Phnom Penh Water Supply Authority
Phnom Penh, Cambodia

1. Background information

Phnom Penh Water Supply Authority (PPWSA) is the only autonomous water supply operator providing clean water to the entire Phnom Penh municipality. Four water treatment plants (WTPs) were constructed to fulfill the water demand in the city. These four WTPs are located along Tonlé Sap and Mekong River, as these two rivers are the main water sources of the plants.

Phnom Penh Water Treatment Plant was initially established in 1895 by a company named Compagnie des Eaux et Electicité de l`Indochine (CEEI), a French water and electricity supply authority in Indochina. It was a small WTP with the capacity of 15,000 m^3/d with 40 km of distribution pipeline network. In 1959, PPWSA was officially established by the Royal Decree signed by King Norodom Sihanouk. PPWSA then increased the capacity to 430,000 m^3/d in 2013 and to 460,000 m^3/d in 2015. **Figure 1** shows the location of treatment plants, their capacity and their activation date.

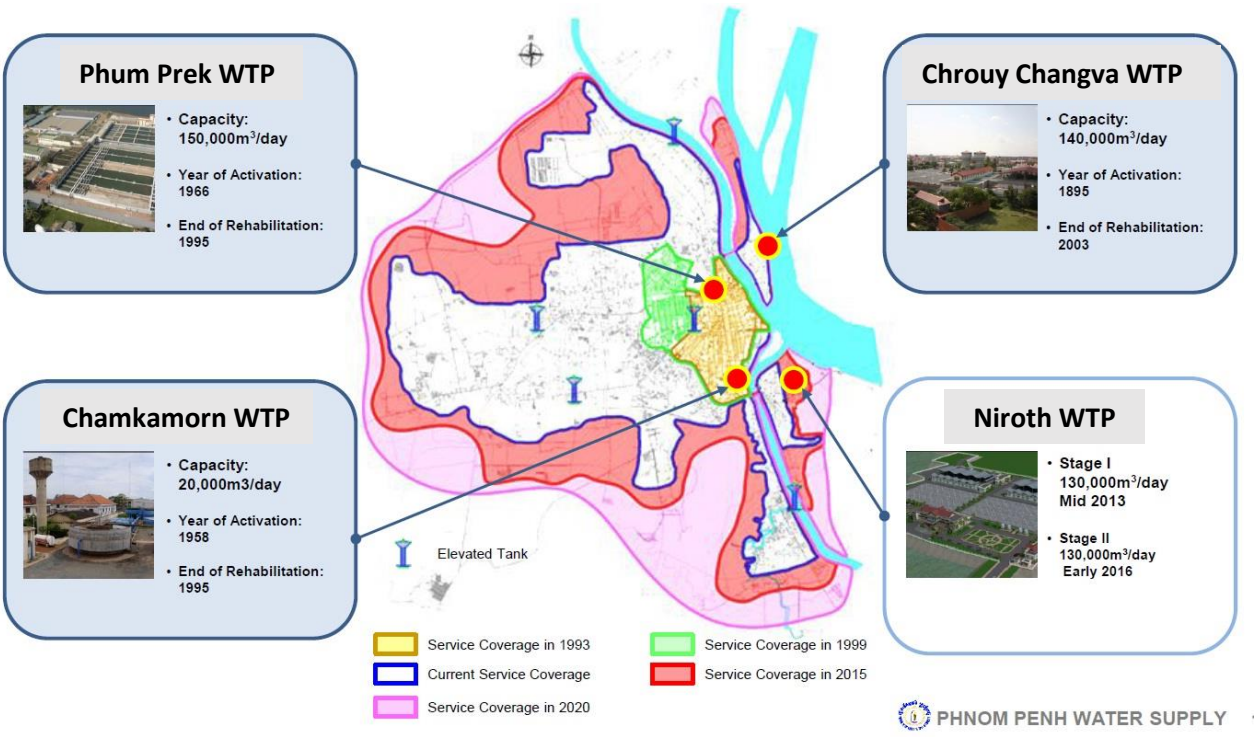

Figure 1 Water treatment plants of Phnom Penh Water Supply Authority

Phum Prek Water Treatment Plant (PPWTP) is one of the four treatment plants, which came into operation in 1966 to supply the clean water to the central area of Phnom Penh. The PPWTP has the capacity of 150,000 m^3/d. The plant was rehabilitated in 1995 by Kubota under the support from Japan International Cooperation Agency (JICA). PPWTP is currently operated with its full capacity to fulfill water demand. Overall information of PPWTP is presented in **Table 1.**

