संदर्भ: ऊँचाहार/ईएमजी /E-7/2026-27/3620 दिनांक: 29.05.2026

सेवा,

उप निदेशक एमओईएफ-सीसी
केंद्रीय भवन, 5 वीं मंजिल
सेक्टर- एच, अलीगंज
लखनऊ-226024 (उत्तर प्रदेश)

विषय: एफ़जीयूटीपीपी (एनटीपीसी ऊँचाहार) के स्टेज -4 के लिए अक्टूबर' 2025 से मार्च' 2026 तक की अवधि के लिए एमओईएफ़ अर्धवार्षिक अनुपालन रिपोर्ट के संदर्भ में।

आदरणीय महोदय/महोदया,

एनटीपीसी ऊंचाहार की अक्तूबर' 2025 से मार्च' 26 तक की अवधि के लिए स्टेज -4 के एमओईएफ अर्धवार्षिक अनुपालन रिपोर्ट को देखने का कष्ट करें ।

उपरोक्त आपकी सूचना हेतु प्रेषित है।

धन्यवाद,

Psinha

(प्रीति सिन्हा)
अपर महाप्रबंधक(तकनीकी सेवाएं)

संलग्नक: 1) अक्तूबर' 2025 से मार्च' 26 तक की अवधि के लिए स्टेज -4 की MOEF छमाही वार्षिक अनुपालन रिपोर्ट ।

प्रतिलिपि:

1. सदस्य सचिव-यूपीपीसीबी, टीसी 12 विभूति खंड, गोमती नगर, लखनऊ -226011
2. मुख्य पर्यावरण अधिकारी, यूपीपीसीबी, टीसी 12 विभूति खंड, गोमती नगर, लखनऊ -226010
3. आंचलिक अधिकारी, केंद्रीय प्रदूषण नियंत्रण बोर्ड, भूमि तल, पिकप भवन, गोमती नगर, लखनऊ-226010

1. Project type: River-valley/ Mining/ Industry/ Thermal/ Nuclear/ Other(specify)	Coal Based Thermal Power Project
2. Name of the project:	Feroz Gandhi Unchahar Thermal Power Project-Unchahar
3. Clearance letter (s)/OM No. and date:	J-13012/50/2010-IA.II (T) dated 10.05.2013
4. Location: a) District (s): b) State (s): c) Location (Latitude/ Longitude):	The proposed site is located between Prayagraj-Lucknow rail/road route at Unchahar, Dist: Raebarelli, UP Main Plant and Township Area: Latitude 25°53'55" N to 25°54'56" N and Longitude, 81°18'50" E. to 81°20'25"E. Ash Disposal Area: Stage-1 Latitude 25°50'13" N to 25°51'29" N and Longitude 81°17'39"E to 81°18'54"E Stage-2 Latitude 25°57'07" N to 25°57'50" N and Longitude 81°21 '19"E to 81°21 '58"E.
5. Address for correspondence : a) Address of the Concerned Project Chief Engineer (with Pin Code & telephone/ telex/ fax numbers): b) Address of the Executive Project Engineer/ Manager	Head of Project Feroz Gandhi Unchahar Thermal Power Project-Unchahar Office: FGUTPP, NTPC Ltd, Unchahar, Distt. Raebareli, U.P.-229406 Tel.: 05311- 278107 GM(O&M) Feroz Gandhi Unchahar Thermal Power Project-Unchahar Office: FGUTPP, NTPC Ltd, Unchahar, Distt. Raebareli, U.P.-229406 Tel.: 05311- 278107 FAX: 05311-291065
6. Salient features: a) Of the Project: b) Of the EMP:	Salient features of the project and environmental management plan are covered in Chapters 10 of EIA Report

