Site Visit & Final Report

TERI Report for Adequate & Sustainable Treatment of Bandhwari Landfill Leachate

Submitted to

The Chairman,
Haryana State Pollution Control Board (HSPCB)
Panchkula, Haryana

By

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NMCG-TERI Centre of Excellence on Water Reuse
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11th December 2023

To
The Chairman,
Haryana State Pollution Control Board (HSPCB),
Panchkula, Haryana.

Subject: Submission of "**TERI Report for Adequate & Sustainable Treatment of Bandhwari Landfill Leachate**"

Respected Sri P. Raghvendra Rao, I.A.S. (Retd)

I am pleased to present to you the "TERI Report for Adequate & Sustainable Treatment of Bandhwari Landfill Leachate", which is prepared after one year of continuous study at TERI, which involved a few visits to the site and a lot of research work on the possible treatment options of the leachate samples brought from the site.

This report highlights our observations related to the landfill leachate site, Leachate Treatment Plant (LTP), current practice of direct leachate treatment using Disk Tube Reverse Osmosis (DTRO) Plant, permeate and reject management from DTRO. Also we have made some recommendations, which according to us will help in overall improvement, integrated and sustainable approaches in adequate treatment and better on-site management of leachate. The experimental work was carried out on complex leachate samples and different studies were carried out where TERI's Advanced Oxidation Technology TADOX® was found to beneficial as an integrated and retrofittable solution. We have proposed how existing LTP and DTRO treatment could be improved and on the basis of entire study a complete **Integrated Leachate Treatment Plan** is proposed.

I hope you find our work and report worthy and I will be happy to present the findings to you and your technical Committee at a suitable opportunity given to us in near future. We believe together we can solve the problem of landfill leachate not just in Bandhwari but also from other landfill sites.

I look forward to your valuable feedback and suggestions in moving ahead.

Thanking you with high regards,

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Executive Summary

The Bandhwari Landfill in Gurugram, Haryana, time and again lead to critical concern due to severe landfill leachate issues, causing alarm among neighbouring villages and alerting the Municipal Corporation of Gurugram (MCG) officials. Operational since 2009, the Bandhwari Landfill serves as a dumping site for all kind of solid waste from Gurugram and Faridabad, accumulating an astounding 2100 TPD (tons per day), leading to the generation of approximately 350 KLD of leachate.

Currently the leachate either finds its way to surrounding environment or goes to Leachate Treatment Plant (LTP), which is often not functional or directly fed to Disc Tube Reverse Osmosis (DTRO) Membrane system for treatment. The reject of which is poorly managed and discharged back to leachate collection ponds, while its permeate is sent across to nearby Sewage Treatment Plant (STP) for further treatment. The former practise of discharging leachate in open to nearby village/ covered forest area poses severe environment, health and occupational hazard, including potential groundwater contamination together with an unbearable stink in the surrounding area leading to air pollution. While latter practise of treating DTRO Permeate in nearby STPs may lead to these STPs becoming dysfunctional and non-compliant for municipal wastewater treatment, for which they are designed. Moreover, this area has a low groundwater table and such kind of malpractices may continue to contaminate ground water through the leachate. Hence the current practices highlight serious concerns and lack of on-site landfill leachate treatment together with immediate attention and finding solution to the problem.

The urge to find a sustainable solution led the Hon'ble Chairman, HSPCB and the Municipal Commissioner, Gurugram to approach to NMCG-TERI Centre of Excellence on Water Reuse (NTCOE) http://nmcgtericoe-wr.in Environment & Waste Management Division of TERI http://teriin.org/waste to study and find a feasible and sustainable solution for adequate and holistic solution for treatment of Landfill Leachate from Bandhwari. Wherein NTCOE has developed TERI Advanced Oxidation Technology called TADOX for adequate and sustainable treatment of municipal and Industrial wastewater having issues of high COD, recalcitrant/ dissolved organics and color https://youtu.be/tCt5rxC7eik

TERI Team led by Dr Nupur Bahadur, Associate Director, Environment & Waste Management Division of TERI, along with her technical team started their work in Dec 2022 by visiting the landfill leachate site on few occasions and provided its observations. The field visits were organized and facilitated by the Regional Office of HSPCB in Gurugram and the MCG Office.

Some of the major observations from the landfill leachate site include mismanagement of leachate ponds, loose transfer of leachate to these ponds, Leachate Treatment Plant (LTP) which being there however not working on regular basis and needs immediate upgradation and improvement in its biological treatment units. The highly unsustainable

direct treatment of leachate using DTRO system and its poor reject management plan was the biggest concern.

In order to find a holistic treatment plan, TERI Team explored the feasibility of integration of TADOX Technology in current treatment practices with following two approaches: (1) **Approach 1: Tadox technology to treat LTP Outlet** and (2) **Approach 2: Tadox technology to treat DTRO Permeate** so that it need not to go to nearby STP for treatment and overall on-site treatment could be achieved. 50-60 litres of different samples from LTP inlet, LTP outlet, DTRO inlet, permeate and reject were brought to TERI R&D Lab in Gurugram and tested for TADOX treatment in small reactor for this capacity.

In **Approach 1**, the LTP outlet was treated using TADOX®, which led to reduction in turbidity by 94%, total suspended solids (TSS) by 63%, total oil content by 50%, biological oxygen demand (BOD) by 51% and chemical oxygen demand (COD) by 35%. Similarly, in **Approach 2**, TADOX® treatment of the DTRO outlet demonstrated significant reduction in total oil content by 98%, total suspended solids (TSS) by 75%, turbidity by 92% and minimum reductions of only 4% in BOD and COD. In terms of removal of recalcitrant organics and COD, TADOX® was found to be more suitable to treat LTP outlets than DTRO Permeate since leachate was treated biologically through the LTP system, whereas DTRO has major advantage of removing TDS. Thus, the results suggest that TADOX® could treat leachate more effectively after biological treatment and TADOX® treated could go to existing DTRO system and finally the permeate could be further treated with TADOX® as a polishing measure, if required. Based on this hypothesis, following schemes are proposed.

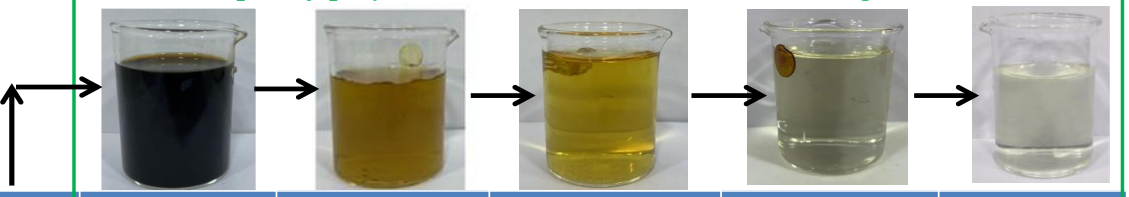
Scheme 1 describes **Expected Water quality parameters from the recommended integrated solution** while **Scheme 2** describes **Proposed Integrated Treatment Plan & Key Recommendations.**

Thus, TERI Report with the holistic **Technology Integration Plan** to treat Bandhwari Landfill leachate is expected to bring revolution in landfill leachate treatment in other areas in the Country as well aiming to protect groundwater resources, promote sustainable waste management practices and seamlessly align with environmental conservation efforts, ultimately ensuring the well-being of the local communities residing nearby such landfill areas.

Scheme 1: Expected Water quality parameters from the recommended solution

Bandhwari Landfill Leachate Treatment

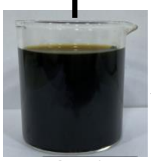
Water quality projections* from the recommended integrated solution



Parameters	Raw Leachate	LTP Outlet	TADOX® Treatment	Modified DTRO Permeate*	TADOX® Polishing*
BOD, mg/l	3522.9	365	178	150*	<30*
COD, mg/l	9200	1840	1200	900*	<250*
TSS, mg/l	207.8	4	1.4	<1	<1
TDS, mg/l	18000	10770	7800	<2100*	<1800*

(*expected parameters when TADOX treated will be the feed for DTRO)

Current Treatment



DTRO Reject

DTRO

DTRO Permeate

To nearby STP for further treatment

Parameters	DTRO Reject
BOD, mg/l	3522.9
COD, mg/l	8800
TSS, mg/l	202.6
TDS, mg/l	22000

Parameters	DTRO Permeate
BOD, mg/l	1400
COD, mg/l	4200
TSS, mg/l	8
TDS, mg/l	968

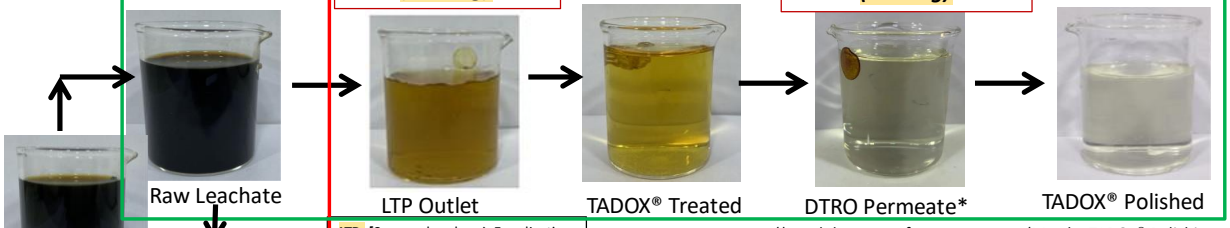
*All Wastewater quality parameters analyzed at a National Accreditation Board for Testing and Calibration Laboratory (NABL), Delhi as per ISO/ IEC 17025:2005.

