Performance Evaluation of Sewage Treatment Plants in Ganga Front Towns (2019)

Central Pollution Control Board

(Ministry of Environment, Forest & Climate Change)

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CHAPTER 1: INTRODUCTION

1.1 Background

In urban areas, water is tapped from rivers, streams, wells and lakes for domestic and industrial consumptions. Almost 80% of the water consumed for domestic use, comes back as wastewater. In most of the cases untreated wastewater is let out which either sinks into the ground as a potential long-term pollutant of ground water or is discharged into the natural drainage system causing pollution in downstream areas.

The water that emerges after household uses contains, organic materials from food, oils, detergents, dust and dirt from floor, soaps and oils and biological material from human body all these referred to as Grey Water. The water used to flush toilets to evacuate human excreta is called Black Water/ Sewage.

In terms of purification technology, grey water is easier to purify as compared to black water, i.e sewage. In India, both grey water and black water are generally mixed and flow to the inlet sump of sewage treatment plants through the sewerage network in the catchment area and is treated as "Raw Sewage" in the STP.

Chemically, wastewater is composed of organic and inorganic compounds. Organic components may consist of carbohydrates, proteins, fats, greases, surfactants, oils, pesticides, phenols, etc., Inorganic components may consist of heavy metals, nitrogen, phosphorus, sulfur, chlorides etc. The amount of oxygen required by micro-organisms for decomposing the organic matter present in sewage is called Biochemical Oxygen demand (BOD). The amount of oxygen needed to chemically oxidize both organic and inorganic matter present in the same sewage with is called as Chemical Oxygen demand (COD).

Raw sewage may have fecal contamination, which may cause serious problem due to their potential for causing diseases from pathogens (disease causing organisms). Coliforms come from the same sources as pathogenic organisms i.e. faeces of warm-blooded animals and humans. Coliforms are relatively easy to identify, are usually present in larger numbers than more dangerous pathogens, and respond to the environment, wastewater treatment, and water treatment similarly to many pathogens. **Hence, testing for coliform bacteria can be a reasonable indication of whether other pathogenic bacteria are present.** Coliform count is analyzed with reference to Total coliform (TC) and faecal coliform.

High concentration of total suspended solids (TSS) is also a major feature of raw sewage. The visible black colour of raw sewage is mainly because of this high TSS tagging it as black water. The raw sewage may also have strong unpleasant smell caused due to septic condition and stagnancy resulting in hardship and health hazard.

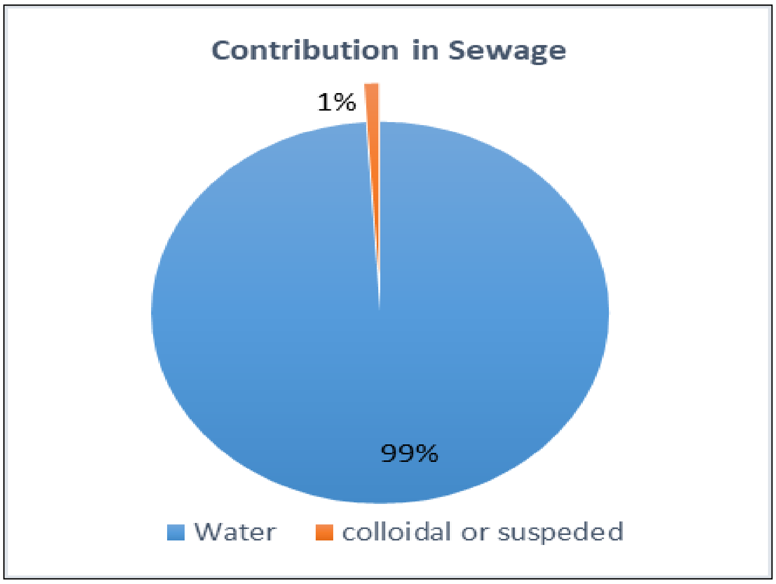

Figure 1: Composition of typical municipal wastewater

Table 1 Physio-Chemical composition of typical municipal wastewater

S. no.	Parameters	Ranges
1	pH	7.15-7.65 unit
2	BOD	200-250 mg/l
3	COD	350-500 mg/l
4	Dissolved Solids	850-1350 mg/l
5	Suspended Solids	350-450 mg/l

In present time, generation and management of all community sewage has become a major problem in densely populated urban areas and far-off rural areas. The generated sewage from the cities and human settlements has the potential of contaminating the surface water such as rivers, lakes and underground water bodies as well as causing serious health effects in human population in the areas living nearby the drains and contaminated rivers.

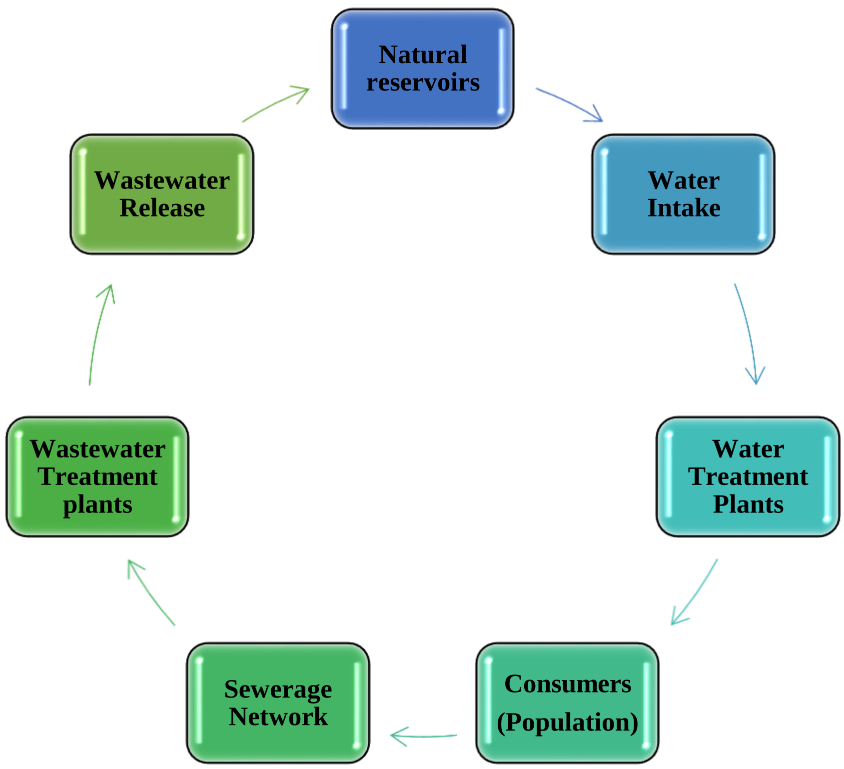

Figure 2: The overall structure of the water system of a metropolis

1.2 Various Treatment technologies

1.2.1 Sewage Treatment Methods

Most of the technologies of Sewage Treatment treats the Wastewater in 3 phases:

A. Pre-treatment Process
B. Primary (Physical/Mechanical Solid removal)
C. Secondary (Biological treatment/bacterial decomposition),
D. Tertiary (Extra filtration& Disinfection)

A. Pre-treatment of sewage involves removal of all solid materials from the raw sewage before they damage or clog the pumps and objects commonly recovered include trash, tree limbs, leaves, branches, glasses, plastic materials and other large objects. This process may also include a sand or grit channel or chamber for the removal of grit or sand, where the velocity of the incoming sewage is adjusted to allow the settlement of sand and grit. Grit removal is necessary to (1) reduce formation of heavy deposits in aeration tanks, aerobic digesters, pipelines, channels, and conduits; (2) reduce the frequency of digester cleaning caused by excessive accumulations of grit; and (3) protect moving mechanical equipment from abrasion and accompanying abnormal wear. B. ***Primary treatment*** removes material that will either float or readily settle out by gravity. It includes the "primary sedimentation tanks" or "primary clarifiers". The tanks are used to settle sludge while grease and oils rise to the surface and are skimmed off.

C. Secondary Treatment or Biological sewage treatment is a process where biological organisms are cultured and allowed to consume the organic matter and multiply their population. Biological organisms secrete enzymes through their cell walls which solubilize the organic matter and the solution is drawn back by organism as food and multiplies their number. The multiplied organisms are settled out and the clear treated sewage is almost free from the organic matter.

D. Tertiary treatment is not always necessary, but disinfection is an important step before discharge of treated sewage. Depending on the end-use of the effluent or for achieving stringent standards for discharge in water bodies, a post-treatment/tertiary filtration treatment step may be required to remove residual suspended solids and/or dissolved constituents followed by disinfection for removal of pathogens.

The biological metabolism can be by any of the following:

A. Aerobic Digestion – by organisms needing oxygen for growth

B. Anaerobic Digestion – by organisms that grow without oxygen

C. Facultative process- Both aerobic and anaerobic system works as per Dissolved Oxygen (DO) level in the system.

A. Aerobic Digestion

The Aerobic system digestion for sewage treatment is carried out by aerobic bacteria which consumes the biodegradable carbonaceous and nitrogenous material and nutrient present in sewage in the presence of oxygen resulting in formation of secondary molecules which can be easily discharged into environment.

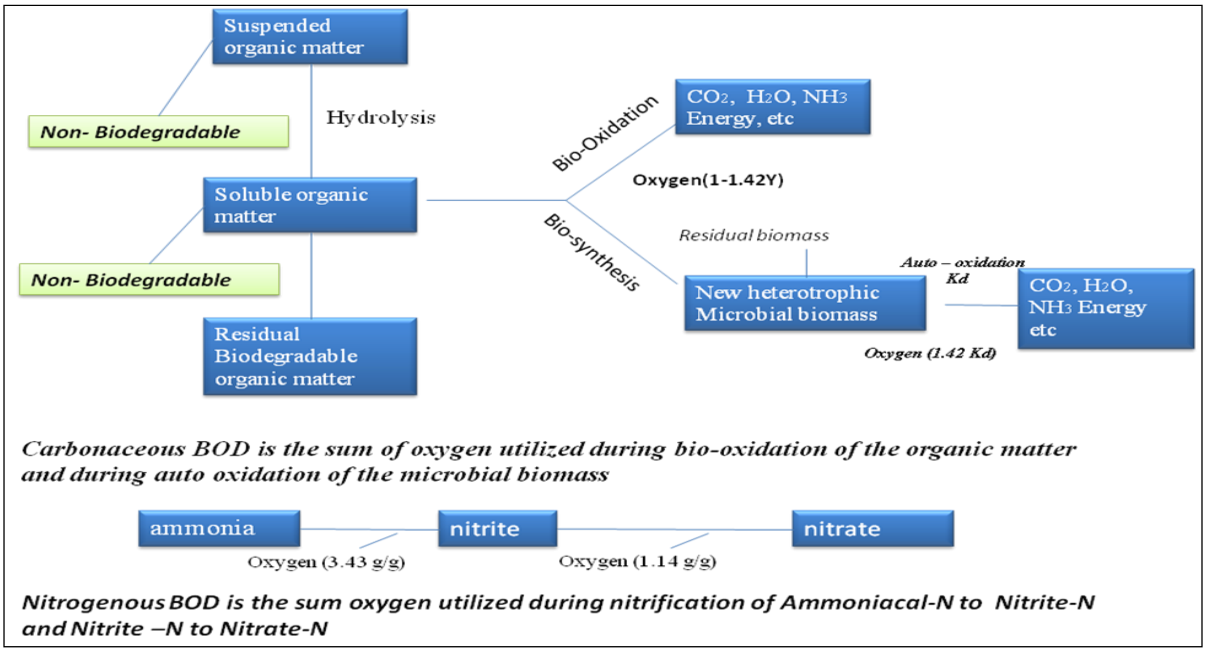

Figure 3: Diagrammatic representation of aerobic degradation of organic matter. *Source: Dr. Akepati S. Reddy, Thapar Centre for Industrial Research & Development, Punjab*

