No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
UPGRADING OF EL MAHALA EL KOBRA
WATER TREATMENT PLANT
IN
THE ARAB REPUBLIC OF EGYPT

DECEMBER 2005

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct a basic design study on the Project for Upgrading of El Mahala El Kobra Water Treatment Plant 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 July 29 to August 30, 2005.

The team held discussions with the officials concerned of the Government of Egypt and conducted a field study at the 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.

December, 2005

Seiji Kojima

Vice-President

Japan International Cooperation Agency

December, 2005

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Upgrading of El Mahala El Kobra Water Treatment Plant in the Arab Republic of Egypt.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from July, 2005 to December, 2005. 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,

Masatoshi Seno

Chief Consultant,

Basic Design Study Team on the project for Upgrading of El Mahala El Kobra Water Treatment Plant in the Arab Republic of Egypt

Yachiyo Engineering Co., Ltd.

Map of the Arab Republic of Egypt

The Perspective of the Water Treatment Plant

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ABBREVIATIONS

- Approx.	: Approximately
- BD	: Basic Design
- BOD	: Biochemical oxygen demand
- COD	: Chemical oxygen demand
- DCI	: Ductile Cast Iron
- DD	: Detail Design
- DO	: Dissolved Oxygen
- E/N	: Exchange of Notes
- FY	: Fiscal Year
- GACWASD	: Gharbeya Company for Water Supply and Sanitary Drainage
- GDP	: Gross Domestic Product
- GL	: Ground level
- GNL	: Gross National Product
- h	: hour
- 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
- min	: minute
- mm	: millimeter
- M/P	: Master Plan
- OJT	: On the Job Training
- PC	: Prestressed Concrete
- PDM	: Project Design Matrix
- PVC	: Polyvinyl Chloride
- RC	: Reinforced Concrete
- rpm	: Revolutions per minute

- sec : second
- TDS : Total Dissolved Solid
- STP : Sewage Treatment Plant
- USAID : US Agency for International Development
- WTP : Water Treatment Plant

Summary

SUMMARY

As the Arab Republic of Egypt (hereinafter referred to as Egypt) witnesses continued population concentration into urban areas, it is faced with the urgent need to implement projects for improving and preserving urban living environments including water supply and sewerage systems.

The Five-Year National Economic and Social Program (2002/2003 ~ 2006/2007) ,which has currently been implemented, gives the highest priority to raising water supply capacity from 19million m^3/day to 26million m^3/day, and to expanding the water transmission and distribution network from 26,000 km to 30,900 km in the waterworks sector by 2007.

Based on these nationwide targets, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) has compiled all large-scale waterworks and sewerage construction projects in the country except the Cairo metropolitan area and the city of Alexandria into a five-year program and is implementing them under the budget authorized by the superior Ministry of Housing and Public Facilities.

The Project has been planned under the fundamental framework. It aims to improve water supply and thereby improve the living environment in the city of El Mahala El Kobra, which is one of the main cities in the Nile Delta region, and the 10 surrounding villages.

The target area of the Project, located in El Mahala El Kobra District in Gharbeya Prefecture, is situated in the center of the Nile delta region with a flat terrain. The city of El Mahala El Kobra is an industrial center containing one of the most prosperous textile sectors in the country. Starting from the 1980s, there has been an influx of population into the city in line with expansion of the textile industry, however, there has not been a corresponding expansion in water supply facilities and the city has been confronted with shortages in its potable water supply.

NOPWASD increased supply capacity of El Mahala El Kobra New Water Treatment Plant from 200 L/sec to 400 L/sec in 2001, however, this has not been enough to resolve the troubles arising from lack of potable water supply in the target area. Currently, potable water to the target area is supplied via the distribution network from this El Mahala El Kobra New Water Treatment Plant (400 L/sec), El Mahala El Kobra Old Water Treatment Plant (360 L/sec) and six compact units and wells (with combined capacity of 814 L/sec).

However, the stable supply of safe water is an emergent issue, because El Mahala El Kobra New and Old Water Treatment Plants have been suffered from extreme deterioration, which have caused difficulties in operation and maintenance, and the small compact units are not appropriate as large-scale urban water supply facilities and they only serve minor distribution areas remote from the new and old water treatment plants and have poor water production efficiency, and concentration of the salt in groundwater from wells has been increasing rapidly and the water has reached the upper limit prescribed under the Egyptian potable water standard.

Under such a background, NOPWASD has designed a plan to successively close the compact units and wells and to replace them with water treatment facilities, and it has requested the Government of Japan to provide Grant Aid regarding the construction of a water treatment plant (800 L/sec) that is beyond the capability of the Egyptian side alone.

In response to the request, the Government of Japan consigned the Japan International Cooperation Agency (JICA) to dispatch a Basic Design Study Team from July 30 to August 29, 2005 in order to implement the basic design for the Project. The Study Team held discussions concerning the contents of the request with officials of the Egyptian Government, NOPWASD and the Gharbeya Company for Water Supply and Sanitary Drainage (GACWASD), conducted surveys of the Project site and gathered relevant materials and data, etc.

Concerning the NOPWASD request, i.e. the new construction of an 800 L/sec water treatment plant in the area of the existing El Mahala El Kobra New Water Treatment Plant, the Study Team conducted survey and assessment of the current conditions of the abovementioned new and old water treatment plants, small compact units and wells. As a result, the Study Team reached such a conclusion that, since the Project has a high degree of urgency with a target year of two years after construction of the new plant, it was preferable to utilize and secure as much water supply as possible from the existing compact units and wells. Accordingly, the Team decided that only one existing well, which has suffered from particularly extreme water quality deterioration, should be closed down.

The Team estimated the water supply and demand balance in the target year of 2010 as follows:

Water supply is totally 1,404 L/sec (760 L/sec from the existing water treatment plants, and a combined 644 L/sec from the existing compact units and wells)

And Water demand is 1,791 L/sec.

Since this estimation shows a shortage of 387 L/sec, the Team decided to construct a new water treatment plant with capacity of 400 L/sec inside the land of the existing treatment plant in order to resolve the issue arising from the shortage of water.

As a result of the said investigations, the Study Team confirmed the need for the urgent construction of water supply facilities in the target area and prepared a Draft Basic Design including a Soft Component upon taking into account GACWASD's capability in the operation and maintenance of the water treatment plant.

Based on the Draft Basic Design, JICA dispatched the Basic Design Outline Explanation Study Team to Egypt from November 5 to November 10, 2005 in order to explain and discuss the contents of the Project.

The following tables show the basic design concept (including current conditions) of water supply development, outline plan of facilities and the Soft Component based on the Basic Design Study.

Basic Design Concept

Item	Construction Concept	
annual	2010 (plan)	2005 (current)
Mean per capita daily water supply	Urban parts 215L Villages (population 10,000 or more) 125L Villages (population less than 10,000) 100L	163L 89L 89L
Water supply rate	100%	100%
Uncharged water rate	30%	30%
Water supply population	Approximately 600,000	Approximately 560,000
Water source	El Mallah Canal	Canal and groundwater
Intake facilities	Two pipelines to facilitate operation and maintenance	
Sludge treatment	Transport sedimentation tank sludge to an existing sewage treatment plant	
Purification basin	Filter bed washing water tank	

Outline of Facilities Plan

<Facilities>

Facility	Components	Scale
① Water intake and conveyance facilities	Intake opening, intake pipe, raw water pit, water conveyance pump equipment	440L/sec *400L/sec x 1.1
② Water treatment facilities	Receiving well (combining rapid mixing basin functions), flocculation basin, coagulated sedimentation basin, rapid filter bed (including filter bed washing water tanks), coagulant injection equipment, chlorine injection equipment, sludge treatment facilities (wastewater basin, sludge basin, thickening tank), chlorine neutralization unit	From the receiving well to the coagulated sedimentation tank 440L/sec *400L/sec x 1.1
③ Transmission and distribution pumps	Install water transmission and distribution pump equipment in the same building as the conveyance pump equipment.	520L/sec *400L/sec x 1.3
④ Operation management equipment	Control panel, monitoring panel, flowmeter, etc.	
⑤ Power receiving and transformer equipment	Power receiving equipment transformer	
⑥ Emergency generator equipment	Diesel generator	
⑦ Related civil and building facilities	Water conveyance and transmission/distribution pump building, chemicals injection building, filter bed management building	

<Equipment>

Item	Contents
① Sludge transportation equipment	10 ton vacuum car: 1 car
② Maintenance tools	General tools for equipment maintenance

<Soft Component>

Item	Contents
① Improvement of water treatment process engineering management	Lectures on the water treatment process, guidance (practical drills) on water quality control and operation of water treatment process operation methods, preparation of formats for inputting and viewing water treatment plant water quality data
② Acquisition of technology for processing and utilizing monitoring system data	Outline explanation of the monitoring system, guidance in data processing methods, technical guidance on information utilization

Moreover, in the event where the Project is implemented under the Grant Aid Scheme of the Government of Japan, the rough Project cost is estimated as 3.516 billion yen (2.414 billion yen for the Japanese scope of works, and 1.102billion yen for the Egyptian scope of works).

However, the rough Project cost does not indicate the grant limit in the E/N. It is estimated that the Project implementation period will comprise 4 months for the implementation design, 3 months for the tender and selection of the contractor, and 25 months for the procurement of the equipment and facilities, and construction of civil engineering works and building works.

The result of examination of the Project from various angles such as the viewpoints of urgency, benefit, operation and maintenance capacity, finance, and environment is as follows;

By constructing a water treatment plant and water transmission and distribution system in El Mahala El Kobra District, which has the most under-developed waterworks system and the worst water supply situation in Gharbeya Prefecture, the Project will enable to supply a sanitary and stable water to the residents in the target area and thus there is necessarily an urgent need. In particular, the implementation of the Project will directly bring the benefit to approximately 600,000 residents (2010) in El Mahala El Kobra District and secure sufficient supply of safe water (100~215 L/person/day) in compliance with the potable water standard.

The new water treatment plant will be operated and maintained by GACWASD, which has approximately 6,000 employees and operates the new and old El Mahala El Kobra Water Treatment Plants through its El Mahala El Kobra Department, which conducts operation and maintenance through 74 personnel members. This organization has operated water treatment plants for approximately 80 years and basically has no problems in terms of operation and maintenance capacity.

Concerning the financial situation, because the Government of Egypt has kept water supply tariffs down as a political policy, the water supply business run by GACWASD shows a deficit, however, the system is financed with a budget allocation from Gharbeya Prefecture on top of revenue from the water tariffs. It is forecast that operation and maintenance costs will increase by 3million LE (approximately 57million yen) as a result of the Project, however, since it is also estimated that operating revenue will increase by 2million LE (approximately 38million yen) as a result of the increase in water supply, the resulting net increase of 1million LE (approximately 19million yen) in operation and maintenance costs may not have a major impact on GACWASD finances.

So far in Egypt, sedimentation tank sludge and filter bed backwashing water have been conventionally discharged into drainage channels without treatment. In the Project, however, thickened sludge from sludge basins and thickening tanks will be transported to an existing sewage treatment plant (8 km from the Project facilities), where it will undergo open-air drying. By doing this, the Project will lead to a major reduction in environmental impact.

Issues that need to be improved and overcome by NOPWASD and GACWASD in future to ensure the proper implementation of the Project and the sustained operation and maintenance of facilities following completion are as follows:

Works to be implemented by the Egyptian side:

- Construction and rehabilitation of water transmission and distribution pipes that will be required by 2010.
- Relocation of existing embedded pipes in the construction site for the planned water treatment plant.

> Improvement of business management

- Enhancement in water treatment process management technology
- Gathering of accurate basic data concerning water supply volume and quality including existing water treatment plants, and facilities operation and maintenance and water transmission management based on such data
- Elucidation of unaccounted-for water and improvement of the tariff collection rate through establishing a water transmission and distribution management system.

> Integrated operation with existing facilities

- Establishing an integrated and organized water transmission and distribution system linking with the existing compact units and water treatment plants.

In the event where the Project is implemented under the Grant Aid Scheme of the Government of Japan, even more sanitary and stable water supply will be provided to residents in the target area and the Project may contribute to the stable economical and social development if the Egyptian side can successfully handle the following issues such as securing of budget to cover costs imposed on the Egyptian side, improvement of management of the water supply business, connection of water supply pipes to the households, responding to new technology, raising technical capacity, and so on. Accordingly, the Project is deemed to be highly significant and to have a high degree of validity.

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CHPATER 1 Background of the Project

CHAPTER 1 BACKGROUND OF THE PROJECT

Egypt is a country located in the northeastern corner of the African Continent and has a land area of some one million km^2 and a population of approximately 70.71million(2002data).
Some 94% of the national land is either desert or wetland and most of the population live in the delta facing the Mediterranean or along the Nile valley.
The annual average population growth is currently is about 2.1% and specially the population has been concentrated on the urban areas in this country. This country has faced an urgent need to improve and to implement the environment conservation policies for the urban peoples in order to meet the increase in demand prompted by the population growth in the urban areas.

Under these situations, the Government of Egypt requested in 2001 the Government of Japan to provide Grant Aid for the Project for upgrading of El Mahala El Kobra Water Treatment Plant, the Project for Water Supply of Sharqiya Governorate, and the Project for Upgrading of Amilia Water Treatment Plant.

In response to the request, the Government of Japan conducted the feasibility studies as a single package for the three projects mentioned above, and decided to give the priority to the second project mentioned above, confirming the necessity and appropriateness of both the first and second projects. The Grant Aid has been given to the second project since 2003 after the basic design study had been properly conducted.

Since the first project for planning to develop and improve the water treatment and supply system and to raise the daily average domestic water supply per capita by 2005 was requested in 2001 by the Government of Egypt, the original contents of the project were revised and amended at the time of studying the basic design in 2005.

The original contents of the request and the revised contents thereof are shown in the following table 1.1

Table 1.1 The original request and the final request

No.	Original Request April 2001	Final Request August 2005
1.	Rehabilitation of the existing Water Treatment Plant. 17,280 /day	Turned down the original request and in near future will be implemented by Egyptian side
2.	Construction of the following facilities ・ 22,000m^3/day Intake Facility Mixing Tank Flocculation Basin Sedimentation Basin Treated Water Tank Distribution Pumps Aluminum Sulphate Dosing Facility	Construction of the folliowing facilities ・ 400/sec (35,000m^3/day) Intake Facility Conveyance Pipe Raw Water Suction Tank Mixing Tank Flocculation Basin Sedimentation Basin Filtration Units with Sump for back wash purpose Aluminum Sulphate Dosing Facility Chlorination Facility Distribution Pump Power Receiving and Transforming Facility Emergency Generator Associated Civil and Building Works

CHPATER 2 Contents of the Project

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

The City of El Mahala El Kobra, which is one of the main cities in the Nile delta region of the Arab Republic of Egypt (hereinafter referred to as Egypt), and the 10 surrounding villages of (1) Mahalat Abou Ali, (2) Batina, (3) El Qaisaria, (4) Ezbat Toma, (5) Ezbat Lona Kamar, (6) Diarb Hashim, (7) Meit El Lith Hashim, (8) Mahalat Hassan, (9) Manshiat El Omara, and (10) Kafr El Genia, have in recent years found it increasingly difficult to secure sufficient water supply for the domestic activities of citizens as a result of population growth, deterioration of existing water supply facilities and salination of groundwater. The daily average water supply per capita in 2005 is estimated as 146 LCD (daily average domestic water supply for residents is 121 LCD), however, since this only corresponds to approximately 70-90% of the development target prescribed by the National Organization for Potable Water and Sanitary Drainage (NOPWASD) and 60-80% of the recommended value given by the Ministry of Housing and Public Facilities, it does not satisfy the required water supply level for urban peoples.

Furthermore, since some facilities are confronted with advancement of deterioration and the quality of groundwater has been getting exacerbated, there is the nation’s most pressing problem to tackle the comprehensive and systematic demolition and renewal of deteriorated facilities and wells.

Even assuming that deteriorated facilities and facilities producing poor quality water may be continuously used, it is forecasted that the daily average water supply per capita will drop to 136 LCD by 2010. Accordingly, the improvement of water treatment and supply system, taking into account the demolition and renewal of existing facilities, is the most urgent matter to be solved.

NOPWASD, the agency in charge of waterworks and sewerage facilities in Egypt, plans to develop water supply facilities and raise the daily average domestic water supply per capita to approximately 160 LCD in El Mahala El Kobra and its surrounding 10 villages.

In order to realize this goal, the Project has been drawn up with the objective of expanding capacity of the El Mahala El Kobra Water Treatment Plant and also of raising the daily average water supply per capita to 185 LCD (the daily average domestic water supply per capita is 161LCD) by 2010.

The following table gives an outline of the scope of works on the Egyptian side and the Japanese side.

1. Scope of Works of the Japanese Side

<Facilities>

Facility	Components	Scale
(1) Water intake and conveyance facilities	Intake inlet, intake pipe, raw water pit, conveyance pump equipment	440L/sec *400L/sec×1.1
(2) Water treatment facilities	Receiving well (also possessing rapid mixing basin functions), flocculation basin, coagulation and sedimentation basin, rapid filtration basin (including filter basin washing water sump), coagulant injection equipment, chlorine injection equipment, sludge treatment facilities (wastewater sump, sludge sump, thickening tank), chlorine neutralization unit	From receiving well to coagulation and sedimentation basin 440L/sec *400L/sec×1.1
(3) Transmission and distribution pump equipment	Install transmission and distribution pump equipment in the same building as the conveyance pump equipment.	520L/sec *400L/sec×1.3
(4) Operation management equipment	Control panel, monitoring panel, flow meter, etc.	
(5) Power receiving equipment	Power receiving equipment, transformer	
(6) Emergency power generation equipment	Diesel generator	
(7) Related civil and building facilities	Conveyance, transmission and distribution pump building, chemical injection building, filter basin management building	

<Equipment>

Item	Contents
(1) Sludge transportation equipment	10 ton vacuum car: 1
(2) Maintenance tools	General tools for maintenance of equipment

<Soft Component>

Item	Contents
(1) Improvement of water treatment process technology management	Lectures on water treatment processes, guidance (practical drills) on water quality control and operation of water treatment processes, and preparation of formats for inputting and viewing water quality data from the water treatment plant
(2) Acquisition of data processing and data utilization using the monitoring system	Outline explanation of the monitoring system, guidance on data processing methods, and technical guidance on information utilization

2. Main Scope of Works of the Egytptian Side

(1) To construct and rehabilitate the water transmission and distribution pipes that will be required in 2010.
(2) To relocate the existing embedded pipelines which may be obstacles to the construction of the new WTP in the Project site.
(3) To assign the personnel required for the technical support (Soft Component)
(4) To implement the works required for the monitoring system

2.2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2.2.1 Design Policy

2.2.1.1 Basic Concept

The Project aims to expand the capacity of the El Mahala El Kobra Water Treatment Plant in order to realize the target water supply. Accordingly, the target works intend to construct facilities on the site provided for the Project inside the existing plant.

In addition to expanding facilities at El Mahala El Kobra Water Treatment Plant, another major component for realizing the objective is the rehabilitation of the transmission and distribution pipe network. However, since this will be implemented as a component of the Egyptian side, it will not be included in the scope of works in the Project to be implemented by the Japanese side.

The Project design will be implemented based on the following basic items.

(1) Project target area

The target area of the Project, as mentioned at the start of the report, shall be the City of El Mahala El Kobra and the 10 surrounding villages of (1) Mahalat Abou Ali, (2) Batina, (3) El Qaisaria, (4) Ezbat Toma, (5) Ezbat Lona Kamar, (6) Diarb Hashim, (7) Meit El Lith Hashim, (8) Mahalat Hassan, (9) Manshiat El Omara, and (10) Kafr El Genia.

(2) Target year

The Project target year shall be set as 2010, which is five years from the present point. The facilities to be constructed shall possess the scale necessary to provide the planned water supply in 2010.

(3) Consideration for future re-expansion and rehabilitation

The existing El Mahala El Kobra Water Treatment Plant, so far can broadly be divided into Phase-1 and Phase-2 (total 200 L/sec) and Phase-3 (200 L/sec). The Egyptian side plans to carry out the full-scale rehabilitation (including re-expansion) of the Phase-1 and Phase-2 facilities (constructed in 1984), which has been suffering from extreme deterioration. Accordingly, the new facilities to be constructed in the Project shall be designed to ensure that the Egyptian side can flexibly implement its re-expansion and rehabilitation of the existing WTP in the future.

2.2.1.2 Concept Regarding Natural Conditions

The natural conditions to be considered in the basic design stage will be characterized into the two areas of meteorology/climate and geology. Local climate features are high temperatures, aridity and seasonal sand storms, and these points shall need to be fully taken into account when designing and planning the execution of structures. In particular, concerning WTP equipment, it will be necessary to adopt dustproof specifications and so on.

The construction site is located on a typical Nile delta alluvial fan. Upper deposits comprise soft to stiff silty clay, while bottom deposits consist of consolidated sand and soil. Apart from the surface soil, since the upper deposits possess sufficient bearing capacity to support general types of structures, as a rule it will be possible to adopt foundations which may be directly constructed on the sound ground.

2.2.1.3 Concept Regarding Social and Economic Conditions

The points to be carefully studied in the basic design, and the countermeasures required to deal with them, are as follows.

(1) Water quality issue arising from the residents

The survey of social conditions has revealed that residents have taken the poor quality of water as their own issue. Accordingly, the Project shall be planned with ample attention devoted to supplying harmless water. In particular, concerning facilities that not only have produced extremely poor quality water but also are difficult to be rehabilitated, stop of use or closure shall be proposed.

(2) Treatment of sludge generated in the water treatment process

Water supply treatment facilities in Egypt, including existing facilities, have so far discharged sludge generated in the water treatment process into drainage canal. However, following establishment of the Environment Ministry in 1994 and the adoption of water source protection policy and environmental standards, it is increasingly necessary to strictly comply with the wastewater quality standards. Moreover, in accordance with the Law Regarding the Protection of the Nile and Waterways Against Pollution, “filter’s washing waters, from the portable water purification stations (plant) must not be discharged into water surfaces without treatment.”
From the viewpoint of the construction cost and operation and maintenance expenses, the best approach to treating sludge is sun-drying, however, the Project construction site does not possess enough space for this. However, since existing sewage treatment plant in El Mahala El Kobra do possess proper sun-drying facilities, sludge shall be transported to the existing sewage treatment plants for treatment.

(3) Industrial water supply

The city of El Mahala El Kobra is the representative textile producing center of Egypt. Since the textile industry requires a lot of water, it will be necessary to study a water supply plan in consideration of industrial water consumption. Accordingly, the amount of water that can be supplied as domestic water supply shall be clarified upon calculating the planned water supply to the industrial and domestic uses respectively.

2.2.1.4 Concept Regarding the Construction and Procurement and Utilization of Local Contractors

Egypt has so far constructed numerous water treatment plants through its own efforts and with assistance from international agencies. Many other buildings and public infrastructures have been also constructed, so Egyptian contractors have sufficient technology required to conduct civil engineering and architectural works and machine installations. Therefore, under the control provided by Japanese engineers and skilled operators, the local operators and workers can construct and complete the Project within the schedule fixed under the Grant Aid scheme. For this reason, in the Project there is no need to employ engineers or workers from other third countries; so rather local operators and workers may be as a rule utilized in this Project.
In terms of the availability of equipment and materials, Egyptian firma have achieved sufficient progress in terms of production volume and quality to be able to supply the major civil engineering and building equipment and materials excluding WTP instruments, ductile cast fittings, valves and ductile cast iron pipes with diameter in excess of 1,000 mm, etc. Accordingly, main equipment and materials for the Project may basically be procured in the local market.

2.2.1.5 Concept Regarding Operation and Maintenance Capacity of the Implementing Agency

After completion of the Project, its plant will be transferred from NOPWASD to the Gharbeya Company for Water Supply and Sanitary Drainage (GACWASD), which shall be responsible for its operation and maintenance. Since GACWASD has already operated and maintained two new and old water treatment plants in El Mahala El Kobra, it has enough basic technology required to operate such facilities.

In the basic design, items specially to be cared for, and the concept for dealing with them, shall be as follows.

(1) Applicable treatment method

Since the Project will expand the existing WTP, it is desirable that existing technology shall be utilized for operating and maintaining the facilities. Therefore, as a rule the same treatment method that has been adopted in the existing WTP shall be applied.

(2) Guidance on initial operation of facilities

Although GACWASD has the basic technology for operating WTP, it must still require guidance on initial operation and maintenance techniques that are peculiar to the treatment of new plant facilities and instruments. Such guidance shall be implemented using the facilities and equipment constructed and installed by the contractor during the contract period.

Moreover, this guidance shall be implemented as OJT during the test operation of WTP conducted by the contractor.

(3) Monitoring system

Introduction of a monitoring system is essential for operating and maintaining the WTP and for managing the overall water transmission and distribution system including the water distribution network. In spite of this, its monitoring function at the existing WTP is insufficient. In the Project, a monitoring system shall be introduced to GACWASD in order to acquire monitoring data from the existing and new WTP.

(4) Technical support

GACWASD has confronted a number of problems arising from its application of operating conditions and monitoring data in its operation and maintenance of the existing WTP. In particular, improvement is required in its monitoring system for water production control and data acquisition. Since this type of technology is required for enhancing the efficient operation of the entire system of WTP, some technical supports shall be given to GACWASD via the Soft Component.

(5) Blackout countermeasures

In the Project area, the local power distribution company knocked out power lasting between 3-4 hours on Friday mornings every two weeks, in order to conduct its maintenance work. However, since it is necessary to constantly operate the WTP and maintain the continuous supply of water for the following two reasons, emergency generator equipment shall be installed in order to cope with the said blackouts:

- Interrupting the water supply may give an adverse impact on residents, and
- Since interrupting the water supply may cause temporary negative pressure inside pipelines, there is such a risk that sewage, etc. may enter the pipelines and sewage contamination may occur.

2.2.1.6 Concept Regarding Setting of Facilities and Equipment Grades

When designing the WTP facilities and equipment to be procured in the Project, careful attention shall be paid to the grades of existing facilities and equipment and the technical level of GACWASD in order to ensure that GACWASD can easily operate and maintain the facilities after its commissioning.

Items to be taken into account in, and the concept for dealing with the grades and functions of facilities and equipment in the basic design are as follows;

(1) Concept concerning application of local design standards

As a rule, the new WTP shall be designed in accordance with the Egyptian Code for Design Basis and Implementation Conditions for Water Treatment Plant, Wastewater Treatment Plant and Pump Station (Ministerial Decree No.52, 1998). This code prescribes detailed requirements ranging from the method of calculating planned water supply to the setting of pipe flow velocity and pump specifications, etc.

(2) Storage capacity

The water treatment plant needs a treated water reservoir capable of absorbing the difference between the hourly water production flow, which is fairly constant, and the water transmission flow, which fluctuates from time to time. As a rule, it will be necessary to secure sufficient storage capacity to cope with blackout and routine maintenance check time as well as sudden fluctuations in the treated water production and transmission flows. Moreover, NOPWASD generally requires that the treated water reservoirs also shall have a function as distribution reservoir for coping with hourly fluctuations at times of water distribution.

