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

OA No 141 OF 2023

IN THE MATTER OF:

GANISETTI SATYANARAYANA & ANR.

.... Applicant

Vs

UNION OF INDIA AND OTHERS

..... Respondents

REPORT FILED BY THE APPCB 3rd RESPONDENT

DATE- 06.07.2024

M/s MADHURI DONTI REDDY
ADVOCATE

STANDING COUNSEL FOR GOVERNMENT OF ANDHRA PRADESH

A.P. POLLUTION CONTROL BOARD

#26, S2, Royal Castle, Gill Nagar Extension, Choolaimedu, Chennai – 600 094.

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BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONE AT CHENNAI
Original Application No. 141 of 2023(SZ)

IN THE MATTER OF:

Ganisetti Satyanarayana & Anr.

.....APPLCANT

VERSUS

Union of India and others

...RESPONDENTS

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Environmental Engineer,
A.P. Pollution Control Board,
Regional Office, Visakhapatnam
Environmental Engineer
A.P Pollution Control Board
Regional Office, Visakhapatnam

Report on Original Application No.141 of 2023(SZ) before the Hon'ble National Green Tribunal, Southern Zone, Chennai filed by Sri Ganisetti Satyanarayana & Anr, R/o Venkatapuram Village, Munagapaka Mandal, Anakapalli District, Andhra Pradesh against M/s. Visakha Pharmacity Limited (Formerly M/s. Ramky Pharmacity (India) Pvt. Ltd.), JNPC, Parawada, Anakapalli District

It is to submit that Sri Ganisetti Satyanarayana & Anr, R/o Venkatapuram Village, Munagapaka Mandal, Anakapalli District has filed a case before the Hon'ble National Green Tribunal(NGT), Southern Zone(SZ), Chennai in Original Application(O.A.) No. 141 of 2023(SZ) and the facts and circumstances, petitioner prayed that this Hon'ble Tribunal may be pleased to:

(i) Declare the action of the Respondents as contrary to the law and the mandatory Specific Conditions No. iii, vi, vii, viii, x, xvi, xviii of Environment Clearance dated 10.3.2005 imposed by the Union of India and quash the Environment Clearance accordingly.

(ii) Direct the Respondents to stop the illegal construction of pond in 50 acres for storing the chemical water near the Thanam village adjoining to the M/s. Ramky Pharmacity Ltd.

(iii) Direct the Respondents to restore the irrigation tanks, water bodies and ground water by taking the corrective measures.

(iv) Impose penalty on the responsible persons, entities for causing damage to the aquatic life in Bay of Bengal, livelihood, health of people, animals and endangering their lives at Thanam, Parawada etc villages of Anakapalli District in Andhra Pradesh.

(v) Rehabilitate the affected population near the Ramky Pharmacity on the basis of assessing the impact of chemical odour nuisance on the people due the release of gases by the Pharma companies.

Copy of the Hon'ble NGT Order dated 04.10.2023 is herewith with enclosed as **Annexure-I.**

In compliance to the Hon'ble NGT Order dated 04.10.2023, the A.P. Pollution Control Board has submitted report on 14.12.2023 to the Hon'ble NGT. Copy of the report dated 14.12.2023 is herewith enclosed as **Annexure-II.**

The Hon'ble NGT issued orders on 26.04.2024 stating that "

1. Mr. K. Sravan Kumar, the learned counsel for the applicant would submit that the APPCB has filed its report relying on the samples collected in the years 2022 & 2023 and highlighted that the current load of pollution is high in the area since a large number of units have become operational now.
2. Mr. Ramesh Sanjay representing Mrs. Madhuri Donti Reddy, the learned counsel for the Andhra Pradesh Pollution Control Board (APPCB) would seek time to file a further report, capturing the analysis of samples collected in the recent past."

Environmental Engineer
A.P. Pollution Control Board
Regional Office, Visakhapatnam

3. Mr. Arun Karthick Mohan, the learned counsel appearing for the 6th Respondent would submit that they have filed the report, which is not before us.
4. Let the same be verified and reach it to the bundle.
5. Post the matter on 08.07.2024.".

Copy of the Hon'ble NGT Order dated 26.04.2024 is herewith enclosed as **Annexure-III.**

In obedience to the above orders, the following is submitted:

1. **List of industries established in the year 2023 – 2024:**

   There are seven no. of industries were started operations in the year 2023-2024 at M/s.Visakha Pharmacity Limited, JNPC, Parawada, Anakapalli District. List of industries at JNPC, Parawada are herewith enclosed as **Annexure-IV.**

2. **Status of Ambient Air Quality:**

   The facility is having 3 online Continuous Ambient Air Quality Monitoring (CAAQM) stations for continuous monitoring the parameters VOC, NH_3 & SO_2(odour causing compounds) located at Tadi(V), Thanam(V) & SEZ Parawada. The online monitoring systems were connected to the web site of APPCB. If there are any exceedances recorded, the auto alerts will be generated and communicated to the facility for rectification. As per reports, the AAQ parameters viz., PM_{10}, $PM_{2.5}$, SO_2, NOx, NH_3 are within the NAAQ standards. Copy of the CAAQ Analysis Reports for the last one year is enclosed as **Annexure-V.**

   APPCB installed One manual ambient air quality station at CETP at a distance of about 1Km from Tanam village and monitoring the air quality for the parameters viz., PM_{10}, $PM_{2.5}$, SO_2, NOx, NH_3. As per the analysis reports, the average monitored values are meeting the NAAQ standards except PM_{10}. Copy of the manual AAQ Reports for the last one year is enclosed as **Annexure-VI**.

3. **Marine outfall Monitoring by APPCB:**

   The consolidated Analysis Report of marine disposals into sea for the last one year i.e., 2023-2024 is enclosed as **Annexure-VII**. Out of 305 samples, 16 samples were rejected from June-2023 to May-2024, the rejection percentage is 5.25% only for the last two years. In case of the treated wastewater standards are not meeting the marine discharge standards, it will not be allowed for discharge into sea and sent back to CETP for re-treatment till comply with the marine discharge standards.

4. **NIO Studies on marine outfall:**

   APPCB conducted studies through National Institute of Oceanography (NIO), Visakhapatnam to assess the marine outfalls of different industries established in the areas between Pydibheemavaram and Nakkapalli of North Andhra Coast in the year 2011. The NIO submitted report in the year 2014 and it is reported that "it is concluded from the present results that the coastal waters studied are not affected by the discharge of industrial effluents through marine outfalls and the small changes noticed may be due to the seasonal variations of chemical constituents caused through run off and other local activities".

Environmental Engineer
A.P Pollution Control Board
Regional Office, Visakhapatnam

APPCB again conducted the study through NIO to carry out an assessment of the marine environment at and around the marine outfall points (MOP) of industries between Pydibhimavaram (Srikakulam district) and Kesavaram (Visakhapatnam district) of north Andhra coast to ascertain cumulative effects, if any, on the ecology, water and sediment quality due to the discharge of treated effluents in to the coastal waters. Accordingly, CSIR-NIO has carried out field campaigns during pre-monsoon (February -March, 2018) and post monsoon (December, 2018) seasons in the coastal waters of north Andhra coast between Pydibhimavarm and Kesavaram for in-situ observations. The NIO submitted report to APPCB in 2020. Copy of the NIO report is herewith enclosed as **Annexure-VIII.**

Based on the recommendations of the NIO report, APPCB has issued instructions to the industries on 27.05.2022 to conduct monthly eco-toxicology tests on treated effluent, trace metals and major organic compounds present in the treated effluent by CSIR-National Institute of Oceanography (NIO), Visakhapatnam.

The facility approached NIO to conduct monthly reports and NIO conducted analysis of marine outfall disposal samples and Sea water samples at marine outfall in Sea. Copy of the NIO monthly reports for marine outfall disposal samples are herewith enclosed as **Annexure-IX**. As per analysis, the following is observed:

Month	Conclusion	Status
September-2023	Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. LC50 and LC10 values after 96 hours are 656% and 101%, respectively. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 14th September 2023 is compliance with the CPCB standards for bio-assay test.	Complied
October-2023	Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 92% for zebrafish in 100% effluent after 96 hours. LC50 and LC10 values after 96 hours are 682% and 113%, respectively. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 12th October 2023 is compliance with the CPCB standards for bio-assay test.	Complied.
November-2023	Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 95% for zebrafish in 100% effluent after 96 hours. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharma City Limited on 21st November 2023 is compliance with the CPCB standards for bio-assay test.	Complied.
January - 2024	Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 92% for zebrafish in 100% effluent after 96 hours. Based on	Complied.

Environmental Engineer
A.P Pollution Control Board
Regional Office, Visakhapatnam

	the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC50 and LC10, respectively) after 96 hours are estimated as 682% and 113%, respectively	
February-2024	Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC50 and LC10, respectively) after 96 hours are estimated as 568% and 115%, respectively.	Complied.
March – 2024	Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 90% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC50 and LC10, respectively) after 96 hours are estimated as 1125% and 121%, respectively	Complied.
April – 2024	Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC50 and LC10, respectively) after 96 hours are estimated as 384% and 109%, respectively.	Complied.
May – 2024	Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 92% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC50 and LC10, respectively) after 96 hours are estimated as 682% and 113%, respectively.	Complied.

5. **Ground water quality monitoring in Tanam and Tadi Villages:**

APPCB is monitoring ground water quality in Tanam & Tadi Villages. As per the analysis results for the period July-2023 to May-2024, all the parameters are within the permissible limits for drinking water specifications except Total Hardness, Total Alkalinity, Sodium, Magnesium, Nitrates and Fluoride concentrations in some samples occasionally. Copy of the reports are herewith enclosed as **Annexure-X**.

Environmental Engineer
A.P Pollution Control Board
Regional Office, Visakhapatnam

6. **Action Taken by APPCB:**

1. The Board is regularly monitoring the common facilities and member industries in the pharmacity once in 6 months to verify the compliance status of the APPCB consent conditions / directions issued to the facility and the industries. Any violations found during the inspection, APPCB is reviewing the facility and industries before external advisory (Task Force) Committee Meeting and issuing directions to the industries time to time for strict compliance with Board conditions.
2. The Board has imposed Environmental compensation for an amount of Rs.3,75,000/- vide order dated 16.05.2023 for non-compliance of CTO & HWA conditions to M/s. SVR Drugs Pvt. Ltd., Plot No.3, JN Pharmacity, Parawada, Anakapalli District. The industry has paid Environmental Compensation of Rs. 3,75,000/- on 22.05.2023. Copy of the Order issued to M/s. SVR Drugs Pvt. Ltd., is herewith enclosed as **Annexure-XI**.
3. The Board has imposed Environmental compensation for an amount of Rs. 3,15,000/- vide notice dated 14.12.2023 for illegal disposal of hazardous waste to M/s. Srikar Laboratories Pvt. Ltd., Plot No.32 A, JNPC, Parawada, Anakapalli District. The industry has paid Environmental Compensation of Rs. 3,15,000/- on 10.01.2024. Copy of the Order issued to M/s. Srikar Laboratories Pvt. Ltd., is herewith enclosed as **Annexure-XII**.

This report is submitted for kind consideration. The APPCB will abide by all such directions as the Hon'ble Tribunal may deem fit and appropriate.

Environmental Engineer,
A.P. Pollution Control Board,
Regional Office, Visakhapatnam

Environmental Engineer
A.P Pollution Control Board
Regional Office, Visakhapatnam

Item No. 01:

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

Original Application No.141 of 2023 (SZ)
(Through Video Conference)

IN THE MATTER OF

Ganisetti Satyanarayana, Andhra Pradesh
... Applicant(s)

Versus

Union of India & Ors.
...Respondent(s)

Date of hearing: 04.10.2023.

CORAM:
HON'BLE SMT. JUSTICE PUSHPA SATHYANARAYANA, JUDICIAL MEMBER
HON'BLE DR. SATYAGOPAL KORLAPATI, EXPERT MEMBER

For Applicant(s): Mr. K. Sravan Kumar

For Respondent(s): Dr. Kuna Suryanarayana for MoEF&CC.
Ms. Madhuri Donti Reddy for R2, R3 & R5.

ORDER

1. Issue Notice to the respondents through Tribunal as well as privately.

2. Dr. Kuna Suryanarayana accepts notice on behalf of the MoEF&CC and Ms. Madhuri Donti Reddy accepts notice on behalf of the respondent nos. 2, 3 and 5.

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3. Post the matter on 06.11.2023.

……..J.M.
(Smt. Justice Pushpa Sathyanarayana)

....E.M.
(Dr. Satyagopal Korlapati)

O.A.No.141/2023 (SZ)
04th October, 2023. AM.

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE BENCH AT CHENNAI
Original Application No. 141 of 2023

IN THE MATTER OF:

Ganisetti Satyanarayana & Anr.

.....APPLCANT

VERSUS

Union of India and others

...RESPONDENTS

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It is certified that all the documents contained in the above annexure are true copies.

Date:31.10.2023

I. Narsi Reddy

Environmental Engineer,
APPCB, Regional Office,
Visakhapatnam

Environmental Engineer
A.P. Pollution Control Board
Regional Office, Visakhapatnam

Report on Original Application No.141 of 2023(SZ) before the National Green Tribunal Southern Bench, Chennai by filed by Sri. Ganisetti Satyanarayana & Anr, R/o Venkatapuram Village, Munagapaka Mandal Anakapalli District, Andhra Pradesh against M/s. Visakha Pharmacity Limited (Formerly M/s. Ramky Pharmacity (India) Pvt. Ltd.,), JNPC, Parawada, Anakapalli District

It is to submit that Sri. Ganisetti Satyanarayana & Anr, R/o Venkatapuram Village, Munagapaka Mandal Anakapalli District has filed a case before the National Green Tribunal Southern Bench, Chennai in O.A.No. 141 of 2023(SZ) and the facts and circumstances, petitioner prayed that this Hon'ble Tribunal may be pleased to:

(i) Declare the action of the Respondents as contrary to the law and the mandatory Specific Conditions No. iii, vi, vii, viii, x, xvi, xviii of Environment Clearance dated 10.3.2005 imposed by the Union of India and quash the Environment Clearance accordingly.

(ii) Direct the Respondents to stop the illegal construction of pond in 50 acres for storing the chemical water near the Thanam village adjoining to the M/s. Ramky Pharmacity Ltd.

(iii) Direct the Respondents to restore the irrigation tanks, water bodies and ground water by taking the corrective measures.

(iv) Impose penalty on the responsible persons, entities for causing damage to the aquatic life in Bay of Bengal, livelihood, health of people, animals and endangering their lives at Thanam, Parawada etc villages of Anakapalli District in Andhra Pradesh.

(v) Rehabilitate the affected population near the Ramky Pharmacity on the basis of assessing the impact of chemical odour nuisance on the people due the release of gases by the Pharma companies.

Copy of the NGT Order dated 04.10.2023 is herewith with enclosed as **Annexure-I.**

In this regard, the status of M/s. Visakha Pharmacity Ltd., (Formerly M/s. Ramky Pharmacity (India) Pvt. Ltd.,), JNPC, Parawada, Anakapalli District is submitted as follows:

1. **Introduction:**

The J.N. Pharmacity was established in the year 2005, to setup a Pharma Park involving common infrastructure facilities viz., Power Plant – 100 MW, Multi Fuel – Gas/Coal/Oil, Power distribution (Substations /Transformers), Hazardous Waste Management (TSDF) – 2,00,000 TPA, Water Treatment Plant, Storage System, Water Distribution System Effluent / Sewerage network, CETP – 50 MLD, Storm Water Drainage, Common Boiler – 230 TPH, Common DG Set – 15 MW, incinerator – 1.5 TPH etc.

The APIIC allocated an area of 2143.0 Acres to establish pharma city in Parawada village, Anakapalli District. Out of 2143.0 Acres, 1429.31 acres have been allotted for development of industrial plots and the remaining 713.69 Acres is allotted for the common infrastructure

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facilities like Roads, Common utilities and green buffer area etc. So far, 104 industries are established and 94 Bulk drug & intermediates, Pharmaceuticals and Chemical units are in operation. The Source of water for pharmacity is Yeleru canal, supplied by Andhra Pradesh Industrial Infrastructure Corporation (APIIC).

The facility is having the following common facilities for treatment of the effluent generated by the member industries.

A. Common Effluent Treatment Plan (CETP)
B. Treatment, Storage and Disposal Facility (TSDF)
C. Incinerator
D. Alternative Fuel & Raw material pre-processing facility (AFRF)

A. Common Effluent Treatment Plant (CETP):

a) The CETP is designed to treat High and Low TDS effluents separately received from member units in the Pharmacity. The APPCB vide CFO order dt.12.08.2021 and 02.09.2021 issued CFO to the CETP to treat the HTDS effluents of 2500 KLD & LTDS effluents of 7053 KLD with validity upto 31.05.2026.

b) The CETP installed five MEEs of each capacity 500 KL/day to treat the HTDS effluent and ETP of 7053 KLD capacity to treat the Low TDS effluents.

c) The facility has provided PLC SCADA system to carry out the automatic operations of the MEEs through control room.

d) Presently, 95 member units are sending their effluents to CETP for further treatment and disposal.

e) The facility installed online continuous effluent quality monitoring system for the parameters viz., pH, TSS, COD & BOD in the marine outfall pipeline to verify the standards of the treated effluent before discharging into Sea and the same is connected to the CPCB/APPCB web sites.

f) The facility is storing the treated effluents in the guard ponds before discharging into the sea. The Capacities of Guard Ponds & marine pipeline details are tabulated as below:

No. of Guard ponds	On Shore (on land)	Off Shore (in sea)	Each Capacity
Total 10 G.P's	Length: 16 Km Diameter: 13.9 " Depth – 4.0 m	Length: 1.75 Km Diameter: 12.4 " Depth – 18.00 m	GP-1, GP-2 & GP-4 = 5400 KL, GP-3 = 5300 KL, GP-5 = 5200 KL, GP-6 = 5000 KL, GP-7 = 4500 KL, GP-8 = 6000 KL, GP-9 = 5000 KL & GP-10 = 5000 KL

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B. Treatment, Storage and Disposal Facility (TSDF):

Landfill is a secured containment system of hazardous waste with an objective to handle the hazardous waste generated in the industries in a scientific manner to prevent soil & ground water contamination.

The facility is having common treatment, storage and disposal facility (TSDF) for treatment and disposal of hazardous wastes.

The hazardous waste having CV less than 2500 K.Cal/Kg & not suitable for Utilizable, Incinerable & Recyclable, the waste is being filled in secured landfill facility duly following the waste stabilization methods to make the hazardous waste suitable for landfilling. The hazardous waste which don't required stabilization is directly filled in secured land fill.

The TSDF carries out stabilization process to make hazardous waste into less leachable, non-reactive before disposal into the landfill.

The waste having Calorific Value > 2500 Kcal/kg & Biodegradable organics > 5% and Non-biodegradable Organics > 20% is being incinerated in the incinerator in the Pharmacity.

The facility is treating and disposing the hazardous waste in accordance with the Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016.

336 industries in Visakhapatnam Zone registered with TSDF, Visakhapatnam for sending their hazardous waste for scientific disposal. Out of which 160 industries are regularly sending the hazardous waste to TSDF. Total area of TSDF, Visakhapatnam is 18.07 acres.

The primary leachate generated from the landfill is being sent as HTDS to the CETP of Pharmacity through closed conduits.

The APPCB issued CTEs to the TSDF in a phased manner from time to time. The first CTE was issued on 16.07.2010. In all the phases including expansions, the Board issued CTEs to this project covering total extent of 18.07 acres and to handle 18,03,200 MT of hazardous waste.

Similarly, CTOs were issued in a phased manner. The first CTO was issued on 02.9.2011. The previous CTO was issued on 23.05.2023 for a period up to 30.04.2026 to handle 1,15,178 MT of hazardous waste. In all phases the total quantity of hazardous waste permitted for disposal in CTOs is 15,22,201 MT.

C. Incinerator

Process of incinerable waste treatment:

The facility receives incinerable waste from the member units of JN Pharmacity, Parawada and from the districts i.e., Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari, Krishna & Guntur. The waste in the form of solid, semi-solid or non-aqueous liquid are stabilized / solidified and then fed to the incinerator for disposal. The facility has installed incinerator of capacity 1.5 TPH to incinerate the incinerable waste.

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In the incinerator, solid waste is fed to the rotary kiln and burnt at a temperature of about 850^{0}C. The gases from the rotary kiln are burnt in the secondary combustion chamber at a temperature of about 1100^{0}C to 1200^{0}C. After completion of incineration, waste is generated in the form of incinerated ash, spray drier salts and bag filter dust. These wastes are disposed in the landfill.

The facility is not regularly operating the incinerator due to shortage of incinerable waste as the industries are sending the waste to use as alternate fuel in the cement industries.

D. Alternative Fuel & Raw material pre-processing facility (AFRF)

The facility is operating Alternative Fuel & Raw material pre-processing facility of capacity 100 TPD in Pharmacity in the name of M/s. Coastal Waste Management Project, Parawada, Anakapalli District. The facility obtained CTO of the Board for a period up to 31.12.2026.

After receiving Semi solid materiel from industries as utilizable waste, the material is blending with rice husk, Saw dust etc. and converting into solid form to ensure CV is >2500 Kcal/kg and after pre-processing the waste is being sent to cement industries for Co-processing / As Alternative Fuel Raw Material.

2. Air pollution and control measures taken up by M/s. Visakha Pharmacity Limited

The main source of air pollution is boilers & fugitive emissions. The facility is having 3 x 10 TPH coal fired boilers (one boiler is standby.) All boilers stacks are provided with mechanical dust collectors followed by bag filters to control dust emissions. The facility provided online stack analyzers for continuously monitoring PM (Particulate Matter) parameter and connected to APPCB/CPCB website. While storing, handling and treating of effluents, the facility provided the following to control fugitive odor causing emisions:

a. All the effluent receiving storage tanks are covered with HDPE hoods followed by double stage scrubber.
b. As per the directions of APPCB, air stripper of MEE is replaced with Steam stripper.
c. Wet scrubbers are provided for the stacks attached to spray drier of MEE system and incinerator.

Most of the industries have installed and operating mechanical dust collectors followed by bag filters as air pollution control equipment to control flue gas emissions from the boilers. Process emissions are controlled by installing scrubbers and fugitive emissions controlled by pumping transfer of solvents through pipelines, centrifuge vents connected to the scrubbers and by installing vent condensers to bulk solvent storage tanks.

The facility is having 3 online Continuous Ambient Air Quality Monitoring (CAAQM) stations for continuous monitoring the parameters VOC, NH_3 & SO_2(odour causing compounds) located at Tadi(V), Thanam(V) & SEZ Parawada. The online monitoring systems were connected to the web site of APPCB. If there are any exceedances recorded,

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the auto alerts will be generated and communicated to the facility for rectification. As per reports, the AAQ parameters viz., PM_{10}, $PM_{2.5}$, SO_2, NOx, NH_3 are within the NAAQ standards. Copy of the CAAQ Analysis Reports for the last one year is enclosed as **Annexure-II.**

APPCB installed One manual ambient air quality station at CETP at a distance of about 500 m from Tanam village and monitoring the air quality for the parameters viz., PM_{10}, $PM_{2.5}$, SO_2, NOx, NH_3. As per the analysis reports, the monitored values are meeting the NAAQ standards. Copy of the manual AAQ Reports are enclosed as **Annexure-III**.

3. **Marine outfall Monitoring by APPCB:**

The member industries located in Pharmacity are sending their effluents (High TDS & Low TDS effluents) to CETP through closed conveyance pipelines with digital flow meters to the CETP to treat the effluents in CETP. After treatment, the treated wastewater is stored in guard ponds and after confirming to the marine discharge standards, the treated wastewater is discharged into sea through marine outfall in presence of APPCB officials with lock & key system.

The consolidated Analysis Report of marine disposals into sea for the last two years is enclosed as **Annexure-IV**. Out of 506 samples, 26 samples were rejected from Jan-2022 to Sep-2023, the rejection percentage is 5% only for the last two years. In case of the treated wastewater standards are not meeting the marine discharge standards, it will not be allowed for discharge into sea and sent back to CETP for re-treatment till comply with the marine discharge standards.

NIO Studies on marine outfall:

APPCB conducted studies through National Institute of Oceanography (NIO), Visakhapatnam to assess the marine outfalls of different industries established in the areas between Pydibheemavaram and Nakkapalli of North Andhra Coast in the year 2011. The NIO submitted report in the year 2014 and it is reported that "it is concluded from the present results that the coastal waters studied are not affected by the discharge of industrial effluents through marine outfalls and the small changes noticed may be due to the seasonal variations of chemical constituents caused through run off and other local activities".

APPCB again conducted the study through NIO to carry out an assessment of the marine environment at and around the marine outfall points (MOP) of industries between Pydibhimavaram (Srikakulam district) and Kesavaram (Visakhapatam district) of north Andhra coast to ascertain cumulative effects, if any, on the ecology, water and sediment quality due to the discharge of treated effluents in to the coastal waters. Accordingly, CSIR-NIO has carried out field campaigns during pre-monsoon (February -March, 2018) and post monsoon (December, 2018) seasons in the coastal waters of north Andhra coast between Pydibhimavarm and Kesavaram for in-situ observations. The NIO submitted report to APPCB in 2020. Copy of the NIO report is herewith enclosed as **Annexure-V.**

Based on the recommendations of the NIO report, APPCB has issued instructions to the industry on 27.05.2022 to conduct monthly eco-toxicology tests on treated effluent, trace

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metals and major organic compounds present in the treated effluent by CSIR-National Institute of Oceanography (NIO), Visakhapatnam.

The facility approached NIO to conduct monthly reports and NIO conducted analysis of marine outfall disposal samples and Sea water samples at marine outfall in Sea. Reports are awaited.

4. **Ground water quality monitoring in Tanam and Tadi Villages:**

APPCB is monitoring ground water quality in Tanam & Tadi Villages. As per the analysis results, all the parameters are within the permissible limits for drinking water specifications except Total Hardness, Nitrates and Fluoride concentrations in some samples occasionally. Copy of the reports are herewith enclosed as **Annexure-VI**.

The Andhra University conducted study on impact of ground water quality due to operations of CETP during the period from November 2020 to April,2021 within 10 km radius from the CETP. As per the study, it was concluded that "Water quality of groundwater is within the permissible limits of drinking water standards. At few places along the coast groundwater quality influenced by salt water intrusion." Copy of the AU report on Hydrology (Ground Water Assessment Studies) - 2021 is herewith enclosed as **Annexure-VII.**

5. **Accidents:**

The Industries and Commerce Department, Govt. of A.P has issued G.O. RT.No. 156 Dated: 04.08.2020 with the following members to conduct a special drive of inspections for ensuring compliance of all the safety protocols and environmental norms by all the industrial units in the state of Andhra Pradesh:

i. Joint Collector (A&W) in charge for Industries & Commerce - Chairman
ii. Deputy Chief Inspector of Factories, Factories Dept. - Member
iii. Inspector of Boilers, Boilers Dept. - Member
iv. Regional Officer, APPCB. - Member
v. Deputy Electrical Inspector - Member
vi. District Fire Officer, APSDRFSD - Member
vii. General Manager, District Industries Centre - Member Convenor

Subsequently, the EFST, Govt. of A.P vide G.O. RT.No. 79 Dated: 03.08.2022 constituted District Level Committee with the following members to verify and ensure complete compliance in respect of safety and environmental requirements in the industrial units and submit reports to the State level Committee. The State level committee shall take necessary remedial measures, in co-ordination with the concerned departments, to avoid occurrence of any accidents in future.

1) District Collector – Chairperson.
2) General Manager, District Industries Centre – Member
3) Deputy Chief Inspector of Factories – Member
4) Deputy Commissioner of Labour – Member – Convenor
5) Regional Officer, APPCB – Member

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About 182 industries were identified and inspected in the Anakapalli District by the above committee and issued improvement notices to the industries by the respective departments to avoid and control accidents.

Accidents	**Action taken by APPCB**
Incident took place due to flash fire at Visakha Solvents on 14.07.2020 at about 10:30 PM while taking the reflex sample during the spent solvent distillation process of Dimethyl Sulfoxide(DMSO). One employee was died and two were injured.	APPCB issued stop production order to M/s. Visakha Solvents Ltd at Plot No.84 A, JN.Pharmacity, Parawada, Visakhapatnam on 14.07.2020 by withdrew of CFO & Hazardous waste authorization orders. The CPCB vide letter dt: 05.03.2021 has directed to M/s. Visakha Solvents to deposit the Environmental Compensation of Rs.30,01,092/-. The management of M/s. Visakha Solvents Limited has paid Rs.30,01,092/- towards Environmental damages to CPCB in connection with the OA No. 134/2020 in compliance of Hon'ble NGT Order dated 23.07.2020. At present, the management has dismantled the unit and closed the activities.
An incident occurred 28.11.2021 in the premises of M/s.Ramky Pharmacity (India) Ltd., (CETP & Incinerator) at HTDS effluent collection tank in intermediate transfer pump house at Pharmacity internal road No-13 during checking of the effluent levels in collection tanks, resulting in the death of two persons.	The Board has constituted a committee consisting the following members to investigate incident occurred in Pharma City on 28.11.2021 resulting death of two employees and also to suggest appropriate measures to avoid reoccurring of similar incidents in future a) Dr. R. R .Tiwari Director NIREH Bhopal. b) Dr. Subrahmanyam. Ch Professor, IIT Hyderabad. c) Dr. U. Vijaya Sarathi Sr Principal Scientist IICT Hyderabad. d) Dr. S. Gananadhamu Assistant Professor NIPER Hyderabad.

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	The committee visited the accident site and also associated pharma industries on 02.12.2021 and 03.12.2021 and made certain suggestions. The Board has reviewed the facility and issued directions on 21.12.2021 which includes committee recommendations to avoid such kind of accidents. The compliance status of the direction dated 21.12.2021 is herewith enclosed as **Annexure-VIII.**

6. Green belt:

The total area of the project is 2143.0 Acres. The facility has developed green belt in an extent of 471 acres with different species which is about 21.97% of total area. The Andhra University has carried out the study to assess the green belt developed by the pharmacity and reported that the pharmacity developed green belt in an area of 471 acres. Copy of Andhra University study report on greenbelt is enclosed as **Annexure-IX.**

7. Construction of pond in the Pharmacity:

The petitioner in the application alleged that the Project Proponent illegally digging large scale pond near Thanam village which will have adverse impact on the agriculture, ground water in the surrounding areas of the village.

In this regard, it is to submit that M/s. Visakha Pharmacity Limited has constructed pond in an area of 2.0 acres in 55 acres land which is not located in the buffer zone area or in the area ear marked for greenbelt development for JN Pharmacity. The issue was reviewed by the Board and issued directions to the facility on 20.07.2022.

The compliance status of the external advisory committee (Task Force) directions dated 20/07/2022 is submitted below:

S.no.	Directions	Compliance
1.	The proposed lined ponds shall not be located in the buffer zone area or in the area ear marked for greenbelt development.	M/s. Visakha Pharmacity Ltd., has purchased 55 acres in Sy.No.165, 166, 167, 168 & 169 and 157(part) in South-West directions adjacent to the JN Pharmacity in addition to the

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<table>
<tr><td></td><td></td><td>existing area of 2143.0 Acres allotted by the APIIC to M/s. Visakha Pharmacity Ltd.

M/s. Visakha Pharmacity Ltd has constructed pond in an area of 2.0 acres in 55 acres land which is not located in the buffer zone area or in the area ear marked for greenbelt development for JN Pharmacity.</td></tr>
<tr><td>2.</td><td>Online water quality monitoring systems shall be provided at storm water outlets with data connectivity to APPCB website.</td><td rowspan="2">Due to objections raised by the villagers of Thanam, the facility has stopped construction of pond for collection of rain water runoff from storm drains of Pharmacity. At present, rain water is existing in the pond.</td></tr>
<tr><td>3.</td><td>The contaminated storm water collected shall be pumped to CETP for further treatment and disposal along with LTDS effluents.</td></tr>
</table>

8. Action Taken by APPCB:

1. The Board is regularly monitoring the common facilities and member industries in the pharmacity once in 6 months by higher officials of APPCB to verify the compliance status of the APPCB consent conditions / directions issued to the facility and the industries. Any violations found during the inspection, APPCB is reviewing the facility and industries before external advisory (Task Force) Committee Meeting and issuing directions to the industries time to time for strict compliance with Board conditions.
2. Five industries in pharmacity dumped the hazardous waste on the bund of vooracheruvu of Tanam village in September, 2016. As part of action, the APPCB has issued stop production orders to the five industries and forfeited the Bank Guarantee of Rs. 50 Lakhs submitted by Visakha Pharmacity for permitting the waste to outside the pharma city.
3. An incident of fish death took place in PeddaCheruvu, Parawada, Visakhapatnam on 30.10.2020. The same was covered in the newspapers on 31.10.2020. The Board has constituted a three-member expert committee of Andhra University and the committee submitted report to the Board on 18.11.2020.
   a) *"The committee opines that the mass mortality of the fish is due to sudden depletion of DO (Dissolved Oxygen) induced by the highly eutrophicated state of the tank.*

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b) The committee further opines that the Peddacheruvvu is a very important wetland of the area, which is left neglected and requires good management for its restoration. The committee recommends that the local bodies should immediately address the problem, in the absence of which, the area is vulnerable for public health problems, more particularly from the vector borne diseases."

The collector & District Magistrate instructed the Joint Collector (Asara & Welfare) to verify the petition along with the following officials:

1. Joint Director, Fisheries Department.
2. Joint Chief Inspector of Factories, Factories Department.
3. Environmental Engineer, A.P. Pollution Control Board.

As per the instructions of the Collector & District Magistrate, Visakhapatnam, the undersigned along with Joint Director, Fisheries Department, Joint Chief Inspector of Factories, Factories Department and Environmental Engineer (FAC), A.P. Pollution Control Board verified the Complaint and submitted report on 18.11.2020 along with the following recommendations:

i. Since there is a suspicion of the villagers & farmers that the channel which is emptying into Oora Cheruvu is discharging untreated wastewater and storm water. It is recommended to divert the wastewater from the channel into the CETP for treatment and discharge into sea through marine pipeline.

ii. M/s. Ramky Pharmacity (I) Pvt Ltd which is operating CETP is directed to prevent the discharge of water through this channel into Oora Cheruvu.

iii. M/s. Ramky Pharmacity (I) Pvt Ltd has to take all precautionary measures not to discharge any type of wastewater through this channel into Oora Cheruvu.

4. The Board issued directions to all the industries in the Pharmacity vide circular memo dated 26.08.2020 to avoid contaminated storm water discharges into the drains leading to contamination of nearby water bodies. Copy of the directions dated 26.08.2020 is herewith enclosed as **Annexure-X.**
5. The Board has constituted a monitoring committee with members from industries, APIIC and APPCB to monitor the industries to curb the illegal discharges of effluents into storm water drains and air pollution in JN Pharmacity. Copy of the proceedings dated 08.09.2020 is herewith enclosed as **Annexure-XI**.
6. The Board has issued work order to NEERI, Hyderabad for carrying out study on "Assessment of Contamination and preparation of Remediation plan for Tanam Cheruvu" located at Tanam Village, Visakhapatnam to M/s. CSIR-National Environmental Engineering Research Institute (NEERI), Hyderabad. Final report is awaited.

I. Nani Reddy

ENVIRONMENTAL ENGINEER

Environmental Engineer
A.P. Pollution Control Board
Regional Office, Visakhapatnam

Annexure -I

Item No. 01:

**BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI**

Original Application No.141 of 2023 (SZ)
(Through Video Conference)

IN THE MATTER OF

Ganisetti Satyanarayana, Andhra Pradesh
... Applicant(s)

Versus

Union of India & Ors.
...Respondent(s)

Date of hearing: 04.10.2023.

CORAM:
HON'BLE SMT. JUSTICE PUSHPA SATHYANARAYANA, JUDICIAL MEMBER
HON'BLE DR. SATYAGOPAL KORLAPATI, EXPERT MEMBER

For Applicant(s): Mr. K. Sravan Kumar

For Respondent(s): Dr. Kuna Suryanarayana for MoEF&CC.
Ms. Madhuri Donti Reddy for R2, R3 & R5.

ORDER

1. Issue Notice to the respondents through Tribunal as well as privately.
2. Dr. Kuna Suryanarayana accepts notice on behalf of the MoEF&CC and Ms. Madhuri Donti Reddy accepts notice on behalf of the respondent nos. 2, 3 and 5.

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3. Post the matter on 06.11.2023.

……..J.M.
(Smt. Justice Pushpa Sathyanarayana)

....E.M.
(Dr. Satyagopal Korlapati)

O.A.No.141/2023 (SZ)
04th October, 2023. AM.

Annexure-II

Real Time Data Acquisition And Monitoring

G Lens

Site Name: Visakha Pharmacity Limited (Earlier Known As .Ramky Pharmacity (India) Ltd., (CETP))

Report: Custom Report

From Date: 2023/01/01 00:00:00 To Date : 2023/10/30 10:59:50

Description	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
Prescribed Standards	0 - 80	0 - 80	0 - 400	0 - 100	0 - 60	0 -
Maximum Data	49.0	34.0	6.32	270.0	180.0	0.58
Minimum Data	1.19	0.65	0.12	4.99	3.45	0.21
Geometric Mean	5.85	3.53	0.66	29.99	19.51	0.5
Median	5.35	3.16	0.59	26.1	17.67	0.5
Standard Deviation	4.33	2.69	0.5	21.83	13.46	0.02
Maximum Value At Time	2023-01-04	2023-01-04	2023-01-04	2023-01-04	2023-01-04	2023-01-04
Minimum Value At Time	2023-07-26	2023-07-26	2023-07-26	2023-07-26	2023-07-26	2023-09-26
Valid Data Points	293	293	293	293	293	295
Total Data Points	303	303	303	303	303	303
Data Availability %	96.7%	96.7%	96.7%	96.7%	96.7%	97.36%

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
1	2023-01-01	4.88	3.39	0.63	26.85	17.91	0.49
2	2023-01-02	4.76	3.31	0.61	26.26	17.50	0.50
3	2023-01-03	NA	NA	NA	NA	NA	NA
4	2023-01-04	49.00	34.00	6.32	270.00	180.00	0.58
5	2023-01-05	10.11	7.02	1.30	55.61	37.08	0.53
6	2023-01-06	9.45	6.56	1.22	52.11	34.72	0.50
7	2023-01-07	8.49	5.89	1.09	46.79	31.19	0.51
8	2023-01-08	5.32	3.69	0.68	29.27	19.53	0.51
9	2023-01-09	6.10	4.23	0.79	33.57	22.38	0.49

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
10	2023-01-10	5.75	3.99	0.74	31.66	21.12	0.48
11	2023-01-11	8.28	5.74	1.06	45.59	30.37	0.49
12	2023-01-12	7.13	4.95	0.92	39.29	26.15	0.50
13	2023-01-13	6.25	4.33	0.81	34.40	22.94	0.50
14	2023-01-14	6.46	4.48	0.84	35.60	23.70	0.47
15	2023-01-15	4.88	3.38	0.63	26.91	17.94	0.50
16	2023-01-16	4.19	2.90	0.54	23.03	15.35	0.50
17	2023-01-17	4.52	3.13	0.58	24.93	16.60	0.50
18	2023-01-18	5.12	3.55	0.66	28.20	18.80	0.51
19	2023-01-19	5.48	3.80	0.71	30.17	20.12	0.50
20	2023-01-20	5.94	4.12	0.77	32.75	21.84	0.50
21	2023-01-21	6.99	4.85	0.90	38.53	25.67	0.49
22	2023-01-22	7.16	4.97	0.92	39.42	26.28	0.50
23	2023-01-23	5.77	4.00	0.74	31.78	21.19	0.50
24	2023-01-24	5.98	4.15	0.77	32.93	21.96	0.48
25	2023-01-25	9.64	6.69	1.23	52.41	35.41	0.54
26	2023-01-26	7.32	5.08	0.94	40.30	26.86	0.51
27	2023-01-27	7.13	4.95	0.92	39.30	26.16	0.49
28	2023-01-28	6.71	4.65	0.86	36.96	24.64	0.49
29	2023-01-29	6.19	4.29	0.80	34.07	22.72	0.51
30	2023-01-30	5.84	4.05	0.75	32.17	21.44	0.51
31	2023-01-31	6.75	4.68	0.87	37.20	24.83	0.49
32	2023-02-01	6.46	4.48	0.83	35.59	23.72	0.51
33	2023-02-02	6.21	4.31	0.80	34.21	22.80	0.51
34	2023-02-03	6.14	4.26	0.79	33.81	22.55	0.49
35	2023-02-04	5.10	3.54	0.67	28.10	18.73	0.57

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
36	2023-02-05	NA	NA	NA	NA	NA	0.44
37	2023-02-06	NA	NA	NA	NA	NA	0.58
38	2023-02-07	6.32	4.39	0.82	34.87	23.22	0.49
39	2023-02-08	5.48	3.80	0.71	30.12	20.08	0.49
40	2023-02-09	4.27	2.96	0.55	23.48	15.68	0.48
41	2023-02-10	4.55	3.16	0.59	25.07	16.72	0.51
42	2023-02-11	4.26	2.96	0.55	23.48	15.65	0.50
43	2023-02-12	5.82	4.04	0.75	32.06	21.31	0.52
44	2023-02-13	4.11	2.85	0.53	22.64	15.10	0.50
45	2023-02-14	7.96	5.50	1.02	43.68	29.11	0.45
46	2023-02-15	6.23	4.32	0.80	34.32	22.88	0.48
47	2023-02-16	5.52	3.83	0.71	30.42	20.28	0.50
48	2023-02-17	5.19	3.60	0.67	28.60	19.07	0.52
49	2023-02-18	5.08	3.53	0.66	28.01	18.68	0.51
50	2023-02-19	3.81	2.65	0.49	21.02	14.01	0.50
51	2023-02-20	3.60	2.50	0.46	19.83	13.23	0.52
52	2023-02-21	4.07	2.83	0.53	22.43	14.96	0.50
53	2023-02-22	3.30	2.29	0.43	18.20	12.13	0.50
54	2023-02-23	5.47	3.79	0.70	30.12	20.07	0.50
55	2023-02-24	5.04	3.49	0.65	27.75	18.50	0.50
56	2023-02-25	4.73	3.28	0.61	26.10	17.40	0.48
57	2023-02-26	4.80	3.33	0.62	26.44	17.63	0.49
58	2023-02-27	4.66	3.24	0.60	25.66	17.12	0.50
59	2023-02-28	4.85	3.36	0.63	26.73	17.82	0.51
60	2023-03-01	5.93	4.11	0.76	32.68	21.79	0.50
61	2023-03-02	6.83	4.74	0.88	37.60	25.07	0.47

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
62	2023-03-03	8.43	5.85	1.09	46.46	30.95	0.51
63	2023-03-04	7.29	5.06	0.94	40.15	26.77	0.50
64	2023-03-05	6.34	4.40	0.82	34.92	23.28	0.51
65	2023-03-06	7.99	5.54	1.03	44.00	29.32	0.50
66	2023-03-07	6.65	4.61	0.86	36.64	24.43	0.50
67	2023-03-08	7.02	4.87	0.90	38.65	25.77	0.50
68	2023-03-09	6.22	4.32	0.80	34.29	22.87	0.50
69	2023-03-10	5.12	3.56	0.66	28.20	18.82	0.48
70	2023-03-11	5.79	4.02	0.75	31.91	21.28	0.51
71	2023-03-12	6.20	4.30	0.80	34.22	22.77	0.48
72	2023-03-13	8.23	5.71	1.06	45.36	30.20	0.52
73	2023-03-14	8.05	5.58	1.04	44.36	29.57	0.50
74	2023-03-15	8.56	5.94	1.10	47.21	31.49	0.49
75	2023-03-16	3.41	2.36	0.44	18.76	12.50	0.51
76	2023-03-17	3.52	2.44	0.45	19.41	12.94	0.51
77	2023-03-18	3.62	2.51	0.47	19.95	13.32	0.50
78	2023-03-19	1.57	1.09	0.20	8.67	5.78	0.49
79	2023-03-20	2.32	1.61	0.30	12.81	8.53	0.49
80	2023-03-21	2.56	1.77	0.33	14.10	9.40	0.49
81	2023-03-22	2.16	1.50	0.28	11.87	7.92	0.50
82	2023-03-23	2.25	1.56	0.29	12.36	8.27	0.50
83	2023-03-24	3.18	2.20	0.41	17.52	11.69	0.44
84	2023-03-25	2.44	1.69	0.31	13.41	8.94	0.50
85	2023-03-26	2.54	1.76	0.33	13.98	9.31	0.49
86	2023-03-27	2.62	1.82	0.34	14.41	9.62	0.48
87	2023-03-28	3.05	2.12	0.39	16.82	11.23	0.49

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
88	2023-03-29	2.67	1.85	0.35	14.70	9.78	0.51
89	2023-03-30	2.85	1.98	0.37	15.70	10.54	0.50
90	2023-03-31	1.63	1.13	0.21	8.99	5.98	0.50
91	2023-04-01	2.43	1.69	0.31	13.36	8.91	0.49
92	2023-04-02	1.80	1.25	0.23	9.94	6.61	0.49
93	2023-04-03	2.41	1.67	0.31	13.28	8.83	0.49
94	2023-04-04	2.78	1.93	0.36	15.34	10.22	0.50
95	2023-04-05	2.04	1.41	0.26	11.23	7.47	0.49
96	2023-04-06	2.33	1.61	0.30	12.84	8.55	0.50
97	2023-04-07	3.28	2.27	0.42	18.05	12.03	0.51
98	2023-04-08	3.87	2.68	0.50	21.29	14.22	0.49
99	2023-04-09	5.11	3.55	0.66	28.23	18.79	0.50
100	2023-04-10	5.09	3.53	0.66	28.02	18.72	0.49
101	2023-04-11	6.59	4.57	0.85	36.22	24.19	0.51
102	2023-04-12	5.89	4.08	0.76	32.42	21.64	0.50
103	2023-04-13	6.27	4.35	0.81	34.44	23.00	0.51
104	2023-04-14	5.44	3.78	0.70	29.97	19.96	0.50
105	2023-04-15	5.93	4.11	0.76	32.72	21.77	0.51
106	2023-04-16	6.76	4.68	0.87	37.24	24.83	0.48
107	2023-04-17	6.36	4.42	0.82	35.03	23.39	0.50
108	2023-04-18	5.82	4.04	0.74	32.07	21.38	0.48
109	2023-04-19	NA	NA	NA	NA	NA	NA
110	2023-04-20	NA	NA	NA	NA	NA	NA
111	2023-04-21	NA	NA	NA	NA	NA	NA
112	2023-04-22	2.72	1.88	0.35	14.99	9.96	0.52
113	2023-04-23	3.54	2.46	0.46	19.53	13.00	0.51

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
114	2023-04-24	7.51	5.21	0.97	41.10	27.42	0.48
115	2023-04-25	6.81	4.73	0.89	37.59	25.12	0.53
116	2023-04-26	11.28	7.83	1.47	62.11	41.39	0.50
117	2023-04-27	9.09	6.29	1.20	50.04	33.38	0.51
118	2023-04-28	14.36	8.65	1.61	34.19	21.79	0.50
119	2023-04-29	30.08	16.50	3.07	51.64	28.86	0.49
120	2023-04-30	3.64	1.99	0.37	15.25	10.56	0.50
121	2023-05-01	2.75	1.47	0.28	11.60	8.02	0.50
122	2023-05-02	3.21	1.76	0.33	13.44	9.31	0.52
123	2023-05-03	1.99	1.09	0.20	8.33	5.77	0.50
124	2023-05-04	2.65	1.45	0.27	11.09	7.68	0.52
125	2023-05-05	2.27	1.24	0.23	9.86	6.59	0.47
126	2023-05-06	2.38	1.30	0.24	9.98	6.90	0.50
127	2023-05-07	3.41	1.87	0.35	14.33	9.92	0.51
128	2023-05-08	3.73	2.04	0.38	15.61	10.81	0.50
129	2023-05-09	3.33	1.82	0.34	13.94	9.66	0.50
130	2023-05-10	5.62	3.08	0.57	23.59	16.32	0.48
131	2023-05-11	4.77	2.62	0.49	20.00	13.85	0.50
132	2023-05-12	4.10	2.25	0.42	17.19	11.90	0.52
133	2023-05-13	4.94	2.71	0.50	20.76	14.37	0.51
134	2023-05-14	8.61	4.72	0.88	36.13	25.02	0.49
135	2023-05-15	9.13	5.01	0.93	38.28	26.50	0.49
136	2023-05-16	15.73	8.63	1.62	42.90	27.72	0.51
137	2023-05-17	6.26	3.43	0.64	26.26	18.18	0.50
138	2023-05-18	4.95	2.72	0.50	20.76	14.37	0.49
139	2023-05-19	5.09	2.79	0.52	21.37	14.80	0.49

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
140	2023-05-20	6.07	3.33	0.62	25.47	17.61	0.49
141	2023-05-21	4.22	2.32	0.43	17.70	12.25	0.50
142	2023-05-22	4.63	2.54	0.47	19.43	13.47	0.49
143	2023-05-23	5.04	2.76	0.51	21.11	14.63	0.49
144	2023-05-24	5.31	2.91	0.54	22.25	15.43	0.49
145	2023-05-25	5.40	2.96	0.55	22.64	15.67	0.49
146	2023-05-26	8.11	4.45	0.81	27.22	18.30	0.49
147	2023-05-27	7.00	3.84	0.71	29.31	20.29	0.50
148	2023-05-28	6.64	3.64	0.68	27.76	19.25	0.51
149	2023-05-29	5.22	2.87	0.54	22.05	15.25	0.51
150	2023-05-30	3.56	1.95	0.36	14.92	10.31	0.48
151	2023-05-31	5.21	2.86	0.53	21.82	15.11	0.48
152	2023-06-01	6.85	3.75	0.70	28.71	19.88	0.51
153	2023-06-02	7.13	3.91	0.73	29.89	20.70	0.50
154	2023-06-03	6.83	3.74	0.70	28.62	19.81	0.50
155	2023-06-04	6.08	3.34	0.62	25.44	17.67	0.51
156	2023-06-05	7.38	4.05	0.76	24.15	16.15	0.50
157	2023-06-06	5.53	3.03	0.56	23.19	16.07	0.51
158	2023-06-07	5.47	3.00	0.56	22.93	15.87	0.49
159	2023-06-08	6.17	3.38	0.63	25.88	17.94	0.49
160	2023-06-09	6.13	3.36	0.63	25.73	17.79	0.49
161	2023-06-10	4.54	2.49	0.46	19.04	13.18	0.51
162	2023-06-11	5.45	2.99	0.56	22.85	15.80	0.50
163	2023-06-12	5.59	3.06	0.57	23.44	16.23	0.50
164	2023-06-13	7.85	4.31	0.80	33.16	22.81	0.46
165	2023-06-14	5.87	3.22	0.60	24.61	17.04	0.49

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
166	2023-06-15	5.61	3.08	0.57	23.53	16.29	0.50
167	2023-06-16	8.64	4.74	0.88	36.27	25.07	0.52
168	2023-06-17	7.42	4.07	0.76	31.12	21.43	0.49
169	2023-06-18	15.78	8.65	1.61	51.66	32.30	0.49
170	2023-06-19	14.33	7.86	1.45	40.29	24.65	0.51
171	2023-06-20	7.69	4.21	0.78	32.24	22.32	0.50
172	2023-06-21	10.68	5.86	1.09	40.26	25.26	0.51
173	2023-06-22	6.45	3.53	0.66	26.88	18.47	0.51
174	2023-06-23	9.42	5.17	0.96	39.50	27.31	0.50
175	2023-06-24	5.25	2.88	0.54	22.03	15.26	0.49
176	2023-06-25	13.64	7.48	1.39	41.28	25.68	0.51
177	2023-06-26	3.26	1.79	0.33	13.70	9.48	0.50
178	2023-06-27	8.43	4.62	0.86	35.25	23.98	0.50
179	2023-06-28	13.03	7.14	1.33	45.41	28.84	0.50
180	2023-06-29	10.18	5.58	1.04	41.20	27.50	0.51
181	2023-06-30	8.56	4.70	0.87	34.44	22.86	0.50
182	2023-07-01	20.15	11.04	2.05	58.86	35.69	0.50
183	2023-07-02	5.33	2.92	0.54	22.13	15.23	0.52
184	2023-07-03	7.00	3.84	0.71	27.18	18.52	0.51
185	2023-07-04	13.53	7.42	1.39	43.41	28.35	0.51
186	2023-07-05	27.37	15.01	2.80	61.81	35.98	0.49
187	2023-07-06	26.66	14.62	2.72	74.70	43.18	0.52
188	2023-07-07	5.57	3.05	0.57	23.70	16.29	0.53
189	2023-07-08	7.30	4.00	0.74	30.68	21.21	0.50
190	2023-07-09	9.09	4.99	0.93	36.69	23.67	0.50
191	2023-07-10	13.10	7.19	1.34	42.35	25.61	0.50

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
192	2023-07-11	3.03	1.66	0.31	12.66	8.78	0.51
193	2023-07-12	2.54	1.39	0.26	10.64	7.37	0.51
194	2023-07-13	3.18	1.74	0.32	13.34	9.23	0.50
195	2023-07-14	7.19	3.94	0.73	27.36	18.21	0.50
196	2023-07-15	5.54	3.04	0.57	23.22	16.03	0.50
197	2023-07-16	3.33	1.83	0.34	13.97	9.68	0.50
198	2023-07-17	4.51	2.48	0.46	18.89	12.98	0.52
199	2023-07-18	3.77	2.07	0.38	15.80	10.92	0.51
200	2023-07-19	2.72	1.49	0.28	11.33	7.84	0.53
201	2023-07-20	1.93	1.06	0.20	8.09	5.61	0.49
202	2023-07-21	1.99	1.09	0.20	8.34	5.78	0.48
203	2023-07-22	2.14	1.17	0.22	8.99	6.22	0.50
204	2023-07-23	2.90	1.59	0.30	12.23	8.47	0.49
205	2023-07-24	1.49	0.82	0.15	6.24	4.32	0.49
206	2023-07-25	1.57	0.86	0.16	6.55	4.54	0.50
207	2023-07-26	1.19	0.65	0.12	4.99	3.45	0.51
208	2023-07-27	2.40	1.32	0.24	10.08	7.01	0.51
209	2023-07-28	3.63	1.99	0.37	15.23	10.55	0.50
210	2023-07-29	3.13	1.72	0.32	13.18	9.14	0.50
211	2023-07-30	4.32	2.37	0.44	18.14	12.54	0.51
212	2023-07-31	4.57	2.51	0.47	19.13	13.24	0.50
213	2023-08-01	3.78	2.07	0.38	15.82	10.96	0.49
214	2023-08-02	4.63	2.54	0.47	19.41	13.44	0.48
215	2023-08-03	4.49	2.45	0.46	18.79	13.07	0.49
216	2023-08-04	5.45	2.99	0.55	22.69	15.73	0.47
217	2023-08-05	11.51	6.31	1.17	48.02	33.32	0.52

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
218	2023-08-06	9.72	5.33	0.99	40.34	26.94	0.52
219	2023-08-07	6.69	3.67	0.68	28.03	19.38	0.50
220	2023-08-08	5.90	3.24	0.60	24.73	17.09	0.51
221	2023-08-09	6.04	3.31	0.61	25.22	17.51	0.48
222	2023-08-10	3.69	2.02	0.38	15.61	10.76	0.50
223	2023-08-11	7.45	4.10	0.75	31.42	21.61	0.50
224	2023-08-12	8.13	4.46	0.82	34.13	23.65	0.50
225	2023-08-13	3.33	1.83	0.34	14.00	9.68	0.52
226	2023-08-14	8.11	4.45	0.82	33.95	23.52	0.49
227	2023-08-15	NA	NA	NA	NA	NA	NA
228	2023-08-16	5.64	3.09	0.57	23.71	16.42	0.52
229	2023-08-17	3.60	1.96	0.36	14.98	10.48	0.51
230	2023-08-18	3.34	1.83	0.34	14.01	9.69	0.51
231	2023-08-19	3.32	1.82	0.34	13.67	9.66	0.52
232	2023-08-20	3.11	1.70	0.32	13.13	9.08	0.51
233	2023-08-21	4.56	2.50	0.46	19.09	13.21	0.50
234	2023-08-22	3.48	1.91	0.35	14.39	10.12	0.51
235	2023-08-23	5.54	3.04	0.57	23.27	16.09	0.50
236	2023-08-24	3.49	1.91	0.35	14.73	10.13	0.51
237	2023-08-25	3.92	2.15	0.40	16.45	11.38	0.50
238	2023-08-26	2.38	1.31	0.24	10.02	6.93	0.50
239	2023-08-27	3.00	1.65	0.31	12.55	8.71	0.50
240	2023-08-28	4.50	2.47	0.46	18.87	13.09	0.50
241	2023-08-29	6.98	3.83	0.71	29.25	20.26	0.49
242	2023-08-30	8.43	4.62	0.86	35.35	24.49	0.51
243	2023-08-31	8.19	4.49	0.83	34.29	23.75	0.50

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
244	2023-09-01	6.00	3.29	0.61	25.20	17.39	0.51
245	2023-09-02	4.41	2.42	0.45	18.51	12.79	0.53
246	2023-09-03	3.90	2.14	0.40	16.20	11.21	0.50
247	2023-09-04	3.72	2.04	0.38	15.62	10.80	0.48
248	2023-09-05	3.19	1.75	0.33	13.29	9.20	0.54
249	2023-09-06	1.97	1.08	0.20	8.21	5.71	0.50
250	2023-09-07	3.27	1.79	0.33	13.73	9.49	0.51
251	2023-09-08	3.88	2.12	0.40	16.19	11.25	0.51
252	2023-09-09	4.06	2.23	0.41	17.00	11.77	0.50
253	2023-09-10	2.26	1.24	0.23	9.47	6.55	0.52
254	2023-09-11	2.65	1.46	0.27	11.10	7.66	0.50
255	2023-09-12	2.07	1.13	0.20	8.60	5.94	0.52
256	2023-09-13	2.55	1.41	0.25	10.61	7.40	0.50
257	2023-09-14	1.96	1.08	0.20	8.25	5.69	0.50
258	2023-09-15	4.35	2.39	0.44	18.25	12.62	0.51
259	2023-09-16	3.21	1.76	0.33	13.49	9.29	0.51
260	2023-09-17	2.40	1.32	0.24	10.07	6.98	0.48
261	2023-09-18	3.13	1.71	0.32	13.19	9.10	0.51
262	2023-09-19	5.58	3.06	0.57	23.40	16.20	0.52
263	2023-09-20	2.34	1.29	0.24	9.74	6.79	0.54
264	2023-09-21	2.67	1.50	0.28	11.14	7.76	0.47
265	2023-09-22	3.17	1.74	0.33	13.41	9.29	0.51
266	2023-09-23	2.23	1.22	0.22	9.40	6.39	0.50
267	2023-09-24	2.76	1.51	0.28	11.55	8.02	0.51
268	2023-09-25	NA	NA	NA	NA	NA	NA
269	2023-09-26	1.49	0.82	0.15	6.24	4.32	0.21

Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
270	2023-09-27	4.55	2.50	0.46	19.05	13.21	0.50
271	2023-09-28	2.98	1.63	0.30	12.51	8.67	0.51
272	2023-09-29	1.53	0.84	0.16	10.19	6.97	0.51
273	2023-09-30	2.51	1.37	0.25	30.81	19.55	0.52
274	2023-10-01	NA	NA	NA	NA	NA	NA
275	2023-10-02	NA	NA	NA	NA	NA	NA
276	2023-10-03	4.10	2.25	0.42	43.50	24.82	0.52
277	2023-10-04	5.06	2.78	0.51	53.59	30.91	0.50
278	2023-10-05	6.72	3.69	0.69	66.80	38.28	0.50
279	2023-10-06	6.52	3.58	0.67	69.13	39.60	0.50
280	2023-10-07	6.72	3.68	0.68	69.95	40.10	0.50
281	2023-10-08	6.83	3.74	0.70	69.51	39.56	0.50
282	2023-10-09	5.35	2.94	0.55	56.95	32.80	0.49
283	2023-10-10	6.13	3.36	0.63	61.89	35.20	0.50
284	2023-10-11	7.16	3.93	0.73	75.03	42.66	0.50
285	2023-10-12	6.87	3.77	0.70	71.47	40.83	0.50
286	2023-10-13	7.52	4.12	0.77	79.33	45.59	0.50
287	2023-10-14	6.09	3.35	0.62	64.96	37.26	0.51
288	2023-10-15	7.16	3.92	0.73	72.91	41.55	0.50
289	2023-10-16	6.54	3.59	0.67	68.96	39.58	0.48
290	2023-10-17	7.25	3.98	0.74	74.73	42.46	0.51
291	2023-10-18	7.22	3.95	0.73	75.92	43.51	0.48
292	2023-10-19	7.79	4.28	0.80	83.00	47.76	0.51
293	2023-10-20	5.73	3.14	0.58	60.88	35.11	0.51
294	2023-10-21	5.21	2.86	0.53	55.49	31.94	0.49
295	2023-10-22	5.56	3.05	0.57	59.13	34.08	0.51

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Sl No	Time	Station_2_Thadi-SO2_U	Station_2_Thadi-NOx_U	Station_2_Thadi-NH3_U	Station_2_Thadi-PM10_U	Station_2_Thadi-PM2.5_U	Station_2_Thadi-VOC_U
296	2023-10-23	4.47	2.45	0.45	47.33	27.31	0.50
297	2023-10-24	5.32	2.92	0.54	56.60	32.57	0.49
298	2023-10-25	5.80	3.18	0.60	61.71	35.56	0.49
299	2023-10-26	5.83	3.20	0.59	62.08	35.69	0.51
300	2023-10-27	5.29	2.90	0.54	56.23	32.32	0.50
301	2023-10-28	9.32	5.09	0.95	73.10	41.79	0.49
302	2023-10-29	6.95	3.81	0.71	73.75	42.50	0.50
303	2023-10-30	5.60	3.07	0.57	59.70	34.30	0.51

Report Details: RPIL | 2023-10-30 11:05:07 | Custom Report

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Real Time Data Acquisition And Monitoring

Site Name: Visakha Pharmacity Limited (Earlier Known As .Ramky Pharmacity (India) Ltd.,(CETP))

Report: Custom Report

From Date: 2023/01/01 00:00:00 To Date : 2023/10/30 10:59:50

Description	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
Prescribed Standards	0 - 80	0 - 80	0 - 400	0 - 100	0 - 60	0 -
Maximum Data	2.92	3.19	2.4	82.75	46.65	1.59
Minimum Data	0.24	0.26	0.19	6.72	3.78	0.13
Geometric Mean	1.01	1.11	0.82	28.36	16.01	0.55
Median	0.87	0.96	0.71	24.53	13.84	0.48
Standard Deviation	0.52	0.57	0.43	14.65	8.27	0.28
Maximum Value At Time	2023-01-25	2023-01-25	2023-01-25	2023-01-25	2023-01-25	2023-01-25
Minimum Value At Time	2023-07-26	2023-07-26	2023-07-26	2023-07-26	2023-07-26	2023-07-26
Valid Data Points	287	289	287	287	287	287
Total Data Points	303	303	303	303	303	303
Data Availability %	94.72%	95.38%	94.72%	94.72%	94.72%	94.72%

Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
1	2023-01-01	0.98	1.07	0.80	27.68	15.62	0.54
2	2023-01-02	1.22	1.33	1.00	34.45	19.46	0.67
3	2023-01-03	1.24	1.35	1.02	35.03	19.76	0.68
4	2023-01-04	1.46	1.60	1.20	41.29	23.28	0.80
5	2023-01-05	1.90	2.07	1.55	53.35	30.13	1.03
6	2023-01-06	2.27	2.48	1.86	64.02	36.13	1.24
7	2023-01-07	2.44	2.65	1.99	68.66	38.74	1.33
8	2023-01-08	1.45	1.58	1.19	40.85	23.07	0.79
9	2023-01-09	1.74	1.90	1.42	48.99	27.68	0.95
10	2023-01-10	1.76	1.92	1.45	49.53	27.97	0.96
11	2023-01-11	2.07	2.26	1.70	58.38	33.04	1.13
12	2023-01-12	1.91	2.09	1.57	53.81	30.36	1.05
13	2023-01-13	1.51	1.64	1.23	42.54	24.02	0.82

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
14	2023-01-14	1.20	1.30	0.98	33.66	19.02	0.65
15	2023-01-15	0.85	0.93	0.69	23.90	13.49	0.46
16	2023-01-16	0.78	0.85	0.64	22.01	12.43	0.43
17	2023-01-17	1.01	1.10	0.82	28.39	15.98	0.55
18	2023-01-18	0.93	1.02	0.77	26.34	14.87	0.51
19	2023-01-19	1.15	1.25	0.94	32.35	18.24	0.63
20	2023-01-20	1.62	1.76	1.32	45.54	25.71	0.88
21	2023-01-21	1.68	1.84	1.38	47.49	26.82	0.92
22	2023-01-22	1.83	2.00	1.50	51.74	29.18	1.00
23	2023-01-23	1.52	1.66	1.25	42.98	24.23	0.83
24	2023-01-24	1.73	1.90	1.41	48.60	27.35	0.94
25	2023-01-25	2.92	3.19	2.40	82.75	46.65	1.59
26	2023-01-26	1.79	1.95	1.46	50.64	28.47	0.98
27	2023-01-27	2.16	2.35	1.77	60.61	34.33	1.17
28	2023-01-28	2.44	2.64	1.99	68.52	38.75	1.33
29	2023-01-29	1.68	1.84	1.38	47.42	26.78	0.92
30	2023-01-30	1.63	1.78	1.33	46.00	25.98	0.89
31	2023-01-31	1.93	2.11	1.58	54.47	30.77	1.05
32	2023-02-01	1.74	1.90	1.43	49.13	27.75	0.95
33	2023-02-02	1.73	1.89	1.42	48.84	27.58	0.94
34	2023-02-03	1.68	1.84	1.38	47.40	26.77	0.92
35	2023-02-04	2.50	2.57	2.05	71.14	40.16	1.37
36	2023-02-05	NA	2.32	NA	NA	NA	NA
37	2023-02-06	NA	2.45	NA	NA	NA	NA
38	2023-02-07	1.33	1.45	1.09	37.54	21.20	0.73
39	2023-02-08	1.38	1.51	1.13	38.82	21.91	0.75
40	2023-02-09	1.09	1.18	0.89	30.60	17.27	0.59
41	2023-02-10	1.13	1.23	0.92	31.79	17.89	0.61
42	2023-02-11	0.95	1.03	0.77	26.70	15.06	0.52

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
43	2023-02-12	1.11	1.21	0.91	31.35	17.70	0.61
44	2023-02-13	1.77	1.94	1.45	49.90	28.19	0.97
45	2023-02-14	2.11	2.30	1.73	59.33	33.45	1.15
46	2023-02-15	2.80	3.05	2.29	78.87	44.53	1.53
47	2023-02-16	1.19	1.30	0.98	33.64	18.98	0.65
48	2023-02-17	1.15	1.26	0.94	32.47	18.33	0.63
49	2023-02-18	1.16	1.27	0.95	32.71	18.47	0.63
50	2023-02-19	0.88	0.96	0.72	24.79	14.00	0.48
51	2023-02-20	0.89	0.97	0.73	25.01	14.11	0.48
52	2023-02-21	0.90	0.98	0.74	25.36	14.32	0.49
53	2023-02-22	1.03	1.12	0.84	29.11	16.42	0.56
54	2023-02-23	0.99	1.08	0.81	27.75	15.69	0.54
55	2023-02-24	0.98	1.07	0.80	27.64	15.60	0.54
56	2023-02-25	1.20	1.30	0.98	33.60	18.99	0.65
57	2023-02-26	1.26	1.38	1.04	35.63	20.14	0.69
58	2023-02-27	1.28	1.40	1.05	35.97	20.33	0.70
59	2023-02-28	1.53	1.66	1.25	42.98	24.26	0.83
60	2023-03-01	1.53	1.69	1.26	43.56	24.61	0.84
61	2023-03-02	2.45	2.67	2.01	69.09	38.96	1.34
62	2023-03-03	1.78	1.94	1.45	50.07	28.28	0.97
63	2023-03-04	1.64	1.79	1.34	46.27	26.11	0.89
64	2023-03-05	2.27	2.47	1.85	63.96	36.20	1.23
65	2023-03-06	1.85	2.02	1.54	52.29	29.53	1.01
66	2023-03-07	1.73	1.89	1.42	48.67	27.56	0.94
67	2023-03-08	1.64	1.79	1.34	46.22	26.08	0.89
68	2023-03-09	2.38	2.60	1.95	67.03	37.81	1.30
69	2023-03-10	1.38	1.50	1.13	38.89	21.97	0.75
70	2023-03-11	1.47	1.60	1.20	41.40	23.37	0.80
71	2023-03-12	NA	NA	NA	NA	NA	NA

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
72	2023-03-13	1.74	1.90	1.42	48.99	27.71	0.95
73	2023-03-14	1.72	1.88	1.41	48.54	27.41	0.94
74	2023-03-15	1.49	1.63	1.22	42.02	23.73	0.81
75	2023-03-16	0.85	0.92	0.69	23.87	13.48	0.46
76	2023-03-17	1.09	1.18	0.89	30.61	17.28	0.59
77	2023-03-18	0.98	1.07	0.80	27.57	15.59	0.53
78	2023-03-19	0.55	0.60	0.45	15.45	8.73	0.30
79	2023-03-20	0.39	0.42	0.32	10.93	6.16	0.21
80	2023-03-21	0.46	0.47	0.37	12.81	7.25	0.25
81	2023-03-22	0.46	0.50	0.38	12.84	7.28	0.25
82	2023-03-23	0.49	0.53	0.40	13.79	7.82	0.27
83	2023-03-24	0.40	0.44	0.33	11.26	6.36	0.22
84	2023-03-25	0.53	0.58	0.44	15.02	8.43	0.29
85	2023-03-26	0.63	0.68	0.51	17.58	9.98	0.34
86	2023-03-27	0.62	0.68	0.51	17.58	9.91	0.34
87	2023-03-28	0.51	0.56	0.42	14.45	8.16	0.28
88	2023-03-29	0.56	0.61	0.46	15.75	8.89	0.30
89	2023-03-30	NA	NA	NA	NA	NA	NA
90	2023-03-31	0.64	0.70	0.53	18.07	10.20	0.35
91	2023-04-01	0.47	0.51	0.39	13.27	7.49	0.26
92	2023-04-02	0.48	0.52	0.39	13.46	7.60	0.26
93	2023-04-03	1.32	1.42	1.05	37.12	21.06	0.70
94	2023-04-04	0.46	0.50	0.38	12.94	7.33	0.25
95	2023-04-05	0.38	0.42	0.31	10.42	6.06	0.20
96	2023-04-06	0.52	0.57	0.43	14.70	8.30	0.28
97	2023-04-07	0.87	0.94	0.71	24.36	13.80	0.47
98	2023-04-08	0.57	0.62	0.46	16.10	9.10	0.31
99	2023-04-09	0.84	0.92	0.69	23.73	13.40	0.46
100	2023-04-10	1.03	1.12	0.84	29.02	16.38	0.56

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
101	2023-04-11	1.23	1.34	1.01	34.63	19.55	0.67
102	2023-04-12	1.23	1.35	1.01	34.73	19.65	0.67
103	2023-04-13	1.03	1.12	0.84	28.98	16.37	0.57
104	2023-04-14	1.00	1.08	0.81	28.05	15.83	0.54
105	2023-04-15	1.41	1.54	1.16	39.83	22.50	0.77
106	2023-04-16	1.32	1.44	1.08	37.23	21.01	0.72
107	2023-04-17	1.15	1.26	0.94	32.49	18.34	0.63
108	2023-04-18	1.33	1.45	1.09	37.42	21.14	0.73
109	2023-04-19	1.12	1.22	0.92	31.53	17.80	0.61
110	2023-04-20	0.93	1.02	0.76	26.33	14.87	0.51
111	2023-04-21	1.18	1.28	0.97	33.09	18.72	0.64
112	2023-04-22	1.01	1.10	0.83	28.45	16.06	0.55
113	2023-04-23	0.87	0.95	0.71	24.38	13.76	0.47
114	2023-04-24	0.78	0.85	0.64	22.04	12.42	0.43
115	2023-04-25	0.73	0.80	0.60	20.59	11.62	0.40
116	2023-04-26	0.93	1.02	0.76	26.30	14.83	0.51
117	2023-04-27	0.92	1.01	0.76	26.03	14.69	0.50
118	2023-04-28	0.87	0.95	0.71	24.53	13.84	0.48
119	2023-04-29	0.78	0.84	0.63	21.87	12.33	0.42
120	2023-04-30	0.98	1.07	0.80	27.69	15.66	0.53
121	2023-05-01	0.45	0.49	0.37	12.71	7.18	0.25
122	2023-05-02	0.49	0.53	0.40	13.73	7.73	0.27
123	2023-05-03	0.71	0.77	0.58	19.96	11.24	0.39
124	2023-05-04	0.60	0.66	0.49	17.03	9.62	0.33
125	2023-05-05	0.56	0.62	0.46	15.89	9.00	0.31
126	2023-05-06	0.52	0.56	0.42	14.46	8.20	0.28
127	2023-05-07	0.32	0.35	0.26	9.06	5.12	0.18
128	2023-05-08	0.53	0.58	0.44	15.02	8.45	0.29
129	2023-05-09	0.57	0.62	0.47	16.12	9.11	0.31

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
130	2023-05-10	0.50	0.54	0.41	14.14	7.99	0.27
131	2023-05-11	0.96	1.05	0.79	27.16	15.35	0.53
132	2023-05-12	0.70	0.77	0.58	19.83	11.20	0.38
133	2023-05-13	0.83	0.90	0.68	23.31	13.17	0.45
134	2023-05-14	1.17	1.27	0.95	32.80	18.54	0.63
135	2023-05-15	1.18	1.28	0.96	33.14	18.71	0.64
136	2023-05-16	1.31	1.43	1.07	37.01	20.85	0.72
137	2023-05-17	0.88	0.96	0.72	24.76	13.97	0.48
138	2023-05-18	0.70	0.77	0.57	19.81	11.18	0.38
139	2023-05-19	0.48	0.53	0.39	13.63	7.69	0.26
140	2023-05-20	0.88	0.96	0.72	24.82	14.01	0.48
141	2023-05-21	0.52	0.57	0.43	14.66	8.29	0.28
142	2023-05-22	0.91	1.00	0.75	25.72	14.52	0.50
143	2023-05-23	0.72	0.78	0.59	20.20	11.40	0.39
144	2023-05-24	0.61	0.67	0.50	17.24	9.74	0.33
145	2023-05-25	0.70	0.76	0.57	19.64	11.09	0.38
146	2023-05-26	0.79	0.86	0.65	22.29	12.60	0.43
147	2023-05-27	0.88	0.96	0.72	24.80	14.00	0.48
148	2023-05-28	1.45	1.58	1.18	40.70	23.08	0.79
149	2023-05-29	NA	NA	NA	NA	NA	NA
150	2023-05-30	1.15	1.26	0.95	32.57	18.38	0.63
151	2023-05-31	0.75	0.82	0.61	21.08	11.94	0.41
152	2023-06-01	0.96	1.04	0.78	26.96	15.22	0.52
153	2023-06-02	1.12	1.22	0.92	31.50	17.77	0.61
154	2023-06-03	0.82	0.90	0.67	23.07	13.04	0.45
155	2023-06-04	0.79	0.86	0.64	22.17	12.52	0.43
156	2023-06-05	0.83	0.91	0.69	23.54	13.28	0.45
157	2023-06-06	0.73	0.79	0.60	20.52	11.58	0.40
158	2023-06-07	1.03	1.13	0.84	29.06	16.40	0.56

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
159	2023-06-08	1.42	1.55	1.16	40.02	22.60	0.78
160	2023-06-09	0.88	0.96	0.72	24.65	13.94	0.48
161	2023-06-10	0.76	0.82	0.62	21.29	12.04	0.41
162	2023-06-11	NA	NA	NA	NA	NA	NA
163	2023-06-12	0.80	0.87	0.65	22.43	12.68	0.44
164	2023-06-13	1.12	1.22	0.91	31.46	17.76	0.61
165	2023-06-14	0.81	0.88	0.66	22.63	12.81	0.44
166	2023-06-15	0.99	1.07	0.80	27.77	15.67	0.54
167	2023-06-16	1.04	1.14	0.85	29.33	16.57	0.57
168	2023-06-17	1.03	1.12	0.84	28.95	16.34	0.56
169	2023-06-18	1.19	1.30	0.97	33.47	18.90	0.65
170	2023-06-19	1.06	1.16	0.87	29.84	16.86	0.58
171	2023-06-20	1.38	1.50	1.13	38.84	21.92	0.75
172	2023-06-21	0.76	0.83	0.62	21.37	12.07	0.41
173	2023-06-22	0.74	0.80	0.60	20.65	11.67	0.40
174	2023-06-23	0.78	0.85	0.64	22.04	12.45	0.43
175	2023-06-24	0.74	0.81	0.61	20.95	11.84	0.41
176	2023-06-25	0.64	0.69	0.52	17.99	10.13	0.35
177	2023-06-26	0.50	0.55	0.41	14.14	7.97	0.27
178	2023-06-27	0.61	0.67	0.50	17.35	9.79	0.33
179	2023-06-28	0.93	1.02	0.76	26.26	14.83	0.51
180	2023-06-29	0.63	0.68	0.51	17.67	9.96	0.34
181	2023-06-30	0.61	0.66	0.50	17.04	9.62	0.33
182	2023-07-01	0.84	0.91	0.69	23.70	13.37	0.46
183	2023-07-02	0.70	0.76	0.56	19.59	11.06	0.38
184	2023-07-03	0.78	0.86	0.64	22.04	12.45	0.43
185	2023-07-04	0.72	0.79	0.59	20.38	11.48	0.40
186	2023-07-05	0.93	1.01	0.76	26.10	14.72	0.50
187	2023-07-06	0.73	0.80	0.60	20.64	11.65	0.40

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
188	2023-07-07	0.55	0.60	0.45	15.46	8.72	0.30
189	2023-07-08	0.67	0.73	0.54	18.78	10.61	0.36
190	2023-07-09	0.71	0.77	0.58	19.95	11.27	0.39
191	2023-07-10	0.97	1.06	0.80	27.32	15.45	0.53
192	2023-07-11	0.89	0.96	0.72	24.91	14.06	0.48
193	2023-07-12	0.64	0.70	0.53	18.17	10.23	0.35
194	2023-07-13	0.66	0.71	0.54	18.45	10.42	0.36
195	2023-07-14	0.81	0.88	0.66	22.71	12.82	0.44
196	2023-07-15	1.19	1.30	0.97	33.48	18.90	0.65
197	2023-07-16	NA	NA	NA	NA	NA	NA
198	2023-07-17	0.46	0.51	0.38	13.09	7.38	0.25
199	2023-07-18	0.43	0.47	0.35	12.04	6.80	0.23
200	2023-07-19	0.36	0.39	0.29	10.05	5.68	0.19
201	2023-07-20	0.45	0.49	0.37	12.58	7.13	0.24
202	2023-07-21	0.42	0.46	0.34	11.82	6.68	0.23
203	2023-07-22	0.66	0.72	0.54	18.43	10.45	0.36
204	2023-07-23	0.71	0.77	0.58	19.94	11.32	0.38
205	2023-07-24	0.55	0.60	0.45	15.55	8.79	0.30
206	2023-07-25	0.69	0.75	0.56	19.41	10.95	0.38
207	2023-07-26	0.24	0.26	0.19	6.72	3.78	0.13
208	2023-07-27	0.29	0.31	0.24	8.09	4.58	0.16
209	2023-07-28	0.30	0.33	0.25	8.60	4.87	0.17
210	2023-07-29	0.42	0.45	0.34	11.67	6.61	0.23
211	2023-07-30	NA	NA	NA	NA	NA	NA
212	2023-07-31	0.68	0.74	0.55	19.14	10.77	0.37
213	2023-08-01	0.65	0.71	0.53	18.28	10.32	0.36
214	2023-08-02	0.48	0.53	0.39	13.55	7.66	0.26
215	2023-08-03	0.53	0.58	0.44	15.03	8.48	0.29
216	2023-08-04	0.48	0.52	0.39	13.39	7.57	0.26

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
217	2023-08-05	0.60	0.65	0.49	16.88	9.53	0.32
218	2023-08-06	0.52	0.56	0.43	14.58	8.25	0.28
219	2023-08-07	0.52	0.56	0.42	14.56	8.23	0.28
220	2023-08-08	0.67	0.73	0.55	18.91	10.67	0.37
221	2023-08-09	0.75	0.81	0.61	21.05	11.87	0.41
222	2023-08-10	0.85	0.93	0.70	23.96	13.53	0.46
223	2023-08-11	0.74	0.81	0.61	20.88	11.79	0.40
224	2023-08-12	0.92	1.01	0.76	25.95	14.67	0.50
225	2023-08-13	0.70	0.77	0.58	19.86	11.20	0.38
226	2023-08-14	0.85	0.93	0.70	24.00	13.54	0.46
227	2023-08-15	NA	NA	NA	NA	NA	NA
228	2023-08-16	0.54	0.59	0.44	15.22	8.59	0.29
229	2023-08-17	0.37	0.40	0.30	10.40	5.85	0.20
230	2023-08-18	0.62	0.67	0.50	17.42	9.84	0.34
231	2023-08-19	0.69	0.75	0.56	19.26	10.88	0.37
232	2023-08-20	0.48	0.52	0.39	13.43	7.59	0.26
233	2023-08-21	0.56	0.61	0.46	15.70	8.87	0.30
234	2023-08-22	0.50	0.54	0.41	14.03	7.94	0.27
235	2023-08-23	0.53	0.58	0.44	14.99	8.46	0.29
236	2023-08-24	0.54	0.59	0.44	15.24	8.59	0.29
237	2023-08-25	0.78	0.85	0.64	21.92	12.37	0.42
238	2023-08-26	0.60	0.66	0.49	17.01	9.60	0.33
239	2023-08-27	0.51	0.56	0.42	14.34	8.11	0.28
240	2023-08-28	0.66	0.72	0.54	18.65	10.52	0.36
241	2023-08-29	1.27	1.39	1.04	35.79	20.18	0.69
242	2023-08-30	1.48	1.62	1.22	41.80	23.60	0.81
243	2023-08-31	1.42	1.54	1.16	39.82	22.50	0.77
244	2023-09-01	1.01	1.11	0.83	28.57	16.12	0.55
245	2023-09-02	0.84	0.92	0.70	23.83	13.47	0.46

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
246	2023-09-03	0.60	0.65	0.49	16.82	9.53	0.33
247	2023-09-04	0.76	0.83	0.62	21.48	12.12	0.42
248	2023-09-05	0.75	0.82	0.62	21.25	11.98	0.41
249	2023-09-06	0.77	0.84	0.63	21.81	12.33	0.42
250	2023-09-07	0.38	0.42	0.32	10.94	6.13	0.21
251	2023-09-08	0.63	0.69	0.52	17.75	10.01	0.34
252	2023-09-09	0.75	0.82	0.60	21.22	11.98	0.41
253	2023-09-10	0.38	0.42	0.31	10.71	6.04	0.21
254	2023-09-11	0.47	0.51	0.38	13.11	7.41	0.25
255	2023-09-12	0.47	0.52	0.38	13.30	7.48	0.26
256	2023-09-13	0.46	0.51	0.38	13.07	7.39	0.25
257	2023-09-14	0.30	0.33	0.25	8.34	4.73	0.16
258	2023-09-15	0.59	0.64	0.48	16.59	9.39	0.32
259	2023-09-16	0.62	0.68	0.51	17.61	9.93	0.34
260	2023-09-17	0.68	0.75	0.56	19.35	10.92	0.37
261	2023-09-18	0.62	0.68	0.51	17.48	9.86	0.34
262	2023-09-19	0.82	0.90	0.67	23.18	13.09	0.45
263	2023-09-20	0.77	0.84	0.63	21.61	12.22	0.42
264	2023-09-21	0.36	0.39	0.30	10.18	5.75	0.20
265	2023-09-22	0.33	0.36	0.27	9.36	5.28	0.18
266	2023-09-23	0.30	0.32	0.24	8.38	4.75	0.16
267	2023-09-24	NA	NA	NA	NA	NA	NA
268	2023-09-25	NA	NA	NA	NA	NA	NA
269	2023-09-26	0.48	0.52	0.39	13.47	7.62	0.26
270	2023-09-27	0.56	0.61	0.46	15.70	8.88	0.31
271	2023-09-28	0.55	0.60	0.45	15.44	8.73	0.30
272	2023-09-29	0.43	0.47	0.35	12.05	6.83	0.23
273	2023-09-30	0.42	0.46	0.34	11.89	6.71	0.23
274	2023-10-01	NA	NA	NA	NA	NA	NA

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Sl No	Time	Station_1_Thanam-SO2_U	Station_1_Thanam-NOx_U	Station_1_Thanam-NH3_U	Station_1_Thanam-PM10_U	Station_1_Thanam-PM2.5_U	Station_1_Thanam-VOC_U
275	2023-10-02	NA	NA	NA	NA	NA	NA
276	2023-10-03	NA	NA	NA	NA	NA	NA
277	2023-10-04	0.81	0.88	0.66	22.71	12.80	0.44
278	2023-10-05	1.21	1.33	1.00	34.25	19.32	0.66
279	2023-10-06	1.98	2.16	1.61	55.67	31.42	1.08
280	2023-10-07	1.34	1.46	1.10	37.61	21.24	0.73
281	2023-10-08	1.17	1.26	0.96	32.96	18.61	0.64
282	2023-10-09	0.94	1.02	0.77	26.39	14.92	0.51
283	2023-10-10	1.31	1.43	1.08	37.05	20.92	0.72
284	2023-10-11	1.30	1.43	1.07	36.71	20.72	0.71
285	2023-10-12	1.80	1.97	1.47	50.89	28.74	0.98
286	2023-10-13	2.03	2.21	1.66	57.11	32.26	1.11
287	2023-10-14	1.75	1.91	1.43	49.26	27.81	0.95
288	2023-10-15	NA	NA	NA	NA	NA	NA
289	2023-10-16	1.28	1.39	1.05	36.06	20.33	0.70
290	2023-10-17	1.99	2.18	1.63	56.28	31.69	1.09
291	2023-10-18	1.95	2.12	1.59	54.77	30.95	1.06
292	2023-10-19	2.13	2.33	1.75	60.01	33.92	1.16
293	2023-10-20	1.39	1.52	1.14	39.17	22.13	0.76
294	2023-10-21	1.16	1.27	0.95	32.73	18.49	0.63
295	2023-10-22	1.34	1.46	1.09	37.64	21.25	0.73
296	2023-10-23	0.83	0.90	0.67	23.31	13.15	0.45
297	2023-10-24	1.00	1.09	0.82	28.12	15.88	0.54
298	2023-10-25	1.17	1.27	0.95	32.80	18.52	0.63
299	2023-10-26	1.29	1.41	1.06	36.42	20.53	0.71
300	2023-10-27	1.42	1.55	1.16	39.99	22.59	0.77
301	2023-10-28	2.29	2.49	1.87	64.40	36.36	1.25
302	2023-10-29	1.61	1.76	1.32	45.37	25.63	0.88
303	2023-10-30	NA	NA	NA	NA	NA	NA

Real Time Data Acquisition And Monitoring

Site Name: Visakha Pharmacity Limited (Earlier Known As .Ramky Pharmacity (India) Ltd., (CETP))

Report: Custom Report

From Date: 2023/01/01 00:00:00 To Date : 2023/10/30 10:59:50

Description	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
Prescribed Standards	0 - 80	0 - 80	0 - 400	0 - 100	0 - 60	0 -
Maximum Data	27.44	12.38	2.42	103.28	64.53	0.69
Minimum Data	1.58	1.45	0.28	12.11	7.58	0.08
Geometric Mean	5.78	5.26	1.02	43.88	27.43	0.29
Median	5.53	5.08	0.98	42.3	26.45	0.28
Standard Deviation	2.58	2.08	0.4	17.35	10.84	0.12
Maximum Value At Time	2023-02-05	2023-01-06	2023-01-06	2023-01-06	2023-01-06	2023-01-06
Minimum Value At Time	2023-07-19	2023-07-19	2023-07-19	2023-07-19	2023-07-19	2023-07-18
Valid Data Points	299	297	297	297	297	297
Total Data Points	303	303	303	303	303	303
Data Availability %	98.68%	98.02%	98.02%	98.02%	98.02%	98.02%

Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
1	2023-01-01	4.97	4.59	0.89	38.22	23.90	0.26
2	2023-01-02	5.48	5.06	0.98	42.10	26.34	0.28
3	2023-01-03	5.90	5.45	1.06	45.53	28.40	0.30
4	2023-01-04	8.06	7.44	1.45	62.01	38.76	0.41
5	2023-01-05	10.88	10.04	1.95	83.71	52.26	0.56
6	2023-01-06	13.42	12.38	2.42	103.28	64.53	0.69
7	2023-01-07	11.46	10.60	2.07	88.35	55.06	0.59
8	2023-01-08	6.56	6.07	1.17	50.29	31.56	0.34
9	2023-01-09	6.48	5.98	1.16	49.83	31.15	0.33
10	2023-01-10	7.89	7.31	1.42	60.68	37.98	0.41
11	2023-01-11	8.83	8.16	1.59	67.94	42.47	0.45
12	2023-01-12	9.21	8.49	1.65	70.89	44.21	0.47

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
13	2023-01-13	7.57	6.99	1.36	58.22	36.40	0.39
14	2023-01-14	8.02	7.39	1.44	61.61	38.51	0.41
15	2023-01-15	6.46	5.97	1.16	49.72	31.12	0.33
16	2023-01-16	6.53	6.01	1.17	50.08	31.30	0.33
17	2023-01-17	7.06	6.52	1.27	54.32	33.97	0.36
18	2023-01-18	7.79	7.20	1.40	60.01	37.52	0.40
19	2023-01-19	7.85	7.25	1.41	60.27	37.67	0.40
20	2023-01-20	8.18	7.55	1.46	63.00	39.34	0.42
21	2023-01-21	9.13	8.42	1.64	70.17	43.79	0.47
22	2023-01-22	9.89	9.12	1.77	75.97	47.54	0.51
23	2023-01-23	7.40	6.84	1.33	56.94	35.59	0.38
24	2023-01-24	7.38	6.81	1.33	56.72	35.42	0.38
25	2023-01-25	9.91	9.18	1.80	76.43	47.95	0.51
26	2023-01-26	8.97	8.24	1.60	68.71	42.96	0.46
27	2023-01-27	8.81	8.13	1.59	67.86	42.41	0.45
28	2023-01-28	9.70	8.94	1.74	74.63	46.65	0.50
29	2023-01-29	9.27	8.56	1.66	71.35	44.60	0.48
30	2023-01-30	8.13	7.50	1.46	62.53	39.09	0.42
31	2023-01-31	10.63	9.82	1.91	81.79	51.14	0.55
32	2023-02-01	9.66	8.91	1.73	74.35	46.43	0.50
33	2023-02-02	9.06	8.36	1.63	69.64	43.53	0.46
34	2023-02-03	8.53	7.88	1.53	65.61	41.05	0.44
35	2023-02-04	7.74	7.15	1.39	59.45	37.20	0.40
36	2023-02-05	27.44	NA	NA	NA	NA	NA
37	2023-02-06	7.99	NA	NA	NA	NA	NA
38	2023-02-07	7.81	7.22	1.40	60.06	37.55	0.40

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
39	2023-02-08	6.48	5.99	1.16	49.85	31.13	0.33
40	2023-02-09	6.64	6.21	1.21	51.69	32.41	0.34
41	2023-02-10	5.76	5.32	1.03	44.26	27.71	0.30
42	2023-02-11	6.71	6.17	1.20	51.31	32.17	0.34
43	2023-02-12	7.94	7.33	1.43	61.07	38.17	0.41
44	2023-02-13	8.60	7.94	1.55	66.18	41.29	0.44
45	2023-02-14	9.67	8.93	1.73	74.34	46.47	0.50
46	2023-02-15	10.47	9.66	1.88	80.51	50.31	0.54
47	2023-02-16	8.38	7.73	1.50	64.42	40.29	0.43
48	2023-02-17	7.95	7.34	1.43	61.18	38.25	0.41
49	2023-02-18	7.14	6.55	1.28	54.83	34.29	0.37
50	2023-02-19	5.91	5.44	1.06	45.46	28.37	0.30
51	2023-02-20	5.17	4.78	0.93	39.79	24.88	0.27
52	2023-02-21	5.75	5.30	1.03	44.17	27.63	0.29
53	2023-02-22	7.50	6.92	1.35	57.71	36.09	0.38
54	2023-02-23	7.13	6.58	1.28	54.88	34.27	0.37
55	2023-02-24	7.60	7.01	1.37	58.48	36.56	0.39
56	2023-02-25	6.46	5.96	1.16	49.67	31.05	0.33
57	2023-02-26	6.38	5.88	1.14	49.03	30.65	0.33
58	2023-02-27	7.03	6.48	1.26	54.06	33.77	0.36
59	2023-02-28	7.81	7.19	1.40	60.18	37.50	0.40
60	2023-03-01	7.65	7.07	1.38	58.90	36.87	0.39
61	2023-03-02	8.89	8.20	1.59	68.20	42.71	0.46
62	2023-03-03	8.23	7.59	1.48	63.47	39.57	0.42
63	2023-03-04	8.07	7.42	1.44	62.24	38.89	0.41
64	2023-03-05	7.76	7.17	1.39	59.73	37.33	0.40

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
65	2023-03-06	9.62	8.89	1.73	74.06	46.24	0.49
66	2023-03-07	8.28	7.63	1.48	63.58	39.80	0.42
67	2023-03-08	7.93	7.31	1.42	60.95	38.10	0.41
68	2023-03-09	8.98	8.25	1.61	68.94	43.06	0.46
69	2023-03-10	7.62	7.04	1.37	58.60	36.68	0.39
70	2023-03-11	7.63	7.05	1.37	58.75	36.75	0.39
71	2023-03-12	8.75	8.07	1.57	67.38	42.08	0.45
72	2023-03-13	8.93	8.25	1.60	68.70	42.92	0.46
73	2023-03-14	10.85	10.01	1.94	83.49	52.24	0.56
74	2023-03-15	8.29	7.60	1.48	63.49	39.75	0.42
75	2023-03-16	5.77	5.31	1.03	44.31	27.87	0.29
76	2023-03-17	5.35	4.93	0.96	41.18	25.73	0.27
77	2023-03-18	4.87	4.50	0.87	37.43	23.41	0.25
78	2023-03-19	2.38	2.20	0.43	18.31	11.43	0.12
79	2023-03-20	3.14	2.91	0.57	24.21	15.13	0.16
80	2023-03-21	3.39	3.13	0.61	26.10	16.36	0.17
81	2023-03-22	3.18	2.94	0.57	24.48	15.33	0.16
82	2023-03-23	3.17	2.93	0.57	24.30	15.25	0.16
83	2023-03-24	3.45	3.19	0.62	26.57	16.59	0.18
84	2023-03-25	3.94	3.64	0.71	30.33	18.96	0.20
85	2023-03-26	3.32	3.06	0.60	25.58	15.94	0.17
86	2023-03-27	3.01	2.78	0.54	23.10	14.44	0.15
87	2023-03-28	3.66	3.39	0.66	28.17	17.62	0.19
88	2023-03-29	3.80	3.51	0.68	29.23	18.26	0.19
89	2023-03-30	3.56	3.28	0.64	27.41	17.14	0.18
90	2023-03-31	2.66	2.46	0.48	20.46	12.78	0.14

SI No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
91	2023-04-01	2.89	2.66	0.52	22.19	13.87	0.15
92	2023-04-02	3.14	2.90	0.56	24.18	15.11	0.16
93	2023-04-03	3.25	3.00	0.58	25.03	15.65	0.17
94	2023-04-04	2.95	2.71	0.53	22.67	14.15	0.15
95	2023-04-05	2.85	2.63	0.51	21.90	13.69	0.15
96	2023-04-06	3.10	2.85	0.55	23.76	14.87	0.16
97	2023-04-07	4.32	3.99	0.78	33.23	20.78	0.22
98	2023-04-08	4.96	4.58	0.89	38.09	23.81	0.25
99	2023-04-09	5.22	4.80	0.93	40.12	25.03	0.27
100	2023-04-10	6.80	6.26	1.21	52.21	32.69	0.35
101	2023-04-11	7.57	6.98	1.36	58.17	36.40	0.39
102	2023-04-12	7.68	7.09	1.38	59.14	36.99	0.39
103	2023-04-13	8.07	7.43	1.44	62.14	38.86	0.41
104	2023-04-14	7.87	7.29	1.42	60.60	37.92	0.40
105	2023-04-15	8.70	8.07	1.59	67.17	41.89	0.45
106	2023-04-16	9.81	9.06	1.76	75.46	47.21	0.50
107	2023-04-17	8.63	7.97	1.55	66.40	41.43	0.44
108	2023-04-18	8.36	7.72	1.50	64.28	40.21	0.43
109	2023-04-19	7.86	7.23	1.41	60.45	37.78	0.40
110	2023-04-20	6.89	6.37	1.24	52.97	33.13	0.36
111	2023-04-21	8.54	7.89	1.53	65.74	41.12	0.44
112	2023-04-22	6.07	5.60	1.09	46.77	29.24	0.31
113	2023-04-23	5.81	5.36	1.04	44.67	27.91	0.30
114	2023-04-24	4.03	3.73	0.72	31.02	19.36	0.21
115	2023-04-25	3.66	3.40	0.66	28.35	17.72	0.19
116	2023-04-26	4.69	4.33	0.84	36.09	22.56	0.24

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
117	2023-04-27	5.53	5.09	0.99	42.38	26.62	0.28
118	2023-04-28	5.84	5.39	1.05	44.95	28.05	0.30
119	2023-04-29	5.05	4.67	0.91	38.80	24.27	0.26
120	2023-04-30	3.86	3.56	0.69	29.67	18.55	0.20
121	2023-05-01	3.23	2.98	0.58	24.88	15.55	0.17
122	2023-05-02	2.82	2.61	0.51	21.76	13.60	0.14
123	2023-05-03	2.37	2.19	0.43	18.24	11.41	0.12
124	2023-05-04	2.55	2.35	0.46	19.57	12.23	0.13
125	2023-05-05	2.43	2.24	0.44	18.67	11.68	0.12
126	2023-05-06	2.44	2.25	0.44	18.78	11.74	0.12
127	2023-05-07	3.68	3.40	0.66	28.31	17.72	0.19
128	2023-05-08	3.27	3.01	0.59	25.28	15.80	0.17
129	2023-05-09	4.30	3.99	0.78	33.05	20.60	0.22
130	2023-05-10	4.83	4.44	0.86	37.31	23.26	0.25
131	2023-05-11	4.49	4.12	0.81	34.61	21.55	0.23
132	2023-05-12	3.96	3.66	0.71	30.43	19.04	0.20
133	2023-05-13	5.13	4.73	0.92	39.52	24.77	0.26
134	2023-05-14	7.89	7.28	1.42	60.73	37.91	0.41
135	2023-05-15	8.57	7.91	1.54	65.92	41.20	0.44
136	2023-05-16	8.39	7.74	1.50	64.51	40.39	0.43
137	2023-05-17	5.81	5.36	1.04	44.69	27.93	0.30
138	2023-05-18	5.32	4.91	0.95	40.91	25.55	0.27
139	2023-05-19	5.37	4.96	0.96	41.37	25.90	0.27
140	2023-05-20	6.26	5.75	1.12	48.25	30.05	0.32
141	2023-05-21	5.22	4.81	0.94	40.03	25.09	0.27
142	2023-05-22	5.62	5.21	1.02	43.21	26.99	0.29

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
143	2023-05-23	5.32	4.91	0.95	40.90	25.62	0.27
144	2023-05-24	5.47	5.05	0.98	42.08	26.32	0.28
145	2023-05-25	5.62	5.19	1.01	43.22	27.01	0.29
146	2023-05-26	5.52	5.08	0.98	42.36	26.49	0.28
147	2023-05-27	6.21	5.73	1.11	47.76	29.86	0.32
148	2023-05-28	6.97	6.43	1.25	53.63	33.51	0.36
149	2023-05-29	5.17	4.77	0.93	39.77	24.85	0.26
150	2023-05-30	5.50	5.09	0.99	42.30	26.43	0.28
151	2023-05-31	6.08	5.62	1.09	46.81	29.21	0.31
152	2023-06-01	7.80	7.20	1.40	59.83	37.53	0.40
153	2023-06-02	7.43	6.86	1.34	57.24	35.75	0.38
154	2023-06-03	5.90	5.44	1.06	45.34	28.35	0.30
155	2023-06-04	5.71	5.26	1.02	43.91	27.43	0.29
156	2023-06-05	5.24	4.81	0.93	40.03	24.95	0.27
157	2023-06-06	6.70	6.16	1.21	51.56	32.09	0.34
158	2023-06-07	6.15	5.68	1.10	47.40	29.63	0.31
159	2023-06-08	7.54	6.96	1.35	57.66	36.13	0.39
160	2023-06-09	6.37	5.88	1.14	49.03	30.65	0.33
161	2023-06-10	6.65	6.13	1.19	51.11	31.95	0.34
162	2023-06-11	5.42	5.00	0.97	41.66	26.04	0.28
163	2023-06-12	5.40	4.98	0.97	41.52	25.97	0.28
164	2023-06-13	6.04	5.58	1.09	46.49	29.04	0.31
165	2023-06-14	6.00	5.54	1.08	46.21	28.90	0.31
166	2023-06-15	6.18	5.70	1.11	47.52	29.73	0.32
167	2023-06-16	8.02	7.40	1.44	61.66	38.53	0.41
168	2023-06-17	6.22	5.75	1.11	47.85	29.94	0.32

Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
169	2023-06-18	7.13	6.57	1.28	54.85	34.27	0.37
170	2023-06-19	4.12	3.81	0.74	31.77	19.87	0.21
171	2023-06-20	4.86	4.47	0.87	37.64	23.48	0.25
172	2023-06-21	4.29	3.94	0.76	32.94	20.68	0.22
173	2023-06-22	3.73	3.44	0.65	28.78	18.03	0.19
174	2023-06-23	3.99	3.68	0.72	31.24	19.21	0.21
175	2023-06-24	3.27	3.03	0.59	25.20	15.75	0.17
176	2023-06-25	2.76	2.54	0.50	21.21	13.26	0.14
177	2023-06-26	3.40	3.14	0.61	26.12	16.31	0.17
178	2023-06-27	3.70	3.41	0.66	28.41	17.79	0.19
179	2023-06-28	4.32	3.99	0.78	33.23	20.76	0.22
180	2023-06-29	3.61	3.33	0.65	27.72	17.36	0.18
181	2023-06-30	3.21	2.96	0.58	24.68	15.42	0.16
182	2023-07-01	3.91	3.61	0.70	30.08	18.80	0.20
183	2023-07-02	4.55	4.20	0.81	34.95	21.89	0.23
184	2023-07-03	6.30	5.81	1.13	48.58	30.29	0.32
185	2023-07-04	3.79	3.49	0.68	29.06	18.17	0.19
186	2023-07-05	3.69	3.40	0.66	28.34	17.75	0.19
187	2023-07-06	2.91	2.68	0.52	22.37	13.98	0.15
188	2023-07-07	3.21	2.97	0.58	24.71	15.45	0.16
189	2023-07-08	3.32	3.06	0.60	25.53	15.96	0.17
190	2023-07-09	3.21	2.96	0.58	24.68	15.42	0.17
191	2023-07-10	5.11	4.71	0.91	39.25	24.58	0.26
192	2023-07-11	4.03	3.71	0.72	31.04	19.37	0.21
193	2023-07-12	3.01	2.78	0.54	23.15	14.49	0.15
194	2023-07-13	3.69	3.42	0.66	28.48	17.81	0.19

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
195	2023-07-14	5.29	4.88	0.95	40.64	25.48	0.27
196	2023-07-15	4.01	3.71	0.72	30.82	19.28	0.21
197	2023-07-16	2.96	2.73	0.53	22.72	14.24	0.15
198	2023-07-17	3.35	3.09	0.60	25.73	16.09	0.17
199	2023-07-18	1.62	1.49	0.29	12.57	7.81	0.08
200	2023-07-19	1.58	1.45	0.28	12.11	7.58	0.08
201	2023-07-20	1.73	1.60	0.31	13.32	8.33	0.09
202	2023-07-21	2.03	1.87	0.36	15.59	9.73	0.10
203	2023-07-22	3.01	2.79	0.54	23.19	14.51	0.15
204	2023-07-23	2.84	2.61	0.51	21.83	13.62	0.15
205	2023-07-24	2.49	2.30	0.45	19.18	11.96	0.13
206	2023-07-25	2.06	1.91	0.37	15.85	9.93	0.11
207	2023-07-26	1.67	1.54	0.30	12.85	8.03	0.09
208	2023-07-27	1.82	1.68	0.33	13.92	8.75	0.09
209	2023-07-28	2.18	2.01	0.39	16.74	10.46	0.11
210	2023-07-29	3.10	2.86	0.56	23.86	14.92	0.16
211	2023-07-30	4.19	3.86	0.76	32.25	20.13	0.22
212	2023-07-31	3.95	3.65	0.71	30.37	18.97	0.20
213	2023-08-01	4.50	4.14	0.80	34.49	21.63	0.23
214	2023-08-02	3.47	3.21	0.62	26.76	16.71	0.18
215	2023-08-03	3.57	3.30	0.64	27.51	17.19	0.18
216	2023-08-04	3.63	3.34	0.65	27.86	17.37	0.19
217	2023-08-05	3.80	3.51	0.68	29.23	18.27	0.19
218	2023-08-06	NA	NA	NA	NA	NA	NA
219	2023-08-07	5.13	4.73	0.92	39.42	24.63	0.26
220	2023-08-08	6.45	5.96	1.16	49.63	31.02	0.33

Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
221	2023-08-09	6.51	6.01	1.17	50.06	31.30	0.34
222	2023-08-10	5.21	4.81	0.94	40.09	25.10	0.27
223	2023-08-11	5.33	4.92	0.96	40.93	25.65	0.27
224	2023-08-12	6.04	5.58	1.08	46.45	29.04	0.31
225	2023-08-13	5.34	4.92	0.96	41.03	25.64	0.27
226	2023-08-14	5.94	5.35	1.07	45.63	28.55	0.30
227	2023-08-15	NA	NA	NA	NA	NA	NA
228	2023-08-16	5.21	4.81	0.93	40.09	25.10	0.27
229	2023-08-17	4.79	4.42	0.86	36.81	23.04	0.25
230	2023-08-18	3.35	3.09	0.60	25.72	16.10	0.17
231	2023-08-19	3.23	2.99	0.58	24.89	15.57	0.17
232	2023-08-20	3.91	3.60	0.70	29.99	18.77	0.20
233	2023-08-21	3.99	3.68	0.72	30.73	19.18	0.20
234	2023-08-22	3.79	3.50	0.69	29.20	18.25	0.19
235	2023-08-23	4.16	3.84	0.75	31.98	19.99	0.21
236	2023-08-24	4.37	4.03	0.78	33.61	21.01	0.22
237	2023-08-25	3.27	3.03	0.59	25.18	15.74	0.17
238	2023-08-26	3.47	3.20	0.62	26.68	16.71	0.18
239	2023-08-27	3.28	3.03	0.59	25.26	15.81	0.17
240	2023-08-28	5.16	4.79	0.93	39.72	24.82	0.26
241	2023-08-29	9.35	8.61	1.67	71.83	44.89	0.48
242	2023-08-30	9.99	9.19	1.80	76.76	48.10	0.51
243	2023-08-31	9.05	8.34	1.61	69.51	43.52	0.46
244	2023-09-01	7.69	7.10	1.38	59.18	36.91	0.39
245	2023-09-02	4.90	4.50	0.88	37.70	23.54	0.25
246	2023-09-03	4.04	3.74	0.73	31.15	19.47	0.21

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
247	2023-09-04	4.40	4.06	0.78	33.88	21.13	0.23
248	2023-09-05	3.35	3.08	0.60	25.80	16.12	0.17
249	2023-09-06	3.73	3.45	0.67	28.74	17.98	0.19
250	2023-09-07	4.38	4.04	0.79	33.65	21.04	0.22
251	2023-09-08	4.03	3.70	0.72	30.93	19.32	0.21
252	2023-09-09	3.58	3.31	0.64	27.59	17.23	0.18
253	2023-09-10	2.83	2.63	0.51	21.80	13.62	0.14
254	2023-09-11	3.94	3.65	0.71	30.29	18.93	0.20
255	2023-09-12	4.63	4.27	0.83	35.58	22.20	0.24
256	2023-09-13	4.35	4.02	0.78	33.47	20.92	0.22
257	2023-09-14	2.79	2.58	0.50	21.43	13.41	0.14
258	2023-09-15	3.29	3.03	0.59	25.29	15.81	0.17
259	2023-09-16	4.00	3.70	0.72	30.80	19.26	0.21
260	2023-09-17	3.39	3.13	0.61	26.14	16.33	0.17
261	2023-09-18	3.92	3.65	0.70	30.11	18.80	0.20
262	2023-09-19	6.36	5.88	1.14	49.07	30.66	0.33
263	2023-09-20	4.35	4.01	0.78	33.42	20.90	0.22
264	2023-09-21	3.49	3.22	0.63	26.82	16.77	0.18
265	2023-09-22	3.00	2.77	0.54	23.06	14.42	0.15
266	2023-09-23	2.89	2.68	0.52	22.22	13.90	0.15
267	2023-09-24	3.47	3.21	0.62	26.69	16.69	0.18
268	2023-09-25	2.61	2.39	0.46	19.95	12.55	0.13
269	2023-09-26	3.17	2.93	0.57	24.45	15.27	0.16
270	2023-09-27	3.70	3.42	0.67	28.47	17.79	0.19
271	2023-09-28	3.84	3.55	0.69	29.59	18.44	0.20
272	2023-09-29	3.32	3.07	0.60	25.57	15.98	0.17

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
273	2023-09-30	4.03	3.72	0.72	30.99	19.35	0.21
274	2023-10-01	NA	NA	NA	NA	NA	NA
275	2023-10-02	NA	NA	NA	NA	NA	NA
276	2023-10-03	4.29	3.97	0.77	33.10	20.69	0.22
277	2023-10-04	6.37	5.87	1.14	48.98	30.64	0.33
278	2023-10-05	6.95	6.40	1.24	53.30	33.37	0.36
279	2023-10-06	7.10	6.55	1.27	54.64	34.14	0.36
280	2023-10-07	7.79	7.19	1.40	59.98	37.50	0.40
281	2023-10-08	7.43	6.89	1.33	57.10	35.72	0.38
282	2023-10-09	6.82	6.28	1.23	52.53	32.79	0.35
283	2023-10-10	6.58	6.09	1.18	50.61	31.65	0.34
284	2023-10-11	7.71	7.12	1.38	59.34	37.11	0.40
285	2023-10-12	8.23	7.60	1.48	63.32	39.55	0.42
286	2023-10-13	8.57	7.92	1.54	65.99	41.25	0.44
287	2023-10-14	7.23	6.68	1.30	55.60	34.77	0.37
288	2023-10-15	6.79	6.26	1.22	52.20	32.63	0.35
289	2023-10-16	7.03	6.49	1.26	54.07	33.81	0.36
290	2023-10-17	9.76	9.01	1.75	75.05	46.89	0.50
291	2023-10-18	8.83	8.15	1.59	67.94	42.46	0.45
292	2023-10-19	8.75	8.07	1.56	67.25	42.06	0.45
293	2023-10-20	7.11	6.56	1.28	54.71	34.17	0.36
294	2023-10-21	6.67	6.16	1.20	51.36	32.08	0.34
295	2023-10-22	6.88	6.36	1.24	52.88	33.04	0.35
296	2023-10-23	5.57	5.07	0.98	42.27	26.45	0.28
297	2023-10-24	6.12	5.65	1.10	47.01	29.41	0.31
298	2023-10-25	5.82	5.37	1.04	44.71	27.96	0.30

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Sl No	Time	Station_3_Sez-SO2_U	Station_3_Sez-NOx_U	Station_3_Sez-NH3_U	Station_3_Sez-PM10_U	Station_3_Sez-PM2.5_U	Station_3_Sez-VOC_U
299	2023-10-26	6.36	5.87	1.14	48.90	30.57	0.33
300	2023-10-27	6.37	5.88	1.14	49.00	30.63	0.33
301	2023-10-28	8.36	7.73	1.50	64.33	40.21	0.43
302	2023-10-29	8.04	7.41	1.44	61.77	38.56	0.41
303	2023-10-30	7.03	6.50	1.27	54.15	33.79	0.36

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Annexure-III

A.P. POLLUTION CONTRL BOARD, ZONAL LABORATORY, VISAKHAPATNAM

AMBIENT AIR QUALITY MONITORING REPORT

M/s Visakha Pharma City Ltd., JNPC, Parawada, Anakapalli District

Parameter	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Ann.Avg.	Annual Average NAAQ Standard
SO2	11.0	11.0	10.0	11.0	12.0	11.0	10.0	10.0	9.8	10.0	11.4	9.9	**10.6**	**50.0**
NO2	22.0	19.0	19.0	21.0	22.0	23.0	22.0	20.0	20.4	20.0	18.9	18.7	**20.5**	**40.0**
NH3	26.0	26.0	25.0	26.0	25.0	26.0	25.0	24.0	23.6	24.0	37.2	40.9	**27.4**	**100.0**
PM10	82.0	71.0	88.0	90.0	107.0	99.0	87.0	79.0	64.0	79.0	61.0	71.0	**81.5**	**60.0**
PM2.5	30.0	27.0	25.0	24.5	44.0	40.5	32.4	29.0	26.0	28.0	26.0	27.0	**30.0**	**40.0**

Note: As per the results all the parameters except PM10 are within the Annual Average NAAQ Standards

SENIOR ENVIRONMENTAL SCIENTIST

Annexure-IV

A.P.POLLUTION CONTROL BOARD
Zonal Laboratory, Visakhapatnam

Consolidated report of marine outfall discharges by M/s. Visakha Pharmacity Limited (formerly M/s Ramky Pharma City (I) Ltd.,) JNPC, Parawada, Anakapalli District.

S.No.	2022 January to December		2023 January to September		Parameters exceeded
	Guard pond samples collected	Guard pond samples rejected	Guard pond samples collected	Guard pond samples rejected	
1	284	9	222	17	COD, NH3-N

Note:

1. Out of 506 samples, 26 samples were rejected from Jan-2022 to Sep-2023, the rejection percentage is 5% only for the last two years.
2. In case of the treated wastewater is not meeting the marine discharge standards, it will not be allowed for discharge into sea and sent back to CETP for re-treatment till comply with the marine discharge standards.

M Rao

SENIOR ENVIRONMENTAL SCIENTIST

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Chapter 7

Off Tikkavanipalem (Zone 5)

Coastal waters off Tikkavanipalem (Zone 5) contain marine outfall points (MOP) of pharmaceutical industry, i.e., M/s. JN Pharama City Ltd. and National Thermal Power Corporation (NTPC) Ltd. (Fig. 2.5). Tikkavanipalem is a coastal village situated towards south of Visakhapatnam. National Institute of Oceanography has carried out Rapid Marine Environmental Assessment studies to identify the marine out fall points for discharge of treated effluents from JN Pharma City Ltd. The NTPC project involves intake pipeline for drawl of seawater for cooling purpose and outfall pipeline for discharge of seawater into the sea. There is an existing corridor for intake of seawater for cooling purpose and discharge of water into the sea through a jetty at land fall point. The estimated discharge through Central Monitoring Basin (CMB) is 5870 cum/hr for Stage – I. The treated wastewater of Stage - I is being discharged into the sea at 400 m from the High Tide Line at a depth of 4 m. The discharge point selected by NTPC was not as suggested by NIO, but as recommended by some other Organization.

The location of the M/s. JN Pharma City is at about 30 km west of Visakhapatnam city. As the Pharma City comprises of several bulk drugs, pharmaceuticals and chemical sectors, the waste discharges are associated with high organic pollutant load. This industry is considered as one of the major 17 groups of industries for priority action for the control of pollution by Central Pollution Control Board. In order to maintain cleaner environment and achieve sustainability of the concerned industrial sector, the Pharma City decided to discharge the treated effluents into the sea through a pipeline as per the new guidelines of Ministry of Environment and Forests (MoEF) and Andhra Pradesh Pollution Control Board (APPCB). The discharge point suggested

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by NIO for JN Pharma City is at a depth of 18 m and at a distance of 1.44 km from the coast. Results of studies conducted in the coastal waters off Tikkavanipalem during pre- and post-monsoon seasons were discussed in this chapter

7.1 Physico-chemical parameters

Results of physico-chemical parameters studied in the coastal waters off Tikkavanipalem (zone 5) during pre monsoon and post monsoon seasons were given Tables 7.1a to 7.1c and 7.2a to 7.2c, respectively. Water column temperature of this zone varied from 26.6 to 27.3^{o}C in the surface and 25.8 to 27.1^{o}C in the bottom, with mean temperature of 27.0^{o}C and 26.4^{o}C, respectively, during pre monsoon (Table 7.1a). Relatively lower ranges of mean temperature were observed during post monsoon in both surface (mean: 24.2^{o}C; range: 23.2 to 24.4^{o}C) and bottom waters (mean: 24.4^{o}C; range: 23.7 to 25.3^{o}C) (Table 7.2a). Salinity ranged from 33.3 to 33.7 PSU, with a mean salinity of 33.5 PSU in the surface, and from 33.5 to 34.0 PSU (mean: 33.7 PSU) in bottom waters of this region during pre monsoon season (Table 7.1a). Compared to the pre monsoon, relatively lower salinities were found during post monsoon, with mean salinities of 29.2 PSU in the surface (range: 28.9 to 29.6 PSU) and 29.5 PSU in the bottom (range: 29.0 to 30.4 PSU) waters of this region (Table 7.2a). Total suspended matter (TSM) varied from 14.5 to 33.8 mg/L (mean: 18.6 mg/L) in the surface and from 15.8 to 23.0 mg/L (mean (18.7 mg/L) in the bottom waters during pre monsoon (Table 7.1a). Slightly lower range of TSM concentrations were found during the post monsoon season both in the surface (range: 8.0 to 21.7 mg/L; mean: 11.9 mg/L) and bottom waters as well (9.1 to 16.2 mg/L and 11.5 mg/L, respectively (Table 7.2a). TSM concentrations found in this study are very close to those reported in the previous study conducted in this region during 2011 (Table 7.3). pH values of surface and bottom waters in the region varied from 7.3 to 8.1 (mean: 7.6) and from 7.4 to 7.9

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(mean: 7.6), respectively, during pre monsoon season (Table 7.1a). During post monsoon season, the ranges of pH values in the surface and bottom waters are relatively higher where it ranged from 8.3 to 9.0 in the surface and from 8.1 to 8.6 in the bottom waters.

Dissolved oxygen (DO) concentrations ranged from 6.1 to 6.7 mg/L (mean 6.3 mg/L) in the surface and from 3.9 to 6.4 mg/L (mean 4.8 mg/L) in the bottom waters during pre monsoon season (Table 7.1b). These DO concentrations are relatively lower when compared to those obtained during pre monsoon season of the year 2011 in this region (6.5 to 8.3 mg/L) (Fig. 7.1) (Table 7.3). Relatively higher DO concentrations were found during post monsoon season in both surface (range: 6.4 to 7.8 mg/L; mean: 7.1 mg/L) and bottom waters (6.6 to 7.7 mg/L and 7.1 mg/L, respectively (Table 7.2b) compared to the pre monsoon season (Table 7.1b). DO concentrations found during the post monsoon season are consistent with those obtained in this region during 2011 study (6.2 to 8.9 mg/L) (Fig. 7.1) (Table 7.3). Relatively lower dissolved oxygen concentrations during pre monsoon season may be due to the increased input of organic matter contamination through the release of treated effluents from JN Pharma City Ltd. and/or from NTPC Ltd. and Hindhuja Ltd. Biochemical oxygen demand for five days (BOD_5) values varied from 3.9 to 4.4 and from 2.5 to 4.1 mg/L, with mean BOD_5 values of 4.0 mg/L and 3.1 mg/L in the surface and bottom waters, respectively, during pre monsoon season (Table 7.1b). Relatively lower ranges of BOD_5 values were found during post monsoon season in both surface (range: 0.2 to 1.4 mg/L; mean: 0.7 mg/L) and bottom (range: 0.3 to 1.7 mg/L; mean: 0.84 mg/L) waters (Table 7.2b). BOD_5 values found in this study are relatively lower during post monsoon season and higher during pre monsoon season when compared to those found in previous monitoring study conducted in this region in 2011 (Table 7.3). Ammonium concentrations ranged from 0.3 to 3.1 µM (mean: 1.2 µM) in the surface and from 0.1 to 3.1 µM (mean: 1.4

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µM) in the bottom waters during pre monsoon (Table 7.1b). Relatively lower concentrations of

Pre monsoon

Post monoon

Fig. 7.1: Comparison of mean dissolved oxygen (DO; mg/L) and biochemical oxygen demand (BOD; mg/L) concentrations in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

ammonium were found in this region during post monsoon season, with similar mean values of 0.3 µM (range: 0.1 to 0.5 µM) in the surface and 0.4 µM (range: 0.3 to 0.6 µM) in the bottom

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waters (Table 7.2b). Relatively higher ammonium concentrations were found at the MOP of JN Pharma City Ltd. in both surface and bottom waters. Phosphate concentrations ranged from 0.4 µM to 2.2 µM (mean: 1.3 µM) in the surface and from 0.7 µM to 2.6 µM (mean: 1.6 µM) in the bottom waters during pre monsoon season (Table 7.1b). Considerably lower concentrations of phosphate were found in the surface (mean: 0.4 µM; range: 0.1 to 0.9 µM) and bottom (0.6 µM; range: 0.1 to 1.5 µM) waters during post monsoon season (Table 7.2c). Dissolved inorganic silicate concentrations ranged from as low as 0.6 µM to as high as 6.4 µM (mean: 4.4 µM) in the surface and from 3.9 to 26.9 µM (mean: 7.6 µM) in the bottom waters during pre monsoon (Table 7.1c). Relatively higher silicate concentrations were found during post monsoon season, with mean silicate concentrations of 6.4 µM (range: 0.3 to 16.3 µM) in the surface and 9.6 µM (range: 4.3 to 20.9 µM) in the bottom waters (Table 7.2c). Higher silicate concentrations during the post monsoon season are mainly due to the influence of freshwater input to the study region through river discharge during the monsoon and equator ward flow of freshwaters from the northern Bay of Bengal by the southward flowing EICC during post monsoon season. Nitrite concentrations ranged from 0.1 to 0.3 µM (mean: 0.2 µM) in the surface and 0.1 to 0.5 µM (mean: 0.2 µM) in the bottom waters during the pre monsoon season (Table 7.1c). Relatively higher concentrations of nitrite were found during post monsoon in the surface (0.1 to 2.7 µM) and bottom (0.1 to 3.4 µM) waters, with mean nitrite concentrations of 0.5 µM and 1.0 µM in the surface and bottom waters, respectively. Dissolved inorganic nitrate concentrations varied from 0.6 to 1.9 µM (mean: 1.0 µM) and from 0.8 to 2.3 µM (mean: 1.3 µM) in the surface and bottom waters, respectively, during pre monsoon (Table. 7.1c). Similar range of nitrate concentrations were found during post monsoon, with man nitrate concentrations of 0.8 µM (range: 0.1 to 3.6 µM) in the surface and 0.8 µM (range: 0.1 to 2.3 µM) in the bottom waters (Table 7.2c). Mean

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total phosphorus (TP) concentrations were found to be 0.9 µM (range: 0.2 to 2.2 µM) in the surface and 1.7 µM (range: 0.7 to 3.0 µM) in the bottom waters of this region during post monsoon season (Table 7.2b). Total petroleum hydrocarbon (TPHC) concentrations varied from as low as 1.5 to as high as 54.0 µg/L (mean: 13.6 µg/L) in the surface and from 2.4 to 38.8 µg/L (mean: 12.8 µg/L) in the bottom waters of this region during post monsoon. These PHC concentrations are higher compared to those obtained during 2011 study in this region (1.0 to 34.1 µg/L), indicating that increased input of PHC to this region in recent years.

Results of physico-chemical parameters studied in the coastal waters off Tikkavanipalem (zone 5) showed no significant deviation from ambient concentrations of the physico-chemical parameters in the coastal waters of east coast of India, except for dissolved oxygen. Mean dissolved oxygen concentrations in bottom waters of this zone during pre monsoon (mean: 4.8 mg/L) are slightly depleted than the threshold limit of dissolved oxygen for healthy coastal waters (5.0 mg/L), indicating that the coastal waters of this region are at the initial stage of deterioration in water quality. It could be due to the increased input of organic matter contamination through treated effluent release from JN Pharma City Ltd. and/or NTPC Ltd. and Hindhuja Ltd. However, coastal waters of this region are well oxygenated during post monsoon season. Comparison of physico-chemical data obtained in this study with that of the study conducted in this region during pre and post monsoon seasons of 2011 was given in Table 7.3. Seasonal variability between pre and post monsoon season were attributed to input of freshwater discharge from rivers during the southwest monsoon (June-September) and southward flow of freshwaters from the northern Bay of Bengal to the present study region by the equator ward flowing east Indian coastal current (EICC) during October-December. Although, PHC concentrations in this study were found to be higher compared to reported values from this region in 2011, however, they are within the threshold limit, indicating no significant pollution of TPHC in this region.

