BEFORE THE HON'BLE NATONAL GREEN TRIBUNAL

PRINCIPAL BENCH, AT NEW DELHI

ORIGINAL APPLICATION NO. 1313 OF 2024

IN THE MATTER OF:

V SRIKANTH … APPLICANT

VERSUS

STATE OF ANDHRA PRADESH & ORS. … RESPONDENTS

INDEX FOR VOLUME-IX

55.	**ANNEXURE- 51** A copy of the Report dated 18.03.2025 on Shoreline changes from Satellite Imageries and Monitoring of Shoreline changes from field measurements.	2036 – 2054
56.	**ANNEXURE- 52** A copy of Report dated 09.01.2025 bearing Ref No. AKPL/EC/ENV/126/2024-25 complying with Phase III expansion of EC & CRZ Clearance Condition No. VIII under Marine ecology stipulates-Submission of Marine Biodiversity Management Plan.	2055 – 2059
57.	**ANNEXURE- 53** A copy of the E-mail sent to AP state Biodiversity Board 21.01.2025.	2060 – 2061
58.	**ANNEXURE- 54** A copy of the Final Report submitted by Suganthi Devadason Marine Research (SDMRI) dated 16.12.2024.	2062 – 2250

FILED BY:

D/8495/2018

[KARANJAWALA & CO.]
ADVOCATES FOR RESPONDENT NO. 4
FIRST FLOOR, 212, ROUSE AVENUE,
DEEN DAYAL UPADHYAY MARG,
NEW DELHI-110002
EMAIL: service@karanjawala.in;
karanjawala@karanjawala.in

PLACE: NEW DELHI
DATE: 26.09.2025

ANNEXURE-46

adani
Ports and Logistics

Ref: AKPL/EHS/APPCB/039/2024-25 Date: 10/07/2024

To

The Environmental Engineer,
A.P. Pollution Control Board,
Regional Office
Plot No.1, Prasanthi Nagar.
Near Nellore Club, Podalakur Road,
SPSR Nellore - 524003.

Dear Sir,

Sub:- Adani Krishnapatnam Port Limited (AKPL) — Task Force Directions – Issued – Compliance Status – Submitted - Reg.

Ref:- 1. APPCB EAC (Task Force) Directions Order No.804/ APPCB/ HO/ECS/ NLR/ 2023 dated 14.12.2023.
2. AKPL Letter No.AKPL/APPCB/EHS/109/2023-24, dated 07.02.2024
3. AKPL Letter No.AKPL/APPCB/NGT/119/2023-24, dated 12.03.2024
4. AKPL Letter No.AKPL/APPCB/NGT/017/2024-25, dated 14.05.2024

It is to submit that the compliance status of AKPL was reviewed by APPCB External Advisory Committee in its meeting held on 06.12.2023 and issued certain directions vide reference 1st cited to comply with.

As per the directions, AKPL has submitted the compliance status with time bound action plan vide reference 2nd & 3rd cited. Ambient Air Quality Monitoring was conducted through in the port complying with the direction no.9 and submitted the Monitoring Report vide reference 4th cited.

Further, complying with the direction no.6, AKPL has established one more Truck Wheel Washing facility to clean all out going trucks passing from South port to outside of Port premises in addition to the existing facility at North side of the Port. The new Wheel washing facility is an advanced automatic sensor based technology comprising with oil skimmer & separator from the washed water, recycling & reusing provision of the water washed thereby reduce the water consumption.

In this regard, furnishing herewith the latest compliance status on the Task Force Directions for kind consideration and submit that AKPL has complied with majority of the directions as committed.

We assure that AKPL will continuously evaluate the environmental impacts during the Port operations and will promote timely initiations for better environment & sustainability with all mitigation measures to prevent the dust pollution to the surrounding environment.

Thanking you.

Yours sincerely,

for Adani Krishnapatnam Port Limited.

Sd/- Dr. D. Jyothi
Vice President-Env.

Encl: as above.

Copy submitted to the Joint Chief Environmental Engineer, APPCB, Legal Cell, Board Office.

Compliance status on the External Advisory Committee (Task Force) directions issued vide APPC Order No.804/APPCB/HO/ECS/NLR/ 2023, dated 14.12.2023.

Sl. No.	Direction	Status/Compliance
1.	The port shall submit time bound action plan for mechanization of South berths to handle coal, within two months.	• There are two coal fired power projects on the southern side of the Port. • Out of two plants one is in operation and the other one will become operational in few months. • AKPL has been transporting the coal through covered trucks for the operational plant. • Once the 2nd one becomes operational, the MOU will be entered with the Power Plants which will take about 6 months, • The mechanization of the cargo handling system would take a minimum time period of 24 months to execute after obtaining consent from the power plants.
2.	The port shall expedite installation of fixed dust separation systems (MDSS) at South berth for handling of coal and other dusty cargo.	AKPL is initiating the process of providing Fixed Dust Suppression Systems (FDSS) at South Berths and expected to be completed by December 2024.
3.	The port shall ensure water sprinkling system and other dust suppression measures are effective for suppression/containment of the dust emissions during handling of coal.	Being Complied. • Provided mist sprinkling system at Hopers, Transfer Towers & at stack yards. • The stockyards are supported by MDSS at all yards including coal and iron ore storage area to suppress dust during stacking of cargo in yards. • Conveyers and Hopper systems are provided with water sprinkling system for handling coal from berths to storage yards to mitigate fugitive dust emissions while handling & transportation.

4.	The port shall deploy road sweeping machines for frequent roads cleaning from berth to south gate and to deploy more no. of road-sweeping machines in consultation with RO, Nellore.	Complied: • Deployed 8 Nos. tractor mounted hydraulic broom sweeping machines. • As per the TF directions 2 No. of heavy duty sweeping machines are provided for effective sweeping of roads, berths and all operational areas.
5.	The port shall ensure to provide cover to trucks carrying the co& from berth to destination.	Complied: Ensuring all the outbound trucks are properly covered & tightened with tarpaulin to avoid transit spillages till it reaches the destination.
6.	The port shall expedite to provide a truck wheel wash facility on the South side.	Complied: AKPL established one more Truck Wheel Washing facility to clean all out going trucks passing from South Port to outside of Port Premises in addition to the existing facility at North side of the Port. The new Wheel washing facility is an advanced automatic sensor based technology comprising with oil skimmer & separator from the washed water, recycling & reusing provision of the water washed thereby reduce the water consumption (Photographs attached as Annexure-I)
7.	The port shall provide STP to cater the domestic waste water generated at South berths.	At South Berth S4, 20 no. of employees are working shift wise, and water is utilization only in 4 No. of toilets provided for the working staff. The estimated sewage generated from toilets of 0.80 KLD is routed to septic tank. The quantity of sewage is too low to provide an additional STP, hence we earnestly urge to withdraw this condition.
8.	The port shall ensure to progressively increase more No. of water sprinklers and other required dust containment/suppression measures while increasing the cargo handling capacity.	AKPL is progressively increasing the No. of water sprinklers and other required dust containment / suppression measures to mitigate the dust emissions on vehicular movement during cargo evacuation on par with the cargo handling capacity.
9.	The port shall install more No. of CAAQM stations to continuously monitor the air quality at representative	Being Complied. As per the Task Force Directions of APPCB, AKPL has carry out the Air Quality Modeling study through a NABET Certified

	locations and to implement adequate measures to prevent air borne dust pollution in the surrounding villages, The locations to install the additional CAAQM stations shall be identified through scientific modelling and shall install in consultation with RO, Nellore.	Consultancy to assess the requirement of additional AAQ/CAAQM Stations. Based on the baseline studies, CAAQM data and Air model studies, two air quality monitoring stations are recommended at the following locations: CAAQM 4 at Latitude – 14 14' 5.58" N & Longitude 80 6' 38.22 E" CAAQM 5 at Latitude – 14 15' 47.85 " N & Longitude 80 4' 39.45 E" The monitoring report was submitted at APPCB RO SPSR Nellore on 14.05.2024 (Attached as Annexure II) appointed a NABET Certified Consultancy to carry-out Air Modeling study to assess the requirement of additional AAQ/ CAAQM Stations.
10.	The port shall furnish preparedness plan to contain the air borne dust emissions for each stock yard/zone wise and during unloading and handling of dusty cargo at berth front.	Being Complied. AKPL has been following Environment Management plan to contain the air borne dust emissions for each stock yard/ zone wise and during unloading and handling of dusty cargo at berth front. • Provided mist sprinkling system at Hopers, Transfer Towers & at stack yards. • Provided MDSS at all yards including coal and iron ore storage area to suppress dust during stacking of cargo in yards. • Ensuring the stacks are continuously wetted with water sprinkling system to suppress the dust at source itself. • Ensuring all the outgoing cargo carrying trucks and wagons are fully covered with tarpaulin and tightened with rope to avoid fugitive emissions/spillage until it reaches the destination. • Deploying Truck mounted sprinklers, heavy-duty Atomized Sprayers, Tractor mounted hydraulic broom sweeping machines for dust

		suppression and to prevent air borne fugitive dust emissions due to vehicle moment. • Provided 2 No. of additional heavy duty sweeping machine for deployment at strategic locations. • Ensuring all the outgoing cargo carrying trucks tires are cleaned before leaving the Port premises. • Providing one more truck tyre washing facility at South Berth location is in progress.
11.	The port shall not draw the ground water under any circumstances. The port shall furnish time bound action plan to meet the water requirement for the port activities, from the sustainable sources.	• AKPL is not drawing any ground water. • The source of water is Muthukur Reservoir with approved withdrawing quantity of 1.0 MLD and Nakkalakalava drain with approved withdrawing quantity of 4.0 MLD. • The water from Muthukur Reservoir has been receiving through tankers and Nakkalakaluva water is being pumped to AKPL Pump house.
12.	The port shall submit action plan to treat the sewage generated from Nellore Municipal Corporation, as to utilize for dust suppression system in the port.	• Nellore Municipal Corporation (NMC) proposed to supply water to industries at Krishnapatnam node and it had conducted a meeting with the industrial representatives on 22.01.2024. AKPL has expressed its willingness to fetch either STP or raw water from NMC. • AKPL intended to take 10 MLD of water for port requirements. • The DPR preparation is in progress at NMC.
13.	The port shall periodically undertake de-silting of the drains and to keep them intact for free flow of the runoff.	Complied. • AKPL has been ensuring periodical de-silting of the drains to ensure free flow of the runoff.

For Adani Krishnapatnam Port Limited
Sd/- D. Jyothi
(Dr. D. Jyothi)
Vice president (Environment & Sustainability)

ADVANCED TRUCK WHEEL WASHING FACILITY AT THE PORT

Krishnapatnam, July 9 (Capital Information): Adani Krishnapatnam Port Limited (AKPL) has started one more Truck Wheel Washing Centre at Southside of the port by Adani Krishnapatnam Port CEO, Mr. GJ Rao on Tuesday to remove dirt, debris, dust and silt from wheels of all outgoing trucks passing from South Port to outside the port premises. This is in addition to the existing facility at northside of the port. Speaking after inaugurating the facility at the South side of the port, Mr. G.J Rao said that the new wheel washing facility is an advanced one an is equipped with automatic sensor-based technology comprising with oil skimmer and separator from washed water. This facility has recycling and reusing provision of water washed thereby to reduce water consumption, he said. Also, CEO said that the Adani Krishnapatnam Port is committed to comply with the statutory norms by implementing all mitigation measures for promotion of environment and sustainability. Chief Operating Officer (COO), Mr. Rajan Babu; HR and Administrative Head, Mr. Ganesh Sharma; Corporate Affairs Head, K.M Ram and other HOD's of all Divisions; HOS's; Civil Construction Management along with Environment Health Safety Teams have participated in the above facility programme.

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TRUCK WHEEL WASHING WITH SCIENTIFIC KNOWLEDGE AT THE KRISHNAPATNAM PORT

Muthukuru, July 9 (Prabha News): Adani Krishnapatnam Port Limited (AKPL) has started one more Truck Wheel Washing Centre at Southside of the port to remove dirt, debris, dust and silt from wheels of all outgoing trucks passing from South Port to outside the port premises. The above centre was launched by Adani Krishnapatnam Port CEO, Mr. GJ Rao on Tuesday. This is in addition to the existing facility at northside of the port. Speaking after inaugurating the facility at the South side of the port, Mr. G.J Rao said that the new wheel washing facility is an advanced one. This is equipped with automatic sensor-based technology comprising with oil skimmer and separator from washed water. This facility has recycling and reusing provision of water washed thereby to reduce water consumption, he said. Also, CEO said that the Adani Krishnapatnam Port is committed to comply with the statutory norms by implementing all mitigation measures for promotion of environment and sustainability. Chief Operating Officer (COO), Mr. Rajan Babu; HR and Administrative Head, Mr. Ganesh Sharma; Corporate Affairs Head, K.M Ram and other HOD's of all Divisions; HOS's; Civil Construction Management along with Environment Health Safety Teams have participated in the above facility programme.

***

STARTING OF TRUCK WHEEL WASHING MACHINE AT THE PORT

Muthukuru: The CEO of Adani Krishnapatnam Port Limited (AKPL), Mr. G.J Rao informed that the AKP Limited has started using Advanced Truck Wheel Washing Machine to remove dirt, debris, dust from wheels of all outgoing trucks passing from Adani Krishnapatnam Port. Also, the CEO informed that the washing wheel was started on Tuesday to clean the dirt of the vehicles which are passing through the South Port. Speaking after inaugurating the washing wheel, Mr. G.J Rao said that the new wheel washing wheel is equipped with automatic sensor-based technology comprising with oil skimmer and separator from washed water. This washing wheel has recycling and reusing provision of water washed thereby to reduce water consumption, he said. Also, CEO said that the Adani Krishnapatnam Port is committed to comply with the statutory norms by implementing all mitigation measures for promotion of environment and sustainability. Chief Operating Officer (COO), Mr. Rajan Babu; Admin Head, Mr. Ganesh Sharma; Corporate Affairs Head, K.M Ram and other HOD's of all Divisions have participated in the above facility programme.

***

ENVIRONMENTAL PROTECTION MEASURES

Muthukuru, News Today: The CEO of Adani Krishnapatnam Port Limited (AKPL), Mr. G.J Rao informed that the AKP Limited has taken all Environmental Protection Measures related to the Port. The said CEO has started the Advanced Truck Wheel Washing Centre on Tuesday at the Krishnapatnam Port and addressed the usage of the Truck Wheel Washing Centre. The above centre was started to clean the dirt of the vehicles which are passing through the South Port and to recycle and reuse the provision of water washed thereby to reduce water consumption. The Chief Operating Officer, Mr. Rajan Babu; Port Officers, Ganesh Sharma have participated in the programme.

***

ADVANCED TRUCK WHEEL WASHING FACILITY AT THE ADANI KRISHNAPATNAM PORT

Simhapuri Today (Krishnapatnam) July, 9: Adani Krishnapatnam Port Limited (AKPL) has started one more Truck Wheel Washing Centre at Southside of the port by Adani Krishnapatnam Port CEO, Mr. GJ Rao on Tuesday to remove dirt, debris, dust and silt from wheels of all outgoing trucks passing from South Port to outside the port

premises. This is in addition to the existing facility at northside of the port. Speaking after inaugurating the facility at the South side of the port, Mr. G.J Rao said that the new wheel washing facility is an advanced one. This is equipped with automatic sensor-based technology comprising with oil skimmer and separator from washed water. This facility has recycling and reusing provision of water washed thereby to reduce water consumption, he said. Also, CEO said that the Adani Krishnapatnam Port is committed to comply with the statutory norms by implementing all mitigation measures for promotion of environment and sustainability. Chief Operating Officer (COO), Mr. Rajan Babu; HR and Administrative Head, Mr. Ganesh Sharma; Corporate Affairs Head, K.M Ram and other HOD's of all Divisions; HOS's; Civil Construction Management along with Environment Health Safety Teams have participated in the above facility programme.

***

ADVANCED TRUCK WHEEL WASHING FACILITY AT THE PORT

Muthukuru, July 9 (Sada mee Kosam): Adani Krishnapatnam Port Limited (AKPL) has started one more Truck Wheel Washing Centre at Southside of the port by Adani Krishnapatnam Port CEO, Mr. GJ Rao on Tuesday to remove dirt, debris, dust and silt from wheels of all outgoing trucks passing from South Port to outside the port premises. This is in addition to the existing facility at northside of the port. Speaking after inaugurating the facility at the South side of the port, Mr. G.J Rao said that the new wheel washing facility is an advanced one and is equipped with automatic sensor-based technology comprising with oil skimmer and separator from washed water. This facility has recycling and reusing provision of water washed thereby to reduce water consumption, he said. Also, CEO said that the Adani Krishnapatnam Port is committed to comply with the statutory norms by implementing all mitigation measures for promotion of environment and sustainability. Chief Operating Officer (COO), Mr. Rajan Babu; HR and Administrative Head, Mr. Ganesh Sharma; Corporate Affairs Head, K.M Ram and other HOD's of all Divisions; HOS's; Civil Construction Management along with Environment Health Safety Teams have participated in the above facility programme.

//TRUE TRANSLATED COPY//

From : Dantuluri Jyothi jyothi@gangavaram.com on behalf of Dantuluri Jyothi

Sent : Tuesday, May 14, 2024, 2:17 PM

To : Ch. Rajasekhar

Subject : AKPL – Conducted Air Quality Model Studies in compliance with the Task Force Directions dated 14.12.2023 – Report – Submitted – Reg.

Attachments: AKPL. – AAQ Study Report Submission – 14.05.2024.pdf

Dear Sir,

It is to submit that the compliance status of AKPL was reviewed by APPCB External Advisory Committee in its meeting held on 06.12.2023 and certain directions were issued *vide* reference vide Order dated 14.12.2023 to comply with.

As per the directions, AKPL has submitted the compliance status and time bound action plan on 07.02.2024 and 12.03.2024.

Further, complying with the condition no.9 of the Task Force Directions, a detailed AAQ study was conducted through a NABET Accredited 3rd Party Agency in consultation with APPCB, RO, Nellore.

The study report along with the recommendations is being submitted for your kind perusal and necessary approvals to proceed further in order to comply with the Directions.

With Best Regards

Dr.D. Jyothi

Vice President – Env

//TRUE COPY//

//TRUE COPY//

adani

Purchase Order

2085

1969

ANNEXURE-47

Seller's Detail	**PO No :** 4802048793 **PO Release Date :** 17.05.2024
S V ENVIRO LABS AND CONSULTANTS ENVIRO HOUSE,B1 BLOCK B IDA AUTONAGAR, VISAKHAPATNAM,530012,01 ANDHRA PRADESH,INDIA PAN:ABTFS0415M GSTIN:37ABTFS0415M1ZO Vendor Code:0000161178 Kind Attn: Phone: Mobile: Email:SVENVIRO_LABS@YAHOO.CO.IN	**Buyer's details** Adani Krishnapatnam Port Ltd PO Bag no 01, Muthukur, Nellore SPSR Nellore 524344 ANDHRA PRADESH PAN AAACK8657J CIN U45203GJ1996PLC128239 GSTIN 37AAACK8657J1Z1 IEC No. 0906018803 **Our Contact Details** Name VINOD KUMAR MADALA Phone +917064460434 Email VINODKUMAR.MADALA@adani.com

Order Value Summary

	Currency	Amount
Basic Price	INR	900,000.00
Other Charges	INR	0.00
Taxes	INR	162,000.00
PO Price	INR	1,062,000.00

In words, RUPEES TEN LAKH SIXTY TWO THOUSAND ONLY

Item 10:- Environmental Monitoring for the FY:2024-2025

SPECIAL TERMS AND CONDITIONS (STC)

1.0 Scope of Work

ADANI KRISHNAPATNAM PORT LIMITED
SCOPE OF WORK FOR ENVIRONMENTAL MONITORING

The scope of work includes sampling (i.e. Collection of samples as per methods approved by BIS / MoEF / CPCB), testing of samples (by MoEF approved laboratories duly following the stipulated procedures as per CPCB / BIS etc.), preparation and submission of results and periodical monitoring reports (both hard and soft copies) catering to the ongoing developmental works and operations of the port in respect of the following environmental parameters.

.

1. Ambient Air Quality as per NAAQMS parameters
2. Ambient Noise Levels
3. Marine Water Quality
4. Turbidity of Deep-Sea Water
5. Marine Sediment Quality
6. Ground Water Quality
7. Soil Quality
8. STP inlet & outlet Quality
9. DG Stacks Emissions Monitoring

Monitoring locations and frequencies of sampling are mentioned in the bellow table and the locations are subjected to change as may be considered necessary during the period of contract.

Section Sample Locations Frequency
1 Ambient Air Quality Monitoring as per NAAQMS
1 Particulate Matter - PM10 1. KrishnapatnamVillage
2. Gopalapuram Village
3. Chalivendram Village
4. Port Main Gate ("O" Point)
5. Amenities Complex
6. New Light House
7. Tamminapatnam Village (South Port) Monthly once
2 Particulate Matter # PM2.5
3 Sulphur Dioxide # SO2
4 Oxides of Nitrogen # Nox
5 Ozone # O3
6 Ammonia # NH3
7 Carbon Monoxide # CO
8 Benzene # C6H6
9 Benzopyrene
10 Lead # Pb
11 Arsenic # As
12 Nickel # Ni

2 Ambient Noise Level Monitoring
1 Day & Night 1. KrishnapatnamVillage
2. Gopalapuram Village
3. Chalivendram Village
4. Port Main Gate ("O" Point)
5. Amenities Complex
6. New Light House
7. Tamminapatnam Village (South Port) Monthly once
3 Marine Water & creek water Quality Monitoring
Physical 1. Port entrance
2. Turning circle
3. Coal berth
4. Reclamation area
5. Buckingham canal (creek)
6. Kandhalerru (creek) Weekly once
1 pH
2 Temperature
3 Salinity
4 Density
Chemical
1 Potassium
2 COD
3 BOD

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4 Oil & Grease
DO
Nitrates
Nitrites
Ammonia
Phosphates
Chlorides
Sodium
Sulphates
Silica
Reactive Silica
Total Phosphorus
Total Nitrogen
Biological
1 Primary Productivity
2 Chlorophyll
3 Phytoplankton
a. Numerical Abundance
b. Diversity
4 Zooplankton
a. Diversity

b. Biomass
c. Coliforms
d. Fecal coliforms
Heavy
Metals
1 Lead
2 Cadmium
3 Copper
4 Zinc
4 Marine Water Turbidity Monitoring
Low Tide
1 Turbidity 4 locations Weekly once
2 Total Dissolved Solids
3 Total Suspended Solids
Medium
Tide
1 Turbidity
2 Total Dissolved Solids
3 Total Suspended Solids
High Tide
1 Turbidity
2 Total Dissolved Solids
3 Total Suspended Solids
Turbidity Monitoring at Deep Sea
Low Tide
1 Turbidity 3 locations in sea Monthly once
2 Total Dissolved Solids
3 Total Suspended Solids
Medium

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Tide
1 Turbidity
2 Total Dissolved Solids
3 Total Suspended Solids
High Tide
1 Turbidity
2 Total Dissolved Solids
3 Total Suspended Solids

5 Marine Sediment Quality Monitoring
Weekly once
Physical 1. Port entrance
2. Turning circle
3. Coal berth
4. Reclamation area
1 Sediment composition
Silt + Clay
Sand
Org matter
2 pH
Chemical
1 Nitrogen
2 Phosphorus
3 Potassium
4 Sodium

Biological
1 Bentho Communities
a Macro Benthos
b Epifauna numerical abundance
c Infauna numerical abundance
Heavy Metals
1 Lead
2 Cadmium
3 Copper
4 Zinc
6 Ground Water Quality Monitoring
Physical 4 locations Once in 6 months
1 pH
2 Electrical Conductivity
Chemical
1 TDS
2 Total Alkalinity
3 Chlorides
4 Sodium
5 Potassium
6 Fluoride
7 Nitrates
8 Cyanides

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9 Total Hardness
10 Salinity
11 Sulphates
12 COD
Heavy metals
1 Mercury
2 Cadmium
3 Arsenic
4 Selenium
5 Iron
6 Lead
7 Chromium
8 Zinc
Biological
1 Total Coliforms
2 Fecal Coliforms
Surface Water Quality Monitoring
Physical
1 pH
Chemical
1 DO
BOD
COD
Oil & Grease

Nitrates
Soil Quality Monitoring
Physical 2 locations Once in six months
1 Texture (Soil Composition)
a Sand
b Silt
c Clay
2 Soil Type
3 pH
4 Bulk Density
5 Electrical Conductivity
6 Water holding capacity
7 Porosity
Chemical
1 Sodium
2 Potassium
3 Phosphates
4 Sodium Absorption Ratio
5 Cation Exchange Capacity
Heavy
Metals
1 Copper
2 Iron
3 Lead
4 Cadmium
5 Chromium

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6 Manganese
STP Inlet & Outlet Quality Monitoring
1 pH Two locations Monthly once
2 Total Solids
3 Total Suspended Solids
4 BOD
5 COD
6 Oil & Grease
DG Stack Emissions Monitoring
1 PM 11 DG sets Once in 6 months
2 NOx
3 CO
4 HC

1.0 Sampling and testing methods
Details of Environmental parameters to be monitored and Collection of samples as per methods approved by BIS/ MoEF/ CPCB, testing of samples by MoEF approved laboratories duly following the stipulated procedures as per CPCB/BIS etc.

1.1 Preservation and Laboratory Analysis
Samples collected shall be preserved as per relevant standards and transported to the agency#s laboratory for further analysis without causing any damage to the samples. All the testing and analyses shall be carried out as per applicable standard procedures.

1.2 Monitoring Team
For this purpose the agency shall assign adequate environmental scientists/engineers with a senior level environmental scientist/engineer having experience in line to lead the team & coordinate the entire monitoring work at field level, testing at their laboratory, analysis and reporting. The details of the Team Leader and other environmental scientists/engineers shall be submitted by the agency immediately upon receipt of this work Order. Replacement of team leader, if required for any reason, during currency of work, shall be done with equally qualified and experienced person and with due intimation to employer. Field tests on samples shall be carried out at site as required. The agency shall provide adequate tools, equipment and man power at the Site Laboratory.

3.0 Monitoring Reports
Monitoring of various parameters shall invariably commence during the 1st week of each month. The monitoring reports shall be submitted within 10 days and shall clearly bring out the status of environment and impact of port constructional and operational activities duly comparing with base line data and standards. Areas of concern, if any, shall be reported along with desired mitigation measures, if any, required to protect the environment.
Following monitoring reports shall be submitted by the monitoring agency:
a) Monthly monitoring reports.
b) Quarterly monitoring reports including Trend analysis.
c) Half yearly reports.
d) Yearly reports.

4.0 Deliverables:
I. Laboratory Test Reports i.e., results of samples tested shall be submitted with the report.
II. The agency shall deploy calibrated equipment and instruments only for sampling and testing of various environmental parameters and such calibration shall be carried out at required intervals by duly authorized

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agencies/methods.
III. Analysis and interpretations of results for each of the environmental parameters monitored catering to port operational and constructional activities duly bringing out details of environmental monitoring carried out, environmental status with respect to Base Line value / CPCB standards, duly identifying areas of concern if any and mitigation measures required, if any shall be submitted in the Monitoring Reports at frequencies mentioned in above table. All Reports shall be submitted in triplicate along with soft copy.
IV. Results of AAQ and Ambient Noise Monitoring shall be submitted by the 10th day of each month of monitoring such that mitigation measures if any required can be initiated immediately.
V. Drafts of Monthly, Quarterly, Half yearly and Yearly Monitoring reports including Trend Analysis shall be submitted within 10 days of completion of monitoring of every month. Within one week of receipt of client#s observations on the Draft Reports, the agency shall submit Final Reports duly incorporating further study / action required as per client#sobservations.
VI. The agency shall prepare and submit draft trend analysis report based on the results of monitoring bringing out impacts of the port operational / constructional activities on various environmental parameters such as air, water, soil, flora and fauna etc., along with variations with respect to base line data / standards and recommend mitigation measures, if any, required. The trend analysis shall be presented through power point presentation once in every quarter at the port and the corresponding trend analysis reports shall be firmed up duly incorporating suggestions by the port, if any during the power point presentation.
VII. The agency (MoEF&CC recognized and National Accreditation Board for Laboratory Testing (NABL) accredited third party) shall audit, prepare and submit second half yearly compliance reports of,
1. Environmental Clearance (EC),
2. Consent for Establishment (CFE) and
3. Consent for Operation (CFO)

4.1 Delayed Submission of Reports:
Periodical Monitoring Reports shall be submitted within the time limit mentioned at Section 4.0.V above. Delayed submission of reports will be viewed seriously. For delay in submission of report up to one week beyond stipulated period excluding extended periods, if any, non-refundable penalty of 25% of the corresponding month#s invoice value shall be levied and deducted from payments to be made to the agency/labs.

2.0 Effective Date
01st April'2024

3.0 Delivery Term
DAP - Delivered at Place

4.0 Delivery Point
AKPL Site, Nellore

5.0 Delivery Schedule

Item 10:- Environmental Monitoringfor the period 01st April'24 to 31st Mar'25

6.0 Price

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Mentioned in Price schedule.

7.0 Taxes
GST applicable@18%

8.0 Payment Terms
Vendor submits the RA bill on monthly basis & Payment shall be made within 15 days after submission of certified invoice.

9.0 Dispatch Documents
Not Applicable

10.0 Liquidated Damages
Not Applicable

11.0 Securities
Not Applicable

12.0 Defect Liability Period
Not Applicable

13.0 Invoicing Address
Not Applicable

14.0 Specific Agreed Terms
Transportation & Accommodations are in the scope of vendor.

15.0 Notice and Communications
a) This PO complies with GCC attached, unless explicitly mentioned otherwise.
b) On accepting or executing this Purchase/Service Order, the vendor agrees to abide by Adani Ports & SEZ Ltd Supplier Code of Conduct. The supplier code of conduct can be accessed using the following link: https://www.adaniports.com/-/media/Project/Ports/Investor/corporate-governance/Policies/Supplier-Code-of-Conduct.pdf

Enclosures:

Disclaimer: This is a system generated document and does not need any/additional/physical signatures

ANNEXURE I
PRICE SCHEDULE

BOQ For 00010. ENVIRONMENT MONITORING.
Plant : 2992

Serial No.	Service Code/Description	UOM	Quantity	Unit Rate	Total Amount
10.	130003252	Months	12.000	75000.00/1	900000.00
	CGST%: 9.00% CGST Amount:				81000.00
	SGST%: 9.00% SGST Amount:				81000.00
	SAC Code: 998346				
	CONSULTANCY CHARGES				

No of Items : 1

Subtotal : 1,062,000.00

	Currency	Amount
Basic Price	INR	900,000.00
Other Charges	INR	0.00
Taxes	INR	162,000.00
PO Price	INR	1,062,000.00

in Words, RUPEES TEN LAKH SIXTY TWO THOUSAND ONLY

Disclaimer: This is a system generated document and does not need any/additional/physical signatures

adani

Ports and
Logistics

ANNEXURE-48

Ref: AKPL/EHS/APPCB/129/2024 **Date: 09/01/2025**

To

Sr. Environmental Engineer, CESS
Andhra Pradesh Pollution Control Board,
Paryavaran Bhavan, APIIC Colony Road, Gurunanak Colony,
Autonagar, Vijayawada- 520007

Dear Sir,

Sub:- AKPL - Water Consumption details – Submitted – Reg.

Ref:- CFO & HWA order no APPCB/VJA/NLR/11344/CFO/HO/2019 dt. 11.11.2022 valid up to 31.08.2027

2094

Please find enclosed herewith the water consumption details for the month of December - 2024, prepared under the Water (Prevention and Control of Pollution) Cess Act, 1977.

Thanking you,

Yours sincerely,

For **Adani Krishnapatnam Port Limited.,**

Encl. a/a

Copy submitted to the Environmental Engineer, A.P. Pollution Control Board, Regional Office, SPSR Nellore for kind information.

Adani Krishnapatnam Port Ltd
PO Bag No 1
Muthukur Mandal
SPSR Nellore 524 344
Andhra Pradesh, India
CIN: U45203GJ1996PLC128239

Tel +91 861 237 7999
Fax +91 861 237 7046
www.adaniports.com

Registered Office: Adani Corporate House, Shantigram, Near Vaishno Devi Circle, S G Highway, Khodiyar, Ahmedabad 382 421, Gujarat, India

1979

adani

Ports and
Logistics

Ref: AKPL/EHS/APPCB/128/2024 **Date: 09/01/2025**

To

The Environmental Engineer,
A.P. Pollution Control Board
Regional Office
SPSR Nellore.

Dear Sir,

Sub:- Monthly CFO Compliance, Environmental Marine & Terrestrial Monitoring Reports and Water Consumption details – Submitted – Reg.

Ref:- CFO & HWA order no APPCB/VJA/NLR/11344/CFO/HO/2019 dated 11.11.2022 valid up to 31.08.2027

@@@

2095

With reference to the above, we are here with submitting the monthly CTO compliance reports and CAAQM, Marine & Terrestrial monitoring results along with Water Consumption details for the month of December -2024.

Thanking you,

Yours sincerely,

For **Adani Krishnapatnam Port Limited.**

Encl. a/a

Adani Krishnapatnam Port Ltd
PO Bag No 1
Muthukur Mandal
SPSR Nellore 524 344
Andhra Pradesh, India
CIN: U45203GJ1996PLC128239

Tel +91 861 237 7999
Fax +91 861 237 7046
www.adaniports.com

Registered Office: Adani Corporate House, Shantigram, Near Vaishno Devi Circle, S G Highway, Khodiyar, Ahmedabad 382 421, Gujarat, India

Adani Krishnapatnam Port Limited

Compliance Report for December 2024 on conditions stipulated in the Consent to Operation (CTO) Order of APPCB Dt. 11.11.2022

S No	CFO conditions	Status
Schedule - A		
1	Any up-set condition in any industrial plant / activity of the industry, which result in, increased effluent / emission discharge and/ or violation of standards stipulated in this order shall be informed to this Board, under intimation to the Collector and District Magistrate and take immediate action to bring down the discharge / emission below the limits.	This condition is noted.
2	The port should carryout analysis of wastewater discharges or emissions through chimneys for the parameters mentioned in this order on quarterly basis and submit to the Board.	Being Followed. The STP inlet & outlet water quality is being analyzed through NABL Accredited 3rd party agency monthly and the reports of same attached, values are within the Standard limits.
3	All the rules & regulations notified by Ministry of Law and Justice, Government of India regarding Public Liability Insurance Act, 1991 should be followed as applicable.	This condition is noted.
4	Notwithstanding anything contained in this consent order, the Board hereby reserves the right and powers to review / revoke any and/or all the conditions imposed herein above and to make such variations as deemed fit for the purpose of the Acts by the Board.	This condition is noted.
5	The industry shall ensure that there shall not be any change in the process technology, source & composition of raw materials and scope of working without prior approval from the Board.	This condition is noted.
6	The applicant shall submit Environment statement in Form V before 30th September every year as per Rule No.14 of E (P) Rules, 1986 & amendments thereof.	Complied Environmental Statement in Form – V is being submitted annually. Latest Form-V Environment Statement for the FY 2023-2024 is submitted on 28.09.2024.
7	The applicant should make applications through Online for renewal of Consent (under Water and Air Acts) and Authorization under HWM Rules at least 120 days before the date of expiry of this order, along with prescribed fee under Water and Air Acts and detailed	Noted, will apply for Auto renewal through online consent management system before 120 days. AKPL obtained CFO & HWA from APPCB vide order No APPCB/VJA/ NLR/ 11344/CFO/HO/2019 dated 11.11.2022 valid up to 31st August 2027.

	compliance of CFO conditions for obtaining Consent & HW Authorization of the Board.	
8	The port should immediately submit the revised application for consent to this Board in the event of any change in the raw material used, processes employed, quantity of trade effluents & quantity of emissions. Any change in the management shall be informed to the Board. The person authorized should not let out the premises / lend / sell / transfer their industrial premises without obtaining prior permission of the State Pollution Control Board.	This condition is noted.
9	Any person aggrieved by an order made by the State Board under Section 25, Section 26, Section 27 of Water Act, 1974 or Section 21 of Air Act, 1981 may within thirty days from the date on which the order is communicated to him, prefer an appeal as per Andhra Pradesh Water Rules, 1976 and Air Rules 1982, to Appellate authority constituted under Section 28 of the Water(Prevention and Control of Pollution) Act, 1974 and Section 31 of the Air(Prevention and Control of Pollution) Act, 1981.	This condition is noted.
10	The conditions stipulated are without prejudice to the rights and contentions of this Board in any Hon'ble court of law.	This condition is noted
11	The port shall be liable to pay Environmental Compensation / Other Environmental Taxes, if any environmental damage caused to the surroundings, as fixed by the Collector & District Magistrate or any other competent authority as per the Rules in vogue.	This condition is noted.
12	The port may explore the possibility of tapping the solar energy for their energy requirements.	This condition is noted.
13	The port should educate the workers and nearby public of possible accidents and remedial measures.	This condition is noted.

<table>
<tr><th>S. No</th><th>Conditions</th><th>Compliance</th></tr>
<tr><td></td><td>Schedule - B</td><td></td></tr>
<tr><td>1.</td><td>The port shall complete mechanizing of Berth No.6 by 31st March 2023.</td><td>Complied.

Mechanization of berth no 6 is completed and in operation.</td></tr>
<tr><td>2.</td><td>The port shall complete the mechanization of Berth No. 5 within 24 months from the date when the coal handled at Berth No. 5 is adequate to handle through mechanization system. Till the mechanization is completed, the port shall do sprinkling along with MDSS to control dust pollution due to handling of coal.</td><td>Being Complied.

Mechanization of berth No.5 work is under progress.
Mobile atomizers and water tankers are being deployed while handling coal at berth no 5.

Ensuring progress increase of the deployment of water sprinklers and other required dust containment / suppression measures to mitigate the dust emissions on vehicular movement during cargo evacuation on par with the cargo handling capacity.</td></tr>
<tr><td>3.</td><td>The port shall maintain the existing greenbelt of 100m width along the periphery. Further, development of 100m green belt at other expansion areas shall be taken up at the time of expansion of the port facility and shall be completed within 3 years.</td><td>Being Complied.

AKPL has planted 46181 saplings in December 2024, and the total plantation for the FY 2024-25 from April to December is 171153.

AKPL has completed plantation of 209.07 Ha of Green belt as on December 2024 along port boundary, around coal yards, avenue& median plantations.</td></tr>
<tr><td>4.</td><td>The port shall develop the 20m width greenbelt along the existing coal stock yards as per EC & CFO conditions within a time period of 2 years</td><td>Complied.

20 meters with greenbelt developed around the coal stack yard zones.</td></tr>
<tr><td>5.</td><td>The port shall maintain storm water drains and improvement of the storm water drains in new areas shall be taken up along with the expansion of the port.</td><td>Being followed.

Storm water drains are being maintained periodically and during monsoon season.</td></tr>
<tr><td>6.</td><td>The source of water is Muthukur Reservoir 1000 KLD and 4 MLD of water from Nakkala kalava irrigation drain. The maximum permitted water consumption after proposed expansion is as following:
<table>
<tr><th>S. No.</th><th>Purpose</th><th>Quantity</th></tr>
</table></td><td>The average water consumption for the December 2024 was KLD i.e.,
<table>
<tr><th>S. No.</th><th>Purpose</th><th>Quantity KLD</th></tr>
<tr><td>1.</td><td>Dust suppressions & Miscellaneous (Fire protection services)</td><td>1894.52</td></tr>
<tr><td>2</td><td>Gardening</td><td>318.39</td></tr>
<tr><td>3.</td><td>Domestic</td><td>618.39</td></tr>
</table></td></tr>
</table>

	1. Dust suppressions & Miscellaneous (Fire protection services) — 1950.0 KLD 2. Gardening — 400.0 KLD 3. Domestic — 650.0 KLD Total: — 3000.0 KLD Separate meters with necessary pipe-line shall be maintained for assessing the quantity of water used for each of the purposes mentioned above	Total: 2831.29 ➢ 4632 KL of STP Treated water has been utilized for greenbelt development within the port premises. ➢ STP sludge is being used as manure for development of green belt within the port. ➢ Provided a Food Waste Converter facility to convert the domestic & canteen waste generated within the Port and utilizing the same as manure for development of Nursery & Greenbelt.
7.	The port shall comply the following effluent discharge standards based on the disposal points permitted: **Outlet** / **Parameter No.** / **Limiting Standards** 1 — pH — 6.50 – 9.00 Total Suspended Solids (TSS at 103 – 105^{0}C) — <100.00 mg/l Oil and Grease — 10.00 mg/l Biochemical Oxygen Demand (BOD 3 days at 27^{0}C) — 30.00 mg/l Fecal Coliform (FC) (Most Probable Number per 100 milliliter, MPN/100ml — <1000 MPN/100 ml	AKPL has been operating - 500 KLD STP (1 X 300 KLD & 1 X 200 KLD) at CVR Amenities Complex - 40 KLD STP Admin. Building ➢ 4632 KL of STP Treated water in the month of Dec'24 has been utilized for greenbelt development. ➢ The STP inlet & outlet water quality is being analyzed through NABL Accredited 3rd party agency monthly and the values are within the limited standards.
8.	The port shall comply with emission limits for DG sets of capacity up to 800 KW as per the Notification G.S.R.520 (E), dated 01.07.2003 and ~S.R.448(E), dated 12.07.2004 under the Environment (Protection) Act Rules. In case of DG sets of capacity more than 800 KW shall comply with emission limits as per the Notification G.S.R.489 (E), dated 09.07.2002 at serial no.96, under the Environment (Protection) Act, 1986	AKPL appointed an NABL Accredited Laboratory for Environment, Terrestrial & Marine Monitoring. DG stack Emission is being monitored by the third party once in 6 months and submitting reports of the same to Board.
9.	The port shall comply with ambient air quality standards of PM10 (Particulate Matter size less than 10µ.m) - 100 µg/ m3; PM2.5 (Particulate Matter size less than 2.5 µm) - 60 l.ig/ m3; S02 - 80 µg/ m3; NOx - 80 l.ig/m3, outside the factory premises at the periphery of the industry. Standards for other parameters as mentioned in the National Ambient Air	Being complied. AKPL is operating 3 no. of Continuous Ambient Air Quality Monitoring stations at CVR Amenities Complex, towards Thamminapatnam Village and towards Krishnapatnam Village for the parameter PM2.5, PM10, SO2, NOx, CO

	Quality Standards CPCB Notification No.E-29016/20/90/PCI-I, dated 18.11.2009. Noise Levels: Day time (6 AM to 10 PM) - 75 dE (A) Night time (10 PM to 6 AM) - 70 dB (A)	and NH3 and connected to APPCB website. As per scientific Air modelling study report, additional 2 more CAAQM stations are installed in the port premises, one station at Northwest direction and second station at South direction. Coordinates of new 2 CAAQM Stations: Northwest side of the port 14°16'0.36"N & 80° 4'36.95"E. South side of the port 14°14'2.49"N & 80° 6'34.63"E. The Daily average for the Month of December 2024 Attached as **Annexure - 1**
10.	The Port shall take all measures including latest available technologies to comply with above ambient air quality standards	Being Complied. AKPL has been implementing the below measures to control emissions: Operating Mechanical Dust Suppression System (MDSS with 248 Nos. of sprinklers) at coal stacking and wagon loading areas. a. 12 Nos. of Truck mounted sprinklers for roads and transit areas. b. 4 Nos. of heavy-duty Atomized Sprayers c. Provided hoppers for cargo unloading. d. Mechanized coal handling at 3 berths i.e., berth 6,7,8. Conveyors are designed with covering hood. e. Operating 2 Heavy duty vacuum sweeping machines and 6 tractor mounted mechanical road sweeping machines. f. Ensuring 100% Tarpaulin coverage to Cargo loaded Trucks and Rakes. g. Erected wind breaking shield on western side. h. Developed 209.07 Ha of Green belt along port boundary,

		around coal yards, avenue& median plantations.
11.	The Port shall not increase the capacity beyond the permitted capacity mentioned in this order, without obtaining CFE & CFO of the Board	Noted for Compliance. AKPL handled 4.25 MMTs of permitted Commodities in the Month of December 2024.
12.	Coal stack heights in all coal yards shall not be more than 12mts.	Noted and being complied
13.	The port shall ensure required wetness all the time on the surface of stockpiles to avoid the dust emissions from the stockpiles.	AKPL has been carrying out sprinkling around the stockpiles and operating MDSS.
14.	The port shall install sufficient number of CAAQM stations in between the villages and the port area. The stations shall be located at the periphery of the villages to monitor all the parameters given in the consent order.	Complied.
15.	The port shall maintain properly the three CAAQM stations provided and shall be connected to APPCB website.	Complied.
16.	Unloading of iron ore from the railway wagons house should be carried out with wagon tipplers only, in case, handling of iron ore is more than 6 MTPA. As and when iron ore handling is to be done intermittently, it should be handled with water sprinkling system at high pressure with swiveling type nozzles operated regularly to cover entire stockpile. Nozzles shall be operated along stockpile at regular Intervals to cover stockpile height and width.	AKPL has been carrying out sprinkling around the stockpiles and operating MDSS during handling of Iron ore.
17.	The port shall take adequate air pollution control measures with respect to the enhanced dusty materials handling capacities	Complied. Deploying 5 no. of jet water tankers in addition to 10 no. of DSS tankers to control dust emissions.
18.	The port shall stock all the dusty materials within the designated storage yards only.	Being Complied All the dusty cargos have been stored in Designated storage yards only.
19.	The port activities are concentrating in north quay by construction of 12th Berth, hence the stocking of dusty materials shall not be extended	Complied.

	towards the residential areas around the port area.	
20.	The dusty materials transporting vehicles shall be closed in all respects/ covered with tarpaulin for controlling fugitive emissions	Being Complied. Provided 27 No. of Truck tarpaulin covering stations and ensuring all the outgoing cargo vehicles are properly covered with tarpaulin and tightened with rope to control fugitive emissions and transit spillages.
21.	The port shall provide wheel washing facility near the dusty cargo stocking area, to the freighted vehicles going outside the port.	Complied. Operating 2 No. of Truck wheel washing facilities and ensuring the outgoing trucks are cleaned properly before leaving the premises. i. One facility at NEC Road, Near to East - West Gate. ii. One facility at Southern side of the Port at North side of the Port.
22.	The port shall inform the modifications made in port infrastructure developments to the MoEF&CC and to the Board time to time.	Being complied.
23.	The port shall obtain EC for any change of scope of the project and shall restrict the port activities as permitted vide EC Orders Dt.26.07.2006 for Phase - I, 13.11.2009 for Phase - II & Phase-III (Expansion) 11.01.2021	Being complied.
24.	The port shall continuously operate the 3 CAAQM stations installed in between villages and port area to monitor all the parameters given in the consent order and upload the data continuously to the APPCB / CPCB websites.	Complied.
25.	The MDSS system shall be in operation wherever the stock of any bulk material (Dusty cargo) is piled in a way to ensure wetness on the surface of stockpiles.	Complied. Deploying 5 no. of jet water tankers in addition to 10 no. of DSS tankers to control dust emissions.
26.	As regards to deviation in location of facilities such as stockpiles and other facilities, from the originally envisaged	Being complied.

	plan, amendments for the EC and CFE have to be obtained immediately.	
27.	The port shall maintain the existing green belt with adequate width and density and in vacant places	Complied.
28.	The port shall use road sweeping machines to clean all port internal roads regularly.	Complied. AKPL has been operating 2 no. of heavy-duty Vaccum Sweeping machines and 6 mechanical road sweeping machines.
29.	The port shall ensure that the trucks transporting cargos to outside the port shall be covered with tarpaulin to avoid fugitive emissions / spillages.	Being complied.
30.	All conveyor belts and other transfer points shall be covered with GI sheets to mitigate fugitive emissions generated during conveying of dusty cargos.	Complied Provided GI Sheet cladding and with sprinklers system to control fugitive emissions.
31.	The port shall maintain water sprinklers for effective control of fugitive emissions generated during handling of cargo and increased volume of vehicular traffic.	Complied. Deploying 5 no. of jet water tankers in addition to 10 no. of DSS tankers to control dust emissions.
32.	The port shall maintain Mechanical Dust Suppression System (MDSS) for stock yards, dusty cargo berths and conveyor belts.	Maintaining Mechanical Dust Suppression System (MDSS) for stock yards, dusty cargo berths and conveyor belts.
33.	The port shall develop and maintain 100 m width greenbelt along the periphery & 20m width around coal stack yards as per EC / CFE condition.	Being followed.
34.	The port shall maintain empty dusty cargo vehicles washing system to clean dusty cargo empty vehicles.	Complied. Operating 2 No. of Truck wheel washing facilities and ensuring the outgoing trucks are cleaned properly before leaving the premises. i. One facility at NEC Road, Near to East - West Gate. ii. One facility at Southern side of the Port at North side of the Port.
35.	The port shall record the energy consumption for the energy meters provided for Sewage Treatment Plant (STP), pump houses to water sprinklers	Being followed.

	/ dust suppression measures and Air Pollution Control Equipments (APCE)	
36.	The port shall not allow any hazardous wastes through the port other than waste oil from DG Set, Waste oil from Ship, Wastes / residues containing oil from ships, used oil generated in the Port without prior permission of Board and shall comply with EC conditions.	Being Complied. All the generated hazardous waste are being disposed through APEMCL portal.
37.	The port shall not store any hazardous waste within the premises as per the time frame mentioned in HWM Rules	Being followed.
38.	In case a leaky container of hazardous cargo is found, a separate permission of the Board may be obtained after establishing the quality and the type of waste for disposal	Being complied
39.	All types of the fertilizers should be stored in the closed warehouses only. The Port should ensure that there should not be any open storage of urea or any other fertilizer materials. There shall not be any effluent generation	Complied. Provided closed sheds of 13 Nos. to store the fertilizers.
40.	The port shall store fuel oils used for construction equipment, vessels and vehicles in a well-designed manner and protect them against fire hazards by construction of compound wall to prevent access to unauthorized elements. The surface run off from storage area shall pass through oil water separator before being discharged.	Complied
41.	The port shall provide fire detection and firefighting facilities with adequate water storage in fire prone areas in consultation with Directorate of firefighting.	Complied. Port is equipped with Fire fighting and detection facilities. Infrastructure like trained Fire Team, Fire Tenders (Multi purpose Fire Tender), semi fire tender etc., available at Port. Fire NOC has been obtained for Buildings (Admin and ETS).
42.	The port shall comply latest technologies for controlling fugitive emissions including the following: a) Fully mechanized handling equipment for loading and unloading operations	Complied. a. Provided coal ship unloaders and conveyor at berths 6,7 & 8 b. Provided water sprinkling system in ship unloaders and

	b) Closed conveyor belt with water sprinkling arrangement for suppression of dust while conveying dusty cargoes like coal, iron ore etc. c) Specially designed iron ore ship loader with necessary precautions to reduce drop height of iron ore into the ship, while handling more than 6 Million Tons per annum. d) Mechanical water sprinkling shall be provided on roads and at dusty cargo storage areas for suppression of dust.	conveyor system for dust suppression c. Provided Mechanical water sprinkling at coal storage yard and tankers to suppress the dust.
43.	The port shall maintain adequate number of ground water monitoring location on scientific basis and the same shall be monitored every six months	There is no ground water withdrawal within the port premises. AKPL appointed a NABL Accredited Laboratory to monitor the Ground water at 4 locations outside the port. As per the analysis reports, there was no adverse impact due to port operations.
44.	The port shall construct the storm water drains to avoid the contamination of runoff with other effluents.	Complied.
45.	The port shall regularly clean the drains to avoid siltation.	Being complied.
46.	The port shall monitor compliance through Environment Management Cell with qualified and trained staff.	Complied
47.	The port shall maintain onsite emergency action plan after carrying out risk analysis and hazop studies	Maintaining
48.	The port shall comply with the conditions of CFE order dated 08.05.2010, 22.02.2018 and 25.2.2021.	Being complied.
49.	The port shall submit monthly monitoring reports to RO: Nellore	Being submitted on a monthly basis.
50.	The port shall comply with standards and directions issued by APPCB / CPCB / MoEF&CC as and when notifications are issued from time to time	Being complied.
51.	The port shall install digital display boards at publicly visible places at the	Provided.

	main gate indicating the products manufactured Vs permitted quantities, treated effluent concentrations Vs discharge standards, Stack emission & AAQ concentrations Vs standards, hazardous waste generation, disposed, stock Vs permitted quantities and validity of CFO; and exhibit the CFO order at a prominent place in the factory premises, as per Hon'ble Supreme Court order	
52.	The port shall submit Half yearly compliance reports to all the stipulated conditions in Environmental Clearance (EC), Consent for Establishment (CFE) and Consent for Operation (CFO) through website i.e., https://pcb.ap.gov.in by 1st of January and 1st July of every year. The first half yearly compliance reports shall be furnished by the port and second half yearly compliance reports shall be the audited through MoEF&CC recognized and National Accreditation Board for Laboratory Testing (NABL) accredited third party	Complied. AKPL has Submitted First Half yearly EC, CTE, CTO compliance report for the period of April'24 to September'24 send to APPCB & CPCB through mail and the same copy was uploaded in Parivesh portal, APPCB Portal on 30.11.2024.
53.	The port shall possess valid NOC issued by the Andhra Pradesh State Disaster Response and Fire Service Dept., (APSDRFSD) and submit a copy at concerned Regional Office, APPCB.	Complied. Fire NOC has been obtained for Buildings (Admin and ETS).
54.	The port shall prepare a safety report and carry out an independent safety audit report of the respective industrial activities including chemical storages / isolated storages by an expert not associated with such industrial activity as required under Rule 10 of MSIHC Rules, 1989 and get it approved by the Factories Dept., and submit the compliance along with copy of the safety report, safety audit report and safety certificate at concerned Regional Office, APPCB.	Complied
55.	The port shall extend training to the working personnel for the prevention of accidents and necessary antidotes to	Being Complied.

	ensure safety, as per the MSIHC Rules, 1989.	
56.	The port shall carryout calibration of safety equipment and leak detection systems at regular intervals and shall certify the same with the Factories Department. That certified copy shall be submitted to the APPCB, R & O.	Being complied.
57.	The port shall install fluorescent Wind Vane at the highest point in the port premises	Installed.
58.	The port shall submit Risk analysis and risk assessment covering worst scenario clearly describing impact within the port premises and outside the port premises and emergency response system.	Complied.
59.	The port shall submit the copy of the safety audit report and On-Site / Off Site Emergency Plans as applicable after being certified by the Factories Department to the APPCB, Regional Office from time to time, if the storage quantity of hazardous chemicals is equal to or, in excess of the threshold quantities specified in schedule 2 & 3 of MSIHC Rules, 1989.	Complied.

Schedule C		
1	The authorized person shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.	This condition is noted and complied.
2	The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the State Pollution Control Board.	This condition is noted and complied.
3	The person authorized shall not rent, lend, sell, transfer, or otherwise transport the Hazardous and other wastes except what is permitted through this authorization.	This condition is noted and complied.
4	Any unauthorized change in personnel, equipment or working conditions as mentioned in the application by the person authorized shall constitute a breach of his authorization	This condition is noted and complied.
5	The person authorized shall implement Emergency Response Procedure (ERP) for which this authorization is being granted	This condition is noted and complied.

	considering all site-specific possible scenarios such as spillages, leakages, fire etc. and their possible impacts and also carry out mock drill in this regard at regular interval of time;	
6	The person authorized shall comply with the provisions outlined in the Central Pollution Control Board guidelines on "Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Waste and Penalty".	This condition is noted and complied.
7	It is the duty of the authorized person to take prior permission of the State Pollution Control Board to close the facility.	This condition is noted and complied.
8	An application for the renewal of an authorization shall be made as laid down under these Rules.	This condition is noted and complied.
9	Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Change or Central Pollution Control Board from time to time.	This condition is noted and complied.
Specific conditions		
10	The port shall comply with the provisions of HWM Rules, 2016 in terms of interstate transport of Hazardous Waste and manifest document prescribed Under Rule 18 and 19 of the HWM Rules, 2016.	This condition is noted and complied.
11	The port shall not store hazardous waste for more than 90 days as per the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.	This condition is noted and complied.
12	The port shall store Used / Waste Oil and Used Lead Acid Batteries in a secured way in their premises till its disposal to the manufacturers / dealers on buyback basis.	This condition is noted and complied.
13	The industry shall transport the hazardous waste to cement industries only through vehicle fitted with GPS tracking system.	This condition is noted and complied.
14	The industry shall maintain 7 copy manifest system for transportation of waste generated and a copy shall be submitted to concern Regional Office of APPCB. The driver who transports Hazardous Waste	This condition is noted and complied

	should be well acquainted about the procedure to be followed in case of an emergency during transit. The transporter should carry a Transport Emergency (TREM) Card	Waste oil generating from the port is being disposed through APEMC Portal authorized vendors.
15	The industry shall maintain proper records for Hazardous and Other Wastes stated in Authorization in Form-3 i.e., quantity of Incinerable waste, land disposal waste, recyclable waste etc., and file annual returns in Form-4 as per Rule 20 (2) of the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.	Complied. The following annual returns were submitted at APPCB, RO, SPSR Nellore on 25.06.2024 1. Form – 3 – E – Waste Annual Statement for the FY 2023 – 2024. 2. Form – 4 – Hazardous Waste Annual Statement for the FY 2023 – 2024. 3. Form – 8 – Used Batteries Returns – Annual Statement for the FY 2023 – 2024.
16.	Annual return shall be filed by June 30th for the period ensuring 31st March of the year.	Complied. The following annual returns were submitted at APPCB, RO, SPSR Nellore on 25.06.2024 1. Form – 3 – E – Waste Annual Statement for the FY 2023 – 2024. 2. Form – 4 – Hazardous Waste Annual Statement for the FY 2023 – 2024. 3. Form – 8 – Used Batteries Returns – Annual Statement for the FY 2023 – 2024.

Annexure – 1

Adani Krishnapatnam Port Limited - CAAQM Daily Averages for December 2024

Date	Location -CVR Complex				
	PM10 - (ug/m3)	PM2.5 - (ug/m3)	SO2 - (ug/m3)	NO2 - (ug/m3)	CO - (mg/m3)
Parameter	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_2**	**CO**
Standard	**100**	**60**	**80**	**80**	**4**
2024-12-01	48.17	35.55	12.97	7.85	1.11
2024-12-02	49.96	31.13	12.71	9.03	1.13
2024-12-03	52.72	29.28	12.54	10.63	1.11
2024-12-04	41.4	26.7	12.14	16.37	1.1
2024-12-05	45.74	29.85	12.39	10.33	1.14
2024-12-06	44.45	31.26	12.21	14.7	1.13
2024-12-07	50.28	30.99	12.35	16.45	1.12
2024-12-08	56.91	38.79	13.28	12.93	1.18
2024-12-09	49.6	31.12	12.85	10.74	1.21
2024-12-10	52.86	31.08	13.04	15.04	1.24
2024-12-11	50.44	30.49	14.4	11.56	1.24
2024-12-12	50.62	29.64	14.61	8.35	1.29
2024-12-13	49.67	29.91	14.72	9.7	1.3
2024-12-14	51.4	30.29	16.52	15.9	1.28
2024-12-15	50.49	29.96	21.46	19.19	1.36
2024-12-16	50.78	30.33	19.8	17.74	1.33
2024-12-17	104.23	87.71	15.89	12.02	0.7
2024-12-18	61.02	55.66	10.21	10.14	0.29
2024-12-19	26.58	32.15	9.95	7.6	0.24
2024-12-20	19.89	25.96	9.35	8.84	0.18
2024-12-21	18.45	17.13	8.85	7.89	0.26
2024-12-22	12.59	16.74	18.32	15.75	0.26
2024-12-23	19.64	26.46	12.79	11.97	0.16
2024-12-24	17.97	10.05	9.36	10.46	0.16
2024-12-25	55.26	37.07	9.32	13.68	0.22
2024-12-26	15.73	27.07	9.38	7.26	0.15
2024-12-27	32.78	31.01	10.18	11.09	0.23
2024-12-28	40.21	37.87	10.25	11.3	0.24
2024-12-29	44.24	33.32	16.07	15.81	0.29
2024-12-30	37.45	35.92	12.41	15.31	0.33
2024-12-31	39.78	52.12	9.73	10.41	0.33
Average	**42.87**	**32.96**	**12.91**	**12.38**	**0.73**

Adani Krishnapatnam Port Limited - CAAQM Daily Averages for December 2024

Date	Location – Thamminapatnam Village				
	PM10 - (ug/m3)	PM2.5 - (ug/m3)	SO2 - (ug/m3)	NO2 - (ug/m3)	CO - (mg/m3)
Parameter	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_2**	**CO**
Standard	**100**	**60**	**80**	**80**	**4**
2024-12-01	3.38	4.2	14.02	10.59	1.84
2024-12-02	12.59	13.04	13.96	7.46	1.85
2024-12-03	15.3	14.48	13.8	7.91	1.82
2024-12-04	6.7	6.48	13.73	13.07	1.81
2024-12-05	8.41	8.66	13.77	13.61	1.84
2024-12-06	7.69	7.14	13.7	8.78	1.83
2024-12-07	9.36	9.29	13.79	9.48	1.8
2024-12-08	15.52	14.96	13.83	8.47	1.85
2024-12-09	53	27.99	13.88	13.19	1.93
2024-12-10	60.05	30.29	15.65	19.82	2
2024-12-11	58.34	30.15	14.15	14.77	2.01
2024-12-12	60.63	29.81	14	11.87	2.06
2024-12-13	73.37	30.25	13.94	15.69	2.06
2024-12-14	57.04	31.97	14.02	16.73	2.02
2024-12-15	61.44	29.38	14.59	19.54	2.15
2024-12-16	67.7	31.06	15.61	18.54	2.12
2024-12-17	70.22	29.04	14.62	18.45	2.16
2024-12-18	54.9	34.44	9.83	10.56	0.76
2024-12-19	18.69	27.08	5.07	3.32	0.16
2024-12-20	17.76	25.39	5.08	3.39	0.2
2024-12-21	6.67	12.75	5.2	3.81	0.12
2024-12-22	6.35	14.34	5.27	4.19	0.13
2024-12-23	18.32	26.79	12.38	13.29	0.14
2024-12-24	16.97	18.8	5.22	2.39	0.13
2024-12-25	38.87	33.79	5.13	2.18	0.17
2024-12-26	14.29	30.25	5.29	2.92	0.09
2024-12-27	52.6	34.59	5.36	6.1	0.19
2024-12-28	47.46	32.14	5.4	5.47	0.2
2024-12-29	49.26	34.24	5.94	4.93	0.21
2024-12-30	48.78	30.46	5.5	5.15	0.26
2024-12-31	67.15	39.02	5.97	0.46	0.27
Average	**37.34**	**25**	**10.34**	**9.59**	**1.12**

Adani Krishnapatnam Port Limited - CAAQM Daily Averages for December 2024

Date	Location – Krishnapatnam village				
	PM10 - (ug/m3)	PM2.5 - (ug/m3)	SO2 - (ug/m3)	NO2 - (ug/m3)	CO - (mg/m3)
Parameter	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO
Standard	100	60	80	80	4
2024-12-01	0	17.98	10.35	11.55	1.29
2024-12-02	59.96	32.48	10.39	12.35	1.32
2024-12-03	33.82	35.2	10.26	12.23	1.28
2024-12-04	14.59	20.9	10.01	12.11	1.26
2024-12-05	13.82	23.88	9.96	11.92	1.29
2024-12-06	11.94	23.11	9.73	12.77	1.27
2024-12-07	16.96	27.9	9.77	13.47	1.27
2024-12-08	42.5	39.1	11.77	14.25	1.32
2024-12-09	67.33	30.95	10.41	13.15	1.36
2024-12-10	78.35	28.35	12.07	14.62	1.41
2024-12-11	66.07	31.94	11.44	13.17	1.41
2024-12-12	59.48	28.86	11.42	12.62	1.47
2024-12-13	61.96	29.06	11.53	12.8	1.45
2024-12-14	75.72	32.82	11.74	12.97	1.44
2024-12-15	52.45	29.22	13.61	8.54	1.51
2024-12-16	73.33	61.17	20.56	0.36	0.37
2024-12-17	54.01	40.02	11.53	0.26	0.52
2024-12-18	29.6	42.47	10.25	9.5	0.57
2024-12-19	6.35	33.19	10.23	12.64	0.47
2024-12-20	9.96	39.46	11.06	10.12	0.53
2024-12-21	1.03	23.02	10.76	8.22	0.42
2024-12-22	0.11	18.7	10.14	7.76	0.35
2024-12-23	14.67	20.59	22.77	12.2	0.36
2024-12-24	19.61	24.47	9.95	9.91	0.4
2024-12-25	29.76	34.52	10.1	9.72	0.49
2024-12-26	19.24	23.96	10.21	6.02	0.38
2024-12-27	42.9	32.44	10.78	6.43	0.48
2024-12-28	44.35	43.24	10.67	6.96	0.5
2024-12-29	50.88	39.28	11.06	7.66	0.53
2024-12-30	51.66	35.08	10.74	8.37	0.56
2024-12-31	59	30.7	10.58	11.78	0.4
Average	**37.98**	**31.85**	**11.56**	**10.09**	**0.86**

Note: All 3 CAAQM stations analyzers was calibrated on 16,17 & 18th dates by OEM.

adani
Ports and Logistics

Adani Krishnapatnam Port Limited

Water Consumption details for the Month of December – 2024

S.NO	Purpose	Permitted Quantity(KLD)	Actual Consumption (KLD)	Total Consumption (KL)
1	Dust Suppression & Miscellaneous (Fire protection services)	1950	1894.52	58730
2	Gardening	400	318.39	9870
3	Domestic	650	618.39	19170
	Total	**3000**	**2831.29**	**87770**

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Ref: SVELC/AKPL/24-12/01

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT ZERO POINT

DATE OF START : 25-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	66.3	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	27.8	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	13.2	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	14.5	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	9.4	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.22	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/02

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT THAMMINAPATNAM VILLAGE

DATE OF START : 25-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	56.8	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	24.6	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	11.3	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	13.5	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	8.6	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.17	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVE LC/AKPL/24-12/03 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT CVR BUILDING

DATE OF START : 25-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	55.1	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	23.4	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	9.6	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	10.7	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	8.0	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.16	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/04 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT GOPALPURAM VILLAGE

DATE OF START : 26-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	54.2	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	22.0	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	10.4	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	11.6	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	9.8	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.13	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/05

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT CHALIVENDARAM

DATE OF START : 26-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	51.8	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	21.3	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	11.9	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	12.6	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	9.5	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.10	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/06

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : AT KRISHNAPATNAM

DATE OF START : 27-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	59.2	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	26.1	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	10.4	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	12.3	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	9.1	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.14	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/07 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **AMBIENT AIR QUALITY**

SOURCE OF COLLECTION : KRISHNAPATNAM VILLAGE
NEAR LIGHT HOUSE COLONY

DATE OF START : 27-12-2024

DURATION OF SAMPLING : 24 hours

ATMOSPHERE CONDITION : Clear Sky

TEST REPORT

S.No	PARAMETER	UNIT	RESULT	STANDARDS	METHOD
1.	Particulate Matter - (PM_{10})	$\mu g/m^3$	53.4	100	IS:5182 - P-23
2.	Particulate Matter - ($PM_{2.5}$)	$\mu g/m^3$	21.9	60	IS:5182 - P-24
3.	Sulphur Dioxide - (SO_2)	$\mu g/m^3$	8.2	80	IS:5182 - P-2
4.	Nitrogen Dioxide - (NO_2)	$\mu g/m^3$	10.1	80	IS:5182 - P-6
5.	Ammonia - (NH_3)	$\mu g/m^3$	<20.0	400	IS:5182 - P-25
6.	Ozone - (O_3)	$\mu g/m^3$	9.3	100	IS :5182 - P-9
7.	Lead - (Pb)	$\mu g/m^3$	< 0.01	01	IS:5182 - P-22
8.	Carbon Monoxide - (CO)	mg/m^3	0.12	2.0	IS:5182 - P-10
9.	Benzene - (C_6H_6)	$\mu g/m^3$	< 0.5	05	IS 5182 - P-11
10.	Benzo(a)pyrene - (BaP)	ng/m^3	< 0.5	01	IS 5182 - P-12
11.	Arsenic - (As)	ng/m^3	< 5.0	06	CPCB Guidelines
12.	Nickel - (Ni)	ng/m^3	< 5.0	20	IS 5182 - P-26

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Ref: SVELC/AKPL/24-12/13 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 06-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	pH	-	7.95	7.84	7.89	8.20
2.	Temperature	°C	27.6	27.9	28.1	28.5
3.	Salinity	Ppt	36.7	36.3	37.1	37.5
4.	Density	gm/ml	1.032	1.035	1.025	1.042
5.	Secchi Disk Transparency	mts	10.3	10.6	10.8	9.5
II.	**Chemical**					
1.	Potassium	mg/l	282	267	293	314
2.	COD	mg/l	13.1	12.6	13.0	13.5
3.	BOD	mg/l	2.7	3.2	3.3	3.6
4.	Oil & Grease	mg/l	< 0.1	< 0.1	< 0.1	0.35
5.	D.O	mg/l	5.2	5.0	4.5	3.4
6.	Nitrates	mg/l	4.9	4.6	5.0	5.8
7.	Nitrites	mg/l	0.12	0.16	0.10	0.19
8.	Ammonia	mg/l	< 0.01	< 0.01	< 0.01	0.36
9.	Phosphates	mg/l	0.20	0.25	0.29	0.40
10.	Chlorides	mg/l	20356	20143	20562	20794
11.	Sodium	mg/l	7649	7986	7573	8450
12.	Sulphates	mg/l	3559	3278	3204	3590
13.	Silicates	mg/l	2.9	2.5	3.1	4.0
14.	Reactive Silica	mg/l	0.015	0.020	0.024	0.029

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Ref: SVELC/AKPL/24-12/13 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 06-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

15.	Total Phosphorus	mg/l	0.18	0.16	0.21	0.33
16.	Total Nitrogen	mg/l	10.1	9.5	11.0	12.3
III.	**Biological**					
1.	Primary Productivity	mgC $m^{-2}d^{-1}$	53	40	45	32
2.	Chlorophyll	mg/m^3	1.52	1.44	1.39	1.27
3.	Phytoplankton					
	a. Numerical abundance	No./ml	244	242	229	204
	b. Diversity	-	2.33	2.27	2.31	2.03
4.	Zooplankton					
a.	Diversity	-	2.16	2.19	2.25	2.04
b.	Biomass	$ml/100m^3$	11.2	11.5	12.1	9.8
c.	Coliforms	CFU/100ml	20	17	23	26
d.	Fecal Coliforms	CFU/100ml	ND	ND	ND	ND
IV.	**Heavy Metals**					
1.	Lead	mg/l	< 0.01	< 0.01	< 0.01	< 0.01
2.	Cadmium	mg/l	< 0.01	< 0.01	< 0.01	0.16
3.	Copper	mg/l	< 0.02	< 0.02	0.016	0.019
4.	Zinc	mg/l	0.020	0.016	0.021	0.034

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Ref: SVELC/AKPL/24-12/14 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 13-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	pH	-	8.03	7.97	8.10	8.32
2.	Temperature	°C	27.9	28.2	28.4	28.7
3.	Salinity	Ppt	36.9	36.5	37.2	37.7
4.	Density	gm/ml	1.034	1.037	1.028	1.045
5.	Secchi Disk Transparency	mts	10.0	10.5	10.6	9.3
II.	**Chemical**					
1.	Potassium	mg/l	290	275	301	327
2.	COD	mg/l	13.5	13.0	13.4	13.9
3.	BOD	mg/l	2.9	3.5	3.6	3.8
4.	Oil & Grease	mg/l	< 0.1	< 0.1	< 0.1	0.39
5.	D.O	mg/l	5.0	4.7	4.3	3.1
6.	Nitrates	mg/l	5.3	4.9	5.4	6.3
7.	Nitrites	mg/l	0.15	0.19	0.14	0.23
8.	Ammonia	mg/l	< 0.01	< 0.01	< 0.01	0.40
9.	Phosphates	mg/l	0.23	0.28	0.33	0.45
10.	Chlorides	mg/l	20442	20227	20632	20870
11.	Sodium	mg/l	7670	8020	7598	8487
12.	Sulphates	mg/l	3576	3294	3227	3613
13.	Silicates	mg/l	3.1	2.8	3.4	4.3
14.	Reactive Silica	mg/l	0.018	0.022	0.026	0.031

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Ref: SVELC/AKPL/24-12/14 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 13-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

15.	Total Phosphorus	mg/l	0.22	0.19	0.24	0.36
16.	Total Nitrogen	mg/l	11.3	10.8	12.6	13.2
III.	**Biological**					
1.	Primary Productivity	mgC $m^{-2}d^{-1}$	52	39	44	31
2.	Chlorophyll	mg/m^3	1.50	1.41	1.37	1.25
3.	Phytoplankton					
	a. Numerical abundance	No./ml	243	240	228	203
	b. Diversity	-	2.31	2.25	2.29	2.01
4.	Zooplankton					
a.	Diversity	-	2.14	2.17	2.23	2.02
b.	Biomass	$ml/100m^3$	11.0	11.3	12.0	9.6
c.	Coliforms	CFU/100ml	17	13	19	22
d.	Fecal Coliforms	CFU/100ml	ND	ND	ND	ND
IV.	**Heavy Metals**					
1.	Lead	mg/l	< 0.01	< 0.01	< 0.01	< 0.01
2.	Cadmium	mg/l	< 0.01	< 0.01	< 0.01	0.13
3.	Copper	mg/l	< 0.02	< 0.02	0.014	0.017
4.	Zinc	mg/l	0.017	0.013	0.018	0.030

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Ref: SVELC/AKPL/24-12/15 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 19-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	pH	-	8.12	8.05	8.23	8.44
2.	Temperature	°C	28.0	28.3	28.6	29.0
3.	Salinity	ppt	36.7	36.4	37.1	37.5
4.	Density	gm/ml	1.031	1.035	1.027	1.042
5.	Secchi Disk Transparency	mts	10.3	10.8	11.0	9.6
II.	**Chemical**					
1.	Potassium	mg/l	276	260	287	305
2.	COD	mg/l	13.2	12.7	13.0	13.5
3.	BOD	mg/l	2.6	3.1	3.3	3.5
4.	Oil & Grease	mg/l	< 0.1	< 0.1	< 0.1	0.36
5.	D.O	mg/l	5.3	5.0	4.5	3.4
6.	Nitrates	mg/l	5.0	4.6	5.1	5.9
7.	Nitrites	mg/l	0.13	0.16	0.11	0.20
8.	Ammonia	mg/l	< 0.01	< 0.01	< 0.01	0.36
9.	Phosphates	mg/l	0.20	0.25	0.29	0.40
10.	Chlorides	mg/l	20362	20158	20550	20787
11.	Sodium	mg/l	7631	7984	7572	8450
12.	Sulphates	mg/l	3550	3276	3203	3591
13.	Silicates	mg/l	2.7	2.4	3.0	4.0
14.	Reactive Silica	mg/l	0.015	0.019	0.023	0.028

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Ref: SVELC/AKPL/24-12/15 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 19-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

15.	Total Phosphorus	mg/l	0.20	0.17	0.21	0.32
16.	Total Nitrogen	mg/l	10.6	10.2	12.0	12.8
III.	**Biological**					
1.	Primary Productivity	mgC $m^{-2}d^{-1}$	54	41	46	33
2.	Chlorophyll	mg/m^3	1.53	1.44	1.40	1.27
3.	Phytoplankton					
	a. Numerical abundance	No./ml	245	243	230	204
	b. Diversity	-	2.34	2.27	2.30	2.02
4.	Zooplankton					
a.	Diversity	-	2.16	2.18	2.25	2.03
b.	Biomass	$ml/100m^3$	11.2	11.5	12.1	9.8
c.	Coliforms	CFU/100ml	19	16	22	25
d.	Fecal Coliforms	CFU/100ml	ND	ND	ND	ND
IV.	**Heavy Metals**					
1.	Lead	mg/l	< 0.01	< 0.01	< 0.01	< 0.01
2.	Cadmium	mg/l	< 0.01	< 0.01	< 0.01	0.11
3.	Copper	mg/l	< 0.02	< 0.02	0.011	0.014
4.	Zinc	mg/l	0.015	0.010	0.015	0.027

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Ref: SVELC/AKPL/24-12/16 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 27-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	pH	-	8.01	7.90	8.11	8.29
2.	Temperature	°C	27.6	28.0	28.2	28.6
3.	Salinity	ppt	36.6	36.2	36.9	37.4
4.	Density	gm/ml	1.029	1.032	1.025	1.040
5.	Secchi Disk Transparency	mts	10.6	11.0	11.3	9.8
II.	**Chemical**					
1.	Potassium	mg/l	262	247	271	290
2.	COD	mg/l	13.0	12.4	12.7	13.1
3.	BOD	mg/l	2.4	2.8	3.0	3.2
4.	Oil & Grease	mg/l	< 0.1	< 0.1	< 0.1	0.31
5.	D.O	mg/l	5.5	5.2	4.6	3.6
6.	Nitrates	mg/l	5.8	5.2	6.0	6.4
7.	Nitrites	mg/l	0.17	0.19	0.15	0.23
8.	Ammonia	mg/l	< 0.01	< 0.01	< 0.01	0.41
9.	Phosphates	mg/l	0.18	0.21	0.26	0.37
10.	Chlorides	mg/l	20296	20074	20450	20708
11.	Sodium	mg/l	7588	7936	7533	8404
12.	Sulphates	mg/l	3521	3245	3167	3546
13.	Silicates	mg/l	2.2	2.0	2.7	3.6
14.	Reactive Silica	mg/l	0.013	0.015	0.020	0.024

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Ref: SVELC/AKPL/24-12/16 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 27-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

15.	Total Phosphorus	mg/l	0.17	0.15	0.18	0.28
16.	Total Nitrogen	mg/l	9.8	9.5	10.9	11.7
III.	**Biological**					
1.	Primary Productivity	mgC $m^{-2}d^{-1}$	56	43	47	34
2.	Chlorophyll	mg/m^3	1.55	1.46	1.42	1.28
3.	Phytoplankton					
	a. Numerical abundance	No./ml	247	245	232	206
	b. Diversity	-	2.35	2.29	2.32	2.04
4.	Zooplankton					
a.	Diversity	-	2.18	2.20	2.27	2.05
b.	Biomass	$ml/100m^3$	11.4	11.6	12.3	10.0
c.	Coliforms	CFU/100ml	22	18	24	29
d.	Fecal Coliforms	CFU/100ml	ND	ND	ND	ND
IV.	**Heavy Metals**					
1.	Lead	mg/l	< 0.01	< 0.01	< 0.01	< 0.01
2.	Cadmium	mg/l	< 0.01	< 0.01	< 0.01	0.09
3.	Copper	mg/l	< 0.02	< 0.02	0.010	0.012
4.	Zinc	mg/l	0.013	0.008	0.013	0.024