In the Project, NOPWASD originally intended to construct a treated water reservoir with the function of water distribution reservoir, however, due to the limited land for the Project, which has not enough space for a new treated water reservoir, it was decided in the basic design that no treated water reservoir would be constructed in spite of conducting a through review of the possibility to construct such a normal treated water reservoir in the new WTP as may have a function to convey the water supply to the water transmission and distribution network . Hence the capacity of the existing treated water reservoir is totally 6,000m3, which is sufficient amount of water for sudden changes between production and distribution of water and also for maintenance check times. When it comes to developing the water transmission and distribution network, it will be desirable for the Egyptian side to construct distribution reservoirs according to need.

(3) Chlorine gas leak countermeasures

WTP in Egypt generally use chlorine gas in order to disinfect treated water. Since chlorine gas has extremely high toxicity, proper measures are required to prevent potential accidents caused by gas leakage. Because the new WTP is planned to be specially located adjacent to apartment blocks, serious attention to resident safety is essential. Accordingly, a chlorine neutralization system shall be installed in the new WTP for emergencies at the occurrence of gas leakage.

2.2.1.7 Concept Regarding Construction and Procurement Methods and Schedule

The points requiring special attention in the basic design, and the countermeasures required to deal with them, are as follows.

(1) Construction method

Construction of the Project will be implemented at the limited site in the existing WTP. Moreover, since the site is located adjacent to private apartment blocks, special care shall be required to ensure that the construction works do not have an adverse impact on the surrounding area.

Since the excavation works adjacent to existing structures in the existing WTP is likely to give adverse impact on the foundations of structures, steel sheet piles, etc. shall be used for earth retaining. Moreover, concerning the method of driving steel sheet piles, it may be necessary to adopt pressure insertion method, because vibratory hammers and the like may be noisy and also may give a harmful vibration on adjacent structures.

(2) Procurement method

Since the Project is a construction of WTP, plant construction works more than the civil engineering and building works will be required. This means that the special know-how for constructing and installing water treatment equipment /plant, etc., which equipment/ plant makers have and hold, is required. Accordingly, it will be necessary to construct the facilities based on a tie-up between a water treatment equipment maker/plant company and a construction firm.

For this reason, a procurement plan has been drawn up after considering joint order from a consortium between a construction firm and a water treatment equipment maker/plant company.

(3) Construction schedule

It is estimated that the construction period for the Project, including the detailed design, will require approximately 32 months starting from the E/N. Only the WTP will be constructed, and therefore its functions will be accomplished progressively. Accordingly, since the Project may be hard to be planned as a phased project, it is necessary to apply a government bond scheme.

2.2.2 Basic Plan

2.2.2.1 Design Conditions

The following paragraphs describe the design conditions to be used in the basic design of the Project.

(1) Design population and design service population

Although some rehabilitation and improvement of the existing network shall be required in the Project target area, on the whole the water distribution network has been already in place and the water supply rate is more or less 100%. Accordingly, the service population more or less corresponds to the population living in the project area. Table 2.1 shows the population in the target area (the design service population) as estimated by NOPWASD.

Annual average population growth in Gharbeya Prefecture is currently estimated as 1.79%, however, the growth rate used in the table up until 2010 is lower than this at around 1.4%. Survey results provided by the Gharbeya Prefecture Information Center indicate that, "although the rate of population growth in Gharbeya Prefecture in the 1980s was 2.6%, this dropped to 1.6% in the 1990s." In view of this, rather than the figure given by Gharbeya Prefecture, the figure given by NOPWASD is considered to be more appropriate for estimating the population in 2010. Accordingly, the estimate figures given by NOPWASD shall be applied for calculating the design service population in the Project target year of 2010.

Table 2.1 Project Service Population

Project Target Area	2005	**2010**	2020	2030	2040
El Mahala El Kobra	431,954	**454,746**	506,210	569,130	646,263
Mahalat Abou Ali	50,900	**60,289**	83,763	116,164	162,128
Batina	11,849	**12,980**	15,466	18,311	21,598
El Qaisaria	9,623	**10,971**	14,120	18,057	23,073
Ezbat Toma	3,921	**4,928**	7,762	12,394	20,247
Ezbat Lona Kamar	2,307	**2,555**	3,109	3,759	4,528
Diarb Hashim	5,043	**5,600**	6,852	8,326	10,083
Meit El Lith Hashim	8,783	**9,124**	9,828	10,565	11,337
Mahalat Hassan	14,412	**15,236**	16,972	18,836	20,845
Manshiat El Omara	12,939	**14,675**	18,696	23,663	29,904
Kafr El Genia	6,814	**7,781**	10,048	12,893	16,534
Total	558,545	**598,885**	692,826	812,098	966,540

(2) Design daily average water supply per capita

The city of El Mahala El Kobra is the representative textile producing center of Egypt. In order to secure the domestic water demand required for resident daily life water, it is necessary to design the water supply, taking into account industrial water consumption. Accordingly, the design water supply shall be set by treating the domestic water supply and industrial water supply separately as follows. Water supply for other purposes shall not be counted because the amount concerned only have a negligible effect on the design total.

1) Design daily water supply per capita

Since it is necessary to calculate the design water supply according to the purpose of use, recommended values given by the Ministry of Housing and Public Facilities shall be applied. In the Project, the said recommended values are the development targets adopted by NOPWASD.

a. Domestic water supply

Based on the recommended values given by the Ministry of Housing and Public Facilities, the design daily average domestic water supply per capita is set as shown in Table 2.2. As is later described in (2) Designed daily average water supply per capita, the overall daily average domestic water supply per capita is approximately 161LCD.

Table 2.2 Design Daily Average Water Supply Per Capita for Domestic Use

Geographic Area	Design daily average water consumption per capita (LCD)	Design unaccounted for water (LCD)	Design daily average water supply per capita (LCD)	Adopted design daily average water supply per capita (LCD)
Population 50,000 or more	150	(15-30)	(165-180)	165
Population less than 50,000	125	(10-25)	(135-150)	135

b. Industrial water supply

The recommended amount of water supply to industrial area given by the Ministry of Housing and Public Facilities is 2 L/ha/sec. However, in consideration of the fact that some factories in the target area are using own wells and the fact that the target amount of water supply given by NOPWASD in the Project is 1 L/ha/sec, the industrial water supply amount to industrial area 1 L/ha/sec is adopted in the basic design.
Moreover, this industrial water supply shall only be applied to El Mahala El Kobra but not to the 10 surrounding villages where industry is not very active.

2) Design mean daily water supply amount

The design daily average water supply, which GACWASD needs to secure in the Project target area in the Project target year, is calculated from the above design population and design daily average water supply per capita , etc. in the manner shown in Table 2.3. In the Project, this figure shall be the design daily average water supply.

Table 2.3 Design Daily Average Water Supply Required by GACWASD in 2010

Geographical Division	Domestic Water Supply			Industrial Water Supply			Total
	Population	Design daily average water supply per capita	Average water supply	Industrial land area	Design water supply per area	Average water supply	
El Mahala El Kobra	454,746	165LCD	75,033m^3/day (868L/sec)	165ha	1L/ha/s	14,256m^3/day (165L/sec)	89,289m^3/day (1,033L/sec) (196LCD)
Villages (50,000 or more)	60,289	165LCD	9,948m^3/day (115L/sec)	-	-	-	9,948m^3/day (115L/sec)
(Less than 50,000)	83,850	135LCD	11,320^{m3}/day (131L/sec)	-	-	-	11,320m^3/day (131L/sec)
Total	598,885	161LCD	96,301m^3/day (1,114L/sec)	165ha	-	14,256m^3/day (165L/sec)	110,557m^3/day (1,279L/sec) (185LCD)

Table 2.4 shows the results of verifying the designed daily average water supply amount given in the above table in light of the general target values given by NOPWASD. As is shown in the table, the figures set in the Project are smaller than the general target amount given by NOPWASD. Since the NOPWASD targets can be revised upwards at the times of re-expansion when necessary, it is enough reasonable that the figures given in Table 2.4 above shall be adopted in a short-term plan such as this Project.

Table 2.4 Verification of the Design Daily Average Water Supply

Geographical Division	NOPWASD General Targets			Project Values
	Population	Daily average water supply per capita	Daily average water supply	
El Mahala El Kobra	454,746	215LCD	97,770m^3/day (1,132L/sec)	89,289m^3/day (1,033L/sec)
Villages (10,000 or more)	114,151	125LCD	14,269m^3/day (165L/sec)	21,268m^3/day (246L/sec)
Villages (less than 10,000)	29,988	100LCD	2,999m^3/日 (35L/sec)	
Total	598,885	192LCD	**115,038m^3/day (1,332L/sec) (192LCD)**	**110,557m^3/day (1,279L/sec) (185LCD)**

(3) Definition of Design Water Supply Amount

The design water supply amount in the Project is defined as follows.

Design water supply : The basic water supply amount for setting the size of each facility in the WTP. According to the code in Egypt, this amount is decided converting the peak monthly water supply amount to the amount per second.

Design water intake : The amount of water taken from the water source

Design water treatment : The amount of water for calculating water treatment facility's capacity

Design water transmission: The amount of water distributed to the service area

As a rule, the above design water supply shall be calculated according to the Egyptian Code for Design Basis and Implementation Conditions for Water Treatment Plant, Wastewater Treatment Plant and Pump Station. The said code prescribes "design" items with the aim of standardizing the design of treatment plants. Table 2.5 shows design water supply and flows according to this code.

Table 2.5 Method for Calculating Design Water Supply and Flows in the Egyptian Code for Design Basis and Implementation Conditions for Water Treatment Plant, Wastewater Treatment Plant and Pump Station

Design Water Supply	Calculation Method	Remarks
Design water supply	Design daily average water supply x 1.25～1.5	Basic amount for setting the scale of treatment plant facilities
Design water intake	Design water supply x 1.1	Applied to setting the scale of facilities from intake to chemical precipitation basins
Design water treatment	Design water supply x 1.1, 440 m3/sec	Applied to setting the scale of filter basins
Design water transmission	Design daily average water supply x 1.6～1.8	Applied to setting the scale of conveyance pump equipment

(4) Design water supply to be secured in the Project

Based on the design daily average water supply mentioned earlier, the capacity of treatment facilities to be constructed in the Project is set as shown below.

1) Capacity that should be possessed by GACWASD in the Project target year

As was mentioned previously, the design daily average water supply that GACWASD needs to secure in the Project target area in 2010 is 1,279 L/sec. Concerning the peak coefficient required for calculating design water supply, NOPWASD has set a value of 1.4 times. Since this is more or less the average amount prescribed in Egypt and the design daily average water supply is set within the standard, a similar value of 1.4 times shall also be adopted in the Project.

Accordingly, the overall design water supply for the Project target area, which GACWASD needs to retain as its nominal capacity, is calculated as 1,719 L/sec as shown below.

Design daily average water supply: 1,279 L/sec x 1.4 = Overall design water supply: 1,719 L/sec

2) Water supply targeted for development in the Project

Existing Water Supply Facilities in the Target Area are shown in the following table 2.6;

Table 2.6 Existing Water Supply Facilities in the Target Area

Name of WTP	Source	Water Supply Capacity	Distribution Area
El Mahala El Kobra New WTP	Canal	400L/sec	El Mahala El Kobra City Batina, El Qaisaria, and Ezbat Toma Villages
	Well	50L/sec	
	Toatal	**450L/sec**	
El Mahala El Kobra Old WTP	Canal	**360L/sec**	El Mahala El Kobra City
Manshiat El Bakari Compact Unit	Canal	180L/sec	El Mahala El Kobra City
	Well	184L/sec	
	Total	**364L/sec**	
Omar Ibn El Khatab Compact Unit	Canal	**60L/sec**	El Mahala El Kobra City
Intake Well	Well	**170L/sec**	El Makala El Kobra City
Abou Ali Compact unit	Canal	60L/sec	Abou Ali Net Work
	Well	25l/sec	
	Total	**85L/sec**	
Abou Ali Well	Well	**25L/sec**	Abou Ali Net work
Kafr El Genina Compact Unit	Canal	**60L/sec**	Kafr El Genina, Mahalat Hassan and Manshiat El Omara Villages
Total		**1,574L/sec**	

In the event that intakes well to be immediately scrapped are shutdown, the nominal supply capacity of existing facilities in the target area shall be 1,404 L/sec.

From the above table, the nominal supply capacity shall be calculated as follows;

(Total Water Supply Capacity) －(Shut down Intake Well) = 1,574L/sec－170L/sec = 1,404L/sec

Shortage of water supply in the target year 2010 shall be calculated as follows;

(Overall design water supply) － (Total Water Supply Capacity) = 1,719L/sec － 1, 404L/sec

= 387L/sec

In the Project, it is planned to construct facilities with designed water supply of 400L/sec, capable of satisfying the above required amount of water supply.

(5) Setting of design quantity of water

Based on the above design water supply of 400 liters per second and method of calculating each design quantity, the design water to be applied to the new WTP in the Project shall be set as shown in Table 2.7.

Table 2.7 Design Water Supply and Flows Applied to Design of the Water Treatment facilities

Design Water Supply and Flows	Calculation Method	Set Design Water Amount
Design water supply	As indicated above	400L/sec
Design water intake	Design water supply x 1.1	440L/sec = 400L/sec x 1.1
Design water treatment	Design water supply x 1.07	428L/sec = 400L/sec x 1.07
Design water transmission	Design water supply x 1.3 (Design daily average water supply x 1.8)	520L/sec = 400L/sec x 1.3

(6) Design water quality

Water conveyed from the new WTP in the Project shall meet the Egyptian potable water standards shown in Table 2.8. Accordingly, the water quality shown in the table below shall be adopted as the designed treated water quality in the Project.

Table 2.8 Design Treated Water Quality

Item	Treated Water
pH	6.5-9.2
Color	Maximum 20-30 on the cobalt-platinum scale
Taste	Permissible scope
Odor	Must be none
Turbidity	5 Jackson units
Residue on evaporation	1,200
Iron	0.3
Manganese	0.1
Copper	1.0
Zinc	5.0
Hardness	500
Calcium	200
Magnesium	150
Sulfide ion	400
Chlorine ion	500
Natrium	200
Aluminum	0.2
Calcium balance	± 0.1

Note: Where units are not specified, assume mg/L.

(7) Design water level and design ground level

Water level in the El Mallah Canal, which is the water source for the WTP, is under control of the Ministry of Irrigation and Water Resources. The water level at the new WTP is AD+5.64 m (HWL) and AD+4.20 m (LWL), so the water level for the new WTP shall be determined based on these levels.

Meanwhile, since the design ground level of the new WTP shall be adjusted to the ground level of the existing facilities, the design ground level of the new WTP may be approximately AD+6.00 m.

(8) Soil conditions

In consideration of soil conditions on the construction site for the Project, facilities shall be designed with attention given to the following points.

1) Groundwater level

The groundwater level at the new planned construction site is shallow at between 0.5 m and 1 m from the ground surface. Accordingly, dewatering and earth retaining works will be required for excavation works.

2) Soil conditions

The surface layer down to around 1.5 m consists of soft clay. Since this is not suitable for structure foundations, it will be necessary to replace the surface soils or to take other appropriate measures when foundations shall be designed in this layer. Apart from the surface layer, the deeper ground layer is considered to possess sub grade bearing capacity of around 150 kN/m^2, which is enough to support foundations of structures.

2.2.2.2 Facilities Layout Plan

The Project facilities described in the following section shall be allocated according to the following basic design. The results of so doing are indicated in Basic Design Drawing BDWG-001.

- The Project facilities shall be constructed at the north part of the Project area, taking into consideration its ease of the future expansion and rehabilitation planned by the Egyptian side.
- On the south part of the Project area, an enough space for future construction of WTP with the similar capacity to the new WTP shall be secured.
- Conveyance pumps and transmission/distribution pumps shall be installed in the same building to enable easier maintenance.
- Roads in the new WTP shall be arranged so that smooth traffic shall be secured for its operation and maintenance.

2.2.2.3 Intake and Conveyance Facilities

(1) Structure of intake facilities

The structure of intake facilities shall be designed based on the following conditions.

1) The water intake facility shall be fitted with two weirs to prevent floating wastes from the canal into the intake. The floating wastes shall be manually picked up, as same as adopted in the existing WTP

2) Stop logs shall be prepared for the cleaning and maintenance of WTP. During its cleaning and maintenance, they can stop flowing water into the intake facility and intake pipe and can be utilized to facilitate the maintenance and cleaning works.

3) The velocity of flowing water into the intake facility shall be less than 0.3 m/second at the LWL in order to prevent sand and gravel intrusion into the intake.

4) Based on the results of discussions with the Tanta branch of the Ministry of Irrigation and Water Resources, stone pitching shall be placed on the bottom of El Mallah Canal in front of the intake facility and on the slopes of the embankment for the river protection.

(2) Intake pipe

1) Two intake pipes of diameter 600 mm shall be installed to facilitate cleaning and maintenance works without stop or suspending operation of WTP.

2) Flow velocity inside the intake pipes shall be approximately 1.0 m/second to prevent mud from accumulating inside the pipes.

3) Based on the results of discussions with the Tanta branch office of the Ministry of Irrigation and Water Resources, the clearance between the bottom of the existing Drain canal and the top of the new intake pipes shall be kept more than 50cm.

(3) Conveyance facilities

1) A partition wall shall be placed inside the raw water pump suction pit to create two tanks, and a simple gate shall be fitted into the partition to give a structure that enables cleaning and maintenance of the tanks to be carried out without suspending operation of the WTP.

2) Mud entering the raw water pump suction pit shall be deposited at the bottom of the pit. Mud shall be periodically removed by proper portable drainage pump.

3) The raw water pump suction pit shall have enough capacity to secure retention time of at least 5 minutes. In the existing WTP the conveyance pumps and transmission/distribution pumps are installed in the same building, therefore the same arrangement shall be adopted in the Project WTP. Moreover, a chain block shall be fitted inside the said building to facilitate maintenance works.

4) Main specifications of the conveyance pump are as follows.

- Pump type : Horizontal shaft volute pump
- Quantity : 3 units (2 normal use + 1 backup)
- Discharge : 13.2 m^3/minute/pump (400 L/sec x 1.1 = 26.4 m^3/minute, 13.2 m^3/minute per pump)

2.2.2.4 Water Treatment Facilities

2.2.2.4.1 Treatment Method (Handling of Raw Water Quality)

Judging from the quality of water in El Mallah Canal, which is the water source for the Project, the water quality items that require treatment in the Project WTP are turbidity and algae. As for the treatment process, the same process that is used at the existing WTP, i.e. rapid filtration, shall be adopted. In order to remove turbidity and algae and thus supply treated water that is bacteriologically safe, chlorine disinfecting shall be carried out. The composition of equipment at the WTP is described in the following sections.

Treatment Flow	Role
Intake facilities	
Pre-chlorine → / Coagulant → Receiving well, chemical mixing basin	Mix in chemicals that will expedite flocculation in the next flocculation basins. Pre-chlorine: Performs disinfection to control propagation inside the water treatment equipment and prevent plant functions from being impeded. Coagulant: Coagulates turbidity and algae.
Flocculation basin	Gently mix in order to bring algae and turbidity into collision and form large flocs. This aids floc settling in the next chemical sedimentation tanks.
Chemical sedimentation basin → Settled sludge → To Sludge Tank	By imparting sufficient surface load to the flocs of turbidity and algae in the water, accelerate sedimentation and discharge them.
Rapid sand filter → Backwash wastewater → Drainage Tank	Filter out turbidity and algae that pass through the chemical sedimentation tanks.
Post-chlorine → Backwash water sump and chlorine mixing basin	Perform chlorine mixing.
Distribution pump sump	

Figure 2.1 Water Treatment Method

2.2.2.4.2 Receiving Well

(1) Outline of equipment

The receiving well will be installed in order to stabilize fluctuations in the level of raw water conveyed by pumps and to accurately distribute the flow of water to the two basin systems. The receiving well will be a square tank. The main specifications of the well are as follows.

Chemical mixing basins usually may adopt mechanical mixing systems (flash mixer, etc.), pump mixing systems or weir structures. In the Project, mechanical mixing shall not be adopted because, even though it offers high reliability, it is prone to breakdowns. The weir structure shall be adopted because it requires no instruments and is easy to maintain.

Since it is surmised that almost all of the turbidity components in raw water consist of rough suspended solids such as clay and so on, weir mixing should be sufficient to secure an ample mixing effect. Moreover, the flow energy of raw water itself may be able to play a supplementary role in the rapid mixing, when the raw water enters the receiving well. Also, the weir can be used to distribute accurate water into the two basins.

- Type : Square tank type
- Rapid mixing method : Weir method
- Design flow : 26.39 m^3/minute
- Dimensions : 1.5m W x 7.8 m L x 5.2 m H x 4.56 m EH
- Quantity : 1 basin
- Capacity : 53.4 m^3/basin
- Weir height : 60 cm

(2) Scale setting

- Retention time : 1~2 minutes (standard in Egypt)/1.5 minutes or more (standard in Japan)
  53.4 m^3 ÷ 26.39 = 2.0 minutes → OK
- Effective depth : 3~5 m (standard in Japan)
  Water depth 4.56 m, 3 m < 4.56 m < 5 m → OK
- Weir height : 60 cm or higher (design experience of General Design Inc., Japan Water Works Association and water treatment plants in Japan and other countries)
  Weir height: 60 cm → OK

2.2.2.4.3 Flocculation Basins

(1) Outline of equipment

There are flocculation systems, which consist of mechanical mixing (flocculator), the vertical diversion flow method, or the horizontal diversion flow method. In the Project, a diversion flow system, which requires no equipment and entails simple maintenance and is also the same sysytem as adopted in the existing WTP, shall be adopted. Assuming the range of water quality in the Project, this system may achieve full effective flocculation. As for the type of diversion flow system, vertical diversion flow shall be adopted, because compared to horizontal diversion flow, there are less short currents and it is harder for sludge to accumulate.

Concerning the flocculation process, it is necessary to impart strong agitation at the start when flocs are small and gradually reduce the mixing force as the flocs grow in size. Accordingly, the tapered flocculation method, in which the agitation strength is reduced as water moves downstream, shall be adopted. Tapered flocculation in the vertical diversion flow method is achieved by gradually widening the water channel (slowing the flow velocity) in the downstream.

- Method : Tapered flocculation vertical diversion flow
- Design flow : 26.39 m^3/minute
- Basin dimensions : 1.1 m W x 0.965 m L x 3.83 m H x 20 streams
  1.5 m W x 0.965 m L x 3.83 m H x 20 streams
  2.3 m W x 0.965 m L x 3.83 m H x 20 streams
- Capacity : 362.20 m^3/basin
- Quantity : 2 basins
- Retention time : 27.45 minutes

(2) Scale setting

- Retention time : 20 ~ 30 minutes (standard in Egypt) / 20~40 minutes as standard (standard in Japan)
- Depth : 2 ~ 4 m (standard in Egypt)
  3.83 m → OK
- Overall G value : 10-75/second (standard in Japan (good mixing conditions))

$$G = \sqrt{(\rho \times g \times Q \times h/(V \times \mu))}$$

$$= \sqrt{(1{,}000 \times 9.81 \times 0.440 \times 0.234/(724.41 \times 0.001))}$$

= 37.42 /second → OK

Where, P: 1,000 kg/m^3
G: 9.81
Q: 0.440 m^3/second
H: 0.235 m (head loss)

V: 724.41 m^3 (volume for 2 basins)

U: 0.001

- G value in each stage

Stage	V (volume：m)	H (head loss: m)	G value(/s)
1^{st} stage	81.31	0.1554	64.22
2^{nd} stage	110.88	0.0587	33.81
3^{rd} stage	170.01	0.0203	16.06

- GT value : 23,000~210,000 standard in Japan (good mixing conditions))

$$GT = \sqrt{(\rho \times g \times h \times T/\mu)}$$

$$= \sqrt{(1{,}000 \times 9.81 \times 0.234 \times 27.45 \times 60/0.001)}$$

$$= 61{,}619 \quad \rightarrow \text{OK}$$

Also, see Reference 1 for detailed hydraulic calculations.

2.2.2.4.4 Coagulation Sedimentation Basins

(1) Outline of equipment

Concerning the sedimentation method, the general cross current system (or called as the horizontal flow system), which is also used in the existing WTP, shall be adopted. The system whereby an inclined panel is installed may show high efficiency, but its harder maintenance system shall not be adopted in the new WTP.

In order to raise the surface load factor and to avoid the water flow disturbances and short circulation flow, which may reduce the removal efficiency, perforated baffles shall be installed in the inflow, the middle and outflow sections.

Troughs shall be placed at the outflow section in order to remove low-turbidity precipitated water without disturbing currents inside the basin. As for the sludge collection method, a reciprocal mechanism comprising a simple structure that is cheap and easy to maintain shall be adopted.

1) Sedimentation basin

- Sedimentation basin type : General cross current single layer sedimentation basin
- Design flow : 26.39 m^3/minute
- Dimensions : 11.0 mW x 40.5 mL x 5.24 mH x 4.5 mEH
- Quantity : 2 basins
- Surface load factor : 29.62 mm/minute
- Mean flow velocity : 0.267 m/minute
- Retention time : 153.8 minutes (2.6 hours)

2) Collection trough

- Dimensions : 2.0 mL x 2 sides x 8 troughs + 11.0m x 2 troughs = 54 m

- Overflow load : 351.85 m^3/(day/m)

3) Perforated baffles

- Quantity : 5 points/basin (1 incoming, 3 middle, 1 outflow)
- Total perforation area : 6% (ratio to flow section area)
- Perforation diameter : 0.1 m

4) Chemical sedimentation basin sludge removal method

- Sludge collection method : Reciprocal method

(2) Scale setting

- Surface load factor : 14 ~ 31 mm (standard in Egypt) / 15 ~ 30 mm (standard in Japan)
  26.39 m^3/minute ÷ 11.0 m ÷ 40.5 m ÷ 2 basins × 1000
  = 29.62 mm/minute → OK
- Retention time : 2 ~ 3 hours (standard in Egypt)
  2.6 hours → OK
- Mean flow velocity : Adopt 0.4 m/minute or less as standard (standard in Japan)
  26.39 m^3/minute ÷ 11.0 m ÷ 4.5 m ÷ 2 basins
  = 0.267 m/minute → OK
- Depth : 2 ~ 4 m (standard in Egypt)/Approximately 3~4 m, sludge depth 0.3 m or more (standard in Japan)
  Based on the design ground level and water level in the sedimentation basin, effective depth shall be set at 4.5 m and sludge depth at 0.74 m.
  (Design water level of sedimentation basin (11.24 m) – Design ground level (6.0 m) = 5.24 m)
  In the Japanese standard, turbidity removal effect increases in line with depth, however, taking construction cost into account, around 3~4 m basin depth is appropriate. Accordingly, as far as the construction cost is reasonable, there is no technical impediment in the deep water basin.
- Aspect ratio : Adopt 3~8 m as standard (standard in Japan)
  40.5m ÷ 11.0m = 3.7 → OK
- Collection troughs and perforated baffles: See Reference 2 for the equipment design
- Selection of the sludge collection method and sludge removal cycle: See Reference 3

2.2.2.4.5 Rapid Filter Basins

(1) Outline of equipment

The rapid filter basins in the Project shall have enough capacity to filter the design water treatment plus an additional 7 % in consideration of the washing water. As for the control system, a semi-automated system using a control panel installed in the filter basin control building shall be adopted. Since this is the same as the system adopted in the existing WTP, it will be easier to deal with breakdowns.

