BANGKHEN WATER TREATMENT PLANT

BACKGROUND

In the last century, there were only about 330,000 people in Bangkok, the capital city of Thailand. Bangkok is known as the Venice of the East because there are many canals constructed to connect with the Chao Phraya River, the main river of the city. As a result, Bangkok residents consume canal water and rain water for all daily-life activities. However, water problems usually occurred in dry season due to canal water became salty, dirty and unsafe for drinking and use for other activities. Occasionally, it caused an outbreak of fatal cholera.

According to King RamaV the Great's awareness of water condition in the future, the water supply project was graciously initiated in 1909 in order to provide clean disinfected water for the residents. Survey, design and construction of raw water canal were launched in the 5 following years. Consequently, water production and distribution system were constructed afterward. Treated water from the project, Bangkok Waterworks, was first supply to Bangkok residents in 1914.

In 1967, the Bangkok Waterworks was changed to Metropolitan Waterworks Authority (MWA), a state enterprise under the Ministry of Interior, which is responsible for clean disinfected water production, transmission and distribution to people living in 3 adjoining provinces, namely, Bangkok, Nonthaburi and Samut Prakan.

WATER SUPPLY PRODUCTION

In fiscal year 2009 starting from 1 October 2008 to 30 September 2009, the number of water supply production was recorded at 1,821.36 million cubic meters or 4.99 million cubic meters per day approximately which was from many sources as followed:

Source of Production	Max.Capacity per Day (m^3)
Bangkhen WTP	3,600,000
Samsen WTP	550,000
Thonburi WTP	170,000
Mahasawat WTP	1,200,000

Note: WTP: Water Treatment Plant

INTRODUCTION

According to the Master Plan of the Bangkok Water Supply, Bangkhen Water Treatment Plant is planned to be the center of water production and transmission. This plant is responsible for supporting water demand in MWA service areas, which are Bangkok, Nonthaburi and Samut Prakan Provinces.

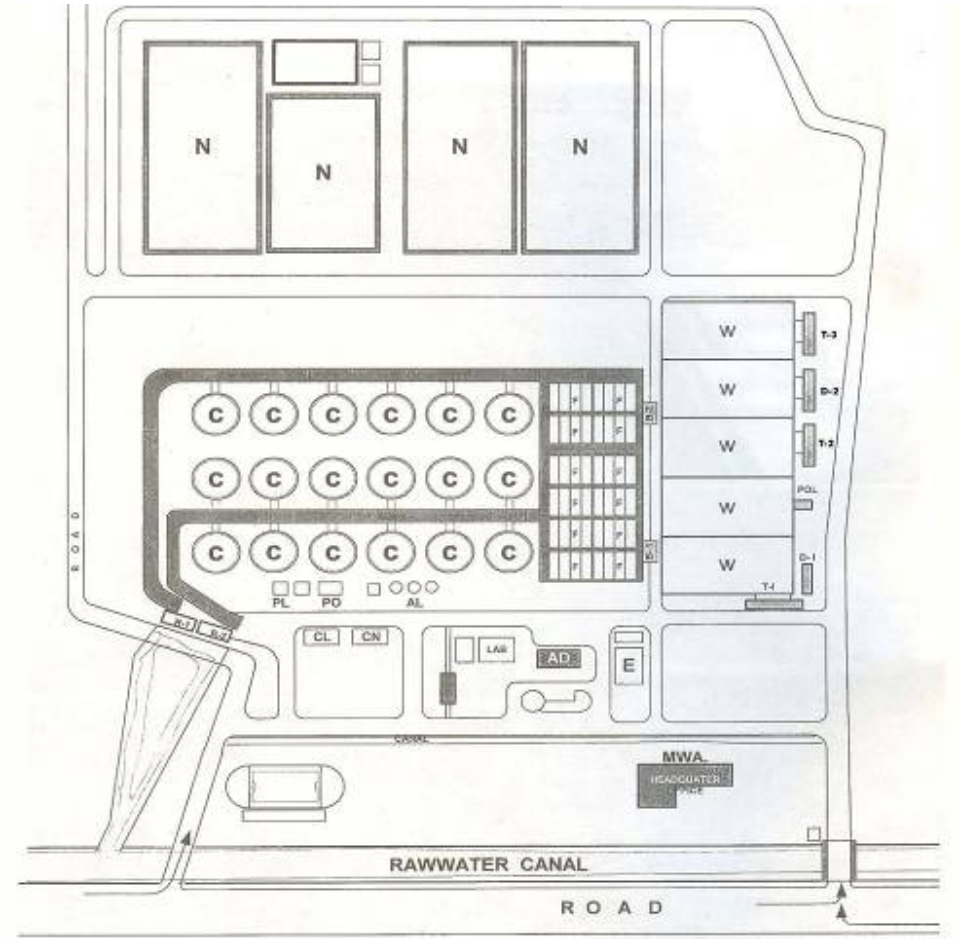
The plant is located on an area of approximately 1.136 square kilometers (710 rais) at Thung Song Hong, Laksi district, about 10 km north of Bangkok Metropolis. It was first started stage I, phase I construction project in 1975 and finished in late 1979, has currently the maximum production capacity of 3,600,000 cubic meters per day. However, it can be expanded to the total maximum capacity of 4.8 million cubic meters per day in order to support water demand increasing in the future.