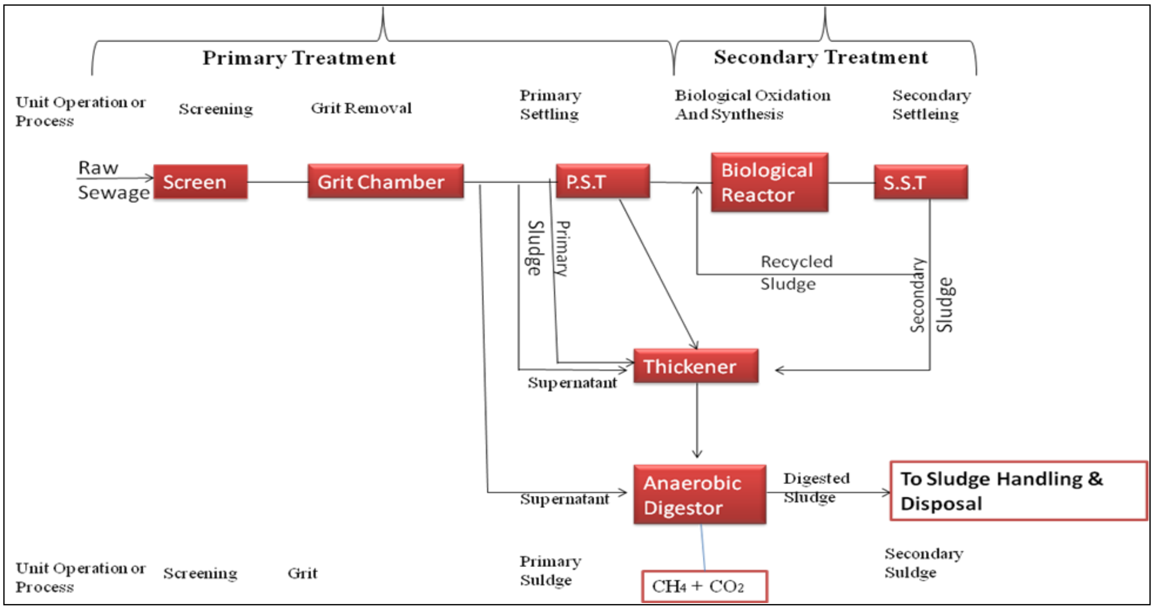

Figure 4: Flow Diagram of Typical Aerobic Mechanized Biochemical Treatment System

The most commonly used aerobic treatment systems are as follows:

Activated Sludge Process (ASP) – It consists of an aeration tank, where organic matter is stabilized by the action of consortium of bacteria (Mixed Liquor - MLSS) under aeration and a secondary sedimentation tank/clarifier (SST), where the biological cell mass is separated from the effluent of aeration tank and the settle sludge is recycled partly to the aeration tank and remaining is wasted and disposed of through sludge handling units.

The important parameters of ASP process are oxygen supply, mixing characteristics, F/M ratio and return activated sludge flow (RAS). BOD & COD reduction up to 95 % can be achieved using ASP. ASP system have many modifications & differ from each other in the manner in which the influent is applied, microorganisms are utilized, and hardware is assembled e.g. Tapered aeration, Extended aeration, Sequencing batch reactor (SBR), Mixed Bed Biofilm Reactor (MBBR) etc.

Sequencing batch reactor (SBR) – The SBR is a type of suspended growth aeration treatment system and consists of a single completely mixed reactor in which all the steps of the activated sludge process occur in batches. The reactor basin is filled within a short duration and then aerated for a certain period of time. After a settling phase the supernatant treated sewage is decanted and disinfected. This process is popular because entire process uses one reactor basin.

Enhanced Nitrogen (N) and Phosphorus (P) removal can be achieved in an SBR. P release and short chain volatile fatty acid (SCVFA) uptake occur during the anaerobic react (stir) operation after fill. P uptake, BOD reduction, and nitrification occur during the aerobic cycle. Denitrification is achieved during the anoxic stir and settling/decant cycles. BOD & COD reduction up to 95 % can be achieved using SBR technology. SBR system can be classified in two type based on feed flow i.e. Conventional SBR and continuous flow SBR.

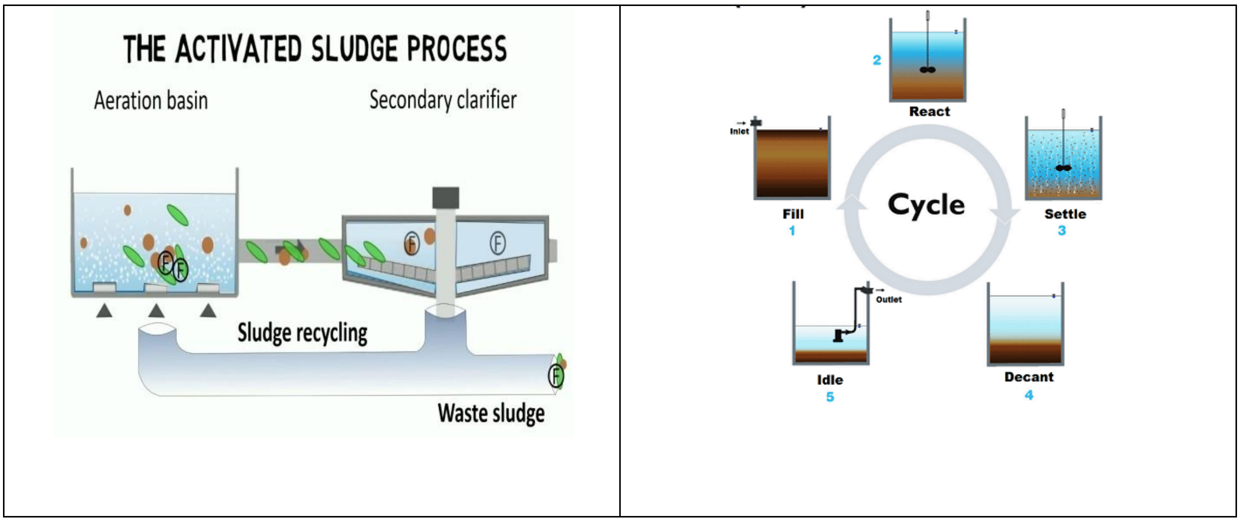

Figure 5: (A) Typical schematic representation of working principle. (B) Schematic representation of working principle of SBR

Figure 6: A STP based on SBR technology at Tapovan, Rishikesh

Moving Bed Biofilm reactor (MBBR) – MBBR process is a type of continuous flow attached growth aeration treatment system. This technology employs thousands of polyethylene biofilm carriers operating in mixed motion within an aerated wastewater treatment basin. Each individual bio-carrier increases productivity through providing protected surface area to support the growth of heterotrophic and autotrophic bacteria within its cells.

MBBR system can be operated with and without sludge recirculation. MBBR process offer some advantages over conventional ASP like increased biomass, reduced volume requirement, lower HRT, high organic loading rate and enhanced nitrification/denitrification in one reactor etc. BOD& COD reduction 80-95 % can be achieved using MBBR technology

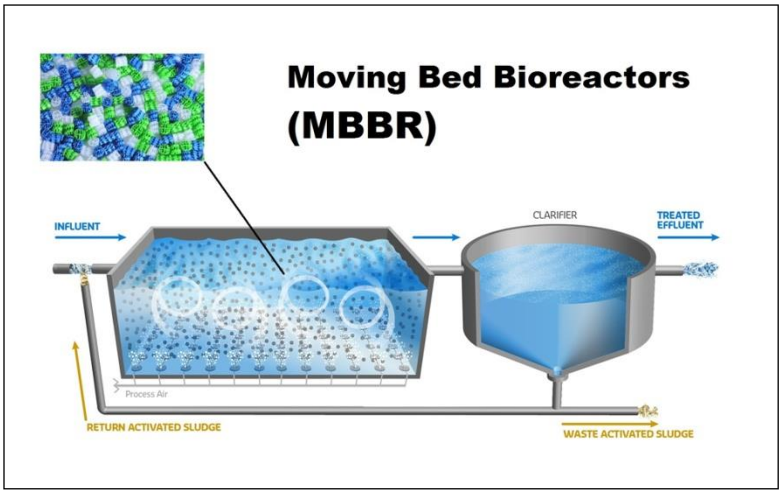

Figure 7: Schematic representation of working principle of MBBR

B. Anaerobic Digestion

Anaerobic digestion is carried out by the organisms which do not require oxygen for metabolism and multiplication. Anaerobic digestion, as a unit process in municipal sewage treatment has been in use since the beginning of this century. Anaerobic treatment itself is very effective in removing of biodegradable organic pollutant leaving mineralised compounds like $NH4^{+}$, $PO4^{-3}$, S^{-2} in the treated effluent. It is employed for stabilization of sludge solids from primary and secondary sedimentation tanks either in closed digesters or open lagoons. In general, the anaerobic biochemical reactions involve four successive stages, namely: (i) hydrolysis, (ii) acidogenesis, (iii) acetogenesis, and (iv) methanogenesis.

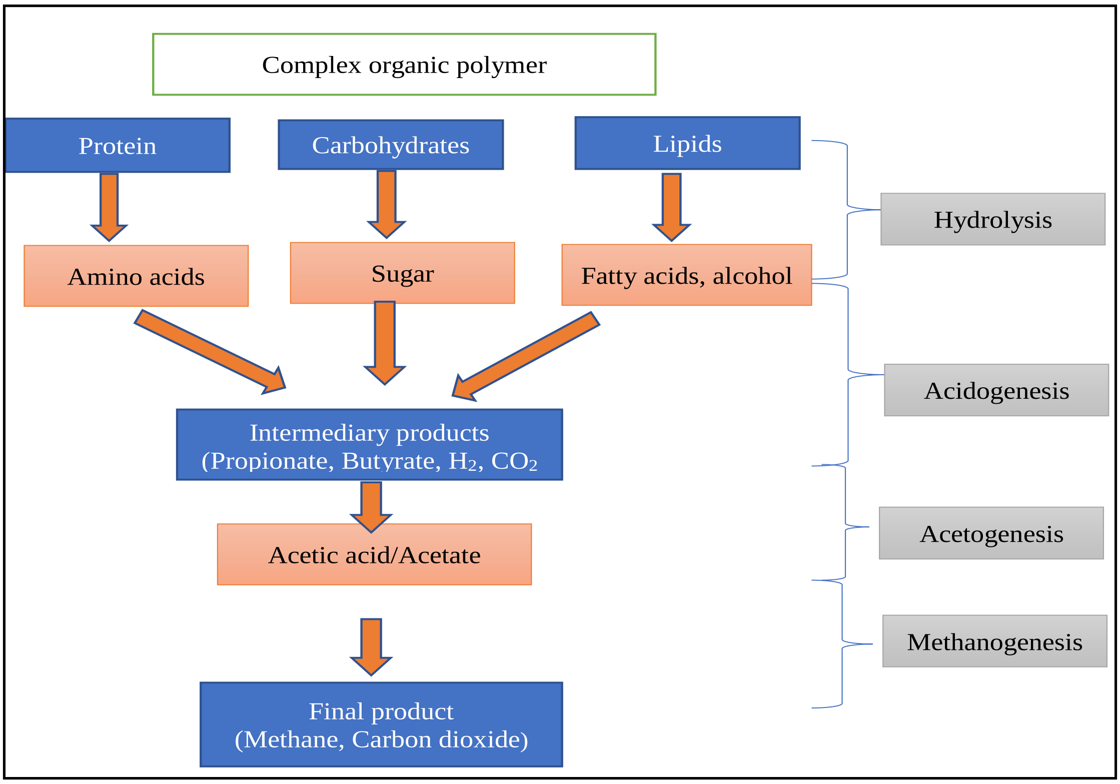

Figure 8: Diagrammatic representation of anaerobic degradation of organic matter

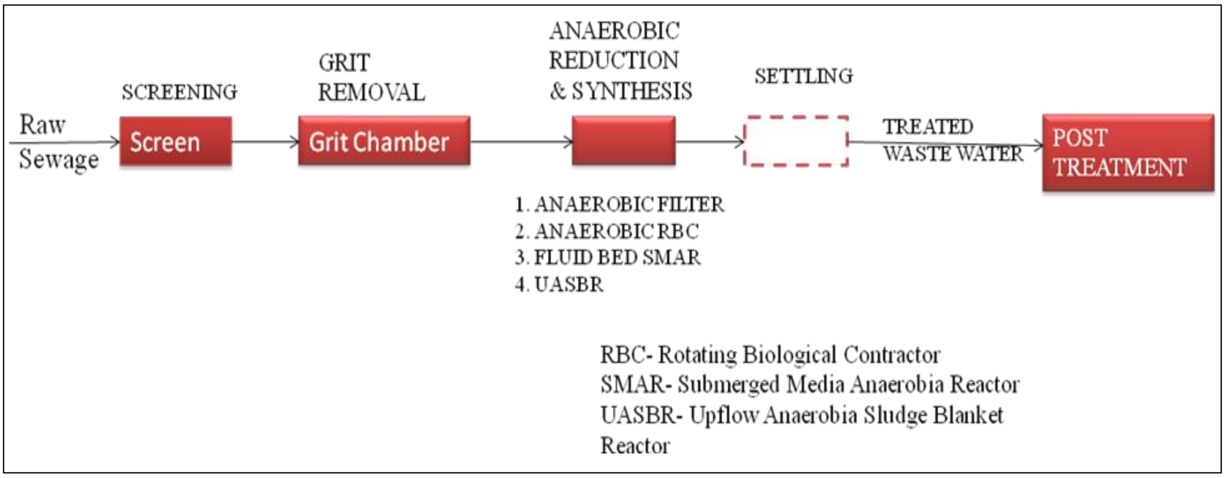

Figure 9: Typical Anaerobic Treatment System Flow diagram

The most commonly used anaerobic treatment systems are as follows:

Up-flow Anaerobic Sludge Blanket (UASB) is a type of suspended growth continuous flow anaerobic digestion system &most widely and successfully used high-rate anaerobic technology for treating several types of wastewater. UASB uses an anaerobic process whilst forming a blanket of granular sludge (size 1-3 mm) which suspends in the tank. Wastewater flows upwards through the blanket and the treatment process takes place by solids entrapment and organic matter conversion into biogas and sludge. The produced biogas bubbles automatically rise to the top of the reactor, carrying water and solid particles, i.e. biological sludge and residual solids. The gases produced cause internal recirculation and upward velocity which keep the granules in suspension.

The design of the UASB reactor combines the features of a high-rate bioreactor with those of an in-built secondary clarifier at the top. In UASB reactors the amount of anaerobic sludge generally is in the range 35-40 kg VSS/m^3 reactor volume (settler included). Wastewater having organic loading rate in the range of 5-20 kg COD/m^3/day can be treated effectively using UASB with 80-95 %reduction in BOD& COD.

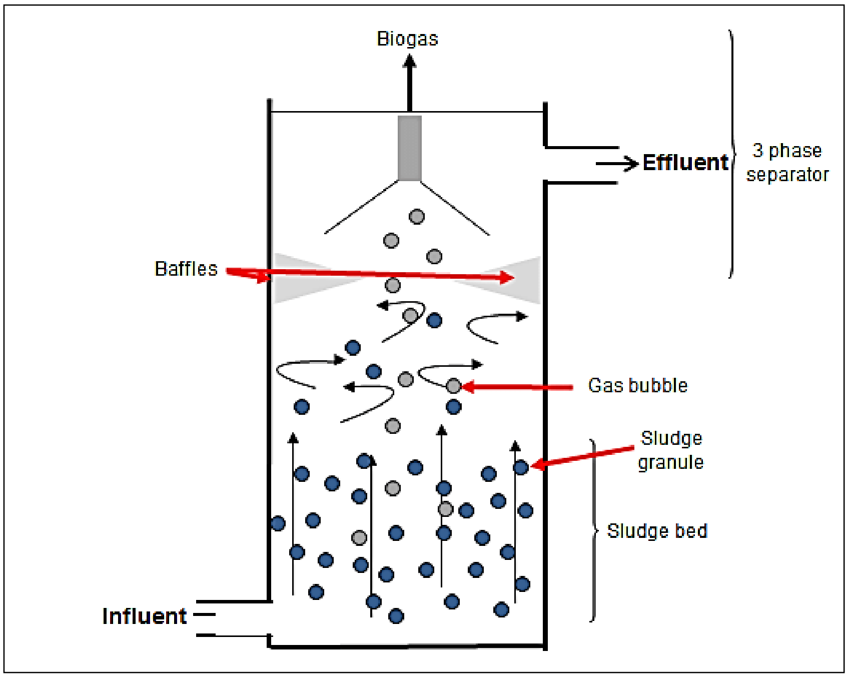

Figure 10: Schematic representation of UASB

C. Facultative Process

Facultative treatment process uses both - aerobic and anaerobic processes of digestion in a single pond and occurs simultaneously. This is confined to stabilization ponds where the upper portion is aerobic and the settled sludge undergoes anaerobic process at the pond bottom.

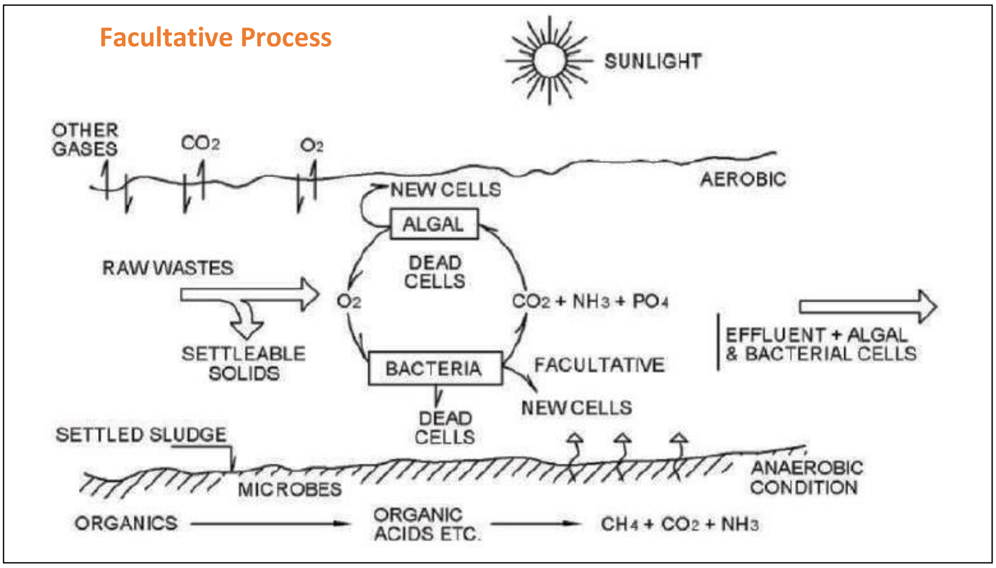

Figure 11: Diagrammatic representation of Facultative Process (CPHEEO, 2013)

The most commonly used facultative treatment system is as follows:

Waste Stabilization Pond (WSP): Waste or wastewater stabilization ponds (WSPs) are large, man-made water bodies in which black water, greywater or faecal sludge are treated by natural occurring processes and the influence of solar light, wind, microorganisms and algae . The ponds can be used individually, or linked in a series for improved treatment. There are three types of ponds, (1) anaerobic, (2) facultative and (3) aerobic (maturation), each with different treatment and design characteristics.

Major source of oxygen are natural reactions and O_2 produce due to photosynthesis. WSPs are low-cost for O&M while BOD and pathogen removal is high. Major disadvantages include; large area, odour problem, insects and ground water contamination. BOD and COD reduction in the range of 50-90% can be achieved using WSP technology.

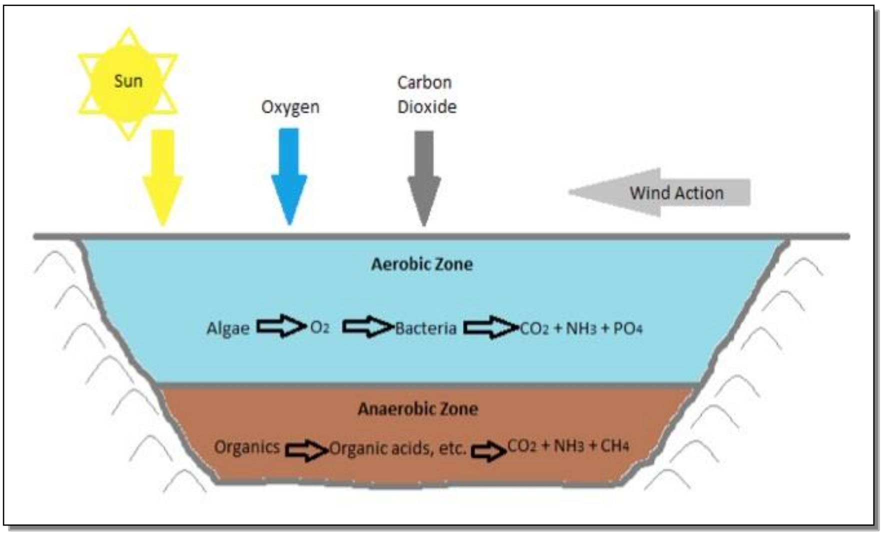

Figure 12: Schematic representation of WSP

1.3 Factors affecting efficiency of STPs

1.3.1 Sludge retention time (SRT): The sludge retention time (SRT) is the average time the activated-sludge solids are in the system. The SRT is an important design and control parameter for the activated-sludge process and is usually expressed in days. SRT of 3-4 days is generally considered good for the optimum functioning of a STP. Selection of sludge age is most fundamental & important decision in the design of activated sludge process. Treatment plant can be classified in three categories i.e. short sludge age (1-5 days), medium sludge age (10-15 days) and long sludge age (> 20 days)

Table 2: Important considerations in the selection of sludge age for the activated sludge system

: **Sludge age**	**Short (1to 5days)**	**Intermediate (10to15 days)**	**Long (>20days)**
Objectives	***COD removal only***	***COD removal, Biological N removal, and /or Biological P removal***	***COD removal, Biological N removal, Biological P removal***
Primary settling	Generally included	Usually included	Usually included
Oxygen demand	Very low	High due to nitrification	Very high due to nitrification and long sludge age
Reactor volume	Very small	Medium to large	Very large
Activated sludge quality	High sludge, very active, stabilization required	Medium sludge, quite active, stabilization required	Low sludge, inactive, no stabilization required
Effluent quality	Low COD High ammonia & phosphate	Low COD Low ammonia & Nitrate, High phosphate	Low COD Low ammonia & Nitrate, Low phosphate
Type	High rate, Step feed, Aerated lagoons, Contact stabilization	Similar to high rate but with nitrification and sometimes denitrification. BNR systems	Extended aeration, SBR BNR systems

1.3.2 Food to mass ratio: The term **Food** to Microorganism **Ratio** (F/M) is actually a measurement of the amount of incoming **food** divided by the mass of Microorganisms in the aeration system. Ideal F: M ratio ranges from 0.1 to 0.6, for the optimum functioning of a STP.