Scheme 2: Proposed Integrated Treatment Plan & Key Recommendations

On-Site complete solution to treat Bandhwari Landfill Leachate

TERI's Proposed Plan

Raw Leachate → Leachate Treatment Plant (LTP) *(existing)* → TADOX® Plant → Disk Tube Reverse Osmosis (DTRO) Plant *(existing)* → TADOX® Plant



Raw Leachate

LTP Outlet

TADOX® Treated

DTRO Permeate*

TADOX® Polished

LTP [Screen chamber→ Equalization Tank → UASB Anaerobic Reactor → MBR Reactor (A/O process)]

(*much better performance expected when TADOX treated will be the feed to DTRO)

(May be TADOX® Polishing not required then)

DTRO Reject

DTRO

DTRO Permeate

To nearby STP for further treatment

Current Treatment

KEY RECOMMENDATIONS

- ✓ Direct leachate treatment using DTRO should be avoided as it is highly resource & energy intensive and does not provide sustainable solution to permeate and reject management.
- ✓ DTRO Permeate sent to Sewage Treatment Plant (STP) for further treatment will make STP dysfunctional and non -compliant.
- ✓ LTP should be operational all the time and its biological process needs to be improved.
- ✓ TADOX® is required to remove color & organics while DTRO is required to remove TDS, so therefore both TADOX® & DTRO should be integrated suitably as per requirement to provide adequate treatment.
- ✓ Based on preliminary study, the proposed On -Site Solution is integrated, adequate, resource & energy efficient, affordable and sustainable.

Site visit to Bandhwari Landfill site, Gurugram

1. Background

According to Ministry of Housing and Urban Affairs (MOHUA) guidelines, Urban India generates about 42 million tons of municipal solid waste (MSW) annually, approximately 1.15 lakh tons per day (TPD), with 83,378 TPD originating from 423 Class-I cities. This figure is expected to soar remarkably to 300 million tons per day (MTD) within the subsequent 35 years. Concerningly, a mere 20-25% of India's MSW undergoes treatment, while a staggering 75-80% is haphazardly disposed of in open landfills. Projections indicate a distressing future, anticipating a demand for 43,000 hectares of land by 2050, propelled by an estimated waste generation of 436 MTD and the proposed 20-meter landfill cover by the Central Pollution Control Board (CPCB).

Bandhwari, an urban village located across Gurugram-Faridabad border, has a landfill, which was established in 2009 and since then this site has been accommodating and dumping solid waste from Gurugram and Faridabad, accumulating an astounding 2100 TPD (tons per day), leading to the generation of approximately 350 KLD of leachate. Time and again, an adequate treatment solution is always sought after, which could be implemented to eliminate contamination caused by landfill leachate at Bandhwari. Moreover, this area has a low groundwater table and the remaining water can get contaminated this way through the leachate.

Recognizing the importance of immediate action, the Haryana State Pollution Control Board (HSPCB) and MCG authorities approached TERI (The Energy and Resources Institute) to devise an efficient treatment plan for the Bandhwari landfill leachate with a possibility of integration of TERI's TADOX Technology, which aims to treat such complex wastewater streams. With this TERI Team led by Dr Nupur Bahadur, Associate Director, Environment & Waste Management Division of TERI, and her technical team members Dr Sarath Chand Pragada and Mr Nipun Bhargava visited site in October and December 2022 after the start of operations of the Leachate Treatment Plant (LTP).

Teri Team collected secondary data available in public domain and from the officials interacted during the site visits etc. Also Teri team collected 50-60 litres of different samples from raw leachate/ LTP inlet, LTP outlet, DTRO inlet, permeate and reject, which were brought to TERI R&D Lab in Gurugram and tested for TADOX treatment in small reactor for this capacity. Based on the visits, observations are presented, results discussed and recommendations made in this report.

2. Objectives of site visit

- ✓ To study the Bhandhwari Landfill Leachate site and associated treatment and management practices taking place currently.
- ✓ To collect the leachate samples from the landfill site and assess feasibility of TADOX® treatment as an integrated and retrofittable solution.
- ✓ To present an on-site holistic leachate treatment plan, utilizing Advanced Oxidation Technology like TADOX to be integrated with the existing LTP and DTRO Membrane Treatment technology.

3. Site visit

3.1 Bandhwari Landfill Site

Fig. 1: Site location of Bandhwari Landfill

3.2 Existing Area Details

Existing Details (Responded by CS, Haryana in OA No. 172 of 2021)		
Particulars	**Area (Sqm)**	**Area (Hectares)**
Total Land Area	1,12,336	11.2
Forest Area	124	0.0124
Aravalli Area	76,800	7.68
Non Forest Area	43,940	4.39
Particulars (existing)	**Area (Sqm)**	**Area (Hectares)**

Landfill Area	60,947	6.1
Green Area	0	0
Road and Open Area	47,921	47.9
Leachate Treatment Area	3468	0.3468

Waste Details	
Particulars	**Quantity**
Incoming Waste	2100 Metric Tonne per day (MTD)
Leachate generation	350 KLD
No. of Ponds	7
Total Capacity of Ponds (Volume of stored Leachate)	33000 m^3
DTRO Plant Capacity (2 × 200 KLD)	400 KLD
Leachate Treatment Plant Capacity	150 KLD
Sanitary Landfill Facility Capacity	375 TPD
Legacy Waste	33 Lakh Metric Tonne (MT)

3.3 Proposed Details as per EC application

Particulars	Area (Sqm)
Total Plot area	123310
Total built up area	15550
Rain water harvesting pit	2
Rain water harvesting storage tanks	2
Power Plant Area	15550
MSW processing area	24700
Roads/ Amenities	11080
Sanitary Landfill	24680
Green Belt	40500
Drain/Sump	6800
Total	123310
Proposed capacity of ISWMF	2100 TPD
Composting	147 TPD

Power Plant	25 KW
Leachate collection	50 KLD
Bio gas production	50-150 m^3/tonnes
Boilers	2
Steam Generation Capacity	144 TPH (2x72 TPH)
Turbo Generator	1x25 MW
Power	500 KW
DG set	1x630 Kva

3.4 Observations

Landfill Site Overview and Observations on Leachate Treatment & Management Practices

Entrance way to landfill site

1. There is handling of waste process, treatment and disposal facility at the existing dumpsite as shown in Fig. 2.
2. No green belt development was observed at site.

Fig. 2: Entrance way to reach landfill site and different leachate treatment units

Dumping location of solid waste

3. The location has been found to be in disarray.
4. The surroundings were unappealing, with heaps of garbage as shown in Fig. 3.

Fig. 3: Dumping location of Solid waste

Drainage system for leachate

5. The drainage system is not adequate to direct the leachate into collection system, as shown in Fig 4.

Fig. 4: Improper drainage system for leachate collection

Leachate collection Ponds

6. The management installed leachate collection ponds to collect the leachate from the dumpsite as depicted in Fig. 5; however, some of these are not maintained well indicating poor housekeeping and likely percolation to aquifers.

Fig. 5: Onsite leachate Collection Pond

Leachate Treatment Plant (LTP)

7. The road leading to Leachate treatment plant (LTP) is concreted. However, it was covered with mud and at places lot of water/leachate spill was observed with no access by foot.
8. LTP contains MBBR hybrid biofilm reactors along with inadequate maintenance of Dissolved Air Floatation (DAF) unit as shown in Fig. 6.

Fig. 6: Leachate treatment plant

Biological Treatment Process units in LTP

9. LTP needs to be modified and has to be looked to design adequacy.
10. LTP needs to be modified and has to be looked to design adequacy.
11. LTP contains MBBR hybrid biofilm reactors along with DAF unit.
12. DAF is normally installed at the beginning of the chemical treatment in order to separate out emulsified oil/substance. Its installation at the end is not understood.
13. Lot of froth in the biological treatment indicates inadequate DAF tank (see Fig. 7) which probably needs more retention time and need to be relooked from design point of view.
14. Any Institute of repute is required to carry out the study based on taking composite samples due to the heterogeneous nature of effluents.

Fig. 7 Dissolved Air Floatation unit

Disc Tube Reverse Osmosis (DTRO) system

15. The leachate being directly treated using DTRO system, which is highly energy and resource intensive. DTRO Membranes need regular replacement. All functional details of DTRO system is shown in Fig. 8.

Fig. 8: Visit to DTRO plant and review of Filtration system and its cleaning period and other miscellaneous technical parameters

Improper maintenance of leachate storage system at DTRO unit

16. The leachate is being transported through low quality pipes partially or completely covered with tarpaulin. The tarpaulin was found to be torn off at many places resulting is spillage of waste near the DTRO unit as shown in Fig. 9.

