Wellawaya Water Treatment Plant
Uva Province, Sri Lanka

1. Background Information

UVA province is the second largest province in Sri Lanka and consists of two district: Badulla and Monaragala district. This province is located in the hilly area where majority of the water treatment plant (WTP) are designed to be gravity fed. There are thirty three functional water schemes in this province out of which only 5 plants are operating with full treatment facilitiy. **Figure 1** shows the location map of Wellawaya WTP.

Figure-1: Location Map of Wellawaya Water Treatment Plant

The National Water Supply and Drainage Board (NWSDB) was established in 1974 and is the only authorized water supply national organization in Sri Lanka. The Wellawaya WTP was constructed in 2007 and is a gravity fed water supply scheme. The treated water from the plant is supplied to the nearby Wellawaya town in Monaragala district. Wellawaya WTP has a capacity of 12,000 m^3/day. **Table 1** presents the overall information of Wellawaya WTP**.**

Table-1 Overall Information of Government Center Water Treatment Plant

Constructed Year	2004
Commission year	2007
Water Source	Kinrindi Oya and Alikote stream
Number of connections	11,673
Peak operating flow (m^3/h)	556
Design Capacity (m^3/day)	12,000
Distribution length	54 km
No. of Plant technicialns working at the plant	3
Treated water standard	Sri Lanka standard (SLS 614:1983) & WHO
Automation	No
Date of access of the source information	May 2015
Reference	NWSDB Management Information System(MIS)

The construction of the Wellawaya WTP began in 2004 with the fund of Asian Development Bank (ADB) and Plan Sri Lanka international Non-Government Organization (NGO) under the 6th ADB funded project. It was then commissioned by the mid of 2007. It initially supplied 3,100 m^3/day for domestic and 1,500 m^3/day for industries and later it increased its production capacity to 12,000 m^3/day (Industry 4,000 m^3/day and 8,000 m^3/day for households).

2. Water treatment process flow

The major water treatment unit processes (**Figure 2**) are presented as below:

- Raw water extraction → Pipeline static mixing (alum + lime) and hydraulic jump → Flocculation (baffled channel type) → Sedimentation → Rapid sand filters → Disinfection (post chlorination with gas chlorine) → Clear Water tank →Storage tanks (500 and 1200 m^3 ground reservoirs) → distribution system with gravity feed.

- Sludge treatment system: sludge generated from sedimentation and backwashing is directly transferred to Sludge drying beds.