Table 1. Overall Information of Phum Prek Water Treatment Plant

Constructed Year	1966 (rehabilitated in 1995)
Water Source	Tonlé Sap River
Number of connections	116,000
Peak Operating Flow (m^3/d)	156,000
Design Capacity (m^3/d)	150,000
Peak/Design flow	1.04
No. of operators working at the plant	22
Date of access of the source information	2015
Reference	http://www.ppwsa.com.kh/

2. Water treatment process flow

The major treatment processes is as follows:

Raw water extraction (intake) → Hydraulic mixing (lime, alum and chlorine) → Flocculation (mechanical mixer) → Sedimentation (rectangular basin) → Rapid sand filtration (fine sand) → Disinfection (chlorine) → Storage tank → High lift pump for distribution.

Sludge generated from treatment process (sedimentation and backwashing) is drained directly to Tonlé Sap River without any treatment.

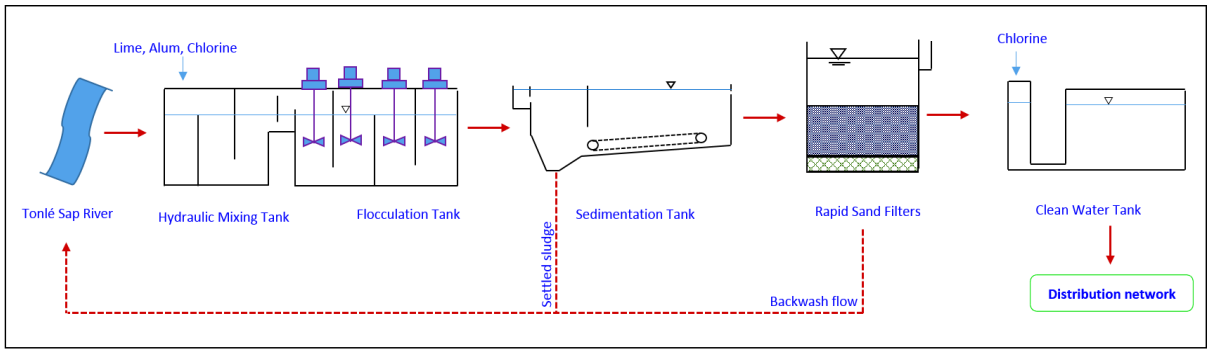

Figure 2 Treatment Process of Phum Prek Water Treatment Plant

❖ Raw Water Extraction

A water intake structure was built to extract water from the Tonlé Sap River. Five intake pumps were used with a total capacity of about 156,000 m^3/d (**Figure 3**).

Figure 3 Raw water intake station

❖ **Hydraulic Mixing**

Three kinds of chemicals were initially introduced for water treatment; lime, alum and chlorine (gas). However, lime and alum is recently replaced by PAC because of its better efficiency in water treatment. Pre-chlorination is still in operation. These chemicals are injected one after another as shown in **Figure 4.**

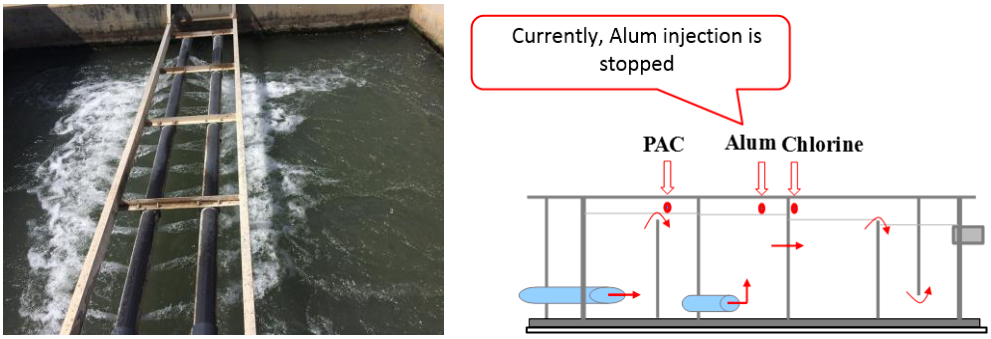

Figure 4 Chemical Feeding (left) and Hydraulic Mixing (right)

❖ **Flocculation**

The water coming from the chemical mixing tank flows into the flocculation tank where the mechanical mixer is introduced to form bigger flocs **(Figure 5).** The detention time of flocculation tank was designed to be 6.2 min.

