extended laterally
	d/Combination of 2a and 2c

3/Multiple family household	a/Secondary unit(s) Up
	b/Secondary unit(s) Down
	c/Units all on one level
	d/Other multiple families

(Schwerdtfeger 1982:34).

Laslett's classification is useful for the definition of the different types of household in this report. According to him there are three types of households : simple, extended and multiple family household (Laslett 1974:28-31)

(Adapted from Laslett 1974:31)

2.5 Residential development

Residential development is real estate development for residential purposes. Some such developments are called a subdivision, when the land is divided into lots with houses constructed on each lot. Such developments became common during the late nineteenth century, particularly in the form of streetcar suburbs.

In previous centuries, residential development was mainly of two kinds. Rich people bought a town lot, hired an architect and/or contractor, and built a bespoke / customized house or mansion for their family. Poor urban people lived in shantytowns or in tenements built for rental. Single-family houses were seldom built on speculation, that is for future sale to residents not yet identified. When cities and the middle class expanded greatly and mortgage loans became commonplace, a method that had been rare became commonplace to serve the expanding demand for home ownership.

2.6 Neighbourhood

A **neighbourhood** or **neighborhood** is a geographically localized community within a larger city, town, suburb or rural area. Neighbourhoods are often social communities with considerable face-to-face interaction among members.. Neighbourhood is generally defined spatially as a specific geographic area and functionally as a set of social networks. Neighbourhoods, then, are the spatial units in which face-to-face social interactions occur – the personal settings and situations where residents seek to realise common values, socialise youth, and maintain effective social control."

2.6.1 Neighbourhood unit

The concept of the **neighbourhood unit**, crystallized from the prevailing social and intellectual attitudes of the early 1900s by Clarence Perry, is an early diagrammatic planning model for residential development in metropolitan areas. It was designed by Perry to act as a framework for urban planners attempting to design functional, self-contained and desirable neighbourhoods in the early 20th century in industrializing

cities. It continues to be utilized, as a means of ordering and organizing new residential communities in a way which satisfies contemporary "social, administrative and service requirements for satisfactory urban existence".

2.6.2 History

Clarence Perry's conceptualization of the neighbourhood unit evolved out of an earlier idea of his, to provide a planning formula for the arrangement and distribution of playgrounds in the New York region. The necessity for a formula such as this was attributed to the rise of the auto-mobile in the early 20th century. During a period where road sense had not yet amalgamated with the social conscious, and many of the urban tools we now use to manage the threat posed by vehicular traffic did not exist, or were not in abundance (such as pedestrian crossings, traffic lights and road signs), developing cities such as New York, which embraced the motor car, suffered street fatality rates in excess of one child a day.

Clarence Perry conceived of neighbourhoods in this time period as islands locked amidst a burgeoning sea of vehicular traffic, a dangerous obstacle which prevented children (and adults) from safely walking to nearby playgrounds and amenities. Perry's neighbourhood unit concept began as a means of

combating this obstacle. Ultimately, however, it evolved to serve a much broader purpose, of providing a discernible identity for the concept of the "neighborhood", and of offering to designers a framework for disseminating the city into smaller subareas (suburbs).

While there is evidence that the concept of the neighbourhood unit emerged as early as 1923, at a joint meeting of the National Community Center Association and the American Sociological Society in Washington, D.C., it was the publication of Clarence Perry's paper, in the 1929 *Regional Plan of New York and Its Environs*, which led to its promotion as a planning tool. Titled, "The Neighborhood Unit, a Scheme for Arrangement for the Family-Life Community", Clarence Perry's monograph offered in concrete terms a diagrammatic model of the ideal layout for a neighborhood of a specified population size. This model provided specific guidelines for the spatial distribution of residences, community services, streets and businesses. Perry's concept of the neighbourhood unit employed a variety of institutional, social and physical design principles, influenced by such popular notions in the 1920s as the separation of vehicular and pedestrian traffic, and arterial boundaries demarcating the inwardly focused neighbourhood cell from the greater urban lattice. The cellular

nature of the neighbourhood unit allowed it to be utilised as a building block in the development of neighbourhood arrays, leading to its systematic modular usage during periods of rapid residential expansion in many countries across the globe.

While Perry's name is most commonly associated with the notion of the neighbourhood unit, the idea of "re-defining and re-planning the city of the basis of neighbourhoods" was not Perry's in isolation. In a paper on the Neighbourhood Unit, Lewis Mumford considers the neighbourhood as it is organically experienced as well as the various – theoretical and practical – influences that lead to Perry's formalisation of the neighbourhood unit as an urban planning mechanism. Mumford credits Perry as taking: "the fact of the neighbourhood; and showing how, through deliberate design, it could be transformed into what he called a neighbourhood unit, the modern equivalent of a medieval quarter or parish: a unit that would now exist, not merely on spontaneous or instinctual basis."

William E. Drummond - a central architect in Frank Lloyd Wright's studio between 1899-1909 - defined the 'Neighbourhood Unit' within his submission to the Chicago City Club's planning competition of 1912. The competition wanted to address, "the theoretical and practical parameters, social and physical, of a micro-community in a suburban context with

a focus on housing; the second concerned a community centre", calling for proposals for a 'quarter-section' site south of central Chicago. Drummond's plan advocated for the neighbourhood unit to be the organising basis of the whole city; to be 'regarded as a unit in the social and political structure of the city'.

The competition was largely a reaction to the squalid urban living conditions in the early part of the twentieth-century. It was part of the larger progressive and reformist era in American politics. Progressives saw the slums as a consequence of corruption and exploitation which they believed could be overcome through local political activation. Drummond was influenced by notable sociologist Charles Cooley, who he credited and surmised in his submission saying, 'in the social and political organization of the city [the neighbourhood] is the smallest local unit'. These sociological and political foundations are interesting when considered against the various applications and permeations of neighbourhood planning.

2.6.3 Principles

The neighbourhood unit was conceived of as a comprehensive physical planning tool, to be utilised for designing self-contained residential neighbourhoods which promoted a community centric lifestyle, away from the "noise of the trains, and out of sight of the smoke and ugliness of industrial plants" emblematic of an industrialising New York City in the early 1900s.



A diagram of Clarence Perry's neighbourhood unit, illustrating the spatiality of the core principles of the concept, from the New York Regional Survey, Vol 7. 1929

Perry's six Neighborhood Unit principles were:

1. Site: A residential unit development should provide housing for that population for which one elementary school is ordinarily required, its actual area depending upon population density.

2. Boundaries: The unit should be bounded on all sides by arterial streets, sufficiently wide to facilitate its by-passing by all through traffic.

3. Open Spaces: A system of small parks and recreation spaces, planned to meet the needs of the particular neighborhood, should be provided.

4. Institution Sites: Sites for the school and other institutions having service spheres coinciding with the limits of the unit should be suitably grouped about a central point, or common.

5. Local Shops: One or more shopping districts, adequate for the population to be served, should be laid out in the circumference of the unit, preferably at traffic junctions and adjacent to similar districts of adjoining neighborhoods.

6. Internal Street System: The unit should be for that purpose provided with a special street system, each highway being proportioned to its probable traffic load, and the street net as a whole thing designed to facilitate circulation within the unit and to discourage its use by through traffic.

The core principles of Perry's Neighbourhood Unit were organised around several physical design ideals:

"Centre the school in the neighbourhood so that a child's walk to school was only about one-quarter of a mile and no more than one half mile and could be achieved without crossing a major arterial street. Size the neighbourhood to sufficiently support a school, between 5,000 to 9,000 residents, approximately 160 acres at a density of ten units per acre. Implement a wider use of the school facilities for neighbourhood meetings and activities, constructing a large play area around the building for use by the entire community.

Place arterial streets along the perimeter so that they define and distinguish the "place" of the neighborhood and by design eliminate unwanted through-traffic from the neighborhood. In this way, major arterials define the neighborhood, rather than divide it through its heart.

Design internal streets using a hierarchy that easily distinguishes local streets from arterial streets, using curvilinear street design for both safety and aesthetic purposes. Streets, by design, would discourage unwanted through traffic and enhance the safety of pedestrians.

Restrict local shopping areas to the perimeter or perhaps to the main entrance of the neighborhood, thus

excluding nonlocal traffic destined for these commercial uses that might intrude on the neighborhood.

Dedicate at least 10 percent of the neighborhood land area to parks and open space, creating places for play and community interaction"

The neighbourhood unit was embraced for its community idealism, and many of the public sectors in those countries which were exposed to the theorem have since adopted its purpose; of protecting and promoting the public health and of considering the safety and welfare of citizens. Furthermore, private developers and investors continue to construct and fund planned communities based upon many of the concepts tenets, due to consumer demand for the idealistic community intimacy associated with living with heteronormative homoreciprocans of similar socioeconomic status. These attractive qualities of the concept of the neighbourhood unit are referred to by Allaire, "as reflecting a nostalgia for rural living".

The neighborhood is the planning unit for a town.

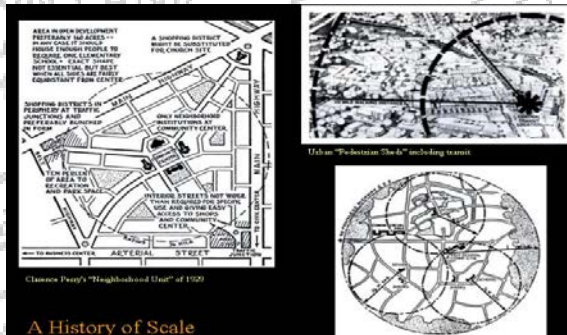
Traditional neighborhoods have specific sizes usually based upon walking distances equivalent to a quarter-mile radius. When the neighborhood combines with other traditional neighborhoods, it becomes a town. In contrast, sprawl is a series of isolated pods that are not well connected to one another. The amount of land acquired by the developer typically determines the size of the pod. When these pods stand alone in the landscape, it is sprawl. When these pods combine with others, it remains sprawl.



Neighborhood size has been defined throughout planning history. This graphic created by Clarence Perry is entitled "Neighborhood Unit of the 1920 New York Regional Plan".

Clarence Perry defines the neighborhood as a component of a town and defines its size based upon a five-minute walking radius. The radius is measured from the center,

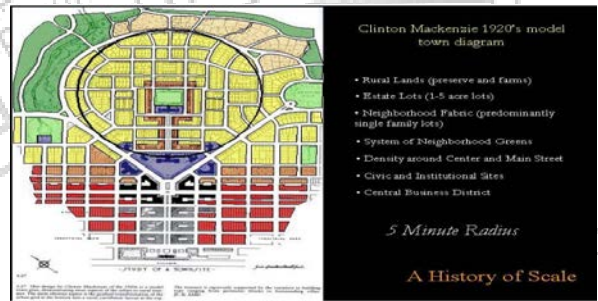
and the center holds the cultural uses such as a school. A five-minute walking distance is approximately 160 acres. Clarence Stein expanded the definition of neighborhood center in 1942 by connecting the neighborhoods together to create towns. In the 1920's and 1940's, the centers and anchors of neighborhoods were the schools. More recently, the quarter-mile walking radius has been expanded to a half mile with the addition of a transit hub. Traditional neighborhood size works well in the town, village, and urban city scales.



A History of Scale

In the 1920's, Clinton McKenzie created the model town diagram that defines all the components that work within a traditional neighborhood. Rural lands stand at the edge. In Florida, the rural edge could be agricultural lands, preserves, and watershed areas. One to five-acre estate lots line the neighborhood edge. The estate lots define the edge of a town instead of having lots scattered throughout the countryside. The estate lots intrinsically connect to the neighborhood. The bulk of the neighborhood is single-family lots ranging from fifty to 200 feet in width.

The lots narrow as the pedestrian moves closer to the center of the neighborhood. The block structure becomes more ridged at the center and more organic as the pedestrian moves out from the center. A system of neighborhood greens connects throughout the neighborhood. The highest density areas are located near the center—townhouses and multifamily units. Because of their size and resilience, the higher density areas surround the neighborhood green or main street. In this diagram, the 1,350-foot radius encapsulates most of the neighborhood. The traditional neighborhood, by definition, allows it to be part of a central business district or a series of other neighborhoods to create a small town or village.

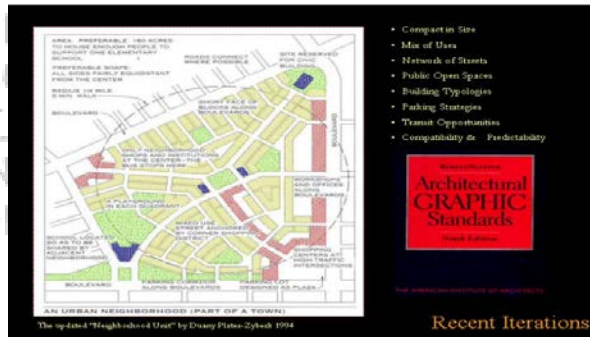


The definition of the five-minute walking radius neighborhood is part of the American Institute of Architects Architectural Graphics Standards which is an industry standard for dimensional criteria for buildings and site planning.

In the early 1990's, the firm of Duany Plater-Zyberk reproduced the

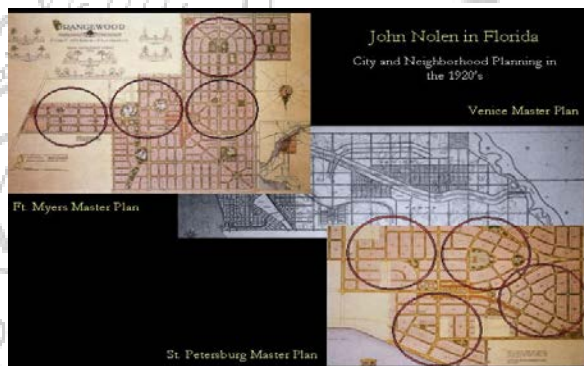
LITERATURE REVIEW

Clarence Perry diagram to demonstrate how the diagram is still effective in planning today.



Florida has a long history of planning by the twentieth century town planner John Nolen.

He created plans throughout Florida including Sarasota, Fort Myers, and St. Petersburg.

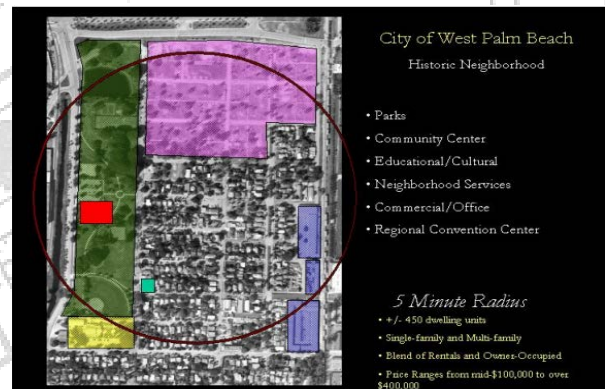


The neighborhood benefits from an enormous city park along its western edge. A public community center, educational and cultural facilities, and neighborhood services are embedded within the neighborhood. Commercial and office uses are located at the perimeter of the neighborhood. A regional convention center is part of the northern portion of the neighborhood. All of these

components fit within the five-minute walking radius, and all the components work well within this neighborhood.

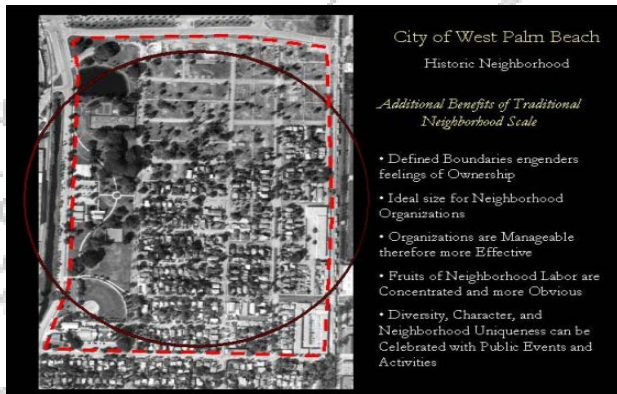
This neighborhood holds over 400 dwelling units including both single and multi-family.

There are both owner-occupied and rental units, and prices range from the middle \$100,000 to over \$400,000. This neighborhood in downtown West Palm Beach demonstrates how a traditional neighborhood continues to serve its residents.



Residents enjoy many intangible benefits living in this neighborhood. Defined neighborhood boundaries engender feelings of ownership in both homeowners and renters. Feelings of ownership automatically give way to spontaneous policing. The five minute walking radius is the perfect size for neighborhood organizations. It is easier to manage a compact neighborhood, and it makes it easier to have a more unified political voice. When the

neighborhood association raises funds, the physical improvements made with these funds are more noticeable since the funds are spread over a small geographical area. Finally, the diversity and character of these neighborhoods create uniqueness and give these neighborhoods a lasting sense of identity.



The Urban Land Institute recently worked with the City of Port St. Lucie on their western annexation areas. Many conclusions brought forth by the Urban Land Institute were consistent with traditional planning. The Urban Land Institute suggested the following:

- creating a unique identity in the neighborhoods that do not currently have a unique identity
- creating individual neighborhood plans
- breaking down the large neighborhoods into smaller components

- creating more interconnectivity
- developing neighborhood guidelines and logos

The Urban Land Institute put forth the concept of “cradle to grave” neighborhoods. If a person can be born, raised, go through college, return to the neighborhood, and live out his or her life in the neighborhood, it implies sustainability, longevity, and history. The Strategic Regional Policy Plan tells how to create “cradle to grave” neighborhoods.



The scale of the traditional, sustainable neighborhood is based upon a five minute walking radius (1/4 mile). When combined with other neighborhoods, it becomes a town thus a city. The neighborhood, therefore, is the planning unit of the town, city, and village.

CHAPTER 2

Similar examples study

2.7.1 International example 1:

Mehrshahr

Residential

Complex

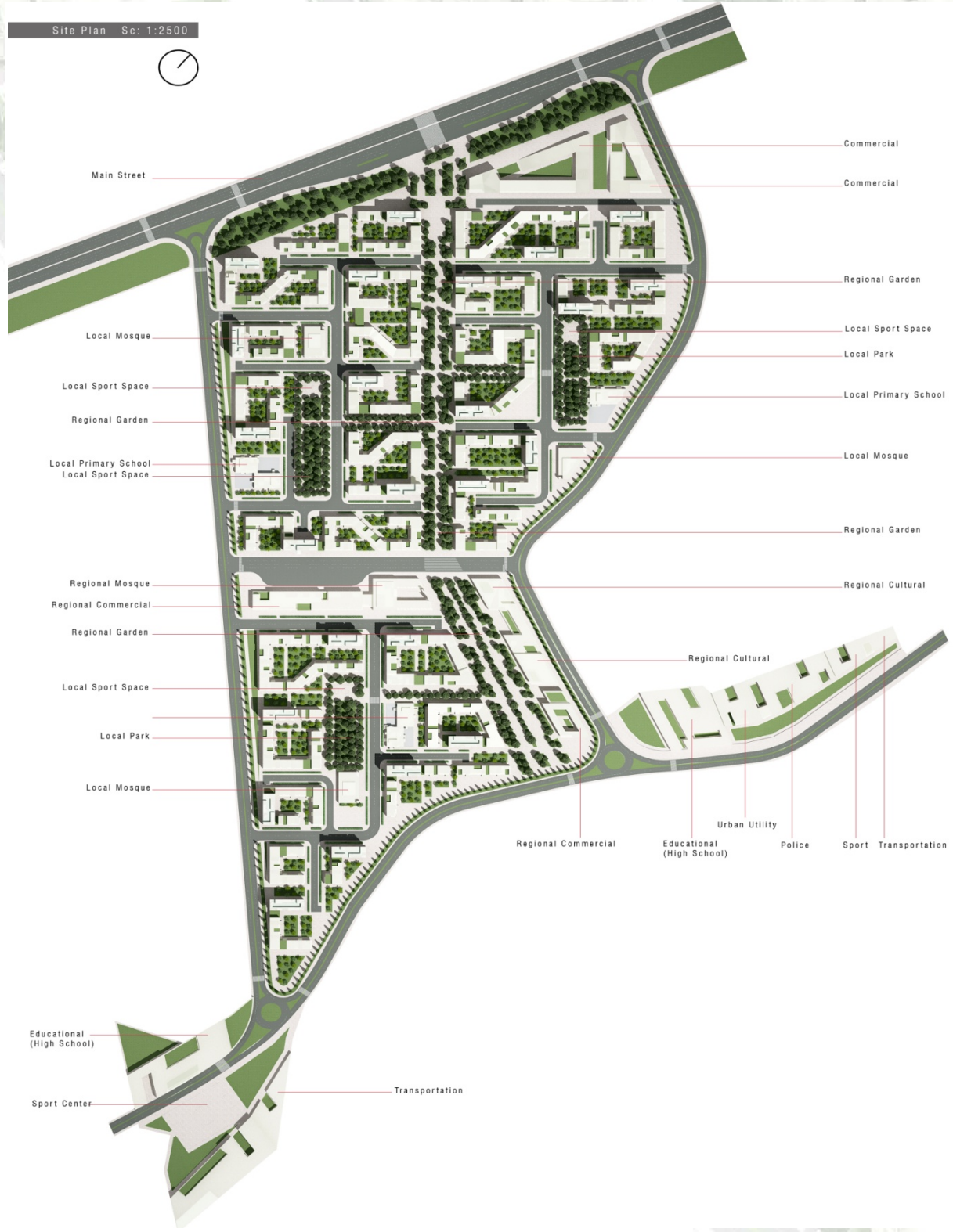
Design



Located in [Karaj](#) which is the fifth largest city of Iran, and located near Tehran. The main purpose of the client and the organizer was to find new ways to develop and build houses for middle layer people of the society in order to have an complex suits to Iranian needs and culture, which has had missed in the recent years.

The complex contains 6000 residential units in a site with about 750000sqm area.

Site Plan Sc: 1:2500



SITE PLAN OF THE RESIDENTIAL NEIGHBOURHOOD

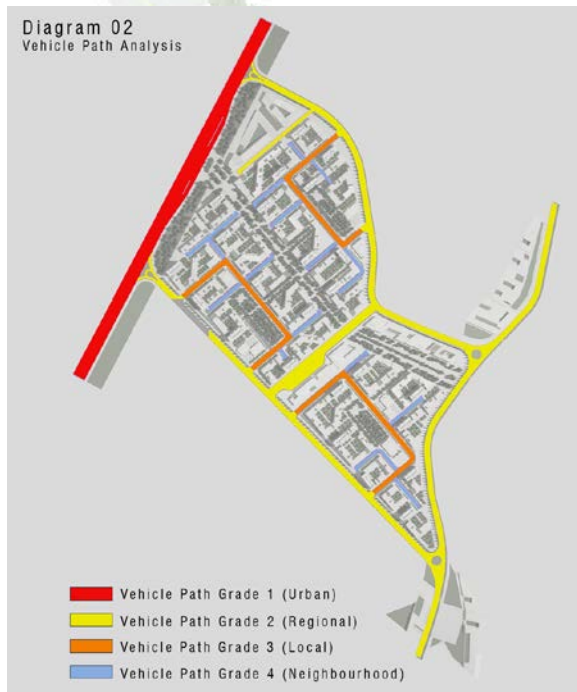
A Site showing all the pedestrian path

The main roads pass through the middle of the neighbourhood cutting it into half. Secondary roads create a link between the different residential blocks, with internal roads around the building itself.

Diagram 01
Pedestrian Path Analysis



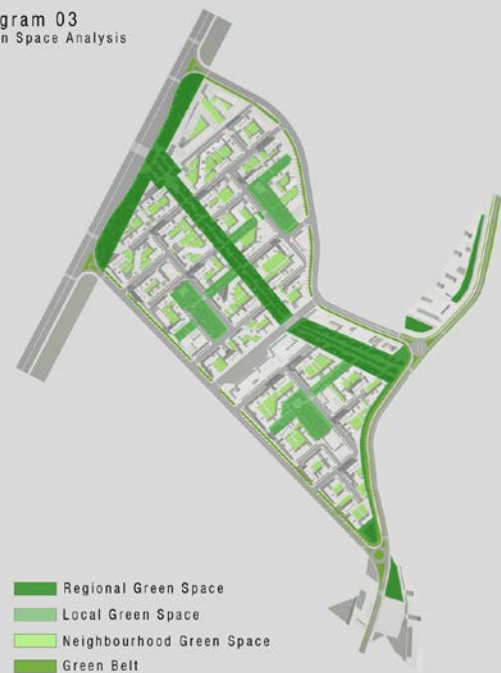
Diagram 02
Vehicle Path Analysis



A site showing the vehicle path.

As observed the vehicle path is in such a way that it doesn't interfere with the pedestrian path for their safety. The main internal roads pass around the complex with the presence of 3 local path and certain inner roads which end in parking lots for the residential buildings.

Diagram 03
Green Space Analysis



A site showing the green areas.

As shown the green areas contribute to a large part of the design. The complex is divided into 3 almost equal parts, there are 3 central green areas for the 3 parts. And each building has a central green area. The main path has a green belt around it, which acts as the main walking park for the complex.

A site showing the built spaces in comparison to the open spaces and green areas.

As shown the open areas are 70 and the built contribute to 30%.

Diagram 04
Massive & Space Analysis

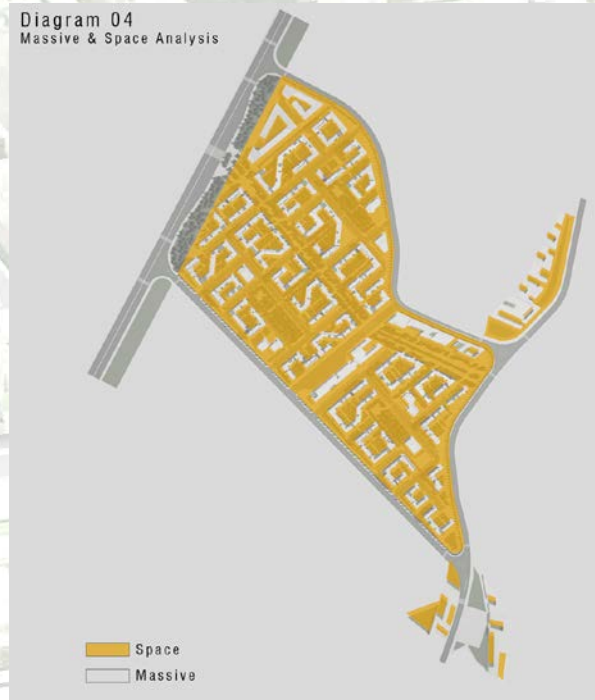


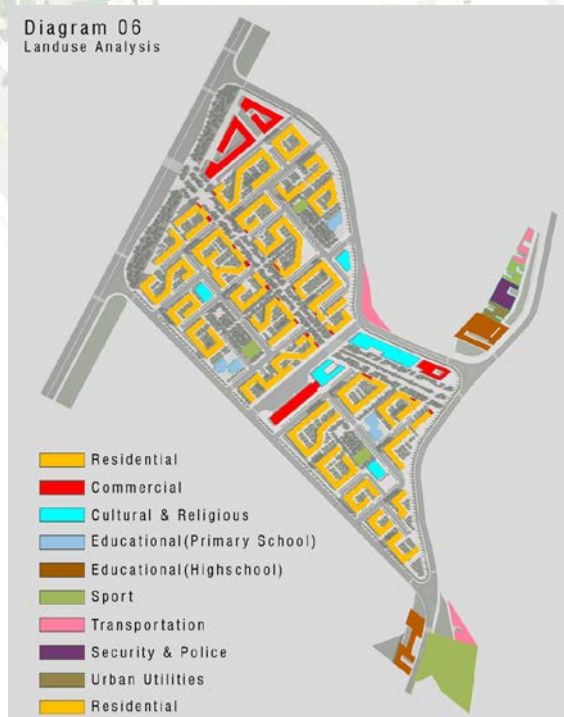
Diagram 05
Block Height Analysis



A site showing the different building heights :

This site shows that the low rise buildings are the major buildings, very less are high rise.

