BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH NEW DELHI

ORIGINAL APPLICATION NO. 857 OF 2018

IN THE MATTER OF:

Dr. Pentapati Pulla Rao .. Applicant

Versus

Union of India & Ors .. Respondents

FURTHER ACTION TAKEN REPORT AFFIDAVIT ON BEHALF OF THE STATE OF ANDHRA PRADESH

(Kindly See Inside)

ADVOCATE OF THE STATE OF ANDHRA PRADESH - MAHFOOZ A. NAZKI

INDEX

SERIAL NO.	PARTICULARS	PAGES NO.
1.	Further Action taken Report Affidavit on behalf of the State of Andhra Pradesh	1-10
2.	Annexure -A (Further Action taken Report of Water Resources Department)	11-24
3.	Annexure -1(A.P. Forest Department Consent letter)	25
4.	Annexure -2 (Plantation Work order to DFO)	26-29
5.	Annexure -3 (Plantation photos in Mulalanka Dump Yard)	30-33
6.	Annexure-4-(AAQ report by NEER, Hyderabad for the months of February, March& November 2020)	34-108
7.	Annexure -5(Letter to CWC, New Delhi on Right bank Spill Channel)	109-110

MAHFOOZ A NAZKI
ADVOCATE FOR THE STATE OF ANDHRA PRADESH

BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH AT NEW DELHI

ORIGINAL APPLICATION NO. 857 OF 2018

IN THE MATTER OF:

DR.PENTAPATI PULLA RAO. ...APPLICANT

Versus

UNION OF INDIA & ORS. ...RESPONDENT

Further Action taken Report Affidavit on behalf of the State of Andhra Pradesh.

*****

I, B.Sudhakara Babu aged about 58 years, S/o Burri Pullaiah Resident of Dowlaiswaram, East Godavari District, being the Chief Engineer, Polavaram Irrigation Project ,Water Resources Department, Govt. of Andhra Pradesh, do hereby state on solemn affirmation as Under.

1. I represent the Respondent No. 6 in the above said matter and am authorized to swear to this affidavit and am conversant with the facts and circumstances of the

present matter. Hence I am competent to swear this affidavit.

2. It is humbly submitted that the Polavaram Irrigation Project is a multipurpose terminal Project being constructed across river Godavari near Polavaram Village about 42 Km on upstream of Godavari Barrage, Dowlaiswaram. The Project envisages Irrigation benefits to an extent of 7.20 Lakh Acres for the up land areas of East Godavari & Visakhapatnam Districts under left main canal (181.50 Km) and West Godavari & Krishna Districts under right main canal (174.00 Km) and generating 960 MW of Hydel Power. In addition to irrigation benefits, 80 TMC of water is proposed to be diverted to Krishna River, supply of 23.44 TMC of drinking water to Visakhapatnam and supply of drinking water to 540 Villages enroute the canals.

3. It is submitted that, Dr. Pentapati Pulla Rao has approached this Hon'ble National Green Tribunal, New Delhi by filing O.A.No.857/2018 on 29-10-2018 to stop the dumping activity in the Moolalanka dump yard.

4. That this Hon'ble Tribunal on **01-11-2018** has given Order for site inspection by 4 members Joint Committee comprising of representative of Central Pollution Control Board, Additional Principal Conservator of Forest (C), Andhra Pradesh pollution control board and District Collector & magistrate for submission of a report on factual aspects.

5. That as per the directions of this Hon'ble Tribunal, the 4 member joint committee has visited the Polavaram Irrigation Project on 11-12-2018 and submitted their report on 29-12-2018, duly recommending some suggestions to be implemented at the site. The Project Authorities have submitted the action taken report to the Nodal Agency i.e. Member secretary APPCB Vijayawada vide Superintending Engineer's letter No. PIPHW/ OT1/AEE-1/CSIS (NGT) Vol.5/ 159-M Dt. 06-03-2019.

6. That thereafter, the Hon'ble Tribunal heard the matter on 19-02-2019 and ordered the joint committee to revisit the site and verify the compliance on action taken

report and furnish a fresh report to this Hon'ble Tribunal.

7. That the joint committee once again visited the project on 25-04-2019 and submitted their observations on 29-04-2019 to the Hon'ble Tribunal.

8. That this Hon'ble Tribunal heard the matter on 10-05-2019 and ordered the joint committee to revisit the site and re verify the compliance and furnish a fresh report to this Hon'ble Tribunal on or before 31-07-2019.

9. That as per the directions, the committee has visited the site on 24.07.2019 and submitted their report dated 30.07.2019 to the Hon'ble Tribunal with their observations. The issue was heard by the Hon'ble NGT on Dt 27.09.201 and, based on the committee report, the Hon'ble NGT directed the Project proponent to take remedial action and furnish an Action Taken Report.

10. As per the aforesaid directions, an Action taken Report was submitted before Hon'ble NGT on 26.10.2019 by the Water Resources Department. The matter was thereafter heard by the Hon'ble NGT on 07.11.2019 and

orders were passed directing the committee to oversee the action taken by the Project proponent and furnish its report preferably by 31.01.2020.

11. That as per the directions, the Joint Committee had visited the project on 22.01.2020 and submitted their report on 29.01.2020 to the Hon'ble Tribunal.

12. Water Resources Department, Government of Andhra Pradesh had also filed An Action Taken Report on 18.02.2020, after the visit of the 4 member joint committee for kind perusal of the Hon'ble National Green Tribunal.

13. Thereafter the matter was heard by the Hon'ble Tribunal on 18.09.2020 wherein it was observed as under:

> *"No further status report has been filed by the State PCB or any other authority. This may be now done before the next date by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF. List again on 11.01.2021".*

14. In compliance with the aforesaid order, Further Action Taken Report by the Water Resources Department, Government of Andhra Pradesh is here with submitted as **Annexure – A** for kind consideration of this Hon'ble Tribunal.

15. It is to humbly submit that as per the reports on Assessment of Ambient Air Quality **(AAQ)** at Polavaram, submitted by **CSIR-NEERI** (National Environmental Engineering Research Institute), Hyderabad, during the months of **February, March & November 2020**, the following conclusions were recorder:

CONCLUSIONS IN THE CSIR - NEERI REPORT:

"*The present study aimed to assess the periodical environmental quality status within 5 km radius of the Polavaram Project. The field work for various components viz., air, groundwater, river water, soil and river sediments was carried out in the study area during 2020 during February, March and November except for*

April to October due to COVID pandemic for assessing the prevailing environmental quality. Based on the primary data collected during the study period, following conclusions are drawn:

- The ambient air quality at all locations in the study area are found to be within National Ambient Air Quality Standards (NAAQS) w.r.to gaseous pollutants (SO2, NO2, O3, CO, NH3 and C6H6), PM10 and PM2.5. The higher values of particulate matter (PM10 and PM2.5) in terms of maximum concentrations in the study area may be due to the vehicular movement and unpaved roads.
- In the villages and residential colonies surrounding the Polavaram project, it is observed that the daytime noise levels vary between 50.2-52.9 dB(A), 50.1-54.5 dB(A) & 51.6-53.8 dB(A) and night time noise levels vary between 43.1-45.0 dB(A), 42.8-44.8 dB(A) & 40.8-44.0 dB(A) during February, March and November 2020, respectively. The noise levels are compared with

CPCB limits for residential areas. The noise levels are observed to be within the CPCB standards for residential areas.

- *The groundwater quality at most of the sampling locations for various parameters was well within the permissible limit of BIS except for TDS, calcium hardness, nitrate, Iron and Manganese concentrations at some locations in groundwater were observed to be more than permissible limit of the BIS which may be attributed to the dominant Rocks.*
- *The river water quality showed values within the range. Phytoplankton and zooplankton showed significant diversity in the study area.*

16. It is most respectfully submitted that as per the reports on Assessment of Ambient Air Quality at Polavaram, submitted by CSIR-NEERI (National Environmental Engineering Research Institute), Hyderabad results of all the parameters are within the National Ambient Air Quality Standards-2009.

17. The Water Resources Department, Government of Andhra Pradesh is fully committed to ensuring all required compliances towards mitigating and eliminating any environmental or ecological damage.

18. Hence, it is humbly prayed that this Hon'ble Tribunal may be pleased to dismiss/ dispose of the above Original Application or pass such an order deemed to be fit and proper in the interest of justice.

6/1/2021

DEPONENT

Chief Engineer
Polavaram Irrigation Project
DOWLAISWARAM.

SOLEMNLY AFFIRMED / EXECUTED BEFORE ME

06/01/2021

NOTARY

Cell:9849713454
PUTREVU RANGA SAI MITRA
ADVOCATE &NOTARY
Off: 11-2-14, Sankaramatha, RAJAHMUNDRY
Res: 17-157/A, Gollapeta, Dowleswaram

VERIFICATION

I, the above named Deponent do hereby state on solemn affirmation that the contents of above Affidavit are true and correct to my knowledge and belief derived from the record of the case, no part of it is false nor anything material has been concealed there from and the Annexure annexed to the Affidavit are true and correct.

Verified at Polavaram on this 06th day of January, 2021.

6/1/2021

DEPONENT

Chief Engineer
Polavaram Irrigation Project
DOWLAISWARAM.

SOLEMNLY AFFIRMED / EXECUTED BEFORE ME

06/01/2021

NOTARY

Cell:9849713454
PUTREVU RANGA SAI MITRA
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Resi: 17-157/A, Gollapeta, Dowleswaram

PUTREVU RANGA SAI MITRA
NOTARIAL

ANNEXURE - A

FURTHER ACTION TAKEN REPORT BY WATER RESOURCES DEPARTMENT, A.P. IN THE MATTER OF O.A.No.857 OF 2018 IN THE HON'BLE NATIONAL GREEN TRIBUNAL

Sl. No.	Recommendations of the Committee during Polavaram site visit on 11-12-2018	Observations/ Remarks of the Committee on 22-01-2020	Further Action Taken by Water Resources Department as on 02.01.2021
1	**Observed disposal of muck without proper height, leveling and gradient**	It is reported that contract of main dam package work was terminated and pre closed during 2019. Fresh tenders were called for and the balance works were awarded to the New Agency vide Agreement No.01/2019-20 dt.08.11.2019. The PIP has informed that they will ensure • Works to maintain proper slopes of existing muck dumps will be started	As reported to the committee, the balance works were awarded to the New Agency vide Agreement No.01/2019-20 dt.08.11.2019 and the works are under progress. • As reported to the committee, the works to maintain proper slopes of existing muck dumps were started immediately and completed in February, 2019, opposite of B.C.Colony. • During the working season in 2019-20, the excavated earth/soil has been utilised for formation

		immediately and will be completed within one month. • After resumption of works by the new contractor, muck will be disposed maintaining the proper slopes as suggested by the Committee.	of internal ring bund, as a part of working arrangement by the agency. • The Earthwork excavation in spill channel has been stopped temporarily due to monsoon rains in 2020 and stagnation of water in the spill channel. Presently, dewatering is going on. After resumption of earth work excavation, the muck will be disposed in dump yard by maintaining proper slopes and the surface evenly, duly complying with the suggestions made by the Committee.
2	**No vegetation / greenbelt have been made on the dumps to stabilize and to prevent air pollution**	The Government of Andhra Pradesh issued G.O.RT.No.35 dt.21.01.2020 administrative sanction for Rs 306.5 Lakhs for "Raising of plantation and 3 year maintenance at Mulalanka dump yard. Tendering process is yet to be started by the PIP. After completion of tendering process and award of work,	The Government of Andhra Pradesh have accorded administrative sanction vide G.O.RT.No.35 dt.21.01.2020 for Rs 306.5 Lakhs for "Raising of plantation and 3 year maintenance at Mulalanka dump yard". The Chief Engineer, PIPHW has accorded Technical sanction to the estimate vide proceedings no. CE/PIPHW/DCE/OT-1/AEE-2/126^{SE} Dated 21.01.2020. The Superintending Engineer,

		plantation will be started. The government has also sanctioned an amount of Rs 84.45 lakhs for carrying out "Ambient Air Quality Monitoring and Water quality tests etc." The work order in this regard addressed to CSIR, NEERI, Hyderabad dt 21.01.2020.	PIPHW Circle, Dowlaiswaram has addressed the Principal Chief conservator of Forests (HoFF), Andhra Pradesh, to issue necessary orders to the concerned Divisional Forest Officer (DFO) to take up the plantation at Mulalanka dump yard, Polavaram. The Principal Chief conservator of Forests (HoFF), Andhra Pradesh, agreed in-principle to take up the work, vide letter dated 19.02.2020 (Annexure–1). The Superintending Engineer has issued work order for raising of plantation in Mulalanka dump yard to the Divisional Forest Officer, Eluru vide Work Order No. SE/ PIPHW/ OT1/AEE1/EIA/Vol.12/01/2020-21 dt 10.09.2020. (Annexure-2). The entire process is slowed down due to Covid-19 and consequent lock down conditions. Meanwhile, 800 nos of bamboo tree saplings were planted in the slopes for stabilization at Mulalanka dump yard opposite of B.C Colony with the help of Forest department in September,2020 (Photographs are enclosed as

			Annexure – 3). Work order for conducting "Ambient Air Quality Monitoring and Water quality tests etc." regularly for one year excluding monsoon season was issued to NEERI, Hyderabad on 21.01.2020. Accordingly, CSIR-NEERI team has conducted the AAQ tests at different locations in the months of February and March 2020. Due to COVID-19 and prevailing lockdown conditions and also as per the Government orders, the field work was not carried out in the months of April and May, 2020.Further, it is to submit that, the NEERI has not conducted the field tests in the months of June, July and August, 2020, due to monsoon season which is not required as per the CPCB guide lines. In September, 2020, NEERI has not conducted field tests informing that due to heavy rains in the region, samplings were not collected. Further, it is to submit that, NEERI, Hyderabad has informed that the sampling for the month

			October, 2020 cannot be carried out due to depression in Bay of Bengal. Also informed that, It is not recommended to conduct sampling during overcast conditions as the data generated during this period is not valid. NEERI, Hyderabad had resumed conducting field tests again from 16th November, 2020 regularly. The samplings were collected in the month of December, 2020 also. The test reports of samplings collected in February, March and November 2020 were furnished on dt 30.12.2020 by e-mail. (NEERI report enclosed as Annexure-4). The test reports of December, 2020 will be received in January, 2021 and the same will be submitted. All necessary remedial measurements will be taken if necessary as per the recommendations of the NEERI and same will be informed.
3	**The Project Authority may re-look at the**	During the earlier inspections, the project authorities were repeatedly informing the	Presently, the land is under the possession of Land owners only and they have been cultivating the lands.

	utilization of 87 Acres acquired adjacent to the existing dumping site (Moolalanka dump site)	committees that the land in question is in the final state of award and same was informed in their ATRs. During the review meeting on 22.01.2020, the Revenue Divisional Officer, Jangareddygudem, West Godavari District has informed to the committee that the 87 acres in question was acquired by GoAP vide order dt18.02.2018. However, the land area mentioned in the award order was 85.35 acres. The committee is of the opinion that since the land is used presently for agriculture by the farmers the Project Authority should avoid utilizing the land for dumping or for any non-agriculture purpose.	As reported earlier, after finalization of balance drawings of Pilot channel and Spill channel right side slope, exact quantities can be finalized and a decision can be taken on returning the unutilized land if any, out of the 85.35Acs proposed land for dumping.
4	**The Project Authority shall immediately prepare an action plan**	During the review, the PIP has informed that • The balance works were entrusted to the New Agency on dt.08.11.2019.The new	The balance works were entrusted to the New Agency on 08.11.2019 and the works are under progress. • As submitted, so far 41.49 Lakh Cu.M.of rock muck

	regarding feasibility of utilizing the excavated material within the Project area and the feasibility of using the land already demarcated near the Zero point.	agency has started Spillway concrete works and dewatering of Spill channel initially and soon will start other works. • A total quantity of 130 Lakh Cum of Rock muck dumps are available at site on right side and further about 17.2 Lakh Cum of useful rock muck will come from the excavation 902 Hill and about 60 Lakh Cum will come from excavation of power house foundations making the total rock muck available 207.2 Lakh cum. • So far 41.49 Lakh Cu.M. of rock muck has been utilised in the partially executed Upstream and Downstream Cofferdams. Further 207 lakh Cu.M. of rock muck will be required for the construction of balance cofferdams, ECRF dam in gap-II, upstream	has been utilised in the partially executed Upstream and Downstream Cofferdams. Further 207 lakh Cu.M.of rock muck will be required for the construction of balance cofferdams, ECRF dam in gap-II, upstream left side guide bund of Approach Channel and for the river protection works. The total rock muck will be utilized in the above works.

		left side guide bund of Approach Channel and for the river protection works. The total rock muck will be utilized in the above works from February, 2020 to December, 2021. • The Government land demarked near the zero point cannot be utilized for dumping as the excavated muck has to be transported through Polavaram village. The land will be utilised for the future needs of the project appropriately.	• Dumping is not allowed at Zero point. The Government land demarked near the zero point will be utilised for the future needs of the project appropriately.
5	**Project Authority made the commitment and assured before the Committee that henceforth i.e., 11-12-2018 onwards dumping**	The project Authority shall continue to abide by their commitment.	The dumping of muck near B.C.Colony has been stopped completely abiding by the promise made to the committee.

	of mucks will not be done near the BC colony area. Copy of commitment is annexed as Annexure-"C".		
6	The project authority shall regularly carry out air quality monitoring in line with National Ambient Air Quality Monitoring Programme and submit reports to MOEF & CC/APPCB.	The Ambient Air Quality Management (AAQM) has been conducted in five places in May, June and July of 2019 and on 18-01-2020. The study reports of May, June & July have already been submitted and the latest reports are also submitted to APPCB and Polavaram Project Authority on Dt.21.01.2020. The GoAP have accorded administrative sanction vide G.O.RT.No.35 dt.21.01.2020 for Rs 406.201 Lakhs for the Estimate for carrying out the Air Quality Monitoring ,water quality tests by M/s NEERI, Hyderabad for Rs.84.45	An Work order was issued to NEERI, Hyderabad on 21.01.2020 for conducting "Ambient Air Quality Monitoring and Water quality tests etc." regularly for one year excluding monsoon season. Accordingly, CSIR-NEERI team has conducted the AAQ tests at different locations in the months of February and March 2020. Due to COVID-19 and prevailing lockdown conditions and also as per the Government orders, the field work was not carried out in the months of April and May, 2020.Further, it is to submit that, the NEERI has not conducted the field tests in the months of June, July and August, 2020, due to monsoon season which is not required as per the CPCB guide lines.

		lakhs plus GST and plantation including providing Tree guards, watering and maintenance for 3 years at Mulalanka dump yard for Rs 306.50 Lakhs. The work order was placed on M/s NEERI, Hyderabad for carrying out the AAQM and water quality studies for one year. Hence, the reports prepared by NEERI, Hyderabad, by collecting data of air environment, Noise environment, ground water and surface water environment and soil environment in line with National Ambient Air Quality Monitoring Programme will be submitted to APPCB &MoEF regularly as suggested by the Committee.	In September, 2020, NEERI has not conducted field tests informing that due to heavy rains in the region, samplings were not collected. Further, it is to submit that, NEERI, Hyderabad has informed that the sampling for the month October, 2020 cannot be carried out due to depression in Bay of Bengal. Also informed that, It is not recommended to conduct sampling during overcast conditions as the data generated during this period is not valid. NEERI, Hyderabad had resumed conducting field tests again from 16th November, 2020 regularly. The test reports of samplings collected in February, March and November 2020 were furnished on dt 30.12.2020 by e-mail. (NEERI report enclosed as Annexure-4). The reports have been submitted regularly to MoEF and APPCB as suggested by the committee.

7	**Strengthening of dump sites with proper heights and slopes along with vegetative cover may be planned immediately in consultation with technical experts.**	Progress as suggested in Point No.2 may be complied.	The Government of Andhra Pradesh have accorded administrative sanction vide G.O.RT.No.35 dt.21.01.2020 for Rs 306.5 Lakhs for "Raising of plantation and 3 year maintenance at Mulalanka dump yard". The Chief Engineer, PIPHW has accorded Technical sanction to the estimate vide proceedings no. CE/PIPHW/DCE/OT-1/AEE-2/126^{SE} Dated 21.01.2020. The Superintending Engineer, PIPHW Circle, Dowlaiswaram has addressed the Principal Chief conservator of Forests (HoFF), Andhra Pradesh, to issue necessary orders to the concerned Divisional Forest Officer (DFO) to take up the plantation at Mulalanka dump yard, Polavaram. The Principal Chief conservator of Forests (HoFF), Andhra Pradesh agreed in-principle to take up the work vide letter dated 19.02.2020 (Anneuxre-1). The Superintending Engineer has issued work order for raising of plantation in Mulalanka dump yard to the divisional forest officer, Eluru vide Work Order No. SE/

			PIPHW/ OT1/AEE1/EIA/Vol.12/01/2020-21 dt 10.09.2020 (Annexure-2). Meanwhile, 800 nos of bamboo tree saplings were planted in the slopes for stabilization at Mulalanka dump yard opposite of B.C Colony with the help of Forest department in the month 09/2020 (Photographs are enclosed as Annexure – 3).
8	**The Committee has verified the restoration of roads after development of cracks as reported in the project approach road during the last monsoon season. The report obtained from Central Design Organization,**	It is reported by the Project Authority that the problem of sliding of Right side bank of spill channel was studied by Prof Ayothiraman of IIT, Delhi and the report furnished by him for providing 35m depth of stone columns was discussed in the 11th DDRP meeting. The agency expressed its inability to construct stone columns to a depth of 35m as recommended by IIT, Delhi and proposed alternative structures to Earthen Embankment.	Prof Ramana I.I.T, Delhi and Dr. R.Chitra, Scientist "E", CSMRS, Delhi were addressed to inspect the site and to furnish suitable option for arresting slipping of banks. Dr. R.Chitra, Scientist "E", CSMRS, Delhi has inspected the site on 18th and 19th of Febraury,2020. As suggested in the DDRP meeting, the final report on Stability assessment of right bank along with recommended ground improvement measures as carried out by IIT, Delhi was submitted to CWC, New Delhi for according approval ,by the Chief Engineer, PIP vide

	Vijayawada, AP is annexed as Annexure – 'D'.	Various alternatives were discussed by the members of the panel and it was decided that the agency shall submit the alternative ground improvement technique or any suitable option in consultation with, IIT Delhi and CSMRS. Prof Ramana I.I.T, Delhi and Mrs. R.Chitra, CSMRS, Delhi have been addressed to furnish suitable option for arresting slipping of banks and they are planned to inspect the site after dewatering of Spill channel. The dewatering of spill channel was started from 16.12.2019 by installing 28 pumps of total capacity about 4000 HP and will be completed by Dt 14.02.2020. Necessary protective measures will be taken up as per their suggestions.	Lr.No.1733, dated 19.12.2020 (Annexure-5). Based on the recommendations of the CWC, New Delhi, necessary design and drawings will be submitted for according approval. Based on the approved drawings, necessary protective measures/works will be taken up. The progress will be updated from time to time.