Fig. 9: Improper maintenance of leachate storage system at DTRO unit

Handling DTRO's Reject and Permeate

17. **Reject** of DTRO is going back to leachate pond as shown in Fig. 10. This indicates inadequate handling of reject, which otherwise would require evaporator to be managed reject making whole process energy intensive.

Fig. 10: Reject of DTRO is back into leachate pond

18. Permeate of DTRO is being transferred through tankers to nearby STPs for further treatment as shown in Fig. 11. This non-compliant effluent would affect functioning of the STP as well and makes the whole leachate treatment highly unsustainable.

Fig. 11: Transportation facility of on-site treated effluent to nearby STPs

Existing Integrated Leachate Treatment Scheme (*Non-Functional*)

The team together visited the LTP site having DTRO in place and found the following Leachate treatment plan.

Treatment of leachate in Leachate Treatment Plant (LTP)

LTP for about 150 m^3 /day treatment capacity is installed, having primary physio-chemical, secondary biological and tertiary DAF treatment plant, with the Process Flow as follows:

Leachate Collection Tank → Screen chamber → Equalization Tank → Up flow Anaerobic Sludge Blanket (UASB) Anaerobic Reactor → Moving Bed Biofilm Reactor (MBBR) (Anoxic/Oxic (A/O) process + Ultra Filtration (UF))→ Nano Filtration (NF)

Treatment of leachate in DTRO plant

There is provision of Disc Tube Reverse Osmosis (DTRO) treatment which is going to be installed as an add on treatment system after DAF. Probably to further reduce the pollution load from leachate.UF→ (NF)→ Reverse Osmosis (RO)→Water to Reuse Tank.

19. Current leachate treatment practices have not been carried out in a stage-by-stage manner as proposed in the integrated plan with LTP followed by DTRO treatment as represented in Fig. 12.

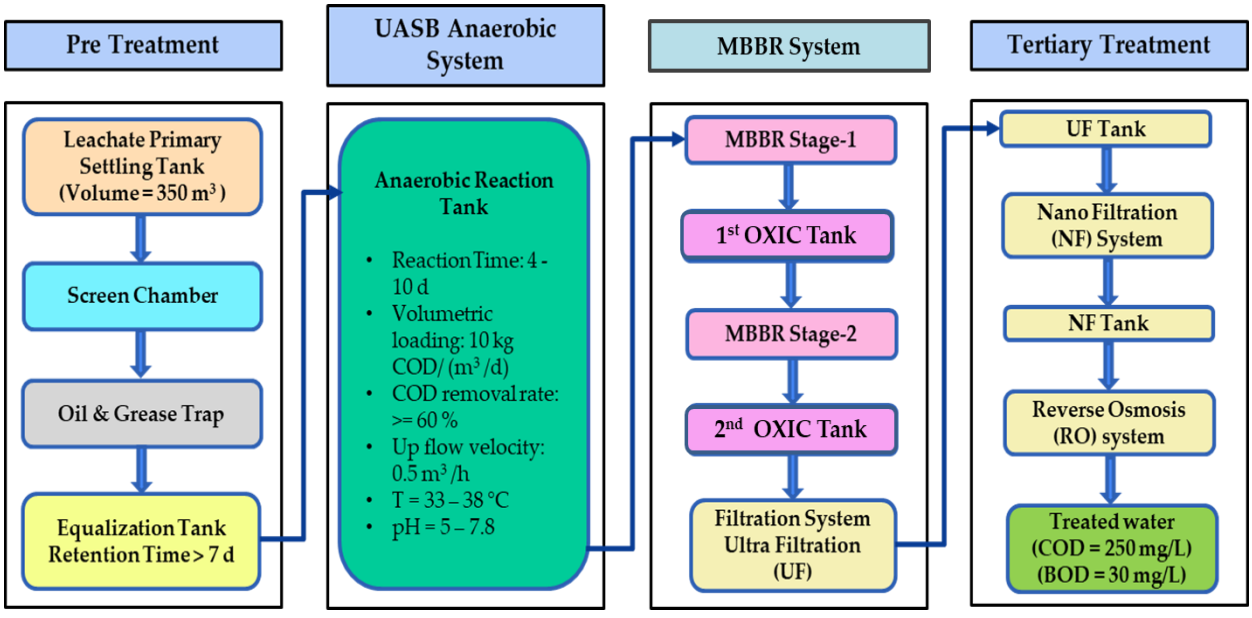


Fig. 12: Leachate Treatment Scheme (Process Flow Diagram)

Either Leachate Treatment Process

20. Currently, raw leachate treatment is carried out concurrently using either leachate treatment unit (LTP) OR DTRO system, as illustrated in Fig. 13.

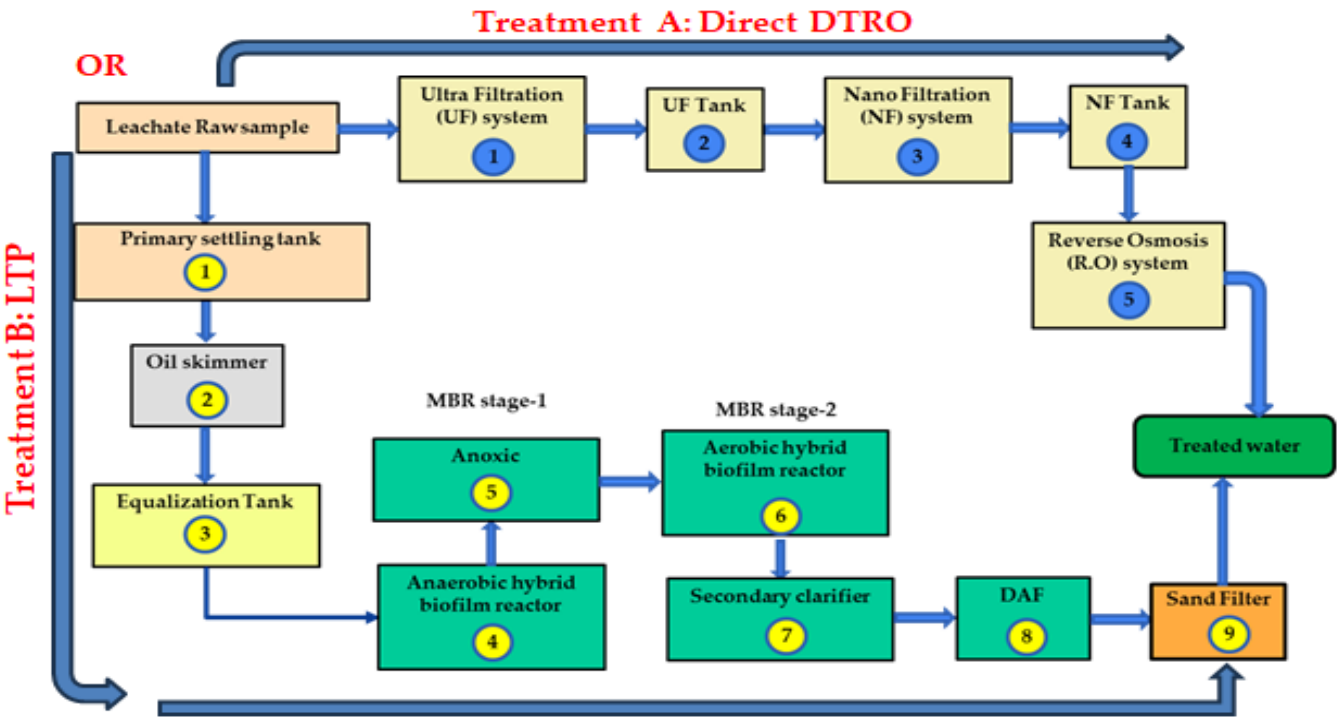


Fig. 13: Current Practice for Leachate Treatment

4. About TERI's TADOX® Technology

Firstly, 50-60 L of each stage of leachate (raw and treated) samples were collected from this section of the landfill in sanitized bottles and containers of 20 L capacity and taken to TERI Gurugram campus and treated as soon as received. Finally, the pre and post treated samples were sent to accredit NABL Lab in Rohini, Delhi for testing and analysis on the next day.

The whole treatment process is shown with process flow diagram Fig. 14.