Filter basin method

Filter basins adopt either the general gravity open-type filter basin system or the self-regulating backwash filter basin system. In the Project, since water sumps for back wash, which will be also used to secure sufficient retention time for chlorine mixing, the normal gravity open-type filter basin system using backwash pumps shall be adopted.

Filter basin washing method

Filter basin washing system consists of the surface wash + backwash approach or the air wash + backwash system. In the existing WTP, the air wash + backwash system is adopted. In the existing system, compressed air equipment shall be required; moreover, since air washing causes air holes to form on parts of the filter bed surface where the flow membrane is weak, thereby preventing adequate surface washing, and air wash nozzles sometimes break to let filter sand escape, there is a risk that the filtration effect will not be fully realized.

In the Project, the surface washing + backwash system shall be adopted because 1) it is widely used in Japan, 2) it is also used with good effect at the existing South Giza WTP, 3) backwash effect and filtration effect during washing may be better compared to the existing system, and 4) maintenance is easy because the main inspection and also repair parts are fitted on above the sand filter.

It will be necessary to use treated water containing residual chlorine as the washing water to prevent propagation of algae and microorganisms during filtration and thus prevent contamination and filtration failure.

NOPWASD pointed out that in Egypt it is obligation that the treated water after filtration but before post-chlorination is used for filter back-wash and requested to explain about the purpose of chlorinated water for back-washing and its financial aspects. Its purpose is mentioned in the sentence above. As for financial aspect, if it is assumed that back wash is conducted once per day the amount of backwash water would be 1,248 m^3/day, which is equivalent to about 3 percent of the total treated water amount. This indicates that 3 percent of chlorine is consumed for back-wash water. Furthermore, if half of the chlorine is applied to pre-chlorination, the consumption of chlorine is 1.5 percent of the total consumption. This amount is very little and does not affect financial feasibility in operation of the WTP.

The main specifications of this equipment are as follows.

- Filtration method : Normal gravity open-type rapid filtration

- Filter basin wash method : Surface washing + backwashing
- Quantity : 4 basins x 2 series = 8 basins
- Washing method : Backwashing + surface washing
- Design flow : 38,000 m^3/day (1.07 times the design supply flow (400 L/sec)
- Number of basins : 8 basins
- Surface area : 33.8 m^2/basin
- Filtration velocity : 140.7 m/day (when all basins are operating)
- Filtration velocity : 160.8 m/day (when 1 basin is being washed)
- Dimensions : 4.5 mW x 7.5 mL
- Backwash flow velocity : 0.6 m^3/m^2/minute
- Backwash time : 6 minutes
- Surface wash flow velocity : 0.2 m^3/m^2/minute
- Surface wash speed : 5 minutes

(2) Scale setting

- Filtration velocity : 120 ~ 180 m/day (standard in Egypt)/120~150 m/day (standard in Japan)
  38,000 m^3/day ÷ 33.8 m^2/basin ÷ 8 basins＝140.7m/day →OK
- Backwashing : Backwash time: 5~6 minutes (standard in Egypt)/4~6 minutes shall be standard (standard in Japan)
- Backwash flow velocity : 0.6 m^3/m^2/minute
- Backwash flow per basin : 20.25 m^3/minute
- Backwash time : 6 minutes
- Washing wastewater flow : 121.5 m^3/basin
  972 m^3/day (washing each basin once per day)
- Backwash pump specifications
  - Type : Submersible pump
  - Quantity : 3 units
  - Necessary discharge rate : 10.13 m^3/minute
  - Total head : 10 m
- Surface washing : 4~6 minutes shall be standard (standard in Japan)
  : 0.2m^3/m^2/minute
  : 6.75m^3/miute
  : 5 minutes
- Surface wash pump specifications
  - Type : Submersible pump
  - Quantity : 2 units (including 1 backup)
  - Necessary discharge rate : 6.75 m^3/minute

Total head : 25 m

Motor output : 45 kW

- Valves

Name	Type	Flow Rate (m^3/min)	Standard flow velocity (m/s)	Diameter (mm)	Actual diameter (mm)	Actual flow velocity (m/s)	Scope of flow velocity (m/s)
Filter basin inflow valve	Motor-operated butterfly valve	3.77	0.6	366	350	0.65	0.5～1.0
Surface wash valve	Motor-operated butterfly valve	6.75	2.5	240	250	2.29	2.0～3.5
Backwash valve	Motor-operated butterfly valve	20.25	2.5	416	400	2.69	2.0～3.5
Treated water valve	Motor-operated butterfly valve	3.77	1.0	283	350	0.65	0.6～1.5
Backwash drainage valve	Motor-operated butterfly valve	27.00	2.0	536	600	1.59	1.5～3.0

2.2.2.4.6 Chemical Dosing Facilities and Chlorine Neutralization Equipment

(1) Outline of equipment

In the Project water treatment system, as same as in the existing WTP, chlorine shall be used for algae removal and sterilization and aluminum sulfate shall be used as a coagulant.
In consideration of safety when handling chlorine, neutralization equipment for leaked chlorine gas shall be planned together with a chlorine injection equipment room and aluminum sulfate mixing room.

Aluminum sulfate injection equipment

Existing water treatment plants in Gharbeya Prefecture usually use liquid aluminum sulfate as a coagulant. In the Project, the same liquid aluminum sulfate shall be used at ordinary times, while solid aluminum sulfate shall be used when supply of the liquid version is suspended or prices are too high. Accordingly, equipment that can meet both types of aluminum sulfate shall be installed.

Chlorine injection equipment

Judging from the quality of raw water, chlorine injection equipment that injects both the pre-chlorine and post-chlorine shall be installed, in order to kill algae and microorganisms that are contained in large quantities in raw water and to sterilize the treated water.

As same as in the existing WTP, 1-ton (1,000 kg) cylinders of liquid chlorine shall be used. The cylinders shall be kept in the storage room provided in the chemical dosing building and shall be carried to the chlorine injection equipment room when needed for use.

As for the method of injection, the vacuum wet chlorine injection method shall be adopted. A vacuum wet chlorine injection unit shall be installed whereby pressurized water is fed to the injector by water feed pump, and the chlorine gas is measured before the chlorine solution is injected. A meter shall be attached to check the remaining quantity of chlorine in the cylinder, and a chain block shall be installed to ensure safety when carrying cylinders in and out.

Leaked chlorine gas neutralization unit

Neutralization equipment shall be installed as a safety measure in the event of leakage of chlorine gas, which is highly toxic. Capacity of the equipment will be determined according to the space of the chlorine injection equipment room and the number of chlorine cylinders installed. Assuming that one 1-ton cylinder leaks for one hour, the equipment shall be set to activate an alarm and automatically start the neutralization as soon as the gas leak is detected.

(2) Scale setting

Aluminum sulfate injection equipment

1) Dissolution tank
- Type : FRP tank
- Quantity : 2 units
- Dimensions : 1.8 mW x 1.8 mL x 1.8 mH x 1.23 mEH
- Capacity : 4.0 m^3/tank

2) Aluminum sulfate injection pump
- Type : Chemical injection pump
- Capacity : 100 L/hour x 10 kg/cm^2 x 0.2 kW
- Quantity : 2 units (including 1 backup)
- Injected amount : q = Q/24 x A x 1/C x 10-3 = 36.12 L/hour
(Assuming an allowance rate of at least 2 times and aluminum injection pump capacity of 100 L/hour)

Where, Q: 38,000 m^3/day (water flow)
A: 30 mg/L (mean chemical injection rate)
B: 8.3% (dissolved concentration)
C: 1.315 (specific gravity)

Item	Mean Value	Remarks
Aluminum sulfate injection rate (mg/L)	30	Optimum injection rate in the JICA study is 20 mg/L. Assuming that the present rate is 40 mg/L, the design mean injection rate shall be set at 30 mg/L. See Appendix 5 Water Quality Test Results (Jar Test).
Aluminum sulfate dosage (L/hour)	36.12	Pump capacity: 100 L/hour
Aluminum sulfate dosage (kg/day)	1140	
Dissolution tank continuous use time (days)	4.6	
Alkalinity reduction	13.500	Alkalinity reduces by 0.45 for every 1 mg/L injected. Alkalinity of raw water is approximately 120, however, since this degree of alkalinity reduction has no effect on coagulation, it will not be necessary to add slaked lime.

3) Storage space for solid aluminum sulfate

Amount of A1203 = Q x A x B x 10-3 = 94.6 (kg Al203/day)

Amount of aluminum sulfate (A1203 14% weight) = 94.6 ÷ 0.14 = 676 (kg 14% Al203/day)

Assuming storage for 20 days, the stored amount will be: 676 (kg 14% Al203/day) ÷ 50 kg bags x 20 days = 270 bags

Assuming a 50 kg bag measures 0.4 mW x 0.8 mL x 0.15 mH, and that 270 bags are arranged as 9 bags x 3 lines a 10 layers:

Length = 0.4 mW x 9 bags x 1.1 (side gap) = 4 m

Width = 0.8 mL x 3 lines = 2.4 m

Height = 0.15 mH x 10 layers = 1.5 m

Therefore, the chemical injection room shall have solid aluminum sulfate storage space of around 2.4 mW x 4 mL x 1.5 mH. In consideration of traffic lines from trucks and to the dissolution tanks, the storage space shall also be given some room to spare.

4) Aluminum sulfate conveyance pumps

- Type : Chemical injection pump
- Capacity : 350 L/hour x 10 kg/cm^2

  Assuming the dissolution tank becomes empty in 12 hours:

  Conveyance pump capacity = 4 m^3 ÷ 12 hours x 1,000 = 333 L/h ->= 350 L/h
- Quantity : 2 units (including 1 backup)

5) Liquid aluminum sulfate storage tank

- Type : FRP tank

- Quantity : 1 unit
- Capacity : 14 m^3
- Storage time : 14 m^3 ÷ 36.12 L/hour ÷ 24 x 103 = 16 days

Chlorine injection unit

1) Pre-chlorine

- Water volume (Q) : 38,000 m^3/day
- Chlorine injection rate : Maximum (A) 7 mg/L (maximum pre-chlorine injection rate) (standard in Egypt), Mean 3 mg/L
- Chlorine cylinder : 1,000 kg
- Maximum dosage : $q = Q \times A \times 10^{-3}$
  = 266 kg/day = 11.08 kg/hour (maximum capacity 6 kg/hour x 2 units = 12 kg/hour)

Item	Mean	Maximum	Remarks
Chlorine injection rate（mg/L）	3.0	7.0	Water quality tests by JICA show that almost all algae in raw water are diatomaceous. Around 2.0~3.0 mg/L is required to sterilize diatomaceous algae.
Chlorine dosage （kg/H）	4.75	11.08	
Alkalinity reduction	4.23	9.870	Alkalinity reduces in the ratio of 1.41 for every 1 mg/L injected.

2) Post-chlorine

The maximum post-chlorine dosage shall be the amount obtained upon subtracting the maximum amount of pre-chlorine injection from the maximum total chlorine dosage (10 mg/L).

- Water volume (Q) : 37,000 m^3/day

- Chlorine injection rate : Maximum (A) 3 mg/L (= 10 mg/L – 7 mg/L), Mean 2 mg/L
- Chlorine cylinder : 1,000 kg
- Maximum dosage : q = Q x A x 10-3
  = 111 kg/day = 4.63 kg/hour (maximum capacity 6 kg/hour x 1 units = 6 kg/hour)

Item	Mean	Maximum
Chlorine injection rate（mg/L）	2.0	3.0
Chlorine dosage （kg/H）	3.17	4.75

3) Cylinder replacement frequency (at times of maximum injection)

- Pre-chlorine dosage : 11.08 kg/hour (maximum capacity 12 kg/hour)
- Post-chlorine dosage : 4.75 kg/hour (maximum capacity 6 kg/hour)
- Total dosage : 15.83 kg/hour
- Cylinder replacement frequency: 63.17 hours (2.6 days)
- Number of cylinders : 8
- Stored amount : 20.8 day supply

Leaked chlorine gas neutralization equipment

1) Caustic soda storage tank

- Type : Square closed tank
- Capacity : 11 m^3
- Concentration : 15 weight % NaOH
- Quantity : 1

2) Neutralization tower

- Type : Vertical cylindrical two tower type
- Capacity : 1,000 kg/hour
- Quantity : 1

3) Caustic soda circulation pump

- Type : Horizontal shaft volute chemical pump
- Capacity : 900 L/minute
- Head : 10 m
- Output : 7.5 kW
- Quantity : 2 units (1 backup)

4) Exhaust fan

- Type : Turbo fan
- Capacity : 60 m^3/minute
- Discharge pressure : 250 mmAq
- Output : 7.5 kW
- Quantity : 1 unit

5) Leak detector

- Type : Dial sensor type
- Capacity : 0 ~ 5 ppm
- Quantity : 1 unit

2.2.2.4.7 Sludge Treatment Facilities

In order to discharge backwash wastewater and settled sludge into the drainage canal, it is necessary to comply with the Egyptian Code concerning Wastewater Discharge into Drainage Canals. With a view to securing wastewater quality that meets the discharge standards as shown in Table 2.9 below, the following options were examined. Moreover, for reference purposes, Reference 4 shows the results of examining different dewatering and drying methods.

Table 2.9 Assessment of Sludge Treatment and Disposal Options

Sludge Disposal Method	Assessment	
1. Current method (direct discharge)	Does not satisfy the final effluent standard (SS)	X
2. Thickening, mechanical dewatering, and dewatered sludge removal	Construction and maintenance costs are expensive. Also, maintenance is complicated.	X
3. Thickening, sun-drying bed, and dried sludge removal	The plant has no space to install sun-drying beds.	X
4. Transport of unthickened wastewater out of the plant, and sun-drying in an existing sewage treatment plant	Unthickened wastewater is too cumbersome to transport.	X
5. Transport of thickened sludge out of the plant, and sun-drying in an existing sewage treatment plant	An effective method providing that the existing sewage treatment plant has enough sun-drying bed capacity	○

Note: See Reference 4 for a comparison of dewatering and drying methods.

As a result of examination, as the optimum approach for backwash wastewater and sedimentation tank sludge treatment and disposal, the method whereby thickened sludge is carried out of the WTP and sun-dried at an existing sewage treatment plant shall be adopted. Accordingly, sludge treatment facilities in the Project shall consist of wastewater sumps, sludge sumps, sludge thickener, equipment for transportation, and sun-drying beds at an existing sewage treatment plant. The roles and main specifications of sludge treatment facilities are given below.

- Wastewater sumps
- Sludge sumps
- Sludge Thickener
- Thickened sludge transportation equipment (vacuum cars)

- Dewatering and drying facilities (existing facilities at an existing sewage treatment plant)

Wastewater sumps

Since the backwashing process uses large amounts of water in a short time, the wastewater sumps shall function as buffers for equalizing load placed on sludge treatment facilities in terms of concentration and quality. The sumps shall receive wastewater from the surface washing and backwashing processes. Supernatant liquid shall be continuously returned to the receiving well to ensure the effective utilization of water resources.

- Type : Reinforced concrete tank
- Dimensions : 6 mW x 10 mL x 4 mD
- Quantity : 2
- Capacity : 480 m^3

(1) Design flow

The sumps will primarily receive surface wash water and backwash water from the filter basins.
Design flow in filter basins = 37,000 m^3/day (440 L/sec x 1.07)

(2) Scale setting

The initial discharge water and washing water flow per cycle are calculated as follows.
Surface washing water flow = 0.2 m/minute x 5 minutes x 33.8 m^2 = 34 m^3/cycle
Backwash water flow = 0.6 m/minute x 6 minutes x 33.8 m^2 = 122 m^3/cycle
Filter basin top and side spaces = 1.7 mD (maximum basin depth – trough height) x 4.5 mL x 7.5 mW x 2.1 mD (trough height – basin bottom) x 1.2 mL x 7.5 mW = 76 m^3
Initial discharged water per cycle + wash water flow = 34 + 122 + 76 = 232 m^3
The wastewater sumps shall have enough capacity to hold at least one cycle of wastewater during times of filter basin washing (standard in Japan). In consideration of cleaning, inspections and repairs, two sumps shall be installed. Taking extension of backwash time (increase in later stage discharged water) into account, the sumps shall have enough capacity to hold water generated from 2.0 cycles.
6 mW x 10 mL x 4 mD x 2 sumps = 480 m^3
480 m^3 ÷ 232 m^3 = 2.07 cycles→ OK

Sludge sumps

The sludge sumps will temporarily hold sludge from the sedimentation basins and wastewater sumps. They will serve to adjust hourly changes in the sludge flow to ensure that uniform amounts are treated in the following thickening and other processes.

- Type : Reinforced concrete tank

- Dimensions : 6 mW x 4 mL x 4 mD
- Quantity : 2 sumps
- Capacity : 192 m^3

(1) Design flow

The sumps will primarily receive sludge from the chemical sedimentation tanks, but they will also accept small amounts of sludge from the wastewater sumps.

Design flow in chemical sedimentation tanks 38,000 m^3/day (400 L/sec x 1.1)

(2) Scale setting

The generated amount of solids is calculated as follows:

$S = Q \times (T \times E1 + C \times E2) \times 10^{-6}$

$= 38{,}000 \times (20\times1.0+30\times8.3/100\times1.53) \times 10\text{-}6 = 0.90$ (t-ds/day) = 900 kg-ds/day

Where, S: Design treated solids (t-ds/day dry weight)
Q: Design intake flow (l/d) 440 (expanded portion)
T: Design raw water turbidity (degrees) 20 (mean)
E1: Conversion rate between turbidity and suspended solids (SS) 1
C: Coagulant injection rate (aluminum sulfate) = 30 mg/L x 8.3/100
However, concentration of aluminum sulfate is assumed to be 8.3%
E2: Ratio of water to aluminum sulfate 1.53

Assuming the concentration of sludge at the bottom of the chemical sedimentation tank is 1% (10 kg-ds/m^3), the discharged amount of water will be as follows.

900 kg-ds/day ÷ 10 kg-ds/m^3 = 90 m^3/day

The sludge sumps will have enough capacity to hold at least one day of generated sludge (standard in Japan). In consideration of generated sludge when raw water turbidity is at the maximum value, capacity sufficient to hold 2.0 days of mean generated sludge shall be provided.

192 m^3 ÷ 90 m^3/day = 2.1 days > 2.0 days → OK

Sludge thickening tanks

These tanks will reduce the volume of sludge generated in the water treatment processes by performing natural gravity sedimentation of the sludge.

- Type : Reinforced concrete tank (with sludge mixer)
- Dimensions : Round basin ψ7 m x 4 mD (38.5 m^2)
- Quantity : 2 tanks

- Capacity : 308 m^3

(1) Design flow

The sludge sumps will receive sludge from the chemical sedimentation tanks. The design flow of the coagulation sedimentation basins is 38,000 m^3/day.

(2) Scale setting

Necessary area of sludge thickening tanks (A) is as follows:

A = S / q1 = 900 / 15 = 60m^2 < 38.5 m^2 x 2 = 77 m^2 → OK

Where, S: Generated solids 900 kg-ds/day
Q1: From solid load 10~20 kg/m^2/day (standard in Japan), adopt 15 kg/m^2/day

Standard effective depth of the sludge thickening tanks shall be 3.5~4.0 m (standard in Japan). Accordingly, effective depth of the sludge thickening tanks shall be 4.0 m.
Therefore, capacity = 38.5 m^2 x 4 m x 2 tanks = 308 m^3

<u>Thickened sludge transportation equipment (vacuum cars)</u>

Thickened sludge shall be carried away by vacuum car. Judging from the amount of thickened sludge at the plant, a 10 ton class vacuum car shall be adopted.

- Type : Vacuum car (approximately 10 ton class)
- Quantity : 1
- Carrying frequency : 3~4 times/day

Assuming the concentration of thickened sludge to be 3%, the amount of thickened sludge will be as follows.

900 kg-ds/day ÷ 0.03 x 10^3 = 30 m^3/day

Carrying time per trip is calculated as around 2 hours as shown below.

- Preparation : 10 minutes (water treatment plant)
- Suction : 10 minutes (water treatment plant)
- Transfer : 30 minutes (water treatment plant to sewage treatment plant)
- Discharge : 20 minutes (sewage treatment plant)
- Transfer : 30 minutes (sewage treatment plant to water treatment plant)
- Total : Approximately 2 hours

Accordingly, in order to complete the necessary work in 1 working day of around 8 hours, one 10-ton vacuum truck is required.

- Capacity of 10 ton vacuum car : Approximately 8,800 L

- Number of trips : 3.4 times/day

Dewatering and drying facilities (existing equipment at an existing sewage treatment plant)

The sun-drying bed method is a natural approach to dewatering and drying sludge. In this facility, after removing supernatant and reducing the water content of sludge by filtration, water content will be further evaporated by solar heat and wind. Then the dried solid sludge will be sold to farmers in the same way as sludge from the sewage treatment plant. Reference 5 gives an outline of sun-drying beds at the existing El Mahala El Kobra Sewage Treatment Plant.

- Dewatering method : Sun-drying (in El Mahala El Kobra Sewage Treatment Plant)
- Disposal method : Selling to farmers as compost (with sewerage sludge)

2.2.2.5 Filter Basin Washing Water Tanks

In the Project, the new WTP shall not have a treated water reservoir with the function of water distribution reservoir, but has water sumps for back wash. Since the Project site has a limited area in the existing WTP, the water sumps shall be constructed underneath the rapid filter basins in an integrated civil engineering structure. Moreover, a nozzle for connecting with distribution pipes shall be equipped with the sumps so that the Egyptian side may hydraulically connect with the existing treated water reservoir in the future. The capacity of water sumps shall be 2,000 m^3, which may be enough to provide back wash water for a minimum of one day's use.

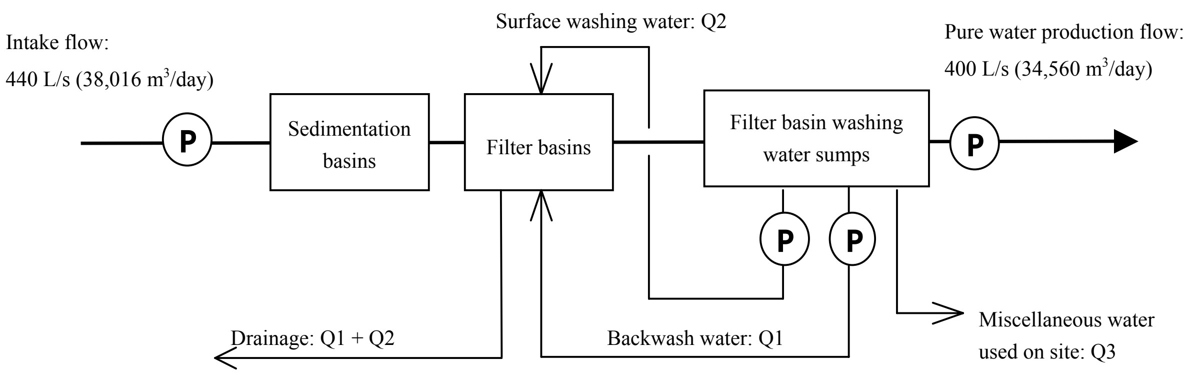


Figure 2.2 Water Balance in the Water Purification Process (Daily Standard)

In the Project, surface washing and backwashing in the eight filter basins shall be carried out once a day. Therefore, since the capacity of the water sumps shall have enough amount of water required for its washing water a day, the necessary capacity has been calculated as follows:

Backwash water flow: Q1 = q1 x A x T x N x C

= 0.6 m^3/minute x 33.75 m^2/basin x 6 minutes x 8 basins x 1.5 = 1,458 m^3

Surface washing: water flow Q2 = q2 x A x T x N x C

= 0.2 m^3/minute x 33.75 m^2/basin x 5 minutes x 8 basins x 1.5 = 405 m^3

Washing water flow: Q1 + Q2 = 1,458 + 405 = 1,858m^3 → 2,000m^3

Where,
- q1: Unit backwash water flow
- q2: Unit surface washing water flow
- A: Area per filter basin (4.5 m x 7.5 m = 33.75 m^2)
- T: Washing time
- N: Number of filter basins (8 basins)
- C: Add-on coefficient

2.2.2.6 Transmission and Distribution Pumps

Transmission and distribution pumps shall be selected based on the design flow rate and design head. When selecting pumps (models and quantities), priority shall be given to pumps that have wide general applicability, are easy to maintain and are standard models on the market. The number of pumps shall be sufficient to allow easy control of capacity according to the actual operating mode.

(1) Design capacity

Since the Project treatment facilities do not possess water distribution functions, the rated pure water production flow shall be the transmission and distribution flow at times of normal operation. However, in case of emergencies such as fire and so on, since it may be urgently required to transmit the water stored in the filter basin washing water sumps, the design capacity of transmission and distribution pumps shall be set as follows. In cases where water stored in the filter basin washing water sumps needs to be transmitted in an emergency, a coefficient of 1.4 shall be applied to the rated transmission and distribution flow at times of normal operation based on the Egyptian code.

- During normal operation: 400 L/sec
- During emergency transmission: 520 L/sec (400 L/sec x 1.4)

(2) Design head

Pure water produced in the Project treatment facilities will be transmitted to the water distribution network together with pure water from the existing facilities. Therefore, it will be necessary to align the design head of transmission and distribution pumps with the transmission pressure of existing pump equipment. Assuming friction loss inside pipes, design head shall be set at 60 m.

(3) Number of pumps and pump capacity

The difference in design capacity between times of normal operation and times of emergency water transmission shall be handled by adjusting the number of operating pumps. Overall there shall be five pumps taking into account installation space, operating modes, required engine capacity per pump and the need for spare pumps. Moreover, capacity per pump shall be as follows:

1) Number of operating pumps

- During normal operation: 3 operating pumps + 2 spare
- During emergency transmission: 4 operating pumps + 1 spare

2) Capacity per pump

- During normal operation: 400 L/sec x 1/3 = 13.3 L/sec = 8.0 m^3/minute
- During emergency transmission: 520 L/sec x 1/4 = 130.0 L/sec = 7.8 m^3/minute

Based on the above calculations, the capacity per pump shall be 8.0 m^3/minute.

(3) Pump model

Judging from the above pump capacity and head, horizontal axis double suction volute pumps that have high general applicability and are easy to maintain shall be adopted. Moreover, the pumps shall be installed at a point lower than the low water level inside the filter basin washing water sumps, in order to enable forced operation and remove the need for water sealing.

2.2.2.7 Operating Method and Monitoring System

2.2.2.7.1 Operating Method

In consideration of the operation and maintenance of WTP after the start of its operation, the manual operating system shall basically be adopted. Judging from the current conditions of the existing WTP, it would be troublesome to introduce the fully automated operation system that is almost adopted in water treatment plants in Japan. Promoting automated operation system may generate a higher frequency of breakdown, and it has been decided to give priority to an easier maintenance system in the new WTP. However, in tandem with the manual approach, a semi-automated system shall be adopted (with possible switchover). The semi-automated system enables a series of operations to be consecutively executed at the push of a switch and is intended to prevent the kind of mistakes that occur in manual operation.

