2.6.3 Informal Area

(1) Definition and typology of informal area in the study area

Definition of informal areas given in several studies and official reports relates to the type of housing units and land tenure and one of the examples explains the definition as follows:

1) According to type of housing:

- Shacks and construction from non-permanent materials, usually tin and wood, represent the dominant typology of informal housing, particularly for recent rural migrants settling in the cities' peri-urban fringe.
- One-room dwellings with shared utilities.
- Cemetery dwelling.
- Housing in non-residential buildings or spaces (spaces earmarked for staircases, garages and rooftop dwellers, occupancy of workshops, shops, monuments, etc).
- Housing built without a permit is also considered informal, as with houses that did not abide by the applicable planning or building standards (setbacks, land coverage, etc).

2) According to land tenure:

- Housing built on illegally owned/occupied land, including squatter on State/public or privately-owned land, or
- Housing built on legally owned land that was illegally converted from agricultural to urban use
- Housing built on legally owned land that was illegally subdivided (i.e. without land subdivision permit)
- Housing built outside of the urban boundaries or cordon, i.e. without planning permission
- Informal areas are plenty and growing in terms of expansion and density. Some of the informal settlements may have a net population density as high as 2,000 persons per hectare (or 960 persons per feddan)[1]. Informal areas are mainly located on and around the urban fringe and agricultural land.

The informal areas have several issues to be solved as follows.

- Limited accessibility to infrastructure and social services such as water supply, sewerage, electricity, garbage collection, etc
- Insufficient roads inside and outside connecting settlements which are generally narrow with a 2-4 meter width

[1] Arab Republic of Egypt Urban Sector Update, Final Draft, February 2007, World Bank

- Insufficient public facilities such as schools, hospitals/clinics, and parks
- High risk of natural disaster such as earthquake on feeble structure of buildings
- Encroachment on agricultural land by illegal subdivision and conversion to settlements

In 1960s, the government began to take actions for rehabilitation and/or resettlement of informal areas in GCR for public housing projects. In the late 1970's, a series of laws and decrees were issued in order to regulate the informal conversion of agricultural land into residential subdivision so as to remedy the urban expansion intruding on agricultural land. In 1990's after damage of earthquake which hit GCR, the national slum upgrading policy was set up for the purpose of improving the living standards of informal settlements and providing with basic needs for infrastructure and social services.

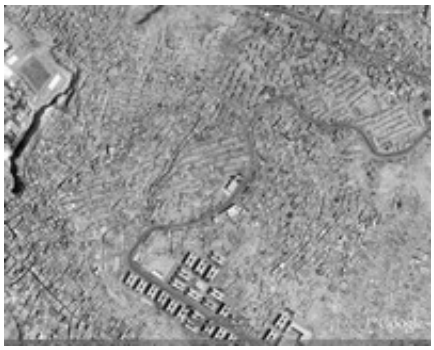
A recent study2 identified four types of informal housing area in the study area. Most common informal housing type is on agricultural land located in and around the peripheral urban areas such as in Giza and Qaliobeya governorates. Informal housing area on desert land is seen in the eastern side of the historic Cairo area called Mashiet Nasser which is in the most atrocious socioeconomic conditions. Remaining two types are seen in built-up areas in deteriorated structures within the medieval urban fabric and shanty housings on the top of old cemeteries.

Continuous efforts by the government need to be exerted on upgrading informal settlement. Priority shall be put on the severely deteriorated informal communities in the study area, such as Type D and C for long-term perspective, and more opportunity for private sector participation shall be promoted in this field for the efficient use of resources3.

[2] Sims, D., Sejoume, M., and El-Shorbagi, M. (2003), UN-HABITAT Understanding Slums: Case Studies for the Global Report, The Case of Cairo, Egypt

[3] Recently a progress of provision of low-income housing development in new urban communities by private real estate companies was published in a news paper, in which the government shall sell some land at LE 70/m^2 and private sector shall facilitate infrastructure and amenity, and then they built and sell units under a certain restriction allowing for low-income housing not exceeding 130 m^2 floor area. (Daily Star Egypt, 12 July 2007)

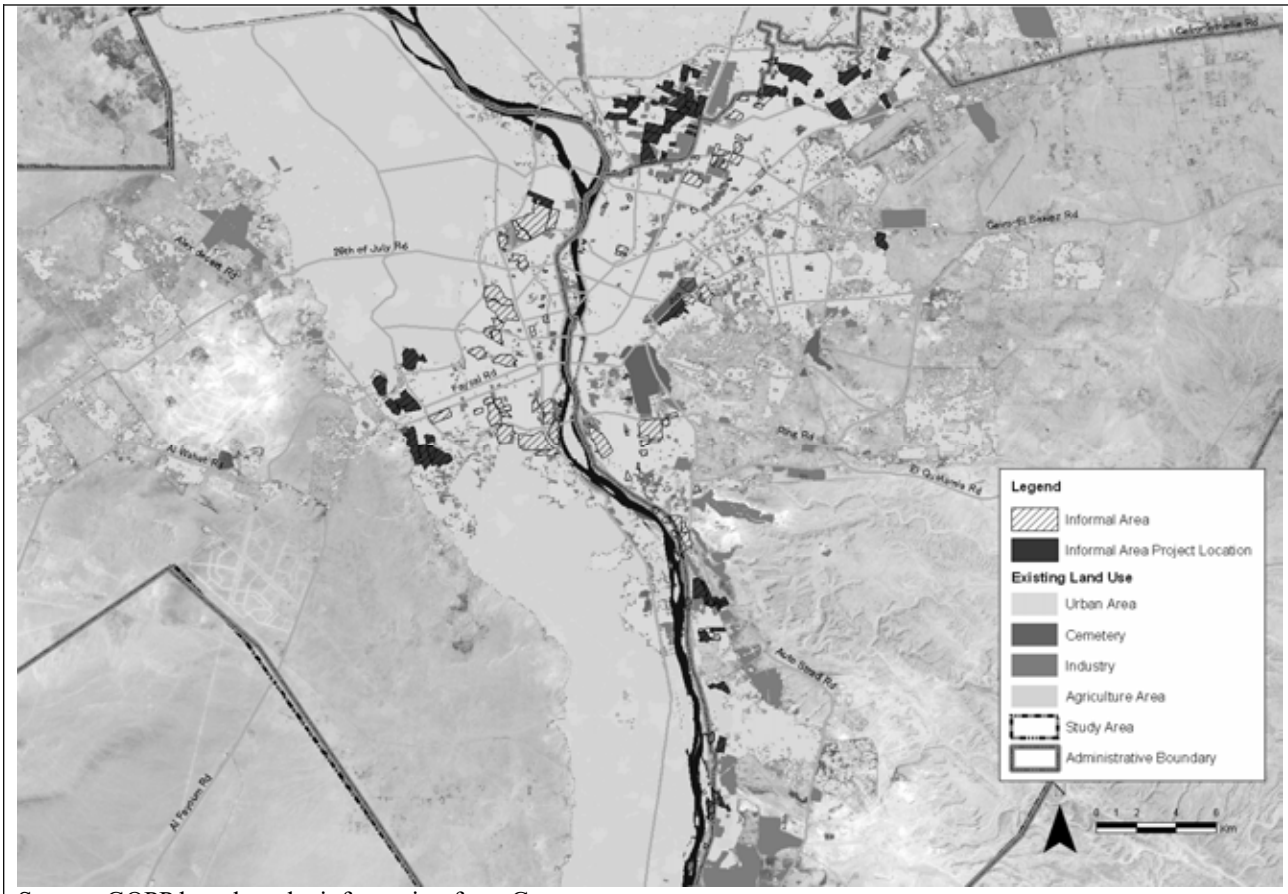
Table2.6.21 Type Informal Areas in the Study Area

Type	Characteristics	Location
A. Informal settlement on former agricultural land  (Shubra Al	This typology is defined as private residential buildings constructed on agricultural land purchased from farmers in areas where there were no subdivision plans and where building permits were not given. As such, the words "squatting" or "invasion" cannot be applied. These areas are illegal, but settlers have certain customary rights derived from interpretations of those portions of the civil code pertaining to hand claims on desert land.	The informal areas in most of urban peripheral areas belong to this type.
B. Informal areas on former desert state land  (Manshiet Nasser)	This typology is defined as private residential buildings constructed on vacant state land by citizens under the process of "hand claim". Such a typology is analogous to the squatting and invasions found in Latin America and throughout the third world. In every case in Greater Cairo the land was marginal desert land without any specific purpose.	Manshiet Nasser began as a site for relocated slum dwellers and garbage collectors, and Ezbet El Haggana began as a hamlet for the families.
C. Informal housing area on deteriorated historic core  (Medieval Cairo)	In the historic city, that is Cairo before the expansions which began after 1860, are found neighbourhoods with a high percentage of old, crowded, and deteriorated structures within the medieval urban fabric. The deteriorated buildings found in these areas are the result of confused ownership (mostly inheritance quarrels) and/or owner neglect due to controlled rents. Many of the families inhabiting these structures are quite poor.	This includes Darb el Ahmar and El Gamalia (especially the eastern sections along the Fatamid walls), and parts of Masr el Qadima, Boulaq Abou Aala, El Khalifa, etc. Also included are historic “villages” such as Qait Bey and el Tonse which serve the vast historical cemetery areas.
D. Informal housing area on deteriorated urban pockets	In various inner areas of Cairo, especially those developed around the beginning of the 20th century are found small pockets of very dilapidated one- to three storey structures which accommodate quite poor families.	Examples include areas around Masr el Qadima, Hekr Sakakini in el Waily, and Teraa el Towfiqia in Mataria.

Source: Summarized from Sims, D., Sejoume, M., and El-Shorbagi, M. (2003), UN-HABITAT Understanding Slums: Case Studies for the Global Report, The Case of Cairo, Egypt, and images are from Google Earth.

(2) Location and statistics of informal areas

The following map shows the location of informal settlements recognized by GOPP and governorates.



Source: GOPP based on the information from Governorates

Figure 2.6.15 Distribution of Informal Area and Ongoing/Planned Project by GOPP

While there are no exact statistics regarding the informal settlements, some statistical information indicates the number of informal settlements and population as shown in the following table. According to latest information by Ministry of Local Development, there are 81 informal communities in Cairo, 36 communities in Giza and 67 communities in Qaliobeya, and the total population of informal residents in three governorates ranges from 3.4 to 4.5 million in different statistics.

Table 2.6.22 Contradictory Informal Settlement Statistics for Cairo, Giza, and Qaliobeya

Governorate	Shoura Council info.93		Governorate/IDSC 1997		MOLD 1999/2000	
	Informal Settlements	Population	Informal Settlements	Population	Informal Settlements	Population
Cairo	79	2,437,988	76	2,098,469	81	-
Giza	32	1,398,000	36	706,953	36	-
Qaliobeya	60	686,350	62	589,343	67	-
Total	174	4,522,338	171	3,394,765	184	

Source: World Bank (2006), Arab Republic Egypt Analysis of Housing Supply Mechanisms
Note: IDSC: Information and Decision Support Centre of Cabinet, MOLD: Ministry of Local Development

2.6.4 Environmental Pollution and Hazards

(1) Environmental pollution

Environmental pollution related to living environment has been examined in terms of noise, air, water, and soil.

The very high levels of particulate matters (PM10) in all places and during all the measurement periods, referring to the results provided by the monitoring stations and measurement campaigns, due to the burning of agricultural waste. High levels of sulfur dioxide (SO_2) and carbon monoxide (CO), often in excess of the standards, were detected at several measurement points, particularly related to the transportation sources. Nitrogen dioxide (NO_2) levels were often in excess of the standards in dense traffic areas because of the increased number of vehicles. The seasonal formation of smog pollution, called the "black cloud", occurs under specific meteorological conditions.

In the river Nile, the water quality was generally within the natural carrying capacity of the river in terms of the organic load. The biological oxygen demand (BOD) is in a range of 5 to 10mg/l, which shows a low organic pollution. The report n°64 of the Ministry of Water Resources and Irrigation (Survey of Nile System Pollution Sources, MWRI, 2002) revealed that the water quality of the main water branches, such as Rosetta branch, Damietta branch, Delta drains, and El Mouheet drain, needed improvement of discharges for wastewater and irrigation. The chemical oxygen demand (COD) in the Rosetta and Damietta branch exceeded the standard value.

Soil protection has appeared as a major environmental issue since urban sprawl has been threatening this resource. Soil pollution by hazardous waste or substances not only threatens the soil resources but also water and health. There is however no assessment of the sites that could have been contaminated by hazardous substances from past or present industrial activities or waste dumping.

Noise levels in the study area are very high, exceeding the standards for day, evening and night, continuously along the main roads, and often in the residential areas near the roads. Studies conducted for noise measurement have shown that road noise was the main source of noise, and noise levels were largely in excess of permitted levels in the residential areas along the arterial roads.

(2) Natural and technical disasters

There are no recorded damages or injuries related to flash floods and landslides. However, the study area is located along two main lines of seismic activity: Northern Red Sea - Gulf of Suez - Cairo - Alexandria trend and Eastern Mediterranean - Cairo - Fayoom depression system trend. Among about 60 earthquakes in the past, two large earthquakes have been observed in 1847 and 1992. The 1992 earthquake of the magnitude at 5.9 on the Richter scale caused severe physical damages with approximately 550 deaths.

There is no major accident related to technical disasters related to industrial activities, fires, and safety management in the study area. However, there are urban areas with a potential risk of technological disasters, which the metropolitan areas in other countries experienced.

(3) Relocation of industrial factories

Ministry of Trade and Industry (MOTI) carried out the first stage of the Study on Relocating Large Factories from Greater Cairo Region in March 2006. This MOTI study consists of two stages, as listed below.

First stage: to identify the large factories in GCR: to classify those factories in accordance with the pollution level: to develop the basic data and economic indicators of the highly polluted factories, which need to be relocated.

Second stage: to propose alternative sites for relocation of the highly polluted factories: to identify the requirements for the relocation process, costs, and socio-economic impacts.

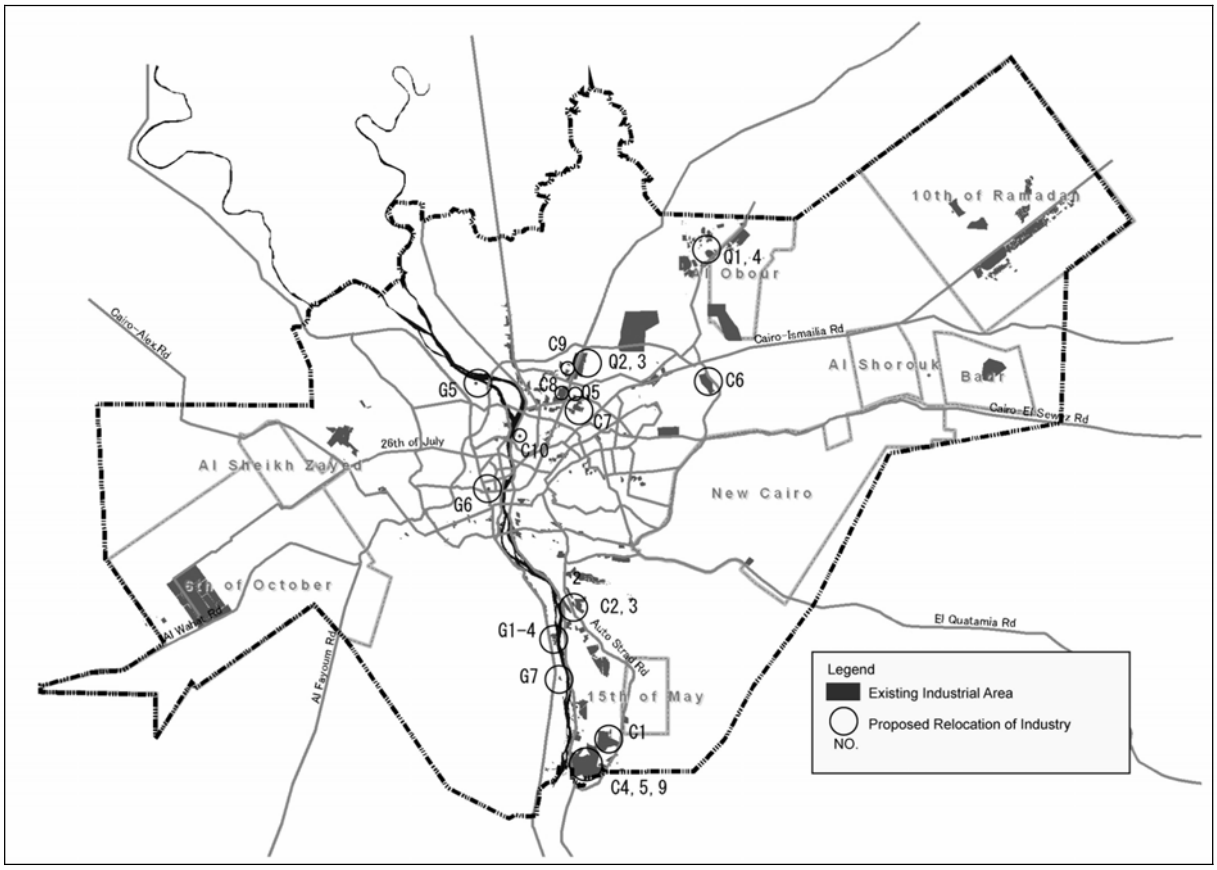
Among 13,483 factories registered by General Authority for Industrial Development (GAID) under MOTI in GCR, MOTI identified 419 large factories having investment cost more than LE10 million or work forces more than 500 workers. The MOTI study classified those large factories into three categories by the level of pollution according to the definition by State for Environmental Affairs. It selected 21 factories to be relocated from existing sites as causing highly negative impacts on the environmental conditions to surrounding areas.

The MOTI study assess the environmental status of the 21 selected factories, and recommended that a new decree for relocation of the polluted factories shall allocate the first priority to shift six factories incompliance to environmental regulations and the second priority to further ten factories.

Table 2.6.23 Financial and Economic Indicators of 21 Polluted Factories and Six Highly Polluted Factories

Item	Unit	21 Factories	6 Factories
1 Total land area	mln sq.m	45.2	7.6
2 Total value of investment	billion LE	11.1	4.3
3 Total work force	1000 workers	56	24.3
4 Total annual production	billion LE	9.2	1.5
5 Total annual wage	billion LE	778	263.4

Source: Study on Transferring Large Factories from Greater Cairo Region-Results of the First Stage, Ministry of Trade and Industry, 2007



Source: Study on Transferring Large Factories from Greater Cairo Region-Results of the First Stage, Ministry of Trade and Industry, 2007
Note: C10 indicates the relocation of tanneries factory to Badr NUC.

Figure 2.6.16 Location of Factories Proposed to be Relocated

Table 2.6.24 Highly-polluting Large Factories to be Relocated in the Study Area

No	Company Name	Work Force	Production	Environmental Impact	Address	Type of production
Cairo Governorate						
C1	National Co. for Cement - Helwan	3,486	578,500	Dust, solid wastes, emissions, work environment	Helwan	Cement, cement bricks, gypsum and Leica granules
C2	Tora Portland Cement Egyptian Co.	2,795	651,457		Tora	Cement
C3	ASEC Cement Co.	1,448	967,500		Helwan	Different types of cement
C4	Al-Nasr for Coke and Basic Chemicals	3,821	764,360	Gas, dust, liquid wastes, work environment	Tebbin	Coke – ammonia fertilizer – carbon dioxide - chemicals
C5	Iron andSteel Eg. Co.	19,747	876,491		Tebbin	Iron and Steel
C6	Heliopolis Co. for Chemical Industries	100	35,000		Heliopolis	Laquers, furnace and plastic paintings - varnishes
C7	Paintings and Chemical Industries Co. – Al-Qoba Factory	766	216,345		Zieton	Paintings, varnishes and print inks.
C8	Al-Nasr Co. for Tires	200	1,977	Gas, dust, solid wastes, work environment	Ghmara -Shoubra	Tires and alex products
C9	General Co. for Minerals	875	264,368		Tebbin	Casting, melting and wiring for non-iron minerals.
Giza Governorate						
G1	Sugar and Integrated Industries Co.	532	35,910	Gas, liquid wastes, work environment	Al-Haoam dia	Alcohol – Acetic Acid - yeast
G2	Sugar and Integrated Industries Co. – Chemicals Factory	536	66,016		Hawamdya	Solvents, organic and adhesive materials, oxygen – Sodium Sulfate
G3	Sugar and Integrated Industries Co. – Al-Haoamdia Refinery	1,644	838,682		Al-Haoam dia	Sugar refining and packaging – Molasses
G4	Sugar and Integrated Industries Co. – Al-Haoamdia Perfumes	327	19,820		Al-Haoam dia	Sugar refining and packaging – Molasses
G5	Al-Nasr Casting Co.	2,000	247,555	Gas, liquid wastes, work environment	Tanash - Imbaba	Steel Castings –high pressure pipes
G6	Eastern Company	12,305	2,953,716	Gas, dust, liquid wastes, work environment	Al-Haram St.	Tobaccos and chopped tobaccos
G7	Cairo Co. for Oils and Soap – Al-Badrasheen Factory	387	3481	Gas, liquid wastes, work	Al-Badras heen	Extracting and refining of vegetable oils – fodders
Qaliobeya Governorate						
Q1	Abu Za'abal Co. for Fertilizers and Chemicals	839	12,876	Gas, Dust, liquid wastes, work environment	Abu Za'abal	Sulfuric Acid – Super Phosphate fertilizer – Phosphoric Acid
Q2	Cairo Co. for Oil Refining - Mostorod	3,224	19,314		Shubra El-Kheim a	Oil Refining for others
Q3	Cooperative Society for Oil	254	3,837		Mostorod	Mixing and Packaging of Oils and Chemicals
Q4	Abu Za'abal Co. for Specialized Chemicals	121	900		Al-Khank a	Vegetable ghee and Edible oil
Q5	Narobeen for Caoutchouc			Fumes	Shubra El Kheima	

Source: Study on Transferring Large Factories from Greater Cairo Region-Results of the First Stage, Ministry of Trade and Industry, 2006

2.7 Housing and Utilities

2.7.1 Housing

(1) Housing stock

The actual housing stock in 1996 was 1.38 times the number of households, while supply has not meet citizens' demand due to construction of expensive housing units targeted at the upper middle to upper class market. Recent national housing policy has emphasized the building of housing units for low-income groups, in accordance with slum upgrading.

Table 2.7.1 Comparison of Annual Growth Rate of Urban Population and Urban Housing Stock by Governorate in 1986-1996

Governorate	Urban Population (1,000)		Urban Households (1,000 households)		Urban Housing Stock (units)		Housing Units per Household in 1996	Annual Growth in 1986-1996 (%)	
	1986	1996	1986	1996	1986	1996		Urban Population	Urban Housing Stock
Cairo	6,007	6,801	1,362	1,659	1,693	2,288	1.38	1.25	1.99
Qaliobeya	909	1,174	202	278	263	386	1.39	2.59	3.25
Giza	2,109	2,590	474	614	639	928	1.51	2.07	2.62
Others	11,948	14,721	2,552	3,290	3,143	4,555	1.40	2.11	2.57
Total	20,974	25,286	4,590	5,840	5,738	8,157	1.42	1.89	2.44

Source: Ministry of Hosing, Utilities and Urban Development
Note: Others include villages and small towns and NUCs.

(2) Housing supply

Last five year, public and private sectors supplied approximately 170,000 formal housing units in three governorates. NUCA has built approximately 34,000 housing units annually until March, 2007.

Table 2.7.2 Number of Housing Units Built During 5th Five Year Plan 2002-2007 in Three Governorates

Gover-norate	Unit Type	Public			Private			Total		
		Built-up Area	NUCs	Total	Built-up Area	NUCs	Total	Built-up Area	NUCs	Total
Cairo	Economy	12,403	170	12,573				12,403	170	12,573
	Middle	498	-	498				498	-	498
	Upper-Middle	4,849	-	4,849				4,849	-	4,849
	Luxurious	-	28	28				-	28	28
	sub-total	17,750	198	17,948	17,356	29,558	46,914	35,106	29,756	64,862
Qalio-beya	Economy	945	-	945			-	945		945
	Middle	-	-	-			-			
	Upper-Middle	-	-	-			-			
	Luxurious	-	-	-			-			
	sub-total	945	-	945	6,715	13,536	20,251	7,660	13,536	21,196
Giza	Economy	2,500	4,548	7,048			-	2,500	4,548	7,048
	Middle	345	1,309	1,654			-	345	1,309	1,654
	Upper-Middle	-	-	-			-			
	Luxurious	-	-	-			-			
	sub-total	2,845	5,857	8,702	34755	40,413	75,168	37,600	46,270	83,870
Total		21,540	6,055	27,595	58,826	83,507	142,333	80,366	89,562	169,928

Source: Ministry of Housing, Utilities and Urban Development
Note: Housing units built by NUCA is not included.

Table 2.7.3 Residential Units (accumulated) in New Urban Community Report till 31/3/2007

New Urban Community	NUCA	Public Sector	Private Company	Private (landlord)	Total units
10th of Ramadan	26,248	13,922	46,046	13,922	100,138
15th of May	17,144	15,934	8,245	15,934	57,257
6th of October	49,317	29,375	140,233	29,375	248,300
Badr	13,737	5,080	1,020	5,080	24,917
Al Obour	22,271	8,880	22,105	8,880	62,136
New Cairo	33,151	24,422	40,432	24,422	122,427
Al Shorouk	25,240	1,720	23,415	1,720	52,095
Al Sheikh Zayed	11,866	13,504	8,354	13,504	47,228
Total	198,974	112,837	289,850	112,837	714,498

Source: Edited from the information of New Urban Communities Authority
Note: Public sector includes Housing Financing Fund or HDB (Housing Development Bank) or Cooperative Construction Authority

Major players of housing supply consist of governorates (44%), NUCA (20%) and Housing and Construction Cooperatives (22%) among the public sector between 1982 and 2005, while the private sector contributes to nearly 90% of the total housing supply.

Total 2.7.4 Publicly-Built Housing Units in Egypt by Implementing Entity1982-2005

Public Entities	Unit	% of total
Governorates	553,776	44.0%
New Urban Community Authority	251,061	20.0%
Housing and Development companies	43,118	3.4%
Joint Projects Agency	17,652	1.4%
Housing and construction cooperatives	278,277	22.1%
Housing Finance Fund	22,168	1.8%
Housing and Development Bank	63,674	5.1%
Development Agency	28,347	2.3%
Total	1,258,073	100.0%

Source: Ministry of Housing, Utilities and Urban Development

During the presidential campaign, a massive housing program was announced in 2005. This program will supply 500,000 economic housing units by 2011. Based on existing affordable housing supply practices (an average unit cost of USD10,000 for Mubarak youth housing project and an overall level of subsidy in the range of 70-75% of total development cost, if land and infrastructure are taken into account), the price tag of this program will equal to USD5 billion.

(3) Tenure

There are two surveys regarding housing tenure in GCR, namely housing demand survey in 2006 by USAID and the opinion poll survey in 2007 by the JICA study team. The result of housing demand survey shows that owned and rented share is amounted to 36.8% and 50.4% respectively. The rented housing is divided into two statuses which comply with the new rent law (Law No.4, 1996) and the old rent law (Rent Control Law (1952, 1958, 1961, 1962)). The old rent law has the large share of 82.3% to the total number of the rented housing units.

Of which owned housing, installment was applied by 72.2%, and 71.1% is registered as a property. There is no distinguish neither formal nor informal, although about half of households in GCR, it is rent status.

The results of the opinion poll survey obtained similar information. The owned housing units have the share of 35.3%, while 49.6% for the rented housing units. The registered housing units are estimated relatively low at 35% of the owned housings units.

Table 2.7.5 Housing Tenure Status in GCR

Tenure Status	Housing Demand Survey (%)			The Opinion Poll Survey (%)	
	Share	Installments	Registered	Share	Registered
Owned	36.8	72.2	71.1	35.3	35
Rent	50.4	100.0	-	49.6	
New Rent Law	8.7 (17.3)	17.3	-	9.1 (18.2)	
Old Rent Law	41.7 (82.3)	82.3	-	40.5 (80.8)	
Free	8.2	-	-	9.3	
Public	4.5	-	-		
Total	100.0	-	-		

Source: Edited from USAID (2007), Housing Demand Survey draft final report

(4) Preferred financial source for purchased housing units

The result of the housing demand survey carried out by USAID shows some preferred financial source for purchased housing units in GCR. More than half of the financial sources are private savings, including remittances from abroad (43.3% and 6.3%). About 30% of these private savings come from selling their property. Only 10.9% of the respondents had formal loans, comprising individual loans (4.6%), loans from the work place (3.8%) and bank loans (2.5%).

In 2005, the Egyptian Government approved a joint cooperation program between the Mortgage Financing Authority and the National Bank of Egypt. The program is designed to finance mortgage with interest rate at below 12% and a term of 10 to 20 years. While this program sounds promising, it is not clear when or how it will be implemented.

Recently international organizations, bilateral organizations, international companies, Egyptian public and private sectors are involved in mortgage finance, supporting real estate financing, technical assistance of information technology to both public and private participants in the real estate and finance industries including legal reform.

Table 2.7.6 Preferred Financial Source for Purchased Housing Units

Financial Source	Sample	Share (%)
Regular income savings	104	43.3
Savings from working abroad	15	6.3
Selling property	72	30.0
Contributions from relatives	22	9.2
Loans from individuals	11	4.6
Loans from work place	9	3.8
Bank loans	6	2.5
Other	1	0.4
Total	240	100.0

Source: USAID (2007), Housing Demand Survey Final Draft

(5) Findings

1) Lack of the consistent housing statistics

Housing statistics is quite limited and is inconsistent among the related agencies. It is vital to establish the appropriate information related to housing for planning and monitoring works. The planning boundary and statistical information should be overlaid.

2) Lack of housing stock for lower income group

It seems enough housing stock, whereas it is insufficient housing stock for lower income group especially for coming years in which population will increase. The affordable housings shall be required to reduce the high population density in main agglomeration.

3) Discouraging reinvestment for housing sector by the Old Rent Law

The old rental law is still dominated, approximately 80% of the total rental housing units. This phenomenon causes that incentives for landlords were despaired for investment of maintenance and upgrading housing units, as the results un-maintained housing stock increases and will remain.

4) Low property registration ratio

In deed it is unknown factor that how many property owners have registered properly. The housing demand survey shows that 71.1% are registered while the opinion poll survey shows only 35%. Property registration needs to be modernized.

5) Immature housing finance system

Only 2.5% of the housing owners were applied bank loan for purchasing housing unit, and the rest, mainly savings, are dominated by nearly half of the purchasers. Of which 30%, they sold previous housing units. A practical and affordable housing finance system shall be modernized in order to vitalize the housing market and enhance the urbanization in new urban communities.

2.7.2 Water Supply

(1) General

The River Nile, which is the main source of water for GCR, is 6,693 km long from its remotest headstream in Burundi to the river mouth at the Mediterranean Sea. There are ten countries in the River Nile basin and nearly 89 million people live in this Basin. Aswan High Dam was constructed in 1959-1970 to accommodate a gross water storage capacity of 169 billion m^3. Egypt has rights to withdraw 55.5 billion m^3/year of water from the Nile out of the total annual discharge of 74 billion m^3/year. Water supply in Egypt mostly relies upon the

water storage in Aswan High Dam. In contrast, the utilized groundwater amounts only to 4 billion m^3/year. The total raw water utilized for purified drinking water supply in urban areas in Egypt is approximately 4 %.

The River Nile and its alluvial aquifer meet all the water supply needs for municipal, irrigation, and industrial uses in the Study Area. However, Egypt is facing increasing water needs with rapidly population growth, accelerated urbanization, improved standard of living and so on. An optimal water management, such as the better utilizations and efficient uses of present water resources, is an essential prerequisite for sustainable development of the Study Area.

This sub-section first describes the, present conditions of water supply, secondly quick analysis of water demand and water supply, and finally recommendations on the efficiency issues on water supply in the Study Area.

(2) Present conditions of water supply

1) Operation agency and responsible organization

The Ministry of Housing, Utilities, and Urban Development (MOHUUD) is the lead ministry with a primary responsibility for the water and wastewater sector in Egypt. The Holding Company for Water and Wastewater (HCWW) established in 2004 is the managing arm of the MOHUUD for all water and wastewater companies in Egypt. Greater Cairo Water Supply Company (GCWSC) and the recently established Giza Water and Wastewater Company (GWWC), a kind of public corporations, are responsible for the purification of raw water and distribution of drinking water to the Study Area. The latter exists only since November 2007 and its organization is still in the phase of recruitment. There is intention to establish a third company to be responsible for Qaliobeya. Figure 2.7.1 depicts the organization chart of GCWSC.

The River Nile divides Greater Cairo into two parts, namely, the West and East Banks. The part of the West Bank has six water utility districts, each of which has its own operation and maintenance, customer service and economic units. The East Bank has 21 water utility districts of the similar nature.

