EVALUATION OF THE EFFECTIVENESS AND PERFORMANCE OF DESALINATION EQUIPMENT IN EGYPT

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ABSTRACT

Water is an essential resource for aspects of human life. The Nile River is considered the main source of water in Egypt where its water covers about 96 % out of the total water requirements of the country. The rest is covered by the available deep groundwater, the rainfall and the water desalination. The present paper presents the results of an investigation undertaken in order to: evaluate the water demand and supply, discuss the desalination technology and give a database on existing desalination plants in Egypt.

Keywords: Egypt – Water Resources – Desalination Units

1. INTRODUCTION

Water is an essential resource for aspects of human life. Fresh water is traditionally supplied by pumping groundwater and withdrawing water from rivers and lakes. As demands for fresh water supplies increase because of population growth and increasing development, water short regions are beginning to turn to unconventional methods of supply.

Egypt; when is examined as a single and concrete geographic entity; does not appear to face water shortage problems. However, some areas are identified as having a crucial situation regarding water supply. These areas are in Sinai, Red Sea coast and Northern Desert coast. The economical development in these areas is basically based on water availability.

Desalination refers to a water treatment process that separates salty water into a wastewater stream of high salt concentration and a fresh water stream of low concentration and is one of the principle alternative sources for fresh water available today.

2. OVERVIEW OF EGYPT

2.1. Physical Characteristics

Egypt is considered one of the most populous countries in the Arab World. Egypt's population is estimated at about 71 million (2002) and 99 % of the population is concentrated on 5.5 % of the country area (in the Nile Valley and Delta). Egypt is divided into 27 administrative Governorates, however, geographically; it is divided into four regions: Nile Valley and Delta, Western Desert, Eastern Desert, and Sinai Peninsula.

2.2. Renewable Energy Sources

The Egyptian strategy for the development of energy conservation measures and renewable energy application targeted to save 10 % of the projected energy consumption through the implementation of energy conservation measures and efficiency improvement of existing facilities, and to develop Renewable Energy Technologies (excluding hydro) to supply 5 % of national primary energy by the year 2005 mainly from solar, wind and biomass.

- **Wind Energy:** The annual average wind speed in Egypt is greater than 2.2 m/s for most areas. The Red Sea coast have strong mean wind speeds (6-15 m/s), while for the Mediterranean Sea coast, the mean wind speeds exist in the range (2-6 m/s).
- **Solar Energy:** The yearly variability of the global solar radiation is a small percentage (< 5 %) when the annual mean value is compared to normal. The annual average global solar radiation over Egypt is 5.2-7.1 kWh/m^2/day.

3. WATER RESOURCES IN EGYPT

The Nile River is considered the main source of water in Egypt where its water covers about 96 % out of the total water requirements of the country. The rest is covered by the available groundwater and the rain falling on the northern coastal areas.

3.1. Surface Water Resources

The 1959 Agreement between Egypt and Sudan estimated the annual supply of the river measured at Aswan as 84 billion m^3. The agreement distributed this quantity at 55.5 billion m^3 for Egypt, 18.5 billion m^3 for Sudan and the remaining 10.0 billion m^3 were allocated for the losses. 23.1 billion m^3 is consumed in the Nile valley till Cairo and the rest amount of 32.4 billion m^3 is supplied to the Nile Delta.

3.2. Groundwater Resources

The volume of groundwater entering the country on an annual basis from Sudan is estimated at 1 billion m^3. The main source of internal recharge is percolation from irrigation water, and its quality depends mainly on the quality of the irrigation water. At the present time, 0.5, 1.4 and 1.5 billion m^3 of water are extracted respectively from the groundwater reservoirs in the Western Desert, the Nile Valley, and the Nile Delta.

3.3. Precipitation (Rainfall)

The mean annual rainfall of 18 mm ranges from 0 mm/year in the desert to 200 mm/year in the north coastal region. The average annual amount of rainfall water that is effectively utilized is estimated to be 1 billion m^3.