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Ref: SVELC/AKPL/24-12/17

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : SURFACE WATER

DATE OF COLLECTION : 06-12-2024

SAMPLE CODE : 1. Buckingham Canal
2. Khandaleru Creek

TEST REPORT

S.No	PARAMETER	UNIT	1	2
I.	**Physical**			
1.	pH	-	7.42	7.26
2.	Temperature	°C	26.5	27.7
3.	Salinity	Ppt	32.7	32.2
4.	Density	gm/ml	1.33	1.45
II.	**Chemical**			
1.	Potassium	mg/l	295	304
2.	COD	mg/l	12.8	13.3
3.	BOD	mg/l	3.2	3.5
4.	Oil & Grease	mg/l	< 0.1	< 0.1
5.	D.O.	mg/l	5.6	5.4
6.	Nitrates	mg/l	1.37	1.19
7.	Nitrites	mg/l	< 0.1	< 0.1
8.	Ammonia	mg/l	0.025	0.030
9.	Phosphates	mg/l	0.40	0.76
10.	Chlorides	mg/l	18120	17851
11.	Sodium	mg/l	7317	7118
12.	Sulphates	mg/l	2754	2790
13.	Silicates	mg/l	1.34	1.46
14.	Reactive Silica	mg/l	0.41	0.55
15.	Total Phosphorus	mg/l	0.25	0.39
16.	Total Nitrogen	mg/l	10.6	9.8

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Ref: SVELC/AKPL/24-12/17

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : SURFACE WATER

DATE OF COLLECTION : 06-12-2024

SAMPLE CODE : 1. Buckingham Canal
2. Khandaleru Creek

III.	**Biological**			
1.	Primary Productivity	mgC $m^{-2}d^{-1}$	48	46
2.	Chlorophyll	mg/m^3	2.74	2.25
3.	Phytoplankton			
	a. Numerical abundance	No./ml	267	281
	b. Diversity	-	2.33	2.63
4.	Zooplankton			
a.	Diversity	-	2.54	2.71
b.	Biomass	$ml/100m^3$	12.0	12.8
c.	Coliforms	CFU/100ml	22	18
d.	Fecal Coliforms	CFU/100ml	ND	ND
IV.	**Heavy Metals**			
1.	Lead	mg/l	<0.01	<0.01
2.	Cadmium	mg/l	<0.01	<0.01
3.	Copper	mg/l	<0.02	0.029
4.	Zinc	mg/l	0.034	0.045

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Ref: SVELC/AKPL/24-12/08 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **NOISE LEVEL MONITOIRNG**

DATE OF START : 25-12-2024 to 27-12-2024

TEST REPORT

S.No	LOCATION	UNIT	Environmental Setting	CPCB STANDARD for Day	Day	CPCB STANDARD for Night	Night	METHOD
1.	Zero Point	dB(A)	Industrial	75.0	67.1	70.0	58.6	IS:4954 – 1968 Noise Level Meter
2.	Tamminipatnam	dB(A)	Industrial	75.0	64.8	70.0	53.2	
3.	CVR Building	dB(A)	Industrial	75.0	60.5	70.0	55.1	
4.	Gopalpuram	dB(A)	Residential	55.0	49.7	45.0	43.8	
5.	Chalivendram	dB(A)	Residential	55.0	52.4	45.0	41.6	
6.	Krishnapatnam	dB(A)	Residential	55.0	53.6	45.0	43.1	
7.	Krishnapatnam Village near Light House	dB(A)	Residential	55.0	51.5	45.0	39.5	

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Ref: SVELC/AKPL/24-12/18

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER (AT HARBOUR)

DATE OF COLLECTION : 06-12-2024

TEST REPORT

S.No	Parameters	Units	Port Entrance (Approach Channel)	Turning Circle	Coal Berth	Reclamation Area (Mutable)
	Low Tide					
1.	Turbidity	NTU	4.5	5.0	6.4	15.1
2.	Total Dissolved Solids	mg/l	32112	31940	31891	33420
3.	Total Suspended Solids	mg/l	11.6	12.0	12.3	15.4
	Medium Tide					
1.	Turbidity	NTU	4.2	4.5	5.6	14.3
2.	Total Dissolved Solids	mg/l	31893	31725	31690	33205
3.	Total Suspended Solids	mg/l	11.0	12.1	11.3	14.2
	High Tide					
1.	Turbidity	NTU	7.2	6.1	7.2	16.9
2.	Total Dissolved Solids	mg/l	32349	32180	32138	33662
3.	Total Suspended Solids	mg/l	13.8	14.0	13.5	18.1

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Ref: SVELC/AKPL/24-12/19

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER

DATE OF COLLECTION : 13-12-2024

TEST REPORT

S.No	Parameters	Units	Port Entrance (Approach Channel)	Turning Circle	Coal Berth	Reclamation Area (Mutable)
	Low Tide					
1.	Turbidity	NTU	4.8	5.3	6.7	15.7
2.	Total Dissolved Solids	mg/l	32032	31872	31806	33356
3.	Total Suspended Solids	mg/l	12.0	12.6	13.1	16.0
	Medium Tide					
1.	Turbidity	NTU	4.5	4.9	6.0	14.9
2.	Total Dissolved Solids	mg/l	32236	32078	32021	33568
3.	Total Suspended Solids	mg/l	11.3	12.5	11.8	15.1
	High Tide					
1.	Turbidity	NTU	7.5	6.3	7.7	17.2
2.	Total Dissolved Solids	mg/l	32476	32319	32268	33799
3.	Total Suspended Solids	mg/l	14.2	14.5	14.1	18.6

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Ref: SVELC/AKPL/24-12/20

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER (AT HARBOUR)

DATE OF COLLECTION : 19-12-2024

TEST REPORT

S.No	Parameters	Units	Port Entrance (Approach Channel)	Turning Circle	Coal Berth	Reclamation Area (Mutable)
	Low Tide					
1.	Turbidity	NTU	4.2	4.8	5.9	14.3
2.	Total Dissolved Solids	mg/l	31883	31726	31684	33192
3.	Total Suspended Solids	mg/l	11.7	12.2	12.6	15.4
	Medium Tide					
1.	Turbidity	NTU	4.0	4.4	5.5	13.6
2.	Total Dissolved Solids	mg/l	32081	31945	31889	33398
3.	Total Suspended Solids	mg/l	11.0	11.9	11.3	14.2
	High Tide					
1.	Turbidity	NTU	6.9	5.8	7.2	16.1
2.	Total Dissolved Solids	mg/l	32326	32181	32124	33642
3.	Total Suspended Solids	mg/l	12.9	13.2	13.5	17.9

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Ref: SVELC/AKPL/24-12/21

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER (AT HARBOUR)

DATE OF COLLECTION : 27-12-2024

TEST REPORT

S.No	Parameters	Units	Port Entrance (Approach Channel)	Turning Circle	Coal Berth	Reclamation Area (Mutable)
	Low Tide					
1.	Turbidity	NTU	4.0	4.5	5.4	13.8
2.	Total Dissolved Solids	mg/l	31725	31564	31488	33006
3.	Total Suspended Solids	mg/l	11.2	11.6	12.0	14.3
	Medium Tide					
1.	Turbidity	NTU	3.7	4.0	4.9	12.8
2.	Total Dissolved Solids	mg/l	31930	31778	31695	33214
3.	Total Suspended Solids	mg/l	10.4	11.2	10.6	13.1
	High Tide					
1.	Turbidity	NTU	6.6	5.3	6.8	15.3
2.	Total Dissolved Solids	mg/l	32175	32012	31936	33446
3.	Total Suspended Solids	mg/l	12.2	12.6	12.8	17.0

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Ref: SVELC/AKPL/24-12/22 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **WATER**

SOURCE OF COLLECTION : MARINE WATER (AT DEEP SEA)

DATE OF COLLECTION : 06-12-2024

TEST REPORT

S.No	Parameters	Units	14°19'26"N & 80°15'43"E	14°16'52"N & 80°17'40"E	14°16'11"N & 80°17'40"E
	Low Tide				
1.	Turbidity	NTU	4.7	4.2	5.3
2.	Total Dissolved Solids	mg/l	34449	34920	35631
3.	Total Suspended Solids	mg/l	6.2	6.7	7.9
	Medium Tide				
1.	Turbidity	NTU	4.2	3.8	4.6
2.	Total Dissolved Solids	mg/l	34214	34637	35346
3.	Total Suspended Solids	mg/l	5.0	5.9	6.3
	High Tide				
1.	Turbidity	NTU	6.1	5.7	6.5
2.	Total Dissolved Solids	mg/l	34787	35147	36490
3.	Total Suspended Solids	mg/l	7.6	8.3	9.7

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Ref: SVELC/AKPL/24-12/23 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **SEDIMENT**

SOURCE OF COLLECTION : MARINE SEDIMENT

DATE OF COLLECTION : 06-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	Sediment composition					
	a. Sand	%	35.8	37.5	34.7	36.3
	b. Silt + Clay	%	64.2	62.5	65.3	63.7
	c. Org. Matter	%	1.32	1.35	1.30	1.40
2.	pH	-	7.81	7.90	8.09	8.26
II.	**Chemical**					
1.	Nitrogen	mg/kg	395	381	378	405
2.	Phosphorus	mg/kg	224	238	251	186
3.	Potassium	mg/kg	340	345	358	370
4.	Sodium	mg/kg	16869	17223	17361	17560
III.	**Biological**					
1.	Benthos Communities					
a.	Macro Benthos	nos/m^2	1160	1165	1153	1144
b.	Epifauna numerical abundance	nos/haul	28	30	28	22
c.	Infauna numerical abundance	nos/m^2	738	716	714	703
IV	**Heavy Metals**					
1.	Lead	mg/kg	0.52	0.51	0.54	0.62
2.	Cadmium	mg/kg	0.061	0.055	0.057	0.082
3.	Copper	mg/kg	< 0.01	< 0.01	< 0.01	0.35
4.	Zinc	mg/kg	0.060	0.076	0.073	0.72

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Ref: SVELC/AKPL/24-12/24 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **SEDIMENT**

SOURCE OF COLLECTION : MARINE SEDIMENT

DATE OF COLLECTION : 13-12-2024

SAMPLE CODE : 1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	Sediment composition					
	a. Sand	%	33.5	35.8	32.9	34.6
	b. Silt + Clay	%	66.5	64.2	67.1	65.4
	c. Org. Matter	%	1.35	1.38	1.33	1.43
2.	pH	-	7.63	7.81	7.98	8.15
II.	**Chemical**					
1.	Nitrogen	mg/kg	397	384	381	408
2.	Phosphorus	mg/kg	226	241	253	189
3.	Potassium	mg/kg	342	348	361	372
4.	Sodium	mg/kg	16875	17231	17368	17571
III.	**Biological**					
1.	Benthos Communities					
a.	Macro Benthos	nos/m^2	1159	1163	1151	1142
b.	Epifauna numerical abundance	nos/haul	27	28	25	20
c.	Infauna numerical abundance	nos/m^2	736	714	713	702
IV	**Heavy Metals**					
1.	Lead	mg/kg	0.55	0.53	0.57	0.64
2.	Cadmium	mg/kg	0.064	0.058	0.061	0.085
3.	Copper	mg/kg	< 0.01	< 0.01	< 0.01	0.38
4.	Zinc	mg/kg	0.063	0.078	0.074	0.75

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Ref: SVELC/AKPL/24-12/25

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **SEDIMENT**

SOURCE OF COLLECTION : MARINE SEDIMENT

DATE OF COLLECTION : 19-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	Sediment composition					
	a. Sand	%	32.1	34.5	31.4	33.7
	b. Silt + Clay	%	67.9	65.5	68.6	66.3
	c. Org. Matter	%	1.33	1.36	1.32	1.41
2.	pH	-	7.78	7.89	8.06	8.28
II.	**Chemical**					
1.	Nitrogen	mg/kg	395	382	378	405
2.	Phosphorus	mg/kg	224	240	250	186
3.	Potassium	mg/kg	340	345	359	370
4.	Sodium	mg/kg	16868	17224	17379	17560
III.	**Biological**					
1.	Benthos Communities					
a.	Macro Benthos	nos/m^2	1160	1164	1153	1143
b.	Epifauna numerical abundance	nos/haul	28	29	26	21
c.	Infauna numerical abundance	nos/m^2	737	716	714	703
IV	**Heavy Metals**					
1.	Lead	mg/kg	0.52	0.51	0.56	0.63
2.	Cadmium	mg/kg	0.062	0.056	0.060	0.083
3.	Copper	mg/kg	< 0.01	< 0.01	< 0.01	0.36
4.	Zinc	mg/kg	0.061	0.075	0.072	0.74

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(ENVIRONMENTAL ENGINEERS & CONSULTANTS IN POLLUTION CONTROL)

Corporate Office & Laboratory : Enviro House, B-1, Block-B, IDA, Autonagar, Visakhapatnam-530012.

Hyderabad: Flat No. 302, H.No. 7-1-396/B/12, Sai Ram Residency, Balkampet Road, S.R.Nagar, Hyderabad-500038.

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Recognized by Govt. of India-MoEF & CC, New Delhi, Accredited by : NABL & NABET

Ref: SVELC/AKPL/24-12/26

Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **SEDIMENT**

SOURCE OF COLLECTION : MARINE SEDIMENT

DATE OF COLLECTION : 27-12-2024

SAMPLE CODE :
1. Port Entrance (Approach Channel)
2. Turning Circle
3. Coal Berth
4. Reclamation Area (Mutable)

TEST REPORT

S.No	PARAMETER	UNIT	1	2	3	4
I.	**Physical**					
1.	Sediment composition					
	a. Sand	%	30.8	32.1	30.2	34.3
	b. Silt + Clay	%	69.2	67.9	69.8	65.7
	c. Org. Matter	%	1.31	1.33	1.30	1.39
2.	pH	-	7.86	7.97	8.24	8.38
II.	**Chemical**					
1.	Nitrogen	mg/kg	393	380	375	402
2.	Phosphorus	mg/kg	222	238	248	184
3.	Potassium	mg/kg	337	343	356	367
4.	Sodium	mg/kg	16860	17214	17370	17551
III.	**Biological**					
1.	Benthos Communities					
a.	Macro Benthos	nos/m^2	1162	1166	1157	1145
b.	Epifauna numerical abundance	nos/haul	29	31	27	23
c.	Infauna numerical abundance	nos/m^2	739	718	715	705
IV	**Heavy Metals**					
1.	Lead	mg/kg	0.50	0.48	0.55	0.62
2.	Cadmium	mg/kg	0.060	0.055	0.058	0.081
3.	Copper	mg/kg	< 0.01	< 0.01	< 0.01	0.35
4.	Zinc	mg/kg	0.059	0.073	0.070	0.72

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Recognized by Govt. of India-MoEF & CC, New Delhi, Accredited by : NABL & NABET

Ref: SVELC/AKPL/24-12/09 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **EFFLUENT**

SOURCE OF COLLECTION : STP INLET – 500KLD

DATE OF COLLECTION : 19-12-2024

TEST REPORT

S.No	Parameter	Unit	Result	Method
1.	pH	-	7.36	APHA, 4500-H+B, 24th Edition 2023
2.	Total Suspended Solids	mg/l	120	APHA, 2540-D, 24th Edition 2023
3.	BOD 3day 27°C	mg/l	110	IS 3025 P 44
4.	Oil & Grease	mg/l	4.0	APHA, 5520-D, 24th Edition 2023
MICROBIOLOGY TEST				
5.	*Fecal coliform*	MPN/100ml	$15X10^3$	IS 1622

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Hyderabad: Flat No. 302, H.No. 7-1-396/B/12, Sai Ram Residency, Balkampet Road, S.R.Nagar, Hyderabad-500038.
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Recognized by Govt. of India-MoEF & CC, New Delhi, Accredited by : NABL & NABET

Ref: SVELC/AKPL/24-12/10 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **EFFLUENT**

SOURCE OF COLLECTION : STP OUTLET – 500KLD

DATE OF COLLECTION : 19-12-2024

TEST REPORT

S.No	Parameter	Unit	Result	Method	STANDARDS
1.	pH	-	7.48	APHA, 4500-H+B, 24th Edition 2023	6.5-9.0
2.	Total Suspended Solids	mg/l	42.0	APHA, 2540-D, 24th Edition 2023	<100
3.	BOD 3day 27°C	mg/l	24.0	IS 3025 P 44	30
4.	Oil & Grease	mg/l	<1.0	APHA, 5520-D, 24th Edition 2023	10
MICROBIOLOGY TEST					
5.	*Fecal coliform*	MPN/100ml	240	IS 1622	<1000

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Recognized by Govt. of India-MoEF & CC, New Delhi, Accredited by : NABL & NABET

Ref: SVELC/AKPL/24-12/11 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **EFFLUENT**

SOURCE OF COLLECTION : STP INLET – 40KLD

DATE OF COLLECTION : 19-12-2024

TEST REPORT

S.No	Parameter	Unit	Result	Method
1.	pH	-	7.51	APHA, 4500-H+B, 24th Edition 2023
2.	Total Suspended Solids	mg/l	98.0	APHA, 2540-D, 24th Edition 2023
3.	BOD 3day 27°C	mg/l	102	IS 3025 P 44
4.	Oil & Grease	mg/l	4.0	APHA, 5520-D, 24th Edition 2023
MICROBIOLOGY TEST				
5.	*Fecal coliform*	MPN/100ml	$11X10^3$	IS 1622

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Ref: SVELC/AKPL/24-12/12 Date: 04-01-2025

NAME AND ADDRESS : **M/s. ADANI KRISHNAPATNAM PORT LIMITED,**
Krishnapatnam Post, Muthukur Mandal,
SPSR Nellore District,
Andhra Pradesh – 524 344.

SAMPLE PARTICULARS : **EFFLUENT**

SOURCE OF COLLECTION : STP OUTLET – 40KLD

DATE OF COLLECTION : 19-12-2024

TEST REPORT

S.No	Parameter	Unit	Result	Method	STANDARDS
1.	pH	-	7.23	APHA, 4500-H+B, 24th Edition 2023	6.5-9.0
2.	Total Suspended Solids	mg/l	18.0	APHA, 2540-D, 24th Edition 2023	<100
3.	BOD 3day 27°C	mg/l	20.0	IS 3025 P 44	30
4.	Oil & Grease	mg/l	<1.0	APHA, 5520-D, 24th Edition 2023	10
MICROBIOLOGY TEST					
5.	*Fecal coliform*	MPN/100ml	190	IS 1622	<1000

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Service Order 2145 2029

ANNEXURE-49

Contractor's details	**SO No :** 5702007591 **SO Release Date :** 28.09.2022
NATIONAL INSTITUTE OF OCEAN TECHNOLOGY CHENNAI,PALLIKARANI VELACHERY TAMBARAM MAIN ROAD, CHENNAI,600001,22 TAMIL NADU,INDIA PAN:AAATN0530G GSTIN:33AAATN0530G1Z6 Vendor Code:0000215956 Kind Attn: Phone: Mobile: Email:BKJENA@NIOT.RES.IN	**Employer's details** Adani Krishnapatnam Port Ltd PO Bag no 01, Muthukur, Nellore SPSR Nellore 524344 ANDHRA PRADESH PAN AAACK8657J CIN U45203GJ1996PLC128239 GSTIN 37AAACK8657J1Z1 IEC No. 0906018803 **Our Contact Details** Name VINOD KUMAR MADALA Phone +917064460434 Email VINODKUMAR.MADALA@adani.com

Order Value Summary

	Currency	Amount
Basic Price	INR	3,500,000.00
Other Charges	INR	0.00
Taxes	INR	630,000.00
SO Price	INR	4,130,000.00

In words, RUPEES FORTY ONE LAKH THIRTY THOUSAND ONLY

Monitoring of Shoreline Changes and Feasibility of Erosion Mitigation Measures for Adani Krishnapatnam Port Limited

SPECIAL TERMS AND CONDITIONS (STC)

1.0 Scope of Work

Monitoring of Shoreline Changes and Feasibility of Erosion Mitigation Measures for Adani Krishnapatnam Port Limited

Deliverables

The following are the deliverables:

1. Feasibility study for shore protection of beach road from erosion shall be submitted within a period of 9 months.
2. Report on shoreline changes analysis using satellite imageries, this report shall be submitted within a period of six months.
3. Report on shoreline monitoring from field measurements to be carried out 4 times during the project period. The first report shall be submitted after completion of one year. Followed by another report after 6 months

2.0 Effective Date

Date of issue of SO.

(Buyer's Authorised Signatory) **(Seller's Authorised Signatory)**

3.0 Site
AKPL Site, Nellore

4.0 Completion Schedule
Project Period: 18 months from Effective date.

5.0 Price
The total cost of the project for a period of 18 months is Rs 35,00,000

6.0 Taxes
GST applicable@18%

7.0 Payment Terms
1. 50% payment at the time of issue of work order against proforma invoice
2. 15% payment at the time of submission of shore protection from erosion
3. 10% payment at the time of submission of report on shoreline change analysis
4. 15% payment on completion of monitoring and submission of fi rst report on shoreline changes from fi eldmeasurements.
5. 10% payment on completion of monitoring and submission of second report on shoreline changes from fi eldmeasurements.

8.0 Liquidated Damages
Not Applicable

9.0 Securities
Not Applicable

10.0 Defect Liability Period
Not Applicable

11.0 Invoicing Address
Not Applicable

12.0 Specific Agreed Terms
Responsibility of AKPL
AKPL shall provide the following for timely completion of the project as agreed vide email dated March 14,2022:
1. Transportation to port and field activities as part of the study.
2. Lodging for staff
3. Facilities required for field measurements and surveys.
4. Bathymetry data for feasibility of shore protection.

13.0 Notice and Communications
a) This PO complies with GCC attached, unless explicitly mentioned otherwise.
b) On accepting or executing this Purchase/Service Order, the vendor agrees to abide by Adani Ports & SEZ

Ltd Supplier Code of Conduct. The supplier code of conduct can be accessed using the following link: https://www.adaniports.com/-/media/Project/Ports/Investor/corporate-governance/Policies/Supplier-Code-of-Conduct.pdf

Enclosures:

(Buyer's Authorised Signatory) **(Seller's Authorised Signatory)**

ANNEXURE I
PRICE SCHEDULE

BOQ For 00020. Shoreline monitoring.
Plant : 2992

Serial No.	Service Code/Description	UOM	Quantity	Unit Rate	Total Amount
10.	130003353 IGST%: 18.00% IGST Amount: SAC Code: 998333 CONSULTANCY CHARGES	LUMP SUM	1.000	3500000.00/1	3500000.00 630000.00

No of Items : 1

Subtotal : 4,130,000.00

	Currency	Amount
Basic Price	INR	3,500,000.00
Other Charges	INR	0.00
Taxes	INR	630,000.00
SO Price	INR	4,130,000.00

in Words, RUPEES FORTY ONE LAKH THIRTY THOUSAND ONLY

(Buyer's Authorised Signatory)

(Seller's Authorised Signatory)

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Ports and Logistics

ANNEXURE-50

Ref. No. AKPL/EC/ENV/007/2025-26 **Date: 09.04.2025**

To

The Environmental Engineer,
A.P. Pollution Control Board,
Regional Office,
SPSR Nellore,
Andhra Pradesh

Dear Sir,

Sub: Adani Krishnapatnam Port Limited (AKPL) – Complying with Phase III expansion of EC & CRZ clearance Conditions – Submission of NIOT Study reports - Reg.

Ref: EC & CRZ Clearance Order No.10-18/2016-IA-III dated 11.01.2021 and APCZMA NOC letter no. 202/CRZ/IND/2019 -30 dated 21.05.2020 accorded to AKPL by the Ministry of Environment, Forests & Climate Changes, New Delhi and APCZMA.

@@@

Adani Krishnapatnam Port Limited had obtained Environmental and Coastal Regulatory Zone clearances from MoEF&CC and Andhra Pradesh Coastal Zone Management Authority (APCZMA) for Phase III expansion of Port. The clearances were subjected to fulfilling of conditions for environmental monitoring as stipulated by the above authorities. In this regard AKPL has approached NIOT to carry out various monitoring studies letter dated 27.05.2021.

S.No.	Condition	Reference
A	Continuous monitoring of circulation of seawater shall be carried out every six months by engaging in a reputed agency like NIOT. The port shall undertake the study of multi-sensor, multi-data data to study the sedimentation studies in the inner harbour channel in addition to the in-	CRZ Clause: PART A: Specific Condition (iv)

Adani Krishnapatnam Port Ltd
PO Bag No 1, Muthukur Mandal,
SPSR Nellore District 524344
Andhra Pradesh, India
CIN: U45203AP1996PLC023529

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S.No.	Condition	Reference
	house studies undertaken as part of regular monitoring of sedimentation in the harbour channel. The monthly reports shall be submitted to APPCB.	
B	The Port shall also undertake the scientific studies by engaging reputed agencies like National Institute of Ocean Technology (NIOT) and Indian Institute of Technology, Chennai to study the feasibility of constructing submerged breakwaters to protect the beach road from seasonal erosion and also during cyclones.	CRZ Clause: PART A: Specific Condition (vii)
C	The applicant shall ensure that continuous monitoring systems of all likely affected parameters including air/fish/flora/fauna/water quality/ waste water discharges/solid waste disposal/construction material disposal etc., are installed and reports shared with the National Institute of Oceanography (NIO) on continuous basis and a monthly report submitted to the APPCB by the NIO, all through construction period and at least for one year after commencement of operations.	CRZ Clause: PART A: Specific Condition (viii)
D	The proposed expansion entails 60 million cu m of dredging in soft soil. As proposed, the PP shall utilize 26 million cu m of dredged sand for reclamation of low-lying areas of port, stockpile 2 million cu m on the coast north of north breakwater for long term coastal protection as recommended by NIOT and disposal of balance 32 million cu m of dredged spoil in the identified dredge disposal area of 56 Km2 beyond (-) 20 m contour. The impact of dredging on the marine environment should be monitored and necessary measures shall be taken on priority basis if any adverse impact is observed. NIOT will oversee the work as scientific body and continue to monitor its impact/benefits for at least 5 years post project completion. Necessary financial assistance to be provided by project proponent to NIOT. The report of the same to be submitted to regional office of MoEF&CC by project proponent.	EC Clause: Specific conditions (vii)

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SPSR Nellore District 524344
Andhra Pradesh, India
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S.No.	Condition	Reference
E	Shoreline should not be disturbed due to dumping. Periodical study on shoreline changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six-monthly monitoring reports.	EC Clause VI: Waste management (ii)

Complying with the above conditions, a study on Shore line changes from satellite imageries and monitoring of shoreline from field measurements and Shoreline protection from erosion report was prepared through National Institute of Ocean Technology (Ministry of Earth Sciences, Government of India) As per the MoEF & CC, EC & CRZ Clearance.

We therefore, submit herewith the study report to comply with the EC & CRZ Clearance stipulated condition.

Thanking You,
Yours Faithfully,
For **M/s Adani Krishnapatnam Port Limited,**

2151

(Authorized Signatory)

Encl: a/a

Copy to:
SHRI N.S. MURALI, IFS
Inspector General of Forests (C),
Ministry of Environment, Forest and Climate Change,
Integrated Regional Office, Vijayawada Green House Complex,
Gopalareddy Road, Vijayawada – 520010, Andhra Pradesh

Adani Krishnapatnam Port Ltd
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ANNEXURE-51

Report on Shoreline changes from satellite imageries and monitoring of shoreline changes from field measurements

Submitted to

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Adani Krishnapatnam Port Limited
Krishnapatnam,
Andhra Pradesh, India

By

National Institute of Ocean Technology
(Ministry of Earth Sciences, Government of India)
Velachery-Tambaram Road,
Pallikaranai, Chennai,
Tamil Nadu, India

Title
Shoreline changes from satellite imageries and monitoring of shoreline changes from field measurements

Client
Adani Krishnapatnam Port Limited

Pages
15

Keywords

Krishnapatnam, Shoreline Changes Analysis, Field measurements, Beach profiling, Digital Shoreline Analysis System, Satellite imageries

Version	Date	Author	Initials	Review	Initials	Approval	Initials
2	28 February 2025	Abhishek T		Aruna Kumar Avula		B K Jena	
1	26 May 2023	Abhishek T		Vijaya Ravichandran		Purnima Jalihal	

State: Final

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1. Introduction

Adani Krishnapatnam Port Limited (AKPL) proposes to carry out shoreline changes as per the EC&CRZ Clearance for Phase-III expansion dated 11.01.2021 from MoEF&CC. The clearance is subjected to compliance of conditions set by MoEF&CC. Condition "(ii) Periodical study on shoreline changes shall be conducted and mitigation carried out, the details be submitted along with the six-monthly reports", requires AKPL to carry out periodic monitoring of shoreline changes for the coast of Krishnapatnam. In this regard National Institute of Ocean Technology was requested to carry out the study.

2. Background

Krishnapatnam Port is located on the East coast of India in Sri Potti Sri Ramulu (SPSR) Nellore District of Andhra Pradesh state. The location of Adani Krishnapatnam Port is shown in Figure 1. Adani Krishnapatnam Port breakwater have been constructed on either side of Kandaleru creek. Adani Krishnapatnam Port breakwater was constructed in 2007.

3. Scope of Work

As per work order NIOT is required to carry out the following:

1. Study on feasibility of protection beach road from seasonal erosion using one dimensional numerical model studies.
2. Monitoring of shoreline changes by carrying out field measurements for a period of 18 months. Beach profiling shall be carried out 4 times during the study period.
3. Analysis of shoreline changes using satellite imageries.

This report focuses on serial number 2 & 3 of the above scope, that is shoreline change study carried out using satellite imageries and the second is monitoring of shoreline using field measurements. The first part of the report focuses on shoreline changes from satellite imageries and the later part focuses on monitoring of shoreline changes for Krishnapatnam coast from field measurements.

4. Methodology for shoreline change analysis

Shoreline change analysis has been carried out using Digital Shoreline Analysis System (DSAS) tool of ESRI ArcGIS. DSAS was developed by United States Geological Service (USGS). DSAS is an extension that enhances the normal functionality of ESRI ArcGIS software, and enables users to calculate shoreline rate-of-change statistics from a time series of multiple shoreline positions. The extension was designed to aid in historic shoreline change analysis. DSAS is also useful for datasets that use polylines as a representation of a feature's position at a specific point in time, such as the forward limit of a glacier, river channel boundaries, land use and land cover maps.

DSAS works by generating orthogonal transects at a user-defined separation and then calculates rates-of-change and associated statistics that are reported in an attribute table. The DSAS tool requires user data to meet specific field requirements.

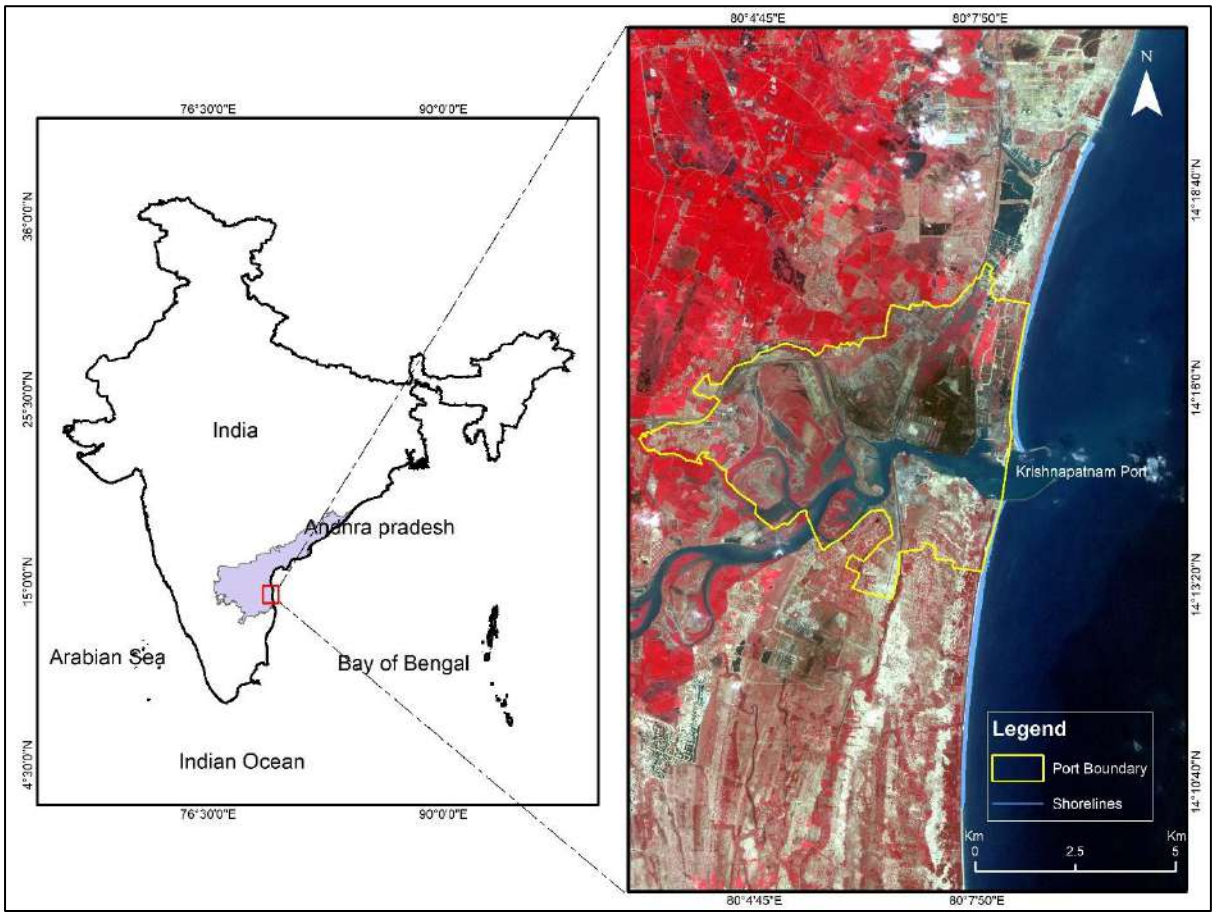

Figure 1: Location of Adani Krishnapatnam Port Limited

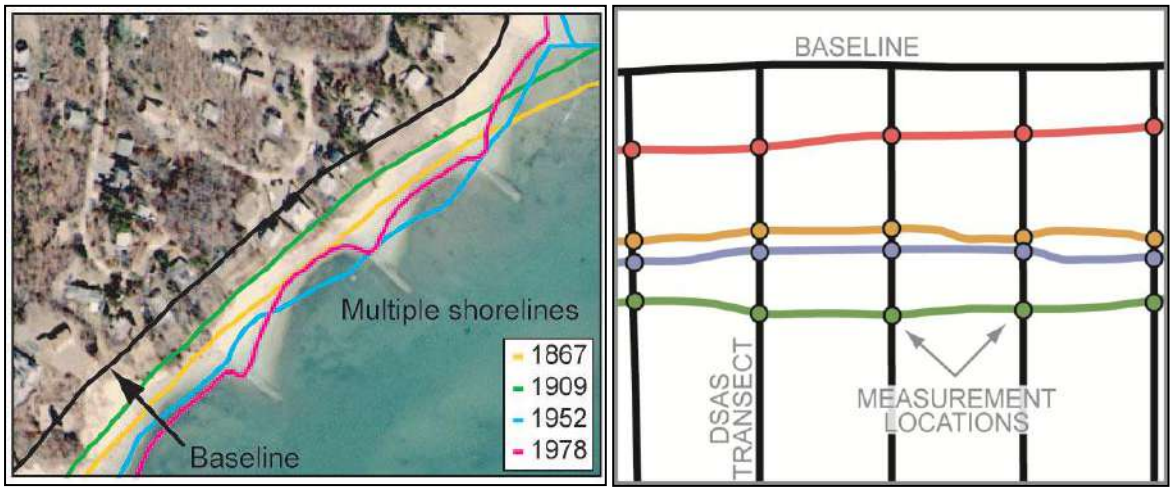

Figure 2: Sample of DSAS input

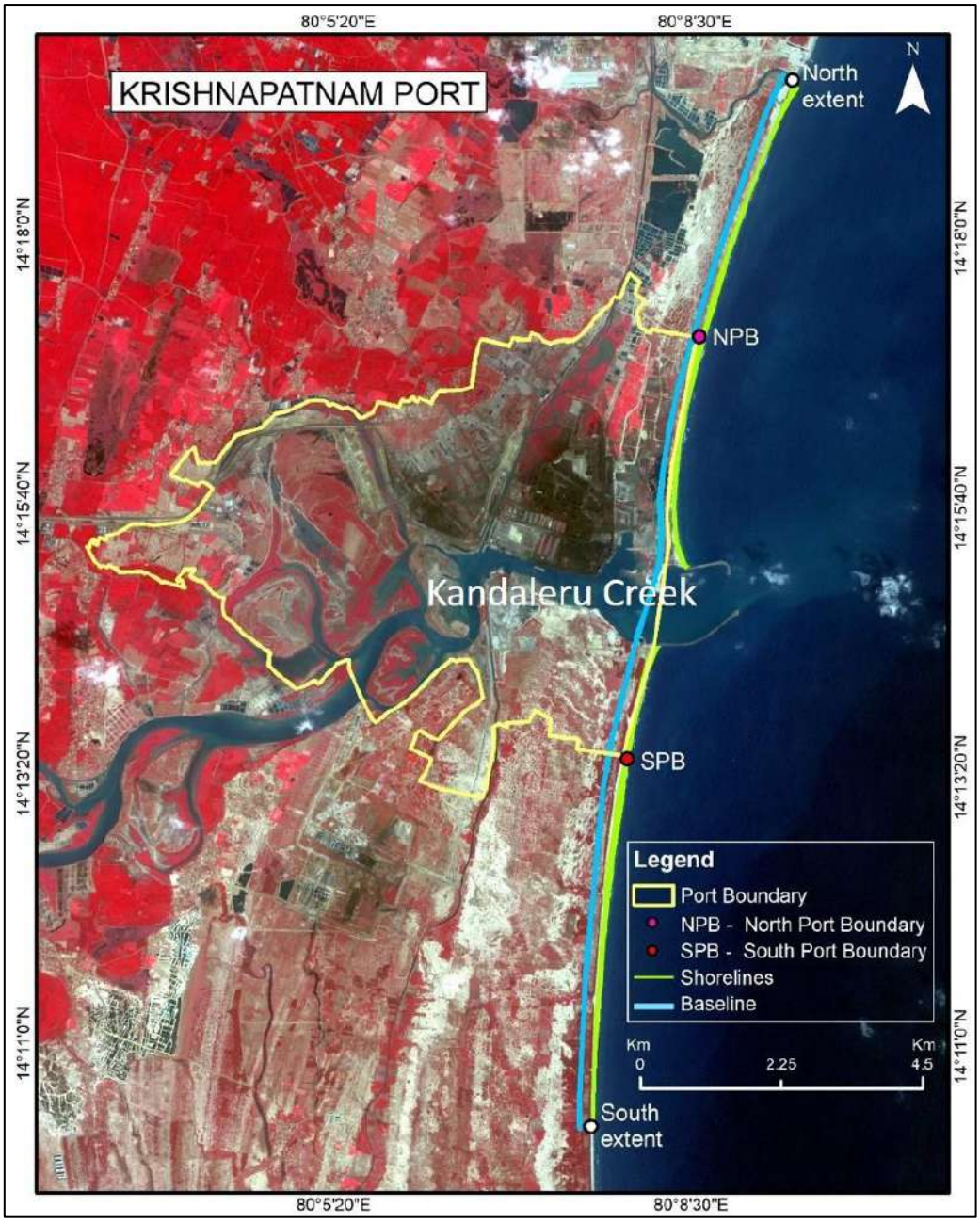

Figure 3: Extents for shoreline change study and the baseline for DSAS analysis

The DSAS approach calculates shoreline rates of change based on the measured differences between the shoreline positions associated with specific time periods as shown in Figure 2. In Figure 2 The baseline represented by the black line and the periodic shorelines are represented by colours Green, Cyan, Yellow and Crimson. The distances of various shorelines are calculated with reference to the base line and following statistical measures are possible in DSAS:

1. Shoreline Change Envelope (SCE): a measure of the total change in shoreline movement considering all available shoreline positions and reporting their distances, without reference to their specific dates.

2. Net Shoreline Movement (NSM): reports the distance between the oldest and the youngest shorelines.
3. End Point Rate (EPR): derived by dividing the distance of shoreline movement by the time elapsed between the oldest and the youngest shoreline positions.

Linear Regression Rate (LRR): determines a rate-of-change statistic by fitting a least square regression to all shorelines at a specific transects. Further statistics associated with LRR include Standard Error of Linear Regression (LSE), Confidence Interval of Linear Regression (LCI) and R-Squared of Linear Regression).

5. Data for shoreline change analysis using satellite imageries

The shoreline change assessment for Krishnapatnam coast using satellite imageries was carried over a period of 18 years from 2005-2023. Shoreline changes were evaluated by comparing Twenty-nine historical shorelines extracted from different satellite imageries. The details regarding satellite, the date of imageries and resolution are listed in Table 1.

As part of this study a stretch of 17.3km along the shoreline has been considered. The Southern extent (14.322°N, 80.156°E) and Northern extent (14.171°N, 80.126°E) of the shoreline considered for the study. The North and South Port Boundaries along the coast are marked as NPB and SPB respectively. The extents of the study area are shown in Figure 3. Transacts were taken at 10m distance along the 17.3km stretch of the coastline for the DSAS analysis. From DSAS analysis net shoreline change and rate of shoreline change were obtained.

Table 1: Details of Satellite Imageries

Sl.no	Satellite / Sensor	Date	Resolution/ Pixel size (m)	Source
1	RS1 LIS4	11/01/2005	5.8	NRSC
2	RS1 LIS4	21/10/2005	5.8	NRSC
3	CARTOSAT-1 PAN	14/03/2006	2.5	NRSC
4	CARTOSAT-1 PAN	18/07/2006	2.5	NRSC
5	CARTOSAT-1 PAN	27/03/2007	2.5	NRSC
6	CARTOSAT-1 PAN	12/04/2007	2.5	NRSC
7	RS1 LIS4	29/10/2008	5.8	NRSC
8	RS1 LIS4	13/08/2009	5.8	NRSC
9	CARTOSAT-1 PAN	02/12/2009	2.5	NRSC
10	CARTOSAT-1 PAN	04/05/2010	2.5	NRSC
11	R2A LIS4	19/11/2011	5.8	NRSC
12	CARTOSAT-1 PAN	17/10/2012	2.5	NRSC
13	RS2 LIS4	23/02/2012	5.8	NRSC
14	RS2 LIS4	30/04/2013	5.8	NRSC
15	RS2 LIS4	12/02/2014	5.8	NRSC
16	CARTOSAT-1 PAN	10/09/2014	2.5	NRSC
17	CARTOSAT-1 PAN	29/09/2015	2.5	NRSC

18	CARTOSAT-1 PAN	27/01/2016	2.5	NRSC
19	R2A LIS4	21/04/2017	5.8	NRSC
20	RS2 LIS4	20/12/2017	5.8	NRSC
21	CARTOSAT-1 PAN	21/02/2018	2.5	NRSC
22	RS2 LIS4	15/06/2018	5.8	NRSC
23	RS2 LIS4	26/08/2019	5.8	NRSC
24	RS2 LIS4	27/10/2020	5.8	NRSC
25	RS2 LIS4	31/10/2020	5.8	NRSC
26	RS2 LIS4	29/04/2021	5.8	NRSC
27	RS2 LIS4	23/02/2022	5.8	NRSC
28	RS2 LIS4	30/05/2022	5.8	NRSC
29	R2A LIS4	06/02/2023	5.8	NRSC

The analysis of shorelines was carried out for two scenarios. The first was prior to the construction of Krishnapatnam Port and the second was after construction of Krishnapatnam Port breakwaters. For the first scenario 6 imageries were used for analysis and for the second scenario 23 imageries were used. Adequate representation of imageries from monsoon and non-monsoon periods was carried out.

6. Results of shoreline change analysis

The stretch of the coast to the south of Kandaleru creek mouth has been considered southern part and the stretch of coast to the North of Kandaleru creek mouth has been considered Northern part. The Breakwaters for Krishnapatnam were constructed in 2007.

The results of shoreline change analysis have been shown in Figure 4 to Figure 7. Figure 4 and Figure 5 show the net shoreline movement before and after construction of Krishnapatnam Port. Figure 6 and Figure 7 show shoreline change rate before and after construction of Krishnapatnam Port.

The statistics for shoreline changes along Krishnapatnam coast have been summarized for Before and After Breakwater construction in Table 2 and Table 3.

Table 2: Shoreline change statistics for Krishnapatnam coast before breakwater construction

Stretch of coast	Shoreline Movement (m)		End Point Rate (m/yr)		Length of Shoreline (m)	
	Accretion	Erosion	Accretion	Erosion	Accretion	Erosion
North	25.72	25.07	8.88	8.66	5960	1650
South	103.46	0	35.73	0	7580	0

Table 3: Shoreline change statistics for Krishnapatnam coast after breakwater construction

Stretch of coast	Shoreline Movement (m)		End Point Rate (m/yr)		Length of Shoreline (m)	
	Accretion	Erosion	Accretion	Erosion	Accretion	Erosion
North	17.07	58.39	1.2	4.09	1220	6390
South	65.28	76.94	4.57	5.39	6290	1290

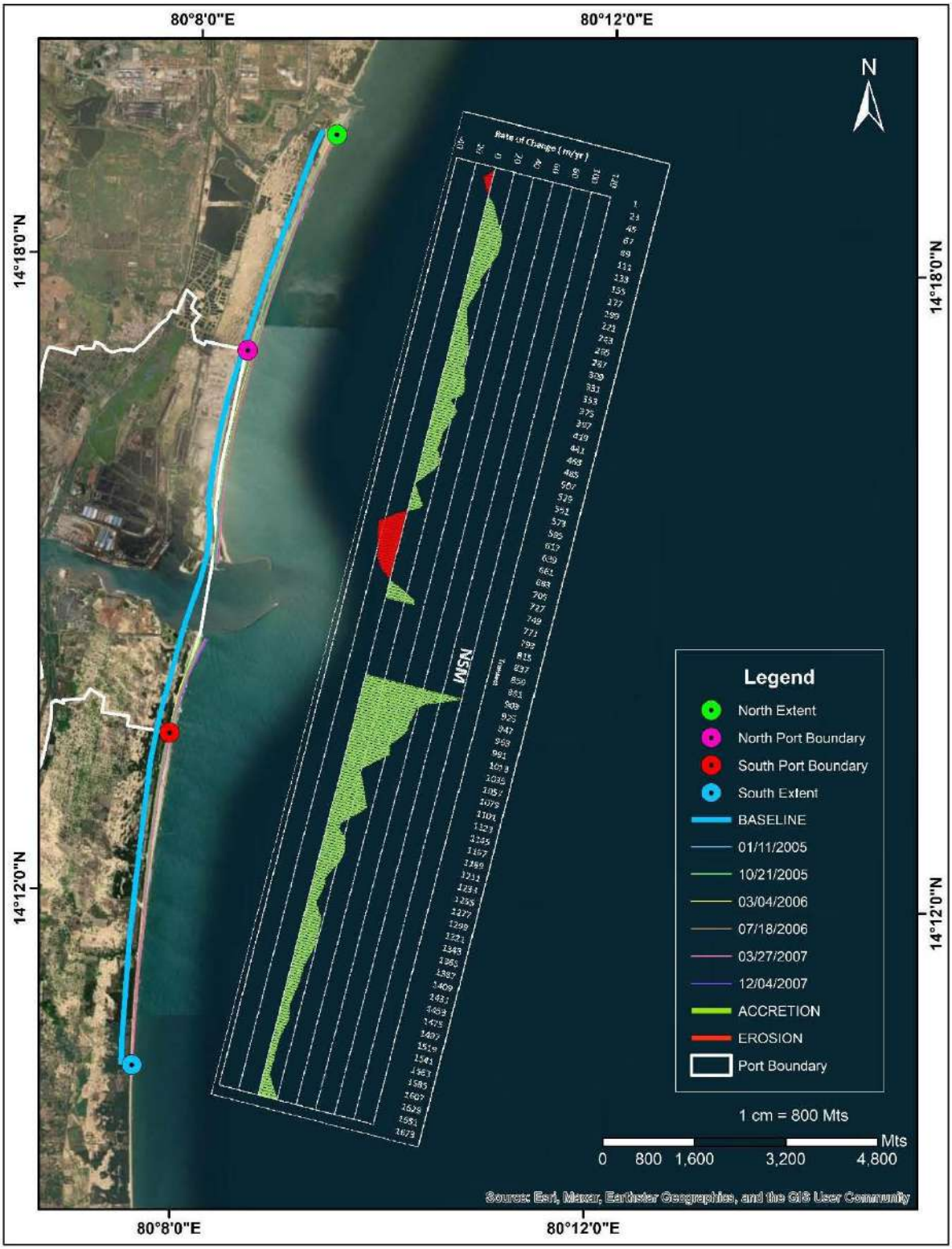

Figure 4: Net shoreline movement before construction of AKPL breakwater

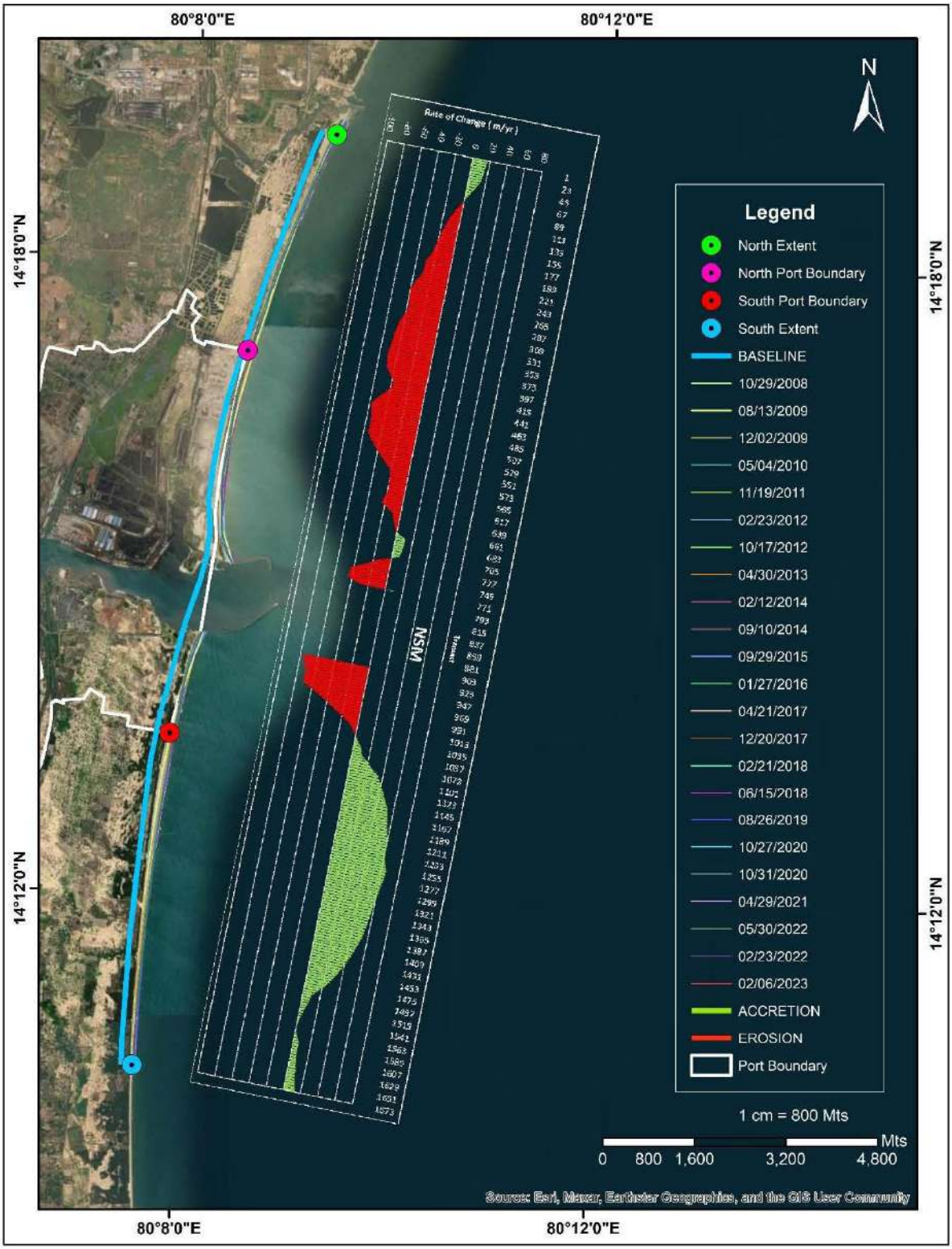

Figure 5: Net shoreline movement after construction of AKPL breakwater

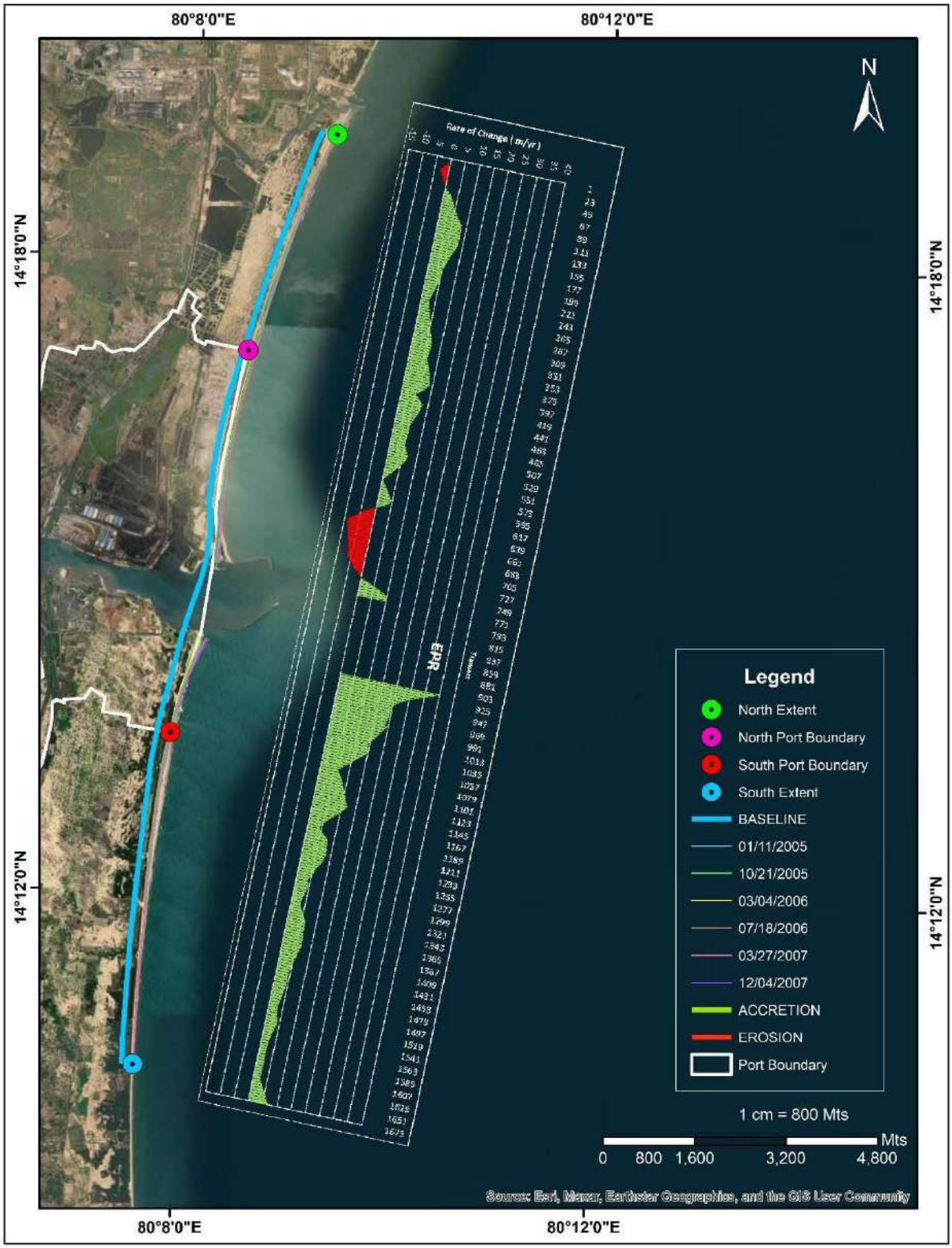

Figure 6 : Rate of shoreline change before construction of AKPL breakwater

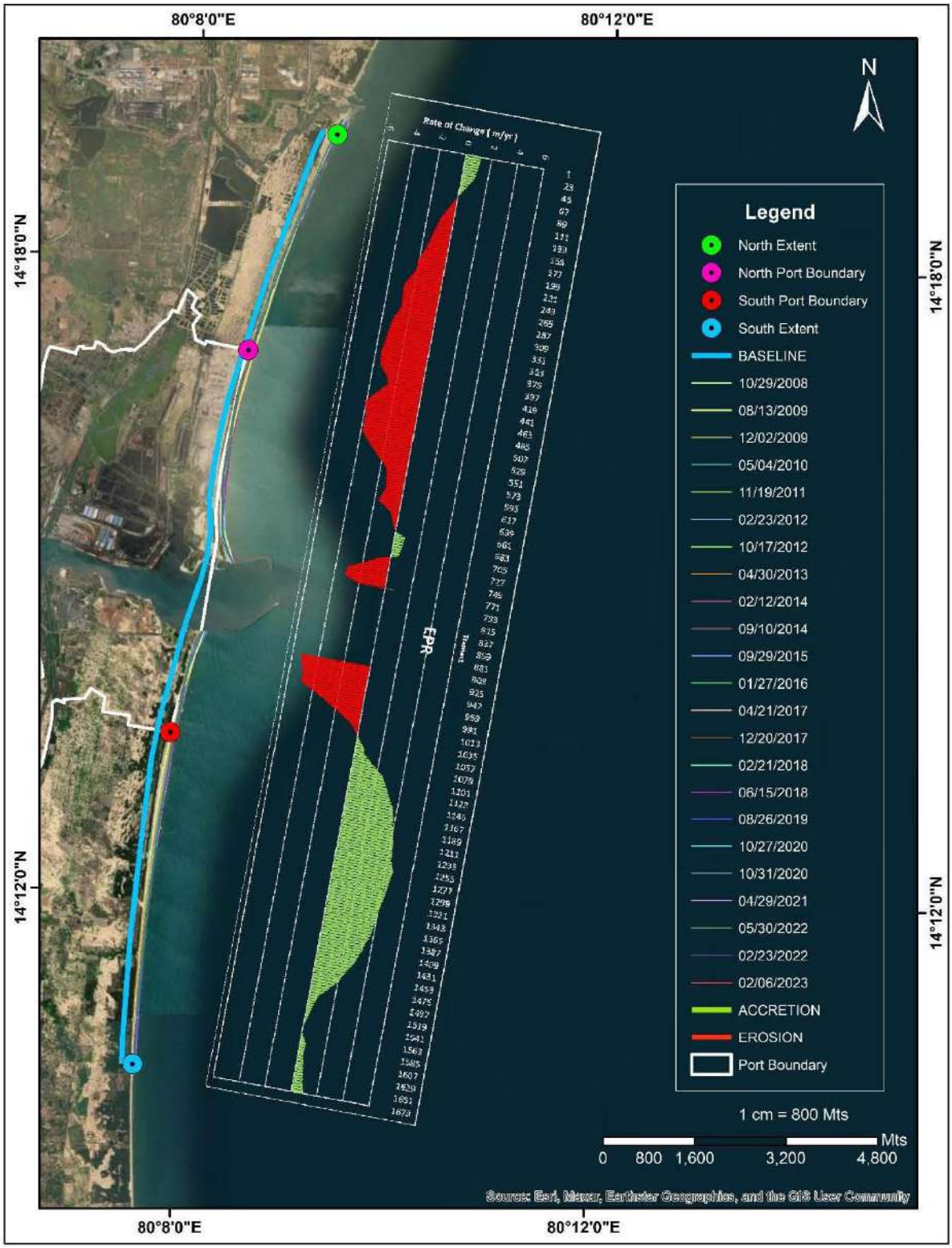

Figure 7 : Rate of shoreline change after construction of AKPL breakwater

7. Data for monitoring of shoreline changes from field measurements

To evaluate shoreline changes, measurements for beach profiling have been carried out over a period of twenty-two months from March 2023 to January 2025. During this period beach profiles have been collected 5 times. The details of the beach profiles collected by NIOT are provided in Table 4.

Beach profiles have been collected for a stretch of 5km on either side of the breakwater at 100m spacing along the shore and at 5m spacing across the shore. An overall stretch of 10km was covered for beach profiling studies. The planned lines of survey for beach profiling are shown in Figure 8.

Beach profiling surveys were carried out using Leica 18T Real Time Kinematic-Global Navigation Satellite System (RTK-GNSS). The detailed specification of the equipment is provided in annexure. As part of the surveys spot levels were obtained along the planned lines as shown in Figure 8 at 5m spacing. These spot levels were obtained with respect to the Chart Datum provided by Adani Krishnapatnam Port Limited. The variation in 0m contour during the study period have been plotted to evaluate the shoreline changes from field measurements. A plot of the all shorelines from the beach profiles is shown in Figure 9.

During the study period Adani Krishnapatnam Port Limited had carried out sand nourishment on to the North of Northern Breakwater of Adani Krishnapatnam Port. A total of 1,08,698 m^3 of sediments were dumped. The nourishment was carried out June 2024.

Table 4: Details of beach profile measurements carried out by NIOT at Krishnapatnam

Year	Period of Survey
2023	06/03/2023 to 11/03/2023
2023	13/06/2023 to 16/06/2023
2024	02/01/2024 to 06/01/2024
2024	02/09/2024 to 06/09/2024
2025	06/01/2025 to 10/01/2025

Figure 8: Planned lines for beach profiling along Krishnapatnam coast.

Figure 9: Shoreline changes from beach profiles along Krishnapatnam coast

8. Results of monitoring of shoreline changes from field measurements

Shoreline change analysis using Digital Shoreline Change Analysis (DSAS) was carried out for the shorelines obtained from beach profiles. The analysis was performed for the data

collected from 2023 to 2024 and from 2024 to 2025. The analysis also evaluates the impact of sand nourishment carried out along Krishnapatnam coast.

The results for analysis carried out from 2023 to 2024 is shown in Figure 10. The statistics of erosion and accretion from the analysis for this period are summarized in Table 5 .

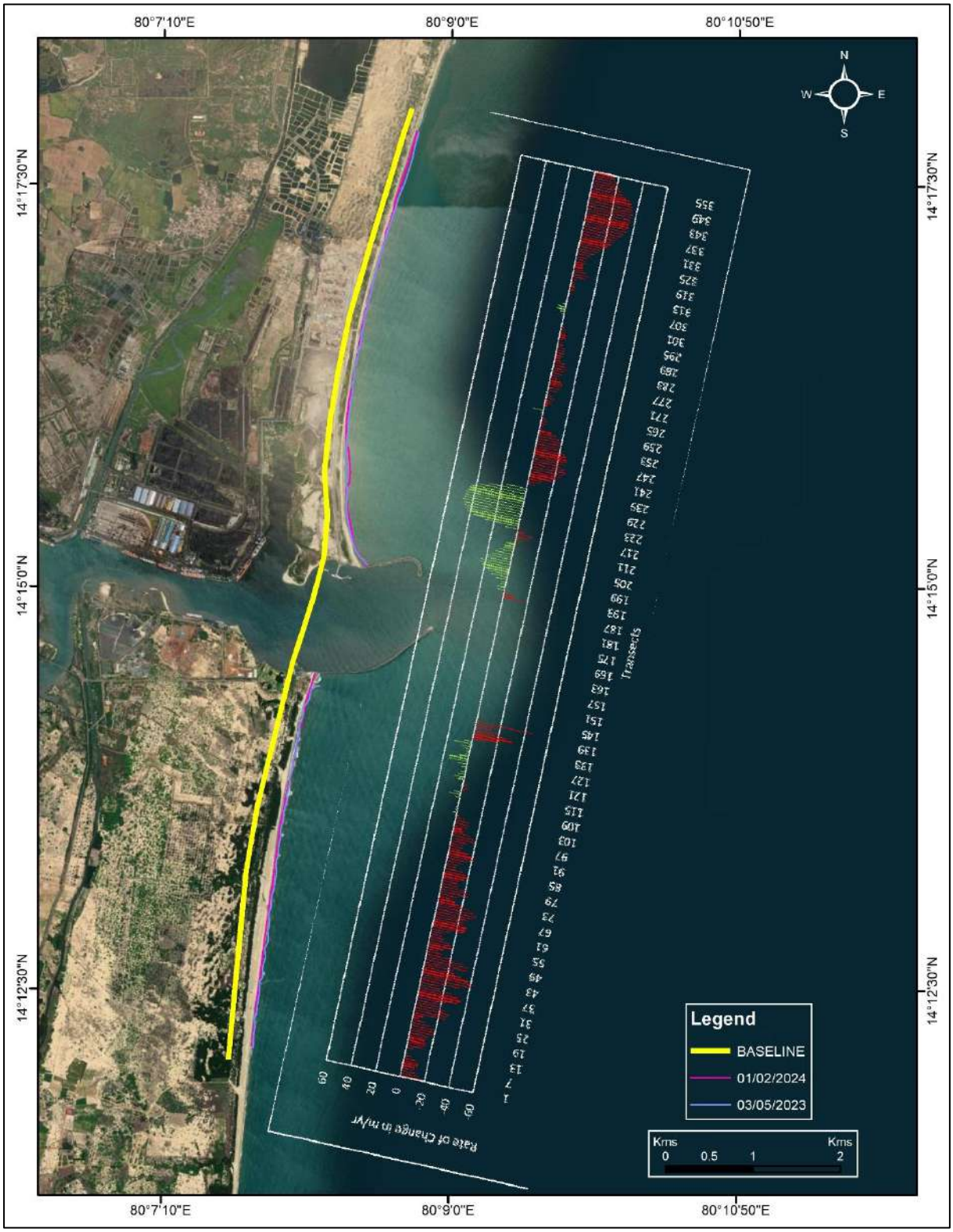

Figure 10 : Shoreline changes along Krishnapatnam coast from 2023-24

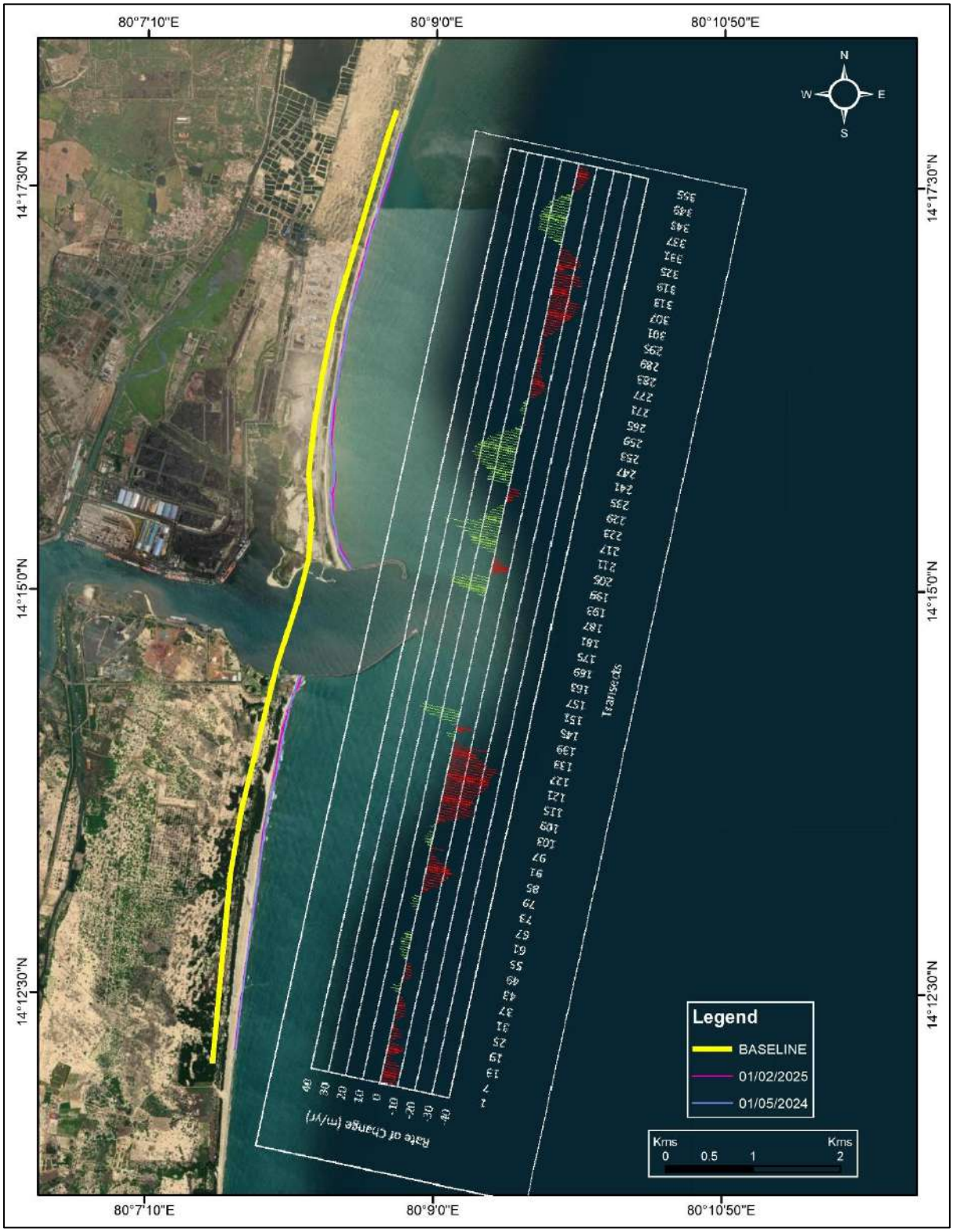

Figure 11 : Shoreline changes along Krishnapatnam coast from 2024-25

The results for analysis carried out from 2024-2025 is shown in Figure 11. The statistics of erosion and accretion from the analysis for this period are summarized in Table 6 .

Table 5: Shoreline change statistics for Krishnapatnam coast from 2023-24

Stretch of coast	End Point Rate (m/yr)		Length of Shoreline (m)		
	Accretion	Erosion	Accretion	Erosion	Total
North	57.62	44.78	1410	3660	5070
South	18.69	38.28	720	3480	4200

Table 6: Shoreline change statistics for Krishnapatnam coast from 2024-25

Stretch of coast	End Point Rate (m/yr)		Length of Shoreline (m)		
	Accretion	Erosion	Accretion	Erosion	Total
North	32.6	17.85	2460	2580	5040
South	23.56	28.54	1320	3030	4350

9. Summary & Conclusion

As part of the study on shoreline changes from satellite imageries for Krishnapatnam coast a stretch of 17.3km has been carried out using s data from 2005 to 2023, which includes pre and post construction of port breakwaters. From the study of pre-construction of breakwaters, it is observed (refer Table 2) that 5.96km of shoreline to the North of Kandaleru Creek has undergone accretion at maximum rate of 8.88m per year and 1.65km has eroded at maximum rate of 8.66m per year. On the Southern side a stretch of 7.58km has undergone accretion at a maximum rate of 35.73m per year and no erosion was observed along this stretch of the coast.

Post-construction of Breakwaters, Northern side of the Port, a stretch of 6.39km of the coast has been subjected to erosion at a maximum rate of 4.09m per year and 1.22km was subjected to accretion at a maximum rate of 1.2m per year. On the southern side of the Port 6.29km of the coast has accreted at a maximum rate of 4.57m per year and 1.29km of the coast has eroded at maximum rate of 5.39m per year.

As part of monitoring of shoreline changes from field measurements, beach profiles were collected five times over a period of twenty-two months from March 2023 to January 2025. During this period sand nourishment of 1,08,698 m^3 was carried out to the North of Northern Breakwater of Krishnapatnam Port in the month of June 2024. Shoreline change analysis from field measurements for 2023-24, it is observed that 1.41km of the Krishnapatnam coast has accreted to the North of Krishnapatnam port Breakwater. Shoreline change analysis for the years 2024-25 indicated accretion of 2.46km to the North of Krishnapatnam Port. This may be due to the sand nourishment carried out on the Northern side of Krishnapatnam Port Breakwater. Sand nourishment has reduced the magnitude and extent of erosion to the North of Krishnapatnam coast.

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ANNEXURE-52

<Track on www.indiapost.gov.in>

<Dial 18002666868> <Wear Masks

CA838561982IN

RP MUTHUKUR S.O <524344>

Counter No:2.11/01/2023.11:02

To:RAMAKRISHNA I.CCF&MEMBER SECRE

PIN:522510, Nagarjuna Nagar S.O

From:ADANI KRISH.MUTHUKURU

Wt:675gms.REG=17.0

Amt:61.36,Tax:9.36,Amt.Paid:61.00(Cash)

o/c 2056

adani
Ports and Logistics

Ref. No. AKPL/EC/ENV/126/2024-25 **Date: 09.01.2025**

To

Ramakrishna, IFS,
CCF & Member Secretary,
AP State Biodiversity Board,
Nagarjuna Nagar, Nagarjuna University, NH-5,
Guntur District, Andhra Pradesh.

Dear Sir,

Sub:- Adani Krishnapatnam Port Limited (AKPL) – Complying with Phase III expansion of EC & CRZ clearance Condition No. VIII under Marine ecology stipulates – Submission of Marine Biodiversity Management Plan- Reg.

Ref:- EC & CRZ Clearance Order No.10-18/2016-IA-III dated 11.01.2021 accorded to AKPL by the Ministry of Environment, Forests & Climate Changes, New Delhi.

@@@

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We submit that Adani Krishnapatnam Port Limited (AKPL) is an operational port located at Krishnapatnam (P), Muthukur (M), SPSR Nellore District.

The Ministry of Environment, Forests & Climate Changes, New Delhi has accorded Environmental & CRZ Clearance to AKPL vide reference cited above for the development of Port under Phase – III (Copy of the EC & CRZ Clearance is attached herewith for your kind reference).

As per the EC & CRZ Condition No. VIII under Marine ecology stipulates that:
"A detailed marine biodiversity management plan shall be prepared through the NIO or any other institute of repute on marine, brackish water and freshwater ecology and biodiversity and submitted to and implemented to the satisfaction of the State Biodiversity Board and the CRZ authority. The report shall be based on a study of the impact of the project activities on the intertidal biotopes, corals and coral communities,

Adani Krishnapatnam Port Ltd
PO Bag No 1, Muthukur Mandal,
SPSR Nellore District 524344
Andhra Pradesh, India
CIN: U45203AP1996PLC023529

Tel +91 861 237 7999
Fax +91 861 237 7046
info@adani.com
www.adaniports.com

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molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds etc. as also the productivity. The data collection and impact assessment shall be as per standards survey methods and include underwater photography."

Complying with the above conditions, a study on Comprehensive Biodiversity Assessment, Impact Assessment and Management Plan was prepared through M/s. Suganthi Devadason Marine Research Institute (SDMRI). As per the MoEF & CC, EC & CRZ Clearance.

We, therefore submit herewith the study report to comply with the EC & CRZ Clearance stipulated condition.

Thanking You,

Yours Faithfully,
For **M/s Adani Krishnapatnam Port Limited,**

(Authorized Signatory)

Encl: a/a

Cc:
Environment Engineer,
A.P Pollution control Board,
Regional Office, SPSR Nellore.
Andhra Pradesh.

Adani Krishnapatnam Port Ltd
PO Bag No 1, Muthukur Mandal,
SPSR Nellore District 524344
Andhra Pradesh, India
CIN: U45203AP1996PLC023529

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www.adaniports.com

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Track Consignment

Quick help

* Indicates a required field.

* Consignment Number

CA838561982IN

Track More

Booked At	Booked On	Destination Pincode	Tariff	Article Type	Delivery Location	Delivery Confirmed On
Muthukur S.O	11/01/2025 11:02:11	522508	61.36	Registered Parcel	Nagarjuna Nagar S.O	15/01/2025 14:39:14

Event Details For : CA838561982IN

Current Status : Item Delivered(Addressee)

Date	Time	Office	Event
15/01/2025	14:39:14	Rain Tree Park B.O	Item Delivered(Addressee)
15/01/2025	09:52:18	Namburu S.O	Item Dispatched
15/01/2025	09:52:18	Namburu S.O	Dispatched to BO
15/01/2025	09:52:18	Namburu S.O	Item Bagged
15/01/2025	09:27:53	Namburu S.O	Item Received
14/01/2025	07:38:49	Guntur RS TMO	Item Dispatched
14/01/2025	06:45:03	Guntur RS TMO	Item Received
14/01/2025	06:33:30	Guntur PH	Item Dispatched
14/01/2025	02:41:25	Guntur PH	Item Bagged
14/01/2025	00:30:22	Guntur PH	Item Received
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13/01/2025	14:48:01	Nagarjuna Nagar S.O	Item Bagged
13/01/2025	11:58:05	Nagarjuna Nagar S.O	Item Redirected to Namburu S.O Insufficient Address
13/01/2025	10:41:10	Nagarjuna Nagar S.O	Item Received
13/01/2025	06:08:04	Guntur RS TMO	Item Dispatched
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13/01/2025	04:01:46	Guntur PH	Item Bagged
12/01/2025	22:46:57	Guntur PH	Item Received
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11/01/2025	11:02:11	Muthukur S.O	Item Booked

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Content owned and updated by Department of Posts, Ministry of Communications, Government of India. Last Updated: **19 Jan 2025**

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ANNEXURE-53

Outlook

Comprehensive Bio diversity study Report of Adani Krishnapatnam Port Limited

From Bolla Srinu <Bolla.Srinu@adani.com>
Date Tue 1/21/2025 5:10 PM
To apsbiodiversityboard@gmail.com <apsbiodiversityboard@gmail.com>
Cc Kaushal Singh <Kaushal.Singh@adani.com>; AKPL ENV <akpl.env@adani.com>; Rambabu Karri <Rambabu.Karri@adani.com>; Vinay Sai Gottapu <VinaySai.Gottapu@adani.com>

4 attachments (14 MB)

Track Consignment SDMRI - AP Biodiversity Board.pdf; AKPL Environmental Impact and Management Plan - Final report_16.12.2024.pdf; SDMRI RO Nellore - ACKNW..pdf; 6 MoEF&CC-EC & CRZ- 11.01.2021-Phase III.PDF;

Dear Sir,

With reference to the above subject, we wish to inform you good selves that we have received EC & CRZ Clearance Order No.10-18/2016-IA-III dated 11.01.2021 for Phase - III by the Ministry of Environment, Forests & Climate Changes, New Delhi.