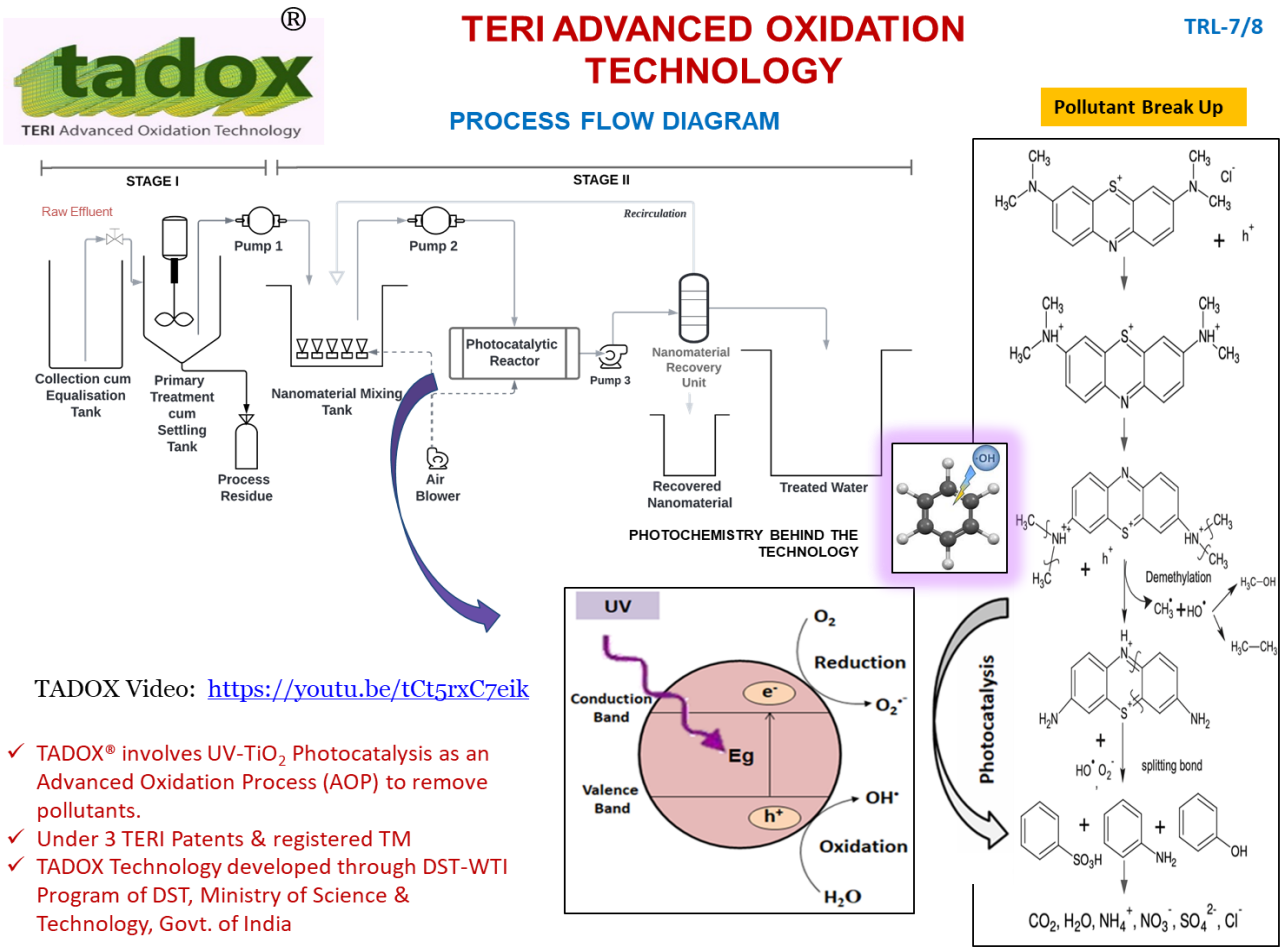


Fig. 14: Scheme of TADOX® Technology

5. Methodology of Treatment and testing of physicochemical parameters

I. The samples were analysed as obtained from the site after mixing the container well in order to obtain a homogenous sample.

II. This untreated sample was termed as a raw sample.

III. All samples (raw and treated) were sent to the laboratory for characterization of basic physicochemical and organic pollutant analysis for pH, TSS, TDS, Conductivity, Turbidity, COD etc. at the same time, primary treatment for the samples was optimized with use of different coagulants and flocculants.

IV. The optimized dose was estimated based on reduction in colour, turbidity and transparency of the sample (based on UV Visible spectra and analysis) and the sludge generation ratio.

V. After optimization of the primary treatment the samples were subjected to TADOX® treatment at batch scale reactor, during which samples from each stage were taken in order to optimize the treatment time.

VI. Finally, after the initial run and optimization, the experiment was run finally, and samples (in duplicates) were taken from each stage. The samples from each stage were characterized in the NABL laboratory and the key results are discussed in the next section.

VII. Analysis of Wastewater quality parameters: All Wastewater quality parameters were analyzed at a National Accreditation Board for Testing and Calibration Laboratory (NABL), Delhi as per ISO/ IEC 17025:2005.

6. Results and Discussion

Firstly, the characteristics of raw samples (LTP inlet and DTRO inlet) and on-field treated samples (LTP outlet, DTRO outlet) were analysed. Adopting TADOX® technology for raw leachate samples, does not result in significant removal of overall organic and inorganic contaminants because the samples are more turbid and coloured, preventing light passage. The main reason could be the current leachate treatment scheme has not been carried out on the field stage by stage. Therefore, TADOX technology can be integrated along with on-field treatment units.

Preliminary Work carried out by TERI Team

In order to find a holistic treatment plan, TERI Team explored the feasibility of integration of TADOX Technology in current treatment practices with following two approaches:

(1) **Approach 1: Tadox technology to treat LTP Outlet** for removal of recalcitrant/ dissolved organics, COD and color.

(2) **Approach 2: Tadox technology to treat DTRO Permeate** so that it need not to go to nearby STP for further treatment / polishing and overall on-site treatment could be achieved.

Thus 50-60 litres of different samples from LTP inlet, LTP outlet, DTRO inlet, permeate and reject were brought to TERI R&D Lab in Gurugram and tested for TADOX treatment in small reactor for this capacity.

In **Approach 1**, the LTP outlet was treated using TADOX®, which led to reduction in turbidity by 94%, total suspended solids (TSS) by 63%, total oil content by 50%, biological oxygen demand (BOD) by 51% and chemical oxygen demand (COD) by 35%. Similarly, in **Approach 2**, TADOX® treatment of the DTRO outlet demonstrated significant reduction in total oil content by 98%, total suspended solids (TSS) by 75%, turbidity by 92% and minimum reductions of only 4% in BOD and COD.

These results are summarized as follows in the Fig. 15.