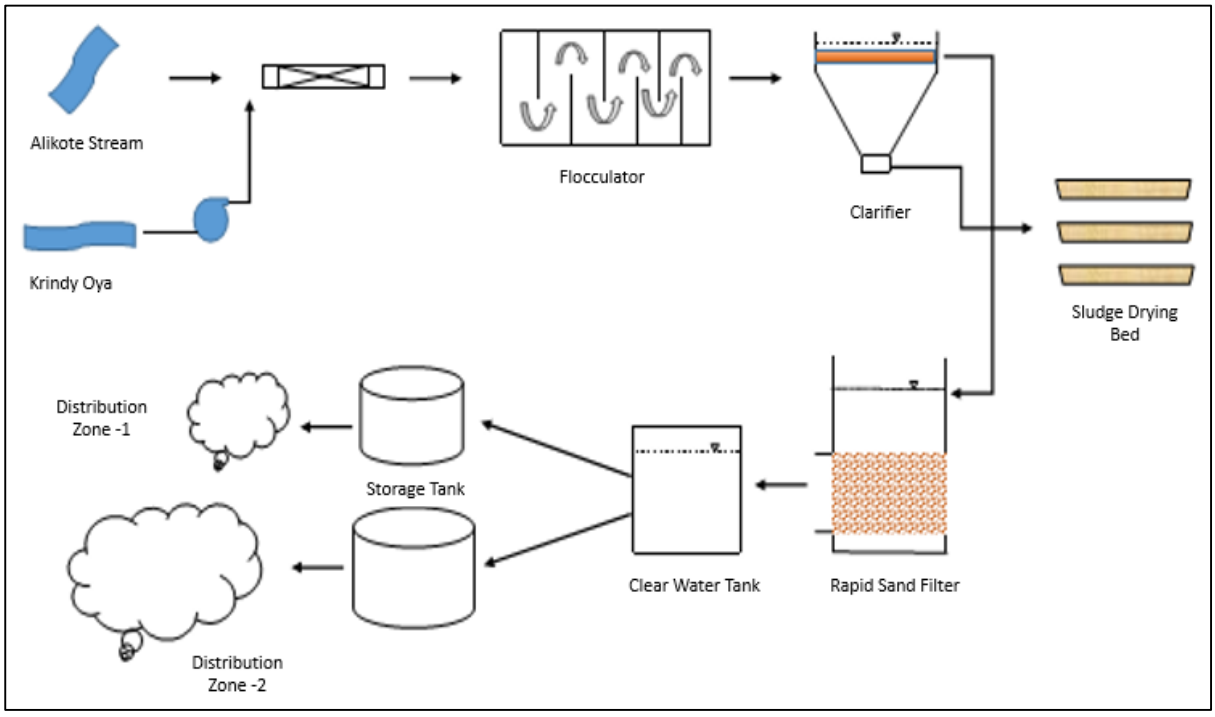

Figure 2 : Schematic Diagram of Water Treatment Processes

2.1 Water intake

The water source, 'Alikote stream' is located at a distance of 7.2 km from the WTP and operates under gravity (265 m head). Secondary water source is 'Kirindy oya' which is utilized only during the dry period (maximum 2- 3 months) by using piping (76 m head H/L pumps)

2.2 Chemical building

Chemicals are used during the coagulation and disinfection process. Alum and lime are used as coagulant which is mixed in the chemical mixing unit at chemical building. Lime reacts with the hardness and natural alkalinity in water to form precipitate. Gas chlorine is used for the disinfection process in the distribution main. It has an expected contact time of 90 minute before it reaches to the end users. Chlorine level is maintained at 1.5 ppm at the end of the pipe network.

2.3 Rapid Mixing

Figure 3 shows the image of static mixer that is installed as a part of the inflow pipeline. Here, Alum and lime solutions are fed by chemical mixing units which are located in chemical house and mixed properly through the creation of hydraulic jump in raw water channel.

Figure- 3: Chemical adding point

2.4 Flocculation

After chemical mixing, water is directed to flocculation tank and the hydraulic retention time of water in the flocculation tank is 20-25 minutes. One long basin is used for flocculation by partitioning it into three big channels. Baffle boards has been installed to extend the contact time of flock formation. However, the disadvantage of hydraulic flocculator is that the G values (velocity gradient value) is the function of flow and cannot be easily adjusted (AWWA, 2005). The velocity gradient of water mixing in the flocculation tank is 42 s^{-1} and it utilizes horizontal wooden baffled boards (around-the-end flow). **(Figure 4)**.

Figure-4 Flocculation tank

2.5 Sedimentation

There are two rectangular sedimentation tank at the Wellawaya WTP (**Figure 5**). The surface loading rate of the clarifier is 1.6 $m^3/m^2.h$. Normally, the surface loading rate is in the range from 0.8 to 2.5 $m^3/m^2.h$. The hydraulic retention time of the basin is 2 hours. Detention time of the conventional basin ranges from 1.5 to 3 hour. The sludge blanket formed are automatically transfered to the collecting chamber to ultimate load. Collected sludge, flows to the sludge drying beds under gravity flow.

Figure-5: Sedimentation basin

2.6 Filtration

There are four rapid sand filtration tanks in Wellawaya WTP **(Figure 6)**. Most effective filter media are dual media and single sand media deep bed filters, because the conventional fine sand removes most of the particles on the top of the sand surface, not full bed depth. The media used in this WTP is fine sand with the effective size of 0.72 mm, with a uniform coefficient of 1.4 and a filter depth of 1,750 mm.

Wellawaya WTP cleans the filter tank by combining surface wash with air blowers followed by water backwash. Backwash process uses 20 m head utilizing 500 m^3 tanks. The backwashing takes approximately 15-20 min and is performed after 60-72 hours. According to the past five years water

quality data, turbidity of the raw water for the most of the time was less than 10 NTU but during the flash flood it peaked to 150–200 NTU as flash flood carried a lot of debris and suspended solids with it. However during the dry season, backwashing is not needed as water quality is very good with very low turbidity level.