As per the EC & CRZ Condition No. VIII (EC Copy attached) under Marine ecology stipulates that:
"A detailed marine biodiversity management plan shall be prepared through the NIO or any other institute of repute on marine, brackish water and freshwater ecology and biodiversity and submitted to and implemented to the satisfaction of the State Biodiversity Board and the CRZ authority. The report shall be based on a study of the impact of the project activities on the intertidal biotopes, corals and coral communities, molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds etc. as also the productivity. The data collection and impact assessment shall be as per standards survey methods and include underwater photography."

Complying with the above conditions, a study on Comprehensive Biodiversity Assessment, Impact Assessment and Management Plan was prepared through M/s. Suganthi Devadason Marine Research Institute (SDMRI) as per the MoEF & CC, EC & CRZ Clearance.

We, therefore herewith submitting the study report to comply with the EC & CRZ Clearance stipulated condition, hard copy of the same send to your good office through registered post with consignment No. CA838561982IN on 11/01/2025 and the same received at your end on 15/01/2025 (Consignment and tracking details attached for kind reference).

Acknowledgement copy of Report submitted to APPCB, RO, Nellore attached for your reference please.

Kindly acknowledge the receipt of this mail.

Thanks & Regards,

Bolla. Srinu,
Manager – Environment,
Adani Krishnapatnam Port Limited (AKPL)
Mobile: +91 9121398072
Email:bolla.srinu@adani.com

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Comprehensive Biodiversity Assessment, Impact Assessment and Management Plan for the Marine, Brackish-water and Freshwater Ecosystems in and around Adani Krishnapatnam Port, Nellore District, Andhra Pradesh

Final Report

Submitted to

Adani Krishnapatnam Port Limited
Krishnapatnam,
Nellore District, Andhra Pradesh

By

By

Suganthi Devadason Marine Research Institute (SDMRI)
(Recognized by Manonmaniam Sundaranar University and U.G.C. &
Recognized Scientific and Industrial Research Organization by the DSIR, GOI)
44 - Beach Road, Tuticorin - 628 001, Tamil Nadu
Tel: 0461 - 2336488, 2323007; Email: director@sdmri.in
Web: http://www.sdmri.in

16.12.2024

PART - I:

Comprehensive Assessment on the Biodiversity of Marine and Brackish Water Ecosystems

i. Comprehensive Assessment

The present comprehensive biodiversity assessment, impact assessment and management plan for the marine, brackish-water and freshwater ecosystems in and around Adani Krishnapatnam Port, Nellore District, Andhra Pradesh was carried out with data and earlier report provided by Adani Krishnapatnam Port Limited (AKPL), Krishnapatnam. For the preparation of a comprehensive assessment on the biodiversity of marine and brackish water ecosystems, regular monitoring data of AKPL for the period of October 2022 to September 2023 was used. Similarly, for the preparation of Impact Assessment and Management Plan, in addition to the monitoring data, data available from the earlier report received from AKPL was used.

List of data and reports received and used for the preparation of Comprehensive Assessment and Management Plan

S No	Data/Report	Agencies	Period
1.	Regular monitoring data of air quality, noise level, water and sediment quality	SV Enviro Labs & Consultants, Yanam	September 2022 to October 2023
2.	Environmental Monitoring of Phase II Development of Adani Krishnapatnam Port First Half-yearly Report	National Centre for Sustainable Coastal Management, Chennai.	May 2022
3.	Environmental Monitoring of Phase II Development of Adani Krishnapatnam Port Second Half-yearly Report	National Centre for Sustainable Coastal Management, Chennai.	February 2023
4.	Assessment of Terrestrial Greenbelt and Mangrove plantation and their carbon stocking potential in Adani Krishnapatnam Port Limited (AKPL), Muthukur-Nellore, Andhra Pradesh	Blue Bay Coastal Research Foundation, Kanchipuram – Chennai	March 2023
5.	Environmental Impact Assessment Report for the Phase – III Expansion of Krishnapatnam Port at Muthukar Mandal, SPSR Nellore Dist., Andhra Pradesh	Cholamandalam MS Risk Services Limited, Chennai	November 2020

ii. Executive Summary

Adani Krishnapatnam Port is located at Krishnapatnam in Muthukur Mandal Nellore District, Andhra Pradesh on the East Coast of India. The port has been operating since March, 2009. The port is well equipped with maritime facilities like berths for handling container and non-container cargo including coal cargo and liquid cargo. The port is well connected with road and railway network. The port lies at the mouth of Kandaleru River, which is one of the major rivers of Andhra Pradesh though non-perennial. The coastal region is endowed with mangrove swamps, aqua ponds, floodplains, coastal dune, sandy beach, and water bodies.

This comprehensive assessment report on the biodiversity of marine and brackish water ecosystems was prepared with the regular monitoring data provided by AKPL and the data was collected by SV Enviro Labs & Consultants. Environmental parameters such as ambient air quality, ambient noise, marine waters of regions including port, creek and deep water, marine sediment, microbial parameters, planktons and benthos were monitored regularly during the regular operation, in order to evaluate the impact of day-to-day port operation on the environment. Standard protocols were followed for the collection and analysis of samples and the results were compared with the standards.

Ambient air quality was monitored through a network of 7 stations. Ambient noise level was monitored at 7 locations. Marine water quality was monitored in 4 stations in the port region, 2 stations in creek waters and 3 stations in deep seawaters. Marine sediment quality was monitored in 4 locations inside the port region. Monitoring was carried out from October 2022 to September 2023. Similarly carbon stock potential in the green belt and mangroves inside the port region were studied during May 2022. Mangrove and other flora and fauna in the creek and coastal region were studied during September to October 2022. In order to assess the impact of regular operations and the various activities of port, a comprehensive Environmental Impact Assessment was prepared by using the regular monitoring data and earlier studies.

The recorded ambient air quality parameters such as PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3, and CO were found to be within limits prescribed by National Ambient Air Quality Standard (NAAQS), whereas NH_3, Pb, C_6H_6, BaP and Ni were below detectable limit throughout the monitoring period. No significant impact on the air quality was observed from the regular emission of exhaust from vehicles, vessels, small boats, tugs, dredgers and DG sets.

The ambient noise levels were monitored as per Central Pollution Control Board (CPCB) guidelines and found to be well within the limits. So no significant impact by the noise level was observed from the regular noise generated by vessels movement, cargo handling, truck traffic, DG sets and dredging activities.

For the marine water in port region and surface water of the creek, the values of quality parameters namely pH, salinity, density, potassium, COD, BOD, oil & grease, dissolved oxygen, nitrate, nitrite, ammonia, phosphate, chloride, sodium, sulphate, silicates, reactive

silica, total phosphorus, total nitrogen, lead, cadmium, copper and zinc are in detectable range. Total phytoplankton, chlorophyll, primary productivity, biomass, zooplanktons are in detectable range. Microbiological parameters such as coliforms are present, whereas fecal coliforms are not detected. Water quality parameters are below the permissible limit of Primary Water Quality Criteria for Class SW-IV Water (For Harbour Waters) published by CPCB in Designated. Absence of pathogenic bacterial communities indicates that the environment is not polluted. The values of turbidity, TDS, and TSS in the marine waters of port region and deep sea region are also within the range.

The marine sediment composition is dominated by silt and clay fractions. The pH levels and the concentrations of organic matter, nitrogen, phosphorus, potassium, sodium, lead, cadmium, copper and zinc were within the limits during the assessment period. The significant amounts of phytoplankton and zooplankton present in the marine environment indicate that the prevailing marine water and sediment qualities are good and the regular port operation and aqueous discharges did not cause any significant impact on the quality of marine waters in the port, creek and deep sea region during the study period. Similarly, the presence of considerable amount of benthic communities during the entire assessment period clearly indicates the healthy nature of the environment.

The significant amounts of phytoplankton and zooplankton present in the marine environment indicate that the prevailing marine water and sediment qualities are good and the regular port operation and aqueous discharges did not cause any significant impact on the quality of marine waters inside, outside port region and in the creek waters during the study period. Similarly, the presence of considerable amount of benthic communities during the entire assessment period clearly indicates the healthy nature of the environment.

The presence of plankton and benthos would support other faunal communities in the study area. The port area is surrounded by mangrove swamp, aqua ponds, flood plains, coastal dunes, sandy beach and water bodies. These ecosystems also support the local fishermen during rough climate seasons. The operation of Adani Krishanapatnam Port did not have any impact on these ecosystems.

Hence, operation of Adani Krishnapatnam Port does not have any significant impact on the ambient air, ambient noise, quality of marine water and sediment, microbial parameters, phytoplankton, zooplankton, benthos, fishes, avifauna and other flora during the study period. Hence the operation of Adani Krishnapatnam Port can be done without disturbing the environment.

iii. Key findings and remarks

S No	Parameters	Key findings	Remarks
1	Ambient air quality	All the tested parameters are within the prescribed limits	No significant impact to the environment
2	Ambient noise levels	All the noise levels are within the prescribed limits	No significant impact to the environment
3	Marine water quality	The levels of pH, DO, BOD, TSS, Turbidity, availability of nutrients, heavy metals and other parameters in the marine water are within the prescribed limits for the study region	It indicates the healthy nature of the environment
4	Marine sediment quality	The levels of organic matter, pH, nitrogen, phosphorus, potassium, sodium and heavy metals in the marine sediments are within the normal range for the study region	It indicates that the environment is not polluted.
5	Microbial communities	The coliform in the marine water ranges from 10.5 x 33.75 CFU/100ml, which is within the prescribed limit; and fecal coliform is absent	Normal microbial population supports ecological functions
6	Planktons	The phytoplankton abundance ranges from 2.01 to 301 nos./ml The zooplankton biomass ranges from 9.48 to 13.95 ml/100m^3	Considerable amounts of phytoplankton and zooplankton in the marine environment indicate that the prevailing marine water and sediment qualities are good
7	Marine benthos	The benthos population ranges between 1121.5 and 1177.75 nos./m^2.	Constant supply of nutrients supports the consistent presence of marine benthos in the environment and it indicates that the

			environment is free from pollution
8.	Other ecological sensitive fauna and flora	Well grown planted green belt are seen inside the port region. Well grown mangrove are seen in the river, creek and inside the port area, which supports planktons, benthos, fishes and avifauna.	The healthier nature of the nearby ecosystems and avifauna clearly indicate that the operation of Adani Krishnapatnam Port does not have any environmental impact.

The results of the regular monitoring of environmental parameters indicate that the day-to-day operations of Adani Krishnapatnam Port do not have any significant impact on the environmental parameters such as ambient air, ambient noise, marine waters of port, creek and deep sea region, marine sediment quality, microbial communities, planktons, benthic, fishes and avifauna populations during the study period.

Chapter 1
Introduction

1.1. Introduction

Adani Krishnapatnam Port is located at Krishnapatnam in Muthukur Mandal, "Sri Potti Sriramulu" Nellore District, Andhra Pradesh on the East Coast of India at Latitude 14°15'10" N and Longitude 80°08'05" E on the north bank of Kandaleru (Upputeru). Krishnapatnam Port is situated at about 180 km north of Chennai (Madras) Port. The port is an all-weather, deep-water, multi-purpose port.

The Environmental Clearance (EC) was accorded for the Phase – I development of this Port by the MoEF, GoI vide Letter No. 10-22/2005-IA-III dated: 26th July, 2006 and the CFE was accorded by the APPCB vide Order No. APPCB/VJA/NLR/ 633/HO/2004/9 – 467 dated 25.05.2004. The Phase - I facility was commissioned during the year 2009.

For the Phase II development of this Port, the Environmental Clearance was accorded by the MoEF, GoI vide F. No. 11 – 62 / 2009 – IA.III dated 13th November, 2009 and MoEF & CC extended vide Order even No. dated 18.08.2015 & 16.04.2018 and amended by MoEF & CC vide order dated 16.3.2016. The CFE was accorded by the APPCB vide Order No. 633/PCB/CFE/RO- NLR/HO/2010-390 dated 08.05.2010 is extended vide APPCB Order dated 02.07.2015 and amended vide APPCB's Orders dated 14.03.2014, 02.07.2015, 10.02.2016, 04.01.2017& 22.02.2018.

The CFO was accorded by the APPCB vide Order No. APPCB/VSP/VJA/ NLR/633/CFO/HO/2009-582 dated 08.06.2009 and same is being periodically renewed. The APPCB was accorded latest CFO renewal Order, vide APPCB's Order No. APPCB/VJA/NLR/11344/CFO/HO/2018 dated 29.07.2018 & 30.08.2018 which is valid till 31st October, 2023. Further, it is amended for additional one berth and increased coal cargo capacity from 46.5 MTPA to 51 MTPA. As of now, 12 berths (3 berth in Phase-I and 9 berths in Phase-II) are operational with necessary infrastructure with capacity to handle 68 MTPA of non-container cargo and 2.0 MTEUsPA of container cargo are commissioned and being operated.

Adani Ports and Special Economic Zone (APSEZ) are part of globally diversified Adani Group, the largest port developer and operator in India. APSEZ acquired KPCL from CVR Group and other investors and changed to Adani Krishnapatnam Port Limited (AKPL).

MoEF & CC granted Environment & CRZ clearance for the "Expansion of Krishnapatnam Port (Phase-III)" vide File No: 1018/2016-IA.III dated 11.01.2021, the project comprising of 16 berths including 3 jetties for liquid cargo and 3 SBMs in deep waters to cater 150.2 MTPA of various types of cargo and 1.1 MTEUsPA of container cargo with dredging of 60 Million cum. AKPL obtained CFE vide order No. 633/APPCB/CFE/RO-NLR/HO/2010 dated 25.02.2021.

The Environmental Management Plan (EMP) envisaged in the Environmental Impact Assessment (EIA) Report is being scrupulously implemented and augmented as needed. Monitoring of Environmental parameters viz., Ambient Air, Ambient Noise, Water Quality (Ground, Surface & Marine), Marine Ecology and Soil as envisaged is being undertaken regularly through an agency having NABL accreditation and approved by MoEF & CC. The results of monitoring comply with the statutory standards. Periodical Reports with results of monitoring thereof are being regularly submitted to the APPCB and the MoEF & CC, RO as stipulated in the EC/CFE/CFO accorded.

1.2. Project Location

Adani Krishnapatnam Port is located in the creek of Kandaleru River in Nellore district of Andhra Pradesh (Fig. 1.1 Fig. 1.2). The Kandaleru River is one of the major rivers of Andhra Pradesh though non-perennial. The port is an all-weather, deep-water, multi-purpose port. The coastal region is endowed with mangrove swamps, aqua ponds, floodplains, coastal dunes, sandy beach, water bodies such as creek, canals, streams and tanks (Rajakumari et al., 2021). Mangroves and hypersaline plants are seen in the intertidal region all along the banks of the river. This environment sustains unique intertidal fauna and flora, which supports the livelihood of the local fishing communities. The Adani Krishnapatnam Port has good network of roads and railways.

Fig. 1.1: Map showing the Adani Krishnapatnam Port

Fig. 1.2. Photograph showing the Adani Krishnapatnam Port

1.3. EIA studies

The regular day-to-day operations of Adani Krishnapatnam Port involve handling cargoes such as containers and non-container cargo including coal cargo and liquid cargo. In addition to this handling of cargoes, other factors such as vessel movement, land runoff, vehicle emission, tug boat emission, DG set operation, maintenance dredging activities, etc might affect the surrounding marine environment. Hence the various environmental parameters have to be regularly monitored to assess if there is any environmental impact caused by the regular day-to-day port operation.

The objective of the EIA study is

a) To assess the existing status of air, noise, physico-chemical and biological characteristics of the prevailing marine/backwater environment during the regular operation of Adani Krishnapatnam Port for different time periods.
b) To study the biodiversity potential of the project site.

1.4. Methodology adopted for EIA studies

- Use of the data of environmental parameters analysed during regular monitoring program for the current Environmental Impact assessment studies.
- Identification of impact on the environment due to various Port operation activities.

Chapter 2
Scope and Methodology

2.1. Scope

The scope of this Environmental Impact Assessment study is to evaluate the impact of port operation on the following environmental components during 2022 and 2023. Sampling was done from October 2022 to September 2023. The monitoring parameters include Ambient Air quality, Noise level intensity, Marine waters of port region, creek region & deep sea region and Marine sediment of port region. The parameters covered under the scope for each of the above attributes are given below.

S.No	Attribute	Parameters	Frequency
1.	**Ambient Air Quality**	• PM_{10} • $PM_{2.5}$ • SO_2 • NO_2 • NH_3 • O_3 • Pb • CO • C6H6 • BaP • As • Ni	Once a month for 24 hours at each location
2.	**Noise Level Monitoring**	• Day Leq in dB(A) • Night Leq in dB(A)	One to two days for every month at each location
3.	**Marine Water**	• pH • Temperature • Salinity • Density • Turbidity • Total Dissolved solids • Total Suspended solids • Potassium • COD • BOD • Oil & Grease • D.O • Nitrates • Nitrites • Ammonia • Phosphates • Chlorides • Sodium	Weekly Once at each location

		• Sulphates • Silicates • Reactive Silica • Total Phosphorus • Total Nitrogen • Primary Productivity • Chlorophyll • Phytoplankton • Zooplankton • (Heavy Metals, such as lead, cadmium, copper and zinc) • Coliforms • Fecal coliforms	
4.	**Marine Sediment**	• Sediment Compositions • pH • Nitrogen • Phosphorus • Potassium • Sodium • Benthos Communities • (Heavy Metals such as lead, cadmium, copper & zinc)	Weekly Once at each location

2.2. Methodology

Methodologies adopted for sampling and analysis for each of the above parameters are detailed below.

S No	Attributes	Measurement Technique		
1.	**Ambient Air Quality**	PM_{10}	Respirable Dust Sampler (Gravimetric method)	IS-5182 (Part- XXIII)
		$PM_{2.5}$	Fine Particulate Sampler (Gravimetric method)	IS-5182 (Part- XXIV)
		Sulphur dioxide	Modified West and Gaeke	IS-5182 (Part-II)
		Oxides of Nitrogen	Jacob & Hochheiser	IS-5182 (Part-VI)
		NH_3	Indophenol Blue Method	-
		Ozone (O_3), Lead (Pb), Carbon Monoxide – CO, Benzene (C_6H_6), Benzo (a) pyrene (BaP),	CPCB Guidelines	IS-5182 (Part – IX, X, XI, XII, XXII, XXVI)

		Arsenic (As) & Nickel (Ni)		
2.	**Ambient Noise Level**	Digital Noise Level Meter – SL Lutron 4001 (IS:4954-1968)		
3.	**Marine Water**	APHA Methods 23rd Edition, 2017		
4.	**Marine Sediment**	ASTM Method		

2.3. Data collection and sampling locations

Data were collected at different locations for the above parameters as described below.

2.3.1. Ambient Air quality

The ambient air quality was assessed through a network of 7 stations within 10 km radius of project site (4 stations at nearby villages & 3 stations inside plant area). The data were collected for 24 hour once in a month from October 2022 to September 2023 (Table 2.1).

Table 2.1: Details of Ambient air quality monitoring locations

Location	Direction w.r.t Project site	Environmental setting
At Zero Point	W	Industrial
At Thamminapatnam Village	S	Industrial
At CVR Building	WNW	Industrial
At Gopalpuram Village	NW	Residential
At Chalivendram	WNW	Residential
At Krishnapatnam	NNW	Residential
At Light House Colony (near Krishnapatnam village)	SW	Residential

2.3.2. Ambient Noise Level

Collection of ambient noise levels at seven locations (4 locations at nearby villages & 3 locations near plant; Table 2.2). Spot noise levels were measured with a pre-calibrated Noise Level Meter – SL Lutron 4001 for day and night periods. The data were collected from October 2022 to September 2023 (Table 2.1).

Table 2.2: Details of Ambient noise level monitoring locations

Location	Direction w.r.t Project site	Environmental setting
At Zero Point	W	Industrial
At Thamminapatnam Village	S	Industrial
At CVR Building	WNW	Industrial
At Gopalpuram Village	NW	Residential
At Chalivendram	WNW	Residential
At Krishnapatnam	NNW	Residential
At Light House Colony (near Krishnapatnam village)	SW	Residential

2.3.3. Marine and brackish water quality

Marine water sampling was carried out once in every week at 4 sampling locations in the port region (Table 2.3). In addition to the marine water quality sampling, brackish water sampling was also carried out at 2 locations in the creek once (surface water) in every month. The marine water and surface water sampling locations are given below. Samples were collected and preserved as per the Standard Operation Procedures (SOP). For the present EIA study, monthly mean value for each location was considered.

Table 2.3: Details of marine and surface water monitoring locations

Location	Sample type	Sampling frequency
Port Entrance (Approach Channel)	Marine water sample (Port)	Weekly once
Turning Circle		
Coal Berth		
Reclamation Area (Mutable)		
Buckingham Canal	Surface water sample (brackish water)	Monthly once
Kandaleru Creek		

Similarly, sampling for turbidity, total dissolved solids and total suspended solids were carried out once in a week at each of the four locations of Marine water sampling in the Port region and three samplings were done in the deep sea region, where dredged material

are disposed. Deep sea sampling was done once in a month. Similarly, monthly mean value for each location was considered for the present EIA study.

Table 2.4: Details of marine water quality for turbidity monitoring locations

Location	Sample type	Sampling frequency
Coal Berth	Marine water sample	Weekly once
Turning Circle		
Approach Channel		
Reclamation Area (Mutable)		
14^{O}19'26"N; 80^{O}15'43"E (DS-1)	Deep sea sample	Monthly once
14 ^{O}16'52"N ; 80^{O}17'40"E (DS-2)		
14^{O}16'11"N; 80^{O}17'40"E (DS-3		

2.3.4. Marine Sediment quality

The marine sediment sampling was carried out once in every week at four locations in the port region listed below (Table 2.5). Samples are collected using Van Veen Grab sampler for physical, chemical, heavy mineral and biological parameters. Samples were collected for the period of October 2022 to September 2023. For the present EIA study, monthly mean value for each location was considered.

Table 2.5: Details of sediment sampling monitoring locations

Location	Sample type	Sampling frequency
Port Entrance (Approach Channel)	Marine sediment sample (Port)	Weekly once
Turning Circle		
Coal Berth		
Reclamation Area (Mutable)		
Kandaleru Creek		

2.3.5. Other ecological flora and fauna assessment

Apart from the regular monitoring parameters, the other ecological sensitive flora and fauna studies were conducted earlier, which includes the following parameters

2.3.5.1. Coastal and marine flora and fauna assessment

The coastal and marine flora and fauna were assessed with systematic rapid field survey.

2.3.5.2. Assessment of terrestrial greenbelt and mangrove plantation for carbon stock

Vegetative structures of the mangrove plantation was estimated using quadrates method. Herpetofauna status was assessed using Intensive Time Constrained Search method, while bird status was assessed using Point Centre count. Mammal species were quantified using direct count methods and indirect evidence were used for avain, reptilian fauna. Carbon sequestration potential was estimated by calculating the tree biomass.

2.4. Comparison of environmental parameters with Standards

Ambient air qualities of assessment data were compared with revised National Ambient Air Quality Standard (NAAQS), and CPCB guidelines (Appendix). Ambient noise levels of assessment data were compared with Central Pollution Control Board (CPCB) guidelines (Appendix). The marine water quality parameters were compared with Primary Water Quality Criteria for Class SW-IV Waters (For Harbour Waters) published by CPCB in Designated Best Use Classification for Coastal Waters (Appendix).

Chapter 3
Monitoring of Environmental Parameters

3.1. General

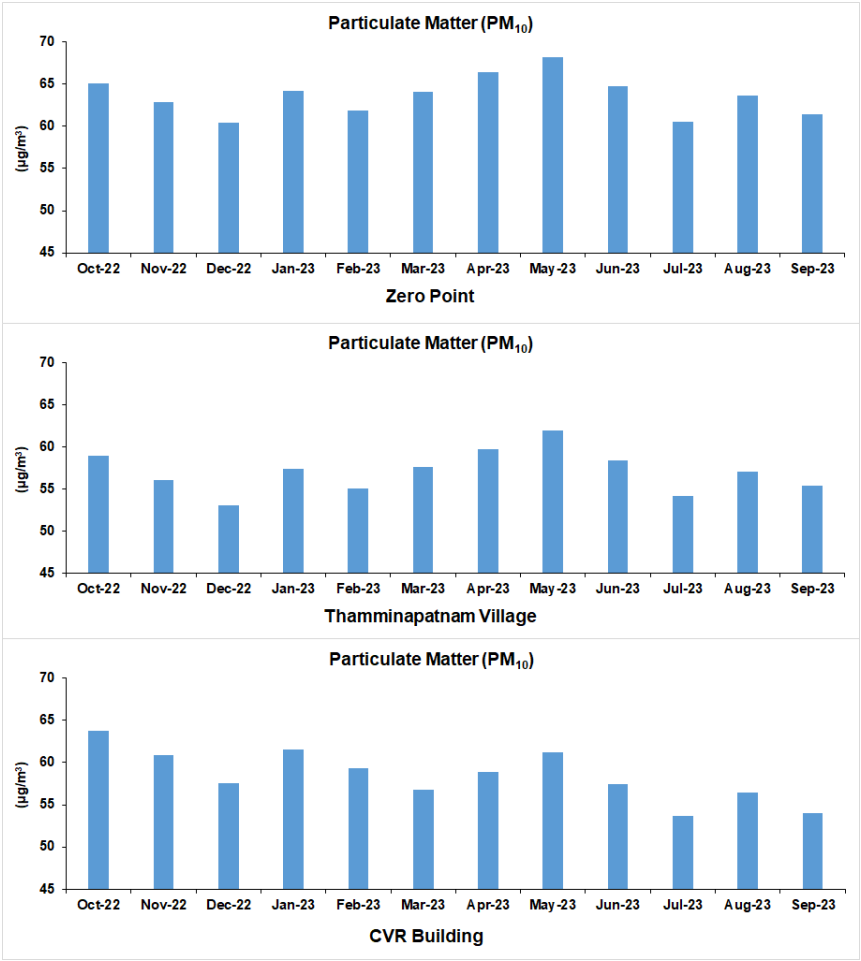
The existing environmental conditions in the Adani Krishnapatnam Port area were established based on the data collected from regular monitoring studies. All the data collected were consolidated for the respective months for each site.

3.2. Ambient Air Quality

Evaluation of the air quality of the study area during the operation phase reveals the following air quality data:

3.2.1. Ambient PM_{10}

The ambient PM_{10} concentration varied from 60.4 µg/m³ to 68.2 µg/m³, 53.0 µg/m³ to 61.9 µg/m³, from 53.7 µg/m³ to 63.8 µg/m³, from 49.6 µg/m³ to 60.4 µg/m³, from 47.9 µg/m³ to 57.6 µg/m³, from 47.2 µg/m³ to 58.3 µg/m³ for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Zero point and the lowest was recorded during December 2022 at Lighthouse colony in Krishnapatnam village (Fig. 3.1).



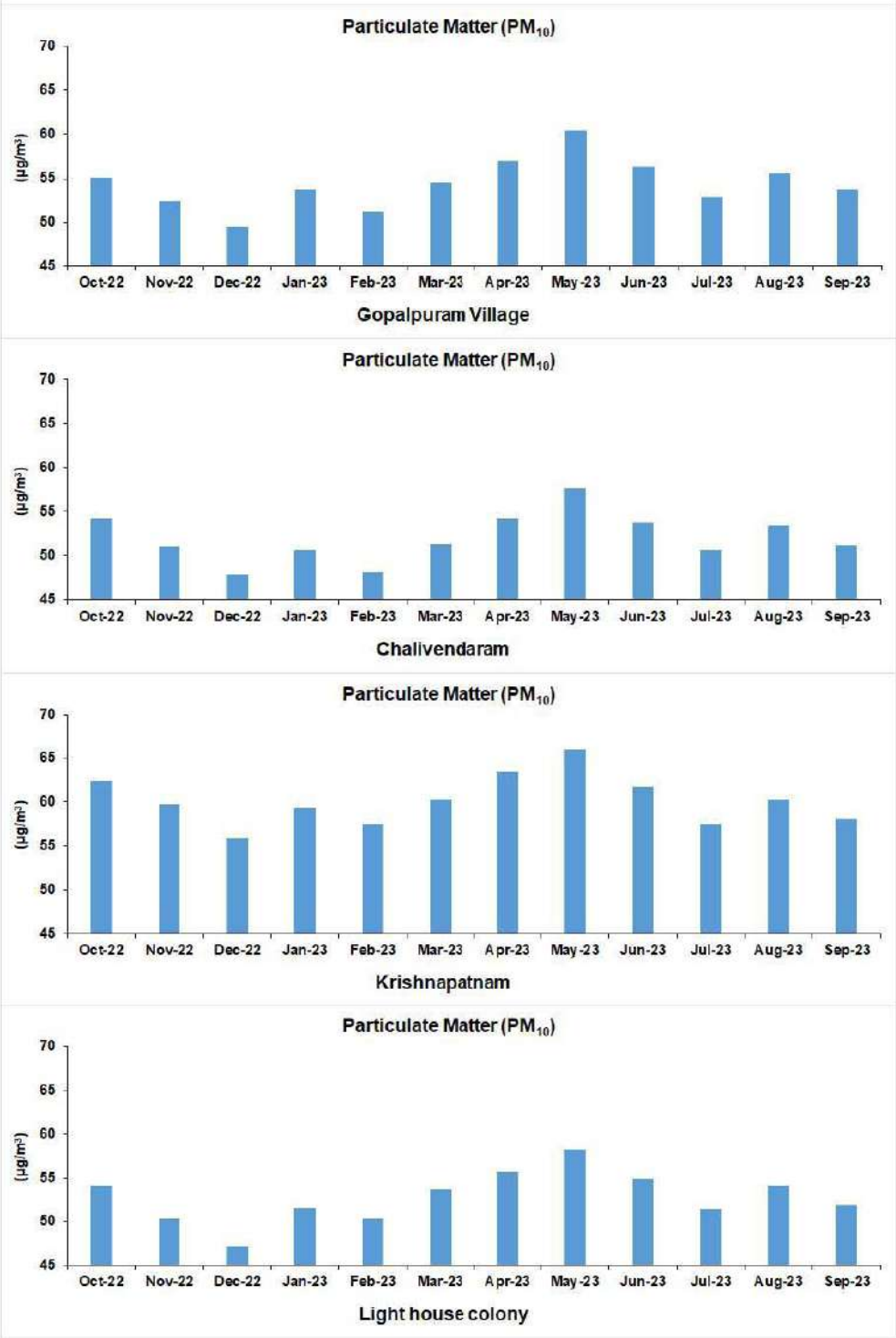
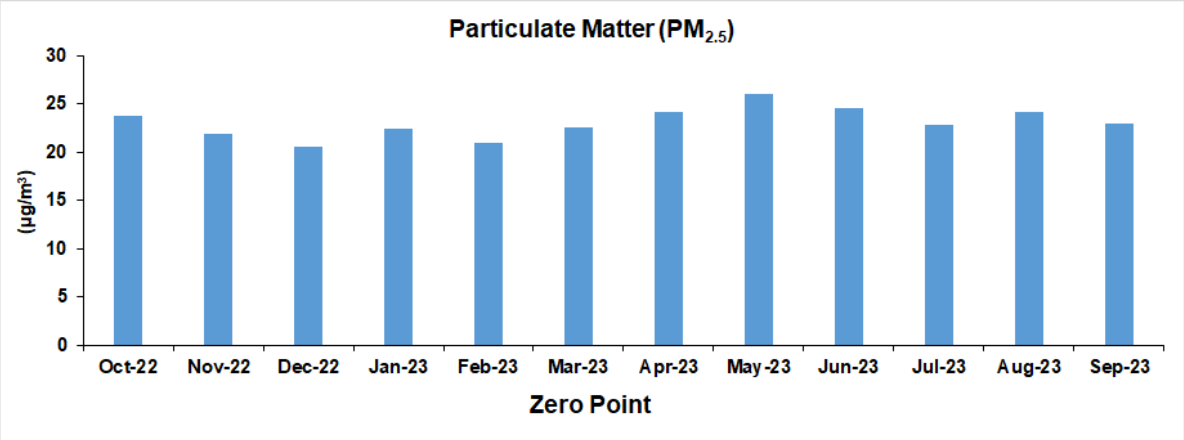
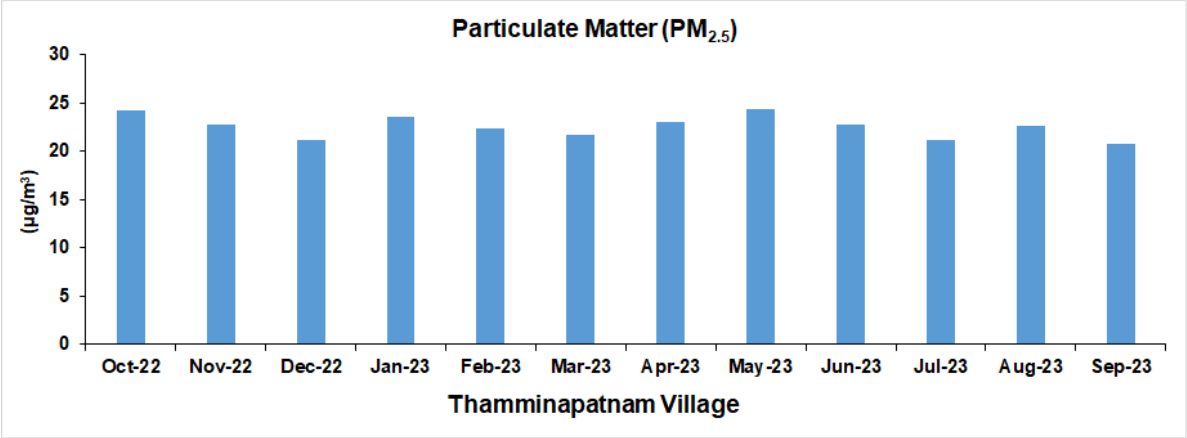


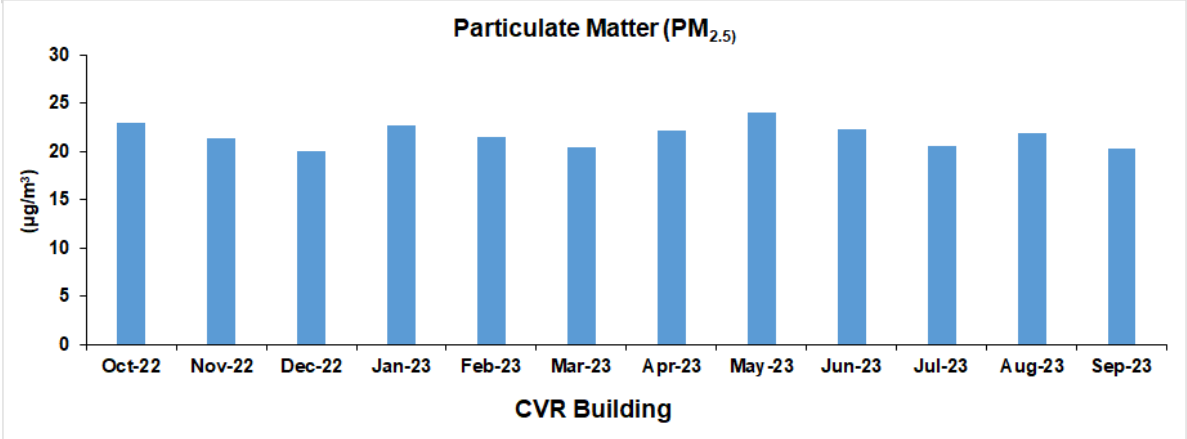
Fig. 3.1: Plot showing the temporal pattern of ambient PM_{10} during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.2.2. Ambient $PM_{2.5}$

The ambient $PM_{2.5}$ concentration varied from 20.6 µg/m³ to 26 µg/m³, 20.8 µg/m³ to 24.3 µg/m³, from 20 µg/m³ to 24 µg/m³, from 18.7 µg/m³ to 25.1 µg/m³, from 17 µg/m³ to 22.3 µg/m³, from 20.6 µg/m³ to 25.6 µg/m³ and from 21.5 µg/m³ 26.7 µg/m³ for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Krishnapatnam village and the lowest was recorded during December 2022 at Chalivendaram (Fig. 3.2).







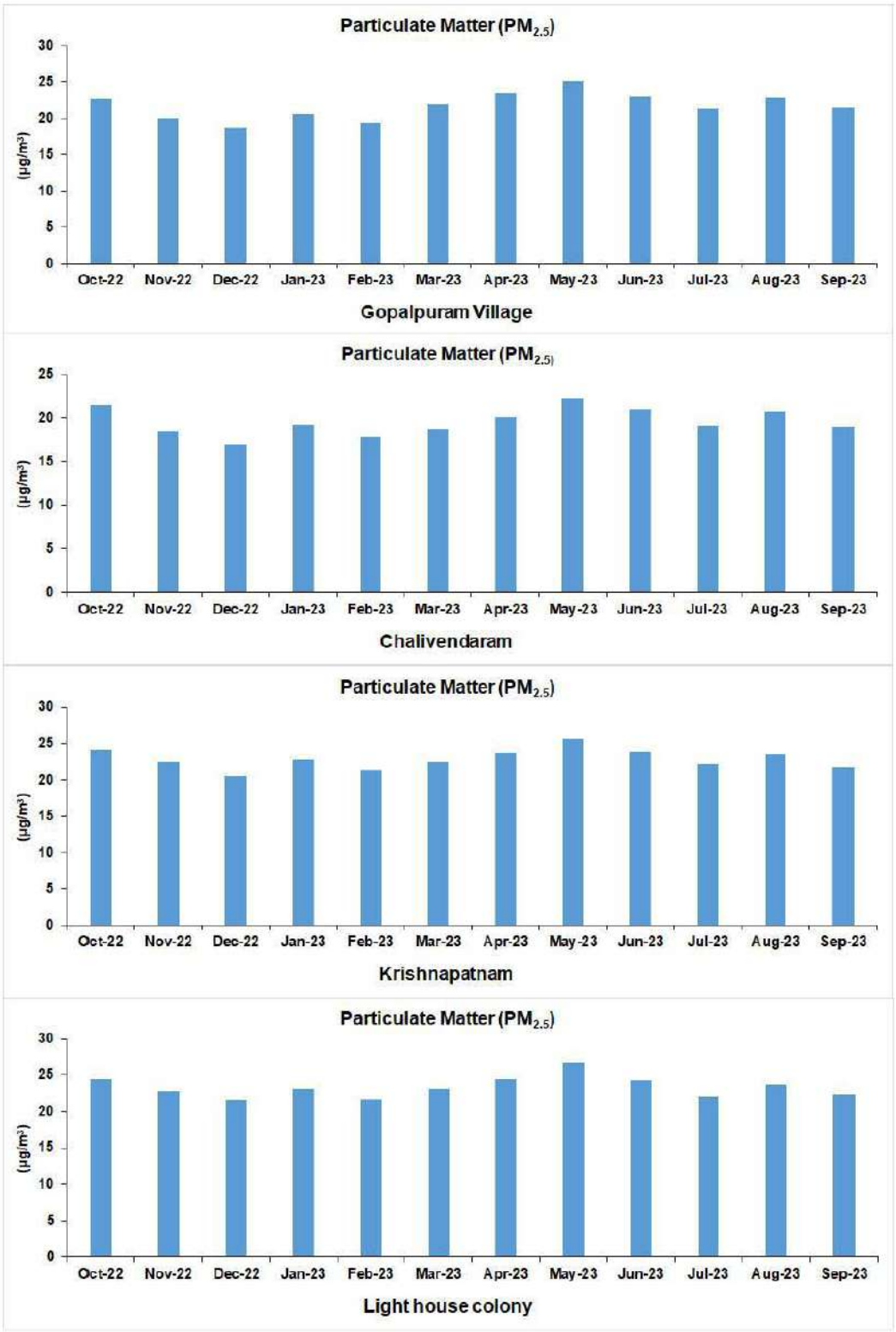
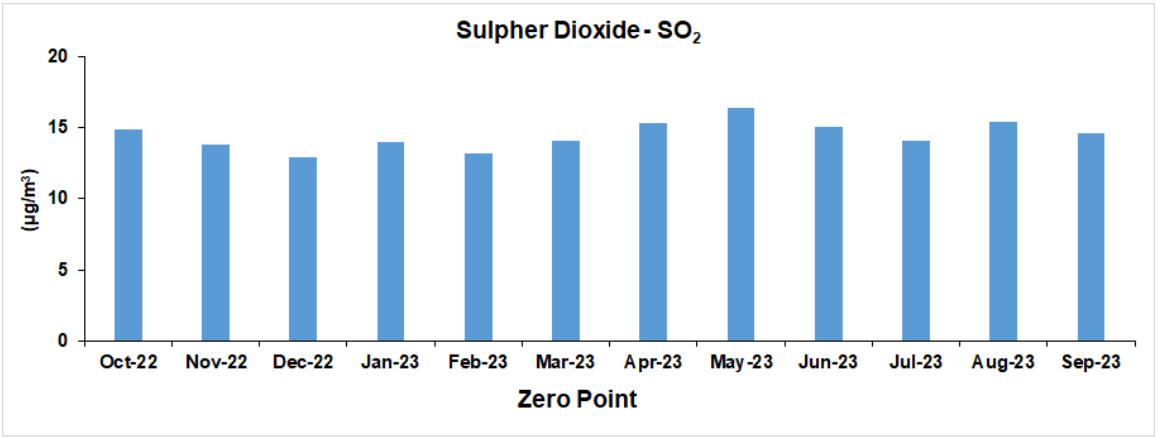
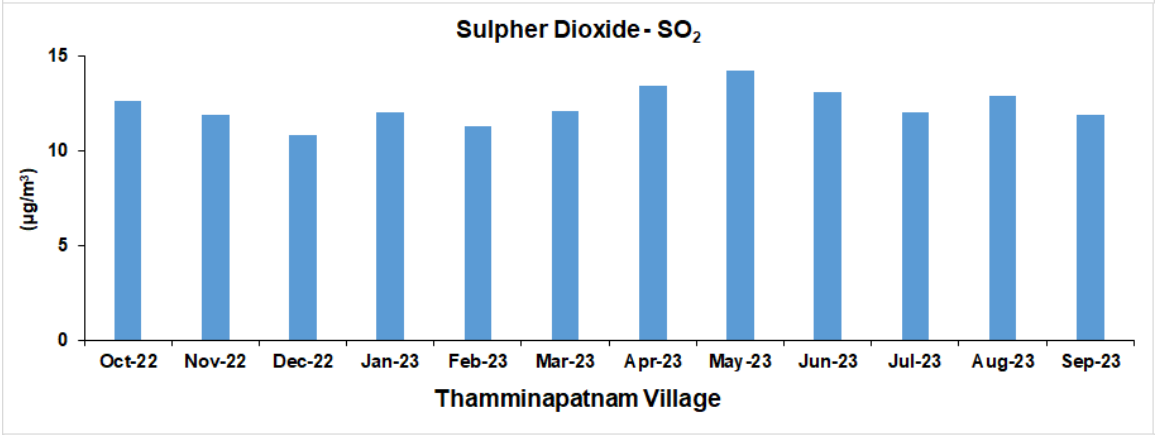


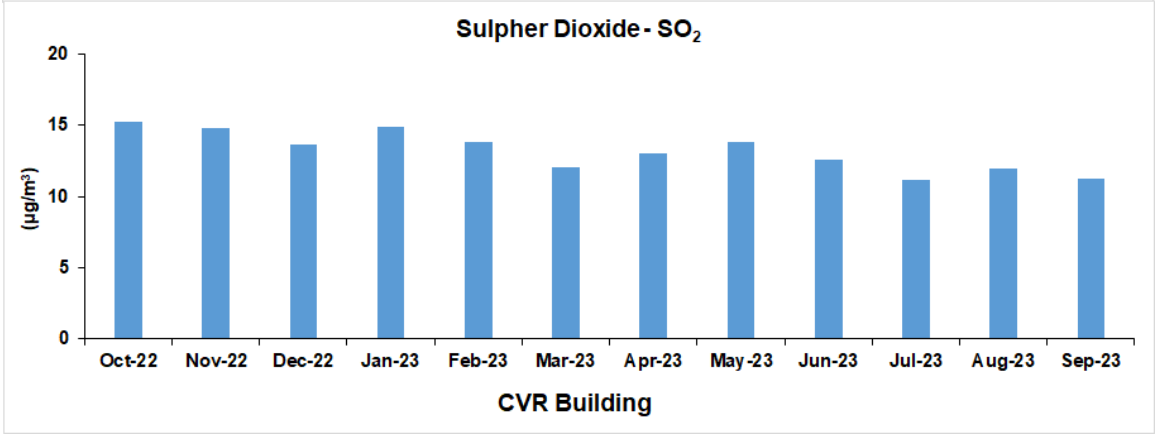
Fig. 3.2: Plot showing the temporal pattern of ambient $PM_{2.5}$ during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.2.3. Ambient SO_2

The ambient SO_2 concentration varied from 12.9 µg/m³ to 16.4 µg/m³, 10.8 µg/m³ to 14.2 µg/m³, from 10.2µg/m³ to 13.4 µg/m³, from 11.3 µg/m³ to 14.5 µg/m³, from 10.8 µg/m³ to 13.5 µg/m³, from 10.6 µg/m³ to 13.4 µg/m³ and from 9.1 µg/m³ and 11.8 µg/m³ for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Zero point and the lowest was recorded during September 2023 at Light house colony in Krishnapatnam village (Fig. 3.3).







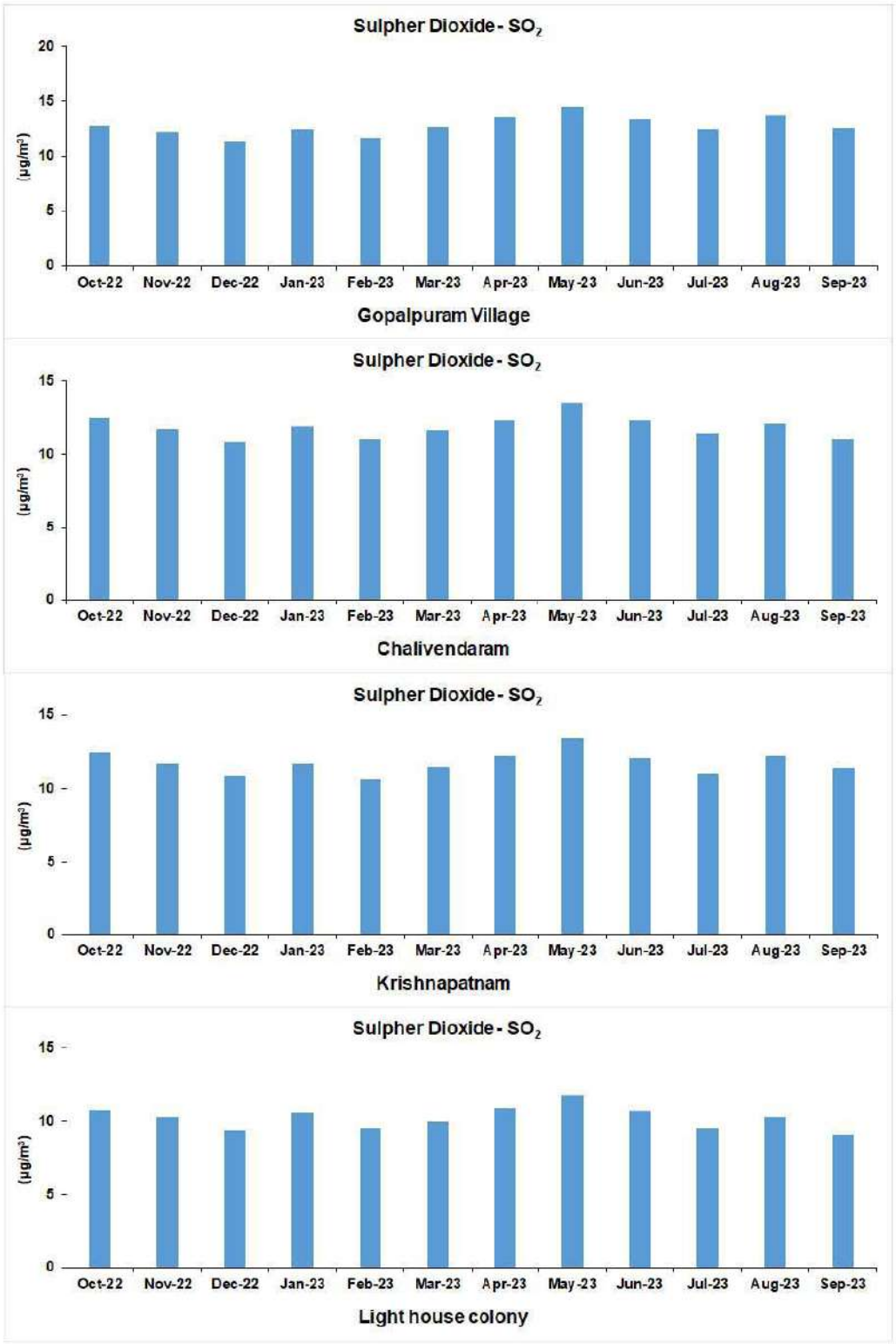
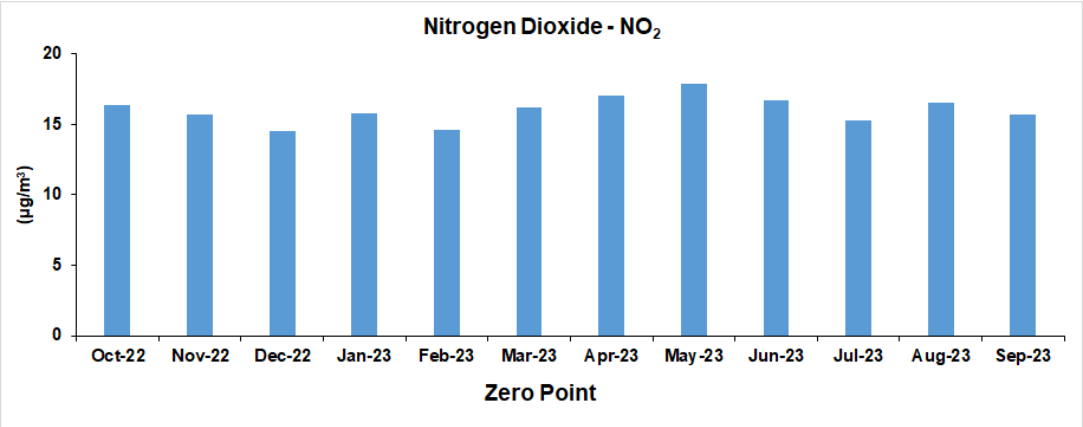
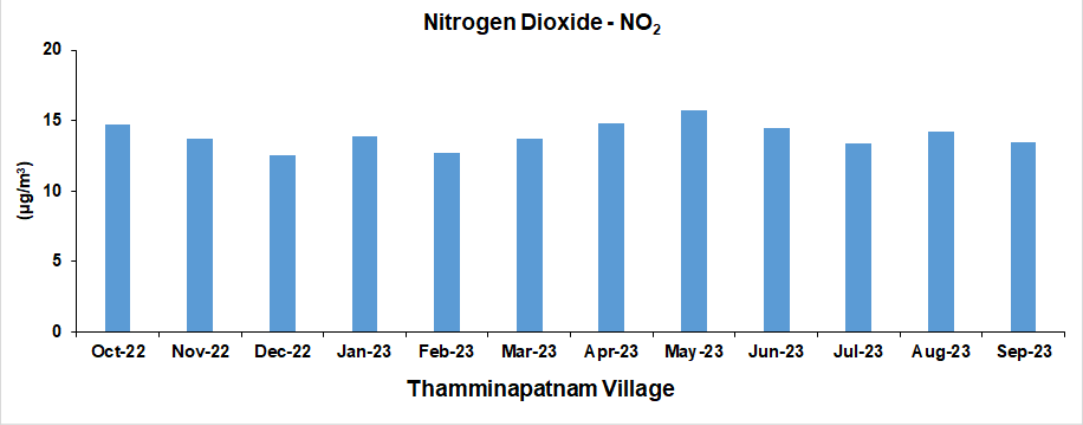


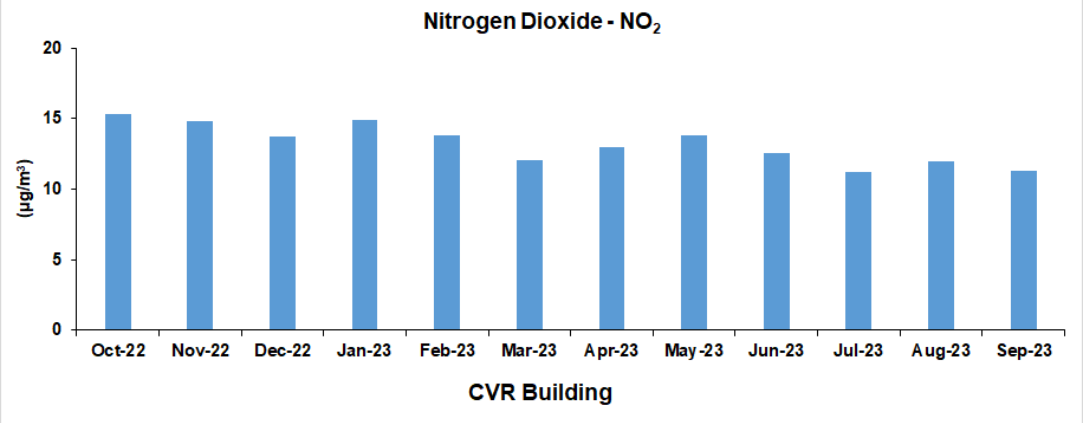
Fig. 3.3: Plot showing the temporal pattern of ambient SO_2 during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.2.4. Ambient NO_2

The ambient NO_2 concentration varied from 14.5 µg/m³ to 17.9µg/m³, 12.5 µg/m³ to 15.7 µg/m³, from 11.2 µg/m³ to 15.3 µg/m³, from 12.8 µg/m³ to 16.7 µg/m³, from 11.9 µg/m³ to 15.1 µg/m³, from 11.4 µg/m³ to 14.8 µg/m³ and from 11.7 µg/m³ to 15 µg/m³ for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Zero point and the lowest was recorded during July 2023 at CVR building (Fig. 3.4).







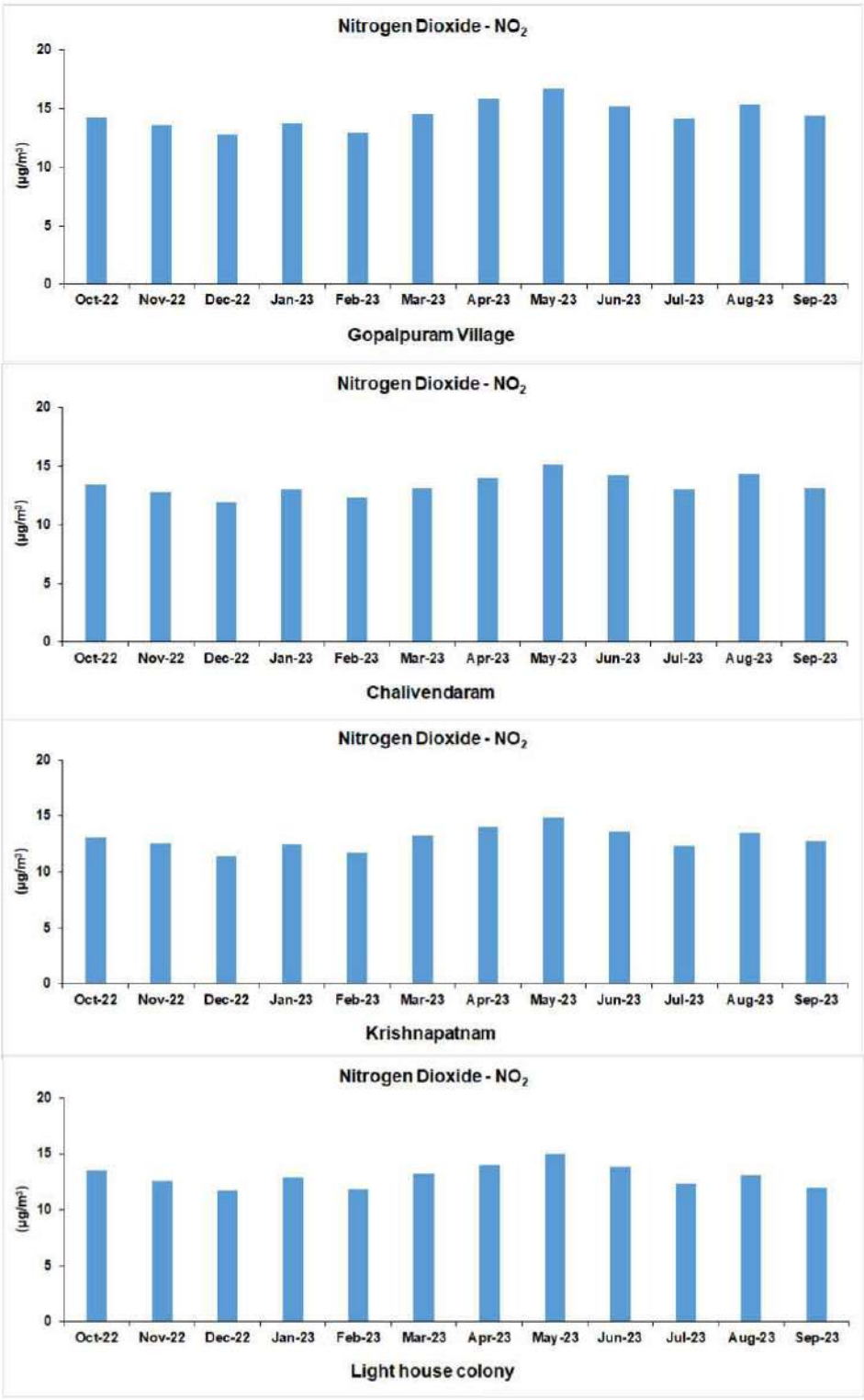
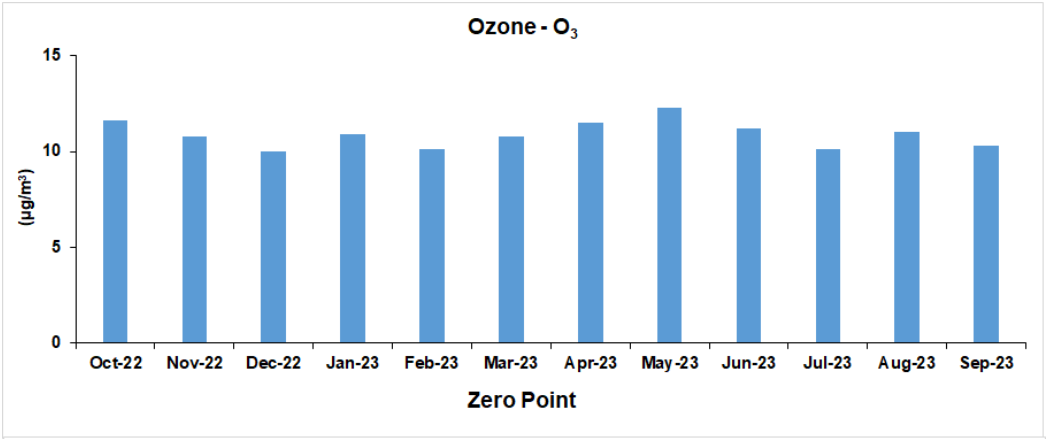
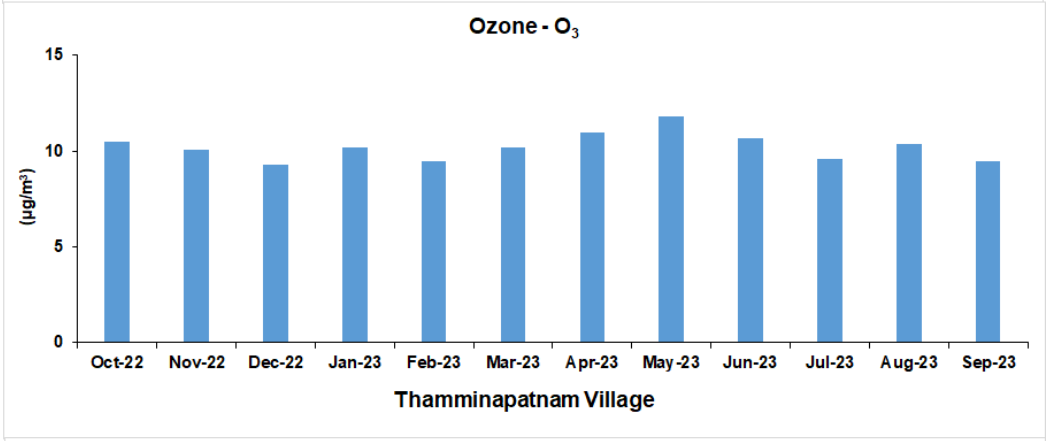


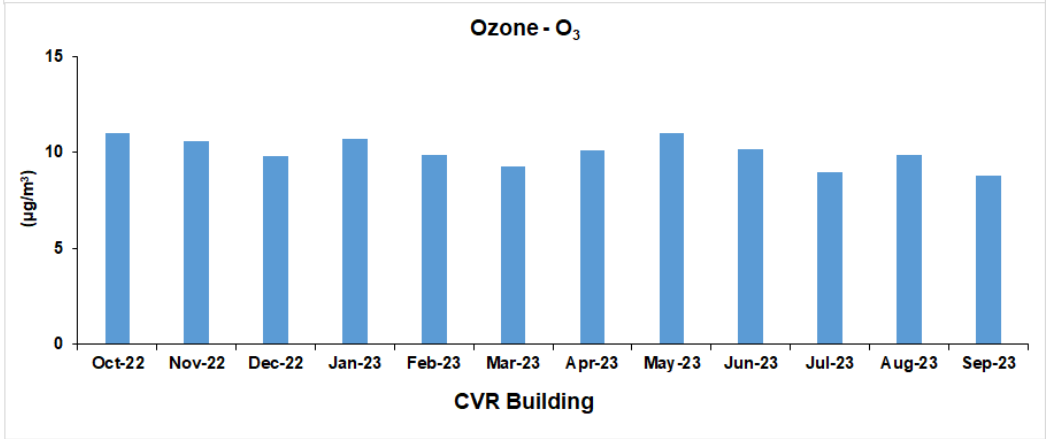
Fig. 3.4: Plot showing the temporal pattern of ambient NO_2 during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.2.5. Ambient Ozone

The ambient O_3 concentration varied from 10 µg/m^3 to 12.3µg/m^3, 9.3 µg/m^3 to 11.8 µg/m^3, from 8.8 µg/m^3 to 11 µg/m^3, from 8.4 µg/m^3 to 10.1 µg/m^3, from 8.6 µg/m^3 to 11.2 µg/m^3, from 8.6 µg/m^3 to 10.8 µg/m^3 and from 8.3 µg/m^3 to 10.9 µg/m^3 for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Light house colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Zero point and the lowest was recorded during December 2022 near Lighthouse colony of Krishnapatnam village (Fig. 3.5).







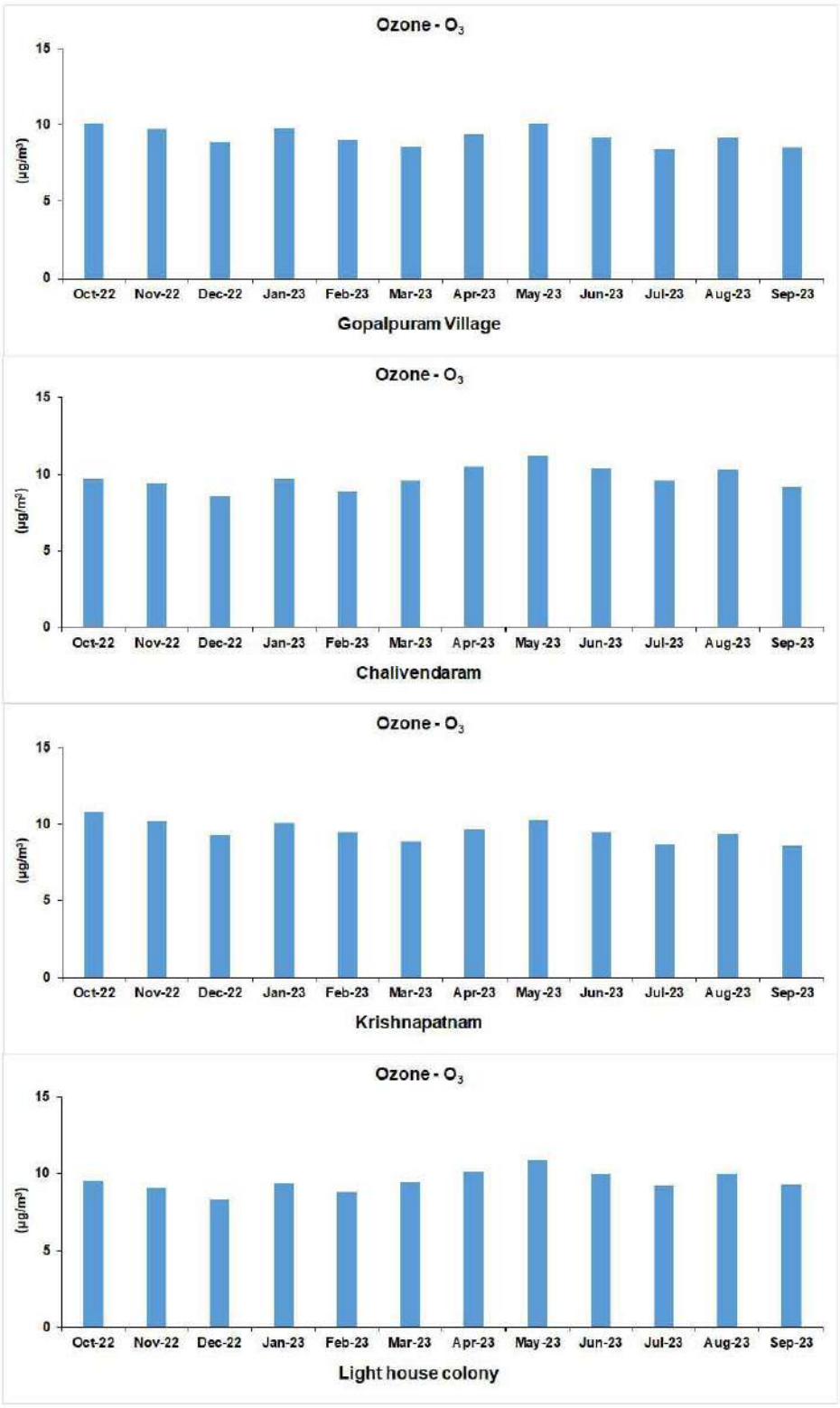
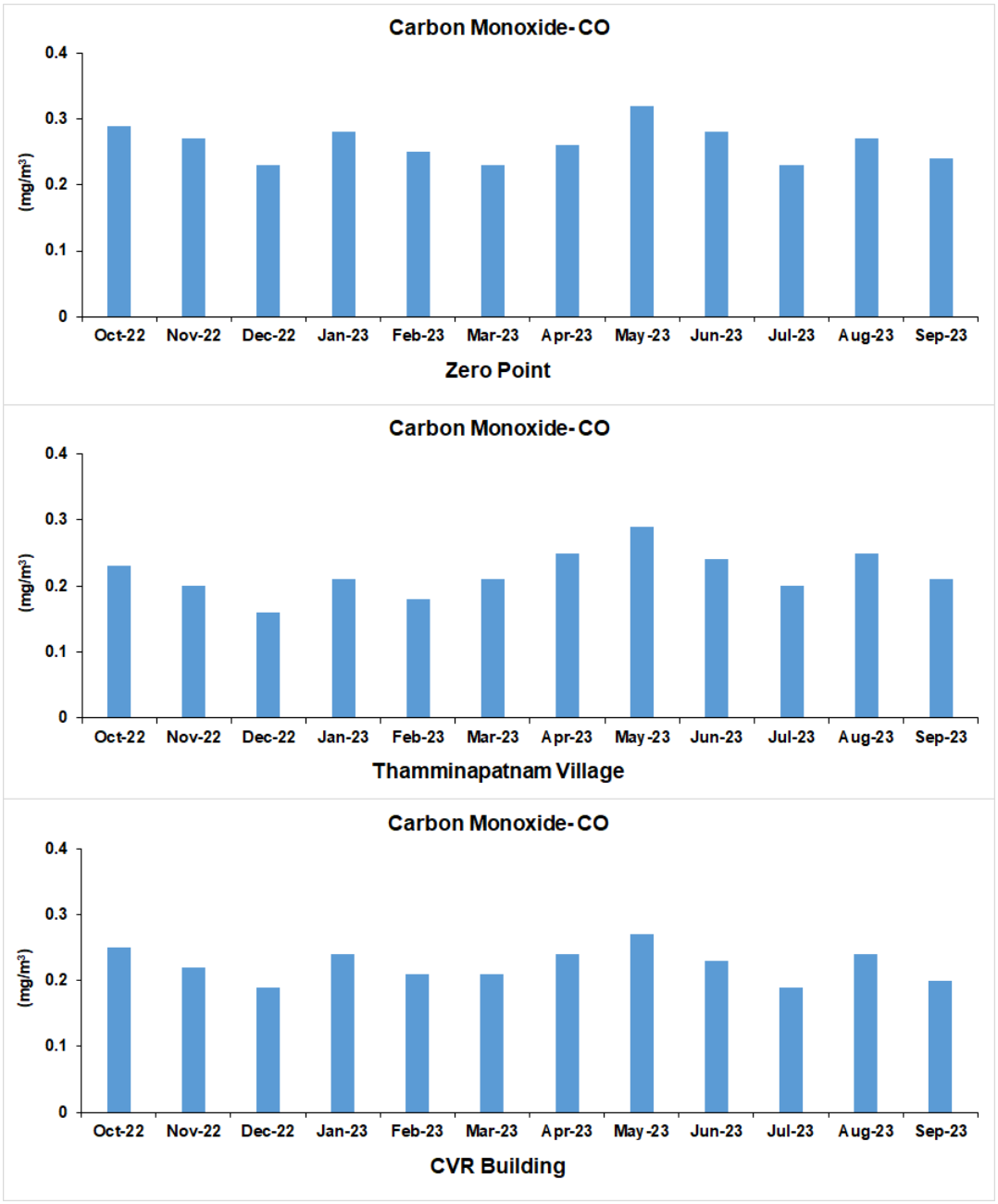


Fig. 3.5: Plot showing the temporal pattern of ambient Ozone during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.2.6. Ambient Carbon Monoxide

The ambient CO concentration varied from 0.23 mg/m^3 to 0.32 mg/m^3, 0.16 mg/m^3 to 0.29 mg/m^3, from 0.19mg/m^3 to 0.27 mg/m^3, from 0.12 mg/m^3 to 0.22 mg/m^3, from 0.1 mg/m^3 to 0.19 mg/m^3, from 0.17 mg/m^3 to 0.26 mg/m^3 and from 0.1 mg/m^3 and 0.22 mg/m^3 for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. During the monitoring period, the highest value was recorded during May 2023 at Zero point and the lowest was recorded during May 2023 at Chalivendaram and during December 2022 at Lighthouse colony in Krishnapatnam village (Fig. 3.6).



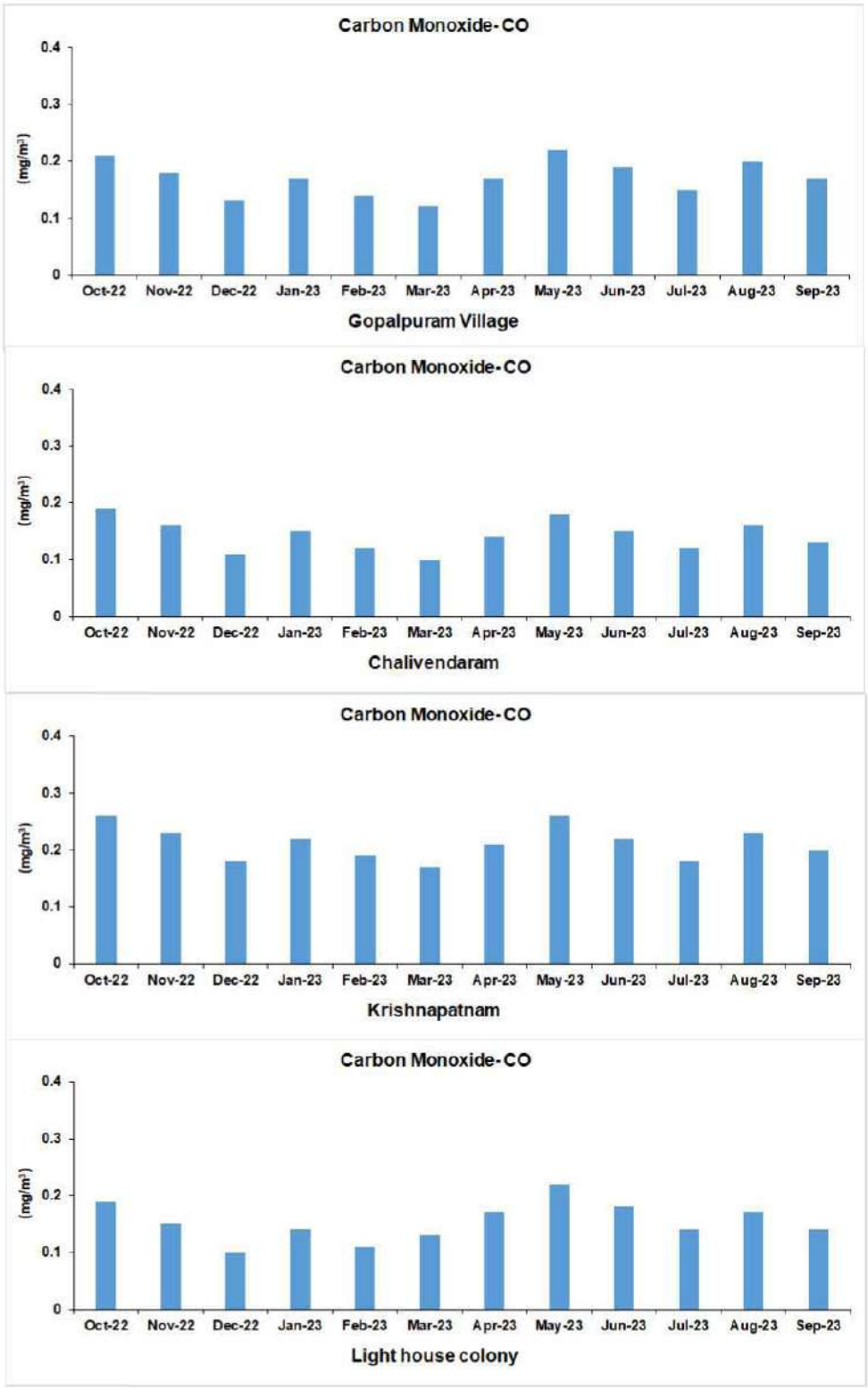


Fig. 3.6: Plot showing the temporal pattern of ambient CO during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

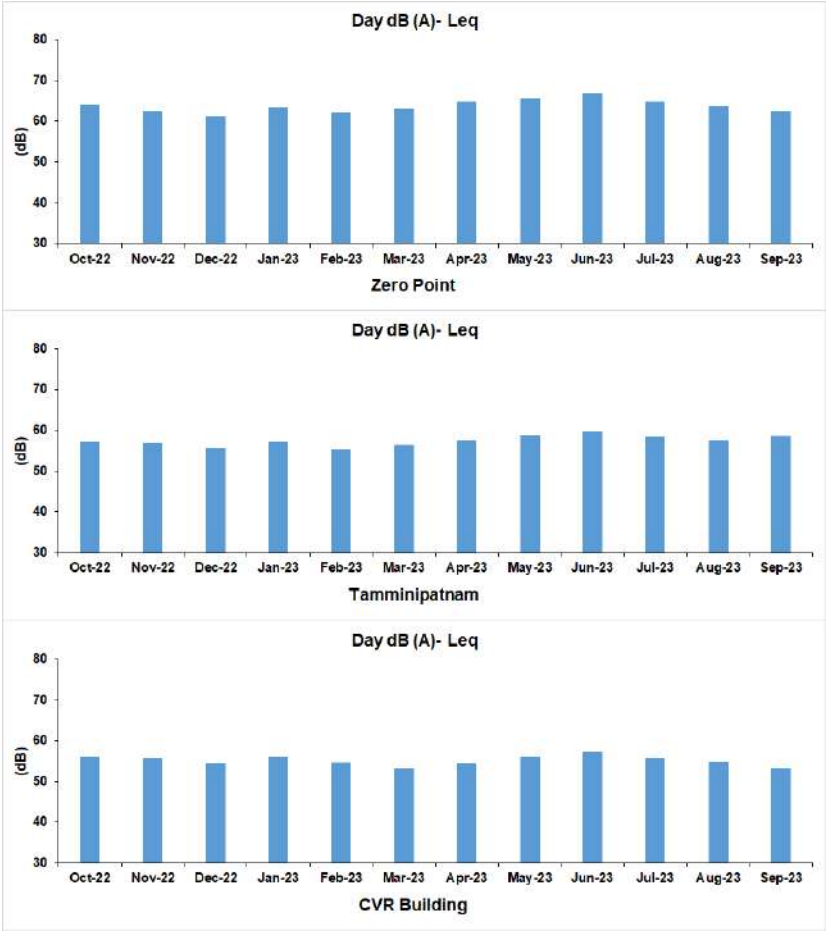
For the other parameters such as Ammonia (NH_3), Lead (Pb), Benzene (C_6H_6), Benzo(a)pyrene (BaP), Arsenic (As) and Nickel (Ni), the values were found <20 µg/m^3, <0.01 µg/m^3, <0.5 µg/m^3, <0.5 ng/m^3, <5.0 ng/m^3 and <5.0 ng/m^3 respectively throughout the study period. All the observed ambient air quality parameters monitored during the study period are within the revised National Ambient Air Quality Standard (NAAQS) (**Appendix 1**).