	(copy already submitted).
7. Break up of the project affected population with enumeration of those losing Houses/ dwelling units only agricultural land only both dwelling units & agricultural land & landless laborers/artisans: a) SC/ ST/ Adivasi b) Others: (Please indicate whether these figures are based on any scientific and systematic survey carried out or only provisional figures, if a survey is carried out give details & year of survey)	NIL Project is expansion of coal based thermal power plant.
8. Financial details: a) Project cost as originally planned and subsequent revised estimates and the year of price reference b) Allocation made for EMP with item wise and year wise break-up	a) Project Cost as Originally Planned: Rs.2848.52 Crores (as on 2012). b) Allocation for EMP: Rs.304.32 Crores (for item wise break-up please refer **Annexure-36**) The EMP has been implemented as integral part of main plant package.
9. Forest land requirement: a) The status of approval for diversion of forest land for non- forestry use b) The status of clearing felling: c) The status of CA, if any: d) Comments on the viability & sustainability of CA program in the light of actual field experience so far	Nil (a) to (d) Not applicable as no Forest Land is involved in the project.
10. The status of clear felling in non-forest areas (Such as submergence area or Reservoir, approach Roads), if any with quantitative information required	Clear felling in non-forest areas were not required to be done.

11. Status of construction (Actual &/or planned): a) Date of commencement (Actual &/or planned): b) Date of completion (Actual &/or planned)	Date of award 13.08.2013 Actual date of COD of Stage IV-Unit #6: 30.09.2017

Status of Implementation of Conditions Stipulated in Environmental Clearance for FGUTPP Unchahar Thermal Power Project, Stage-IV (500 MW)

Sl. No	Specific Stipulation	Compliance Status (Oct'2025 to March'2026)
i	Soil salination due to seepage from canal around Umran Ash pond shall be addressed based on the findings made by IIT, Kharagpur and continuous monitoring for ground water quality around the ash pond shall be undertaken.	**Complied** A pump house has been commissioned for seepage water recycling. Regular monitoring of ground water quality around the ash pond is also being undertaken in-house as well as external reputed agencies such as IITR/TERI/NETEL/Hubert on regular basis. Soil Quality Analysis report is attached at **annexure-1(pg 1-2)**
ii	Environmental clearance is subject to obtaining clearance from the standing Committee of the National Board of Wildlife under the Wildlife Protection Act, 1972.	**Complied** NTPC Unchahar has obtained clearance from the Standing Committee of NBWL vide minutes of 32nd meeting dated 20.02.2015 Ref no 6-209,2014 WL-1**.** **Annexure-2(pg 3-6)**
iii	Conservation action plan for the Bird Sanctuary /Marshy area located in the study area, formulated in consultation with the concerned Department shall be immediately implemented.	**Being Complied** Conservation Plan for Bird Sanctuary /Marshy Land located in study area has already been prepared and submitted to MOEF & CC. The same is under deliberation with State Forest Department for implementation.

at Unchahar in District Rae Bareli in Uttar Pradesh

iv	Sulphur and ash contents in the coal to be used in the project shall not exceed 0.5 % and 34% respectively at any given time. In case of variation of coal quality at any point of time fresh reference shall be made to the Ministry for suitable amendments to environmental clearance condition wherever necessary.	**Complied** Based on notification dated 20.05.2022 condition relating to ash content in coal exceeding 34% has been removed. Sulphur content in coal reported as less than 0.5%. Coal Analysis Report from M/s Hubert Enviro Care System for March 2026 is attached as **annexure-3 (pg 7-9)** wherein Ash in Coal is 41.3% and Sulphur is 0.4%.
v	Bi-flue stack of 275 m height with flue gas velocity not less than 22 m/s shall be installed and provided with continuous online monitoring equipment's for SOx, NOx and PM2.5 & PM10. Mercury emissions from stack may also be monitored on periodic basis.	**Complied** Stack of 275 m height with exit flue gas velocity not less than 22 m/s has been installed. Further, Continuous Monitoring condition has been amended as per amendment in EC dated 21.10.2020 by MoEF&CC attached at **Annexure-4** (**pg 10-12**) Continuous online monitoring for SPM, SOx and NOx, has been installed and being monitored. Third party monitoring is being done regularly. Report attached at **Annexure-5(pg 13-14)**
vi	No mine void filling or filling up of low lying areas with fly ash shall be undertaken.	**Complied**
vii	COC of 5.0 shall be adopted and water requirement shall be restricted to maximum 35 cusecs only.	**Being Complied.** Efforts are being to maintain COC-5. Average water consumption for stg 4 is 9.74 cusecs for the period of Oct'25 to March'26 i.e. (7,15,420 M3/month) for stage 4 at PLF of 66.03%. Average water consumption is less than allowable specified limit.