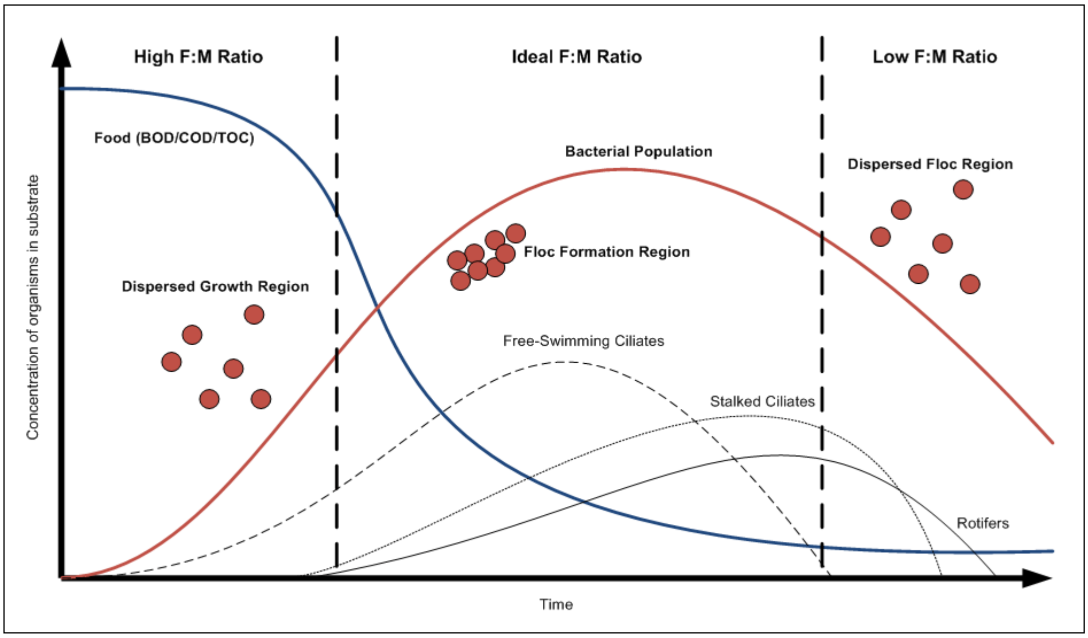

Figure 12: F/M ratio dynamics with respect to time

1.3.3 Sludge volume index: Sludge Volume Index (SVI) is an extremely useful operational parameter to measure in a wastewater treatment process. Sludge Volume Index (SVI) is used to describe the settling characteristics of sludge in the aeration tank in Activated Sludge Process. It is a process control parameter to determine the recycle rate of sludge. If SVI ranges between 100-150 ml/g is considered to be ideal for the proper functioning of a STP. SVI is used as an empirical measure which links the sludge characteristics and settler design.

1.3.4 Aeration: Aeration is the process of adding air into wastewater. Providing oxygen for the bacteria that break down organic matter in wastewater is vital, because it acts as the fuel for the aerobic biodegradation of pollutants. Aeration is an essential process in the majority of wastewater treatment plants and accounts for the largest fraction of plant energy costs, ranging from 45 to 75 % of the plant energy expenditure. Aeration systems transfer oxygen into the liquid media by shearing the liquid surface with a mixer or turbine, or by releasing air through macroscopic orifices or porous materials, or through direct contact of air and a large water surface. While analysing or specifying aeration systems, it is important to define efficiency parameters. These are necessary to compare different technologies, as well as to monitor aeration systems over extended time in operation.

CHAPTER 2: OPERATIONAL STATUS OF SEWAGE TREATMENT PLANT IN GANGA FRONT TOWNS (2019)

2.1 Monitoring of STPs in Ganga front towns

Central Pollution Control Board carries out quarterly monitoring of Sewage Treatment Plants and Common Effluent Treatment Plants installed or commissioned or under construction or under trial in Ganga Front Towns under the PIAS project *of Namami Gange* funded by National Mission for Clean Ganga (NMCG). The present study is based on the STP monitoring carried out during June – December, 2019. Monitoring of STPs in Dehradun city of Uttarakhand was also carried out despite the city not being on the bank of river as river Ganga flows through Raiwala area of Dehradun district and hence the treated effluent reaches the river Ganga through river Bindal Rao via river Song.

The inspected STPs were constructed to treat the domestic sewage by adopting technologies such as activated sludge process (ASP), sequencing batch reactor (SBR), up-flow anaerobic sludge blanket (UASB), moving bed biofilm reactor (MBBR) and waste stabilization pond (WSP). Apart from disposing off in river Ganga, a sizeable amount of treated sewage is used for irrigation purposes, gardening etc.

Table 3: Sewage treatment plants in Ganga front town

S.No.	Treatment system	Total Number	Total Capacity of STPs (MLD)	Names of STPs& Capacity (MLDs)
1.	Activated Sludge process (ASP)	19	698.06	**Uttarakhand (3 nos.)** Tehri (5), IDPL (14), Jagjeetpur (18) **Uttar Pradesh (8 nos.)** Narora NAPS (2.2), Jajmau (130), Jajmau (43), Sajari (42), Naini (80), Dinapur (140), Bhagwanpur (9.8), DLW(12) **Bihar (2)** Beur (20), Saidpur (45) **West Bengal (6)** Titagarh (4.5), Naihati (11.56), Bhatpara (10), Bhatpara (8.5), Garden Reach (5.75), Cossipore (45)
2.	Sequencing batch reactor (SBR)	21	325.52	**Uttarakhand (17)** Gangotri (1), Badrinath (0.26), Joshimath (1.08), Srinagar (1), Sangam Bazar (0.15), Shanti Bazar (0.075), Tapovan (3.5), Swarg Ashram (3), Jagjeetpur (27), Sarai (18), Old Mothrowala (20), New Mothrowala (20), Kargi (68), Jakhan (1), Salawala (0.71), Vijay Colony (0.42), Indira Nagar (5)

				Uttar Pradesh (3) Kannauj (13), Salori (14), Goithaha (120) **West Bengal (1)** Gayeshpur (8.33)
3.	Moving bed biofilm reactor (MBBR)	7	37.06	**Uttarakhand (4)** Gyansu (2), Kirti Nagar (0.05), Srinagar (3.5), Kirtinagar (0.01), **Uttar Pradesh (3)** Anupsahar (1.5) Zone A, Anupsahar (1), Zone B, Salori, Allahabad (29)
4.	Up flow anaerobic sludge blanket (UASB)	7	322	**Uttar Pradesh (7)** Bijnor (24), Brijghat (3), Garh (6), Jajmau (5), Bingawan (210), Rajapur (60), PakkaPokhra (14).
5.	Waste stabilization pond (WSP)	22	174.29	**Uttarakhand (1)** Lakkarghat (6) **Uttar Pradesh (4)** Anupsahar (0.85) Zone A, Anupsahar (1.75) Zone B, Vindhayachal (4) Fatehgarh (2.7) **West Bengal (17)** Titagarh (4.5), Bandipur (22), Baidyabati (6), Kona (30), Panihati (12), Konnagar (22),Berhrampore(3.7), Jiaganj-Azimganj (1.39), Chandannagar (4.5), Bhatpara (0.5), Nabadwip (10.5), KankinaraMadrail, (10), Kalyani (10), Bansberia(1.39), Garulia (7.9), Maheshtala (4), Hatisur (10)
6.	Aerated Lagoon (AL)	4	65.9	**West Bengal (4)** Bhadreswar (7.6), Champadani(0.3), South Suburban (43), Bagahajatin (15)
7.	Electro-coagulation (EC)	11	1.56	**Uttarakhand (11)** Chamoli (0.05), Chamoli (0.76), Forest Nala (0.1), SangamNala (0.05), Near Police Chowki (0.05), Old Bridge (0.1), Near Ward 1 & 3 STP (0.1), Near SBI Bank (0.1), Near Dart Pull (0.075), Army Bend (0.1), AnoopNegi Memorial School (0.075)
8.	Trickling Filter (TF)	5	133.06	**West Bengal (5)** Kamarhati(40), Howrah(45), Serampore (18.9), Chandannagar(18.16), Kalyani Block(11)
9.	Bio – tower technology (BT)	3	85	**Uttar Pradesh (3)** Pongaghat(10), Kodra(25), Numayadahi(50)
10.	Trickling Filter with ASP	1	80	**Uttar Pradesh (1)** Dinapur (80)

11.	Soil Bio-Technology (SBT)	1	1.4	**Uttarakhand (1)** Bah Bazar ,Devprayag (1.4)
13.	Bio-digester (Anaerobic filter)	1	NA	**Uttarakhand (1)** Tekla, Uttarkashi (0.30)
14.	Fixed Bed Biofilm Activated Sludge Process (FBBAS)	1	31	**West Bengal (1)** Jaggadalpura-Bhatpara (31)

2.2 Operation & Maintenance of STPs in Ganga states

2.2.1 Status of STPs in Ganga front town based on 2019 reports (June – December, 2019)

Ganga river directly receives treated/untreated sewage from Ganga front towns of five states - Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. In Ganga front towns, the total sewage generation (2017-18) accounts to approximately 3558.5 MLD. However, the total installed capacity of STPs (December 2019) was 1956.7 MLD and the utilized sewage treatment capacity was1064.2 MLD. There was a gap of 45% in sewage generation and treatment in Ganga front towns. Out of the five states, maximum gap in sewage generation and treatment was found in Bihar (86.5%) followed by West Bengal (65.9%). STPs installed in Bihar were non-operational and no STP was installed in Jharkhand in 2019.

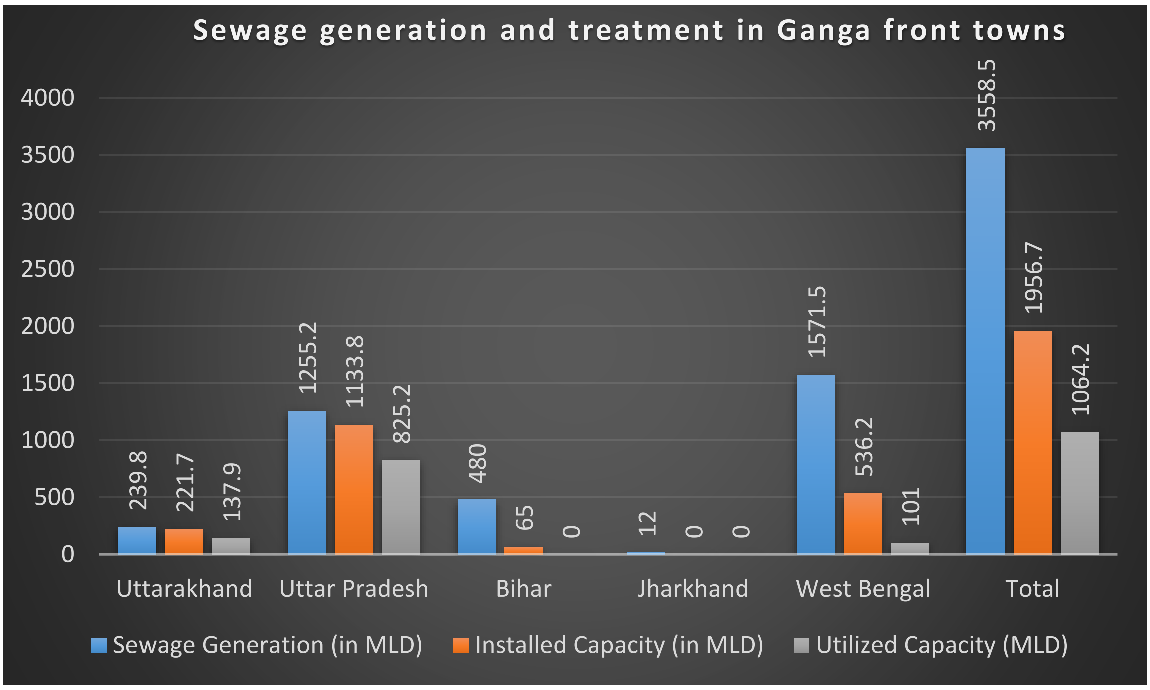

Figure 13: Sewage generation and treatment capacities in Ganga front towns

Out of the total installed capacity of STPs (1956.7 MLD), 1560.5 MLD was operational and 396.2 MLD was non-operational. Maximum installed capacity was in Uttar Pradesh however no STP was installed in Jharkhand. In Jharkhand, STPs were under trial/construction at Sahibganj town (2 STPs of total capacity 12 MLD) and at Rajmahal town (one STP of capacity 3.5 MLD). The STPs in Patna, Bihar are under upgradation and new STPs are under construction. The non-operational capacity of STPs in West Bengal (288.1 MLD) was higher than the operational capacity (248.1 MLD). In Uttarakhand, 99.95% of the installed capacity was operational.

