BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
WATER SUPPLY DEVELOPMENT
IN
NORTHWEST PART OF SHARQIYA GOVERNORATE
IN THE ARAB REPUBLIC OF EGYPT

SEPTEMBER 2003

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

PREFACE

In response to a request from the Government of the Governorate in the Arab Republic of Egypt, the Government of Japan decided to conduct a basic design study on the Project for Water Supply Development in Northwest Part of Sharqiya Governorate in the Arab Republic of Egypt and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Egypt a study team from May 17 to Jun 30, 2003.

The team held discussions with the officials concerned of the Government of Egypt, and conducted a field study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Egypt in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Arab Republic of Egypt for their close cooperation extended to the teams.

September, 2003

川上隆朗

Takao Kawakami
President
Japan International Cooperation Agency

September, 2003

LETTER OF TRANSMITTAL

We are pleased to submit to you the implementation review study report on the Project for Water Supply Development in Northwest Part of Sharqiya Governorate in the Arab Republic of Egypt.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from May 14 to September 30, 2003. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Egypt and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

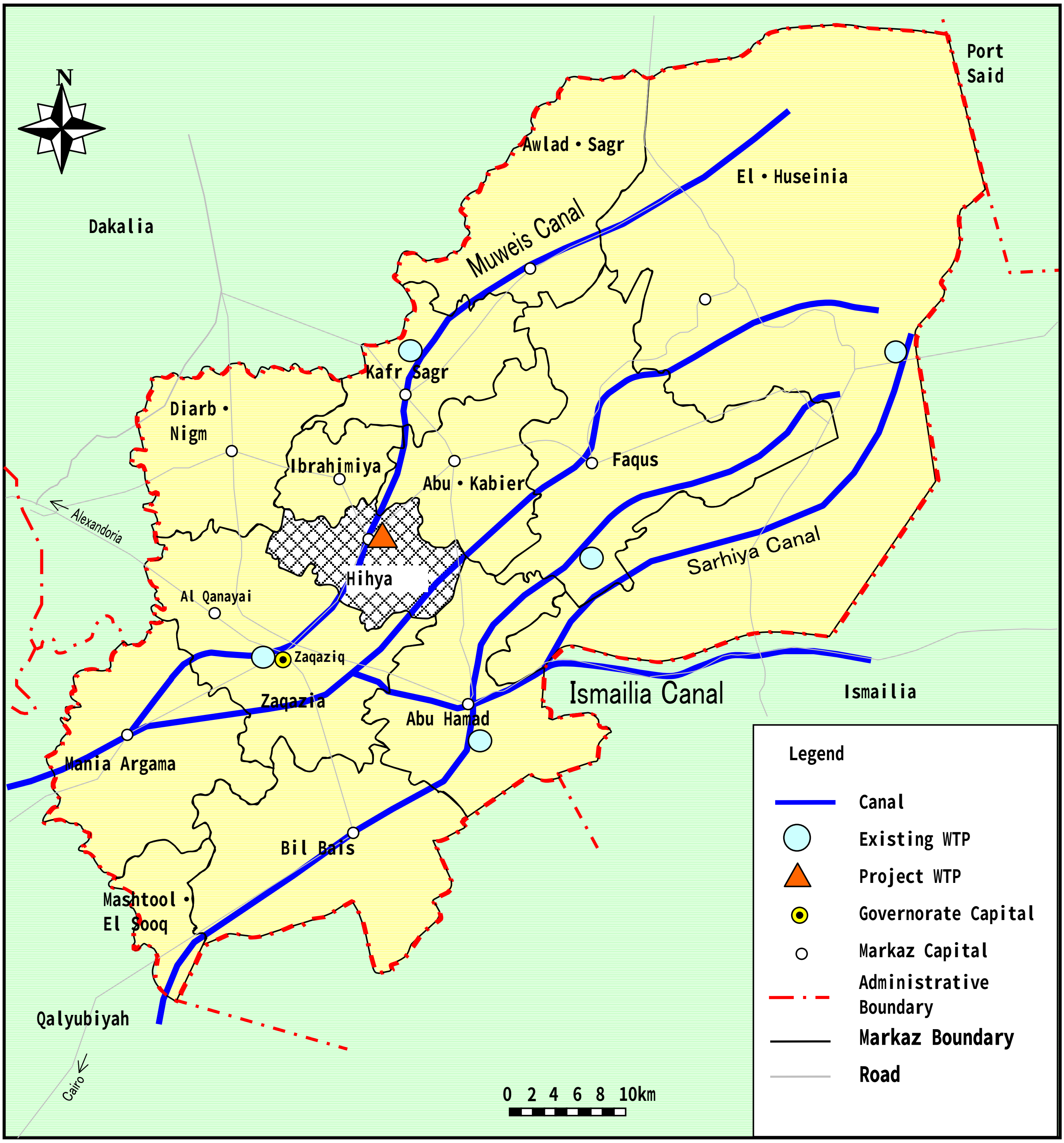
Very truly yours,

佐伯 昇

Noboru Saeki

Project Manager,
Implementation Review Study Team on the
Project for Water Supply Development in
Northwest Part of Sharqiya Governorate
in the Arab Republic of Egypt.
Yachiyo Engineering Co., Ltd.

Map of the Arab Republic of Egypt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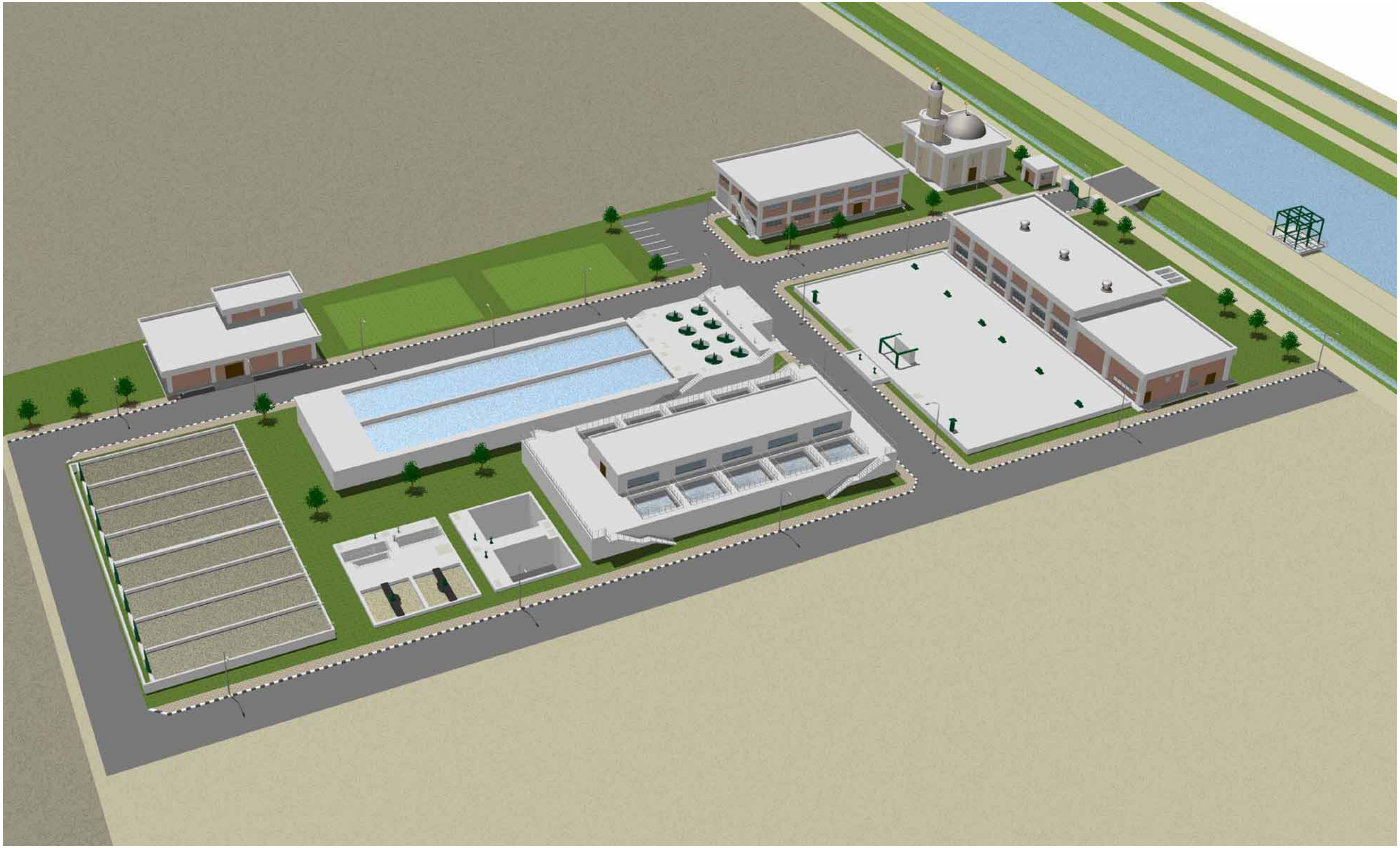
STUDY AREA



The Perspective of the Water Treatment Plant

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Abbreviations

- AD	: Alexandria Datum (Mean Sea Water Level)
- Approx.	: Approximately
- BD	: Basic Design
- BOD	: Biochemical oxygen demand
- COD	: Chemical oxygen demand
- DCI	: Ductile Cast Iron
- DD	: Detail Design
- E/N	: Exchange of Notes
- FY	: Fiscal Year
- GDP	: Gross Domestic Product
- GL	: Ground level
- GNL	: Gross National Product
- GOGCWS	: General Organization for Greater Cairo Water Supply
- GTZ	: Deutsche Gesellschaft für Techniche Zusamenarbeit
- HHWL	: Highest High Water Level
- HWL	: High Water Level
- IMF	: International Monetary Fund
- JICA	: Japan International Cooperation Agency
- JIS	: Japanese Industrial Standards
- JPY	: Japanese Yen
- kW	: Kilo Watt
- L	: Liter
- LCD	: Liter per capita per day
- LE	: Egyptian Pound
- LWL	: Low water level
- M/D	: Minutes of Discussion
- mL	: Milli - liter
- M/P	: Master Plan
- MWI	: Ministry of Water Resources and Irrigation
- NOPWASD	: National Organization for Potable Water and Sanitary Drainage
- OJT	: On the Job Training

- PC	: Prestressed Concrete
- PDM	: Project Design Matrix
- pH	: Hydrogen ion exponent
- PVC	: Polyvinyl Chloride
- RC	: Reinforced Concrete
- rpm	: Revolutions per minute
- SHEGAWASD	: Sharqiya Economical General Authority for Water and Sanitary Drainage
- TDS	: Total Dissolved Solid
- USAID	: US Agency for International Development
- WTP	: Water Treatment Plant

Summary

Summary

The government of the Arab Republic of Egypt (hereinafter referred to as “Egypt”) aims improvement of social service in its long–term development plan, which target year is 2022. Fifth Socio-Economic Development Five-Year Plan (2002/03 to 2006/07) adopts policies to improve and preserve the urban living environment including water supply and sewage service. National Organization for Portable Water Supply & Sanitary Drainage (hereinafter referred to as NOPWASD), which is responsible body for water supply and sewer service in the country has formulated the Fifth Five-Year Plan and has conducted projects in 25 Governorates.

Sharqiya Governorate, the Project area, locates in the eastern part of the Nile Delta in the north Egypt. The population is 4,798,000 (2002), which is the 5th biggest Governorate in Egypt. NOPWASD has already constructed 5 water treatment plants in Sharqiya Governorate in accordance to the Master Plan (M/P) established with cooperation by Japanese Technical Cooperation. These plants are run by Sharqiya Economic General Authority of Water & Sanitary drainage (SHEGAWASD). On the other hand, three Markaz (Hihya, Ibrahimiya and Diarb Nigm: population 649,000 in 2002), which are located in the western part of the Governorate, have been left without water treatment plant. Water supply in the three Markaz currently relies on groundwater. However, the water quality has been deteriorating due to salination *etc*. and it has been aware as an emergency issue to stably supply safe water.

Under these conditions, NOPWASD formulated water supply M/P for the three Markaz and requested Grant Aid related to those water treatment plant not to be constructed by self-help effort alone, to the Government of Japan.

Upon the request by the Government of Egypt, the Government of Japan completed “Preliminary Study for water supply development in the Greater Cairo and Lower Egypt” in January 2003 and has decided to conduct Basic Design (hereinafter referred to as BD) study. Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched the BD study team (hereinafter referred to as the Team) from 17th May to 30th June in 2003. The Team discussed the contents of the request with the Government of Egypt, NOPWASD and SHEGAWASD, examined the current condition of the Project area and collected relating information, *etc*.

NOPWASD originally had planned the capacity of the water treatment plant to be constructed as 15,000 m^3/day with considering use of groundwater, which is relatively salt unaffected. However, the national organization judged it is not unlikely to utilize groundwater in 2020 due to development of salination and claimed that the new water treatment plant would supply water based on the surface water of the Muweis canal only after treatment. As a consequence

of the discussions, it was determined to set the target year for the facility construction as 2010. This is because of unclearness of saline development and flexibility for changes of water quality, population growth and progress of regional development. The discussion also concluded water supply unit per capita would also determine after the field survey on water supply in the neighboring area.

Original request had included the start 6km of water transmission main in Japanese cooperation. Yet, it is necessary to construct water distribution network between the water treatment plant to be constructed and water consuming area. Therefore, all construction work of water distribution network would be borne by the Egyptian side.

The Team formulated Basic Design Plan including soft component on improvement of facility operation and maintenance ability by SHEGAWASD after confirming the necessity of construction of the new water treatment plant.

JICA dispatched Draft Report Explanation Team to Egypt between 2nd and 13th of September, 2003, and the Mission explained and discussed with the Egyptian side based on the basic design plan.

The components of the BD for construction of water supply system and the soft component are summarized in the following tables.

<u>Basic Design Policy</u>

Item	Policy	2002
Target Year	2010	
Average water supply per capita per day	Urban 215L Rural (not more than 10,000) 100L Rural (more than 10,000) 125L	60L (average in Governorate)
Water supply rate	100%	90%
Uncollected water rate	20%	40%
Population	Approx. 220,000	170,000
Water resource	Water treatment plant to be constructed, groundwater where Stalinization is not developed and new compaction unit at the central Hihya station	Groundwater
Raw water intake facility	Considering future development	
Sludge treatment	Not directly discharge into the canal Sludge treatment	

Summary of the Facility

Item	Content
Water treatment plant Design water supply Design raw water intake	 35,000 m^3/day 115,500 m^3/day (considering the future expansion)
Treatment system	Horizontal flow sedimentation + Rapid sand filter
Sludge treatment	Dry bed treatment
Emergency power source	750 kVA x 1 unit
Central monitoring and administration building	Approx. 1,000 m^2
Supplemental water resource	Existing groundwater where salinity has not affected 3,000 m^3/day New compact unit 4,000 m^3/day

Summary of Soft Component Plan

Item	Content
Technical guidance on water treatment plant system	Operation system Operation and maintenance Operation and water transmission management
Technical guidance on information management technology	Setting management target Establishment of database Information utilization

If the Project is implemented by Japan's Grant Aid, the estimated total cost of the Project is 4.06 billion Japanese Yen (2.92 and 1.14 billion Japanese Yen by the Japanese and the Egyptian sides, respectively), the total implementation period is expected as 3.5 months for detail design, 3.5 months for tender and selection of contractors and 28.0 months for procurement and construction. This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Appropriateness of the Project was examined from the aspects of emergence, benefit, maintenance ability, finance and environment as the following.

Hihya Markaz has the poorest infrastructure for water supply service in Sharqiya Governorate and water supply condition is seriously severe. The Project will enable to constantly supply clean water to the local residents and its emergency is high. By implementing the Project, the number of beneficiary is 223.5 thousands people (2010) and the necessary amount of safe water (100 to 215 LCD), which satisfies the drinking water standard, will be supplied.

SHEGAWASD shall operate and maintain the water treatment plant to be constructed. SHEGAWASD has approximately 5,000 employees and conduct water supply business to the whole population of Sharqiya Governorate (approximately 480 million people). The organization has already experience in operation of vertical rapid sand filter type of water treatment plant. Therefore, their ability for operation and maintenance is not problematic.

In financial aspect, SHEGAWASD's water supply business is in deficit because the unit price for water supply is smaller than the one for raw cost of water treatment. It is necessary to raise the water charge. Due to the current situation, it is anticipated the whole balance of water supply business after implementation of the Project (2006) will be still in deficit. However, it is expected to improve the income from water charge by increasing the volume of water supply and decreasing unaccounted for water rate.

Direct discharge of sludge from sedimentation basin and backwashing water will not be planned. The Project includes sludge treatment by drying bed and will reduce load on the environment.

The pending tasks in need of further improvement and related recommendations for NOPWASD and SHEGAWASD for the successful implementation of the Project and the sustainable operation and maintenance of the new facilities after the completion of the Project are described below.

- Implementation of works borne by the Egyptian side
    - Water transmission mains and water distribution network
    - Construction work for the rest of two Markaz (Ibrahimiya and Diarb Nigm Markaz)
- Improvement of Business management
    - Analysis of unaccounted for water and improvement of water charge collection rate by building up water transmission management system, which covers the nation.
    - Revision of the water charge to a level capable of financing the operation and maintenance cost of the facilities to secure the prospect of self-reliant finance with improving the organization and facility management effectively.
    - Effective use of facilities and improvement of the charged water supply ratio through improvement of the maintenance skills of staff members
    - Appropriate assignment of staff members and reduction of the personnel cost through a review of the water supply facilities and required staff strength
- Necessity for integrating management with the existing facility
    - Establishment of integrated water transmission and distribution system with the existing groundwater and compact unit

- Securing pressure adjustment, installation of booster pump and equalization basin

If the Project is implemented by Japan’s Grant Aid, the above-mentioned points will be the issues and the Egyptian side is require to conduct in accordance with the pending tasks and recommendations. Nevertheless, implementation structure and willingness to conduct the above points have already been confirmed. Therefore, it is possible to implement the Project. The significance and adequacy of the Project are high.

