

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE
BENCH AT CHENNAI**

Appeal No. 68 of 2021

BETWEEN:

1. M/s. Sri Mahalakshmi Hatcheries
Represented by its proprietor
Mr. D. Sagar Reddy
S/o D. Venkata Ramana Reddy
Office at Srinivasa Satram, Kothapatnam Village,
Kota Mandal, Sidavaram Post,
Nellore – 524 411
Email: sagar.duvvuru@gmail.com
Ph +91 8978374567

2. Mr. Pernati Shyam Prasad Reddy
S/o Pernati Chenchurama Reddy
Residing at Allampadu Village, Molanganuru ost,
Kota Mandal, SPSR Nellore District
Andhra Pradesh – 524 411
Email: syampernati@gmail.com
Ph 91 9449275554

... Appellants

And

1. State Environment Impact Assessment Authority (SEIAA)
Represented by its Chairman
No.33-26-14, D/2 Near Sunrise Hospital,
Pushpa Hotel Centre,
Chalamvari Street, Kasturibaipet,
Vijayawada 520010,
Email: chairman@appcb.gov.in
Ph 0866 2463200.

2. Andhra Pradesh Pollution Control Board
Represented by its Member Secretary,
D.No.33-26-14, D/2 Near Sunrise Hospital,
Pushpa Hotel Centre,
Chalamvari Street, Kasturibaipet,
Vijayawada 520010,
Email: membersecy@appcb.gov.in
Ph 0866 2463200.

3. M/s. Divi's Laboratories Limited
Represented by its Managing Director
303, DIVIs towers,
Cyber Hills, Gachibowli,
Hyderabad 500 032.
Email: mail@divislaboratories.com
Ph +91 40 23786300

... Respondents

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THE ADDITIONAL AFFIDAVIT**

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Dated at Chennai on this the 13th day of November, 2022.

COUNSEL FOR 3RD RESPONDENT



1

ANDHRA PRADESH POLLUTION CONTROL BOARD
D.No. 33-26-14 D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
Chalamalavari Street, Kasturibaipet, Vijayawada – 520010.

Website :www.pcb.ap.gov.in

CONSENT ORDER FOR ESTABLISHMENT

Order No.258/APPCB/CFE/RO-NLR/HO/2020

Dt. 02.12.2021

Sub: APPCB – CFE - **M/s. Divi's Laboratories Limited, Survey No. 397, 401, 402, 403, 446, 676, 681, 682, 683, 700 to 709, Krishnapatnam Industrial Area (KIA), Kothapatnam (V), Kota (M), SPSR Nellore District** - Consent for Establishment (CFE) of the Board under Sec.25 of Water (P & C of P) Act, 1974 and Under Sec.21 of Air (P & C of P) Act, 1981 - Issued - Reg.

- Ref: 1) APPCB NOC dt.28.10.2020 for marine outfall to discharge treated effluents.
2) EC dt.28.06.2021 issued by SEIAA, A.P.
3) Industry's CFE application received through OCMMS on 02.11.2021.
4) R.O's inspection report dt.08.11.2021.
5) CFE Committee meeting held on 11.11.2021.
6) Proponent's mail dt.12.11.2021

1. In the reference 3rd cited, an application was submitted to the Board seeking Consent for Establishment (CFE) to produce the following products with installed capacities as mentioned below, with a project cost of Rs.150.0 Crores.

S. No.	Name of the Products	Quantity (MTPA)
1.	1-6-methoxy-2-naphthylethanone	5000
2.	2-S - Acetoxy propionylchloride	72
3	ATIPA DICHLORIDE	300
4.	3- Hydroxy acetophenone	320
5.	p-methoxy phenyl acetic acid	780
6.	2-1-cyclohexenylethylamine	540
7.	Octamandalate	780
8	Dextromethorphan HBr	420
9.	4-4-chlorophenylcyclohexanecarboxylic acid	50
10.	Benzyladrinone HCl	500
11.	2n-butyl-4-chloro-5-formyl imidazole	300
12.	Z-L Valine	180
13	C10-Dialdehyde	150
14	1,2,3-Tri-O-Acetyl-5-deoxy-n-ribofuranose	50
15	N-Hydroxysuccinimide	60

16	Dimethylacetylene di carboxylate	60
17	DL-2,2-dimethylcyclopropane carboxylic acid	10
18	Acetonide	132
19	l-Pentanol	84
20	Astaxanthin	60
21	B-Carotene	150
22	Beta-iodidine ethyl triphenyl phosphene bromide	380
23	Lycopene	25
24	Canthaxanthin	5
25	APO Carotenol	25
26	Lutein	50
	Total Production Capacity	10,483 MTPA

2. As per the application, the above activity is to be located at **Survey No. 397, 401, 402, 403, 446, 676, 681, 682, 683, 700 to 709, Krishnapatnam Industrial Area (KIA), Kothapatnam (V), Kota (M), SPSR Nellore district** in an area of 81.74 Ha.
3. The above site was inspected by the Asst. Environmental Engineer, Regional Office, A.P Pollution Control Board, Nellore on 06.11.2021 and observed that the site is surrounded by
 - North** : Land belongs to M/s. Krishnapatnam Infratech Limited & RF.
 - South** : Village R&B road followed by Sandy Agriculture lands.
 - East** : Agriculture land and vacant sand dunes.
 - West** : Sandy Agriculture lands followed by Buckingham canal.
4. The Board, after careful scrutiny of the application, verification report of Regional Officer and recommendations of the CFE Committee, hereby issues **CONSENT FOR ESTABLISHMENT** to the project under Section 25 of Water (Prevention & Control of Pollution) Act 1974 and Section 21 of Air (Prevention & Control of Pollution) Act, 1981 and the rules made there under. **This order is issued to manufacture the products as mentioned at para (1) only.**
5. This Consent order issued is subject to the conditions mentioned in the Annexure.

6. This order is issued from pollution control point of view only. Zoning and other regulations are not considered.
7. **This order is valid for a period of 7 years from the date of issue.**

Encl: Annexure

**BATCHU
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PRASAD**

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postalCode=520010, st=Andhra Pradesh, cn=BATCHU SIVA PRASAD
Date: 2021.12.02 15:22:06 +05'30'

CHIEF ENVIRONMENTAL ENGINEER

To

**M/s. Divi's Laboratories Limited,
Divi Towers, 1-72/23(P)/DIVIS/303,
Cyber Hills, Gachibowli,
Hyderabad.
sbalaji@divislabs.com**

Copy to: 1. The JCEE, Z.O: Vijayawada for information and necessary action.
2. The EE, R.O: Nellore for information and necessary action.

ANNEXURE

1. The proponent shall obtain Consent for Operation (CFO) from APPCB, as required Under Sec.25/26 of the Water (P&C of P) Act, 1974 and under sec. 21/22 of the Air (P&C of P) Act, 1981, before commencement of the trial runs.
2. The applicant shall provide separate energy meters for Effluent Treatment Plant (ETP) and Air pollution Control equipments to record energy consumed. An alternative electric power source sufficient to operate all pollution control systems shall be provided.
3. The industry shall construct separate storm water drains and provide rain water harvesting structures. No effluents shall be discharged in to the storm water drains.

Water:

4. The source of water is Surface Water from Kandaleru reservoir supply, Bore wells and De-salination plant and the maximum permitted water consumption is as following:

S. No.	Purpose	Quantity (KLD)
1.	Process	810
2.	Reactor, Floor washings, scrubbers make up etc.	200
3.	RO / DM Plant	200
4.	Boiler	500
5	Cooling tower	700 (Fresh 200 KLD + Recycled 500 KLD)
6	Domestic	100
7	Hostels	170
8	Green Belt	520(Fresh 320 KLD + Recycled 200 KLD)
Total :		3200 KLD

Fresh water – 2500 KLD, Recycled water – 700 KLD

Separate meters with necessary pipe-line shall be provided for assessing the quantity of water used for each of the purposes mentioned above.

5. The maximum waste water generation shall not exceed the following:

S. No.	Source	Quantity (KLD)
1.	Process (HTDS –57.07, LTDS –500.16, High COD -24.36, High TDS & High COD- 129.563, NaCl effluent – 100.83), AlCl ₃ & H ₂ SO ₄ containing effluents -140.84 KLD, Recovery effluents- 49.14 KLD)	1002
2.	Reactor, Floor Washings, scrubbers etc	180
3.	RO/DM Plant	200
4.	Boiler	425
5.	Cooling Tower	420

6.	Domestic	90
7.	Hostels	153
	Total	2470 KLD

Out of total effluent generation of 2470 KLD, 700 KLD recycled / reused, 1727 KLD Marine discharge.

Treatment & Disposal:

Source of effluent	Treatment units	Mode of final disposal
HTDS - Process	MEE -13.5 KL/hr & ATFD - 3.5 KL/hr capacity	MEE condensate and ATFD condensate mixed with low TDS effluents
High COD – Process	Stripper - 15 KL/hr capacity	Stripper condensate to cement industries. Stripped off effluent to ETP.
HTDS & HCOD process	Stripper-15 KL/hr, MEE -13.5 KL/hr & ATFD- 3.5 KL /hr	MEE condensate and ATFD condensate mixed with low TDS effluents for further treatment in ETP.
LTDS – Process, washings, scrubber water	ETP of 1200 KLD capacity consists of Oil & Grease traps, Equalization cum neutralization tanks, Primary settling tanks, Aeration tanks, Settling tanks, Sludge drying beds, Temporary storage tanks, Guard ponds (6nos. x 800 KL)	The treated waste water proposed to discharge into the sea through marine outfall.
LTDS (Boiler blow down, Cooling town blow down & DM plant/ Raw RO plant reject) + condensate from MEE, ATFD		
NaCl stream effluents	to Neutralize	The Neutralized NaCl effluents proposed to discharge into the sea through marine outfall.
Domestic	Two STPs of capacity 250 KLD each	To utilize for greenbelt development after treatment in STPs

6. The treatment system consisting of stripper, MEE, ATFD system with condenser and Biological ETP, RO plant shall be installed and commissioned. All the units of the treatment system shall be impervious to prevent ground water pollution. The units of treatment system shall be constructed above the ground level.

Effluents shall not be discharged on land or into any water bodies or aquifers under any circumstances.

7. The industry shall provide digital flow meters with totalisers at the inlet and outlet of Stripper, MEE and ETP.

8. The industry shall install online real time monitoring system along with web camera facilities as per the directions of CPCB. The industry shall connect them to APPCB / CPCB websites as per CPCB directions.
9. Floor washing shall be admitted into the effluent collection system only and shall not be allowed to find their way in storm drains or open areas. All pipe valves, sewers, drains shall be leak proof.
10. The LTDS and HTDS effluents shall be stored in above ground level collection tanks separately.
11. The industry shall provide tank in tank system for effluent collection at production blocks. Free board shall be maintained in the tanks to prevent spillages.
12. The industry shall construct rain water runoff tank for collection and storage of first flush storm water. The industry shall maintain dry condition outside drains in un-rainy season.

Air:

13. The Air pollution Control equipment shall be installed along with the commissioning of the activity and shall comply with the following for controlling air pollution.

S. No.	Details of Stack	Stack 1	Stack-2	Stack-3	Stack-4	Stack-5
a)	Attached to:	Boilers	DG Set	DG Set	DG Set	DG Set
b)	Capacity	2 x 24.0 TPH (One stand by)	5x 1500 KVA	4 x1250 KVA	1x 1000 KVA	1X320 KVA
c)	Name of the Fuel :	Coal – 120 TPD	Diesel	Diesel	Diesel	Diesel
d)	Stack height above ground	30m Common stack	30 m each	30m each	30m	7m
e)	Air Pollution Control Equipment:	ESP	Acoustic enclosure	Acoustic enclosure	Acoustic enclosure	Acoustic enclosure

Note: The industry vide mail dt. 12.11.2021 had informed that out of 2 x 24 TPH boilers, one is stand-by. The proposal of incinerator is dropped.

14. A sampling port with removable dummy of not less than 15 cm diameter shall be provided in the stack at a distance of 8 times the diameter of the stack from the nearest constraint such as bends etc. A platform with suitable ladder shall be provided below 1 meter of sampling port to accommodate three persons with instruments. A 15 AMP 250 V plug point shall be provided on the platform.
15. The industry shall provide the monitoring system to all the stacks / vents in the plant. Regular monitoring shall be carried out and report shall be submitted to the Regional officer.

16. The industry shall provide multi-stage scrubbers to the process vents to control the process emissions. The industry shall provide online pH measuring facility with auto recording system to the scrubbers provided to treat the process emissions.
17. The industry shall provide VOC monitoring system with auto recording facility.
18. The industry shall implement adequate measures to control all fugitive emissions from the plant.
19. The proponent shall ensure compliance of the National Ambient Air quality standards notified by MoEF, GoI vide notification No. GSR. 826 (E), dated. 16.11.2009 during construction and regular operational phase of the project at the periphery.

The generator shall be installed in a closed area with a silencer and suitable noise absorption systems. The ambient noise level shall not exceed 75 dB(A) during day time and 70 dB(A) during night time.

20. The proponent shall not use or generate odour causing substances or Mercaptans and cause odour nuisance in the surroundings.
21. The industry shall send the used / spent solvents to the recyclers (or) process them at their own solvent recovery facility within the premises.
22. The evaporation losses in solvents shall be controlled by taking the following measures:
 - i) Chilled brine circulation shall be carried out to effectively reduce the solvent losses into the atmosphere.
 - ii) Transfer of solvents shall be done by using pumps instead of manual handling.
 - iii) Closed centrifuges shall be used to reduce solvent losses.
 - iv) All the solvent storage tanks shall be connected with vent condensers to prevent solvent vapours.
 - v) The reactor vents shall be connected with primary & secondary condensers to prevent escaping of solvent vapour emissions into atmosphere.

Solid Waste:

23. The industry shall comply with the following for disposal of Solid wastes:

S. No.	Name of solid waste	Quantity	Method of disposal
1.	Process Residues	11,739 kg/day	To the authorized Cement industries for co-processing (or) TSDF for incineration
2.	Spent Carbon	134 kg/day	

3.	Spent Solvents	200 KL /day	Recovery within the premises / to authorised agency for recovery.
4.	Mixed Spent Solvents	40 KL/day	To authorized recovery units / Authorized cement plant for co-processing.
5.	Spent acid	187 KL/day	To authorized agencies.
6.	Spent Catalyst	200 kg/day	To the Supplier for recovery
7.	Containers & Container Liners of Hazardous chemicals & Hazardous wastes.	Containers – 2000 Nos./month Liners – 5000 kg/month	To authorized agencies, after complete detoxification for re-use/ recycle.
8.	Used Oil / Waste Lubrication Oil	100 Ltrs/month	Used as lubricant within the premises / to authorized Re-processors / Recyclers / to the Cement industries for co-processing.
9.	Multiple effect evaporation salts	13,658 kg/day	TSDf for secured land fill / authorized pre-processing units / cement industries for co-processing.
10.	ETP Sludge	200 kg/day	
11.	Process salts	1152 kg/day	
12.	Incineration ash	75 kg/day	
13.	Boiler Ash (Fly & bottom) (Non haz waste)	30 TPD	To Brick Manufacturers.
14.	Insulation waste	1 TPD	Sent to authorized agencies / TSDf / Cement Industries

24. The proponent shall place the chemical drums and / or any drums in a shed provided with concrete platform only. The Platform shall be provided with sufficient dyke wall and effluent collection system. The industry shall provide containers detoxification facility. Container & Container liners shall be detoxified at the specified covered platform with dyke walls and the wash wastewater shall be routed to low TDS collection tank.
25. The following rules and regulations notified by the MoEF&CC, GoI shall be implemented.
- Regulation of Persistent Organic Pollutants Rules, 2018.
 - Hazardous waste and other wastes (Management and Transboundary Movement) Rules, 2016.
 - Plastic Waste Management Rules, 2016.
 - Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989
 - Fly Ash Notification, 2016.
 - Batteries (Management & Handling) Rules, 2010.
 - E-Waste (Management) Rules, 2016.
 - Construction and Demolition waste Management Rules, 2016.
 - Solid Waste Management Rules, 2016.

Other Conditions:

26. This order is issued subject to cases / appeals pending in any Court of law / NGT.
27. The A.P. Pollution Control Board already formulated the Standard Operating Procedures (SOPs) for monitoring of Marine outfall systems in the state. The industry shall comply with those SOPs.
28. The proposed area is sandy soil with high permeability. The industry shall take all precautionary measures to avoid spillage of chemicals. The industry shall handle all solvents, chemicals and effluents with due care. The industry shall provide clay layer of about 3 feet thickness at all chemical handling areas and ETP area to prevent contamination of groundwater, in case of any spillages.
29. The industry shall construct all ETP units above ground level, keeping in view soil conditions of the proposed area.
30. Yammadineplem village is located at a distance of about 200 m from the proposed project site. Hence, the industry shall take all preventive measures to control VOCs, such as multi-stage scrubbers & multi-stage condensers to the reactors; multi-stage scrubber to the spray dryer; hood with scrubber to the effluent collection tanks; condensers to all solvent storage tanks and closed conduits for conveyance of effluent. The industry shall plant more trees towards village side.
31. As per the EC order dt.28.06.2021, the industry was permitted to install 1 x 24 TPH coal fired boiler. But, now the industry proposed to install 2 x 24 TPH boilers, of which one boiler would be stand-by. The proponent shall obtain EC (Amendment) to that extent before applying for CFO of the Board.
32. The industry shall comply with all the conditions stipulated in the EC dt.28.06.2021 issued by SEIAA, A.P.
33. "The industry shall comply with the industry specific standards with respect to process emissions stipulated by the MoEF & CC, Gol, New Delhi from time to time."

S. No.	Details of process emissions	Emission Control system	Emission Standard
1.	HCl	Multi stage water scrubbers and alkali scrubbers in series.	35 mg/Nm ³
2.	NH ₃		30 mg/Nm ³
3.	Sulphuric acid mist		50 mg/Nm ³
4.	Chlorine		15 mg/Nm ³

34. The industry shall display online data outside the main factory gate on quantity and nature of hazardous chemicals being used in the plant, water & air emissions and solid waste generated within the factory premises, as per Hon'ble Supreme Court order.

35. **The industry shall prepare a safety report and carry out an independent safety audit report of the respective industrial activities including chemical storages / isolated storages by an expert not associated with such industrial activity as required under Rule 10 of MSIHC Rules, 1989 and get it approved by the Factories Dept., and submit the compliance along with copy of the safety report, safety audit report and safety certificate at concerned Regional Office, APPCB.**
36. **The industry shall submit a copy of the NOC issued by the Andhra Pradesh State Disaster Response and Fire Service Dept., (APSDRFSD) at concerned Regional Office, APPCB.**
37. **The industry shall submit risk assessment report covering worst scenario clearly describing impact within the industry premises and outside the industry premises and emergency response system.**
38. **The industry shall obtain PESO clearance & policy under PLI Act before applying for CFO of the Board.**
39. The industry shall inventorize the storage quantities of hazardous chemicals (raw materials), products, as per the hazard nature of reactivity / toxicity / flammability / explosive stored/handling in the premises as defined in the Management of Storage, Import of Hazardous Chemicals (MSIHC) Rules, 1989 and the details shall be furnished to the Factories Department and to the Regional Office, APPCB on monthly basis duly certifying the same.
40. The industry shall identify major accident hazard chemicals & list out the hazardous chemicals endangered to human health & environment and the details shall be furnished to the Factories Department and to the Regional Office, APPCB time to time duly certifying the same by the industry. Further the industry shall extend training to the working personnels while handling hazardous chemicals for prevention of accidents and necessary antidotes to ensure the safety, as per the MSIHC Rules, 1989.
41. The industry shall carryout calibration of safety equipments and leak detection systems at regular intervals and shall certify the same with the Factories Department. That certified copy shall be submitted to the APPCB, Regional Office. The industry shall install fluorescent Wind Vane at the highest point in the industry premises.
42. **The industry shall comply with the Technical suggestions at Chapter No. 7.3 & 7.4 for Hazardous Chemical handling industries by High Power Committee (HPC) of Govt. of Andhra Pradesh. The HPC report is available at www.ap.gov.in.**
43. The industry shall utilize DG power for captive consumption only & power shall not be supplied to grid and shall follow the amendments issued by MoEF & CC/CPCB from time to time on DG sets in respect of conditions & standards.

44. Green belt shall be developed all along the boundary & vacant spaces with tall growing trees with good canopy and it shall not be less than 33% of the total area.
45. The industry shall submit the information regarding usage of Ozone Depleting Substance once in six months to the Regional Office and Zonal Office of the Board.
46. The industry shall submit compliance to the conditions stipulated in the EC and CFE orders to the concerned Regional Officer of APPCB every six months and shall upload the same at APPCB website viz.,
https://pcb.ap.gov.in/UI/Submission_Compliance_of_EC_CFE_CFO_Direction.aspx.
47. Concealing the factual data or submission of false information / fabricated data and failure to comply with any of the conditions mentioned in this order attracts action under the provisions of relevant pollution control Acts.
48. Notwithstanding anything contained in this conditional letter or consent, the Board hereby reserves its right and power Under Sec. 27(2) of Water (Prevention and Control of Pollution) Act, 1974 and Under Sec.21(4) of Air (Prevention and Control of Pollution) Act, 1981 to revoke the order, to review any or all the conditions imposed herein and to make such modifications as deemed fit and stipulate any additional conditions.
49. Any person aggrieved by an order made by the State Board under Section 25, Section 26, Section 27 of Water Act, 1974 or Section 21 of Air Act, 1981 may within thirty days from the date on which the order is communicated to him, prefer an appeal as per Andhra Pradesh Water Rules, 1976 and Air Rules,1982, to such authority (hereinafter referred to as the Appellate Authority) constituted under Section 28 of Water (Prevention and Control of Pollution)Act,1974 and Section 31 of the Air (Prevention and Control of Pollution) Act, 1981.

**BATCHU
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PRASAD**

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Date: 2021.12.02 15:22:52 +05'30'

CHIEF ENVIRONMENTAL ENGINEER

To

**M/s. Divi's Laboratories Limited,
Divi Towers, 1-72/23(P)/DIVIS/303,
Cyber Hills, Gachibowli,
Hyderabad.**

Divi's Proposed dedicated Marine Discharge Pipeline – Longitudinal Section diagram

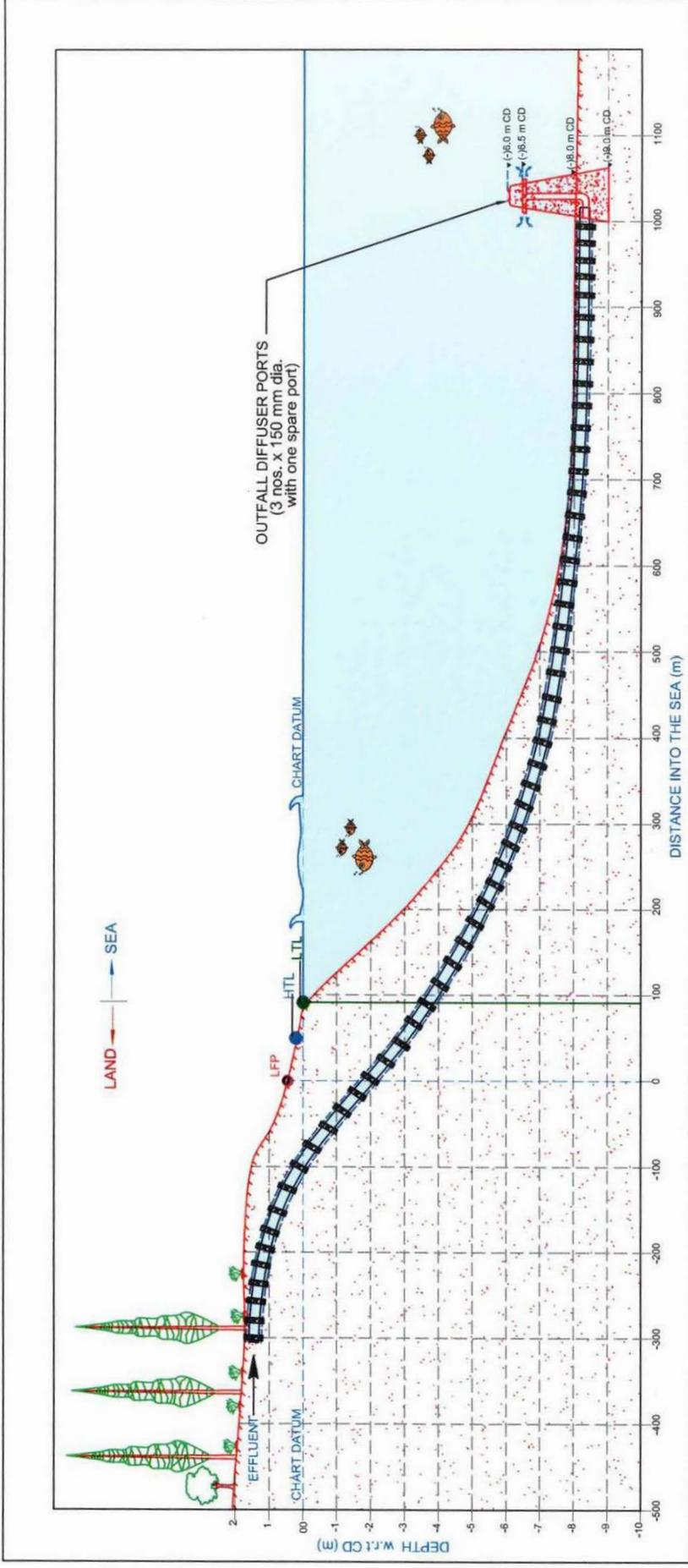
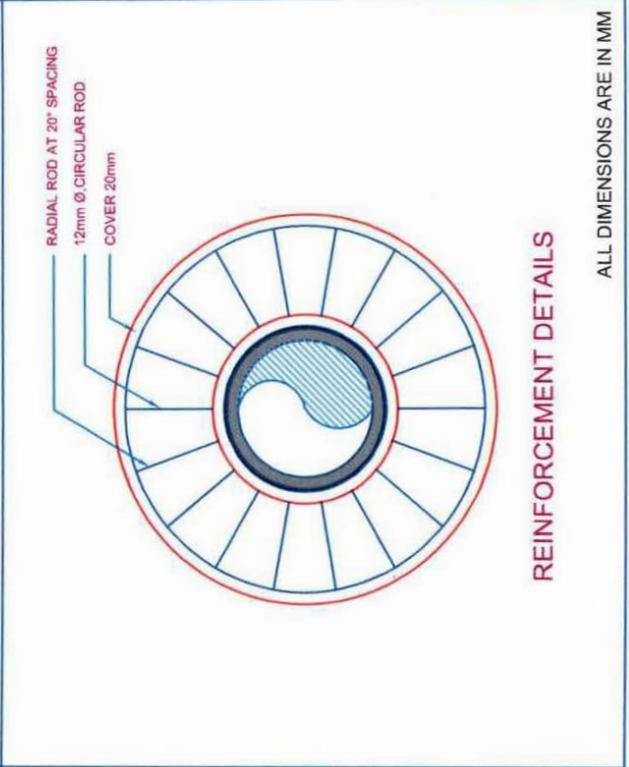
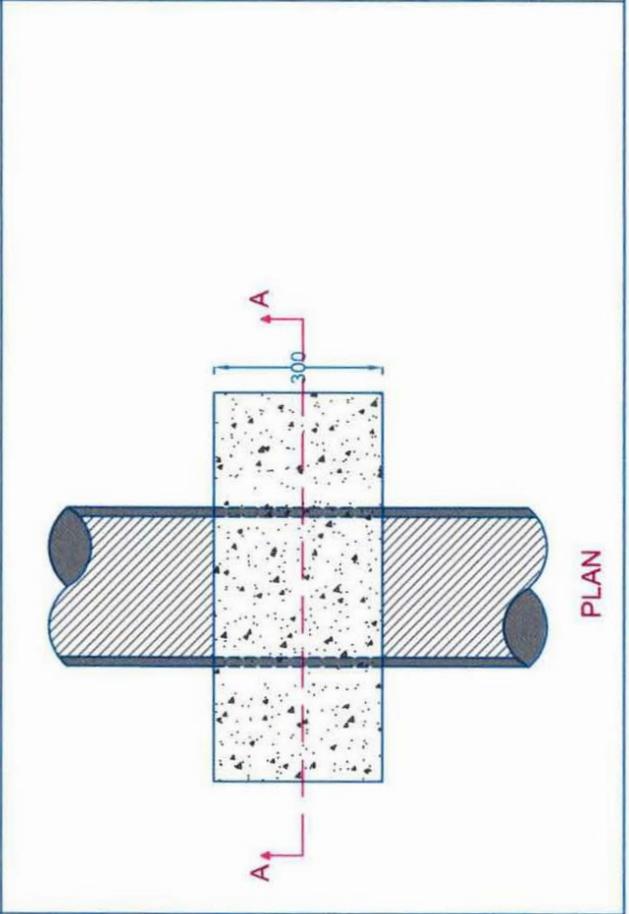
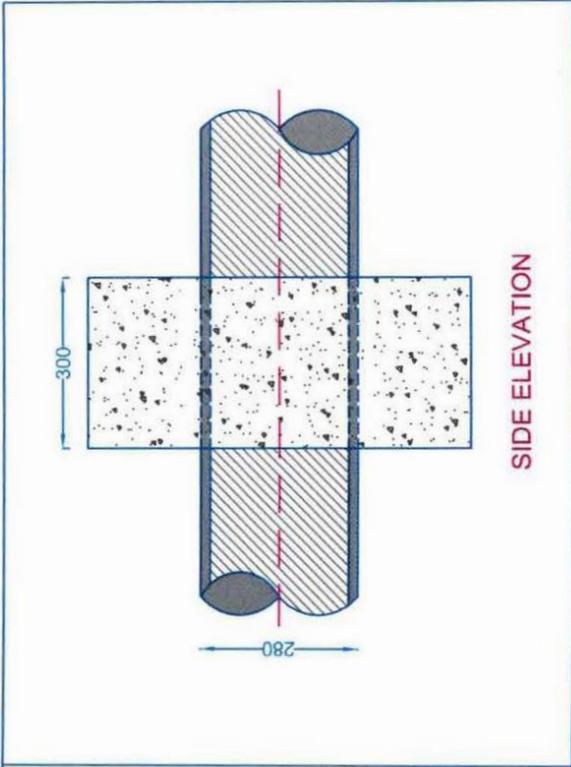
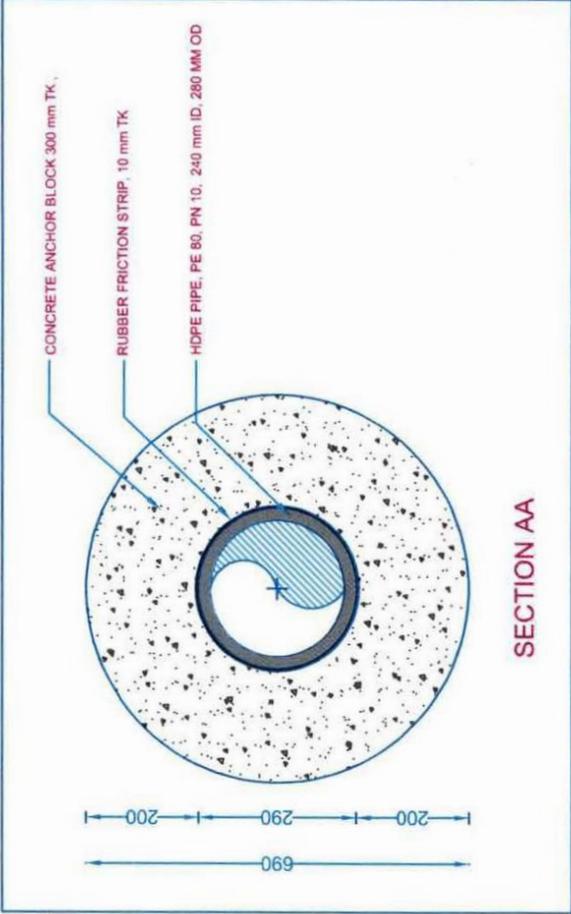


FIG. 2.2. LONGITUDINAL SECTION OF SEAWATER OUTFALL SCHEME

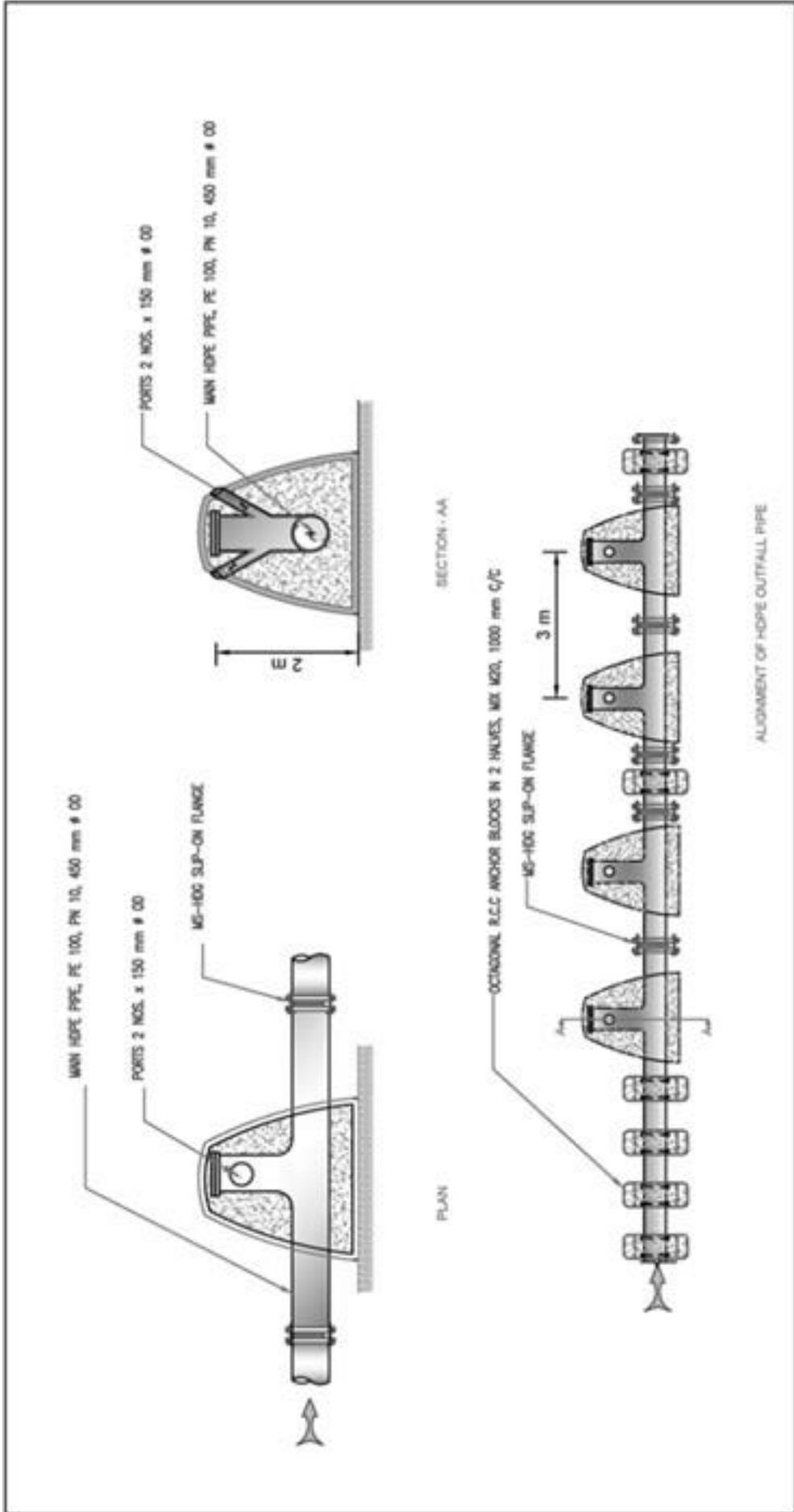
- The Outfall Diffuser will be located at 1000m from Landfall Point (LFP) at the water depth of 8m.
- Outfall will have 3 nos. x 150 mm dia. Ports (with one Spare port) – Multiple port diffuser arrangement.
- Outfall pipeline will be laid on the Seabed which will eventually get buried into the Sea floor

Marine Discharge Pipeline – Anchor Block Design



ALL DIMENSIONS ARE IN MM

Marine Discharge Pipeline – Diffuser Sectional Diagram



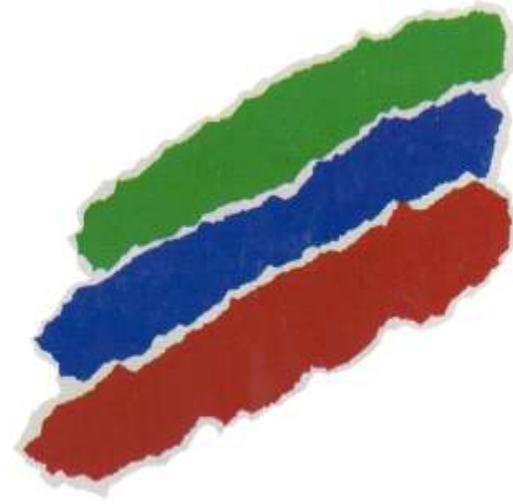
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**Monthly monitoring of Eco-toxicity of treated effluent
June 2022**

Sponsored by

**Divis Laboratories Ltd
Visakhapatnam**



June, 2022

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**Monthly monitoring of Eco-toxicity of treated effluent
June 2022**

SPONSORED BY

**Divis Laboratories Ltd
Visakhapatnam**



NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific & Industrial Research)
Regional Centre, Visakhapatnam – 530 017



June, 2022

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Foreword

Andhra Pradesh Pollution Control Board (APPCB), zonal office, Visakhapatnam has issued a notice (No. 2313/PCB/ZO-VSP/NIO/2022) on 27th May 2022 to all the marine discharge industries and CETPs to conduct monthly eco-toxicology tests on treated effluent, and trace metals and major organic compounds present in the treated effluent by CSIR-National Institute of Oceanography (NIO), Visakhapatnam. In this connection, M/s Divis Laboratories Limited has contacted CSIR-NIO, Regional Centre, Visakhapatnam to take up a study on monthly assessment of the eco-toxicity (bio-assay), trace metals and major organic compounds of the treated effluent from the guard ponds of M/s Divis Laboratories Limited to fulfil the specific condition of APPCB. After considering the proposal, CSIR-NIO has agreed to carry out the study on monthly assessment of the treated effluent for the above-mentioned investigations. CSIR-NIO has conducted first field campaign for the month of June on 25th June 2022 and treated effluent was collected from the guard pond No. 9. This report is the compilation of the data obtained for various investigations conducted on the treated effluent.

List of Contributors to the project

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Acknowledgements

The work was sponsored by M/s. Divis Laboratories Limited (DLL), Visakhapatnam. CSIR-National Institute of Oceanography (NIO) acknowledges **Dr. Rao**, Director, DLL, **Mr. S. Balaji**, Deputy General Manager - ECD and **Mr. Prasad**, Senior Manager – ECD for their keen interest, involvement, support and continuous interaction with us. We are thankful to **Dr. Sunil Kumar Singh**, Director, CSIR-NIO for his support and encouragement to carry out this study.

Executive Summary

As part of the continuous monthly studies on the assessment of the quality of treated effluent of M/s Divis Laboratories Limited, the treated effluent was collected from the guard pond No. 9 in the Divis Laboratories Limited on 25th June 2022. This treated effluent was tested for its eco-toxicity, levels of trace metals and major organic compounds. A 4-day (96 hours) bio-assay experiment was conducted on the treated effluent using zebra fish following the method IS: 6582-1971 (Re-affirmed, 2003) as suggested by the CPCB. The results of the bio-assay experiment revealed that the eco-toxicity levels of the treated effluent collected from M/s Divis Laboratories Limited meet the CPCB standard of '90% survival after 96 hours in the 100% effluent' as the mortality of the zebra fish in 100% effluent after 96 hours is only 9.99%. Based on the survival rate of zebra fish at different concentrations of effluent, the median lethal concentration (LC50) is . Trace metal concentrations determined in the treated effluent are within the limits prescribed by CPCB for treated effluent of sea discharge. These results suggest that the treated effluent collected from the guard pond No. 9 on 25th June 2022 meets the CPCB norms for release in to the sea.

