**CHAPTER 1 : TECHNICAL DESCRIPTION**

**1.1 INTRODUCTION**

The objectives of this project initiative is to protect and improve upon the natural environmental resources in the vicinity, meet statutory mandates, improve water quality characteristics in the Vrishabhavathi river intern in the tube wells and surface water bodies, reduce health risks, maintain micro climatic conditions suitable for survival of aquatic life, environs etc. As part of this initiative of BWSSB, it is proposed to Design and construct 100 MLD capacity Sewage treatment plant (STP) based on sequencing batch reactor technology with biological nutrient removal (BNR) system at Hebbal, Bangalore with successful operation and maintenance of the STP for 10 years.

**Salient Features of 100 MLD Sewage Treatment Plant at Hebbal**

The Sewage Treatment Plant consists of Pre-Treatment Units with Primary Clarifier followed by Biological Unit (SBR Technology), Chlorination System followed by Fine Filtration Unit, Sludge Handling Unit and Biogas based Power Plant Facility.

* India’s First Largest STP based on Sequencing Batch Reactor Technology with Bio - methanation with 1.0 MW Power Plant.
* Fully Automized Plant with PLC & SCADA System.
* Treated sewage from the plant can be recycled for non-potable use like Irrigation, Golf Course, and Gardening etc.
* The sludge generated from the plant can be used as Fertilizer having high nutrient values of Nitrogen & Phosphorous.
* Biological system with Fine Bubble Diffused Aeration with Turbo Blower having Variable Frequency Drive will save 30 to 35% Energy.
* Less footprint requirement i.e. 5 Ha. (Approx.) for 100 MLD STP.
  1. **DESIGN BASIS**

**1.2.1. Design Flow**

1.2.1.1. 250 MLD Capacity Terminal Sewage Pumping Station (TSPS)

Design average flow : 250 MLD

Peak factor (P.F.) : 2

Design peak flow : 500 MLD

1.2.1.2. 100 MLD Capacity Sewage Treatment Plant (STP)

Design average flow : 100 MLD

Peak factor (P.F.) : 2.0

Design peak flow : 200 MLD

Recycle flow : 4.1 MLD

1.2.1.3. 160 MLD Capacity Sludge Handling Plant (SHP) with Biogas Generation

Quantity of Sludge to be dewatered : Sludge generated from proposed 100 MLD STP + Sludge generated from existing 60 MLD STP

**1.2.2. Sewage Characteristics for Design Purpose**

Table – 1: Sewage Characteristics for Design Purpose

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **Parameters** | **Unit** | **Raw sewage** | **Treated Sewage** |
| 1 | pH | - | 6.5-8.5 | 6.5-9.0 |
| 2 | BOD 5 @ 20oC | mg/L | 350 | ≤ 10 |
| 3 | COD | mg/L | 650 | ≤ 50 |
| 4 | Total Suspended Solids (TSS) | mg/L | 400 | ≤ 10 |
| 5 | Volatile Suspended solids (VSS) | mg/L | 280 | - |
| 6 | TKN | mg/L | 60 | - |
| 7 | NH4- N | mg/L | 50 | < 5 |
| 8 | N-Total | mg/L | - | < 10 |
| 9 | Total Phosphorous | mg/L | 7 | <1 |
| 10 | Dissolved Phosphorous | mg/L | - | <1 |
| 11 | Residual Chlorine | mg/L | - | 0.2 |
| 12 | Dissolved oxygen (DO) | mg/L | - | > 2 |
| 13 | Fecal Coliform Count | MPN/100 mL | 8 x 106 | 100 |
| 14 | Total Coliform Count | MPN/100 mL | 11 x 106 | 10000 |
| 15 | Minimum temperature | oC | 26 |  |
| 16 | Maximum temperature | oC | 29 |  |

**1.2.3 Treated Sludge Quality Requirements**

Sludge quality : Thickened, Anaerobically digested and dewatered sludge.