4. PRESENT WATER SITUATION ANALYSIS

The water balance is essential to any water resource system and is defined as the understanding of the dynamic relationship in space and time between supply sources and demand sites. Figure 1 illustrates the Nile water balance approach and the 1987-1996 Nile water allocation. Five larger boxes are shown in the figure: *Inflow, Outflow, Diversion, Crop Evapotranspiration (ETc), and Evaporative Depletion*; each of them represents a term in the water balance equation:

$$\boldsymbol{ETc = Inflow - Evaporative\ Depletion - Outflow}$$

The *Inflow* generates system *Diversion*. *Diversion* represents the actual water flowing in the system and includes the inflow-generated by groundwater and reuse of drainage. *Diversion* will always be larger than the *Inflow* in a closed water system. The *Outflow* accounts for all water leaving the system. *Evaporative depletion* represents the water consumed or lost by Municipal and Industrial (M&I) use, irrigation system evaporation, and irrigation system phreatophytes.

Releases from the High Aswan Dam averaged 54.38 billion m^3/year, 20.6 of that was unavailable for crop production due to: outflows to the sea (1.94 billion m^3 of Nile flow and 12.39 billion m^3 of drainage), drainage pumped to the desert depression is 1.0 billion m^3, and 5.25 billion m^3 of non-crop evaporative depletion (2.31 billion m^3 evaporated from the surface of the Nile, canals and drains, 0.7 billion m^3 consumed by evapotranspiration of phreatophytes, and 2.24 billion m^3 lost through consumption and evaporation associated with municipal and industrial water use).

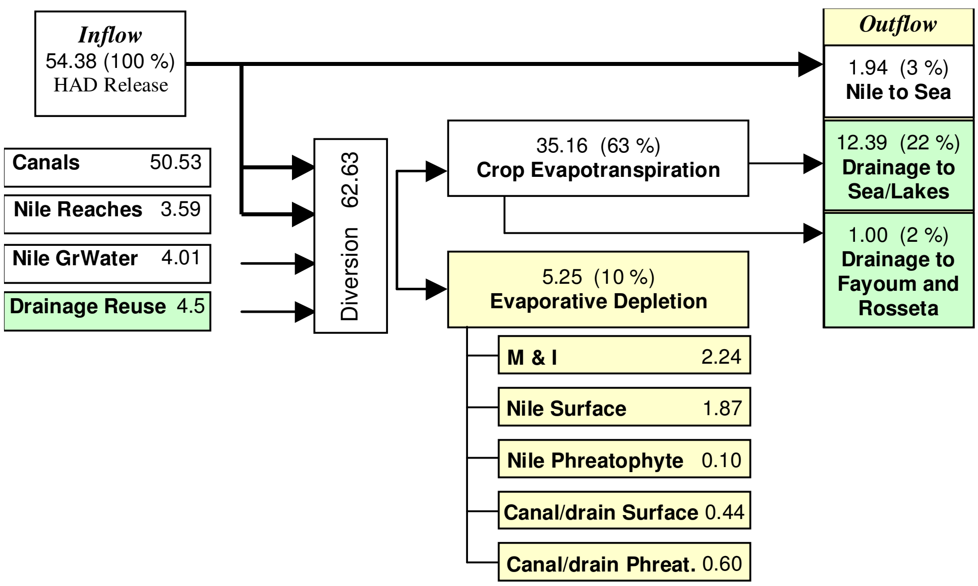

Figure 1 1987-1996 Average Nile water balance, Zhu et al. (2000)

The evaluation of Nile water allocation is achieved by looking at the diversions. On average, there was 62.6 billion m^3 of water flowing in the system as diversions each year, of which 53.7 billion m^3 was for irrigation, and 8.9 billion m^3 for municipal and industrial use. The sources of these diversions included: canals (50.53 billion m^3), direct intake from the Nile reaches (3.59 billion m^3), groundwater (4.01 billion m^3), and reuse of drainage (4.5 billion m^3). Due to Nile-generated groundwater and reuse of irrigation return-flow, this 62.6 billion m^3 of diversion was 15.2 % more than the 54.38 billion m^3 of High Aswan Dam inflow.

5. TRENDS IN WATER DEMAND AND SUPPLY

A forecasting study for the year 2020 on the water situation in Egypt shows clearly that it is in a critical situation regarding its renewable water resources. In 1995, the per capita share was 1034; while in 2020 will be 684 m^3/capita. Table 1 shows the currently available resources, their uses and the % shortage during 2005-2025. The available water resources that can be supplied ranges from 61.9 billion m^3 in 2005 to 65.5 billion m^3 in 2025. Shortage in the water resources can be managed till 2005 in case of the implementation of the Upper Nile Projects.