3.3. Ambient Noise

Ambient noise quality was monitored during the study period. From the recorded noise levels at each monitoring location, the day equivalent (L_{eq} – Day) noise level and night equivalent (L_{eq} – Night) noise level were calculated.

3.3.1. L_{eq} – Day

The day equivalent noise levels varied from 61.2 dB(A) to 66.8 dB(A), from 55.4 dB(A) to 59.6 dB(A), 53.1 dB(A) to 57.3 dB(A), from 46.3 dB(A) to 51.9 dB(A), 49.2 dB(A) to 54.2 dB(A), from 51.2 dB(A) to 55.4 dB(A), from 48.6 dB(A) to 51.7 dB(A) for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. It was maximum at Zero point during June 2023 and minimum at Gopalpuram during September 2023 (Fig. 3.7).



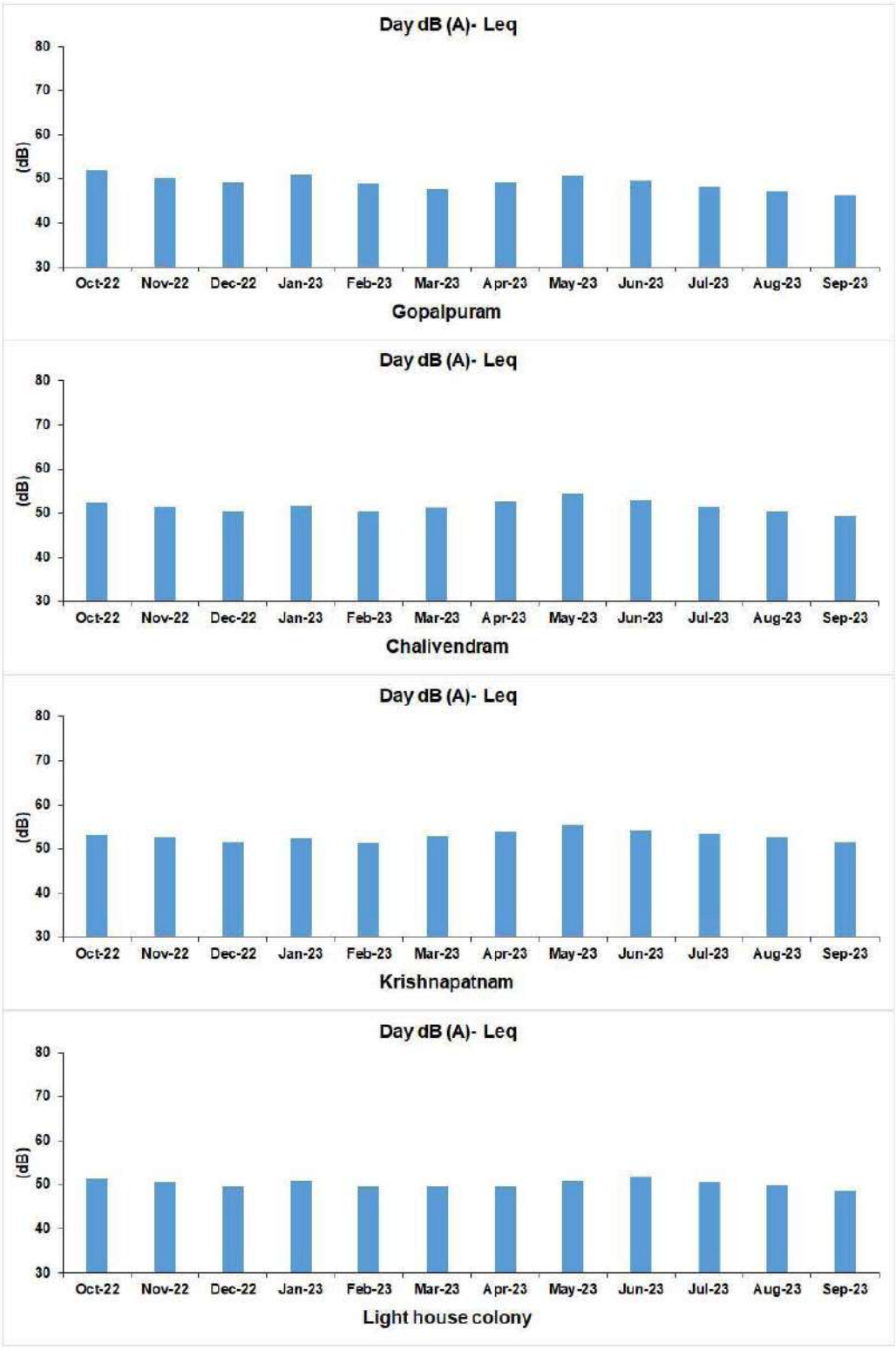
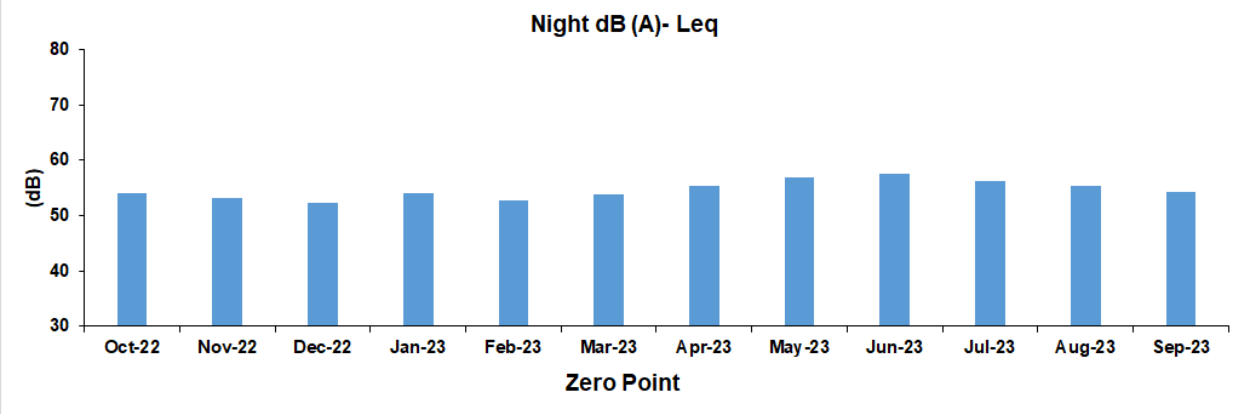
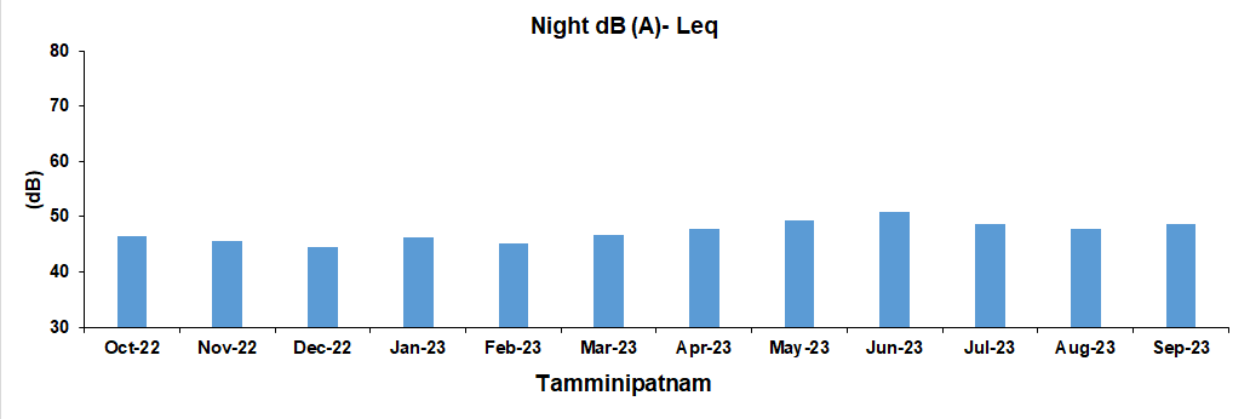


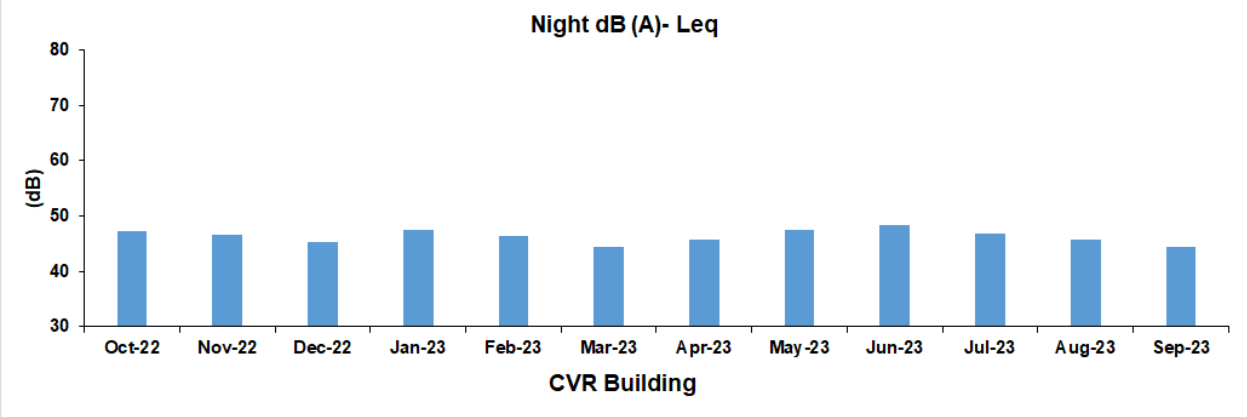
Fig. 3.7: Plot showing the temporal pattern of L_{eq} – Day during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

3.3.2. L_{eq} – Night

The night equivalent noise levels varied from 52.4 dB(A) to 57.6 dB(A), from 44.6 dB(A) to 50.9 dB(A), 44.5 dB(A) to 48.4 dB(A), from 38.2 dB(A) to 42.9 dB(A), 36.1 dB(A) to 40.7 dB(A), from 38.7 dB(A) to 43.6 dB(A), from 37.46 dB(A) to 41.4 dB(A) for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Krishnapatnam Lighthouse colony during October 2022 to September 2023. It was maximum at Zero point during June 2023 and minimum at Chalivendaram during September 2023 (Fig. 3.8).







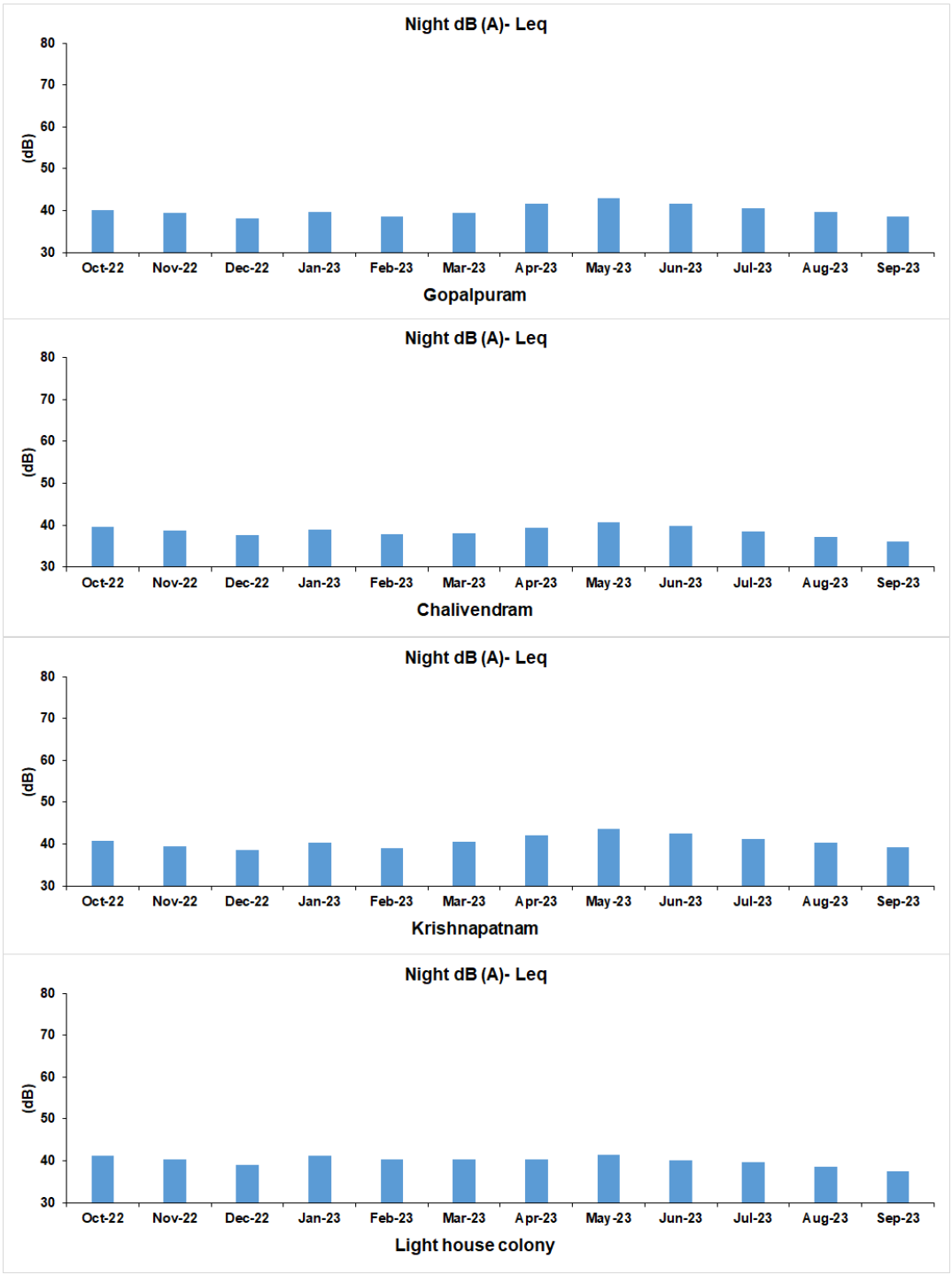


Fig. 3.8: Plot showing the temporal pattern of L_{eq} – Night during monitoring period for Zero point, Thaminapatnam village, CVR building, Gopalpuram village, Chalivendaram, Krishnapatnam and Lighthouse colony (Krishnapatnam)

Noise levels recorded during the study period are within the limit as per Central Pollution Control Board (CPCB) guidelines (**Appendix 2**).

3.4. Marine water quality

Water samples were assessed for water quality for surface water samples from Buckingham Canal & Kandaleru Creek, for marine water inside Port region from Port Entrance (Approach channel), Turning Circle, Coal Berth & Reclamation Area and for three stations for deep sea from DS-1, DS-2 & DS-3 water, and the results are listed below. Only turbidity, total dissolved solids and total suspended solids parameters were monitored for the deep sea water locations.

3.4.1. pH

Marine water

The pH in the marine water ranged from 7.83 to 8.05, from 7.81 to 7.99, from 7.79 to 8.24 and from 7.90 to 8.35 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.9). During the monitoring period, the highest value was recorded during August 2023 at Reclamation Area and the lowest recorded during November 2022 at Coal berth.

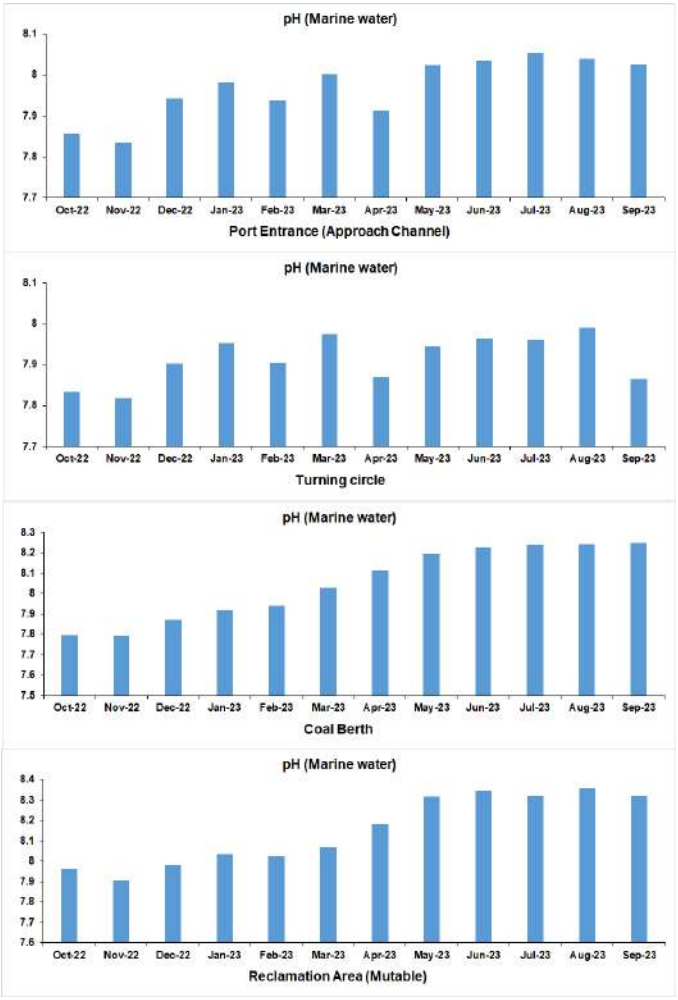


Fig. 3.9: Temporal variation of pH for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The pH in the surface water ranged from 7.44 to 7.89 and from 7.3 to 7.85 for Buckingham Canal and Khandaleru Creek respectively (Fig. 3.10). During the monitoring period, the highest value was recorded during March and May 2023 at Buckingham Canal and the lowest recorded during September 2023 at Kandaleru Creek.

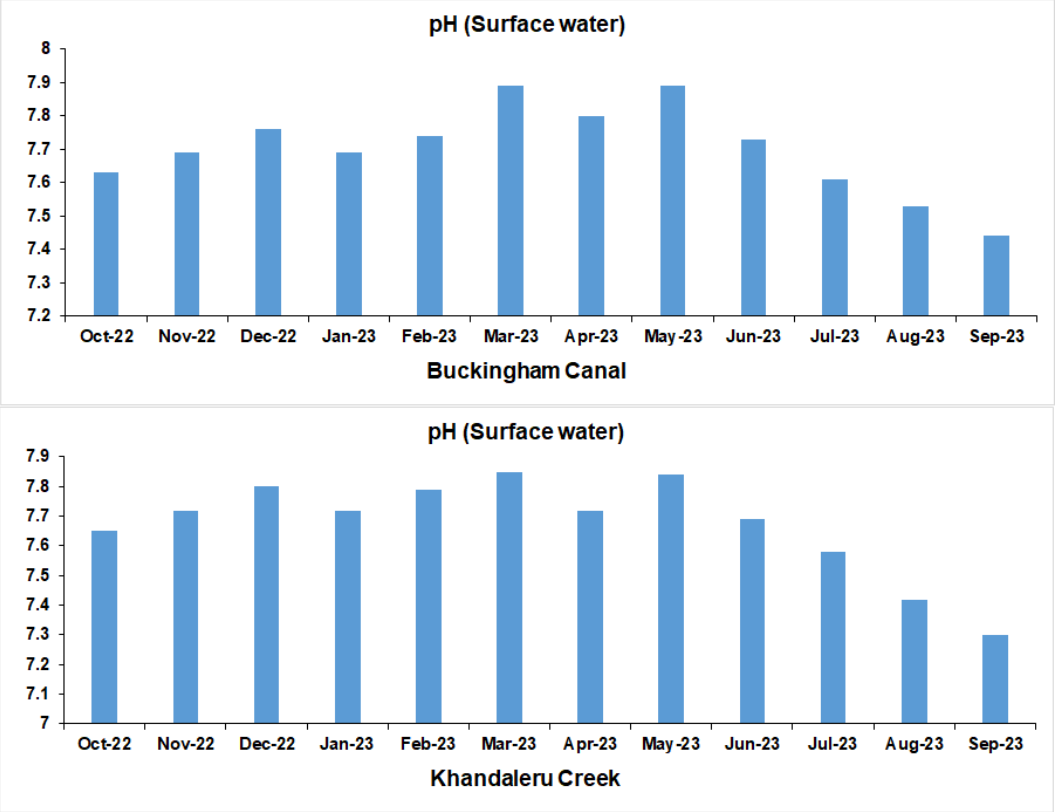


Fig. 3.10: Temporal variation of pH for the monitoring perod for surface waters (Buckingham Canal and Kandaleru Creek)

3.3.2. Temperature

Marine water

The temperature in the marine water ranged from 27.4° C to 28.8° C, from 27.6° C to 28.8° C, from 27.6° C to 28.6° C and from 28.1° C to 29.1° C for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.11). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during September 2023 at Port Entrance.

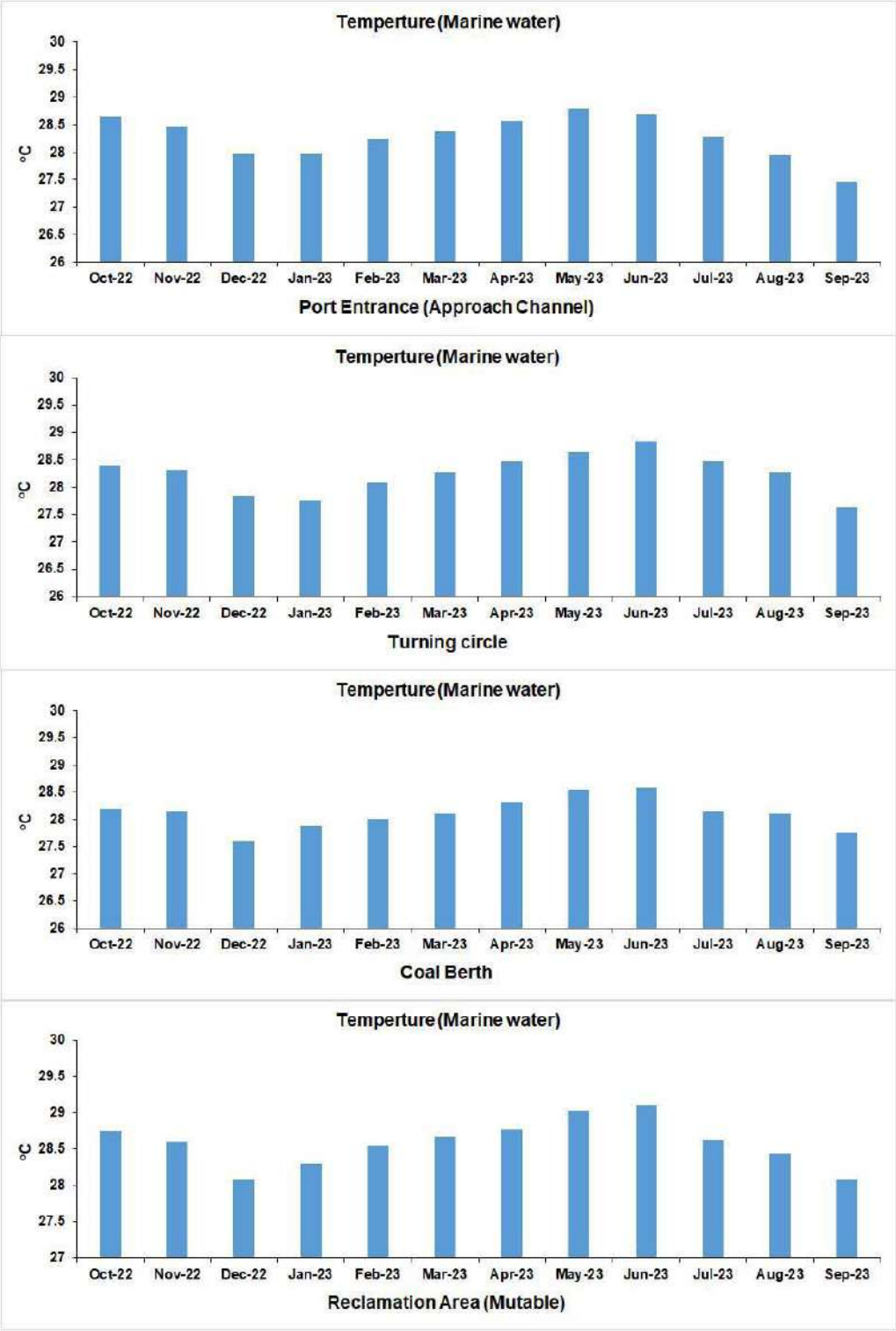


Fig. 3.11: Temporal variation of temperature for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The temperature in the surface water ranged from 25.50° C to 27.20° C and from 25.80° C to 27.50° C for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.12). During the monitoring period, the highest value was recorded during September 2023 at Kandaleru Creek and the lowest recorded during December 2022 at Buckingham Canal.

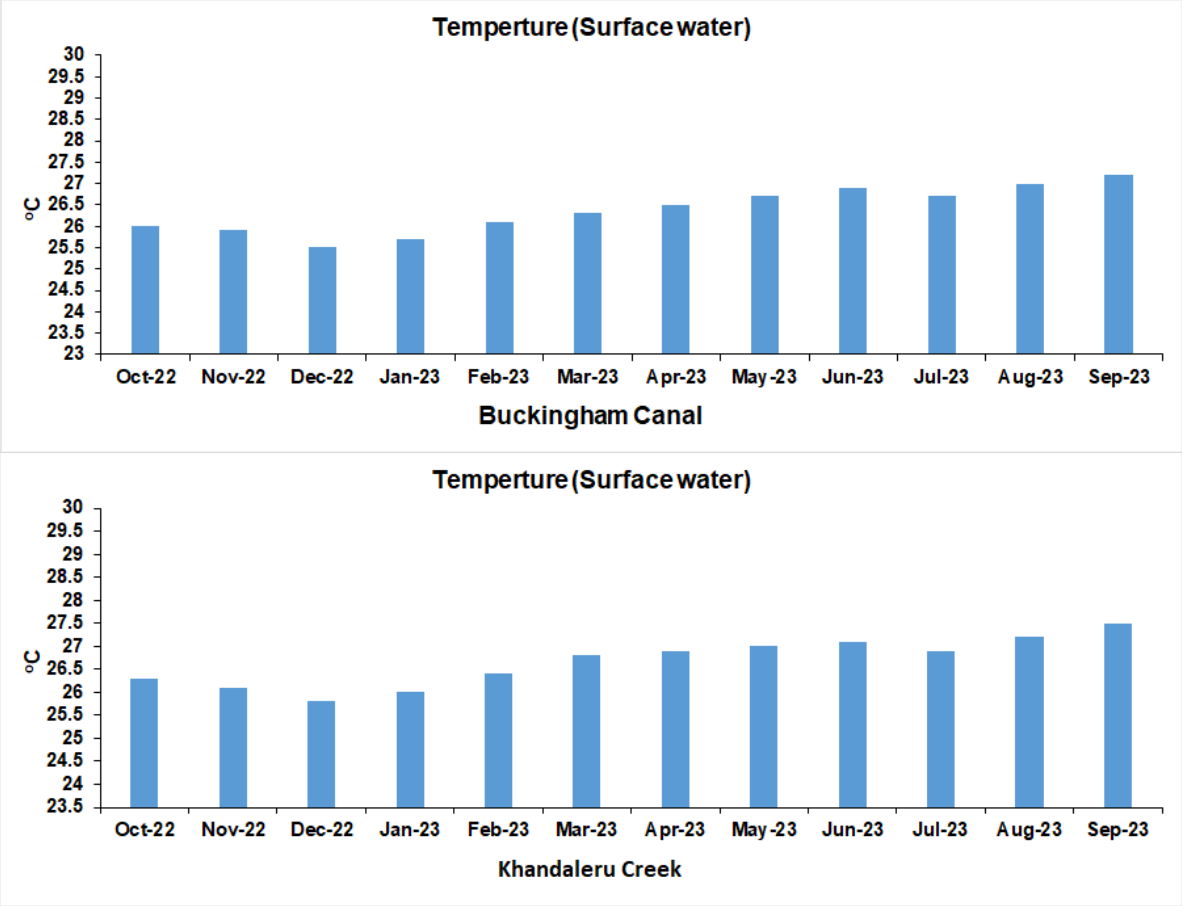


Fig. 3.12: Temporal variation of temperature for the monitoring period for surface waters (Buckingham Canal and Khandaleru Creek)

3.3.3. Salinity

Marine water

The salinity in the marine water ranged from 36.35 ppt to 37.63 ppt, from 36.48 ppt to 37.85 ppt, from 36.73 ppt to 38.08 ppt and from 37.10 ppt to 38.33 ppt for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.13). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Port entrance.

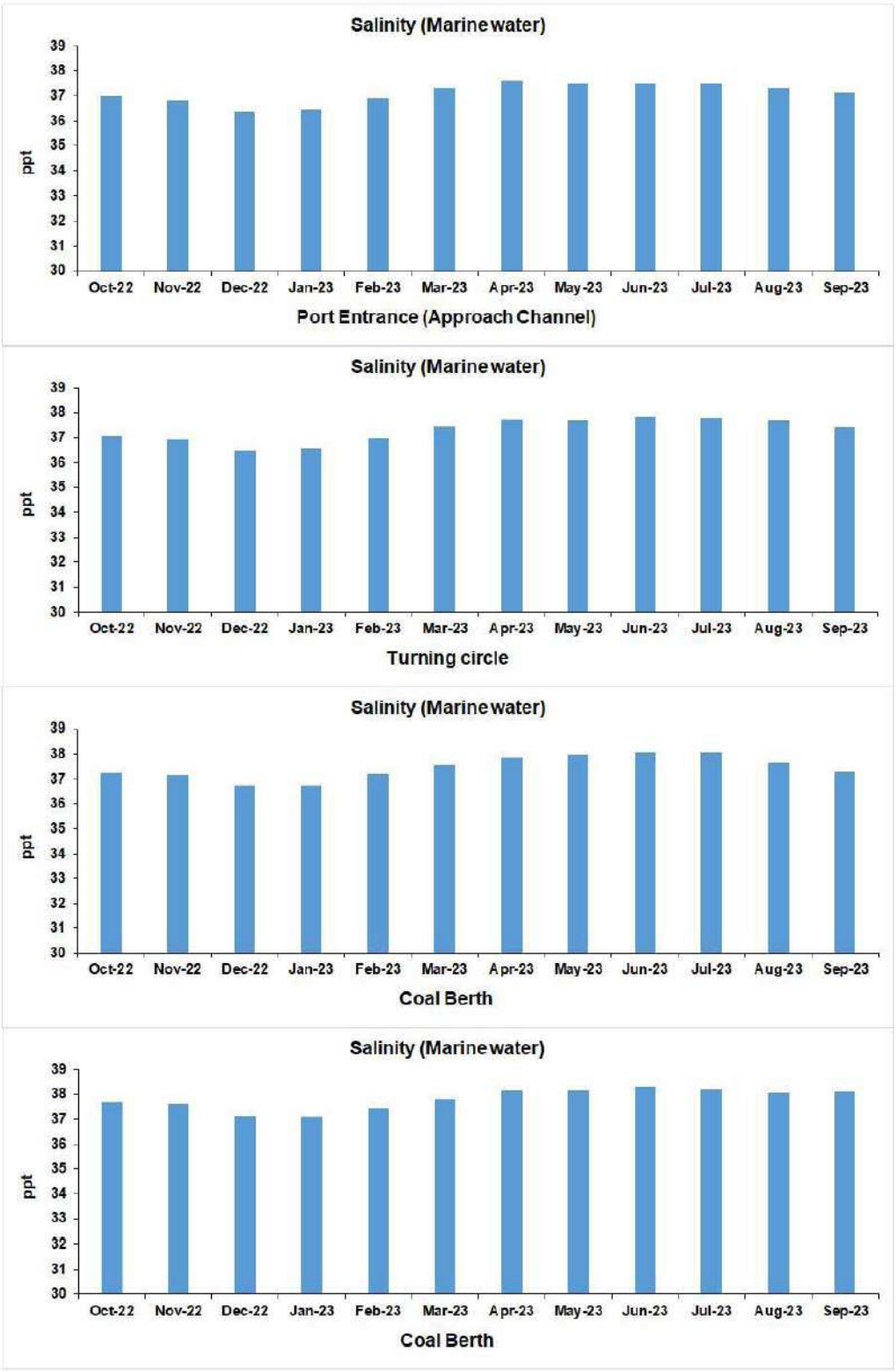


Fig. 3.13: Temporal variation of salinity for the monitoring period for marine water (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The salinity in the surface water ranged from 32.50 ppt to 33.20 ppt and from 31.90 ppt to 32.50 ppt for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.14). During the monitoring period, the highest value was recorded during August 2023 at Buckingham Canal and the lowest recorded during November 2022 at Kandaleru Creek.

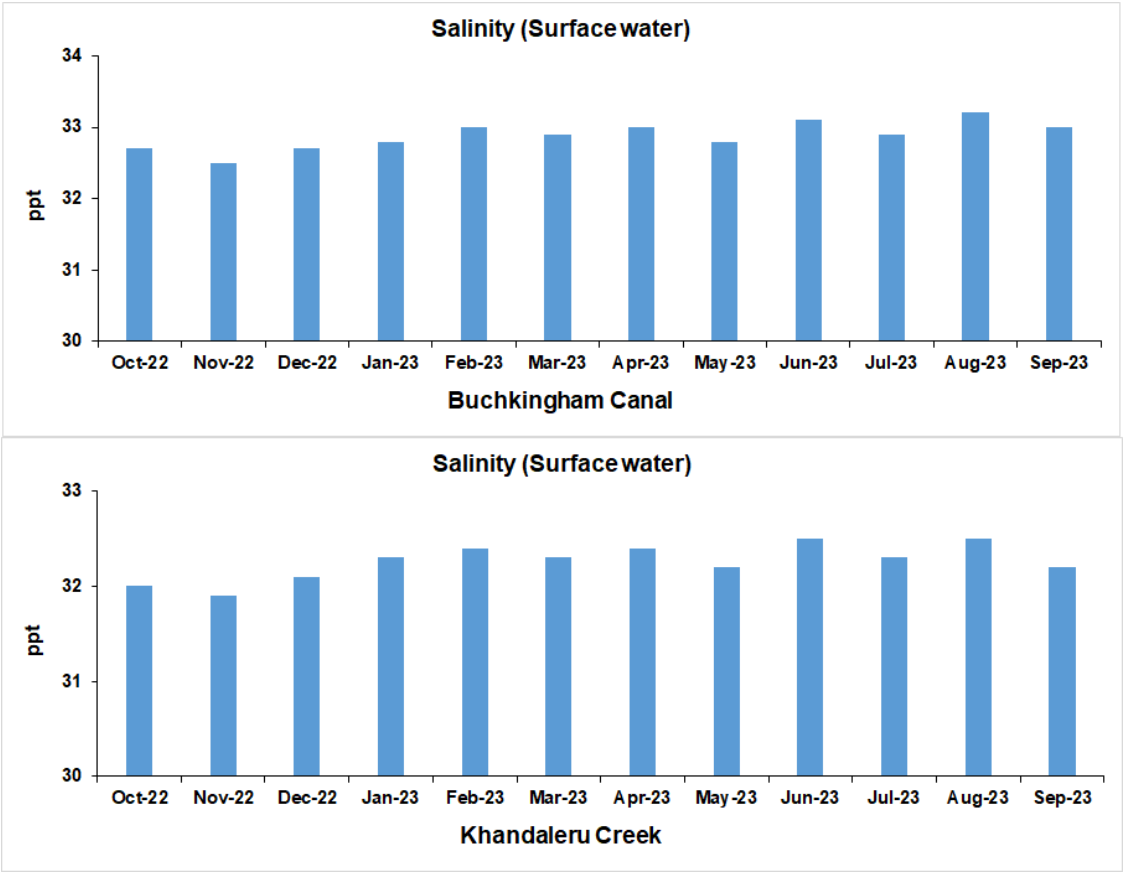


Fig. 3.14: Temporal variation of salinity for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.3.4. Density

Marine water

The density in the marine water ranged from 1.01 gm/ml to 1.04 gm/ml, from 1.02 gm/ml to 1.05 gm/ml, from 1.01 gm/ml to 1.04 gm/ml and from 1.02 gm/ml to 1.05 gm/ml for Port Entrance, Turning circle, Coal Berth and Reclamation Area respectively (Fig. 3.15). During the monitoring period, the highest value was recorded during April, May, June 2023 and June 2023 at Turning Circle and Reclamation Area respectively, and the lowest recorded during December 2022 at Port entrance and Coal berth.

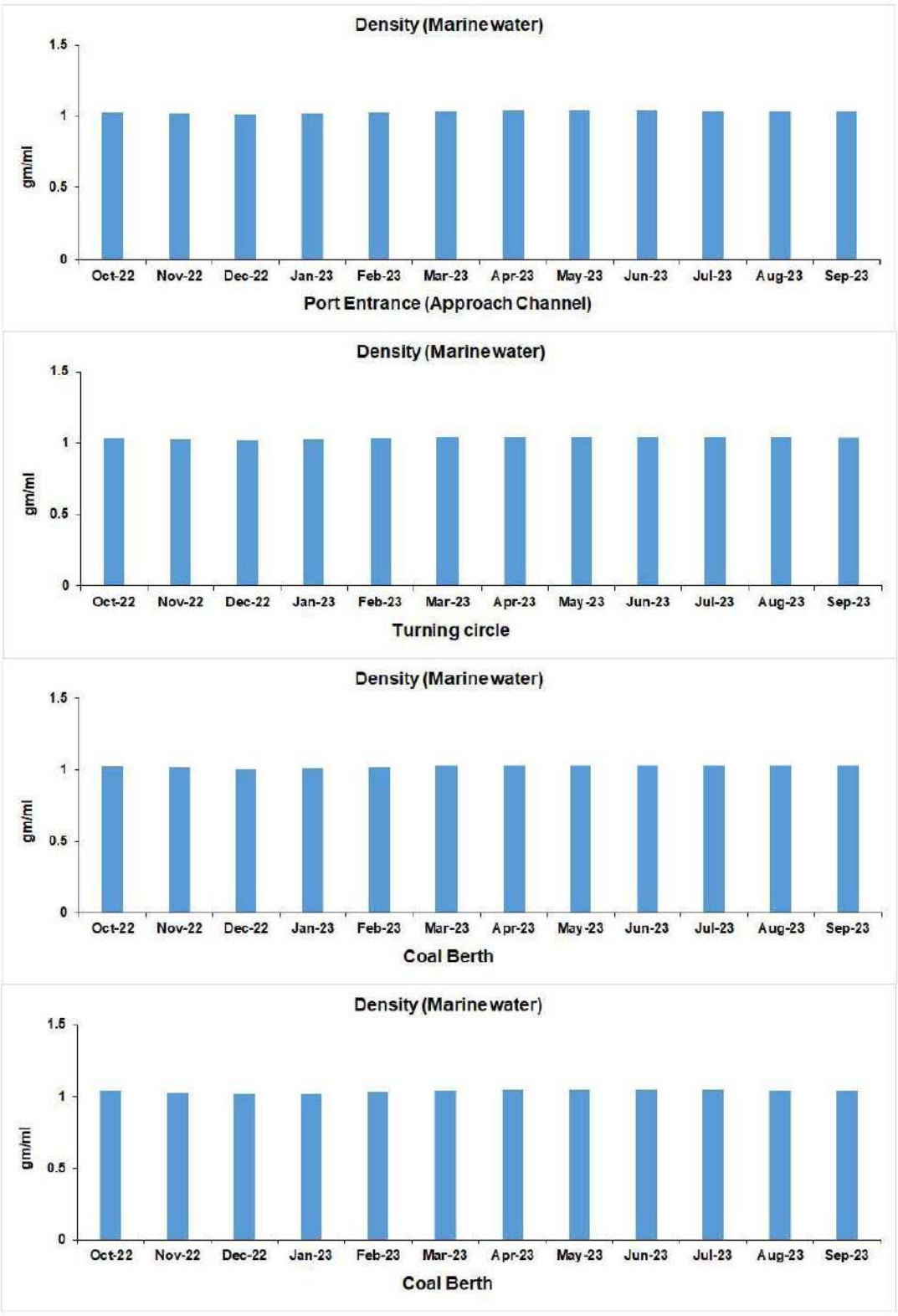


Fig. 3.15: Temporal variation of density for the monitoring period for marine water (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The density in the surface water ranged from 1.41 gm/ml to 1.51 gm/ml and from 1.56 gm/ml to 1.65 gm/ml for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.16). During the monitoring period, the highest value was recorded during January 2023 at Kandaleru Creek and the lowest recorded during August 2023 at Buckingham Canal.

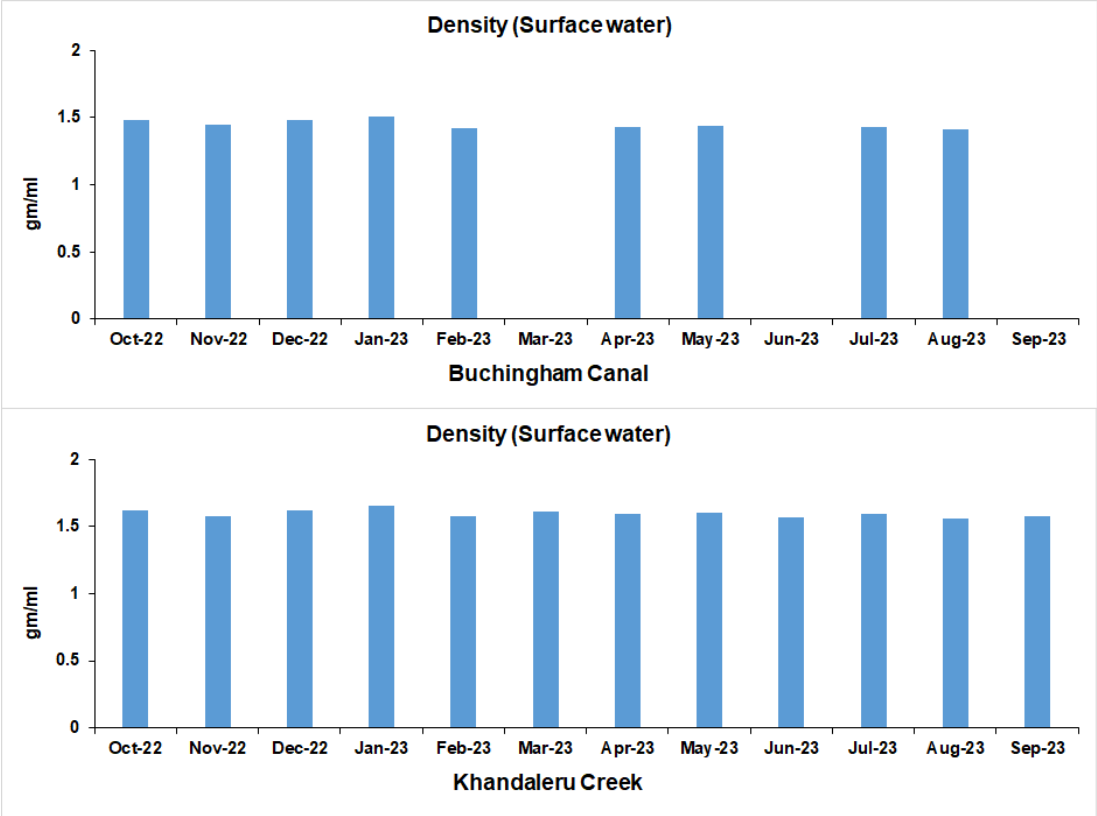


Fig. 3.16: Temporal variation of density for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.5. Secchi Disk Transparency

Marine water

The Secchi disk transparency in the marine water ranged from 10.15 mts to 12.80 mts, from 10.82 mts to 12.30 mts, from 9.85 mts to 11.53 mts and from 8.55 mts to 10.48 mts for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.17). During the monitoring period, the highest value was recorded during December 2022 and January 2023 at Port Entrance and the lowest recorded during July 2023 at Reclamation Area.

Fig. 3.17: Temporal variation of secchi disk transparency for the monitoring period for marine waters (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

3.4.6. Turbidity

Marine water

The Turbidity in the marine water ranged from 5.49 to 6.08, from 5.89 to 6.72, from 5.73 to 6.81 and from 16.85 to 18.93 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.18). During the monitoring period, the highest value was recorded

during June 2023 at Reclamation Area and the lowest recorded during February 2022 at Port Entrance.

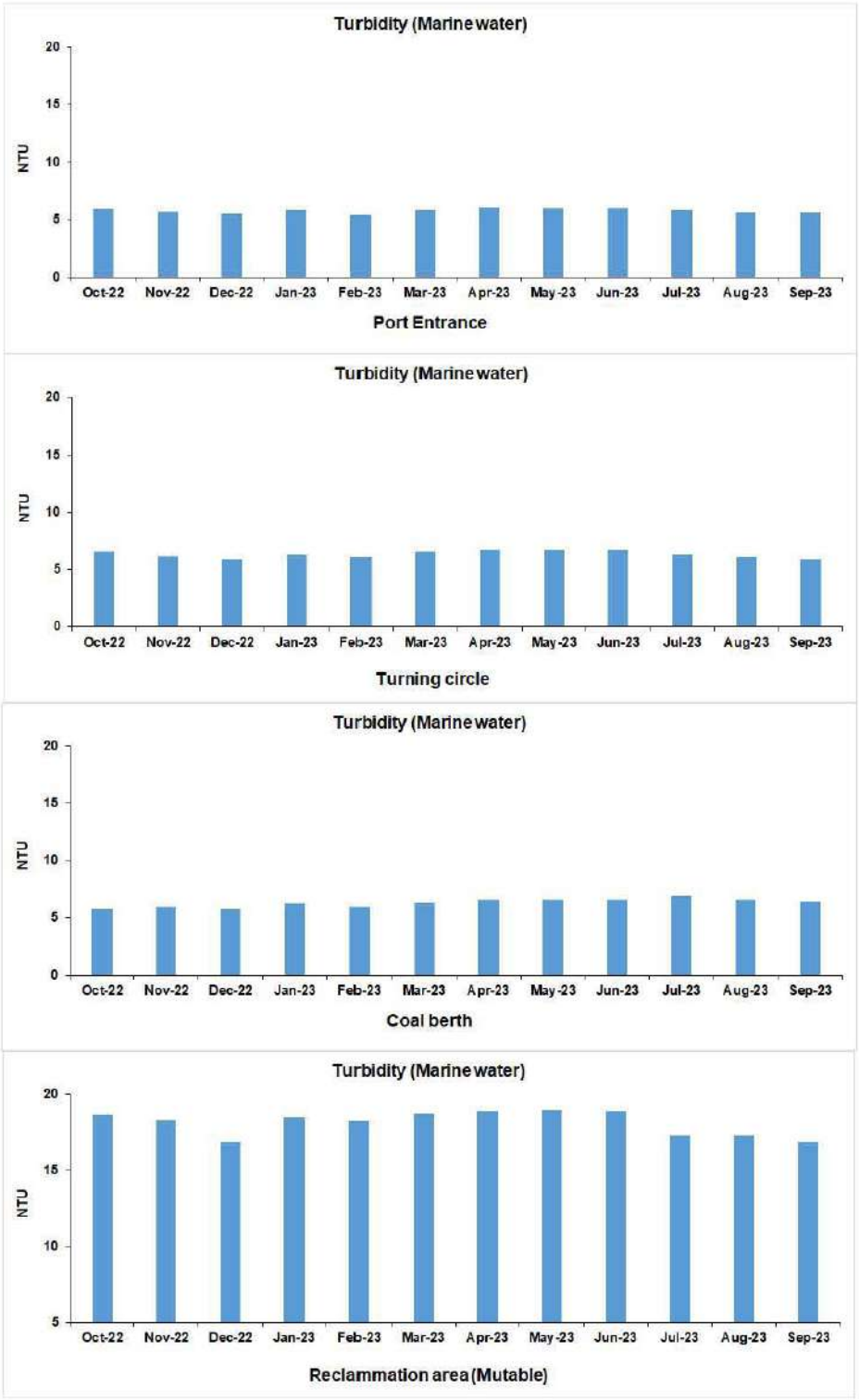


Fig. 3.18: Temporal variation of turbidity for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Deep sea water

The Turbidity in the deep sea water ranged from 4.76 to 5.86, from 4.33 to 5.4 and from 5.36 to 6.06 for DS 1, DS 2 and DS 3 respectively (Fig. 319.). During the monitoring period, the highest value was recorded during August 2023 at DS 3 and the lowest was recorded during Nov 2022 at DS 2.

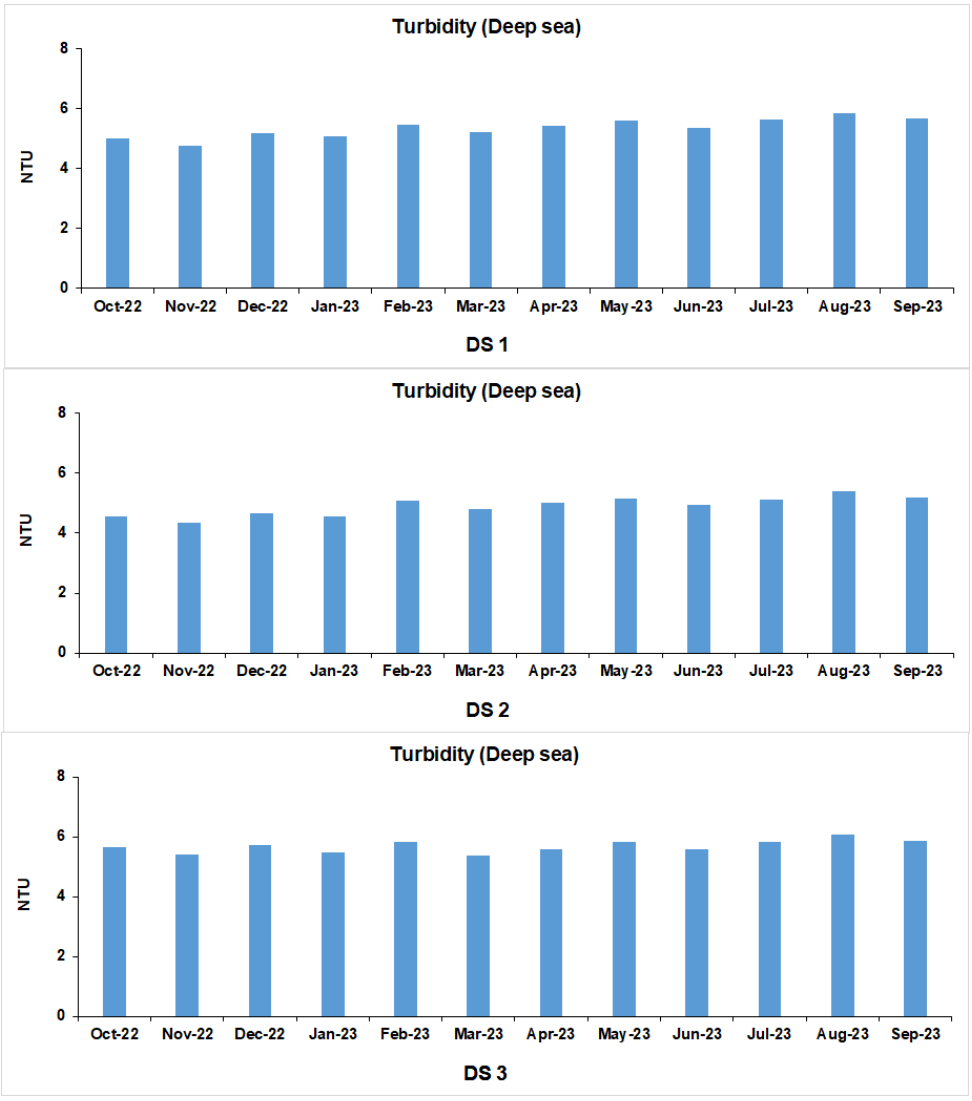


Fig. 3.19: Temporal variation of turbidity for the monitoring period for deep sea waters (DS-1, DS-2 & DS-3)

3.4.7. Total dissolved solids

Marine water

The TDS in the marine water for the port entrance, turning circle, coal berth, and reclamation area varied from 31587.5 to 33095.4 mg/l, 31485 to 33328.7 mg/l, 31623.7 to 33391.4 mg/l, and 31294.7 to 34351.7 mg/l, respectively (Fig. 3.20). July 2023 and March

2023 had the monitoring period's greatest and lowest values recorded in the reclamation area.

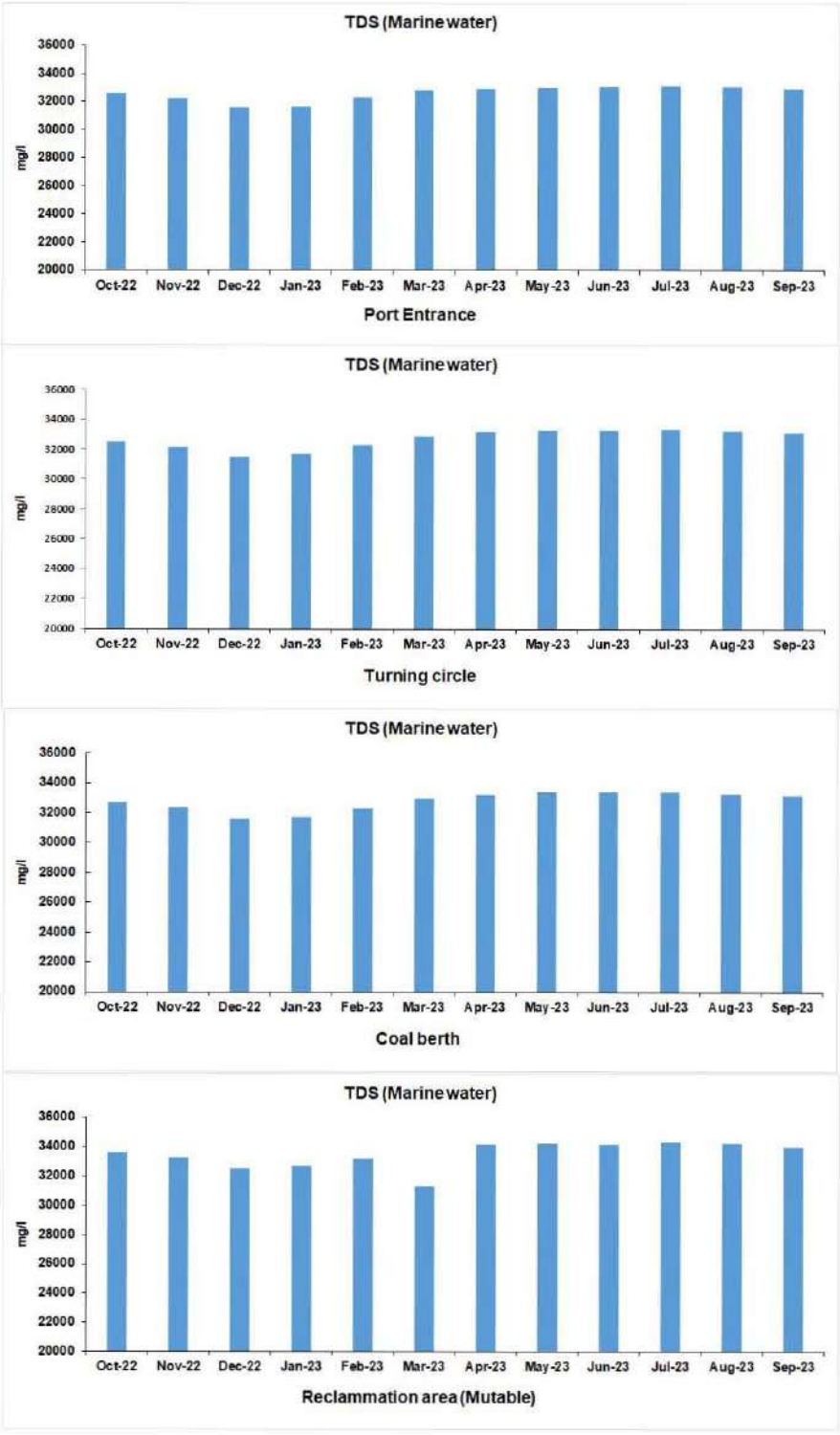


Fig. 3.20: Temporal variation of total dissolved solids for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Deep Sea water

For DS 1, DS 2, and DS 3, the TDS in the deep sea varied from 33702.7 to 35031 mg/l, from 34167.3 to 35570 mg/l, and from 34816 to 36315 mg/l, respectively (Fig. 3.21). The monitoring period observed the lowest values recorded at DS 1 in November 2022 and the highest values recorded in the DS 3 in August 2023.

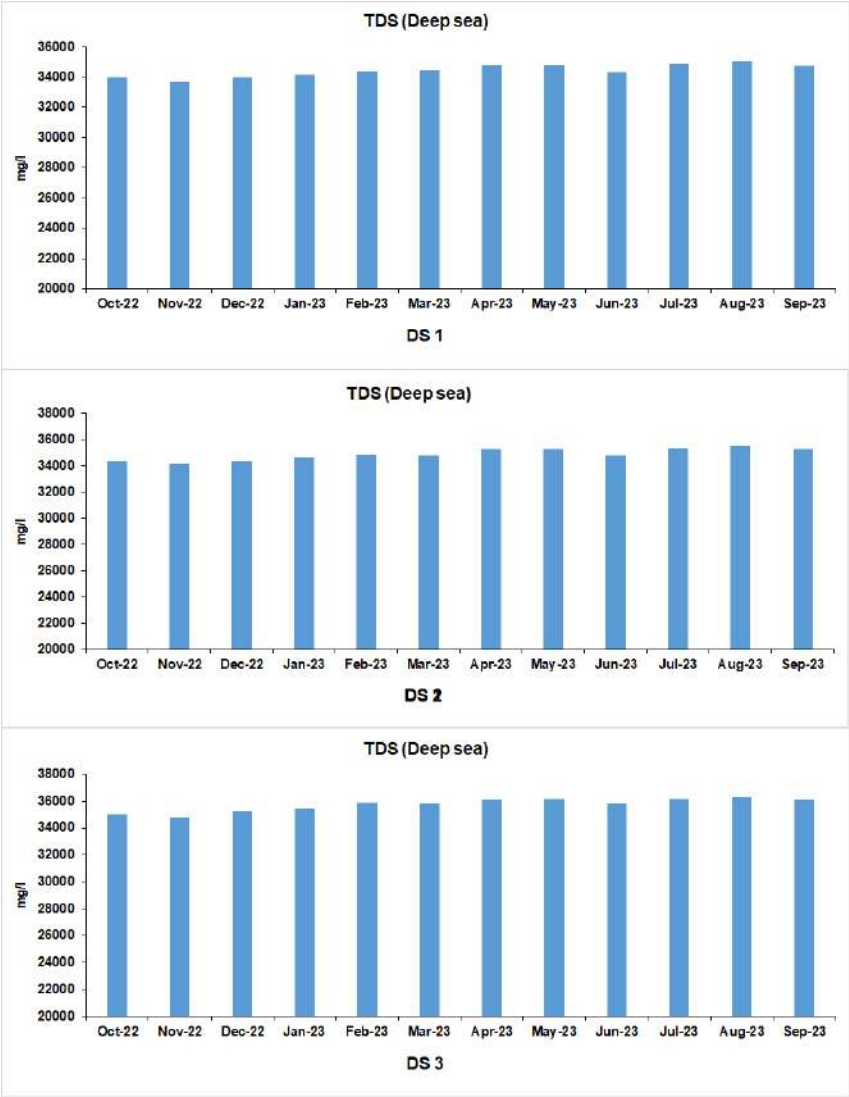


Fig. 3.21: Temporal variation of total dissolved solids for the monitoring periods for deep sea waters (DS-1, DS-2 & DS-3)

3.4.8. Total suspended solids

Marine water

For the port entrance, turning circle, coal berth, and reclamation area, the TSS in the marine water ranged from 11.18 to 14.96 mg/l, from 12.11 to 16 mg/l, from 12.45 to 16.86 mg/l, and from 14.39 to 19.96 mg/l, respectively (Fig. 3.22). The highest level of TSS was

recorded at the reclamation area in October 2022, and the lowest level of TSS was recorded at the port entrance in September 2023, during the monitoring period.

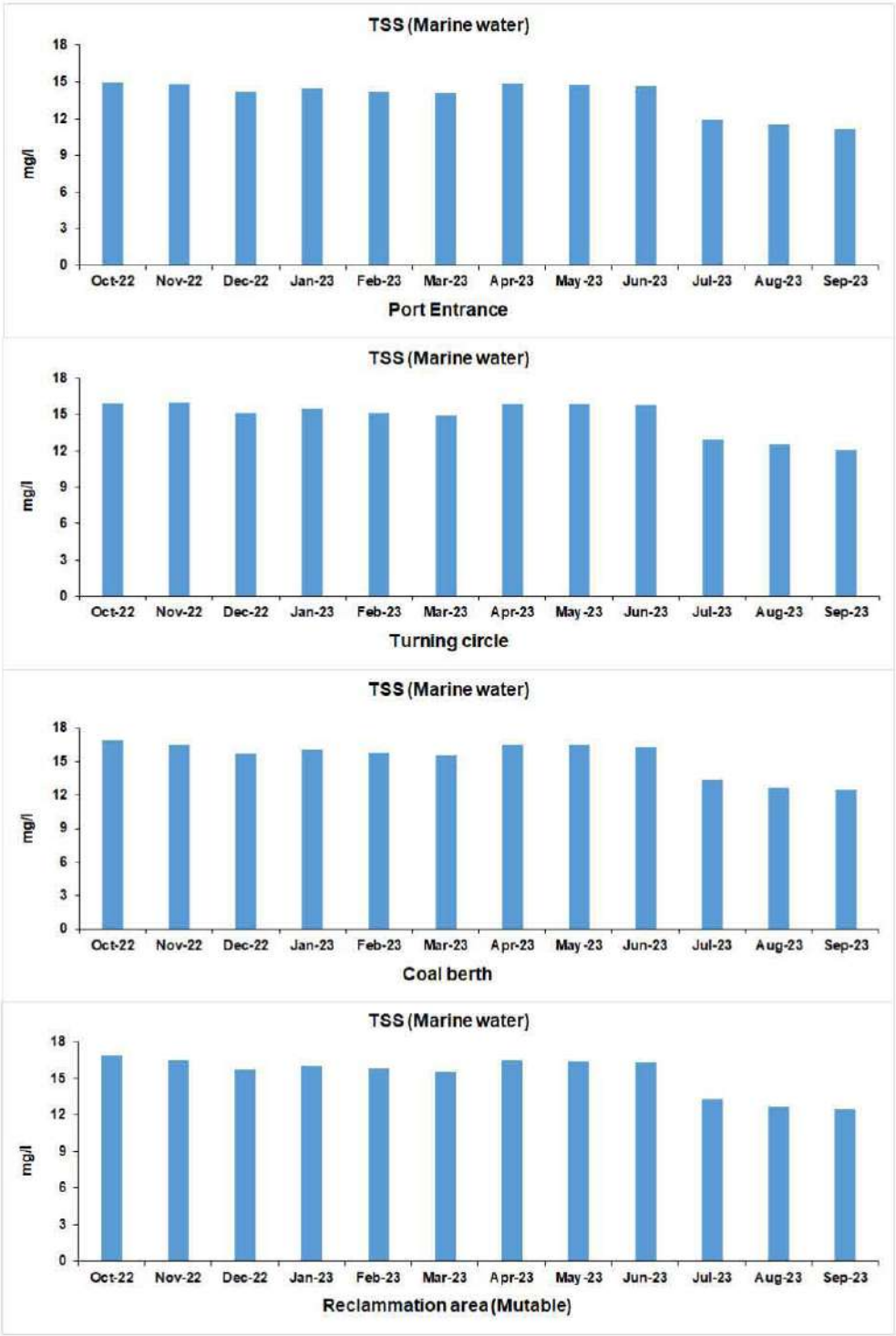


Fig. 3.22: Temporal variation of total suspended solids for the monitoring periods for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Deep sea water

The Total suspended solids in the deep sea water varied between 5.8 and 7.5 mg/l (Fig. 3.23). During the monitoring period, the highest value was recorded during June 2022 at DS3 and the lowest recorded during September and November 2022 at DS1 respectively.

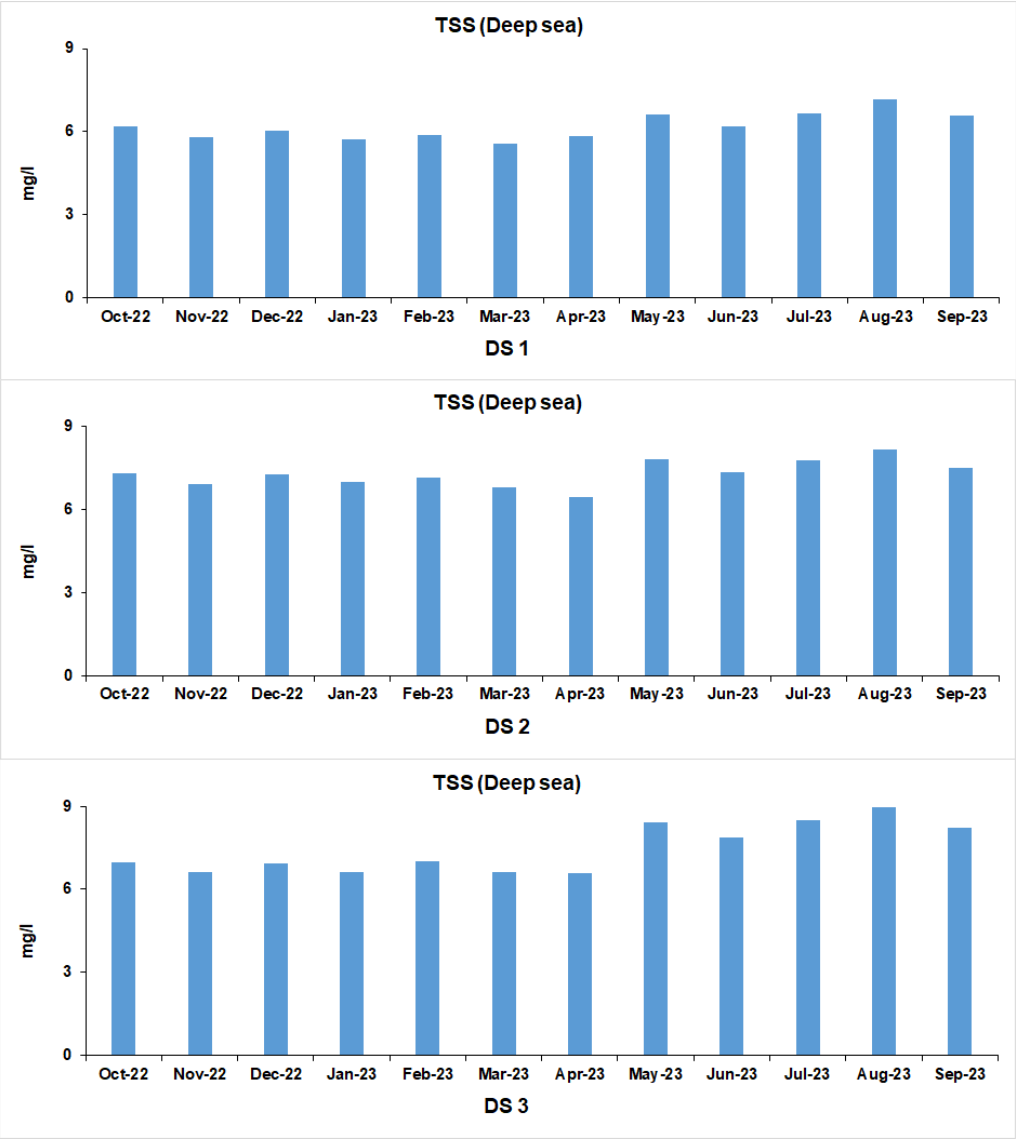


Fig. 3.23: Temporal variation of total suspended solids for the monitoring period for deep sea waters (DS-1, DS-2 & DS-3)

3.4.9. Potassium

Marine water

The amount of potassium in the marine water ranged from 241 mg/l to 347 mg/l, from 227 mg/l to 332 mg/l, from 263 mg/l to 374 mg/l and from 288 mg/l to 388 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.24.). During

the monitoring period, the highest value was recorded during May 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle

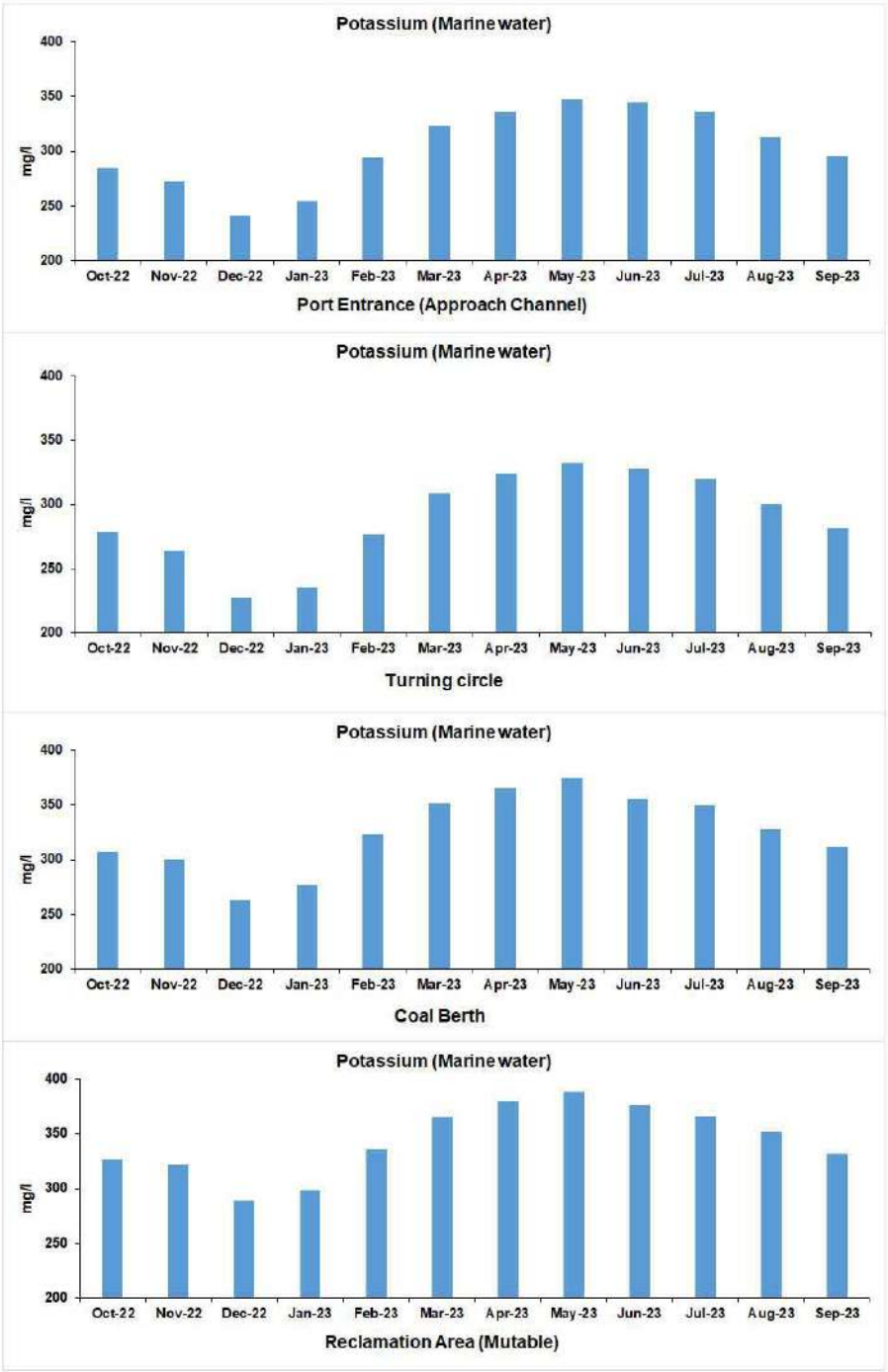


Fig. 3.24: Temporal variation of potassium for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The amount of potassium in the surface water ranged from 236 mg/l to 315 mg/l and from 258 mg/l to 321 mg/l for Buckingham Canal and Khandaleru Creek respectively (Fig. 3.25.). During the monitoring period, the highest value was recorded during June 2023 at Kandaleru Creek and the lowest recorded during November 2023 at Buckingham Canal.

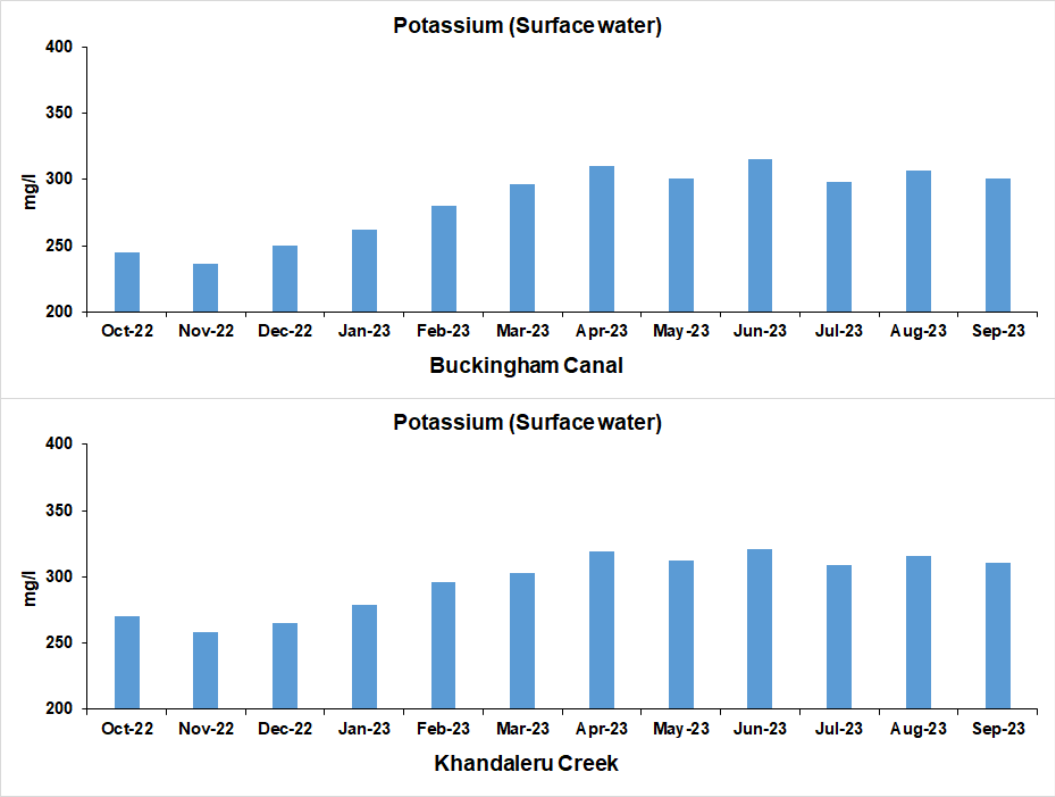


Fig. 3.25: Temporal variation of Potassium for the monitoring periods for surface waters (Buckingham Canal and Khandaleru Creek)

3.4.10. COD

Marine water

The chemical oxygen demand in the marine water ranged from 12.54 mg/l to 14.05 mg/l, from 12.68 mg/l to 14.30 mg/l, from 12.30 mg/l to 13.75 mg/l and from 13.18 mg/l to 14.70 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.26). During the monitoring period, the highest value was recorded during February 2023 at Reclamation Area and the lowest recorded during September 2023 at Coal Berth.

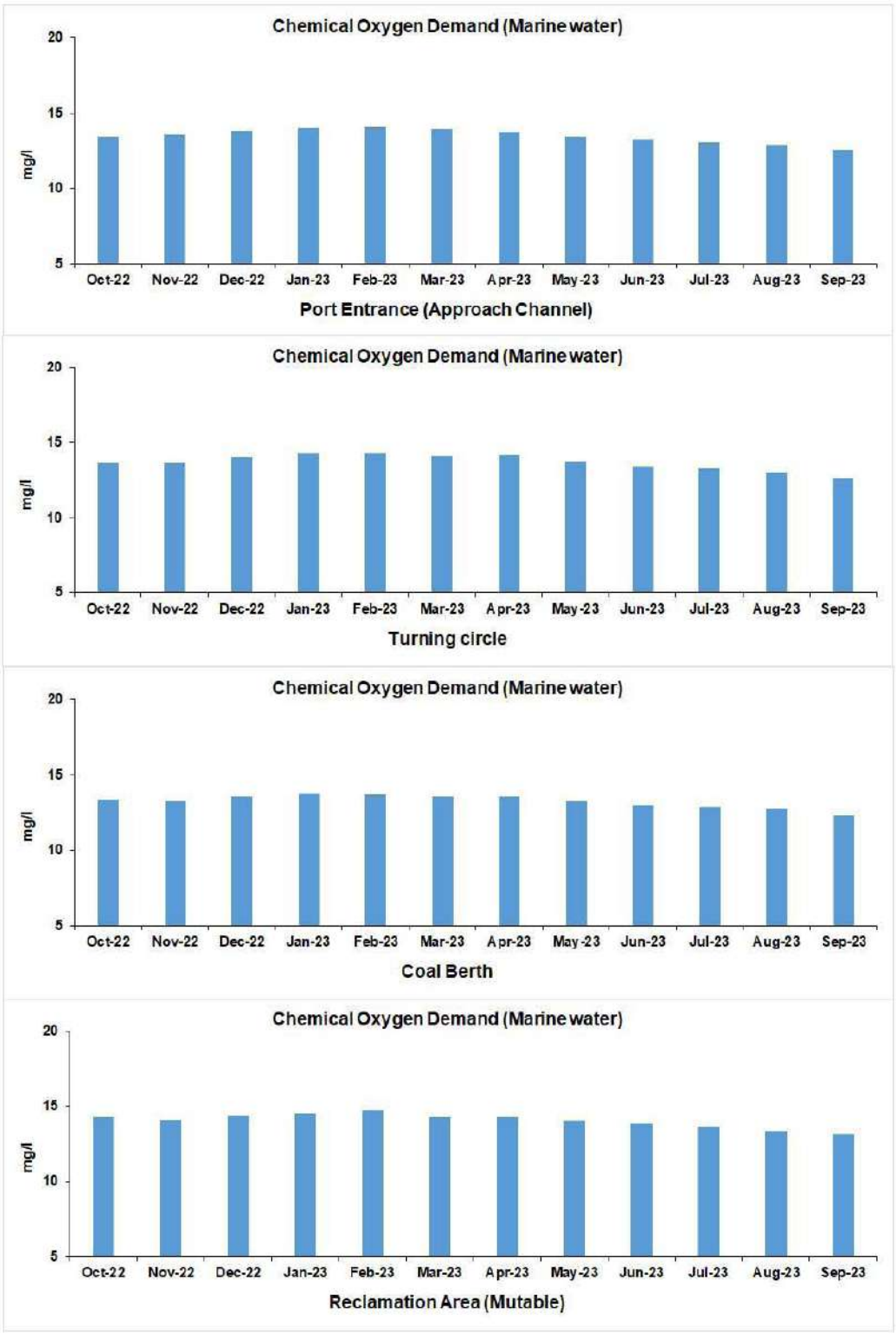


Fig. 3.26: Temporal variation of chemical oxygen demand for the monitoring periods for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The chemical oxygen demand in the surface water ranged from 13.10 mg/l to 13.80 mg/l and from 13.00 mg/l to 14.00 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.27). During the monitoring period, the highest value was recorded during August 2023 at Kandaleru Creek and the lowest recorded during October 2022 at Kandaleru Creek.