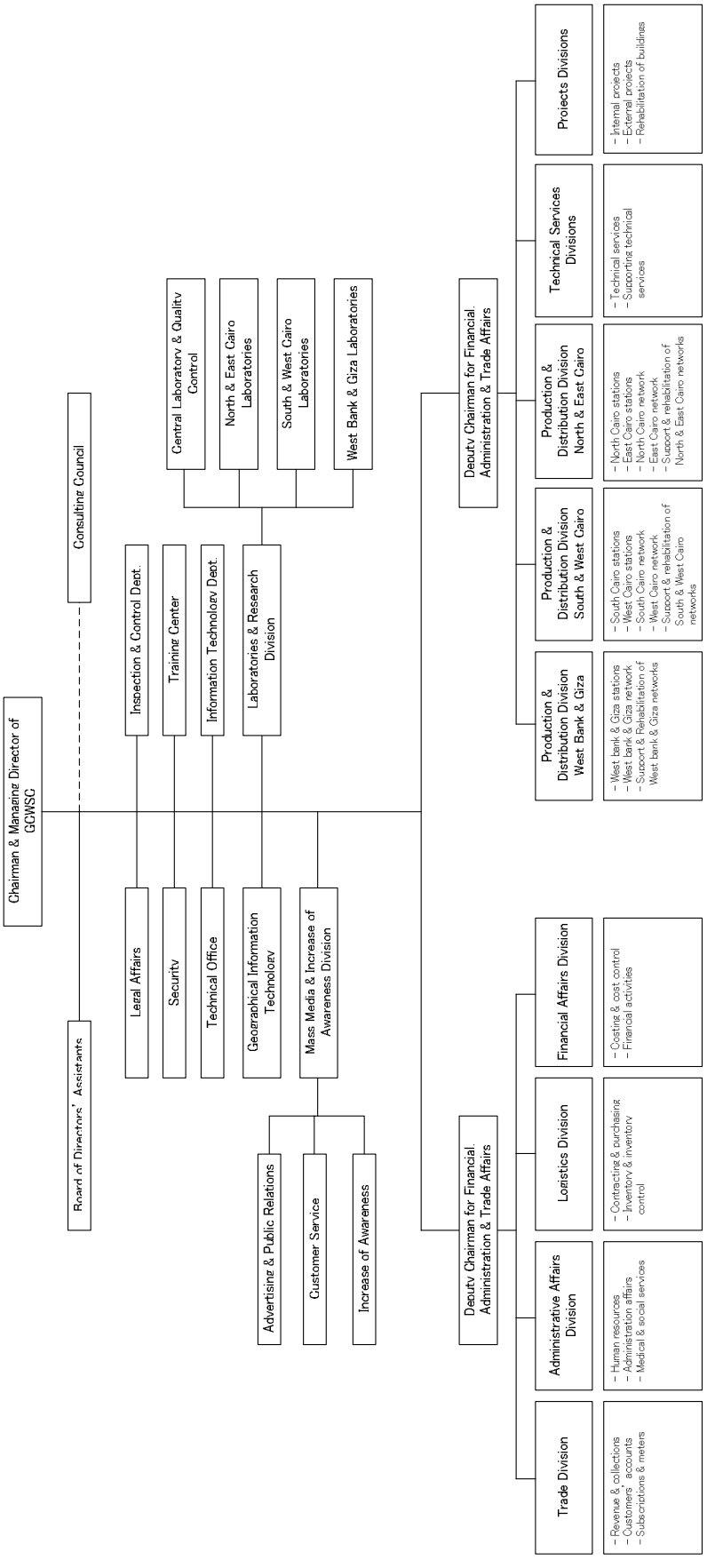


Figure 2.7.1 Organization Chart of GCWSC

Table 2.7.7 Water Utility District under GCWSC

West Bank	East Bank			
Al Ahram	Shobra Al Kheima	Al Khlafawi	Al Zawla	New Cairo
Sakiat Mekky	Bahteem	Al Zatoon	Alhay Al Asher	Al Maadi
Ket Kat	Al Marg	Al Zawla	Naser City	Helwan
West Munira	Ain Shams	Alhay Al Asher	El Waily	15 th May
Al Warak	Al Salam	Naser City	Manshiet Nasser	El Tebeen
Al Remaia	Al Nahda	El Waily	Ain Al Sira	
	Masr Al Gadeda	Al Zatoon	Al Mokatam	

Source: GCWSC

2) Existing facilities

Currently, there are 18 Water Purification Plants (WPP) serving the Study Area. Of these, 16 WPPs withdraw raw water from the River Nile and the remaining two WPPs withdraw raw water from Ismailia Canal. The water purification capacity of these 18 WPPs in the Study Area is summarized in Table 2.7.8. The total water purification capacity in the study area is 8,742,000 m^3/day. Location of these 18 WPPs is shown in Figure 2.7.2.

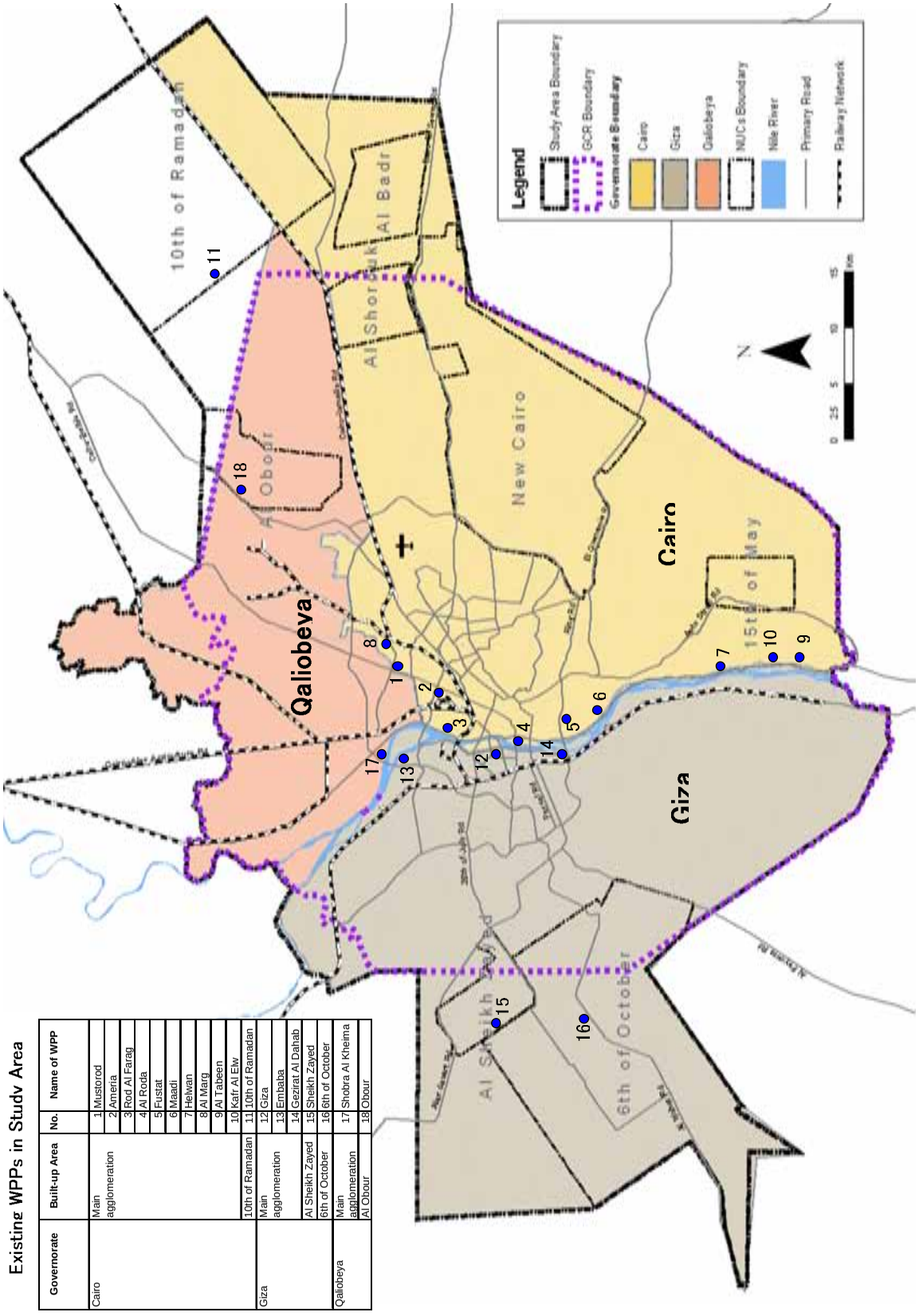
In addition to the surface water source, some areas utilize groundwater source, though the quantity of groundwater source is insignificant compared to that of surface water.

Table 2.7.8 Existing Water Purification Plants in the Study Area

Governorate	Built-up Area	No.	Name of WPP	Purification Capacity (1,000 m^3/day)
Cairo	Main Agglomeration	1	Mustorod	1,150
		2	Ameria	420
		3	Rod Al Farag	900
		4	Al Roda	174
		5	Fustat	1,050
		6	Maadi	90
		7	Helwan	250
		8	Al Marg	100
		9	Al Tabeen	650
		10	Kafr Al Elw	110
(Sharqia)	10th of Ramadan	11	10th of Ramadan*	570
Giza	Main Agglomeration and Villages and small towns	12	Giza	150
		13	Embaba	900
		14	Gezirat Al Dahab	450
	Al Sheikh Zayed	15	Sheikh Zayed	450
	6th of October	16	6th of October	268
Qaliobeya	Main Agglomeration and Villages and small towns	17	Shobra Al Kheima	400
	Al Obour	18	Obour*	660
Total Capacity				**8,742**

Source: CAPWO via GOPP

Note: * Two WPPs draw raw water from Ismailia Canal.
Groundwater is excluded in this table. Only some villages in Qaliobeya and in Giza take their water from groundwater sources. About 4 % of the population of the villages in Qaliobeya and 31% in Giza are receiving groundwater as their main source of drinking water.



Existing WPPs in Study Area

Governorate	Built-up Area	No.	Name of WPP
Cairo	Main agglomeration	1	Mustorod
		2	Ameria
		3	Rod Al Farag
		4	Al Roda
		5	Fustat
		6	Maadi
		7	Helwan
		8	Al Marg
		9	Al Tabeen
		10	Kafr Al Elw
	10th of Ramadan	11	10th of Ramadan
Giza	Main agglomeration	12	Giza
		13	Embaba
		14	Gezirat Al Dahab
	Al Sheikh Zayed	15	Sheikh Zayed
	6th of October	16	6th of October
Qaliobeya	Main agglomeration	17	Shobra Al Kheima
	Al Obour	18	Obour

Figure 2.7.2 Location Map of WPPs in Study Area

3) Water supply system

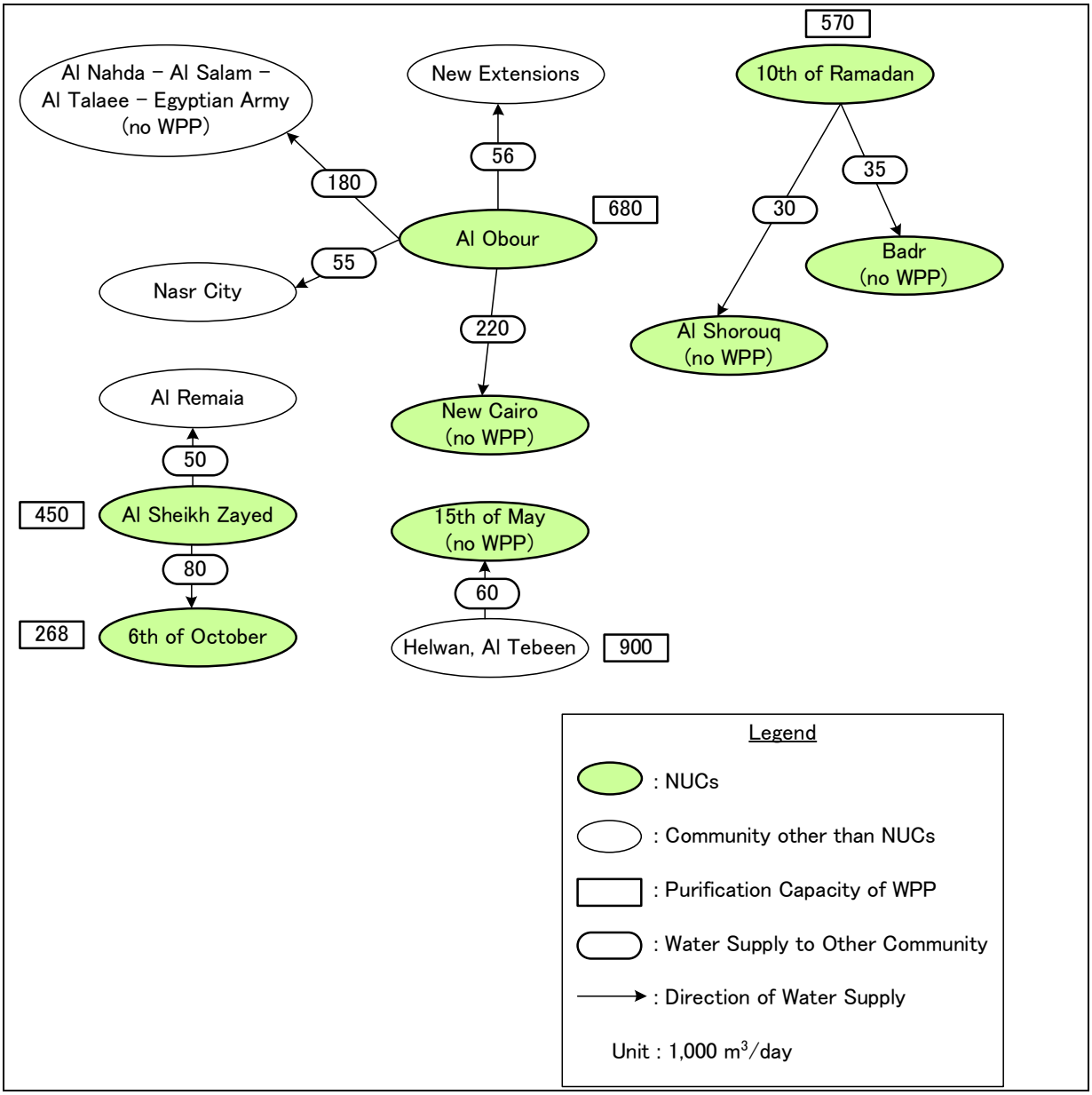
A large part of water purification is carried out in the Cairo Governorate as shown in Table 2.7.9. The purified water is transferred from some WPPs to other NUCs, since few NUCs have WPPs on their own. Four NUCs, namely, Badr, Al Shorouq, New Cairo and 15th of May do not possess own WPPs as shown in Figure 2.7.3, and they receives purified water from WPPs in other built-up areas.

Table 2.7.9 Water Supply Balance in the Study Area (2007)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Purification Capacity	Water Supply		Balance
			Going Out	Coming In	
		(1)	(2)	(3)	(1) - (2) + (3)
Cairo	Main agglomeration	4,894	60	0	4,834
	Badr	0	0	35	35
	Al Shorouq	0	0	30	30
	New Cairo	0	0	220	220
	15th of May	0	0	60	60
(Sharqia)	10th of Ramadan	570	65	0	505
Giza	Main agglomeration	1,500	213	50	1,337
	Al Sheikh Zayed	450	130	0	320
	6th of October	268	0	80	348
	Villages and small towns	0	0	213	213
Qaliobeya	Main agglomeration	400	209	291	482
	Al Obour	660	511	0	149
	Villages and small towns	0	0	209	209
Total		**8,742**	**1,188**	**1,188**	**8,742**

Source: CAPWO via GOPP



Source: CAPWO via GOPP

Figure 2.7.3 Water Supply System for NUCs

4) Water quality standard

The water quality standards used in Egypt are mostly similar to the maximum permissible levels in WHO (World Health Organization) standards as shown in Table 2.710. Usually the rapid sand filtration method is used for water purification process. Periodical water quality checks as in daily, weekly and monthly are carried out in WPPs as well as at several locations in the water distribution network.

Table 2.7.10 Water Quality Standards in Egypt

Items	Purified Water	Groundwater	WHO Standards (Maximum Permissible Level)
pH	6.5 – 9.2	6.5 – 9.3	6.5 – 9.2
Color (Hazen)	50	50	50
Taste	Acceptable	Acceptable	Unobjectionable
Odor	Acceptable	Acceptable	Unobjectionable
Turbidity	Jackson Unit 5	Jackson Unit 10	25
(TDS)	1,200	1,200	1,500
Total Hardness	500	500	500
Calcium	200	200	200
Magnesium	150	150	150
Nitrates	*45	*45	-
Fluoride	0.9	0.9	-
Chloride	500	500	600
Sulphate	400	400	400
Iron	1	1	1
Manganese	0.5	0.5	0.5
Copper	1.5	1.5	1.5
Lead	0.1	0.1	0.1
Zinc	15	15	15

Source: Preliminary study for water supply development in Greater Cairo and Lower Egypt, 2003 JICA

Note: TDS: Total Dissolved Solids, Values: Upper limit unless stated otherwise noticed. Units: ppm unless stated otherwise.

5) Water demand

The water demand in the Study Area is discussed here in two main factors, residential and industrial usage. The water demand in 2007 is preliminarily estimated for each NUC, and the other areas are categorized to the main agglomeration and villages and small towns in each governorate.

a) Water demand for residential usage

Residential water usage is estimated by multiplying the population and per capita consumption. The population for 2007 by the JICA Study Team and the per capita consumption rate according to the Egyptian code provided by GOPP is used for the estimation. The per capita consumption rate is supposed to include water leakage from distribution system, but it is noticed that water leakage as given in the code is lower than the actual leakage reported in other studies (Actual water leakage is reported to be more than 20 % while the Egyptian code considers it as only 7 %). Table 2.7.11 shows the present per capita consumption for residential water usage.

Some people in villages and small towns use groundwater from wells instead of water supply systems, although it is difficult to grasp the exact condition of water sources in villages and small towns. As shown in Table 2.7.12, present water demand for residential usage in the Study Area is estimated as 3,324,000 m^3/day. Present water demand for residential usage in the eight NUCs is estimated as 202,000 m^3/day, which accounts for 6 % of the total water demand for residential usage.

Table 2.7.11 Present Per Capita Consumption for Residential Usage

Built-up Area	Per Capita Consumption (litre / day)
NUCs	300
Main agglomeration in Cairo and Giza	220
Main agglomeration in Qaliobeya	180
Villages and small towns	130

Source: Egyptian Code provided by GOPP

Table 2.7.12 Present Water Demand for Residential Usage in the Study Area (2007)

Governorate	Built-up Area	Population	Per Capita Consumption	Daily Consumption
		(1)	(2)	(1) x (2)
		(1,000 Person)	(litre/day)	(1,000 m^3/day)
Cairo	Badr	18	300	5
	Al Shorouq	28	300	9
	New Cairo	125	300	38
	15th of May	92	300	28
	Main agglomeration	7,629	220	1,678
(Sharqia)	10th of Ramadan	137	300	41
Giza	Al Sheikh Zayed	45	300	13
	6th of October	168	300	50
	Main Agglomeration	3,424	220	753
	Villages and small towns	1,641	130	213
Qaliobeya	Al Obour	61	300	18
	Main agglomeration	1,492	180	269
	Villages and small towns	1,604	130	209
Total		**16,464**		**3,324**

Source: JICA Study Team

b) Water demand for industrial usage

The industrial water demand is estimated by multiplying the area allocated for industries and the specific industrial water usage criteria per hectare as given in the Egyptian code. Table 2.7.13 shows the industrial water use criteria according to the Egyptian code. The land use data provided by MOTI is used for the estimation. As the area of industrial land actually includes roads, parking lots, green belts and so on, the net area for industries is assumed as 80 percent of the total industrial land in this estimation. As shown in Table 2.7.14, water demand for industries in 2007 is estimated as 795,000 m^3/day.

Table 2.7.13 Water Demand Criteria for Industrial Water Usage

Location of Industrial Area	Criteria
	(litre / ha / second)
NUCs	3.0
Other than NUCs	2.0

Source: Egyptian Code for the Design Criteria and Implementation Requirements for Water Purification Plants, Wastewater Treatment Plants, and Wastewater Pump Stations, Ministerial Decree No. (52), 1998.

Table 2.7.14 Present Water Demand for Industry (2007)

Governorate	Built-up Area	Total Industrial Land*	Developed Industrial Land as of 2007*	Land for Plants as of 2007	Industrial Water Criteria **	Daily Water Demand
		(1)	(2)	(3) = (2) x 0.8	(4)	(5) = (3) x (4) x 0.0864
		(ha)	(ha)	(ha)	(litre/ha/s)	(1,000 m^3/day)
Cairo	Badr	973	247	198	3.0	51
	Al Shorouq	58	0	0	3.0	0
	New Cairo	458	0	0	3.0	0
	15th of May	156	9	7	3.0	2
	Main agglomeration	386	37	30	2.0	5
(Sharqia)	10th of Ramadan	4,000	1,414	1,131	3.0	293
Giza	Al Sheikh Zayed	0	0	0	3.0	0
	6th of October	3,740	1,308	1,046	3.0	271
	Main agglomeration	598	507	406	2.0	70
Qaliobeya	Al Obour	1,203	440	352	3.0	91
	Main agglomeration	834	82	66	2.0	11
Total		**12,406**	**4,261**	**3,235**		**795**

Source: JICA Study Team
Note: * Industrial land area in each built-up area is provided by MOTI.
** Industrial water use criteria as provided in the Egyptian code.

c) Total water demand in 2007

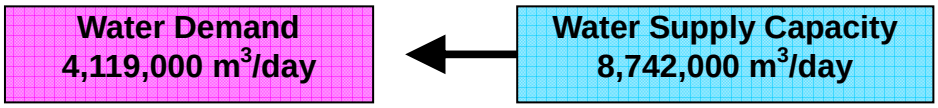
As shown in Table 2.7.15, the total water demand in the study area in 2007 is estimated as 4,119,000 m^3/day. The present water demand in eight NUCs is estimated as 913,000 m^3/day, which corresponds to 22 % of the total water demand. The total water demand in 2007 is significantly less than the available water purification capacity in the Study Area as shown in Figure 2.7.4.

Table 2.7.15 Total Water Demand in the Study Area (2007)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Residential Usage	Industrial Usage	Total Water Demand
		(1)	(2)	(1) + (2)
Cairo	Badr	5	51	57
	Al Shorouq	9	0	9
	New Cairo	38	0	38
	15th of May	28	2	30
	Main agglomeration	1,678	5	1,683
(Sharqia)	10th of Ramadan	41	293	334
Giza	Al Sheikh Zayed	13	0	13
	6th of October	50	271	322
	Main agglomeration	753	70	823
	Villages and small towns	213	0	213
Qaliobeya	Al Obour	18	91	110
	Main agglomeration	269	11	280
	Villages and small towns	209	0	209
Total		**3,324**	**795**	**4,119**

Source: JICA Study Team
Note: * Per capita of water demand is provided by GOPP



Source: JICA Study Team

Figure 2.7.4 Water Supply Balance in 2007

d) Financial situation

The Trade Division in GCWSC is responsible for the tariff collection and customer database and management for water supply.

The water tariff for each category of usage as tabulated in Table 2.7.16 has been applied since September 2004 when HCWW was established in order to recover the costs to cover O&M. The establishment of HCWW was aimed at financial autonomy and HCWW targets not only recovering O&M but ultimately covering the capital cost and achieving a profit.

Table 2.7.16 Water Tariff by GCWSC

No.	Categories of Usage	Water Tariff (LE/m^3)
1	Domestic	
	From $1m^3$ to $10m^3$ monthly	0.23
	From $11m^3$ to $30m^3$ monthly	0.25
	More than $30m^3$ monthly	0.35
	Building under construction	0.80
2	Fixed rate for Governorate Houses	
	1 room flat	3.00
	2 rooms flat	3.60
	3 rooms flat	4.80
	more than 3 rooms flat	6.00
3	Unions, and factions premises, syndicate and political parties	0.48
4	Non-governmental places for workshop / youth yards / youth centers	0.42
5	Embassies	0.48
6	Small factories /workshops /coffee shops /local restaurants /shops	0.70
7	Large factories / gas station / 2nd and 3rd class hotels / private school	0.80
8	Private hospitals / 1st class hotels / funfairs 1st class restaurant	1.25
9	Raw water	0.22
10	National associations	0.42
11	(B) class sport clubs subsidized by the ministry of youth	0.48
12	Governmental medical insurance hospital	0.70
13	(A) class sports clubs	1.00
14	Garages and bakeries	0.70
15	Raw water for free zones and investment companies	0.19
16	Purified water	0.22
17	Governmental office / localities / governmental factories	0.65

Source: HCWW

7) Existing plan and on-going project

The Organization for the Execution of Greater Cairo and Alexandria Potable Water and Wastewater Project (CAPWO) prepared a new five-year development plan which

covers financial years from 2007 to 2011. This new five-year development plan was approved by the Ministry of Planning in accordance with the sixth national development plan. The total investment budget for the water supply expansion and improvement in the Study Area was amended to be approximately LE 4.6 billion.

HCWW is in the process of updating a master plan for both water and wastewater sectors for GCR for the target year 2037. A number of water and wastewater projects will be identified in the near future accordingly.

Based on the plans, the water supply capacity will be expanded from 8,742,000 m^3/day to 14,572,000 m^3/day as shown in Table 2.7.17. The water purification capacity in 6th of October will be increased five times following a large scale extension plan.

Table 2.7.17 Future Water Purification Capacity in the Study Area

Unit: 1,000 m^3/day

Governorate	Built-up Area	Name of WPP	Purification Capacity (1,000 m^3/day)		
			Existing	Plan*	Total in Future
Cairo	Main agglomeration	Mustorod	1,150	150	1,300
		Ameria	420	200	620
		Rod Al Farag	900	100	1,000
		Al Roda	174	0	174
		Fustat	1,050	200	1,250
		Maadi	90	400	490
		Helwan	250	100	350
		Al Marg	100	600	700
		Altabeen	650	100	750
		Kafr Al Elw	110	0	110
	New Cairo	New Cairo	0	2,000	2,000
(Sharqia)	10th of Ramadan	10th of Ramadan	570	230	800
Giza	Main agglomeration	Giza	150	0	150
		Embaba	900	400	1,300
		Gezirat Al Dahab	450	150	600
	Al Sheikh Zayed	Sheikh Zayed	450	0	450
	6th of October	6th of October	268	1,000	1,268
	Villages and small towns		0	0	0
Qaliobeya	Main agglomeration	Shobra Al Kheima	400	200	600
	Al Obour	Obour	660	0	660
	Villages and small towns		0	0	0
Total			**8,742**	**5,830**	**14,572**

Source: CAPWO via GOPP

Note: * Plan includes extension and newly construction of WPPs which will be completed before 2027. Groundwater is excluded in this table.

8) Existing problems for water supply

Water supply in the Study Area has some problems in the existing facilities, networks and distribution systems as follow:

- In some WPPs, the exact water productions are not measured since the water flow meters in some of the WPPs are not functional.
- Many household connections are not metered, and hence, the quantity of drinking water and leakage is not known precisely.
- According to USAID, actual per capita consumption is estimated as 340 litre/day from the total water supply quantity and population in GCR. It is composed of 80 litre/day of leakage water, 130 liter/day of wasting water in residences and 130 litre/day of actual usage in residences.
- Unstable water pressure and unreliable supply may cause pollution of drinking water by contaminated groundwater or leaking wastewater entering into the water distribution system through damaged joints.
- Some of the presently used pipe materials should be investigated, and old or damaged pipes should be replaced, especially asbestos cement pipes.
- In some part of the water supply system, pipe diameters and hydraulic pressures are unsuitable for the demand, which should be adjusted.
- The water tariff is considerably low and that does not make people pay attention to water leakage or conservation of water resources.
- Parts of informal settlement areas are not served with the water supply system.
- Plans of water distribution networks are not prepared completely.

(3) Quick analysis of water demand and water supply in 2027

1) Projection of future water demand

a) Water demand for residential usage

Future water demand in 2027 is preliminary estimated in this study. The population projection by the JICA Study Team is used for the estimation. Two scenarios for the per capita consumption are assumed as follows:

Scenario 1: Per capita consumption will not increase up to the year 2027

Scenario 2: Per capita consumption will increase till the year 2027

According to GOPP, recently all of the studies for water demand in Egypt follow the method in *Scenario 1*. GOPP requested JICA Study Team to follow the same method. On the other hand, per capita consumption is usually considered to increase as the people's standard of living is improved in the future. Moreover, an increase in the leakage in aged pipes may need compensation by increasing per capita consumption.

Assumptions for increasing rate of the per capita consumption in *Scenario 2* are shown in Table 2.7.18. The increasing rate for NUCs is set at 1.0 % because the Egyptian code sets per capita consumption as high value (300 litre/day) and most of

drinking water distribution system is still new. The increasing rate for the main agglomeration and villages and small towns is set at 2.0 % and 3.0 %, respectively.

Projected future water demand for residential usage in eight NUCs is in the range from 1.2 million m^3/day to 1.5 million m^3/day as shown in Table 2.7.19. It is almost six times the present water demand. Estimated water demand for residential usage in the eight NUCs accounts for 20 % of the total water demand for residential usage.

Table 2.7.18 Assumed Increasing Rate of per Capita Consumption

Built-up Area	Rate (percent per year)
NUCs	1.0
Main agglomeration	2.0
Village and small towns	3.0

Source: JICA Study Team

Table 2.7.19 Estimated Water Demand for Residential Usage (2027)

Governorate	Built-up Area	Population (1) (1,000 Person)	Per Capita Consumption (2) (litre/day)	Daily Consumption (1) x (2) (1,000 m^3/day)
Scenario 1 (No increase in Per Capita Consumption for Residential Usage)				
Cairo	Badr	151	300	45
	Al Shorouq	459	300	138
	New Cairo	494	300	148
	15th of May	200	300	60
	Main agglomeration	9,184	220	2,020
(Sharqia)	10th of Ramadan	586	300	176
Giza	Al Sheikh Zayed	242	300	73
	6th of October	1,208	300	362
	Main agglomeration	4,545	220	1,000
	Villages and small towns	2,134	130	277
Qaliobeya	Al Obour	819	300	246
	Main agglomeration	2,010	180	362
	Villages and small towns	2,161	130	281
Total		**24,192**		**5,188**
Scenario 2 (Per Capita Consumption for Residential Usage is assumed increasing)				
Cairo	Badr	151	366	55
	Al Shorouq	459	366	168
	New Cairo	494	366	181
	15th of May	200	366	73
	Main agglomeration	9,184	327	3,003
(Sharqia)	10th of Ramadan	586	366	214
Giza	Al Sheikh Zayed	242	366	89
	6th of October	1,208	366	442
	Main agglomeration	4,545	327	1,486
	Villages and small towns	2,134	235	501
Qaliobeya	Al Obour	819	366	300
	Main agglomeration	2,010	267	537
	Villages and small towns	2,161	235	508
Total		**24,192**		**7,557**

Source: JICA Study Team

b) Water demand for industrial usage

In assumption that water demand criteria for industrial water usage (shown in Table 2.7.13) is to be stable up to the year 2027 and planned industrial land is to be developed completely by the year 2027, the water demand for industry in the Study Area in 2027 is estimated at 2,447,000 m^3/day as shown in Table 2.7.20.

Table 2.7.20 Estimated Water Demand for Industry (2027)

Governorate	Built-up Area	Total Industrial Land* (1) (ha)	Developed Industrial Land as of 2007* (2) (ha)	Land for Plants as of 2027 (3) = (1) x 0.8 (ha)	Industrial Water Criteria ** (4) (litre/ha/s)	Daily Water Demand (5) = (3) x (4) x 0.0864 (1,000 m^3/day)
Cairo	Badr	973	247	778	3.0	202
	Al Shorouq	58	0	46	3.0	12
	New Cairo	458	0	366	3.0	95
	15th of May	156	9	125	3.0	32
	Main agglomeration	386	37	309	2.0	53
(Sharqia)	10th of Ramadan	4,000	1,414	3,200	3.0	829
Giza	Al Sheikh Zayed	0	0	0	3.0	0
	6th of October	3,740	1,308	2,992	3.0	775
	Main agglomeration	598	507	479	2.0	83
Qaliobeya	Al Obour	1,203	440	963	3.0	249
	Main agglomeration	834	82	667	2.0	115
Total		**12,406**	**4,261**	**9,925**		**2,447**

Source: JICA Study Team
Note: * Industrial land area in each built-up area is provided by MOTI.
** Industrial water use criteria as provided in the Egyptian code.

c) Total water demand in 2027

As shown in Table 2.7.21, the water demand in the study area in 2027 is estimated as in the range from 7,635,000 to 10,004,000 m^3/day. Water demand for industrial usage accounts for approximately 30 % of the total water demand. The estimated water demand in the eight NUCs ranges from 3,443,000 m^3/day to 3,717,000 m^3/day, which corresponds approximately to 40 % of the total water demand. Because of the rapid population increase and expanding industrial usages, the eight NUCs will have a sizable share in the water demand, particularly 10th of Ramadan and 6th of October NUCs.

Table 2.7.21 Estimated Water Demand (2027)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Residential Usage (1)	Industrial Usage (2)	Total Water Demand (1) + (2)
Scenario 1 (No increase in Per Capita Consumption for Residential Usage)				
Cairo	Badr	45	202	247
	Al Shorouq	138	12	150
	New Cairo	148	95	243
	15th of May	60	32	92
	Main agglomeration	2,020	53	2,074
(Sharqia)	10th of Ramadan	176	829	1,005
Giza	Al Sheikh Zayed	73	0	73
	6th of October	362	775	1,138
	Main agglomeration	1,000	83	1,083
	Villages and small towns	277	0	277
Qaliobeya	Al Obour	246	249	495
	Main agglomeration	362	115	378
	Villages and small towns	281	0	281
Total		**5,188**	**2,447**	**7,635**
Scenario 2 (Per Capita Consumption for Residential Usage is assumed increasing)				
Cairo	Badr	55	202	257
	Al Shorouq	168	12	180
	New Cairo	181	95	276
	15th of May	73	32	105
	Main agglomeration	3,003	53	3,057
(Sharqia)	10th of Ramadan	214	829	1,044
Giza	Al Sheikh Zayed	89	0	89
	6th of October	442	775	1,217
	Main agglomeration	1,486	83	1,569
	Villages and small towns	501	0	501
Qaliobeya	Al Obour	300	249	549
	Main agglomeration	537	115	553
	Villages and small towns	508	0	508
Total		**7,557**	**2,447**	**10,004**

Source: JICA Study Team

2) Water supply balance in 2027

The water supply capacity will be raised from 8,742,000 m^3/day to 14,572,000 m^3/day as described in Table 2.7.17. In this analysis, quantity of purified water supply in the built-up areas is assumed similar with the present condition. Table 2.7.22 shows the future water supply balance in the Study Area.

