BEFORE THE NATIONAL GREEN TRIBUNAL,

PRINCIPAL BENCH, NEW DELHI

EXECUTION NO. 11/2017

IN

O. A. No. 159/2013

IN THE MATTER OF:-

ALL INDIA LOKADHIKAR SANGATHAN ...APPLICANT

VERSUS

GOVT. OF NCT OF DELHI & ORS. ...RESPONDENTS

INDEX

(D. S. KHARAT)

ADDITIONAL DIRECTOR

CENTRAL POLLUTION CONTROL BOARD

PARIVESH BHAWAN, EAST ARJUN NAGAR

DELHI-110032.

PLACE: DELHI

DATED: 05.04.2019

Report of the Expert Committee in the Matter of M.A. No. 1715/2018 & M.A. No. 20/2019 In Execution Application No.11/2017, In O.A. No. 159/2013 With Review Application No. 01/2019 (I.A. No. 34/2019, I.A. No. 35/2019 & I.A. No. 49/2019, In Execution Application No.11/2017, In O.A. No. 159/2013 & O.A. No. 77/2016 With Review Application No. 07/2019 (I.A. No. 72/2019), Execution Application No.11/2017, In O.A. No. 159/2013 & O.A. No. 77/2016 With I.A. No. 74/2019 , In Original Application No. 77/2016; All India Lokadhikar Sangathan Versus Govt. of NCT of Delhi & Ors. With All India Lokadhikar Sangathan Versus Govt. of NCT of Delhi& Ors. With All India Lokadhikar Sangathan Versus Govt. of NCT of Delhi& Ors. With M/s. Ashok Vihar Mira Mandal Versus Delhi Pollution Control Committee & Ors. In compliance of Hon'ble National Green Tribunal (NGT) Order dated February 7, 2019.

Hon'ble National Green Tribunal (NGT) in the above matter passed an order on February 7, 2019 and the main portion of the Order is reproduced below:

> *However, before considering the matter further, it is necessary to ascertain the impact of the industry on the air quality of Delhi which is already highly polluted, on river Yamuna which is also subjected to severe pollution by several polluting activities, industrial as well as municipal, impact on the green belt and the inhabitants on account of huge hazardous waste already dumped and further potential for generation of such hazardous waste, if the pickling industry is to be allowed and the mechanism, if any, to deal with the poisonous liquids flowing in the area as depicted in the photographs caused damage to the environment, including the ground water. It is also necessary to ascertain the quantification of damage already caused and the cost of restoration of the environment, required to be incurred.*
>
> *The above questions may also require conducting of carrying capacity of the area on the anvil of sustainable development in permitting such hazardous and polluting activity.*
>
> *To enable this to be done, we constitute an Expert Committee comprising representatives from a senior Scientist of CPCB, a senior Scientist of National Environmental Engineering Research Institute (NEERI) and a senior Scientist of IIT, Roorkee. The nodal agency will be the CPCB.*
>
> *The Committee may visit the site and study the above issues and furnish a report to this Tribunal. If viability of such industries in the area is found, the conditions and precautions required in the matter may be mentioned.*
>
> *The report may be furnished as far as possible within two months from today by e-mail at ngt.filing@gmail.com.*

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We make it clear that it will be open to either side to furnish set of papers, including photographs and orders found relevant, based on the record of the present case, within two weeks from today. Any report earlier furnished may also be taken into account.

The CPCB may put the report on its website after the report is received. If there are any objection to the report, the same may be filed before this Tribunal.

A copy of the Hon'ble NGT Order dated 7.2.2019 is enclosed as **Annexure-1.**

In pursuance to the Hon'ble NGT Order, Central Pollution Control Board co-ordinated with the concerned Institutions to obtain nominations for the Expert Committee. The Expert Committee constituted vide CPCB Order No. IPC-V(SSI)/NGT/OA159/2019/ 18045-47 dated March 25, 2019 (**Annexure-2**), had the following members:

1. Professor A.A. Kazmi, Deptt. Of Civil Engineering, IIT Roorkee (Nominated by Director, IIT Roorkee);
2. Dr. S.K. Goyal, CSIR-NEERI (Nominated by Director, CSIR-NEERI); and
3. Dr. Narender Sharma, Additional Director, CPCB (Nodal officer, Nominated by Central Pollution Control Board).

As per Order of Hon'ble NGT, the expert Committee also took into account the following earlier relevant reports in this regard to assess the viability of such industries in this area and for studying the carrying capacity:

1. Inspection Report on "Soil and groundwater contamination due to improper sludge disposal of Wazirpur CETP" :

Based on a complaint received at CPCB regarding soil and groundwater contamination due to dumping of CETP sludge by Wazirpur CETP outside its premises, a Joint team comprising of officers from CPCB, DPCC and DSIIDC has inspected the site, the alleged dumpsite and the surrounding areas near CETP, Wazirpur on 07/03/2016. The Inspection Report is attached as **Annexure-3**.

The summary of the findings of the Joint Inspection is reproduced below:

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- *The soil in open area in front of the CETP where the waste material was allegedly buried appears to an amended soil with colour similar to background soils, however after excavation, a layer of dark coloured material mixed with soil (appears to be sludge/waste) appeared at a depth of about 6 feet below the top surface. Such dark coloured layers were observed up to 11 feet deep at two locations (at distance of 65 feet) during excavation. The layer of dark coloured material mixed with soil appears to be sticky, semisolid mass with unpleasant odour.*

- *Both the soil samples collected from surface and at a depth of about 10.5 feet below the surface at location 1 (in front of CETP premises) shows presence of heavy metals like iron (Fe), Zinc (Zn), manganese (Mn), nickel (Ni), lead (Pb), copper (Cu) chromium (Cr), vanadium (V) and Arsenic (As). Heavy metals such as chromium, copper and nickel were found exceeding the screening values many folds in both the samples except arsenic in sample 1 and in addition, lead, zinc and vanadium were also found exceeding the screening values in sample 2. The concentration of heavy metals in soils were compared with Canadian screening values for residential areas since, soil standards are not yet developed in the country. Further, Canadian screening standards were adopted for identification of probably contaminated sites in the country in a project undertaken by MoEF&CC.*

- *The soil sample i.e. Sample 3 collected at location 2 at a distance of about 65 feet from the location 1 was also having similar characteristic as that of Sample 2 collected from location 1.*

- *Reconnaissance carried out by CPCB indicates that all three Samples – 1, 2 and 3 were contaminated with heavy metals with concentrations above the Canadian screening standards (for residential areas). The contamination is attributed to improper handling and disposal of CETP sludge. Since the investigation is carried out in a limited area, it is required to carry out detailed site investigation in the areas to ascertain the extent of contamination. In case of widespread contamination, exceeding the screening values and*

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intervention values, it may warrant remediation of these contaminated areas.

- *A sample of soil (Sample 4) collected from the open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP was also found to contain heavy metals like iron (Fe), Zinc (Zn), manganese (Mn), nickel (Ni), lead (Pb), copper (Cu) chromium (Cr), vanadium (V) and Arsenic (As). The concentration of the same is similar to the concentration of heavy metals found in soil samples collected at location 1 and 2. Further, concentration of organic carbon in soil samples 2, 3 & 4 were found around 2 %.*

- *The analysis of samples indicates that soil samples 2, 3 & 4 and CETP sludge have same constituents with comparable concentrations. This indicates that, the CETP sludge has been buried in the suspected area in front of CETP at Wazirpur and dumped in the open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP.*

- *The groundwater sample collected from CETP premises exceed the BIS drinking water standards for iron and manganese, whereas only manganese was found above the drinking water standards in bore-well of DJB pump house. Another bore-well of DJB pump house at the back side of CETP found to be exceeding drinking water iron, manganese and lead.*

- *With regard to general parameters, TDS, nitrate and sulphates were found above the drinking water standards in groundwater sample collected from bore-wells of CETP and DJB pump house (at the back side of CETP), whereas only TDS and Nitrate exceeded drinking water standards in bore- well of DJB pump house in front side of CETP.*

- *The allegation made by the complainant with regard to CETP sludge buried in open area in front of CETP premises is correct. In addition, the surface soil sample collected from open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP indicates CETP sludge*

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dumping in the said area.

The following recommendations were given by the Joint Inspection Team:

- *The operator of the CETP facility is liable for environmental damages caused due to improper handling of hazardous waste and shall be directed to take immediate response measures and environmental site assessment and remediation (if required) as per the guidelines published by CPCB "Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty".*
- *CETP society may be directed to engage a 3rd party consultant having relevant experience to carry out detailed environmental site assessment as per the aforesaid guidelines of CPCB within one month. They shall submit a report to DPCC on detailed site assessment within 4 months thereafter.*
- *Penalty may be imposed on CETP society for improper handling or disposal of CETP sludge.*
- *Since there is no common TSDF in Delhi, CETP society shall create additional sludge storage facility till the time such common facility is established.*
- *CETP society shall provide shed on the sludge storage area near the tertiary treatment units.*
- *CETP society shall ensure that sludge removed from filter press should not be stored in open and it shall be ensured that dewatered sludge is lifted immediately and shifted to sludge storage area.*

2. NEERI's Report on Status of Common Effluent Treatment Plants (CETPs) in National Capital Region (NCR), Delhi:

This study was carried out by CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur in June, 2018, for assessment of the performance of all the CETPs in NCR of Delhi (**Annexure-4**). **During this assessment, Pickling industries connected to Wazirpur, SMA and Badli CETPs were in operation.**

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The major observations and conclusions of the Assessment Report prepared by NEERI are reproduced below:

- *The current design of CETPs is based on CSIR-NEERI's study performed during 1996 and implemented in 2004-2005. As informed by LUB the signature of several industries in different sectors has changed significantly over the last 10-15 years and it is high time the CETPs are revisited for a complete check-up to see performance & technology adequacies and minimize sludge production.*

- *The toxicity levels of all the CETP samples (mainly with respect to Cr, Cu, Fe, Zn) were extremely high and hence these cannot be used "as it is" for any road construction or similar activity. The possibility of stabilization of these toxic metals through known techniques needs to be examined.*

- *The Sludge samples cannot be used "as it is" for any road construction or similar activity and proper stabilization is vital.*

- *It is imperative to mention that data obtained in terms of removal efficiencies are superficial and do not reflect actual performance of CETP under existing operating conditions since all the CETPs are operating much below the designed capacities.*

- *The CETPs require up-gradation for targeting effective TKN removal as well as other parameters.*

- *Studies on reuse of treated effluent reveals that the current situation is not promising especially regarding the bacteriological parameter, i.e. Thermo-tolerant coliform. The water quality of effluent indicated presence of thermos-tolerant coliforms (indicator) and infectious pathogens such as pathogenic E.coli, cryptosporidium oocysts and Giardia cysts.*

- *Overall, the treated effluent water quality was observed to be in non-compliance with reuse water standards and hence is suggested to avoid reuse of treated effluent until proper treatment improvements are done.*

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3. CPCB's Assessment of Performance of CETPs conducted in January-February, 2019:

CPCB conducted performance assessment of all the CETPS in the month of January-February, 2019 and the results of three CETPs i.e. Wazirpur CETP, Badli CETP and SMA CETP, having membership of Pickling Industries are attached as **Annexure-5, Annexure-6** and **Annexure-7** respectively. **During this assessment by CPCB, Pickling Industries were not in operation.**

Analysis of the performance data of CETPs revels that none of the three CETPs is achieving the prescribed standards.

In Wazirpur CETP, the parameters of BOD (70 mg/l > 30 mg/l), F^- (14 mg/l > 2 mg/l), NO_3-N (96 mg/l > 10 mg/l), O&G (18 mg/l > 10 mg/l), FDS (6388 mg/l > 2100 mg/l), Fe (7.82 mg/l > 3 mg/l) and Mn (7.19 mg/l > 2 mg/l) were found significantly higher in concentration than prescribed standards.

In Badli CETP, the parameters of BOD (78 mg/l > 30 mg/l), F^- (19.66 mg/l > 2 mg/l), NO_3-N (26 mg/l > 10 mg/l), SO_4 (1209 mg/l > 1000 mg/l), FDS (2396 mg/l > 2100 mg/l) and Fe (4.74 mg/l > 3 mg/l) were found much beyond the prescribed standards.

In SMA CETP, the parameters of FDS (5360 mg/l > 2100 mg/l), SO_4 (1639 mg/l > 1000 mg/l), Cl^- (1104 mg/l > 1000 mg/l), CN^- (0.66 mg/l > 0.2 mg/l) were reported higher than prescribed standards.

It is evident from the above assessment carried out by CPCB that CETPs having membership of Steel Pickling units are not meeting the prescribed norms even in the absence of Effluents from Steel Picking Units. Once these CETPs start receiving effluents from Steel Pickling units, the values of parameters specific to steel pickling units such as Fe, NO_3-N, SO_4 and F^- are expected to further go up.

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As directed in the Order of the Hon'ble National Green Tribunal, the Expert Committee Visited the Site (Wazirpur Area) on March 28, 2019, to study the issues raised in the Application and the findings of the Expert Committee are as follows:

- *DPCC vide Letter No. DPCC/CMC-III/Wazirpur/2018/2740 dated 06/12/2018 has issued directions in Compliance of the Order of Hon'ble National Green Tribunal dated 16/10/2018 in the matter of All India Lokadhikar Sangthan Vs. Govt. of NCT of Delhi & Others, for stopping operations of Stainless Steel Pickling Industries .*

- *In view of the above Directions of DPCC, the pickling industries were not in operation at the time of visit of the Expert Committee. The committee could neither see nor study the adequacy and performance of Primary Effluent Treatment facilities of the Pickling Industries. For the same reasons, the Expert Committee could not assess the impact of pickling industries on air and river Yamuna as well.*

- *The Expert Committee also visited the Wazirpur Common Effluent Treatment Plant (CETP) where primary treated effluent from the pickling Industries is received for further treatment. A list of 104 Pickling Industries having CETP Membership was provided by the representative of Wazirpur CETP (**Annexure-8**). Since, CETP is not receiving effluent from Steel Pickling Units at the moment, the assessment of the performance of CETP for treatment of effluents from Steel Pickling Units could not be made by Expert Committee.*

Conclusions and Recommendations:

- *The Expert committee could neither see nor study the adequacy and performance of Primary Effluent Treatment facilities of the Pickling Industries, since the pickling industries were not in operation as per directions of DPCC. For the same reasons, the Expert Committee could not assess the impact of pickling industries on air and river Yamuna as well.*

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- *Since, CETP is not receiving effluent from Steel Pickling Units at the moment, the assessment of the performance of CETPs for treatment of effluents from Steel Pickling Units could not be made by Expert Committee.*

- *The findings of earlier reports (CPCB and NEERI) indicate that CETP installed to treat the wastewater/ effluent generated in the Wazirpur Industrial Area needs to be revisited to ensure proper treatment of the effluent generated not only from Steel Pickling Industries but also from mixed effluents received from other industries/activites of the area as well.*

- *It is recommended to conduct a detailed study including assessment of carrying capacity considering all types of industries and other activities with potential of air, soil and water pollution generation in this industrial area, since Pickling is only one of the intermediate process industries linked with a number of other upstream and downstream industries in the region. This study will also involve evaluation of CETPs for suggesting better pre-treatment of pickling liquor, cleaner production, improved air pollution control measures and upgradation of CETPs for tertiary treatment including nitrogen removal. This study may be undertaken under the supervision of the Expert Committee constituted as per Hon'ble NGT Order in this matter and is estimated to take 6 months' time for completion of the study and preparation of the report.*

The Joint Expert Committee shall abide by the Directions of Hon'ble National Green Tribunal in this matter.

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Dr. Narender Sharma CPCB	**Dr. S.K. Goyal** CSIR-NEERI	**Prof. A.A. Kazmi** IIT, Roorkee

Date: April 4, 2019

Item Nos. 01 to 04 Court N0.1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

M.A. No. 1715/2018 & M.A. No. 20/2019
In
Execution Application No.11/2017
In
O.A. No. 159/2013
With
Review Application No. 01/2019
(I.A. No. 34/2019, I.A. No. 35/2019 & I.A. No. 49/2019
In
Execution Application No.11/2017
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O.A. No. 159/2013 & O.A. No. 77/2016
With
Review Application No. 07/2019
(I.A. No. 72/2019)
Execution Application No.11/2017
In
O.A. No. 159/2013 & O.A. No. 77/2016
With
I.A. No. 74/2019
In
Original Application No. 77/2016

All India Lokadhikar Sangathan Applicant(s)

Versus

Govt. of NCT of Delhi & Ors. Respondent(s)

With

All India Lokadhikar Sangathan Applicant(s)

Versus

Govt. of NCT of Delhi& Ors. Respondent(s)

With

All India Lokadhikar Sangathan Applicant(s)

Versus

Govt. of NCT of Delhi& Ors. Respondent(s)

With

M/s. Ashok Vihar Mira Mandal Applicant(s)

Versus

Delhi Pollution Control Committee & Ors. Respondent(s)

Date of hearing: 07.02.2019

CORAM: **HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON**
HON'BLE MR. JUSTICE R. S. RATHORE, JUDICIAL MEMBER
HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER
HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER
HON'BLE DR. SATYAWAN SINGH GARBYAL, EXPERT MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

For Applicant(s): Mr. S.K. Bhatacharya and Mr. Brij Mohan Garg, Advocates

For Respondent(s): Mr. Sanjeev Ralli and Mr. Balaji Arusha, Advocates for DPCC
Mr. Krishna Kumar, Advocate for MoEF&CC
Ms. Pinky Anand, ASG, Mr. Hemant Arya, Advocate and Mr. Dinesh Jindal, LO
Mr. Vinay Kr. Garg, Senior Advocate, Mr. Ajay Jain and Mr. Pranay Jain, Advocates
Mr. Vivek Kumar Tandon, Advocate for CETP
Mr. Kush Sharma, ASC, for DDA
Mr. Tanmaya Mehta, Mr. Rajeev Aggarwal and Mr. Anunaya Mehta, Advocates of Review Applicant
Ms. Puja Kalra, Advocate for North MCD
Mr. Vinayak Gupta, Advocate and Mr. Harish Chandra, EE (Civil) for DSIIDC

ORDER

1. Review Application Nos. 1 and 7 of 2019 have been filed by the Wazirpur Industrial Estate Welfare Society and the Government of National Capital Territory of Delhi (GNCTD) and the Delhi Pollution Control Committee (DPCC) respectively, for review of the order of this Tribunal dated 16.10.2018 in Execution Application No. 11/2017 in O.A. No. 159/2013 and O.A. No. 77/2016.

2. M.A. No. 1715/2018 in E.A. No. 11/2017 in O.A. No. 159/2013 seeks enforcement of order dated 16.10.2018. I.A. No. 74/2019 in O.A. No. 77/2016 seeks direction to deal with the hazardous waste dumped at the green belt in Ashok Vihar, Phase-II, Delhi.

3. Our attention has been drawn to the order of the Hon'ble Supreme Court dated 14.12.2018 in *C.A. No. 11726-11727 of 2018* filed against the above order of this Tribunal by the GNCTD/DPCC and the Welfare Society of Wazirpur Industrial Estate, giving liberty to

move this Tribunal by way of review. In the course of the said order, observation made by the Hon'ble Supreme Court are as follows:

i. On the subject of decision of Delhi Government to allow industries to continue subject to compliance with the Environmental legislation contrary to the Master Plan.

"Be that as it may, no administrative decision can be taken in violation of the Master Plan" .. ………………………………………

"Prima facie, the above note only permits a determination of whether a particular industry, factory or activity falls in a specified entry. The negative or prohibited list cannot be amended by an administrative act in violation of the Master Plan."

ii. On the subject of direction to deposit Rs. 50 Crores as compensation for damage to the environment.

"Prima facie, the direction is relatable to the provisions of Section 17 of the National Green Tribunal Act, 2010. Consequently, we direct that in terms of the order passed by the NGT and before the applications for review are entertained, an amount of Rs. 15 crores be deposited within four weeks by GNCTD. The deposit shall abide by the final result of the applications for review."

iii. On the subject of reopening the industries which have been closed in pursuance of order of this Tribunal.

"Ms. Indira Jaising stated that in compliance with the order passed by the NGT, the operation of the industry has been stopped by disconnecting water and electricity connections. This position shall continue until the Tribunal disposes of the review petitions, and thereafter will be subject to the outcome."

4. The issue pertains to environmental hazards caused by the Stainless Steel Pickling (SSP) industries which figures at entry no. 88 in the prohibited/negative list of industries in the Master Plan, 2021. The other issue is handling of hazardous waste generated by the said industry.

5. This Tribunal in order dated 16.10.2016, *inter-alia*, observed that the industries in question were contributing to the waste dumped into the river Yamuna and were discharging acidic effluents which were highly polluted and impacted the air quality of Delhi. The said

industries were inherently polluting which led to their being placed in the prohibited list in the Master Plan. Inspite of order of Delhi High Court and this Tribunal, the Delhi Government failed to stop their operations.

6. We may briefly refer to the background in which the issue arises. In view of provisions of the Master Plan-2001, the Hon'ble Supreme Court noted that industries prohibited from operating in Delhi as per Master Plan are to be shifted from Delhi[1]. In the said judgment it was noted that Delhi was one of the most polluted cities in the world. The quality of ambient air was hazardous and diseases are on the increase. There was lack of open space. On land occupied by the hazardous industries being surrendered, the same could be used for community needs.[2] The issue of compliance of the provisions of the Master Plan was also considered in the later judgments of the Hon'ble Supreme Court. It was noted that hazardous industries had been shifted out of Delhi but certain industries were continuing in residential/non-conforming areas which were also required to be shifted out of Delhi in view of Master Plan-2021. In situ regularization was not permissible. It was necessary that the authority should not consider legalizing illegalities so that Delhi was left for future generations without being polluted. The stand of the Central Government and Delhi government in avoiding implementation of Master Plan was disapproved.[3]

7. However, it appears that the hazardous industries continued to operate in violation of the provisions of the Master Plan. On 23.03.2012, the DPCC directed closure of the said industries. In the first round of litigation, the said direction was quashed by the Delhi High Court on account of a procedural technicality but in next round

[1] (1996) 4 SCC 351 para 1
[2] Para 7 ibid
[3] (2004) 6 SCC 588 para 60

of litigation, vide order dated 11.11.2013 in *W.P. (C) No. 6904/2013*, it was held that in view of the Master Plan, prohibition for the industry was operative from 23.09.2013 and that the industries could not resume their activities without consent of the DPCC. The High Court also observed that the industries were highly polluting industries having effect on water/water bodies/drains.

8. The Tribunal, in the order dated 16.10.2018, referred to various earlier proceedings, including the order dated 17.10.2014 in O.A. No. 159/2013 noting the stand of the DPCC that the DPCC will not grant any permission to such units. Reference was also made to the order dated 13.12.2016 in Execution Application No. 33/2016. In the said order it was noted that in a meeting of the Delhi Government, DPCC, Delhi Development Authority (DDA) and Central Pollution Control Board (CPCB), a decision was taken to the effect that the pickling industries are in prohibited category. Consent to Operate had expired. In the order dated 25.07.2017 in Execution Application No. 11/2017, the Tribunal had required DPCC to explain why order of the Tribunal had not been implemented. In order dated 14.12.2017 in the same case, it was noted that the Secretary, Environment and the Secretary, Industries were required to ascertain the status of the pickling industries. Again, in the order dated 08.01.2018, it was noted by the Tribunal that there was a consensus that pickling industries could not be permitted after three years from 23.09.2013. In order dated 21.02.2018, the Tribunal again recorded the statement that the industries could not be allowed to work after three years from 23.09.2013. The Tribunal observed that after 23.09.2016, the industries did not have any Consent to Operate and were being run illegally. The Tribunal also observed that the metals used in pickling industries produced corrosive wastes and effluent discharge from these industries contained toxic waste harmful to the health and

aquatic life. Untreated effluents were being discharged in the river Yamuna. Accordingly, the operation of the industries was required to be stopped and the Delhi Government was required to pay Rs. 50 Crores for the damage to the environment which could be recovered from the erring industries or the erring officers. The amount was to be deposited with the CPCB.

