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

Takao Kawakami
President
Japan International Cooperation Agency
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,

Noboru Sacki
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
STUDY AREA
List of Figures & Tables

Figure 2.1 Composition of Equipments in the Water Treatment Facility .......................... 27
Figure 2.2 Water Supply Facility in Hihya Markaz .......................................................... 58
Figure 2.3 Organization Chart of Facility Construction Contractors ............................... 105
Figure 2.4 Implementation Structure for Equipment Procure Contractors ....................... 108
Figure 2.5 Consultant for Supervision ............................................................................. 108
Figure 2.6 Implementation Schedule .............................................................................. 117
Figure 2.7 Basic Policy of Maintenance .......................................................................... 120
Figure 2.8 Organization Chart of SHEGAWASD ............................................................. 139
Figure 2.9 Organization Chart of SHEGAWASD Hihya Branch ....................................... 140

Table 1.1 Capacity of the Existing Water Supply Facilities in Hihya Markaz .................... 1
Table 1.2 Contents of Request by the Government of Egypt ............................................. 2
Table 2.1 The Target Areas in 3 Markaz Master Plan ..................................................... 8
Table 2.2 Results of CENSUS and Design Population .................................................... 9
Table 2.3 Planned Population at Each Target Year ....................................................... 10
Table 2.4 Calculation Method of Design Water Supply and Flows ................................. 12
Table 2.5 Design Water Supply for 3 Markaz ............................................................... 17
Table 2.6 Design Water Supply and Flows for New Water Treatment Plant .................. 18
Table 2.7 Design Raw Water Quality ............................................................................. 19
Table 2.8 Design Treated Water Quality ...................................................................... 20
Table 2.9 Wastewater Quality Standards ..................................................................... 20
Table 2.10 Design Water Level and Design Foundation Height ...................................... 21
Table 2.11 Soil Characteristics of Upper Stratum ........................................................... 21
Table 2.12 Components of the Facility .......................................................................... 23
Table 2.13 Comparison among Reinforced Concrete, Ductile Cast Iron and Steel Pipes .. 25
Table 2.14 Required Area for Drying Bed ..................................................................... 42
Table 2.15 Margin for Each Design Flow ..................................................................... 43
Table 2.16 Water Quality Analysis ................................................................................ 47
Table 2.17 Laboratory Equipments ................................................................................ 48
Table 2.18 Glass and Plastic Containers ....................................................................... 48
Table 2.19 Equipments in the Central Monitoring and Administration Building .............. 54
Table 2.20 List for Consumable Items .......................................................................... 60
Table 2.21 Emergency Spare Parts .............................................................................. 60
Table 2.22 List of Maintenance Tools ........................................................................... 62
Table 2.23 Content of PC ................................................................. 63
Table 2.24 Specification of Tractor Shovel .................................... 64
Table 2.25 Work Demarcation for Facility Construction ............... 103
Table 2.26 Work Demarcation for Equipment Procurement of Japan and Egypt .......................... 105
Table 2.27 Japanese Execution Management Structure ................ 107
Table 2.28 Japanese Supervisors for Execution and Procurement ... 111
Table 2.29 Country for Procurement of Main Construction Materials ............................................. 112
Table 2.30 Country for Procuring Equipments .............................. 113
Table 2.31 Quality Control Items .................................................. 114
Table 2.32 Main Items for Operation and Maintenance of the New WTP ........................................ 121
Table 2.33 Standard Check List for Pump and Motor Equipments .......................... 122
Table 2.34 Standard Check for Electricity Receiving Equipment .......................... 122
Table 2.35 Persons required for the new water treatment plant of the project .................................. 124
Table 2.36 Operation and Maintenance Cost for the Project .............. 127
Table 2.37 Annual Revenue and Expenditure .................................. 128
Table 2.38 Detail Activity Plan ...................................................... 134
Table 2.39 Work Schedule for Soft Component ............................. 138
Table 2.40 Members for the Soft Component at New Facility .......... 141
Table 3.1 Present Situation, Problems, Improvement Measures and Positive Effects
Associated with the Project ...................................................... 143
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 Technische Zusammenarbeit
- **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
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>Prestressed Concrete</td>
</tr>
<tr>
<td>PDM</td>
<td>Project Design Matrix</td>
</tr>
<tr>
<td>pH</td>
<td>Hydrogen ion exponent</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
</tr>
<tr>
<td>RC</td>
<td>Reinforced Concrete</td>
</tr>
<tr>
<td>rpm</td>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>SHEGAWASD</td>
<td>Sharqiya Economical General Authority for Water and Sanitary Drainage</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solid</td>
</tr>
<tr>
<td>USAID</td>
<td>US Agency for International Development</td>
</tr>
<tr>
<td>WTP</td>
<td>Water Treatment Plant</td>
</tr>
</tbody>
</table>
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 m³/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 2\textsuperscript{nd} and 13\textsuperscript{th} 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.

### Basic Design Policy

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water treatment plant</td>
<td></td>
</tr>
<tr>
<td>Design water supply</td>
<td>35,000 m³/day</td>
</tr>
<tr>
<td>Design raw water intake</td>
<td>115,500 m³/day (considering the future expansion)</td>
</tr>
<tr>
<td>Treatment system</td>
<td>Horizontal flow sedimentation + Rapid sand filter</td>
</tr>
<tr>
<td>Sludge treatment</td>
<td>Dry bed treatment</td>
</tr>
<tr>
<td>Emergency power source</td>
<td>750 kVA x 1 unit</td>
</tr>
<tr>
<td>Central monitoring and administration building</td>
<td>Approx. 1,000 m²</td>
</tr>
<tr>
<td>Supplemental water resource</td>
<td>Existing groundwater where salinity has not affected</td>
</tr>
<tr>
<td></td>
<td>3,000 m³/day</td>
</tr>
<tr>
<td></td>
<td>New compact unit</td>
</tr>
<tr>
<td></td>
<td>4,000 m³/day</td>
</tr>
</tbody>
</table>

### Summary of Soft Component Plan

<table>
<thead>
<tr>
<th>Item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical guidance on water maintenance</td>
<td>Operation system</td>
</tr>
<tr>
<td>treatment plant system</td>
<td>Operation and maintenance</td>
</tr>
<tr>
<td></td>
<td>Operation and water transmission management</td>
</tr>
<tr>
<td>Technical guidance on information technology</td>
<td>Setting management target</td>
</tr>
<tr>
<td></td>
<td>Establishment of database</td>
</tr>
<tr>
<td></td>
<td>Information utilization</td>
</tr>
</tbody>
</table>

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

Preface
Letter of Transmittal
Location Map / Perspective
List of Figures & Tables
Abbreviations
Summary

CHAPTER 1  Background of the Project ................................................................. 1

