Standard Operating Procedure

Bode Water Treatment Plant

(As of 2023/12/25)

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1. A. Overview of the facility

A-1. General Information

(1) Facility name: Bode Water Treatment Plant

(2) Facility type: Surface (sub-surface) and ground water treatment plant

(3) Establishment: 2004

(4) Water source: Surface (sub-surface) water from Manohara Infiltration Galleries and ground water from several deep tubwells around the vicinity of Madhyapur Thimi area.

(5) Design capacity: 21.7 MLD (Design)

(6) Access: 1 km (3 mins drive) from Bode Chowk.

(7) Objective: Removal of turbidity, organic matter, bacteria, ammonia, and other harmful matter from the raw water.

A-2: Components of the Process

There are ten (10) processing facilities in Bode WTP as outlined below:

(1) Water intake facility

(2) Flocculation and sedimentation basin

(3) Coagulant (PAC) feeding facility

(4) Slaked lime feeding facility

(5) Rapid sand filter (RSF)

(6) Clear water reservoir (CWR) and transmission pump facilities

(7) Sludge and drainage basin facility

(8) Sludge drying bed facility

(9) Bleaching powder feeding facility

(10) Water quality testing facility

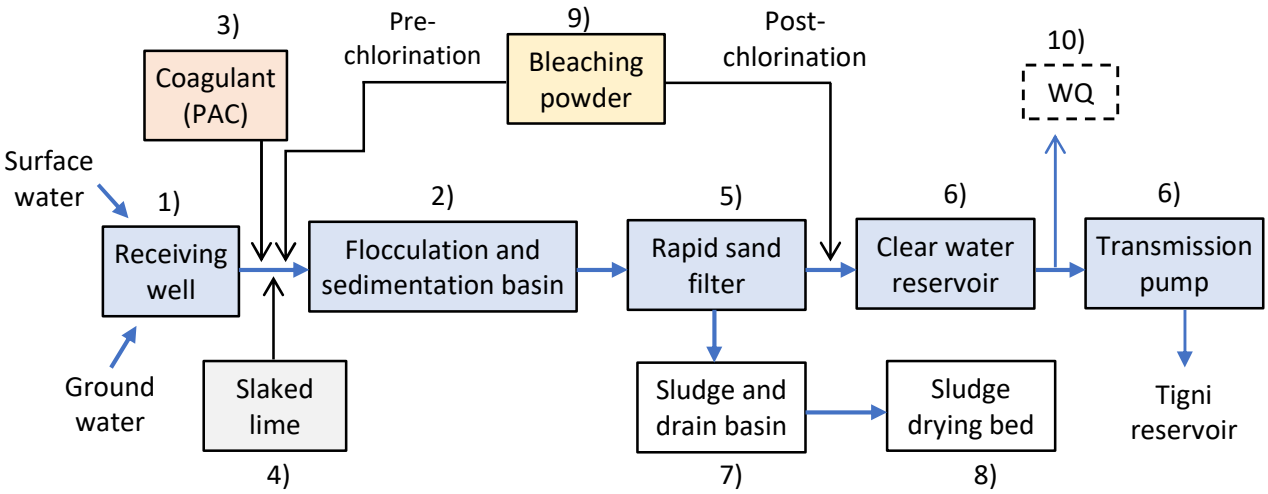


Figure 1: Schematics of Bode Water Treatment Plant

Prior to the understanding of operation and maintenance of individual process, it is important to keep daily record of total inflow of water into the system.

(1) Surface water inflow: Record readings from the flowmeter

(2) Groundwater inflow: Record individual pumps inflow rate

2. Flocculation and Sedimentation Equipment

2.1. Introduction

Purpose: Purpose of this equipment is to remove most of the flocs that have grown large through the processes of chemical feeding, mixing and flocculation by means of settling separation process to lighten the load for the rapid sand filter.

Mechanism: Flocculation agent and alkali are fed into the raw water flowing in from the receiving well in order to effect rapid mixing.

The gates at the distribution weir shall be opened and closed in order to change the number of basins according to fluctuations in the quantity of the treated water.

2.2. Equipment Outline

Item	Type	Size/Details	No. of units
Receiving well	RCC	4.3 m x 4.3 m x 3.95 m	1
Inlet Flow Arrangement Canal	RCC	26.05 m x 0.95 m x 1.55 m	1
Flocculation basin	Horizontal and vertical baffle type	Width 1 m x length 2.2 m x water depth approx. 3.95-3.45 m x 42 Sequences Retention period = 25 to 40 minutes	3
Sedimentation Basin			
Sludge Hopper	Horizontal flow type sedimentation basin	Width 2.2 m x length 2.2 x water depth approx. 4.95 m	15
Sedimentation Basin		Width 7 m x length 31 m x water depth approx. 3.55-3.372 m	3
Collecting Conduit		Width 7 m x length 3 m x water depth 3.372 m	3
Outlet Conduit		Width 26.05 m x 0.95 m x water depth 1.5 m	3
Raw Water Overflow Weir	Square Type	2000W x 300H x 20T Synthetic Lumber	1
Raw Water Flow Meter	Flow Indicator Type	250W x 250W x 1100H Aluminum Cast	1
Raw Water Drainage Valve	Outside Screw Soft Seal Valve	100A Body FCD450 Wedge Gate Set FCD/EPDM	1
Raw Water Inflow Gate	Outside Screw Sluice Gate	400W x 400H Frame FC200 Gate Disk FC200	3

Item	Type	Size/Details	No. of units
Head Stock	Manual Operated Type	Body FC200 Spindle SUS304	3
Weir Plate (for Baffling Type Flocculation Basin)	Square Type	900W x 400HX20T x 36 sets 1100W x 300H x 20T x 87 sets Synthetic Lumber	
Sludge Drainage Valve	Muddy-Hi Valve	250A Body FCD450 Disk FCD450	15
Prime Valve for Sludge Drainage	Outside Screw Soft Seal Valve	250A Body FCD450	15
Water Collecting Trough		300W x 300H x 3390L FRP	12
Hydrant (Washing Valve)	Mechanical Coupling Type	40A CAC406	12
Hose Box		600W x 270L x 1200H SEHC (Electrolytic zinc-coated steel)	3

2.3. Operation of the Flocculation and Sedimentation Equipment

Operation plan

The horizontal flow sedimentation tank has a uniform flow because of the gravitational settling effect. In general, it has a longer retention time, a high stabilizing function against load fluctuation, a relatively simple structure, no mechanical equipment, and a high efficiency.

Floc Formation

Floc formation at inflow of Sedimentation Basin 3-4 times in a day.

- Morning before chemical dosing adjustment
- 30-40 minutes after of chemical dosing adjustment
- 3-4 hours after in afternoon
- Second time in the afternoon, if possible
-

Jar Test

Floc formation
Floc formation shall be confirmed at inflow of Sedimentation Basin.

Sludge removal Floc Outflow
Floc outflow from Sedimentation Basin (Tough) at the same time when check floc formation.

Inlet of Sedimentation Basin

Outlet of Sedimentation Basin

Sludge accumulation at the bottom
Floc outflow from Sedimentation Basin (Tough) at the same time when check floc formation.

In order to minimize the settled sludge, sludge valves shall be operated.

The valves shall be open and kept for 30 seconds, then close.

Flocculation/ Sedimentation operation

Monitoring of operation conditions

a. Inflow condition; by checking water level of inflow channel, flocculation tanks, and effluent troughs.
b. Treatment process; by checking turbidity of raw water, generation of flocs in flocculation tank, and settled water turbidity/flocs leaking at effluent troughs.
c. Accumulation of sludge at the bottom of sedimentation tanks.

Sedimentation Basin

Sedimentation basins allow suspended particles as called floc to settle out of water as it flows slowly through the tank. A layer of accumulated solids, called sludge, forms at the bottom of the tanks, and is periodically removed.

To confirm the proper function of sedimentation basins, the followings shall be carried regularly.

a. Check floc formation at inflow of Sedimentation Basin
b. Check floc outflow from Sedimentation Basin (Tough)
c. Sludge removal by sludge valves
d. Check sludge accumulation at the bottom.

Figure 2: Flocculation basin

Cleaning of sediment deposited in hooper chamber

Cleaning of sedimentation tank by draining out sludge and water from it

Figure 3: Sedimentation basin during draw-off and cleaning process

Sludge draining operation: It is necessary to periodically drain the sludge from the hoppers and sedimentation basins. The cycle depends on the quality of raw water, more turbid raw water results in more sludge production and requires more frequent draining operation. However, drain one basin per day to prevent sludge from solidifying. The drainage process is as follow:

(1) Open inflow valve for sludge and drainage basin

↓

(2) Choose the basin from which the sludge is to be drained

↓

(3) Open the first sludge drainage valve from the upstream side of that basin

↓

(4) Start Sludge pump

↓

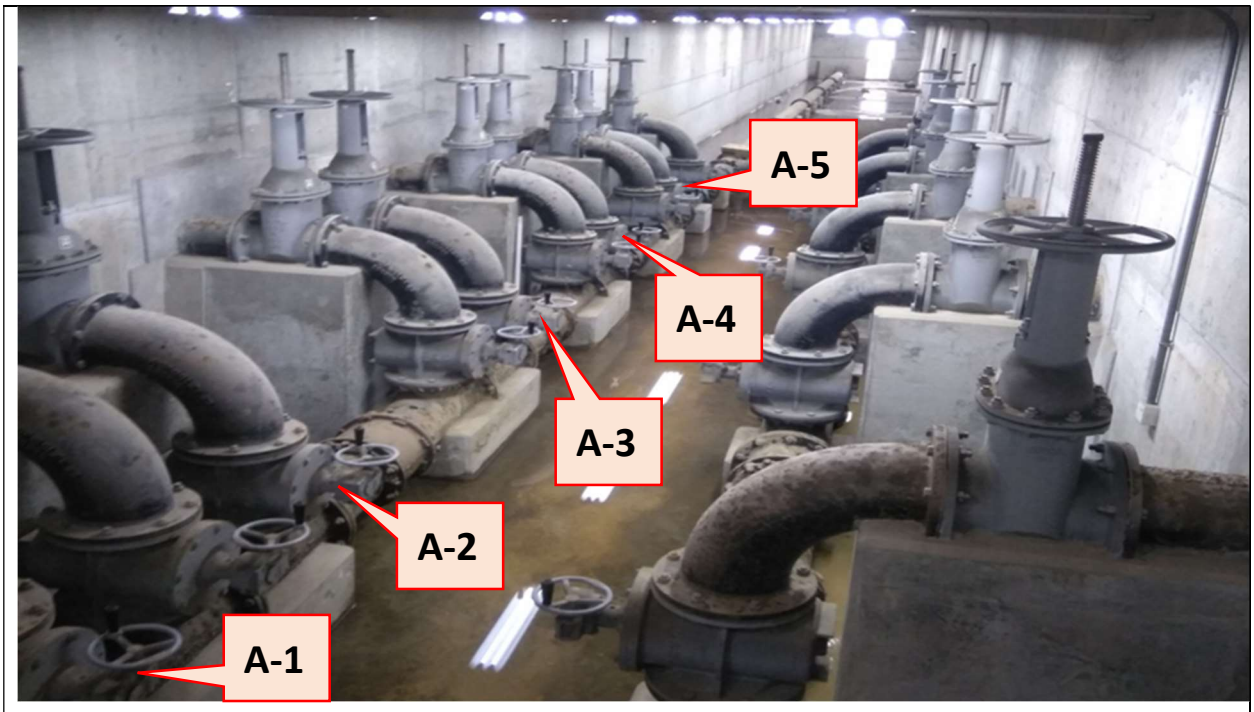
(5) After a fixed time, close sludge drainage valve

↓

(6) Repeat from 3 to 5

↓

(7) Close inflow valve for sludge and drainage basin



Sludge drainage valves

Left row: Sludge valve of sedimentation tank A and B, i.e., valves A1, B1, A2, B2, A3, B3, A4, B4, A5, B5

Right row: Sludge valves of sedimentation tank C, i.e., valves C1-C5.

Figure 4: Sludge drainage valves

In order to drain sludge of sedimentation tank A open all the sludge drainage valves A1 to A5 and operate sludge pump until operation is done. Similarly, to drain sludge from B and C tanks open the respective valves of each tank i.e. B1-B5 and C1-C5 at a time until sludge of each tank is completely drained out.