9. The Hon'ble Supreme Court noted the plea that a decision of the Delhi Government dated 12.10.2018 could not be placed before the Tribunal and that under the Master Plan, 2021 though the category of industries was in prohibited list, the Environment Department in consultation with the Industries Department could take a final decision as to which industry was falling in the said list.

10. Further contention on behalf of the industries noted in the order of the Hon'ble Supreme Court is that the ETPs and the CETPs had been established which had the effect of abating the pollution and that the industry should be permitted to point out before this Tribunal that there has been an amendment in the Master Plan or that the Tribunal had no jurisdiction to pass the order.

11. We have heard learned Counsel for the Delhi Government, DPCC, DDA, the industries and the learned Counsel for the CETP in support of the Review Applications and learned counsel for the applicant in opposition thereto.

12. We have also heard learned Counsel for the applicant in M.A. No. 1715/2018 in E.A. No. 11/2017 in O.A. No. 159/2013 seeking enforcement of order dated 16.10.2018 and I.A. No. 74/2019 in O.A. No. 77/2016 seeking direction to deal with the hazardous waste dumped.

13. I.A. No. 74/2019 mentions that 7,000 tonnes of hazardous waste containing poisonous and toxic chemicals has been dumped on the green belt in the densely populated residential area at Ashok Vihar, Phase-II, Delhi. Order of the Tribunal dated 22.09.2016 records that NCT of Delhi does not have any mechanism or plan to treat the said hazardous waste and that they have sought allotment of land for the purpose from DDA as well as the Government of Haryana. The DDA has expressed its inability to give such land.

14. Learned Counsel for the review applicant submitted that order dated 16.10.2018 should be reviewed in view of order of Delhi Government dated 100.12.2018. The Master Plan could not be given effect in view of decision of Delhi Government. ETPs/CETP are operative and there is no pollution. Order of compensation could not be passed. Learned Counsel for the DDA has referred to letter dated 28.01.2019 addressed to the Urban Development Department of Central Government to the effect that the Central Government may like to consider the recommendations of the Delhi Government dated 16.01.2019 for deletion of SSP industries from serial no. 88 of the list of prohibited industries.

15. It is an undisputed fact that there is no amendment to the Master Plan. The SSP industry is part of prohibited list. The power of Delhi Government is limited to only determine whether a particular activity is part of such prohibited list and not to ignore the said list or modify the said list or permit industry falling in the said list to operate with or without any condition.

16. Learned ASG for Delhi Government has not been able to show the alleged order of the Delhi Government dated 12.10.2018 relied before the Hon'ble Supreme Court. However, she made reference to minutes of meeting held on 04.04.2018 in pursuance of order of NGT order

dated 14.12.2017 to determine whether the pickling industrial activity was covered by prohibited list of industries. In the said meeting there is reference of earlier meeting dated 27.12.2017 appointing a Committee of two SEs of DSIIDC and two officers of DPCC to inspect the level of compliance by the pickling industries. In the said meeting, recommendation was to consider whether SS pickling activity could be allowed to operate subject to compliance of consent condition of DPCC with regard to installation of ETPs and periodic checks of functioning of ETPs. Reference is also made to letter addressed to DDA dated 16.1.19 to delete item no. 88 from list of prohibited industries.

17. Learned counsel for the applicant submitted that no ground has been made out for the review of order of this Tribunal dated 16.10.2018. The review applications are liable to be dismissed. It is pointed out that the scope of order of this Tribunal dated 14.12.2017 which is the basis of meeting dated 27.12.2017 was limited to consider the question whether pickling industry was in the prohibited list but the Delhi Government assumed jurisdiction to go into the question of deleting the said industry from the prohibited list in the Master Plan. This was neither a suggestion of this Tribunal nor is within the purview of the Delhi Govt. In any case, the exercise undertaken of inspecting the industrials areas and suggesting deletion of the prohibited list can hardly be the justification for amendment of the Master Plan. Even otherwise, the Master Plan prohibiting highly polluting industry in Delhi cannot be amended to permit such prohibited industry without dealing with the circumstances under which such a provision was made namely, inherent nature of generation of pollution by such industries, adverse impact of such industry on polluted ambient air, impact on polluted Yamuna river and overall environment of Delhi. Such amendment could be thought

of only if facts which led to inclusion of inherently polluting industries in the list are addressed which has not been done. It will be ridiculous to say that ambient air quality has improved, environment of Delhi has improved so as to permit inherently polluting industries to be continued, reversing the earlier statutory provisions of the Master Plan-2001 and 2021. Master Plan amendment of such massive nature which may add to the pollution of Delhi cannot be a light hearted exercise without having any study of the public health and the needs for environment. It was also submitted that impact of adding acidic effluents and generation of hazardous waste required serious studies particularly when it has been consistently found in the past that mere ETP/CETP were not enough to take care of discharge of acidic and metal bearing effluent by the pickling industries.

18. Reference has also been made to the order of this Tribunal dated 06.11.2015 in *Rakesh Jain vs. DPCC, Appeal No. 46/2015* showing that the DPCC itself had found the SSP industry to be highly polluting and that the ETP/CETP were of no avail in the matter. The impact of polluting industries is not only on the air quality on account of release of acids in the process of electroplating. Its impact is also on the river Yamuna. Air of Delhi as well as river Yamuna are facing challenge by ever increasing pollution.

19. The photographs have been placed on record depicting very grim picture of flowing of liquids which are said to be poisonous and harmful to the soil and the inhabitants.

20. Thus it is clear:

    i. There is no amendment to the master Plan.

    ii. There is no power with the Delhi Government to permit industrial activity falling in the prohibited list in the Master Plan.

iii. No study has been carried out which can be the basis to justify amendment of the Master Plan. There is no information on the Comprehensive Environmental Pollution Index (CEPI) in respect of the area.

iv. Mere setting up of ETPs/CETP is not enough to permit activities of prohibited industries in violation of the Master Plan.

v. Consistent decisions of DPCC and Delhi Government and their authorities recorded in the orders of this Tribunal show that high amount of pollution is actually being caused by the pickling industries. There is no change of circumstances.

vi. Huge amount of hazardous waste is being generated and dumped and is not being scientifically disposed.

vii. Photographs on record depict grim picture of polluted effluents flowing through the drains and entering Yamuna.

21. Principle of sustainable development is a part of right to life.[4] No inherently polluting activity can be allowed in violation of law.[5] The polluter can be prohibited from carrying on polluted activities and can also be required to pay the cost of restoration of the environment. Even the authorities which connive with the polluter or failed to perform their duties inspite of orders of the Court or Tribunal can be required to pay cost for damage to the environment. The precautionary principle requires anticipating and prohibiting inherently polluting activities. Environment belongs to people.[6] Regulatory authorities dealing with the environment are trustees to exercise their powers for the people to protect environment. Access to potable water and to fresh air are fundamental rights of citizens.[7] Precautionary principle is to be strictly observed in areas which are already polluted and do not have any carrying capacity to permit any further polluting activity. In this circumstances, we find it difficult to accept the review applications.

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[4] Vellore Citizens v. Union of India (1996) 5 SCC 647
[5] M.C. Mehta v. Union of India & Ors., (1997) 3 SCC 715
[6] *Supra* note 4
[7] A.P. Pollution Control Board II v. M.V. Nayudu & Ors., (2001) 1 SCC 162

22. However, before considering the matter further, it is necessary to ascertain the impact of the industry on the air quality of Delhi which is already highly polluted, on river Yamuna which is also subjected to severe pollution by several polluting activities, industrial as well as municipal, impact on the green belt and the inhabitants on account of huge hazardous waste already dumped and further potential for generation of such hazardous waste, if the pickling industry is to be allowed and the mechanism, if any, to deal with the poisonous liquids flowing in the area as depicted in the photographs caused damage to the environment, including the ground water. It is also necessary to ascertain the quantification of damage already caused and the cost of restoration of the environment, required to be incurred.

23. The above questions may also require conducting of carrying capacity of the area on the anvil of sustainable development in permitting such hazardous and polluting activity.

24. To enable this to be done, we constitute an Expert Committee comprising representatives from a senior Scientist of CPCB, a senior Scientist of National Environmental Engineering Research Institute (NEERI) and a senior Scientist of IIT, Roorkee. The nodal agency will be the CPCB.

25. The Committee may visit the site and study the above issues and furnish a report to this Tribunal. If viability of such industries in the area is found, the conditions and precautions required in the matter may be mentioned.

26. A copy of this order be sent to the CPCB by e-mail for coordination and compliance.

27. The report may be furnished as far as possible within two months from today by e-mail at ngt.filing@gmail.com.

28. We make it clear that it will be open to either side to furnish set of papers, including photographs and orders found relevant, based on the record of the present case, within two weeks from today. Any report earlier furnished may also be taken into account.

29. The CPCB may put the report on its website after the report is received. If there are any objection to the report, the same may be filed before this Tribunal.

List the matter for further consideration on the date already fixed i.e. 27.05.2019.

Adarsh Kumar Goel, CP

R. S. Rathore, JM

S.P. Wangdi, JM

K. Ramakrishnan, JM

Dr. Satyawan Singh Garbyal, EM

Dr. Nagin Nanda, EM

February 07, 2019
M.A. No. 1715/2018 & M.A. No. 20/2019
In Execution Application No.11/2017 In
O.A. No. 159/2013 and other connected matters
DV

CENTRAL POLLUTION CONTROL BOARD
(Ministry of Environment, Forest and Climate Change, Govt. of India)
'Parivesh Bhawan', East Arjun Nagar
Shahdara, Delhi-110032
Tel: +91 11 43102030; Telefax: +91 11 22305793

No. IPC-V(SSI)/NGT/OA159/2019 March 25, 2019

Order

The Hon'ble NGT vide its order dated 07/02/2019 in the matter of M.A. No. 1715/2018 & M.A. No. 20/2019 in Execution Application No. 11/2017 in OA No. 159/2013; All India Lokadhikar Sangathan Vs Govt of NCT of Delhi &Ors. constituted Expert Committee comprising of a Senior Scientist of CPCB, a Senior Scientist of National Environmental Engineering Research Institute (NEERI) and a Senior Scientist of IIT Roorkee, to visit the site, study the issues and prepare a report. The nodal agency in this matter is CPCB.

In compliance of the above order, the Central Pollution Control Board (CPCB), Delhi constitutes the Committee comprising of the following members:

1. Prof. A.A. Kazmi, Dept. of Civil Engineering, IIT Roorkee (Nominated by Director, IIT Roorkee);
2. Dr. S. K. Goyal CSIR-NEERI, Nagpur (Nominated by Director, CSIR-NEERI); and
3. Dr. Narender Sharma, Additional Director (Nominated by CPCB, Delhi).

Terms of Reference:

a) The 3-Member Committee shall accomplish work as per the Hon'ble NGT Order dated 07/02/2019, to submit report within the time frame fixed by the Hon'ble NGT.
b) CPCB shall pay an amount of Rs 5000/- to non-official members per meeting and car facility as per the Hon'ble NGT order dated 20.04.2017 and guideline issued by MoEF&CC in this regard. Sampling, Laboratory facilities and Secretarial services would be provided by CPCB.
c) Dr. Narender Sharma, Additional Director, IPC-V(SSI) Division, CPCB is nominated as the nodal officer for the Committee.

(Prashant Gargava)
Member Secretary

To

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Copy to:

I/c F&A/LO(UT)

(Prashant Gargava)

Annexure III

Inspection Report

on

"Soil and groundwater contamination due to improper sludge disposal of Wazirpur CETP"

Background

CPCB has received a complaint dated 21/01/2016 made by Shri Brij Mohan Garg, Convener, Wazirpur Industries Joint Action Committee regarding soil and groundwater contamination due to dumping of CETP sludge by Wazirpur CETP outside its premises. The said complaint was addressed to Hon'ble Minister of Environment, Forest & Climate Change (MoEF&CC) which was forwarded to CPCB by MoEF&CC with directions to conduct an inspection in the matter. Another complaint on the similar matter was received in DPCC.

In response above, the following officers from CPCB, DPCC and DSIIDC have inspected the site the alleged dumpsite and the surrounding areas near CETP, Wazirpur on 07/03/2016:

1. Ankush Tewani, EE, CPCB Head Office, Delhi
2. G. Rambabu, EE, CPCB Head Office, Delhi
3. Chandan Singh, RA, CPCB
4. M.I. Siddiqui, EE, DPCC
5. Rajeev Sharma, EE, DPCC
6. Abid Ali, Trainee Engineer, DPCC
7. Sharat Kumar, SE, DSIIDC

The representatives of Wazirpur Industries Joint Action Committee, the residents of Ashok Viharand J.J. cluster Jailorwala Baghwere also present during inspection:

1. Brij Mohan Garg, Convener, Wazirpur Industries Joint Action Committee
2. Naval Gupta, Wazirpur Industries Joint Action Committee
3. Pradeep Tewotia, Representative of Ashok Vihar Residential Area
4. Representative of J.J. cluster Jailorwala Bagh

1. Details of Sampling

The inspection team collected samples of soil at different depths, CETP sludge and groundwater from adjoining locations of CETP at Wazirpur. The details of sampling are given below:

(a) Soil and Sludge samples

Four soil and sludge samples were collected from following three locations/ sources:

Sample 1 & 2	Two soil samples were collected at a location (the suspected sludge burying site) in front of CETP premises at different depths. Sample 1 is of top soil from the surface and sample 2 is collected at a depth of about 10.5 feet. The sample collected at 10.5 feet appears to be a layer of sludge/waste material mixed with soil.
Sample 3	Soil mixed with layers of sludge/waste material collected at a depth of 9 feet from the same open area as mentioned above at a distance of about 65 feet from the first location.
Sample 4	One soil sample from surface collected from the open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP.

The location of the three soil samples marked as 1, 2 and 3 are shown with help of Google Earth at Annexure A.

Soil excavation for sampling was done with help of JCB. At the request of the complainant the samples collected at depth of 10.5 feet and 9 feet were shared with them.

(b) CETP Sludge Samples

One sample each of the dewatered sludge removed from filter press and the dry sludge stored in the CETP premises was also collected.

(c) Groundwater Samples

Groundwater samples were collected from three locations/ sources:

i) Bore well inside the CETP premises. The groundwater level was about 120 feet as informed by representative of the CETP society. At the request of the complainant this sample was also shared with them.
ii) DJB Pump House, Phase II, Ashok Vihar adjacent to Khojewala Park (opposite to House No. 125 A) located at the front side of CETP at approximate distance of 150 feet from CETP premises. The groundwater level was around 100-120 feet as informed by the DJB pump operator.
iii) DJB Pump House adjacent to JJ cluster, JailorwalaBagh, Ashok Vihar Phase II located at back side of CETP at approximate distance of 100 feet from CETP premises. The pump house is not in operation and not used for water supply as informed by the residents of JJ cluster. The groundwater level was around 240 feet as informed by residents of JJ cluster.

The location of the three groundwater sampling points marked as A, B, and C are shown with help of Google Earth at Annexure A.

2. Observations and Findings

(i) Primary Observation(s) w.r.t. sludge burying site

Thesoil in open area in front of the CETP where the waste material was allegedly buried appears to an amended soil with colour similar to background soils, however after excavation, a layer of dark coloured material mixed with soil (appears to be sludge/waste) appeared at a depth of about 6 feet below the top surface. Such dark coloured layers were observed up to 11 feet deep at two locations (at distance of 65 feet) during excavation (Photographs enclosed Annexure B). The layer of dark coloured material mixed with soil appears to be sticky, semisolid mass with unpleasant odour.

(ii) Observation on CETP sludge management inside CETP premises –

a. CETP sludge is stored within enclosed area made of concrete walls near the filter press and the tertiary treatment units. The enclosed sludge storage area near the filter press is covered with shed but the enclosed sludge storage area near tertiary treatment units is not covered with shed.

b. The height of sludge storage area has been gradually increased by CETP society to accommodate storage of sludge generated from effluent treatment, which is a concern for structural failure due to weight/excess loading.

c. The sludge collection area beneath the filter press was filled up completely with sludge and sludge was found spread in open area.

(iii) Analysis Results (of Soil, waste material and CETP Sludge)

Samples of soiland CETP sludge were analysed for heavy metals and organic carbon. The results of heavy metals are given in Annexure C. Observations on the basis of analysis results are as below;

a. Both the soil samples (sample 1 & 2) collected from surface and at a depthsof about 10.5 feet below the surface at location 1 (in front of CETP premises) shows presence of heavy metals like iron (Fe), Zinc (Zn), manganese (Mn),nickel (Ni), lead (Pb), copper (Cu) chromium (Cr), vanadium (V) and Arsenic (As). Heavy metals such as chromium, copper andnickelwere found exceeding the screening values many folds in both the samplesexcept arsenic in sample 1 and in additionlead, zinc and vanadium were also found exceeding the screening valuesin sample 2. The concentration of heavy metals in soils were compared with Canadian screening values for residential areas since, soil standards are not yet developed in the country. Further, Canadian screening standards were adopted for identification of probably contaminated sites in the country in a project undertaken by MoEF&CC.

b. The soil sample i.e. Sample 3 collected at location 2 at a distance of about 65 feet from the location 1 was also having similar characteristic as that of Sample 2 collected from location 1.

c. Reconnaissance carried out by CPCB indicates that all three Samples – 1, 2 and 3 were contaminated with heavy metals with concentrations above the Canadian screening standards (for residential areas).The contamination is attributed to improper handling and disposal of CETP sludge. Since the investigation is carried out in a limited area, it is required to carry out detailed site investigation in the areas to ascertain the extent of contamination. In case of widespread contamination, exceeding the screening values and intervention values, it may warrant remediation of these contaminated areas.

d. A sample of soil (Sample 4) collected from the open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETPwas also found to contain heavy metals like iron (Fe), Zinc (Zn), manganese (Mn), nickel (Ni), lead (Pb), copper (Cu) chromium (Cr), vanadium (V) and Arsenic. The concentration of the same is similar to the concentration of heavy metals found in soil samples collected at location 1 and 2. Further, concentration of organic carbon in soil samples 2, 3 & 4 were found around 2 %. The analysis result is given at Annexure D.

e. The analysis of samples indicates that soil samples 2, 3 &4 andCETP sludge have same constituents with comparable concentrations. This indicates that, the CETP sludge has been buried in the suspected area in front of CETP at Wazirpur and dumped in the open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP.

(iv) Analysis Results of Groundwater Samples

The analysis results of groundwater samples collected for heavy metals and general parameters concentration are given at Annexure E and the observations on basis of analysis results are as below:

a. The groundwater sample collected from CETP premises exceed the BIS drinking water standards for iron and manganese, whereas only manganese was found above the drinking water standards in bore well of DJB pump house. Another bore-well of DJB pump house at the back side of CETP found to be exceeding drinking water iron, manganese and lead.

b. With regard to general parameters, TDS, nitrateand sulphates were found above the drinking water standards in groundwater sample collected from bore-wells of CETP and DJB pump house (at the back side of CETP), whereas only TDS and Nitrate exceeded drinking water standards in bore well of DJB pump house in front side of CETP.

(v) The allegation made by the complainant with regard to CETP sludge buried in open area in front of CETP premises is correct. In addition, the surface soil sample collected from open area outside and adjacent to the boundary wall of CETP near the sludge storage area of the CETP indicates CETP sludge dumping in the said area.

(vi) CETP sludge has been classified as Hazardous Waste under category 35.3 as per Schedule-I of Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016 and hence the operator of CETP shall ensure storage, handling and disposal of the same as per the authorization issued under the said Rules.

3. Recommendations

(i) The operator of the CETP facility is liable for environmental damages caused due to improper handling of hazardous waste and shall be directed to take immediate response measures and environmental site assessment and remediation (if required) as per the guidelines published by CPCB “Guidelines onImplementing Liabilities for EnvironmentalDamages due to Handling & Disposal ofHazardous Waste and Penalty” (copy enclosed).

(ii) CETP societymay be directed to engage a 3rd party consultant having relevant experience to carry out detailed environmental site assessment as per the aforesaid guidelines of CPCBwithin one month. They shall submit a report to DPCC on detailed site assessment within 4 months thereafter.

(iii) Penalty may be imposed on CETP society ~~and its members~~ for improper handling or disposal of CETP sludge.

(iv) Since there is no common TSDF in Delhi, CETP society shall create additional sludge storage facility till the time such common facility is established.

(v) CETP society shall provide shed on the sludge storage area near the tertiary treatment units.

(vi) CETP society shall ensure that sludge removed from filter press should not be stored in open and it shall be ensured that dewateredsludge is lifted immediately and shifted to sludge storage area.

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Annexure A

Untitled Placemark
CETP
JJ cluster
Untitled Placemark
Untitled Placemark
Lal Bagh
Railway Rd
Ashok Vihar residential area
Pocket A Road
Pocket B
Pocket C 1
Mojiwala Bagh Village
Block N
GT Karnal Rd
Image © 2016 DigitalGlobe
© 2016 Google
Google
Imagery Date: Sep 25, 2014
28°42'04.36" N 77°10'35.75" E elev 215 m
Eye alt 1.28 km

Annexure B

Soil layer at depth of 10.5 feet having colour of sludge

Soil layer at depth of 9 feet having colour of sludge

Soil sample collected from surface

Sludge samples having colour of sludge collected from two locations

Annexure C

Analysis results of Soil, waste material and CETP Sludge samples w.r.t heavy metals

S.No	Sampling Source/ Location	As (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Zn (mg/Kg)	Co (mg/Kg)	Se (mg/Kg)	V (mg/Kg)
1	Soil sample from surface in front of CETP (location 1)	**14.0**	0.003	**2,379.6**	**325.8**	52,374.8	1,418.5	**137.8**	53.6	97.5	16.0	BDL	52.0
2	Soil at a depth of 10.5 feet at Location 1	**62.0**	BDL	**26,919.6**	**2,785.8**	270,014.8	6,418.5	**799.8**	**187.6**	**207.5**	40.0	BDL	**142.0**
3	Soil sample at depth of 9 feet in front of CETP premises (location 2)	**36.0**	BDL	**19,199.6**	**2,701.8**	199,214.8	8,878.5	**949.8**	37.6	**205.5**	**50.0**	BDL	100.0
4	Soil sample adjacent to boundary wall near sludge storage area of the CETP	**26.0**	BDL	**24,699.6**	**2,963.8**	227,294.8	4,978.5	**993.8**	35.6	113.5	42.0	BDL	100.0
	*screening standard for Soil and Sediment	12	10	64	63	-	-	50	140	200	50	1	130
	Minimum Detection Limit	0.05	0.04	0.06	0.04	0.07	0.04	0.05	0.03	0.06	0.04	0.11	0.05

*Canadian Screening values for Soil and Sediment Residential/ Parkland

S. No	Sampling Source/ Location	As (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Zn (mg/Kg)	Co (mg/Kg)	Se (mg/Kg)	V (mg/Kg)
1.	CETP sludge from beneath filter press	30	BDL	29,739.6	3,925.8	278,974.8	7,898.5	2,005.8	39.6	259.5	94.0	BDL	118.0
2.	CETP sludge stored in sludge storage area	12.0	BDL	17,179.6	3,999.8	152,514.8	22,678.5	1,95.8	11.6	285.5	124.0	BDL	112.0

Annexure D

Analysis results of Soil, waste material and CETP Sludge samples w.r.t organic carbon

S.No	Sampling Source/ Location	Organic Carbon %
1	Soil sample from surface in front of CETP (location 1)	0.31
2	Soil at a depth of 10.5 feet at Location 1	2.94
3	Soil sample at depth of 9 feet in front of CETP premises (location 2)	2.59
4	Soil sample adjacent to boundary wall near sludge storage area of the CETP	2.70
5	CETP sludge stored beneath filter press	1.07
6	CETP sludge stored in sludge storage area	0.13

Annexure E

Analysis results of groundwater samples w.r.t heavy metals and general parameters

S. No	Sampling Source/ Location	As (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Zn (mg/l)	Co (mg/l)	Se (mg/l)	V (mg/l)
1	CETP	BDL	BDL	BDL	BDL	**0.63**	**2.09**	BDL	BDL	0.02	BDL	BDL	BDL
2	DJB pump house in front of CETP	BDL	BDL	BDL	BDL	0.10	**0.12**	BDL	BDL	BDL	BDL	BDL	BDL
3	DJB pump house at back of CETP	BDL	BDL	BDL	BDL	**1.40**	**0.92**	BDL	**0.02**	0.06	BDL	BDL	BDL
4	Indian Drinking water standards	0.01	0.003	0.05	0.05	0.30	0.10	0.02	0.01	5	-	0.01	-
	Minimum Detection Limit (μg/l)	0.49	0.42	0.56	0.35	0.67	0.43	0.54	0.31	0.59	0.35	1.13	0.52

S.No	Sampling Location	pH	COD (mg/l)	TDS (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	Sulphate (mg/l)
1	CETP	6.8	08	**1080**	132	**205**	**365**
2	DJB pump house in front of CETP	7.1	BDL	**580**	90	**49**	128
3	DJB pump house at back of CETP	7.0	BDL	**1325**	166	**125**	**388**
4	Indian Drinking water standards	6.5-8.5	-	500	250	45	200

Annexure IV

Report

Status of Common Effluent Treatment Plants (CETPs) in National Capital Region (NCR), Delhi

Submitted to

Laghu Udyog Bharti
New Delhi

CSIR-National Environmental Engineering Research Institute, Nagpur
2018

Foreword

Laghu Udyog Bharti (LUB), New Delhi is closely working with CETP associations of Delhi and approached CSIR-NEERI in May 2018 to address issues pertinent to CETPs in Delhi. Accordingly, CSIR-NEERI visited Delhi during June 2018 to carry out the performance assessment of CETPs under existing operating conditions. This report incorporates details of field based investigations related to i) Disposal/ Reuse of stored sludge ii) Adequacy of primary treatment systems for minimization of sludge and iii) Reuse of treated effluent. The report also presents existing status with respect to above issues and also includes recommendations for action.