The Bangkhen WTP is divided into 6 categories, namely, raw water section, clarification, filtration, water storage, transmission and distribution, and sludge lagoon.

1. RAW WATER SECTION

Raw Water Resource

Raw water used in MWA water treatment process is taken from Chao Phraya River at Sam Lae Pumping Station. Sam Lae Pumping Station is located at Sam Lae, Pathum Thani Province, about 18 km. north of the Bangkhen Water Treatment Plant. Sam Lae Pumping Station, first constructed in 1967, currently comprises 3 pumping buildings lying across the raw water canal with a projected area of 22x16 square meters and 19 meters high each. Intake side faces to Chao Phraya River with Coarse bar racks, which are installed at the inlet channels in order to stop large particles entering the pumps. Building working areas are divided into 2 levels, namely, basement and overground floor. The basement is 8 meters underground equipped with horizontal axial flow pumps, each of which has 400 cubic meters per minute capacity, whereas the overground floor is 11 meters high and houses main control panels, electrical devices and other necessary appurtenances. The total maximum raw water pumping capacity is 5.8176 million cubic meters per day.



BUILDING IDENTIFICATION

AD	Administration Building
AL	Alum Building
B-1, B-2	Back Wash Water Pumping Station
C	Clarifier Tanks
CL	Chlorine Building
CN	Chlorine Neutralization
D-1, D-2	Distribution Pumping Station
E	Electrical Substation
F	Filter Tanks
LAB	Laboratory
N	Sludge Lagoons
PL	Pre-Lime Building
PO	Polyelectrolyte Building
POL	Post-Lime Building
R-1, R-2	Raw Water Pumping Station
T-1, T-2, T-3	Transmission Pumping Station
W	Filtered Water Reservoir

BANGKHEN RAW WATER PUMPING STATIONS

Raw water from raw water canal is pumped to Bangkhen raw water pumping stations through coarse and fine screen before transmitted to the water treatment process. Each pumping building has a projected area of 17 x 40 square meters and 18 meters high. The building working areas are categorized into 2 levels, namely, basement and overground floor. The basement in the first building is 4 meters underground equipped with 6 horizontal mixed flow pumps rated at 348 cubic meters per minute, whereas the other building equipped with 3 horizontal mixed flow pumps which one is rated at 174 cubic meters per minute and the others are 348 cubic meters per minute. Magnetic-air cooled variable speed drive can vary from 80 to 100 percent of rated motor speed. The overground floor is 13 meters high and houses the control panels and switch boards for pump operation.