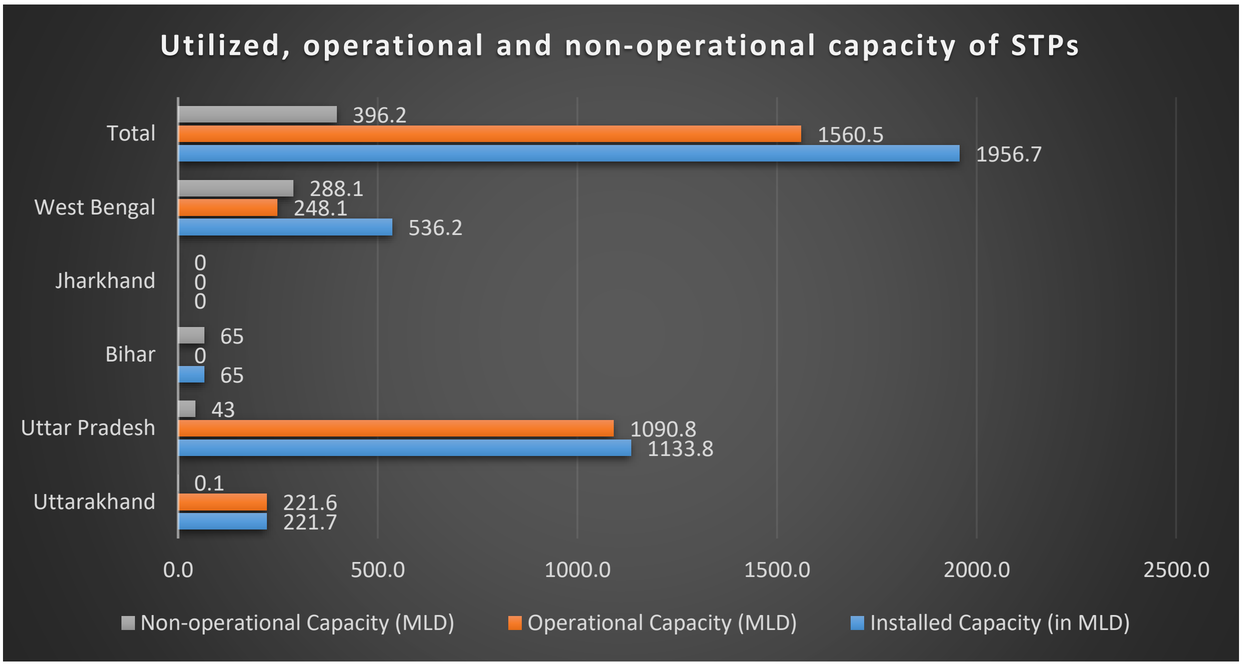

Figure 14: Status of STPs in the five Ganga states w.r.t to treatment capacities.

During year 2019, a total of 103 STPs were monitored. Out of 103, the highest number of STPs were in Uttarakhand (38) followed by West Bengal (34) and Uttar Pradesh (29). Highest number of non-operational STPs was in West Bengal, where 18 out of 38 STPs were found non-operational.

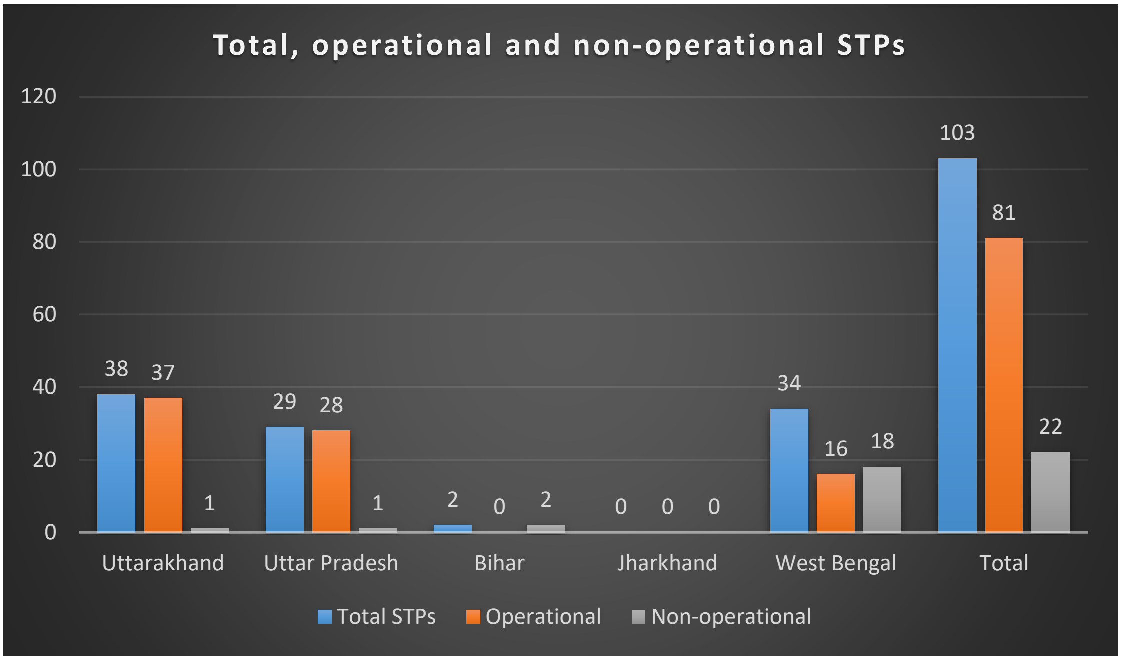

Figure 15: Status of STPs in the five Ganga states.

Based on the characteristics of treated sewage, 70 STPs were complying and 11 were non-complying with respect to general discharge norms. Six STPs in Uttarakhand and five STPs in Uttar Pradesh were non-complying.

CPCB issued Directions under section 18 (1) (b) of Environment (Protection) Act, 1986 to Uttarakhand Pollution Control Board (UKPCB), Uttar Pradesh Pollution Control Board (UPPCB), Bihar State Pollution Control Board (BSPCB) and West Bengal Pollution Control Board (WBPCB) in June, 2019 to take actions against non-complying, non-operational as well as for STPs without valid consent to operate.

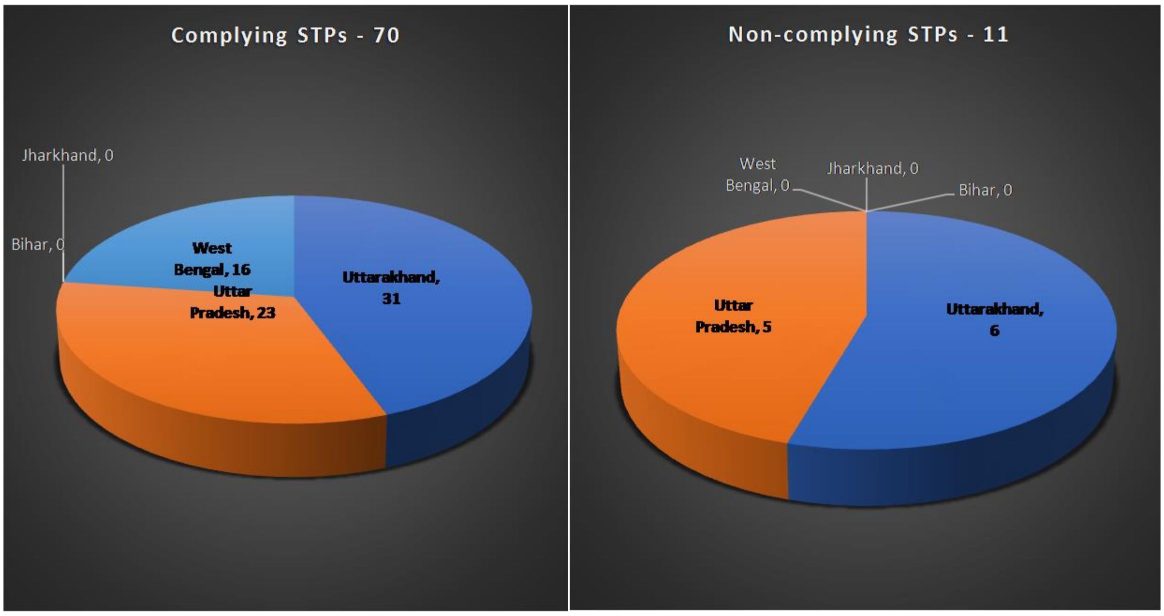

Figure 16: Status of STPs in the five Ganga states.

2.3 Comparative Evaluation of Sewage Treatment Capacity in Ganga Front Towns

The utilized capacity of all monitored STPs was 42% in 2017-18; which increased to 62% in 2018-19 and reported at 60 % in 2019-20.

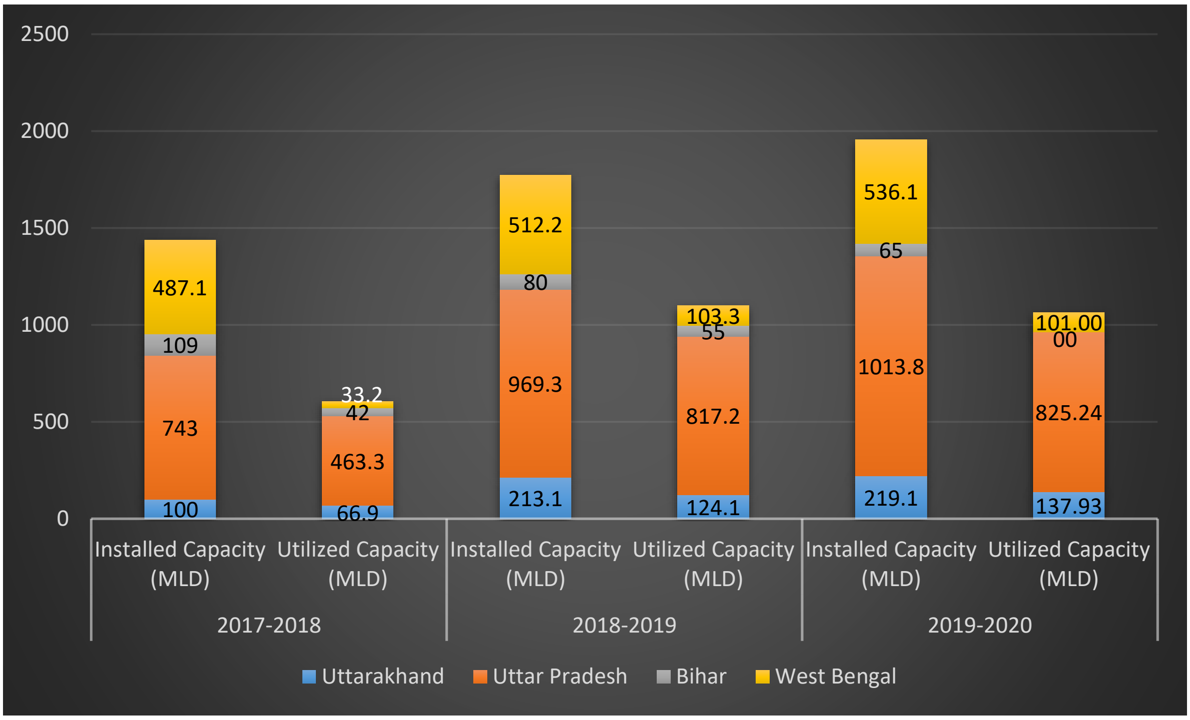

Figure 17: Comparison of treatment capacities (installed and utilised) in the five Ganga states (2019)

The total number of monitored STPs (doesn't include under construction/under trial STPs) has increased over the years from 68 in 2017-18; 82 in 2018-19; 103 in 2019 December.