The trust and support extended by LUB New Delhi and CETP Association to CSIR-NEERI during the field investigations studies is gratefully acknowledged.

Rakesh

Nagpur **Rakesh Kumar**

July 11, 2018

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Dr. Rakesh Kumar

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I. Preamble

CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur has been instrumental in designing and commissioning Common Effluent Treatment Plants (CETPs) for homogenous and heterogeneous industrial clusters in the country. CETPs helped in achieving 'Economics of Scale' in waste treatment, thereby reducing the cost of pollution abatement. CSIR-NEERI has carried out feasibility assessment studies of CETPs including identification of types and volumes of wastes generated, estimation of future waste loads, identification of treatment options, cost apportionment studies and evaluation of cleaner technologies etc. CETPs designed and commissioned by CSIR-NEERI at various industrial clusters helped in prevention of water and soil pollution.

Laghu Udyog Bharti (LUB) is closely working with CETP associations of Delhi and had visited CSIR-NEERI on May 17, 2018 to discuss issues pertinent to CETPs in Delhi and requested CSIR-NEERI to address comprehensively. Minutes of the meeting are presented in Annexure – I. Following issues were discussed and accordingly CSIR-NEERI has submitted a comprehensive project proposal to LUB Delhi.

A) Disposal/ Reuse of stored sludge with due concerns in modifications of regulatory norms: Under existing conditions, the chemical sludge generated at the CETPs is posing serious burden on the industry as it is not being allowed to be disposed of and advised to store in the CETP premises.

B) Adequacies of CETPs for minimization of sludge production: The current design of CETPs is based on CSIR-NEERI's study performed during 1996 and implemented in 2004-2005. As informed by LUB the signature of several industries in different sectors has changed significantly over the last 10-15 years and it is high time the CETPs are revisited for a complete check-up to see performance & technology adequacies and minimize sludge production.

C) Reuse of treated effluent from CETPs: To examine the potential for recycling approximately 24000 m^3/d effluent for non-potable purpose such as toilet flushing etc.

D) Training Needs: CSIR-NEERI to provide training to CETP personnel for smooth functioning of CETPs.

Post discussions, three teams from CSIR-NEERI visited Delhi during June 2018 to carry out the performance assessment of CETPs under existing operating conditions.

II. Study Area

The list of CETPs visited and studied by CSIR-NEERI teams along with its treatment capacity, sludge generation and address are given in Table 1 and the map showing location of CETPs at NCR, Delhi is shown in Figure 1.

Accordingly, this report comprises of status of CETPs of under existing operating conditions and incorporates necessary recommendations for further course of action:

1) Treatment, disposal and reuse of stored chemical sludge with recourse to recycle and reuse use while also considering Regulatory Norms,

2) Adequacies of CETPs for minimization of sludge production,

3) Reuse of treated effluent from CETPs

Each of above components is described in following sections.

Table 1: List of CETPs at NCR, Delhi

Sr.No.	Name of CETP	Address	Present flow (Million Litres Per Day)*	Approx. Stored Sludge in Tones*
1.	CETP, Lawrence Road	KeshavPuram, Tri Nagar New Delhi, Delhi 110035	2	700
2.	CETP, Naraina	Block CB, Naraina Village, Naraina, Delhi 110028	5	3203
3.	CETP, GTK Karnal	B block Gate, Karnal Road, Industrial Area, Industrial Area, Daulat Ram Dharamvir Axles, Ashok Vihar, Delhi, 110009	3	1266
4.	CETP, Nangloi	Block C, Delhi State Industrial and Infrastructure Development, Nangloi, Delhi, 110041	1.5	554
5.	CETP, Mayapuri	Opp. Govt of India press, phase-I Mayapuri industrial area, New Delhi – 110064	4	1459
6.	CETP, SMA	Block E, Rajasthan Udyog Nagar, Jahangirpuri Delhi, 110033	2.5	500
7.	CETP, Wazirpur	Block B, Wazirpur Industrial Area Delhi 110052	1.5	1400
8.	CETP, Badli	Behind Suraj Park, Sector-18, Rohini, Delhi-110085	2	1360
9.	CETP, Mangolpuri	A-Block, Mangolpuri, Delhi, 110034	1.5	300
10.	CETP, Jhilmil	87-A, Jhilmil Industrial Area Delhi 110095	5	276
11.	CETP, Okhla	141, C Block Rd, Pocket C, Okhla Phase I, Okhla Industrial Area, New Delhi, Delhi 110020	4	3500

* Based on secondary data provided by CETP's association

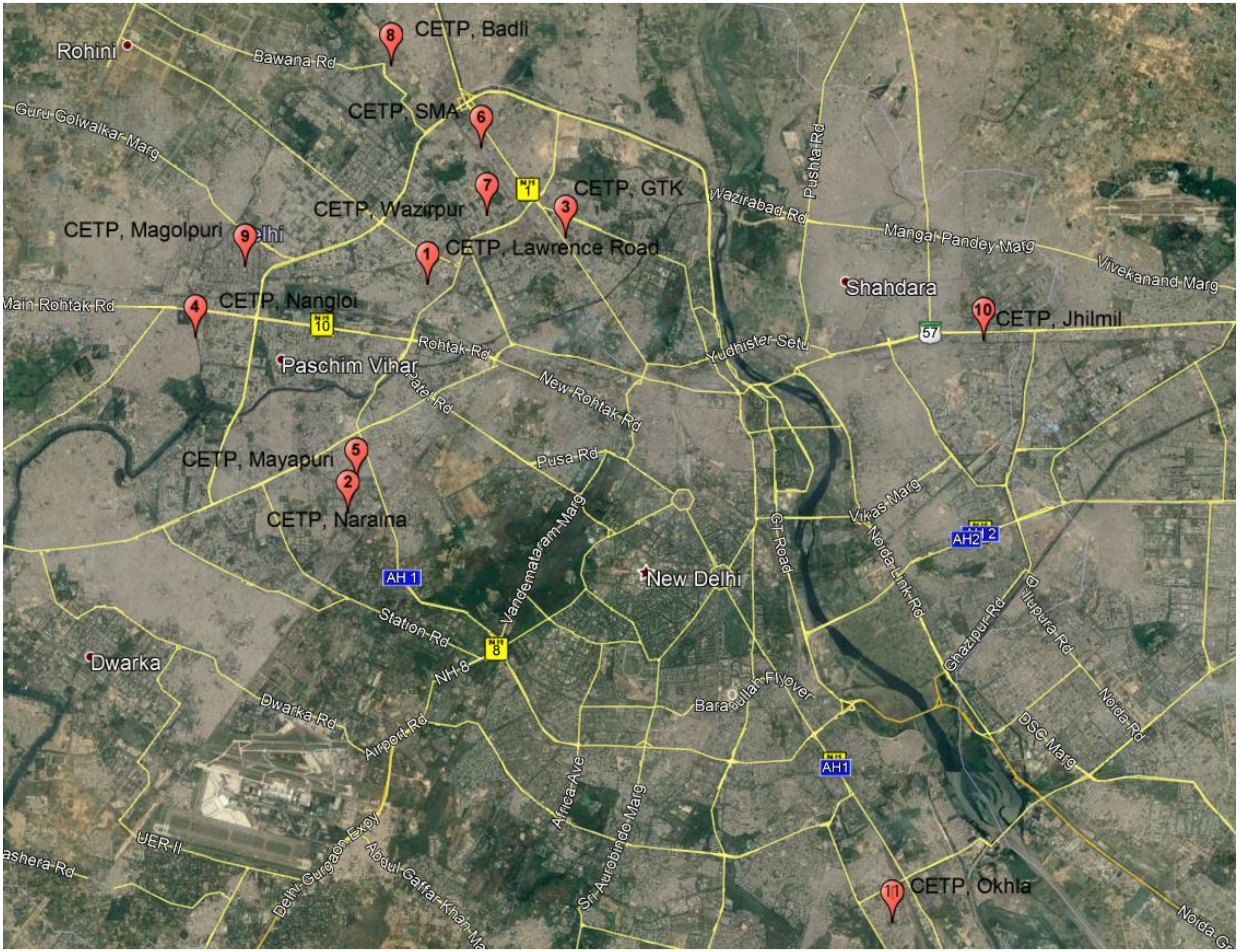


Figure 1: Map showing locations of CETPs at NCR, Delhi

1. Treatment, disposal and reuse of stored chemical sludge with recourse to recycle and reuse use while also considering Regulatory Norms

A team from CSIR-NEERI visited 11 CETPs Delhi during June 5-6, 2018 for preliminary assessment of sludge and grit storage areas. Sludge and Grit samples were collected from the storage areas within the CETPs during the visit and analysed for following parameters.

1) Proximate analysis
2) pH
3) Heavy Metal analysis
4) Toxicity Characteristics Leaching Procedure (TCLP)

All these analyses were carried out as per Standard procedures and methods such as SW846. The preliminary results for various parameters are presented in Tables 2 - 6.

Table 2: Proximate Analysis of Stored Sludge and Grit at CETPs Delhi

Sr. No.	Sample from CETP	Moisture content (%)	Volatile solids (%)	Ash content (%)
1	Lawrence Road Industrial CETP Grit	2.40	5	**91.40**
2	Lawrence Road Industrial CETP Final Sludge	63.80	15.2	20.20
3	Naraina CETP Grit	44.40	9.2	45.60
4	Naraina CETP Sludge	**79.20**	5	13.8
5	GT Karnal RD CETP Grit	60.88	7.4	30.54
6	GT Karnal RD CETP GT Sludge	65.00	7.4	24.6
7	Nangloi CETP Grit	34.80	**22.4**	41.00
8	Nangloi CETP Sludge	61.40	17	19
9	Mayapuri CETP Grit	7.60	**27.6**	**63.40**
10	Mayapuri CETP Sludge	20.56	17.4	53.89

Sr. No.	Sample from CETP	Moisture content (%)	Volatile solids (%)	Ash content (%)
11	SMA CETP Grit	6.40	**20.8**	**69.00**
12	SMA CETP Sludge	**75.60**	4.2	19.20
13	Wazirpur CETP Grit	67.80	7.2	24.00
14	Wazirpur CETP Sludge	58.80	5.4	35.20
15	Badli CETP Grit(Plant closed since 1 month)	43.60	12.6	41.80
16	Badli CETP Sludge (Plant closed since 1 month)	**85.40**	5	9.00
17	Mangolpuri CETP Grit	32.20	17.2	49.20
18	Mangolpuri CETP Sludge	46.20	**22.6**	28.60
19	Jhilmil CETP Sludge	56.60	15.8	24.20
20	Jhilmil CETP Grit	38.80	8.6	51.00
21	Okhla CETP Grit	**82.36**	9.4	8.01
22	Okhla CETP Sludge	**89.42**	4.8	5.58

In case of some CETPs, Moisture content, volatile solids and ash content were observed to be on higher side.

Table 3: pH of Stored Sludge and Grit at CETPs Delhi

Sample Sr. No.	Sample from CETP	pH
1	Lawrence Road Industrial CETP Grit	8.16
2	Lawrence Road Industrial CETP Sludge	7.86
3	Naraina CETP Grit	9.75
4	Naraina CETP Sludge	9.19
5	Karnal RD CETP Grit	9.8
6	Karnal RD CETP GT Sludge	7.14
7	Nangloi CETP Grit	8.44
8	Nangloi CETP Sludge	7.19
9	Mayapuri CETP Grit	8.46
10	Mayapuri CETP Sludge	8.31
11	SMA CETP Grit	8.45
12	SMA CETP Sludge	7.91
13	Wazirpur CETP Grit	**3.92**
14	Wazirpur CETP Sludge	**3.81**
15	Badli CETP Grit(Plant closed since 1 month)	7.50
16	Badli CETP Sludge (Plant closed since 1 month)	8.48
17	Mangolpuri CETP Grit	8.25
18	Mangolpuri CETP Sludge	8.03
19	Jhilmil CETP Sludge	7.23
20	Jhilmil CETP Grit	8.4
21	Okhla CETP Grit	8.32
22	Okhla CETP Final Sludge	7.74

Table 4: Total Heavy Metals concentrations in Stored Sludge and Grits at CETPs Delhi

Sample no.	Cadmium (mg/kg)	Cobalt (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
HWM 2016 Standards	1.0	80.0	5.0	25.0	-	10.0	20.0	5.0	250.0
CPCB standards (CETP)	1.0	-	2.0	3.0	3.0	2.0	3.0	0.1	5.0
1; Lawrence Road Grit	**3.7**	31.82	**1487.8**	**2037.09**	**61956.9**	**1479.38**	**441.51**	**174.42**	**2935.07**
2; Lawrence Road Sludge	**4.68**	29.77	**1277.47**	**5980.98**	**70828.2**	**1421.01**	**270.58**	**182.05**	**7668.3**
3; Naraina Grit	**3.31**	47.08	**1335.36**	**2763.03**	**46922.4**	**749.7**	**771.99**	**239.26**	**3095.75**
4;Naraina Sludge	**5.99**	28.96	**2154.97**	**3740.99**	**51868.9**	**338.03**	**1055.11**	**318.56**	**4673.66**
5; GT Karnal Grit	**17.37**	29.12	**2072.49**	**2229.07**	**59992.7**	**969.03**	**648.83**	**442**	**5758.06**
6; GT Karnal Sludge	**17.7**	35.83	**2659.16**	**2022.9**	**53206.8**	**889.75**	**596.7**	**434.61**	**10403.4**
7; Nangloi Grit	**10.77**	72.26	**3752.44**	**9666.54**	**42956.2**	**1826.53**	**925.34**	**1026.15**	**3684.92**
8; Nangloi Sludge	**30.38**	78.82	**7635.55**	**12837.3**	**84825.6**	**915.62**	**1236.25**	**3200.53**	**4783.17**
9; Mayapuri Grit	**343.28**	**110.24**	**18107.9**	**27970**	**135884**	**5606.47**	**5992.7**	**6945.63**	**27882.9**
10; Mayapuri Sludge	**296.56**	61.5	**10420.5**	**17184.5**	**113138**	**10100**	**3377.65**	**2328.13**	**20896.4**
11; SMA Grit	**83.28**	**356.34**	**89757.6**	**18554.3**	**168867**	**27800.9**	**4076.77**	**1408.86**	**6446.82**
12; SMA Sludge	**6.58**	**245.44**	**36674.7**	**5625.58**	**59561.6**	**25751**	**3917.82**	**94.56**	**1659.15**
13; Wazirpur Grit	**0**	**95.55**	**57569.1**	**1644.84**	**84944.5**	**17173.9**	**1138.39**	**88.9**	**208.32**
14; Wazirpur Sludge	**0**	**299.39**	**79643.3**	**8485.04**	**190941**	**31321**	**4236.47**	**130.37**	**858.73**
15; Badli*Grit	**5.38**	**156.15**	**32600**	**23470**	**185918**	**11634.5**	**3278.53**	**1962.51**	**12984**
16; Badli*Sludge	**2.33**	**109.62**	**44853**	**7027.74**	**60881.1**	**13011**	**2361.47**	**475.61**	**4672.82**
17; Mangolpuri Grit	**150.81**	**268.62**	**20842.7**	**10314.3**	**93395.9**	**1650**	**8369.76**	**2896.83**	**13347.2**
18; Mangolpuri Sludge	**35**	**112.61**	**10127.5**	**7552.46**	**74351.5**	**1218.19**	**4925.8**	**2716.74**	**13987.2**
19; Jhilmil Sludge	**153.45**	69.78	**90059.7**	**110622**	**50453.5**	**2874.39**	**41317.1**	**7981.37**	**25373.7**
20; Jhilmil Grit	**56.35**	43.26	**29079.4**	**53446.3**	**61194.2**	**2060.15**	**11033**	**3525.25**	**12147.7**
21; Okhla Grit	**19.64**	9.2	**315.95**	**1930.69**	**21251.5**	**267.06**	**206.59**	**68.03**	**718.34**
22; Okhla Sludge	**26.16**	11.29	**462.2**	**2237.08**	**11872.1**	**413.68**	**455.14**	**42.33**	**1684.01**

* CETP was out of operation for the last one month

Table 5: Leachable Heavy metals (TCLP) Stored Sludge and Grit at CETPs Delhi

Elements	HWM 2016 Standard	CPCB standards (CETP)	Lawrence Road		Naraina		GT Karnal		Nangloi Grit
			Grit	Sludge	Grit	Sludge	Grit	Sludge	
Aluminium (Al)	-	-	1403.75	3029.94	466.23	5137.10	597.17	1709.05	1711.76
Barium (Ba)	100.0	-	58.25	85.31	**182.45**	**416.36**	**318.08**	**147.00**	**108.78**
Beryllium (Be)	0.75	-	0.17	0.04	0.13	0.17	0.05	0.00	0.07
Cobalt (Co)	80.0	-	0.00	0.00	0.00	0.00	0.00	0.00	-91.98
Iron (Fe)	-	3.0	**4813.12**	**12088.15**	**16486.92**	**32979.36**	**37412.16**	**4378.73**	**1530.42**
Gallium (Ga)	-	-	1.91	0.00	0.00	0.00	0.73	0.00	0.00
Indium (In)	-	-	386.44	359.45	442.75	578.83	845.82	0.00	0.00
Lithium (Li)	-	-	5.44	4.48	2.03	5.18	3.31	4.31	5.29
Manganese (Mn)	10.0	2.0	**916.75**	**1180.15**	**314.39**	**179.55**	**480.44**	**602.75**	**1111.08**
Strontium (Sr)	-	-	559.66	964.04	270.15	220.31	455.80	697.24	983.55
Thallium (Tl)	7.0	-	0.30	0.62	0.00	0.00	0.00	0.00	1.09
Uranium (U)	-	-	41.80	81.44	116.27	228.17	272.59	33.98	23.75
Vanadium (V)	24.0	0.2	0.00	0.00	13.00	0.00	21.57	0.00	0.00
Zinc (Zn)	250.0	5.0	**3716.72**	**1291.30**	**2003.68**	**3616.52**	**3534.66**	**9642.17**	**2586.08**

Table 5 (Continued): Leachable Heavy metals (TCLP) Stored Sludge and Grit at CETPs Delhi

Elements	HWM 2016 Standard	CPCB standards (CETP)	Nangloi Sludge	Mayapuri		SMA		Wazirpur	
				Grit	Sludge	Grit	Sludge	Grit	Sludge
Aluminium (Al)	-	-	6887.57	749.63	64.32	1294.27	120.35	1099.42	634.85
Barium (Ba)	100.0	-	78.64	49.36	80.52	99.14	103.99	35.27	23.77
Beryllium (Be)	0.75	-	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Cobalt (Co)	80.0	-	0.00	0.00	0.00	0.00	42.32	0.00	0.00
Iron (Fe)		3.0	15619.5	1050.96	97.45	8154.12	25.05	4909.48	3894.46
Gallium (Ga)	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indium (In)	-	-	253.54	131.55	0.00	502.49	478.87	0.00	409.84
Lithium (Li)	-	-	11.91	6.61	5.41	11.68	3.29	2.08	1.57
Manganese (Mn)	10.0	2.0	569.60	3493.26	363.98	15169.6	19348.9	5788.34	23968.8
Strontium (Sr)	-	-	776.48	895.34	1159.30	1151.43	815.60	129.62	377.58
Thallium (Tl)	7.0	-	0.00	4.64	0.00	28.78	39.66	9.44	54.64
Uranium (U)	-	-	121.21	0.00	27.89	36.98	0.00	8.81	0.00
Vanadium (V)	24.0	0.2	0.00	16.65	25.22	0.00	69.70	-4.46	0.00
Zinc (Zn)	250.0	5.0	1041.73	19263.5	30.96	3263.79	159.41	187.59	349.06

Table 5 (Continued): Leachable Heavy metals (TCLP) Stored Sludge and Grit at CETPs Delhi

Elements	HWM 2016 Standard	CPCB standard (CETP)	Badli*		Mangolpuri		Jhilmil		Okhla	
			Grit	Sludge	Grit	Sludge	Sludge	Grit	Grit	Sludge
Aluminium (Al)	-	-	3106.0	1523.48	4370.19	848.54	1750.89	3526	488.82	974.42
Barium (Ba)	100.0	-	56.97	236.04	93.13	114.92	62.95	306.11	170.15	209.48
Beryllium (Be)	0.75	-	0.06	0.01	0.01	0.00	0.00	0.07	0.02	0.00
Cobalt (Co)	80.0	-	0.00	0.00	151.83	0.00	0.00	0.00	0.00	0.00
Iron (Fe)		3.0	54600	18849.6	908.54	2237.64	1350.73	10371	6120.59	3432.03
Gallium (Ga)	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indium (In)	-	-	1644.4	442.89	155.75	0.00	253.90	328.51	29.13	40.55
Lithium (Li)	-	-	4.46	2.75	8.49	10.91	4.33	2.40	1.11	1.57
Manganese (Mn)	10.0	2.0	8629.76	7649.48	1212.50	823.49	2139.59	1093.51	394.04	480.01
Strontium (Sr)	-	-	131.96	121.05	2058.94	2374.49	877.65	476.74	228.89	293.73
Thallium (Tl)	7.0	-	14.02	12.14	2.12	0.38	3.55	0.13	0.00	0.00
Uranium (U)	-	-	353.66	109.82	0.00	8.93	0.00	31.71	42.18	27.26
Vanadium (V)	24.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc (Zn)	250.0	5.0	12588.39	3324.40	10101.85	8766.56	16590.35	9941.32	806.37	1243.88

* CETP was out of operation for the last one month

Table 6: Leachable Heavy metals (TCLP using ICP-MS)

Sample no.	Silver (Ag) (mg/kg)	Arsenic (As) (mg/kg)	Cadmium (Cd) (mg/kg)	Chromium (Cr) (mg/kg)	Copper (Cu) (mg/kg)	Nickel (Ni) (mg/kg)	Lead (Pb) (mg/kg)	Selenium (Se) (mg/kg)
HWM 2016 Standards	5.0	5.0	1.0	5.0	25.0	20.0	5.0	1.0
CPCB Standards (CETP)	-	0.2	0.05	0.1	3.0	3.0	0.1	0.05
1; Lawrence Road Grit	**46.346**	**0.798**	**0.696**	**48.894**	**9.102**	**50.766**	**1.170**	**0.635**
2; Lawrence Road Sludge	0.076	0.000	**0.163**	**4.554**	**9.342**	**10.326**	**0.618**	**0.137**
3; Naraina Grit	0.397	0.168	**0.285**	**3.162**	**3.978**	**190.866**	**1.518**	**0.270**
4;Naraina Sludge	3.626	0.031	**0.702**	**34.314**	**18.102**	**174.066**	**5.088**	**0.196**
5; GT Karnal Grit	0.300	**0.397**	**0.612**	**4.794**	0.000	**65.466**	**6.018**	**0.205**
6; GT Karnal Sludge	0.077	0.000	**0.990**	**2.088**	**0.564**	**36.186**	**1.092**	**0.188**
7; Nangloi Grit	0.103	0.096	**4.728**	**28.434**	**544.722**	**166.266**	**28.398**	**0.196**
8; Nangloi Sludge	0.047	**1.122**	**1.158**	**90.114**	**93.522**	**73.266**	**29.478**	**0.268**
9; Mayapuri Grit	0.010	**3.354**	**22.020**	**5.814**	**676.122**	**748.866**	**1.722**	**0.677**
10; Mayapuri Sludge	0.112	0.000	**0.181**	**0.810**	**6.642**	**20.826**	0.000	**0.161**
11; SMA Grit	0.029	0.000	**2.220**	**85.914**	**6.402**	**417.666**	**0.402**	**0.202**
12; SMA Sludge	0.074	0.000	**0.449**	**2.538**	**4.032**	**435.066**	0.000	**0.112**
13; Wazirpur Grit	0.000	**1.662**	0.033	**246.834**	**223.362**	**504.324**	**0.139**	0.000
14; Wazirpur Sludge	0.000	0.000	**0.064**	**578.034**	**345.162**	**591.324**	0.000	0.000
15; Badli*Grit	0.038	0.000	**0.618**	**137.514**	**18.882**	**452.466**	**1.878**	**0.225**
16; Badli*Sludge	0.403	0.000	**0.196**	**264.114**	**8.322**	**454.266**	**0.258**	**0.125**
17; Mangolpuri Grit	0.000	0.000	**12.360**	**61.314**	**130.722**	**1192.866**	**5.004**	**0.356**
18; Mangolpuri Sludge	0.000	0.000	**0.882**	**8.274**	**3.228**	**562.266**	**3.966**	**0.298**
19; Jhilmil Sludge	0.000	0.000	**8.760**	**319.914**	**3208.122**	**3634.866**	**6.258**	**0.394**
20; Jhilmil Grit	0.121	0.000	**2.706**	**99.714**	**670.122**	**1102.866**	**5.838**	**0.211**
21; Okhla Grit	0.380	0.000	**1.656**	**0.000**	**6.462**	**13.746**	0.000	0.041
22; Okhla Sludge	0.020	0.000	**5.454**	**0.336**	**40.542**	**23.586**	**0.109**	0.045

* CETP was out of operation for the last one month

1.1 Observations:

- The Ash content of Lawrence Road, Mayapuri, SMA and Jilmil CETPs sludge was found to be greater than 50%.
- Wazirpur CETP sludge and Grit are highly acidic, while Narina and G T Karnal CETP sludge had pH above 9.0.
- The toxicity levels of all the CETP samples (mainly with respect to Cr, Cu, Fe, Zn) were extremely high and hence these cannot be used “as it is” for any road construction or similar activity. The possibility of stabilization of these toxic metals through known techniques needs to be examined.