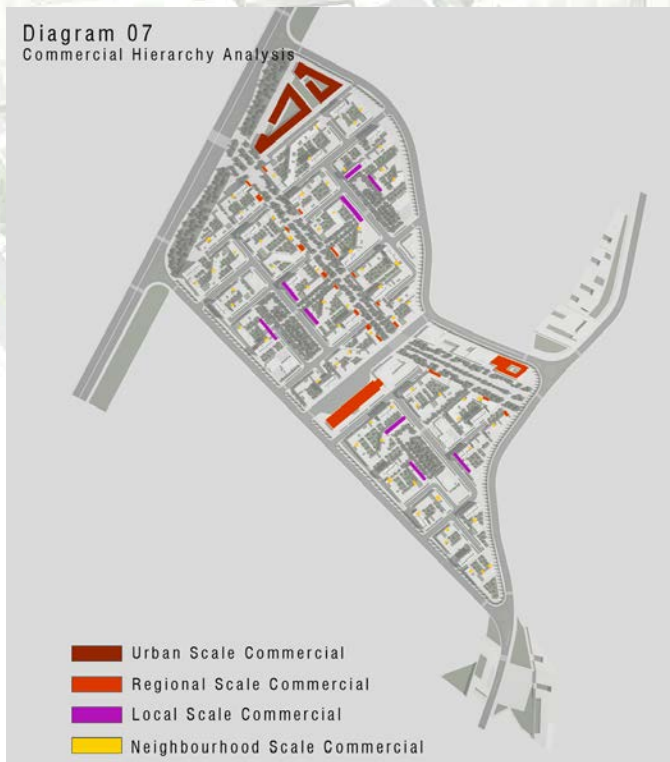
Diagram 06
Landuse Analysis



Shows that the main landuse in this project is residential.

LANDUSE SITE PLAN

Diagram 07
Commercial Hierarchy Analysis



A site showing the placement of the trading spaces in the neighbourhood:

The main commercial area is in the top right area, next to the main road. While the regional are placed between every few buildings, and the small commercials are present in every building.

The designer group traced 6 main strategies to design the master plan. First, having a main space to unite the elements of the complex, second, designing characterized spaces, third, observing the hierarchy from public spaces to private ones, fourth, observing the meaning of housing district, fifth, distribution of activities according to spatial hierarchy and structure of the complex and finally, having continuity in public green spaces.

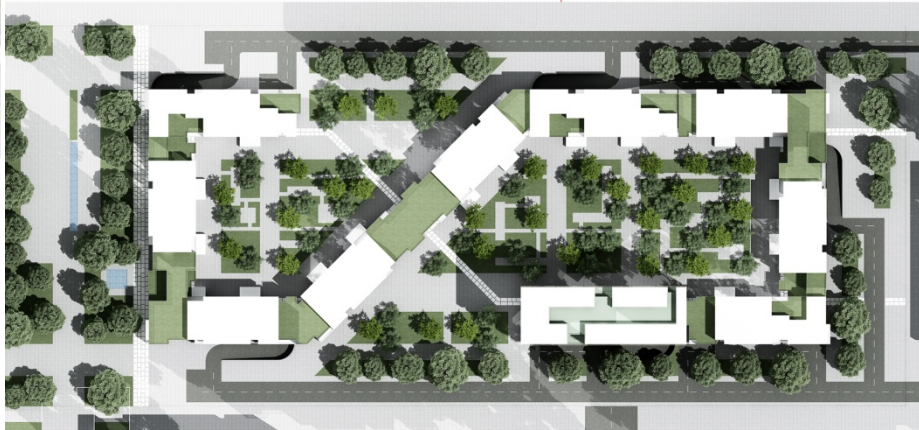
DIFFERENT PERSPECTIVES SHOWING DIFFERENT PARTS OF THE COMPLEX



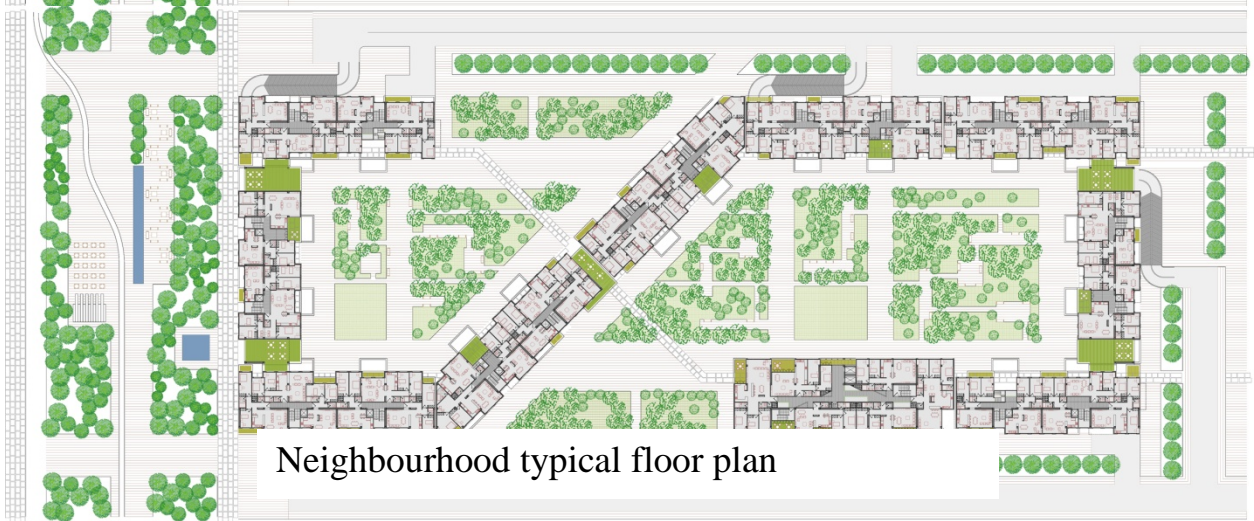


The complex includes 3 residential districts which are united by a longitudinal garden together. The design concepts of this garden are inspired by traditional and old Iranian gardens. Regional activities such as commercials, cultural and religious buildings are designed along this axis. Each district has a local park which is located in the middle part and joined to the central park by a pedestrian path. Main local buildings such as mosque, primary schools and open sport spaces are located in these parks and have easy pedestrian access to residential blocks.

Neighbourhood Site Plan Sc: 1:600



Neighbourhood ground floor plan



Neighbourhood typical floor plan



Zone A General View



High-Rise Blocks
Low-Rise Blocks
Half Low-Rise Blocks

Zone	A	Number	Area										Sum					
			High-Rise Blocks	Low-Rise Blocks	Half Low-Rise Blocks	Other	Other	Other	Other	Other	Other	Other						
Areas in One Block	High-Rise Blocks	1	110	40	500	2800	7340	1471	381	188	198	15302	89	78	3	48	119	140
Areas in One Block	Low-Rise Blocks	1	130	70	380	1400	2415	430	69	25	120	4890	27	34	4	36	80	104
Areas in One Block	Half Low-Rise Blocks	1	50	35	180	700	1230	225	35	15	63	2443	14	17	2	13	89	107
Areas in Zone A	High-Rise Blocks	48	4800	2020	18000	64800	117000	20700	374	1512	5700	224706	1242	1564	184	1008	82	104
Areas in Zone A	Low-Rise Blocks	13	550	350	1800	7000	12300	2050	269	110	520	24630	142	170	20	160	100	120
Areas in Zone A	Half Low-Rise Blocks	1	200	140	700	2800	4500	840	125	55	231	9180	53	65	8	52	300	350
Sum		62	5400	3090	25800	93800	134100	24140	668	276	780	32640	1834	2292	204	1160	114	140



Zone B General View



Zone	B	Number	Area										Sum					
			High-Rise Blocks	Low-Rise Blocks	Half Low-Rise Blocks	Other	Other	Other	Other	Other	Other							
Areas in One Block	High-Rise Blocks	1	110	40	500	2800	7340	1471	381	188	198	15302	89	78	3	48	119	140
Areas in One Block	Low-Rise Blocks	1	130	70	380	1400	2415	430	69	25	120	4890	27	34	4	36	80	104
Areas in One Block	Half Low-Rise Blocks	1	50	35	180	700	1230	225	35	15	63	2443	14	17	2	13	89	107
Areas in Zone B	High-Rise Blocks	34	3700	1400	14000	50400	137800	27000	1282	748	3420	136806	702	624	84	480	119	140
Areas in Zone B	Low-Rise Blocks	10	500	300	1500	5700	10200	1800	282	102	480	19800	102	126	16	108	100	120
Areas in Zone B	Half Low-Rise Blocks	5	200	140	700	2800	4500	840	125	55	231	9180	53	65	8	52	300	350
Sum		49	4400	2040	16200	56900	149500	30000	1689	905	4071	165786	857	815	108	640	239	290



Zone C General View



High-Rise Blocks
Low-Rise Blocks
Half Low-Rise Blocks

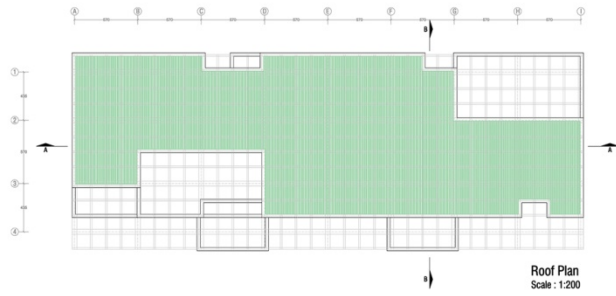
Zone	C	Number	Area										Sum					
			High-Rise Blocks	Low-Rise Blocks	Half Low-Rise Blocks	Other	Other	Other	Other	Other	Other							
Areas in One Block	High-Rise Blocks	1	110	40	500	2800	7340	1471	381	188	198	15302	89	78	3	48	119	140
Areas in One Block	Low-Rise Blocks	1	130	70	380	1400	2415	430	69	25	120	4890	27	34	4	36	80	104
Areas in One Block	Half Low-Rise Blocks	1	50	35	180	700	1230	225	35	15	63	2443	14	17	2	13	89	107
Areas in Zone C	High-Rise Blocks	34	3700	1400	14000	50400	137800	27000	1282	748	3420	136806	702	624	84	480	119	140
Areas in Zone C	Low-Rise Blocks	10	500	300	1500	5700	10200	1800	282	102	480	19800	102	126	16	108	100	120
Areas in Zone C	Half Low-Rise Blocks	5	200	140	700	2800	4500	840	125	55	231	9180	53	65	8	52	300	350
Sum		49	4400	2040	16200	56900	149500	30000	1689	905	4071	165786	857	815	108	640	239	290



Residential neighborhoods designed around the local park and each one has a middle yard with green spaces and grounds for playing children. Kindergarten, meeting space, rest and leisure rooms, some shops and janitor houses are located on the ground floors. Each neighborhood has combination of residential blocks with different heights in order to have different interesting spaces. Besides, each block consists of various houses to response different family tastes.



2nd Floor Plan
Scale : 1:200



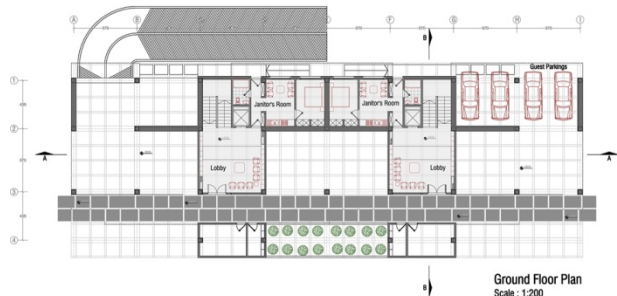
Roof Plan
Scale : 1:200



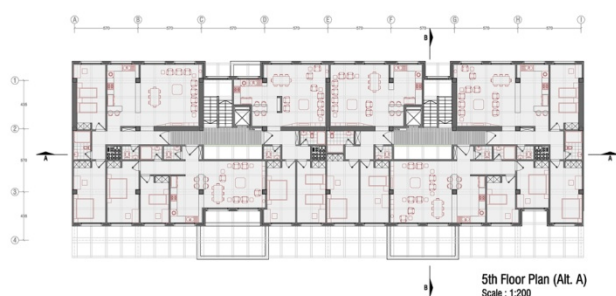
First Floor Plan
Scale : 1:200



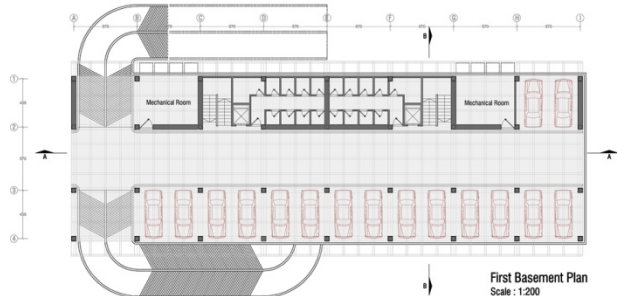
5th Floor Plan (Alt. B)
Scale : 1:200



Ground Floor Plan
Scale : 1:200



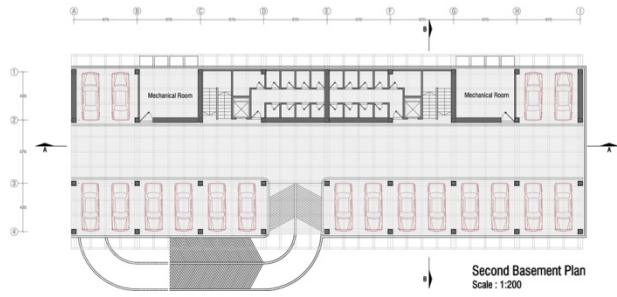
5th Floor Plan (Alt. A)
Scale : 1:200



First Basement Plan
Scale : 1:200



4th Floor Plan
Scale : 1:200

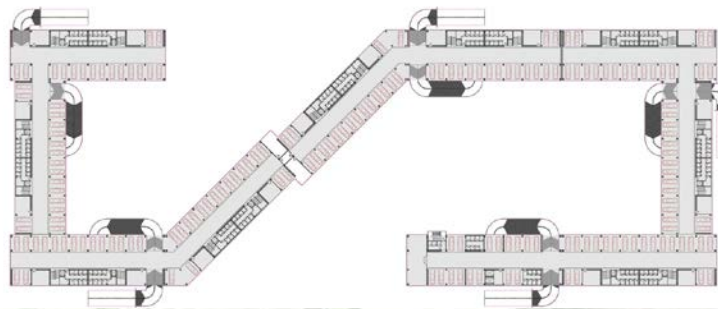


Second Basement Plan
Scale : 1:200

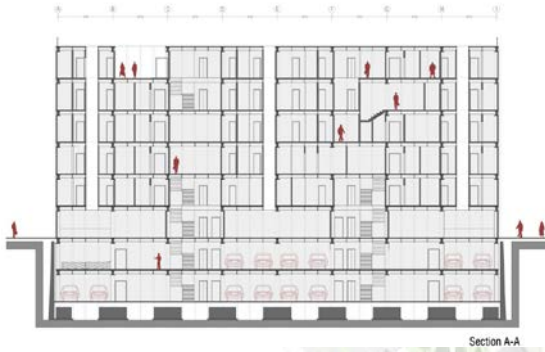


3rd Floor Plan
Scale : 1:200

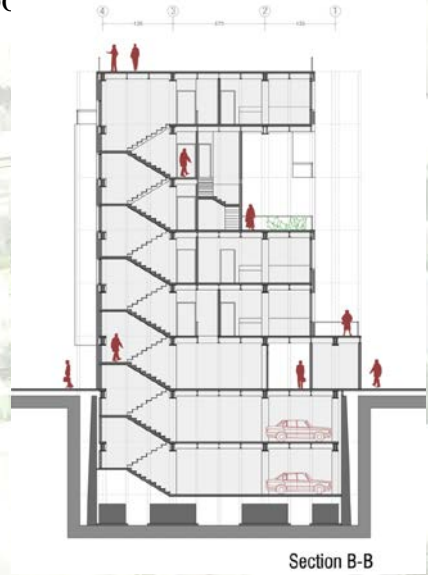
Low rise plans



Neighbourhood basement flocc



Section A-A



Section B-B



Main elevation



An aerial photograph of a city neighborhood, showing a grid of streets and modern, multi-story buildings. A prominent main street runs diagonally through the center of the neighborhood. The buildings are light-colored with dark window frames. There are some green spaces and trees scattered throughout the area.

Pros of the neighborhood:

- *Availability of services to all sectors of the neighborhood.*
- *Providing more than one design to provide different people's needs.*
- *Scattered green areas all over the neighborhood for good ventilation.*
- *Underground car parks to save area's above ground.*
- *The neighborhood respects the traditions of the people its built for.*
- *All the building's are well oriented and well ventilated.*

Cons of the neighborhood:

- *The 3 sectors don't have an area that unites them together.*
- *Lack of creativity in the site design.*
- *Having a main street passing right through the middle of the neighborhood.*
- *The transportation space is not located next to the main street.*
- *Absence of health services.*

2.7.2INTERNATIONAL EXAMPLE 2:

Project name:

Mera Nagar Housing

Location :

Deh Nagan, Karashi , Sindh, Pakistan

Project description:

It is a Comprehensive Township Scheme which covers the development of low cost housing units, commercial areas, recreational/amenities areas (parks/playgrounds, health care, schools and infrastructure facilities (road network, sewerage disposal system, water supply, electricity, water treatment plant).

The Master Plan has been developed in an area along the River Lyari. The building blocks have been placed with consideration to the existing variation in site topography and contours. A central pedestrian spine runs through the development flanked with building blocks on either side. This low-rise high density scheme utilizes the horizontal arrangement parallel to the communal spine and the housing units are grouped around intimate open spaces. Despite the modern facades the layouts of units are traditional in principle and sensitive to the privacy requirements of the residents. The overall design is environmentally sustainable as the individual housing units and their clustered placement around smaller open spaces make maximum utilization of Karachi's south western breeze. Concepts of cross ventilation within the housing units in addition to communal courts acting as wind catchers have been incorporated.

Thus the Master Plan revolves around the following key points :

- a) Contextual response to the site topography, wind direction and solar path.
- b) Energy consciousness/cost consciousness
- c) Use of indigenous materials and local knowledge
- d) Self sustainability through community development

The Scheme aims towards community development with a capacity building and training program for creating self- sustainability. This is to be accomplished

through the development of a Vocational Training Center where the community women, young men and children will be given workshops in skill enhancement.

Project components:

Phase 1 :

- Housing units
- Community centers
- School
- Bazaar

Phase 2:

- Housing units
- Masjid
- Bazaar
- Vocational centre
- Other amenities

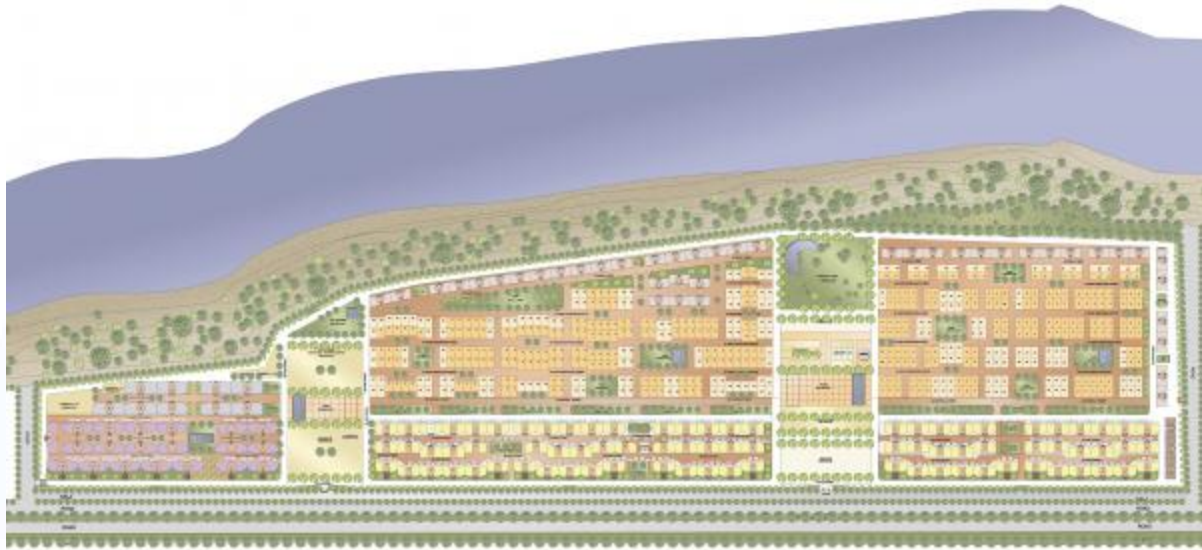
The project consists of exactly 1773 housing units, accommodating 7 people / household

Project goal:

- Improve the human spirit to empower and enable the people
- Provide affordable houses and engender community living and participation
- Respond to the growing need for clean water ,shelter, healthcare and education

Project area:

50 acres of land at Deh Nagan in Karachi.

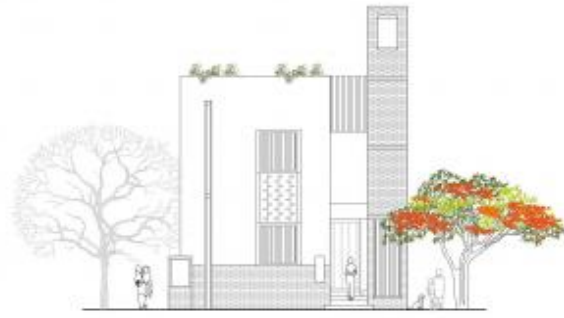


MASTER PLAN

MERA NAGAR (LOW-COST HOUSING)
DEH NAGAN, KARACHI, PAKISTAN



GROUND FLOOR PLAN



FRONT ELEVATION



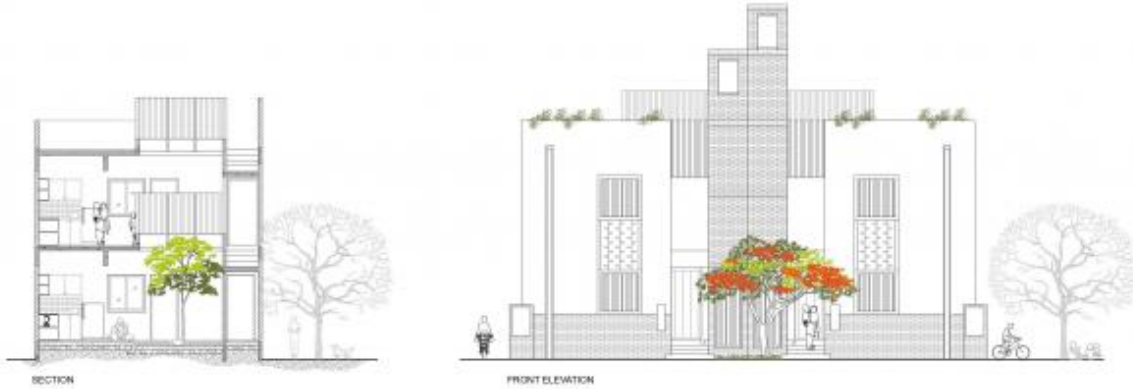
SECTION



SECTION

HOUSING UNIT
CATEGORY A

MERA NAGAR (LOW-COST HOUSING)
DEH NAGAN, KARACHI, PAKISTAN



HOUSING UNIT
CATEGORY A2

NERA NAGAR (LOW-COST HOUSING)
DEH NAGAR, KARACHI, PAKISTAN



VIEWS OF THE HOUSING UNITS IN A MOHALLAH
VARIATION IN MATERIALS, PEDESTRIAN PATHWAYS AND SHARED COMMUNAL GREEN SPACES

NERA NAGAR (LOW-COST HOUSING)
DEH NAGAR, KARACHI, PAKISTAN

Pro's:

- Main services are all placed at the centers
- The green areas are well allocated
- Site is very well organized, roads and houses location
- Car roads surround the housing areas but do not pass through it
- Having 3 different design areas in the site, providing different choices for occupants
- Having only 2 main entrances, which is good for security concerns

Con's:

- The site is planned in a way by which only few occupants have a good view towards the sea
- The neighbourhood doesn't have a main central area where all people can gather together
- Type A houses are not suitable for a household of 7 people due to lack of rooms

2.7.3 LOCAL EXAMPLE STUDY:

1/A LOW-COST HOUSING PROJECT IN KHARTOUM NORTH.EL SHABIYA

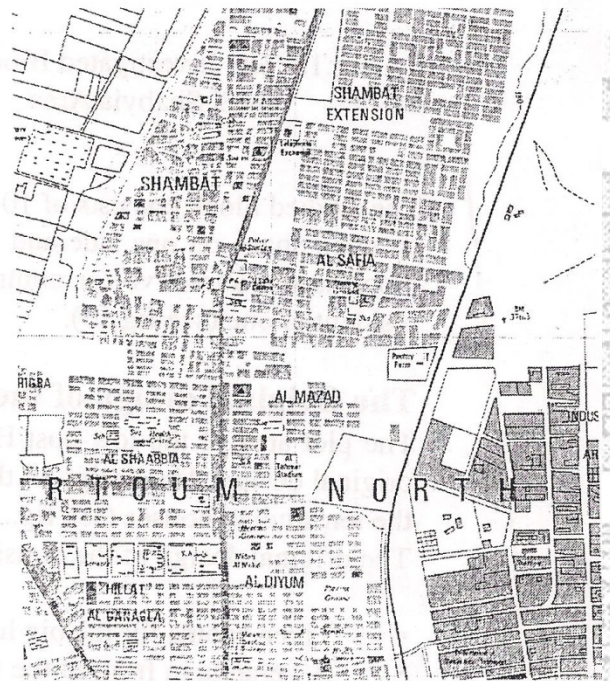
The governmental low-cost housing project has targeted workers with nuclear families. The fact that the houses have similar areas and design and are constructed with the same building materials and techniques, can facilitate the detection of changes and additions.