2.2.2.7.2 Monitoring System

In the Project, it is planned to introduce a monitoring system with the aim of ensuring the appropriate operation and maintenance of water treatment facilities. Data obtained from the facilities in the WTP will be displayed on the monitoring panel in the electricity room, and transferred from the display panel to a computer. The computer will store and process the data and output the results as information necessary for operation and maintenance. Table 2.10 shows a list of the target data. Since data will be acquired not only from the new WTP but also the existing WTP, the necessary apparatus shall be prepared by the Egyptian side. Moreover, concerning the method of processing the data acquired in the monitoring system and the method of utilizing the resulting information, technical assistance and training shall be given to the Egyptian side via the Soft Component of the Project.

Table 2.10 Data Acquired in the Monitoring System

Target Facility	Type of Data	Place of Data Acquisition	Data Acquiring Instrument
This Project	Intake flow	Intake pump discharge pipe	Flowmeter
	Transmission and distribution flow	Transmission and distribution pump discharge pipe	Flowmeter
	Residual chlorine concentration in pure water	Transmission and distribution pump discharge pipe	Residual chlorine gauge
	Capacity of filter basin washing water tanks	Filter basin washing water tanks	Level meter
	Electric energy	Power receiving panel (inside the electricity room)	Wattmeter
Overall purification plant	Transmission and distribution flow	Transmission and distribution pipes from the plant Works borne by the Egyptian side	Flowmeter
	Residual chlorine concentration in pure water	Transmission and distribution pipes from the plant Works borne by the Egyptian side	Residual chlorine gauge

2.2.2.8 Power Receiving Facilities

(1) Existing equipment

El Mahala El Kobra Water Treatment Plant currently obtains electric power transmitted from El Mahala El Kobra Substation via the Abou Ali switching station and received by means of the following equipment.

- Lead-in lines: 2 lines (ordinary use and backup)
- Lead-in method: Underground line
- Lead-in voltage: 11 kV, 3 phase 3 wire, 50 Hz
- Transformer capacity: 2 x 1,000 kVA
- Model: Outdoor shelter-contained type

(2) Power receiving equipment

The new WTP in the Project will also obtain electric power transmitted from El Mahala El Kobra Substation via the Abou Ali switching station. New power lines will be installed in order to receive the necessary power.
Specifications on the power receiving equipment in the Project are as follows:

- Lead-in lines: 2 lines (ordinary use and backup)
- Lead-in method: Underground line
- Lead-in voltage: 11 kV, 3 phase 3 wire, 50 Hz
- Transformer capacity: 2 x 1,250 kV

Since the 11 kV distribution line to be installed and connected from Abou Ali substation to the Project is a part of the scope of works of the Egyptian side, NOPWASD will make a contract with the power distribution company under its jurisdiction. Moreover, since internal regulations of the said company may require that the power factor at the receiving end shall be at least 90%, the overall power factor in the Project shall also be planned to be more than 90%.

(3) Electric Substation

The transformer in the Project shall be installed in the electricity room. The transformer shall have a cover fitted over the live part. The main specifications of the transformer shall be as follows.

- Transformer: 11 kV/380 – 220 V, 50 Hz, 1,250 kVA
- Outdoor oil-immersed self-cooling type: 2 units (ordinary use + backup)
- High-voltage distribution panel: Vacuum circuit breaker (VCB), self-standing closed distribution panel
- Low-voltage distribution panel: Circuit breaker for molded wiring

(4) Power distribution method

Concerning the wiring, a cable pit and cable rack shall be adopted, and conduits shall be adopted for the terminals. As for the electricity system, the following system shall be adopted based on the power network in the local area.

- High-voltage: 11 kV, 3 phase 3 wire, 50 Hz
- Low-voltage: 380-220 V, 3 phase 3 wire, 50 Hz
- Direct current (control system): DC100 V 3-2-9, emergency generator

2.2.2.9 Emergency Generator

(1) Need for emergency generator equipment

Power for the Project will be received through two lines from the 11 kV city distribution grid, however, according to the local power distribution company, power outages are regularly conducted (once every two weeks, 3-4 hours per time) in order to conduct system maintenance. Moreover, NOPWASD requires all water treatment plants to install emergency generator equipment since cessation of plant operation may give an adverse impact on the local residents and the power distribution in the local networks are unreliable.

Water distribution in the Project area is planned to be carried out by using pumps. Therefore, any stoppages in the water treatment plant will have a major impact on water supply to the local area. In consideration of this, emergency generator equipment shall be installed as a countermeasure against power outages in the Project.

Concerning the type of emergency generator equipment, a diesel generator similar to that adopted in the existing WTP shall be installed.

(2) Necessary capacity of the emergency generator

Concerning the emergency generator capacity, NOPWASD stipulates that the capacity shall have at least 50% of the overall load capacity, to ensure the minimum required water supply functions during power outages. For this reason, in accordance with the NOPWASD regulations, the capacity of emergency generator equipment in the Project shall be determined upon taking into account the operation load (of transmission pumps, chlorine injection units, chlorine neutralizers, etc.) needed to secure the minimum required water transmission during power outages, as well as the necessary equipment (monitoring control equipment, etc.) for immediately restoring treatment plant functions after power is restored. Concerning the capacity of the emergency generator equipment in the Project, the highest value obtained from the following three methods shall be adopted with respect to the emergency operation load (equivalent to 50% of the total load capacity).

1) Capacity based on required input during full load routine operation

$$P_{G1} = \frac{P_0}{\eta \times P_f}$$

Where, PG1: Generator output (kVA)

Po: Sum of total load output (kW) (value taking the load demand factor into account)

η: Load efficiency

Pf: Load power factor

2) Capacity based on voltage drop at times of motor start-up

$$P_{G2} = P_S \times \left(\frac{1}{V_d} - 1 \right) \times X_d$$

Where, PG2: Generator output (kVA)

Ps: Inrush capacity at startup (kVA)

Vd: Allowable voltage drop (generally 20~30%)

Xd: Generator direct axis excessive reactance (generally 20~30%)

3) Capacity based on instantaneous peak load

$$P_{G3} = \frac{\Sigma W_0 + (QL_{max} + \cos\theta\, QL)}{KG \times \cos\theta\, G}$$

Where, PG3: Generator output (kVA)

∑Wo: Total load during current operation (kW)

QLmax: Peak startup inrush load (kVA)

cosθQL: Power factor during peak startup inrush load

KG: Overload resistance of generator engine (generally 1.2)

cosθG: Generator power factor (usually 0.8)

4) Determination of generator capacity

Each calculated capacity is as follows:

P_{G1} = 576.1 kVA

P_{G2} = 570.2 kVA

P_{G3} = 528.9 kVA

Accordingly, the required generator capacity is 571.6 kVA or more, and 625 kVA is selected here.

(3) Fuel Tank Capacity

Fuel storage capacity of the emergency generator equipment shall be determined based on the frequency of power outages and voltage fluctuations. Power outages and voltage fluctuations occur once per day and last for around 3-4 hours. Therefore, assuming 4 hours per day to be the maximum, the necessary capacity is calculated by the following expression:

Necessary capacity (L) = Fuel consumption (135 l/h) x Operating time x Operating days

= 135 x 4 x 14 = 7,560 L

Accordingly, tank capacity shall be set at 10 m^3.

Incidentally, fuel tanks in the Project shall be the outdoor type (above ground).

2.2.2.10 Civil Engineering and Building Facilities

Building facilities required for operation and maintenance of WTP shall equip with air conditioning system, lighting equipment, waterworks and fire extinguishing equipment. The building facilities planned are as follows.

1) Pump building

- Building area : Approximately 620 m^2
- Structure : Reinforced concrete structure
- Exterior appearance: Block walls, iron doors, aluminum window frames
- Composition : Conveyance and transmission/distribution pump room, generator room, transformer room, receiving panel room, warehouse
- Equipment : Ventilation, lighting, plumbing facilities, fire extinguishing equipment

2) Chemical dosing building

- Building area : Approximately 210 m^2
- Structure : Reinforced concrete structure
- Exterior appearance: Block walls, iron doors, aluminum window frames
- Composition : Chlorine neutralization room, solid aluminum sulfate warehouse and dissolution tank room, liquid aluminum sulfate dissolving tank and injection room
- Equipment : Chlorine neutralization equipment and lighting

3) Filter control building

- Building area : Approximately 150 m^2
- Structure : Reinforced concrete structure
- Exterior appearance: Block walls, iron doors, aluminum window frames
- Composition : Filter control room
- Equipment : Ventilation and lighting equipment

2.2.2.11 Operation and Maintenance Equipment

(1) Sludge transportation equipment

Thickened sludge generated in the sludge treatment facilities shall be carried away by vacuum car. Specifications of the vacuum car are as follows. For details, see Section 3-2-4-7 Sludge Treatment Facilities.

- Type : Vacuum car (approximately 10 ton class)
- Quantity : 1
- Carrying frequency : 3 ~ 4 times/day

(2) Water quality analysis equipment

Water quality test is an important factor in water quality control. Water quality test is carried out with the following three main objectives

- To grasp the quality of raw water and thus set appropriate chemical dosages,
- To detect adverse changes in raw water quality as early as possible and to establish its removal and disposal system, and
- To grasp water quality in water treatment processes and monitor whether or not appropriate water treatment is being conducted, and also to take appropriate measures in the event of water quality troubles.

Judging from the quality of raw water, the water quality items that require priority treatment in the Project are turbidity, bacteria and algae. The water quality control methods that have been adopted are as shown below.

Table 2.11 Water Quality Control Methods

Item	Treatment Method	Control Contents
1 - Turbidity	Coagulated sedimentation, rapid filtration	Turbidity will be controlled by adjusting pH and alkalinity and injecting appropriate doses of coagulant. However, since raw water at the new WTP has sufficiently high alkalinity and an appropriate pH value, it will not be necessary to control these items. Accordingly, only the coagulant dosage will be subjected to control.
2 - Bacteria	Pre- and post-chlorine treatment	Raw water and filtered water will be sterilized by pre- and post-chlorine treatment. Moreover, the chlorine injection will be controlled to ensure that ample residual chlorine remains at the ends of distribution pipes in the service area.
3 - Algae	Pre-chlorine treatment	Algae in raw water will be sterilized by the pre-chlorine treatment before water enters the filter beds. This will prevent the algae from hindering the filter beds.

1) Sampling

The following table shows the sampling points, test items and test frequency that will be adopted for water quality management. As at present, water samples will be obtained manually and taken to the laboratory for testing.

Table 2.12 Water Quality Test Items, Sampling Points and Test Frequency at the New WTP

Test Item	Sampling Point	Test Frequency
All items	Raw water (receiving tank) Treated water (distribution pump tank)	Once per day
Turbidity	Receiving tank (raw water) Water after sedimentation Water after filtration Treated water	Same as present, i.e. every 2 hours from 08.00 to 14.00
Residual chlorine	Before entering the sedimentation basin Water after sedimentation Treated water	Same as present, i.e. every 2 hours from 08.00 to 14.00

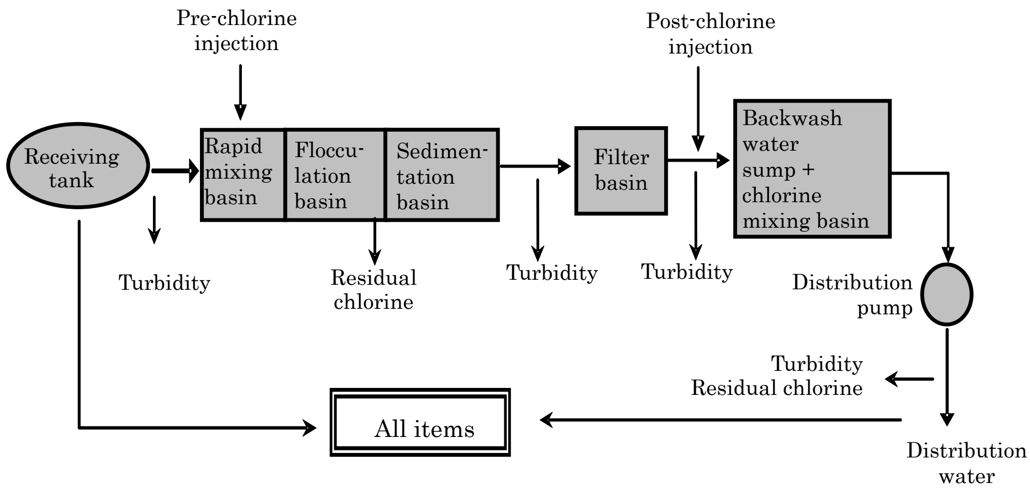


Figure 2.3 Water Quality Test Sampling Points and Test Items

2) Water treatment process management personnel and assignments

Two chemical test staff and one technician currently work in the existing water quality test laboratory. The same organization will also conduct the water quality tests for the new water treatment plant.

Meanwhile, in order to manage the water treatment processes, a full-time control manager will be required in addition to the water quality test staff. However, since the existing plant does not have a full-time manager, it will be necessary to assign new water treatment process staff. In order to keep maintenance costs down, it is proposed that the responsible engineer be selected from the existing work force and be retrained for the job.

The work duties of each job position in the water treatment process at the water treatment plant are as follows.

Water treatment process manager

- Overall management of water treatment processes
- Compilation of the water treatment process operation schedule based on the annual operation plan

- Management of chemical dosing, flocculation and settled sludge accumulation
- Planning of chemical purchase and storage quantities
- Management of sludge treatment
- Analysis of water flow reports from machine and electrical operators and water quality analysis findings from water quality testing staff
- Investigation of optimum water treatment process operation methods and instruction of findings to personnel
- Implementation of necessary measures to prevent deterioration of water quality

<u>Water quality analysis supervisor</u>

- Routine water quality tests (chemical and biological) based on manuals to ensure the safety of treated water
- Computerized storage of water quality test results
- Provision of chemical dosage data to the water treatment process staff
- Provision of water quality test data
- Special purpose water quality tests, e.g. algae tests, etc.
- Procurement and storage of water quality test chemicals, apparatus and expendable items

<u>Water treatment plant operating staff</u>

- Appropriate operation and control of raw water pumps, water transmission pumps and other electrical and mechanical equipment according to instructions from engineers in charge of controlling water treatment processes and personnel in charge of the water treatment plant (senior engineers)
- Monitoring and control of water intake and treatment processes based on plans
- Washing and cleaning of the receiving tanks, rapid mixing basins, flocculation basins, chemical sedimentation tanks and filter basins
- Maintenance and inspection of wastewater and sludge equipment, removal of thickened sludge, and management of the vacuum car
- Preparation and storage of daily operation records detailing intake flow, treated water flow, pump operation, chemical dosages, chemical and electricity consumption, water level in treated water tanks and other necessary items
- Securing of plant hygiene
- Monitoring of wasteful water use in the plant

3) Operation and maintenance

Table 2.13 and Figure 2.4 show the operation and maintenance items in main facilities and equipment at the new WTP. Concerning the detailed operation and maintenance contents, the Japanese contractor will supply operation manuals when handing over the facilities upon completion of works, and OJT (on-the-job training) will be conducted in order to transfer technology on plant operation and maintenance.

Table 2.13 Operation and Maintenance Items for the Main Facilities and Equipment

Facility/Equipment	Operation Item	Control Item
Intake pump	Control of number of operating pumps	Regular equipment maintenance
Conveyance pipe	—	Sludge removal, washing
Incoming flow adjustment valve	Incoming flow adjustment	—
Receiving tank	—	Sludge removal, washing
Rapid mixing basin	—	Sludge removal, washing
Flocculation basin	—	Sludge removal, washing
Chemical sedimentation tank	—	Sludge removal, washing
Rapid filter basin	Filter bed washing	Regular equipment maintenance, replenish/replacement of filter sand
Chemical injection equipment	Chemical dosage (coagulant, chlorine)	Regular equipment maintenance
Backwash water sump and chlorine mixing basin	—	Sludge removal, washing
Wastewater sump, sludge sump, thickening tank	—	Equipment maintenance
Transmission and distribution pumps	Control of number of operating pumps	Regular equipment maintenance

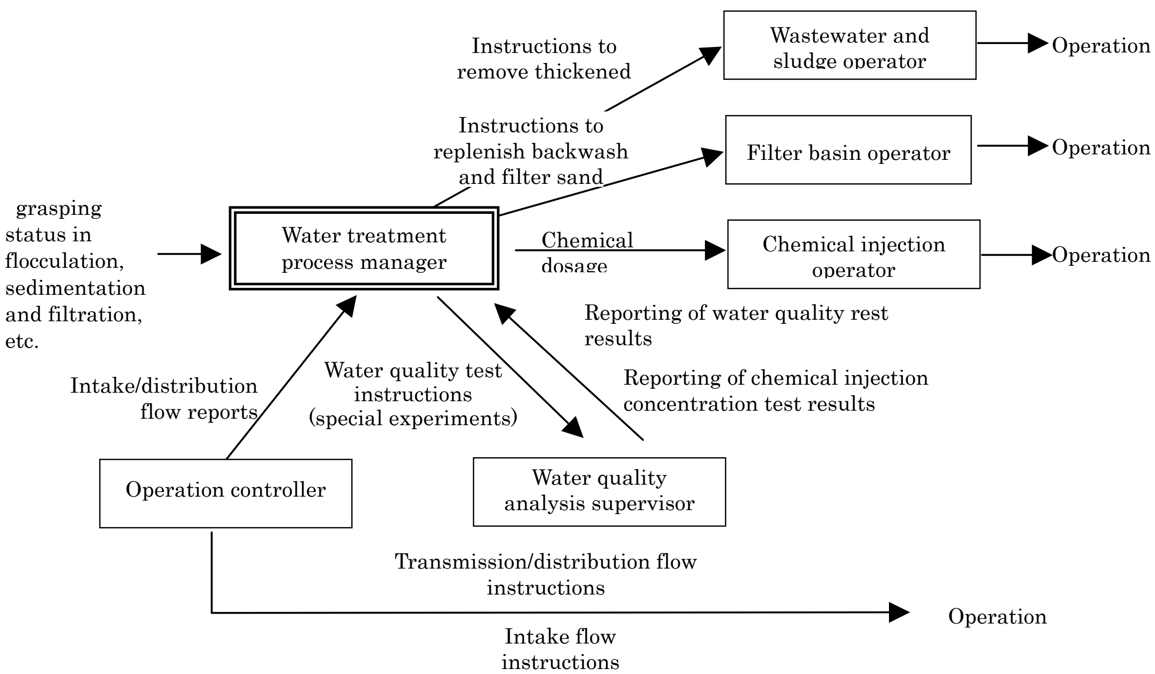


Figure 2.4 Water Treatment Plant Instructed Items

(3) Maintenance tools

Spare parts, mainly comprising of the expandable items that will be consumed in the WTP in the first year following handover to the Egyptian side, will be procured as part of the Japanese scope of works. Spare parts here refer to expendable items for instruments and electrical equipment, however, since many of the machines and electrical equipments in the Project will be procured from Japan, it may be difficult to procure and store all the said items before the facilities start operating. Accordingly, spare parts shall be procured at the same time as facilities construction and kept in storage after the facilities start operating. The contents and quantities of spare parts shall be determined within a reasonable scope as recommended by the equipment makers or suppliers.

(4) Spare parts for plant equipment

The existing new and old water treatment plants each have workshops containing lathes and other machine tools for repairing and maintaining existing plant equipment. Since the same workshops can also be used to repair the equipment of facilities constructed in the Project, machine tools such as lathes, etc. shall not be included in the procurement scope. The tools procured in the Project shall mainly consist of machine tools used for maintaining the constructed equipment and electrical instruments, and measuring instruments used when installing equipment. Also, gas masks for use in cases of chlorine gas escapes, etc. shall also be procured. Table 2.14 shows the list of maintenance tools.

Table 2.14 List of Maintenance Tools

Machine Tools	Spanners, Wrenches, etc.	General Tools
Measuring instruments	Dial gauge	Measuring device used when installing equipment
	Six gauge	
	Slide gauge	
	Vibration meter	Routine maintenance following installation
	Noise gauge	
	Rotating meter	
	Thermometer	Routine maintenance
	Clamp meter	Maintenance of electrical equipment
	Tester	
	Insulation resistance tester	
Safety equipment	Gas mask	For use in the event of chlorine gas escapes

2.2.2.12 Water Transmission and Distribution Pipe Network

(1) Objective

Following Project completion, in other words, after completion of the construction of the new 400L/sec water treatment plant, the capacity of the El Mahala El Kobra New Water Treatment Plant will be expanded up to 850 L/sec, combined with the existing 400L/sec water treatment plant and existing 50 L/sec wells. But there is a possibility that the existing water distribution pipe network may not distribute sufficient water to the consumers in the target area.

NOPWASD has compiled a long-term water distribution pipe development plan for 2040 year however, various discussions about the Project between the Japan side led NOPWASD to submit to the Japan side a new plan for improving the existing water distribution pipe network, which will be implemented after completion of the Project. This examination paper has been prepared in order to examine and verify the validity of the new plan.

(2) Improvement Plan for the Existing Water Distribution Pipe Network

1) Long-term water distribution pipe network development plan (target year 2040)

NOPWASD has compiled its own long-term water distribution pipe development plan for 2040 year. This plan has been made on such assumptions that all wells and compact units for water supply sources in the target area shall be closed and replaced by the rehabilitated and/or new water treatment plants, and that the water treatment plant will be expanded up to 800 L/sec and will have a water supply capacity of 1,200 L/sec. It has developed a water pipe network development plan based upon the above assumptions and the plan has the following three components:

① Utilization of the existing pipes,
② Rearrangement of the existing pipes, and
③ Installation of new pipes

This development plan entails implementing large-scale rehabilitation works in almost all parts of the city. In the plan, a new distribution pipeline will be installed along the outer ring road around El Mahala El Kobra City, thereby building a loop distribution main around the city.

2) Water distribution pipe network development plan in the Project (target year 2010)

The Project has the 2010 target year and aims to utilize the existing well facilities and compact units as water sources as much as possible. In this Project, a new 400 L/sec water treatment plant will be constructed and its water supply capacity will be expanded up to 850 L/sec, as aforementioned in section (1)

. Since the water distribution pipe installation works shall be completed by the Project completion year of 2009, the plan is a reality- based one, in which the limited available works period has been thoroughly considered. The plan does not entail the installation of new water distribution pipes, but rather is based on the replacement of the existing pipes by larger diameter in those areas, where the pipes diameter will not be sufficient to cope with the increased water flow from the expanded water treatment plant. In cases where replacement shall be required, the reasonable pipe diameters (i.e. the sizes assumed in the above long-term development plan for 2040 year) are adopted. Figure 2.5 shows the existing water distribution pipe network in El Maharl El Kobra City, and it also indicates the pipes that are to be newly installed under the above long-term development plan for 2040 year.

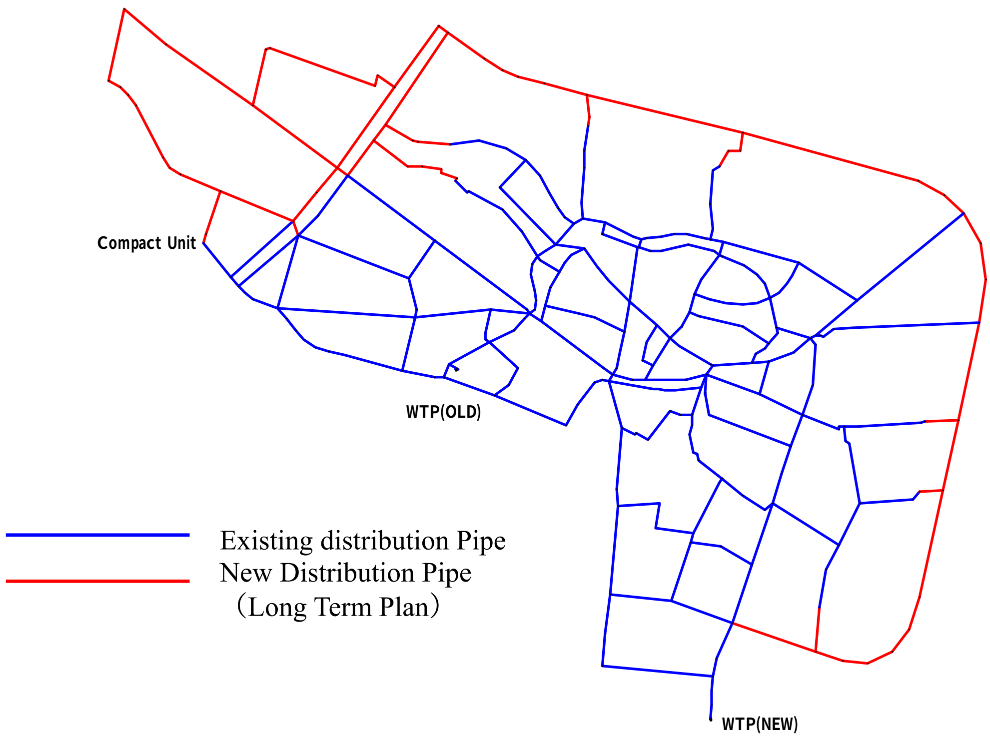
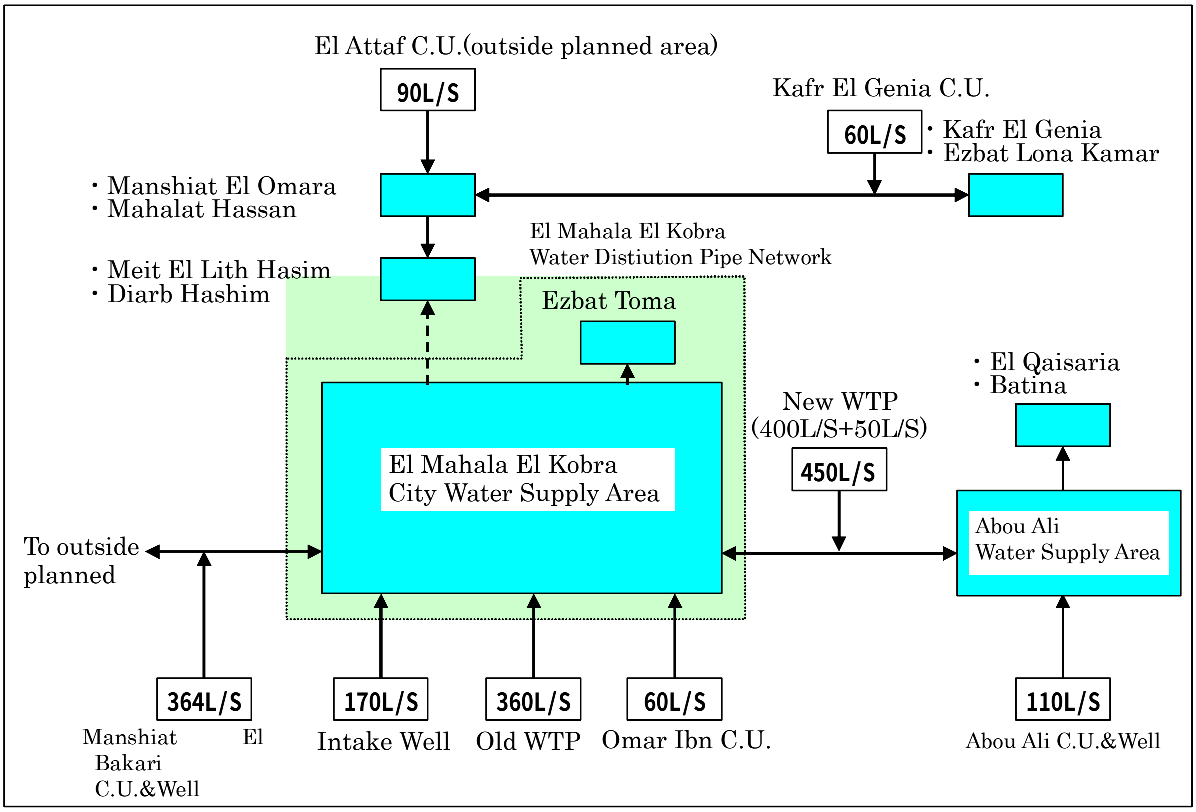