9	**Adequate dust suppression measures like providing water spraying may be arranged till good vegetative cover attained. Similarly, water spraying may be arranged for wetting the approach "roads/village roads etc. at the project areas and nearby villages."**	During inspection the committee have observed the spraying of water on approach road to suppress the dust. The PIP further informed that after resumption of earth work the number of tankers engaged will be increased according to the requirement as suggested by the committee.	As per the present site conditions, five water tankers have been engaged for sprinkling water on the approach roads to suppress the dust. As and when required more no of tankers will be used for suppression of dust in the project area/nearby villages.

PUTREVU RANGA SAI MITRA NOTARIAL

6/1/2021
Chief Engineer
Polavaram Irrigation Project
DOWLAISWARAM.

Cell:9849713454
PUTREVU RANGA SAI MITRA
ADVOCATE &NOTARY
Off: 11-3-10, Seshamahal, RAJAHMUNDRY
Resi: 17-157/A, Gollapeta, Dowleswaram

06/01/2021
NOTARY

GOVERNMENT OF ANDHRA PRADESH
FOREST DEPARTMENT

From
Sri N.Prateep Kumar, I.F.S.,
Principal Chief Conservator of Forests
(Head of Forest Force),
Andhra Pradesh, "AranyaBhavan",
Nagarampalem, KM.Munshi Road,
Guntur -522 004.

To
The Superintending Engineer,
PIPHW Circle,
Dowlaiswaram,
E.G.Dist., 533 125,
Email :seishw@gmail.com

Ref.No. EFSO2-20053/08/2018/NC-1(i) Dated: 19.02.2020.

Sir,

Sub:- PIPHW: O.A No 857 of 2018 filed by Dr. P.P Rao before Hon'ble NGT, New Delhi - 4 Member Joint committee - Request to take up the plantation at Mulalanka dump yard at Polavaram Project Head works Dam, West Godavari District – Consent – Furnishing - Reg.

Ref:- Superintending Engineer,PIPHW Circle,Dowlaiswaram Lr.no. SE/PIPHW/OTI/AEE-I/EIA/vol.11/100^{M},Dt.14.02.2020.

***

Adverting to the reference cited, it is informed that the A.P Forest Department, as per request made in the reference cited, agrees in-principle to take up the work i.e, Raising and Maintenance of plantation for three years over 200 acres at Mulalanka Dump yard at Polavaram Project Head works Dam, West Godavari District with the funds provided by the A.P Water Resources Department. Based on the field conditions detailed action plan will be furnished in this regard for requirement of funds.

Yours faithfully,
Sd/-S.S.Sreedhar,
for Principal Chief Conservator of Forests
(Head of Forest Force).

Copy to the Conservator of Forests, Rajahmundry Circle,
Rajamahendravaram.

// True Copy//

for Principal Chief Conservator of Forests

19/02/2020

By RPAD 26

GOVERNMENT OF ANDHRA PRADESH
WATER RESOURCES DEPARTMENT

From:
Sri M. Nagi Reddy, ME, MIE.,
Superintending Engineer,
PIPHW Circle
Dowlaiswaram 533125
Ph#/FAX: 0883 2417559(8)/
0883 -2417557
Email: seishw@gmail.com

To:
Divisional Forest Officer
Social Forestry Division,
Eluru, West Godavari District.

Work Order No.SE/PIPHW/OT1/AEE1/EIA/Vol.12/01/2020-21, Dt.10.09.2020.

Gentlemen,

Sub:- Water Resources Department – Polavaram Irrigation Project- Polavaram Head Works – West Godavari District – Entrustment of work of "Raising of Plantation and 3 years maintenance at Mulalanka Dump yard" to State Forest Department – Work Order Issued – Reg.

Ref:-
1. G.O RT No. 35, Water Resources Department, Dt, 21.01.2020.
2. Chief Engineer, PIPHW, Polavaram, Technical Sanction to the Estimate vide Proceeding No. CE/PIPHW/DCE/OT-1/AEE-2/126^{SE}, Dt. 21.01.2020.
3. T.O Lr. No. SE/PIPHW/OT-1/AEE1/EIA/Vol.11/100^{M}, Dt. 14.02.2020.
4. Principal Chief Conservator of Forests (HoFF). Guntur Lr. No. EFSO2-2053/08/2018/NC-1(i), Dt. 19.02.2020.
5. Principal Conservator of Forest, Guntur Ref NoEFSO2-20053/08/2018/NC1(ii), Dt. 20.02.2020 addressed to Conservator of Forest, Rajahmundry.
6. DFO, Eluru, letter Ref. No.42/2020/DM, Dt. 13.03.2020.
7. DFO, Eluru, letter addressed to the Conservator of Forest, Rajahmundry, Ref No.42/2020/DM, Dt. 19.05.2020.
8. DFO, Eluru letter No. Rc. No.42/2020/DM, Dt. 15.07.2020.
9. T.O Lr. No. SE/PIPHW/OT-1/AEE1/EIA/Vol.12/360^{CE}, Dt. 24.07.2020.
10. CE, PIP, Dowlaiswaram Memo No. CE/PIP/DCE-1/OT-3/AEE-3/AAQ & Plantation/Vol.2, Dt. 04.08.2020.
11. Executive Engineer, PIPHW, Division 3, Polavaram Lr. No.147^{SE}, Dt.5.8.2020.

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With reference to 4th cited, it is to inform that the Principle Conservator of Forest, Guntur has agreed in-principle to take up the work i.e, Raising and Maintenance of Plantation for 3 years over 200 Acres at Mulalanka Dump yard at Polavaram Project Head Works, West Godavari District with the funds provided by the AP Water Resources Department.

The Chief Engineer, PIP, Dowlaiswaram has permitted to entrust the work of Raising of Plantation and 3 years maintenance at Mulalanka dump yard to the state Forest Department as per Technical Sanction Proceedings vide reference 2nd cited.

In this connection, the subject work i.e, Raising of Plantation and 3 years maintenance at Mulalanka dump yard is herewith entrusted to the State forest Department for Total amount of Rs. 3,04,62,892/- including GST at 12% (As per Technical Sanction). The item wise work details and related amounts are tabulated below:

S. No.	Item of Work	Amount in Rs.
1	Raising of Plantation at Mulalanka Dumping Area of Polavaram Irrigation Project	Rs. 1,76,74,398/-
2	1st year maintenance of Plantation at Mulalanka Dumping Area of Polavaram Irrigation Project	Rs. 63,55,244/-
3	2nd year maintenance of Plantation at Mulalanka Dumping Area of Polavaram Irrigation Project	Rs. 27,63,769/-
4	3rd year maintenance of Plantation at Mulalanka Dumping Area of Polavaram Irrigation Project	Rs. 4,05,600/-
	Total in Rs.	Rs. 2,71,99,011/-
	GST @12%	Rs. 32,63,881/-
	Grand Total in Rs.	Rs.3,04,62,892/-

The entrustment of work is subjected to the following Terms and Conditions:

I. Raising of Plantation:

Scope of Work includes:

1. The Plant Species must be suitable to the native soil of dumped material.
2. The saplings shall be planted at a spacing of 5 m x 5 m covering 400 nos per Ha.
3. Watch and ward shall be provided.
4. Tree guards shall be provided to protect the plants.
5. Replacement of casualties at 20% during the raising year.
6. Repairs to tree guards, application of fertilizers, chemicals, soil working including weeding, watering to the plants and etc.,

II. 1st year maintenance:

Scope of work includes

1. Replacement of causalities at 25% during the 1st year maintenance.
2. Repairs and subsequent repairs to tree guards.

3. Watch and ward shall be provided.
4. Application of fertilizers, chemicals, soil working including weeding, watering to the plants and etc.,

III. 2nd year maintenance:

Scope of work includes

1. Repairs to tree guards.
2. Watch and ward shall be provided.
3. Application of fertilizers, chemicals, soil working including weeding, watering to the plants and etc.,

IV. 3rd year maintenance:

Scope of work includes

1. Watch and ward shall be provided.
2. Application of fertilizers, chemicals, soil working including weeding, watering to the plants and etc.,

The watch and ward under 3rd year maintenance of plantation shall be permitted with prior permission of the Executive Engineer, PIPHW, Division No 3, Polavaram. The watch and ward engaged for 3rd year maintenance shall carryout pruning of epidemic branches and repairs to the tree guards in addition to the protection of Plantation.

Mode of Payment:

i. For Raising of Plantation an amount of Rs. 1,76,74,398/- + GST 12% will be paid in advance immediately after commencement of the work by Forest Department.
ii. For 1st year maintenance an amount of Rs. 63,55,244/- + GST 12% will be paid immediately after completion of raising of plantation.
iii. For 2nd year maintenance an amount of Rs. 27,63,769/- + GST 12% will be paid immediately after completion of 1st year maintenance.

iv. For 3rd year maintenance an amount of Rs. 4,05,600/- + GST 12% will be paid immediately after completion of 2nd year maintenance.

The levelling of site and Approach roads as per the site conditions will be done by the Executive Engineer, PIPHW, Division No 3, Polavaram. The site will be handed over immediately after receiving the letter of acceptance.

Yours faithfully,

Superintending Engineer,
PIPHW Circle, Dowlaiswaram.


OPPO A1k
FRIDAY
9 11 2020


FRIDAY
9 11 2020


OPPO A1k
FRIDAY
9 11 2020


SATURDAY
9 12 2020

Interim report

COMPLIANCE MONITORING AND ASSESSMENT OF AMBIENT AIR QUALITY, NOISE LEVELS AND WATER QUALITY AT POLAVARAM, W.G.DIST., ANDHRA PRADESH

Sponsor

Executive Engineer (FAC), P.I.P.H.W. Divn. No. III
Polavaram – 534315

CSIR-National Environmental Engineering Research Institute
Hyderabad Zonal Centre
Uppal Road, Hyderabad-500007

December 2020

Project Personnel

CSIR-NEERI, Hyderabad Zonal Centre

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Mr. S. Harirama Kumar	Mr. M. Paresh Kumar
Mr. Shaik Fareed	Mr. K. Yadagiri
Ms. P. Priyanka	Mr. P. Ramulu
Mr. Madhu	Ms. Yashaswitha
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Dr. Rakesh Kumar
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Chapter 1

Introduction

1.0 Preamble

The Polavaram Irrigation Project is a multipurpose terminal Project across river Godavari near Polavaram Village about 42 km on upstream of Godavari Barrage, Dowlaiswaram. The Project envisages Irrigation benefits to an extent of 7.20 Lakh acres for the up land areas of East Godavari & Visakhapatnam Districts under left main canal (181.5 km) and West Godavari & Krishna Districts under right main canal (174 km) and generating of 960 MW of Power. In addition to irrigation benefits 80 TMC of Godavari water is proposed to be diverted to Krishna River and supply 23.44 TMC of drinking water to habitations and industries in and around Visakhapatnam city including Vizag steel plant. Water saved in Krishna River will be used for drought prone areas of Rayalseema region.

The construction Polavaram Project is taken up after obtaining all the statutory clearances from the various ministries of Government of India. The environmental concerns during the construction forms the part of the Environmental Impact Assessment report and only after considering all such impact and its mitigation measures, the Ministry of Environment & Forest has granted clearance to the project on 25.10.2005.

The dumping yards are common features of any construction project which itself is a standard practice of minimizing pollution. The status of compliance with the conditions specified in the clearances i.e., Air Quality Monitoring Test Reports, Noise Level and Water Quality Tests Reports have to be submitted to the Ministry of Environment and Forests, Government of India and APPCB, Vijayawada (NGT OA No. 857 of 2018-Tribunal order dated 01.11.2018).

In this regard, Executive Engineer (FAC), P.I.P.H.W. Divn. No. III, Polavaram approached CSIR-NEERI, Hyderabad Zonal Centre to take up the Environmental Quality Assessment in and around Polavaram Irrigation project including dumping site to know the environmental impacts and to suggest any mitigative measures, if required.

Based on the technical discussions and site visit by CSIR-NEERI HZC scientists and the information provided by Executive Engineer (FAC), P.I.P.H.W. Divn. No. III, Polavaram, an environmental monitoring and assessment study with reference to ambient air quality, noise levels and water quality is proposed with the following objectives and scope of work.

1.1 Objectives

- To identify the monitoring locations for air, water and soil quality based on local meteorology, land cover/topography and other available information/charts
- To monitor ambient air quality (AAQ), noise levels and water quality, soil quality at identified locations in and around project site.
- To assess the AAQ levels, noise levels and water quality, soil quality in and near Polavaram dumping site and suggest suitable mitigation measures, if required.

1.2 Scope of Work and Methodology

The environmental quality data will be generated in the project site on monthly basis in the year excluding monsoon season (June-August). The environmental assessment includes generation of data on the air, noise and water environments of the study area. The data collection will be done for

Terrestrial Environment

a. Air Environment
b. Noise Environment
c. Groundwater and surface water Environment
d. Soil Environment

Terrestrial Environment

Air Environment

- Selection of sampling stations: About three AAQ stations will be selected based on the local meteorology, dumping site area, accessibility, availability of electricity and local people's support.
- The ambient air quality (AAQ) monitoring stations will be established and 24 h sample collection will be done for following parameters: Particulate Matter (size less than 10 µm or PM_{10}), Particulate Matter (size less than 2.5 µm or $PM_{2.5}$), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Ozone (O_3), Carbon monoxide (CO), Ammonia (NH_3), Benzene (C_6H_6), Particulate metals like lead

(Pb), Arsenic (As) and Nickel (Ni) and particulate associated Benzo-alpha-pyrene (BaP), as per National Ambient Air Quality Standards (NAAQS) Criteria by Central Pollution Control Board (CPCB), New Delhi.

- The samples will be collected each station for every month except monsoon season (June-August) as per CPCB guidelines.
- Collection of hourly meteorological data comprising wind speed, wind direction, temperature, relative humidity, cloud cover, solar insolation and rainfall (from secondary data sources or from nearest IMD station).
- Total samples for AAQ in a year= 3 (stations) X 8 (twice in a week for one month) X 9 (months excluding June-August) = 216
- Delineation of mitigation measures after assessing the AAQ levels

Noise environment

- Day Time and Night time noise levels will be monitored at each station, twice a week for one month, preferably at the ambient air quality monitoring sites and selected locations.
- Total samples for noise levels in a year= 10 (stations) X 4 (once in a week for one month) X 2 (day and night) X 9 (months excluding June-August) = 720
- Delineation of mitigation measures after assessing the noise levels

Groundwater environment

- Groundwater will be collected at the representative locations and will be analyzed for the following parameters: pH, TSS, TDS, Fluoride, salinity, total alkalinity, Total hardness, sulphates, nitrate, phosphate, Chloride, total coliforms, DO, BOD, heavy metals like Fe, B, Ni, Zn, Pb, Cr, Cr, Cu, As, Mn, Hg.
- Measurement of groundwater levels in bore wells once in a month in identified quarter
- Total samples for Groundwater quality in a year= 10 (stations) X 9 (months excluding June-August) = 90
- Recommendations on water conservation measures
- Delineation of mitigation measures after assessing the water quality.

Soil environment

- Assessment of Soil quality in the study area will be carried out at selected stations for physico-chemical parameters like pH, Conductivity, Organic Carbon, Texture, Bulk Density, Particle Density, Porosity, water holding capacity, Soluble Cations (Calcium, Magnesium, Sodium, and Potassium), Sulphates, Chlorides, Available N, P & K, Sodium Absorption Ratio (SAR).
- Total samples for soil quality in a year= 5 (stations) X 2 (pre- and post-monsoon seasons in a year) = 10

Surface water Environment

- Surface water will be collected at the available locations and will be analyzed for the following parameters: pH, TDS, Fluoride, salinity, total alkalinity, Total hardness, sulphates, nitrate, phosphate, Chloride, total coliforms, DO, BOD, heavy metals like Fe, B, Ni, Zn, Pb, Cr, Cr, Cu, As, Mn, Hg.
- Sediment samples will be characterized for Texture, Total Organic Carbon and heavy metals (Al, As, Cr, Mn, Fe, Co, Cd, Pb, Ni, Cu, Zn)
- Biological Environment:
    - Phytoplankton count, major genera and generic diversity
    - Zooplankton count, major genera and group diversity
    - Numerical and biomass density per unit area, identification of species and species diversity of benthic fauna in sediments.
- Total samples for surface water and sediments = 5 (stations) X 2 (surface water and sediment) X 3 (pre- and post-monsoon seasons and winter season in a year) = 30

1.3 Layout of the report

The report is presented in the following structure:

Chapter 1: Introduction (this chapter)

Chapter 2: Description of Study Area

Chapter 3: Prevailing Environmental Quality Status

Chapter 4: Conclusions and Future Work

Chapter 2

Description of Study Area

(Source: CGWB Report, W.G. District)

3.0 INTRODUCTION

The project site lies in between the latitudes N 17° 12' 30" to N 17° 19' 00" and longitudes E 81° 36' 00" to E 81° 42' 00". A 5 km radius buffer has been prepared around the project site.

31. CLIMATE AND RAINFALL

The climate is tropical in nature and is influenced by the topographical variations and maritime influence. The Deccan Plateau has more of a temperate climate than the coastal belt. The Eastern Ghats in Vishakhapatnam and its neighbourhood play a significant role, which acts as a barrier to easterly winds in association with depression from Bay of Bengal during the southwestern monsoon.

3.2 SOILS

The different soils in the area are red loams, sandy loams, sandy soils and black cotton soils. Red loamy soils are predominate and occupy about 70% in the District. Sandy loamy soils are largely confined to the coastal areas and to certain stretches in the interior mandals. Black cotton soils occur in some parts of the area.

3.3 DRAINAGE

Godavari rivers and its tributaries drain the northern and central part and Pennar river drains in southern part of state before joining Bay of Bengal. There are 3 major basins and 11 medium river basins in the state. The drainage pattern is generally dendritic with wide valleys in western peniplain. The drainage in Eastern Ghat is coarse and dendritic with steep and narrow valleys. Youthful streams and valleys mark the eastern coastal tract intersected by innumerable feeder and distributary canal system. The delta of river are very extensive and characterized by considerable thickness of alluvial material.

Chapter 3

Prevailing Baseline Environmental Status

3.0 FIELD WORK

Field work of the Polavaram project was undertaken by CSIR-NEERI, HZC Team during the months February, March and November 2020 except for the months April to October due to the COVID pandemic. A 5 km buffer around the Polavaram project site was prepared. The locations were plotted in the study area for various environments. The monitoring for various environments like air, noise, water, land etc. was carried out in the whole study area.

3.1 Air Environment

Ambient Air Quality Study

The ambient air quality status in the study area is carried out during February, March and November 2020 at 5 locations selected based on local topography and meteorological conditions using network design criteria and monitoring was carried out as per CPCB guidelines. The sampling locations were presented in Table 3.1.1. The locations of air quality monitoring in the study area are shown in Fig. 3.1.1.

Micrometeorology

Meteorological data of wind speed, wind direction, temperature and relative humidity were collected from nearest Meteorological Station (Nidadavolu, WG Dist., A.P) from Climatological Tables of India Meteorological Department.

The windrose diagram for February (**Fig. 3.1.2a**) shows that the predominant winds are from S, E, N, NE, SE and SW directions. The wind speed has been observed in the range of 0.5 - 4.5m/s. Ambient temperature varied between 19.7 - 31.9^{O}C during February, while the relative humidity was observed in the range of 54-79%

The windrose diagram for March (**Fig. 3.1.2b**) shows that the predominant winds are from S, SW, E, NE N, and SE directions. The wind speed has been observed in the range of 0.5 - 4.8m/s. Ambient temperature varied between 22.2 - 34.1^{O}C during March, while the relative humidity was observed in the range of 54-79%.

The windrose diagram for November (**Fig. 3.1.2c**) shows that the predominant winds are from E, NE, N and SE directions. The wind speed has been observed in

the range of 0.5 - 3.2m/s. Ambient temperature varied between 20.9 - 30.6^{O}C during November, while the relative humidity varied in the range of 66-80%.

Ambient Air Quality Status

Ambient air quality sampling for Particulate Matter (size less than 10 µm or PM_{10}), Particulate Matter (size less than 2.5 µm or $PM_{2.5}$), Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_X) and Ammonia (NH_3) on 24 hrly basis was made Ozone (O_3) and Carbon Monoxide (CO) on 1 hrly basis & Benzene as spot concentrations were monitored. The techniques/methods used for monitoring and analysis of air quality parameters are given in Table 3.1.2. The data collected was subjected to statistical analysis like minimum, maximum, average and standard deviation. The Particulate metals like lead (Pb), Arsenic (As) and Nickel (Ni) along with Benzo(*α*)pyrene (BaP) in the particulate matter were analysed. The observed ambient air quality data within the study area for February, March and November 2020 are given in Tables 3.1.3, 3.1.4 and 3.1.5, respectively**.** The parameters were analyzed following standard methods and concentration levels were compared with National Ambient Air Quality Standards (NAAQS) prescribed by Central Pollution Control Board (Annexure I).