CHAPTER 2.  Contents of the Project ................................................................. 3
  2.1  Basic Concept of the Project ................................................................... 3
    2.1.1  Overall Goal and Project Target ....................................................... 3
    2.1.2  Basic Concept of the Project .............................................................. 4
  2.2  Basic Design of the Requested Japanese Assistance ............................... 5
    2.2.1  Design Policy .................................................................................. 5
    2.2.2  Basic Plan (Construction Plan/Equipment Plan) ............................... 8
      2.2.2.1  Design Conditions ................................................................... 8
      2.2.2.2  General Layout for New Water Treatment Plant ...................... 22
      2.2.2.3  Raw Water Intake Facility .......................................................... 23
      2.2.2.4  Raw Water Pump and Transmission Pump House ................... 25
      2.2.2.5  Water Treatment Facility ............................................................. 27
      2.2.2.6  Water Transmission Pump Equipment ..................................... 45
      2.2.2.7  Laboratory Equipment ................................................................. 47
      2.2.2.8  Operation Control Facility ............................................................. 49
      2.2.2.9  Power Receiving Equipment ......................................................... 49
      2.2.2.10  Emergency Generator ................................................................. 51
      2.2.2.11  Civil Works and Building Construction ..................................... 53
      2.2.2.12  Transmission Mains and Distribution Lines ............................ 56
      2.2.2.13  Operation and Maintenance Equipment ................................... 59
    2.2.3  Basic Design Drawing ..................................................................... 66
    2.2.4  Implementation Plan ....................................................................... 99
      2.2.4.1  Implementation and Procurement Policy ................................... 99
      2.2.4.2  Implementation Conditions ......................................................... 102
      2.2.4.3  Scope of Works ....................................................................... 103
2.2.4.4 Consultant Supervision ................................................................. 105
2.2.4.5 Procurement Plan ........................................................................ 111
2.2.4.6 Quality Control Plan .................................................................... 113
2.2.4.7 Implementation Schedule .............................................................. 116
2.3 Obligation of the Recipient Country ..................................................... 117
  2.3.1 Works Undertaken by NOPWASD ................................................. 117
  2.3.2 Works Undertaken by SHEGAWASD ............................................ 119
2.4 Project Operation Plan ......................................................................... 120
  2.4.1 Basic Policy .................................................................................. 120
  2.4.2 Item for Regular Check ................................................................. 121
  2.4.3 Spare Parts Purchase Plan .............................................................. 123
  2.4.4 Structure for Operation and Maintenance ....................................... 123
2.5 Project Cost Estimation ....................................................................... 125
  2.5.1 Cost Estimation for the Project ...................................................... 125
  2.5.2 Operation and Maintenance Cost Estimation ............................... 126
2.6 Other Relevant Issues (Soft Component) ............................................. 129

CHAPTER 3. Project Evaluation and Recommendations .................................. 143
  3.1 Project Effect .................................................................................... 143
  3.2 Recommendations ............................................................................ 144

Appendices
  1. Member List of the Study Team
  2. Study Schedule
  3. List of Parties Concerned in the Recipient Country
  4. Minutes of Discussions
  5. Comparison Table for Main Water Treatment Facilities
  6. Cost Estimation Borne by the Recipient Country
  7. References
CHAPTER 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 km² 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 m³/day (approx. 162 LCD). Yet, the actual water supply is approx. 17,680 m³/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>
<thead>
<tr>
<th>Facility</th>
<th>Quantity</th>
<th>Design Water Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact Unit (Source: Muweis Canal)</td>
<td>2 stations, 3 units 2,000m³/day</td>
<td>6,000m³/day</td>
</tr>
<tr>
<td>Well (Source: Groundwater)</td>
<td>13 wells 25,490 m³/day</td>
<td>25,490 m³/day</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>31,490 m³/day</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>No</th>
<th>Original Request (December 2002)</th>
<th>Request at Preliminary Study (January 2003)</th>
<th>Request at signing on BD Minutes (May 2003)</th>
</tr>
</thead>
</table>
| 1  | Construction of WTP 15,000m³/day x 1 unit | Construction of WTP 103,680m³/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)  
-Diameter of 500mm x approx. 6.0km | Construction of transmission pipes  
-Diameter of 1,200mm x approx. 0.2km (for inside the plant)  
-Diameter of 500mm x approx. 6.0km | Construction of transmission pipes  
-Diameter of 1,200mm x approx. 0.2km (for inside the plant) |
CHAPTER 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 m³ 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>
<thead>
<tr>
<th>Target Year</th>
<th>1st stage</th>
<th>2nd stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>This Project (2010)</td>
<td>Expansion Plan (2020)</td>
</tr>
<tr>
<td>Subject Area</td>
<td>Hihya Markaz</td>
<td>i) Hihya Markaz (population growth between 2010 and 2020) ii) Ibrahimiya iii) Diarb Nigm (1 city and 3 villages)</td>
</tr>
</tbody>
</table>

Table 2.1 The Target Areas in 3 Markaz Master Plan
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>
<thead>
<tr>
<th>Markaz</th>
<th>1986 CENSUS</th>
<th>1996 CENSUS</th>
<th>2010</th>
<th>2020</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hihya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban (Hihya City)</td>
<td>29,234</td>
<td>36,257</td>
<td>47,550</td>
<td>56,949</td>
<td>80,329</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(2.18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(702.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural (28 villages)</td>
<td>115,987</td>
<td>134,971</td>
<td>175,810</td>
<td>210,025</td>
<td>296,490</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(0.67 to 4.08)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(12.9 to 237.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 10,000 habitants</td>
<td>0</td>
<td>0</td>
<td>80,648</td>
<td>97,740</td>
<td>180,987</td>
</tr>
<tr>
<td>Not more than 10,000 habitants</td>
<td>115,987</td>
<td>134,971</td>
<td>95,162</td>
<td>112,285</td>
<td>115,503</td>
</tr>
<tr>
<td>Total</td>
<td>145,221</td>
<td>171,228</td>
<td>223,360</td>
<td>266,974</td>
<td>376,819</td>
</tr>
<tr>
<td>Ibrahimiya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban (Ibrahimiya City)</td>
<td>24,477</td>
<td>29,085</td>
<td>36,283</td>
<td>42,072</td>
<td>55,743</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(1.74)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(460.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural (18 villages)</td>
<td>65,951</td>
<td>79,448</td>
<td>101,722</td>
<td>121,094</td>
<td>174,146</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(0.37 to 4.56)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(3.9 to 173.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 10,000 habitants</td>
<td>14,243</td>
<td>15,638</td>
<td>47,964</td>
<td>87,438</td>
<td>130,788</td>
</tr>
<tr>
<td>Not more than 10,000 habitants</td>
<td>51,708</td>
<td>63,810</td>
<td>53,758</td>
<td>33,656</td>
<td>43,348</td>
</tr>
<tr>
<td>Total</td>
<td>90,428</td>
<td>108,533</td>
<td>138,005</td>
<td>163,166</td>
<td>229,879</td>
</tr>
<tr>
<td>Diarb Nigm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban (Diarb Nigm City)</td>
<td>32,198</td>
<td>43,507</td>
<td>62,825</td>
<td>80,125</td>
<td>128,431</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(3.06)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(1130.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural (43 villages)</td>
<td>207,014</td>
<td>252,320</td>
<td>321,486</td>
<td>378,910</td>
<td>521,762</td>
</tr>
<tr>
<td>(Annual Population Growth Rate: %)</td>
<td>(0.56 to 3.32)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Annual Population Increase: persons)</td>
<td>(9.8 to 329.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 10,000 habitants</td>
<td>10,696</td>
<td>59,381</td>
<td>133,754</td>
<td>236,323</td>
<td>390,754</td>
</tr>
<tr>
<td>Not more than 10,000 habitants</td>
<td>196,318</td>
<td>192,939</td>
<td>187,732</td>
<td>142,587</td>
<td>131,008</td>
</tr>
<tr>
<td>Total</td>
<td>239,212</td>
<td>295,827</td>
<td>384,311</td>
<td>459,035</td>
<td>650,193</td>
</tr>
<tr>
<td>Rural (3 villages)</td>
<td>14,325</td>
<td>17,614</td>
<td>22,891</td>
<td>27,274</td>
<td>----</td>
</tr>
<tr>
<td>More than 10,000 habitants</td>
<td>0</td>
<td>11,893</td>
<td>15,525</td>
<td>18,538</td>
<td>----</td>
</tr>
<tr>
<td>Not more than 10,000 habitants</td>
<td>14,325</td>
<td>5,721</td>
<td>7,366</td>
<td>8,736</td>
<td>----</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Item</th>
<th>Target Year</th>
<th>1st Stage</th>
<th>2nd Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>This Project (2010)</td>
<td>Expansion Plan (2020)</td>
</tr>
<tr>
<td>Project Area</td>
<td>Hihya Markaz</td>
<td>i) Hihya Markaz (population growth between 2010 and 2020) ii) Ibrahimiya iii) Diarb Nigm (1 city and 3 villages)</td>
<td>i) Hihya Markaz ii) Ibrahimiya iii) Diarb Nigm (all area)</td>
</tr>
<tr>
<td>Planned Served Population (Person)</td>
<td>Hihya</td>
<td>223,360</td>
<td>266,974</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>47,550</td>
<td>56,949</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>175,810</td>
<td>210,025</td>
</tr>
<tr>
<td></td>
<td>Ibrahimiya</td>
<td>163,166</td>
<td>220,879</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>42,072</td>
<td>55,743</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>121,094</td>
<td>165,136</td>
</tr>
<tr>
<td></td>
<td>Diarb Nigm</td>
<td>107,399</td>
<td>(1 city &amp; 3 villages) 659,100</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>80,125</td>
<td>128,431</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>27,274</td>
<td>530,669</td>
</tr>
</tbody>
</table>