Table 7.1a: Spatial variability in temperature (^oC), Salinity (PSU), total suspended matter (mg/L) and pH in surface and bottom waters off Tikkavanipalem coast during the pre monsoon season

Station	Temperature (^oC)		Salinity (PSU)		TSM (mg/l)		pH	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	26.8	26.8	33.7	33.5	17.6	18.0	7.3	7.6
TVM-2	26.9	26.7	33.6	33.5	17.0	20.2	7.6	-
TVM-3	26.9	26.8	33.5	33.6	15.0	16.5	7.7	7.8
TVM-4	-	-	-	-	-	-	7.9	7.6
TVM-5	26.8	26.7	33.5	33.6	33.8	22.1	7.3	7.7
TVM-6	27.2	26.6	33.5	33.9	-	17.3	7.6	7.4
TVM-7	27.1	27.1	33.5	33.5	16.3	17.9	7.3	7.4
TVM-8	27.2	26.0	33.4	33.8	23.0	21.9	7.7	7.7
TVM-9	27.3	26.0	33.3	33.8	-	15.8	-	7.7
TVM-10	27.3	26.5	33.4	33.7	15.9	19.9	7.5	7.5
TVM-11	27.0	25.9	33.3	33.9	14.5	23.0	7.3	7.5
TVM-12	27.1	25.9	33.4	33.9	18.7	18.5	7.4	7.5
TVM-13	27.0	25.8	33.3	34.0	20.4	17.8	8.1	7.6
TVM-14	27.2	26.0	33.4	33.8	17.2	19.0	7.4	7.7
TVM-15	27.0	26.2	33.4	33.8	14.6	18.2	7.8	7.8
TVM-16	27.1	26.1	33.4	33.9	17.6	19.8	7.8	7.9
NTP-MOP	26.8	26.9	33.7	33.7	19.6	15.8	7.6	7.5
JNP-MOP	26.6	26.0	33.6	33.8	18.0	15.8	-	-

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Table 7.1b: Spatial variability in dissolved oxygen (mg/L), biochemical oxygen demand (BOD_5; mg/L), ammonium (µM) and phosphate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	DO (mg/l)		BOD_5 (mg/l)		Ammonium (µM)		Phosphate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	-	6.1	4.2	4.0	0.6	0.6	0.5	0.7
TVM-2	6.7	5.9	4.4	3.9	0.3	-	1.3	1.3
TVM-3	6.1	6.2	4.1	4.1	0.6	1.3	1.3	1.2
TVM-4	6.2	3.9	4.0	2.5	1.3	0.3	1.6	1.7
TVM-5	6.1	6.4	4.1	4.0	1.3	0.1	1.8	1.9
TVM-6	6.4	6.1	4.1	3.6	0.7	0.6	1.7	1.7
TVM-7	6.5	6.4	4.3	4.1	0.4	2.0	2.0	2.6
TVM-8	6.4	4.4	3.9	2.8	0.7	0.6	1.8	2.0
TVM-9	6.4	4.2	4.0	2.9	1.1	0.6	0.9	0.9
TVM-10	6.4	4.0	3.9	2.6	0.4	1.3	1.3	1.7
TVM-11	6.7	3.9	3.9	2.5	0.4	2.0	1.8	2.3
TVM-12	6.4	4.1	3.9	2.5	1.8	2.7	0.9	1.4
TVM-13	6.2	3.9	4.2	2.5	2.1	1.4	0.8	1.7
TVM-14	6.2	4.0	3.9	2.6	2.6	2.8	0.9	1.9
TVM-15	6.1	3.9	4.0	2.6	1.3	1.7	0.4	0.7
TVM-16	6.2	3.9	4.3	2.6	1.6	1.4	0.5	2.2
NTP-MOP	6.2	4.1	4.1	2.6	0.9	0.9	1.7	0.8
JNP-MOP	-	-	-	-	3.1	3.1	2.2	1.7

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Table 7.1c: Spatial variability in silicate (µM) nitrite (µM) and nitrate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	Silicate (µM)		Nitrite (µM)		Nitrate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	5.1	26.9	0.1	0.2	1.0	1.2
TVM-2	-	-	0.2	0.2	0.9	1.0
TVM-3	5.4	4.8	0.1	0.2	0.9	1.6
TVM-4	6.4	4.5	0.1	0.2	1.2	0.8
TVM-5	5.9	9.0	0.1	0.2	0.9	0.8
TVM-6	5.7	7.5	0.2	0.1	0.9	1.2
TVM-7	4.6	5.2	0.2	0.1	1.2	1.4
TVM-8	3.1	8.1	0.2	0.2	1.0	1.4
TVM-9	3.1	7.3	0.3	0.1	1.1	1.0
TVM-10	0.9	5.9	0.2	0.2	0.8	1.3
TVM-11	3.9	7.3	0.2	0.3	0.8	0.9
TVM-12	4.1	7.4	0.3	0.4	0.9	1.2
TVM-13	3.9	5.4	0.2	0.5	1.2	1.2
TVM-14	4.5	5.0	0.2	0.3	0.6	1.0
TVM-15	3.2	9.0	0.1	0.2	0.9	1.9
TVM-16	3.9	7.8	0.1	0.2	1.9	2.3
NTP-MOP	5.4	4.1	0.1	0.1	0.7	1.1
JNP-MOP	0.6	3.9	0.1	0.2	1.2	1.0

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Table 7.2a: Spatial variability in temperature (^oC), Salinity (PSU), total suspended matter (mg/L) and pH in surface and bottom waters off Tikkavanipalem coast during the post monsoon season

Station	Temperature (^oC)		Salinity (PSU)		pH		TSM (mg/l)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	24.1	24.0	29.3	29.3	8.4	8.5	8.9	-
TVM-2	24.3	24.3	29.3	29.2	8.6	8.6	11.1	10.7
TVM-3	24.3	24.4	29.3	29.0	8.6	8.4	10.1	9.8
TVM-4	24.3	24.5	29.2	29.7	8.3	8.4	9.8	14.2
TVM-5	24.3	24.3	29.0	29.4	8.4	8.4	9.5	14.4
TVM-6	24.4	24.2	29.2	29.3	8.4	8.6	17.9	12.2
TVM-7	24.3	23.9	29.2	29.3	8.5	8.5	10.7	10.4
TVM-8	24.2	24.3	29.3	29.3	9.0	8.5	21.7	16.2
TVM-9	24.1	24.4	29.3	29.5	8.6	8.6	9.9	10.6
TVM-10	24.0	24.7	29.4	29.3	8.6	8.1	10.7	9.1
TVM-11	24.2	25.3	29.3	30.3	8.5	8.5	16.7	10.1
TVM-12	24.2	24.3	29.3	30.2	8.5	8.4	8.0	9.3
TVM-13	24.1	25.2	29.4	30.4	8.6	8.5	10.5	15.5
TVM-14	23.2	24.9	29.6	29.9	8.5	8.5	15.0	11.7
TVM-15	24.0	24.5	29.3	29.3	8.4	8.4	10.9	10.6
TVM-16	24.3	24.2	28.9	29.3	8.5	8.4	10.5	10.5
JNP-MOP	24.3	24.4	29.2	29.3	8.4	8.3	10.5	9.7
NTPC-MOP	24.2	23.7	29.0	29.2	8.6	8.4	11.5	10.4

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Table 7.2b: Spatial variability in dissolved oxygen (mg/L), biochemical oxygen demand (BOD_5; mg/L), total phosphorous (µM) and ammonium (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	DO (mg/l)		BOD_5 (mg/l)		TP (µM)		Ammonium (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	6.7	6.7	1.0	1.2	0.5	0.8	0.3	0.4
TVM-2	7.2	7.1	1.4	1.7	0.8	0.7	0.5	0.6
TVM-3	7.0	6.9	1.0	1.4	0.7	1.1	0.5	0.6
TVM-4	7.6	7.3	0.6	0.9	1.3	2.3	0.4	0.4
TVM-5	7.3	7.4	0.2	0.8	0.2	1.4	-	0.3
TVM-6	6.7	6.8	0.8	1.0	2.2	2.8	0.4	0.5
TVM-7	6.4	6.6	1.2	1.5	1.0	2.5	0.1	0.3
TVM-8	6.8	6.8	0.3	0.7	1.0	2.9	0.3	0.4
TVM-9	7.8	7.7	0.4	0.6	1.0	1.4	0.3	0.4
TVM-10	7.1	7.1	0.2	0.5	0.7	1.1	-	-
TVM-11	7.5	7.4	0.6	0.4	0.6	1.7	0.3	0.4
TVM-12	6.6	6.8	0.7	0.6	0.8	3.0	0.5	0.5
TVM-13	7.0	7.0	0.5	0.3	0.4	0.9	0.3	0.5
TVM-14	7.5	7.3	0.3	0.5	1.2	1.9	0.1	0.3
TVM-15	6.6	6.6	1.3	1.1	0.7	1.2	0.4	0.5
TVM-16	7.6	7.5	1.0	0.8	0.8	1.0	0.1	0.3
JNP-MOP	7.2	7.2	0.3	0.5	1.7	1.2	0.5	0.5
NTPC-MOP	6.6	6.7	0.7	0.6	1.1	2.0	-	0.4

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Table 7.2c: Spatial variability in nitrite (µM), nitrate (µM), phosphate (µM) and silicate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	Nitrite (µM)		Nitrate (µM)		Phosphate (µM)		Silicate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	0.6	0.2	0.5	0.1	0.4	0.7	0.7	11.2
TVM-2	1.1	0.7	0.6	0.6	0.2	0.2	4.6	7.3
TVM-3	0.3	0.2	0.4	0.6	0.5	0.1	6.9	8.4
TVM-4	2.7	3.4	1.9	2.3	0.2	0.9	6.4	7.6
TVM-5	0.2	0.2	0.6	1.0	-	0.3	7.9	8.7
TVM-6	0.2	2.7	0.4	1.9	0.2	1.5	8.8	4.3
TVM-7	0.2	0.4	0.9	0.4	0.8	0.7	0.3	6.8
TVM-8	0.2	0.1	0.5	0.4	0.1	0.7	7.9	11.6
TVM-9	0.2	2.5	0.1	2.2	0.7	0.7	8.3	11.2
TVM-10	0.2	1.0	0.6	0.2	0.2	0.2	8.7	17.5
TVM-11	0.1	0.2	0.4	0.4	0.5	0.7	5.8	4.8
TVM-12	0.3	0.5	0.3	0.6	0.5	0.7	6.0	7.3
TVM-13	0.2	7.7	1.5	0.1	0.2	0.2	2.1	7.0
TVM-14	0.6	0.2	3.6	0.4	0.9	0.9	6.4	6.8
TVM-15	0.3	2.4	0.4	1.7	0.2	0.9	5.2	15.2
TVM-16	0.3	0.8	0.4	0.6	0.3	0.7	1.2	7.1
JNP-MOP	0.4	0.2	0.4	0.9	0.7	0.2	16.3	8.7
NTPC-MOP	0.5	0.4	0.4	0.5	0.7	1.0	11.4	20.9

Table 7.2d: Spatial variability in total petroleum hydrocarbon concentrations (TPHC; µg/L) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	PHC (µg/L)	
Name	Surface	Bottom
JNP-MOP	54.0	4.3
NTPCMOP	4.0	19.9
TVM-1	8.7	-
TVM2	18.1	12.8
TVM3	6.4	2.4
TVM4	5.7	3.0
TVM5	18.4	7.0
TVM6	-	3.0
TVM7	15.2	3.7
TVM8	1.5	10.1
TVM9	9.8	5.9
TVM10	**-**	**-**
TVM11	**4.2**	**10.3**
TVM12	**-**	**37.5**
TVM13	**9.9**	**38.8**
TVM14	**27.6**	**5.1**
TVM15	**7.1**	**28.6**
TVM16	**-**	**-**

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Table 7.3: Comparison of data obtained for various physico-chemical parameters during pre monsoon and post monsoon seasons of 2011 and 2018 (present study) in the coastal waters off Tikkavanipalem.

Parameter	Pre monsoon		Post monsoon	
	2011	Present study	2011	Present study
Temperature	26.9 – 27.9	25.8 – 27.3	29.3 – 30.1	23.2 – 25.3
Salinity	30.9 – 33.7	33.3 – 34.0	17.9 – 22.5	28.9 – 30.4
TSM	8.8 – 14.2	14.5 – 33.8	8.9 – 22.3	8.0 – 21.7
pH	7.9– 8.3	7.3 – 8.1	8.0 – 8.3	8.1 – 8.6
DO	6.5 – 8.3	3.9 – 6.7	6.2 – 8.9	6.4 – 7.8
BOD	1.0 – 3.3	2.5 – 4.4	2.6 – 4.4	0.2 – 1.4
Ammonium	0.03 – 0.54	0.1 – 3.1	0.9 – 2.5	0.1 – 0.6
Nitrite	0.04 – 0.54	0.1 – 0.5	0.04 -0.54	0.1 – 3.4
Nitrate	1.5 – 13.6	0.6 – 2.3	2.9 – 15.0	0.1 – 3.6
Phosphate	0.3 – 1.1	0.4 – 2.6	0.8 – 2.5	0.1 – 1.5
Silicate	3.2 – 10.6	0.26– 26.9	10.9 – 28.1	0.3 – 20.9
PHC	4.9 – 34.1	-	1.0 – 11.5	1.5 – 54.0

7.2 Biological parameters

7.2.1. Chlorophyll *a*

During the pre monsoon period, Chl-*a* concentration varied from 2.17 to 7.54 mg/m^3 in surface and from 1.38 to 10.16 mg/m^3 in bottom waters of this region. Whereas, Chl-*a* concentration ranged from 0.49 to 4.14 mg/m^3 in surface and from 0.38 to 3.96 mg/m^3 in bottom waters during post monsoon season. Relatively higher Chl-*a* concentration was found during the pre monsoon season compared to the post monsoon season. This observation is concurrent with those reported previously in coastal waters of this region and along east coast of India. Elevated concentrations of Chl-*a* was reported in coastal waters of the central east coast of India during pre monsoon season (February – April) due to the occurrence of mild coastal upwelling during

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this period. Coastal upwelling brings nutrient-rich sub surface waters into the surface and enhances primary production in euphotic zone of the region. It is a seasonal phenomenon and it does not occur during the post monsoon season.

Altogether, 44 phytoplankton species/forms are reported from this region in the present study. The number of species varied from 14 to 29 during pre monsoon and from 20 to 21 during post monsoon. These ranges are comparable during pre monsoon and slightly lower during post monsoon when compared to those obtained in 2011 study in this region (Table 7.6). Diatoms were dominant over dinoflagellates in this region during both pre and post monsoon seasons. The dominance of diatoms was seen at every station. Some of the major species found in this region are: *Nitzschia, Navicula, Skeletonema, Thalassiosira, Rhizosolenia, Coscinodiscus, Chaetoceros, Gyrosigma, Pleurosigma, Cerastium, Prorocentrum, Trichdesmium* and *Leptocylindrus*

Phytoplankton abundance ranged from 4200 to 10450 No./L in the surface and from 2300 to 14000 No./L in bottom waters during the pre monsoon season (Table 7.4). Phytoplankton abundance during post monsoon period varied from 4400 No./L to 8600 No./L in the surface and from 4600 to 8740 No./L in bottom waters (Table 7.5). MOP of NTPC recorded considerably lower phytoplankton abundance in both surface (5800 No./L) and bottom (5600 No./L) compared to the surrounding stations in this region (mean: 7103 No./L and 7158 No./L, respectively) during pre monsoon season (Fig. 7.2a). However, station at MOP of JN Pharma City Ltd recorded higher phytoplankton abundance in the surface (8650 No./L) and lower abundance in the bottom waters (6450 No./L) during pre monsoon than the surrounding stations in this region (7103 No./L and 7158 No./L, respectively) (Fig. 7.2a). Similarly, during post monsoon season also MOP of NTPC Ltd. recorded considerably lower phytoplankton biomass both in surface (4400 No./L) and bottom (4600 No./L) compared to the surrounding stations in

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this region (5730 No./L and 7199 No./L, respectively) (Fig. 7.2b). Consistent with pre monsoon season, MOP of JNP recorded higher phytoplankton abundance in the surface (7400 No./L) and lower abundance in the bottom waters (5200 No./L) than the surrounding stations in this region (5730 No./L and 7199 No./L, respectively) (Fig. 7.2b). Contrasting to surface waters, bottom waters at MOP of JN Pharma City Ltd. recorded lower phytoplankton biomass during pre monsoon (6450 No./L) and post monsoon (5200 No./L) than the surrounding stations in this region (7158 No./L and 7199 No./L, respectively). Compared to 2011 study conducted in this region, phytoplankton abundance was significantly higher in this study than those found in 2011 study during both pre monsoon and post monsoon seasons (Fig. 7.4a) (Table 7.6).

Plate 7.1: Microscopic images of some phytoplankton

Zooplankton, which feed on phytoplankton, is the secondary producer in the marine food chain. Zooplankton abundance in the sampling stations of this zone was presented in Table 7.4 and 7.5 for pre monsoon and post monsoon seasons, respectively. Copepods are the most dominant species in the zooplankton abundance. The other groups reported during the study

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period were Hydromedusae, siphanophores, chaetognatha, decapods larvae, polycheate larvae, gastropod larvae, lucifers, cladocerans, and fish eggs and larvae. Zooplankton abundance ranged from 600 to 2600 No./m^3 during pre monsoon season (Table 7.4), and significantly lower abundance was recorded at the MOP of NTPC Ltd. (600 No./m^3) and JN Pharma City Ltd. (960 No./m^3) compared to the mean zooplankton abundance in this zone (1795 No./m^3) (Fig. 7.3a). During the post monsoon season, numerical abundance of zooplankton varied from 625 No./m^3 to 1324 No./m^3. MOPs of NTPC Ltd and JN Pharma City Ltd have recorded slightly lower abundance of zooplankton (789 No./m^3 and 860 No./m^3, respectively) compared to the adjacent stations in this region (938 No./m^3) during post monsoon season (Fig. 7.3b). However, during both pre monsoon and post monsoon seasons, MOPs of NTP Ltd. and JN Pharma City Ltd. recorded relatively lower values of zooplankton abundance compared to the mean abundance in this zone.

Seasonal variations of the zooplankton abundance show that the zooplankton abundance was high during pre monsoon season compared to post monsoon season. Zooplankton abundance is mainly regulated by the phytoplankton abundance, which was found to be relatively low during the post monsoon period compared to pre monsoon. The same pattern of the distribution of zooplankton abundance was also found in the previous monitoring study conducted in this region in 2011. The results of the zooplankton abundance suggest that zooplankton abundance were in line with the phytoplankton abundance. Relatively low zooplankton abundance MOP locations than the surrounding locations, suggest that the impact of industrial effluent on zooplankton is considerable but it is localized as the impact of effluent decreases rapidly with increasing distance from MOP (<2 km from MOP). Compared to 2011 observations in this region, zooplankton abundance found in this study was considerably higher during post monsoon

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(Fig. 7.4b) (Table 7.6). Data is not available during pre monsoon season of 2011 to compare our results during pre monsoon season.

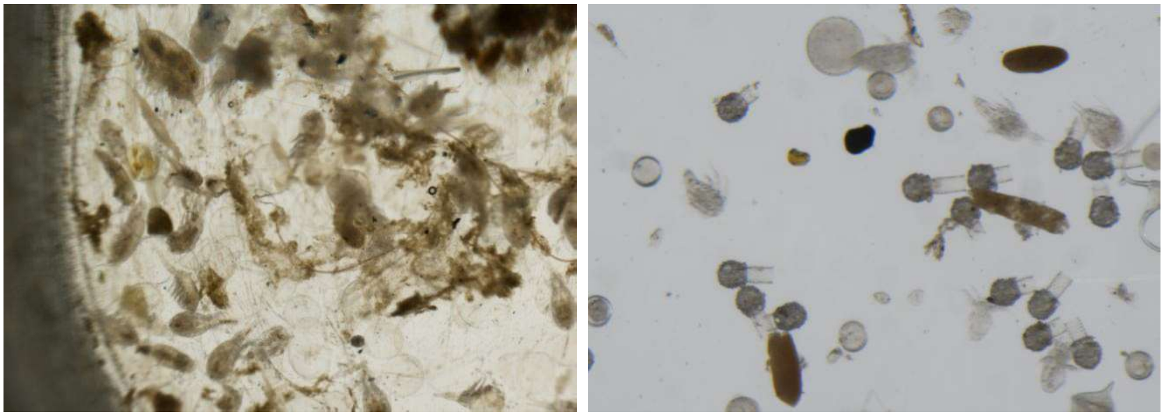

Plate 7.2: Microscopic images of some zooplankton

Benthos play a significant role in transitional ecosystems, by filtering phytoplankton and then offer a food source for fish, thereby linking primary producers with higher trophic levels. Benthic monitoring is a comparatively effective and reliable technique that can serve as early indicators of environmental changes. Benthic organisms are generally divided into two categories, namely, macro benthos and meio benthos, based on their size structure. The distribution and abundance of macro fauna in different locations of this zone during the pre and post monsoon seasons are given in Table 7.4 and Table 7.5, respectively. A total of 38 macro benthic groups/genus/ species are reported in the present study that all are belongs to 8 major groups. Polychaets are the most dominant form of macro benthos. Members of families commonly found in the study region are Megalonidae, Cirratulidae, glyceridae, Spionidae and Capitellidae. Glycera sp., Prionospiopinnata, Lumbrinereis sp., Eunice sp. and Magelona sp. Among crustaceans, amphipods and cumaceans were dominant. The mollusca were represented

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by bivalves and gastropods. No endangered species or invasive species was found during the present study.

Macro benthos abundance ranged from 600 No./m^2 to 2900 No./m^2 during pre monsoon (Table 7.4) and from 800 No./m^2 to 1600 No./m^2 during the post monsoon (Table 7.5) seasons. Seasonally, macro benthos abundance was higher during the pre monsoon period (mean: 2512 No./m^2) compared to post monsoon period (1300 No./m^2). The macro faunal abundance was significantly less at marine outfall point of JN Pharma City Ltd. (600 No./m^2 and 900 No./m^2 during pre and post monsoon seasons, respectively) and NTPC Ltd. (650 No./m^2 and 800 No./m^2 during pre and post monsoon seasons, respectively) compared to surrounding stations in this region (2512 No./m^2 and 1300 No./m^2 during pre and post monsoon seasons, respectively) (Fig. 7.3a and b). Relatively less macro faunal density at the MOP locations and the high abundance in the adjacent locations within the zone indicate that the effect of industrial effluent on macro faunal density was considerable but localized. Dilution of industrial effluent with increasing distance from the MOP might have decreased its influence on macro benthic density in the surrounding locations of MOP than at MOP.

Numerical counts of the meio-fauna were in the range of 220 to 780 No./10cm^2 during pre monsoon (Table 7.4) and 400 to 940 No./10cm^2 during post monsoon season (Table 7.5). Nematodes were found to be the most dominant species. Total meio faunal abundance was significantly low at the MOPs of JN Pharma City Ltd. and NTPC Ltd. during both pre monsoon (238 No./10cm^2 and 220 No./10cm^2, respectively) and post monsoon seasons (500 No./10cm^2 and 400 No./10cm^2, respectively), compared to the mean abundance of the adjacent locations in this zone (650 No./10cm^2 and 765 No./10cm^2, respectively) (Fig. 7.3a and b). Total meio-faunal abundance was less at the MOP locations compared to the surrounding locations within the

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zones, indicating that considerable impact of the industrial effluents on meio faunal abundance in the study region. However, relatively higher meio faunal abundance at locations within the 2 km from MOP locations suggest that the impact of industrial effluent on meio faunal abundance was localized and limits up to less than 2 km from MOP.

Compared to 2011 observations from this region, both macro and meio faunal abundance found during post monsoon season of the present study were considerably higher compared to those found during the post monsoon season of 2011 study (Fig. 7.4b) (Table 7.6). However, macro and meio faunal abundance data is not available for the pre monsoon season of 2011 to compare our results of pre monsoon season (Fig. 7.4b) (Table 7.6). Significant increase in abundance of phytoplankton, zooplankton, macro benthos and meio benthos in our study compare to 2011 data indicate that the impact of treated effluent release from M/s JN Pharma City Ltd. and NTPC Ltd. is not significant on the abundance of phytoplankton, zooplankton, macro benthos and meio benthos in this region.

Plate 7.3: Microscopic images of some benthic organisms

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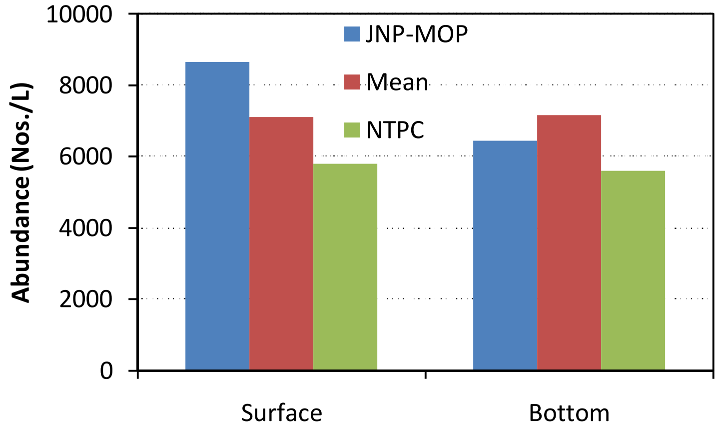

Fig. 7.2a: Comparison of phytoplankton abundance (No./L) at marine outfall points of JN Pharmacity Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during pre monsoon season

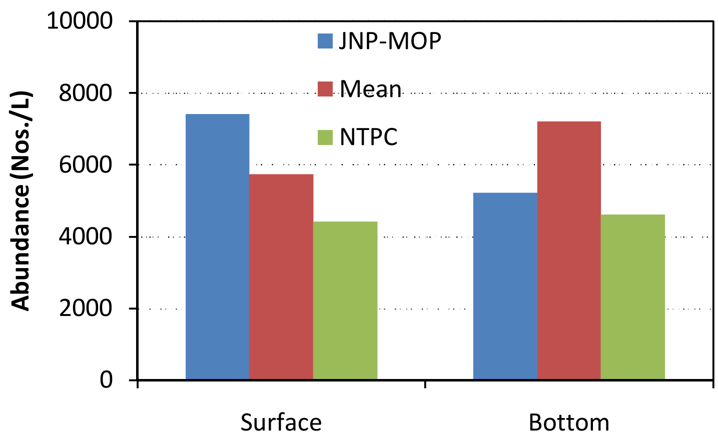

Fig. 7.2b: Comparison of phytoplankton abundance (No./L) at marine outfall points of JN Pharmacity Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during post monsoon season

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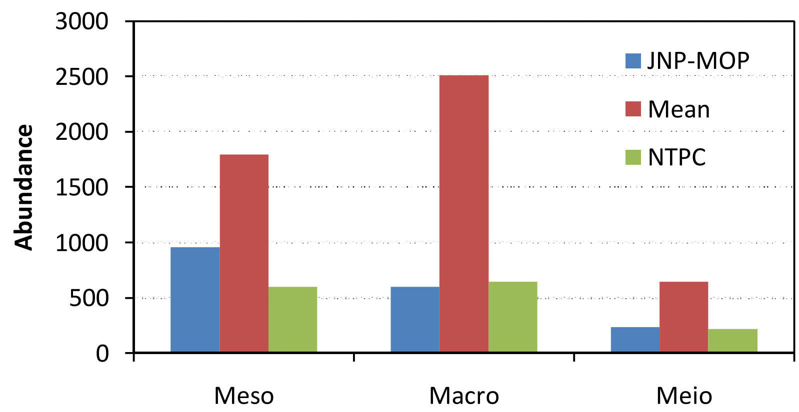

Fig. 7.3a: Comparison of abundance of Meso zooplankont (Meso; No./m^3), macro benthos (Macro; No./m^2) and meio benthos (Meio; No./10cm^2) at marine outfall points of JN Pharma City Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during pre monsoon season

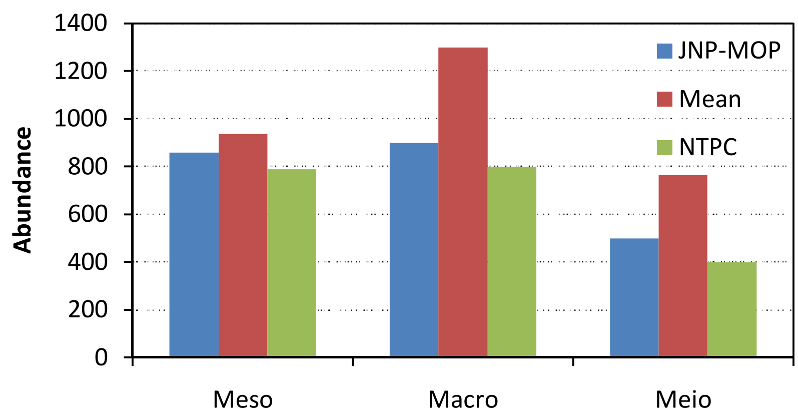

Fig. 7.3b: Comparison of abundance of Meso zooplankont (Meso; No./m^3), macro benthos (Macro; No./m^2) and meio benthos (Meio; No./10cm^2) at marine outfall points of JN Pharma City Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during post monsoon season

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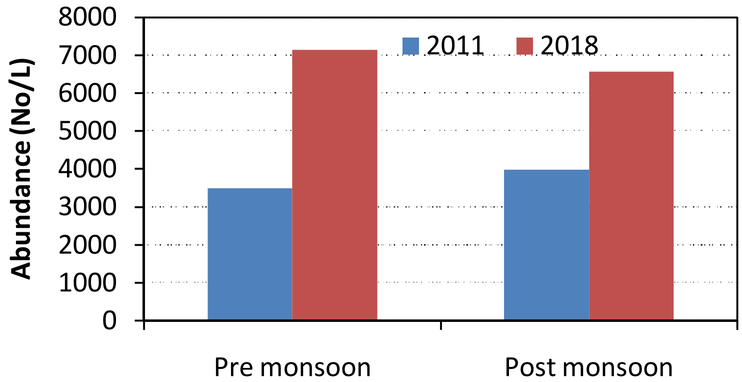

Fig. 7.4a: Comparison of mean phytoplankton abundance (No./L) found in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

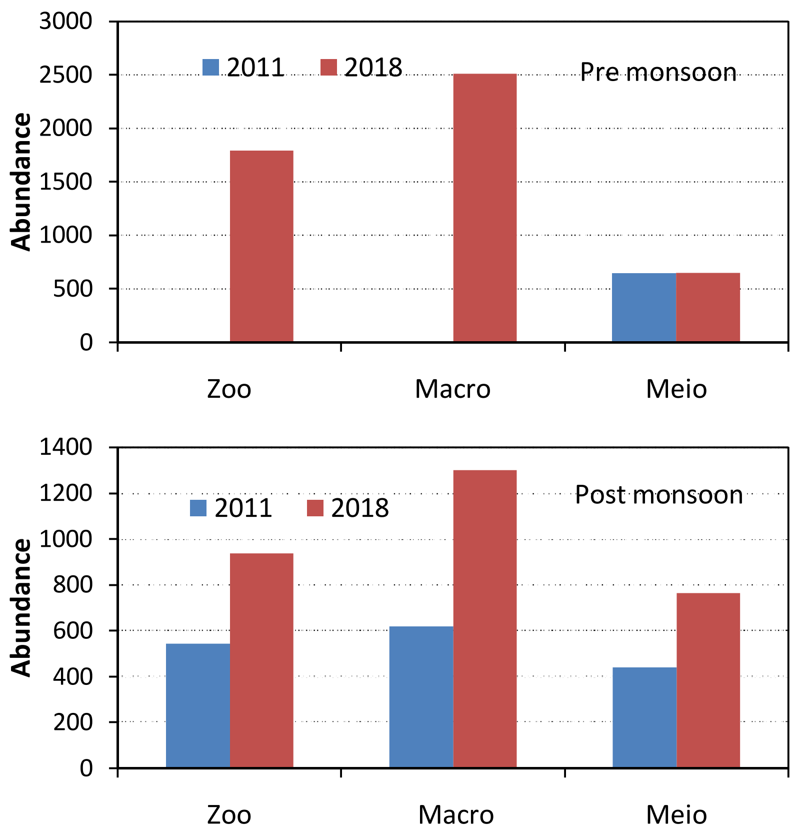

Fig. 7.4b: Comparison of mean abundance of zooplankton (No./m^3), macro benthos (No./m^2) and meio benthos (No./10cm^2) found in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

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Table 7.4: Details of the biological parameters in coastal waters off Tikkavanipalem during pre monsoon season

Stations	Chlorophyll *a* (mg/m^3)		Phytoplankton (No./L)		Meso zooplankton abundance ($No./m^3$)	Macro benthos abundance ($No./m^2$)	Meio benthos abundance $No./10cm^2$
	Sur	Bot	Sur	Bot			
TVM1	4.08	4.89	10450	8450	1100	-	-
TVM2	5.14	5.37	8650	6400	2140	-	-
TVM3	7.2	7.92	9600	3450	2160	-	-
TVM4	6.2	5.4	8400	10750	1080	2250	740
TVM5	7.54	10.16	7500	10560	-	-	-
TVM6	6.25	4.9	6800	8400	2450	-	-
TVM7	-	5.83	-	6450	-	-	-
TVM8	3.58	4.58	4200	10580	1900	-	-
TVM9	-	6.03	-	11450	2200	-	-
TVM10	3.01	2.87	5640	5400	2100	2250	600
TVM11	4.45	2.6	4800	6800	2600	2650	480
TVM12	4.71	1.92	5600	2600	1400	-	-
TVM13	2.17	1.38	4800	2300	1600	-	-
TVM14	6.19	9.17	9400	14000	1400	2900	780
TVM15	4.9	2.88	6400	2600	1600	-	-
TVM16	5.45	4.69	7200	4350	1400	-	-
NTPC - MOP	5.05	5.05	5800	5600	600	650	220
JNP-MOP	6.3	4.36	8650	6450	960	600	238

Table 7.5: Details of the biological parameters in coastal waters off Tikkavanipalem during post monsoon season

Station Name	Chlorophyll *a* (mg/m^3)		Phytoplankton (No./L)		Meso zooplankton abundance No./m^3	Macro benthos abundance (No./m^2)	Meio benthos abundance No./10cm^2
	Surface	Bottom	Surface	Bottom			
TVM 1	-	1.15	4600	6800	920	-	-
TVM 2	0.49	1.32	5200	7200	1140	-	-
TVM 3	3.72	2.9	4600	6400	1060	-	-
TVM 4	2.49	2.44	5400	8000	1040	1600	760
TVM 5	1.25	2.14	6400	8200	860	-	-
TVM 6	0.78	1.55	7600	8400	1324	-	-
TVM 7	4.14	1.13	4600	5400	625	-	-
TVM 8	3.84	3.96	5200	8460	860	-	-
TVM 9	1.25	1.82	5640	6400	1014	-	-
TVM 10	0.58	0.96	4600	5600	945	1400	940
TVM 11	1.71	1.09	5100	8740	780	1200	600
TVM 12	4.11	0.38	8600	5600	820	-	-
TVM 13	-	1.55	6450	8100	890	-	-
TVM 14	-	0.57	4600	7100	920	1000	760
TVM 15	2.79	2.55	5040	6140	840	-	-
TVM 16	1.9	2.61	8060	8640	965	-	-
NTPC MOP	2.22	2.14	4400	4600	789	800	400
JNP- MOP	1.94	1.44	7400	5200	860	900	500

Comparison of biological characteristics observed in this study with that of the study conducted in this region during 2011 was given in Table 7.6

Table 7.6: Comparison of biological characteristics found in present study with earlier studies conducted in the coastal waters off Tikkavanipalem

Parameter	2009-2010	2011		Present study	
		Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
Phytoplankton abundance ($x10^4$ cells/ L)	0.42-1.80	0.25-1.47	0.19-1.26	0.42-1.40	0.44-0.87
Species richness	11-18	13-28	12-25	14-29	20-21
Zooplankton abundance (No./m^3)	73-146	-	317-683	600-2600	625-1324
Macro benthos abundance (No./m^3)	450-2100	-	125-1650	600-2900	800-1600
Meio faunal abundance (No./m^3)	440-1344	-	267-825	220-780	400-940

7.3 Microbiological parameters

Both surface and bottom water samples collected from the study area were analyzed for the following microbiological parameters:

1. Total viable count (TVC) – R2A Agar seawater medium,
2. Total Coliform (TC) – Mac Conkey's Agar,
3. *Escherichia coli* like organisms (ECLO) – Mac Conkey's Agar,
4. *Enterococcus feacalis* like organisms (EFLO) – Mac Conkey's Agar,
5. *Pseudomonas aeruginosa* like organisms (PALO) – Cetrimide Agar,
6. *Vibro* like organisms (VLO) – TCBS Agar,
7. *Vibro cholerae* like organisms (VCLO) – TCBS Agar,
8. *Vibro parahaemolyticus* like organisms (VPLO) – TCBS Agar

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Certain aquatic microbes serve as excellent indicator of pollution. Microbes, in particular bacteria react quickly to changes in the environmental conditions. An assessment of the microbial activity is possible by the determination of the microbial biomass (total viable count). Therefore the total viable counts implies an indirect measure of *in situ* activity in contrast to number of specific indicator microbes, and this has been used as one of the principal criteria of pollution in natural water. Besides the pollution indicator bacteria such as total coliforms (TC), *Escherichia coli* like organisms (ECLO) and *Enterococcus feacalis* like organisms (EFLO) occurring the coastal waters have also been included. These indicator bacteria will presumably shows that sewage discharge with human faecal matter is present, which also indicates that possible presence of pathogenic bacteria in the water samples. Apart from that some pathogenic bacteria such as *Pseudomonas aeruginosa* like organisms (PALO), *Vibro cholerae* like organisms (VLO) and *Vibro parahaemolyticus* like organisms (VPLO) abundance was also studied.

Bacterial counts of the water samples collected during pre and post monsoon seasons in the coastal waters off Tikkavanipalem are given in Tables 7.7 and 7.8. The values of TVC in the surface and bottom water were in the range of 0.3 to 4.0 and 1.3 to 5.6 CFUx10^3/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 0.8 to 18.7 and 0.8 to 24.0 CFUx10^3/ml, in the surface and bottom water respectively (Table 7.8a). Total Coliform counts in the surface and bottom water were in the range of 0.4 to 3.9 and 1.4 to 6.3 CFUx10^2/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 0.1 to 25 and 0.1 to 39.2 CFUx10^2/ml, in the surface and bottom water respectively (Table 7.8a). Similarly the *Escherichia coli* like organism counts in the surface and bottom water were in the range of 0.1 to 0.9 and 0.2 to 1.1 CFUx10^1/ml during pre monsoon season (Table 7.7a). The values during

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post monsoon season were 1.0 to 126.0 and 1.0 to 392 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8a). *Enterococcus faecalis* like organism counts in the surface and bottom water were in the range of 0.1 to 2.6 and 0.5 to 2.0 CFUx10^1/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 1.0 to 10 and 1.0 to 50 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8a). *Pseudomonas aeruginosa* like organism counts in the surface and bottom water were in the range of 0.2 to 4.3 and 2.1 to 9.4 CFUx10^3/ml during pre monsoon season (Table 7.7b). The values during post monsoon season were 0.2 to 9.2 and 0.6 to 65 CFUx10^3/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio* like organism counts in the surface and bottom water were in the range of 0.1 to 2.0 and 0.2 to 0.9 CFUx10^1/ml during pre monsoon season (Table 7.7b). The values during post monsoon season were 1.0 to 2.0 and 1.0 to 11.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio cholerae* like organism counts in the surface and bottom water were in the range of 1.5 to 9.0 and 0.1 to 0.2 CFUx10^1/ml during pre monsoon season (Table 7.7b). The VCLO count during post monsoon season were 2.0 and 3.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio parahaemolyticus* like organism counts in the surface and bottom water were in the range of 0.1 to 0.3 and 0.1 to 0.2 CFUx10^1/ml during pre monsoon season (Table 7.7b). The VPLO counts during post monsoon season were 1.0 and 1.0 to 8.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b).

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Table 7.7a. Spatial variability in total viable count (TVC; CFU/ml), total coli forms (TC, CFU/ml), *Escherichia coli* like organism (ECLO, CFU/ml) and *Enterococcus faecalis* like organism (EFLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	TVC ($CFU*10^3/ml$)		TC ($CFU*10^2/ml$)		ECLO ($CFU*10^1/ml$)		EFLO ($CFU*10^1/ml$)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	2.6	2.2	2.9	2.5	0.6	0.4	0.8	0.8
TVM2	1.5	-	1.6	-	0.4	-	0.4	-
TVM3	2.3	2.6	2.5	2.9	0.5	0.5	0.7	0.9
TVM4	1.9	3.1	1.8	3.7	0.9	0.6	1.1	1.2
TVM5	1.1	1.6	1.0	1.9	0.5	0.3	0.6	0.6
TVM6	0.3	1.8	0.4	2.0	0.1	0.3	0.1	0.7
TVM7	2.4	3.4	2.6	3.8	0.6	0.6	0.7	1.2
TVM8	2.2	2.0	2.4	2.2	0.5	0.4	0.6	0.7
TVM9	1.5	-	1.7	-	0.4	-	0.4	-
TVM10	3.3	1.7	3.6	2.0	0.8	0.3	1.0	0.6
TVM11	1.7	5.6	1.9	6.3	0.4	1.1	0.5	2.0
TVM12	2.0	2.7	2.2	3.0	0.5	0.5	0.6	1.0
TVM13	1.0	4.2	1.1	4.7	0.3	0.8	0.3	1.5
TVM14	2.3	5.3	2.5	6.0	0.6	1.0	0.7	1.9
TVM15	1.9	1.9	2.0	2.2	0.5	0.4	0.5	0.7
TVM16	1.7	3.2	1.8	3.6	0.4	0.6	0.5	1.1
NTPC-MOP	0.8	1.3	0.9	1.4	0.2	0.2	0.2	0.5
JNP-MOP	4.0	2.1	3.9	2.3	2.2	0.6	2.6	1.1

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Table 7.7b. Spatial variability in *Pseudomonas aeruginosa* like organism (PALO, CFU/ml), *Vibrio* like organism (VLO, CFU/ml), *Vibrio cholerae* like organism (VCLO, CFU/ml) and *Vibrio parahaemolyticus* like organism (VPLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	PALO ($CFU*10^3$/ml)		VLO ($CFU*10^1$/ml)		VCLO ($CFU*10^1$/ml)		VPLO ($CFU*10^1$/ml)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	1.6	3.7	0.6	0.3	0.1	0.1	0.1	0.1
TVM2	0.9	-	0.3	-	0.1	-	0.1	-
TVM3	1.3	4.4	0.5	0.4	0.1	0.1	0.1	0.1
TVM4	1.6	4.9	0.8	0.5	0.2	0.1	0.2	0.1
TVM5	0.9	2.5	0.4	0.3	0.1	0.1	0.1	0.1
TVM6	0.2	3.1	0.1	0.3	-	0.1	-	0.1
TVM7	1.4	5.6	0.5	0.5	0.1	0.1	0.1	0.1
TVM8	1.3	3.3	0.5	0.3	0.1	0.1	0.1	0.1
TVM9	0.9	-	0.3	-	0.1	-	0.1	0.-
TVM10	1.9	2.9	0.7	0.3	0.2	0.1	0.1	0.1
TVM11	1.0	9.4	0.4	0.9	0.1	0.2	0.1	0.2
TVM12	1.2	4.5	0.4	0.4	0.1	0.1	0.1	0.1
TVM13	0.6	7.0	0.2	0.6	0.1	0.2	-	0.1
TVM14	1.4	8.9	0.5	0.8	0.1	0.2	0.1	0.2
TVM15	1.1	3.2	0.4	0.3	0.1	0.1	0.1	0.1
TVM16	1.0	5.3	0.4	0.5	0.1	0.1	0.1	0.1
NTPC-MOP	0.5	2.1	0.2	0.2	-	-	-	-
JNP-MOP	4.3	3.5	2.0	0.3	0.5	0.1	0.2	0.1

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Table 7.8a. Spatial variability in total viable count (TVC; CFU/ml), total coli forms (TC, CFU/ml), *Escherichia coli* like organism (ECLO, CFU/ml) and *Enterococcus faecalis* like organism (EFLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	TVC ($CFU*10^3$/ml)		TC ($CFU*10^2$/ml)		ECLO ($CFU*10^1$/ml)		EFLO ($CFU*10^1$/ml)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	0.9	3.9	-	-	-	-	-	-
TVM2	0.8	2.0	-	0.4	-	4	-	-
TVM3	5.2	0.9	4.0	39	0	392	-	-
TVM4	11.4	13.2	2.9	-	105	-	-	-
TVM5	3.1	10.6	2.4	-	-	-	-	-
TVM6	15.3	8.8	0.4	-	1.0	-	1	-
TVM7	1.5	9.6	0.1	0.9	-	9	-	12
TVM8	1.3	0.8	-	2.8	10	28	10	1
TVM9	-	-	-	-	-	-	-	-
TVM10	18.7	4.5	0.8	0.1	32	1	-	-
TVM11	0.9	3.7	21.4	-	-	-	-	-
TVM12	16.8	24	9	1.2	4	12	-	-
TVM13	11.7	13.5	6.6	0.4	15	4	-	-
TVM14	13.4	10.1	5.1	-	11	-	-	-
TVM15	-	11.3	-	-	-	-	-	-
TVM16	15.0	5.3	25	-	-	-	-	-
NTPC-MOP	1.1	7.8	19	1.4	126	14	-	50
JNP-MOP	-	-	-	-	-	-	-	-

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Table 7.8b: Spatial variability in *Pseudomonas aeruginosa* like organism (PALO, CFU/ml), *Vibrio* like organism (VLO, CFU/ml), *Vibrio cholerae* like organism (VCLO, CFU/ml) and *Vibrio parahaemolyticus* like organism (VPLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	PALO ($CFU*10^3/ml$)		VLO ($CFU*10^1/ml$)		VCLO ($CFU*10^1/ml$)		VPLO ($CFU*10^1/ml$)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	1.2	-	-	-	-	-	-	-
TVM2	1.2	0.6	-	-	-	-	-	-
TVM3	2.5	8.5	1	11	-	3	1	8
TVM4	7.7	-	2	1	2	-	-	1
TVM5	0.6	1.2	-	2	-	-	-	2
TVM6	5.3	3.4	-	-	-	-	-	-
TVM7	0.6	5.6	-	-	-	-	-	-
TVM8	0.2	6.2	-	-	-	-	-	-
TVM9	-	-	-	-	-	-	-	-
TVM10	3.7	1.5	-	-	-	-	-	-
TVM11	9.2	1.7	-	-	-	-	-	-
TVM12	1.3	2.6	-	-	-	-	-	-
TVM13	6.6	5.3	-	5	-	-	-	5
TVM14	3.8	3.4	-	7	-	-	-	7
TVM15	-	2.9	-	-	-	-	-	-
TVM16	5.3	-	-	-	-	-	-	-
NTPC-MOP	1.6	65	-	-	-	-	-	-
JNP-MOP	-	-	-	-	-	-	-	-

Table 7.9: Comparison of microbial populations found during the pre monsoon and post monsoon seasons of this study (2018) with those obtained during the previous monitoring study conducted in this region in 2011.

Region	Type of bacteria	This study (2018)		Previous study (2011)	
		Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
Tikkavanipalem (zone 5)	TVC (CFUx10^3/ml)	0.3-5.6	0.8-24	2.9-19	3.1-9
	TCC (CFUx10^2/ml)	0.4-6.3	0.1-39	0.6-5	0.1-1.5
	ECLO (CFUx10^1/ml)	0.1-1.1	1.0-392	0.1-15	0.8-5
	VLO (CFUx10^1/ml)	0.1-2.0	1.0-11	0.9-214	0.7-82

TVC counts are more during post monsoon season compared to pre monsoon season. When compared to 2011 data, TVC counts found in this study are lower during pre monsoon season and higher during post monsoon season. TC counts are more during post monsoon season. These counts are more or less similar during pre monsoon season and higher during post monsoon season compared 2011 data. ECLO counts are more during post monsoon season and these counts are lower during pre monsoon season and higher during post monsoon season compared to 2011 data. EFLO, PALO and VLO counts are more during post monsoon than pre monsoon season. VCLO and VPLO counts are very low and no considerable seasonal variability was found.

Microbiological quality of the seawater in this region is not good as the presence of indicator bacteria and some pathogenic bacteria in higher concentrations than the standard levels. The presence of indicator bacteria and some pathogenic bacteria in concentrations higher than the standard levels in coastal waters in this region indicated that coastal waters of this region is considerably contaminated with untreated domestic sewage.

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Chapter 13

RECOMMENDATIONS

Present study region, the coastal waters of north Andhra coast extending from off Pydibhimavaram to off Kesavaram was investigated during pre and post monsoon seasons for physico-chemical, biological, micro biological and sedimentolgical parameters in order to assess the impact of industrial effluent release through the marine outfall points (MOPs) on the seawater quality and ecosystem of the region, if any. The *in-situ* observations and sample collection was carried from 17th February to 08th March 2018 during the pre monsoon season and from 08th December 2018 to 1st January 2019 during the post monsoon season. Results of our investigations in the study region during both the seasons (pre and post monsoon) were described in detail in chapters 3 to 12. Based on findings of this study the following recommendations have been made to maintain the seawater quality and the health of the ecosystem in the coastal waters of north Andhra coast.

- ✓ Since the dissolved oxygen concentrations are depleted and ecosystem at MOPs is impacted, continuous yearly monitoring of the north Andhra coast is very much required, at least for the next two years, to monitor the DO levels and to understand the expansion/compression of impacted area around the MOP location, and to take necessary timely precautions to protect the seawater quality and the health of the ecosystem in the region
- ✓ Time series experiments (continuous daily measurements at MOP and surrounding locations for one week; before, during and after effluent release) should be conducted at

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least for two industries (one in the south and the other in the north of Visakhapatnam) to understand the impact of effluent release on the ecosystem in the region.

- ✓ Since the seasonal variability in all the parameters is very high in the study region, monitoring should be conducted with high temporal resolution, at least 4 times in a year, for example, February, May, September and December.
- ✓ In order to assess the impacted area around the MOP location, it should be covered at least 5km (instead of 2km in the present study) from the MOP in both the directions along the coast.
- ✓ Further treatment for industrial effluents is required to reduce their toxicity before discharging into the sea because the treated effluents from all the industries are mildly acute toxic.
- ✓ Bio assay tests for industrial effluents must be conducted on monthly time scale at least for one year to understand the variability in the quality of effluent because the composition of the treated effluent is highly variable with time for any industry.
- ✓ Trace metals (chromium, manganese, cobalt, nickel, copper, cadmium, zinc etc) concentrations should be determined in the treated effluents of industries before discharging in to the sea, coastal waters, and benthic organisms along with surface sediments in order to assess the trace metal contamination in the food chain.
- ✓ Sludge remained in the guard ponds should be removed on regular time intervals to avoid its transport into the sea along with effluent.
- ✓ Since, fish is more susceptible to contamination of organic compounds the major organic compounds present in the treated effluent should be understood before discharging into the sea.

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- ✓ Antibiotic resistivity of the indicator and pathogenic bacteria present in the waters of the study region should be investigated
- ✓ As microbiological studies indicated significant input of untreated domestic sewage to the present study region, it is strongly recommended to take necessary steps to prevent the transport of untreated domestic sewage into the sea.

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Annexure-VI

A.P. POLLUTION CONTROL BOARD, ZONAL LABORATORY, VISAKHAPATNAM

CONSOLIDATED ANALYSIS REPORTS OF BOREWELL SAMPLES COLLECTEDF IN TADI AND TANAM VILLAGES -2022

Bore well sample collected at MPP School, Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	7.43	815	676	104.9	216	168	0.03	46.94	0.68	0.03	35.96	0.07	86.4	21.38	39.64	4.04	0.001	0.184	0.036	0.003	0.003	0.008	<0.001	<0.001	<0.001
21.04.2022	8.33	720	564	110.02	184	183	BDL	43.00	0.16	BDL	30.31	BDL	96	24.99	31.63	4.28	0.001	<0.001	0.021	<0.001	0.002	0.006	<0.001	<0.001	<0.001
30.06.2022	6.74	626	407	88	224	200	BDL	20.72	0.43	BDL	1.99	BDL	64	15.5	38.52	23.19	0.002	<0.001	0.023	0.001	0.002	0.004	<0.001	<0.001	<0.001
06.08.2022	7.72	862	524	107.14	228	208	0.01	22.69	0.74	0.06	2.42	BDL	91.2	3.89	36.1	20.59	0.004	<0.001	0.026	0.001	0.002	0.004	<0.001	<0.001	<0.001
31.10.2022	7.24	979	792	181.36	266	298	0.02	28.26	0.68	0.07	8.26	BDL	78.4	24.56	40.21	12.36	0.006	0.001	0.03	0.001	0.003	0.008	<0.001	<0.001	<0.001
24.12.2022	7.34	1024	612	128.68	216	208	0.03	42.36	0.74	0.05	18.54	BDL	86.4	27.21	50.36	13.12	0.006	0.002	0.036	0.003	0.004	0.01	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**45**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

Bore well sample collected at Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	7.73	1246	1026	213.57	296	347	0.02	35.14	1.24	0.01	32.51	0.04	118.4	33.05	124.7	1.16	0.001	<0.001	0.018	0.001	0.002	0.007	<0.001	<0.001	<0.001
21.04.2022	8.28	1092	852	220.9	280	270.4	0.01	31.92	1.21	0.18	30.48	0.04	110.8	38.54	120.6	1.26	0.001	0.001	0.026	0.003	0.002	0.008	<0.001	<0.001	<0.001
30.06.2022	7.46	719	467	83.1	288	184	BDL	21.46	1.12	0.12	18.32	BDL	73.6	25.2	26.94	1.16	0.001	0.001	0.03	0.002	0.003	0.009	<0.001	<0.001	<0.001
06.08.2022	7.41	1024	748	183.35	296	292	BDL	24.38	0.45	0.09	19.69	BDL	118.4	45.68	28. 64	2.04	0.006	0.001	0.029	0.002	0.003	0.009	<0.001	<0.001	<0.001
31.10.2022	8.27	945	736	176.45	322	278	0.01	30.18	0.52	0.08	18.36	BDL	120.2	47.24	30.16	2.31	0.008	0.004	0.032	0.003	0.004	0.018	<0.001	<0.001	<0.001
24.12.2022	7.69	928	682	133.35	304	267	0.02	38.54	0.62	0.08	16.36	BDL	121.6	27.21	42.36	3.1	0.009	0.006	0.038	0.002	0.004	0.016	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**45**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

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Bore well sample collected at BC Colony, Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	7.22	1141	910	146.7	384	280	0.04	120.18	0.7	0.02	32.64	0.08	153.6	34.02	32.86	3.18	0.002	0.176	0.032	0.002	0.003	0.008	<0.001	<0.001	<0.001
21.04.2022	8.00	1023	896	136.92	340	280	0.02	168.68	0.42	0.29	30.92	0.08	160.8	35.68	51.69	2.86	0.018	0.002	0.042	0.004	0.003	0.009	<0.001	<0.001	<0.001
30.06.2022	6.69	1043	678	166.3	340	228	0.02	30.58	0.51	0.26	29.37	BDL	99.2	22.35	58.75	2.48	0.016	0.003	0.04	0.003	0.004	0.01	<0.001	<0.001	<0.001
06.08.2022	7.30	1037	748	181.81	424	284	0.02	32.34	0.89	0.52	21.78	BDL	109.6	43.31	42.49	2.41	0.009	0.001	0.042	0.003	0.004	0.01	<0.001	<0.001	<0.001
31.10.2022	7.03	1014	724	179.56	458	252	0.03	36.1	0.78	0.06	23.53	BDL	102.8	45.28	46.25	3.24	0.012	0.002	0.048	0.004	0.006	0.016	<0.001	<0.001	<0.001
24.12.2022	7.47	1162	790	176.92	320	283	0.04	56.8	0.86	0.09	20.58	BDL	118	42.54	58.92	4.18	0.014	0.006	0.044	0.005	0.005	0.018	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

Bore well sample collected at Tanam (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	8.16	838	682	120.05	200	275	BDL	20.86	0.82	BDL	5.25	BDL	80	37.91	44.68	2.62	0.003	<0.001	0.036	0.001	0.004	0.007	<0.001	<0.001	<0.001
21.04.2022	8.27	2200	668	140.94	140	280	BDL	18.92	0.79	BDL	6.2	BDL	84.8	35.24	60.5	2	0.004	<0.001	0.038	0.001	0.004	0.008	<0.001	<0.001	<0.001
30.06.2022	7.48	1992	1295	264.1	244	424	BDL	68.32	1.38	0.03	8.32	0.01	43.2	33.00	290	5.01	0.006	0.001	0.04	<0.001	0.006	0.005	<0.001	<0.001	<0.001
06.08.2022	7.67	1563	1376	344.5	184	512	0.01	62.54	0.98	0.04	10.89	BDL	73.6	25.27	310	7.02	0.003	0.002	0.046	<0.001	0.006	0.005	<0.001	<0.001	<0.001
31.10.2022	7.61	1889	1024	242.12	286	365	0.02	56.32	0.76	0.06	12.14	BDL	92.4	28.16	184.6	6.24	0.004	0.003	0.052	0.001	0.004	0.008	<0.001	<0.001	<0.001
24.12.2022	8.03	1604	958	259.17	220	310	0.01	50.18	0.61	0.04	13.86	BDL	88	43.74	152.14	6.56	0.006	0.005	0.064	0.002	0.003	0.007	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

Bore well sample collected at ZP High School, Tanam (V)`

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	7.70	1493	1252	217.36	300	518	BDL	22.18	0.79	BDL	14.4	BDL	120	55.4	160.3	1.64	0.014	0.001	0.034	0.001	0.004	0.006	<0.001	<0.001	<0.001
21.04.2022	8.31	1410	1298	122.25	276	600	0.02	131.44	1.01	0.01	37.99	BDL	22.4	53.46	299.1	2	0.016	0.002	0.034	0.002	0.005	0.006	<0.001	<0.001	<0.001
30.06.2022	7.39	1544	1004	122.3	264	480	BDL	60.23	0.92	0.02	12.57	0.01	49.6	34.02	218.05	1.66	0.018	0.001	0.038	0.001	0.007	0.008	<0.001	<0.001	<0.001
06.08.2022	7.44	1235	986	88.46	232	528	BDL	58.19	1.02	0.03	22.12	BDL	92.8	27.22	132.64	2.38	0.008	<0.001	0.032	0.001	0.007	0.008	<0.001	<0.001	<0.001
31.10.2022	7.38	1822	1028	94.52	256	460	0.01	55.68	1.14	0.04	20.52	BDL	86.8	24.13	146.3	2.52	0.007	<0.001	0.038	0.001	0.006	0.012	<0.001	<0.001	<0.001
24.12.2022	7.71	1635	984	206.47	240	373	0.01	61.86	1.16	0.06	18.52	BDL	96	40.32	152.36	3.18	0.006	0.002	0.041	0.001	0.005	0.014	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

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Bore well sample collected at NTR Statue Main Road, Tanam (V)																								
Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
28.02.2022	7.72	1642	1314	314.54	500	489	BDL	22.81	0.52	BDL	24.8	BDL	200	79.7	46	5.48	0.002	0.001	0.03	<0.001	0.003	0.008	<0.001	<0.001	<0.001
21.04.2022	8.47	1532	1012	320.55	640	308	0.03	27.08	0.62	0.01	18.82	BDL	172	80.78	43.5	2.01	0.003	0.001	0.032	<0.001	0.004	0.007	<0.001	<0.001	<0.001
30.06.2022	7.01	1103	717	107.6	232	352	0.01	34.4	0.62	0.02	10.22	0.02	51.2	25.2	141.4	1.77	0.004	0.002	0.036	0.001	0.004	0.006	<0.001	<0.001	<0.001
06.08.2022	7.86	1815	1504	528.12	576	446	0.01	45.69	0.72	0.06	14.62	BDL	180.4	91.37	162.8	3.05	0.002	0.001	0.038	0.001	0.004	0.006	<0.001	<0.001	<0.001
31.10.2022	7.31	2086	1362	452.29	542	405	0.01	42.51	0.82	0.08	16.18	BDL	172.6	64.62	174.2	3.15	0.003	0.002	0.046	0.002	0.005	0.007	<0.001	<0.001	<0.001
24.12.2022	7.57	2500	1356	410.76	492	460	0.02	52.82	0.74	0.06	14.6	BDL	119.68	98.17	168.26	3.25	0.004	0.004	0.052	0.001	0.004	0.006	<0.001	<0.001	<0.001
Permissible	**No Relax**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**No Relax**	**0.3**	**No Relax**	**No Relax**	**1.5**	**15**	**0.05**	**No Relax**	**No Relax**

Note : As per the analysis results all the parameters are within the permissible standards prescribed in IS 10500 : 2012 drinking water specification.

M Ravi

SENIOR ENVIRONMENTAL SCIENTIST

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A.P.POLLUTION CONTROL BOARD,ZONAL LABORATORY, VISAKHAPATNAM

CONSOLIDATED ANALYSIS REPORTS OF BOREWELL SAMPLES COLLECTED IN TADI AND TANAM VILLAGES -2023

Bore well sample collected at MPP School, Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.70	2033	1268	249.39	172	460	0.02	82.6	0.72	0.05	14.58	BDL	148.8	49.16	136.28	4.58	0.008	0.006	0.072	0.001	0.002	0.009	<0.001	<0.001	<0.001
17.04.2023	7.50	1626	1060	109.6	260	440	BDL	77.12	1.36	0.22	21.47	BDL	41.6	38.00	170.3	5.55	<0.001	0.012	0.029	<0.001	<0.001	0.02	<0.001	<0.001	<0.001
07.06.2023	6.17	1018	662	53.8	180	252	BDL	1.63	0.28	BDL	0.44	BDL	49.6	13.6	65.07	0.12	<0.001	0.002	0.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.43	1546	1010	117.36	292	560	BDL	62.38	0.85	0.03	5.28	0.01	116.8	35.96	175.1	1.49	<0.001	0.002	0.01	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Permissible	**NR**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

Bore well sample collected at Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.38	2083	1792	410.76	536	623	0.04	98.4	1.86	0.08	20.28	BDL	214.4	76.78	184.66	6.16	0.006	0.005	0.064	0.003	0.003	0.012	<0.001	<0.001	<0.001
17.04.2023	7.90	2210	1436	214.9	164	280	BDL	16	2.00	0.01	27.93	BDL	17.6	29.20	334.7	10.32	<0.001	0.001	0.021	<0.001	<0.001	0.004	<0.001	<0.001	<0.001
07.06.2023	6.92	766	496	88	292	260	BDL	16.57	0.36	0.01	14.7	BDL	86.4	18.4	56.68	1.78	<0.001	<0.001	0.036	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.37	3110	2026	482.79	600	652	0.02	113	0.77	BDL	16.1	0.01	240	66.09	277.1	2.23	<0.001	0.02	0.038	<0.001	<0.001	0.005	<0.001	<0.001	<0.001
Permissible	**NR**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

Bore well sample collected at BC Colony, Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.57	1710	1276	197.36	288	517	0.03	75.6	0.84	0.07	18.36	BDL	115.2	44.71	172.2	3.92	0.005	0.004	0.052	0.002	0.004	0.01	<0.001	<0.001	<0.001
17.04.2023	7.65	2860	1858	334.2	516	284	BDL	59.4	0.77	0.11	43.65	0.05	68.8	83.5	171.2	2.2	<0.001	0.024	0.047	0.001	<0.001	0.032	<0.001	<0.001	<0.001
07.06.2023	6.55	576	374	132	356	284	BDL	20.1	1.26	0.01	22	BDL	99.2	26.2	58.08	4.18	<0.001	<0.001	0.061	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.74	2270	1480	259.17	172	615	0.01	90.3	2.5	0.01	6.42	0.01	68.8	20.41	387	1.95	<0.001	0.001	0.021	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Permissible	**NR**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

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Bore well sample collected at Tanam Village

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.42	1076	882	188.24	320	288	0.02	56.3	0.76	0.05	16.56	BDL	98.0	35.96	104.86	4.18	0.008	0.008	0.04	0.003	0.005	0.008	<0.001	<0.001	<0.001
17.04.2023	7.65	821	536	60.1	304	272	0.02	15.98	1.16	0.01	14.52	0.01	76.8	27.30	35	2.32	<0.001	<0.001	0.046	<0.001	<0.001	0.003	<0.001	<0.001	<0.001
07.06.2023	7.68	2260	1468	249.2	124	588	0.01	110	0.89	0.16	29.74	BDL	36.8	7.7	414.8	3.19	<0.001	0.001	0.016	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.36	868	568	122.25	332	370	BDL	13.46	1.06	0.07	4.08	0.02	132.8	39.85	34.56	2.85	<0.001	0.007	0.072	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Permissible	**NR**	--	**2000**	**1000**	**600**	**600**	--	**400**	**1.5**	--	**45**	--	**200**	**100**	--	--	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

Bore well sample collected at ZP High School, Tanam (V)`

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.16	974	846	182.79	224	267	0.01	52.8	0.58	0.04	14.18	BDL	89.6	24.30	120.36	14.26	0.007	0.004	0.038	0.001	0.003	0.006	<0.001	<0.001	<0.001
17.04.2023	7.07	1014	654	124.9	368	284	0.03	22.24	0.63	0.02	21.47	0.03	105.6	25.30	52.97	2.37	<0.001	0.001	0.063	<0.001	<0.001	0.021	<0.001	<0.001	<0.001
07.06.2023	7.77	1702	1108	132	268	604	BDL	10.95	1.11	0.06	29.8	0.01	48	35.9	250.55	6.44	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.35	594	390	54.9	176	260	BDL	3.04	0.68	BDL	2.03	0.02	70.4	20.41	23.43	24.92	<0.001	0.021	0.037	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Permissible	**NR**	--	**2000**	**1000**	**600**	**600**	--	**400**	**1.5**	--	**45**	--	**200**	**100**	--	--	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

Bore well sample collected at NTR Statue Main Road, Tanam (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb
03.02.2023	7.01	1130	972	198.72	360	315	0.03	68.9	0.8	0.06	16.5	BDL	104	29.16	142.72	5.32	0.012	0.009	0.048	0.004	0.006	0.012	<0.001	<0.001	<0.001
17.04.2023	7.54	828	538	94.9	316	264	0.01	16.23	1.13	0.01	14.65	BDL	80	28.20	45.17	2.15	<0.001	<0.001	0.045	<0.001	<0.001	0.003	<0.001	<0.001	<0.001
07.06.2023	7.33	2920	1896	498.9	488	680	0.01	61.1	0.49	0.19	49.9	BDL	88	65.1	349.35	2.78	<0.001	<0.001	0.003	0.001	0.002	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.03	962	630	171.15	360	351	BDL	7.86	0.83	0.06	1.07	0.04	144	41.79	37.63	1.37	<0.001	0.007	0.072	<0.001	<0.001	0.015	<0.001	<0.001	<0.001
Permissible	**NR**	--	**2000**	**1000**	**600**	**600**	--	**400**	**1.5**	--	**45**	--	**200**	**100**	--	--	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**

Note :1. As per the analysis results all parameters are within the permissible limits prescribed in IS :10500 2012 drinking water specification except Total Hardness, Nitrates and Fluoride concentrations in some samples occasionally.