1. Introduction

Some of the coast-based industries discharge their treated effluent in to the sea through a designated marine outfall point after fulfilling the criterion set up by the central pollution control board (CPCB) and Andhra Pradesh state pollution control board (APPCB) for the treated effluent. APPCB has established a lock and key system for the guard ponds to release of treated effluent into the sea. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobino Pharma Ltd., Lantech Pharmaceuticals Ltd., SMS Pharmaceuticals Ltd., Divis Laboratories Ltd., Hetero Drugs Ltd., Deccan Fine Chemicals India Pvt. Ltd.) and one text tile industry (Brandix India Apparel City Pvt Ltd) processing their effluent in the ETP (effluent treatment plant) and discharge the treated effluent in to the coastal waters of north Andhra coast (between Pydibhimavaram and Kesavaram). In addition, two CETPs (common effluent treatment plant), namely, Visakha Pharmacy Ltd. and Achyutapuram SEZ Ltd process the effluents received from various pharmaceutical industries in the CETP and discharge the treated effluent in to the sea. National Thermal Power Corporation and Rastriya Ispat Nigam Ltd. draw seawater for the cooling purpose the discharge the warm and high salinity water back to the sea.

Andhra Pradesh Pollution Control Board (APPCB), Visakhapatnam has issued a notice (No. 2313/PCB/ZO-VSP/NIO/2022) to all sea discharge industries on 27th May, 2022 and instructed to assess the quality of treated effluent on monthly time scales for a period of one year through the bio-assay experiments and the levels of trace metals and major organic compounds in the treated effluent by the CSIR-National Institute of Oceanography, Visakhapatnam. With reference to this, M/s Divis Laboratories Limited has approached CSIR-NIO, Visakhapatnam to carry out the above-mentioned studies on their treated effluent for the period of one year (from June 2022 to May 2023) on monthly time intervals. In this connection, CSIR-NIO has collected the treated effluent from the guard pond No. 9 M/s Divis

Laboratories Limited on 25th June 2022 and to carryout bio-assay experiment for four days using zebra fish and to determine the concentration levels of trace metals and major organic compounds present in the treated effluent.

1.2 Objective:

The main objective of this study is to assess the quality of treated effluent of M/s Divis Laboratories Limited through bio-assay test and concentration levels of trace metals and organic constituents present in the treated effluent, and to compare the results with the CPCB standards for compliance/non-compliance.

1.3 Sample collection:

A Niskin water sampler (10L, plate. 1.1) was used to treated effluent sample from guard pond No.9 of M/s Divis Laboratories Limited on 25th June, 2022 for dissolved oxygen (DO), biochemical oxygen demand for five days (BOD₅), pH, dissolved inorganic nutrients and microbial community studies. Water samples were collected in pre-cleaned in white jerry cans (20L) for bio-assay studies and for filtration of samples for chlorophyll-a and total suspended matter.



Plate 1.1: Niskin sampler (10L) used for collection of water samples

1.4 Methodology

The Physico-chemical parameters were analysed through the standard procedures following Carrit and Carpenter (1966), Grashoff (1974), Suzuki and Ishimaru (1990) and Grassoff et al. (1992). The detailed methodology of each parameter is given below.

a) pH

pH of the treated effluent sample collected in air-tight glass bottle (60ml) was measured using Metrohm pH analyzer (Titrand 865). Standard buffer solutions (Merck, Germany) were used for calibration of the instrument. Based on the repeated analysis of aliquots of standards and samples, the precision of the analysis for pH is 0.002 units.

b) Dissolved Oxygen (DO)

Winkler's method was adopted for the determination of DO concentrations. A measured volume of effluent sample was fixed immediately after collection with the reagents Winkler's A (manganous chloride) and Winkler's B (alkaline potassium iodide). Standard titration with sodium thiosulphate was adopted for the analysis purpose. Concentration of DO was expressed in mg/l. The precision of analysis, expressed as standard deviation with this method was $\pm 0.07\%$.

c) Biochemical Oxygen Demand (BOD)

Samples for the determination of biochemical oxygen demand were collected in triplicate. The dissolved oxygen concentration was immediately determined using one of the triplicate samples according to Winkler's method. The remaining bottles were left for five days at 20°C in the BOD incubator. Dissolved oxygen in these samples was determined after fixing the samples on completion of five days incubation. BOD₅ was computed from the initial DO concentrations and expressed in mg/l.

d) Ammonium - Nitrogen (NH_4^+ - N_2)

Ammonical - Nitrogen in treated effluent sample was determined with the indophenol blue method using trione. Care was taken for the analysis of ammonium and ammonia free distilled water was used for analysis to avoid any contamination as ammonia is highly soluble in water. The absorbance of the coloured complex was measured at 630 nm in Spectrophotometer against a standard. NH_4 - N is expressed in $\mu\text{mol/l}$ and the precision of analysis, in terms of standard deviation, is $\pm 0.02 \mu\text{mol/l}$

e) Nitrite - Nitrogen (NO_2^- - N_2)

Nitrite was determined by the method of Bend Schneider and Robinson whereby the nitrite in water sample was diazotised with sulphanilamide and coupling with N-1-Naphthyl ethylene diamine dihydrochloride. The absorbance of the resultant azo-dye was measured at 543 nm against a standard solution. Concentrations of NO_2^- - N in seawater is expressed in $\mu\text{mol/l}$.

f) Nitrate - Nitrogen (NO_3^- - N_2)

Nitrate in effluent sample was first reduced to nitrite using heterogeneous reduction by passing the buffered samples through an amalgamated cadmium column and the resultant nitrite was determined as above. The measured absorbance was due to initial nitrite present in the sample and nitrite obtained by reduction of nitrate in the sample. Necessary correction was therefore applied for any nitrite initially present in the sample. Concentrations of NO_3^- - N in seawater were expressed in $\mu\text{mol/l}$. The precision of analysis for both nitrite and nitrate, in terms of standard deviation, is $\pm 0.02 \mu\text{mol/l}$

g) Phosphate - Phosphorus (PO_4^{3-} -P)

Inorganic phosphate was measured by the method of Murphy and Riley in which the samples were made to react with acidified molybdate reagent and then reduced using ascorbic acid. The absorbance of the resultant phosphorous molybdenum blue complex was measured at 880

nm against a standard. Concentrations of PO_4^{3-} - P in effluent samples were expressed in $\mu\text{mol/l}$. The precision of analysis, in terms of standard deviation, is $\pm 0.01 \mu\text{mol/l}$

h) Silicate - Silicon (SiO_4^{2-} -Si)

Silicate - silicon was also estimated by reaction with acid - molybdate and ascorbic acid in the presence of oxalic acid. The interference of phosphate is prevented by addition of oxalic acid. The absorbance of the resultant silico - molybdenum blue complex was measured at 810 nm in Spectrophotometer against a standard. Concentrations of SiO_4^{2-} - Si in effluent sample was expressed in $\mu\text{mol/l}$. The precision of analysis, expressed as standard deviation, is $\pm 0.02 \mu\text{mol/l}$

i) Total suspended matter (TSM)

One litre of effluent sample was filtered through pre-weighed Polycarbonate filter ($0.47 \mu\text{m}$; Millipore) and after filtration the filter was dried for about 2 days at 60°C . The dried filter was weighed and noted down the reading. The filter was dried again and took the weight measurement. This procedure was continued until the weight loss of the filter due to drying is zero. The weight of the material retained on the filter was considered as TSM concentration and was expressed mg/L.

j) Bio-assay test (Eco-toxicology test)

The bio-assay test was performed following the CPCB standard method (IS:6582-2001) using zebra fish (*D. Rerio*) as test species. Bio-assay test was conducted on different effluent concentrations, such as 0% (control), 10%, 20%, 30%, 50%, 60%, 90% and 100% and the test was conducted for 4 days (96 hours.). Mortality of zebra fishes in different concentrations were noted down at regular time intervals of 1h, 6h, 12h, 24h, 36h, 48h, 60h, 72h, 84h and 96 hours. LDP line software was used to calculate the median lethal concentration (LC50) of treated effluent for 24h, 48h, 72h and 96 hours.

k) Trace metals

Trace metal concentrations in the treated effluent sample collected from the guard pond of the industry was filter through 0.22 μm polycarbonate filter to remove the particles. The filter water was analysed for trace metals by Inductively Coupled Plasma – Mass Spectrometer (ICP-MS). Internal standards, such as Li, Sc, Ge, Y, In, Tb and Bi were added in the effluent sample and determined the concentrations of these elements along with other trace metals to monitor the performance of the ICP-MS instrument. International standard (NIST 1640a) was run to check the accuracy of the trace metal concentration. Calibration curve was established by running the standards of different concentrations (0.5, 1.0, 5.0, 25, 50 and 100 PPB) before the analysis of effluent samples. In most of the cases, the linear fit with a r^2 value of 0.9999 was obtained.

About 100 ml of sample was sub-sampled into a pre-sterilized bottle for bacterial analysis. All samples were collected with precautions required for microbiological analysis, analyzed in the laboratory. Sample serially diluted to 3 times of 10^{-1} to 10^{-3} with sterile salt water. Heterotrophic bacterial counts were determined using R2A agar. Around 100 μl of each serially diluted water samples are plated on R2A agar plates and spread with sterile glass rod and incubated at 37 °C for 48-72 hours. The colonies formed on the plates are counted using colony counter and represented as number of colony forming units per ml of water sample after considering dilution factor. Total coliform counts were obtained by plating water samples on MacConkey agar. The colonies formed on the plates are counted using colony counter and represented as number of colony forming units per ml of water sample after considering dilution factor. The colonies of pink-red colour and with bile precipitate are counted as ECLO on MacConkey agar plates. The colonies of colourless to pale pink are counted as EFLO on MacConkey agar plates. PALO counts were obtained by plating water samples on Cetrimide agar. The colonies exhibiting fluorescence at 250nm and a blue green pigmentation are considered as PALO. VLO counts were obtained by plating water samples on TCBS agar. The

colonies formed on the TCBS agar plates are counted as VLO. The colonies of yellow colour are counted as VCLO on TCBS agar plates. The colonies of bluish green colour are counted as VPLO on TCBS agarplates.

2. Results

2.1 Treated effluent characteristics

Treated effluent was tested for DO, BOD₅, pH, TSM and dissolved inorganic nutrients and the results were provided in Table 2.1.

S. No.	Parameter	Concentrations	CPCB standard*
1	DO (mg/l)	5.49	-
2	BOD ₃ (mg/l)	3.88	30
3	pH	7.455	6.0 – 8.5
4	Nitrate-N	0.8	-
5	Phosphate -P	1.2	5.0
6	Silicate -Si	8.4	-
7	TSM (mg/l)	77.3	100
8	Chl-a (mg/m ³)		-

*: as per Environment (Protection) Second Amendment Rules, 2021

Dissolved oxygen (DO) concentration of the treated effluent is 5.49 mg/l. BOD₃ of the effluent is 3.88 mg/l which is far below the standard limit of 30 mg/l set by CPCB. pH of the treated effluent is 7.455 and it is well within the CPCP limit of 6.0 - 8.5 (Table 2.1). Concentration of total suspended matter (TSM) is 77.3 mg/l and it is also within the limit of 100 mg/l set by CPCB. Dissolved inorganic nutrients such as nitrate and phosphate concentrations in the effluent are within the standard limits of CPCB.

Abundance (CFU/ml) of various bacterial populations in the effluent of M/s Divis Laboratories Limited is given in Table 2.2. Both ECLO (*Escherichia coli* like organism) and VCLO (*Vibrio cholerae* like organism) were not grown. Total viable count (TVC) was 1.65×10^5 CFU/ml and it is within the range of the TVC found in the coastal waters off north Andhra coast ($0.003 - 1.94 \times 10^5$ CFU/ml). Counts of VLO was found to be 130 CFU/ml in the treated effluent and it is also within the range EFLO values reported for north Andhra coastal waters in 2018 (1.0 – 295 CFU/ml). VPLO count found in the effluent (130 CFU/ml) is also considerably lower than the mean VPLO count found in the coastal waters of North Andhra Pradesh in 2018 (mean: 460 CFU/ml; range: 0-1168 CFU/ml).

Table 2.2: Abundance of various bacterial populations in the effluent of M/s Divis Laboratories Limited

Bacteria	Abundance (CFU/ml)
TVC	1.65×10^5
ECLO	NG
EFLO	19.3×10^3
VLO	1.3×10^2
VCLO	NG
VPLO	1.3×10^2

TVC	Total Viable Count
ECLO	<i>Escherichia coli</i> like organism Count
EFLO	<i>Enterococcus faecalis</i> like organism Count
VLO	<i>Vibro</i> like organism Count
VCLO	<i>Vibrio cholerae</i> like organism Count
VPLO	<i>Vibrio parahaemolyticus</i> like organism Count
NG	No Growth

2.2 Bio-assay test

Survival rate of zebra fish at various time intervals during the experiment period of 96 hours in different concentrations of treated effluent was given in Table 2.2

Effluent concentration of 0% represent the control and no mortality of zebra fish was observed in the control. The first mortality of zebra fish was observed in the effluent concentration of 50% in the last 12 hours of the experiment. In the 100% effluent concentration, the first mortality was observed in the first 6 hours of the experiment and 90% of the zebrafish were survived after the completion of the experiment (i.e., 96 hours) (Table 2.2).

Table 2.2: Survival rate (%) of zebra fish at different time periods exposed to different concentrations of effluent

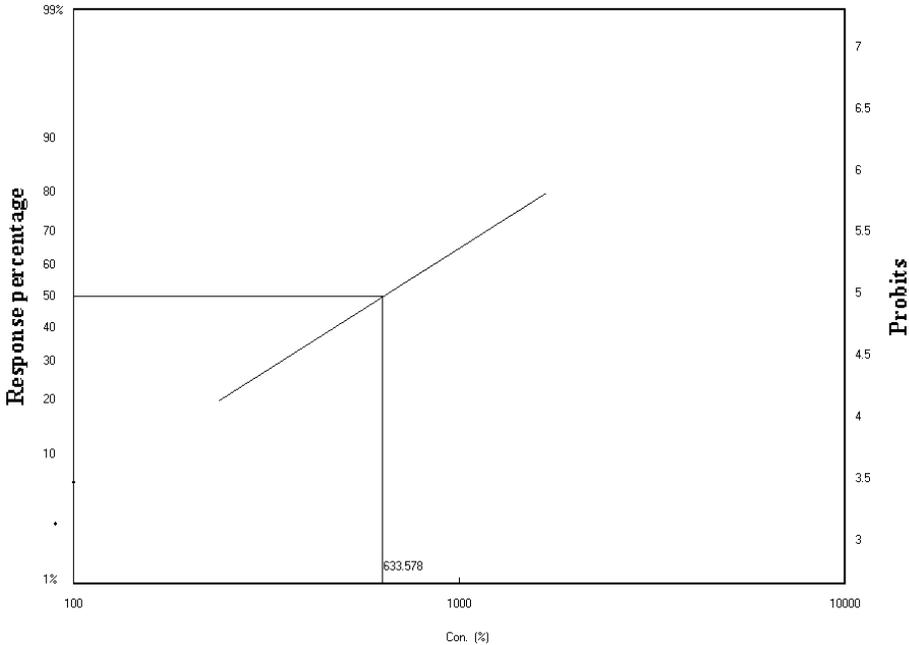
Exposure time	Effluent Concentration							
	Control	10%	20%	30%	50%	60%	90%	100%
1 hr	100	100	100	100	100	100	100	100
6 hr	100	100	100	100	100	100	96.66	96.66
12 hr	100	100	100	100	100	96.66	96.66	96.66
24 hr	100	100	100	100	100	96.66	96.66	93.33
36 hr	100	100	100	100	100	96.66	96.66	93.33
48 hr	100	100	100	100	100	96.66	93.33	93.33
60 hr	100	100	100	100	100	96.66	93.33	93.33
72 hr	100	100	100	100	100	96.66	93.33	90
84 hr	100	100	100	100	100	93.33	90	90
96 hr	100	100	100	100	96.66	93.33	90	90

Mortality rate of zebra fish (%) observed in the test concentrations of 0%, 10%, 20%, 30%, 50%, 60%, 90% and 100% during the exposure time of 24 h, 48 h, 72 h and 96 hours was given in the Table 2.3.

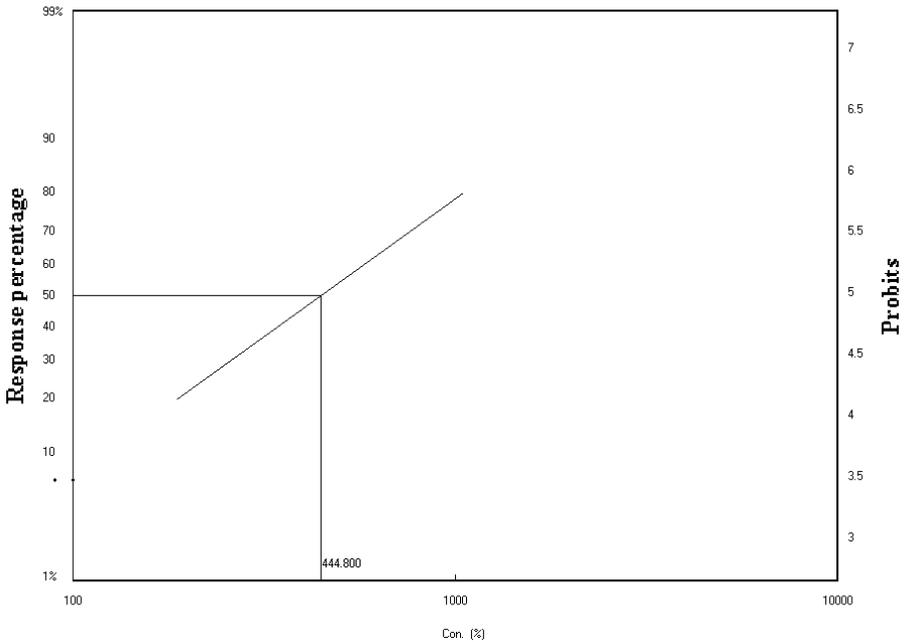
Table 2.3: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	<i>Cumulative Mortality (%) of zebra fish</i>			
	<i>Exposure periods</i>			
	24 hrs	48 hrs	72 hrs	96 hrs
Control (0%)	0	0	0	0
10%	0	0	0	0
20%	0	0	0	0
30%	0	0	0	0
50%	0	0	0	3.33
60%	3.33	3.33	3.33	6.66
90%	3.33	6.66	6.66	9.99
100%	6.66	6.66	9.99	9.99

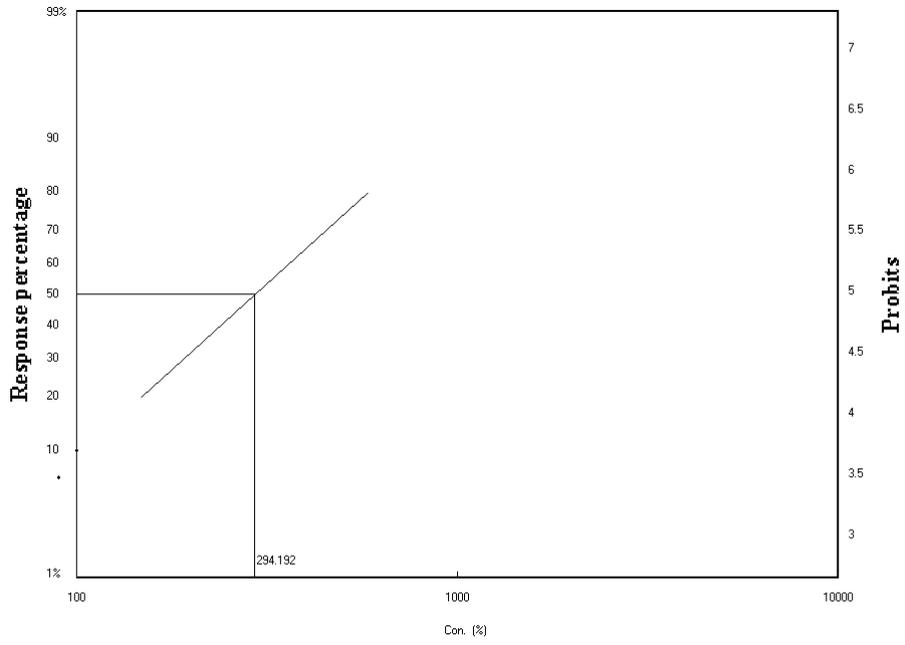
Based on the above observations, median lethal concentrations of treated effluent of 24h, 48h, 72h and 96h were calculated using LDP Line software and were given in Table 2.4.



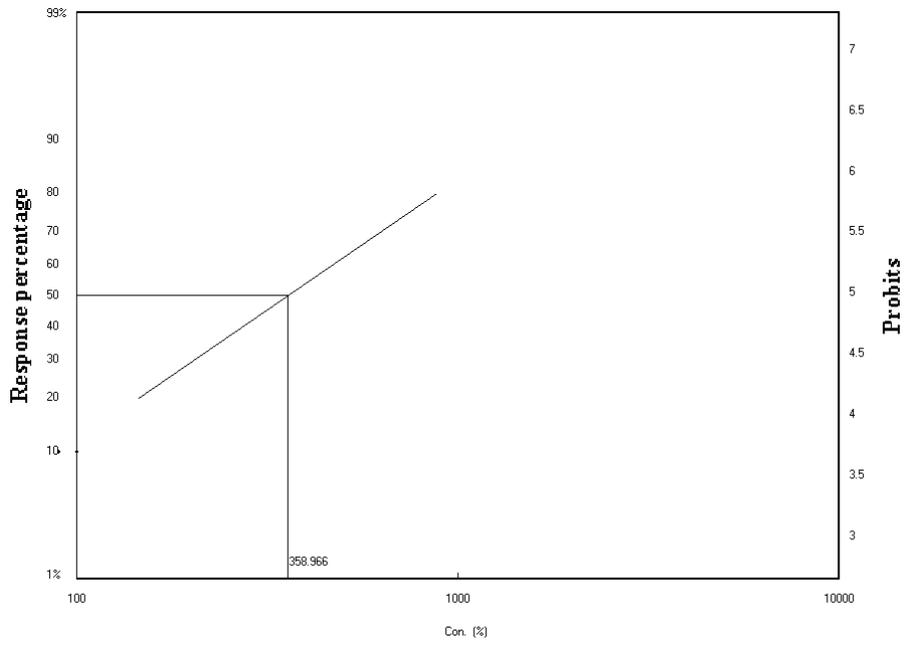
24 h



48 h



72 h



96 h

Table 2.4: Median Lethal concentrations (LC₅₀) of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Exposure time (h)	LC ₅₀ (%)	Upper limit	Lower limit
24	633.6	-	-
48	292.8	1360.5	181.6
72	294.1	1360	181.6
96	358.9	1411	211.3

2.3 Trace metals

Trace metals in the seawater are essential for biota, however, elevated concentrations of trace metals cause negative impact on the biological organisms. Further, accumulation of heavy metals in the tissues of edible fishes through biomagnification enters into humans. Hence, determination of trace (heavy) metals concentrations in the coastal waters are very important. Treated effluent release in to the sea from industries is one of the possible sources of trace metals in the coastal waters. Hence, trace metals such as vanadium (V), chromium (Cr), manganese (Mn), Iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), Arsenic (As), Selenium (Se), cadmium (Cd) and lead (Pb) were analysed by ICP-MS in the treated effluent collected from M/s Divis Laboratories Limited. Concentrations of these metals in the effluent are given in Table 2.5 and compared with the standard (maximum) limits of CPCB for these trace metals in the treated effluent for sea discharge.

Table 2.5: Trace element concentrations in the treated effluent

Element	Effluent Conc.	CPCB
	($\mu\text{g/l}$)	limit
V	9.0	200
Cr	5.5	2000
Mn	570.0	2000
Fe	80.7	3000
Co	4.1	-
Ni	22.9	2000
Cu	28.0	3000
Zn	200.7	5000
As	1.6	200
Se	14.0	50
Cd	1.0	50
Pb	6.2	100

All the elements listed above are very well within the standard limits of CPCB for effluent for sea discharge, suggesting that treated effluent release into the sea from M/s Divis Laboratories Limited may not result in any accumulation of trace elements in the coastal waters of north Andhra coast.

3. Conclusion

Treated effluent collected from the guard pond No. 9 of M/s Divis Laboratories Limited has qualified for the bio-assay test and trace metal concentrations in the effluent are very well within the limits of CPCB.



Real Time Data Acquisition And Monitoring

Site Name: Divis Laboratories Limited Unit-2

Report: Custom Report

From Date: 2022/10/20 09:00:00 To Date : 2022/10/20 15:47:38

Description	ETP-TOC_U	ETP-BOD_U	ETP-COD_U	ETP-pH_U	ETP-TSS_U	ETP-LTDS FLOW_U
Prescribed Standards	0 -	0 - 75	0 - 225	6.5 - 8.5	0 - 100	0 -
Maximum Data	32.46	27.01	81.15	7.95	14.16	214.95
Minimum Data	0.05	0.04	0.12	7.57	1.07	10.38
Geometric Mean	20.63	17.16	51.57	7.77	4.2	203.69
Median	23.04	19.17	57.6	7.8	3.95	212.74
Standard Deviation	6.96	5.79	17.4	0.11	2.35	38.35
Maximum Value At Time	2022-10-20 09:15	2022-10-20 09:15	2022-10-20 09:15	2022-10-20 15:30	2022-10-20 09:15	2022-10-20 12:00
Minimum Value At Time	2022-10-20 09:00	2022-10-20 09:00	2022-10-20 09:00	2022-10-20 10:15	2022-10-20 09:00	2022-10-20 15:45
Valid Data Points	28	28	28	28	28	28
Total Data Points	28	28	28	28	28	28
Data Availability %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

SI No	Time	ETP-TOC_U	ETP-BOD_U	ETP-COD_U	ETP-pH_U	ETP-TSS_U	ETP-LTDS FLOW_U
1	2022-10-20 09:00	0.05	0.04	0.12	7.81	1.07	194.86
2	2022-10-20 09:15	32.46	27.01	81.15	7.63	14.16	200.39
3	2022-10-20 09:30	7.60	6.32	18.99	7.64	5.57	205.88
4	2022-10-20 09:45	8.41	7.00	21.02	7.62	3.78	209.12
5	2022-10-20 10:00	9.62	8.01	24.06	7.61	2.78	211.41
6	2022-10-20 10:15	16.88	14.05	42.22	7.57	2.35	212.49
7	2022-10-20 10:30	27.78	23.11	69.45	7.59	2.12	213.28
8	2022-10-20 10:45	25.29	21.04	63.22	7.62	2.06	214.30
9	2022-10-20 11:00	21.55	17.93	53.87	7.67	2.35	213.40
10	2022-10-20 11:15	21.83	18.16	54.57	7.70	2.79	214.25
11	2022-10-20 11:30	22.25	18.51	55.62	7.73	3.08	214.34
12	2022-10-20 11:45	22.59	18.80	56.48	7.76	3.34	214.67
13	2022-10-20 12:00	23.11	19.23	57.77	7.77	3.51	214.95
14	2022-10-20 12:15	22.99	19.13	57.46	7.79	3.72	214.66
15	2022-10-20 12:30	22.80	18.97	56.99	7.79	3.83	214.77
16	2022-10-20 12:45	22.96	19.10	57.38	7.80	4.07	214.48
17	2022-10-20 13:00	23.19	19.29	57.97	7.81	4.14	214.15
18	2022-10-20 13:15	23.16	19.27	57.89	7.82	4.26	213.74
19	2022-10-20 13:30	23.11	19.23	57.77	7.83	4.31	213.29
20	2022-10-20 13:45	23.64	19.67	59.09	7.83	4.34	212.97
21	2022-10-20 14:00	24.28	20.20	60.70	7.85	4.41	212.52
22	2022-10-20 14:15	24.18	20.12	60.45	7.85	4.58	212.14
23	2022-10-20 14:30	24.03	20.00	60.09	7.87	4.90	211.84
24	2022-10-20 14:45	23.94	19.92	59.86	7.89	5.20	211.36
25	2022-10-20 15:00	23.81	19.81	59.53	7.91	5.37	210.45

SI No	Time	ETP-TOC_U	ETP-BOD_U	ETP-COD_U	ETP-pH_U	ETP-TSS_U	ETP-LTDS FLOW_U
26	2022-10-20 15:15	23.09	19.21	57.73	7.93	5.26	212.51
27	2022-10-20 15:30	22.02	18.32	55.04	7.95	7.31	190.71
28	2022-10-20 15:45	11.01	9.16	27.52	7.94	2.81	10.38

Report Details: Divis | 2022-10-20 15:48:32 | Custom Report



ANDHRA PRADESH POLLUTION CONTROL BOARD
 D. No. 33-26-14 D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
 Chalamalavari Street, Kasturibaipet, Vijayawada – 520 010
 Website: www.pcb.ap.gov.in

Lr.No. CRZ/Legal/NGT-829 of 2019/2019 366

23.11.2020

To
 ✓ The Chairman,
 Central Pollution Control Board,
 Parivesh Bhawan, East Arjun Nagar,
Delhi - 110032.

Sir,

Sub: APPCB - CRZ - Hon'ble NGT (Principal Bench), New Delhi order dated 21.09.2020 in O.A. No. 829/2019 - Action Plan - Submitted - Reg.

Ref: 1. CPCB directions dated: 31.08.2020
 2. Hon'ble NGT, New Delhi Order dated 21.09.2020 in O.A.No.829 of 2019 in the matter of Lt. Col. Sarvadaman Singh Oberoi vs Union of India & Ors

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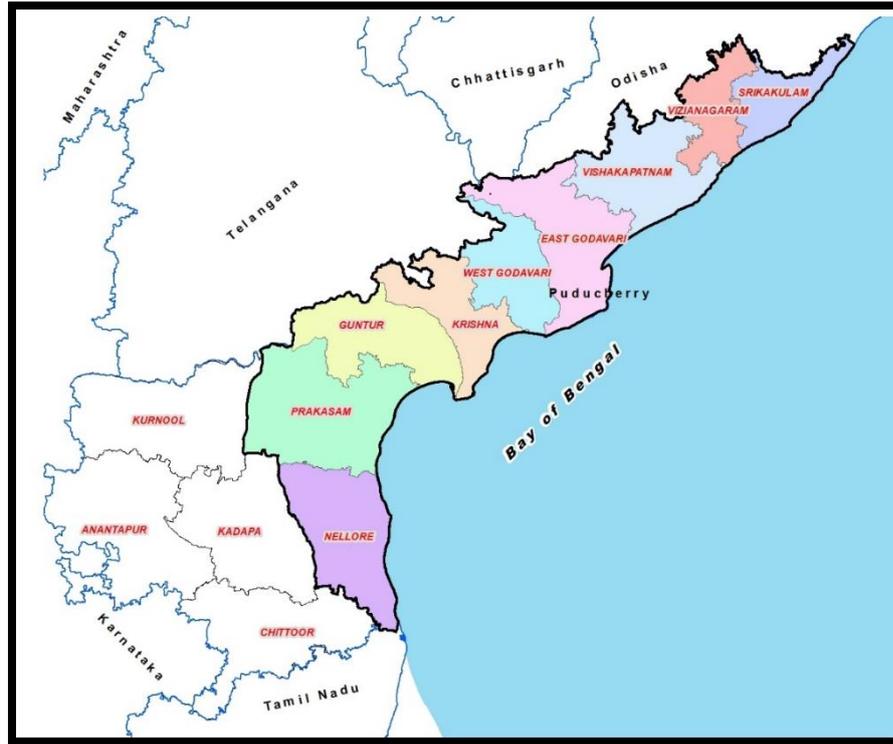
This has references to the above, the Action Plan for the Control of Coastal Pollution for the State of Andhra Pradesh in compliance to Hon'ble NGT order dated 21.09.2020 in O.A. NO. 829 of 2019 in the matter of Lt. Col. Sarvadaman Singh Oberoi vs Union of India & Ors, is herewith enclosed for information and necessary action.

Yours faithfully,

Encl: As above


MEMBER SECRETARY

**ACTION PLAN
for
Control of Coastal Pollution
of
Andhra Pradesh (Srikakulam to Nellore)**



**Report in compliance of orders of the Hon'ble National Green Tribunal
(O.A.No.829 of 2019 Order dated: 21.09.2020)**

**Submitted to:
Central Pollution Control Board, New Delhi**



**ANDHRA PRADESH POLLUTION CONTROL BOARD
VIJYAWADA, A.P.**

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ABBREVIATIONS

S. No.	Acronym	Abbreviation
1	CPCB	Central Pollution Control Board
2	IDA	Industrial Development Area
3	MA&UD	Municipal Administration and Urban Development Department
4	NGT	National Green Tribunal
5	CRC	Coastal Rejuvenation Committee
6	SPCB	State Pollution Control Board
7	APPCB	Andhra Pradesh State Pollution Control Board
8	UTs	Union Territories
9	GVMC	Greater Visakhapatnam Municipal Corporation
10	NCCR	National Centre for Coastal Research

S. No.	Acronym	Abbreviation
1	BOD	Bio-chemical Oxygen Demand
2	COD	Chemical oxygen demand
3	DO	Dissolved oxygen
4	ETP	Effluent Treatment Plant
5	KLD	Kilo Liters per Day
6	LPCD	Liters per capita per day
7	MLD	Million Liters per day
8	MSW	Municipal Solid Waste
9	OCEMS	Online continuous effluent monitoring system
10	STP	Sewage Treatment Plant
11	TPD	Tons Per Day
12	TDS	Total Dissolved Solids
13	TOC	Total organic carbon
14	TSS	Total suspended solids
15	TSDF	Treatment storage and disposal facility
16	ULB	Urban Local Body
17	ZLD	Zero Liquid Discharge
18	MRF	Material Recovery Facility
19	CBWTF	Common Bio-medical Waste Treatment Facility
20	C&D Waste	Construction & Demolition Waste
21	E-Waste	Electronic Waste
22	MTA	Metric Tons per Annum
23	SLF	Scientific Land Facility
24	SL	Sample Location

1. Executive Summary

Information on "Municipal Sewage, Industrial effluent and Waste Management scenario in Coastal Areas"

in compliance to Hon'ble NGT order passed in O.A. No. 829 of 2019

Table 1.1

Sl.No.	Contents		
1	Basic Information		
	Name of the SPCB/PCC	:	Andhra Pradesh Pollution Control Board, Vijayawada
2	Categorization of Coastal Areas in the State/UT (Please indicate location-wise relevant category indicated below)		
	Coastal area location		9 Districts are located in Coastal Area covering a length of 975 KMs Coastal Line.
(i)	SW-I (Salt Pans, Shell Fishing, Māriculture and Ecologically Sensitive Zone)		
	Salt Pans	:	i. Naupada Village, Santhabommali Mandal & Bhavanapadu Village, Vajrapukotturu Mandal in Srikakulam District; ii. Machilipatnam in Krishna District; iii. Kothapalem, Repalle Mandal in Guntur; iv. Kothapatnam area & China Ganjam Village in Prakasam District; v. Iskapalli Village, Alur Mandal in Nellore District, Andhra Pradesh
	Ecologically Sensitive Zone	:	i. Krishna Wildlife Sanctuary in Krishna & Guntur Districts; ii. Coringa Wildlife Santuary, Kakinada, East Godavari District; 3. Pulicat Lake Bird Sanctuary in Nellore District, Andhra Pradesh.
(ii)	SW-II (Bathing, Contact Water Sports and Commercial Fishing)		
	Bathing	:	i. Visakhapatnam, Visakhapatnam District ii. Rajamahendravaram, East Godavari

			District, Andhra Pradesh.
		:	<p>i. Bandaruvanipeta, Budagatlapalem, Bhavanapadu, Kalingapatnam in Srikakulam District;</p> <p>ii. Visakhapatnam Urban, Pudimaka in Visakhapatnam District;</p> <p>iii. Kakinada in East Godavari District;</p> <p>iv. Biyyaputippa in West Godavari District;</p> <p>v. Machilipatnam in Krishna District;</p> <p>vi. Nizampatnam in Guntur District;</p> <p>vii. Kothapatnam, Vodarevu, Ramayapattanam in Prakasam District and</p> <p>viii. Krishnapatnama Port area in Nellore District, Andhra Pradesh.</p>
(iii)	SW-III (Industrial cooling, Recreation (non-contact and Aesthetics))		
	Industrial Cooling	:	<p>i. Parawada, Simhadri, Visakhapatnam, Visakhapatnam District;</p> <p>ii. Nelatur & Pynampuram Villages, Painapuram Village, Muthukur Mandal; Vakarlapudi & Sivarampuram Villages, Muthukur Mandal and Tamminapatnam & Mommidi Villages, Chilakur Mandal, SPSR Nellore District, Andhra Pradesh.</p>
	Recreation (non-cont) and Aesthetics	:	<p>i. Visakhapatnam, Visakhapatnam District;</p> <p>ii. Suryalanka beach, Bapatla, Guntur District;</p> <p>iii. Chirala, Prakasam District, Andhra Pradesh.</p>
(iv)	SW-IV (Harbour)	:	<p>i. Visakhapatnam & Gannavaram in Visakhapatnam District;</p> <p>ii. Kakinada in East Godavari District;</p> <p>iii. Machilipatnam, Krishna District;</p> <p>iv. Krishnapatnam Port, SPSR Nellore District, Andhra Pradesh</p>
(v)	SW-V (Navigation and Controlled Waste Disposal)	:	NIL

3	Major cities/ Towns located in Coastal Areas in the State/UT	
(i)	Major Cities/Towns located in Coastal Areas	i. Visakhapatnam, Visakhapatnam District; ii. Kakinada, East Godavari District; iii. Chirala in Prakasam District; Andhra Pradesh
(ii)	Major Drains outfall into Creeks/ Estuaries/ Sea Water and their total numbers	: 31 Nos. i. Creeks in Tekkali, Kuppili, Balarampuram, Komaravanipeta, Pukkalapeta and Donkaluru in Srikakulam District; (6 Nos.) ii. Major Drains - 13 Nos. in Visakhapatnam, Visakhapatnam District; iii. Teki Drain & Tulya bhaga drain in East Godavari District; (2 Nos.) iv. Yenamadurru Drain, Gonteru & Uppeteru (3 No.) in West Godavari District; v. Gunderu drain, Sivaganga drain, Lazzabanda drain, Pedalanka drain & Thalapalem drain in Krishna District; (5 Nos.) vi. Nallamada drain in Guntur District; vii. Kunderu drain in Prakasam District, Andhra Pradesh.
4	Status of Sewage Generation, its Treatment and Disposal in Coastal Areas	
(i)	Total Sewage Generation in Coastal Areas in the State/UT (in MLD)	: 249.72 MLD i. 204 MLD: ULBs - Greater Visakhapatnam Municipal Corporation (GVMC) in Visakhapatnam District; ii. 36 MLD: Kakinada Municipal Corporation in East Godavari District; iii. 9.72 MLD: Chirala Municipality in Prakasam District;
(ii)	Total No. of STPs in Coastal Areas	: 18 Nos (18 Nos in GVMC in Visakhapatnam District)
(iii)	Total Installed Capacity of STPs (in MLD)	: 177.0 MLD

(iv)	Actual total sewage treated in STPs at present (in MLD)	:	100.95 MLD
(v)	Gap in Sewage Treatment in coastal areas (in MLD)	:	72.72 MLD (249.72 MLD - 177.0 MLD)
(vi)	No. of STPs presently under construction to meet the gap in Sewage treatment in Coastal areas in the State/UT	:	3 Nos. i. 2 Nos at GVMC in Visakhapatnam District of Capacities - 2.0 MLD & 46.0 MLD; ii. 1 Nos at Kakinada in East Godavari District of capacity - 5.0 MLD;
(viii)	Quantity of untreated sewage discharged into Coastal water (in MLD)	:	148.77 MLD (i. 103.05 MLD GVMC in Visakhapatnam District; (ii. 36 MLD Kakinada Municipal Corporation in East Godavari District; (iii. 9.72 MLD: Chirala Municipality in Prakasam District)
(ix)	Quantity of treated sewage discharged into Coastal water (in MLD)	:	60.95 MLD (Out of 100.95 MLD, 40.0 MLD is utilized in watering the Green Belt, dust suppression and wetting operations). 5.0 MLD - Port Trust for dust suppression. 10.0 MLD - Golf Court for wetting. 25.00 MLD - Watering for green belt/plantation by GVMC. An MOU is entered between GVMC & Industries (M/s. HPCL & M/s. RIL) for utilization of treated sewage water of 75.0 MLD.
5.	Status of industries in coastal areas		
(i)	Total No. of industries located in Coastal areas	:	165 Nos. (3 Nos. - Srikakulam District; 3 Nos. - Vizianagaram District; 13 Nos. - Visakhapatnam District; 83 Nos. - East Godavari District (out of 83 Nos., 60 Nos. are Prawn Seed Hatcheries Processing units); 12 Nos. - Guntur District (Prawn Hatcheries only);

		<p>58 Nos. - Prakasam District (out of 58 Nos., 52 Nos. are small scale dyeing units, 3 Nos. Prawn Processing); 5 Nos. - SPSR Nellore District)</p> <p>Note: In Visakhapatnam District,</p> <ol style="list-style-type: none"> i. M/s. Ramky Pharmacity (India) Ltd., has been issued single consent with single discharge point which houses 86 Nos of Industries. ii. M/s. Hetero Infrastructure SEZ Ltd., has been issued single consent with single discharge point which houses 4 Nos of industries. iii. M/s. Brandix India Apparel City Pvt. Ltd., APSEZ has been issued single consent with single discharge point which housed 14 Nos of industries. iv. Atchutapuram SEZ has been issued single consent with single discharge point which houses 22 Nos of industries. <p>** Earlier the total industries in the District were communicated instead of the industries near to the Coastal areas.</p>	
(ii)	Category wise No. of industries	:	
	(a) Total No. of 17 Category Highly Polluting Industries	:	<p>25 Nos. (3 Nos. - Srikakulam District; 2 Nos. - Vizianagaram District; 12 Nos. - Visakhapatnam District; 3 Nos. - East Godavari District; 5 Nos. - SPSR Nellore District ;)</p> <p>Note: In Visakhapatnam District,</p> <ol style="list-style-type: none"> i. M/s. Ramky Pharmacity (India) Ltd., has been issued single consent with single discharge point which houses 86 Nos of Industries. ii. M/s. Hetero Infrastructure SEZ Ltd., has been issued single consent with single discharge point which

			<p>houses 4 Nos of industries.</p> <p>iii. Atchutapuram SEZ has been issued single consent with single discharge point which houses 22 Nos of industries.</p> <p>** Earlier the total industries in the District were communicated instead of the industries near to the Coastal areas.</p>
	(b) Total No. of Grossly Polluting Industries	:	Nil
6.	Status on Industrial Effluent Generation and CETPs in Coastal Areas		
(i)	Total industrial effluent generated by industries (in MLD)	:	<p>2764.62 MLD (Out of this, once through cooling water is 2481.33 MLD).</p> <p>(0.9 MLD - Srikakulam District; 1.3145 MLD - Vizianagaram District; 2725.37 MLD - Visakhapatnam District*; 15.35 MLD - East Godavari District; 1.694 MLD - Prakasam District; 20 MLD - Nellore District **)</p> <p>*2461.33 MLD once through cooling which is discharged into the sea.</p> <p>**20 MLD once through cooling which is discharged into the sea.</p> <p>The total industrial effluent generation is 283.29 MLD excluding once through cooling.</p>
(ii)	Total No. of industries having captive ETPs	:	<p>53 Nos.</p> <p>(3 Nos. - Srikakulam District; 3 Nos. - Vizianagaram District; 12 Nos. - Visakhapatnam District; 23 Nos. - East Godavari District; 12 Nos. - Prakasam District;)</p>
(iii)	Total No. of Captive ETPs operating by industries complying with discharge norms	:	<p>53 Nos.</p> <p>(3 Nos. - Srikakulam District; 3 Nos. - Vizianagaram District; 12 Nos. - Visakhapatnam District; 23 Nos. - East Godavari District; 12 Nos. - Prakasam District;)</p>

(iv)	Total treated effluent discharged in Coastal areas (in MLD)	:	<p>2756.97 MLD (Out of this, once through cooling water is 2481.33 MLD).</p> <p>(0.9 MLD - Srikakulam District; 1.3145 MLD - Vizianagaram District; 2725.37 MLD - Visakhapatnam District*; 7.7 MLD - East Godavari District; 1.694 MLD - Prakasam District; 20 MLD - Nellore District **)</p> <p>*2461.33 MLD once through cooling which is discharged into the sea.</p> <p>**20 MLD once through cooling which is discharged into the sea.</p> <p>***However 7.65 MLD (2764.62 MLD - 2756.97 MLD) is treated in ZLD system by the industries in Kakinada, East Godavari District.</p>
(v)	No. of CETPs located in the Coastal areas	:	3 Nos.
	(a) Location wise CETPs with installed capacity (in MLD)	:	<p>1) Parwada, Visakhapatnam, Andhra Pradesh (5 MLD - LTDs 3.5 MLD & HTDS-1.5 MLD).</p> <p>2) M/s Brandix India Apparel City Pvt. Ltd, APSEZ, Atchuthapuram (M), Visakhapatnam., Andhra Pradesh (20 MLD).</p> <p>3) M/s. Atchutapuram Effluent Treatment plant (1.5 MLD).</p>
	(b) No. of industries having membership of CETPs	:	126 Nos. (126 Nos. - CETPs, Visakhapatnam)
(vi)	Gap in industrial effluent treatment in coastal areas (in MLD)	:	Nil
(vii)	Total untreated industrial effluent discharged in Coastal water (in MLD)	:	No untreated industrial effluent is discharged into the Coastal Waters.