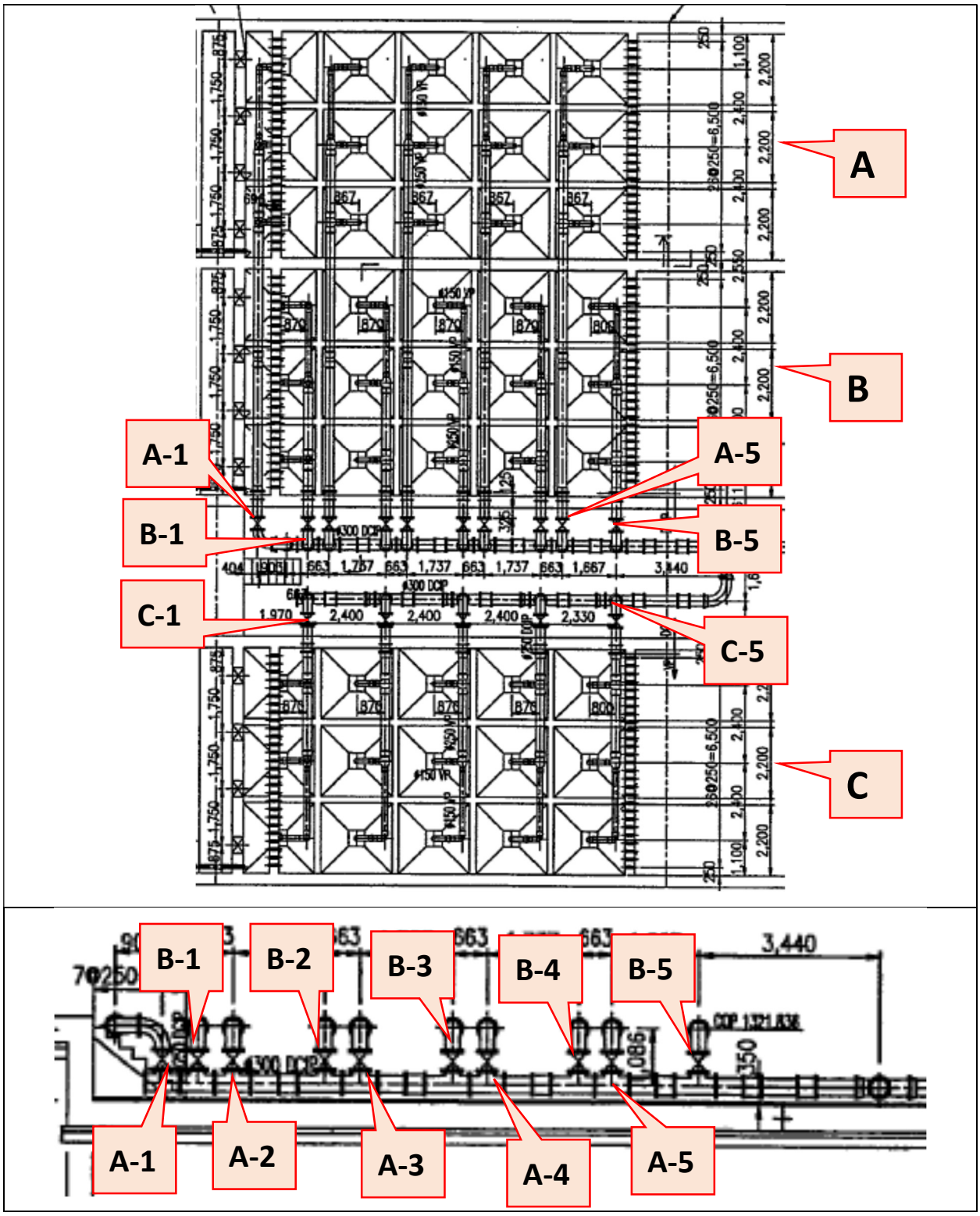


Figure 6: Arrangement of sludge draining valves (top: plan, bottom: section)

Operation process for washing the basins

(1) Open inflow valve for sludge and drainage basin

↓

(2) Choose the basin from which water is to be drained

↓

(3) Change chemical feeding rate and intake pump supply rate to 2/3

↓

(4) Close raw water gate of chosen basin

↓

(5) Open the first sludge drainage valve from the lower side of that basin

↓

(6) Start sludge pump and return pump (Sludge drain basin)

↓

(7) Wash the inside of the basin by using water nozzles

↓

(8) Open all sludge drainage valves when water level dropped to the top of hopper

↓

(9) Remove sludge with human power when there is lot of quantity

↓

(10) When finished washing, close all sludge drainage valves and open raw water gate

↓

(11) Repeat 4 to 10 process to 2 bains

↓

(12) Close inflow valve for sludge and drainage basin

↓

(13) Stop sludge and return pump

↓

(14) Change chemical feeding rate and intake pump supply rate to normal

Regarding the time for sludge drainage

- The time for sludge drainage differs according to the inflowing sludge.
- Decide the sludge drainage time according to the time required for change of turbidity of sludge water flowing into the sludge basin.
- Sludge drainage time will be about 1 minutes.

Sludge drainage shall be done in the following manner (for reference):

Rainy season: ***one*** basin per day

Dry season: ***one*** basin per week

Fix the days by experience.

Washing of the basin shall be done in the following manner (for reference):

Once a year during the dry season, if necessary, once more during the rainy season.

Visually inspection outside of all equipment daily for any sign of unusual point.

3. Rapid Sand Filter

3.1. Outline of Facility

Purpose: This equipment is used to remove the turbidity, iron, and manganese in water processed by the flocculation and sedimentation basin.

Equipment Outline

Item	Type	Size/Details	No. of units
Open-type natural gravity filter	RCC	22.68 m^2 (width 3.15 m x length 7.2 m)	8
Filter bed	Filter Sand	Effective diameter (uniformity coefficient) 0.6 mm Uniformity coefficient: Below 1.5 Layer depth: 600 mm	
	Supporting Gravel	First layer: Effective diameter 2-4 mm Layer depth: 50 mm Second layer: Effective diameter 4-6 mm Layer depth: 50 mm Third Layer: Effective diameter 6-10 mm Layer depth: 50 mm Fourth layer: Effective diameter 10-20 mm Layer depth: 50 mm	
Under drain	Perforated Block		
Washing equipment: Surface and back-washing system			
Surface-washing pump	Submersible Volute Pump	Volume of discharge: 4.54 m^3/min Lift: 21 m Diameter: 200A Motor: 400V x 50Hz x 30kW	
Make-up pump	Submersible Sewage Pump	Volume of discharge: 1.18 m^3/min Lift: 6.0 m Diameter: 100A Motor: 400V x 50Hz x 3.7kW	

3.2. Valves and pumps operation

Open/ closed condition of valves and pumps operation

	During filtration	During washing	During inspection
Water inflow valve (V-1)	Open	Closed	Closed
Water discharge gate (G-1)	Closed	Open	Open
Clear water gate (G-2)	Open	Open	Closed
Drain valve	Closed	Closed	Open
Surface-washing valve (V-3)	Closed	Open	Closed
Surface-washing pump		Operation of 1 pump	
Make-up pump		Operation of 1 pump	

Figure 5: Valves and gates of rapid sand filter basins

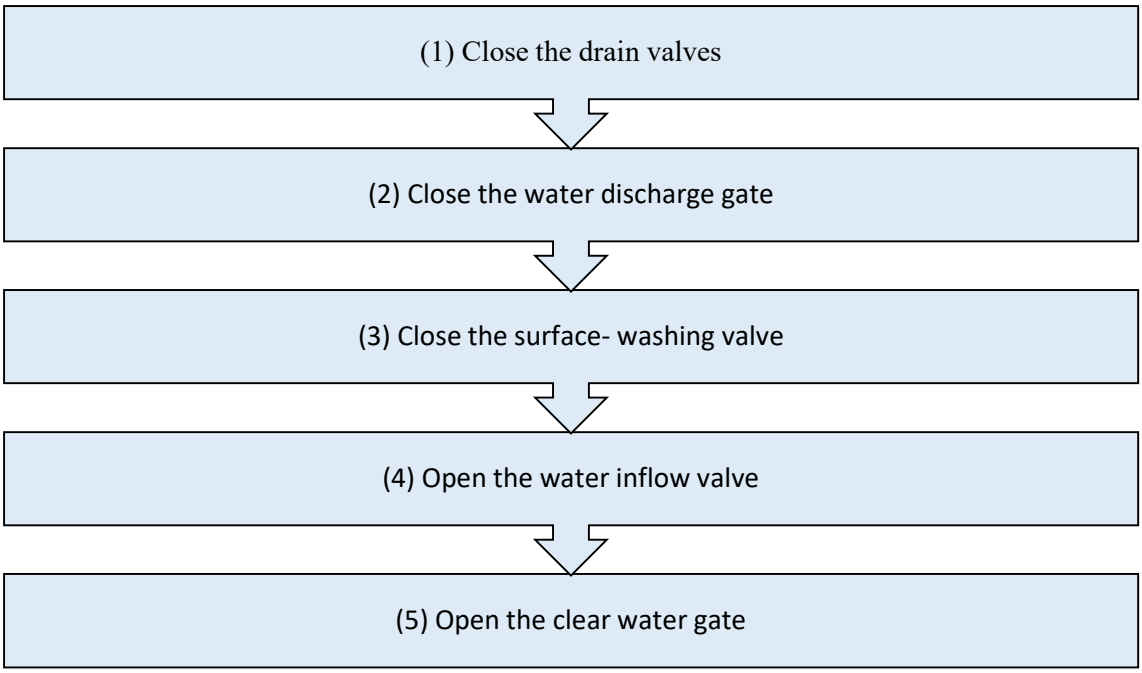
In the above left picture shows raw water inflow weir, raw water inflow gates and valves, whereas the right picture shows arrangement of surface washing pipes and valves.

Figure 6: Pumps of rapid sand filter basins

The above picture shows surface washing pump and left-hand side shows the makeup pump.

3.3. Operation process of the rapid sand filter

(1) Filtration operation



Monitoring of Filtering Operation Conditions

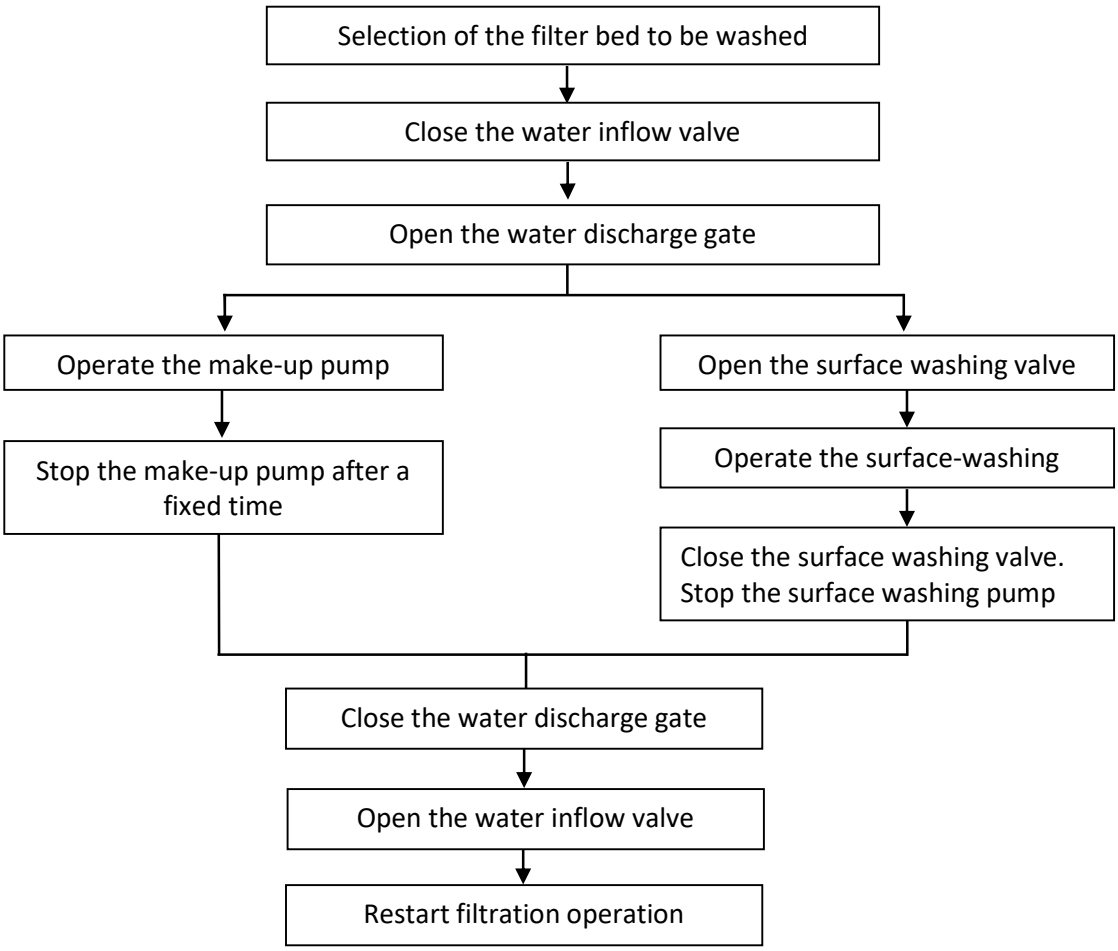
a. Inflow condition, by checking water level of inflow channel.
b. Head loss of filtering condition, by checking water level of filters.
c. Treatment process, by checking turbidity of inflow water and head loss by water level of filters.

(2) Back-washing operation

(1) Select the filter bed which should be washed
↓
(2) Choose the basin from which water is to be drained
↓
(3) Change chemical feeding rate and intake pump supply rate to 2/3
↓
(4) Close raw water gate of chosen basin
↓
(5) Open the first sludge drainage valve from the lower side of that basin
↓
(6) Start sludge pump and return pump (Sludge drain basin)
↓
(7) Wash the inside of the basin by using water nozzles
↓
(8) Open all sludge drainage valves when water level dropped to the top of hopper
↓
(9) Remove sludge with human power when there is lot of quantity
↓
(10) When finished washing, close all sludge drainage valves and open raw water gate
↓
(11) Repeat 4 to 10 process to 2 bains
↓
(12) Close inflow valve for sludge and drainage basin
↓
(13) Stop sludge and return pump
↓
(14) Change chemical feeding rate and intake pump supply rate to normal

1. •Select the filter bed which should be washed
2. •Close the inflow valve of the filter bed
3. •Open the discharge gate of the filter bed
4. •Open the surface-washing valve of the filter bed
5. •Operate the surface-washing pump
6. •Operate the make-up pump
7. •After a fixed time, close the surface-washing valve, and stop the surface-washing pump
8. •After a fixed time, close the water discharge gate, and stop the make-up pump
9. •Open the water inflow valve

Flow chart for back washing operation



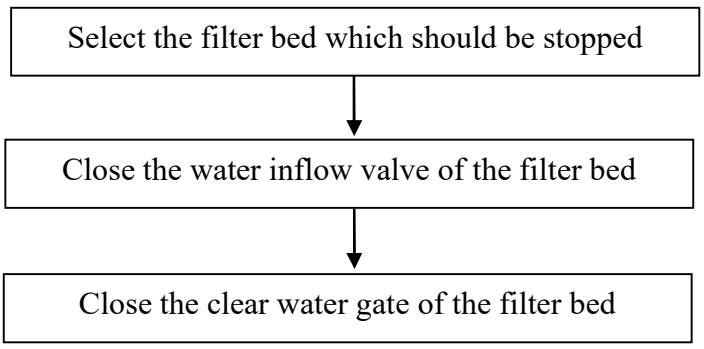
Monitoring of Filtering Conditions and Backwashing

a. Monitor head loss of filtering condition, by checking water level of filters.
b. Check filtering hours.
c. If the filtering hour exceeds 72 hours or water level of filter is high, start backwashing.
d. Follow the procedures described above in the "back washing operation".
e. Backwashing should be continued for 10 to 20 minutes depending on the clearness of filter bed as shown in the following photos.