Particulate Matter

The 24hourly minimum-maximum values and average PM_{10} and $PM_{2.5}$ concentrations at all the sampling locations during February, March and November 2020 are given in Tables 3.1.3, 3.1.4 and 3.1.5, respectively. It is observed that the average PM_{10} concentrations varied between 58 - 94 µg/m^3*,* 59 - 83 µg/m^3 and 45 - 75 µg/m^3, respectively, during February, March and November 2020 within the study area and found that the average PM_{10} concentrations are within the NAAQS *(*PM_{10} - 100 µg/m^3) at all locations. It is observed that the average $PM_{2.5}$ concentrations varied between 37 - 50 µg/m^3, 20 - 34 µg/m^3 and 29 - 40 µg/m^3, respectively, during February, March and November 2020 within the study area and found that the average $PM_{2.5}$ concentrations are within the NAAQS ($PM_{2.5}$ - 60 µg/m^3*)*. The higher values of particulate matter (PM_{10} and $PM_{2.5}$) in terms of maximum concentrations in the study area may be due to the vehicular movement and unpaved roads.

Gaseous Pollutants

Sulfur dioxide and Oxides of Nitrogen

The 24hourly minimum-maximum values and average SO_2 and NO_X concentrations at all the sampling locations during February, March and November 2020 are given in Tables 3.1.3, 3.1.4 and 3.1.5, respectively. The average concentrations of SO_2 are found to be varying within the range of 2 - 4 µg/m^3, 4 - 5 µg/m^3 and 2 - 4 µg/m^3, respectively, during February, March and November 2020. The average concentrations of NO_X are found to be varying within the range of 5 - 6µg/m^3, 6 - 6µg/m^3 and 5 - 7µg/m^3 in the study area during February, March and November 2020, respectively. The levels of SO_2 and NO_x were observed well below NAAQS (80 µg/m^3).

Ammonia

Atmospheric ammonia (NH_3) is a pollutant which is highly soluble in water, its major sink in the atmosphere is by wet deposition. The residence time of ammonia in the lower level of the atmosphere is a few hours, though in the calm environment it may exist for weeks. Ammonia is the major base present in the atmosphere and is therefore important in neutralizing acidic species such as SO_2, H_2SO_4, HNO_3 and HCl. To assess the levels of ammonia in air, samples were collected by passing air through absorbing media and analyze by wet chemical method. The average concentrations of NH_3 are found to be varying within the range of 22 - 39µg/m^3 (Table 3.1.3), 22 - 41µg/m^3 (Table 3.1.4) and 9 - 17µg/m^3 (Table 3.1.5), respectively, during February, March and November 2020 within the study area and these values are well within the NAAQS (400 µg/m^3).

Ozone

Ozone (O_3) is a secondary air pollutant formed by photochemical reactions involving NOx and VOCs, mainly hydrocarbons. In the presence of solar radiation, nitrogen dioxide (NO_2) dissociates to form nitric oxide (NO) and an oxygen atom (O). O_3 is then formed by O_2 reacting with the oxygen atom (O). However, when hydrocarbons are present, NO is converted to NO_2, thus leaving little NOx to react with O_3. This reaction leads to a build-up of O_3 in the atmosphere. Sources of NO_2

and VOCs are primarily anthropogenic, generally produced during combustion processes from automobile emissions and industrial activities.

To assess the levels of ozone in air, samples were collected by passing air through absorbing media during day time (1000-1800 h) assuming ozone production occurs in the presence of solar radiation, NOx and VOCs. The samples were analyzed by wet chemical method. The average concentrations of O_3 are found to be varying within the range of 9 - 39 µg/m^3 (Table 3.1.3), 11 - 26µg/m^3 (Table 3.1.4) and 8 - 15 µg/m^3 (Table 3.1.5) during February, March and November 2020, respectively, within the study area which were below the NAAQS (1 h avg. 180 µg/m^3).

Carbon Monoxide (CO)

Carbon monoxide is a colourless and odourless gas. It is formed when substances containing carbon are burned with an insufficient supply of air. The combustion of fuels such as petrol, gas, coal and wood generate carbon monoxide. Gas and wood used for cooking and heating in appliances like stoves and barbecues add to such emissions. Apart from it, motor vehicles are also one of the main sources of carbon monoxide pollution in urban and sub-urban environment.

The concentrations of CO measured as 1 hrly averages are found to be ranging from 0.15 to 0.19mg/m^3 (Table 3.1.3), 0.15 to 0.18mg/m^3 (Table 3.1.4) and 0.12 - 0.16µg/m^3 (Table 3.1.5) during February, March and November 2020, respectively, in the study area and the values are found to be less than NAAQS (1 hr. avg. 4 mg/m^3).

Benzene

The spot concentrations of Benzene are observed to be below detectable limit (BDL) during February, March and November 2020 within the study area and are well within NAAQS (Tables 3.1.3, 3.1.4 and 3.1.5).

Particulate Associated Toxic Pollutants

Airborne particles are important carriers of metals, some of which possess toxic properties. The concentrations and size distributions of trace metals are governed by the nature of emissions to the atmosphere as well as rates of wet and dry deposition, cloud processing, and exchange of air between the boundary layer

and the free troposphere, and chemical transformations. The elevated metal concentrations can pose a serious risk to human health. Fossil fuel utilization, such as liquid fuel for vehicular exhaust and lubricant residues, are considered as important contributors. Heavy metals like lead, arsenic and nickel associated with particulate matter were determined.

Lead (Pb)

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have been motor vehicles (such as cars and trucks) and industrial sources includes near lead smelters, waste incinerators, utilities, and lead-acid battery manufacturers. Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. Lead is persistent in the environment and accumulates in soils and sediments through deposition from air sources, direct discharge of waste streams to water bodies, mining, and erosion. Ecosystems near point sources of lead demonstrate a wide range of adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates. The observed Pb concentrations at all the locations ranged from BDL - 0.05 µg/m^3 (Table 3.1.3), BDL - 0.08 µg/m^3 (Table 3.1.4) and BDL - 0.07 µg/m^3 (Table 3.1.5) in the study area during February, March and November 2020, respectively, and are well below the NAAQS (1 µg/m^3).

Arsenic (As)

Arsenic (As) is a naturally occurring element widely distributed in the earth's crust. Inorganic forms of arsenic are found throughout the environment. It is released into the air by volcanoes, weathering of arsenic-containing minerals and ores, and commercial or industrial processes. Metal smelters release elevated inorganic arsenic into the air. Other air sources of inorganic arsenic exposure include burning of plywood treated with an arsenic wood preservative. Acute (short-term) high-level inhalation exposure to arsenic dust or fumes can cause gastrointestinal effects

(nausea, diarrhea, abdominal pain) and nervous system disorders. Chronic (long-term) inhalation exposure to inorganic arsenic can cause irritation of the skin and mucous membranes and lung cancer. Arsenic concentrations are found be ranging from BDL - 1.22ng/m^3 (Table 3.1.3), BDL - 0.64ng/m^3 (Table 3.1.4), and BDL (Table 3.1.5) during February, March and November 2020, respectively, in the study area and are well below prescribed standards (NAAQS for As - 6 ng/m^3).

Nickel (Ni)

Nickel is a naturally occurring element and can be combined with other metals, such as iron, copper, chromium and zinc, to form alloys. These alloys are used to make coins, jewelry, and items such as valves and heat exchangers. Most nickel is used to make stainless steel. Nickel can be released into ambient air from oil and coal combustion, nickel metal refining, sewage sludge incineration, and other sources. Respiratory effects are associated with chronic exposure to nickel in the air, which can cause chronic bronchitis, lung and nasal sinus cancers. The observed Ni concentrations at all the locations are found to be ranged from BDL - 2.34ng/m^3 (Table 3.1.3), BDL - 1.26ng/m^3 (Table 3.1.4) and BDL - 1.84µg/m^3 (Table 3.1.5) in the study area during February, March and November 2020, respectively, which were below the NAAQS (20 ng/m^3).

Benzo (α) pyrene (BaP)

BaP is the most well-known polycyclic aromatic hydrocarbon (PAH) in a large group of organic compounds with two or more fused aromatic rings. PAHs are formed mainly as a result of incomplete combustion of organic materials during industrial and other anthropogenic activities including processing of coal and crude oil, combustion of natural gas, combustion of refuse, vehicular traffic, cooking and tobacco smoking, as well as natural episodes such as forest fires. Motor vehicle exhaust and their re-suspension are major contributors of PAHs, including benzo[α]pyrene. BaP will tend to be adsorbed onto particulates during cooling and condensation in the atmosphere and generally exist in the particle phase at normal ambient temperatures in the atmosphere. Particle sizes will be mostly <2.5 µm (aerodynamic diameter). Processes governing the fate of BaP in the atmosphere are the same processes that govern transport and removal of these small particles from the atmosphere.

The BaP concentrations are not detected at all locations in the study area during February, March and November 2020, respectively, (Tables 3.1.3, 3.1.4 and 3.1.5) and NAAQS for BaP is 1 ng/m^3.

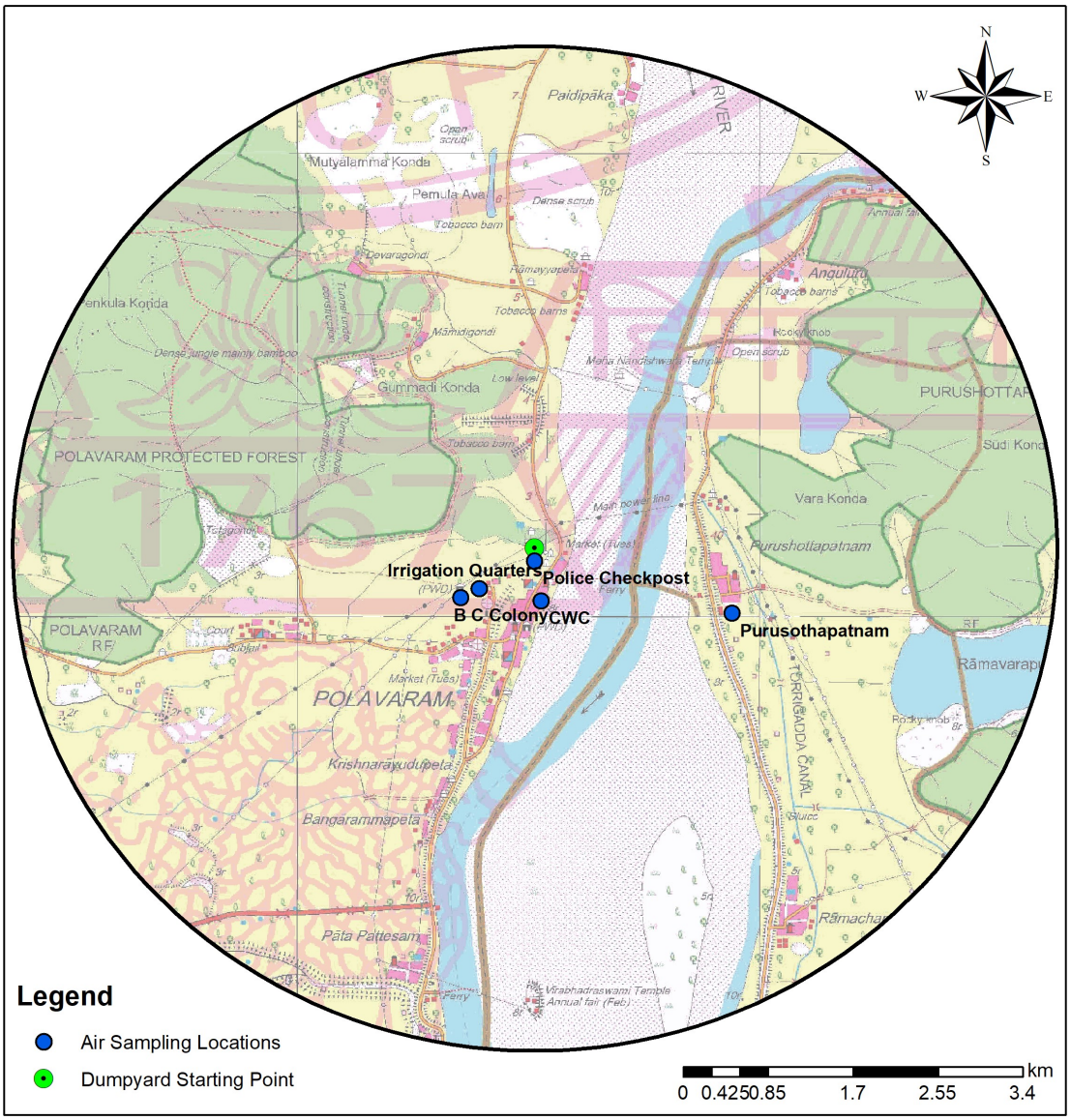
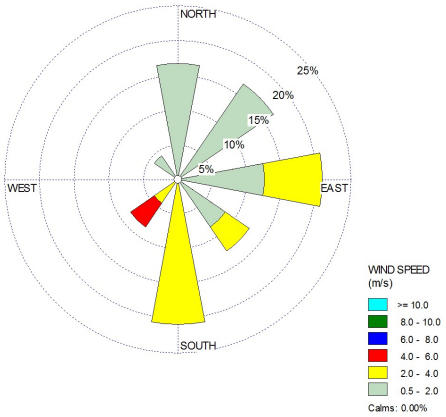
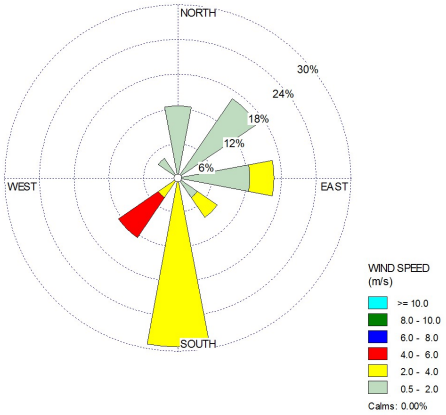


Fig. 3.1.1 Air quality monitoring locations within the study area

(a)



(b)



(c)

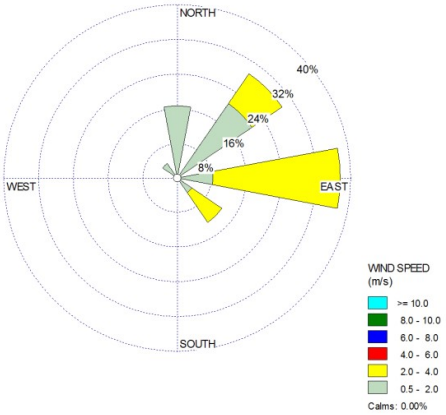


Fig. 3.1.2 Windrose for (a) February, (b) March and (c) November - Polavaram

Table 3.1.1: Air Quality Sampling Locations

Sr. No	Sampling Location	Latitude	Longitude
1.	Irrigation Quarter	N 17° 15' 09"	E 81° 38' 29"
2.	BC Colony	N 17° 15' 06"	E 81° 38' 23"
3.	Police Check Post	N 17° 15' 18"	E 81° 38' 47"
4.	Purusothapatnam	N 17° 15' 01"	E 81° 39' 51"
5.	CWC	N 17° 15' 05"	E 81° 38' 49"

Table 3.1.2: Techniques Used for Ambient Air Quality Monitoring

Sr. No.	Parameter	Monitoring Technique
1.	Particulate Matter size < 10 microns or PM_{10}	Gravimetric
2.	Particulate Matter size less than 2.5 microns or $PM_{2.5}$	Gravimetric
3.	Sulphur Dioxide (SO_2)	EPA Improved West and Geake Method
4.	Oxides of Nitrogen (NO_X)	Modified Jacobs-Hoechheiser Method
5.	Ammonia (NH_3)	Nesslers Method
6.	Ozone (O_3)	UV Photometric method
7.	Carbon monoxide (CO)	Quest CO monitor
8.	Lead (Pb)	AAS/ICP method for sampling on EPM 2000
9.	Benzene	Benzene Analyzer
10.	Arsenic(As),	AAS/ICP method for sampling on EPM 2000 or equivalent filter paper
11.	Nickel (Ni)	AAS/ICP method for sampling on EPM 2000 or equivalent filter paper
12.	Benzo(alpha)pyrene (BaP)	Solvent extraction analysis on GC-MS

Table 3.1.3: Ambient Air Quality during February 2020

S. No.	Location Name	PM_{10}	$PM_{2.5}$	SO_2	NO_X	NH_3	O_3	As	Pb	Ni	CO	Benzene	B(a)P
		µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m³	µg/m³	ng/m³	mg/m³	µg/m³	ng/m³
		24 hr	24 hr	24 hr	24 hr	24 hr	1 hr	24 hr	24 hr	24 hr	1 hr	Spot	24 hr
1.	Irrigation Quarter	92±36 (54-126)	50±24 (23-86)	4±3 (2-7)	5±1 (5-6)	22±9 (13-31)	28±15 (19-45)	1.22	0.02	0.36	0.16	BDL	BDL
2.	BC Colony	58±18 (32-73)	37±17 (17-57)	2±1 (2-4)	6±1 (5-7)	26±24 (5-54)	26±9 (20-37)	BDL	BDL	2.34	0.15	BDL	BDL
3.	Police Check Post	94±32 (69-129)	50±18 (32-77)	4±3 (2-8)	6±1 (5-7)	39 ±14 (23-48)	39±17 (26-58)	1.13	0.05	1.17	0.19	BDL	BDL
4.	Purusothapatnam	86±34 (51-137)	48±30 (25-96)	3±2 (2-6)	6±1 (5-7)	29±14 (12-46)	21±7 (12-28)	0.84	BDL	0.89	0.15	BDL	BDL
5.	CWC	66±33 (34-118)	46±17 (27-72)	3±2 (2-6)	5±1 (5-7)	37±15 (12-50)	9±2 (7-11)	BDL	BDL	BDL	0.18	BDL	BDL
NAAQS		**100**	**60**	**80**	**80**	**400**	**180**	**6**	**1**	**20**	**4**	**5**	**1**

Note: The 24 hrly average concentrations of particulate matter and gaseous pollutants are reported as **Avg. ± S.D (Minimum - Maximum).**
BDL - Below Detectable Limit

Table 3.1.4: Ambient Air Quality during March 2020

S. No.	Location Name	PM_{10}	$PM_{2.5}$	SO_2	NO_X	NH_3	O_3	As	Pb	Ni	CO	Benzene	B(a)P
		µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m³	µg/m³	ng/m³	mg/m³	µg/m³	ng/m³
		24 hr	24 hr	24 hr	24 hr	24 hr	1 hr	24 hr	24 hr	24 hr	1 hr	Spot	24 hr
1.	Irrigation Quarter	59±15 (45-80)	32±17 (15-60)	4±2 (2-6)	6±3 (3-9)	38±18 (16-60)	26±18 (18-37)	0.32	BDL	BDL	0.15	BDL	BDL
2.	BC Colony	61±18 (42-87)	20±18 (13-30)	4±3 (2-8)	6±1 (5-7)	22±17 (5-50)	20±4 (15-26)	BDL	0.01	1.26	0.18	BDL	BDL
3.	Police Check Post	83±47 (40-129)	34±19 (21-56)	5±3 (2-8)	6±2 (5-8)	26±4 (23-31)	14±5 (7-18)	0.64	BDL	1.12	0.16	BDL	BDL
4.	Purusothapatnam	70±18 (45-93)	29±13 (15-55)	4±3 (2-8)	6±1 (5-8)	41±18 (17-70)	24±8 (16-38)	BDL	0.02	BDL	0.15	BDL	BDL
5.	CWC	83±25 (57-109)	31±12 (17-44)	4±2 (2-6)	6±2 (5-8)	24±18 (13-50)	11±2 (9-13)	BDL	0.08	1.16	0.17	BDL	BDL
NAAQS		**100**	**60**	**80**	**80**	**400**	**180**	**6**	**1**	**20**	**4**	**5**	**1**

Note: The 24 hrly average concentrations of particulate matter and gaseous pollutants are reported as **Avg. ± S.D (Minimum - Maximum).**
BDL - Below Detectable Limit

Table 3.1.5: Ambient Air Quality during November 2020

S. No.	Location Name	PM_{10}	$PM_{2.5}$	SO_2	NO_X	NH_3	O_3	As	Pb	Ni	CO	Benzene	B(a)P
		µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m³	µg/m³	ng/m³	mg/m³	µg/m³	ng/m³
		24 hr	24 hr	24 hr	24 hr	24 hr	1 hr	24 hr	24 hr	24 hr	1 hr	Spot	24 hr
1.	Irrigation Quarter	65±23 (45-95)	38±11 (23-50)	2±0 (2-2)	5±0 (5-5)	11±7 (5-20)	10±6 (5-18)	BDL	0.04	BDL	0.12	BDL	BDL
2.	BC Colony	61±12 (46-85)	40±14 (19-64)	3±2 (2-9)	5±0 (5-5)	17±20 (5-58)	14±8 (5-28)	BDL	0.03	1.84	0.14	BDL	BDL
3.	Police Check Post	51±11 (39-62)	31±6 (26-41)	4±4 (2-11)	7±5 (5-15)	17±14 (6-36)	15±9 (7-27)	BDL	0.01	1.29	0.16	BDL	BDL
4.	Purusothapatnam	45±27 (14-80)	29±6 (22-33)	2±0 (2-3)	5±0 (5-5)	9±3 (6-12)	8±3 (6-12)	BDL	BDL	0.63	0.12	BDL	BDL
5.	CWC	75±30 (34-104)	37±3 (34-41)	4±3 (2-9)	5±0 (5-5)	13±1 (12-13)	12±2 (10-15)	BDL	0.07	1.41	0.15	BDL	BDL
NAAQS		**100**	**60**	**80**	**80**	**400**	**180**	**6**	**1**	**20**	**4**	**5**	**1**

Note: The 24 hrly average concentrations of particulate matter and gaseous pollutants are reported as **Avg. ± S.D (Minimum - Maximum).**
BDL - Below Detectable Limit

3.2 Noise Environment

Noise often defined as an unwanted sound which interferes with speech communication, causes annoyance, distracts from work, and disturbs sleep, deteriorating quality of life. Elevated noise levels have been associated with adverse impact on human health, ranging from minor annoyance to physiological damage. Noise pollution survey is required to be carried out in the study area to evaluate the impact of noise on the surrounding environment. According to the World Health Organization (WHO), noise pollution is the third most hazardous type of environmental pollution after that air and water pollution.