7. Waste management scenario in coastal areas		
S. No.	Type of Waste	Quantity of waste generation (MTA) in the State
(i)	Hazardous waste	3,09,560.8752 MTA The generated waste by the industries is disposed to TSDFs (2 Nos.) which is authorized by APPCB.
(ii)	Bio-medical waste	1,432.718 MTA The generated waste by the HCEs is disposed to CBWTFs (9 Nos.) which is authorized by APPCB.
(iii)	Municipal solid waste	5,66,780 MTA The generated waste by the ULBs is disposed through material recovery facilities, waste to energy plants and SLFs, which are authorized by the APPCB.
(iv)	Plastic waste	21,553.75 MTA The generated waste by the ULBs is utilized for road construction, disposed to material recovery facility, registered recyclers and cement plants, which are authorized by the APPCB.
(v)	e-waste	0.075 MTA The generated waste from the ULBs is disposed to authorized e-waste processing units 3 nos.
(vi)	C&D waste	40,432 MTA The C&D waste generated is collected through waste call centres and collection centres and disposed through authorized C&D waste processing facilities.
* No Solid Waste is disposed into the Coastal Waters. All the wastes are disposed into the Common Waste treatment Facilities.		

9.	Water Quality of Coastal waters (From 2010 - 11 to 2019-20)& Summary		
(i)	No. of water quality monitoring stations	:	40 Stations
(a)	CPCB	:	12 Nos.
(b)	SPCB	:	28 Nos.
<p>The Water Quality Analysis of the Coastal Waters results reveals that all the 40 monitored locations are complying with the primary water quality criteria for SW-IV norms notified under Environment Protection rules 1986 except for the parameters pertaining to DO, pH & BOD at the locations of the sea waters is complying to the marine primary water quality criteria SW-IV parameters at some of the sample locations in Visakhapatnam & East Godavari Districts.</p> <p>At present the MA&UD; Government of A.P has started construction of STPs: 2 Nos. at GVMC Visakhapatnam with capacities 2.0 MLD & 46.0 MLD and 1 No. at Kakinada, East Godavari with a capacity of 5.0 MLD STPs. The STPs will be commissioned by December 2021.</p>			

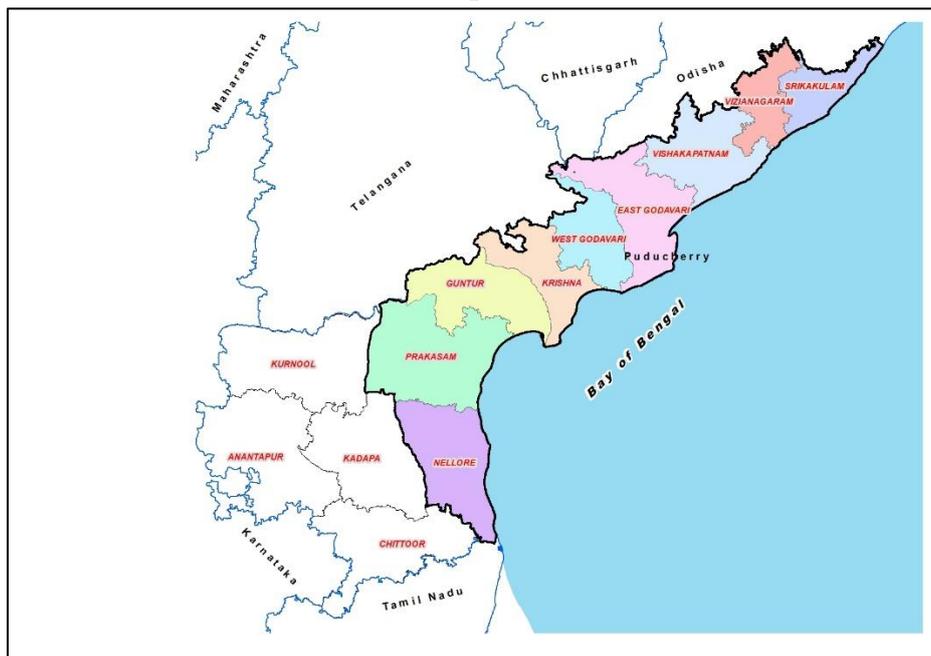
2.0 Preamble

In the State of Andhra Pradesh, 9 Districts are having coastal line covering a distance of 975 Kms., starting from Srikakulam to Nellore. The details of coast line stretches and the latitude and longitudes of the District coast line is as detailed below:

Table 2.1

Sl. No	District	Length of the Coast Line (Kms.)	From		To	
			Latitude	Longitude	Latitude	Longitude
1	Srikakulam	163	19° 4' 37.901" N	84° 45'54.277" E	18° 4' 41.846" N	83° 39' 50.461" E
2	Vizianagaram	21	18° 4' 41.846" N	83° 39' 50.461" E	17° 56' 51.440" N	83° 31' 29.971" E
3	Vishakapatnam	141	17° 56' 51.440" N	83° 31' 29.971" E	17°14' 54.641" N	82° 32' 28.901" E
4	East Godavari	173	17° 14' 54.641" N	82° 32' 28.901" E	16° 19' 0.784" N	81° 42' 47.617" E
5	West Godavari	17	16° 19' 0.784" N	81° 42' 47.617" E	16° 20' 49.518" N	81° 33' 31.608" E
6	Krishna	125	16° 20' 49.518" N	81° 33' 31.608" E	15° 42' 25.267" N	80°50' 0.582" E
7	Guntur	72	15° 42' 25.267" N	80° 50' 0.582" E	15° 47' 50.796" N	80° 25' 2.704" E
8	Prakasam	100	15° 47' 50.796" N	80° 25' 2.704" E	15° 0' 23.438" N	80° 3' 14.326" E
9	Nellore	164	15° 0' 23.438" N	80° 3' 14.326" E	13° 33' 52.071" N	80° 16' 7.249" E
		975				

Map 2.1
AP Coastal Map (Not to Scale)



The present action plan has been prepared in compliance to the directions given by Hon'ble NGT in O.A.No.829 of 2019 for taking remedial action for rejuvenation of Coastal Water Stretches in Andhra Pradesh.

3.0 Hon'ble NGT Directions in O.A.No.829 of 2019

Hon'ble NGT, while referring to the observations of the Hon'ble Supreme Court in Indian Council for Enviro Legal Actions V/s UOI (Union of India), (1996) 3 SCC 2012 that degradation of coastal areas was a matter of serious concern and effected aesthetic and Environment which required Environmental Management Plans to ensure that coastal water remains fit for Human and Aquatic Life, and issued the following directions to the 13 coastal State Pollution Control Board / Pollution Control Committees to comply with:

- i. Ensure proper treatment and disposal of industrial effluent generated from water polluting industries located in the coastal State / UTs by ensuring installation of captive ETPs or disposal of industrial effluent through CETPs by prescribing PETS Standards under consent mechanism and for safe disposal or utilization of treated effluents in accordance with the disposal modes permitted under Environment (Protection) Act, 1986.
- ii. Ensure proper treatment and disposal of industrial hazardous waste generated from hazardous waste generating industries located in the coastal States / UTs and to ensure requisite infrastructure for environmentally sound management of generated hazardous waste in accordance with the Hazardous and Other Waste (Management & Transboundary Movement) Rules, 2016 as amended notified under the Environment (Protection) Act, 1986.
- iii. Associate with National Center for Coastal Research (NCCR), Chennai under Ministry of Earth Sciences for monitoring and assessment of coastal waters within the jurisdiction of the coastal States / UTs up to 5 Km from shore and to evolve strategies for protection of the coastal areas in association with Coastal Zone Management Authority in the State.
- iv. Prepare time bound comprehensive action plans along with implementing agencies in consultation with the respective Coastal Zone Management Authority for Control of Coastal Pollution in the States / UTs, and submit to CPCB within three months from the date of issuance of these directions i.e. by 25th November 2020.

4.0 CPCB Directions:

Central Pollution Control Board issued directions under section 18 (1) (B) of the water (Prevention and Control of Pollution) Act, 1986 in the matter of control of Marine Pollution in Coastal States / UTs, vide F. No. 14011 (O. A. No. 829) / 1/WQM-I/2020-5562, dated 31.08.2020. The directions are:

- a) Directions under Section 33 of water (Prevention of Control of Pollution) Act 1974, shall be issued to all the concerned Local Bodies / Urban Bodies / Municipalities / Authorities in the Coastal areas of Andhra Pradesh within 15 days from the date of issuance of these directions:
 - i. To set up for sewage collection, convince treatment and its disposal to cover the entire local / urban / coastal area within the respective jurisdiction.
 - ii. To develop adequate capacity of sewage treatment using convention STPs or other technology and ensue to comply with the discharge norms as prescribed by the Andhra Pradesh SPCB under consent mechanism prescribed under Water Act, 1974.
 - iii. For ensuring treatment and use of treated sewage for non-portable purposes such as industrial process Railways & Bus cleaning flushing of toilets through dual piping, construction activities, horticulture and irrigation etc.
 - iv. To set up requisite facilities for collection, transportation, treatment and disposal of Municipal Solid Waste, Plastic Waste, Construction and Demolition Waste generated as well as bio-mining of the existing legacy dumpsites in accordance with the Solid Waste Management Rules, 2016, Plastic Waste Management Rules, 2016 and Construction & Demolition Waste Management Rules, 2016 as amended respectively, notified under the Environment (Protection) Act, 1986, in the coastal areas within the respective jurisdiction of the State / UT.
 - v. For periodic cleaning and removal of plastic waste/solid waste in coastal areas to prevent marine pollution and for ensuring its safe disposal in accordance with the provisions notified under the Environment (Protection) Act, 1986.
 - vi. To submit a time bound action plan for management of sewage, municipal solid waste, plastic waste, C & D waste generated in the respective jurisdiction of the local / urban bodies in coastal areas as mentioned in afore-said paras, within a period of two months from the date of issuance of these directions.

- b) That Andhra Pradesh Pollution Control Board (APPCB) shall
- i. Ensure proper treatment and disposal of industrial effluent generated from water polluting industries located in the coastal areas of the Andhra Pradesh State by ensuring installation of captive ETPs or disposal of industrial effluent through CETPs by prescribing PETP Standards under consent mechanism and for safe disposal or utilization of treated effluents in accordance with the disposal modes permitted under Environment (Protection) Act, 1986.
 - ii. Ensure proper treatment and disposal of industrial hazardous waste generated from hazardous waste generating industries located in the coastal areas of the Andhra Pradesh State and to ensure requisite infrastructure for environmentally sound management of generated hazardous waste in accordance with the Hazardous and Other Waste (Management & Transboundary Movement) Rules, 2016 as amended notified under the Environment (Protection) Act, 1986.
 - iii. Associate with National Center for Coastal Research (NCCR), Chennai under Ministry of Earth Sciences for monitoring and assessment of coastal waters within the jurisdiction of the Andhra Pradesh up to 5 km from shore and to evolve strategies for protection of the coastal areas in association with Coastal Zone Management Authority in the State.
 - iv. Prepare time bound comprehensive action plans along with implementing agencies in consultation with Andhra Pradesh State Coastal Zone Management Authority for control of coastal Pollution and Andhra Pradesh, State, and submit to CPCB within three months from the date of issuance of these directions i.e. by 25 November 2020.

5.0 Action Plan:

The Coastal Areas of Andhra Pradesh has been classified into four zones such as SW- 1 (Salt Pas, Shell Fishing, Mariculture and Ecologically Sensitive Zone), SW-11 (Bathing, Contact Water Sports and Commercial Fishing), SW-III (Industrial Cooling, Recreation) and SW-IV (Harbour). There are 3 major towns/cities present in the coastal areas of AP State and about 30 major drains outfall into Creek/Estuaries/Sea Water of Indian Ocean. Major industries located are Iron & Steel; Petro Chemical; Port activity; Fertilizers, Thermal Power Plants & Bulk Drug units etc.

The Hon'ble NGT in Original Application No. 829/2019, dated 21.09.2020 while disposing the case ordered the States to submit comprehensive action plan along with implementation agencies for the control of coastal pollution. In compliance to the orders of the Hon'ble NGT the action plan for the control of coastal pollution is as below:

The components of the action plan are

- Sewage Management
- **Industrial Effluent Management**
- Waste management

5.1 Status of Sewage Management Scenario in AP Coastal Areas

In Andhra Pradesh coastal areas, total sewage generation is 249.72 MLD (i.e. 204 MLD Greater Visakhapatnam Municipal Corporation (GVMC) in Visakhapatnam District, Kakinada Municipal Corporation-36 MLD; Chirala Municipality, Prakasam District - 9.72 MLD). In total 18 STPs are existing in GVMC, Visakhapatnam, with an installed capacity of 177.0 MLD. The total sewage treated in 18 STPs is about 100.95 MLD and the gap in sewage treatment in coastal areas of AP is 148.77 MLD.

At present the MA&UD; Government of A.P has started construction of STPs: 2 Nos. at GVMC Visakhapatnam with capacities 2.0 MLD & 46.0 MLD and 1 No. at Kakinada, East Godavari with a capacity of 5.0 MLD STPs. The STPs will be commissioned by December 2021.

The APPCB will pursue with the MA&UD, Govt. of A.P for further facilities based on the gaps.

5.2 Status on Industrial Effluent Management Scenario in Coastal Areas

5.2.1 Total Industries:

There are 165 industries located in the coastal areas of Andhra Pradesh i.e. Srikakulam District (3), Vizianagaram District (3), Vishakhapatnam District (13); East Godavari District (83), Prakasam District (58), SPSR Nellore District (5).

In Visakhapatnam District, 86 Nos. of industries are located in M/s. Ramky Pharmacity (India) Ltd., 4 Nos. of industries in M/s. Hetero Infrastructure SEZ Ltd., 14 Nos. of industries in M/s. Brandix India Apparel City Pvt. Ltd, APSEZ, 22 Nos. of industries in M/s. Atchutapuram SEZ, which are issued with single consent with single discharge point. In East Godavari District, out of 83 Nos., 60 Nos. are Prawn Seed Hatcheries units; in Guntur District all 12 Nos. are Prawn Hatcheries; in Prakasam District, out of 58 Nos., 52 Nos. are small scale dyeing units, 3 Nos. Prawn Processing;

Earlier the total industries in the entire Districts were communicated instead of the industries located near to the Coastal areas.

5.2.2 17 Category Industries:

There are 25 numbers of 17 categories highly polluting industries present in the coastal areas (i.e. Srikakulam District-3 nos.; Vizianagaram District-2 nos.; Visakhapatnam District-12 nos.; East Godavari District-3 nos.; SPSR Nellore District-5 nos).

In Visakhapatnam District, 86 Nos. of industries are located in M/s. Ramky Pharmacity (India) Ltd., 4 Nos. of industries in M/s. Hetero Infrastructure SEZ Ltd., 22 Nos. of industries in M/s. Atchutapuram SEZ, which are issued with single consent with single discharge point.

Earlier the total industries in the entire Districts were communicated instead of the industries located near to the Coastal areas.

5.2.3 Total Industrial Effluent Generation:

Total industrial effluent generated by the industries is about 2764.62 MLD (i.e. Srikakulam district- 0.90 MLD; Vizianagaram district- 1.3145 MLD, Visakhapatnam District- 2725.37 MLD; East Godavari District- 15.35 MLD; Prakasam District-1.694 MLD; SPSR Nellore District-20 MLD).

Out of 2764.62 MLD, 2481.33 MLD of effluent is once through cooling waste water (Visakhapatnam District - 2461.33 MLD and 20 MLD - Nellore District) and **industrial effluent is only 283.29 MLD.**

In total 53 Nos. of industries are having captive ETPs, complying to the effluent discharge norms (i.e. Srikakulam District-3 nos.; Vizianagaram District-3 nos.; Visakhapatnam District -12 nos; East Godavari District-23 nos.; Prakasam District - 12 Nos.).

There are 3 CETPs having installed capacity of 25.07 MLD i.e. CETP at Parawada, Visakhapatnam, Andhra Pradesh (5 MLD - LTDs 3.5 MLD & HTDS-1.5 MLD), CETP at M/s Brandix India Apparel City Pvt. Ltd, APSEZ, Atchuthapuram (M), Visakhapatnam, Andhra Pradesh (20 MLD), CETP at M/s. Atchutapuram SEZ (1.5 MLD), Visakhapatnam, Andhra Pradesh About 169 industries are having membership of 3 CETPs.

5.2.4 Treated effluent disposal into sea:

The APPCB is regularly monitoring the treated effluent disposal into sea by the industries and CETPs. The industries and CETPs are permitted to discharge the treated effluent through marine out fall in the sea in the presence of APPCB officials only after the effluents are meeting the discharge standards. Total treated effluent discharged in coastal areas is about 2756.97 MLD including once through cooling water of 2481.33 MLD (i.e. Srikakulam district- 0.90 MLD; Vizianagaram district-1.3145 MLD, Visakhapatnam District- 2725.37 MLD; East Godavari District- 7.7 MLD; Prakasam District-1.694 MLD; SPSR Nellore District-20 MLD).

Total industrial effluent generated by the industries is about 2764.62 MLD including once through cooling of 2481 MLD. The Total treated effluent discharged in coastal areas is about 2756.97 MLD. Effluent of 7.65 MLD is disposed of by adopting ZLD system. **Hence, no untreated industrial effluent is discharged into the Coastal Waters.**

The APPCB will continue the monitoring of the industrial effluent discharge into the sea waters and ensure that, the untreated industrial effluents are not permitted to discharge into the sea through regular vigilance.

5.3 Waste Management scenario in coastal areas of Andhra Pradesh:

5.3.1 **Hazardous waste** is generated is about 3, 09,560.8752 MTA. The waste is disposed to 02 Nos. of Hazardous Waste Treatment Storage and Disposal Facilities (TSDFs) authorized by APPCB [viz., 1) M/s. Coastal Waste Management Project, (A division of M/s. Ramky Enviro Engineers Ltd.,) at JN Pharma City, Parawada, Visakhapatnam, Andhra Pradesh. (9,50,000 MT); 2) M/s. Coastal Waste Management Project (CWMP), Unit 2 (A Division of Mumbai Waste Management Limited), Raviguntapalli village, Rapur Mandal, Nellore District, Andhra Pradesh (95,000 MT).

5.3.2 **Bio-medical Waste** generated is 1,432.718 MTA and is disposed off through 9 Common Bio-medical Waste Treatment Facilities (CBWTFs) authorized by APPCB.

Common Bi-medical Waste Treatment Facilities in Coastal Districts Andhra Pradesh

Table 5.1

S. No.	District	Name & Address of CBWTF
1	Srikakulam	M/s. Rainbow Industries, Sy.No. 21/1, Pathakunkam(V), Laveru(M), Srikakulam District.
2	Visakhapatnam	M/s. Maridi Eco Industries (Andhra) Pvt. Ltd., Sy.No.314, Kapulupada, Bheemunipatnam (M), Visakhapatnam District.
3	Visakhapatnam	M/s. Vasishta Environ Care, Plot No 27A25, Denotified Area AP SEZ, Atchutapuram Rambilli (M), Visakhapatnam District.
4	East Godavari	M/s. EVB Technologies (P) Ltd., Sy.No.560, Kanavaram(V), Rajanagaram(M), East Godavari District.
5	West Godavari	M/s Safenviron & Associates, R.S.No.181/1, Nallamadu (V), Ungutur (M), West Godavari District.
6	Krishna	M/s. Safenviron (Unit-II), Sy.No.164/1A, Dharmavarapupadu Thanda (V), Jaggaiahpet (M), Krishna District.
7	Guntur	M/s. Safenviron, Chinakakani (V), Mangalagiri (M), Guntur District.
8	Prakasam	M/s. Ongole Medical Waste Treatment Facility, Sy.No.316/1, Kanduluru (V), Tanguturu (M), Prakasam District
9	SPSR Nellore	M/s. S S Bio Care, S.No 61, Plot No-2, APIIC, Attivaram village, Ozili (M), SPSR Nellore District.

- 5.3.3 **Municipal solid waste** is generated at 5,66,780 MTA; The generated waste by the ULBs is disposed through material recovery facilities, waste to energy plants and SLFs, which are authorized by the APPCB i.e., M/s. Jindal Urban Waste Management (Visakhapatnam) Ltd., for Waste to Energy Plant (which is under construction) to produce 15 MWH power by utilizing solid waste of 4,08,800 TPA generated in 2 ULBs (i.e., Srikakulam & GVMC), 2 Nos (GVMC & Chirala) of Scientific Land Facility (SLF) and with 33,945 TPA capacity and Material Recovery Facilities (MRFs) to recover the material from the municipal solid waste.
- 5.3.4 **Plastic waste** is generated at 21,553.75 MTA, the generated waste by the ULBs is utilized for road construction, disposed to material recovery facility, registered recyclers and cement plants, which are authorized by the APPCB. The non-recyclable plastic waste generated is being utilized for road construction by GVMC & Kakinada Municipal Corporations. About 16.5 Tons of plastic waste utilized to lay about 9 Kms. road. Material Recovery Facilities (MRFs) have been established to recover the plastic waste from the municipal solid waste. The recyclable plastic waste is being sent to registered recyclers. The non-recyclable plastic waste is being sent to cement plants for co-incineration. Authorization issued to 8 cement units to use non-recyclable plastic waste as an alternative fuel (co-incineration).
- 5.3.5 **E-waste** generation is 0.075 MTA, The generated waste from the ULBs is disposed to authorized e-waste processing units 3 nos. The APPCB issued authorization to the following dismantling facilities to handle the e-waste as per E-Waste Management Rules:
- 1) M/s. Green waves Environmental Solutions, Visakhapatnam of capacity- 40 TPM.
 - 2) M/s. Veera Waste Management, Visakhapatnam of capacity - 19.4 TPD.
 - 3) M/s. Apna Bhoomi, Srikakulam of capacity - 1 TPD
- 5.3.6 **C&D waste** is generated at about 40432 MTA. The C&D waste generated is collected through waste call centres and collection centres and disposed through authorized C&D waste processing facilities. Authorization is issued by APPCB to 2 Nos (M/s. Pro Enviro C&D Waste Management Pvt. Ltd., Visakhapatnam and Pro Enviro C&D Waste Management Pvt. Ltd., Vijayawada) with capacity of 102200 TPA. The end product of sand and gravel from the Construction & Demolition Waste Processing Facilities is being supplied to industries and also being used in construction of roads.

The APPCB will continue the monitoring of the Solid Waste generated and their disposal and ensure that, the Solid Wastes are not disposed into the sea through regular vigilance.

6.0 Monitoring of Water Quality of Coastal Waters:

The APPCB is regularly monitoring the Water quality of coastal waters under NWMP. The water quality is monitored at 40 (12 CPCB & 28 APPCB) locations. District wise sampling locations are as below:

Table 6.1

Sl. No.	District	Sampling Locations
1.	Srikakulam	3 Nos.
2.	Vizianagaram	1 Nos.
3.	Visakhapatnam	13 Nos.
4.	East Godavari	9 Nos.
5.	West Godavari	1 Nos.
6.	Prakasam	2 Nos.
7.	Nellore	4 Nos.
8.	Guntur	3 Nos.
9.	Krishna	4 Nos.
	Total:	40 Nos.

Table 6.2: Annual Average values of quality of coastal waters of Bay of Bengal

Coastal water quality monitoring data - Andhra Pradesh (Annual average values for the period from 2010-11 to 2019-20)									
S. No.	Sample Description	YEAR	D O	pH	TS S	BO D	NO ₃ -N	NH ₃ - N	PO ₄
I. Srikakulam District									
1	Confluence of marine outfall of M/s Dr. Reddy Labs Ltd., & M/s. Aurobindo Pharma Ltd., Pydibheemavaram.(Ranasthalam) SL-1	2010-11	5	7.4	9	1.8	0.5	0.04	0.8
		2011-12	7.2	7.8	8	2	0.3	0.01	0.1
		2012-13	6.2	7.5	244	2.6	0.64	0.2	0.08
		2013-14	6.7	8.1	34	1.4	0.14	0.22	0.39
		2014-15	6.8	8.1	80	1.3	0.1	0.1	0.58
		2015-16	5.5	7.7	55	1.3	0.4	0.2	0.3
		2016-17	5.7	7.2	93	1.6	1.1	0.08	0.14
		2017-18	6.3	7.6	40	1.4	0.6	0.21	0.12
		2018-19	5.7	7.6	102	1.3	0.53	2.15	0.03
2019-20	5.9	7.7	64	1.8	0.57	0.03	0.03		
2	Confluence point of river Vamsadhara at Kalingapatnam.	2010-11	6.7	7.8	7	1.5	0.25	0.05	0.45
		2011-12	5.4	8	12	1	0.4	BDL	0.5
		2012-13	6.6	7.5	224	2.2	0.66	0.01	0.11

	SL-2	2013-14	6.6	7.5	--	1.9	0.27	0.24	0.97
		2014-15	6.6	7.8	46	1.7	0.5	0.3	0.7
		2015-16	5.6	7.6	46	1.5	0.8	0.4	0.3
		2016-17	5.9	7.2	116	1.5	0.62	0.12	0.08
		2017-18	6.5	7.1	103	1.9	1.0	0.2	0.5
		2018-19	6.1	7.4	80	1.5	1.6	0.2	0.3
		2019-20	7	7.4	77	2.2	0.76	0.09	0.03
3	Confluence of river Nagavali at Peda Ganagalavani peta.	2010-11	5.9	7.6	5	1.4	0.8	BDL	0.25
	SL-3	2011-12	5.6	7.8	8	1	0.4	0.01	0.1
		2012-13	6.8	7.4	240	2	0.63	0.02	0.06
		2013-14	6.7	7.9	57	1.8	0.11	0.37	0.83
		2014-15	6.7	7.9	31	1.7	0.09	0.21	0.83
		2015-16	6	7.7	43	1.5	0.4	0.3	0.5
		2016-17							0.06
			5.5	7.3	74	1.5	1.4	0.06	6
		2017-18	6.3	7.5	44	1.4	0.73	0.08	0.16
		2018-19	5.8	7.6	112	1.5	1.47	0.11	0.03
		2019-20	6.4	7.4	106	2.3	0.71	0.2	0.03
II. Vizianagaram District									
4	Confluence of marine outfall of M/s. Matrix Laboratories Ltd., Thammayyapalem.	2010-11	5.4	8	9	1.4	1.08	0.02	0.1
	SL-4	2011-12	6.8	7.7	10	2	0.4	0.04	0.1
		2012-13	6.6	7.5	230	2.2	0.65	0.08	0.08
		2013-14	6.7	8.1	37	1.2	0.18	0.11	0.48
		2014-15	6.7	8.1	24	1.1	0.17	0.07	0.02
		2015-16	5.8	7.4	39	1.3	0.4	0.07	0.24
		2016-17	5.8	7.2	89	1.9	0.8	0.05	0.18
		2017-18	6.6	7.7	85	1.3	0.8	0.01	0.33
		2018-19	5.9	7.7	89	1.4	0.5	1.02	0.02
		2019-20	5.6	7.6	61	1.8	0.52	0.03	0.03
III. Visakhapatnam District									
5	Confluence of marine outfall of M/s. Divi's Laboratories Ltd., Chippada.	2010-11	6	7.42	8	1.1	1.19	0.04	0.26
	SL-5	2011-12	7.5	8.2	10	2	0.3	0.03	0.1
		2012-13	6.9	7.4	400	2	0.79	0.04	0.18
		2013-14	6.7	7.9	28	1.2	1.12	0.51	0.8
		2014-15	6.7	7.8	26	1.2	0.95	0.4	0.7
		2015-16	5.6	7.6	52	1.4	0.3	0.1	0.2
		2016-17	6.5	7.1	88	2.4	0.6	0.1	0.09
		2017-18	5.8	7.5	119	1.2	0.59	0.06	0.24
		2018-19	5.6	7.64	115	1.4	0.52	0.05	0.18
		2019-20	5.7	7.5	84	2.3	0.63	0.17	0.08
6		Confluence point of	2010-11	6.8	7.4	5	1.6	0.9	BDL

	Gosthani river joining the sea near Bheemili municipal office. SL-6	2011-12	5.7	7.9	12	1	0.6	0.03	0.2
		2012-13	7	7.2	430	2.6	1.02	0.1	0.22
		2013-14	6.9	8.1	46	1.2	0.26	0.51	0.85
		2014-15	6.9	8	30	1.2	0.19	0.42	0.84
		2015-16	6.3	7.7	51	1.5	0.4	0.1	0.9
		2016-17	6.2	7.3	120	2	0.6	0.09	0.12
		2017-18	6.8	7.7	93	1.7	1.68	0.28	0.31
		2018-19	5.1	7.68	118	1.3	1.13	0.84	0.09
		2019-20	5.8	7.5	92	2.5	1.22	0.04	0.18
7	Confluence point of Gambheeram Gedda joining the sea near Excel Hatcheries, Mangamma varipeta, Bheemili Road. SL-7	2010-11	6.4	7.25	6	1.5	2.2	BDL	0.15
		2011-12	6.2	8	16	2	0.7	ND	0.2
		2012-13	6.8	7.2	415	2	1.05	0.14	0.03
		2013-14	6.9	8	29	1.4	1.02	0.56	0.83
		2014-15	6.8	8	29	1.4	0.94	0.4	0.78
		2015-16	6.3	7.7	44	2.3	1.1	0.3	1.3
		2016-17	5.3	7.6	96	2.2	3.8	0.2	0.6
		2017-18	5.9	7.8	52	1.7	4.6	0.45	0.6
		2018-19	5	7.6	77	1.3	4.96	0.53	1.54
2019-20	5	7.5	62	2.8	5.6	0.18	0.9		
8	Confluence point of Sewage joining the sea at Shanti Ashramam. SL-8	2010-11	5.5	7.9	7	1	1.8	0.05	0.18
		2011-12	6	8.1	6	1	0.5	ND	1.2
		2012-13	6.9	6.9	410	2.2	1.33	1.2	0.38
		2013-14	6.7	7.9	48	1.4	0.77	0.55	0.81
		2014-15	6.7	7.9	48	1.4	0.7	0.41	0.81
		2015-16	5.9	7.8	45	1.5	0.9	0.3	0.9
		2016-17	5.8	7.3	126	2.2	1.1	0.06	0.15
		2017-18	5.9	7.5	118	1.7	4.1	0.17	0.2
		2018-19	5.1	7.46	109	1.3	1.51	0.12	0.08
2019-20	5	7.5	62	2.8	5.6	0.18	0.9		
9	Confluence point of Sewage joining the sea at Fishing Harbour. SL-9	2010-11	6.2	7.42	6	1.6	1.3	BDL	0.28
		2011-12	5.6	7.9	8	1	0.4	0.19	1.1
		2012-13	7.1	6.9	390	2.2	1.31	1.2	0.14
		2013-14	6.6	7.9	55	1.2	0.94	0.8	0.69
		2014-15	6.5	7.9	53	1.3	0.9	0.7	0.69
		2015-16	5.2	7.5	53	1.6	0.5	0.2	0.8
		2016-17	5.9	7.2	129	2.2	0.8	0.05	0.14
		2017-18	6.7	7.5	98	1.7	1.13	0.04	0.16
		2018-19	5	7.53	91	1.2	0.87	0.06	0.05
2019-20	4.7	7.4	93	2.2	0.92	0.01	0.1		
10	Sea water collected	2010-11	5.8	8	8	1.2	1.4	0.04	0.09

	at Visakhapatnam Port Trust jetty near Marine Department.	2011-12	6.4	7.8	10	2	1	0.02	0.1
		2012-13	7.2	7.4	420	2.6	0.79	0.3	0.16
		2013-14	6.7	7.7	65	1.3	0.76	1.01	1.94
	SL-10	2014-15	6.7	7.7	65	1.3	0.75	0.9	1.9
		2015-16	5.5	7.4	44	1.5	0.8	0.3	0.7
		2016-17	6.1	7.3	113	2.4	1.2	0.37	0.25
		2017-18	6.5	7.6	114	1.6	0.98	0.67	0.41
		2018-19	5.1	7.72	91	1.3	1.55	0.41	0.35
		2019-20	3.6	7.3	91	3.4	1.19	0.07	0.09
11	Confluence of sewage of lavender canal joining the sea at harbour.	2010-11	6.7	7.5	8	1.8	0.89	0.06	0.28
		2011-12	5.2	8.3	12	2	3.2	ND	2.1
		2012-13	6.6	6.9	390	2	1.2	1.3	0.08
		2013-14	6.8	7.9	43	1.3	0.63	1.48	1.88
	SL-11	2014-15	6.8	7.9	43	1.3	11.5	1.48	1.88
		2015-16	5.1	7.5	39	1.5	1.3	0.4	1.9
		2016-17	5.5	7.3	81	1.4	2.0	0.71	0.72
		2017-18	6.1	7.6	98	1.6	6.6	0.2	1.24
		2018-19	4.7	7.5	100	1.4	4.91	0.91	1.14
		2019-20	3	8	119	16	6.22	2.3	1.8
12	Confluence point of Mehadrigedda surplus coarse along with all the industrial effluents joining the sea at parallel bridge near dockyard.	2010-11	5.8	6.2	5	2	1.54	0.07	0.55
		2011-12	7.2	7.9	16	1	0.8	0.02	0.6
		2012-13	6.2	7.1	470	2.6	1.5	1.5	0.11
		2013-14	6.9	7.9	40	1.3	0.121	0.86	1.61
		2014-15	6.9	7.9	39	1.3	0.09	0.85	9.2
		2015-16	5.4	7.4	50	1.4	0.8	0.13	1.8
		2016-17	5.6	7	94	1.7	2.2	0.14	0.5
		2017-18	5.9	7.4	97	1.6	5.18	0.06	0.22
		2018-19	4.7	7.3	88	1.2	4.95	0.95	0.94
	SL-12	2019-20	3.8	7.4	95	11.2	3.03	0.37	1.57
13	Confluence point of steel plant effluent joining the sea at Gangavaram creek near Dibbapalem.	2010-11	5	7.0	6	1	2	BDL	1.5
		2011-12	7.4	7.4	8	1	3.3	0.01	1.8
		2012-13	6.9	7.6	460	2.6	0.83	BDL	0.04
		2013-14	6.7	8.0	30	1.2	0.53	0.47	0.64
		2014-15	6.6	8.0	33	1.2	0.14	0.24	0.47
		2015-16	5.8	7.6	51	1.4	0.5	0.1	0.4
	SL-13	2016-17	6.1	7.3	100	5.6	0.7	0.08	0.16
		2017-18	6	7.4	96	2	4.4	0.07	BDL
		2018-19	5.7	7.8	118	1.5	0.6	0.06	0.03
		2019-20	5.6	7.6	87. 3	4.5	2	0.03	0.08

