Network on Water Technology in Asia and Pacific

Kandy South Water Treatment Plant
Sri Lanka

1. Background information of the water treatment plant

The Kandy South water treatment plant (KSWTP) was commissioned on 29th January 2010 at a cost of 72.34 million US$. The main responsibility of this plant is to treat raw water extracted from the Mahaweli Ganga River and supply the treated water to 15 reservoirs located in South Kandy Metropolitan area. This plant is designed to produce 35,000 m^3/d of drinking water complying with the SLS standards (Ordinance of SLS standard 614: Part 1 & 2 - Sri Lanka Standards Institute, 1985). It will serve 250,000 consumers before the design horizon of year 2030. **Table 1** below presents the details about the Kandy South WTP.

Table 1 Overall information of Kandy South WTP (Wijesinghe, 2013)

Water Supply Scheme	Kandy South
Type of source	Surface water
Name of the source	Mahaweli Ganga River
Year of commissioning	2010
Design capacity (m^3/d)	35,000
Present production (m^3/d)	18,000
Treated water quality standard	SLS 614:1983
Number of connections	25,200
Number of consumers	113,400
Distribution length (km)	510
Topography	Mountainous
Highest elevation–MSL (m)	740
Lowest elevation-MSL(m)	477
Climate	Tropical climate
Automation	Supervisory Control and Data Acquisition (SCADA)

The current water demand is only at 60% of its designed capacity. The water treatment facilities comprise of: 1) Intake section, including the Mahaweli River with impound weir, coarse and fine screen; intake well with submersible pumps and sludge removal pumps; 2) Treatment processes, including aerator, lime and alum feeding, pre- chlorination, pulsator clarifiers , sand filters, backwashing system, post chlorination and neutralization system; 3) Storage, including high lift pump house; 4) Sludge treatment; and 5) Other accessories, including supervisory control and data acquisition (SCADA), programmable logistic controls (PLCs) and radio systems.

2. Water treatment process flow

The water treatment process at KSWTP includes:

> Raw water extraction → Aerator → Rapid mixing (*hydraulic jump*) → Flocculation & Sedimentation by pulsator clarifier → Rapid sand filters → Disinfection (*Gas chlorination*)→ Clear water tank → Distribution network

Figure 1 below presents the overall water treatment flow of the KSWTP.