The existing consumption of water for irrigation stands at 48 billion m^3/year for 7.5 million feddans. Increasing the cultivated area will increase the water requirement to 75.58 billion m^3 in 2025. The municipal and industrial water requirements in Egypt are taking an upward trend from 9.2 billion m^3/year in 2005 to 11.96 billion m^3/year in 2025.

Table 1. Available resources (billion m^3/year), their uses and the % shortage during 2005-2025, Darwish et al. (1998)

Data	Year	
	2005	2025
<u>**Aspects of Usage**</u>		
Agriculture	58.50	75.58
Drinking Water & Industry	9.20	11.96
Total of Needed Water	67.70	87.54
Current Available Resources	61.90	65.50
Shortage	5.80	22.04
Sufficiency Ratio (%)	91.43	74.82

6. OVERVIEW OF DESALINATION TECHNOLOGY

Desalination is a treatment process that removes salts from water. Saline solutions other than sea water are typically described as brackish water with a salt concentration from 1,000 ppm to 11,000 ppm TDS. Normal sea water has a salinity of 35,000 ppm TDS.

Several desalination processes have been developed but not all of them are reliable and in commercial use. On the basis of their commercial success, desalination technologies have been classified into major and minor desalination processes, as indicated in Table 2. Thermal processes for seawater desalination are: Multistage-Flash Distillation (MSF), the Multi Effect Distillation (MED or ME), the Vapor Compression (VC) process and the solar distillation. Membrane processes consist of Reverse Osmosis (RO) and Electrodialysis (ED) processes. Electrodialysis is confined to the desalination of brackish water while Reverse Osmosis can be used for both, brackish and sea water desalination.

Two critical parameters of the desalination processes are the quality of the produced water and the energy required:

- Product water quality depends on the desalination process. Distillation processes produce water around 20 ppm TDS. Membrane processes are usually designed to produce water of 100-500 ppm TDS.
- Desalination processes are energy intensive and the cost of energy can account for up to 50 % of the overall production cost. It is also important to notice that low energy requirements do not necessarily indicate the least cost desalination method.

The selection of a process is based on several parameters, such as site conditions, local circumstances, etc. The "best" desalination system for a particular application will be the system that reliably produces water of the expected quality and quantity at reasonable cost.

Desalination using renewable energy sources (RES) does offer the potential of providing a sustainable source of potable water for some communities, particularly those in arid areas. The successful RES-Desalination applications prove that the coupling of the two technologies is technically mature and capable to provide fresh water at a reasonable cost. Table 3 gives the RES-Desalination installed plants in Egypt. The desalination technology is the Reverse Osmosis (RO) and the RES technologies are the photovoltaic (PV) and wind energy.

Table 2. Commercially available desalination processes

Major Processes	Minor Processes
▪ *Thermal* - Multistage-Flash Distillation (MSF) - Multi Effect Distillation (MED) - Vapor Compression Distillation (VC) ▪ *Membrane* - Reverse Osmosis (RO) - Electrodialysis (ED)	- Freezing - Membrane Distillation - Solar Humidification

Table 3. List of RES-Desalination installed plants in Egypt

RES-Desalination System	Location	Production	Feed Water Type	RES Nominal Power	Operating Year
PV-RO	High Voltage Lab., Giza	5 - 7 m^3/day	Brackish water	7 kWp PV	1980
PV-RO	El-Hamrawein	60 m^3/day	Brackish water	18.5 kWp PV	1986
Wind-RO	Marsa Matrouh	25 m^3/day	Sea water	-	1987
Wind-RO	Cairo	300 m^3/day	Brackish water	-	1995

7. DESALINATION IN EGYPT

Due to the fact that water demand is larger than the conventional supply, the utilization of non-conventional water resources became evident. Egypt is sharing as the other Mediterranean countries this dilemma.

Egypt has long shorelines of about 2,450 km on both the Mediterranean and the Red Sea. Salt concentration in the Mediterranean waters is about 35,000 mg/l, while in the Red Sea it is about 40,000 mg/l. Desalination of seawater is being practiced in Egypt in some locations along the Mediterranean coast, the Red Sea coast, and in north and south Sinai.

