BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,
Principal Bench, New Delhi

O.A. No. 773/2022

Rajesh Pareek — Applicant

Vs.

State of Uttar Pradesh — Respondent

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(P.K. Mishra)
Scientist 'F'
Central Pollution Control Board
Delhi-110032

Date: 29.11.2023
Place: Delhi

REPORT FILED BY CENTRAL POLLUTION CONTROL BOARD IN THE MATTER OF OA NO. 773 OF 2022 TITLED RAJESH PAREEK VS STATE OF UTTAR PRADESH

1.0 BACKGROUND

The Hon'ble NGT in the matter of Rajesh Prateek Vs State of Uttar Pradesh (in OA No 773 of 2022) in its order dated 11/4/2023 directed the following:

> *"Para 6: ……In the course of chlorination for disinfection, density of chlorine with corresponding BOD values need proper standardization so as to control formation of tri-halomethane (THM). CPCB may specifically examine this aspect. Phyto-remediation is claimed to have been undertaken without showing its results which may be merely an excuse to waste public money which needs to be checked by the statutory regulators including CPCB. CPCB may fileits report within three months".*

In compliance to above-said direction, CPCB has submitted interim report before the Hon'ble NGT and Hon'ble NGT in its order dated 05/10/2023 had further directed as under:

> *"Para 4: ……. CPCB is also directed to conclude the study and place the complete report before 30.11.2023".*

A copy of NGT order dated 5/10/2023 is placed as **Annexure I**.

2.0 ACTION TAKEN AS PER THE DIRECTIONS OF HON'BLE TRIBUNAL

In compliance to the directions of Hon'ble NGT, following actions initiated by CPCB for compliance of directions:

[A] Assessment of Phyto-remediation projects carried out on drains

In-Situ bio-remediation techniques involve treatment at the site using aquatic plants and/or microbial remediation methods. *In- Situ* treatment systems like phyto-remediation, bio-remediation, etc. can be commissioned in shorter time duration (few months only) compared to conventional systems, are easy to operate, and requires less energy as compared to conventional treatment technologies. *In- situ* treatment, depending on effluent characteristics, site conditions, and type of treatment systems, may either provide desired quality of treated effluent or act as supplementary to conventional treatment technologies. In any case, wherever feasible, it can be used as an interim remedial measure and help in reducing pollution load or polishing of treated effluent from Sewage Treatment Plants. The common *in-situ* treatment systems are Microbial Bioremediation, Phytoremediation, Constructed Wetland System and Root Zone Treatment. Adequate space and appropriate flow are general requirements for adoption of these technologies. Details of above mentioned *In-situ* bio-remediation techniques indicating methodology, parameters for the feasibility assessment, existing experiences, etc. areas follow:

Phytoremediation

Phytoremediation is a bioremediation process that uses various typesof plants to remove, transfer, stabilize, and/or destroy contaminants inthe soil and groundwater. Phytoremediation involves the removal of organic compounds and nutrients from wastewater through bio- sorption/uptake by pollution-tolerant aquatic plants (such as algae, water hyacinth, duckweeds, etc.) growing in the wastewater. Quite often such plants grow along the littoral zones on either side of the drain.

i. Performance assessment of Phyto-remediation projects

In Mathura, an In-situ remediation/Phyto-remediation project is deployed on drains. Noida Authority has also installed Phytoremediation projects in Noida drain.

CPCB vide letters dated 21/08/2023 & 12-09-2023 (**Annexure II & III**), requested SPCBs/PCCs/RDs and NMCG for providing findings of case studies being performed on assessment of "Phyto-remediation projects carried out on drains". In response, 08 SPCBs/UTs namely Assam, Himachal Pradesh, Lakshadweep, Puducherry, Telanagana, Mizoram, Kerala and Tamil Nadu have informed that they have no phyto-remediation projects in their States. In Kerala, Alappuzha at Chathanadu, a decentralized waste management project named DEWATS system has been established for treatment of wastewater generated from Chathanadu colony, which consists of a septic tank, an aerobic baffle reactor and a planted gravel filter. System was found to be effective in waste management and tackling pollution.

CPCB has carried assessment of drains having in-situ Phytoremediation remediation in the catchment of River Ganga. The details of both studies are as under:

a. **Constructed Wetland in Noida Drain carried out of NOIDA Authority:** One number of in-situ constructed wetland installed in Noida Drain near Sector-50 and 02 in-situ constructed wetland are in process. The constructed wetland comprises of 03 ponds andConstructed wetland having 5-10 furrows of 1 to 4 m width separatedby ridges of 1 m high, 0.5 m wide and composed of river bed pebbles of 80-50 mm size. Samples of Noida drain were collected at to assess the performance of In-situ constructed wetland. The results are depicted in Table 1.

Table 1: Analytical results of Constructed wetland installed at Noida Drain

S. No.	Sampling Location	pH	COD (mg/L)	BOD (mg/L)	TSS (mg/L)	PO_4-P (mg/L)	NH_3-N (mg/L)
1.	Before Remediation	7.3	274	104	122	4.52	29
2.	After Remediation	7.2	257	84	87	7.53	26

The analytical results revealed that concentration at inlet and outlet of constructed wetland with respect to BOD, COD and TSS was same and no substantial improvement observed.

b. **Post-monsoon monitoring of drains:** CPCB carried out monitoring of drains in the catchment of river Ganga and tributaries, wherein phytoremediation is deployed. To assess the phytoremediation effect, CPCB has carried out monitoring of 07 drains (06 drains in Kanpur and 01 in Moradabad) and water quality data is presented in Table 2.

Table 2: Water Quality of phytoremediation projects of drains at Bithoor, Kanpur and Moradabad.

Name of Drains	Capacity	Town / Catchment	Sample Collected	pH	Colour (Hazen)	BOD (mg/l)	COD (mg/l)	TSS (mg/l)
Laxman Ghat Drain	NA	Bithoor, Kanpur	Before Remediation	7.6	25	19.1	65.3	7.1
			After Remediation	7.4	15	10.3	39.2	4.8
Brahamawat Ghat Drain	80 KLD	Bithoor, Kanpur	Before Remediation	7.4	30	79.2	197	187
			After Remediation	7.5	25	11.3	34.3	6.4
Kalwari Ghat Drain	270 KLD	Bithoor, Kanpur	Before Remediation	7.7	20.1	84	178	32.8
			After Remediation	7.6	75	68.2	126	26.5
Peashwa Nala	100 KLD	Bithoor, Kanpur	Before Remediation	7.7	40	43	130	8.33
			After Remediation	7.5	30	16.9	72.4	6.5
Bhannu Nala	600 KLD	Bithoor, Kanpur	Before Remediation	7.5	100	65	155	26.7
			After Remediation	7.5	100	65	155	26.7
Luv Kush Darin	220 KLD	Bithoor, Kanpur	Before Remediation	7.4	50	89.6	224	72.5

			After Remediation	7.4	100	59	168	37.2
Nawabpura Drain-2	NA	Moradabad	Before Remediation	6.9	<05	578	1309	2951
			After Remediation	7.3	BDL	76	249	111

** NA – Not available

The analytical results of drain reveals that percentage reduction of BOD after phytoremediation ranges between 18.81% to 86.85% and BOD concentration, after remediation varies between 10.3 mg/L to 76 mg/L. Out of 7 drains, only 01 drain namely Brahamawat Ghat Drain having capacity of 80 KLD shows BOD reduction upto 85 %.

However, analysis also reveals that there was no substantial reduction in organic load of wastewater in drains having higher hydraulic load.

The technology namely Decentralized Wastewater Treatment System (DEWATS) adopted principle of Phytoremediation has mentioned in manual on Sewerage and Sewage Treatment Systems during November, 2013 of Central Public Health and Environmental Engineering Organisation (CPHEEO). DEWATS can be adopted as ex-situ for treatment of domestic wastewater with low hydraulic load.

[B] Formation of standardization to control formation of THMs

Review of existing literature: Research papers were reviewed for needed assessment of prevailing practices, national & international scenario. Gist is as under:

Disinfection is the process designed to kill or inactivate most microorganisms in wastewater, including essentially all pathogenic organisms. Contrast this to sterilization, which is the removal and destruction of all living microorganisms, including pathogenic and saprophytic bacteria, vegetative forms and spores.

Chlorine is the most widely used disinfectant in drinking water treatment and wastewater treatment due to its availability, low cost,

and broad spectrum antimicrobial efficacy. The principal chlorine compounds used at wastewater treatment plants are chlorine (Cl_2), sodium hypochlorite (NaOCl), calcium hypochlorite [$Ca(OCl_2)$] and chlorine dioxide (ClO_2).