1.2 Preliminary Conclusions

- The Sludge samples cannot be used “as it is” for any road construction or similar activity and proper stabilization is vital.

2. Adequacy of CETPs for Minimization of Sludge Production

2.1. Preamble

This section addresses issue of Adequacy of CETPs for minimization of sludge production. Accordingly, CSIR-NEERI conducted field investigations including sampling and laboratory analysis of 11 CETPs as per the list presented in Table 1 and recorded observations. It was informed by the CETP Association that out of 13 CETPs, two CETPs viz. Narela and Bawana are operated by Delhi State Government and are not part of CETP Association, hence were not included in field investigation studies. CETPs association was also requested to furnish inventory details as indicated in Annexure – II.

2.2. Objectives

The major objectives of the visit are outlined as follows:-

1. Collection of secondary data such as treatment capacity, flow diagram, types of coagulants/flocculants used and general visual observations.
2. Sampling and analysis to assess the performance of Primary Treatment System of CETPs vis-à-vis quality of primary sludge generated.

2.3. Sampling & Analysis

Samples were collected in polyethylene container for analysis of physico-chemical parameters. Samples were directly collected into acid-rinsed 1L poly-propylene bottles without filtration for physico-chemical parameters. For trace elements, the samples were collected in 100 ml bottles. Measurements for pH and dissolved solids concentration were made on site during sampling. All other analyses were performed in laboratories at CSIR-NEERI, Nagpur. Sample preservation was performed immediately after sample collection. The collected samples were preserved, processed and analyzed for major ions, trace elements and other physico-chemical parameters according to Standard Methods for the Examination of Water and Wastewater, 23rd Ed., American Public Health Association, American Water Works Association and Water Environment Federation, Washington DC, 2017. Heavy metals were quantified using inductively coupled plasma optical emission spectrometry (ICP-OES).

2.3.1 Physico-chemical characteristics

Field monitoring and sampling for 11 CETPs were carried out during June 11-12, 2018. The results of physico-chemical parameters are presented in the following sections. The values presented are average of at least three independent analyses. Sampling protocol followed at all the CETPs was as follows:

Three grab samples of effluent/wastewater were collected from all the 11 CETPs at three different locations viz:

A. At the outlet of Equalization Tank before dosing of chemicals/coagulants.
B. At the outlet/ v-notch overflow of tube settler/clarifier.
C. Primary settled sludge from tube settler underflow /inlet to sludge thickener.

2.4. CETP Process flow Diagram

The process flow diagram for all the 11 CETPs is more or less the same. Combined raw effluent is first screened to remove large floating bodies and then fed to grit chambers for the removal of inorganic solids. The effluent is then passed through equalization basins equipped with agitators/mixers to ensure complete mixing of effluent and make it suitable for physic-chemical treatment. Effluent from equalization tank is fed to baffled pre-chlorination tank (over and under baffles) with the aim of reducing COD of effluent since Chlorine is known to be strong oxidant and helps in chemically degrading COD of effluent. Designed contact time of 30 minutes is provided in pre-chlorination contact tank. Effluent is then fed to flash mixers where coagulants and flocculants are added for further physico-chemical treatment to remove both organic and inorganic colloidal as well as suspended solids. Effluent after dosing is fed to tube settlers wherein suspended solids settle at the bottom and clarified effluent overflows from weirs into effluent launders which is then subjected to tertiary treatment.

Clarified effluent from tube settlers is given tertiary treatment using a set of dual media filters (sand and fly ash) followed by activated carbon filters. Provision of these units is made to ensure complete removal of any remaining solids, traces of sludge, color, heavy metals etc. All the filters are periodically backwashed to avoid clogging. Final treated effluent is disinfected using chlorine (post chlorination) to ensure complete removal of microorganisms present if any. Primary settled sludge in tube settler is dewatered using sludge thickener where sludge settles at the bottom. Thickened sludge from sludge thickener is then dewatered mechanically using either filter press or rotary vacuum drum filter (RVDF). Clarified water from sludge thickener and filtrate from mechanical sludge dewatering is put back into equalization tank. Dewatered sludge from the sludge handling equipment is then stored in enclosed sheds built at site itself since the sludge is known to contain hazardous heavy metals and the final treated effluent is discharged into municipal drains. A general schematic process flow diagram of CETPs is presented in Figure 2.

Out of 11 CETPs visited by CSIR-NEERI, physico-chemical treatment is provided in 10 CETPs followed by tertiary treatment. However at CETP, Mangolpuri secondary/biological treatment system is provided in addition to physico-chemical treatment.

Performance assessment of primary treatment systems for each CETP is described in following sections:

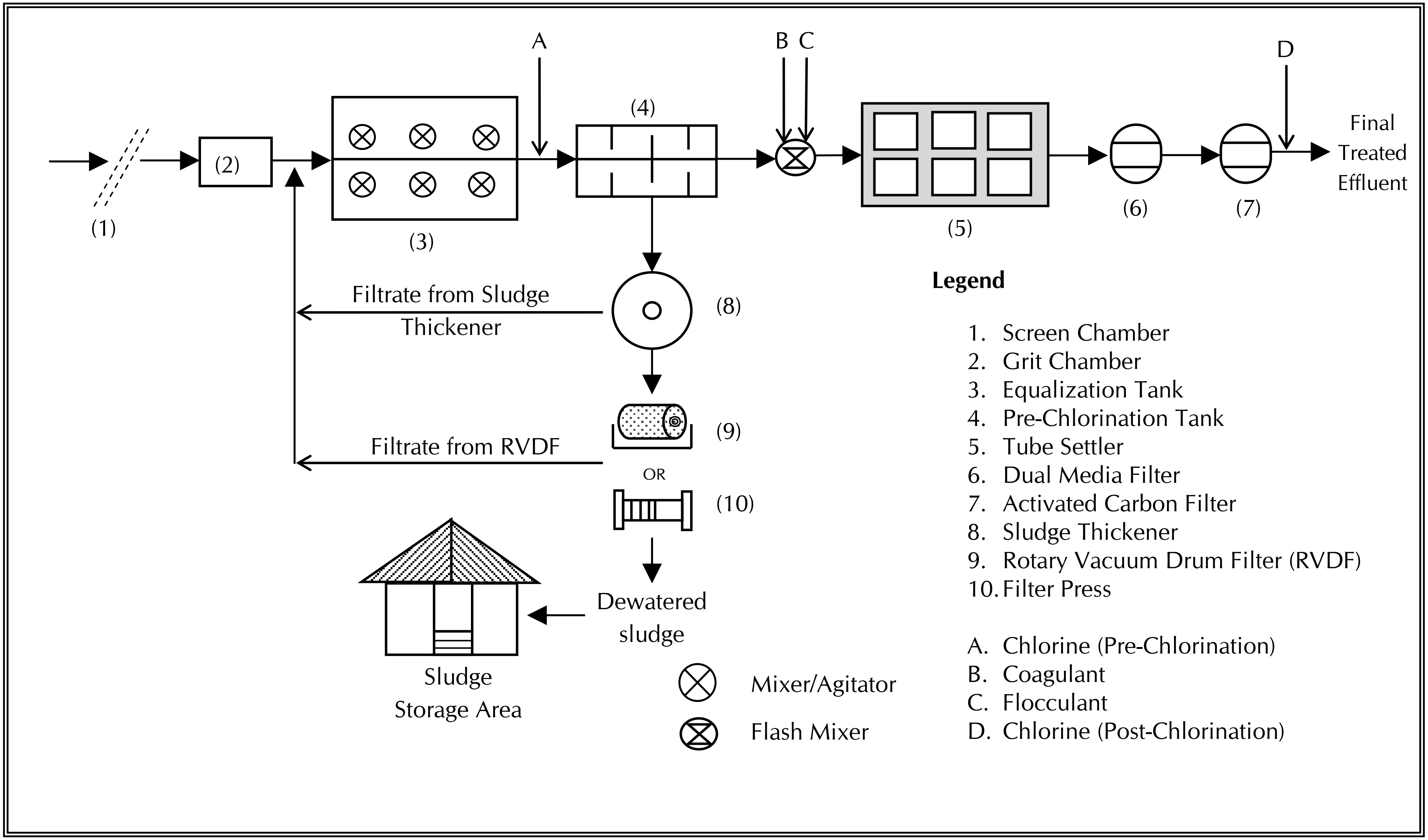


Figure 2: General Schematics of physico-chemical treatment route followed by tertiary treatment and sludge management of CETPs, Delhi

2.5 Performance Assessment of Primary Treatment Systems

2.5.1. CETP, Lawrence Road

Observations:

1. No mixing arrangement in equalization basin was observed at the time of monitoring. As a result of insufficient mixing, solids from the raw effluent tend to settle at the bottom of equalization tank and undergo anaerobic digestion with the passage of time. Figure 3 presents status of equalization basin.
2. This can be realized by the presence of gas bubbles which come out frequently from the bottom of the equalization tank to top of water surface as shown in Figure 4
3. Moreover out of the two equalization basin, one of the basins is used as sludge holding tank. The primary settled sludge from tube settler is brought to equalization tank which is unscientific and shouldn't be practiced.

Figure 3: Equalization tank at CETP, Lawrence Road

Figure 4: Equalization tank at CETP, Lawrence Road

Performance assessment of primary treatment system for **Lawrence Road CETP** is as follows:

Table 7: Physico-chemical Characteristics of Effluent#
Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.55	7.47	-
2.	**Total Suspended Solids (TSS)**	780	54	93.07
3.	**Total Dissolved Solids (TDS)**	4500	4558	-
4.	**COD**	875	160	81.71
5.	**Total Kjeldhal Nitrogen (TKN)**	297	256	13.80
6.	**Sulphate (SO_4^{2-})**	789	878	-
7.	**Chloride (Cl^-)**	1600	1550	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	BDL	BDL
11.	**Chromium**	0.21	BDL
12.	**Copper**	1.95	0.03
13.	**Iron**	21.87	1.42
14.	**Manganese**	1.48	1.09
15.	**Nickel**	BDL	BDL
16.	**Lead**	0.11	BDL
17.	**Zinc**	3.04	0.07

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 7 A: Physico-chemical Characteristics of Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**64800**	**6.48**
2.	**Total suspended solids (TSS)**	**60300**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	0.33
5.	**Cobalt**	0.75
6.	**Chromium**	24.45
7.	**Copper**	184.90
8.	**Iron**	2096.45
9.	**Manganese**	56.02
10.	**Nickel**	BDL
11.	**Lead**	10.18
12.	**Zinc**	349.81

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

CETP Lawrence Road operates at nearly 16.67% operating flow capacity. Tables 7 & 7A present physico-chemical characteristics of CETP Lawrence Road**.**

- As shown in Table 7, TSS at the outlet of equalization tank was 780 mg/L and at the outlet of tube settler it was 54 mg/L resulting in as high as 93% TSS removal.
- The COD to TKN ratio at inlet to tube settler was ~ 3.0. The COD removal efficiency was found to be ~82 %. A large part of the COD is associated with TSS matter as not much soluble COD is expected to be removed through physicochemical treatment. However, the physicochemical treatment was ineffective in controlling TKN. Only 13.7 % TKN removal could be achieved.
- The concentrations of heavy metals in the influent to tube settler were quite low (<1 mg/L) except for copper (1.95 mg/L), iron (21.87 mg/L), manganese (1.48 mg/L) & zinc (3.04 mg/L). The metals were removed significantly through the physicochemical treatment, and their concentrations were below detectable limit except Iron and manganese concentrations which were 1.42 and 1.09 mg/L, respectively.
- The underflow of the tube settler contained 6.48 % of solids (**Table 7A**). It also contained chromium (24.45 mg/L), copper (184.90 mg/L), Iron (2096.45 mg/L), manganese (56.02 mg/L), lead (10.18 mg/L) and zinc (349.81 mg/L) in high concentrations implying that dried sludge would have much higher concentrations of these heavy metals.

2.5.2. CETP, Naraina

Observations:

1. Agitators/mixers were provided in both the equalization tank at CETP, Naraina. At the time of visit only three out of four agitators were operational. However all the agitators provided were of under capacity as can be seen in Figure5.
2. Insufficient mixing leads to settling of suspended solids in equalization tank which further undergoes anaerobic digestion and the effluent becomes septic. This also adds to unpleasant aesthetics in adjoining area due to methane and hydrogen sulphide produced during anaerobic digestion of settled solids.

Figure 5: Inadequate mixing at Equalization Basin

3. Primary settled sludge is further dewatered in sludge thickener. At the time of visit, sludge was found floating in the thickener. Floating sludge was flowing over weirs of sludge thickener resulting in carryover of suspended solids into clarified water.
4. Screens followed by grit chambers are provided prior to equalization tank. Nevertheless periodic cleaning of grit chambers is not practiced as a result large quantity of grit was found deposited in grit channels.

Performance assessment of primary treatment system for **Naraina CETP** is as follows:

Table 8: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 11, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.28	6.75	-
2.	**Total Suspended Solids (TSS)**	320	36	88.75
3.	**Total Dissolved Solids (TDS)**	1056	1144	-
4.	**COD**	296	61	79.39
5.	**Total Kjeldhal Nitrogen (TKN)**	272	187	31.25
6.	**Sulphate (SO_4^{2-})**	83	215	-
7.	**Chloride (Cl^-)**	350	337	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	0.01	BDL
11.	**Chromium**	1.07	BDL
12.	**Copper**	5.47	0.05
13.	**Iron**	13.52	2.46
14.	**Manganese**	0.64	0.16
15.	**Nickel**	2.24	0.23
16.	**Lead**	0.35	BDL
17.	**Zinc**	4.39	BDL

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 8 A: Physico-chemical Characteristics of Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids(TS)**	**14860**	**1.49**
2.	**Total suspended solids(TSS)**	**6580**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	BDL
5.	**Cobalt**	0.06
6.	**Chromium**	8.92
7.	**Copper**	24.85
8.	**Iron**	237.12
9.	**Manganese**	1.39
10.	**Nickel**	11.79
11.	**Lead**	0.870
12.	**Zinc**	35.56

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Table 8 and 8 A shows the performance assessment of primary treatment system. The CETP operates at 23.15% operating flow capacity.

- The physicochemical analysis of Naraina CETP effluent (Table 8)shows that TSS at the inlet of the tube settler was 320 mg/L and at the outlet it was 36 mg/L resulting in 88.75 % TSS removal.
- The COD to TKN ratio at inlet of CETP was ~1.08. The COD and TKN removal efficiency was nearly 79 and 31%, respectively. Once again, some of the COD removed can be associated with TSS matter.
- The concentrations of heavy metals in the influent were quite low (<1 mg/L) except for chromium (1.07 mg/L), copper (5.47 mg/L), iron (13.52 mg/L), nickel (2.24 mg/L) & zinc (4.39 mg/L). However, after tube settling process, all the concentrations of heavy metals; As, Cd, Co, Cr, Cu, Pb and Zn were reduced to below detectable limit.
- The slurry sampled from the underflow of the tube settler contains only 1.49 % of solids (Table 8 A). Heavy metals such Chromium (8.92 mg/L), copper (24.85 mg/L), Iron (237.12 mg/L), manganese (1.39 mg/L), nickel (11.79 mg/L), lead (0.87 mg/L) and zinc (35.56 mg/L) were detected in high concentrations. This indicates that dried sludge may have much higher concentrations of the toxic metals.

2.5.3. CETP, GT Karnal Road

Observations:

1. It was found that the dosing arrangements for alum and polyelectrolyte are inadequate. There are two parallel channels through which effluent is taken from equalization tank to tube settlers through distribution channels.
2. Dosing arrangements are such that alum is dosed into effluent in one channel and polyelectrolyte is dosed into second channel as shown in Figure 6.
3. Also it is imperative to mention that, there is no arrangement for flocculation either in the form of flocculation chamber or baffled tank. As a result, flocculation of colloidal solids in effluent couldn't be very effective.
4. Sludge is further dewatered in sludge thickener. It was observed that sludge has accumulated at the top surface of sludge thickener as shown in Figure 7 which may be attributed to faulty sludge withdrawal cycles.

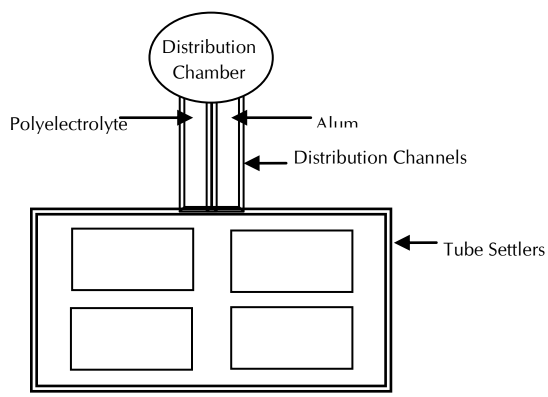


Figure 6: Inadequate dosing arrangement at CETP, GT Karnal Road

Figure 7: Floating sludge of sludge thickener at CETP, GT Karnal Road

Performance assessment of primary treatment system for **G T Karnal Road CETP** is as follows:

Table 9: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	8.07	8.14	-
2.	**Total Suspended Solids (TSS)**	212	60	71.69
3.	**Total Dissolved Solids (TDS)**	1820	1816	-
4.	**COD**	247	97	60.72
5.	**Total Kjeldhal Nitrogen (TKN)**	246	259	--
6.	**Sulphate (SO_4^{2-})**	205	200	-
7.	**Chloride (Cl^-)**	750	750	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	BDL	BDL
11.	**Chromium**	0.24	0.06
12.	**Copper**	0.22	0.05
13.	**Iron**	4.13	0.88
14.	**Manganese**	0.24	0.21
15.	**Nickel**	0.03	BDL
16.	**Lead**	0.04	0.01
17.	**Zinc**	1.75	0.39

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 9 A: Physico-chemical Characteristics of "Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**9900**	**0.99**
2.	**Total suspended solids (TSS)**	**6890**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	BDL
5.	**Cobalt**	0.06
6.	**Chromium**	9.61
7.	**Copper**	8.68
8.	**Iron**	201.39
9.	**Manganese**	5.46
10.	**Nickel**	0.04
11.	**Lead**	1.93
12.	**Zinc**	80.02

#Sampled from underflow of tube settler; All parameters are in mg/L except pH
BDL – Below detectable limit

CETP at G T Karnal Road has second highest operating flow capacity and among all the CETPs and operates at 50% capacity. Tables 9 & 9A present physico-chemical characteristics of CETP G T Karnal**.**

- As given in Table 9 TSS concentration at the outlet of equalization tank was 212 mg/L indicating that the physicochemical treatment at this CETP resulted in 71% TSS removal.
- The COD removal efficiency was found to be ~61 %. Once again, TKN present in the effluent appears not amenable for removal through primary physicochemical treatment.
- The concentrations of heavy metals in the effluent from both the inlet and outlet of tube settler were quite low.
- The slurry sampled from the underflow of the tube settler contains <1 % of solids (Table 9 A) indicating poorer performance. The slurry contained heavy metals such Chromium (9.61 mg/L), copper (8.68 mg/L), Iron (201.39 mg/L), manganese (5.46 mg/L), lead (1.93 mg/L) and zinc (80.02 mg/L) were detected in high concentrations.

2.5.4. CETP, Nangloi

Observations:

1. Mixers/Agitators are installed in the equalization tank but the mixing capacity of agitators is not efficient.
2. The CETP, Nangloi design capacity is 12 MLD, however at present daily inflow at CETP is just 3.5 to 4 MLD.

Performance assessment of primary treatment system for **Nangloi CETP** is as follows:

Table 10: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.8	7.37	-
2.	**Total Suspended Solids (TSS)**	296	42	85.81
3.	**Total Dissolved Solids (TDS)**	6024	5924	-
4.	**COD**	247	119	51.82
5.	**Total Kjeldhal Nitrogen (TKN)**	224	218	2.67
6.	**Sulphate (SO_4^{2-})**	595	527	-
7.	**Chloride (Cl^-)**	2437	2124	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	0.01	BDL
11.	**Chromium**	0.90	0.13
12.	**Copper**	1.36	0.22
13.	**Iron**	9.55	5.27
14.	**Manganese**	0.49	0.42
15.	**Nickel**	0.39	0.09
16.	**Lead**	0.32	0.04
17.	**Zinc**	0.43	0.06

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 10 A: Physico-chemical Characteristics of Slurry[#] from Tube Settler

Sr. No.	Parameters	Characteristics	Percent Solids (%)
1.	**Total solids**	**27322**	**2.73**
2.	**Total suspended solids (TSS)**	**20800**	
Heavy Metals			
3.	**Arsenic**	BDL	
4.	**Cadmium**	0.17	
5.	**Cobalt**	0.37	
6.	**Chromium**	40.63	
7.	**Copper**	63.06	
8.	**Iron**	584.44	
9.	**Manganese**	6.32	
10.	**Nickel**	11.45	
11.	**Lead**	16.36	
12.	**Zinc**	35.24	

[#]Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Design capacity of CETP, Nangloi is 12 MLD and at present it receives nearly 1.5 MLD of effluent. Thus this CETP operates at 12.5 % of its original designed capacity. Performance assessment of primary treatment system is presented in Tables 10 and 10 A.