CONTENTS

CHPATER 1　Background of the Project

CHAPTER 1 Background of the Project

Egypt is a country located in the northeastern corner of the African Continent and has a land area of some one million km^2 and a population of approximately 70.71 million (2002 data). Some 94% of the national land is either desert or wetland and most of the population live in the delta facing the Mediterranean or valleys along the Nile valley.

The current Fifth Five Year Plan by the nation and NOPWASD adopts policies which mainly aim at construction and rehabilitation of water supply infrastructure such as water treatment plant. However, the present severe economic situation implies implementation of projects might be difficult by its self-help effort alone.

The main industry of Hihya Markaz in Sharqiya Governorate, which is the Project area, is agriculture and the Markaz has a population of approximately 194,000 (2002). Water supply in the area relies on Muweis canal, which originates from Nile River, and groundwater. As shown in Table 1.1, the design water supply capacity is 31,490 m^3/day (approx. 162 LCD). Yet, the actual water supply is approx. 17,680 m^3/day (approx. 101 LCD), which is extremely low number. This is due to deterioration of water supply facilities. It is reported that this causes frequent water supply cut off, too. Furthermore, as have been pointed out in a number of studies undertaken by Japan, salinity level in groundwater has gradually increased over decades. The residence in Sharqiya Governorate has to rely on the water supply which quality has been deteriorating and the quantity is insufficient.

Table 1.1 Capacity of the Existing Water Supply Facilities in Hihya Markaz

Facility	Quantity	Design Water Supply
Compact Unit （Source: Muweis Canal）	2 stations, 3 units 2,000m^3/day×3units	6,000m^3/day
Well（Source: Groundwater）	13 wells	25,490 m^3/day
Total		31,490 m^3/day

NOPWASD has expressed that “compaction unit is a small-scale simple facility for emergency improvement of water supply and it cannot be expected to purify water as was originally designed due to deterioration of the facility” and “future utilization of groundwater as domestic water (drinking water) is not expected owing to increasing salinity in groundwater”. NOPWASD formulated a water supply M/P for 3 Markaz (Hihya, Ibrahimiya and Diarb Nigm) which includes construction or rehabilitation of water treatment plant and water transmission network in June 2002. The Government of Egypt has requested Grant Aid relating to construction of water treatment plant and water transmission network as shown in Table 1.2 to the Government of Japan in December 2002 due to severe economic status and, therefore, hard prospect of the construction.

Table 1.2 Contents of Request by the Government of Egypt

No	Original Request (December 2002)	Request at Preliminary Study (January 2003)	Request at signing on BD Minutes (May 2003)
1	Construction of WTP 15,000m^3/day x 1 unit	Construction of WTP 103,680m^3/day x 1 unit	Construction of WTP The capacity shall be determined by the future population and design water supply based on the BD study.
	Water intake facility	Water intake facility	Water intake and Sludge Treatment facilities
2	Construction of transmission pipes -Diameter of 900mm x approx. 0.2km (for inside the plant)	Construction of transmission pipes -Diameter of 1,200mm x approx. 0.2km (for inside the plant)	Construction of transmission pipes -Diameter of 1,200mm x approx. 0.2km (for inside the plant)
	-Diameter of 500mm x approx. 6.0km	-Diameter of 500mm x approx. 6.0km	

CHPATER 2　Contents of the Project

Chapter 2. Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Target

2.1.1.1 Overall Goal

Egypt has aimed to improve social service as one of the target of a long-term development conception for 2022. The country has coped with improvement and preservation projects on the living environment including water supply and sewage system. The Fifth Five-Year Socio-Economic Development Plan (from 2002/03 to 2006/07) puts emphasise on construction and improvement of water supply facility. The Plan sets the goal at improvement of water supply system with increasing in the daily water production capacity up to 260 millions m^3 and extending water transmission main system up to 31,000 km.

NOPWASD is the responsible authority for the national water and sewer service except the Greater Cairo region and Alexandria Governorate. NOPWASD has arranged project programmes in the Fifth Five Years Plan and has promoted water supply improvement projects in 14 governorates.

NOPWASD has already constructed 5 water treatment plants in Sharqiya Governorate (population: 4,798,000 in 2002), which locates in the east of the Delta area in the northern part of Egypt. SHEGAWASD is the responsible organization for operation and maintenance of these treatment plants. However, there has been no water treatment plant equipped in three Markaz of Hihya, Ibrahimiya and Diarb Nigm (population: 649,000 in 2002). The inhabitants in the three Markaz are compelled to receive water supply from groundwater, which quality has been steadily deteriorating and the volume is not sufficient enough.

Overall Goal: Improving the living condition and hygienic environment by improving water supply to the all habitants in Sharqiya Governorate.

2.1.1.2 Project Target

NOPWASD formulated a water supply Master Plan in order to construct water treatment plants and water transmission main system in these three Markaz (June 2002). The Project is a plan to construct the water treatment plant and water transmission main for serving to Hihya Markaz where water quality is the worst deteriorate among the three Markaz.

Project Purpose: Increasing water supply volume, stabilizing water supply and improving quality of water supplied.

2.1.2 Basic Concept of the Project

The Project aims to improve the quality of transmitted water and secure average water supply per capita by constructing the new water treatment plant, which will intake water from Muweis Canal (originates in River Nile), and by constructing or arranging water transmission system from small scale water treatment stations such as groundwater wells and compact units, and the new water treatment plant to the Project site.

However, as the whole region of Hihya Markaz, the Project is also composed of utilization of groundwater in the southern region and a new compact unit, which just has started.

(1) Undertakings to be covered by the Japan's Grant Aid Assistance

i) Construction of water intake facility and raw water pipes

ii) Construction of raw water pipe and transmission pump facility

iii) Construction of water treatment facility

iv) Construction of sludge treatment facility

v) Construction of emergency generator facility

vi) Construction of central and administration building including water analysis equipments

vii) Technical support for operation and maintenance (Soft Component)

(2) Undertakings to be borne by the Egyptian side

i) Construction of water transmission / distribution pipeline for integrating into complete water supply system in Hihya Markaz with the new water treatment plant to be constructed by the Japanese side

ii) Operation and maintenance

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Natural Conditions

The area where the new water treatment plant will be constructed as Japanese Assistance is an agricultural land along Muweis canal. The location is approximately 1 km north from Hihya City. The characteristic of the natural conditions on the project site and design policy corresponding to the conditions are summarized to the following four points.

- Structure and facility design shall take into account the meteorological conditions such as high temperature, dry, seasonal sand storm, *etc*. In particular, equipments installed outside the buildings shall be sand-proof specification. Applying sludge treatment system by drying bed shall be examined owing to the good dry meteorological condition.
- The Project site is converted from agricultural land, so that the existing ground level is relatively low. There is a certain risk to be covered by the canal water when it reaches to high water level (HWL). Therefore, the design ground level for the Project is set at AD +7.77m, which is above the road for dredging vehicle as HHWL, and the reclamation shall be executed to this level.
- The Project site has the geological condition of the typical Nile River delta alluvial-cone depositional land. The result of the geological survey reveals the upper and the bottom layers are composed of clay and condensed sandy materials, respectively. Direct foundation at 2 to 4 meters below the present ground level can sustain the civil and building facilities to be constructed.
- Water treatment facilities in Egypt, including South Giza Water Treatment Plant, which was constructed by Japanese Assistance, has been directly discharging sludge into River Nile. However, since the establishment of the Ministry of Environment in 1994, adopting water resources protecting policy and environmental standards, discharge standard (1982) have rigorously applied to ban discharge of sludge and back-washed water without any treatments. There is a raw water intake point of the Kafr Saqr Water Treatment Plant, which locates at the downstream of the planned Hihya water treatment plant. Therefore, it is necessary to include treatment of sludge and back-washed water in the Project.

(2) Social Conditions

The Project of the constructing water treatment plant has significant positive effects on improvement of drinking water from highly saline groundwater to treated water which origin is the River Nile, increase in water supply volume and employment, which requires relatively general technical ability, *etc*. However, the following two points shall be aware. The Basic Design Study Team make recommendations to NOPWASD, which is responsible organization for construction, and SHEGAWASD, which conduct operation and maintenance.

- The Project targets Hihya Markaz among the three Markaz water service improvement project (Hihya, Ibrahimiya and Diarb Nigm). It is necessary to progress a separated project in the rest of two Markaz without any discrimination.
- Operation and maintenance cost for supplying good quality water will be bigger than the current cost with well pumps. The expense will be charged on the beneficiaries and an increase of water tariff is inevitable. The result of social survey shows willingness to pay in the subject area is high. It seems possible to raise the price of water. However, the weak in the society shall be considered for the raise of water tariff.

(3) Local Design Standard

There is an Egyptian waterworks facilities design standard (The Egyptian Code for Water Supply Facilities: Ministerial Decree No. 52, 1998). Facility designs in the Project shall follow this legislation. This Code regulates the details of water supply facilities such as the method of calculation for design water supply, water flow speed in pipe, specification of pumps, *etc*.

(4) Local Contractors

Egypt has constructed a number of water treatment facilities through its own effort and cooperation with international organizations. Additionally, local building contractors have extensive experience in basic civil engineering construction and installation of electricity devices since erection of general facilities and public infrastructure is prosperous in the country. Facilities in the Project do not require any specific construction methods. It is possible that local contractors and workers conduct the construction under supervision of Japanese engineers. Thus, it is not necessary to utilize contractors and workers from the third countries.

Main civil works/construction materials, except mechanical/electrical devices in the plant, ductile cast iron pipe fittings, valves, ductile cast iron over 1,000 mm in diameter, can be procured in Egypt as a consequence of improvement of productivity and quality. Therefore, construction materials will be principally purveyed in the local market.

(5) Improvement of Operation and Maintenance Ability

Staffs in SHEGAWASD have operation and maintenance skills for basic equipments since the employees have experience in running small-scale water treatment facilities such as the existing compact unit. On the other hand, few have experience in operating full-scale water treatment plant. Hence, it is essential to conduct On the Job Training (OJT) relating to operation and maintenance of the plant equipments by Japanese engineers in the duration of the construction.

In addition, it shall be considered that the constructed facility will be effectively and efficiently run through providing spare parts, testing equipments, tools for maintenance and manual for operation and maintenance.

Moreover, the Project aims to build up technological capacity and ability required for operation and maintenance of the water treatment plant, constructed in the Project, through systematic training (from theory of water treatment to methods of operation and maintenance of actual equipments) by applying Soft Component.

Management of the water service is interrupted by water transmission main system because there is no counter measure against leakage of water. No existing material shows the existing pipe rout and other important information. Additionally, management of water tariff collection is not efficient due to insufficient management of client data. Therefore, it cannot be expected to improve the service from the current situation.

The soft component will fully utilize the NOPWASD's and GOGCWS's training institutions, which was constructed with cooperation by the USAID and by Japan's technical cooperation, respectively, and therefore, Egyptian trainers who had nurtured at the institutions. Furthermore the Project applies the existing facilities and personnel that are the results of the each donor's assistance (*e.g.* the South Giza water treatment plant, constructed by the Japanese Grant Aid: Offering opportunities to contact the actual operation).

(6) The range of Facility and Equipments

The scope of the Japanese cooperation under the Project is to construct a water treatment plant, which is necessary for water supply to Hihya Markaz (Target Year: 2010). The plant shall be able to stably provide water even at power off or peak hours of electricity demand. However, as there is a plan for the future expansion of the Project facility, the design of the facility shall consider any disturbance factors for the future development in perspective.

(7) Establishment of the Grade for Facility and Equipments

Technical level and specification of equipments for the Project facility shall be set that SHEGAWASD will easily handle for operation and maintenance after provision.

(8) Implementation Schedule

It is deemed to take 28 months to implement the construction of the plant. The facility to be constructed is only water treatment plant and it cannot be expected to show the function step by step. Therefore, it is difficult to be implemented as cooperation scheme divided into several single fiscal years and is necessary to apply obligation of national grant monies beyond authorized annual allocation for a multi-year construction project.

2.2.2 Basic Plan (Construction Plan/Equipment Plan)

2.2.2.1 Design Conditions

(1) Target Year

There are two target years; the target year of the Project and the target year of the whole project plan including the future expansion. The target year of the Project is 2010, which is about 5 years after the completion of the construction (middle of 2006) taking urgency of Japan's Grant Aid Scheme.

On the other hand, the Egyptian side drew up Three Markaz Master Plan (M/P) on Hihya, Ibrahimiya and Diarb Nigm in June 2002. As a course for acquiring the budget has been secured and there is high possibility to conduct the future expansion, the whole project plan shall deliberate the M/P.

The water supply M/P is divided into two; 1st stage (target year: 2020) and 2nd stage (target year: 2040). The Project belongs to a part of the 1st stage of the whole project plan. *i.e*. the Project targets to construct a water treatment facility that water is supplied for Hihya Markaz and the target year is 2010, with considering the whole project plan (water supply for 3 Markaz and target year of 2020).

Therefore, the M/P is modified as in Table 2.1 due to implementation of the Project.

Table 2.1 The Target Areas in 3 Markaz Master Plan

Target Year / Item	1st stage		2nd stage
	This Project (2010)	Expansion plan (2020)	Expansion Plan (2040)
Subject Area	Hihya Markaz	i) Hihya Markaz (population growth between 2010 and 2020) ii) Ibrahimiya iii) Diarb Nigm (1 city and 3 villages)	i) Hihya Markaz ii) Ibrahimiya iii) Diarb Nigm (all area)

The Egyptian side is responsible for laying transmission pipes. Because the roads in the area are narrow and are hard to newly install and replace the pipes, the water transmission main shall be designed to meet water demand of the target year, 2040. In the Project, it is obligatory for the Egyptian side to lay water pipes, which enable to send water throughout Hihya Markaz before the completion of the works by the Japanese side.

(2) Design Population and Served Population

Design population of the each target year (2010, 2020 and 2040) is calculated from the average of the annual population increases and the average growth rates in the Census in 1986 and 1996 in the M/P (refer to Table 2.2). This method adapts to Hihya and the other two Markaz where the speed of development is slow and the population growth rate has been constantly maintained for a long time. Therefore, the design population in the M/P is employed in the Project.

Table 2.2 Results of CENSUS and Design Population

Markaz		1986 CENSUS	1996 CENSUS	2010	2020	2040
Hihya	Urban (Hihya City)	**29,234**	**36,257**	**47,550**	**56,949**	**80,329**
	(Annual Population Growth Rate: %)		(2.18)			
	(Annual Population Increase: persons)		(702.3)			
	Rural (28 villages)	**115,987**	**134,971**	**175,810**	**210,025**	**296,490**
	(Annual Population Growth Rate: %)		(0.67 to 4.08)			
	(Annual Population Increase: persons)		(12.9 to 237.3)			
	More than 10,000 habitants	0	0	80,648	97,740	180,987
	Not more than 10,000 habitants	115,987	134,971	95,162	112,285	115,503
	Total	**145,221**	**171,228**	**223,360**	**266,974**	**376,819**
Ibrahimiya	Urban (Ibrahimiya City)	**24,477**	**29,085**	**36,283**	**42,072**	**55,743**
	(Annual Population Growth Rate: %)		(1.74)			
	(Annual Population Increase: persons)		(460.8)			
	Rural (18 villages)	**65,951**	**79,448**	**101,722**	**121,094**	**174,146**
	(Annual Population Growth Rate: %)		(0.37 to 4.56)			
	(Annual Population Increase: persons)		(3.9 to 173.1)			
	More than 10,000 habitants	14,243	15,638	47,964	87,438	130,788
	Not more than 10,000 habitants	51,708	63,810	53,758	33,656	43,348
	Total	**90,428**	**108,533**	**138,005**	**163,166**	**229,879**
Diarb Nigm	Urban (Diarb Nigm City)	**32,198**	**43,507**	**62,825**	**80,125**	**128,431**
	(Annual Population Growth Rate: %)		(3.06)			
	(Annual Population Increase: persons)		(1130.9)			
	Rural (43 villages)	**207,014**	**252,320**	**321,486**	**378,910**	**521,762**
	(Annual Population Growth Rate: %)		(0.56 to 3.32)			
	(Annual Population Increase: persons)		(9.8 to 329.8)			
	More than 10,000 habitants	10,696	59,381	133,754	236,323	390,754
	Not more than 10,000 habitants	196,318	192,939	187,732	142,587	131,008
	Total	**239,212**	**295,827**	**384,311**	**459,035**	**650,193**
	Rural (3 villages)	**14,325**	**17,614**	**22,891**	**27,274**	----
	More than 10,000 habitants	0	11,893	15,525	18,538	----
	Not more than 10,000 habitants	14,325	5,721	7,366	8,736	----

Design served population is set at 100% of the population at the target year as it has currently been approximately 90% in Sharqiya Governorate and Hihya Markaz. Thus, the design served population is equal to the design population. Table 2.3 shows the calculated population in the three Markaz in each target year.

Table 2.3 Planned Population at Each Target Year

Item \ Target Year		1st Stage: This Project (2010)	1st Stage: Expansion Plan (2020)	2nd Stage: Expansion Plan (2040)
Project Area		Hihya Markaz	i) Hihya Markaz (population growth between 2010 and 2020) ii) Ibrahimiya iii)Diarb Nigm (1 city and 3 villages)	i) Hihya Markaz ii) Ibrahimiya iii)Diarb Nigm (all area)
Planned Served Population (Person)	Hihya	223,360	266,974	376,819
	Urban	47,550	56,949	80,329
	Rural	175,810	210,025	296,490
	Ibrahimiya		163,166	220,879
	Urban		42,072	55,743
	Rural		121,094	165,136
	Diarb Nigm		107,399 (1 city & 3 villages)	659,100 (All area)
	Urban		80,125	128,431
	Rural		27,274	530,669

(3) Design Average Water Supply per Capita

To establish design average water supply per capita per day for designing water treatment facility, the design standard of NOPWASD, comparison with national water resource per capita, actual water supply in Sharqiya Governorate and the result of social survey are referred.