Disinfection by Chlorination

As per the *Chapter 5 of CPHEEO Manual, 2013*, in case of the wastewater which comes from anaerobic processes like UASB, the provision of an aerobic polishing treatment is mandatory before chlorination. The usual dosage used is 10 mg/L and the flow through detention time in the contact tank is 30 minutes based on average flow. Suitable baffles are provided in these tanks to maximize the contact. These tanks shall not be covered, because chlorine gas may be permeating into the concrete and corrode the concrete slab, due to which roof may be collapsed. Hence, open tanks and free wind movement must be allowed to blow across the tank. This will also help in detecting excess chlorination. The residual chlorine after the contact has been generally detected at 1 to 1.5 mg/L at the maximum and there are no offensive odours arising there from.

Break-point reaction with chlorine

The maintenance of a residual (combined or free) for the purpose of wastewater disinfection is complicated because free chlorine not only reacts with ammonia, as noted previously, but also is a strong oxidizing agent. The term “breakpoint chlorination” is the term applied to the process whereby enough chlorine is added to react with all oxidizable substances such that if additional chlorine is added it will remain as free chlorine. The main reason for adding enough chlorine to obtain a free chlorine residual is that effective disinfection can usually then be assured.

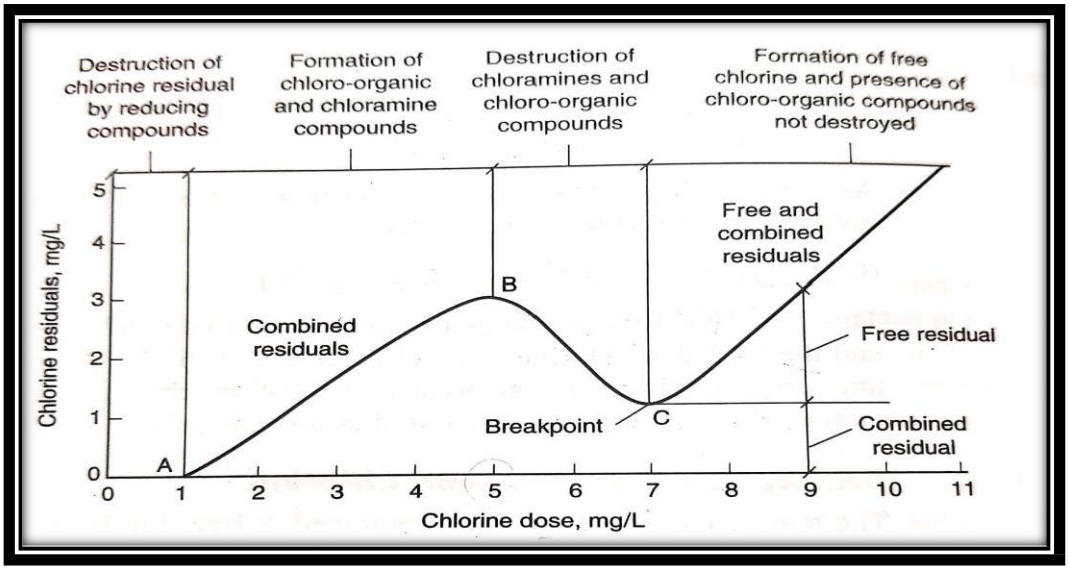

Fig 1: Generalized curve regarding breakpoint chlorination of wastewater

As chlorine is added, readily oxidizable substances such as Fe^{2+}, Mn^{2+}, H_2S and organic matter react with the chlorine and reduce most of theit to the chloride ion point A of Fig 1). After meeting this immediatedemand, the added chlorine continues to react with the ammonia to form chloramines between point A & B. For mole ratios of chlorine to ammonia less than 1, monochloramine and dichloramine will be formed.

Free available residual chlorine is the amount of chlorine which exists in the treated water system as hypochlorous acid and hypochlorite ions after the chlorine demand has been satisfied. Free residual chlorination is the application of chlorine to water to produce a free available chlorine residual.

Untreated wastewater contains nitrogen in the form of ammonia and various combined organic forms. The effluent from most treatment plants also contains significant amounts of nitrogen in the form of ammonia or nitrate if the plant is designed to achieve nitrification. Because hypochlorous acid is a very active oxidizing agent, it will react

readily with ammonia in the wastewater to form three types of chloramines in successive reactions:

(i) $NH_3 + HOCL \longrightarrow NH_2Cl$ (monochloramine) + H_2O

(ii) $NH_2Cl + HOCl \longrightarrow NHCl_2$ (dichlroramine) + H_2O

(iii) $NHCl_2 + HOCl \longrightarrow NCl_3$ (nitrogen trichloride) + H_2O

These reactions are dependent on the pH, temperature and contact time, and on the ratio of chlorine to ammonia. The two species that predominate in most cases are monochloramine and dichloramine. The chlorine in these compounds are called "combined available chlorine". Chloramines also serve as disinfectants, although they are slow-reacting.

The distribution of these two forms is governed by their rates of formation, which are dependent on the pH and temperature. Between point B and breakpoint, point C, some chloramines will be converted to nitrogen trichloride, the remaining chloramines will be oxidized to nitrous oxide and nitrogen, and the chlorine will be reduced to the chloride ion. With continued addition, of chlorine, most of the chloramines will be oxidized at the breakpoint. Continued addition of chloramine passed the breakpoint, will result in a directly proportional increase in the free available chlorine (unreacted hypochlorite).

Formation of Trihalomethanes (THMs)

THMs forms when free chlorine reacts with natural organic material present in water, over an extended contact time throughout water treatment processes, as occurs during conventional chlorination. The short-term (i.e., <10 min) formation of disinfection by-products (THMs) is relatively unknown for decentralized drinking water treatment applications, where treated water is often utilized immediately.

The relative efficiencies of disinfectants vs their by-products are long engaging the attention worldwide. Most of the reported works are only

in respect of surface waters, ground water, surface run-off water etc. the *findings of these studies do not fully apply to disinfection of treated sewage.* The *USEPA-Design Manual on Municipal Wastewater Disinfection-EPA/625/1-86/021* observes that even otherwise, the issue of attention has been the disinfection by-products. Though it is contended that chlorination may result in by-products of Tri-halomethanes, it needs to be realized that it is the case only when chlorination of humic substances takes place and a treated sewage from an aerobic STP does not have humic substances. Moreover, the inherent alkalinity in sewage curtails on the THM formation potential because the alkalinity in sewage scavenges and hydroxyl free radicals.

THM is simply any single carbon atom containing any three halides. Halides are any elements from group VII of the periodic table. Common halides found in wastewater are chlorine, bromine and sometimes iodine. Hence, there can be many different THM's. However, 04 compounds that make up Trihalomethanes are i) Chloroform, ii) Dichlorobromomethane (DCBM), iii) Dibromochloromethane (DBCM) and iv) Bromoform.

Health effects of THM

The major exposure routes to THM include consumption of drinking water and dermal contact with chlorinated water. A less obvious way that people can be exposed to THM is breathing it in via water vapours. When we take hot showers or use steaming-hot water, we breathe-in the chemicals through the water vapour which further released into the air. The human health risks associated with THM are provided in following table-

Compound	Reference dose (mg/kg/day)	Carcinogenicity*
Chloroform	0.01	Probable human carcinogen - based on sufficient evidence of carcinogenicity in animals
Dibromochloromethane	0.02	Possible human carcinogen
Bromoform	0.02	Probable human carcinogen - based on sufficient evidence of carcinogenicity in animals
*(*Data source : US EPA)*		

A less obvious way that people can be exposed to THM is breathing it in via water vapours. When we take hot showers or use steaming-hot water, we breathe-in the chemicals through the water vapour which further released into the air.

THMs impact on health are not immediately recognizable, but rather develop slowly over time. Long-term exposure to trihalomethanes has been linked to many serious illnesses, including:

- ✓ Increased risk for various cancers, including bladder and colon cancer.
- ✓ Pregnancy problems and birth defects in infant children.
- ✓ Damage to the heart, lungs, kidney, liver and central nervous system.

Control of THM's in Wastewater

The main precursor of THMs is the naturally occurring organic matter (NOM) in the water which can be represented in the form of dissolved organic carbon (DOC). A viable solution exists for wastewater treatment plants using sodium hypochlorite to decrease or eliminate the formation of THM's, without losing any disinfection potential. This is accomplished by controlling the amount of Ammonia-N in the effluent.