VSS/TSS in dewatered sludge : 70% (maximum)

TSS in dewatered sludge : 25% (minimum)

**1.3. LIST OF MAJOR PROCESS UNITS OF TREATMENT PLANT:**

**1.3.1. 250 MLD Capacity TSPS**

* + Common chamber
  + Receiving chamber
  + Mechanical and manual coarse screen channel
  + TSPS Wet well
  + TSPS pumps

**1.3.2. 100 MLD Capacity STP**

* + Inlet chamber
  + Fine screen channel
  + Common screen outlet channel
  + Vortex grit chamber
  + Parshall flume - I & Parshall flume - II
  + Primary clarifier distribution chamber
  + Primary clarifier
  + Splitter Box
  + SBR basins
  + Alum dosing tanks with mixers and dosing pumps
  + SBR outlet chamber
  + CCT inlet chamber
  + Chlorine contact tank
  + Disc Filtration unit
  + Treated sewage outfall chamber
  + Plant drain sump
  + Plant water sump and overhead tank

**1.3.3. 160 MLD Capacity SHP**

* + Thickener feed sump and Pump House
  + Archimedean screw thickener
  + Thickened sludge/Digester feed sump and Pump House
  + Anaerobic digesters with sludge mixing system
  + Digested sludge / COTDM feed sump and Pump House
  + COTDM (Combined thickening and dewatering machine)
  + Poly dosing tanks with mixers and dosing pumps
  + Filtrate sump
  + Biogas flaring and Scrubbing system, Biogas Holders and Biogas Engine

**1.4. NARRATIVE DESCRIPTION OF TREATMENT PROCESS**

**1.4.1. 250 MLD Capacity Terminal Sewage Pumping Station (TSPS)**

The common chamber (1No.) of TSPS shall receive the raw sewage from BWSSB sewer lines. The incoming sewage shall be conveyed from the common chamber to receiving chamber (1 No.) and then to the coarse screen channel, where the sewage shall be screened using coarse screens (6 Nos.: 4 Nos. Working (Mechanical) + 2 Nos. Standby (Manual)) placed in channels. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A belt conveyor positioned above ground level shall convey the screenings through a SS304 chute to a screening collection Bins positioned at ground level. All screens shall be provided with thimble mounted isolation Sluice gates both on upstream and downstream.

The screened sewage from the coarse screens (located in TSPS) shall be collected in the TSPS wet well. The wet well shall be provided with submersible type raw sewage pumps for lifting the raw sewage to inlet chamber of STP. 3 types of raw sewage pumps shall be provided: (a) 25 MLD capacity pumps [6 Nos. (2W+4S)] and 50 MLD capacity pumps [2 Nos. (1W+1S)] for proposed 100 MLD STP, (b) 30 MLD capacity pumps [5 Nos. (2W+3S)] for existing 60 MLD STP.

**1.4.2. 100 MLD Capacity Sewage Treatment Plant (STP)**

The wastewater stream of 100 MLD capacity STP mainly consists of

(i) Pre-treatment units

(ii) Biological treatment units

(iii) Chlorination and filtration units.

* **Pre-treatment**

The inlet chamber shall receive the sewage from the TSPS, from where it will be conveyed to the fine screens [3 Nos. (2W+1S)] (Fine screens shall be supplied by BWSSB). The screened materials removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. Thimble mounted gates shall be provided at upstream & downstream of screen channel to allow isolation of screen channel for maintenance. A belt conveyor positioned above ground level shall convey the screenings through a SS304 chute to screening collection bins positioned at ground level. After screening the sewage shall flow to common screen outlet channel (1 No.) from where the flow will be conveyed to Vortex Grit chamber (4 Nos.).

Dewatered grit shall be collected in a trolley positioned at ground level from the grit classifier discharge. A PST bypass sewage stream shall be provided from the common outlet channel of vortex grit chamber, which is to be blended with settled sewage at the splitter box to achieve BOD5 at the SBR inlet as 250 mg/L for efficient BNR process to get desired outlet discharge norms for TN and TP as per tender. Hence, two different Parshall flumes shall be provided to serve the purpose with flow measuring and regulating units. The Parshall flume -I shall be provided for stream having PST followed by SBR, whereas Parshall flume II shall be provided for raw sewage after degritting conveying directly to SBR. The sewage flow from Parshall flume I enters the primary clarifier distribution chamber (1 No.), thereafter to the primary clarifier (4 Nos.). Clarifier mechanism shall be central driven type with half bridge. The sludge settled at the bottom of the primary clarifier shall flow by gravity to thickener feed sump.