Design average supply per capita is the amount of average water supply per capita per day. It includes physical loss (approximately 20%), hence, the actual volume of available water at end point subscribes this amount.

1) Facility Design Standard of NOPWASD

The average supply per capita in the NOPWASD's standard applies the following numbers as a national standard (the numbers in blanket ( ) indicate physical loss in transmission mains during water supply).

Capital City	:	250 LCD (25 – 50 litre)
Urban	:	215 LCD (22 – 43 litre)
Rural (more than 10,000)	:	125 LCD (12 – 23 litre)
Rural (Not more than 10,000)	:	100 LCD (10 – 20 litre)

These numbers are nearly equal to the ones of neighbouring Middle East countries in semi-arid region (except oil producing countries) and are tremendously low as including physical loss.

2) National Water Resources

Water resources for providing drinking water at nation-wide level depend on water from Nile River and groundwater. MWI supplied 3.94 billion m^3 of water for 68 million people as utilization of the water resources in 2000. This is equivalent to 158 litres per person per day. The Ministry plans to supply 8.8 billion m^3 for 89 million people in 2017, which is equal to 270 litres per capita per day.

Therefore, water use with the volume in the NOPWASD's standard is enough sustainable for future water utilization.

National Average Water Resources for Domestic Use

	Unit	2000	2017
Domestic Water per Capita	Liter per day	158	270

3) Water Supply Condition in Sharqiya Governorate

The current water supply in the subject area is 100 LCD whereas it is 120 LCD, which nearly reaches at the NOPWASD's standard, in the region where water treatment plants have already installed. However, there is 40% of unaccounted for water including physical loss. Therefore, the amount of water use at consumption level has not reached to the standard.

SHEGAWASD has a Governorate water supply plan for 2010. The objectives of this plan are to construct new water treatment plants including the Project facility, reduction of groundwater use, counter-measure against water leakage by construction and rehabilitation of water transmission mains, improvement of effective water ratio (10 %) and SHEGAWASD targets to achieve the NOPWASD standard of average water supply per capita per day (the number in blanket is in 2020).

Surface Water Treatment Plant (Nile River)	:	213,346	(68,591)
Compact Unit (Nile River)	:	11,640	(7,785)
Groundwater	:	49,000	(90,805)
Total in the Governorate	:	273,986	(167,181)
Population	:	5,553,000	(4,798,017)
Water supply service ratio	:	100 %	(90%)
Water Supply per capita per day	:	132L	(101L)

As have been seen above, it is appropriate to set the target year in 2010 and comprise the NOPWASD's standard in the Project.

(4) Definition of Design Water Supply and Flows

The design water supply and flows for planning water treatment plant shall be defined as the followings.

- Design water supply : basic water supply volume for determining the capacity of each water treatment facility
- Design intake flow : raw water intake volume from the canal
- Design treatment flow : water volume for determining the capacity of rapid sand filter
- Design transmission flow : water volume to be transmitted to the water distribution network

The above-mentioned each design water supply and flow shall be calculated in accordance with the Egyptian Code for Design Basis and Implementation Conditions for Water Treatment Plant, Wastewater Treatment Plant and Pump Station, Volume 3 Water Treatment Plant, Ministerial Decree No.52 – 1998 (hereinafter referred to as "the Egyptian Code").

According to the above code, each design water supply and flow shall be determined by the formula as mentioned in Table 2.4.

Table 2.4 Calculation Method of Design Water Supply and Flows

Design Water Supply and Flows	Calculation Method	Remarks
Design water supply	Design daily average supply x 1.25～1.5	Used for determining the capacity of each facility of the new water treatment plant.
Design intake flow	Design water supply x 1.1	Used for determining the capacity of the facilities from water intake facility to sedimentation basin
Design treatment flow	Design water supply x 1.07	Used for determining the capacity of rapid sand filter
Design transmission flow	Design water supply x 1.6~1.8	Used for determining the capacity of water transmission pump

(5) Design Water Supply

The design water supply shall be calculated for Ibrahimiya Markaz and a part of Diarb Nigm Markaz (1 city and 3 villages) as well as Hihya Markaz since it has to be determined with taken into account for the overall plan for the year 2020.

The overall plan shall be formulated in such a manner that the water treatment facility is located in three lines at the same plant as follows.

- 1st line ： Hihya Markaz
- 2nd line ： Ibrahimiya Markaz
- 3rd line ： Diarb Nigm Markas (1 city and 3 villates) + Population increase from 2011 to 2020 for Hihya Markaz

1st line : for Hihya Markaz

1) Target year：2010

2) Daily average water supply

(Daily average water supply for the Year = Annual water supply/365days)

The design daily average water supply per capita shall be as follows in accordance with the national plan for drinking water which has been applied by NOPWASD for the water supply facility planning in the whole region of Egypt.

- For cities ： 215 LCD
- For villages ： 100 LCD (for the population of not more than 10,000 cap)
  125 LCD (for the population of more than 10,000 cap)

3) Design population and design served population

The design population for the year 2010 shall be as follows in accordance with the results of national census of 1986 and 1996, and the water supply M/P for 3 Markaz. The service population shall be the same as the design population since it is anticipated that the service ratio will reach to 100% by the year 2010.

- For city ： 47,550 cap
- For villages ： 95,162 cap (for the population of not more than 10,000cap)
  80,648 cap (for the population of more than 10,000 cap)
  223,360 cap

4) Design water supply

i) Monthly maximum required water supply
(Monthly maximum water supply/Days of the month)
Since the peak factor (monthly maximum water supply/annual daily average water supply) is 1.25 to 1.5 according to the Egyptian Code No.52, 1.4 shall be applied as the average (the same figure as Master Plan for 3 Markaz).

- For city ：47,550 x 0.215 x 1.4 = 14,313m^3/day
- For villages ：(95,162 x 0.100 + 80,648 x 0.125) x 1.4 = 27,436m^3/day

Total 41,749m^3/day

ii) Available water supply from the existing water supply facilities

Following two existing water supply facilities are to be considered in the planning the water treatment plant of the Project. The results of water analysis and field measurement by the Team revealed the TDS concentration of El Alaqma's groundwater is 673 and 672 mg/L, respectively (Egyptian standard is 1,200 mg/L). El Alaqma's well is located at the southern edge of the Study area. If the speed of saline groundwater development is considered, it is concluded that the groundwater of El Alaqma will be utilized at least until 2010.

- New compact unit which was constructed by the Ministry of Higher Education and Science and has been operated since July 20 2003: 50 L per s (4000 m^3/day)
- El Alagma wells: 25 L/s (3000 m^3/day)

iii) Design water supply

The design water supply is determined by the following formula.

Design water supply	= Monthly maximum required water supply－Available water supply from the existing water supply facilities

Since the daily maximum required water supply is 41,749m^3/day and the available water supply from the existing water supply facilities is 7,000m^3/day, the design water supply shall be as follows.

Design water supply = 41.749 － 7,000 = 34,749m^3/day

2^{nd} line : Ibrahimiya Markaz

1) Target year：2020 (from the M/P for 3 Markaz)

2) Daily average water supply

(Daily average water supply for the year = Annual water supply/365days)

The design daily average water supply per capita shall be as follows in accordance with the national plan for drinking water which has been applied by NOPWASD for the water supply facility planning in the whole region of Egypt.

- For cities ： 215 LCD
- For villages ： 100 LCD (for the population of not more than 10,000cap)
  125 LCD (for the population of more than 10,000 cap)

3) Design population and design served population

The design population for the year 2020 shall be as follows in accordance with the results of the national Census in 1986 and 1996, and the M/P for 3 Markaz. The service population shall be the same as the design population since it is expected that the service ratio will reach to 100% by the year 2020.

- For city ： 42,072 cap
- For villages ： 33,656 cap (for the population of not more than 10,000cap)

  87,438 cap (for the population of more than 10,000 cap)

  163,166 cap

4) Design water supply

i) Monthly maximum required water supply

(Monthly maximum water supply/Days of the month)

Since the peak factor (monthly maximum water supply/annual daily average water supply) is between 1.25 and 1.5 according to the Egyptian Code No.52, 1.4 shall be applied as the average (the same figure as M/P for 3 Markaz).

- For city ：42,072 x 0.215 x 1.4 = 12,664m^3/day
- For villages ：(33,656 x 0.100 + 87,438 x 0.125) x 1.4 = 20,013m^3/day

Total 32,677m^3/day

ii) Available water supply from the existing water supply facilities

Groundwater in Ibrahimiya has been deteriorating and is anticipated not to use in the year 2020. Therefore, the available amount from the existing facility is zero (0).

iii) Design water supply

Since the monthly maximum required water supply is 32,677m^3/day and the available water supply from the existing water supply facilities is zero, the design water supply shall be as follows.

Design water supply = 32,677 － 0 = 32,677m^3/day

3^{rd} line : Diarb Nigm Markaz (1 city and 3 villages)＋Hihya Markaz (for the population increased from 2011 to 2020)

1) Target year：2020 (from the M/P for 3 Markaz)

2) Daily average water supply

(Daily average water supply for the year = Annual water supply/365days)

The design daily average water supply per capita shall be as follows in accordance with the national plan for drinking water which has been applied by NOPWASD for the water supply facility planning in the whole region of Egypt.

- For cities ： 215 LCD
- For villages ： 100 LCD (for the population of not more than 10,000 cap)
  125 LCD (for the population of more than 10,000 cap)

3) Design population and design served population

The design population for the year 2020 shall be as follows in accordance with the results of national census of 1986 and 1996, and M/P for 3 Markaz. The service population shall be the same as the design population since it is anticipated that the service ratio will reach to 100% by the year 2020.

For city：	80,125 cap + 9,399 cap (Hihya Markaz)	=	89,524 cap
For villages:	18,538 cap + 17,123 (Hihya Markaz)	=	35,661 cap
	8,736 cap + 17, 092 (Hihya Markaz)	=	25,828 cap
			151,013 cap

4) Design water supply

i) Monthly maximum required water supply

(Monthly maximum water supply/Days of the month)

Since the peak factor (monthly maximum water supply/annual daily average water supply) is 1.25 to 1.5 according to the Egyptian Code No.52, 1.4 shall be applied as the average (the same figure as M/P for 3 Markaz).

・For city	：89,524 x 0.215 x 1.4	=	26,947m^3/day
・For villages	：(35,661 x 0.100 + 25,828 x 0.125) x 1.4	=	9,512m^3/day
		Total	36,459m^3/day

ii) Available water supply from the existing water supply facilities

It is considered that the newly constructing compact unit at the Hihya central water station can be used by 2020 and wells located in the southern part of Diarb Nigm Markaz will be used continuously with the production rate of 25 L/s, which is sufficient to cover the shortage in the First Line Plant. However, this available water from the existing facility amounts to 7,000m^3 and is assumed to use in the First Line Plant. Therefore, the available water in the Third Line Plant is zero (0).

iii) Design water supply

Since the monthly maximum required water supply is 36,459m^3/day and the available water supply from the existing water supply facilities is zero, the design water supply shall be as follows.

Design water supply = 36,459 − 0 = 36,459m^3/day

<u>Summary of design water supply for 3 Markaz</u>

The design water supply for 3 Markaz is summarized as shown in Table 2.5.

Table 2.5 Design Water Supply for 3 Markaz

Plant	Target Area of Water Treatment Plant		Target Year	Design Water Supply (calculated)	Design Water Supply (applied)
1st	Hihya Markaz		2010	34,749	35,000
2nd	Ibrahimiya Markaz		2020	32,677	35,000
3rd	Diarb Nigm Markaz (1 city and 3 villages) + Hihya Markaz (population increase from 2011 to 2020)		2020	36,459	35,000
Overall Plan		m^3/day		103,885	105,000
		L/s		1,200	1,215

Although the design water supply for the Project is calculated as 32,677-36,459m^3/day as shown in the above table, the one line capacity of 35,000m^3/day shall be adopted as the design water supply because applying the same capacity for the one line has an advantage for the operation and maintenance, and this idea is the most common for the planning of water treatment plant. Therefore, 35,000m^3/day for each line shall be adopted for designing the water treatment facilities.

(6) Design Water Flows

1) Design Intake Flow

The water intake facility is designed taking into account the overall plan for 2020. The design intake flow shall be 110% of the design water supply which includes the water for back washing and the plant maintenance in accordance with the Egyptian Code.

Therefore, the design intake flow is calculated as follows.

$$105{,}000 \times 1.1 = 115{,}500 m^3/day$$

However, the capacity of these facilities between the raw water pump and sedimentation basin shall be designed with consideration of the Project only.

$$35{,}000 \times 1.1 = 38{,}500 m^3/day$$

2) Design Treatment Flow

The water treatment plant shall be designed for the Project Site (Hihya Markaz) for the year 2010. The design treatment flow shall be 107% of the design water supply which includes the water for back washing and the plant maintenance in accordance with the Egyptian Code. Therefore, the design treatment flow is calculated as follows.

$$35{,}000 \times 1.07 = 37{,}500 m^3/day$$

3) Design Transmission Flow

According the Egyptian Code, the design transmission flow shall be calculated as the daily maximum water supply. Since the peak factor for determining the daily maximum water supply is 1.6 to 1.8 (Daily maximum water supply/Average daily water supply for the year), the averaged figure of 1.7 shall be applied.

- For city : 47,550 x 0.215 x 1.7 = 17,380m^3/day
- For villages : (95,162 x 0.100 + 80,648 x 0.125) x 1.7 = 33,315m^3/day

Total 50,695m^3/day

Meanwhile, the available water supply from the existing water supply plants is 7,000m^3/day. Therefore, the design transmission flow is calculated as follows.

$$50{,}695 - 7{,}000 = 43{,}695 m^3/day \rightarrow 44{,}000 m^3/day$$

4) Design Water Supply and Flows for the New Water Treatment Plant

The design water supply and flows are summarized as shown in Table 2.6.

Table 2.6 Design Water Supply and Flows for New Water Treatment Plant

Item	Amount (m^3/day)	Remarks
Design water supply	35,000	Basic volume representing the water treatment plant
Design intake flow	115,500	Applied for intake facility
	38,500	Applied for facilities between raw water pump and flocculation /sedimentation basins
Design treatment flow	37,500	Applied for rapid sand filter
Design transmission flow	44,000	Applied for transmission pump

(7) Design Water Quality

1) Raw Water Quality

The resource of the raw water is Muweis Canal, which is branched from River Nile. The canal slope at the upper part of the Project Site is gentle (3 cm per 1 km) and the flow speed is approximately 0.5 m/s. The characteristics of the canal water are rich with algae, which is considered derived from living drainage, whereas suspended solid (SS) is in low concentration. Table 2.7 shows the design raw water quality of the project water treatment plant. These values in the table are based on water quality analysis by the basic design team, the study by the pre-study team and existing data of SHEGAWASD.

The Egyptian drinking water quality standard has the first and second classifications, which are seen in the table, third classification, which is about organic and inorganic substances, and fourth category relating to microorganisms. The water of Muweis Canal is utilized as a resource of drinking water at cities (including Zagazig City) in the upper stream and satisfies the standard. Therefore, any special treatment for the third and the fourth category will not be examined in the Project.

Table 2.7 Design Raw Water Quality

	Raw Water
pH	7-9
Turbidity	10-20
TDS mg/L	200-350
Iron (Fe) mg/L	<3.5
Manganese mg/L	<0.1
Copper mg/L	0
Zinc mg/L	0
Total Hardness mg/L	120-180
Calcium mg/L	25-35
Total Alkalinity ($CaCO_3$) mg/L	110-180
Magnesium mg/L	10-15
Sulphate (SO_4) mg/L	0-200
Chloride mg/L	10-45
Algae (count/mL)	4000-9000

2) Treated Water Quality

For the target quality of the treated water produced from the water treatment plant for the Project, the Egyptian water quality standard for the drinking water (1995 Decree) shall be applied as shown below.

Water quality parameters mentioned in the drinking standard other than Table 2.8, such as heavy metals and chemical substances in third category shall be deemed to satisfy the requirements in the standard without particular measure for the reason mentioned above.

Table 2.8 Design Treated Water Quality

	Treated Water
pH	6.5 – 9.2
Colour	20-30 as maximum Cobalt Platinum Scale
Taste	Acceptable
Odour	Nil
Turbidity	Jackson Unit 5
TDS mg/L	1200
Iron (Fe) mg/L	0.3
Manganese mg/L	0.1
Copper mg/L	1.0
Zinc mg/L	5.0
Total Hardness mg/L	500
Calcium mg/L	200
Magnesium mg/L	150
Sulphate (SO_4) mg/L	400
Chloride mg/L	500
Sodium (Na) mg/L	200
Aluminium mg/L	0.2
Calcium Balance	+/- 0.1

3) Wastewater after Back Washing

The Egyptian standard for wastewater discharging (1982) into canals is seen in Table 2.9. Either of the following discharge wastewater quality standards shall be applied depending upon the canals where wastewater is discharged.

Table 2.9 Wastewater Quality Standards

	1982 Decree	
Parameter	Discharge into Wastewater Canal	Discharge into Freshwater Canal
pH	6 – 9	6 – 9
SS mg/L	50	30
TDS mg/L	2000	800
DO mg/L	>4	---
COD mg/L	80	30
BOD mg/L	50	30
Nitrate mg/L	1	1
Sulphate ion mg/L	10	5
Oil/Grease mg/L	5000	2500
Coliform in 100 cc	35	35
Total Metals mg/L	1	1
Colour	---	No Colour
Residual Chlorine mg/L	---	1

(8) Design Water Level and Design Ground Level

The Project site has already secured at 50 km point of Muweis Canal. The site faces to Muweis Canal and it is approximately 4 ha of square (200m x 200m).