- TSS at the outlet of equalization tank was 296 mg/L and at the outlet of tube settler it was 42 mg/L resulting in 86% TSS removal.
- COD of the effluent was 247 mg/L at the inlet of the tube settler whereas at the outlet it was 119 mg/L indicating ~ 52% COD removal efficiency. TKN removal could not be achieved during primary physicochemical treatment.
- Concentrations of heavy metals in primary treated wastewater were quite low (<1 mg/L) except for Iron (5.27 mg/L). Concentrations of rest of the heavy metals were either below detectable limit or very low in the tube settler outlet sample.
- The slurry sampled from the underflow of the tube settler (Table 10 A) contains nearly 2.7 % of solids. Heavy metals such Chromium (40.63 mg/L), copper (63.06 mg/L), Iron (584.44 mg/L), manganese (6.32 mg/L), nickel (11.45 mg/L), lead (16.36 mg/L) and zinc (35.24 mg/L) were detected in high concentrations.

2.5.5. CETP, Mayapuri

Observations:

CETP, Mayapuri is designed to handle flow of 12 MLD, however at present combined industrial effluent available for treatment is only 4 MLD on an average.

1. Agitators/mixers installed in equalization tank are of under capacity and not able to provide adequate mixing. Moreover out of six only three agitators were operational at the time of visit.
2. Pre-Chlorination tank is well managed and chlorine dose of nearly 130 mg/L is added prior to physico-chemical treatment. The picture showing pre-chlorination tank is shown in Figure 8.

Figure 8: Pre-Chlorination tank at CETP, Mayapuri

2. Sludge withdrawal mechanism from sludge thickener is not practiced properly.

Performance assessment of primary treatment system for **Mayapuri CETP** is as follows:

Table 11: Physico-chemical Characteristics of Effluent[#]

Date of monitoring: June 11, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.5	8.2	-
2.	**Total Suspended Solids (TSS)**	256	34	86.71
3.	**Total Dissolved Solids (TDS)**	2470	2776	-
4.	**COD**	229	140	38.86
5.	**Total Kjeldhal Nitrogen (TKN)**	280	250	10.71
6.	**Sulphate (SO_4^{2-})**	223	179	-
7.	**Chloride (Cl^-)**	1050	1075	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	0.01	BDL
10.	**Cobalt**	BDL	BDL
11.	**Chromium**	0.63	0.03
12.	**Copper**	1.04	0.12
13.	**Iron**	19.29	2.48
14.	**Manganese**	2.53	0.89
15.	**Nickel**	BDL	0.02
16.	**Lead**	0.17	0.08
17.	**Zinc**	1.55	BDL

[#]Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 11 A: Physico-chemical Characteristics of Slurry[#] from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**60830**	**6.08**
2.	**Total suspended solids(TSS)**	**57400**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	2.69
5.	**Cobalt**	0.42
6.	**Chromium**	76.76
7.	**Copper**	133.27
8.	**Iron**	2087.35
9.	**Manganese**	121.47
10.	**Nickel**	43.43
11.	**Lead**	20.36
12.	**Zinc**	274.03

[#]Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Design capacity of CETP, Mayapuri is 12 MLD and at present it receives nearly 4 MLD of effluent. Thus this CETP operates at 33.33 % of its original designed capacity. Performance assessment of primary treatment system is presented in Tables 11 and 11 A.

- TSS at the outlet of equalization tank was 256 mg/L and at the outlet of tube settler post physico-chemical treatment it was 34 mg/L resulting in around 87% TSS removal.
- Notably a significant COD reduction was not achieved during physico-chemical treatment with only 38.86 % COD removal efficiency which attributes to the fact that much of its COD is in dissolved form (soluble) rather than in suspended form.
- A very little reduction in TKN and sulphates was observed during primary physicochemical treatment.
- All heavy metals in the primary treated effluent were well below prescribed discharge standards of CPCB.
- Physico-chemical analysis of primary settled sludge as shown in Table 13A showed that Iron concentration was maximum 2087.35 mg/L followed by Zinc having concentration of 274.03 mg/L.

2.5.6. CETP SMA

Observations:

1. All the agitators/mixers (2 Nos.) were not operational at the time of visit as shown in Figure 9 (Left Photograph). Agitators should always be kept on to avoid settling of suspended solids in equalization tank and to avoid septic conditions.
2. Coagulants/flocculants dosing arrangement were not adequate since the same is not provided with flash mixing as shown in Figure 9 (Right Picture).

Figure 9: Equalization Tank (left) & inadequate dosing arrangement (right)

Performance assessment of primary treatment system for **SMA CETP** is as follows:

Table 12: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	4.26	9.55	-
2.	**Total Suspended Solids (TSS)**	548	46	91.60
3.	**Total Dissolved Solids (TDS)**	7024	6312	-
4.	**COD**	98	59	39.80
5.	**Total Kjeldhal Nitrogen (TKN)**	254	247	2.75
6.	**Sulphate (SO_4^{2-})**	2351	1991	-
7.	**Chloride (Cl^-)**	1375	1312	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	0.37	BDL
11.	**Chromium**	6.48	0.05
12.	**Copper**	2.96	0.04
13.	**Iron**	142.55	1.34
14.	**Manganese**	69.87	1.16
15.	**Nickel**	5.78	0.03
16.	**Lead**	0.06	BDL
17.	**Zinc**	1.52	BDL

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 12 A: Physico-chemical Characteristics of Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**19460**	**1.95**
2.	**Total suspended solids (TSS)**	**11960**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	BDL
5.	**Cobalt**	1.43
6.	**Chromium**	179.35
7.	**Copper**	23.16
8.	**Iron**	1547.82
9.	**Manganese**	271.45
10.	**Nickel**	30.41
11.	**Lead**	1.00
12.	**Zinc**	12.15

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

CETP, SMA operates at 20.83 % of its designed capacity with the present average flow of 2.5 MLD as against its designed flow capacity of 12 MLD. Performance assessment of primary treatment system is presented in Tables 12 and 12A.

- Removal of suspended solids was more than 90 % and its concentration at the outlet of tube settler was 46 mg/L.
- It is imperative to mention that COD concentration at the inlet of tube settler was only 98 mg/L indicating presence of very little organic matter. Notably 39.80 % COD removal was achieved in tube settler.
- A very little reduction in TKN was observed and TDS concentration was very high of the order of nearly 7000 mg/L.
- Primary settled sludge had TS concentration of 19460 mg/L indicating satisfactory settling performance of SS and the concentration of Iron was maximum i.e. 1547.82 mg/L followed by Manganese (271.45 mg/L) and Chromium (179.35 mg/L).

2.5.7. CETP, Wazirpur

Observations:

1. Only one agitator/mixer is provided in equalization tank but was not operational at the time of visit. The colour of effluent is brick red which is mainly due to Iron since the said industrial area has large numbers of steel pickling industries.
2. Although the primary treated effluent quality after physico-chemical treatment was excellent having COD of 80 mg/L and SS of 38 mg/L, it is important to note that the CETP was being run at 1/4th of its designed capacity (24 MLD) as can be seen in Figure 10 which shows effluent is bypass back into equalization tank from main effluent pumping line.
3. This practice of bypassing incurs unnecessary pumping cost and increases holding time of effluent in equalization basin.

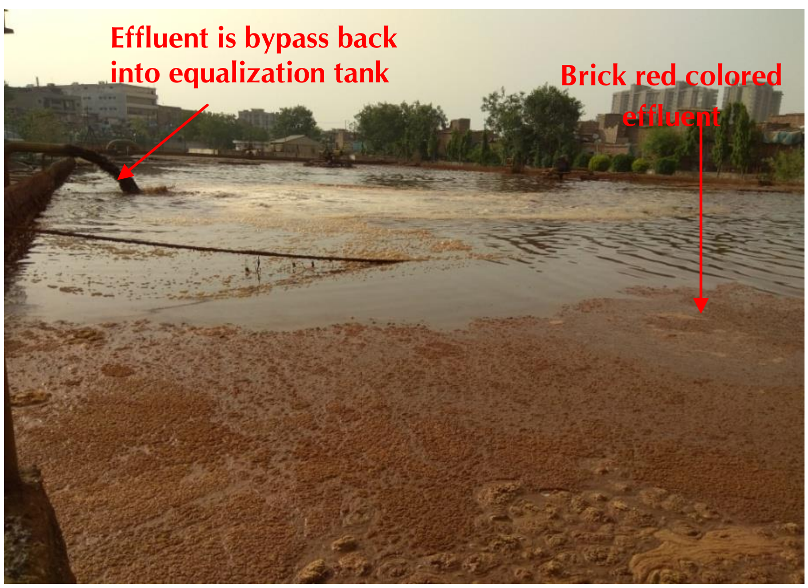


Figure10: Effluent bypass back into Equalization Tank at CETP, Wazirpur

4. It was learnt that the tube settlers frequently get chocked if run on higher flow rates and as a result operators are compelled to run CETP at lesser flow rates than its designed capacity.

Performance assessment of primary treatment system for **Wazirpur CETP** is as follows:

Table 13: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 11, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.4	8.48	-
2.	**Total Suspended Solids (TSS)**	3728	38	98.98
3.	**Total Dissolved Solids (TDS)**	6074	6238	-
4.	**COD**	331	96	71.00
5.	**Total Kjeldhal Nitrogen (TKN)**	222	209	5.85
6.	**Sulphate (SO_4^{2-})**	2665	1639	-
7.	**Chloride (Cl^-)**	1000	1050	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	0.80	BDL
11.	**Chromium**	88.32	BDL
12.	**Copper**	21.47	0.04
13.	**Iron**	557.30	1.42
14.	**Manganese**	97.35	1.10
15.	**Nickel**	12.40	BDL
16.	**Lead**	0.22	BDL
17.	**Zinc**	2.14	0.07

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 13 A: Physico-chemical Characteristics of Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**51380**	**5.14**
2.	**Total suspended solids (TSS)**	**40560**	

Heavy Metals		
3.	**Arsenic**	0.71
4.	**Cadmium**	BDL
5.	**Cobalt**	4.50
6.	**Chromium**	728.56
7.	**Copper**	129.63
8.	**Iron**	3475.84
9.	**Manganese**	562.72
10.	**Nickel**	85.47
11.	**Lead**	1.91
12.	**Zinc**	17.79

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Present average flow at Wazirpur CETP is 1.5 MLD as against its design flow of 24 MLD as a result this CETP operates at only 6.25 % of its actual designed capacity. Performance assessment of primary treatment system is presented in Tables 13 and 13 A.

- Color of influent at the equalization tank was brick-red because of the presence of high concentration of iron present i.e. 557.30 mg/L since this industrial complex has large number of steel pickling industries.
- TSS removal efficiency was found to be excellent i.e. 98.98 % and COD removal efficiency was 71 % with the primary treated effluent has COD of 96 mg/L.
- A very high concentration of sulphates was found at the inlet of tube settler and its concentration was 2665 mg/L which reduced to 1639 mg/L after physico-chemical treatment showing only 38.49 % removal efficiency.
- Heavy metals at the outlet of tube settler were below detection limit indicating good performance for heavy metals removal.
- In primary settled sludge (Table 13 A), Iron was found to be maximum and its concentration was 3475.84 mg/L followed by Chromium, Manganese and Copper having concentration of 728.56, 562.72, 129.63 mg/L respectively.

2.5.8. CETP, Badli

Observations:

1. CETP, Badli was not operational at the time of visit. A layer of brick red colored sludge was found floating in pre-chlorination tank and the flocculation chamber was completely chocked because of suspended solids.

Figure11: Pre-Chlorination Tank (left) and flocculation chamber (right)

Performance assessment of primary treatment system for **Badli CETP** is as follows:

Table 14: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	6.45	7.77	-
2.	**Total Suspended Solids (TSS)**	1304	56	95.70
3.	**Total Dissolved Solids (TDS)**	2320	2002	-
4.	**COD**	798	91	88.60
5.	**Total Kjeldhal Nitrogen (TKN)**	275	226	17.82
6.	**Sulphate (SO_4^{2-})**	833	833	-
7.	**Chloride (Cl^-)**	325	350	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	0.23	BDL
11.	**Chromium**	47.77	0.12
12.	**Copper**	12.38	0.08
13.	**Iron**	278.43	5.31
14.	**Manganese**	35.60	4.41
15.	**Nickel**	6.29	BDL
16.	**Lead**	0.87	0.04
17.	**Zinc**	19.06	BDL

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 14 A: Physico-chemical Characteristics of Slurry# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	19646	**1.96**
2.	**Total suspended solids (TSS)**	16580	

Heavy Metals		
3.	**Arsenic**	0.02
4.	**Cadmium**	BDL
5.	**Cobalt**	1.04
6.	**Chromium**	289.76
7.	**Copper**	58.82
8.	**Iron**	1341.72
9.	**Manganese**	134.92
10.	**Nickel**	31.34
11.	**Lead**	3.80
12.	**Zinc**	103.09

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Design capacity of CETP, Badli is 12 MLD however the CETP operates at 12.5 % of its original designed capacity. The CETP was non-operational, and at the time of sampling it was made functional. Performance assessment of primary treatment system is presented in Tables 14 and 14 A.

- Since the CETP was non-operational for long, the TSS concentration at the outlet tube settler was found to reduce from 1304 to 56 mg/L. Thus the removal efficiency of 95.7% is actually superficial.
- Similarly, COD of effluent at the outlet of tube settler was found to reduce from 798 to 91 mg/L indicating more than 88% removal efficiency.
- However, there was marginal reduction in TKN concentration which decreases from 275 to 226 mg/L indicating nearly 18% efficiency.
- Concentrations of heavy metals in the influent except As, Cd and Co were more than 5 mg/L; chromium (47.77 %), copper (12.38 mg/L), iron (278.43 mg/L), manganese (35.60 mg/L), nickel (6.29 mg/L) & zinc (19.06 mg/L). Lead was also detected in the influent sample (0.87 mg/L).
- Concentrations of heavy metals in the tube settler outlet sample such as As, Cd, Co, Cr, Cu, Ni, Pb and Zn were either below detectable limit or very low. Iron and manganese concentrations were 5.31 and 4.41 mg/L, respectively.
- The slurry from the underflow of the tube settler contains only ~2 % of solids (Table 14a). Heavy metals such Chromium (289.76 mg/L), copper (58.82 mg/L), Iron (1341.72 mg/L), manganese (134.92 mg/L), nickel (31.34 mg/L), lead (3.80 mg/L) and zinc (103.09 mg/L) were detected in high concentrations.
- It is imperative to mention that, since the CETP was not operational, the above data in terms of removal efficiencies are superficial and do not reflect actual performance of CETP under existing operating conditions.

2.5.9. CETP, Mangolpuri

Observations:

1. Agitators/Mixers (2 Nos.) are provided in equalization tank but the efficiency of mixers have reduced over a period of time and is not able to provide complete mixing in equalization tank.

Figure 12: Poor mixing in equalization tank

2. Scum removal mechanism vis-a-vis rotary scrapper arrangement in one of the clariflocculator was not working.

Figure13: Poorly managed Clariflocculator

3. Sludge thickener was found to be of very low capacity and the feed mechanism of primary settled sludge into sludge thickener was not adequate as evident from the figure.

Figure 14: Sludge Thickener

Performance assessment of primary treatment system for **Mangolpuri CETP** is as follows:

Table 15: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.56	7.53	-
2.	**Total Suspended Solids (TSS)**	564	214	62.05
3.	**Total Dissolved Solids (TDS)**	5942	6916	-
4.	**COD**	661	312	52.79
5.	**Total Kjeldhal Nitrogen (TKN)**	222	187	15.76
6.	**Sulphate (SO_4^{2-})**	927	781	-
7.	**Chloride (Cl^-)**	2187	2312	-
	Heavy Metals			
8.	**Arsenic**	BDL	BDL	
9.	**Cadmium**	BDL	BDL	
10.	**Cobalt**	0.02	BDL	
11.	**Chromium**	1.80	0.83	
12.	**Copper**	1.56	0.68	
13.	**Iron**	16.76	6.74	
14.	**Manganese**	0.62	0.53	
15.	**Nickel**	0.61	0.08	
16.	**Lead**	0.84	0.34	
17.	**Zinc**	4.19	1.73	

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 15 A: Physico-chemical Characteristics of Slurry[#] from Tube Settler

Sr. No.	Parameters	Characteristics	Percent Solids (%)
1.	**Total solids**	**71000**	**7.10**
2.	**Total suspended solids (TSS)**	**63080**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	0.54
5.	**Cobalt**	1.38
6.	**Chromium**	186.44
7.	**Copper**	110.71
8.	**Iron**	1192.96
9.	**Manganese**	42.28
10.	**Nickel**	93.16
11.	**Lead**	58.03
12.	**Zinc**	338.71

[#]Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

CETP at Mangolpuri is the only plant having both physico-chemical followed by biological treatment system. This CETP operates at 62.5% operating flow capacity; highest among all the CETPs. Performance assessment of primary treatment system is presented in Tables15 and 15 A.

- TSS concentration at the outlet of tube settler reduces from 564 to 214 mg/L resulting in 62%efficiency. COD at the outlet of tube settler reduces from 661 to 312 mg/L indicating nearly 53% removal efficiency. Whereas TKN removal was observed to be only 16% which reduces from 222 to 187 mg/L.
- Concentrations of heavy metals in the influent were quite low ($<$1 mg/L) except for chromium (1.80 %), copper (1.56 mg/L), iron (16.76 mg/L), & zinc (4.19 mg/L). Concentrations of heavy metals such as As, Cd, Co, Cr, Cu, Mn, Ni, and Pb were either below detectable limit or very low in the tube settler outlet sample. Iron and zinc concentrations were 6.74 and 1.73 mg/L, respectively.
- The slurry from the underflow of the tube settler has approximately 7% of solids concentration as shown in Table 15 A. Heavy metals such Chromium (186.44 mg/L), copper (110.71 mg/L), Iron (1192.96 mg/L), manganese (42.28 mg/L), nickel (93.16 mg/L), lead (58.03 mg/L) and zinc (338.71 mg/L) were detected in high concentrations.

2.5.10. CETP, Jhilmil

Observations:

1. Effluent from equalization tank is pumped and fed to two nos. of parallel baffled flocculation chambers through two parallel distribution channels after coagulants/flocculants dosing.
2. But an unequal flow distribution through distribution channels into two parallel flocculation chambers was observed as evident from Figure15.

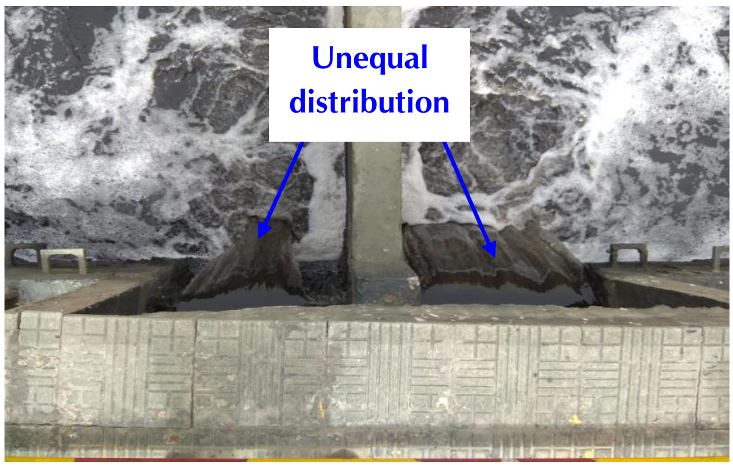


Figure15: Unequal flow distribution at Flocculation Chambers

3. As a consequence, desired flow though velocity in baffle tank cannot be maintained and suspended solids tends to settle in the tank as can be seen in Figure16due to less flow through velocity.

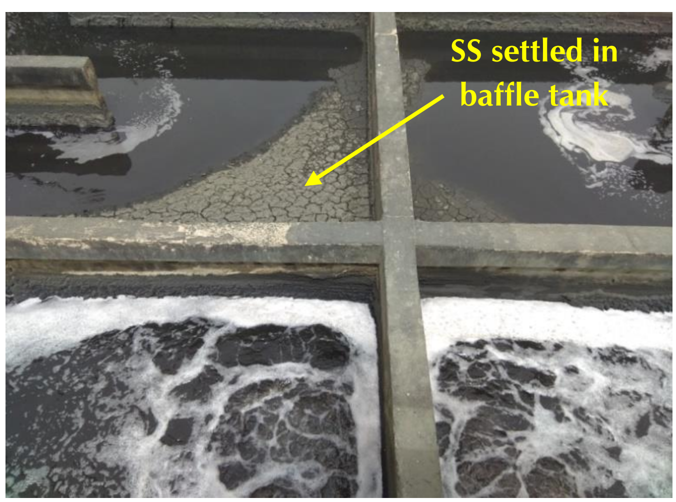


Figure16: SS settled in Baffle tank

Performance assessment of primary treatment system for **Jhilmil CETP** is as follows:

Table 16: Physico-chemical Characteristics of Effluent#

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler	Outlet of Tube settler	Removal (%)
1.	**pH**	7.7	7.82	-
2.	**Total Suspended Solids (TSS)**	98	72	26.53
3.	**Total Dissolved Solids (TDS)**	2990	3010	-
4.	**COD**	150	95	37.00
5.	**Total Kjeldhal Nitrogen (TKN)**	271	260	4.05
6.	**Sulphate (SO_4^{2-})**	472	473	-
7.	**Chloride (Cl^-)**	975	1000	-

Heavy Metals			
8.	**Arsenic**	BDL	BDL
9.	**Cadmium**	BDL	BDL
10.	**Cobalt**	BDL	BDL
11.	**Chromium**	1.88	1.81
12.	**Copper**	1.56	1.13
13.	**Iron**	1.87	0.56
14.	**Manganese**	1.08	0.93
15.	**Nickel**	0.98	0.96
16.	**Lead**	0.11	0.17
17.	**Zinc**	0.02	0.07

#Grab samples; All parameters are in mg/L except pH
BDL – Below detectable limit

Table 16A: Physico-chemical Characteristics of Sludge# from Tube Settler

Sr. No.	Parameters	Characteristics	Solids (%)
1.	**Total solids**	**50390**	**5.04**
2.	**Total suspended solids (TSS)**	**47190**	

Heavy Metals		
3.	**Arsenic**	0.97
4.	**Cadmium**	2.28
5.	**Cobalt**	0.58
6.	**Chromium**	1054.93
7.	**Copper**	1338.87
8.	**Iron**	961.21
9.	**Manganese**	40.48
10.	**Nickel**	545.96
11.	**Lead**	97.94
12.	**Zinc**	515.35

#Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

Table 16 and 16A shows the performance assessment of primary treatment system. The CETP operates at nearly 30% operating flow capacity.

- TSS concentration at 30% operating flow capacity at the outlet of tube settler reduces from 98 to 72 mg/L resulting in 26.53% efficiency.
- Whereas, COD concentration at the outlet of tube settler decreases from 150 to 95 mg/L indicating 37% removal efficiency.
- TKN removal could not be achieved during primary physico-chemical treatment.
- Concentrations of heavy metals in the influent were quite low (<1 mg/L) and concentrations of some heavy metals including chromium (1.88 %), copper (1.56 mg/L), iron (1.87 mg/L), manganese (1.08 mg/L), & nickel (0.98 mg/L) were between 1 to 2 ppm.
- Concentrations of these heavy metals in the tube settler outlet sample were also found to be around 1 ppm.
- The slurry from the underflow of the tube settler has nearly 5 % of solids as shown in Table 16 A. Heavy metals such cadmium (2.28 mg/L), chromium (1054.93 mg/L), copper (1338.87 mg/L), Iron (961.21 mg/L), manganese (40.48 mg/L), nickel (545.96 mg/L), lead (97.94 mg/L) and zinc (515.35 mg/L) were detected in high concentrations and 0.97 ppm As was also found to be present.

2.5.11. CETP, Okhla

Observations:

CETP, Okhla was not operational at the time of visit. The effluent in equalization tank underwent eutrophication and algae have dominated at most of the places as shown in Figure 17.