Table 2.7.22 Future Water Supply Balance in the Study Area (2027)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Purification Capacity	Water Supply		Balance
			Going Out	Coming In	
		(1)	(2)	(3)	(1) - (2) + (3)
Cairo	Main agglomeration	6,744	60	0	6,684
	Badr	0	0	35	35
	Al Shorouq	0	0	30	30
	New Cairo	2,000	0	220	2,220
	15th of May	0	0	60	60
(Sharqia)	10th of Ramadan	800	65	0	735
Giza	Main agglomeration	2,050	277	50	1,823
	Al Sheikh Zayed	450	130	0	320
	6th of October	1,268	0	80	1,348
	Villages and small towns	0	0	277	277
Qaliobeya	Main agglomeration	600	281	291	610
	Al Obour	660	511	0	149
	Villages and small towns	0	0	281	281
Total		**14,572**	**1,324**	**1,324**	**14,572**

Source: JICA Study Team
Note: Water supply for villages and small towns is depending on the water demand. Water demand for Scenario 1 is used for it.

3) Comparison study between water demand and water supply

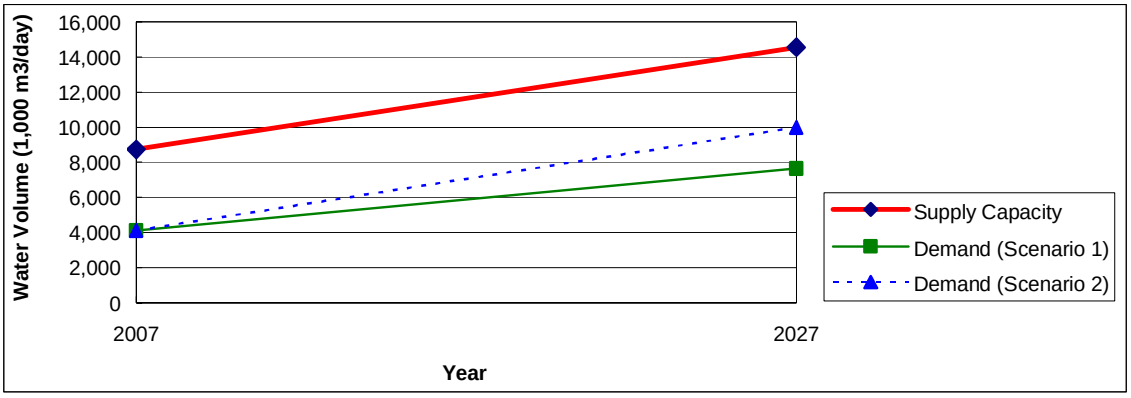
The comparison between the water supply capacity and the demand is summarized in Table 2.7.23 and Figure 2.7.5, respectively. The figure indicates that overall water supply capacity will be enough for water demand in the year 2027. However, some NUCs such as Al Obour, 10th of Ramadan, Badr will require water supply from the main agglomeration in Cairo Governorate. Water supply capacity of 6th of October will satisfy its water demand because of a large scale extension plan.

Table 2.7.23 Comparison between Water Demand and Water Supply Capacity in 2027

Unit: 1,000 m^3/day

Governorate	Built-up Area	Water Supply Capacity* (1)	Water Demand (2)	Balance (1) - (2)
Scenario 1 (No increase in Per Capita Consumption for Residential Usage)				
Cairo	Badr	35	247	-212
	Al Shorouq	30	150	-120
	New Cairo	2,220	243	1,977
	15th of May	60	92	-32
	Main agglomeration	6,684	2,074	4,610
(Sharqia)	10th of Ramadan	735	1,005	-270
Giza	Al Sheikh Zayed	320	73	247
	6th of October	1,348	1,138	210
	Main agglomeration	1,823	1,083	740
	Villages and small towns	277	277	0
Qaliobeya	Al Obour	149	495	-346
	Main agglomeration	610	378	133
	Villages and small towns	281	281	0
Total		**14,572**	**7,635**	**6,937**
Scenario 2 (Per Capita Consumption for Residential Usage is assumed increasing)				
Cairo	Badr	35	257	-222
	Al Shorouq	30	180	-150
	New Cairo	2,220	276	1,944
	15th of May	60	105	-45
	Main agglomeration	6,684	3,057	3,627
(Sharqia)	10th of Ramadan	735	1,044	-309
Giza	Al Sheikh Zayed	320	89	231
	6th of October	1,348	1,217	131
	Main agglomeration	**1,599	1,569	30
	Villages and small towns	501	501	0
Qaliobeya	Al Obour	149	549	-400
	Main agglomeration	**383	553	-269
	Villages and small towns	508	508	0
Total		**14,572**	**10,004**	**4,568**

Source: JICA Study Team
Note: * Water supply capacity in 2027 is provided by GOPP
** It is into account that Villages and small towns are supplied water from Main agglomeration in each Governorate.



Source: JICA study team

Figure 2.7.5 Comparison between Water Demand and Water Supply Capacity

(4) Efficiency issues on water supply

As described above, the total water supply capacity with planned extensions will be enough to cover the water demand. However, some issues have to be raised regarding the water quantity as well as the supply system. The recommendations for improvement of the water supply in the Study Area are as follow.

1) Water balance

- For the four NUCs located in the northwest direction of the Study Area, namely, 10th of Ramadan, Badr, Al Shorouq and Al Obour, there will be shortage of water supply. Hence, these NUCs will need to receive purified water from WPPs in the Governorate of Cairo such as WPP at Mustorod and Al Marg.
- Although 10th of Ramadan and Al Obour have their own WPPs, they are expected to have shortage of purified water in 2027. It is worth studying extension or construction of new WPPs in Badr and Al Shorouk. Review of water supply balance in the built-up area also may as well provide a surplus capacity to solve the problem.
- 15th of May is also expected to have some shortage of water in 2027. It is worth reviewing the water supply balance in the built-up area.

2) Operation and maintenance

- Reduce unaccounted for water including leakage. Proper and regular preventive maintenance of the water supply system as well as metering of water supply to all users are the key measures in achieving this goal.
- Restrict the use of purified water for other purposes such as irrigation of private or public gardens and green belts. This action would contribute to conservation of valuable water resources and make more water available for higher priority needs.

- Increase water tariff in order to cover the cost of operation and maintenance and depreciation of capital investment. This action will discourage the public to waste valuable water.

- Reduce the network leakage. Pipe diameters should be checked through hydraulic modeling of the pipe network to maintain an appropriate distribution system.

- Establish a proper maintenance system including preparation of water distribution network drawings, procurement of leakage inspection equipment, educations/trainings tools for leakage inspection and so on.

- Establish Qaliobeya Water and Wastewater Company in line with the decentralizing the operation and maintenance of the water supply system, improving system performance, and give more attention to the villages and small towns of Qaliobeya.

3) Efficiency issues on villages and small towns

- Investigate the water quality and disinfection process in the villages and small towns where groundwater is used for water supply.

- It was stated that some rural areas in Qaliobeya and Giza Governorates are taking their water supply from groundwater sources. If the groundwater is proven not contaminated by any pollution sources, it is often more economical than the surface water as less comprehensive purification works is required than the surface water. However, quality of groundwater should be carefully examined before a decision is made to use. If contamination of groundwater by sewage is detected, disinfection with chlorine must be avoided completely due to the risk of forming carcinogenic compounds. For villages, which are located far from the main WPP and have no wastewater system, the probability of groundwater contamination is usually high. Under such circumstances it is recommended to use compact units for treating surface water from nearby water courses as a source to supply the villages and avoid groundwater.

2.7.3 Wastewater Treatment

(1) General

Residential and industrial wastewater is mainly collected and treated within the Study Area. The agricultural drains are mainly the ultimate receptor of wastewater after treatment. Since rainfall in the Study Area is little (approximately 25 mm/year), storm water drainage is generally not considered except in special areas of high priority and importance.

Environmental issues related to wastewater treatment in the Study Area are the great concern because the food productions including agriculture and fishery rely heavily on re-use of the waste- and drain-water.

This sub section, first describes the present conditions of wastewater treatment, secondly a quick analysis of wastewater generation and wastewater treatment capacity, and finally recommendations for efficiency issues on wastewater treatment, in the Study Area.

(2) Present conditions of wastewater treatment

1) Operation agency and responsible organization

Ministry of Housing, Utilities and Urban Development (MOHUUD) is responsible for sewage systems on the national level. There are two organizations under MOHUUD. First, Organization for Execution of Greater Cairo and Alexandria Portable Water and Wastewater Projects (CAPWO), which is responsible for the implementation of all projects related to water and sewage systems in the Greater Cairo and Alexandria areas. Second, National Organization for Portable Water and Sanitary Drainage (NOPWASD), which is responsible for projects related to water supply and sewage systems in whole Egypt except for the Greater Cairo and Alexandria areas. On the other hand, HCWW was established in 2004 to be responsible for the management of all water and wastewater companies in Egypt.

Greater Cairo Sanitary Drainage Company (GCSDC) and the recently established GWWC, are responsible for the operation and maintenance of the sewage system in the Study Area. The latter exists only since November 2007 and its organization is still in the phase of recruitment. There is intention to establish a third company to be responsible for Qaliobeya. Figure 2.7.5 shows the organization chart of GCSDC.

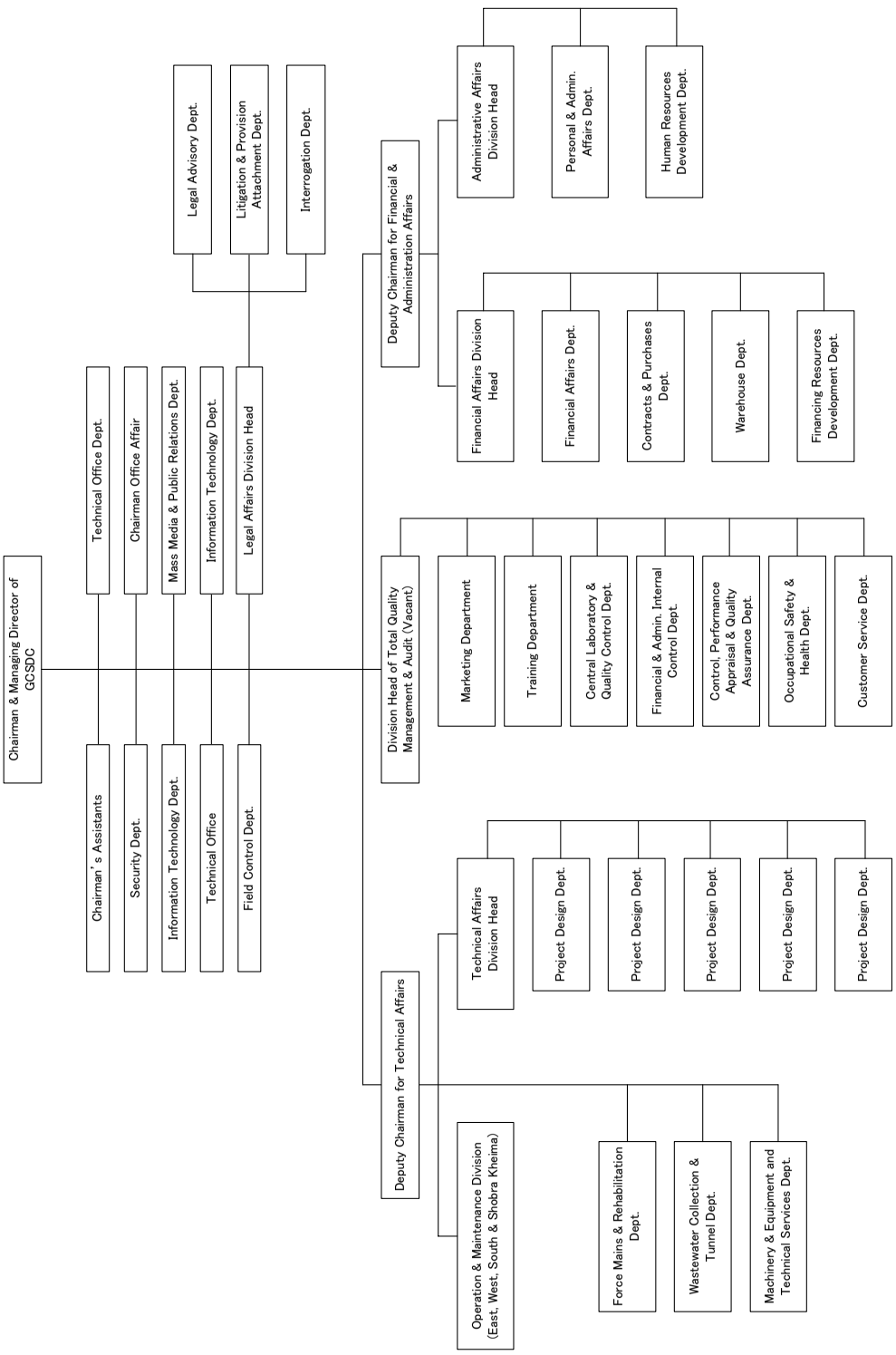


Figure 2.7.6 Organization Chart of GCSDC

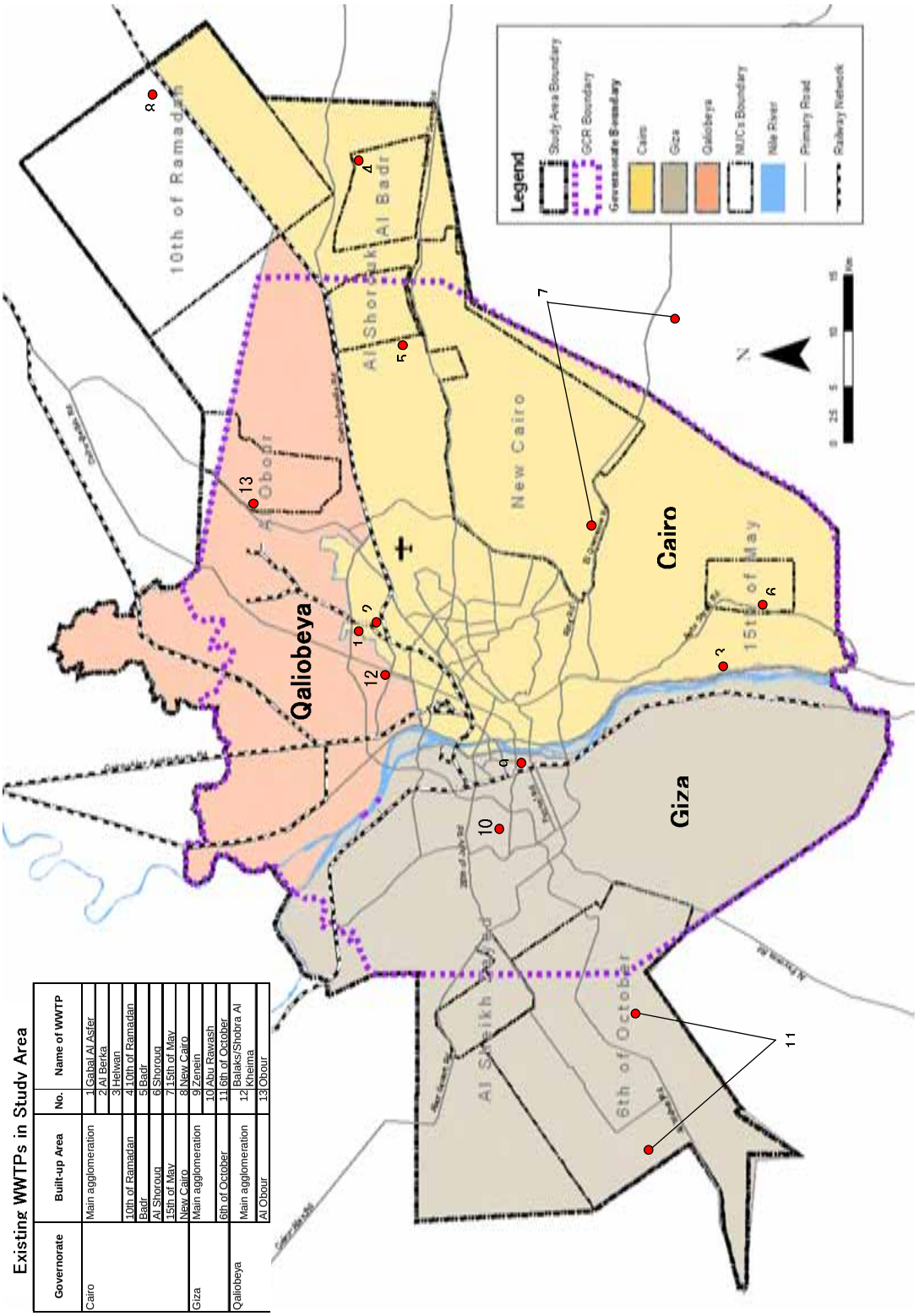
2) Existing treatment facilities

There are 13 Wastewater Treatment Plants (WWTP) to serve the Study Area. The treatment capacity of these 13 WWTPs in the Study Area is shown in Table 2.7.24. The total treatment capacity in the study area is 4,557,000 m^3/day. Locations of the 13 WWTPs are shown in Figure 2.7.7.

Table 2.7.24 Existing Wastewater Treatment Plant in the Study Area

Governorate	Built-up Area	No.	Name of WWTP	Treatment Capacity (1,000 m^3/day)	Treatment Method *
Cairo	Main agglomeration	1	Gabal Al Asfer	1,700	AS
		2	Al Berka	600	AS
		3	Helwan	350	AS
	Badr	4	Badr	26	SP
	Al Shorouq	5	Shorouq	27	MandP
	15th of May	6	15th of May	30	TT
	New Cairo	7	New Cairo	8	CU
(Sharqia)	10th of Ramadan	8	10th of Ramadan	381	MandP, AL
Giza	Main agglomeration and Villages and small towns	9	Zenein	330	AS
		10	Abu Rawash	400	Primary
	6th of October	11	6th of October	100	TT
Qaliobeya	Main agglomeration and Villages and small towns	12	Balaks/Shobra Al Kheima	600	TT
	Al Obour	13	Obour	5	SP
Total Capacity				**4,557**	

Source: CAPWO via GOPP
Note: * AS: Activated Sludge, MandP: Mechanical and Primary, AL: Aerated Lagoon, SP: Stabilization Pond, TT: Tertiary Treatment, CU: Compact Unit



Existing WWTPs in Study Area

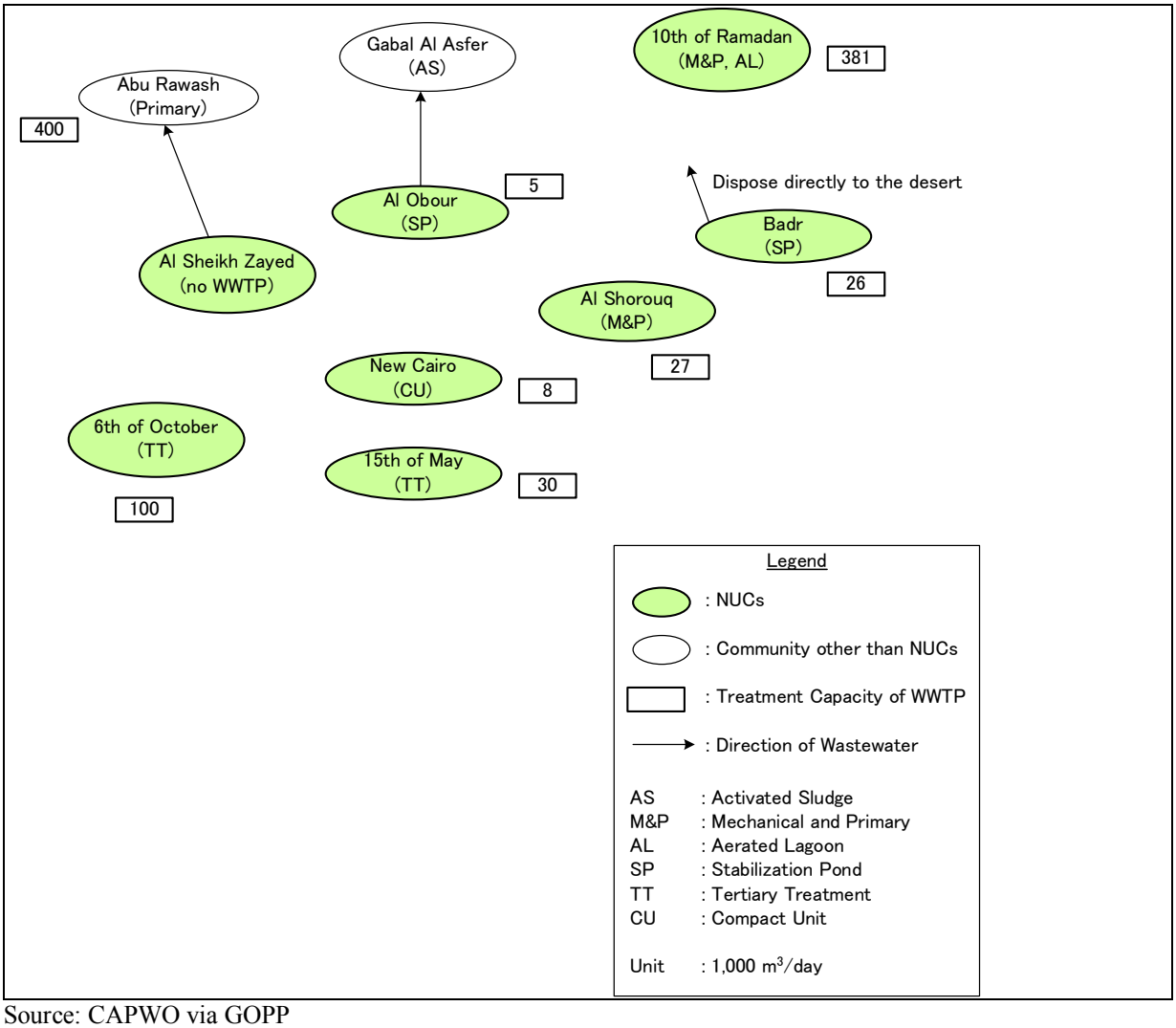
Governorate	Built-up Area	No.	Name of WWTP
Cairo	Main agglomeration	1	Gabal Al Asfar
		2	Al Berka
		3	Helwan
	10th of Ramadan	4	10th of Ramadan
	Badr	5	Badr
	Al Shoroud	6	Shoroud
	15th of May	7	15th of May
	New Cairo	8	New Cairo
Giza	Main agglomeration	9	Zenein
		10	Abu Rawash
	6th of October	11	6th of October
Qaliobeya	Main agglomeration	12	Balaks/Shobra Al Kheima
	Al Obour	13	Obour

Figure 2.7.7 Location Map of WWTPs in Study Area

3) Wastewater treatment system

As for the treatment method, the activated sludge (AS) is adopted for the wastewater treatment plants in the urban areas because it requires relatively small area of land for the plants compared with other methods such as stabilization pond (SP), aerated lagoon (AL) and so on. Though the AS is a compact and efficient method, the cost of operation and maintenance is relatively high. For some of the NUCs, SP and AL are used where land is available, as the low operation and maintenance cost is incurred.

As shown in Figure 7.2.8, wastewater generated in Al Sheikh Zayed is transferred to WWTP in Abu Rawash since there is not WWTP in Al Sheikh Zayed. The quantity of generated wastewater in Al Obour and Badr exceeds the wastewater treatment capacity of their WWTPs. Therefore, some generated wastewater of Al Obour is transferred to Gabal Al Asfer WWTP in Cairo Governorate and that of Badr is disposed to the desert directly.



Source: CAPWO via GOPP

Figure 2.7.8 Wastewater Treatment System for NUCs

4) Water quality standard

a) Wastewater discharge to the River Nile

The Law 48 prohibits direct wastewater discharge to the River Nile and specifies water quality standard for treated wastewater since 1982. Table 2.7.25 shows the water quality standard for treated wastewater discharge to agriculture drains.

Table 2.7.25 Water Quality Standards for Treated Wastewater Discharge to Drains

Items	Unit	Treatment Requirement
pH		6 – 9
Temperature	℃	Not more than 35
Dissolved Oxygen	mg/l	Not Less than 5.0
Absorption of Activated Oxygen	mg/l	Less than 60.0
COD (Permanganate method)	mg/l	Less than 40.0
COD (Dichromate method)	mg/l	Less than 80.0
SS	mg/l	Less than 50.0
Sulphate	mg/l	Less than 1.0
Oils and Greases	mg/l	Less than 10.0
Nitrates	mg/l	Less than 50.0

Source: Law 48 (1982) in Egypt

b) Industrial wastewater discharge to sewage system

The Decree No. 44 of the year 2000 (amending the executive law No. 93/1962) was issued to regulate the quality of the industrial effluent discharge to sewerage system. The article 14 of this decree provides criteria and specifications to be fulfilled in the liquid wastes emanating from industrial or commercial establishments to drain into public wastewater network.

Table 2.7.26 Water Quality Standards for Industrial Wastewater Discharge to Sewage System

Items	Unit	Treatment Requirement	Items	Unit	Treatment Requirement
pH		6 – 9.5	**Heavy Minerals***		
Temperature	℃	Not more than 43	Hexavalent Chromium	mg/l	Less than 0.5
COD (Dye Chromate)	mg/l	Less than 1,100.0	Cadmium	mg/l	Less than 0.2
BOD_5	mg/l	Less than 600.0	Lead	mg/l	Less than 1.0
TSS	mg/l	Less than 800.0	Mercury	mg/l	Less than 0.2
Solute Sulfides	mg/l	Less than 10.0	Silver	mg/l	Less than 0.5
Oils and Lubricants	mg/l	Less than 100.0	Copper	mg/l	Less than 1.5
Total Nitrogen	mg/l	Less than 100.0	Nickel	mg/l	Less than 1.0
Cyanide	mg/l	Less than 0.2	Tin	mg/l	Less than 2.0
Phenol	mg/l	Less than 0.05	Arsenic	mg/l	Less than 2.0
Precipitates	cm^3/l	After 10 minutes 8 After 15 minutes 15	Boron	mg/l	Less than 1.0

Source: Law 44 (2000) in Egypt
Note: Total Heavy Minerals shall not exceed 5mg/l.

In addition, industrial wastewater must be clear of etherized oil, calcium, carbide, and organic solvents, or any other matter the existence of which is considered by the concerned authority to represent an impending danger to the workers in charge of the network maintenance, or to be harmful to the wastewater installations or treatment process, or its existence would lead to environmental pollution as a result of draining

the industrial process effluents into the sanitary drainage water. Industrial wastewater shall also be clear of any insecticides or radioactive materials.

5) Treatment process for industrial wastewater

The treatment processes for industrial wastewater can be classified in three types as follows:

Type-1: Wastewater generated in industrial plants is transferred through sewerage system to municipal WWTP if the quality is not violating law 44/2000. The appropriately treated wastewater (complying with law 48, see water quality standard shown in Table 2.7.25) is discharged to drains.

Type-2: In case the industrial wastewater is heavily polluted, wastewater is treated preliminary within the industrial plants, and the effluent is transferred through sewerage system to a municipal WWTP. Finally, appropriately treated wastewater (complying with law 48, see water quality standard shown in Table 2.7.25) is discharged to drains.

Type-3: In some cases industrial wastewater is treated completely within the industrial plants and then discharged directly from the industrial plant to drains or a nearby water body.

Figure 2.7.9 illustrates the treatment process classification for industrial wastewater schematically. The quantities of industrial wastewater were not defined according to the above classification basis in this study. Hence, it is assumed that all the industrial wastewater requires treatment in municipal WWTP.

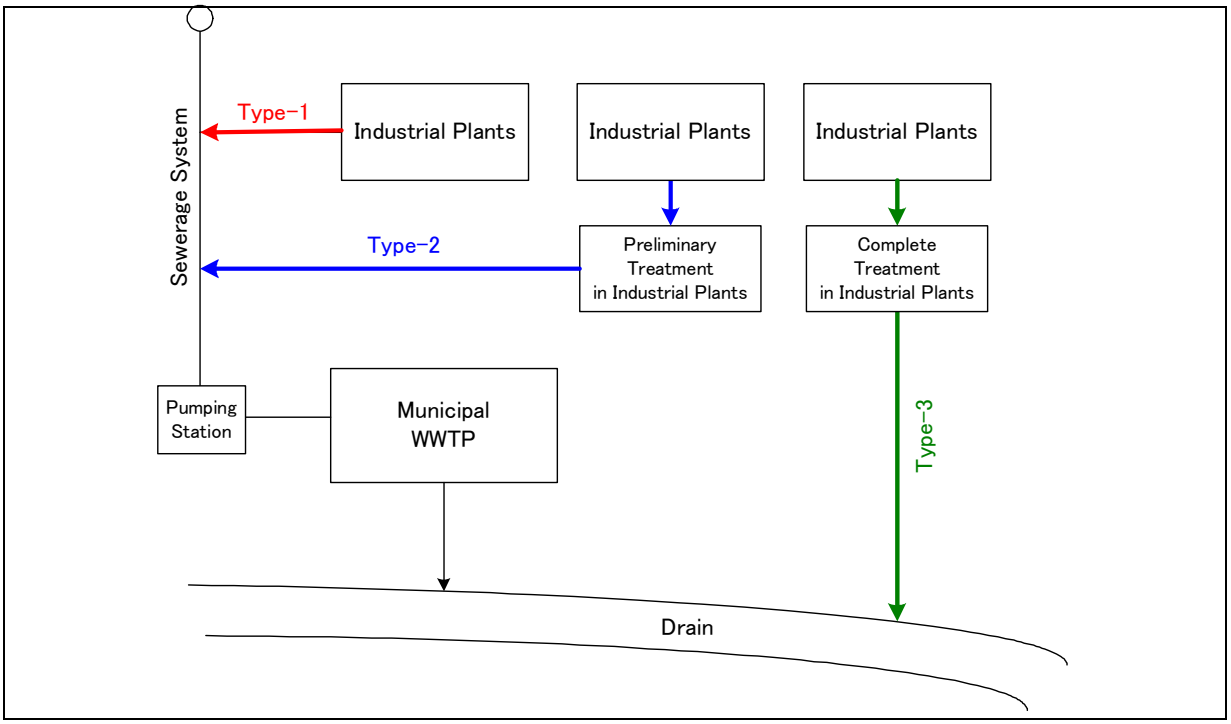


Figure 2.7.9 Sketch of Treatment Process Classification for Industrial Wastewater

6) Demand for wastewater treatment

Wastewater treatment demand in 2007 is preliminarily estimated in each NUC, and the remaining area is categorized as the main agglomeration and villages and small towns in each governorate. In this study, quantity of wastewater treatment demand is assumed as 80 percent of water supply demand. In addition to this, the infiltration flow, which may enter the sewers from the joints or any damages in the sewer pipes, is considered as 15 % of net wastewater generation.

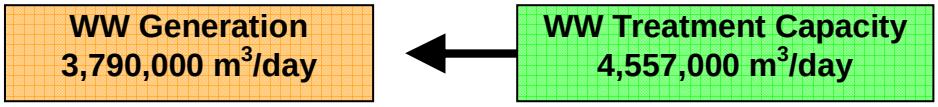
The quantity of wastewater treatment demand in the study area in 2007 is estimated as 3,790,000 m^3/day as shown in Table 2.7.27. The wastewater generation in 2007 is slightly less than the wastewater treatment capacity in the Study Area as shown in Figure 2.7.10.

Table 2.7.27 Wastewater Generation in the Study Area (2007)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Water Supply Demand	Net WW Generation	Infiltration	WW Generation
		(1)	(2) =	(3) =	(4) =
			(1) x 0.8	(2) x 0.15	(2) + (3)
Cairo	Badr	57	45	7	52
	Al Shorouq	9	7	1	8
	New Cairo	38	30	5	35
	15th of May	30	24	4	27
	Main agglomeration	1,683	1,347	202	1,549
(Sharqia)	10th of Ramadan	334	267	40	307
Giza	Al Sheikh Zayed	13	11	2	12
	6th of October	322	257	39	296
	Main agglomeration	823	659	99	757
	Villages and small towns	213	171	26	196
Qaliobeya	Al Obour	110	88	13	101
	Main agglomeration	280	224	34	258
	Villages and small towns	209	167	25	192
Total		**4,119**	**3,296**	**494**	**3,790**

Source: JICA Study Team



Source: JICA Study Team

Figure 2.7.10 Wastewater Treatment Balance in 2007

7) Financial situation

The Financial Affairs Division in GCSDC is responsible for the tariff collection and customer database and management for wastewater treatment.

The wastewater tariff is surcharged as a percentage rate of the tariff for the purified water as shown in Table 2.7.28. This wastewater tariff has been applied since September 2004 when HCWW was established.

Table 2.7.28 Wastewater Tariff

No.	Categories of Usage	Purified Water Tariff (LE/m^3)	Wastewater Surcharge (%)*
1	Domestic		
	From $1m^3$ to $10m^3$ monthly	0.23	35
	From $11m^3$ to $30m^3$ monthly	0.25	35
	More than $30m^3$ monthly	0.35	35
	Building under construction	0.80	70
2	Fixed rate for Governorate Houses		
	1 room flat	3.00	35
	2 rooms flat	3.60	35
	3 rooms flat	4.80	35
	more than 3 rooms flat	6.00	35
3	Unions, and factions premises, syndicate and political parties	0.48	70
4	Non-governmental places for workshop / youth yards / youth centers	0.42	35
5	Embassies	0.48	70
6	Small factories /workshops /coffee shops /local restaurants /shops	0.70	70
7	Large factories / gas station / 2nd and 3rd class hotels / private school	0.80	70
8	Private hospitals / 1st class hotels / funfairs 1st class restaurant	1.25	70
9	Raw water	0.22	-
10	National associations	0.42	35
11	(B) class sport clubs subsidized by the ministry of youth	0.48	35
12	Governmental medical insurance hospital	0.70	70
13	(A) class sports clubs	1.00	70
14	Garages and bakeries	0.70	70
15	Raw water for free zones and investment companies	0.19	-
16	Purified water	0.22	-
17	Governmental office / localities / governmental factories	0.65	70

Source: HCWW
Note: * (Wastewater Tariff) = (Purified Water Tariff) x (Wastewater Surcharge)

8) Existing plan and on-going project

The Organization for the Execution of Greater Cairo and Alexandria Potable Water and Wastewater Project (CAPWO) prepared a new five-year development plan which covers financial years from 2007 to 2011, and was approved by the Ministry of Planning. A total investment budget for wastewater expansion and improvement in the Study Area is amended to be approximately LE 5.3 billion.