By contrasting to the result of topographic survey during the field study and the water level data obtained from Sharqiya branch of Ministry of Water Resources and Irrigation (MWI) at the 50 km point of Muweis Canal, the design water level of Muweis Canal, which is the water resources of the Project, and the design ground level of the Project site is determined as Table 2.10.

Table 2.10 Design Water Level and Design Foundation Height

Item	Height	Note
LWL	AD + 5.25m	
HWL	AD + 6.25m	
HHWL	AD + 7.25m	The highest water level in the past
Bank level of Muweis Canal	AD + 7.75m	Design height of the road for dredging vehicle
Design road height at branch irrigation course	AD + 7.77m	
Design ground level	AD + 7.77m	To adjust the height of the dredging road
Average existing ground level	AD + 7.10m	
Height of necessary reclamation	0.67m	However, back filled soil from construction work fills 0.20m up to the design ground level, the reclamation height, which Egyptian side is in charge, is 0.47m.

(9) Soil Condition

The result of geological survey at 5 boring points during the field survey indicates the geological conditions at the Project site as Table 2.11.

Table 2.11 Soil Characteristics of Upper Stratum

Item	Soil Characteristics value
Shrinkage Limit	12 to 16 %
Unit Volume Weight	1.65 to 1.95 g/cm^3
Unconfine of Compressive strength	0.34 to 1.6 kg/cm^2
Soil Strength	
Angle of internal friction（φ）	22.6°
Cohesion（C）	0.26 kg/cm^2
Groundwater Level	GL- 2.5 to GL- 4.9m
Chemical Analysis	
Average pH	7.17
Average CL^-	148 ppm
Average SO_3	399 ppm
Estimated Bearing Capacity of Soil	
2 to 3m under the existing GL	Approx. 10t/m^2
5 to 6m under the existing GL	Approx. 10 t/m^2 to 15t/m^2
8 to 10m under the existing GL	Approx. 20t/m^2
Deeper than 10m under the existing GL	Approx. 30t/m^2

The soil up to 2m under the existing ground level is a soft layer, which has not been solidified. Therefore, it is necessary for the foundation of main facilities to be placed at the depth of 2m or more under the existing ground level or for the layer of the depth to be replaced with improved sand, which is a mixture of sand and cement.

(10) Climate Condition

The climate condition is as the followings.

i) Average Temperature (Shadow) ：21℃
ii) Average Summer Temperature (Shadow) ：33.7℃
iii) Average Winter Temperature (Shadow) ： 7.2℃
iv) Annual Precipitation ：30mm
v) Average Summer Precipitation ：0mm
vi) Average Winter Precipitation ：5.3mm
vii) Average Summer Humidity ：54%
viii) Average Winter Humidity ：60%

2.2.2.2 General Layout for New Water Treatment Plant

(1) Basic Concept of the Design

The general layout for the new water treatment plant is formulated with taking into account of the following items.

1) The overall plan shall be prepared for the year 2020 and the Project is a part of this overall plan.

2) The future extension shall be considered in the layout for the facilities.

3) The new water treatment plant for Hihya Markaz to be constructed by the Japanese side is designed for the year 2010 except the raw water intake facility.

4) The raw water pump and transmission pump are installed in the same pump house.

5) If there is shortage of land from the acquired land (200m x 200m) after examination of the layout plan based on the above-mentioned policy, NOPWASD will further obtain the area for insufficient at the future expansion.

(2) Components of the Facilities

The components of the facilities in the Project are seen in Table 2.12.

Table 2.12 Components of the Facility

No	Name	Component
1	Water Intake Facility	Including intake pipe and raw water pump pit
2	Raw water pump facility	
3	Water Treatment Facility	Receiving well, Flush mixer Chemical mixing basin, Flocculation basin, Sedimentation basin, Rapid sand filter, Chemical feeding facility, Sludge treatment facility, Treated water reservoir
4	Water Transmission Facility	As raw water pump facility
5	Laboratory	Analytical equipments for water analysis
6	Operation Control Facility	Control panel, Monitoring panel, Flow meter
7	Power Receiving and Transforming Facility	Power receiving equipments, Transformer
8	Emergency Generator	Diesel generator
9	Facility for Civil and Building works	Administration unit, Intake and transmission pump unit, chemical feeding unit, Filtration unit

(3) Facility Layout Plan

The totality facility layout plan with considering the above and necessary facilities and equipments is shown in the Basic Design Drawing SWP-01.

It is necessary for the Egyptian side to acquire further 21.5 to 34.2m x 200m of the land in addition to the existing Project site for facility expansion for 2020. The shortage of the land attributes to that NOPWASD had not considered the treatment facility for backwashed water.

2.2.2.3 Raw Water Intake Facility

(1) Basic Concept of the Design

Water intake facility is designed with considering the future expansion in accordance to the M/P. Otherwise it is necessary to shut down the canal and cease operation of the existing facility for a certain period. It is also due to certainty of implementation of the future expansion and uneconomical characteristics if another intake facility is constructed in the future expansion separately.

(2) Structure for Raw Water Intake Facility

The raw water intake structure shall be designed under the following conditions:

- The raw water intake structure shall be placed at the 50 kilometre point of Muweis Canal.
- Two sets of screens shall be installed in the intake structure to avoid intrusion of the floating waste into further system. The floating waste shall be picked up and removed by hand sweeper.
- The stop logs will be installed to maintain the raw water intake facilities. These stop

logs will be usually kept in the store.

- Steel structure and hook shall be installed on the working floor of the raw water intake facility in order to ease the functions for installation and pulling up of the screens and stop logs.
- The velocity of flow through the intake structure will be less than approx. 0.3 m/s at the low water level of Muweis Canal to prevent intrusion of gravel and sand.
- Masonry works shall be applied for protecting the bottom of Muweis Canal in front of the raw water intake structure and the slope of the bank of Muweis Canal. The extent of the protection area is 8m of up and down stream of the intake facility.

(3) Raw Water Intake Pipe

- Three raw water pipes shall be installed between water intake structure and raw water pit in considering of the future expansion.
- The flow velocity inside the raw water pipe shall be approximately 1.0 m/s to avoid accumulation of sedimentation in the pipe. The minimum speed for preventing sand sedimentation in the pipe is 0.6 m/s. The diameter of the pipe is 800 mm.

  〔$38,500m^3$/day÷(24 hours x 60min x 60s÷(π x 0.8^2÷4) = 0.9m/s)

- By the agreement of the discussion with MWI Sharqiya Branch, the interval between the top of raw water pipe and the bottom of the irrigation canal is more than 0.5 m.
- The following pipes are examined regarding the diameter of raw water pipes, construction environment, easiness for construction, difficulty for procurement, economical factor, quality, etc.
  - Reinforced concrete pipe
  - Ductile cast iron pipe
  - Steel pipe

As shown in Table 2.13, reinforced concrete pipe is superior to ductile cast iron pipe and steel pipe. Thus, reinforced pipe is employed in the Project.

Table 2.13 Comparison among Reinforced Concrete, Ductile Cast Iron and Steel Pipes

Characteristics	Reinforced Concrete Pipe	Evaluation	Ductile Cast Iron Pipe	Evaluation	Steel Pipe	Evaluation
Safety ・Pressure hearing intensity	Skew change is the smallest under the same load condition	○	Skew change is small under the same load condition	△	Easy to change due to large skew	×
Construction ・Connection of pipes	Easy with a short period and simple tools. No need to consider springs and weather condition	○	Easy with a short period and simple tools. No need to consider springs and weather condition	○	Welding and X ray inspection requires time and high skill. Spring and weather condition significantly influence on the work.	×
Quality ・Non-Erodibility ・Internal non-erodibility ・Life	Specific non-erodibility Significant non-erodible characteristics 40 to 50 years (LCC is small)	○ ○ ○	Specific non-erodibility Significant non-erodible characteristics by alkaline non-erodible effect of cement laying 40 years (LCC is small)。	○ ○ ○	Less than DCI Non-erodibile paint shall b applied, but this makes construction more difficult 25 years (LCC is large)	× × ×
Concrete Protection	Not required	○	Required	×	Required	×
Regional Characteristics and work environment	Intake pipe is placed under the bank of the canal and irrigation course. Therefore, it is necessary to recover the function as soon as possible	○	Intake pipe is placed under the bank of the canal and irrigation course. Therefore, it is necessary to recover the function as soon as possible	○	Connected points need to be painted. However, the paint of the surface shall be dried before laying back. Therefore, it takes more than a day.	×
Cost	The lowest cost	○	8% more expensive than iron	×		△
Total	◎		○		×	

Note: LCC: Life Cycle Cost

Basic design (BD) drawings reflecting the above conditions are shown from SWP-06 to 08.

2.2.2.4 Raw Water Pump and Transmission Pump House

SHEGAWASD claimed that garbage and mud contained in the raw water cause accumulation in the raw water suction tank and impediment smooth water inflow. Therefore, the following measures will be taken into consideration under the Project.

(1) Raw Water Pit and Raw Water Suction Tank (BD drawing No. SWP-08)

- Raw Water Pit shall be installed in the open area of the upstream side of Raw Water Suction Tank. Canal water inflows into Raw Water Pit by the water level difference between the tank and the pit through the three (3) raw water pipes. Accumulated mud/sludge will be periodically discharged by portable submerged drain pump by the plant operator.
- Other than two (2) screens set at the water intake facility as a counter measure against inflowing garbage, there is one (1) raking screen installed. It is for preventing intrusion of garbage into the Raw Water Suction Tank.
- A pipe with 2 m in length will be installed in Raw Water Pit as blank flanges for the future expansion.
- The volume of Raw Water Pit and Raw Water Suction tank shall be designed to keep at least 5 min. per unit as the retention time. Raw water pumps and transmission pumps will be installed in one (1) pump house. A motor operated overhead crane will be provided for the maintenance of pump facilities.

(2) Raw Water Pump (BD drawing No. SWP-09 and 10)

As Raw Water Pump is to feed the raw water to receiving well, fluctuation of pump operation head is less. Therefore, less number of pumps to be installed is acceptable for the operation. For the Project, 3 pumps (2 for regular and 1 for stand-by) is planned taking into account unexpected accidents.

As Design Intake Flow is 38,500 m^3/day, discharge volume of one pump is

13.37(m^3/min) = 19,250(m^3/day) = 38,500(m^3/day)/2(pumps).

As the total head is 15m and discharge volume is 13.37m^3/min, centrifugal pump is appropriate to be installed.

The main specification of raw water pump is as the followings.

Pump Type	:	Horizontal or vertical centrifugal pump
Number of Pump	:	3 (2 for regular and 1 for spare operations)
Discharge Quantity	:	13.37 m^3/min (per 1 unit)
Pumping Head	:	15 m
Output of Main Motor	:	Approx. 55 kW

2.2.2.5 Water Treatment Facility

(1) Measure against Raw Water Quality

The water analysis done for the raw water of Muweis Canal as the water source of the Project during the field survey reveals the main items required to be treated are turbidity and algae. Algae are a flock of various phytoplankton and, thus, the characteristics of deposition *etc.* differ depending upon raw waters. The following diagram shows the component of water treatment equipment for the treatment facility (Figure 2.1).

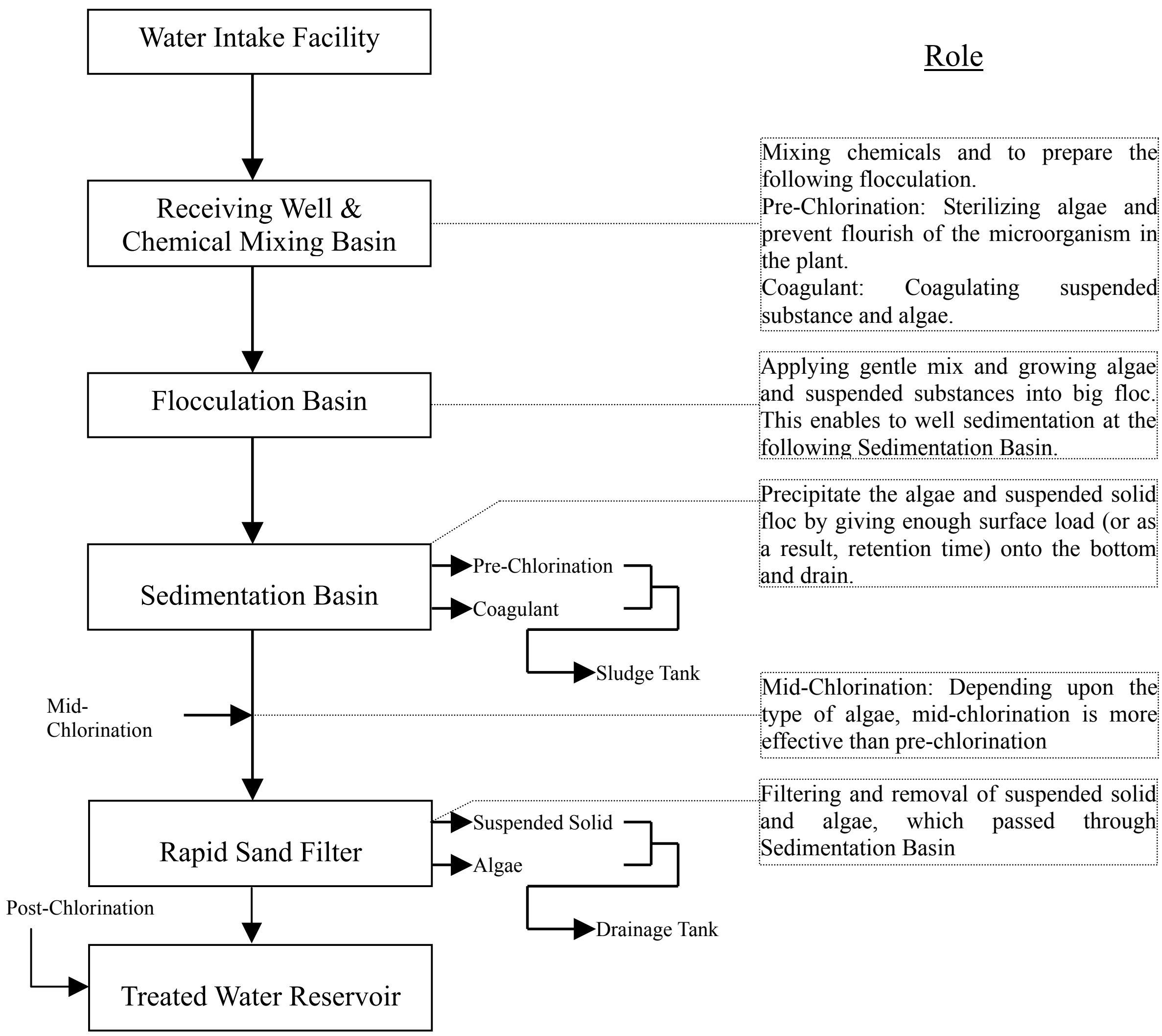


Figure 2.1 Composition of Equipments in the Water Treatment Facility

(2) Designed Water Flow

The designed water flow for the facilities between the Receiving Well and Sedimentation

Basin shall be 38,500 m^3/day adding 10% of design water supply with the water losses from sludge discharge in the water treatment process taken into account. For Rapid Sand Filter, it shall be 37,500 m^3/day adding 7% of the design water supply with the water loss from backwashing taken into account.

(3) Type, Capacity and Size of the Facilities

Egyptian Code No. 52 is applied for design of type, capacity and size of each facility. However, "Design Criteria for Waterworks Facilities" is adopted if the Egyptian Code does not define or if the Japanese standard is considered appropriate.

The details for sludge discharging and filter washing systems of Mixing Basin, Flocculation Basin and Sedimentation Basin are examined. The result of the comparison is attached in Appendix-5.

1) Receiving Well (SWP-12, 14 and 15)

i) Facility

Receiving Well is installed to stabilize the raw water level, which pumps convey, precisely distributes into two ponds and ease the following treatment processes. The shape is rectangular tank type as it is widely applied. The following is the main specifications.

Type	:	Rectangular tank type
Size	:	3 m^w x 3.5 m^l x 4.5 m^d (effective depth)
Capacity	:	47 m^3
Number	:	1 basin

ii) Design Criteria

Design Water Flow

38,500 m^3/day

Design Capacity

Retention Time

$\boxed{\text{1 to 2 minutes (Egypt) / more than 1.5 minutes (Japan)}}$

$$47\mathrm{m}^3 \div \frac{38{,}500\mathrm{m}^3/\mathrm{day}}{24\mathrm{h/day} \times 60\,\mathrm{min/h}} = 1.8\mathrm{min} > 1.5\mathrm{min} \rightarrow \mathrm{OK}$$

Effective Depth

$\boxed{\text{3 to 5 m (Japan)}}$

Water depth is 4.5 m. Therefore, 3 m < 4.5 m < 5 m → OK

2) Mixing Basin (SWP-12, 14 and 15)

i) Facility

Mixing Basin is installed for rapid mixing of coagulant, which is injected before this facility, and effective flocculation.

There are various types of Mixing Basin such as mechanical flocculation (*e.g.* flush mixer) and pressured water mixing types. Flush mixer type is applied in the Project. Flush mixing tank method is superior to pressured water mixing type in respects to reliability for mixing, easiness of maintenance, effectiveness and smaller size.