Review of National/International Standard for THM (BIS/USEPA/WHO)

a. BIS Drinking Water Specification (IS10500:2012)

THM Compounds	BIS Drinking Water Specification
Chloroform	0.2 mg/L
Bromodichloromethane	0.06 mg/L
Dibromochloromethane	0.1 mg/L
Bromoform	0.1 mg/L

b. USEPA Standards for disinfection by-products (DBPs)

Stage	Total THM standard	Halo-Acetic Acids (HAA) Standard
Initial	100 mg/L	-
Stage 1	80 mg/L	60 mg/L
Stage 2	40 mg/L	30 mg/L

Note: Stages are not defined by USEPA

c. WHO Guideline Values for THM in Drinking Water (WHO, 1996)

THM Compounds	WHO Guideline Value
Chloroform	200 µg/L or 0.2 mg/L
Bromodichloromethane	60 µg/L or .06 mg/L
Dibromochloromethane	100 µg/L or 0 .1 mg/L
Bromoform	0 .1 mg/L

ii. Action taken by CPCB on the aspect of THM

Based on the literature review, it is found that there is no direct relation between dosing of chlorination with corresponding BOD to control formation of THM. It is also found that possibility of formation THMs arises only in case of dosing of chlorination beyond breakpoint i.e., 5 mg/L. However, the usual dosage of chlorine in STP in field practice is adopted as 5 mg/L.

In order to substance the above facts and to generate baseline data of THMs after chlorination and also to establish correlation between TOC/DOC/THM, CPCB has taken following initiatives/actions:

a. Shortlisting of STPs carried out to capture variation in strength of sewage w.r.t BOD & COD and plant design capacity, treated technology etc. Subsequently, Regional Directorates of CPCB were requested to shortlist STPs having facility of Chlorination for required inspection and sampling based on sampling criteria.

b. Technical Working Group (TWG) was constituted to examine the subject matter and make recommendations on needed standardization so as to control formation of THMs and to discuss statistical correlation reviewing available data, international practices/norms to understand relevant chemistry.

c. Subsequently, three meetings of the TWG were organized in this regard. Copy of office order regarding constitution of TWG and minutes of the meetings are attached as **Annexure IV & V.**

d. For practical authentication/data collection, (i) sampling protocol for required sampling & analysis (**Annexure VI**) and; (ii) a questionnaire format to obtain required information on operational parameters/functioning of Chlorination Unit in STPs (**Annexure VII**) are prepared.

e. CPCB, H.O – Delhi, Regional Directorate, Chennai and Vadodara carried out sampling at STPs based on different technologies having chlorination facility during August – November, 2023 for physico- chemical, bacteriological and THMs.

f. Inspection and monitoring of 22 no. of STPs were performed (05 in Gujarat, 03 in Tamil Nadu and 03 in Delhi, 05 in Agra and 06 in Mathura).

g. Analytical results with respect to Physio-chemical parameters, residual chlorine concentration and THMs are depicted in **Table 1 to 16** attached as **Annexure VIII**. Test method for analysis of each parameter are summarised in **Table-17 attached as Annexure IX.**

4.0 Major observations & Findings

Based on inspections and analytical results of samples following observations are made:

General Observations:

a. Total 22 STPs covered/ selected had operational capacity in the range of 4.0 MLD to 120.0 MLD.

b. Out of 22 Number of STPs covered under the study, 08 STPs are based on SBR, 02 STPs on modified ASP- MBBR, 03 STPs on Oxidation ponds, 06 no. of STPs on UASB technology and 03 STPs on ASP technology.

c. Out of 22 STPs, 01 STP (Masani, Vrindavan) was found non-operational.

d. Of the 21 STPs, chlorination form was done in gaseous form in 11 no. of STPs and liquid in 10 no. of STPs.

e. Of the STPs, 05 no. of STPs had automatic feeding of chlorination and 16 no. of STPs had manual feeding of chlorination facility.

f. In respect of analytical results, following observations are made in respect of THMs, Residual Chlorine and Fecal Coliform reduction.

STPs monitored in Gujarat:

i. All STPs monitored are based on SBR technology have manual feeding of chlorine in gaseous form (5-6 ppm).

ii. Residual chlorine in the post-chlorination samples collected was observed in the range of BDL – 0.89 ppm.

iii. Reduction in 04 STPs viz. Vamali, Kapurai, Chhani and Bhayali w.r.t fecal coliform from the order of 10^4 MPN/ 100 mL in pre-chlorination samples to < 1000 MPN/100 mL in post-chlorination samples was observed at chlorine dosing of 5.0 -6.0 ppm.

iv. Reduction in Nadiad STP w.r.t fecal coliform count has also been observed from the order 10^7 MPN/ 100 mL to 10^4 MPN/ 100 mL.

v. The results also reveal that **THMs formation in all STPs is below the limit of quantification** at chlorine dosing ranging between 05-06 ppm.

STPs monitored in Tamil Nadu:

i. Samples were collected from 03 STPs (01 no. on SBR technology and 02 no. ASP+ MBBR) having manual feeding of chlorine in the range of 3-6 ppm.

ii. Reduction in 02 STPs viz. Nasapakkam and Koyembedu w.r.t fecal coliform from 1600 MPN/ 100 mL in pre-chlorination samples to Nil in post-chlorination samples at chlorine dosing of 3.0 -6.0 ppm was observed.

iii. The results also reveal that **THMs formation is below the limit of quantification** at all STPs at chlorine dosing ranging between 03-06 ppm.

STPs monitored in Delhi:

i. Samples were collected from 03 STPs (Kondli phase –I, Nilothi phase – II and Pappaklalan phase -II), all are based on ASP technology have automatic feeding of chlorine in gaseous form ranging 3.0 – 5.0 ppm.

ii. Reduction in all 03 STPs w.r.t fecal coliform from the order of 10^4 MPN/ 100 mL to < 1.8 MPN/100 mL in post-chlorination samples was observed at chlorine dosing of 3.0 - 5.0 ppm.

iii. The results also reveal that **THMs formation is below the limit of quantification** at all STPs at chlorine dosing ranging between 03-06 ppm.

STPs monitored in Uttar Pradesh:

In Mathura:

i. Samples were collected from 05 STPs, based on SBR, UASB & Oxidation pond technology have manual/ automatic feeding of chlorine (3.0 – 5.0 ppm) in gaseous/ liquid form.

ii. Maximum reduction in fecal coliform from the order of 10^7 MPN/ 100 mL to 3.6 MPN/100 mL in post-chlorination samples at chlorine dosing of 3.0 - 5.0 ppm was observed in 01 STPs viz. Laxmi Nagar, Mathura (16 MLD).

iii. The results also reveal that **THMs formation is below the limit of quantification** at all STPs at chlorine dosing ranging between 03-06 ppm.

In Agra:

i. Samples were collected from 05 STPs, based on SBR & UASB technology having manual/ automatic feeding of chlorine (3.0 – 5.0 ppm) in gaseous/ liquid form.

ii. Maximum reduction in fecal coliform from the order of 10^4 MPN/ 100 mL to < 1.8 MPN/100 mL in post-chlorination samples at chlorine dosing of 3.0 - 5.0 ppm was observed in 01 STP viz. Dhandupura.

iii. The results also reveal that **THMs formation is below the limit of quantification** at all STPs except Dhandupura at chlorine dosing ranging between 03-06 ppm.

5.0 Concluding Remarks

i. In respect of Phyto-remediation projects, it is observed that technology deployed for drains having hydraulic load of less than 100 KLD shows reduction of organic loading upto 85 %. There was no substantial reduction in organic load of wastewater in drains having higher hydraulic load.

ii. There is no direct relation found between dosing of chlorination with corresponding BOD to control formation of THM. Possibility of formation THMs arises only in case of dosing of chlorination beyond breakpoint i.e., 5 mg/L. However, the usual 5 mg/L dosage of chlorinein STP in field practice is adopted.

iii. Based on analytical results, it is found that dosing of chlorine at 05 ppm rate and required chlorine demand, possibility of formation of THMs in wastewater is negligible. To meet the desired standards i.e.
230 MPN/ 100 mL, optimum performance of biological secondary treatment and needed tertiary treatment should be ensured for effective Fecal coliform reduction.

iv. Treatment plant shall be designed considering the Faecal Coliform removal efficiency, Log unit Upto3<4 so that disinfection system based on chlorination up to dosing of 05 ppm can work efficiently.

v. In order to have reliable findings, more data is needed along with required Lab scale study (chlorination in Lab and analyse sample forTHM) etc. by IIT/ NEERI.