HCWW is in the phase of preparing both water and wastewater master plan updates for Greater Cairo Region with the target year of 2037. A number of water and wastewater projects will be identified for implementation in the near future.

Based on the extension plans, the wastewater treatment capacity will be raised from the present 4,557,000 m^3/day to 9,786,000 m^3/day in future. Wastewater treatment capacity in 2027 is shown in Table 2.7.29.

Table 2.7.29 Future Wastewater Treatment Capacity in the Study Area

Governorate	Built-up Area	No.	Name of WWTP	Treatment Capacity (1,000 m^3/day)			Treatment Method **
				Existing	Plan*	Total in Future	
Cairo	Main agglomeration	1	Gabal Al Asfer	1,700	500	2,200	AS
		2	Al Berka	600	0	600	AS
		3	Helwan	350	700	1,050	AS
	Badr	4	Badr	26	144	170	SP
	Al Shorouq	5	Shorouq	27	200	227	MandP
	15th of May	6	15th of May	30	0	30	TT
	New Cairo	7	New Cairo	8	1,250	1,258	CU
(Sharqia)	10th of Ramadan	8	10th of Ramadan	381	465	846	MandP, AL
Giza	Main agglomeration	9	Zenein	330	0	330	AS
		10	Abu Rawash	400	800	1,200	Primary
	6th of October	11	6th of October	100	1,170	1,270	TT
Qaliobeya	Main agglomeration	12	Balaks/Shobra Al Kheima	600	0	600	TT
	Al Obour	13	Obour	5	0	5	SP
Total Capacity				**4,557**	**5,229**	**9,786**	

Source: CAPWO via GOPP

Note: * Plan includes extension and newly construction of WPPs which will be completed before 2027.
** AS: Activated Sludge, MandP: Mechanical and Primary, AL: Aerated Lagoon, SP: Stabilization Pond, TT: Tertiary Treatment, CU: Compact Unit.

9) Existing problems for wastewater treatment

The wastewater collection and treatment system in the study area is facing some problems as summarized in the following:

- Only a primary treatment step is currently established at Abu Rawash WWTP including coarse and medium screens, grit chambers, primary sedimentation tanks, and chlorine contact tanks.
- About 85% of the main agglomeration and 11% of villages and small towns in the Study Area are connected to wastewater systems. For the reminder wastewater is discharged untreated to agricultural drains or desert land directly, causing significant pollution and water quality degradation. In remote villages and small towns, which are not connected to wastewater services, people simply discharge the gray water (ex. Dishing, washing cloths and both) to their backyards or roads. Soak away pits are widely used for black water (feces and urine), but this practice causes contamination of the nearby groundwater in the long term. Sludge is removed by night soil trucks equipped with a suction hose.
- The monitoring of water quality and pollution sources is not conducted effectively, and the results are not properly registered, analyzed, or regularly reported to the authorities.
- The treatment of industrial wastewater is not seriously considered by industrialists and up till now not carried out satisfactorily.
- Part of the treated wastewater is used for irrigation but sometimes drinking water is used for it.
- Most of informal settlements are not served by the wastewater treatment systems.
- Sludge produced in treatment plants is inadequately treated. It often contains heavy metals, and thus can not be used as fertilizer.
- Although the rainfall in the Study Area is little, rainfall water remains on the road long time due to the lack of drainage, causing traffic jam.

(3) Quick analysis of wastewater generation and wastewater treatment capacity in 2027

1) Projection of future wastewater treatment demand

Projection of wastewater generation in 2027 is carried out using the same method of estimation for 2007. The projection is estimated for two scenarios following the water supply demand scenarios.

As shown in Table 2.7.30, wastewater generation in the Study Area in 2027 is estimated in the range from 7,024,000 to 9,204,000 m^3/day, which is 1.5 times or double of wastewater generation in 2007.

Table 2.7.30 Estimated Wastewater Generation (2027)

Unit: 1,000 m^3/day

Governorate	Built-up Area	Water Supply Demand	Net WW Generation	Infiltration	WW Generation
		(1)	(2) =	(3) =	(4) =
			(1) x 0.8	(2) x 0.15	(2) + (3)
Scenario 1 (No increase in Per Capita Consumption for Residential Usage)					
Cairo	Badr	247	198	30	227
	Al Shorouq	150	120	18	138
	New Cairo	243	195	29	224
	15th of May	92	74	11	85
	Main agglomeration	2,074	1,659	249	1,908
(Sharqia)	10th of Ramadan	1,005	804	121	925
Giza	Al Sheikh Zayed	73	58	9	67
	6th of October	1,138	910	137	1,047
	Main agglomeration	1,083	866	130	996
	Villages and small towns	277	222	33	255
Qaliobeya	Al Obour	495	396	59	456
	Main agglomeration	477	382	57	439
	Villages and small towns	281	225	34	258
Total		**7,635**	**6,108**	**916**	**7,024**
Scenario 2 (Per Capita Consumption for Residential Usage is assumed increasing)					
Cairo	Badr	257	206	31	236
	Al Shorouq	180	144	22	165
	New Cairo	276	221	33	254
	15th of May	105	84	13	97
	Main agglomeration	3,057	2,445	367	2,812
(Sharqia)	10th of Ramadan	1,044	835	125	960
Giza	Al Sheikh Zayed	89	71	11	81
	6th of October	1,217	974	146	1,120
	Main agglomeration	1,569	1,255	188	1,443
	Villages and small towns	501	401	60	461
Qaliobeya	Al Obour	549	440	66	505
	Main agglomeration	652	522	78	600
	Villages and small towns	508	406	61	467
Total		**10,004**	**8,003**	**1,200**	**9,204**

Source: JICA Study Team

2) Comparison study between wastewater treatment quantity and wastewater treatment capacity

The comparison between the wastewater generation and treatment capacity is shown in Figure 2.7.11. The figure indicates that overall wastewater treatment capacity will be enough for the wastewater generation up to the year 2027.

However, some NUCs such as Al Obour, Badr and 15th of May will have a shortage of wastewater treatment capacity as shown in Table 2.7.31. These NUCs will require additional wastewater treatment capacity or transferring of excessive wastewater to other treatment systems. In this case feasibility study should be carried out to select an optimum solution.

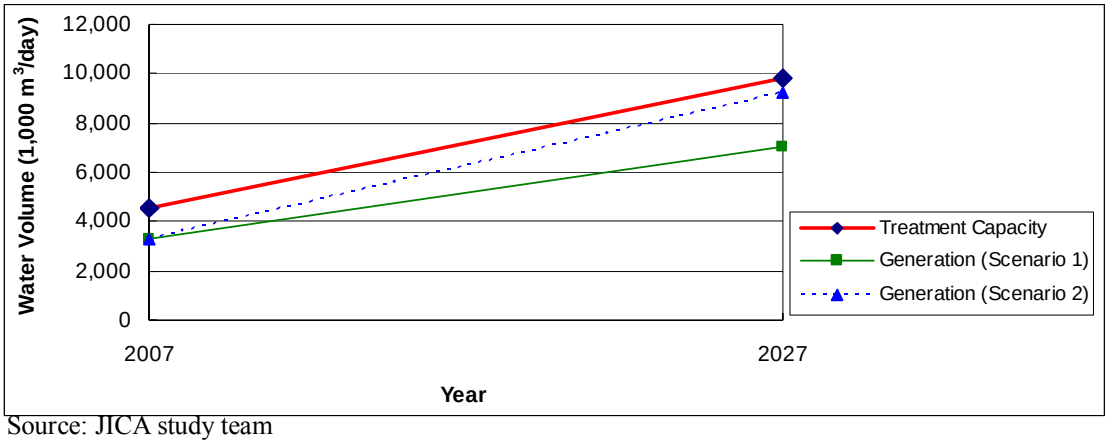
As shown in Figure 2.7.7, the generated wastewater from Al Obour and Al Sheikh Zayed have been transferred to Gabal Al Asfer (Cairo) and Abu Rawash (Giza), respectively and the generated wastewater from Badr is disposed to the desert directly.

Table 2.7.31 Comparison between WW Generation and Wastewater Treatment Capacity in 2027

Unit: 1,000 m^3/day

Governorate	Built-up Area	Wastewater Treatment Capacity	WW Generation	Balance
		(1)	(2)	(1) - (2)
Scenario 1 (No increase in Per Capita Consumption for Residential Usage)				
Cairo	Badr	170	227	-57
	Al Shorouq	227	138	89
	New Cairo	1,258	224	1,034
	15th of May	30	85	-55
	Main agglomeration	3,850	1,908	1,942
(Sharqia)	10th of Ramadan	846	925	-79
Giza	Al Sheikh Zayed	0	67	-67
	6th of October	1,270	1,047	223
	Main agglomeration	1,530	996	534
	Villages and small towns	0	255	-255
Qaliobeya	Al Obour	5	456	-451
	Main agglomeration	600	439	161
	Villages and small towns	0	258	-258
Total		**9,786**	**7,024**	**2,762**
Scenario 2 (Per Capita Consumption for Residential Usage is assumed increasing)				
Cairo	Badr	170	236	-66
	Al Shorouq	227	165	62
	New Cairo	1,258	254	1,004
	15th of May	30	97	-67
	Main agglomeration	3,850	2,812	1,038
(Sharqia)	10th of Ramadan	846	960	-114
Giza	Al Sheikh Zayed	0	81	-81
	6th of October	1,270	1,120	150
	Main agglomeration	1,530	1,443	87
	Villages and small towns	0	461	-461
Qaliobeya	Al Obour	5	505	-500
	Main agglomeration	600	600	0
	Villages and small towns	0	467	-467
Total		**9,786**	**9,204**	**582**

Source: JICA Study Team



Source: JICA study team

Figure 2.7.11 Comparison between WW Generation and WW Treatment Capacity

(4) Efficiency issues on wastewater treatment

As described earlier, the total wastewater treatment capacity will be sufficiently planned to handle the wastewater generation. However, some issues have to be raised concerning the sewage system. The recommendations for the improvement of the wastewater treatment in the Study Area are as follow:

1) Wastewater treatment balance

- 10th of Ramadan and Badr will have shortage of wastewater treatment capacity. Hence, it is recommended that the extension plan on the WWTP in 10th of Ramadan and Badr are to be reviewed.
- Although 15 of May will have shortage of wastewater treatment capacity, it does not yet have an extension plan of WWTP. It is recommended to carry out a study for extension or new construction of WWTP.

2) Operation and maintenance

- Installing the secondary treatment step for WWTP at Abu Rawash is essential and considered as the highest priority project by CAPWO, as the WWTP now comprises only of a primary treatment step.
- Reuse the treated wastewater as much as possible in purposes such as irrigation, car wash, road watering, toilet flushing, etc. as part of a water resources conservation strategy.
- Give more attention to the treatment of industrial effluents, and enhance enforcement of existing environmental regulations on all industries.
- To accelerate the establishment of Qaliobeya Water and Wastewater Company in line with the decentralizing of the operation and maintenance of the wastewater system, improving system performance, and give more attention to the villages of Qaliobeya.

3) Efficiency issues on villages and small towns

- Provide some wastewater systems to the villages, which presently lack this service in Giza and Qaliobeya Governorates within the Study Area.
- To investigate the water quality and disinfection process in the villages and small towns where groundwater is used for water particularly the areas without a wastewater system.

4) Wastewater treatment technology and reuse

- In rural areas with no WWTP, it is not recommendable to use compact wastewater treatment units. First other alternatives such as waste stabilization ponds need to be envisaged fully. This is because qualified manpower to operate and maintain such plants is usually unavailable at each village. Compact units can only be implemented if land is not available and existing WWTP is far and economically not feasible to pump village wastewater to it.
- In general, the use of waste stabilization pond or similar natural treatment system is recommended for areas wherever land is available, because the treated effluent can be reused for irrigation of green belts or forests.
- Concerning 10th of Ramadan city, the wastewater contains a relatively high portion of industrial effluents and thus aerated lagoon treatment system is not the appropriate option and effluent quality does not comply therefore with law 48/1982. It is recommended to carry out treatability tests for the raw wastewater and select the treatment technology most appropriate for this type of wastewater.

2.7.4 Solid Waste

(1) Current conditions and problem of municipal solid waste management (MSWM) in the study area

1) General conditions of present MSWM

In the Greater Cairo Region, the generation of Municipal Solid Waste (MSW) is continuously increasing with the progress of urbanization, concentration of population and economic and industrial development. The problem of solid waste in the Study Area can be summarized in the fact that the existing systems neither meet the needs of the society nor provide appropriate service to all its classes due to inadequacy in regards to different components, resources, capabilities and potential of the entire system along with the lack of a favorable atmosphere towards the waste problem. This has been reflected in widespread garbage piled up visibly in many places which lead to pollution. Study Area generates an estimated 3.2 million m^3/year of MSW in 2008 growing at an estimated 3.2 % per year. In urban area, 30-95 % of collected waste is disposed of in landfills[1].

2) Waste generation

a) Waste quantity and flow

The total amount of disposed MSW in the three governorates and NUCA is estimated approximately 9,000 ton/day (2008). In Egypt, the waste is classified into seven categories based on source and type as follows: Residential, Industrial, Commercial, Institutional, Construction and Demolition, Localities service and Treatment waste. The average unit generation rate of MSW in Egypt was 0.65 kg/day (urban area), 0.35kg/day (rural area)[2]. Figure 2.7.12 shows a typical flow of waste in the Study Area. The Sustainable Solid Waste Management (SSWM) shall require the promotion of material recovery and minimization of waste volume to be disposed.

[1] World Bank- METAP 2004
[2] World Bank- METAP 2004

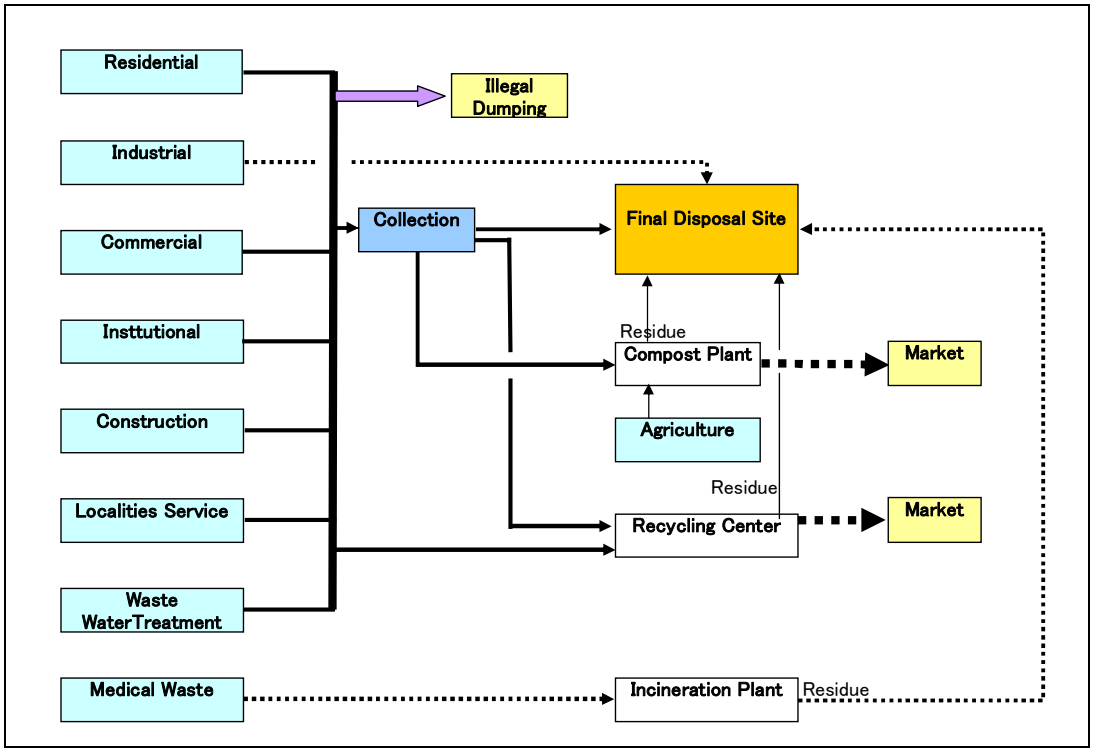
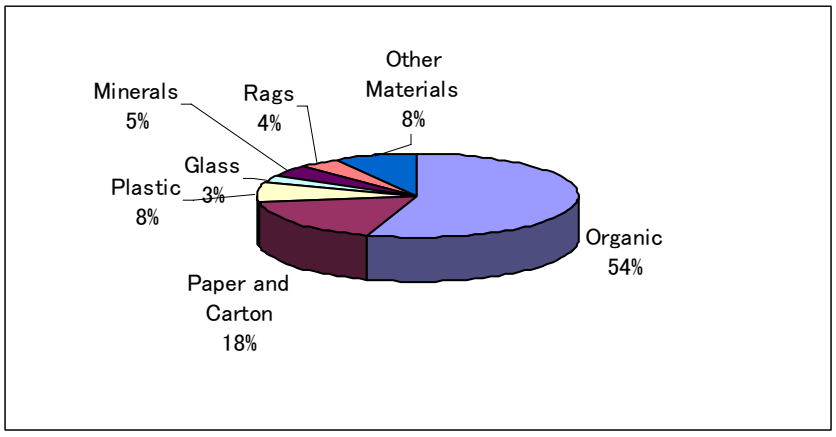


Figure 2.7.12 Typical Flow of Waste in Egypt

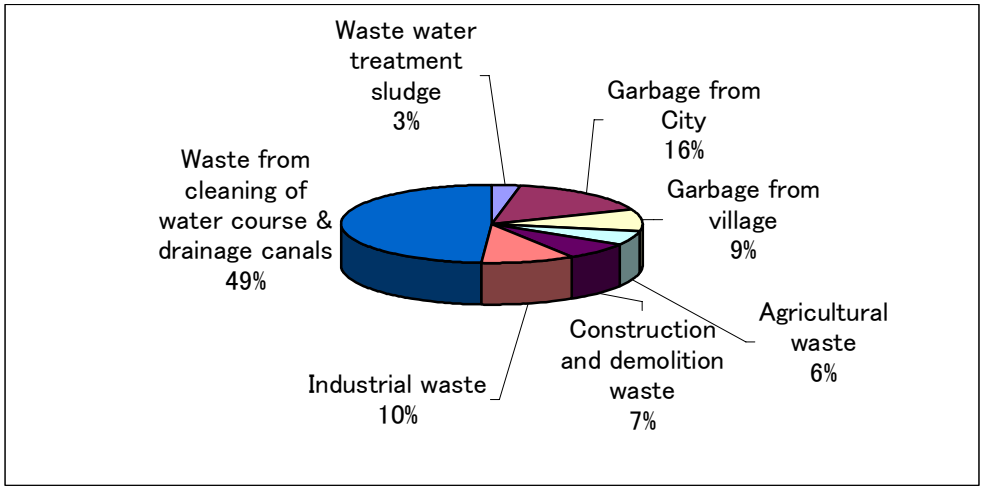
b) Waste composition

MSW composition in Egypt was recorded in the Egyptian Solid Waste Management (SWM) strategy published in 2000. Figure 2.7.13 shows the composition of the municipal solid waste generated in Egypt. Organic waste that had to be utilized as resource for compost accounts for 54% of MSW according to this data. Figure 2.7.14 shows the compositions of generated waste in Egypt, covering all the waste as described the above sub-section.



Source: EEAA

Figure 2.7.13 Composition of Generated MSW in Egypt: 2005



Source: EEAA

Figure 2.7.14 Classification of Generated Waste in Egypt: 2005

c) Construction waste

The total amount of construction waste in the Study Area is estimated at 5,266 ton/day, which represents 35-45 % of the total amount of construction waste generated in Egypt. This amount is disposed of in various sites including open dumping areas and some landfills. Almost 25 % of this amount is generated in the NUCs alone due to the construction boom in progress. Construction wastes are generated in new buildings and civil engineering works, which include excavated materials (rocks and soils), damaged bricks, bituminous materials, woods, cardboards, and other redundant materials. Demolition wastes are generated when buildings and other structures are demolished. (According to ADB report, construction waste accounts for 20% of waste generated in Egypt[3]).

3) Existing facilities

a) Final disposal sites

Figure 2.7.15 shows the location of final disposal sites (sanitary landfills and controlled landfills) and composting plants in the Study Area. Approximately 3.2 million m3 /year of waste is transferred to one of these landfill sites (Al Wafaa Al Ammal, Katamiya and 15th of May dump site in Cairo, Shobramant dump site in Giza and Abou Zabal dump site in Qalyobeya). There are three types of landfills in the Study Area, namely Controlled open landfill, Controlled landfill, Sanitary landfill. Most of them are located in Cairo Governorate and three landfills in Giza Governorate and NUCA, and one landfill in Qalyobeya Governorate. It is important to realize that this variety of landfills include four sanitary landfills operated and managed by private sector, while the rest are controlled landfills and controlled open landfills which are either operated by the public sector or private sector.

[3] ADB report, Study on SWM options for Africa

Liner systems, leachate collection, leachate treatment or gas venting is not provided other than at sanitary landfill. A part of the construction material is used as cover soil for landfill operation. In every landfill sites, waste is unloaded to the ground from the vehicles and pushed over by a bulldozer with some of the construction materials, and flattened with soils around the waste by a bulldozer. Placing a daily soil cover over the dumped waste, which is the most fundamental work for a sanitary landfill, is far from sufficient in controlled landfill and open dumping site. Insufficient cover soil is causing sources for health and hygiene problems such as dust, odor and flies, frequent natural combustion, and littering with plastic bags on neighboring lands.

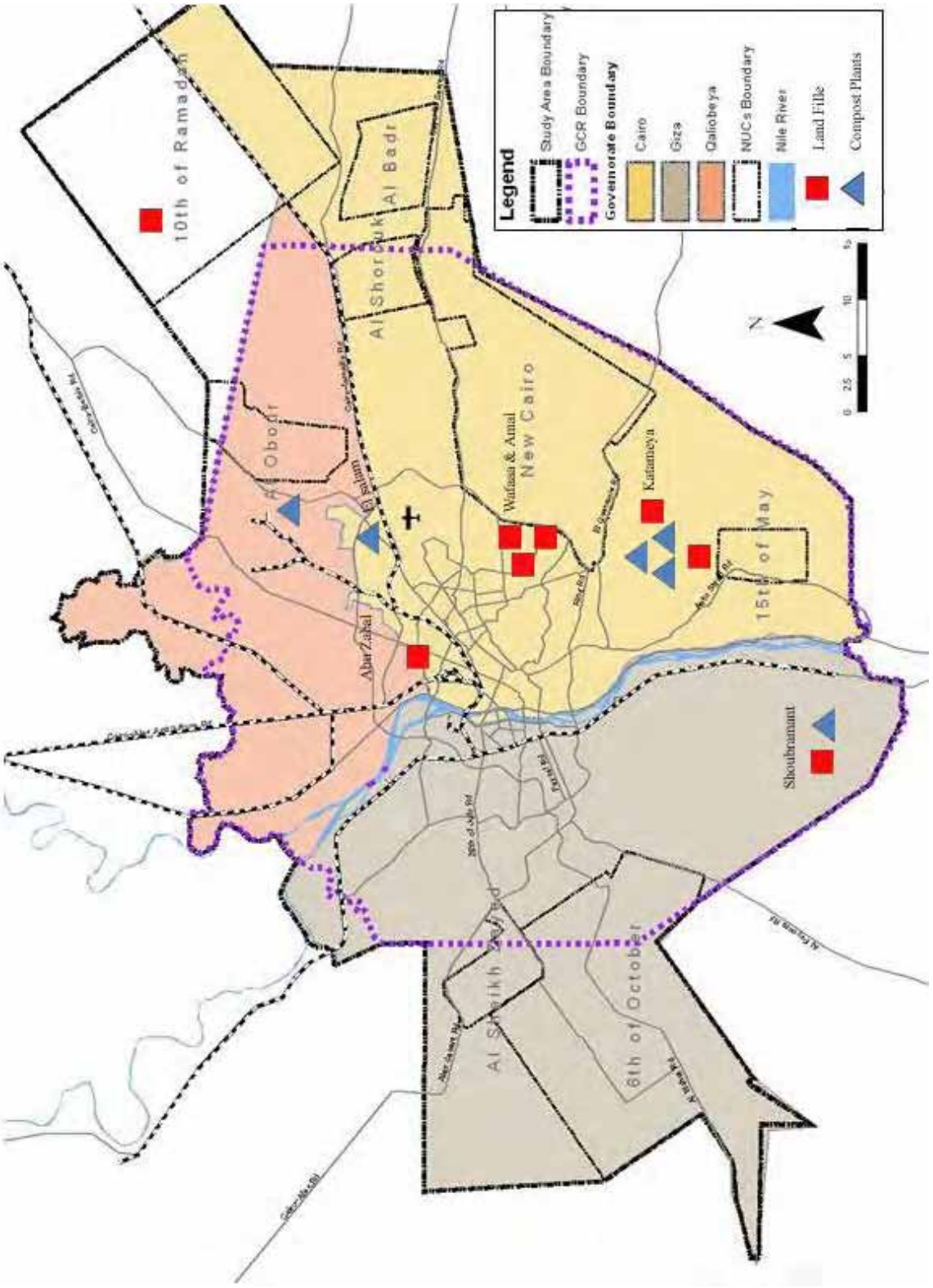


Figure 2.7.15 Location of SWM Facilities

Table 2.7.32 Final Disposal Site in the Study Area

Governorate	Cairo	Giza	Qalyobeya	NUCs
Sanitary landfill[4]	4	0	0	0
Controlled landfill[5]	1	1	1	1
Controlled open dumping site[6]	5	2	0	3
Total	10	3	1	3

Table 2.7.33 Compost Plant in the Study Area

Governorate	Cairo	Giza	Qalyobeya	NUCs
Number of Plant	5	1	0	0

b) Recycling

Recycling activities are undertaken in some extent particularly in Cairo Governorate. Valuable materials such as plastic, paper, steel, aluminum are sorted out and reprocessed mostly by micro-enterprises. Since 1980, a business model has been introduced to a traditional family based waste management organizations. Waste recycling is currently carried out through the following method;

- Source separation of organics from non-organic
- Source recovery of non-organics
- Re-use and recycling of man-made waste
- Trade and transport of recovered materials

The recycling activity in Egypt is fully managed and controlled by either the public organization, private companies or Zabbaleen, which conducts collection and transportation as one of the SWM organization. Recyclables are presently collected and sold in markets only by Zabbaleen. Other than the above, there are no other parties conducing the material recovery in Study Area.

Composting Plant: Cairo Governorate

[4] Landfill is constructed based on Egyptian government standards equipped with international standard facilities such as leachate and gas pipes and liner sheets etc.

[5] Landfill has facilities such as fencing, a weigh bridge, administrative area, a liner sheet, but no leachate or gas collection pipes.

[6] Landfill has no facilities as described the above and no administrative area.

4) Operation agencies and responsible organizations

The ministries including the Ministry of State for Local Development (MSLD) and the Ministry of State for Environmental Affairs (MSEA) play a key role in establishing policies and assisting governorates while private companies come into the circle with a specified role. They also facilitate and monitor private company participation at the Governorate level, support the implementation of SWM strategy, and undertake public awareness activities. In addition MOHUUD through the NUCA plays a pivotal role in managing SWM in their respective cities. A ministerial SWM committee has been established to facilitate and monitor private company's participation at the governorate level.

Both Cairo and Giza governorates have public institutions that act as service provider - waste collector- and service controller, which are called Cairo Cleaning and Beautification Authority (CCBA) for Cairo, and Giza Cleaning and Beautification Authority (GCBA) for Giza. Both institutions have a branch office in each district, which is responsible for monitoring contractors such as domestic companies and Zabbaleen.

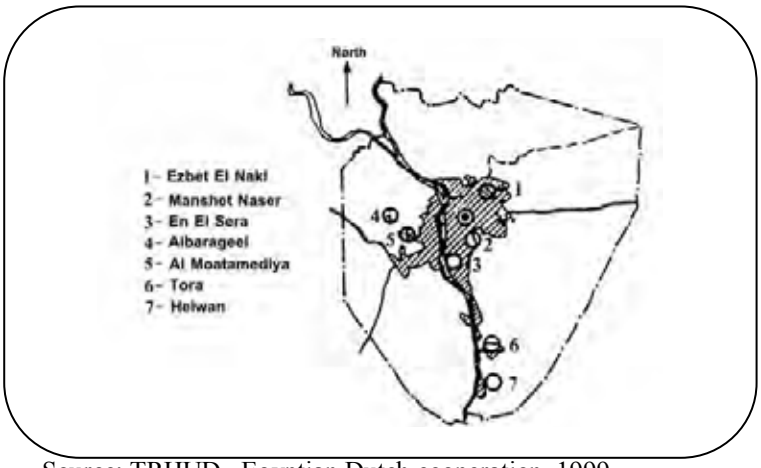
Local Government Authorities (governorates, markaz, city and village levels) serve as supervisor in addition to being service providers. Governorates are fully responsible for all SWM activities (planning, financial, institutional, contracting, operation, monitoring, control, law enforcement and public awareness).

5) Privatization

a) Zabbaleen system

The Zabbaleen refers to some people in an Egyptian community who are employed in the governorate to collect and dispose of waste. The Zabbaleen in Cairo (estimated 60,000-70,000 people) are mostly poor farmers from Upper Egypt. For the past five decades they have played an important role in the collection of waste of the Study Area, hauling away waste by donkey carts or trucks.

They sort out the collected waste for recyclable materials and sell to local entrepreneurs, and a large amount of organic materials are extracted and used as pig feed. Collectors from each area have a collection license from the local municipality for an assigned area. In Cairo, the waste management activities of the Zabbaleen account for approximately 10 percent of the waste generated in the Study Area. Figure 1.5-01 shows the map illustrating the sites of garbage collectors area. They are involved in solid waste collection and recycling in all parts of the Study Area including NUC, either in a formal contract or without.



Source: TRHUD –Egyptian Dutch cooperation, 1999

Figure 2.7.16 Operation Areas of Zabbaleen

b) Domestic private operators

In the last few years, some well organized domestic private companies have entered the solid waste management sector in Egypt, particularly in large cities. Domestic private operator must have a collection license or a service contract the assigned area from the municipality. Waste collected by private operators is delivered either to the Zabbaleen or directly to disposal sites. The scope of the service contract of private operator includes collection of waste from household, shops and workshops, streets, squares, gardens, and transportation to the main public landfill sites. The scope of the service contract could also include service for industrial establishments. The duration of a contract is typically three years. These actors are playing a key role especially in Giza and Cairo Governorates where they entered into partnership with international private companies[7].

c) International operators

International operators such as FFC (Spanish), Urbaser (Spanish), and AMA (Italian) started operation of MSW in the Study Area. These companies assist operation by upgrading necessary equipment for MSWM and training of Egyptian engineers. To date, operators have been awarded contracts through a competitive bidding for the following governorates: Cairo districts (north, east and west[8]) and Giza urban districts. The contract duration is between 10-15 years. Under the government policy to privatize the sector, the above waste management service operators will provide an integrated solid waste management service including collection, transportation, treatment, and disposal services for municipal, health care and industrial non-hazardous waste for the whole governorate.

[7] World Bank – METAP 2004

[8] **East zone** is composed of 8 hai (ain shams, nozha, Misr Al-Gadeeda (Heliopolis), Nasr city (east), Nasr city (west), matariya, El Salam, El Marg).
West zone is composed of 8 hai (abdein, el waily, bab el sheriya, mousky, West, boulaq, wasat, Monshaet Naser).
North zone is composed of 7 hai (el sahel, sharabiya, Al-Zaweya Al-Hamra, shoubra, Rod Al-Farag, Hadaeq Al-Qobba, Al-Zaytoon.

6) Collection and transportation

a) Collection system

In the Study Area today, there are three collection systems working simultaneously: the formal system operated by the municipalities which targets street sweeping and emptying large curb-side containers; the informal Zabbaleen system of door to door service (a highly efficient service for capturing recyclable materials for re-sale and green organic materials for use as animal feed); and organized private enterprises for servicing SWM. The municipal system is patchy in its performance, but private enterprise may be beyond the budget limit of many parts in the Study Area. In general rural parts of the Study Area try to manage their solid waste themselves, but in an unsafe manner pausing both public health and environmental concerns. Organic waste is fed to farmers' animals and the residual waste (organic and non-organic) is dumped alongside such as in waterways, drains, deserted lands or brought to neighboring dumping sites where it is burned.

Waste Transportation Vehicles: Cairo Governorate

b) Equipment and staffs

Staff for the operation and the maintenance related to MSW management services total around 40,000 personnel. The operations staff of Governorates in the workshops and final disposal sites do not have sufficient experience and are not well trained. In addition, there is lack of specific technology in solid waste management, especially in sanitary landfill systems and planning and design of SWM systems. Therefore, additional transfer of knowledge and training for improvement of operations of SWM system in the Study Area is required. In the operation, lack of transportation equipment and poor maintenance including lack of preventive maintenance causes decrease in efficiency of transporting waste to intermediate or final disposal sites.

c) Laws and regulations related to SWM

In the past five years, the GOE has established a policy and institutional framework for the long-term management of solid waste across the country, which included the

establishment of a joint ministerial committee, co-chaired by MSEA and MSLD, to coordinate the implementation of the strategy and the preparation of the national strategy for Integrated Municipal Solid Waste Management. A national SWM strategy was adopted in 2000. It reinforces the role of Governorates in service delivery and gives support to private sector participation.

7) Intermediate treatment

a) Recycling activities

Over the past 25 years the Zabbaleen have created small scale enterprises for the collection and recovery of materials from domestic waste. Presently Zabbaleen conducts a very active recycling operation in Cairo governorate. In Egypt recycling accounts for 2% of the total amount of generated waste[9].

b) Composting

A total of 56 municipal solid waste composting plants have been established in Egypt by MSLD at the cost of 265 million EGP. Though these plants cover the entire country, many of them are not operating satisfactorily due to the lack of technical expertise and operational know-how within the municipalities, as well as design drawbacks of the plants themselves. In the Study Area, a total of eight composting plant are in operation presently. Composting plants are only available in Cairo and Giza Governorates. Some of these plants are serving NUCs (Obour and New Cairo).