Type	:	Turbine type Flush Mixer
Caliber/Pivot	:	1,400 mm / 25.4 rpm
Size	:	3.5 m^w x 3.5 m^l x 2.5 m^d
Capacity	:	30.6 m^3
Number	:	1 set

ii) Design Criteria

a) Design Water Flow

38,500 m^3/day

b) Design Capacity

Retention Time

$\boxed{\text{0.5 to 1 minutes (Egypt) / 1 to 5 minutes (Japan)}}$

Tank Capacity: 3.5 m^w x 3.5 m^l x 2.5 m^d = 30.6

$$30.6m^3 \div \frac{38{,}500m^3/day}{24h/day \times 60\,min/h} = 1.1min \quad 1min \rightarrow OK$$

Wing Type of Flush Mixer

$\boxed{\text{1/3 to 1/2 of chemical sedimentation basin (Egypt)}}$

$$3.5m \times \frac{1}{3} = 1.17m$$

$$3.5m \times \frac{1}{2} = 1.75m$$

Wing configuration of flush mixer is 1.4 m

$$1.17m < \phi 1.4m < 1.75m \rightarrow OK$$

Speed of circulation

$\boxed{\text{More than 1.5 m/s (Japan)}}$

$$\text{Circulation Speed} = \frac{25.4rpm \times \pi \times \phi 1.4m}{60sec/min}$$

$$= 1.86m/s > 1.5\ m/s \rightarrow OK$$

3) Flocculation Basin (SWP-12, 14 and 15)

i) Facility

Flocculation immediately follows after the flush mixing basin. It is necessary for sedimentation and filtration to consolidate suspended particle with the intention of avoiding destruction of flocculated materials. The flocculation basin is placed between the flush mixing and the chemical sedimentation basins. As it is required to apply strong mixing power at the first stage and to gradually lower the power with the growth of flocks. Therefore, tapered flocculation type flocculator, which enables to decline mixing power with distance and area, is employed for the Project.

There are four (4) types of flocculation basins; (i) mechanical mixing (horizontal), (ii) mechanical mixing (vertical), (iii) vertical baffled channel and (iv) horizontal and vertical combined baffled channel flocculation basins. In the Project, mechanical mixing flocculation basin (vertical) is employed as it easily corresponds for change of raw water quality and many existing water treatment plants have employed this type.

Type	:	Mechanical mixing vertical flocculator
Size	:	$4.25m^W \times 4.25m^L \times 3.5m^D \times 8$ basins $+ 2m^L \times (8.9m^W \times 2$ lines$) \times 3.5m^D$(hinterland)
Capacity	:	630.4 m^3 (total of 8 basins)
Number	:	8 basins (4 rows $\times$ 2 lines)

ii) Design Criteria

a) Design Water Supply

38,500 m^3/day

b) Design Capacity

Retention Time

$\boxed{\text{20 to 30 minutes (Egypt) / 20 to 40 minutes (Japan)}}$

Capacity $4.25m^W \times 4.25m^L \times 3.5m^D \times 4$ rows $\times 2$ lines $+ 2m^L \times (8.9m^W \times 2$ lines$) \times 3.5m^D = 630.4m^3$

$$630.4m^3 \div \frac{38{,}500m^3/\text{day}}{24\text{h/day} \times 60\,\text{min/h}} = 23.6\text{min} \quad \rightarrow \quad \text{OK}$$

Water Depth

$\boxed{\text{2 to 4 m (Egypt)}}$

As water depth is 3.5 m

$2m < 3.5m < 4m \quad \rightarrow \quad$ OK

Speed of circulation

$\boxed{\text{0.15 to 0.8 m/s (Japan)}}$

[First line flocculator]

Diameter 3m, speed 1.5 to 6.2rpm

$$\text{Circulation Speed} = \frac{(1.5\sim6.2)\ \text{rpm} \times \pi \times \phi 3\text{m}}{60\text{sec/min}}$$

$= 0.24\text{m/s} \sim 0.97\ \text{m/s} \rightarrow$ OK

As it is a tapered flocculation type, the second lone is set as slightly larger.

[Second line flocculator]
Diameter 3m, speed 0.94 to 3.8 rpm

$$\text{Circulation Speed} = \frac{(0.94\sim3.8)\ \text{rpm} \times \pi \times \phi 3\text{m}}{60\text{sec/min}}$$

$= 0.15\text{m/s} \sim 0.6\ \text{m/s} \rightarrow$ OK

4) Sedimentation Basin (SWP-12, 13, 14, 16 and 17)

i) Facility

Sedimentation Basin is installed in order to remove large size floc by sedimentation and to reduce load at the following filtration basin.

There are horizontal flow and up-flow types of sedimentation basins and the existing water treatment plants in Sharqiya Governorate and Egypt adopt either basin system at the equal number. However, the up-flow type has a problem with incomplete sedimentation and excessive loads on filter basin. Therefore, the horizontal flow type of sedimentation basin is employed in the Project.

Type	:	Horizontal type single layer sedimentation basin
Size	:	$8.5\text{m}^W \times 52\text{m}^L \times 4\text{m}^D$
Capacity	:	$1{,}768\text{m}^3$
Number	:	2 basins

ii) Design Criteria

a) Design Water Flow

$38{,}500\ \text{m}^3/\text{day}$

b) Capacity

Surface Load $\boxed{14\sim31\text{mm/min (Egypt)}/15\sim30\text{mm/min (Japan)}}$

$$\frac{38{,}500\text{m}^3/\text{day}}{24\text{h/day} \times 60\text{min/h}} \div 8.5\text{m} \div 52\text{m} \div 2\ \text{basin}$$

$= 30.2\text{mm/min} \rightarrow$ OK

Retention Time 2～3h (Egyptian Standard)

$$1{,}768\text{m}^3 \times 2\ \text{basin} \div \frac{38{,}500\text{m}^3/\text{day}}{24\text{h/day}} = 2.2\text{h} \rightarrow \text{OK}$$

Average Flow Speed	Less than 0.4m/min（Japan）
	$\dfrac{38{,}500m^3/day}{24h/day \times 60min/h} \div (8.5m^W \times 4m^L \times 2set)$
	$= 0.39m/min \leqq 0.4m \rightarrow$ OK
Water Depth	2～4m（Egypt）/approx. 3～4m、Bottom sludge 0.3m（Japan）
	Effective water depth 4m＋Bottom sludge thickness 0.5m → OK
Horizontal and vertical ratio	3～8（Japan）
	$52m/L \div 8.5m^W = 6.1$
	$3 < 6.1 < 8 \rightarrow$ OK
Number	More than 2 ponds (Japan)

2 basins (width: 8.5m per basin) are installed in consideration of cleaning, inspection and repair. Two lines of sludge collectors with maximum width of 4.5 m are also equipped in a basin. Therefore, the total number of 4 lines of sludge collectors shall be equipped in the whole basin.

5) Rapid Sand Filter (SWP-18 to 20)

i) Facility

Rapid Sand Filter is placed for filtering small flocculated particles, which cannot be removed with chemical sedimentation basin. Concerning the volume of washing water, the capacity of the sand filter in the Project is 107% of the design water supply. Controlling method employs semi-automatic operation type by controlling panel installed in the Central Monitoring and Administration Building as the other existing facilities. This enables to correspond to faults occurring in the system.

Filtering method

There are two types of filtering basins namely balanceable system between water level and head loss of sand filters and flow rate or water level control system. The Project employs balanceable system between water level and head loss of sand filters, which is superior in easiness of mechanical and electrical because the number of valves is relatively small. This aims to simplify maintenance works and to reduce maintenance cost.

Washing sand filter

Surface water washing + backwashing and air cleaning + backwashing types are the typical filter washing method. The existing water treatment facility applies the latter type. However, there are disadvantages. This method requires compaction equipment. Air washing often causes air holes on the surface of the filter layer where floc membrane is weak and this disables sufficient washing. Moreover, the air washing damages on the air-washing nozzle and may cause spillage of filtering sand.

The Project applies the surface washing + backwashing method since it has extensive achievement of use in Japan, it has better filtering effect, and maintenance is easier in comparison to air filtering method. The followings show specifications.

Filtering Type	:	Rapid Sand Filter
Washing method	:	Self backwashing (Surface washing + Backwashing)
Size	:	$5.7m^W$ x $7.0m^L$
Surface Area	:	$40m^2$/pond
Number	:	5 basins x 2 lines = 10 basins (2 for stand-by)

ii) Design Criteria

a) Design Water Volume

37,400 m^3/day

b) Capacity

Filtration rate

120 to 180 m/day (Egypt) / 120 to 150 m/day (Japan)

If 8 ponds run

$37{,}500m^3/day \div 40m^2/pond \div 8pond$

$= 117m/day < 120m/day \rightarrow$ OK

Washing

0.3 to 0.6 (Egypt), 0.3 to 0.9 m/min (m^3/m^2/min (Japan)

If 0.6 m/min and 5 min/cycle per pond is applied,

$40m^2/basin \times 0.2m/basin = 8m^3/min/basin$

$24m^3/min \times 5min/cycle = 120m^3/cycle$

Surface Washing

0.15 to 0.2 m/min (Japan)

If 0.2 m/min and 5 min/cycle per pond is applied,

$40m^2/basin \times 0.2m/basin = 8m^3/min/basin$

$8m^3/min \times 5min/cycle = 40m^3/cycle$

Filtering Area

$40m^2$/basin (Egypt)

$40m^2$/basin

Sand Layer

More than 0.7 m (Egypt), 0.6 to 0.7 m (Japan)

0.7 m

Gravel Layer	$\boxed{\text{0.3 to 0.6 m (Egypt), 0.2 m (Japan)}}$ 0.3 m
Height of gravel head	$\boxed{\text{1.0 to 1.5 m (Egypt)}}$ As the Project employs natural balance system, the height of the sand head is not applied.
Washing period	$\boxed{\text{5 to 6 min (Egypt), 4 to 6 min (Japan)}}$ 5 min
Total washing period	$\boxed{\text{10 to 15 min (Egypt), 8 to 12 min (Japan)}}$ Surface washing (5 min) + backwashing (5 min) = total 10 min.
Air washing	$\boxed{\text{50 to 70 m}^3\text{/m}^2\text{/min (Egyptian standard)}}$ Air washing is not relevant to this project
Interval of effluent trough	$\boxed{\text{1.5 to 2.1 m (Egypt), less than 1.5 m (Japan)}}$ 1.5 m

6) Chemical Dozing House (SWP-21)

As the other existing water treatment plants, the Project applies chloride and aluminium sulphate as sterilizer and coagulant, respectively.

For safety reason to deal with chloride, leaked chlorine neutralization equipments, chloride feeding room and aluminium sulphate adjusting room are placed.

i) Chlorine dozing equipment

There are a considerable amount of bacteria and algae in raw water. Thus the chlorine dozing equipment is used for sterilizing these microorganisms in the raw water and chlorination of treated water.

Chlorine cylinders, brought by tracks, are placed in the chemical dozing house. These cylinders are lifted with chain hoist and stored in the chlorine storage room. The chain hoist set onto a weight scale in the chloride weighing room. The cylinder is connected to chlorine dozing equipment and supply to each pond after mixing with water.

Vacuum wet type chlorinator is employed as the other existing treatment plants. Liquid status chloride is dozed after high pressure water is supplied in dozing and measuring chloride gas by vacuum wet chlorinator. Chain block is prepared in chlorine dozing equipment room for identifying the amount of chloride in the cylinder and safety reason.

Design Water Flow and the Criteria

a) Design Water Flow

Receiving well:	Pre-chlorination	38,500 m^3/day
Lower chemical sedimentation basin:	Mid-chlorination	38,500 m^3/day
Lower filtration basin:	Post-chlorination	35,000 m^3/day

b) Capacity

Quantity

> 7 g/m^3 (pre- or mid-chlorination) (Egyptian standard)
> 10 g/m^3 (sum of pre-, mid- and post-chlorination) (Japanese standard)

[pre- + middle-chlorination]

$38{,}500 m^3/day \times 7 g/m^3 \div 24 h/day$

$= 11.2$ kg/h → 6 kg/h × 3unit (1 for spare)

[Post-chlorination]=[total chloride]－[Pre-chlorination＋mid-chlorination]

$38{,}500 m^3/day \times 10 g/m^3 \div 24 h/day = 16$ kg/h

16 kg/h－6 kg/h × 2unit＝4 kg→2 kg/h × 2unit

ii) Aluminium Sulphate Dozing Facility

The existing water treatment plants in Sharqiya Governorate widely employ solid phase aluminium sulphate as a coagulant.

To secure stable supply of the coagulate chemical, the project picks up the same material. It is considered to use liquid phase aluminium sulphate in the future. Therefore, the facility can adopt both solid and liquid phase of aluminium sulphate and the dozing pump is shared. Dozing method is dissolving solid + chemical store + dozing.

a) Design Water Flow

Chemical mixing basin: 38,500 m^3/day

b) Capacity

Supply equipment

A liquid phase aluminium sulphate supply pump supplies alum to chemical sedimentation basin.

The result of jar test shows the consumed quantity of 8% liquid phase alum is 20 to 40 mg/L,

Quantity＝38,500m^3/day × 20～40g/m^3 (8% alum) ＝770～1,540kg/day (8% alum)

Thus, the amount of Al_2O_3 is,

$$Al_2O_3 = 770 \sim 1{,}540 \text{kg/day} \times 0.08$$
$$= 61.6 \sim 123.2 \text{kg} Al_2O_3\text{/day}$$

If this is made of x kg of solid phase alum (Al_2O_3 14%wt) dissolved,

$$x \text{ kg/day (14\% alum)} \times 0.14 = 61.6 \sim 123.2 \text{ kg } Al_2O_3\text{/day}$$

$$\therefore \quad x = 440 \sim 880 \text{ kg (14\% Alum)/Day}$$

To make 8% liquid phase alum from 14% solid phase alum (440 to 880 kg), the quantity of water quantity w kg/day is as followings.

$$\frac{440 \sim 880\text{kg} \times 0.14}{w + 440 \sim 880\text{kg}} = 0.08 \quad \rightarrow \quad w = 330 \sim 660 \text{ kg/day}$$

Therefore, as specific gravity of 8% liquid alum is 1.315, the quantity to be applied in the chemical sedimentation basin is;

$$((440 \sim 880) + (330 \sim 660)) \quad = 770 \sim 1{,}540 \text{kg/day}$$
$$= 586 \sim 1{,}171 \text{ L/day}$$
$$= 24.4 \sim 48.8 \text{ L/h}$$

The capacity of supply is 100 L/h allowing clearance of approx. 200% for corresponding to water quality. The specification of liquid aluminium sulphate is as the followings.

Type	:	Chemical Dozing Pump
Capacity	:	100 L/h
Number	:	2 units (1 for stand-by)

Storage Facility

The followings are the storage facility for alum.

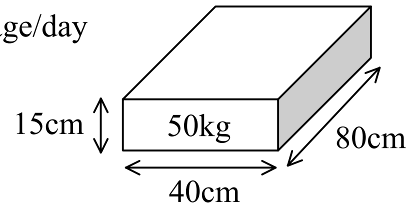
- Solid aluminium sulphate dissolving tank
- Liquid aluminium sulphate transmission pump
- Aluminium sulphate storage tank

The followings are the assumption that solid aluminium sulphate is stored for 20 days. The consumption of alum per day is assumed as 440 to 880 kg, one package contains 50 kg,

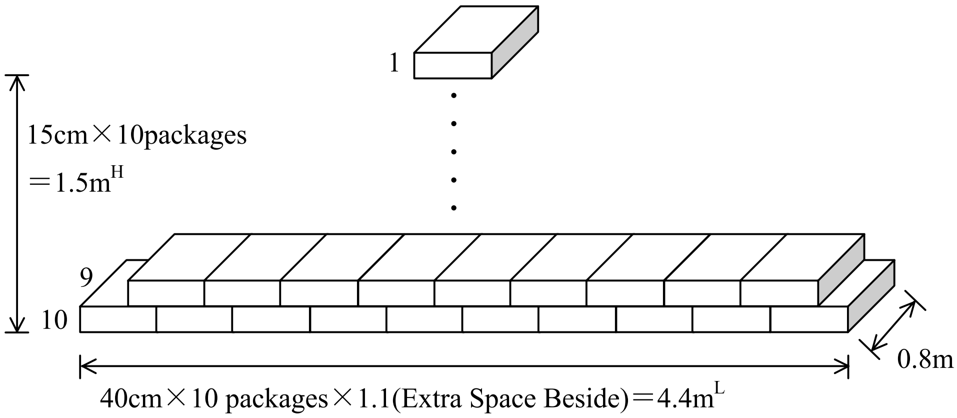
$440 \sim 880$ kg/day $\div$ 50 kg/package $= 8.8 \sim 17.6$ package/day

If stored for 20 days,

$8.8 \sim 17.6$ package/day $\times$ 20day $= 160 \sim 320$ package



If one package is assumed as the figure



If $(10+9+8+7+6+5+4+3+2+1) = 55$ packages are placed in $0.8\text{mm}^{H} \times 4.4\text{m}^{L} \times 1.5\text{m}^{H}$ of open space with 3 lines,

$0.8\text{m}^{W} \times 3 \times 1.1$ (extra space beside) $= 2.64\text{m}^{W}$

If 440 kg is chosen、55 package $\times$ 3 line $=$ 165 package $>$ 160 packages in $2.64\text{mm}^{W} \times 4.4\text{m}^{L} \times 1.5\text{m}^{H}$ open space

If 880 kg is chosen, 55 package $\times$ 6 line $=$ 330 package $>$ 320 package in $5.28\text{mm}^{W} \times 4.4\text{m}^{L} \times 1.5\text{m}^{H}$ open space

Therefore, the chemical dozing house is designed to have enough room for $6\text{m}^{W} \times 5\text{m}^{L}$ alum storage space and working space, conveyance line for lorry and transmission line for the dissolving tank. The total of alum for 30 days use shall be stored (solid status or in package for 20 days and liquid phase in the storage tank for 10 days)

If liquid phase alum is used in the future, it is anticipated to deal 7% aluminium sulphate for storing and dozing. As the calculation above, the quantity used in a day X kg is;

$61.6 \sim 123.2\ kgAl_2O_3/day = X\ \ kg/day \times 0.07$

$X = 880 \sim 1{,}760\ kg/day$

$= \dfrac{880 \sim 1760}{1.265}$ L/day (specific gravity 1.265)

$= 696 \sim 1{,}391 L/day$

If stored period is 10 days, the volume of the storage tank is

$696 \sim 1{,}391 L/day \times 10 day = 6{,}960 \sim 13{,}910 L/day \rightarrow 7 \sim 14 m^3$

If stored period is 20 days, the volume of the tank is

$696 \sim 1{,}391 L/day \times 20 day = 13{,}920 \sim 27{,}820 L/day \rightarrow 14 \sim 28 m^3$

Therefore, the capacity of the storage tank is determined as 14 m^3.