Methodology

The objective of the survey of noise pollution is to assess the impacts during construction of Polavaram project. Noise levels were measured as 'A' weighted average in the identified locations within the 5 km study area with dumping yard as centre. The sound pressure levels were monitored using a precision integrated sound level meter (Larson Davis Model 831), which has capability to measure (online) sound pressure level on continuous basis. The day time noise levels were monitored between 6 am to 10 pm and the night time noise levels between 10 pm to 6 am. The noise monitoring locations are depicted in Figure 3.2.1 and listed in Table 3.2.1.

Baseline Noise Levels in the study area

The observed noise (Leq) levels were monitored during February, March and November 2020 within the study area are presented in the Table 3.2.2. In the villages and residential colonies surrounding the Polavaram project, it is observed that the daytime noise levels vary between 50.2-52.9 dB(A), 50.1-54.5 dB(A) & 51.6-53.8 dB(A) and night time noise levels vary between 43.1-45.0 dB(A), 42.8-44.8 dB(A) & 40.8-44.0 dB(A) during February, March and November 2020, respectively. The noise levels are compared with CPCB limits for residential areas. The noise levels are observed to be within the CPCB standards for residential areas (Annexure II) during day and night time.

The noise levels at locations near the construction activities of Polavaram project are compared with CPCB limits for commercial areas as the activities may fall in mixed category. The observed Leq values of day time noise levels during February, March and November 2020 respectively are varying between 64.2-70.2 dB(A), 62.6-66.6 dB(A) and 59.4-68.6 dB(A). The night time noise levels are within the range of 52.2-67.9 dB(A), 53.6-60.9 dB(A) and 50.7-60.7 dB(A), respectively during February, March and November 2020 near the construction activities of Polavaram project. It is observed that daytime and night time noise levels are exceeding the CPCB limits for commercial zone at most of the sites. These higher noise levels are attributed to operation of DG sets, Excavators, Cranes, Crushers, movement of trucks, vehicles, and concrete mixers etc. in connection with ongoing construction activities of Polavaram.

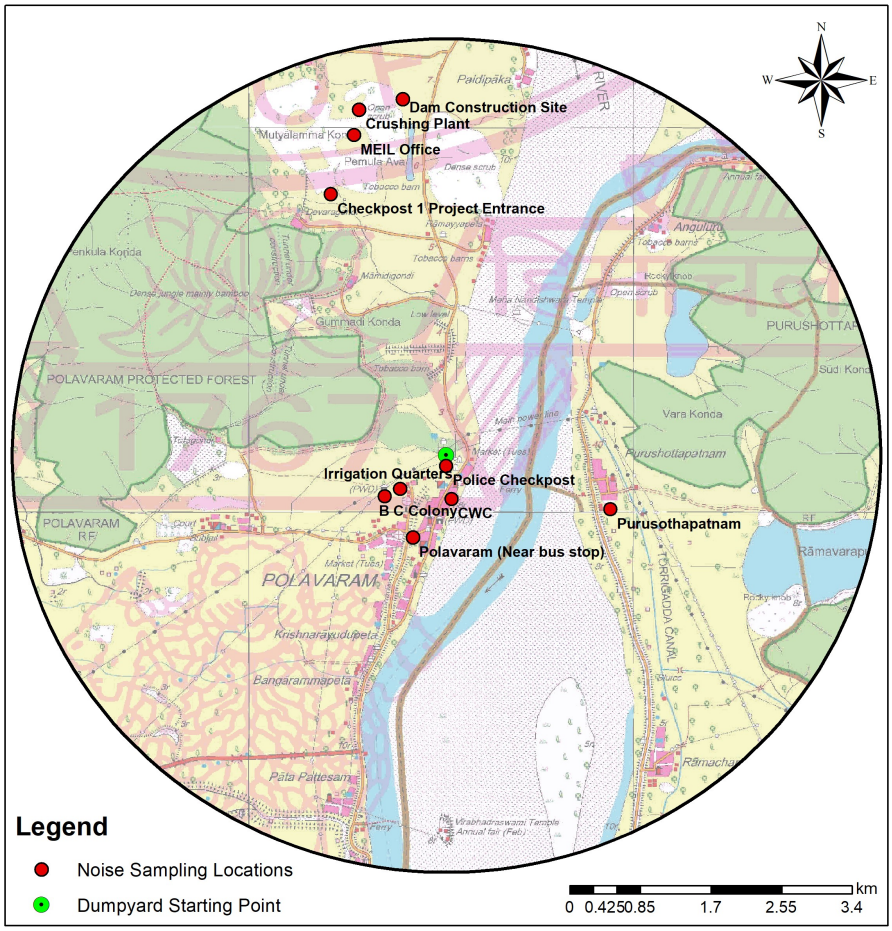


Fig. 3.2.1 Noise monitoring locations in the study area

Table 3.2.1: Details of Noise Sampling Locations

S. No.	Noise Monitoring Locations	Latitude	Longitude
1	Irrigation Quarters	N 17° 15' 09"	E 81° 38' 29"
2	B C Colony	N 17° 15' 06"	E 81° 38' 23"
3	Police Checkpost	N 17° 15' 18"	E 81° 38' 47"
4	Purusothapatnam	N 17° 15' 01"	E 81° 39' 51"
5	CWC	N 17° 15' 05"	E 81° 38' 49"
6	Checkpost 1 project entrance	N 17° 17' 04"	E 81° 38' 02"
7	MEIL office	N 17° 17' 27"	E 81° 38' 11"
8	Crushing Plant	N 17° 17' 37"	E 81° 38' 13"
9	Dam construction site	N 17° 17' 41"	E 81° 38' 30"
10	Polavaram (near bus stop)	N 17° 14' 50"	E 81° 38' 34"

Table 3.2.2: Noise Levels [dB(A)] at Sampling Locations

S. No.	Noise Monitoring Locations	February 2020		March 2020		November 2020	
		Day Time (Leq)	Night Time (Leq)	Day Time (Leq)	Night Time (Leq)	Day Time (Leq)	Night Time (Leq)
Locations in Residential area							
1	Irrigation Quarters	52.2	43.5	54.5	43.2	53.8	43.8
2	B C Colony	50.2	45.0	51.4	44.8	51.6	44.0
3	Police Check post	50.8	45.0	50.1	44.5	52.5	43.8
4	Purusothapatnam	52.7	43.1	52.8	42.8	51.8	40.8
5	CWC	52.9	43.9	53.5	44.1	53.0	43.1
CPCB Standards for Residential Area		**55**	**45**	**55**	**45**	**55**	**45**
Locations in Commercial area							
6	Check post 1 project entrance	64.2	61.1	66.3	57.6	65.9	54.8
7	MEIL office	65.0	52.2	62.6	53.9	59.4	50.7
8	Crushing Plant	70.2	67.9	66.6	60.9	64.0	60.7
9	Dam construction site	65.6	62.5	65.6	58.4	68.6	55.2
10	Polavaram (near bus stop)	67.6	56.3	65.2	53.6	65.5	54.6
CPCB Standards for Commercial Area		**65**	**55**	**65**	**55**	**65**	**55**

3.3 Water Environment

Groundwater Quality

Water is the most crucial element of life, the rapid urbanization and expansion of infrastructure creates stress on water environment in many ways: depletion of water sources, Increase in demand and pollution in water sources by the discharge of domestic sewage and solid waste.

To address the issues raised it is necessary to analyze the quality of the existing water resources to represent the prevailing status of water quality and to delineate the measures for improving the quality of water environment.

In order to assess quality of water, Physico-Chemical, Nutrient, Oxygen Demand and Bacteriological parameters having relevance to public health and aesthetic significance are selected and accordingly samples are collected and analyzed as per the standard methods (APHA AWWA 22nd Edition 2012) prescribed for surface and Groundwater.

According to the existing activities related to water environment occurring in the study area, depending on topography, surface runoff as well as natural/manmade drainage for irrigation and canal systems the water quality survey has been planned and appropriate sampling locations for both Surface and Groundwater were identified within the study area of 5 km radial distance around project site.

Groundwater Quality

The 11 Groundwater samples were collected from dug (open) wells as well as from bore wells / hand pumps on monthly basis in and around the Polavaram project site within the study area (Fig. 3.3.1). The water quality analysis data was assessed for various parameters and Presented in the Tables:

Physical parameters

- In general, pH in groundwater reflects the suitability of groundwater for drinking purpose. The water samples collected from all the sites has pH ranging from 6.8 – 7.5, 7.0 – 7.5 and 6.7 – 7.3, respectively, during February, March and

November 2020. The observed pH values were within the normal range as per the BIS norms.

- The Turbidity values in the study area ranged from 0.1 – 0.6 mg/l, 0.1 – 0.5 mg/l, and 0.1 – 0.8 mg/l, respectively, during February, March and November 2020. The observed Turbidity values are found in the limits of BIS for all the samples.
- TDS is a measure of dissolved elements present in water. TDS values in ground water ranged from 337 - 1552 mg/l, 351 – 1427 mg/l and 365 - 178 mg/l, respectively, February, March and November 2020. The observed values are within the Permissible limits of BIS Standards.

Inorganic Parameters

- The Total Hardness values in the study area ranged from 232 – 880mg/l, 252 – 884mg/l and 140 – 780mg/l, respectively, during February, March and November 2020. Expect at some locations most of samples showed total hardness values within the permissible limit of BIS.
- Ca hardness values (as $CaCO_3$) in the study area ranged from 133 – 463mg/l, 150 – 421mg/l and 108 – 448mg/l, respectively, during February, March and November 2020. The locations where Higher Ca hardness values observed may be due to dominant rocks.
- The observed chloride concentration varied from 25 - 364mg/l, 26 – 402mg/l and 23 - 462mg/l, respectively, during February, March and November 2020. The observed Chloride values are normal with respect to permissible limit of BIS.
- Sulphate content in the groundwater varied from 11 – 171 mg/l, 6 – 190 mg/l and 7 - 99 mg/l, respectively, during February, March and November 2020. The sulphate values for all groundwater samples were within the permissible limits of BIS.
- The sodium levels in the groundwater varied from 16 – 187 mg/l, 26 – 168 mg/l, and 44 - 303 mg/l, respectively, during February, March and November 2020.
- The Fluoride levels in the groundwater varied from 0.24 – 1.0 mg/l, 0.11 – 1.3 mg/l, and 0.1 – 0.51 mg/l, respectively, during February, March and November 2020. The observed values are within the permissible limit of BIS.

Nutrient Demand Parameters

- The nitrate content in the groundwater varied in the range of 3.5 – 172 mg/l, 3.0 – 16.3 mg/l, and 0.2 – 1.39mg/l, respectively, during February, March and November 2020. The observed vales are normal, but the highest value of Nitrate was observed at Pattiseema during February 2020 may due to the Irrigation Practices.
- BOD observations are normal and ranging from 1 – 2.5 mg/l, 0.9 – 2.2mg/l and <0.5 – 6.3 mg/l, respectively, during February, March and November 2020.

Bacteriological Parameters

- Portability of groundwater with respect to microbiological analysis was checked using MPN Index. The MPN values ranged between 33 - >1600, 350 - >1600 and <1.8 - >1600 during February, March and November 2020, respectively.

Heavy Metals

- Heavy Metals like As, B, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn were analyzed and observed that most of the element concentrations were below the BIS during the study Period
- Iron and Manganese concentrations at some locations were observed to be more than permissible limit of the BIS, which may be attributed to the dominant Rocks

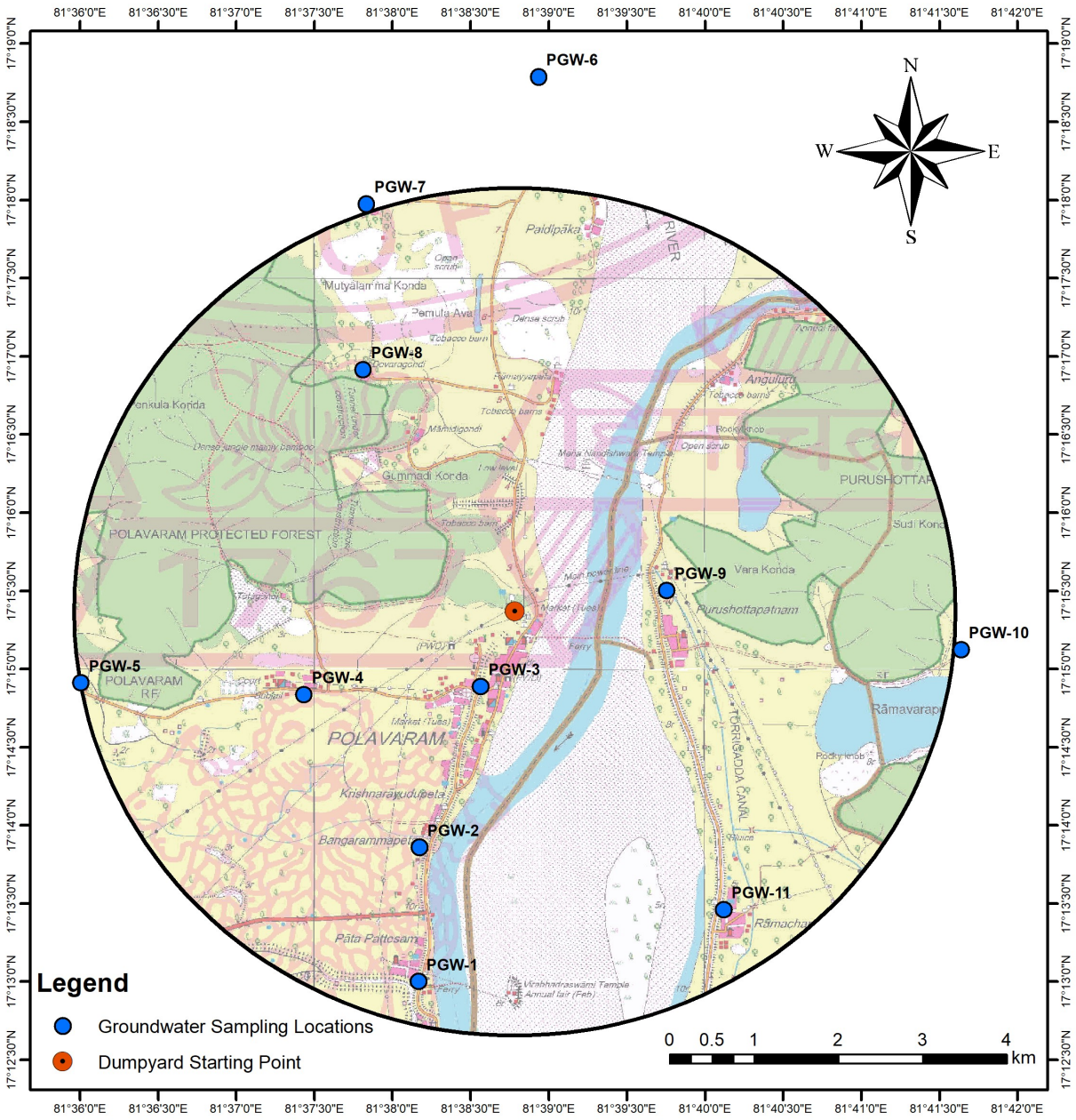


Figure 3.3.1: Groundwater sampling locations in the study area

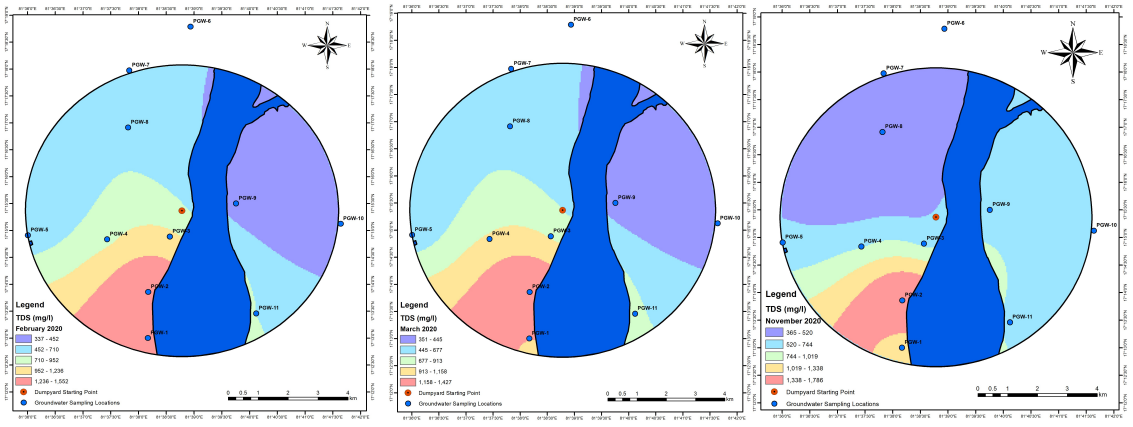


Figure 3.3.2A,B,C: TDS map of the study area

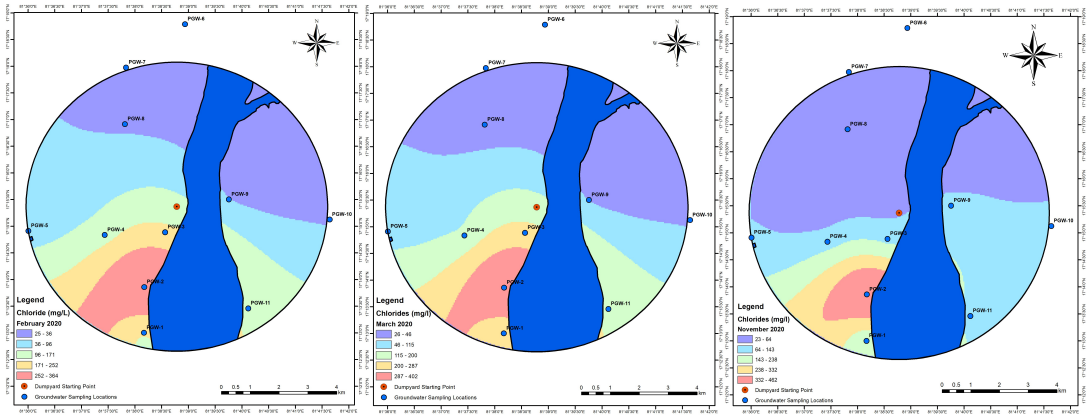


Figure 3.3.3A,B,C: Chloride map of the study area

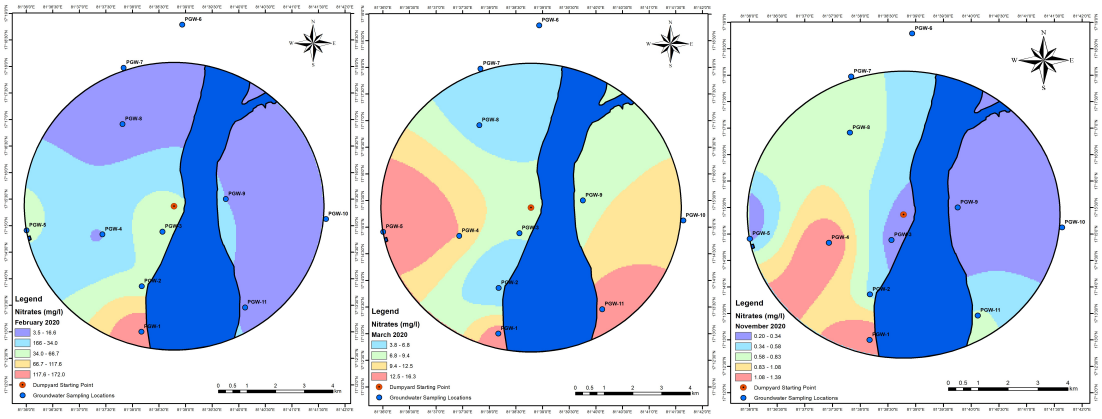


Figure 3.3.4A,B,C: Nitrate map of the study area

Table 3.3.1: Details of Groundwater Sampling Locations (2020)

S. No	Location Name	Sample Code	Latitude	Longitude	Type	Water level (m)		
						February	March	November
1	Pattisema	PGW-1	17°13'00.05"	81°38'10.08"	HP	5.3	-	0.3
2	Bangaramapeta	PGW-2	17°13'51.55"	81°38'10.38"	DW	3.0	3.0	1.7
3	Polavaram	PGW-3	17°14'53.29"	81°38'33.91"	DW	3.2	4.0	1.4
4	New Devaragondi	PGW-4	17°14'50.18"	81°37'26.05"	HP	3.5	-	1.6
5	Itukalakota	PGW-5	17°14'54.66"	81°36'00.46"	HP	2.5	2.4	2.8
6	Singanapalli	PGW-6	17°18'47.25"	81°38'56.16"	HP	2.5	-	0.6
7	Chegondapalli	PGW-7	17°17'58.57"	81°37'50.09"	DW	3.0	4.5	1.5
8	Old devaragondi	PGW-8	17°16'54.89"	81°37'48.82"	DW	1.5	1.5	0.7
9	Purushohapatnam	PGW-9	17°15'30.16"	81°39'45.48"	HP	2.0	-	1.7
10	Nelakota	PGW-10	17°15'07.42"	81°41'38.57"	HP	2.0	-	0.7
11	Ramachandrapuram	PGW-11	17°13'27.65"	81°40'07.26"	HP	3.5	-	1.7