(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 m³ 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 m³ 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.

<table>
<thead>
<tr>
<th>National Average Water Resources for Domestic Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water per Capita</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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).

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

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>
<thead>
<tr>
<th>Design Water Supply and Flows</th>
<th>Calculation Method</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design water supply</td>
<td>Design daily average supply x 1.25—1.5</td>
<td>Used for determining the capacity of each facility of the new water treatment plant.</td>
</tr>
<tr>
<td>Design intake flow</td>
<td>Design water supply x 1.1</td>
<td>Used for determining the capacity of the facilities from water intake facility to sedimentation basin</td>
</tr>
<tr>
<td>Design treatment flow</td>
<td>Design water supply x 1.07</td>
<td>Used for determining the capacity of rapid sand filter</td>
</tr>
<tr>
<td>Design transmission flow</td>
<td>Design water supply x 1.6—1.8</td>
<td>Used for determining the capacity of water transmission pump</td>
</tr>
</tbody>
</table>

(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 = 14,313 m³/day
- For villages : (95,162 x 0.100 + 80,648 x 0.125) x 1.4 = 27,436 m³/day

Total : 41,749 m³/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 2003: 50 L per s (4000 m³/day)
- El Alagma wells: 25 L/s (3000 m³/day)

iii) Design water supply

The design water supply is determined by the following formula.

\[
\text{Design water supply} = \text{Monthly maximum required water supply} - \text{Available water supply from the existing water supply facilities}
\]

Since the daily maximum required water supply is 41,749 m³/day and the available water supply from the existing water supply facilities is 7,000 m³/day, the design water supply shall be as follows.

\[
\text{Design water supply} = 41,749 - 7,000 = 34,749 \text{ m}^3/\text{day}
\]

2nd 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/365 days)

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 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:
  - For the population of not more than 10,000 cap: 33,656 cap
  - For the population of more than 10,000 cap: 87,438 cap
  - Total: 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: \(42,072 \times 0.215 \times 1.4 = 12,664\ \text{m}^3/\text{day}\)
- For villages:
  - \((33,656 \times 0.100 + 87,438 \times 0.125) \times 1.4 = 20,013\ \text{m}^3/\text{day}\)
  - Total: 32,677 m³/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 32,677 m³/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 = 32,677 m³/day
3rd 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/365 days)

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 = 26,947 m$^3$/day
- For villages: (35,661 x 0.100 + 25,828 x 0.125) x 1.4 = 9,512 m$^3$/day
  Total 36,459 m$^3$/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 7,000m³ 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 36,459m³/day and the available water supply from the existing water supply facilities is zero, the design water supply shall be as follows.

\[
\text{Design water supply} = 36,459 - 0 = 36,459\text{m}^3/\text{day}
\]

Summary of design water supply for 3 Markaz

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

**Table 2.5 Design Water Supply for 3 Markaz**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Target Area of Water Treatment Plant</th>
<th>Target Year</th>
<th>Design Water Supply (calculated)</th>
<th>Design Water Supply (applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Hihya Markaz</td>
<td>2010</td>
<td>34,749</td>
<td>35,000</td>
</tr>
<tr>
<td>2nd</td>
<td>Ibrahimiya Markaz</td>
<td>2020</td>
<td>32,677</td>
<td>35,000</td>
</tr>
<tr>
<td>3rd</td>
<td>Diarb Nigm Markaz (1 city and 3 villages) + Hihya Markaz (population increase from 2011 to 2020)</td>
<td>2020</td>
<td>36,459</td>
<td>35,000</td>
</tr>
<tr>
<td>Overall Plan</td>
<td></td>
<td></td>
<td>103,885</td>
<td>105,000</td>
</tr>
</tbody>
</table>

(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.

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

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

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

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.

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

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

Total \( 50,695 \text{m}^3/\text{day} \)

Meanwhile, the available water supply from the existing water supply plants is 7,000m³/day. Therefore, the design transmission flow is calculated as follows.

\[ 50,695 - 7,000 = 43,695 \text{m}^3/\text{day} \]

\[ \square 44,000 \text{ m}^3/\text{day} \]