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Item No. 09 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 773/2022

Rajesh Pareek Applicant

Versus

State of Uttar Pradesh Respondent

Date of hearing: 05.10.2023

CORAM: HON'BLE MR. JUSTICE PRAKASH SHRIVASTAVA, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE DR. A. SENTHIL VEL, EXPERT MEMBER

Respondent: Mr. Pradeep Misra & Mr. Daleep Dhyani, Advs. for UPPCB

ORDER

1. The issue involved in this Original Application is in respect of discharge of untreated sewage in Yamuna at Mathura-Vrindavan. The Tribunal in the earlier proceedings had taken note of the stand of the applicant that there are 36 drains in Mathura-Vrindavan discharging sewage into river Yamuna and the quality of water in Yamuna is unfit to sustain any life and also that out of 36 drains in Mathura-Vrindavan, 30 drains were tapped while 6 of them remained untapped. The official claim of 70 MLD sewage being treated in Mathura-Vrindavan is noted to be fallacious.

2. Considering the gravity of issue involved in the matter, the Tribunal by order dated 11.04.2023 had issued following directions:-

> *"11. In the light of the said order and observations in the present case, the* ***Chief Secretary, U.P, in coordination with other concerned authorities in the State, may ensure remedial action in the present case also for which a special meeting of concerned officers be convened preferably within one month to inter alia consider that untapped drains are intercepted anddiverted to the identified STPs preferably within two months, treated sewage from each STP is provided to the identified command area for irrigation/agriculture and only during non- utilization period, treated sewage goes to river, performance of***

six STPs is evaluated and improved with defined mode of disposal, chlorination method and formation of THMs are studied in the light of protocol for chlorine dosing corresponding to BOD levels, treatment of effluent of industries individually or through CETP in terms of consented mode of disposal*. An action taken report be filed within four months by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCRSupport PDF and not in the form of Image PDF."*

3. After the above order, a report dated 10.08.2023 on behalf of UPPCB has been filed disclosing that Environmental Compensation of Rs. 3.25 crores has been imposed upon the City Commissioner, Mathura-Vrindavan at the rate of Rs. 5 lakhs per drain per month for 13 months for five drains. Another report dated 04.10.2023 has been filed by the CPCB in which Table 3 indicates very high number of Fecal Coliform at outlet of STPs which cannot be allowed to be discharged into river or for other human contact purpose. This also shows that chlorination is not effective. The conclusion and recommendations contained in the report are as follows:-

"3.0 CONCLUSION & RECOMMENDATION

In view of above facts, following conclusion are made in respect of Phytoremediation projects and THMS formation in treated wastewater of STPS:

1. *In respect of Phytoremediation projects, it is observed that technology deployed for drains having hydraulic load of less than 100 KLD shows reduction of organic loading upto 85 %. There was no substantial reduction in organic load of wastewater in drains having higher hydraulic load.*

2. *In respect of formation of standardization to control formation of THMS, it is observed that there is no direct relation found between dosing of chlorination with corresponding BOD to control formation of THM. It is also found that possibility of formation THMs arises only in case of dosing of chlorination beyond breakpoint i.e., 5 mg/L. However, the usual dosage of chlorine in STP in field practice is adopted as 5 mg/L.*

3. *The results of STPs installed at Mathura and Vrindavan depicts that dosing of chlorination at rate of 5ppm do not form any THMS in wastewater.*

   In order to validate the above facts and desired correlation of chlorine dosing, BOD and THMS, CPCB has undertaken similar studies on more STPs spread across the Country.

   The detailed study shall be completed by CPCB within two months and findings will be discussed in the Technical Working Group

(TWG) constituted by CPCB and further recommendations / concluding remarks of TWG shall be covered in the report to be submitted in the similar matter of O.A. No. 840 of 2022 titled Dr. Sanjay Kulshresthra Vs Government of U.P. & Others."

4. No action taken report on behalf of Chief Secretary, Uttar Pradeshhas been filed. We also find that the direction contained in the paragraph11 of the order dated 11.04.2023 has not been fully complied with till now. In the background of the aforesaid fact, we direct the Chief Secretary, UPto file the action taken report in pursuance to the directions contained inthe paragraphs 11 of the order dated 11.04.2023. Let the said report befiled within six weeks by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of ImagePDF. CPCB is also directed to conclude the study and place the complete report before 30.11.2023.

5. Learned Counsel appearing for UPPCB has submitted that he will convey this order to the Chief Secretary of the State of Uttar Pradesh.

6. List this matter on 30.11.2023.

Prakash Shrivastava, CP

Sudhir Agarwal, JM

Dr. A. Senthil Vel, EM

October 05, 2023
Original Application No. 773/2022
SN

Annexure - II

OFFICE COPY

F. No. A-14011/1/2023-WQM-I (OA No 773 of 2022) 3387-3428

21/8/2023

To

The Member Secretary
(All SPCBs/PCCs)

Subject: Hon'ble NGT order dated 11/4/2023 in OA No 773 of 2022 tiled Rajesh Prateek Vs State of Uttar Pradesh, regarding

Sir,

Enclosed please find a copy of the Hon'ble NGT order dated 11/4/2023 in OA No. 773 of 2022 in the matter of Rajesh Prateek Vs State of Uttar Pradesh, for your information. The tribunal has directed following:

Para 6: "Phyto-remediation is claimed to have been undertaken without showing its results which may be merely an excuse to waste public money which needs to be checked by the statutory regulators including CPCB"

In compliance to the above-said direction given by Hon'ble NGT, it is requested to provide requisite details & findings of case studies being performed in your jurisdiction on assessment of "Phyto-remediation projects carried out on drains". Early reply is requested latest by 30/8/2023 through email on eepkm.cpcb@nic.in & vishalgandhi.cpcb@nic.in .

This may please be treated as 'URGENT'.

Yours faithfully,

(P.K. Mishra)
Divisional Head, WQM-I

Encl.: As above
Copy to:

1 All RDs, CPCB : For kind information and follow- up with the SPCBs/PCCs, please.

2 PS to MS, CPCB : For kind information of 'MS', please

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
निर्गत...
दिनांक...22/08/2023

21/08/23
(P.K. Mishra)

Annexure - III

OFFICE COPY

F. No. A-14011/1/2023-WQM-I (OA No 773 of 2022) /579/4255-4259 21/9/2023

To

All members of Technical Working Group (TWG)
(IIT Kanpur, IIT Delhi, NEERI, BIS & DJB)

Subject: Second meeting of the "Technical Working Group" constituted 'to examine the course of chlorination for disinfection, density of chlorine with corresponding BOD values need proper standardization so as to control formation of Tri-Halo methane (THM)- regarding.

Sir,

This has reference to our office order no F. No. A-14011/1/2023-WQM-I (OA No 773 of 2022) vide dated 29.8.2023 regarding constitution of a "Technical Working Group" (TWG) on the subject cited above. Second meeting of this "Technical Working Group" is scheduled to be held on **26.09.2023 at 11.00 AM through video-conferencing**. A copy of agenda item of the said meeting is annexed (**Annexure-I**).

You are requested to kindly make it convenient to attend the meeting.

Yours faithfully,

(P.K. Mishra)
Divisional Head, WQM-I

Encl: As above
Copy to:

1. DH, IT Division : For kind information and provide weblink for the said meeting.
2. PS to MS, CPCB : For kind information of 'MS', please

21/09/23
(P.K. Mishra)

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
निर्गत
दिनांक 21/09/2023

Annexure - IV

25

124493/2023/WQM-I-HO

CENTRAL POLLUTION CONTROL BOARD
"Parivesh Bhawan", East Arjun Nagar, Delhi-110032
OFFICE ORDER

F. No. A-14011/1/2023-WQM-I (OA No 773 of 2022) 1410 **29/8/2023**

Subject: Constitution of "Technical Working Group"- regarding.