Due to COVID-19 Pandemic condition Environmental monitoring from April to October 2020 was suspended

Table 3.3.2: Groundwater Quality Physical Parameters (2020)

S. No	Sample Code	pH			Turbidity (NTU)			TSS (mg/l)			EC (µs/cm)			TDS (mg/l)		
		Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov
1	PGW-1	7.1	7.0	6.7	0.4	0.5	0.1	4.1	5.8	1.1	2110	1920	1972	1358	1164	1136
2	PGW-2	6.8	7.0	6.7	0.1	0.1	0.1	2.3	2.2	1.2	2660	2540	3070	1552	1427	1786
3	PGW-3	7.2	7.5	6.9	0.1	0.1	0.1	0.5	2.6	0.4	1692	1639	1246	1010	897	681
4	PGW-4	7.2	7.2	6.8	0.3	0.2	0.5	1.1	2.0	0.8	1570	1644	1268	889	954	723
5	PGW-5	7.2	7.2	6.8	0.1	0.1	0.1	6.0	2.2	0.1	1038	983	1066	599	537	605
6	PGW-6	7.1	7.1	6.8	0.6	0.1	0.8	1.7	0.6	45.7	1128	1121	1256	720	666	681
7	PGW-7	7.2	7.1	6.9	0.1	0.1	0.1	0.3	1.2	1.9	1190	1194	1221	750	737	714
8	PGW-8	7.1	7.1	7.2	0.2	0.1	0.1	1.2	2.2	4.5	1029	979	665	674	626	365
9	PGW-9	7.5	7.4	7.0	0.1	0.1	0.2	0.3	2.4	1.1	560	571	938	337	351	656
10	PGW-10	6.9	7.1	7.0	0.5	0.1	0.1	1.6	2.4	0.3	992	958	1059	614	563	640
11	PGW-11	7.4	7.5	7.3	0.2	0.4	0.2	1.0	3.4	0.9	1229	1291	1212	715	726	667
IS: 10500-2012 (Desirable-Permissible Limits)		**6.5 - 8.5**			**1 - 5**			**-**			**-**			**500 - 2000**		

Table 3.3.3: Groundwater Quality-Inorganic Parameters (2020)

S.No	Sample Code	Total Hardness (as $CaCO_3$)			Ca Hardness (as $CaCO_3$)			Mg Hardness (as $CaCO_3$)			Sodium as Na			Potassium as K		
		mg/l			mg/l			mg/l			mg/l			mg/l		
		Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov
1	PGW-1	836	808	524	463	380	368	373	428	156	108	112	174	5	4	8
2	PGW-2	880	884	780	447	421	448	433	463	332	139	145	303	39	45	61
3	PGW-3	560	496	288	259	199	192	301	297	96	119	121	140	6	7	21
4	PGW-4	364	380	336	184	173	236	180	207	100	187	168	155	8	3	2
5	PGW-5	392	376	140	235	229	108	157	147	32	48	54	167	1	2	7
6	PGW-6	640	620	524	290	263	320	350	357	204	16	29	44	1	1	2
7	PGW-7	428	410	408	227	214	192	201	196	216	69	76	95	35	50	45
8	PGW-8	428	417	160	192	180	112	236	237	48	70	61	69	19	27	14
9	PGW-9	232	252	328	161	150	220	71	102	108	23	26	48	1	1	3
10	PGW-10	396	361	288	133	158	188	263	203	100	56	65	118	6	8	7
11	PGW-11	404	399	196	200	203	136	204	196	60	83	103	161	1	1	3
IS: 10500-2012 (Desirable-Permissible Limits)		**200 - 600**			**-**			**-**			**-**			**-**		

Table 3.3.4: Groundwater Quality-Inorganic Parameters (2020)

S. No	Sample Code	Total Alkalinity as CaCO3 mg/l			Sulphate as SO_4^{2-} mg/l			Chloride as Cl^- mg/l			Salinity ‰			Fluoride as F mg/l			Silica as SiO_2 mg/l		
		Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov
1	PGW-1	644	432	524	109	190	97	179	225	178	0.41	0.37	0.32	0.98	0.21	0.10	40	57	28
2	PGW-2	616	516	632	171	84	99	364	402	462	0.65	0.73	0.83	0.62	0.31	0.18	37	44	29
3	PGW-3	488	356	348	80	60	65	189	229	111	0.34	0.41	0.20	0.85	0.46	0.27	38	38	18
4	PGW-4	388	516	392	106	91	77	141	136	102	0.25	0.25	0.18	1.00	1.30	0.38	51	53	23
5	PGW-5	376	268	328	28	27	30	71	102	82	0.12	0.18	0.15	0.90	0.51	0.37	34	33	37
6	PGW-6	664	392	472	11	6	16	25	48	56	0.04	0.08	0.10	0.28	0.11	0.15	44	41	38
7	PGW-7	508	504	452	62	41	61	48	52	66	0.08	0.09	0.12	0.73	0.43	0.40	28	36	44
8	PGW-8	544	484	276	29	29	7	32	28	23	0.06	0.05	0.04	0.60	0.28	0.29	23	40	26
9	PGW-9	204	208	292	26	32	46	36	42	74	0.06	0.08	0.13	0.24	0.23	0.10	15	23	34
10	PGW-10	460	448	392	27	24	37	33	26	52	0.06	0.05	0.09	0.80	0.74	0.51	20	38	47
11	PGW-11	304	264	328	99	80	63	148	175	120	0.27	0.32	0.22	0.32	0.20	0.40	15	16	26
IS: 10500-2012 (Desirable-Permissible Limits)		**200-600**			**200-400**			**250-1000**			**-**			**1-1.5**			**-**		

Table 3.3.5: Groundwater Quality-Nutrient and Demand Parameters (2020)

S. No	Sample Code	Nitrate as NO^-_3 mg/l			Total Phosphorus mg/l			DO mg/l			BOD mg/l		
		Feb	March	Nov	Feb	March	Nov	Feb	March	Nov	Feb	March	Nov
1	PGW-1	172	14	1.39	0.010	0.014	0.014	1.5	2.0	1.5	1.5	0.9	<0.5
2	PGW-2	46	2.7	0.53	0.042	BDL	0.161	1.5	2.7	0.4	1.1	1.3	3.0
3	PGW-3	50	7.4	0.22	0.029	0.014	0.167	3.0	6.4	2.7	1.4	1.9	2.5
4	PGW-4	16.4	12.1	1.35	0.041	0.014	0.034	3.5	2.4	1.9	2.2	1.1	0.6
5	PGW-5	39.9	16.3	0.26	0.063	0.005	0.056	3.2	3.5	1.3	1.1	1.0	1.0
6	PGW-6	3.5	3.8	0.24	0.048	BDL	0.017	2.5	3.6	1.9	1.6	1.2	0.7
7	PGW-7	24.3	16.3	0.48	0.065	BDL	0.069	2.8	1.9	0.5	2.3	1.6	6.3
8	PGW-8	7.1	5.5	0.71	0.032	0.023	0.028	2.8	2.0	1.5	2.0	1.5	<0.5
9	PGW-9	16.8	8.6	0.20	0.047	0.022	0.026	3.4	4.0	1.1	2.5	2.2	0.8
10	PGW-10	44.3	8.3	0.20	0.122	0.017	0.425	2.4	4.0	1.0	1.0	0.9	<0.5
11	PGW-11	7.9	15.1	0.60	0.059	0.023	0.041	4.0	4.3	1.0	2.5	2.1	0.7
IS: 10500-2012 (Desirable-Permissible Limits)		**45**			**-**			**-**			**-**		

Table 3.3.6: Groundwater Quality- Microbial Parameters (2020)

S NO	Sample Code	MPN		
		1ml	10ml	INDEX
		Feb	March	Nov
1	PGW-1	1600	350	>1600
2	PGW-2	>1600	>1600	240
3	PGW-3	140	>1600	220
4	PGW-4	920	>1600	130
5	PGW-5	220	350	2.0
6	PGW-6	1600	350	<1.8
7	PGW-7	>1600	>1600	220
8	PGW-8	47	>1600	79
9	PGW-9	48	>1600	130
10	PGW-10	33	>1600	240
11	PGW-11	350	>1600	<1.8

Table 3.3.7A: Groundwater Quality- Heavy Metals (2020)

S NO	Sample Code	As			B			Cd			Co			Cr			Cu		
		mg/l																	
		Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov
1	PGW-1	0.004	BDL	BDL	0.083	BDL	0.161	BDL	BDL	BDL	BDL	BDL	0.001	BDL	BDL	0.007	BDL	BDL	BDL
2	PGW-2	0.004	BDL	BDL	0.112	BDL	0.036	BDL	BDL	0.003	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3	PGW-3	BDL	BDL	BDL	0.023	BDL	BDL	BDL	BDL	0.002	BDL	BDL	BDL	BDL	BDL	0.001	BDL	BDL	BDL
4	PGW-4	0.003	BDL	BDL	0.104	BDL	0.218	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.005	0.003	BDL	0.006
5	PGW-5	0.002	BDL	BDL	0.026	BDL	0.020	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001	BDL	BDL
6	PGW-6	0.001	BDL	BDL	0.027	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001	0.028	BDL	0.006	BDL	BDL	0.002
7	PGW-7	0.001	BDL	BDL	0.079	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.014	BDL	BDL	BDL	BDL	BDL
8	PGW-8	0.002	BDL	BDL	0.075	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.010	BDL	BDL	BDL	BDL	BDL
9	PGW-9	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002	BDL	BDL	BDL	BDL	BDL
10	PGW-10	BDL	BDL	BDL	0.027	BDL	0.064	BDL	BDL	BDL	BDL	BDL	BDL	0.006	BDL	0.002	BDL	BDL	BDL
11	PGW-11	0.002	BDL	BDL	0.046	BDL	0.033	BDL	BDL	BDL	BDL	BDL	BDL	0.010	BDL	0.004	BDL	BDL	0.002
IS: 10500-2012 (Desirable-Permissible Limits)		**0.01-0.05**			**0.5-1.0**			**0.003-NR**			**-**			**0.05-NR**			**0.05-1.5**		

Table 3.3.7B: Groundwater Quality- Heavy Metals (2020)

S.No	Sample Code	Fe			Mn			Ni			Pb			Zn			Hg		
		mg/l																	
		Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov	Feb	Mar	Nov
1	PGW-1	0.875	1.27	0.892	0.134	0.130	0.236	BDL	BDL	BDL	BDL	BDL	0.004	BDL	BDL	0.091	BDL	BDL	BDL
2	PGW-2	BDL	0.020	BDL	0.021	0.040	0.051	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.031	BDL	BDL	BDL
3	PGW-3	BDL	0.110	0.121	BDL	0.070	0.075	BDL	BDL	BDL	BDL	BDL	0.001	BDL	BDL	0.092	BDL	BDL	BDL
4	PGW-4	1.718	0.170	2.103	0.036	0.020	0.216	BDL	BDL	BDL	0.014	BDL	0.005	0.035	BDL	0.405	BDL	BDL	BDL
5	PGW-5	0.072	0.280	0.245	0.030	0.050	0.052	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.019	BDL	BDL	BDL
6	PGW-6	3.907	0.240	3.076	0.305	0.190	0.435	BDL	BDL	BDL	0.005	BDL	0.017	0.157	BDL	0.303	BDL	BDL	BDL
7	PGW-7	0.440	0.040	BDL	0.089	0.030	0.107	0.002	BDL	BDL	0.003	BDL	0.001	0.050	BDL	0.006	BDL	BDL	BDL
8	PGW-8	0.088	BDL	0.044	0.565	BDL	0.130	BDL	BDL	0.001	BDL	BDL	0.001	BDL	BDL	0.008	BDL	BDL	BDL
9	PGW-9	BDL	0.033	0.242	0.012	BDL	0.013	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.090	BDL	BDL	BDL
10	PGW-10	0.779	0.200	0.023	0.025	0.050	BDL	BDL	BDL	BDL	0.002	BDL	0.001	0.313	BDL	0.010	BDL	BDL	BDL
11	PGW-11	1.172	0.320	0.646	0.308	0.030	0.279	0.001	BDL	BDL	0.002	BDL	0.004	0.495	BDL	0.523	BDL	BDL	BDL
IS: 10500-2012 (Desirable-Permissible Limits)		**0.3-NR**			**0.1-0.3**			**0.02-NR**			**0.01-NR**			**5-15**			**0.01-NR**		

3.4 SURFACE WATER ENVIRONMENT

The Surface water sampling point's selection was done based on the Polavaram project activity. In total 5 surface water samples along the Godavari River were collected during February 2020 from Top Surface and Bottom level. Among the 5 Samples collected, 2 samples were located in Upstream and 3 Samples were located in downstream region of Study Area (Fig. 3.4.1). The river water sampling locations are listed in Table 3.4.1.

Physico-chemical parameters along with biological indicators of pollution have been identified for assessing the prevailing status of river water environment and identification of impacts due to proposed developmental activities in and around project site. Water quality data various parameters were presented in the following tables and discussed as follows:

- The parameters pH varied from 7.1 – 7.4, Turbidity varied from 0.1- 0.3 TSS varied from 0.2-5.9 during February 2020 in the study area.
- TDS values in river water at all locations during February 2020 ranged from 82 - 113mg/l, all samples showed normal TDS values with respect to river water Quality.
- Inorganic Parameters i.e. Total Alkalinity, Total Hardness, Chloride, Sulphate and Fluoride are observed to be normal and in optimum level during February 2020
- The N-Nitrate content in the river water samples varied from 0.17 – 0.28 mg/l during February 2020 and the observed values are normal.
- Phosphate as phosphorus concentrations in the river water samples ranged from BDL – 0.010 mg/l during February 2020 which indicates low level.
- The dissolved oxygen in the river water samples are fairly good and ranged from 6.6 – 7.8 mg/l during February 2020 .
- The biological oxygen demand are normal in the river water samples and varied from 1.1 – 3.5 mg/l, during February 2020 indic.
- Total coliforms and Fecal Coliforms in river water varied from 1800 – TNC and ND-1080 CFU/100ml during February 2020.

- Heavy Metals like As, B, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn were observed to normal in concentrations during February 2020.

Phytoplankton:

Phytoplankton are known as the primary producers which is essential for the survival and sustainability of other aquatic organisms. The diversity of phytoplankton could be disturbed by environmental changes and thus they are one of the indicators to monitor the effect of environmental imbalance in the water body.

- Analyses of water samples illustrated good abundance of phytoplankton community in surface water (Table 3.4.7).
- The diversity of phytoplankton varied across samples. The number of phytoplankton genera ranged from 15 to 30.
- The abundance of phytoplankton in the samples was in the range between $202x10^3$ to $478x10^3 L^{-1}$.
- Most abundant phytoplankton in the samples were *Navicula* sp. (10.75%), *Closterium* sp. (8.93%), *Oscillatoria* sp. (6.47%), *Nodularia* sp. (5.85%) and *Stauroneis* sp. (5.78%).
- The Shannon-Wiener Diversity Index (SWDI) was found to be varied from 2.308 to 3.025 indicating good water quality with respect to phytoplankton.

Zooplankton:

The group zooplankton is known as primary consumer or secondary producers. The diversity of zooplankton is important for the productivity of water environment.

- The analyses of zooplankton assemblage suggested moderate to fair level of diversity in the study environment (Table 3.4.8).
- The most abundant zooplankton in the samples were *Keratella* sp. (73.33%), *Notholca* sp. (8.58%), *Mayorella* sp. (7.02%) and *Leptodora* sp. (4.68%).
- The diversity was observed to be different across sampling sites. The number of zooplankton per sample varied from five to eleven.

- The abundance of zooplankton was found to be varied from 897 to 8165 per m^3.
- The SWDI ranged from 0.060 to 1.235 which suggests that the zooplankton is under moderate level of stress. The low SWDI in some samples was attributed to the highest abundance of *Keratella* sp. in the samples.

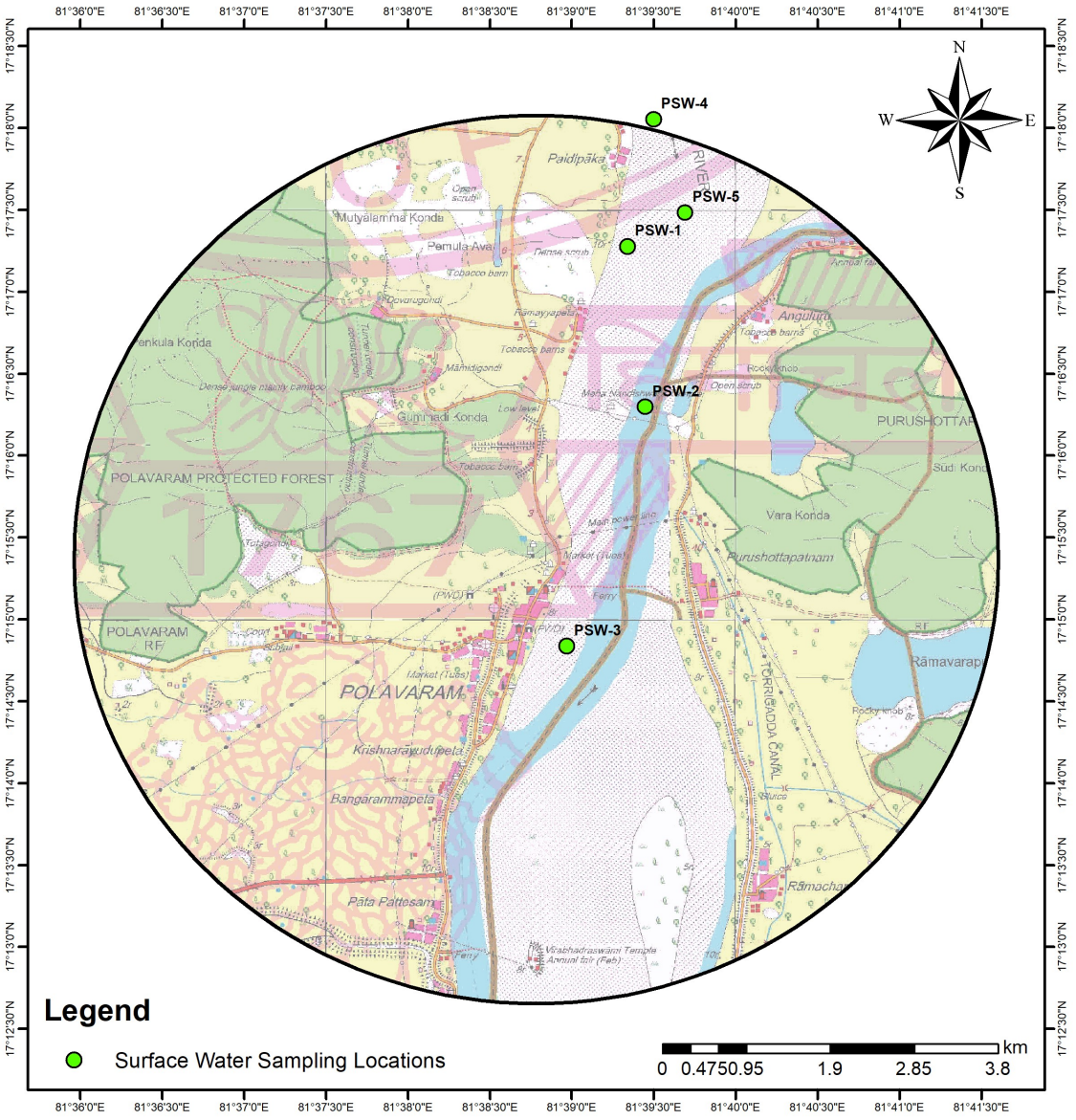


Figure 3.4.1: River sampling locations in the study area

Table 3.4.1: Surface Water Quality- Details of the Sampling Points

(February 2020)

S No.	Location	Sample Code	Latitude	Longitude	Depth (m)	Transparency (m)
1.	Godavari River	PSW-1S PSW-1B	17°17'16.67"	81°39'20.42"	6.0	2.0
2.	Godavari River	PSW-2S PSW-2B	17°16'17.88"	81°39'26.89"	9.0	2.0
3.	Godavari River	PSW-3S PSW-3B	17°14'50.26"	81°38'58.19"	3.0	1.5
4.	Godavari River	PSW-4S PSW-4B	17°18'03.22"	81°39'29.91"	3.0	2.0
5.	Godavari River	PSW-5S PSW-5B	17°17'24.01"	81°39'41.50"	2.8	2.0

Table 3.4.2: Surface Water Quality- Physical Parameters (February 2020)

S No.	Sample Code	pH	Turbidity	TSS	EC	TDS
			NTU	mg/l	µs/cm	mg/l
1	PSW-1S	7.3	0.1	0.3	134	82
2	PSW-1B	7.2	0.2	1.6	175	112
3	PSW-2S	7.4	0.1	0.3	164	108
4	PSW-2B	7.1	0.3	5.9	178	113
5	PSW-3S	7.1	0.2	0.3	172	109
6	PSW-3B	7.3	0.3	5.0	169	108
7	PSW-4S	7.1	0.2	0.2	162	101
8	PSW-4B	7.1	0.3	4.3	178	113
9	PSW-5S	7.2	0.1	0.6	173	110
10	PSW-5B	7.1	0.2	1.3	173	112

Table 3.4.3: Surface Water Quality-Inorganic Parameters (February-2020)