* **Biological treatment**

The sewage after pre-treatment shall flow by gravity to the SBR splitter box (1 No.) from where it shall be distributed to the individual SBR basins through thimble mounted gates to allow isolation of each basin. The splitter box of SBR receives flow from outlet of primary clarifier and also from the Parshall flume II.

Total 6 Nos. of SBR basins shall be provided to achieve BNR process and the required effluent standards as per Table -1, i.e. BOD, TSS, and TN at the outlet ≤ 10 mg/L and TP ≤ 1 mg/L . Co-current nitrification and denitrification takes place in the aeration zone of SBR basin. The detailed process description of SBR is mentioned in Annexure-IV.

The SBR basins shall be complete with Air blowers (9 Nos. (6W+3S), each of capacity 10800 Nm3/hr), Diffusers, Grid piping, Return Activated Sludge (RAS) pumps [12 Nos. (6W + 6S)] of capacity 360 m3/hr, Surplus Activated Sludge pumps [12 Nos. (6W + 6S)] of capacity 220 m3/hr, Stainless steel decanters, Auto Valves and PLC etc. All cycles will be automatically controlled using PLC. Excess sludge will be pumped intermittently with the help of SAS pumps to the thickener feed sump.

****Alum is not needed for removal of phosphorous, as the required reduction of phosphorous in the treated effluent can be achieved by the biological removal in the SBR basins. However, an alum dosing system with alum dosing tanks [2 Nos.] and alum dosing pumps [3 Nos. (2W+1S)] of capacity 850 LPH shall be provided to dose alum in the SBR inlet (as a backup chemical phosphorous removal) in case, if there is a change in the BOD : TP ratio at the inlet during actual plant operation.

* **Chlorination and Fine Filtration**

Treated effluent from SBR basins will flow to Chlorine Contact Tank (1 No.) through thimble mounted gates for disinfection. The Chlorine Contact tank shall be designed for maximum decanting flow from SBR, i.e. 101.9 MLD, as there shall not be any peak flow at outlet of SBR process. Chlorine shall be injected via an inline vacuum ejector [4 Nos. (2W+2S)] of 15 kg/hr capacity each placed in the CCT inlet chamber just upstream of the Chlorine Contact Tanks. A chlorination building shall be provided to house all chlorination equipment including chlorine tonners, chlorinators, chlorine booster pumps [4 Nos. (2W+2S)] and all associated equipments. An emergency chlorine scrubber and all associated systems and controls shall be provided to contain and neutralize any chlorine gas leaks.

The disinfected effluent from the chlorine contact tank enters the influent channel of Disc filter (1No.). Treated sewage from SBR shall have BOD5 & TSS outlet characteristics ≤ 10 mg/L (required effluent standard). In case of any abnormal increase of TSS in raw sewage, it has been assumed to receive TSS outlet from SBR as 20 mg/L. Considering such worst case scenario, 68 MLD capacity fine filtration system shall be provided out of total 101.9 MLD as and when required. To achieve 10 mg/L TSS in finally treated sewage, rest of the 33.9 MLD shall not be taken to fine filtration unit, but blended with filtered water in treated sewage outfall chamber. The filter backwash water will be taken to the Filtrate sump, which shall be recycled back to inlet of STP along with the filtrate from the sludge handling units.

BWSSB has decided to recycle the treated sewage for irrigation purpose in collaboration with irrigation department, Bangalore. Irrigation department / BWSSB shall construct the receiving chamber (with isolation gate arrangement) of finally treated sewage coming from treated sewage outfall chamber of the proposed STP. The required quantity of flow shall be pumped by irrigation department whereas; balance quantity shall be disposed through the disposal pipe line.

* **Bypass arrangements**

Bypass arrangement shall be provided at Inlet chamber, Splitter box and from Chlorine contact tank**.** The bypass flow stream from theInlet chamber, Splitter box and the CCT shall be taken to the treated sewage outfall chamber.