Desalination in Egypt started some twenty years ago for (additional) drinking water supply to coastal towns and in the petroleum sector and the energy sector. Most of the old installations are evaporation plants. In recent years, a large number of RO plants and ED plants have become operational in different economic sectors:

- *Tourism sector*, mainly along the Red Sea Coast, South Sinai and the Northern Coast.
- *Petroleum sector*, for production water in remote working locations.
- *Industrial sector*, mainly applied in the pharmaceutical, textile and fertilizers.
- *Public water supply*, mainly to remote coastal towns.
- *Health sector*, small units to provide high quality water to hospitals.

Table 4 gives the different economic sectors and the usually used desalination technology and the quantities of desalinated water produced and expected up to the year 2017. The vast majority of the tourism sector has been of the RO type. The petroleum, electricity generation and defense sectors have long been customers of the thermal desalination processes.

Table 4. Desalination technologies and produced and expected desalinated water at different sectors in Egypt, Fath (2001)

Sector	Used Desalination Technology	1997	2002	2017
Tourism sector	RO			
- *Red Sea*		14,000	31,600	50,900
- *Sinai*		4,500	12,000	19,000
Petroleum sector	RO, ED	30,000	30,000	30,000
Industrial sector	RO, ED, VC	24,000	65,500	82,000
Public water supply	RO	5,500	35,500	52,000
Total		**78,000**	**174,600**	**233,900**

8. LOCAL MANUFACTURING AND DESIGN CAPABILITIES OF DESALINATION UNITS IN EGYPT

Desalination manufacturing and design capabilities have emerged in Egypt due to the fast build-up of small plants in remote areas. Local capabilities emerged in the fields of thermal desalination operation and maintenance where Egyptians have been employed and/or trained. Further a number of factories have announced capabilities to assemble Reverse Osmosis Plants. Capabilities for design of intakes and outfalls have been long been available for open channel breakwaters and for wells.

Traditionally, suppliers of thermal desalination equipment carrying out the detailed engineering have not been local. Certain items such as small boilers, civil works, welding on site have been carried out locally. Fabrication facilities are abundant for thermal desalination. These are composed of shipbuilding yards, steel manufacturers and boiler manufacturers. Electrical equipment is largely locally manufactured under licenses. Items such as Instrumentation and Control and other auxiliaries are uneconomical to manufacture locally.

Various local companies have been established to deal with RO Plants design, engineering, procurement, assembly and construction. However, due to the relative novelty of Clients to the process, small unit sizes involved, marginal importance of the utility to the design of the tourist resort itself, least cost approach to procurement, absence of sufficient guarantees for life of membranes and plant, RO performance has not always matched requirements.

9. COST OF DESALINATED WATER PRODUCED IN EGYPT

The cost of water produced by desalination is the main factor affecting the usage of desalination technology, not only in Egypt but also in many other countries with limited resources of water. In Egypt, the production cost varies from 2.9 to 5.8 L.E./m^3 depending on the desalination process and the plant construction date. The selling price is dependent on the consuming sector such as public water supply or tourism. In Sharm El-Sheikh, in many of the resorts the drinking water is supplied to the hotels and restaurants at a price of 8 to 12 L.E./m^3.

Production cost for desalination processes is divided into direct and indirect capital costs and annual operating costs. Direct capital costs include the purchase cost of major equipment, auxiliary equipment, land and construction. Indirect capital costs include the freight and insurance, construction overhead, owner's costs and contingency costs. Annual operating costs include labor, energy, chemicals, spare parts and miscellaneous items.

Several design and operational variables affect unit product cost, such as: salinity and quality of feed water, plant capacity, site conditions, qualified labor, energy cost and plant life and amortization. The treatment process cost of seawater is significantly higher than the cost of treating brackish groundwater. Membrane processes are becoming more competitive as membranes are being produced that require less feed pressure and have improved contaminant removal rates and increased stability.

10. DESALINATION UNITS IN EGYPT

The total installed capacity in Egypt amounted to approximately 100,000 m^3/d in 1996 but has sharply increased in the last four years till probably around 150,000 m^3/d in 1999. Actually, it is not easy to compile a full list of present installations. The European Desalination Association maintains a database on existing desalination plants. According to the International Desalination Association (IDA), there are about 230 desalination units in Egypt with a total capacity of 220,000 m^3/day. Table 5 presents the capacities of different desalination processes commonly used in Egypt.