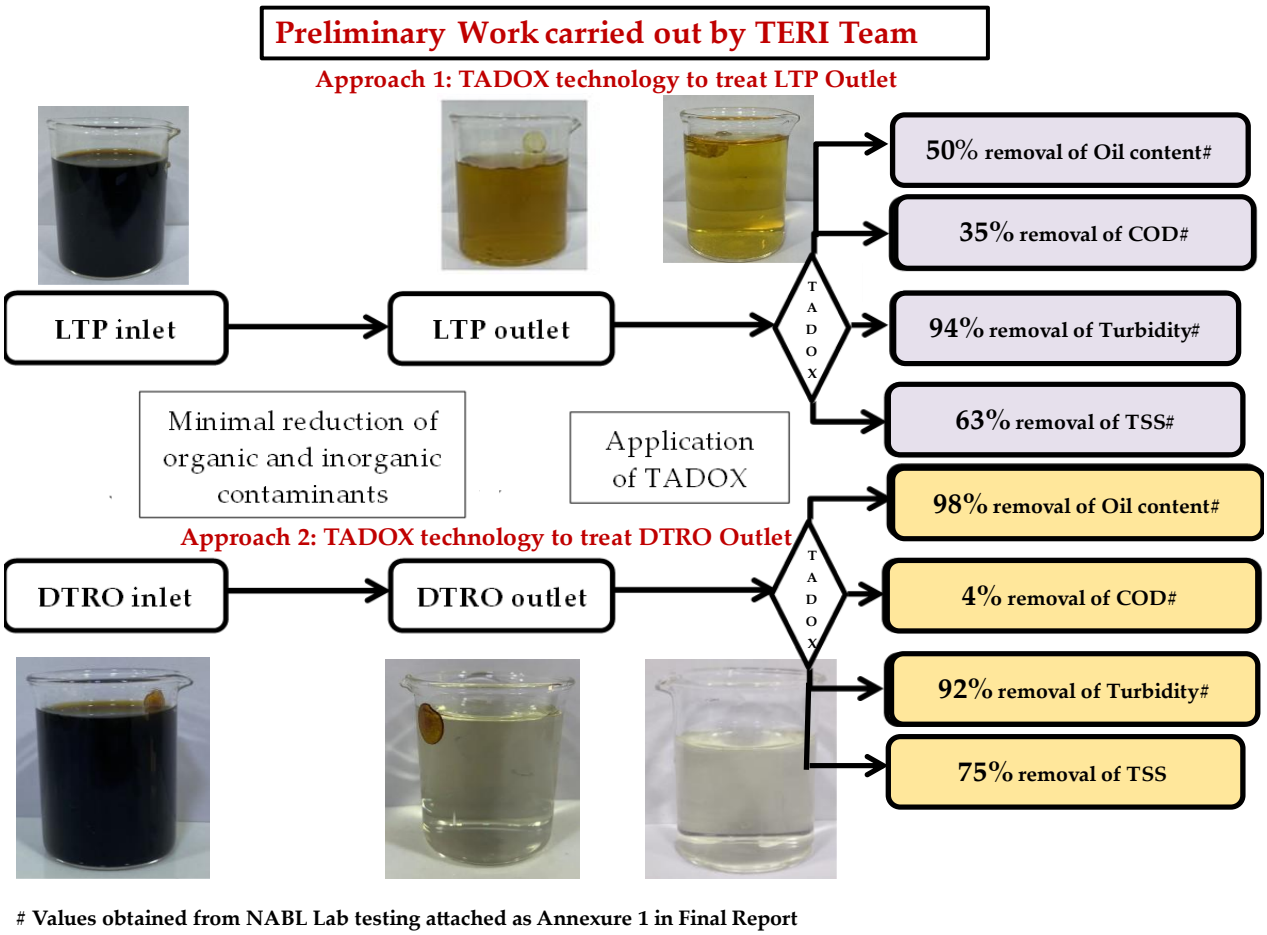
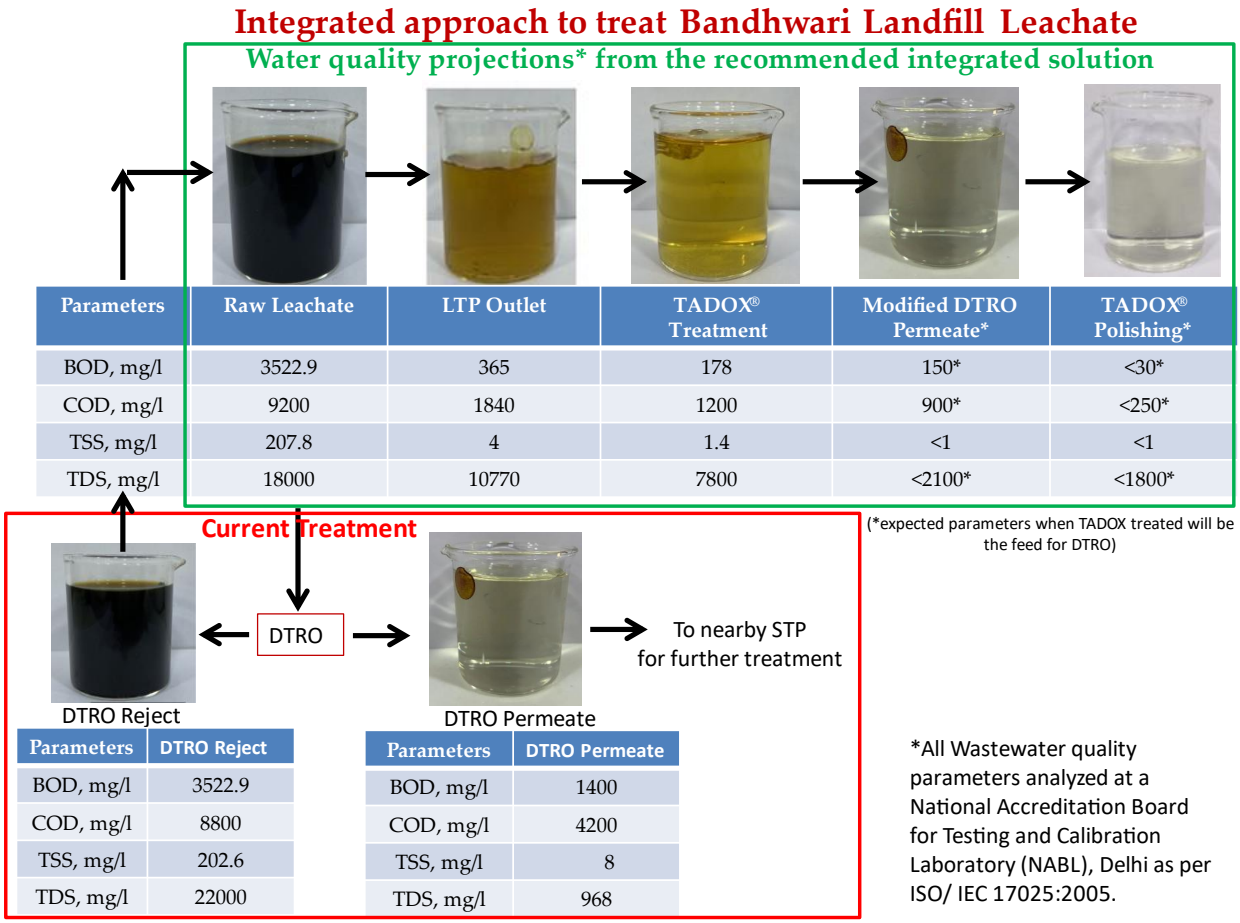


Fig. 15. TADOX treatment feasibility assessment for (1) LTP Outlet and (2) DTRO Permeate

7. Integrated approach to treat Bandhwari Landfill Leachate

In terms of removal of recalcitrant organics and COD, TADOX® was found to be more suitable to treat LTP outlets than DTRO Permeate since leachate was treated biologically through the LTP system, whereas DTRO has major advantage of removing TDS. Thus, the results suggest that TADOX® could treat leachate more effectively after biological treatment and TADOX® treated could go to existing DTRO system and finally the permeate could be further treated with TADOX® as a polishing measure, if required. Based on this hypothesis, following scheme as depicted in Fig. 16 is proposed with the water quality parameters anticipated therein.



Parameters	Raw Leachate	LTP Outlet	TADOX® Treatment	Modified DTRO Permeate*	TADOX® Polishing*
BOD, mg/l	3522.9	365	178	150*	<30*
COD, mg/l	9200	1840	1200	900*	<250*
TSS, mg/l	207.8	4	1.4	<1	<1
TDS, mg/l	18000	10770	7800	<2100*	<1800*

Parameters	DTRO Reject
BOD, mg/l	3522.9
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TSS, mg/l	202.6
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Parameters	DTRO Permeate
BOD, mg/l	1400
COD, mg/l	4200
TSS, mg/l	8
TDS, mg/l	968

Fig. 16. Wastewater quality projections based on the proposed technology integration scheme for treatment of leachate.

Conclusion

Integration of TADOX® Technology (LTP- TADOX®-DTRO- TADOX® series Scheme)

In terms of organic matter, TADOX® can handle LTP outlets more successfully than DTRO since leachate was treated biologically through the LTP system, whereas DTRO majorly has filtration process for reduction in TDS. In this regard, the biological treatment could minimize the complexity of organic loading over the TADOX® treatment when compare to DTRO. The results suggest that TADOX® can treat leachate substantially more effectively after applying the pre-biological conditions. Also, integration of TADOX® technology in this problem would be highly recommended as per the preliminary studies carried out by Teri. Thus following is the proposed on-Site solution, as depicted in Fig. 17, which proves to be integrated, adequate, resource and energy-efficient, cost-effective, and sustainable.