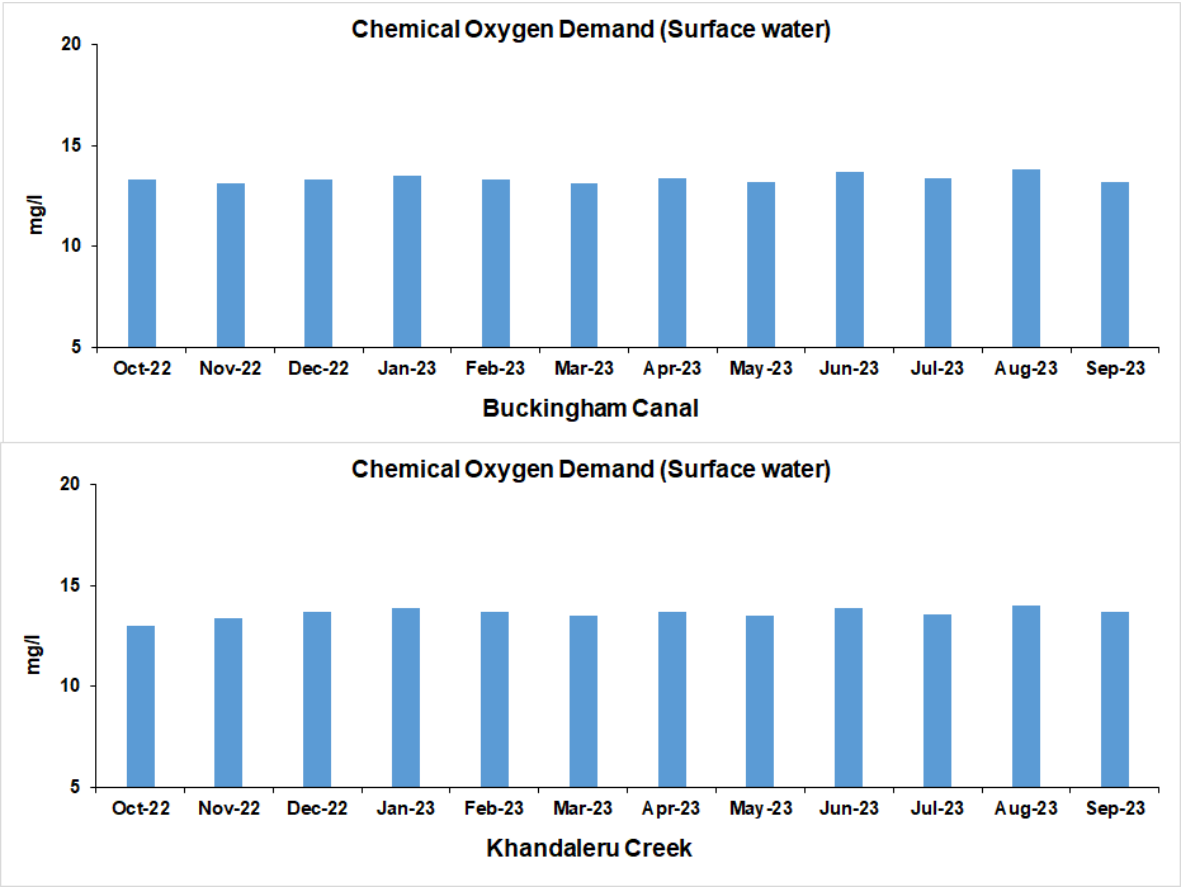


Fig. 3.27: Temporal variation of chemical oxygen demand for the monitoring periods for surface waters (Buckingham Canal and Khandaleru Creek)

3.4.11. BOD

Marine water

The biological oxygen demand in the marine water ranged from 2.70 mg/l to 3.42 mg/l, from 2.82 mg/l to 3.58 mg/l, from 2.48 mg/l to 3.35 mg/l and from 3.20 mg/l to 3.85 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.28). During the monitoring period, the highest value was recorded during October 2022 at Reclamation Area and the lowest recorded during September 2023 at Coal Berth.

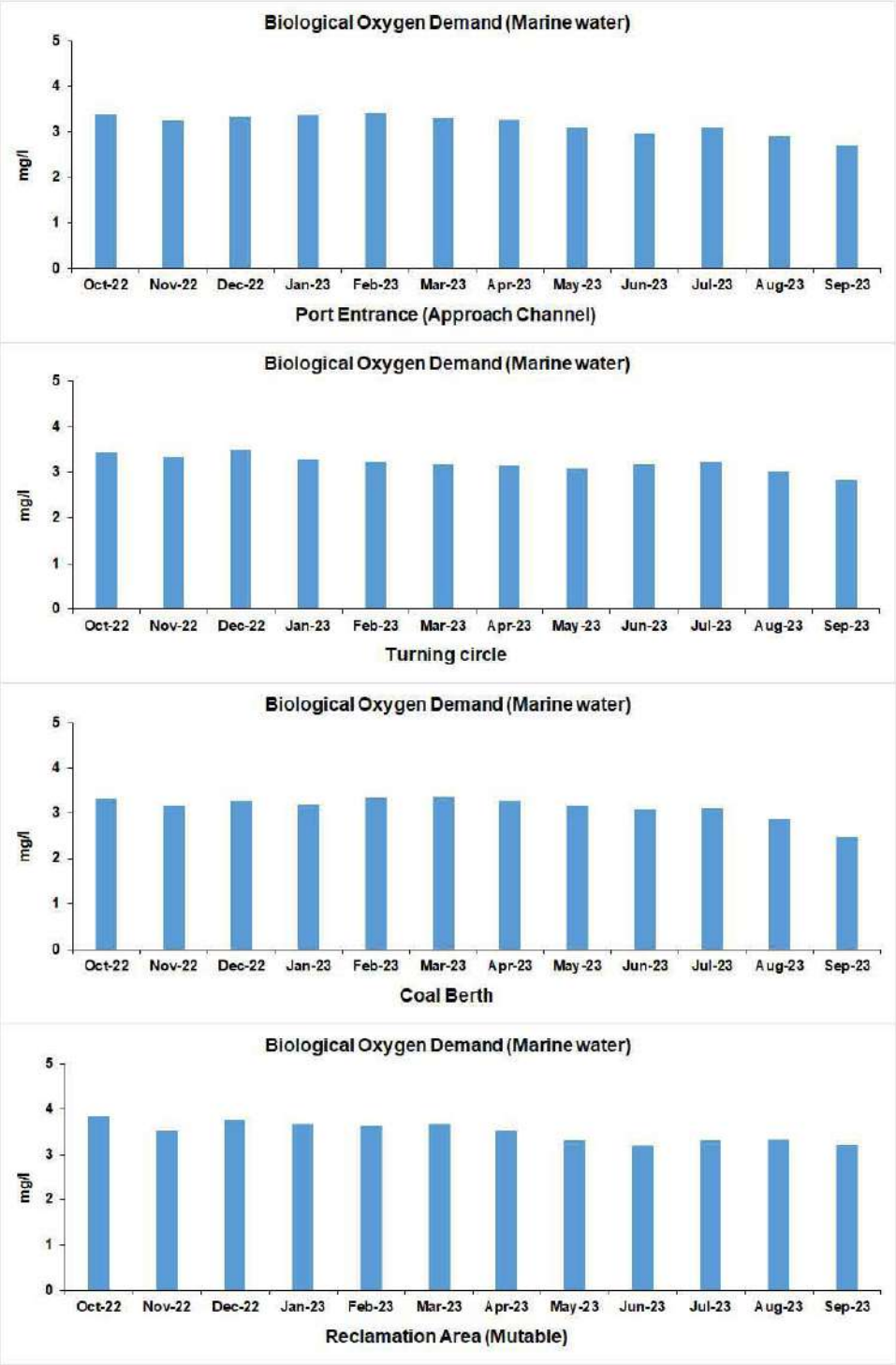


Fig. 3.28: Temporal variation of biological oxygen demand for the monitoring periods for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The biological oxygen demand in the surface water ranged from 3.10 mg/l to 3.40 mg/l and from 3.20 mg/l to 3.80 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.29). During the monitoring period, the highest value was recorded during December 2023 at Kandaleru Creek and the lowest recorded during May and September 2023 at Buckingham Canal.

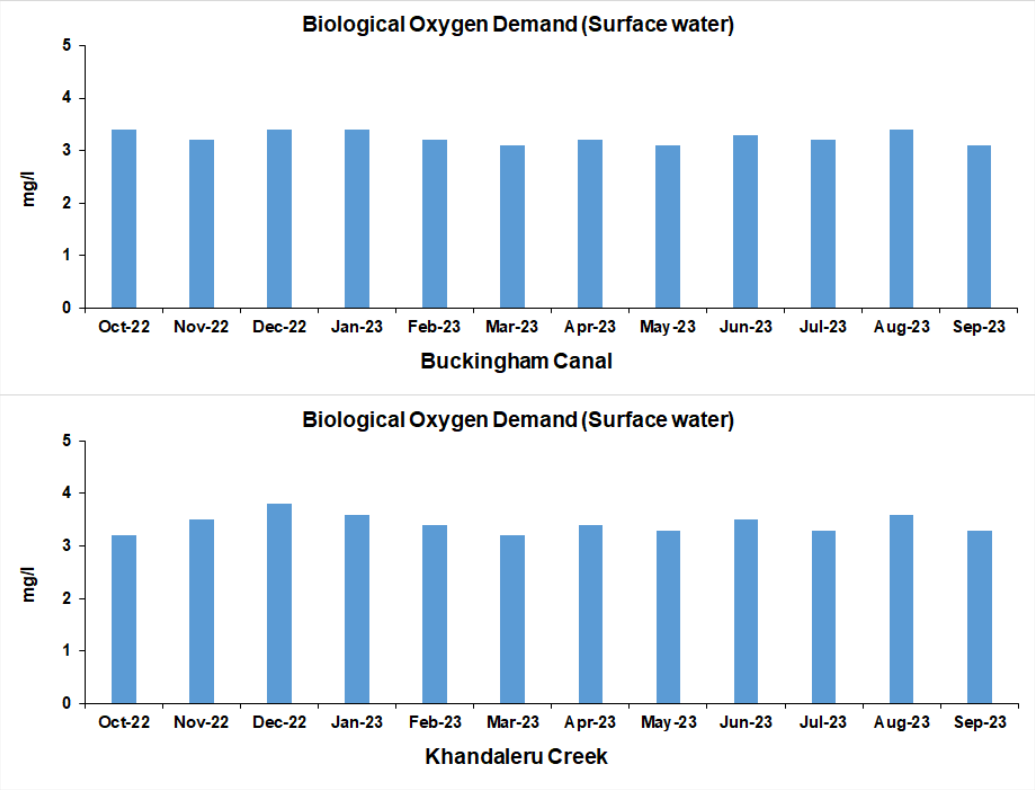


Fig. 3.29: Temporal variation of biological oxygen demand for the monitoring periods for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.12. Oil and grease

Marine water

The oil and grease levels in the marine water were below <0.1 mg/l for Port Entrance, Turning Circle and Coal Berth, where it varied from 0.34 to 0.55 mg/l for Reclamation Area (Fig. 3.30). During the monitoring period, the highest value was recorded during December 2022 and it was lowest in the month of March 2023.

Surface water

The oil and grease values in the surface water were less than <0.1 mg/l at the monitoring stations during the study period.

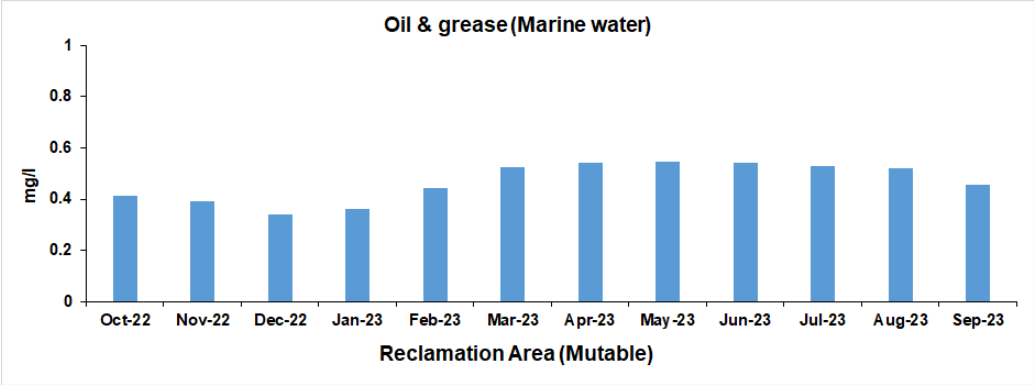
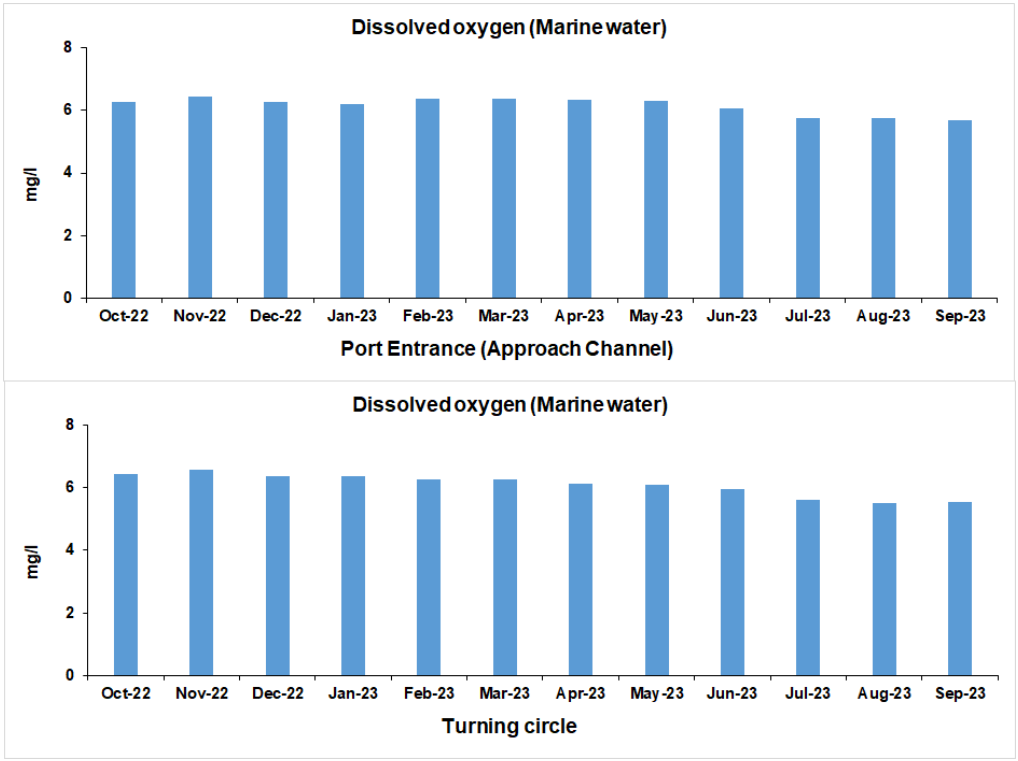


Fig. 3.30: Temporal variation of oil & grease for reclamation area for monitoring period for marine waters

3.4.13. Dissolved Oxygen (DO)

Marine water

The dissolved oxygen in the marine water ranged from 5.68 mg/l to 6.42 mg/l, from 5.5 mg/l to 6.58 mg/l, from 5.30 mg/l to 6.35 mg/l and from 3.90 mg/l to 4.38 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.31). During the monitoring period, the highest value was recorded during November 2022 at Turning Circle and the lowest recorded during July 2023 at Reclamation area.



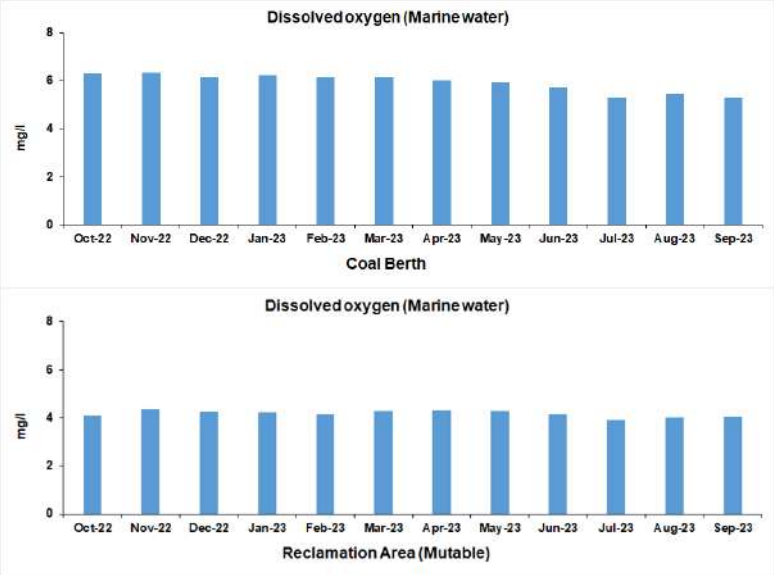


Fig. 3.31: Temporal variation of dissolved oxygen for the monitoring periods for marine waters (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

Surface water

The dissolved oxygen in the surface water ranged from 6.00 mg/l to 6.90 mg/l and from 5.70 mg/l to 6.60 mg/l for Buckingham Canal and Khandaleru Creek respectively (Fig. 3.32.). During the monitoring period, the highest value was recorded during November 2022 at Buckingham Canal and the lowest recorded during August 2023 at Kandaleru Creek.

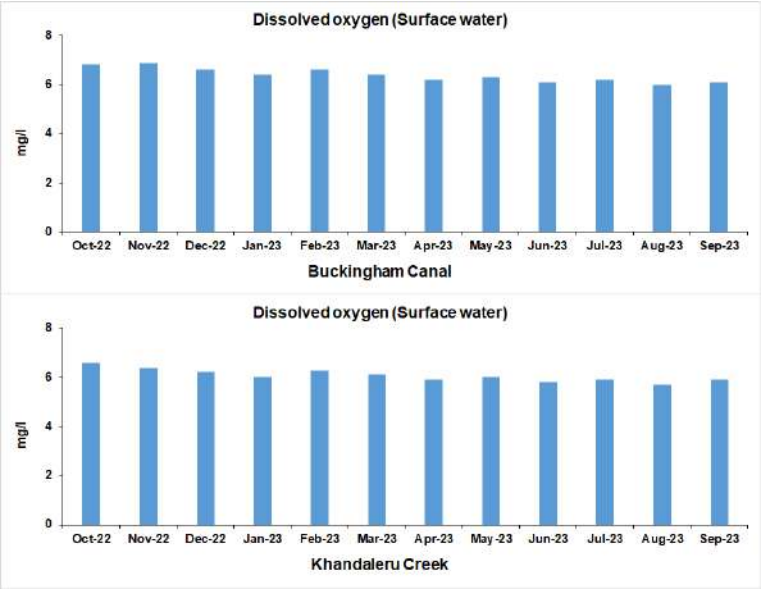


Fig. 3.32: Temporal variation of dissolved oxygen for the monitoring period for surface waters (Buckingham Canal and Khandaleru Creek)

3.4.14. Nitrates

Marine water

The nitrates in the marine water ranged from 4.00 mg/l to 6.50 mg/l, from 3.80 mg/l to 6.38 mg/l, from 4.23 mg/l to 6.73 mg/l and from 5.40 mg/l to 7.70 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.33). During the monitoring period, the highest value was recorded during April 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle.

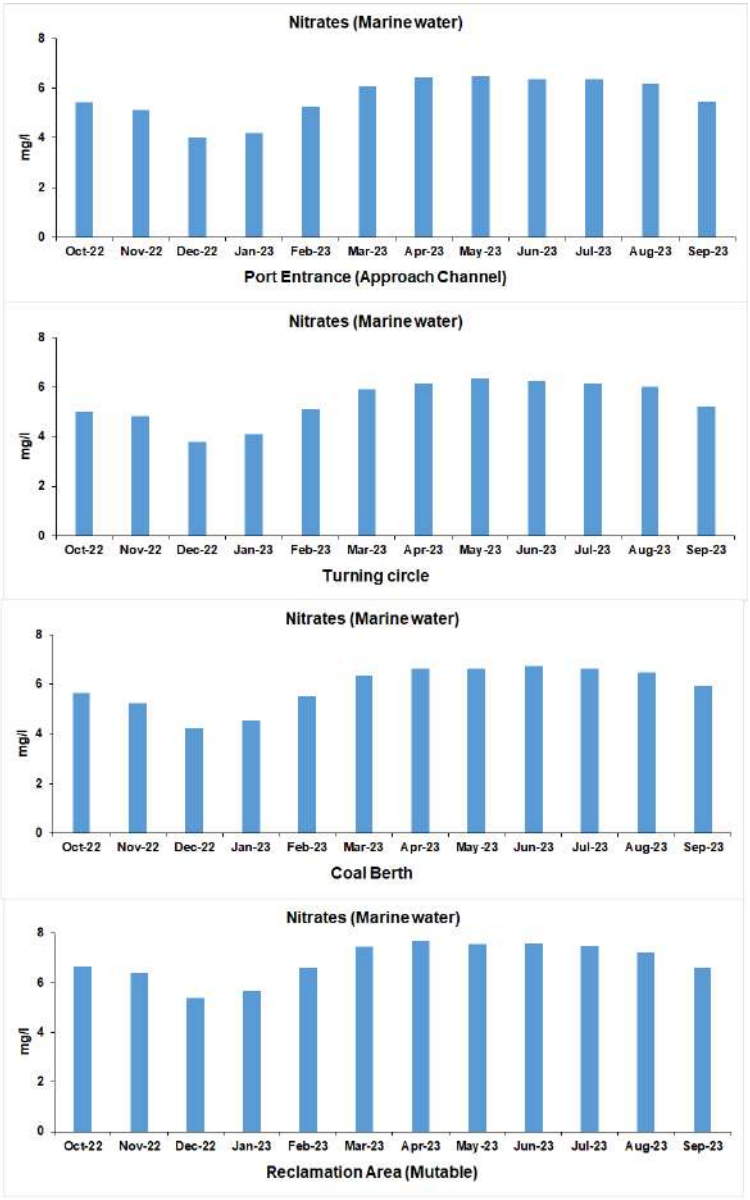


Fig. 3.33: Temporal variation of nitrates for the monitoring period for the monitoring periods for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The nitrates in the surface water ranged from 1.03 mg/l to 1.30 mg/l and from 1.00 mg/l to 1.23 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.34). During the monitoring period, the highest value was recorded during August 2023 at Buckingham Canal and the lowest recorded during September 2023 at Kandaleru Creek.

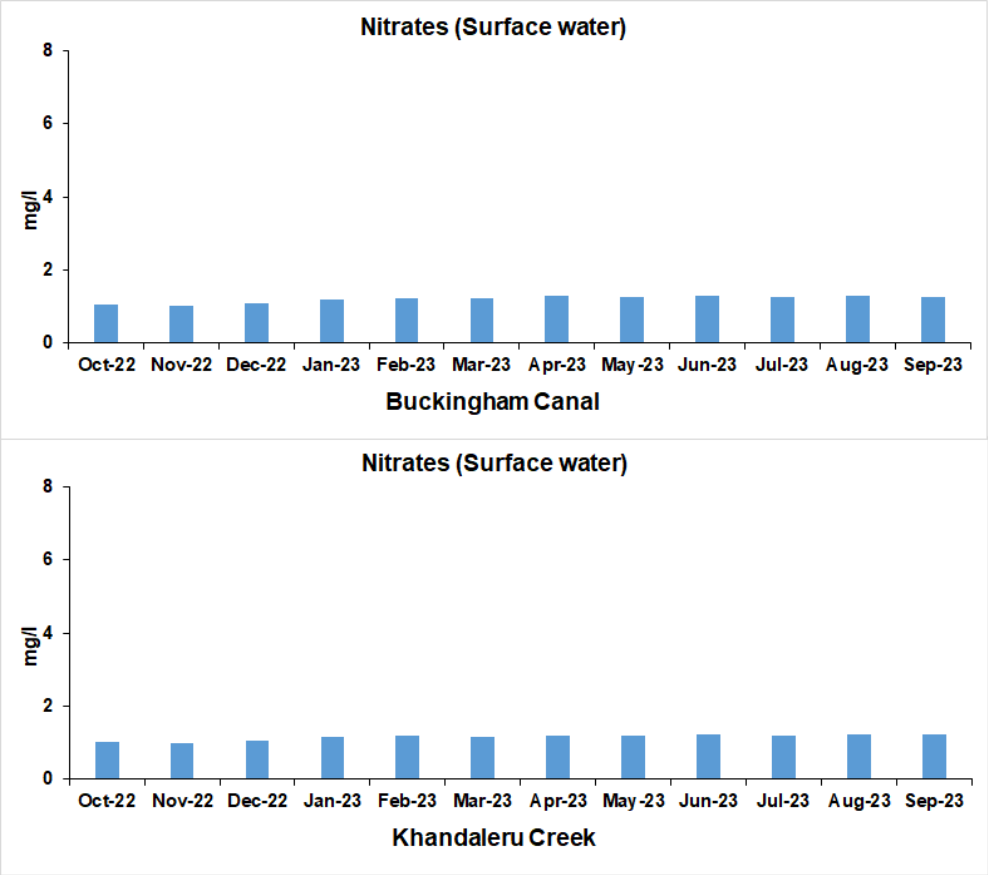


Fig. 3.34: Temporal variation of nitrates for the monitoring period for surface waters (Buckingham Canal and Khandaleru Creek)

3.4.15. Nitrites

Marine water

The nitrites in the marine water ranged from 0.03 mg/l to 0.29 mg/l, from 0.04 mg/l to 0.31 mg/l, from 0.03 mg/l to 0.33 mg/l and from 0.08 mg/l to 0.37 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.35). During the monitoring period, the highest value was recorded during May 2023 at Reclamation Area and the lowest recorded during December 2022 at Port entrance and Coal Berth.

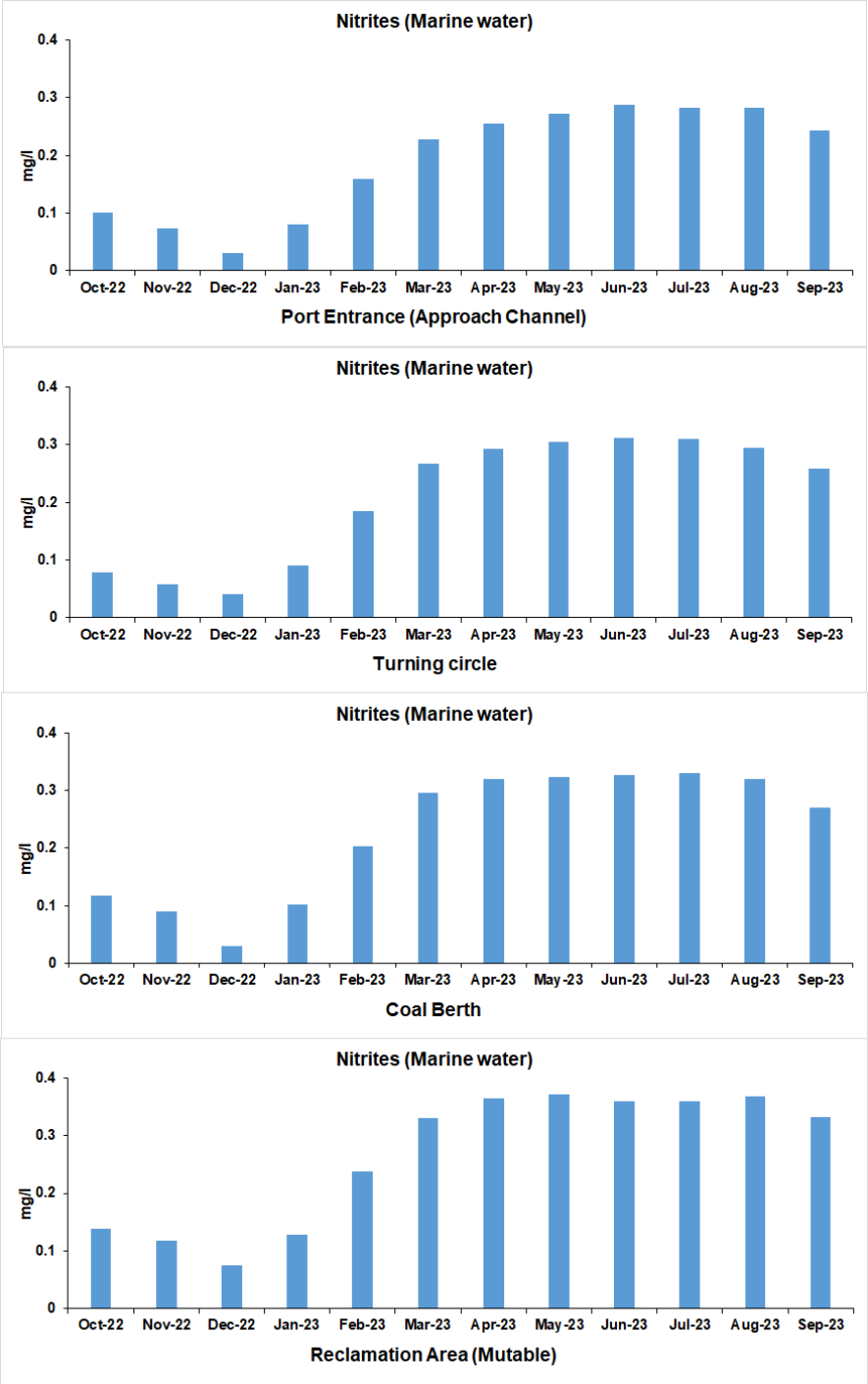


Fig. 3.35: Temporal variation of nitrites for the monitoring period for the monitoring periods for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The nitrites in the surface water were below <0.1 mg/l at the monitoring stations during the study period.

3.4.16. Ammonia

Marine water

The ammonia in the marine water ranged from 0.34 mg/l to 0.59 mg/l for Reclamation Area, whereas in Port Entrance, Turning Circle and Coal Berth the presence of ammonia was below <0.001 mg/l. (Fig. 3.36). During the monitoring period, the highest value was recorded during May 2023 at Reclamation Area and the lowest recorded during December 2022 at Reclamation Area.

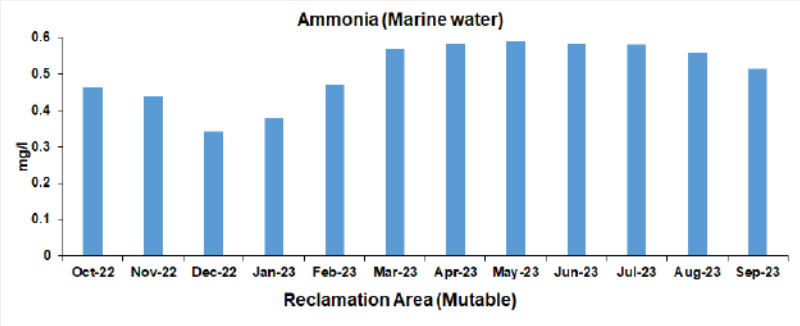


Fig. 3.36: Temporal variation of ammonia for the reclamation area for marine waters

Surface water

The ammonia in the surface water ranged from 0.02 mg/l to 0.03 mg/l and from 0.03 mg/l to 0.04 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.37). During the monitoring period, the highest value was recorded during June 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

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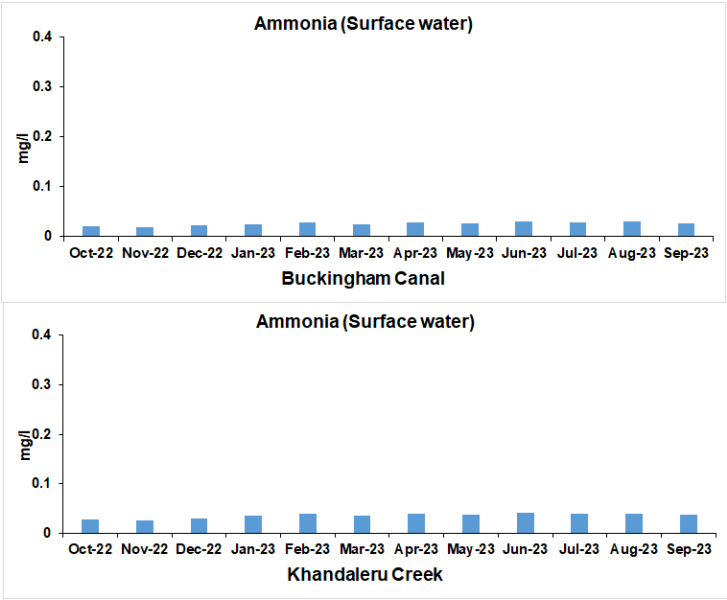


Fig. 3.37: Temporal variation of ammonia for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.17. Phosphates

Marine water

The phosphates in the marine water ranged from 0.13 mg/l to 0.41 mg/l, from 0.15 mg/l to 0.43 mg/l, from 0.20 mg/l to 0.45 mg/l and from 0.39 mg/l to 1.47 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.38). During the monitoring period, the highest value was recorded during August 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

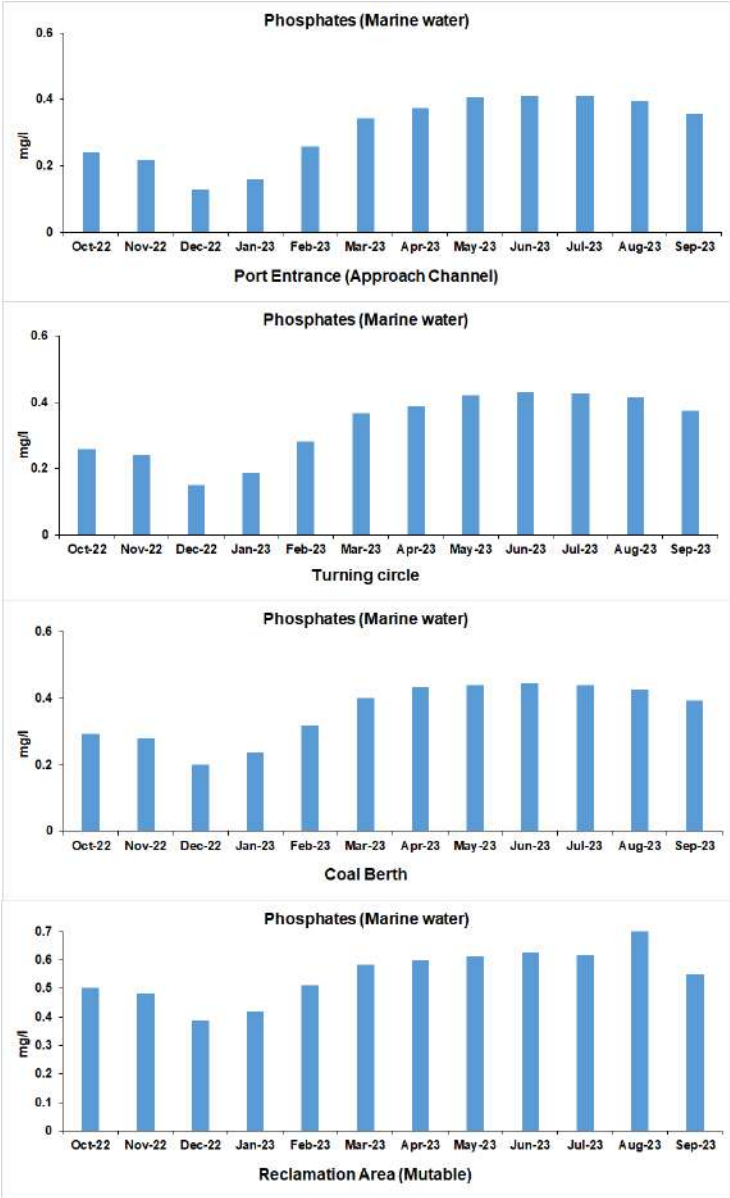


Fig. 3.38: Temporal variation of phosphate for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The phosphates in the surface water ranged from 0.27 mg/l to 0.40 mg/l and from 0.72 mg/l to 0.83 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.39). During the monitoring period, the highest value was recorded during August 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

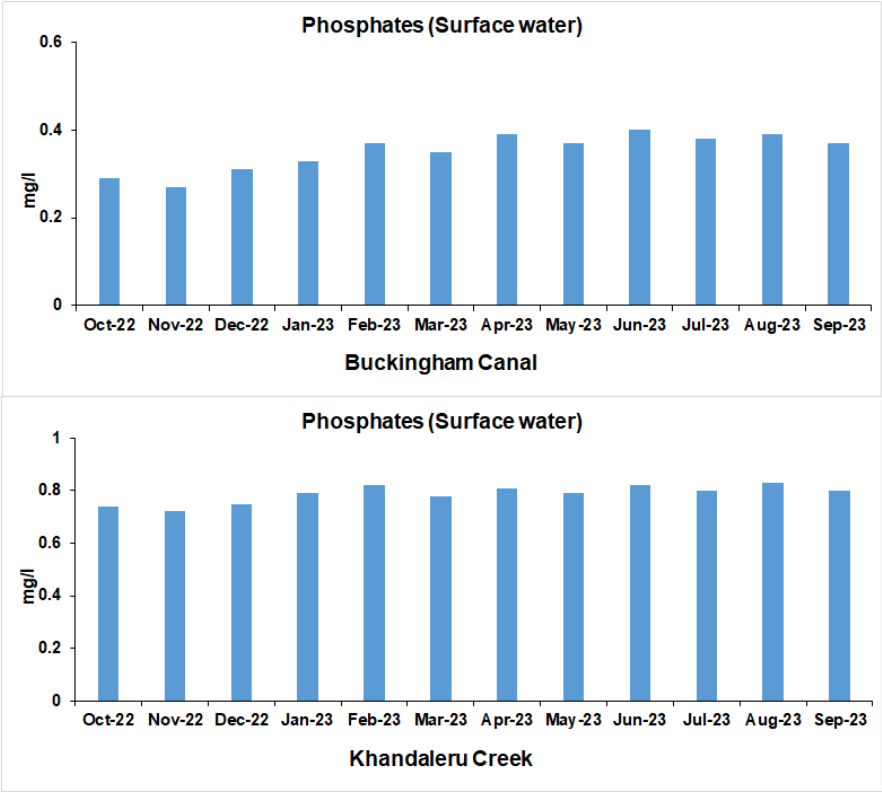


Fig. 3.39: Temporal variation of phosphate for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.18. Chlorides

Marine water

The chlorides in the marine water ranged from 20143 mg/l to 21000 mg/l, from 20214 mg/l to 21007 mg/l, from 20364 mg/l to 21077 mg/l and from 20555 mg/l to 21283 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.40). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

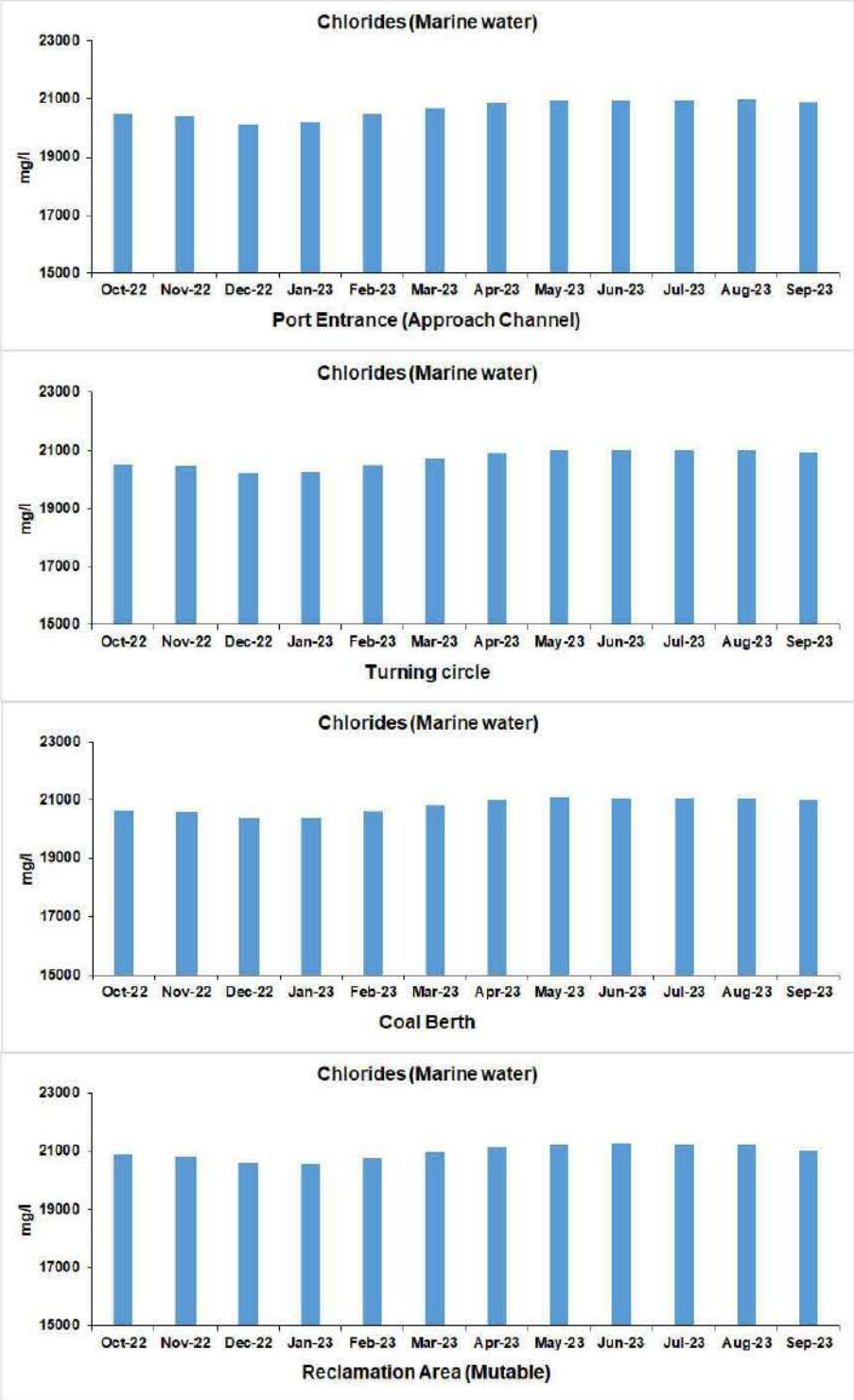


Fig. 3.40: Temporal variation of chloride for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The chlorides in the surface water ranged from 18043 mg/l to 18310 mg/l and from 17672 mg/l to 18024 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.41). During the monitoring period, the highest value was recorded during June 2023 at Buckingham Canal and the lowest recorded during November 2022 at Kandaleru Creek.

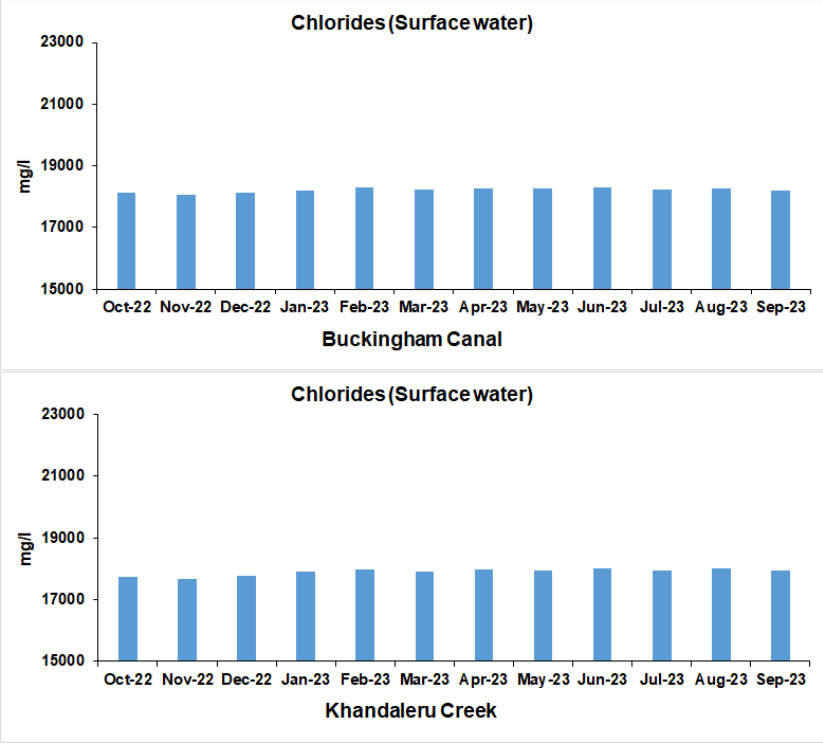


Fig. 3.41: Temporal variation of chloride for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.19. Sodium

Marine water

The sodium in the marine water ranged from 7593 mg/l to 7968 mg/l, from 7711 mg/l to 8277 mg/l, from 7595 mg/l to 8268 mg/l and from 8102 mg/l to 8681 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.42). During the monitoring period, the highest value was recorded during August 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

Fig. 3.42: Temporal variation of sodium for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The sodium in the surface water ranged from 7193 mg/l to 7438 mg/l and from 6954 mg/l to 7210 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.43). During the monitoring period, the highest value was recorded during June 2023 at Buckingham Canal and the lowest recorded during November 2022 at Kandaleru Creek.

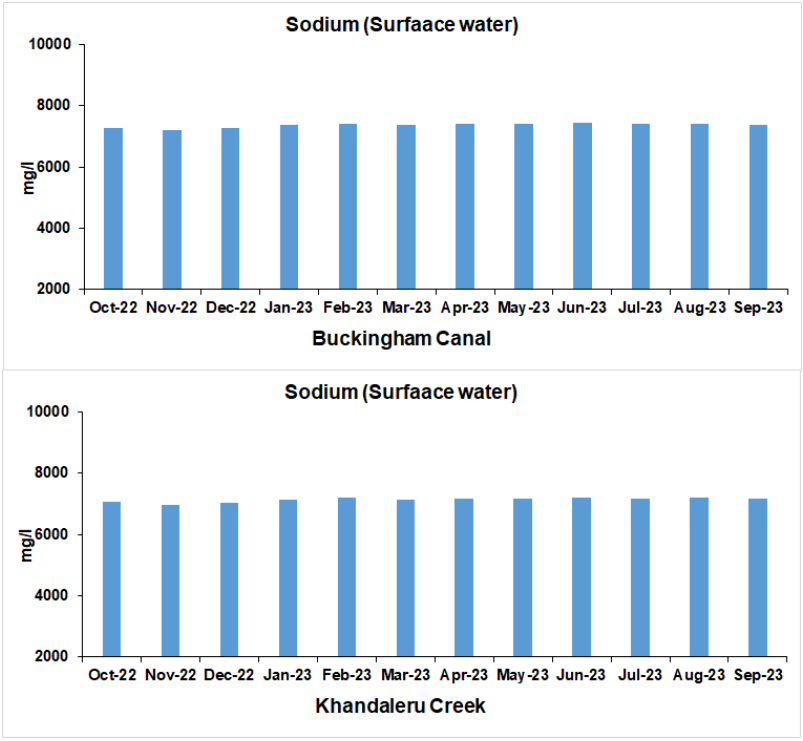


Fig. 3.43: Temporal variation of sodium for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.20. Sulphates

Marine water

The sulphates in the marine water ranged from 3155 mg/l to 3625 mg/l, from 2925 mg/l to 3456 mg/l, from 2977 mg/l to 3435 mg/l and from 3212 mg/l to 3734 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.44). During the monitoring period, the highest value was recorded during June 2023 at Port Entrance and the lowest recorded during December 2022 at Turning Circle.

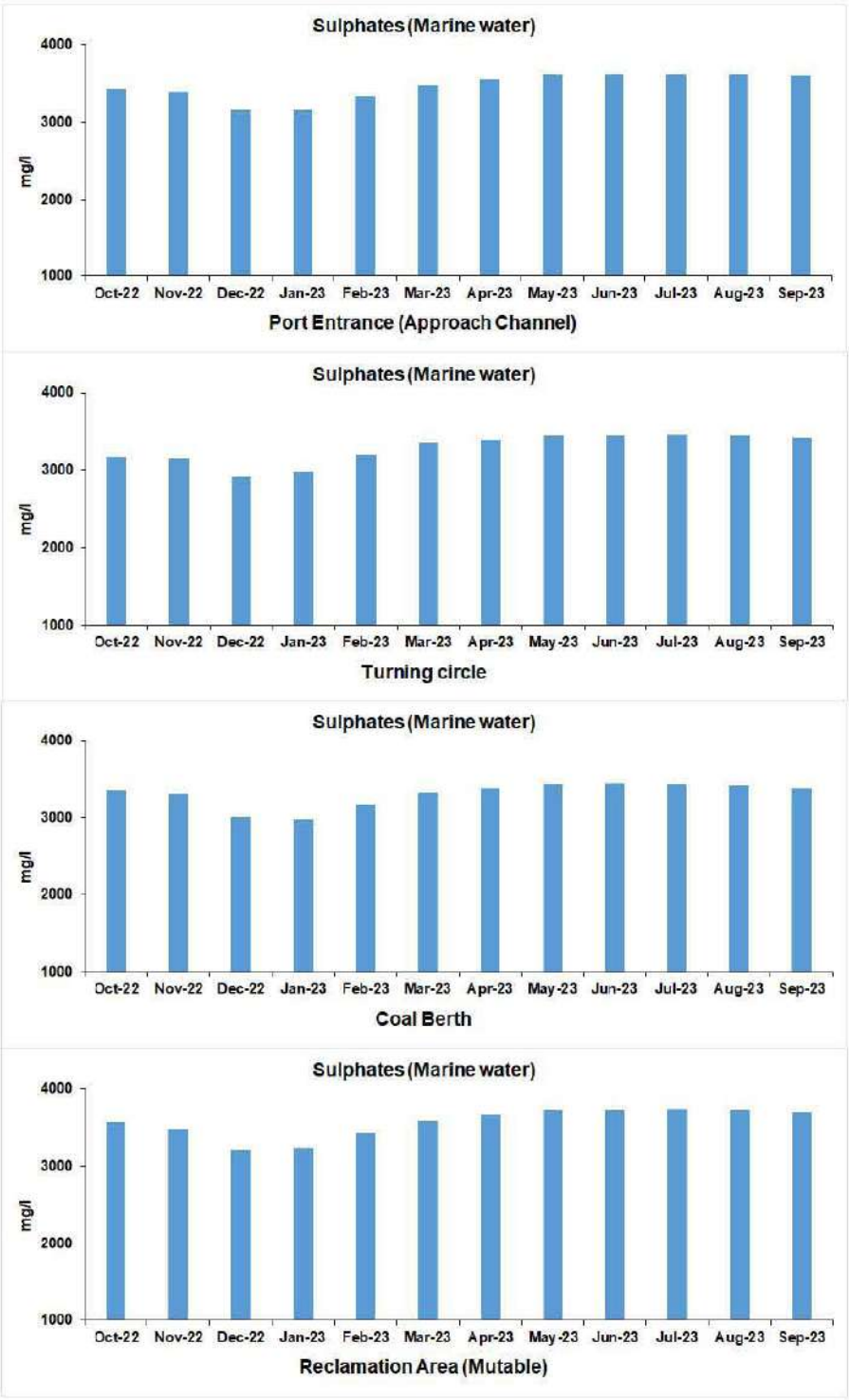


Fig. 3.44: Temporal variation of sulphate for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The sulphates in the surface water ranged from 2646 mg/l to 2866 mg/l and from 2738 mg/l to 2932 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.45). During the monitoring period, the highest value was recorded during February 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

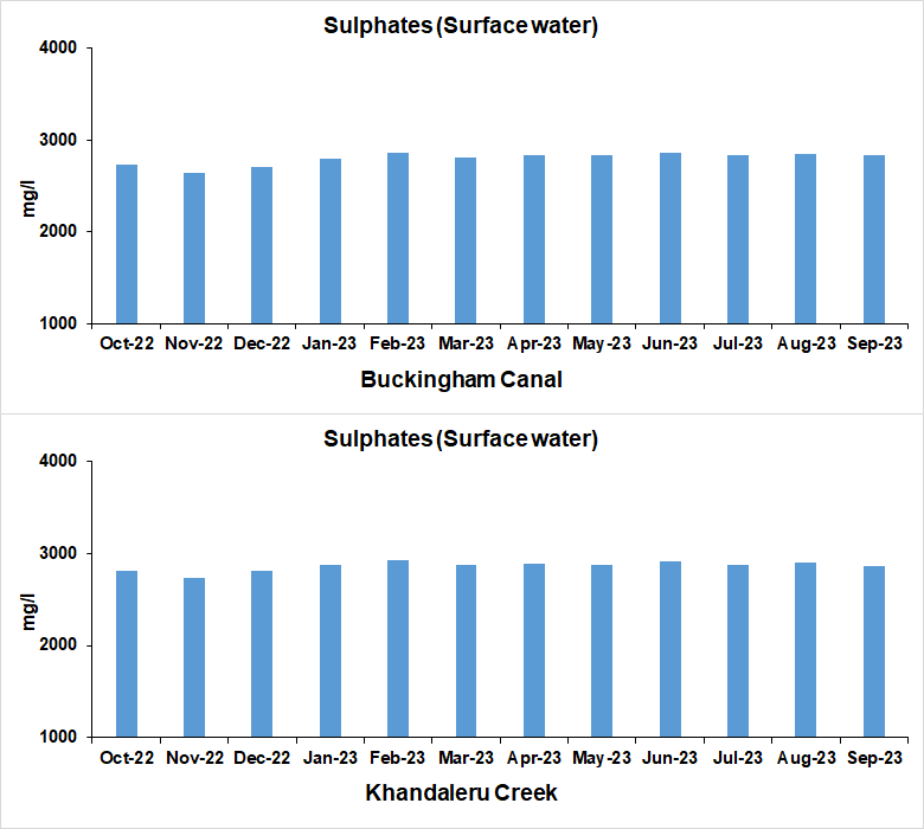


Fig. 3.45: Temporal variation of sulphate for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.21. Silicates

Marine water

The silicates in the marine water ranged from 1.60 mg/l to 3.65 mg/l, from 1.90 mg/l to 4.10 mg/l, from 1.80 mg/l to 4.25 mg/l and from 2.43 mg/l to 4.68 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.46). During the monitoring period, the highest value was recorded during June 2023 at Port Entrance and the lowest recorded during December 2022 at Port Entrance.

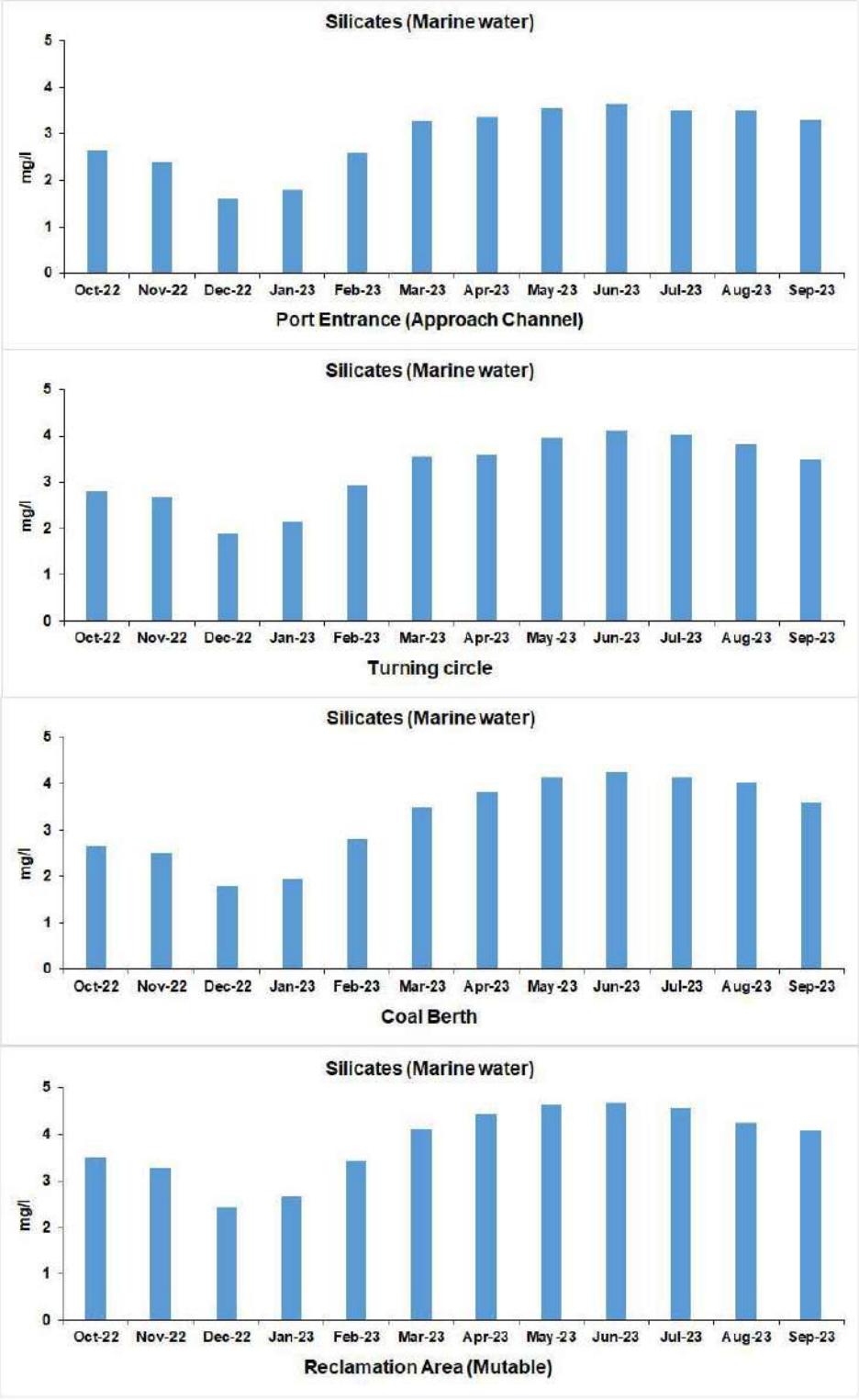


Fig. 3.46: Temporal variation of silicate for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The silicates in the surface water ranged from 1.27 mg/l to 1.45 mg/l and from 1.42 mg/l to 1.61 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.47). During the monitoring period, the highest value was recorded during June 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

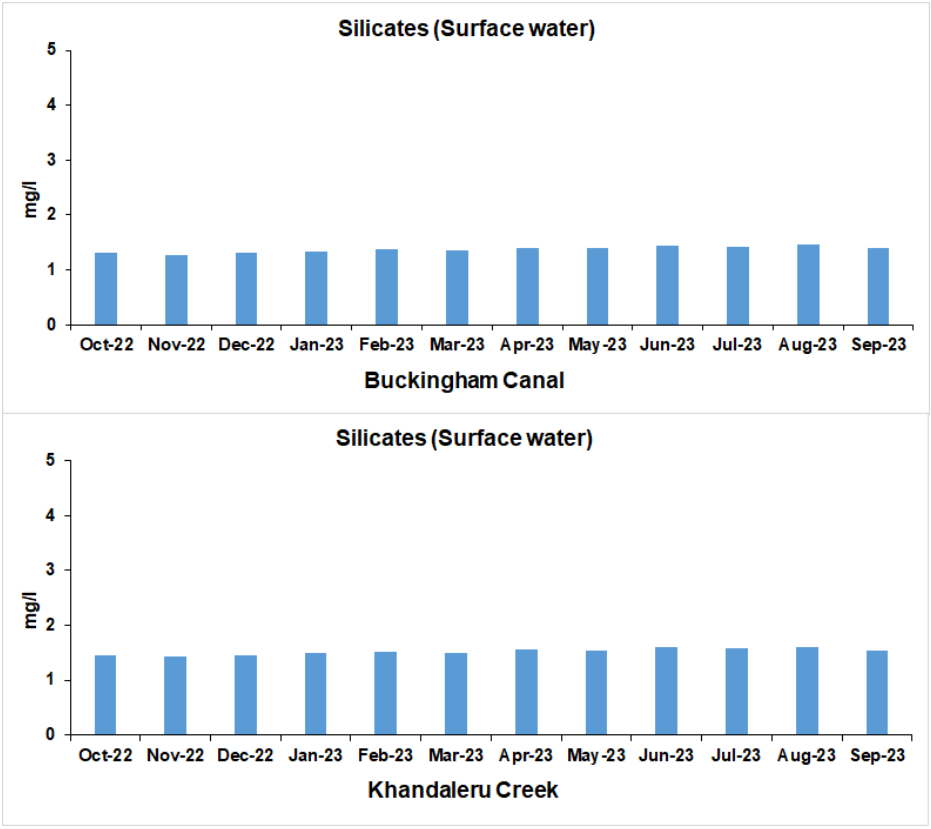


Fig. 3.47: Temporal variation of silicate for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.22. Reactive silica

Marine water

The Reactive silica in the marine water ranged from 0.01 mg/l to 0.03 mg/l, from 0.01 mg/l to 0.04 mg/l, from 0.01 mg/l to 0.04 mg/l and from 0.02 mg/l to 0.05 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.48). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance, Turning Circle and Coal Berth.

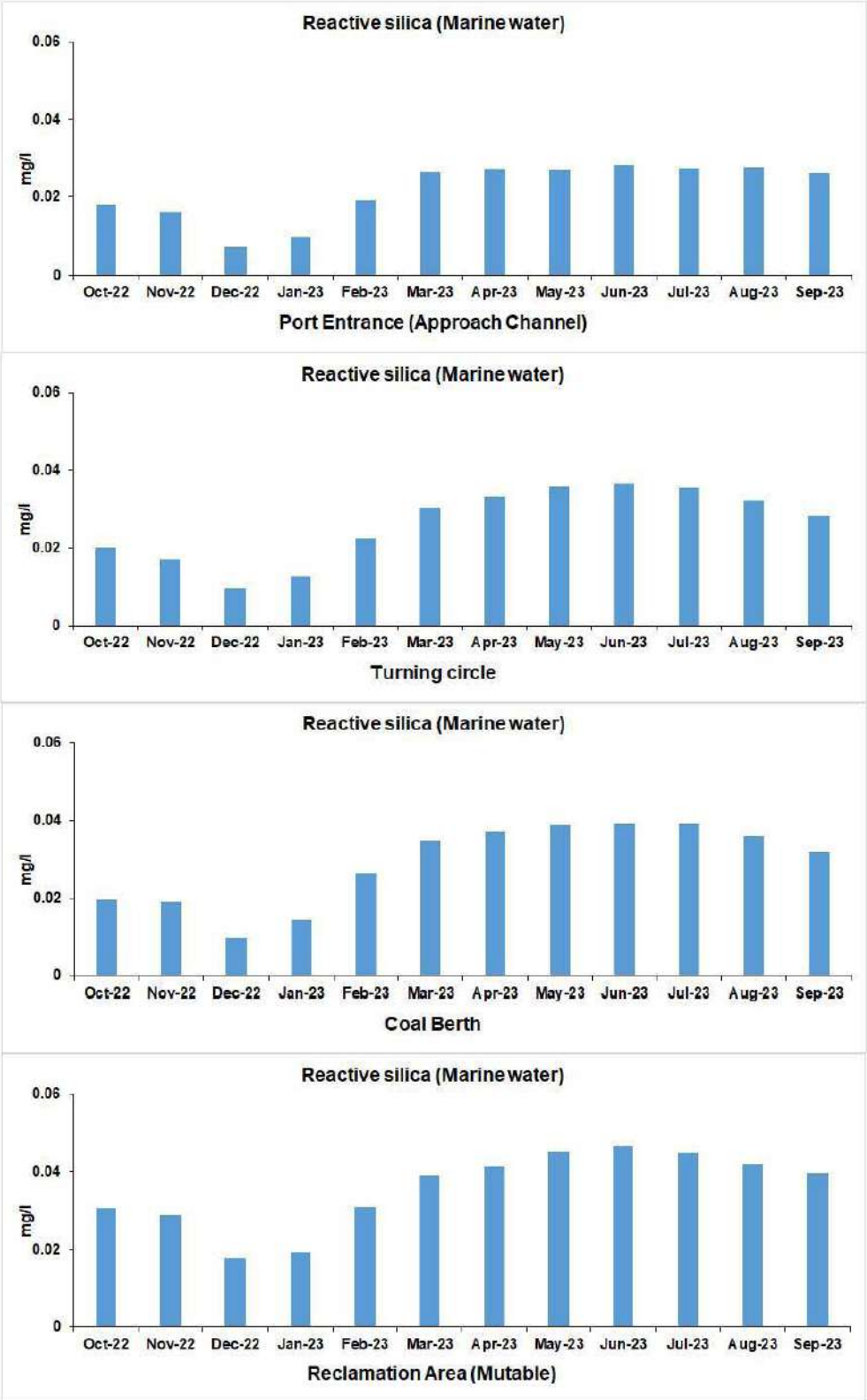


Fig. 3.48: Temporal variation of reactive silica for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The reactive silica in the surface water ranged from 0.30 mg/l to 0.44 mg/l and from 0.45 mg/l to 0.60 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.49). During the monitoring period, the highest value was recorded during August 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

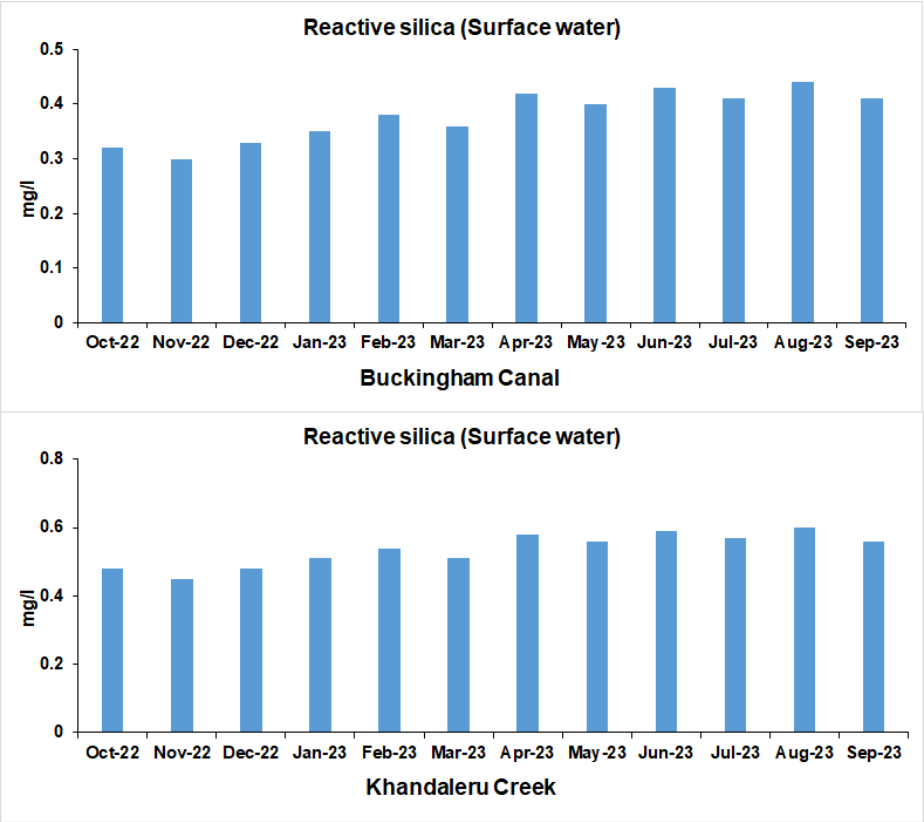


Fig. 3.49: Temporal variation of reactive silica for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.23. Total Phosphorus

Marine water

The total phosphorus in the marine water ranged from 0.09 mg/l to 0.35 mg/l, from 0.07 mg/l to 0.33 mg/l, from 0.11 mg/l to 0.41 mg/l and from 0.21 mg/l to 0.53 mg/l for Port Entrance, Turning circle, Coal Berth and Reclamation Area respectively (Fig. 3.50). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

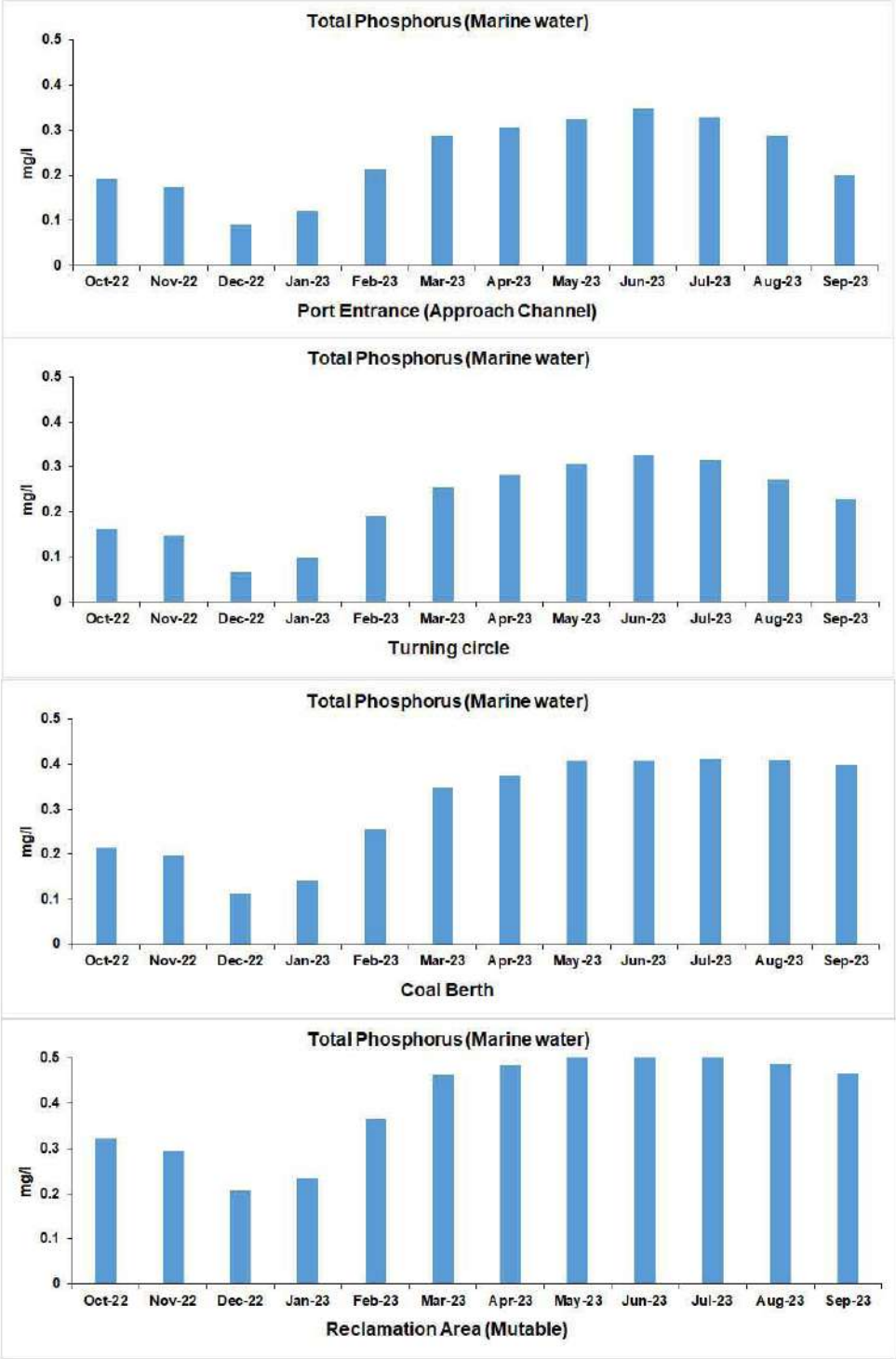


Fig. 3.50: Temporal variation of total phosphorus for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The total phosphorus in the surface water ranged from 0.21 mg/l to 0.32 mg/l and from 0.36 mg/l to 0.48 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.51). During the monitoring period, the highest value was recorded during August 2023 at Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal.

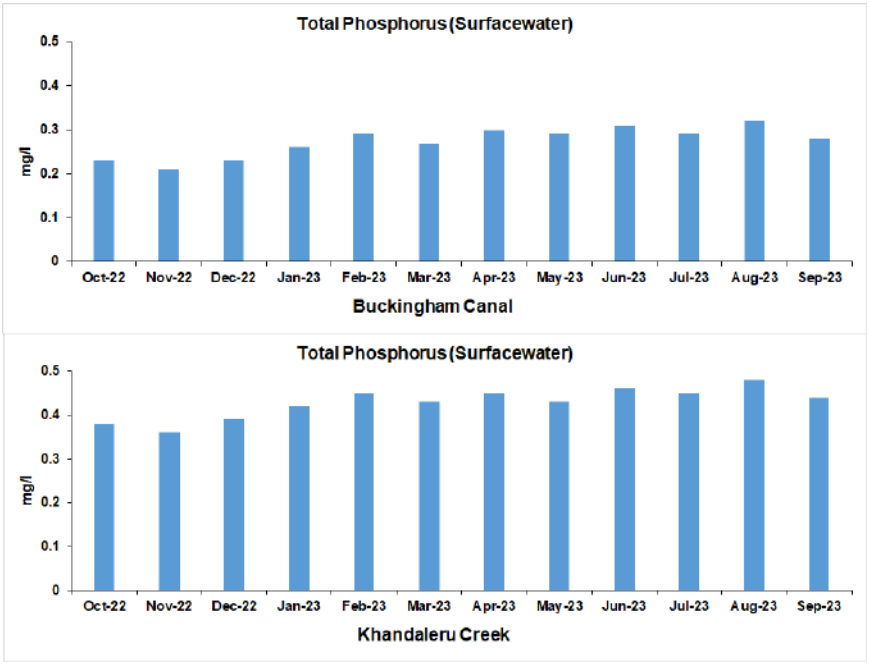


Fig. 3.51: Temporal variation of total phosphorus for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.24. Total Nitrogen

Marine water

The total nitrogen in the marine water ranged from 9.50 mg/l to 12.20 mg/l, from 9.23 mg/l to 11.55 mg/l, from 10.18 mg/l to 13.35 mg/l and from 11.68 mg/l to 14.45 mg/l for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.52). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle.

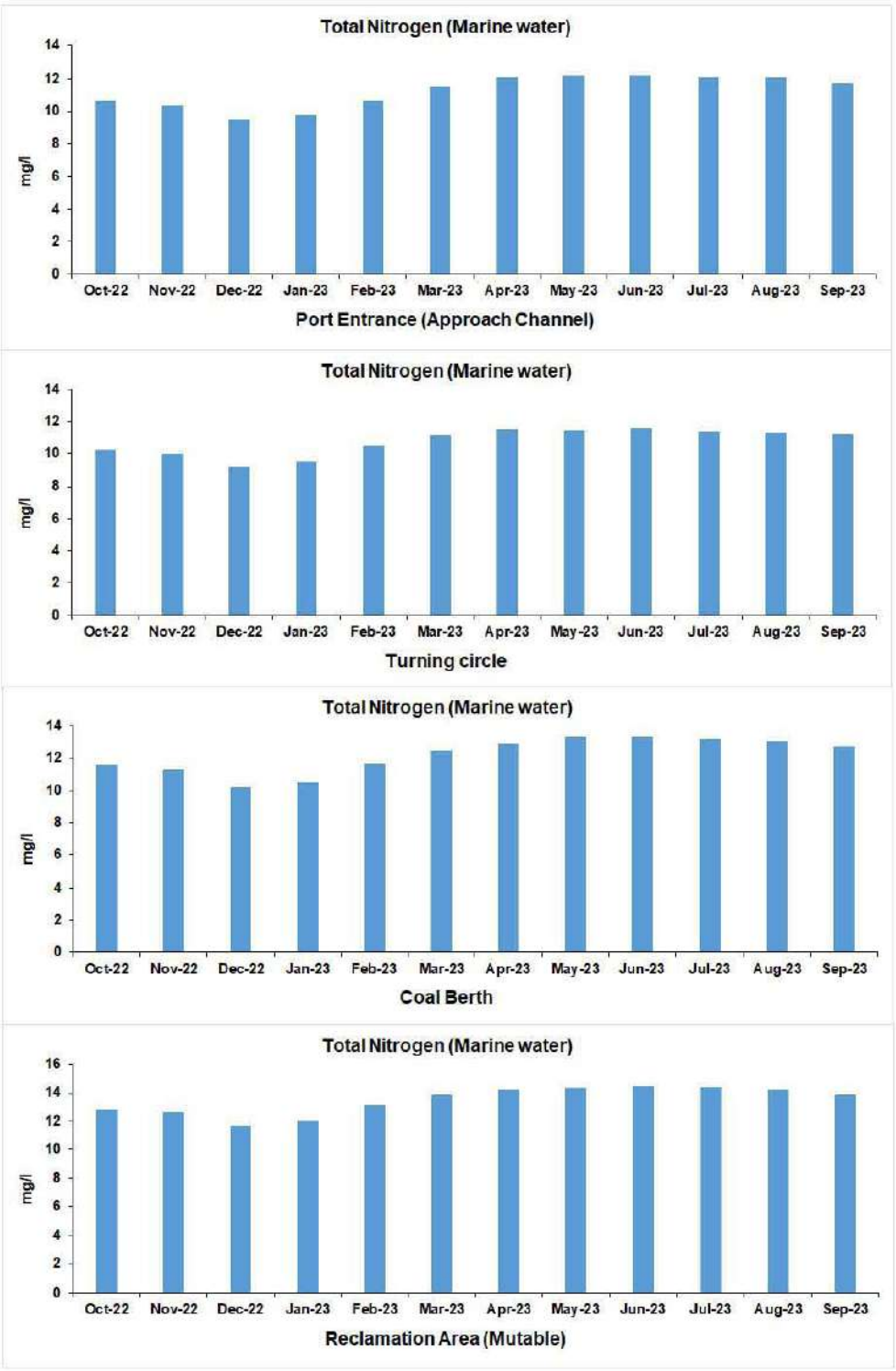


Fig. 3.52: Temporal variation of total nitrogen for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The total nitrogen in the surface water ranged from 9.50 mg/l to 11.20 mg/l and from 9.00 mg/l to 10.40 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.53). During the monitoring period, the highest value was recorded during August 2023 at Buckingham Canal and the lowest recorded during November 2022 at Kandaleru Creek.