14	Confluence point of steel plant effluent joining the sea near Appikonda village. SL-14	2010-11	5.8	8.3	7	1.5	1.54	0.05	0.65
		2011-12	7.6	8.2	12	2	0.9	0.1	0.1
		2012-13	7	7.6	380	2.2	0.82	BDL	0.09
		2013-14	6.7	7.9	33	1.2	0.146	0.44	0.45
		2014-15	6.5	8.1	25. 1	1.2	0.63	0.21	0.59
		2015-16	6	7.7	47	1.6	0.7	0.1	0.3
		2016-17	6.2	7.3	125	2.4	0.9	0.18	0.12
		2017-18	6.5	7.4	129	1.6	0.59	0.02	0.27
		2018-19	6	7.8	117	1.4	0.54	0.03	0.03
		2019-20	5	7.8	123	8	1.8	0.4	0.05
15	Confluence point of Mutyalammalem gedda Joining the sea at Mutyalammalem near NTPC SL-15	2010-11	5.7	8.31	8	1.6	1.6	0.06	0.75
2011-12		7.2	8.1	6	2	0.8	0.4	1.1	
2012-13		7.2	7.4	400	2	0.9	BDL	0.08	
2013-14		6.2	8.1	25	1.2	0.65	0.62	0.59	
2014-15		6.7	8	30	1.2	0.53	0.26	0.64	
2015-16		6.3	7.6	45	1.4	0.3	0.1	0.5	
2016-17		6	7.1	99	2.7	1	0.06	0.17	
2017-18		6.4	7.2	91	1.6	1.71	0.02	0.17	
2018-19		5.6	7.4	127	1.3	1.38	0.19	0.03	
2019-20		5.5	7.7	103	2	0.55	0.04	0.03	
16	Confluence point of River Sarada and River Varaha at Bangarammapalem. SL-16	2010-11	6	8.24	7	1.5	2.4	0.03	0.08
2011-12		5.2	7.9	10	1	1	ND	0.1	
2012-13		3.8	7.4	86	1.3	0.16	0.08	0.03 6	
2013-14		6.5	8	48	1.3	0.19	0.48	0.4	
2014-15		6.5	8	45	1.3	0.16	0.29	0.38	
2015-16		5.8	7.6	46	1.5	0.3	0.03	0.34	
2016-17		6.3	7.23	126	2.9	0.65	0.17	0.04	
2017-18		6.4	7.3	109	1.6	0.56	0.34	0.11	
2018-19		5.9	7.74	119	1.3	0.6	0.05	0.03	
2019-20		6	8	55	2	0.5	0.02	0.03	
17	Rushikonda beach SL-17	2019-20	6	7.7	64. 8	1.7	0.4	0.03	0.04
IV. East Godavari District									
18	Sea water collected near Uppada, Kakinada. SL-18	2010-11	6.2	8.5	6	1.4	0.9	0.04	0.1
		2011-12	5.6	7.6	6	1	0.4	0	0.1
		2012-13	4.4	7.4	200	1.4	0.65	BDL	BDL
		2013-14	6.8	8	31	1.3	0.47	0.29	0.63
		2014-15	6.8	8	31	1.3	0.39	0.26	0.64

		2015-16	6	8	42	1.0	1.0	0.1	0.4
		2016-17	5.6	7.3	103	2.0	1.4	0.15	0.04
		2017-18	6.6	7.7	77	1.5	1.3	0.05	0.18
		2018-19	6.3	7.8	100	15.7	1.3	0.07	0.06
		2019-20	5.8	7.6	53	2.1	1.31	0.03	0.09
19	Sea water collected near Kumbhabhishekam temple, Kakinada. SL-19	2010-11	5.8	7	9.0	1.6	1.52	0.05	0.16
		2011-12	5	7.3	8	1.0	1.6	0	1.2
		2012-13	4.8	7.3	198	1.4	0.98	0.3	0.02
		2013-14	6.8	7.7	27	1.2	0.61	0.52	1.16
		2014-15	6.8	7.7	27	1.2	0.35	0.47	1.16
		2015-16	5.8	7.5	56	1.7	0.9	0.4	0.7
		2016-17	5.6	7.16	120	1.9	1.4	0.24	0.12
		2017-18	6.4	7.4	109	1.3	1.7	0.21	0.16
		2018-19	6.1	7.4	91	1.6	1.9	0.3	0.27
		2019-20	4.4	7.4	37	2.9	2.3	0.04	0.28
20	Sea water collected near Deep water port, Kakinada (1 km away from jetty). SL-20	2010-11	6.8	7.58	7	1	2.32	BDL	0.08
		2011-12	6	7.9	12	2	0.2	0	0.1
		2012-13	4.6	7	40	1	1.92	0.38	0.06
		2013-14	6.8	7.7	32	1.2	0.11	0.84	1.29
		2014-15	6.8	7.7	32	1.2	0.07	0.84	1.31
		2015-16	4.2	7.5	38	1.3	0.8	0.4	0.8
		2016-17	5.5	7.3	77	1.5	1.5	0.16	0.14
		2017-18	6	7.6	70	2.9	2.51	0.23	0.28
		2018-19	4.6	7.6	76	1.3	3.4	0.23	0.43
		2019-20	4.7	7.5	50	2.2	2.3	0.03	0.22
21	Confluence point of River Thandava at Pentakota. SL-21	2010-11	6.8	8	4	1.2	1.15	0.06	0.05
		2011-12	5.4	6.8	8	1	1.1	0.2	0.1
		2012-13	4.2	7.3	210	2	0.64	BDL	0.02
		2013-14	6.7	8	37	1.3	0.32	0.35	0.52
		2014-15	6.7	8	38	1.3	0.24	0.26	0.52
		2015-16	6	7.5	44	1.6	0.6	0.5	0.5
		2016-17	6.4	7.2	103	2.1	1.1	0.13	0.06
		2017-18	6.9	7.4	68	1.5	1.2	0.03	0.12
		2018-19	6.5	7.7	100	1.63	1.1	0.08	0.06
		2019-20	5.6	7.6	77	1.8	0.7	0.02	0.06
22	Sample collected from Upputeru channel Opp.Circle Telecom Training Centre, Kakinada.	2010-11	7	7.3	6	1.5	1.33	0.04	0.12
		2011-12	5.8	7.8	14	1	1.7	0	1
		2012-13							0.04
			5.2	7	36	1.2	2.24	0.34	4
		2013-14	7	7.6	33	1.3	0.41	0.86	1
		2014-15	7.1	7.6	28	1.3	0.16	0.99	1.14

	SL-22	2015-16	4.5	7.3	43	2.3	0.9	0.3	0.8
		2016-17	4.9	7.2	85	1.7	1.6	0.28	0.25
		2017-18	5.6	7.4	74	1.3	2.3	0.25	0.33
		2018-19	4.9	7.5	60	1.3	3.2	0.4	0.47
		2019-20	5.8	7.6	53	2.1	1.31	0.03	0.09
23	Sample collected from Upputeru channel near Indrapalem, Kakinada (Confluence of East Eleru drain and Bikkavolu drain). SL-23	2010-11	6.8	7.15	7	1.4	2.8	0.01	0.25
		2011-12	6.2	7.5	16	2	2.4	0	2.1
		2012-13	5.4	7	32	1	2.2	1.8	0.04
		2013-14	6.8	7.7	38	1.3	0.56	0.78	1.12
		2014-15	6.8	7.3	38	1.2	0.42	0.82	1.12
		2015-16	4.9	7.4	38	1.5	0.6	0.2	1.8
		2016-17	5.5	7.3	65	1.7	1.6	0.28	0.22
		2017-18	5.9	7.5	45	1.5	2.4	0.13	0.3
		2018-19	5	7.7	60	1.3	2.5	0.37	0.31
		2019-20	2.9	7.2	33	3.2	2.88	0.03	0.4
24	Confluence point of Chollangi snanala revu and Ramannapalem drain. SL-24	2010-11	6.4	7.45	9	1.5	3.3	0.02	0.15
		2011-12	5.2	7.9	10	1	2.6	0	2.1
		2012-13	4.6	7.3	110	1.4	2.5	2.16	0.08
		2013-14	6.9	7.8	31	1.2	0.12	0.41	0.78
		2014-15	6.9	7.8	32	1.2	0.11	0.38	0.81
		2015-16	5.6	7.4	30	1.4	0.8	0.4	1
		2016-17	5.7	7.1	58	1.8	1.7	0.07	0.16
		2017-18	6.1	7.5	59	2	2.04	0.19	0.23
		2018-19	5.4	7.6	82	1.4	1.8	0.07	0.14
		2019-20	2.5	7.4	74	3	2.3	0.01	0.23
25	Confluence point of River Gautami Godavari at Bhairavapalem village. SL-25	2010-11	5.8	7.9	8	1.2	2.4	0.01	0.19
		2011-12	5.4	7.8	8	1	0.4	0	0.1
		2012-13	4.4	7.3	260	2	3.5	0.22	0.09
		2013-14	6.9	7.9	42	1.3	0.16	0.8	0.68
		2014-15	6.9	7.9	42	1.3	0.12	0.88	0.68
		2015-16	6.5	7.5	48	1.4	0.3	0.3	1.4
		2016-17	6.2	7.24	100	1.8	1.26	0.08	0.12
		2017-18	6.5	7.3	90	1.8	1.3	0.15	0.18
		2018-19	5.9	7.5	102	1.4	1.06	0.1	0.05
		2019-20	6.3	7.3	126	2.1	1.4	0.04	0.05
26	Confluence point of River Vynateya Godavari at Vodalarevu village, near Amalapuram.	2010-11	7	6.5	7	1.4	2.3	BDL	0.07
		2011-12	5	7.6	14	1	0.4	0	0.1
		2012-13	4.8	7.2	300	2.2	1.2	0.12	0.02
		2013-14	6.9	7.9	43	1.3	0.21	0.32	0.63 9

	SL-26	2014-15	6.9	7.9	43	1.3	0.11	0.32	0.64
		2015-16	6.6	7.6	48	1.6	0.3	0.1	1.5
		2016-17	5.8	7.1	104	1.7	1.8	0.04	0.06
		2017-18	6.1	7.5	115	1.4	0.53	0.04	0.19
		2018-19	6.1	7.6	124	1.5	1	0.08	0.05
		2019-20	6.2	7.4	149	2.2	1.21	0.02	0.05
V. West Godavari District									
27	Confluence point of River Vashista Godavari at Chinnamynavanilanka.	2010-11	7.2	8	9	1	1.8	BDL	0.18
		2011-12	5.2	7.7	6	2	2.9	0	0.4
		2012-13	4.6	7.2	160	1.4	1.1	0.16	0.16
		2013-14	7	7.7	20	1.2	0.27	0.24	0.39
		2014-15	7	7.7	20	1.2	0.24	0.24	0.39
	SL-27	2015-16	6.6	7.6	47	1.7	0.5	0.04	0.7
		2016-17	5.3	6.3	123	1.95	0.8	0.032	0.09
		2017-18	6.1	7.5	115	1.4	0.53	0.04	0.19
		2018-19	6	7.5	101	1.4	0.85	0.49	0.23
		2019-20	6.7	7.6	69	2.1	0.73	0.04	0.06
VI. Prakasam District									
28	Kothapatnam beach.	2014-15	5.5	8.14	--	0.7	--	--	--
	SL-28	2015-16	6.7	7.8	--	2	0.8	--	0.1
		2016-17	5.5	7.9	--	2.2	0.8	--	BDL
		2017-18	6.4	7.7	--	4.2	0.7	--	BDL
		2018-19	5.6	7.5	--	3.7	0.88	--	BDL
		2019-20	5.5	7.8	--	3.03	0.89	--	BDL
29	Vadarevu Beach, Chirala.	2014-15	6.3	8.16	--	0.7	--	--	--
	SL-29	2015-16	5.8	7.8	--	1.5	0.4	--	0.1
		2016-17	5.7	7.8	--	2.1	0.6	--	BDL
		2017-18	6.4	7.5	--	3.8	0.7	--	BDL
		2018-19	5.6	7.8	--	3.9	0.6	--	BDL
		2019-20	5.4	7.6	--	3.2	1.04	--	BDL
VII. Nellore District									
30	Loading Point - Krishnapatnam port.	2014-15	5.7	8.04	--	0.8	--	--	--
	SL-30	2015-16	6.3	7.83	--	1.8	0.8	--	0.1
		2016-17	5.9	7.7	--	2.3	0.9	--	BDL
		2017-18	6	7.6	--	4	0.7	--	BDL
		2018-19	5.4	7.6	--	3.9	1.0	--	BDL
		2019-20	5.3	7.7	--	3	0.99	--	BDL
31	Pulicat lake-Bheemulavaripalem.	2014-15	5	8	--	0.8	--	--	--
		2015-16	5.7	7.7	--	2.2	1.7	--	BDL
		2016-17	6	7.6	--	2.6	1.2	--	BDL

	SL-31	2017-18	6.3	7.5	--	3.9	1.4	--	BDL
		2018-19	5.4	7.3	--	3.9	2.1	--	BDL
		2019-20	5.5	7.8	--	3.1	1.22	--	BDL
32	North Extent Krishnapatnam port.	2014-15	5.7	8.01	--	0.7	--	--	--
		2015-16	6.2	7.19	--	1.8	0.8	--	0.1
		2016-17	5.8	7.6	--	2.1	0.7	--	BDL
	SL-32	2017-18	6.6	7.6	--	4	0.8	--	BDL
		2018-19	5.7	7.5	--	3.7	1.03	--	BDL
		2019-20	5.5	7.7	--	3.2	1.02	--	BDL
33	South Extent - Krishnapatnam port.	2014-15	6	8.04	--	0.6	--	--	--
		2015-16	6.2	7.72	--	1.9	0.8	--	0.1
		2016-17	6.1	7.7	--	2.2	0.8	--	BDL
	SL-33	2017-18	6.5	7.6	--	4	0.7	--	BDL
		2018-19	5.6	7.6	--	3.6	0.9	--	BDL
		2019-20	5.6	7.8	--	3	1.05	--	BDL
VIII. Guntur District									
34	Fishing Harbar , Nizampatnam.	2014-15	5.8	7.97	--	1.1	--	--	--
		2015-16	6.1	7.77	--	2.4	0.44	--	BDL
		2016-17	5.8	7.8	--	2.2	0.6	--	BDL
	SL-34	2017-18	6.9	7.5	--	3.8	0.7	--	BDL
		2018-19	5.2	7.9	--	3.9	0.51	--	BDL
		2019-20	5.7	7.7	--	3.3	1.75	--	BDL
35	Fishing Harbar, After confluence with sea,Nizampatnam Nizampatnam.	2014-15	5.8	7.97	--	1.1	--	--	--
		2015-16	6.1	7.77	--	2.4	0.44	--	BDL
		2016-17	5.8	7.8	--	2.2	0.6	--	BDL
		2017-18	6.9	7.5	--	3.8	0.7	--	BDL
		2018-19	5.2	7.9	--	3.9	0.51	--	BDL
	SL-35	2019-20	5.5	7.7	--	3.2	1.12	--	BDL
36	Suryalanka Beach.	2014-15	5.7	8.08	--	0.7	--	--	--
		2015-16	6.1	7.83	--	2	0.5	--	0.1
		2016-17	5.7	7.8	--	2.3	0.7	--	BDL
	SL-36	2017-18	6.4	7.7	--	3.7	0.72	--	BDL
		2018-19	5.5	7.81	--	4.1	0.51	--	BDL
		2019-20	5.6	7.6	--	3.2	1.13	--	BDL
IX. Krishna District									
37	Manginapudi beach, Machilipatnam.	2014-15	5.9	8.0	--	0.7	--	--	--
		2015-16	5.7	7.6	--	2	0.85	--	BDL
		2016-17	5.9	7.8	--	2.1	0.6	--	BDL

	SL-37	2017-18	6.4	7.4	--	3.9	0.7	--	BDL
		2018-19	5.6	7.7	--	4	0.6	--	BDL
		2019-20	5.5	7.6	--	3.1	1.1	--	BDL
38	Upputeru after confluence with sea, Etiparru.	2014-15	5.8	7.77	--	0.8	--	--	--
		2015-16	6.1	7.52	--	2.5	0.8	--	0.1
		2016-17	5.6	7.7	--	2	0.7	--	BDL
		2017-18	6.7	7.3	--	4	0.7	--	BDL
	SL-38	2018-19	5.7	7.6	--	3.9	1.2	--	BDL
		2019-20	5.6	7.7	--	3.3	1.5	--	BDL
39	Upputeru before confluence with sea, Pedatadika.	2014-15	5.8	7.9	--	0.7	--	--	--
		2015-16	6	7.48	--	2.2	1.1	--	BDL
		2016-17	5.7	7.8	--	1.8	0.66	--	BDL
		2017-18	6.5	7.5	--	4.1	0.8	--	BDL
	SL-39	2018-19	5.8	7.6	--	3.8	1.4	--	BDL
		2019-20	5.6	7.7	--	3.2	1.4	--	BDL
40	River Krishna at confluence with sea at Palakayathippa beach, Hamsaladeevi.	2014-15	5.8	7.82	--	0.6	--	--	--
		2015-16	6.5	7.6	--	1.7	1.04	--	BDL
		2016-17	5.9	7.7	--	2.2	0.61	--	BDL
		2017-18	6.4	7.4	--	3.9	0.7	--	BDL
		2018-19	5.8	7.6	--	3.9	0.6	--	BDL
	SL-40	2019-20	5.5	7.9	--	3.2	0.9	--	BDL
Note: All values are expressed in mg/l except pH.									

Table 6.3

LEGENDS							
DO - Dissolved Oxygen							
BOD - Bio-Chemical Oxygen Demand							
TSS - Total Suspended Solids							
NO ₃ - N - Nitrate Nitrogen							
NH ₃ - N - Ammonical Nitrogen							
PO ₄ - Phosphates							
BDL: Below detectable limit.							
Category	DO	pH	TSS	BOD	NO ₃ -N	NH ₃ -N	PO ₄
Standard SW- I	5.0	6.5 - 8.5	--	--	--	--	--
Standard SW- II	4.0	6.5 - 8.5	--	3.0	--	--	--

Standard SW- III	3.0	6.5 - 8.5	--	--	--	--	--
Standard SW- IV	3.0	6.5 - 9.0	--	5.0	--	--	--
Standard SW- V	3.0	6.0 - 9.0	--	--	--	--	--
Note: All values are expressed in mg/l except pH.							
Standard SW- I: For salt pans, shell fishing, mariculture and ecologically sensitive zone.							
Standard SW- II: For bathing, contact water sports and commercial fishing.							
Standard SW- III: For industrial cooling, recreation (non-contact) and aesthetics.							
Standard SW- IV: For harbour waters.							
Standard SW- V: For navigation and controlled waste disposal.							

As per sea water quality carried out for the period from 2010 - 11 to 2019-20 at 40 locations in the coastal area the annual average values indicates pH (6.2 - 8.5), D.O (2.5 - 7.6 mg/L), TSS (4.0 - 873.0 mg/L, BOD (0.6 - 16.0 mg/L), NO₃-N (0.09 - 6.6 mg/L), NH₃-N (0.01 - 2.3 mg/L), Inorganic PO₄- (0.02 - 9.2 mg/L), and the results reveals that all the 40 monitored locations annual average values are complying with the Primary Water Quality Criteria for SW-IV norms notified under the Environment (Protection) Rules, 1986, except for the following as below:

Table 6.4

No. of locations monitored	No. of locations not complying to the marine primary water quality criteria parameter			Remarks
	DO	pH	BOD	
40 (CPCB - 12 & APPCB - 28)	2 (SL - 23, SL - 24)	2 (SL - 12, SL - 27)	4 (SL-11, SL-12, SL-14, SL-18)	Sea water Bay of Bengal at other locations are complying with criteria parameters. Proposals for establishment of STPs are submitted for the treatment of the sewage to meet the water quality.

The Water Quality Analysis of the Coastal Waters results reveals that all the 40 monitored locations are complying with the primary water quality criteria for SW-IV norms notified under Environment Protection rules 1986 except for the parameters pertaining to

DO, pH & BOD at the sample locations in Visakhapatnam & East Godavari Districts (ie. Confluence of sewage of lavender canal joining the sea at harbour, Confluence point of Mehadrigeedda surplus coarse along with all the industrial effluents joining the sea at parallel bridge near dockyard, Confluence point of steel plant effluent joining the sea near Appikonda village, Sea water collected near Uppada, Kakinada, Sample collected from Upputeru channel near Indrapalem, Kakinada and Confluence point of Chollangi snanala revu and Ramannapalem drain).

At present the MA&UD; Government of A.P has started construction of STPs: 2 Nos. at GVMC Visakhapatnam with capacities 2.0 MLD & 46.0 MLD and 1 No. at Kakinada, East Godavari with a capacity of 5.0 MLD STPs. The STPs will be commissioned by December 2021.

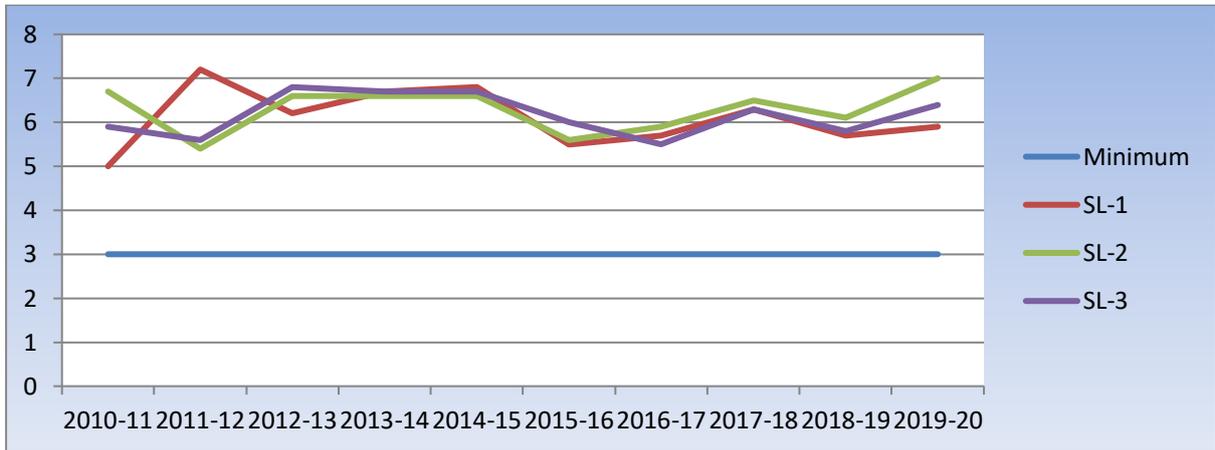
In light of the full-fledged treatment systems provided by the industries, no significant industrial pollution is caused to coastal waters of Andhra Pradesh. However, Urban Local Bodies (ULBs) need to manage the domestic sewage and solid waste as per the existing rules and regulations of the relevant Acts to ensure the wholesomeness of coastal waters of Bay of Bengal all along the 975 kms coast of Andhra Pradesh. **The APPCB is regularly monitoring the coastal waters of Bay of Bengal along with the stretch of 975 Kms. at 40 locations covering all the Coastal Districts in A.P regularly on monthly basis.**

7.0 Graphical Representation of Coastal Water Quality

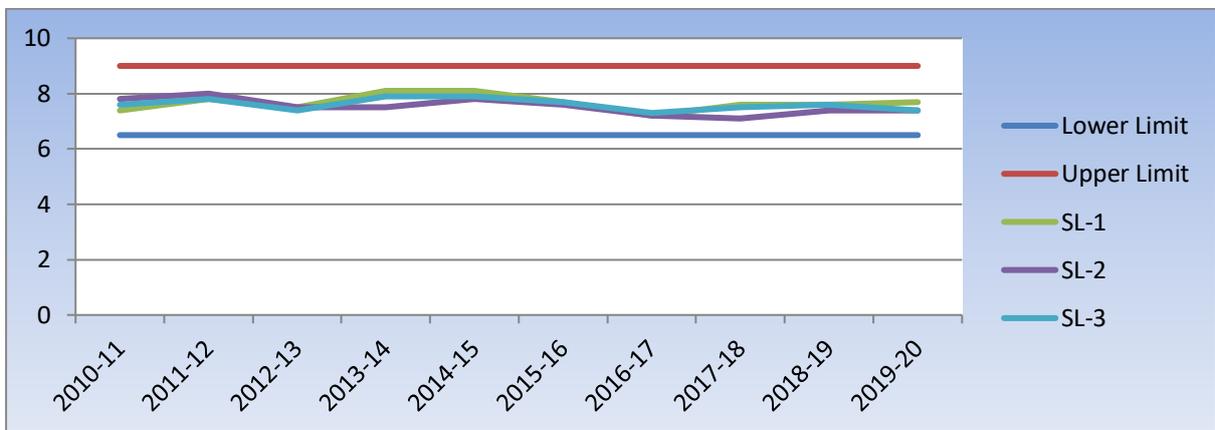
The Graphical representation of coastal water monitoring data of 40 locations District wise for the year 2010-11 to 2019-20 is as below:

District: Srikakulam - 3 Sample locations (SL-1, SL-2 & SL-3)

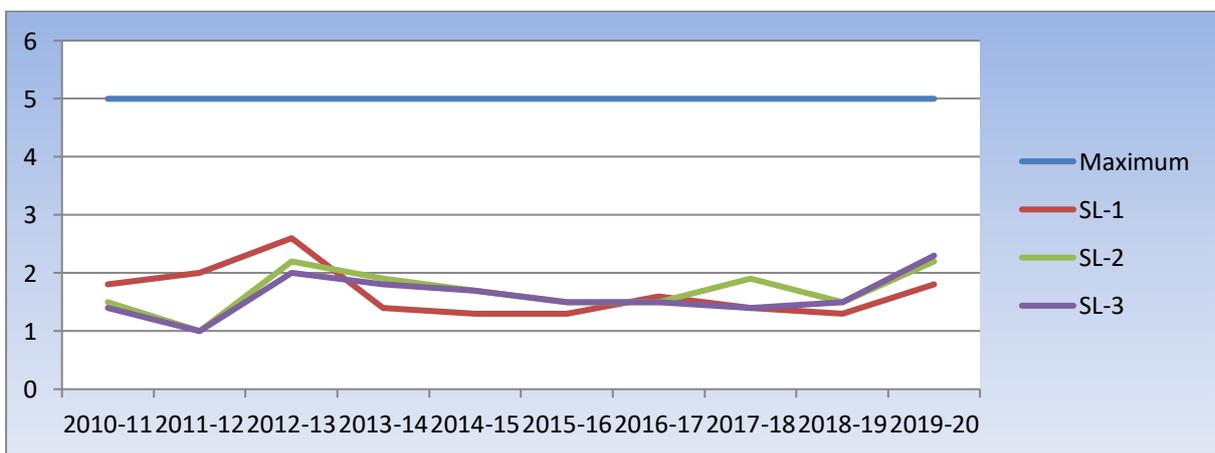
Graph - 7.1 for DO



Graph - 7.2 for pH

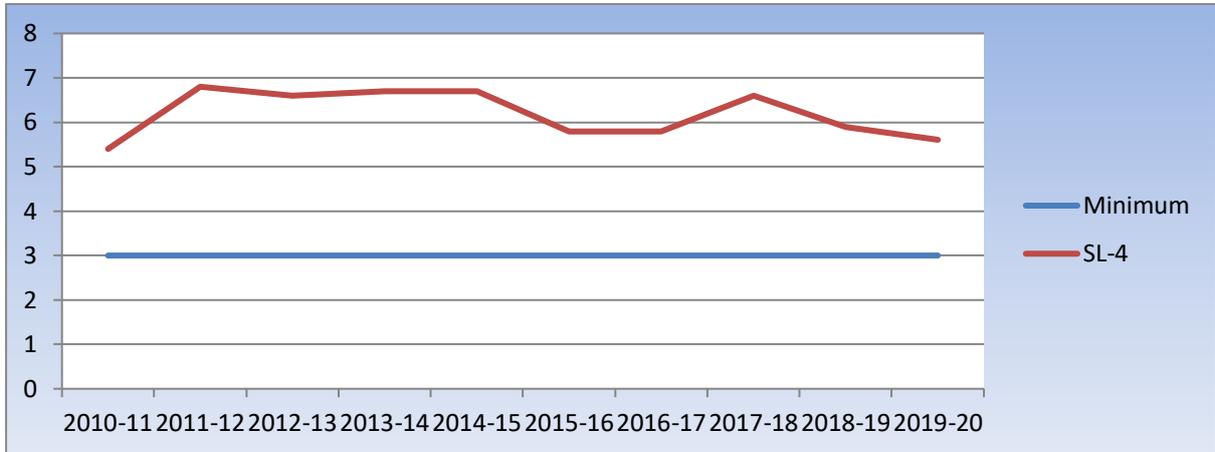


Graph - 7.3 for BOD

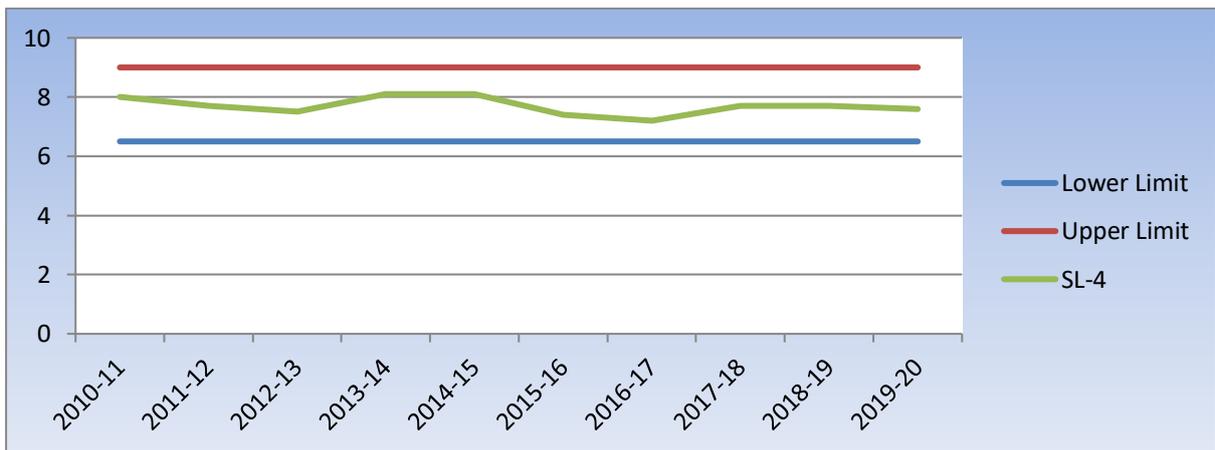


District: Vizianagaram - 1 Sample location (SL-4)

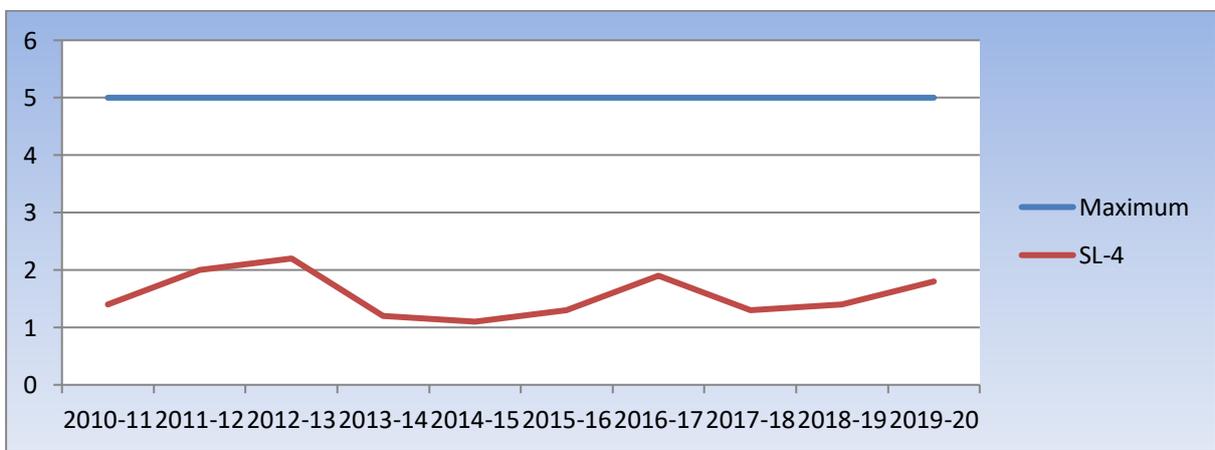
Graph - 7.4 for DO



Graph - 7.5 for pH

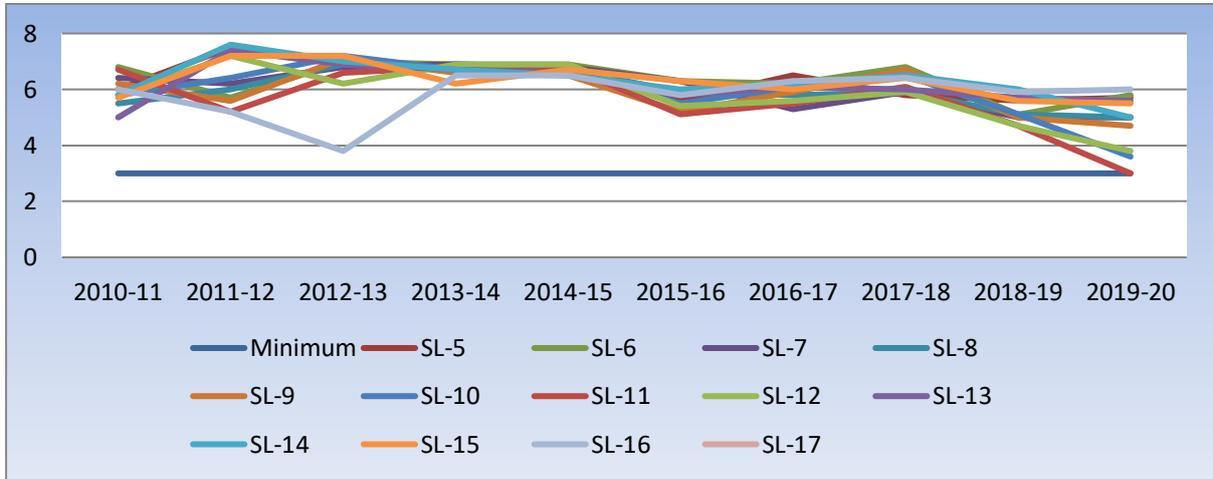


Graph - 7.6 for BOD

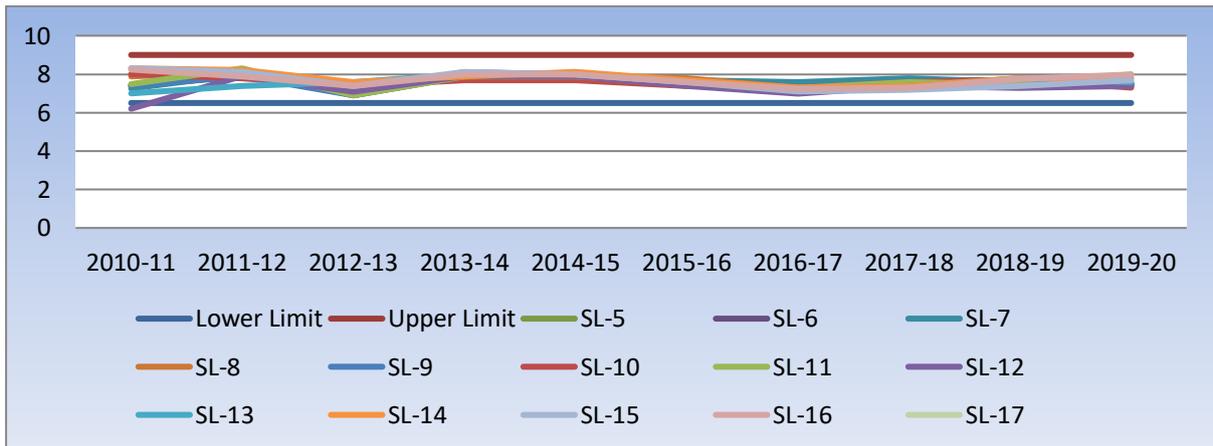


District: Visakhapatnam - 13 Sample locations (SL-5, SL-6, SL-7, SL-8, SL-9, SL-10, SL-11, SL-12, SL-13, SL-14, SL-15, SL-16 & SL-17)

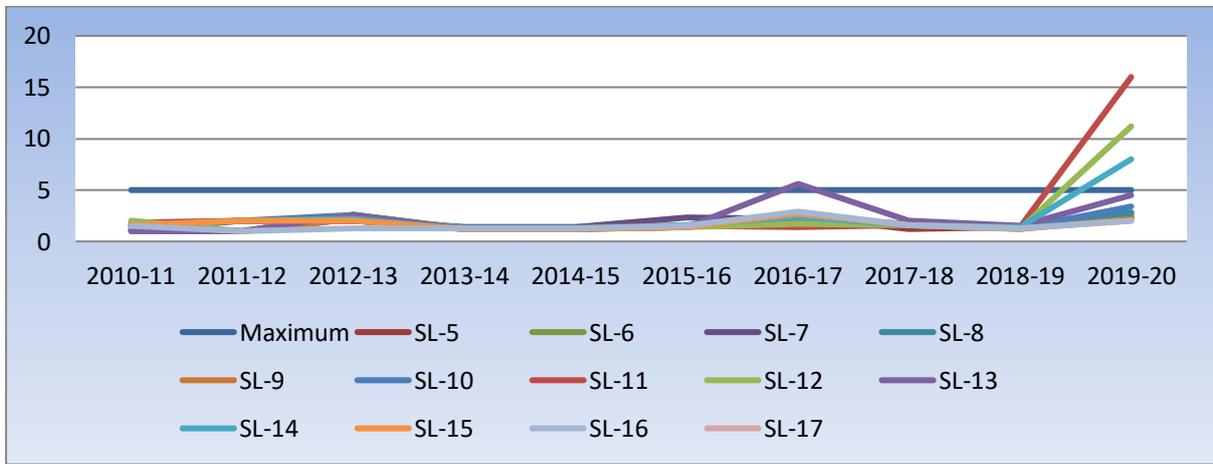
Graph - 7.7 for DO



Graph - 7.8 for pH

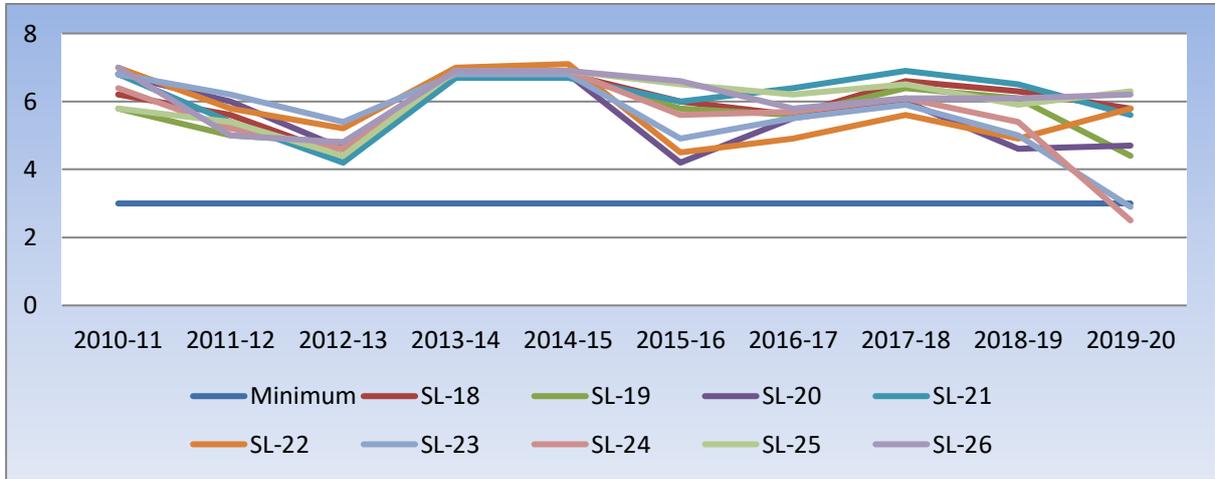


Graph - 7.9 for BOD

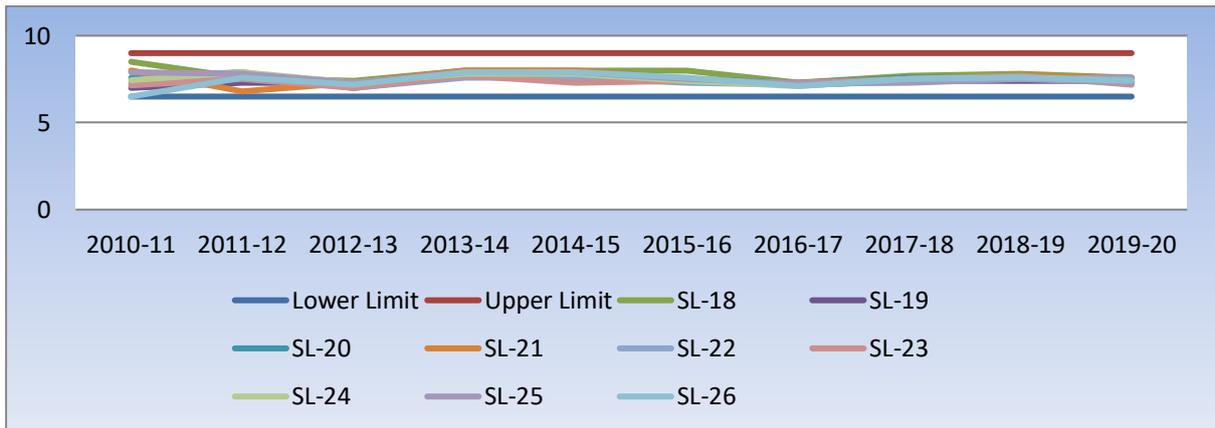


District: East Godavari - 9 Sample locations (SL-18, SL-19, SL-20, SL-21, SL-22, SL-23, SL-24, SL-25 & SL-26)