Figure 17: Non-operational CETP at Okhla

Performance assessment of primary treatment system for **Okhla CETP** is as follows:

Table 17: Physico-chemical Characteristics of Effluent[#]

Date of monitoring: June 12, 2018

Sr. No.	Parameters	Inlet of Tube settler*	Outlet of Tube settler
1.	**pH**	7.87	Not operational
2.	**Total Suspended Solids (TSS)**	154	
3.	**Total Dissolved Solids (TDS)**	1928	
4.	**COD**	307	
5.	**Total Kjeldhal Nitrogen (TKN)**	323	
6.	**Sulphate (SO_4^{2-})**	165	
7.	**Chloride (Cl^-)**	650	
Heavy Metals			
8.	**Arsenic**	BDL	Not operational
9.	**Cadmium**	BDL	
10.	**Cobalt**	BDL	
11.	**Chromium**	0.06	
12.	**Copper**	1.74	
13.	**Iron**	2.44	
14.	**Manganese**	0.33	
15.	**Nickel**	BDL	
16.	**Lead**	0.05	
17.	**Zinc**	0.01	

[#]Plant was not operational during monitoring; *Grab sample from equitization basin;
All parameters are in mg/L except pH; BDL – Below detectable limit;

Table 17 A: Physico-chemical Characteristics of Slurry[#] from Tube Settler

Sr. No.	Parameters	Characteristics	Percent Solids (%)
1.	**Total solids**	**103580**	**10.36**
2.	**Total suspended solids (TSS)**	**97700**	

Heavy Metals		
3.	**Arsenic**	BDL
4.	**Cadmium**	7.66
5.	**Cobalt**	0.86
6.	**Chromium**	25.33
7.	**Copper**	240.70
8.	**Iron**	1001.26
9.	**Manganese**	49.18
10.	**Nickel**	38.40
11.	**Lead**	5.99
12.	**Zinc**	264.02

[#]Sampled from underflow of tube settler; All parameters are in mg/L
BDL – Below detectable limit

CETP Okhla operates at nearly 16.67% operating flow capacity. However, the CETP was not operational at the time of monitoring. Tables 17& 17A present physico-chemical characteristics of CETP Okhla**.**

- TSS and COD at the outlet of equalization tank were 154 and 307 mg/L respectively.
- TKN concentration at the outlet of equalization tank was also on higher side (323 mg/L).
- Concentrations of heavy metals in the influent were quite low (<1 mg/L) except for copper (1.74 mg/L) and iron (2.44 mg/L).
- The slurry from the underflow of the tube settler contains ~10 % of solids (Table 17 A).
- Heavy metals such cadmium (7.66 mg/L), chromium (25.33 mg/L), copper (240.70 mg/L), Iron (1001.26 mg/L), manganese (49.18 mg/L), nickel (38.40 mg/L), lead (5.99 mg/L) and zinc (264.02 mg/L) in slurry were detected in high concentrations.

Table 18 presents summary of performance assessment of primary treatment of CETPs with respect to SS and COD removals and highlights presence of significant heavy metal concentrations under existing operating conditions. It may be noted that the operating flow capacity of CETPs varies from as low as 6.25% to a maximum of 62.5%. Accordingly, CETPs which are operating at higher operating flow capacity have low SS and COD removals. This indicates that performance of CETPs needs to be improved for achieving optimum reductions in SS, COD and heavy metals.

Table 18: Summary of Adequacy Assessment of CETPs

Name of CETP	Design Capacity (MLD)	Present flow (MLD)	Operating FlowCapacity (%)	Efficiency of Tube Settler @ % Flow		Notable Heavy Metals in Sludge
				SS Removal	COD Removal	
Lawrence Road	12	2	16.67	93.07	81.71	Fe, Zn, Cu
Naraina	21.6	5	23.15	88.75	79.39	Fe, Zn, Cu
GT Karnal	6	3	50.0	71.69	60.72	Fe, Zn
Nangloi	12	1.5	12.5	85.81	51.82	Fe, Cu, Zn,Cr
Mayapuri	12	4	33.33	86.71	38.86	Fe, Zn, Cu, Mn
SMA	12	2.5	20.83	91.60	39.80	Fe, Mn
Wazirpur	24	1.5	6.25	98.98	77.00	Fe, Mn, Cr
Badli	12	2	16.67	95.70	88.60	Fe, Mn, Cr
Mangolpuri	2.4	1.5	62.5	62.05	52.79	Fe
Jhilmil	16.8	5	29.76	26.53	36.67	Fe, Cu, Cr
Okhla	24	4	16.67	--	--	Fe, Zn, Cu

3. Reuse of Treated Effluent from CETPs

3.1. Introduction

Discharge of wastewater to surface water bodies make water unfit for drinking purpose. In addition, limited water supply and demand increase water stress in regions, with some serious conflicts among countries. While there is water scarcity, many applications require water of low quality compared to drinking purpose. Wastewater reclamation or reuse of treated wastewater has been identified as an imperative approach to meet current and future water needs (Baresel et al 2016; USEPA 2012; WHO 2006). Water reclamation converts wastewater to water that can be reused for various applications.

Collection and use of wastewater is practiced since ancient times. To ensure safe reuse, water should be free from pathogens, opportunistic pathogens, micro-pollutants and emerging pollutants (Falk et al., 2011). Recent evidences suggest that waterborne pathogens are ineffectively removed from existing wastewater treatment systems and that indicators used to assess water quality fail to detect their presence precisely (USEPA, 2015). Many waterborne diseases are linked to ineffective treatment processes to remove pathogens (Okoh et al., 2007). A well-known disease outbreak was in Milwaukee in 1993, claiming 104 lives and infecting more than 400,000 people due to parasitic protozoa, Cryptosporidium parvum. Besides efficacy of treatment process, it is necessary the multi-barrier process meet health targets (UN ESCAP 2015).

3.1.1 Background of project

The study was initiated by Laghu Udyog Bharti (LUG) in association with DSIDC and Industrial Associations to revisit all the Common Effluent Treatment Plants (CETPs) of Delhi for revival of their operation & process control; exploration of sludge recycle & reuse and assessment of treated effluent reuse for non-potable purpose. This component deals with assessment of treated effluent and its potential reuse for non-potable purposes. To ensure safe reuse, a global screening of guidelines different applications was done (US EPA 2002, WHO 2006). Furthermore, a review of existing treatment processes and water quality reports of CETPs was conducted.

3.1.2 Objectives

The objectives of study are:

i. To assess the effluent wastewater quality for microbiological parameters

ii. To evaluate health risks on utilization of treated effluent for non-potable purposes e.g. landscape irrigation, industrial purpose and toilet flushing.

3.1.3 Need for study

Indian cities experience water crisis due to industrialization and population growth. The increasing water scarcity led countries to explore alternate water resources. One of the alternative sources is use of treated wastewater for non-potable water applications. Reuse of treated wastewater for non-potable purposes has already been under consideration in developed countries. Treated effluents has been put to use for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a groundwater basin (referred to as ground water recharge) (Jahne et al., 2017; Rose et al.,1996).

Although reuse of treated effluents presents several potential environmental and fiscal benefits, a matter of considerable concern is the potential human health risk associated with exposed population in contact to waterborne pathogenic microbes present in effluent water (Petterson & Ashbolt, 2003). A range of pathogens and organic pollutants have been identified and few have also reported to pose health risks. These risks are either health consequences (possible diseases) or occupational safety problems for those working in Wastewater treatment plants (WWTPs) or living nearby WWTPs. Hence,the focus of the sub-component is to examine the feasibility of treated effluent for its reuse for non-potable purposes (landscape irrigation, toilet flushing) and assess health risks to a level that fulfill the USEPA and European guideline and health targets as there no such guidelines in India.

3.2 Selected reuse applications

A review of common non-potable wastewater reclamation applications was done at the commencement of the study (WHO, 2006). Reuse alternatives were finalized on basis of quantity of treated effluent generated by CETPs in Delhi. However, the reuse application depends on quality of treated effluent. The potential reuse alternatives are as follows:

1. Irrigation: it is the most common application of treated wastewater. However, the application is divided into restricted and non-restricted irrigation including food crops, non-food crops and seed crops depending on the treated effluent water quality.
2. Industrial purpose: Treated effluent is used for industrial applications including water used for cooling, washing instruments and machines, boiler make-up water; industrial process water in pulp & paper, chemical, petrochemical, coal & cement industries, etc.
3. Toilet flushing: Treated effluent is also used for toilet flushing in industrial building and nearby households.

3.3 Reuse guidelines and health targets

Review of global reuse water quality standards and guidelines revealed important water quality parameters checked by countries before finalization of reuse application. In 2012, US EPA developed a comprehensive water reuse guideline recognizing the need to provide guidance to stakeholders and managers. Furthermore, the country specific guidelines and rules were also developed. Countries California and Florida have guidelines for reuse since 2001. Florida regulations focuses on treatment processes and water quality parameters (Table 19).The guideline value of the parameters and minimum treatment requirement depend upon the application.

Table 19: Water quality Parameters and standards

Category	**Parameters**	**US EPA guideline (For Agricultural reuse)**	**US EPA guideline (For Industrial reuse)**
Microbiological	Total coliforms	-	-
	Fecal coliforms	Not detected/100ml	$\leq$ 200 CFU/100ml
	Viruses	-	-
	Helminth eggs	$<$1 count/L	-
Physical	Colour	-	-

	pH	6.0-9.0	6.0-9.0
	Turbidity	≤ 2NTU	-
	Total dissolved solids	-	-
	Total suspended solids	-	≤ 30mg/L
Chemical	BOD	≤ 10mg/L	≤ 30mg/L
	COD	-	-
	Nutrients	-	-

In 2006, WHO documented guidelines for safe reuse of wastewater and human excreta to provide guidance to regulators and decision makers ensure safe waste management, disposal and reuse. Standard values are defined for physico-chemical and microbiological standard but their still exists no target value of pharmaceutical products and personal care products. The health targets are also defined on the basis of disability adjusted life years (DALYs) per person per year.

3.4 Quantitative Microbial Risk Assessment (QMRA) framework

Quantitative Microbial Risk Assessment (QMRA) is a framework used to estimate the magnitude of probability-of-infection on exposure to pathogens in exposed population (Haas et al., 1999). It has been gaining attention for estimating magnitude of risk associated with specific scenarios (Hamilton et al., 2006). Last revised World Health Organisation (WHO) guidelines for agricultural reuse (published in 2005) recommended the use QMRA (Blumenthal et al., 2000; Carr, 2005; WHO, 2006) for better regulations and assessment of systems for ensuring safe reuse of human wastes.

General QMRA framework comprises four distinct steps:

1. *Hazard Assessment*: This step involves identification of the microbial agent and the range of human illness and disease associated with the specific pathogen.

2. *Exposure Assessment*: This section mainly estimates the mean concentration of pathogen or indicator in water on exposure. The dose is calculated using the concentration of microorganisms in the environmental medium (such as soil or water) being studied and the amount of that environmental medium a person is exposed to. Once dose is calculated, it is incorporated into an equation specifically for the pathogen being studied.
3. *Dose- response assessment*: Dose-response models have already been created for a variety of microorganisms and the model is specific to a microorganism and route of exposure. Dose-response models are created using data from studies that investigated how many individuals were infected when exposed to a certain amount of microorganism of interest.
4. *Risk Characterization*: This step integrates dose-response analysis and exposure assessment to estimate the probability of infection, uncertainty and variability of the hazard studied.

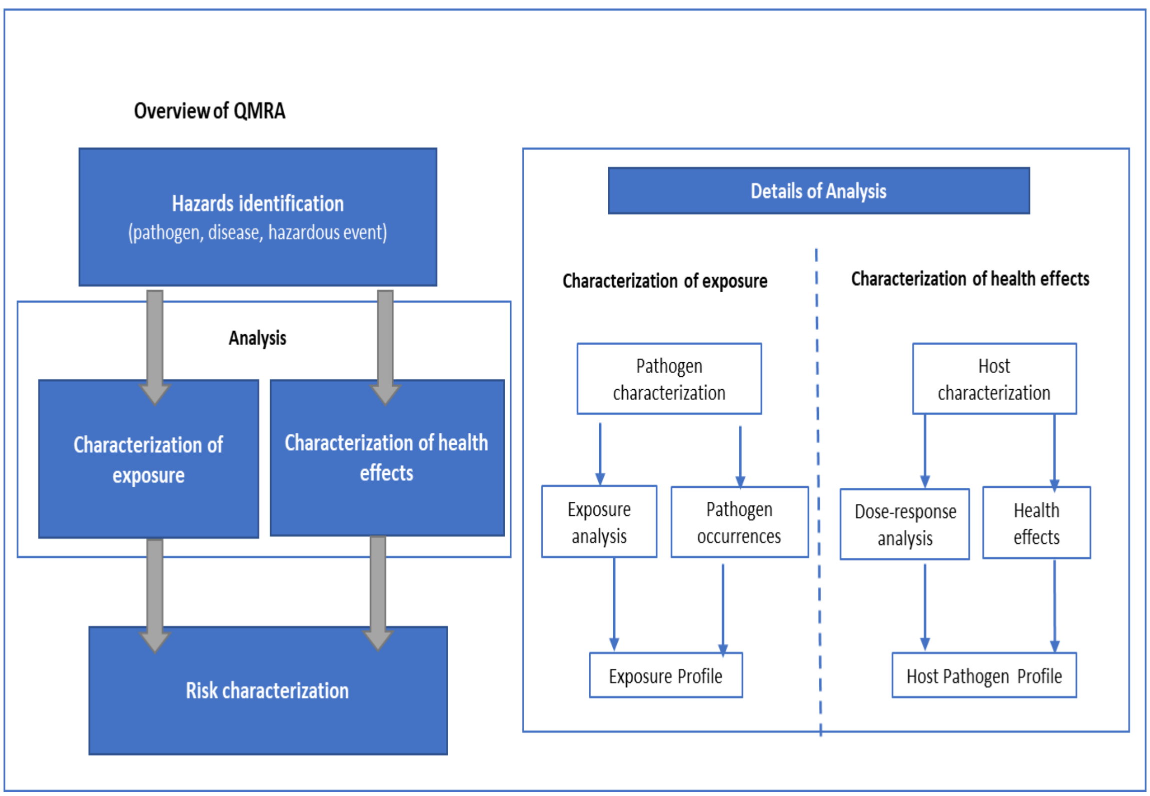


Figure 18: QMRA framework (Haas et al., 1999)

3.5 Development of the QMRA Model

3.5.1 Hazard Identification

Cryptosporidium parvum and *Giardia* were chosen as representative of the expected risk from treated effluent for this scenario. These parasitic protozoans have potential to be transmitted to human hosts from non-human source, causing gastrointestinal infections in humans (Smith et al., 2007). According to CDC (2013) in developed countries, nearly 2% of adults and 6–8% of children are infected with Giardia, while one third of the people in the developing world have had giardiasis. The Giardia and Cryptosporidium (oo)cysts can survive for months in surface water and in soil. Even small concentrations of virulent and infectious cysts may contribute a detectable outbreak (Plutzer et al., 2010). Furthermore, Cryptosporidium is the second most common waterborne pathogen worldwide, with an estimated 30,000 cases of cryptosporidiosis occurring annually in the USA (Yoder et al., 2012), and is identified in 2% of all diarrhoea cases in developed countries compared to a 7% rate in children and 14% in AIDS patients (Chen et al., 2002, Kotloff et al., 2013).

In addition to parasitic protozoans, Salmonella spp. was identified as a source of hazard in edible crop irrigation with treated wastewater. Reports suggested farmers and children living around farms irrigated with wastewater have high degree of Salmonella infections as compared to population living around farms not irrigated with wastewater (Melloul et al., 2001). It is ubiquitous Gram-negative enteric pathogen causing intestinal illnesses such as gastroenteritis, bacteremia, and typhoid fever (Amha et al., 2015). It is predominantly found in sewage and can be present in the effluent water released from wastewater treatment facilities (Levantesi et al. 2012).

3.5.2 Exposure Assessment

The major exposure routes associated with treated effluent reuse for food crop irrigation considered are:

(a) The accidental ingestion of treated effluent by farmers and children playing in farms, and,

(b) The consumption of food crops irrigated with treated effluent by farmers and consumers

The worst-case scenarios were used for the study to represent more realistic scenarios such as accidental ingestion of treated effluent by farmers and children without washing hands and any protection. For consumption of crop produce, assumption was produce is consumed by farmers within 0-2 days while consumers consume produce within 3-5 days. All parameters and detailed descriptions regarding the exposure scenarios are stated in Table 20.The chosen volumes and frequencies are based on literature that dealt with such estimations (Busgang et al., 2018). Monte Carlo method was used to propagate uncertainties due to variability in input parameters.

Table 20: Scenarios and parameters considered for QMRA

Exposure Scenario	Activity	Exposure route	Volume (ml) Avg (min-max)	Frequency	Comment	Reference
1	Accidental drinking	Accidental consumption by: 1. Farmers 2. Children playing fields	1.5 (1-2) 2	300days 300days	Assumption farmers do not use any protection during farming and children playing in fields are also exposed	Razak et al 2008
2	Food crop irrigation	Ingestion of farm produce by 1. Farmers 2. Consumers	10-20gm 10-20gm	16 days (crop consumed once a week and grown 4 months)	scenario examine the possibility of food crops becoming contaminated with pathogens from direct irrigation with treated effluent	Busgang et al 2018

The daily dose of each pathogen was calculated using eq (1) and eq (2) for scenario 1 and scenario 2 respectively.

Scenario1: Accidental ingestion

D (cfu/day) = C * I -- (eq. 1)

Scenario 2: Food crop consumption

D (cfu/day) = $C*I_f*V*10^{-w}$ * exp ($^{-kdt}$) ---------------------------------- (eq. 2)

Where D is the daily dose of bacteria exposed per day (cfu/day), C is the concentration of pathogen in treated effluent, I is the quantity of water ingested per day (ml/day), I_f is the average amount of food consumed by people (g/day), w is the log10 reduction in bacterial concentration from washing of produce, $k_d$is the kinetic day constant (day $^{-1}$) and t is withholding period (days) (Busgang et al., 2018, Razak et al., 2008). Additional parameters, constants and distributions used for calculation of dose for scenarios are specified in Table 2.

Table 21: Additional parameters and constants used

Parameter		value	distribution	reference
Withholding days	t (farmers) t (consumers)	0-2 days 3-5 days	Uniform Uniform	Baker et al., 2013
Decay constant	K_d	0.05, 0.33	Uniform	Busgang et al., 2018
Food (salad) crop ingested	I_f	10-20gm	Uniform	Busgang et al., 2018

3.5.3 Dose-Response assessment

The dose-response model is used to determine the risk of infection at various doses of exposure to *Cryptosporidium parvum, Giardia* and *Salmonella typhi*. Previous studies used the exponentialdose-response model for *Cryptosporidium parvum*and*Giardia*and beta-Poisson for Salmonella (Qmrawiki).

Exponential model: $P_{inf,d} = 1 - e^{k*D}$

Where k is infectivity parameter and D is dose

Beta – Poisson: $P_{inf,d} = 1 - [1 + \frac{D}{N_{50}} (2^{\frac{1}{\alpha}} - 1)]^{-\alpha}$

Where P_{inf} is probability of infection, *D* is the dose, α is slope parameter and N_{50} is median infectious dose

The annual risk of infection was calculated using

$P_{inf,\ annual} = 1 - (1 - P_{inf,d})^n$

Where n is exposure days per year

Table 22 states the dose-response models used in the study.

Table 22: Dose-response parameters

Pathogen	Parameter	Value
Cryptosporidium	k	5.72E-02
Giardia	k	1.99E-02
Salmonella	α N_{50}	1.75E-01 1.11E+06

3.5.4 Risk characterization

The annual probability of infection was determined for each exposure scenario, and the risk was characterized as above or below the maximum tolerable risk suggested according to the US EPA and WHO (less than 1 in 10^4). Any risk above the target level requires proper treatment barrier to reduce health impact. In addition, the annual probability of infection was characterized as above or below the maximum tolerable risk suggested according to the DALY (1 in 10^{-6} per person per year), where DALY is calculated by the following equation:

$DALY = P_{ill} * B * S_f$

Where P_{ill} is the probability of symptomatic illness occurring, B is the pathogen-specific burden of disease, and S_f is the susceptible fraction of the population. For current study, the entire population was assumed to be susceptible to infection by all pathogens (Sf = 1) and no immunity development was considered.

3.6 Wastewater quality monitoring

3.6.1 Sampling

Wastewater sampling was done at 10 CETPs. Effluent water samples were collected from each CETP to evaluate outlet water quality. All samples were collected and analysed for physico-chemical and microbiological water quality. For microbiological parameters, 500ml of water was collected in pre-sterilized swirl packs with sodium thiosulphate pellet. Samples were separately collected for metal analysis with concentrated nitric acid as a preservative. Samples were filtered using 0.22µm pore size syringe filters for metal analysis. An aliquot of sample was collected in glass beaker to measure on-field parameters. All sample bottles collected were transported back to laboratory in ice box at 4°C. Further care was taken to analyse water samples collected for microbiological parameters within 10 hours of sample collection.

3.6.2. Wastewater quality parameters

All wastewater samples were analyzed according to Standard Methods (APHA-AWWA, 2012) for physico-chemical and microbiological parameter. Table 23 indicates pH, EC, TDS and temperature measured using combine Hanna probe. Turbidity was measured using turbidity meter. Residual free chlorine was also measured at CETPs performing chlorination step. Metal analysis was done using ICP-OES.

Table 23: Water quality parameters analysed

Category	**Parameters**
On-site	pH, temperature, TDS, EC, Residual Chlorine
Chemical analysis	Heavy metal
Microbiological	Thermotolerant coliforms, pathogenic *E.coli*, *Cryptosporidium* and *Giardia*

For microbiological analysis, water samples were tested for thermotolerant coliforms, *Salmonella* and protozoa *(Cryptosporidium* and *Giardia)*. For thermotolerant coliform (TTC) and *Salmonella*membrane filtration technique (MFT) was used. Water samples were serially diluted to $10^{-2}$and 10^{-4} and samples were filtered through 0.45micron filter membranes using filter assembly. These membranes were then placed on pre-prepared mFC agar plates for TTC and m-BSA plates and incubated at 44.5℃ and 37℃ for 24h. All samples were analysed in triplicates.

For *Cryptosporidium* and *Giardia* enumeration, USEPA standard protocol (Method 1623.1) was used. 20L sample was filtered using hollow fibre membranes. Samples were finally visualized under fluorescent microscope for *Cryptosporidium*oocysts and *Giardia* cysts.

3.6.3 Limitations of study

The water sampling was done once during dry season of June. All microbiological analysis was done in triplicates except for *Cryptosporidium* and *Giardia* analysis. For comparing water quality, only internationally accepted guidelines and regulations were considered.

3.7 Results and Observations

3.7.1 Water quality analysis

Water quality monitoring revealed current water quality status of effluent. Table 24 summarizes physico-chemical characteristics of treated effluent at 10 CETPs. pH of treated effluent was observed in range of 7-8.3 while conductivity of water samples was in range of 1694 to 4000 ΩS /cm. Turbidity of samples was usually observed above permissible range of 5 NTU as per reuse guidelines stipulated by WHO (2006). All effluent treated samples had colour and sometimes peculiar septic odour causing bad odour issues at CETP sites.

Table 24: Characteristics of treated effluent at 10 CETPs

CETP	Effluent water characteristics						
	pH	EC (ΩS /cm)	TDS (mg/L)	Temp (°C)	Turbidity (NTU)	Colour	Weather
Lawrence Road	7.38	3999	2000	32.6	20.4	Black	Sunny
Naraina	7.03	3423	1892	33.3	24.6	Brown	Windy
GT karnal	7.72	2952	1470	35.1	23.9	Greenish	Sunny
Nangloi	7.25	3999	2000	34	33.9	Light brown	Sunny
Mayapuri	7.83	3999	2000	33.3	28.3	Brown	Cloudy
SMA	7.6	4000	2000	33.3	5.95	Light brown	Sunny
Wazirpur	8.03	1694	2000	33.3	16.24	Light brown	Sunny
Badli	7.12	2411	1199	35.6	5.6	Light brown	Sunny
Mangolpuri	7.57	4002	2000	33.1	6.82	Clear	Sunny
Jhilmil	7.68	3475	1735	33.4	60.3	Light brown	Cloudy
Okhla	Sampling could not be done						

Microbiological analysis was undertaken to check for potential pathogenic or disease-causing organisms. It recognised that the major risk to people using recycled water was due to infections from microorganisms. Results showed high density of thermotolerant coliform in all water samples. The concentration of thermotolerant coliforms ranged between 3 to 5 Logs per millilitre of water (Figure 19). The presence of thermotolerant coliforms in water samples indicates human and animal faeces contamination. These coliforms are generally harmless. Because there are a lot more coliforms in human faeces than pathogens, they serve as useful indicator of faecal contamination in water. They also indicate water treatment efficiency and thus useful for assessing the reuse safety of treated effluent. Similarly, *Salmonella* concentration was found to be range between 1 to 2logs (Figure 20). Further, on interactions with CETP plant managers, it was revealed by Plant Operators that all CETPs were designed to handle industrial waste and hence treatment process couldn't handle wastewater water having BOD more than 120 mg/L.