2/ A NEIGHBOURHOOD WITH TRADITIONAL HOUSES IN THE OLD PART OF OMDURMAN

The houses have different plot sizes and the building materials and techniques vary a lot . The first house built in this plot was in 1910. The land is free-hold. The ownership of the houses are changing through inheritance or selling. All the household members in the traditional houses are relatives, in contrast to the" low-cost houses" where the household members knew their neighbors only after moving to the houses.

2.7.3.1/EL SHABIYA AREA:

This area is in Khartoum North, and lies 7 Km to the north of Khartoum centre. El Shabyia was developed between 1958 to 1963 to provide housing for the workers from the Khartoum North Industrial Area. Around 1048 were constructed. The design, execution and distribution of the houses was undertaken by the department of housing which, at that time, was the Ministry of Local Government. Eligibility criteria for obtaining a house in El Shabiya consisted of three conditions as described by Bannaga:



1/ The householder should be a Sudanese and supporting a family of at least five members who should be living permanently with him.

2/ The applicant should be employed by the government or the public sector and have regular monthly wage.

3/ The gross monthly wage of an applicant should not be less than £S 12 and not more than £S25(Bannaga 1987).

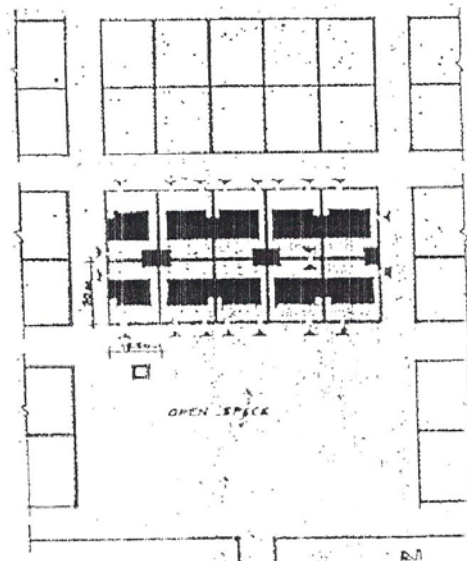
HOUSE TYPE:

There are two types of houses, small two bed-roomed ones in plots of 252, 262 or 290sq.m and three bed-roomed ones in plots of 300, 310 or 334sq.m. The houses were constructed with plain concrete foundations and cement block walls, roofed with asbestos corrugated sheets. The doors and windows were made from Moski timber. Shopping, educational and health facilities were provided within the general plan of the settlement.

The beneficiaries were required to deposit down payments, equal to 10% of the total cost of the house and the services provided. The balance were to be paid on installments over a period of 20 years(Shoeib 1973).

The studied block consists of 10 houses. It is located in the middle of the settlement, having an open space on one side and small roads on the 3 remaining sides. The location of this block is not attractive for commercial development. As a result the block remained as a residential one.

The Original Design of the studied houses in El Shabiya:

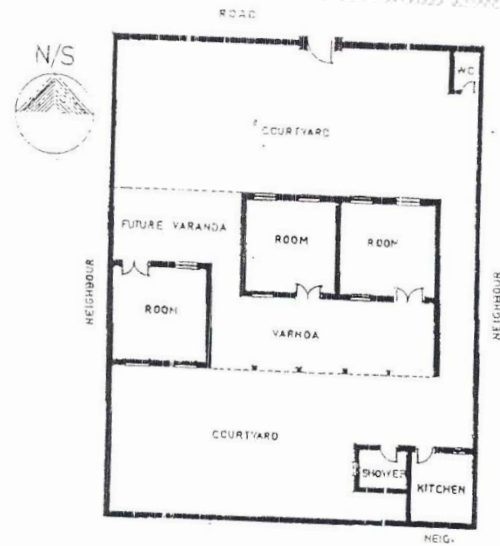


The Investigated Block
in El Shabyia Area

The plot area of the low-cost house is 310 sq.m and the built area was 91 sq.m in the original design. The design of the houses, building materials and techniques is the same for the 10 studied houses.

The original design consisted of:

- * Three bedrooms for the big houses.*
- * A veranda in front of the two adjacent rooms*
- * A front courtyard*
- * A back courtyard*
- * A kitchen and bathroom which were located in the back courtyard*
- * A toilet in the front courtyard*
- * Each house has one entrance except for the corner plots which have two entrances*



The Original Plan of the Low-cost House

The house layout consisted of one room facing the front courtyard. The other two rooms with a veranda faced the back courtyard. They were meant to be the family rooms. The kitchen and the bathroom were in the back courtyard, while the toilet was located in the front courtyard.



A family living hall in a low-cost house.

FIRST EXAMPLE:

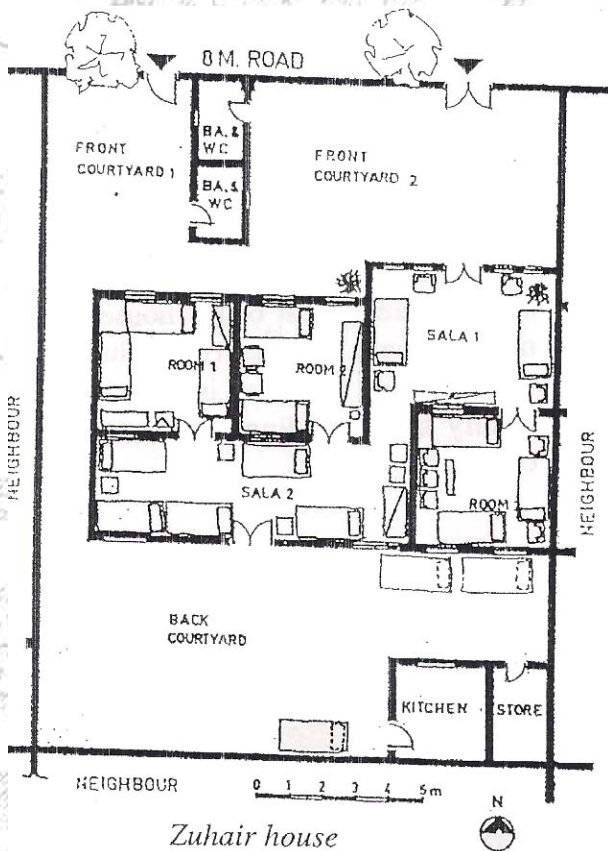
ZUHAIR HOUSE:

A house consisting of 9 members:

Area of the house in sq.m:

Built up area= 140 m²

Courtyards = 170 m²



THE USE OF SPACE BY FEMALES

SYSTEM OF SETTINGS \ SYSTEM OF ACTIVITIES	BACK YARD	FRONT YARD	KITCHEN	VERANDA 1	VERANDA 2	BATH & W.C	STORE	ROOM 1	ROOM 2	ROOM 3	OPEN SPACE
COOKING			○								
EATING	●							○			
SLEEPING								○			
LAUNDRY	○										
HYGIENE						○					
STORING							○	○	○		
GUEST RECEIVING	●			○							
SOCIAL EVENTS	●			○				○			○
OTHERS	●										

THE USE OF SPACE BY MALES

SYSTEM OF SETTINGS \ SYSTEM OF ACTIVITIES	BACK YARD	FRONT YARD	KITCHEN	VERANDA 1	VERANDA 2	BATH & W.C	STORE	ROOM 1	ROOM 2	ROOM 3	OPEN SPACE
COOKING											
EATING		●									
SLEEPING			●								
LAUNDRY											
HYGIENE						○					
STORING							○	○	○		
GUEST RECEIVING	●			○							
SOCIAL EVENTS	●										○
OTHERS	●	●									

The main house entrance is from the north side. The house has 2 entrances, both from the north side, one for females and one for males. The front courtyard is used by males and the back is used by females. The house consists

of 3 bedrooms and 2 saloon, 2 outside toilets, a kitchen and a store. The house is well ventilated due to the presence of courtyards. But at the same time there is no cross ventilation. The zones are well placed to give maximum comfort to the females and males.

Second House:

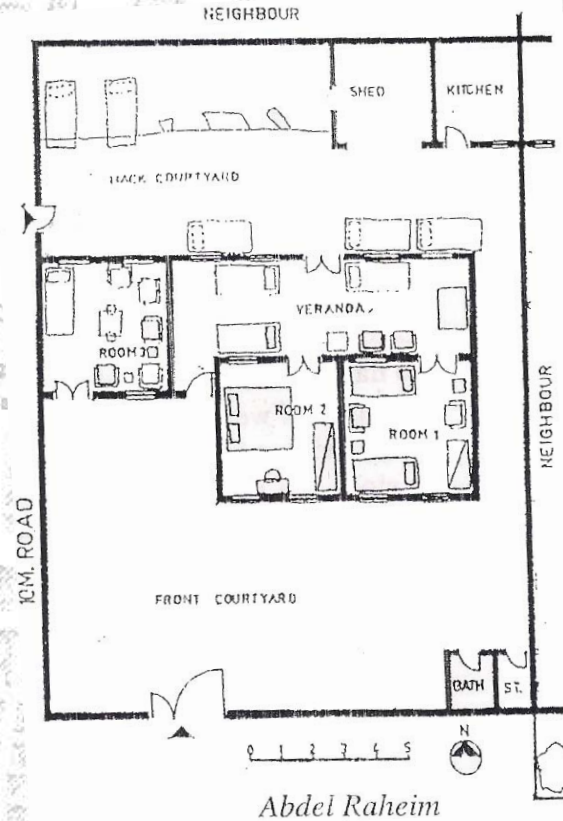
ABDEL RAHEIM House:

Consists of one family having 11 members.

Area of the house in sq.m:

Built area= 96m²

Courtyards=214m²



Abdel Raheim

THE USE OF SPACE BY FEMALES

SYSTEM OF SETTINGS	BACK YARD	FRONT YARD	KITCHEN	VERANDA 1	VERANDA 2	BATH & W/C	STORE	ROOM 1	ROOM 2	ROOM 3	SHED	OPEN SPACE
COOKING	●		○					○				
EATING	●		○					○				
SLEEPING	●			○								
LAUNDRY	○											
HYGIENE						○		○	○			
STORING							○	○				
GUEST RECEIVING	●			○								
SOCIAL EVENTS	●			○								
OTHERS	●											

THE USE OF SPACE BY MALES

SYSTEM OF SETTINGS	BACK YARD	FRONT YARD	KITCHEN	VERANDA 1	VERANDA 2	BATH & W/C	STORE	ROOM 1	ROOM 2	ROOM 3	SHED	OPEN SPACE
COOKING	●							○				
EATING	●	●						○				
SLEEPING	●	●						○				
LAUNDRY								○				
HYGIENE						○		○	○			
STORING							○	○				
GUEST RECEIVING	●											
SOCIAL EVENTS	●											
OTHERS	●											

This house contains 2 bedrooms, one veranda, a living room, a kitchen, shed, 2 bathrooms. There are two courtyards, each with its own entrance to provide maximum privacy. The house area's provide a good use for the concept of low-cost housing, where the occupants care more about courtyards than spaces.

2.7.3.2/TRADITIONAL AREA:

History of the traditional houses:

The area of the studied houses, lies in the centre of old Omdurman , 6km to the North-east of Khartoum centre. Intensive urbanization in this area began in the 1880's when Omdurman was made the capital of Mahadiyya state. The development progressed in a piece-meal manner with no definite plans and minimal restrictions on land acquisition. Plots areas ranged from 500-2000 sq.m, with mainly single storey houses.

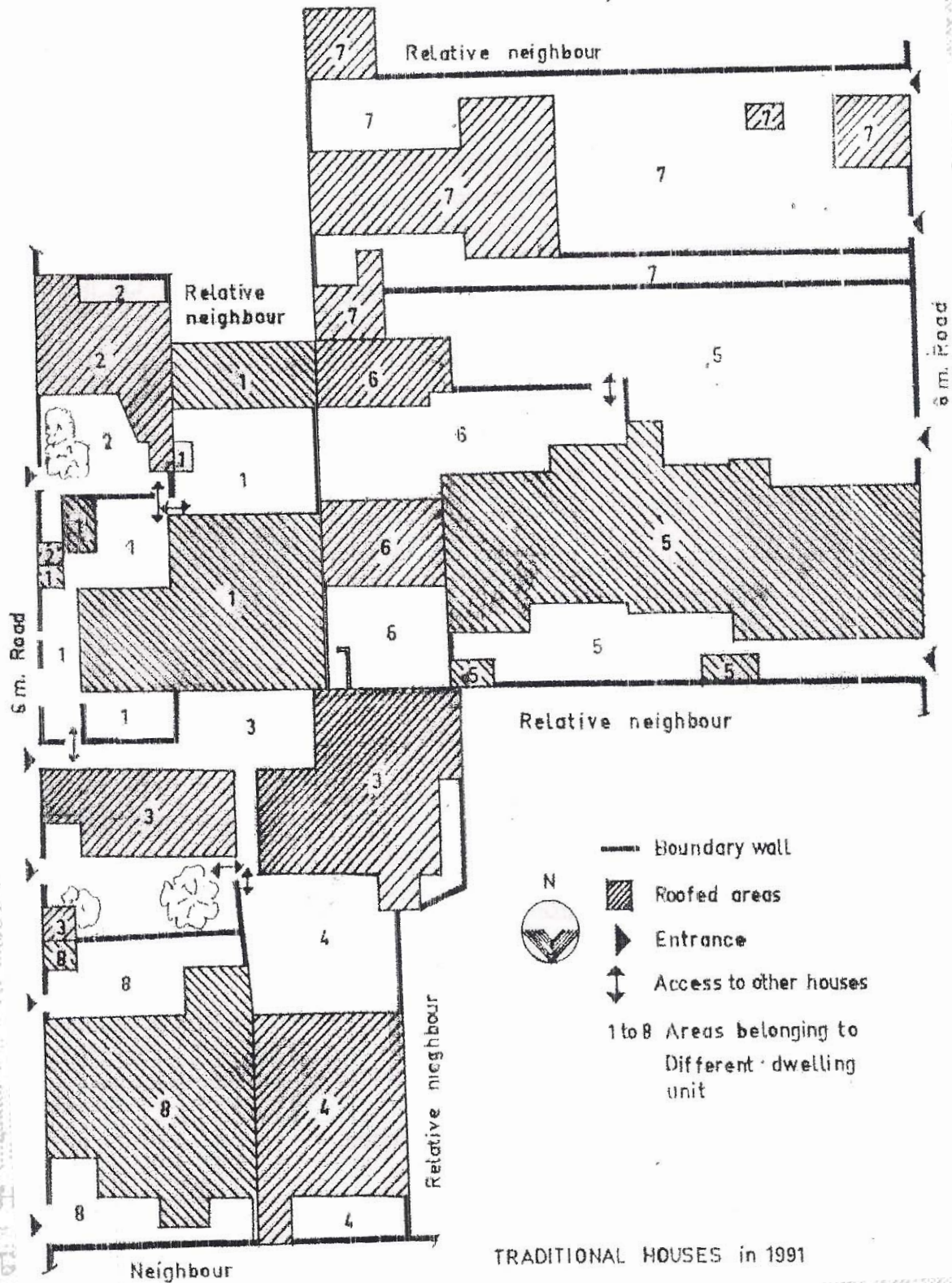


Later, this part of Omdurman city was planned by the first British Commissioner Bramble. When planning this part of Omdurman, the areas of the houses were reduced because the north, east and west roads were widened.

The houses built in 1910, had large areas of 4000 to 5000sq.m. In every house they had a drinking well. The inhabitants in each house were composed of one extended family. At present, the blocks extends about 100m east-west and 250m north-south with an area of 1850sq.m . The founder of the house "housh", the ancestor of the present inhabitants, had 9 sons and 10 daughters. These days, some of the extended family members and their families live in about 20 houses.

This block was chosen for many reasons. Firstly, it is an example of old houses with extended family way of living. Secondly, it is not very much affected by the many changes in the area despite its proximity to Omdurman commercial centre.

Traditional houses in 1991



TRADITIONAL HOUSES in 1991

Example:

Fahiema dwelling unit:

The house consists of 11 members

Area of the dwelling unit in sq.m:

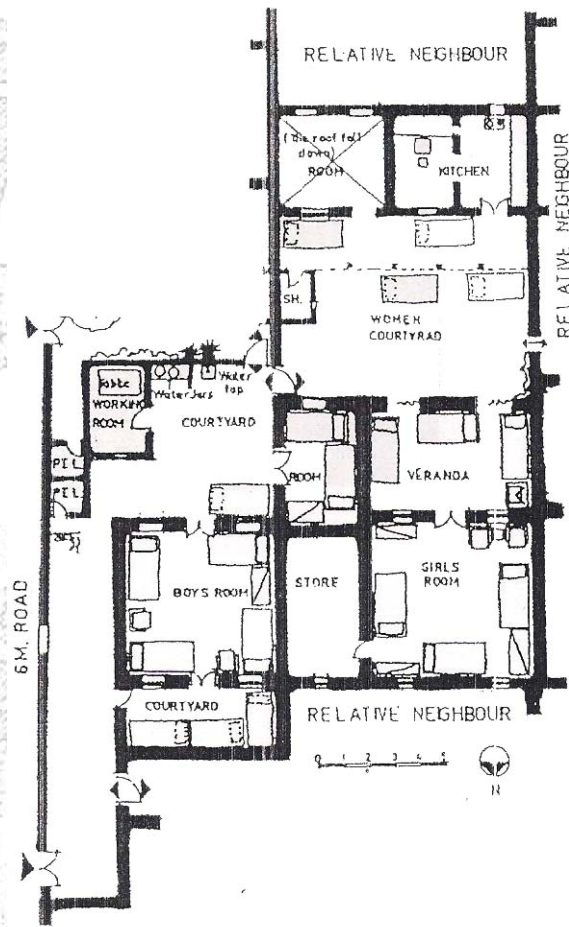
Plot area=281m²

Built up area =172m²

Courtyards= 109 m²

Construction:

The walls are 40-50 cm mud bricks plastered with Zeybala. Wooden doors and windows. The floors are padded earth. The roof is balady,



Fahiema dwelling unit

The house design is very complicated.

There are many entrances to the house, as the house is separated into 3 different areas, one for the males, one for the females, and the last area is the services having a kitchen and the storage area.

The house has areas which are well ventilated and other areas which are not at all ventilated.

On the basis of privacy, there are many entrances, 2 to the house, and many between the 3 zones. And not all rooms have the same privacy level. Also the presence of rooms which have 2 entrances.

CHAPTER 3

Project Study

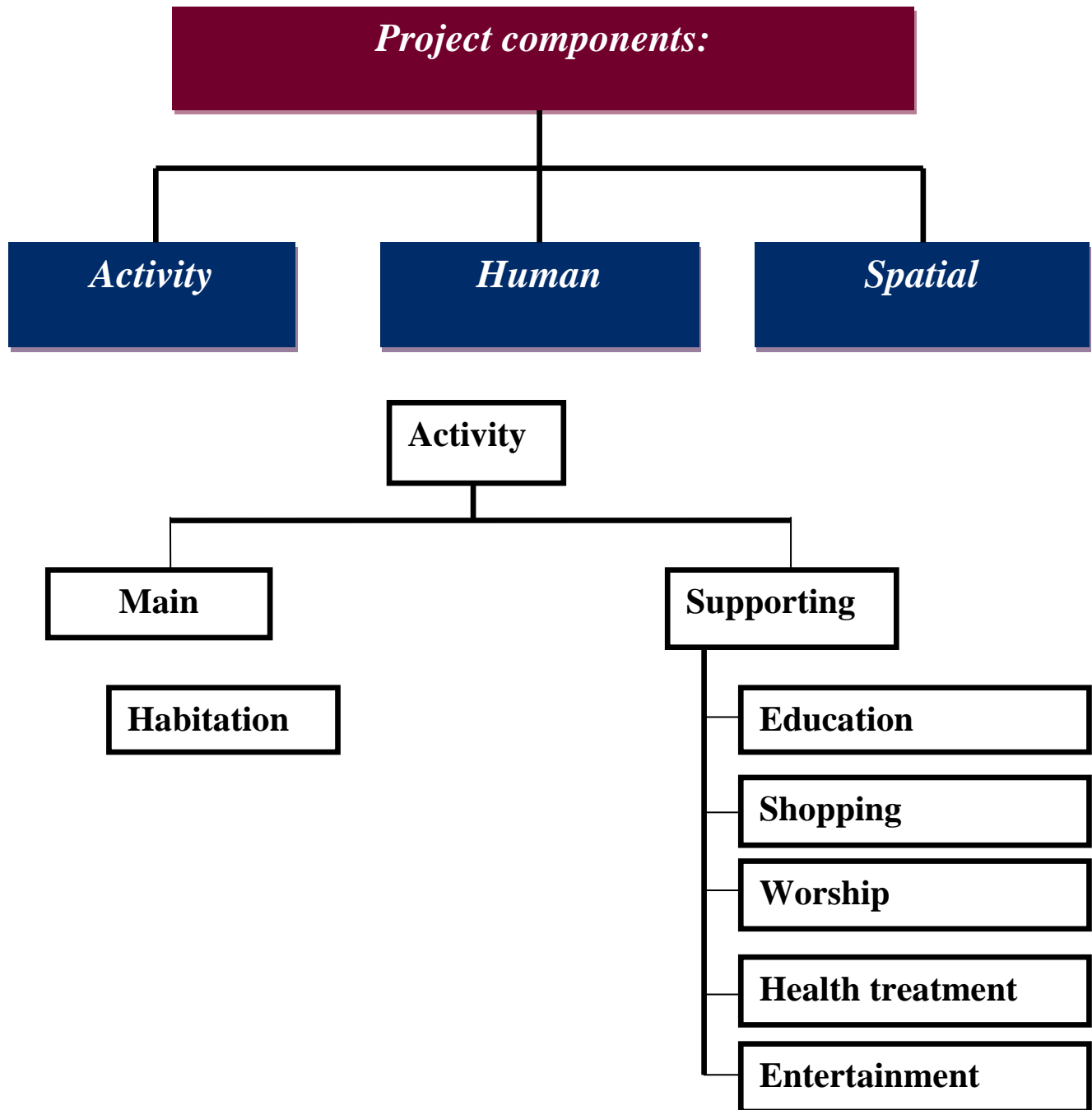
- **Project components**
- **Components of a residential neighbourhood**
- **Services**
- **Activities table**
- **Functional relationship diagrams**
- **Site study**
- **Zoning**

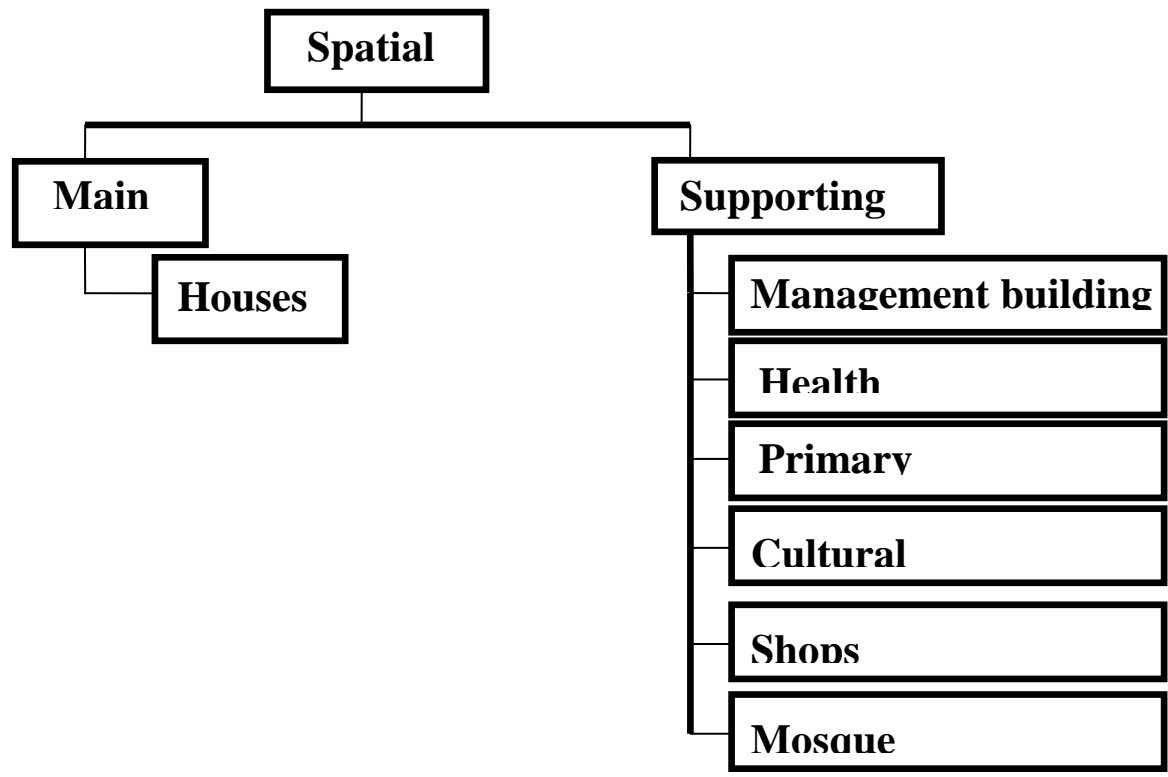
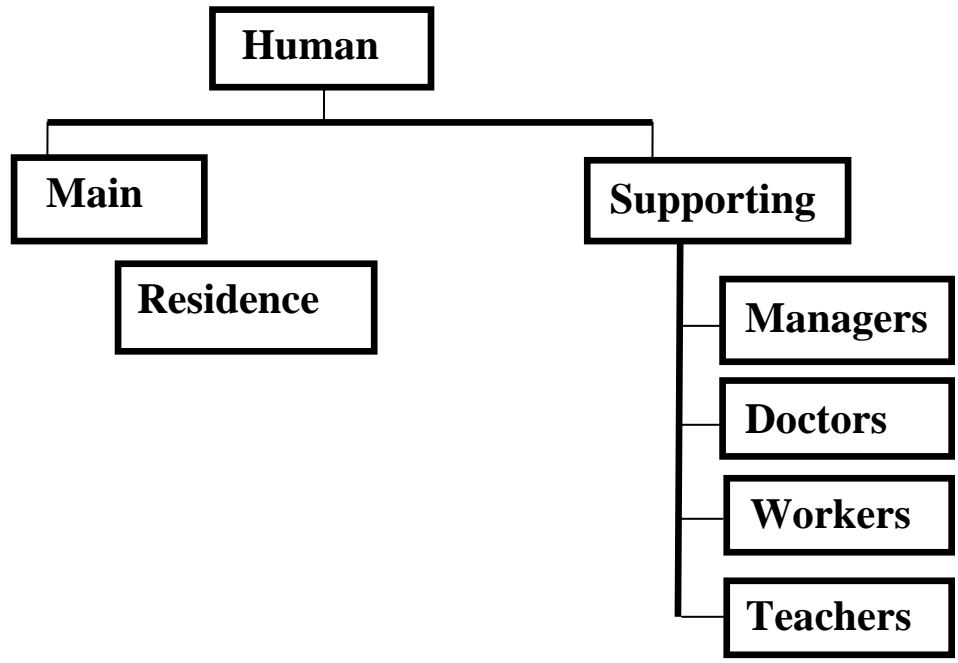
3.1 Project components:

The project composes mainly of two parts:

1/ residential houses

2/ services to those houses and the neighboring areas





3.1.1 Components of a residential neighbourhood:

- Houses
- Educational services : kindergarten + primary school
- Health centre
- Commercial/trade services
- Religious services
- Green areas

3.1.2 Movement and paths inside the neighbourhood:

1/ pedestrian path :

- Maximum lengths = 500m
- In straight lines
- Maximum slope = 10%
- Providing seating areas every 20m

2/ bicycle path:

- By the pedestrian walks sides or parallel to it
- Minimum width = 1.65m
- Maximum slope = 16%
- Presence of seating areas every 60m
- Presence of ramps at change of levels

3/ car roads:

Should be as few as possible, and designed in a way where it doesn't cross path with bicycle and pedestrian path, and if it does be safe

3.1.3 Categorizing services by functions

Two types

1/ Public Services

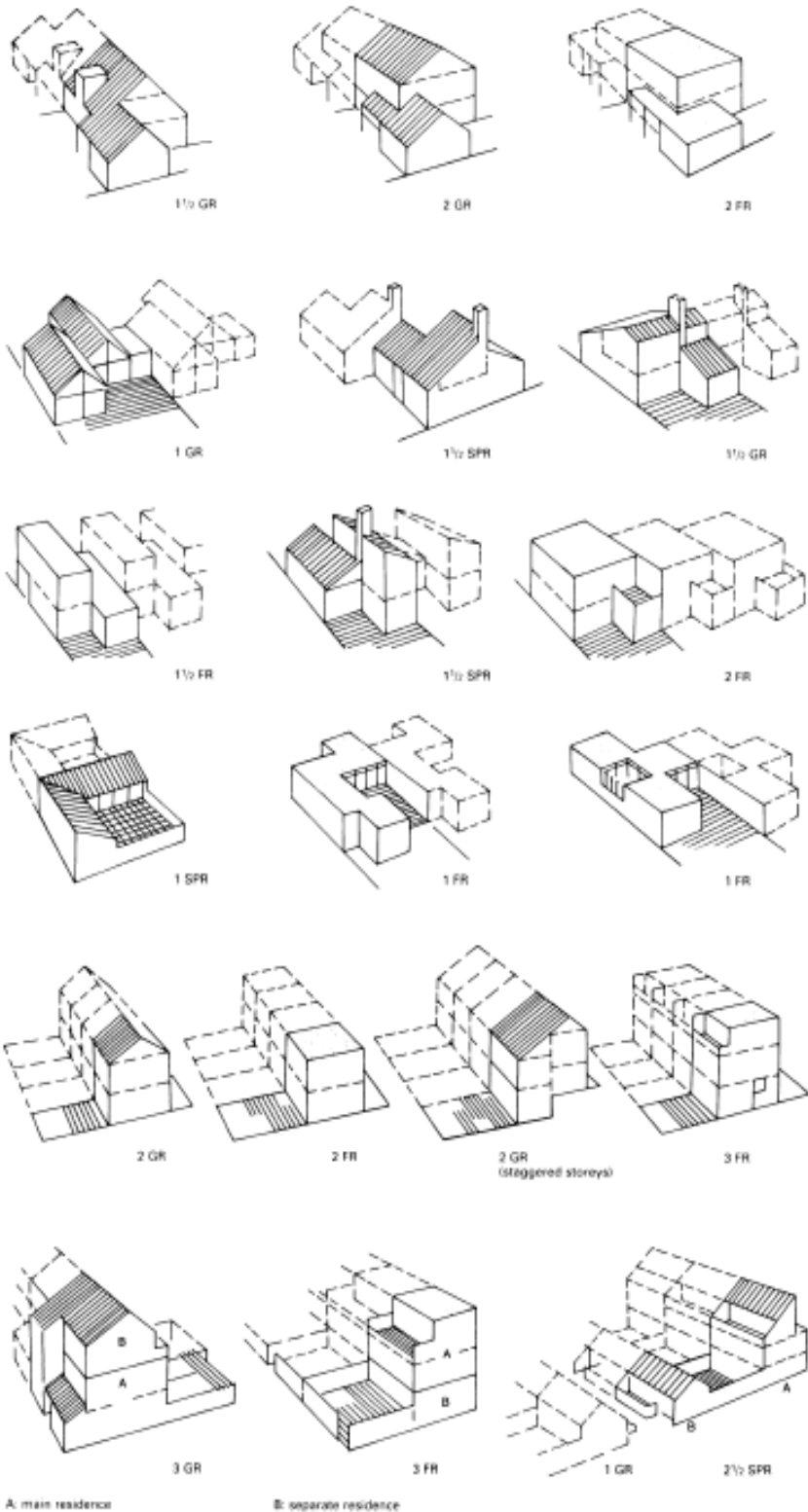
Roads, water supply, drainage services, electricity, etc. The factors that groups of buildings can't function without, therefore its called the infrastructure

2/Urban services, after housing is considered the most important factor for the houses it serves. And as the areas and nature of buildings May vary, they stay the same:

- Educational services
- Health services
- Trade services
- Green area
- Administrative services
- Cultural
- Social
- Worship

SPACE STUDY

3.1.1.1 HOUSES



3.1.1.1.1 Housing types:

1. semi-detached house:

Offers wide planning freedom and solar orientation potential. Minimum size of individual plot = 375m²

2. linked housing:

This type is economical and has space-saving benefits as well as adequate solar orientation potential. Offering high-density housing with good quality living standards, this building form is recommended. Minimum size of individual plot = 225m²

3. houses with courtyard garden:

Offers high-density housing and agreeable living quality combined with wide planning freedom. Minimum size of individual plot = 270m²

4. terraced houses:

Although they have reduced adaptability for solar orientation. This is the most economical residential form. High-density developments that offer occupants good living standard are possible with uniform plans.

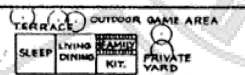
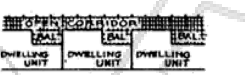

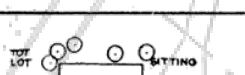
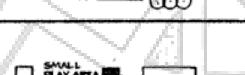
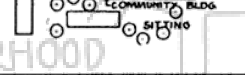
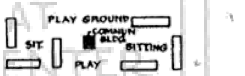

5. town houses :

High density housing for urban development using standard or individual designs.

key:
1, 1 1/2: number of storeys
GR: gable roof
SPR: single-gatch roof

SPACE STUDY

3.1.1.1.2 Summary of typical housing arrangements

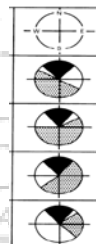
Residential Element	Area Served (radius in ft. or mi.)	Number of Families Served	Types of Open Space and Community Facilities Required	Plan Relationships
Single-family detached home	0-40 ft.	1	Patio, outdoor recreation area, family room	
Single dwelling unit in a multi-unit building	0-40 ft.	1	Terrace or balcony, open corridor, outdoor living room	
Typical floor in a multi-unit building	40-200 ft.	4-10	Enclosed play space, enclosed sitting area	
Apartment building	200-400 ft.	10-150	Outdoor areas for play and sitting, roof deck, pool, community room, tot lot	
Complex of apartment buildings or a residential block or street	400-800 ft.	30-500	Outdoor areas for play and sitting, pool or pools, small community building	
Hamlet or cluster of blocks	800-4000 ft.	90-1,500	Outdoor areas for sports, play (playground) and sitting, pool or pools, community building	
Single neighborhood	¼-½ mi.	1,000-5,000	Play field (sports), playground, sitting and picnic areas, pools, large community building	
Cluster of neighborhoods	½-2 mi.	3,000-15,000	Play fields, playgrounds, sitting and picnic areas possibly with a lake, pools, recreation and community center	

3.1.1.1.3 Housing orientation:

As a rule, sites for residential development are preferred in the areas where the winds are southern or western. This means that the houses will receive fresh air while northern and eastern dust carrying winds will be stopped before reaching those areas.

The arrangement of the houses on the site plan should have an orientation based on the path of the sun producing optimum levels of sunlight in specific parts of the dwelling at certain times of the day.

Principle use of space	Principle period of use
Living area	Afternoon to evening
Eating area/dining room	Morning to evening
Children's room	Afternoon to evening
bedroom	Night: morning sun desired



SPACE STUDY

3.1.1.1.4 HOUSE SPACES STUDY:

3.1.1.1.4.1 Kitchens:

Built - in units are generally available from 20-120cm with a height of 85 cm.

The various elements are usually assembled in a way where they cant be altered later. With worktops and storage surfaces.

The materials used in the kitchen include wood, metal, plywood, chipboard and plastic. Shelves are of wood or plastic-coated chipboard ; metal shelves are best for pots and hot pans.

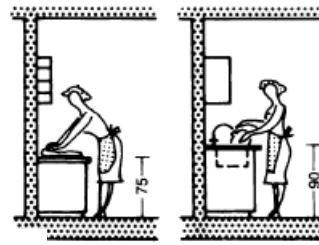
Sliding or folding doors are useful if space is restricted because they require no extra space when opened. The dimensions of the built-in units are taken into consideration when designing the layout and storage areas of a space- efficient kitchen.

Provide sufficient shock-proof sockets : a minimum of one double socket for each working and preparation area.

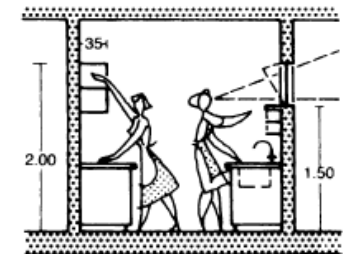
Kitchens should face east of west and be adjacent to any vegetable / herb garden and cellar. Ideally the kitchen should look out on the garden gate, house door , children's play area and the patio. They should be well located with respect to the pantry. Dining room and utility room.

Good lighting of the work surfaces is another essential provision. An appropriate arrangement in the kitchen to ease work would be , from left to right ; storage surface, cooker, preparation area, sink, drainage surface.

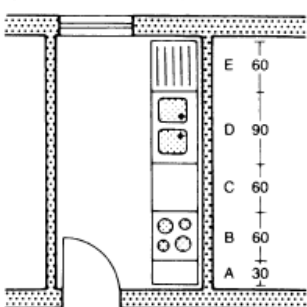
A width between the sides of 1.20 m essential door free movement and using of appliances and fittings. With a depth of each side of 60cm that gives a minimum kitchen width of 2.40m.



Normal table height of 85 cm lies between the best heights for baking and dish-washing

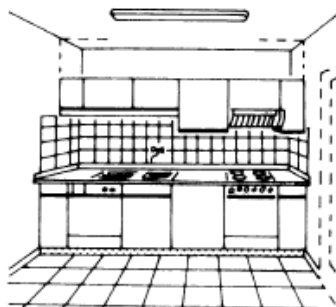


Worktops and storage 60cm deep

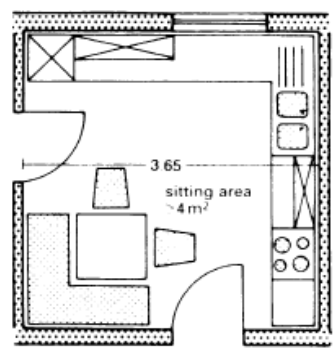


A - storage surface - 30 B - cooker 60 C - storage surface - 60 D - sink (according to maker) E - standing/drainage surface

One-sided kitchen

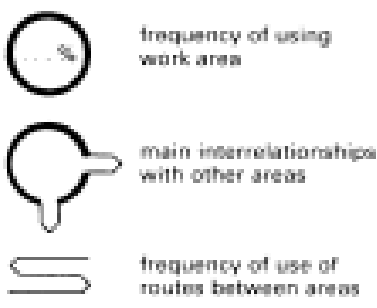
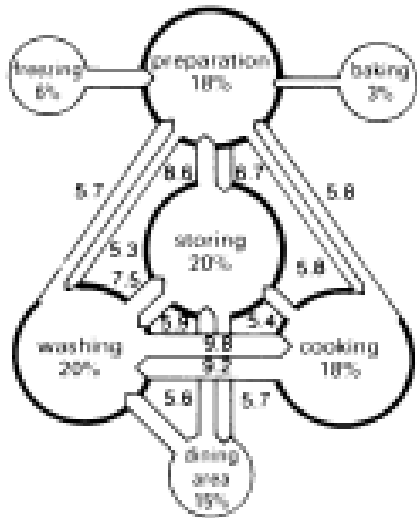


Perspective view of one-sided kitchen



L-shaped kitchen with dining area

SPACE STUDY

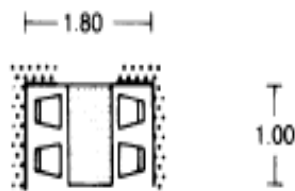


Use of kitchen areas

3.1.1.1.4.2 Dining rooms:

It is often desirable to have spaces in the kitchen for eating snacks, breakfast etc. this can be provided by including a retractable table with a height of 70-75cm. a movement area of atleast 80cm is required at the left and right side of the table

number of diners	width (cm)	depth (cm)	space required (m ²)
four people		≥ 130	2.6
five people		≥ 180	3.8
six people	≥ 180	≥ 195	3.9
seven people		≥ 245	5.1
eight people		≥ 260	5.2

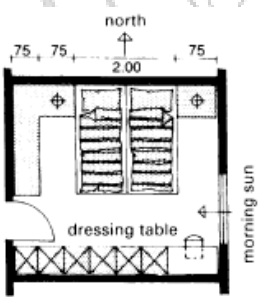


Smallest space for dining table and recess

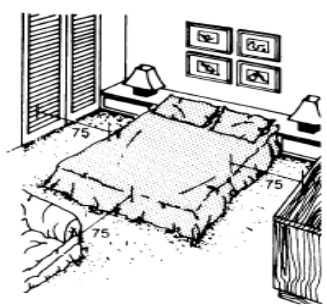
$$\text{Ø round table} = \frac{\text{seat width (m)} \times \text{number of people}}{3.142}$$

3.1.1.1.4.3 Bedrooms :

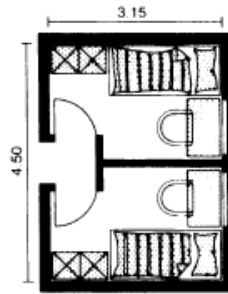
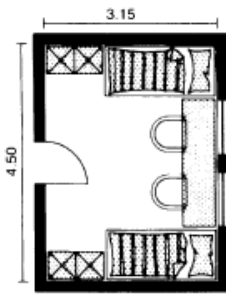
To ensure comfort while sleeping , the bed length should be 250 mm longer than the individuals height. The bedroom layout should have 750mm around the bed.



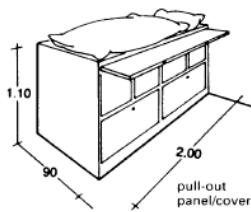
Bedroom with space for dressing table and side cupboard



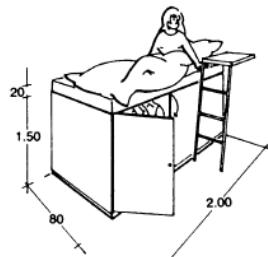
About 1m of cupboard length should be planned per person.



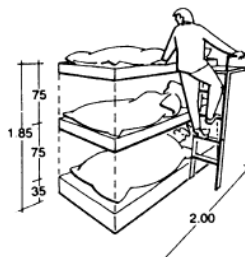
Bunk beds and units



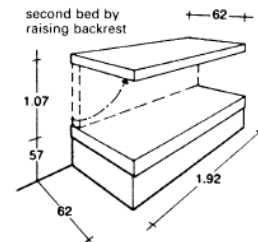
Bed on cupboard unit



Bed on cupboard for small rooms, ships' cabins etc.



Bunk for railway sleeping cars, holiday homes etc.



Pullman bed for caravans and railway sleeping cars

3.1.1.1.4.4 Bathrooms :

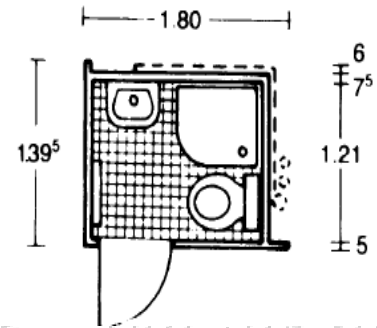
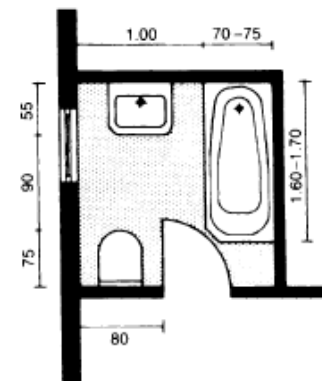
Location:

The most convenient location for the bathroom is adjacent to the bedrooms (and the WC if it is not incorporated in the bathroom itself). Although showers are compact and offer preferred by young people, baths are generally more suitable for the elderly.

Connections can be provided in the bathroom for washing machines and laundry baskets.

Bathrooms with WCs are self-contained rooms which are equipped with all the fittings necessary to meet the sanitary needs of the occupants. However the plan should ideally include two separate lockable rooms for the bathroom and WC which is essential for dwellings for more than 5 people.

A bathtub and/or shower tray plus a wash-basin are installed in the bathroom. While a flushing toilet, bidet and hand washing basin are installed in the WC.



SPACE STUDY

For cost efficiency and technical reasons the bathroom , WC and kitchen should be planned such that they share the same ducts.

The bathroom and WC should be oriented towards the east, and should normally be naturally lit and ventilated. A temperature of 20 degrees C is suitable for WCs at home. And a bathroom temperature of about 22-24 degrees C is about right.

Bathrooms are particularly susceptible to damp so appropriate sealing must be provided. Surfaces must be easy to clean because of high air humidity and condensation. And the wall and ceiling plaster must be able to withstand the conditions.

At least one sealed electrical socket should be provided at a height of 1.30 m for electrical equipment.

3.1.1.1.4.5 House total area:

	Section	Spatial component	No. of spaces	Spaces of different units	Total area
Housing	Living	Living area	1	56	56
	cooking+ dining	Kitchen + dining area	1	14	14
	Sleeping	Bedroom	1	15.3	15.3
			2	14.2	28.4
	Bathing	Bathroom	1	3.7	3.7
			2	2.1	4.2
Total area= 122 m2					

Total no of houses =

Total no. of houses destroyed= 2,823 houses

Low income percentage in the area=35.1%

Therefore: . 35% of 2,823= 988 houses

As to the department of planning and architecture minimum house plot area should be 200 m2,

There are 3 types of houses, each housing different number of members,

SPACE STUDY

The houses are divided into 3 classes:

- 1st class type has an area of $14 * 18m = 252m^2$
- 2nd class has an area of $15 * 15 m = 225m^2$
- 3rd class type has an area of $12 * 17 m = 204m^2$

Total number of houses = $988/3 = 329.3$

$329.3 * 252 = 82992 m^2$

$329.3 * 225 = 74092.5 m^2$

$329.3 * 204 = 67177.2 m^2$

Therefore, total area = $224261.7 m^2$

Considering a 4% growth rate per year over the next 10 years, increase in number of houses equals + 396 houses

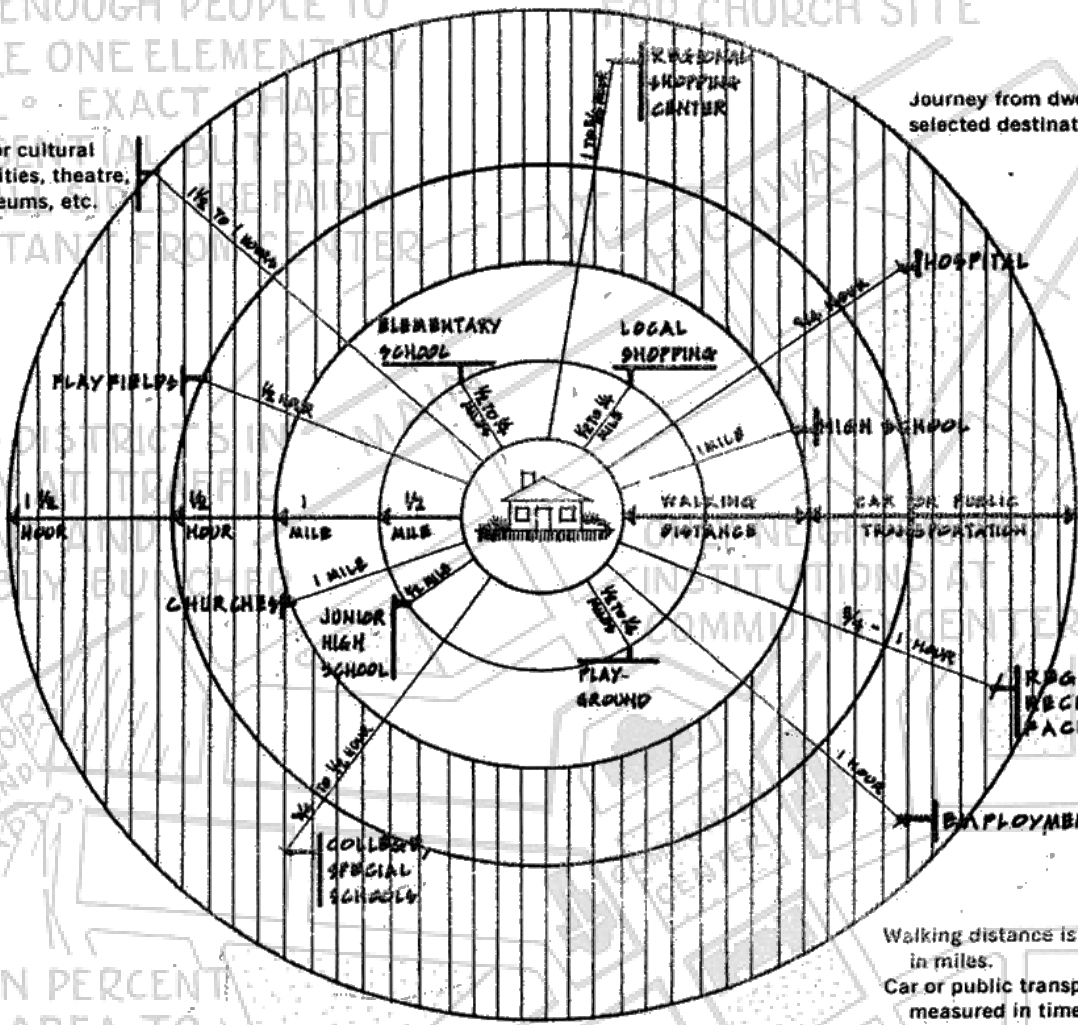
Having an area of $89704.68 m^2$

Total area = $224261.7 + 89704.68 = 313966.38 m^2 = 31$ hectares



SPACE STUDY

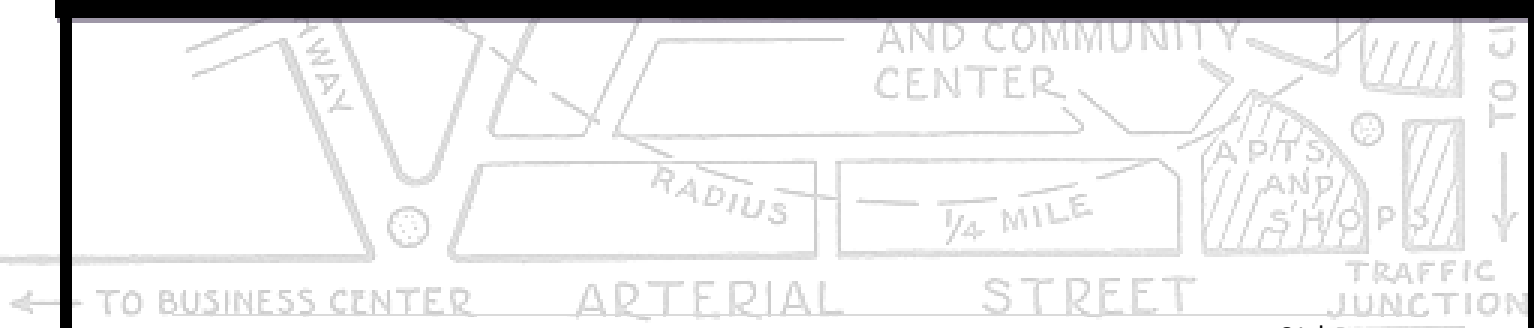
Major cultural facilities, theatre, museums, etc.



Journey from dwelling unit to selected destinations.

Walking distance is measured in miles.
Car or public transportation is measured in time.

3.1.3.2 Serving radius



3.1.3.3 Health services:

3.1.3.3.1 Health centre:

- Services around 5000 individual
- Includes health clinics, prevention areas, mother and child care, specialized health clinics
- Services an area of radius 1000m
- Services a residential neighbourhood

3.1.3.3.2 Site location principles:

- Should be reached easily and quickly
- Providing an area for future expansion
- Providing enough parking lot
- Providing multiple entrances for ease of movement
- Away from pollution sites

Space of individual in various health practices= 0.6 m²
 Total number of individuals = 6916
 Total area =4149.6 m²/ 0.4 hectares

3.1.3.4 Commercial areas :

- Placed next to other public services in the neighbourhood
- Maximum slope = 5%
- Connected to the main streets and transportation services
- Separations of product supply roads, car movement and pedestrian walks
- Providing enough parking lots
- Usually takes 15% of total services area

Types of commercial shop	For every 1000 individual		
	Number	Space of one store / m ²	Total area/ m ²
Fruits + vegetables	2	50	100
Grocery + bakery + pharmacy	0.7	50	35
Services (plumber. Carpenter etc).	1.5	40	60

No. of individuals ~ 7000
 Total area of shops per a 1000 individual = 100+35+60= 195 m²
 Total area For 7000 individuals = 195*7 =1365 m²/0.1 hectare

3.1.3.5 Educational

3.1.3.5.1/ kindergarten – serves age group of 45days- 4yrs

5.8%of the total population. Its presence depends on the no. of families in need of its service, the space between the two should not be more than 500m, and from the house shouldn't be more than 300m. A distance the child can walk without being tired. The kindergarten is connected to the house by a pedestrian pathway for traffic movement, and can also be reached from various roads.