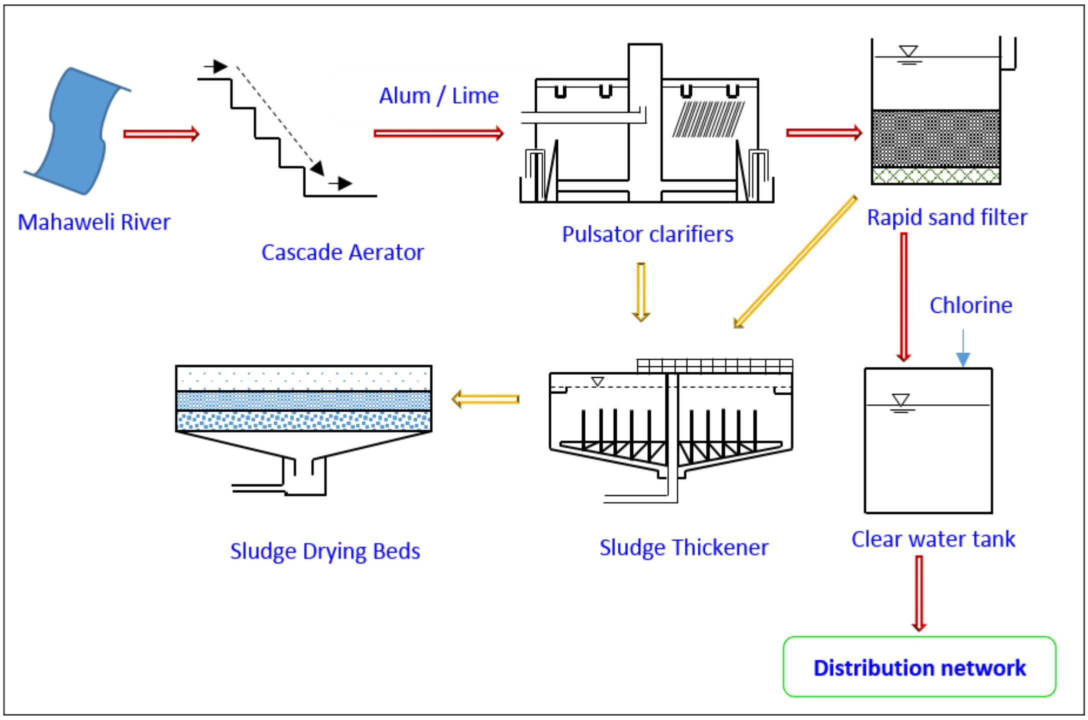

Figure 1 Water treatment process at Kandy South water treatment plant

2.1 Catchment

The KSWTP extracts raw water from the longest river in Sri Lanka, known as the Mahaweli River. Its catchment area covers 1/6th of the country's land area of 65,610 km^2. However, the treatment plant is located in middle stretch of the river. There is a large hydropower generation plant located about 30 km upstream to the WTP. The river passes through many urban and local settlements and therefore its water carries many pollutants coming from urbanized areas.

Figure 2 Mahaweli River

Figure 3 Screens of Intake

2.2 Treatment Processes

The KSWTP consisted of a river intake with two bar screens of 20 mm and 6 mm openings. River water is pumped to an aerator and sent through two pulsators and six sand filters set in parallel. Alum is used as the coagulant and lime is added as needed (Table 2). Pre-and post-chlorination is also carried out. There are 15 reservoirs and treated water is pumped to 3 levels via 9 booster pumping stations.

Table 2 Information of chemical used at the plant

Chemical	Dosage
Lime	3 - 4 ppm
Chlorine	2.5 kg/h
Alum	5 - 14 ppm

The full system is controlled by a SCADA system which is connected via radio signals. Online measurements are implemented for raw water pH, turbidity, color and treated water free Cl_2 level. The treatment processes provided the step-by- step process and control steps which enable hazards and risks identification that could affect the quality of treated water. In Kandy South WTP, fine screen is cleaned manually.

Figure 4 Cascade aerator

Figure 5 Pulsator clarifier

The hydraulic retention time of water at pulsator clarifier is 20 minutes. The sludge blanket up-flow rate is 3 m/h and clarifier up-flow rate is 2.43 m/h. The effluent of pulsator clarifiers is passed through the rapid sand filter. The filtrate velocity is 7.75 m/h with the filtrate rate of 244m^3/h. The filtrated water has very low turbidity (0.2- 0.3 NTU). The filtration basin requires backwashing when the head loss reached 0.9 m (negative pressure gauge). Usually, the backwash frequency is 48 h with the backwash flow rate of 472 m^3/h. Percentage of sand loss due to backwash is negligible

Figure 6 Lime Storage

The cost of chemical used per thousand m^3 of treated water: 2.94 US$

Figure 7 Sludge collection pit

Amount of sludge produced per day is 1 m^3. After collecting sludge at sludge collection pit, it is dried at sludge drying beds (3 beds, 3-5 months per batch). The dried sludge is then disposed at landfill.

2.3 Water distribution

Treated water is distributed to a total of 35,390 connections through 15 reservoirs. The consumers are from domestic, commercial, government and other sectors. The total water consumption by different users and the respective proportion are shown in **Table 3**. Hence, the users of water from the KSWTP are identified for the National Water Supply and Drainage Board (NWSDB) to determine the different water quality required to meet the needs of these different customers.

Table 3 Total water consumption and the respective proportion by different users

Category	Consumption (m^3/month)	Consumption (m^3/d)	Proportional percentage (%)
Domestic	367,124	12,237.5	88.30
Commercial	11,107	370.2	2.70
Government	3,660	122.0	0.90
Others	33,818	1,127.3	8.10
Total	415,709	13,856.8	100

2.4 Operational Monitoring

Two log books are kept to record the water quality data obtained from the laboratory (turbidity and pH recording at 2 h intervals, color and electrical conductivity on daily basis) and jar test data. In addition, online measurements of raw water pH, turbidity and color are being recorded by the SCADA system.