2. NR: No Relaxation

SENIOR ENVIRONMENTAL SCIENTIST

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Annexure-VII

A REPORT ON THE HYDROGEOLOGICAL AND HYDROLOGICAL INVESTIGATION AT COMMON EFFLUENT TREATMENT PLANT (CETP) AREA OF M/S. RAMKY PHARMACITY(INDIA) LTD, JAWAHARLAL NEHRU PHARMA CITY (JNPC), PARAWADA, VISAKHAPATNAM DISTRICT, ANDHRA PRADESH

SUBMITTED TO

RAMKY PHARMA CITY (INDIA) LIMITED

JNPC, Commercial hub, Road No.13/RNB, Visakhapatnam

2021 **TECHNICAL REPORT**

Prepared By

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A REPORT ON THE HYDROGEOLOGICAL AND HYDROLOGICAL INVESTIGATION AT COMMON EFFLUENT TREATMENT PLANT (CETP) AREA OF M/S. RAMKY PHARMACITY(INDIA) LTD, JAWAHARLAL NEHRU PHARMA CITY (JNPC), PARAWADA, VISAKHAPATNAM DISTRICT, ANDHRA PRADESH

Name of the Client	:	M/s RAMKY PHARMA CITY (INDIA) LIMITED JNPC, Commercial hub, Road No.13/RNB Visakhapatnam
Site of Investigation	:	CETP Area Ramky Pharmacity, Parawada Visakhapatnam
Reference	:	WO NO: 0400058852, dated 05-11-2020 PR No.: 3000060065
Investigation period	:	November, 2020 to April, 2021

1. INTRODUCTION (Very Brief Activity about the Industry):

In response to a communication received from M/s Ramky Pharma City (India) Pvt. Ltd., JNPC, Parawada, Visakhapatnam Dt. to conduct Hydrogeological and Hydrological investigation around its Common Effluent Treatment Plant (CETP), investigation has been taken up on behalf of Centre for Scientific and Industrial Consultancy, Andhra University. Common Effluent Treatment Plant (CETP) is one of the Environmental monitoring unit in M/s Ramky Pharma City (India) Limited Industrial unit located in JNPC, at Parawada village, Parawada mandal in Visakhapatnam district. CETP receives effluents from User Industries of Pharma City for treatment and disposal. The following treatment systems are provided:

1. Low TDS treatment system
2. High TDS treatment system
3. Treatment for cyanided bearing effluents
4. Treatment for Heavy metal (Chromium) bearing effluents.

Effluent Conveyance network with HDPE pipelines is provided in JNPC for conveyance of effluents from industries to CETP. This conveyance system is designed to carry Low TDS and High TDS effluents separately through two conveyance lines. Cyanide and Heavy Metal bearing wastes which will be relatively very low in volume are conveyed through road tankers to CETP. Limits of various parameters for discharge into the above conveyance systems are as per PCB guide lines.33.

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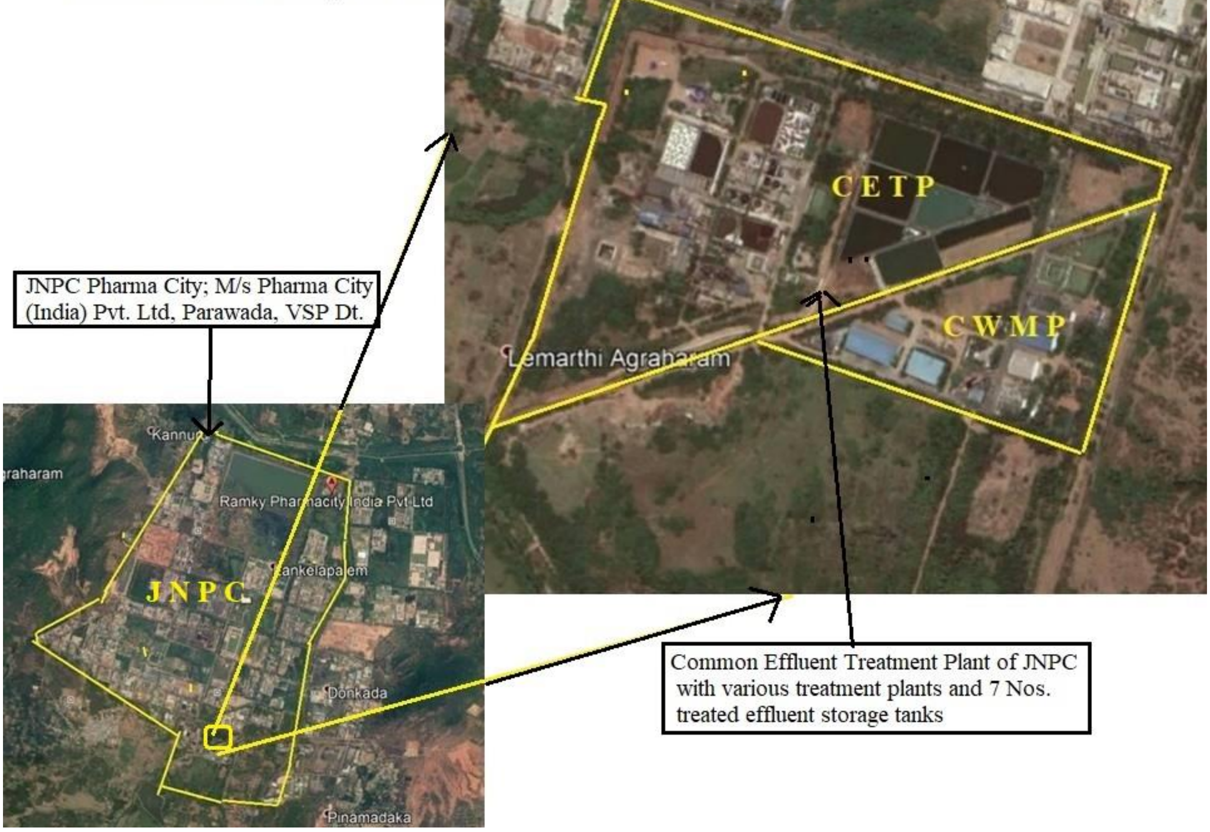
Low TDS effluent Treatment system is designed to treat 3.5 MLD (3500 M^3 / day) of effluents. High TDS effluent Treatment system is designed to treat 1.5 MLD (1500 M^3 / day) of effluents. Wastes containing traces of Cyanide and heavy metals like chromium effluents are taken to high TDS stream for further treatment.

Guard Ponds

Nine Guard Ponds are provided with total 47200m^3 capacities to hold treated effluents. Effluent collected in ponds will tested by PCB for outlet parameters for discharge to marine coastal areas (sea). During this period effluent will be collected in next Guard Pond. After conformity of the parameters for discharge standards, effluents will be pumped to Marine Out Fall through a conduit after getting clearance from PCB in the presence of PCB officials. If the treated effluents from Guard Ponds are rejected by PCB, the treated water will be taken back for further treatment. Satellite image of the JNPC and CETP areas are shown in fig. 1.1 JNPC Ramky

Fig. 1: JNPC Ramky Pharma City (India) Pvt. Ltd. Parawada, Visakhapatnam Dt.



Pharma City (India) Pvt. Ltd. Spread in an area of about 693 Hectares as per the boundary marked in fig. 1.1 Common Effluent Treatment Plant (CETP) is part of JNPC and its area is about 16.6 Hec. as marked above that consists of 9 guard ponds and effluent treatment units.

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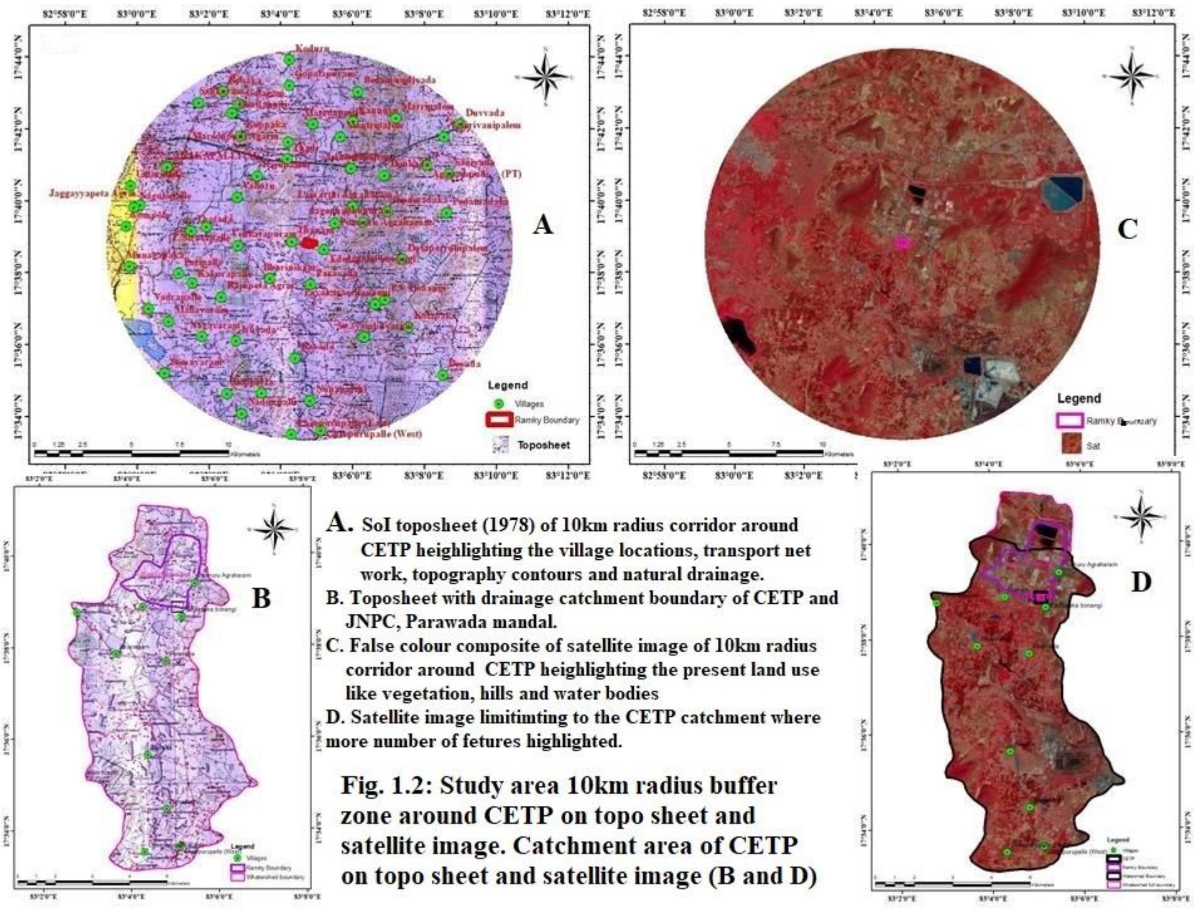
The treated effluent will be delivered into marine fall (Sea) after getting permission from APPCB.

1.1 Proposed Studies: Purpose of the Hydrgeological investigation is to establish base line data on groundwater parameters like water table fluctuations, broadly present status of groundwater potential and exploration at regional and local level, quality of groundwater, identification of aquifer zones, geological and geomorphological features. The other related themes like drainage, catchment divisions, water bodies and present land use/ land cover also required. Rainfall of the region and rainwater harvesting for improvement of groundwater potential also dealt. Number of thematic maps will be prepared at small scale maps taking the study area CETP as centre and data will be collected and consolidated to 10km radius corridor from the centre point. Similarly large scale thematic maps will be prepared considering the drainage catchment of CETP area. Base maps of small scale and large scale are shown in the following image mosaics of topo sheet updated up to 1978 and satellite image of 2020. All the themes prepared further on the proposed objectives are both on the 10km radius as well study



A. SoI toposheet (1978) of 10km radius corridor around CETP heighlighting the village locations, transport net work, topography contours and natural drainage.
B. Toposheet with drainage catchment boundary of CETP and JNPC, Parawada mandal.
C. False colour composite of satellite image of 10km radius corridor around CETP heighlighting the present land use like vegetation, hills and water bodies
D. Satellite image limitimting to the CETP catchment where more number of fetures highlighted.

Fig. 1.2: Study area 10km radius buffer zone around CETP on topo sheet and satellite image. Catchment area of CETP on topo sheet and satellite image (B and D)

area catchment is shown in fig. 1.2. Ten kilometres corridor area is about 314 sq.km and the selected catchment area is about 65 sq.km. Influence of the effluents on hydro mostly limited to the watershed catchment of the CETP as shown B and D.

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1.1.1 Objectives:

- To study the land forms and drainage pattern with special reference to ground water regime.
- To study ground water conditions and fluctuations with respect to seasons.
- To study the impact of CETP activity on ground water regime.
- To study the characteristics of environmental hydrology and their vulnerability to Effluent treatment activity.
- Suggestions to improve the quality and quantity of groundwater through Rainwater harvesting.

1.1.2 Scope of Study:

- To map and characterize the drainage network from the SOI topo sheets up to 10km buffer zone for regional analysis and catchment area on large scale where CETP located.
- To observe the hydrogeomorphological features from the available recent remote sensing data from Google Earth. Land use/ land cover mapping from the remote sensing data.
- Collection, collation and compilation of hydro-geological information with special reference to ground water storage, sub-surface geology, hydrochemical behavior, climate characteristics. The data need to be processed for presentation and prediction of future behavior activity in the region.
- Detailed investigation parameters will be limited to 1.0km radius- identification of more number of observation wells/ bore wells, groundwater levels, groundwater quality analysis.
- To study hydrological aspects of existing streams, tanks etc. with respect to effluent treatment plant surroundings.
- Implementation of Rainwater harvesting in the CETP as per the site condition. Ultimately suggest designs of rainwater harvesting for total rainwater conservation within the site.

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1.2. Methodology:

The magnitude of impact shall depend upon size of the ETP, collection, treatment processes, storage and disposal from end to end and contact with the natural drains, water bodies, soil etc. intervention of the disciplines is necessary in impact assessment. While establishing the data base, primary as well secondary data is essential for which data has been collected from the various government published records, maps of last few decades and also digital data being gathered and updated from time to time through remote sensing technology. Primary data is collected around the study area regarding surface hydrology and subsurface hydrogeology.

- Survey of India topo sheets have the very accurate information regarding topography, elevation contours, natural drainage network, transportation network, villages, land use etc. The above said information has been extracted from the 1:25,000 scale maps and produced as thematic maps. Remote sensing data is also to be extracted after geocoding the images with topo sheets. Geological survey has prepared geology maps with to the district level and the geology information has been obtained by geocoding the GSI maps and extracted to the required scale. Mandal wise groundwater potential estimations and exploitation levels were prepared and updated up to 2015 by the state and Central Ground water Boards and published data has been utilised in this report. Climatic data such as rainfall and temperature has been collected from secondary sources.
- Present land use/ land cover, hydrogeomorphology, changes in water bodies and slope thematic maps have been prepared from the remote sensing data. Depth to water table, chemical analysis of groundwater and some chemical parameters themes are prepared from the primary data collected during the investigation. Resistivity soundings have been conducted within CETP area and subsurface geology, aquifer zones have been identified through field investigation during investigation. Groundwater recharge due to rainfall has been estimated based on the Andhra Pradesh state hydrograph network stations and field observations.
- Groundwater resource and its utilization has been worked out as per norms prescribed by the Ground Water Estimation Committee (GEC-2015), Government of India.

1.3 Location and Communication:

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The study area Common Effluent Treatment Plant (CETP) is located in Jawaharlal Nehru Pharma City (JNPC) is located in Parawada mandal, abutting GVMC, Visakhapatnam district, Andhra Pradesh.

The CETP area falls under the topo sheet No. 65 O/2 and the geographical coordinates are: Latitude: 17°38'58.7"N to 17°38'48.40"N and Longitude: 83°04'39.80"E to 83°05'02.00"E

The CETP area is a part of the JNPC and concerned to almost all the units in the Pharma City from which liquid waste is collected, processed and suppose to dispose safely into the marine fall. Geographical coordinates of the JNPC are: Latitude: 17°40'27.3"N to 17°38'36.40"N and Longitude: 83°04'47.60"E to 83°05'38.40"E.

Regional analysis on certain parameters is required and as per ToR, the extension is 10km radius. Regional scaled map available is the topo sheet prepared by Survey of India. A 10km radius topo sheet along with mandal boundaries and village locations area marked on the fig. 1.3. The mandals that cover the CETP and its physiographic catchment where the impact of the industry may suppose to influence are partly Parawada and Pedagantyada. All the village locations in 10 km radius are marked in fig. 1.3. The villages that falls in the CETP catchment area are: Tanam, E.Bonangi, Venkatapuram, Bharanikam, Parawada, Dharmaraayudupalem Vennelapalem, Somunaidupalem, Mula swayambhuvaram etc. National High-way- 16 is just 4km from CETP and 2km from JNPC north boundary. Nearest is town Anakapalli through which NH-16 as well GT Railway track is connected. Nearest Air port is Visakhapatnam which is about 17km from the Pharma city.

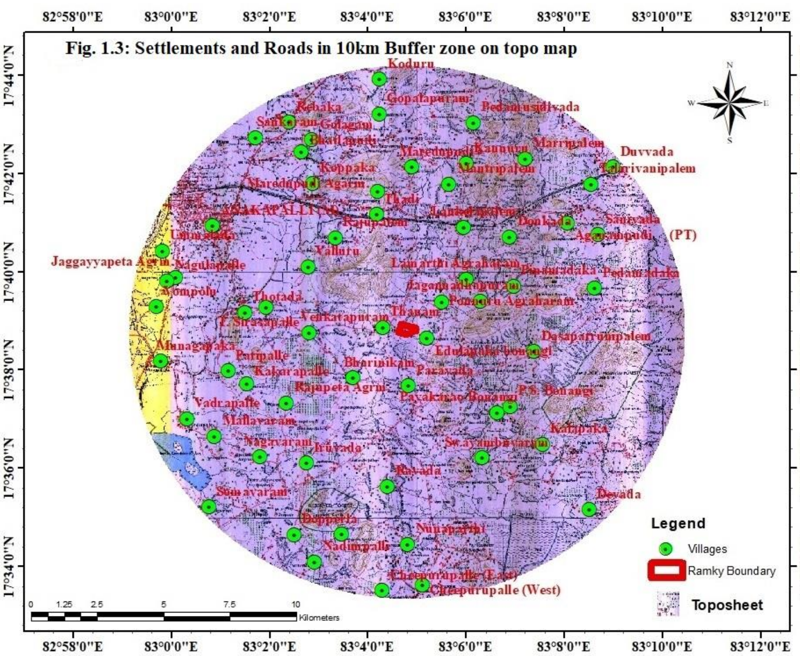

Fig. 1.3: Settlements and Roads in 10km Buffer zone on topo map

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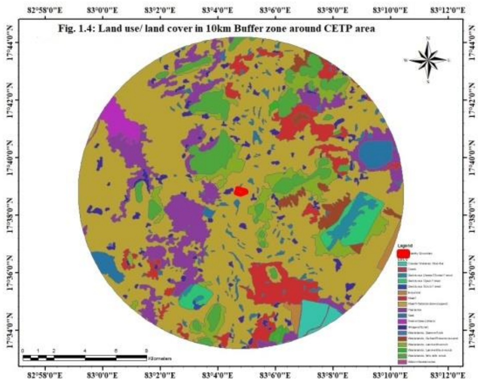
1.4. Land Utilization:

Land use/ Land cover (LULC) pattern of any region is an outcome of various physical and cultural factors and their utilization by man in time and space.

The CETP area (16.6 Ha.) is meant for treating the common effluent from all the industries belong to JNPC. Land use/ land cover of the study area as well buffer zone of 10 km radius around the study area is to be studied to know the impact of CETP as per the ToR, MoEF. Present land use/ land cover of the buffer zone is mapped using the recent satellite image, i.e., march, 2020. Ten kilometer radius high resolution satellite image is shown in fig. 1.4.



1.4.1 Land Use Land Cover Statistics of CETP Buffer Zone:

The core and buffer area Land use classes of Buffer zone 10 km radius statistics of the CETP is listed in table 1.1. The area covered with Agricultural land (kharif, kharif+Rabi, plantation and fallow) is major area around 72.52 % of the total area, followed by waste land categories- uplands with or without scrub, gullied and ravenous land of about 14.42 % and built-up land include industrial, urban and rural area is about 4.76%. There is considerable area under coastal wet land and mudflats about 1.21% and area under forest is about 1.05%. Water bodies include irrigation tanks, channels and other drainage is about 3.86%. The area under different land use/ land cover is represented in a pie diagram shown below.

Table 1.1: Land use classes of Buffer zone 10 km around CETP

S.No	Name	Area Sq.km	Area in %
1	Coastal Wetland, Mud-flat	3.81	1.21
2	Creek	0.23	0.07
3	Deciduous Dense/Closed Forest	3.29	1.05
4	Deciduous Open Forest	6.53	2.08
5	Industrial	2.03	0.65
6	Kharif	22.08	7.04
7	Kharif+Rabi(double-cropped)	171.44	54.67
8	Plantation	33.91	10.81
9	Tank	11.98	3.82
10	Towns/cities(Urban)	3.76	1.20
11	Villages(Rural)	9.12	2.91
12	Wastelands, Barren-Rock	0.041	0.01
13	Wastelands, Gullied/Ravenous-Land	5.39	1.72
14	Wastelands, hills with scrub	19.72	6.29
15	Wastelands, Land-without-scrub	0.79	0.25
16	Wastelands, Land-with-scrub	19.31	6.16
17	Water-channel-area	0.17	0.05
	Total	313.601	100.00

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1.4.1.1 Land area: The catchment area of the CETP include the natural drainage boundary around CETP and the main drain that joins with back water drain up to NTPC at Mula swayambhuvaram near the coast.

Five types of land use/ land cover categories have been identified in the catchment area and listed in table- 1.2. Land use/ land cover map of CETP catchment area is shown in fig. 1.5. Maximum coverage area is agricultural land that include khari, kharif&rabi and plantation is about 42.88 sq.km, built up land include industrial and rural is about 9.17 sq.km and is 14.14%. Waste land categories hills with and without scrub is about 8.87sq.km and is about 13.68%. Deciduous forest area is 1.24sq.km ans 1.91%. Water bodies include tanks, ponds and stream courses cover about 2.67 sq.km and is about 4.12%.

Table 1.2: Land use/ land cover in the CETP catchment area.

S.No	Name	Area (sq.km)	Area in %
1	Deciduous Dense/Closed Forest	0.13	0.20
2	Deciduous Open Forest	1.11	1.71
3	Industrial	7.14	11.01
4	Kharif	7.28	11.23
5	Kharif+Rabi(double-cropped)	29.48	45.47
6	Plantation	6.12	9.44
7	Tank	2.67	4.12
8	Villages(Rural)	2.03	3.13
9	Wastelands, hills with scrub	4.19	6.46
10	Wastelands, Land-without-scrub	4.68	7.22
	total	64.83	100.00

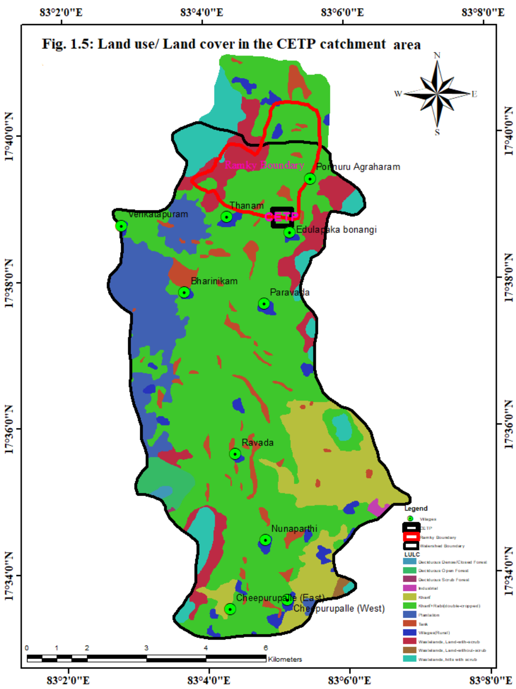

Fig. 1.5: Land use/ Land cover in the CETP catchment area

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2.0 GEOMORPHOLOGY

It is the study on origin and evolution of land forms by physical, chemical and biological process by natural agents like air, rivers, oceans, glaciation and biological activities. Hydro-geomorphology is the study of groundwater occurrence, storage and movement in these land forms and depends on their presence in various climatological conditions.

2.1 Physiography

Physical geography also known as physiography is one of the two fields of geography. Here it is described the surface topography mapped and recorded in the topo sheets is presented in fig. 2.1. The map shows the present topography in the 10km corridor of the study area. After the weathering process has taken place on the earth, the present status of the topography is shown as contour map fig. nearest hill range is Tadi konda on the west and NW side of the CETP and JNPC areas and its strike/ alignment direction is NE-SW and its maximum elevation is 346m. CETP area is in between 20m and 40m contour and is in the valley portion. Another hill (203m) range striking N-S direction is near Gorla Anakapalli on the west side of the CETP. Koppaka konda is on the north side of JNPC on the north side of railway track with max elevation of 306m. Kannuru konda with max elevation of 291m , Devikonda with strike of NE-SW direction and max elevation of 259m are on the east side. Dopper konda with max elevation of 184m with forest cover over it is on the south side of the CETP. Isolated hills near Parawada is 204m, Vennelapalem hills 170m and 158m on the south east side. Near to NTPC at Swayambhuvaram village max elevation of the hill is 130m. However within 4km to 5km radius there are number of hill ranges indicates the corridor area is highly undulating.

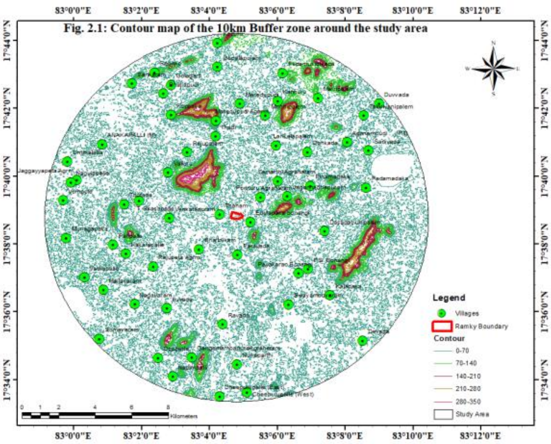

Fig. 2.1: Contour map of the 10km Buffer zone around the study area

Within the CETP watershed, Tadikonda hill on the west, Devikonda hill on the east, Dopper konda on south and Vennelapalem hills and Swayambhuvaram hill on the east and SE side as shown in fig. Drainage originating from the east and west side hills formed as main drain near Bharanikam and there onwards it is well formed stream and its local name is Kharjurapugedda till it reaches the NTPC boundary and from there it is back water area.

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2.2 Hydrogeomorphology:

Various geomorphological features have been identified and mapped from the high resolution satellite image in the 10km corridor are shown in fig. 2.2. Mainly, they are six categories of geomorphological features covering the corridor area and listed in table 2.1. Each geomorphic feature is explained with reference to groundwater occurrence and potential.

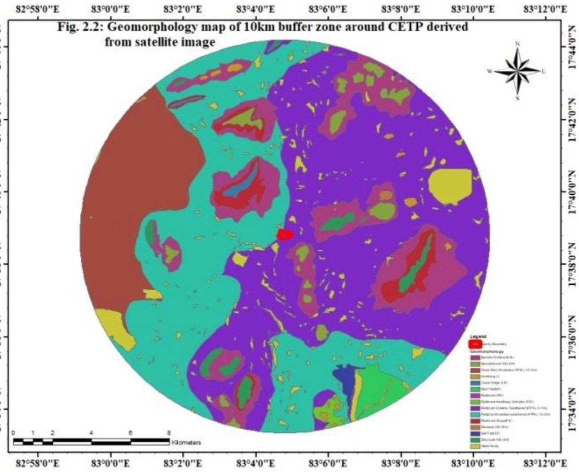

Fig. 2.2: Geomorphology map of 10km buffer zone around CETP derived from satellite image

2.2.1 Denudational origin

Landform of denudational origin is formed where the denudation process dominates over the other process. Most of the landform resulting due to this process is the combined effect of mechanical and chemical weathering. Denudation is the process of removal of material by erosion and weathering. Land forms of such origin are:

Pediment zone: The pediment and related group consists of i) Pediment, ii) Pediment Inselberg Complex (PIC), iii) Pediplain Shallow Weathered (PPS), 0-10m, iv) Pediplan Moderate weathered (PPM), 10-20m, Total pediment zone is 224.30sq.km which about 71.21% with in corridor area. Sub classes pediment and pediment inselberg complex cover about 21042 sq.km which is 67.10%, with respect to groundwater occurrence and potential it is poor potential zone due to occurrence of semi-weathered rock and hard rock at surface level or at very shallow depth. These areas are the steep slopes of the hill ranges, elevated places with or without scrub. Pediplain shallow and pediplain moderate weathered zones have water bearing zones up

Table 2.1: Geomophological Feature areas in the 10km Radius corridor

S.No	Names	Area Sq.km	%
1	Bazada Shallow(BJS)	0.23	0.07
2	Denudational Hill (DH)	3.29	1.05
3	Flood Plain Moderate (FPM), 10-20m	6.53	2.08
4	Inselberg (I)	2.03	0.65
5	Linear Ridge (LR)	22.08	7.04
6	Mud Flat(MF)	2.28	0.73
7	Pediment (PD)	198.44	63.28
8	Pediment Inselberg Complex (PIC)	11.98	3.82
9	Pediplain Shallow Weathered (PPS), 0-10m	3.76	1.20
10	Pediplan Moderate weathered (PPM), 10-20m	9.12	2.91
11	Piedmont Slope(PS)	33.91	10.81
12	Residual Hill (RH)	5.39	1.72
13	Salt Flat(SF)	3.52	1.12
14	Structural Hill (SH)	8.26	2.63
15	Water Body	2.79	0.89
		313.61	100.00

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to 10m to 20m depth and these two cover about 11.98 sq.km which is 3.82%. These zones are extended between middle slopes to near to flood plains. With respect to groundwater potential, these zones come under moderate to good water potential aquifer zones.

Piedmont slope cover about 33.91sq.km which is about 10.81% of the corridor. It is weathered and semi-weathered rock buried under soil and mostly occurs in the mid slopes to foot hill region. The zone may have poor to moderate groundwater potential.

Denudational and Structural Hills: It is a highly dissected hill which has obliterated the structures. Denudational hills occupy an area of 3.29 sq.km and is about 1.05%. Residual hill is a small remnant hill, which has witnessed all forms of denudation. These hills covered 5.39 sq.km and is about 1.72%. Groundwater potential point of view, there may be very little dependable source.

Landform of structural origin is related to structural aspect of the area. Most of the landforms under this class have genesis related to underlying structure. The structural control could be active structures whose form is directly impressed on the modern landscape or ancient structural features whose influence on a modern landscape is due primarily to differential erosion. Structural hills cover an area of 8.26 sq.km and are 2.63% of the corridor. Major fracture/ fault zones in these structural hills are potential zones of groundwater, but their areal extent may be limited few tens of meters and length may be in kilometers.

Land forms of fluvial origin:

The word fluvial is used in Earth science to refer to processes and landforms produced by running water. As with other surficial processes, running water can either erode material from the earth's landscape, or deposit layers of sediment. The resulting landforms can thus be classified as either erosional landforms or depositional landforms. The incredible power of running water in carving various erosional and depositional landforms is well known. The fluvial dissection of the landscape consists of valleys and their included channel ways organized into a system of connection known as a drainage network. Drainage networks display many types of quantitative regularity

Flood plain: The surface or strip of relatively smooth land adjacent to a river channel formed by the present river in its existing regimen and covered with water when the river overflows its banks at times of high water. It is built of alluvium carried by the stream/river during floods and deposited in the sluggish water beyond the influence of the swiftest current. Identified flood plain- Flood Plain Moderate (FPM), 10-20m along the well-developed streams in the corridor area is about 6.53sq.km which is about 2.08%. Flood plains are supposed to be good

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groundwater potential area and shallow water table is expected. Aquifer gets recharged from stream flows as well from the applied irrigation.

Land forms of Marine Origin: As the site of investigation is abutting coast, there is marine action continuously. In the 10km corridor it is extended to the coast. Within this corridor area the coastal land form- mud flat exists and is about 2.28 sq.km that come to 0.73%. Because the land form is marine origin, groundwater may be saline.

2.3 Hydrogeomorphology of the CETP Catchment: The dominant land form in the CETP catchment is pediment occupies 59.77 sq.km which is 92.15% of the catchment and the remaining area is hilly terrain that consists of inselbergs, pediplain, residual hill and structural hills shown in fig. 2.3. Areal extent of each feature is is listed in table However, the pediment zone area may have poor to moderate groundwater potential.

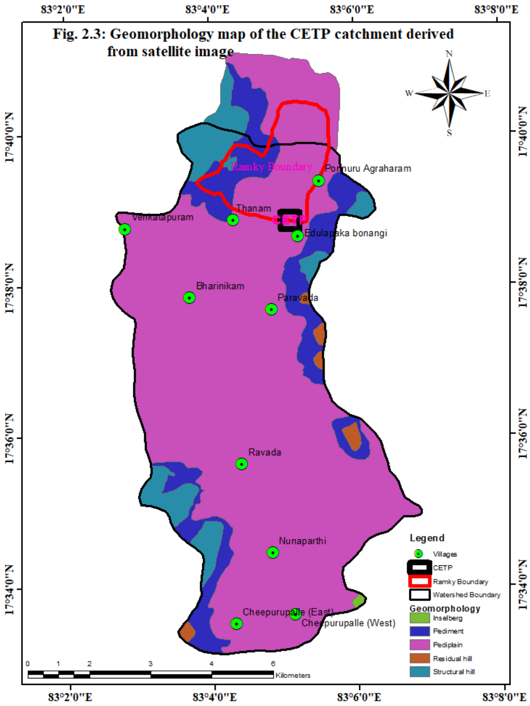

Fig. 2.3: Geomorphology map of the CETP catchment derived from satellite image

Table 2.2: Geomophological Feature areas in the CETP catchmentr

S.No	Name	Area Sq.km	Area in %
1	Inselberg	0.07	0.11
2	Pediment	59.77	92.15
3	Pediplain	0.05	0.08
4	Residual hill	2.66	4.10
5	Structural hill	2.31	3.56
		64.86	100.00

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2.4 Drainage

Drainage discussed here is the water ways formed naturally by removal of a surface's water from an area with excess of water. A drainage basin is any area of land where precipitation collects and drains off into a common outlet, such as into a stream/ river/ bay, or other body of water. The drainage basin includes all the surface water from rain runoff and nearby streams that run downslope towards the shared outlet, as well as the groundwater underneath the earth's surface. Drainage basins connect into other drainage basins at lower elevations in a hierarchical pattern, with smaller sub-drainage basins, which in turn drain into another common outlet.

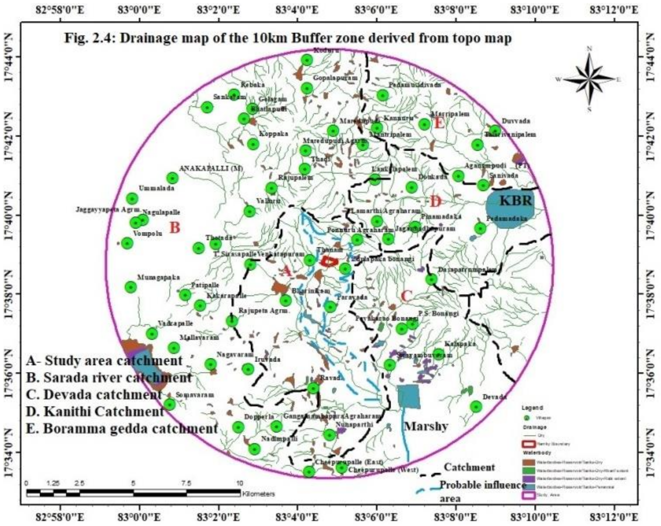

Fig. 2.4: Drainage map of the 10km Buffer zone derived from topo map

Drainage pattern and catchment areas of the 10 km corridor is shown in fig. 2.4. Broadly the corridor area is divided into 5 catchments. The watershed where CETP is located is marked as catchment- A, originating from the hills around JNPC, Parawada area and finally join with the mud flats/ marshy land at NTPC. Catchment- B comes under Sarada river basin and nearly 40% of the corridor area falls in this basin. Main stream from this catchment join with the Kondakarla lake located in the SW edge part of the corridor. Catchment- C originate from some part of Devi konda, pedda konda and hillocks around Vennelapalem. Main stream from all these hills join in the mud flats at Devada and Palavalasa where NTPC ash ponds exists. Stagnated water from this region join with the salt water creek and finally join with sea at Mutyalammapalem. Drainage for Catchment- D originates from northern parts of Devokonda and Peddakonda and southern part of Kannuru konda. The main drain is Pamu gedda that used to join Kanithi cheruvu but it is by passed the tank after converting it as Kanithi Balancing Reservoir (KBR). Borammagedda stream originates from Kannuru konda and drains along northern edge of the Steel Plant and joins into Pamu gedda down below the KBR near Peda Gantyada.

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2.4.1. Drainage description of the Study area- Catchment - A:

The catchment where CETP located is about 65 sq.km that includes JNPC at the northern boundary, some industrial units around Parawada and NTPC at the southern end of the catchment is shown in fig.2.5. Catchment shape looks like a fern leaf extending from north to south for about 12.5 km up to NTPC and about 4.5km in the east-west. JNPC is at the northern boundary and is extending about 3.2km in N-S and 2.2km to 2.8km in E-W direction. CETP is at the southern boundary of JNPC. Blue lines are the streams of 1st, 2nd and 3rd streams and blue polygons are water bodies/ tanks extracted from topo sheet. Before the industrialisation of that area there are at least 40 to 50 tanks used for irrigation. Satellite image of the some area show that some missing due to land conversion. Main drain of this catchment join became the creek at NTPC boundary due to sea water intrudes along the creek up to the ash ponds of NTPC.

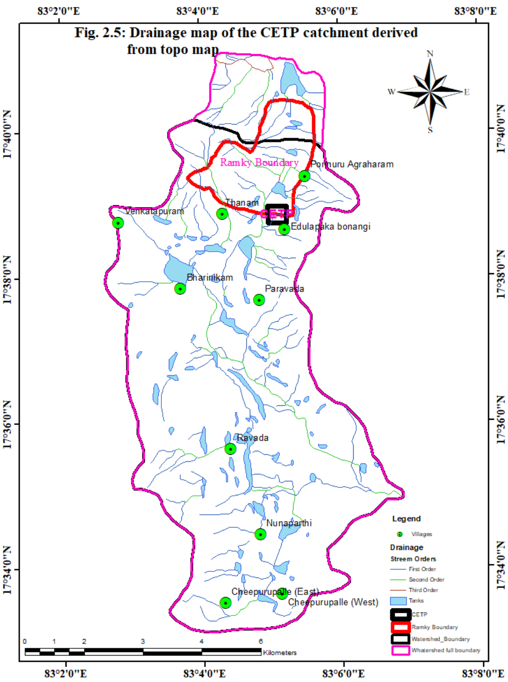

Fig. 2.5: Drainage map of the CETP catchment derived from topo map

2.4.2: Drainage around CETP: Drainage pattern 1.0km around the CETP is extracted from the topo sheet is shown in fig. 2.6. First order streams originate from some part of the Tadi konda on the west side and some part of Devikonda on the east side shown with light blue colour lines and water bodies with blue polygons. Surface topography contours 30m and 40m are present on the east and west side of CETP. Topographic contours show that the CETP is located in the centre of the localised valley through which the main stream originating from JNPC traverse across. However, a drain is constructed along the north boundary of CETP to divert surface run off from the JNPC main stream catchment as well from the hill slopes of Edullapalli Bonangi from east side. All the runoff/ storm water is diverted through the newly constructed drain towards west direction and at the end point of the CETP site, the drain is along the west boarder of CETP till it reaches a tank which is about200m distance from southern border as shown in fig.

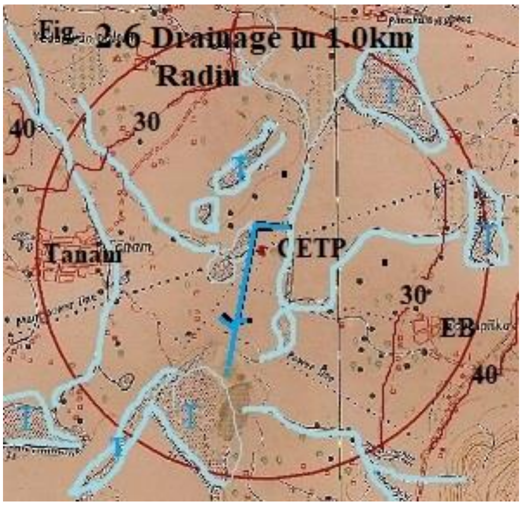

Fig. 2.6 Drainage in 1.0km Radiu

2.6. Natural drain which is abandoned within the CETP is used to transport the effluent from the other Ramky industries through a HDPE conduit to various effluent treatment units for processing. Treated effluent is stored in 9 lined ponds in CETP area for required time to release it into specified place in the sea. Another HDPE conduit run through subsurface along the drain to carry the treated water from the ponds further for about few kilometres towards sea till it reached the destination.

After establishing the various industrial units in the Ramky Pharma (JNPC), surface runoff/ storm water from various units join the lined drains made outside each industry along the roads. Runoff/ storm water may consists of rainwater mix with effluent spills from the individual units and finally join with the main natural drain that travers from north to south in JNPC which is diverted along the north and west border of CETP. Thus the storm water/ runoff from each unit in most part of the JNPC drain through the main drain that traversing through the north and west boarder of CETP and finally join a tank/ pond located at the southern tip of the JNPC.

3. HYDROMETEOROLOGY

3.1 Rainfall & Climate of District: Climatologically the district experiences tropical sub-humid type of climate with moderate summer and good seasonal rainfall. The southwest monsoon sets in the second week of June and lasts till September end. October and November receive rainfall from northeast monsoon. Winter season with cool and fine weather prevails from December to February followed by summer season upto early June. The average annual rainfall of the district is 1116 mm. and monthly rainfall ranges from nil rainfall in January to 207.5 mm in October. October is the wettest month of the year. The mean seasonal rainfall distribution is 673.5 mm. in southwest monsoon (June-September), 271.8 mm. in northeast monsoon (October-December), 10.9 mm. rainfall in Winter (Jan-Feb) and 159.6 mm in summer (March – May). The percentage distribution of rainfall, season-wise, is 60.36% in southwest monsoon, 24.36 % in northeast monsoon, 0.97 percentage in winter and 14.3 % in summer. The annual rainfall ranges from 708 mm in 2002 to 1703 mm in 2010. The annual rainfall departure ranges from -37 % in 2002 to +53% in 2010. The southwest monsoon rainfall contributes about 60 % of annual rainfall. It ranges from 459 mm in 2002 to 864 mm in 2006. The year 2002 and 2009 experienced drought conditions in the district as the annual rainfall recorded in these two years is 37 % and 34% less than the long period average (LPA) respectively. The cumulative departure of annual rainfall from LPA indicates that the rainfall departure as on 2011 is negative i.e. 40%, showing deficit rainfall. The annual rainfall during 2012 is 1218 mm.

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3.2 Rainfall in the Parawada Mandal

The district has the benefit of receiving rainfall during both the South-West and North-East Monsoon periods. While the Normal Rainfall of the district for the South-West Monsoon period is 673.5 mm. and for the North-East Monsoon period is 271.8 mm. The Rainfall received during the Winter Period and Hot Weather Period is negligible, their respective normal being 10.9 mm. and 159.6 mm. The Annual Normal Rainfall of the district is 1116 mm. The nearest rain gauge to the study area is Parawada and rainfall data of neighbouring mandala is presented in table 3.1.

Table 3.1 Rainfall data for Parawada and surrounding Mandals that cover the study area

S.No	Mandal	Geographical coordinates		Normal rainfall(mm)
		Latitude	longitude	
1	Parawada	N17^{0}37’35”	E83^{0}04’55”	1130.5
2	Pedagantyada	N17^{0}39’46”	E83^{0}12’29”	1086.3
3	Munagapaka	N17^{0}38’05”	E82^{0}59’47”	1183.0
4	Anakapalli	N17^{0}40’48”	E82^{0}01’04”	1105.7
5	Avrage			1126.4

Source: Statistical Hand book of Visakhapatnam District

The above data showing that the average annual rainfall of the study area is 1126.4mm is near to the district average annual rainfall of 1116mm.

3.3 WATER QUALITY OF THE STUDY AREA

The water resources, both surface and groundwater play an important role in the development of the area. Likewise, the water resources of the area have been studied to establish the current status of water quality in the area. The parameters of prime importance were selected under physical, chemical inorganic, chemical organic groups. Groundwater samples are collected from 6 open wells, one bore well and surface water source from the downstream pond of CETP are collected. The water samples were collected in pre-treated sampling cans and transported to laboratory for analysis. Samples are collected during post monsoon of 2020 in the November month and pre monsoon of 2021 during the last week of March 2021. Due care was taken during sampling &transportation of these samples. Locations of the water samples are shown in fig. 3.1.

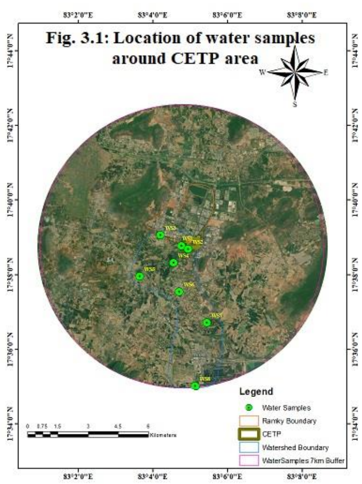

Fig. 3.1: Location of water samples around CETP area

Sampling locations were selected on basis of:

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a) Drainage pattern and catchment

b) Location of residential, irrigation and industrial areas representing different activities

c) Likely areas those can represent baseline conditions

Ground water samples were collected from 7 locations and surface water samples were collected from one location. The locations of the water samples collected in the study area are furnished in the table 3.2.

Table: 3.2 Water Sampling Stations

Code	Station	Latitude	Longitude	Source of collection
WS1	CETP	83.04’47.67	17.38’46’’.48	Ground water Bore well
WS2	CETP	83.04’58’’.26	17.38’40’’.82	Ground water Open well
WS3	Thanam	83.04’14’’.02	17.39’3’’.90	Ground water Open well
WS4	Bharanikam	83.03’40’’.47	17.37’57’’.04	Ground water Open well
WS5	Parawada	83.04’43’’.56	17.37’32’’.28	Ground water Open well
WS6	Vennelapalem	83.05’28’’.16	17.36’43’’.00	Ground water Borewell
WS7	NTPC	83.05’09’’.36	17.35’00’’.69	Ground water Open well
WS8	Thanam	83.04’34’’.79	17.38’19’’.04	Surface water Tank

The collected samples were analyzed in accordance with “Standard Methods for Examination of Water and Wastewater Analysis” published by APHA. Analysis results are listed in table 3.3

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Table: 3.3 Ground water quality results of post monsoon- 2020 and pre-monsoon of 2021

Table 3.3 contd…

Sampling Site	pH		Conductivity (μ mhos)		TDS mg/l		HCO_3		Cl mg/l	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
WS1	8.30	8.5	1951	1340	1101	884	353	250	371	55.3
WS2	8.40	8.5	2142	1360	1359	898	231	110	85	110
WS3	7.90	8.6	2340	1450	1544	957	73	50	96	147
WS4	7.90	8.0	1690	2280	1115	1504	268	60	443	60
WS5	8.10	7.5	1770	1820	1168	1201	73.2	150	31.9	100
WS6	8.20	8.0	1864	1780	1208	1175	140	70	130	154
WS7	8.00	8.1	1890	1640	1247	1082	250	1.4	220	43.4
WS8	8.10	8.4	1856	2340	1308	1544	345	50	167	30

WS1 (Bore well) and WS2 (Open well) are in the CETP site

Sampling Site	NO_3 mg/l		Na mg/l		K mg/l		Ca mg/l		Mg mg/l		TH mg/l	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
WS1	0.074	0.01	139	138	51.7	0.8	38.40	48	102.65	127.9	384	644
WS2	0.078	-	63.94	74.0	1.17	1.2	41.60	89.6	103.46	66.4	326	496
WS3	0.080	-	736	31	1.95	3.2	44.80	30.4	104.43	59.5	292	320
WS4	0.051	-	287.5	6.9	5.46	0.39	54.40	118.4	70.31	77.1	288	612
WS5	0.070	0.06	12.19	73.3	2.73	1.56	33.60	57.6	109.31	171.8	276	848
WS6	0.062	0.02	87	87	63	35	34.20	48	95.60	104.4	292	548
WS7	0.060	-	158	135	20	1.2	32.00	38.4	200.08	52.7	492	312
WS8	0.068	0.02	80	14	20	0.78	34.20	75.2	110.62	154.2	248	820

3.3.1 Ground Water Quality of the Study Area

The above listed parameters aerial distribution thematic maps for selected parameters for post and pre monsoon are shown in fig. 3.2.

- The pH limit fixed for drinking water samples as per IS:10500 is 6.5 to 8.5. During the study period, the pH of the groundwater was found varying between 7.9 and 8.4 during post monsoon and the same variable between 7.5 and 8.6. The pH values for all the samples collected in the study area during study period were found to be within the acceptable limits.
- The desirable limit for total dissolved solids as per IS:10500 is 500 milligrams per litre (mg/l) whereas the permissible limits in absence of alternate source is 2000mg/l. In groundwater samples collected from the study area, the total dissolved solids (TDS) were found to be varying between 1101 mg/l and 1544 mg/l during post monsoon and varies between 884 mg/l and 1504 mg/l indicates

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TDS values are beyond desirable limits. The TDS of all the samples were below the permissible limit of 2000 mg/l.

- The desirable limit for Chloride is 250 mg/l as per IS: 10500 whereas the permissible limit of the same is 1,000mg/l. The Chloride levels in the groundwater samples collected in the study area were ranging from 85-443 mg/l during post monsoon and during pre-monsoon it is between 30mg/l and 147mg/l. Five samples are within the desirable limits and 3 samples are within the permissible limits during post monsoon and all the samples are within desirable limits during pre-monsoon. All the samples are within permissible limits.
- The desirable limit as per IS:10500 for hardness is 300 mg/l, where as the

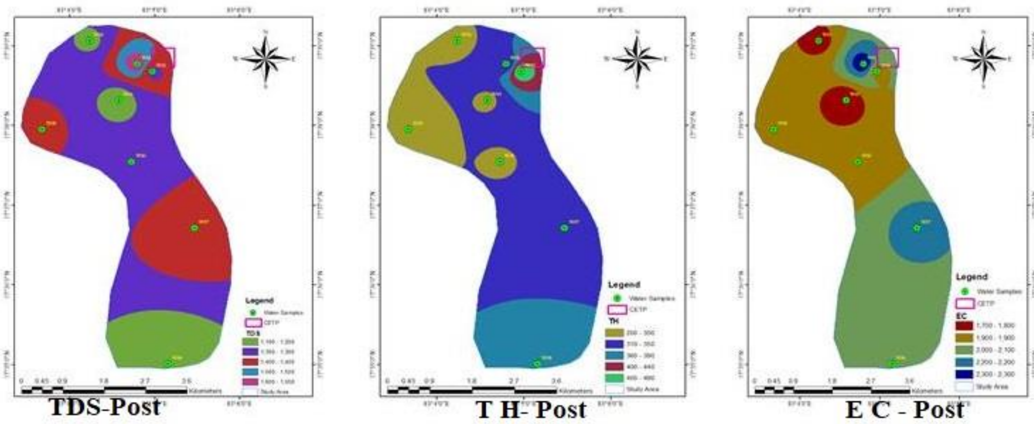
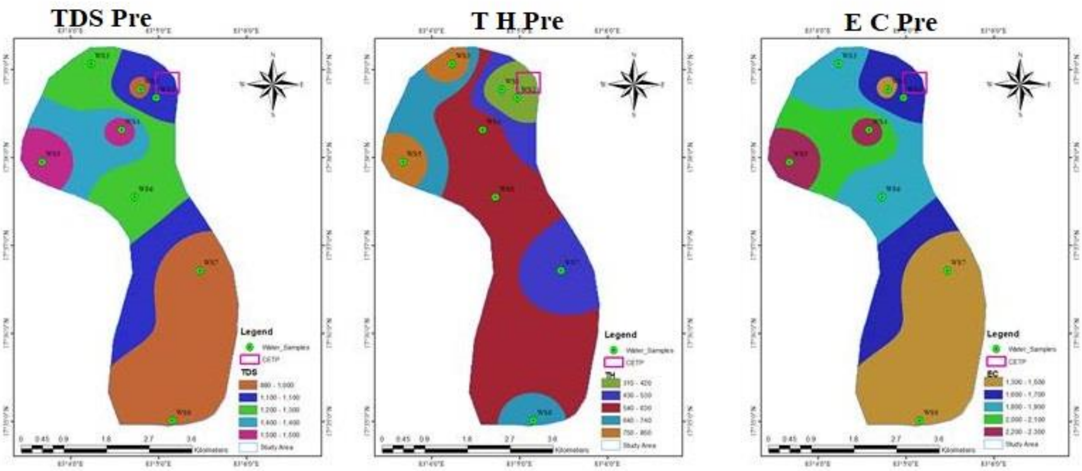


Fig. 3.2: Aerial distribution of some chemical parameters in CETP Catchment Area



permissible limit for the same is 600 mg/l. In the groundwater samples collected from the study area, the hardness was found to be varying from 248 mg/l to 492 mg/l in which 5 samples are within desirable limits during post monsoon and 3 samples are within the permissible limits. During pre-monsoon samples value range between 312mg/l to 848mg/l indicates all are above desirable limits but within the permissible limits.

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- Nitrates (NO_3) in both the seasons is less than 0.08mg/l indicates that the parameter is within the permissible limits.

An overview of the results obtained reveals that none of parameters were found beyond the permissible limits of IS: 10500 Drinking Water Standards during post monsoon of 2020 and pre-monsoon of 2021.

4. HYDROLOGY AND SURFACE WATER UTILIZATION

4.1 Irrigation Sources in the District: Visakhapatnam district is covered with 2 major basins Sarada, Varaha and Mehadrigedda, completely within the district and Gosthani and Thandava basins covered partially. All the above said rivers originate from the eastern part of the eastern ghats in Visakhapatnam Dt. Reservoirs are constructed across the above said rivers in the foot hill regions and water being used for irrigation and water supply to Visakhapatnam town from Thatipudi, Raiwada and Mehadrigedda reservoirs. Besides the above said reservoirs there are hundreds of irrigation tanks, canals from river diversions, tube wells and open wells and small lift irrigation sources. The area irrigated under various modes of source is given below:

Canals	:	53657 Hec.
Tanks	:	32587 Hec.
Tube wells	:	27,667 Hec.
Dug wells	:	11,921 Hec.
Lift	:	89 Hec.
Other sources	:	24,655 Hec.
Gross Irrigated area:		1,51,251 Hec.

Data source: Statistical hand book of Visakhapatnam Dt.

4.2 Water Sources from Outside the District: Surface water source from the reservoirs Thatipudi, Raiwada and Mehadrigedda that exists within the district not only irrigating thousands of acres in their ayacut but also became prime drinking water supply sources to Visakhapatnam city. Total water required for the Visakhapatnam Steel Plant is about 70 MGD being supplied from the Yeleru reservoir is around 150km distance through a open canal located in East Godavari. During summer when there is in sufficient reserves in the reservoir, required quantity of water being augmented from Godavari river bed which is about 50km further upstream from Yeleru canal through infiltration wells. This is the major source drawn from inter district. JNPC also drawing about 10 MLD from Yeleru canal.

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4.3 Surface water Utilisation in Parawada mandal: Irrigation in Parawada mandal is through surface water bodies like tanks and ponds and groundwater source from tube wells and open wells. Area irrigated under various sources is listed below.

Canals	:	Nil
Tanks	:	171 Hec.
Tube wells	:	183 Hec.
Dug wells	:	39 Hec.
Lift	:	Nil
Other sources	:	Nil
Gross Irrigated area:		608 Hec.

Data source: Statistical hand book of Visakhapatnam Dt. (2016)

The above data shows that irrigation in the mandal being carried through tanks, tube wells and open wells. Water bodies present in the JNPC/ CETP catchment area is shown in fig. 4.1.Blue polygons are the tanks mostly concentrated in the central part of the watershed along the main stream course. There are more than 60 water bodies shown in the topo sheet, but at present these may be reduced to less than 20 due to industrialization/ urbanization as well the agricultural land also converted as settlement area. However, irrigation area is limited to change of land use and at present the gross irrigated area is only 608 Hec. Even though some water bodies are not disturbed, the ayacut area under these converted as urban land. These surface water bodies may be getting polluted by the liquid/ solid waste being generated in the urbanized lands. However, stored water in these water bodies may be useful for groundwater recharge.

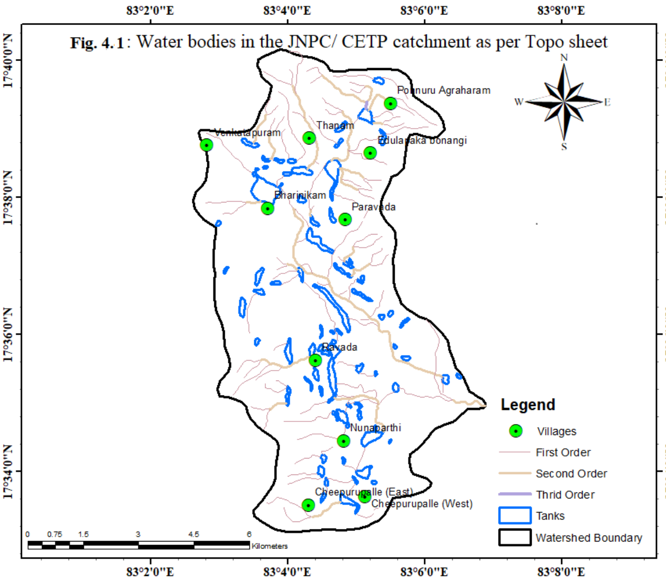

Fig. 4.1: Water bodies in the JNPC/ CETP catchment as per Topo sheet

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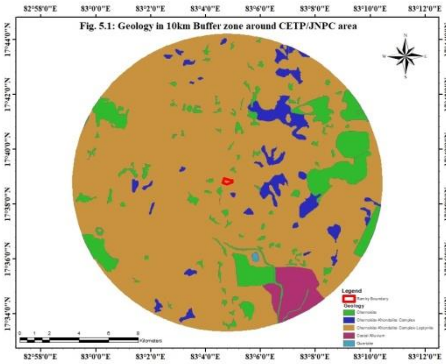
5. GEOLOGY

5.1 Geology in the 10km Radius:



It is very essential to know the geology of the region where hydrogeological investigations being carried because groundwater occurrence, distribution and movement depend on the type of rock and its weathering nature. Secondary data on geology is acquired from GSI published maps. Besides the secondary data, primary data is also collected during our field visits for land use hydrogeomorphology and water table observations. A buffer zone map of 10km radius around the JNPC/ CETP area is presented in fig. 5.1. The area consists of Crystalline Basements complexes of Archaean age as well coastal environment. Crystalline rocks consists of khondalite, charnockite, quartzite and leptynite rocks is shown in fig. . Geomorphology of the area is buried pediment, inslebergs complex with isolated hills and hill ranges of khondalite rock with NE to SW and E to W strike direction with dip variable between 60^0 to 80^0 due south. Nearly 80% of the area consists of khondalite- charnockite-leptinite rock complex is shown in dark brown colour. In this rock complex zone top layer of the rock formations consists of khondalite and charnockite/ leptinite may present as intrusive rocks at shallow or deeper depth. As per the field observations, this rock is present in the north and NW part between 5km and 10km radius. Hill ranges present around Rabaka village are charnockite hills where black stone road metal being quarried. At Lankelapalem junction the hill range belong to khondalite rock between 290m and 40m altitude and below the 40m black rock (charnockite) being quarried below 20m altitude. Leptinite rock is present as inselberg complex (rock outcrops at ground level) between lankelapalem and Aganampudi.

Charnockite rock area is shown in green colour where the entire rock formation from top surface to deeper the same rock exists. Blue colour area is khondalite-charnockite complex area where top layers of geological formation consists of khondalite followed by charnockite rock as intrusion body at shallow or deeper depth. At Edullapalli Bonangi small hill mounds cross section shows that top 10m to 12m consists of khondalite rock followed by charnockite rock where black metal being quarried. Quartzite rock appears as intrusive veins in khondalite rock. These are observed in some parts of Thadikonda and Devi konda.

Coastal alluvium is shown in purple colour and is to the SE of the study area between 8km and 10km distance.

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5.2 Geology in the JNPC/CETP Catchment: The study area surrounded by Thanam hill village on the west, bodi konda on the south, parawada hill and devikonda on the east side. Geology map of the CETP catchment is shown in fig.5.2, Nearly 95% of the catchment area covered by khondalite rock. Small patches of hypersthene granite and magnetite quartzite are observed along the eastern part of the catchment.