Technical Performance

	Station 1	**Station 2**
Type of Pumps	Horizontal Mixed Flow	Horizontal Mixed Flow
No. of Installed Units	6	4
Rated Capacity per Unit	348 - 358 CMM	174 – 348 CMM
Rated Head	9.3 – 10 M	9.3 – 10 M
Driver Size	900 – 1340 HP	500 – 1340 HP
Voltage (3-phase, 50 Hzs)	6600 Volts	6600 Volts
Max. Speed	300 – 320 RPM.	200 – 407 RPM.


ABB

2. CLARIFICATION

Raw water is pumped from raw water pumping stations passing through the influent channel to the clarification section. Lime is added in controlled quantities in order to improve water quality and activate sedimentation efficiency during the clarification process. Moreover, Chlorine is added to stop the growth of algae and moss that may causes clarification effectiveness reduction.

18 flat conical tanks of clarifiers, solid contact units of slurry recirculation type, were constructed in Bangkhen Water Treatment Plant with 58 meters diameter each. The design loading rate of each clarifier is 70 millimeters per minute and permits 200,000 cubic meters a day clarifier rate. Therefore, 3,600,000 cubic meters is currently the total maximum daily capacity of clarification. The tank is divided into 2 zones, namely, reaction and sedimentation zones. The reaction zone is in the center area of the tank where water is agitated and mixed with alum and polyelectrolyte. The remaining area is the sedimentation zone where the mixture between raw water and chemical substances form floc and sedimentation takes place.

As a result, the water and sludge are then separated due to the clear water flow to the surface while the accumulated sludge settles at the bottom of the tank for sludge removal process. The clarified water is radial collected in launders and then enters to filters through the effluent channels.

Technical Performance

Type of Clarifier	Slurry Recirculation (Solid Contact Recirculation)
No. of Installed Units	18
Size of each unit	Diameter 58 M.
Clarification rate per unit	200,000 CMD.
Pre-lime Feeding	5 ppm – 15 ppm in Influent Channel
Alum Dose	20 ppm – 70 ppm at Clarifier Inlet Channel
Polyelectrolyte Dose (anion)	0.03 ppm – 0.10 ppm in Reaction Zone
Effluent Water Quality Control	Turbidity is in the Range of 5-7 NTU
Sludge Removal System	Automatic Sludge Drain from the bottom of clarifier

3. FILTRATION

The clarified water is delivered through the clarifier effluent channels to rapid sand/anthracite coal filters. 48 filters are currently installed; however, 33-36 of them are practically used in operation. Each filter with the area of 9.4 x 27.4 square meters is designed for the initial rated capacity of 75,000 – 100,000 cubic meters per day. However, filtration capability can be increased up to 120,000 cubic meters per day with possible operation depending on raw water quality, seasons or in case that filters have to operate over the rated capacity under special conditions. The dual media consists of 0.8 m. anthracite coal on the top layer and 0.4 m. graded sand at the bottom layer. Under media layer, about 10,980 nozzles are installed, while each filter is controlled individually. Air/water backwash system is operated after every 48 hours of filtration in order to remove clogging of the filter media.

Technical Performance

Type of Filtration	Rapid Sand/Anthracite Coal	
No. of Installed Units	48	
No. of Operating Units	33-36	
Filter Bed Area Per Unit	256 Sq.M.	
Initial Rated Capacity per Unit	75,000 – 100,000	
% Increase of hydraulic Capability per Unit	60	
Min. Filtration rate	200 mm./min	
Nozzle Spacing	0.1524 M.	
Flow per Nozzle During Filtration	70 – 127 cu.cm/s.	
Depth of Top Water (Max.)	2.25 M.	
Free Board (Min.)	0.80 M.	
	Anthracite coal	Sand
Thickness of Media used	0.80 M.	0.40 M.
Specific Gravity	1.45 – 1.70	2.60 - 2.70
Moh Scale	3.00 – 3.75	
Max. Particle Size	4.00 MM.	2.00 MM.
Effective Grain Size	0.80MM.± 0.005	0.45 MM.± 0.05
Max. Uniformity Coefficient	Less than 1.50	
Porosity for Normal Packing	0.5 – 0.6	0.4 – 0.5
Length of Filter Run	Manual control by maximum head loss = 2.0 M or 48 hours operation	
Backwashing System	Air / Water	
Air Scouring rate	100 cu.m/sq.m/hr	
Back Wash Water rate	50 $m^3/m^2/hr$	
Flow per Nozzle During Backwashing with Water	354 cu.cm./s	
Bed Expansion During Backwashing	20% - 30 %	
Effluent Water Quality	Turbidity 1-2 NTU	