All above data and plant production data are collected daily by the call center established at the regional support center and handed to the Deputy General Manager for his observations and necessary actions. In addition, data are forwarded to the Water Quality Assurance and Inspection Unit for continuous monitoring and investigations if required.

All defects are observed and recorded based on the type of record, date of observation, remedial activities, reported officer's details and supervisor's details. The related defects are recorded in the respective civil, mechanical or electrical log books (**Figure 8**) and are further categorized as major and minor defects. Such information is summarized at the end of each month for reporting.

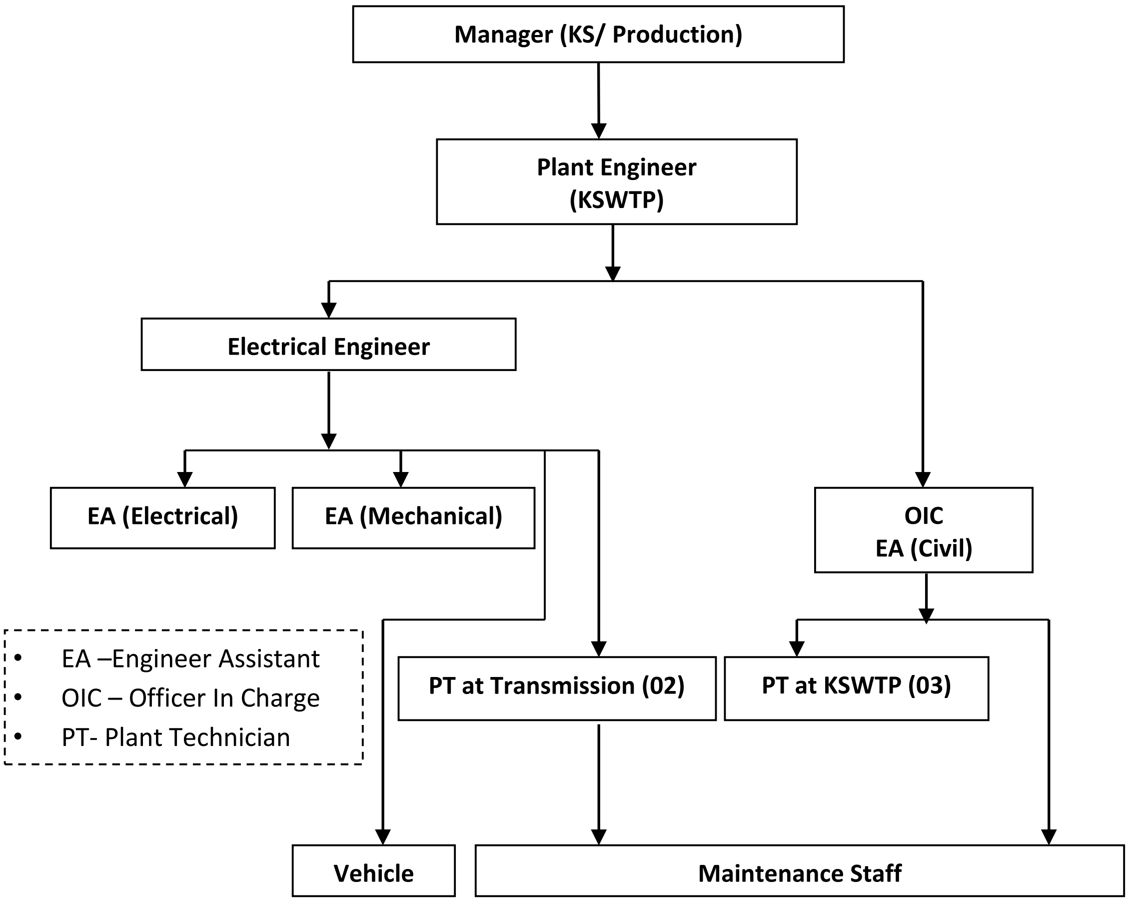

Figure 8 Organization Chart of the treatment plant

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

Table 4 below shows the current threats to treatment plant. According to the source of hazards, different issues are considered.