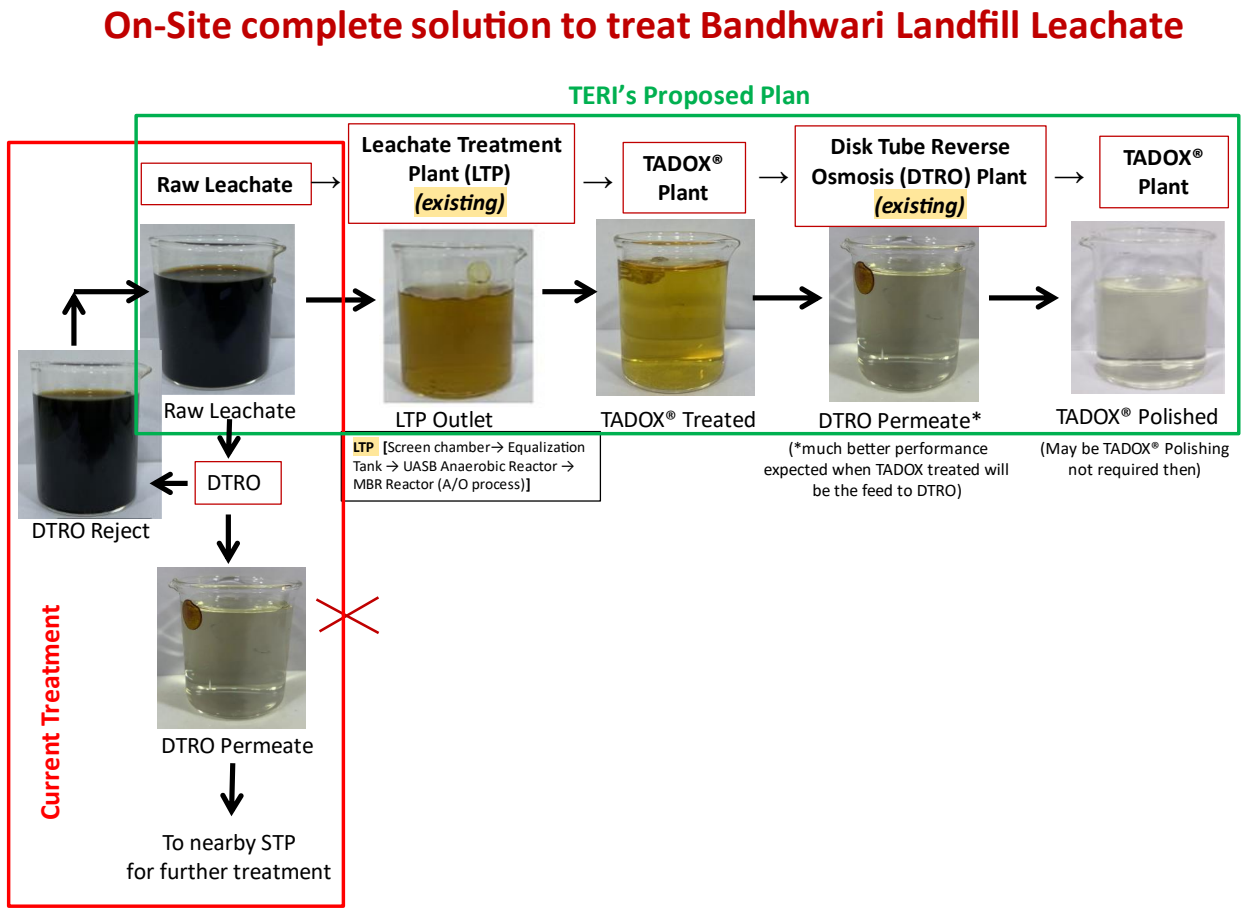


Fig. 17. TERI's proposed Integrated Leachate Treatment Plan vs Current Treatment

8. Key Recommendations & Way Forward

1. Direct leachate treatment using DTRO should be avoided as it is highly resource & energy intensive and does not provide sustainable solution to permeate and reject management.

2. DTRO Permeate sent to Sewage Treatment Plant (STP) for further treatment will make STP dysfunctional and non-compliant.

3. LTP should be operational all the time and its biological process needs to be improved.

4. TADOX® is required to remove color & organics while DTRO is required to remove TDS, so therefore both TADOX® & DTRO should be integrated suitably as per requirement to provide adequate treatment.

5. Based on preliminary study, the proposed On-Site Solution is integrated, adequate, resource & energy efficient, affordable and sustainable.

6. TERI Team should work further in detail on the process flow and integration of LTP, TADOX and DTRO for adequate and on-site treatment of Bandwari Landfill Leachate along with setting up of 150 KLD TADOX Plant as a retrofittable solution.

9. About TERI's Environment and Waste Management Division

The Energy and Resources Institute (TERI) is an independent, multi-dimensional organization, with capabilities in research, policy, consultancy and implementation. TERI is an innovator and agent of change in the energy, environment, climate change and sustainability space, having pioneered conversations and action in these areas for over four decades.

https://www.teriin.org/waste

10. About NMCG-TERI Centre of Excellence on Water Reuse

Considering the need for optimizing the water usage and reuse of treated wastewater, National Mission for Clean Ganga (NMCG) has taken many initiatives including development of a National Framework on Treated Wastewater Reuse, in association with India-European Union Water Partnership (IEWP). TERI is actively working in the domain of water reuse and has developed a wastewater treatment technology called TERI Advanced Oxidation Technology (TADOX®) which could be integrated in current systems to achieve adequate treatment of municipal and industrial wastewater, help achieve ZLD in a much affordable and sustainable manner and enhance treated wastewater reuse. https://youtu.be/tCt5rxC7eik

NMCG thus sanctioned for setting up a NMCG-TERI Centre of Excellence on Water Reuse (NTCOE) in collaboration with TERI. NTCOE is a quadripartite association between NMCG, TERI, Industry and Knowledge partners, which envisages to design and foster research and innovation, including identification of knowledge gaps for research and need for new ideas, supporting targeted research and spurring and nurturing needed innovation to develop clean, green, cost and resource effective wastewater treatment technologies for reuse of treated water. Hence together with the government, academia and industry support, this CoE is the first of its kind in the Country on treated wastewater reuse, which also meets the objectives under Clause 5.3 & 4.2 of the Ganga Knowledge Centre (GKC) for creating knowledge partnerships.

http://www.nmcgtericoe-wr.in

11. About the PI

Dr Nupur Bahadur is Associate Director and Heads NMCG-TERI Centre of Excellence on Water Reuse and also she is the Area Convenor, TADOX® Technology Centre for Water Reuse in the Water Resources Division, TERI. She obtained Ph.D. in Chemistry from IIT Roorkee in 2005 working in the area of Photochemistry and Photocatalysis for pollution abatement. She is the Inventor of TERI's Advanced Oxidation Technology (TADOX®) technology. Her 22 years of Professional experience involves, teaching, research, technology development & demonstration, patents & trademark, policy intervention, consultancy, capacity building and Technopreneur roles.

LinkedIn Profile: https://www.linkedin.com/in/dr-nupur-bahadur-40909771/

12. About TERI's TADOX® Technology

The Energy and Resources Institute (TERI), New Delhi has developed a novel technology called TERI Advanced Oxidation Technology (TADOX®), which provides treatment of wastewater stream containing high color, COD, BOD, TOC, dissolved organics, micropollutants, non-biodegradable and persistent organic pollutants (POPs) in effluents from grossly polluted industries and municipal wastewater. TADOX® is under TERI's Patent (grant awaited) and also under various categories of Trademark with the Trademark Office, Govt. of India. TADOX® involves UV-Photocatalysis as an Advanced Oxidation Process (AOP), leading to oxidative degradation and mineralization of targeted pollutants. Also it involves, novel approaches which make very less use of chemicals in the overall treatment leading to much reduced quantum of sludge, preventing secondary pollution.

YouTube Link of the 5 min video of TADOX® Technology: https://youtu.be/fgpBa1_Atyc

This technology has been developed under **DST Water Mission, Water Technology Initiative (WTI) Program of Ministry of Science & Technology, Govt. of India** during July 2017-July 2020 and the outcomes have been announced through its Press Release on 25th Aug 2021: https://pib.gov.in/PressReleasePage.aspx?PRID=1748888

Department of Science & Technology, Govt. of India published the successful outcome on its website at https://dst.gov.in/new-advanced-oxidation-technology-can-enhance-waste-water-reuse-lower-cost

This technology has received following Awards at various forms: (i) **'Design and Manufacturing Technologies for 'Make in India'** by Dr. Harsh Vardhan, Union Cabinet Minister, Ministry of Science and Technology, Govt. of India during IISF; (ii) **STE Water Award 2019** for **Technological Innovation in Wastewater Treatment**; (iii) **Aqua Excellence Award 2019** for '**Development of Technology'** by Mr. Gajendra Singh Shekhawat, Union Cabinet Minister, Ministry of Jal Shakti, Govt. of India in World Aqua Congress.

In Oct 2020, **National Mission for Clean Ganga (NMCG),** Ministry of Jal Shakti and TERI signed an MoU to explore possibilities of TADOX® implementation in point source pollution abatement across ETPs/STPs under Namami Gange Programme. In Jan 2022, National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Govt. of India and TERI came forward to establish 1st of its kind Centre of Excellence called **NMCG-TERI CoE on Water Reuse** (https://lnkd.in/dnZiniWR).

A. TADOX® Technology for Industrial Wastewater Treatment

The TADOX® treated colorless and high-quality water going to subsequent tertiary system involving RO may prevent bio-fouling of membranes, enhance life span and efficiency of RO systems and reduce overall load on subsequent evaporators like MEE and MVR etc. **enabling sustainable and affordable ZLD compliance with 85-90% enhanced water**

reusability. Further, **having small footprint, few hours treatment time and together with resource & energy efficiency, the overall treatment is expected to bring down OPEX by 30-40% than current values**. Further, TADOX® could be **integrated and retrofittable** in existing treatment systems depending on the nature and constitution of the matrix; e.g. for streams having high COD, it could be integrated at pre-biological stage to enhance biodegradability; for streams having high BOD, at post-biological or polishing stage to remove recalcitrant and dissolved organics.

B. TADOX® Technology in Sewage and Municipal Wastewater Treatment

In case of Sewage and Municipal wastewater treatment, TADOX® having Advanced Oxidation is sufficient for **direct treatment, without any kind of biological treatment** or disinfection technology, **not even requiring any kind of grey and black water stream segregation**. With total treatment time of 4-5 h, together with high grade treated water quality (in many cases Class A Grade water quality, as per CPCB, Govt. of India Norms) makes it an excellent choice in improving current efficiencies in wastewater treatment together **offering augmentation of capacity within existing infrastructure**. Also it could serve as **Decentralized Wastewater Treatment system and micro-STP** in upcoming and existing infrastructural projects, townships, commercial complexes, Green Buildings, AMRUT and Smart Cities Project. Also under SBM 2.0, where the requirement is to enhance treated water reuse, this technology could be used at the polishing stage of the current STPs.

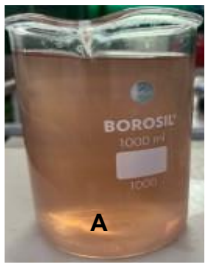
C. Technology Readiness Level (TRL)

Currently technology is at TRL 7, with first 10 KLD TADOX® WWT Plant operational since Aug 2020 in TERI Gurugram campus. This plant is treating wastewater coming from a collection sump, having wastewater from toilets, research laboratories, hostel, canteens, laundry etc. No stream segregation of any kind is required. The technology is ready for commercialization. Various wastewater treatment companies have come forward to seek license and implement TADOX® Technology.