S NO	Sample Code	Total Alkalinity	Total Hardness	Ca Hardness	Mg Hardness	Cl^-	Salinity	SO^{-2}_4	F
		mg/l	mg/l	mg/l	mg/l	mg/l	‰	mg/l	mg/l
1	PSW-1S	48	44	24	20	16	0.02	4	0.13
2	PSW-1B	60	48	24	24	25	0.04	4	0.18
3	PSW-2S	52	48	39	9	25	0.04	3	0.51
4	PSW-2B	60	52	27	25	25	0.04	3	0.12
5	PSW-3S	56	44	27	17	25	0.04	4	0.27
6	PSW-3B	60	44	27	17	22	0.04	5	0.14
7	PSW-4S	56	52	31	21	16	0.02	7	0.28
8	PSW-4B	64	48	31	17	21	0.04	5	0.16
9	PSW-5S	60	44	39	5	21	0.04	5	0.32
10	PSW-5B	60	48	31	17	25	0.04	3	0.11

Table 3.4.4: Surface water Quality – Demand and Nutrient Parameters (February 2020)

S.No	Sample Code	DO	BOD	$N\text{-}NO_3$	$P\text{-}PO_4$
		mg/l	mg/l	mg/l	mg/l
1	PSW-1S	6.8	2.3	0.22	BDL
2	PSW-1B	6.6	1.8	0.28	BDL
3	PSW-2S	7.2	3.0	0.22	BDL
4	PSW-2B	7.0	1.1	0.24	BDL
5	PSW-3S	7.3	2.3	0.20	BDL
6	PSW-3B	7.4	1.5	0.20	BDL
7	PSW-4S	7.7	3.2	0.23	BDL
8	PSW-4B	7.4	3.5	0.23	BDL
9	PSW-5S	7.8	3.3	0.19	BDL
10	PSW-5B	7.3	3.5	0.17	0.010

Table 3.4.5: Surface Water Quality- Microbial Parameters (February 2020)

S. No	Sample Code	Total Viable count		T.C	F.C
		CFU/0.1ml	CFU/1ml	CFU/100ml	CFU/100ml
1	PSW-1S	179	$1790X10^5$	1800	ND
2	PSW-2S	131	$1310X10^5$	TNC	1080
3	PSW-3S	195	$1950X10^5$	1840	120
4	PSW-4S	133	$1330X10^5$	2600	300
5	PSW-5S	143	$1430X10^5$	2120	80

Table 3.4.6: Surface Water Quality - Heavy Metals (February 2020)

S No	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
		mg/l										
1.	PSW-1S	BDL	0.007	BDL	BDL	0.008	BDL	0.182	0.024	0.004	BDL	0.061
2.	PSW-2S	0.002	0.031	BDL	BDL	0.011	BDL	0.094	0.028	0.005	BDL	0.135
3.	PSW-3S	BDL	BDL	BDL	BDL	0.008	BDL	0.211	0.016	BDL	BDL	0.004
4.	PSW-4S	BDL	BDL	BDL	BDL	0.005	BDL	0.012	0.080	BDL	BDL	BDL
5.	PSW-5S	BDL	BDL	BDL	BDL	0.014	BDL	0.005	0.078	0.003	BDL	BDL

Table 3.4.7: Diversity of phytoplankton community in surface water samples

Phytoplankton Genera (No'sx10^3/L)	PSW-1		PSW-2		PSW-3		PSW-4		PSW-5	
	No's	%	No's	%	No's	%	No's	%	No's	%
Amphora sp.	13	3.79	16	4.82	--	--	--	--	--	--
Anabaena sp.	7	2.04	--	--	--	--	--	--	16	7.92
Ankistrodesmus sp.	17	4.96	8	2.41	4	0.84	14	5.93	--	--
Bacillaria sp.	7	2.04	--	--	--	--	--	--	5	2.48
Blue Green Algae	--	--	--	--	30	6.28	--	--	--	--
Chodatella sp.	3	0.87	--	--	--	--	--	--	--	--
Cladophora sp.	--	--	3	0.90	--	--	--	--	--	--
Closterium sp.	36	10.50	47	14.16	31	6.49	20	8.47	--	--
Coscinodiscus sp.	3	0.87	4	1.20	1	0.21	--	--	--	--
Cyclotella sp.	13	3.79	1	0.30	21	4.39	--	--	--	--
Cymbella sp.	10	2.92	--	--	8	1.67	--	--	--	--
Diatoms	16	4.66	10	3.01	36	7.53	20	8.47	36	17.82
Fragilaria sp.	--	--	5	1.51	8	1.67	19	8.05	--	--
Golenkinia sp.	--	--	6	1.81	--	--	--	--	--	--
Grammotophora sp.	--	--	--	--	1	0.21	--	--	--	--
Gyrosigma sp.	--	--	--	--	12	2.51	--	--	3	1.49
Merismopedia sp.	8	2.33	9	2.71	27	5.65	17	7.20	3	1.49
Microspora sp.	--	--	4	1.20	--	--	2	0.85	--	--
Mougeotia sp.	--	--	12	3.61	--	--	--	--	--	--
Navicula sp.	48	13.99	26	7.83	47	9.83	34	14.41	35	17.33
Nitzschia sp.	24	7.00	14	4.22	22	4.60	19	8.05	--	--
Nodularia sp.	17	4.96	44	13.25	30	6.28	--	--	28	13.86
Nostoc sp.	12	3.50	23	6.93	22	4.60	--	--	8	3.96
Oedogonium sp.	5	1.46	--	--	22	4.60	8	3.39	--	--
Oocystis	--	--	6	1.81	5	1.05	--	--	--	--
Oscillatoria sp.	8	2.33	39	11.75	44	9.21	12	5.08	--	--
Pediastrum sp.	--	--	--	--	2	0.42	--	--	1	0.50
Phacus sp.	--	--	16	4.82	14	2.93	--	--	--	--
Pinnularia sp.	21	6.12	10	3.01	10	2.09	8	3.39	--	--
Pleurosigma sp.	--	--	14	4.22	--	--	--	--	--	--
Prorocentrum sp.	--	--	--	--	6	1.26	--	--	6	2.97
Red Algae	4	1.17	--	--	3	0.63	--	--	1	0.50
Scenedesmus sp.	10	2.92	9	2.71	--	--	--	--	4	1.98
Skeletonema sp.	--	--	--	--	28	5.86	10	4.24	5	2.48
Sphaerocysts	--	--	--	--	5	1.05	--	--	--	--
Staurastrum sp.	14	4.08	--	--	4	0.84	--	--	2	0.99
Stauroneis sp.	30	8.75	--	--	28	5.86	34	14.41	30	14.85
Synedra sp.	--	--	--	--	2	0.42	17	7.20	19	9.41
Tetraedron sp.	17	4.96	--	--	--	--	--	--	--	--
Tribonema sp.	--	--	--	--	1	0.21	2	0.85	--	--
Trichodesmium sp.	--	--	--	--	4	0.84	--	--	--	--
Volvox sp.	--	--	6	1.81	--	--	--	--	--	--
SWDI	**2.904**		**2.804**		**3.025**		**2.525**		**2.308**	
Diversity	**23**		**23**		**30**		**15**		**16**	
Total (No'sx10^3/L)	**343**		**332**		**478**		**236**		**202**	

Table 3.4.8: Diversity of zooplankton in surface water samples

Zooplankton Genera (No's/M^3)	PSW-1		PSW-2		PSW-3		PSW-4		PSW-5	
	No's	%	No's	%	No's	%	No's	%	No's	%
Ceratium sp.	250	3.06	--	--	--	--	--	--	--	--
Cypridopsis sp.	--	--	11	0.39	--	--	10	1.11	1	0.08
Daphnia sp.	--	--	--	--	--	--	--	--	10	0.78
Diaphanosoma sp.	250	3.06	--	--	--	--	--	--	--	--
Diaptomus sp.	14	0.17	10	0.36	7	--	--	--	10	0.78
Doliolum sp.	--	--	12	0.43	8	0.24	--	--	4	0.31
Eubranchipus sp.	--	--	--	--	5	0.28	12	1.34	--	--
Eurecyrus sp.	9	0.11	--	--	--	0.17	--	--	--	--
Keratella sp.	5000	61.24	2125	76.25	2875	--	500	55.74	1250	98.04
Lathonura sp.	--	--	4	0.14	--	99.17	--	--	--	--
Leptodora sp.	375	4.59	250	8.97	--	--	125	13.94	--	--
Limnocalanus sp.	4	0.05	--	--	3	--	--	--	--	--
Macrothrix sp.	4	0.05	--	--	1	0.10	--	--	--	--
Mayorella sp.	1125	13.78	--	--	--	0.03	--	--	--	--
Notholca sp.	1125	13.78	--	--	--	--	250	27.87	--	--
Simocephalus sp.	--	--	125	4.49	--	--	--	--	--	--
Fish Eggs	--	--	250	8.97	--	--	--	--	--	--
Foraminifera	9	0.11	--	--	--	--	--	--	--	--
SWDI	**1.235**		**0.854**		**0.060**		**1.064**		**0.119**	
Diversity	**11**		**8**		**6**		**5**		**5**	
Abundance	**8165**		**2787**		**2899**		**897**		**1275**	

3.5 Sediment Quality

Sediment Characterization

Suspended matter may be divided into different categories that generally are divided as organic and inorganic suspended matter. Organic suspended matter contains mainly phytoplankton. Inorganic part contains mainly sediments that are suspended by currents and waves, or taken to the water column by human activities like dredging and dumping.

Five river sediment samples were collected as per the standard procedure using Van Veen Grab Sampler to evaluate the existing status of sediment quality. Sediments samples were collected from Godavari River during February 2020. The locations identified within project area are given in Table 3.5.1 and Fig. 3.5.1.

Representative sediment samples were collected from the project site for evaluation of the physico-chemical characteristics of sediment. Standard methods have been followed for the analysis of sediment samples. Sediment quality delineated through specific parameters, viz Particle Size Distribution, Texture, Total Organic carbon and Heavy Metals. Heavy metals in sediment samples were determined by extracting sediment by Hydrochloric acid and Nitric acid mixture digestion and analysed on ICP-OES (SW-846-6010-B / EPA).

The sediment texture is observed to be predominantly sandy as Fine sand is dominant with a range from 63.97 to 94.61% in all the sediment samples. TOC content in sediments varied from 0.069 to 0.440 %. Sediment Quality is furnished in Table 3.5.2.

Heavy Metals

Selected Sediment samples from study area were analyzed for heavy metals such as Boron (1.05 to 4.00 mg/kg), Chromium (2.21 to 7.37 mg/kg), Zinc (BDL to 3.84 mg/kg), Lead (0.50 to 1.12 mg/kg), Nickel (1.54 to 4.21 mg/kg), Cadmium (0.11 to 0.35 mg/kg), Iron (1083 to 3204 mg/kg) , Manganese (24.76 to 43.76 mg/kg), Copper (0.80 to 3.22 mg/kg) ,Cobalt (0.91 to 2.27 mg/kg) , Mercury (0.01 to 0.02 mg/kg), Arsenic (BDL) (Table 3.5.3). The heavy metals occur in the sediment as cations and are adsorbed by the negatively charged sediment particle. They are held strongly as complex on the surface of clay alumino silicates hydrated oxide and humus. The heavy metal concentrations in the sediments

samples of the study area below USEPA, Indian river system and World river system standards.

Benthic fauna:

Benthic fauna is one of the indicators of productivity in water environment. The environmental stress or factors such as climate, pH, season, water flow, etc could affect the diversity of benthic fauna and thus studying the diversity of Benthos could help to understand the environmental stress in the water environment.

- Analyses of sediment samples indicate moderate level of diversity of benthic organisms (Table 3.5.4).
- The organisms such as *Sphaerium* sp. (34.92%), *Gonibasis* sp. (11.11%), *Pisidium* sp. (10.17%) and Copepods (9.52%) were found to be abundant in the sediments samples collected from the surface water.
- The diversity of organisms in the sediment samples varied from four to six which suggests that the diversity of benthic organisms do not vary drastically.
- The abundance of benthic organisms ranged from 180 to 900 per m^2.
- The ecological index (SWDI) was noticed to range between 0.790 and 1.631 and the values suggest moderate level of stress on the organisms in the River sediment.

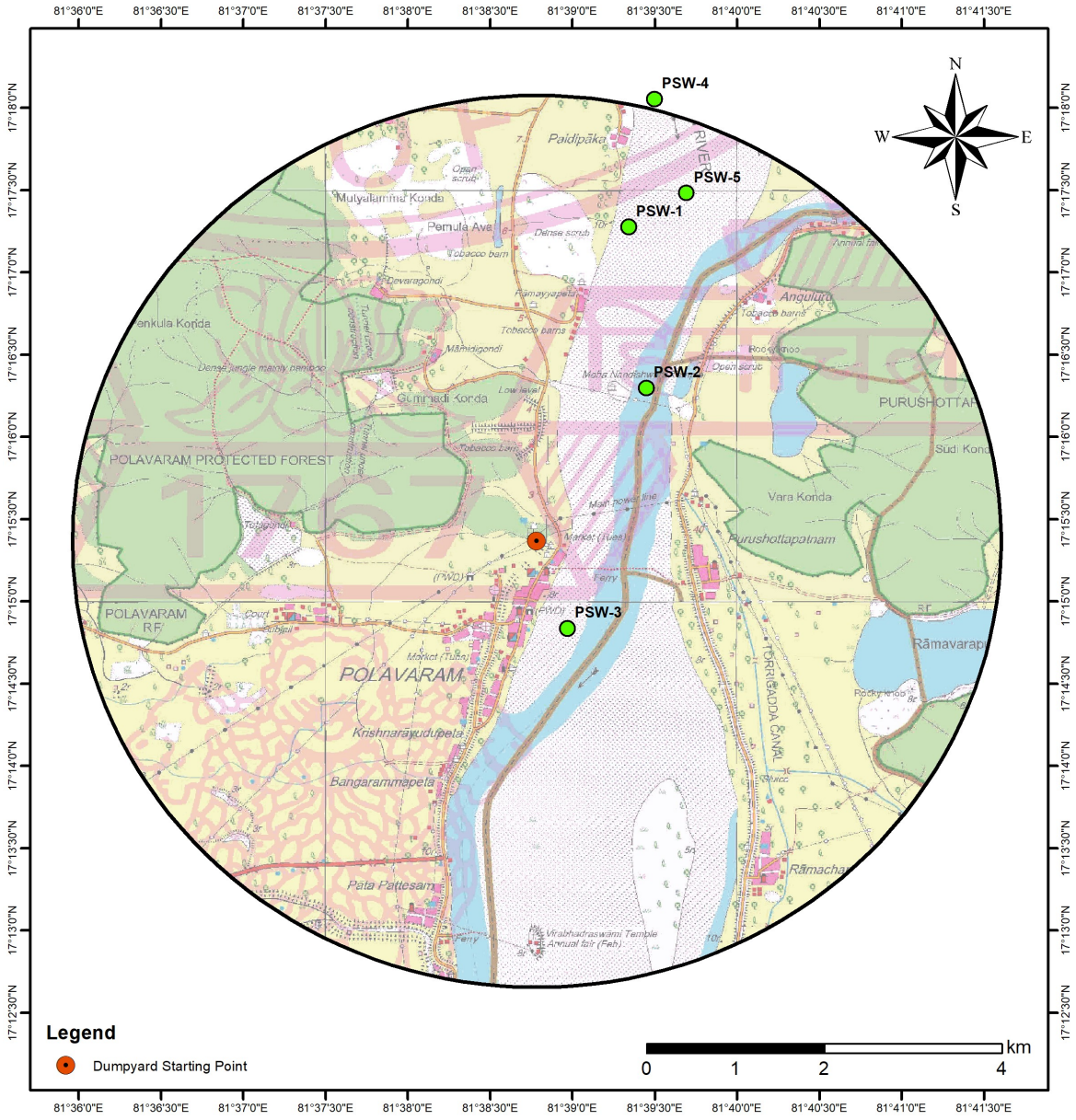


Fig. 3.5.1: Sediment sampling locations

Table 3.5.1: Sediment sampling locations and GPS co-ordinates

Sr. No.	Sample Code	Village	Latitude	Longitude
1.	SW-1	Coffer Dam	17°17'16.67"	81°39' 20.42"
2.	SW-2	Beside Janakiramudu Temple	17°16'17.88"	81°39' 26.89"
3.	SW-3	Polavaram Reva	17°14'50.26"	81°38' 58.19"
4.	SW-4	Paidipaka opp	17°18'03.22"	81°39' 29.91"
5.	SW-5	Auguluru	17°17' 29.01"	81°39' 41.50"

Table 3.5.2: Particle Size Distribution and TOC

S. No	Sample Code	Particle Size Distribution (%)				Texture	TOC
		Coarse Sand	Fine Sand	Silt	Clay		
1.	PSW-1	27.42	64.81	0.89	6.88	Sand (S)	0.304
2.	PSW-2	8.34	79.82	3.83	8.01	Loamy Sand (LS)	0.227
3.	PSW-3	8.46	66.02	7.86	17.66	Sandy Loam (SL)	0.440
4.	PSW-4	28.47	63.97	0.05	7.51	Sand (S)	0.136
5.	PSW-5	0.21	94.61	1.37	3.81	Sand (S)	0.069

Table 3.5.3: Heavy Metals in Sediment Samples

Sr. No.	Sample Code	As	B	Cd	Cr	Co	Cu	Fe	Hg	Mn	Ni	Pb	Zn
		--------mg/kg---------											
1.	PSW-1	BDL	1.80	0.17	2.36	1.14	0.80	1487	0.01	26.42	2.02	0.50	BDL
2.	PSW-2	BDL	4.00	0.35	7.15	2.27	3.22	3204	0.01	77.08	4.21	1.11	2.45
3.	PSW-3	BDL	2.33	0.21	2.89	1.72	1.30	1900	0.01	43.76	2.70	0.53	1.28
4.	PSW-4	BDL	1.05	0.11	2.21	0.91	0.39	1083	0.01	24.76	1.54	0.18	BDL
5.	PSW-5	BDL	3.65	0.30	7.37	1.76	2.15	2708	0.02	32.47	3.03	1.12	3.84

Table 3.5.4: Diversity of benthic organisms in the sediment samples

Benthos organisms (No's/M^2)	PSW-1		PSW-2		PSW-3		PSW-4		PSW-5	
	No's	%	No's	%	No's	%	No's	%	No's	%
Pleuroceridae										
Gonibasis sp.	225	35.71	--	--	90	25.00	--	--	--	--
Sphaeriidae	--	--	--	--	--	--	--	--	--	--
Sphaerium sp.	--	--	45	25.0	--	--	360	40.00	585	76.47
Pisidium sp.	135	21.43	--	--	--	--	135	15.00	--	--
Unionidae	--	--	--	--	--	--	--	--	--	--
Margaritifera sp.	--	--	45	25.0	135	37.50	--	--	45	5.88
Unio sp.	--	--	--	--	--	--	180	20.00	--	--
Lymnaeidae	--	--	--	--	--	--	--	--	--	--
Lymnaea sp.	--	--	--	--	--	--	--	--	45	5.88
Copepods	90	14.29	45	25.0	45	12.50	90	10.00	--	--
Crustaceans	45	7.14	--	--	45	12.50	--	--	--	--
Amphipoda	90	14.29	45	25.0	--	--	45	5.00	--	--
Polychaete	--	--	--	--	45	12.50	--	--	90	11.76
Fish Larvae	45	7.14	--	--	--	--	90	10.00	--	--
SWDI	**1.631**		**1.347**		**1.494**		**1.583**		**0.790**	
Diversity	**6**		**4**		**5**		**6**		**4**	
Abundance	**630**		**180**		**360**		**900**		**765**	

3.6 Land Environment

The proposed project site is situated at Polavaram, West Godavari Distyrict, A.P. Physiographically the district is divided into two natural regions. viz., Alluvial plain and upland areas. The alluvial plain covers 30% of the area in southern part of the Eluru – Kovuru railway line while uplands which include agency area constitutes 70% of the total district area. The important landforms in the district include Structural hills, Pediplain, Pediment inselberg complex, Coastal landforms and Valley fills.

The project location falls in Krishna – Godavari Zone of agro climatic zones. The zonescover East Godavari Part, West Godavari, Krishna, Guntur, and contiguous areas of Khammam, Nalgonda and Prakasam. Rainfall of this zone is 800-1100mm. Soil type is deltaic alluvium, red soils with clay, red loams, coastal sands and saline soils. Paddy, Groundnut, Jowar, Bajra, Tobacco, cotton, chillies, Sugarcane and Horticultural Crops are the important crops grown.

The different type of soils encountered in the west Godavari district are red soils, black cotton soils, deltaic alluvial soils and coastal sands,the red soils are seen mostly around Chintalapudi, Koyyalagudem, Nallajerla and southeast Polavaram villages They are permeable and well drained to moderately well drained. The black cotton soils are encountered in around Eluru, Nidamarru places in the district. Deltaic alluvial soils are very deep and highly fertile. These are seen mostly in around Polavaram, Kovvuru, Nidadavolu and Tanuku places.The coastal sands are seen occurring as patches in the south west and southern most parts of the district.

Paddy is the major crop in this District in both of the Seasons. During Kharif Season, Sugarcane is the 2nd major crop. Both Paddy and Sugarcane together contributes around 95% of total cropped area. During Rabi Season Crops namely Maize, Tobacco, Groundnut, Pulses and Sunflower are other major sown areas. Mango, Coconut, Oil palm, Cashew, Citrus, Banana, Turmeric, Sapota, Papaya, Cucumber, Gourds, Bhendi, Brinjal, Tomato, Cabbage, Cauliflower and Leafy vegetables which are treated as other important Horticulture Crops grown in the District.