Figure -6: Filtration units

2.7 Storage and disinfection

After filtration, the treated water is sent to clear water tank and pumped into two ground reservoirs. 500 m^3 reservoir is located at higher elevation and is fed by low lift pumps while the 1200 m^3 reservoirs is fed by gravity flow. Distribution network is connected to both the tanks on zonal basis and full system operates under gravity. The total length of the distribution network is around 85 km.

For the disinfection process, gas chlorine is injected directly to the distribution main to maintain the chlorine level of 1.5 ppm at the end-point. **Figure 7** shows the gas chlorine system which operates in the Wellawaya WTP.

Figure-7: Gas chlorine adding system

2.8 Sludge drying bed

Sludge from the clarifiers and backwash is sent to sludge drying beds (**Figure 8**) and filtered water from it is conveyed to the natural stream. Effluent quality are within the standard of Sri Lanka and there

have not been any complaint from the Central Environmental Authority, Sri Lanka. There are three sludge drying bed in Wellwaya WTP.

Figure-8: Sludge drying beds

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

- At the normal operation period, flocs observed in the flocculation tank are of very small size. Some flocks settles down during the flocculation process because of the damage to baffle boards. However, quality of water source does not affect much to the treatment system.
- The Wellawaya WTP lacks technical personnel and skilled labor to deal with technical issues.
- The sludge drying beds are not cleaned regularly which reduces it draining capacity.
- The WTP has very low storage capacity which causes operational difficulties during the night time when the water demand is minimum. The additional of the raw water has to be diverted to the drainage during this time.

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

During the rainy season some parameter exceeds the design limits. Raw water turbidity reaches about 150 to 200 NTU .

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

In the unfavorable condition when the raw water quality exceeds the design limit (often during the heavy rainfall) the plant is shut down until the rain stops. According to the past records, management has stopped the operation of the WTP for a maximum period of three hour.

6. Recent investment made for the plant's improvement

There has not been any recent investment or effort for the improvement of the WTP.

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

- Skilled manpower is needed for efficiently operating the WTP
- Flocculation unit needs proper maintenance as some flocs settles down during the flocculation process due to the damage in the baffle boards.

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

Customers are satisfied with the water quality but the region often experiences problem during the wet season when the WTP has to be shut down due to the deteriorated quality of river water. Complaints increases in the winter season as the WTP fails to meet the demand of the consumers.

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

Wellawaya WTP has decided to capitalize the high head of the intake to generate hydroelectricity under the energy saving program. The management has planned to use the generated electricity for internal consumption.

10. Other Highlights

Wellawaya WTP fully operates under gravity and does not require pumping except for the storage tank, which is located at the highest point of WTP.

11. Water quality data

Table 2: Raw Water and Treated Water Quality in 2015

Parameter	Units	SLS 614:Part 1&2		Treated water
		Maximum desirable level	Minimum permissible level	
Colour	Pt-Co	5	30	**5**
Turbidity	FTU/NTU	2	8	1.8
pH		6.5	9	8.21
Conductivity	µS/cm	750	3500	384
Alkalinity	mg/L $CaCO_3$	200	400	218
Hardness	mg/L $CaCO_3$	250	600	198
Ammonium	mg/L	-	0.06	0.01
Nitrite	mg/L	-	0.01	0.01
Nitrate	mg/L	-		0.004
Chloride	mg/L	200	1200	243
Sulphate	mg/L	200	400	2
Phosphate	mg/L	-	2.0	1.01
Fluoride	mg/L	0.5	1.5	0.61
Total Iron	mg/L	0.3	1.0	0.18
Manganese	mg/L	0.03	0.5	0.03
Calcium	mg/L	100	240	65
Total Coliforms at 35°C/100 mL	CFU/100 mL	0	10	0
Escherichia Coli at 44°C/100 mL	CFU/100 mL	0	0	0

12. References

American Water Works Association. (1999). Water Quality and Treatment (6th edition). New York: McGraw-Hill. ISBN: 978-0071630115

American Water Works Association. (2005). Water Treatment Plant Design (4th ed.). New York: McGraw-Hill. ISBN: 0-07-141872-5

NWSDB Management Information System(MIS)

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