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>
<thead>
<tr>
<th>Item</th>
<th>Amount (m³/day)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design water supply</td>
<td>35,000</td>
<td>Basic volume representing the water treatment plant</td>
</tr>
<tr>
<td>Design intake flow</td>
<td>115,500</td>
<td>Applied for intake facility</td>
</tr>
<tr>
<td></td>
<td>38,500</td>
<td>Applied for facilities between raw water pump and floculation/sedimentation basins</td>
</tr>
<tr>
<td>Design treatment flow</td>
<td>37,500</td>
<td>Applied for rapid sand filter</td>
</tr>
<tr>
<td>Design transmission flow</td>
<td>44,000</td>
<td>Applied for transmission pump</td>
</tr>
</tbody>
</table>
(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>
<thead>
<tr>
<th>Parameter</th>
<th>Raw Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7-9</td>
</tr>
<tr>
<td>Turbidity</td>
<td>10-20</td>
</tr>
<tr>
<td>TDS mg/L</td>
<td>200-350</td>
</tr>
<tr>
<td>Iron (Fe) mg/L</td>
<td>&lt;3.5</td>
</tr>
<tr>
<td>Manganese mg/L</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Copper mg/L</td>
<td>0</td>
</tr>
<tr>
<td>Zinc mg/L</td>
<td>0</td>
</tr>
<tr>
<td>Total Hardness mg/L</td>
<td>120-180</td>
</tr>
<tr>
<td>Calcium mg/L</td>
<td>25-35</td>
</tr>
<tr>
<td>Total Alkalinity (CaCO₃) mg/L</td>
<td>110-180</td>
</tr>
<tr>
<td>Magnesium mg/L</td>
<td>10-15</td>
</tr>
<tr>
<td>Sulphate (SO₄) mg/L</td>
<td>0-200</td>
</tr>
<tr>
<td>Chloride mg/L</td>
<td>10-45</td>
</tr>
<tr>
<td>Algae (count/mL)</td>
<td>4000-9000</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Table 2.8 Design Treated Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treated Water</strong></td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Taste</td>
</tr>
<tr>
<td>Odour</td>
</tr>
<tr>
<td>Turbidity</td>
</tr>
<tr>
<td>TDS mg/L</td>
</tr>
<tr>
<td>Iron (Fe) mg/L</td>
</tr>
<tr>
<td>Manganese mg/L</td>
</tr>
<tr>
<td>Copper mg/L</td>
</tr>
<tr>
<td>Zinc mg/L</td>
</tr>
<tr>
<td>Total Hardness mg/L</td>
</tr>
<tr>
<td>Calcium mg/L</td>
</tr>
<tr>
<td>Magnesium mg/L</td>
</tr>
<tr>
<td>Sulphate (SO₄) mg/L</td>
</tr>
<tr>
<td>Chloride mg/L</td>
</tr>
<tr>
<td>Sodium (Na) mg/L</td>
</tr>
<tr>
<td>Aluminium mg/L</td>
</tr>
<tr>
<td>Calcium Balance +/− 0.1</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Table 2.9 Wastewater Quality Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1982 Decree</strong></td>
</tr>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>SS mg/L</td>
</tr>
<tr>
<td>TDS mg/L</td>
</tr>
<tr>
<td>DO mg/L</td>
</tr>
<tr>
<td>COD mg/L</td>
</tr>
<tr>
<td>BOD mg/L</td>
</tr>
<tr>
<td>Nitrate mg/L</td>
</tr>
<tr>
<td>Sulphate ion mg/L</td>
</tr>
<tr>
<td>Oil/Grease mg/L</td>
</tr>
<tr>
<td>Coliform in 100 cc</td>
</tr>
<tr>
<td>Total Metals mg/L</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Residual Chlorine mg/L</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Item</th>
<th>Height</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWL</td>
<td>AD + 5.25m</td>
<td></td>
</tr>
<tr>
<td>HWL</td>
<td>AD + 6.25m</td>
<td></td>
</tr>
<tr>
<td>HHWL</td>
<td>AD + 7.25m</td>
<td>The highest water level in the past</td>
</tr>
<tr>
<td>Bank level of Muweis Canal</td>
<td>AD + 7.75m</td>
<td>Design height of the road for dredging vehicle</td>
</tr>
<tr>
<td>Design road height at branch irrigation course</td>
<td>AD + 7.77m</td>
<td></td>
</tr>
<tr>
<td>Design ground level</td>
<td>AD + 7.77m</td>
<td>To adjust the height of the dredging road</td>
</tr>
<tr>
<td>Average existing ground level</td>
<td>AD + 7.10m</td>
<td></td>
</tr>
<tr>
<td>Height of necessary reclamation</td>
<td>0.67m</td>
<td>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.</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Item</th>
<th>Soil Characteristics value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrinkage Limit</td>
<td>12 to 16 %</td>
</tr>
<tr>
<td>Unit Volume Weight</td>
<td>1.65 to 1.95 g/cm³</td>
</tr>
<tr>
<td>Unconfine of Compressive strength</td>
<td>0.34 to 1.6 kg/cm³</td>
</tr>
<tr>
<td>Soil Strength</td>
<td></td>
</tr>
<tr>
<td>Angle of internal friction (φ)</td>
<td>22.6°</td>
</tr>
<tr>
<td>Cohesion (C)</td>
<td>0.26 kg/cm²</td>
</tr>
<tr>
<td>Groundwater Level</td>
<td>GL-2.5 to GL-4.9m</td>
</tr>
<tr>
<td>Chemical Analysis</td>
<td></td>
</tr>
<tr>
<td>Average pH</td>
<td>7.17</td>
</tr>
<tr>
<td>Average Cl⁻</td>
<td>148 ppm</td>
</tr>
<tr>
<td>Average SO₃</td>
<td>399 ppm</td>
</tr>
<tr>
<td>Estimated Bearing Capacity of Soil</td>
<td></td>
</tr>
<tr>
<td>2 to 3m under the existing GL</td>
<td>Approx. 10t/m²</td>
</tr>
<tr>
<td>5 to 6m under the existing GL</td>
<td>Approx. 10t/m² to 15t/m²</td>
</tr>
<tr>
<td>8 to 10m under the existing GL</td>
<td>Approx. 20t/m²</td>
</tr>
<tr>
<td>Deeper than 10m under the existing GL</td>
<td>Approx. 30t/m²</td>
</tr>
</tbody>
</table>
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 °C
ii) Average Summer Temperature (Shadow) : 33.7 °C
iii) Average Winter Temperature (Shadow) : 7.2 °C
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

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

(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.

\[
(38,500 \text{m}^3/\text{day} = (24 \text{ hours} \times 60 \text{ min} \times 60 \text{ s}) \times 0.82 \times 4) = 0.9 \text{m/s})
\]

- 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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Reinforced Concrete Pipe</th>
<th>Evaluation</th>
<th>Ductile Cast Iron Pipe</th>
<th>Evaluation</th>
<th>Steel Pipe</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pressure hearing intensity</td>
<td>Skew change is the smallest under the same load condition</td>
<td>□</td>
<td>Skew change is small under the same load condition</td>
<td>□</td>
<td>Easy to change due to large skew</td>
<td>□</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Connection of pipes</td>
<td>Easy with a short period and simple tools. No need to consider springs and weather condition</td>
<td>□</td>
<td>Easy with a short period and simple tools. No need to consider springs and weather condition</td>
<td>□</td>
<td>Welding and X ray inspection requires time and high skill. Spring and weather condition significantly influence on the work.</td>
<td>□</td>
</tr>
<tr>
<td>Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Non-Erodibility</td>
<td>Specific non-erodibility Significant non-erodible characteristics</td>
<td>□</td>
<td>Specific non-erodibility Significant non-erodible characteristics by alkaline non-erodible effect of cement laying</td>
<td>□</td>
<td>Less than DCI</td>
<td>□</td>
</tr>
<tr>
<td>• Internal non-erodibility</td>
<td>40 to 50 years (LCC is small)</td>
<td>□</td>
<td>40 years (LCC is small)</td>
<td>□</td>
<td>25 years (LCC is large)</td>
<td>□</td>
</tr>
<tr>
<td>Concrete Protection</td>
<td>Not required</td>
<td>□</td>
<td>Required</td>
<td>□</td>
<td>Required</td>
<td>□</td>
</tr>
<tr>
<td>Regional Characteristics and work environment</td>
<td>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</td>
<td>□</td>
<td>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</td>
<td>□</td>
<td>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.</td>
<td>□</td>
</tr>
<tr>
<td>Cost</td>
<td>The lowest cost</td>
<td>□</td>
<td>8% more expensive than iron</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

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

$$13.37 \text{m}^3/\text{min} = 19,250 \text{m}^3/\text{day} = \frac{38,500 \text{m}^3/\text{day}}{2 \text{pumps}}.$$

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

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

<table>
<thead>
<tr>
<th>Pump Type</th>
<th>Horizontal or vertical centrifugal pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pump</td>
<td>3 (2 for regular and 1 for spare operations)</td>
</tr>
<tr>
<td>Discharge Quantity</td>
<td>13.37 m$^3$/min (per 1 unit)</td>
</tr>
<tr>
<td>Pumping Head</td>
<td>15 m</td>
</tr>
<tr>
<td>Output of Main Motor</td>
<td>Approx. 55 kW</td>
</tr>
</tbody>
</table>
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).