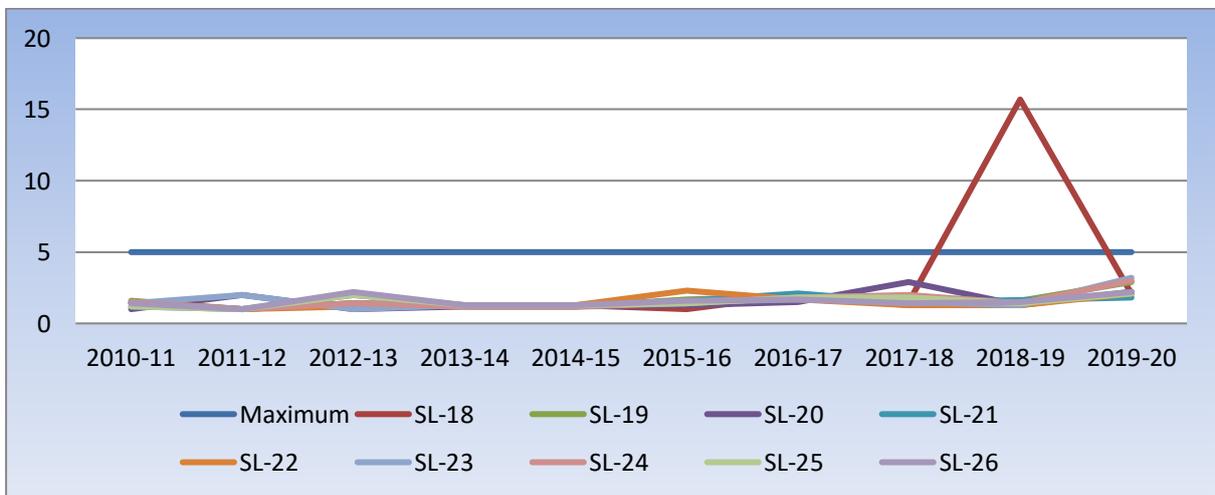
Graph - 7.10 for DO



Graph - 7.11 for pH

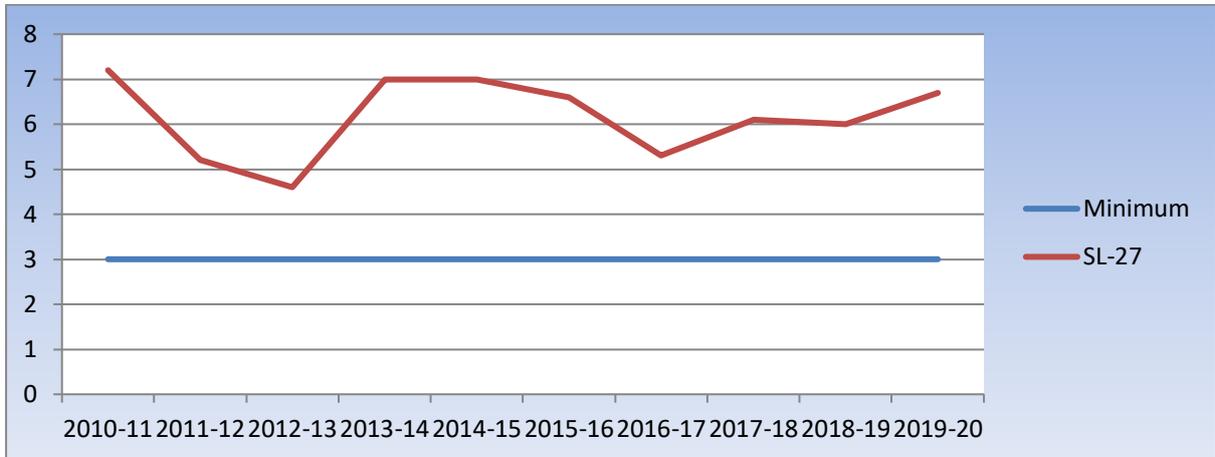


Graph - 7.12 for BOD

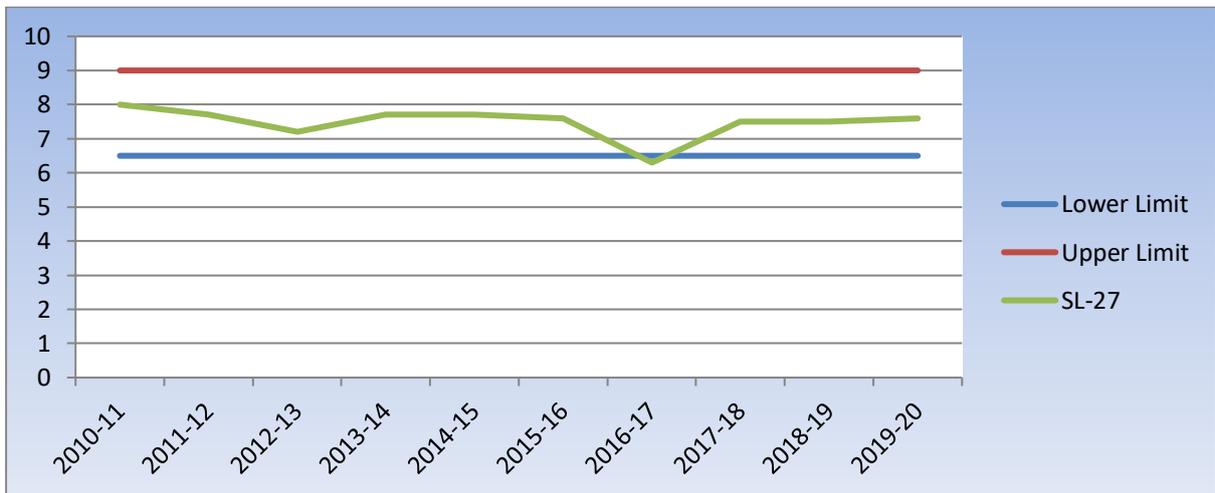


District: West Godavari - 1 Sample location (SL-27)

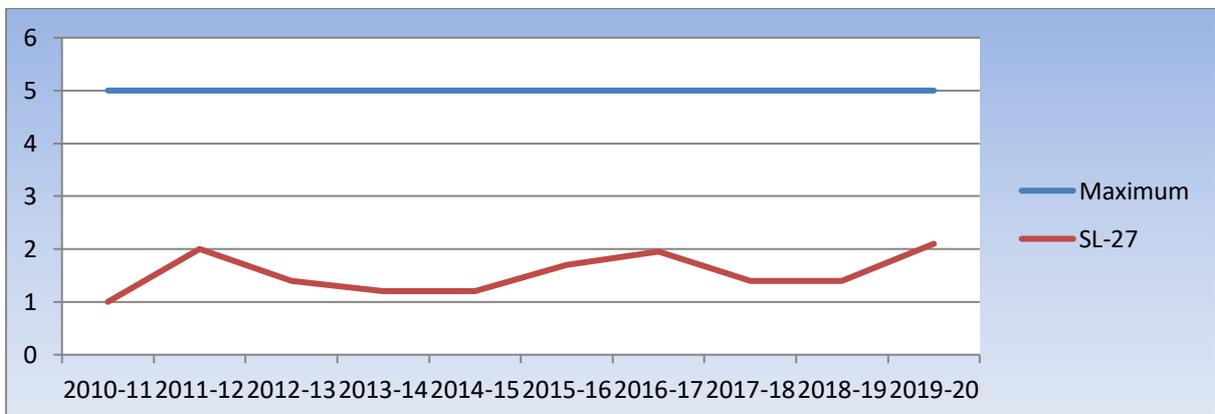
Graph - 7.13 for DO



Graph - 7.14 for pH

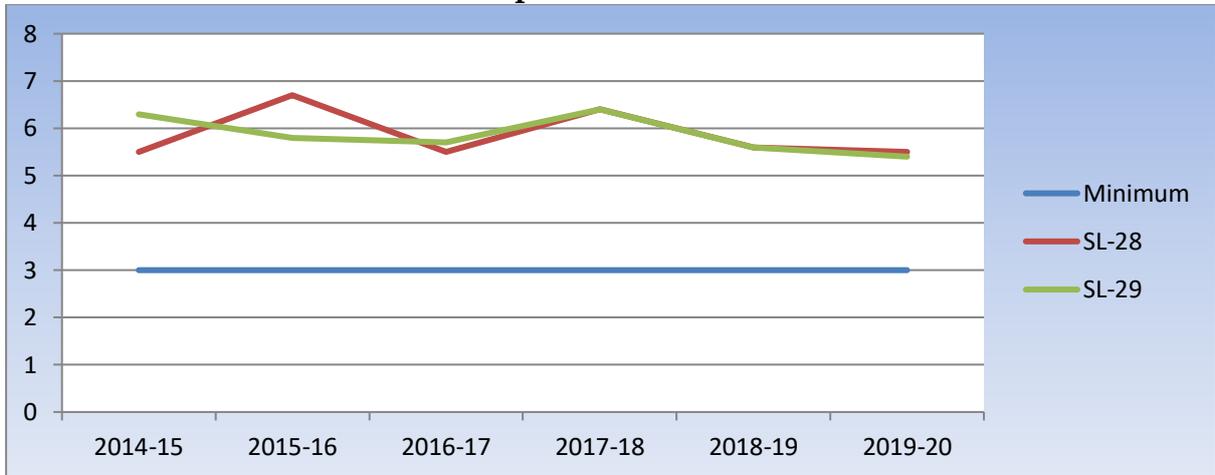


Graph - 7.15 for BOD

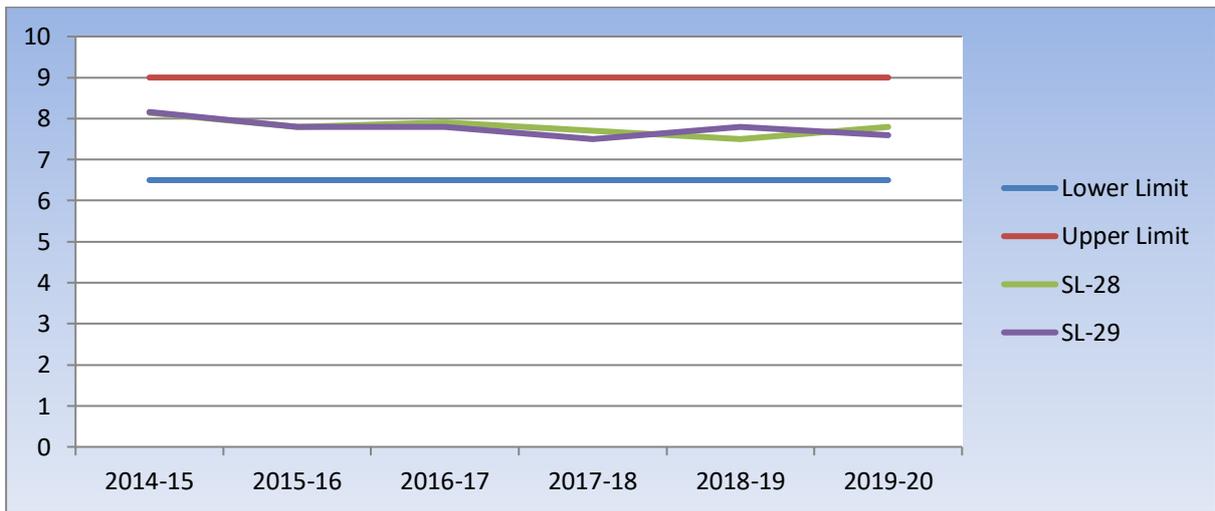


District: Prakasam - 2 Sample locations (SL-28 & SL-29)

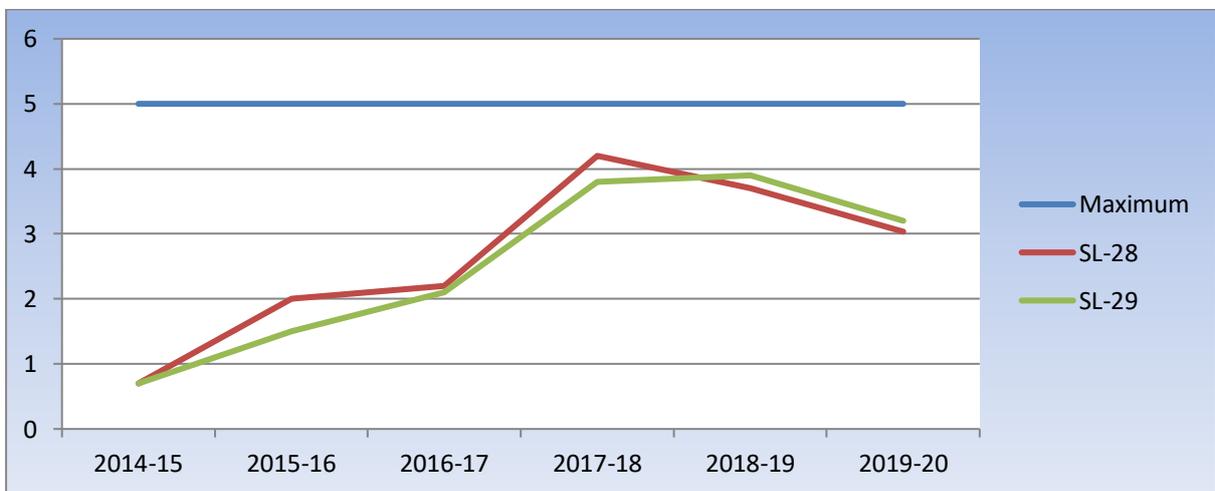
Graph - 7.16 for DO



Graph - 7.17 for pH

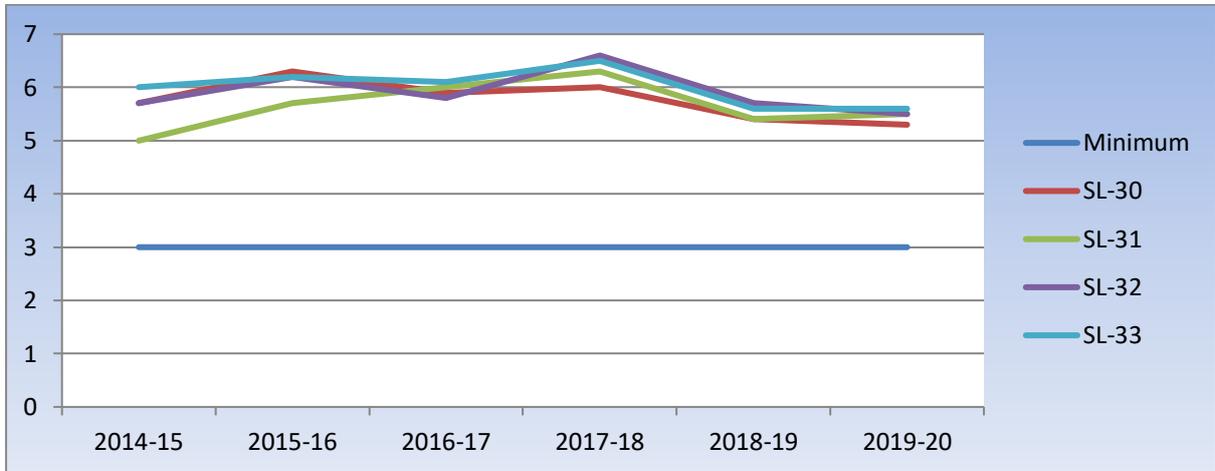


Graph - 7.18 for BOD

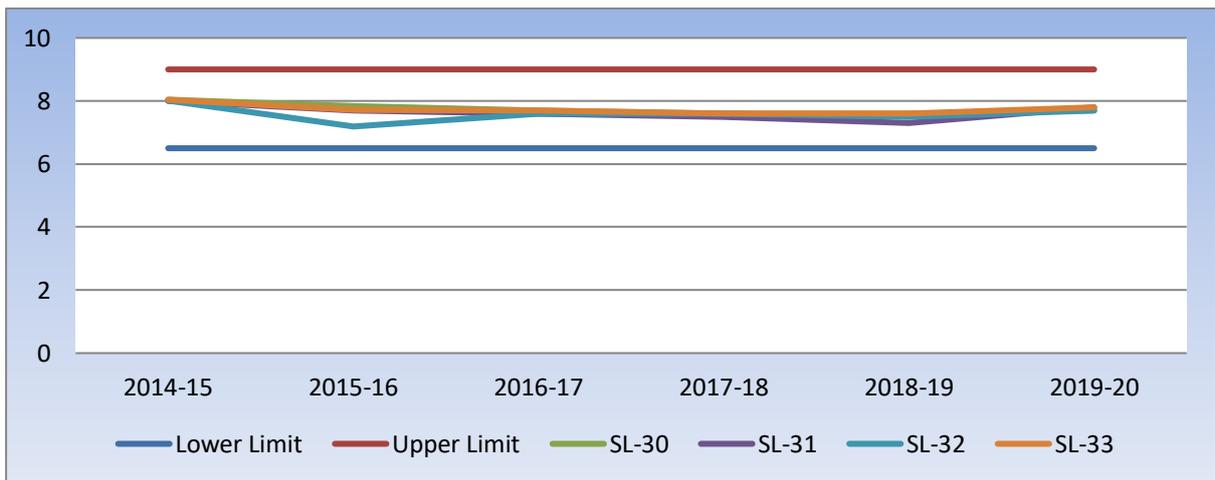


District: Nellore - 4 Sample locations (SL-30, SL-31, SL-32 & SL-33)

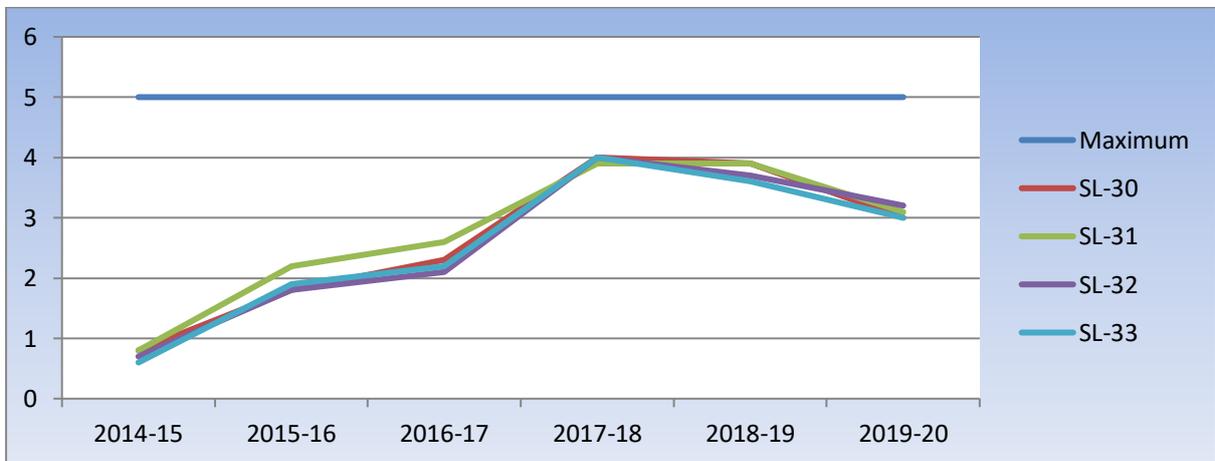
Graph - 7.19 for DO



Graph - 7.20 for pH

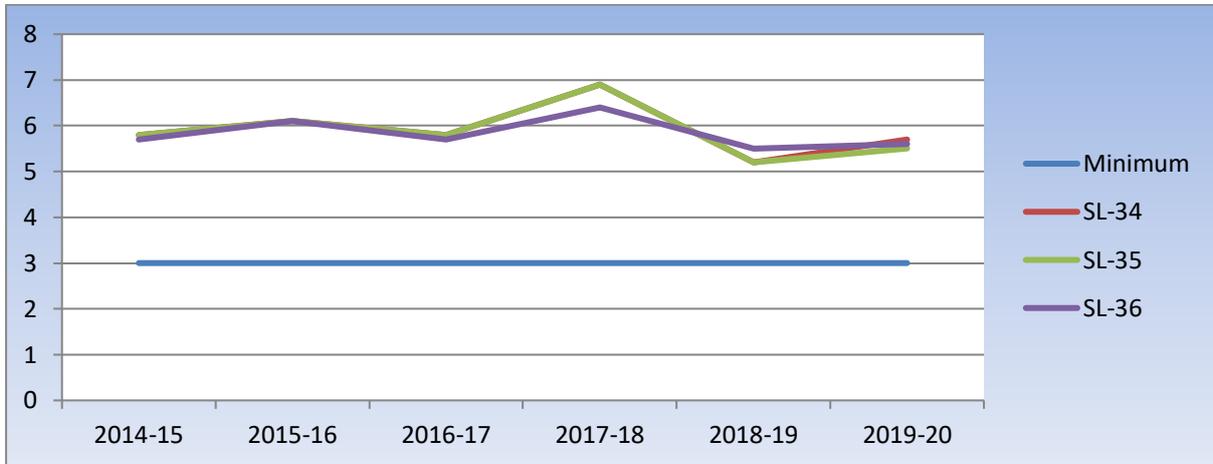


Graph - 7.21 for BOD

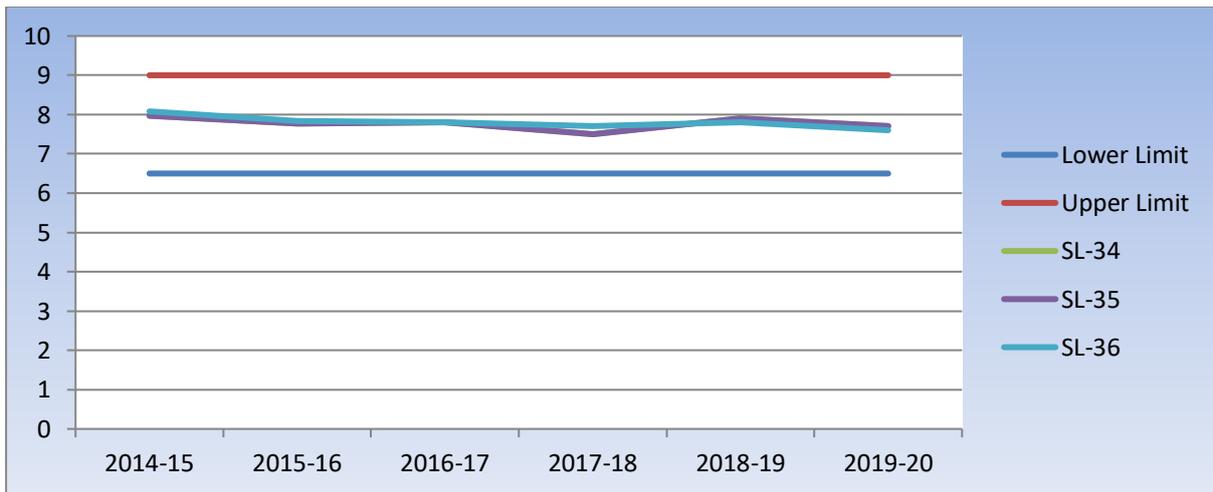


District: Guntur - 3 Sample locations (SL-34, SL-35 & SL-36)

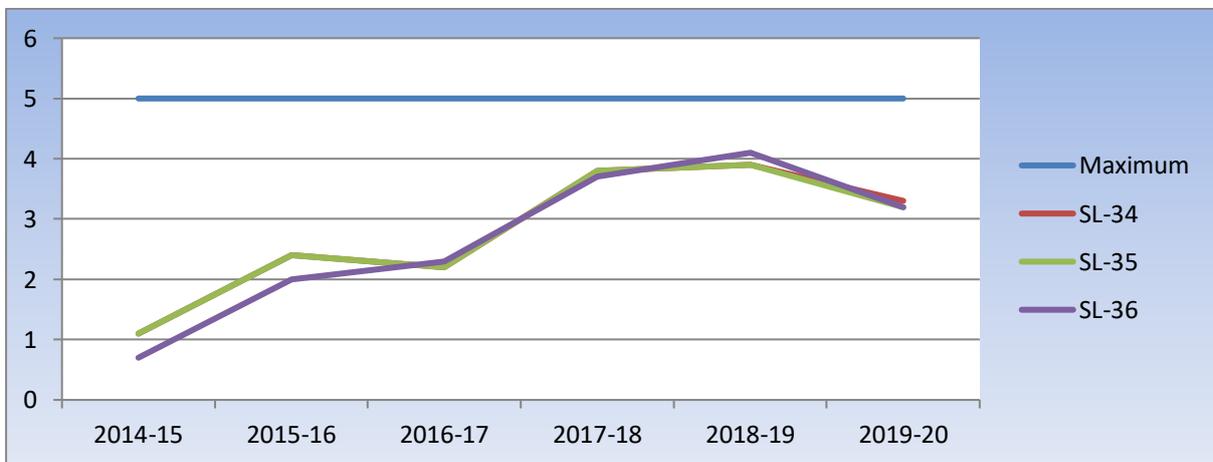
Graph - 7.22 for DO



Graph - 7.23 for pH

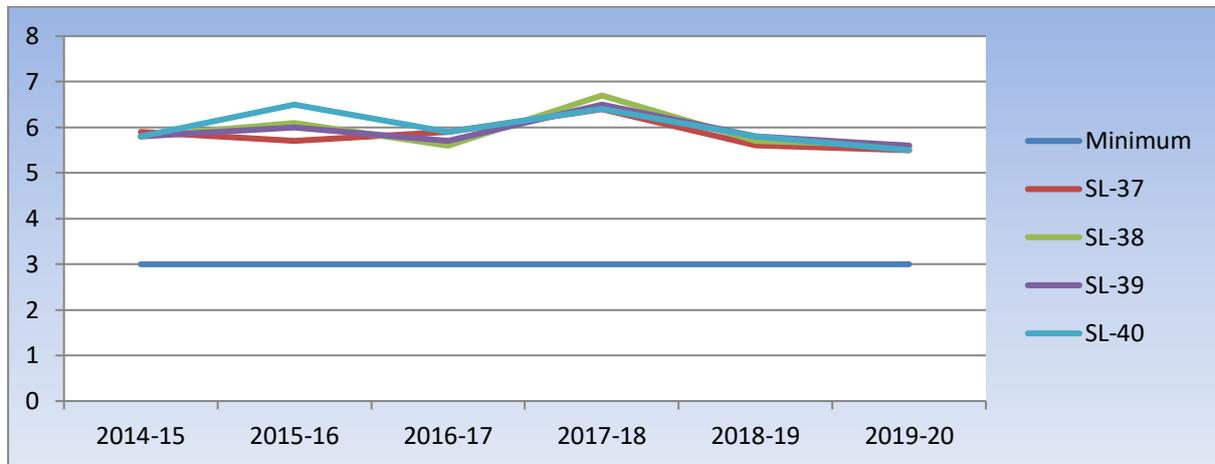


Graph - 7.24 for BOD

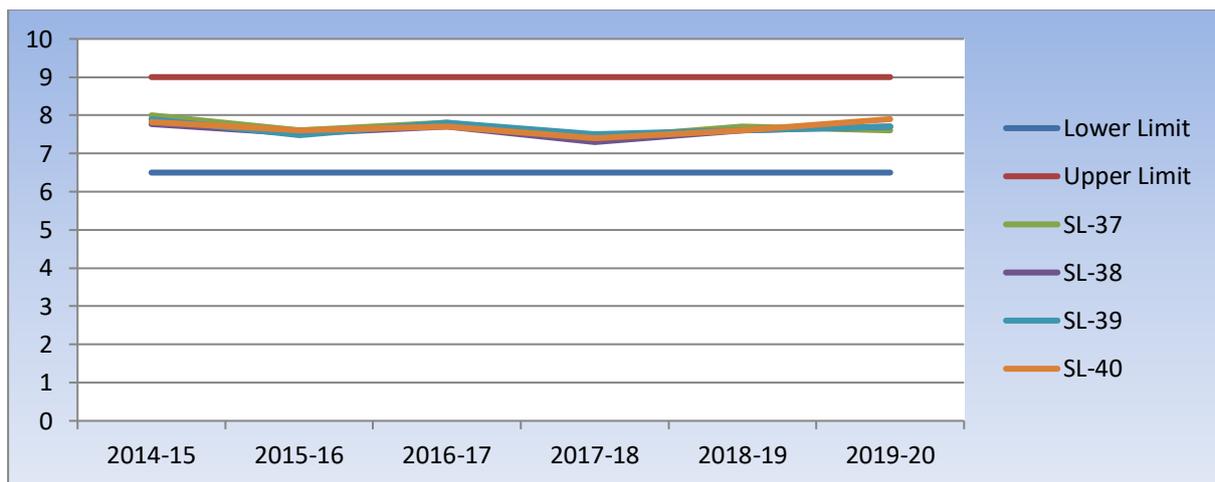


District: Krishna- 4 Sample locations (SL- 37, SL-38, SL-39 & SL-40)

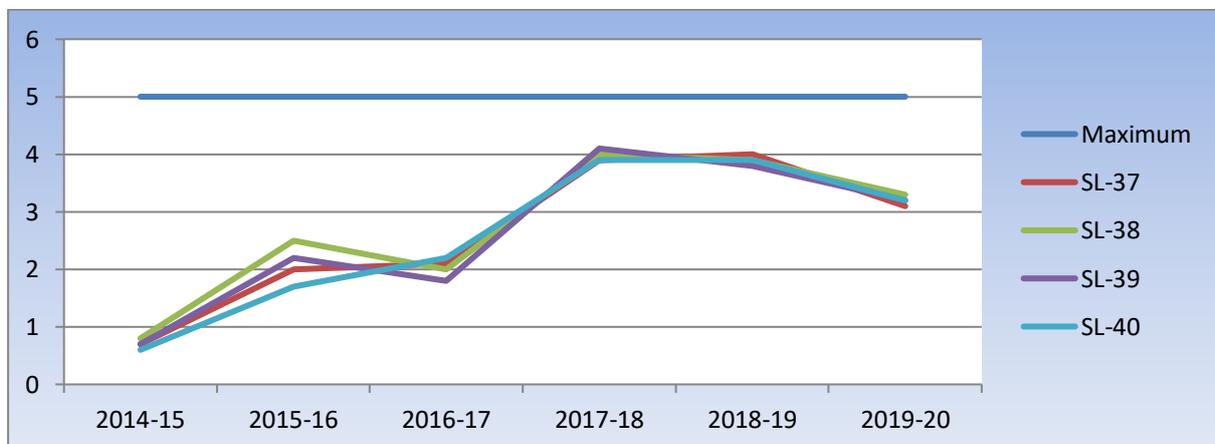
Graph - 7.25 for DO



Graph - 7.26 for pH



Graph - 7.27 for BOD



8.0 Action Plan for control of Coastal Pollution in Andhra Pradesh:

Table 8.1

S. No.	Activity	Timeline	Responsibility
1	Water quality monitoring of sea coast at 40 locations in association with NCCR, Chennai.	To be continued	Andhra Pradesh Pollution Control Board and NCCR.
2	Monitoring of performance of STPs for compliance.	To be continued	APPCB / Municipal authorities
3	Monitoring of industrial discharges of all industrial establishment including marine discharge units for compliance.	To be continued	Andhra Pradesh Pollution Control Board / Industries
4	To develop adequate capacity of sewage treatment using convention STPs or other technology and ensure to comply with the discharge norms as prescribed by the Andhra Pradesh SPCB under consent mechanism prescribed under Water Act, 1974.	December 2021	Municipal Administration & Urban Development Department / DMA / ULBs.
5	To set up for sewage collection, convince treatment and its disposal to cover the entire local / urban / coastal area within the respective jurisdiction.	December 2021	Municipal Administration & Urban Development Department / DMA / ULBs.
6	To set up requisite facilities for collection, transportation, treatment and disposal of Municipal Solid Waste, Plastic Waste, Construction and Demolition Waste generated as well as bio-mining of the existing legacy dumpsites in accordance with the Solid Waste Management Rules, 2016, Plastic Waste Management Rules, 2016 and Construction & Demolition Waste Management Rules, 2016 as amended respectively, notified under the Environment (Protection) Act, 1986, in the coastal areas within the respective jurisdiction of the State / UT.	Facilities established. To be monitored continuously	Municipal Administration & Urban Development Department / DMA / ULBs/APPCB.

7	For periodic cleaning and removal of plastic waste/solid waste in coastal areas to prevent marine pollution and for ensuring its safe disposal in accordance with the provisions notified under the Environment (Protection) Act, 1986.	To be continuously monitored	APPCB and Municipal Administration & Urban Development Department / DMA / ULBs.
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9.0 Conclusion:

From the above it can be inferred that, there is no significant industrial pollution caused due to the full fledged effluent treatment systems provided by the industries. The coastal waters at some places (*i.e. Confluence of sewerage of lavender canal joining the sea at harbour, Confluence point of Mehadrigedda surplus coarse along with all the industrial effluents joining the sea at parallel bridge near dockyard, Confluence point of steel plant effluent joining the sea near Appikonda village in Visakhapatnam District & Sea water collected near Uppada, Kakinada, Sample collected from Upputeru channel near Indrapalem, Kakinada and Confluence point of Chollangi snanala revu and Ramannapalem drain in East Godavari District*) are contaminated due to the flow of untreated sewage through the drains joining the sea. The MA&UD Department is proposing to develop adequate capacity of Sewage Treatment Systems (STPs) along with requisite facilities for collection, transportation & treatment of sewage.

The APPCB will follow up the establishment of adequate facilities with the MA&UD Department. Also regular monitoring will be carried out for assessing the water quality of the sea waters to meet the marine primary water quality criteria parameters. The APPCB along with the other stake holder Departments will adhere to the action plan being submitted in maintaining the water quality by implementing all the measures for solid waste management and effluent/sewage management.

Conventional and zero liquid discharge treatment plants for textile wastewater through the lens of carbon footprint analysis

S. Mohan , Ninad Oke  and D. Gokul 

ABSTRACT

Effluent treatment plants act as the last line of defense against the discharge of pollutants from industrial effluents. The higher resource consumption, variety of dyes, and auxiliary chemicals used for textile manufacturing classify it as a highly polluting industry. Standards for color, organics, and dissolved solids are becoming more stringent with time, and local regulators are forced to insist on the establishment of zero liquid discharge (ZLD) units. However, the application of the ZLD concept has the major limitation of high energy consumption when compared with the conventional wastewater treatment plant. The application of carbon footprint analysis to both units would provide a comprehensive solution to the carbon footprint computation and bring out the advantages of the ZLD. The carbon footprint of a typical ZLD treatment facility in south India was found to be 10,598 tons of carbon dioxide equivalent per year (tCO₂eq/year), which is only one-third more than that of a conventional treatment plant. The carbon footprint of a given ZLD treatment facility can effectively be used as a performance indicator to limit the overall energy consumption.

Key words | carbon footprint, greenhouse gas emission, sustainability, zero liquid discharge

HIGHLIGHTS

- Comparative evaluation of the carbon footprint between conventional and zero liquid discharge (ZLD) treatment plants for textile wastewater is the first of its kind.
- Comprehensive carbon emission quantification by the inclusion of carbon footprint due to the discharge of treated effluent into water bodies/land and ground water extraction within the system boundaries.
- Carbon footprint of the ZLD treatment plant was found to be nearly 35% higher than the carbon footprint of the conventional treatment plant with a capacity of 4.4 million liters per day.
- The application of carbon footprint analysis is a novel performance analysis tool for comparing the different industrial wastewater treatment plants including the ZLD system.

INTRODUCTION

The concentration of greenhouse gases (GHGs) in the earth's atmosphere has increased at an alarming rate in recent years

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due to various anthropogenic activities (Althor *et al.* 2016). The concentration of GHGs above the carrying capacity of the earth's atmosphere directly leads to global temperature rise, which in turn causes sea-level rise, flooding, and extreme weather phenomena (Pandey *et al.* 2011).

In the year 2010, global greenhouse emissions were reported as 48,629 metric tCO₂eq, of which nearly 3% of the

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global emissions were contributed by the waste management sector (Singh & Maurya 2016). In India, the contribution from the waste management sector was 3.34%, which is found to be above the global average (Singh *et al.* 2016). It underlines the immediate need for a well-developed methodology to quantify GHG emissions from this sector to implement emission mitigation practices further.

The wastewater treatment plants have a positive contribution towards environmental impact mitigation through the wastewater treatment, but their energy consumption must also be considered to understand the overall environmental impact. Recent developments in the concept of zero liquid discharge (ZLD) facilities are important for the resource recovery approach. High energy consumption by the reject management system in ZLD facilities demands a well-developed methodology to quantify the environmental impact of the wastewater treatment plants.

The wastewater treatment aspects become a major concern in the case of industrial effluent discharge to the natural receiving bodies. The textile industry has a major contribution to the economic development of India as it is the second-highest exporter of textiles after China. Textile industries simultaneously lead to massive production of textile manufacturing effluents containing various dyes and auxiliary chemicals (Pattnaik & Dangayach 2019).

Coimbatore city is also known as the Manchester of India as the textile manufacturing has thrived in southern parts of the country (Manikandan *et al.* 2015). Enough availability of raw materials and cheap labor further enhance the socio-economic growth associated with textile manufacturing activities. With the ever-increasing textile manufacturing practices in southern India, the adverse environmental impact becomes a major concern for regulatory authorities.

The practice of setting up the common effluent treatment plant (CETP) for textile manufacturing industry clusters has been implemented by the regulatory bodies in India. In the textile dyeing process, salts like NaCl and Na₂SO₄ are added to enhance dye fixation on the cellulose fiber (Holkar *et al.* 2016). The combined effluent from textile manufacturing processes is highly colored, having high organic load and extremely high total dissolved solids. As the CETP generally provides treatment only up to the secondary level, the total dissolved solid content was not completely removed from the discharged treated textile effluent. The higher salt

content is a major concern for the natural receiving water bodies. Therefore, regulatory bodies made it mandatory for all the textile industries with effluent discharge of more than 25 m³/day to set up a ZLD facility.

ZLD refers to the installation of facilities and systems which will enable an industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and inorganic compounds/salts) into residue in the solid form by adopting a method of concentration and thermal evaporation (CPCB 2015). Conventionally, the secondary treated textile effluent from the effluent treatment plant (ETP) was being discharged at various places, which would ultimately find its way into the receiving natural water bodies. The ETP treatment scheme was not designed to remove the dissolved solid content and heavy metals in the textile effluent. Salt content beyond the specified levels in the water can have an adverse impact on the receiving agricultural lands. The textile effluent contains toxic heavy metals like chromium, and its release to natural water bodies can lead to possible bioaccumulation and biomagnification concerns (Paździor *et al.* 2017).