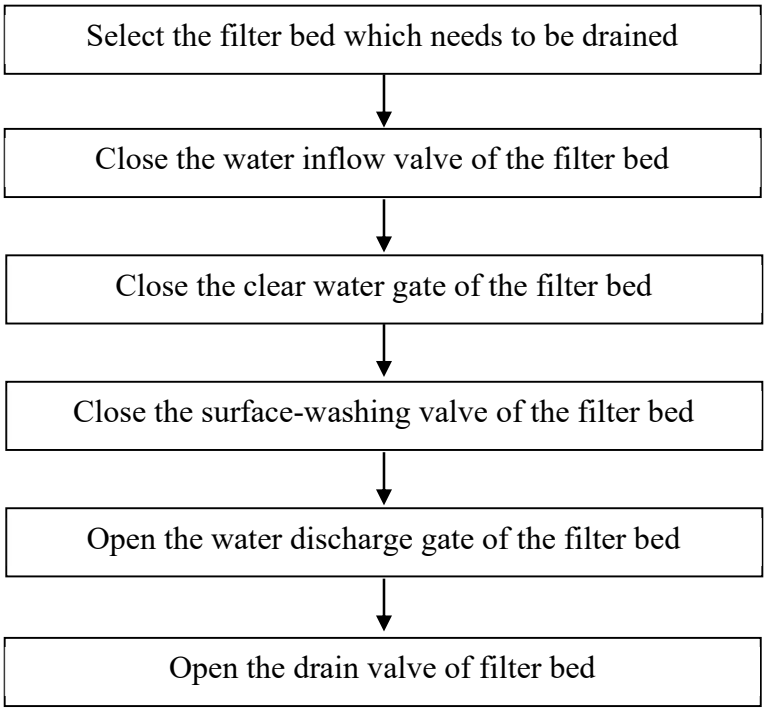
	
Dirty water (initially)	Clear water (completion of backwash)

Figure 7: Appearance of RSF bed before and after backwashing

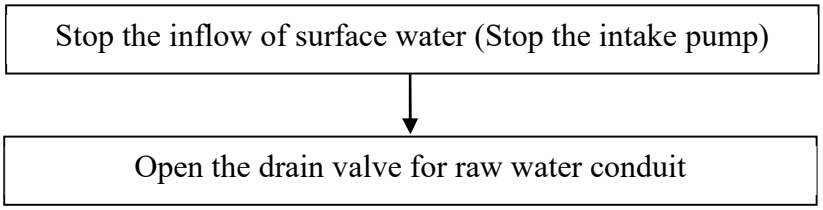
Process for stopping filters



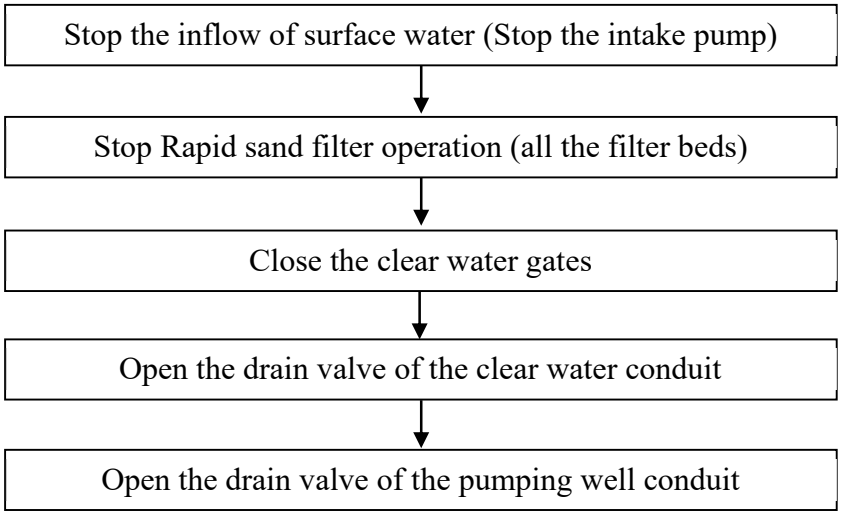
Process for draining of filter bed



Process of draining raw water conduit



Process of draining clear water conduit and pumping well



4. PAC Feeding Equipment

4.1. General

Purpose

Feeding mechanism: PAC comes as a powder which is dissolved in the dissolution tank to the specified concentration, transferred to a storage tank by the transmission pump, and then fed to the raw water at fixed quantities at suitable intervals.

Feeding point

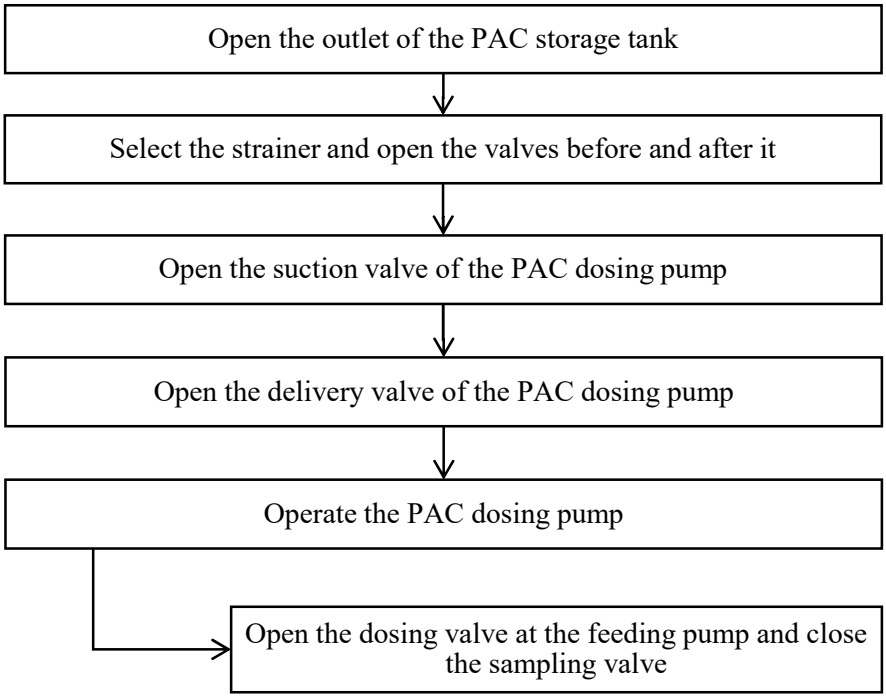
For coagulation (Raw water)

Flocculation and Sedimentation Basin overflow weir

Equipment Outline

Item	Type	Size/Details	No. of units
Coagulant Dissolution tank	Open vertical cylindrical tank (polyethylene)	Capacity: 1000 L Accessories: Plates for Agitator and its iron frame fitting	2 tanks
Coagulant Flashing Agitator	Portable Type	Motor: 0.2 kW x 400 V x 50 Hz	2 units
Coagulant Transmission pumps	Magnet pump	Capacity: 40 A x 40 l/min x 10m Motor: 0.4 kW x 400V x 50 Hz	2 pumps
Coagulant storage tanks	Closed vertical cylindrical tank (polyethylene)	Capacity: 2000 L	2 tanks
Coagulant Feeding Pump	Diaphragm pump	Capacity: 0.9 L/min Motor: 0.2 kW x 400 V x 50 Hz Accessories: Relief valve: 15A x 3 sets Pressure gauge: 15A x 5 sets Back pressure valve: 15A x 1 set Air chamber: 15A x 1 unit	3 units
Piping and valves	Polyvinyl	Pipes, valves, hard polyvinyl pipes for city water; ball valves, diaphragm valves Diameter: 16 – 50 A	1 set

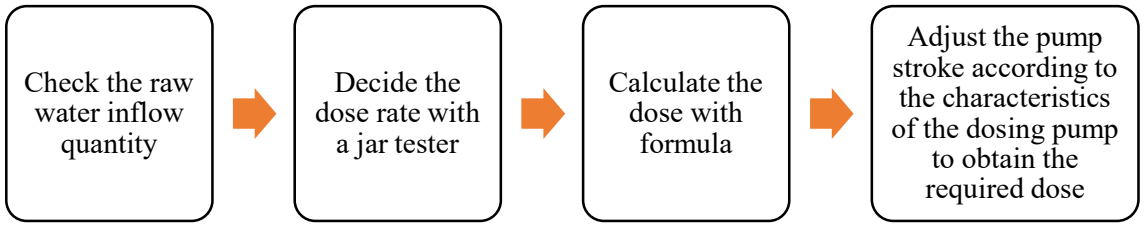
Overall process



(Note: For feed confirmation and measuring of the dosage, close the dosing valve and open the sampling valve)

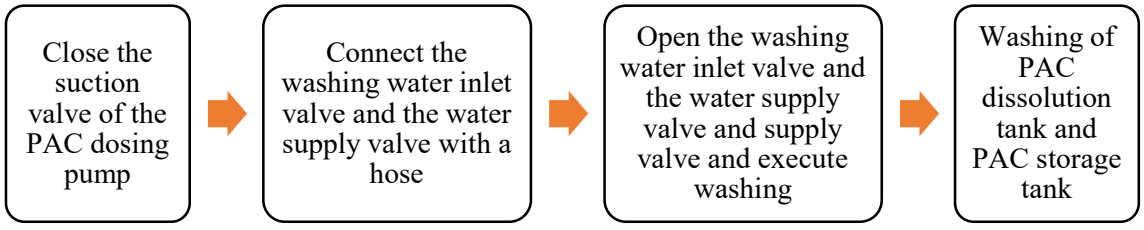
Adjustment of the PAC dosage

(Dosage must be set separately for surface and ground water)

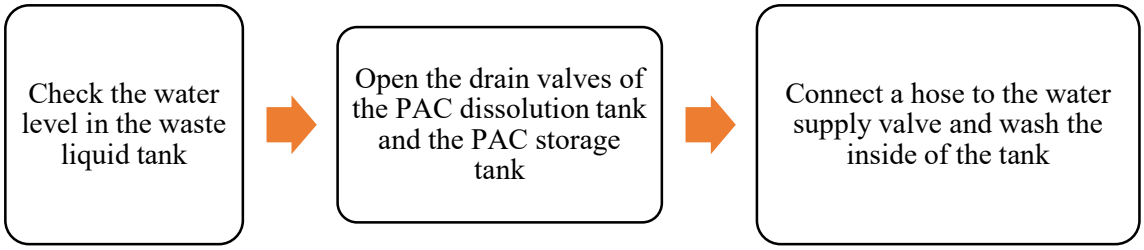


Washing of dosing pump and feeding pipe

(When the feeding is to be stopped for long time, wash the dosing pump and feeding pipe)



When the feeding is to be stopped for a long time, wash the PAC dissolution tank and the PAC storage tank



4.2. PAC Solution preparation

a. Prepare PAC solution as shown below.

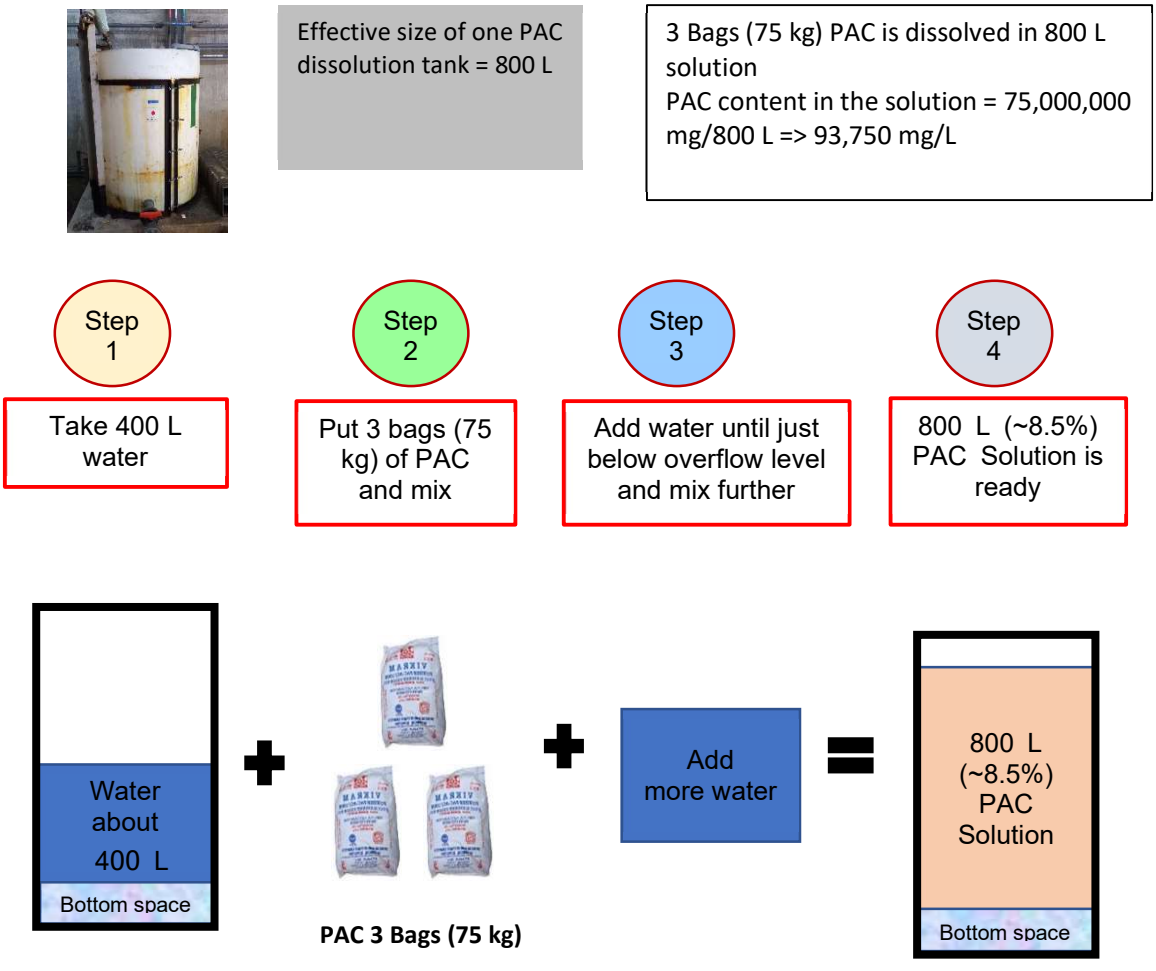


Figure 8: Schematics PAC solution preparation in Bode WTP

1. Close the outlet valve and the drainage valve of the PAC dissolution tank (LWL)

⇩

2. Fill about 50% (400 L) of the tank with water

⇩

3. Add 3 bags (75 kg) of PAC

⇩

4. Operate the agitator

⇩

5. Add more water until just below overflow level, continue agitating for about 2-3 hours

b. Transfer PAC solution to PAC storage tanks

Operation procedure

1. Close the outlet valve and the drainage valve of the PAC storage tank

⇩

2. Open the inlet valve of the PAC storage tank

⇩

3. Open the outlet valve of the PAC dissolution tank

⇩

4. Open the suction valve of the transmission pump

⇩

5. Open the delivery valve of the transmission pump

⇩

6. Operate the transmission pump

⇩

7. Check the liquid level of the PAC storage tank and stop the transmission pump if:

Specified level has reached, or

PAC storage tank overflows and the overflow returns to the PAC dissolution tank

4.3. Deciding Dosage (Feeding Rate)

PAC dosage (feeding rate) shall be decided in the following manner.