8) Disposal of solid waste

Approximately 9,000 ton/day of waste is hauled into the existing final disposal sites located in the three governorates, and there are 17 landfill sites in Study Area. A soil covering is applied occasionally, but not always in controlled landfills and open landfills. Insufficient covering soil is causing health and hygiene problems such as dust, odor and flies, frequent natural combustion, and littering with plastic bags on neighboring lands. Soluble contaminants leach into and pollute ground water.

Landfill Operation : Calyobeya (right) and Giza Governorate (left)

[9] World Bank - METAP, 2004, Regional Solid Waste Management Project in Mashreq and Maghreb Counties, Country Report – Egypt.

9) Maintenance workshop

Maintenance workshops are available in every governorates, and Cairo Governorate alone has more than 14 workshops dispersed in different zones. The workshops located in the smaller towns and rural areas has only minor maintenance equipment. The most common trouble for almost every workshops is the lack of well trained operational staff. In Giza and Qalyobeya Governorate, proper maintenance workshops are available only in the urban part while workshops in smaller towns and rural areas suffer from the equipment shortage. If the operationefficiency is to be improved, they have to furnish with a minimum level of equipment required for engine overhauling and periodic maintenance of vehicles and equipment for landfill operations.

Operational Equipment: Calyobeya Governorate

10) Financial situations of MSWM

The monthly collection fees for waste from households are collected by the governorate and Zaballeen community. Basically, the operation cost of MSW including the final disposal site is paid by each governorate to operators according to the contract. As for the required cost for MSW in the Study Area, each governorate allots a subsidy from the central government budget; but the system is still not sustainable from the financial point of view. Table 2.7.34 shows budget allocation of each governorate including NUCA.

Table 2.7.34 Amount of Budget for MSWM in the Study Area

Governorate	Budget (million LE)	Notes
Cairo governorate	304	
Giza governorate	72.87	
Qualiobiya governorate	NA	Not available
NUCA	41.39	

Source: JICA Study Team

11) Problems of the existing MSWM

- Regarding the present production of compost at the existing plant, both the quantity and quality are not sufficient because of inadequate facilities and the mixed collection of waste. The produced compost thus cannot be sold to the market due to the low quality.
- In general the effectiveness of solid waste management remains patchy, as some rural areas are unable to afford privatized service, and thus continue to rely on traditional practices of managing their waste on their own with poor outcomes.
- As the collection rates in some rural area are low, many rural settlements continue polluting their environment through inadequate disposal methods under the absence of financial, technical and human resources means.
- Currently, the government seldom extends private services for MSW to rural area. More attention needs to be given to public awareness, community social consideration and public consultation in rural areas.
- In Giza and Qalyobeya, either the local government or NGO's and community based organization provides the service in certain villages. In the latter case there is persistent lack in capacities and resources to deal with waste in the right manner.
- There are often operational problems such as deficiency in maintenance capabilities and inadequacies in workshops and garages.
- Meager qualified and trained technical cadres for management and operation processes and their low-level remunerations and wages which discourage requisite expansions to operate further in this field and rather nurture disinterest in it.
- Shortfall in finance from all sources plus insufficiency in operational budgets.
- There is generally a lack of sufficiently controlled public landfills and sanitary dumpsites that conform to environmental conditions for safe disposal of solid waste remains.
- The public awareness regarding the solid waste issue is generally low, which is causing the general public to be indifferent on the issue of MSW.

(2) Issue and proposal required for improvement of MSWM

1) Summary

It is observed that the existing MSWM in the Study Area is burdened with many operational and financial problems. For solving the problems and improving the operation system, dedicated countermeasures needs to be undertaken in future. In general, the proper MSWM ought to decrease hygienic troubles, and contribute to the

beautification of the land including the Study Area. In addition, better performance in operation will result in a reduced operation cost which is currently being subsidized by the public sector.

As for recycling, material recovering for non-organic recyclables, especially aluminum cans, iron scrap, plastics and paper items, should be promoted to reduce the waste disposed to the landfill. Presently, "3R" (Reduce, Reuse, Recycle) has become a world wide trend in addressing the SWM issue. If the recycling activity (composting and recycling of valuable material) is enhanced, the service life of the landfill site will be extended. The market price of scrap metal is maintained at a reasonably stable level presently and is expected to continue at the high price level in the future. Recycling also reduces the environmental impacts from the activities of obtaining raw materials. Therefore, expanding and improving the recycling activities are highly recommend.

The existing landfill sites will be utilized for more 10-15 years continuously and therefore Study Team assessed that no new site for extension other than on-going project site will be necessary at the moment. An appropriate waste disposal system must have the required capacity, structure, location and the users for the landfill should be well informed and be aware of the situation of each site. A sound structure is needed in any sanitary landfill i.e. stability, leachate control and gas vent with proper operation. Also, post-closure management of the landfill site must also be taken into consideration.

2) Projection of future solid waste generation

a) General

The projection of quantity of future waste generation is one of the basic parameters for preparing a future plan. Waste generation quantities at present and in the period until 2027 have been estimated by considering the solid waste generation mechanism and the socio-economic parameters in consideration of growing population, business prospect and increment of GDP, etc.

b) Quantity of MSW for planning

Table 2.7.35 summarizes the estimated quantity of MSW disposed into landfill from 2008 to 2027. The table assumes that the quantities of commercial, residential, institutional and other businesses waste, bulky waste, and industrial and construction/demolition waste will increase gradually during the period.

Currently, some of the industrial waste is collected together with municipal solid waste and dispose of at municipal landfill sites. However, from the fundamental viewpoint that industries have to treat and dispose of the waste generated by their industrial processes by themselves under the polluter pays principal, only the municipal waste, including commercial waste, will be disposed of at public landfill sites, and a separate landfills have to be prepared for industrial waste in the future.

The target for waste collection and transportation in 2027 was set for each governorate including private sectors and Zabbaleen. Waste collection quantity may vary according to the extent of 3R activities, and the quantity of composting and recycling are fractions of the total quantity.

Table 2.7.35 Estimated Quantity of Disposed MSW into Landfill (Unit: 1000 ton)

Unit: tons/day

Governorate	2008	2012	2017	2022	2027
Cairo	5,194	6,127	6,878	7,752	8,540
Giza	2,196	2,630	3,022	3,483	3,915
Qualiobiya	951	1,119	1,279	1,442	1,574
NUC	610	1,261	2,156	3,290	4,451
Total	8951	11,137	13,335	15,967	18,480

Source: JICA study team 2008

3) Strategies of MSWM for Greater Cairo Region

The long-term prospective for the MSWM sector toward 2027 comprise of improved financial capacity of the governorates, including related public organizations, and also the increased capacity-to-pay of the citizens and enterprises. Toward 2027, the MSWM system in the Study Area will have to be much improved and modernized as summarized below:

- Collection of MSW will be done by more modern and appropriate vehicles.
- Segregated collection will be introduced in the Study Area for proceeding and expanding 3R activities with high performance.
- Recycling and composting will be improved and enhanced, which has an aim of reuse and reduction of MSW.
- Widely introduce sanitary landfill system in the operation of landfills. Environment-friendly landfill operation will be commenced at all landfills.
- For establishing stable operation of MSWM, self-finance system will be introduced with cost recovery system.
- Collection rate in Study Area especially urban area will be increased by privatization.

4) Collection and transportation system

a) Planning policy

Suitable collection services can help make the daily life comfortable for citizens, keep the townscape of the city beautiful, and improve the public health and the regional environment. The basic planning policies of the collection and transportation systems are as follows:

- Achievement of full coverage of collection area in urban area of the Study Area

- Establishment of a sustainable collection and transportation system in consideration of the characteristics of the urban area and rural area.
- Introduction of a segregated collection system to promote and expand 3R activities

b) Coverage of waste collection

The waste collection services provided by governorates and other institutions cover approximately 60 to 90%[10] of the urban area. It is assumed that solid waste not put out for waste collection is presently around 25-30% of all domestic waste. A portion of this non-discharged waste includes the quantity of resource materials being recovered by Zabbaleen. In view of the obligation assigned to MSWM, a target collection rate of 90% is adopted in the future for the entire urban area of the governorates. This rate could be achieved with the deployment of effective services and improvement of required facilities, equipment and awareness of the population.

c) Method of collection and transportation

It would be appropriate to adopt a conventional method similar to those currently practiced; the waste is collected and transported by collection vehicles. The collection points are waste bins installed in the private site or waste-collection points. A noteworthy aspect is that a numbers of the existing collection vehicles have already been in use for long years and badly deteriorated. In order to ensure continuous and efficient collection and transportation services, the vehicles should be replaced with new ones progressively.

d) Selection of waste collection and transportation vehicles

It is proposed in the long term plan that compactor truck will be adopted as the appropriate collection and transportation vehicle, after objectively evaluating the transportation efficiency of each of the several types of vehicles presently used. In case the waste collection system including equipment is to be changed, its possible effects shall be studied in depth in advance.

e) Introduction of segregated collection

With the aim of facilitating the recovery of materials for recycling and composting, segregated waste collection will be introduced in the urban area where Zabbaleen currently collects MSW and recycles. MSW will be classified into several categories (example: kitchen waste, recyclable materials, and other waste). Thought the cost of a segregated collection system is generally higher than that of a mixed collection system, segregated waste collection is regarded as a primary requirement for attaining environment-friendly operation of MSWM, as it will bring about benefits of reducing the quantity of waste disposal and enhancing the recovery of valuable resource materials. Reducing the quantity of waste for disposal will reduce the environmental burden to landfill sites, and the recovery of resource materials contributes to the economic status of the governorates. In the economic terms, the cost for segregated

[10] GOE made five years plan (1997-2002) to raise MSW collection efficiency in the country with following target; large city:-90%, Governorate capital -80%, small provincial town-70%, large village-60%.

collection will be partly offset by benefits that will accrue from selling compost products and recyclable materials and also by reducing landfill cost.

5) Intermediate treatment

a) Operation for recovery of recyclables

Promoting the recovery of recyclables by segregated collection will require preparatory works and other considerations on implementation as follows;

- A proposed system for recovery of recyclable materials from MSW will coexist with the existing recovery operation conducted by Zabbaleen, and shall be coordinated closely to discuss the most efficient share of the work with regards to area, method and marketing.
- The recovery of recyclable materials will be verified through the pilot project.
- Conditions of market of recycle materials shall be verified with cooperation of Zabbaleen and other organizations.
- The collection capacity of the implementation bodies should satisfy the performance of residents for segregated discharge. Therefore, a prerequisite for improved recycling is to establish a sustainable system of periodic segregated collection through the provision of an appropriate waste collection and transportation system.

b) Community composting plan

In addition to the plan for recycling, composting will also be promoted in the future as a component of the 3R activities; composting reduces the quantity of waste disposal and recycles organic materials. The planning policy for composting will incorporate the following:

- Sustainable composting methods shall be established in support of appropriate technology.
- Secure a firm market for compost products.
- Provision of an appropriate public awareness program.

c) Type of composting

The production of compost will be promoted in two ways. One is home composting, which is to be practiced in each household in rural and semi-urban areas. The other is the compost processing performed in centralized composting yards which utilize organic waste including kitchen waste collected from the residents. Presently, eight (8) composting plants are in operation in the Study Area. However, some of them are said to cause problems in the quality and production system. As previously mentioned, the skills needed to manage a community composting plant and associated equipment have not been acquired within the existing organizations concerned. The community

composting system shall be improved and modified in the future, since community composting is being attempted in many places in the world recently.

6) Final disposal system

a) Landfill

The aim of solid waste disposal was defined historically as being to remove solid waste immediately from the generated area to reduce the risk of hygiene related and environmental problems for the community. A final disposal plan is closely related to an efficient collection and transportation plan, and also to an intermediate treatment plan to reduce the amount of waste to be disposed of, extend the life of landfills and reduce the risk of hygiene related and environmental problems for the community. There are two major components of the final disposal plan, namely, closure of existing landfills and establishment of new landfills.

In preparing the closure plan for the landfills, the following policies shall mainly be considered:

- To estimate the remaining years of life of each existing landfills.
- To propose a closure procedure, taking account of measures for reducing the risk of hygiene related and environmental problems, the financial situation and level of technology within the organization responsible for MSWM, and also land use after the stabilization of reclaimed land.

In preparing the construction plan for new landfills, the following policies are to be mainly considered:

- To estimate an area necessary for landfills
- To propose structural and disposal plans, based on type, form and composition of MSW, regional geological, hydrological and climate conditions, along with reducing the risk of hygiene and environmental problems, and also considering the financial situation.

b) Introduction of sanitary landfill system

In order to minimize the negative environmental impact caused by landfills, it is proposed to introduce a sanitary landfill system as issued by the government. The sanitary landfill system is effective in reducing the potential environmental risks of landfill operations by accelerating the stabilization of dumped waste. The sanitary landfill will be provided with a leachate collection and treatment system and a gas extraction pipe.

c) Introduction of soil covering

Currently, soil covering is not carried out in all of the existing landfills, thereby causing environmental problems. It is proposed that soil covering be done in the landfills to control such problems as littering of waste, offensive odors, breeding of vermin, and spontaneous combustion of dumped waste.

d) Introduction of the section landfill concept

In the operation of new landfills, it is recommended to adopt waste disposal in segmented cells, each divided by soil embankments. The introduction of section landfill is expected to reduce leachate volume and stabilize the landfill earlier.

e) Leachate treatment

In the basic design stages, calculation of leachate generation volume, estimation of leachate treatment volume and a plan of the leachate regulating reservoir should be carefully conducted taking into account climate and geological conditions and site restrictions.

f) Evaluations of the existing landfill sites.

There are seven main landfills in the Study Area, and the result of preliminary evaluations by Study Team for use as final disposal sites for the MSW in the future are as follows:

- Wafaa and Ammal 1 landfill (Cairo) was constructed in 1984, and is now reaching the end of its service life. Presently, site preparation work of new landfill which has area of 100 feddan[11] has already started.
- Wafaa and Ammal 2 landfills (Cairo) with an area of 100 feddan was constructed in 2003. The remaining capacity is about 17 million m^3, which can be utilized for more than 10 years.
- Waffaa and Ammal 3 landfills (Cairo) which has an area of 100 feddan is under construction at present. This landfill was designed as a controlled landfill and it will be utilized instead of Katamiya landfill in the future.
- Katamiya landfill (Cairo) has an area of only 50 feddan, and the remaining capacity is only 10 million m^3. After closing of this landfill, Waffaa and Ammal 3 landfills will be utilized instead.
- 15 of May landfill (Cairo) has an area of 100 feddan and still retains half of service period. This landfill will be utilized in the future continuously.
- Shoubramant landfill (Giza) has a remaining capacity of 40 million m^3, and it will be utilized for another 15 years continuously.
- Abou landfill of (Qalyobeya) has a remaining capacity of 4.55 million m^3, and it will be utilized for another 10 years.

7) Environmental and social consideration

a) Social considerations

Social consideration should be one of the top priorities for the decision makers in the Study Area when coping with the challenges of SWM. Efforts to decrease the amount

[11] 1 feddan = 4200m^2

of waste should be decentralized, as the 3R principles depend fully on the people's willingness to reduce their waste and to deal with the waste as a source of income for the poor. Financial aspects such as the lacking financial resources could be dealt with in awareness campaigns and by working together with elected leaders and religious leaders with power and leadership.

b) Environmental considerations.

Environment in the Study Area should be respected, and people should avoid throwing waste in canals and streets, while private and public service providers should refrain from open dumping practices. This shall eradicate long and medium term negative impacts on the surrounding environment and on health conditions, especially amongst the poor communities. Relevant laws and EIA regulations should be fully respected.

8) Training of staff and trainers

For increasing efficiency in operation of MSWM, it requires betterment of the knowledge of the staff working at various levels. The staff training programs shall provide the following subjects:

- 3R programs for the managers and staff of public offices and enterprises.
- Legislation related to MSWM.
- Methods of mobilizing people's participation and raising public relations skill for the staff of agencies in contact with the people.
- Technologies regarding segregated waste collection, composting, recycling and landfill for the staff of MSW operating organizations.

2.7.5 Power Supply

(1) Present status in Egypt

Since the nationalization of electricity generation, transmission and distribution in 1962, an organization for electricity supply has been organized and expanded along with an increase in nationwide demand of electricity. Presently Egyptian Electricity Holding Company (EEHC) which was converted from Egyptian Electricity Authority (EEA) in 2000 and is still owned by the state is responsible for electricity supply. EEHC affiliates seven (7) regional electricity production companies, one (1) electricity transmission company and nine (9) regional electricity distribution companies, as shown in Figure 2.7.17 Implementation of the projects for electric power production is ordinarily approved by Board of Directors of EEHC with a time schedule. The electricity production companies generate electric power and sell to the Egyptian Electricity Transmission Company (EETC), and then to the electricity distribution companies.

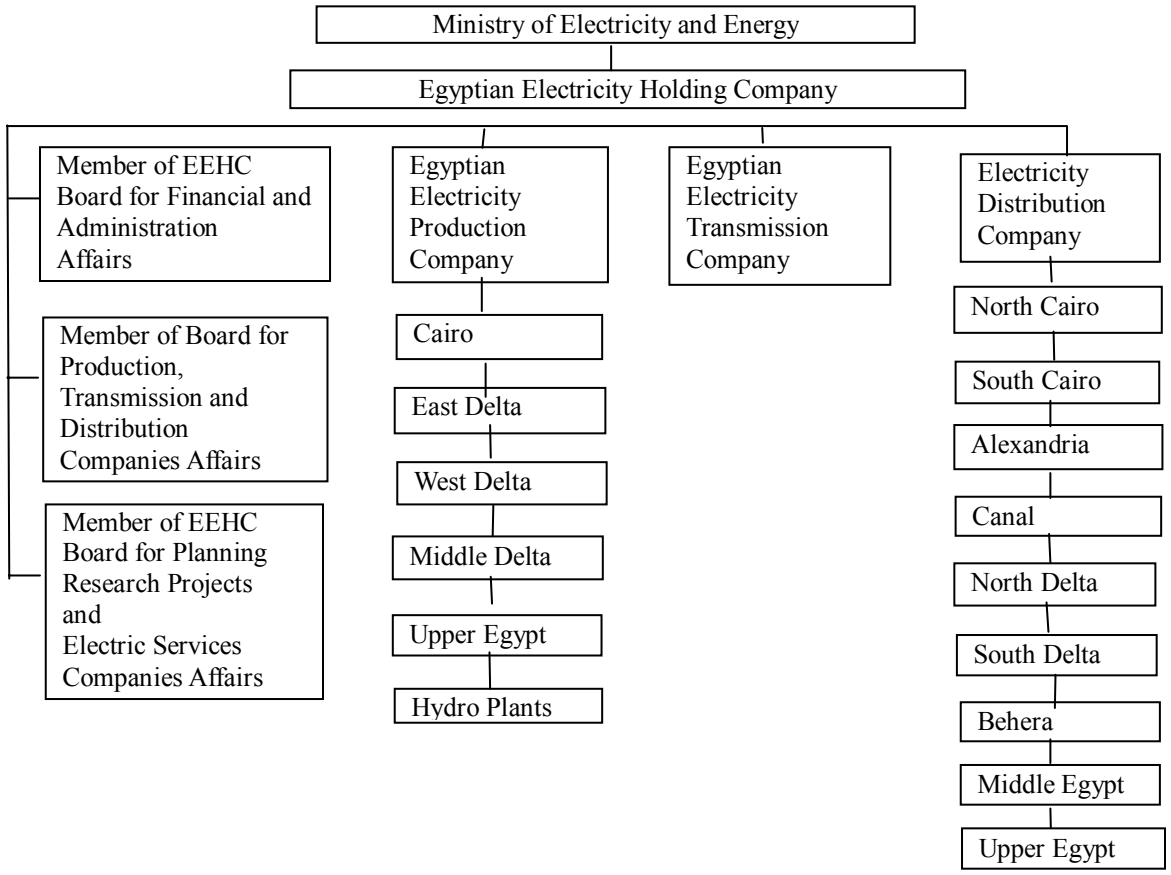


Figure 2.7.17 Organization of Electricity Sector

1) Electric power production

The total generated electric power in Egypt was 108,368Gwh (2005/2006) and the total installed generation capacity was 20,247.2MW (2005/2006) to meet the peak load of 17,300MW. This generation includes electric power generated by the private sector; BOOT (Build, Own, Operate and Transfer) scheme and IPP (Independent power producer). The electric power production in Egypt, including power production by five production companies under EEHC, is shown in Table 2.7.36.

Table 2.7.36 Electric Power Production in Egypt (2005/2006)

Item	Unit	2005 /2006 Total	Electricity Production Company				
			Cairo	W.Delta	E. Delta	Upper Egypt	Hydro
Peak Load in Egypt	MW	17,300					
Generated Electricity Energy in Egypt							
Total Generated Energy	Gwh	108,368	23,469	22,557	24,214	11,325	12,644
Hydro	Gwh	12,644					12,644
Thermal total	Gwh	81,565	23,469	22,557	24,214	11,325	
Combined Cycle	Gwh	20,236	9,363	8,312	9,971	11,325	
Steam	Gwh	53,285	13,957	14,120	13,890		
Gas	Gwh	8,044	149	125	353		
Wind	Gwh	552			552		
Others(IPP,BOOT)	Gwh	13,607		4,847	9,724		
Installed Electricity Generation Capacity in Egypt							
Total Installed Capacity	MW	20,247.2	4,355	5,187.8	5,975	1,968	2,783.4
Hydro	MW	2,783.4					2,783.4
Thermal total	MW	17,485.8	4,355	5,187.8	5,975	1,968	
Combined Cycle	MW	3,948.9	1,985	473.9	1,490	0	
Steam	MW	11,570.5	2,270	3,341.5	3,991	1,968	
Gas	MW	1,966.4	100	1,372.4	494	0	
Wind	MW	183			183		
Others(IPP,BOOT)	MW	2,047.5			1,365	682.5	

Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company

The thermal power with steam turbine is still the main engine with a share more than 55% of total installed capacity, and 43% of total generated electricity. However, since 1980's the combined cycle power generation with natural gas (NG) firing gas turbine has been introduced and became the main stream for new projects.

The power generation by BOOT schemes financed by the private sector also shares around 10% and is expected to increase in future. The wind power station (renewable energy) also started operation.

The main power generation company to supply electricity to the Study area is Cairo Electricity Production Company (CEPC), the details of which are shown in Table 2.7.37.

The location of power generation plants of CEPC is shown in Figure 2.7.18.

Table 2.7.37 List of Electric Power Stations of CEPC (2005/2006)

Name	Type	Gross Power Generation (GWh)	PeakLoad (MW)	Installed Capacity (MW)	Fuel Consumption (ktoe)
Shoubra El-Kheima	St	8,099	1,290	1,260	1,849
Cairo West	St	1,918	348	350	492
Cairo West Ext.	St	3,941	690	660	869
Cairo South I	CC	3,753	505	570	830
Cairo South II	CC	1,134	179	165	223
Cairo North	CC	4,476	1,212	1,250	880
Wadi Hof	G	107	76	100	41
Tebbin	G	42	34	46	16

Note: St: Steam, CC: Combined Cycle, G: Gas, ktoe: kilo ton oil equivalent
Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company

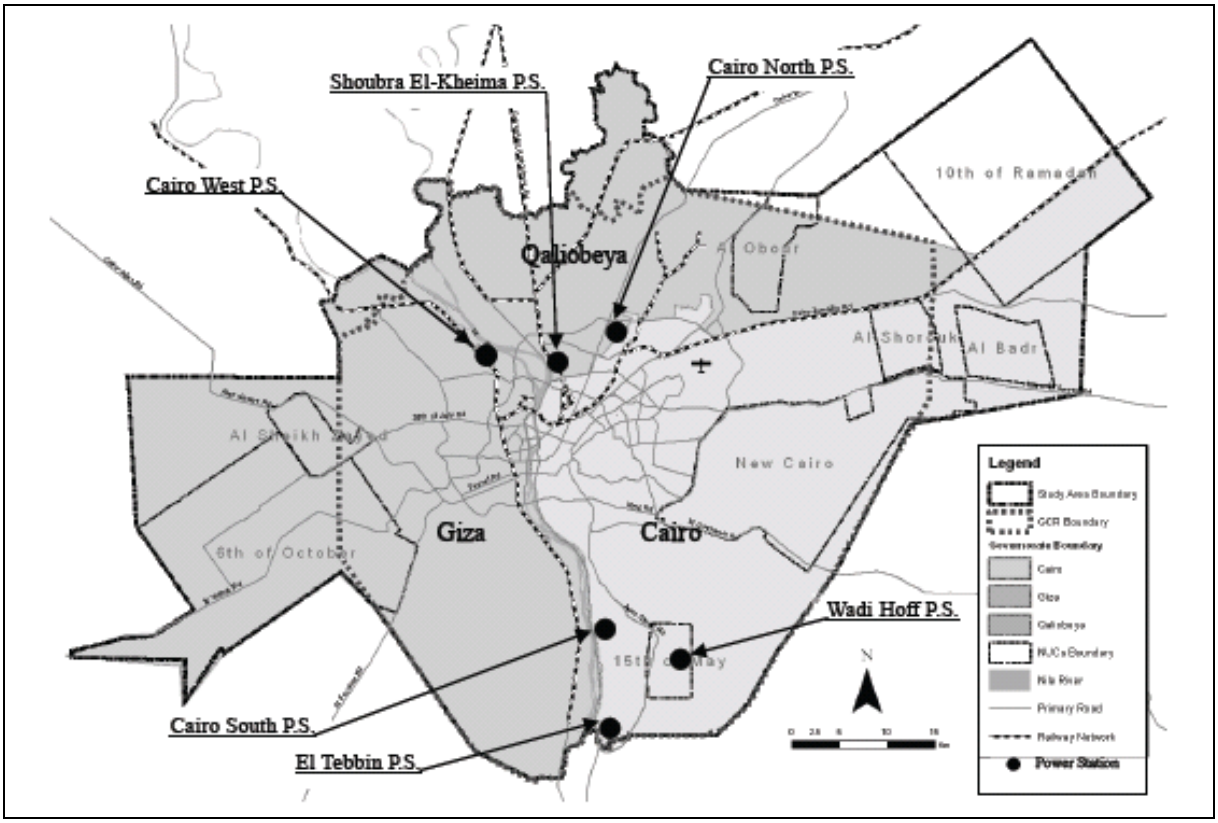


Figure 2.7.18 Location of Power Generation Plants of CEPC

2) Electric power transmission

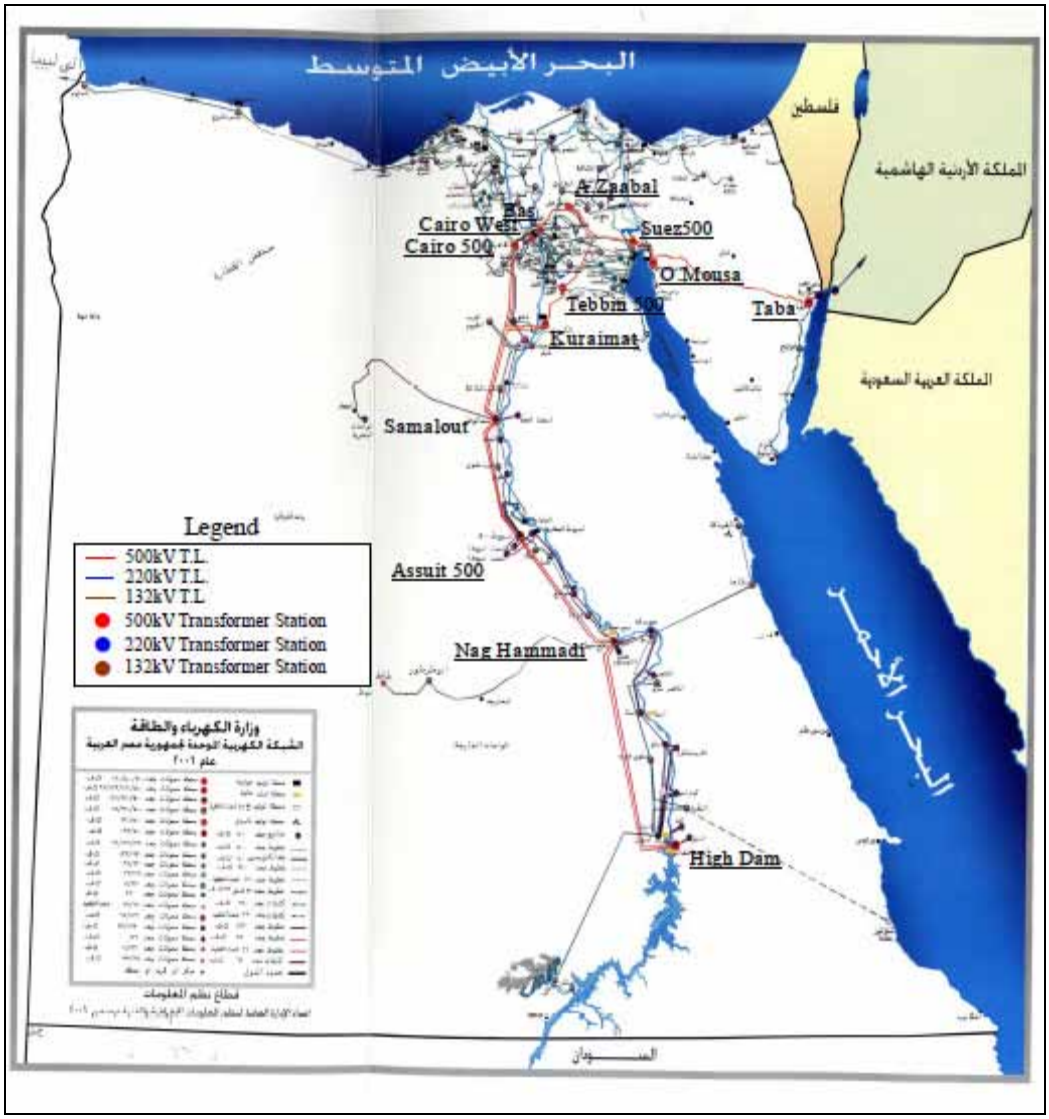
The main role of EETC is the management, operation and maintenance of the electric power transmission grids of extra high and high voltage transmission lines all over Egypt for an optimal economic usage of the grids, as shown in Figure 2.7.19. EETC purchases the electricity produced at the power generation stations according to the needs, and sells it to the high voltage users and regional electricity distribution companies at medium voltage (22kV, 11kV). The power grid is interconnected with the networks of neighbouring Arab countries including Syria, Jordan and Libya etc. for stability within the networks.

The capacity and length of transmission lines and transformers for the Greater Cairo area from which the electricity for the Study area is supplied are summarized in Table 2.7.38. The total transformer capacity to supply to the electricity distribution companies for the Study area is regarded enough as it exceeds the peak load in the area as explained in *3)*.

Table 2.7.38 Electricity Transmission in Greater Cairo (2005/2006)

Primary Voltage	Unit	500kV	220kV	66kV		
Secondary Voltage		220kV	66kV	Total	(2'ry)22kV	(2'ry)11kV
Total Transformer Capacities	MVA	1,500	7,725	11,491		
No.of Transformer Station		3	20	94	8	86
Transmission Lines	km	212	1,066	2,769		

Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company



Source: Egyptian Electricity Transmission Company

Figure 2.7.19 Electric Power Grid in Egypt

3) Electric power distribution

Both of North Cairo Electricity Distribution Company (NCEDC) and South Cairo Electricity Distribution Company (SCEDC) distribute electricity to the consumers in medium (22kV, 11kV) and low voltage (400-230V). Most of electricity is purchased from EETC and some amount directly from the power stations of CEPC in medium voltage. The details of NCEDC and SCEDC are shown in Table 2.7.39.

The area covered by NCEDC and SCEDC is almost equal to the Study area except for 10th of Ramadan NUC which is supplied by Canal Distribution Company.

The distribution company directly deals with the customers including the tariff collection. Therefore, managing, operating and maintaining the medium and low voltage grid in well serviceable conditions is an important task for NCEDC and SCEDC.

Tariff meter reading and collection of tariff is executed manually by the staff of the distribution company. The tariff structure is set in lower rate for consumers with small amount of consumption and higher rate for the consumer with larger consumption. Table 2.7.40 shows the typical electricity tariff rates for residential and approximate ratio of customers.

Table 2.7.39 Medium and Low Voltage Grids of NCEDC and SCEDC (June 2006)

Item		NCEDC	SCEDC
Area responsible for distributing electricity		North and East Cairo serving 21 districts and cities in Great Cairo	South and West Cairo and Giza serving 24 districts and cities of Great Cairo
No. of Customer(2005-06)		2,943,823	3,674,767
Maximum load (2004-05) (MW)		2,115	2,785
No. of Medium Voltage Distributors		251	266
Length of Medium Voltage Grid (km)	Overhead Lines	510	2,658
	Underground Cables	11,954	15,128
	Total	12,464	17,817
Length of Low Voltage Grid (km)	Overhead Lines	2,547	4,102
	Underground Cables	27,611	27,414
	Total	30,158	31,816
Total No. of Distribution Transformers		12,866	15,634
Distribution Transformers Capacities (MVA)		9,488	9,445
No. of Low Voltage Boxes and Boards		34,145	46,326

Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company

Table 2.7.40 Electricity Tariff Structure and Ratio of Customer (2006)

Description	Price(Pt/kwh)	Approximate ratio customer number(%)
1) First 50 kwh Monthly	5.0	1
2) 51 - 200 kwh Monthly	9.2	5
3)201 - 350 kwh Monthly	12.5	60-70
4)351 - 650 kwh Monthly	18	10
5)651 - 1000 kwh Monthly	25.5	5
6)more than 1000kwh Monthly	31	

Source: Annual Report of Egyptian Electricity Holding Company and information from NCEDC

4) Fuel supply

The main fuel for power production plant is natural gas (NG), which shares around 80% of total fuel in Egypt. NG is normally supplied at 30 bars in pipeline with pressure reducing stations in user site and by the contract with NG distributing company. Heavy Fuel Oil (HFO: No.6 fuel oil equivalent) is used for the power station where NG grid is not connected or the capacity of NG supply pipeline is not sufficient for new projects. Switching from liquid fuel to NG is promoted under the national policy which also has an environmental advantage. The power production plant normally stores HFO for emergency reserve. Light Fuel Oil (LFO) is used for start-up of boiler. The present situation of supply of the fuel with its components is shown in Table 2.7.41.