Hon'ble NGT vide order dated 11/4/2023 in OA No 773 of 2022 titled Rajesh Pareek Vs State of Uttar Pradesh has directed CPCB, *'to examine the course of chlorination for disinfection, density of chlorine with corresponding BOD values need proper standardization so as to control bformation of tri-halomethane (THM)".*

In compliance to the directions of the Hon'ble NGT, a "Technical Working Group" is hereby constituted to examine the subject matter. The said working group consists of following members:

1. Sh. A.A. Kazmi, Professor, IIT Roorkee
2. Representative of BIS, Delhi
3. Representative of IIT, Delhi
4. Representative of NEERI, Nagpur
5. Representative of DJB, Delhi
6. Sh. Vishal Gandhi, Scientist E, WQM-I Division, CPCB
7. Sh. P.K. Mishra, DH, WQM-I Division, CPCB

Terms of Reference (ToR) of the Technical Working Group shall be as follows:

- To examine the subject matter and make recommendations on needed standardization so as to control formation of THMs.
- To discuss statistical correlation reviewing available data, international practices/ norms to understand relevant chemistry.
- The group, if needed will perform the required detailed inspection & testing.
- The group may invite suppliers of chlorine, leading STP operators etc, if needed
- The group will submit its report within three months from the date of constitution of the group.

This issues with the approval of the Competent Authority, Central Board.

(P.K. Mishra)
Divisional Head, WQM-I

To

1.	Sh. A. A. Kazmi Professor, Environmental Engineering IIT, Delhi	:	For information & necessary action, please.
2.	Additional Director General, BIS, Delhi	:	With a request to nominate suitable representative in the said Technical Working Group.
3.	Director, IIT, Delhi	:	-do-
4.	Director, NEERI, Nagpur	:	-do-
5.	Chief Engineer, DJB, Delhi	:	-do-

Copy to:

1. PS to CCB, CPCB — For information of 'CCB', please
2. PS to MS, CPCB — For information of 'MS', please

29/8/2023
O/C

29/8/23
(P.K. Mishra)

Annexure – V

Central Pollution Control Board
(Ministry of Environment, Forest & Climate Change, Govt. of India)
Parivesh Bhawan, East Arjun Nagar, Delhi – 110032
****

Minutes of the meeting of Technical Working Group (TWG) constituted to examine the course of chlorination for disinfection, in sewage treatment and make recommendations on needed standardization so as to control formation of Tri-Halo methane (THM)

The first meeting of Technical Working Group (TWG) to examine the course of Chlorination in STPs for disinfection and make recommendations on needed standardization so as to control formation of Tri-halomethanes (THMs) was held on 05.09.2023 at 11:30 AM through Video Conferencing. List of participants attended the meeting is given in **Annexure-I**.

Following is the record of discussions:

01) Sh. P. K. Mishra, Divisional Head, WQM-I Division, CPCB welcomed the participants and briefed about the direction under point 6 of Hon'ble NGT order dated 11/4/2023 in OA No 773 of 2022 for CPCB. He further pointed out terms of reference (TOR) of the TWG & stressed on importance of proper study/evaluation in STP w.r.t the given assignment and need for finalizing **(a)** criteria for shortlisting of STP for study **(b)** needed sampling & monitoring protocol & **(c)** questionnaire (operational parameters/functioning of chlorination Unit in STPs). He further asked Sh. Vishal Gandhi to make a brief presentation on standardization of Chlorination process for disinfection in sewage treatment.

02) Sh. Vishal Gandhi, Scientist E, CPCB made a presentation highlighting the directions of Hon'ble NGT, disinfection method by chlorination in STPs, break-point of chlorination and precursors for formation of THMs in STPs.

03) Prof. Kazmi, IIT - Roorkee suggested to include Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) in the sampling protocol. He also suggested that

grab samples will be adequate for the present study and the outlet sample to be collected after 30 min. of chlorination.

04) Dr. A Ramesh Kumar, NEERI – Nagpur informed that USEPA method based on GC-MS for analysis of THMs may also be referred.

05) Ms. Shubhanjali Umrao, Sc B, BIS confirmed that at present BIS has no specific guideline for THM and further informed that APHA test method is prescribed for analysis of THMs in drinking water.

After in depth discussion, following recommendations were made:

1. Short-listing of STPs, where chlorination is performed shall be carried out based on plant capacity and treatment technology.
2. Sampling and Monitoring in identified STPs shall be performed as per following sampling and monitoring protocol for THMs:

(i) Sampling Location and Matrix

Samples shall be selected from STPs having facility of disinfection through chlorination only. Samples for analysis of various parameters shall be collected as per following details:

Sampling location	Parameters
After Secondary Treatment/ Before Chlorination	pH, BOD, COD, TOC, DOC TSS, All forms of Nitrogen - (Ammonical Nitrogen, Nitrate, TKN), TC, FC
After Chlorination / Outlet	pH, BOD, COD, TOC, DOC, TSS, All forms of Nitrogen - (Ammonical Nitrogen, Nitrate, TKN), TC, FC, THM & its components (chloroform, bromodichloromethane, dibromochloromethane, and bromoform)

(ii) Frequency of Sampling

Chlorine dosing at the inlet of chlorination tank shall be recorded. Samples as mentioned above shall be taken as per following frequency:

- Grab samples i) at the inlet and ii) outlet of chlorination tank after 30 minutes of chlorine dosing.
- Sampling to be done for consecutive 02 days.
- Each day at least two sets of samples at different possible dosing rate shall be collected.

(iii) Sampling Collection, Preservation and Analysis

Sampling collection, preservation and analysis for THMs and chloroamines shall be carry out as per prescribed standard methods. Details of sampling pre-requisite are as follows:

- Sample Quantity required- 1 Ltr.
- Sample should be preserved at 4 degree C
- Sample Bottle- PTFE White bottle/ Amber glass bottle

3. To obtain required information on Operational parameters/functioning of Chlorination Unit in STPs, as per prescribed format. A copy of questionnaire finalized during the meeting is attached (**Annexure II**).

4. To hold next meeting after completion of in depth field study and literature review.

The meeting ended with vote of thanks to the Chair.

Annexure-I

List of participants:

1. Prof. Kazmi, IIT - Roorkee
2. Sh. P. K. Mishra, Divisional Head, WQM-I Division, CPCB
3. Sh. Vishal Gandhi, Scientist E, WQM-I Division, CPCB
4. Dr. A Ramesh Kumar, NEERI- Nagpur
5. Ms. Shubhanjali UMrao, Sc – B, BIS
6. Sh. S. K. Singh, Chief Engineer, DJB
7. Sh. K.C. Meena, CE(ww)-I, DJB
8. Sh. P.K. Gupta, ACE, DJB
9. Sh. S.K. Bhardwaj, DJB
10. Sh. Sanjay Sharma, DJB

Annexure – VI

SAMPLING PROTOCOL FOR REQUIRED ANALYSIS
(Ref: In the matter of Hon'ble NGT order dated 11/4/2023 in OA No 773 of 2022 tiled Rajesh Prateek Vs State of Uttar Pradesh)

1.0 Sampling Location and Matrix

Samples shall be selected from STPs having facility of disinfection through chlorination only. Samples for analysis shall be taken as per following details:

Sampling location	Parameters
After Secondary Treatment/ Before Chlorination	pH, BOD, COD, TOC, DOC TSS, All forms of Nitrogen - (Ammonical Nitrogen, Nitrate, TKN), TC, FC
After Chlorination / Outlet	pH, BOD, COD, TOC, DOC, TSS, All forms of Nitrogen - (Ammonical Nitrogen, Nitrate, TKN), TC, FC, THM & its components (chloroform, bromodichloromethane, dibromochloromethane, and bromoform)

DOC: Dissolved Organic Carbon

2.0 Frequency of Sampling

Chlorine dosing at the inlet of chlorination tank shall be recorded. Samples as mentioned above shall be taken as per following frequency:

1. Grab samples i) at the inlet and ii) outlet of chlorination tank after 30 minutes of chlorine dosing.
2. Sampling to be done for consecutive 02 days.
3. Each day at least two sets of samples at different possible dosing rate shall be collected.