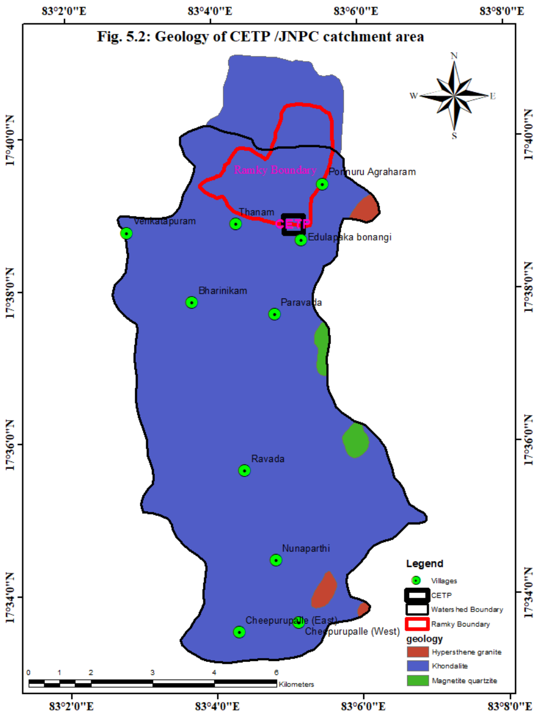


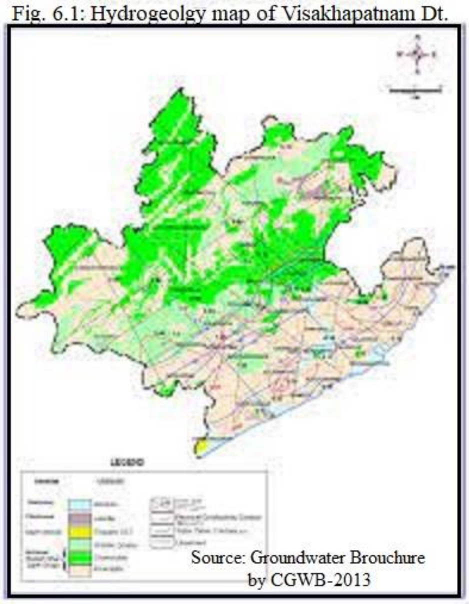
Fig. 5.2: Geology of CETP /JNPC catchment area

With respect to groundwater occurrence, khondalite rock will have good potential due to its high weathering and fracturing nature to deeper depth of rock mantle. Charnockite and leptinite rocks are hard and prone to low weathering and groundwater potential may be limited. Coastal alluvium consists of mud flats, salt pans and beach sands. Groundwater in this zone mostly saline and freshwater in the coastal sands may be very shallow and thin layer.

6 HYDRO-GEOLOGICAL ASPECTS

6.1 Hydrogeology at District level: The district is underlain by variety of geological formations from the oldest Archaeans to Recent Alluvium. The Archaean group of rocks includes Khondalites and Charnockites of Eastern Ghat super group and Granitic gneisses of Migmatite group. The Gondwana rocks which are represented by sandstones are in very limited aerial extent. The recent alluvium is prevalent along the rivers. Prominent lineaments are trending in NE-SW, NW-SE and ENE-WSW (Fig.6.1). Groundwater occurs in almost all geological formations. From the ground water point of view, the aquifers in the district can be broadly classified into hard formations (khondalites, charnockites, quartzites, granitic gneisses etc.) and soft formations (sand stones and alluvium). Ground water occurs under unconfined to semi-confined conditions in the hard formations, while it occurs under unconfined to confined conditions in soft formations. The yields in the weathered zones of hard formations range from

Fig. 6.1: Hydrogeolgy map of Visakhapatnam Dt.



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25 to 100 m^3/day. The bore wells drilled in the hard formations, generally tap the fractured and fissured zones. The yields of the bore wells in these formations range between 5 to 25 m^3/hr. Sand stones are exposed in the small isolated places around Nakkavanipalem and Elamanchili. In these formations, ground water occurs under both unconfined and confined conditions. The depth of dug wells in alluvium formations ranges from 2 to 10 mbgl and the yields generally ranges from 40 to 250 m^3/day. The depth of filter points/tubewells varies from 9 to 35 m with discharges ranging from 15 to 30 m^3/hour. The transmissivity values of the aquifers in the consolidated formations generally vary from 1 to 772 m^2/day, whereas specific capacity ranges from 1 to 290 lpm/mdd.

6.2 Water Level Fluctuation

Based on the water level data (year 2017) of ground water monitoring wells, pre monsoon depth to water levels map is prepared and presented in Fig.no.6.2. The depth to water level maps show varied water level zones due to underlying terrain and also different geological set up with complex type of hydrogeomorphical structures present in the district. Premonsoon (May, 2017) depth to water level map reveals, in general, the water levels are deep particularly in the hilly area of the district. Depth to water levels varies from 5 to 10 mbgl, except at Chintapalli, where water level recorded 15.78 mbgl. In the southern part of the district i.e., near to the coast, the water levels are comparatively shallow- 2m to 5m along the coast and adjacent to the river courses.

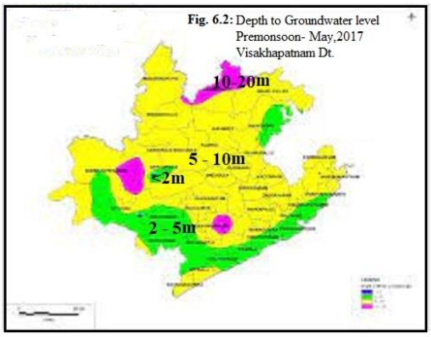

Fig. 6.2: Depth to Groundwater level Premonsoon- May,2017 Visakhapatnam Dt.

During the post monsoon period (November, 2017), in general, the water levels follow nearly same trend as shown fig. 6.3. Water levels in the most part of northern area show less than 5 m. except at Potinamallaya Palem (5.80 m). The Shallow water levels, <2m were observed in South-Western part of the district. The shallow water level was recorded at Addaroddu (0.30 m). The shallow water levels in the area might be due to location of wells close to surface water bodies/ in topographic low levels. From the trend of both pre and post monsoon levels it can be safely concluded that the area, in general, is not prone to water logging. The seasonal water level fluctuation varies from 0.03 m. (G.K.veedhi) to 14.22m. (Chintapallii). In general, the seasonal fluctuation is more in the hilly area compared to coastal plains.

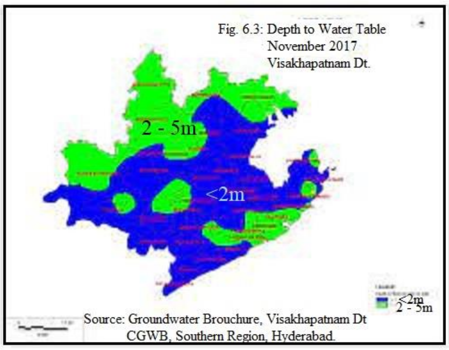

Fig. 6.3: Depth to Water Table November 2017 Visakhapatnam Dt.

Source: Groundwater Brouchure, Visakhapatnam Dt CGWB, Southern Region, Hyderabad.

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6.3 Ground Water Resources:

As per the present ground water resource estimation (2008-2009) the total annual ground water recharge in the district is estimated to be 78,383 ha.m. (Command area = 11,794 ham and Non Command area = 66,689 ham) and the net annual ground water availability in the district after allowing the unavoidable natural discharges is 71689 ham (command area 10683 ham. and in Non command area 61,006 ham.). The gross ground water draft for all purposes is estimated as 23,100 ham out of which 6300 ham is in command area and 16,800 ham is in Non Command area. Thus the ground water available for future irrigation needs after allocating the ground water for future domestic and industrial needs is 38,264 ham in the entire district, which is 3,282 ham in command area and 34,982 ham in non command areas of the district. Groundwater potential in the surrounding mandals of the study area is given in Table- 6.1

Table 6.1: Mandal Wise Ground Water Resources in 10km Radius around study area (As on March 2009)

1	Administrative unit/ District	Sub unit	Net annual ground water availability (ham)	Existing gross ground water draft for all uses(ham)	Ground water balance (ham)	Stage of ground water development %	Category
1	Parawada	Command	0	0	0	0	
		Non Com	1459	486	973	33	Safe
		Total	1459	486	973	33	Safe
2	Munagapaka	Command	225	132	93	59	Safe
		Non Com	665	302	363	45	Safe
		Total	890	434	456	49	Safe
3	Pedagantyada	Command	0	0	0	0	
		Non Com	1212	81	1131	7	Safe
		Total	1212	81	1131	7	Safe
4	Anakapalli	Command	746	444	302	60	Safe
		Non Com	1076	495	581	46	Safe
		Total	1822	939	883	52	safe

Ground water utilization in the district is 32% of the total groundwater potential for all the purposes. Average groundwater utilization in 10km radius of the study area is around 35% in which Anakapalli and Munagapaka mandals utilization is about 50% due to heavy irrigation. However, district and mandals groundwater utilization is in safe zone and lot of groundwater potential available for future exploration.

6.4 Hydrogeological Condition in the JNPC/ CETP Catchment

Entire catchment of JNPC/CETP catchment comes under khondalite terrain. Nearly 20% of the catchment area consists of settlements and real estates and equal area under hills and forest. Still there is little area being used for agricultural activity. Earlier irrigation was carried through tank storage water and groundwater from open wells. In the recent years groundwater being

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used through tube wells for irrigation as well for industrial and domestic needs in the residential area. However, JNPC drawing about 10 MLD from Yeleru canal for industrial needs. Groundwater also being explored by the individual industrial units for their domestic and industrial needs.

6.5 Water Level Fluctuation around JNPC/CETP area

Water table measurements have been carried in the observation wells established in and around the catchment area during the post monsoon of 2020 (November, 2020) and pre monsoon season of 2021 (April, 2021). Nineteen open wells are selected for water level observations and the data is presented in table 6.2.

Table 6.2: Post and Pre monsoon Groundwater levels in and around JNPC/CETP Catchment

Well No.	Village	Type of well	Latitude	Longitude	Total Depth (m)	Water Level -Post (m)	Water Level -Pre (m)	WL diff. post& pre(m)
WL1	Kothapalem	OW	83^{0}04’42.8”	17040’18.9”	11.82	5.42	11.2	5.78
WL2	Thadi Colony	OW	83^{0}04’44.9”	17^{0}40 ’20.8”	11.48	8.95	11.02	2.07
WL3	ChinnaThadi	OW	83^{0}04’49.6”	17^{0}40’35.6”	10.64	3.5	8.60	5.10
WL4	ChinnaThadi	OW	83^{0}04’49.5”	17^{0}40’35.4”	9.00	6.8	8.70	1.90
WL5	ChinnaThadi	OW	83^{0}04’49.4”	17^{0}40’35.5”	7.25	5.85	6.21	0.36
WL6	PeddaThadi	OW	83^{0}04’29.8”	17^{0}40’39.8”	8.00	2.20	7.90	5.70
WL7	Thanam	OW	83^{0}04’14.1”	17^{0}39’03.25”	10.60	2.50	8.50	6.00
WL8	Thanam	OW	83^{0}04’18.9”	17^{0}38’44.9”	6.50	1.10	3.25	2.15
WL9	Thanam	OW	83^{0}04’17.4”	17^{0}38’37.4”	6.50	1.00	6.40	5.40
WL10	Paravada	OW	83^{0}04’34.1”	17^{0}37’58.1”	6.30	2.10	5.00	2.90
WL11	Bharnikam	OW	83^{0}03’40.9”	17^{0}37’57.1”	5.40	2.50	4.40	2.90
WL12	Venkantapuram	OW	83^{0}03’28.0”	17^{0}38’56.4”	6.40	3.25	5.40	2.15
WL13	Venkantapuram	OW	83^{0}02’41.36”	17^{0}38’41.55”	7.90	6.00	7.80	1.80
WL14	Sirasapalli	OW	83^{0}02’02.38	17^{0}39’08.36”	14.0	11.65	13.60	1.95
WL15	GorlaAnakapalli	OW	83^{0}01’25.67	17^{0}39’26.51”	7.75	2.85	4.00	1.25
WL16	Rajupet	OW	83^{0}02’16.86	17^{0}37’22.0”	13.45	8.90	10.90	2.00
WL17	Ramarayadupeta	OW	83^{0}02’40.86	17^{0}39’23.77”	10.00	7.75	9.90	2.15
WL18	Valluru	OW	83^{0}02’32.02	17^{0}40’06.00”	8.70	4.30	8.50	4.20
WL19	CETP	OW	83^{0}04’ 58.6”	17^{0}38 40.86”	7.62	3.30	5.45	2.15

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Even though there are bore wells in the study area, it was not possible to take measurements in them. Most of the open wells were irrigation wells and because of change of land use most of them are idle. Some of them are in the low lying areas and some are in the foot hill region. During post monsoon season depth to water table varies between 1.0m at Tanam almost in the centre of the valley and 11.65m at Sirasapalli over the hill flank.

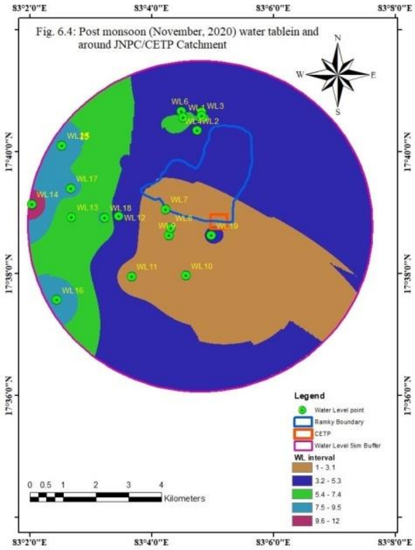

Fig. 6.4: Post monsoon (November, 2020) water tablein and around JNPC/CETP Catchment

Based on the water level data (year 2020) of ground water monitoring wells, post monsoon depth to water levels map is prepared and presented in Fig.6.4. Area covered is about 2km radius from CETP. Brownish colour patch is the area where water table is between 1.0m and 3.1m that include CETP and Tanam villages and also follow the valley portion. Water table in the blue colour varies between 3.2m and 5.3m that cover entire JNPC area, Bharanikam and the area along the main stream course. More than 5m depth of water table is observed on the west side of the study area covering the villages Tadi, Sirasapalli, Rajupeta and Venkatapuram. Water table in the pre monsoon varies between minimum depth of 3.25m and maximum depth of 13.60m is at the same locations of minimum and maximum recorded during post monsoon.

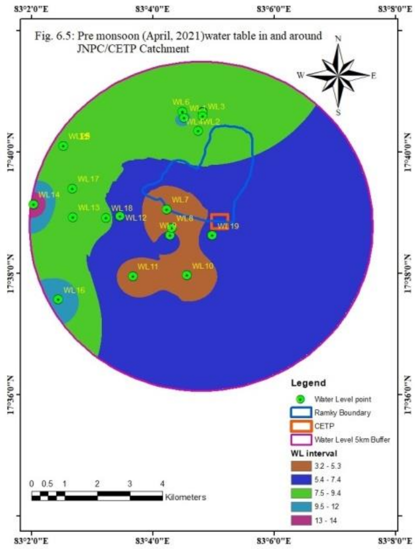

Fig. 6.5: Pre monsoon (April, 2021)water table in and around JNPC/CETP Catchment

Pre monsoon period (April, 2021) water table variations are shown in fig. 6.5. depth to water table varies between 3.2m and 5.3m is recoded at the villages Tanam, Bharanikam and in the valley portion at Parawada. Blue colour represent the water table region between 5.4m and 7.5m depth that cover the south and east portion up to 2km radius of CETP. Northern part of JNPC and west side of the study area has water table more than 7.5m depth. At Sirasapalli village depth to water table is beyond 13.60m depth. Water level maps show varied water level zones due to underlying terrain and also different geological set up with complex type of hydrogeomorphical structures present. In general, the water levels are deep particularly in the hilly area of the region.

The shallow water levels near Tanam, Bharanikam and the wells adjacent to main stream course in the area might be due to location of wells close to surface water bodies/ in topographic low levels. As per the trend of the pre and post monsoon water levels it can be safely concluded that the area, in general, is not prone to water logging. The seasonal water level fluctuation

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varies from 0.36 m. (China Thadi) to 6.00m. (Tanam). In general, the seasonal fluctuation is more in the hilly area compared to valley areas and coastal plains.

7. SUBSURFACE INVESTIGATION FOR LITHOLOGY AND AQUIFERS DELINEATION

In order to determine the subsurface lithology and identify the aquifer zones, surface geophysical method Vertical Electrical Soundings have been conducted. Detailed investigation is explained below.

7.1 Subsurface lithological profile in CETP Area: In the earlier chapters, land use, geology, geomorphology, climate and rainfall conditions, hydrogeological aspects- groundwater potential, water table fluctuations are dealt. This chapter mainly concentrated only in the CETP area to know the subsurface layers include aquifer zones. Geophysical surficial exploration method- Electrical resistivity soundings have been conducted at number of places and sub layers have been demarcated. In this method physical property of soil/ rock is measured that include resistivity of the material, fluid filled in the pore spaces of the material and quality of fluid. Because the industry is mainly dealing with treatment of liquid effluent discharged from all the industrial units in JNPC.

7. 2 Resistivity Method for delineation of subsurface layers: Vertical Electrical soundings (VES) have been conducted in the CETP area only covering the entire Plant, leaving the ponds, processing units and roads wherever concretisation is carried. VES are carried as per the IS code 3043:1987 electrode configuration to the subsurface layers up to 70m to 80m depth. VES locations are noted with GPS and are transferred on to the google image of CETP shown in fig. 7.1. It was possible to collect conduct the VES mainly in the open areas, greenbelt and along the margins of the roads where the soil is exposed. Broadly, different land use in CETP measured from google image are as follows:

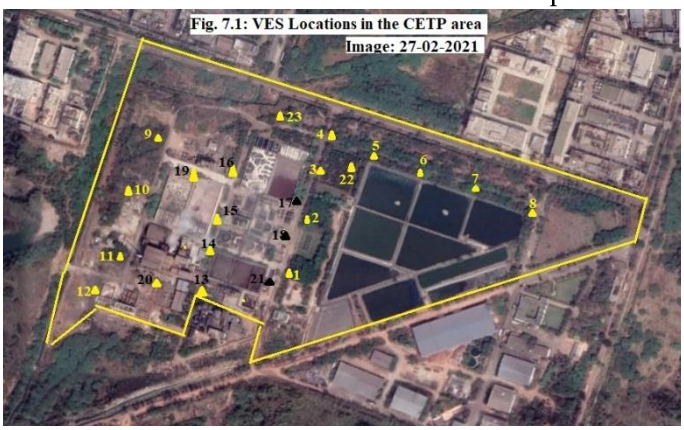
Fig. 7.1: VES Locations in the CETP area
Image: 27-02-2021

Total CETP area: 16.6024 Hec.

Ponds area: 3.724 Hec.

Processing Units: 4.166 Hec.

Green belt& open: 5.9094Hec.

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Roads& others: 2.803 Hec.

VES are conducted at 23 locations. Each sounding is interpreted and layer thicknesses are arrived and designated synthesizing the geological hydrogeological field observations. Some of the field photos in the site of investigation is shown as mosaic in fig. 7.2. Resistivity

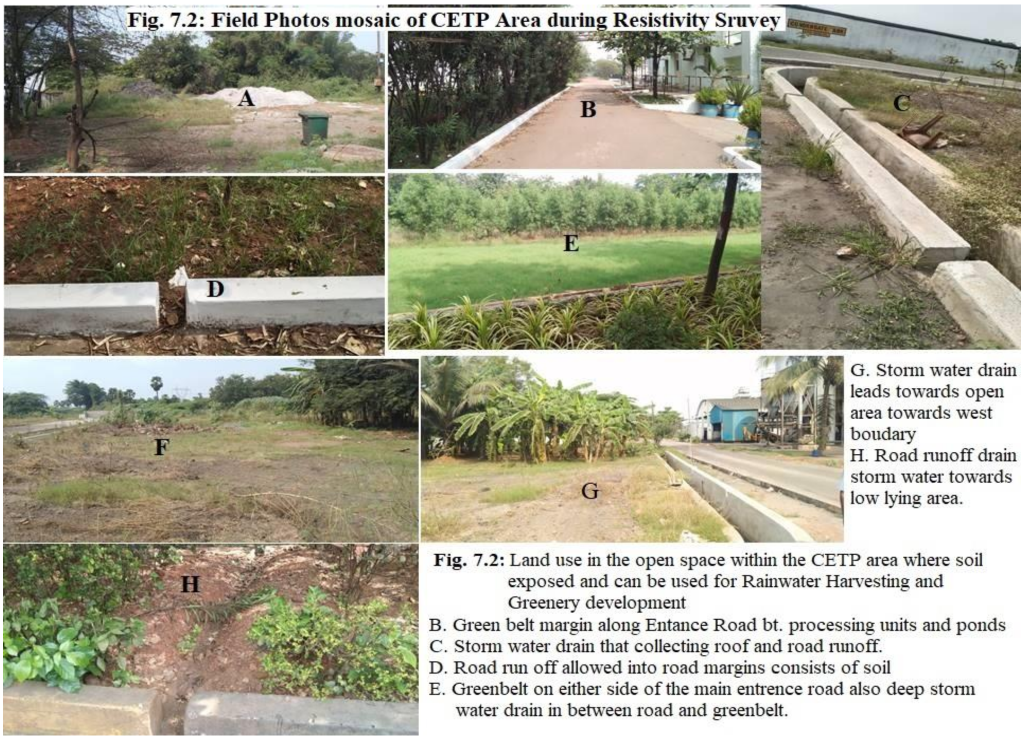

Fig. 7.2: Land use in the open space within the CETP area where soil exposed and can be used for Rainwater Harvesting and Greenery development
B. Green belt margin along Entance Road bt. processing units and ponds
C. Storm water drain that collecting roof and road runoff.
D. Road run off allowed into road margins consists of soil
E. Greenbelt on either side of the main entrence road also deep storm water drain in between road and greenbelt.

soundings not only help in identifying the subsurface layers, but also indicate quality of groundwater that saturated the aquifer zones. Vertical cross sections are prepared grouping the soundings as traverses. Four vertical cross sections shown in traverses A.. to D in figs, 7.3a to 7.3c.

7.2.1 Vertical cross section along Traverses A&B: Six soundings have been conducted along traverse- A and the vertical cross section (Fig. 7.3a)shows that the top soil thickness varies between 3m and 5m followed by weathered rock which is the shallow unconfined aquifer zone extend up to 12m to 20m depth. Fractured rock zone which is the deep aquifer zone may be under semi confined condition noticed between 12m to 20m and 30m to 40 m depth. Beyond 40m depth hard rock is noticed.

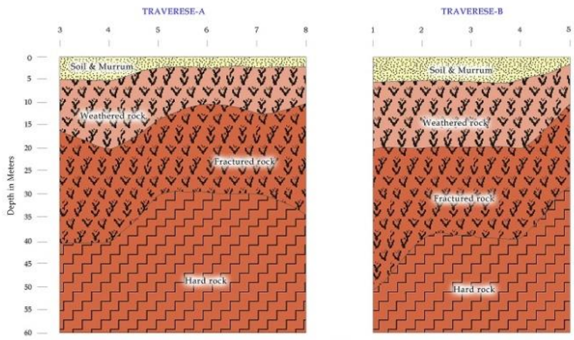

Fig. 7.3a: Vertical Lithological cross sections along Traverses- A and B

Vertical cross section of traverse- B: Five VES soundings have been conducted along this traverse. Vertical cross section (fig. 7.3a) shows that the top soil thickness varies between 2m

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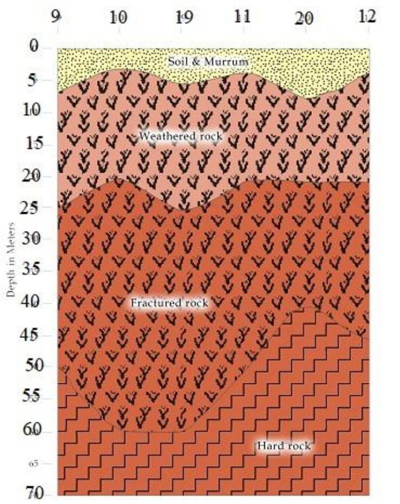
and 5m followed by weathered rock which is the shallow unconfined aquifer zone extend up to 15m to 20m depth. Fractured rock zone which is the deep aquifer zone may be under semi confined condition noticed between 15m to 20m and 30m to 50 m depth. Deep fracturing up to 50m depth is noticed at VES-1. Beyond 30m/50m depth hard rock is noticed.

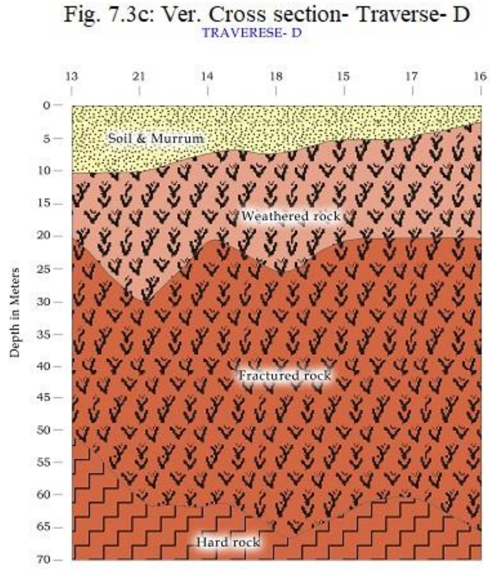
7.2.2 Vertical cross section along Traverses C: Six VES have been conducted along this traverse. Vertical cross section of traverse- C (fig. 7.3b) shows that the top soil thickness varies between 3m and 6m followed by weathered rock which is the shallow unconfined aquifer zone extend up to 20m to 25m depth. Fractured rock zone which is the deep aquifer zone may be under semi confined condition noticed between 20m to 25m and 45m to 60 m depth. Deep fracturing up to 60m depth is noticed between VES-9 and 19. Beyond 45m/60m depth hard rock is noticed.

Fig. 7.3b: Vertical cross section along Traverse-C



7.2.3 Vertical cross section of traverse- D: Seven VES have been conducted along this traverse. Vertical cross section of traverse- D (fig. 7.3c) shows that the top soil thickness varies between 2m and 10m followed by weathered rock which is the shallow unconfined aquifer zone extend up to 20m to 30m depth. Fractured rock zone which is the deep aquifer zone may be under semi confined condition noticed between 20m to 30m and 50m to 65 m depth. Deep fracturing up to 65m depth is noticed between VES-14 and 16. Beyond 50m/65m depth hard rock is noticed. In general depth to hard rock is deeper as we approach from east side to west side. Similarly thickness of fractured rock zone increase towards west boarder. Resistivity sounding data revealed the subsurface layers as i) top layer- brownish clayey loam- the layer thickness varies between 2m to maximum of 10m and is thin in the east side increases towards west side of the site. ii) second layer- weathered rock- yellow/ brownish disintegrated khondalite rock. Thickness this layer varies between 10m and 25m and is thin in the east side and increase towards west border. iii) third layer- fractured rock- Thickness of fractured khondalite rock varies between 25m and 40m.

Fig. 7.3c: Ver. Cross section- Traverse- D



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Soil layer and weathered rock can be considered as unconfined aquifer and fractured zone can be considered as semi-confined aquifer.

8. IMPACT OF THE COMMON EFFLUENT TREATMENT PLANT (CETP) ON GROUNDWATER REGIME

Resistivity survey revealed subsurface lithology and is discussed with respect water bearing nature as unconfined and confined conditions. Piezometers are established at 5 places in bore wells constructed for that purpose within CETP around the treated water storage ponds and an open well as shown in fig. 8.1. Piezometric wells are constructed with 200mm diameter, cased

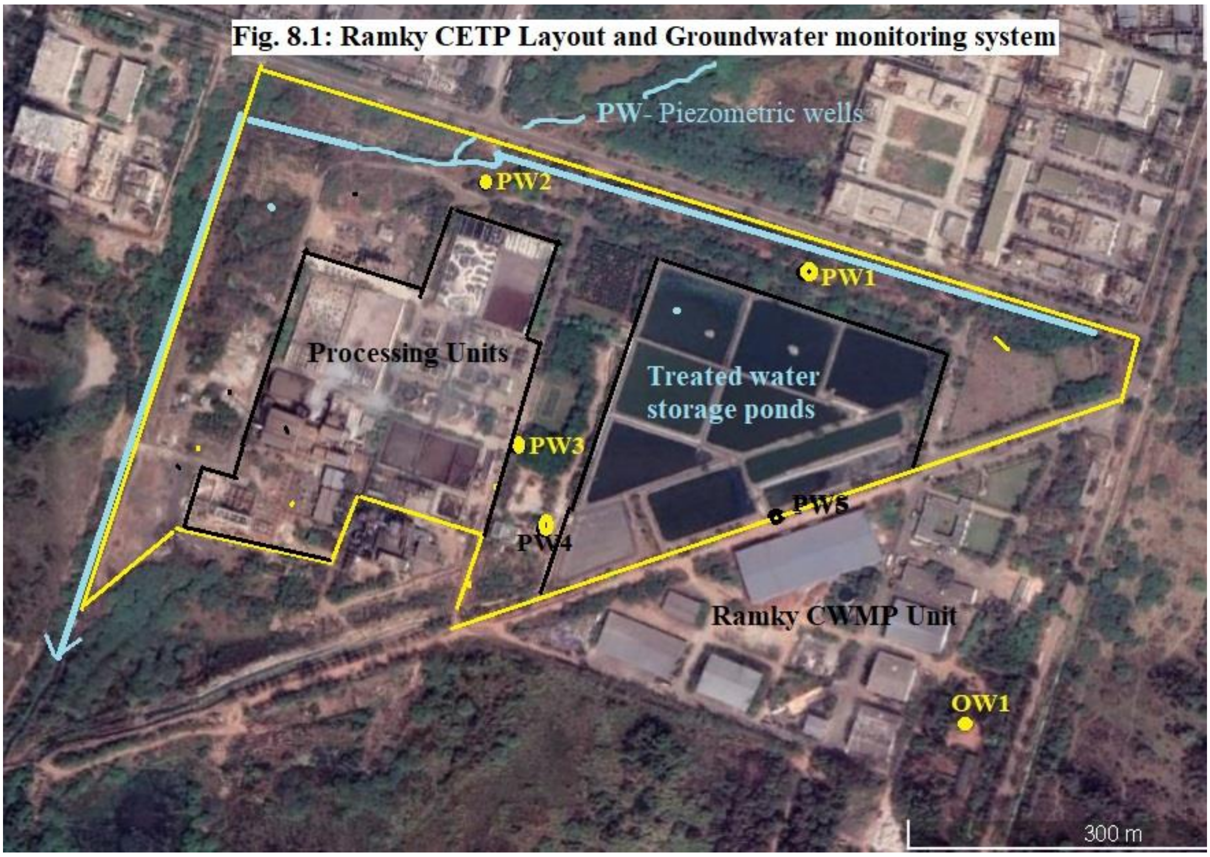

Fig. 8.1: Ramky CETP Layout and Groundwater monitoring system

with 150mm diameter slotted casing and drilled to 20m depth. Piezometer wells are marked as PW1…PW5 and existing open well OW1 with 6.5m diameter and total depth 7.63m located in CWMP is chosen as observation well shown in the above fig. 8.1. Broadly CETP area is marked as a) treated water storage ponds are, b) effluent treatment processing units area and c) greenbelt and open area for common facilities. Water table variations and quality being monitored for every 3 months by Ramky under third party- Andhra University supervision. Water levels observed by our team for the above said 6 wells during post monsoon of 2020 and pre monsoon of 2021 are presented in table – 8.1.

Table -8.1: Water table observation in CETP during Post and Pre monsoon seasons

		Longitude	Latitude	Total Depth (m)	Water Level-in (m)	WL diff.

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Well No.	Type of well				Post	Pre	
OW1	OW	83^{0}04’58.4”	17^{0}38’40.7”	7.63	4.19	5.30	1.11
WL2	PW1	83^{0}04’54.26”	17^{0}38’51.13”	20.12	0.95	1.72	0.77
WL3	PW2	83^{0}04’46.8”	17^{0}38’53.38”	18.42	1.33	3.20	1.87
WL4	PW3	83^{0}04’47.07”	17^{0}38’46.9”	19.53	1.42	2.45	1.03
WL5	PW4	83^{0}04’49.4”	17^{0}40’35.5”	7.66	1.53	3.81	2.28
WL6	PW5	83^{0}04’29.8”	17^{0}40’39.8”	8.15	1.25	3.90	2.65

The above data shows that water table is very shallow and depth varies between 0.95m to 1.53m during post monsoon period and the same varies between 1.72m and 3.90m during pre monsoon. Water table fluctuation varies between 0.77m and 2.65m. Shallow water table in these piezometer wells may be due to large quantity of treated water storage in the ponds. In the observation open well water table is beyond 4m and is also located about 400m away from the ponds. Groundwater fluctuation in open well is only 1.11m.

There are bore wells in CETP yielding good quantity of water being used for domestic/ green belt in little quantities.

Water samples collected from the observation wells within CETP – samples collected in PW3 and open well OW1 are analysed for chemical analysis and presented in table 8.2.

Table 8.2: Chemical Analysis of groundwater samples in PW3 and OW1

S.No	Parameters	Water sample in PW- 3		Water sample in Open well	
		Latitude	Longitude	Latitude	Longitude
		Post monsoon	Pre monsoon	Post monsoon	Pre monsoon
1	pH	8.30	8.5	8.4	8.5
2	Conductivity µ mhos/cm	1951	1340	2142	1360
3	TDS mg/l	1101	884	1359	898
4	HCO3 mg/l	353	250	231	110
5	Chlorides mg/l	371	55.3	85	110
6	No3 mg/l	0.074	0.01	0.078	0.02
7	Sodium mg/l	139	138	63.94	73.96
8	Potassium mg/l	51.7	0.8	1.17	1.2
9	Calcium mg/l	38.4	48	41.6	89.6
10	Magnesium mg/l	102.65	127.9	103.46	66.4
11	Total Hardness mg/l	384	644	326	496

TDS values are higher (>500), but within the permissible limits (<1500). Total hardness is higher (>300), but within the permissible limits (<600). All the chemical parameters are within the permissible limits of drinking water standards. However, post monsoon period samples chemical parameters are high during post monsoon than the pre monsoon which is supposed to be vice-versa. Quality of groundwater is within the permissible limits of drinking water standard.

All the treated effluent storage ponds are lined with concrete and supposed not to seep into subsurface. The reasons for shallowness of the water table may be i) site of investigation is in the low lying area to that region and adjacent to main surface runoff drain, of course it is now

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diverted about 200m west side and parallel, ii) there is tank measuring about 15.24 Hec. about 200m downstream of CETP always filled with water either from storm water or from industrial sullage that is drained from the JNPC area via diverted drain along CETP border. All the time, area between above said tank and CETP, top soil will be in wet condition and sometimes water logging condition. Shallow water table in the CETP all the time may be shallow, because of the above said reasons.

The industry has assured water supply from Yeleru canal and being stored in big surface storage reservoir constructed at the northern border of JNPC. However, groundwater utilisation is inevitable at least to the small quantities for gardening and for some domestic needs. Some rainwater harvesting measures to be taken up to improve the groundwater quality and quantity and is discussed in the following chapter.

9. SUMMARY AND CONCLUSIONS

Based on the field observations and secondary data collected from various sources, the following are the conclusions from various disciplines:

- Secondary data information has been collected to the extent of 10km radius buffer zone around JNPC/ CETP area. Total buffer zone is 314 sq.km and CETP catchment is about 65 sq.km.
- Field investigations like water table observations, water samples collection have been limited to 2km to 3km as well JNPC catchment. Subsurface geophysical investigation is limited to CETP area.
- Even though CETP is a part of JNPC, it is processing all the liquid waste generated in JNPC, and the processed material being disposed to the destination after getting a green signal from P C B.
- Buffer zone covered by Parawada, Pedagantyada, Munagapaka, Anakapalli mandals of Visakhapatnam Dt. JNPC catchment is totally in Parawada mandal.
- Land use/ land cover mapping shows that agricultural land occupies about 72% and hills and forest cover 15% of the buffer zone and in the CETP catchment it is 65 % and 15% respectively. Industrial area is about 10% in Parawada manadal.
- Physiography of the study area is very undulating land with number of hill ranges, isolated hills and upland with or without scrub.
- Drainage in the buffer zone can be divided into 5 catchments and the drainage density also high indicates moderate to high rainfall runoff. Average rainfall of the district is 1116mm and ave. rainfall of Parawada mandal is 1126mm.

- Water quality of groundwater is within the permissible limits of drinking water standards. At few places along the coast groundwater quality influenced by salt water intrusion.
- There are small reservoirs and number of tanks and few groins for surface water supply for irrigation. Since last decade groundwater for irrigation through open wells and tube wells increased enormously. However, groundwater utility of the district is about 32% and around the study area it is 35%. Still there scope for groundwater development.
- Visakhapatnam city getting lot amount of surface water for its domestic and industrial usage from various reservoirs at a distance ranging between 70km to 200km in and out the district. JNPC receiving 10 MLD from Yeleru canal.
- Geology of the entire district is dominated by crystalline rock- khondalite. In the Parawada mandal nearly 95% of the area covered by khondalite rock.
- Depth to water table varies between less than 2m to 16m in the district. In the area 2km around JNPC field observations shows that post monsoon water levels varies between 1.0m and 11.6m and in the same wells, water table varies between 3.25m and 13.60m in pre monsoon season.
- Subsurface investigations in the CETP indicate that i) the top soil thickness varies between 2m to maximum of 10m and is thin in the east side increases towards west side of the site. ii) second layer- weathered rock- yellow/ brownish disintegrated khondalite rock. Thickness this layer varies between 10m and 25m and is thin in the east side and increase towards west border, iii) third layer- fractured rock- Thickness of fractured khondalite rock varies between 25m and 40m.
- Piezometric observation wells around the treated water storage ponds indicate that water table varies between 0.95m to 1.53m during post monsoon period and the same varies between 1.72m and 3.90m during pre monsoon. Water table fluctuation varies between 0.77m and 2.65m. Shallow water table all the time in the CETP may be due to its location in the low lying area as well a big perennial water body is about 200m distance. Besides that water ponds spread in an area of about 4 Hec. in the CETP may also the reason for shallow water table. Even though the ponds are lined with concrete, there may be some cracks in it percolates storage water to subsurface.
- However, quality of groundwater in the piezometric wells is within the permissible limits of drinking water standards. Groundwater levels, quality of water of the 5

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piezometer wells being monitored monthly by CETP and the analysis laboratory is Coastal Waste Management Project (CWMP), of Ramky Enviro Engineers Limited, JNPC, Visakhapatnam. Twenty three parameters being assessed from the water samples that include parameters- physical, chemical, biological and metals. Post and pre monsoon samples analysed are enclosed as Annexure- 1.

10. Recommendations

In the hydrogeological point of view, some measures are to be taken for improving the quality and quantity of groundwater.

10.1: Rainwater Harvesting: Nearly 2/3 area of the Plant covered with i) treated water storage ponds, ii) Various processing units of the treatment plant and roads& others infrastructure facilities. In the 1/3rd area, there is large area under green belt along the northern border, roads side tree rows and open land along the west border as shown in fig. 10.1. Yellow colour polygon is the vacant open area. Blue polygon is the green belt area. There is scope for rainwater harvesting in the green belt as well in the open area. Considering the land use and topographical conditions of the area suitable harvesting structures are: i) trenches across the slope of the ground, ii) small dykes along the border of the green belt and iii) recharge pits along the road berms.

10.1.1 Trench across slope: The open area along the west border is about 350m length and 60m width consists of some bushes and plants. The diverted stream on the north border flows along the west border of the site. Five trenches are proposed in the vacant land aligning across the slope. Each trench should be excavated for about 50m to 55m length, 0.5m width and 1.0m depth. Trench should be filled to ¾th level with permeable material like boulders at bottom, gravel at the centre and sand as top layer. Excavated soil should be placed on the downstream side of the trench as a bund. A trench constructed at one of the industry is shown in fig. 10.2 as photo mosaic. One of the sites selected for rainwater harvesting structure- Recharge trench near to the west border of the site is shown in fig. 10.3. In the above shown example, trench is

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filled with sand to the top level. Instead of filling permeable material to the top level, top 25cm is to be left vacant to accommodate more water in the trench. Once in a year trench is to be maintained by removing the deposited silt and make it permeable.

10.1.2 Mini/Micro Dykes along the Outer Border of the Green belt: Main green belt exists along the northern border of CETP spread in an area of 350m E-W length and 40m width that include 8m road. Green belt consists of plantation of about 10m width along the border, about 15m width of grass land in between a drain and northern compound wall as shown in fig. 10.4. There is 8m width road and on its berms 2m to 3m width beautification plants are grown all along the road that leads to liquid waste processing Plant. There is a big drain between road margin and grass plantation shown above to drain the excess runoff from the road and its margin as well from the grass land area. It is suggested that the walls of the drain should be at least 15cm above the soil filled level for which 15cm height brick wall (mini/micro dyke) may be constructed to store the runoff for some time which comes from the road and grass land. Storm water gets stored within the grass area and road margins and percolates within a day or two. Thus mini dykes may be constructed along the road green belt between ponds and main processing units. The structure is small, but the impact on groundwater recharge will be high.

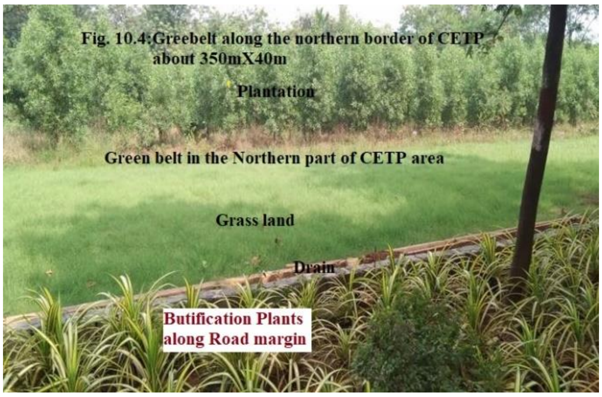

Fig. 10.4:Greebelt along the northern border of CETP about 350mX40m

10.1.3 Recharge pits along the Road Berms: There are number of roads in the processing units area with 5m width and more than a kilometre length. About 3m width of concrete/ bituminous surface and 2m berm consists of soil surface on either of the road. A six inches height dyke is constructed along the road in between bituminous and soil berm as shown in fig. 10.5. Road runoff is allowed over the berms at number of places leaving small gaps in the dyke. Road runoff will be 80% of the rainfall occur and is a good amount of water for the total length of the roads. Road runoff can be harvested by construction a rainwater harvesting structure-recharge well over the berm. Fig. 10.5 shows the location of the recharge well and adjustment of the ground slope towards the well. Top surface of the recharge well should be at the lowest level

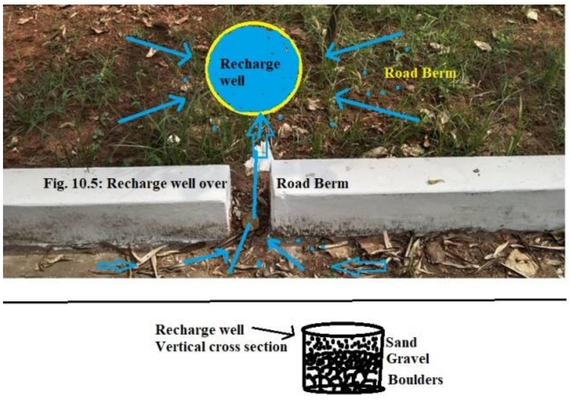

Fig. 10.5: Recharge well over

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than surroundings to allow the road runoff as well runoff from surrounding berm area. Thus the road runoff also can be conserved.

As per the site conditions the above said three type of Rainwater harvesting structures are suitable.

a) Need for the Rainwater Harvesting:

- CETP is located in the lowest valley portion of the JNPC and a major stream traversing through the site but is diverted along the boundary. The industry is dealing with liquid waste treatment and management of the entire units in its upper catchment JNPC. Large quantities being stored in concrete lined ponds. Intake and outlets of the liquid waste is handled through impermeable conduits. Any spill overs in the upper catchment has to pass through the main drain which is abutting CETP.
- There is every possibility of leakage of liquid waste may be small quantities from the storage ponds and from the main stream that carries spillages or any other pollution from the upper catchment. Surface flow may directly join the 15 Hec. tank that located about 200m downstream of CETP. Piezometers observation indicates groundwater is very shallow all around storage tanks indicate that there may be some leakages from storage ponds. Mainly groundwater in the shallow aquifer zone gets influenced by the ponds and stream.
- Quality parameters of groundwater are mostly beyond desirable limits, but within the permissible limits. Instead of letting rainwater into the drains, it may be used for recharging aquifer that improves quality of groundwater, because rainwater is very good quality when it joins the aquifer which is a little inferior quality get improved by diluting with rainwater.
- It is suggested that storage tanks may be checked and treated to stop seepage cracks/ joints in the concrete when they are vacated.
- The place available for rainwater harvesting is the open area on the west part of CETP area and greenbelt. Harvesting structures cost is very little amount, but the benefit from improving the quality of groundwater will be enormous. Rainwater harvesting structures cost is only at the time of establishment, but the quantity is renewable every year.

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Dr.V.Venkateswara Rao
Professor (Retd.), Geo-Engineering, A.U
QCI-NABET Accredited FAE in Hydrogeology & Geology,
Visakhapatnam- 530 003

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Annexure-VI II

The compliance status of the external advisory committee (Task Force) directions dated 21.12.2021 is submitted below:

S.No.	Directions	Compliance
1.	The Facility shall immediately implement the recommendations made by the Committee	
	Recommendations by the Committee	
	i. Training of the operators on electrical, chemical, fire safety and they should know how to give the first aid. First aid box must be provided.	Complied. Safety training are being conducted for all operators once in a month. First aid box is provided.
	ii. Multi gas analysers with alarm system should be kept on top of the tank and the display should be kept outside.	Complied. Multi gas analyzer (for measuring CO, O_2, LEL, H_2S) are provided with alarm system and digital display outside the pump house.
	iii. Proper sign boards have to be in place.	Complied.
	iv. Tanker Level indicator should be in place. Manual opening valves should be kept outside to ensure a minimum manual intervention.	Complied.
	v. Tank opening will be covered with grills. Proper sampling practices should be followed. The necessary equipment should be used for sampling.	Complied.
	vi. Fuming hood should be arranged and it should be connected to wet scrubber.	Complied.
	vii. Exhaust fans should be arranged.	Complied.

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	viii. No smoking zone area display & PPE sign boards.	Complied.
	ix. CC-Camera must be arranged.	Complied.
	x. Online Ph meters should be arranged.	Complied.
	xi. PVC casing of electrical wiring.	Complied.
	xii. Personal should enter only with proper gas masks and other PPE kits.	Provisions are made.
	xiii. Ambulance should be kept ready near the site to handle emergency.	Complied.
	xiv. On a long run, attempts should be made to pump the effluent directly to the CETP:	Complied.
	xv. Industries should also estimate the parameters of the effluent regularly at their facility, before discharging.	Complied.
	xvi. The Ramky should maintain all the above systems to the adjacent new collection system also which is under construction.	Complied.
2.	The Facility shall remove all underground pipelines if any and ensure that no effluent is bypassed from designated treatment and disposal system under any circumstances. The facility also needed to periodically (At-least once in a month) inspect the marine disposal pipe line system to ensure that there should not be any unauthorized connections.	Complied.
3.	The Facility shall fund for establishment and operation of continuous flow and effluent quality monitoring system including, on polluter pay principle, in-addition to the existing online monitoring system operated by the industry in the premises at discharge point, to have proper accountability.	Complied. The facility provided continuous effluent quality monitoring system including camera for observing flow at sea disposal point by the Board and connected to APPCB website.

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4.	The Facility shall augment treatment systems, if needed, to ensure continuous compliance of prescribed discharge standards.	Complied.
5.	The Facility shall prepare comprehensive plan of action to prevent reoccurrence of accidents / implementation of adequate safety measures in consultation with reputed organizations and shall furnish report to the Board within 3 months along with the implementation schedule.	The facility has appointed Dupont Safety Solutions (International reputed Safety Organization) for study and implementation of safety aspects to prevent reoccurrence of accidents.

G NAGI REDDY Digitally signed by G NAGI REDDY
Date: 2023.10.30 21:13:57 +05'30'

ENVIRONMENTAL ENGINEER

Annexure-IX

Prof.P.Jagadeeswara Rao
Dept. of Geo-Engineering
College of Engineering (A)
Andhra University
Visakhapatnam-530 003.

Phone (O) 2844956
Mobile: 09290452308
pjr_geoin@rediffmail.com
Fax: 0891-2755324
pjagadeeswararao.geoeng@auvsp.edu.in

Study report on Green Belt in Ramky Pharma City, Parawada Mandal, Visakhapatnam District

This is in response to the request made by the Ramky Pharma City, Visakhapatnam, Prof.P.Jagadeeswara Rao, Dept. of Geo-Engineering and Centre for Remote Sensing, College of Engineering (A), Andhra University, Visakhapatnam and his team had been carried out study to assess the green belt (lung space) in their premises. The details of which are given below.

They reported that the Ramky Pharma City, Visakhapatnam covers an area of 2145 acres land, covering in Parawada Mandal, Visakhapatnam District, Andhra Pradesh. Out of 2145 acres land, they developed green belt in 360 acres which accounts 16.78%. With this backdrop, they approached the undersigned to assess the present green belt in the Ramky Pharma City, Visakhapatnam.

The survey team visited the area from time to time during the study for physical verification of green belt. Besides, the concerned area toposheet is geometrically rectified in the ERDAS-Imagine-9.2 software (Fig.2) and taken the study area as an Area of Interest (AOI) on the basis of their CAD drawing (Fig.1). The AOI has been digitised in ArcGIS-9.2 software and converted the shape file (.shp) in to file (.kml) file format to drape over to the Google Earth image. The study area has been extracted from the Google Earth image (Quickbird) of 1 m resolution of 2014 which is fairly good to extract vegetation from the image (Fig.3).

The Google image is rectified with the concerned area toposheet and bring the data in the common projection system to extract green belt on the Google Earth image through visual interpretation techniques.

The image is post Hud-Hud period wherein some portion of the green belt area is shown as sparse vegetated area (helipad area). From the field work, it is ascertained that the area is severely affected by the Hud-Hud cyclone in October, 2014.

In this study, 471 acres green belt has been assessed from the Google Earth image through visual interpretation techniques which accounts 21.95 % area is under green belt (Fig.4). Photos taken during field visit is also enclosed which gives fairly good chance to verify the area (Photos. 1,2, 3).

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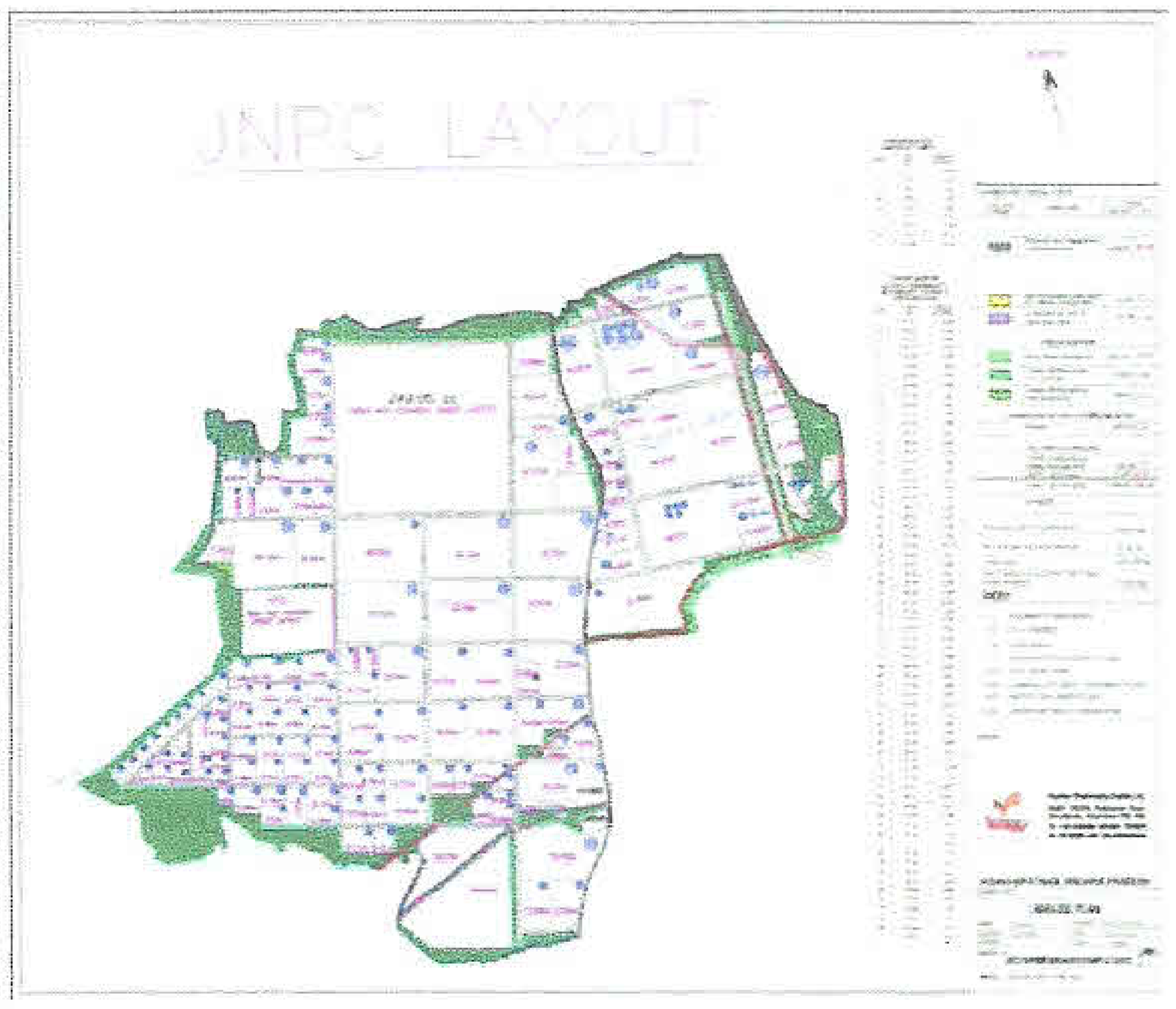
In this study, the Ramky Pharma City, Visakhapatnam area is covered = 2145 acres

In this study, Green belt covering 471 acres = 21.95% area is under green belt.

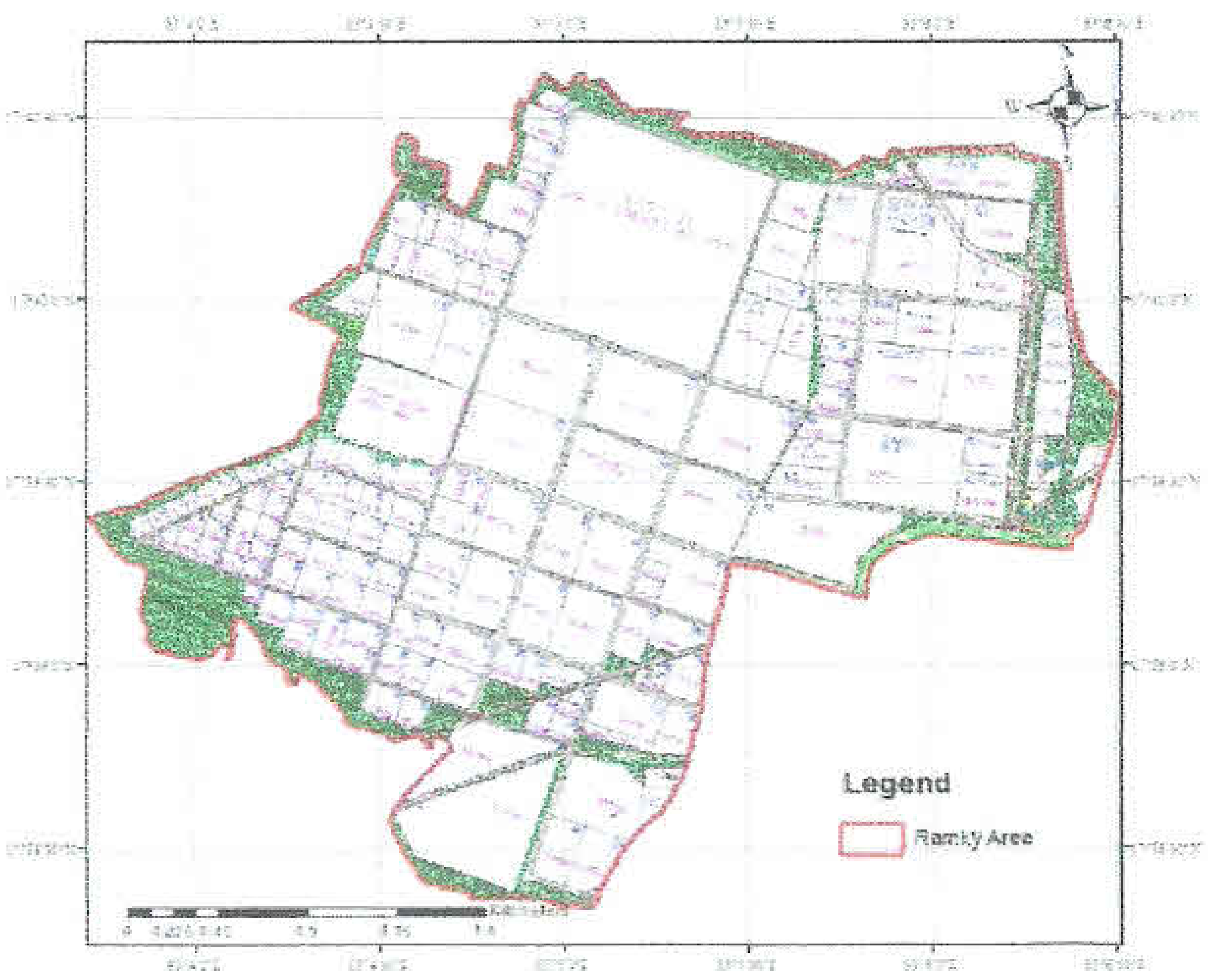
The objective of the study is to assess the area is under green belt (Vegetation). It is observed, the area is maintaining a good greenery in terms of green belt, where the area is only meant for green belt. Similarly, on either side of the roads avenue plantation has also delineated as the lung space (greenery) in the area. Observed destruction of vegetation during 2014 Hud-Hud cyclone in the 80 acre helipad area. Owing to afforestation/reforestation the same area again resampled and the trees whose branches were cut-off were grown.

The Ramky pharma left its boundary to develop exclusively green belt which is around 360 acres. In this study, avenue plantation and other areas where standing vegetation is there is also considered, which is around 471 acres.