* **Plant Water Utility system**

A portion of the disinfected effluent from CCT shall flow by gravity to the Plant Water sump and shall be pumped through plant water submersible pumps [2 Nos. (1W+1S)] having capacity 250 m3/hr each for storage to an elevated plant water tank for multiple applications including but not limited to alum and polymer solution preparation, motive water for chlorination, general cleaning and flushing needs and for landscaping etc.

****Bore wells shall be provided for pumping fresh ground water to an overhead tank. Submersible bore well pumps [3 Nos. (2W + 1SS)] of capacity 10 m3/hr shall be provided for pumping water from the bore well. Bore well water shall be used for safety showers, domestic potable needs and laboratory needs.

1 lakh L capacity Overhead tank (with partition) shall be provided for storage of plant water and bore well water as per tender requirement.

* **Plant Drain system**

Plant drain pipes of all the units shall be connected to the plant drain sump through necessary piping arrangement. As per Clause 9, corrigendum-I dtd: 06-05-17, the plant drain sump shall be provided to collect drain flow from the inlet pre-treatment units and wash water from the dosing area. Hence, the design drain flow is considered based on the highest basin volume (which has to be drained), that means supernatant/liquid volume of primary clarifier. Moreover, 2 Nos. of submersible type dewatering pump having capacity of 300 m3/hr each with 15 m head shall be provided as store standby. The SBR tank shall be drained through installed RAS pump and pumped to adjacent SBR tank as per process requirement. All sludge units shall be drained through relevant pumps and finally sent to mechanical dewatering unit. The sewage in the plant drain sump will be pumped to the inlet chamber by using submersible pumps [2 Nos. (1W + 1S)] having capacity 250 m3/hr.

**1.4.3. 160 MLD Capacity Sludge Handling Plant (SHP)**

The 160 MLD capacity Hebbal SHP mainly consists of :

(i) Archimedean Screw thickener

(ii) Anaerobic Sludge Digester

****(iii) Dewatering unit : COTDM

* **Archimedean Screw thickeners**

The primary sludge from primary clarifier and the secondary sludge from the SBR basins will be collected in the thickener feed sump**.** Efficient sludge mixing system shall be provided in the thickener feed sump.The combined primary and secondary sludge shall be pumped to screw thickeners [4 Nos. (2W + 2S)] by horizontal centrifugal type Thickener feed pumps [4 Nos. (2W + 2S)] of capacity 55 m3/hr. For proper thickening of the sludge, polyelectrolyte dosing facility shall be provided by 2 Nos.(1W+1S) of poly dosing tanks & 4 Nos. (2W+2S) of poly dosing pumps of capacity 1850 LPH each. The filtrate from the sludge thickeners shall be collected in the filtrate sump (1 No.) and the thickened sludge from the thickeners will flow by gravity to thickened sludge sump (1 No.). Efficient sludge mixing system shall be provided in the thickened sludge sump.

As per discussion held with M/S. NJS and CE BWSSB, the thickeners in the existing 60 MLD STP are not in good working condition and hence, it was decided to adopt 1 No. of mechanical screw thickeners out of 2 Nos. of standby thickeners proposed for new 100 MLD STP at Hebbal to achieve better sludge quality. Moreover, 1 No. of poly dosing pump having capacity of 1850 LPH shall also be provided from proposed STP to BWSSB for their future utilization of the screw thickener.

The additional quantity of sludge generated from existing 60 MLD STP shall be conveyed to the proposed thickened sludge sump by thickened sludge pumps [2 Nos. (1W + 1S)] of capacity 11 m3/hr.

* **Anaerobic Sludge digester**

Thickened sludge shall be pumped to the digesters [4 Nos.] by progressive cavity screw type Digester feed pumps [4 Nos. (2W + 2S)] of capacity 15.5 m3/hr. For proper mixing of the sludge in the digester, sludge mixing pumps [12 Nos. (4W + 8S)] of capacity 1200 m3/hr shall be provided. Out of total 8 Nos. of Standby pumps, 4 Nos. (1 No. per digester) of pumps shall be used for draining out the anaerobic digester unit. The gas generated in the digesters shall be collected by biogas collecting blowers [6 Nos. (4W+2S)] of capacity 190 m3/hr and the collected gas shall be fed to Biogas-Scrubbing system. The scrubbed biogas shall be stored in the gas balloon holders (4 Nos.). The stored biogas shall be then fed to Chiller (1 No.) and finally to biogas engine (1 No.) of 1 MW capacity with biogas engine feed blowers [2Nos. (1W+1S)] of capacity 500 m3/hr for generation of electricity.