3.0 Sampling Collection, Preservation and Analysis

Sampling collection, preservation and analysis for THMs and chloroamines shall be carry out as per prescribed standard methods. Details of sampling pre-requisite are as follows:

1. Sample Quantity required- 1 Ltr.
2. Sample should be preserved at 4 degree C
3. Sample Bottle- PTFE White bottle/ Amber glass bottle

Annexure – VII

CENTRAL POLLUTION CONTROL BOARD
Parivesh Bhawan, East Arjun Nagar, Delhi-110032

QUESTIONNAIRE

Operational parameters/functioning of Chlorination Unit in STPs

S.No.	Information on	Details
1	i) Name & address of the STP	
	ii) Contact person & contact number	
2	i) Installed treatment capacity of the plant (MLD) ii) Population served (Approx)	
3	Operational Capacity (in MLD)	
4	Observed flow of STP during monitoring	
5	Treatment technology (UASB, MBBR, SBR, ASP etc)	
6	Chlorination dosing (in ppm) a. Chlorination form (gas/liquid/solid) b. Pre-chlorination dose c. Pre-chlorination contact time d. Post-chlorination dose e. Post-chlorination contact time	
7	Design of chlorination contact chamber -Dimension of chlorination contact number	
8	Arrangement to control feeding (automatic/manual) (Y/N, if yes then details)	
9	Available sampling and analysis record with STP (enclose data of previous two months w.r.t flow, ClO_2 dosing rate, BOD, COD, THM, if done)	

Annexure – VIII

Table 1: Analytical results of STPs located in Gujarat with respect to Physio-chemical parameters

STP location	Installed Capacity (MLD)	Technology	Day of monitoring	Chlorination dosing (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters								
						pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	T. Coli. MPN/100ml.	F. Coli. MPN/100ml.
Vemali, Vadodara	13 MLD	SBR	Day I	5.0	Pre	8.20	4.6	10.82	4.9	0.40	0.70	3.89	$33x10^4$	$13x10^4$
					Post	8.38	3.4	7.22	2.5	0.54	0.84	4.30	7.8	4.5
				6.0	Pre	8.28	3.6	11.15	2.8	1.15	1.65	3.82	$22x10^4$	$11x10^4$
					Post	8.25	16.0	8.69	1.7	0.51	1.06	3.35	11	4.5
			Day II	5.0	Pre	7.99	2.5	10.33	3.3	0.56	1.51	3.20	$14x10^5$	$70x10^4$
					Post	8.22	4.7	12.63	1.2	0.47	0.67	2.92	**33**	13
				6.0	Pre	8.27	5.6	8.69	1.8	0.64	1.48	4.51	$17x10^5$	$49x10^4$
					Post	8.20	3.5	14.27	2.1	0.54	1.18	3.33	79	23
Kapurai, Vadodara	60 MLD	SBR	Day I	5.0	Pre	7.69	4.8	23.29	2.3	0.43	1.23	4.25	$11x10^6$	$33x10^5$
					Post	7.28	5.4	27.72	1.4	0.46	1.29	3.86	350	79
				6.0	Pre	7.75	3.3	18.04	1.0	0.25	0.90	3.24	$49x10^5$	$23x10^5$
					Post	7.78	1.0	19.52	1.8	0.27	1.43	3.35	130	49
			Day II	5.0	Pre	7.71	6.5	22.63	5.3	0.42	1.60	5.41	$49x10^5$	$17x10^5$
					Post	7.78	9.7	21.48	6.2	0.94	1.79	2.89	$28x10^2$	790
				6.0	Pre	7.83	4.7	21.97	3.9	0.27	0.90	4.06	$33x10^5$	$13x10^5$
					Post	7.75	5.6	21.81	3.1	0.35	1.68	4.70	920	130
Chhani, Vadodara	50 MLD	SBR	Day I	5.0	Pre	7.31	2.3	9.9	1.0	0.31	1.82	6.64	$92x10^6$	$35x10^6$
					Post	7.37	1.0	7.6	1.2	0.27	1.68	6.15	170	11
				6.0	Pre	7.22	1.9	10.08	1.8	0.58	2.13	7.28	$22x10^6$	$33x10^5$
					Post	7.33	2.0	12.91	1.5	0.37	2.35	6.55	11	4.5
			Day II	5.0	Pre	7.79	3.7	11.77	2.6	0.93	1.85	6.10	$11x10^6$	$33x10^5$
					Post	7.75	2.9	11.26	2.1	0.87	1.37	5.29	13	7.8
				6.0	Pre	7.53	3.5	18.19	5.4	1.67	1.71	7.72	$11x10^6$	$49x10^5$
					Post	7.28	3.0	12.47	3.3	1.54	1.68	6.35	13	4.5
Bhayali, Vadodara	45 MLD	SBR	Day I	5.0	Pre	7.49	3.0	16.09	2.2	3.92	4.54	3.03	$16x10^7$	$54x10^6$
					Post	7.43	6.0	12.38	2.6	4.6	5.07	2.42	NIL	NIL
				6.0	Pre	7.40	3.1	15.21	1.2	0.47	1.60	4.66	$54x10^6$	$49x10^5$
					Post	7.59	2.5	18.21	0.5	0.32	5.0	3.66	110	17
			Day II	5.0	Pre	7.89	2.6	10.82	2.0	1.04	2.10	3.77	$35x10^6$	$11x10^6$
					Post	7.86	3.5	17.49	1.1	1.02	2.18	2.96	2.0	NIL
				6.0	Pre	7.87	5.8	9.69	1.9	0.65	1.60	3.91	$49x10^5$	$23x10^5$
					Post	7.81	2.1	10.82	1.4	0.30	2.40	4.11	7.8	2.0
Nadiad, Gujarat	51.26 MLD	SBR	Day I	5.0	Pre	8.23	49	138.4	31.3	18.1	26.8	2.47	$92x10^7$	$35x10^7$
					Post	8.22	38	127.8	61.8	17.9	26.6	2.85	$92x10^4$	$24x10^4$

STP location	Installed Capacity (MLD)	Technology	Day of monitoring	Chlorination dosing (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters								
						pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	T. Coli. MPN/100ml.	F. Coli. MPN/100ml.
				6.0	Pre	8.15	32	89.2	30.9	16.0	20.7	0.23	$22x10^7$	$79x10^6$
					Post	8.16	55	77.9	16.9	15.9	20.1	0.42	$16x10^5$	$35x10^4$
			Day II	5.0	Pre	8.18	31	113.4	34.3	14.7	20.9	1.39	$49x10^6$	$23x10^6$
					Post	8.21	36	104.5	22.1	14.9	19.7	1.01	$11x10^3$	$14x10^2$
				6.0	Pre	8.11	30	77.9	24.3	12.2	16.7	1.27	$23x10^6$	$13x10^6$
					Post	8.12	27	82.8	18.3	12.3	16.1	0.77	$54x10^4$	$39x10^3$

Table – 2: Residual chlorine concentration after chlorination at different dosing in samples of STPs located in Gujarat

STP locations	Installed Capacity (MLD)	Form of chlorination (solid/ liquid/ gaseous)	Arrangement of chlorination dosing (automatic/ manual)	Schedule of chlorination	Chlorine dosing (in ppm)	Parameters
						Resi.Cl_2(mg/l)
Vemali, Vadodara	13 MLD	Gaseous	Manual	Day I	5.0 ppm	0.44
					6.0 ppm	BDL
				Day II	5.0 ppm	BDL
					6.0 ppm	0.15
Kapurai, Vadodara	60 MLD	Gaseous	Manual	Day I	5.0 ppm	BDL
					6.0 ppm	0.21
				Day II	5.0 ppm	BDL
					6.0 ppm	0.44
Chhani, Vadodara	50 MLD	Gaseous	Manual	Day I	5.0 ppm	0.35
					6.0 ppm	0.45
				Day II	5.0 ppm	0.55
					6.0 ppm	0.67
Bhayali, Vadodara	45 MLD	Gaseous	Manual	Day I	5.0 ppm	0.89
					6.0 ppm	0.44
				Day II	5.0 ppm	0.85
					6.0 ppm	0.76
Nadiad, Gujarat	51.26 MLD	Gaseous	Manual	Day I	5.0 ppm	BDL
					6.0 ppm	BDL
				Day II	5.0 ppm	0.25
					6.0 ppm	0.12

Table 3: Analytical results of STPs in Gujarat with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP location	Installed Capacity (MLD)	Day of monitoring	Chlorination dosing (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters	
					TOC (mg/ L)	DOC (mg/l)
Vemali, Vadodara	13 MLD	Day I	5.0	Pre	5.08	4.32
				Post	6.46	4.04
			6.0	Pre	5.08	4.32
				Post	4.48	4.08
		Day II	5.0	Pre	4.04	3.34
				Post	4.02	3.14
			6.0	Pre	3.46	3.30
				Post	4.50	4.00
Kapurai, Vadodara	60 MLD	Day I	5.0	Pre	8.59	8.32
				Post	8.79	6.89
			6.0	Pre	6.16	4.26
				Post	5.97	5.12
		Day II	5.0	Pre	10.37	7.71
				Post	10.18	9.36
			6.0	Pre	7.32	6.92
				Post	9.49	7.44
Chhani, Vadodara	50 MLD	Day I	5.0	Pre	5.94	5.04
				Post	4.70	4.58
			6.0	Pre	7.0	4.66
				Post	6.32	4.94
		Day II	5.0	Pre	5.68	4.50
				Post	5.88	4.84
			6.0	Pre	6.36	5.08
				Post	7.34	4.90
Bhayali, Vadodara	45 MLD	Day I	5.0	Pre	5.10	4.86
				Post	6.72	4.76
			6.0	Pre	3.74	3.30
				Post	2.56	2.32
		Day II	5.0	Pre	4.42	2.24
				Post	3.88	2.56
			6.0	Pre	4.26	4.06
				Post	4.12	3.82
Nadiad, Gujarat	51.26 MLD	Day I	5.0	Pre	30.48	27.96
				Post	29.44	25.56
			6.0	Pre	25.88	25.84
				Post	17.80	15.84
		Day II	5.0	Pre	23.32	19.76
				Post	18.24	18.12
			6.0	Pre	15.08	14.00
				Post	16.80	13.08