Ramky Pharma City, Visakhapatnam area is covered		= 2445 acres
APIIC Reservoirs + R&B Roads	(-)	= 300 acres
	Total =	=2145 acres
Reported by Ramky Green belt area		= 360 acres (16.78%)
Green belt assessed through remote sensing study		**= 471 acres (21.95%)**



1. CAD drawing



2. Geometric rectification of CAD drawing

Fig.1: Study area CAD drawing

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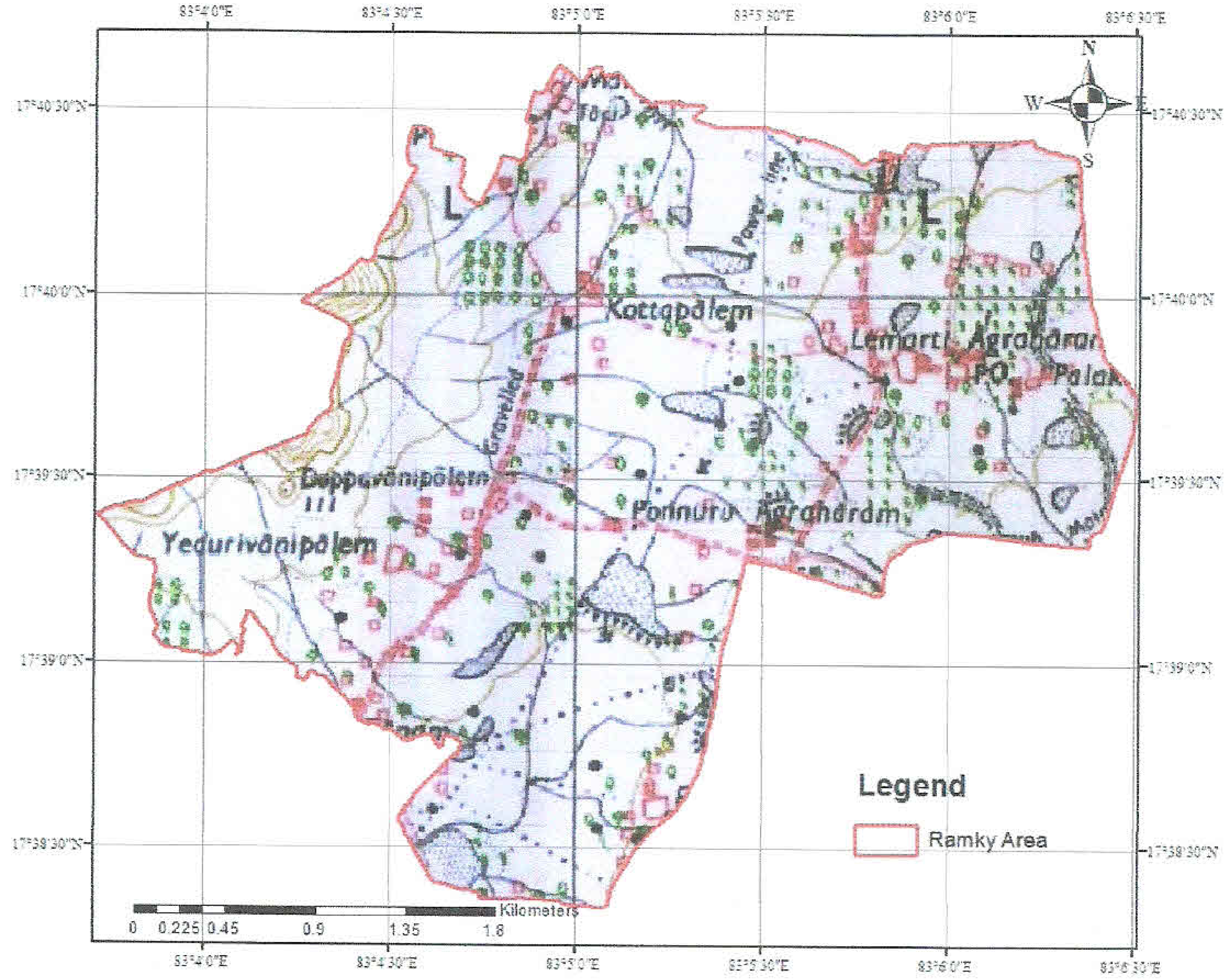

Fig.2: Ramky area as viewed on Toposheet

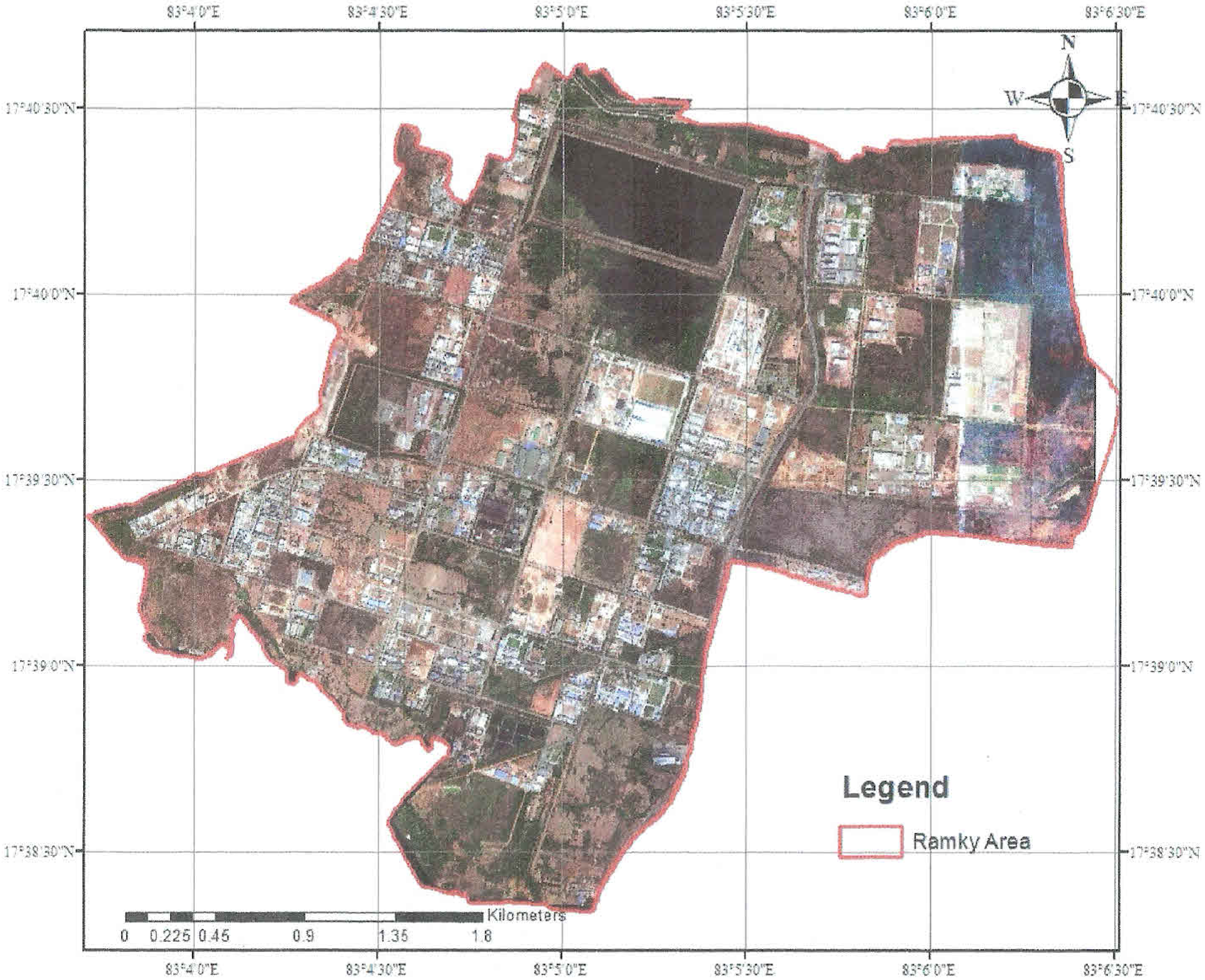

Fig.3: Ramky area as viewed on Google Earth Image

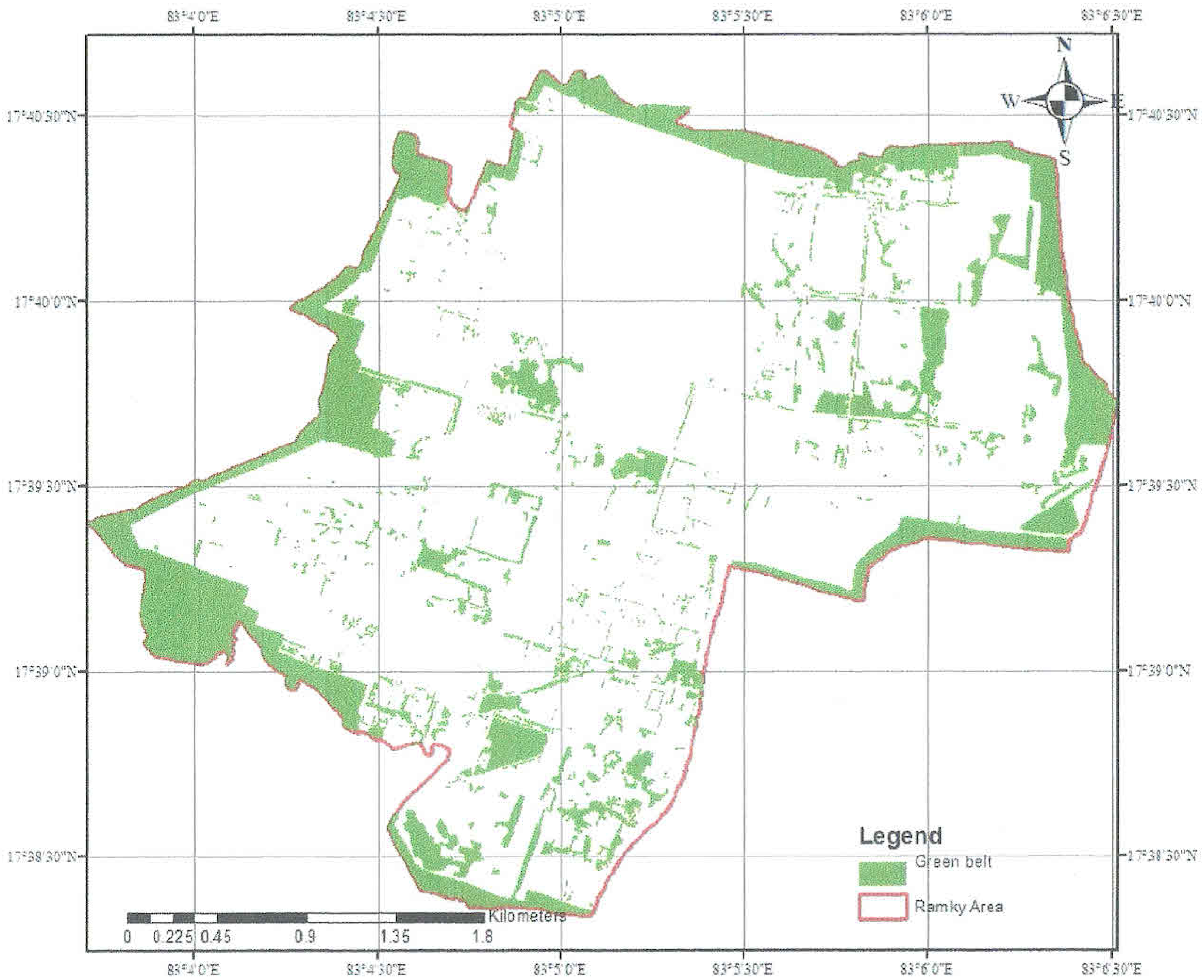

Fig.4: Green Belt map

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Field Photos

Photo 1:Ramky Admin Buildings with backdrop of APIIC reservoir

Photo 2: Avenue plantation

Photo 3: Aerial view of Ramky pharma city

Ramky Pharma City, Visakhapatnam area is covered **= 2145 acres**

Green belt assessed through remote sensing study **= 471 acres (21.95%)**

(Note: It should be noted that the recommendations are based on the visual interpretations of Google Earth satellite image studies. It should be further noted that this study is only of recommendatory nature).

Investigator

Prof. P. JAGADEESWARA RAO, Ph.D.
Department of Geo-Engineering &
Centre for Remote Sensing
College of Engg. (A), Andhra University
VISAKHAPATNAM-530 003

Annexure-X

ANDHRA PRADESH POLLUTION CONTROL BOARD
ZONAL OFFICE:: VISAKHAPATNAM
D.No.39-33-20/4/1,Madhavadhara Vuda Colony, Visakhapatnam - 530018.
Ph : 0891-2719380

Circular Memo/APPCB/ZO-VSP/Tech./2020 **Date: 26.08.2020**

Sub: APPCB – ZO-VSP –Industries Operating in M/s. Ramky Pharma city –Directions Issued - Reg.

****

The Board officials, during inspection of M/s. Ramky Pharma city observed that the washings generated from the non process sources in the plant premises are being disposed directly into storm water drains outside the plant premises in violation of the CFO condition. Also the contaminated storm water during rains is not contained in the premises and is also being discharged into storm water drains, thereby causing water pollution of the nearby water bodies and also ground & soil contamination in the area. As per the CFO condition the industry shall provide proper drainage system so that the rain water shall not be allowed to mix with either trade effluents or domestic effluent and shall maintain dry condition of storm water drains in the non-rainy season. The floor washings also shall be admitted into effluent collection system only and shall not be allowed to find their way into storm water drains or open areas.

In view of the above, the following directions are hereby issued to all the industries in M/s. Ramky Pharmacity, Parawada:

1. The industry shall construct a dyke of height 1 foot in the storm water drain both upstream and downstream of their industry to demonstrate the non discharge of any type of effluents into the storm water drains on non rainy days.
2. The industry shall lift the water accumulated in the storm water drains between the dykes along the boundary of the industry into their effluent storage tanks and shall be sent to CETP for further treatment.
3. The industry shall maintain the storm water drain all along the premises in dry condition on all non rainy days.

You are hereby directed to take immediate action for compliance of the above directions and submit the compliance report along with photographic evidences within a week.

Rajendra Reddy Thuraka
Digitally signed by Rajendra Reddy Thuraka
Date: 2020.08.26 16:36:41 +05'30'
JOINT CHIEF ENVIRONMENTAL ENGINEER

To
All the industries.

ANDHRA PRADESH POLLUTION CONTROL BOARD
ZONAL OFFICE:: VISAKHAPATNAM
D.No.39-33-20/4/1,Madhavadhara Vuda Colony, Visakhapatnam - 530018.
Ph : 0891-2719380

PROCEEDINGS OF THE JOINT CHIEF ENVIRONMENTAL ENGINEER
A P POLLUTION CONTROL BOARD, ZONAL OFFICE, VISAKHAPATNAM

PRESENT: Sri T.Rajendra Reddy, M.Tech.,
Joint Chief Environmental Engineer

Procds. No. 2434/APPCB/ZO-VSP/2020 Date: 08/09/2020

Sub: APPCB – ZO-VSP – Tech. – Meeting conducted with the JNPC Manufacturers Association Members and Executive Body Members of JNPCNGPIA Service Society, APIIC, IALA at Zonal Office, Visakhapatnam on 31.08.2020 – Monitoring Committee in JN Pharamacity – Constituted - Orders issued – Reg.

Ref:
1. Meeting held with the JNPC manufacturers association members and executive body members of JNPCNGPIA service society, APIIC, IALA at Zonal Office, Visakhapatnam on 31.08.2020.
2. E-mail from the EO, JNPCMA on 04.09.2020.

***

ORDER:

The Board officials, during inspection of JN Pharmacity observed seepages of effluents with high pollution load are oozing out into storm water drains which are ultimately joining Ooracheruvu thereby causing surface water, ground water pollution & soil contamination in the area. .

A meeting was held at Zonal Office Visakhapatnam on 31.08.2020 with the JNPC Manufacturers Association Members and Executive Body Members of JNPCNGPIA Service Society, APIIC, IALA and reviewed on contamination of Ooracheruvu due to the contaminated storm water runoff joining during rainy days.

It was decided in the meeting to form a committee consisting of members of association and one PCB official and one representative from Ramky Pharmacity to effectively monitor the industries to curb the illegal discharges of effluents into storm water drains and air pollution in JN Pharmacity.

The EO, JNPCMA vide ref. 2nd cited, communicated the members of the committee to monitor the industries in JN Pharmacity.

In view of the above, A.P. Pollution Control Board hereby constitute the monitoring committee with the following members to effectively monitor the industries to curb the illegal discharges of effluents into storm water drains and air pollution in JN Pharmacity.

S. No.	Name of the member	Organization/Industry	
1.	Sri. K Srinivasa Rao	M/s. Vasudha Pharma Chem Ltd	Member
2.	Sri. M Srinivasa Rao	M/s. Laurus Labs Ltd	Member
3.	Sri. B Ram Babu	M/s. Rampex Labs (P) Ltd	Member
4.	Sri. N V B S Bhaskar Rao N	M/s. Synergene Active Ingredients (P) Ltd	Member
5.	Sri. P Ravi Teja	M/s. JPR LABS (P) lTD	Member
6.	Sri. P Sri Harsha Varma	M/s. Vasudha Pharma Chem Ltd	Member
7.	Sri. M P Dora	M/s. Rakshit Pharmaceuticals (P) Ltd	Member

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8.	Sri. P S Tagore	M/s. Granules Omnichem (P) Ltd - SEZ	Member
9.	Sri. D Sai Kiran	M/s. Mylan Laboratories Ltd - SEZ	Member
10.	Sri. L. Ramakrishna Rao	Assistant Manager, Safety, Ramky Pharmacity (CETP)	Member
11.	Sri. K. Suryanarayana	EO, APIIC, IALA, Parawada	Member
12.	Sri. G. Raghava Reddy	AEE, APPCB, ZO-VSP	Member convener

The committee shall:

i. Constitute teams for monitoring of industries in JN Pharmacity for illegal discharge of effluents, joining of effluents into storm water drains & air pollution in JN Pharmacity.

ii. Constitute a working team to identify reputed organizations to carryout status study on the quality of soil, water and other parameters etc and for preparation of remediation plan of Ooracheruvu, Thadi, Visakhapatnam.

iii. Sri. G. Raghava Reddy, Member Convener shall co-ordinate the monitoring team & working teams and finalize reports & action plan and submit to the Joint Chief Environmental Engineer, Zonal Office, Visakhapatnam

JOINT CHIEF ENVIRONMENTAL ENGINEER

To
All the members of monitoring committee.

Copy submitted to the Member Secretary, APPCB, Vijayawada for information
Copy to the Environmental Engineer, Regional Office, Visakhapatnam for information.
Copy to the EO, JNPCMA with a request to serve a copy of orders with respect to committee members.
Copy to the Executive Officer, APIIC, IALA, Parawada for information.
Copy to the JNPC Manufacturers Association Members and Executive Body Members of JNPCNGPIA Service Society, APIIC, IALA for information.

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Item No.02:-

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

(Through Video Conference)

Original Application No. 141 of 2023 (SZ)

IN THE MATTER OF:

Ganisetti Satyanarayana,
Andhra Pradesh and Anr.

…Applicant(s)

Versus

Union of India,
Rep. by its Secretary,
MOEF & CC, New Delhi and ors.

...Respondent(s)

Date of hearing: 26.04.2024.

CORAM:

HON'BLE Mr. JUSTICE ARUN KUMAR TYAGI, JUDICIAL MEMBER

HON'BLE Dr. SATYAGOPAL KORLAPATI, EXPERT MEMBER

For Applicant(s): Mr. K. Sravan Kumar.

For Respondent(s): Dr. Kuna. Suryanarayana for R1.
Mr. Ramesh Sanjay represented
Mrs. Madhuri Donti Reddy for R2, R3 & R5.
Mrs. Revathi Manivanan for R4.
Mr. Arun Karthick Mohan for R6.

ORDER

1. Mr. K. Sravan Kumar, the learned counsel for the applicant would submit that the APPCB has filed its report relying on the samples collected in the years 2022 & 2023 and highlighted that the current load of pollution is high in the area since a large number of units have become operational now.

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2. Mr. Ramesh Sanjay representing Mrs. Madhuri Donti Reddy, the learned counsel for the Andhra Pradesh Pollution Control Board (APPCB) would seek time to file a further report, capturing the analysis of samples collected in the recent past.

3. Mr. Arun Karthick Mohan, the learned counsel appearing for the 6th Respondent would submit that they have filed the report, which is not before us.

4. Let the same be verified and reach it to the bundle.

5. Post the matter on **08.07.2024.**

Sd/-
Justice Arun Kumar Tyagi, JM

Sd/-
Dr. Satyagopal Korlapati, EM

O.A. No. 141/2023(SZ)
26th April, 2024. Mn.

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List of industries were started operations in the year 2023-2024 at JNPC, Parawada, Anakapalli District:

S.No	Name of the industry	Line of activity	Year of commencement	CTO	Validity
1	M/s. Alithia Pharmaceuticals Pvt. Ltd, Plot No. 31B, Jawaharlal Nehru Pharmacity, Thanam (V), Parawada Mandal, Anakapalli District	Bulk drugs	Sep-23	07.09.2023	31.07.2026
2	M/s Azico Pharmaceuticals Pvt. Ltd., Plot No. 31C, Jawaharlal Nehru Pharmacity, Thanam(V), Parawada Mandal, Anakapalli District	Bulk drugs	Aug-23	22.08.2023	31.07.2028
3	M/s. Devi Pharmatech Private Limited, Plot Nos. 12 & 15 , Industrial Park Phase –III, at Sy.No.09 (part), 17(part), 18 (part) 16 (part) of Lemarthi (V), and 217 (Part) of Tadi (V), Parawada (M), Anakapalli District	Bulk drugs	Aug-23	01.08.2023	30.06.2026
4	M/s. Spar Pharma LLP, Sy. No. part of 99, 187, 190, 187 & 192, Plot No.3A Jawaharlal Nehru Pharmacity, Thadi (V), Parawada (M), Anakapalli District	Bulk drugs	Mar-23	07.11.2022	30.09.2027
5	M/s. Eugia Steriles Private Limited (Formerly M/s.Aurocure Private Limited), Tadi Village, Parawada Mandal, Anakapalli District	Formulations	Mar-23	27.02.2023	31.01.2025
6	M/s. Synac Pharmaceuticals Pvt. Ltd., Plot No. 31 D, J.N. Pharmacity, Thanam Village, Parawada Mandal, Anakapalli District	Bulk drugs	Sep-23	22.08.2023	31.07.2024
7	M/s. Granules CZRO Private Limited, Plot No 120,121 Part, SEZ, Jawaharlal NehruPharmacity, Parawada, Anakapalli District	Bulk drugs	Mar-24	23.03.2024	31.01.2026

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Real Time Data Acquisition And Monitoring

Site Name: Visakha Pharmacity Limited (Earlier Known As .Ramky Pharmacity (India) Ltd., (CETP))

Report: Custom Report

From Date: 2023/06/01 00:00:00 To Date : 2024/05/31 23:59:00

Description	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
Prescribed Standards	0 - 100	0 - 60	0 - 80	0 - 80	0 - 400
Maximum Data	96.36	53.0	62.0	34.0	6.32
Minimum Data	4.99	3.45	1.19	0.65	0.12
Geometric Mean	41.21	23.57	7.98	7.17	0.61
Median	43.29	25.68	7.25	3.95	0.55
Standard Deviation	23.68	12.66	5.17	5.96	0.46
Maximum Value At Time	2023-12-07	2023-12-07	2024-01-10	2024-01-10	2024-01-10
Minimum Value At Time	2023-07-26	2023-07-26	2023-07-26	2023-07-26	2023-07-26
Valid Data Points	314	314	313	313	313
Total Data Points	366	366	366	366	366
Data Availability %	85.79%	85.79%	85.52%	85.52%	85.52%

Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
1	2023-06-01	28.71	19.88	6.85	3.75	0.70
2	2023-06-02	29.89	20.70	7.13	3.91	0.73
3	2023-06-03	28.62	19.81	6.83	3.74	0.70
4	2023-06-04	25.44	17.67	6.08	3.34	0.62
5	2023-06-05	24.15	16.15	7.38	4.05	0.76
6	2023-06-06	23.19	16.07	5.53	3.03	0.56
7	2023-06-07	22.93	15.87	5.47	3.00	0.56
8	2023-06-08	25.88	17.94	6.17	3.38	0.63
9	2023-06-09	25.73	17.79	6.13	3.36	0.63

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
10	2023-06-10	19.04	13.18	4.54	2.49	0.46
11	2023-06-11	22.85	15.80	5.45	2.99	0.56
12	2023-06-12	23.44	16.23	5.59	3.06	0.57
13	2023-06-13	33.16	22.81	7.85	4.31	0.80
14	2023-06-14	24.61	17.04	5.87	3.22	0.60
15	2023-06-15	23.53	16.29	5.61	3.08	0.57
16	2023-06-16	36.27	25.07	8.64	4.74	0.88
17	2023-06-17	31.12	21.43	7.42	4.07	0.76
18	2023-06-18	51.66	32.30	15.78	8.65	1.61
19	2023-06-19	40.29	24.65	14.33	7.86	1.45
20	2023-06-20	32.24	22.32	7.69	4.21	0.78
21	2023-06-21	40.26	25.26	10.68	5.86	1.09
22	2023-06-22	26.88	18.47	6.45	3.53	0.66
23	2023-06-23	39.50	27.31	9.42	5.17	0.96
24	2023-06-24	22.03	15.26	5.25	2.88	0.54
25	2023-06-25	41.28	25.68	13.64	7.48	1.39
26	2023-06-26	13.70	9.48	3.26	1.79	0.33
27	2023-06-27	35.25	23.98	8.43	4.62	0.86
28	2023-06-28	45.41	28.84	13.03	7.14	1.33
29	2023-06-29	41.20	27.50	10.18	5.58	1.04
30	2023-06-30	34.44	22.86	8.56	4.70	0.87
31	2023-07-01	58.86	35.69	20.15	11.04	2.05
32	2023-07-02	22.13	15.23	5.33	2.92	0.54
33	2023-07-03	27.18	18.52	7.00	3.84	0.71
34	2023-07-04	43.41	28.35	13.53	7.42	1.39
35	2023-07-05	61.81	35.98	27.37	15.01	2.80

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
36	2023-07-06	74.70	43.18	26.66	14.62	2.72
37	2023-07-07	23.70	16.29	5.57	3.05	0.57
38	2023-07-08	30.68	21.21	7.30	4.00	0.74
39	2023-07-09	36.69	23.67	9.09	4.99	0.93
40	2023-07-10	42.35	25.61	13.10	7.19	1.34
41	2023-07-11	12.66	8.78	3.03	1.66	0.31
42	2023-07-12	10.64	7.37	2.54	1.39	0.26
43	2023-07-13	13.34	9.23	3.18	1.74	0.32
44	2023-07-14	27.36	18.21	7.19	3.94	0.73
45	2023-07-15	23.22	16.03	5.54	3.04	0.57
46	2023-07-16	13.97	9.68	3.33	1.83	0.34
47	2023-07-17	18.89	12.98	4.51	2.48	0.46
48	2023-07-18	15.80	10.92	3.77	2.07	0.38
49	2023-07-19	11.33	7.84	2.72	1.49	0.28
50	2023-07-20	8.09	5.61	1.93	1.06	0.20
51	2023-07-21	8.34	5.78	1.99	1.09	0.20
52	2023-07-22	8.99	6.22	2.14	1.17	0.22
53	2023-07-23	12.23	8.47	2.90	1.59	0.30
54	2023-07-24	6.24	4.32	1.49	0.82	0.15
55	2023-07-25	6.55	4.54	1.57	0.86	0.16
56	2023-07-26	4.99	3.45	1.19	0.65	0.12
57	2023-07-27	10.08	7.01	2.40	1.32	0.24
58	2023-07-28	15.23	10.55	3.63	1.99	0.37
59	2023-07-29	13.18	9.14	3.13	1.72	0.32
60	2023-07-30	18.14	12.54	4.32	2.37	0.44
61	2023-07-31	19.13	13.24	4.57	2.51	0.47

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
62	2023-08-01	15.82	10.96	3.78	2.07	0.38
63	2023-08-02	19.41	13.44	4.63	2.54	0.47
64	2023-08-03	18.79	13.07	4.49	2.45	0.46
65	2023-08-04	22.69	15.73	5.45	2.99	0.55
66	2023-08-05	48.02	33.32	11.51	6.31	1.17
67	2023-08-06	40.34	26.94	9.72	5.33	0.99
68	2023-08-07	28.03	19.38	6.69	3.67	0.68
69	2023-08-08	24.73	17.09	5.90	3.24	0.60
70	2023-08-09	25.22	17.51	6.04	3.31	0.61
71	2023-08-10	15.61	10.76	3.69	2.02	0.38
72	2023-08-11	31.42	21.61	7.45	4.10	0.75
73	2023-08-12	34.13	23.65	8.13	4.46	0.82
74	2023-08-13	14.00	9.68	3.33	1.83	0.34
75	2023-08-14	33.95	23.52	8.11	4.45	0.82
76	2023-08-15	NA	NA	NA	NA	NA
77	2023-08-16	23.71	16.42	5.64	3.09	0.57
78	2023-08-17	14.98	10.48	3.60	1.96	0.36
79	2023-08-18	14.01	9.69	3.34	1.83	0.34
80	2023-08-19	13.67	9.66	3.32	1.82	0.34
81	2023-08-20	13.13	9.08	3.11	1.70	0.32
82	2023-08-21	19.09	13.21	4.56	2.50	0.46
83	2023-08-22	14.39	10.12	3.48	1.91	0.35
84	2023-08-23	23.27	16.09	5.54	3.04	0.57
85	2023-08-24	14.73	10.13	3.49	1.91	0.35
86	2023-08-25	16.45	11.38	3.92	2.15	0.40
87	2023-08-26	10.02	6.93	2.38	1.31	0.24

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
88	2023-08-27	12.55	8.71	3.00	1.65	0.31
89	2023-08-28	18.87	13.09	4.50	2.47	0.46
90	2023-08-29	29.25	20.26	6.98	3.83	0.71
91	2023-08-30	35.35	24.49	8.43	4.62	0.86
92	2023-08-31	34.29	23.75	8.19	4.49	0.83
93	2023-09-01	25.20	17.39	6.00	3.29	0.61
94	2023-09-02	18.51	12.79	4.41	2.42	0.45
95	2023-09-03	16.20	11.21	3.90	2.14	0.40
96	2023-09-04	15.62	10.80	3.72	2.04	0.38
97	2023-09-05	13.29	9.20	3.19	1.75	0.33
98	2023-09-06	8.21	5.71	1.97	1.08	0.20
99	2023-09-07	13.73	9.49	3.27	1.79	0.33
100	2023-09-08	16.19	11.25	3.88	2.12	0.40
101	2023-09-09	17.00	11.77	4.06	2.23	0.41
102	2023-09-10	9.47	6.55	2.26	1.24	0.23
103	2023-09-11	11.10	7.66	2.65	1.46	0.27
104	2023-09-12	8.60	5.94	2.07	1.13	0.20
105	2023-09-13	10.61	7.40	2.55	1.41	0.25
106	2023-09-14	8.25	5.69	1.96	1.08	0.20
107	2023-09-15	18.25	12.62	4.35	2.39	0.44
108	2023-09-16	13.49	9.29	3.21	1.76	0.33
109	2023-09-17	10.07	6.98	2.40	1.32	0.24
110	2023-09-18	13.19	9.10	3.13	1.71	0.32
111	2023-09-19	23.40	16.20	5.58	3.06	0.57
112	2023-09-20	9.74	6.79	2.34	1.29	0.24
113	2023-09-21	11.14	7.76	2.67	1.50	0.28

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
114	2023-09-22	13.41	9.29	3.17	1.74	0.33
115	2023-09-23	9.40	6.39	2.23	1.22	0.22
116	2023-09-24	11.55	8.02	2.76	1.51	0.28
117	2023-09-25	NA	NA	NA	NA	NA
118	2023-09-26	6.24	4.32	1.49	0.82	0.15
119	2023-09-27	19.05	13.21	4.55	2.50	0.46
120	2023-09-28	12.51	8.67	2.98	1.63	0.30
121	2023-09-29	10.19	6.97	1.53	0.84	0.16
122	2023-09-30	30.81	19.55	2.51	1.37	0.25
123	2023-10-01	NA	NA	NA	NA	NA
124	2023-10-02	NA	NA	NA	NA	NA
125	2023-10-03	43.50	24.82	4.10	2.25	0.42
126	2023-10-04	53.59	30.91	5.06	2.78	0.51
127	2023-10-05	66.80	38.28	6.72	3.69	0.69
128	2023-10-06	69.13	39.60	6.52	3.58	0.67
129	2023-10-07	69.95	40.10	6.72	3.68	0.68
130	2023-10-08	69.51	39.56	6.83	3.74	0.70
131	2023-10-09	56.95	32.80	5.35	2.94	0.55
132	2023-10-10	61.89	35.20	6.13	3.36	0.63
133	2023-10-11	75.03	42.66	7.16	3.93	0.73
134	2023-10-12	71.47	40.83	6.87	3.77	0.70
135	2023-10-13	79.33	45.59	7.52	4.12	0.77
136	2023-10-14	64.96	37.26	6.09	3.35	0.62
137	2023-10-15	72.91	41.55	7.16	3.92	0.73
138	2023-10-16	68.96	39.58	6.54	3.59	0.67
139	2023-10-17	74.73	42.46	7.25	3.98	0.74

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
140	2023-10-18	75.92	43.51	7.22	3.95	0.73
141	2023-10-19	83.00	47.76	7.79	4.28	0.80
142	2023-10-20	60.88	35.11	5.73	3.14	0.58
143	2023-10-21	55.49	31.94	5.21	2.86	0.53
144	2023-10-22	59.13	34.08	5.56	3.05	0.57
145	2023-10-23	47.33	27.31	4.47	2.45	0.45
146	2023-10-24	56.60	32.57	5.32	2.92	0.54
147	2023-10-25	61.71	35.56	5.80	3.18	0.60
148	2023-10-26	62.08	35.69	5.83	3.20	0.59
149	2023-10-27	56.23	32.32	5.29	2.90	0.54
150	2023-10-28	73.10	41.79	9.32	5.09	0.95
151	2023-10-29	73.75	42.50	6.95	3.81	0.71
152	2023-10-30	56.95	32.75	5.35	2.93	0.54
153	2023-10-31	53.84	30.96	5.05	2.77	0.51
154	2023-11-01	42.88	24.63	4.01	2.20	0.41
155	2023-11-02	22.28	12.90	2.10	1.16	0.21
156	2023-11-03	17.85	10.24	1.68	0.92	0.17
157	2023-11-04	21.59	12.43	2.03	1.11	0.21
158	2023-11-05	19.35	11.14	1.82	1.00	0.19
159	2023-11-06	17.56	10.18	1.67	0.90	0.17
160	2023-11-07	50.35	28.95	4.73	2.59	0.48
161	2023-11-08	58.89	33.86	5.53	3.02	0.56
162	2023-11-09	64.70	37.24	6.05	3.33	0.62
163	2023-11-10	NA	NA	NA	NA	NA
164	2023-11-11	87.99	50.64	8.31	4.55	0.84
165	2023-11-12	72.24	41.59	6.79	3.72	0.69

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
166	2023-11-13	94.32	52.66	9.32	5.11	0.95
167	2023-11-14	86.05	48.22	8.35	4.58	0.85
168	2023-11-15	76.38	43.95	7.17	3.94	0.73
169	2023-11-16	32.85	18.89	3.08	1.69	0.31
170	2023-11-17	44.26	25.43	4.15	2.27	0.42
171	2023-11-18	33.12	19.10	3.11	1.71	0.31
172	2023-11-19	35.77	20.62	3.34	1.84	0.34
173	2023-11-20	28.63	16.49	2.67	1.44	0.27
174	2023-11-21	32.06	18.49	3.02	1.65	0.31
175	2023-11-22	36.87	21.20	3.45	1.89	0.35
176	2023-11-23	66.99	38.53	6.28	3.45	0.64
177	2023-11-24	79.35	45.68	7.51	4.12	0.75
178	2023-11-25	73.91	42.54	6.93	3.80	0.71
179	2023-11-26	78.36	45.12	7.36	4.04	0.75
180	2023-11-27	70.23	40.37	6.63	3.64	0.67
181	2023-11-28	56.39	32.62	5.31	2.91	0.54
182	2023-11-29	63.07	36.30	5.90	3.25	0.60
183	2023-11-30	58.21	33.43	5.45	3.00	0.56
184	2023-12-01	68.41	39.39	6.42	3.52	0.66
185	2023-12-02	43.17	24.85	4.05	2.22	0.41
186	2023-12-03	41.23	23.80	3.87	2.14	0.39
187	2023-12-04	44.31	25.53	4.17	2.29	0.43
188	2023-12-05	15.31	8.75	1.44	0.79	0.14
189	2023-12-06	NA	NA	NA	NA	NA
190	2023-12-07	96.36	53.00	9.05	4.96	0.92
191	2023-12-08	50.53	29.10	4.75	2.60	0.49

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
192	2023-12-09	34.40	19.76	3.23	1.76	0.33
193	2023-12-10	35.56	20.48	3.32	1.83	0.34
194	2023-12-11	NA	NA	NA	NA	NA
195	2023-12-12	NA	NA	NA	NA	NA
196	2023-12-13	NA	NA	NA	NA	NA
197	2023-12-14	NA	NA	NA	NA	NA
198	2023-12-15	NA	NA	NA	NA	NA
199	2023-12-16	74.29	42.56	6.98	3.81	0.71
200	2023-12-17	70.49	40.33	6.66	3.65	0.68
201	2023-12-18	80.77	46.26	7.75	4.25	0.79
202	2023-12-19	88.60	50.16	8.82	4.82	0.90
203	2023-12-20	92.88	51.98	9.05	4.96	0.93
204	2023-12-21	85.92	48.96	8.72	4.78	0.89
205	2023-12-22	85.08	48.96	7.99	4.38	0.81
206	2023-12-23	84.55	48.14	8.12	4.45	0.83
207	2023-12-24	85.23	48.55	8.37	4.59	0.85
208	2023-12-25	84.90	48.38	8.24	4.52	0.84
209	2023-12-26	78.67	45.09	7.44	4.08	0.76
210	2023-12-27	71.70	41.15	6.90	3.78	0.71
211	2023-12-28	62.06	35.68	5.84	3.20	0.60
212	2023-12-29	74.57	42.73	7.04	3.87	0.72
213	2023-12-30	85.59	48.01	8.50	4.67	0.86
214	2023-12-31	85.91	49.16	8.16	4.48	0.83
215	2024-01-01	85.07	48.54	8.18	4.49	0.83
216	2024-01-02	91.89	51.87	8.91	4.89	0.91
217	2024-01-03	95.46	52.99	11.70	6.42	1.20

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
218	2024-01-04	89.34	50.82	8.75	4.80	0.89
219	2024-01-05	64.56	37.14	6.09	3.34	0.62
220	2024-01-06	75.72	43.08	7.26	3.92	0.74
221	2024-01-07	60.92	35.07	5.69	3.13	0.58
222	2024-01-08	NA	NA	NA	NA	NA
223	2024-01-09	94.02	52.62	32.86	18.02	3.25
224	2024-01-10	96.00	53.00	62.00	34.00	6.32
225	2024-01-11	NA	NA	NA	NA	NA
226	2024-01-12	NA	NA	NA	NA	NA
227	2024-01-13	NA	NA	NA	NA	NA
228	2024-01-14	NA	NA	NA	NA	NA
229	2024-01-15	NA	NA	NA	NA	NA
230	2024-01-16	NA	NA	NA	NA	NA
231	2024-01-17	NA	NA	NA	NA	NA
232	2024-01-18	NA	NA	NA	NA	NA
233	2024-01-19	NA	NA	NA	NA	NA
234	2024-01-20	NA	NA	NA	NA	NA
235	2024-01-21	NA	NA	NA	NA	NA
236	2024-01-22	NA	NA	NA	NA	NA
237	2024-01-23	NA	NA	NA	NA	NA
238	2024-01-24	NA	NA	NA	NA	NA
239	2024-01-25	NA	NA	NA	NA	NA
240	2024-01-26	NA	NA	NA	NA	NA
241	2024-01-27	NA	NA	NA	NA	NA
242	2024-01-28	NA	NA	NA	NA	NA
243	2024-01-29	NA	NA	NA	NA	NA

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
244	2024-01-30	NA	NA	NA	NA	NA
245	2024-01-31	NA	NA	NA	NA	NA
246	2024-02-01	NA	NA	NA	NA	NA
247	2024-02-02	NA	NA	NA	NA	NA
248	2024-02-03	NA	NA	NA	NA	NA
249	2024-02-04	NA	NA	NA	NA	NA
250	2024-02-05	NA	NA	NA	NA	NA
251	2024-02-06	NA	NA	NA	NA	NA
252	2024-02-07	NA	NA	NA	NA	NA
253	2024-02-08	NA	NA	NA	NA	NA
254	2024-02-09	NA	NA	NA	NA	NA
255	2024-02-10	NA	NA	NA	NA	NA
256	2024-02-11	NA	NA	NA	NA	NA
257	2024-02-12	NA	NA	NA	NA	NA
258	2024-02-13	NA	NA	NA	NA	NA
259	2024-02-14	NA	NA	NA	NA	NA
260	2024-02-15	52.79	25.68	11.76	15.04	0.58
261	2024-02-16	52.40	26.77	11.71	15.05	0.55
262	2024-02-17	52.68	26.24	11.63	15.22	0.54
263	2024-02-18	52.30	26.58	11.54	15.05	0.56
264	2024-02-19	52.66	26.75	11.52	15.08	0.54
265	2024-02-20	52.37	26.52	11.46	14.91	0.54
266	2024-02-21	52.50	26.45	11.50	15.03	0.55
267	2024-02-22	52.52	26.24	11.42	15.10	0.56
268	2024-02-23	52.49	26.31	11.56	14.89	0.56
269	2024-02-24	52.59	26.69	11.57	15.05	0.55

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
270	2024-02-25	52.22	26.37	11.42	15.00	0.55
271	2024-02-26	52.74	26.43	11.50	15.00	0.54
272	2024-02-27	52.34	26.29	11.59	14.79	0.55
273	2024-02-28	52.27	26.56	11.57	15.06	0.56
274	2024-02-29	52.69	26.44	11.54	14.86	0.56
275	2024-03-01	52.26	26.52	11.48	14.93	0.54
276	2024-03-02	52.68	26.76	11.49	14.97	0.55
277	2024-03-03	52.32	26.49	11.36	15.06	0.54
278	2024-03-04	52.65	26.45	11.59	14.95	0.54
279	2024-03-05	52.63	26.24	11.43	15.09	0.54
280	2024-03-06	52.40	26.84	11.49	15.00	0.54
281	2024-03-07	52.48	26.32	11.54	14.95	0.55
282	2024-03-08	52.40	26.29	11.47	14.96	0.53
283	2024-03-09	52.59	26.18	11.56	15.12	0.55
284	2024-03-10	52.54	26.27	11.65	14.96	0.55
285	2024-03-11	52.55	26.70	11.57	15.16	0.54
286	2024-03-12	52.90	26.37	11.60	15.25	0.54
287	2024-03-13	52.29	25.84	11.21	14.94	0.53
288	2024-03-14	52.70	26.28	11.57	15.05	0.55
289	2024-03-15	52.48	26.36	11.62	15.08	0.55
290	2024-03-16	52.66	26.90	11.57	15.00	0.55
291	2024-03-17	52.44	26.01	11.66	15.09	0.55
292	2024-03-18	52.50	26.73	11.51	15.01	0.55
293	2024-03-19	52.59	26.60	11.63	14.85	0.55
294	2024-03-20	52.41	26.41	11.47	15.08	0.55
295	2024-03-21	52.65	26.20	11.66	14.91	0.55

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
296	2024-03-22	52.34	26.44	11.60	15.02	0.56
297	2024-03-23	52.56	26.77	11.50	15.05	0.55
298	2024-03-24	52.27	26.47	11.46	14.97	0.56
299	2024-03-25	52.65	26.66	11.55	15.03	0.55
300	2024-03-26	52.66	26.37	11.59	15.03	0.55
301	2024-03-27	52.71	26.78	11.57	15.12	0.55
302	2024-03-28	52.69	26.40	11.59	14.94	0.54
303	2024-03-29	52.66	26.01	11.40	15.02	0.54
304	2024-03-30	52.58	26.50	11.61	15.04	0.54
305	2024-03-31	52.48	26.32	11.45	14.99	0.54
306	2024-04-01	52.62	26.41	11.33	14.96	0.55
307	2024-04-02	52.57	26.49	11.49	14.94	0.56
308	2024-04-03	52.52	26.81	11.68	15.00	0.56
309	2024-04-04	52.52	26.47	11.56	14.95	0.55
310	2024-04-05	52.57	26.28	11.45	14.98	0.55
311	2024-04-06	52.66	26.48	11.46	14.90	0.55
312	2024-04-07	52.53	26.78	11.55	15.01	0.55
313	2024-04-08	52.36	26.16	11.61	14.88	0.55
314	2024-04-09	54.32	26.15	12.22	14.77	0.49
315	2024-04-10	52.01	28.19	11.96	15.90	0.69
316	2024-04-11	NA	NA	NA	NA	NA
317	2024-04-12	52.96	26.31	11.44	15.02	0.55
318	2024-04-13	52.49	26.23	11.42	15.00	0.55
319	2024-04-14	52.40	26.46	11.45	15.06	0.56
320	2024-04-15	52.72	26.50	11.49	15.10	0.54
321	2024-04-16	52.78	26.47	11.40	15.07	0.54

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
322	2024-04-17	52.47	26.64	11.59	14.98	0.55
323	2024-04-18	52.52	26.38	11.73	15.06	0.55
324	2024-04-19	52.51	26.26	11.45	14.99	0.56
325	2024-04-20	52.27	26.50	11.56	14.63	0.50
326	2024-04-21	NA	NA	NA	NA	NA
327	2024-04-22	52.66	26.62	11.85	14.92	0.55
328	2024-04-23	52.64	26.66	11.50	14.94	0.55
329	2024-04-24	52.21	26.42	11.56	14.98	0.56
330	2024-04-25	52.62	26.76	11.57	15.02	0.54
331	2024-04-26	52.26	26.12	11.36	14.99	0.56
332	2024-04-27	52.20	26.35	11.50	14.88	0.56
333	2024-04-28	52.97	26.26	11.57	15.10	0.53
334	2024-04-29	52.37	26.03	11.83	14.76	0.58
335	2024-04-30	51.78	26.05	11.20	14.60	0.54
336	2024-05-01	NA	NA	NA	NA	NA
337	2024-05-02	52.60	26.44	11.55	15.03	0.55
338	2024-05-03	35.62	18.46	11.55	14.81	0.55
339	2024-05-04	12.22	6.98	11.47	14.95	0.54
340	2024-05-05	13.33	7.62	11.56	15.00	0.55
341	2024-05-06	13.38	7.65	11.44	15.05	0.55
342	2024-05-07	10.44	5.96	11.53	14.99	0.55
343	2024-05-08	15.48	8.84	11.51	15.11	0.55
344	2024-05-09	9.12	5.21	11.47	15.14	0.55
345	2024-05-10	11.54	6.59	11.48	15.09	0.54
346	2024-05-11	11.85	6.77	11.61	14.95	0.53
347	2024-05-12	NA	NA	NA	NA	NA

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Sl No	Time	Station_2_Thadi-PM10 - (ug/m3) Raw	Station_2_Thadi-PM2.5 - (ug/m3) Raw	Station_2_Thadi-SO2 - (ug/m3) Raw	Station_2_Thadi-NOx - (ug/m3) Raw	Station_2_Thadi-NH3 - (ug/m3) Raw
348	2024-05-13	NA	NA	NA	NA	NA
349	2024-05-14	17.67	10.10	11.48	14.95	0.55
350	2024-05-15	16.96	9.69	11.61	14.99	0.55
351	2024-05-16	10.07	5.75	11.49	14.95	0.55
352	2024-05-17	9.48	5.42	NA	NA	NA
353	2024-05-18	10.18	5.81	11.46	14.63	0.56
354	2024-05-19	6.15	3.51	11.28	15.29	0.56
355	2024-05-20	8.20	4.68	11.57	14.94	0.56
356	2024-05-21	9.81	5.60	11.57	14.96	0.54
357	2024-05-22	10.48	5.99	11.39	15.02	0.56
358	2024-05-23	9.12	5.21	11.55	14.95	0.56
359	2024-05-24	11.71	6.69	11.43	14.97	0.55
360	2024-05-25	20.70	11.83	11.45	14.92	0.54
361	2024-05-26	24.00	13.71	11.51	14.99	0.55
362	2024-05-27	26.09	14.91	11.55	15.06	0.56
363	2024-05-28	28.89	16.51	11.42	14.95	0.55
364	2024-05-29	26.77	15.30	11.65	15.04	0.56
365	2024-05-30	25.42	14.52	11.55	14.90	0.56
366	2024-05-31	25.94	14.82	11.45	15.14	0.52

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ZONAL LABORATORY :: VISAKHAPATNAM
39-33-20/4/1,Madhavadhara VUDA Colony,
Visakhapatnam - 530018. *Ph : 0891 – 2719380/481*

Consolidated statement of Analysis Results

NAMP Location: M/s.Visakha Pharmacity,JNPC,Parawada,Anakapalli District

Parameters	Monthly average(µg/m3)													
	Jun-23	July-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Average	Standard
PM10	79.0	61.0	71.0	70.0	93.0	120.0	118.0	138.0	104.0	81.0	66.0	67.0	89	60.
PM2.5	28.0	26.0	27.0	28.0	37.0	41.0	46.0	50.0	37.0	33.0	27.0	25.0	33.75	40.0
SO2	10.0	11.4	10.0	11.0	11.0	10.0	10.0	12.0	11.0	10.0	9.0	9.0	10.34	50.0
NO2	20.0	18.9	19.0	22.0	26.0	24.0	21.0	25.0	23.0	22.0	22.0	21.0	21.99	40.0
NH3	24.0	37.2	41.0	30.0	29.0	27.0	28.0	31.0	28.0	26	26.0	24.0	29.27	100.0

NAMP: National Ambient Air Quality Monitoring Programme.

27/06/24
SENIOR ENVIRONMENTAL SCIENTST

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A.P. POLLUTION CONTROL BOARD
ZONAL LABORATORY:: VISAKHAPATNAM

Consolidated report of marine outfall discharges by M/s Visakhapatnam Pharma City Limited (Formerly M/s Ramky Pharma City (I) Ltd.,) JNPC, Parawada, Anakapalli District for the period from June 2023 to May 2024

S.No.	June 2023 to May 2024		Parameters exceeded
	Guard Pond Samples Collected	Guard Pond Samples Rejected	TSS,COD & NH_3-N
1.	305	16	

Note:

1. Out of 305 samples, 16 samples were rejected from June 2023 to May 2024, the rejection percentage is 5.25% only for the last year.
2. In case of the treated wastewater is not meeting the marine discharge standards, it will not be allowed for discharge into sea and sent back to CETP for re-treatment till comply with the marine discharge standards.

SENIOR ENVIRONMENTAL SCIENTIST

03/7/24

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Chapter 7

Off Tikkavanipalem (Zone 5)

Coastal waters off Tikkavanipalem (Zone 5) contain marine outfall points (MOP) of pharmaceutical industry, i.e., M/s. JN Pharama City Ltd. and National Thermal Power Corporation (NTPC) Ltd. (Fig. 2.5). Tikkavanipalem is a coastal village situated towards south of Visakhapatnam. National Institute of Oceanography has carried out Rapid Marine Environmental Assessment studies to identify the marine out fall points for discharge of treated effluents from JN Pharma City Ltd. The NTPC project involves intake pipeline for drawl of seawater for cooling purpose and outfall pipeline for discharge of seawater into the sea. There is an existing corridor for intake of seawater for cooling purpose and discharge of water into the sea through a jetty at land fall point. The estimated discharge through Central Monitoring Basin (CMB) is 5870 cum/hr for Stage – I. The treated wastewater of Stage - I is being discharged into the sea at 400 m from the High Tide Line at a depth of 4 m. The discharge point selected by NTPC was not as suggested by NIO, but as recommended by some other Organization.

The location of the M/s. JN Pharma City is at about 30 km west of Visakhapatnam city. As the Pharma City comprises of several bulk drugs, pharmaceuticals and chemical sectors, the waste discharges are associated with high organic pollutant load. This industry is considered as one of the major 17 groups of industries for priority action for the control of pollution by Central Pollution Control Board. In order to maintain cleaner environment and achieve sustainability of the concerned industrial sector, the Pharma City decided to discharge the treated effluents into the sea through a pipeline as per the new guidelines of Ministry of Environment and Forests (MoEF) and Andhra Pradesh Pollution Control Board (APPCB). The discharge point suggested

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by NIO for JN Pharma City is at a depth of 18 m and at a distance of 1.44 km from the coast. Results of studies conducted in the coastal waters off Tikkavanipalem during pre- and post-monsoon seasons were discussed in this chapter

7.1 Physico-chemical parameters

Results of physico-chemical parameters studied in the coastal waters off Tikkavanipalem (zone 5) during pre monsoon and post monsoon seasons were given Tables 7.1a to 7.1c and 7.2a to 7.2c, respectively. Water column temperature of this zone varied from 26.6 to 27.3^{o}C in the surface and 25.8 to 27.1^{o}C in the bottom, with mean temperature of 27.0^{o}C and 26.4^{o}C, respectively, during pre monsoon (Table 7.1a). Relatively lower ranges of mean temperature were observed during post monsoon in both surface (mean: 24.2^{o}C; range: 23.2 to 24.4^{o}C) and bottom waters (mean: 24.4^{o}C; range: 23.7 to 25.3^{o}C) (Table 7.2a). Salinity ranged from 33.3 to 33.7 PSU, with a mean salinity of 33.5 PSU in the surface, and from 33.5 to 34.0 PSU (mean: 33.7 PSU) in bottom waters of this region during pre monsoon season (Table 7.1a). Compared to the pre monsoon, relatively lower salinities were found during post monsoon, with mean salinities of 29.2 PSU in the surface (range: 28.9 to 29.6 PSU) and 29.5 PSU in the bottom (range: 29.0 to 30.4 PSU) waters of this region (Table 7.2a). Total suspended matter (TSM) varied from 14.5 to 33.8 mg/L (mean: 18.6 mg/L) in the surface and from 15.8 to 23.0 mg/L (mean (18.7 mg/L) in the bottom waters during pre monsoon (Table 7.1a). Slightly lower range of TSM concentrations were found during the post monsoon season both in the surface (range: 8.0 to 21.7 mg/L; mean: 11.9 mg/L) and bottom waters as well (9.1 to 16.2 mg/L and 11.5 mg/L, respectively (Table 7.2a). TSM concentrations found in this study are very close to those reported in the previous study conducted in this region during 2011 (Table 7.3). pH values of surface and bottom waters in the region varied from 7.3 to 8.1 (mean: 7.6) and from 7.4 to 7.9

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(mean: 7.6), respectively, during pre monsoon season (Table 7.1a). During post monsoon season, the ranges of pH values in the surface and bottom waters are relatively higher where it ranged from 8.3 to 9.0 in the surface and from 8.1 to 8.6 in the bottom waters.

Dissolved oxygen (DO) concentrations ranged from 6.1 to 6.7 mg/L (mean 6.3 mg/L) in the surface and from 3.9 to 6.4 mg/L (mean 4.8 mg/L) in the bottom waters during pre monsoon season (Table 7.1b). These DO concentrations are relatively lower when compared to those obtained during pre monsoon season of the year 2011 in this region (6.5 to 8.3 mg/L) (Fig. 7.1) (Table 7.3). Relatively higher DO concentrations were found during post monsoon season in both surface (range: 6.4 to 7.8 mg/L; mean: 7.1 mg/L) and bottom waters (6.6 to 7.7 mg/L and 7.1 mg/L, respectively (Table 7.2b) compared to the pre monsoon season (Table 7.1b). DO concentrations found during the post monsoon season are consistent with those obtained in this region during 2011 study (6.2 to 8.9 mg/L) (Fig. 7.1) (Table 7.3). Relatively lower dissolved oxygen concentrations during pre monsoon season may be due to the increased input of organic matter contamination through the release of treated effluents from JN Pharma City Ltd. and/or from NTPC Ltd. and Hindhuja Ltd. Biochemical oxygen demand for five days (BOD_5) values varied from 3.9 to 4.4 and from 2.5 to 4.1 mg/L, with mean BOD_5 values of 4.0 mg/L and 3.1 mg/L in the surface and bottom waters, respectively, during pre monsoon season (Table 7.1b). Relatively lower ranges of BOD_5 values were found during post monsoon season in both surface (range: 0.2 to 1.4 mg/L; mean: 0.7 mg/L) and bottom (range: 0.3 to 1.7 mg/L; mean: 0.84 mg/L) waters (Table 7.2b). BOD_5 values found in this study are relatively lower during post monsoon season and higher during pre monsoon season when compared to those found in previous monitoring study conducted in this region in 2011 (Table 7.3). Ammonium concentrations ranged from 0.3 to 3.1 µM (mean: 1.2 µM) in the surface and from 0.1 to 3.1 µM (mean: 1.4

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μM) in the bottom waters during pre monsoon (Table 7.1b). Relatively lower concentrations of

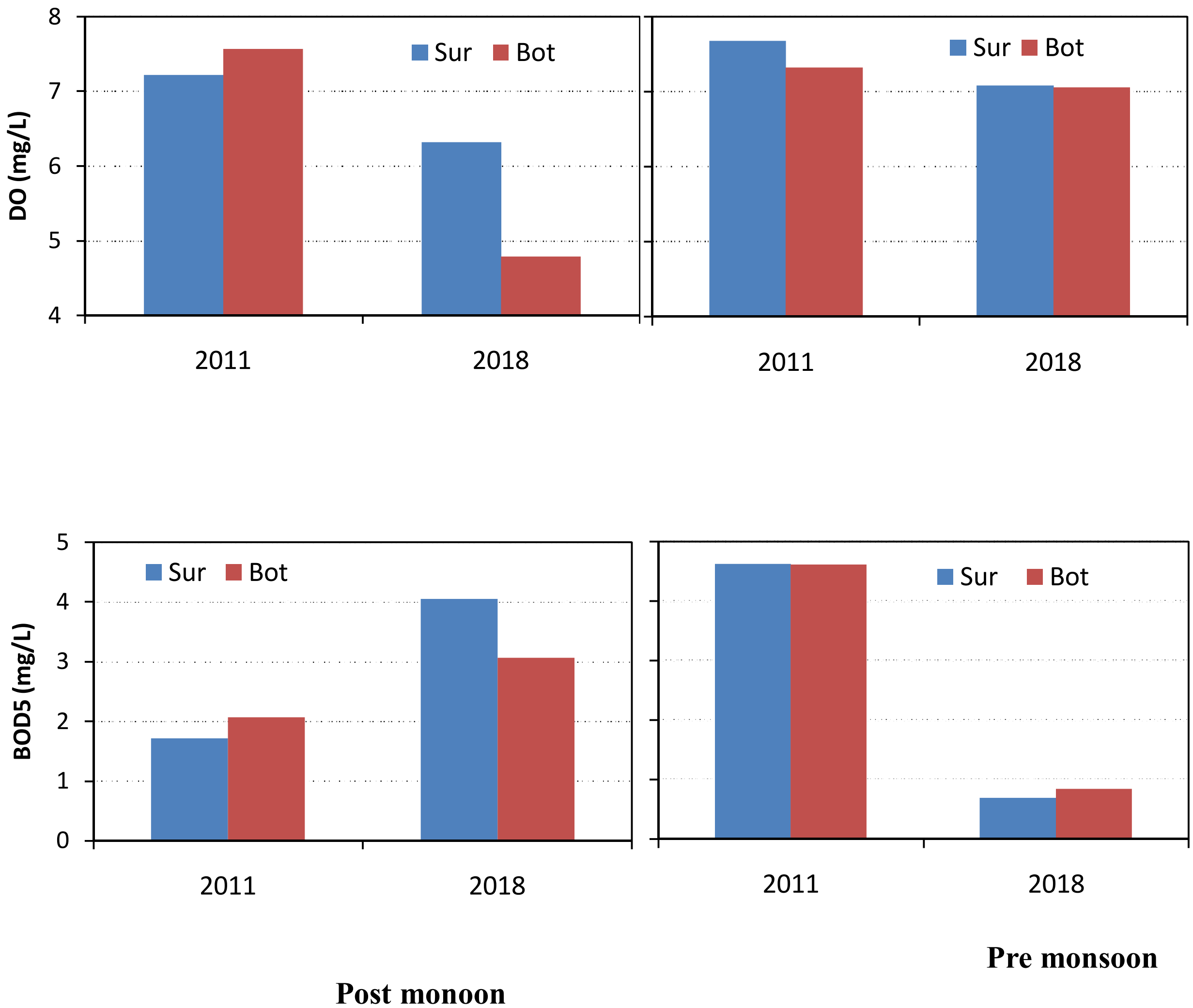

Fig. 7.1: Comparison of mean dissolved oxygen (DO; mg/L) and biochemical oxygen demand (BOD; mg/L) concentrations in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

ammonium were found in this region during post monsoon season, with similar mean values of 0.3 μM (range: 0.1 to 0.5 μM) in the surface and 0.4 μM (range: 0.3 to 0.6 μM) in the bottom

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waters (Table 7.2b). Relatively higher ammonium concentrations were found at the MOP of JN Pharma City Ltd. in both surface and bottom waters. Phosphate concentrations ranged from 0.4 µM to 2.2 µM (mean: 1.3 µM) in the surface and from 0.7 µM to 2.6 µM (mean: 1.6 µM) in the bottom waters during pre monsoon season (Table 7.1b). Considerably lower concentrations of phosphate were found in the surface (mean: 0.4 µM; range: 0.1 to 0.9 µM) and bottom (0.6 µM; range: 0.1 to 1.5 µM) waters during post monsoon season (Table 7.2c). Dissolved inorganic silicate concentrations ranged from as low as 0.6 µM to as high as 6.4 µM (mean: 4.4 µM) in the surface and from 3.9 to 26.9 µM (mean: 7.6 µM) in the bottom waters during pre monsoon (Table 7.1c). Relatively higher silicate concentrations were found during post monsoon season, with mean silicate concentrations of 6.4 µM (range: 0.3 to 16.3 µM) in the surface and 9.6 µM (range: 4.3 to 20.9 µM) in the bottom waters (Table 7.2c). Higher silicate concentrations during the post monsoon season are mainly due to the influence of freshwater input to the study region through river discharge during the monsoon and equator ward flow of freshwaters from the northern Bay of Bengal by the southward flowing EICC during post monsoon season. Nitrite concentrations ranged from 0.1 to 0.3 µM (mean: 0.2 µM) in the surface and 0.1 to 0.5 µM (mean: 0.2 µM) in the bottom waters during the pre monsoon season (Table 7.1c). Relatively higher concentrations of nitrite were found during post monsoon in the surface (0.1 to 2.7 µM) and bottom (0.1 to 3.4 µM) waters, with mean nitrite concentrations of 0.5 µM and 1.0 µM in the surface and bottom waters, respectively. Dissolved inorganic nitrate concentrations varied from 0.6 to 1.9 µM (mean: 1.0 µM) and from 0.8 to 2.3 µM (mean: 1.3 µM) in the surface and bottom waters, respectively, during pre monsoon (Table. 7.1c). Similar range of nitrate concentrations were found during post monsoon, with man nitrate concentrations of 0.8 µM (range: 0.1 to 3.6 µM) in the surface and 0.8 µM (range: 0.1 to 2.3 µM) in the bottom waters (Table 7.2c). Mean

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total phosphorus (TP) concentrations were found to be 0.9 µM (range: 0.2 to 2.2 µM) in the surface and 1.7 µM (range: 0.7 to 3.0 µM) in the bottom waters of this region during post monsoon season (Table 7.2b). Total petroleum hydrocarbon (TPHC) concentrations varied from as low as 1.5 to as high as 54.0 µg/L (mean: 13.6 µg/L) in the surface and from 2.4 to 38.8 µg/L (mean: 12.8 µg/L) in the bottom waters of this region during post monsoon. These PHC concentrations are higher compared to those obtained during 2011 study in this region (1.0 to 34.1 µg/L), indicating that increased input of PHC to this region in recent years.

Results of physico-chemical parameters studied in the coastal waters off Tikkavanipalem (zone 5) showed no significant deviation from ambient concentrations of the physico-chemical parameters in the coastal waters of east coast of India, except for dissolved oxygen. Mean dissolved oxygen concentrations in bottom waters of this zone during pre monsoon (mean: 4.8 mg/L) are slightly depleted than the threshold limit of dissolved oxygen for healthy coastal waters (5.0 mg/L), indicating that the coastal waters of this region are at the initial stage of deterioration in water quality. It could be due to the increased input of organic matter contamination through treated effluent release from JN Pharma City Ltd. and/or NTPC Ltd. and Hindhuja Ltd. However, coastal waters of this region are well oxygenated during post monsoon season. Comparison of physico-chemical data obtained in this study with that of the study conducted in this region during pre and post monsoon seasons of 2011 was given in Table 7.3. Seasonal variability between pre and post monsoon season were attributed to input of freshwater discharge from rivers during the southwest monsoon (June-September) and southward flow of freshwaters from the northern Bay of Bengal to the present study region by the equator ward flowing east Indian coastal current (EICC) during October-December. Although, PHC concentrations in this study were found to be higher compared to reported values from this

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region in 2011, however, they are within the threshold limit, indicating no significant pollution of TPHC in this region.