In the ZLD effluent treatment facility, reverse osmosis is provided as the tertiary treatment. The permeate stream can be reused as the process water by textile industries. The reject stream is further fed to a multiple effect evaporator to enhance water recovery. The reject from a multiple effect evaporator is sent to the Agitated Thin Film Dryer (ATFD). The water recovered from the ATFD unit is reused as the boiler feed, and colored powder is considered as hazardous solid waste. The wastewater from textile manufacturing activities can effectively be reused by the implementation of the concept of ZLD (Vishnu *et al.* 2008; Lu *et al.* 2010; Tong & Elimelech 2016; Chavan 2017). The uniform water quality parameters of the reused water are advantageous to the industries, as they can get a constant source of high-quality process water. As the conventional treatment plants are not designed to remove heavy metals and complex xenobiotic organics, implementation of ZLD treatment facilities would eliminate the discharge of these emerging pollutants through industrial effluents (Yaqub & Lee 2019). Figure 1 presents a general schematic flow diagram of the ZLD wastewater treatment plant for the textile industry. After the secondary treatment, effluent is passed through multiple stages of the reverse osmosis process to remove the dissolved solids efficiently. There are two

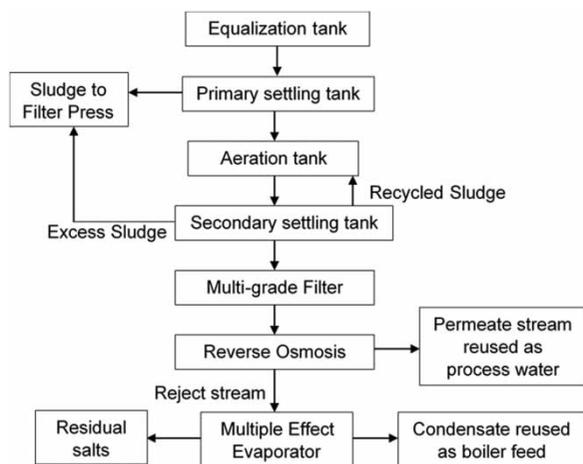


Figure 1 | Schematic flow diagram of a zero liquid discharge effluent treatment facility.

primary sources of hazardous solid waste in the ZLD facility. Firstly, the sludge generated from primary and secondary settling tanks, and second the residual salt obtained from a multiple effect evaporator (De Benedetto & Klemes 2009). An effective hazardous solid waste management system is required at such facilities. It is important to quantify the direct emissions from the secondary treatment stage as they can be effectively mitigated by process modifications (de Haas et al. 2011). By avoiding the formation of anaerobic zones in the aeration tank of biological treatment, direct CH_4 and N_2O emissions can be effectively controlled (Ramírez-Melgarejo et al. 2019). A ZLD wastewater treatment facility effectively reduces the pollution load on land and natural water bodies. In the case of the ZLD wastewater treatment facility, effluent discharge is totally avoided, ensuring water resource recovery from the industrial effluent (Yan et al. 2016). Considering the added advantage of the uniform quality of the reused water over available groundwater with variable quality, textile manufacturers are supporting the establishment of ZLD treatment facilities. Hence, critical analysis of energy required, environmental impact, and pollution potential are to be evaluated based on scientific analysis to comparatively evaluate these aspects.

The quantification of GHG emissions due to certain human activity is important as only after a proper quantification is proper monitoring possible. This quantification process, in case of a product manufacturing step, product disposal option, or for a treatment plant, cannot be a subjective analysis as it will hinder the comparativeness of

different studies. Therefore, the application of the concept of carbon footprint is required as it provides a platform to compare the GHG emissions from various considered sources reported globally. The use of the term carbon footprint was first started as a subset of 'ecological footprint' proposed by Wackernagel & Rees (1996). Ecological footprint refers to the biologically productive land and sea area required to sustain a given human population expressed as global hectares. In similar lines, the carbon footprint can be interpreted as the land area required to assimilate the entire CO_2 produced by humankind during its lifetime.

As per the Intergovernmental Panel on Climate Change (IPCC), the carbon footprint can be defined as a measure of the total amount of GHG emissions of a defined person, organization, or region associated with certain activities, production processes, and life cycle of a product as a whole. The specific time horizon considered for carbon footprint calculation is generally 100 years (IPCC 2019).

There are various globally accepted methodologies for the calculation of carbon footprint. Some major publications in the above context include PAS 2050, ISO standards, and IPCC guidelines. The publicly available specifications-2050 (PAS 2050) of the British Standard Institution (BSI) is used for the assessment of the life cycle GHG emissions associated with the goods and services (BSI 2011). ISO 14064 (parts 1 and 2) is an international standard for the determination of boundaries, the quantification of GHG emissions, and removal. The standards for designing GHG mitigation projects are also provided (ISO 2006a, 2006b). The ISO 14067 document specifies the guidelines for quantification and reporting of the carbon footprint of a product. The GHG emission quantification methodology specified by the IPCC 2006 guidelines for National Greenhouse gas inventories was found to be most robust and applicable for wider scenarios, considering data availability constraints. The methodology follows the 'top-down' or input-output analysis approach, which is most suitable for the complex systems like wastewater treatment plants.

The scope one emission includes the GHG emission due to on-site fossil fuel use within the system boundary. The indirect emissions accounted under scope two and scope three are caused due to activities of the facility, but not directly emitted at the site. The major emissions widely considered under scope two are the emissions due to the

generation of purchased electricity (IPCC 2019). The emissions due to associated transportation of employees, chemicals, and waste material disposal are accounted for under the scope three category. The carbon footprint analysis was used by various researchers to quantify the GHG emissions from domestic wastewater treatment plants (Pagilla *et al.* 2009; Mo & Zhang 2012; Parraviciniak *et al.* 2016). There exists a clear lack of quick and reliable tools for carbon footprint calculation, considering the data limitations in the case of developing countries. The understanding of the concept of carbon footprint and its appropriate field-scale application is important for the reporting of anthropogenic greenhouse emissions from the ETPs.

The objective of the present study was to study the environmental impact associated with the treatment of industrial textile effluent. The two possible scenarios considered in the present study included a conventional treatment system and a ZLD treatment system. Carbon footprint was used as the parameter to comparatively analyze the environmental impact of considered scenarios. Carbon footprint calculation methodology was developed for the application to the wastewater treatment sector in developing countries. Actual field-scale data were collected through extensive industrial visits for the carbon footprint analysis. The expected research outcome included significant inputs for the decision-making authorities towards the establishment of either the conventional or ZLD effluent treatment system.

The following section on methods and techniques includes the details of the proposed carbon footprint calculation methodology. Various steps of carbon footprint analysis applied to conventional and ZLD treatment systems are presented in this section. It is followed by the results and discussion on the finding of comparative carbon footprint analysis. Lastly, the conclusion section presents the collective findings of present research along with the key inputs to textile manufacturers on the selection of appropriate textile effluent treatment system.

METHODS AND TECHNIQUES

Study area

In the present research work, a comparative analysis of carbon footprint for a ZLD textile effluent treatment facility

and a conventional treatment facility discharging the secondary treated effluent to the receiving natural water bodies was performed. The overall treatment capacity of the considered plant in Tirupur district, Tamil Nadu, India, was 4.4 million liters per day, of which 2.2 million liters per day was operational capacity at the time of data collection. Out of the treatment capacity of 2.2 million liters per day, 78% of the effluent was recycled back by the ZLD facility.

In the identification of significant GHG sources, system boundary plays an important role. Only the direct and indirect GHG emission sources considered in the system boundary will be considered for the calculation of carbon footprint. The definition of the boundary condition should include both the special and temporal scales. The system boundaries for the present study are shown in Figure 2.

The data for the present comparative study were collected in the year 2016. On the temporal scale, we are considering an annual operational period for both types of treatment systems. Considering the lack of data on embodied emissions for different types of construction materials being used, the analysis was limited to the operation phase of the considered wastewater treatment plants.

The treatment capacity of the wastewater treatment plant is a key parameter to determine possible GHG emissions from the treatment process. To avoid the misleading results due to different treatment plant capacity values, the treatment plant activities up to secondary treatment were considered the same in the present study for both the scenarios. GHG emissions associated with the tertiary treatment and reject management were considered only for the ZLD facility. Transportation of settled sludge and residual solids to the Transport, Storage, and Disposal Facility (TSDF) was included in the carbon footprint calculations. In the case of the conventional treatment plant, methane emissions associated with the discharge of secondary treated effluent were considered. Based on plant data of percentage effluent recycled, an equivalent amount of groundwater extraction and associated GHG emissions were considered for the conventional treatment plant scenario.

Carbon footprint calculation methodology

The methodology of the calculation of carbon footprint for the wastewater treatment plants can be divided into three

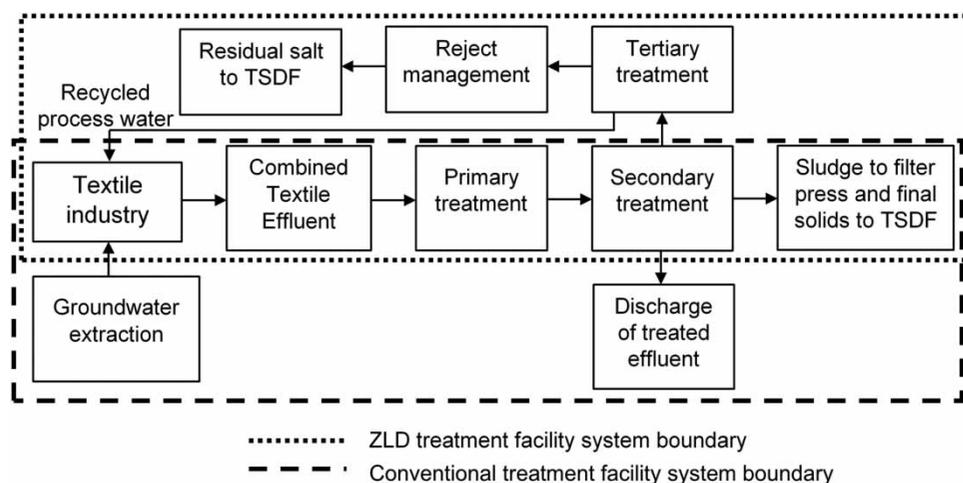


Figure 2 | Schematic representations of system boundaries for the comparative carbon footprint analysis study.

steps. The first step includes the identification of key sources of direct and indirect GHG emissions. The second step can be termed as the quantification step in which one attempts to quantify the emissions from the identified source. The final step involves the use of appropriate emission factors (EFs) to report the data in terms of carbon dioxide equivalents calculated over a time horizon of 100 years.

The three major GHGs widely considered for the carbon footprint analysis of wastewater treatment plants include carbon dioxide, methane, and nitrous oxide (Wiedmann & Minx 2008). The individual emission rate of other GHGs is considered much lower when compared with that of these three GHGs together (UK POST 2006). The capacity to trap the energy in the atmosphere is different for different GHGs. It is quantified in terms of 'global warming potential' which is based on the radioactive effect of 1 kg of the gas over 100 years, compared with the effect of 1 kg of CO₂, and it is expressed as CO₂ equivalents. As per the IPCC fifth assessment report published in 2014, the global warming potential values for methane and nitrous oxide are 28 and 265, respectively.

The EF associated with electricity consumption to be used for Indian conditions is 573.88 kg CO₂-eq per MW of electricity consumed (Singh & Maurya 2016). This factor depends on the electricity generation profile used in the country and associated emissions. Direct emissions on the wastewater treatment plant site include the wood used as a boiler feed material and the use of diesel for backup

power generators on-site. The EF used for wood in the proposed methodology is 1.644 tCO₂eq per ton of wood used. In the case of the diesel use on-site as a generator feed, the EF of 0.00255 tCO₂eq per liter of diesel can be used (Sridhar 2010). GHG emissions due to vehicular transport depend on the type of vehicle. The EFs for different types of vehicles used in India are given in Table 1.

The methane emissions from the biological treatment stage are determined by considering operating conditions of the aeration basin. The nitrous oxide emissions are only from nitrification and denitrification stages (Pagilla et al. 2009). In the case of developing countries like India, these nitrous oxide emissions need not be included in the carbon footprint calculations as they are lesser when compared with other GHG emissions (Ramírez-Melgarejo et al. 2019). The limited data availability limits practicability of the inclusion of nitrous oxide emissions at the field scale. For the quantification of the methane emissions from

Table 1 | EFs for different types of vehicle used (Ramachandra et al. 2014)

Type of vehicle	CO ₂ EF (g/km)	CH ₄ EF (g/km)	N ₂ O EF (g/km)
Motorcycles and mopeds	27.79	0.18	0.002
Cars and jeeps	164.22	0.17	0.005
Buses	567.03	0.09	0.03
Trucks and lorries	799.95	0.09	0.03
Tractors and trailers	515.2	0.09	0.03

biological treatment, the determination of the annual average methane conversion factor is required. The annual average methane conversion factor varies from 0 to 0.4. In the case of a properly operated aeration basin, the lowest value can be used, and the highest value is to be used for heavily overloaded plant operations. The annual average methane conversion factor range of 0.4–1.0 represents anaerobic treatment units. The equations used in the present study were obtained from chapter 6 of 2019 refinement to the 2006 IPCC guidelines for National Greenhouse Gas Inventories. Following Equations (1) and (2), it can be used effectively for the calculation of methane emissions from the biological treatment unit.

$$E_{\text{CH}_4, \text{wwt}, a, y} = \sum_{i=1}^{365} \Delta \text{COD}_{a,i} * Q_{a,i} * B_{\text{ww}} * \text{GWP}_{\text{CH}_4} * \text{MCF}_{\text{ww}} \quad \text{if } \text{OR}_i < 0.8 \quad (1)$$

$$E_{\text{CH}_4, \text{wwt}, a, y} = 0 \quad \text{if } \text{OR}_i > 0.8 \quad (2)$$

where,

$E_{\text{CH}_4, \text{wwt}, a, y}$ are the methane emissions from a biological treatment unit in the year y due to improper operation or overloading (tCO₂eq/year);

$\Delta \text{COD}_{a,i}$ is the quantity of the chemical oxygen demand (COD) removed by the biological treatment unit in the i th day of the year y (t/m³);

$Q_{a,i}$ is the quantity of the influent wastewater in the i th day of the year y (m³);

B_{ww} is the possible, maximum methane-producing capacity of wastewater treated in the year y , and the maximum quantity of methane that can be produced from a given quantity of COD is considered 0.25 kg CH₄/kg COD as per IPCC 2006;

GWP_{CH_4} is the global warming potential of methane (tCO₂eq/tCH₄);

MCF_{ww} is the annual average methane conversion factor for the year y , representing the fraction of organic load that would be degraded to methane;

OR_i is the oxidization ratio that represents the fraction of total organics removed in the biological treatment stage in the i th day of the year y . The OR_i can be calculated

using the following equation:

$$\text{OR}_i = \frac{\Delta \text{COD}_{a,i}}{\text{COD}_{\text{in},a,i}} \quad (3)$$

where,

$\text{COD}_{\text{in},a,i}$ is the COD at the inlet of the aeration tank for the i th day of the year y (tCOD).

In a conventional wastewater treatment plant, it is general practice to discharge the secondary treated effluent to the natural receiving water body. The GHG emissions associated with the treated effluent discharge can be quantified, as discussed below.

The methane emissions due to the discharge of effluent containing degradable organic carbon into receiving water bodies can be calculated as given in the following equation:

$$E_{\text{CH}_4, \text{wwt}, \text{eff}, y} = B_{\text{ww}} * \text{GWP}_{\text{CH}_4} * \text{MCF}_{\text{ww}, \text{eff}, y} * \sum_{m=1}^{12} \text{COD}_{\text{eff}, m} * Q_{\text{eff}, m} \quad (4)$$

where,

$E_{\text{CH}_4, \text{wwt}, \text{eff}, y}$ are the methane emissions due to the presence of degradable organic carbon in the effluent in the year y (tCO₂eq/year);

$\text{MCF}_{\text{ww}, \text{eff}, y}$ is the average methane conversion factor in the year y , representing the fraction of organic load in the effluent that is degraded to CH₄ in the year y ;

$\text{COD}_{\text{eff}, m}$ is the quantity of chemical oxygen demand in the effluent of the wastewater treatment plant in the month m of the year y (tCOD/m³);

$Q_{\text{eff}, m}$ is the quantity of effluent containing the degradable organic carbon that is discharged into the receiving body in the month m of the year y (m³).

The annual average methane conversion factor is calculated using Equation (5). The factor f_d accounts for the depth of the natural receiving body, and the factor f_T is used to incorporate the temperature dependence of methane generation.

$$\text{MCF}_{\text{ww}} = f_d * f_T \quad (5)$$

The default value for f_d varies with depth as 0.7 if the depth of the water body is more than 5 m, 0.5 if the depth is in a range of 1–5 m, and 0 if the depth is less than 1 m. India, being a tropical country, comparatively higher temperatures are observed in the receiving water bodies throughout the year. Therefore, the value of f_T can be considered as one for equatorial countries.

The emissions associated with groundwater extraction include two major parts as the emissions associated with the electricity consumption for pumping and emissions from the transportation of groundwater from the pumping site to the textile manufacturing facility. The groundwater requirement was estimated based on the actual quantity of water required and from where the groundwater has been extracted and transported. The worked-out figures were in line with published data by Shah et al. (2004); Subburaj (2008); and Grönwall & Jonsson (2017). These data were also corroborated with industry experts. During our interaction with the textile manufacturers, they have clearly mentioned that they prefer to use the reclaimed water for the textile processing than the groundwater as the quality of the groundwater varies considerably according to the pumping site. The water is transported in lorries from the pumping site to textile facilities, and currently, around 172 such lorries are operating in Tirupur district, with 15 km as average distance traveled per trip. The proposed carbon footprint calculation methodology can be summarized as shown in Figure 3.

RESULTS AND DISCUSSION

The following section presents the results obtained from the comparative analysis of carbon footprint for a ZLD effluent treatment facility and a conventional effluent treatment facility. From the field visits and data provided by plant operators, the major carbon emission sources were identified. Direct and indirect GHG emissions were calculated as per the IPCC guidelines.

Table 2 presents the data on the quantification of GHG emission sources used in both the scenarios compared in the present analysis. Sludge transportation requirements for a ZLD treatment facility were found to be more than that for the conventional treatment plant, as the transport of

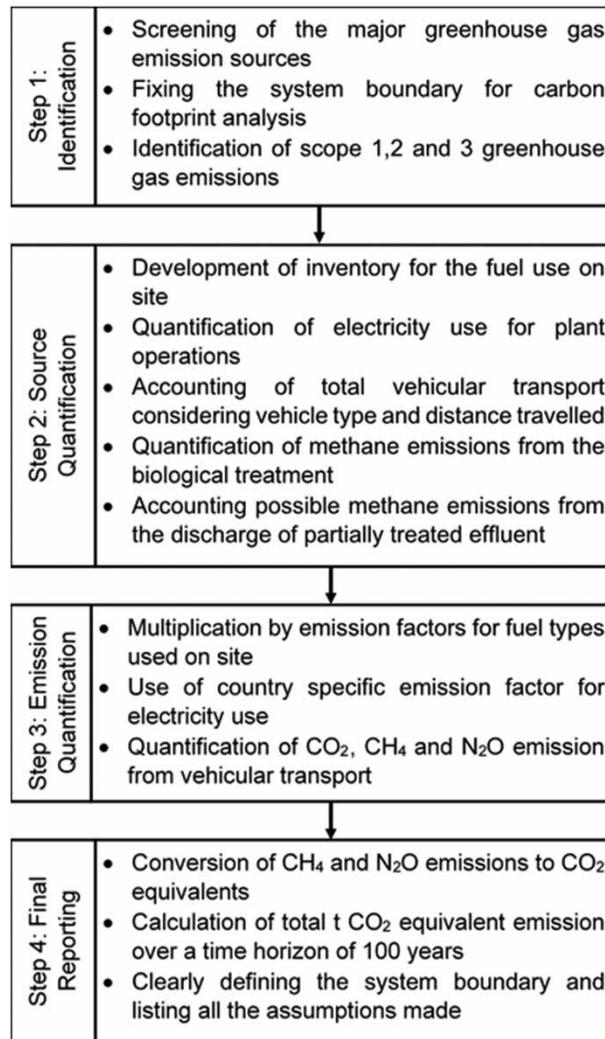


Figure 3 | Summary of the carbon footprint calculation methodology.

both dewatered settled sludge and residual salts was considered.

The GHG emissions for the quantified sources are calculated by multiplying with respective EFs, as discussed in the Methods and Technique section. Table 3 represents a model calculation of the carbon footprint for a conventional treatment plant as per the proposed methodology.

The results of the calculated carbon footprint for a ZLD treatment facility and a conventional treatment facility are presented in Table 4. The total carbon footprint was observed to be 10,598.31 tCO₂eq/year for a ZLD treatment facility, the same the conventional treatment facility was found to be 7,761.22 tCO₂eq/year. The total transportation presented in row three of Table 4 included the

Table 2 | Source quantification for carbon footprint calculation

GHG emission source	Conventional treatment facility	ZLD treatment facility
Fuel use on-site	2,190 t/year wood used	4,380 t/year wood used
Electricity consumption	1,753,731 kWh/year	4,661,367 kWh/year
Transportation	157,000 km by truck	198,000 km by truck
CH ₄ emission from biological treatment unit	1,606 t COD/year treated at slightly loaded condition	
CH ₄ emission due to treated effluent discharge	Effluent COD of 25 mg/L	Not applicable
Groundwater pumping	762,105 kWh/year	Not applicable
Groundwater transport	941,700 km by water lorries	Not applicable

transportation associated with sludge disposal and groundwater transport in the case of a conventional treatment facility.

As per the findings by Gupta & Singh (2012), the GHG emission from a domestic wastewater treatment plant in New Delhi, India, was found to be nearly

3,028 tCO₂eq/year. The reported GHG emissions were less when compared with the present study findings because the emissions associated with the discharge of treated wastewater were not considered within the system boundaries by Gupta & Singh (2012). In the case of the domestic wastewater treatment plant at Patna, India, the GHG emissions were quantified as nearly 6,584 tCO₂eq/year by Singh & Maurya (2016). The on-site sludge digestion unit was considered by Singh & Maurya (2016), leading to higher on-site methane emissions. In both the mentioned studies, the system boundary was limited to the wastewater treatment plant premises boundary. From Table 4, it can be observed that for the fuel use on-site and electricity consumption, the emissions from the ZLD treatment facility are higher than those from the conventional treatment facility based on the positive value of percentage difference of carbon emissions with respect to the conventional treatment facility, calculated as the (Emissions from the ZLD treatment facility – Emissions from the conventional treatment facility)/Emissions from the conventional treatment facility. Percentage individual emission contribution from considered GHG emission sources is presented in Figure 4(a) and 4(b) for the ZLD treatment facility and conventional treatment facility, respectively. In the case of a ZLD

Table 3 | Model calculation for carbon footprint of conventional treatment plant

Emission source	Quantification of source activity (a)	Quantification of GHG emission (emission factor × a = b)	Carbon footprint (GWP × b) (tCO ₂ eq/year)
Fuel use on-site	2,190 t/year wood used	1.644 tCO ₂ eq per ton of wood ⁽ⁱ⁾	3,600.36
Electricity consumption	1,753,731 kWh/year	573.88 kg CO ₂ -eq per MW ⁽ⁱⁱ⁾	1,006.43
Transportation	157,000 km by truck	CO ₂ (g/km) CH ₄ (g/km) N ₂ O (g/km) 799.95 0.09 0.03	127.23
CH ₄ emission from biological treatment unit	Treating 1,606 t COD/year	0.05 ⁽ⁱⁱⁱ⁾ × 0.25 (t CH ₄ /t COD) × 1,606 (t COD/year)	562.10
CH ₄ emission due to treated effluent discharge	Effluent COD of 25 mg/L	0.00025 (t COD/m ³) × 803,000 (m ³ /year) × 1 ^(iv) × 0.9 ^(v) × 0.25 (t CH ₄ /t COD)	1,264.72
Groundwater pumping	762,105 kWh/year	573.88 kg CO ₂ -eq per MW	437.35
Groundwater transport	941,700 km by water lorries	CO ₂ (g/km) CH ₄ (g/km) N ₂ O (g/km) 799.95 0.09 0.03	763.16

⁽ⁱ⁾Based on the type of fuel.⁽ⁱⁱ⁾Country-specific factor.⁽ⁱⁱⁱ⁾Based on the organic load on biological treatment stage.^(iv)Based on the temperature variation in receiving natural water body.^(v)Based on the mixing depth of receiving natural water body.

Table 4 | Summary of the comparative carbon footprint analysis

GHG emission source	Conventional treatment facility (tCO ₂ eq/year)	ZLD treatment facility (tCO ₂ eq/year)	Percentage difference with respect to conventional treatment facility
Fuel use on-site	3,600.36	7,200.70	+ 100
Electricity consumption	1,006.3	2,675.06	+ 165.83
Total transportation	890.39	160.45	– 81.98
CH ₄ emission from biological treatment unit	562.10	562.10	0
CH ₄ emission due to treated effluent discharge	1,264.72	0	– 100
Groundwater pumping	437.35	0	– 100
Total	7,761.22	10,598.31	

treatment facility, fuel use on-site and electricity consumption can be identified as the GHG emission hotspots. In the case of a conventional treatment facility, methane emissions due to treated effluent discharge contribute the second-highest percentage of GHG emissions underlining the importance of water recycling by establishing a ZLD treatment facility. The complex organic compounds present in the textile effluent are considered as a potential threat to human health and aquatic organisms (Makene *et al.* 2019). Therefore, it is important to develop strategies that would minimize the carbon footprint of the designed ZLD wastewater treatment plants for industrial effluents, which in turn would minimize the overall environmental impact.

The availability of freshwater resources for any industrial production is particularly important. Considering the scarcity of natural freshwater resources, wastewater reuse potential has become an important factor for sustainable production (Cetinkaya & Bilgili 2019). The establishment of ZLD ETPs results in a reliable continuous process water source for the textile manufacturing industries. Also, the uniformity in water quality parameters of reused water further proves advantageous.

Based on the results of the present work, it was found that it is important to minimize the energy requirements for ZLD wastewater treatment plants. The energy consumption by reject management units can be significantly reduced by source segregation of the effluent streams. Only the effluent streams containing a high concentration of dissolved solids can be treated separately and supplied to the tertiary treatment units. The source segregation leads to a reduced volume of reject stream to be handled by reject management

systems. This can lead to a reduction in the total operation time of reject management units, resulting in reduced energy consumption. The use of renewable energy sources should be encouraged along with the establishment of ZLD wastewater treatment plants, which can ensure a reduced carbon footprint by the reduction of scope two carbon emissions. The carbon footprint of a given ZLD treatment facility can be used effectively as a performance indicator to further limit the energy consumption on site.

CONCLUSION

The textile manufacturing facilities in southern India are thriving with the rising demand, and associated environmental impact is a major concern for regulators. The concept of ZLD treatment plants has been well established for such polluting industries but needs further critical analysis in terms of associated climate change impact due to higher energy consumption. Any well-quantified efforts towards the reduction of the carbon footprint of ZLD treatment facilities can further reduce the overall environmental impact of textile manufacturing activities. The conclusions of the present research work can be summarized as follows:

1. Carbon footprint analysis can be used as an effective tool to quantify carbon emissions from the ETPs, which supports further understanding of the pollution hotspots at the ETPs.
2. The total carbon footprint was estimated as 10,598 tCO₂eq/year for a ZLD treatment facility, whereas for the

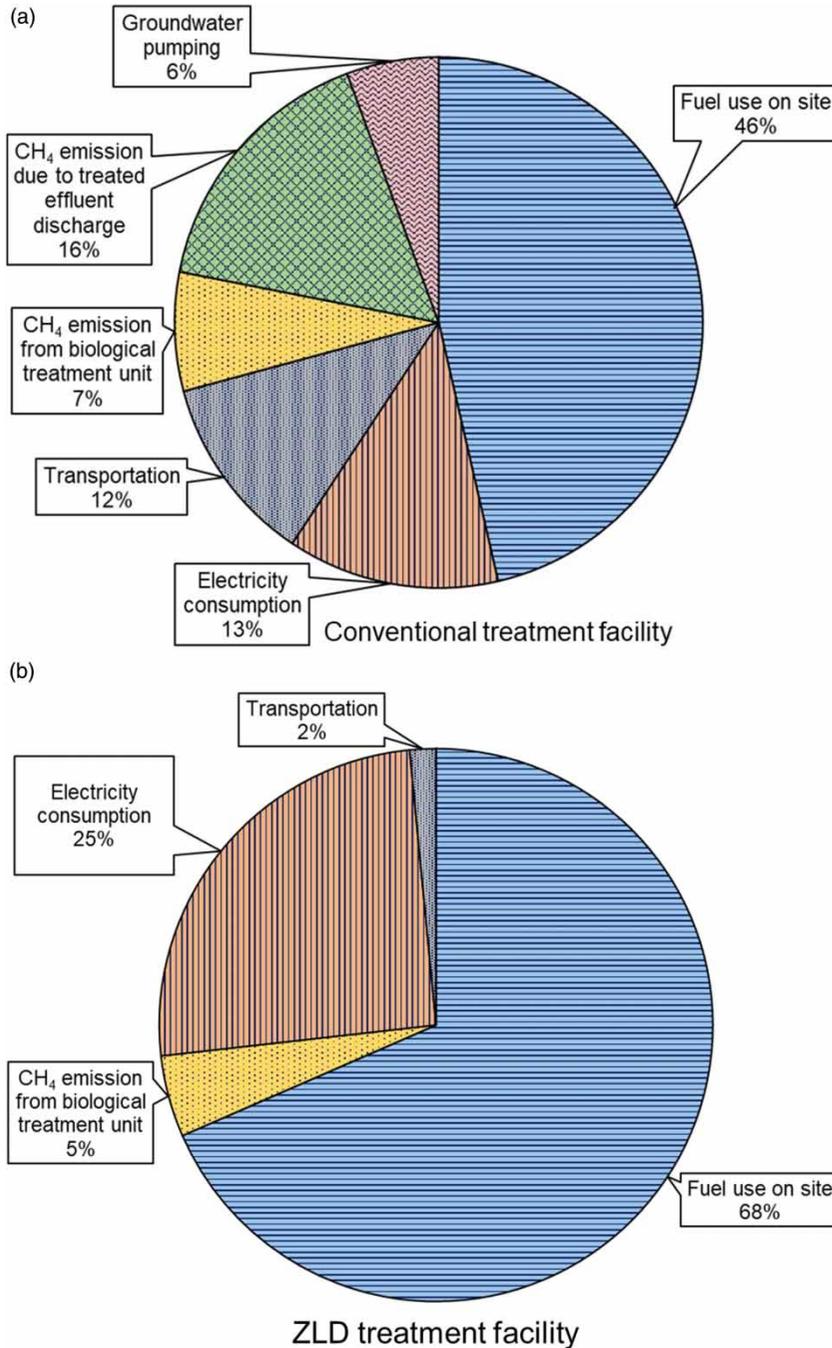


Figure 4 | Percentage emission contribution from various GHG emission sources for (a) conventional treatment facility and (b) ZLD treatment facility.

conventional treatment facility, it was found to be 7,761 tCO₂eq/year.

3. Second- and third-highest GHG emission contribution in terms of percentage was found to be associated with the groundwater extraction and treated effluent discharge in

case of a conventional treatment plant, indicating the importance of effluent recycling.

4. The performance of various ZLD treatment plants can be compared using carbon footprint as a performance indicator to compare the energy efficiency of various units.

5. It is concluded that the carbon footprint analysis is an important tool for comparing alternate strategies in wastewater treatment as well as to evaluate the tradeoff between the environmental protection and energy requirement.

The carbon footprint of the ZLD treatment facility was found to be nearly 1.36 times the carbon footprint of a conventional treatment plant. However, efforts should be made to develop technologies that would minimize the carbon footprint, in line with the low-carbon technologies which are being attempted by many researchers across the globe.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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Analysis of flow and energy aspects of Zero Liquid Discharge (ZLD) technology in treatment of tannery effluents in Tamil Nadu, India

(Presented during the XXXIV IULTCS Congress Chennai/India 05-08 February 2017)

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Analysis of flow and energy aspects of Zero Liquid Discharge (ZLD) technology in treatment of tannery effluents in Tamil Nadu, India

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Abstract

In the course of conventional treatment of tannery effluent the composition of Total Dissolved Solids (TDS) somewhat changes but its total level remains virtually constant and considerably exceeds typical discharge norms. The global trend of processing of fresh hides, i.e. salt-free raw material is continuously expanding; for a host of reasons this approach is non-existent in India.

The precarious situation with water and soil pollution in the area of tannery clusters along the Palar River prompted the state environmental authorities to press for adherence to TDS discharge limits as well as to impose an approach not practiced in the tanning industry: a Zero Liquid Discharge (ZLD) concept.

Essentially, the ZLD systems concentrate dissolved solids by Reverse Osmosis (RO) and some kind of Multi Effect Evaporation (MEE) until only damp solid waste remains. Solid waste is disposed and nearly all water is reclaimed and reused. Accordingly, some of the existing Common Effluent Treatment Plants (CETPs) have been supplemented by RO and MEE, together with auxiliary steps (tertiary treatment, water softening etc.).

The analysis investigates and relates raw and equalized effluent inflows, RO feed, permeate and reject, evaporator feed and condensate and the yield of recovered, reusable water. Since the energy costs are critical for the viability of the entire concept, data about energy consumption (thermal, electrical main and Diesel) at key stages (RO, multistage evaporation) are consolidated, analysed and correlated. Additional energy needs and costs are compared with those for conventional (CETP) treatment and estimates made of the carbon footprint increase caused by the ZLD operations.

Keywords: TDS, ZLD, effluent flows, evaporation heat, energy consumption, energy costs, carbon footprint

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Introduction

In the tanning area of Ranipet, Vellore District there are about 200 tanneries grouped in three clusters, each serviced by a CETP with treated effluent ultimately ending in the Palar River which in the recent years is mostly dry with no flow. There are neither sewerage networks nor sewage treatment plants in the adjacent municipalities.

Total Dissolved Solids (TDS), mainly chlorides and sulphates in tannery effluent have become the major environmental concern in arid and semi-arid regions as they make the receiving water recipients unfit both for livestock watering and for irrigation. Although a certain percentage emanates from pickling, deliming, tanning and wet finishing, the main source of TDS, especially of sodium chloride, is salt from preservation. It is estimated that worldwide at least 3.0 million tons of common salt per year are discharged into water recipients. Whilst specific discharge limits for TDS vary, generally they cannot not be achieved by conventional treatment.

Environmental damage caused by salting gradually prevails over its convenience aspects; the tanning industry in Europe has already largely switched to processing of salt-free raw material and this trend is continuously expanding (e.g. Brazil). For a host of reasons, while enforcing the TDS limit of 2100 mg/l, state environmental authorities and the tanning industry have chosen a different strategy: to adopt a Zero Liquid Discharge (ZLD) approach. The existing CETPs, following the usual treatment technology, have been supplemented by advanced, energy intensive methods like Reverse Osmosis (RO) and Multi Effect Evaporation (MEE) together with the necessary auxiliary steps (tertiary treatment, water softening etc.).

This paper attempts to analyse effluent flows, energy aspects and the impact on carbon footprint of the ZLD segment at three CETP+ZLD system(s) in Vellore District after a few years of operations. In that context, experience from the CLRI - UNIDO project in 1998-2000 in operating a pilot two-stages RO plant of 1 m³/h capacity (albeit using solar pans instead of advanced evaporators) proved quite useful. The conclusion was that the system *per se* was technically viable but that O&M cost (only partly off-set by the price paid for fresh water) were quite prohibitive mainly due to high energy inputs.

Selection of plants for analysis

The plants selected cover the three main types of clusters: processing raw hides/skins to finished leather, (RANITEC), predominantly from raw to wet blue (VISHTEC) and from wet blue/EI to finished leather (SIDCO). The three plants basically follow the same technology, are operated by quite professional staff and the managements willing to cooperate. They are all connected to the Care AIR centre (server) of the TNPCB, the flow data are recorded in real time and counterchecks are possible.

Water consumption, effluent flows, yield

One claim is that addition of the ZLD stage has resulted in water consumption decrease from about 28 to only 11-12 l/kg of wet salted weight; increase in concentrations of pollutants support that claim. The opposing view is that local tanners already have long experience in economizing with water brought by tanks from considerable distances. To further halve

such low consumption within 3 – 5 years is does not look quite likely. In addition, according to some UNIDO studies, the theoretical minimum is about 12 l/kg and it requires sophisticated recycling equipment.

The permeate from RO system and the condensate from evaporator are combined and distributed back to the tanneries through a recovered water conveyance system.

Table 1. Effluent flows, RANITEC, April 2015 – March 2016

ITEM	Unit	TOTAL
Inflow to CETP	m ³	415,185
RO Feed	m ³	411,652
RO Feed vs. inflow	%	99 %
RO Permeate	m ³	296,331
Permeate vs. RO feed	%	72 %
RO Reject	m ³	115,321
RO reject vs. RO feed	%	28 %
Evaporator feed	m ³	118,632
Evaporator condensate	m ³	121,770
Evaporator condensate vs. evaporator feed, %	%	103 %
Total recovered water	m ³	414,963
Total recovered water vs. RO feed %	%	102 %
Total recovered water vs. inflow to CETP %	%	101 %
Salt residue	tons	5,043
Salt residue vs. raw effluent, kg/m ³	kg/ m ³	12.1

The (full) table shows some expected but also some perplexing figures and proportions.

- RO feed vs. inflow to CETP ratio varies from 81 – 114, average 99 %
- Permeate vs. RO feed varies from 57 – 80, average 72 %
- RO reject vs. RO feed varies from 20 – 43, average 28 %
- Evaporator condensate vs. feed varies from 97 – 109, average 103 %
- Total recovered water vs. RO feed from 96 – 106, average 102 %
- Total recovered water vs. inflow to CETP varies from 80 – 113, average 101 %
- Salt produced is 5043 tonnes, from 9.7 – 14.3 average 12.1 kg/m³

For an accurate flow balance, it would be necessary to take into account additions such as water used for dissolving of chemicals and water from boilers as well as all losses (evaporation, sludge).

The main flow parameters for SIDCO and VISHTEC follow a similar pattern and are merged into a summary table.

Table 2. Comparison of flow rates in three ZLD plants in tannery clusters in Vellore District

ZLD	RANITEC	SIDCO	VISHTEC
ITEM	Apr 15 – Mar 16	Sep 15 – May 16	Apr 15 – Mar 16
	<i>Average flow rates and spans</i>		
RO feed vs. inflow to CETP	99 % (81 – 114)	99 % (97 – 101)	101 % (99 – 104)
Permeate vs. RO feed	72 % (57 – 80)	76 % (67 – 83)	75 % (71 – 81)
RO reject vs. RO feed	28 % (20 – 43)	24 % (17 – 33)	25 % (19 – 29)
Total recovered water vs. inflow	101 % (80 – 113)	98 % (94 – 101)	101 % (97 – 105)
Total recovered water vs. RO feed	102 % (96 – 106)	97 % (94 – 101)	100 % (98 – 101)
Salt residue vs. raw effluent, kg/m ³	12.1 kg/m ³ (10.6 – 14.3)	6.2 kg/m ³ (4.7 – 8.5)	12.8 kg/m ³ (11.0 – 13.9)

Note: In the case of SIDCO, the inflow to CETP is actually the flow measured at the outlet of the equalization tank.

The overall flow balance is from the tanner's viewpoint satisfactory: all losses due to evaporation (rather low due to high air humidity) and water removed with sludge are compensated by additions for dissolution of chemicals, water softening and washes. Ultimately, the effluent inflow coincides with the volume of water sent back to tanneries for reuse, its quality is superior to fresh water is due to low hardness; however, most likely due to absence of proper nitrification/denitrification during the biological treatment, there is strong presence of nitrogen in the condensate.