Table 4: Analytical results of STPs in Gujarat with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP location	Installed Capacity (MLD)	Day of monitoring	Chlorination dosing (in ppm)	Source of sampling (pre/ post – chlorination)	THM and its compounds (in mg/L)			
					Chloroform	Bromodichloromethane	Dibromochloromethane	Bromoform
Vemali, Vadodara	13 MLD	Day I	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
		Day II	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
Kapurai, Vadodara	60 MLD	Day I	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
		Day II	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
Chhani, Vadodara	50 MLD	Day I	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
		Day II	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
Bhayali, Vadodara	45 MLD	Day I	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
		Day II	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
Nadiad, Gujarat	51.26 MLD	Day I	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
		Day II	5.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND
			6.0	Pre	ND	ND	ND	ND
				Post	ND	ND	ND	ND

Table 5: Analytical results of STPs located in Tamil Nadu with respect to Physio-chemical parameters

STP locations	Installed Capacity (MLD)	Technology	Form of chlorination	Dosing of chlorination (in ppm)	Source of sampling (pre/ post – chlorination)	Physio Chemical parameters								
						pH	TSS (mg/ L)	COD (mg/ L)	BOD (mg/ L)	NH_3 – N (mg/ L)	TKN (mg/ L)	NO3 – N (mg/ L)	TC (MPN / 100 mL)	FC (MPN/ 100 mL)
Nesapakam, Chennai	54 MLD	ASP modified to MBBR	Liquid	6.0	Pre	7.7	5	16.4	BLQ	6.5	7.2	1.8	500	90
					Post	7.6	11	29	3	5.5	8.9	1.0	Nil	Nil
				5.0	Pre	7.7	6	16.4	BLQ	6.3	8.6	3.3	900	110
					Post	7.6	3	29	4	5.6	8.1	3.6	Nil	Nil
				4.0	Pre	7.5	4	16.1	BLQ	2.1	3.2	5.9	34	Nil
					Post	7.6	BLQ	8.1	BLQ	2.1	3.8	6.6	60	Nil
				3.0	Pre	7.6	BLQ	20	3	BLQ	2.9	7.2	70	Nil
					Post	7.6	BLQ	12	BLQ	BLQ	4.3	6.4	Nil	Nil
Koyembedu, Chennai	120 MLD	ASP modified to MBBR	Liquid	6.0	Pre	7.4	10	33	8	6.3	7.5	3	500	220
					Post	7.4	BLQ	37	4	5.5	9.5	3.3	1600	1600
				5.0	Pre	7.3	BLQ	53	10	5.8	7.2	4.5	500	140
					Post	7.7	4	70	9	6	7	5	300	23
				4.0	Pre	7.5	BLQ	8.1	BLQ	2.3	5.2	2.6	1600	110
					Post	7.6	7	16	BLQ	2.2	3.8	2.8	1600	500
				3.0	Pre	7.5	BLQ	12	BLQ	2.5	5	2.3	500	110
					Post	7.6	BLQ	8.1	BLQ	2.6	3.5	1	500	200
Kodunagiyur, Chennai	120 MLD	SBR	Gaseous	6.0	Pre	7.4	BLQ	29	4	BLQ	4	3.3	500	30
					Post	7.5	5	20	3	6.2	7.5	3.1	1600	60
				5.0	Pre	7.5	BLQ	16	BLQ	BLQ	4.3	2.3	280	22
					Post	7.3	BLQ	45	7	BLQ	3.8	1.8	500	110
				4.0	Pre	7.5	6	16	BLQ	BLQ	2.3	2.6	300	23
					Post	7.4	BLQ	28	4	BLQ	3.5	5.9	500	140
				3.0	Pre	7.4	11	12	BLQ	BLQ	2	4.1	1600	1600
					Post	7.3	7	24	3	1.4	3	2	1600	1600

Table 6: Analytical results of STPs in Tamil Nadu with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP locations	Installed Capacity (MLD)	Form of chlorination	Arrangement of chlorination dosing (automatic/ manual)	Dosing of chlorination (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters	
						TOC (mg/ L)	DOC (mg/ L)
Nesapakam, Chennai	54 MLD	Liquid	Manual	6.0	Pre	6.2	3.1
					Post	11	9.2
				5.0	Pre	6.2	4.6
					Post	11	7.7
				4.0	Pre	6.1	3
					Post	3	1.5
				3.0	Pre	7.6	4.6
					Post	4.6	1.5
Koyembedu, Chennai	120 MLD	Liquid	Manual	6.0	Pre	12.4	7.7
					Post	14	11
				5.0	Pre	20	14
					Post	26	12
				4.0	Pre	3	1.5
					Post	6	4.6
				3.0	Pre	4.6	3
					Post	3	1.5
Kodunagiyur, Chennai	120 MLD	Gaseous	Manual	6.0	Pre	11	7.7
					Post	7.7	6.2
				5.0	Pre	6.2	5
					Post	17	11
				4.0	Pre	6.1	3
					Post	11	6
				3.0	Pre	4.6	3
					Post	9.1	6.1

Table 7: Analytical results of STPs in Tamil Nadu with respect to THMs

Sl. No.	STP locations	Chlorination dosing (in ppm)	THM and its compounds (in mg/ L)				
			Bromoform	Dibromo-chloromethane	Bromodl-chloromethane	Chloroform	Chloroamines
1.	Nesapakam, Chennai (54 MLD)	6ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		5ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		4ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		3ppm	BLQ	BLQ	BLQ	BLQ	BLQ
2.	Koyembedu, Chennai (120 MLD)	6ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		5ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		4ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		3ppm	BLQ	BLQ	BLQ	BLQ	BLQ
3.	Kodunagiyur, Chennai (120 MLD)	6ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		5ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		4ppm	BLQ	BLQ	BLQ	BLQ	BLQ
		3ppm	BLQ	BLQ	BLQ	BLQ	BLQ

Table 8: Analytical results of STPs located in Delhi with respect to Physio-chemical parameters

STP locations	Installed Capacity (MLD)	Technology	Source	Parameters								
				pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	T. Coli. MPN/100 ml.	F. Coli. MPN/100 ml.
Kondli Phase – I	45.5 MLD	ASP	Pre	7.2	BDL	22	04	1	1.7	7.2	$13X\ 10^4$	$13X10^4$
			Post- (5 ppm)	7.1	BDL	32	05	03	4	7.9	< 1.8	< 1.8
			Post (3 ppm)	7.0	BDL	30	05	02	3	7.7	< 1.8	< 1.8
Nilothi Phase II	90.8 MLD	ASP	Pre	7.2	41	103	25	12	12	2.8	$13X10^5$	$33X10^4$
			Post (3 ppm)	6.8	27	133	25	22	26	1.2	$14X10^5$	$68X10^3$
			Post (5 ppm)	7.3	29	108	33	16	21	1.3	4	4
Pappankala Phase II	91 MLD	ASP	Pre	7.1	11	44	9	4	5	7.9	$92X10^4$	$92X10^4$
			Post (3 ppm)	6.8	BDL	43	8	03	4	8.2	4	1.8
			Post (5 ppm)	6.9	BDL	56	13	04	5	8.1	2	< 1.8

Table 9: Analytical results of STPs in Delhi with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP locations	Installed Capacity (MLD)	Arrangement of chlorination dosing (automatic/ manual)	Form of chlorination (Solid/ liquid/ Gaseous)	Dosing of chlorination (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters	
						TOC (mg/ L)	DOC (mg/ L)
Kondli Phase - I	45.5 MLD	Automatic	Gaseous	-	Pre	11.23	10.15
				5.0	Post	9.89	9.96
				3.0	Post	10.46	10.83
Nilothi Phase II	90.8 MLD	Automatic	Gaseous	-	Pre	40.32	33.74
				3.0	Post	40.19	33.79
				5.0	Post	42.08	37.32
Pappankala Phase II	91 MLD	Automatic	Gaseous	-	Pre	11.23	11.18
				3.0	Post	12.52	11.17
				5.0	Post	13.28	11.28