Procedure of deciding PAC dosage (feeding rate)

1. Flow measurement (m^3/day or m^3/hr) (by WTP Engineer)
(Automatic measurement record can be taken when this system is installed and ready)

⇩

2. Find out the required PAC dosing rate by Jar Test (by Central Lab)
(Turbidity versus PAC dosing rate chart is under preparation, it can be referred when ready)

⇩

3. Calculate PAC dosage (feeding rate) (by WTP Engineer)

⇩

4. Adjust PAC pump setting (by WTP operator)

⇩

5. Check Floc formation (by Central Lab/WTP)

Calculation

Simplified formula to calculate dosage (feeding rate) of PAC solution	$= \frac{Q\ (m^3/h) \times D\ (mg/L)}{93.750}$ L/h Where, Q = Raw water flow rate D = PAC dosing rate as determined by the jar test
Example	If Q=12 MLD = 12,000 m^3/day = 500 m^3/h, and D= 11 mg/L, then The dosage (feeding rate)= $= \frac{500\ m^3/h \times 11\ mg/L}{93.750}$ = 59 L/h=0.98 L/min

Estimate from Chart

- Find the PAC dosing rate (mg/L PAC) on the X-axis
- Go up to meet the raw water inflow rate
- Go left to meet the Y-axis

This value on Y-axis is the PAC dosage (feeding rate) for PAC solution.

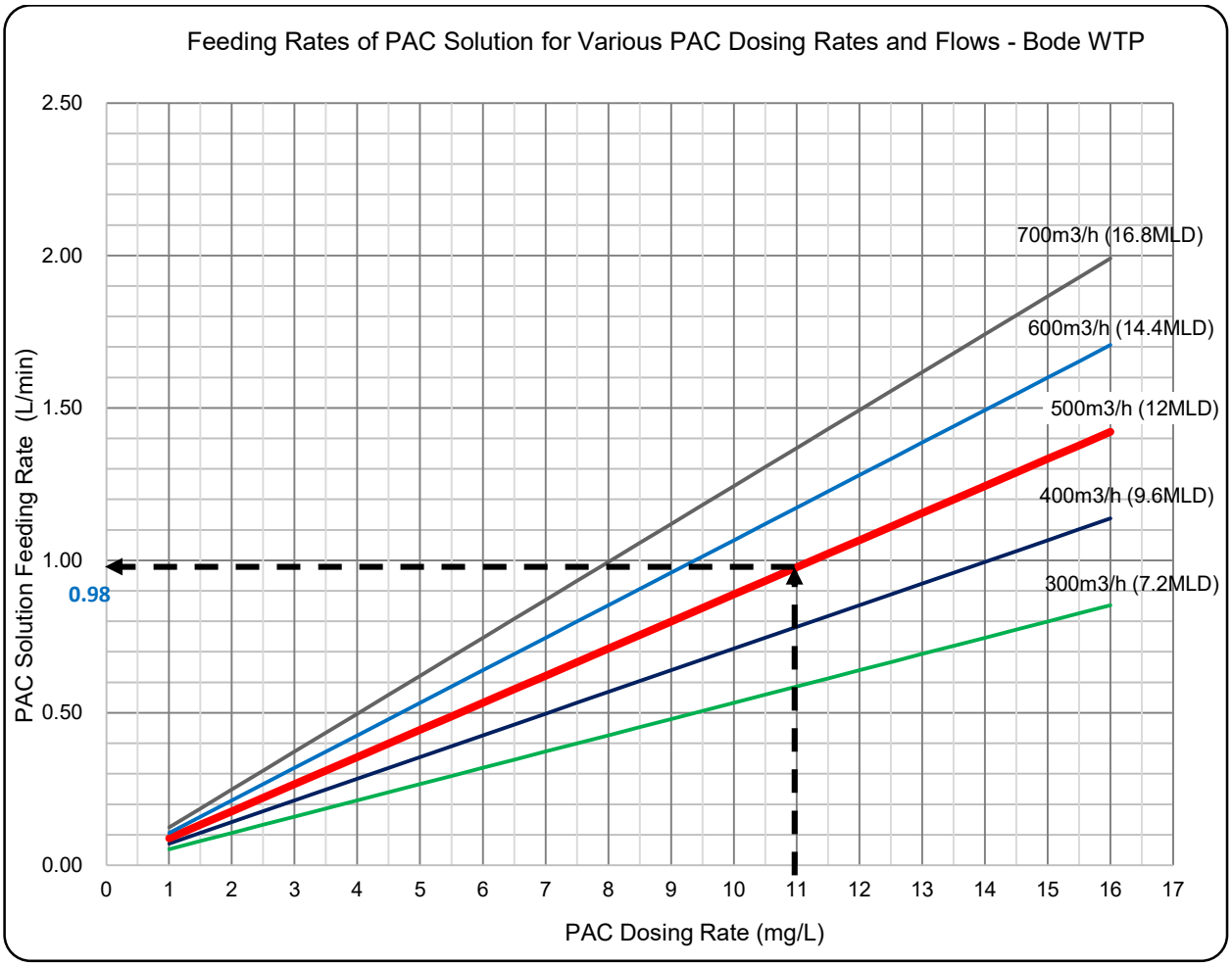


Figure 9: Chart of PAC solution feeding rates for various PAC dosing rates and flows

As an example, if the raw water inflow is 12 MLD and PAC dosing rate is 11 mg/L, then the PAC solution feeding rate would be 0.98 L/min.

Estimate from Table

The same can also be estimated from the table, as follows:

- Find the PAC dosing rate (mg/L PAC) on the first column
- Go right to meet the raw water inflow rate
- The value in that cell is the PAC dosage (feeding rate).

Table 1: PAC solution feeding rates for various PAC dosing rates and flows

Dosing Rate (mg/L)	Daily Volume of Solution for 500 m^3/h Flow (L/day)	Feeding Rate (L/min)								
		300m^3/h (7.2MLD)	350m^3/h (8.4MLD)	400m^3/h (9.6MLD)	450m^3/h (10.8MLD)	500m^3/h (12MLD)	550m^3/h (13.2MLD)	600m^3/h (14.4MLD)	650m^3/h (15.6MLD)	700m^3/h (16.8MLD)
1	128	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.12
2	256	0.11	0.12	0.14	0.16	0.18	0.20	0.21	0.23	0.25

Dosing Rate (mg/L)	Daily Volume of Solution for 500 m^3/h Flow (L/day)	Feeding Rate (L/min)								
		300m^3/h (7.2MLD)	350m^3/h (8.4MLD)	400m^3/h (9.6MLD)	450m^3/h (10.8MLD)	500m^3/h (12MLD)	550m^3/h (13.2MLD)	600m^3/h (14.4MLD)	650m^3/h (15.6MLD)	700m^3/h (16.8MLD)
3	384	0.16	0.19	0.21	0.24	0.27	0.29	0.32	0.35	0.37
4	512	0.21	0.25	0.28	0.32	0.36	0.39	0.43	0.46	0.50
5	640	0.27	0.31	0.36	0.40	0.44	0.49	0.53	0.58	0.62
6	768	0.32	0.37	0.43	0.48	0.53	0.59	0.64	0.69	0.75
7	896	0.37	0.44	0.50	0.56	0.62	0.68	0.75	0.81	0.87
8	1,024	0.43	0.50	0.57	0.64	0.71	0.78	0.85	0.92	1.00
9	1,152	0.48	0.56	0.64	0.72	0.80	0.88	0.96	1.04	1.12
10	1,280	0.53	0.62	0.71	0.80	0.89	0.98	1.07	1.16	1.24
11	1,408	0.59	0.68	0.78	0.88	0.98	1.08	1.17	1.27	1.37
12	1,536	0.64	0.75	0.85	0.96	1.07	1.17	1.28	1.39	1.49
13	1,664	0.69	0.81	0.92	1.04	1.16	1.27	1.39	1.50	1.62
14	1,792	0.75	0.87	1.00	1.12	1.24	1.37	1.49	1.62	1.74
15	1,920	0.80	0.93	1.07	1.20	1.33	1.47	1.60	1.73	1.87
16	2,048	0.85	1.00	1.14	1.28	1.42	1.56	1.71	1.85	1.99
17	2,176	0.91	1.06	1.21	1.36	1.51	1.66	1.81	1.96	2.12
18	2,304	0.96	1.12	1.28	1.44	1.60	1.76	1.92	2.08	2.24
19	2,432	1.01	1.18	1.35	1.52	1.69	1.86	2.03	2.20	2.36
20	2,560	1.07	1.24	1.42	1.60	1.78	1.96	2.13	2.31	2.49

4.4. PAC Dosing (Feeding) Pump Setting

- Refer to Figure 10 (performance curve of the pump)
- In y-axis, mark the feeding rate in L/min
- Find out the Stroke Length for the above feeding rate on x-axis
- Adjust the knob for the Stroke Length and lock it by the locking screw (Ref. Photo 1).

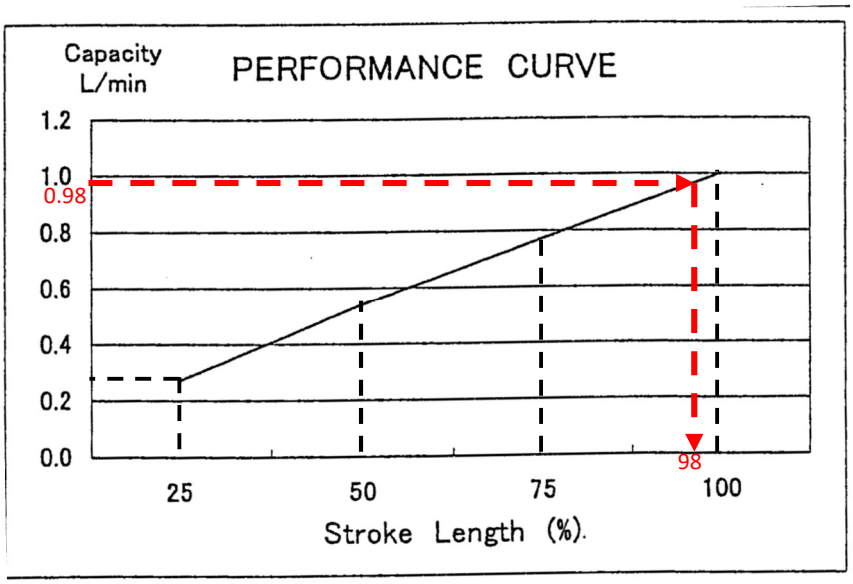


Figure 10: PAC solution feeding pump performance curve

For example, if the feeding rate is 0.98 L/min (59 L/h), then the required stroke length is 98%.