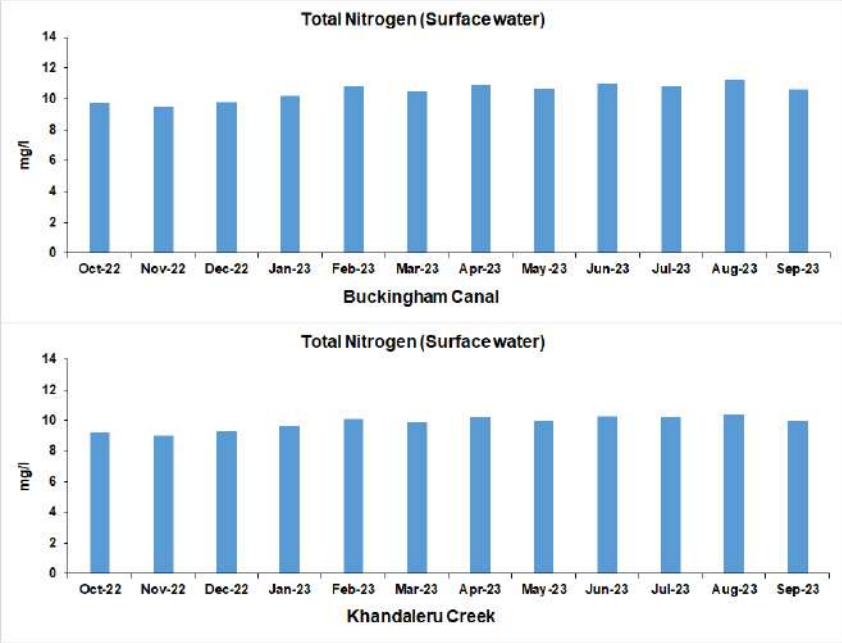


Fig. 3.53: Temporal variation of total phosphorus for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.25. Lead

Marine water

The Lead level was below <0.01 mg/l in the marine water at Port Entrance, Turning Circle, Coal Berth and Reclamation Area.

Surface water

The Lead concentration was below the <0.01 mg/l in the surface water at Buckingham canal and Kandaleru Creek.

3.4.26. Cadmium

Marine water

The concentration of cadmium in the marine water ranged from 0.15 to 0.42 mg/l, for Reclamation Area. Other areas like Port Entrance, Turning Circle, Coal Berth and Reclamation Area have Cadmium below <0.01 mg/l in the marine water (Fig. 3.54). During the monitoring period, the highest value was recorded during May and June 2023 and the lowest recorded during December 2022 at Reclamation Area.

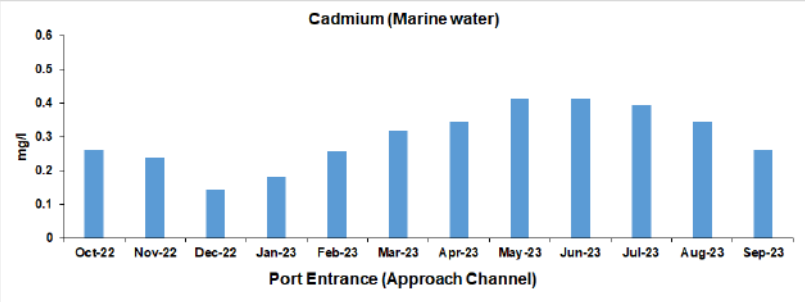


Fig. 3.54: Temporal variation of cadmium for the monitoring period for marine waters of reclamation area

Surface water

The cadmium was below the <0.01 mg/l in the surface at Buckingham Canal and Kandaleru Creek.

3.4.27. Copper

Marine water

The concentration of copper in the marine water ranged from 0.01 to 0.05 mg/l, from 0.02 to 0.05 mg/l for Coal Berth and Reclamation Area respectively, whereas copper concentration was <0.02 mg/l in the marine waters of Port Entrance and Turning circle (Fig. 3.55). During the monitoring period, the highest value was recorded during June 2023 at Coal Berth and Reclamation Area and the lowest recorded during December 2022 at Coal Berth and Reclamation Area

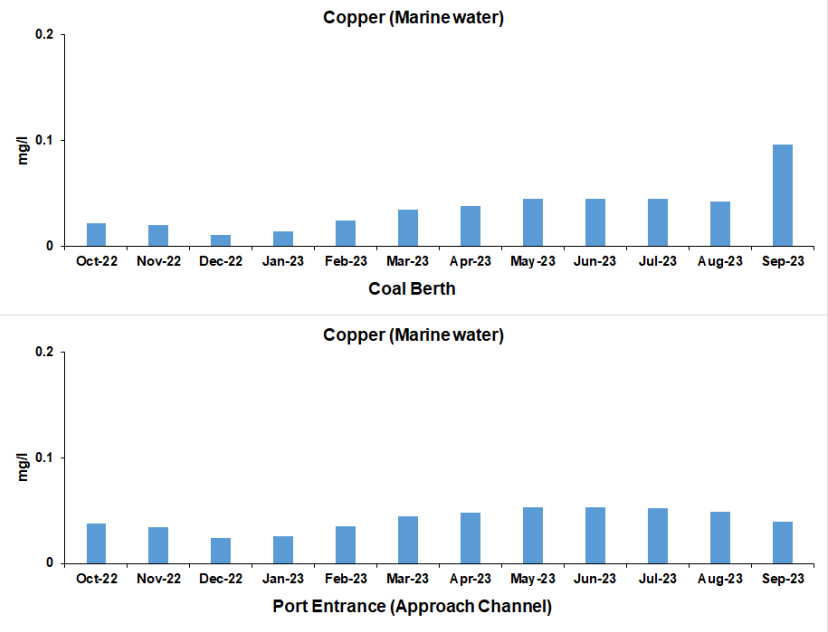


Fig. 3.55: Temporal variation of copper for the monitoring period for marine waters (Coal Berth and Reclamation Area)

Surface water

The concentration of copper in the surface water ranged from 0.01 to 0.31 mg/l for Kandaleru Creek, whereas for Buckingham Canal it was <0.02 mg/l (Fig. 3.56.). During the monitoring period, the highest value was recorded during August 2023 and the lowest recorded during November 2022 at Kandaleru Creek.

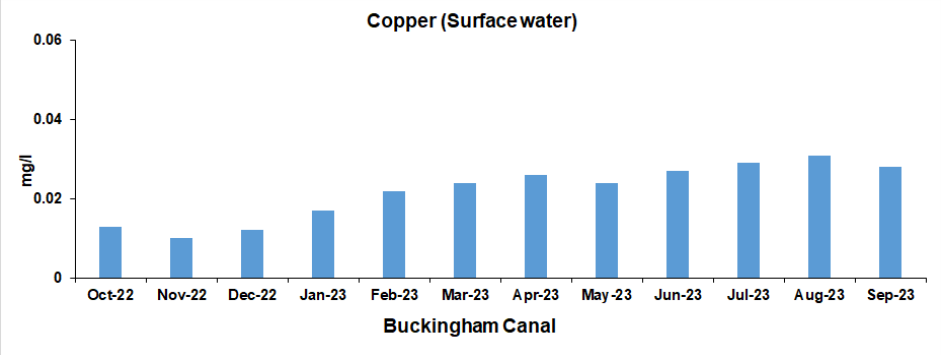
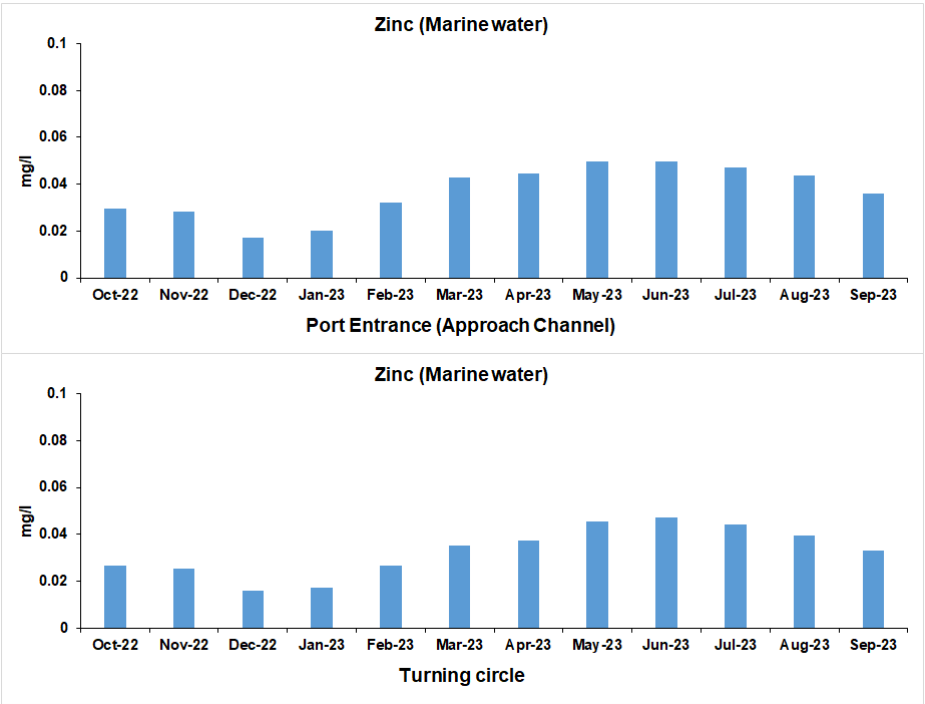


Fig. 3.56: Temporal variation of copper for the monitoring period for surface waters of Buckingham canal

3.4.28 Zinc

Marine water

The concentration of zinc in the marine water ranged from 0.02 to 0.05 mg/l, from 0.02 to 0.05 mg/l, from 0.02 to 0.06 mg/l and from 0.04 to 0.07 mg/l for Port Entrance, Turning circle, Coal Berth and Reclamation Area respectively (Fig. 3.57). During the monitoring period, the highest value was recorded at Reclamation Area and the lowest recorded at Turning Circle.



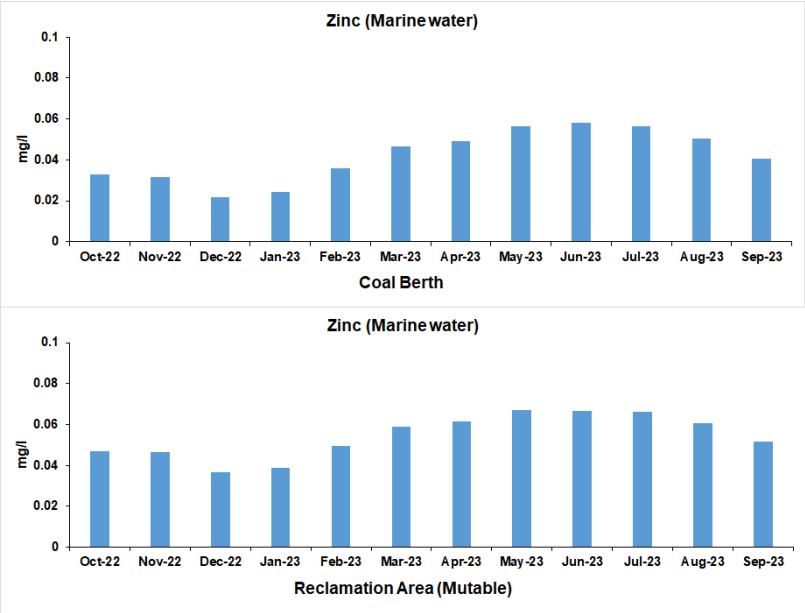


Fig. 3.57: Temporal variation of zinc for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The concentration of zinc in the surface water ranged from 0.01 to 0.04 mg/l and from 0.02 to 0.04 mg/l for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.58). During the monitoring period, the highest value was recorded during July and August 2023 at Buckingham Canal and Kandaleru Creek and the lowest recorded during November 2022 at Buckingham Canal and Kandaleru Creek.

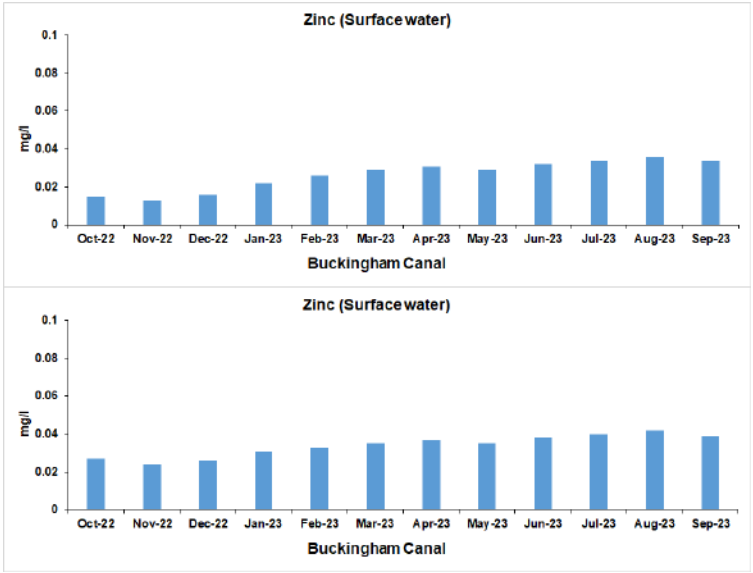


Fig. 3.58: Temporal variation of total phosphorus for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.29. Primary productivity

Marine water

The primary productivity in the marine water ranged from 41.50 to 58.75 mgC $m^{-2}d^{-1}$, from 30.50 to 40.50 mgC $m^{-2}d^{-1}$, from 31.75 to 51.00 mgC $m^{-2}d^{-1}$ and from 21.75 to 36.00 mgC $m^{-2}d^{-1}$ for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.59). During the monitoring period, the highest value was recorded during December 2022 at Port Entrance and the lowest recorded during June 2023 at Reclamation Area.

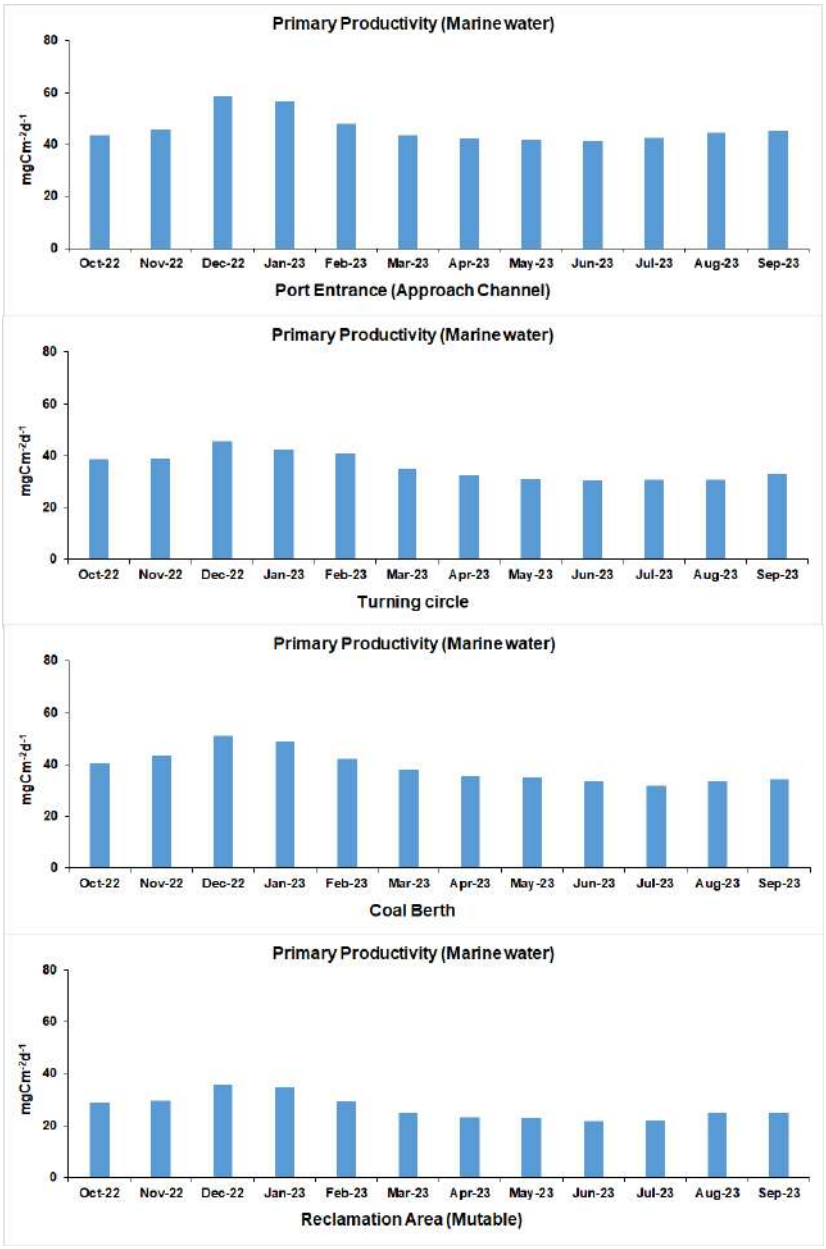


Fig. 3.59: Temporal variation of primary productivity for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The primary productivity in the surface water ranged from 48.00 to 58.00 mgC $m^{-2}d^{-1}$ and from 45.00 to 54.00 mgC $m^{-2}d^{-1}$ for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.60). During the monitoring period, the highest value was recorded during November 2022 at Buckingham Canal and the lowest recorded during August 2023 at Kandaleru Creek.

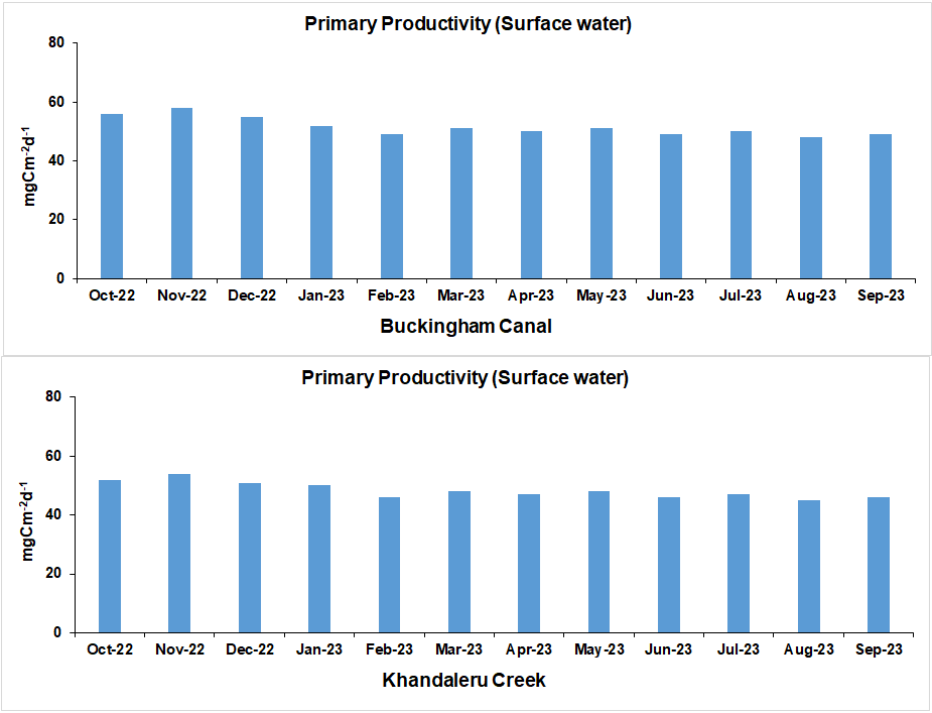


Fig. 3.60: Temporal variation of primary productivity for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.30. Chlorophyll

Marine water

The chlorophyll level in the marine water ranged from 1.52 to 1.70 mg/m^3, from 1.37 to 1.59 mg/m^3, from 1.32 to 1.57 mg/m^3 and from 1.25 to 1.42 mg/m^3 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.61). During the monitoring period, the highest value was recorded during December and January 2023 at Port Entrance and the lowest recorded during July 2023 at Reclamation Area.

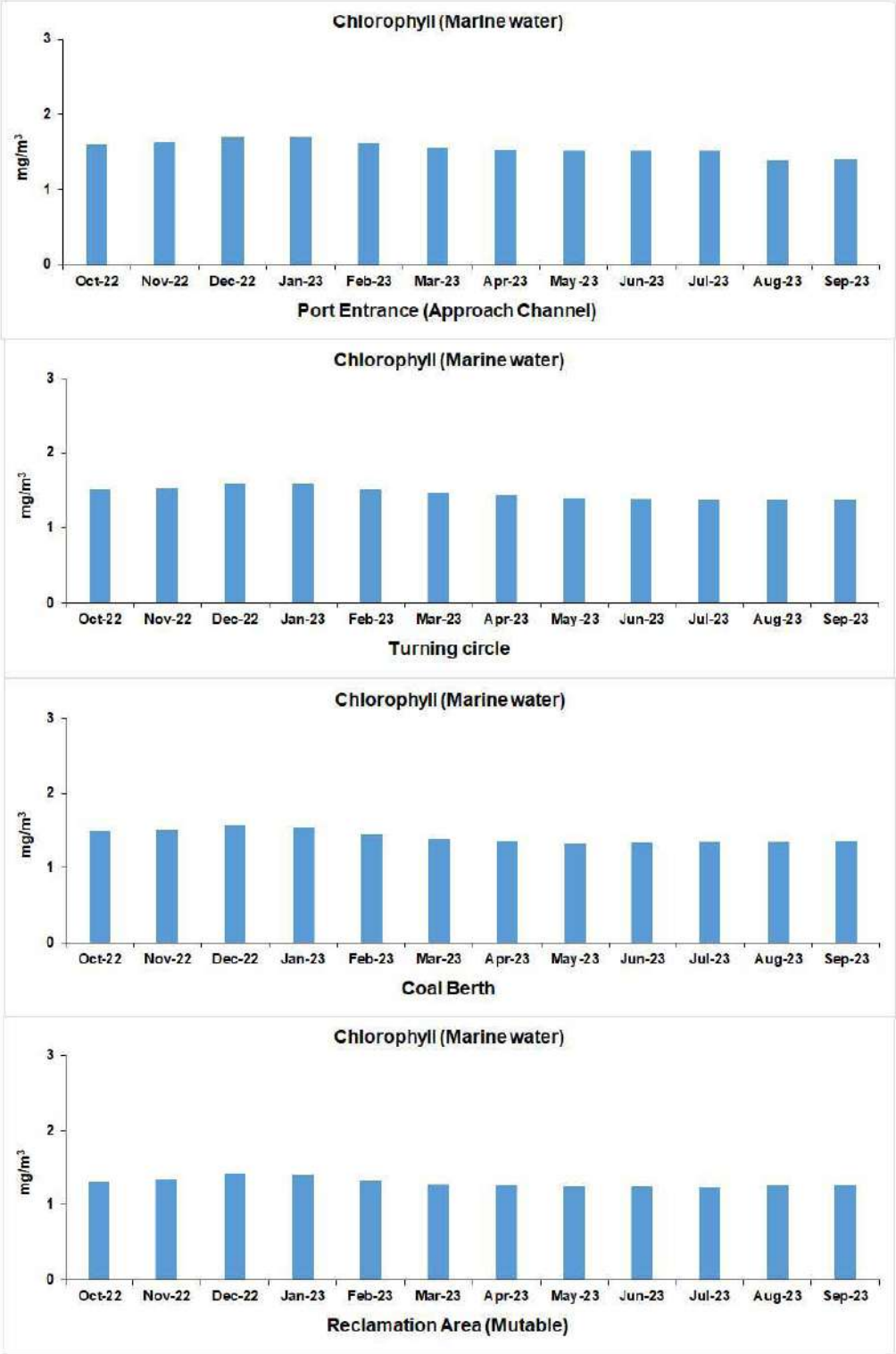


Fig. 3.61: Temporal variation of chlorophyll for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The chlorophyll level in the surface water ranged from 2.75 to 2.89 mg/m^3 and from 2.28 to 2.40 mg/m^3 for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.62). During the monitoring period, the highest value was recorded during November 2022 at Buckingham Canal and the lowest recorded during August 2023 at Kandaleru Creek.

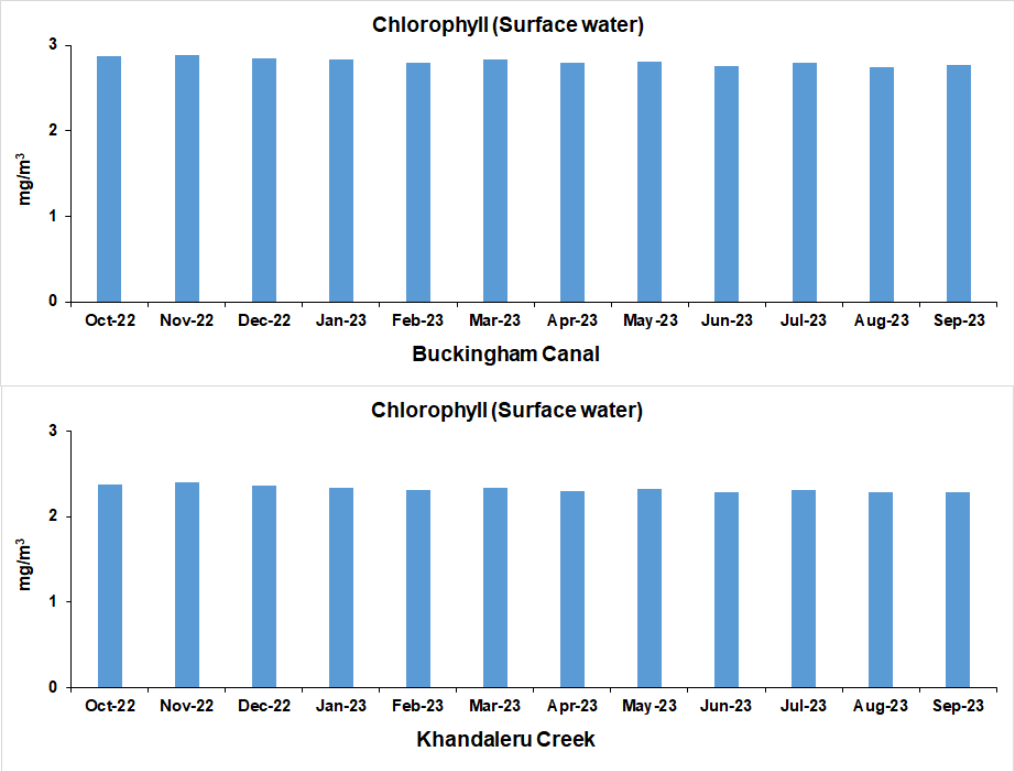


Fig. 3.62: Temporal variation of chlorophyll for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.31. Phytoplankton abundance

Marine water

The numerical abundance of phytoplankton in the marine water ranged from 2.33 no./ml to 261.00 no./ml, from 2.27 no./ml to 253.75 no./ml, from 2.22 no./ml to 247.75 no./ml and from 2.03 no./ml to 219.5 no./ml for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.63). During the monitoring period, the highest value was recorded during December 2022 at Port Entrance and the lowest recorded during May and July 2023 at Reclamation Area.

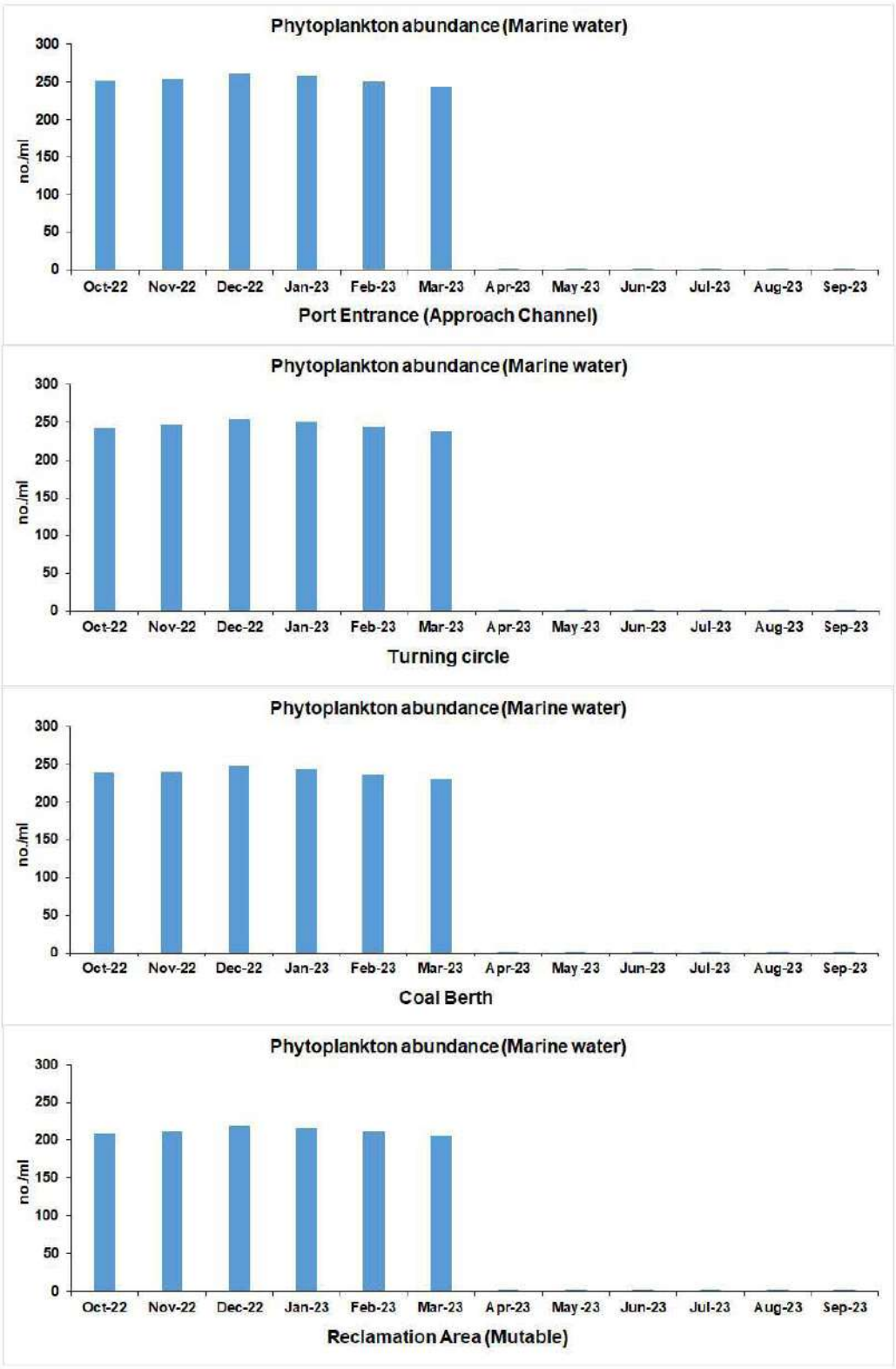


Fig. 3.63: Temporal variation of phytoplankton abundance for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The phytoplankton abundance in the surface water ranged from 266.0 to 283.0 no./ml and from 2.83 to 301.00 No./ml for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.64). During the monitoring period, the highest value was recorded during November 2022 at Kandaleru Creek and the lowest recorded during April 2023 at Kandaleru Creek.

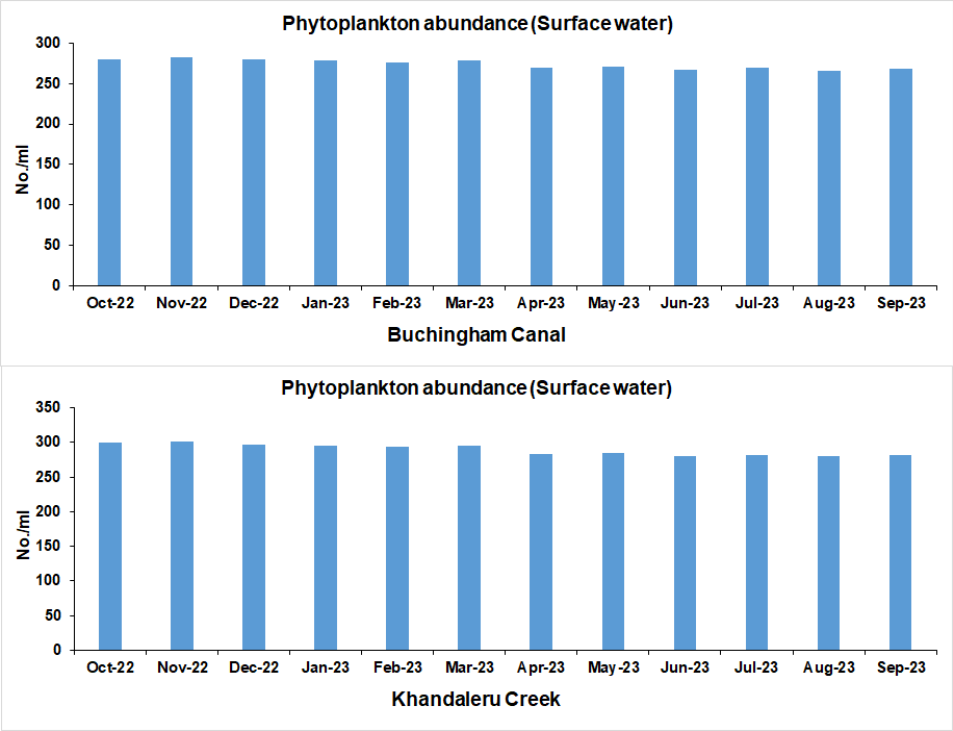


Fig. 3.64: Temporal variation of phytoplankton abundance for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.32. Phytoplankton diversity

Marine water

The phytoplankton diversity in the marine water ranged from 2.18 to 2.44, from 2.15 to 2.42, from 2.28 to 2.76 and from 1.95 to 2.44 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.65). During the monitoring period, the highest value was recorded during December 2022 at Coal Berth and the lowest recorded during June 2023 at Reclamation Area.

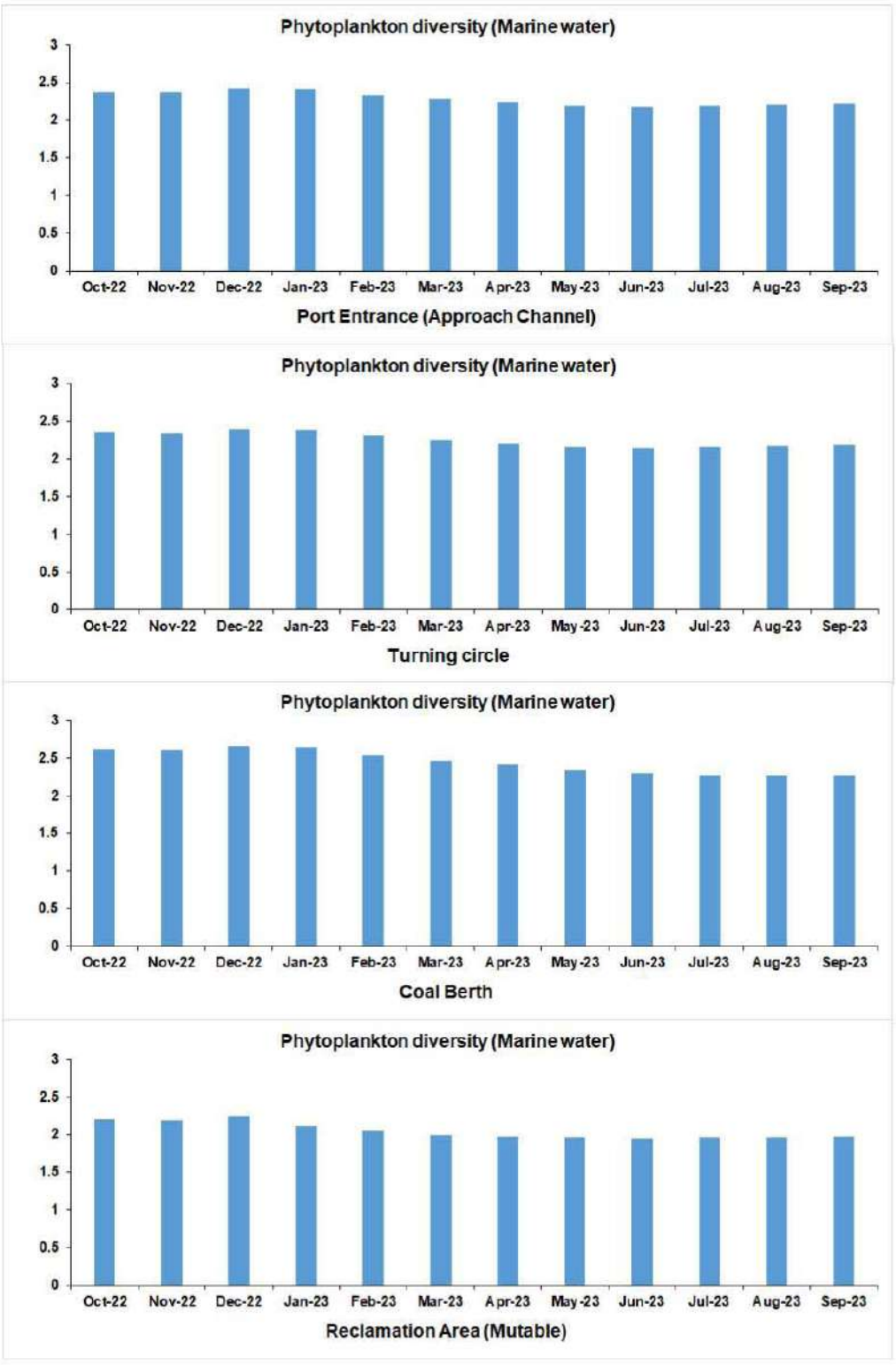


Fig. 3.65: Temporal variation of phytoplankton diversity for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The phytoplankton diversity in the surface water ranged from 2.31 to 2.43 and from 2.63 to 2.75 for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.66). During the monitoring period, the highest value was recorded during November 2022 at Kandaleru Creek and the lowest recorded during June 2023 at Buckingham Canal.

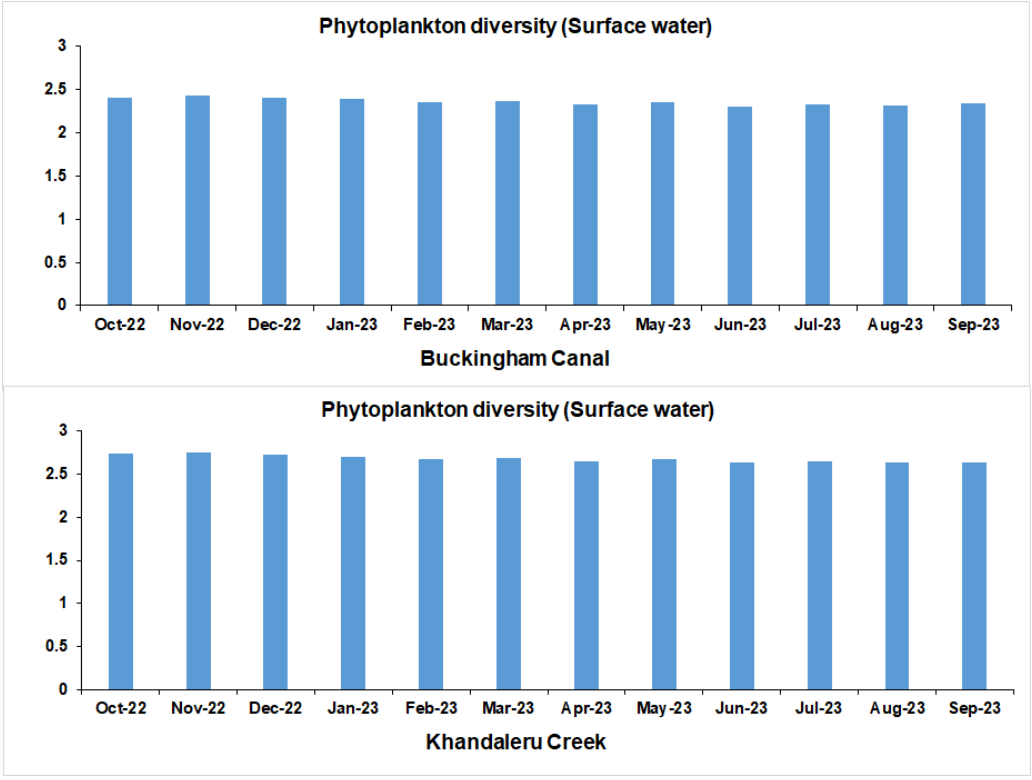


Fig. 3.66: Temporal variation of phytoplankton diversity for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.33. Zooplankton diversity

The Zooplankton diversity in the marine water ranged from 2.11 to 2.30, from 2.14 to 2.35, from 2.16 to 2.43 and from 1.92 to 2.13 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.67). During the monitoring period, the highest value was recorded during December 2022 at Coal Berth and the lowest recorded during July 2023 at Reclamation Area.

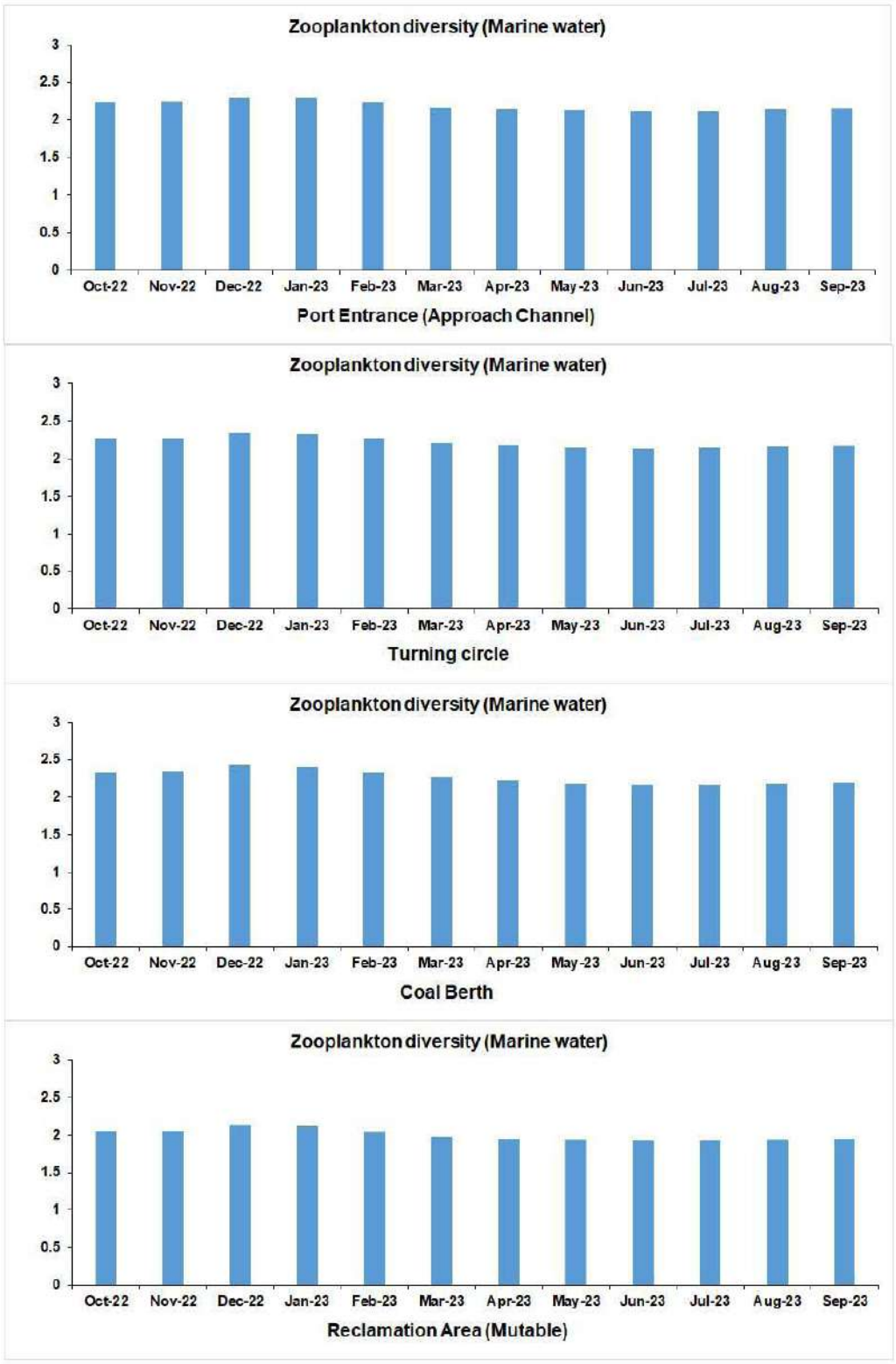


Fig. 3.67: Temporal variation of zooplankton diversity for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The Zooplankton diversity in the surface water ranged from 2.31 to 2.43 and from 2.63 to 2.75 for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.68). During the monitoring period, the highest value was recorded during November 2022 at Kandaleru Creek and the lowest recorded during June 2023 at Buckingham Canal.

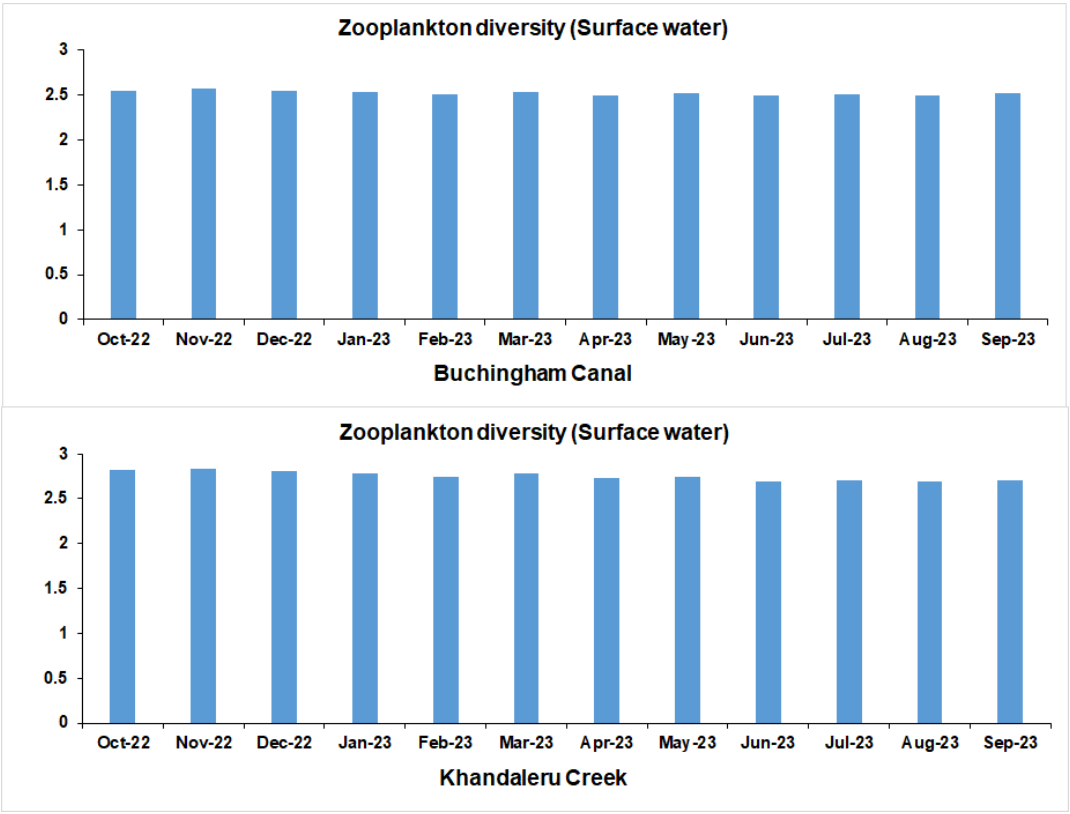


Fig. 3.68: Temporal variation of zooplankton density for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.34. Zooplankton biomass

Marine water

The Zooplankton biomass in the marine water ranged from 10.62 to 12.90 ml/100m^3, from 11.37 to 13.80 ml/100m^3, from 11.27 to 13.50 ml/100m^3 and from 9.47 to 9.80 ml/100m^3 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.69). During the monitoring period, the highest value was recorded during December 2022 at Turning Circle and the lowest recorded during April 2023 at Reclamation Area.

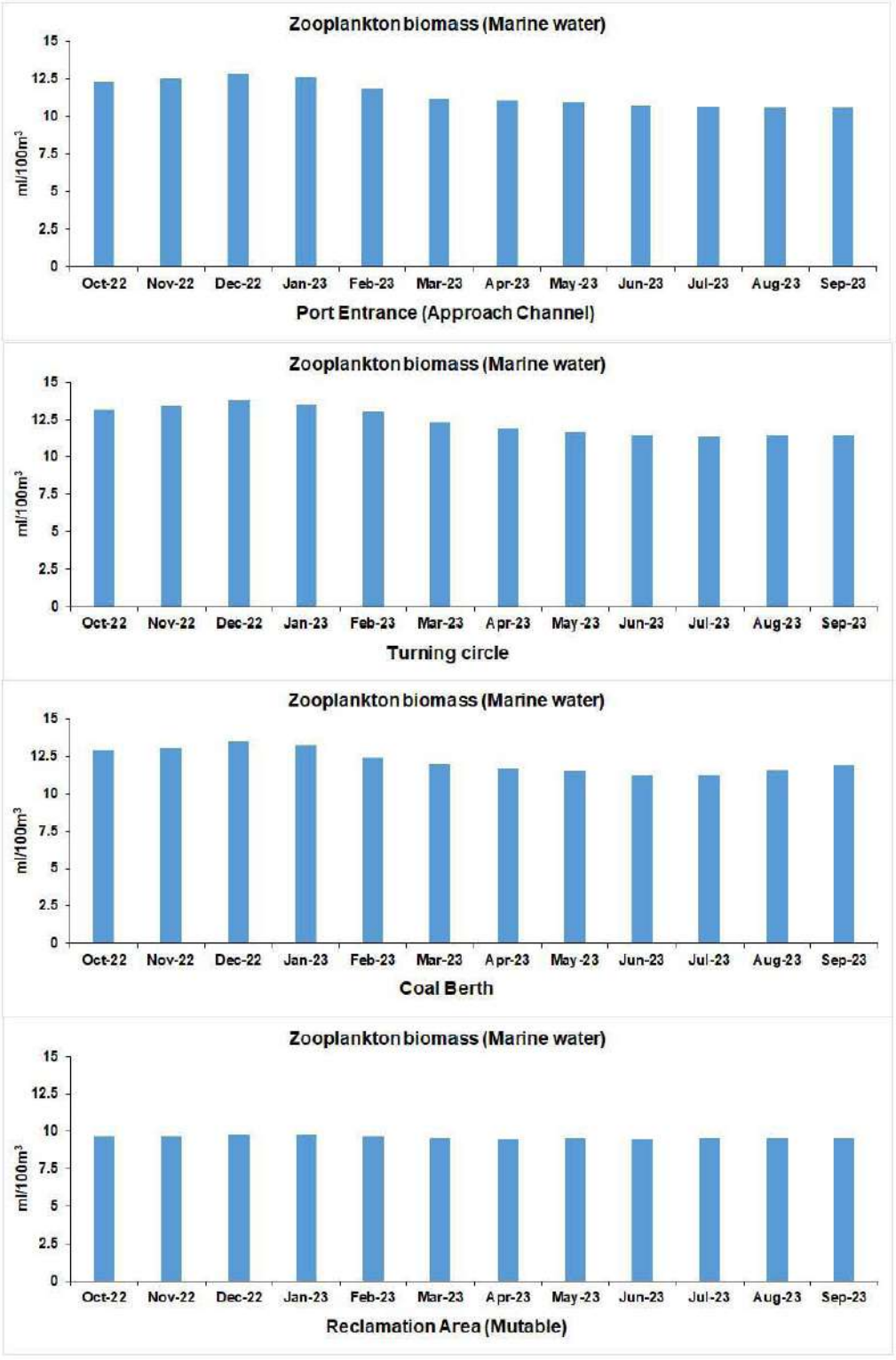


Fig. 3.69: Temporal variation of zooplankton biomass for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The Zooplankton diversity in the surface water ranged from 12.10 to 12.90 ml/100m^3 and from 12.90 to 13.80 ml/100m^3 for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.70). During the monitoring period, the highest value was recorded during November 2022 at Kandaleru Creek and the lowest recorded during June and August 2023 at Buckingham Canal.

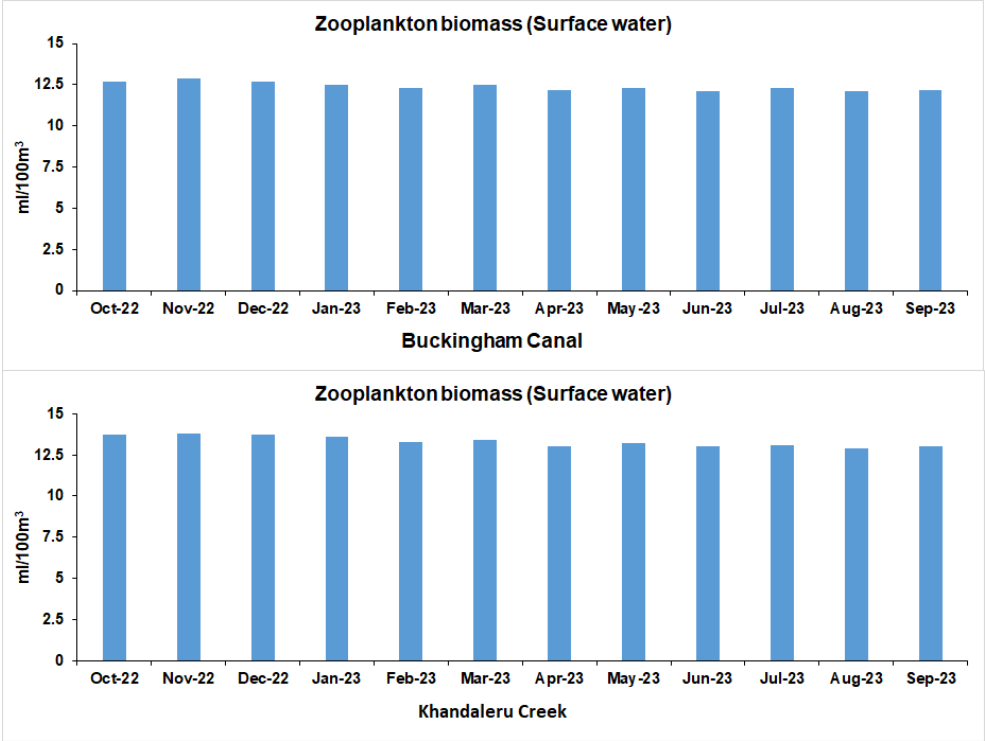


Fig. 3.70: Temporal variation of zooplankton biomass for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.35. Coliforms

Marine water

The concentration of Coliforms in the marine water ranged from 14.5 to 27.5 CFU/100ml, from 10.5 to 18.0 CFU/100ml, from 10.5 to 23.5 CFU/100ml and from 20.5 to 33.75 CFU/100ml for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.71). During the monitoring period, the highest value was recorded during February 2023 at Reclamation Area and the lowest recorded during November and October 2022 at Turning Circle and Coal Berth respectively.

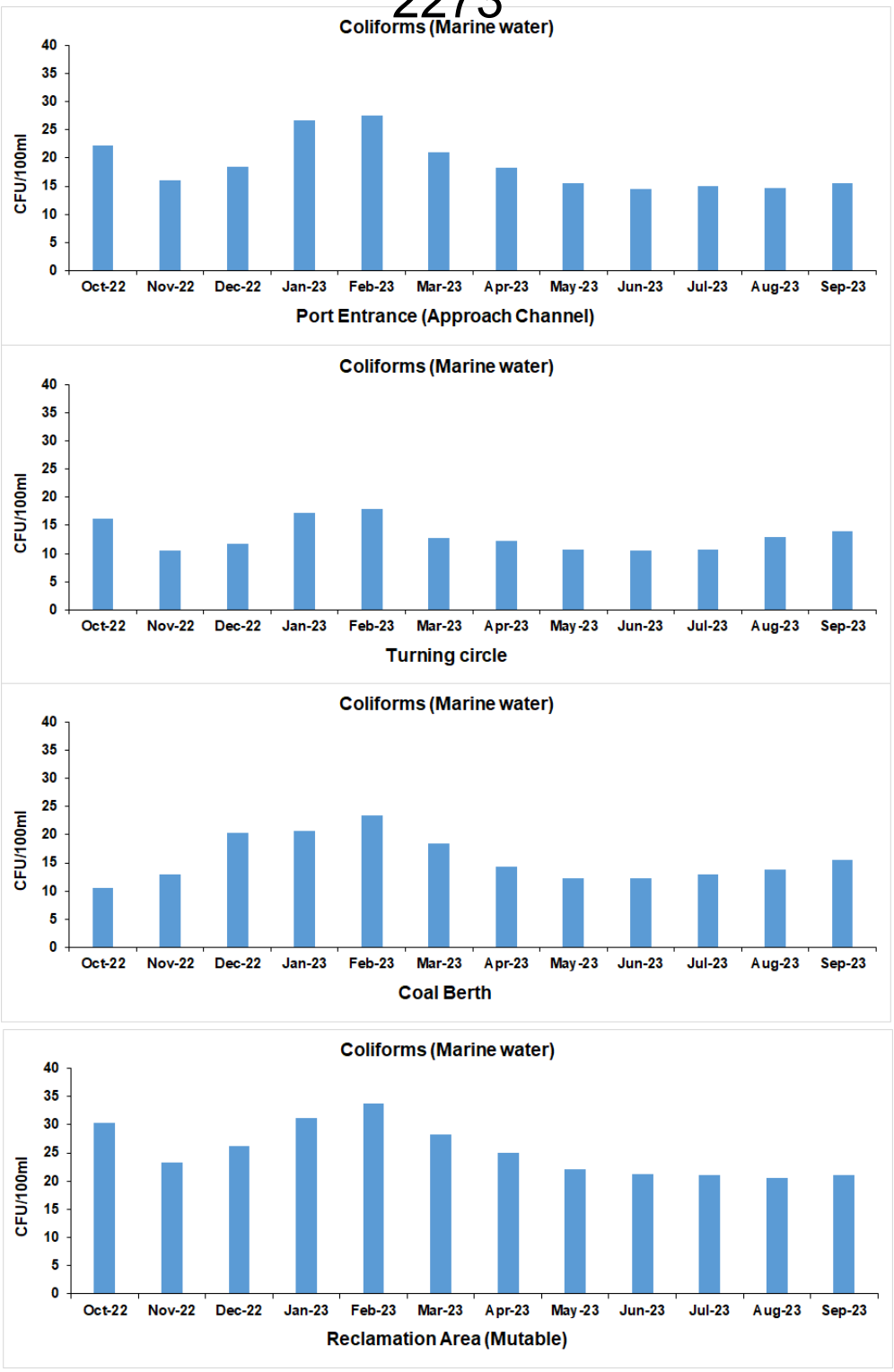


Fig. 3.71: Temporal variation of coliforms for the monitoring period for marine waters (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

Surface water

The concentration of coliforms in the surface water ranged from 21.00 to 29.00 CFU/100ml and from 15.00 to 25.00 CFU/100ml for Buckingham Canal and Kandaleru Creek respectively (Fig. 3.72). During the monitoring period, the highest value was recorded

during January 2023 at Buckingham Canal and the lowest recorded during November 2022 at Kandaleru Creek.

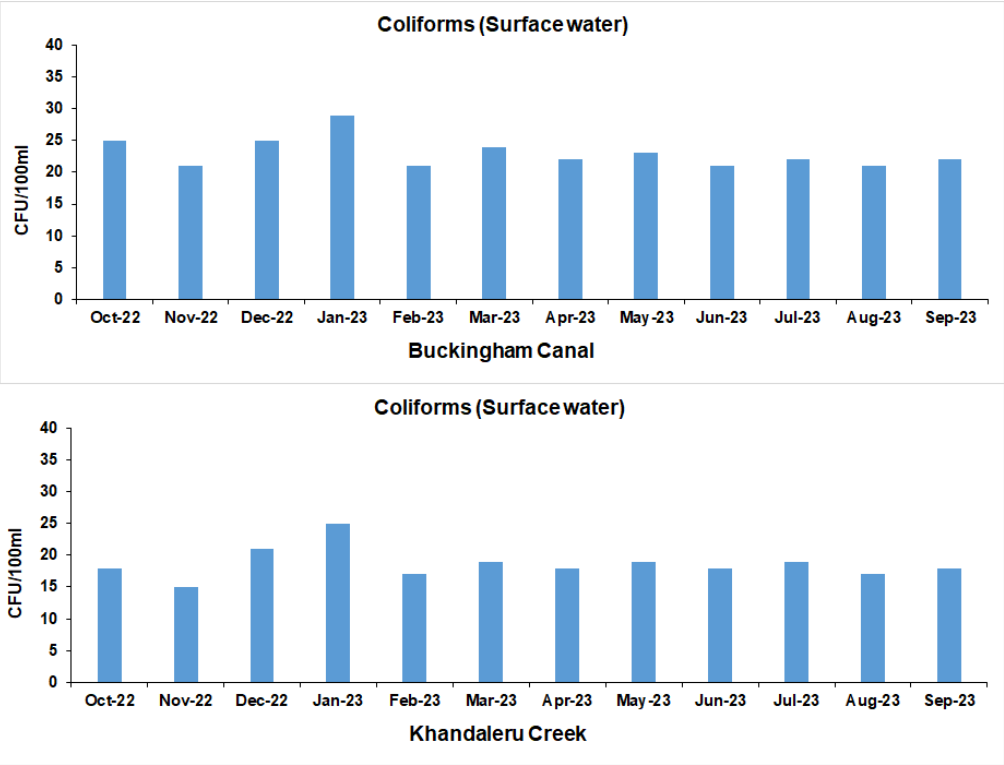


Fig. 3.72: Temporal variation of coliforms for the monitoring period for surface waters (Buckingham Canal and Kandaleru Creek)

3.4.36. Fecal Coliforms

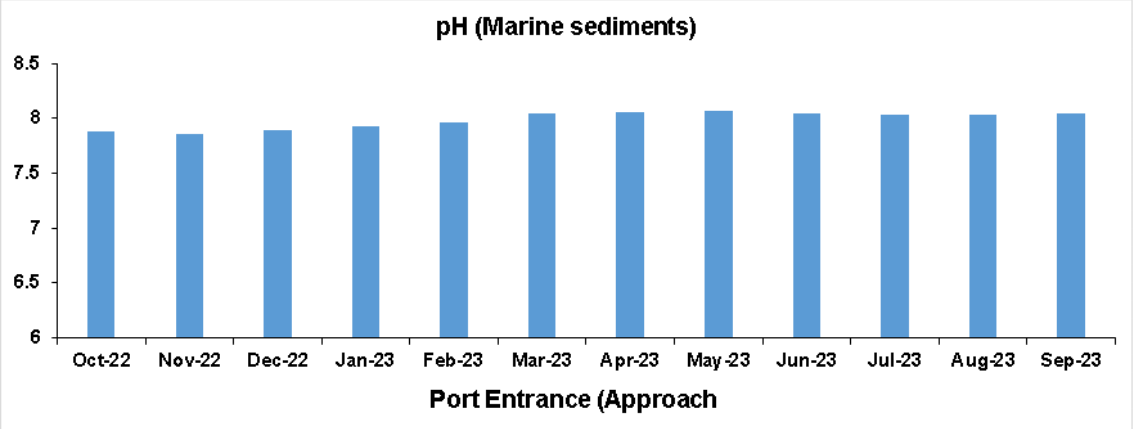
Fecal coliforms are absent in both marine and surface waters during the monitoring period.

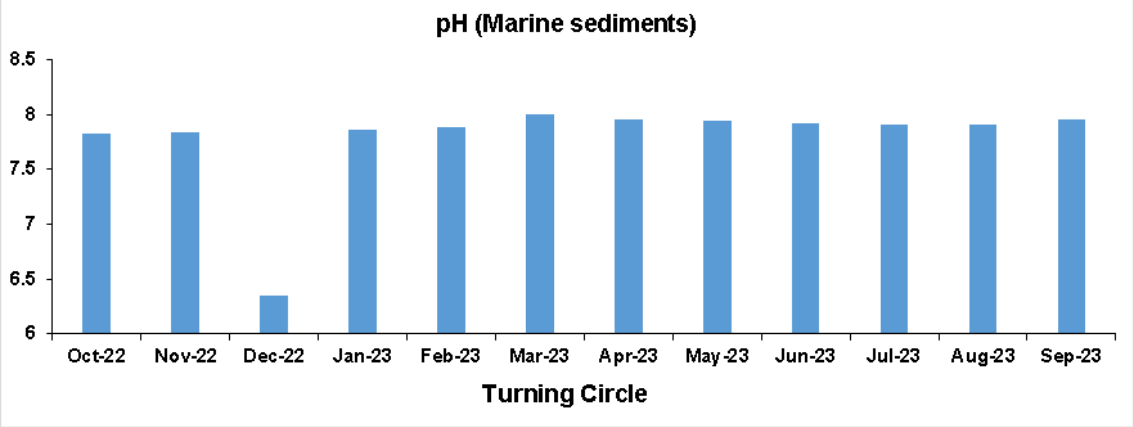
3.5. Marine sediment quality

Marine sediment samples were collected from Port region covering Port Entrance, Turning Circle, Coal Berth and Reclamation Area during monitoring period in order to assess the quality and the results are listed below.

3.5.1. pH

The pH in the marine sediment ranged from 7.86 to 8.07, from 6.34 to 7.99, from 7.78 to 8.24 and from 7.89 to 8.33 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.73). During the monitoring period, the highest value was recorded during September 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle.





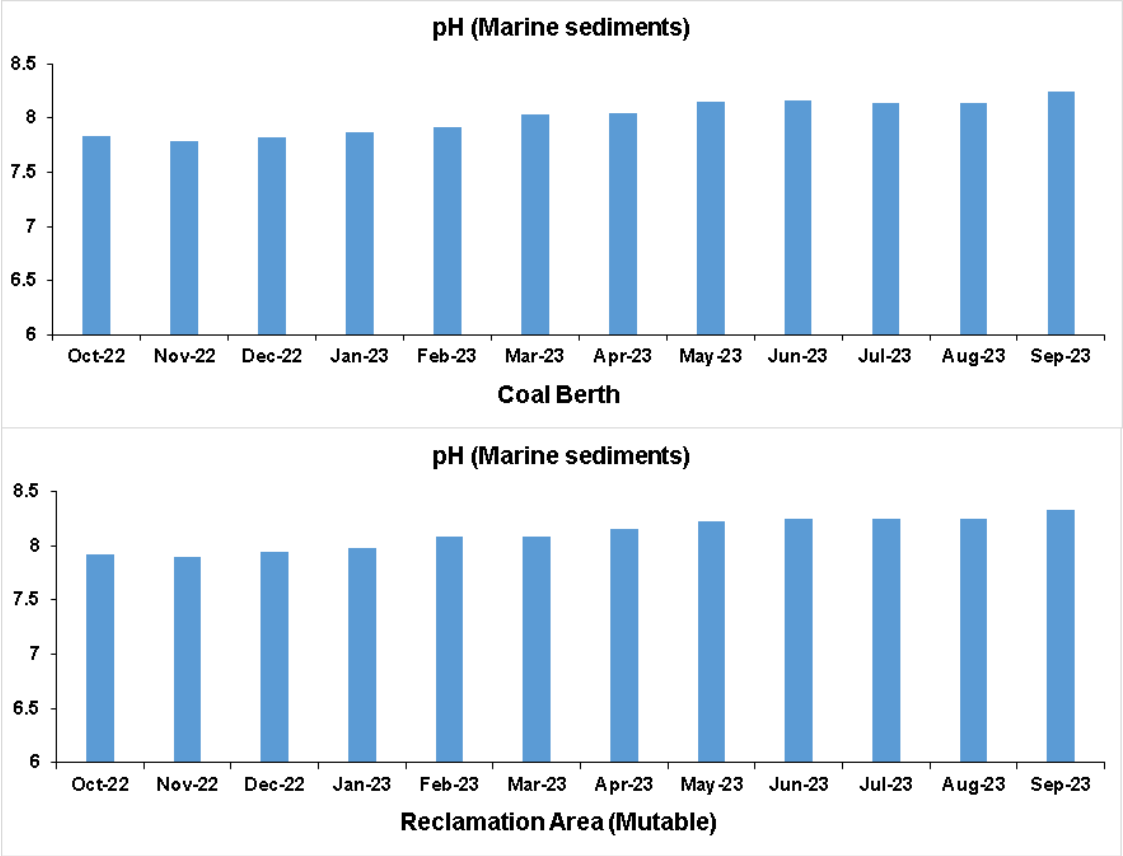


Fig. 3.73: Temporal variation of pH for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.2. Sediment compositions

The sand fraction in the marine sediment ranged from 36.03 to 37.08%, from 35.23 to 36.25%, from 35.57 to 36.67% and from 33.75 to 36.0% for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.74). During the monitoring period, the highest value was recorded during July 2023 at Port Entrance and the lowest recorded during December 2022 at Reclamation Area.

The Silt + clay fraction in the marine sediment ranged 62.92 to 63.97%, from 63.75 to 64.77%, from 63.33 to 64.43 and from 64 to 66.25 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.74). During the monitoring period, the highest value was recorded during July 2023 at Reclamation Area and the lowest recorded during February 2023 at Port Entrance.

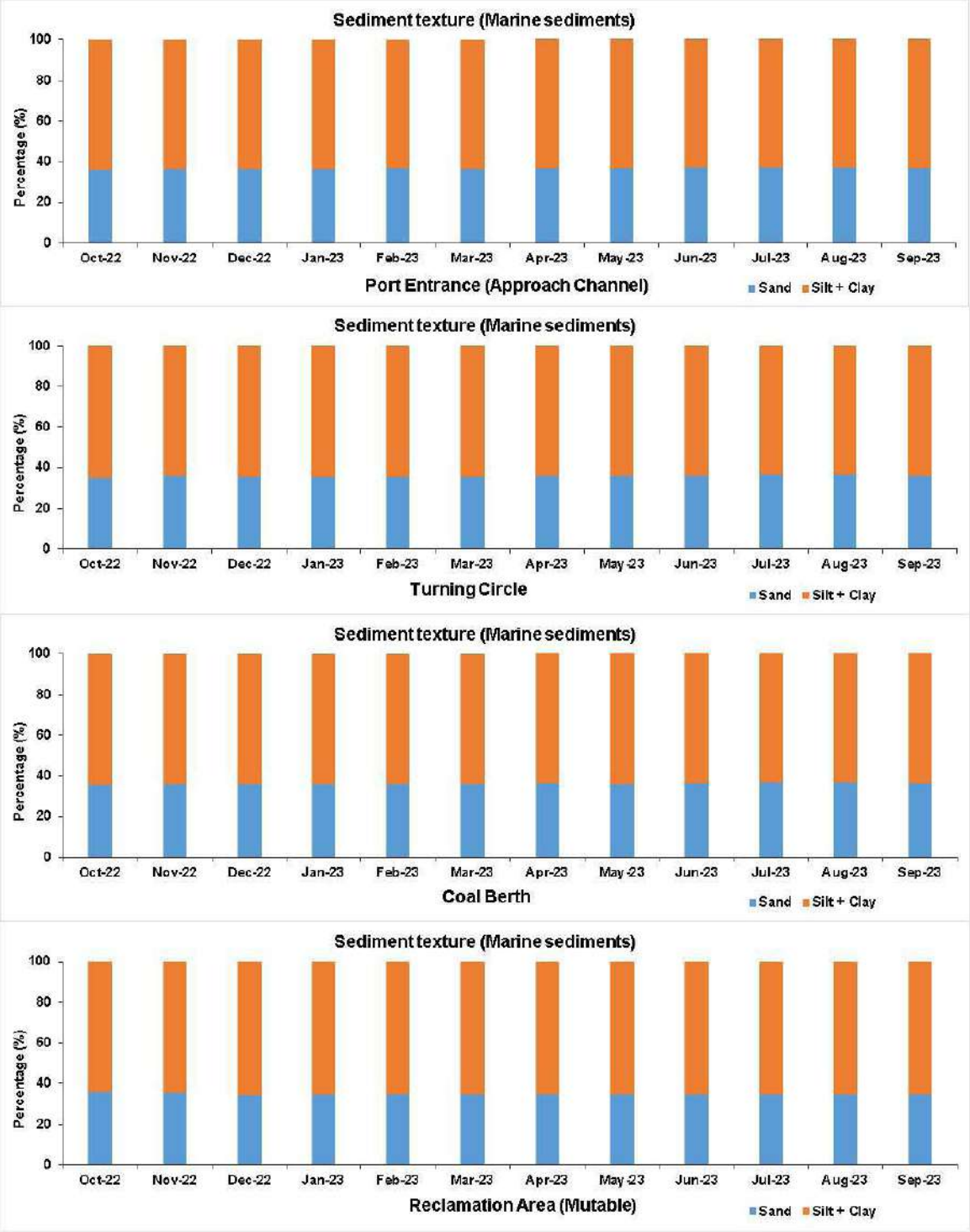


Fig. 3.74: Temporal variation of sediment texture for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.3. Organic matter

The concentration of Organic matter in the marine sediment ranged from 1.26 to 1.43%, from 1.24 to 1.4%, from 1.3 to 1.40% and from 1.38 to 1.50% for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.75). During the monitoring period, the highest value was recorded during July 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle.

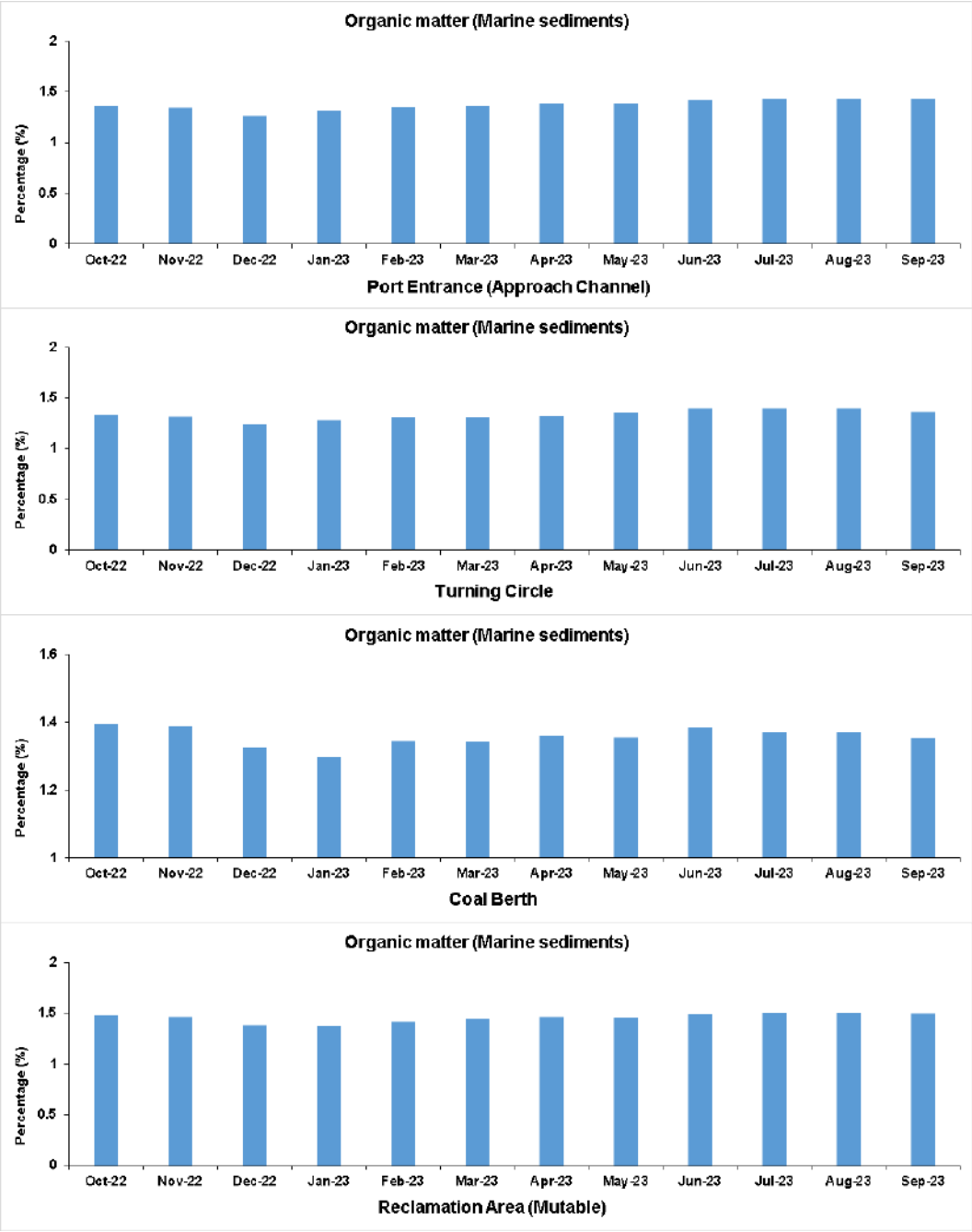


Fig. 3.75: Temporal variation of Organic matter for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.4. Nitrogen

The concentration of Nitrogen in the marine sediment ranged from 312.5 to 391.5 mg/kg, from 319.25 to 387.25 mg/kg, from 288.75 to 359.75 mg/kg and from 330.5 to 392.25 mg/kg for Port Entrance, Turning circle, Coal Berth and Reclamation Area respectively (Fig. 3.76). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Coal Berth.