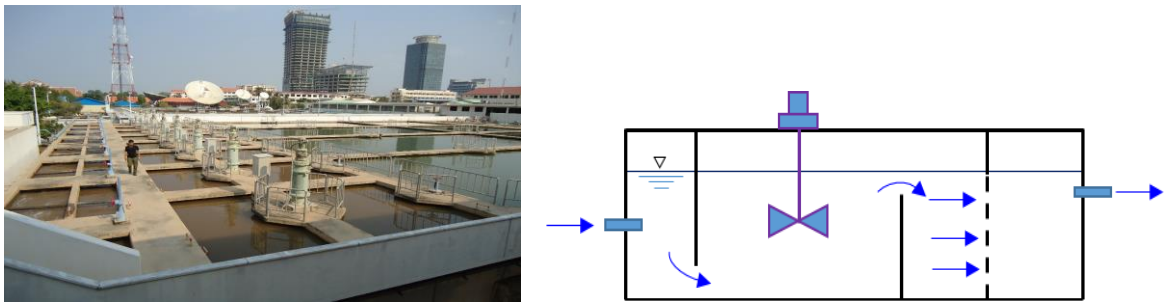

Figure 5 Flocculation tank

❖ **Sedimentation Tank**

Sedimentation tank is a rectangular type with circular-notched weir. The tank has a total length of 50 m and is divided into three compartments by perforated wall. The detention time is set to be around 2 h with a surface loading rate of 5 $m^3/m^2.h$. The sludge at the bottom of the tank is automatically withdrawn and discharged back into the downstream of the river. **Figure 6** illustrates the sedimentation tank.

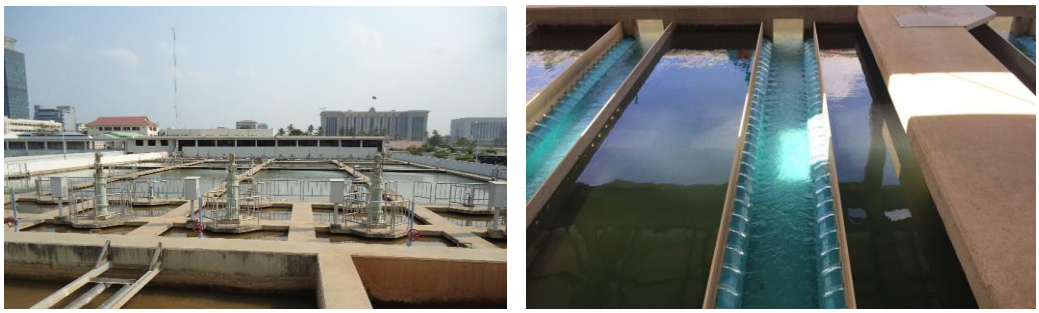

Figure 6 Sedimentation Tank

❖ **Rapid Sand Filtration**

The rapid sand filter uses fine sand as the filter media with the effective size of 0.8 – 1.0 mm, uniformity coefficient of 1.5 and a filter depth of 1.0 m, with the support gravel of 0.1 m. The filtration rate is 16.0 m/h and the bed area is 48.8 m^2. Backwashing is carried by a combination of water and air scouring. **Figure 7** shows the sand filtration tank and control panel.

Figure 7 Filtration tank and control panel

❖ **Disinfection (Chlorine)**

Chlorine (gas) is injected into the filtrated water with the dosage of 2.2 mg/L before transferring to the storage tank. Then, the water is pumped for distribution (**Figure 8**).

Figure 8 Post chlorination

❖ **Sludge disposal**

There is no sludge treatment system at PPWTP. Sludge generated from the plant (sedimentation tank and backwashing process) is discharged back into the Tonlé Sap River at the downstream of the water intake (**Figure 9**).

Figure 9 Sludge outlet at the down stream of the river

3. Aspects of treatment processes posing most difficulty for daily operation

There are no significant problems with the treatment plant facilities. The treatment plant was well designed and the treatment efficiency was found to be good. Some of the problems encountered in the entire treatment plant operation are as follows:

- PPWTP has no remaining space for the future plant expansion to fulfill the increasing water demand from the rapidly growing urban population in Phnom Penh capital.