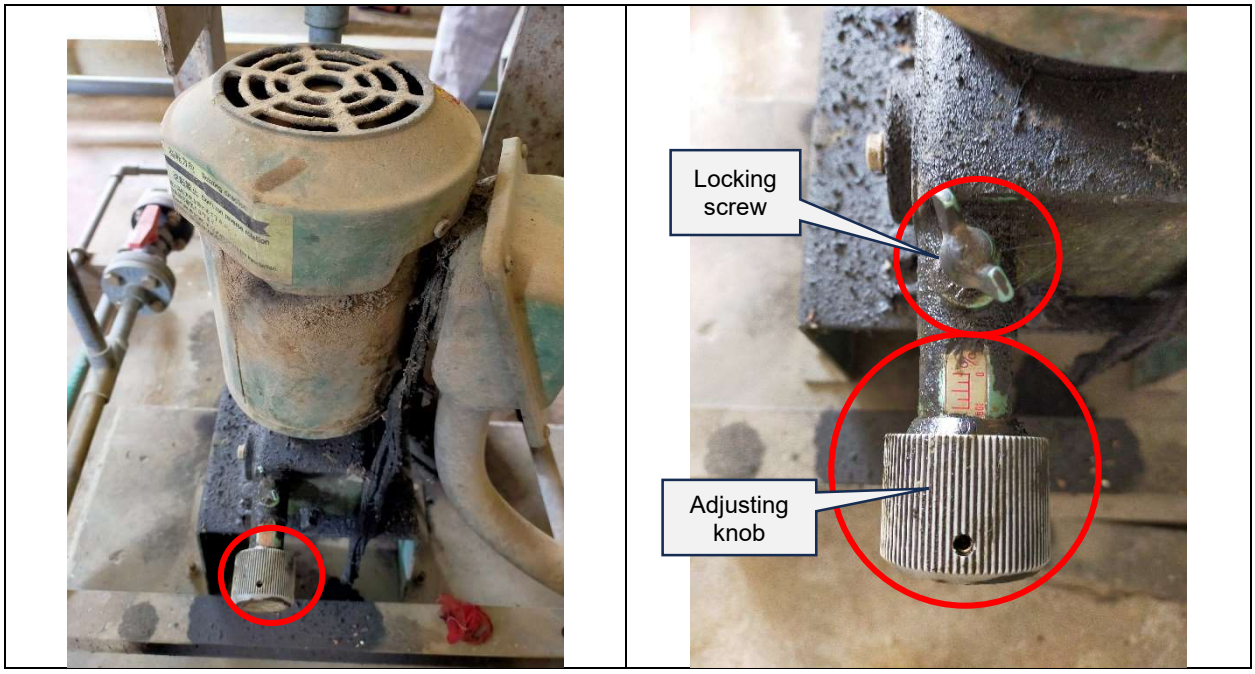


Photo 1: Setting method for adjusting PAC feeding rate

Jar test is used to find out optimum PAC dosing rate. But there is not enough Jar test data for Bode WTP. The following is a sample chart from New Sundarijal WTP done on Bagmati River water. Required PAC dosing rate can be estimated from the chart similar to this for various turbidities. When further data becomes available for Bode WTP this cart shall be updated.

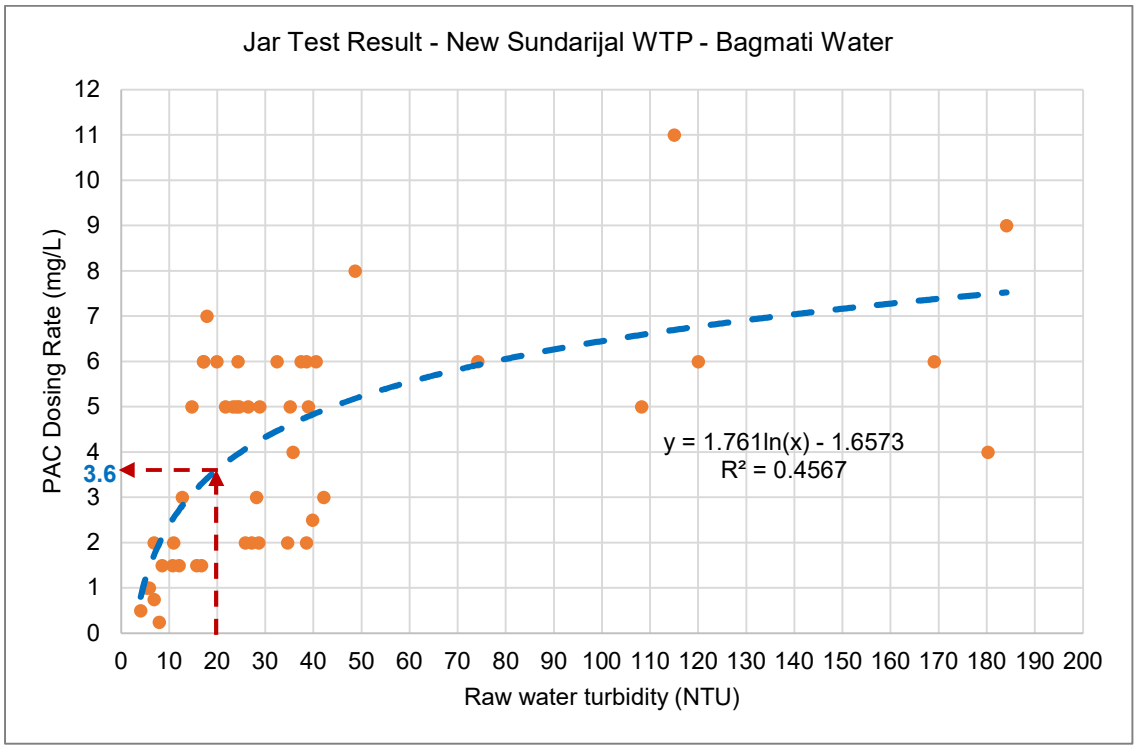


Figure 11: Jar Test Result of Bagmati River water done at New Sundarijal WTP

(The example shows if the turbidity is 20 NTU, the required PAC dosing rate is about 3.6 mg/L)

Selection of dosing pumps

Dosage	Pumping operation
0 to 0.9 L/min	One feeding pump
0.9 to 1.8 L/min	Two feeding pumps

5. Chlorine Feeding Equipment

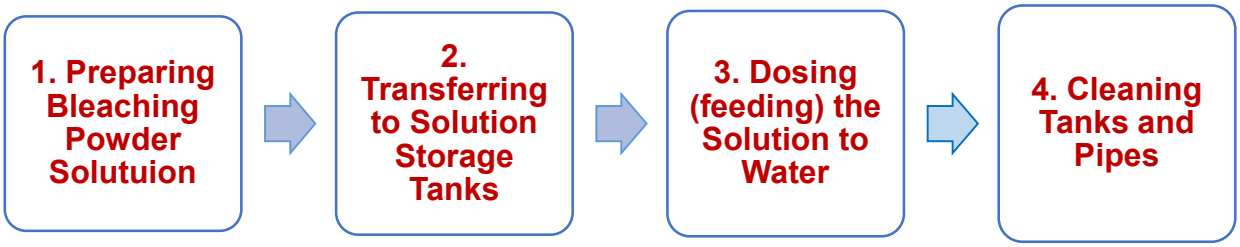
Outline

This equipment uses the chloride of lime as sterilization of filtered water. After dissolving bleaching powder into the concentration specified in the dissolution tank, solution is sent to a storage tank with a transmission pump. The solution is injected into filtered water with the feeding unit.

Equipment Outline

Item	Type	Size/Details	No. of units
Bleaching powder dissolution tank	Vertical open cylindrical type Polyethylene	Capacity: 1000 L Accessories: Plate for agitator and its iron frame fitting	3
Agitator	Portable Type	Motor: 400 V x 50 Hz x 0.4 kW	3
Transmission pump	Centrifugal Pump	Discharge Volume: 80 L/min Lift: 10 m Motor: 400 V x 50 Hz x 0.75 kW	2
Bleaching powder storage tank	Vertical open cylindrical type Polyethylene	Capacity: 2000 L Accessories: Fitting	2
Feeding Unit	Gravitational Drip Type (PVC)	Discharge Volume: 1.8 L/min	3
Piping and valves	Polyvinyl pipe Valve: ball valve, diaphragm valve etc	Diameter: 15-100A	1

Main steps



5.1. Preparing Bleaching Powder Solution

Effective volume of dissolution tank = 725 L × 3 Nos.

Chlorine content in the bleaching powder = 30%

Prepare bleaching powder solution following the schematics and details shown below.

Effective volume of bleaching powder dissolution tank **= 725 L**

3 Bags (75 kg bleaching powder = 22.5 kg chlorine in 725 L solution =>
Chlorine content of the solution = 22,500,000 mg/725 L = 31,034 mg/L (SG~1.04)

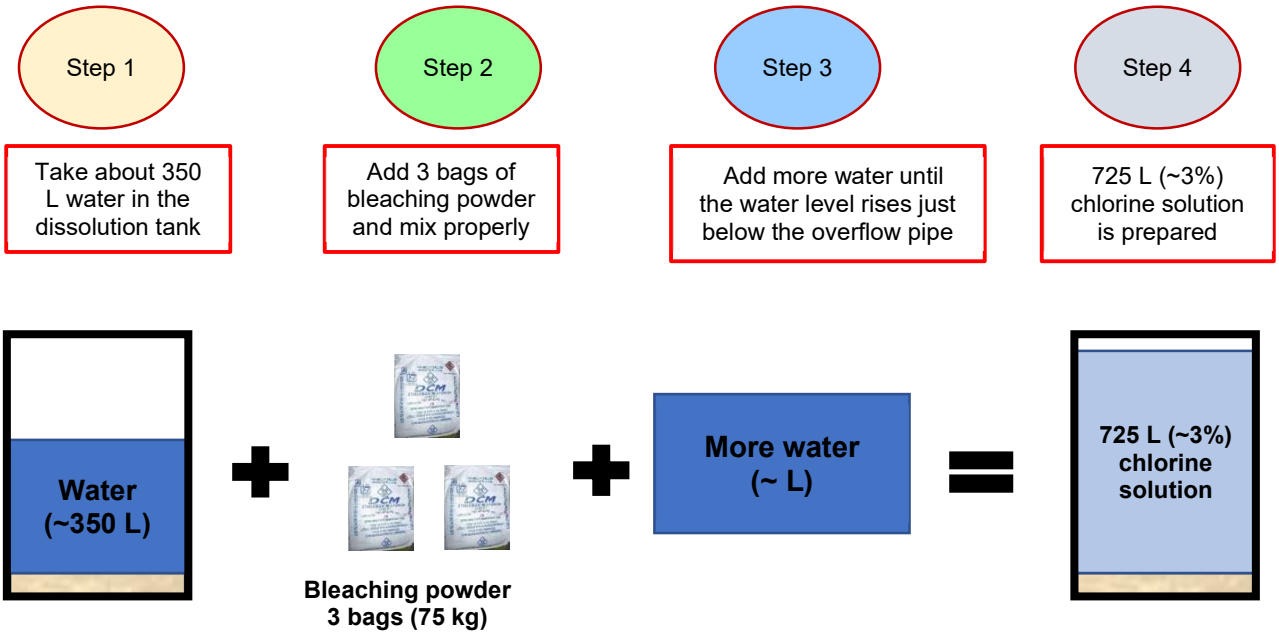


Figure 12: Schematics bleaching powder solution preparation

Bleaching powder dissolution tank

Bleaching powder solution storage tank

Photo 2: Bleaching powder dissolution and storage tanks in Bode WTP

Operation procedure

1. Close the outlet valve and the drainage valve of the dissolution tank

⇩

2. Fill about 50% (350 L) of the tank with water

⇩

3. Add 3 bags (75 kg) of bleaching power

⇩

4. Operate the agitator

⇩

5. Add water until the level reaches just below the overflow pipe, continue agitating for about 20 minutes

⇩

6. Allow 30 minutes to settle

⇩

7. Transfer the solution to the storage tank with the transmission pump

⇩

8. Repeat the Steps 1-7 in another tank or in the same tank after cleaning it

5.2. Transferring the Bleaching Powder Solution to Storage Tanks

Operation procedure (Storage tank capacity 2 m^3)

1. Close the outlet valve and the drainage valve of the bleaching powder storage tank

⇩

2. Open the inlet valve of the bleaching powder storage tank

⇩

3. Open the outlet valve of the bleaching powder dissolution tank

⇩

4. Open the suction valve of the transmission pump

⇩

5. Open the delivery valve of the transmission pump

⇩

6. Operate the transmission pump

⇩

7. Check the liquid level of the storage tank and stop the transmission pump when the maximum storage level has been reached or liquid in the dissolution tank has been finished

5.3. Feeding the Bleaching Powder Solution to Water

Procedure

1. Find out chlorine demand (how many mg of chlorine to be dosed per L of water) from lab test

⇩

2. Calculate the required chlorine dosing rate (mg/L) = Chlorine demand (mg/L) + Desired residual chlorine (mg/L) = D mg/L,
OR
Measure the residual chlorine of treated water and decide dosing rate.

⇩

3. Check the raw water inflow quantity or find out daily filtered water volume Q (m^3/day or m^3/h)

⇩

4. Calculate dosage (feeding rate) of the solution according to Formula, Chart, or Table

⇩

5. Adjust the dosage (feeing rate) as per calculated feeding rate

⇩

6. Measure residual chlorine (minimum FRC should be 1 ppm) after about 30 minutes and adjust the dosage (feeding rate) if required so that the required FRC is obtained

a) Methods of calculating chlorine dosage (feeding rate)

Three methods; (1) By using formula, (2) By using Chart, or (3) From the Table

(1) By using formula

Flow = Q m^3/h

Chloring dosing rate = D mg/L

You can use the following formula:

$$\text{Feeding rate} = \frac{Q\ m^3/h \times D\ mg/L}{31.034}\ L/h$$

For example, if the flow rate is 500 m^3/h (12 MLD) and the dosing rate is 3.0 mg/L, then the feeding rate = 500 × 3.0 /31.034 = 48.3 L/h = 0.81 L/min.

(2) By using Chart

Refer to the following Chart to determine dosage (feeding rate) of bleaching powder solution for various flows and chlorine dosing rates.

First read the Cl_2 dosing rate (mg/L) along the X-axis → go up to the daily flow line → go left to Y-axis and read the dosage (feeding rate).

Dosage (Feeding Rate) Chart for Bode WTP

For example, if the Cl_2 dosing rate is 3.0 mg/L and the daily water flowrate is 500 m^3/h (12 MLD), the dosage (feeding rate) comes out to be 0.81 L/min.