Technical Performance

Description	Backwash Water Pump		Air Blower	
	Station 1	Station 2	Station 1	Station 2
Type of Pumps	Volute	Volute	Rotary	Rotary
Number of Installed Units	3	3	3	3
Rated capacity Per Unit	108 CMM	108 CMM	210 CMM	210 CMM
Rated Head	8 M	8.4 M	0.5 M	0.5 M
Drive Size	250 Hp	250 Hp	429 Hp	429 Hp
Voltage(3-phase, 50 Hzs)	380 V.	380 V.	380 V.	380 V.
Max. Speed	406 RPM.	368 RPM.	735 RPM.	740 RPM.


17

4. WATER STORAGE

Filtered water is delivered and collected in water storage, called Reservoir. Where post-lime and chlorine, disinfecting substances, are dosed to improve water quality in order to maintain MWA drinking water standard.

The reservoir is a reinforced concrete tank with 5 meters height. Its total capacity is 360,000 cubic meters which is about 10 percent of daily treated water production of Bangkhen Water Treatment Plant.

5. TRANSMISSION AND DISTRIBUTION

Transmission Pumping Stations

The treated water from the Bangkhen Water Treatment Plant is transmitted and distributed to the majority of MWA customers by transmission and distribution pumping stations through water tunnels and conduits. Each transmission pumping station building, 13 x 69 square meters projected area with 12 meters high, is connected to the reservoir. Its working areas are divided into 2 levels, namely, basement and overground floor. The basement is 3 meters underground equipped with 5 volute pumps comprising a 153 cubic meters per minute rated capacity pump and 4 of 300 cubic meters per minute rated capacity pumps for the first station, whereas the second station equipped with 4 volute pumps having a rated capacity of 300 cubic meters per minute each. The overground floor is 9 meter height installed with pump control panels, electrical devices and pump appurtenances.

Surge Tower

In addition, a surge control tower is installed between the transmission station and the tunnel in order to overcome rapid change of water flow rate, called Water Hammer phenomena. In the case of pump, valve or power failures, the tower, a steel cylinder with 11 meters diameter and a total height of 70 meters consisting of 23 meters underground and 47 meters overground, is designed to dissipate water energy and collect water flowing in the wrong direction.

Technical Performance of Transmission

	Station 1		**Station 2**		**Station 3**
Type of Pumps	Volute	Volute	Volute	Volute	Volute
Number of Installed Units	4	1	4	1	3
Rated Capacity per Unit	300 CMM	153 CMM	300 CMM	300 CMM	300 CMM
Rated Head	32 M	32 M	33 M	33 M	35 M
Driver Size	2575 Hp	1330 Hp	2815 Hp	2815 Hp	2950 Hp
Voltage (3-phase, 50 Hz)	6600 V.	6600 V.	6600 V.	6600 V.	6600 V.
Maximum Speed	375 RPM.	500 RPM.	360 RPM.	375 RPM.	368 RPM.

Technical Performance of Distribution

	Station 1	Station 2	
Type of Pumps	Volute	Volute	Volute
Number of Installed Units	5	3	1
Rated Capacity per Unit	111 CMM	111 CMM	125 CMM
Rated Head	50 M	50 M	35 M
Driver Size	1570 Hp	1570 Hp	1200 Hp
Voltage (3-phase, 50 Hz)	6600 V.	6600 V.	6600 V.
Maximum Speed	720 RPM.	745 RPM.	594 RPM.

Transmission & Distribution System

Transmission and Distribution System can be described as followed:

Central System

1. Transmission by tunnels, which diameters vary from 2.0 to 3.4 meters with the total length of 105 kilometers, depth of 20 meters underground. There is 2 routes transmit treated water to distribution pumping stations.