Table 2.7.41 Fuel for Electricity Production in Egypt (2005/2006)

Kind of Fuel	Consumption (Oil Equivalent) Nation Wide		Consumption (Volume) Nation Wide		Cairo	Consumption (Weight %)				
	Unit		Unit			C	H	S	N2	Ash
Natural Gas	ktoe	14,688 (79.6%)	$M.m^3$	17,298	5,194	75	25			
H.F.O(Mazout)	ktoe	3,687 (20.0%)	1,000 Tons	3,691	831	86	10.5	3	0.05	0.2
L.F.O(Solar)and Special L.F.O	ktoe	72.4 (0.4%)	Ton	70,072	2253	86.3	12.5	1	0.05	0.1
Total	ktoe	18,448 (100%)								

Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company

5) Quality of service to consumers

The quality of electricity supply to consumers shall generally be depicted from the following three points, and present status was assessed in Cairo region as follows.

i) Reliability: According to the staff of West Cairo Power Station, the supply outage of power station is very scarce, limited to only once or twice per year, which is in high level of supply continuity. The power plant visited also showed high level of operation and maintenance.
The distribution company substation/transformer stations in the Study area visited were physically well protected by standardized building and the armoured cable for underground feeding line. The medium voltage distribution feeders are mostly ring-main connections to avoid total supply failure.

ii) Availability: The standard period of annual planned outage of power station for maintenance and stipulated inspections is one month and the periodical major check is one day (daytime only) for every 3 months. The unscheduled outage is mainly due to fault of boiler. The availability at more than half of power generation station exceeds 90% and the efforts to increase the available time by shortening maintenance period was reported by staff of power station visited.

iii) Serviceability: The timely connection to electricity distribution system for new customers or new facilities is important in the newly developed Study area. The delay of electricity supply to customers and public utilities would affect the smooth development of the area. According to NCEDC, 10 days are target lead time for supplying electricity in case meter has been installed.

6) Environmental aspects

The main environmental impacts to be considered in the production of electricity are pollution of air and water of Nile River. The Egyptian government regulates the maximum level of emission from fuel-burning sources by Law No.4 of 1994 and discharged water to the Nile River by Law No.48 of 1982.

Cairo West Power Station was selected and surveyed due to usage of HFO as fuel and discharge of water to the Nile River. The compliance to Laws is observed as summarized in Table 2.7.42 for data on Sep.2007. Although HFO which contains 3% of sulfur is presently used as regular fuel of No.5 and 6 units of Boiler in Cairo West Power Station, the pollutants in air emission including SO2 was within the limit. The inclusion of pollutants in waste water and temperature rise of exhausted cooling water were also lower than the limit. All of environmental monitoring data collected by staff of Cairo West Power Station are assessed periodically by the inspector of Egyptian Environmental Affairs Agency (EEAA).

Table 2.7.42 Environmental Impact of Electricity Production Plant (during Sep.2007)
(1) Emission(Maximum reading)

Area	Pollutant	Environmental Law 4/1994	Power Plant		
			Cairo West	Cairo south	Shoubra El kheima
Air	NOx	300mg/m3	250	183.58	195.85
	CO	500mg/m3	78	65.11	69.11
	SO2	4000mg/m3	2229	1574.47	0

(2)Water Pollution

Area	Pollutant	Law No.48/1982 Protection of Nile River	Power Plant		
			Cairo West	Cairo south	Shoubra El kheima
Liquid Effluent to Nile River	pH	6-9	7.7		
	BOD	30mg/L	4.5		
	Iron	1mg/L	0.18		
	Oil and Grease	5mg/L	2.4		
	Total suspended Particles(TSP)	30mg/L	5.1		
	Cooling Water Temperature increase	Max absolute temp 35 degreeC at discharge point,	31.5	31	32
		less than 5 degreeC increase outside of mixing zone	4.5	6	4

Source: Cairo West Power Station

(2) Future demand and supply

1) Historical trends in Egypt

EEHC summarizes historical trends of sector-wise power demand since 1982 and future forecast of demand till 2022 as shown in Table 2.7.43. While the average annual growth rate of total electricity demand (sales) in Egypt during 25 years since 1982 is 7.25%, EEHC forecast the same as 5.18% in 2021-22. This means the growth will slow down in the future, especially in the residential sector and public/commercial sector, in spite of a slight increase in industry sector.

Table 2.7.43 Historical Trend and Forecast for Sectors

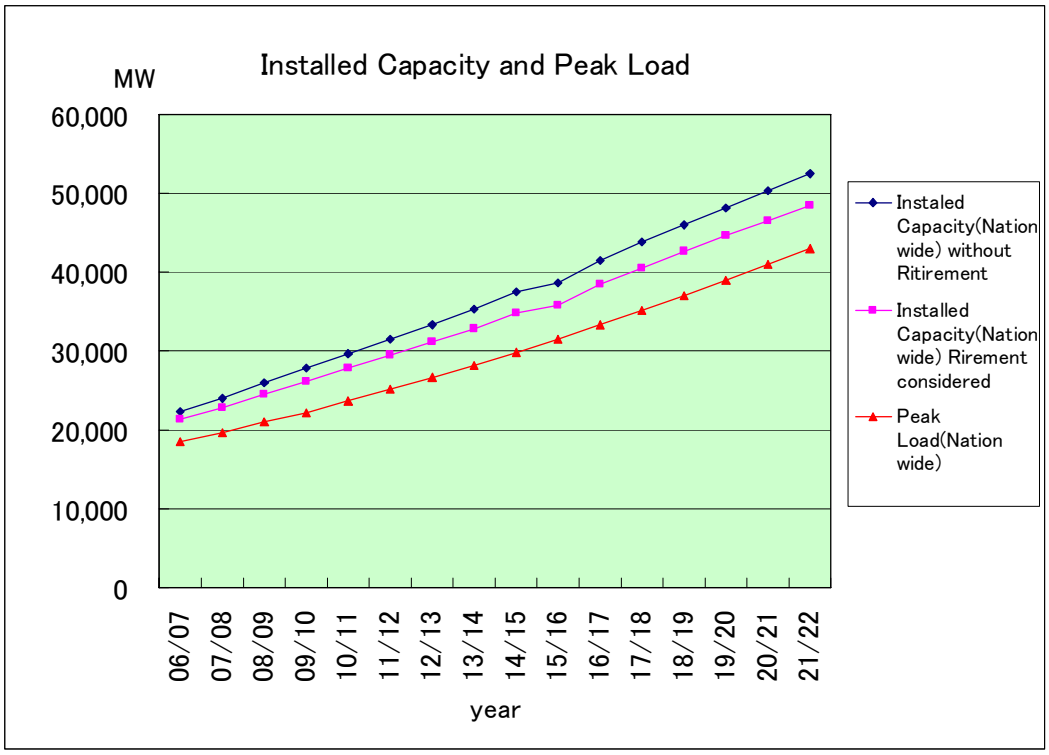
Sectors(GWh)	Average Annual Growth. Rate(%) 1982 -06	05/06	06/07	Ann. G. Rate (%) 06-07	11/12	16/17	21/22	Ann. G. Rate (%) 21-22
Peak load(MW)	6.64	17,300	18,430	6.53	25,110	33,320	43,020	5.03
Total Generated Energy	6.89	108,357	115,581	6.67	157,750	210,317	273,068	5.14
Total Energy Sales	7.25	92,055	98,832	7.36	136,891	185,258	241,773	5.18
Total Industry (Ratio:%)	5.24	32,701 (35.5)	34,596 (35.3)	5.79	47,295 (34.7)	63,194 (34.3)	82,711 (34.3)	5.32
Agriculture (Ratio:%)	6.18	3,719 (4.0)	4,040 (4.1)	8.63	5,576 (4.1)	7,394 (4.0)	9,510 (3.9)	4.93
Residential (Ratio:%)	9.37	33,900 (36.8)	36,080 (36.8)	6.43	50,068 (36.8)	69,001 (37.4)	90,234 (37.4)	5.12
Public Utilities +Lighting (Ratio:%)	8.78	21,735 (23.7)	11,403 (11.6)	7.39	15,869 (11.7)	20,977 (11.4)	26,674 (11.2)	4.65
Commercial and Others (Ratio:%)			6,542 (6.7)		9,759 (7.2)	13,527 (7.3)	18,066 (7.5)	5.69
Government (Ratio:%)			5,396 (5.5)		7,548 (5.5)	10,390 (5.6)	13,803 (5.7)	5.60
Total		92,055 (100.0)	98,057 (100.0)	6.52	136,116 (100.0)	184,483 (100.0)	240,998 (100.0)	5.20

Source: Egyptian Electricity Holding Company

2) Future supply

According to the information on the planned electricity generation projects of EEHC, the peak load of total Egypt is forecasted in 2021-22 as 43,020MW. The installed capacity of electricity production in 2021-22 is planned to be 52,561MW, and this figure has a reserve of 18%. This figure, however, does not reflect the retirement of outdated plants.

The life span of electricity production plants differs according to the type of plant, fuel and maintenance grade, but in general the life of electricity production plant is 50 years for Hydro plant, 35 to 40 years for NG firing plant and 30 to 35 years for HFO firing plant. Assuming the plants commissioned before 1970's would have to be retired before 2020, the capacity of retirement was assumed to be 4,000 MW at 2022, and accordingly 1,000 MW at 2007, 2,000 MW at 2012, 3,000MW at 2017. Taking this retirement into consideration, the installed capacity in 2021/22 would be 48,561MW and the corresponding reserve would be 11.5% to the peak load. This still is regarded rational, as developed countries normally take 8 to 10% reserve of generation capacity. This forecast is shown in Figure 2.7.20.



Source: Egyptian Electricity Holding Company

Figure 2.7.20 Electricity Forecast in Egypt

3) Analysis for the study area

The total electrical energy and per capita consumption in Egypt in 2004/2005 is estimated by EEHC to be 1,450kWh and 165W per person. The same for 2006/2007 and for the later year were calculated from electricity energy generated in Egypt divided by the estimated population. This Electricity energy in Egypt per capita shows the growth rate of around 4% per year. The same electricity demand growth rate applied for the Study area and its electricity demands were calculated as shown in Table 2.7.44.

Table 2.7.44 Electricity Demand of the Study area

		unit	2006-07	2011-12	2016-17	2021-22
Population of Egypt (estimated)		Mill.	74.1	81.4	88.5	94.1
Electricity energy (generated)of Egypt		Gwh	115,581	157,750	210,317	273,068
Electrical Energy/Capita of Egypt		kwh	1,559	1,938	2,377	2,902
Population of the Study area		1,000	16.464	18,411	20,369	22,334
Electrical Energy/Capita of study area(assumed)		kwh	2,106	2,570	3,098	3,668
Tentatively calculated electricity demand for the Study area based on information from EEHC.	Energy	Gwh	34,674 (30.0%)	47,325 (30.0%)	63,095 (30.0%)	81,920 (30%)
	Peak load	MW	5,529 (30.0%)	7,533 (30.0%)	9,996 (30.0%)	12,906 (30.0%)

According to unofficial information from EEHC, the maximum demand in Cairo region normally shares 30 to 35% of the peak load. Roughly calculated result based on 30% of total Egypt demand is shown in Table 2.7.30 for the Study area. As the sum of

Maximum load (2004-05) of NCEDC and SCEDC is 4,900MW (excluding 10th of Ramadan) as shown in Table 2.7.44, the calculated peak load for the Study area 5,529 MW (2006/07) is considered to be in a reasonable range.

(3) Ongoing/future projects

EEHC has the plan of electricity generation projects till 2021/22, on the basis of which Fig. 2.7.20 was produced.

The Table 2.7.45 shows the outline of ongoing projects based on the EEHC annual report and news on Web site. Some delays are seen in implementation of projects as compared with EEHC plan, but still regarded not critical for a long term supply and demand balance.

Table 2.7.45 Outline of Ongoing Projects

Company	Project name	Type	Gas turbine generator		Steam turbine generator	
			Output (MW) (manufacturer)	Com. year	Output(MW) (manufacturer)	Com. year
Cairo	Cairo North II	CC	2x250 (GE)	06	1x250 (Alstom)	07
E.Delta	Talka	CC	2x250(Sadelmi)	06	1/250 (Alstom)	08
Upper	Kurimat-3	CC	2x250(Alstom)	10	1x250(Alstom)	10
W.Delta	Nubaria-3	CC	4x250(Siemens)	05	2x250(Siemens)	10
Cairo	Cairo West-7,8	St			2x350(MHI)	10
Upper	Kurimat(Solar/Themal)	Solar +CC	(Solar)30	10		
			120(Iberinco, GE,Mitsui)	10		
Cairo	Tebbin	St			2x350(Alstom)	10
W.Delta	Sidi Kir	CC	2x250(MHI)	09	1x250(Alstom)	
M.Delta	El Atf	CC	2x250(MHI)	09	1x250	

Source: Source: Annual Report. Ministry of Electricity and Energy / Egyptian Electricity Holding Company and Web site news

1) Thermal production

The steam turbine generation account for more than 55% of total electricity generation at present. The combined cycle generation which achieves higher thermal efficiency is increasing in on-going and future projects. While some thermal power plants are still fired by HFO due to the delay in pipeline connection of NG. Gas turbines should be fired by NG, which will not generate SOx during combustion.

2) Renewable energy

New and Renewable Energy Authority aims at 3% of total energy demand to be supplied by a new energy in cooperation with EEHC. The main option for new and renewable energy is wind energy in Red Sea region, which is planned to reach 845MW in 2010. Another choice is solar energy. Kurimat solar and thermal combined power generation which generates 30MW by solar and 120MW by Gas turbine and steam turbine is under progress for commission in 2010.

(4) Recommendations for efficiency issues

The improvement of efficiency in energy generation and consumption is the major issue for sustainable global development in avoidance of environmental impact such as climatic change of the earth. The recommendations to be promoted for improvement of efficiency in wide sense are described for supply side and demand side as follows.

1) Supply side efficiency improvement

- The improvement of energy efficiency in electricity generation can be achieved by increased machine performance and operation optimization. Operation in lower efficiency load zone shall be avoided by shutting down low efficiency machines.
- The more use of NG as fuel shall be promoted to decrease emission of CO2 and other pollutants.
- The introduction of low environmental impact equipments, such as the low NOx burner, waste liquid fuel recycle system and low loss transformer, is also important.
- The present Environmental Law regulates the limit only for the individual plant. Along with increase of plants, it is requested to adopt the concept of "Regional Emission Restriction" which would regulate the total mass of pollution load of a specified area in order to prevent the total deterioration of the environment in the region.
- Electricity developing companies should maintain proper information on new housing/urban development projects so that they could provide power in time for new customers when they connect.

2) Demand side efficiency improvement

i) The developed countries and some Arab countries adopt the time and season varied tariff system which shall promotes consuming electricity in less load time for the electricity production company. The possibility of introducing such a time and season varied tariff system which may require the accompanied metering system shall be studied.

ii) Demand-side management (DSM) including the following efficiency improving measures to be promoted.

- Cooperation with industrial companies for shifting some loads out of peak load period (daily and seasonally). (EEHC reports implementation of a pilot project.)
- Use of efficient lighting fixture like high frequency fluorescent lamp and compact fluorescent lamps as promoted by NCEDC and SCEDC.

- Manufacturing and purchase of high efficiency electrical household appliances. In this regard, Ministry of Industry and Technology Department has issued the decrees for energy efficiency standards for three appliances (refrigerator, washing machines and air conditioners) and these appliances are fitted with Energy Efficiency Label (EEL) which shows the energy efficient level by five grade of A (highest) to E(lowest). Use of highly efficient electric furnaces ought to be promoted particularly in newly developed housing units which tend to consume more electricity.

iii) Energy Efficiency Building Codes for residential and commercial building were issued by the Ministry of Housing in cooperation with the Ministry of Electricity and Energy. These Codes stipulate the standard and guideline for designing of comprehensive energy consuming system. The designers of buildings and houses shall comply with this guidance.

iv) Implementation of activities based on Environmental Management Systems (EMS) like ISO14001 for institutions and private companies is recommended as an effective means for improving eco-friendly awareness and for all members of the community to save energy and reduce activities that affect the environment.

2.7.6 Analysis and Conclusion related to Housing and Utilities

(1) Housing

Provision of affordable housing finance for low to middle income group, recent survey shows that housing loans provided by individuals, employees and bank by preferred financial source for purchased housing units is by 10.9% only. Recently Mortgage law in 2001 was enacted, however it is pointed out that secondary market of the mortgage in Egypt is limited even mortgage entities were established under advisory of World Bank and USAID.

More contribution to affordable housing by private sector is efficient use of limited budget in construction of housing units, operation and maintenance of housing units built.

(2) Water supply

With respect to water supply in the Study Area, the planned capacity expansions will meet the total demand up to the year 2027.Several issues have to be raised, however, regarding the water quantity as well as the supply system. Some NUCs will need to receive purified water from water purification plants in the Governorate of Cairo to cover the future shortage of water supply. In parallel, reduction of unaccounted for water including leakage will be indispensable for efficient water use. Proper and regular preventive maintenance of the water supply system as well as metering of water supply to all users are the key measures in rationalizing the water use. For the villages and small towns where groundwater is used for water supply, investigation of the water quality and disinfection process is strongly recommended to clarify the risk of groundwater contamination.

(3) Wastewater

The overall wastewater treatment capacity in the Study Area will be sufficient under the on-going capacity expansion plans to handle the wastewater generation. It is recommendable that reviewing of the extension plan for some NUCs with future shortage of wastewater treatment capacity be carried out. Installing the secondary treatment step for wastewater treatment plant at Abu Rawash is essential and considered as the highest priority project by CAPWO. Providing wastewater systems to the villages and small towns without any wastewater treatment systems in Giza and Qaliobeya Governorates within the Study Area is highly recommended.

(4) Solid waste

Most of municipal solid waste (MSW) in the Study Area is burdened causing operational and financial problems. Introduction of the proper management shall decrease hygienic troubles, and contribute to the beautification of the land including the Study Area. In addition, better performance in operation will result in a reduction in the operation cost which is currently being subsidized by the public sector. The existing landfill sites will be utilized for more 10-15 years continuously and therefore no new site for extension other than on-going project site will be deemed necessary at the moment. A waste disposal system must have the required capacity, structure, location and the users for the landfill should be well informed of the situation of each site. A sound structure is needed in any sanitary landfill i.e. stability, leachate control and gas vent with proper operation. Also, post-closure management of the landfill site must also be taken into consideration.

As for recycling, material recovering for non-organic recyclables, especially aluminum cans, iron scrap, plastics and paper items, should be promoted to reduce the waste disposed to the landfill. Presently, "3R" (Reduce, Reuse, Recycle) has become a world wide trend in addressing the SWM issue. If recycling activities such as composting and recycling of valuable material are enhanced, the service life of the landfill sites will be extended.

(5) Power supply

The electricity generation, transmission and distribution is planned and implemented by Egyptian Electricity Holding Company and its affiliated companies. There are the demand forecast till the year 2021-22 and the capacity expansion plan of generation plants in due balance. The progress of the ongoing projects seems to be almost as scheduled, and the electricity supply in GCR including NUC is also stable and uninterrupted. An important issue is a fuel for thermal power station and its environmental influence. Natural Gas (NG) is preferred, but Heavy Fuel Oil (Mazout) which contains Sulfur is still used in GCR. The switching to NG will have environmental advantage and shall be promoted. It is recommended that the improvement of efficiency further be pursued in both electricity supply and demand sides, as proposed in the foregoing section.

2.8 Main Challenges and Assets

This section summarizes the main challenges and assets of the study area, based on the analysis of the present conditions depicted in the Sections 2.1 through 2.7.

Overcrowding or excessive accumulation of population in the city center area could be a major cause for the urban problems in the study area, and may have effects on various kinds of problems such as inefficiency in economic activities, poor and insufficient living environment, socioeconomic inequality, pervasive poverty, chronic traffic congestions, etc. Following table shows advantages and disadvantages of the mega city as summarized by OECD (Organization for Economic Co-operation and Development). These comparisons may hold some truth in the case of the study area, as the morphology of Cairo shows excessive population density in some areas of the study area.

Table 2.8.1 Advantages and Disadvantages of Mega City

Advantage	Disadvantage
1) Agglomeration economy allows large metro region and thus attracts global or regional headquarters, offers a wide range of choices in resources (primarily labors, but also some elements of supply chains and research institutes) concentrates more specialized business service and infrastructure. 2) Metro region typically providing contrasting advantages of specialization and diversity 3) More favorable pattern of metro regions closely linked with their capacity to concentrate R&D activities and generate innovations. 4) Metro region tends to have greater endowment of human capital. 5) Metro regions have a large stock of physical capital measured by equipment of firms and the stock of buildings and infrastructure facilities.	1) Exclusion and poverty becomes urban phenomena. 2) Increasing socioeconomic inequalities between high income people working in high value-added service and low-income population 3) Poverty and social exclusion lead to significant costs including high level of criminality and strong spatial polarization 4) Congestion costs are particularly prominent, notably traffic congestion but also other form of pollution, such as reduced air and water quality, high noise level and degradation of green areas. 5) Poor quality of infrastructure may become a problem in some places because of the costs of maintaining a good-quality physical environment when there is a high concentration of people and activities

Source: Summarized from OECD (2006), OECD Territorial Review Competitive Cities in the Global Economy

OECD[12] pointed out that "bigger means richer" until a certain threshold (around 7 million), and beyond that the correlation between metro region size and income become negative, suggesting the existence of diseconomies of agglomeration in mega cities. In fact, overcrowding population affects on following urban problems.

1) Poly centric economic and culture brings depression in other cities and rural areas
2) Urban functions paralyzes widely by natural disaster occurred
3) Poverty and social exclusion may lead increasing criminality level
4) Lacking housing units may cause increasing informal housing areas
5) Unemployment increase when there is no industry which it corresponds to population
6) Chronic traffic congestions occurs

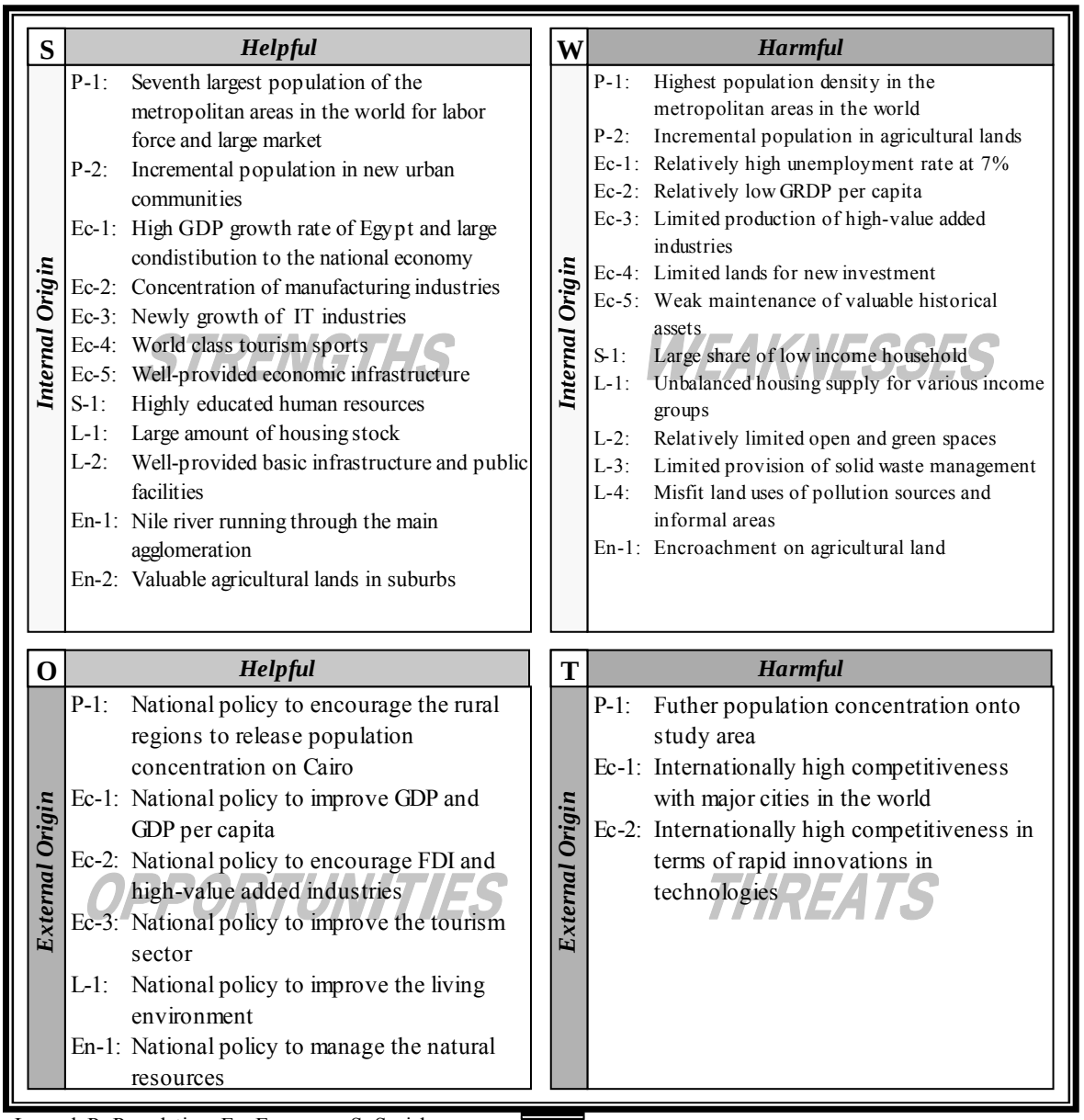
[12] OECD (2006), Competitive Cities in the Global Economy

7) Environmental problems, air pollution, water quality degradation, occur

2.8.1 Overview of *SWOT Analysis* for the Study Area

SWOT Analysis is a widely practiced planning tool to evaluate the ***S***trengths, ***W***eaknesses, ***O***pportunities, and ***T***hreats involved in a project or in a planning context. The SWOT analysis involves specifying the objective of the planning process or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective, which shall accmodate favarouble environment for living, economic activities, and natural resources to sustain the attractive city.

The following matrix describes the the ***S***trengths, ***W***eaknesses, ***O***pportunities, and ***T***hreats identified for the Study Area, as analyzed and identified in the previous Secions of this chapter related to population, economic activities, urbanization, land use, and people's perception. The SWOT matrix yielded four major planning tasks, namely, the ,main challenges and assets, as explaained in the next Section.



Legend: P- Population, Ec- Economy, S- Social development, L- Living environment, En- Environment

Main Challenges and Assets

1: *Over-concentration in the main agglomeration* : Rectifying population concentrations in the main agglomeration by promoting the growth of new urban communities and efficient land use in all existing built-up areas
2: *Insufficient lands for new business activities* : Encouraging provision of competitive lands for new business activities to enhance economic activities, reduce unemployment rate, and improve household income
3: *Improper management of natural and cultural resources* : Encouraging the management of existing resources by controlling urban growth and improving protection of existing natural and cultural assets
4: *Imperfect living environment* : Improving living environment by dissolving misuses and providing public transportation and offering affordable housing, utilities and facilities for various income groups

Source: JICA Study Team

Figure 2.8.1 SWOT and Main Challenges for the Study Area

2.8.2 Over-concentration in the Main Agglomeration

(1) Seventh largest metropolis in the world

The study area has a population of 16 million today (2006) and is ranked as the seventh largest urban agglomeration in the world, and is grow at an annual average rate of 2.2% in 1996-2006. The population growth will inevitably bring about an expansion of urban areas and a possible increase in the population density in the existing agglomeration. This may lead to deterioration of the living the environment unless the urbanization is carefully controlled and managed.

(2) Inefficient control of land use within the agglomeration area

Effective land use is required to mitigate the issues arising from the population concentration in the agglomeration area. Examples of ways to achieve efficient control of land use are described below.

- Factories that are polluting environment need to be relocated to areas outside the main agglomeration.
- To enhance the efficient use of limited land resources, the development of new cemeteries while the expansion of existing cemeteries need to be prohibited.
- Relocation or redevelopment of transportation facilities, such as freight stations or workshops, may be considered for the restructuring of the main agglomeration.
- Relocation of the central government offices from the city center to suburban location shall be promoted in parallel with the possible redevelopment at the present site within the center of the study area.
- The area of public parks and green areas needs to be increased throughout the urban area

(3) Vitalizing the new urban communities

Population growth in NUCs has proceeded at a relatively high rate of 11% per year between 1996 and 2006. Even though the population shift to NUCs has commenced, there are a large number of vacant housing units in NUCs. To fill up those vacant housing units and vitalize the NUCs, further efforts will be required to mitigate the incremental population in the main agglomeration and villages and small towns.

The housing demand survey conducted by USAID in 2006 revealed that for more than 50% of surveyed households, the household income is limited to less than LE 10,000 per year (or less than 147 USD/month). Housing expenditure for more than 80% of surveyed households is less than LE 2,000 per year (or less than 29 USD/month). Monthly rental payments for housing under the old law was estimated at only LE 41/month for the mean price and LE 27/month for the median price. Taking into account the relatively low housing expenditures, provision of affordable housing for people willing to move to NUCs is required in order to promote a population shift to NUCs.

2.8.3 Insufficient lands for New Business Activities

(1) Strong economic prospects

Egypt has been experiencing high economic growth rates in recent years, and strong economic prospects are projected for the medium and long terms. While the Egyptian economy continues to grow rapidly, the engine powering the development comes primarily from the services and manufacturing sectors that require highly qualified and well educated human resources. In this regard, the future economic development shall depend partly on the strength of the capital region of Egypt, i.e. the study area, where some of the best and finest of the nation's human resources and economic opportunities are concentrated. The information technology (IT) based industry will have an increasing importance as an engine for economic growth.

(2) Saturation of the existing central business district

Various activities, such as government, business, tourism, hotels, and commercial are concentrated in and around the existing central business district (CBD) and the cumulative effect of this saturates the capacity in CBD area. Thus the potential of CBD to offer large scale new locations for modern offices and international businesses is very limited if not none.

The existing CBD needs to be redeveloped and rehabilitated with renewed urban functions. At the same time, the government area now located near CBD needs to be planned for relocation within a few years time, the implementation of which will reduce the concentration of activities in the main agglomeration substantially.

(3) Promoting new locations for new business centers in NUC

In the Opinion Poll Survey for enterprises in the study area, it turned out that about 30% of the enterprises are already located in NUCs and about 13% of enterprises have a plan to relocate or open a new office in NUCs. The combined percentage of the above two will be 43%, meaning that about half of the questioned enterprises are either already in NUCs or have some plan to do business in NUCs.

With the CBD saturating with regard to capacity to provide site for new businesses for enterprises, it will be NUCs that will take this role in the future. The planning of NUCs shall be such that accommodate business areas for new offices and businesses.

2.8.4 Improper Management of Natural and Cultural Resources

(1) Delineating the urban area for the target year 2027

For the five-year period between 2001 and 2007, new urbanization have encroached upon 2,000 ha agricultural lands. Even so, a large portion of the new urbanization has occurred on desert land, as it accounts for 56% or 7,100ha. In the existing master plan, the Ring Road and other physical boundaries, such as roads and railways, are considered as the allowable limits of urbanization, but in practice, the urban area does extend beyond these physical boundaries.

These physical boundaries, however, have generally functioned almost adequately to prevent excessive expansion of the urban areas.

A new law concerning the physical planning, building works and urban harmony will specify the requirements for a boundary to be defined as a limit of urban areas. This will present a good opportunity to designate the urban area, which will assist with managing the random sprawl of urban areas. An institutional system endorsed by having legal status and reliable organization for monitoring and control needs to be established to control future urbanization in the GCR.

(2) Insufficient framework for conservation of historical and cultural resources

The future economic growth will be empowered by the tertiary industry, of which the tourism industry is one of the key industries for Egypt, and it will be crucial that the tourism industry shall have sustainable strength and maintain its dominant position. The study area has plenty of historical resources, and needs to preserve and maintain those resources.

2.8.5 Imperfect Living Environment

(1) Improvement of informal development areas

Comprehensive statistics are not available for the informal development areas. Existing references show that the informal areas are largely spread over the agglomeration area. Sometimes, the population density in the informal areas significantly exceeds 3,000 people/ha. The informal housing is less expensive than that in formal housing areas, and this encourages people to construct informal housing. GOE has struggled to reduce the development informal housing units. Its efforts have succeeded to some extent. However, a large area of informal development still exists.

(2) Market-driven and active housing market

The housing demand survey reveals that 7% of the surveyed housing units are vacant in 2006. The highest vacancy rate of 16% was found in 6th of October NUC. The survey confirmed the reasons for vacant units as being the desire of owners to keep units vacant for future use by their children (60% of the respondents), avoiding the risk of losing the unit or being unable to evict unsuitable tenants. Measures need to be taken to activate the housing market, since its stagnation will lower the efficiency of budget installment allocations for urban development and the provision of public services.