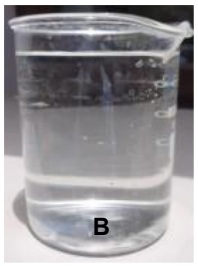
13. Successful Case Studies from Haryana

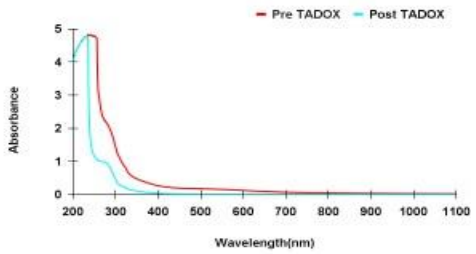
(A) Petrochemical Industry wastewater from Panipat

Haryana Case study B: Petrochemical Industry Wastewater treatment in Panipat



6 h





KEY RESULT: TADOX® treatment led to removal of colour, COD and BOD, making sample aesthetically pleasant and improved treatability for downstream tertiary treatment, enabling sustainable and affordable ZLD compliance and enhanced water reuse.

S. No	Parameters	Unit	Pre-TADOX (A) (Raw sample)	Post TADOX (B) (Treated sample)	% Removal
1	pH Value	-	7.84	9.69	-
2	Turbidity	NTU	76	5	93
3	Colour	Hazen	711	18	97
4	COD	mg/L	400	160	60
5	BOD	mg/L	43	2	96
6	Total Dissolved Solids (TDS)	mg/L	4005	3680	8

(B) Textile Industry wastewater from Sonipat

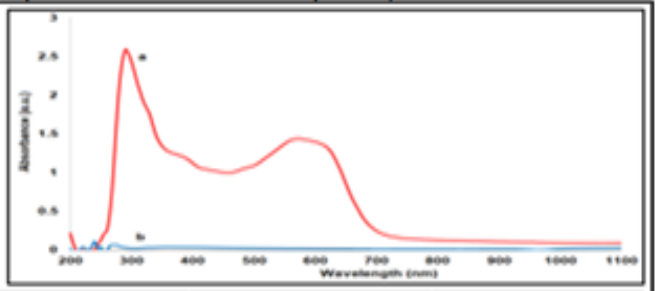
Haryana Case study A: Textile Wastewater treatment in Sonipat

ETP, Textile Unit, Barhi Industrial Area, Sonipat

(KEY RESULT: End-to-end TADOX Treatment of effluent from equalization tank, without any kind of biological treatment at any stage, led to adequate treatment and ZLD compliance)

5 h

a. Pre Treated b. Post Treated



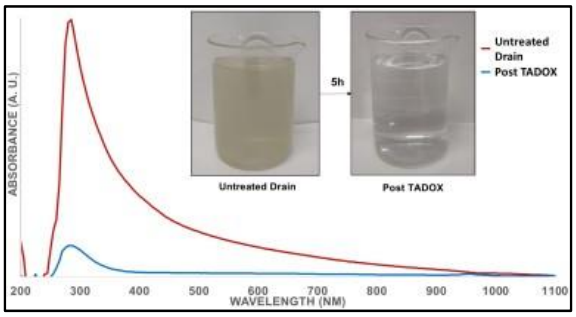
S. No.	*Parameter (mg/l)*	Pre Treated	Post Treated	% change
1	pH	10.3	9.1	-
2	Conductivity (µmho/cm)	5144	198	96%
4	TSS	1800	172	90.5%
5	TDS	2566	146	94%
6	Chloride	720	12.5	98%
7	Hardness	115	25	78%
8	BOD_5	24	10	ZLD
9	COD	304	44	

(C) Open Drain in Gurugram

8

Haryana Case Study D: Mandi Village Drain in Gurugram

(passing through TERI Campus)



Parameter, Unit	Untreated Drain	TADOX Treated
E. coli, MPN/100ml	30.1x 10^3	16
Total coliform bacte MPN/100ml	28 x 10^4	30
Total count, CFU x 105/100ml	106	0.004

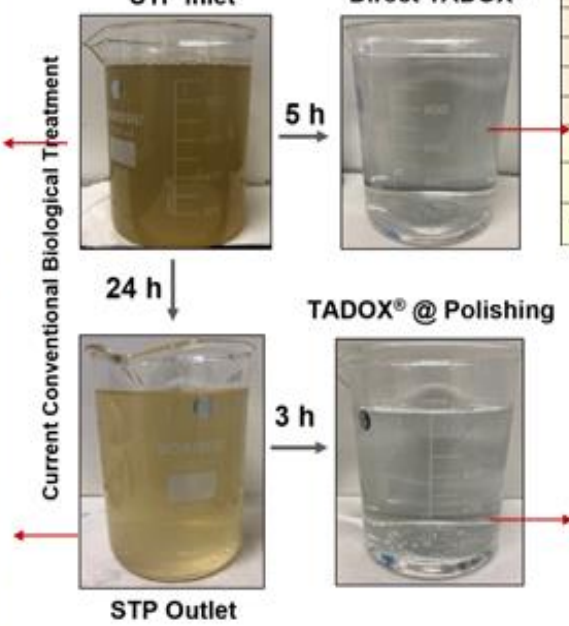
Parameter, Unit	Untreated Open Drain	TADOX Treated
pH Value	7.29	8.4
Conductivity, µmho/cm	1276	271.3
Total Dissolved Solids mg/l	637	135.6
COD, mg/l	96	35
BOD, mg/l	27	< 1
DO, mg/l	3.2	6.3
Nitrate Nitroge,mg/l	45.1	31.8
Nitrite Nitrogen, mg/l	1.4	5.2
Total Kjeldahl Nitroge mg/l	9.33	3.65
Phosphate, mg/l	2.65	0.1

(D) Direct Sewage Treatment in STP in TERI Campus in Gurugram

Haryana Case Study D: Sewage treatment in Gurugram

STP INLET	
pH	7.9
Colour, (Pt- Co) (CU)	185
COD, mg/L	650
BOD, mg/L	261
TSS, mg/L	380
Total N, mg/L	32.0
Total P, mg/L	81.2
E. coli, MPN/100 ml	1.02 x 10^5
Total Coliform bacteria, MPN/100 ml	6.12 x 10^6
Total count, CFU/100 ml	5.24 x 10^5

STP OUTLET	
pH	8.2
Colour, (Pt- Co) (CU)	125
COD, mg/L	400
BOD, mg/L	78
TSS, mg/L	110
Total N, mg/L	30
Total P, mg/L	13
E. coli, MPN/100 ml	1.21 x 10^4
Total Coliform bacteria, MPN/100 ml	1.13 x 10^5
Total count, CFU/100 ml	1.84 x 10^4



DIRECT END-TO-END TADOX®	
pH	8.0
Colour, (Pt- Co) (CU)	8
COD, mg/L	64
BOD, mg/L	7
TSS, mg/L	<5
Total N, mg/L	1.9
Total P, mg/L	<1
E. coli, MPN/100 ml	16
Total Coliform bacteria, MPN/100 ml	1.16 x 10^2
Total count, CFU/100 ml	28

TADOX® AT POLISHING STAGE	
pH	8.1
Colour, (Pt- Co) (CU)	5
COD, mg/L	46
BOD, mg/L	<3
TSS, mg/L	<5
Total N, mg/L	1.7
Total P, mg/L	<1
E. coli, MPN/100 ml	<8
Total Coliform bacteria, MPN/100 ml	3.13x 10^2
Total count, CFU/100 ml	11

14. NABL Testing & Analysis Report (Annexure 1)

PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000001F

Test Report No. : PRPL/WS/011122-013

Name of the Customer : The Energy and Resources Institute (TERI)

Name & Address of the project : "Landfill Site"at Bandhwari, Gurugram, Haryana - 122101

Location of Sampling & GPS detail : Onsite

Sampling Plan & Procedure : PRPL/WP/WS/058

Date of Monitoring/ Date of collection : 01/11/2022

Date of Receipt of Sample at lab : 01/11/2022

Sample Description : S1 - DTRO Inlet (Raw Sample)

Sample Quantity : 2 Lt.

Sample Collected by : By the Client

Tests started on : 02/11/2022

Tests Completed on : 07/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	>1000
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	8.27
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	3180
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	1528
5	Fluoride	mg/L	APHA 4500-F D 23rd edition 2017	1.8
6	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	1680
7	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	5600
8	Total Kjeldahl Nitrogen	mg/L	APHA 4500 N(Org) B 23rd edition 2017	587.4
9	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	7.6
10	Total Solids	mg/L	APHA 2540B 23rd edition 2017	1538.4
11	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	10.4

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TC-6993

Issue Date : 11/01/2023

ULR No. : TC699323000000001F **Test Report No. :** PRPL/WS/011122-013

Remarks:

1. The results mentioned above relate only to the Sample received and Tested by us.
2. The test report shall not be reproduced either in full or part without the written approval of the Laboratory.
3. Samples received shall be disposed off after one month from the date of issue of Test Report unless specified otherwise.
4. Samples for BOD and DO, Colour shall be disposed off after 7 days from the date of issue of test report.