Table 4 Current threats to treatment plant

Water supply system	Hazardous event (source of hazard)	Associated hazards (and issues to consider)
Catchment	• Seasonal variations • Extreme droughts • Agriculture • Small scale industry including service stations, slaughter houses, poultry farms, direct sewage discharge and effluent from septic tanks • Development/land clearance	• Changes in river water quality • Inadequate supply of water • Microbial contamination, pesticides nitrate • Chemical and microbial contamination • Potential loss of source water due to contamination • Run-off with high total solids
Treatment	• Power supplies • Treatment failure • Fluctuation in free Cl concentration • Inadequate filter media depth • Instrumentation failure • Flooding	• Interrupted treatment/loss of disinfection • Untreated water • Inadequate treatment • Inadequate particle removal • Loss of control • Loss or restriction of treatment works
Distribution	• Any hazard not controlled/mitigated within treatment • Main burst • Excessive leakage • Inadequate monitoring • Pressure fluctuations • Intermittent supply • Use of unapproved materials • Unprotected service reservoir access	As identified in treatment • Ingress of contamination • Ingress of contamination • Poor water quality • Ingress of contamination • Ingress of contamination • Contamination of water supply • Contamination
Consumers	• Unauthorized connections • Lead pipes • Inappropriate storage systems	• Contamination by backflow • Lead contamination • Contamination

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

Pollution of water catchments is the main challenge that needs attention from the water management authorities. In addition, contamination during the distribution phase also poses a major impact. Similarly, high non-revenue water (26%) mainly due to aging utilities (pipelines and accessories) has become a costly problem (Wijesinghe, 2013).

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

Mainly Water Safety Plan is implemented to address the contamination problems and protect water during treatment, distribution, as well as for catchment protection and conservation. In addition, non-revenue water (NRW) reduction programs are proposed to implement. E.g. District meter area (DMA) concept.

6. Recent investment made for the plant's improvement

Installed new Variable Speed Drives (VSDs) to optimize the energy usage of intake pumps. The unnecessary energy consumption could be saved by installing a VSD to achieve the efficiency curves. VSD can adjust the delivery flow rate to adapt to the required level (Wijesinghe, 2013).

7. Technologies, facilities or other types of assistance needed to better cope with operational and management difficulties in 3) and 4).

- Soft starter panels of motor control centers (MCCs) to be installed
- Capacitor bank optimization to be done
- Backwash time and pump operations could be optimized according to the requirement
- Chemical dosing pumps could be automated
- Training programs on water safety plan
- Non-Revenue Water reduction awareness programs - by conducting water audit for whole distribution system, the amount and area of the non-revenue water can be recorded. Firstly, it is necessary to classify the main reasons of NRW then considering all possible methods to modify the system. Besides, improving customer's awareness on NRW issue should also be carried out.

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

NWSDB has established a Call Center that operates 24 h to address customers' complaints. This is important to receive feedbacks from consumers to further improve the water supply services and to provide assurance to the customers that NWSDB strives to provide good quality water that meets the local potable water standards. However, no frequent complaints are received.

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

- Supervisory control and Data acquisition (SCADA) system
- Motorized valve actuators.
- Radio telemetry system

10. Other Highlights

Since Kandy South water treatment plant is a new, recently commissioned plant, advanced treatment technology is used as compared to other older WTPs. No customer complaints received so far. Whole treatment process of the KSWTP is now operated automatically. This automation process however increases the treatment cost, mainly due to huge amount of electricity consumption (80% of the total expense). Energy consumption at various operational processes of the KSWTP is shown in **Figure 9**, and the cost of WTP operation in **Figure 10** below.