Figure 2.5 Distribution Pipe Network in El Mahala El Kobra City

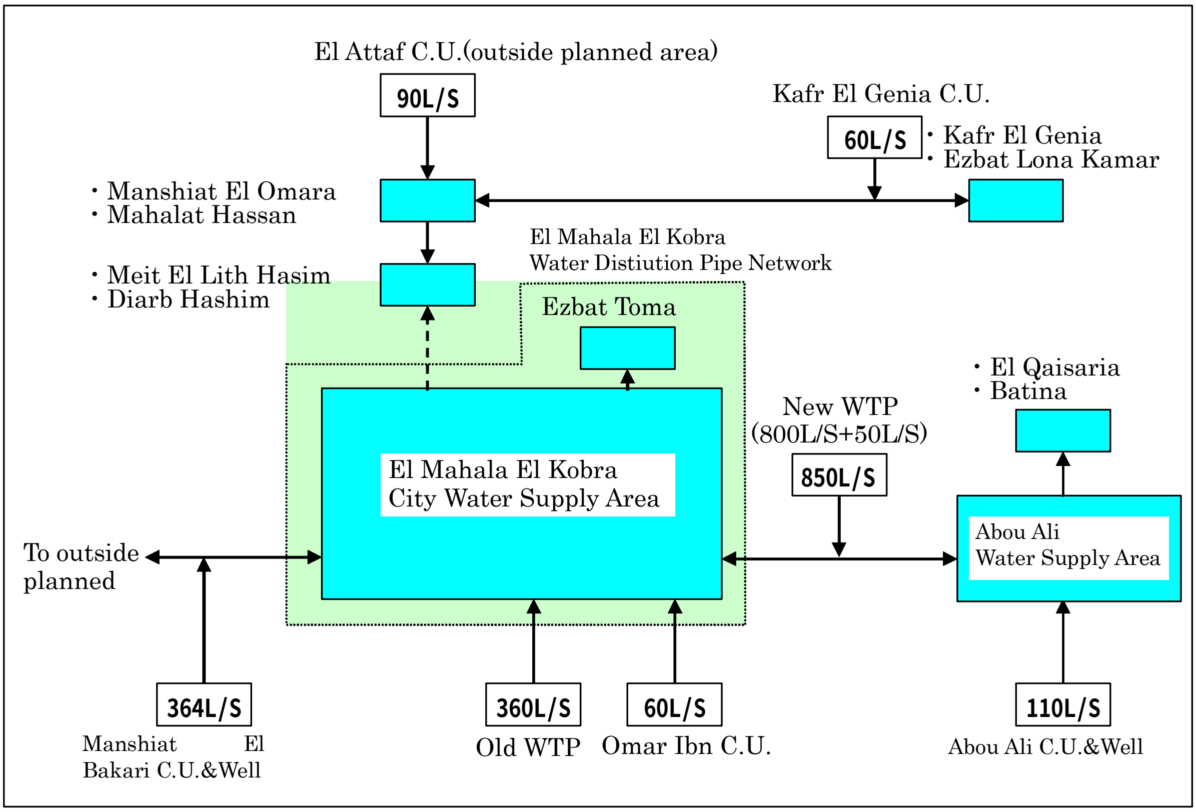
(3) Water distribution system in the target area

In order to clarify the alignment of the water distribution pipe network, the distribution areas and water supply sources in the planned area, the water distribution system has been shown in Figure 2.5. The figures shown in Fig.2.5 indicate each water supply capacity of the treatment plant, compact units and well facilities, specifically, the peak daily water supply potential. The city of El Mahala El Kobra accounts for almost 70% of total required water supply in the target area, and when Abou Ali distribution district and the two villages of El Qaisaria and Batina, which are neighboring to the city, are added in, this figure rises to more than 80%. The treated water supplied from the expanded water treatment plant will mainly be distributed to the city of El Mahala El Kobra. Abou Ali distribution district and the two villages of El Qaisaria and Batina are also very important water distribution areas, though they are not directly connected to the water pipe network. In addition, the village of Ezbat Toma, located close to the city, is included in the water distribution network and directly have received water through it. Except these four areas, the other six villages are rural districts located away from the city of El Mahala El Kobra. The six villages have not directly received water supply from the water distribution network, but relied on the water supply from the existing nearby compact units. Of these six villages, Diarb Hashim and Meit El Lith Hashim have received water from the city water distribution network until recently, while booster pumps have been used to transmit water from here to Mahallat Hassan and Mansiat El Omara. Since the supply water from the city water distribution network became insufficient, the supply source for these four villages has been switched to a compact unit (El Ataf compact unit) outside of the Project area. In the Project, it is also planned to close down intake wells, where the water quality has been deteriorated especially due to salination of the groundwater. Accordingly, the water sources and the water distribution areas in the El Mahala El Kobra City's water distribution network for 2010 year are shown as follows:

Supply sources	: El Mahala El Kobra Old WTP, El Mahala El Kobra New water WTP, Manshiat El Bakari compact unit plus wells, Omar Ibn compact unit
Distribution districts	: El Mahala El Kobra City, Ezbat Toma village



Current Situation



After Completion of Project

Figure 2.6 Water Distribution System in the Project Area

(4) Examination method

In verifying the validity of the NOPWASD water distribution pipe network development plan, the examination has been carried out to make sure that the distributed water from the respective water sources reaches the whole water distribution areas. Specifically speaking, it is to check to see if sufficient water pressure is maintained at various points on the network in the case where the designed water consumption occurs at each point. When we conduct a new plan for the water distribution pipe network, the flow velocity inside pipes is an important factor in the plan from the viewpoint of economic design. Since the examination here targets the existing water distribution pipe network, the flow velocity inside pipes is not counted as one of the criteria for evaluation.

1) Validity assessment criteria

Validity assessment criteria are the following two points:

a) To keep the water pressure at least 30 m at all points in the water distribution pipe network, and
b) To keep the water pressure uniform in the water distribution pipe network. (to keep the water pressure flat in the network)

Explanation of a) : Egypt has a lot of collective housings and condominiums and its code requires 25m water pressure at the end users in order directly to supply water to the consumers who are living on fourth and/or fifth floor. However, taking into account the friction loss in the water pipes from the distribution main to the end consumers, 30 m water pressure is assumed as the minimum required water pressure for the water distribution network.

Explanation of b) : The water distribution areas in the city of El Mahala El Kobra are not zoned, i.e. the whole city comprises a single large zone. In case that there are large variations in water pressure within such a wide distribution area, even if the minimum water pressure is maintained at each point, there is a possibility that some distribution areas will not receive sufficient water supply after the actual operation will be implemented (depending on the difference of flow between the designing water usage and actual water usage). Accordingly, no existence of local low water pressure areas is one of the assessment criteria.

2) Examination procedure

When calculating the water supply pressure, the water distribution pipe network is modeled and hydraulic calculation is implemented with a special program. The program used here is EPANET2, which has been developed by the US Environmental Protection Agency (EPA) and is widely used and relied on throughout the world. EPANET2 is an open program with a disclosed program source that uses the node water level method as the analysis algorithm (it is a method by which channel flow rate and water supply pressure are sought with water pressure at the source given as the boundary condition). Moreover, EPANET2 can be applied to models such as the Project where pumps are used to transmit water from multiple water sources.

Figure 2.7 shows the examination procedure. The examination here assesses the NOPWASD water distribution pipe network plan, which basically proposes to identify those areas where pipe replacing is necessary due to the diameter of existing pipes being rendered insufficient by completion of the Project. Hydraulic calculation will be conducted according to a procedure in line with this purport, and the eventual findings will be compared with the NOPWASD development plan to assess its validity. Moreover, water to the target distribution network will be pumped from three water supply facilities, i.e. El Mahala El Kobra Old WTP, El Mahala El Kobra New WTP and Manshiat El Bakari WTP, and the three pumps will mutually interact so that operation points shift according to the pressure balance in the water distribution network. Therefore, in order to confirm that the hydraulic calculation results can reproduce actual water supply conditions, it shall be confirmed that the calculated operation points of each pump are close to the rated points.

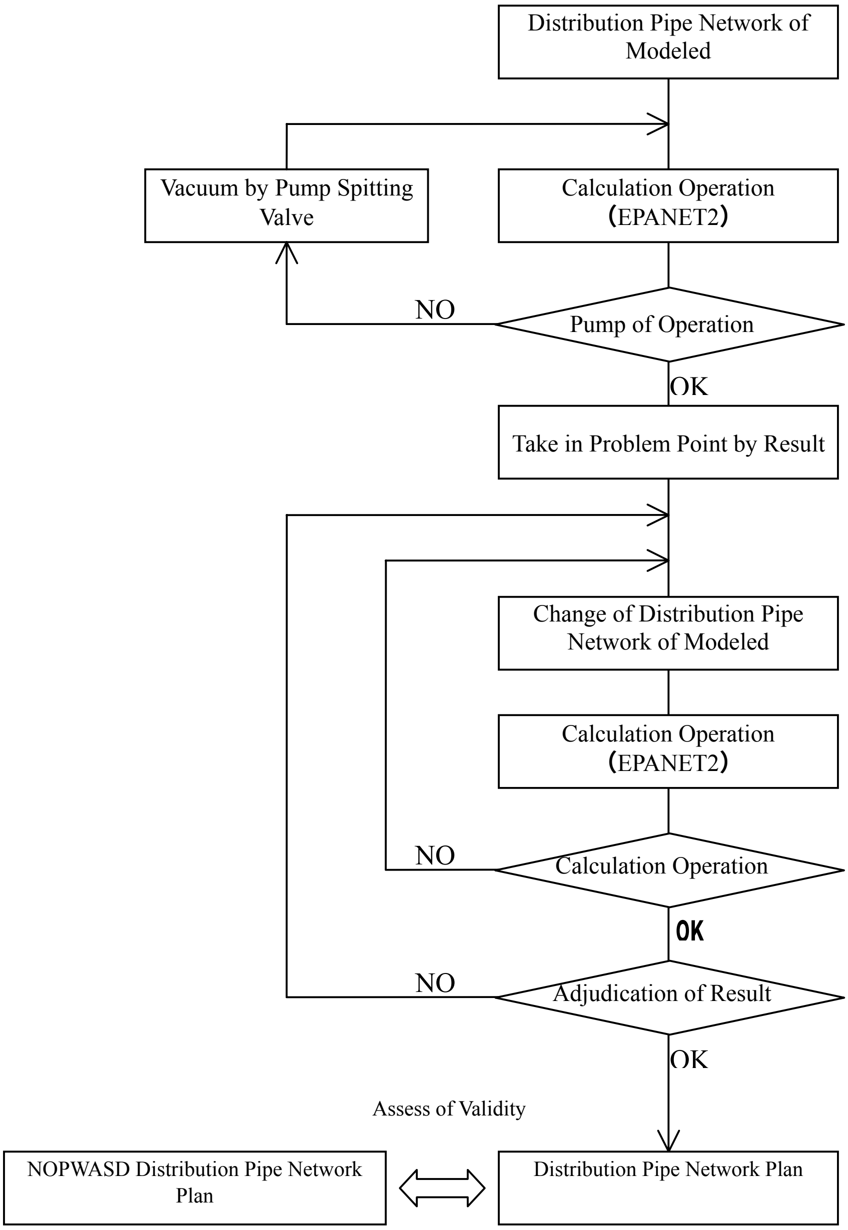


Figure 2.7 Examination Flow

(5) Preparation of the calculation model

1) Modeling of the water distribution pipe network

The pipe network model was prepared based on GIS data obtained from the GIS Data Center in Tanta. Basically speaking, the model was made by extracting pipe diameters of 200 mm or more. Furthermore, although numerous discrepancies were found in the NOPWASD plan in terms of diameters and routes of existing water distribution pipes, the GIS data are considered to be correct and have been adopted because they have been prepared based on the know-how of GACWASD personnel who have been involved in pipe network maintenance and are fully acquainted with the installed positions. Figure 2.8 indicates the model drawing of the existing water distribution pipe network.

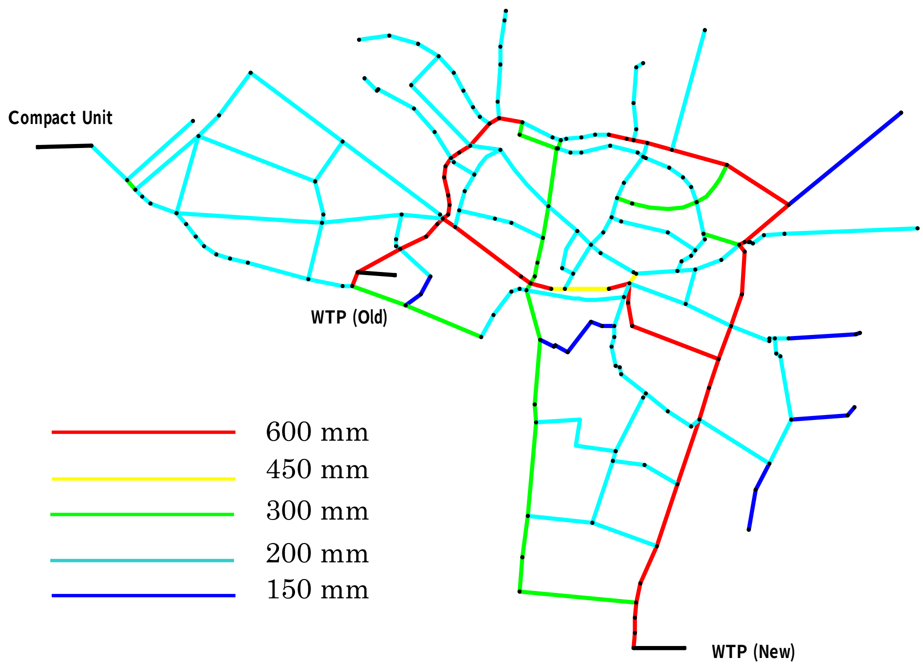


Figure 2.8 Distribution Pipe Network Model

2) Calculation of nodal water flows

Water flow in the pipe network is represented at each node on the pipe network model and apportioned as the nodal water flow. The total water flow from water sources in the water distribution pipe network is apportioned to each node according to the residential area ratio. Pipe diameters need to be large enough to distribute the peak hourly water supply and it is necessary to use the peak hourly water supply from water supply facilities, however, the facilities in question currently supply water at a constant rate without having an hourly peak. In calculating the total water supply flow, the following conditions were assumed: 1) the water supply from Omar Ibn compact unit is excluded because the said amount is small and the said facility has incurred large maintenance costs and has low operating efficiency; 2) all water supply from the expanded water treatment plant will be distributed to the city water distribution pipe network (safe side in the examination); and 3) a part of the water supply from the Manshiat El Bakari supply facility is counted as a water supply source to the city water distribution pipe network. Total water supply from water supply facilities works out as follows:

Expanded water treatment plant	: Existing water treatment facilities (400 L/sec) + Well facilities (50 L/sec) + Peak hourly water supply from water treatment facilities expanded in the Project (520 L/sec) = 970 L/sec
Old water treatment plant	: 360 L/sec

Manshiat El Bakari water supply facilities : 100 L/sec (value estimated from diameter of connecting pipes)

Therefore, total water supply to the water distribution pipe network is 1,430 L/sec; which is apportioned to each node. As for the apportionment method, Tiesen division is used to obtain the load area ratio of nodes, and this load area ratio is multiplied by the total water supply to obtain the water flow at each node. Figure 2.9 shows the location of residential districts and nodes for giving the nodal water flows in the water distribution area.

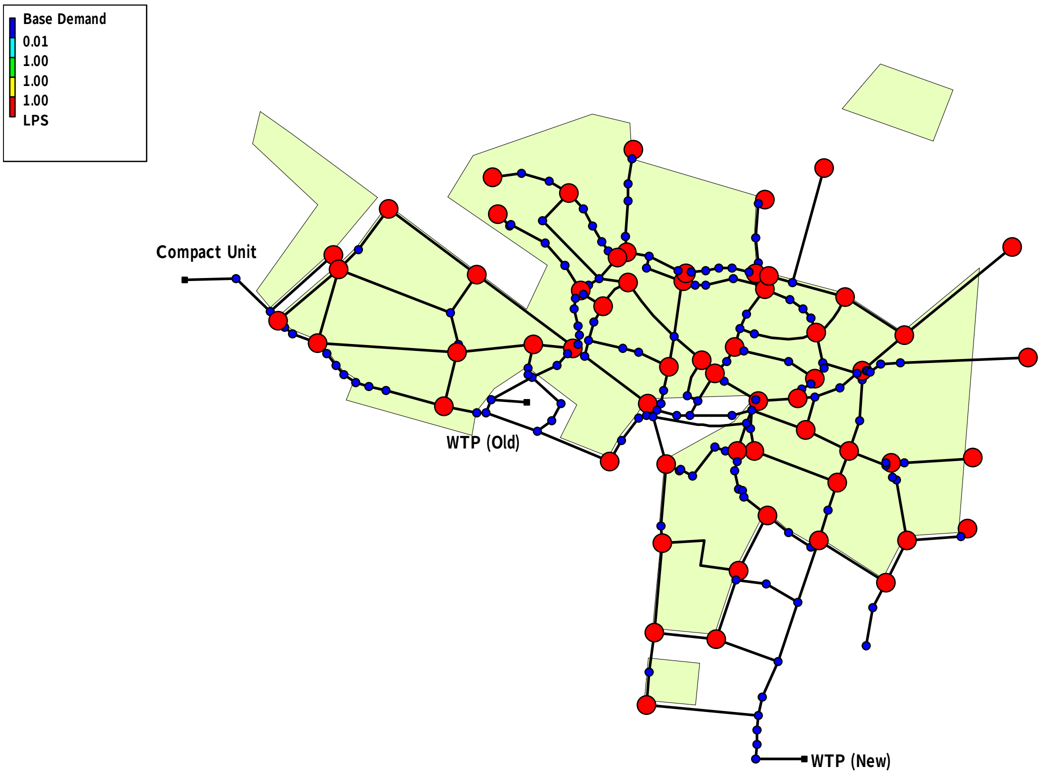
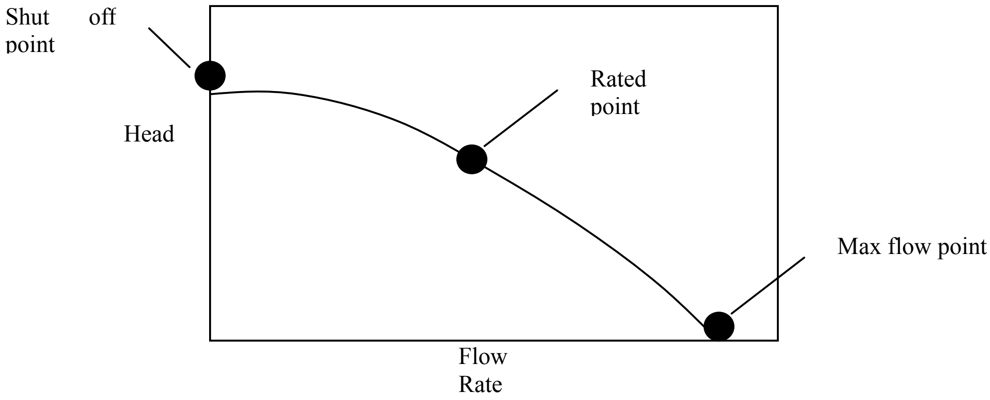


Figure 2.9 Residential Districts and Nodes Giving Nodal Water Flows

3) Modeling of water sources

Water to the target distribution network is supplied by pumps from three supply facilities, i.e. El Mahala El Kobra Old WTP, El Mahala El Kobra New WTP and Manshiat El Bakari WTP. These pumps are modeled here. The water transmission pressure of each pump is 60 m, and the rated flow is transmitted with a head of 60 m. In EPANET2, the performance curve (flow-head curve) of each pump is given based on rated values, and pump operation points are identified from the pressure balance with the pipe network based on the performance curve. It is better to use actual curves for the pump performance curve however, since no actual curves are available, the standard performance curve of EPANET2 is used. This curve gives the flow rate and head at each rated point and is approximated as the secondary curve by seeking the pump cutoff point (flow = 0, head = 133% of rated head) and peak flow point (flow rate = two times the rated flow rate, head = 0 m) from the rated point.



The pump rated points of the three water supply facilities are as follows:

New water treatment plant	: Rated flow rate = 970 L/sec, rated head = 60 m
Old water treatment plant	: Rated flow rate = 360 L/sec, rated head = 60 m
Mansiat El Bakari water supply facility	: Rated flow rate = 100 L/sec, rated head = 60 m

(6) Calculation results and observations

1) Case where the existing distribution pipe network is not developed

① Calculation results

Figure 2.10 shows the calculation results. This shows the distribution of water supply pressure at each node. It is necessary to conduct pressure reduction of 23 m and 20 m at the pump outlets in the Old WTP and Manshiat El Bakari WTP respectively.

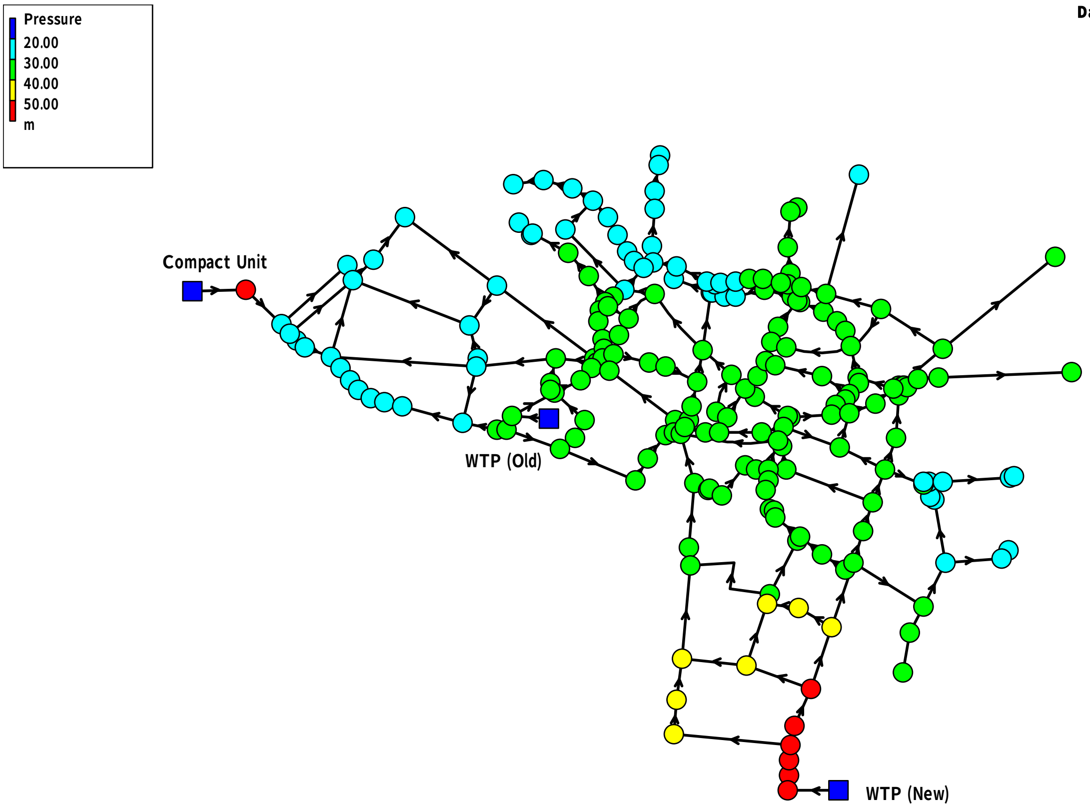


Figure 2.10 Calculation Results
(Case where the Existing Pipe Network is Used as it is): Pressure

② Observations on the results

In case the water supply from the expanded water treatment plant will increase from the current 450 L/sec to 970 L/sec without improving the existing water distribution pipe network, in order to transmit the water supply to the city distribution area, it will be essential to reduce the transmission pressure at other water treatment facilities. The water pressure will need to be reduced by 23 m and 20 m at Old WTP and Manshiat El Bakari water treatment facility respectively. In this case, the water pressure in the center of the city will increase from 30 m to 40 m, which is a satisfactory level for water supply pressure; however, the water pressure in peripheral districts and districts close to Manshiat El Bakari water treatment facility will fall to less than30 m, which is lower than the water pressure criteria of 30 m to be adopted for this examination. Since the water supply pressure falls as the distance increases from the expanded treatment plant, the pipe diameters shall be increased properly at the points on the water distribution pipe network, in order to allow the friction loss resulting from the increasing flow of water supply, otherwise the friction loss shall be covered by the difference in the water pressure. In case there is such a big difference in the water supply pressure in the supply area, there will be a possibility that some areas will receive a good water supply but others will do a poor water supply. In order to avoid such a problem, it is necessary to equalize and smooth out pressure in the distribution area as much as possible when planning the network. Accordingly, we are able to foresee that there are numerous problems, unless a proper improvement of the existing water distribution pipe network shall be implemented in the Project.

2) Case where the existing water distribution pipe network is developed

① Calculation results

Based on the calculation model used in the case of no development of the water distribution pipe network, hydraulic calculation has been conducted until the satisfactory results can be obtained, searching for adequate pipe diameters to allow the required water pressure. Figure 2.11 shows the finally obtained water distribution network, in which some existing pipes shall be replaced by larger diameter pipes, and Figure 2.12 shows the hydraulic calculation results in the pipe network as shown in Fif.2.11. The larger pipes diameters are adopted in the NOPWASD development plan for 2040 year.