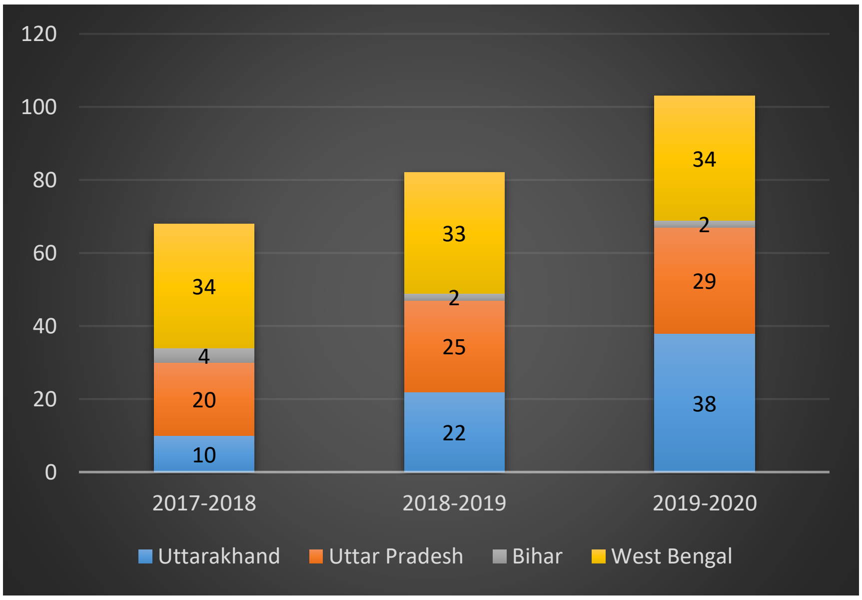

Figure 18: Graphical representation of increase in number of STPs (2017-18 to 2019-2020)

CHAPTER 3
FINDINGS AND STATE WISE SPECIFIC OBSERVATIONS

3.1. Uttarakhand

The state wise specific findings on the basis of inspection carried out during December, 2019 are given as below –

- Uttarakhand has 38 STPs which were monitored by CPCB along 15 Ganga front towns. The plants are managed mainly by UK Jal Nigam and UK Jal Sansthan.
- The entire expenses for the operation and maintenance are borne by Government of Uttarakhand.
- The total installed capacity for monitored STPs was 227.71 MLD, with utilized capacity of 137.93 MLD.
- The treated sewage was discharged into River Ganga and its tributaries.
- OCEMS has been installed in 7 STPs out of 38 STPs whereas others are in process of installation of OCEMS.
- The performance of 6 out 38 STPs was found non- complying with respect to discharge standards and 1 STP was found non – operational.
- The STP at Forest Nala (Nandprayag), Old Bridge (Karanprayag), Near SBI Bank (Rudraprayag), Srinagar, 3.5 MLD (Srinagar), Kirtinagar, 0.01 MLD (Kirtinagar) and Kargi (Dehradun) were found non – complying with respect to discharge standards.
- The STP at Ward 1&3, Karanprayag was found non – operational on the day of visit due to muddy sewage at the inlet.

Table 4: Performance of STPs in Uttarakhand

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity (MLD)	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
General discharge standard					**5.5 – 9.0**		**30**		**250**		**100**		**50**	
1.	**Gangotri 1 MLD**	Gangotri	SBR	0.3	6.4	7.3	131	8	437	27	99	BDL	20×10^6	780
2.	**Tekla (0.3 MLD)**	Uttarkashi	Biodigestor	-	7.1	6.8	80	17	222	70	116	18	14×10^7	49×10^4
3.	**Chamoli 0.76 MLD**	Gopeshwar	EC	-	6.8	7.1	134	18	296	70	105	30	-	-
4.	**Chamoli 0.05 MLD**		EC	-	7.1	6.7	30	9	142	25	28	15	-	-
5.	**Joshimath 1.08 MLD**	Joshimath	SBR	-	7.5	8.4	7	10	28	24	108	13	-	-
6.	**Badrinath 0.26 MLD**	Badrinath	SBR	0.02	7.4	7.5	1120	6	7670	30	10520	BDL	-	-
7.	**Gyansu 2 MLD**	Uttarkashi	MBBR	1.8	6.8	6.7	93	6	241	18	96	BDL	14×10^6	20 × 103

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity (MLD)	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
8.	**Forest Nala 0.10 MLD**	Nandprayag	EC	0.025	-	6.8	-	45	-	149	-	20		2×10^4
9.	**SangamNala 0.05 MLD**		EC	0.025	6.9	7.0	12	15	39	45	24	10	-	$< 18 \times 10^2$
10.	**Police Chowki 0.05 MLD**	Karanprayag	EC	0.05	6.7	6.4	11	6	46	18	< 10	< 10	-	-
11.	**Old Bridge 0.10 MLD**		EC	0.05	6.6	6.8	96	105	210	252	67	96	-	40×10^4
12.	**Ward 1 & 3 0.10 MLD**		EC	-	-	-	-	-	-	-	-	-	-	-
13.	**SBI Bank 0.10 MLD**	Rudraprayag	EC	0.037	7.2	6.	114	64	331	171	69	30	-	92×10^5
14.	**Dart Pull 0.075 MLD**		EC	0.05	6.9	7.1	8	4	56	29	BDL	< 10	-	17×10^3
15.	**Army Bend 0.10 MLD**		EC	-	6.9	6.9	38	4	131	8	40	18	-	27×10^4
16.	**AnoopNegi Memorial School 0.075 MLD**		EC	-	7.2	7.0	62	6	264	15	242	< 10	-	170
17.	**Tehri 5 MLD**	Tehri	ASP	2.5	6.8	6.7	203	BDL	606	15	269	BDL	-	40×10^2
18.	**Srinagar 3.5 MLD**	Srinagar	MBBR	1.6	6.7	6.9	322	55	735	161	621	110	-	11×10^5
19.	**Srinagar 1 MLD**		MBBR	0.5	7.0	6.9	16	11	50	39	122	17	-	78×10^2
20.	**Kirti Nagar 0.05 MLD**	Kirti Nagar	MBBR	0.03	6.6	7.0	199	13	373	26	612	22	-	2×10^4
21.	**Kirtinagar 0.01 MLD**		MBBR	0.01	5.5	6.7	338	91	647	259	211	123	-	17×10^6
22.	**Bah Bazar 1.4 MLD**	Devprayag	SBT	1.4	7.1	7.2	150	30	322	76	191	41	-	-
23.	**Sangam Bazar 0.15 MLD**		SBR	0.15	7.3	7.3	144	5	475	26	151	10	-	-
24.	**Shanti Bazar 0.075 MLD**	Devprayag	SBR	0.03	7.0	7.1	235	30	600	103	309	42	-	-
25.	**Tapovan 3.5 MLD**	Tapovan	SBR	1	7.0	6.5	112	BDL	240	6	120	BDL	-	40×10^2
26.	**Swarg Ashram 3 MLD**	Rishikesh	SBR	2.8	6.8	7.3	122	4	302	18	134	BDL	24×10^9	22×10^4
27.	**Lakkarghat 6 MLD**		WSP	16	6.8	6.8	161	26	385	83	232	26	25×10^9	21×10^5
28.	**IDPL 14 MLD**		ASP	1	6.82	6.91	57	19	147	62	87	33	$> 16 \times 10^{10}$	2×10^5
29.	**Jagjeetpur 27 MLD**	Haridwar	SBR	27	7.0	7.1	231	5	107	18	211	BDL	-	<1.8
30.	**Jagjeetpur 18 MLD**		ASP	18	7.0	7.1	91	4	197	10	158	BDL	-	<1.8
31.	**Sarai Jawalapur 18 MLD**		SBR	18	7.0	6.9	100	10	260	18	337	BDL	-	14×10^3
32.	**Mothrowala New 20 MLD**	Dehradun	SBR	9	7.5	7.1	88	25	246	77	161	16	-	35×10^5
33.	**Mothrowala Old 20 MLD**		SBR	15	7.5	7.6	100	7	238	17	169	16	-	26×10^5
34.	**Kargi 68 MLD**		SBR	15	7.3	7.8	223	11	538	24	523	10	-	93×10^6
35.	**Jakhan 1 MLD**		SBR	0.48	7.3	7.8	330	12	561	32	436	10	-	68×10^5
36.	**Salawala 0.71 MLD**		SBR	0.4	7.3	7.4	245	9	596	24	427	10	-	21×10^4
37.	**Vijay Colony 0.42 MLD**		SBR	0.4	7.4	7.4	191	11	424	31	255	10	-	45×10^5
38.	**Indira Nagar 5 MLD**		SBR	4.5	7.2	7.4	40	3	141	15	88	BDL	-	11×10^5

All parameters are expressed in mg/l except pH and FC – MPN/100ml

3.2 Uttar Pradesh

The state wise specific findings on the basis of inspection carried out during December, 2019 are given as below –

1. Uttar Pradesh has 29 STPs which were monitored by CPCB along 10 Ganga front towns. The plants were managed mainly by UP Jal Nigam.
2. The entire expenses for the operation and maintenance are borne by Government of Uttar Pradesh.
3. Out of total 29 STPs, 5 were found non- complying with respect to discharge standards and 1 was found non-operational.
4. The STPs at Fatehgarh (Farrukhabad), 5 MLD Jajmau STP (Kanpur), Bingawan (Kanpur), Ponghat (Prayagraj) and Kodra (Prayagraj) were found non – complying with respect to discharge standards.
5. The STP at Jajmau 43 MLD (Kanpur) was found non – operational on day of visit.
6. The total installed capacity for monitored STPs was 1133.8 MLD, with utilized capacity of 825.24 MLD.
7. The treated sewage is discharged into River Ganga and its tributaries.

Table 5: Performance of STPs in Uttar Pradesh

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
General discharge standard					5.5 – 9.0		30		250		100		1000	
1.	Bijnor (24 MLD)	Bijnor	UASB	12	7.2	7.7	47	8	150	48	75	BDL	4×10^6	< 1.8
2.	Brajghat (3 MLD)	Garhmukteshwar	UASB	1.5	7.7	7.9	8	5	22	10	82	12	-	680
3.	Garh (6 MLD)		SBR	2.69	7.6	7.6	3	2	13	7	248	BDL	-	< 18
4.	Fatehgarh (2.7MLD)	Farrukhabad	WSP	3	8.1	9.4	108	49.7	246	160	245	119	7.9×10^7	3.3×10^5
5.	Kannauj (13 MLD)	Kannauj	SBR	13	7.6	8.2	18	5.15	60.6	24.6	70.8	27.5	-	1.3×10^5
6.	Jajmau (43 MLD)	Kanpur	ASP	NA	-	-	-	-	-	-	-	-	-	-
7.	Jajmau (130 MLD)		ASP	120	7.3	7.8	150	17.1	461	65.2	455	32	1.6×10^8	2.8×10^7
8.	Jajmau (5 MLD)		UASB	4	7.3	7.4	159	73	370	155	406	38.6	1.6×10^8	1.7×10^7
9.	Bingawan (210 MLD)		UASB	150	7.6	7.7	119	47.6	269	88.3	412	31.3	5.4×10^8	4.9×10^6
10.	Sajari (42 MLD)		ASP	15	7.8	8.0	96	12.9	232	27	253	10.8	9.2×10^8	< 1.8
11.	Salori (29 MLD)	Allahabad	MBBR	11.13	7.3	7.4	37.3	12.6	203	89.8	244	60.3	3.3×10^6	1.7×10^6