Liquid aluminium sulphate storage tank

Type	:	FRP tank
Capacity	:	14 m^3
Number	:	1 unit

Aluminium sulphate dissolving tank

Type	:	FRP tank (with mixer)
Capacity	:	4 m^3
Number	:	2 units

Liquid aluminium sulphate transmission pump

Type	:	Chemical dozing pump
Capacity	:	350 L/h Assume the tank is emptied in a half day. $\frac{4m^3}{12h} = 333L/h \rightarrow 350L/h$
Number	:	2 units (1 for stand-by)

iii) Chlorine Gas Leak Neutralization Equipment

Chlorine gas leak neutralization equipment is installed for safety reason and the capacity of it is determined from the size of chlorine feeding equipment room and the volume of chlorine gas cylinder. The assumption of leakage is that 1 cylinder with 1 t (1,000 kg) of the gas leaks for 1 hour. Therefore, the capacity of the neutralization equipment is 1,000 kg/h. Once a detector perceives leakage of chlorine gas, it issues warning and automatically starts Chlorine gas leak neutralization equipment.

7) Sludge Treatment Facility (SWP-22 to 27)

Sludge treatment facility consists of drainage tank, sludge tank, sludge thickener and sludge drying bed. The role and specification of each facility are as the followings.

i) Drainage Tank

The role of the equipment is to buffer the load of concentration and quality of sludge in sludge treatment facility because washing drainage requires a significant amount of washing water within a short time. Drainage tank receives drainage of surface washing and back flush water. The drain is separated into solid and liquid. The upper clear layer is returned into receiving well for effective use of water resources.

Type	:	Reinforce Steer Concrete Tank
Size	:	$12m^W$ x $8.5m^L$ x $4m^D$
Capacity	:	408 m^3
Number	:	2 units

a) Design Water Flow

The facility receives drainage primarily from filtration basin.

Designed flow at filtration＝37,500m^3/day

b) Capacity

Capacity $\boxed{\text{More than 1 cycle of filtration (Japanese Standard)}}$

Water volume per 1 cycle of washing

Surface washing: 0.2m/min×5min×40m^2＝40m^3/cycle

Back flush: 0.6m/min×5min×40m^2＝120m^3/cycle

Size of the filtration basin(*)

$$= \{(\text{maximum depth}+10{,}320)-(\text{height of trough}+6{,}320)\} \times 5.7\ m^L \times 7\ m^W$$
$$+ \{(\text{height of trough}+6{,}320)-(\text{basin bottom}+2{,}920)\} \times 1.2m^L \times 7\ m^W$$
$$=160+29$$
$$=189m^3\ (*)$$

Washing water per cycle＝40+120+189＝349m^3

(*) HHWL is applied for calculating the size.

$$\frac{8.5m^W \times 12m^L \times 4m^D \times 2\text{basin}}{349m^3} = 2.4\text{cycle}\ (**) > \text{more than 1 cycle} \rightarrow \text{OK}$$

(**) All drainage pours into this drainage tank. Thus, with the supernatant of the drying bed (6m×23.5m×$1m^D$/basin) taken into account, more than 2 cycles are considered.

ii) Sludge Tank

Type	:	Reinforce concrete tank
Size	;	7 m^W x 4 m^L x 4 m^D
Capacity	:	112 m^3
Number	:	2 units

a) Design Water Flow

The tank primarily receives sludge from chemical sedimentation basin.

Design water flow in chemical sedimentation basin = 38,500 m^3/day

b) Capacity $\boxed{\text{More than 1 day (Japanese standard)}}$

Sludge emitted more than 2 days

Emitted solid volume	1,035 kg-ds/day <refer to 9) Design water supply and Design water Flow for Each Equipment>
Sludge Sediment Concentration	1 % (10 kg-ds/m^3)
Withdrawn Sludge	1,035÷10＝103.5m^3/day
	112m^3×2 unit＝224m^3
	$\frac{224m^3}{103.5m^3/day}$ ＝2.2day＞2day → OK

iii) Sludge Thickener Tank

This tank reduces the sludge volume with thickening the sludge concentration by gravity.

Type	:	Reinforce concrete tank (with scraper)
Size	;	7 m^W x 7 m^L x 4 m^D (circle shape φ7m)
Area	:	308 m^2
Number	:	2 basins

a) Design Water Flow

This tank receives discharging sludge from discharging sludge tank.

The discharging sludge tank receives sludge from sedimentation basin and the capacity is 38,500 m^3/day

b) Capacity

<u>Solid Load</u> $\boxed{\text{10～20kg-ds/m}^2\text{・day (Japan)}}$

Solid volume generated 1,035 kg-ds/day

$$\text{Area} = (\frac{7}{2})^2 \pi \times 2Ba \sin s = 77.0m^3$$

1,035 kg-ds/day÷(10～20kg-ds/m^2・day)=51.5～103.5m^3/day

∴$51.5m^2 < 77.0\ m^2$→OK

<u>Effective Depth</u> $\boxed{\text{3.5～4m (Japan)}}$

4m

Therefore, Capacity=$\left(\frac{7}{2}\right)^2 \pi \times 4m \times 2Ba\sin s = 308m^3$

iv) Drying Bed

Sludge after sludge thickener tank is dehydrated up to 60% of moisture content by drying with solar heat and wind after separation of clear water layer and decrease in moisture content of sludge with filtering.

Method: Drying Bed
Size: 23.5m^W x 6m^L(Effective length) x 8 basins
Area: 1,128 m^2
Quantity: 1 Unit

The dried sludge is transferred and treated at an existing landfill site which locates near Ahammed Orabby Street (approx. 3 km east from the project site).

<u>Capacity</u>

Generating Solid Volume: 1,035 kg-ds/d <refer to 9) Intake and chemical sedimentation>

The tank is assumed to thicken the concentration up to 3%. The unit solid volume is

1,000 x 0.03 = 30kg-ds/m^3

If the height is 1 m as the figure on the right,

30 x 1.0 = 30kg-ds/m^2

The area is determined from the value in winter when less dryness.

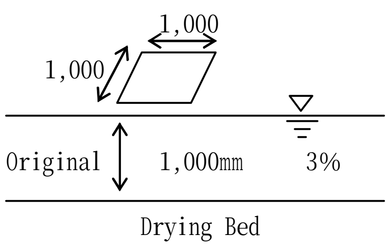


Table 2.14 shows the required area, which is derived from the required area for drying bed in summer in Japan and actual evaporation data in Egypt.

Table 2.14 Required Area for Drying Bed

	Characteristics of Dryness in Japan and Required area				Egyptian Data and Required Area		
Moisture Content After Dehydration	Season	Evaporation	Period	Required Area（A）	Season	Evaporation	**Required Area A×4/4.4**
70 %	Summer	4mm/d	12days	$1035kg\text{-}ds/30kg\text{-}ds/m^2 \times 12day = 414m^2$	Winter	4.4mm/d	**$376m^2$**
60 %	Summer	4mm/d	23days	$1035kg\text{-}ds/30kg\text{-}ds/m^2 \times 23day = 794m^2$	Winter	4.4mm/d	**$722m^2$**
50 %	Summer	4mm/d	35days	$1035kg\text{-}ds/30kg\text{-}ds/m^2 \times 35day = 1208m^2$	Winter	4.4mm/d	**$1098m^2$**

The average evaporation in summer (June to August) in Japan is approximately 4 mm/day. Actual data in Egypt in 2001 shows that December has the lowest evaporation near the project site and the value is 4.4 mm/day, which is very similar to the one in summer in Japan.

It is assumed that the evaporation on meteorological data in Egypt and drying characteristics in summer in Japan is proportional. Japanese “Design Criteria for Waterworks Facilities” recommends sludge cake after drying should be dehydrated approximately 60% of moisture content for sludge transportation.

If the area for drying bed is assumed as $23.5m^w \times 6m^L \times 8unit = 1{,}128m^2$ and 2 units cease due to conveyance, the actual working area is determined as the following.

$$1{,}128m^2 \times \frac{6}{8} = 846m^2$$

Therefore, by contrasting to Table 2.14, moisture content of the dehydrated cake is approximately 57% and the approximate retention period for sludge is 27 days.

According to the data, the evaporation in summer in Egypt is 12.8 mm/day, which is 3 times larger than Japanese value. Thus it is expected to dry sludge at narrower area.

8) Treated Water Reservoir (SWP-28 to-30)

i) Facility

Treated water reservoir is a facility to adjust imbalance between the filtered and the peak transmission water volume and to store treated water for corresponding to the peak water demand.

There will be two basins in this facility. The volume of the stored water is calculated from the extent of the Project site, available depth (4 m below the ground level) and Egyptian Code (15 to 40% of designed water supply and 80% of fire extinguish water):

Type : Reinforced concrete underground tank
Size : $30m^W$ x $51m^L$ x $4m^D$
Capacity : $6{,}000m^3$(Effective Volume)
Number : 1 unit (2 basins)

ii) Reservoir Volume

a) Designed Flow
$35{,}000m^3$/day

b) Capacity
The following assumption and method is applied to calculate the volume of fire extinguish water.

Fire occurs in Hihya City where has the largest population in the Markaz. The fire is extinguished in 2 hours. The required water volume to extinguish fire is 60 m^3 per hour per 10,000 persons in the other area. No more than 2 fires occur simultaneously.

$$\text{Fire Extinguish Water} = 60m^3/h \times 2h \times \frac{\text{Population of Hihya City}}{10{,}000}$$
$$= 60 \times 2 \times \frac{47{,}550}{10{,}000}$$
$$= 571m^3$$

Therefore,
$$\text{Capacity of the reservoir} = 35{,}000m^3/day \times 0.15 + 571 \times 0.8$$
$$= 5.707 \quad \rightarrow \quad 6{,}000m^3$$

9) Design Water Supply and Design Water Flow for Each Equipment

Design water flow at each equipment is calculated from design water supply 35,000 m^3/day and a certain design margin for water consumption inside the plant (*e.g.* washing). Although the margin is determined in the Egyptian Code, Table 2.15 examines validity of each margin.

Table 2.15 Margin for Each Design Flow

Design water supply	$35{,}000m^3$/day	Nominal water supply Volume
Design intake flow	$35{,}000m^3 \times 1.1 = 38{,}500m^3$/day	Intake to sedimentation basin
Design treatment flow	$35{,}000m^3 \times 1.07 = 37{,}500m^3$/day	Rapid sand filter
Design transmission flow	$44{,}000m^3$/day	Taking into account the daily maximum

<u>Intake to Chemical Sedimentation Basin</u>

It is necessary to maintain the volume of the water more than 37,500 m^3/day after self-consumption at intake and chemical sedimentation basin. Self-consumption is the amount of water drained with sludge at the chemical sedimentation basin.

[Volume of generated solid]

$$= 38{,}500\text{m}^3/\text{day} \times \{1.1\ (\text{Turbidity Coefficient}) \times (\text{Designed Turbidity } 20 - \text{Treated Water Turbidity } 0^{*}) + 40\text{mg/L}\ (\text{Injection Rate}) \times 0.08\ (Al_2O_3\ \text{Concentration}) \times \frac{2\times 78\ (2Al(OH)_3\ \text{Molecular Weight})}{102\ (Al_2O_3\ \text{Molecular Weight})}\} \times 10^{-3}$$

= 1,035 kg-ds/day

If the concentration of sludge at the bottom of chemical sedimentation basin is 10 % (10 kg-ds/m^3), the volume of drainage is

$$1{,}035\ \text{kg-ds/day} \div 10\ \text{kg-ds/m}^3 = 103.5\text{m}^3/\text{day}$$

$$38{,}500\text{m}^3/\text{day} - 103.5\text{m}^3/\text{day} = 38{,}397\text{m}^3/\text{day} > 37{,}500\text{m}^3/\text{day} \rightarrow \text{OK}$$

<u>Filer Basin</u>

The volume of water after filtering needs to be more than 35,000 m^3/day after self-consumption at the basin.

Self-consumption means the amount of water used for washing sands of the basin and the volume is calculated as the following.

Size of Rapid Sand Filter basin (per basin) = {(Water Level of Treated Water Reservoir: +7,920) + (maximum daily water rise: +1,000mm/day (assumption))} - (height of trough +6,320) × 5.7m^L × 7m^W + {(height of trough: +6,320) − (bottom: +2,920)} × 1.2m^L × 7m^W
=104m^3 + 29m^3
=133m^3

Surface washing and back washing water (per basin) = (0.2m/min × 5min + 0.6m^3/min × 5min) × 40m^2
=160m^3

<u>Sub Total: 133 m^3 + 160 m^3 = 293 m^3 (per basin)</u>
<u>Total: 293 m^3/day × 10 basins = 2,930 m^3/day (10 basins)</u>

The volume receiving from the upper side is 38,397 m^3/day, therefore,

$$38{,}397\ \text{m}^3/\text{day} - 2{,}930\ \text{m}^3/\text{day} = 35{,}467\ \text{m}^3/\text{day} > 35{,}000\ \text{m}^3/\text{day} \rightarrow \text{OK}$$

If the sedimentation condition at the chemical sedimentation basin before filter back flushing is good, the load on filter basin reduces. Hence, the frequency of back flushing decreases (the calculation took once in a day, but becomes once in 2 days) or the maximum water level rise (+1,000 mm/day in assumption) becomes smaller and, therefore, the volume of back flushing water is reduced.

Because it is designed with the Egyptian standard, which takes safer values than the Japanese standard, the flow speed is as the followings.

10 basins	$38{,}397m^3/day \div 10baisn \div 40m^2/basin =$ 96m/day
8 basins	$38{,}397m^3/day \div$ 8basin $\div 40m^2/basin =$ 120m/day

These values are less than the Japanese standard (120 to 150 m/day). Due to the decrease in the surface load, the frequency of back flushing reduces.

If the sedimentation is not sufficient enough, the load on the filer basin increases. This may increase in the frequency of back flushing or the maximum daily water level rise. In such occasion, the settlement shall be adjusted with the volume of coagulate and chloride, and changing the rotation of the flocculator at the chemical sedimentation basin.

2.2.2.6 Water Transmission Pump Equipment

(1) Water Transmission Pump Controlling Function

The role of water transmission pump is generally stable supply of treated water to consumption reservoir in water transmission steer pipe. According to the Three Markaz M/P by NOPWASD, it is expected that water transmission pump at water treatment plant shall adjust the transmission volume depending on local water consumption demand. Therefore, the transmission volume is as the followings.

Average Treated Water	:	35,000 m^3/day
Variance	:	70% of the average treated water
Maximum Transmission Volume	:	44,000 m^3/day

(2) Transmission Pumping Head

NOPWASD set the pumping head as 80 m in the M/P because the target year is 2040. However, the necessary pumping head is 60 m with considering water transmission condition in 2010. If a pump is placed in 80 m pumping head, it will be required to introduce a pressure reduction facility in the water transmission network. As a consequence, significant energy will be lost during the transmission. Thus, the total pumping head for water transmission pump in the project shall be 60 m, which takes in account the exit pumping head as 52 m and low water level at treated water reservoir.

However, if the detail of the transmission mains are reviewed, it is judged that the significant transmission loss occurs at a certain area where the pipe diameter is small. This area has not been rehabilitated. If one size larger pipes are installed, approximately 12 m of pressure loss can be decreased. Therefore, it is recommended to enlarge the size of transmission pipes for the Project.

(3) Transmission Pump

As have been mentioned, it is necessary to adjust the volume of water transmission in correspond to water demand. With considering the pattern of pump operation, it is appropriate that maximum 3 pumps will be run for peak time plus one reservation pump. The design water supply volume is 44,000 m^3/day. Thus, the volume per pump is:

$$44{,}000\ (m^3/day)/3\ (unit) = 14{,}556\ (m^3/day) = 10.19\ (m^3/min)$$

<u>Pump Type</u>

The total pumping head of 60 m and the volume of 10.19 m^3/min indicates the capacity of volute pump. The Project employs double suction volute pump, which can divide casing with respect to easiness of maintenance.

Maximum Transmission Volume	:	44,000 m^3/day 30.56 m^3/min
Volume per Pump	:	10.19 m^3/min
Pumping Head	:	60 m
Output	:	Approx. 160 kW
Operation Range	:	80 – 110 %
Type	:	Horizontal Double Suction Volute Pump
NPSH	:	Approx. 4m

(4) Control of Pump Operation

The volume and pressure for water transmission are partially controlled by changing the number of running pumps in daily operation. However, the water distribution side is principally responsible for controlling the pressure inside water transmission system. Any system for controlling pressure in pipes will not be introduced for safety reason. It is recommended that the supervisor shall give suitable advice for changing the number of operating pumps.

(5) Counter Measure against Water Hammer

Water distribution network under the Project is borne by the Egyptian side and it will be gradually constructed for the target year of 2040. Therefore, the Egyptian side shall consider the issue of water hammer.

The Japanese side shall prepare slow closing valve at the exist of the water transmission pump for potential water hammer in case if the water transmission pump stops at electricity power off and so on. This shall be done for protecting the transmission pump.

2.2.2.7 Laboratory Equipment

Laboratory for water quality analysis is necessary to check the change in raw water quality and safety of treated water. The laboratory shall be installed in the central monitoring and administration building. The following items in Table 2.16 will be examined on daily basis. These items are the same as the other laboratories at water treatment plant in Sharqiya Governorate. These analytical parameters are basic items and if abnormal values are found, other university or commercial laboratories will conduct further precise analysis.