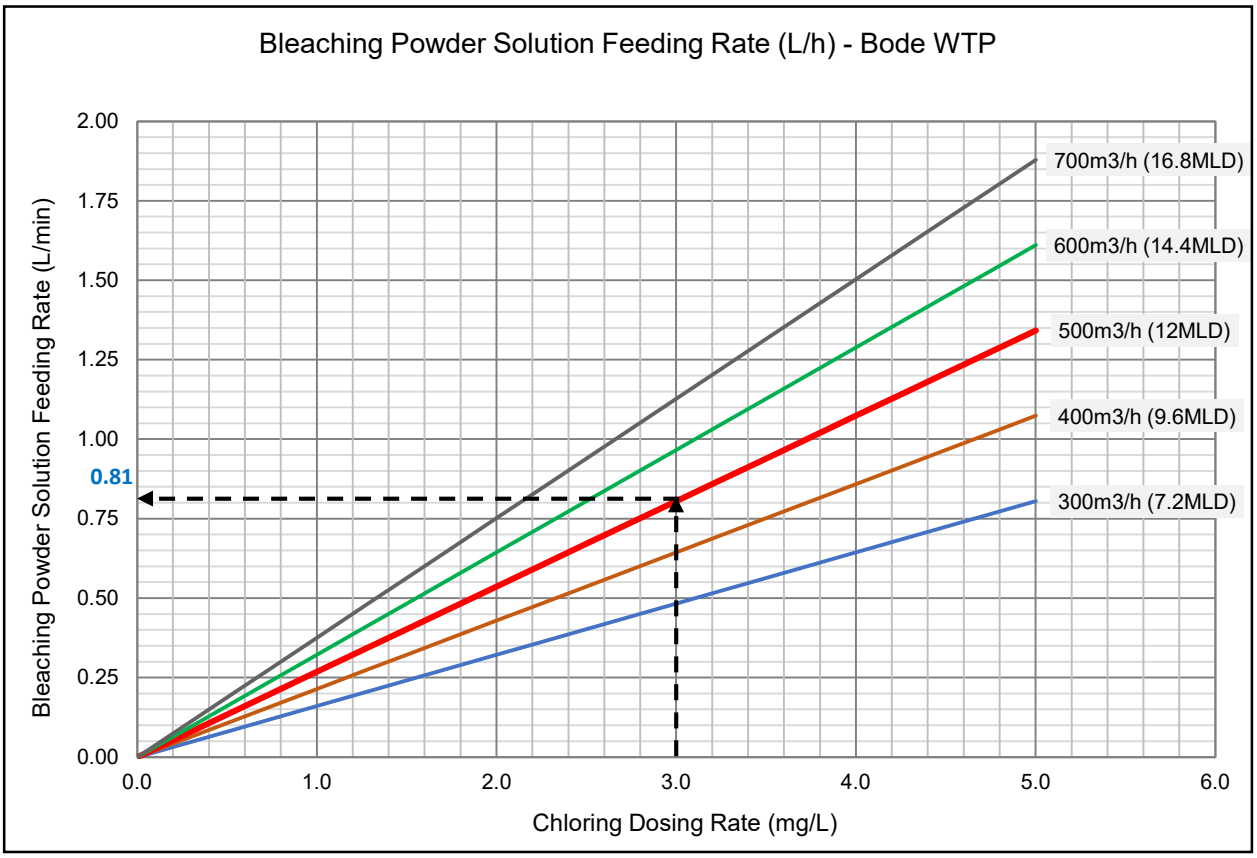


Figure 13: Bleaching powder solution feeding rates for various chlorine dosing rates and flows

(3) By using Table

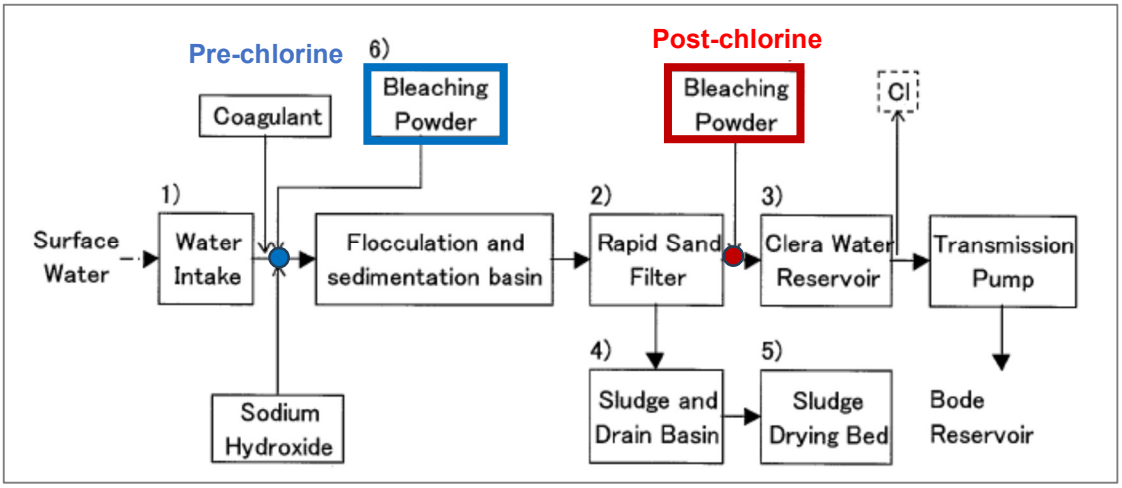
Find the row of dosing rate from the leftmost column → Go right on that row until meeting the water flow rate → The value in intercepting cell is the feeding rate.

Table 2: Bleaching powder solution feeding rate

Chloring dosing rate (mg/L)	Bleaching powder solution feeding rate (L/min) – Bode WTP									Daily volume required for 500 m^3/h flow (L/day)
	300m^3/h (7.2MLD)	350m^3/h (8.4MLD)	400m^3/h (9.6MLD)	450m^3/h (10.8MLD)	500m^3/h (12MLD)	550m^3/h (13.2MLD)	600m^3/h (14.4MLD)	650m^3/h (15.6MLD)	700m^3/h (16.8MLD)	
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1.0	0.16	0.19	0.21	0.24	0.27	0.30	0.32	0.35	0.38	387
1.5	0.24	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56	580
2.0	0.32	0.38	0.43	0.48	0.54	0.59	0.64	0.70	0.75	773
2.5	0.40	0.47	0.54	0.60	0.67	0.74	0.81	0.87	0.94	967
3.0	0.48	0.56	0.64	0.73	0.81	0.89	0.97	1.05	1.13	1,160
3.5	0.56	0.66	0.75	0.85	0.94	1.03	1.13	1.22	1.32	1,353
4.0	0.64	0.75	0.86	0.97	1.07	1.18	1.29	1.40	1.50	1,547
4.5	0.73	0.85	0.97	1.09	1.21	1.33	1.45	1.57	1.69	1,740
5.0	0.81	0.94	1.07	1.21	1.34	1.48	1.61	1.75	1.88	1,933
5.5	0.89	1.03	1.18	1.33	1.48	1.62	1.77	1.92	2.07	2,127
6.0	0.97	1.13	1.29	1.45	1.61	1.77	1.93	2.09	2.26	2,320
6.5	1.05	1.22	1.40	1.57	1.75	1.92	2.09	2.27	2.44	2,513

b) Chlorine dosing locations

- For pre-chlorination: Overflow weir to Flocculation and Sedimentation Basin
- For post-chlorination: Rapid Sand Filter overflow weir



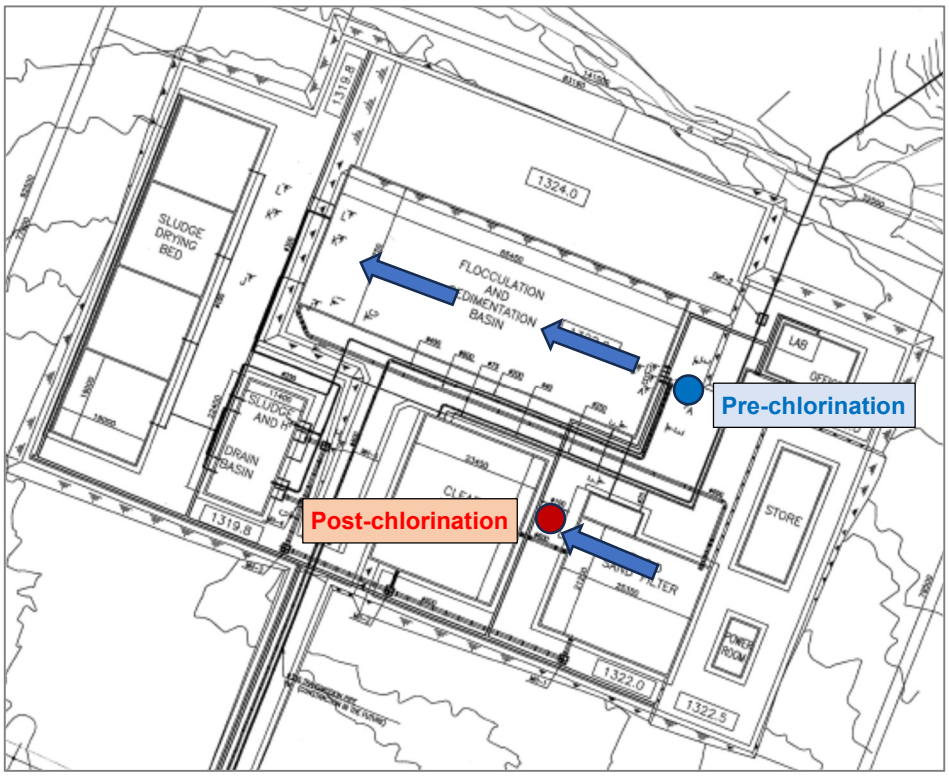


Figure 14: Chlorine dosing locations (pre- and post-chlorination) at Bode WTP

c) Operation procedure of bleaching powder solution feeding system

Bleaching powder solution coming to constant head tank from storage tank. The solution is fed from this constant head tank by gravity.

Photo 3: Constant head tanks for feeding bleaching powder solution

- The specified quantity (as determined above) is fed by gravity through constant head tanks.
- The quantity is adjusted manually with the valves on the feeding line.
- There are three feeding units.
- When the desired quantity cannot be fed by one unit, use multiple units.

Operation procedure

1. Open the outlet valve of the bleaching powder solution storage tank

⇩

2. Select the strainer and open the vales before and after it

⇩

3. Open the suction valve of the bleaching powder solution feeding unit

⇩

4. For confirmation of the feeding and for dosage measuring, close the feeding valve and open the sampling valve

⇩

5. Adjust the feeding rate by adjusting the delivery valve of the feeding unit

⇩

6. Open the feeding valve at the feeding point and close the sampling valve

5.4. Cleaning Tanks and Pipes

a) Washing of feeding unit and feeding pipe

When the injection is stopped for a ling time, the feeding unit and the feeding pipe need to be washed.

Operation procedure

1. Close the suction valve of the bleaching powder solution feeding unit

⇩

2. Connection a hose to the water supply valve

⇩

3. Open the washing water inlet valve and the water supply valve and execute washing

b) Drainage of the bleaching powder dissolution tank

Undissolved material remaining at the bottom of the tank does not contain any chlorine. It should be drained out after dissolution and transfer of solution each time.

Operation procedure

1. Open the drainage valve of the bleaching powder dissolution tank

⇩

2. Open the water supply valve of the dissolution water tank, and flush the residue that remains in the drainpipe by water

⇩

3. And connect a hose to the water supply valve and execute drainage while washing the inside of the tank with water

c) Washing of bleaching powder dissolution tank and the solution storage tank

When feeding is to be stopped for a long time, wash the bleaching powder dissolution tank and the solution storage tank.

Operation procedure

1. Open the drainage valves of the bleaching powder dissolution tank and the bleaching powder solution storage tank

⇩

2. Connect a hose to the water supply valve and wash the inside of tanks

6. Sodium Hydroxide Feeding Equipment:

This equipment is not in use.

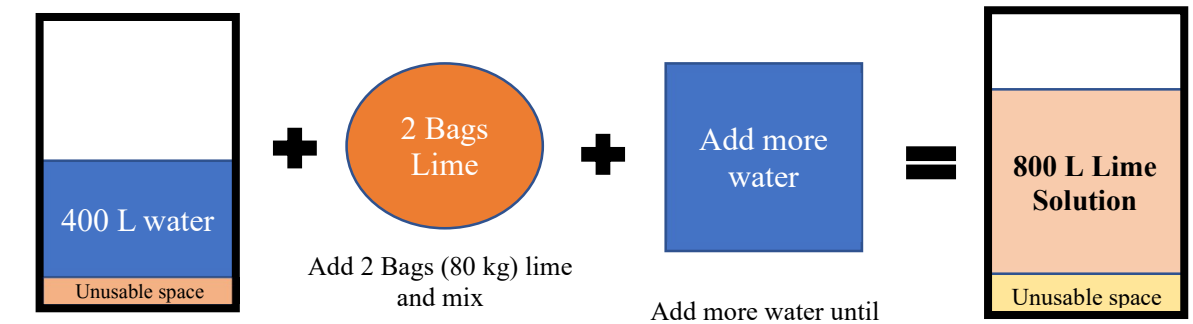
Note: Due to prolong health hazard issue created by handling of NaOH manually to the operators of treatment plant NaOH feeding equipment are no longer used in Bode Treatment Plant.

7. Lime Feeding Equipment

7.1. Lime Solution Preparation

In Bode WTP lime solution is prepared by dissolving 2 bags (80 kg) of lime in 800 L of water.