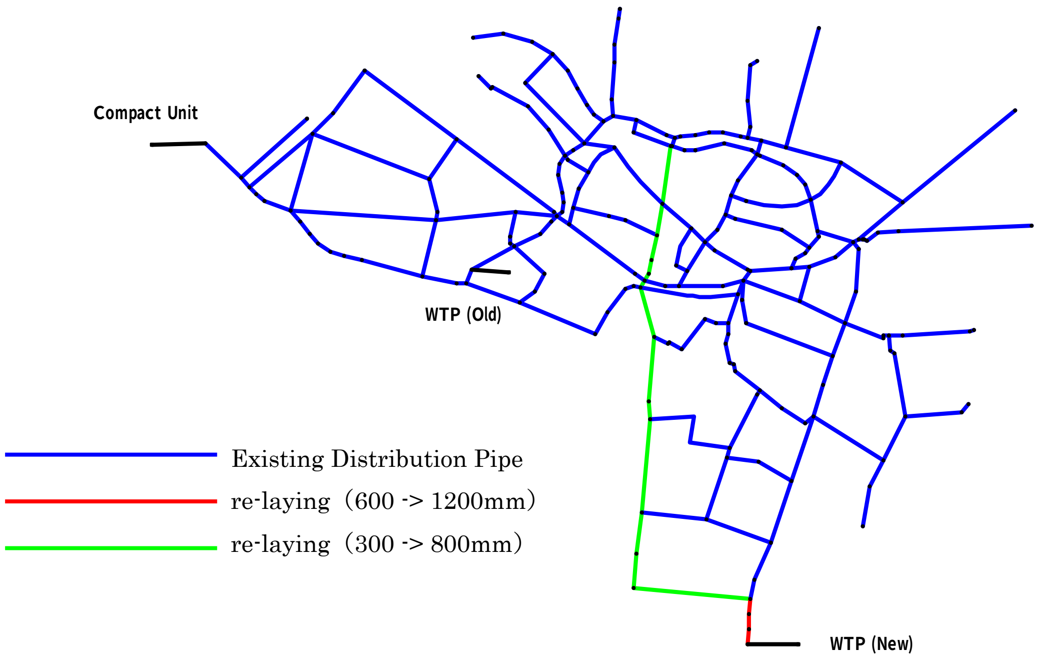


Figure 2.11 Replacing of Existing Water Distribution Pipes

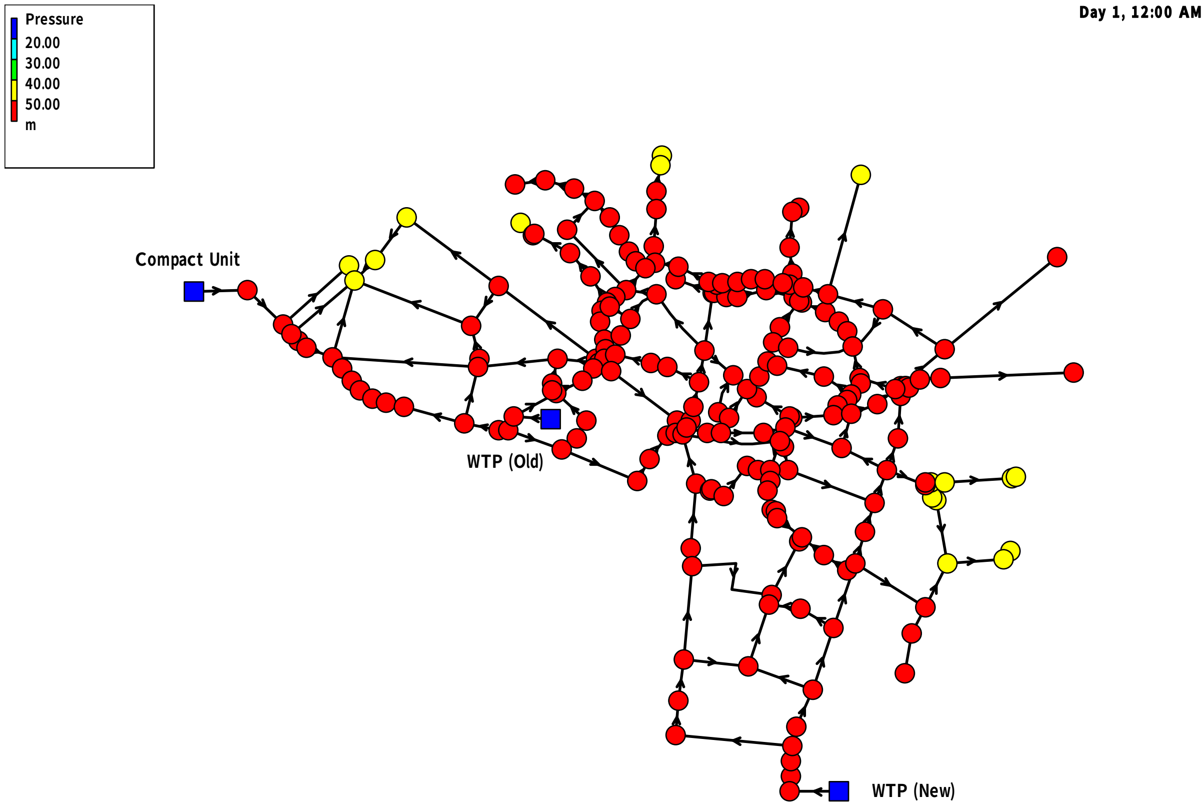


Figure 2.12 Calculation Results (Pressure)

② Observations on the results

The result of replacing water distribution pipes in the network along the route from the expanded treatment plant to the city center shall satisfy the assessment criteria as mentioned aforesaid in section1) of (4). As is shown in the results, the water pressure in most of the distribution areas is higher than 50 m, while it is 40~50 m in just a few areas in the city. There may be little fluctuation in the water supply pressure and the problem arising from the chronic insufficient water supply pressure which has been currently witnessed in some areas may be resolved. The basic concept of the plan to develop the existing water distribution pipe network is to install the large pipe between the expanded water treatment plant and the city center and, as far as this main route is properly established, it will be possible that in every corner of the water distribution areas the water supply may be received through the branches from the main pipe. Judging from the alignment of the existing water distribution pipe network, we think that the water distribution pipe network itself in the city of El Mahala El Kobra has been well prepared for the consumers in every corner of the areas so far and that problems surrounding the water supply in the distribution areas are mainly the shortage of water supply.

Upon successful completion of the works in improving the city's water distribution pipe network, it will create wide range of spin-off effects in the city. For example, it will become possible to use the balancing tank in El Laban area (this is currently idle due to insufficient water pressure in the system). Moreover, it will be possible that the two villages of Diarb Hashim and Meit El Lith Hasim will be able to receive sufficient water, while they currently have not received water from the city's water distribution pipe network due to the low water supply presure.

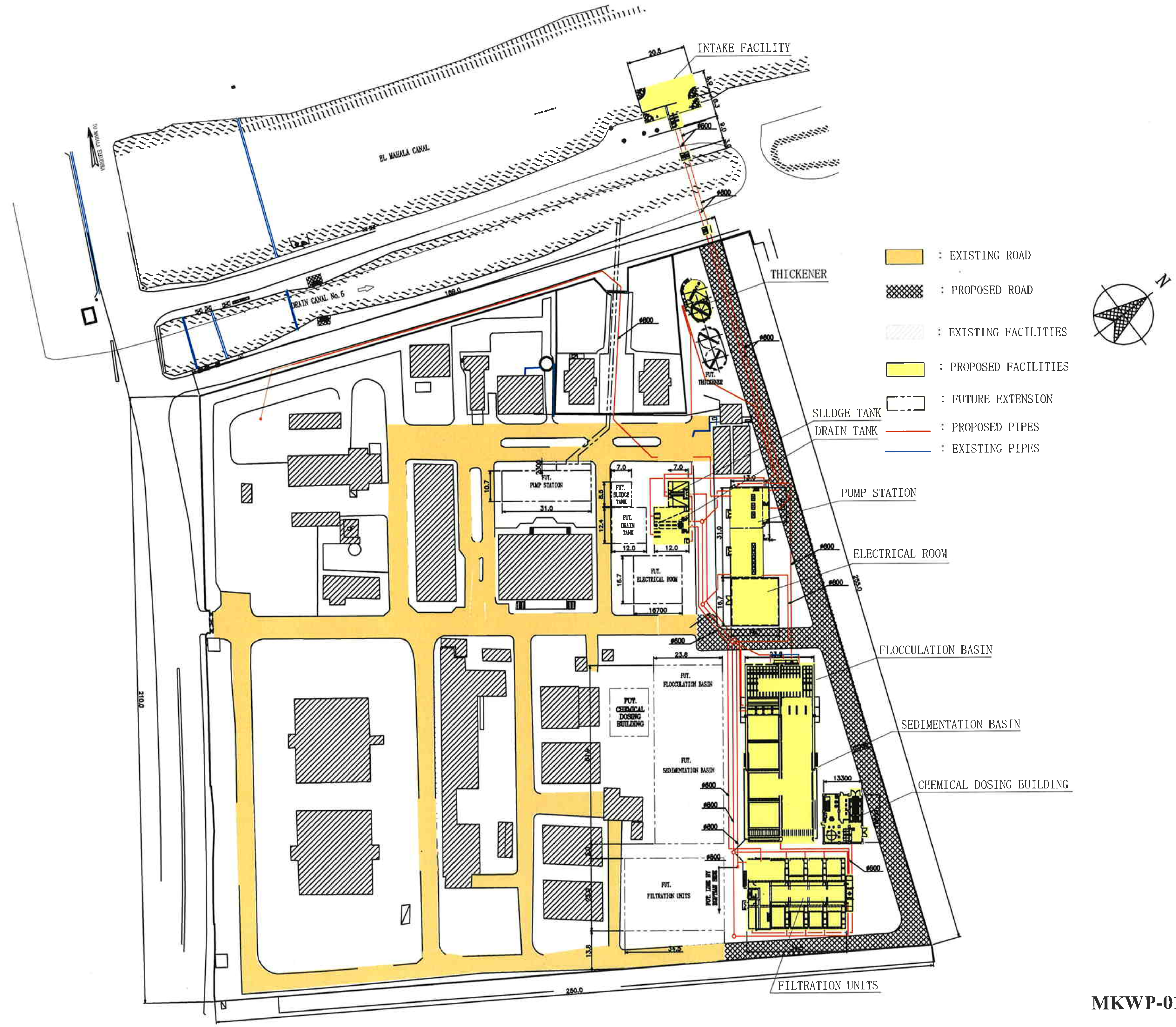
(7) Conclusion

The new NOPWASD plan for developing the existing distribution pipe network, which was compiled in line with the Project, has the basic concept of installing a large diameter water transmission pipe between the expanded water treatment plant and the city center. We recognize that the new NOPWASD development plan is a reasonable plan, which basically corresponds to the development plan obtained as a result of the above examination. Hence, the new NOPWASD plan also includes replacing of other distribution pipes. In this Project, it is possible to exclude these pipes from the above NOPWASD plan, from the viewpoint of ensuring the operation of the facilities, which will be prepared and constructed and/or rehabilitated in the Project. Further discussions concerning these pipes shall be held with NOPWASD before deciding the final scope of the development works.

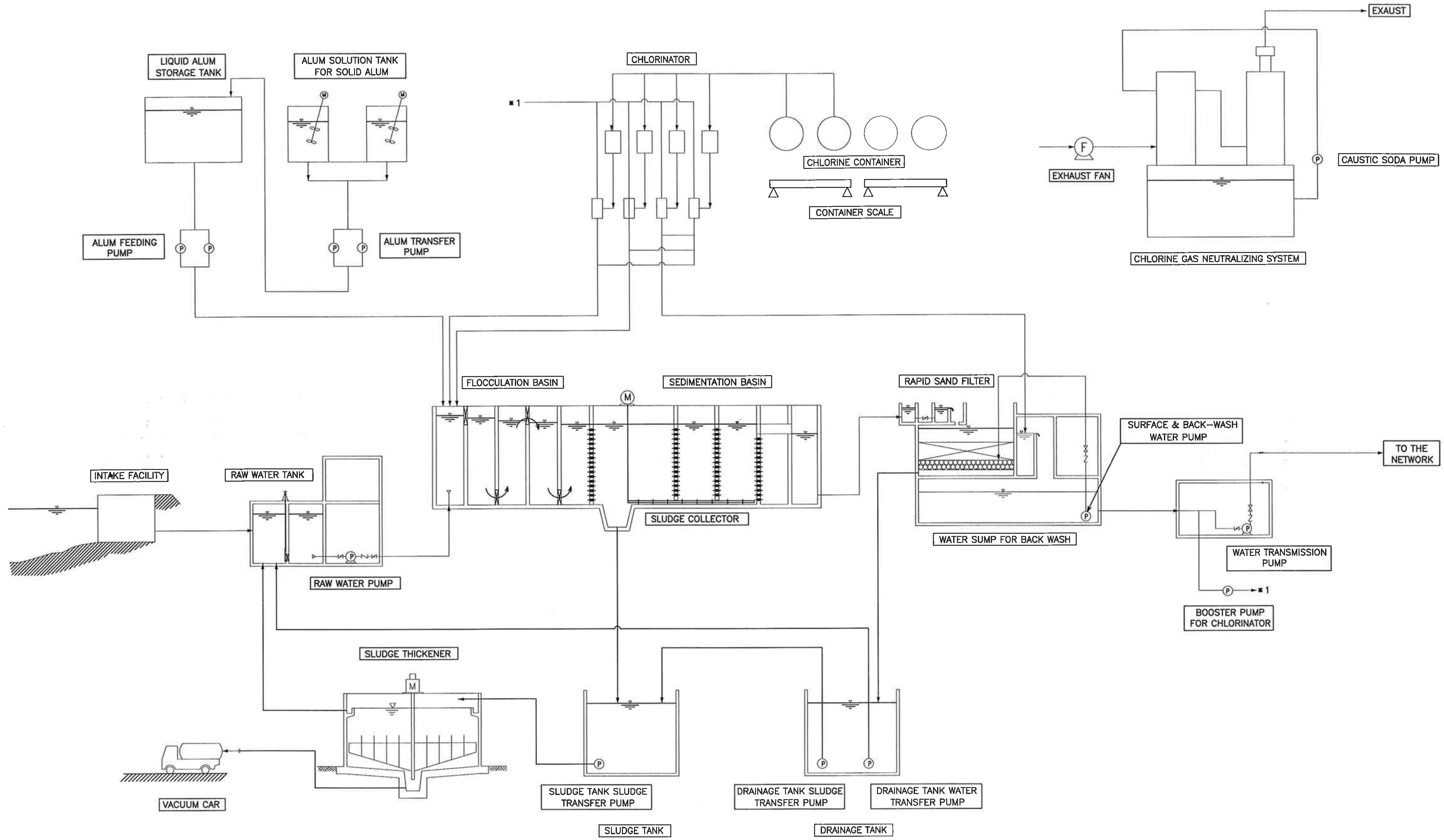
2.2.3 Basic Design Drawing

The basic design drawings of the Project are shown from next page as follows;

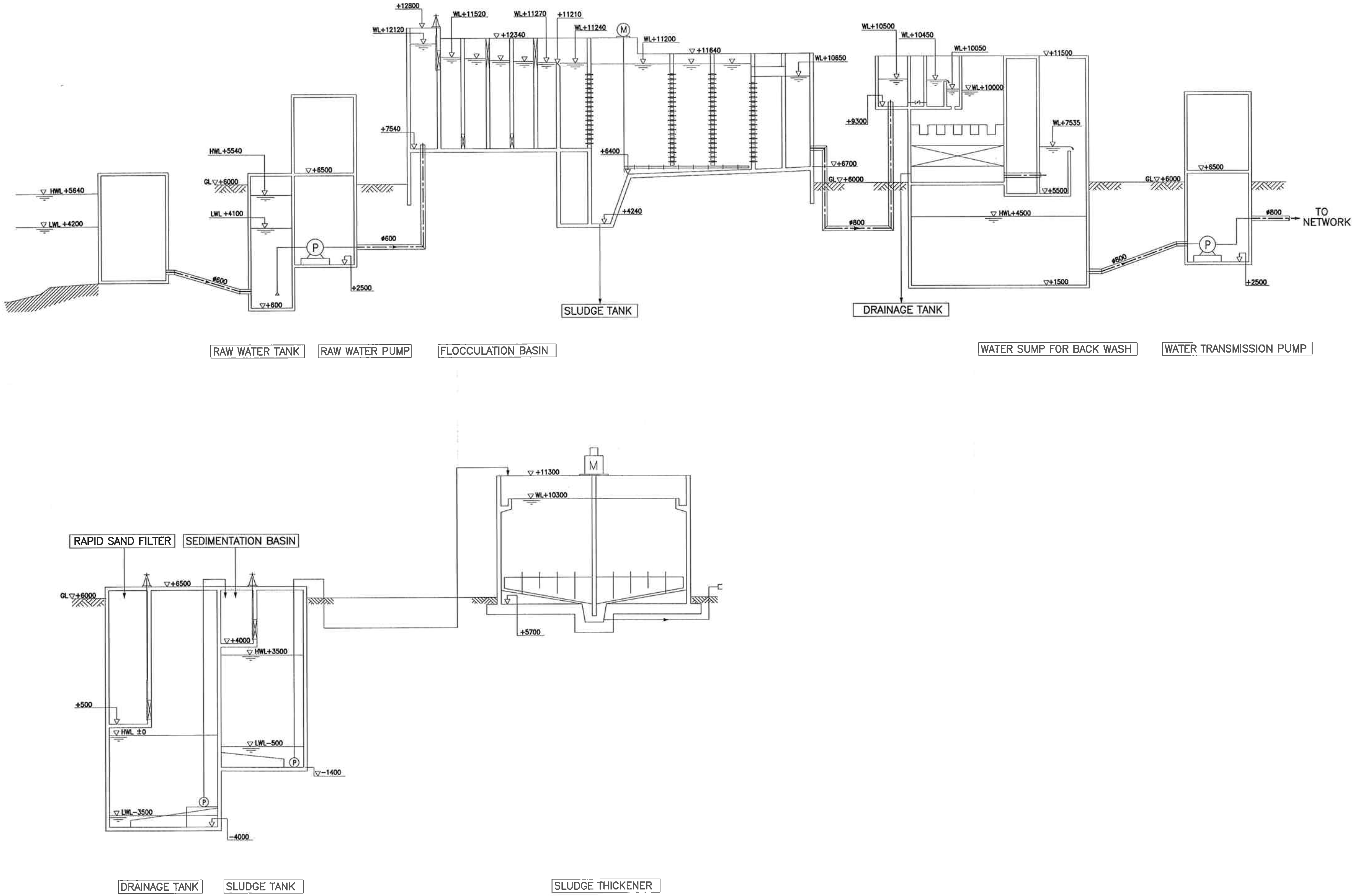
Drawing No.	**Drawing Title**
MKWP-01	General Layout
MKWP-02	System Flow Diagram
MKWP-03	Hydraulic Profile
MKWP-04	Flow Diagram of Intake Facilities, Raw Water and Transmission Pump
MKWP-05	Flow Diagram of Water Purification System
MKWP-06	Flow Diagram of Aluminum Sulfate Feeding System
MKWP-07	Flow Diagram of Chlorine System and Leaked Chlorine Neutralizing System
MKWP-08	Flow Diagram of Drainage And Sludge Treatment System
MKWP-09	Monitoring System and Instrumentation
MKWP-10	Single Line Diagram
MKWP-11	Water Intake Facility (1/2)
MKWP-12	Water Intake Facility (2/2)
MKWP-13	Pump Station and Electrical Room (1/2)
MKWP-14	Pump Station and Electrical Room (2/2)
MKWP-15	Building Plan of Pump Station and Electrical Room
MKWP-16	Sedimentation Basin (1/2)
MKWP-17	Sedimentation Basin (2/2)
MKWP-18	Rapid Sand Filter (1/3)
MKWP-19	Rapid Sand Filter (2/3)
MKWP-20	Rapid Sand Filter (3/3)
MKWP-21	Chemical Dosing Building (1/2)
MKWP-22	Chemical Dosing Building (2/2)
MKWP-23	Drainage Tank & Sludge Tank (1/2)
MKWP-24	Drainage Tank & Sludge Tank (2/2)
MKWP-25	Sludge Thickener



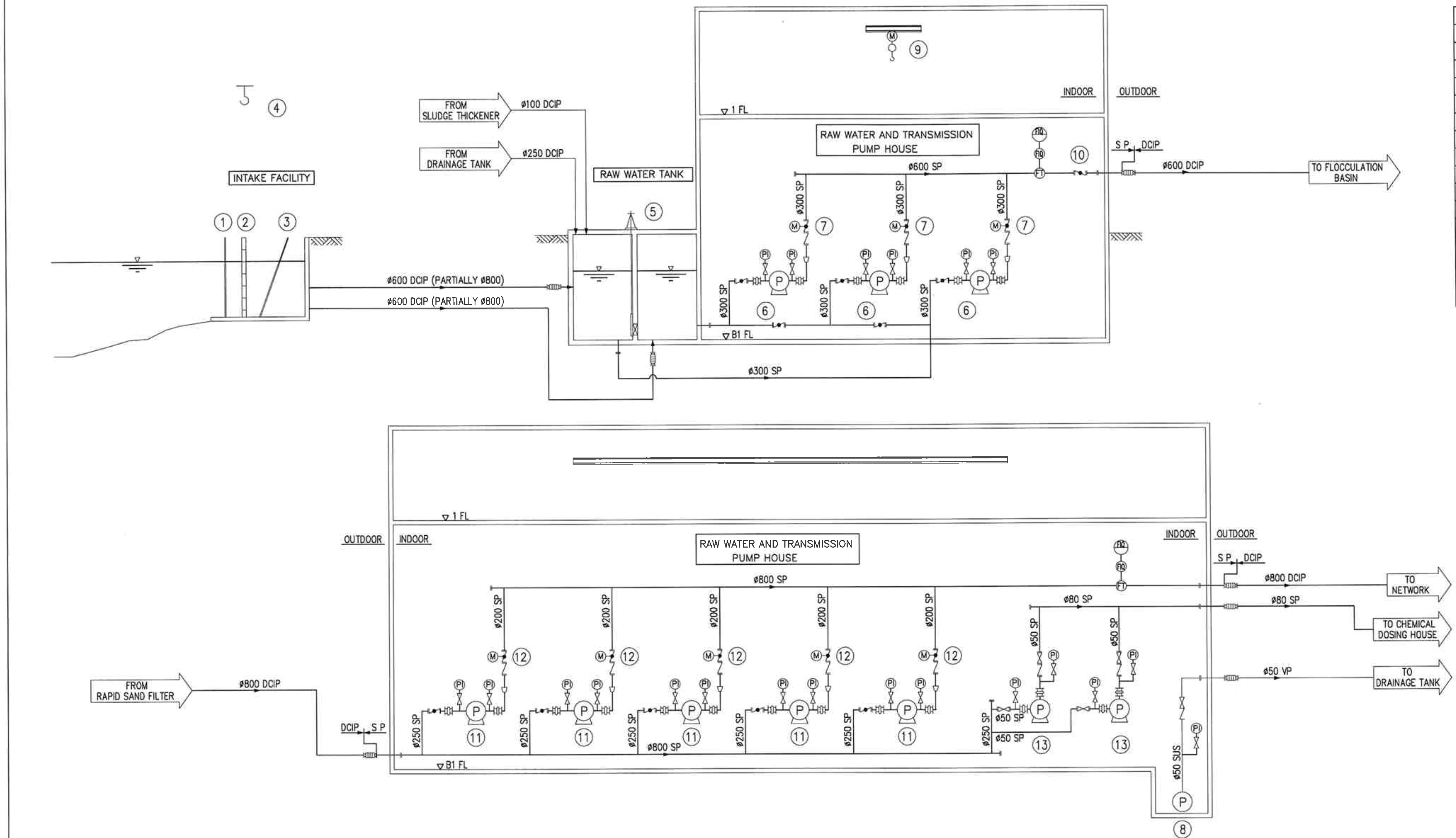
MKWP-01 General Layout



MKWP-02 System Flow Diagram



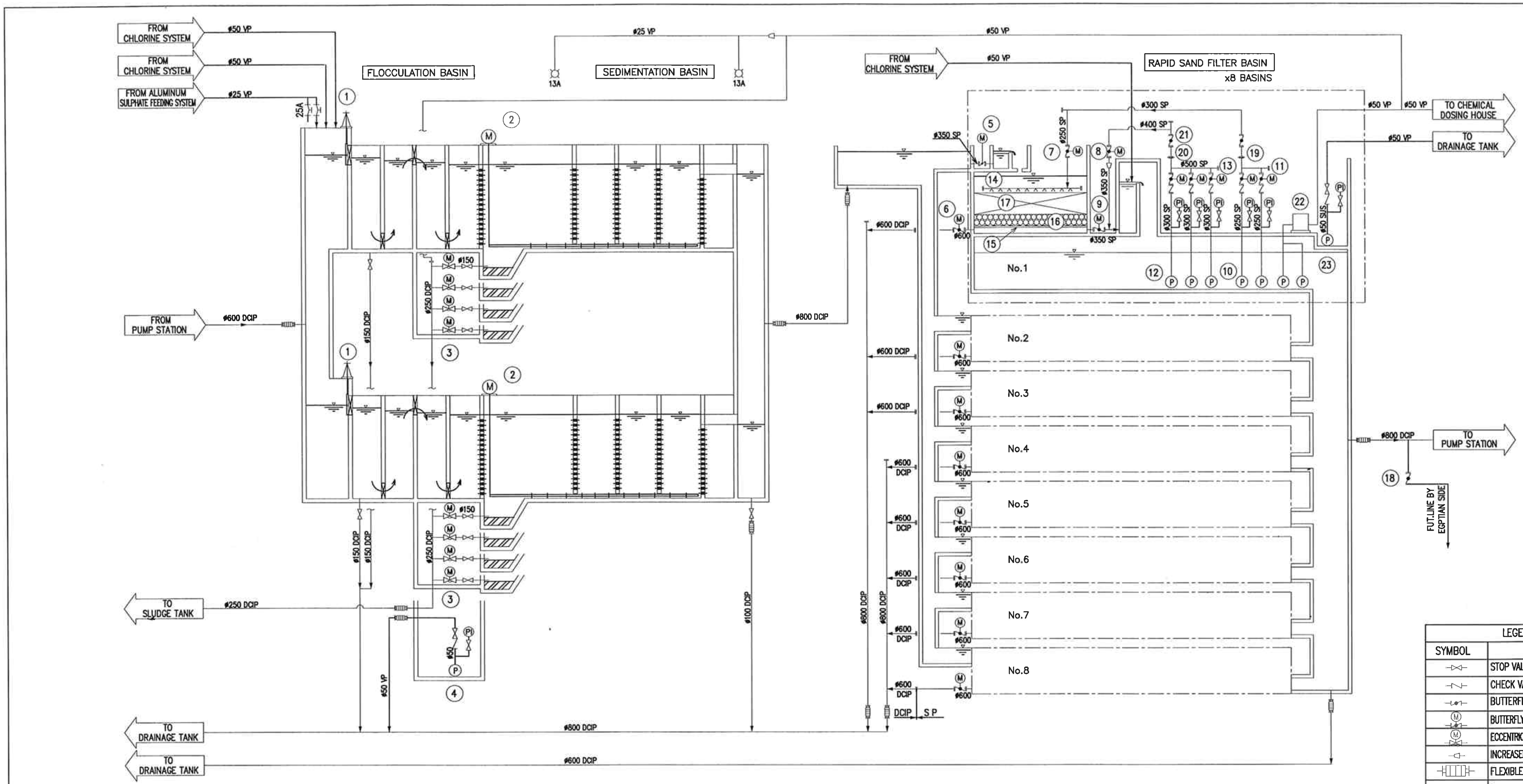
MKWP-03 Hydraulic Profile



LEGEND	
SYMBOL	NAME
—⋈—	STOP VALVE(MANUAL)
—N—	CHECK VALVE
—⊷—	BUTTERFLY VALVE(MANUAL)
(M)	BUTTERFLY VALVE(MOTOR OPERATED)
—▷—	INCREASER OR REDUCER
—⊞—	FLEXIBLE TUBE
‖	EXPANSION JOINT
(P)	PUMP
(M)	MOTOR
(PI)	PRESSURE INDICATOR
(FT)	FLOW TRANSMITTER
(FIQ)	FLOW INDICATING TRANSMITTER
S P	STEEL PIPE
DCIP	DUCTILE CAST IRON PIPE
V P	PVC PIPE