Soil Characteristics

Twelve locations were identified for soil quality assessment at different

villages within the study area including project site. The locations and names of villages are given in Table 3.6.1 and their relative locations are as depicted in Fig. 3.6.1. Representative soil samples were collected from 15-30 cm depth at identified locations/villages and project site for the analysis of physico-chemical characteristics to represent existing soil quality (baseline) status.

The standard methods have been followed for the analysis of soil samples. The international pipette method (Black, 1965 and Piper 1966) was adopted for determination of particle size analysis. The textural diagram was derived using "SEE soil class 2.0 version based on the United States Department of Agriculture (USDA) classification of soils. Physical parameters such as bulk density, porosity and water holding capacity were determined by KR Box method (Keen and Raczkowski, 1921).

The chemical characteristics of soil were determined by preparing soil extract in distilled water in ratio 1:2 (Jackson, 1967). Organic carbon was determined by Walkey and Black method (1979). Fertility status of soil in terms of available nitrogen was determined by Kjeldhal method and available phosphorus was determined by chlorostannous reduced molybdophosphorous blue colour method (Olsen method, 1954). Potassium was determined by flame photometric method (Jackson ML 1967). Heavy metals in soil were determined by extracting soil with conc. H_2SO_4 and conc. HNO_3 followed by analysis on Inductively Coupled Plasma Spectrometer (ICP) (APHA, 1995).

Physical Characteristics

Physical characteristics of soil samples are delineated through specific parameters, viz., particle size distribution, texture, bulk density, porosity and water holding capacity. The particle size distribution in terms of percentage of total sand, silt and clay is furnished in Table 3.6.2.

Particle size distribution, also known as gradation, refers to the proportions by dry mass of a soil distributed over specified particle-size ranges. Soil particles vary greatly in size, and soil scientists classify soil particles into sand, silt, and clay. Starting with the finest, clay particles are smaller than 0.002 mm in diameter. Particle size distribution is a major factor as it influences water holding capacity, bulk density, Soil moisture availability, and nutrient content. The size of soil particles is important. The amount of open space between the particles influences how easily water moves

through a soil and how much water the soil will hold. Too much clay, in proportion to silt and sand, causes a soil to take in water very slowly. Such a soil gives up its water to plants slowly. Fine sand content (33.72 to 76.86%) of the soil samples collected from the study area are found to be higher as compared to silt and clay content. Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Texture influences the ease with which soil can be worked, the amount of water and air it holds, and the rate at which water can enter and move through soil. Soil texture is a classification of soil based on its physical texture and characteristics, particularly the size of the particles that make up the soil. The predominant texture of soil in study area is sandy clay loam and sandy loam followed by sand (Fig.3.6.2).

Soil bulk density is the mass of dry soil per unit of bulk volume, including the air space. Soil bulk density can vary substantially among different soil types and is affected by management practices. Particle density is volumetric mass of solid soil. It differs from bulk density because the volume used does not include pore spaces. The bulk density and particle density of soils in the region are in the range of 0.96 to 1.26 g/cm^3 and 2.00 to 2.63 g/cm^3 (Table 3.6.3).

Soil porosity is a measure of air-filled pore spaces and gives information about movement of gases, inherent moisture, and development of root system and strength of soil. Soil Water Holding Capacity is controlled primarily by the soil texture and the soil organic matter content. The porosity and water holding capacity of soil samples in study area are found in the ranges: 40.81-59.71% and 33.96 – 62.07% (Table 3.6.3), as the soils of the study area are mostly sandy loam in texture.

Chemical Characteristics

The collected soil samples were analysed for various chemical parameters, viz. pH, electrical conductivity, soluble cations and anions, Sodium Adsorption Ration (SAR), nutrients and organic carbon content in the soil samples are presented in Tables 3.6.4 - 3.6.5.

pH is an important parameter to indicate of the alkaline or acidic nature of the soil. It also affects the microbial population as well as the solubility of metal ions and regulates nutrient availability. Variation in pH of soil within the study area is presented in Table 3.6.4 and it was observed that the majority of the soil samples

are moderately acidic to moderately alkaline in nature with pH variation from 6.25 to 7.33.

The soluble salts were determined from soil saturated extract (1:2). The soluble salts in soil samples are expressed in terms of electrical conductivity (EC) and have been observed in the range: 0.067 to 0.312 mS/cm (Table 3.6.4), which fall in the normal category (<1 mS/cm). Amongst the soluble cations, Ca^{2+} and Mg^{2+} are observed in the range of 0.002 to 0.025 and 0.01 to 0.62 meq/100g and Na^{+}, and K^{+} are in the ranges of 0.12 to 0.62 and 0.07 to 0.65 meq/100g of soil extract respectively (Table 3.6.4).

Sodium adsorption ratio (SAR), along with pH, characterizes salt-affected soils. It is an easily measured property that gives information on the comparative concentrations of Na+, Ca2+, and Mg2+ in soil solutions. SAR of soil samples of the study area ranged from 0.77 to 5.55 except in the the samples from Ramachandra puram (13.44). The SAR of a soil extract takes into consideration that the adverse effect of sodium is moderated by the presence of calcium and magnesium ions. When the SAR rises above 12 to 15, serious physical soil problems arise and plants have difficulty in absorbing water. The most important anions present in soluble state in the soil are chlorides and sulphates. Chlorides ranged from 0.52 to 0.96 meq/100gm and sulphates content ranged from 0.014 to 0.033 meq/100 gm. Most of the samples from the study area are found to be in Non-Salinized range with respect to Chloride.

Organic matter present in soil influences its physical and chemical properties. It commonly accounts for as much as one third or more of the cation exchange capacity of the surface soil and is responsible for stability of soil aggregates. Organic carbon in soil samples vary in the range 0.24 to 1.38 % which is low to very high and available potassium levels are from medium to high, varies from 69.10 to 1133 and phosphorus levels ranged from 308 to 726kg/ha, respectively. However, available nitrogen showed low to medium range value i.e. in the range 75.26 to 326 kg/ha. Soil fertility ratings are rated as per ICAR. The results show that the soil in study area is poor in nutrient level. The fertility status of soil is presented in Table 3.6.5.

Heavy Metals

The heavy metals occur in the solution as cations and are adsorbed by the negatively charged soil particle. They are held strongly as complex on the surface of clay alumino silicates hydrated oxide and humus. In general, adsorption increases with pH. Although the trace metals in soil are very important for the quality of soil and environment, excessive level of trace elements can cause water pollution, toxicity in plants, foods and ultimately in animals and humans that feed upon them. The heavy metals also create problems in the nutrient utilization by plant and also marked reduction in chlorophyll content. As a result, the limits of metal deposition rates to soils should take into account the general ecotoxicity, phytotoxicity, transfer to animals and risk to the human health. The trace metal concentrations in soils may be affected by the deposition of wastes released from various industries and other related establishments.

All soils naturally contain trace levels of metals. The presence of metals in soil is, therefore, not indicative of contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed. Depending on the local geology, the concentration of metals in a soil may exceed the ranges (from literature).

Soil samples were also analyzed for heavy metals such as Arsenic (BDL), Boron (7.81 to 17.16 mg/kg)) Cadmium (0.65 to 1.96 mg/kg), Chromium (11.87 to 27.81 mg/kg), Cobalt (3.07 to 9.69 mg/kg), Copper (5.98 to 32.01 mg/kg), Iron (5789 to 11486 mg/kg), Mercury (0.01 to 0.03 mg/kg), Manganese (110 to 437 mg/kg), Nickel (7.34 to 23.84 mg/kg), Lead (1.42 to 4.49 mg/kg) and Zinc (7.98 to 29.44 mg/kg). The observed concentrations are presented in Table 3.6.6. The heavy metal concentrations in the study area are below Screening and response levels as per MoEF&CC Guidance Document for assessment and remediation of contaminated site in India.

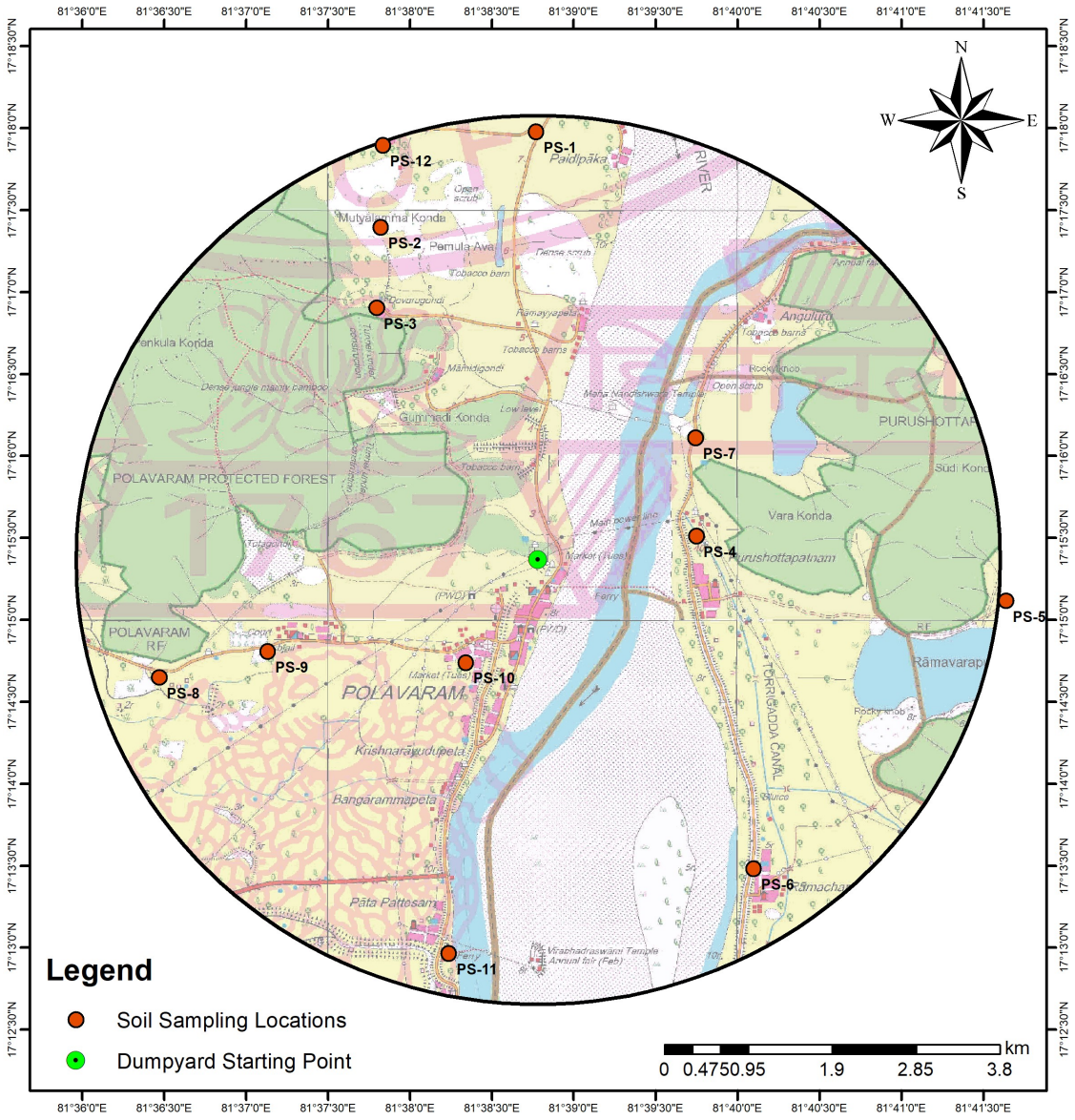


Fig. 3.6.1: Soil sampling locations

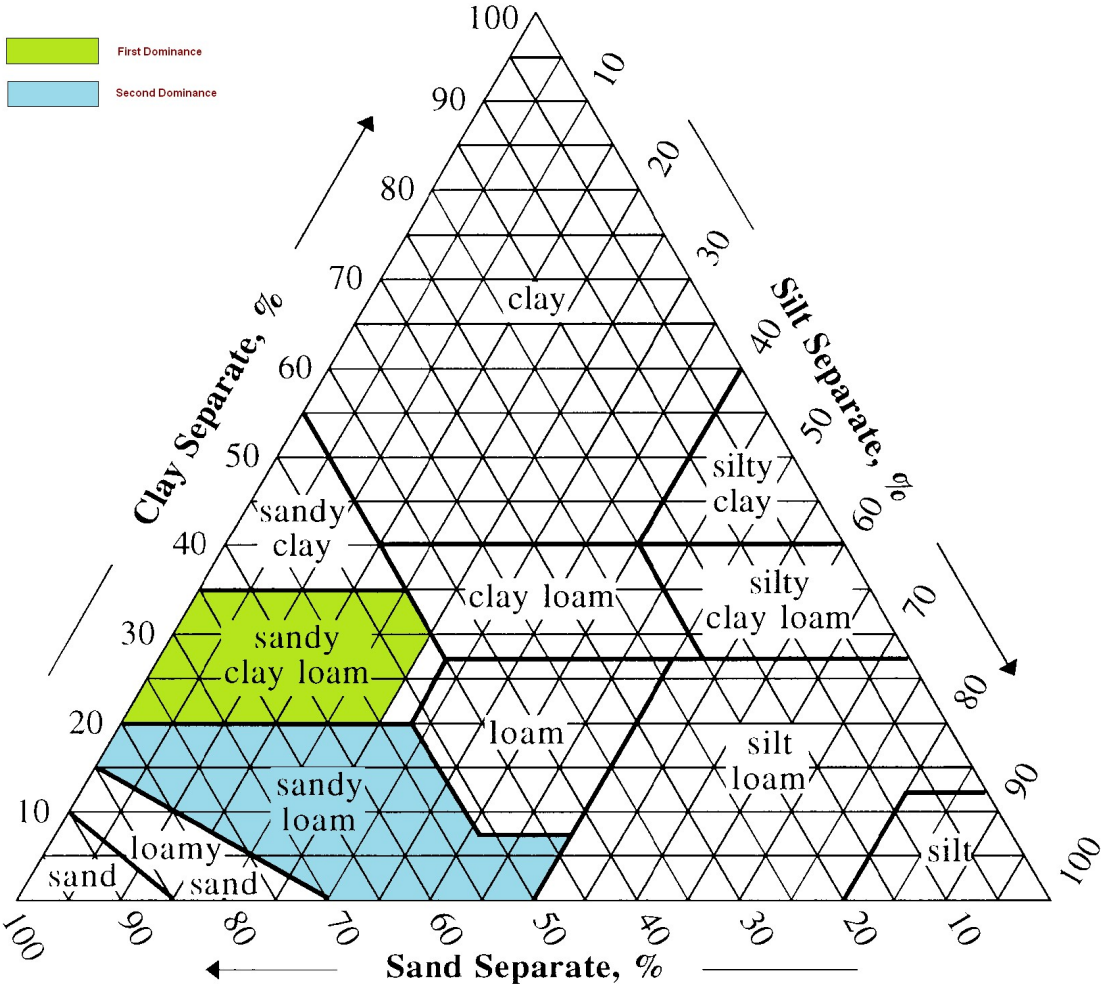


Figure 3.6.2 : Predominant Soil Texture

Table 3.6.1: Soil Sampling Locations and GPS co-ordinates

Sr. No.	Sample Code	Village	Latitude	Longitude	Source	Soil Color
Soil Samples						
1.	PS-1	Paidipaka Village	17°17'58.66"	81°38'46.29"	Open scrub	Black
2.	PS-2	Mutyalamma Konda	17°17'23.78"	81°37'49.41"	Open scrub, Bare area	Red
3.	PS-3	Devaragonda	17°16'54.25"	81°37'47.81"	Open scrub	Black
4.	PS-4	Purushotha Patanam	17°15'30.78"	81°39' 44.92"	House Garden	Black
5.	PS-5	Nelakota	17°15'06.91"	81°41'38.40"	Open scrub	Black
6.	PS-6	Ramachandra puram	17°13'28.74"	81°40'05.97"	Open scrub	Black
7.	PS-7	Auguluru	17°16'06.77"	81°39'44.70"	Open scrub	Red
8.	PS-8	Itukala kota(Pattiseema Attipothala patanam)	17°14'38.90"	81°36'28.17"	Open scrub	Red
9.	PS-9	Ramaithpeta	17°14'48.48"	81°37'07.91"	Open scrub	Black
10.	PS-10	Polavaram	17°14'44.47"	81°38'20.53"	Open scrub	Black
11.	PS-11	Pattiseema	17°12'58.04"	81°38'14.33"	Open scrub	Black
12.	PS-12	Chegondapalli	17°17'57"	81°37'47"	Open scrub	Black

Table 3.6.2: Soil Samples Particle Size Distribution

S.No.	Sample Code	Particle Size Distribution (%)				Soil Texture
		Coarse Sand	Fine Sand	Silt	Clay	
1.	PS-1	2.66	76.86	14.49	5.98	Loamy Sand (LS)
2.	PS-2	28.97	61.11	3.68	6.24	Sand (S)
3.	PS-3	23.43	49.37	4.14	23.06	Sandy Clay Loam (SCL)
4.	PS-4	11.71	67.95	3.55	16.79	Sandy loam (SL)
5.	PS-5	9.29	71.35	4.10	15.26	Sandy Loam (SL)
6.	PS-6	5.31	62.13	12.16	20.40	Sandy Clay Loam (SCL)
7.	PS-7	8.77	48.13	22.29	20.81	Sandy Clay Loam (SCL)
8.	PS-8	16.07	66.74	4.29	12.91	Sandy Loam (SL)
9.	PS-9	5.15	33.72	6.49	54.65	Clay (C)
10.	PS-10	2.04	65.75	4.30	27.91	Sandy Clay Loam (SCL)
11.	PS-11	1.20	65.50	20.56	12.75	Sandy Loam (SL)
12.	PS-12	38.35	57.45	1.59	2.60	Sand (S)

Table 3.6.3: Soil Physical Properties

S.No.	Sample Code	Density (g/cc)		Porosity Percent (%)	Water Holding Capacity (%)
		Bulk	Particle		
1.	PS-1	1.10	2.00	44.90	47.90
2.	PS-2	1.26	2.50	49.58	33.96
3.	PS-3	1.21	2.04	40.81	41.49
4.	PS-4	1.06	2.63	59.71	46.65
5.	PS-5	1.15	2.63	56.26	43.88
6.	PS-6	0.96	2.04	52.82	62.07
7.	PS-7	1.01	2.00	49.39	50.00
8.	PS-8	1.21	2.38	49.38	41.39
9.	PS-9	1.19	2.04	41.67	60.56
10.	PS-10	1.18	2.33	49.37	44.91
11.	PS-11	1.10	2.56	57.10	54.14
12.	PS-12	1.15	2.50	53.80	40.18

Table 3.6.4: Chemical Properties of Soil Extract (water soluble)

S.No.	Sample Code	pH	EC	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	SO_4^{-}	Cl^{-}	SAR
			mS/cm	---------(meq/100gm)---------						
1.	PS-1	6.74	0.177	0.004	0.62	0.14	0.07	0.015	0.96	0.77
2.	PS-2	6.25	0.067	0.004	0.01	0.13	0.07	0.014	0.88	4.46
3.	PS-3	7.21	0.224	0.006	0.03	0.17	0.12	0.020	0.72	3.71
4.	PS-4	6.86	0.200	0.006	0.03	0.14	0.16	0.025	0.52	3.46
5.	PS-5	7.09	0.312	0.008	0.04	0.12	0.21	0.024	0.76	2.49
6.	PS-6	7.14	0.206	0.004	0.03	0.62	0.65	0.033	0.68	13.44
7.	PS-7	6.71	0.145	0.005	0.03	0.15	0.10	0.022	0.80	3.29
8.	PS-8	6.89	0.181	0.025	0.13	0.16	0.07	0.014	0.84	1.83
9.	PS-9	7.33	0.208	0.002	0.03	0.15	0.07	0.020	0.76	3.60
10.	PS-10	6.29	0.150	0.003	0.09	0.16	0.07	0.017	0.76	2.40
11.	PS-11	7.13	0.177	0.016	0.03	0.16	0.07	0.016	0.92	3.34
12.	PS-12	6.75	0.142	0.004	0.01	0.17	0.20	0.026	0.72	5.55

Table 3.6.5: Soil Fertility Status

S.No.	Sample Code	Organic Carbon (%)	Available		
			N	P	K
			kg/ha		
1.	PS-1	0.90	176	388	231
2.	PS-2	0.42	75.26	340	68.10
3.	PS-3	0.75	163	487	1133
4.	PS-4	1.34	251	603	203
5.	PS-5	1.31	238	726	1117
6.	PS-6	1.40	213	623	1305
7.	PS-7	1.38	326	438	603
8.	PS-8	0.24	87.80	308	103
9.	PS-9	0.84	138	412	477
10.	PS-10	0.65	201	417	268
11.	PS-11	0.59	188	362	391
12.	PS-12	1.02	188	652	168
Poor soil		**< 0.5**	**< 280**	**<10**	**<108**
Medium soil		**0.5-0.75**	**280-560**	**10-24.6**	**108-280**
Fertile soil		**>0.75**	**> 560.0**	**> 24.6**	**>280**

Nutrient status Classification: Source: Soil Testing in India, Dept. of Agri. And Cooperation, Ministry of Agriculture, Govt. of India, 2011

Table 3.6.6: Heavy Metals in Soil Samples

Sr. No.	Sample Code	As	B	Cd	Cr	Co	Cu	Fe	Hg	Mn	Ni	Pb	Zn
		--------mg/kg---------											
1.	PS-1	BDL	15.44	1.29	19.83	7.67	17.25	10468	0.01	252	14.88	3.16	19.55
2.	PS-2	BDL	11.76	0.98	20.07	3.26	18.52	8254	0.01	112	12.54	1.92	11.02
3.	PS-3	BDL	7.81	0.65	12.47	3.07	8.42	5944	0.02	110	7.34	1.79	7.98
4.	PS-4	BDL	11.55	3.24	20.92	6.75	21.66	8266	0.03	270	14.57	3.59	27.07
5.	PS-5	BDL	7.93	0.67	12.74	3.79	5.98	5789	0.02	211	8.01	1.54	11.90
6.	PS-6	BDL	8.00	0.69	11.87	4.82	8.77	6100	0.03	218	8.46	1.73	14.61
7.	PS-7	BDL	14.84	1.23	21.17	7.81	16.91	10191	0.02	318	17.57	2.04	17.73
8.	PS-8	BDL	13.59	1.13	12.75	5.43	7.31	9496	0.03	168	10.48	1.42	11.46
9.	PS-9	BDL	14.02	1.32	23.62	6.74	32.01	9933	0.01	146	23.84	4.49	29.44
10.	PS-10	BDL	11.23	1.05	20.29	7.23	15.16	8858	0.03	302	13.74	3.47	21.86
11.	PS-11	BDL	17.16	1.42	27.81	9.69	22.91	11456	0.02	437	22.93	3.85	26.52
12.	PS-12	BDL	13.48	1.12	14.55	5.02	11.73	9379	0.03	236	9.58	3.06	18.21

Chapter 4

Conclusions & Future Work

4.1 CONCLUSIONS

The present study aimed to assess the periodical environmental quality status within 5 km radius of the Polavaram Project. The field work for various components viz., air, groundwater, river water, soil and river sediments was carried out in the study area during 2020 during February, March and November except for April to October due to COVID pandemic for assessing the prevailing environmental quality. Based on the primary data collected during the study period, following conclusions are drawn:

- ✓ The ambient air quality at all locations in the study area are found to be within National Ambient Air Quality Standards (NAAQS) w.r.to gaseous pollutants (SO_2, NO_2, O_3, CO, NH_3 and C_6H_6), PM_{10} and $PM_{2.5}$. The higher values of particulate matter (PM_{10} and $PM_{2.5}$) in terms of maximum concentrations in the study area may be due to the vehicular movement and unpaved roads.
- ✓ In the villages and residential colonies surrounding the Polavaram project, it is observed that the daytime noise levels vary between 50.2-52.9 dB(A), 50.1-54.5 dB(A) & 51.6-53.8 dB(A) and night time noise levels vary between 43.1-45.0 dB(A), 42.8-44.8 dB(A) & 40.8-44.0 dB(A) during February, March and November 2020, respectively. The noise levels are compared with CPCB limits for residential areas. The noise levels are observed to be within the CPCB standards for residential areas
- ✓ The observed Leq values of day time noise levels during February, March and November 2020 respectively are varying between 64.2-70.2 dB(A), 62.6-66.6 dB(A) and 59.4-68.6 dB(A). The night time noise levels are within the range of 52.2-67.9 dB(A), 53.6-60.9 dB(A) and 50.7-60.7 dB(A), respectively, during February, March and November 2020 near the construction activities of Polavaram project. It is observed that daytime and night time noise levels are exceeding the CPCB limits for commercial zone at most of the sites. These higher noise levels are attributed to operation of DG sets, Excavators, Cranes, Crushers, movement of Trucks, vehicles, and concrete mixers etc. in connection with ongoing construction activities of Polavaram.