Figure 1. A simplified scheme of water adding & losses in the course of ZLD process

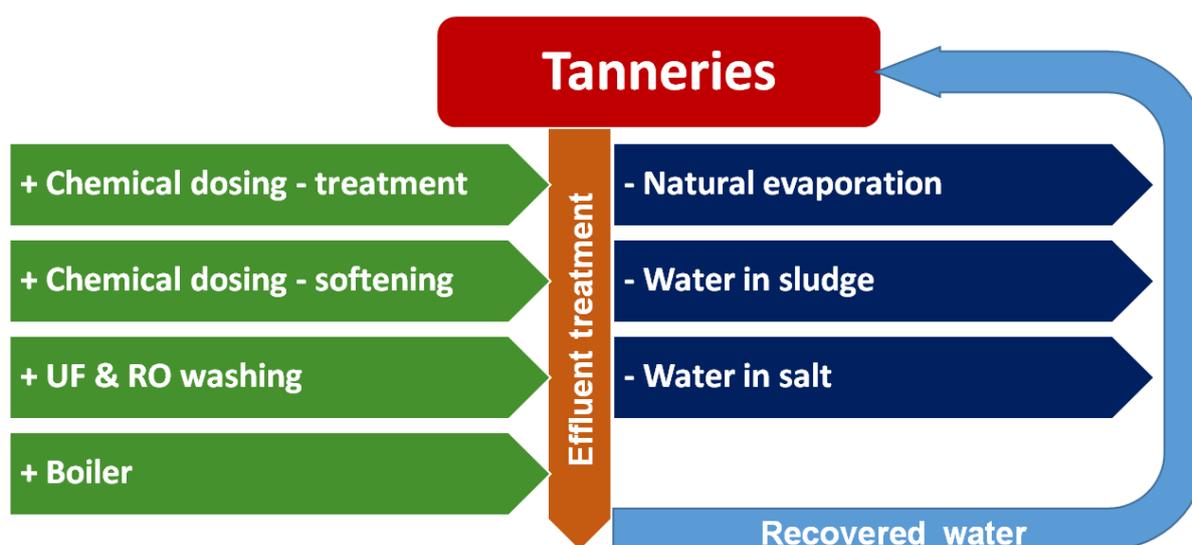
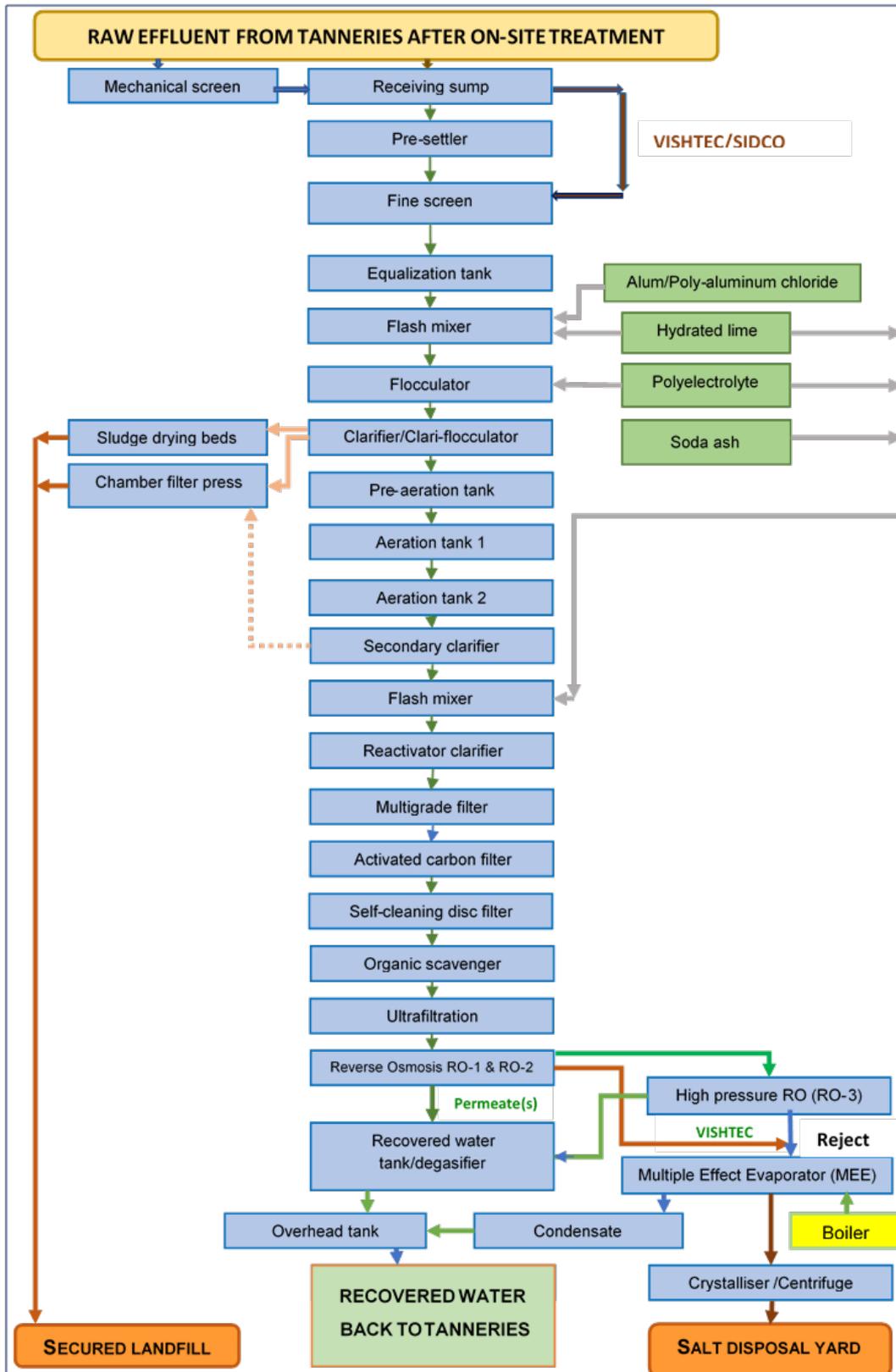


Figure 2. A simplified flow-chart of the ZLD treatment at RANITEC, Vellore District



The ZLD is not so much treatment but rather a salt removal and sequestration system. For good results, it should operate with constant chemistry and constant flow for which they were specifically designed and must be monitored continuously. Preparatory, post-CETP

“conditioning” steps, in particular water softening, often require dosing of different chemicals, including salts, which is quite a paradox for what is essentially a salt removal system.

Figure 3. Pallavaram CETP, Aeration and clarifier tanks; Ultrafiltration units; Reverse osmosis; Multiple evaporators



The permeate from the RO system and the condensate from evaporator are combined and as the recovered water and metered distributed back to one-day storage capacity tanks in individual tanneries. The salt-laden solid residue is stored in bags in a huge salt storage yard.

Norms, monitoring

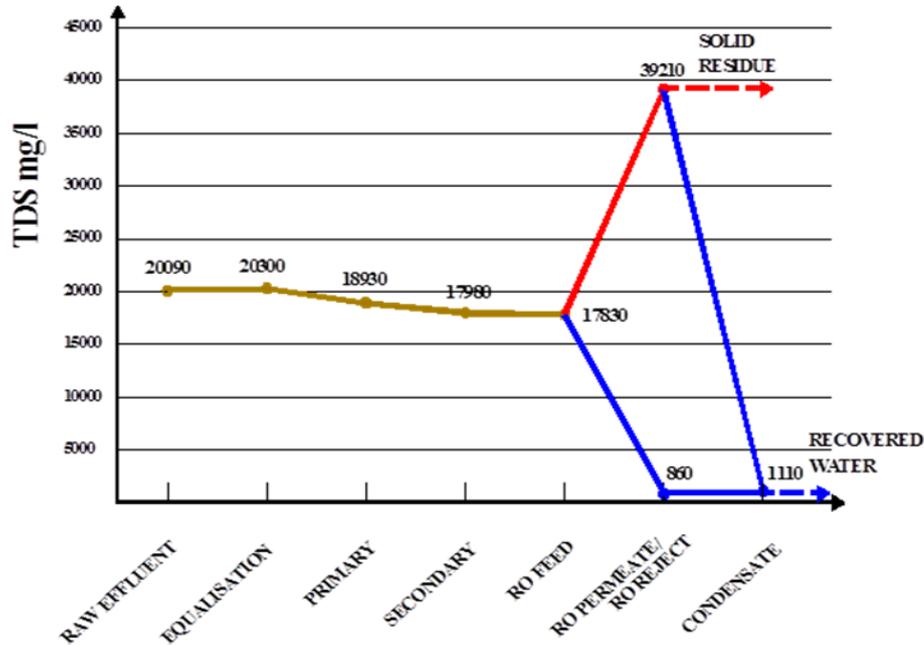
Water used in tanneries in clusters in the Vellore District is in most cases a mixture of water from own drilled wells and (better) water drawn from the Palar River bed further upstream and brought by tankers; the supply and characteristics of fresh water are inconsistent and unpredictable and comprehensive analyses of fresh water apparently are not available. Reportedly, the TDS of fresh water is in the range of 800-1500 mg/l, hardness 200-800 mg/l (tankers) and 1000 - 3000 mg/l, hardness 800-2000 mg/l (own wells). Thus, the usual problem of TDS is compounded by the high TDS/hardness level of fresh water.

To meet the TNPCB discharge norms for Dissolved solids (inorganic), 2100 mg/L, Chloride 1000 mg/L and Sulphates 1000 mg/L, a very different set up in the whole supply chain, mixing of treated effluent with municipal wastewater and/or advanced methods of decreasing the TDS level are required.

Unfortunately, differences in values found by CETP's own laboratories and analyses carried out by independent laboratories (third parties) too often exceed normal and acceptable variations. Inevitably, this casts a kind of shadow of doubt and possibly undue reserve in considering the laboratory statistical data.

The Computerized Operations Management System for the Ranipet CETP includes analytical data for key treatment units as well as sludge disposal record and sludge & leachate analysis.

Figure 4. Total Dissolved Solids (TDS), monthly averages, RANIPET, April 2015 – March 2016



Energy considerations

Energy consumption in tanneries depends on factors such as tannery location (geographic zone), production method, equipment, performance of electric motors, the ratio of manual vs. mechanical/automated handling (e.g. in moving the hides), drying methods, solid waste treatment, effluent treatment technology etc.

Generally, water (float) heating and drying, almost equally, make about two thirds of the energy consumption for leather processing itself. The type of energy source is also very relevant: fossil fuel (natural gas, coal, Diesel), renewable (wood, biomass) or self-generated renewable (solar energy, wind). Optimisation of electric motors, use of electric motors with higher efficiency and reducing the level of reactive energy are an important part of (electric) energy savings measures. The use Diesel generators is limited to emergencies.

Table 3. Energy consumption & cost, Primary, Secondary & Tertiary Treatment (PST), RANITEC, April 2015- March 2016

ITEM	Unit	TOTAL
Inflow to CETP	m ³	415,185
Units consumed in KWh (EB)	kWh	2,349,980
Diesel litres (DG)	L	47,711
Units consumed in KWh (DG)	kWh	110074
Units consumed in KWh (EB+DG)	kWh	2,460,054
Total units vs. inflow	kWh/m ³	5.9
EB cost per unit	Rs.	9.1
EB power cost	Rs.	21,567,943
Diesel price	Rs./L	62
Cost of Diesel	Rs.	2,958,082
Total energy cost	Rs	24,526,025
Total energy cost vs. inflow	Rs. /m³	59 (USD 0.9)*

*At Rs. 66.3 to 1 USD

Table 4. Energy consumption & cost, Reverse Osmosis + Evaporation, RANITEC, April 015- March 2016

ITEM	Unit	TOTAL
Inflow to CETP	m ³	415,185
RO reject	m ³	115,321
Units consumed in kWh (EB)	kWh	4,168,830
Diesel litres (DG)	L	74,029
Units consumed in kWh (DG)	kWh	196,992
Units consumed in kWh (EB+DG)	kWh	4,365,822
Total units vs. inflow	kWh/m ³	10.0
EB cost per unit	Rs.	9.10
Total EB power cost	Rs.	37,492,478
Diesel price	Rs./L	62
Cost of Diesel	Rs.	4,589,798
Total power cost (EB + Diesel)	Rs.	42,082,276
Power cost (EB + Diesel)	Rs./m ³	101
Firewood used	Kg	7,406,396
Firewood price	Rs./kg	4.2
Firewood/m ³ of reject	kg/m ³	64
Cost of fuel (firewood) for MEE	Rs.	31,106,863

ITEM	Unit	TOTAL
Total energy cost	Rs.	73,189,139
Total energy cost vs. inflow	Rs./m³	176 (USD 2.7)

The main energy parameters for SIDCO and VISHTEC generally follow a similar pattern and are merged into a summary table.

Table 5. Energy consumption & cost, Reverse Osmosis + Evaporation, RANITEC, SIDCO & VISHTEC 2015-2016

ITEM	Average per month			
	Unit	RANITEC	SIDCO	VISHTEC
Inflow to CETP	m ³	34,599	28,533	11,871
Units consumed in kWh (EB)	kWh	347,403	227,004	9,5795
Units per inflow	kWh	10.0	8.0	8.1
Total electricity cost (EB)	Rs.	21,567,943	1,407,422	593,928
Diesel consumed	L	6,169	1.193	732
Diesel cost	Rs.	382,483	73,959	45,353
Cost of power (EB + Diesel)/m ³	Rs./m ³	101	52	54
Firewood used	Kg	617,200	512,902	259,916
Firewood/m ³ of reject	kg/m ³	64	77	88
Cost of fuel for evaporator	Rs.	2,592,239	2,277,283	1,143,632
Total energy cost	Rs.	6,099,095	3,756,618	1,833,784
Total energy cost vs. inflow	Rs./m³	176 (USD 2.7)	132 (USD 2.0)	154 (USD 2.3)

Remark: Despite some variations, the price of firewood has been taken as Rs. 4.2/kg. Similarly, despite variations in Diesel prices during the year, its cost was calculated at Rs. 62/L as the yearly average; also, there are significant differences among plants in using Diesel as a source of energy.

Table 6. Comparison of energy consumption & cost, PST vs. ZLD stage (Reverse Osmosis + Evaporation), RANITEC, April 2015- March 2016

Item	Unit	PST	ZLD	Total	Total vs. PST, %
		1	2	3 (1+2)	4 (3/1)
Inflow	m ³ /year	415,185			
Electrical energy (EB)	kWh/year	2,349,980	4,168,830	6,518,810	277%
Total electrical energy vs. inflow	kWh/m ³	5.7	10.0	15.7	277 %
Cost of electrical energy (EB)	Rs./kWh	9.10			
Cost of electrical energy (EB)	Rs./year	21,384,818	37,936,353	59,321,171	277%
Cost of electrical energy (EB) vs. inflow	Rs./m ³	52	91	143	275%
Total electrical energy (EB) consumed in MJ	MJ/year	8,459,928	15,007,788	23,467,716	277%
Consumption of Diesel fuel	L/year	47,711	74,029	12,1740	255%
Diesel price	Rs./L	62			
Cost of Diesel	Rs./year	2,958,082	4,589,798	7,547,880	255%
Consumption of fuel, Diesel in MJ	MJ/year	1,860,729	2,887,131	4,747,860	255%
Consumption of firewood	kg/year		7,406,396	7,406,396	
Cost of firewood per kg	Rs./kg		4.2	4.2	
Total cost of firewood	Rs./year		31,106,863	31,106,863	
Total firewood consumption, MJ	MJ/year		122,205,534	122,205,534	
Overall energy consumption (EB+Diesel+ firewood)	MJ/year	10,320,657	140,100,453	150,421,110	1457%
Total energy cost (EB+Diesel+ firewood)	Rs./year	24,342,900	73,633,014	97,975,914	402%
Total energy in MJ vs. inflow	MJ/m³	25	337	362	1457%
Total energy cost vs. inflow	Rs./m³	59	177	236 (\$ 3.6)	402%

Note: Minor discrepancies due to rounding up!

The following table shows shares of the main components of energy consumption and costs.

Table 7. Energy consumption & cost comparisons, RANITEC, April 2015- March 2016

Item	Rate %
Share of PST energy in Total energy consumed	7%
Share of ZLD energy in Total energy consumed	93%
Share of PST energy cost in Total energy cost	25%
Share of ZLD energy cost in Total energy cost	75%
Share of electrical energy in Total energy consumed, MJ	16%
Share of thermal (Diesel) energy in Total energy consumed. MJ	3%
Share of thermal (firewood) energy in Total energy consumed. MJ	81%

* including Diesel Values rounded up!

The impact of addition of the ZLD stage (RO + MEE) to the conventional treatment can be summarized as follows:

- The consumption of electrical energy went up nearly three times
- The overall energy consumption (electrical and thermal) went up nearly 15 times
- The cost of electrical energy, including its unit cost (Rs./m³) went up nearly three times
- The total cost of energy (electrical and thermal) went up about 4.5 times
- The share of ZLD energy in total energy consumed is about 93 %
- The share of ZLD energy cost in total energy cost is about 78 %

Chemicals from the ZLD stage, O&M costs, salt residue

In addition to sodium chloride applied for preservation of hides and skins, chemicals used in the course of leather processing and usual chemicals used for during the primary treatment (lime, alum, polyelectrolytes), significant amounts of chemicals affecting the TDS content are added during tertiary treatment, water softening, RO and evaporation steps: hydrochloric acid, sodium metabisulphite, antiscalant, polyphosphates, caustic soda, sodium bicarbonate etc.

According to some local lab analysis, the salt residue produced contains, on dry basis, chlorides 54.10 %, sodium 35.03 %, calcium 0.86 %, magnesium 0.30 %, sulphates 1.45 %, silica 1.30 % etc. The moisture is about 11 % and loss on ignition (organic matter) about 5%.

The reported, indicative O&M cost for the year 2015/2016 are between USD 6.9 – 8.7/m³, part of it assumingly offset by saving the cost of fresh water of about USD 1.4/m³. In absence of reliable data about raw material input, yields etc. it is not possible to relate the O & M cost to leather output, educated guesses put them from about Rs. 20/m² (RANITEC), Rs. 23/m² (SIDCO) to Rs. 40/m² (VISHTEC), corresponding to USD 0.30, USD 0.35 and USD 0.60 per square metre.

The salt residue represents a very serious environmental challenge, quantities generated are impressive. Only in year 2015/2016, the RANITEC plant has produced 5043 tonnes, VISHTEC 1818 tonnes and SIDCO 1591 tonnes. Unfortunately, currently there are substantial differences between the theoretical values for the RO + Evaporation stage and the actual outputs of salt residue at three plants considered.

Table 8. Apparent gaps in TDS balance at RO stage, tonnes per year

Item	Unit	RANITEC	VISHTEC	SIDCO*
RO feed	m ³ /year	411,652	143,753	254,955
TDS in RO feed	mg/L	17,830	17,920	9,160
TDS in RO Feed	t/year	7,340	2,576	2,335
Permeate	m ³ /year	296,331	108,315	194,113
TDS in permeate	mg/L	860	465	388
TDS in permeate	t/year	255	50	75
Reject	m ³ /year	115,321	35,438	60,842
TDS in Reject	mg/L	39,210	39,420	36,100
TDS in Reject	t/year	4,522	1,397	2,196
TDS in permeate + TDS in Reject	t/year	4,777	1,447	2,271
Difference: TDS in RO Feed – (TDS in permeate + TDS in Reject)	t/year	2,563	1,129	64
Difference	%	35 %	44 %	3 %

*actually for nine months only

There are views and computations suggesting substantially lower figures. According to them, the unaccounted loss at RANITEC is 4.65 %, at SIDCO 3.72 % and only 0.15 % at VISHTEC. However, some logic and estimates in those computations such as the share of *Volatile portion of salt lost in evaporation* or in transportation and some other are very questionable. Obviously, the complexity of the issue requires extensive, independent monitoring and analysis over at least one year.

Carbon footprint - the impact of ZLD stage on CO₂ emissions

Values used for computations:

- Average CO₂ emissions for electricity production in India: 0.9.kg CO₂/kWh (2012)⁶
- Calorific value of Diesel used by DG: 39 MJ/L
- CO₂ emissions from Diesel: 74.1 kg CO₂/GJ of thermal energy⁷
- CO₂ emission/L of Diesel: (39 x 74,1)/1000 = 2.9 kg CO₂/L of Diesel
- Calorific value of firewood used by evaporation boilers: 16.5 MJ/kg
- CO₂ emissions from firewood burning: 109.6 kg CO₂/GJ of thermal energy⁸
- CO₂ emission/kg of firewood: (16.5 x 109.6)/1000 = 1.8 kg CO₂/kg of firewood
- COD of effluent before biological treatment: 2490 mg O₂/L
- COD of effluent after secondary clarifier: 260 mg O₂/L
- COD degraded during biological treatment: (2490 – 260)=2230 mg O₂/L
- Estimated COD : TOC ratio: 3 : 1
- CO₂ : TOC ratio: 3.67 : 1

⁶ www.iea.org/statistics/statisticssearch

⁷ www.volker-quashning

⁸ www.volker-quashning

Table 9. Leather production, flow, electrical energy & firewood consumption at the CETP+ ZLD plant RANITEC, 2015-2016:

Item	Unit	CETP	ZLD	Total CETP & ZLD
Total estimated leather produced	sq.ft	96,353,038		
Total estimated leather produced	m ²	8,951,486		
Flow	m ³ /year	415,185		
Consumption of electrical energy (EB)	kWh/year	2,349,980	4,168,830	6,518,810
Consumption of Diesel	L/year	47,711	74,029	12,1740
Consumption of firewood	kg/year		7,406,396	7,406,396

Based on above values and data it is possible to derive figures for the CF pertaining to the RANITEC plant and relate them to the estimated leather output.

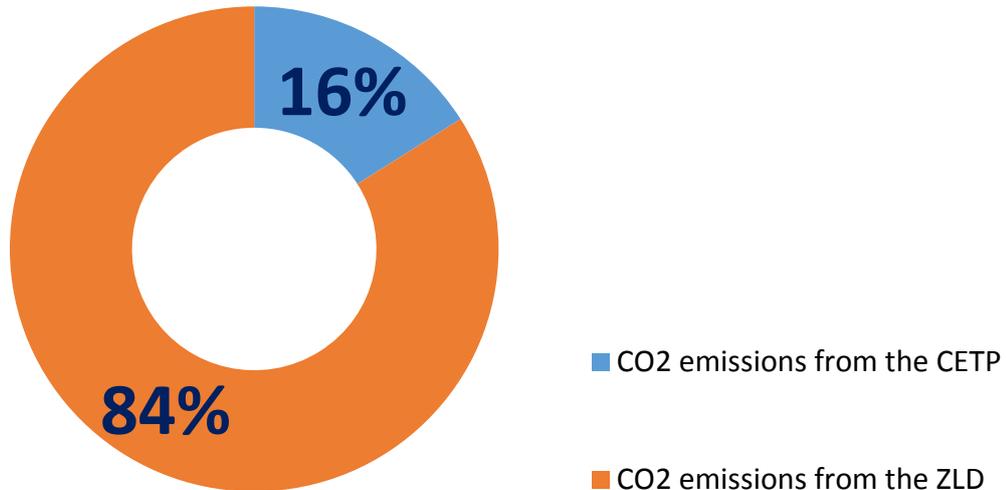
Table 10. CO₂ emissions from the CETP + ZLD plant RANITEC, March 2015 – April 2016

Item	Unit	CETP	ZLD	Total CETP & ZLD
Total estimated leather produced	sq.ft	96,353,038		
Total estimated leather produced	m ²	8,951,486		
Flow	m ³ /year	415,859		
Consumption of electrical energy (EB)	kWh/year	2,349,980	4,168,830	6,518,810
Consumption of Diesel	L/year	47,711	74,029	121,740
Consumption of firewood	kg/year		7,406,396	7,406,396
COD removed	kg/year	927,366	-	-
TOC removed during biological treatment	kg/year	309,122	-	-
CO ₂ emissions from consumption of electrical energy (EB)	kg/year	2,114,982	3,751,947	5,866,929
CO ₂ emissions from Diesel	kg/year	138,362	214,684	353,046
CO ₂ emissions from biological treatment	kg/year	1,134,478		1,134,478
CO ₂ emissions from firewood for MEE boiler	kg/year	-	13,331,513	13,331,513
Total CO_{2e} emissions, year	kg/year	3,387,822	17,298,144	20,685,966
Total CO_{2e} emissions, year	tonnes/year	3,388	17,298	20,686
Total CO_{2e} emissions, %	%	16	84	100
CO_{2e} est. emission vs. leather production	kg/sq.ft	0.04	0.18	0.22

Note: The figures about CO₂ emissions include neither leather processing nor sludge disposal, they pertain only to conventional effluent treatment (CETP) and RO and evaporation stage (ZLD) albeit without disposal of residual salt.

In summary, the ZLD stage has increased the CO_{2e} emissions of the RANITEC plant by about six times.

Figure 5. Shares of CETP & ZLD stages in the total CO₂ emissions, RANITEC, 2015-16



Conclusions

The dramatic situation with water and soil pollution along the Palar River together with public and buyers' pressure eventually prompted the TNPCB to enforce the discharge limit for Dissolved solids (inorganic) of 2100 mg/L; apparently, the ZLD system was imposed as the only approach to supplement the conventional treatment.

Reportedly, this has resulted in water consumption close to the theoretical minimum (12 m³/tonne) and substantial underutilization of CETP & ZLD plants. A very strong opposing view is that i) the tanners from the area already had a long experience in economizing with water ii) rather complex water saving and float recycling system is required to achieve such low level iii) the necessary technology modifications take time and that iv) a close, independent scrutiny is needed to verify this claim.

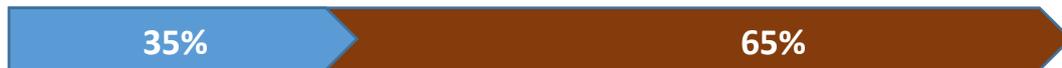
The average yearly flow rates along the treatment line in three ZLD plants considered are:

✓ RO feed vs. inflow from	99 - 101 %
✓ RO permeate vs. RO feed	72 - 76 %
✓ RO reject vs. RO feed	24 - 28 %
✓ Total recovered water vs. inflow	97 - 102 %

It means that various water additions virtually offset all losses and the volume of recovered (reusable) water coincides with the CETP inflow.

Figure 6. The energy impact of the ZLD stage in relation to the conventional treatment

The consumption and costs of electrical energy went up nearly 3x



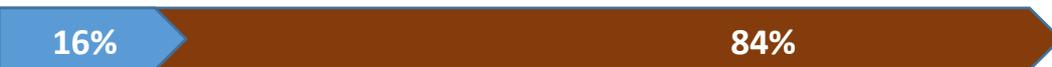
The overall energy consumption (electrical and thermal) went up nearly 15x



The total cost of energy (electrical and thermal) went up about 4x



CO₂ emissions rise approximately 6x



Legend

■ PST ■ RO + MEE

The reported, indicative O&M cost for the year 2015/2016 are between USD 6.9 – 8.7/m³, part of it assumingly offset by saving the cost of fresh water of about USD 1.4/m³.

The salt residue produced poses a very serious environmental challenge; in 2015/2016 it was 5043 t (RANITEC), 1816 t (VISHTEC) and 1591 t (SIDCO). Unfortunately, there are substantial differences between the theoretical values and the actual outputs; large quantities are “missing” without convincing explanation.

Computing average CO₂ emissions for electricity production in India, calorific value of firewood used by evaporation boilers, CO₂ emissions/kg of firewood, COD degraded during biological treatment, estimated COD/TOC ratio and CO₂/TOC ratio, it works out that the ZLD stage has increased the CO_{2e} emissions at RANITEC by more than six times.

There is no doubt that industrial scale ZLD in treatment of tannery effluents is technically feasible, advanced technologies applied impressive, recycling of the purified water is both logical and practical. However, the system is not robust and a viable solution for reutilization and/or safe disposal of solid residue is not in sight; moreover, within about three years O & M cost may exceed the installation cost.

It is quite late but possibly not too late to thoroughly (re)consider potential alternatives, a combination of short- and long-term options such as construction of proper sewage systems & WWTW in the townships in the Vellore District allowing mixing of treated tannery effluents with urban waste water⁹, simultaneous strong support to organized slaughter of some

⁹ It seems that the CETP plant at the Pallavaram cluster near Chennai is already benefitting from the existence of the municipal wastewater works (WWW); reportedly, it is permitted to skip the evaporation stage.

livestock (buffaloes, goats/sheep) and salt-free preservation, concentration of wet blueing works etc.

Finally, further work by a multidisciplinary ground team is needed to closer study issues such as detailed water mass balance, the exact impact of chemicals added and changes in the TDS composition along the process, optimization of auxiliary processes (ultrafiltration, water softening), possibly establish a more rigorous data recording etc.

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Google Earth Satellite Images

1. Details of Three Hatcheries Location
2. Distance between Hatcheries and Divi's Industry
3. Distance between Mahalakshmi Hatchery Sea water Intake location and Divis Landfall point & Diffuser Location
4. CRZ (0 – 500m) lines as per NZMA Maps, CRZ rules 2011 and Location of Hatcheries
5. Photographs of Inlets and Outlets of Hatcheries

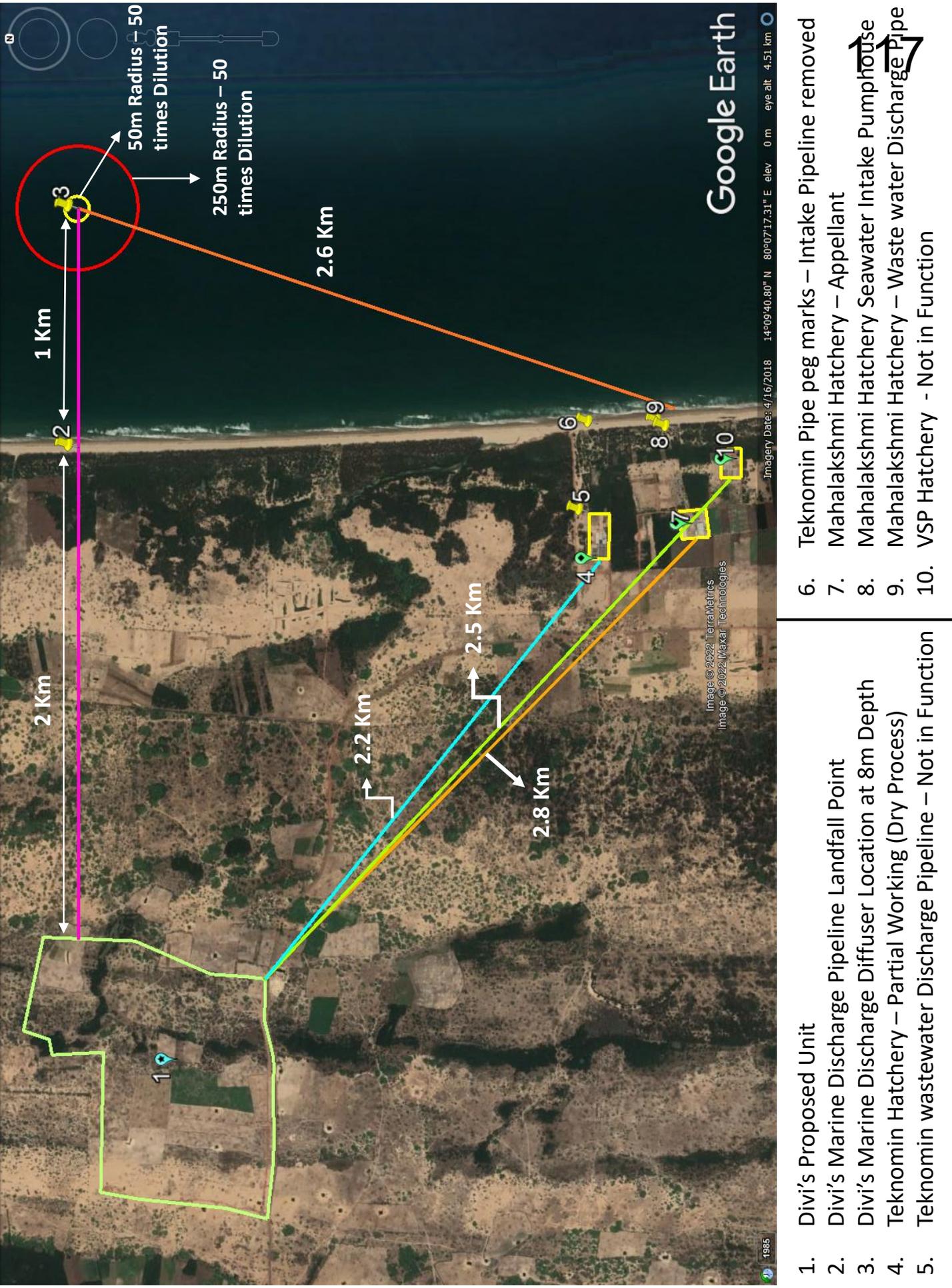


Image © 2022 TerraMetrics
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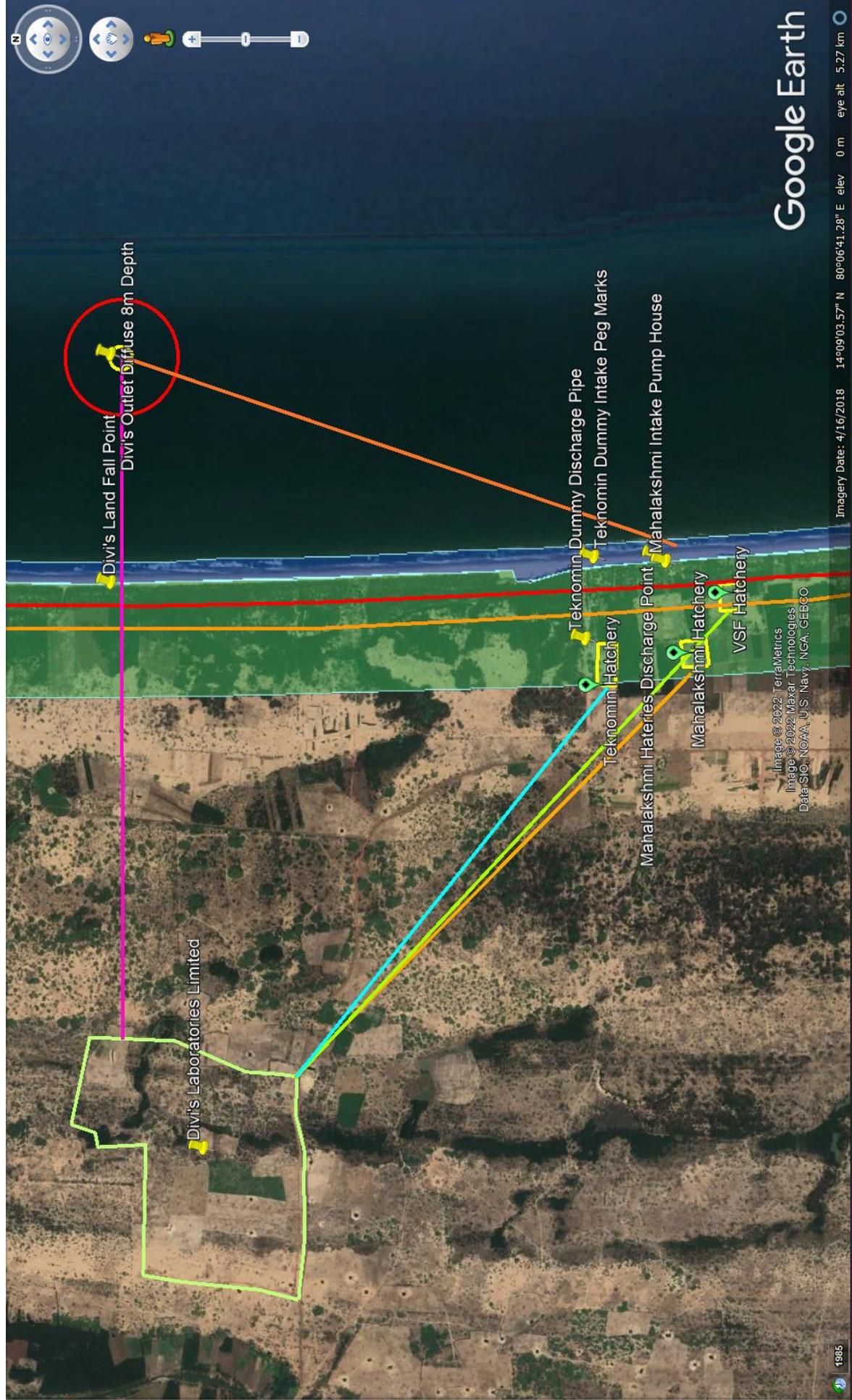
Google Earth

Imagery Date: 4/16/2018 14°09'40.80" N 80°07'17.31" E elev 0 m eye alt 4.51 km

6. Teknomin Pipe peg marks – Intake Pipeline removed
7. Mahalakshmi Hatchery – Appellant
8. Mahalakshmi Hatchery Seawater Intake Pump house
9. Mahalakshmi Hatchery – Waste water Discharge Pipe
10. VSP Hatchery - Not in Function

1. Divi's Proposed Unit
2. Divi's Marine Discharge Pipeline Landfall Point
3. Divi's Marine Discharge Diffuser Location at 8m Depth
4. Teknomin Hatchery – Partial Working (Dry Process)
5. Teknomin wastewater Discharge Pipeline – Not in Function

Location Details with CZR areas (0-500m) as per approved CRZMA Maps, CRZ Rules 2011



Hatcheries in CZR areas (0-500m) as per approved CRZMA Maps, CRZ Rules 2011



Mahalakshmi Hatchery (Appellant) – Location of Open waste water Discharge and Sea water Intake pump house



Mahalakshmi Hatchery (Appellant) – Photograph of Open waste water discharge on Sea Shore



GPS Map Camera



Kothapatnam, Andhra Pradesh, India
Kothapatnam, Andhra Pradesh, India

Lat 14.147758°

Long 80.127786°

15/10/22 04:32 PM GMT +05:30

Mahalakshmi Hatchery (Appellant) – Photograph of Sea water Intake pumphouse installed on Sea Shore

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GPS Map Camera



Kothapatnam, Andhra Pradesh, India

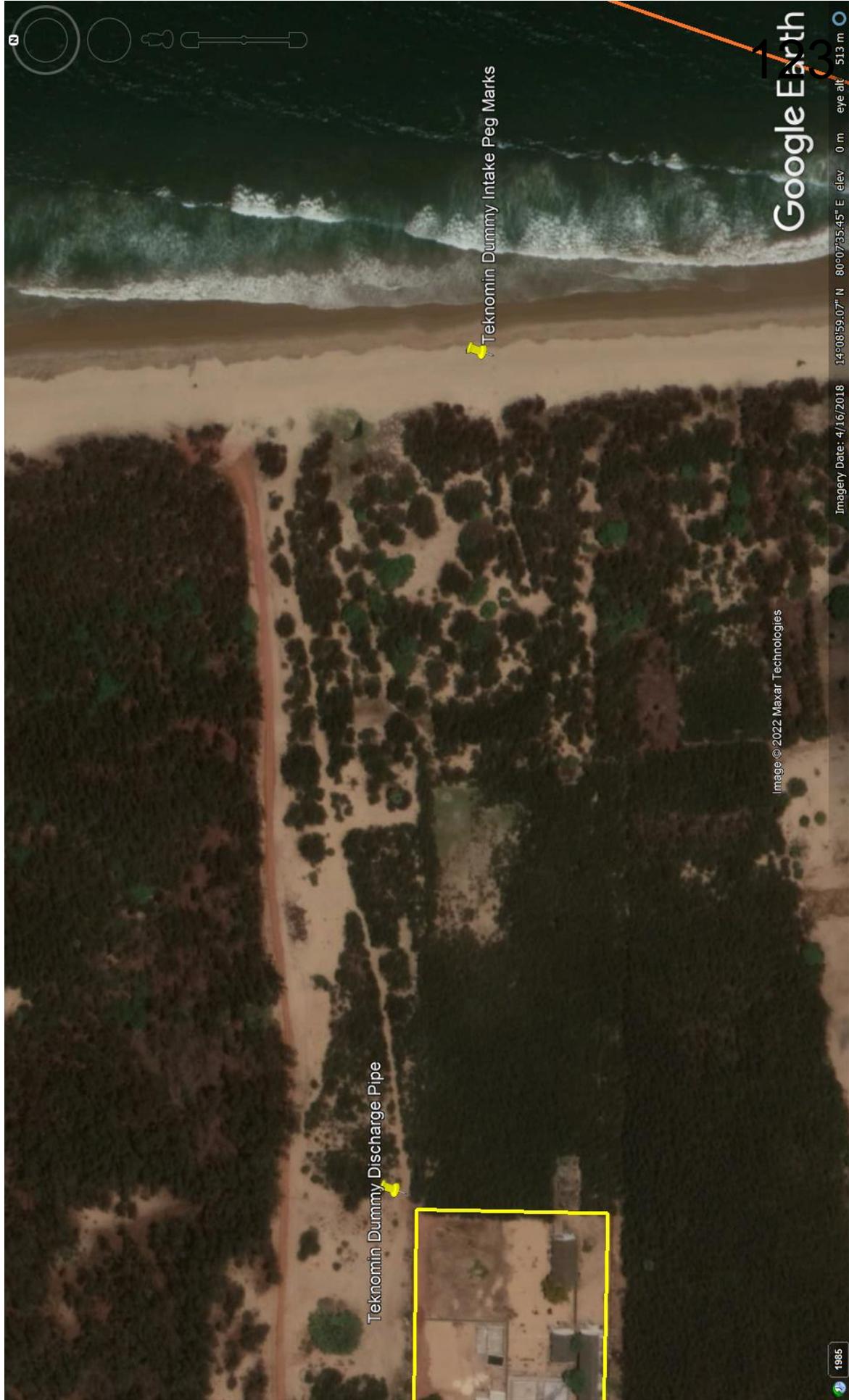
Kothapatnam, Andhra Pradesh, India

Lat 14.147083°

Long 80.127773°

15/10/22 04:36 PM GMT +05:30

Teknomin Hatchery – Location of waste water Discharge pipe line and Intake Peg Marks – Uninstalled Pipelines