EQUIPMENT NO.	①	②	③	④	⑤	⑥	⑦
NAME	BAR SCREEN	STOP LOG FOR INTAKE	SCREEN FOR INTAKE	CHAIN HOIST FOR INTAKE	INTAKE BY-PASS GATE	RAW WATER PUMP	DISCHARGE VALVE FOR RAW WATER PUMP
TYPE/SHAPE	SCREEN (VERTICAL)	STOP LOG	SCREEN (INCLINED)	CHAIN HOIST (MANUAL OPERATION)	MANUAL GATE	HORIZONTAL DOUBLE SUCTION VOLUTE PUMP	MOTOR OPERATED BUTTERFLY VALVE
CAPACITY	W1.3m×H3.5m	W1.4m×H3.5m	W1.3m×H3.5m×ANGEL APPROX. 70°	1.5ton	□800mm	13.2m³/min×12m×45kW	ø300mm×0.2kW
QUANTITY	2	2	2	1	1	3	3
NOTE						(INCLUDING 1 STANDBY)	
EQUIPMENT NO.	⑧	⑨	⑩	⑪	⑫	⑬	
NAME	DRAINAGE PUMP	CHAIN HOIST FOR PUMP	BUTTERFLY VALVE FOR RAW WATER PUMP FLOW METER	TRANSMISSION PUMP	DISCHARGE VALVE FOR TRANSMISSION PUMP	WATER PRESSURE BOOSTER PUMP FOR CHLORINATOR	
TYPE/SHAPE	SUBMERSIBLE PUMP	MOTOR OPERATED CHAIN HOIST	MANUALLY OPERATED BUTTERFLY VALVE	HORIZONTAL DOUBLE SUCTION VOLUTE PUMP	MOTOR OPERATED BUTTERFLY VALVE	HORIZONTAL MULTISTAGE PUMP	
CAPACITY	0.1m³/min×10m×0.4kW	2.8ton×3.5/0.64kW	ø600mm (PARTIALLY ø800)	8.0m³/min×60m×132kW	ø200mm×0.2kW	200L/min×60m×5.5kW	
QUANTITY	1	1	1	5	5	2	
NOTE				(INCLUDING 1 STANDBY)		(INCLUDING 1 STANDBY)	

MKWP-04 Flow Diagram of Intake Facilities, Rawa Water and Transmission Pump



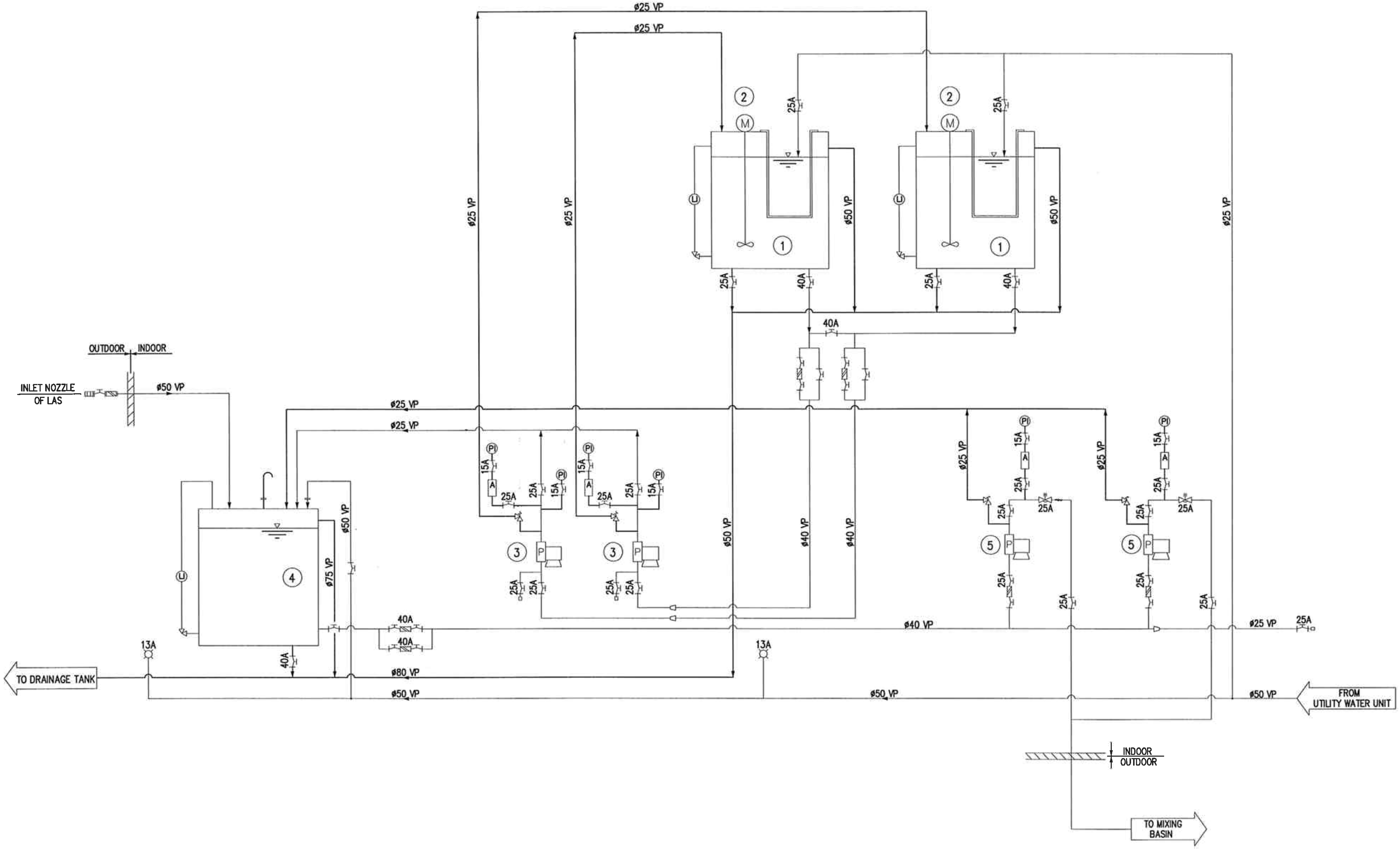
EQUIPMENT NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NAME	INLET MOVABLE WEIR FOR FLOCCULATION BASIN	SLUDGE COLLECTOR FOR SEDIMENTATION BASIN	SLUDGE TRANSFER VALVE FOR SEDIMENTATION BASIN	DRAINAGE PUMP	FILTRATION BASIN INLET VALVE	FILTRATION BASIN WASTE WATER VALVE	FILTRATION BASIN SURFACE WASH VALVE	FILTRATION BASIN BACKWASH WATER VALVE	FILTRATION BASIN TREATED WATER VALVE	SURFACE WASH WATER PUMP
TYPE/SHAPE	MOVABLE WEIR	RECIPROCATING FLIGHT	MOTOR OPERATED ECCENTRIC VALVE	SUBMERSIBLE PUMP	MOTOR OPERATED BUTTERFLY VALVE	MOTOR OPERATED BUTTERFLY VALVE	MOTOR OPERATED BUTTERFLY VALVE	MOTOR OPERATED BUTTERFLY VALVE	MOTOR OPERATED BUTTERFLY VALVE	SUBMERSIBLE PUMP
CAPACITY	800mmwx 300mmst	5.5mWx 40mLx 1.5Kw	ø150mmx0.2kW	0.1m³ /min× 10m× 0.4kW	ø350mmx0.2kW (STEM EXTENSION)	ø600mmx0.75kW	ø250mmx0.2kW	ø400mmx0.2kW	ø350mmx0.2kW	6.75m³/min× 25m× 45kW
QUANTITY	2	4	8	1	8	8	8	8	8	2
NOTE										(INCLUDING 1 STANDBY)
EQUIPMENT NO.	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
NAME	DISCHARGE VALVE FOR SURFACE WASH WATER PUMP	BACKWASH WATER PUMP	DISCHARGE VALVE FOR BACKWASH WATER PUMP	SURFACE WASH SYSTEM	UNDERDRAIN SYSTEM	FILTER GRAVEL	FILTER SAND	CONNECTION VALVE	FLOW METER FOR SURFACE WASH WATER PUMP	FLOW METER FOR BACKWASH WATER PUMP
TYPE/SHAPE	MOTOR OPERATED BUTTERFLY VALVE	SUBMERSIBLE PUMP	MOTOR OPERATED BUTTERFLY VALVE	NOZZLE TYPE(SUS)	STRAINER TYPE	FILTER GRAVEL	FILTER SAND	MANUAL OPERATED BUTTERFLY VALVE	ORIFICE TYPE	ORIFICE TYPE
CAPACITY	ø250mmx0.2kW	10.13m³/min× 10m× 30kW	ø300mm× 0.2kW	FILTRATION BASIN 4.5mW× 7.5mL	FILTRATION BASIN 4.5mW× 7.5mL	FILTER GRAVEL	0.5~0.65mmxH600mm	ø800mm	ø300mm	ø500mm
QUANTITY	2	3	3	8	8	85m³	170m³	1	1	1
NOTE		(INCLUDING 1 STANDBY)								
EQUIPMENT NO.	(21)	(22)	(23)							
NAME	FLOW CONTROL VALVE FOR BACKWASH WATER	UTILITY WATER UNIT	DRAINAGE PUMP							
TYPE/SHAPE	MANUAL OPERATED BUTTERFLY VALVE	PRESSURE UTILITY UNIT	SUBMERSIBLE PUMP							
CAPACITY	ø500mm	20~320lit/minx21~36m (SUBMERGED PUMPx2)	0.1m³ /min× 10m× 0.4kW							
QUANTITY	1	1	1							
NOTE										

LEGEND

SYMBOL	NAME
	STOP VALVE(MANUAL)
	CHECK VALVE
	BUTTERFLY VALVE(MANUAL)
	BUTTERFLY VALVE(MOTOR OPERATED)
	ECCENTRIC VALVE(MOTOR OPERATED)
	INCREASER OR REDUCER
	FLEXIBLE TUBE
	EXPANSION JOINT
	WATER FAUCET
(P)	PUMP
(M)	MOTOR
(PI)	PRESSURE INDICATOR
S P	STEEL PIPE
DCIP	DUCTILE CAST IRON PIPE
V P	PVC PIPE

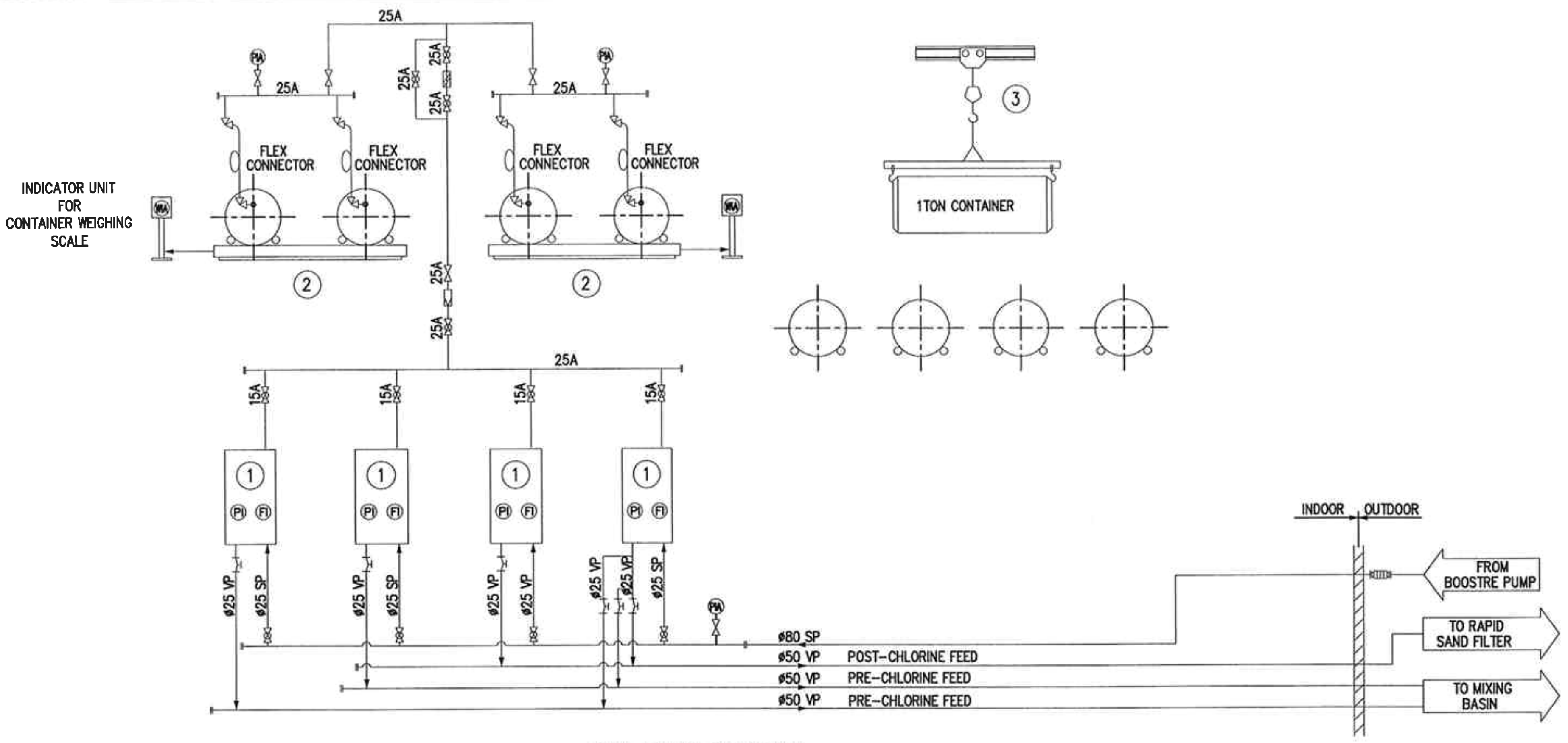
MKWP-05 Flow of Water Purification System

LEGEND	
SYMBOL	NAME
	DIAPHRAGM VALVE
	CHECK VALVE
	STRAINER
	BACK PRESSURE VALVE
	RELIEF VALVE
	GAUGE VALVE
	HOSE COUPLING
A	AIR CHAMBER
	HOSE JOINT
	WATER FAUCET
	INCREASER OR REDUCER
LS	LEVEL SWITCH
LIA	LEVEL INDICATOR ALARM
PI	PRESSURE INDICATOR
SUS	STAINLESS STEEL PIPE
VP	PVC PIPE



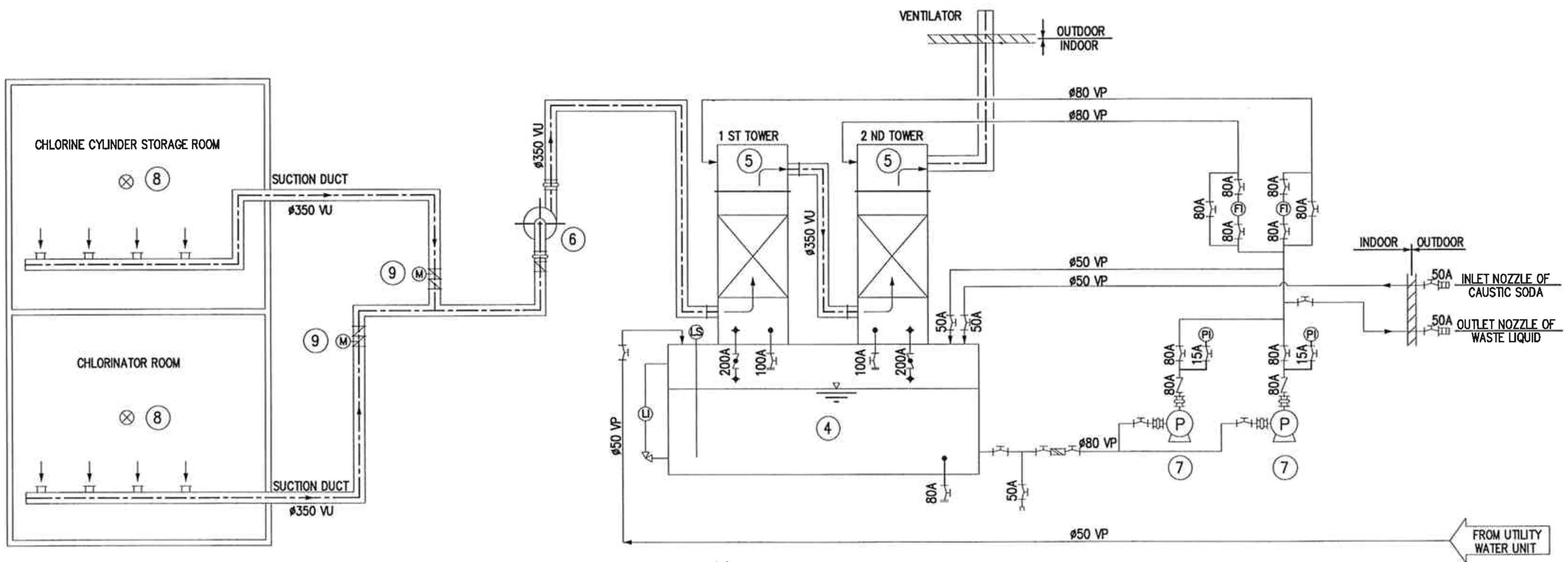
EQUIPMENT NO.	1	2	3	4	5
NAME	SOLID ALUMINUM SOLUTION TANK	ALUMINUM AGITATOR	ALUMINUM TRANSFER PUMP	ALUMINUM STORAGE TANK	ALUMINUM FEEDING PUMP
TYPE/SHAPE	RECTANGULAR OPEN TOP TANK (FRP+SS)	REMOVABLE MIXER	DIAPHRAGM PUMP	VERTICAL CYLINDRICAL CLOSED TANK(FRP)	DIAPHRAGM PUMP
CAPACITY	4m³(1.8mWx1.8mLx1.8mH)	0.75kW	350L/hx3kgf/cm² x0.2kW	14m³ (ø3.3mx2.0mH)	100L/hx8kgf/cm² x0.2kW
QUANTITY	2	2	2	1	2
NOTE	(INCLUDING 1 STANDBY)		(INCLUDING 1 STANDBY)		(INCLUDING 1 STANDBY)

MKWP-06 Flow Diagram of Aluminum Sulfate Feeding System



CHLORINE SYSTEM

LEGEND	
SYMBOL	NAME
	BOLL VALVE
	GLOBE VALVE
	DIAPHRAGM VALVE
	CHECK VALVE
	DAMPER
	MOTOR ACTUATED DAMPER
	STRAINER
	VACUUM REGULATOR
	ANGLE VALVE
	FLEXIBLE TUBE
	EXPANSION JOINT
P	PUMP
M	MOTOR
PI	PRESSURE INDICATOR
PIA	PRESSURE INDICATOR WITH CONTACT
WIA	WEIGHT INDICATOR WITH CONTACT
LI	LEVEL INDICATOR
FI	FLOW METER
LS	LEVEL SWITCH
SP	STEEL PIPE
VP, VU	PVC PIPE
⊗	CHLORINE GAS DETECTOR
	WATER FAUCET
	HOSE JOINT

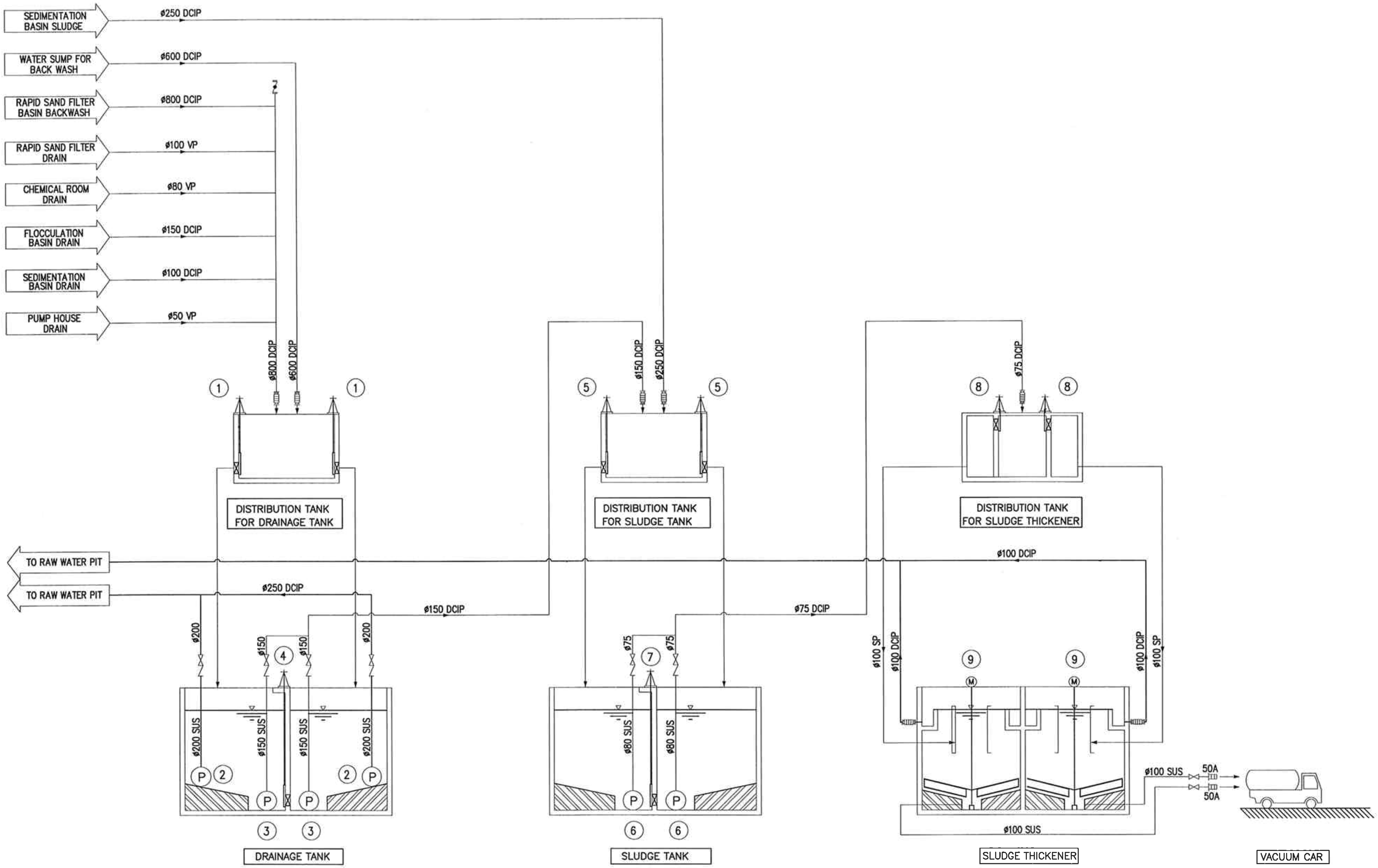


LEAKED CHLORINE NEUTRALIZING SYSTEM

EQUIPMENT NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨
NAME	CHLOLINATOR	CONTAINER WEIGHING SCALE	CHAIN HOIST FOR CHLORINE	CAUSTIC SODA STORAGE TANK	ABSORPTION TOWERS	EXHAUST FAN	CAUSTIC SODA PUMP	CHLORINE GAS DETECTOR	CHANGEOVER DAMPER
TYPE/SHAPE	VACUUM OPERATED GAS FEEDER (WALL MOUNT TYPE)	LOAD CELL	CHAIN HOIST WITH GEARED TROLLY (MANUAL OPERATION)	RECTANGULAR CLOSED TANK	DOUBLE TOWERS	TURBO FAN	HORIZONTAL CENTRIFUGAL CHEMICAL PUMP	SEMI-CONDUCTOR	MOTOR OPERATED DAMPER
CAPACITY	6kgCl_2/h	0~4000kg	2.5ton	11m³	1000kg /h	60m³/minx250mmAqX7.5kW	900L/minx10mx 7.5kW	0~5ppm, 1 Panel+2 Sensors	ø350mmx 0.2kW
QUANTITY	4	2	1	1	1SET	1	2	1SET	2
NOTE	(INCLUDING 1 STANDBY)						(INCLUDING 1 STANDBY)	WITH INDICATOR UNIT AND ALARM CONTACTS	

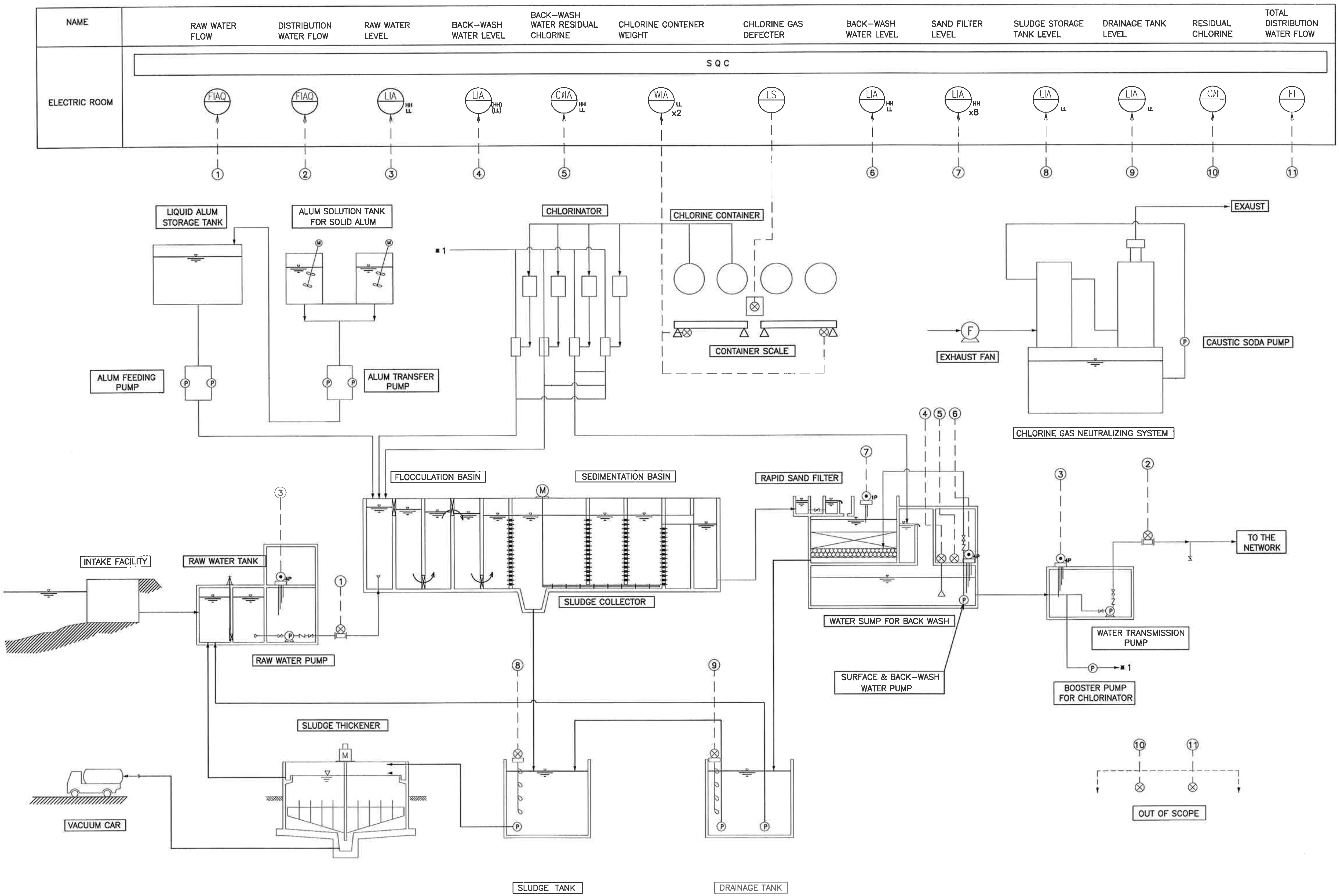
MKWP-07 Flow Diagram of Chlorine System and Leaked Chlorine Neutralizing System