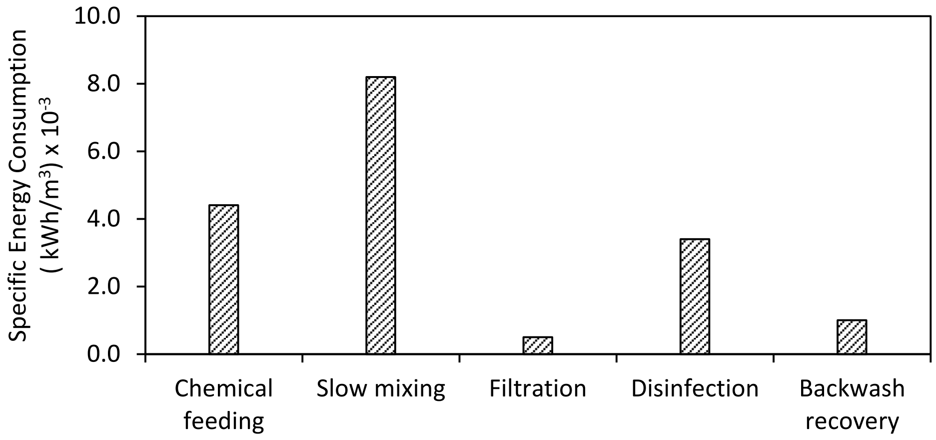

Figure 9 Specific energy consumption of different treatment units at Kandy South WTP

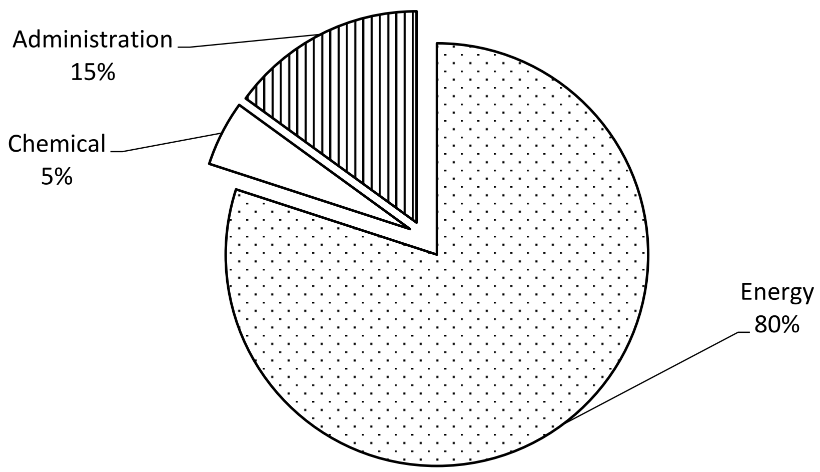

Figure 10 Proportional percentage of different expenses at KSWTP (Wijesinghe, 2013)

11. Water quality data

Table 5 shows the treated water quality data. The results show that all the parameters are well within the range of the national water quality standard (SLS 614: Part 1 & 2).

Table 5 Treated water quality

Parameter	Units	SLS 614:Part 1&2		Treated water quality at KSWTP
		Maximum desirable level	Minimum permissible level	
Colour	Pt-Co	5	30	
Turbidity	FTU/NTU	2	8	0.58
pH		6.5	9	6.70
Conductivity	µS/cm	750	3500	53
Alkalinity	mg/L $CaCO_3$	200	400	21.2
Hardness	mg/L $CaCO_3$	250	600	22.4
Ammonium	mg/L	-	0.06	0.02
Nitrite	mg/L	-	0.01	0.004
Nitrate	mg/L	-		0.70
Chloride	mg/L	200	1200	10
Sunphate	mg/L	200	400	7.23
Phosphate	mg/L	-	2.0	0.24
Fluoride	mg/L	0.5	1.5	0.096
Total Iron	mg/L	0.3	1.0	0.02
Manganese	mg/L	0.03	0.5	
Calcium	mg/L	100	240	8.75
Total Coliforms at 35^{o}C/100 mL	CFU/100 mL	0	10	0
Escherichia Coli at 44^{o}C/100 mL	CFU/100 mL	0	0	0

12. References

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