Space depends on the no. of kids and the total area is 1.5% from the total neighbourhood

No . of kids = $0.12 * 6916 = 830$ kids

Area per kid = $3m^2$

Total area= $3 * 401 = 2490m^2 / 0.25$ hectare

3.1.3.5.2/ Primary school – Age group 6-12

Area depends on the population of the neighbourhood or the area its serving, about 2000-8000 individuals, this determines the no. of

classes, where each class student exceed 32students. Area of individual in school = $10m^2$, Including classes, play areas, paths, other built areas & empty spaces. Area of school of school can also be calculated by taking $9-12m^2$ per family in the neighbourhood

- School is to be placed in a quite area , next to the services centre & can be reached by path by feet without crossing any streets & if streets are a must they should be local & slow
- Schools should have parking lots
- Walking distance = 300m, max 500m

3.1.3.5.2.1 General principles of school

- Site should be appropriate for various school functions, Classes, labs, management, play areas in both shape & area.
- Walking distance to the site should be suitable for all houses & streets should be safe
- The site should be away from pollution areas or other activities that create noises

$\% \text{ of kids} = 13.5 + 12.7 = 26.2\%$

Total no. of kids = $0.26 * 6919 = 1813$

Area per kid = 10 m^2

Total area = $1813 * 10 = 18130 \text{ m}^2 / 1.8$
hectare

3.1.3.6 Green areas :

3.1.3.6.1 Types of green areas:

➤ *Open areas* - usually available for different entertainment functions + garden

➤ *Local green areas* , serving 3000 individual. Usually used for kids play areas, playgrounds and it's for a residential neighbourhood

➤ *Green areas between groups of buildings*, mainly used for children play areas, family sitting area, and placed in areas where servicing radius is $1/2 \text{ km}$

Kids play area = $1 \text{ m}^2/\text{individual}$

Sports areas = $13 \text{ m}^2/\text{individual}$

Small gardens = $10 \text{ m}^2/\text{individual}$

Public gardens = $16 \text{ m}^2/\text{individual}$

Total area per individual = 40 m^2

For residential neighbourhoods - the local park should have a minimum area of 5 acres, and serves 800m

3.1.3.6.2 Planning principles:

➤ *Used as an area between various functions*

➤ *Should be connected with each other*

➤ *Small areas to be provided inside the residential area providing a safe path for kids*

➤ *Large parks and play areas should be placed in the centre of the neighbourhood*

➤ *Medium size gardens with play fields to be placed in areas close to schools, to be used by it*

Area per individual = 40 m^2

Total no. of individual = 6919

Total area = $40 * 6919 = 276640 \text{ m}^2 / 27.6$
hectares

3.1.3.7 Religious services :

3.1.3.7.1 Mosque :

3.1.3.7.2 Principles of site location:

- Should be visible from all areas and angles., and buildings around it are not to be high
- Providing 3 entrances: males, females, wado'a area
- Surrounded by green areas
- Enough parking lot around it
- Close to commercial area

Type of mosque : local

Servicing area: residential neighbourhood

No of individuals served : 5000

No of praying people : 800

Walking distance / m : 300-400

Services available : wado'a area, imam room. Store

Parking area/ m²=500

Services area : praying area = 20%

Services area/m²= 100

Total area = 600m²

Area of individuals in the mosque (m²/ individual): 0.12

Area of single praying person to the total mosque area = 1.2 m²

Total no of individuals = 6916

Per 5000 , area = 600m²

Therefore. Per 6919 individual = 829.92 m²/0.083 hectares

Area of individual =2.5m²

Total area = 6916*2.5=34580m²/ 3.4 hectare

3.1.4 Total areas:

Areas :

Houses = 31 hectares

Health centre= 0.4 hectares

Kindergarten=0.25 hectare

Primary school=1.8 hectare

Commercial areas= 0.1 hectare



























































Green areas=27.6 hectares

Mosque= 0.083 hectares

Social centre= 3.4 hectare

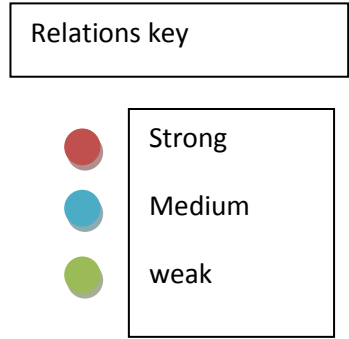
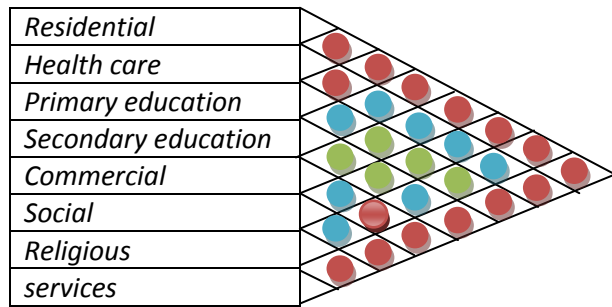
Total area : 65 hectares

ACTIVITIES TABLE

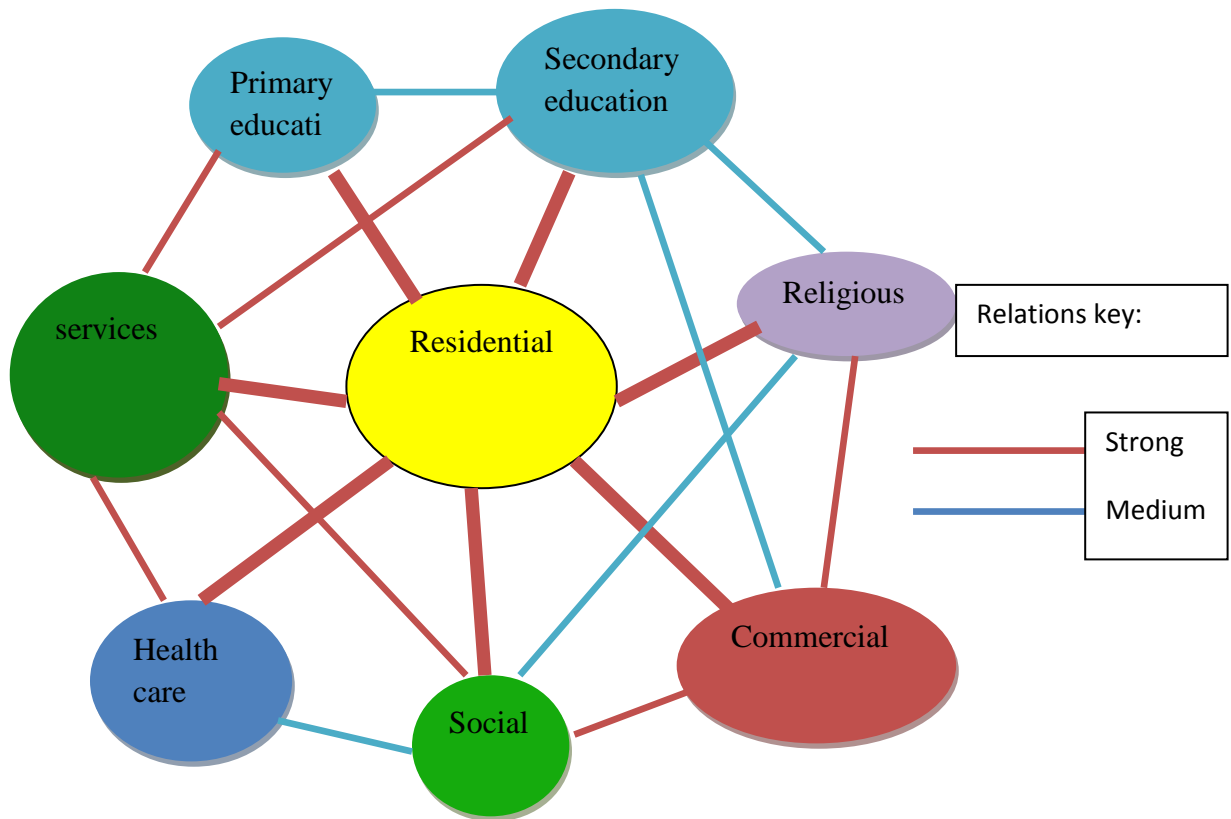
Main activity	Activity done	Functional requirement	Ecological requirement				No.of users	Time of use
			Natural ventilation	Artificial ventilation	Natural lighting	Artificial lighting		
Housing (a single family)	living	Sofas, tables.					7	6am-12pm
	sleeping	Beds, tables, closets					2	24 hours
	cooking	storage surface, cooker, preparation area, sink, drainage surface.					2	6am-12pm
	dining	Dining table					4	Meals time
	bathing	Toilet, washing basin, shower					2-3	24 hours
Education (per class)	Primary learning	Tables, chairs, beds					20	7am-12 pm
	Secondary learning	Tables, chairs					30	7am-2pm
Health care	Treatment	Beds, Chairs. Desks					-	8am-5pm 7pm-10pm
	Diagnosis	Beds, Chairs. Desks. X-ray machine. Ultra sound machine	-		-		-	8am-5pm 7pm-10pm
	prevention	Beds, Chairs. Desks					-	8am-5pm
shopping	Grocery shopping	Shelves, refrigerators					-	7am-11pm
	Clothes shopping	shelves					-	9am-11pm
social	gathering	Couches..					-	9am-11pm
worship	praying	Praying mat					800	Prayer times
	reading	Mats					800	5am-10pm

FUNCTIONAL RELATIONSHIP DIAGRAMS

3.3.1 Matrix diagram

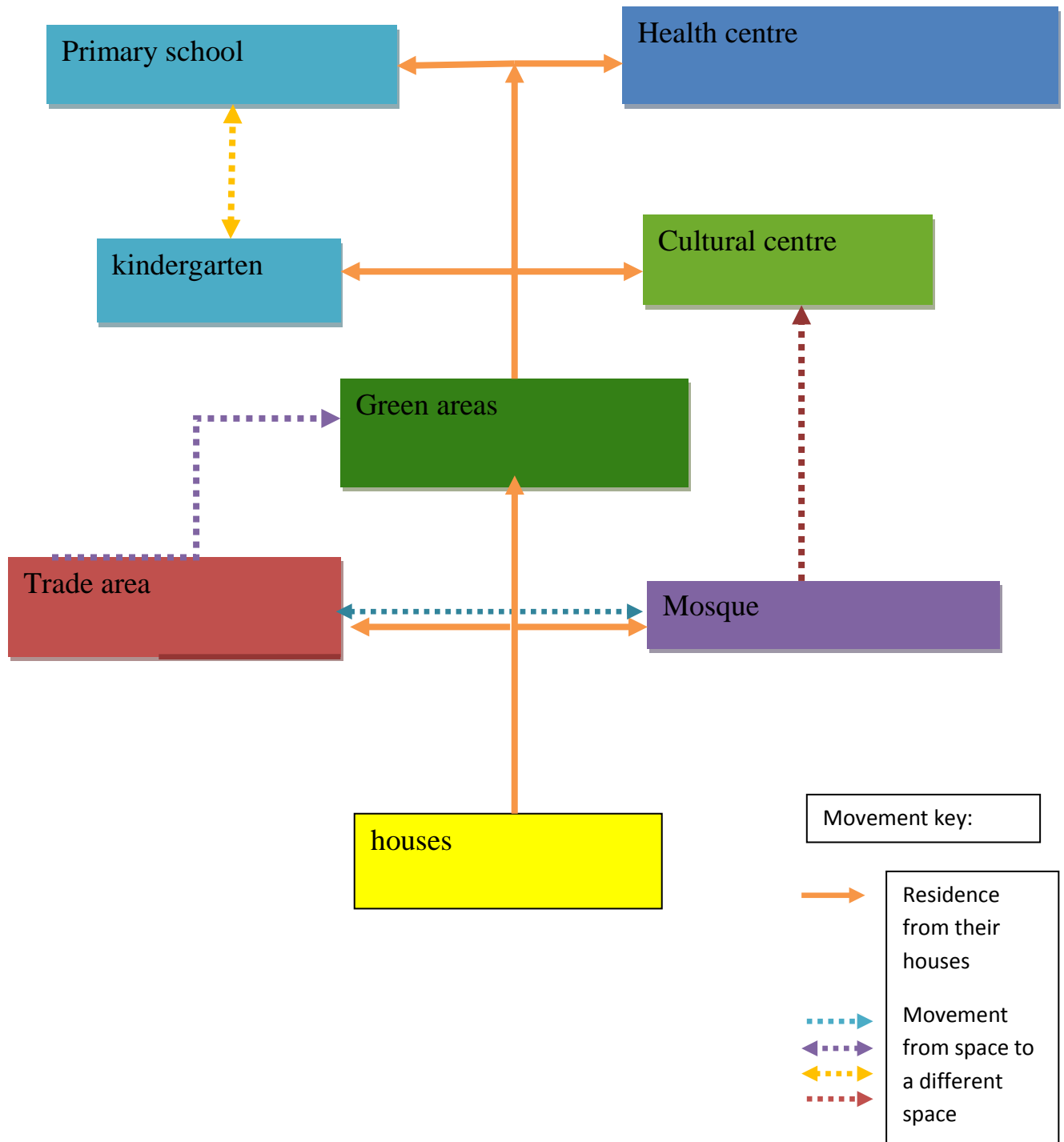


3.3.2 Bubble diagram



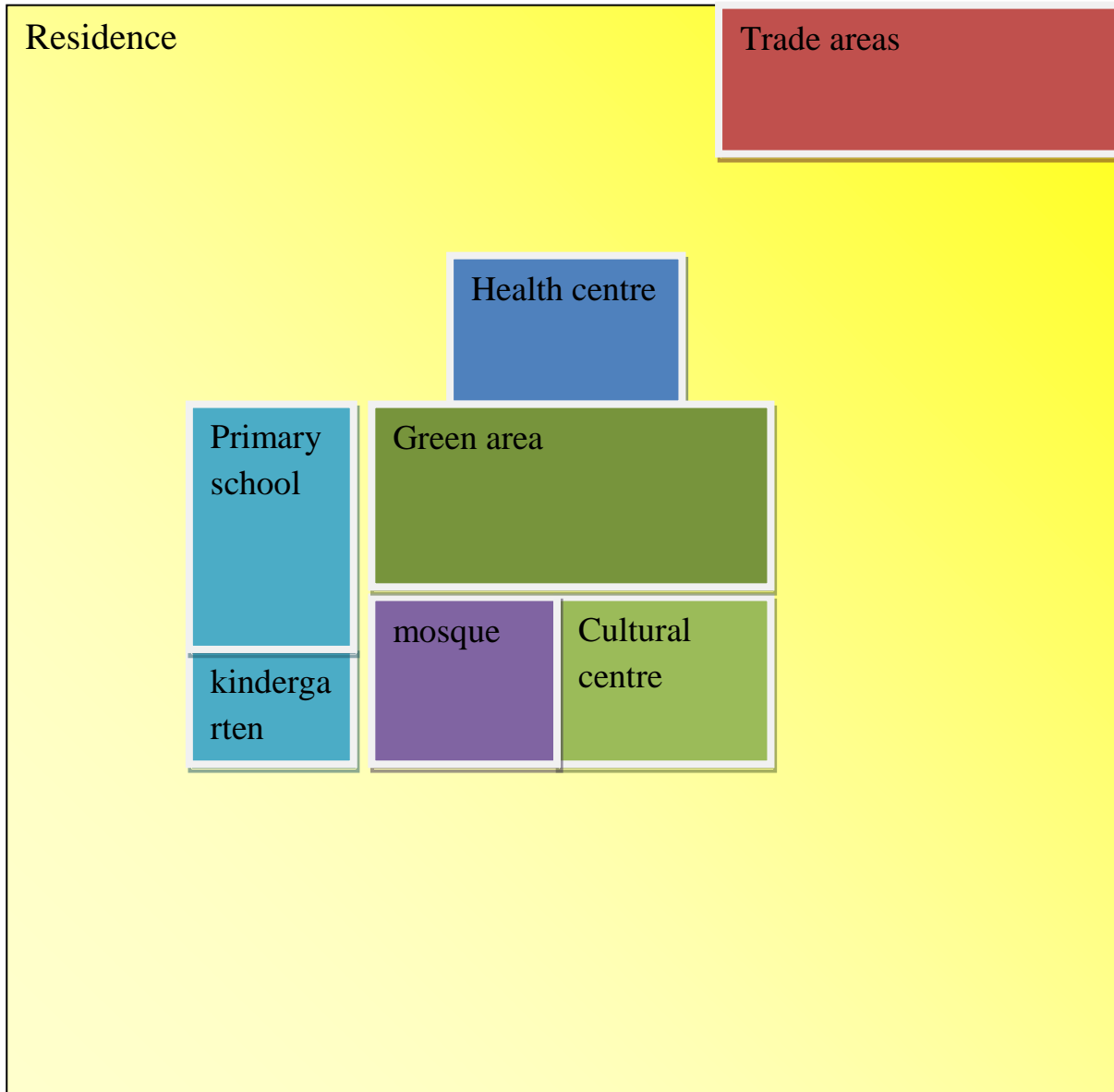
FUNCTIONAL RELATIONSHIP DIAGRAMS

3.3.3 General movement diagram



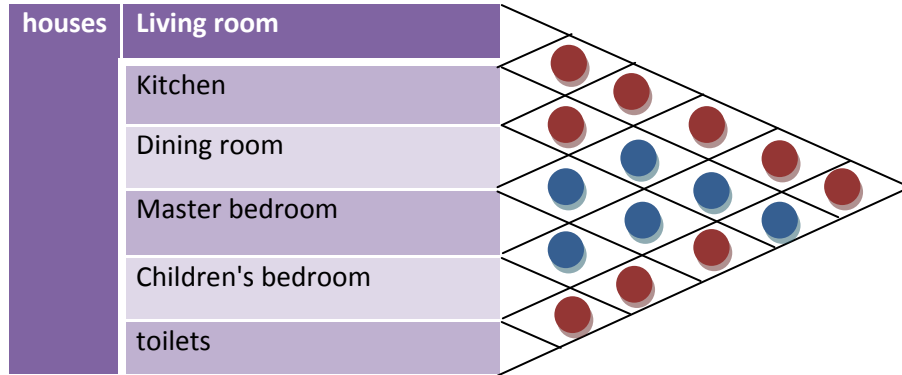
FUNCTIONAL RELATIONSHIP DIAGRAMS

3.3.4 General adjacency diagram :



RESIDENTIAL FUNCTIONAL RELATIONSHIP DIAGRAMS

3.3.5 Matrix diagram



Relations key

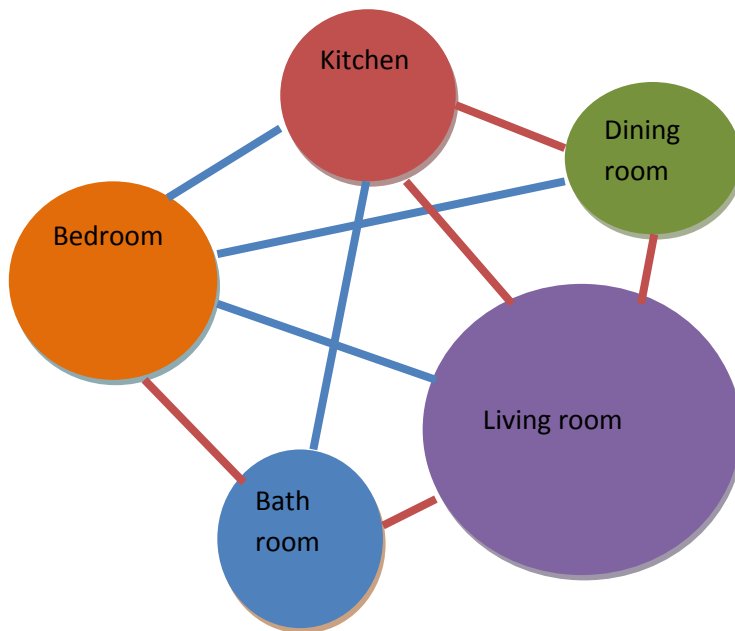


Strong



medium

3.3.6 Bubble diagram



Relations key:



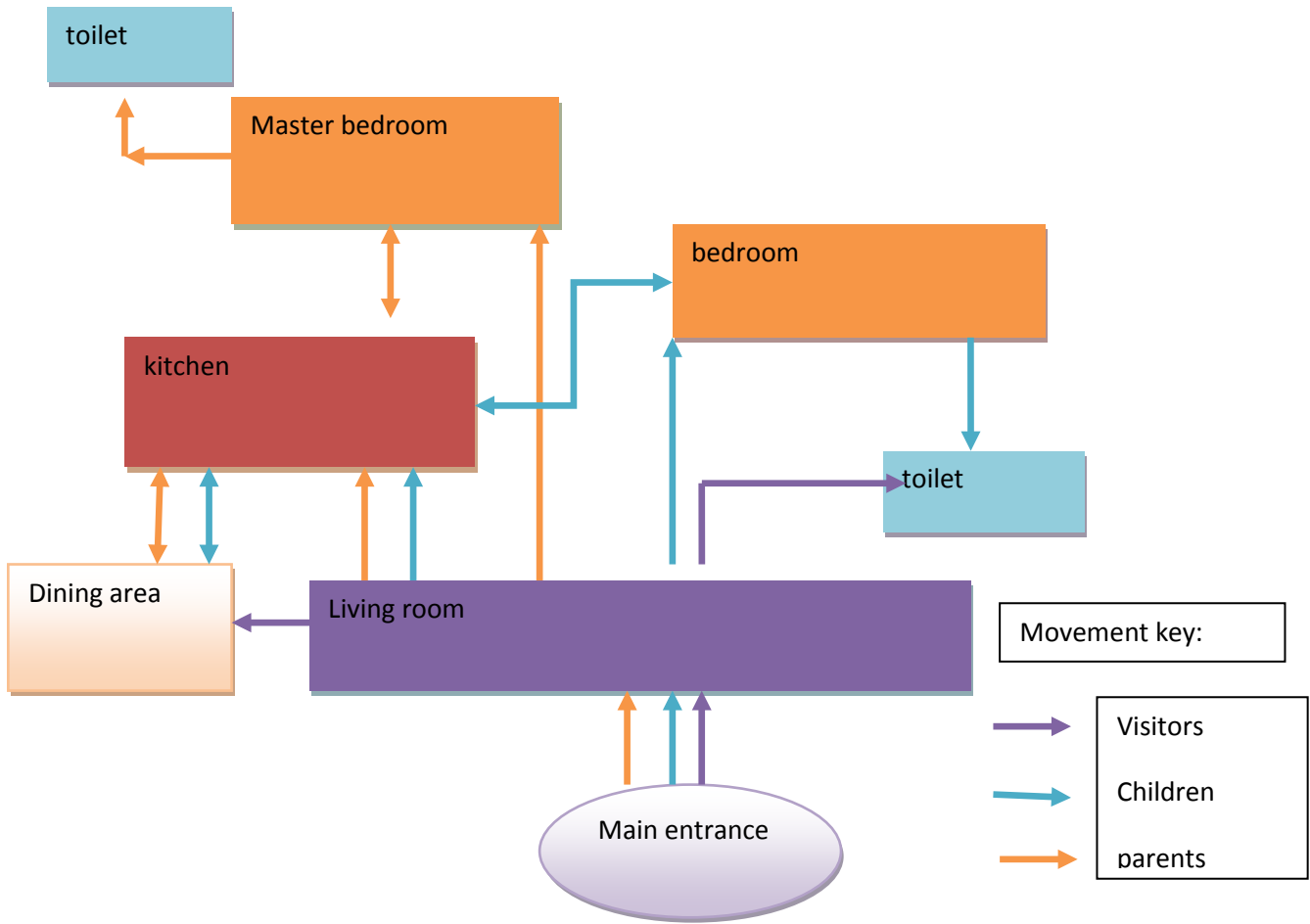
Strong



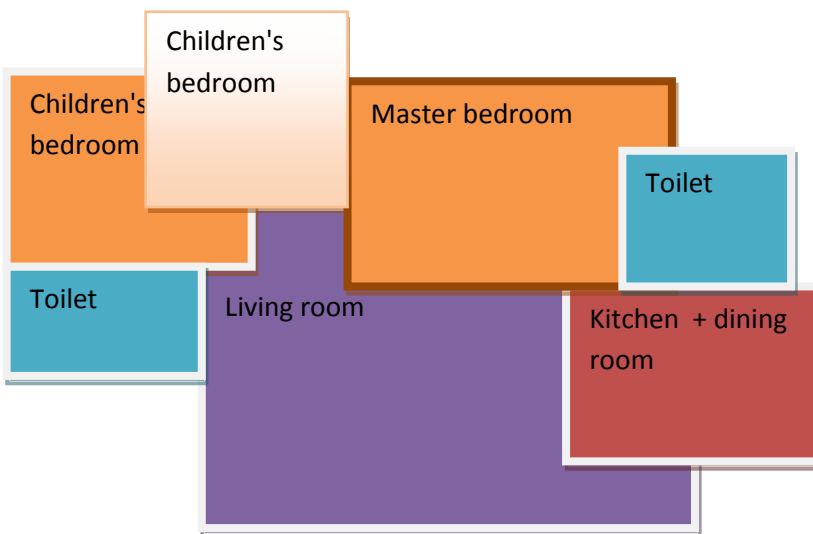
medium

RESIDENTIAL FUNCTIONAL RELATIONSHIP DIAGRAMS

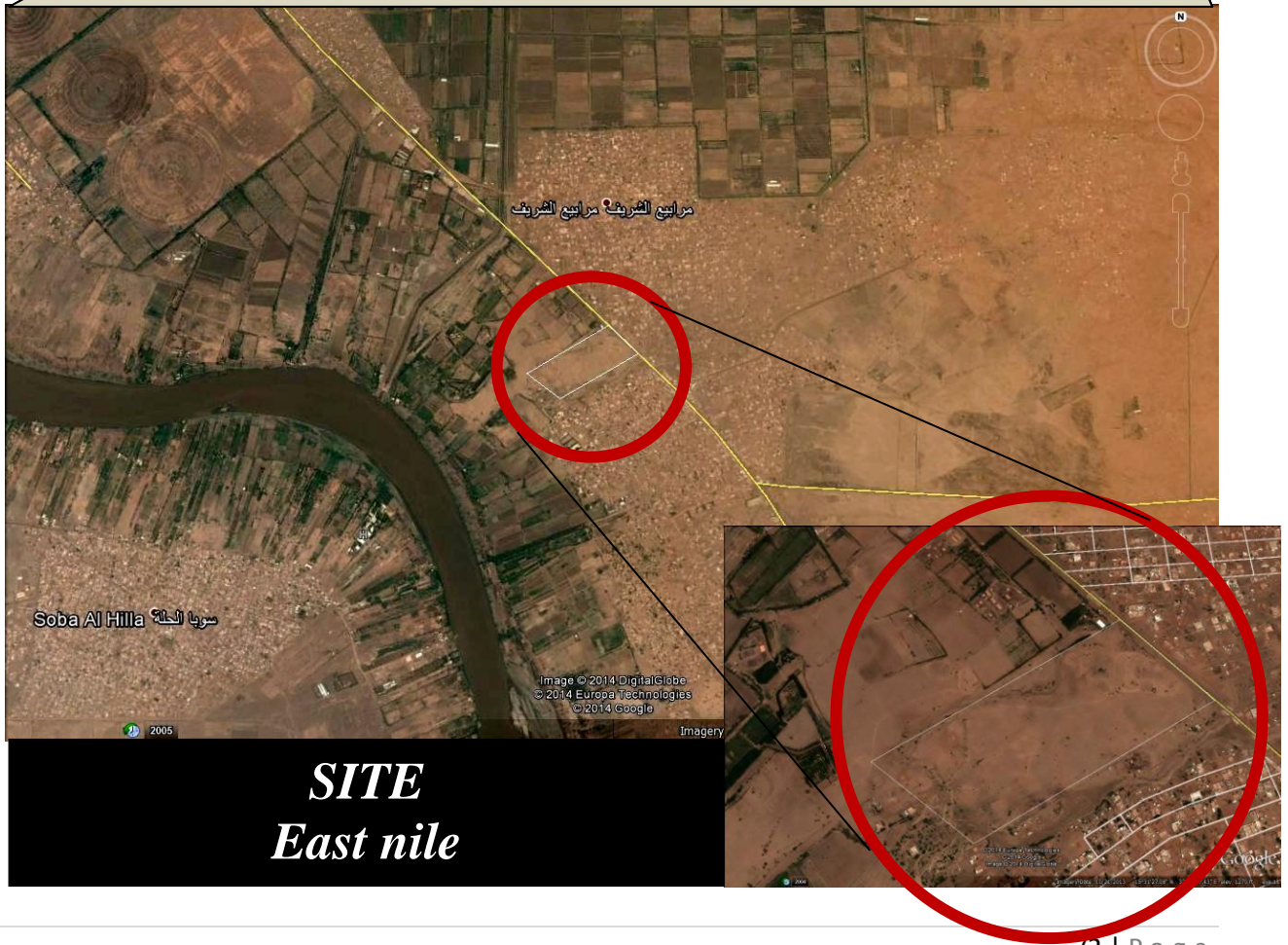
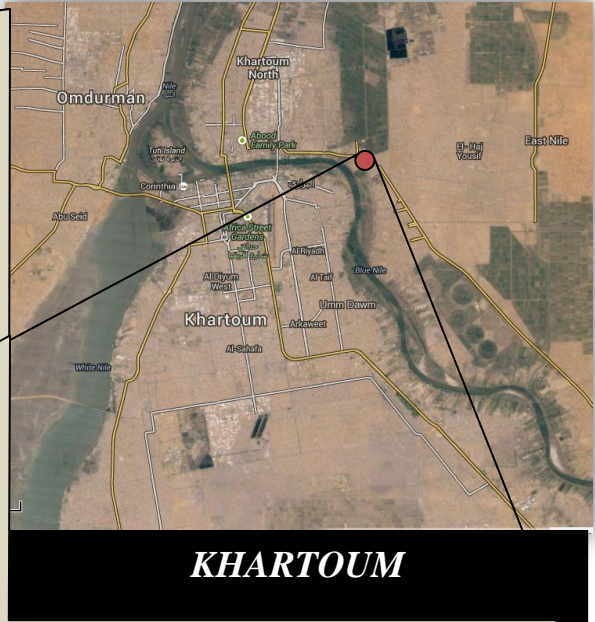
3.3.7 Movement diagram:



3.3.8 Adjacency diagram



3.4.1 SITE LOCATION

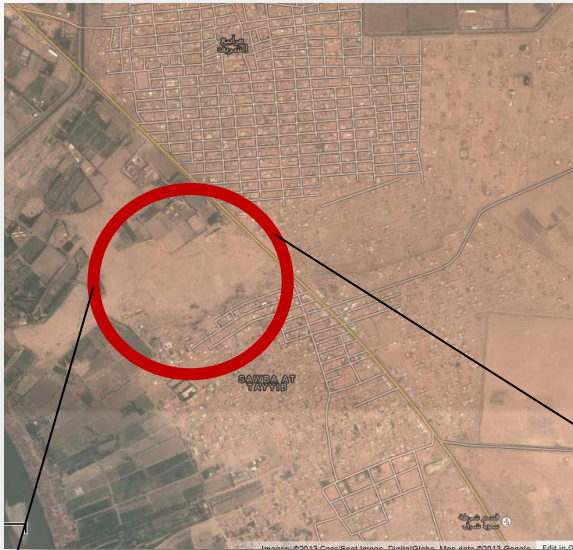


3.4.1 SITE LOCATION

The site lies in Soba Al Tayib area, East Nile Locality, Khartoum State .

The site is surrounded by residential areas to the east and southern side, and by farms to the north and western side.

A main road, Al Ghazafi road, lies to the eastern side of the site.



3.4.1.1 Reasons for choosing the site:

- Availability of services (electricity and water supply, public transportation by the main road etc)
- Good orientation
- Suitable for residential neighbourhood, as to its surroundings
- Close to the area where people lost their houses

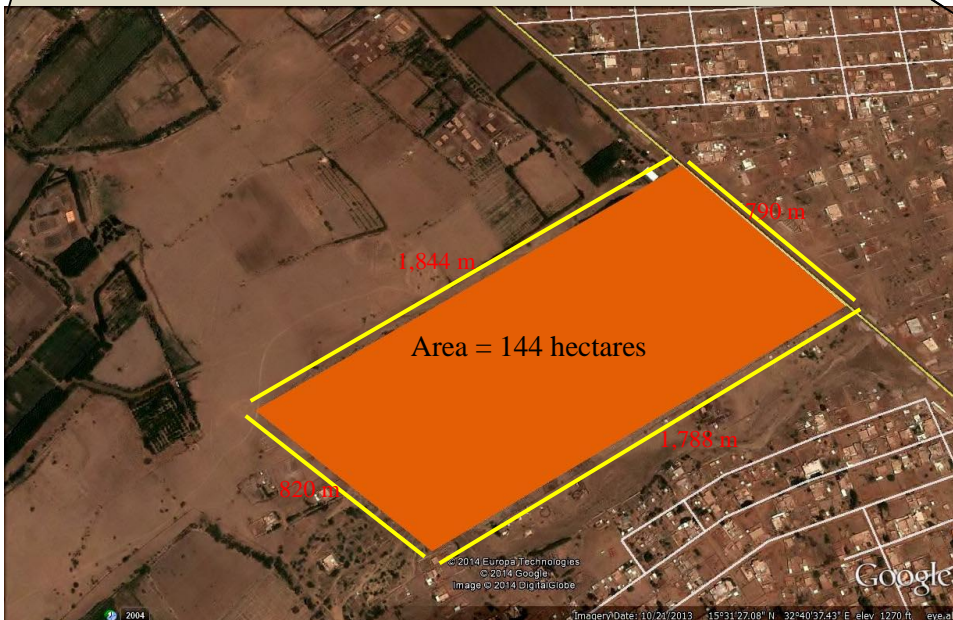
3.4.1.2 Reaching the site :

*From Khartoum and Bahri ,
from the main bus stations*

Khartoum : Al Arabi

*Bahri : Central station, take Al
Aylafoon transportation.*

*From Omdurman main bus
station, ride to Bahri or
Khartoum's main stations then
ride the bus heading to Al
Aylafoon .*



The site lies in an area where the soil is best suitable for agriculture, the soil is not leveled.

The site has different contours in it, sloping down from the south west corner to the north east corner. These contours are basically caused by sands and rocks, the highest point levels up to .70 m, and the lowest point is in level with the street.

3.4.2 SITE STUDY:

3.4.2.1 Climate factors :

Climate is the most important natural environment factor, and has a great effect on the distribution of plants, animals and humans on the earth surface.

As the study of terrain, Geology, soil , underground water , plants, natural hazards such as floods, streams, earth quakes, local climatic factors , study of natural view.

3.4.2.1.1 Factors affecting climate:

- Latitude and longitude*
- Distribution of sand and water*
- Terrain*
- Streams*
- Wind direction*

3.4.2.2 Environmental study:

The natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species.

The natural environment is contrasted with the built environment, which comprises the areas and components that are strongly influenced by humans. A geographical area is regarded as a natural environment.

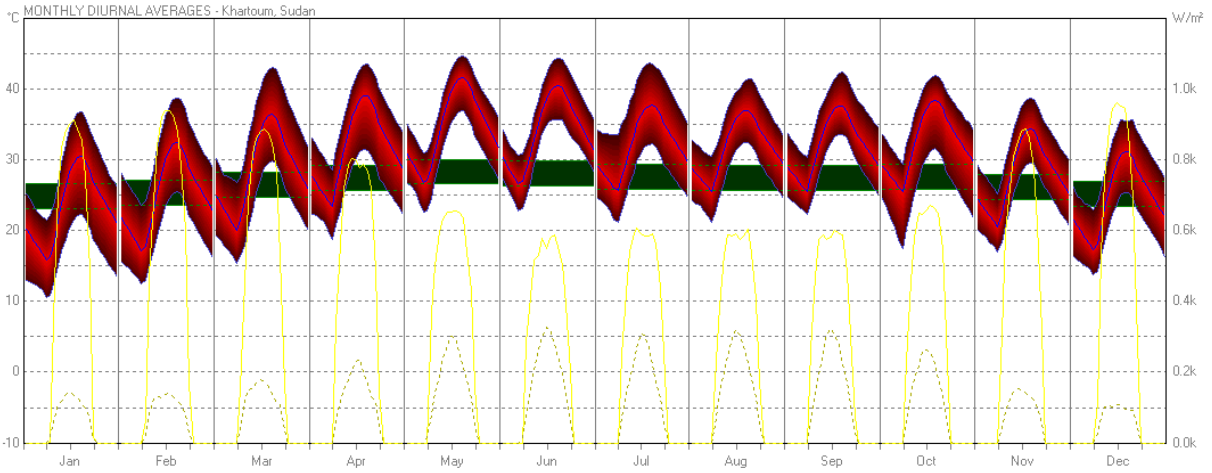
The climate of the area is hot dessert climate, extremely hot in summer , warm in winter.

3.4.2.2.1/ TEMPERATURE:




Temperature is considered the most important factor of the climatic conditions, as it affects the human life and the human activities, and also affects the other climate factors , as its increase in an area and decrease in another affects the air pressure thus affects the air movement, and also has a great effect on the rainfall as it affects the evaporation and humidity. It also affects the planning process as it influences the type of materials used in the building process, building type, types of planting. Etc.

SITE STUDY:

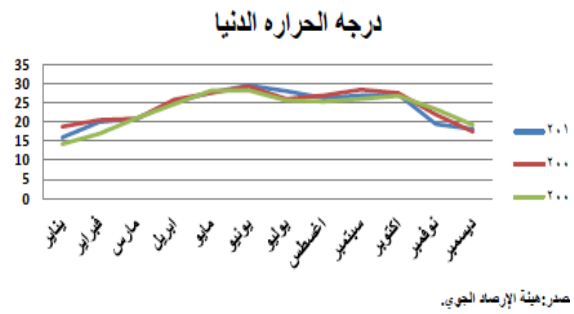
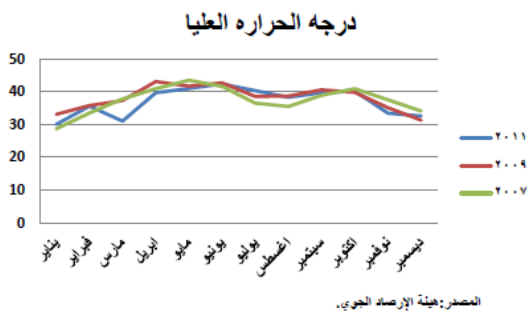
General temperature chart for the Khartoum state:



The above diagram shows the difference in temperature at the different month during the year and the human/s comfort zone.

-  Temperature degrees
-  Direct sunlight
-  Indirect sunlight

Temperature degrees at the east Nile state:

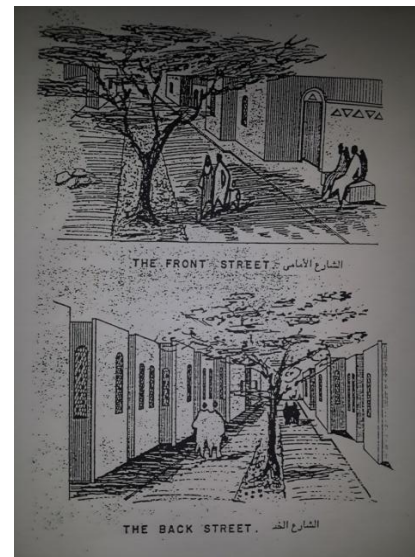
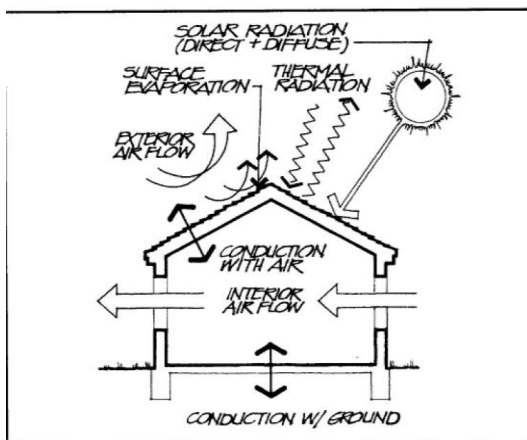


SITE STUDY:

A great difference between the high and low temperatures during the day and throughout the years. And sometimes the difference is greater than the human's comfort zone, and can cause health problems.

Solutions :

- *Use of building materials that have insulation properties, and the use of insulating materials to absorb heat during the day and supply warmth at night.*
- *Use of winds to get rid of temperatures inside various spaces.*
- *Due to the hot climate, the outside paths should be shaded as much as possible by means of trees or buildings . and the distance between the houses . work areas and leisure areas should be as short as possible.*



3.4.2.2/ RELATIVE HUMIDITY:

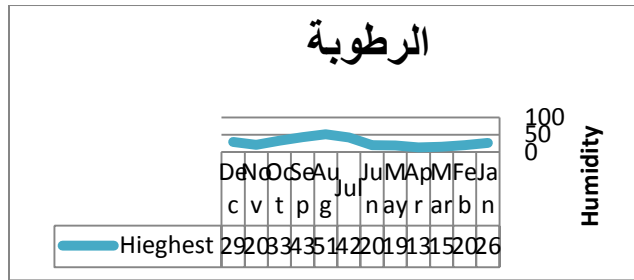
The presence of water vapour in the air. If the amount of vapour increases, the air becomes too humid, otherwise it becomes too dry.

Affects on the planning process:

- *Types of planting (trees, green areas etc)*
- *Irrigation system used*
- *Type of building insulation*
- *Surface drainage*

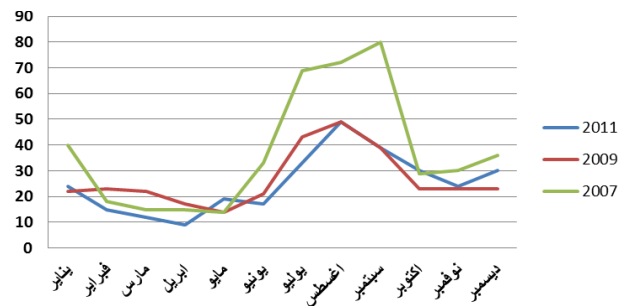
SITE STUDY:

Relative humidity at Khartoum state:



Humidity drops in summer to 6.8% during daytime

Relative humidity at east Nile locality



3.4.2.2.3/ SOLAR RADIATION:

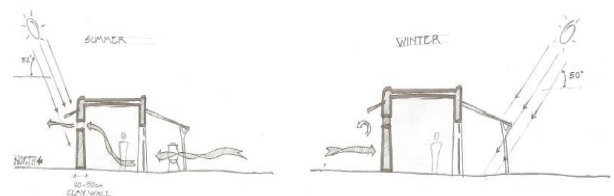
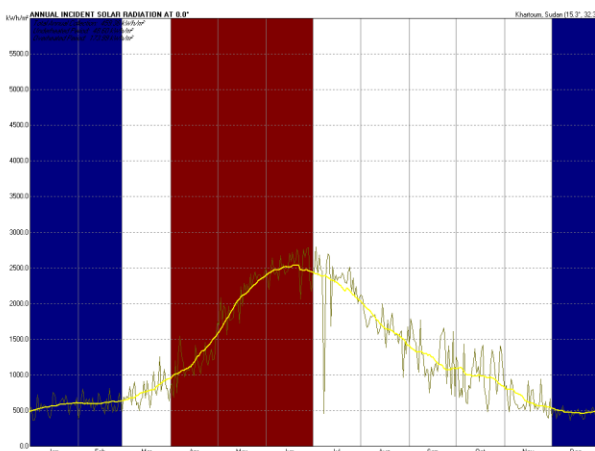
Solar radiation is radiant energy emitted by the sun, particularly electromagnetic energy.

Long period exposition produces a suntan or a sunburn on people who have been in sunlight for extended periods of time.

It's effect of the planning process :

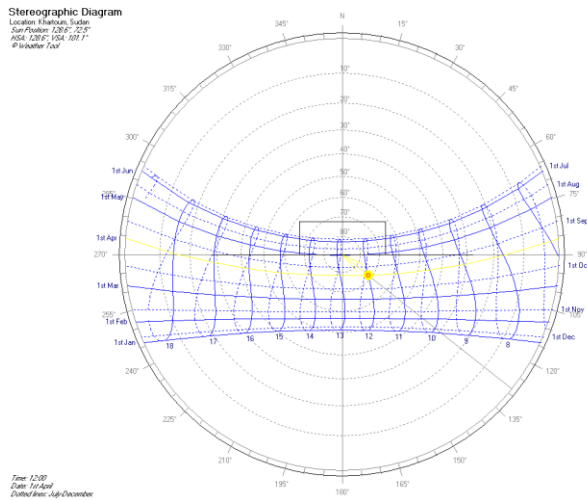
- Choosing the right location of trees, its height, density and type, that can stand high sun temperatures.
- Correct orientation of different buildings, shades and paths and its relation with the sun's movement.
- Type of sunshades used.

Solar radiation during the different month of the year.



SITE STUDY:

Highest radiations are in June and July



The following diagram shows the angle of sun's radiation and the best orientation to avoid direct radiation.

- *Best orientation of the building is 90°*
- *Highest radiations are in June . July. August*
- *Use of solar panels for energy production(eco-friendly)*
- *Use of rays for*

natural lighting

- *Planting trees that depends on sun's radiation for growth*

3.4.2.2.4/WINDS:

Wind is the flow of gases on a large scale. On the surface of the Earth, wind consists of the bulk movement of air.

Wind s flow freely due to absence of wind blockers(high buildings. Trees. Hills etc)

- *North to north-eastern winds carry sands and dust*
- *Wind speed reaches 60km / hour*

Effects of wind on the planning process :

- *Defines the orientation of the building and the window openings*
- *Placement of trees to work as wind blockers for sand carrying winds*
- *Placement of green areas and water surfaces to be used for purifying and spreading of natural smells*
- *Dimensions and orientation of rods*

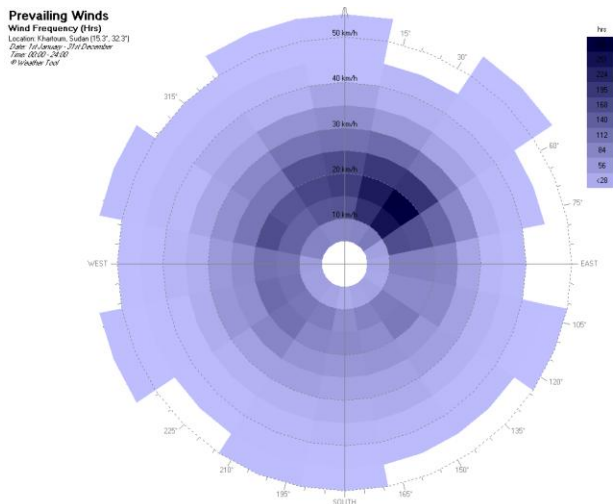
Uses :

- *Providing eco-friendly energy*
- *Natural ventilation*

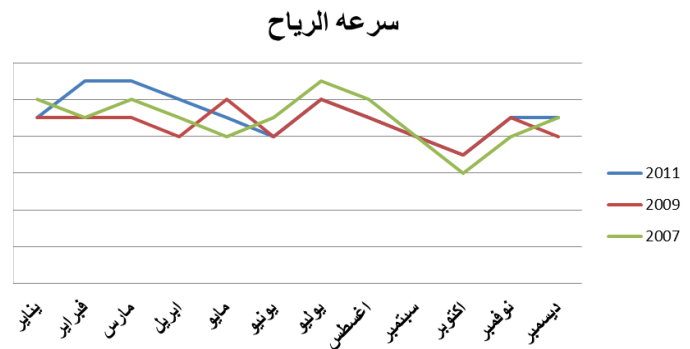
SITE STUDY:

Solutions :

- *Planting a tree belt to act as wind blockers*
- *Using water areas to clarify the air*
- *Placing the building openings at high and low areas for direct ventilation*



Winds in Sudan



Wind speed at Sharg Al Neel state:

3.4.2.2.5/ RAINFALL:

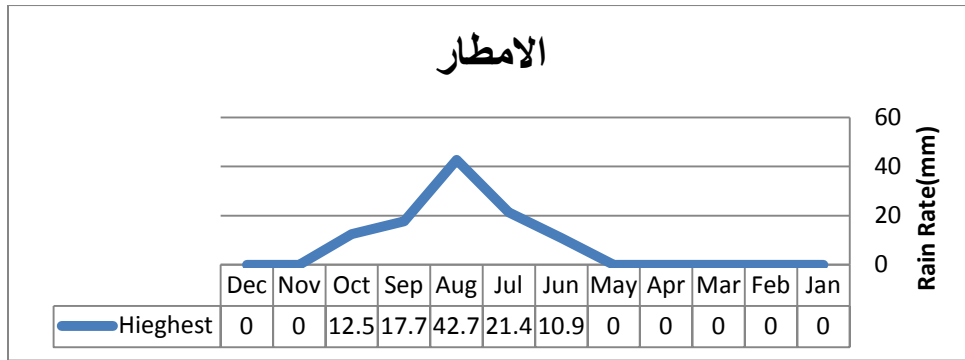
- *Stops the crawling of desert sands*
- *Used for irrigation*
- *Decreases the area's temperature*
- *Fills the wells*

Problems caused by rainfalls:

- *Formation of ponds*
- *Spread of diseases*
- *Effects buildings, especially those built by traditional materials*

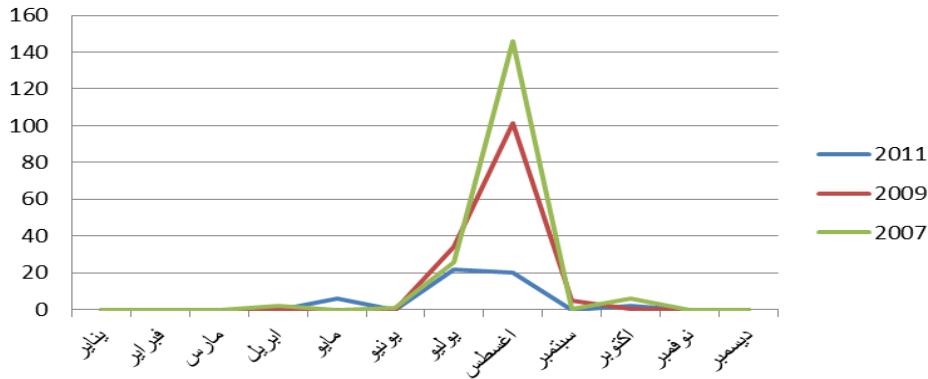
SITE STUDY:

Annual rainfall at Khartoum state:



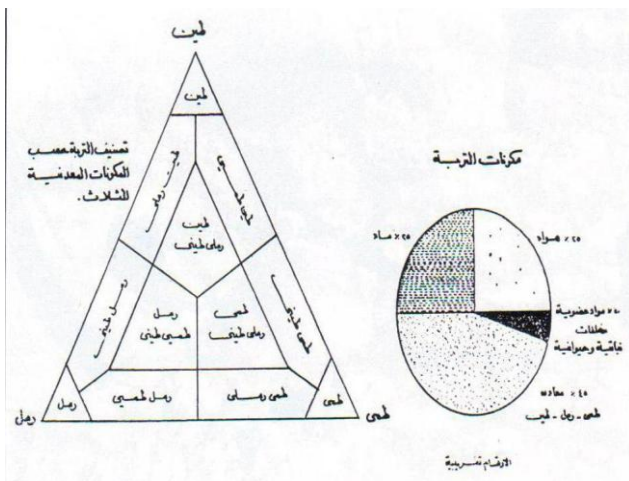
Annual rainfall at Sharg Al Neil locality

هطول الامطار (مم) (3)



3.4.2.2.6/SOIL:

The site has a clay soil, best suitable for agriculture, but isn't stable enough for building, therefore, treatments while building has to be done, in choosing the type of foundations.



0-10cm *dry loam*

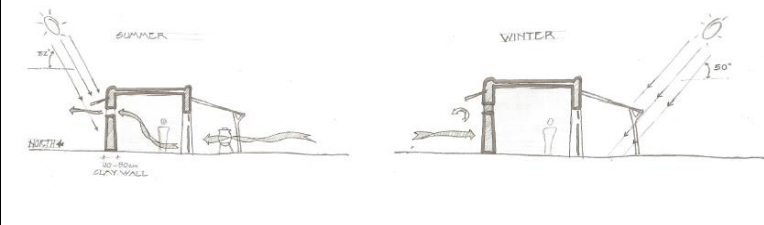
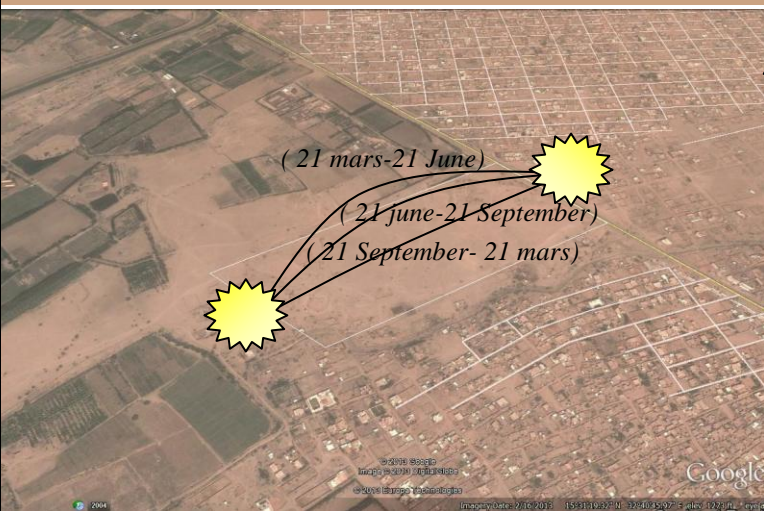
10-55cm *dry silt load with some lamination of clay*

55-105cm *silt loam*

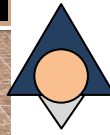
105-175cm *dominant dry silt clay loam*

SITE STUDY:

3.4.2.3 Stereological sun path diagram



North



During summer(21 mars-21 June), the sun rays fall with a slope of 32 degrees from the northern side.