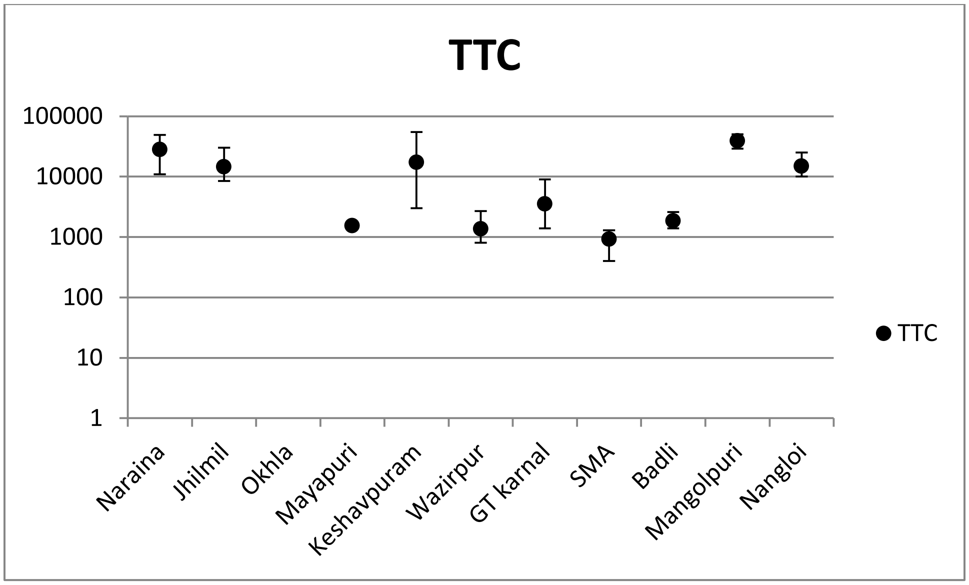


Figure 19: Variation in level of microbiological contamination at CETPs

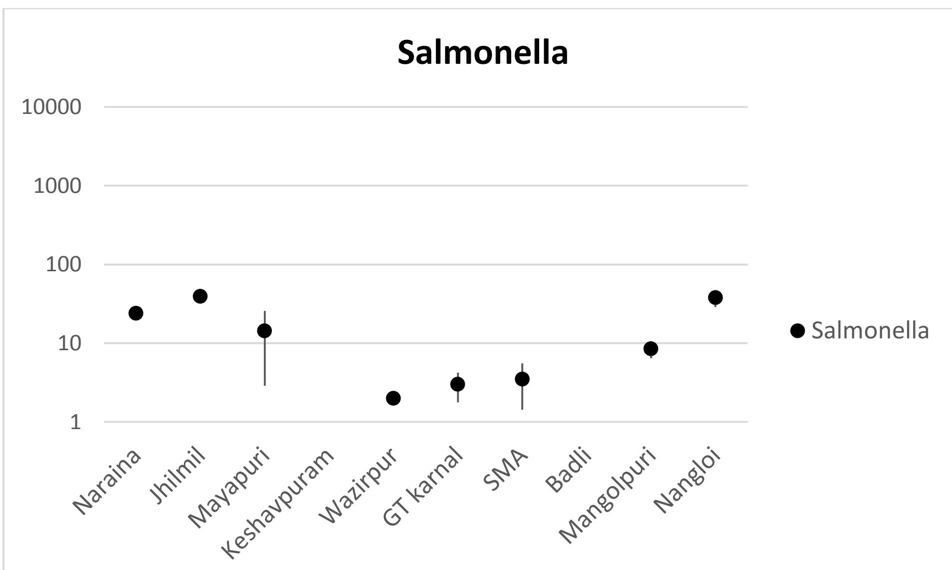


Figure 20: Variation in level of Salmonella contamination at CETPs

In addition, water samples also showed presence of protozoans *Cryptosporidium* and *Giardia* in water samples. Treated water samples from CETPs Naraina, Lawrence Road and Wazipur showed presence of Cryptosporidium in concentration 6, 5 and 8 oocysts per 20 liters respectively. Giardia cysts were found in Naraina (3 cysts /20 L), Wazipur (1 cycts /20L), Badli (2 cysts/20L) and Mangolpuri (1 cysts/ 20L) water sample. Presence of these parasitic protozoans poses a health concern. Although there are no standard guidelines for protozoan concentration in treated effluent but are found to be persistent in the environment and also resistant to chlorination.

Table 25: Cryptosporidium and Giardia concentration in treated effluent

Sr. No	Name of CETP	Cryptosporidium oocysts	Giardia cysts
1	Lawrence Road	0	0
2	Naraina	6	3
3	GT Karnal	8	0
4	Nangloi	0	0
5	Mayapuri	5	0
6	SMA	0	0
7	Wazirpur	0	1
8	Badli	0	2
9	Mangolpuri	0	1
10	Jhilmil	0	0
11	Okhla	0	0

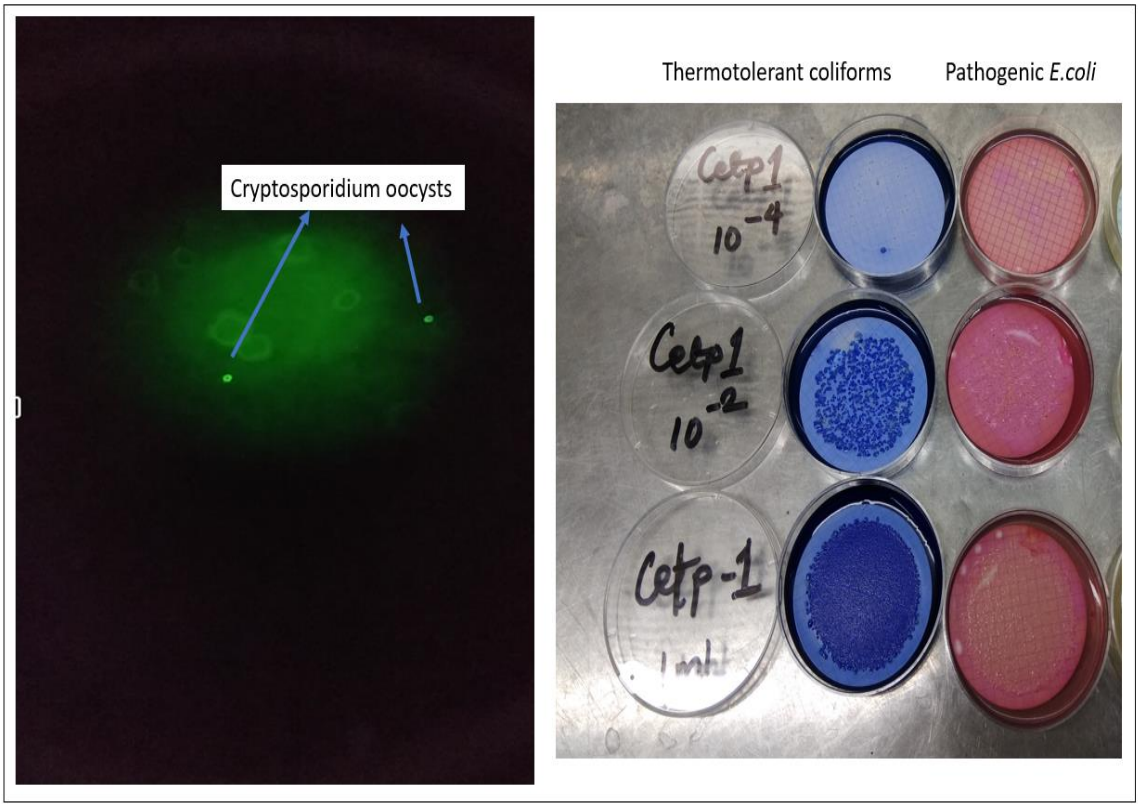


Figure 21: Microbiological analysis of water samples

3.8 Potential reuse applications of effluent from CETPs

Practice of wastewater reuse mainly dependent on infrastructural status covering wastewater treatment capacity and capability, climate, water supply, balance between water requirement and demand, intensity of agricultural activities, population, social habits like cultural and religious prejudice, and many other factors (Vilanaova et al., 2002). Figure 22 depicts the design capacity of CETPs to produce treated effluent and the current outflow rate of CETPs. It is observed that CETPs operate at 10-33% of its designed capacity. It was reported that higher flow rates caused choking of tube settlers and hence CETPs operate at low inflow rate.

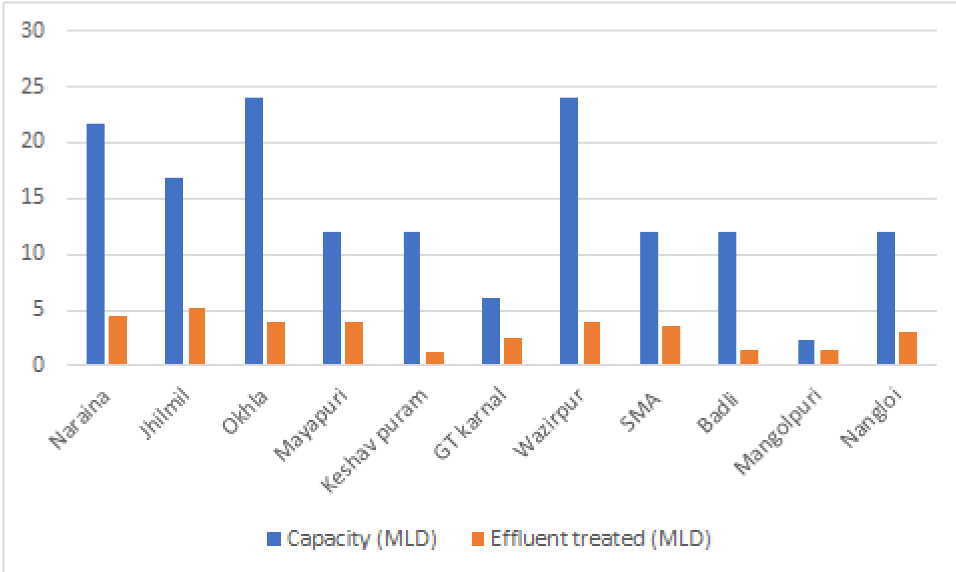


Figure 22: Status of effluent generation by CETP

3.8.1 Risk Assessment

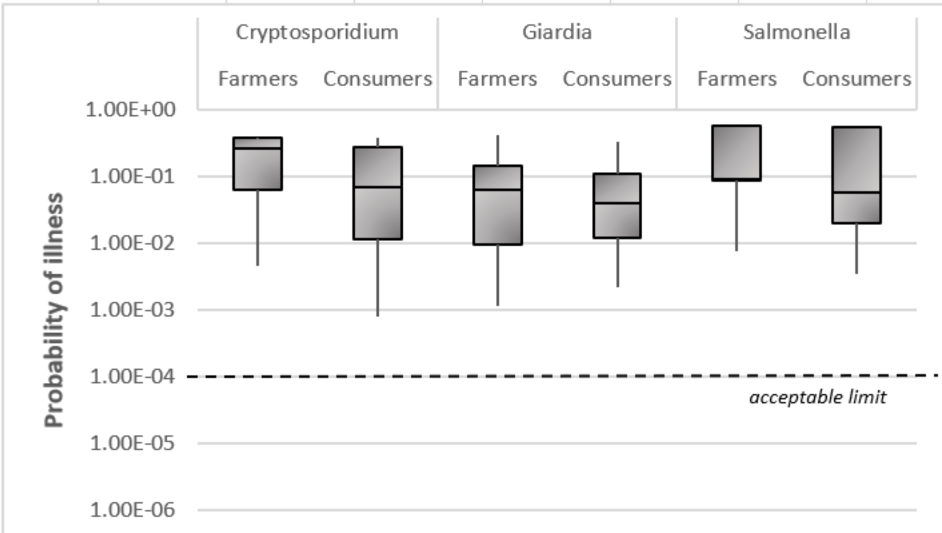
The risk of infection for each pathogen for specific scenario was calculated. For both the scenarios and both the pathogens, annual risk of infection was observed high. The risk of infection from *Cryptosporidium, Giardia*and *Salmonella* is related to the actual dose ingested by a person and not to its concentration in the treated effluent. It is therefore clear that different exposure scenarios will result in the reception of different quantities of pathogen; hence, the probability of infection will vary among scenarios.

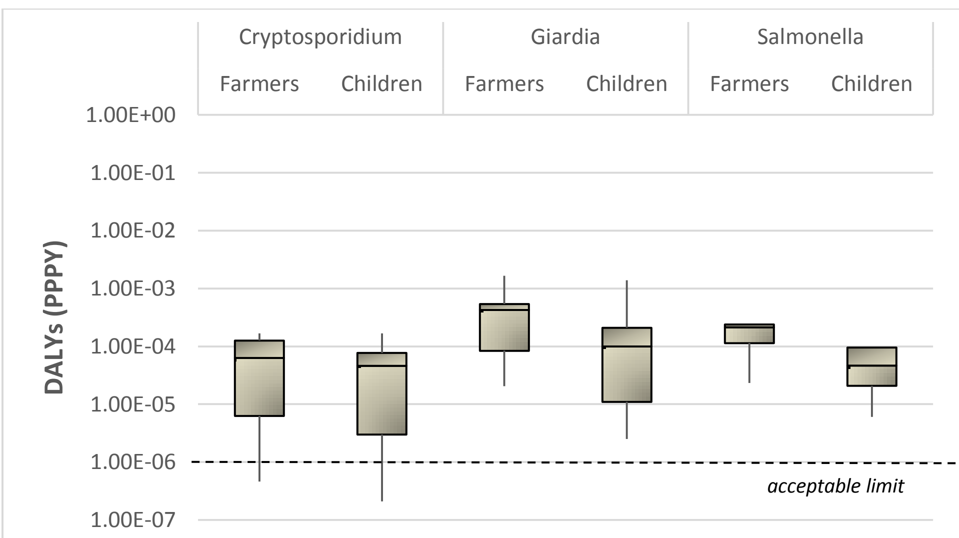
The results showed current exposure scenarios, the risk was higher than the DALY limit. The average Cryptosporidium concentration was 2oocysts/20L and for Giardia was 1cysts/20L. The DALY Cryptosporidium on accidental ingestion by farmers was $5.7X10^{-5}$ PPPY and $4.34X10^{-5}$PPY for children. Similarly, for *Giardia* the DALY calculated was $3.43X10^{-4}$ and $8.9X10^{-5}$ for farmers and children respectively.

In case of crop irrigation, the risk calculated for farmers was$1.15X10^{-4}$ PPPY Cryptosporidium and $3.44X10^{-4}$ PPY Giardia and for consumers was $3.08x10^{-5}$ Cryptosporidium and $2.1X10^{-4}$ PPPY Giardia. For Salmonella, the DALY was found to be higher than protozoans.

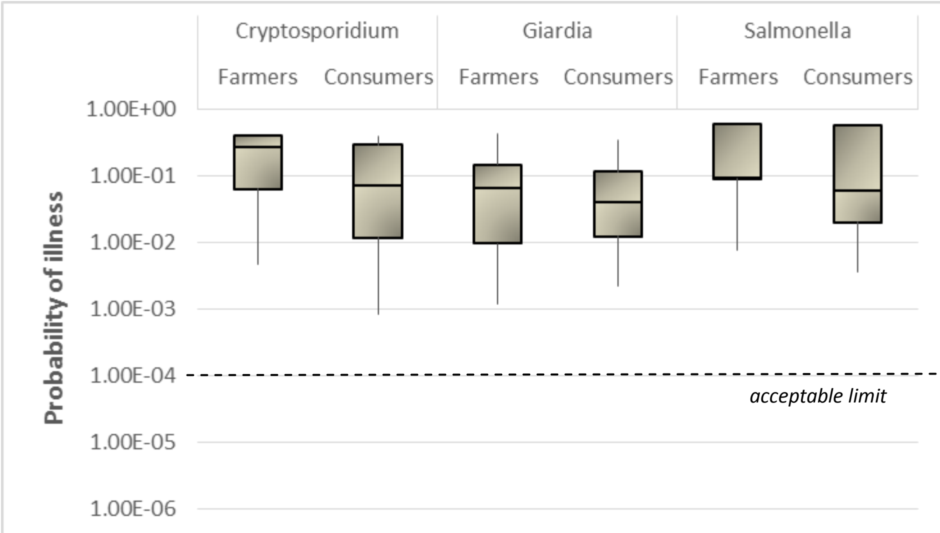
Figure 23: Annual risk of infection and DALYs for scenario

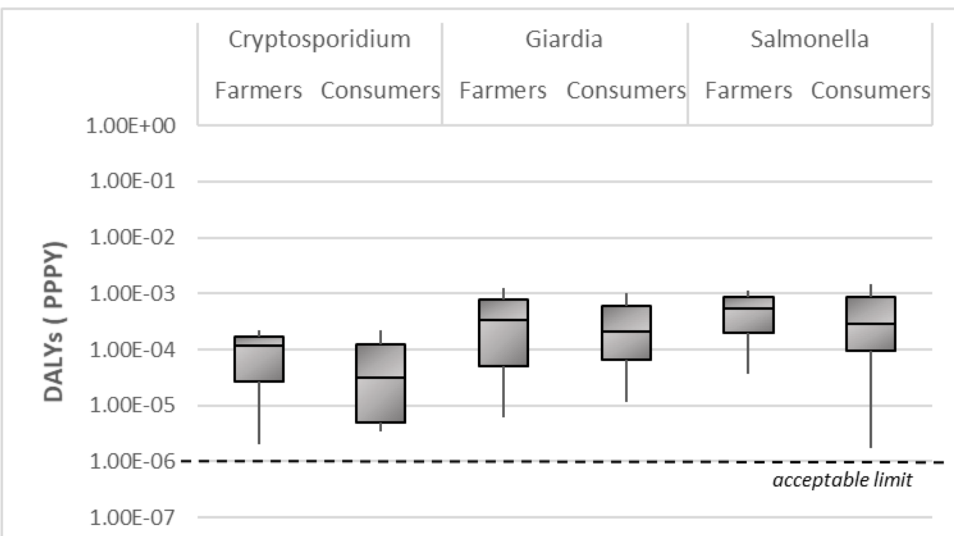
a) Accidental ingestion





b) Food crop consumption





The overall results suggests that the present high concentration of pathogens in treated effluent is high and does represent a high risk of gastrointestinal infections in exposed population.

While developed countries have established low risk guidelines or standards based on a high technology and high-cost approach, many developing countries prefer to adopt WHO guidelines that are low-cost technologies and focus on health risks. **However, the current**

situation in CETPs suggests reuse of treated wastewater for irrigation or other application should only be permitted after effective disinfection system is in place because of heavy load of bacterial contamination.

Figure 24: Treated effluent from Mayapuri CETP used for irrigation of vegetables.

3.9 Conclusion and Recommendations

Following conclusion and suggestions were drawn from the study:

a. The suitability of the effluent was evaluated according to the existing national and international water quality standards. From the data, it is evident that the current situation is not promising especially regarding the bacteriological parameter, i.e. Thermotolerant coliform. The main cause of the problem is either the lack of disinfection units and/or improper operation of the existing ones.

b. The water quality of effluent not only revealed the presence of thermotolerant coliforms (indicator) but also showed presence of infectious pathogens such as pathogenic *E.coli, cryptosporidium* oocysts and *Giardia* cysts.
c. Physical effluent water characteristics were also not as per international guidelines and regulations.
d. Overall, the treated effluent water quality was observed to be in non-compliance with reuse water standards and hence is suggested to avoid reuse of treated effluent until proper treatment improvements are done.
e. Risk assessment based on QMRA principles were undertaken inadvertent consumption (accidental drinking) and application of treated effluent in agriculture crops (food crop irrigation) based on monitored data. QMRA indicates very high risk of reuse of treated effluent. It is recommended that proper disinfection should be in place prior to reuse of treated effluent. Disinfection should include application of UV in addition to chlorination to remove protozoa (*cryptosporidium* oocysts and *Giardia* cysts) from treated effluent.

3.10 References

- Amha, Y. M., Kumaraswamy, R., & Ahmad, F. (2015). A probabilistic QMRA of Salmonella in direct agricultural reuse of treated municipal wastewater. Water Science and Technology, 71(8), 1203-1211.
- BareselC.,Dahlgren L.,Lazic A., Kerchove A., Almemark M., Ek M, Ottosson, Karlsson, Yang J, Allard A., Ejhed H., Björk A. (2016). Reuse of treated wastewater for non-potable use (ReUse). IVL Swedish Environmental Research Institute.
- Busgang, A., Friedler, E., Gilboa, Y., & Gross, A. (2018). Quantitative Microbial Risk Analysis for Various Bacterial Exposure Scenarios Involving Greywater Reuse for Irrigation. Water, 10(4), 413.
- Craig, D. L., Fallowfield, H. J., &Cromar, N. J. (2004). Use of microcosms to determine persistence of Escherichia coli in recreational coastal water and sediment and validation with in situ measurements. Journal of Applied Microbiology, 96(5), 922-930.

- EPA, U. (2004). Guidelines for water reuse. Washington, DC, 450.
- Haas, Charles N., Joan B. Rose, and Charles P. Gerba. Quantitative microbial risk assessment. John Wiley & Sons, 1999.
- Jahne, M. A., Schoen, M. E., Garland, J. L., &Ashbolt, N. J. (2017). Simulation of enteric pathogen concentrations in locally-collected greywater and wastewater for microbial risk assessments. Microbial Risk Analysis, 5, 44-52.
- Melloul, A. A., Hassani, L., &Rafouk, L. (2001). Salmonella contamination of vegetables irrigated with untreated wastewater. World Journal of Microbiology and Biotechnology, 17(2), 207-209.
- Okoh, A. I., Odjadjare, E. E., Igbinosa, E. O., &Osode, A. N. (2007). Wastewater treatment plants as a source of microbial pathogens in receiving watersheds. African Journal of Biotechnology, 6(25).
- Petterson, S. A., &Ashbolt, N. J. (2003). WHO guidelines for the safe use of wastewater and excreta in agriculture: Microbial risk assessment section. World Health Organ., Geneva, Switzerland.
- Rose, J. B., Dickson, L. J., Farrah, S. R. & Carnahan, R. P. (1996), Removal of pathogenic and indicator microorganisms by a full-scale water reclamation facility. Water Research, 30(11), pp. 2785–2797.
- U.S. Environmental Protection Agency 2012. Guidelines for Water Reuse (No. EPA/600/R-12/618). Office of Wastewater Management, Office of Water, Washington.

4. Overall Observations on Functioning of CETPs

4.1 Treatment, disposal and reuse of stored chemical sludge

- The Ash content of Lawrence Road, Mayapuri, SMA and Jilmil CETPs sludge was found to be greater than 50%.
- Wazirpur CETP sludge and Grit are highly acidic, while Narina and G T Karnal CETP sludge had pH above 9.0.
- The toxicity levels of all the CETP samples (mainly with respect to Cr, Cu, Fe, Zn) were extremely high and hence these cannot be used "as it is" for any road construction or similar activity. The possibility of stabilization of these toxic metals through known techniques needs to be examined.