- There is no sludge treatment system. The sludge generated from the plant is discharged back into the river at downstream of water intake. This will be a problem in the future if the local authority does not allow discharging the sludge back into the river.

- It has been seen that there is algae growth at sedimentation and filtration tanks, although pre-chlorine was injected. This might be due to malfunction of the pre-chlorination system or too low chlorine dose for high turbidity water. Thus, a monitoring procedure on algae growth should be prepared and implemented.

- Post-chlorine injection device sometimes breaks down or clog. However, it is not serious as there is a spare part for replacement.

In addition, water quality changes significantly during rainy season as shown in **Figure 10**.

Figure 10 Apparent change of water quality
(Left: rainy season; Right: dry season)

4. Aspects of water services management in general posing most difficulty at the moment

PPWSA has a responsibility to supply water in the entire area of Phnom Penh. With a rapid increase of urban and sub-urban population, and business activities, PPWSA is facing with a challenge of large water demand. PPWSA has followed the master plan, but it still cannot supply enough water to the whole population of Phnom Penh.

5. Measures taken now to cope with 3) and 4)

PPWSA is planning to build a new water treatment plant to overcome the high water demand of the Phnom Penh population. It is at the study phase and is planned to be implemented in 2016.

6. Recent investment made for the plant's improvement

One more treatment plant site is expected to be constructed in 2016.

7. Customer's opinion on water quality and water services in general

It was informed that there is no complaint from customers on water quality. However, there is no complaint registration mechanism in place. If customers want to complain, they can do via phone call or inform directly to the staff at the cashier counter. Hence, PPWSA should implement a complaint/feedback mechanism where customers can express their concerns.

8. Advanced technology used in this water treatment plant or any points to improve the process, water quality and capacity.

No

9. Water quality data

The raw water and treated water quality produced by PPWSA in 2013 are presented in **Table 2**. Overall, the measured parameters were under WHO standard for drinking water purpose.

Table 2 Raw water and treated water quality

No.	Parameters	Unit	Raw water	Treated Water	Distributed Water (average)	WHO standard
1	Turbidity	NTU	102	<0.89	<1.03	5
2	pH	-	7.64	7.04	7.58	6.5-8.5
3	Free available chlorine	mg/l	0	0.88	0.26	0.1-1
4	Total available chlorine	mg/l	0.05	1.02	0.42	0.5-2
5	Total Coliform	CFU/100ml	21,313	0	0	0
6	Fecal Coliform	CFU/100ml	5,391	0	0	0
7	E. coli	CFU/100ml	5,391	0	0	0

10. Other highlight

- Chemical usage: lime, chlorine, poly aluminum chloride
- Water tariff:
  - **Domestic**
    - 0 – 7 m^3/month : 0.14 US$/$m^3$
    - 8 –15 m^3/month: 0.19 US$/$m^3$
    - 16 – 50 m3/month: 0.25 US$/$m^3$
    - Over 50 m^3/month: 0.32 US$/$m^3$
  - **Public Administration Institution and Wholesalers-communities**
    - 0.26 US$/$m^3$ (without considering of quantity)
  - **Commercial, Autonomous state authorities and wholesalers**
    - 0 – 100 m^3/month : 0.24 US$/$m^3$
    - 101 – 200 m^3/month: 0.29 US$/$m^3$
    - 201 – 500 m^3/month: 0.34 US$/$m^3$
    - Over 500 m^3/month: 0.36 US$/$m^3$
- In 2004, PPWSA received the Asian Development Bank Water Prize for "Dramatically overhauling Phnom Penh's water supply system and demonstrating leadership and innovation in project financing and governance".
- In 2006, H.E. Ek Sonn Chan was awarded the Ramon Magsaysay Award – the Asian equivalent of the Nobel Prize - for Government Service.
- In 2010, PPWSA received the Stockholm Industry Water Award (SIWI, 2010). This was the honor to record the great achievements of PPWSA. Typically, PPWSA satisfied the whole city water

demand in 1998. Non-revenue water (NRW) reduced from 72 % (1993) to 6 % (2008). It means that the cost-recovery efficiency was improved, the collection ratio of water bill achieved 98 %. PPWSA sets the future goal for NRW is 4 % by 2020.

11. References

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