CHAPTER 3 GOAL, DEVELOPMENT STRATEGIES, AND SPATIAL DEVELOPMENT PLAN FOR THE STUDY AREA

3.1 Goal, Objectives, and Development Strategies

3.1.1 Goal for Cairo 2027

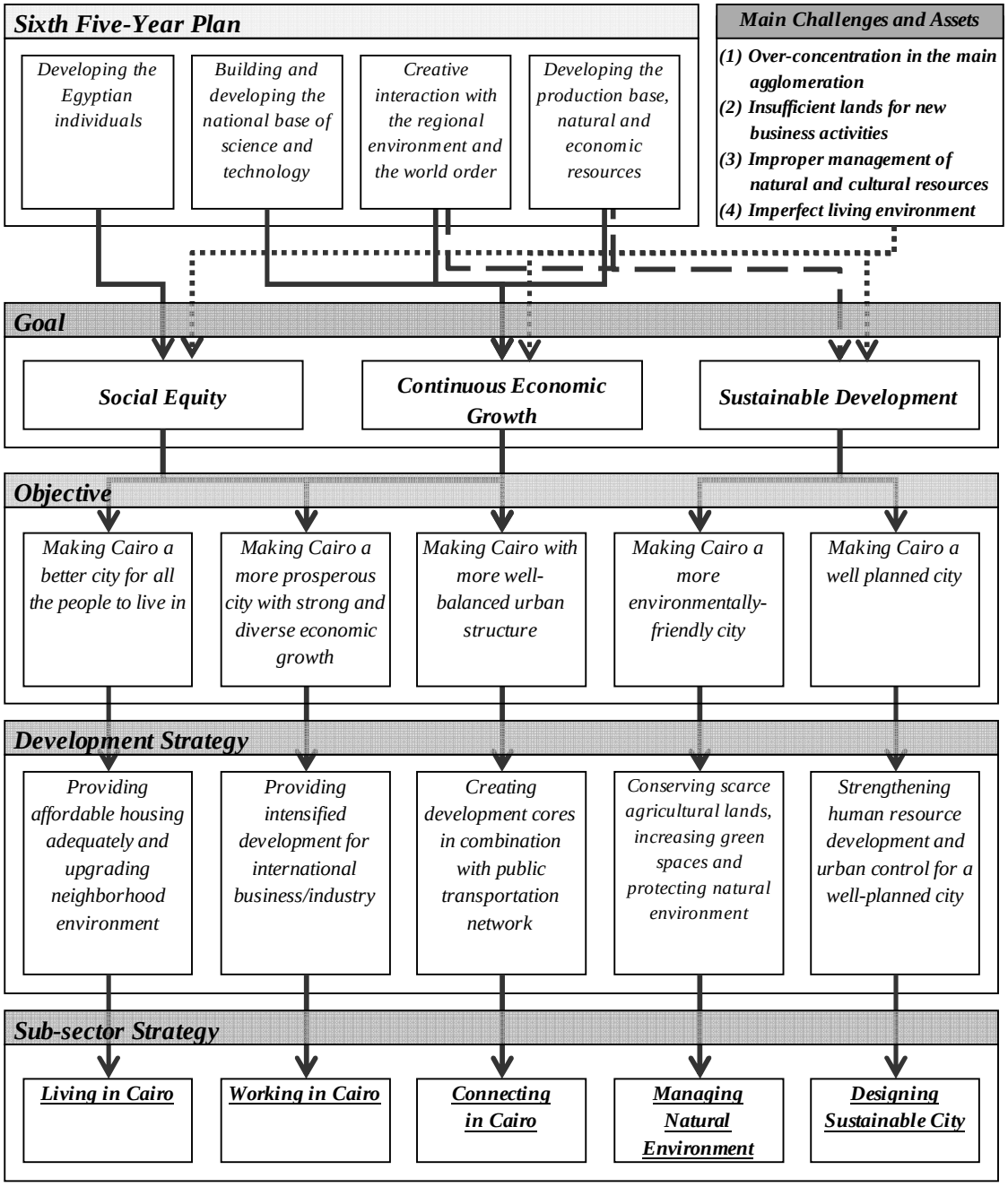
The spatial structure of the study area has to be properly shaped and managed in order to fulfill the requirements of the main challenges mentioned in Chapter 2 and incorporate the proposed main axes of the Sixth Five Year Plan. Thus, the following goals for the study area for the target year of 2027 have been set up in order to meet the above objectives:

1) "*Social Equity"* to provide an equitable living environment for all the people living and working in the Study Area

2) "*Continuous Economic Growth*" to bring about uninterrupted growth of the urban economy, achieving wealth and stabi:lity for the people in the area and attracting competitive international businesses, which will improve the quality of life for all the people in the Study Area.

3) "*Sustainable Development*" to bring about future development that enables more effective use of scarce resources such as land, capital and skilled labor in the Study Area..

The proposed goals were the basis for formulating objectives, development strategies, and sub-sector strategies for the study area, as depicted in Figure 3.1.1.



Source: JICA Study Team
Note: Cairo in this figure defines to cover the study area.

Figure 3.1.1 Goal, Objective, and Development Strategy for the Study Area until 2027

3.1.2 Objectives and Development Strategy

Objectives for the study area toward 2027 have been set up on the basis of the proposed goals. The objectives consist of five focal points, as mentioned below:

1) "*Making Cairo a better city for all the people to live in*": Outcome of the continuous growth and sustainable development of the Study Area has to be enjoyed not by a

limited number of people with good means of livelihood, but equally by all the people including those with limited means of livelihood with a fair share for all.

2) "*Making Cairo a more prosperous city with strong and diverse economic growth*": In order to attract new businesses and high value industries mainly in NUCs, it is imperative for the Study Area to have a competitive advantage for attracting such businesses and industries, while taking into consideration the national and regional strategic plans.

3) "*Making Cairo with more well-balanced urban structure*": Excessive population concentration in the main agglomeration needs to be remedied by converting to a multi-polar urban structure. Urban development will be integrated and incorporated with the urban transport network into a single format to encourage reshaping of the urban structure.

4) "*Making Cairo a more environmentally-friendly city*": Green and open spaces are limited and dispersed in the main agglomeration, and agricultural lands extend in the outskirts along the bountiful River Nile that runs through the Study area. The environmental potential needs to be managed fully for the attractive townscape and amiable urban environment for the people in the Study Area. Infringement of urban development on the agricultural areas needs to be controlled, as these agricultural areas are the precious green area of the Study Area.

5) "*Making Cairo a well planned city*": To realize the sustainable development of the Study Area, the master plan needs to be duly implemented by the responsible authorities. Urban planning laws and their enforcement system need to be strengthened so as to form the city into the preferable shape. The Study Area has plenty of historical, cultural and natural resources that make the city beautiful and attractive with unique townscape for tourists and citizens alike. More efforts should be made to maintain, preserve and utilize these resources to make the townscape more attractive.

To realize the proposed objectives toward 2027, the development strategies for the study area have been formulated as mentioned below:

1) "*Providing affordable housing adequately and upgrading neighborhood environment*": A range of supply side issues needs to be addressed such as the supply of more affordable housing, improvement of informal areas and a better quality of living environment by upgrading of informal areas

2) "*Providing intensified development for international business/industry*": Urban development needs to create the business environment for promoting the international competitiveness by providing the new candidate sites for their activities in new urban communities, taking into consideration the infrastructure and traffic conditions. The efforts will be also made for the tourism sector by encouraging existing potentials of historical assets.

3) "*Creating development cores in combination with public transportation network*": Future scale and phasing of development with the existing capacity is integrated to

create multi-polarized urban form with public transportation by integrating main agglomeration and new urban communities.

4) "*Conserving scarce agricultural lands, increasing green spaces and protecting natural environment*": Growth can only be accommodated without encroaching on agriculture land, protection area, and open spaces.

5) "*Strengthening human resource development and urban control for a well-planned city*": Enhancement planning authority is needed to realize urban planning.

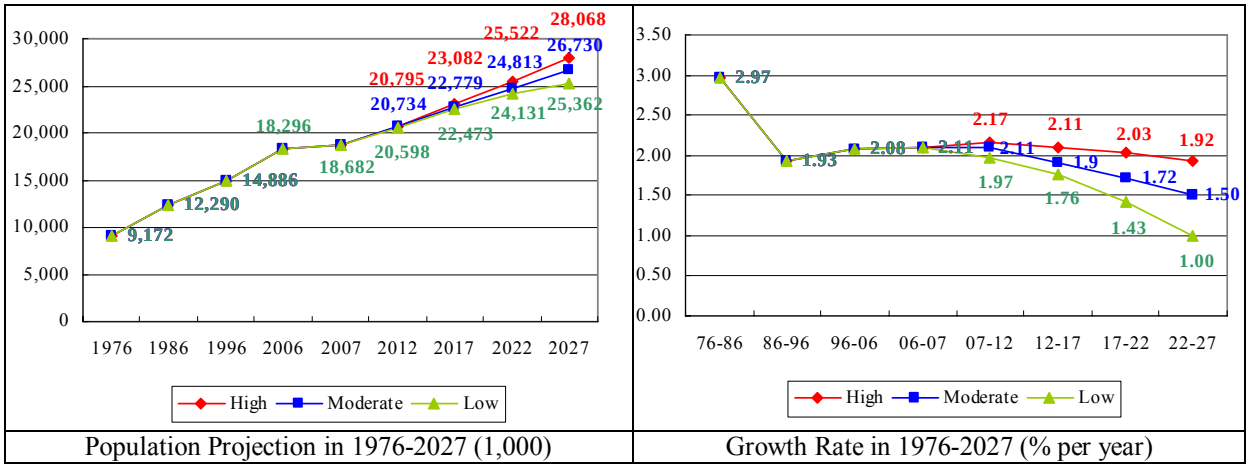
3.2 Population Projection and Direction of Future Urbanization

3.2.1 Population Projection until 2027

(1) Population projection of three governorates up to 2027

Three scenarios of population projection have been conceived for the three governorates of Cairo, Giza, and Qaliobeya up to 2027 based on different growth rates (Figure 3.2.2). In the low scenario, the growth rate will decline to 1% per year, which was the proposed level in the Long Term Vision 2022. In the highest scenario, the growth rate will remain around 2% per year up to 2027. For the moderate scenario, the growth rate will remain around 2% in the beginning and slow down to a level of 1.5% per year which is the level proposed by CDC's population projection.

The percentage of the Egyptian population residing in the three governorates over the past three decades (1976-2006) has remained stable at around 25% but started to increase in 1996-2006, due to the growth of new urban communities. The latest growth rate (Census 2006) was 2.08% per year, which was slightly higher than the level of 1.95% per year projected by CDC. Taking into account this gradually increasing share of the total population by these three governorates, and the growth rate being slightly higher than that of CDC's estimation, the JICA Study Team predicted that the total population in the three governorates will be 27 million for the target year of 2027 assuming a moderate growth rate case. The three governorates will maintain their share of the total Egyptian population, which will be less than 26%.

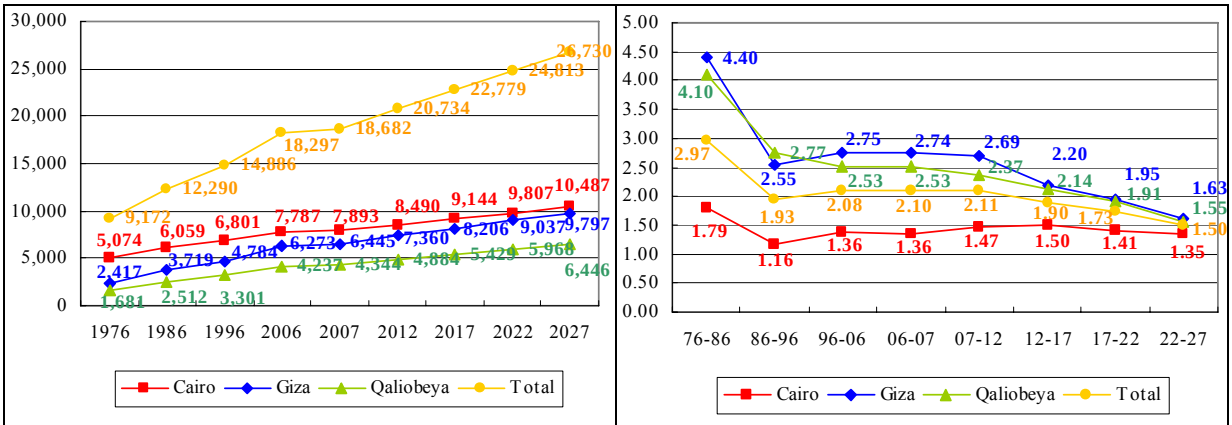


Population Projection in 1976-2027 (1,000) | Growth Rate in 1976-2027 (% per year)

Source: Census, CAPMAS for 1976-2006
Source: JICA Study Team for 2007-2027

Figure 3.2.1 Three Scenarios of Population Projection and Growth Rate for Three Governorates up to 2027

The population of the three governorates up to 2027 was estimated on the basis of population growth by each *shiakha* in 1996-2006. The population will be approximately 10.5 million in Cairo Governorate, 9.8 million in Giza, Governorate and 6.4 million in Qaliobeya Governorate (Figure 3.2.2).



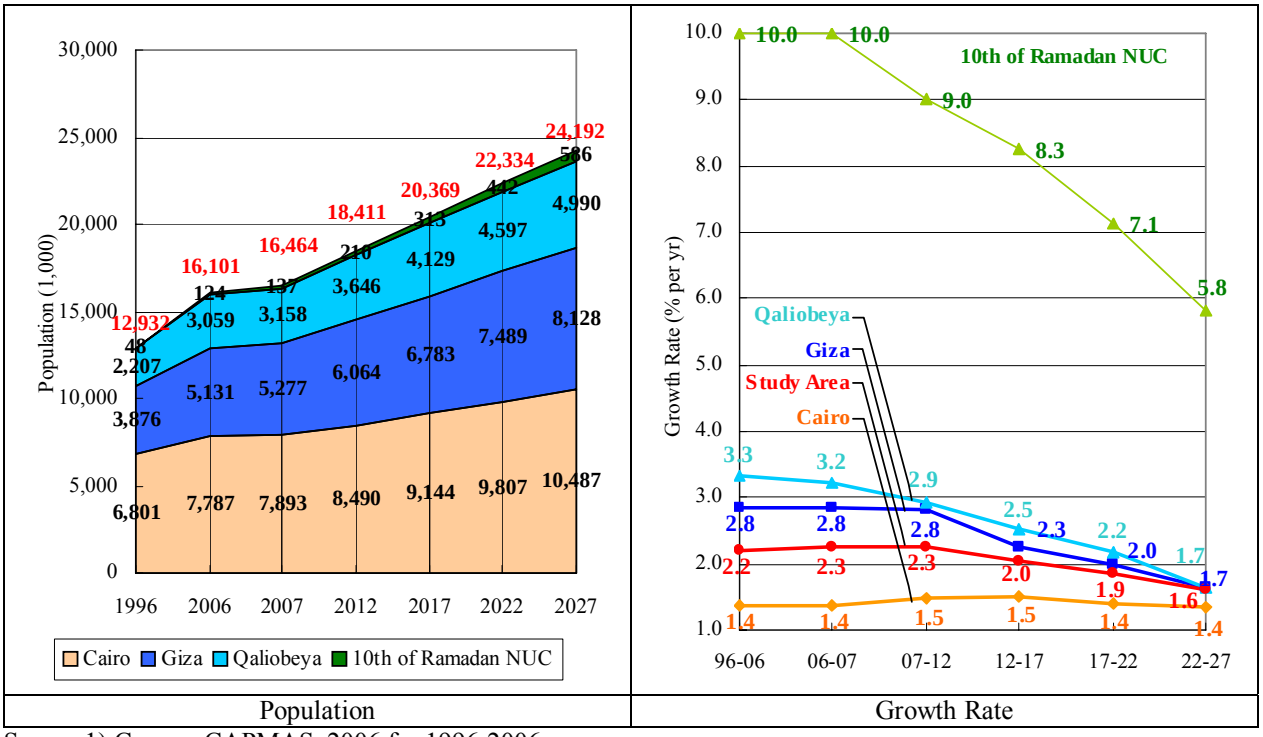
Population in 1976-2027 | Growth Rate in 1976-2027

Source: Census, CAPMAS for 1976-2006
Source: JICA Study Team for 2007-2027

Figure 3.2.2 Population Projection and Growth Rate by Governorate up to 2027

(2) Population projection of the study area up to 2027

The population within the study area is projected to be about 24 million in the target year of 2027 on the basis of population growth rate by *shiakha* in 1996-2006 (Figure 3.2.3). The population growth rate will remain higher than that of three governorates, due to the attraction of NUCs.



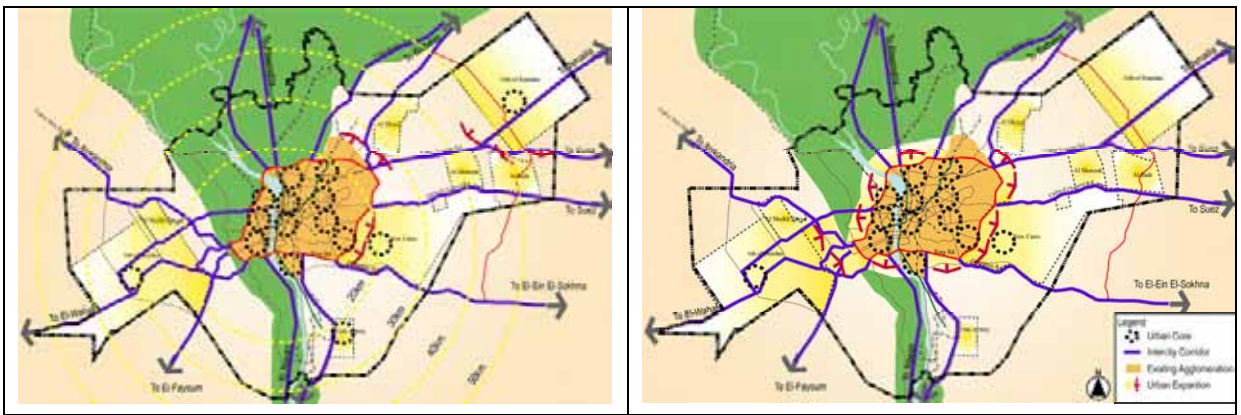
Population | Growth Rate

Source 1) Census, CAPMAS, 2006 for 1996-2006
Source 2) JICA Study Team for 2007-2027

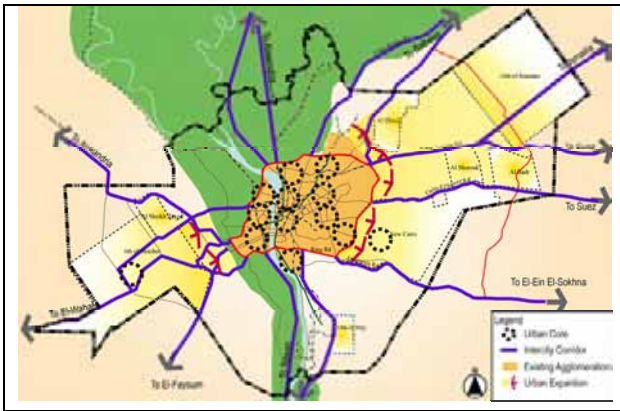
Figure 3.2.3 Population Projection and Growth Rate of the Study Area until 2027

3.2.2 Future Growth Pattern

Three alternatives of future growth pattern for the study area were formulated based on existing built-up areas, direction of urban expansion, and population growth (Figure 3.2.4). Alternative-1 was envisioned to show the future urbanization based on the current population growth as a base case, in which urbanization was presumed to proceed randomly around the main agglomeration. Alternative-2 presumed that the future urbanization and population growth would progress in the continuous form from the main agglomeration to the east and west directions. Alternative-3 indicated the future urbanization and population growth would be controlled to occur in NUCs in the east and west of the main agglomeration so as to prevent the continuous urbanization from the main agglomeration.



Existing Urbanization in 2006 | Alt-1: Trend Basis

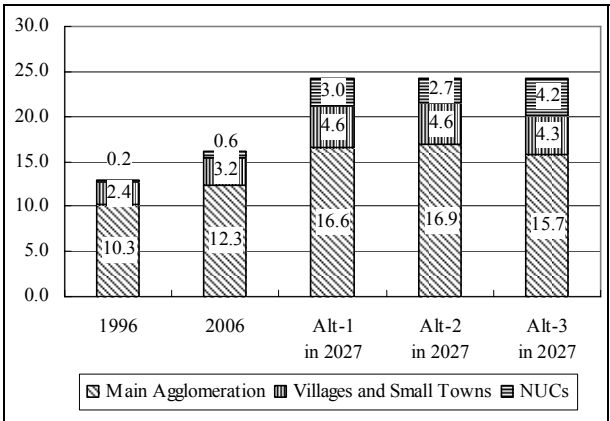


Alt-2: East-West Direction	Alt-3: Multi-polarized Cores

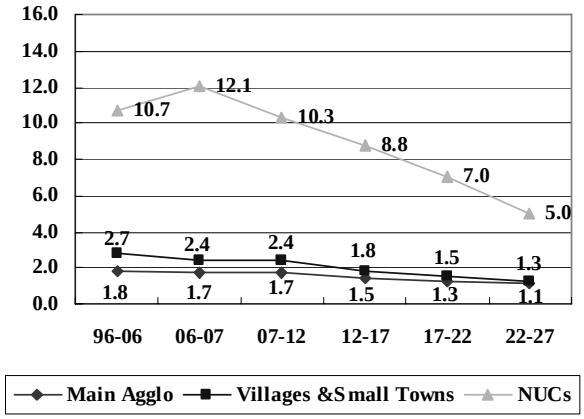
Source: JICA study team

Figure 3.2.4 Existing Urbanization and Three Alternatives of Future Growth Pattern until 2027

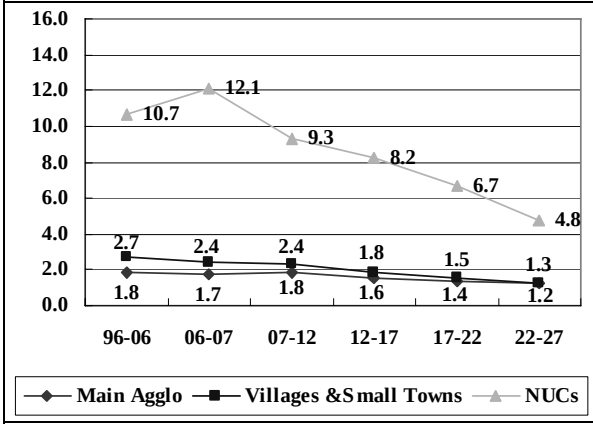
Population distribution divided into the main agglomeration, villages and small towns and NUCs is shown below for the three alternatives. This revealed that Alternative-3 would have the largest population in NUCs at 4.2 million and would reduce the population in the main agglomeration and villages and small towns most (Figure 3.2.5).



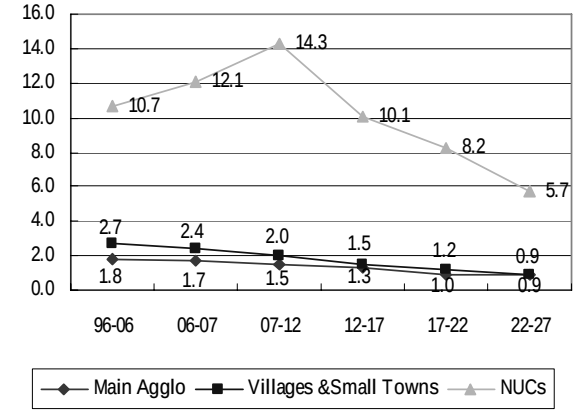
Population Distribution by Alternatives



Population Growth Rate of Alternative-1



Population Growth Rate of Alternative-2



Population Growth Rate of Alternative-3

Source: JICA study team

Figure 3.2.5 Population Distribution by Alternatives of Future Urbanization

The following table shows the relative advantages and disadvantages of the three alternatives, based on the five objectives established earlier for the study area.

Table 3.2.1 Advantages and Disadvantage of Three Alternatives for Future Growth Pattern

Objectives	Criteria	Alternative -1 (Trend Basis)	Alternative-2 (East-West Direction)	Alternative -3 (Multi-polarized Cores)
Making Cairo a better city for all the people to live in	Easing over-concentration in main agglomeration	Negative	Negative	Positive
	Compact built-up area suitable for living	Negative	Negative	Positive
Making Cairo a more prosperous with strong and diverse economic growth	Creating economic areas	Negative	Negative	Positive
Making Cairo with more well-balanced urban structure	Urbanization focusing on NUCs	Negative	Negative	Positive
Making Cairo a more environmentally-friendly city	Preventing encroachment on agriculture land	Negative	Positive	Positive
Making Cairo a well planed city	Efficient infrastructure development	Negative	Negative	Positive

Source: JICA study team

Alternative 1 will lead to more concentration in the main agglomeration and uncontrolled, random urban expansion outwards; this will not be beneficial for meeting each planning objective for the future. Alternative 2 will have directional control of urbanization along the east and west axis, but will not concentrate on NUCs as site for new urbanization, thus reducing the effects of infrastructure development and other public investment to promote NUCs. Alternative 3 will have positive effects from each of the established planning objectives. Therefore, Alternative 3 has been selected as the most preferable future growth pattern among the three alternatives that were analyzed by the study team.

3.3 Planning Framework

3.3.1 Planning Framework of the Study Area until 2027

Planning framework for the study area was formulated in terms of population, economy, and social development as mentioned below.

(1) Population: Total population in the study area will be 24.2 million in 2027 with the incremental population of 8.1 million for the period 2007-2027. According to the population structure proposed by CDC, the share to the total of the population who are15 years or older will increase from 71% in 2006 to 78% in 2027.

(2) GRDP and GRDP per capita: GRDP will increase with the annual growth rate of 8% in the period of 2006-2012 as proposed in the Sixth Five Year Plan. Following the proposed growth rate in the Long Term Vision, the high growth rate will remain and slow down to 6% in 2022-2027. This strong growth will contribute to increase the GRDP per capita with an average growth rate at 5% per year.

(3) Employment: Unemployment rate will be improved from 7% in 2006 to 5% in 2027. This improvement will provide more than seven million workers in 2027.

(4) Education enrolment: An attendance rate for primary education will continue at 100% in 2027, while that of preparatory and secondary education will improve to 100% as proposed in the Sixth Five Year Plan. The enrolment rate for the universities will be improved to 50%. As a result, the total number of students in the study area will be 5.8 million in 2027.

The planning framework for the study area until 2027 was summarized in Table 3.3.1.

Table 3.3.1 Planning Framework of the Study Area until 2027

Indicator			Unit	2006[1)]	2007[2)]	2012[2)]	2017[2)]	2027[2)]
Population	Total[1)]		1000	16,101	16,464	18,411	20,369	24,192
	Annual Growth Rate		%	2.22 (96-06)	2.25 (06-07)	2.26 (07-12)	2.04 (12-17)	1.61 (22-27)
	Age Structure [3)] (<5/5-14/>)		%	10/19/71	10/18/72	9/17/74	8/16/76	7/15/78
Economy	GRDP		million LE	164,372	177,521	260,837	365,837	670,757
	Annual Growth Rate		%	-	8 (06-07)	8 (07-12)	7 (12-17)	6 (22-27)
	GRDP per Capita		LE per capita	10,209	10,782	14,167	17,960	27,726
	Labor Force[4)]		1,000	4,613	4,777	5,506	6,316	7,761
	Unemployment		%	7	6	6	5	5
	No. of Workers	Primary	1,000	260	266	306	349	427
		Secondary	1,000	1,667	1,741	2,014	2,311	2,824
		Tertiary	1,000	2,384	2,467	2,876	3,323	4,126
		Total	1,000	4,310	4,475	5,196	5,982	7,378
Education	Enrolment Rate (Prim/Prep/Sec/Univ)		%	100/50/ 58/37	100/52/ 59/37	100/63/ 61/40	100/71/ 71/44	100/100/ 100/50
	No. of Students	Primary	1,000	1,827	1,828	1,963	2,075	2,333
		Preparatory	1,000	479	501	675	847	1,281
		Secondary	1,000	593	612	709	914	1,334
		University	1,000	504	519	565	646	877

Source 1) Census, CAPMAS, 2006
Source 2) JICA Study Team
Source 3) Population projection, Cairo Demographic Center, 2001
Note 4) Labor force includes the population in the age group above 15 years old excluding the people who are unemployed student, house wife, not intends to work, aged, handicapped, and not decided to work

3.3.2 Distribution of Population, Employment, and Student until 2027

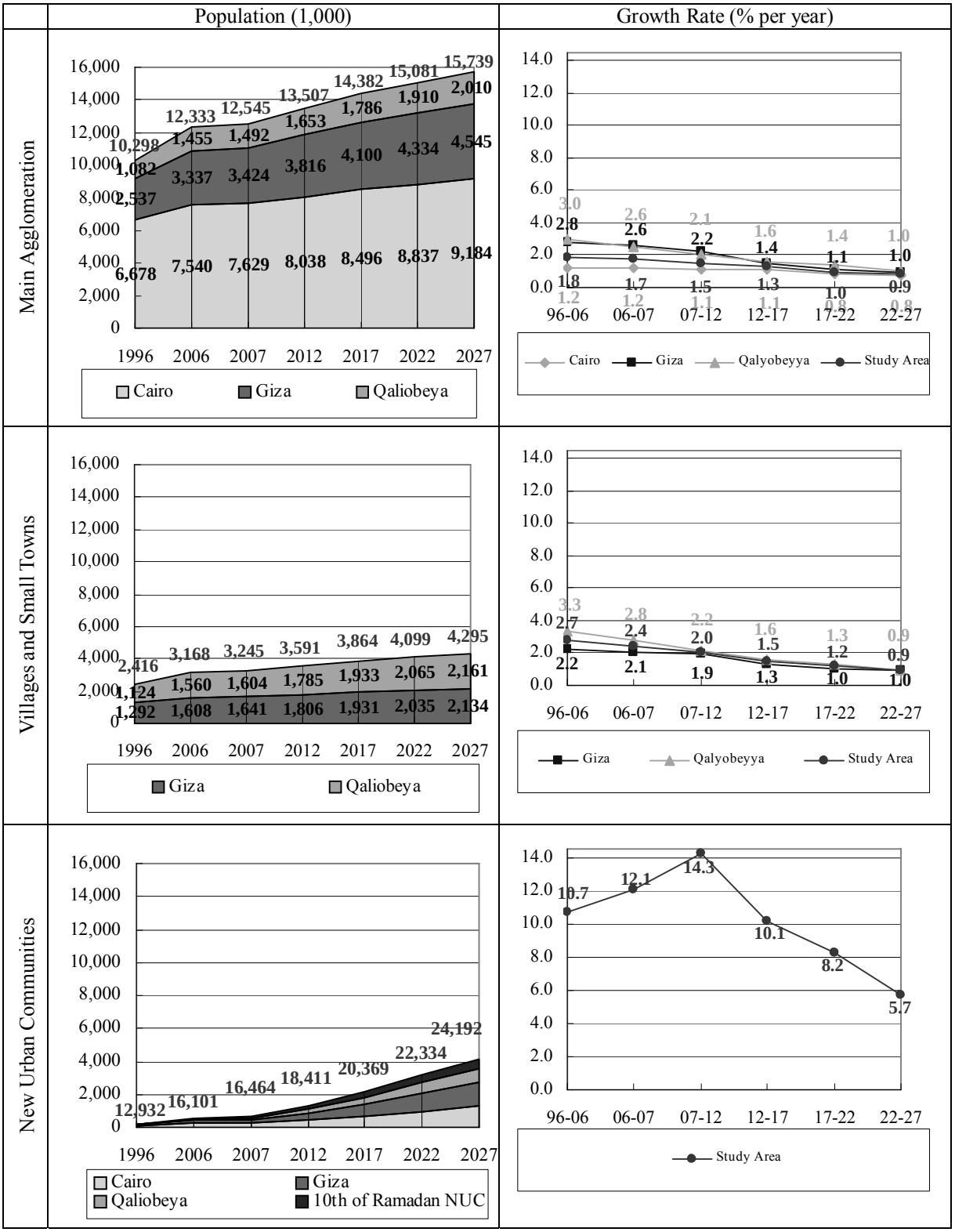
(1) Population distribution of the study area up to 2027

Following the selected future growth pattern, the population distribution by *shiakha* was estimated for the target year of 2027 and also the intermediate years of 2007, 2012, 2017, and 2022. The method for determining the population distribution is summarized below.

- The growth curves for each *shiakha* were set up from two starting points (1996 and 2006) up to the maximum population capacity for each *shiakha*.
- The maximum capacity was set to the highest density of existing built-up areas for all *shiakha* in the main agglomeration and to the highest density of existing built-up areas for the other areas (new urban communities and villages and small towns).

As the result, the population was estimated at 15.7 million in the main agglomeration, and 4.3 million in the villages, while the population in NUCs was projected to reach 4.2 million (Figure 3.3.1). More than 40% of the incremental population in the study area from 2006 to 2027 will reside in NUCs. The average growth rate in the main agglomeration and villages in

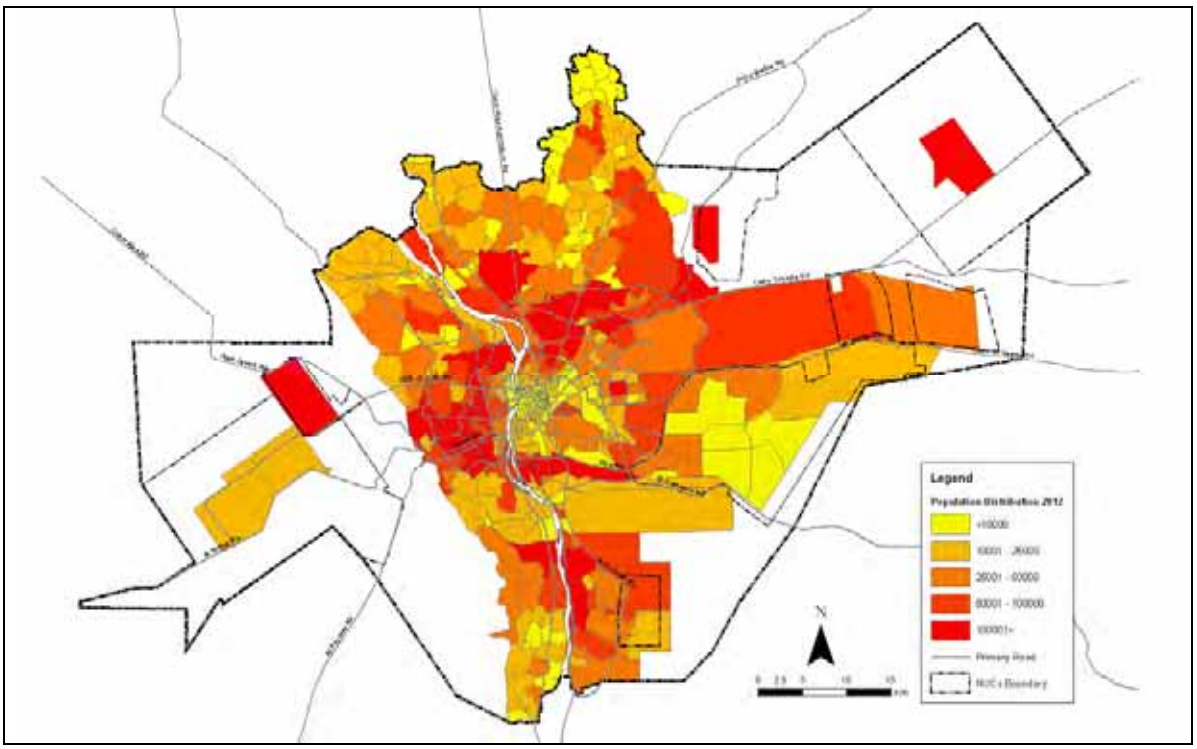
2007-2027 was decreased to less than 1%/year, while that of the NUCs was set at a high rate around 10%/year.