End of Report

Analyst

Authorized Signatory

Authorized Signatory
Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000002F

Test Report No. : PRPL/WS/011122-014

Name of the Customer	:	The Energy and Resources Institute (TERI)
Name & Address of the project		"Landfill Site"at Bandhwari, Gurugram, Haryana - 122101
Location of Sampling & GPS detail	:	Onsite
Sampling Plan & Procedure	:	PRPL/WP/WS/058
Date of Monitoring/ Date of collection	:	01/11/2022
Date of Receipt of Sample at lab	:	01/11/2022
Sample Description	:	Post TADOX
Sample Quantity	:	2 Lt.
Sample Collected by	:	By the Client
Tests started on	:	02/11/2022
Tests Completed on	:	07/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	968
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	8.02
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	3068
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	1473
5	Fluoride	mg/L	APHA 4500-F D 23rd edition 2017	1.73
6	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	1614
7	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	5376
8	Total Kjeldahl Nitrogen	mg/L	APHA 4500 N(Org) B 23rd edition 2017	568.02
9	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	7.36
10	Total Solids	mg/L	APHA 2540B 23rd edition 2017	1483
11	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	10

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TC-6993

Issue Date : 11/01/2023

ULR No. : TC699323000000002F **Test Report No. :** PRPL/WS/011122-014

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End of Report

Analyst

Authorized Signatory

Authorized Signatory
Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000003F

Test Report No. : PRPL/WS/011122-015

Name of the Customer : The Energy and Resources Institute (TERI)

Name & Address of the project : "Landfill Site"at Bandhwari, Gurugram, Haryana - 122101

Location of Sampling & GPS detail : Onsite

Sampling Plan & Procedure : PRPL/WP/WS/058

Date of Monitoring/ Date of collection : 01/11/2022

Date of Receipt of Sample at lab : 01/11/2022

Sample Description : S2 - DTRO Outlet (Raw Sample)

Sample Quantity : 2 Lt.

Sample Collected by : By the Client

Tests started on : 02/11/2022

Tests Completed on : 07/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	12.8
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	7.06
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	2621
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	968
5	Fluoride	mg/L	APHA 4500-F D 23rd edition 2017	0.4
6	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	1400
7	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	4200
8	Total Kjeldahl Nitrogen	mg/L	APHA 4500 N(Org) B 23rd edition 2017	347.3
9	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	4.4
10	Total Solids	mg/L	APHA 2540B 23rd edition 2017	976
11	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	8

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TC-6993

Issue Date : 11/01/2023

ULR No. : TC699323000000003F

Test Report No. : PRPL/WS/011122-015

Remarks:

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End of Report

Analyst

Authorized Signatory

Authorized Signatory
Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000004F

Test Report No. : PRPL/WS/011122-016

Name of the Customer : The Energy and Resources Institute (TERI)

Name & Address of the project : "Landfill Site"at Bandhwari, Gurugram, Haryana - 122101

Location of Sampling & GPS detail : Onsite

Sampling Plan & Procedure : PRPL/WP/WS/058

Date of Monitoring/ Date of collection : 01/11/2022

Date of Receipt of Sample at lab : 01/11/2022

Sample Description : Post TADOX

Sample Quantity : 2 Lt.

Sample Collected by : By the Client

Tests started on : 02/11/2022

Tests Completed on : 07/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	1.1
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	7.94
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	2532
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	934
5	Fluoride	mg/L	APHA 4500-F D 23rd edition 2017	0.38
6	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	1344
7	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	4032
8	Total Kjeldahl Nitrogen	mg/L	APHA 4500 N(Org) B 23rd edition 2017	103.76
9	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	0.1
10	Total Solids	mg/L	APHA 2540B 23rd edition 2017	936
11	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	2

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TC-6993

Issue Date : 11/01/2023

ULR No. : TC699323000000004F

Test Report No. :PRPL/WS/011122-016

Remarks:

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End of Report

Analyst

Authorized Signatory

Authorized Signatory
Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000005F **Test Report No. :** PRPL/WS/231122-001

Name of the Customer : The Energy and Resources Institute (TERI)

Name & Address of the project : "Landfill Site"at Bandhwari, Gurugram, Haryana - 122101

Location of Sampling & GPS detail : Onsite

Sampling Plan & Procedure : PRPL/WP/WS/058

Date of Monitoring/ Date of collection : 23/11/2022

Date of Receipt of Sample at lab : 23/11/2022

Sample Description : S3 - LTP Outlet (Raw Sample)

Sample Quantity : 2 Lt.

Sample Collected by : By the Client

Tests started on : 24/11/2022

Tests Completed on : 29/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	47.2
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	7.34
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	21540
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	10770
5	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	365.4
6	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	1840
7	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	2
8	Total Solids	mg/L	APHA 2540B 23rd edition 2017	10773.8
9	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	3.8

Remarks:

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4. Samples for BOD and DO, Colour shall be disposed off after 7 days from the date of issue of test report.

End of Report

Analyst

Authorized Signatory

Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000006F

Test Report No. : PRPL/WS/231122-002

Name of the Customer : The Energy and Resources Institute (TERI)

Name & Address of the project : "Landfill Site"at Bandhwari, Gurugram, Haryana - 122101

Location of Sampling & GPS detail : Onsite

Sampling Plan & Procedure : PRPL/WP/WS/058

Date of Monitoring/ Date of collection : 23/11/2022

Date of Receipt of Sample at lab : 23/11/2022

Sample Description : Post TADOX

Sample Quantity : 2 Lt.

Sample Collected by : By the Client

Tests started on : 24/11/2022

Tests Completed on : 29/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	2..82
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	9.86
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	15640
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	7800
5	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	177.9
6	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	1200
7	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	1
8	Total Solids	mg/L	APHA 2540B 23rd edition 2017	7801.4
9	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	1.4

Remarks:

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4. Samples for BOD and DO, Colour shall be disposed off after 7 days from the date of issue of test report.

End of Report

Analyst

Authorized Signatory

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Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000007F Test Report No. : PRPL/WS/231122-003

Name of the Customer	:	The Energy and Resources Institute (TERI)
Name & Address of the project		"Landfill Site"at Bandhwari, Gurugram, Haryana - 122101
Location of Sampling & GPS detail	:	Onsite
Sampling Plan & Procedure	:	PRPL/WP/WS/058
Date of Monitoring/ Date of collection	:	23/11/2022
Date of Receipt of Sample at lab	:	23/11/2022
Sample Description	:	S4 - LTP Inlet (Raw Sample)
Sample Quantity	:	2 Lt.
Sample Collected by	:	By the Client
Tests started on	:	24/11/2022
Tests Completed on	:	29/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	104
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	8.68
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	35900
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	18000
5	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	3522.9
6	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	9200
7	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	14
8	Total Solids	mg/L	APHA 2540B 23rd edition 2017	18207.8
9	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	207.8

Remarks:

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4. Samples for BOD and DO, Colour shall be disposed off after 7 days from the date of issue of test report.

End of Report

Analyst

Authorized Signatory

Authorized Signatory
Chandra Shekhar Jha

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PERFACT RESEARCHERS PVT LTD

TC-6993

Issue Date : 11/01/2023

TEST REPORT

Waste Water (Effluents/ Sewage) Analysis

ULR No. : TC699323000000008F

Test Report No. :PRPL/WS/231122-004

Name of the Customer	:	The Energy and Resources Institute (TERI)
Name & Address of the project		"Landfill Site"at Bandhwari, Gurugram, Haryana - 122101
Location of Sampling & GPS detail	:	Onsite
Sampling Plan & Procedure	:	PRPL/WP/WS/058
Date of Monitoring/ Date of collection	:	23/11/2022
Date of Receipt of Sample at lab	:	23/11/2022
Sample Description	:	S5 - DTRO Reject(Raw Sample)
Sample Quantity	:	2 Lt.
Sample Collected by	:	By the Client
Tests started on	:	24/11/2022
Tests Completed on	:	29/11/2022

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results
1	Turbidity	NTU	APHA 2130 B 23rd edition 2017	>1000
2	pH at 25°C	--	APHA 4500-H+ B 23rd Edition 2017	7.17
3	Conductivity	µmhos/cm	APHA 2510 B 23rd edition 2017	44000
4	Total Dissolve Solids	mg/L	APHA 2540 C 23rd edition 2017	22000
5	Biochemical Oxygen Demand (BOD @ 20°C for 5 days)	mg/L	APHA 5210 B 23rd edition 2017	3522.9
6	Chemical oxygen demand	mg/L	APHA 5220 B&C,23rd edition 2017	8800
7	Oil & Grease	mg/L	APHA 5520 B 23rd edition 2017	15
8	Total Solids	mg/L	APHA 2540B 23rd edition 2017	22202.6
9	Total Suspended solids	mg/L	APHA 2540-D 23rd edition 2017	202.6

Remarks:

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End of Report

Analyst

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