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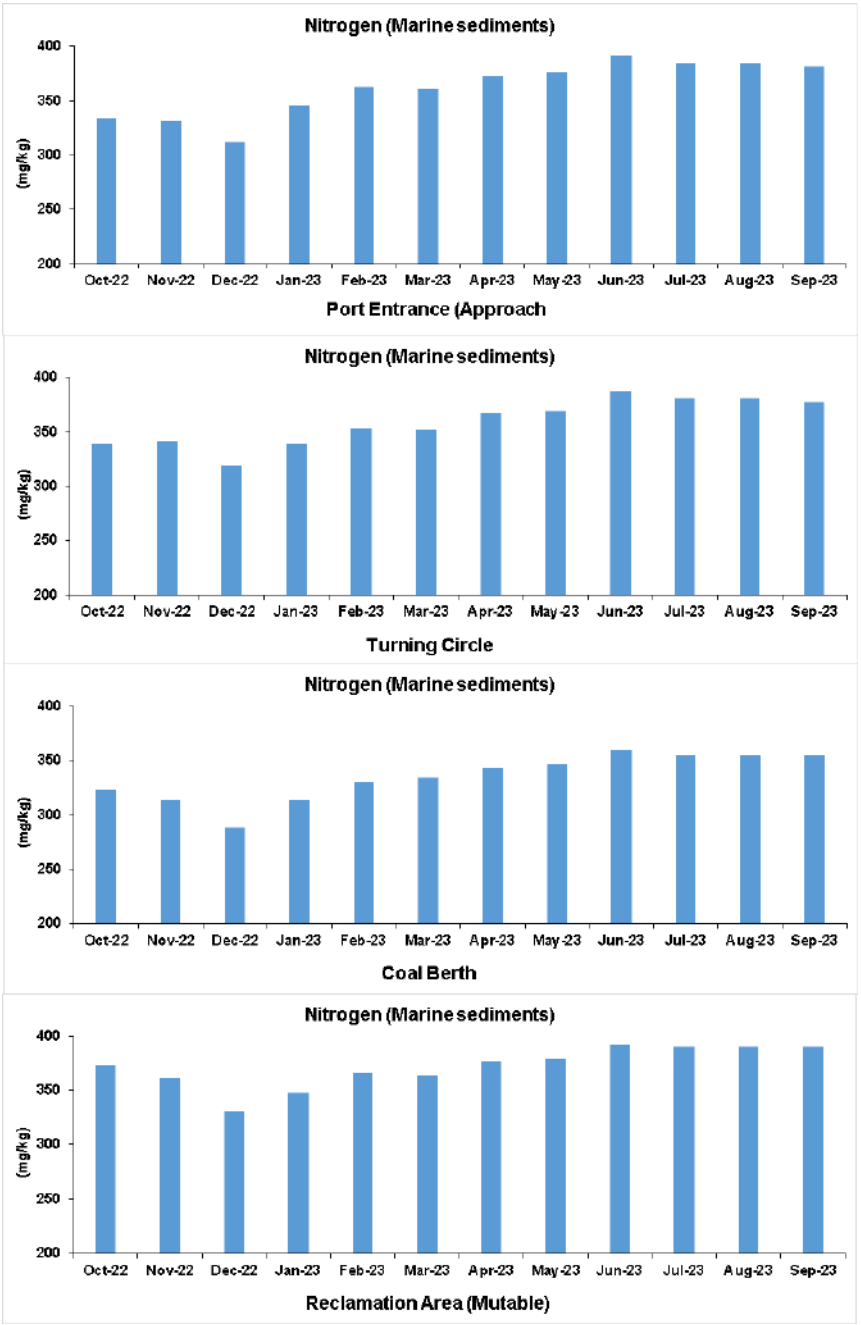

Fig. 3.76: Temporal variation of Nitrogen for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.5. Phosphorus

The concentration of Phosphorus in the marine sediment ranged from 170 to 230.25 mg/kg, from 185.75 to 240.5 mg/kg, from 209 to 263 mg/kg and from 239.8 to 337.5 mg/kg for Port Entrance, Turning circle, Coal Berth and Reclamation Area respectively (Fig. 3.77). During the monitoring period, the highest value was recorded during March 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

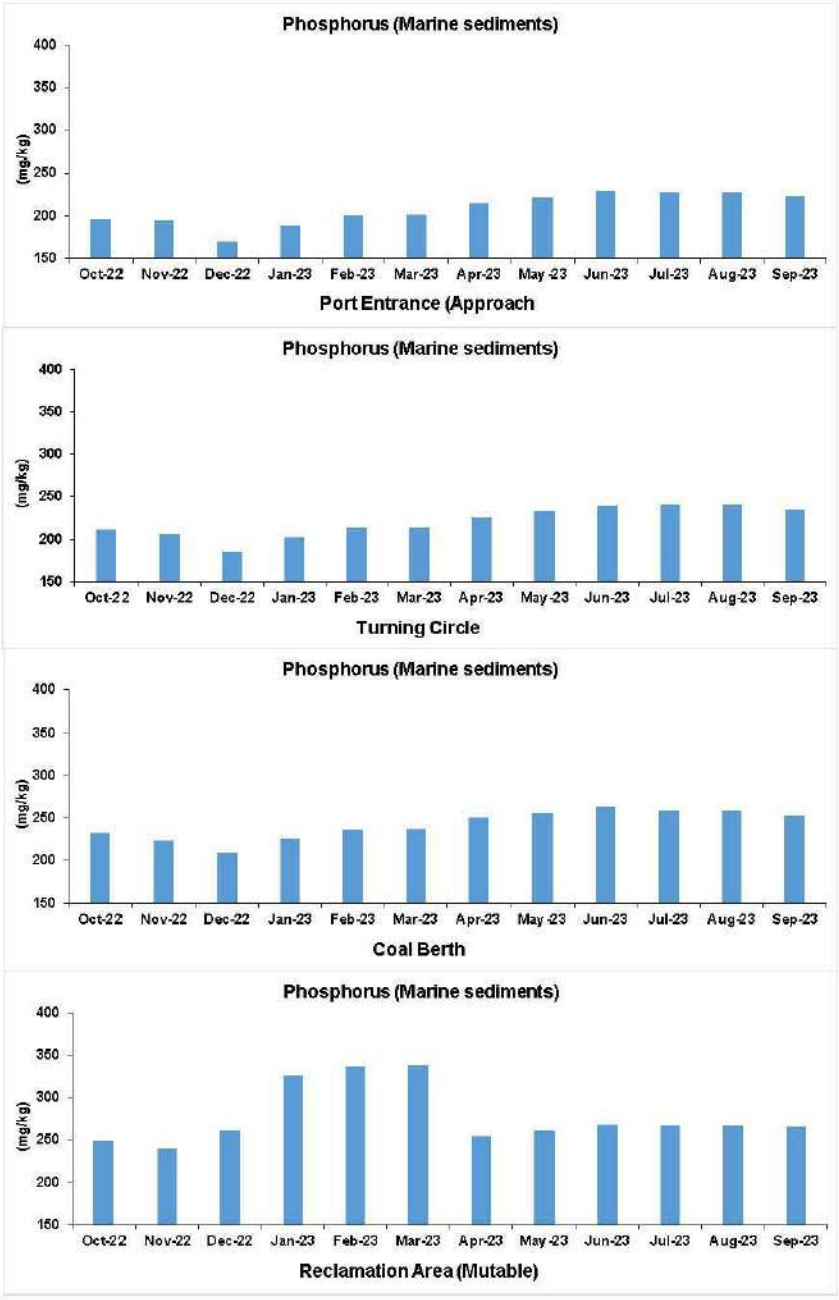

Fig. 3.77: Temporal variation of Phosphorus for the monitoring period for marine sediments (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

3.5.6. Potassium

The concentration of Potassium in the marine sediment ranged from 236.75 to 361 mg/kg, from 332.25 to 370.5 mg/kg, from 306.0 to 356.75 mg/kg and from 329 to 376.75 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.78). During the monitoring period, the highest value was recorded during June 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

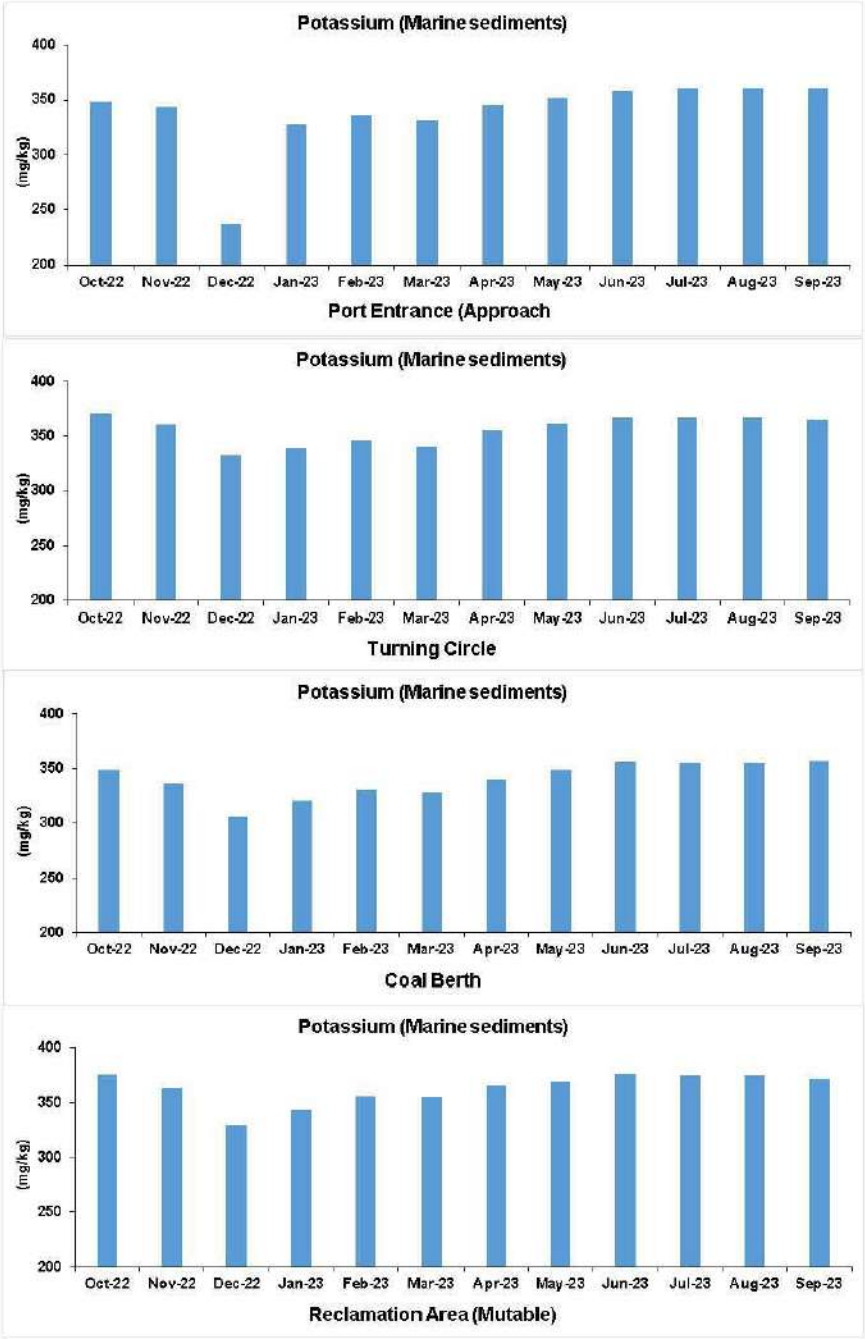

Fig. 3.78: Temporal variation of Potassium for the monitoring period for marine sediments (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

3.5.7. Sodium

The concentration of Sodium in the marine sediment ranged from 16541 to 16899.3 mg/kg, from 17103 to 17488.8 mg/kg, from 17130 to 17423.8 mg/kg and from 17260 to 17630.8 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.79). During the monitoring period, the highest value was recorded during July 2023 and August 2023 at Reclamation Area and the lowest recorded during December 2022 at Port Entrance.

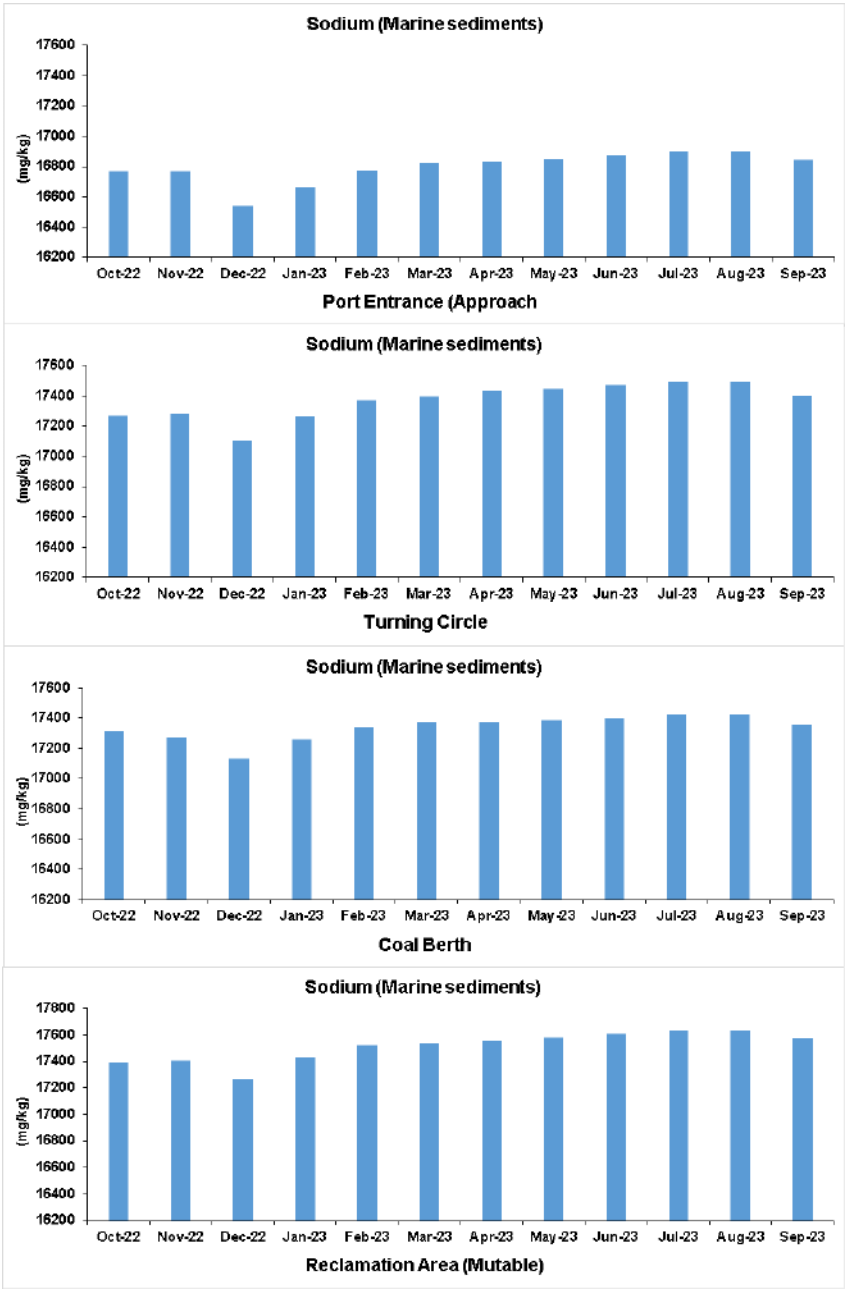

Fig. 3.79: Temporal variation of Sodium for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.8. Zinc

The concentration of Zinc in the marine sediment ranged from 0.4525 to 0.0645 mg/kg, from 0.06325 to 0.085 mg/kg, from 0.06975 to 0.08675 mg/kg and from 0.61 to 0.8125 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.80). During the monitoring period, the highest value was recorded during July 2023 and August 2023 at Coal Berth and the lowest recorded during December 2022 at Port Entrance.

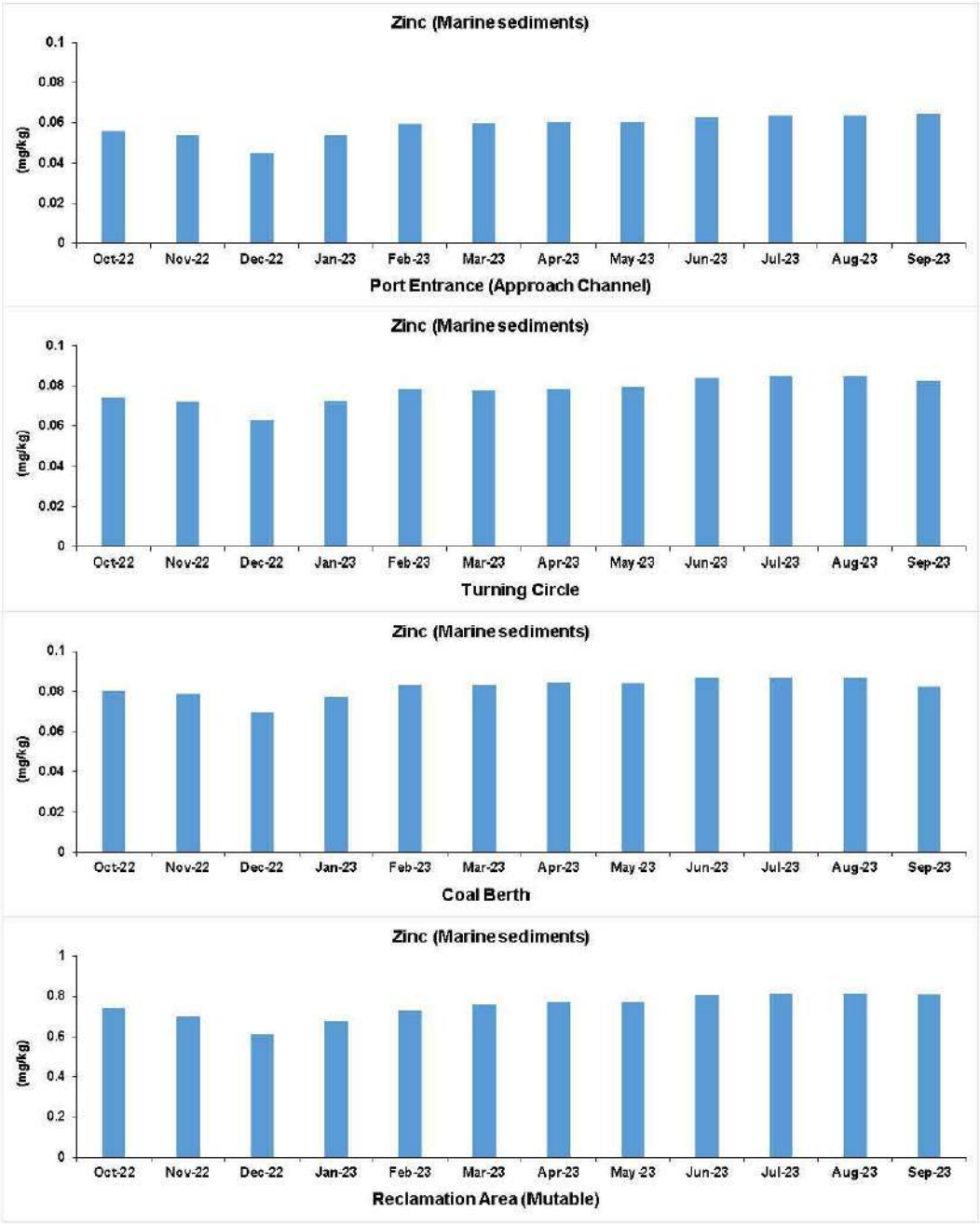

Fig. 3.80: Temporal variation of Zinc for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.9. Copper

The concentration of Copper in the marine sediment ranged from 0.29 to 0.47 mg/kg for the Reclamation Area during the monitoring period, whereas it was <0.01 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.81). During the monitoring period, the highest value was recorded during July 2023 and the lowest was recorded during December 2022 at Reclamation Area.

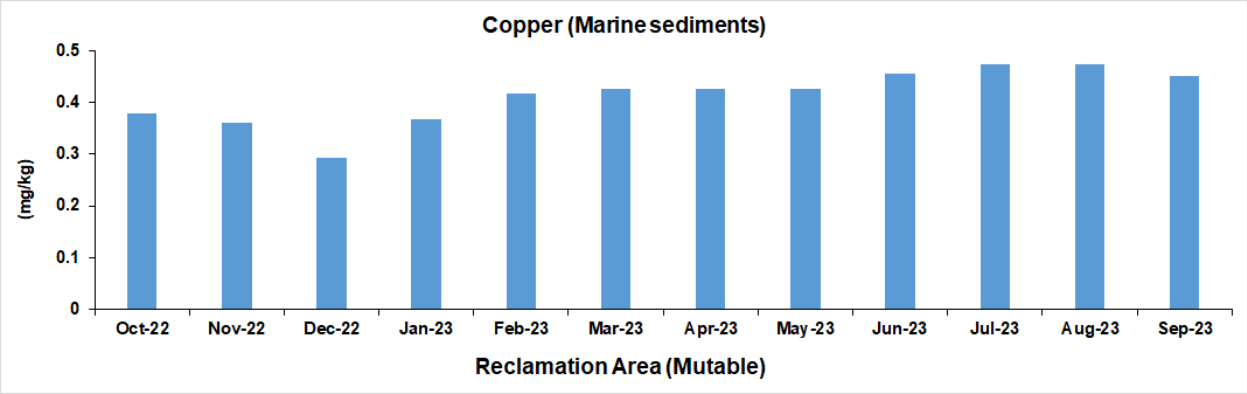

Fig. 3.81: Temporal variation of copper for the monitoring period for marine sediments at Reclamation Area

3.5.10. Cadmium

The concentration of Cadmium in the marine sediment ranged from 0.0485 to 0.075 mg/kg, from 0.0365 to 0.065 mg/kg, from 0.051 to 0.0725 mg/kg and from 0.068 to 0.09575 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.82). During the monitoring period, the highest value was recorded during July 2023 and August 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle.

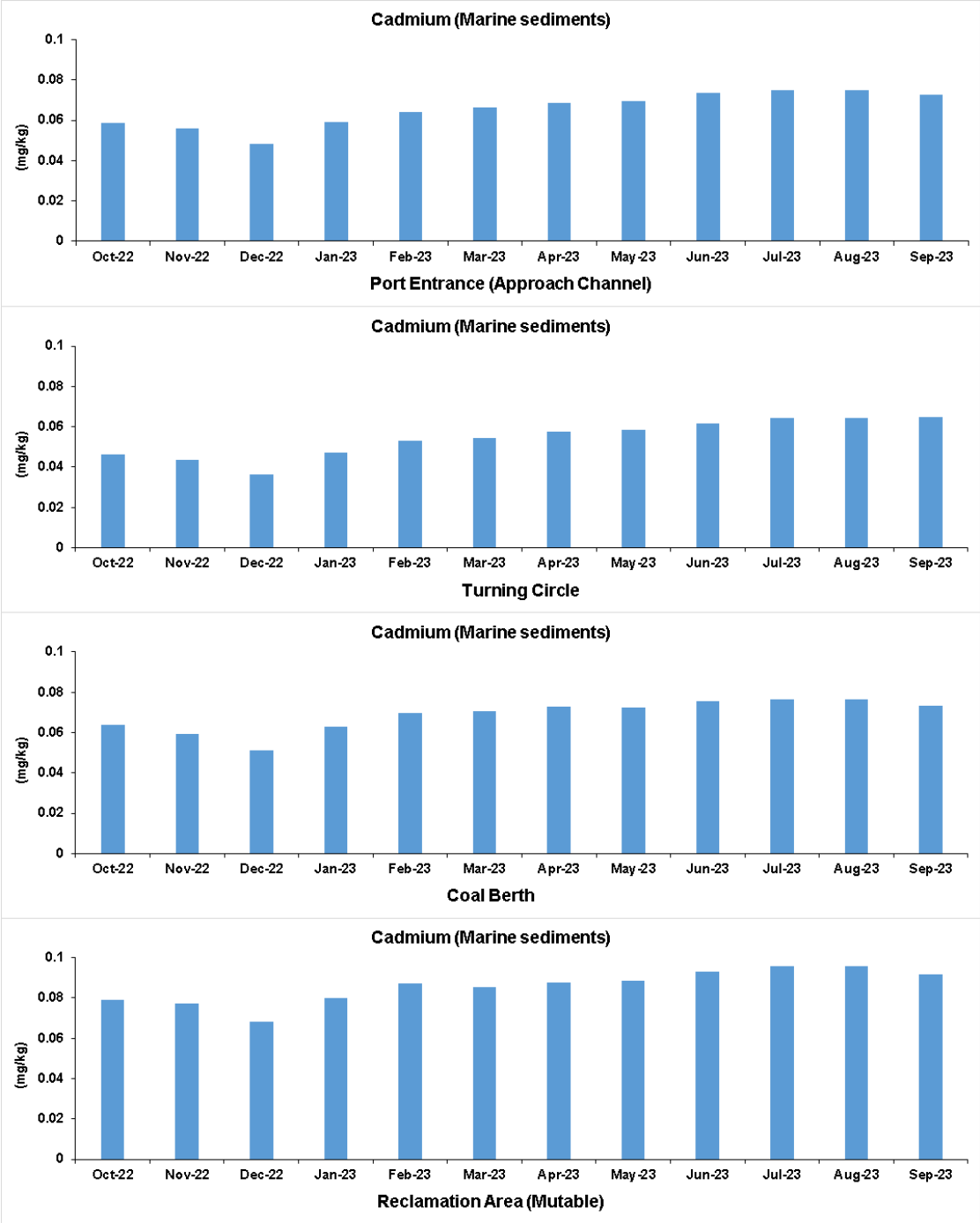

Fig. 3.82: Temporal variation of cadmium for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.11. Lead

The concentration of Lead in the marine sediment ranged from 0.335 to 0.5325 mg/kg, from 0.275 to 0.4775 mg/kg, from 0.295 to 0.55 mg/kg and from 0.435 to 0.67 mg/kg for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.83).

During the monitoring period, the highest value was recorded during July 2023 and August 2023 at Reclamation Area and the lowest recorded during December 2022 at Turning Circle

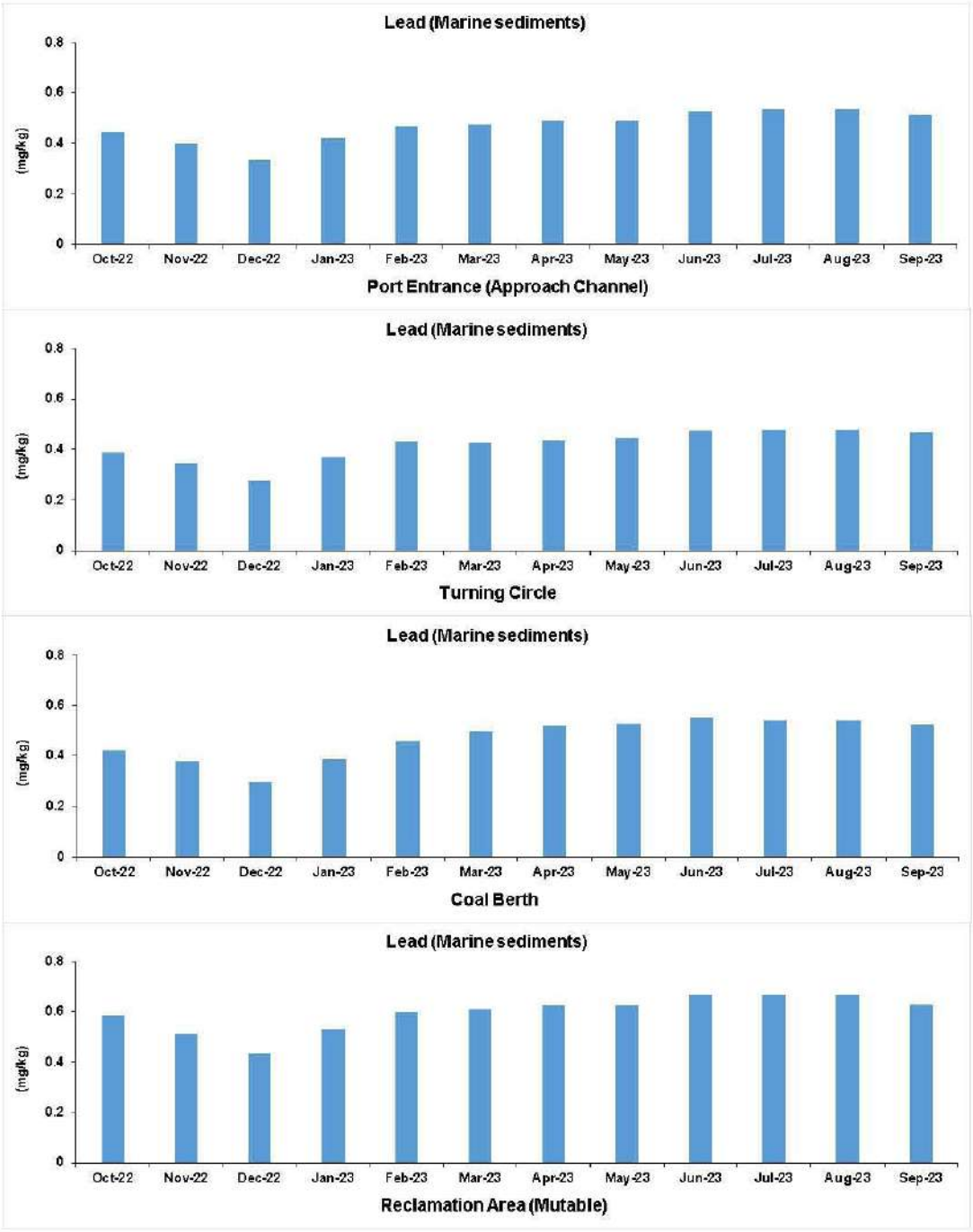

Fig. 3.83: Temporal variation of lead for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.5.12. Benthos communities

3.5.12.1. Macrobenthos

The Macrobenthos levels in the marine sediment ranged from 1157.5 to 1170.5 no/m^2, from 1158.75 to 1177.75 no/m^2, from 1144.5 to 1156.5 no/m^2 and from 1121.5 to 1141.5 no/m^2 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.84). During the monitoring period, the highest value was recorded during December 2022 at Turning Circle and the lowest recorded during April 2023 at Reclamation Area.

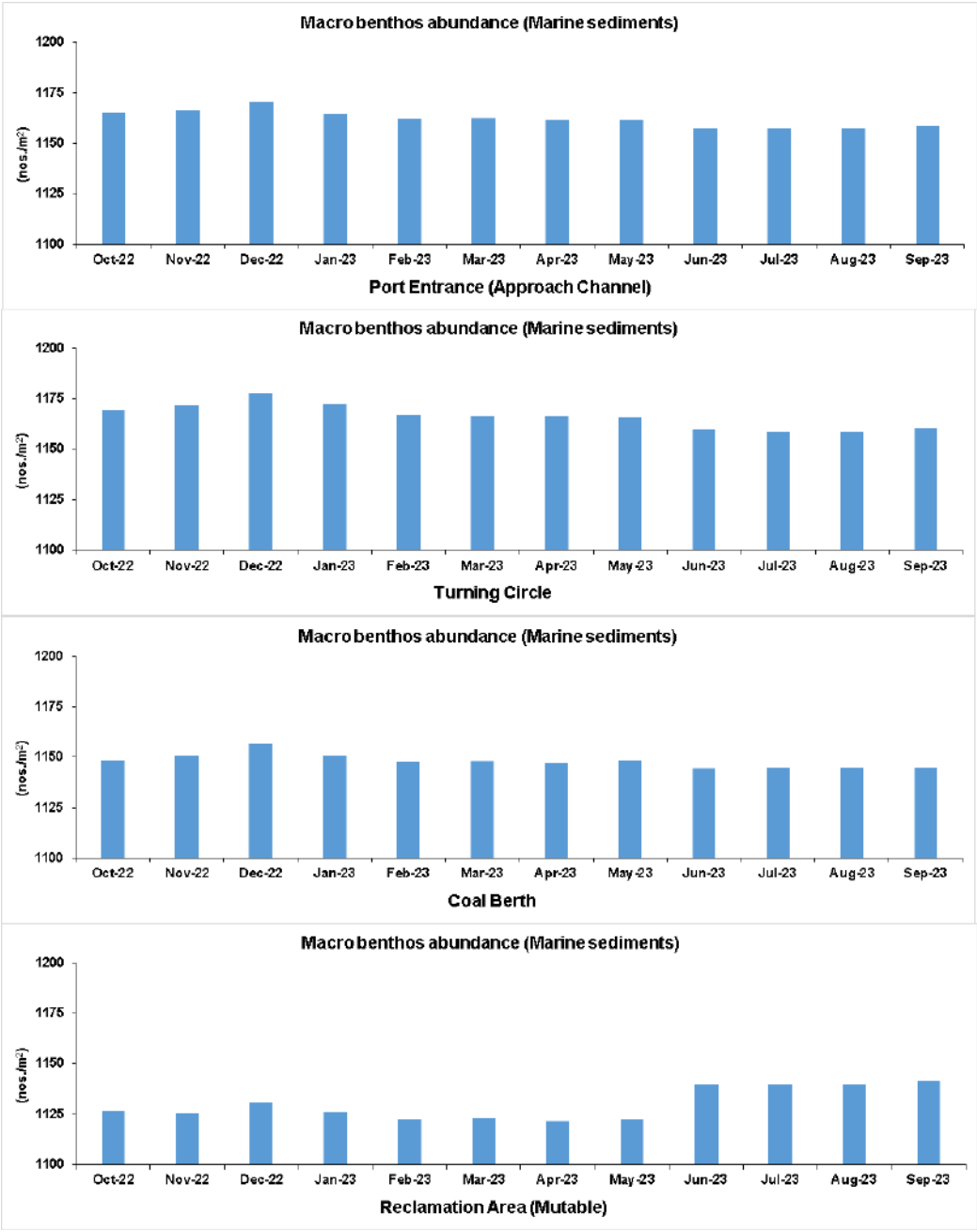

Fig. 3.84: Temporal variation of macrobenthos for the monitoring period for marine sediments (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

3.5.12.2. Epifaunal numerical abundance

The Epifaunal numerical abundance in the marine sediment ranged from 29.25 to 37.75 nos/haul, from 27.5 to 36.25 nos/haul, from 23.75 to 35.25 nos/haul and from 18.5 to 24.75 nos/haul for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.85). During the monitoring period, the highest value was recorded during July 2022 at Port Entrance and the lowest recorded during October 2023 at Reclamation Area.

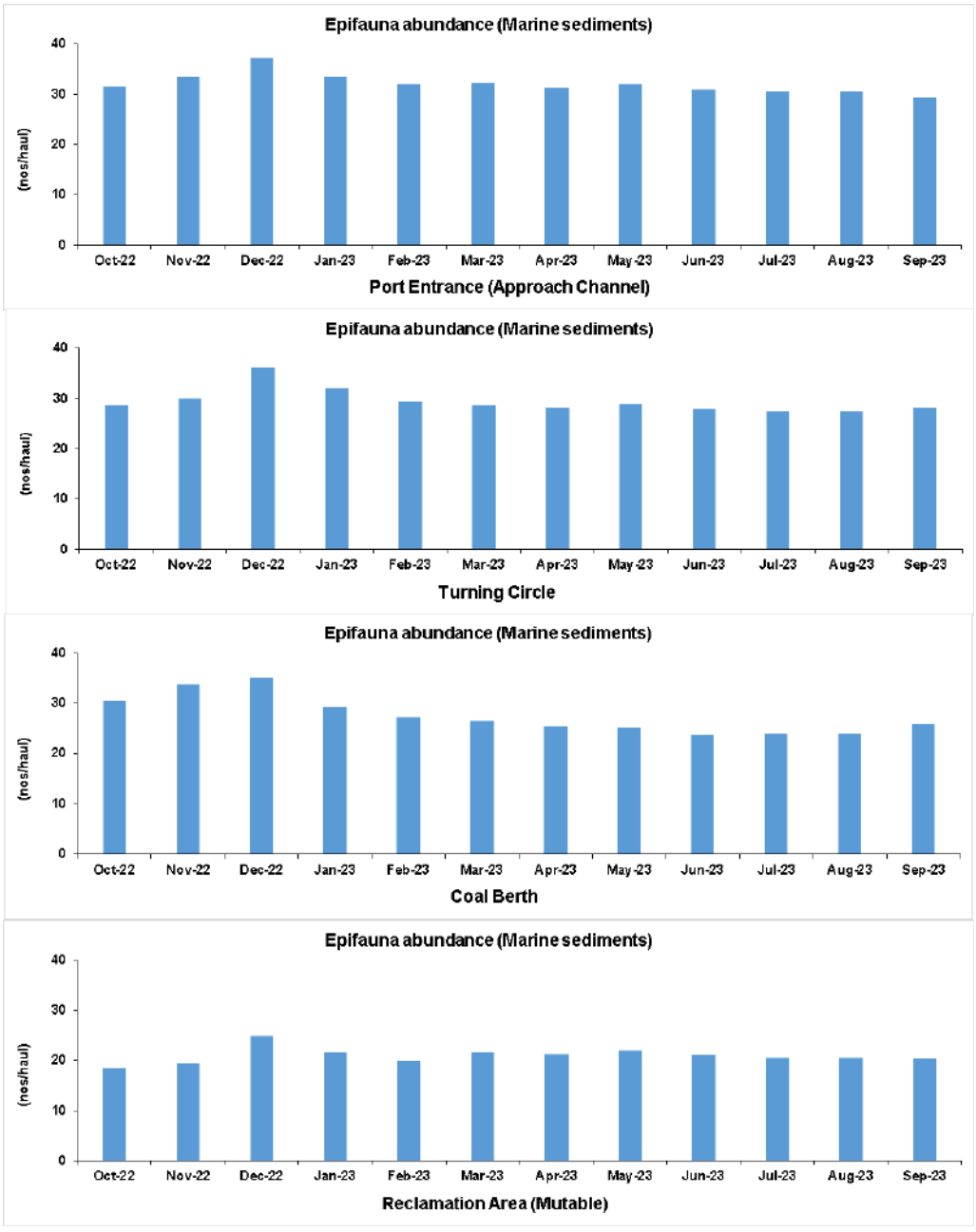

Fig. 3.85: Temporal variation of Epifaunal abundance for the monitoring period for marine sediments (Port Entrance, Turning circle, Coal Berth and Reclamation Area)

3.5.12.3. Infauna numerical abundance

The Infauna numerical abundance in the marine sediment ranged from 740.75 to 751.25 no/m^2, from 714 to 725.75 no/m^2, from 709 to 720.75 no/m^2 and from 697.75 to 706.5 no/m^2 for Port Entrance, Turning Circle, Coal Berth and Reclamation Area respectively (Fig. 3.86). During the monitoring period, the highest value was recorded during July 2022 at Port Entrance and the lowest recorded during February 2023 at Reclamation Area.

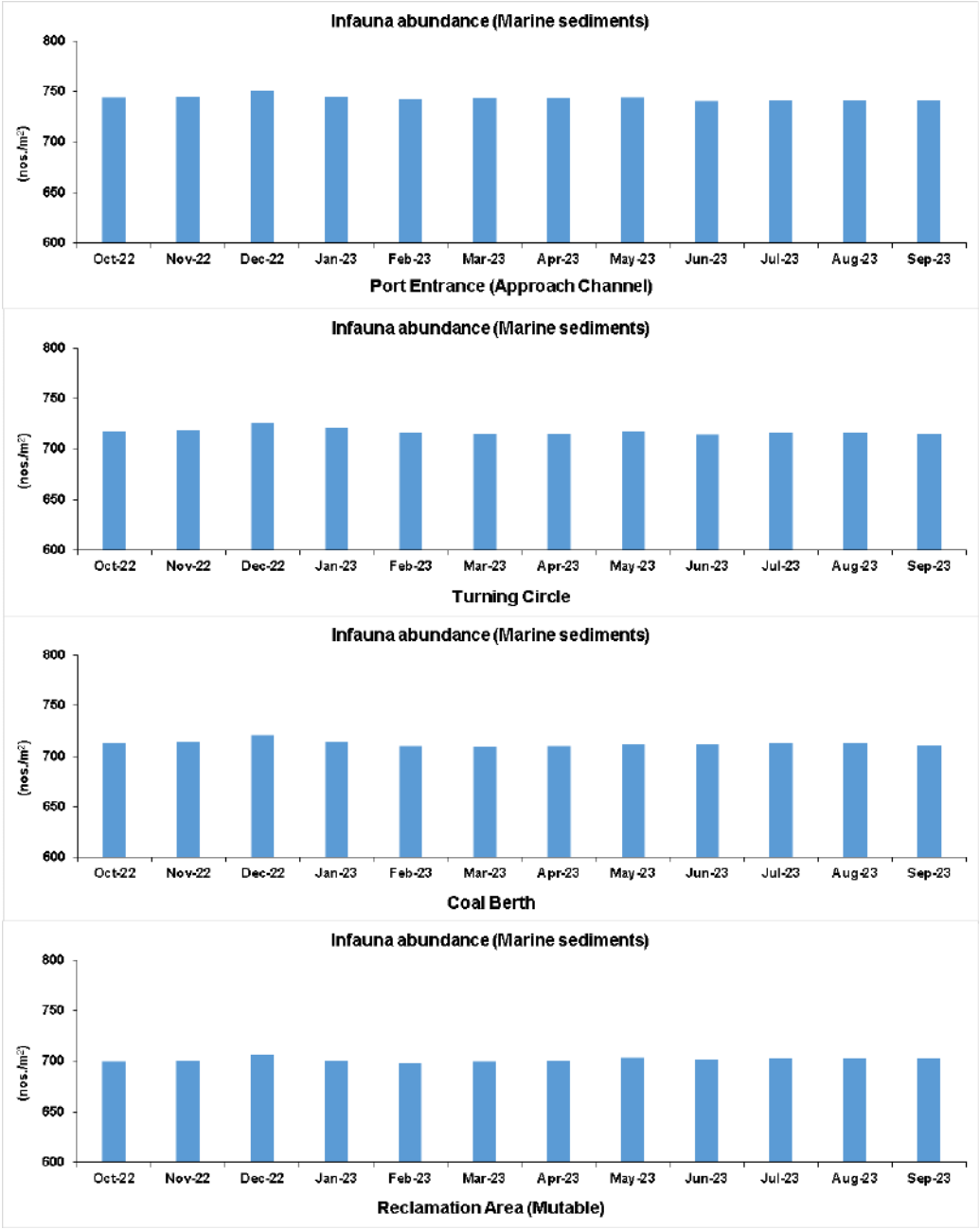

Fig. 3.86: Temporal variation of Epifaunal abundance for the monitoring period for marine sediments (Port Entrance, Turning Circle, Coal Berth and Reclamation Area)

3.6. Other ecologically sensitive flora and fauna

The study area is surrounded by sensitive ecological systems such as river, coastal dune, creek with different flora and fauna.

3.6.1. Mangrove and salt marshes

Mangroves are seen in Kandaleru river and it creek region near the port region, but they are absent inside the port area and the coastal zone. Mangroves are seen as patches and lines. There is two major mangroves seen along the banks of creek, which are located adjacent to the Buckingham canal and Kandaleru creek respectively. Located on the eastern side of the port and adjacent to the reserve forest. Here, the mangroves are distributed along the banks as well as in the islets. The cover of mangrove in the Krishnapatnam Port region is 52 ha. Totally, nine mangrove species are recorded, which are *Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Lumnitzera racemosa, Ceriops decandra, Rhizophora mucronata, Bruguiera gymnorrhiza* and *Bruguiera cylindrica*. *Ceriops,* in which, *Avicennia marina* is the most dominant species. Further, the AKPL has undertaken the plantation of mangroves upstream and downstream of the creek, about 50,000 mangrove saplings were planted in 50 ha adopting the fish-bone technique. As per the estimate, the overall mangrove plantation showed a total stock of 324.9 tonnes of carbon.

Six types of halophytic plants were also observed namely *Suaeda maritime, Suaeda monoica, Tecticornia indica, Sesuvium portulacastrum, Heliotropium curassavicum* and *Cressa cretica.* They are seen in the periphery of mangrove patches and also with mangroves along the banks of the river. *Chaetomorpha* sp. was the algae observed in this region.

3.6.2. Coastal Vegetation

As a part of green initiative and to meet legal mandate, Krishnapatnam Port has developed 191.5 ha of terrestrial green belt beside 50 ha of mangrove plantation. Around 4 million trees in the greenbelt alone apart from mangrove plantation so far since 2013. Totally 69 flora containing trees, herbs, grasses, climbers and shrubs were recorded. Among them *Peltophorum pterocarpum, Casuarina equisetifolia, Conocarpus lancifolius* and *Cassia siamea* were most abundant in the greenbelt. Based on the quadrate density studies, a total of 8,04,730 trees were estimated to be present in the 191.5 ha. The overall carbon stock potential in 191.5 ha of green belt is 25,261.67 tons of carbon, with a CO_2 equivalent of 92,609.27 tones. Good amount of dune vegetation were observed, which includes seven species namely, *Cyperus arenarius, Ipomoea pes-caprae, Glinus oppositifolius, Spinex littoreus, Ammophila arenaria, Oldelandia corpymbosa* and Zizphus nummulaia.

3.6.3. Other fauna

The faunal community recoded in creek and coastal region includes 12 fishes, 7 crustaceans, 45 molluscs, 1 lepidoptera, 10 aves and 1 reptiles in the river, creek and waterlogged area (Table 3.1)

Table 3.1: Coastal and marine fauna recorded along the creeks and coastal region at Adani Krishnapatnam Port Limited

Family	Scientific name	Common name
Fishes		
Carangidae	*Caranx* sp.	
Carangidae	*Megalaspis cordyla*	Torpedo Scad, Horse mackerel
Engraulidae	*Thryssa malabarica*	Malabar Thryssa, Moustached Thryssa
Gobiidae	*Boleophthalmus boddarti*	Boddart's goggle-eyed goby
Haemulidae	*Pomadasys* sp.	
Mugilidae	*Liza* sp.	
Pristigasteridae	*Opisthopterus tardoore*	Long-finned Herring, Tardoore
Sciaenidae	*Otolithes ruber*	Tiger tooth croaker
Scombridae	*Rastrelliger kanagurta*	Indian mackerel
Sillaginidae	*Sillago sihama*	Silver Sillago, Sand whiting
Terapontidae	*Terapon jarbua*	Crescent Perch, Squeaking Perch
Trichiuridae	*Trichiurus* sp.	
Crustaceans		
Grapsidae	*Grapsus sp.*	Sally Lightfoot crab
Ocypodidae	*Uca annulipes*	Porcelain Fiddler Crab
Ocypodidae	*Uca triangularis*	Triangular Fiddler Crab
Portunidae	*Portunus pelagicus*	blue swimming crab
Portunidae	*Portunus sanguinolentus*	Three-spot swimming crab
Portunidae	*Scylla serrata*	Indo-Pacific swamp crab
Varunidae	*Metaplax indica*	
Molluscs		
Anomiidae	*Anomia ephippiium*	Common jingle shell
Architectonicidae	*Architectonica perspectiva*	Clear sundial
Arcidae	*Anadara inaequivalvis*	Inequivalent ark
Arcidae	*Anadara pilula*	Pill Ark
Arcidae	*Tegillarca rhombea*	Blood Clam
Arcidae	*Tegillarca granosa*	Malaysian cockle
Babyloniidae	*Babylonia zeylanica*	Indian Babylon
Babyloniidae	*Babylonia spirata*	Spiral Babylon
Bursidae	*Bufonaria rana*	Common frog shell
Bursidae	*Bufonaria* sp.	
Calyptraeidae	*Desmaulus extinctorium*	Cup-and-saucer snails
Carditidae	*Cardites bicolor*	Two-toned cardita

Carditidae	*Vepricardium asiaticum*	Asiatic cockle
Cassidae	*Phalium glaucum*	Grey bonnet or glaucus bonnet
Clavatulidae	*Turricula* sp.	Turned turrid
Ellobiidae	*Cassidula nucleus*	Banded mangrove helmet snail
Ficidae	*Ficus variegata*	True fig shell
Glycymerididae	*Glycymeris taylori*	Common European bittersweet
Haminoeidae	*Haminoea* sp.	White bubble shell
Harpidae	*Harpa davidis*	Madras harp or David harp
Mactridae	*Mactra chinensis*	Chinese Mactra
Mactridae	*Mactra luzonica*	Luzon trough shell
Mactridae	*Mactra ochracea*	
Melongenidae	*Volegalea cochlidium*	Spiral melongena
Muricidae	*Rapana rapiformis*	Turnish shaped rapa
Muricidae	*Murex ternispina*	Black-spined murex
Mytilidae	*Modiolus* sp.	Horse mussel
Naticidae	*Neverita didyma*	Bladder moon snail or moon shell
Olividae	*Agaronia gibbosa*	Gibbous olive
Onchidiidae	*Peronia* sp.	
Ostreidae	*Saccostrea cucullata*	Mangrove Oyster
Ostreidae	*Magallana bilineata*	Philippine cupped oyster
Pharidae	*Siliqua radiata*	Sunset Siliqua
Pinnidae	*Atrina chinensis*	Comb Pen Shell
Potamididae	*Terebralia palustris*	Giant Mangrove Whelk
Potamididae	*Pirenella cingulata*	Girdled horn shell
Potamididae	*Telescopium Telescopium*	Telescope snail
Pteriidae	*Pinctada imbricata*	Akoya pearl oyster
Sepiidae	*Sepia* sp.	Cuttle fish
Tellinidae	*Tellinimactra edentula*	Elongate tellin
Turritellidae	*Turritella duplicate*	Duplicate turret
Turritellidae	*Turritella acutangula*	Duplicate turret
Veneridae	*Marcia opima*	Venus Shell
Veneridae	*Sunetta concinna*	
Veneridae	*Sunetta scripta*	
Lepidoptera		
Acraea violae	Tawny Coster	
Aves		
Ardea alba	Great Egret	
Egretta garzetta	Little Egret	
Ardea intermedia	Median egret	
Ardeola grayii	Indian pond heron	

Anastomus oscitans	Asian openbill stork	
Charadrius leschenaultii	Greater Sand Plover	
Pelecanus philippensis	Grey Pelican	
Numenius arquata	Eurasian curlew	
Calidris minuta	Little stint	
Tringa nebularia	Common green shank	
Reptiles		
Gerarda prevostiana	Glossy Marsh Snake	

Chapter 4
Environmental Impact Assessment

4.1. Background

The day-to-day operations of Adani Krishnapatnam Port might cause disturbance to the coastal environment and associated biodiversity. So it is mandatory to have regular monitoring to evaluate the impact on air, noise, marine water and sediment.

4.2. Impact due to regular port operation

During the operational phase of the Port, vessel movement, storage and handling of cargo such as containers, non-container, coal cargo and liquid cargo will be a part of the Port activities.

The results of the present monitoring of port region creek and deep water and sediment parameters show that the values are within the prescribed range. The pH in the marine water of port region ranges between 7.79 and 8.36, whereas in the creek region it ranges between 7.3 and 7.89, which is within the limits suggested by Central Pollution Control Board (CPCB) – permissible limits of Primary Water Quality Criteria for Class SW-IV water (for Harbour Waters) for coastal. The dissolved oxygen in the marine water of the port region ranges between 3.90 and 6.58 mg/l, whereas for the creek region, it ranges between 5.7 and 6.9 mg/l, which are within the limits suggested by Central Pollution Control Board (CPCB, Class SW-IV). Biological oxygen demand varies from 2.48 to 3.85 mg/l and from 3.1 to 3.8 mg/l for port region and creek region respectively, which is within the limit suggested by Central Pollution Control Board (CPCB, Class SW-IV).

Similarly, the microbial parameters are also within the prescribed range. The coliform in the marine water in the port region ranges from 10.5 to 33.75 CFU/100ml and for creek water it ranges from 15 to 29 GFU/100ml, which are within the limits suggested by Central Pollution Control Board (CPCB) – permissible limits of Primary Water Quality Criteria for Class SW-IV water (for Harbour Waters) for coastal waters. The fecal coliforms are absent in the marine and surface waters.

As planktons are the primary producers, they are very essential for the food web in the aquatic ecosystem, and any significant change in the plankton profile will affect the marine biodiversity. In the present assessment, phytoplanktons were observed. The phytoplankton abundance ranges from 2.01 to 261 no.ml and from 266 to 301 no./ml for the port region and creek region respectively. Zooplankton biomass ranges from 9.48 to 13.8 ml/100m^3 and from 12.1 to 13.8 ml/100m^3 for the port region and creek region respectively. Chlorophyll ranges between 1.25 and 1.7 mg/m^3 for the port region and ranges between 2.28 and 2.89 mg/m^3 for creek region respectively. The primary productivity ranges between 21.75 and 58.75 mgC$m^{-2}d^{-1}$ for the port region and between 45 and 58 mgC$m^{-2}d^{-1}$ for creek region. Plankton and other parameters are within the range for the assessment period. Nutrients could also play an important role in the phytoplankton density.

Marine benthos was recorded in the port region's marine sediments during the assessment period. The benthos population ranges between 1121.5 and 1177.75 nos./m^2. The range of

Epifaunal numerical abundance is from 18.5 to 37.75 nos./haul and the Infauna numerical abundance ranges from 697.75 to 751.25 nos./m^2. The presence of benthos indicates that the environment is free from pollution.

The various environment parameters monitored such as marine water and sediment samples, microbial parameters, planktons and benthos are well within the prescribed range, which indicates that the existing Port operations such as vessel movement, cargo storage and handing have no adverse impact on the marine and terrestrial environments.

4.3. Impact due to aqueous discharges

During the operational phase there will be continuous movement of cargo vessels and port crafts around the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage)/sewage, bilge water, solid wastes etc. In addition, land-based sources of pollution such as runoff from the cargo berths, sewage, STP outfall and effluents from the port operations would also affect the port, creek and deep water and sediment qualities in and around the harbour basin.

But the results show that the marine water and sediment parameters monitored are within the prescribed range and some of the parameters are also below detectable range. The presence of healthy mangroves in the creek region and the range of biological parameters within the range, indicates that there is no impact on the environment due to operation of various Port activities.

4.4. Air pollution

During the operational phase, due to increase in the movement of traffic, emissions from the moving vehicles will also increase. The exhaust from the DG set at the port, the tugs, launches, diesel-operated small boats, vessel exhaust, dredgers etc are likely to enhance a pollution load during operational phase. Cargo handling to and from port and their storage at port may increase air pollution in terms of vehicular emission and fugitive dust emission.

The recorded values of air qualities during the study period are within the prescribed range as per the revised National Ambient Air Quality Standard (NAAQS), which indicates that the various current activities of port have no impact on the air quality.

The AKPL region is having developed terrestrial green belt of 191.5 ha and 50 ha of mangroves in the creek and adjoining region. These vegetation not only control the air quality, but also sequester more carbon and enhance aesthetics of port.

4.5. Noise pollution

During the operational phase, noise is generated due to vessel movement, cargo handling, cargo storage, truck traffic, DG set and dredging activities. This increases the noise level within the Port area.

The ambient noise levels monitored at regular interval at different locations during study period of the project are well within the prescribed limit as per Central Pollution Control Board (CPCB) guidelines, and hence there is no noise pollution due to the operations of Port activities.

4.6. Impact due to regular port maintenance

Regular maintenance of infrastructures, berths and channel are important for the effective functioning of the port. The maintenance of infrastructures could increase the load/contamination in marine water and sediment from the runoff. Similarly, the degrading of channel could increase turbidity and levels of dissolved solids and suspended solids in the water column, which might ultimately affect the marine biodiversity. In the present assessment, the values of turbidity, range from 5.49 NTU to 18.33 and from 4.33 to 6.06 NTU; the TDS varies from 31,294 to 34351.6 mg/l and from 33,702 to 36,315mg/l; the TSS varies from 11.18 to 19.96 mg/l and from 5.56 to 8.96mg/l for marine waters of port region and deep sea region respectively. which indicates that the environment is free from excess loads and the presence of benthos, fishes, avifauna and reptiles in the creek and coastal region also indicates that the regular port maintenance has no impact on the environment.

4.7. Potential impact due to location

The existing land use of the port including port infrastructures, berths, cargo storage yard, and cargo handling activities are within the CRZ. Further, the various environmental parameters examined in ambient air quality, ambient noise, waters of port, creek and deep water and marine sediments of port area are within the prescribed limits. Hence there is no significant impact due to the handing of various types of cargo in the port.

Chapter 5
Summary and Conclusion

Adani Krishnapatnam Port is located at Krishnapatnam in Muthukur Mandal Nellore District, Andhra Pradesh on the East Coast of India. The port, located at the mouth of Kandaleru River, has been operating since March, 2009. The coastal region is endowed with mangrove swamps, aqua ponds, floodplains, coastal dunes, sandy beach and water bodies such as river, creek, canals, streams and tanks. The port is well connected with road and railway network. The port is well-equipped with infrastructure for handling cargos like container, non-containers, coal cargo and liquid cargo.

The environmental attributes such as meteorological data, ambient air quality, ambient noise level, quality of marine water including port, creek and deep region, quality of sediment, microbial parameters, planktons, and benthos, were monitored regularly during October 2022 to September 2023, in order to evaluate the impact of port operation on the environment. Standard protocol was followed for sample collection and analysis. Similarly carbon stock potential in the green belt and mangroves inside the port region were studied during May 2022. Mangrove and other flora and fauna in the creek and coastal region were studied during September to October 2022

Ambient air quality parameters such as PM_{10} concentration varies between 47.2 µg/m^3 and 67.6 µg/m^3, $PM_{2.5}$ concentration varies between 17 µg/m^3 and 26.7 µg/m^3, SO_2 concentration varies between 9.1 µg/m^3 and 16.4µg/m^3, NO_2 concentration varies between 11.2 µg/m^3 and 17.9 µg/m^3, O_3 concentration varies between 8.3 µg/m^3 and12.3 µg/m^3 and CO concentration varies between 0.1 µg/m^3 and 0.32 µg/m^3. The concentrations of NH_3, Pb, C_6H_6, BaP and Ni are below detectable limit throughout the monitoring period. All the air quality parameters are found to be within limits prescribed by NAAQS. There is no significant impact on the air quality due to the operation of the Port activities

Noise levels, monitored as per CPCB guidelines, varies between 46.3 dB(A) to 66.8 dB(A) for day and 36.1 dB(A) to 57.6 dB(A) for night and are found to be within the limits. So there is no significant impact due to the noise level in the operation of Port.

In marine water (Port) and surface water (creek) the pH varies from 7.3 to 8.36; temperature varies from 25.5 to 29.1^oC; salinity varies from 31.9 to 38.33 ppt; density varies between 1.01 and 1.65 mg/l; potassium ranges from 227.7 to 388 mg/l; COD varies from 12.3 to 14.7 mg/l; BOD varies from 2.48 to 3.85 mg/l; oil & grease ranges between <0.1 and 0.55 mg/l; dissolved oxygen content varies from 3.9 to 6.9 mg/l; nitrate ranges between 1 and 7.7 mg/l; nitrite ranges from <0.1 to 0.37 mg/l; ammonia as NH_3 varies from <0.01 to 0.59 mg/l; phosphate ranges between 0.13 and 14.7 mg/l; chloride varies between 17,672 and 21,282 mg/l; sodium ranges from 6,954 to 8681 mg/l; sulphate varies from 2,646 to 3,734 mg/l; silicate ranges from 1.27 to 4.68 mg/l; reactive silica ranges from 0.0072 to 0.60 mg/l; total phosphorus ranges from 0.065 to 0.53 mg/l; total nitrogen varies between 9.0 and 14.45 mg/l; cadmium ranges between <0.01 and 0.42 mg/l. copper varies between <0.01 and 0.31 mg/l; zinc varies between 0.013 and 0.067 mg/l; lead is below 0.01 mg/l. In port water and deep sea water, the turbidity varies between 4.33 and 18.33 NTU; TDS varies between 31,294 and 36,315 mg/l; TSS varies between 5.56 and 19.96 mg/l. Values of marine water quality are within the permissible limits of Primary Water

Quality Criteria for Class SW-IV Waters (For Harbour Waters) published by CPCB in Designated Best Use Classification for Coastal Waters.

The sediment composition of the monitored area is dominated by silt and clay fraction. sand varies between 33.75 and 37.08 %; slit+clay range from 62.92 to 66.25%; the organic matter ranges between 1.24 and 1.49%; the organic matter ranges between 1.24 and 1.505%; pH ranges from 6.345 to 8.33; nitrogen varies between 288.75 and 392.25 mg/kg; phosphorus ranges between 170 and 337.5 mg/kg; potassium ranges from 236.75 to 376.75 mg/kg; sodium ranges from 16541 to 17630.75 mg/kg; zinc ranges from 0.0453 to 0.8125 mg/kg; copper content varies from 0 to 0.4725 mg/kg; cadmium content varies between 0.0365 and 0.09575 mg/kg and lead content ranges from 0.275 to 0.67 mg/kg.

The coliform in the marine water ranges from 10.5 to 33.75 CFU/100 ml, whereas fecal coliform is not detected in marine waters and surface waters. The ranges of microbial communities are within the limits suggested by Central Pollution Control Board (CPCB) – permissible limits of Primary Water Quality Criteria for Class SW-IV water (for Harbour Waters) for coastal waters.

The phytoplankton density ranges from 2.01 to 301.0 nos./ml, whereas the zooplankton abundance ranges between 9.47 and 13.8 ml/100m^3. Zooplankton diversity varies between 1.92 and 2.84. Chlorophyll ranges between 1.24 and 2.89 mg/m^3, while primary productivity ranges between 21.75 and 58.75 $mgCm^{-2}d^{-1}$. Plankton and other parameters are within the range during the assessment period. Nutrients could also play an important role in the phytoplankton density.

Marine benthos was recorded during the assessment period. The benthos population ranges between 1121.5 and 1177.75 nos./m^2. The range of Epifauna numerical abundance is from 18.5 to 37.75 nos./haul and the Infauna numerical abundance ranges from 697.75 to 750.5 nos./m^2. The presence of good amounts of benthos clearly indicates the good health status of the environment and the dominance of foraminifera indicates a pollution-free environment.

Adani Krishnapatnam Port are is surrounded by Kandaleru River, creek with well grown mangroves. The port is having developed 191.5 ha of terrestrial green belt with 69 species and 50 ha of mangrove plantation with 9 species. The results of the various environmental parameters monitored clearly indicate that the day-to-day operations of Adani Krishnapatnam Port do not have any significant impact on the ambient air, ambient noise, marine water, marine sediment, microbial parameters, phytoplankton, zooplankton, benthos and other ecologically sensitive flora and fauna in the creek and coastal region during the study period.

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Appendix

Air quality standards – Appendix 1

NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION

New Delhi, the 18th November, 2009

No.B-29016/20/90/PCI-L—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in super session of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and Other Area	Ecologically sensitive area (notified by Central Govt.)	
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual*	50	20	• Improved West and Geake • Ultraviolet fluorescence
		24 hours**	80	80	
2	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual*	40	30	• Modified Jacob & Hochheiser (Na-Arsenite) • Chemiluminescence
		24 hours**	80	80	
3	Particulate Matter (size less than 10 µm) or $PM_{10} \mu g/m^3$	Annual*	60	60	• Gravimetric • TOEM • Beta attenuation
		24 hours**	100	100	
4	Particulate Matter (size less than 2.5 microns) or $PM_{2.5}$ $\mu g/m^3$	Annual*	40	40	• Gravimetric • TOEM • Beta attenuation
		24 hours**	60	60	
5	Ozone (O_3) $\mu g/m^3$	8 hours **	100	100	• UV photometric • Chemiluminescence • Chemical method
		1 hour **	180	180	
6	Lead (Pb) $\mu g/m^3$	Annual*	0.5	0.5	• AAS / ICP method after sampling on EPM 2000 or equivalent filter paper • ED – XRF using Teflon filter
		24 hours**	1.0	1.0	
7	Carbon Monoxide (CO) mg/m^3	8 hours**	2	2	Non Dispersive Infra RED (NDIR) Spectroscopy
		1 hour**	4	4	
8	Ammonia (NH_3) $\mu g/m^3$	Annual*	100	100	• Chemiluminescence • Indophenol blue method
		24 hours**	400	400	
9	Benzene (C_6H_6) $\mu g/m^3$	Annual*	5	5	• Gas chromatography based continuous analyser • Adsorption and desorption followed by GC analysis
10	Benzo (a) Pyrene (BaP) – particulate phase only ng/m^3	Annual*	1	1	Solvent extraction followed by HPLC / GC analysis
11	Arsenic (As) ng/m^3	Annual*	6	6	AAS / ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni) ng/m^3	Annual*	20	20	AAS / ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

Noise quality standards – Appendix 2

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

Marine water quality standards – Appendix 3

PRIMARY WATER QUALITY CRITERIA FOR CLASS SW-IV WATERS (FOR HARBOUR WATERS) BY CPCB, INDIA

Primary Water Quality Criteria for Class SW-IV Waters (For Harbor waters)			
S.No	Parameter	Standards	Rationale/Remarks
1	pH range	6.0-9.0	To minimize corrosive and scaling effect
2	Dissolved oxygen	3.0mg/l or 40% saturation value whichever is higher	Considering the biodegradation of oil and inhibition tooxygen production through photosynthesis
3	Colour and odour	No visible colour or offensive odour	None from reactive chemicals which corrode paints/metallic surfaces
4	Floating materials.	10mg/l oil, grease and scum (including petroleum products)	Floating matter should be free from excessive living organisms which may clog or coat operative parts of marine vessels/equipment
5	Fecal coliform	500/100 ml (MPN)	Not exceeding 1000/100ml in 20% of samples in the year and in 3 consecutive samples in monsoon months
6	Biochemical oxygen demand (BOD) (3 days at 27°C)	5mg/l decomposable wastes	To maintain water reactively free from pollution caused by sewage and other

Photos

Photography showing ambient noise quality monitoring

Photograph showing marine environmental monitoring

Photograph showing mangrove species recorded at Adani Krishnapatnam Port Limited

Photograph showing marine fauna recorded at Adani Krishnapatnam Port Limited

Photograph showing marine fauna recorded at Adani Krishnapatnam Port Limited

Photograph showing green initiatives of Adani Krishnapatnam Port Limited

PART - II:

Impact Assessment and Management Plan

Impact Assessment and Management Plan on Environment, Biodiversity and Fishery of the Rivers, Creek and Sea in and around Adani Krishnapatnam Port, Nellore District, Andhra Pradesh

1. Impact Assessment

1.1. Background

Adani Krishnapatnam Port is located at Krishnapatnam in Muthukur Mandal, "Sri Potti Sriramulu" Nellore District, Andhra Pradesh on the East Coast of India at Latitude 14°15'10"N and Longitude 80°08'05"E on the north bank of Kandaleru (Upputeru) (Fig. 1). Krishnapatnam Port has been developed on BOST (Build-Operate-Share-Transfer) basis through a special purpose company called "Krishnapatnam Port Company Limited (KPCL)" in terms of the Concession Agreement entered with Government of Andhra Pradesh (GoAP). Adani Ports and Special Economic Zone (APSEZ) is holding a major stake in KPCL over CVR Group and other investors. Adani Krishnapatnam Port Limited (AKPL) is being developed in phases as an all-weather, deep-water, multi-purpose port. EC and CRZ clearance were granted by Ministry of Environment, Forests and Climate Change, Government of India (MoEF&CC – GoI) in 2006, 2009 and 2021 respectively for the Phases – I, II & III.

At present, there are 13 berths operating with necessary infrastructure with a capacity to handle 78 MTPA of non-container cargo and 2.0 MTEUs PA of container cargo. Right now, MoEF & CC granted Environment & CRZ clearance for the "Expansion of Krishnapatnam Port (Phase-III)" vide File No: 1018/2016-IA.III dated 11.01.2021, the project comprising of 16 berths including 3 jetties for liquid cargo and 3 SBMs in deep waters to cater 218.2 MTPA of various types of cargo and 3.1 MTEUsPA of container cargo on 2752 ha of designated land (Fig. 2). AKPL obtained CFE vide order no. 633/APPCB/CFE/RO-NLR/HO/2010 dated 25.02.2021. The proposed project is located at the mouth of Kandaleru River in Nellore district of Andhra Pradesh in the Bay of Bengal, which falls within the Indo-Pacific realm, arguably the world's richest region in terms of biodiversity. The fishery resources of Bay of Bengal provide livelihood to thousands of fisher folk living along the coastline immediate to the project site. Further, the proposed project area is in the vicinity of critical marine ecosystems such as mangroves. The area encompasses the sea, river, creek, canal, and water bodies with considerable biodiversity.

Marine biodiversity is very important in terms of ecology and economy. Blue economy has been given priority in recent years. The biodiversity of a marine ecosystem is fragile and suffers when physical, chemical or biological parameters are changed. In view of the ecological and economic benefits of biodiversity, the developmental activities along the coastal belt have to be carried out with utmost care by following all measures of

conservation, management and protection. The construction of new ports or extensions of existing ones ought to be undertaken, but at the same time it is important to carry out the developmental activities without damaging the environment, biodiversity and its ecological services. Hence, effective conservation and management plans should be in place to mitigate the impacts of project activities. Monitoring of biological parameters in and around the project site is warranted for any developmental activity. Such monitoring carried out before, during and after the developmental activity would help to better manage and minimize the impacts as well as to take appropriate remedial measures through effective mitigation actions. The proposed developmental activities and likely impacts on the biodiversity of Bay of Bengal (marine zone), Kandaleru River and Buckingham Canal are detailed below.

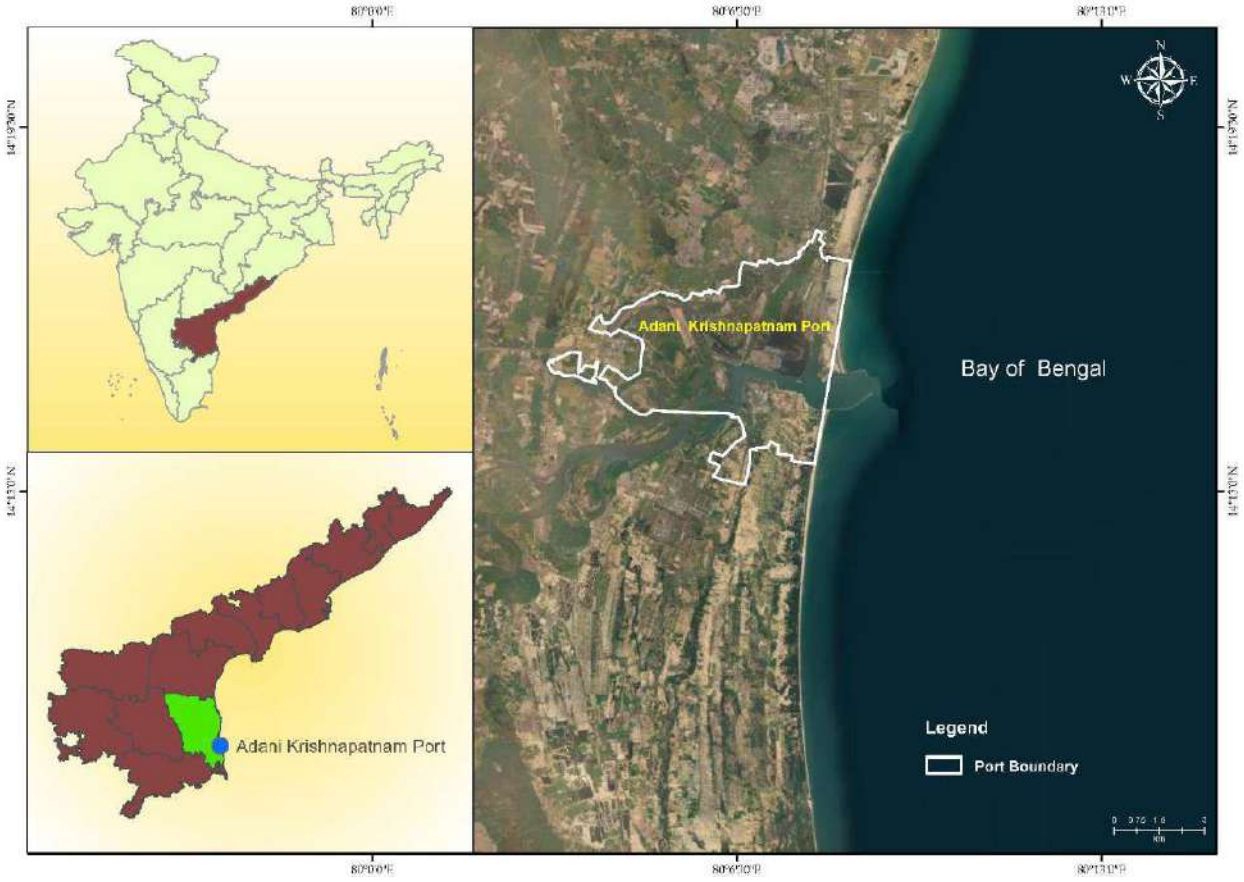

Fig. 1: Location of Adani Krishnapatnam Port, Nellore District, Andhra Pradesh

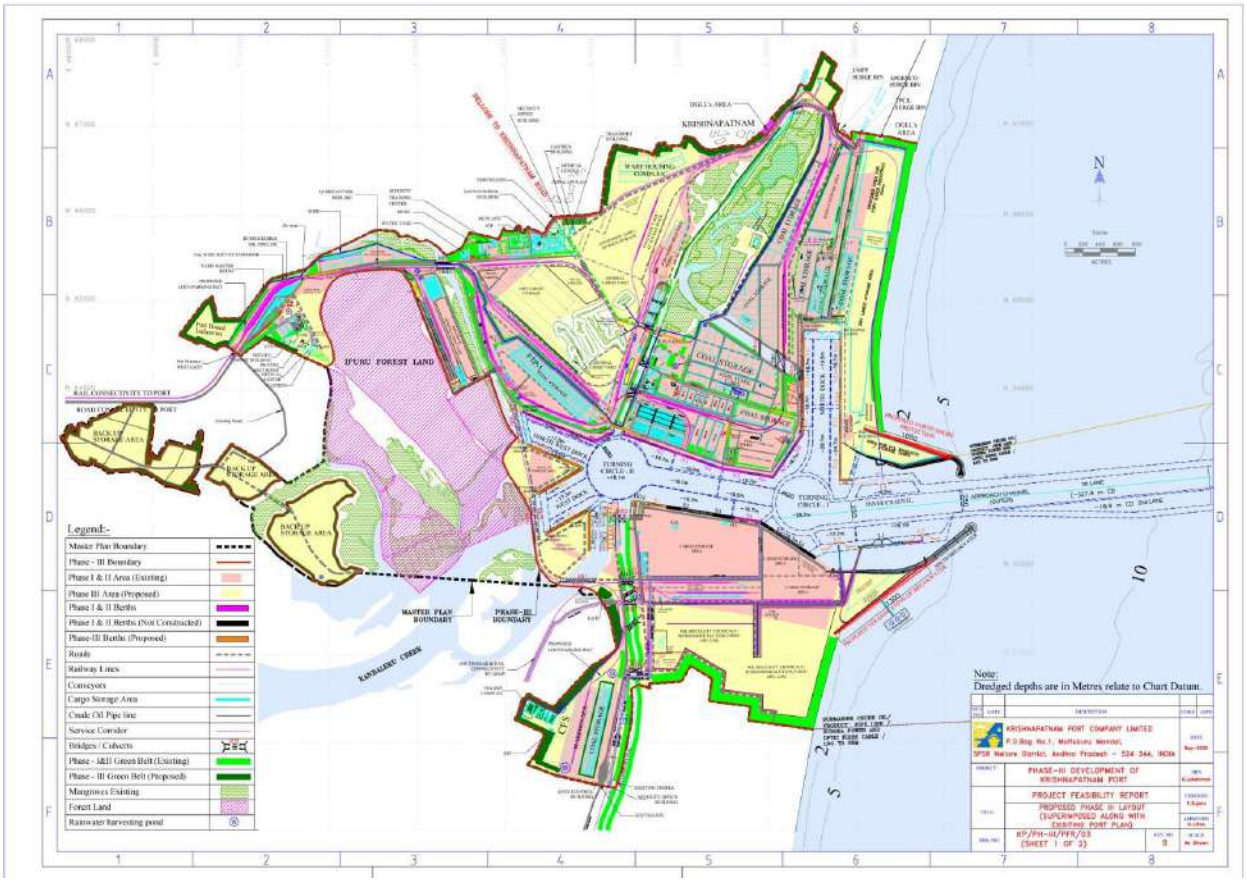

Fig. 2: Proposed layout of the Phase III development, AKPL

1.2. Major Project Activities

The major activities undertaken during the construction and operation phases that could potentially impact the marine environment include,

A. During Construction Phase

1. Dredging and disposal of dredged spoil
2. Straightening of Kandaleru Creek (Dredging and reclamation)
3. Strengthening of Breakwater (Reclamation)
4. Construction of Berths and SBM
5. Modulating Ephemeral drains and bridges (trestles/silts)
5. Other allied infrastructure development activities close to intertidal zone in creek and nearshore region, such as land reclamation, backup storage structures, Operational control buildings, road and rail network and bridges
6. Laying of Sub-Sea Pipelines

B. During Operation Phase

1. Maintenance Dredging and Disposal
2. Cargo Handling in the Waterfront & Offshore Berth/Jetty
3. Ship Traffic
4. Discharge from ETP and Bilge Water

1.3. Impacts on the environment and biodiversity due to the proposed activities during construction phase

1.3.1. Dredging and Dredged spoil disposal Activity

1.3.1.1. Impact on benthic organisms

Dredging and dredged spoil disposal are one of the key activities in the proposed project and they are expected to cause disturbance to the creek and coastal environment and their associated biodiversity. Benthic organisms will suffer the maximum damage as they are directly affected. Dredging for deepening the creek, port region and sea bottom will remove the benthic organisms that live in the area. In the creek and port region represents 18 and 19 benthic macrofaunal species respectively belonging to 5 major taxa namely Gastropoda, Bivalvia, Crustacea, Polychaeta and Nemertea were observed, and similarly 27 and 22 meiofauna species with 4 taxa namely Foraminifera, Nematoda, Ostracoda and Copepoda were observed in the port and creek region. In the vicinity of coastal environment a total of 20 macrofaunal species belonging to 4 major taxa namely Gastropoda, Crustacea, Bivalvia and Polychaeta were observed, and similarly 27 species with 4 taxa namely Foraminfera, Nematoda, Ostracoda, and Copepoda were observed. Dredging for the proposed layout condition would increase the load of suspended sediments in the nearby water. Sedimentation in the dredged channel would likely be heavy and would also affect all the benthic organisms. Sedimentation caused by dredging could potentially bury the benthic organisms in the nearby region. Owing to the increased sedimentation rate light penetration to the sea floor will be greatly reduced, which will limit the occurrence of benthic organisms. Study conducted by NIOT indicates that dredging activities would result in the reduction of species diversity of benthos by 50% and their population density by 60%. Dredging of channel would change the hydrodynamic condition in the creek region.