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
12.	Salori (14 MLD)		SBR	9.7	7.2	7.4	31.6	BDL	119	9.48	114	5.5	1.3×10^{7}	< 1.8
13.	Rajapur (60 MLD)		UASB	94.34	7.2	7.6	48.1	17.2	180	68.5	192	15.4	4.9×10^{6}	< 1.8
14.	Pongaghat (10 MLD)		BT	7.7	7.4	7.9	100	32.8	188	60	154	41.6	1.6×10^{9}	2×10^{4}
15.	Kodra (25 MLD)		BT	29	7.3	7.4	66.8	33.7	174	90.2	217	12.4	7.9×10^{7}	2 × 104
16.	Naini (80 MLD)		ASP	63.5	7.1	7.4	116	8.75	341	55.3	253	39.5	7.9×10^{6}	7.8×10^{4}
17.	Numayadahi (50 MLD)		BT	68.5	7.3	8.0	73.9	16.2	214	69.3	209	47.3	7.9×10^{7}	< 1.8
18.	PakkaPokhra (14 MLD)	Mirzapur	UASB	18.5	7.1	7.2	71.3	13.3	208	52.2	161	16.9	4.5×10^{5}	2.3×10^{5}
19.	Vindyachal (4 MLD)		WSP	3	6.9	8.2	132	29.7	292	72.6	168	61	4.9×10^{6}	3.3×10^{5}
20.	Dinapur 80 MLD	Varanasi	TF &ASP	83.3	7.1	7.7	90.5	12.6	195	34.7	229	6.6	1.7×10^{8}	3.3×10^{5}
21.	Dinapur 140MLD		ASP	80.54	7.1	7.3	65.9	6.91	234	27.4	167	13.8	3.3×10^{7}	< 1.8
22.	Bhagwanpur (9.8 MLD)		ASP	10.5	7.2	7.6	96.9	15.1	229	37	142	18.2	2.2×10^{8}	7.9×10^{6}
23.	Goithaha (120 MLD)		SBR	30	7.5	7.5	65.6	17.1	170	70.9	156	25	4.9×10^{6}	3.3×10^{5}
24.	DLW(12 MLD)		ASP	3.83	7.4	7.7	20.9	12.7	53.2	30.8	129	10.4	2.2×10^{7}	1.3×10^{5}
25.	Narora (2.27 MLD)	Narora	ASP	2	7.4	7.3	38	6	151	33	138	BDL	16×10^{12}	92×10^{4}
26.	Anupsahar STP Zone A 1.5 MLD	Anupshahr	MBBR	1.5	7.6	7.2	45	10	150	26	79	28	-	17×10^{3}
27.	Anupsahar STP Zone A 0.80 MLD		WSP	0.85	7.3	7.6	25	25	120	120	215	40	-	17×10^{4}
28.	AnupsaharSTP Zone B 1.75 MLD		WSP	1.75	7.2	7.9	124	4	492	38	579	BDL	-	17×10^{2}
29.	AnupsaharSTP Zone B 1.0 MLD		MBBR	1	7.4	7.6	65	17	203	45	137	20	-	27×10^{2}

All parameters are expressed in mg/l except pH and FC – MPN/100ml

3.3 Bihar

In Bihar, 2 STPs were monitored by CPCB and both were found non – operational.

Table 6: Performance of STPs in Bihar

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
General discharge standard					**5.5 – 9.0**		**30**		**250**		**100**		**-**	
1.	**Beur (35 MLD)**	Patna	ASP	NA	**Non - Operational**									
2.	**Saidpur (45 MLD)**		ASP	NA	**Non - Operational**									

All parameters are expressed in mg/l except pH and FC – MPN/100ml

3.4 West Bengal

The state wise specific findings on the basis of inspection carried out are given as below –

- West Bengal has 34 STPs which were monitored by CPCB along 22 Ganga front towns.
- 18 out 29 STPs were found non – operational at time of inspection.
- The reason of high no. of non-operational STPs are: Poorly maintained ponds resulting in Eutrophication, High weed growths, broken walls, floating solid waste etc., de-sludging has not been carried out since long time, no or less sewage was received at inlet due to poor sewerage network or non-functioning of MPS, corroded/damaged equipment of plants, unsatisfactory method of sludge disposal etc.
- The total installed capacity for monitored STPs was 536.17 MLD, with utilized capacity of 101 MLD.

Table 7: Performance of STPs in West Bengal

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
General discharge standard					5.5 – 9.0		30		250		100		1000	
1.	**Titagarh (ASP) (4.5 MLD)**	Titagarh	ASP	4.5	6.7	6.8	106	28	316	76	378	48	78×10^5	28×10^5
2.	**Titagarh (WSP) (4.5 MLD)**		WSP	4.5	6.7	6.8	106	28	316	76	378	48	78×10^5	28×10^5
3.	**Bandipur (14 MLD)**		WSP	NA	**Non - Operational**									
4.	**Bansberia (0.3 MLD)**	Bansberia	WSP	NA	**Non - Operational**									
5.	**Kamarhati (60 MLD)**	Kamarhati	TF	NA	**Non - Operational**									
6.	**Garulia (4.1 MLD)**	Garulia	WSP	NA	**Non - Operational**									
7.	**Maheshtala (4 MLD)**	Maheshtala	WSP	NA	**Non - Operational**									
8.	**Bhadreswar (7.6 MLD)**	Bhadreshwar	AL	5.5	6.9	7.3	88	26	128	80	146	26	13×10^6	92×10^3
9.	**Baidyabati (6 MLD)**	Baidyabati	WSP	5	7.3	7.5	28	6	88	64	19	13	7×10^6	21×10^2
10.	**Howrah (Arupara) (45 MLD)**	Howrah	TF	NA	**Non - Operational**									
11.	**Kona (30 MLD)**		WSP	NA	**Non - Operational**									
12.	**Champadani (0.3 MLD)**	Champdani	AL	NA	**Non - Operational**									
13.	**Panihati (12 MLD)**	Panihati	WSP	NA	**Non - Operational**									
14.	**Gayeshpur, Halishar&Kanchrapara (8.33 MLD)**	Kanchrapara	SBR	1.5	6.9	7.6	50	9	112	48	63	28	35×10^6	< 1.8
15.	**Serampore (18.9 MLD)**	Serampore	TF	NA	**Non - Operational**									
16.	**Konnagar (Rishra) (22 MLD)**	Konnagar	WSP	NA	7.69	8.2	21	7	40	16	17	14	35×10^4	230

S.No	Name of STP (Installed capacity in MLD)	City/Town	Technology	Utilised Capacity	Analysis result of treated sewage									
					pH		BOD		COD		TSS		FC	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
17.	**Berhrampore (3.7 MLD)**	Murshidabad	WSP	NA	**Non - Operational**									
18.	**Jiaganj, Azimpur (1.39 MLD)**	Jiaganj-Azimganj	WSP	NA	**Non - Operational**									
19.	**Naihati (11.56 MLD)**	Naihati	ASP	7	7.1	8.2	60	3	204	36	332	44	13×10^6	<1.8
20.	**Chandannagar**	Chandannagar	WSP	4.5	7.2	9.2	17	8	68	32	55	21	49×10^5	17×10^2
21.	**Chandannagar**		TF	16.5	7.2	7.7	17	9	68	20	55	13	49×10^5	33×10^2
22.	**Bhatpara-Jagaddal (10 MLD)**	Bhatpara	ASP	NA	**Non - Operational**									
23.	**Jagaddal, Bhatpara (8.5 MLD)**		ASP	NA	**Non - Operational**									
24.	**Jaggadal – Bhatpara (31 MLD)**		FBBAS)	20	6.8	7.1	67	2.5	116	24	166	26	49×10^5	33×10^2
25.	**Jaggadal – Bhatpara (0.5 MLD)**		WSP	NA	**Non - Operational**									
26.	**Kankinara, Madrail (10 MLD)**		WSP	NA	**Non - Operational**									
27.	**Garden Reach (57.5 MLD)**	Kolkata	ASP	NA	**Non - Operational**									
28.	**Cossipore, Chitpur, Bangur (45 MLD)**		ASP	NA	7.3	7.7	32	8	100	36	22	10	13×10^6	<1.8
29.	**South Suburban /Kearapukur, Haridevpur (43 MLD)**	South Suburban	AL	NA	7	8.4	66	15	136	4	148	14	49×10^5	17×10^2
30.	**Bagahajatin (15 MLD)**	Kolkata	AL	NA	**Non - Operational**									
31.	**Hatisur (10 MLD)**		WSP	3.5	7	7.5	55	20	80	40	29	25	33×10^6	16×10^5
32.	**Nabadwip (10.5 MLD)**	Nabadwip	WSP	10.5	7.31	8.69	36	15	162	65	155	60	68×10^6	790
33.	**Kalyani Block-B2,B3 (11MLD)**	Kalyani	TF	11	7	7.8	112	18	148	80	297	32	13×10^7	80
34.	**Kalyani Town area (10 MLD)**		WSP	10	7	7.8	112	6	148	44	297	16	13×10^7	140

All parameters are expressed in mg/l except pH and FC – MPN/100ml

Table 8: Status of Sewage Treatment and Utilized Capacity against Sewage Generation from Ganga Front Towns Monitored under PIAS

State	Estimated Sewage generation (MLD) 2017-18	2017-2018			2018-2019			2019-2020		
		Number of STP	Installed Capacity (MLD)	Utilized Capacity (MLD)	Number of STP	Installed Capacity (MLD)	Utilized Capacity (MLD)	Number of STP	Installed Capacity (MLD)	Utilized Capacity (MLD)
Uttarakhand	239.8	10	100.0	66.9	22	213.1	124.1	38	221.71	137.93
Uttar Pradesh	1255.2	20	743.0	463.3	25	969.3	817.2	29	1133.8	825.24
Bihar	480.0	4	109.0	42.0	2	80.0	55.0	02	65	00
Jharkhand	12.0	0	0.0	0.0	0	0.0	0.0	0	0	0
West Bengal	1571.5	34	487.1	33.2	33	512.2	103.3	34	536.17	101.00
Total	**3558.5**	**68**	**1439.1**	**605.3**	**82**	**1774.6**	**1099.6**	**103**	**1848.9**	**1155.19**

Note:

- No STP was commissioned in Ganga front town of Jharkhand, two STPs were under construction: Sahibganj town (2 STPs total capacity of 12 MLD) and at Rajmahal town (one STP of capacity 3.5 MLD).
- No STP was operational in Ganga front town of Bihar during 2019.
- The data for sewage generation is approximate and based on data provided by respective SPCBs for the year 2017-18.
- Large number of non-functional STPs in West Bengal has proposed plan for upgradation and rehabilitation.

CHAPTER 4
EFFICIENCY OF VARIOUSTREATMENT TECHNOLOGIES

4.1 Activated sludge process (ASP): The efficiency of the STPs working on ASP technology has been tabulated in the table 8. The following observations can be made from the table:

1. The efficiency w.r.t to Biochemical oxygen demand (BOD) was found to range between 66.67%- 100%. The highest efficiency was observed at Tehri STP.
2. For COD the STPs running with ASP technology were found to show efficiency between 57%-97.52 % where Tehri STP was found to have highest efficiency
3. For TSS the STPs were found to show efficiency between 54.5% - 97% where Bhagwanpur STP, Varanasi was found to have highest efficiency at 97% while Cossipore, Chitpur, Bangur STP showed lowest efficiency.

Table 9: Table showing efficiency of STP running with ASP technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	Tehri (5 MLD)	Tehri	100	97.5	100
2.	IDPL (14 MLD)	Rishikesh	66.7	57.8	62.1
3.	Jagjeetpur (18 MLD)	Haridwar	95.6	94.92	100
4.	Jajmau (43 MLD)	Kanpur	Non-operational		
5.	Jajmau (130 MLD)		88.6	85.9	92.9
6.	Sajari (42 MLD)		86.6	88.4	95.7
7.	Naini (80 MLD)	Allahabad	92.5	83.8	84.4
8.	Dinapur 140MLD	Varanasi	89.5	88.3	91.7
9.	Bhagwanpur (9.8 MLD)		84.4	83.8	87.2
10.	DLW(12 MLD)		39.2	42.1	91.9
11.	Narora (2.27 MLD)	Narora	84.2	78.1	100
12.	Beur (35 MLD)	Patna	Non-operational		
13.	Saidpur (45 MLD)		Non-operational		
14.	Titagarh (ASP) (4.5 MLD)	Titagarh	73.6	75.9	87.3
15.	Naihati (11.56 MLD)	Naihati	95	82.4	86.7
16.	Bhatpara-Jagaddal (10 MLD)	Bhatpara	Non-operational		
17.	Jagaddal, Bhatpara (8.5 MLD)		Non-operational		
18.	Garden Reach (57.5MLD)	Kolkata	Non-operational		
19.	Cossipore, Chitpur, Bangur (45 MLD)		75	64	54.5

Note: In case of outlet value as BDL the efficiency is calculated as 100%

4.2 SBR Technology: The efficiency of the STPs working on the SBR technology has been tabulated in the table9. The following can be inferred from the table:

1. Efficiency of the above technology ranges for BOD is found to range between 31%-99% with highest efficiency of BOD removal at Badrinath STP 0.26 MLD.
2. Efficiency of SBR was found to vary between 14%-95% with respect to COD
3. With respect to TSS, the efficiency of the STPs ranged between 55% and 98%.