Effective size of the lime mixing tank = **800 L**



Take about 400 L water

Add 2 Bags (80 kg) lime and mix

Add more water until the level reaches just below the overflow pipe

7.2. Dosing Rate and Dosage (Feeding Rate) Instruction

Lime dosing rate and dosage (feeding rate) shall be done in the following manner:

1. Flow measurement (m^3/day or m^3/hr) (by WTP Engineer)
   (Automatic measurement record can be taken when this system is installed and ready)

⇩

2. Find out the required Lime dosing rate by Jar Test (by Central Lab)

⇩

3. Calculate Lime dosage (feeding rate)/ Lime pump setting (by WTP Engineer)

⇩

4. Adjust Lime pump setting (by WTP operator)

⇩

5. Check pH and floc formation (by Central Lab/WTP)

7.3. Dosage (Feeding Rate) Calculation

Simplified formula to calculate dosage (feeding rate) of lime solution	$= \frac{Q\ (m^3/h) \times D\ (mg/L)}{100}$ L/h Where, Q = Raw water flow rate D = Lime dosing rate as determined by the jar test
Example	If Q=12 MLD = 12,000 m^3/day = 500 m^3/h, and D= 10 mg/L, then The dosage (feeding rate) = $\frac{500\ m^3/h \times 10\ mg/L}{100}$ = 50 L/h = 0.83 L/min

Reference chart and table for Lime solution dosage (feeding rate) calculation:

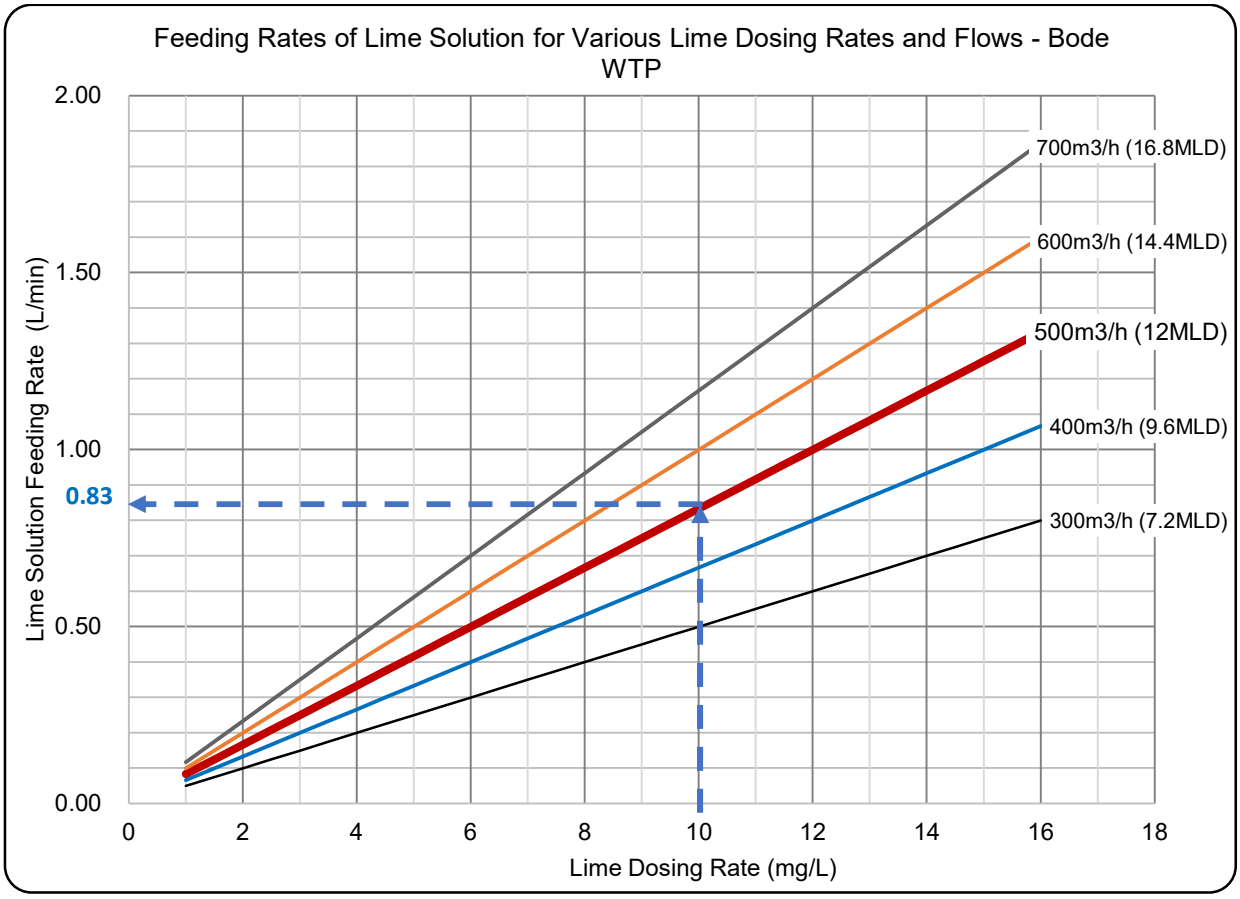


Figure 15: Chart of lime solution feeding rates

The feeding rates can also be calculated from the following Table.

Table 3: Lime solution feeding rates

		Lime Solution Feeding Rate (L/min)								
Dosing Rate (mg/L)	Daily Volume of Solution for 500 m^3/h Flow (L/day)	300 m^3/h (7.2 MLD)	350 m^3/h (8.4 MLD)	400 m^3/h (9.6 MLD)	450 m^3/h (10.8MLD)	500 m^3/h (12 MLD)	550 m^3/h (13.2MLD)	600 m^3/h (14.4MLD)	650 m^3/h (15.6MLD)	700 m^3/h (16.8MLD)
1	120	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12
2	240	0.10	0.12	0.13	0.15	0.17	0.18	0.20	0.22	0.23
3	360	0.15	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.35
4	480	0.20	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47
5	600	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.54	0.58
6	720	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70
7	840	0.35	0.41	0.47	0.53	0.58	0.64	0.70	0.76	0.82
8	960	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93
9	1,080	0.45	0.53	0.60	0.68	0.75	0.83	0.90	0.98	1.05
10	1,200	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17
11	1,320	0.55	0.64	0.73	0.83	0.92	1.01	1.10	1.19	1.28
12	1,440	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40
13	1,560	0.65	0.76	0.87	0.98	1.08	1.19	1.30	1.41	1.52
14	1,680	0.70	0.82	0.93	1.05	1.17	1.28	1.40	1.52	1.63
15	1,800	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75
16	1,920	0.80	0.93	1.07	1.20	1.33	1.47	1.60	1.73	1.87
17	2,040	0.85	0.99	1.13	1.28	1.42	1.56	1.70	1.84	1.98
18	2,160	0.90	1.05	1.20	1.35	1.50	1.65	1.80	1.95	2.10
19	2,280	0.95	1.11	1.27	1.43	1.58	1.74	1.90	2.06	2.22
20	2,400	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33
21	2,520	1.05	1.23	1.40	1.58	1.75	1.93	2.10	2.28	2.45
22	2,640	1.10	1.28	1.47	1.65	1.83	2.02	2.20	2.38	2.57
23	2,760	1.15	1.34	1.53	1.73	1.92	2.11	2.30	2.49	2.68
24	2,880	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80
25	3,000	1.25	1.46	1.67	1.88	2.08	2.29	2.50	2.71	2.92
26	3,120	1.30	1.52	1.73	1.95	2.17	2.38	2.60	2.82	3.03
27	3,240	1.35	1.58	1.80	2.03	2.25	2.48	2.70	2.93	3.15
28	3,360	1.40	1.63	1.87	2.10	2.33	2.57	2.80	3.03	3.27
29	3,480	1.45	1.69	1.93	2.18	2.42	2.66	2.90	3.14	3.38
30	3,600	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50

7.4. Lime Solution Feeding Pump Setting

The setting is same as for PAC feeding pump setting. Please refer to it.

8. Clear Water Reservoir

This equipment has the function to adjust and to ease the disproportion between the amount of filtered water and the water supply volume of water caused in the drive management of the water treatment.

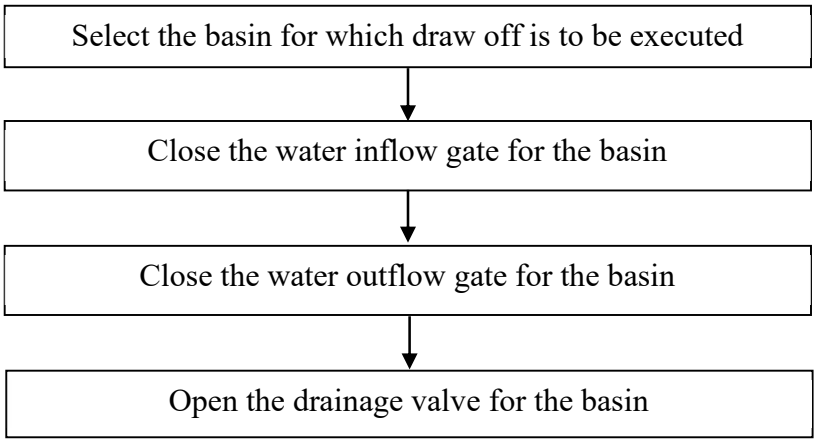
Equipment Outline

Item	Type	Size/Details	No. of units
Clear water reservoir	RCC rectangular Semi-underground closed type	Effective capacity: 1026.3 m^3 Residence time: 68 min for 21.7 MLD raw water Dimension:2.5 m W x 11 m L x 3 m D 2.5 m W x 13.5 m L x 3 m D 2.85 m W x 3 m L x 3 m D	2 basins
Drain Pump	Submersible Sewage Pump	Motor: 400 V x 50 Hz x 0.4 kW Diameter: 50 A Volume of Discharge: 0.1 m^3/min Lift: 7 m	1 pump
Internal Water Supply Pump	Packed Booster Pump System	Motor: 400 V X 50 Hz X 3.7 kW Diameter: 50A/ 65A Volume of Discharge: 500 L/min; Lift: 30 m	2 pumps
Sampling Pump	Centrifugal Pump	Motor: 400 V X 50 Hz X 0.75 kW Diameter: 40A Volume of Discharge: 100 L/min; Lift: 12 m	2 pumps

Operation Method

The clear water reservoir is composed of two basins, and each basin can be used independently. In case of independent operation, operate the inflow and the outflow gate of the respective basin.

Draw off of the clear water reservoir



Preparation for operation of the water supply pump

Power supply of control panel

Select the turning off switch of the ON/OFF switch on control panel and supply the power supply to control panel

↓

Turn on power switch in control panel. The lamp on the control panel lights up

Operation of the water supply pump

In case of the automatic operation

Open the suction valve of the water supply pump (No.1 and No.2)

↓

Open the delivery valve of the water supply pump

↓

Select the turning on switch of the ON/OFF switch on control panel

↓

Push the pump selection key, and select a "Parallel alternation"
(Note: Push the operating mode key and select either of "Parallel alternatio" / "No. 1" / "No. 2". Select "Parallel alternation" usually.)

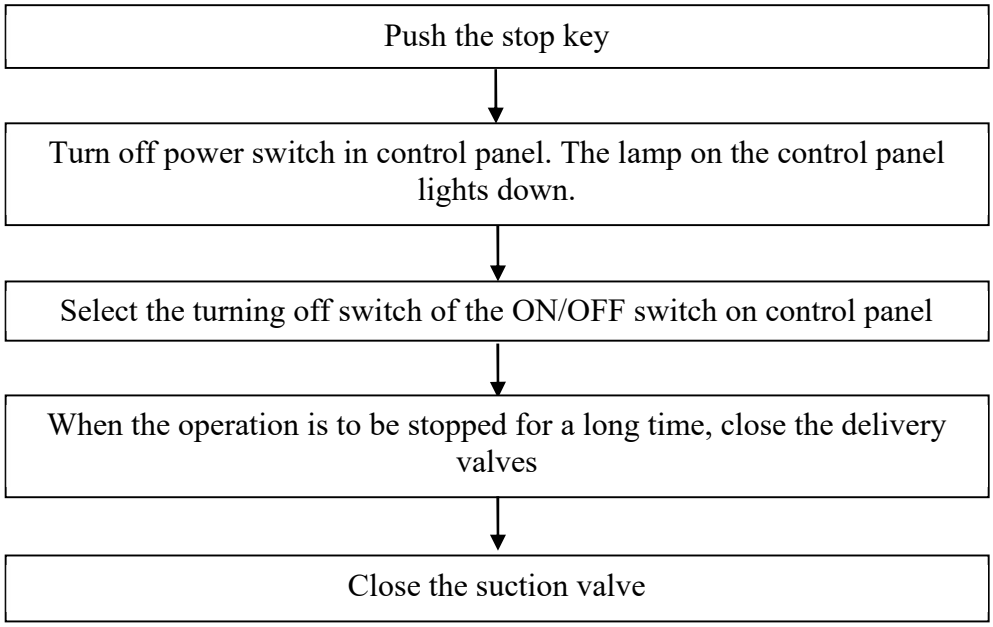
↓

Push the operation mode key, and select the "Automatic operation"