Transportation and dispersion characteristics of pollutants model study indicate that in the vicinity of port in the coastal water the concentration is diluted within 24 h (pollutant concentration is about 30% at a diameter of 10 m at the port location for a time period of 24 h) indicating that the tidal currents and high wave action could reduce the sedimentation load in the dredge site as well as dredge spoil dumping site. Similarly for the creek and port area, the strong tidal currents and lateral mixing will lower the load of sediment in the water column. It was proposed to dredge 60 MCM in Phase-III, in which 32 MCM amount of dredged material will be disposed inside the proposed dumping side in the offshore region. Dumping of dredged soil is also likely to affect all the benthic organisms in

the dumping site apart from causing excessive sedimentation. Changes caused in bathymetry and hydrodynamic conditions could potentially eliminate certain fragile benthic organisms. However, there are no threatened or endangered species of benthic fauna recorded in the project site. The dumping of dredged sediment at the dumping site will decrease the bathymetry there and it will not only harm the benthic organisms but will also increase sedimentation and it might change the present magnitude of current in the creek and port region.

1.3.1.2. Impact on plankton and productivity

Dredging and disposal of dredging sediment activities will churn up the bottom sediment and disperse fine particulate matter in the water column and would influence the turbidity and concentration of suspended solids. These activities affect the harmony of the marine environment by increasing the suspended sediment concentrations, sediment deposition and turbidity. Besides this direct effect, indirect impacts like changes in circulation pattern, hydrodynamic condition and littoral sediment transport are also likely. This will reduce light penetration and consequently suppress photosynthetic efficiency and primary productivity in the water column.

Planktons are primary producers and form the centre of a food web in an aquatic ecosystem. When planktons are affected due to the proposed project activities, the entire food web will be disrupted. The proposed project area has phytoplankton abundance of 2.01 to 261 no./ml inside the port region and an abundance of 266 to 301 no./ml in the brackish water region (creek and Buckingham canal) with a density of 1.95 to 2.66 and 2.31 to 2.75 respectively. The zooplankton biomass ranges from 9.48 to 13.8 ml/100m^3 and from 12.1 to 13.8 ml/100m^3 for port region and brackish water region respectively. Chlorophyll ranges between 1.25 and 1.70 mg/m^3 for port region and ranges between 2.28 and 2.89 for brackish water region (creek & canal) during 2022 and 2023. The primary productivity ranges between 21.75 and 58.75 $mgCm^{-2}d^{-1}$ for the port region and between 45.0 and 58.0 $mgCm^{-2}d^{-1}$ for brackish water region (creek & canal). Similarly, four phytoplankton groups namely bacillariophyceae, dinophyceae, cyanophyceae and chlorophyceae were observed in this region as per NCSCM report (2023), 52 species of phytoplankton and 22 mesozooplankton taxa were observed in which diatoms dominates in phytoplankton and Veliger larva dominates in Zooplanktons. The likelihood of changes due to the current patterns caused by the proposed project activities would affect the nutrient movement and plankton density. Nutrients play a vital role in phytoplankton density and diversity, and thus would affect the plankton abundance.

1.3.1.3. Impact on fishery resources

The impact on fishes may be due to physical impact of suspended solids in the water column due to dredging and also due to change in food chain. Fishes have a free movement and they have the tendency to avoid area with high turbidity. They may return to the same location after the completion of construction and dredging activities upon improvement of water conditions. The impact caused to the plankton community and benthic organisms

would directly affect the fishery resources. A total of 12 species of fin fish and 7 crustaceans were recorded in the creek and coastal region. Hence, it is likely that fishery resources in the dredging and disposal sites will be affected by the proposed activities in short-term with localized impact.

The present range of turbidity 5.49 to 18.33 NTU in the water column of port region will increase during dredging and reclamation work inside the port, creek region and the adjoining coastal region. Increased turbidity caused by dredging and disposal of dredged sediments may cause significant changes in fish behaviour, which include avoidance, disorientation, decreased reaction time, increased or decreased predation, increased or decreased feeding activity, and physical injury and even mortality. The present level of noise varying between 46.3 to 66.8 dB(A) and 36.1 to 57.6 dB (A) for day and night near the port region is within the limit. But increase of noise level during dredging would force the fishes in the area to move away. Suspended sediment concentration in the dredging and disposal of dredged sediments sites influences the fish availability in the area. As the creek acts as breeding and spawning ground for fishes, dredging in the creek region will have a significant impact on the fishery resources. At the dredging zone, smothering of eggs in spawning grounds is likely to reduce the fish population. Moreover, benthic fishery resources such as shrimps and crabs will be disturbed and dislocated and hence their population is likely to be affected during dredging operations.

1.3.1.4. Impact of dredging

In KPCL port Phase III expansion, it was proposed to dredge 60 MCM of material. The port possesses three cutter suction dredgers and three trailer suction dredgers as part of marine infrastructure facility. The suction dredgers are the hydraulic dredgers that make use of the centrifugal pumps for at least part of the transport process of moving the dredged material out of water or horizontally transporting the material to another site. The Trailer Suction Hopper Dredgers (TSHD) are used for dredging in soils which is intended for reclamation of land areas in the capital dredging and for disposal in the identified disposal ground. Capital dredging will increase the turbidity of the marine waters. The increase in the turbidity of the present levels, which ranges from 5.49 to 18.33 NTU, will affect the marine organisms. The marine organisms can tolerate certain range, but extreme levels may be fatal. The elevated noise levels during dredging activities will have impact on the fishes.

The positive impact of dredging are that the dredging activities will release the oxygen and nutrients trapped in the bottom of the creek and marine sediments; the eutrophication will be controlled due to mixing of the water column and will help in restoring the health of the aquatic ecosystem. The present strong flow field predicted in the mangrove creeks, could remove the suspended the load in the creek and port region during dredging.

1.3.1.5. Impact of dredged spoil disposal

A total of 32 million m^3 disposed at the dumping ground beyond (-) 20 m contour identified in the Phase II development will be utilised for Phase-III also. A total area of 56 km^2 (5 km X 11.2 km) will be utilized as per the recommendations by the NIOT study report on dredging and disposal of dredged materials. The dredged spoil impact was modelled using DELFT 3D model. The disposal will be done using the hopper barge with limited dumping periods which will cause short-term turbidity in the water column but will disperse soon since the fine sediments ranges between 63.45 and 66.25% are present in the port region. The dumping grounds identified in the Bay of Bengal do not have any fragile ecosystem and thus the disposal would not cause severe damage to the environment. The quality of dredged soil and the disposed soil is of same quality and so there is no transfer of any adverse impact. The concentration of heavy metals in the proposed dredged sediments are non-toxic and therefore there will be no ecological/environmental impact during dumping except the increase in the present levels of turbidity which ranges from 4.33 to 6.06 NTU and suspended load which ranges 5.8 to 7.5 mg/l respectively in the water column.

1.3.2. Straightening of Kandaleru Creek (Dredging and reclamation)

1.3.2.1. Impact on benthic organisms

The Kandaleru creek passes through Krishnapatnam port and drains into the Bay of Bengal. For the ease of access, the meander of Kandaleru Creek will be straightened by forming a straight cut of the existing sand bar near the west for development of west dock and thereafter reclaim the meander at north and south arms of the creek. This area serves as back space required for the berths, of which three are in the west dock and one is in the north-west dock. The area of the creek that will be cut for the west dock basin is about 13.7 Ha is considered after excluding the forest area which was earlier 18.8 Ha. The increase in the depth of the creek region from 2 to 16 m and changing of intertidal region to subtidal region for the proposed North dock, North-west dock and South dock regions will affect shallow water and intertidal benthic habitats in the proposed dock region.

1.3.2.2. Impact due to change in hydrodynamics

At present the influence of waves in the creek is observed upto the port region, whereas beyond the port region, the hydrodynamics in the creek is predominantly depending upon the wind and tidal forcing parameters. Opening up of existing sand bar present on the western side of creek for about 300 m wide would change the existing hydrodynamic condition, which may affect the present benthic population which ranges between 1121.5 and 1177.75 nos./m^2 and epifauna abundance which ranges between 18.5 to 37.75 nos./haul during 2022 & 2023. Similarly, the creek rerouting model study conducted by NIOT, indicate that the water level in the rerouted channel drops by 2 cm due to deepening of the channel and the depth averaged velocities in the creek are reduced from 0.3 m/s to 0.15 m/s in the rerouted channel. The reduction in flow velocities due to rerouting may lead to siltation of docks, which will affect the benthic communities in this region. To

maintain the depth for navigation of ship, regular maintenance dredging has to be done. This will increase present turbidity level which ranges from 5.49 to 18.33 NTU and total suspended sediments, which ranges from 11.18 to 19.96 mg/l. The suspension of sediment in the water column is likely during maintenance dredging and disposal and will have their likely impact on benthic and pelagic organisms. Associated fishery resources are also likely to be affected during maintenance dredging and disposal of dredged sediment during the operational phase. As fishes have a free movement and they tend to avoid area with high turbidity and return to the same location after the completion of dredging activities upon improvement of water conditions. The rerouted model study also indicates that there is no significant change in flow of Buckingham canal and Upputeru creek. The pollutant concentration and dispersion model indicates that pollutant concentration near the port locations is insignificant and can be minimized by regulating the flow in the creek.

1.3.3. Strengthening of Breakwater (Reclamation)

1.3.3.1. Impact on benthic organisms due to strengthening of breakwater

Strengthening of breakwaters for shoreline protection along windward side of South and North breakwater for a respective distance of 1,300 and 1,050 m will be done along the shore. It is proposed to undertake necessary protection works to withstand waves and reclaim to a uniform level by utilizing the dredged sand. Nearly 2 MCM of dredge spoil will be used for reclamation of 32.5 Ha of land, which will ultimately affect the intertidal and subtidal benthic organisms present in the proposed breakwater strengthening area and nearby area. This will consequently affect the associated fishery resources in the reclamation area.

1.3.3.2. Impact on shoreline due to strengthening of breakwater

The study of shoreline changes due to the strengthening of breakwaters carried out by NIOT indicates a possible change in hydrodynamic scenario near the shore and also within the project boundary that can lead to 58% accretion and rest erosion in the 11.18 km shoreline. Seven specie of sand dune flora were observed in the coastal track in this region (*Cyperus arenarius, Ipomoea pes-caprae, Glinus oppositifolius, Spinex littoreus, Ammophila arenaria, Oldenlandia corymbosa* and *Zizyphus nummularia*). The model study also suggested that about 2.0 million cum of dredged materials will be deposited towards the North of the North breakwater to maintain the coastal stability of the shoreline for the period of 10 years, which will affect the coastal vegetation.

1.3.4. Construction of Berths and SBM

1.3.4.1. Impact on benthic organisms

Construction of 16 berths will be done in the creek region and near to the shore region. Coal berths are proposed in the North dock and container cargo berths in the West dock

with required back-up area for cargo storage/warehouses and other pertinent infrastructure. Similarly, Jetties for small crafts, Coast guard vessels and repair Dry Docks are proposed in Phase – III development. Intertidal and subtidal benthic organisms will be the primary victims of the proposed berths. The pile driving activates in the creek during berth construction may alter water environment and cause disturbance to the sediment as well as biological environment. Changes in bathymetry around the proposed berths would potentially also affect the macrobenthic population ranging between 1121.5 and 1177.75 nos./m^2 and epifaunal abundance from 18.5 to 37.75 nos/haul in the port region. The spillage of construction material may also affect the marine water quality. This could increase the present levels of turbidity which ranges from 5.49 to 18.33 NTU; similarly, materials like cement are highly alkaline and can significantly alter the present level of pH (7.3 to 8.36) of port and creek water, harming aquatic life. If the fishes ingest construction debris, leads to internal injuries or death. Similarly, 3 Single Buoys Moorings (SBM) are also proposed as part of project development in the deep waters within the port limits at a distance of about 16.5 to 18.7 km from the shore, which will also ultimately affect the benthic habitat and associated fishes during the piling and other construction activities. Construction of berth and SBM structures can create new surface for biofouling communities.

1.3.4.2. Impact on plankton and productivity

The construction of berths in the creek is likely to affect the current pattern and nutrient circulation. This change in the current circulation will affect the flushing of seawater inside the proposed port. The creek rerouting model study indicates that the water level in the channel drops by 2 cm due to deepening of the channel and the depth-averaged velocities in the creek are reduced from 0.3 m/s to 0.15 m/s, and this will impact the plankton and productivity. Leaking of construction related chemicals, such as fuels, lubricants or antifouling agents can introduce toxins that harm plankton, which will affect the food chain. There is a possibility of some phytoplankton species to dominate under altered conditions, producing toxins harmful to marine life.

1.3.4.3. Impact on mangroves and associated biodiversity

The hydrodynamics in the creek predominantly depends upon the wind and tidal forcing parameters. The construction of berths is likely to affect the flushing of water in the creek. The creek rerouting model study indicates that the water level in the rerouted channel drops by 2 cm and the depth averaged-velocities in the creek are reduced from 0.3m/s to 0.15 m/s. Similarly, the ST model predictions clearly indicate erosion in the creek region near the mangroves, associated biodiversity and avifauna, which can destabilize the nearby river banks. Erosion and sedimentation can potentially smothering mangrove roots and hindering its regeneration. Mangroves store large amount of carbon in the soil (mean value of soil organic carbon stock for 1 m depth is 386 MgC/ha), their destruction and degradation can releases CO_2, which can reduce the carbon sequestration, contributing to climate change. The reduction in mangrove coverage can increase coastal vulnerability to erosion, storms and flooding. Their loss can also lead to eutrophication or declines in water

quality. It is also estimated that soil organic carbon in the port and creek region ranges from 0.01 to 1.99%. Already AKPL is also undertaking plantation of mangroves upstream and downstream of the creek, about 50,000 mangrove saplings were planted in 50 ha, which will increase the carbon storage and sequestration to mitigate climate change. The overall mangrove plantation showed a total carbon stock of 324.9 tonnes.

1.3.4.4. Impact on fishery resources

The likely changes in current speed caused by the construction of 16 new berths inside the creek and existing Ports would affect the plankton communities and thus the dependent fishery resources. Impact on phytoplankton abundance due to wave and current pattern changes is likely to affect the present primary productivity (ranges from 21.75 to 58.75 $mgCm^{-2}d^{-1}$) and zooplankton abundances, and would consequently affect the fishery resources (11 fish species and 7 crustaceans in the creek region). Impacts on benthic and pelagic organisms would also eventually affect the fishery resources of the area. The shoreline changes in the vicinity of the proposed project area would affect the benthic organisms and consequently the associated fishes will also be affected. There will be increase in noise level during construction of berth, which will force the fishes to migrate from that locations.

1.3.4.5. Impact on Creek

Kandaleru Creek is a biologically rich water body. As the existing port and the proposed port extension are located inside the creek, the tidal water in the creek can reach about 30 km inland through the creek and play important role in the water supply for mangrove. The creek is likely to be affected due to the presumed hydrological changes caused by proposed project activities such as straightening of Kandaleru River, construction of berths, strengthening of existing breakwaters, dredging and reclamation. The hydrological changes may affect the mangroves in the creek. The presumed increase of the sediment load and turbidity may affect pelagic and benthic organisms in the creek. The creek is biologically connected with other water bodies such as Bay of Bengal, Kandaleru River and Buckingham Canal. Damage caused on the biodiversity in any of these water bodies would also affect the biodiversity in Kandaleru creek.

1.3.5. Modulating Ephemeral drains and bridges (trestles/silts)

There are 4 ephemeral drains in the approved Master Plan Area, of which one comes under the Forest Land and excluded from the present development. Even though the other 3 ephemeral drains will be kept intact, and efforts will be made for continuing the flow of water during the Phase III operation, the construction of culvert for road and rail network across two of the drains may hinder the flow of sediment to the downstream direction. In course of time this could leads to head loss within the culvert due to deposition of sediment and can cause waterlogging. It can reduce hydrological connectivity between upstream and downstream ecosystem.

Development of two road and four railway bridges on Kandaleru Creek, three road bridges on Buckingham Canal, two road bridges on drain/creek, modification of the existing bridge on Upputeru Creek as road bridge and rail-cum-road bridge and strengthening of 3 existing bridges/culverts on Buckingham Canal could affect the creek and canal ecosystem. The construction of pile, stilts/trestles for bridges could affect the channel morphology, substrate property and flow regime. The spillage of construction materials and concrete will also affect the water flow in the channel. The benthic assemblages found under the proposed bridge locations and along the embankments will be affected due to the construction and piling of sediments. Totally 69 floral species of trees, herbs, grasses, climbers and shrubs were observed inside the port region, with an overall carbon stock of 25,261.67 tons of carbon sequestered in 191.5 ha with a CO_2 equivalent of 92,609.27 tones. The flora assemblages that are present along the construction site, bridges and creek embankment will also be affected. So far, AKPL has planted over 2.7 million sapling on the premises of the Port area.

1.3.6. Other allied infrastructure development activities close to intertidal in creek and inshore region, such as land reclamation, backup storage structures, rail and road network and bridges.

1.3.6.1. Impact on mangroves and associates

In the vicinity of the proposed project area, two major mangrove habitats occur with reasonable extent due to available of freshwater supply form Kandaleru River, whereas, in the proposed Phase III project area sparse mangrove cover with 52 ha is seen. Totally nine mangrove species are recorded, which are *Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Lumnitzera racemosa, Ceriops decandra, Rhizophora mucronata, Bruguiera gymnorrhiza* and *Bruguiera cylindrica*. Eight types of halophytic plants are also observed in the mangrove areas along with other coastal vegetation. Even though it was planned not to utilize mangrove cover area that exists inside the Phase – III expansion area, land reclamation works may lead to loss of shores, seabed, flora and fauna within the reclaimed areas. Land reclamation activities such as construction of buildings, rails, roads, bridges, and parking areas for the proposed project can impact the floodplain and may reduce the infiltration of water into the ground. This may hinder the water flow to the sea and is likely to flood the adjacent water bodies during heavy floods and it would affect the mangroves and associates. Blocking of low-lying areas would increase the water flow in the water bodies and it would consequently increase the run-off into the sea causing sedimentation. Moreover, reclamation in the area would cause sedimentation in the water bodies such as Buckingham Canal and Kandaleru River and it may affect all the benthic and pelagic organisms in the mangrove area. Mangrove associated fishing activities and other fishing activities are likely to have minimal impact due to the land reclamation activities. Stockpiling and handling of materials during construction activities have the potential to cause particulate matter pollution in the adjacent mangroves. On the other hand, afforestation of a total area of 50 ha of mangroves has been done in this region.

1.3.6.2. Impact on avifauna and other animals

The landforms observed in the study area include river, intertidal region, water body, canal, creek, cultivable land, non-cultivable land, forest, and sandy beach, and hence the density and diversity of birds are considerably high. At least 52 species of migratory and resident birds were sighted during the study period. The most common birds recorded are Bee-eaters, Mynas, Larks, Lapwings, Kites, Drongos Black Drongo, Ashy Drongo and Indian Roller. Inside the port, in the greenbelt region, 13 bird species under 11 families were observed. Similarly, 3 mammals, 5 reptiles and amphibians were observed. The increase in the volume of traffics is likely to have an adverse effect on the environment and lead to air pollution, noise pollution and water pollution. The extension and construction of new lanes will affect the land use pattern of the proposed area. The construction of infra-structure in the creek and the nearby waterlogged areas, which are nesting and feeding ground for birds are going to be affected. Similarly, the increase of noise due to the construction will force the birds to move away. Common amphibians such as Toads and Frogs, major reptiles such as Cobra, Common Krait, Vipers, Rat Snake and Monitor Lizard were also found. Mammals such as Jackal, Indian Hare, Wild boar and Grey Mongoose commonly sighted within the area of 20 km radius will have impact to during construction and operations.

1.3.7. Laying of Sub-Sea Pipelines

The laying of sub-sea pipelines would require minor dredging, laying and refilling or anchoring and hence would affect the benthic organisms that live in the area. A localized sedimentation is very likely and it would affect both benthic and pelagic organisms. When plankton and benthic organisms are affected, it would affect the dependent fishery resources.

1.4. Impacts on the environment and biodiversity due to the proposed activities during Operation Phase

1.4.1. Maintenance Dredging and Disposal

Maintenance dredging and disposal to ensure depths will be a major operational activity on a continual basis as the port is situated inside the creek. It was proposed to undertake an annual maintenance dredging of 1.02 million cum from the approach channel and the harbor areas for proposed Phase–III development. Potential turbidity and suspended solids would affect the dredged and disposal areas. The suspension of sediment in the water column is likely during maintenance dredging and disposal and will have their likely impact on benthic and pelagic organisms. Associated fishery resources are also likely to be affected during maintenance dredging and disposal during the operational phase.

1.4.2. Cargo Handling in the Waterfront & Offshore Berth/Jetty

The port is going to handle general cargo, liquid cargo, container cargo, coal and iron ore vessels. During cargo handling operations in the water front and offshore berth, discharges and emissions are likely. Dry bulk cargoes generally produce a lot of dust which can impact both benthic and pelagic organisms and would consequently affect the fishery resources. Liquid bulks that are handled via pipelines may carry the hazard of static sparks, any accidental spillage, leakage and emissions, which would also affect the organisms that live in the vicinity.

1.4.3. Ship Traffic

During the operational phase, ship traffic will be very high in the vicinity of the proposed project area and so is likely to cause pollution. The traffic forecast studies conducted by Krishnapatnam Port for the year 2025-26 indicate 226.0 MTPA of various types of non-container cargo + 5.5 MTEUs PA of container cargo. The pollution related to ship traffic includes fuel leakage from ships, leaching of antifouling paints, transfer of harmful aquatic organisms, dumping of wastes and oil spills. Apart from these disturbances, air pollution, noise pollution and wave generation would also affect the environment. At present, the port authority is taking several appreciable measures to reduce dust particles suspended in ambient air. Further, increased shipping traffic would affect the paths of fishing boats near the proposed project area and would make the area prone to collisions with larger marine animals such as dolphins.

In case of an oil spill inside the port, all the organisms inside the creek, starting from plankton to fishes, will be significantly affected. Oil spills outside but adjacent to the port will mostly affect the organisms in the northern side of the port. The impacts of oil spills last long and will have detrimental effects on the benthic and pelagic organisms.

1.4.4. Discharge from ETP and Bilge Water

If CPCB norms are not followed, the end products of the ETP may contain biodegradable organic substances and micro-organisms, and non-biodegradable and toxic substances that can contaminate coastal waters. Sewage sludge is the solid, semisolid, or slurry residual material that is produced as a by-product of wastewater treatment processes. If the sludge is not treated properly it would cause serious environmental implications. Similarly, the disposal of bilge water will create serious environmental problems.

2. Mitigation and Management Plan

2.1. Background

Considering the growing population, increasing demands and the need for coastal developmental activities, in particular, construction of new seaports and extension of existing ones are inevitable for economic growth and job opportunity. Equally, managing the environment in its original state is most important and imperative for the sustainability and long term benefits. Any development activity is bound to have some impact on the environment and biodiversity. Activities associated with port development could negatively impact the coastal water quality and natural resources such as mangroves and marine flora and fauna. However effective measures of mitigation and management could help to reduce these negative impacts for sustainable and inclusive development which ensures the health of the marine environment.

This section of the report is aimed to suggest measures for maintaining a healthy biological environment and this would also help to form proper management strategies to conserve the existing biodiversity in and around the proposed project site and to recommend mitigation measures if there is any loss to biodiversity due to project activities. These mitigation measures would help in conserving the biodiversity and protecting the associated marine, brackish and fresh water ecosystems through effective action plan and monitoring. Based on the comprehensive baseline data gathered and the possible impacts on biodiversity predicted, a holistic mitigation and management framework for conserving the marine biodiversity and ecology in the vicinity of the proposed project area are suggested below.

2.2. Baseline Data Creation and Monitoring of Biological Parameters

It is mandatory to collect baseline data on the marine environment in the vicinity of the proposed project area in line with developmental activities. Baseline data have already been collected on water quality parameters, planktonic and benthic composition, density, diversity and productivity in the relevant water bodies namely Bay of Bengal, Kandaleru Creek and Buckingham Canal. This baseline data creation has been done prior to the initiation of construction activities for the proposed Phase–III project. The baseline data created in the present study will be used for the purpose of monitoring changes during the construction and operational phases by carrying out regular monitoring. On the basis of baseline data, it is essential to have continuous and periodic monitoring of the marine and brackish environment in terms of vital parameters which are indicative of the health of the marine, brackish-water and freshwater environments. Regular monitoring of vital parameters will provide indication of any deviation from the baseline status. This will help the project proponents and managers to take appropriate remedial measures. Thus, this established baseline data on biodiversity in and around the project site will serve to monitor changes throughout the project activities.

2.3. Mitigation and Management Measures during Construction Phase

Mitigation measures during the different phases of the project will be required for activities related to dredging, straightening of creek, strengthening of breakwaters, port infrastructure development and waste discharges. The major impact visualized during the construction phase is related to capital dredging and reclamation. The effects of dredging and reclamation on the marine environment should be evaluated by analyzing the suspended solid loads in the water column, fate and stability of the dredge spoils and general effects of port activity on the marine ecology. As the baseline information is available, it will indicate the changes in water and sediment quality caused by dredging.

It is better to plan the environmentally hostile activities of the construction phase during lean fishing season. To reduce the dispersal of suspended load and siltation, tidal conditions should be considered before the operation. Environmentally suitable dredger has to be selected to minimize the release of fine sediments. Monitoring of water quality has to be carried out before and after the dredging process as the quality of water column might be affected due turbidity caused by dredging. Proper disposal of dredged sediments into the dumping site (including reclamation site) with silt traps, sediment screen and containment bunds should be done to reduce the dispersal of silt and turbidity. A safety exclusion zone around the dredging vessel in accordance with the international standards and best practices should be adopted. Near-shore dredging for berth construction should be carefully done so that dredge spoils, suspended matter and turbid waters do not reach intertidal belts and mangrove areas. Turbidity curtains can be used to minimize sediment transport. Dredging activities shall be confined to fair weather seasons and avoided during monsoon and days of heavy rainfall.

In spite of all these precautionary measures if turbid plumes are observed in the nearby mangrove areas dredging practice should be modified in tune with the tidal condition until no more signs of sedimentation are reported in the subsequent monitoring studies. Rescheduling the dredging operation during that part of the tidal cycle which generates maximum plumes should be done or the pace and intensity of dredging should be sustainably managed. For the disposal of dredged spoil, most appropriate type and size of haul/transport barges has to be selected. Appropriate hydraulic pipeline has to be selected depending upon the dredged material type. Similarly, submerged discharges should be taken up for hydraulic disposal of dredged material.

Impacts arising out of domestic wastewater, sewage, construction related and other anthropogenic waste that are likely to reach the water bodies namely Kandaleru River Kandaleru Creek, Bay of Bengal, and Buckingham Canal should be reduced through provision of adequate sanitary facilities and disposal of wastes during construction. Waste oil, garbage and building material rubble from construction, remodeling, repair and demolition structures should be managed in such a way that they do not reach the water bodies. Solid waste generated in the dredging and construction activities should be used within the port for reclamation activities and for leveling of low-lying areas on the land environment as well as of shore protection work. The pile driving activities in the creeks

may alter the water environment and cause disturbance to the sediment as well as biological environment. Similarly, during construction of culverts and bridges for roads and rail network, spilling of construction materials into the creek and drain should be prevented and, at any point of time, the flow of water in the creek and ephemeral drains should not be obstructed for the construction purposes. Runoff from the construction activities should be prevented from flowing into the drains.

Provision of adequate drainage should be in place to solve stagnation and subsequent contamination of coastal waters. As the depth of the creek near the port premises is going to be deepened, there is a possibility for saline water intrusion in the nearby region so proper measures have to be taken up to prevent saline water intrusion. Site cleanliness and removal of any oil, grease and other spillages to designated pits are mandatory. Hazardous waste that arises from volatile chemicals and paints should be disposed as per the Hazard Waste Management Rules, 2016. It is important that construction related activities near intertidal zone are confined to the smallest area possible, which will very much reduce the construction related impacts on the creek and coastal waters. Appropriate stringent monitoring plan *(see Monitoring Protocol section)* should be in place for water bodies such as Bay of Bengal, Kandaleru Creek Kandaleru River and Buckingham Canal to take all necessary precautionary and remedial measures.

2.4. Mitigation and Management Measures during Operational Phase

The following mitigation and management measures are recommended for implementation during the operational phase. Sewage generated from the port operations should be treated in sewage treatment plant and the treated water can be used for other purpose like horticulture and greenbelt development within the port boundary limit and around the cargo storage area. Runoff from the storage yards will be routed through collection pits for segregation of solids and further

The solid waste generated from the port during operational phase should be properly segregated, stored and disposed. All the constructions should be planned in such a way that they do not restrict the prevailing tidal entrance into the creek and mangrove habitats and also the ephemeral drains into the creek. The minor and major oil/chemical spillages should be effectively controlled with appropriate tools and equipment. Critical parameters such as suspended solids, DO, BOD and nutrients should be regularly monitored and compared with baseline study. Use of biocides should be kept at the minimum and their concentration at the outlet should be regularly tested. Comprehensive and easy to implement Standard Operating Procedure (SOP) should be made for each category of cargo in order to avoid oil or chemical spillages. The operating staff at the berth should be trained in such operations and also in handling emergencies. Transfer of bulks to the coal stack yards should only be through closed conveyors. Dedicated pumps, water tanks, filter, nozzles, water sprinklers, compressor should be installed at stack yards to have efficient water spray pattern to reduce wind-blown dust. Adequate number of heavy-duty atomizers should be deployed in the way of transit. During operational phase, truck movements on

the bridges built over the water course should be avoided to minimize spillage of cargoes into the water ways. The cargo should be covered properly while transportation.

2.4.1. Mitigations and Management Measures on Maintenance dredging

Maintenance dredging to ensure depths as required for navigation of vessels will be a major operational activity on a continual basis as the port lies in the creek. The following mitigation and management measures are recommended during port operation. Suitable dredging equipment for fine sediments should be used to minimize the level of turbidity during maintenance dredging operations. If the sediment is contaminated, measures are to be taken in order to limit the lateral movement of turbid water during dredging activity. Appropriate silt curtains should be used to reduce sediment transportation. Dredging activity should not be undertaken during periods of rapid water current and strong trade winds. Establishment of a dredging monitoring *(see Monitoring Protocol section)* and emergency response plan will be useful to monitor the direction of the plume and to monitor for equipment malfunction and accidental dredge spills.

Impacts to the dredge material relocation ground and adjacent areas should be minimised through relocation of the dredge material in such a manner as to uniformly spread it over the relocation ground. Detailed assessment on water quality and biological resources should be carried out to identify the problems at the earliest.

2.4.2. Management of Benthic Organisms and Plankton in the Water Bodies

Fair amount of benthic macrofauna and meiofauna occur in the proposed project area, though corals and seagrasses are absent. Soft corals, sponges and molluscs are some of the important benthic macrofauna. Hence, rapid underwater assessment of these fragile organisms should be done to have a clear picture about the bottom habitat in the creek and offshore region. Survey should be done at least once in a year during the construction phase and once in two years during operational phase to compare their abundance with baseline information.

The presence of macro- and meiobenthic organisms is also significant in the proposed project area. Hence, permanent monitoring locations should be fixed in all the water bodies including Kandaleru River, Kandaleru Creek and the Bay of Bengal and Buckingham Canal for regular monitoring. Monthly sample collection and monitoring should be done to understand the changes in benthic biota. If the amount of benthic organisms goes drastically down from the baseline data, necessary remedial measures should be adopted.

Planktonic community and productivity in the vicinity of the proposed project site is moderate. Dredging and reclamation are the major activities that increase water turbidity and suspended load thereby impacting plankton community and productivity. Hence, measures should be taken to reduce the run-off slurry and sediment plume through silt traps and turbidity curtains. As mentioned above, regular and continuous monitoring *(see*

Monitoring Protocol section) of plankton density and diversity in permanently fixed locations should be done during the different phases of the proposed project.

2.4.3. Management of Mangroves and Associated Biodiversity

Mangrove habitats occurring along the Kandaleru Creek and at the mouth of the Buckingham Canal are critical for the associated biodiversity and fishery resources. Nine mangrove species namely *Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Lumnitzera racemosa, Ceriops decandra, Rhizophora mucronata, Bruguiera gymnorrhiza* and *Bruguiera cylindrica* are available in the area along with six halophytic plants. Establishment of facilities for the port is a continuous process and the expansion of infrastructure over the coming years will bring about notable changes in the landscape and seascape in and around the port in the creek region. Long term human activity of this magnitude will have repercussions on the mangroves, and their conservation and management deserve top priority. Any impact on the mangrove habitats may affect the livelihood of the dependent fishermen. The following measures can be taken to monitor the health of mangroves and associated biodiversity in the proposed project area.

As per the earlier studies, opening of sand bar formation east of the Ipuru Reserve Forest for navigation of vessels, would improve tidal fluctuation to the mangroves and improved the growth and spread of mangroves and its associated species. Even though there is no direct impact on the existing mangroves, it is the responsibility of the project proponents to take care of the existing nearby mangrove area without any damage. Already the Port is involved in mangrove afforestation. A dedicated action plan should be in place for continuous mangrove monitoring and maintenance (*see Annexure - 1*).

It is important that in any natural resource management effort, stressors acting on the ecosystem are to be identified and removed in order to maintain the ecosystem balance. Hence, regular monitoring of physico-chemical parameters in the mangrove areas should be done to understand the deviation from the baseline due to proposed project activities.

It should be ensured that wastes generated during the construction and operation phases do not in any case enter the mangrove waters. Special attention should be given to chemical and hydrocarbon spillages in the port waters. Immediate measures should be taken to contain spillage and to reduce impact. Oil emergency contingency plan is to be put in place. Waste oil, garbage and building material rubble should be managed in such a way that they do not reach mangroves.

Information on mangrove characteristics such as species and their height and the traits has been collected during the study before the initiation of the project. Based on this information, vegetation structure of mangroves should be studied once in a year. This assessment and the data generated earlier could be used to check short-term and long-term mangrove health.

Mangrove formations in the vicinity of the port should be mapped using GIS and RS once a year to monitor changes in their physical extent. The base maps will track changes, if any, in the physical extent in subsequent years. These mapping exercises will help monitor changes in the mangrove formations.

As an integral part of mangrove ecosystem, mangrove macrofauna is a reliable indicator of the health status of this ecosystem. Regular monitoring (once in six months) of mangrove macrofaunal abundance, diversity and composition will throw light on the diversity and dynamics of this ecosystem. Comparison of data over the years will reveal the status of mangrove faunal component, which could be linked with overall ecosystem changes.

During the initial induction period, environmental training and awareness imparting should be given to all port-related personnel and contractors on the ecological and environmental importance of coastal habitat and the measures necessary to protect and preserve this habitat.

2.4.4. Management of Birds and other fauna

Altogether 52 species of birds were recorded in and around the project area. Apart from them 3 mammals, 5 reptiles and amphibians were recorded. And there are many resident and migratory birds and other faunal communities within the proposed project area. Monitoring of birds and other faunal communities in the vicinity of the project area should be carried out to assess the changes in avifaunal and other faunal diversity due to the proposed project. Periodical monitoring (once in six months) of birds would identify the positive or negative changes in bird composition of the area.

Sporadic nesting of Olive Ridley turtles (*Lepidochelys olivacea*) and their carcasses were recorded in the Krishnapatnam beach area. Hence proper action plans should be executed during strengthening of breakwater particularly in shoreline region. Similarly, action plans should be executed to reduce the noise during dredging operations with existing acoustic controls on noise-generating equipment. Arrangements should be made to monitor marine mammals during construction and operational phases particularly during dredging and reclamation period by employing dedicated marine biologists on board in order to avoid accidental deaths of these rare marine species. Any incident of injury or mortality during the project activities should be immediately reported.

2.4.5. Management of Fishery Resources

Many of the project activities likely to have impact on the pelagic and benthic organisms would eventually affect the fishery resources. A total of 11 fish species and 7 crustaceans were observed in the creek region. Turbidity, sedimentation, and pollution of water and air might lead to the migration of fish populations from the proposed project area. Moreover, due to the straightening of creek, construction of the proposed berth, strengthening of breakwaters, there is a likelihood of loss of fishing ground for the fishermen, and deployment of artificial reef structures to enhance fishery resources will compensate that.

Deployment of artificial reef structures (*Annexure - 2*) are comparatively cheaper and easily implementable and would provide substrate that will support marine organisms. Artificial reef modules should be so designed as to enhance biodiversity and fish production, and once built they will last many decades supporting rich faunal components since they provide ideal habitat for them. They have great potential to enhance biodiversity by attracting diverse marine fauna within a short period of time.

Artificial fish habitats would attract not only fishes but also all the benthic organisms, and would create a diverse ecosystem which would provide long-lasting results. The impact of artificial fish habitats should also be studied regularly (covering the four seasons in a year) to assess the enhancement of biodiversity, fish production and socio-economic conditions of the dependent fisher folk

2.4.6. Management of Creek and Associated Biodiversity

Kandaleru Creek is ecologically sensitive with dynamic ecosystems such as mangroves salt marsh, oyster reef beds. Due to the likely impact on the biodiversity of creek, permanent monitoring sites should be fixed for monthly sample collection and analysis of physical, chemical and biological parameters.

Fishing for livelihood is significant in and around the creek. Shell fishes such as shrimps and crabs are the major economic contributors to the income of the fishermen. Sea ranching (*Annexure - 3*) of cultured fingerlings of these shrimps and crabs would provide sustainable fishery yield to the fishermen.

2.4.7. Management of ETP Discharges

Wastes produced during the construction of effluent treatment plant should be carefully removed. The treated effluent should be regularly checked for water quality according to the norms of CPCB. Water quality in the outfall area should be regularly monitored to identify the changes. Usage of well treated effluents for greenbelt development within the project area can be considered. The sludge should be properly treated, which involves a combination of thickening, digestion, and dewatering processes according to the norms. In any case, the sludge should not be dumped into the sea. The final destination of treated and dewatered sludge is earth and so it should be buried underground in a sanitary landfill as per the norms of CPCB. It may also be used on agricultural land to take advantage of its value as a soil conditioner and fertilizer after due analysis.

2.4.8. Management of Ship Traffic Impacts

During operational phase, ship movements will be on the creek to the berths. During the ship movement over the water course damage should be avoided from spillage of cargoes in the water. The cargo should be covered properly while transportation. Ships should be prevented from discharging water into the creek during anchorage. Discharges of ballast water and all other kinds of wastes should be regulated and a proper disposal system

should be in place. The loading and unloading should completely be mechanized to avoid spillage of cargoes. Proper training should be given to the staff on salvage, marine firefighting, and spill prevention and preparedness for reducing the risk of occurrence of an incident and, if an incident occurs, for appropriately responding to prevent further damage or to remove oil spilled in the marine environment. Speed restrictions can greatly reduce impacts and risks related to animal injuries and accidents with fishing boats. The post project monitoring of water and sediment quality in the marine environment is important as part of the marine environment management.

3. Monitoring Protocol

The proposed project area is in the vicinity of critically important marine ecosystems such as mangroves, creeks and river and marine zone. The coastal area between Katepalli Beach and Srinivasa Satram Beach has been covered in the assessment, which includes coastal wetlands, inland region, Kandaleru River, Kandaleru Creek, Buckingham Canal and Bay of Bengal. The project area has a reasonable extent of mangrove habitat as freshwater supply is available. Mangroves are seen along the Kandaleru River, Kandaleru Creek and at the mouth of Buckingham Canal. Significant level of fishing activities happens in these water bodies. Apart from mangroves, other coastal vegetation and agriculture activities also occur in the vicinity of the proposed project site. The marine zone namely Bay of Bengal falls within the Indo-Pacific realm, arguably the world's richest region in terms of biodiversity. The fishery resources of Bay of Bengal provide livelihood to thousands of fisher folk living along the immediate coastline from the project site. Considering the importance of project area from the ecological, biological and social perspectives, comprehensive monitoring protocol should be in place to take appropriate and timely management and remedial actions during the construction and operation phases of the project. It is also important that the project proponents should take up livelihood and conservation initiatives like mangrove conservation, deployment of Multipurpose Artificial Fish Habitats (Artificial Reefs) for the enhancement of biodiversity and fish production, and regular sea ranching of cultured fingerlings of shrimps and crabs.

3.1. Construction Phase

Comprehensive and regular monitoring during the construction phase is crucial to manage the environmental impacts and to protect the environmental health and biodiversity. Ocean is dynamic and disturbances for short period would disappear but in the creek environment the period of disturbances depends on the hydrodynamic and tidal forcing of the creek. However, if the disturbances persist for long, particularly dredging and reclamation, they would make considerable impact on the environment in the absence of proper monitoring of the activities. The systematic monitoring would help to understand the status of environmental health during the construction period and accordingly the management and remedial action could be taken up. In case of mangrove, river and Buckingham Canal, the area is sheltered and hence constant monitoring of environmental parameters should be in place to take effective management and remedial actions in the face of any adverse impacts.

Figures 3 to 4 give details of the project area and the suggested monitoring locations during construction phase.

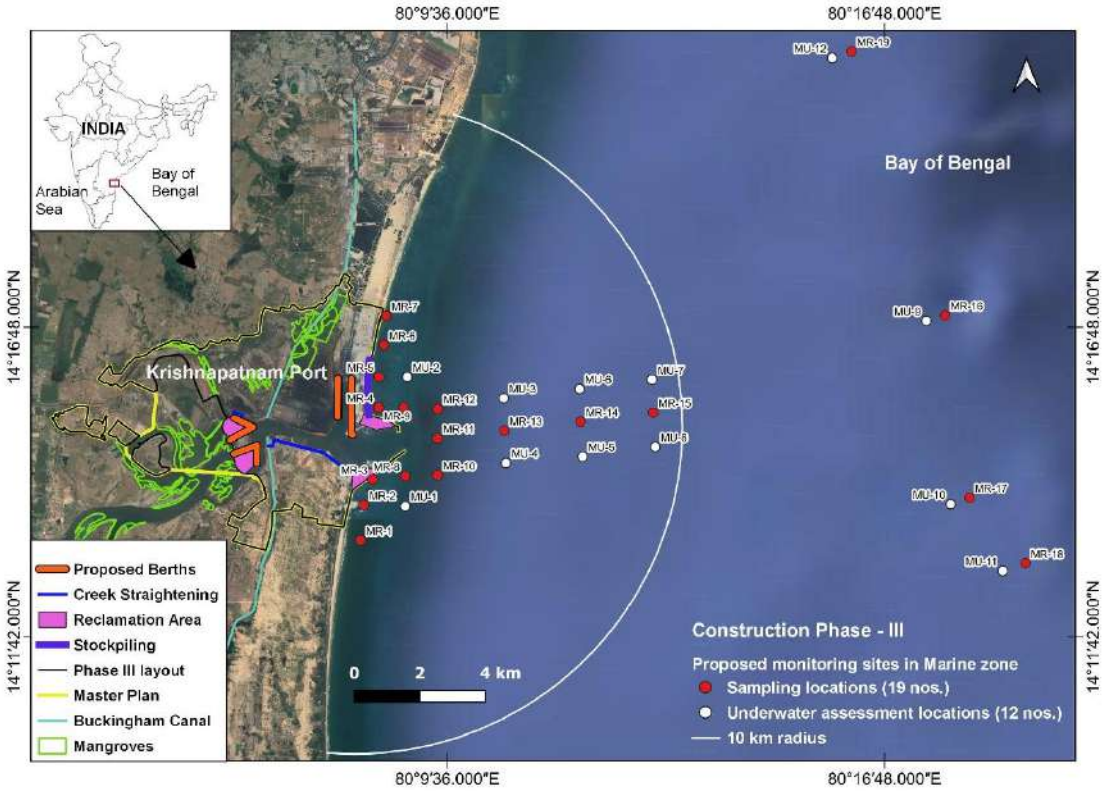

Fig. 3: Map showing the monitoring locations in the marine zone during construction phase

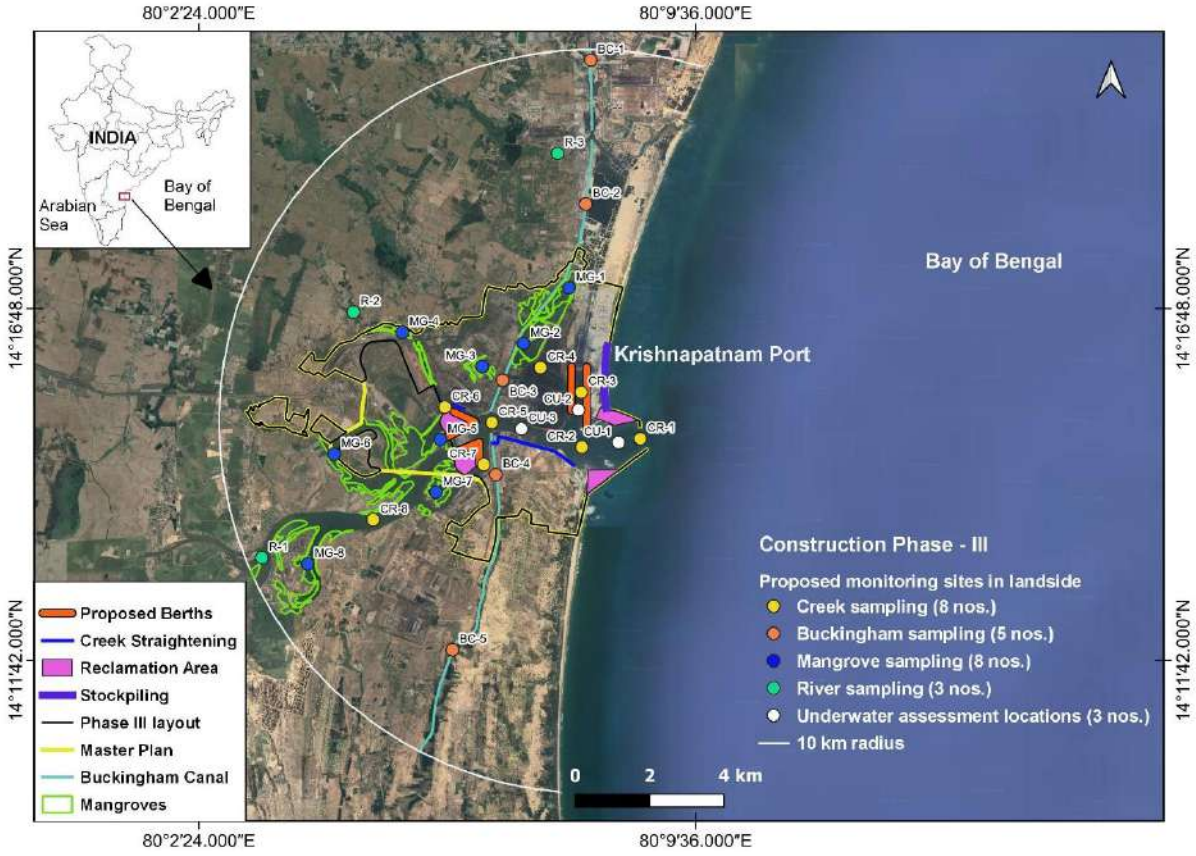

Fig. 4: Map showing the monitoring locations in the land side covering coastal wetlands, inland region, Kandaleru Creek, Kandaleru River, Buckingham Canal and Mangroves during construction phase

Proposed Monitoring Locations for Water & Sediment Sampling and Underwater Assessment Locations in accordance with Project Activities during Construction Phase

MARINE ZONE (31 Monitoring Locations – 19 sampling locations and 12 underwater assessment locations)

I- South of Krishnapatnam Port

Total sampling numbers -5 (MR-1 to MR-3, MR-8 & MR-10)
Sampling distance
Perpendicular to coast – 1 km
Along the coast – 1 km
One underwater assessment location (MU-1) at about 1.5 km from coast

II – North of Krishnapatnam Port

Total sampling numbers – 6 (MR-4 to MR-7, MR-9 & MR-12)
Sampling distance – approximately 1km from the coast
Along the coast – 1 km
One underwater assessment location (MU-2) at about 1.5 km from coast

III - Dredging channel

Total sampling numbers - 4 (MR-11, MR-13 to MR-15)
Sampling distance – approximately 1 km to 7 km from the port breakwater

Six underwater assessment locations (MU-3 to MU-8)
Assessment locations – approximately 3 km and 7 km from the port breakwater, along the coast – 2 km

IV - SBM

Total sampling numbers - 3 (MR-16 to MR-18)
Sampling distance – approximately 16 to 18 km from the shore

Three underwater assessment location (MU-9 to MU-11) at about 16 to 18 km from the shore

V- Dredging soil disposal

Total sampling numbers - 1 (MR-19)
Sampling distance –approximately 11 km from the shore

One underwater assessment location (MU-12) at about 11 km from shore

LAND SIDE (27 Monitoring Locations – 24 sampling locations and 3 underwater assessment locations)

I - Kandaleru Creek

Proposed Berth inside the Port Basin (Dredging & Reclamation)

Total sampling numbers – 3 (CR-3, CR-6 & CR-7)

One underwater assessment location (CU-2)

Proposed Creek straightening and dredging Channel inside the Port Basin (Dredging & Reclamation)

Total sampling numbers – 3 (CR-1, CR-2 & CR-5)

Two underwater assessment locations (CU-1 & CU-3)

Inside the Creek

Total sampling numbers – 2 (CR-4 & CR-8)

II - Buckingham Canal

Total sampling numbers – 5 (BC-1 to BC-5)

III - Mangroves

Total sampling numbers – 8 (MG-1 to MG-4, north of the Krishnapatnam Port & MG-5 to MG-8, south of the Krishnapatnam Port)

IV – River

Total sampling numbers – 3 (R-1 in Kandaleru river, R-2 & R-3 other drainage flow)

Table 1: Details of monitoring components, parameters to be monitored, locations and monitoring frequency during construction phase

S No	Components	Parameters to be Monitored	Locations	Monitoring frequency
I - Marine Zone				
1.	Marine Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Marine Biology **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	19 (Surface and bottom) covering all project activities such as Dredging, Reclamation, disposal of dredged material and SBM.	***Monthly*** *(However, the parameters like Chlorophyll content, TSS, TDS, salinity, turbidity, oil and grease, DO, BOD and COD should be monitored* ***fortnightly*** *in 11 locations (MR-8, MR-10, MR-11, MR-12, MR-9, MR-4, MR-5, MR-6, MR-13, MR-14, MR-15) during dredging and reclamation period.*

2.	Marine Sediment Quality	<u>Physical & Chemical properties:</u> Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC), oil and grease <u>Heavy metals:</u> Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium <u>Bacteriological parameters:</u> Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count <u>Marine Biology</u> **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices	19 locations covering all project activities such as Dredging, Reclamation, disposal of dredged material and oil spill.	**Monthly** *(However, the parameters like organic matter, organic carbon, sediment texture, oil and grease should be monitored* ***fortnightly*** *in 11 locations (MR-8, MR-10, MR-11, MR-12, MR-9, MR-4, MR-5, MR-6, MR-13, MR-14, MR-15) during dredging and reclamation period.*
3.	Fish Population Monitoring	Diversity and Abundance	Randomly selected 6 sites around the project area (dredging and reclamation sites)	**Monthly**
4.	Rapid underwater biodiversity Assessment	Diversity and Abundance	12 locations covering activities dredging, disposal of dredged materials in Marine Zone	**Yearly once** *(Apart from yearly monitoring, if there is any requirement during Dredging and*

				reclamation period additional underwater assessment should be done wherever required)
II – Kandaleru Creek				
1.	Water Quality	<u>Physical properties:</u> Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility <u>Chemical Properties</u> Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) <u>Heavy metals:</u> Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt <u>Bacteriological parameters:</u> Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count <u>Biological parameters</u> **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	8 Locations (Surface and bottom)	**Monthly** *(However, the parameters like Chlorophyll content, TSS, TDS, salinity, turbidity, oil and grease, DO, BOD and COD should be monitored* ***fortnightly*** *in 6 locations (CR-1, CR-2, CR-3, CR-5, CR-6, CR-7) during dredging and reclamation period.*
2.	Sediment Quality	<u>Physical & Chemical properties:</u>	8 Locations.	**Monthly**

		Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC), Oil & grease Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Marine Biology **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		*(However, the parameters like organic matter, organic carbon, sediment texture, oil and grease should be monitored **fortnightly** in 6 locations (CR-1, CR-2, CR-3, CR-5, CR-6, CR-7) during dredging and reclamation period.*
3	Fish Population Monitoring	Diversity and Abundance	Randomly selected 2 sites in the creek region (new berth and reclaimed area)	**Quarterly**
4.	Rapid underwater biodiversity Assessment	Diversity and Abundance	3 locations covering activities dredging, reclamation and construction in the Creek (Port basin)	**Yearly once** *(Apart from yearly monitoring, if there is any requirement during Dredging and reclamation period additional underwater assessment should be done*

				wherever required)
III - Buckingham Canal				
1.	Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	5 Locations (Surface and bottom)	**Quarterly** Locations BC-1 to BC-5
2.	Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters:	5 Locations.	**Quarterly** Locations BC-1 to BC-5

		Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		
IV - Mangroves				
1.	Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	8 Locations (Surface and bottom)	**Monthly** Locations MG-1 to MG-8
2.	Sediment Quality	Physical & Chemical properties:	8 Locations.	**Monthly**

		Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) <u>Heavy metals:</u> Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium <u>Bacteriological parameters:</u> Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count <u>Biological parameters</u> **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		Locations MG-1 to MG-8
3.	Mangrove Area Monitoring	• Species composition and vegetation structure • Density, height, growth and canopy • Associated fauna and flora. • Numbers, species composition, size and structure of fish populations. • Juvenile fishes, especially target species. • Threats (sedimentation) etc. • Avifauna (Diversity and abundance)	8 sites	**Half Yearly** Locations MG-1 to MG-8
V. River				
1.	Water Quality	<u>Physical properties:</u> Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility <u>Chemical Properties</u> Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) <u>Heavy metals:</u> Copper, Ferrous, Nickel, Mercury, Manganese, Chromium,	3 Locations (Surface and bottom)	**Monthly** Locations R-1 to R3

		Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices		
2.	Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices	3 Locations.	**Monthly** Locations R-1 to R3
VI – Others (Turtles, Mammals etc.)				
1.	Others – Turtles, Mammals etc	Presence of Turtles, Mammals etc. in the study area. Diversity and abundance; Action to rescue them if seen in activity area	(Around the project/operation site)	Marine Biologists

				onboard should monitor during dredging and reclamation period

3.2. Operational Phase

The activities of the project during the operational phase have to be regularly monitored in a holistic manner in order to manage and protect the health of environment and biodiversity. It is important to closely monitor the sites of reclamation, sites of sediment disposal, and sediment deposition to record any changes in and depletion of environmental quality. The concrete structures are to be monitored to record any sedimentation and also to know if organisms are attached to them. The number of monitoring locations in the marine zone is the same as that during the construction phase in order to collect continuous data so as to monitor the health status and to take appropriate conservation and management measures, wherever required. Similarly, in the land side covering coastal wetlands, inland region, Kandaleru Creek covering Port basin, Kandaleru River & other drainage and Buckingham Canal, the number of sampling locations are similar to the number during the construction phase, which would help to take effective management and remedial actions, in case of any adverse impacts.

Figures 5 & 6 give details of the suggested monitoring locations during operational phase

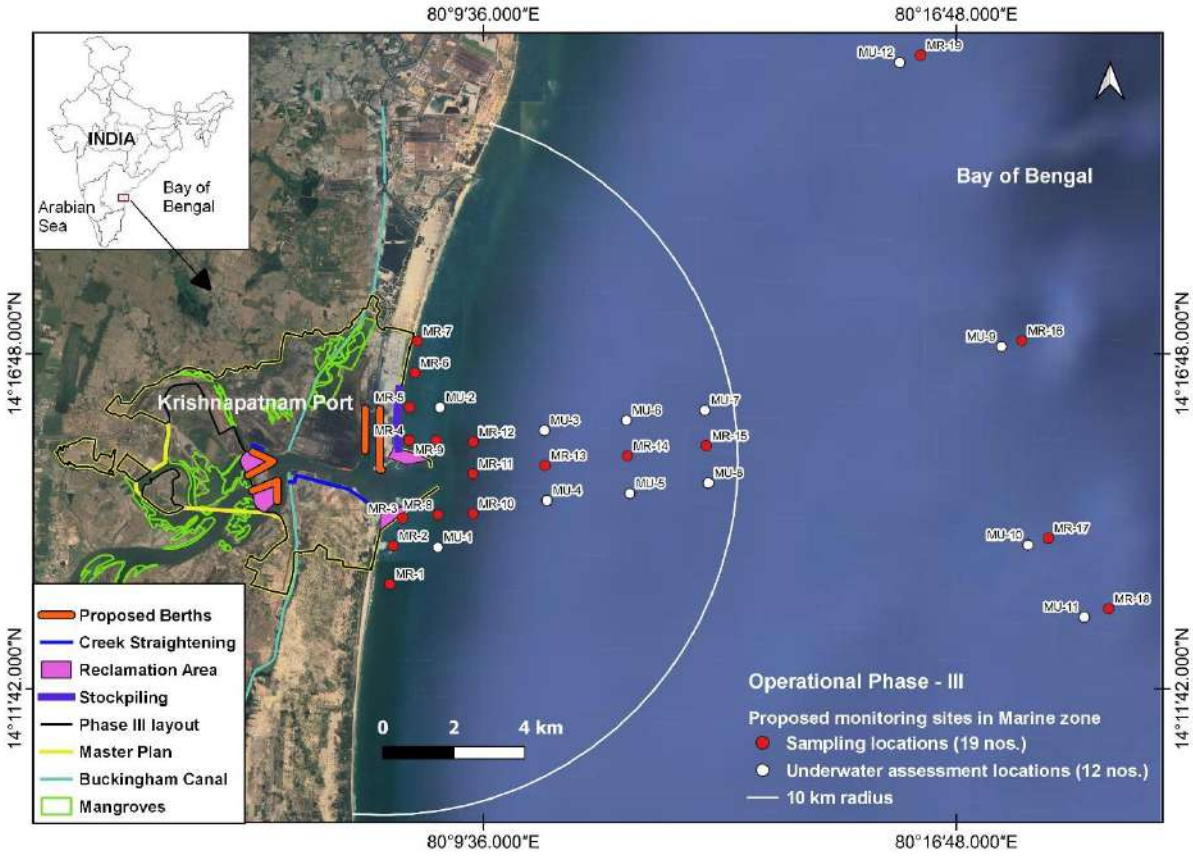

Fig. 5: Map showing the monitoring locations in the marine zone during operational phase

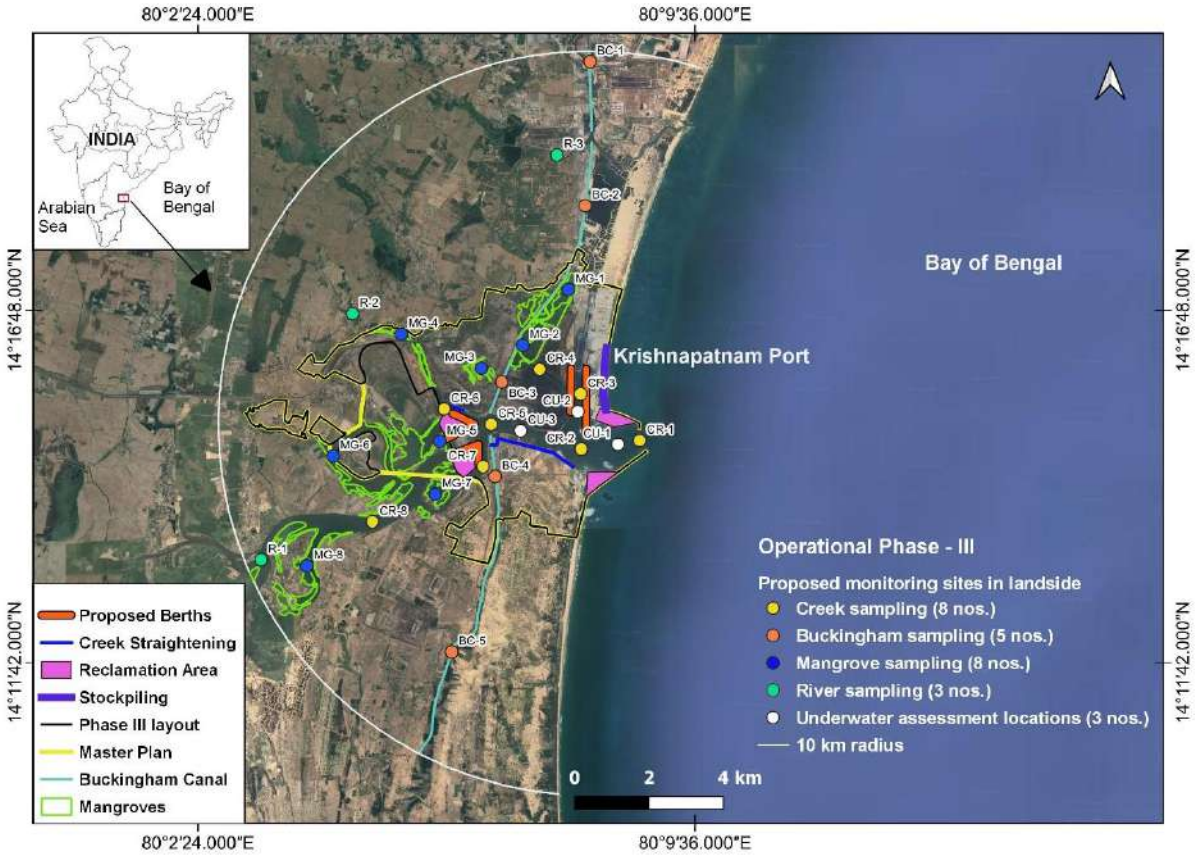

Fig. 6: Map showing the monitoring locations in the land side covering coastal wetlands, inland region, Kandaleru Creek, Kandaleru River, Buckingham Canal and Mangroves during operational phase

Proposed Monitoring Locations for Water & Sediment Sampling and Underwater assessment Locations in accordance with Project Activities during Operational Phase

MARINE ZONE (31 Monitoring Locations – 19 sampling locations and 12 underwater assessment locations)

I- South of Krishnapatnam Port

Total sampling numbers -5 (MR-1 to MR-3, MR-8 & MR-10)
Sampling distance
Perpendicular to coast – 1 km
Along the coast – 1 km
One underwater assessment location (MU-1) at about 1.5 km from coast

II – North of Krishnapatnam Port

Total sampling numbers – 6 (MR-4 to MR-7, MR-9 & MR-12)
Sampling distance – approximately 1km from the coast
Along the coast – 1 km
One underwater assessment location (MU-2) at about 1.5 km from coast

III - Dredging channel

Total sampling numbers - 4 (MR-11, MR-13 to MR-15)
Sampling distance – approximately 1 km to 7 km from the port breakwater

Six underwater assessment locations (MU-3 to MU-8)
Assessment locations – approximately 3 km and 7 km from the port breakwater, along the coast – 2 km

IV - SBM

Total sampling numbers - 3 (MR-16 to MR-18)
Sampling distance – approximately 16 to 18 km from the shore

Three underwater assessment locations (MU-9 to MU-11) at about 16 to 18 km from the shore

V- Dredging soil disposal

Total sampling numbers - 1 (MR-19)
Sampling distance –approximately 11 km from the shore

One underwater assessment location (MU-12) at about 11 km from shore

LAND SIDE (27 Monitoring Locations – 24 sampling locations and 3 underwater assessment locations)

I - Kandaleru Creek

Proposed Berth inside the Port Basin (Dredging & Reclamation)

Total sampling numbers – 3 (CR-3, CR-6 & CR-7)

One underwater assessment location (CU-2)

Proposed Creek straightening and dredging Channel inside the Port Basin (Dredging & Reclamation)

Total sampling numbers – 3 (CR-1, CR-2 & CR-5)

Two underwater assessment locations (CU-1 & CU-3)

Inside the Creek

Total sampling numbers – 2 (CR-4 & CR-8)

II - Buckingham Canal

Total sampling numbers – 5 (BC-1 to BC-5)

III - Mangroves

Total sampling numbers – 8 (MG-1 to MG-4, north of the Krishnapatnam Port & MG-5 to MG-8, south of the Krishnapatnam Port)

IV – River

Total sampling numbers – 3 (R-1 in Kandaleru river, R-2 & R-3 other drainage flow)

Table 2 give details of components, parameters to be monitored, locations and monitoring frequency during operational phase.

Table 2: Details of monitoring components, parameters to be monitored, locations and monitoring frequency during operational phase

S No	Components	Parameters to be Monitored	Locations	Monitoring frequency
I - Marine Zone				
1.	Marine Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Marine Biology **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	19 locations (Surface and bottom)	**Monthly**
2.	Marine Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC), Oil & grease	19 locations	**Monthly**

		Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Marine Biology **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		
3.	Fish Population Monitoring	Diversity and Abundance	Randomly selected 6 sites around the project area	**Quarterly**
4.	Rapid underwater biodiversity Assessment	Diversity and Abundance	Marine Zone (in line with Construction phase data)	**Once in two years**
II – Kandaleru Creek				
1.	Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas*	8 Locations (Surface and bottom)	**Monthly**

		aeruginosa, Streptococcus faecalis, Shigella count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices		
2.	Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC), Oil & grease Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Marine Biology **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices	8 Locations	**Monthly**
3	Fish Population Monitoring	Diversity and Abundance	Randomly selected 2 sites in the creek region (new berth and reclaimed area)	**Quarterly**
4.	Rapid underwater biodiversity Assessment	Diversity and Abundance	3 locations (CU-1 to CU-3) in the Creek (Port basin)	**Once in two years**
III - Buckingham Canal				
1.	Water Quality	Physical properties:	5 Locations (Surface and	**Quarterly**

		Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	bottom)	Locations BC-1 to BC-5
2.	Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Macro-benthos:** Population Density, Percentage Composition,	5 Locations.	**Quarterly** Locations BC-1 to BC-5

		Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		
VI - Mangroves				
1.	Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Pigment Parameters:** Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices	8 Locations	**Quarterly** Locations MG-1 to MG-8
2.	Sediment Quality	Physical & Chemical properties: Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium Bacteriological parameters:	8 Locations.	**Quarterly** Locations MG-1 to MG-8

		Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices		
3.	Mangrove Area Monitoring & Avifauna	• Species composition and vegetation structure • Density, height, growth and canopy • Associated fauna and flora. • Numbers, species composition, size and structure of fish populations. • Juvenile fishes, especially target species. • Threats (sedimentation) etc. • Avifauna (Diversity and abundance)	8 sites	**Yearly**
V - River				
1.	Water Quality	Physical properties: Temperature, Salinity, pH, Electrical Conductivity (EC), Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids(TDS), Visibility Chemical Properties Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia, Nitrite, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate, Petroleum Hydrocarbon (PHC) Heavy metals: Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt Bacteriological parameters: Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count Biological parameters	3 Locations (Surface and bottom)	**Quarterly** Locations R1 to R3

		Pigment Parameters: Chlorophyll –a, Phaeo-pigments, Total biomass **Phytoplankton:** Primary Productivity, Population Density, Percentage Composition, Diversity Indices **Zooplankton:** Population Density, Percentage Composition, Diversity Indices		
2.	Sediment Quality	<u>Physical & Chemical properties:</u> Soil pH, Soil Texture (Sand, Silt, Clay), Organic Matter, Total Nitrogen, Total Phosphate, Petroleum Hydrocarbon (PHC) <u>Heavy metals:</u> Copper, Ferrous, Nickel, Mercury, Manganese, Chromium, Arsenic, Lead, Zinc, Cobalt, Cadmium, Selenium <u>Bacteriological parameters:</u> Total Viable Count, Total Coliform, Faecal Coliform, *Escherichia coli, Vibrio cholera, Vibrio parahaemolyticus, Pseudomonas aeruginosa, Streptococcus faecalis, Shigella* count, *Salmonella* count <u>Biological parameters</u> **Macro-benthos:** Population Density, Percentage Composition, Diversity Indices **Meio-benthos:** Population Density, Percentage Composition, Diversity Indices	3 Locations.	**Quarterly** Locations R1 to R3
VI – Others (Turtles, Mammals etc)				
1.	Others (Turtles, Mammals etc)	Presence of Turtles, Mammals etc. in the study area. Diversity and abundance; Action to rescue them if seen in activity area	(Around the project/operation site)	Marine Biologists should monitor during maintenance dredging & disposal and ship navigation routes near the project site
VII – Monitoring concrete structures outside the new berths for biodiversity & sedimentation				
1.	Concrete	Biodiversity: Epifauna, Fish Population	In and around concrete	**Quarterly**

	structures outside the newly constructed berths		structures outside the newly constructed berths	

Annexure - 1: Mangrove Management Plan (during construction & Operational Phases)

4.1. Existing mangrove resources in the vicinity of the proposed project area

Mangroves are dynamic marine ecosystems that offer food and shelter to a wide range of ecologically and economically important marine species. The proposed project area is endowed with water bodies of different salinities, suitable for mangrove growth. Mangroves are frequently seen in Kandaleru Creek, Kandaleru River and at the mouth of the Buckingham Canal. Mangroves are seen as patches and lines. Small to larger patches of mangroves are seen on the intertidal region present inside and on the banks of the river, mainly outside the project boundary. Similarly, sparse distributions of mangroves are seen in the proposed Phase III. Mangroves are also seen at the mouth of the Buckingham Canal, where it meets the Kandaleru Creek. Halophytic plants are also seen in association with mangroves. Well-grown healthy mangrove vegetation is seen in most of the patches, whereas stunted and degraded mangroves are also seen in a few patches where flushing of water is limited. Mangrove cover is more extensive in the south-to-central part of the Kandaleru River, whereas in the northern part mangrove cover is comparatively low.

The nine species of mangroves observed in the study area are *Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Lumnitzera racemosa, Ceriops decandra, Rhizophora mucronata, Bruguiera gymnorrhiza* and *Bruguiera cylindrica*. Six types of halophytic plants are also observed in the mangrove area along with other coastal vegetation. Significant level of fishing happens in the mangrove area near the proposed project site and provides livelihood to hundreds of fishermen who live in the vicinity.

4.2. Impact on mangroves due to the project activities

Construction of buildings, roads, rails, bridges, parking areas involves reclamation of low-lying areas which are natural flood plains. Land reclamation activities during the constructional phase are likely to impact the mangroves. These activities may hinder the flow of water into sea during floods and it may reduce the floodplain area cover and may reduce the infiltration of water into the ground. Potential reduction in low-lying areas may hinder the water flow to the sea and may flood the adjacent water bodies during heavy floods and the flood water may take its course via the channels and is likely to impact the banks of water bodies during a flood and the mangroves. Likely increase in the water may consequently increase the run-off into the sea causing sedimentation. Moreover, reclamation in the area would cause sedimentation in the water bodies such as Buckingham Canal and Kandaleru River and it may affect all the benthic and pelagic organisms.

4.3. Management of mangroves

4.3.1. Coastal communities and mangroves

In spite of no ownership rights to mangrove or its resources, coastal village communities near the proposed project area have considerable independence over the manner in which they use them. Different types of fishing activities take place in the mangroves occurring in the vicinity of the proposed project area. The communities have been using the mangroves sustainably for hundreds of years and hence they have a deep understanding of mangrove ecology and utilization. Coastal communities have also knowledge about mangrove degradation due to different factors. Hence, coastal communities will remain a key stakeholder in management initiatives, which will include schemes to appreciate and reward community conservation management. By educating the local communities on conservation of mangrove habitats, their capacity in mangrove conservation and management should be strengthened.

4.3.2. Management of indirect impacts

4.3.2.1. Altered Tidal Flushing

There is a likelihood of changes in tidal flushing into the mangrove habitats due to the proposed project activities. Some small intertidal channels may have disrupted flows while other channels may have comparatively faster flow. The causeway should be designed to maintain adequate tidal flow for the support of healthy mangrove habitat. Engineering design of the infrastructure facility should ensure the tidal flushing from the water bodies through appropriate provision.

4.3.2.2. Slippage of Fill

There is a possibility of the earth fill used during the construction of the infrastructure facility to slip down slope and spread out to the mangrove area, and this may bury mangrove pneumatophores. Hence, construction workers should be trained to work carefully not to allow the slippage of fill into mangrove areas. Engineering measures to manage and/or prevent slippage of fill, as much as practicable, include the use of rock armouring to contain fill to the base of the channel crossing and stabilize earth fill as it is placed.

4.3.2.3. Dust Deposition

Dust generated during the construction and operational phases of the proposed project could result in the deposition of dust on surrounding mangroves. Dust deposition on mangroves and other vegetation can block photosynthetic processes and growth. Proper dust management plan should be in place to avoid any increased dust concentrations. The following measures will be useful in reducing dust deposition:

- Watering of unsealed roads, exposed surfaces, active construction areas and stockpiles
- Use of environmentally safe dust suppressants
- Restriction of vehicle movements and vehicle speeds to reduce dust emissions
- General housekeeping practices to manage waste materials within the construction site that may generate dust
- Awareness programs to ensure that all persons onsite are aware of the need to minimize dust emissions
- Reporting of any community complaints regarding dust levels

4.3.2.4. Mangrove associated biodiversity

Accumulation of dust on mangrove leaves adjacent to the proposed development may impact organisms inhabiting mangrove canopies. Indirectly, the proposed development may also impact the avifauna through noise disturbance during construction and operational phases of the project. Impacts on mangrove associated organisms will primarily be managed by reducing the impacts to mangroves. Management of indirect impacts on mangrove avifauna will be by restricting direct habitat loss to the defined project footprint.

4.3.2.5. Mangrove monitoring

Monitoring to assist in the management of potential impacts on mangrove vegetation associations will include,

- Mangrove mapping
- Mangrove health surveys
- Monitoring of any sediment accumulation and turbidity within mangrove vegetation associations
- Assessment of water and sediment quality in the vicinity of the infrastructure development area

4.3.2.6. Mangrove mapping

Satellite images and field surveys should be used to map the distribution and coverage of mangrove vegetation situated in and near the proposed project area. Mangrove mapping should be done prior to the commencement of the project to provide current information on mangrove distribution and at project milestones including the completion of clearing activities and through the operational phase. Mangrove distribution and cover should be compared to the baseline data to confirm that the negative impact does not exceed the approved limits.

4.3.2.7. Mangrove health surveys

Mangrove health surveys should be undertaken once in a year to detect the negative impacts as soon as possible. Mangrove health monitoring will consist of regular visual assessments to determine mangrove condition. Mangrove monitoring sites should be established before the construction activities begin. The number and location of these sites should be fixed based on the baseline survey. Parameters such as number of species, number of trees, number of dead limbs, number of stems per tree, stem diameters, health status of trees, height of trees and foliage density should be collected during health surveys. A change in mangrove health leading to increased yellowing, wilting and dead leaves at any monitoring site should be shared and discussed with the stakeholders for proper action. The health survey should use the available results of the mangrove mapping and sedimentation monitoring to determine if the decline in mangrove health is directly related to the infrastructure development of the proposed project activities.

4.3.2.8. Turbidity and Sedimentation

Turbidity and sedimentation should be monitored in the mangrove area to provide an early warning of any potential changes due to the proposed project activities. Monitoring of sedimentation and turbidity should be done at the same monitoring sites as used in the mangrove health surveys.

4.3.2.9. Assessment of water and sediment quality

Regular sample collection and monitoring of water and sediment quality parameters from permanent monitoring sites will be of utmost importance to understand the deviations from the baseline. It will enable the managers to take corrective action if a parameter goes higher or lower than the permissible limits.

Table 3 gives details of the mangrove survey and monitoring protocol.

Table 3: Mangrove survey and monitoring protocol

Assessment	Periodicity
Mangrove health surveys (Natural & Rehabilitated Mangroves) Mangrove diversity Number of trees present Number of dead limbs Number of stems per tree Stem diameters Health status of trees Height of trees Foliage density	Annual
Mangrove mapping	Annual

Annexure - 2: Multipurpose Artificial Fish Habitats for the enhancement of biodiversity, fish production, and sustained livelihood (during construction and operational phases)

In marine ecosystems Artificial Fish Habitats (AFH) serve multiple purposes, the most important of which are biodiversity and fisheries enhancement and coastal protection. Worldwide, artificial fish habitats are also used for several other purposes like improvement of recreational and commercial fisheries (increase of fish production and creation of new fishing grounds), control of inshore trawling, restoration of degraded habitats, control of beach erosion, provision of spawning areas, creation of recreational diving sites and climate change adaptation. AFHs enhance fishery production, and help to stop migration of fishes due to climate change, and thereby sustain the livelihood of the dependent fisher folk.

The proposed AFH deployment activity has the following purposes:

- to increase fish production through the development of Artificial Fish Habitats
- to help fisher folk have a sustained fish catch throughout the year
- to enhance the daily income of poor fishermen and improve socio-economic conditions
- to enrich the marine biodiversity
- to assess the impact of AFHs on the socio-economic aspects
- to study the adaptive benefits of climate change impacts on both the fishermen community and the environment

Purpose

To compensate the fishery loss to the fishermen of the nearby coastal villages.

AFH deployment sites

Adequate AFH modules need to be deployed, covering considerable extent of fishing grounds at every 1 km outside the proposed project area in Bay of Bengal. It is suggested to deploy such AFHs in 15 sites in the first phase before the start of operational phase. The deployment of artificial fish habitats (artificial reefs) should start parallel to Tupilipalem and should be done upto to Katepalli at every 1 km parallel to the shore. Artificial fish habitats would attract not only fishes but also all the benthic organisms, and would create a diverse ecosystem which would provide long-lasting results.

Impact Assessment

The impact of artificial fish habitats should also be studied regularly (covering the four seasons in a year) to assess the enhancement of biodiversity, fish production and socio-economic conditions of the dependent fisher folk.

Annexure - 3: Sea ranching of commercially important organisms in Kandaleru Creek (during operational phase)

Commercial fishing by small-scale fishermen is practiced to a significant degree in Kandaleru Creek as it is one of the brackish waters in this region. Important catch includes shrimps and crabs. On account of the likely impact on these commercially important fishery resources due to the proposed project activities, eco-friendly and sustainable measures leading to livelihood enhancement may be considered. To compensate the loss, fingerlings of cultured shellfishes can be ranched in this Kandaleru creek region. Release of fingerlings would certainly help the fishermen to get good catch sustainably for a long time. Ranching of *Penaeus* spp., *Portunus* spp. and *Scylla serrata* would provide much economic benefits to the fishermen.

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