Source: Census, CAPMAS, 2006 for 1996-2006
Source: JICA Study Team for 2007-2027

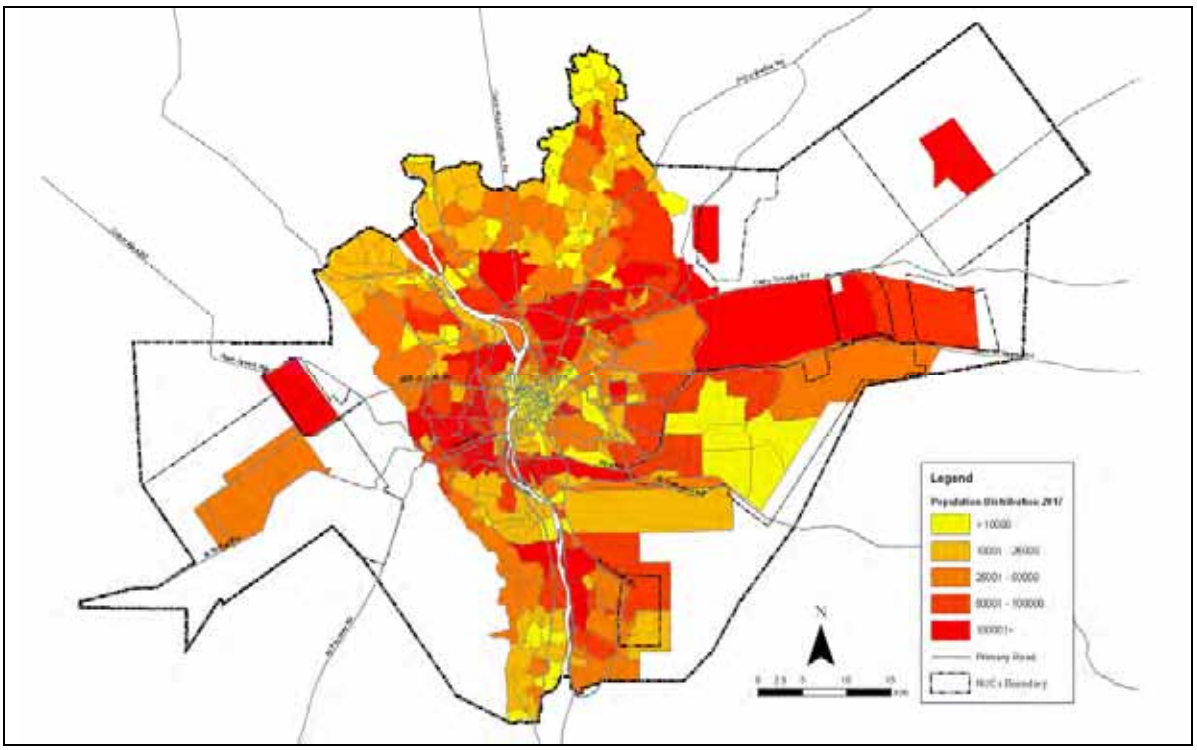
Figure 3.3.1 Population and Growth Rate by Built-up Area until 2027 (trend base)

Population distribution by *shiakha* in 2012, 2017, and 2027 is shown in Figures 3.3.2 through 3.3.4. An average growth rate by *shiakha* in 2006-2027 is shown in Figure 3.3.5.



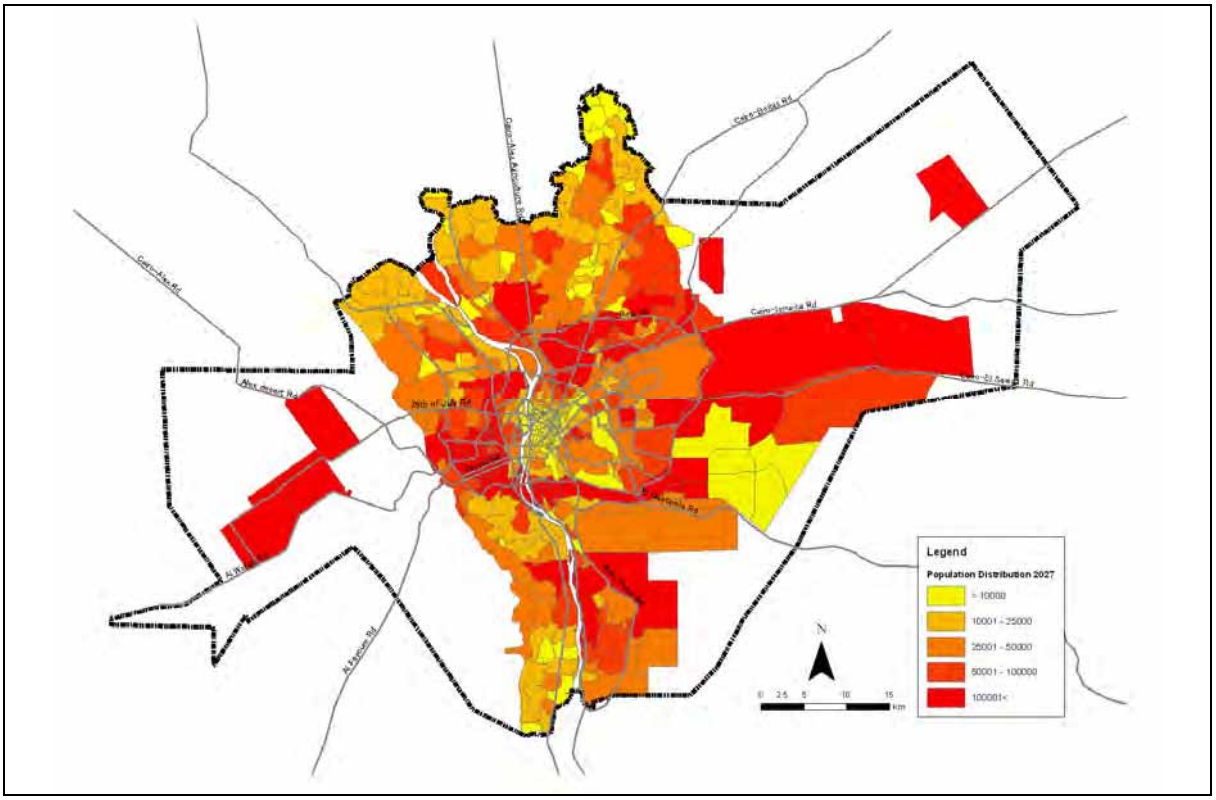
Source: JICA study team

Figure 3.3.2 Population Distribution by *Shiakha* in 2012



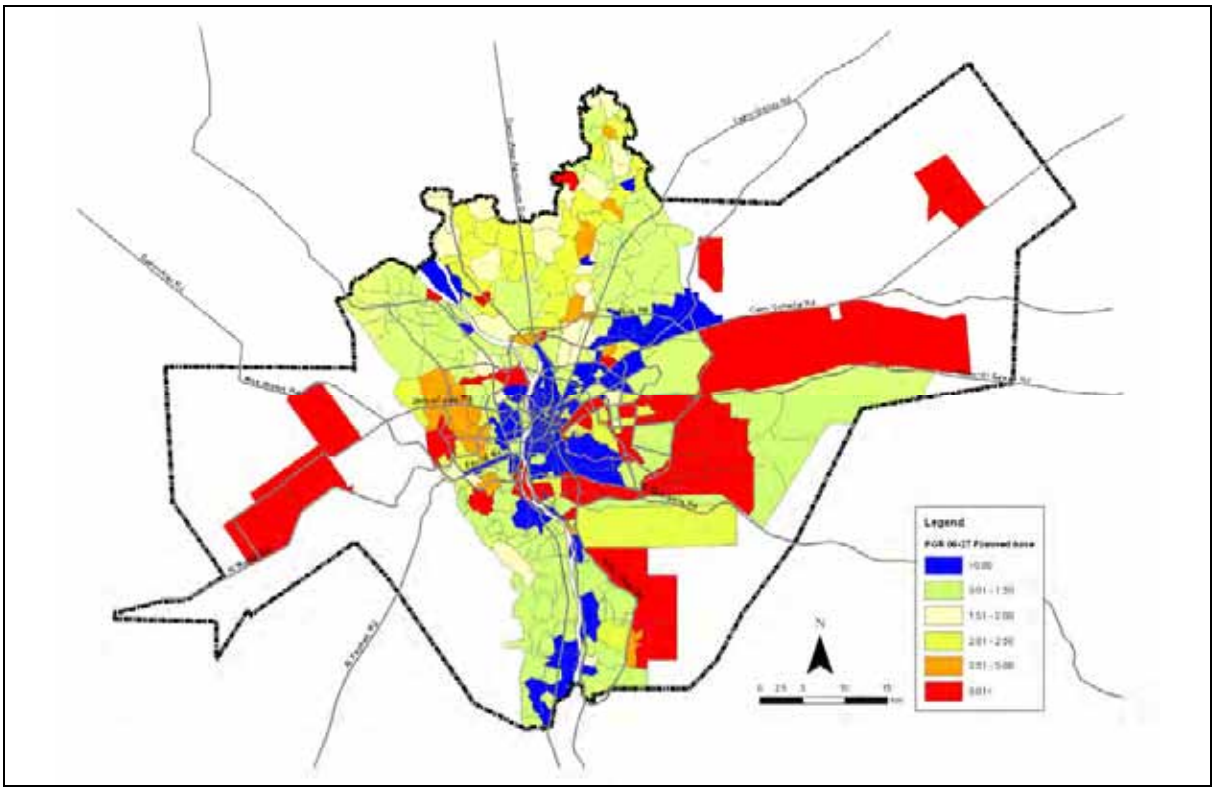
Source: JICA study team

Figure 3.3.3 Population Distribution by *Shiakha* in 2017



Source: JICA study team

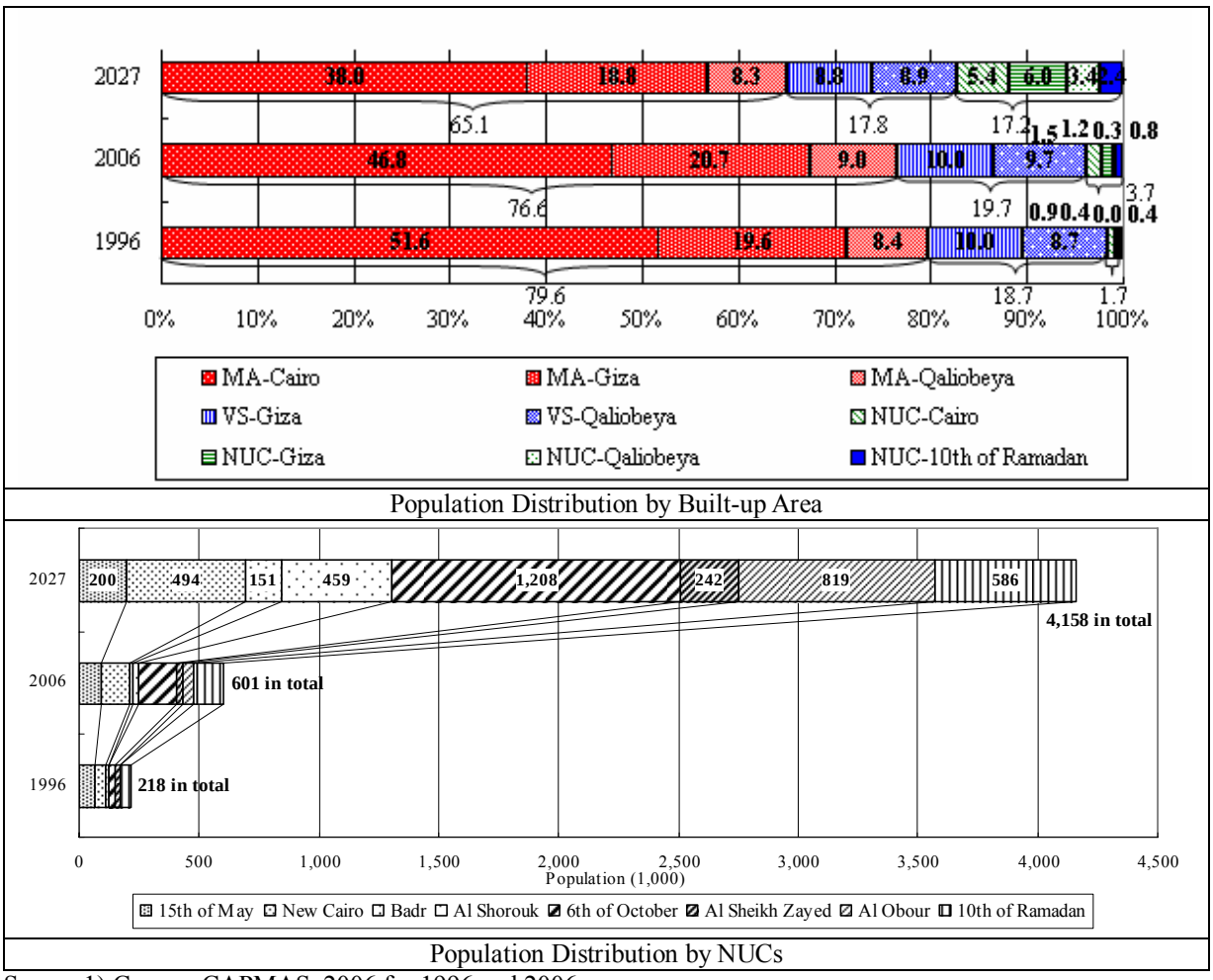
Figure 3.3.4 Population Distribution by *Shiakha* in 2027



Source: JICA study team

Figure 3.3.5 Average Population Growth Rate by *Shiakha* in 2006-2027

The high population growth rate will contribute to boost the incremental population in NUCs. The share of NUCs to the total population in the study area will increase from 1.7% in 1996 to 17.2% in 2027, while it will reduce the shares of main agglomeration to 65.1% and villages and small towns to 17.8% (Figure 3.3.6). Figure 3.3.6 also shows the population distribution by NUCs in 1996, 2006 and 2027.

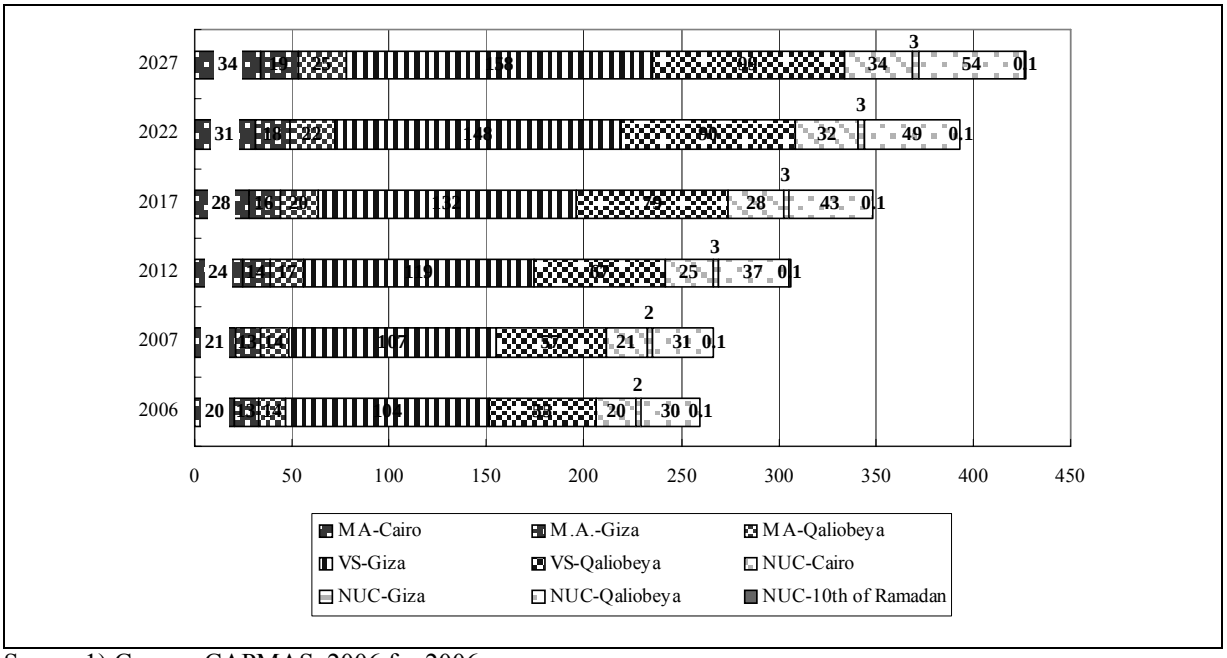


Source 1) Census, CAPMAS, 2006 for 1996 and 2006
Source 2) JICA study team for 2027

Figure 3.3.6 Population by Built-up Area and NUCs in 1996-2027

(2) Employment distribution

The estimated number of workers employed in primary industry in the study area was distributed according to the area of agricultural land by *shiakha* as shown in Figure 3.3.7.



Source 1) Census, CAPMAS, 2006 for 2006
Source 2) JICA study team for 2007-2027
Note: MA-Main Agglomeration, VS-Villages and Small Towns, NUC-New Urban Communities

Figure 3.3.7 Distribution of Workers in Primary Industry in the Study Area in 2006-2027

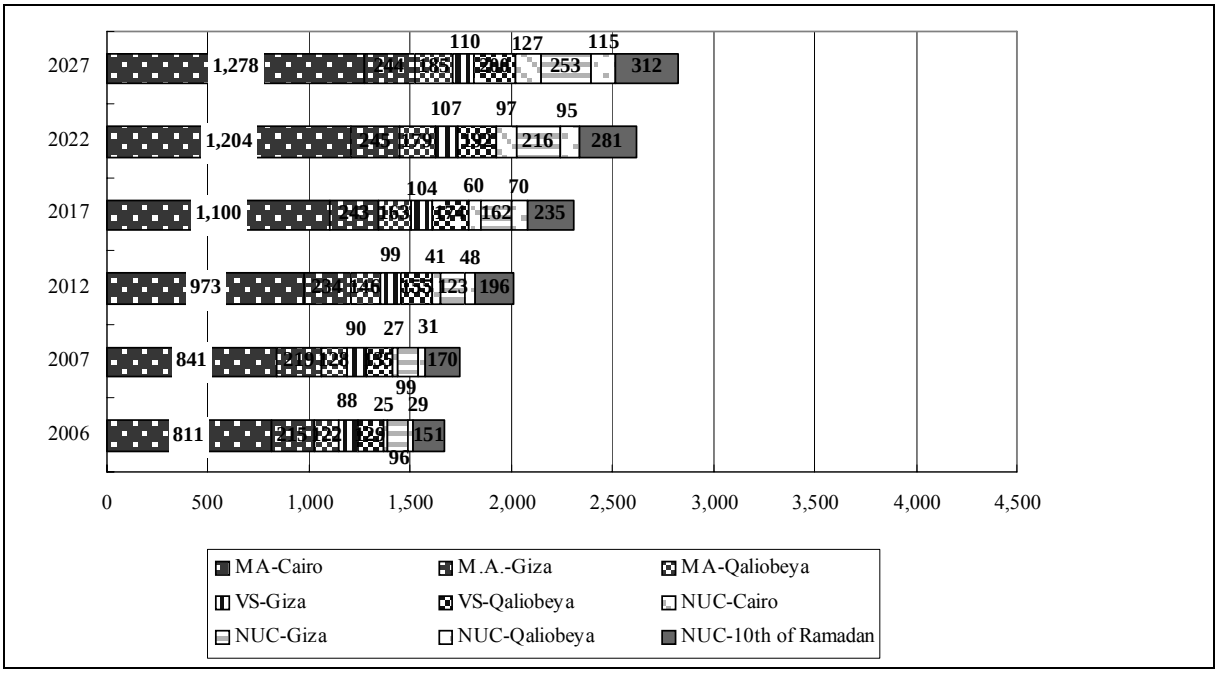
Secondary industry workers were classified into two categories. The first category was the industrial workers on the local job level, which was considered to be proportional to the population. The other category was defined as the workers at factories. In this Study, the former is defined as non-manufacturing, and the latter is defined as manufacturing. The measures taken to split the secondary industry workers into more detailed categories are described in Table 3.3.2 below.

Table 3.3.2 Methodology for Distribution of Workers in the Secondary Industry

Category	Description
1)Non-manufacturing	i) The Transportation Master Plan and Feasibility Study of Urban Transport Projects in Greater Cairo Region in the Arab Republic of Egypt (CREATS plan), as described later in Chapter 4, provides data for the number of workers and the population in each *shiakha*, as determined in 2001 on the basis of a household interview survey (HIS). The HIS was carried out for 57,000 households, and was supplemented by ten other types of surveys. ii) As a result, the unit demand was estimated at 40 workers per 1,000 people for the zone outside the Ring Road, while it was estimated at 60 workers per 1,000 people for the zone inside the Ring Road. Those two unit demands were considered as average rates for estimating the number of workers for non-manufacturing in each *shiakha*. iii) To reflect the maturity of the non-manufacturing sector in the future, the unit demand outside the Ring Road was set to increase to the level similar to that inside the Ring Road, while the unit demand inside the Ring Road was set to increase from the existing level up to 2027.
2) Manufacturing	i) Number of workers employed in manufacturing in NUCs follows the latest statistics, which was provided by NUCA in 2007. The additional number of workers up to 2027 follows the number of job opportunities which will be created by new tenants, according to the statistics provided by NUCA. ii) The remaining workers for the manufacturing sector were distributed based on the size of the industrial areas of each *shiakha*.

Source: JICA study team

As the result, the number of workers by built-up area was estimated as shown in Figure 3.3.8.



Source 1) Census, CAPMAS, 2006 for 2006
Source 2) JICA study team for 2007-2027
Note: MA-Main Agglomeration, VS-Villages and Small Towns, NUC-New Urban Communities

Figure 3.3.8 Distribution of Workers in Secondary Industry in the Study Area in 2006-2027

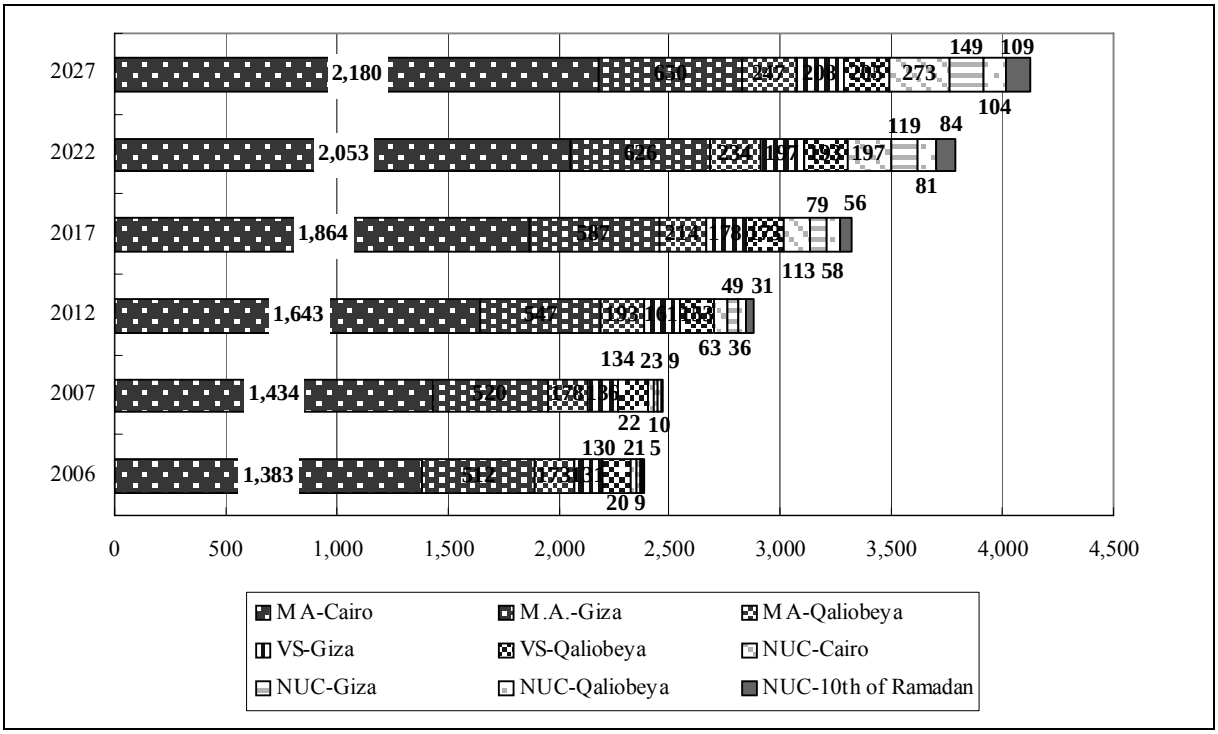
Workers in the tertiary industry were classified into two categories: the local job level and others, in a similar way to that used for the secondary industry. The measures used for estimating both categories are described below.

Table 3.3.3 Methodology for Distribution of Workers in the Tertiary Industry

Category	Description
1) Community level	i) The CREATS plan estimated the number of workers and population in each zone based on the HIS survey of 57,000 sample households. This survey was undertaken in 2001. Unit demand for the number of workers at the community level (workers per 1,000 population) was analyzed by the revolution method to determine the correlation between the number of workers and population size. ii) As a result, the unit demand was estimated at 100 workers per 1,000 population for the zone outside the Ring Road, while it was estimated at 150 workers per 1,000 population for the *shiakha* inside the Ring Road. Those two unit demand were considered the average rate for estimating the number of workers for non-manufacturing in each zone. iii) On the basis of the unit demands described above, the number of workers at the community level was estimated for each *shiakha*.
2) Urban level	i) Workers at the urban level were distributed to each zone according to the worker numbers at the urban level for each zone, as estimated by the CREATS plan. ii) Thereafter, the additional demand was distributed, according to the population in each zone up to 2027.

Source: JICA study team

As the result, the number of workers by built-up area was estimated as shown in Figure 3.2.15.



Source 1) Census, CAPMAS, 2006 for 2006
Source 2) JICA study team for 2007-2027
Note: MA-Main Agglomeration, VS-Villages and Small Towns, NUC-New Urban Communities

Figure 3.3.9 Distribution of Workers in Tertiary Industry in the Study Area in 2006-2027

(3) Student distribution

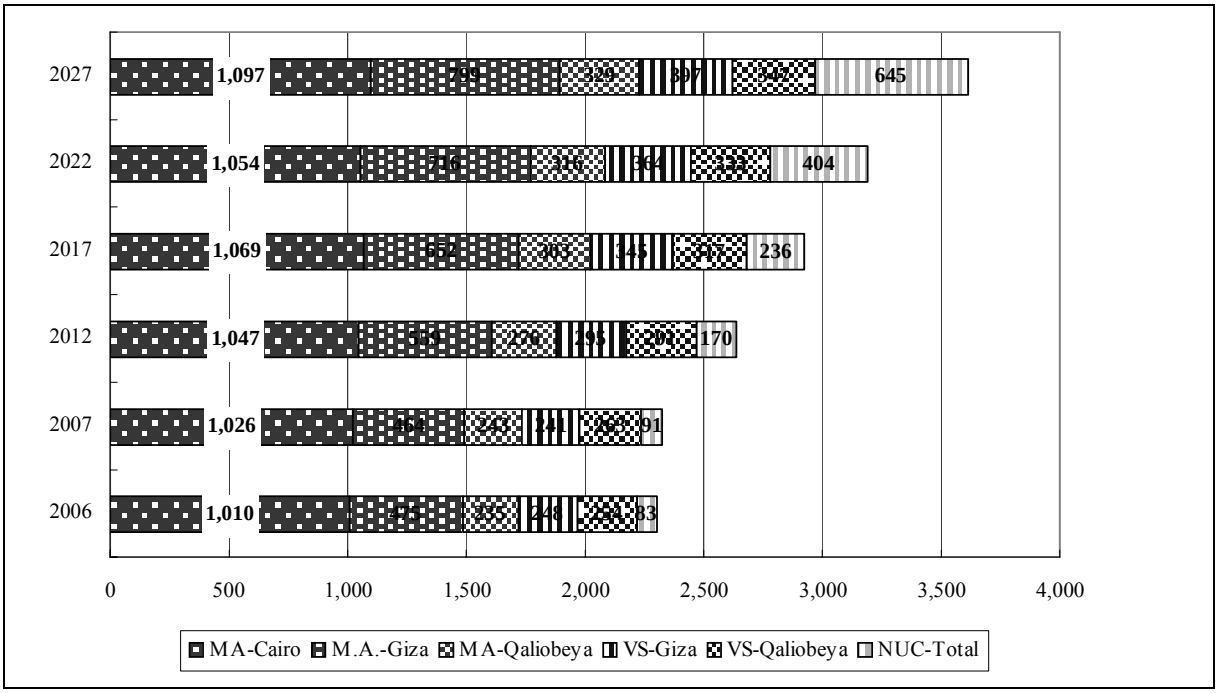
The number of students in primary, preparatory, and secondary education was presumed to follow the population distribution in the study area. High educational facilities, such as university, are concentrated in Cairo, and some of universities are shifting to areas outside the main agglomeration, such as New Cairo NUC. To mitigate the further concentration in the main agglomeration, the new universities will be encouraged to locate in NUCs, such as New Cairo and 6th of October.

Table 3.3.4 Methodology for Distribution of Students in the Study Area

Category	Description
Primary and preparatory	The unit demand of students was estimated as about 140 students per 1,000 population. Based on this unit demand, the number of students in each *shiakha* was estimated, and thereafter the number of students in each *shiakha* up to 2027 was estimated with the assumption that the unit demand will increase to achieve the attendance rates nominated for future years up to 2027.
Secondary	The unit demand of students was estimated at about 40 students/1,000 population. On the basis of this unit demand, the number of students in each *shiakha* was distributed to each *shiakha* one in 2006. The unit demand was designed to increase to the level which will match the attendance rates nominated for future years up to 2027.
Tertiary	The unit demand of university students was distributed according to the location of existing universities. Thereafter, the additional students for future years up to 2027 were distributed according to the population size of each zone.

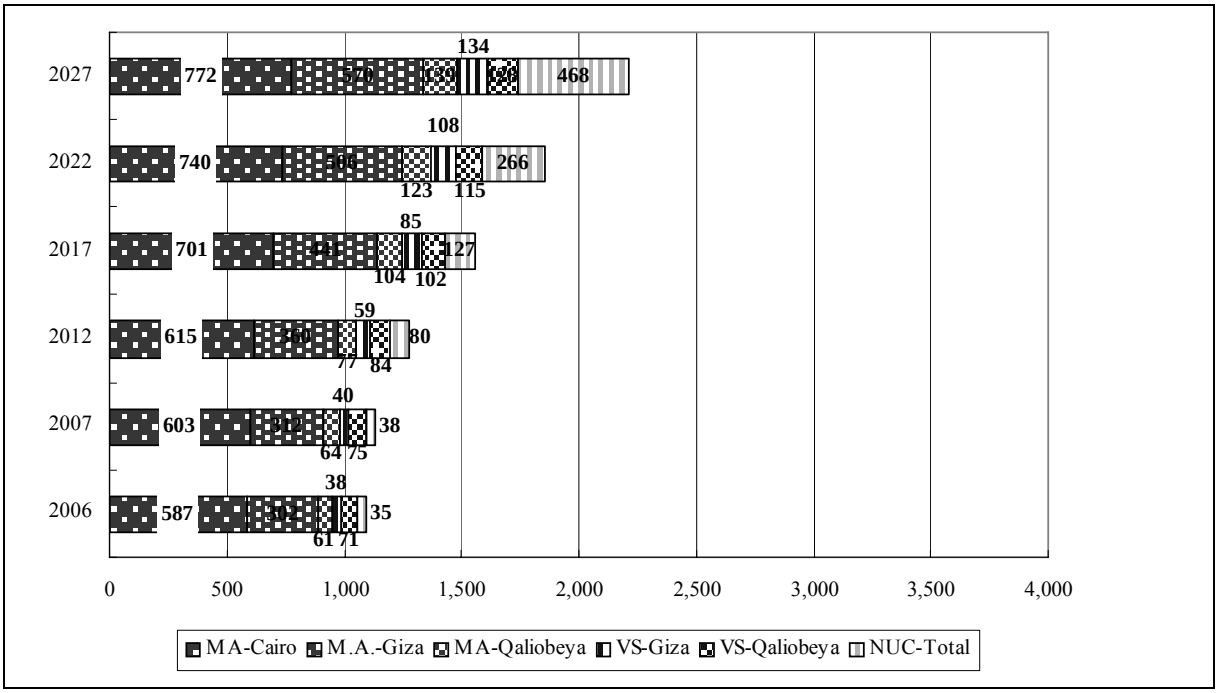
Source: JICA study team

As the result, the number of students by built-up area was estimated as shown in Figure 3.3.10 for primary and preparatory education and Figure 3.3.11 for secondary and higher education.



Source 1) Census, CAPMAS, 2006 for 2006
Source 2) JICA study team for 2007-2027
Note: MA-Main Agglomeration, VS-Villages and Small Towns, NUC-New Urban Communities

Figure 3.3.10 Distribution of Students in Primary and Preparatory in the Study Area in 2006-2027



Source 1) Census, CAPMAS, 2006 for 2006
Source 2) JICA study team for 2007-2027
Note: MA-Main Agglomeration, VS-Villages and Small Towns, NUC-New Urban Communities

Figure 3.3.11 Distribution of Students in Secondary and Higher in the Study Area in 2006-2027