Teknomin Hatchery – Photographs - Condition of waste water discharge pipeline & discharge outlet on Sea Shore – Not in working condition

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GPS Map Camera

Kothapatnam, Andhra Pradesh, India
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15/10/22 04:27 PM GMT +05:30



Google



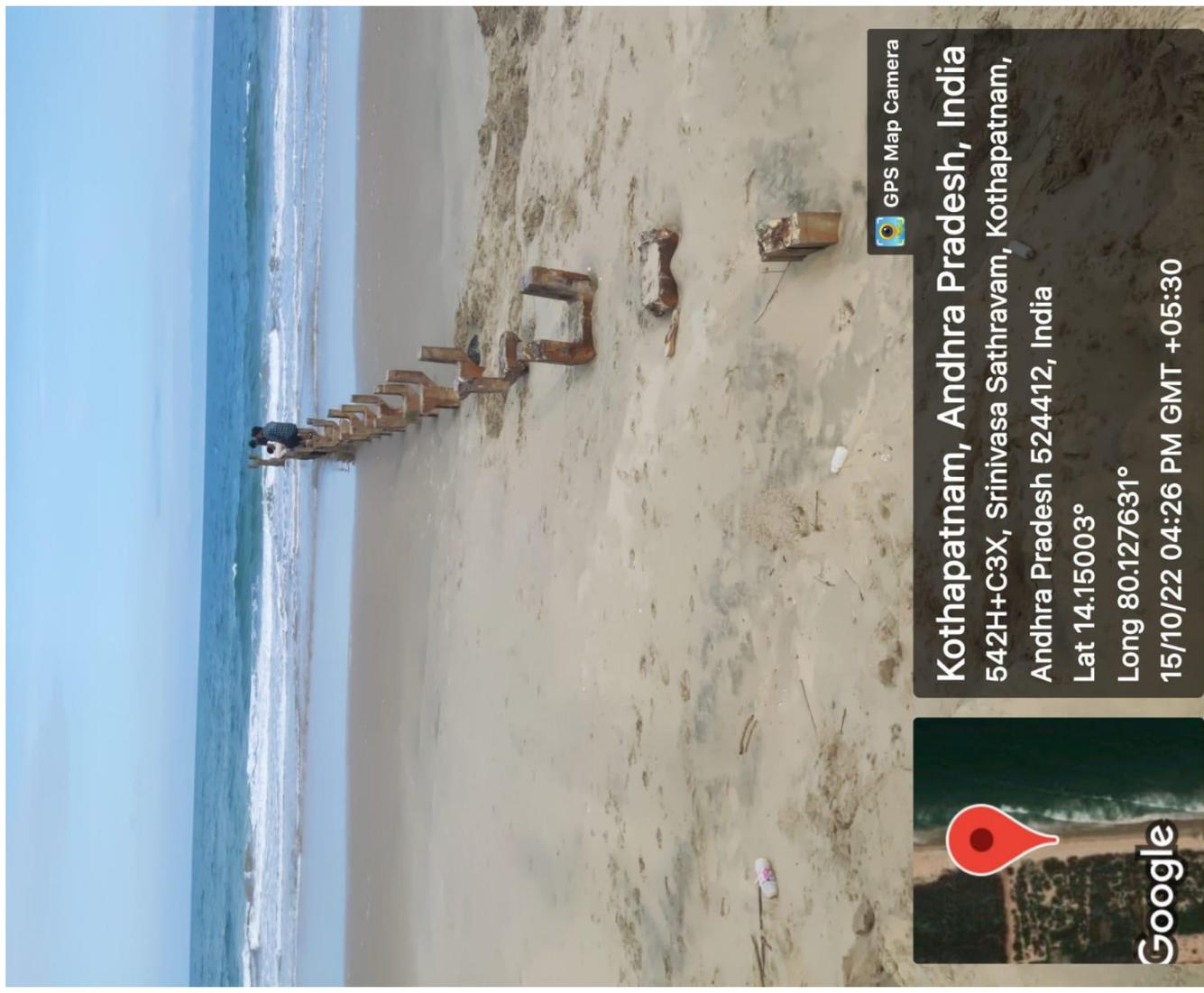
GPS Map Camera

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Lat 14.150272°
Long 80.12423°
15/10/22 04:05 PM GMT +05:30



Google

Teknomin Hatchery – Photographs – Intake Pipeline Peg marks – No intake pipelines found



GPS Map Camera

Kothapatnam, Andhra Pradesh, India
542H+C3X, Srinivasa Sathravam, Kothapatnam,
Andhra Pradesh 524412, India
Lat 14.15003°
Long 80.127631°
15/10/22 04:26 PM GMT +05:30



VSF Hatchery – Location and Open discharge seen in satellite image

126



VSF Hatchery – Gates are closed for long time period – Not working



GPS Map Camera

Kothapatnam, Andhra Pradesh, India

44WF+GG, Srinivasa Sathravam, Kothapatnam, Andhra

Pradesh 524412, India

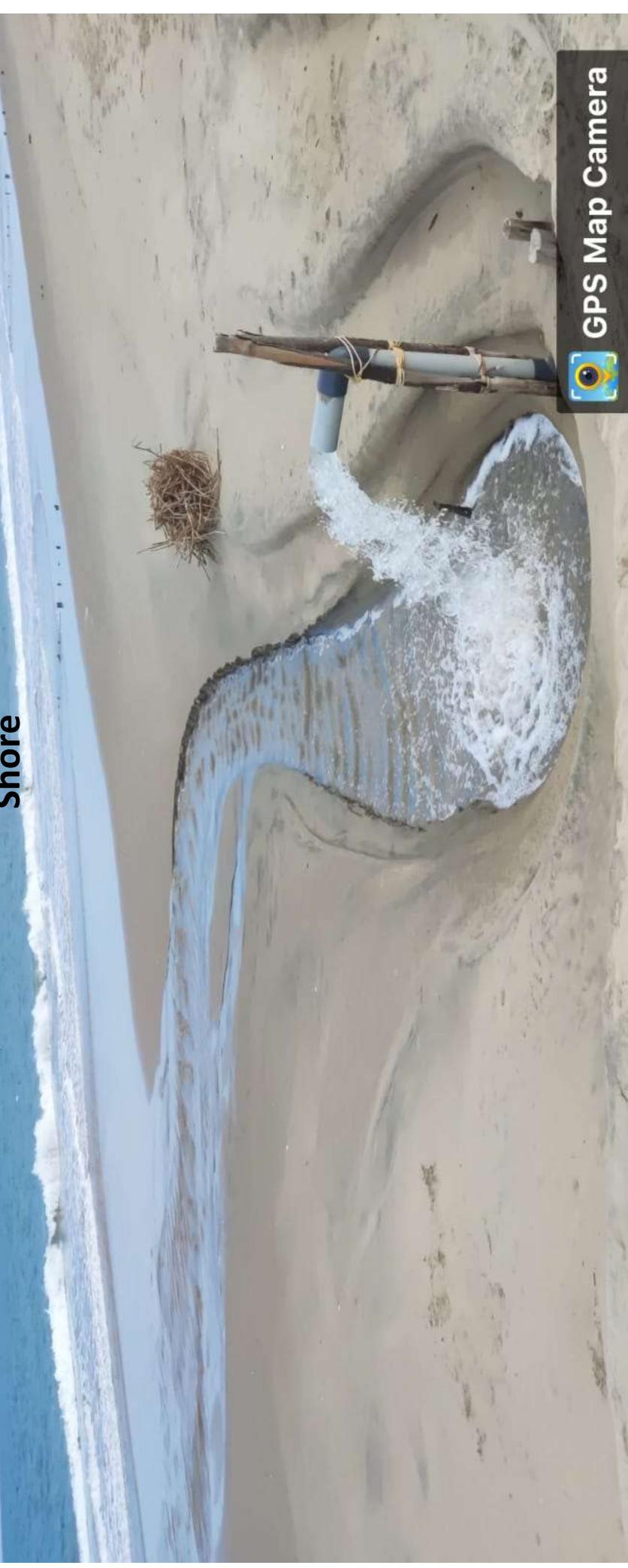
Lat 14.145467°

Long 80.125495°

15/10/22 04:17 PM GMT +05:30

100

Mahalakshmi Hatchery (Appellant) – Photograph of Open waste water discharge on Seashore



GPS Map Camera



Kothapatnam, Andhra Pradesh, India
Kothapatnam, Andhra Pradesh, India

Lat 14.147758°

Long 80.127786°

15/10/22 04:32 PM GMT +05:30

Mahalakshmi Hatchery (Appellant) – Photograph of Sea water Intake pumphouse installed on Sea Shore



GPS Map Camera



Google

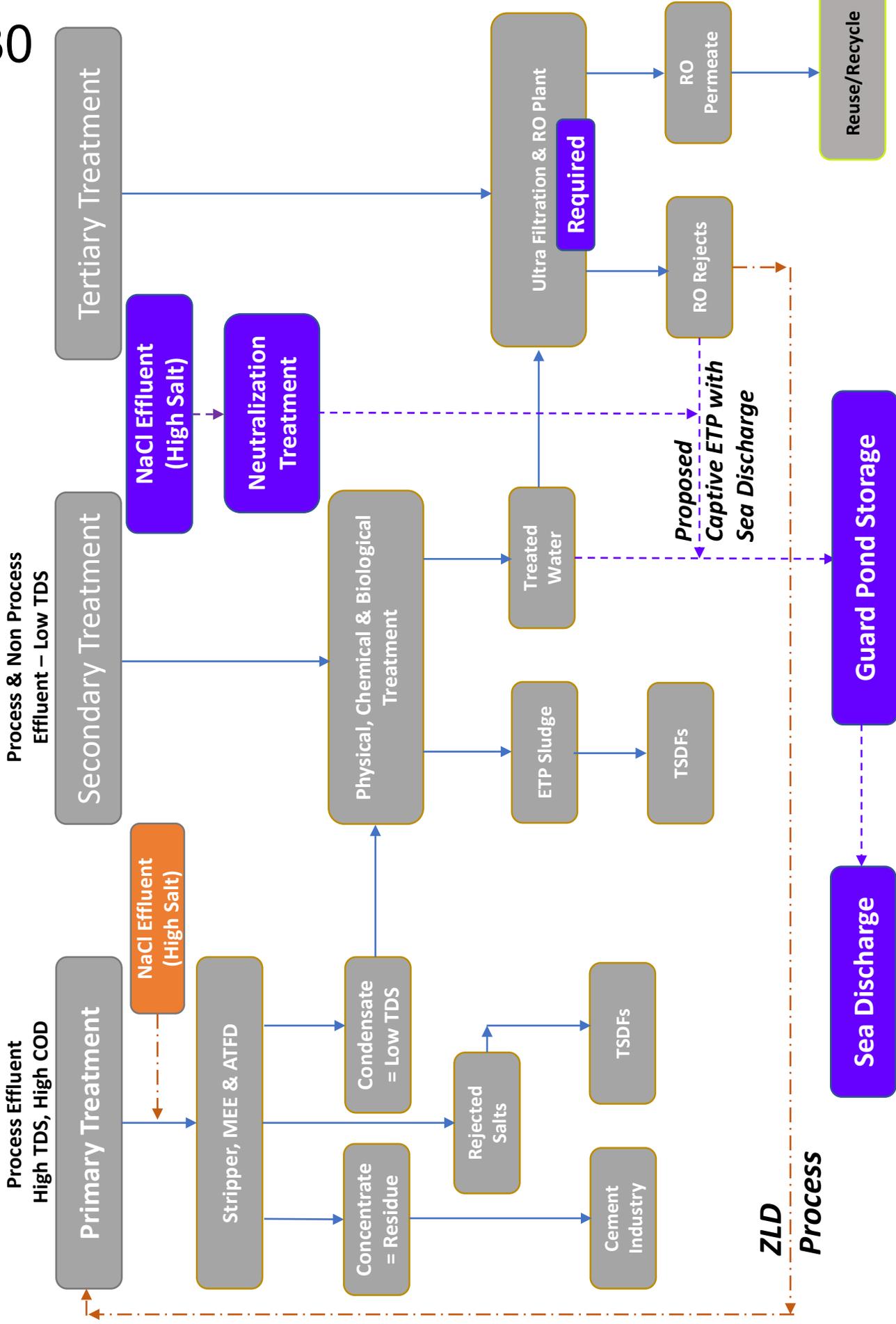
Kothapatnam, Andhra Pradesh, India
Kothapatnam, Andhra Pradesh, India

Lat 14.147083°

Long 80.127773°

15/10/22 04:36 PM GMT +05:30

Three Stage Treatment Process - Proposed Captive ETP Process and ZLD Process



Environmental Impacts – ZLD Process

- **Due to Re-Treatment of RO Rejects, Excess Treated Water, NaCl Effluent in ZLD process**
 - Increase the salt concentration and effluent quantity load in Primary Treatment.
 - Continues recycle of RO Rejects and Excess treated water shall further increase the Mixed Salts/Rejected Salts and generates additional Hazardous Waste.
 - Primary Treated is Thermal Process with use of Fossil Fuels
 - Additional energy consumption shall increase of GHG, CO₂et,
 - Results Increase the Scope 1 (Fossil Fuels) and Scope 3 Emissions (Transportation of Additional Fuels and Hazardous Waste)
- **Due to Increase of Salts load and Effluent Quantity in Primary Treatment**
 - Decrease the efficiency of Primary treatment, results increase the salt concentration in Condensate from Primary treatment sent to Secondary Treatment.
 - Results Increase the Chemical Usage to maintain the Salts load in secondary treatment for effective Biological Treatment.
 - Results, increase the ETP Sludge and generates additional Hazardous Waste.
 - Increase in electricity consumption in Secondary treatment and increase in GHG, CO₂et
 - Results, increase the Scope 2 (Electricity) and Scope 3 Emissions (Transportation of Additional Hazardous Waste)

Environmental Benefits – Proposed Captive ETP

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- **Treating NaCl Effluent as Separate stream and discharge in Sea after meeting Marine Discharge Standards, MoEF&CC, CPCB/APPCB**
 - Decrease the additional Salt concentration in Primary Treatment, hence less Hazardous waste (Mixed salts/Rejected salts) generation – Less Scope 3 Emissions
 - Decrease the fuel consumptions for additional energy requirement, hence less GHG emissions, CO₂et emission – Less Scope 1 Emissions
 - Increase in efficiency of Primary Treatment
- **Discharge of excess treated water and RO rejects in Sea after meeting Marine Discharge Standards, MoEF&CC, CPCB/APPCB**
 - No additional usage of Chemicals to reduce salt concentration in secondary treatment for effective Biological Treatment.
 - No additional electricity is required for effective Secondary treatment, hence less CO₂et emission – less Scope 2 Emissions
 - No additional ETP Sludge generation – less Hazardous waste and less Scope 3 emissions.
 - Environmentally feasible option for implantation of Desalination Plant for Industries Fresh water Requirement and reduce the use of Ground water source.

Thus, Proposed Full-fledged Captive ETP is more Environmentally Sustainable solution for Proposed Industry as it is located near Coastal Area than the ZLD ETP process.

General Standards For Discharge Of Environmental Pollutants Part-a : Effluents - [Schedule – VI] Of The Environmental (Protection) Rules 1986

Parameter	Marine Coastal Areas – Maximum Limit	Parameter	Marine Coastal Areas – Maximum Limit
Suspended solids mg/l, Max.	100 mg/l	Hexavalent Chromium (as Cr+6)	1.0 mg/l
Particulate size of suspended solids	(a) Floatable solids, max. 3 mm.	Total chromium (as Cr.)	2.0 mg/l
	(b) Settleable solids, max. 850 microns.	Copper (as Cu)	3.0 mg/l
pH Value	5.5 to 9.0	Zinc (As Zn.)	15 mg/l
Temperature	shall not exceed 5oC above the receiving water temperature	Selenium (as Se.)	0.05 mg/l
		Nickel (as Ni)	5.0 mg/l
Oil and grease	20 mg/l	Cyanide (as CN)	0.2 mg/l
Total residual chlorine	1.0 mg/l	Fluoride (as F)	15 mg/l
Ammonical nitrogen (as N),	50 mg/l	Sulphide (as S)	5.0 mg/l
Total Kjeldahl Nitrogen (as NH3)	100 mg/l	Phenoile compounds (as C ₆ H ₅ OH)	5.0 mg/l
		Radioactive materials: a & b (a) Alpha emitter micro curie/ml. (b) Beta emitter micro curie/ml.	10 ^{^-} 7 10 ^{^-} 6
Free ammonia (as NH3)	5.0 mg/l	Bio-assay test	90% survival of fish after 96 hours in 100% effluent
Biochemical Oxygen demand [3 days at 27oC]	100 mg/l	Manganese (as Mn)	2 mg/l
Chemical Oxygen Demand	250 mg/l	Iron (as Fe)	3 mg/l
Arsenic (as As)	0.2 mg/l	Vanadium (as V)	0.2 mg/l
Mercury (as Hg)	0.01 mg/l	Nitrate Nitrogen	20 mg/l
Lead (as Pb)	2.0 mg/l		
Cadmium (as Cd)	2.0 mg/l		

- Andhra Pradesh Pollution Control Board (APPCB), ZO - Visakhapatnam Notice No. 2313/PCB/ZO-VSP/NIO/2022) on 27th May 2022.
- All the marine discharge industries and CETPs to conduct monthly eco-toxicology tests on treated effluent, and trace metals and major organic compounds present in the treated effluent by CSIR National Institute of Oceanography (NIO), Visakhapatnam.
- M/s Divis Laboratories Limited, Unit -2, Vishakapatnam has contacted CSIR-NIO, Regional Centre, Visakhapatnam to take up a study on monthly assessment of the treated effluent from the guard ponds of M/s Divis Laboratories Limited to fulfil the specific condition of APPCB.
- CSIR - NIO concluded that, Treated effluent collected from the guard pond No. 9 of M/s Divis Laboratories Limited has qualified for the bio-assay test and trace metal concentrations in the effluent are very well within the limits of CPCB.
- Reports of the same is submitted to APPCB, Sample report of June 2022 is submitted.



Real Time Data Acquisition And Monitoring

Site Name: Divis Laboratories Limited Unit-2

Report: Custom Report

From Date: 2022/10/20 09:00:00 To Date : 2022/10/20 15:47:38

Description	ETP-TOC_U	ETP-BOD_U	ETP-COD_U	ETP-pH_U	ETP-TSS_U	ETP-LTDS FLOW_U
Prescribed Standards	0 -	0 - 75	0 - 225	6.5 - 8.5	0 - 100	0 -
Maximum Data	32.46	27.01	81.15	7.95	14.16	214.95
Minimum Data	0.05	0.04	0.12	7.57	1.07	10.98
Geometric Mean	20.63	17.16	51.57	7.77	4.2	203.69
Median	23.04	19.17	57.6	7.8	3.95	212.74
Standard Deviation	6.96	5.79	17.4	0.11	2.35	38.35
Maximum Value At Time	2022-10-20 09:15	2022-10-20 09:15	2022-10-20 09:15	2022-10-20 15:30	2022-10-20 09:15	2022-10-20 12:00
Minimum Value At Time	2022-10-20 09:00	2022-10-20 09:00	2022-10-20 09:00	2022-10-20 10:15	2022-10-20 09:00	2022-10-20 15:45
Valid Data Points	28	28	28	28	28	28
Total Data Points	28	28	28	28	28	28
Data Availability %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

- The report is downloaded from APPCB website (Real Time Data Acquisition and Monitoring).
- the report shows that the treated NaCl effluent is very well within the standards of APPCB and CPCB Marine Discharge Standards.

- The APPCB has installed the monitoring stations at 40 locations in the Coastal Marine outfall locations under the guidelines of National Water Quality Monitoring Programme (NWQMP), India and Monitoring since 2010.
- APPCB has submitted the annual average values of quality of Coastal Water of Bay of Bengal for the period from 2010-2011 to 2019-2020.
- One of the monitoring stations is installed in “Confluence of marine outfall of M/s Divi’s Laboratories Ltd., Chippada.”
- As per the historical data (2010-2011 to 2019-2020) of Coastal water monitored in station near respondent unit discharge point presented in the report shows that the Industry has not changed or impacted the Coastal/Sea water quality due to the Treated effluent discharged by our industry.
- All the Coastal quality parameters are complying with the Primary Water Quality Criteria for SW IV norms (For Harbour Water) notified under the Environmental (Protection) Rules, 1986.

III. Visakhapatnam District		2010-11	6	7.42	8	1.1	1.19	0.04	0.26
5	Confluence of marine outfall of M/s. Divi's Laboratories Ltd., Chippada.	2011-12	7.5	8.2	10	2	0.3	0.03	0.1
		2012-13	6.9	7.4	400	2	0.79	0.04	0.18
		2013-14	6.7	7.9	28	1.2	1.12	0.51	0.8
		2014-15	6.7	7.8	26	1.2	0.95	0.4	0.7
		2015-16	5.6	7.6	52	1.4	0.3	0.1	0.2
		2016-17	6.5	7.1	88	2.4	0.6	0.1	0.09
		2017-18	5.8	7.5	119	1.2	0.59	0.06	0.24
		2018-19	5.6	7.64	115	1.4	0.52	0.05	0.18
		2019-20	5.7	7.5	84	2.3	0.63	0.17	0.08
			SL-5						



ANDHRA PRADESH POLLUTION CONTROL BOARD
 D. No. 33-26-14 D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
 Chalamalavari Street, Kasturibaipet, Vijayawada – 520 010
 Website: www.pcb.ap.gov.in

Lr.No. CRZ/Legal/NGT-829 of 2019/2019 366 23.11.2020

To
 The Chairman,
 Central Pollution Control Board,
 Parivesh Bhawan, East Arjun Nagar,
 Delhi – 110032.

Sir,

Sub: APPCB – CRZ - Hon'ble NGT (Principal Bench), New Delhi order dated 21.09.2020 in O.A. No. 829/2019 – Action Plan - Submitted – Reg.

Ref: 1. CPCB directions dated: 31.08.2020
 2. Hon'ble NGT, New Delhi Order dated 21.09.2020 in O.A.No.829 of 2019 in the matter of Lt. Col. Sarvadaman Singh Oberoi vs Union of India & Ors

**

This has references to the above, the Action Plan for the Control of Coastal Pollution for the State of Andhra Pradesh in compliance to Hon'ble NGT order dated 21.09.2020 in O.A. NO. 829 of 2019 in the matter of Lt. Col. Sarvadaman Singh Oberoi vs Union of India & Ors, is herewith enclosed for information and necessary action.

Yours faithfully,

MEMBER SECRETARY

Encl: As above

9.0 Conclusion:

From the above it can be inferred that, there is no significant industrial pollution caused due to the full fledged effluent treatment systems provided by the industries. The coastal waters at some places (i.e. Confluence of sewage of lavender canal joining the sea at harbour, Confluence point of Melantragedda surplus course along with all the industrial effluents joining the sea at parallel bridge near dockyard, Confluence point of steel plant effluent joining the sea near Apprikonda village in Visakhapatnam District & Sea water collected near Uppada, Kakinaada, Sample collected from Upputuru channel near Indrapalem, Kakinaada and Confluence point of Chollangi snanala revu and Ramannapalem drainini East Godavari District) are contaminated due to the flow of untreated sewage through the drains joining the sea. The MA&UD Department is proposing to develop adequate capacity of Sewage Treatment Systems (STPs) along with requisite facilities for collection, transportation & treatment of sewage.

The APPCB will follow up the establishment of adequate facilities with the MA&UD Department. Also regular monitoring will be carried out for assessing the water quality of the sea waters to meet the marine primary water quality criteria parameters. The APPCB along with the other stake holder Departments will adhere to the action plan being submitted in maintaining the water quality by implementing all the measures for solid waste management and effluent/sewage management.

Conventional and zero liquid discharge treatment plants for textile wastewater through the lens of carbon footprint analysis

by S. Mohan , Ninad Oke and D. Gokul, Environmental and Water Resources Engineering Division, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, Tamil Nadu 600 036.

Summary of the comparative carbon footprint analysis

GHG emission source	Conventional treatment facility (tCO ₂ eq/year)	ZLD treatment facility (tCO ₂ eq/year)	Percentage difference with respect to conventional treatment facility
Fuel use on-site	3,600.36	7,200.70	+ 100
Electricity consumption	1,006.3	2,675.06	+ 165.83
Total transportation	890.39	160.45	- 81.98
CH ₄ emission from biological treatment unit	562.10	562.10	0
CH ₄ emission due to treated effluent discharge	1,264.72	0	- 100
Groundwater pumping	437.35	0	- 100
Total	7,761.22	10,598.31	

The conclusions of the present research work can be summarized as follows:

1. The total carbon footprint was estimated as 10,598 tCO₂- eq/year for a ZLD treatment facility, whereas for the conventional treatment facility, it was found to be 7,761 tCO₂eq/year.
2. The carbon footprint of the ZLD treatment facility was found to be nearly 1.36 times the carbon footprint of a conventional treatment plant
3. Carbon footprint of the ZLD treatment plant was found to be nearly 35% higher than the carbon footprint of the conventional treatment plant with a capacity of 4.4 million liters per day.

Analysis of flow and energy aspects of Zero Liquid Discharge (ZLD) technology in treatment of tannery effluents in Tamil Nadu, India

by J. Buljan, K.V. Emmanuel, M. Viswanathan, M. Bosnić, I. Král', Presented during the XXXIV IULTCS Congress Chennai/India 05 – 08 February 2017 - United Nations Industrial Development Organization (UNIDO)

The impact of addition of the ZLD stage (RO + MEE) to the conventional treatment can be summarized as follows:

- The consumption of electrical energy went up nearly three (3x) times
- The overall energy consumption (electrical and thermal) went up nearly Fifteen (15x) times
- The share of ZLD energy in total energy consumed is about 93%
- Total CO₂e emissions per year is 20,686 tons/year, the share of ZLD stage alone is 17,298 tons/year
- The ZLD stage has increased the CO₂e emissions of the RANITEC CETP plant by about six (6) times
- Salt residue represents a very serious environmental challenge, quantities generated by RANITEC plant is 5043 tonnes in just one year.

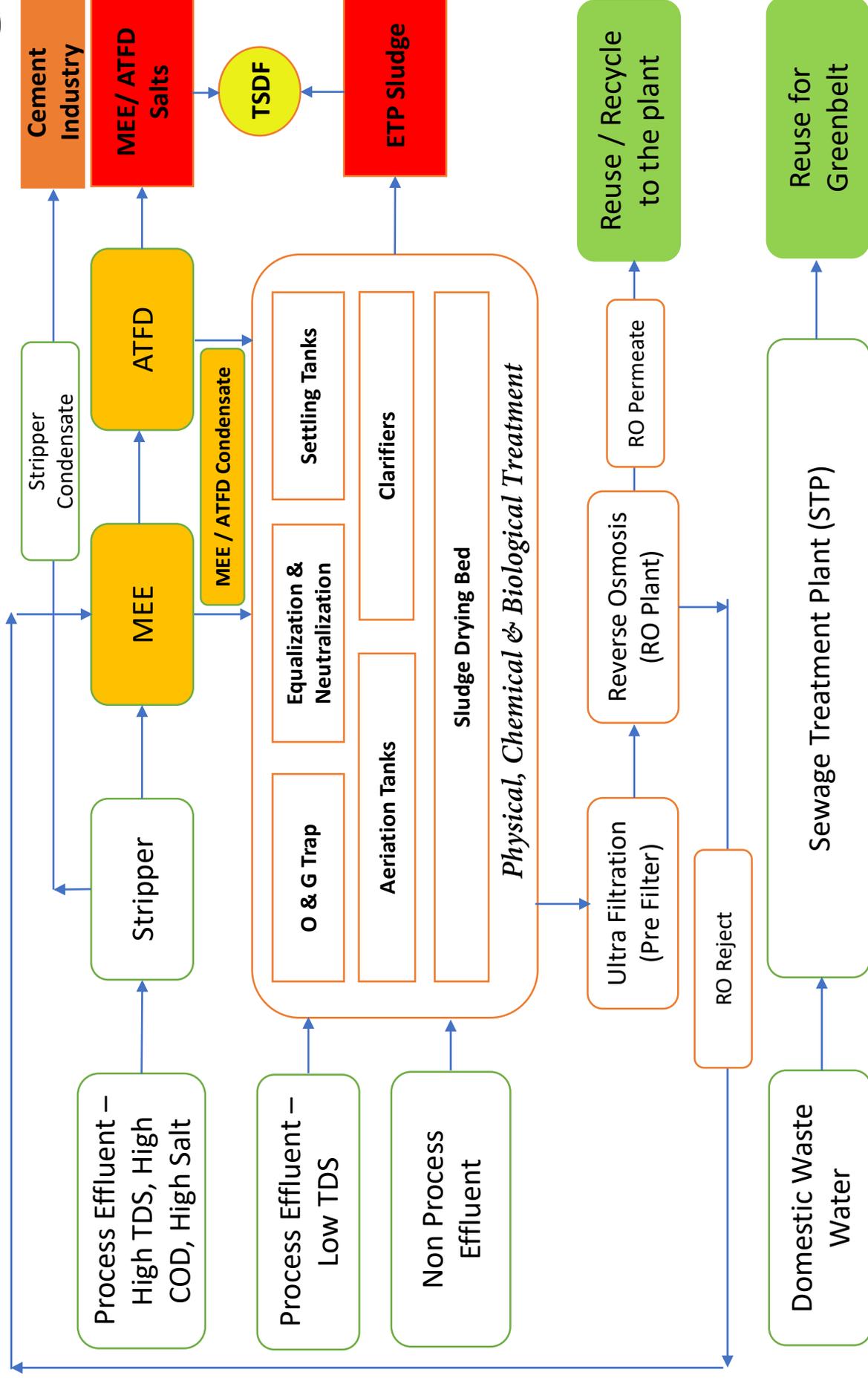
Table 10. CO₂ emissions from the CETP + ZLD plant RANITEC, March 2015 – April 2016

Item	Unit	CETP	ZLD	Total CETP & ZLD
Total estimated leather produced	sq.ft	96,353,038		
Total estimated leather produced	m ²	8,951,486		
Flow	m ³ /year	415,859		
Consumption of electrical energy (EB)	kWh/year	2,349,980	4,168,830	6,518,810
Consumption of Diesel	L/year	47,711	74,029	121,740
Consumption of firewood	kg/year		7,406,396	7,406,396
COD removed	kg/year	927,366	-	-
TOC removed during biological treatment	kg/year	309,122	-	-
CO ₂ emissions from consumption of electrical energy (EB)	kg/year	2,114,982	3,751,947	5,866,929
CO ₂ emissions from Diesel	kg/year	138,362	214,684	353,046
CO ₂ emissions from biological treatment	kg/year	1,134,478		1,134,478
CO ₂ emissions from firewood for MEE boiler	kg/year	-	13,331,513	13,331,513
Total CO ₂ e emissions, year	kg/year	3,387,822	17,298,144	20,685,966
Total CO ₂ e emissions, year	tonnes/year	3,388	17,298	20,686
Total CO ₂ e emissions, %	%	16	84	100
CO ₂ e est. emission vs. leather production	kg/sq.ft	0.04	0.18	0.22

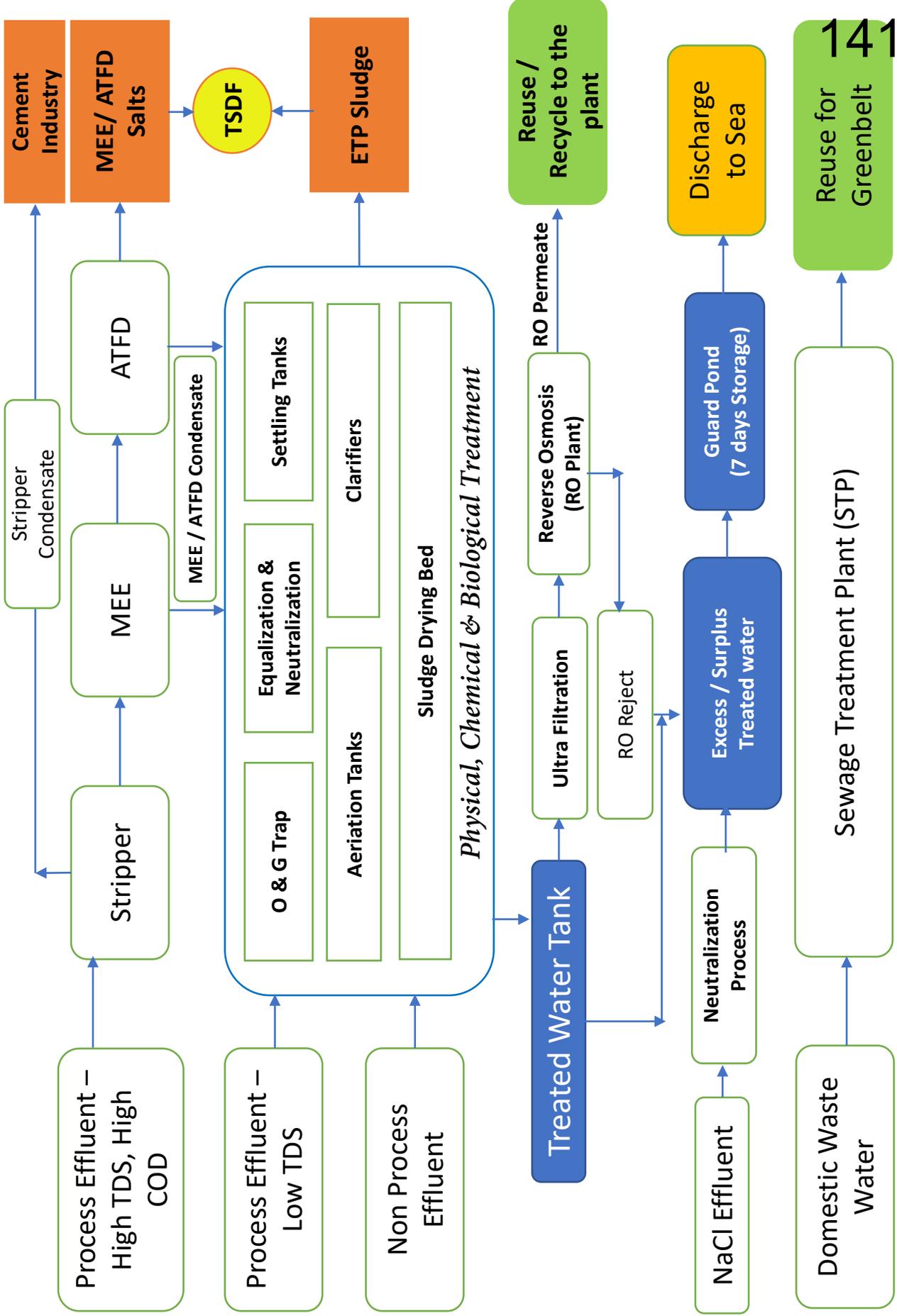
Note: The figures about CO₂ emissions include neither leather processing nor sludge disposal, they pertain only to conventional effluent treatment (CETP) and RO and evaporation stage (ZLD) albeit without disposal of residual salt.

ZLD - Effluent Treatment Plant

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Captive Effluent Treatment Plant with Sea Discharge



Guard Pond Storage to Discharge



(Pan, Tilt, Zoom) PTZ Online
Camera Connected to PCBs

Online Effluent Monitoring system connected to State and Central PCBs



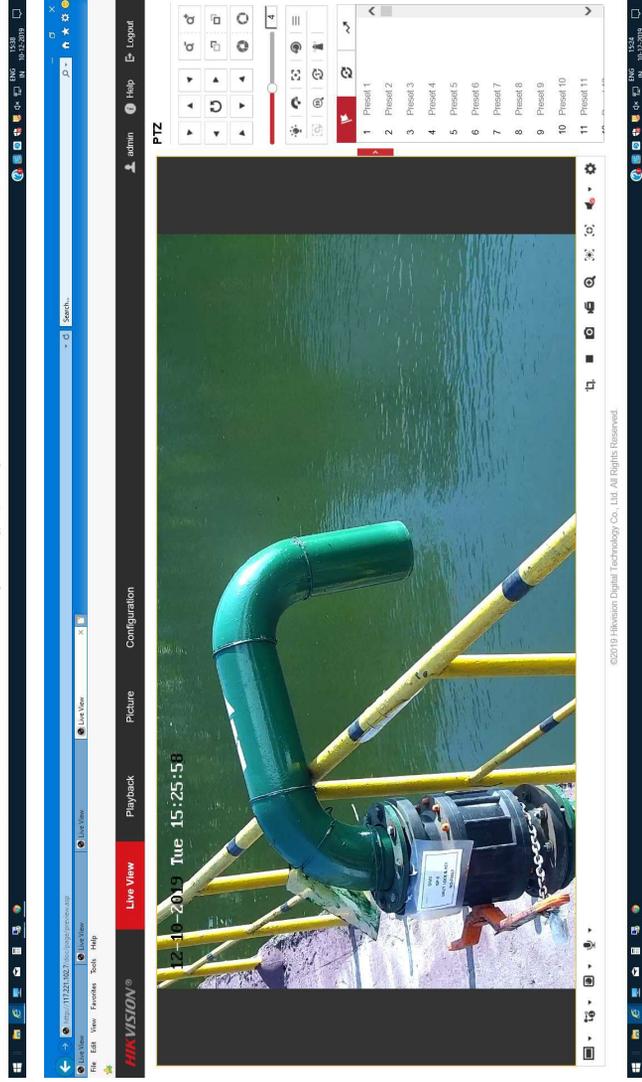
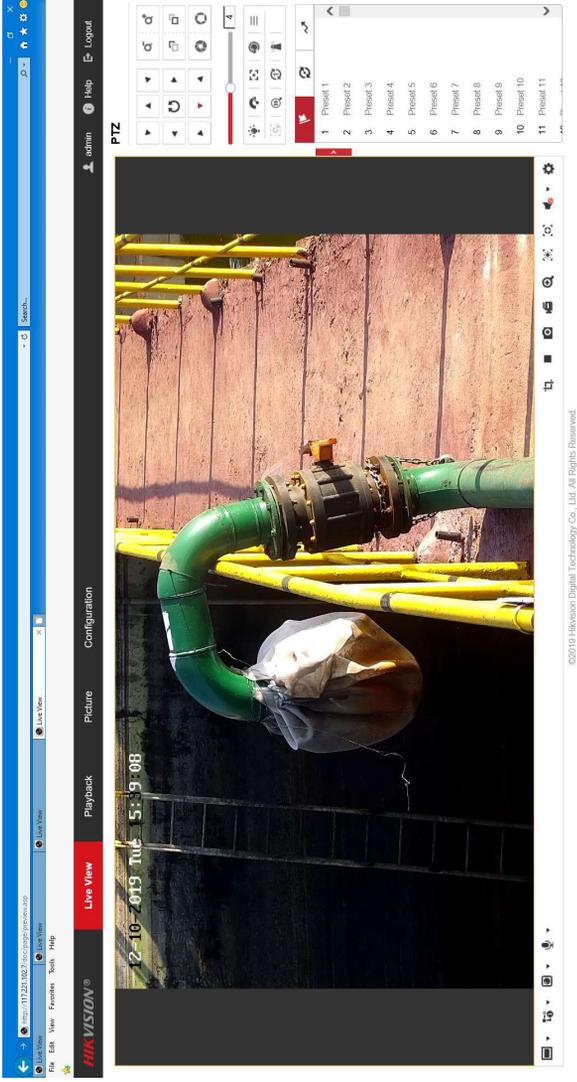
Online Total Organic
Compound (TOC) Analyzer



Online meters connected to State & Central PCB
for Effluent Monitoring – pH & TSS

Visibility of guard pond inlet seals through PTZ camera from the PCBs website

IOT device for data uploading to PCB servers



Display Board at Entrance showing Effluents and Quality details

APPCB – Lock and Seal of the Industry Effluent Discharge



PERIODICAL INSPECTION OF UNDER WATER SEA DISCHARGE LINE



**BEFORE THE HON'BLE NATIONAL
GREEN TRIBUNAL SOUTHERN
ZONE BENCH AT CHENNAI**

Appeal No. 68 of 2021

M/s. Sri Mahalakshmi Hatcheries
And Anr.

... Appellants

And

SEIAA
And 2 Ors.

... Respondents

**ANNEXURES FILED ALONG WITH
THE ADDITIONAL AFFIDAVIT
FILED BY THE 3RD RESPONDENT**

**M/s. Rahul Balaji 670/95
COUNSEL FOR 3RD RESPONDENT**