(2) Designed Water Flow

The designed water flow for the facilities between the Receiving Well and Sedimentation...
(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 : $3 \text{ m}^3 \times 3.5 \text{ m}^3 \times 4.5 \text{ m}^d$ (effective depth)
- Capacity : $47 \text{ m}^3$
- Number : 1 basin

ii) Design Criteria

Design Water Flow

- 38,500 m$^3$/day

Design Capacity

- Retention Time
  \[
  \frac{38,500 \text{ m}^3/\text{day}}{24\text{ h/day} \times 60\text{ min/h}} = 1.8\text{ min} > 1.5\text{ min} \quad \square \quad \text{OK}
  \]

- Effective Depth
  \[
  \frac{47 \text{ m}^3}{3 \text{ to } 5 \text{ m (Japan)}}
  \]

Water depth is 4.5 m. Therefore, 3 m < 4.5 m < 5 m \quad \square \quad \text{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: 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 m\(^3\)

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

Wing Type of Flush Mixer: 1/3 to 1/2 of chemical sedimentation basin (Egypt)

\[
3.5m \div \frac{1}{3} = 1.17m
\]

\[
3.5m \div \frac{1}{2} = 1.75m
\]

Wing configuration of flush mixer is 1.4 m
1.17m < □ 1.4m < 1.75m □ OK

Speed of circulation: More than 1.5 m/s (Japan)

\[
\text{Circulation Speed} = \frac{25.4 \text{rpm}}{60 \text{sec/min}} \times 1.4m
\]

= 1.86m/s > 1.5 m/s □ 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 : $4.25m^\text{W} \times 4.25m^\text{L} \times 3.5m^\text{D} \times 8$ basins + $2m^\text{L} \times (8.9m^\text{W} \times 2$ lines) $\times 3.5m^\text{D}$(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 : [20 to 30 minutes (Egypt) / 20 to 40 minutes (Japan)]
Capacity $4.25m^\text{W} \times 4.25m^\text{L} \times 3.5m^\text{D} \times 4$ rows $\times 2$ lines + $2m^\text{L} \times (8.9m^\text{W} \times 2$ lines) $\times 3.5m^\text{D} = 630.4m^3$

$630.4m^3 \times \frac{38500m^3/day}{24h/day \times 60min/h} = 23.6min \quad OK$

Water Depth : [2 to 4 m (Egypt)]
As water depth is 3.5 m
$2m < 3.5m < 4m \quad OK$

Speed of circulation : [0.15 to 0.8 m/s (Japan)]
[First line flocculator]
Diameter 3m, speed 1.5 to 6.2rpm
Circulation Speed = \( \frac{1.5 \sim 6.2 \text{ rpm}}{60 \text{sec/min}} \times 3 \text{ m} \) 
= 0.24 m/s \( \sim \) 0.97 m/s  \( \square \) 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
Circulation Speed = \( \frac{0.94 \sim 3.8 \text{ rpm}}{60 \text{sec/min}} \times 3 \text{ m} \) 
= 0.15 m/s \( \sim \) 0.6 m/s  \( \square \) 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 : 8.5m\(^W\) x 52m\(^L\) x 4m\(^D\)
Capacity : 1,768m\(^3\)
Number : 2 basins

ii) Design Criteria

a) Design Water Flow
38,500 m\(^3\)/day

b) Capacity
Surface Load $\sim 31$ mm/min (Egypt)/$\sim 30$ mm/min (Japan) 
\[ \frac{38,500 \text{ m}^3/\text{day}}{24 \text{ h/day} \times 60 \text{ min/h}} \square 8.5 \text{ m} \times 52 \text{ m} \times 2 \text{ basin} \]
= 30.2 mm/min  \( \square \) OK

Retention Time $\sim 3$ h (Egyptian Standard) 
\[ \frac{1,768 \text{ m}^3 \times 2 \text{ basin}}{38,500 \text{ m}^3/\text{day}} \times \frac{24 \text{ h/day}}{24 \text{ h/day}} = 2.2 \text{ h} \square \] OK
<table>
<thead>
<tr>
<th>Average Flow Speed</th>
<th>Less than 0.4m/min (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38,500m³/day</td>
<td>8.5m³/h x 4m x 2set</td>
</tr>
<tr>
<td>24h/day x 60min/h</td>
<td>0.39m/min x 0.4m</td>
</tr>
<tr>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>2–4m (Egypt)/approx. 3–4m, Bottom sludge 0.3m (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective water depth</td>
<td>4m + Bottom sludge thickness 0.5m</td>
</tr>
<tr>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Horizontal and vertical ratio</th>
<th>3–8 (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>52m/L x 8.5m³ = 6.1</td>
<td></td>
</tr>
<tr>
<td>3 &lt; 6.1 &lt; 8</td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>More than 2 ponds (Japan)</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>Filtration rate</th>
<th>120 to 180 m/day (Egypt) / 120 to 150 m/day (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>If 8 ponds run</td>
<td>37,500m(^3)/day □ 40m(^2)/pond □ 8pond</td>
</tr>
<tr>
<td></td>
<td>= 117m/day &lt; 120m/day □ OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Washing</th>
<th>0.3 to 0.6 (Egypt), 0.3 to 0.9 m/min (m(^3)/m(^2)/min (Japan))</th>
</tr>
</thead>
<tbody>
<tr>
<td>If 0.6 m/min and 5 min/cycle per pond is applied,</td>
<td></td>
</tr>
<tr>
<td>40m(^2)/basin □ 0.2m/basin = 8m(^3)/min/basin</td>
<td></td>
</tr>
<tr>
<td>24m(^3)/min □ 5min/cycle = 120m(^3)/cycle</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface Washing</th>
<th>0.15 to 0.2 m/min (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If 0.2 m/min and 5 min/cycle per pond is applied,</td>
</tr>
<tr>
<td></td>
<td>40m(^2)/basin □ 0.2m/basin = 8m(^3)/min/basin</td>
</tr>
<tr>
<td></td>
<td>8m(^3)/min □ 5min/cycle = 40m(^3)/cycle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Filtering Area</th>
<th>40m(^2)/basin (Egypt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40m(^2)/basin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sand Layer</th>
<th>More than 0.7 m (Egypt), 0.6 to 0.7 m (Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.7 m</td>
</tr>
</tbody>
</table>

33
Gravel Layer

0.3 to 0.6 m (Egypt), 0.2 m (Japan)
0.3 m

Height of gravel head

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

5 to 6 min (Egypt), 4 to 6 min (Japan)
5 min

Total washing period

10 to 15 min (Egypt), 8 to 12 min (Japan)

Surface washing (5 min) + backwashing (5 min) = total 10 min.