Table 10: Table showing reduction efficiency of STP running with SBR technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	**Gangotri (1 MLD)**	Gangotri	93.9	93.8	-
2.	**Joshimath (1.08 MLD)**	Joshimath	-	14.2	88
3.	**Badrinath (0.26 MLD)**	Badrinath	99.5	99.6	-
4.	**Srinagar (1 MLD)**	Srinagar	31.3	22	86.1
5.	**Sangam Bazar (0.075**	Devprayag	96.5	94.5	93.4
6.	**Shanti Bazar (0.05**		87.2	82.8	86.4
7.	**Tapovan (3.5 MLD)**	Tapovan (Rishikesh)	-	97.5	-
8.	**Swarg Ashram (3 MLD)**	Rishikesh	96.7	94.0	-
9.	**Jagjeetpur (27 MLD)**	Haridwar	97.8	83.2	-
10.	**SaraiJawalapur (14 MLD)**		90	93.0	-
11.	**Mothrowala New(20 MLD)**	Dehradun	71.6	68.7	90.1
12.	**Mothrowala Old (20 MLD)**		93	92.8	90.5
13.	**Kargi (68 MLD)**		95.1	95.5	98.1
14.	**Jakhan (1 MLD)**		96.4	94.3	97.7
15.	**Salawala (0.71 MLD)**		96.3	95.9	97.6
16.	**Vijay Colony(0.42 MLD)**		94.3	92.7	96.1
17.	**Indira Nagar (5 MLD)**		92.5	89.4	-
18.	**Kannauj (13 MLD)**	Kannauj	71.4	59.4	61.2
19.	**Salori (14 MLD)**	Allahabad	-	92.0	95.2
20.	**Goithaha (120 MLD)**	Varanasi	73.9	58.3	84
21.	**Gayeshpur, Halishar&Kanchrapara (8.33 MLD)**	Kanchrapara	82	57.1	55.6

4.3 Waste stabilization pond (WSP): The efficiency of the STPs working on the WSP technology has been tabulated in the table10. The following observations can be made from the table

1. Efficiency of the above technology for BOD was found to range between 53% and 97% with highest efficiency of BOD removal at Anupshahar 1.75 MLD STP.
2. Efficiency of WSP was found to vary between 34 % and 92% with respect to COD.
3. With respect to TSS, the efficiency of the STPs ranged from 51% to 100%.

Table 11: Table showing reduction efficiency of STP running with WSP technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	**Lakkarghat (6MLD)**	Rishikesh	83.9	78.4	88.8
2.	**Fatehgarh (2.7MLD)**	Farrukhabad	54	35	51.4
3.	**Vindyachal (4 MLD)**	Mirzapur	77.5	75.1	63.7
4.	**Anupsahar STP Zone A (0.80 MLD)**	Anupshahar	0	0	81.4
5.	**AnupsaharSTP Zone B (1.75 MLD)**		96.8	92.3	100
6.	**Titagarh (WSP) (4.5 MLD)**	Titagarh	73.6	75.9	87.3
7.	**Bandipur (14 MLD)**	Titagarh	Non- operational		
8.	**Bansberia (0.3 MLD)**	Bansberia	Non- operational		
9.	**Garulia (4.1 MLD)**	Garulia	Non- operational		
10.	**Maheshtala (4 MLD)**	Maheshtala	Non- operational		
11.	**Baidyabati (6 MLD)**	Baidyabati	78.6	27.2	31.6
12.	**Kona (30 MLD)**	Howrah	Non- operational		
13.	**Panihati (12 MLD)**	Panihati	Non- operational		
14.	**Konnagar (Rishra) (22 MLD)**	Konnagar	66.7	60	17.7
15.	**Berhrampore (3.7 MLD)**	Murshidabad	Non- operational		
16.	**Jiaganj, Azimpur (1.39 MLD)**	Jiaganj-Azimganj	Non- operational		
17.	**Chandannagar**	Chandannagar	52.9	52.9	61.8
18.	**Jaggadal – Bhatpara (0.5 MLD)**	Bhatpara	Non- operational		
19.	**Kankinara, Madrail (10 MLD)**	Bhatpara	Non- operational		
20.	**Hatisur (10 MLD)**	Kolkata	63.7	50	13.8
21.	**Nabadwip (10.5 MLD)**	Nabadwip	58.38	59.9	61.2
22.	**Kalyani Town area (10 MLD)**	Kalyani	94.6	70.3	94.6

Note: In case of outlet value as BDL the efficiency is calculated as 100%

4.4 Up flow anaerobic sludge blanket (UASB): The efficiency of the STPs working on the UASB technology has been tabulated in the table11. Following observations can be made from the table:

1. Efficiency of the above technology for BOD was found to range between 33% - 83%.
2. Efficiency of UASB was found to vary between 46%- 75 % with respect to COD.

3. With respect to TSS, the efficiency of the STPs ranged between 85.36 % and 92%.

Table 12: Table showing reduction efficiency of STP running with UASB technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	**Bijnor (24 MLD)**	Bijnor	83	68	-
2.	**Brajghat (3 MLD)**	Garhmukteshwar	37.5	54.5	85.4
3.	**Garh (6 MLD)**		33.3	46.2	-
4.	**Jajmau (5 MLD)**	Kanpur	54.1	58.1	90.5
5.	**Bingawan (210 MLD)**		60	67.2	92.4
6.	**Rajapur (60 MLD)**	Allahabad	64.2	61.9	92
7.	**PakkaPokhra (14 MLD)**	Mirzapur	81.3	74.9	89.5

4.5 Moving Bed Biofilm reactor (MBBR): The efficiency of the STPs working on MBBR technology has been tabulated in the table12. The following observations can be made from the table

1. Efficiency of the above technology ranges for BOD was found to range between 66 % and 94%.
2. Efficiency of MBBR system was found to vary between 55 % and 93 % with respect to COD.
3. With respect to TSS, the efficiency of the STPs ranged from 41% to 100%.

Table 13: Table showing reduction efficiency of STP running with MBBR technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	**Gyansu (1 MLD)**	Uttarkashi	93.5	92.5	100
2.	**Srinagar (3.5 MLD)**	Srinagar	82.9	78.1	82.3
3.	**Kirti Nagar (0.05 MLD)**	Kirti Nagar	93.5	93.0	96.4
4.	**Kirtinagar (0.01 MLD)**		73.1	60	41.8
5.	**Salori (29 MLD)**	Allahabad	66.2	55.8	75.3
6.	**Anupsahar STP Zone A (1.5 MLD)**	Anupshahr	77.8	82. 7	64. 6
7.	**Anupsahar STP Zone B (1.0 MLD)**		73.8	77.8	85.4

Note: In case of outlet value as BDL the efficiency is calculated as 100%

4.6 Electro-coagulation (EC): The efficiency of the STPs working on the EC technology has been tabulated in the table 13. Following observations can be made from the table

1. Efficiency of the above technology ranges for BOD is found to range between 43% and 90 %

2. Efficiency for COD reduction was found to vary between 48 % and 94 %
3. With respect to TSS, the efficiency of the STPs ranged from 46% to 96%.

Table 14: Table showing reduction efficiency of STP running with Electro-coagulation technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Analysis result of treated sewage		
			BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	Chamoli (0.76 MLD)	Gopeshwar	86.6	76.4	71.4
2.	Chamoli (0.05 MLD)		70	82.4	46.4
3.	Forest Nala (0.10 MLD)	Nandprayag	Untreated sewage at inlet not collected		
4.	SangamNala (0.05 MLD)		-	-	58.3
5.	Police Chowki (0.05MLD)	Karanprayag	45. 5	60.9	90
6.	Old Bridge (0.10 MLD)		-	-	-
7.	Ward 1 & 3 (0.10 MLD)		Non-operational		
8.	SBI Bank (0.10 MLD)	Rudraprayag	43.8	48. 7	56.5
9.	Dart Pull (0.075 MLD)		50	48.2	-
10.	Army Bend (0.10 MLD)		89.5	93.9	55
11.	AnoopNegi Memorial School (0.075 MLD)		90.3	94.3	95.9

Table 15: Table showing reduction efficiency of STP running with other technology

S. No	Name of STP (Installed capacity in MLD)	City/Town	Other Technologies	Analysis result of treated sewage		
				BOD Reduction (%)	COD Reduction (%)	TSS Reduction (%)
1.	Tekla (0.3 MLD)	Uttarkashi	Biodigestor	78.8	68.5	84.5
2.	Bah Bazar (1.4 MLD)	Devprayag	SBT	80	76.4	78.5
3.	Pongaghat (10 MLD)	Allahabad	BT	67.2	68.1	73
5.	Kodra (25 MLD)		BT	49.5	48.2	94.3
8.	Numayadahi (50 MLD)		BT	78.1	67.6	77.4
9.	Dinapur(80 MLD)	Varanasi	TF &ASP	86.1	82.2	97.1
10.	Kamarhati (60 MLD)	Kamarhati	TF	Non-operational		
11.	Bhadreswar (7.6 MLD)	Bhadreshwar	AL	70.4	37.5	82.1
12.	Howrah (Arupara) (45	Howrah	TF	Non-operational		
13.	Champadani (0.3 MLD)	Champdani	AL	Non-operational		
14.	Serampore (18.9 MLD)	Serampore	TF	Non-operational		
15.	Chandannagar (18.6 MLD)	Chandannagar	TF	47.1	70.6	76.4
16.	Jaggadal – Bhatpara (31 MLD)	Bhatpara	FBBAS)	96.3	79.3	84.3
17.	South Suburban /Kearapukur, Haridevpur (	South Suburban	AL	77.3	97.1	90.5
18.	Bagahajatin (15 MLD)	Kolkata	AL	Non-operational		

CHAPTER 5
CONCLUSION

The study was done to assess the performance evaluation and compliance verification of sewage treatment plants installed in Ganga front towns. There are various technologies in use for the treatment of raw sewage before their discharge into surface water system viz. biological treatment and non-biological systems. The biological treatment systems use either the aerobic, anaerobic or facultative digestion method to degrade the organic content present in the raw sewage followed by tertiary treatment at many plants and ultimately discharges the treated sewage after disinfection to control the number of pathogenic organism within limits. However, non-biological treatment system such as electro-coagulation technology based system is also installed at some towns which use electrochemical technology followed by tertiary treatment and ozone based disinfection system. During the present study, analysis of different treatment technologies was carried out for their treatment efficiency. Some of the important conclusory remarks are as follows -

- The utilized capacity of all monitored STPs has increased over past three years, which was 42% in 2017-18; and increased to 62% in 2018-19 and reported as 60 % in 2019-20. The total number of monitored STPs has increased over the years from 68 in 2017-18; 82 in 2018-19 and 103 in 2019-20.
- In state of Uttarakhand, 31 out of 38 STPs were found complying with respect to discharge standards and 1 STP was found non – operational. In Uttar Pradesh, 24 out of 29 STPs were found complying with respect to discharge standards. Both STPs of Bihar were found to be non-operational at the time of inspection. 18 out of29 STPs of West Bengal were found to be non – operational at the time of inspection.
- In Bihar and West Bengal, most of the STPs were either under-construction/ up-gradation under the *Namami Gange* Programme. Recently, 2 STP in Bihar with a total of 80 MLD capacity (43 MLD Beur STP and 37 MLD Karmalichak STP) were made operational.
- The efficiency of SBR technology was found to be higher than other technologies in terms of removal of organic pollutants from raw sewage. Though ASP and OP

technologies have shown slightly lower efficiency than that of SBR technology, have promising efficiency to reduce the pollution load of raw sewage, the main objective of sewage treatment.

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