4.2 Adequacy of CETPs for Minimization of Sludge Production

- Out of 11, only 7 nos of CETPs have provided the inventory details. However the details of chemical consumption were not provided thereby making it difficult to estimate the chemical dosages applied currently.
- TDS concentrations at the outlet of tube settler were often found to be higher than the inlet TDS values. This could be attributed to the addition of chemicals such as coagulants/flocculants.
- The TKN concentrations of effluent being received at all 11 CETPs are on higher sides (>200 ppm). Ammonia-nitrogen contributes ~14 to 20% to TKN.
- There was either very little or no TKN removal achieved during primary physico-chemical treatment across all CETPs monitored. However, TSS or COD removal efficiency in most of the CETPs were quite significant under existing condition (under capacity). This implies that TKN in the CETP effluent is in soluble form.
- It is imperative to mention that data obtained in terms of removal efficiencies are superficial and do not reflect actual performance of CETP under existing operating conditions since all the CETPs are operating much below the designed capacities.
- The CETPs require up-gradation for targeting effective TKN removal as well as other parameters.

4.3 Reuse of treated effluent from CETPs

- Studies on reuse of treated effluent reveals that the current situation is not promising especially regarding the bacteriological parameter, i.e. Thermotolerant coliform.
- The water quality of effluent indicated presence of thermotolerant coliforms (indicator) and infectious pathogens such as pathogenic E.coli, cryptosporidium oocysts and Giardia cysts.
- Overall, the treated effluent water quality was observed to be in non-compliance with reuse water standards (Table 26) and hence is suggested to avoid reuse of treated effluent until proper treatment improvements are done.
- Presently, there is no such guideline available in India. For reference purpose, US EPA, WHO and European Commission guidelines are presented in Table 26.

Table 26: Comparison of Guideline values for Potential non-potable reuse applications with CETPs treated effluent water quality

Sr. No.	Category	Sub-category	Application	Guideline			
				Faecal coliform (cfu/100ml)	E.coli (cfu/100ml)		Health protection level; DALYs (PPPY)
				1	*2*	*3*	*1,2*
1	Urban reuse	Unrestricted	Irrigation of parks, toilet use, fire-fighting	<1	$\leq 10^{3}$		$\leq 10^{-6}$
		Restricted	Golf course, Cemeteries	<200	$\leq 10^{4}$		$\leq 10^{-6}$
2	Agricultural Reuse	Food crops	Salad crops, crops eaten raw	<1	$\leq 10^{3}$ (root crops) $\leq 10^{4}$ (leaf crops)	<100 <100	$\leq 10^{-6}$
		Non-food crops	Fodder, seed crops	<200	$\leq 10^{4}$	<100	$\leq 10^{-6}$
		Processed food	Vineyards, Orchards	<200	-		$\leq 10^{-6}$
3	Recreational Reuse		Boating, fishing	<1	-		$\leq 10^{-6}$
4	Construction use		Cement making	<200	-		
5	Environmental Reuse		Natural wetlands	<200	-		
6	Industrial Reuse		Cooling, Recirculation	<200	-		
7	Aquaculture				$\leq 10^{5}$ Produce consumers		$\leq 10^{-6}$

Sr. No.	Category	Sub-category	Application	Guideline			
				Faecal coliform (cfu/100ml)	E.coli (cfu/100ml)		Health protection level; DALYs (PPPY)
				1	2	3	1,2
					$\leq 10^4$ (Workers)		
8	**CETPs (Contamination level observed)**			**10^6-10^8**	**10^5-10^7**		**10^{-3}-10^{-5}**

Note: [1] US EPA guideline, [2] WHO guidelines, [3] European Commission guidelines

- Risk assessment based on QMRA principles were undertaken for inadvertent consumption (accidental drinking) and application of treated effluent in agriculture crops (food crop irrigation) based on monitored data. QMRA indicates very high risk of reuse of treated effluent.

Component wise summary of CETP status details and recommended actions is presented in Table 27.

Table 27: Summary of CETP status details and recommended actions

Sr. No.	Issue	Current Status (as per data in this report)	Recommended Actions
1	Treatment, Disposal and Reuse of stored sludge	– Currently, the dried sludge from CETPs is bagged and stored in covered shades as per the consent. – In some of the CETPs, where shed space is exhausted, sludge is stored wherever the space is available. Further, it was observed that the sludge bags have been found ruptured and torn due to weathering effects, leading to spillage of sludge. – The sludge from all the CETPs is found to contain toxic heavy metals in significantly high concentration, exceeding the standards prescribed in HWM rules 2016 & CPCB Standards. – The Sludge samples cannot be used "as it is" for any road	– LUB/CETP management need to undertake detailed assessment of industrial input sludge for stabilization and reuse of chemical sludge in the form of cement mortar, pavement blocks etc, and TCLP tests on the final product(s) before scale-up/implementation. – At each CETP, sludge quality is different and therefore site specific plan needs to be addressed. – A small quantity of sludge, say 5-20% by weight, may be mixed with cement mortar for preparation of cement blocks / bricks for TCLP testing. Depending on the results, it may be considered for further use.

Sr. No.	Issue	Current Status (as per data in this report)	Recommended Actions
		construction or similar activity and proper stabilization is vital.	
2	Adequacies of CETPs for minimization of sludge production	– Among 11 CETPs, only 2 operate above 50% flow capacity and rest operate at flow capacity between 6 – 30%. – Tube settler based primary treatment system constitutes the major part of the CETP treatment scheme that accounts for substantial removal of TSS. – Currently observed TSS removal (in the range 70-90%) at many of the CETPs is due to very low hydraulic load received at CETPs, while chemical application as per design is applied. It is imperative that the solid-liquid separation would become inefficient at design flow rates of a CETP. – It is possible that a part of the organic load (COD) is adsorbed on the SS particles. This accounts for more than 60% COD removal observed frequently through physico-chemical based primary treatment unit – The CETPs were designed for inlet TKN concentration of 25 mg/L TKN. However, effluent having 10-12 times higher TKN concentration is currently received. It is found that the existing primary treatment operation was ineffective in controlling TKN present in the influent. Thus, CETPs need to be upgraded to address high TKN concentrations also. – Several heavy metals are present in the slurry samples collected from tube settler underflow. This qualitatively implies that the dried sludge may also have toxic heavy metals in significantly	– LUB/CETP management should undertake exercise of Optimization of chemical dosing commensurate with current hydraulic load and to minimize sludge formation – Undertake retrofit exercise for better CETP performance.

Sr. No.	Issue	Current Status (as per data in this report)	Recommended Actions
		higher concentrations. This is found to be true from the data collected under item (1) above.	
3	Reuse of treated effluent from CETPs	– Currently there exist no well laid down Standards for 'Reuse for Toilet Flushing' Water Quality Standards in India. – The water quality of final treated effluent (collected at the outlet of CETPs) revealed the presence of thermos-tolerant coliform bacteria (indicator) as well as infectious pathogens, eg., pathogenic E.coli, cryptosporidium oocysts and Giardia cysts. – The main problem is that some of the CETPs lack disinfection units and if exist they are not properly operated. – The tertiary treatment systems (GAC and DM Filters) in CETPS were found to be non-operational and/or defunct. – QMRA indicates very high risk of reuse of treated effluent even for agricultural applications.	LUB/CETP management may consider: – to Interact with MoEFCC/CPCB to delineate 'Toilet Reuse Water Quality Standards' for Indian context. – to provide or upgrade adequate tertiary treatment facilities (including disinfection units) to ensure the treated effluent water quality to be in compliance with relevant reuse water standards and hence is suggested to avoid reuse of treated effluent until proper treatment improvements are done. – It is recommended that proper disinfection should be in place prior to reuse of treated effluent. Disinfection may include application of UV in addition to chlorination to remove protozoa (cryptosporidium oocysts and Giardia cysts) from treated effluent.

Annexure – I

Minutes of the meeting held between CSIR-NEERI & Laghu Udhyog Bharati (LUB) at 10:30 am on 17th May, 2018 (Thursday)

Venue: Committee Room No.:1 (CSIR-NEERI)

The following members were present in the meeting:

CSIR-NEERI

1. Dr. Rakesh Kumar, Director, CSIR-NEERI
2. Dr. N. N. Rao, Chief Scientist & Head, WWTD
3. Dr. A. N. Vaidya, Chief Scientist & Head, SHWMD
4. Dr. Pawan Labhsetwar, Senior Principal Scientist & Head, WTMD
5. Dr. Girish Pophali, Principal Scientist , WWTD
6. Dr. Sunil Kumar, Senior Scientist, SHWMD
7. Dr. Hemany Bherwani, Scientist, DRC

Laghu Udhyog Bharati (LUB)

Shri Om Prakash Gupta, General Secretary, LUB, Delhi (Email: gensecretary@lubdelhi.com; jointsecretary@delhi.com)
Shri Ravinder Nath Bansal, Member R&D National Committee, Ex. President LUB, Delhi
Shri.Neeraj Sehgal, Joint Secretary, LUB, Delhi
Shri. Prem Prakash, Wazipur CETP, Delhi
Shri. Sunil Sirsikar, National secretary, LUB
Shri. Udayan Shrouti
Shri Shrikant Dandrikar
Shri Mr. Abhishek (representative from AMPRI, Bhopal)

Dr. Rakesh Kumar chaired and opened the discussion meeting by welcoming all the dignitaries from LUB. A round of introduction of participants took place.

The following major issues pertinent to CETPs in Delhi were put forth by Shri Gupta. All the other participants deliberated upon them and agreed to address comprehensively:

1. **Management of chemical sludge**: The chemical sludge generated at the CETPs is posing serious burden on the industry as it is not being allowed to be disposed of and advised to store in the CETP premises.
    - A solution targeting its reuse either in cement industry or road construction or any other possibility is sought.
    - CSIR-NEERI suggested a comprehensive study aiming at sludge characterization followed by application of available technologies & user mapping.
    - It would include profiling and ranking of technologies, policy analysis (world over), and interfacing with regulatory authorities.

1/2

Continued…

- NEERI also suggested CETP level interventions to minimize sludge generation is also suggested.

2. **Reuse of treated water from CETPs**: Approximately 24000 m^3/d effluent is treated at CETPs in Delhi. The members from LUB felt that currently the treated water from CETPs is wastefully discharged into drains.
   - The treated water could be reused as toilet flush water for toilets built under Swachch Bharat Mission.
   - CSIR-NEERI to conduct a study on the suitability of treated water from CETPS for the desired end-use.

3. **Revisiting CETPs:** The current design of CETPs was based on CSIR-NEERI's study performed during 1996 and implemented in 2004-2005. As informed by LUB the signature of several industries in different sectors has changed significantly over the last 10-15 years and it is hightime the CETPs are revisited for a complete check-up to see performance & technology adequacies.
   - With the advent of new approaches/technical advancements substantial reduction in sludge generation and improvements in waste utilization or O&M cost savings can be expected.
   - It is proposed to revisit the CETPs with the objective of minimizing sludge generation through technology upgradation and other measures leading to reduction sludge handling costs.

4. **Training Needs**: The training needs of the CETP personnel were also discussed. CSIR-NEERI has suitable training modules ready for training CETP personnel and this activity can be taken up in near future.
5. After deliberations, it was decided that NEERI shall evaluate the water quality from CETP and suggest practical remedial action plan to improve the quality by 30th June 2018.
6. LUB shall coordinate with all CETP societies operating in Delhi for follow up for necessary information whensoever desired by NEERI for detailed study of sludge being produced by them.
7. NEERI shall keep LUB on their mailing list for dissemination of all related important information.
8. LUB & NEERI shall meet periodically to work for continuous improvement in creating awareness and resolving environment related issues.

The meeting ended with a vote of thanks to the Chair.

Dr. Rakesh Kumar
Director NEERI

Shri Om Prakash Gupta, ,
General Secretary, LUB

CSIR - National Environmental Engineering Research Institute
सी.एस.आई.आर - राष्ट्रीय पर्यावरण अभियांत्रिकी अनुसन्धान संस्थान

Proforma for Inventory of CETP

(Attach additional sheets wherever required)

1.	Name of CETP and complete address (including name of contact person, contact no, fax, email id)	:			
2.	Type of Industry/industrial effluent being received at CETP	:	• Red	:	
			• Orange	:	
			• Green	:	
3.	Chemical used requirement	:			
	• Name	:			
	• At installed operational capacity	:			
	• Under present condition (Jan to June, 2018)	:			
4.	Nature of fuel used	:			
	• Electricity	:			
	• Coal	:			
	• Furnace oil	:			
	• Diesel	:			
	• Any other	:			
5.	Wastewater generation (Jan to June, 2018)	:			
	• Process effluent/	:			
	• Sewage	:			
6.	Wastewater treatment facilities at CETP	:			
	• Flow diagram	:			
	• Brief description of unit operation and process	:			
	• Design capacity	:			
	• Present flow rate	:			
	• Treatment performance for consent parameters based on records (Jan to June, 2018)	:			

 Continued…

7.	Treated effluent discharge	:			
	• Mode of disposal	:			
	• Discharge location	:			
	• Distance from industry to point of discharge	:			
8.	Effluent recycle/ reuse, if practiced	:			
	• Purpose	:			
	• Quantity	:			
	• Details	:			
9.	Existing solid & hazardous waste generation	:	Waste Type		kg or tones/day
			ETP sludge	:	
			Lime sludge	:	
			Ash	:	
			Garbage	:	
			Spent oil	:	
			Any other	:	
10.	Solid and hazardous waste management (Details/ treatment, if any/ mode of disposal)	:			
11.	DPCC Consent with respect to the following	:			
12.	• Treated effluent discharge location	:			
13.	• Quantity (m^3/day)	:			
14.	• Consent limit	:			
15.	• Solids & hazardous waste disposal	:			

Annexure- [illegible] Annexure-5

Central Pollution Control Board, Delhi

Wazirpur CETP, Delhi **Date of Visit: 03/01/2019**

Sl. No.	Parameters	Inlet	Outlet	Prescribed Standards
1.	pH	7.03	8.64	6-9
2.	TSS	2360	**150**	100
3.	COD	641	207	250
4.	BOD	132	**70**	30
5.	Cl^-	577	625	1000
6.	F^-	22	**14**	2
7.	SO_4^-	1021	961	1000
8.	NO_3-N	94	**96**	10
9.	NH_3-N	43	45	50
10.	PO_4-P	0.20	0.10	5
11.	Phenol	BDL	BDL	1
12.	O&G	28	**18**	10
13.	FDS	6404	**6388**	2100
14.	CN^-	-	**0.21**	0.2
15.	As	BDL	BDL	0.2
16.	Cd	BDL	BDL	0.05
17.	Cr	73.10	0.39	2
18.	Cu	12.80	0.06	3
19.	Fe	678.18	**7.82**	3
20.	Mn	19.11	**7.19**	2
21.	Ni	6.74	1.72	3
22.	Pb	0.03	BDL	0.1
23.	Se	BDL	BDL	0.05
24.	V	0.18	BDL	0.2
25.	Zn	0.0059	0.0003	5

BDL: Below Detection Limit

All values are in mg/l except pH.

Annexure-6 Annexure-6

cpcb

Central Pollution Control Board, Delhi

SMA CETP, Delhi **Date of Visit: 08/02/2019**

Sl. No.	Parameters	Inlet	Outlet	Prescribed Standards
1.	pH	6.97	7.95	6-9
2.	COD	246	92	250
3.	BOD	61	16	30
4.	TDS	4460	5900	
5.	FDS	3912	**5360**	2100
6.	TSS	419	34	100
7.	NH_3-N	19	30	50
8.	PO_4-P	1.85	0.08	5
9.	NO_3-N	22.76	9.76	10
10.	SO_4^{-2}	737	**1639**	1000
11.	Cl^-	600	**1104**	1000
12.	F^-	1.61	1.60	2
13.	Phenol	0.11	0.08	1
14.	TKN	32	40	50
15.	CN^-	0.45	**0.66**	0.2
16.	O&G	6	BDL (<05)	10
17.	As	BDL	BDL	0.2
18.	Cd	BDL	BDL	0.05
19.	Cr	7.71	0.05	2
20.	Cu	1.50	0.04	3
21.	Fe	82.01	0.93	3
22.	Mn	27.33	1.19	2
23.	Ni	2.11	0.08	3
24.	Pb	0.04	BDL	0.1
25.	Sb	BDL	BDL	0.05
26.	V	BDL	BDL	0.2
27.	Zn	0.88	0.01	5
28.	Hg	0.00603	0.00362	0.01

BDL: Below Detection Limit

All values are in mg/l except pH.

Annexure-7 Annexure-7

cpcb

Central Pollution Control Board, Delhi

Badli CETP, Delhi **Date of Visit: 15/02/2019**

Sl. No.	Parameters	Inlet	Outlet	Prescribed Standards
1.	pH	2.90	7.05	6-9
2.	COD	681	197	250
3.	BOD	161	**78**	30
4.	TSS	425	61	100
5.	FDS	1836	**2396**	2100
6.	NH_3-N	12	16	50
7.	PO_4-P	2.64	2.97	5
8.	NO_3-N	37	**26**	10
9.	SO_4^-	1213	**1209**	1000
10.	Cl^-	394	311	1000
11.	F^-	6.79	**19.66**	2
12.	Phenol	BDL	BDL	1
13.	TKN	19	21	50
14.	O&G	62	10	10
15.	As	BDL	BDL	0.2
16.	Cd	BDL	BDL	0.05
17.	Cr	29.67	0.20	2
18.	Cu	4.02	0.07	3
19.	Fe	220.66	4.74	3
20.	Mn	30.37	2.18	2
21.	Ni	2.60	0.16	3
22.	Pb	0.09	BDL	0.1
23.	Sb	BDL	BDL	0.05
24.	V	BDL	BDL	0.2
25.	Zn	8.55	0.15	5
26.	Hg	BDL	BDL	0.01

BDL: Below Detection Limit

All values are in mg/l except pH.

Pickling Industries

Annexure-8

Block - A

S.No	NEERI NO	NAME	ADDRESS
1	1451	SAGAR STEEL INDUSTRIES	A - 14
2	2524	JAI PARAS STEEL	A - 16
3	2421	SATVIR JAIN	A - 16
4	1636	SIRI KRISHNA ROLLING INDUSTRIES	A - 16
5	3051	SAGAR STEEL INDUSTRIES	A - 18
6	1155	P B STEEL	A - 24
7	2298	PRADEEP INDUSTRIES	A - 31
8	556	GOEL STEEL INDUSTRIES	A - 35
9	1658	SHREE LAXMI INDUSTRIES	A - 39
10	2489	GANPATI STEEL	A - 47
11	1949	KASTURI STEEL INDUSTRIES	A - 65
12	709	JAGDAMBA STEEL /G S ENTERPRISES	A - 74/2
13	15	A V METAL WORKS	A - 75/2
14	1005	MITTAL RE ROLLING INDUSTRIES	A - 76/2
15	275	MANISH INDUSTRIES	A - 83
16	1963	DEEPAK INDUSTRIES	A - 83/5
17	990	METAL FABRICATORS	A - 85/3

18	313	BRIJ MOHAN RAM MOHAN	A - 86/2
19	2408	SHRI RAM ROLLING WORKS	A - 93/14
20	34	PARSVNATH STEELS/ ADISH JAIN	A - 95
21	42	AGGARWAL INDUSTRIES	A - 95/5
22	2729	HARISH TRADERS	A - 96/1
23	1302	RAHUL UDYOG	A - 96/1A
24	1480	SARASWATI TRADERS	A - 96/2
25	130	ARTI INDUSTRIES	A - 97/1
26	2539	JAYNA STRIPS	A - 97/1A
27	1980	DURGA INDUSTRIES	A - 97/3
28	2815	SHRI RAM INDUSTRIES (NEW)	A - 97/3
29	2499	GANPATI ROLLING MILLS	A - 98/6
30	1984	DURGA INDUSTRIES	A - 99/4
31	2411	SHREE KRISHNA INDUSTRIES	A - 101/1
32	2472	ARIHANT INDUSTRIES	A - 101/1A
33		S.R.INDUSTRIES	A - 101/11
34	2412	VISHWAKARMA METAL	A - 101/12
35	2235	A K INDUSTRIES	A - 102/1A
36	1070	NATIONAL INDUSTRIES INDIA	A - 102/2
37	1562	SHIVA STEEL	A - 102/6

38	1061	NARESH STEEL FABRICATION	A - 104/2
39	128	ARPAN METAL CO.	A - 104/5
40	2001	J N STEEL & CO.	A - 111/1
41	2415	SHREE SHYAM STEEL	A - 113/1
42	3062	VEERA INDUSTRIES	A - 117
43	2546	SHRI BANKEY BIHARI ROLLING	A - 118
44	74	MITUL INDUSTRIES	A - 124
45	766	JAY KAY ENTERPRISES	A - 127
46	1697	KALYAN STEEL	A - 130
47	2420	JAGDISH KUMAR	A - 133

Block - A,GR

S.No	NEERI NO	NAME	ADDRESS
1	457	DURGA ENTERPRISES	A - 5 GR
2	2024	R.K.STEEL	A - 12 GR
3	1435	S V INDUSTRIES	A - 59 GR
4		KARTIK BANSAL	A - 71, GR
5		SUMEET	A - 78 GR
6	2744	ASHISH STEEL INDUSTRIES	A - 93/4 GR
7	512	GANGA INDUSTRY	A - 113, GR
8	2567	JINDAL ENTERPRISES	A - 116 GR
9	2427	PARKASH RE ROLLING WORKS	A - 131 GR
10		SUMEET	A - 133 GR

		Block - B	
S.No	NEERI NO	NAME	ADDRESS
1	257	BHAGWATI STEELS	B - 25
2		PANKAJ JAIN	B - 27/2
3	258	BHAGWATI STEELS	B - 28/4
4	2479	PREMIER INDUSTRIES	B - 62
5	2347	BHAWANI INDUSTRIES	B - 62/1
6		SHREE GANPATI INDUTRIES	B - 63
7	622	HARI RAM BABU LAL	B - 63
8	1147	ONKAR STEELS	B - 67/1
9		NAVEEN KUMAR	B - 68/1
10		SUSHIL AGGARWAL	B - 68/1
11	947	MAHAVIR STEEL INDUSTRIES	B - 68/1
12		SUSHIL / SURENDER	B - 68/1
13	1629	SINGHAL UDYOG	B - 70
14	2107	VIJAY KUMAR	B - 71

Block - B,GR

S.No	NEERI NO	NAME	ADDRESS
1	569	GOYAL ENTERPRISES	B - 7 GR
2	2117	SHIV INDUSTRIES	B - 7 GR
3	1269	TIRUPATI METAL	B - 8 GR
4	2727	BISHWA NATH	B - 9 GR
5		AKASH INDUSTRIES	B - 22 GR
6	1618	SIDDATHA INDUSTRIES	B - 31 GR
7		PARVEEN JAIN	B - 33/3 GR
8	2478	GUPTA ENTERPRISES	B - 47/2 GR
9	2743	VARDHMAN METAL INDUSTRIES	B - 50 GR
10	1876	VINOD JAIN Prop. S K STEEL	B - 58 GR

Block - C

S.No	NEERI NO	NAME	ADDRESS
1	2231	SINGAL STEEL ROLLING	C - 12/1
2		PARVEEN JAIN	C - 12/1
3	2497	U LIKE EXPORTS	C - 34
4	2378	VINAYAK INDUSTRIES	C - 36/1
5		SATPAL JAIN	C - 36/1
6	2511	GURU FAKIR METAL UDYOG	C - 37
7	2728	SHANKAR LAL / ABHISHEK INDUSTRIES	C - 39/1
8	2712	RAJINDER JAIN	C - 40
9	1785	TIRUPATI INDUSTRY	C - 40/1
10	2224	HARI RAM	C - 40/3
11	2476	PRIME ENTERPRISES	C - 44
12		RAM NIWAS JAIN	C - 54
13	2526	PARMOD STEEL	C - 54
14		TARUN KUMAR	C - 55/1
15		RAJEEV STEEL	C - 55/1
16	1884	VISHAL INDUSTRIES	C - 55/1
17	2510	GAURAV STEEL	C - 55/1

18	2487	KUSUM STEEL CO.	C - 57
19	182	AVTAR REFRIGRATION INDUSTRIES	C - 57/1
20	2256	BALAJI STEEL	C - 58/3
21	2186	EASTERN ENGINEERING WORKS	C - 86

BLOCK - SHED

S.No	NEERI NO	NAME	ADDRESS
1	1868	VIKAS ENTERPRISES	SHED - 43
2	2501	RAVI STEEL INDUSTRIES	SHED - 69