Table 5. Desalination Inventory in Egypt, (2000 IDA Worldwide Desalting Plants Inventory)

Process	MSF	MED	VC	RO	ED	Total
Capacity (m^3/day)	**33,652**	**2,577**	**12,350**	**139,133**	**33,385**	**221,097**
% to total	15.22%	1.16%	5.59%	62.93%	15.10%	

Having a database for the desalination units in Egypt is important. Table 6 (Appendix) gives the available data for the desalination units in Egypt. It includes 143 desalination units with a total capacity of 155,641 m^3/day. According to Table 6, Table 7 shows the desalinated water produced at tourist cities in Sinai and Red Sea. The biggest amount of desalinated water is produced at Sharm El-Sheikh City (44,280 m^3/day) with 28.45% of the total produced desalinated water in Egypt.

Table 7. Desalination capacity in tourist cities

City	Desalinated Water (m^3/day)	% to Total Desalinated Water
Sharm El-Sheikh	44,280	28.45%
Hurghada	19,500	12.53%
Taba	12,350	7.93%
Noweiba	8,190	5.26%
Dahab	6,100	3.92%
Total	90,420	**58.09%**

11. CONCLUSIONS

The Nile water is fixed and limited in quantity, so the need of desalination in the future is essential to have good quality water. Other facts, which make the importance of desalination, are:

1) Increasing salinity of the abstracted groundwater due to over pumping from the groundwater. The over withdrawal of drainage water leads to deteriorating the quality of mixed water.
2) Accumulated pollution in the water environment at the tail ends of water courses in north delta. It has been observed that pollution levels along some drains and in some northern lakes have reached the red limits.

A database for the desalination units is collected and can be updated for the new desalination units. The future vision towards desalination in Egypt differs from one location to the other according to objectives, water source, energy source and appropriate technology. For example, for the north coast areas, small (less than

20 m^3/d) to medium (between 20 and 400 m^3/d) RO units using direct seawater is suitable, while for Sinai and Red Sea, medium RO units using brackish water and seawater is recommended for domestic purposes.

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Table 6. Desalination units in Egypt

Governorate	Location	Total Capacity (m^3/d)	Process	*Customer*	Water Quality	User
Alexandria	Alexandria	130	RO	**Pharco Pharma**	Sea	Industrial
	Ameriya	11732	ED	El-Ameriya Textile Co.	Brackish	Industrial
	Bourg El-Arab	4000	RO	Government	Brackish	Tourism
	Sidi Krir	10000	MSF	EEA	Sea	Power
El-Dakahlia	Abu Madi	200	ED	Petrobel Co.	Brackish	Industrial
El-Suez	Ayoun Moussa	10000	MSF	EEA	Sea	Power
	El-Ein Sokhna	300	RO	DORNE MARINA	Sea	Tourism
	Zeit Bay	240	TVC	SUCO	Sea	Industrial
		240	TVC	SUCO	Sea	Industrial
Matrouh	Abu Senan	170	ED			Industrial
	Aguiba	85	ED	Badr for Petroleum Co.		Industrial
	El-Alamain	2000	RO	GOUT	Brackish	Tourism
	El-Hosna	200	ED	MOD	Brackish	Municipal
	El-Kasr El-Gadid	400	ED		Brackish	Municipal
	El-Nekhila	200	ED	MOD	Brackish	Municipal
	Kasr Gabriel	400	ED	MOD	Brackish	Municipal
	Sallum	200	ED	MOD	Brackish	Municipal
	Shammasa	200	ED	MOD	Brackish	Municipal
	Sidi Barrani	400	ED	MOD	Brackish	Municipal
	Siwa Oasis	400	ED	MOD	Brackish	Municipal
	Um El-Rakham	400	ED	MOD	Brackish	Municipal

Table 6 (continued)