The digested sludge will be conveyed to the digested sludge sump (1 No.) by gravity. Efficient sludge mixing system shall be provided in the digested sludge sump to avoid sludge settling in the sump.

* **COTDM (Combined thickening and dewatering machine)**

The digested sludge from the COTDM feed sump will be pumped to the COTDM units by progressive cavity screw type COTDM feed pumps [6 Nos. (3W + 3S)] of capacity 25 m3/hr. The polymer dosing system shall be provided for conditioning of the thickened sludge before dewatering. The poly dosing system will consist of poly electrolyte storage facility, poly dosing tanks [6 Nos. (3W+ 3S)] each with mixers and polyelectrolyte dosing pumps [6 Nos. (3W + 3S)] of capacity 3600 LPH each .The common poly dosing tanks shall be provided for Screw thickener as well as COTDM facility. The centrate from the dewatering unit shall be collected in the filtrate sump.

The total filtrate collected in the filtrate sump will be recycled back to the inlet chamber of the STP by submersible pumps [2 Nos. (1W + 1S)] of capacity 170.83 m3/hr.

**1.5. PROCESS DESIGN / UNIT SIZING CALCULATION: DESIGN CONCEPT AND PHILOSOPHY**

The process design for 100 MLD Capacity STP at Hebbal, is done as per tender corrigendum-I & III dated 06-05-17 & 16-5-17 respectively, as well as specific note mentioned in Volume II, Part-11, Section 7-Specifications, Particular Mechanical Requirements, Table 1 & Table 2 of tender.

**1.5.1 Unit sizing calculation of TSPS units**

**1.5.2 Process design /Unit sizing Calculation of STP units**

* The plant is designed for biological nutrient removal with sludge handling and dewatering unit and also biogas engine system.
* The process design calculation of the STP units has been done in following 2 steps.

**STEP I: Mass Balance Calculation**

The primary clarifier followed by SBR system has been designed initially considering the raw sewage characteristics mentioned in the tender. During this step, the sludge production from primary clarifier and SBR has been evaluated and process design of sludge handling units like thickener, digester and COTDM units has been carried out and hence, found the total quantity of Filtrate flow generated during first iteration.

Moreover, it has been assumed to consider BOD5 inlet to SBR unit as 250 mg/L to achieve efficient BNR process. And hence, it is assumed to consider 82 MLD inlet flow to primary clarifier, whereas remaining 18 MLD shall be directly fed to Splitter box. To achieve this hydraulic flow regulation it is proposed to provide 2 Nos. of Parshall flumes having different relevant design flow with flow meter and isolation gate arrangement.

**STEP II: Unit Sizing/Process design calculation**

The characteristics and total quantity of other flow i.e., filtrate flow with backwash water flow from filtration unit has been evaluated and the said flow shall be recycled back to inlet chamber of proposed STP, where it shall be blended with incoming raw sewage from proposed TSPS. Here, the mixed flow characteristics has been evaluated to design Primary clarifier followed by SBR and all relevant sludge handling units accordingly, considering the flow capacity and characteristics derived from mass balance calculation.

After first iteration, to achieve 250 mg/L BOD5 concentration at the inlet of SBR, the Primary clarifier shall be fed with 87.6 MLD flow and remaining 16.5 MLD [= (104.1 – 87.6) MLD] shall be conveyed by separate Parshall flume to the inlet of SBR unit, to achieve efficient BNR process. Moreover, Parshall flume I shall be designed for peak flow of 171.1 MLD [= (204.1 - (16.5\*2)) MLD] and the required design flow for Parshall flume-II shall be 18 MLD (initial flow) x 2.0 PF = 36 MLD. However, Parshall Flume -II is designed for peak flow of 50 MLD, so that sufficient BOD5 can be provided to SBR in case of excessive BOD5 removal in the primary clarifier.