Table 7.1a: Spatial variability in temperature (^{o}C), Salinity (PSU), total suspended matter (mg/L) and pH in surface and bottom waters off Tikkavanipalem coast during the pre monsoon season

Station	Temperature (^{o}C)		Salinity (PSU)		TSM (mg/l)		pH	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	26.8	26.8	33.7	33.5	17.6	18.0	7.3	7.6
TVM-2	26.9	26.7	33.6	33.5	17.0	20.2	7.6	-
TVM-3	26.9	26.8	33.5	33.6	15.0	16.5	7.7	7.8
TVM-4	-	-	-	-	-	-	7.9	7.6
TVM-5	26.8	26.7	33.5	33.6	33.8	22.1	7.3	7.7
TVM-6	27.2	26.6	33.5	33.9	-	17.3	7.6	7.4
TVM-7	27.1	27.1	33.5	33.5	16.3	17.9	7.3	7.4
TVM-8	27.2	26.0	33.4	33.8	23.0	21.9	7.7	7.7
TVM-9	27.3	26.0	33.3	33.8	-	15.8	-	7.7
TVM-10	27.3	26.5	33.4	33.7	15.9	19.9	7.5	7.5
TVM-11	27.0	25.9	33.3	33.9	14.5	23.0	7.3	7.5
TVM-12	27.1	25.9	33.4	33.9	18.7	18.5	7.4	7.5
TVM-13	27.0	25.8	33.3	34.0	20.4	17.8	8.1	7.6
TVM-14	27.2	26.0	33.4	33.8	17.2	19.0	7.4	7.7
TVM-15	27.0	26.2	33.4	33.8	14.6	18.2	7.8	7.8
TVM-16	27.1	26.1	33.4	33.9	17.6	19.8	7.8	7.9
NTP-MOP	26.8	26.9	33.7	33.7	19.6	15.8	7.6	7.5
JNP-MOP	26.6	26.0	33.6	33.8	18.0	15.8	-	-

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Table 7.1b: Spatial variability in dissolved oxygen (mg/L), biochemical oxygen demand (BOD_5; mg/L), ammonium (µM) and phosphate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	DO (mg/l)		BOD_5 (mg/l)		Ammonium (µM)		Phosphate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	-	6.1	4.2	4.0	0.6	0.6	0.5	0.7
TVM-2	6.7	5.9	4.4	3.9	0.3	-	1.3	1.3
TVM-3	6.1	6.2	4.1	4.1	0.6	1.3	1.3	1.2
TVM-4	6.2	3.9	4.0	2.5	1.3	0.3	1.6	1.7
TVM-5	6.1	6.4	4.1	4.0	1.3	0.1	1.8	1.9
TVM-6	6.4	6.1	4.1	3.6	0.7	0.6	1.7	1.7
TVM-7	6.5	6.4	4.3	4.1	0.4	2.0	2.0	2.6
TVM-8	6.4	4.4	3.9	2.8	0.7	0.6	1.8	2.0
TVM-9	6.4	4.2	4.0	2.9	1.1	0.6	0.9	0.9
TVM-10	6.4	4.0	3.9	2.6	0.4	1.3	1.3	1.7
TVM-11	6.7	3.9	3.9	2.5	0.4	2.0	1.8	2.3
TVM-12	6.4	4.1	3.9	2.5	1.8	2.7	0.9	1.4
TVM-13	6.2	3.9	4.2	2.5	2.1	1.4	0.8	1.7
TVM-14	6.2	4.0	3.9	2.6	2.6	2.8	0.9	1.9
TVM-15	6.1	3.9	4.0	2.6	1.3	1.7	0.4	0.7
TVM-16	6.2	3.9	4.3	2.6	1.6	1.4	0.5	2.2
NTP-MOP	6.2	4.1	4.1	2.6	0.9	0.9	1.7	0.8
JNP-MOP	-	-	-	-	3.1	3.1	2.2	1.7

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Table 7.1c: Spatial variability in silicate (µM) nitrite (µM) and nitrate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	Silicate (µM)		Nitrite (µM)		Nitrate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	5.1	26.9	0.1	0.2	1.0	1.2
TVM-2	-	-	0.2	0.2	0.9	1.0
TVM-3	5.4	4.8	0.1	0.2	0.9	1.6
TVM-4	6.4	4.5	0.1	0.2	1.2	0.8
TVM-5	5.9	9.0	0.1	0.2	0.9	0.8
TVM-6	5.7	7.5	0.2	0.1	0.9	1.2
TVM-7	4.6	5.2	0.2	0.1	1.2	1.4
TVM-8	3.1	8.1	0.2	0.2	1.0	1.4
TVM-9	3.1	7.3	0.3	0.1	1.1	1.0
TVM-10	0.9	5.9	0.2	0.2	0.8	1.3
TVM-11	3.9	7.3	0.2	0.3	0.8	0.9
TVM-12	4.1	7.4	0.3	0.4	0.9	1.2
TVM-13	3.9	5.4	0.2	0.5	1.2	1.2
TVM-14	4.5	5.0	0.2	0.3	0.6	1.0
TVM-15	3.2	9.0	0.1	0.2	0.9	1.9
TVM-16	3.9	7.8	0.1	0.2	1.9	2.3
NTP-MOP	5.4	4.1	0.1	0.1	0.7	1.1
JNP-MOP	0.6	3.9	0.1	0.2	1.2	1.0

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Table 7.2a: Spatial variability in temperature (^{o}C), Salinity (PSU), total suspended matter (mg/L) and pH in surface and bottom waters off Tikkavanipalem coast during the post monsoon season

Station	Temperature (^{o}C)		Salinity (PSU)		pH		TSM (mg/l)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	24.1	24.0	29.3	29.3	8.4	8.5	8.9	-
TVM-2	24.3	24.3	29.3	29.2	8.6	8.6	11.1	10.7
TVM-3	24.3	24.4	29.3	29.0	8.6	8.4	10.1	9.8
TVM-4	24.3	24.5	29.2	29.7	8.3	8.4	9.8	14.2
TVM-5	24.3	24.3	29.0	29.4	8.4	8.4	9.5	14.4
TVM-6	24.4	24.2	29.2	29.3	8.4	8.6	17.9	12.2
TVM-7	24.3	23.9	29.2	29.3	8.5	8.5	10.7	10.4
TVM-8	24.2	24.3	29.3	29.3	9.0	8.5	21.7	16.2
TVM-9	24.1	24.4	29.3	29.5	8.6	8.6	9.9	10.6
TVM-10	24.0	24.7	29.4	29.3	8.6	8.1	10.7	9.1
TVM-11	24.2	25.3	29.3	30.3	8.5	8.5	16.7	10.1
TVM-12	24.2	24.3	29.3	30.2	8.5	8.4	8.0	9.3
TVM-13	24.1	25.2	29.4	30.4	8.6	8.5	10.5	15.5
TVM-14	23.2	24.9	29.6	29.9	8.5	8.5	15.0	11.7
TVM-15	24.0	24.5	29.3	29.3	8.4	8.4	10.9	10.6
TVM-16	24.3	24.2	28.9	29.3	8.5	8.4	10.5	10.5
JNP-MOP	24.3	24.4	29.2	29.3	8.4	8.3	10.5	9.7
NTPC-MOP	24.2	23.7	29.0	29.2	8.6	8.4	11.5	10.4

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Table 7.2b: Spatial variability in dissolved oxygen (mg/L), biochemical oxygen demand (BOD_5; mg/L), total phosphorous (µM) and ammonium (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	DO (mg/l)		BOD_5 (mg/l)		TP (µM)		Ammonium (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	6.7	6.7	1.0	1.2	0.5	0.8	0.3	0.4
TVM-2	7.2	7.1	1.4	1.7	0.8	0.7	0.5	0.6
TVM-3	7.0	6.9	1.0	1.4	0.7	1.1	0.5	0.6
TVM-4	7.6	7.3	0.6	0.9	1.3	2.3	0.4	0.4
TVM-5	7.3	7.4	0.2	0.8	0.2	1.4	-	0.3
TVM-6	6.7	6.8	0.8	1.0	2.2	2.8	0.4	0.5
TVM-7	6.4	6.6	1.2	1.5	1.0	2.5	0.1	0.3
TVM-8	6.8	6.8	0.3	0.7	1.0	2.9	0.3	0.4
TVM-9	7.8	7.7	0.4	0.6	1.0	1.4	0.3	0.4
TVM-10	7.1	7.1	0.2	0.5	0.7	1.1	-	-
TVM-11	7.5	7.4	0.6	0.4	0.6	1.7	0.3	0.4
TVM-12	6.6	6.8	0.7	0.6	0.8	3.0	0.5	0.5
TVM-13	7.0	7.0	0.5	0.3	0.4	0.9	0.3	0.5
TVM-14	7.5	7.3	0.3	0.5	1.2	1.9	0.1	0.3
TVM-15	6.6	6.6	1.3	1.1	0.7	1.2	0.4	0.5
TVM-16	7.6	7.5	1.0	0.8	0.8	1.0	0.1	0.3
JNP-MOP	7.2	7.2	0.3	0.5	1.7	1.2	0.5	0.5
NTPC-MOP	6.6	6.7	0.7	0.6	1.1	2.0	-	0.4

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Table 7.2c: Spatial variability in nitrite (µM), nitrate (µM), phosphate (µM) and silicate (µM) concentrations in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	Nitrite (µM)		Nitrate (µM)		Phosphate (µM)		Silicate (µM)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
TVM-1	0.6	0.2	0.5	0.1	0.4	0.7	0.7	11.2
TVM-2	1.1	0.7	0.6	0.6	0.2	0.2	4.6	7.3
TVM-3	0.3	0.2	0.4	0.6	0.5	0.1	6.9	8.4
TVM-4	2.7	3.4	1.9	2.3	0.2	0.9	6.4	7.6
TVM-5	0.2	0.2	0.6	1.0	-	0.3	7.9	8.7
TVM-6	0.2	2.7	0.4	1.9	0.2	1.5	8.8	4.3
TVM-7	0.2	0.4	0.9	0.4	0.8	0.7	0.3	6.8
TVM-8	0.2	0.1	0.5	0.4	0.1	0.7	7.9	11.6
TVM-9	0.2	2.5	0.1	2.2	0.7	0.7	8.3	11.2
TVM-10	0.2	1.0	0.6	0.2	0.2	0.2	8.7	17.5
TVM-11	0.1	0.2	0.4	0.4	0.5	0.7	5.8	4.8
TVM-12	0.3	0.5	0.3	0.6	0.5	0.7	6.0	7.3
TVM-13	0.2	7.7	1.5	0.1	0.2	0.2	2.1	7.0
TVM-14	0.6	0.2	3.6	0.4	0.9	0.9	6.4	6.8
TVM-15	0.3	2.4	0.4	1.7	0.2	0.9	5.2	15.2
TVM-16	0.3	0.8	0.4	0.6	0.3	0.7	1.2	7.1
JNP-MOP	0.4	0.2	0.4	0.9	0.7	0.2	16.3	8.7
NTPC-MOP	0.5	0.4	0.4	0.5	0.7	1.0	11.4	20.9

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Table 7.2d: Spatial variability in total petroleum hydrocarbon concentrations (TPHC; µg/L) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	PHC (µg/L)	
Name	Surface	Bottom
JNP-MOP	54.0	4.3
NTPCMOP	4.0	19.9
TVM-1	8.7	-
TVM2	18.1	12.8
TVM3	6.4	2.4
TVM4	5.7	3.0
TVM5	18.4	7.0
TVM6	-	3.0
TVM7	15.2	3.7
TVM8	1.5	10.1
TVM9	9.8	5.9
TVM10	**-**	**-**
TVM11	**4.2**	**10.3**
TVM12	**-**	**37.5**
TVM13	**9.9**	**38.8**
TVM14	**27.6**	**5.1**
TVM15	**7.1**	**28.6**
TVM16	**-**	**-**

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Table 7.3: Comparison of data obtained for various physico-chemical parameters during pre monsoon and post monsoon seasons of 2011 and 2018 (present study) in the coastal waters off Tikkavanipalem.

Parameter	Pre monsoon		Post monsoon	
	2011	Present study	2011	Present study
Temperature	26.9 – 27.9	25.8 – 27.3	29.3 – 30.1	23.2 – 25.3
Salinity	30.9 – 33.7	33.3 – 34.0	17.9 – 22.5	28.9 – 30.4
TSM	8.8 – 14.2	14.5 – 33.8	8.9 – 22.3	8.0 – 21.7
pH	7.9– 8.3	7.3 – 8.1	8.0 – 8.3	8.1 – 8.6
DO	6.5 – 8.3	3.9 – 6.7	6.2 – 8.9	6.4 – 7.8
BOD	1.0 – 3.3	2.5 – 4.4	2.6 – 4.4	0.2 – 1.4
Ammonium	0.03 – 0.54	0.1 – 3.1	0.9 – 2.5	0.1 – 0.6
Nitrite	0.04 – 0.54	0.1 – 0.5	0.04 -0.54	0.1 – 3.4
Nitrate	1.5 – 13.6	0.6 – 2.3	2.9 – 15.0	0.1 – 3.6
Phosphate	0.3 – 1.1	0.4 – 2.6	0.8 – 2.5	0.1 – 1.5
Silicate	3.2 – 10.6	0.26– 26.9	10.9 – 28.1	0.3 – 20.9
PHC	4.9 – 34.1	-	1.0 – 11.5	1.5 – 54.0

7.2 Biological parameters

7.2.1. Chlorophyll *a*

During the pre monsoon period, Chl-*a* concentration varied from 2.17 to 7.54 mg/m^3 in surface and from 1.38 to 10.16 mg/m^3 in bottom waters of this region. Whereas, Chl-*a* concentration ranged from 0.49 to 4.14 mg/m^3 in surface and from 0.38 to 3.96 mg/m^3 in bottom waters during post monsoon season. Relatively higher Chl-*a* concentration was found during the pre monsoon season compared to the post monsoon season. This observation is concurrent with those reported previously in coastal waters of this region and along east coast of India. Elevated concentrations of Chl-*a* was reported in coastal waters of the central east coast of India during pre monsoon season (February – April) due to the occurrence of mild coastal upwelling during

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this period. Coastal upwelling brings nutrient-rich sub surface waters into the surface and enhances primary production in euphotic zone of the region. It is a seasonal phenomenon and it does not occur during the post monsoon season.

Altogether, 44 phytoplankton species/forms are reported from this region in the present study. The number of species varied from 14 to 29 during pre monsoon and from 20 to 21 during post monsoon. These ranges are comparable during pre monsoon and slightly lower during post monsoon when compared to those obtained in 2011 study in this region (Table 7.6). Diatoms were dominant over dinoflagellates in this region during both pre and post monsoon seasons. The dominance of diatoms was seen at every station. Some of the major species found in this region are: *Nitzschia, Navicula, Skeletonema, Thalassiosira, Rhizosolenia, Coscinodiscus, Chaetoceros, Gyrosigma, Pleurosigma, Cerastium, Prorocentrum, Trichdesmium* and *Leptocylindrus*

Phytoplankton abundance ranged from 4200 to 10450 No./L in the surface and from 2300 to 14000 No./L in bottom waters during the pre monsoon season (Table 7.4). Phytoplankton abundance during post monsoon period varied from 4400 No./L to 8600 No./L in the surface and from 4600 to 8740 No./L in bottom waters (Table 7.5). MOP of NTPC recorded considerably lower phytoplankton abundance in both surface (5800 No./L) and bottom (5600 No./L) compared to the surrounding stations in this region (mean: 7103 No./L and 7158 No./L, respectively) during pre monsoon season (Fig. 7.2a). However, station at MOP of JN Pharma City Ltd recorded higher phytoplankton abundance in the surface (8650 No./L) and lower abundance in the bottom waters (6450 No./L) during pre monsoon than the surrounding stations in this region (7103 No./L and 7158 No./L, respectively) (Fig. 7.2a). Similarly, during post monsoon season also MOP of NTPC Ltd. recorded considerably lower phytoplankton biomass both in surface (4400 No./L) and bottom (4600 No./L) compared to the surrounding stations in

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this region (5730 No./L and 7199 No./L, respectively) (Fig. 7.2b). Consistent with pre monsoon season, MOP of JNP recorded higher phytoplankton abundance in the surface (7400 No./L) and lower abundance in the bottom waters (5200 No./L) than the surrounding stations in this region (5730 No./L and 7199 No./L, respectively) (Fig. 7.2b). Contrasting to surface waters, bottom waters at MOP of JN Pharma City Ltd. recorded lower phytoplankton biomass during pre monsoon (6450 No./L) and post monsoon (5200 No./L) than the surrounding stations in this region (7158 No./L and 7199 No./L, respectively). Compared to 2011 study conducted in this region, phytoplankton abundance was significantly higher in this study than those found in 2011 study during both pre monsoon and post monsoon seasons (Fig. 7.4a) (Table 7.6).

Plate 7.1: Microscopic images of some phytoplankton

Zooplankton, which feed on phytoplankton, is the secondary producer in the marine food chain. Zooplankton abundance in the sampling stations of this zone was presented in Table 7.4 and 7.5 for pre monsoon and post monsoon seasons, respectively. Copepods are the most dominant species in the zooplankton abundance. The other groups reported during the study

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period were Hydromedusae, siphanophores, chaetognatha, decapods larvae, polycheate larvae, gastropod larvae, lucifers, cladocerans, and fish eggs and larvae. Zooplankton abundance ranged from 600 to 2600 No./m^3 during pre monsoon season (Table 7.4), and significantly lower abundance was recorded at the MOP of NTPC Ltd. (600 No./m^3) and JN Pharma City Ltd. (960 No./m^3) compared to the mean zooplankton abundance in this zone (1795 No./m^3) (Fig. 7.3a). During the post monsoon season, numerical abundance of zooplankton varied from 625 No./m^3 to 1324 No./m^3. MOPs of NTPC Ltd and JN Pharma City Ltd have recorded slightly lower abundance of zooplankton (789 No./m^3 and 860 No./m^3, respectively) compared to the adjacent stations in this region (938 No./m^3) during post monsoon season (Fig. 7.3b). However, during both pre monsoon and post monsoon seasons, MOPs of NTP Ltd. and JN Pharma City Ltd. recorded relatively lower values of zooplankton abundance compared to the mean abundance in this zone.

Seasonal variations of the zooplankton abundance show that the zooplankton abundance was high during pre monsoon season compared to post monsoon season. Zooplankton abundance is mainly regulated by the phytoplankton abundance, which was found to be relatively low during the post monsoon period compared to pre monsoon. The same pattern of the distribution of zooplankton abundance was also found in the previous monitoring study conducted in this region in 2011. The results of the zooplankton abundance suggest that zooplankton abundance were in line with the phytoplankton abundance. Relatively low zooplankton abundance MOP locations than the surrounding locations, suggest that the impact of industrial effluent on zooplankton is considerable but it is localized as the impact of effluent decreases rapidly with increasing distance from MOP (<2 km from MOP). Compared to 2011 observations in this region, zooplankton abundance found in this study was considerably higher during post monsoon

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(Fig. 7.4b) (Table 7.6). Data is not available during pre monsoon season of 2011 to compare our results during pre monsoon season.

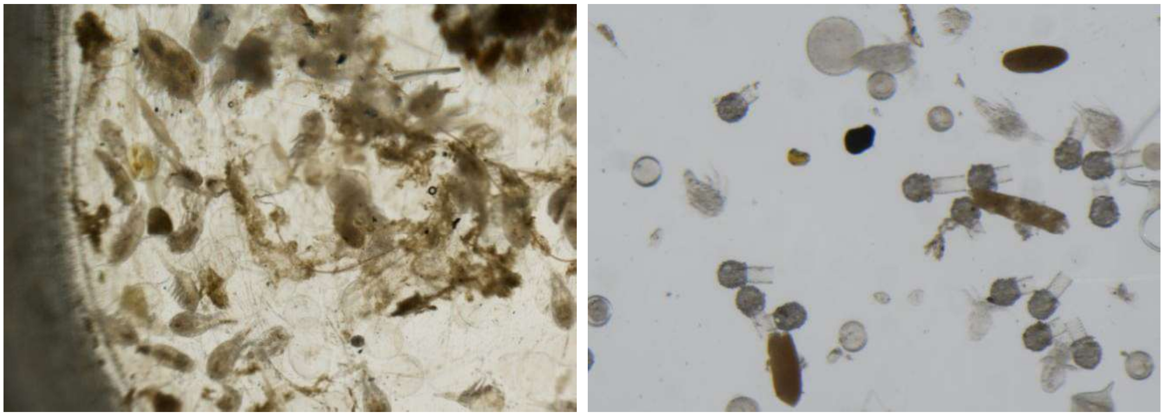

Plate 7.2: Microscopic images of some zooplankton

Benthos play a significant role in transitional ecosystems, by filtering phytoplankton and then offer a food source for fish, thereby linking primary producers with higher trophic levels. Benthic monitoring is a comparatively effective and reliable technique that can serve as early indicators of environmental changes. Benthic organisms are generally divided into two categories, namely, macro benthos and meio benthos, based on their size structure. The distribution and abundance of macro fauna in different locations of this zone during the pre and post monsoon seasons are given in Table 7.4 and Table 7.5, respectively. A total of 38 macro benthic groups/genus/ species are reported in the present study that all are belongs to 8 major groups. Polychaets are the most dominant form of macro benthos. Members of families commonly found in the study region are Megalonidae, Cirratulidae, glyceridae, Spionidae and Capitellidae. Glycera sp., Prionospiopinnata, Lumbrinereis sp., Eunice sp. and Magelona sp. Among crustaceans, amphipods and cumaceans were dominant. The mollusca were represented

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by bivalves and gastropods. No endangered species or invasive species was found during the present study.

Macro benthos abundance ranged from 600 No./m^2 to 2900 No./m^2 during pre monsoon (Table 7.4) and from 800 No./m^2 to 1600 No./m^2 during the post monsoon (Table 7.5) seasons. Seasonally, macro benthos abundance was higher during the pre monsoon period (mean: 2512 No./m^2) compared to post monsoon period (1300 No./m^2). The macro faunal abundance was significantly less at marine outfall point of JN Pharma City Ltd. (600 No./m^2 and 900 No./m^2 during pre and post monsoon seasons, respectively) and NTPC Ltd. (650 No./m^2 and 800 No./m^2 during pre and post monsoon seasons, respectively) compared to surrounding stations in this region (2512 No./m^2 and 1300 No./m^2 during pre and post monsoon seasons, respectively) (Fig. 7.3a and b). Relatively less macro faunal density at the MOP locations and the high abundance in the adjacent locations within the zone indicate that the effect of industrial effluent on macro faunal density was considerable but localized. Dilution of industrial effluent with increasing distance from the MOP might have decreased its influence on macro benthic density in the surrounding locations of MOP than at MOP.

Numerical counts of the meio-fauna were in the range of 220 to 780 No./10cm^2 during pre monsoon (Table 7.4) and 400 to 940 No./10cm^2 during post monsoon season (Table 7.5). Nematodes were found to be the most dominant species. Total meio faunal abundance was significantly low at the MOPs of JN Pharma City Ltd. and NTPC Ltd. during both pre monsoon (238 No./10cm^2 and 220 No./10cm^2, respectively) and post monsoon seasons (500 No./10cm^2 and 400 No./10cm^2, respectively), compared to the mean abundance of the adjacent locations in this zone (650 No./10cm^2 and 765 No./10cm^2, respectively) (Fig. 7.3a and b). Total meio-faunal abundance was less at the MOP locations compared to the surrounding locations within the

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zones, indicating that considerable impact of the industrial effluents on meio faunal abundance in the study region. However, relatively higher meio faunal abundance at locations within the 2 km from MOP locations suggest that the impact of industrial effluent on meio faunal abundance was localized and limits up to less than 2 km from MOP.

Compared to 2011 observations from this region, both macro and meio faunal abundance found during post monsoon season of the present study were considerably higher compared to those found during the post monsoon season of 2011 study (Fig. 7.4b) (Table 7.6). However, macro and meio faunal abundance data is not available for the pre monsoon season of 2011 to compare our results of pre monsoon season (Fig. 7.4b) (Table 7.6). Significant increase in abundance of phytoplankton, zooplankton, macro benthos and meio benthos in our study compare to 2011 data indicate that the impact of treated effluent release from M/s JN Pharma City Ltd. and NTPC Ltd. is not significant on the abundance of phytoplankton, zooplankton, macro benthos and meio benthos in this region.

Plate 7.3: Microscopic images of some benthic organisms

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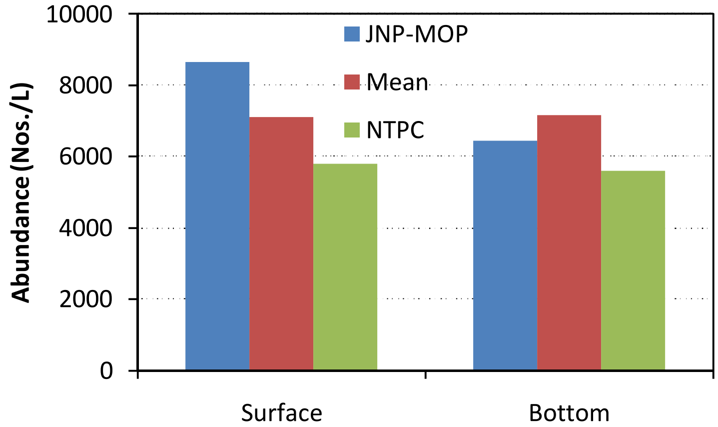

Fig. 7.2a: Comparison of phytoplankton abundance (No./L) at marine outfall points of JN Pharmacity Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during pre monsoon season

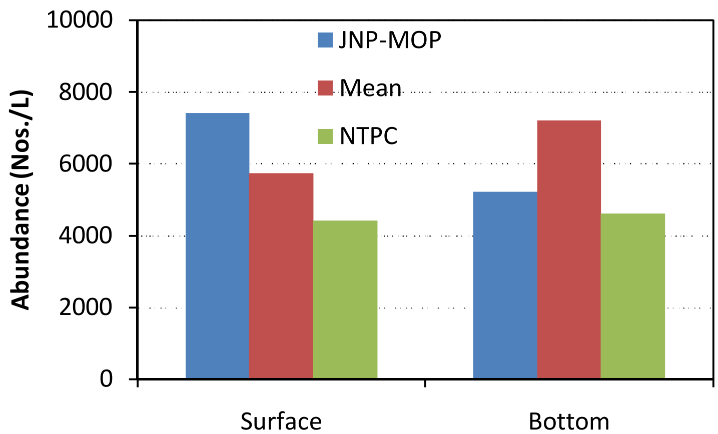

Fig. 7.2b: Comparison of phytoplankton abundance (No./L) at marine outfall points of JN Pharmacity Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during post monsoon season

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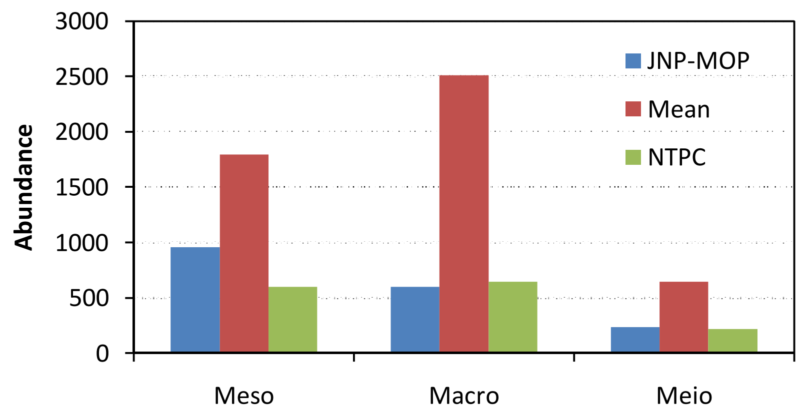

Fig. 7.3a: Comparison of abundance of Meso zooplankont (Meso; No./m^3), macro benthos (Macro; No./m^2) and meio benthos (Meio; No./10cm^2) at marine outfall points of JN Pharma City Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during pre monsoon season

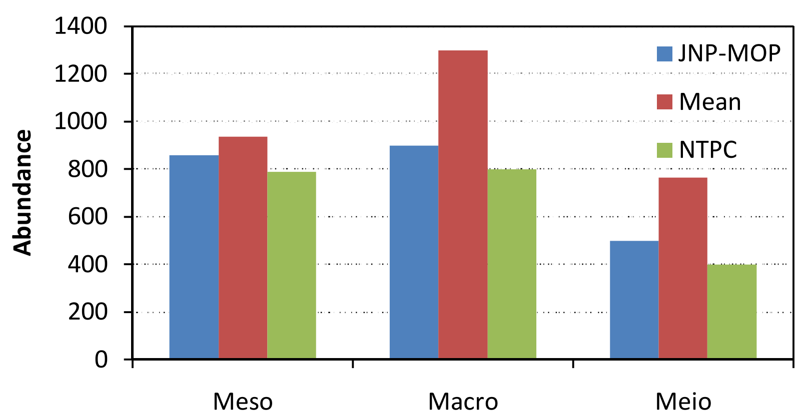

Fig. 7.3b: Comparison of abundance of Meso zooplankont (Meso; No./m^3), macro benthos (Macro; No./m^2) and meio benthos (Meio; No./10cm^2) at marine outfall points of JN Pharma City Ltd. (JNP-MOP) and NTPC Ltd. with that of the mean phytoplankton abundance in surrounding stations of this zone during post monsoon season

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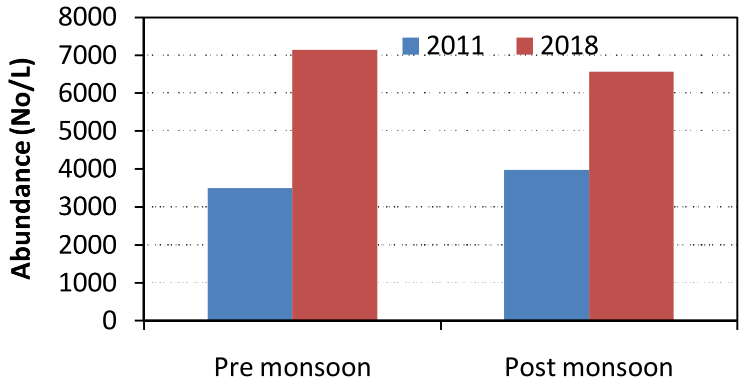

Fig. 7.4a: Comparison of mean phytoplankton abundance (No./L) found in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

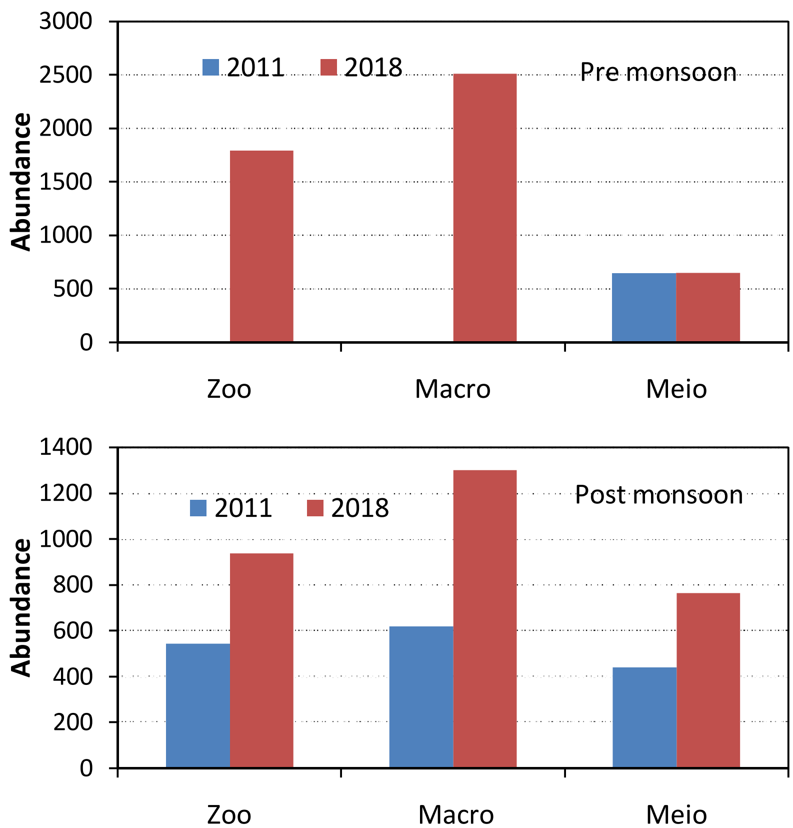

Fig. 7.4b: Comparison of mean abundance of zooplankton (No./m^3), macro benthos (No./m^2) and meio benthos (No./10cm^2) found in coastal waters off Tikkavanipalem during pre monsoon and post monsoon seasons of the present study with that of the study conducted in 2011 in this region

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Table 7.4: Details of the biological parameters in coastal waters off Tikkavanipalem during pre monsoon season

Stations	Chlorophyll *a* (mg/m^3)		Phytoplankton (No./L)		Meso zooplankton abundance ($No./m^3$)	Macro benthos abundance ($No./m^2$)	Meio benthos abundance $No./10cm^2$
	Sur	Bot	Sur	Bot			
TVM1	4.08	4.89	10450	8450	1100	-	-
TVM2	5.14	5.37	8650	6400	2140	-	-
TVM3	7.2	7.92	9600	3450	2160	-	-
TVM4	6.2	5.4	8400	10750	1080	2250	740
TVM5	7.54	10.16	7500	10560	-	-	-
TVM6	6.25	4.9	6800	8400	2450	-	-
TVM7	-	5.83	-	6450	-	-	-
TVM8	3.58	4.58	4200	10580	1900	-	-
TVM9	-	6.03	-	11450	2200	-	-
TVM10	3.01	2.87	5640	5400	2100	2250	600
TVM11	4.45	2.6	4800	6800	2600	2650	480
TVM12	4.71	1.92	5600	2600	1400	-	-
TVM13	2.17	1.38	4800	2300	1600	-	-
TVM14	6.19	9.17	9400	14000	1400	2900	780
TVM15	4.9	2.88	6400	2600	1600	-	-
TVM16	5.45	4.69	7200	4350	1400	-	-
NTPC - MOP	5.05	5.05	5800	5600	600	650	220
JNP-MOP	6.3	4.36	8650	6450	960	600	238

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Table 7.5: Details of the biological parameters in coastal waters off Tikkavanipalem during post monsoon season

Station Name	Chlorophyll *a* (mg/m^3)		Phytoplankton (No./L)		Meso zooplankton abundance No./m^3	Macro benthos abundance (No./m^2)	Meio benthos abundance No./10cm^2
	Surface	Bottom	Surface	Bottom			
TVM 1	-	1.15	4600	6800	920	-	-
TVM 2	0.49	1.32	5200	7200	1140	-	-
TVM 3	3.72	2.9	4600	6400	1060	-	-
TVM 4	2.49	2.44	5400	8000	1040	1600	760
TVM 5	1.25	2.14	6400	8200	860	-	-
TVM 6	0.78	1.55	7600	8400	1324	-	-
TVM 7	4.14	1.13	4600	5400	625	-	-
TVM 8	3.84	3.96	5200	8460	860	-	-
TVM 9	1.25	1.82	5640	6400	1014	-	-
TVM 10	0.58	0.96	4600	5600	945	1400	940
TVM 11	1.71	1.09	5100	8740	780	1200	600
TVM 12	4.11	0.38	8600	5600	820	-	-
TVM 13	-	1.55	6450	8100	890	-	-
TVM 14	-	0.57	4600	7100	920	1000	760
TVM 15	2.79	2.55	5040	6140	840	-	-
TVM 16	1.9	2.61	8060	8640	965	-	-
NTPC MOP	2.22	2.14	4400	4600	789	800	400
JNP- MOP	1.94	1.44	7400	5200	860	900	500

Comparison of biological characteristics observed in this study with that of the study conducted in this region during 2011 was given in Table 7.6

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Table 7.6: Comparison of biological characteristics found in present study with earlier studies conducted in the coastal waters off Tikkavanipalem

Parameter	2009-2010	2011		Present study	
		Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
Phytoplankton abundance ($x10^4$ cells/ L)	0.42-1.80	0.25-1.47	0.19-1.26	0.42-1.40	0.44-0.87
Species richness	11-18	13-28	12-25	14-29	20-21
Zooplankton abundance (No./m^3)	73-146	-	317-683	600-2600	625-1324
Macro benthos abundance (No./m^3)	450-2100	-	125-1650	600-2900	800-1600
Meio faunal abundance (No./m^3)	440-1344	-	267-825	220-780	400-940

7.3 Microbiological parameters

Both surface and bottom water samples collected from the study area were analyzed for the following microbiological parameters:

1. Total viable count (TVC) – R2A Agar seawater medium,
2. Total Coliform (TC) – Mac Conkey's Agar,
3. *Escherichia coli* like organisms (ECLO) – Mac Conkey's Agar,
4. *Enterococcus feacalis* like organisms (EFLO) – Mac Conkey's Agar,
5. *Pseudomonas aeruginosa* like organisms (PALO) – Cetrimide Agar,
6. *Vibro* like organisms (VLO) – TCBS Agar,
7. *Vibro cholerae* like organisms (VCLO) – TCBS Agar,
8. *Vibro parahaemolyticus* like organisms (VPLO) – TCBS Agar

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Certain aquatic microbes serve as excellent indicator of pollution. Microbes, in particular bacteria react quickly to changes in the environmental conditions. An assessment of the microbial activity is possible by the determination of the microbial biomass (total viable count). Therefore the total viable counts implies an indirect measure of *in situ* activity in contrast to number of specific indicator microbes, and this has been used as one of the principal criteria of pollution in natural water. Besides the pollution indicator bacteria such as total coliforms (TC), *Escherichia coli* like organisms (ECLO) and *Enterococcus feacalis* like organisms (EFLO) occurring the coastal waters have also been included. These indicator bacteria will presumably shows that sewage discharge with human faecal matter is present, which also indicates that possible presence of pathogenic bacteria in the water samples. Apart from that some pathogenic bacteria such as *Pseudomonas aeruginosa* like organisms (PALO), *Vibro cholerae* like organisms (VLO) and *Vibro parahaemolyticus* like organisms (VPLO) abundance was also studied.

Bacterial counts of the water samples collected during pre and post monsoon seasons in the coastal waters off Tikkavanipalem are given in Tables 7.7 and 7.8. The values of TVC in the surface and bottom water were in the range of 0.3 to 4.0 and 1.3 to 5.6 CFUx10^3/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 0.8 to 18.7 and 0.8 to 24.0 CFUx10^3/ml, in the surface and bottom water respectively (Table 7.8a). Total Coliform counts in the surface and bottom water were in the range of 0.4 to 3.9 and 1.4 to 6.3 CFUx10^2/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 0.1 to 25 and 0.1 to 39.2 CFUx10^2/ml, in the surface and bottom water respectively (Table 7.8a). Similarly the *Escherichia coli* like organism counts in the surface and bottom water were in the range of 0.1 to 0.9 and 0.2 to 1.1 CFUx10^1/ml during pre monsoon season (Table 7.7a). The values during

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post monsoon season were 1.0 to 126.0 and 1.0 to 392 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8a). *Enterococcus faecalis* like organism counts in the surface and bottom water were in the range of 0.1 to 2.6 and 0.5 to 2.0 CFUx10^1/ml during pre monsoon season (Table 7.7a). The values during post monsoon season were 1.0 to 10 and 1.0 to 50 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8a). *Pseudomonas aeruginosa* like organism counts in the surface and bottom water were in the range of 0.2 to 4.3 and 2.1 to 9.4 CFUx10^3/ml during pre monsoon season (Table 7.7b). The values during post monsoon season were 0.2 to 9.2 and 0.6 to 65 CFUx10^3/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio* like organism counts in the surface and bottom water were in the range of 0.1 to 2.0 and 0.2 to 0.9 CFUx10^1/ml during pre monsoon season (Table 7.7b). The values during post monsoon season were 1.0 to 2.0 and 1.0 to 11.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio cholerae* like organism counts in the surface and bottom water were in the range of 1.5 to 9.0 and 0.1 to 0.2 CFUx10^1/ml during pre monsoon season (Table 7.7b). The VCLO count during post monsoon season were 2.0 and 3.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b). *Vibrio parahaemolyticus* like organism counts in the surface and bottom water were in the range of 0.1 to 0.3 and 0.1 to 0.2 CFUx10^1/ml during pre monsoon season (Table 7.7b). The VPLO counts during post monsoon season were 1.0 and 1.0 to 8.0 CFUx10^1/ml, in the surface and bottom water respectively (Table 7.8b).

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Table 7.7a. Spatial variability in total viable count (TVC; CFU/ml), total coli forms (TC, CFU/ml), *Escherichia coli* like organism (ECLO, CFU/ml) and *Enterococcus faecalis* like organism (EFLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	TVC ($CFU*10^3/ml$)		TC ($CFU*10^2/ml$)		ECLO ($CFU*10^1/ml$)		EFLO ($CFU*10^1/ml$)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	2.6	2.2	2.9	2.5	0.6	0.4	0.8	0.8
TVM2	1.5	-	1.6	-	0.4	-	0.4	-
TVM3	2.3	2.6	2.5	2.9	0.5	0.5	0.7	0.9
TVM4	1.9	3.1	1.8	3.7	0.9	0.6	1.1	1.2
TVM5	1.1	1.6	1.0	1.9	0.5	0.3	0.6	0.6
TVM6	0.3	1.8	0.4	2.0	0.1	0.3	0.1	0.7
TVM7	2.4	3.4	2.6	3.8	0.6	0.6	0.7	1.2
TVM8	2.2	2.0	2.4	2.2	0.5	0.4	0.6	0.7
TVM9	1.5	-	1.7	-	0.4	-	0.4	-
TVM10	3.3	1.7	3.6	2.0	0.8	0.3	1.0	0.6
TVM11	1.7	5.6	1.9	6.3	0.4	1.1	0.5	2.0
TVM12	2.0	2.7	2.2	3.0	0.5	0.5	0.6	1.0
TVM13	1.0	4.2	1.1	4.7	0.3	0.8	0.3	1.5
TVM14	2.3	5.3	2.5	6.0	0.6	1.0	0.7	1.9
TVM15	1.9	1.9	2.0	2.2	0.5	0.4	0.5	0.7
TVM16	1.7	3.2	1.8	3.6	0.4	0.6	0.5	1.1
NTPC-MOP	0.8	1.3	0.9	1.4	0.2	0.2	0.2	0.5
JNP-MOP	4.0	2.1	3.9	2.3	2.2	0.6	2.6	1.1

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Table 7.7b. Spatial variability in *Pseudomonas aeruginosa* like organism (PALO, CFU/ml), *Vibrio* like organism (VLO, CFU/ml), *Vibrio cholerae* like organism (VCLO, CFU/ml) and *Vibrio parahaemolyticus* like organism (VPLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during pre monsoon season

Station	PALO ($CFU*10^3/ml$)		VLO ($CFU*10^1/ml$)		VCLO ($CFU*10^1/ml$)		VPLO ($CFU*10^1/ml$)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	1.6	3.7	0.6	0.3	0.1	0.1	0.1	0.1
TVM2	0.9	-	0.3	-	0.1	-	0.1	-
TVM3	1.3	4.4	0.5	0.4	0.1	0.1	0.1	0.1
TVM4	1.6	4.9	0.8	0.5	0.2	0.1	0.2	0.1
TVM5	0.9	2.5	0.4	0.3	0.1	0.1	0.1	0.1
TVM6	0.2	3.1	0.1	0.3	-	0.1	-	0.1
TVM7	1.4	5.6	0.5	0.5	0.1	0.1	0.1	0.1
TVM8	1.3	3.3	0.5	0.3	0.1	0.1	0.1	0.1
TVM9	0.9	-	0.3	-	0.1	-	0.1	0.-
TVM10	1.9	2.9	0.7	0.3	0.2	0.1	0.1	0.1
TVM11	1.0	9.4	0.4	0.9	0.1	0.2	0.1	0.2
TVM12	1.2	4.5	0.4	0.4	0.1	0.1	0.1	0.1
TVM13	0.6	7.0	0.2	0.6	0.1	0.2	-	0.1
TVM14	1.4	8.9	0.5	0.8	0.1	0.2	0.1	0.2
TVM15	1.1	3.2	0.4	0.3	0.1	0.1	0.1	0.1
TVM16	1.0	5.3	0.4	0.5	0.1	0.1	0.1	0.1
NTPC-MOP	0.5	2.1	0.2	0.2	-	-	-	-
JNP-MOP	4.3	3.5	2.0	0.3	0.5	0.1	0.2	0.1

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Table 7.8a. Spatial variability in total viable count (TVC; CFU/ml), total coli forms (TC, CFU/ml), *Escherichia coli* like organism (ECLO, CFU/ml) and *Enterococcus faecalis* like organism (EFLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	TVC ($CFU*10^3$/ml)		TC ($CFU*10^2$/ml)		ECLO ($CFU*10^1$/ml)		EFLO ($CFU*10^1$/ml)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	0.9	3.9	-	-	-	-	-	-
TVM2	0.8	2.0	-	0.4	-	4	-	-
TVM3	5.2	0.9	4.0	39	0	392	-	-
TVM4	11.4	13.2	2.9	-	105	-	-	-
TVM5	3.1	10.6	2.4	-	-	-	-	-
TVM6	15.3	8.8	0.4	-	1.0	-	1	-
TVM7	1.5	9.6	0.1	0.9	-	9	-	12
TVM8	1.3	0.8	-	2.8	10	28	10	1
TVM9	-	-	-	-	-	-	-	-
TVM10	18.7	4.5	0.8	0.1	32	1	-	-
TVM11	0.9	3.7	21.4	-	-	-	-	-
TVM12	16.8	24	9	1.2	4	12	-	-
TVM13	11.7	13.5	6.6	0.4	15	4	-	-
TVM14	13.4	10.1	5.1	-	11	-	-	-
TVM15	-	11.3	-	-	-	-	-	-
TVM16	15.0	5.3	25	-	-	-	-	-
NTPC-MOP	1.1	7.8	19	1.4	126	14	-	50
JNP-MOP	-	-	-	-	-	-	-	-

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Table 7.8b: Spatial variability in *Pseudomonas aeruginosa* like organism (PALO, CFU/ml), *Vibrio* like organism (VLO, CFU/ml), *Vibrio cholerae* like organism (VCLO, CFU/ml) and *Vibrio parahaemolyticus* like organism (VPLO, CFU/ml) in surface and bottom waters off Tikkavanipalem coast during post monsoon season

Station	PALO ($CFU*10^3/ml$)		VLO ($CFU*10^1/ml$)		VCLO ($CFU*10^1/ml$)		VPLO ($CFU*10^1/ml$)	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
TVM1	1.2	-	-	-	-	-	-	-
TVM2	1.2	0.6	-	-	-	-	-	-
TVM3	2.5	8.5	1	11	-	3	1	8
TVM4	7.7	-	2	1	2	-	-	1
TVM5	0.6	1.2	-	2	-	-	-	2
TVM6	5.3	3.4	-	-	-	-	-	-
TVM7	0.6	5.6	-	-	-	-	-	-
TVM8	0.2	6.2	-	-	-	-	-	-
TVM9	-	-	-	-	-	-	-	-
TVM10	3.7	1.5	-	-	-	-	-	-
TVM11	9.2	1.7	-	-	-	-	-	-
TVM12	1.3	2.6	-	-	-	-	-	-
TVM13	6.6	5.3	-	5	-	-	-	5
TVM14	3.8	3.4	-	7	-	-	-	7
TVM15	-	2.9	-	-	-	-	-	-
TVM16	5.3	-	-	-	-	-	-	-
NTPC-MOP	1.6	65	-	-	-	-	-	-
JNP-MOP	-	-	-	-	-	-	-	-

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Table 7.9: Comparison of microbial populations found during the pre monsoon and post monsoon seasons of this study (2018) with those obtained during the previous monitoring study conducted in this region in 2011.

Region	Type of bacteria	This study (2018)		Previous study (2011)	
		Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
Tikkavanipalem (zone 5)	TVC (CFUx10^3/ml)	0.3-5.6	0.8-24	2.9-19	3.1-9
	TCC (CFUx10^2/ml)	0.4-6.3	0.1-39	0.6-5	0.1-1.5
	ECLO (CFUx10^1/ml)	0.1-1.1	1.0-392	0.1-15	0.8-5
	VLO (CFUx10^1/ml)	0.1-2.0	1.0-11	0.9-214	0.7-82

TVC counts are more during post monsoon season compared to pre monsoon season. When compared to 2011 data, TVC counts found in this study are lower during pre monsoon season and higher during post monsoon season. TC counts are more during post monsoon season. These counts are more or less similar during pre monsoon season and higher during post monsoon season compared 2011 data. ECLO counts are more during post monsoon season and these counts are lower during pre monsoon season and higher during post monsoon season compared to 2011 data. EFLO, PALO and VLO counts are more during post monsoon than pre monsoon season. VCLO and VPLO counts are very low and no considerable seasonal variability was found.

Microbiological quality of the seawater in this region is not good as the presence of indicator bacteria and some pathogenic bacteria in higher concentrations than the standard levels. The presence of indicator bacteria and some pathogenic bacteria in concentrations higher than the standard levels in coastal waters in this region indicated that coastal waters of this region is considerably contaminated with untreated domestic sewage.

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Chapter 13

RECOMMENDATIONS

Present study region, the coastal waters of north Andhra coast extending from off Pydibhimavaram to off Kesavaram was investigated during pre and post monsoon seasons for physico-chemical, biological, micro biological and sedimentolgical parameters in order to assess the impact of industrial effluent release through the marine outfall points (MOPs) on the seawater quality and ecosystem of the region, if any. The *in-situ* observations and sample collection was carried from 17th February to 08th March 2018 during the pre monsoon season and from 08th December 2018 to 1st January 2019 during the post monsoon season. Results of our investigations in the study region during both the seasons (pre and post monsoon) were described in detail in chapters 3 to 12. Based on findings of this study the following recommendations have been made to maintain the seawater quality and the health of the ecosystem in the coastal waters of north Andhra coast.

- ✓ Since the dissolved oxygen concentrations are depleted and ecosystem at MOPs is impacted, continuous yearly monitoring of the north Andhra coast is very much required, at least for the next two years, to monitor the DO levels and to understand the expansion/compression of impacted area around the MOP location, and to take necessary timely precautions to protect the seawater quality and the health of the ecosystem in the region
- ✓ Time series experiments (continuous daily measurements at MOP and surrounding locations for one week; before, during and after effluent release) should be conducted at

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least for two industries (one in the south and the other in the north of Visakhapatnam) to understand the impact of effluent release on the ecosystem in the region.

- ✓ Since the seasonal variability in all the parameters is very high in the study region, monitoring should be conducted with high temporal resolution, at least 4 times in a year, for example, February, May, September and December.
- ✓ In order to assess the impacted area around the MOP location, it should be covered at least 5km (instead of 2km in the present study) from the MOP in both the directions along the coast.
- ✓ Further treatment for industrial effluents is required to reduce their toxicity before discharging into the sea because the treated effluents from all the industries are mildly acute toxic.
- ✓ Bio assay tests for industrial effluents must be conducted on monthly time scale at least for one year to understand the variability in the quality of effluent because the composition of the treated effluent is highly variable with time for any industry.
- ✓ Trace metals (chromium, manganese, cobalt, nickel, copper, cadmium, zinc etc) concentrations should be determined in the treated effluents of industries before discharging in to the sea, coastal waters, and benthic organisms along with surface sediments in order to assess the trace metal contamination in the food chain.
- ✓ Sludge remained in the guard ponds should be removed on regular time intervals to avoid its transport into the sea along with effluent.
- ✓ Since, fish is more susceptible to contamination of organic compounds the major organic compounds present in the treated effluent should be understood before discharging into the sea.

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- ✓ Antibiotic resistivity of the indicator and pathogenic bacteria present in the waters of the study region should be investigated
- ✓ As microbiological studies indicated significant input of untreated domestic sewage to the present study region, it is strongly recommended to take necessary steps to prevent the transport of untreated domestic sewage into the sea.

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Monthly monitoring of Eco-toxicity of treated effluent

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Visakhapatnam

September 2023

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

September 2023

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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. Visakha Pharmacity Limited 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 guard ponds of M/s. Visakha Pharmacity 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, and the same was completed by May 2023. M/s. Visakha Pharmacity Limited has extended the contract for three more months (September-November 2023) to assess the eco-toxicology of treated effluent from MBR plant outlet tank. CSIR-NIO conducted field campaign for the month of September on 14th September 2023 and treated effluent was collected from the MBR outlet tank. This report is the compilation of the data obtained for various investigations conducted on the treated effluent.

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List of Contributors to the project

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The work was sponsored by M/s. Visakha Pharmacity Limited, Visakhapatnam. CSIR-National Institute of Oceanography (NIO) acknowledges **Dr. P. P. Lal Krishna,** Managing Director, Visakha Pharmacity Limited, Visakhapatnam for his 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.

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Executive Summary

As part of continuous monthly studies on the assessment of the quality of treated effluent from M/s. Visakha Pharmacity Limited, treated effluent was collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 14th September 2023. A 4-day (96 hours) long bio-assay experiment was conducted on the treated effluent using zebrafish 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 MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the CPCB standard of ‘90% survival after 96 hours in the 100% effluent’ as the mortality of zebrafish in 100% effluent after 96 hours is 9% only. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC_{50} and LC_{10}, respectively) after 96 hours are estimated as 656% and 101%, respectively. These results suggest that the treated effluent collected from the MBR outlet tank of M/s. Visakha Pharmacity Limited on 14th September 2023 is compliance with the CPCB standards for bioassay test.

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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 the treated effluent into the sea after meeting the criterion set up by CPCB and APPCB. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobindo 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 Pharmacity Ltd. and Atchutapuram effluent treatment plant Ltd. (AETL) 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. Visakha Pharmacity Limited 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

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intervals. In this connection, CSIR-NIO completed this study by May 2023. M/s. Visakha Pharmacity Limited has extended the study to assess the treated effluent quality for three more months (September to November 2023

1.1 Objective:

The main objective of this study is to assess the quality of treated effluent from MBR outlet tank of M/s. Visakha Pharmacity Limited through bio-assay test using zebrafish, and to compare the results with the CPCB standards for compliance/non-compliance.

1.2 Sample collection:

A Niskin water sampler (10L, plate. 1.1) was used to collect treated effluent sample from MBR outlet tank of M/s. Visakha Pharmacity Limited on 14th September 2023 for dissolved oxygen (DO), biochemical oxygen demand for three days (BOD_3), pH, dissolved and inorganic nutrients. 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

1.3 Methodology

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

1.3.1 pH

pH of the treated effluent sample collected in air-tight glass bottle (60ml) was measured using Metrohm pH analyzer (Titrando 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.

1.3.2 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, expresses\d as standard deviation with this method was ±0.07%.

1.3.3 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 three days at 20ºC in the BOD incubator. Dissolved oxygen in these samples was determined after fixing the samples on completion of three days incubation. BOD_3 was computed from the initial DO concentrations and expressed in mg/l.

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1.3.4 Nitrate - Nitrogen (NO_3^- -N)

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 µmol/l. The precision of analysis for both nitrite and nitrate, in terms of standard deviation, is ±0.02 µmol/l.

1.3.5 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 µmol/l. The precision of analysis, in terms of standard deviation, is ±0.01 µmol/l.

1.3.6 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 µmol/l. The precision of analysis, expressed as standard deviation, is ±0.02 µmol/l.

1.3.7 Total suspended matter (TSM)

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One litre of effluent sample was filtered through pre-weighed Polycarbonate filter (0.22 µm; 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.

1.3.8 Bio-assay test (Eco-toxicology test)

The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes 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 concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

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2 Results

2.1 Treated effluent characteristics

Treated effluent was tested for DO, BOD_3, pH, TSM and dissolved inorganic nutrients and the results were provided in Table 2.1.

Table 2.1. Physico-chemical characteristics of treated effluent

S. No.	Parameter	Concentrations	CPCB standard*
1	DO (mg/l)	6.56	-
2	BOD_3 (mg/l)	2.41	30
3	pH	7.077	6.0 – 8.5
4	Nitrate-N	0.05	-
5	Phosphate -P	1.12	5.0
6	Silicate -Si	1.53	-
7	TSM (mg/l)	13.1	100
8	Chl-*a* ($\mu g/m^3$)	0.83	-

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

Dissolved oxygen (DO) concentration of the treated effluent is 6.56 mg/l. BOD_3 of the effluent is 2.41 mg/l which is below the standard limit of 30 mg/l set by CPCB. pH of the treated effluent is 7.077 and it is also within the CPCB limit of 6.0 - 8.5 (Table 2.1). Concentration of total suspended matter (TSM) is 13.1 mg/l. TSM concentrations is far below the standard 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.

2.2 Bio-assay test

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

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Effluent concentration of 0% represent the control and no mortality of zebrafish was observed in the control. The first mortality of zebrafish was observed in the effluent concentration of 50% after 84 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 24 hours of the experiment and 91% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.2).

Table 2.2: Survival rate (%) of zebrafish 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	97
48 hr	100	100	100	100	100	100	97	97
60 hr	100	100	100	100	100	100	97	94
72 hr	100	100	100	100	100	97	94	94
84 hr	100	100	100	100	100	97	94	91
96 hr	100	100	100	100	97	94	91	91

Mortality rate of zebrafish (%) 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.

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

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebrafish***			
	Exposure periods (hr)			
	24	48	72	96
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
60%	0	0	3	6
90%	0	3	6	9
100%	0	3	6	9

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 48h, 72h and 96h of the experiment were calculated using LDP Line software and were given in Table 2.4.

Table 2.4: Median Lethal concentrations (LC_{50} and LC_{10}) of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	954	142
96	656	101

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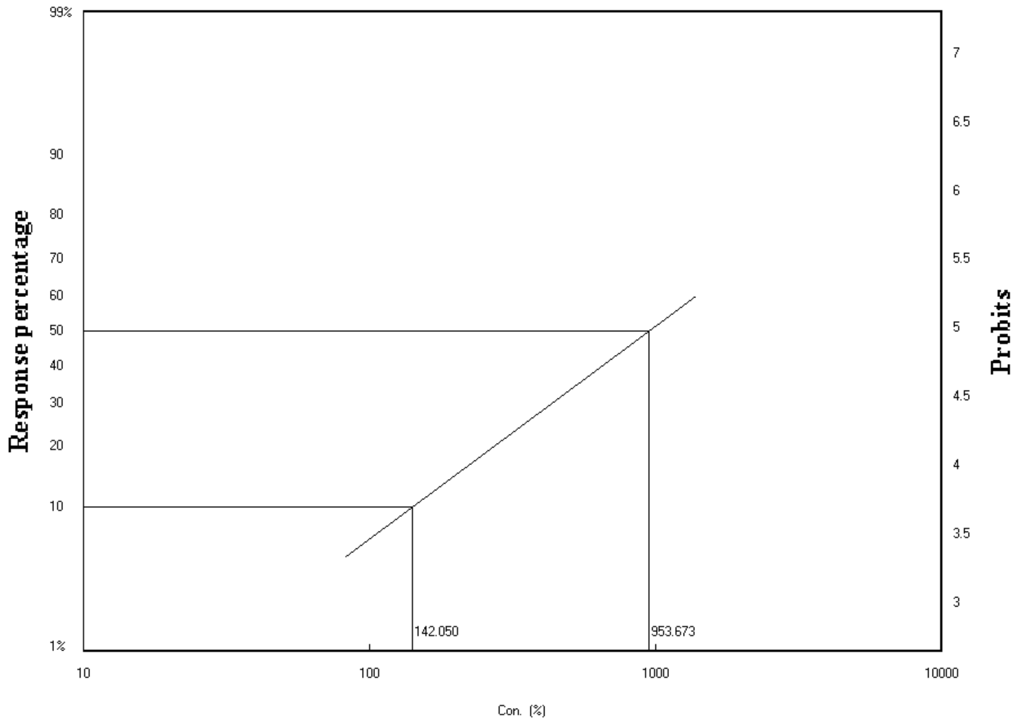
99%
90
80
70
60
50
40
30
20
10
1%
Response percentage
7
6.5
6
5.5
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4
3.5
3
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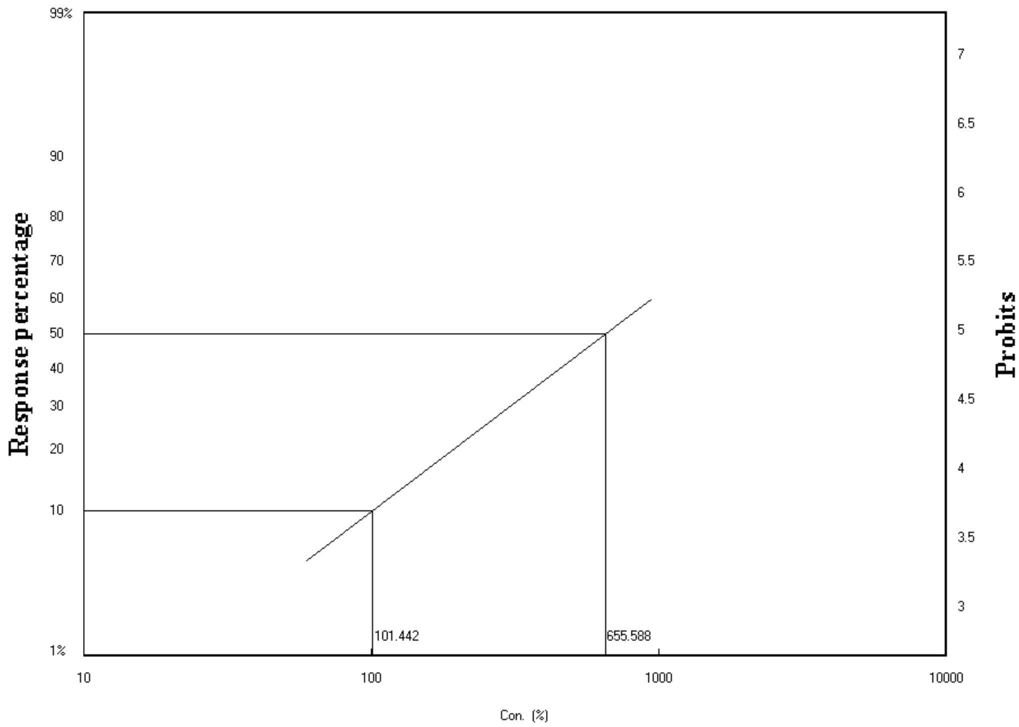
10
100
1000
10000
Con. (%)

72 h


99%
90
80
70
60
50
40
30
20
10
1%
Response percentage
7
6.5
6
5.5
5
4.5
4
3.5
3
Probits
101.442
655.588
10
100
1000
10000
Con. (%)

96h

 230

3. Conclusion

Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. LC_{50} and LC_{10} values after 96 hours are 656% and 101%, respectively. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 14th September 2023 is compliance with the CPCB standards for bio-assay test.

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SSP3474)

Monthly monitoring of Eco-toxicity of treated effluent

Sponsored by

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

1.3 Methodology

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

1.3.1 pH

pH of the treated effluent sample collected in air-tight glass bottle (60ml) was measured using Metrohm pH analyzer (Titrando 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.

1.3.2 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, expresses\d as standard deviation with this method was ±0.07%.

1.3.3 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 three days at 20ºC in the BOD incubator. Dissolved oxygen in these samples was determined after fixing the samples on completion of three days incubation. BOD_3 was computed from the initial DO concentrations and expressed in mg/l.

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1.3.4 Nitrate - Nitrogen (NO_3^- -N)

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 µmol/l. The precision of analysis for both nitrite and nitrate, in terms of standard deviation, is ±0.02 µmol/l.

1.3.5 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 µmol/l. The precision of analysis, in terms of standard deviation, is ±0.01 µmol/l.

1.3.6 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 µmol/l. The precision of analysis, expressed as standard deviation, is ±0.02 µmol/l.

1.3.7 Total suspended matter (TSM)

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One litre of effluent sample was filtered through pre-weighed Polycarbonate filter (0.22 µm; 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.

1.3.8 Bio-assay test (Eco-toxicology test)

The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes 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 concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

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2 Results

2.1 Treated effluent characteristics

Treated effluent was tested for DO, BOD_3, pH, TSM and dissolved inorganic nutrients and the results were provided in Table 2.1.

Table 2.1. Physico-chemical characteristics of treated effluent

S. No.	Parameter	Concentrations	CPCB standard*
1	DO (mg/l)	6.79	-
2	BOD_3 (mg/l)	3.53	30
3	pH	6.952	6.0 – 8.5
4	Nitrate-N	0.69	-
5	Phosphate -P	0.67	5.0
6	Silicate -Si	1.49	-
7	TSM (mg/l)	5.7	100
8	Chl-*a* ($\mu g/m^3$)	0.55	-

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

Dissolved oxygen (DO) concentration of the treated effluent is 6.79 mg/l. BOD_3 of the effluent is 3.53 mg/l which is below the standard limit of 30 mg/l set by CPCB. pH of the treated effluent is 6.952 and it is also within the CPCB limit of 6.0 - 8.5 (Table 2.1). Concentration of total suspended matter (TSM) is 5.7 mg/l. TSM concentrations is far below the standard 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.

2.2 Bio-assay test

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

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Effluent concentration of 0% represent the control and no mortality of zebrafish was observed in the control. The first mortality of zebrafish was observed in the effluent concentration of 60% after 60 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 24 hours of the experiment and 92% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.2).

Table 2.2: Survival rate (%) of zebrafish 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	96
48 hr	100	100	100	100	100	100	96	96
60 hr	100	100	100	100	100	100	96	96
72 hr	100	100	100	100	100	96	96	92
84 hr	100	100	100	100	100	96	92	92
96 hr	100	100	100	100	100	96	92	92

Mortality rate of zebrafish (%) 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.

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

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebrafish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	4	4
90%	0	4	4	8
100%	0	4	8	8

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 48h, 72h and 96h of the experiment were calculated using LDP Line software and were given in Table 2.4.