Governorate	**Location**	**Total Capacity (m^3/d)**	**Process**	*Customer*	**Water Quality**	**User**
North Sinai	Abu Aweigila	100	RO		Brackish	Municipal
	El-Arish	400	ED	Egoth Oberoi El Arish Hotel		Tourism
		1200	ME	EEA	Sea	Power
		2400	ED		Brackish	Municipal
	El-Hasana	300	ED		Brackish	Municipal
	El-Kuntilla	150	RO		Brackish	Municipal
	Nakhl	200	RO		Brackish	Municipal
Red Sea	Abu Ramad	100	RO	MOD	Brackish	Municipal
		500	RO	MOD	Brackish	Municipal
	Abu Soma Bay	1500	MVC	Abu Soma Development Co.	Brackish	Tourism
		3000	MVC	Abu Soma Development Co.	Brackish	Tourism
	El-Quseir	300	RO	Movenpick Resort El Quseir	Sea	Tourism
		1200	RO	Utopia Beach Club		Tourism
	Halayeb	100	RO	MOD	Brackish	Municipal
		500	RO	MOD	Brackish	Municipal
	Hamata	100	RO	MOD	Sea	Municipal
	Hurghada	200	RO	Jasmine Village		Tourism
		200	RO	The Oberoi Sahl Hasheesh	Sea	Tourism
		200	RO	Warda El Sahara Village		Tourism
		250	RO	El Samaka Club Hotel		Tourism
		250	RO	Sofitel Hurghada Hotel		Tourism
		300	RO	Calimera Golden Beach		Tourism
		300	RO	Coral Beach Resort		Tourism
		300	RO	Giftoun Tourist Village		Tourism
		300	RO	Hilton Hurghada Plaza	Sea	Tourism

Table 6 (continued)

Governorate	**Location**	**Total Capacity (m^3/d)**	**Process**	*Customer*	**Water Quality**	**User**
	Hurghada	300	RO	**Hurghada Marriott Beach Resort**	Sea	Tourism
		300	RO	Iberotel Arabella Village		Tourism
		300	RO	Marlin Inn Hotel		Tourism
		300	RO	Melia Pharaoh Hotel	Sea	Tourism
		300	RO	Mirette Hotel & Beach Resort		Tourism
		300	RO	**Paradise Golden 5 Hotel**		Tourism
		300	RO	Zahbia Village		Tourism
		350	RO	Hurghada Intercontinental Resort		Tourism
		350	RO	Sindbad Beach Resort		Tourism
		500	RO	Grand Resort	Brackish	Tourism
		500	RO	Le Meridien Hurghada Hotel		Tourism
		500	RO	MOD	Brackish	Municipal
		500	RO	Royal Azur Resort		Tourism
		500	RO	Shedwan Golden Beach Village	Sea	Tourism
		600	RO	**Arabia Tourist Village**		Tourism
		700	RO	Beach Albatros Hotel	Sea	Tourism
		1000	RO	Le Meridien Makadi Bay Hotel		Tourism
		1400	RO	El-Safa Co. for Water Desalination	Brackish	
		4000	RO	**El-Yosr Desalination Plant**	Sea	
		4200	RO	El Gouna Movenpick Resort		Tourism
	Marsa Alam	100	RO	MOD	Brackish	Municipal
		150	RO	Kahramana Beach Resort		Tourism
		500	RO	MOD	Brackish	Municipal
		500	RO	MOD	Brackish	Municipal
		500	RO	North Marsa Alam City		

Table 6 (continued)

Governorate	**Location**	**Total Capacity (m^3/d)**	**Process**	*Customer*	**Water Quality**	**User**
	Marsa Hemera	100	RO	**MOD**	Sea	Municipal
	Ras Ghareb	1000	RO	MOD	Sea	Municipal
		5000	ED	General Co. for Petroleum		Industrial
	Ras Shokeir	1520	ED	Khaleeg El-Suez Petroleum Co.		Industrial
		24	ED	Petroleum Pipes Co.		Industrial
	Shalatin	100	RO	MOD	Brackish	Municipal
		500	RO	**MOD**	Brackish	Municipal
		500	RO	MOD	Sea	Municipal
South Sinai	Abu Rudeis	780	ED	Petrobel Co.		Industrial
	Dahab	300	RO	Hilton Dahab Resort	Sea	Tourism
		500	RO	Pullman		Tourism
		800	RO	Helnan Dahab Hotel		Tourism
		2000	RO	MOD	Brackish	Municipal
		2500	RO	Sheikh Zayed		
	Noweiba	150	RO	Tropicana Noweiba Hotel	Sea	Tourism
		200	RO	Tropicana Noweiba Hotel	Sea	Tourism
		240	RO	Helnan Noweiba Hotel		Tourism
		300	ED	MOD		
		300	RO	Hilton Noweiba Coral Resort	Sea	Tourism
		2000	MED	MOD		
		5000	RO	MOD	Brackish	Tourism
	Sharm El-Sheikh	100	RO	New Fantazia Hotel		Tourism
		180	RO	**Aida Beach Sharm El Sheikh Hotel**		Tourism
		200	RO	Seti Sharm Hotel		Tourism
		200	RO	Sheraton Sharm Hotel, Resort, Villas	Sea	Tourism