LEGEND	
SYMBOL	NAME
─⋈─	STOP VALVE(MANUAL)
─N─	CHECK VALVE
─╢▯▯▯╟─	FLEXIBLE TUBE
(P)	PUMP
(M)	MOTOR
SP	STEEL PIPE
DCIP	DUCTILE CASE IRON PIPE
SUS	STAINLESS STEEL PIPE
VP	PVC PIPE
⊔⊔	HOSE JOINT

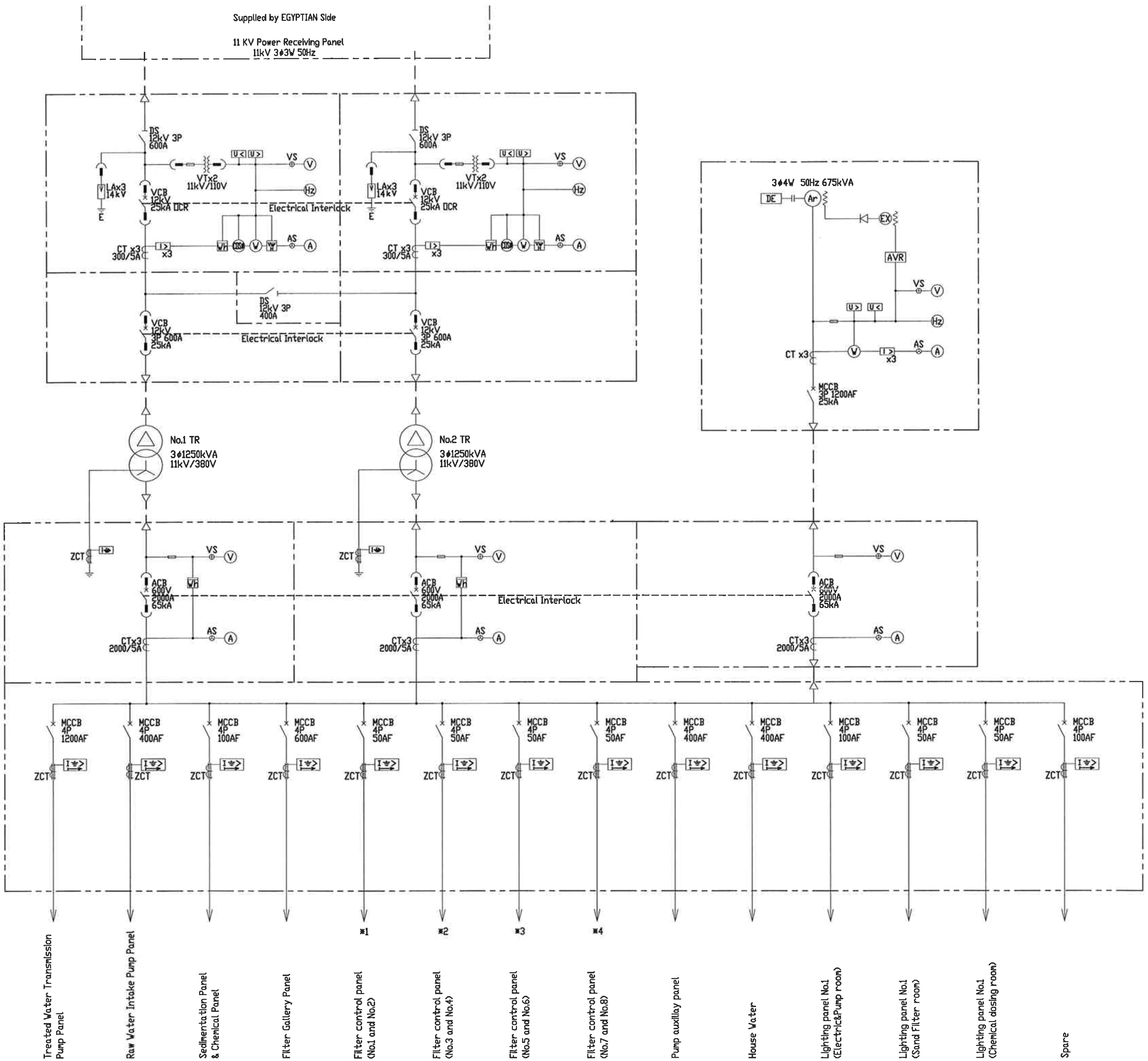


EQUIPMENT NO.	1	2	3	4	5	6	7	8	9
NAME	DRAINAGE TANK WATER INLET GATE	DRAINAGE TANK WATER TRANSFER PUMP	DRAINAGE TANK SLUDGE TRANSFER PUMP	CONNECTION GATE FOR DRAINAGE TANK	SLUDGE TANK SLUDGE INLET GATE	SLUDGE TANK SLUDGE TRANSFER PUMP	CONNECTION GATE FOR SLUDGE TANK	THICKENER INLET WEIR	THICKENER SLUDGE COLLECTOR
TYPE/SHAPE	GATE WITH MANUAL OPERATION GEAR	SUBMERSIBLE PUMP	SUBMERSIBLE PUMP	GATE WITH MANUAL OPERATION GEAR	GATE WITH MANUAL OPERATION GEAR	SUBMERSIBLE PUMP	GATE WITH MANUAL OPERATION GEAR	MOVABLE WEIR	CENTER ROTOR TYPE
CAPACITY	□800mm	4m^3/minx15mx15kW	1.5m^3/minx15mx7.5kW	□500mm	□700mm	0.2m^3/minx15mx3.7kW	□500mm	500mmWx 300mm st	ø7mx 0.4kW
QUANTITY	2	2	2	1	2	2	1	2	2
NOTE									

MKWP-08 Flow Diagram of Drainage and Sludge Treatment System

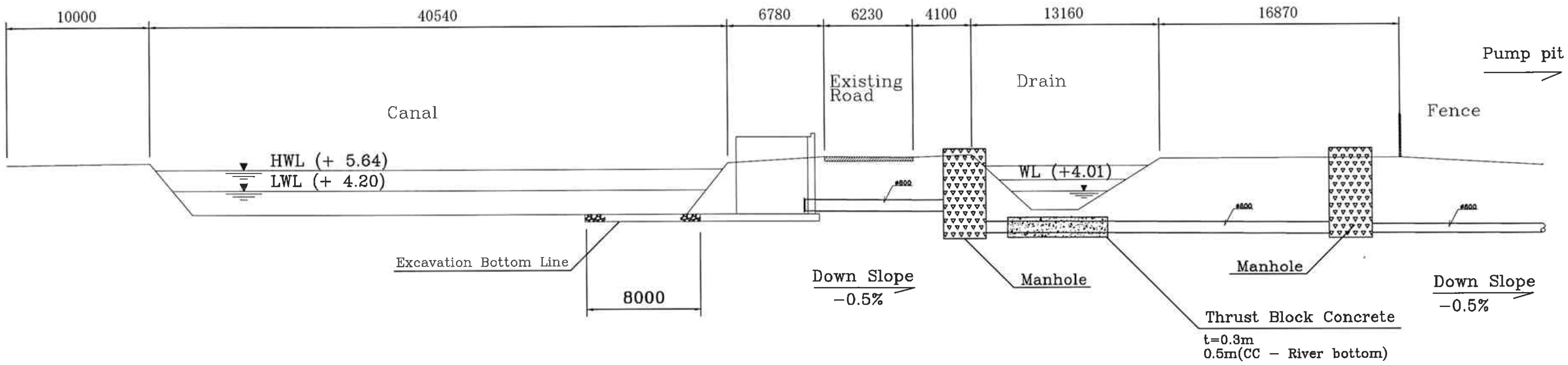


MKWP-09 Monitoring System and Instrumentation

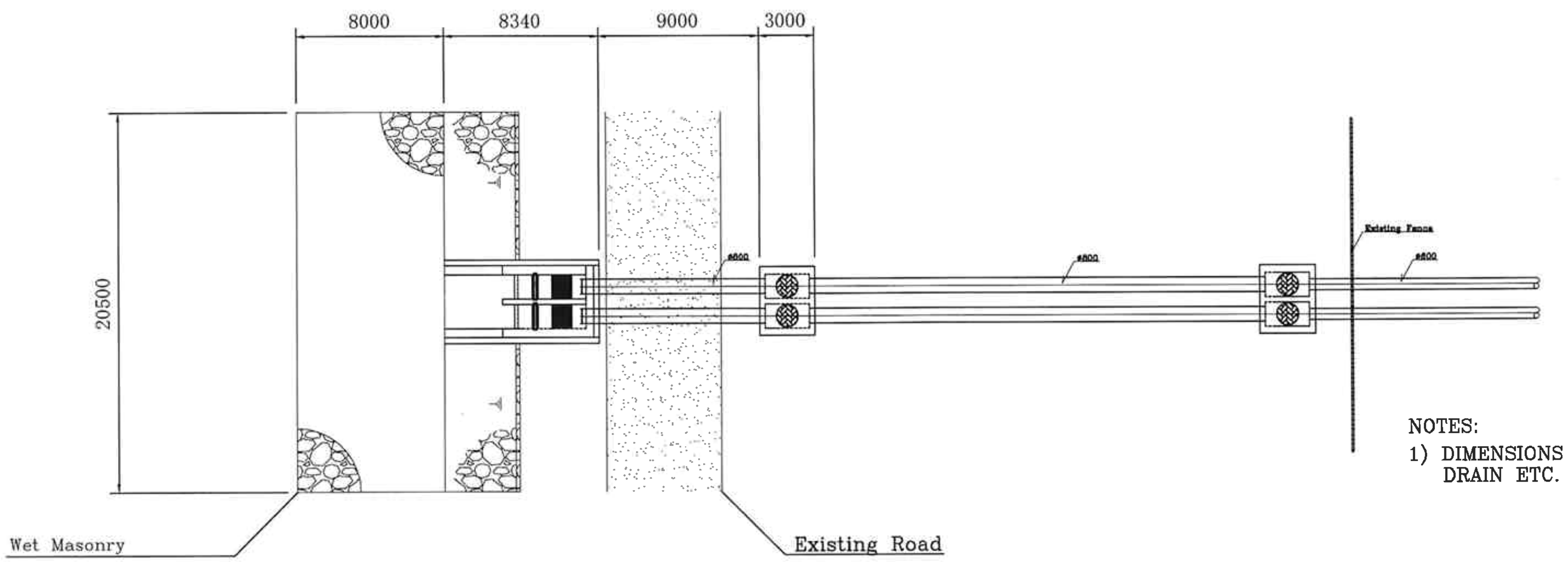


MKWP-10 Single Line Diagram

SECTION OF EL MALLAH CANAL AT WATER INTAKE FACILITY



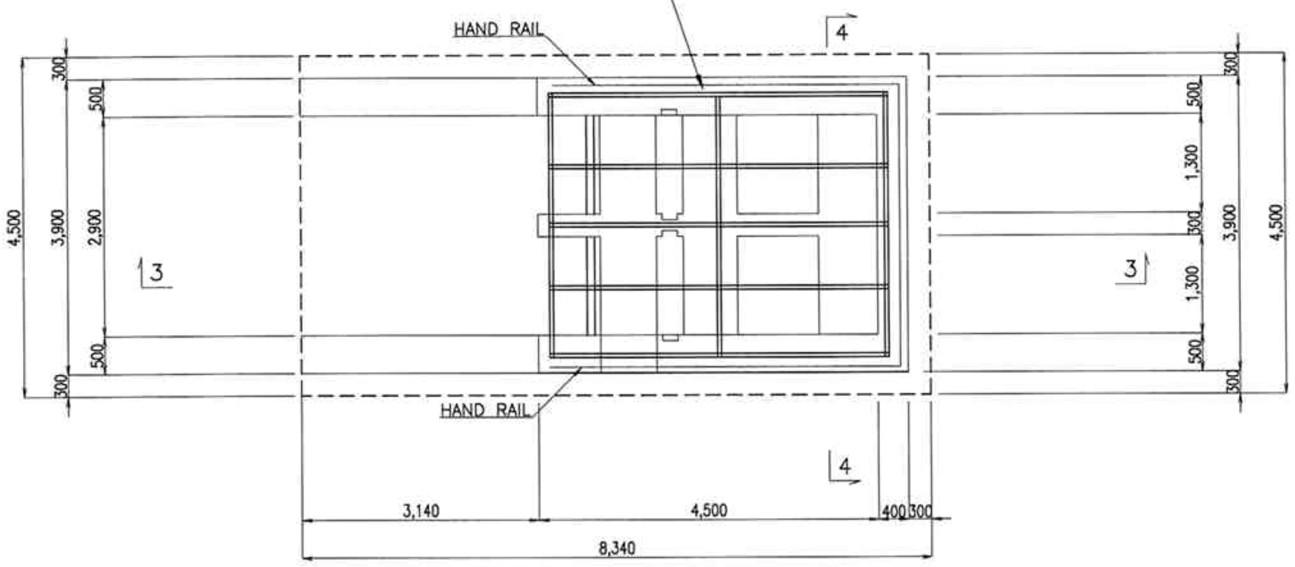
PLAN OF WATER INTAKE FACILITY



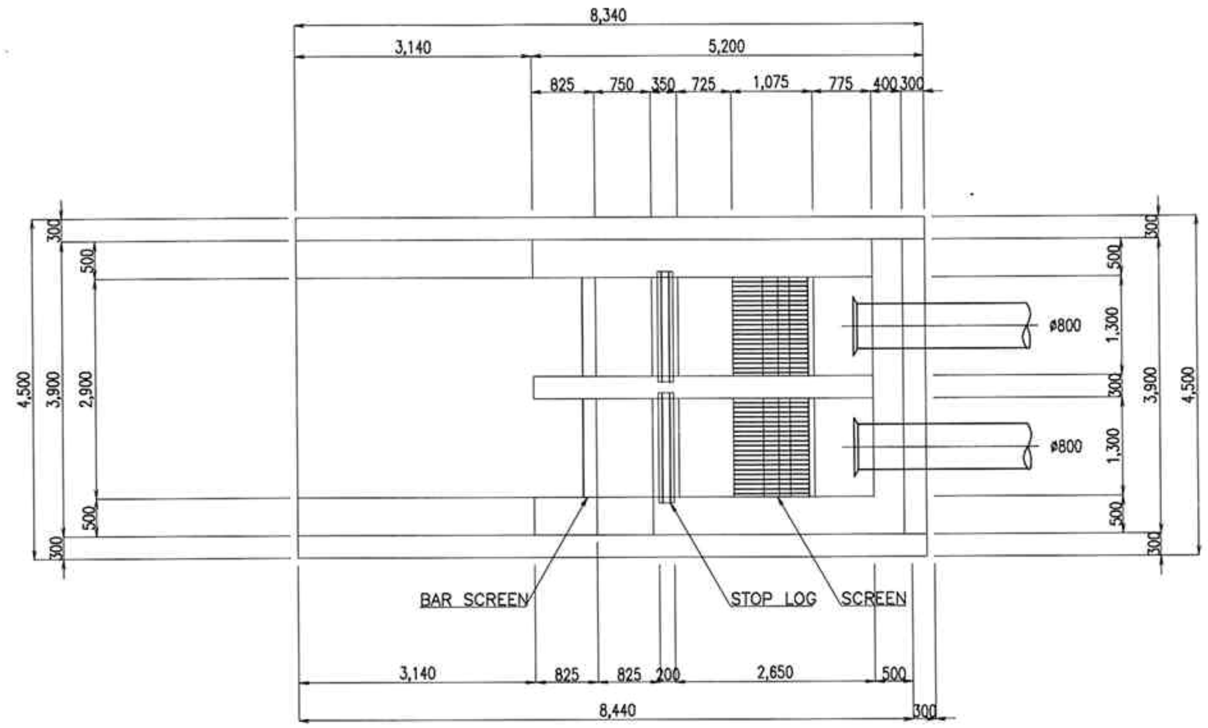
NOTES:
1) DIMENSIONS FOR CANAL, BANK, DRAIN ETC. ARE APPROXIMATE.

MKWP-11 Water Intake Facility(1/2)

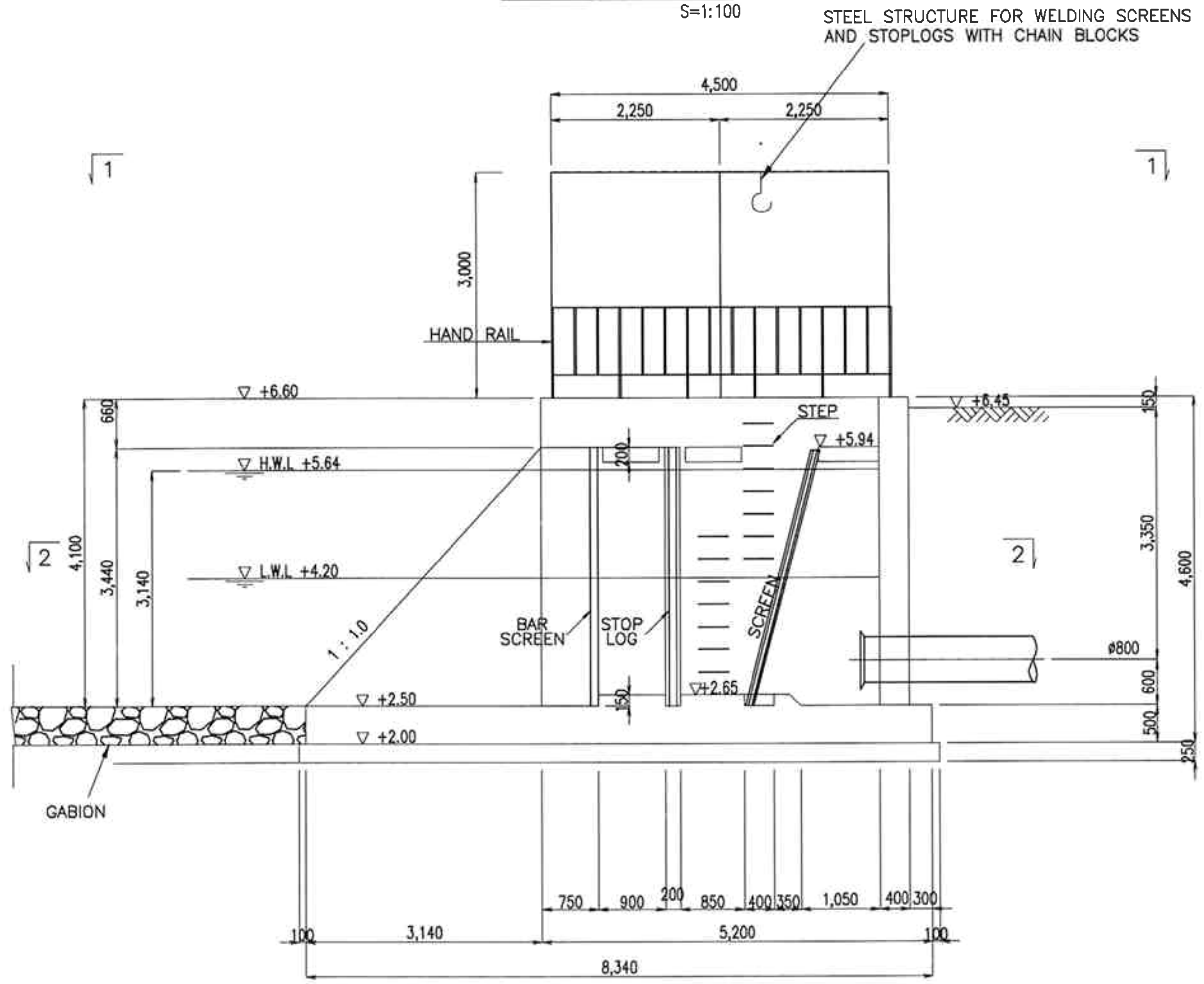
SECTION 1-1
S=1:100



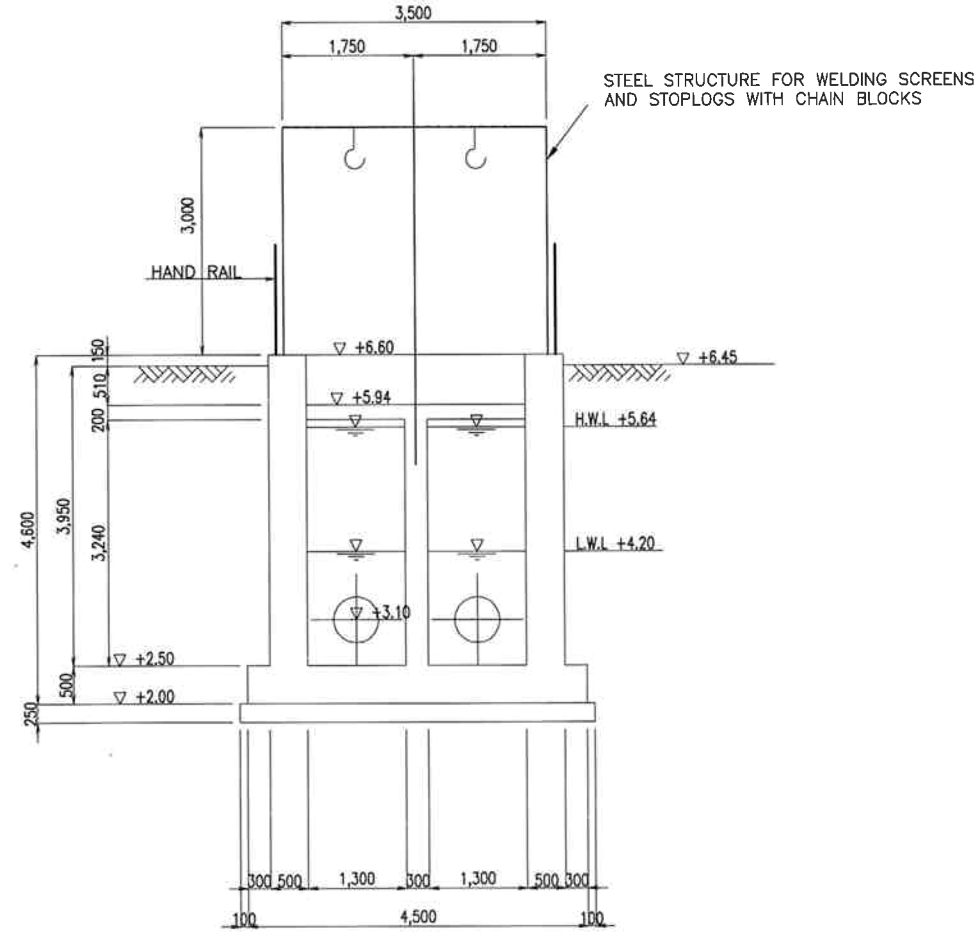
SECTION 2-2
S=1:100



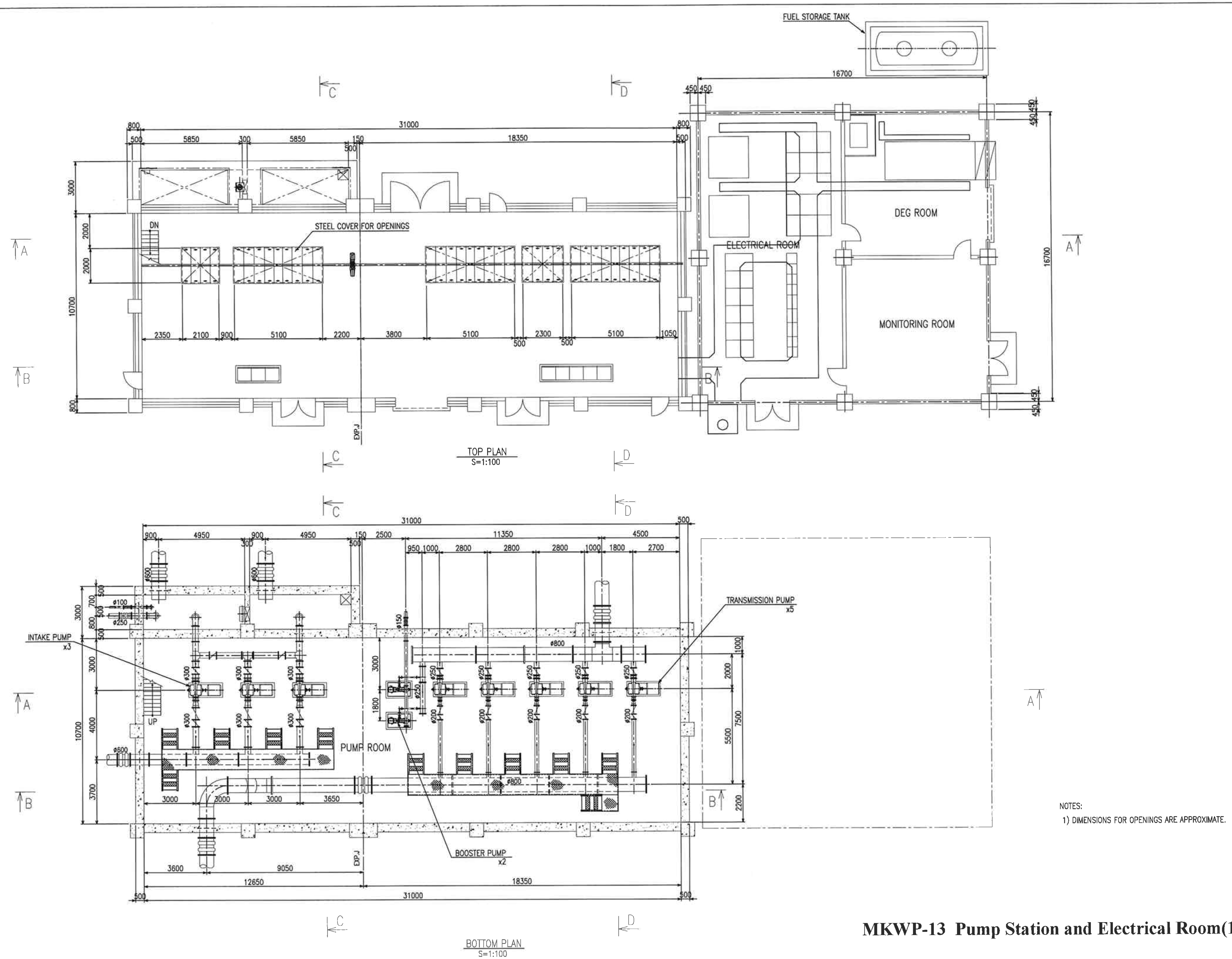
SECTION 3-3
S=1:100



SECTION 4-4
S=1:100



MKWP-12 Water Intake Facility(2/2)



MKWP-13 Pump Station and Electrical Room(1/2)