- ✓ The groundwater quality at most of the sampling locations for various parameters was well within the permissible limit of BIS except for TDS, calcium hardness, nitrate
- ✓ Iron and Manganese concentrations at some locations in groundwater were observed to be more than permissible limit of the BIS which may be attributed to the dominant Rocks
- ✓ The river water quality showed values within the range. Phytoplankton and zooplankton showed significant diversity in the study area.
- ✓ Soil texture in the study area varies from loamy sand, sandy clay loam, clay and sand, whereas, loamy sand and sandy clay loam are the prominent textural class

4.2 FUTURE WORK

- The sampling work for all the components are per the schedule will be carried out
- Analysis of the samples for various environmental components will be continued.

References

APHA (2012). Standard methods for analysis of the water and waste water analysis, 22nd editions.

BIS (2012). Indian standard specification for drinking water. IS: 10500.

Annexure - I

Annexures

National Ambient Air Quality Standards – 2009

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1.	Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20	-Improved west and Gaeke
		24 Hours **	80	80	-Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO_X), $\mu g/m^3$	Annual *	40	30	-Modified Jacob & Hochheiser (Na-Arsenite)
		24 Hours **	80	80	-Chemiluminescence
3.	Particulate Matter (Size less than 10 µm) or PM_{10} $\mu g/m^3$	Annual *	60	60	-Gravimetric -TOEM
		24 Hours **	100	100	-Beta attenuation
4.	Particulate Matter (Size less than 2.5 µm) or $PM_{2.5}$ $\mu g/m^3$	Annual *	40	40	-Gravimetric -TOEM
		24 Hours **	60	60	-Beta attenuation
5.	Ozone (O_3) $\mu g/m^3$	8 hours **	100	100	-UV photometric
		1 hour**	180	180	-Chemiluminescence - Chemical method
6.	Lead (Pb) $\mu g/m^3$	Annual *	0.50	0.50	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
		24 Hours **	1.00	1.00	-ED-XRF using Teflon filter
7.	Carbon Monoxide (CO) mg/m^3	8 hours **	02	02	-Non Dispersive Infrared Spectroscopy
		1 hour *	04	04	
8.	Ammonia (NH_3) $\mu g/m^3$	Annual *	100	100	-Chemiluminescence
		24 Hours **	400	400	-Indophenol blue method
9.	Benzene (C_4H_4) $\mu g/m^3$	Annual *	05	05	-Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10.	Benzo Pyrene (BaP) - particulate phase only ng/m^3	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
11.	Arsenic(As) ng/m^3	Annual *	06	06	-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 taken twice a week 24 hourly at uniform intervals

** 24 hourly or 8 hourly or 01 hourly monitored values as applicable shall be compiled 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

Annexure-II

Ambient Air Quality Standards in Respect of Noise

(as recommended by CPCB)

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

Notes:

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 defined as an area comprising not less than 100 meters around hospitals, Educational Institutions and courts. The silence zones are zones which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four abovementioned 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 related to human hearing

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

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

[The Gazette of India Extraordinary
MoEF Notification, 14 February, 2000]

Annexure-III

Specifications for Drinking Water - (IS 10500: 2012)

S. No.	Substance or characteristic	Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	Remarks
Essential Characteristics				
1.	Colour Hazen Units, max	5	15	Extended to 15 only if toxic substances are not suspected in absence of alternate sources
2.	Odour	Agreeable	Agreeable	a. test cold and when heated b. test after several dilutions
3.	Taste	Agreeable	Agreeable	Test to be conducted only after safety has been established
4.	Turbidity (NTU) Max	1	5	-
5.	pH value	6.5 to 8.5	No relaxation	-
6.	Total hardness (mg/l, $CaCO_3$) Max.	200	600	-
7.	Iron (mg/l, Fe) Max	0.3	No relaxation	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
8.	Chlorides (as Cl) mg/l Max	250	1000	-
9.	Free residual chlorine (mg/l), Min	0.2	1	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/L
Desirable Characteristics				
10.	Total dissolved solids, mg/l, max	500	2000	-
11.	Calcium (mg/l, Ca) Max.	75	200	-
12.	Magnesium (mg/l, Mg) Max.	30	100	-
13.	Copper (mg/l, Cu) Max.	0.05	1.5	-
14.	Manganese (mg/l, Mn) Max.	0.1	0.3	Total concentration of manganese (as Mn) and iron(as Fe) shall not exceed 0.3 mg/l
15.	Sulphate (mg/l, SO_4) Max.	200	400	May be extended upto 400 provided Magnesium (as Mg) does not exceed 30
16.	Nitrate(mg/l, NO_3) Max.	45	No relaxation	-
17.	Fluoride(mg/l, F) Max.	1.0	1.5	-
18.	Phenolic compounds (mg/l C_6H_5OH) Max.	0.001	0.002	-
19.	Mercury (mg/l, Hg) Max	0.001	No Relaxation	-
20.	Cadium (mg/l, Cd) Max.	0.003	No Relaxation	-

S. No.	Substance or characteristic	Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	Remarks
21.	Selenium (mg/l, Se) Max.	0.01	No Relaxation	-
22.	Total Arsenic (mg/l, As) Max.	0.01	0.05	-
23.	Cyanide(mg/l, CN) Max.	0.05	No Relaxation	-
24.	Lead (mg/l, Pb) Max.	0.01	No Relaxation	-
25.	Zinc(mg/l, Zn) Max.	5	15	-
26.	Anionic detergents (mg/l, MBAS) Max	0.2	1.0	-
27.	Total Chromium(mg/l),Max.	0.05	No relaxation	-
28.	Polynuclear aromatic hydrocarbons (mg/l, PAH) Max.	0.0001	No relaxation	-
29.	Mineral oil (mg/l) Max.	0.05	No relaxation	-
30.	Pesticides (mg/l) Max.	-	No relaxation	-
Radioactive materials				
31.	Alpha emitters (Bq/l) Max.	0.1	No relaxation	-
32.	Beta emitters (pci/l) Max.	1.0	No relaxation	-
33.	Alkalinity (mg/l) Max.	200	600	-
34.	Aluminium (mg/l, Al) Max.	0.03	0.2	-
35.	Boron(mg/l) Max.	0.5	1.0	-

Annexure-IV

Methods for Preservation and Analysis of Water Samples

S. No.	Parameter	Units of Expression	Preservative and Storage Condition	Reference: APHA 21st Edition Methods
Physical Parameters				
1.	Temperature	^{0}C	Analyze immediately	2550 – B: (Thermometer)
2.	pH	--	Analyze immediately	4500-H^+ - B: (Electrode)
3.	Conductivity	µs/ms	Refrigeration at 4^{O}C	2510 – B: (Conductivity meter)
4.	Total dissolved solids	mg/l	Refrigeration at 4^{O}C	2540 – C: (dried at 180^{0}C & gravimetric)
5.	Total suspended solids	mg/l	Refrigeration at 4^{O}C	2540 – D: (dried at 103^{0}C-105^{0}C & gravimetric)
6.	Turbidity	NTU	Refrigerate and Analyze immediately	2130 – B: (Nephelometric)
Inorganic Parameters				
7.	Total alkalinity	as $CaCO_3$ mg/l	Refrigerate and Analyze immediately	2320 – B: (Titration)
8.	Hardness	as $CaCO_3$ mg/l	Add HNO_3 to pH < 2 and refrigerate	2340 – C: (EDTA Titrimetric)
9.	Chloride	mg/l	Not Required	4500-Cl^- - B: (Argentometric)
10.	Sulphate	mg/l	Refrigeration at 4^{O}C	4500-SO_4^{--} - E: (Turbidimetric)
11.	Fluoride	mg/l	Not Required	4500-F^- - D: (SPADNS)
12.	Sodium and potassium	mg/l	Not Required	3500- K, Na-B: (Flame Photometric)
Nutrient and Demand Parameter				
13.	Nitrate	as NO_3^- - N mg/l	Refrigerate and analyze immediately	4500-NO_3^- B: (UV spectrophotometric)
14.	Total Phosphate	mg/l	Refrigeration at 4^{O}C	4500-P-D: (Stannous Chloride)
15.	Dissolved Oxygen [DO]	mg/l	Analyze immediately	4500-O-C: (Azide modification)
16.	COD	mg/l	Add H_2SO_4 at pH <2 refrigerate & analyze immediately	5220-B: (Open Reflux)
17.	BOD	mg/l	Refrigeration at 4^{O}C & analyze immediately	5210-B: (BOD Test at 27 ^{0}C)
18.	Total Kjeldhal Nitrogen	mg/l	Refrigerate and Add H_2SO_4 to pH<2	4500- N_{ORG}-B: (Macro-kjeldhal)
19.	Oil and grease	mg/l	Add H_2SO_4 at pH <2 refrigerate	5220 –B: (Liquid-Liquid Partition Gravimetric)
Heavy Metals				
20.	Heavy metals	mg/l	Add HNO_3 to pH <2	3030 –E, 3125 - B: (ICP- MS)

Annexure-V

Soil Fertility Ratings

S.No	Soil Nutrients	Soil Fertility Ratings		
		Low	Medium	High
1	Organic carbon as a measure of available Nitrogen (%)	< 0.5	0.5 - 0.75	> 0.75
2	Available N as per alkaline permanganate method (kg/ha)	< 280	280 - 560	> 560
3	Available P by Olsen's method (kg/ha) in Alkaline soil	< 10	10 - 24.6	> 24.6
4	Available K by Neutral N, ammonia acetate method (kg/ha)	< 108	108 - 280	> 280

pH Range	Soil Reaction Rating
<4.6	Extremely acid
4.6-5.5	Strongly acid
5.6-6.5	Moderately acid
6.6-6.9	Slightly acid
7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Strongly alkaline

General interpretation of EC values

S.No.	Soil	EC (mS/cm)	Total salt content (%)	Crop reaction
1.	Salt free	0-2	<0.15	Salinity effect negligible, except for more sensitive crops
2.	Slightly saline	4-8	0.15-0.35	Yield of many crops restricted
3.	Moderately saline	8-15	0.35-0.65	Only tolerant crops yield satisfactorily
4.	Highly saline	>15	>0.65	Only very tolerant crops yield satisfactorily

(Source: Methods Manual, Soil Testing in India, Dept. of Agri. And Cooperation, Ministry of Agriculture, Govt. of India, 2011)

Annexure-VI

Metals Concentrations Typically Found in Unpolluted Soil and Soil Clean Up Standards

Metal (Symbol)	Typical Concentrations in Natural Soils (mg/kg)
Aluminium (Al)	10000 - 300000*
Antimony (Sb)	< 1 - 8.8
Arsenic (As)	< 0.1 - 73
Barium (Ba)	10-1500
Beryllium (Be)	<1 - 7
Cadmium (Cd)	<0.010 - 2
Chromium (Cr)	1-1000
Cobalt (Co)	< 0.3 - 70
Copper (Cu)	< 0.6-495
Iron (Fe)	7000 - >550000*
Lead (Pb)	2 - 200*
Magnesium (Mg)	50 - 50000
Manganese (Mn)	< 2 -7000
Mercury (Hg)	3.40
Molybdenum (Mo)	0.2 - 5*
Nickel (Ni)	5 - 500*
Potassium (K)	50 - 37000
Selenium (Se)	< 0.1 - 3.9
Silver (Ag)	0.01 - 8
Strontium (Sr)	50 - 1000*
Thallium (Tl)	0.1 - 0.8
Tin (Sn)	2 - 200*
Titanium (Ti)	1000 - 10000
Zinc (Zn)	< 3.0 - 264
Zirconium (Zr)	60 - 2000 *

(Source: Frink, Charles R., 1996. "A Perspective of Metals in Soils", Journal of Soil Contamination, 5(4):329- 359. Table A8: Most Likely Concentrations of EPA Target Analytes in Uncontaminated Soils of the Northeast (mg/kg [ppm] dry weight. www.newhallinfo.org)* Lindsay, W. 1979. Chemical Equilibrium in Soils. New York: John Wiley and Sons. (in: US EPA, 1987. A Compendium of Superfund Field Operations Methods. Exhibit 16-2. "The Content of Various Elements in Soils." www.epa.gov,

 # Criteria are 100 mg/kg for hexavalent chromium and 3900 mg/kg for trivalent chromium

Annexure-VII

Soil (Screening and Response levels)							
S.No	**Chemical Name**	**Chemical Group**	**Response levels**	**Screening Levels**			
				Agricultural	**Residential/ parkland**	**Commercial**	**Industrial**
			mg/kg				
1.	Arsenic	Metal	50	12	12	12	12
2.	Boron	Inorganic	-	2	-	-	-
3.	Cadmium	Metal	13	1.4	10	22	22
4.	Chromium	Metal	-	64	64	87	87
5.	Cobalt	Inorganic	190	40	50	300	300
6.	Copper	Metal	190	63	63	91	91
7.	Iron	Inorganic	-	-	-	-	-
8.	Mercury	Metal	36	6.6	6.6	24	50
9.	Manganese	Inorganic	-	-	-	-	-
10.	Nickel	Metal	-	-	-	-	-
11.	Lead	Metal	530	70	140	260	600
12.	Zinc	Metal	720	200	200	360	360

Guidance document for assessment and remediation of contaminated sites in India: volume II-2.1-b Screening and Response levels, 1st Edition, December 2015, by MoEF&CC, GoI https://cpcb.nic.in/uploads/hwmd/MoEFCC_guidelines_contaminatedsites.pdf

Annexure VIII

Heavy metals	[a] USEPA Sediment Standards	[b] Average Shale Values	[c] Toxicity Reference Values	[d] Indian River System	[e] World River System
Co	50	19	-	-	20
Cu	31.6	45	16	28	100
Cr	43.4	90	26	87	100
Ni	22.7	68	16	27	90
Cd	0.99	0.30	0.60	-	-
Zn	121	95	110	16	350
Pb	35.8	20	31	-	-

Heavy metal ion concentration in Sediment

References

[a,c] USEPA (1999) National recommended water quality criteria-correction-United State Environmental Protection Agency EPA 822-Z-99-001, http://www.epa.gov./ostwater/pci/revcom), pp 25

[b] Turekian KK, Wedepohl DH (1961) Distribution of the element in some major units of the earth's crust. Bull Geol Soc Am 72:175–192

[d] Subramanian V, Sitaswad R, Abbas N, Jha PK (1987) Environmental geology of the Ganga River basin. J Geol Soc India 30:335–355

[e] Martin J, Meybeck M (1979) Elemental mass-balance of material carried by major world rivers. Mar Chem 7(3):178–206. doi: 10.1016/0304-4203(79)90039-2

Harendra Singh et.al (2017),Assessment of heavy metal contamination in the sediment of the River Ghaghara, a major tributary of the River Ganga in Northern India Applied Water Science, Volume 7, Issue 7, pp 4133–4149

GOVERNMENT OF ANDHRA PRADESH
WATER RESOURCES DEPARTMENT

From
Sri B.Sudhakara Babu,
M.Tech.,F.I.E.,
Chief Engineer,
Polavaram Irrigation Project,
Dowlaiswaram – 533 125.

To
The Chief Engineer,
Designs (NW&S),
Central Water Commission,
6th Floor, Seva Bhavan,
R.K. Puram,
New Delhi – 110 066.

Lr.No: CE/PIP/SE(DPM)/EE(P)/DEE1(P)/AEE13(P)/1733 Dt: 19.12.2020.

Sir,

Sub.:- PIPHW – PART-A – Balance works of "Investigation, survey, preparation of Designs & Drawings and L.P. Schedules etc., (1) Construction of Earth Dam Gaps I & III, Earth cum Rock Fill Dam for Gap-II, Spill Channel, Approach channel and Pilot channel (2) Construction of Spillway with crest level +25.72 and its ancillary works and (3) Excavation of foundations of 960 MW Hydro Electric Power House, Approach channel, Intake structure, Tail race pool, Tail race channel etc., of Polavaram Irrigation Project and O & M" for 5 years including defect liability period of 2 years – **Submission of Stability assessment of right bank of Spill Channel from Ch: 0+900m to 2+030m and from 2+600m to 2+920 m in soil reaches with ground improvements measures as carried out by IIT, New Delhi - Reg.**

Ref.:-

1. L.S. Agreement No. 1/2019-20, Dt: 08.11.2019.
2. 11th DDRP Minutes communicated vide PPA Lr. No. 3/26/2015/PPA/ 179- 198, Dt: 16.01.2019.
3. Minutes of 14th DDRP meeting held at Hyderabad on 08.03.2020.
4. CE/PIPHW Lr. No.CE/PIPHW/DCE/OT-1/AEE-1/Spillway design/ 439M, Dt: 21.05.2020.
5. CWC Lr. No.T-31012/1/2019-CMDD (NWS) DTE, Dt.05.07.2020
6. T.O. Lr.No. CE/PIP/SE(DPM)/EE(P)/DEE1(P)/AEE13(P)/803, Dt: 18.08.2020.
7. T.O. Lr.No. CE/PIP/SE(DPM)/EE(P)/DEE1(P)/AEE13(P)/917, Dt: 08.09.2020.
8. Minutes of 15th DDRP meeting held on 29.09.2020 through video conference.
9. T.O. Lr.No. CE/PIP/SE(DPM)/EE(P)/DEE1(P)/AEE13(P)/1629, Dt: 07.12.2020.
10. SE/PIPHW/Dowl Lr. No. SE/PIPHW/OT2/AEE4/MEIL (D)/Vol.10/683CE, Dt: 18.12.2020.

*****

In continuation to this office letter vide reference 9th cited, the final report on stability assessment of right bank of Spill Channel from Ch: 0+900m to 2+030m and from 2+600m to 2+920 m in soil reaches with ground improvements measures as carried out by IIT, New Delhi as submitted by the Superintending Engineer, PIPHW Circle, Dowlaiswaram is here with submitted for according approval.

Encl: Report on Stability Assessment - 2 Nos.

Yours faithfully,
Sd/- B. Sudhakara Babu, 19.12.2020
Chief Engineer,
Polavaram Irrigation Project,
Dowlaiswaram.

1. Copy along with enclosures submitted to the Polavaram Project Authority, Hyderabad-500 004 for information and necessary action. Further it is requested to place the report before the ensuing DDRP meeting.

   Encl: Report on Stability Assessment - 1 No.

2. Copy along with enclosures submitted to CE, CDO for kind information and the CE, CDO is requested to communicate the observations/views to CE, CWC, New Delhi and a copy may please be communicated to this office.

   Encl: Report on Stability Assessment - 1 No.

3. Copy communicated to Superintending Engineer, PIPHW Circle, Dowlaiswaram for information and necessary action.

Sd/- B. Sudhakara Babu, 19.12.2020
Chief Engineer,
Polavaram Irrigation Project,
Dowlaiswaram.

// t.c.f., //

19/12/2020
Executive Engineer (P)

19/12/2020