During winter(21 September- 21 mars) , they fall with a degree of 50 degrees due south

And during autumn times (21 june-21 September) , the sun is almost directly overhead

3.4.2.4 Noise level and view around the site



North



The site is surrounded by residential areas and farms, there is no nice areas of views around it.

One side of the site lies right next to main road, therefore that side (eastern side) experiences high noise levels from the cars and other vehicles passing by at that road.



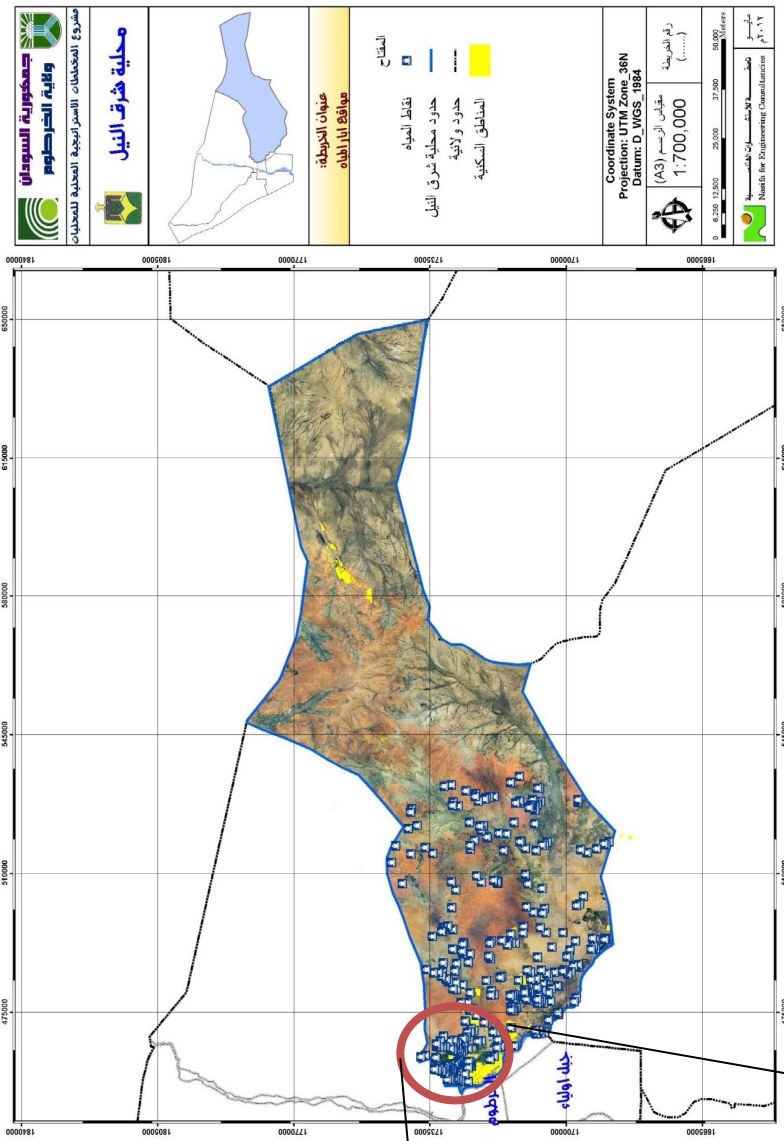
No areas of nice view at that side

High nose levels

Low noise levels

SITE STUDY(SERVICES) :

3.4.2.5 WATER SUPPLY:



Average water usage /individual= 130l/day

Amount of water produced in the locality = 1052m³/day

There is a main water supply system covering all parts of the locality.

Main water sources are wells and the Nile water.

Distribution is through a system of pipes, and water is stored i overhead water tanks.

Main water supply to the site is from the eastern side.

Nearest well is less than 1 km away



SITE STUDY(SERVICES):

3.4.2.6 ELECTRICITY SUPPLY:

Nearest electricity station lies around 2.2 km due north of the site.



3.4.2.7 SURFACE DRAINAGE:

There is a main surface drainage line passing by the road (al Ghazafi drainage)

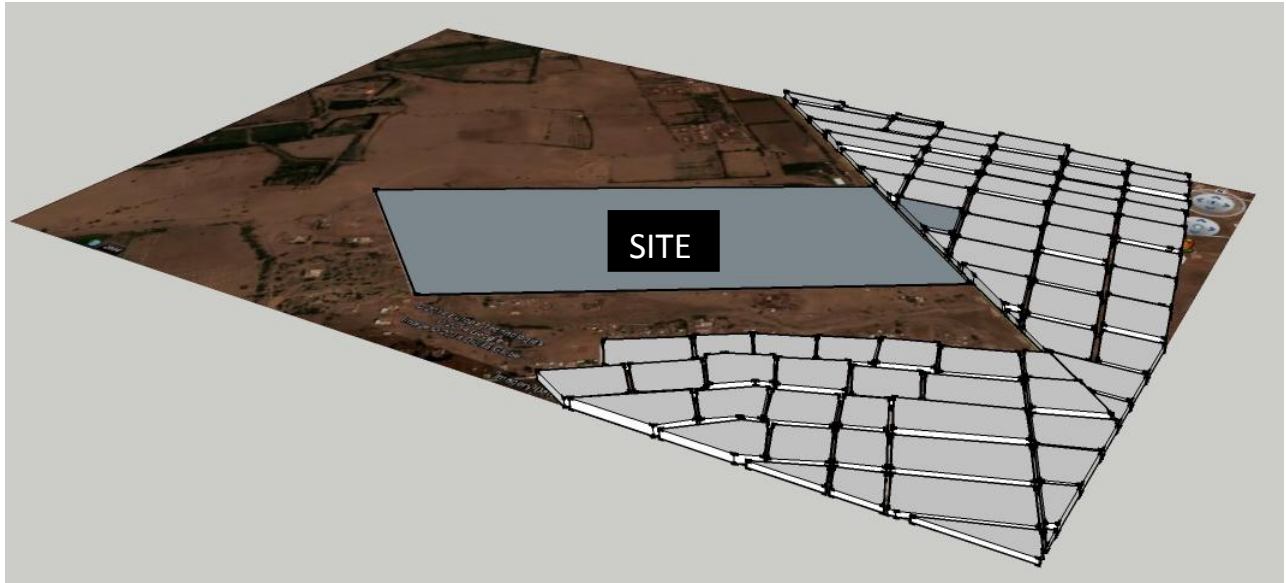
3.4.2.8 SEWAGE TREATMENT:

There is no sewage treatment system, ways of treatment are usually septic tanks or just simple ground dug holes.

SITE STUDY:

3.4.2.9 BUILDING HEIGHTS:

The site is surrounded by residential areas mainly houses and farms. The houses vary in height mainly 1-2 stories, giving that some houses of 2 stories can have a height of 6 m, others 8 m.

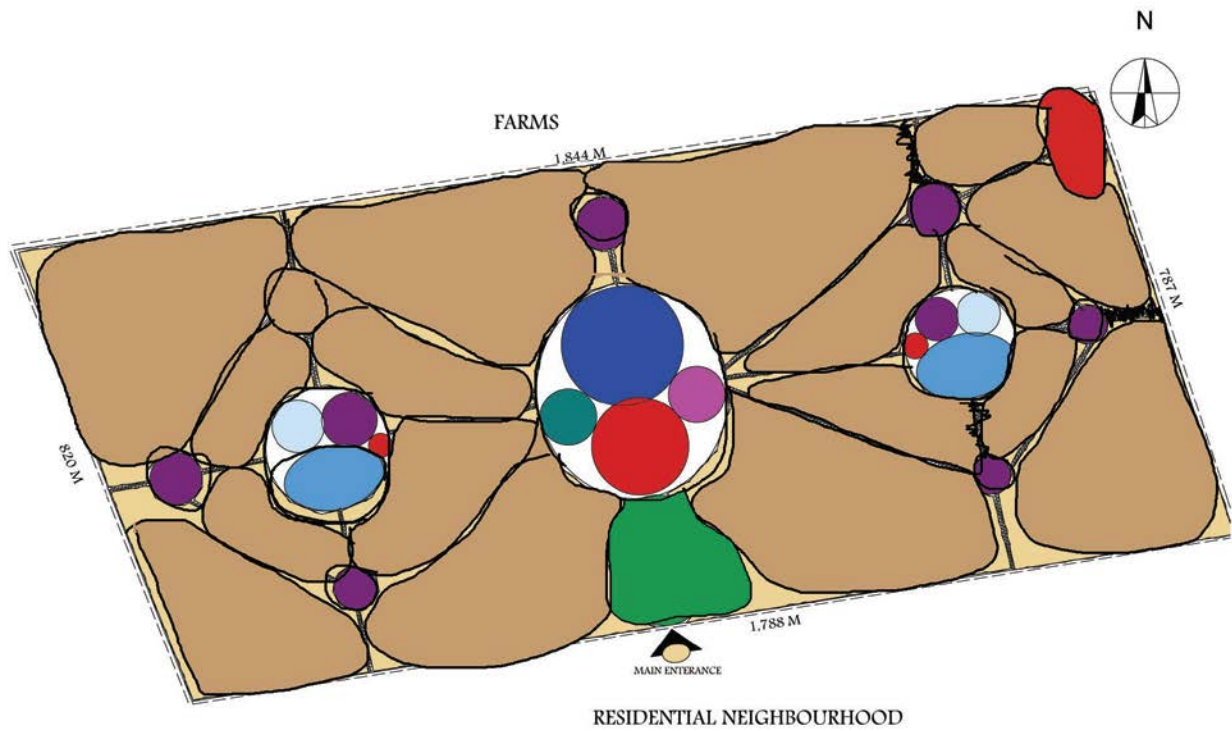


3.5.1 Planning principles:









- *Main entrance by the south side, away from the street noises and close to the neighboring residential areas.*
- *Having the main public park by the entrance, to act as an attraction for the city.*
- *Placing the main activities such as the healthcare centre, trade and cultural centre, in the middle, to be at an equal distance from all parts of the neighbourhood.*
- *Having 4 primary schools, 2 for males and 2 for females, each 2 placed at the secondary centres, for its serving radius.*
- *Having a kindergarten in the middle of every few clusters with a serving radius of 200-300m and a distance of 500m between each 2.*
- *Having a secondary trade area by the top right corner by the street, to act as a source of income to the neighbourhood.*
- *Having 2 main mosques, serving a radius of 500m, and a few more by the kindergartens serving a radius of 100-200m.*
- *Having small trade areas by the small mosques.*
- *Placing main roads between the tertiary centres, and roads from all centres leading to the main centre.*
- *Having playfields next to the schools.*
- *Having a buffer zone by the road side to reduce noise levels and car exhausts pollution.*

3.5.2 Design principles:

- *Bedrooms located at the eastern side(receiving morning sunlight)*
- *Kitchen and bathrooms by the east or western side away from the winds direction.*
- *Having 2 houshes , one by the front for males and the 2nd back for females*
- *Having an external saloon with a link to the house for recieving male guests, and a seperate living room for the house occupants*
- *Having an external bathroom to be used by the guests welcomed at the housh area.*



KEY:

	Residential
	Green area
	Cultural centre
	Shops
	School + kindergartens
	Healthcare centre
	Mosque
	Tertiary centres (mosque, kindergarten, trade area)

CHAPTER 4

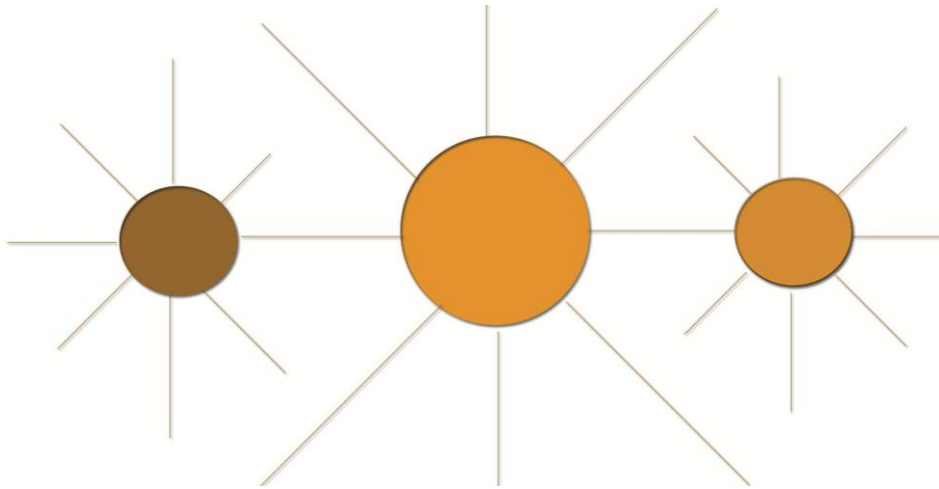
Design Progress

- **Design concept**
- **Initial design stage**
- **Second design stage**
- **Third design stage**
- **Final design stage**

4.1 Design concept:

The project being of low-cost, the main concept was the use of natural resources mainly natural ventilation, thus the presence of courtyards.

The planning concept came mainly from the zoning, having one main centre serving the entire neighbourhood and 2 secondary centres, having a main road connecting all the 3 centres and all the remaining roads leading directly to the centres, hence came the shape.



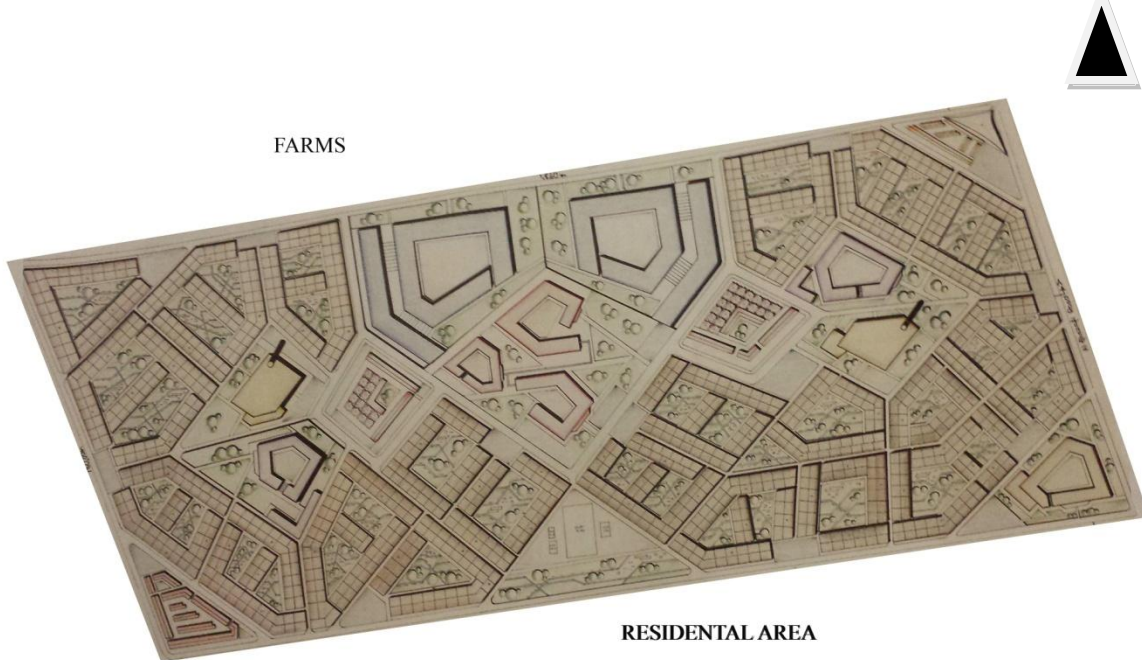
One of my main aims was to not have a symmetrical shape, so as to do that the secondary centres varied in sizes and later on changed the position of one of them.

4.2 Initial design stage:

- *The main entrance was from the north side, not defined as well as it should be.*
- *The schools were the main buildings seen from the main entrance side.*
- *The main centre consisted of a cultural centre, a sports centre and a public library.*
- *The health care centre was placed at the bottom right as so to be close to the main street and to serve the areas around the neighbourhood as well.*
- *The main playgrounds were at the southern side.*
- *The secondary centres consisted of a mosque, kindergarten and trade area.*
- *There were also secondary trade areas at the top right corner and at the bottom left corner.*

DESIGN PROGRESS

- *The idea of the side parking were used, in which every cluster had a parking lot area, that was given the fact that only a small percentage own a car.*

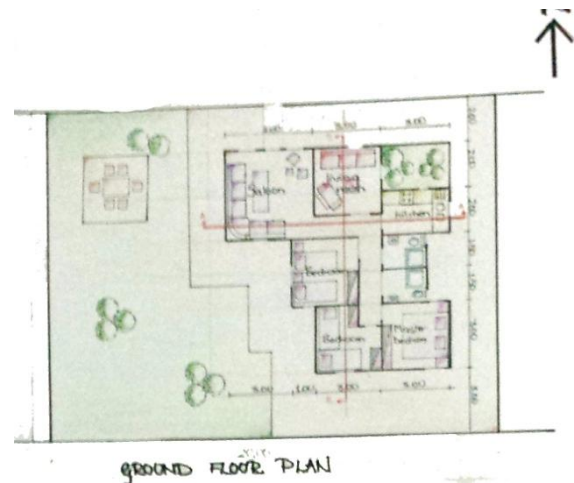


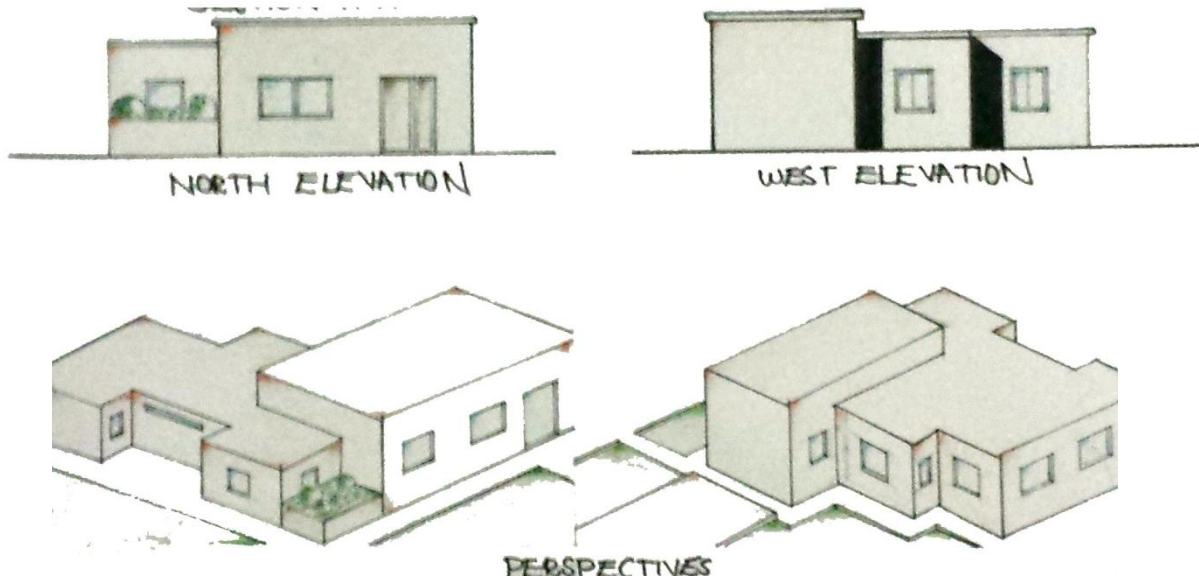
4.2.1 Houses:

- *The plot sizes were 15*20m.*
- *The 3 house design were in such a way that almost half the plot areas were used as a housh, an open area (that being one of the main spaces in a low-cost house in Sudan)*

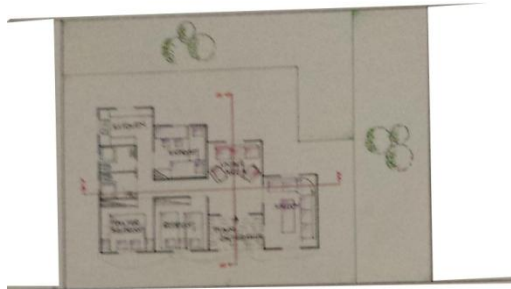
4.2.1.1 Design 1:

- *Enterance is from the eastern side*
- *The house has 2 entrances', one for the men's saloon and the other to the remaining parts of the house*
- *Areas of different spaces where in such a way as to fit the furniture layout.*
- *An important factor of the design as the closeness of the toilets and kitchen for drainage purposes.*

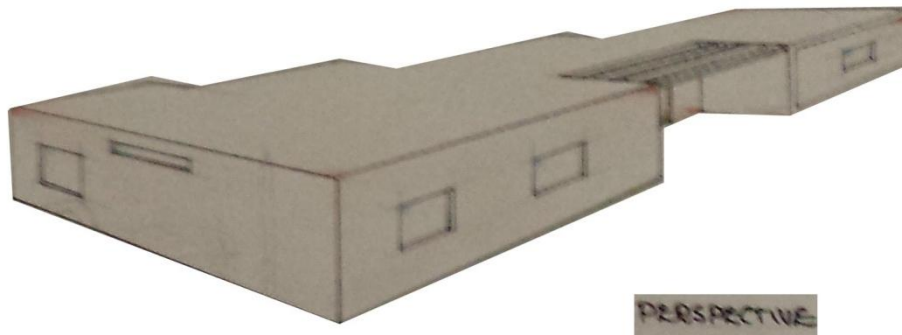




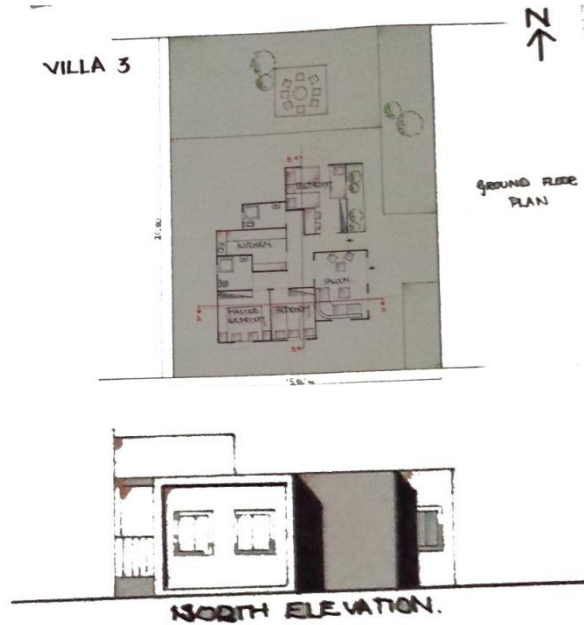
4.2.1.2 Design 2:



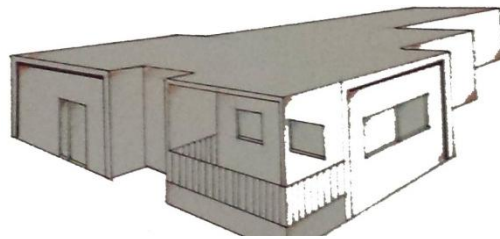
- The main entrance was from the south side
- The house has 2 entrances', one for the men's saloon and the other for the living area,
- From the main hall, there is a corridor leading to the remaining spaces
- The bathrooms and kitchen are placed in one line for drainage purposes.



4.2.1.3 Design 3:



- The main entrance is from the eastern side.
- The house has 2 entrances' one for the men's saloon and the other for the house.
- The bathrooms and kitchen are placed in one line for drainage purposes.



4.2.2 Pro's of the planning:

- Site is not congested.
- Presence of green areas (to be used as small parks)

4.2.3 Con's:

- Main entrance is not well located and not defined from the site plan
- Large plot sizes
- Serving radius of schools and kindergartens and their numbers
- Dwellings:
 - small spaces
 - Toilets locations
 - Having half the space used as housh
 - Not having a living area in 2

4.3 Design phase 2:



- The main entrance is from the south side
- The secondary centres varied in sizes,
- The house plot were made 15*15
- The kindergartens were increases in number and the distance between them 500m.
- The health care centre was moved to the centre
- The roads were widened into 10m roads, with the main roads 15 m,
- The trade area to the bottom left was cancelled and turned into a cluster of houses.

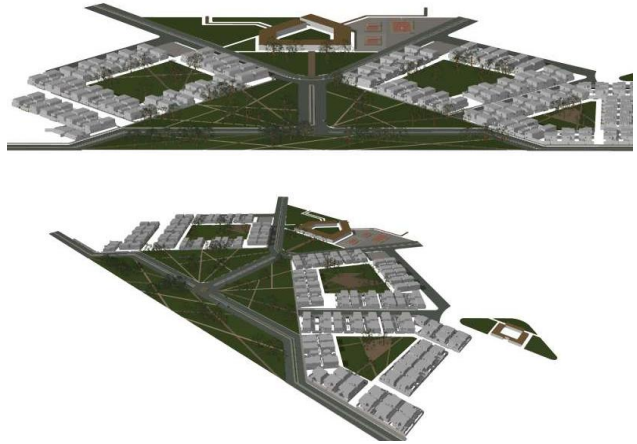
4.3.1 PART PLAN(Residential area):



DESIGN PROGRESS

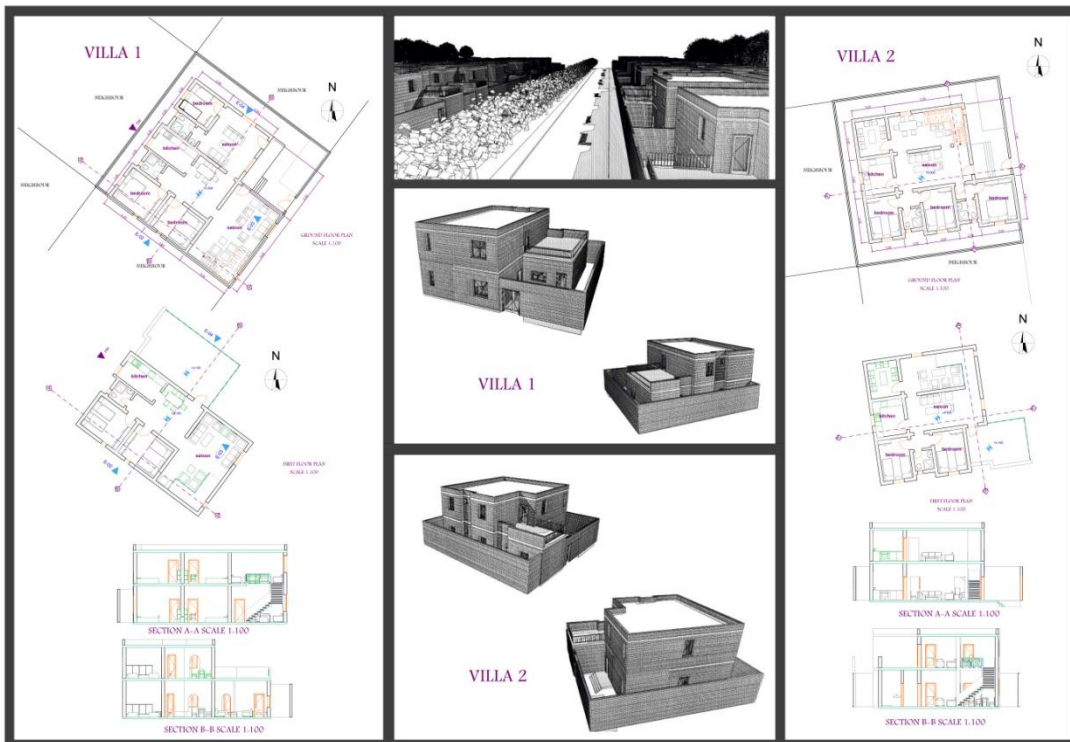
The following master plan shows the layout of 4 of the clusters , the roads around them, the green areas, the sand parts in the middle of the green areas.