Table 10: Analytical results of STPs in Delhi with respect to THMs

STP location	Chlornation dosing (in ppm)	THM and its compounds				
		Bromoform	Dibromo-chloromethane	Bromodl-chloromethane	Chloroform	Chloroamines
Kondli Phase - I	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	3 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Nilothi Phase II	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	3 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Pappankala Phase II	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	3 ppm	BLQ	BLQ	BLQ	BLQ	BLQ

Table 11: Analytical results of STPs located in Mathura with respect to Physio-chemical parameters

STP locations	Installed Capacity (MLD)	Technology	Source	Parameters								
				pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	T. Coli. MPN/100 ml.	F. Coli. MPN/100 ml.
Laxmi Nagar, Mathura	16 MLD	UASB	Pre	7.2	179	298	119	28	-	-	$92X10^8$	$94X10^7$
			Post-(5 ppm)	7.1	96	142	41	20	-	-	6.1	3.6
Laxmi Nagar, Mathura	14.5 MLD	Oxidation pond	Pre	7.4	702	436	177	21	-	-	$16X10^8$	$16X10^8$
			Post (5 ppm)	7.1	94	147	49	16	-	-	$14x10^5$	$94X10^4$
Masani, Mathura	30 MLD	SBR	Inlet	7.1	198	223	56	19	-	-	-	-
			Pre	6.9	40	66	12	06	-	-	$16x10^5$	$54x10^4$
			Post (5 ppm)	7.0	40	67	13	01	-	-	$11x10^3$	$49x10^2$
Pagal baba, Vrindavan	4 MLD	Oxidation pond	Pre	7.4	148	226	57	24	-	-	$17X10^{11}$	$13X10^{11}$
			Post-(5 ppm)	7.2	92	143	44	16	-	-	$54x10^4$	$54x10^4$
Maant Road, Vrindavan	8 MLD	UASB	Pre	7.0	148	263	92	31	-	-	$35X10^7$	$35X10^7$
			Post-(5 ppm)	7.1	70	186	54	27	-	-	$70x10^5$	$70x10^5$
Masani, Vrindavan	6.8 MLD	Oxidation pond		Plant was found non-operational								

Table 12: Analytical results of STPs in Mathura with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP locations	Installed Capacity (MLD)	Arrangement of chlorination dosing (automatic/ manual)	Form of chlorination (Solid/ liquid/ Gaseous)	Dosing of chlorination (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters	
						TOC (mg/ L)	DOC (mg/ L)
Laxmi Nagar, Mathura	16 MLD	Manual	Liquid	5.0	Post	41.51	49.14
Laxmi Nagar, Mathura	14.5 MLD	Manual	Liquid	5.0	Post	33.76	34.59
Masani, Mathura	30 MLD	Automatic	Gaseous	5.0	Post	23.11	22.34
Pagal baba, Vrindavan	4 MLD	Manual	Liquid	5.0	Post	39.98	59.96
Maant Road, Vrindavan	8 MLD	Manual	Liquid	5.0	Post	34.37	51.66

Table 13: Analytical results of STPs in Mathura with respect to THMs

STP location	Chlornation dosing (in ppm)	THM and its compounds				
		Bromoform	Dibromo-chloromethane	Bromodl-chloromethane	Chloroform	Chloroamines
Laxmi Nagar, Mathura	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	6 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Laxmi Nagar, Mathura	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	6 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Masani, Mathura	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	6 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Pagal baba, Vrindavan	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	6 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Maant Road, Vrindavan	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	6 ppm	BLQ	BLQ	BLQ	BLQ	BLQ

Table 14: Analytical results of STPs located in Agra with respect to Physio-chemical parameters

STP locations	Installed Capacity (MLD)	Technology	Source	Parameters								
				pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	T. Coli. MPN/100 ml.	F. Coli. MPN/100 ml.
Sadarvan, Bichpuri, Agra	36 MLD	SBR	Pre	7.1	56	148	49	16	-	-	$13x10^5$	$13x10^5$
			Post-(5 ppm)	7.0	67	145	56	17	-	-	$11x10^8$	$11x10^8$
			Post (3 ppm)	7.3	65	148	45	16	-	-	$70x10^5$	$70x10^5$
Bichpuri, Agra	40 MLD	UASB	Pre	7.2	60	355	92	25	-	-	$11x10^5$	$79x10^4$
			Post (5 ppm)	7.1	51	419	149	16	-	-	$17x10^5$	$17x10^5$
Devori Road, Agra	12 MLD	UASB	Pre	6.9	43	106	28	10	-	-	$28x10^5$	$22x10^5$
			Post (5 ppm)	7.3	61	106	28	11	-	-	$22x10^7$	$11x10^7$
Dhandupura	24 MLD	UASB	Pre	7.0	166	147	61	10	-	-	$33x10^4$	$13x10^4$
			Post (5 ppm)	7.1	125	128	36	02	-	-	<1.8	<1.8
Jaganpura	24 MLD	UASB	Pre	7.1	62	143	45	11	-	-	$11x10^2$	$11x10^2$
			Post (5 ppm)	7.2	65	140	44	10	-	-	$22x10^6$	$14x10^6$

Table 15: Analytical results of STPs in Agra with respect to Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)

STP locations	Installed Capacity (MLD)	Arrangement of chlorination dosing (automatic/ manual)	Form of chlorination (Solid/ liquid/ Gaseous)	Dosing of chlorination (in ppm)	Source of sampling (pre/ post – chlorination)	Parameters	
						TOC (mg/ L)	DOC (mg/ L)
Sadarvan, Bichpuri, Agra	36 MLD	Automatic	Gaseous	-	Pre	46.26	53.93
				3.0	Post	45.06	43.83
				-	Pre	45.43	51.77
				5.0	Post	37.00	44.66
Bichpuri, Agra	40 MLD	Manual	Liquid	-	Pre	49.10	47.13
				5.0	Post	43.08	51.63
Devori Road, Agra	12 MLD	Manual	Liquid	-	Pre	31.24	34.02
				5.0	Post	33.51	29.95
Dhandupura	24 MLD	Manual	Liquid	-	Pre	46.38	47.63
				5.0	Post	37.94	41.66
Jaganpura	24 MLD	Manual	Liquid	-	Pre	33.90	32.52
				5.0	Post	29.02	32.58

Table 16: Analytical results of STPs in Agra with respect to THMs

STP location	Chlornation dosing (in ppm)	THM and its compounds				
		Bromoform	Dibromo-chloromethane	Bromodl-chloromethane	Chloroform	Chloroamines
Sadarvan, Bichpuri, Agra	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
	3 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Bichpuri, Agra	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Devori Road, Agra	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ
Dhandupura	5 ppm	BLQ	0.282	0.166	0.272	3.12
Jaganpura	5 ppm	BLQ	BLQ	BLQ	BLQ	BLQ

Annexure - IX

Table -17: Parameter wise Test Methods used for analysis of STP samples

S. No.	Parameter	Test Method
1.	pH	APHA 4500 H^+ - B, 24th Ed. 2023
2.	COD (mg/L)	APHA 5220 B, 24th Ed. 2023
3.	BOD (mg/L)	APHA 5210 B, 24th Ed. 2023, 4500 OC (5 days at 20° C), IS-3025 part 44:1993, BOD (3 days at 27° C)
4.	TSS (mg/L)	APHA 2540 D, 24th Ed. 2023
5.	NH_3-N (mg/L)	APHA 4500 NH_3 - B&C, 24th Ed. 2023
6.	PO_4-P (mg/L)	APHA 4500 PD, 24th Ed. 2023
7.	Total Coliform (MPN/100 mL)	APHA 23rd Ed. 2017
8.	Fecal Coliform (MPN/100 mL)	
9.	Bromoform (mg/L)	APHA 6232, 23rd Ed. & VEL/STP/FC-31, Issue No. 01, Issue date 01/11/2021
10.	Dibromo-chloromethane (mg/L)	
11.	Bromodl-chloromethane (mg/L)	
12.	Chloroform (mg/L)	
13.	Chloroamines (mg/L)	IS:3025(P-26):2021 (Colorimetric Method using DPD)
14.	TOC (mg/L)	APHA 5310 B, 23rd Ed.
15.	DOC (mg/L)	