   First route, transmit the treated water from Transmission Pumping Station No.1 in the Bangkhen Water Treatment Plant to distribution pumping stations in Phahol Yothin, Lum Phini, Rat Burana and Tha Phra, respectively. Its total length is 35 kilometers.

   Second route, transmit the treated water from Transmission Pumping Station No.3 in the Bangkhen Water Treatment Plant to distribution pumping stations in Minburi, Lad Krabang and Bang Plee, respectively. Its total length is 70 kilometers.
2. Transmission by conduit, which diameters vary from 2.0 to 3.2 meters with the total of 48 kilometers, depth of 4 meters underground, transmit the treated water from Transmission Pumping Station No.2 to distribution pumping stations in Lad Phrao, Klong Toey and Samrong, respectively.

Consequently, the water is pumped to main trunks which diameters range from 500 to 2,000 mm. with 1,524 km. total length. The water then enters into distribution pipes which diameters range from 100 to 400 mm. with a total length of 18,109 km. Moreover, there is 5,813 km. total length of service pipes.

There are 12 distribution pumping stations in the system excluding the direct distribution pumping stations constructed at the Bangkhen, Samsen, Thonburi and Mahasawat Water Treatment Plants as followed:

1. Phahol Yothin Distribution Pumping Station
2. Lum Phini Distribution Pumping Station
3. Klong Toey Distribution Pumping Station
4. Lad Phrao Distribution Pumping Station
5. Samrong Distribution Pumping Station
6. Tha Phra Distribution Pumping Station
7. Rat Burana Distribution Pumping Station
8. Minburi Distribution Pumping Station
9. Petch Kasem Distribution Pumping Station
10. Lad Krabang Distribution Pumping Station
11. Bang Plee Distribution Pumping Station
12. Pracha Nukool Distribution Pumping Station (via Bypass System)

6. SLUDGE LAGOON

Sludge is drained from the bottom of the clarifiers and backwash water from the filters is pumped to sludge lagoon. Dried accumulated sludge is periodically removed, whereas the recycled water is flow back to the process at about 30,000 cubic meters a day.

WATER QUALITY CONTROL

The MWA has adopted the World Health Organization (WHO, 2006) criteria and standard to control its water quality strictly in order to ensure that its treated water is undoubtedly drinkable. The water quality analysis has been done continuously in every water treatment process starting from raw water resources to the final stage at the customers' places. The number of heavy metals, insecticides, and pesticides trihalometanes, those are contaminated in water are tested physically and chemically. In addition, bacteria and algae inside of the water are tested biologically. Water quality control tests are conducted every 4 hours in MWA production process and Free Residual Chlorine testing is done every 2 hours. Moreover, tap water sampling from all distribution pumping stations and customers' places in every branch office area is daily tested. In addition, the water quality from resource is monthly checked.

TAP WATER IS DRINKABLE EVERYWHERE

The drinkable water project which has been campaigned with a slogan “Tap water is drinkable everywhere” has cooperated with Mahidol University. This project is done to ensure that the quality of MWA tap water is good enough for drink. This enhances public confidence and trust.

The MWA purpose is to encourage people to drink tap water, trust that tap water is good for health and cheaper than filtered or bottled water. Moreover, it can save energy used in boiling process, and reduce environmental problems from water container garbage. Also, it builds up a good impressive image of the country’s sanitation that Thailand can provide good quality tap water to meet the International Standard.

ISO 9001 Certification

Bangkhen Water Treatment Plant is assigned to implement the quality assurance system, ISO 9001:2008 for every process of water production, transmission and distribution system. Bangkhen WTP quality policy is “Bangkhen Water Treatment Plant intends to improve water production process to be continuously effective for water quality meeting customer satisfaction”. According to the full cooperation and devoted work of our staff, Bangkhen WTP has been successfully achieved the ISO 9001 certification from the Management System Certification Institute (Thailand) since May, 2010. We are proud to present to all customers that our production process could be a guarantee of MWA water quality. Customers can therefore be confident in tap water whenever and wherever they are.