Table 2.16 Water Quality Analysis

Item	Test Method
Physical Analysis	
Colour	
Taste	
Odour	
Turbidity	Turbidity meter
Temperature	Thermometer
Chemical Analysis	
pH	pH Meter
Conductivity	Conductivity meter
Total Dissolved Solid	Evaporation
Chlorine	Chlorine ion meter
Total Alkalinity	Titration
Total Hardness	Titration
Calcium	Measuring Hardness (as $CaCO_3$)
Magnesium	Titration
Iron	Oxidation/Reduction Method
Manganese	Oxidation/Reduction Method
Biological Analysis	
Algae	Culture Test
Total *E. Coli*	Culture Test

Therefore, the following listed equipments are necessary to conduct the above test.

Table 2.17 shows the equipments required and the number installed under the Project.

Table 2.17 Laboratory Equipments

		Quantity	Purpose
1	Fridge	1	Pspare samples and chemicals
2	Balance (electric)	1	Weighing samples and chemicals
3	pH and Conductivity Meter with termometer	1	Measuring temperature, pH and conductivity
4	Turbidity Meter	1	Measuring turbidity
5	Chlorine Meter	1	Measuring chlorine (ion)
6	Hot Plate	1	Heating analyte and chemicals
7	Muffle Furnace	1	Heating analyte and chemicals with high temperature
8	Magnetic Stirrer	1	Stirring samples and chemicals with magnet
9	Auto Clave	1	Sterilization of equipments It is particularly important for biological analysis
10	Colony Counter	1	Counting bacterial and algae colony
11	Microscope (optical)	1	Observing bacterial colony
12	Thermostat Cultivator	1	Cultivating bacterial and algae colony
13	Hot Water Bath	1	Cultivating bacterial and algae colony Keeping samples and chemicals at stable temperature
14	Distilled Apparatus	1	Producing distilled water
15	Jar Tester	1	Jar test

Installation of Micro Kjeldahl system (analysis of nitrogen) was reqested in the early stage of the basic design study However, the result of raw water analysis for nitrate, nitrite and ammonia shows there is no nitrite concentration in treated water at Zagazig WTP. Therefore, there is little meaning to introduce this system and Kjeldahl system will not be installed.

Glass and plastic containers such as beaker and pipettes will be necessary to operate the listed equipment. Table 2.18 shows minimum required glass and plastic containers at the opening stage.

Table 2.18 Glass and Plastic Containers

Item	Quantity	Item	Quantity
Beaker		Volume Metric Cylinder (plastic)	
50 mL	3	100 mL	2
100 mL	3	1,000 mL	1
500 mL	3	Volume Metric Flask	
Burette		100 mL	3
50 mL	2	500 mL	1
Burette Stand	2	1,000 mL	1
Whole Pipette		Triangle Flask	
1 mL	1	500 mL	3
10 mL	2	Stainless Spoon	2
25 mL	2	Petri Dish	3
50 mL	2		
Rubber Syringe	3		

Equipments such gauze for algae analysis shall be prepared by Egypt except the ones for preliminary trial.

2.2.2.8 Operation Control Facility

Operation and control of each equipment in the water treatment plant principally shall be done manually, comparable to the other existing water treatment plants in Sharqiya Governorate.

The main electricity circuit is concentrated equipment by equipment and the operation board is placed closed to the equipment itself. This intends practicality of operation and adaptation to accidents.

Monitor and alarm board is placed in the operation monitoring room of the central monitoring and administration building. The water treatment system and operation condition of each equipment shall be displayed graphically. This enables that operators can easily grasp the operation condition of the whole facility. Especially for securing safety operation of raw water intake pump, the design of the facility takes account of monitoring the water level of inflow to the pump. There is space kept for installation of monitoring and alarm board for the future expansion in the same room.

Raw and treated water flow meters are installed. An integrated flow meter is placed in the monitoring and alarm board and corresponds to appropriate management of transmission volume. Although the existing water treatment plants in Sharqiya Governorate take the records of flow volume with their printed form, the data is not available due to luck of paper. To prevent the same situation, the output of the integrated flow volume is digitalised. The data is deal with the computer in the administrator’s room. The record is preserved with ordinary paper after printing out.

2.2.2.9 Power Receiving Equipment

(1) Power Receiving Equipment

The power supply to the project water treatment plant will be derived from the existing Hihya B distribution station with 10.5 kV 2 line power receiving type (10.5 kV, 50 Hz, regular and spare) of underground cable is applied.

The laying and connecting construction of this 10.5 kV distribution line between Hihya B switch facility and the new water treatment plant is in charge of the Egyptian work and NOPWASD shall consign the task to the subject electricity distribution company.

According to the rule of the subject electricity company, the end power factor shall be bigger than 0.9% and this value is applied in the Project.

The following articles are considered for designing because the power receiving equipment will be shared as a mutual facility in the future expansion.

- Location: The location of the equipment in the Project is selected with considering the future expansion and easiness of the future construction
- Expansion of switchboard: The self-standing cubicle type switchboard method is selected to allow the easy installation of additional switchboards in future for expansion. The bus bar of the switchboard of the Project should have sufficient capacity to meet the increased demand under the overall expansion plan.

(2) Transformer and other equipments

Switchboard for the transmission equipment is placed in the electricity room. The transformer is located outdoor adjacent to the electricity room. For avoiding direct lays, roof shall be set. Fence surrounding the equipment is necessary for safety reason.

The followings are the specification of the main equipment.

- Transformer: 10.5 kV/380-220V, 50Hz, Outdoor type Oil Injection Self-Cooling Type. 1,250 kVA (2 units, regular and spare)
- High Voltage Switchboard; Vacuum Breaker (VCB), Self-Closing switchboard type
- Low Voltage Switchboard Molded circuit breaker(MCB)

1,250 kVA for capacity of the power receiving transformer is selected because the total load is 1,100 (kVA) from the design load. Excessive decrease of voltage at peak hour of the transformer capacity is calculated from the following formula. The required transformer capacity of the subject transformer (1,250 kVA) for the excessive hours is 1,365 kVA from the design load. The decrease in voltage is 5.5%, which is within acceptable voltage drop level (10%). Therefore, 1,250 kVA is appropriate.

Decrease in voltage of transformer at peak hour

$$V_d = \frac{P}{P_n} \times \%Z = \frac{1365}{1250} \times 5 = 5.5(\%)$$

Where Pn : Standard transformer volume (1250 kVA)
%Z: Transformer impedance

(3) Wiring

Cable pits and cable racks shall be applied in the electricity room. Distribution lines are laid into cable pit and onto cable rack. Conduit tubes are used for the terminal section.

The following electricity system is applied due to the subject area’s electricity type.

High voltage:	10.5 kV, 3phase 3wire, 50 Hz
Low voltage:	380-220 V, 3phase 4wire, 50 Hz
Direct Current: (for control system)	DC 100 V

2.2.2.10 Emergency Generator

(1) Necessity of Emergency Generator Equipment

According to the subject electricity distribution company of the Project area, electricity cut off due to maintenance work of the city electricity distribution system occurs periodically once in a week and several decade minutes to 3 hours. SHEGAWASD claims there is voltage drop at peak electricity consumption hour between 7 and 10 pm (3 hours). NOPWASD puts an obligation to equip an emergency generation facility at each water treatment plant since the influence of local water treatment plant operation on the local inhabitant is significant and local electricity operation system is unstable.

It is deemed that the influence of ceasing operation of the new project plant on the local water supply is momentous because treated water in the subject are is supplied with pressure transmission system. Therefore, the emergency generator equipment, as a counter-measure for electricity cut off, shall be established in the Project.

The type of the emergency generator is a diesel engine similar to the other existing water treatment plants.

(2) Capacity of Emergency Generator

The regulation of NOPWASD stipulates the capacity of emergency generator equipment shall be more than 50% of the total load. This aims to continue minimum required water supply function at electricity cut-off.

The Project follows the NOPWASD regulation. The emergency generator purposes to transmit the minimum required water at electricity cut off. The necessary load for the emergency operation (such as transmission pump, chloride injector, chloride neutralization equipment) and necessary equipments for early recover from power failure are selected. The capacity of the generator is determined from the above process.

The capacity of the planned emergency generator is calculated on the basis of the following three formula in respect to the selected emergency operation load (approximately 50% of the total load). The largest capacity is employed in the Project.

1) Capacity of the total load under regular operation input: $P_{G1} = \dfrac{Po}{\eta \, x Pf}$

where P_{G1}: Generator output (kVA),
P_0: Sum of the total load output (kW)
η : Efficiency of load:
Pf: Power factor

2) Capacity of voltage decline at starting electric motor: $P_{G2} = Ps \times (\dfrac{1}{Vd} - 1) \times Xd'$

where P_{G2}: Generator output (kVA)
P_s: Plugging capacity (kVA)
Vd: Capable voltage drop (20 to 30% in general)
Xd': Horizontal shaft excessive reactance (20 to 30% in general)

3) Capacity of the instantaneous maximum load: $P_{G3} = \dfrac{\Sigma Wo + \{QLmax \times \cos\theta\, QL\}}{KG \times \cos\theta\, G}$

where P_{G3}: Generator output (kVA)
Σ Wo: Sum of the load during operation (kW)
Qlmax: Maximum starting rush load (kVA)
cos θ QL: Starting power factor of maximum starting rush load
KG: Overload capacity of generator (1.2 in general)
cos θ G: Generator power factor (0.8 in general)

Capacity of the Generator

The results of the calculation are as followings.

P_{G1} = 677 kVA
P_{G2} = 562 kVA
P_{G3} = 628 kVA

Therefore, the required generator capacity is more than 677 kVA and 700 kVA is chosen.

(3) Capacity of Fuel Tank

The fuel storage capacity for the emergency generator is determined from the frequency of electricity cut-off and the voltage variation occurrence.

As the frequency and the duration of electricity cut-off and voltage variation occurrence are once in a day and several decade minutes to 3 hours, the maximum value of 3 hours in a day is taken for the following formula to calculate the capacity.

Generator Capacity (kVA)x Fuel Consumption (0.25 L/hr・kVA) x 3 hours x 14days

= Required Capacity (L)

700 x 0.25 x 3 x 14 = 7,350L

Therefore, the tank capacity is determined as 8 m^3.

Outdoor type underground tank is applied in the Project.

(4) Type of the Emergency Generator Equipment

The followings show the specifications of the emergency generator equipment.

Capacity	:	700 kVA, Indoor type
Number	:	1 unit
Power system	:	3 phase, 4 wire, 50 Hz, 380-220V
Starting method	:	Battery assisted manual start
Fuel	:	Diesel Oil
Daily tank capacity	:	For 3 hours (cut off in a day), 0.6 m^3
Fuel storage tank capacity	:	For 2 weeks, 8 hours
Room ventilation capacity	:	Ventilation capacity satisfying the necessity air for the Diesel engine and the capable keeping room temperature (40℃ when outside temperature is 30℃) 1,418 m^3/min (ventilation:188 times per hour)

2.2.2.11 Civil Works and Building Construction

(1) Content

Civil engineering and building construction works are as the followings.

- Buildings	:	• Central Monitoring and Administration Building • Raw Water Pump and Transmission Pump House (including Electricity Room) • Chemical Dozing House • Rapid sand Filter Operation Building
- Building equipments	:	Lighting, ventilation, air condition, fire alarm, sanitary equipments *etc.*
- Road inside the plant		
- Drainage facility in the plant		

(2) Facility Layout Plan

The civil engineering works and facility layout plan is as shown in Basic Design Drawing SWP-01.

(3) Content of the Facility

Civil engineering work and building planning are drawn up regarding the most suitable layout for that the water treatment plant constructed in the project shows its full function and ability. Additionally, Selection of materials for constructing each facility is designed with considering availability in Egypt, work schedule, future maintenance and endurance. The content of each facility is described below.

1) Central Monitoring and Administration Building

i) Main specification

Foundation:	:	Direct foundation
Structure	:	Reinforced concrete, 2 stories
Floor	:	Reinforced concrete + Terrazzo tile (Partially anti-dust paint and ceramic tile)
Partition	:	Concrete block
Outside wall	:	Brick
Construction material	:	Aluminium or steel
Land area	:	30.0m x 16.0m = 480m^2
Other	:	An outside ladder to the roof

ii) Names of main rooms and area

The names of main rooms, area, building equipments are shown as Table 2.19.

Table 2.19 Equipments in the Central Monitoring and Administration Building

Floor	Name	Area (m^3)	Equipment
GF	Lobby, Corridor	108	Light, Alarm
	Laboratory	72	Light, Ventilation, Air condition, Alarm
	Engineer Room 1	48	Light, Ventilation, Alarm
	Engineer Room 2	48	Light, Ventilation, Alarm
	Storage 1	36	Light, Ventilation, Alarm
	Storage 2 & Workshop	120	Light, Ventilation, Alarm
	Toilet and hot water supply room	48	Toilet, Light, Ventilation, Alarm
1F	Stair and corridor	96	Light, Alarm
	Manager Room	36	Light, Ventilation, Air condition, Alarm
	Monitoring Room	72	Light, Ventilation, Air condition, Alarm
	Computer Room	36	Light, Ventilation, Air condition, Alarm
	General Affair Office	96	Light, Ventilation, Air condition, Alarm
	Conference Room	96	Light, Ventilation, Air condition, Alarm
	Toilet and hot water supply room	48	Toilet, Light, Ventilation, Alarm
Total		960	

iii) Building Equipment

Light equipment	:	JIS illumination standard is applied. Principally fluorescent or mercury light
Ventilation equipment	:	Natural ventilation with fan or ventlouver
Air conditioning equipment	:	Package type air conditioner
Alarm equipment	:	Each room shall equip smoke detector

2) Chemical Dozing House

i) Main Specification

Foundation:	:	Direct foundation
Structure	:	Reinforced concrete, 2 stories

Floor	:	Reinforced concrete + anti-dust paint (Partially ceramic tile)
Partition	:	Concrete block
Outside wall	:	Brick
Construction fittings	:	Aluminium or steel
Land area	:	23.65mm x 14.80m = 350m^2
Other	:	An outside ladder to the roof

ii) Building Equipment

Lighting	:	JIS illumination standard is applied. Principally fluorescent or mercury light
Ventilation	:	Natural ventilation with fan or ventlouver Cylinder room shall be forcibly exhausted
Alarm	:	Each room shall equip photoelectric smoke detector

3) Raw Water Pump and Transmission Pump House

i) Main Specification

Foundation:	:	Direct foundation
Structure	:	Reinforced concrete, 2 stories
Floor	:	Reinforced concrete Reinforced concrete + Anti-dust paint
Partition	:	Concrete block
Outside wall	:	Brick
Construction fittings	:	Aluminium or steel
Land area	:	16.70mm x 54.55m = 911m^2 (including electricity room 16.70 x 17.65m = 295m^2)
Other	:	An outside ladder to the roof

ii) Building Equipment

Name	Area (m^3)	Equipment
Pump Room	616	Lighting
Electricity Room	209	Lighting, ventilation, alarm (fire alarm), sun shade for transformer, fan type ventilation on the wall
Generator Room	70	Outdoor roof fan, ventflouver x 1 Fuel tank for DEG (8 m^3) Roof fun x 3
Total	895	

Lighting	:	JIS illumination standard is applied. Principally fluorescent or mercury light
Ventilation	:	Natural ventilation with fan or ventlouver Exhaustion fan will be installed for the roof of DEG room
Alarm	:	Each room shall equip photoelectric smoke detector

4) Rapid Sand Filter Administration Building

i) Main Specification

Foundation:	:	Direct foundation
Structure	:	Reinforced concrete, 2 stories
Floor	:	Reinforced concrete
		Reinforced concrete + anti-dust paint
Outside wall	:	Brick
Construction fittings	:	Aluminium or steel
Floor area	:	10.30m x 38.65m = 398.10m^2

ii) Building Equipment

Lighting	:	JIS illumination standard is applied. Principally fluorescent or mercury light
Ventilation	:	Natural ventilation with fan or ventlouver

5) External Works for the Plant

i) Internal Road of the Plant

Internal road of the plant for the operation and maintenance vehicles shall be prepared in the shape of rounding from the entrance to each facility. The road shall be made of asphalt and equip crossfall with considering drainage of rainfall. The road shall be designed with regarding parking space, too.

ii) Outdoor Lighting

The Egyptian side bear on the preparation of outdoor lighting for maintenance and inspection works and necessary for lighting of the road.

iii) Drainage Appliance

The following drainage appliance for rainfall, sewage and domestic water from the administration building and mosque shall be prepared.

- Rainfall: There is extremely little rainfall in the Project area (6mm in 2002). Therefore, the rainwater shall be naturally drained by the crossfall and penetrate into the ground.
- Sewage and domestic water from office, mosque, *etc*.: Septic tank shall be prepared at the central monitoring and administration unit. The Egyptian side shall bear the treatment after the septic tank.