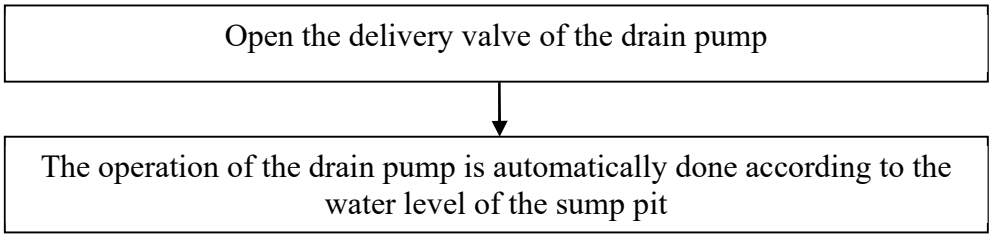
↓

Push the operation key

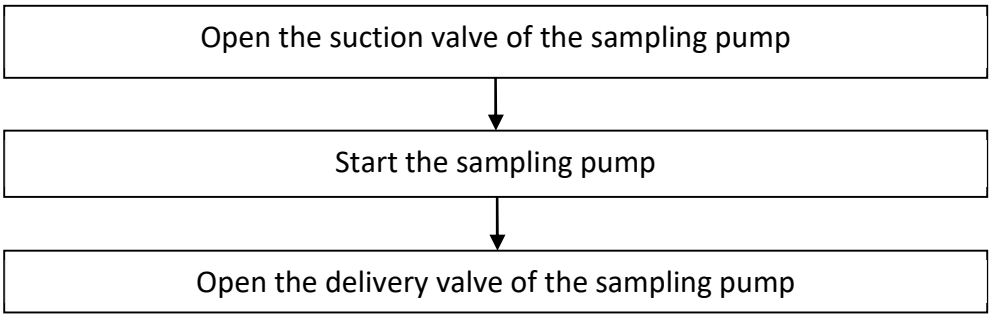
Stopping of the water supply pump



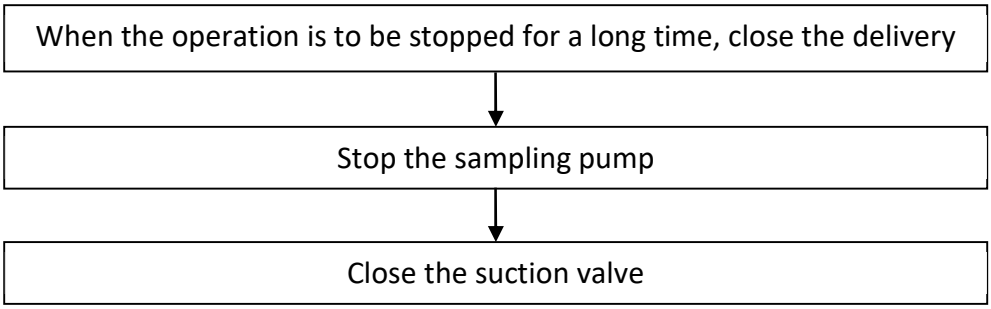
Operation of the drain pump



Operation of the sampling pump



Stopping of the sampling pump



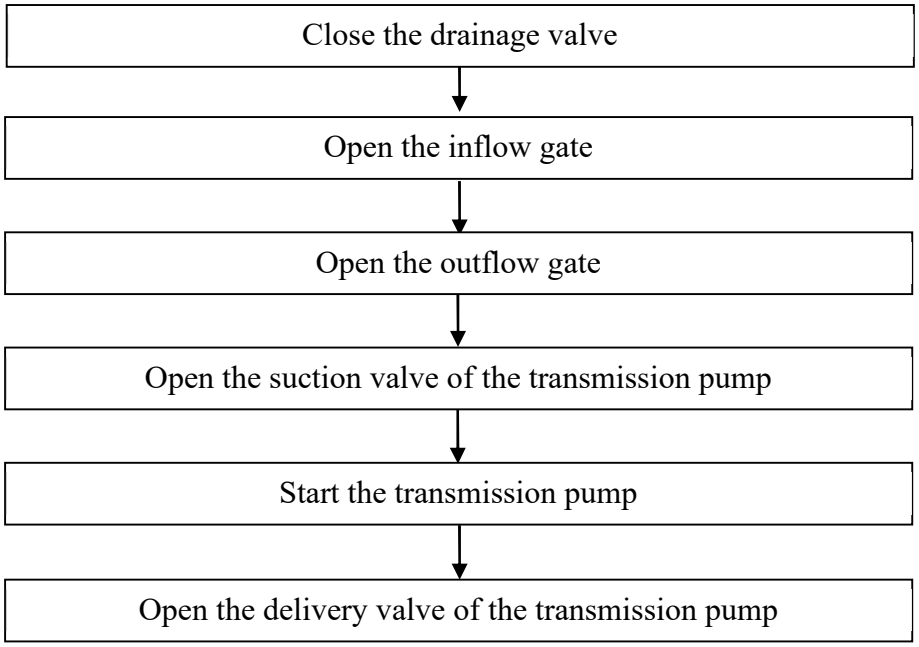
Water Transmission Facilities for Bode Reservoir

This equipment is set up for supplying the water processed in the filtration plant to the Bode Reservoir.

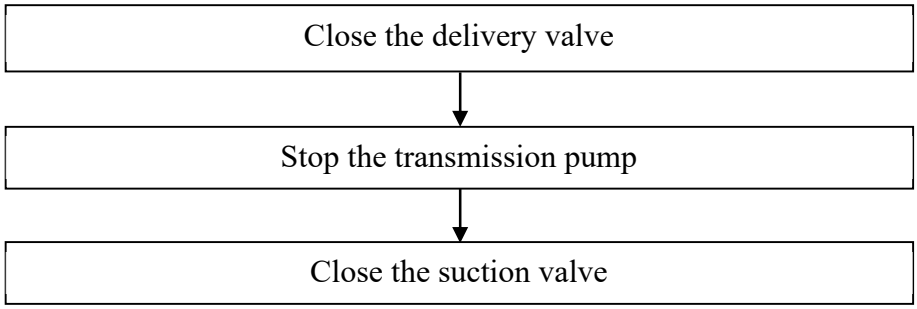
Item	Type	Size/Details	No. of units
Transmission Pump to Bode Reservoir	Double Suction Volute Pump	Motor: 400V x 50Hz x 45 kW Diameter:150A/100A Volume of discharge: 2.5 m^3/min Lift: 52 m	3

Operation Procedure

Operation of Transmission Pump



Stopping of the transmission pump



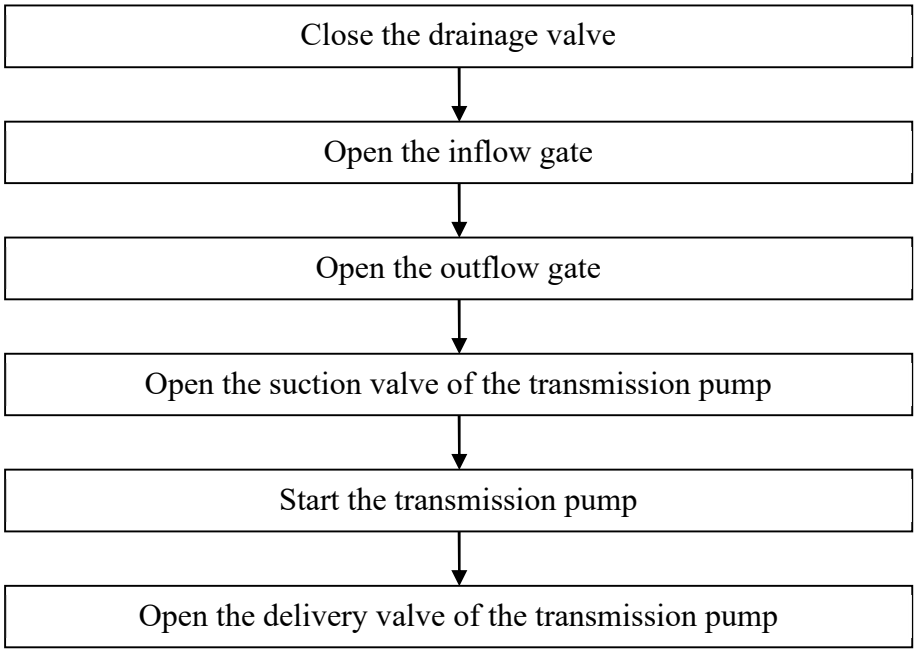
Water Transmission Facilities for Min Bhawan Elevated Tank

This equipment is set up for supplying the water processed in the filtration plant to the Minbhawan Elevated Tank.

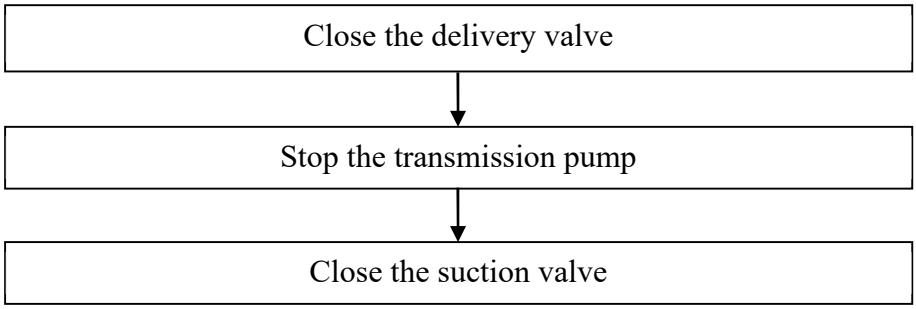
Item	Type	Size/Details	No. of units
Transmission Pump to Min Bhawan Elevated Tank	Double Suction Volute Pump	Motor: 400 V x 50 Hz x 55 kW Diameter: 200A/100A Volume of discharge: 2.57 m^3/min Lift: 68 m	5

Operation Procedure

Operation of Transmission Pump



Stopping of the transmission pump


Close the delivery valve
Stop the transmission pump
Close the suction valve

9. Sludge and Drainage Basin

This equipment has the capacity to store backwash sludge of the rapid sand filter for 1 time. Moreover, this equipment has the function to return the supernatant water to the receiving well and to transfer the sludge to the sludge and drying bed.

Equipment Outline

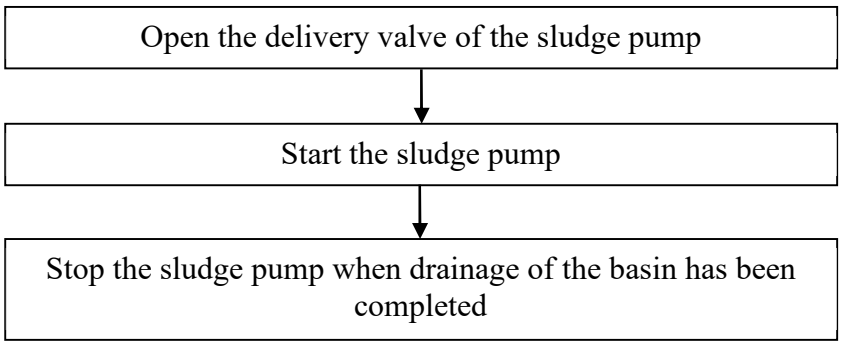
Item	Type	Size/Details	No. of units
Sludge and Drain Basin	RCC rectangular open type	W 10.6 m x L 10.6 m x D 2.2 m Effective capacity: 494.4 m^3	2
Sludge Pump	Submersible Sewage Pump with Cutter	Motor: 400 V x 50 Hz x 3.7 kW Diameter: 80A Discharge capacity: 0.8 m^3/min Lift: 12 m	2
Supernatant Water Return Pump	Submersible Sewage Pump	Motor: 400 V x 50 Hz x 11 kW Diameter: 150A Discharge capacity: 2.1 m^3/min Lift: 13 m	2

Operation Method

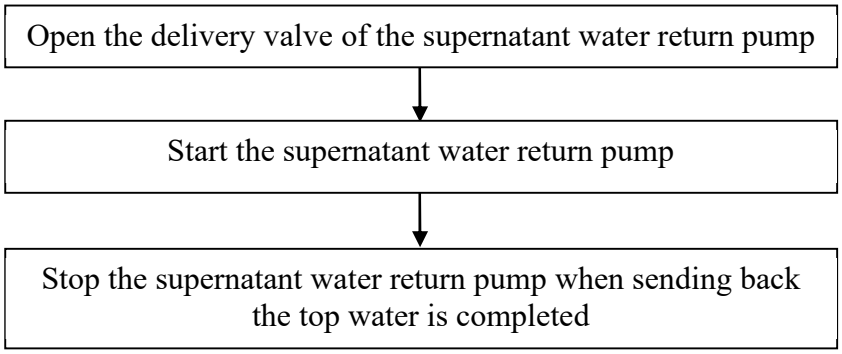
Checking of the opening and closing state of an inflow gate.

Open the inflow gate of either drain pond which is selected for use to accept the washing drain of the rapid filter.

Operation of Sludge pump



Operation of the supernatant water return pump

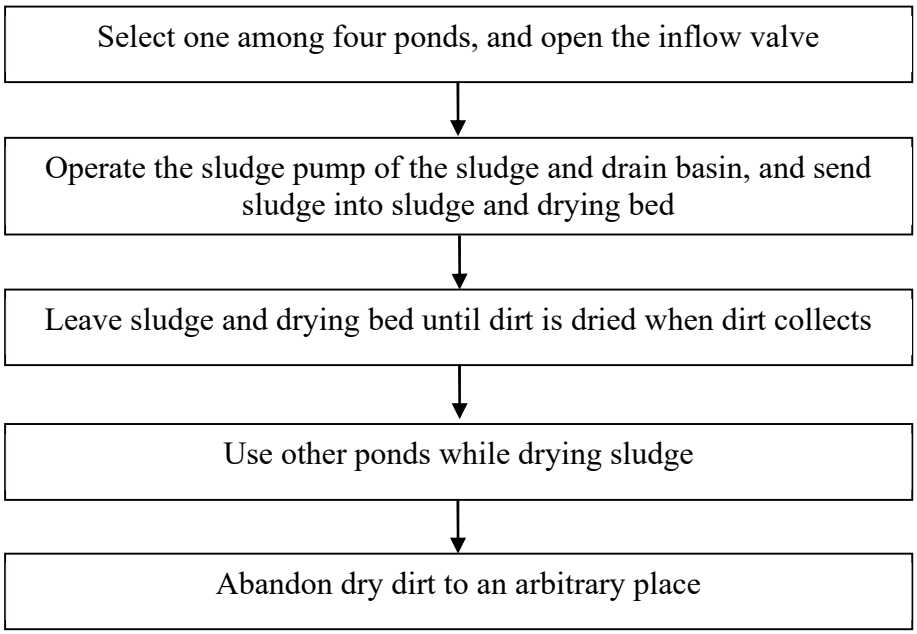


10. Sludge and Drying Bed

This equipment is installed in order to dry the sludge and drain basin.

Item	Type	Size/Details	No. of units
Sludge and Drying Bed	RCC rectangular open type	W 10.6 m x L 10.6 m x D 2.2 m	4

Operation of the sludge and drying bed



11.Photos

Figure 16: Rapid sand filter

Figure 17: Rapid Sand Filter(Raw water gate and Raw water valve)

Figure 18: Transmission pumps

Figure 19: Chlorine Transfer pump

Figure 20: Sludge basin

Figure 21: Sludge pump

Figure 22: Sludge drying bed

Figure 23: Clear water reservoir

Figure 24: Transmission line from CWR

Figure 25: Sedimentation basin – Trough

Figure 26:Raw Water Inflow Gate

Figure 27:Raw water flow meter (not operational currently)

Figure 28: Hose box for washing

Figure 29: Sedimentation basin - trough

Figure 30: Sedimentation basin after draw-off during cleaning process

End of SOP.