Air washing

50 to 70 m³/m²/min (Egyptian standard)

Air washing is not relevant to this project

Interval of effluent trough

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 chlorine 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

<table>
<thead>
<tr>
<th>Quantity</th>
<th>7 g/m$^3$ (pre- or mid-chlorination) (Egyptian standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 g/m$^3$ (sum of pre-, mid- and post-chlorination) (Japanese standard)</td>
</tr>
</tbody>
</table>

$[\text{pre- + middle-chlorination}]$

\[
38,500 \text{ m}^3/\text{day} \times 7 \text{ g/m}^3 \times 24 \text{h/day} = 11.2 \text{ kg/h} \times 6 \text{ kg/h} = 64 \text{ unit (1 for spare)}
\]

$[\text{Post-chlorination}] = [\text{total chloride}] - [\text{Pre-chlorination} + \text{mid-chlorination}]

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

16 \text{ kg/h} - 6 \text{ kg/h} = 4 \text{ kg} \times 2 \text{ kg/h} = 8 \text{ unit}$

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 = 38,500 m$^3$/day $\times$ 20 to 40 g/m$^3$ (8% alum) = 770 to 1,540 kg/day (8% alum)
Thus, the amount of Al₂O₃ is,

\[
\text{Al}_2\text{O}_3 = 770 \sim 1,540 \text{ kg/day} \times 0.08
\]

\[
= 61.6 \sim 123.2 \text{ kg Al}_2\text{O}_3/\text{day}
\]

If this is made of \( x \) kg of solid phase alum (Al₂O₃ 14\% wt) dissolved,

\[
x \text{ kg/day (14\% alum)} \times 0.14 = 61.6 \sim 123.2 \text{ kg Al}_2\text{O}_3/\text{day}
\]

\[
\Rightarrow x = 440 \sim 880 \text{ kg (14\% Alum)}/\text{Day}
\]

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.

\[
\frac{440 \sim 880 \text{ kg } \times 0.14}{w + 440 \sim 880 \text{ kg}} = 0.08 \Rightarrow w = 330 \sim 660 \text{ kg/day}
\]

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

\[
((440 \sim 880) + (330 \sim 660)) = 770 \sim 1,540 \text{ kg/day}
\]

\[
= 586 \sim 1,171 \text{ L/day}
\]

\[
= 24.4 \sim 48.8 \text{ L/h}
\]

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.
440～880 kg/day 調 ≅ 50 kg/package = 8.8～17.6 package/day

If stored for 20 days,
8.8～17.6 package/day 調 20day = 160～320 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 0.8mm\(^H\) 調 4.4m\(^L\) 調 1.5m\(^H\) of open space with 3 lines,
0.8m\(^W\) □ 3 □ 1.1 (extra space beside) = 2.64m\(^W\)

If 440 kg is chosen, 55 package □ 3 line = 165 package > 160 packages in 2.64mm\(^W\) □ 4.4m\(^L\) □ 1.5m\(^H\) open space

If 880 kg is chosen, 55 package □ 6 line = 330 package > 320 package in 5.28mm\(^W\) □ 4.4m\(^L\) □ 1.5m\(^H\) open space

Therefore, the chemical dozing house is designed to have enough room for 6m\(^W\) □ 5m\(^L\) 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;
61.6～123.2 kgAl₂O₃/day = X kg/day □ 0.07

X = 880～1,760 kg/day

\[ \frac{880～1760}{1.265} \text{ L/day (specific gravity 1.265)} \]

\[ = 696～1,391 \text{ L/day} \]

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

\[ 696～1,391 \text{ L/day} \div 10 \text{ day} = 6,960～13,910 \text{ L/day} \Div 7～14 \text{ m}^3 \]

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

\[ 696～1,391 \text{ L/day} \div 20 \text{ day} = 13,920～27,820 \text{ L/day} \Div 14～28 \text{ m}^3 \]

Therefore, the capacity of the storage tank is determined as 14 m³.

Liquid aluminium sulphate storage tank

Type : FRP tank
Capacity : 14 m³
Number : 1 unit

Aluminium sulphate dissolving tank

Type : FRP tank (with mixer)
Capacity : 4 m³
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 = 37,500 m^3/day

b) Capacity

- **Capacity**: More than 1 cycle of filtration (Japanese Standard)

Water volume per 1 cycle of washing

- Surface washing: 0.2 m/min □ 5 min □ 40 m^2 = 40 m^3/cycle
- Back flush: 0.6 m/min □ 5 min □ 40 m^2 = 120 m^3/cycle

Size of the filtration basin(*)

\[
\text{Size of the filtration basin}(*) = \left\{ (\text{maximum depth} + 10,320) - (\text{height of trough} + 6,320) \right\} \quad 5.7 \text{ m}^L \quad 7 \text{ m}^W \\
+ \left\{ (\text{height of trough} + 6,320) - (\text{basin bottom} + 2,920) \right\} \quad 1.2 \text{ m}^L \quad 7 \text{ m}^W \\
= 160 + 29 \\
= 189 \text{ m}^3 \quad (\ast)
\]

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

(\ast) HHWL is applied for calculating the size.

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

(\ast\ast) All drainage pours into this drainage tank. Thus, with the supernatant of the drying bed (6m □ 23.5m □ 1 m^3/basin) taken into account, more than 2 cycles are considered.
ii) Sludge Tank

Type : Reinforce concrete tank
Size : 7 m\text{W} \times 4 \text{m}\text{L} \times 4 \text{m}\text{D}
Capacity : 112 m\text{^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\text{^3}/day

b) Capacity
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
Withdrawn Sludge

$$\frac{1,035 \cdot 10}{112 m^3 \cdot 2 \text{ unit}} = 224 m^3$$

$$\frac{224 m^3}{103.5 m^3/day} = 2.2 \text{ day} > 2 \text{ day} \quad \square \quad \text{OK}$$

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\text{W} \times 7 \text{m}\text{L} \times 4 \text{m}\text{D} (circle shape \quad \square \quad 7m)
Area : 308 m\text{^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\text{^3}/day

b) Capacity

Solid Load \quad 10 \sim 20\text{kg-ds/m}^2 \cdot \text{day (Japan)}

Solid volume generated 1,035 kg-ds/day

$$\text{Area} = \left(\frac{7}{2}\right)^2 \cdot 2Ba \sin s = 77.0 m^3$$
1,035 kg-ds/day (10 ~ 20kg-ds/m² · day) = 51.5 ~ 103.5 m³/day

\[ 51.5 m² < 77.0 m² \] \[ \text{OK} \]

**Effective Depth**

\[ 3.5 \sim 4 \text{m (Japan)} \]

4m

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

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:** 23.5 m\(^W\) x 6 m\(^L\) (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).

**Capacity**

**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

\[ 1,000 \times 0.03 = 30 \text{kg-ds/m}^3 \]

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

\[ 30 \times 1.0 = 30 \text{kg-ds/m}^2 \]

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.
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 $1,128 \text{m}^2$ and 2 units cease due to conveyance, the actual working area is determined as the following.

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

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):

![Table 2.14 Required Area for Drying Bed](image)
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,
\[
\text{Capacity of the reservoir} = 35,000m^3/day \times 0.15 + 571 \times 0.8 = 5.707 \times 6,000m^3
\]

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>
<thead>
<tr>
<th>Design water supply</th>
<th>Nominal water supply Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design intake flow</td>
<td>Intake to sedimentation basin</td>
</tr>
<tr>
<td>Design treatment flow</td>
<td>Rapid sand filter</td>
</tr>
<tr>
<td>Design transmission flow</td>
<td>Taking into account the daily maximum</td>
</tr>
</tbody>
</table>

Table 2.15 Margin for Each Design Flow

Intake to Chemical Sedimentation Basin

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]

\[ 38,500 \text{m}^3/\text{day} \quad \times \quad \left\{ 1.1 \left( \text{Turbidity Coefficient} \right) \right\} \quad \times \quad \left\{ \left( \text{Designed Turbidity} \quad 20 \right) \quad \div \quad \left( \text{Treated Water Turbidity} \quad 0^* \right) \right. \quad \div \quad \left. 40 \text{mg/L} \left( \text{Injection Rate} \right) \right\} \quad \div \quad 0.08 \left( \text{Al}_2\text{O}_3 \text{Concentration} \right) \quad \times \quad \frac{2 \div 78 \left( \text{2Al(OH)}_3 \text{Molecular Weight} \right)}{102 \left( \text{Al}_2\text{O}_3 \text{Molecular Weight} \right)} \quad \times \quad 10^3 \]

\[ = 1,035 \text{ kg-ds/day} \]