Table 6 (continued)

Governorate	**Location**	**Total Capacity (m^3/d)**	**Process**	*Customer*	**Water Quality**	**User**
	Sharm El-Sheikh	250	RO	Riu Palace Sharm El Sheikh		Tourism
		250	RO	Tower Club Hotel	Sea	Tourism
		260	RO	**Fayrouz Hilton Resort**	Sea	Tourism
		260	RO	Novotel Aquamarine		Tourism
		300	RO	Crowne Plaza Resort		Tourism
		300	RO	Hilton Sharm Waterfalls Resort		Tourism
		300	RO	Hotel Maxim Plaza		Tourism
		300	RO	Intercontinental Garden Reef Resort		Tourism
		300	RO	**Royal Rojana Resort**		Tourism
		300	RO	Savoy Sharm El-Sheikh		Tourism
		300	RO	Sea Club Nubian Village		Tourism
		300	RO	Sheraton Sharm Hotel, Resort, Villas	Sea	Tourism
		350	RO	**Beach Al Batros Sharm**		Tourism
		380	RO	Jolie Ville Moevenpik Resort		Tourism
		400	RO	Concorde El Salam Sharm El-Sheikh Hotel		Tourism
		400	RO	Coral Bay Hotel – Sheikh Coast		Tourism
		400	RO	Hilton Sharks Bay Resort		Tourism
		400	RO	International Hospital	Sea	Municipal
		450	RO	New Tower Club		Tourism
		450	RO	Sonesta Beach Resort Sharm	Sea	Tourism
		500	RO	Amphoras Holiday Inn Resort		Tourism
		500	RO	Coral Beach Montazah Resort	Sea	Tourism
		500		El-Nassagoun El-Sharkiyoun		
		500	RO	Hilton Sharm Dreams Hotel	Sea	Tourism
		500	RO	Holiday Inn Resort	Sea	Tourism

Table 6 (continued)

Governorate	**Location**	**Total Capacity (m^3/d)**	**Process**	*Customer*	**Water Quality**	**User**
	Sharm El-Sheikh	500	RO	**Iberotel Grand Sharm Hotel**		Tourism
		500		Radisson SAS Golden Resort		Tourism
		500	RO	Reef Oasis Beach Resort		Tourism
		500	RO	Sharm El-Sheikh Marriott Beach Resort		Tourism
		500		South Nabk Desalination Plant		
		600	RO	Ghazala Gardens Hotel		Tourism
		950	RO	Hyatt Regency Sharm El Sheikh Hotel		Tourism
		1200	RO	Four Seasons Sharm El-Sheikh South Hotel		Tourism
		1200	RO	Pyramisa Sharm El-Sheikh Resort	Sea	Tourism
		1500		Gardenia Desalination Plant		
		2000		Youth Hostel		
		2500	RO	El-Montaza Desalination Plant		
		3000	RO	Golf Hotel Sharm Moevenpik		Tourism
		3000		International Co. Desalination Plant		
		3000		Sinai for Environmental Services		
		4000	RO	MOD	Sea	Municipal
		9000	RO	South Sinai Desalination Plant	Sea	Municipal
	Taba	600	RO	MOD		
		750	RO	Taba Golden Coast	Sea	Tourism
		2000	MVC	MOD	Sea	Tourism
		4000	RO	Maleh Company		
		5000	RO	MOD	Brackish	Tourism

Process

E.D. Electrodialysis

M.E.D. Multiple Effect Desalination

M.V.C. Mechanical Vapor Compression

R.O. Reverse Osmosis

T.V.C. Thermal Vapor Compression

Customer

EEA Egyptian Electricity Authority

MOD Ministry of Housing & Utilities and Urban Communities (Development Authorities)