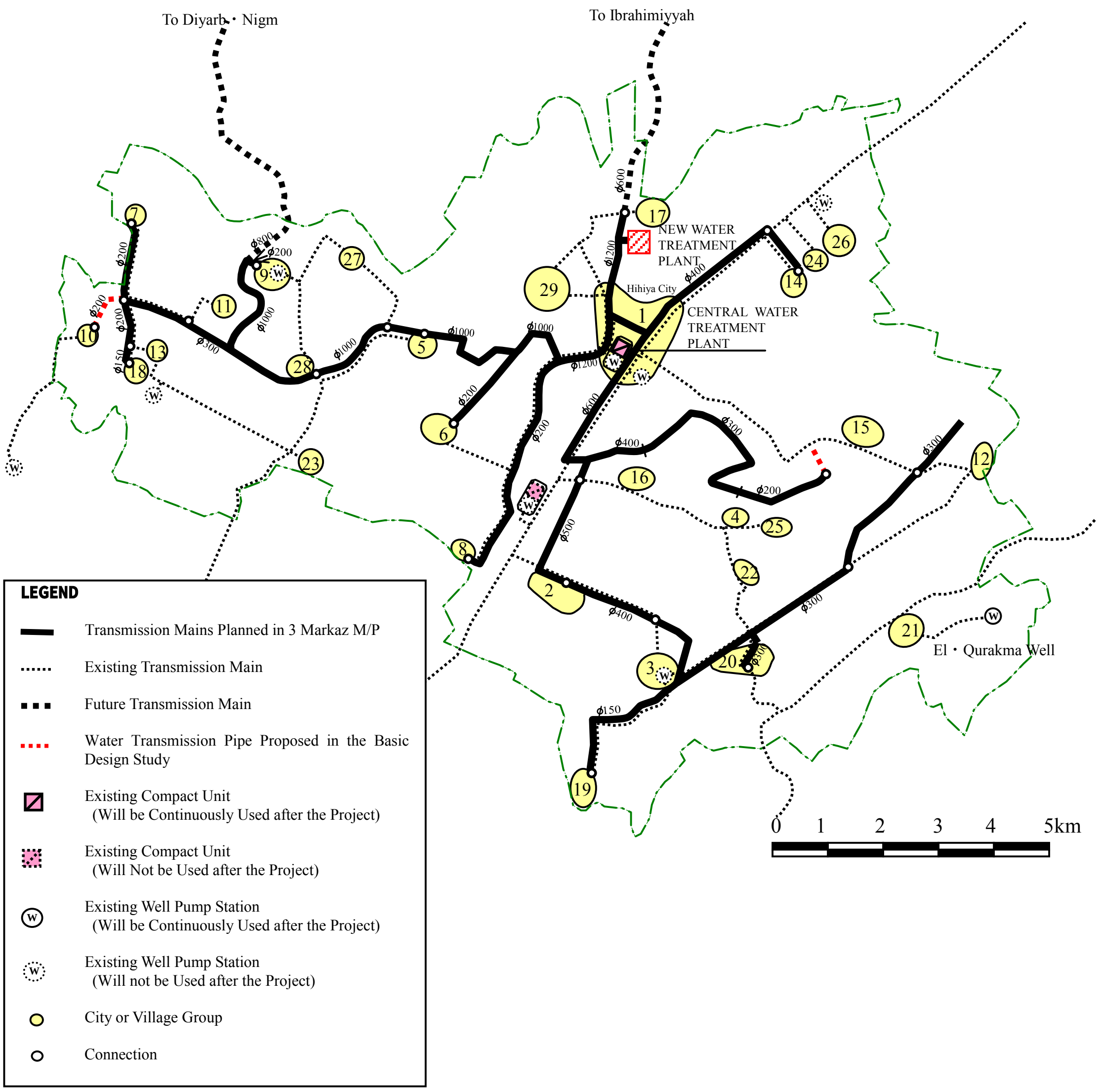
2.2.2.12 Transmission Mains and Distribution Lines

For supplying safe and stable treated water to the subject area, it is important to expand and rehabilitate the transmission mains and secondary branches for Hihya City and the other 28 villages of the water supply area.

NOPWASD has had a plan to establish transmission main system for 2040. This national water authority will be in charge for construction of water transmission mains for covering the water supply area in parallel to the implementation of the Project. According to the NOPWASD's plan, reservoir and a pressure adjusting facility for utilizing the existing compaction unit is necessary for stable water supply are necessary.

A certain degree of water transmission mains have been already established through Hihya Markaz (Hihya city and the 28 villages) and the water served population is 90%. SHEGAWASD will conduct expansion and rehabilitation of distribution networks during implementation of the Project.

Figure 2.2 shows the transmission mains and the water supply coverage area of the water treatment facility constructed in the Project.



Village Group of List

No.	Village group name	No.	Village group name	No.	Village group name
1	Hihiya City	11	Kafr El Ayed	21	El Ala mah
2	El Adwah	12	El Salamoun	22	Ezabat El Musallami
3	El Awasgah	13	El Mahmoudia	23	Khulwat Abu Hatab
4	El Zarzamoun	14	El Mutawaa	24	Sharshimah
5	El Ihsaniyah	15	Hoad Negeih	25	El Fawaqsa
6	El Shabraween	16	Subeih	26	El Skakrah
7	Kafr El Sheikh El Zawahri	17	Kafr Abu Hatab	27	Ezzbat El Khudari
8	Kafr Awlad Attiyah	18	Kafr Al Mahmoudia	28	Kafr Dabous
9	Manzel Hayan	19	Kafr Hammoudah Amaat	29	Mahdiyah
10	Munshaat Ghali Mansour	20	Kafr Agiba		

Figure 2.2 Water Supply Facility in Hihya Markaz

2.2.2.13 Operation and Maintenance Equipment

SHEGAWASD is required to appropriately operate and maintain the plant constructed in the Project. However, the financial status of SHEGAWASD indicates the organization is not ready to prepare the necessary equipments immediately. Hence, the Project includes the following categories under the Japanese cooperation owing to the following reasons and assists the implementation of suitable operation and maintenance by SHEGAWASD.

- Spare parts for water treatment plant equipment
- Maintenance tools for water treatment plant equipment
- Water quality analysis equipment
- Operation equipment for water treatment plant

(1) Spare Parts for Water Treatment Plant Equipment

The facility constructed in the Project is composed of civil/building construction and various mechanical and electrical equipments. It is hard to procure the import-required mechanical and electrical equipments immediately when repair for maintenance and faults are necessary. Therefore, it is important to procure the following spare parts with construction of the plant and swift repairs.

i) Consumable items:	Consumable items required after a certain period	:1 set
ii) Emergency Spare Parts:	Parts which are necessary for emergency repair without ceasing the operation of the facility	:1 set

It is demanded that SHEGAWASD deliberately purchase and keep the spare parts by the organization's self-effort. However, it is difficult for SHEGAWASD to list up necessary spare parts and lay a contemplating purchase plan before the utilization of the facility. Therefore, the spare parts procurement necessary at the start of the facility operation is included in the Japanese cooperation. SHEGAWASD will utilize these prepared spare parts. Meanwhile, it is expected that SHEGAWASD will establish a plan for purchasing spare parts and an implementing structure for contemplating purchase of goods.

1) Consumable Items

It is considered that parts of the plant are necessarily changed every 2 years. Table 2.20 shows the parts and consumable items required to replace within the first 2 years after starting operation of the plant. To support SHEGAWASD promoting to lay a spare part purchase plan by its own effort, the project shall include the consumable items in Table 2.20 for the first 2 years. These goods will be procured at the same time of construction works as consumable items.

Table 2.20 List for Consumable Items

Facility/Equipment	Spare Parts to be procured	Quantity	Note
Pump Group A	Gland Packing, Gasket	Twice x No. Pump	
	Sleeve	Once x No. Pump	Raw Water and transmission pumps
	Liner Ring	Once x No. Pump	Raw Water pump only
Pump Group B	Mechanical Seal, Gasket	Once x No. Pump	
Pump Group C	Diaphragm, Packing, Gasket	Once x No. Pump	
Filter basin surface washing device	Nozzle	10% of active No.	
Chlorine injector	Packing etc.	Once x No. Equipment	
Cl gas detector	Electrolyte (500ml)	10 units	
Emergency Generator	Generator Filter/Element *etc.*	Once x No. Equipment	
	Fuel Tank Filter	Once x No. Equipment	

Note:

Pump Group A: Raw Water pump, Transmission pump, Chlorination equipment booster pump, Sludge drain pump for sedimentation basin, Sludge drain pump for sludge thickener tank.

Pump Group B: Floor drain pump, Rapid sand filter surface washing pump, Drainage pump for drainage tank, Back sending pump for drainage tank, Sludge drain pump for sludge drain basin, Caustic soda pump, Waste chemical drain pump for chemical dozing house.

Pump Group C: Aluminium sulphate transfer pump, aluminium sulphate supply pump

2) Emergency Spare Parts

To prevent ceasing the treatment plant operation for a long time when fault occurs, it is necessary to permanently prepare those parts, which are easily damaged and significantly effects on the operation of the facility. The goods, which are minimum required spare parts and introduced in the Japanese Cooperation scheme, are shown in Table 2.21. These equipments will be procured with facility construction. SHEGAWASD shall make a necessary budget for preparing the necessary parts regularly after using the procured spare parts.

Table 2.21 Emergency Spare Parts

Facility/Equipment	Spare Part to be procured	Quantity	Note
Equipment Group A	Compound gauge	For each Pump	
Equipment Group B	Control device (0.2. 0.4 and 0.75 kw)	1 unit per each	
	Switch (0.2. 0.4 and 0.75 kw)	2 unit per each	
Slow closing check Valve	Non-transmission detector, connection protection relay	1	
Sludge collector for chemical sedimentation basin	Piece of all chain used for repair	8 pieces/chain type	2 repair/ all units
	Flight	4 Sets	1 pair for repair/ all units
Inflow gate for drainage tank	Electricity Operation Equipment	1 unit	
	Switch	2 units	1 replace per all units

Table 2.21 Emergency Spare Parts (Cont.)

Facility/Equipment	Spare Part to be procured	Quantity	Note
Chemical dozing house equipment	Chlorine injector vacuum adjusting device	For each unit	
	Chlorine injector eject device	For each unit	
	Chlorine injector flow meter	For each unit	
	Chlorine container weight load cell	1	
	Chlorine container weight indicator (meter)	1	
	Chlorine cylinder valve	4 cylinders	
	Chlorine emergency shut down valve	1	
	Pressure meter with alarm indicator for chloride gas	For 1 unit	
	Globe valve for chloride gas	4	
	Chlorine neutralization tower manometer	For 1unit	
	Caustic soda pump coupling	For 1 unit	
	Chlorine gas detector sensor unit	For 1 unit	
	Exhaustion fan V belt	For 2 units	
	Exhaustion fan anti vibration rubber	For 1 unit	
	Exhaustion fan suction pressure meter	For 1 unit	
	Exhaustion fan wind speed meter with thermic ray	For 1 unit	
	Caustic Soda flow meter for indoor pipe	2	
	Strainer for indoor pipe（PVC40A）	2	
	Strainer for indoor pipe（PVC25A）	1	
	Regulating valve for indoor pipe	2	
	Back pressure regulating valve for indoor pipe	1	
	Accumulator for indoor pipe	2	
	Diaphragm for indoor pipe (PVC40A)	4	
	Diaphragm for indoor pipe (PVC25A)	9	
	Diaphragm for indoor pipe (PVC15A)	3	
Equipment in electricity room	High-tension board lump	1 set (100%)	1 replace per each unit
	Low-tension board lump	1 set (100%)	1 replace per each unit
	Low voltage board fuse	1 set (100%)	1 replace per each unit
Emergency generator	Fan belt	For 1 unit	
	Belt for generator	For 1 unit	
	Nozzle tip	For 1 unit	
	Starter switch	For 1 unit	
	Baffle meter	For 1 unit	
	Register	For 1 unit	
	Overhaul gasket kit	For 1 unit	
	Suction valve	For 1 unit	
	Exhaustion valve	For 1 unit	
	Automatic voltage baffler	1 unit	

Note:

Equipment Group A: Raw water pump, Transmission pump, Each floor drain pump, Chloride equipment water pressure booster pump. Sludge drain pump for sedimentation basin, Back sending pump for drain tank, Sludge drain pump for drainage tank, Sludge drain pump for sludge drain tank, Sludge drain pump for sludge thickener tank, Chlorine cylinder, Aluminium sulphate transmission pump, Aluminium sulphate supply pump, Caustic soda pump, Chemical drainage pump for injection

Equipment Group B: Sludge drain valve for chemical sedimentation basin, Inflow valve for filtration basin, Surface washing valve for rapid sand filter, Drain valve for rapid sand filter, Inflow gate for drainage tank

(2) Maintenance Tools for Water Treatment Plant Equipment

Various mechanical and electrical equipments will be installed for construction of the plant. Daily maintenance and repair for any faults are necessary. Tools and each measurement equipments are required for the maintenance and repair. The water treatment plant shall regularly equip these tools.

These tools are necessary not only for maintenance and repair but also for installation of the mechanical equipments. Therefore, these tools for maintenance and repair works are procured with the construction of the water treatment plant. The tools will be utilized as regularly equipped tools after implementation of the plant.

Under the Project, the procurement of these tools shall be covered within Japanese Cooperation scheme and will be procured with facility construction (Table 2.22).

Table 2.22 List of Maintenance Tools

No.	Item		Specification	Quantity
1	Mechanical tools	General tool	Spanner, Wrench etc.	1 set
3	Handicraft tool	Electric screw cutter	15A～80A	1
4		Electric drill (body)	Portable	1
5		Electric drill (tooth)	1mm～13mm	1set
6	Oil Injection tool	Grease Gun	200cc	1
7	Measurement Tool	Dial Gage	Accuracy 0.01mm with stand	1
8		Thickness gage	100mm, 0.03～1.00	1
9		Slide caliper	Depth over 100mm	1
10		Clump Meter	AC600A, AC600V	1
11		Tester	Dandy type	1
12		Insulation Register	Dandy type	1
13		Vibrometer	Dandy type	1
14		Noise Level Meter	Dandy type	1
15		Rotation Meter	Dandy type	1
16		Thermometer	0～100℃	10

(3) Water Quality Analytical Equipment

For the quality control of treated water as a product of the facility constructed and management of treatment process, water quality analysis is a must. Thus, analytical instrument shall be installed in the plant. Water quality analytical instruments will be immediately utilize after implementation of the works including trial runs.

Therefore, analytical instruments will be used for the chemical examination and trial operation. The analytical instruments, which are listed in Table 2.17 and Table 2.18 for minimum water quality management, are procured within Japanese Cooperation. It is required to complete procurement work of the instruments before the plant's trial operation.

(4) Equipment for Water Treatment Plant Operation

Management of water treatment plant is constituted with various management process of capital, work, safety, *etc*. and suitable enforcement of all management process is required. Among the management process, the following process needs exclusive equipments.

- Transmitted water data management
- Appropriate sludge treatment after drying

The Japanese Cooperation covers the following equipment procurement, which shall be regularly equipped at the new treatment water plant as treatment plant management tool.

i) Personal Computer	:	For transmission data management	1 set
ii) Tractor Shovel	:	For loading dried sludge onto trucks	1

1) Personal Computer

A set of personal computer is necessary to collect the transmission and other data and to carry on operation condition management. This equipment is needed for trial run and operation and preservation of the plant. Thus, the procurement of computer is included in the Japanese Cooperation and the computer shall be prepared before the trial operation. Procurement content for the minimum required component for operation management is as shown in Table 2.23.

Table 2.23 Content of PC

No	Item	Specification	Quantity
1	Personal Computer	Desk top, Windows XP(English)、Ward process and spreadsheet software（Arabic）、Key board (Arabic shall be available)	1set
2	Display	CRT or TFT, 17inch	1
3	Printer	Ink Calour Jet、A3 available	1
4	Spare printer cartridge	For the printer above, Colour and Black	Each 10
5	Printer Cable	USB、For the above equipments	1

2) Tractor Shovel

For carrying out the dried sludge periodically, it is necessary for the water treatment plant constructed to prepare sludge loading and conveying equipments. SHEGAWASD has not had experience with appropriate sludge treatment. Therefore, promotion of suitable sludge conveyance is necessary. From the condition of local transportation machinery, sludge occurrence volume, *etc*., the project procure tractor shovel as shown in Table 2.24. This equipment is needed for trial run and operation and preservation of the facility. Thus, the procurement of the tractor shovel is included in the Japanese Cooperation and the machinery shall be prepared before the trial operation.

The spare parts are not included in the project since alternative tractor shovel can be procured in the Egyptian market during repairing work.

Table 2.24 Specification of Tractor Shovel

No.	Item	Specification	Quantity
1	Tractor Shovel	Wheel type Bucket capacity: not less than 0.5 m^3 Output: not less than 25 kw Dumping Clearance: more than 2.4 m	1

a) Local condition of equipment conveyance

Regarding the sludge occurrence volume, it is sufficient to prepare a small truck or dump truck with average of 1 car per trip/day. The distance between the project plant and waste disposal site is approximately 3 km. If the work is done with 1 car per trip/day, it is estimated to take approximately 1 hour/trip including loading and loss. Thus, it is possible to use the truck for conveying sludge in the duration of other works.

SHEGAWASD owns 10 trucks and small dump trucks. Thus, sludge can be conveyed with them. As Egypt is sufficiently developed in the field of land transportation and construction equipment lease market, even if SHEGAWASD cannot utilize its own cars, the organization can trust the other private company to convey the sludge.

Therefore, the Project does not cover the procurement of transportation equipment.

b) Sludge occurrence volume

The estimated volume of sludge occurrence is 1 ton per a day (solid status). Sludge at the primary stage contains 97% of water, which is almost as liquid, but it becomes with moisture content of 57% after drying, which enables to transport as solid. If sludge with 57% of moisture content is assumed, the total volume of sludge is calculated as 2.4 ton per a day (1 ton as solid and 1.4 ton as water).

Therefore, the sludge necessary to be conveyed is approximately 17 ton/week (2.4 ton x 7 days). If 1 day off per week and is considered and the result is converted to working day base, the average is 2.8 t/day, which is equivalent to approximately 3 m^3 (1,5m^3 = 1 ton x 1.5 m^3/ton as solid and 1.4 m^3 = 1.4 ton x 1.0 m^3/ton as water). According to the result of weight and volume calculation, it is concluded average of 1 trip/day with small truck is sufficient.

c) Sludge loading equipment

Manpower work for shipping off the sludge can be capable. However, it is impossible to load 3 tons/day of sludge onto truck. Hence, sludge loading equipment is necessary for the new treatment plant.

It is suitable to select tractor shovel, which is exclusive equipment for loading. Wheel type of tractor shall be chosen regarding speed and damage on the drying bed.

The ability of the tractor shovel shall be determined not from the capacity for loading but the necessary dumping clearance because the average loading volume is small ($3m^3$/day). It is assumed to load on small truck or dumping truck and the height of the bed side of the truck (3t) is approximately 2.3 m in the Project. Therefore, the dumping clearance is not less than 2.4m and the tractor shovel satisfying the size shall be procured.