4.3.2 ENTERANCE AREA:



The following site shows the main entrance area, and the clusters around that area.

4.3.3 HOUSES DESIGN:



4.3.3.1 VILLA 1:

- *The main entrance is from the north-east side*
- *The house has two entrance , one to the saloon area and the other to the main living hall.*
- *The house consists of 3bedrooms, 2 for house use and one for guests.*
- *The house has 2 indoor bathrooms, and 1 kitchen, all next to each other*
- *The house design , is a simple grid design*
- *The house is of 2 floors. The first floor consists of 2 bedrooms, a bathroom, a kitchen, saloon and a large terrace.*

4.3.3.2 VILLA 2:

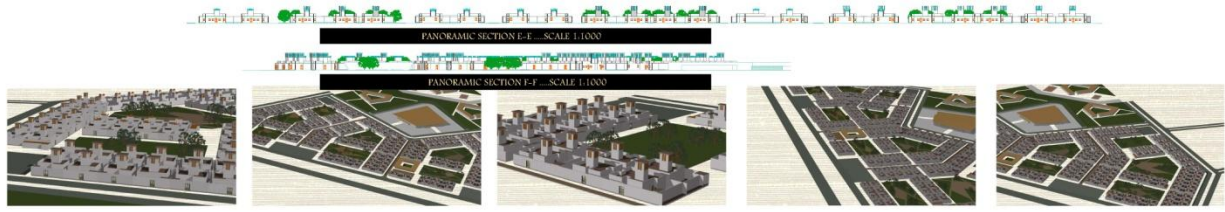
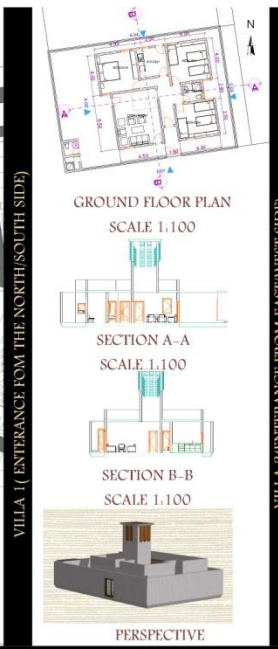
- *The main entrance is from the eastern side.*
- *The house has only one entrance,*
- *The hall is divided into 2, 1st part is the dining area and the 2nd part is the seating area.*
- *The dining area is connected to an outside sitting area.*
- *The house has 3 bedrooms, 2 bathrooms and one kitchen in the ground floor, and 2 bedrooms, a bath , a kitchen, a saloon and a terrace in the 1st floor.*

4.3.4 Pro's :

- *Services are well located to serve all the people*
- *Main entrance well defined*
- *All the main activities are in the centre, best serve all the people*
- *The plots are well located and the streets around them.*
- *The acute angles formed at the end of each cluster is eliminated, with only a few left.*

4.3.5 Cons:

- *Pedestrian path*
- *Hierarchy of different services (trade, mosque....)*
- *Very few low cost houses are of 2 floors, stairs are usually outside the house.*
- *A very small area is present for a housh*
- *Only one housh is there, the need for 2 in low-cost housing.*



4.4.1 House design:

Two concepts were used:

4.4.1.1 Concept 1: COURTYARD

The presence of a courtyard in the middle of the house with all the spaces opened towards it.

The house is a 2 storey house, consisted of 3 bedrooms, 2 bathrooms, a kitchen, a saloon and a housh in its ground floor, in its first floor : 2 bedrooms, a kitchen , a bathroom and a large terrace.

4.4.1.2 Concept 2: WIND CATCHERS

The presence of wind catchers in the middle of the house, to ventilate all its spaces.

The house consisted of 3 bedrooms, 2 bathrooms, a kitchen and a saloon.

The house was only of 1 floor.

4.4.2 Pro's :

- *Pedestrians can walk around freely with no fear of getting hit by a car.*
- *Different plot sizes provides options for various families with different household numbers.*

4.4.3 Cons :

- *Absence of roads passing in front of the houses, for emergency vehicles in case of emergency.*
- *Hierarchy of different activities, trade, praying areas etc,*
- *Houses:*
 - *Wind catchers for only one floor is a waste of building material.*
 - *Courtyard houses, the spaces are not well ventilated, no cross ventilation.*
 - *Kitchen is in the north side, food smells will enter the house.*
 - *Families have no living area.*

4.5 Final design phase:



The main entrance is from the south side, having the public park as the identifying factor for it. The main attraction seen from the entrance is the main trade centre. At the centre, there is also the cultural centre, main management building and the healthcare centre.

As seen there are four types of residential plots, which revolve around 2 secondary central areas containing the primary schools, mosque and a trade area. There is also a trade area to the north east side by the road for yearly needs, and also as a source of income to the neighbourhood.

Hierarchy of different services, as seen there are also tertiary centres containing the kindergartens along with small mosques and a small trade area. These are placed in accordance to the kindergartens, them having a serving radius of not more than 100-200 m.

There is a main pedestrian path passing by the entire neighbourhood, having 3 lanes, one for people, one for bicycles and the 3rd is a seating area(green area).

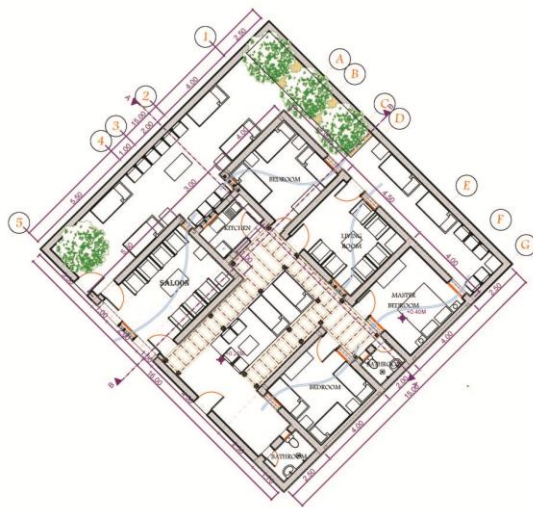
Around the neighbourhood is a buffer zone, made as a walking park.

And there is a buffer zone by the road to the east filled with trees to act as noise as smoke blockers.



4.5.1 Villa type 1:

The house has one entrance, which enters into a courtyard acting as a plaza, leading to all the different house spaces. The house has 2 bedrooms, 2 bathrooms, a kitchen, a living room and a saloon. Male guests are welcomed at the men's saloon, or at the housh right behind the saloon. Female guests can either be welcomed at the living room or the back housh which is connected to the back yard used by the kitchen. As observed the house is semi-detached from its eastern side.



4.5.2 Villa type 2:

The house has two entrances', one which opens to an interior courtyard and the other opens to the main housh used for receiving male guests. The house has 3 bedrooms, 2 bathrooms, a kitchen, a living room and a saloon. Male guests are welcomed at the men's saloon, which has a door that opens to the men receiving housh. Female guests can either be welcomed at the living room which has a door opening to the back housh also suitable for receiving guests. . As observed the house is semi-detached from its south-eastern side.



4.5.3 Villa type 3:

The house has one entrance from the street, and two entrances' to the house area, ne to be used by male guests entering the saloon and the other by the house occupants. The house has 2 bedrooms, 2 bathrooms, a kitchen with a store, a large living hall and a saloon. There are two houshes , the front one for men and the one at the side for females.

CHAPTER 5

Technical Solutions

- **Structure system used**
- **Site Landuse**
- **Electricity supply**
- **Water supply**
- **Sewage treatment**
- **Surface drainage**
- **Air conditioning**

TECHNICAL SOLUTIONS

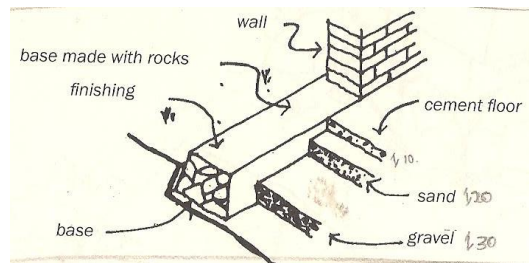
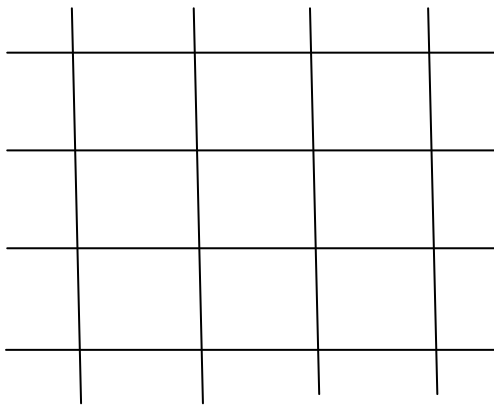
5.1 STRUCTURE SYSTEM USED

The houses were designed in a way so that the foundation, Walls and roof would be of low cost materials, Using low cost building techniques.

*The system used was load bearing wall made of **adobe bricks** with cascajes prefabricated slab (lightweight concrete)used for roofs or vaults made of adobe bricks, having a strip foundation base.*

5.1.1 FOUNDATION:

Strip foundation used, with the base filled with crushed rocks, and filled with cement-sand mixture 1:10. Areas between the foundations are filled with a layer of gravel 30 cm followed by a 20cm sand layer with cement floor on top 10cm.



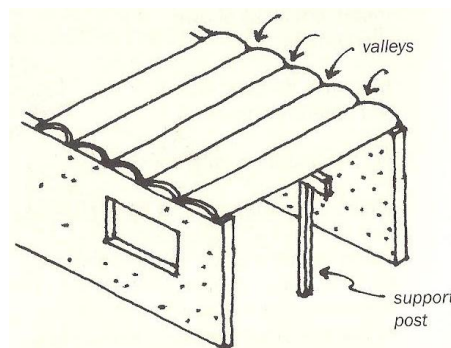
5.1.2 WALLS:

Walls are built from adobe bricks made of sand excavated from the site, with lime-sand plaster 1:6

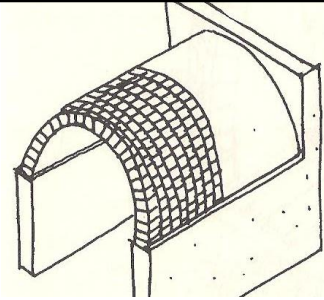
5.1.3 ROOFS:

There are 2 types of roofs:

1/ Cascajes prefabricated lightweight concrete slabs



2/ Adobe brick vaults,

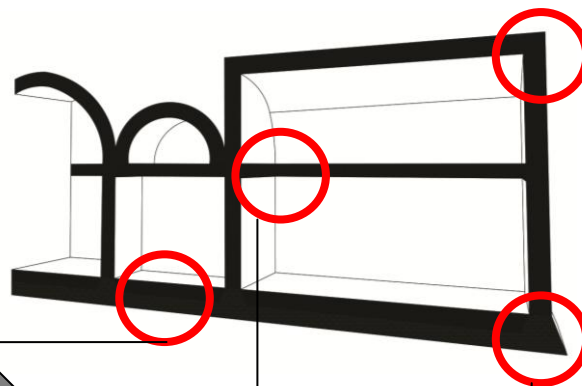


Both with reinforced concrete beams.

5.1.4 House type 1 structure:

The following picture shows the structure of the 1st house with its walls and beams.

Floors : a layer of gravel 30 cm, al layer of sand on top of that 20cm and a layer of cement for the floor finishing 10cm

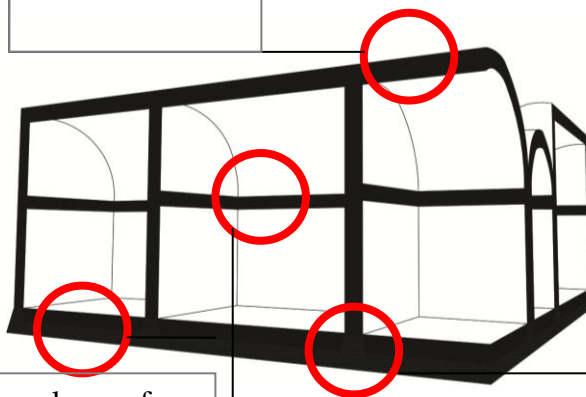


Walls made of adobe bricks, with lime-sand plaster 1:6

Walls made of adobe bricks, with lime-sand plaster 1:6

Reinforced concrete beams

Strip foundation with a base of crushed rocks, filled with cement-sand mixture 1:10



Floors : a layer of gravel 30 cm, al layer of sand on top of that 20cm and a layer of cement for the floor finishing 10cm

Reinforced concrete beams

Strip foundation with a base of crushed rocks, filled with cement-sand mixture 1:10

TECHNICAL SOLUTIONS

5.2 SITE LANDUSE



Built areas:

Houses :804676.6 m²

Schools :74465m²

Kindergartens:26233 m²

Mosques / praying areas:55963 m²

Trade areas:47135 m²

Management area:11994 m²

Health centre:12110 m²

Cultural centre:15161.7 m²

Open spaces/ green areas:344862 m²



5.3 SITE TREATMENT

5.3.1 Roads + pedestrian path:



Car roads vary in width : main roads =25m, secondary roads= 16m, streets = 8m
Pedestrian path are divided into 2, one for pedestrians to walk in ,other is for bicycles.

5.3.2 Green areas:



Green areas contribute to a large part of the neighbourhood, used as courtyards for natural ventilation.

TECHNICAL SOLUTIONS

5.4 WATER SUPPLY

Water is supplied from wells less than 1km away from the site and stored in overhead tanks. The water then enters the site and is stored in 5 different locations in underground water tanks, each having a capacity of =9,5000 L, and supplies a different part of the neighbourhood. Water supply system used is the Grid Iron System

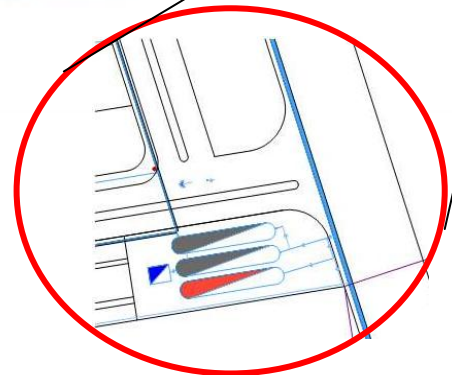
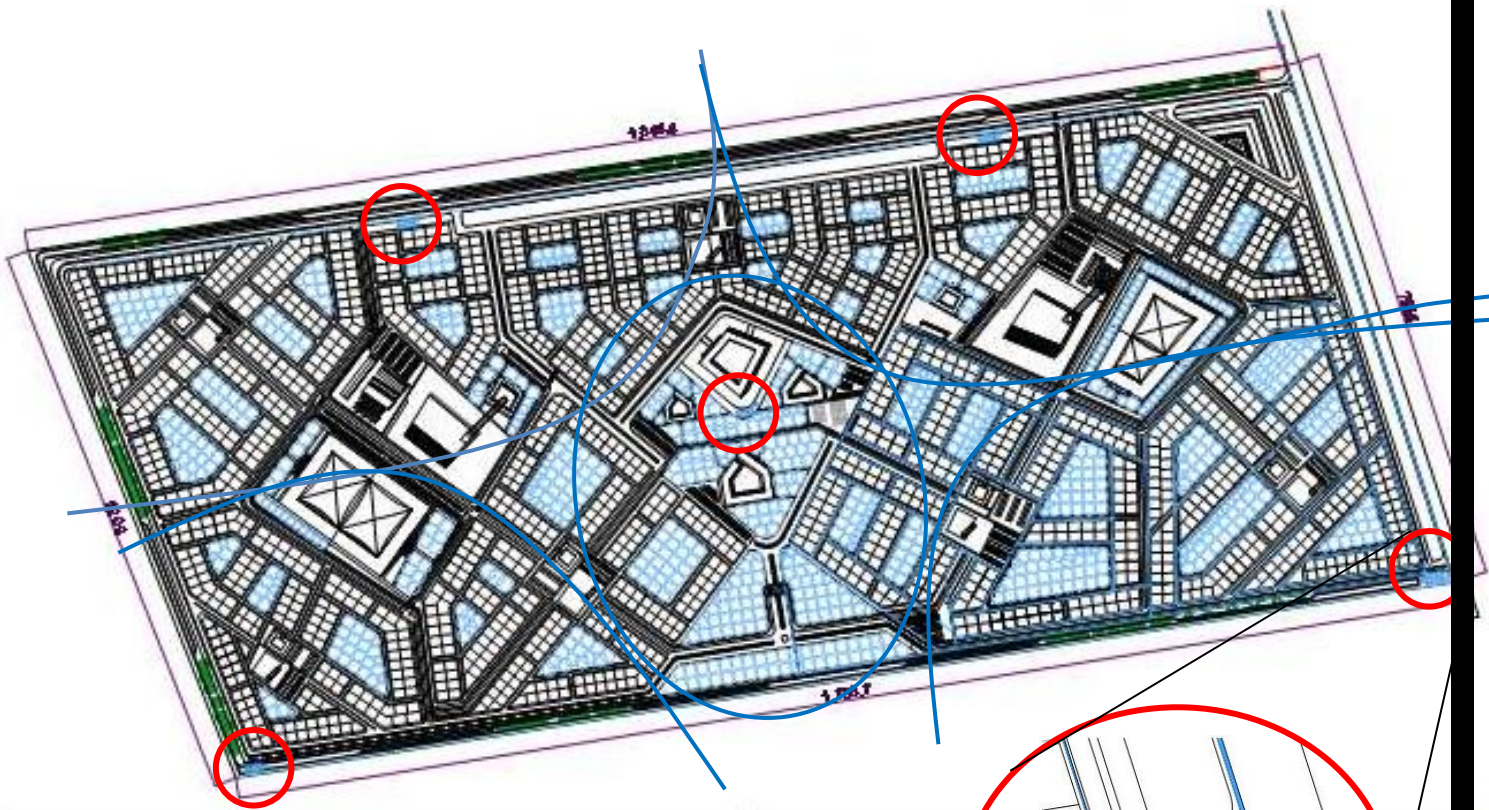
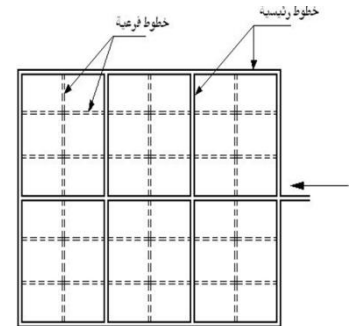
Daily water need/ person= 130 L

Total no. of people = 6919

Therefore, total water need = 899470 L

Total number of underground water tanks = 10

The tanks are 12 foot in diameter and of length 10.8 m



Water from the main supply is stored in 2 underground water tanks, with the presence of an emergency water tank (red colour) for fire fighting, and a small rainwater collector tank.

The red circles are drawn around the position of the underground water tanks, and the lines in blue show which part they serve.

TECHNICAL SOLUTIONS

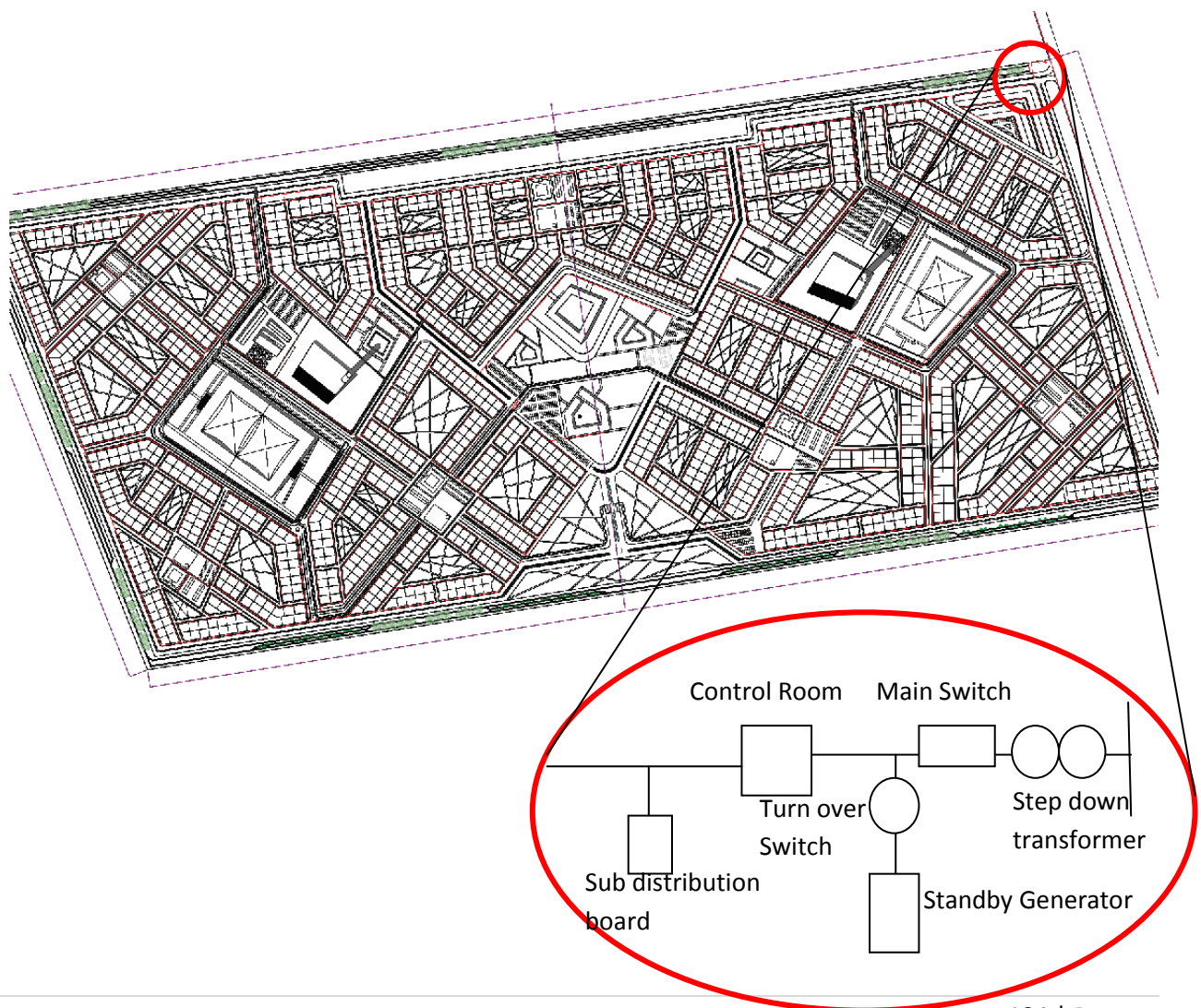
5.5 ELECTRICITY SUPPLY

The nearest electricity station lies 2.2 km from the site.

The houses are each supplied with 220v of electricity

There are 5 electricity lines supplying the neighbourhood, all in parallel connections.

Electricity supply process: from the main station, electricity reaches at 3000kv, therefore at the point of entering the neighbourhood(top right), there is a step down transformer changing that high voltage to 415 v, this will be then further stepped down to 220v, for residential houses. After the step-down transformer comes the main supply switch, responsible for controlling the entire neighbourhood, from that 2 connections are made, one to the control room, the other to a standby generator. From the main control room, many connections are made, all parallel, supplying different parts of the neighbourhood.



Epilogue :

I ask god to help all of those working in this field of study, and i can just hope that my project would be of a benefit to them, helping provide a shelter for those with a low-income that being the third need in life .

Alaa
Kaha

References :

1. Ministry of planning and architecture, Khartoum, Khartoum state
2. Municipality of Sharg Al Neel
3. www.eastnile.gov.sd
4. National Centre of Metrology and Seismology
5. Ministry of land surveying
6. Birtles, T.(1982). Clarence Perry and the neighbourhood unit.
7. Neufert, E. and Thackara, J.(1980), Architect's data, 1st ed, London: Grancida.
8. De Chiara, J. , Panero, J. and Zelnik, M. (1995). Time-saver standards for housing and residential development. 1st ed. New York : McGraw Hill
9. Watson, D. , Plattus, A. and Shibley, R.(2003). Time-saver standards for urban design, 1st ed. New-York: McGraw Hill
10. Lengen J. (2008). Handbook for the barefoot architect. 1st ed. Bolinas, California, USA: Shelter Pub
11. Bannaga.M.Y(1987), "Family and Community Life in a Housing Estate, El-Sha'abiya, Khartoum North". In Family Life in Sudan, Mohammed Salih M.A, and Mohammed Salih M.A;(eds)Graduate college, University of Khartoum ,Sudan.
12. Elias,B.O(1970), "Space Standard in Low-cost Housing Areas with Specific Reference to Urban Areas of Central Sudan" Unpublished Ph.D Thesis, University of Edinberg.
13. Elias,B.O(1973)," A comprehensive model for housing standards. Theoretical analysis and application to the Sudan". In Ekistics, Vol 36,No.216 November 1973.

14. Elias, B.O (1977), " Social Aspects of housing Standards". In the Social Impact of Housing Goals, Standards, Social indicators and Popular Participation, United Nations, Newyork.
15. El Kheir, Osman (1988), "Nafeer Housing Project, at Khartoum Sudan". Unpublished report, Stockholm.
16. El Kheir, Osman (1989), "Technological Aspects of Popular Settlements in Greater Khartoum", Unpublished PhD Thesis, Khartoum University ,Sudan
17. Fawzi ,Saad Ed Din (1954), " Social aspects of low-cost Housing in the northern Sudan". Ministry of Social Affairs, Sudan Government, Khartoum
18. [www. Archdaily .com/16558/low-cost residential neighbourhood](http://www.Archdaily.com/16558/low-cost-residential-neighbourhood)
19. Lawrence, Rodrick J. (1987), " Housing, Dwellings and Homes, design theory, research and practice". John Wiley and Sons. Chichester
20. McLean , W.H. (1910), " The Planning of Khartoum and Omdurman", a paper presented in " The Town Planning Conference, London 10-15 October 1910, Royal Institute of British Architects.