If the concentration of sludge at the bottom of chemical sedimentation basin is 10 % (10 kg-ds/m³), the volume of drainage is

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

\[ 38,500 \text{m}^3/\text{day} \quad - \quad 103.5 \text{m}^3/\text{day} \quad = \quad 38,397 \text{m}^3/\text{day} > 37,500 \text{m}^3/\text{day} \quad \square \quad \text{OK} \]

Filer Basin

The volume of water after filtering needs to be more than 35,000 m³/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.

\[
\text{Size of Rapid Sand Filter basin (per basin)} = \left\{ \left( \text{Water Level of Treated Water Reservoir:} \ + \ 7,920 \right) \\
+ \left( \text{maximum daily water rise:} \ + \ 1,000 \text{mm/day} \ \text{(assumption)} \right) \right\} \\
- \left( \text{height of trough} \ + \ 6,320 \right) \quad \div \quad 5.7 \text{mL} \quad \div \quad 7 \text{m}^w \\
+ \left\{ \left( \text{height of trough:} \ + \ 6,320 \right) \ - \ \left( \text{bottom:} \ + \ 2,920 \right) \right\} \quad \div \quad 1.2 \text{mL} \quad \div \quad 7 \text{m}^w \\
= 104 \text{m}^3 \ + \ 29 \text{m}^3 \\
= 133 \text{m}^3
\]

\[
\text{Surface washing and back washing water (per basin)} = \left( 0.2 \text{m/min} \quad \div \quad 5 \text{min} + 0.6 \text{m}^3/\text{min} \quad \div \quad 5 \text{min} \right) \quad \div \quad 40 \text{m}^2 \\
= 160 \text{m}^3
\]

\[
\text{Sub Total:} \quad 133 \text{m}^3 \ + \ 160 \text{m}^3 \quad = \quad 293 \text{ m}^3 \ \text{(per basin)} \\
\text{Total:} \quad 293 \text{ m}^3/\text{day} \quad \div \quad 10 \text{ basins} \quad = \quad 2,930 \text{ m}^3/\text{day} \ \text{(10 basins)}
\]

The volume receiving from the upper side is 38,397 m³/day, therefore,

\[ 38,397 \text{ m}^3/\text{day} \quad - \quad 2,930 \text{ m}^3/\text{day} \quad = \quad 35,467 \text{ m}^3/\text{day} \quad > \quad 35,000 \text{ m}^3/\text{day} \quad \square \quad \text{OK} \]

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.

\[
\begin{align*}
10 \text{ basins} & \quad 38,397 \text{m}^3/\text{day} \div 10 \text{basin} \div 40 \text{m}^2/\text{basin} = 96 \text{m/day} \\
8 \text{ basins} & \quad 38,397 \text{m}^3/\text{day} \div 8 \text{basin} \div 40 \text{m}^2/\text{basin} = 120 \text{m/day}
\end{align*}
\]

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 filter 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 m³/day
- Variance : 70% of the average treated water
- Maximum Transmission Volume : 44,000 m³/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:

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

**Pump Type**

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.

<table>
<thead>
<tr>
<th>Maximum Transmission Volume</th>
<th>44,000 m$^3$/day 30.56 m$^3$/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume per Pump</td>
<td>10.19 m$^3$/min</td>
</tr>
<tr>
<td>Pumping Head</td>
<td>60 m</td>
</tr>
<tr>
<td>Output</td>
<td>Approx. 160 kW</td>
</tr>
<tr>
<td>Operation Range</td>
<td>80 – 110 %</td>
</tr>
<tr>
<td>Type</td>
<td>Horizontal Double Suction Volute Pump</td>
</tr>
<tr>
<td>NPSH</td>
<td>Approx. 4m</td>
</tr>
</tbody>
</table>

(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>
<thead>
<tr>
<th>Item</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>Odour</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>Turbidity meter</td>
</tr>
<tr>
<td>Temperature</td>
<td>Thermometer</td>
</tr>
<tr>
<td><strong>Physical Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>pH Meter</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Conductivity meter</td>
</tr>
<tr>
<td>Total Dissolved Solid</td>
<td>Evaporation</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Chlorine ion meter</td>
</tr>
<tr>
<td><strong>Chemical Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>Titration</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>Titration</td>
</tr>
<tr>
<td>Calcium</td>
<td>Measuring Hardness (as CaCO₃)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Titration</td>
</tr>
<tr>
<td>Iron</td>
<td>Oxidation/Reduction Method</td>
</tr>
<tr>
<td>Manganese</td>
<td>Oxidation/Reduction Method</td>
</tr>
<tr>
<td><strong>Biological Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Algae</td>
<td>Culture Test</td>
</tr>
<tr>
<td>Total <em>E. Coli</em></td>
<td>Culture Test</td>
</tr>
</tbody>
</table>

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

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

Installation of Micro Kjeldahl system (analysis of nitrogen) was requested 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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker</td>
<td>3</td>
<td>Volume Metric Cylinder (plastic)</td>
<td>2</td>
</tr>
<tr>
<td>50 mL</td>
<td>3</td>
<td>100 mL</td>
<td>2</td>
</tr>
<tr>
<td>100 mL</td>
<td>3</td>
<td>1,000 mL</td>
<td>1</td>
</tr>
<tr>
<td>500 mL</td>
<td>3</td>
<td>Volume Metric Flask</td>
<td></td>
</tr>
<tr>
<td>Burette</td>
<td>1</td>
<td>100 mL</td>
<td>3</td>
</tr>
<tr>
<td>50 mL</td>
<td>2</td>
<td>500 mL</td>
<td>1</td>
</tr>
<tr>
<td>Burette Stand</td>
<td>2</td>
<td>1,000 mL</td>
<td>1</td>
</tr>
<tr>
<td>Whole Pipette</td>
<td>1</td>
<td>Triangle Flask</td>
<td></td>
</tr>
<tr>
<td>1 mL</td>
<td>1</td>
<td>500 mL</td>
<td>3</td>
</tr>
<tr>
<td>10 mL</td>
<td>2</td>
<td>Stainless Spoon</td>
<td>2</td>
</tr>
<tr>
<td>25 mL</td>
<td>2</td>
<td>Petri Dish</td>
<td>3</td>
</tr>
<tr>
<td>50 mL</td>
<td>2</td>
<td>Rubber Syringe</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

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 close 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 lack of paper. To prevent the same situation, the output of the integrated flow volume is digitalised. The data is dealt 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

\[
V_d = \frac{P}{P_n} \square \% Z = \frac{1365}{1250} \square 5 = 5.5(\%)
\]

Where \( P_n \): 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: DC 100 V
(for control system)

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 area 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: 
\[ P_{G1} = \frac{P_0}{\eta \times Pf} \]
where
- \( P_{G1} \): Generator output (kVA),
- \( P_0 \): Sum of the total load output (kW)
- \( \eta \): Efficiency of load:
- \( Pf \): Power factor

2) Capacity of voltage decline at starting electric motor: 
\[ P_{G2} = P_s \left( \frac{1}{V_d} - 1 \right) \times Xd' \]
where
- \( P_{G2} \): Generator output (kVA)
- \( P_s \): Plugging capacity (kVA)
- \( V_d \): 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: 
\[ P_{G3} = \frac{\Box Wo + \{QL_{max} \times \cos \Box QL\}}{KG \times \cos \Box G} \]
where
- \( P_{G3} \): Generator output (kVA)
- \( \Box Wo \): Sum of the load during operation (kW)
- \( QL_{max} \): Maximum starting rush load (kVA)
- \( \cos \Box QL \): Starting power factor of maximum starting rush load
- \( KG \): Overload capacity of generator (1.2 in general)
- \( \cos \Box G \): Generator power factor (0.8 in general)

Capacity of the Generator

The results of the calculation are as followings.

\[ P_{G1} = 677 \text{ kVA} \]
\[ P_{G2} = 562 \text{ kVA} \]
\[ P_{G3} = 628 \text{ kVA} \]

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 \cdot kVA) x 3 hours x 14days

\[ = \text{Required Capacity (L)} \]
\[ 700 \times 0.25 \times 3 \times 14 = 7,350 \text{L} \]
Therefore, the tank capacity is determined as 8 m³.