Table 2.4: Median Lethal concentrations (LC_{50} and LC_{10}) of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	1550	152
96	682	113

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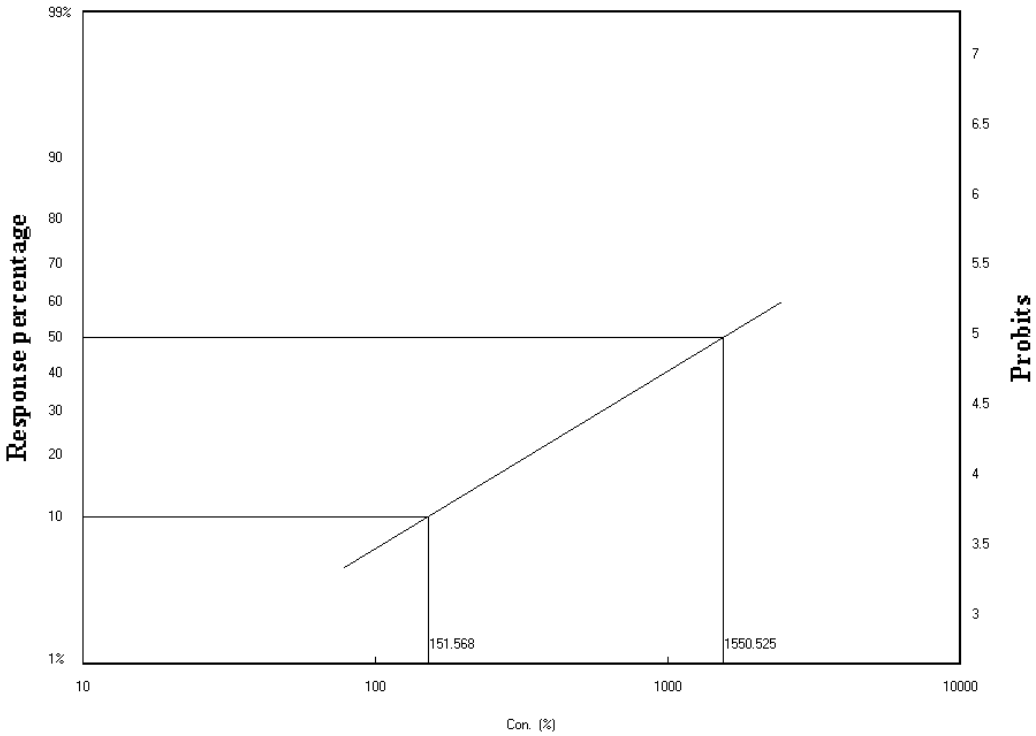
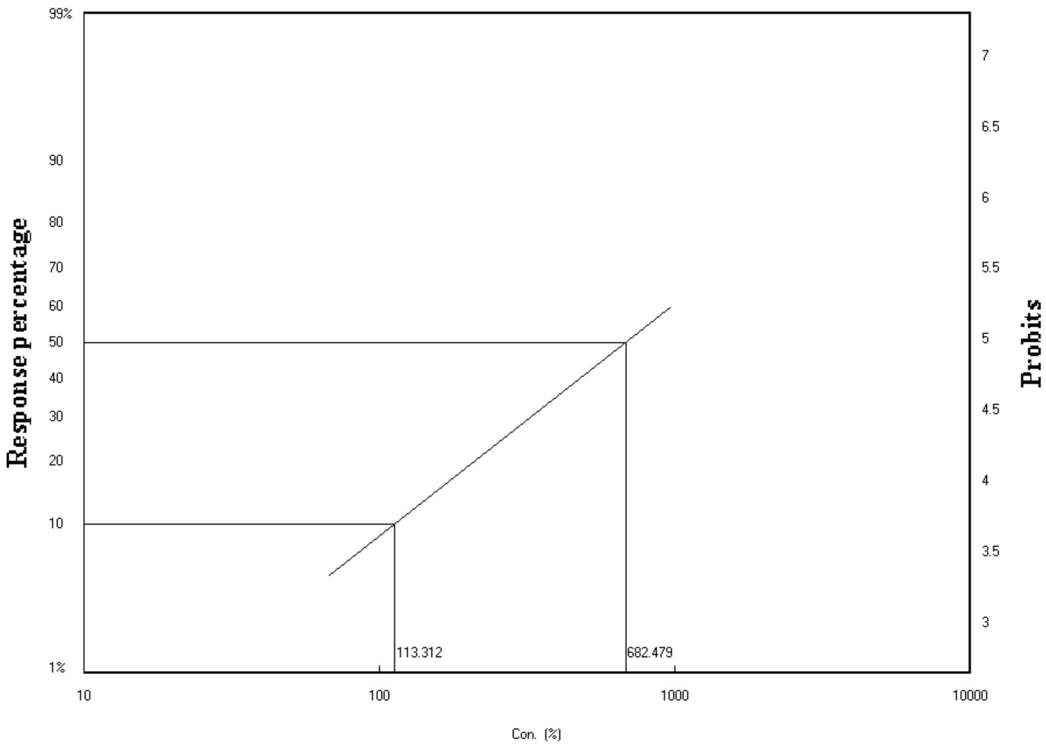


99%
90
80
70
60
50
40
30
20
10
1%
Response percentage
7
6.5
6
5.5
5
4.5
4
3.5
3
Probits
151.568
1550.525
10
100
1000
10000
Con. (%)

72 h



99%
90
80
70
60
50
40
30
20
10
1%
Response percentage
7
6.5
6
5.5
5
4.5
4
3.5
3
Probits
113.312
682.479
10
100
1000
10000
Con. (%)

96h

247

3. Conclusion

Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 92% for zebrafish in 100% effluent after 96 hours. LC_{50} and LC_{10} values after 96 hours are 682% and 113%, respectively. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 12th October 2023 is compliance with the CPCB standards for bio-assay test.

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Monthly monitoring of Eco-toxicity of treated effluent

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November 2023

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Monthly monitoring of Eco-toxicity of treated effluent

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

November 2023

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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. Visakha Pharmacity Limited 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 guard ponds of M/s. Visakha Pharmacity 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, and the same was completed by May 2023. M/s. Visakha Pharmacity Limited has extended the contract for three more months (September-November 2023) to assess the eco-toxicology of treated effluent from MBR plant outlet tank. CSIR-NIO conducted field campaign for the month of November on 21st November 2023 and treated effluent was collected from the MBR outlet tank. This report is the compilation of the data obtained for various investigations conducted on the treated effluent.

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Executive Summary

As part of continuous monthly studies on the assessment of the quality of treated effluent from M/s. Visakha Pharmacity Limited, treated effluent was collected from MBR outlet tank of M/s. Visakha Pharmacity Limited on 12th October 2023. A 4-day (96 hours) long bio-assay experiment was conducted on the treated effluent using zebrafish 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 MBR outlet tank of M/s. Visakha Pharmacity Limited fulfilled the CPCB standard of '90% survival after 96 hours in the 100% effluent' as the mortality of zebrafish in 100% effluent after 96 hours is 5% only. These results suggest that the treated effluent collected from the MBR outlet tank of M/s. Visakha Pharma City Limited on 21st November 2023 is compliance with the CPCB standards for bioassay test.

1. Introduction

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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 the treated effluent into the sea after meeting the criterion set up by CPCB and APPCB. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobindo 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 Pharmacity Ltd. and Atchutapuram effluent treatment plant Ltd. (AETL) 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. Visakha Pharmacity Limited 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 completed this study by May 2023. M/s. Visakha

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Pharma City Limited has extended the study to assess the treated effluent quality for three more months (September to November 2023)

1.1 Objective:

The main objective of this study is to assess the quality of treated effluent from MBR outlet tank of M/s. Visakha Pharma City Limited through bio-assay test using zebrafish, and to compare the results with the CPCB standards for compliance/non-compliance.

1.2 Sample collection:

A Niskin water sampler (10L, plate. 1.1) was used to collect treated effluent sample from MBR outlet tank of M/s. Visakha Pharmacity Limited on 21st November 2023 for dissolved oxygen (DO), biochemical oxygen demand for three days (BOD_3), pH, dissolved and inorganic nutrients. 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

1.3 Methodology

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

1.3.1.1 pH

pH of the treated effluent sample collected in air-tight glass bottle (60ml) was measured using Metrohm pH analyzer (Titrando 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.

1.3.1.2 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, expresses\d as standard deviation with this method was ±0.07%.

1.3.1.3 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 three days at 20ºC in the BOD incubator. Dissolved oxygen in these samples was determined after fixing the samples on completion of three days incubation. BOD_3 was computed from the initial DO concentrations and expressed in mg/l.

1.3.1.4 Ammonium - Nitrogen (NH_4^+ -N)

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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 µmol/l and the precision of analysis, in terms of standard deviation, is ±0.02 µmol/l

1.3.1.5 Nitrite - Nitrogen (NO_2^- -N)

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 µmol/l.

1.3.1.6 Nitrate - Nitrogen (NO_3^- -N)

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 µmol/l. The precision of analysis for both nitrite and nitrate, in terms of standard deviation, is ±0.02 µmol/l

1.3.1.7 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

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measured at 880 nm against a standard. Concentrations of PO_4^{3-} - P in effluent samples were expressed in μmol/l. The precision of analysis, in terms of standard deviation, is ±0.01 μmol/l.

1.3.1.8 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 μmol/l. The precision of analysis, expressed as standard deviation, is ±0.02 μmol/l.

1.3.1.9 Total suspended matter (TSM)

One litre of effluent sample was filtered through pre-weighed Polycarbonate filter (0.22 μm; 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.

1.3.1.10 Bio-assay test (Eco-toxicology test)

The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes in different concentrations were noted down at regular time intervals of 1h, 6h, 12h, 24h, 36h, 48h, 60h,

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72h, 84h and 96 hours. LDP line software was used to calculate the median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

2 Results

2.1 Treated effluent characteristics

Treated effluent was tested for DO, BOD_3, 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)	6.85	-
2	BOD_3 (mg/l)	2.81	30
3	pH	7.051	6.0 – 8.5
4	Nitrate-N	0.82	-
5	Phosphate -P	0.81	5.0
6	Silicate -Si	1.64	-
7	TSM (mg/l)	6.8	100
8	Chl-*a* (mg/m^3)	0.61	-

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

Dissolved oxygen (DO) concentration of the treated effluent is 6.85 mg/l. BOD_3 of the effluent is 2.81 mg/l which is below the standard limit of 30 mg/l set by CPCB. pH of the treated effluent is 7.051 and it is also within the CPCB limit of 6.0 - 8.5 (Table 2.1). Concentration of total suspended matter (TSM) is 6.8 mg/l. TSM concentrations is far below the standard 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.

2.2 Bio-assay test

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Survival rate of zebrafish at various time intervals during the experiment period of 96 hours in different concentrations of treated effluent was given in Table 2.3

Effluent concentration of 0% represent the control and no mortality of zebrafish was observed in the control. The first mortality of zebrafish was observed in the effluent concentration of 90% after 84 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 72 hours of the experiment and 95% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.3).

Table 2.3: Survival rate (%) of zebrafish 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	100
48 hr	100	100	100	100	100	100	100	100
60 hr	100	100	100	100	100	100	100	100
72 hr	100	100	100	100	100	100	100	100
84 hr	100	100	100	100	100	100	100	95
96 hr	100	100	100	100	100	100	95	95

Mortality rate of zebrafish (%) 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 2.4.

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Table 2.4: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	0	0
90%	0	0	0	5
100%	0	0	5	5

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment could not be calculated using LDP Line software

3. Summary

Treated effluent collected from the MBR outlet tank of M/s. Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 95% for zebrafish in 100% effluent after 96 hours. The characteristics of the treated effluent collected from MBR outlet tank of M/s. Visakha Pharma City Limited on 21st November 2023 is compliance with the CPCB standards for bio-assay test.

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Monthly monitoring of Eco-toxicity of treated effluent

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Regional Centre, Visakhapatnam – 530 017

January 2024

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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 Visakha Pharmacity Limited 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 guard ponds of M/s Visakha Pharmacity 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, and the same was completed by May 2023. M/s Visakha Pharmacity Limited has extended the contract for three more months (September-November 2023) to assess the eco-toxicology of treated effluent from MBR plant outlet tank. CSIR-NIO conducted studies for three months and submitted reports. M/s VPL has issued order (No. 0400069607 dated 25.01.2024) to conduct only bioassay studies on treated effluent from January to December 2024. In this connection, CSIR-NIO has conducted field campaign for collection treated effluent and results were given in this report.

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Ms. Sreelakshmi

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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 the treated effluent into the sea after meeting the criterion set up by CPCB and APPCB. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobindo 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 Pharmacity Ltd. and Atchutapuram effluent treatment plant Ltd. (AETL) 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 Visakha Pharmacity Limited approached CSIR-NIO, Visakhapatnam to carry out the above-mentioned studies on their

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treated effluent for the period of one year (from June 2022 to May 2023) on monthly time intervals. In this connection, CSIR-NIO completed this study by May 2023. M/s Visakha Pharma City Limited has extended the study to assess the treated effluent quality for three more months (September to November 2023). M/s Visakha Pharma City Limited issued work order (No. 0400069607 dated 25.01.2024) to conduct bio-assay studies on treated effluent from January to December 2024.

1.1 Objective:

The main objective of this study is to assess the quality of treated effluent from MBR outlet tank of M/s Visakha Pharma City Limited through bio-assay test using zebrafish, and to compare the results with the CPCB standards for compliance/non-compliance.

1.2 Sample collection and method:

Treated water samples were collected in pre-cleaned in white jerry cans (20L) for bio-assay studies on 1st February 2024 from MBR out let tank filling the guard pond No. 6. The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes 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 concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

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2 Results

Survival rate of zebrafish at various time intervals during the experiment period of 96 hours in different concentrations of treated effluent was given in Table 2.1

Effluent concentration of 0% represents 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 60% after 72 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 36 hours of the experiment and 92% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.1).

Table 2.1: 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	100
48 hr	100	100	100	100	100	100	100	96
60 hr	100	100	100	100	100	100	96	96
72 hr	100	100	100	100	100	100	96	96
84 hr	100	100	100	100	100	96	96	92
96 hr	100	100	100	100	100	96	92	92

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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 2.2.

Table 2.2: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	0	4
90%	0	0	4	8
100%	0	4	4	8

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment calculated using LDP Line software were given in Table 2.3 and Fig. 2.1

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	-	-
96	682	113

Table 2.3: Median lethal concentrations for 24h, 48h, 72h and 96 hours

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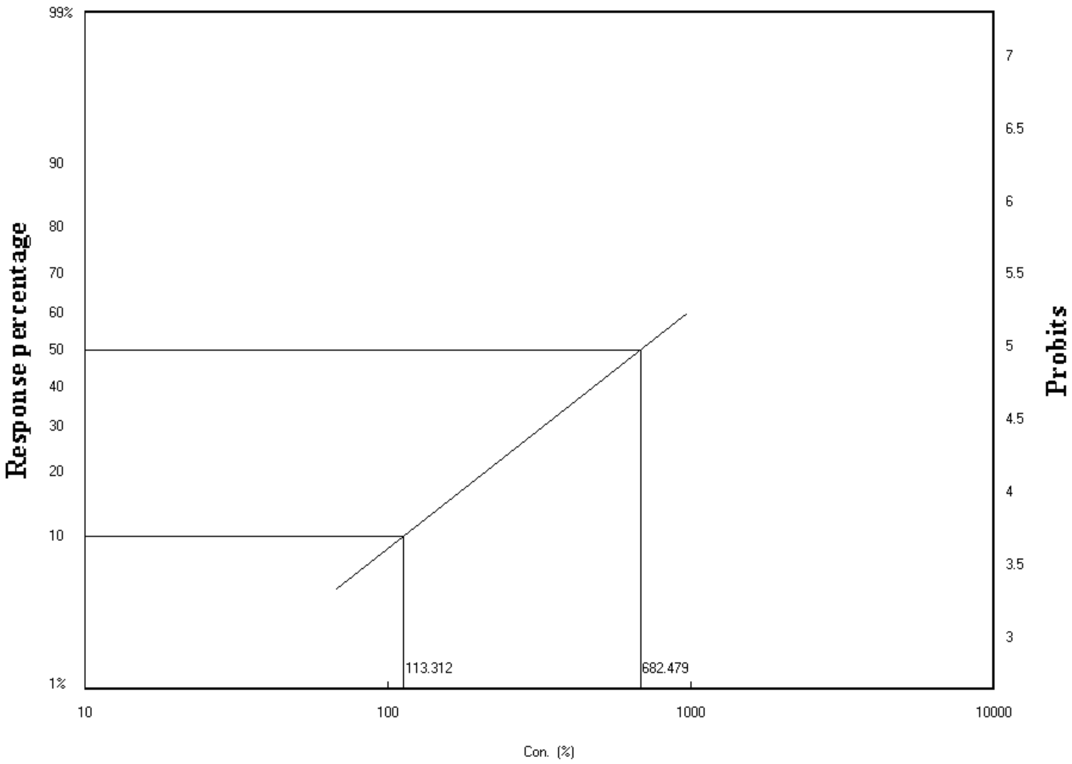

Fig.2.1: LC_{50} and LC_{10} values of treated effluent after 96 hours of the experiment

3. Summary

Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 92% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC_{50} and LC_{10}, respectively) after 96 hours are estimated as 682% and 113%, respectively.

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Monthly monitoring of Eco-toxicity of treated effluent

Sponsored by

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Visakhapatnam

February 2024

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Regional Centre, Visakhapatnam – 530 017

February 2024

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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 Visakha Pharmacity Limited 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 guard ponds of M/s Visakha Pharmacity 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, and the same was completed by May 2023. M/s Visakha Pharmacity Limited has extended the contract for three more months (September-November 2023) to assess the eco-toxicology of treated effluent from MBR plant outlet tank. CSIR-NIO conducted studies for three months and submitted reports. M/s VPL has issued order (No. 0400069607 dated 25.01.2024) to conduct only bioassay studies on treated effluent from January to December 2024. In this connection, CSIR-NIO has conducted field campaign on 22nd February 2024 for collection treated effluent from MBR tank outlet and results were given in this report.

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List of Contributors to the project

<u>Scientist-In-Charge</u>

Dr. V.V.S.S. Sarma

<u>Project Leader</u>

Dr. TNR Srinivas

<u>Data Collection, Processing & Analysis</u>

Dr. T.N.R. Srinivas

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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 the treated effluent into the sea after meeting the criterion set up by CPCB and APPCB. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobindo 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 Pharmacity Ltd. and Atchutapuram effluent treatment plant Ltd. (AETL) 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.

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treated effluent for the period of one year (from June 2022 to May 2023) on monthly time intervals. In this connection, CSIR-NIO completed this study by May 2023. M/s Visakha Pharma City Limited has extended the study to assess the treated effluent quality for three more months (September to November 2023). M/s Visakha Pharma City Limited issued work order (No. 0400069607 dated 25.01.2024) to conduct bio-assay studies on treated effluent from January to December 2024.

1.1 Objective:

The main objective of this study is to assess the quality of treated effluent from MBR outlet tank of M/s Visakha Pharma City Limited through bio-assay test using zebrafish, and to compare the results with the CPCB standards for compliance/non-compliance.

1.2 Sample collection and method:

Treated water samples were collected in pre-cleaned in white jerry cans (20L) for bio-assay studies on 22nd February 2024 from MBR out let tank filling the guard pond No. 10. The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes 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 concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

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2 Results

Survival rate of zebrafish at various time intervals during the experiment period of 96 hours in different concentrations of treated effluent was given in Table 2.1

Effluent concentration of 0% represents 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% after 84 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 24 hours of the experiment and 91% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.1).

Table 2.1: 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	97
48 hr	100	100	100	100	100	100	97	97
60 hr	100	100	100	100	100	100	97	94
72 hr	100	100	100	100	100	97	97	94
84 hr	100	100	100	100	100	97	94	91
96 hr	100	100	100	100	97	97	94	91

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Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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
60%	0	0	3	3
90%	0	3	3	6
100%	0	3	6	9

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment calculated using LDP Line software were given in Table 2.3 and Fig. 2.1

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	2333	201
96	568	115

Table 2.3: Median lethal concentrations for 24h, 48h, 72h and 96 hours

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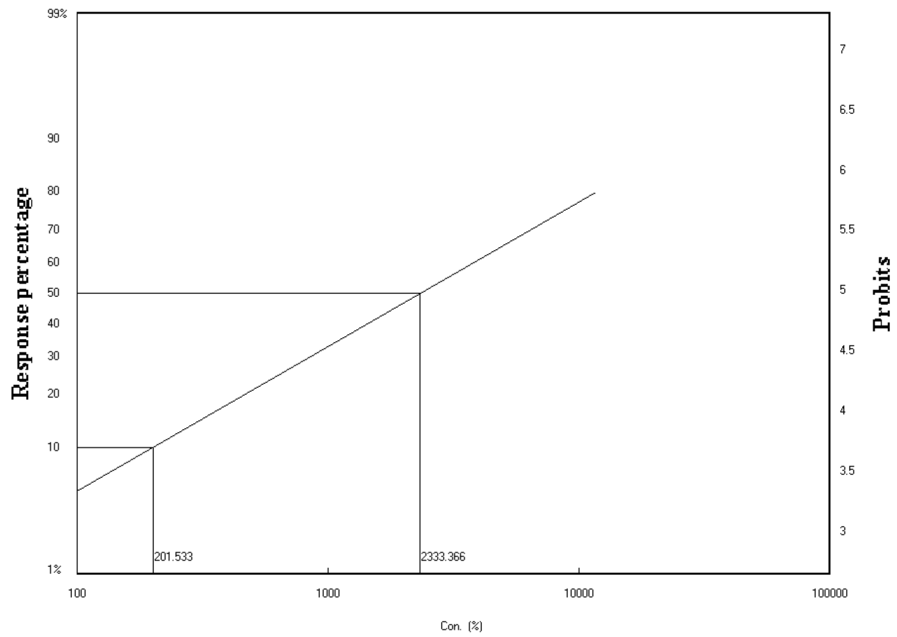
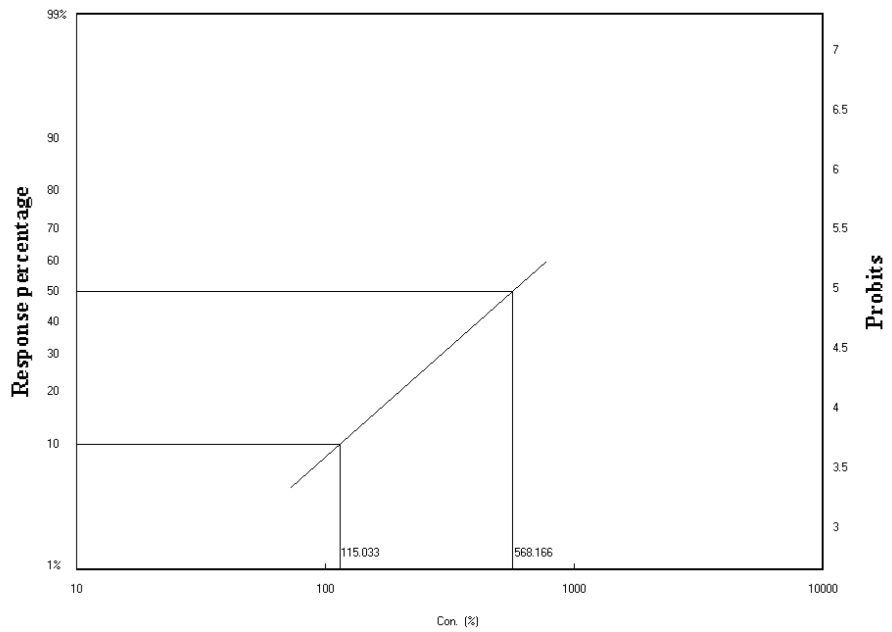


72h



96h

Fig.2.1: LC_{50} and LC_{10} values of treated effluent after 96 hours of the experiment

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Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC_{50} and LC_{10}, respectively) after 96 hours are estimated as 568% and 115%, respectively.

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Monthly monitoring of Eco-toxicity of treated effluent

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March 2024

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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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	100
48 hr	100	100	100	100	100	100	100	95
60 hr	100	100	100	100	100	100	95	95
72 hr	100	100	100	100	100	100	95	95
84 hr	100	100	100	100	100	95	95	90
96 hr	100	100	100	100	100	95	95	90

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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 2.2.

Table 2.2: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	0	5
90%	0	0	5	5
100%	0	5	5	10

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment calculated using LDP Line software were given in Table 2.3 and Fig. 2.1

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	-	-
96	1125	121

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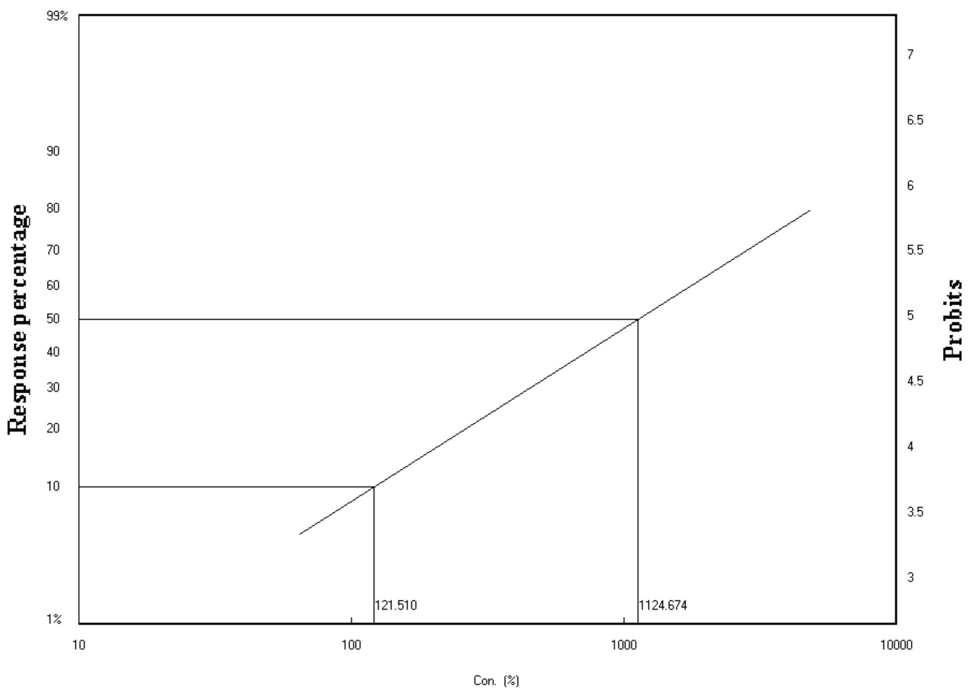

Fig.2.1: LC_{50} and LC_{10} values of treated effluent after 96 hours of the experiment

3. Summary

Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 90% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC_{50} and LC_{10}, respectively) after 96 hours are estimated as 1125% and 121%, respectively.

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Visakhapatnam

April 2024

	सीएसआईआर – राष्ट्रीयसमुद्रविज्ञानसंस्थान **CSIR-NATIONAL INSTITUTE OF OCEANOGRAPHY** **(वैज्ञानिकतथाऔद्योगिकअनुसंधानपरिषद)** **(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)** **दोना पावला, गोवा** भारत **/ DONA PAULA, GOA - 403004 India** **फ़ोन/Tel : 91(0)832-2450450/ 2450327** फैक्स **/Fax: 91(0)832-2450602** **इमेल-/e-mail :** ocean@nio.org **http://** www.nio.org	

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Monthly monitoring of Eco-toxicity of treated effluent

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Visakha Pharmacity Limited
Visakhapatnam

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

April 2024

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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 Visakha Pharmacity Limited 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 guard ponds of M/s Visakha Pharmacity 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, and the same was completed by May 2023. M/s Visakha Pharmacity Limited has extended the contract for three more months (September-November 2023) to assess the eco-toxicology of treated effluent from MBR plant outlet tank. CSIR-NIO conducted studies for three months and submitted reports. M/s VPL has issued order (No. 0400069607 dated 25.01.2024) to conduct only bioassay studies on treated effluent from January to December 2024. In this connection, CSIR-NIO has conducted field campaign on 18th April 2024 for collection treated effluent from MBR tank outlet and results were given in this report.

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List of Contributors to the project

<u>**Scientist-In-Charge**</u>

Dr. V.V.S.S. Sarma

<u>**Project Leader**</u>

Dr. TNR Srinivas

<u>**Data Collection, Processing & Analysis**</u>

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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 the treated effluent into the sea after meeting the criterion set up by CPCB and APPCB. There are 7 pharmaceutical industries (Andhra Organics Ltd., Aurobindo 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 Pharmacity Ltd. and Atchutapuram effluent treatment plant Ltd. (AETL) 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 Visakha Pharmacity Limited approached CSIR-NIO, Visakhapatnam to carry out the above-mentioned studies on their

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treated effluent for the period of one year (from June 2022 to May 2023) on monthly time intervals. In this connection, CSIR-NIO completed this study by May 2023. M/s Visakha Pharma City Limited has extended the study to assess the treated effluent quality for three more months (September to November 2023). M/s Visakha Pharma City Limited issued work order (No. 0400069607 dated 25.01.2024) to conduct bio-assay studies on treated effluent from January to December 2024.

1.1 Objective:

The main objective of this study is to assess the quality of treated effluent from MBR outlet tank of M/s Visakha Pharma City Limited through bio-assay test using zebrafish, and to compare the results with the CPCB standards for compliance/non-compliance.

1.2 Sample collection and method:

Treated water samples were collected in pre-cleaned in white jerry cans (20L) for bio-assay studies on 18th April 2024 from MBR out let tank filling the guard pond No. 4. The bio-assay test was performed following the CPCB standard method (IS:6582-1971) using zebrafish (*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 zebrafishes 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 concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent for 24h, 48h, 72h and 96 hours.

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2 Results

Survival rate of zebrafish at various time intervals during the experiment period of 96 hours in different concentrations of treated effluent was given in Table 2.1

Effluent concentration of 0% represents 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 60% after 60 hours of the experiment. In the 100% effluent concentration, the first mortality was observed after 36 hours of the experiment and 91% of zebrafish were survived after completion of the experiment (i.e., 96 hours) (Table 2.1).

Table 2.1: 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	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	100
48 hr	100	100	100	100	100	100	100	97
60 hr	100	100	100	100	100	100	97	94
72 hr	100	100	100	100	100	97	97	94
84 hr	100	100	100	100	100	97	94	91
96 hr	100	100	100	100	100	97	94	91

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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 2.2.

Table 2.2: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	3	3
90%	0	0	3	6
100%	0	3	6	9

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment calculated using LDP Line software were given in Table 2.3 and Fig. 2.1

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	2333	201
96	384	109

Table 2.3: Median lethal concentrations for 24h, 48h, 72h and 96 hours

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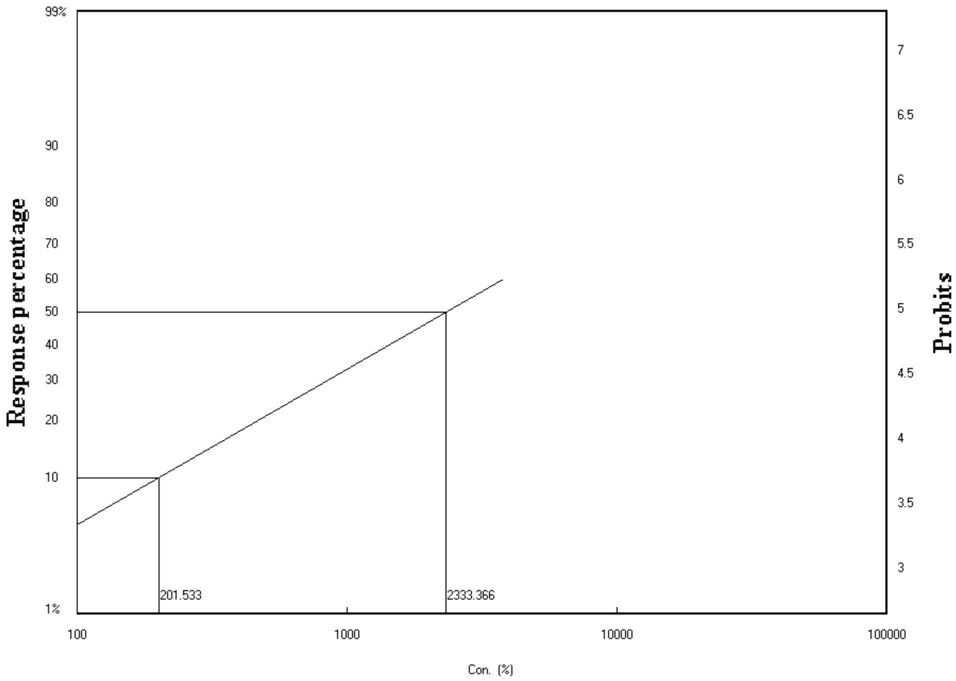
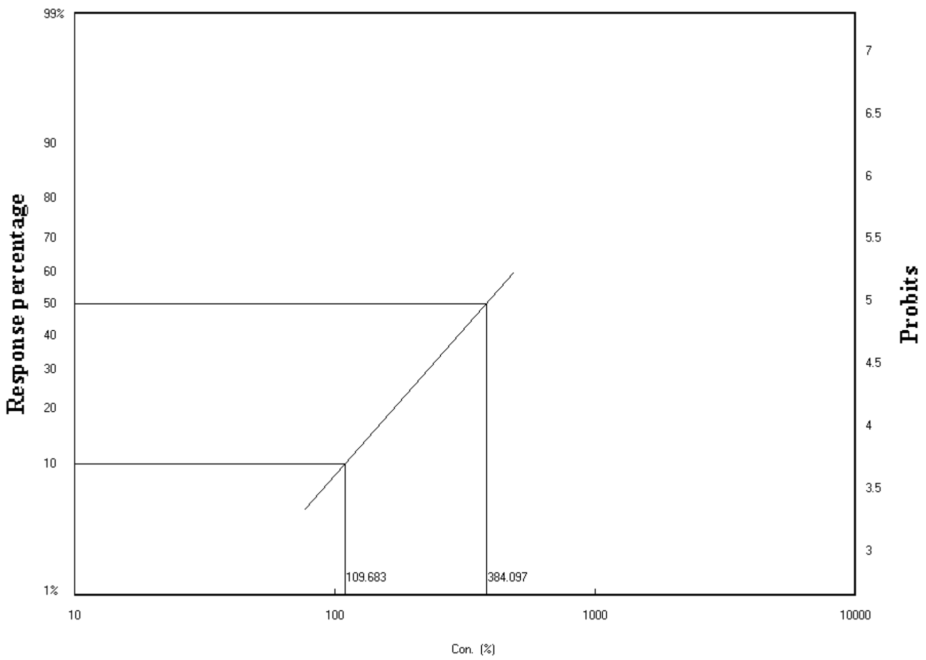


72h



96h

Fig.2.1: LC_{50} and LC_{10} values of treated effluent after 96 hours of the experiment

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3. Summary

Treated effluent collected from the MBR outlet tank of M/s Visakha Pharma City Limited fulfilled the norms of CPCB for bio-assay test with the survival rate of 91% for zebrafish in 100% effluent after 96 hours. Based on the survival rates of zebrafish at different concentrations of effluent, the median lethal concentrations for 50% and 10% mortality of zebrafishes (LC_{50} and LC_{10}, respectively) after 96 hours are estimated as 384% and 109%, respectively.

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6 hr	100	100	100	100	100	100	100	100
12 hr	100	100	100	100	100	100	100	100
24 hr	100	100	100	100	100	100	100	100
36 hr	100	100	100	100	100	100	100	100
48 hr	100	100	100	100	100	100	100	96
60 hr	100	100	100	100	100	100	96	96
72 hr	100	100	100	100	100	100	96	96
84 hr	100	100	100	100	100	96	96	92
96 hr	100	100	100	100	100	96	92	92

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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 2.2.

Table 2.2: Cumulative mortality of zebra fishes in different concentrations of effluent at exposure periods of 24h, 48h, 72h and 96 hours.

Test concentrations (% v/v)	***Cumulative Mortality (%) of zebra fish***			
	Exposure periods (hr)			
	24	48	72	96
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	0
60%	0	0	0	4
90%	0	0	4	8
100%	0	4	4	8

Based on the above observations, median lethal concentrations for the mortality of 50% and 10% of test organisms (LC_{50} and LC_{10}, respectively) of treated effluent after 24h, 48h, 72h and 96h of the experiment calculated using LDP Line software were given in Table 2.3 and Fig. 2.1

Exposure time (h)	LC_{50} (%)	LC_{10} (%)
24	-	-
48	-	-
72	-	-
96	682	113

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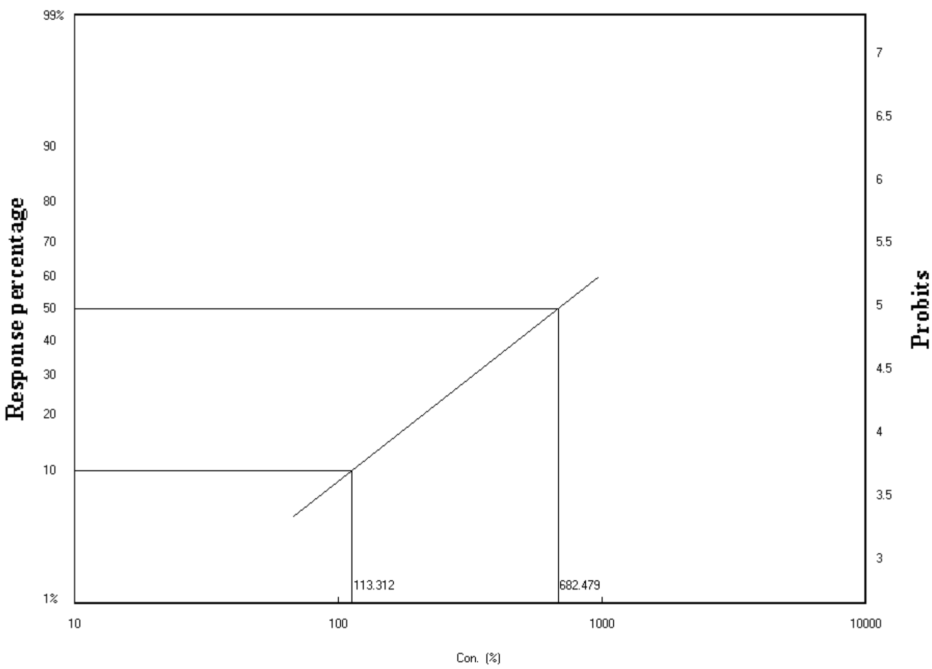

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ANDHRA PRADESH POLLUTION CONTROL BOARD
ZONAL LABORATORY :: VISAKHAPATNAM

39-33-20/4/1,Madhavadhara VUDA Colony, Visakhapatnam - 530018

LiFE Lifestyle for Environment

Consolidated statement of Analysis Results of Bore well Samples collected in Tadi (V) and Tanam (V) for the period of 2023-2024

Bore well sample collected at MPP School, Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb	Hg
07.06.2023	6.17	1018	662	53.8	180	252	BDL	1.63	0.28	BDL	0.44	BDL	49.6	13.6	65.07	0.12	<0.001	0.002	0.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.43	1546	1010	117.36	292	560	BDL	62.38	0.85	0.03	5.28	0.01	116.8	35.96	175.1	1.49	<0.001	0.002	0.01	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
28.10.2023	7.37	568	344	24.99	124	167	0.04	7.10	0.65	0.02	1.23	BDL	64	60	23.68	26.71	<0.001	0.023	0.034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
30.12.2023	7.64	2382	1550	254.28	391	540	0.05	116.32	1.26	0.02	24.52	BDL	210	181	304.2	2.56	<0.001	0.006	0.024	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
16.02.2024	7.13	544	356	24.99	192	248	BDL	11.62	1.12	BDL	1.26	BDL	36.8	24.3	27	28.86	--	--	--	--	--	--	--	--	--	--
30.04.2024	7.34	551	358	44.9	204	205	BDL	36.7	1.27	BDL	17.3	BDL	49.6	19.40	34.8	32.7	--	--	--	--	--	--	--	--	--	--
Permissible	**NR**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**	**NR**

Bore well sample collected at Tadi (V)

Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb	Hg
07.06.2023	6.92	766	496	88	292	260	BDL	16.57	0.36	0.01	14.7	BDL	86.4	18.4	56.68	1.78	<0.001	<0.001	0.036	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.37	3110	2026	482.79	600	652	0.02	113.00	0.77	BDL	16.1	0.01	240	66.09	277.1	2.23	<0.001	0.02	0.038	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001
28.10.2023	7.52	844	516	94.97	228	155	0.05	14.62	0.86	0.18	16.91	BDL	108	120	36.3	2.74	<0.001	0.006	0.068	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001
30.12.2023	7.72	2956	1928	396.09	218	487	0.04	126.51	0.74	0.06	48.14	BDL	280	312	286.6	2.74	<0.001	0.02	0.02	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
16.02.2024	7.23	754	492	84.97	320	264	BDL	19.44	0.76	0.14	11.99	BDL	28.8	60.2	38.65	2.19	--	--	--	--	--	--	--	--	--	--
30.04.2024	7.22	913	596	139.9	328	180	BDL	24.8	BDL	0.2	29	BDL	73.6	34.90	42.7	3.2	--	--	--	--	--	--	--	--	--	--
Permissible	**NR**	**--**	**2000**	**1000**	**600**	**600**	**--**	**400**	**1.5**	**--**	**--**	**--**	**200**	**100**	**--**	**--**	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**	**NR**

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Bore well sample collected at NTR Statue Main Road, Tanam (V)																										
Date	pH	EC	TDS	Cl	TH	TA	P	SO4	F	NO2-N	NO3	NH3-N	Ca	Mg	Na	K	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb	Hg
07.06.2023	7.33	2920	1896	498.9	488	680	0.01	61.1	0.49	0.19	49.9	BDL	88	65.1	349.35	2.78	<0.001	<0.001	0.003	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
21.08.2023	7.03	962	630	171.15	360	351	BDL	7.86	0.83	0.06	1.07	0.04	144	41.79	37.63	1.37	<0.001	0.007	0.072	<0.001	<0.001	0.015	<0.001	<0.001	<0.001	<0.001
28.10.2023	7.33	2930	1764	384.84	324	428	0.05	120.72	0.87	0.04	46.83	BDL	192	132	368.1	1.63	<0.001	0.022	0.026	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001
30.12.2023	7.32	1134	740	132.03	120	203	0.05	20.16	0.48	0.02	20.52	BDL	180	140	49.28	2.74	<0.001	0.006	0.074	<0.001	<0.001	0.014	<0.001	<0.001	<0.001	<0.001
16.02.2024	7.04	2700	1758	439.86	896	456	BDL	160.46	0.7	BDL	36.38	BDL	166.4	116.6	154.57	5.17	--	--	--	--	--	--	--	--	--	--
30.04.2024	7.63	1105	720	99.9	192	170	BDL	76.5	BDL	BDL	31.6	BDL	41.6	21.30	98.2	4.3	--	--	--	--	--	--	--	--	--	--
Permissible	**NR**	--	**2000**	**1000**	**600**	**600**	--	**400**	**1.5**	--	--	--	**200**	**100**	--	--	**NR**	**0.3**	**NR**	**NR**	**1.5**	**15**	**0.05**	**NR**	**NR**	**NR**

Note:

1. All values are expressed in mg/l except pH.
2. As per the analysis results all parameters are within the permissible limits prescribed in IS: 10500 2012 As per the analysis results, all the parameters are within the permissible limits for drinking water specifications except Total Hardness, Nitrates and Fluoride concentrations in some samples occasionally.
3. **NR:** No Relaxation.

SENIOR ENVIRONMENTAL SCIENTIST

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ANDHRA PRADESH POLLUTION CONTROL BOARD
Paryavaran Bhavan, APIIC Colony Road,
Gurunanak Colony, Autonagar, Vijayawada- 520007
Phone. No.0866-2463200, Website : https://pcb.ap.gov.in/

Order No.302/APPCB/HO/ECS/VSP/2023- **Date: 16/05/2023.**

DIRECTIONS

Sub: APPCB – HO - ECS - M/s. SVR Drugs Pvt. Ltd., Plot No.3, JN Pharmacity, Parawada, Visakhapatnam – Non-compliance of the consent conditions – CTE for change of product mix rejected by Board on 02.03.2023 - recommended to EAC for review and to levy Env. Compensation – Recommendations of RO, Visakhapatnam - review in EAC meetings held on 03.04.2023 and 08.05.2023 – - **Directions - Issued** - Reg.

Ref:
1. CTO Order No : APPCB/VSP/VSP/253/HO/CTO/2021- dt: 25/03/2021.
2. Industry's CTE (CPM) application received through OCMMS dt. 02.02.2023.
3. Officials of RO, Visakhapatnam inspected the industry on 12.02.2023.
4. The CFE meeting held on 28.02.2023.
5. External Advisory Committee (Task Force) meeting held on 03.04.2023
6. RO report dt. 29.04.2023.
7. EAC meeting held on 08.05.2023

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WHEREAS you are operating the industry in the name & style of M/s. SVR Drugs Pvt. Ltd., located at Plot No.3, JN Pharmacity, Parawada, Visakhapatnam is bulk drug manufacturing unit.

WHEREAS the Board vide ref. 1st cited, issued Consent to Operation (CTO) to the industry on 25.03.2021 stipulating certain conditions, valid up to 30.04.2023 to manufacture combination of any 8 products on campaign basis at any point of time - 2800 Kgs/day.

WHEREAS vide ref. 2nd cited, the industry proposed for Change of Product Mix and applied for CTE (CPM) of the Board with following product mix: The changes in product mix are as follows:

- Total products will be 37 including validation products. Presently 31 products are permitted.
- Dropped 10 No. of existing products.
- Added 16 No. of new products.
- Retained 15 No. of products.
- Increased or decreased the production quantity of existing 6 products.
- No change in water consumption and wastewater generation. Proposed to manufacture 2800 Kgs/day with the combination of any 8 products on campaign basis at any point of time.

WHEREAS the CTE committee in its meeting held on 28.02.2023 and observed the following:

a. The production capacity of 4-Difluoro- 2-Nitroaniline (BED-1) Pantoprazole Sodium Intermediate exceeded in the month of Jan-2023.
b. The industry has to comply with several conditions stipulated by the Board in the CTO order even after lapse of one year.
c. Necessary precautions are to be taken for storage and handling of Hydrogen &

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prepare safety report if required.

d. The levy of environmental compensation (EC) may be considered for the industry based on no. of days of non-compliances.
e. As per the recommendations of CTE committee, the CTE for change of product mix was rejected by order dt.02.03.2023 and recommended to refer to EAC committee for review and levy of EC for violation period.

WHEREAS the industry was reviewed before the External Advisory Committee (Task Force) meeting held on 03.04.2023 and directed RO, Visakhapatnam to submit report on the latest compliance status and the Environmental Compensation to be levied on the industry for the violation of CTO conditions vide memo dated 18.04.2023.

WHEREAS the industry again applied for CTE (CPM) as the earlier application was rejected and the CTE application was reviewed before CTE committee meeting held on 17.04.2023 at Board Office, Vijayawada and the committee recommended to issue CTE (CPM) to the industry after receipt of undertaking on Rs.100/- stamp paper w.r.t payment of Environmental Compensation.

WHEREAS the officials of RO, Visakhapatnam inspected the industry on 27.03.2023 and observed the latest compliance status on non-compliance observed (12.02.2023) earlier as below:

1. The industry provided energy meters to the scrubber, Bag filter and at Effluent Treatment plant.
2. The industry vent condensers are installed and connected to the storage tanks.
3. The industry has constructed containers detoxification facility at the covered platform with dike walls. The container washings are collected in the sump and transferred through pump to LTDS collection tank.
4. The industry manufacturing productions within the limits.
5. The industry provided 2 VOC meters additionally at Solvent storage yard and at the centre of all 4 Production Blocks and requested IT Cell, APPCB for connectivity to APPCB Website. Existing VOC meter is at security main gate near admin building which is connected to APPCB server.
6. The industry provided two more Ammonia Sensors at storage tanks of Ammonia.
7. The industry provided following safety measures/ equipment for the storage and handling of hydrogen gas.

- Nitrogen blanketing in Hydrogenation reactor.
- Safety valve and Rupture disc provided on reactor.
- Flame arrestors are provided on vent line of reactor and extended up to roof level.
- Open well ventilated and fragile roofs are provided on reactor.
- SOP's are prepared and Safety trainings has been conducted to operators.
- Dump vessels are provided.
- Static and electric earthing are provided.
- 2 No. of Hydrogen gas detectors are provided along with alert hooter.
- DCP Modules are provided on the reactors.
- Fire Hydrant System & Fire Extinguishers are provided at the Hydrogenator.
- Oxygen breathing analysers and Aluminium Aprons are provided to the operators.

8. The compliance status on non-compliance observed in the CTE committee meeting held on 17.04.2023 are as follows:

a. The industry has requested IT Cell APPCB for online connectivity to two new VOC meters.
b. The industry submitted action plan to develop greenbelt in the coming monsoon season in the extent of 1.0 acre in addition to the existing 1.0 acre of greenbelt (35%).

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WHEREAS the report of the RO on the compliance status and levy of EC vide ref. 6th cited was reviewed during the EAC (TF) meeting held on 08.05.2023. The representatives of the industry and EE, RO, Visakhapatnam attended the meeting through VC. The representative of the industry informed that they have rectified the non compliances by 08.03.2023 and further informed that they have produced a product of 600 kg/batch against the consented capacity of 500 kg/batch. The excess production was done only for few days for due to technical reasons, whereas the annual average production is within the permitted capacity.

After detailed discussions, the committee recommended to levy the EC from violation observed 12.02.2023 to the date of compliance by 08.03.2023. Accordingly, the Board hereby issues the following directions to M/s. SVR Drugs Pvt. Ltd., Plot No.3, JN Pharmacity, Parawada, Visakhapatnam under Sec.33 (A) of Water (Prevention and Control of Pollution) Act, 1974 and under Sec.31 (A) of Air (Prevention & Control of Pollution) Act, 1981 and amendments thereof:

1. ***The industry shall ensure that there shall not be production of any un-consented products and capacities more than the permitted capacity.***
2. ***The industry shall segregate the effluent into HTDS & LTDS at source of generation.***
3. ***Effluent shall not be discharged onland or into storm water drains or aquifers under any circumstances. Floor washings shall be admitted into effluent collection system only and shall not be allowed to find their way into storm water drains or open areas.***
4. ***The industry shall operate the 2 stage scrubbing system for scrubbing emissions from reactors, centrifuges.***
5. ***The industry shall maintain the flow meters with totalizers intact and shall maintain records of LTDS and HTDS effluent generated and disposed.***
6. ***The industry shall provide storm water drains and a tank for collection of first flush contaminated storm water. The contaminated storm water collected shall be pumped back and treated along with LTDS effluents.***
7. ***The industry shall take all necessary measures for VOC emission control and shall maintain VOC analyzer with data logger intact.***
8. ***The industry shall maintain the records of effluent and hazardous waste generated and disposed for each category and shall produce to inspecting officials.***
9. ***The industry shall comply with CPCB directions dated 05.02.2014 and 02.03.2015 regarding the guidelines issued for periodical calibration of online pollution monitoring systems from time to time.***
10. ***The industry shall pay the EC of Rs. 3,75,000/- within a month, for the violation period from 12.02.2023 to 08.03.2023.***

You are hereby directed to note that, should you violate any one of the directions mentioned above, action will be initiated under Sec.33 (A) of Water (Prevention & Control of Pollution) Amendment Act, 1988 and Sec.31(A) of Air (Prevention & Control of Pollution) Amendment Act, 1987 without any further notice, in the interest of Public Health and Environment.

This Order comes into effect from today i.e., 16/05/2023.

B Sreedhar Ias
MEMBER SECRETARY

To

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The occupier,
M/s. SVR Drugs Pvt. Ltd.,
Plot No.3, JN Pharmacity,
Parawada, Visakhapatnam.

Copy to:

1. The Joint Chief Environmental Engineer, Zonal Office, Visakhapatnam for information and necessary action.
2. The Environmental Engineer, Regional Office, Visakhapatnam for information and necessary action.

Signed by B Sreedhar Ias
Date: 16-05-2023 12:18:45
Reason: Approved

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ANDHRA PRADESH POLLUTION CONTROL BOARD
Dr. YSR Paryavaran Bhavan, APIIC Colony Road,
Gurunanak Colony, Autonagar, Vijayawada- 520007
Phone. No.0866-2463200, Website : https://pcb.ap.gov.in/

Order No.801/APPCB/HO/ECS/ANKP/VSP/2023- **Date: 14/12/2023.**

SHOW CAUSE NOTICE

Sub: APPCB – HO - ECS - M/s. Srikar Laboratories Pvt. Ltd., Plot No.32 A, JNPC, Parawada, Anakapalli District – Telephonic Complaint - illegal dumping of hazardous waste - Non-compliance to CTO & HWA conditions – Monitoring (TF) Committee meeting held on 06.12.2023 – Levy of Environmental Compensation – Show Cause Notice - Issued - Reg**.**

Ref:
1. CFO renewal Order dt. 17.05.2022.
2. Stop production order issued to the industry on 25.05.2016.
3. Revocation of stop production order issued on 23.06.2016.
4. Telephonic complaint received from Sri Allavarapu Venkata Ramana on 29.10.2023.
5. Inspection of the dump site and your industry by Board Officials on 31.10.2023, 02.11.2023 & 03.11.2023.
6. Monitoring (Task Force) Committee Meeting held on 06.12.2023.

***

WHEREAS you are operating the industry in the name & style of M/s. Srikar Laboratories Pvt. Ltd., is located at Plot No.32A, JNPC, Parawada, Visakhapatnam and engaged in manufacturing of Bulk Drugs and Intermediates – 2600 Kgs/day.

WHEREAS the Board vide ref. 1st cited, issued CTO & HWA vide order dated: 17.05.2022 to manufacture any 4 products at any point of time, out of 52 permitted bulk drugs and API products with a max production capacity of 2600 Kg/day. The consent is valid up to 30.06.2027.

WHEREAS the Board vide ref. 2nd cited, issued stop production order to your industry on 25.05.2016 due to the Fire accident resulted in air and water pollution problems in the area.

WHEREAS the Board issued revocation of the stop production order vide order dt.23.06.2016 with the following directions:

a. The industry shall dispose off Hazardous solid waste generated during the fire accident to TSDF, Pharmacity, Visakhapatnam immediately.
b. The industry shall take suitable measures to avoid odour nuisance in and around factory premises.
c. The industry shall construct concrete raised platform for storage of hazardous waste under the shed.
d. The industry shall commission new ammonia chilling plant along with re-commission of the plant.
e. The industry shall commission water scrubber to contain fugitive emission of Aluminium Chloride along with starting of plant.
f. The industry shall take immediate steps to obtain Responsible Care Certification.

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WHEREAS the Regional Office, Visakhapatnam vide ref. 3rd cited, received a telephonic complaint from Sri. Allavarapu Venkata Ramana, Ex Vice-Sarpanch, Pallapu Anandapuram, Munagapaka Mandal, Anakapalli District on 29.10.2023 informing that industrial hazardous waste was illegally dumped in the coconut garden (17.61612 E & 82.945707 N) belongs to Sri Karri Ustelu Naidu abutting Pallapu Anandapuram and Khazipalli Village Road Munagapaka (M), Anakapalli District, which is causing severe odour nuisance in the area and may cause ground water pollution.

WHEREAS the Board Officials inspected the dump site on 31.10.2023 and observed that bags containing coal ash mixed with inorganic solid waste & Spent Carbon were buried in the coconut garden belongs to Sri Karri Ustelu Naidu, Pallapu Anandapuram (V), Munagapaka (M), Anakapalli District. Solid waste sample was collected from the hazardous waste dump in the coconut garden of Ustelu Naidu, Pallapu Anandapuram, Anakapalli District on 31.10.2023 and submitted to Zonal Laboratory Visakhapatnam for analysis. During inquiry, the land owner Sri Karri Ustelu Naidu informed that Sri Venkatesh who is regularly lifting the coal ash from M/s. Srikar Laboratories Pvt. Ltd., Plot No.32 A, JNPC, Parawada dumped the hazardous waste in his land and also informed that the waste belongs to M/s. Srikar Laboratories Pvt. Ltd., Plot No.32 A, JNPC, Parawada.

WHEREAS a case was filed by Sri. Marasi Somu Naidu S/o. Late Chinna Sanyasi, Pallapu Anandapuram, Munagapaka Mandal, Anakapalli District in Police Station, Munagapaka (V&M) against Sri Karri Anantha Ramakrishna Naidu S/o. Sri Karri Ustelu Naidu (land owner) stating that he was doing farming and living along with his family in Pallapu Anandhapuram Village of Munagapaka Mandal. On 25.10.2023 at 15.00hrs, Karri Anantha Ramakrishna Naidu brought the waste from pharma company, Parawada and dug a hole and dumped in his coconut fields besides the road, which is hazardous waste.

WHEREAS on the request of the Board, M/s. Coastal Waste Management Project, (A division of Re Sustainability Limited), JN Pharmacity, Parawada, Anakapalli District has lifted 34 MT of hazardous waste from the dumpsite to TSDF for treatment & safe disposal.

WHEREAS the Board Officials again inspected the above said dumpsite and M/s. Srikar Laboratories Pvt. Ltd., on 02.11.2023 & 03.11.2023 and collected samples from the following locations -

a. Agricultural Bore Well Sample collected near dump area
b. Solid waste sample from dump area at Pallapu Anandapuram (V), Munagapaka (M), Anakapalli District and the analysis report of the samples are as follows -

S. No.	Parameter	Units	Sample collected from the dump site on 31.10.2023	Sample collected from the dump site on 02.11.2023
1.	Physical State	--	Solid	Solid
2.	pH	--	10.92	11.07
3.	Electrical Conductivity (1: 5) Ratio)	µS/cm	19540	25200
4.	Calorific Value	Cal/gm	1220	1160
5.	Loss on Ignition (LOI) (Dry Basis)	%	36.7	30.46
6.	Loss on Drying (LOD)	%	32.9	33.16
7.	Total Organic Carbon (TOC)	%	11.97	13.38
8.	TCLP Chromium (as	m	0.031	0.028

	Cr)	g/l		
9.	TCLP Manganese (as Mn)	mg/l	0.019	0.022
10.	TCLP Iron (as Fe)	mg/l	<0.001	<0.001
11.	TCLP Nickel (as Ni)	mg/l	<0.001	<0.001
12.	TCLP Copper (as Cu)	mg/l	<0.001	<0.001
13.	TCLP Zinc (as Zn)	mg/l	<0.001	<0.001
14.	TCLP Arsenic (as As)	mg/l	<0.001	<0.001
15.	TCLP Cadmium (as Cd)	mg/l	<0.001	<0.001
16.	TCLP Lead (as Pb)	mg/l	<0.001	<0.001
17.	TCLP Mercury (as Hg)	mg/l	<0.001	<0.001

From the above analysis reports, it was noted that the dumped solid waste samples observed to be hazardous in nature which is supposed to be disposed in secured landfill after stabilization.

c. During inspection of industry on 03.11.2023, Sri D. Chaitanya Varma, Plant Head was present and the following observations were made:

i. On verification of the gate passes, it was noticed that the industry sent hazardous waste in Two lorries bearing no. AP 39 TE 2460, & AP 39 UD 4469 in the name of coal ash to Balakrishna Bricks, Kasimkota on 25.10.2023. But Sri Venkatesh, transporter of coal ash, buried the waste in the land of Sri Karri Ustelu Naidu, Pallapu Anandapuram(V), Munagapaka(M), Anakapalli District instead of sending to Balakrishna Bricks, Kasimkota(V).

ii. The analysis reports of the solid sample collected from the dump site on 31.10.2023 & 02.11.2023, it was noted that the dumped solid waste samples observed to be hazardous in nature which is supposed to be disposed in secured landfill after stabilization.

iii. Ground water (Bore well) sample was collected near the dump area on 02.11.2023 and as per analysis, no contamination in ground water is observed.

iv. The details of production for the last six months during the period from May-2023 to Oct-2023 are as follows:

- The industry exceed the production capacity of 5-Bromoacetyo Salicylamide in the month of Jun-23 & Jul-23 i.e., produced 179.4 Kgs/ day and 171.32 Kgs/day respectively as against the consented capacity of 166.67 Kgs/day.
- The industry exceed the production capacity of Fexofenadine Hydrochloride also exceeded in the month of May-23, August- 223 & October 23 i.e., produced 151.74 Kgs/ day, 154.06 Kgs/day and 152.35 Kgs/day respectively as against the consented capacity of 150 Kgs/day.

v. 2 Tons of Spent Carbon and 5 Tons of Inorganic Solid Waste along with 27 Tons of coal ash were disposed illegally in the dump area at Pallapu Anandapuram(V), Munagapaka(M), Anakapalli District.

vi. At present 3.338 T of Spent carbon and 21.638 T of In Organic Solid Waste is stored in the premises for disposal as per the disposal option mentioned in the consent order

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i.e., to cement plants for coprocessing / TSDF for incineration and TSDF for secured land filling respectively.

WHEREAS hearing was conducted before the Monitoring Committee (Task Force) Meeting of A.P. Pollution Control Board held on 06.12.2023. The representatives of the industry attended the meeting and EE, RO, Visakhapatnam through VC. The EE, RO, Visakhapatnam informed that the industry has disposed about 2 Tons of Spent Carbon and 5 Tons of Inorganic Solid Waste along with 27 Tons of coal ash were disposed illegally at Pallapu Anandapuram(V), Munagapaka(M), Anakapalli District. The dumped solid waste samples observed to be hazardous in nature, which is supposed to be disposed in secured landfill after stabilization. At present 3.338 T of Spent carbon and 21.638 T of In- Organic Solid Waste are stored in the premises for disposal as per the disposal option mentioned in the consent order i.e., to cement plants for coprocessing / TSDF for incineration and TSDF for secured land filling respectively. Further informed that the industry has exceeded the production quantity during May to October, 2023 for certain products. The representative of the industry informed that hazardous waste was mistakenly disposed along with coal ash to brick manufacturing units. Soon after the matter came to their notice the waste along with contaminated soil was lifted from the dump site and sent to TSDF. Further informed that the monthly production quantity of certain products were slightly increased due to higher yield, however on annual basis the production quantity will be within the consented capacity.

After detailed review, the Committee recommended to levy Environmental Compensation for an amount of Rs. 3,15,000/- (Rupees Three Lakhs Fifteen Thousand only) as per CPCB guidelines (Environmental Compensation (EC) = Q x ERF x R), for indulging in illegal disposal of 7 Tons of Hazardous waste outside the premises. The industry to pay the EC within a month.

In view of the above, you are hereby directed to **show cause** to why the Board shall not levy environmental compensation of Rs. 3,15,000/- (Rupees Three Lakhs Fifteen Thousand only) for indulging in illegal disposal of 7 Tons of Hazardous waste outside the premises. Further you are directed to furnish your reply within 15 days from date of issue of this notice.

Should you fail to furnish your reply within time or failed to furnish valid reasons, the Board will be constrained to issue necessary orders on levying of environmental compensation for indulging in illegal disposal of Hazardous waste outside the premises in violation of CTO & HWA, in the interest of public health and Environment, without any further notice.

B Sreedhar Ias
MEMBER SECRETARY

To
The Occupier,
M/s. Srikar Laboratories Pvt. Ltd.,
Plot No.32 A, JNPC,
Parawada,
Anakapalli District.

Copy to:

1. The Joint Chief Environmental Engineer, Zonal Office, Visakhapatnam for information and necessary action.
2. The Environmental Engineer, Regional Office, Visakhapatnam for information and necessary action.