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 m³
- **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 m³/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 = 480m²
- 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>
<thead>
<tr>
<th>Floor</th>
<th>Name</th>
<th>Area (m²)</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF</td>
<td>Lobby, Corridor</td>
<td>108</td>
<td>Light, Alarm</td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td>72</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>Engineer Room 1</td>
<td>48</td>
<td>Light, Ventilation, Alarm</td>
</tr>
<tr>
<td></td>
<td>Engineer Room 2</td>
<td>48</td>
<td>Light, Ventilation, Alarm</td>
</tr>
<tr>
<td></td>
<td>Storage 1</td>
<td>36</td>
<td>Light, Ventilation, Alarm</td>
</tr>
<tr>
<td></td>
<td>Storage 2 &amp; Workshop</td>
<td>120</td>
<td>Light, Ventilation, Alarm</td>
</tr>
<tr>
<td></td>
<td>Toilet and hot water supply room</td>
<td>48</td>
<td>Toilet, Light, Ventilation, Alarm</td>
</tr>
<tr>
<td>1F</td>
<td>Stair and corridor</td>
<td>96</td>
<td>Light,</td>
</tr>
<tr>
<td></td>
<td>Manager Room</td>
<td>36</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>Monitoring Room</td>
<td>72</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>Computer Room</td>
<td>36</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>General Affair Office</td>
<td>96</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>Conference Room</td>
<td>96</td>
<td>Light, Ventilation, Air condition, Alarm</td>
</tr>
<tr>
<td></td>
<td>Toilet and hot water supply room</td>
<td>48</td>
<td>Toilet, Light, Ventilation, Alarm</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>960</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Area (m^2)</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Room</td>
<td>616</td>
<td>Lighting, ventilation, alarm (fire alarm), sun shade for transformer, fan type ventilation on the wall</td>
</tr>
<tr>
<td>Electricity Room</td>
<td>209</td>
<td>Lighting, ventilation, alarm (fire alarm), sun shade for transformer, fan type ventilation on the wall</td>
</tr>
<tr>
<td>Generator Room</td>
<td>70</td>
<td>Outdoor roof fan, ventlouver x 1 Fuel tank for DEG (8 m^3) Roof fan x 3</td>
</tr>
<tr>
<td>Total</td>
<td>895</td>
<td></td>
</tr>
</tbody>
</table>

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

55
4) Rapid Sand Filter Administration Building

i) Main Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Direct foundation</td>
</tr>
<tr>
<td>Structure</td>
<td>Reinforced concrete, 2 stories</td>
</tr>
<tr>
<td>Floor</td>
<td>Reinforced concrete</td>
</tr>
<tr>
<td></td>
<td>Reinforced concrete + anti-dust paint</td>
</tr>
<tr>
<td>Outside wall</td>
<td>Brick</td>
</tr>
<tr>
<td>Construction fittings</td>
<td>Aluminium or steel</td>
</tr>
<tr>
<td>Floor area</td>
<td>$10.30m \times 38.65m = 398.10m^2$</td>
</tr>
</tbody>
</table>

ii) Building Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>JIS illumination standard is applied. Principally fluorescent or mercury light</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Natural ventilation with fan or ventlouver</td>
</tr>
</tbody>
</table>

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.
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.

1. **Consumable Items:** Consumable items required after a certain period : 1 set
2. **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

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

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

<table>
<thead>
<tr>
<th>Facility/Equipment</th>
<th>Spare Part to be procured</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Group A</td>
<td>Compound gauge</td>
<td>For each Pump</td>
<td></td>
</tr>
<tr>
<td>Equipment Group B</td>
<td>Control device (0.2. 0.4 and 0.75 kw)</td>
<td>1 unit per each</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switch (0.2. 0.4 and 0.75 kw)</td>
<td>2 unit per each</td>
<td></td>
</tr>
<tr>
<td>Slow closing check Valve</td>
<td>Non-transmission detector, connection protection relay</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sludge collector for chemical sedimentation basin</td>
<td>Piece of all chain used for repair</td>
<td>8 pieces/chain type</td>
<td>2 repair/ all units</td>
</tr>
<tr>
<td></td>
<td>Flight</td>
<td>4 Sets</td>
<td>1 pair for repair/ all units</td>
</tr>
<tr>
<td>Inflow gate for drainage tank</td>
<td>Electricity Operation Equipment</td>
<td>1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switch</td>
<td>2 units</td>
<td>1 replace per all units</td>
</tr>
<tr>
<td>Facility/Equipment</td>
<td>Spare Part to be procured</td>
<td>Quantity</td>
<td>Note</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-------------------------------------------------------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Chemical dozing house equipment</td>
<td>Chlorine injector vacuum adjusting device</td>
<td>For each unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine injector eject device</td>
<td>For each unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine injector flow meter</td>
<td>For each unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine container weight load cell</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine container weight indicator (meter)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine cylinder valve</td>
<td>4 cylinders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine emergency shut down valve</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure meter with alarm indicator for chloride gas</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Globe valve for chloride gas</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine neutralization tower manometer</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caustic soda pump coupling</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine gas detector sensor unit</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustion fan V belt</td>
<td>For 2 units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustion fan anti vibration rubber</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustion fan suction pressure meter</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustion fan wind speed meter with thermic ray</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caustic Soda flow meter for indoor pipe</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strainer for indoor pipe (PVC40A)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strainer for indoor pipe (PVC25A)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regulating valve for indoor pipe</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Back pressure regulating valve for indoor pipe</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accumulator for indoor pipe</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diaphragm for indoor pipe (PVC40A)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diaphragm for indoor pipe (PVC25A)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diaphragm for indoor pipe (PVC15A)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Equipment in electricity room</td>
<td>High-tension board lump</td>
<td>1 set (100%)</td>
<td>1 replace per each unit</td>
</tr>
<tr>
<td></td>
<td>Low-tension board lump</td>
<td>1 set (100%)</td>
<td>1 replace per each unit</td>
</tr>
<tr>
<td></td>
<td>Low voltage board fuse</td>
<td>1 set (100%)</td>
<td>1 replace per each unit</td>
</tr>
<tr>
<td>Emergency generator</td>
<td>Fan belt</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Belt for generator</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nozzle tip</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Starter switch</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baffle meter</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Register</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overhaul gasket kit</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suction valve</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustion valve</td>
<td>For 1 unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Automatic voltage baffler</td>
<td>1 unit</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Specification</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tractor Shovel</td>
<td>Wheel type</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bucket capacity: not less than 0.5 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output: not less than 25 kw</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dumping Clearance: more than 2.4 m</td>
<td></td>
</tr>
</tbody>
</table>

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 m³ (1,5m³ = 1 ton x 1.5 m³/ton as solid and 1.4 m³ = 1.4 ton x 1.0 m³/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.