viii	Special package with implementation schedule for providing free potable drinking water supply in the nearby villages and schools shall be undertaken in a time bound manner.	**Being Complied** Special package with implementation schedule for providing free potable drinking water supply in the nearby villages has been undertaken. 61 no over head tank with piped drinking water installation completed. **Annexure-6(pg-15)**
ix	Continuous monitoring of Ganga River quality shall be undertaken regularly and records maintained.	**Being Complied** Regular monitoring of Ganges River quality is being done. The report is being submitted to MoEF&CC from time to time Latest test report dated 24.01.2026 is attached at **Annexure-7(pg 16-17)**
X	The project proponent shall regenerate degraded water body (if any) located nearby within 5.0 km at least.	**Being Complied** The regeneration of the degraded water body (Pond) has already been taken up under R & R plan. "Kaithwal pond" Work is completed. Bikai pond restoration and beatification is also completed. Pond Restoration at Bhawanideenpur is also completed. Ref **Annexure-8(pg 18-20)**
xi	An amount of Rs 11.95 Crores as one time investment shall be earmarked for activities to be taken up under CSR during construction phase of the Project. Recurring expenditure for CSR thereafter shall be Rs 2.4 Crores per annum till the life of the plant. Social Audit by a reputed University or an Institute shall be carried out annually and details to be submitted to MoEF besides putting it on Company's website.	**Not applicable.** This condition was modified vide amended Environment clearance of MoEF & CC letter dated 21.10.2020. Refer **Annexure-4(pg 10-12)** CSR work enlisted against 11.95 crore as attached in **Annexure 8A**,(**pg-21)** till date 11.57 crore work completed. Social Audit Report attached at **Annexure 35.(pg 379-493)** New study awarded to Indian institute of corporate affair report awaited.

xii	As part of CSR activity, provision for supply of small fly ash brick making units in and around the ash dykes to few self-help groups for stoppage of clay brick making units to conserve natural clay, prevent air pollution as also furthering the use of fly ash by manufacturing fly ash bricks in and around the vicinity of the project besides providing sustenance to the locals.	**Being Complied.** One ash bricks plant installed near plant premises. **Annexure-8B(pg 22-24)** These stipulations have been included in CSR/ CD activities.
xiii	The company, in consultation with local authorities, should also develop a suitable marketplace out of one time CSR funds for local community at an appropriate location. the market infrastructure developed could possibly be allotted to the local community in rotation (such as weekly/ fortnightly/ monthly), so that more no. of locals including women are benefited from the same infrastructure. Besides their sustenance, this will go a long way to build a very high report with local community	**Complied** Work for development of a marketplace had already completed and handover to Gram Pradhan. Ref **Annexure-9(pg-25)**
xiv	To monitor the quality of ground water beneath the ash dyke, Piezometers should be installed within the ash dyke below the ground level. It is also important to know the amount of accumulated water beneath the ash. Periodic monitoring of water quality from marshes surrounding the ash dykes and Katiha drain, Allahabad and Pratapgarh Branches of Sharda Sahayak Canal and spillovers from spillways of ash dykes should be monitored.	**Being Complied.** Ground water monitoring has already being done through bore well, dug well & hand pumps nearby area of ash dyke. Existing ash dyke is being used for Stage-IV and no new ash dyke has been envisaged for Stage-IV. **Annexure-10(pg 26-31)** Piezometers has been installed in the existing ash dykes. **Annexure-11(pg32-39)** Monitoring report of Sharda Sahayak Canal report attached at **Annexure-12(pg 40)** The ground water monitoring is being carried out for all stages including Stage-IV and reports are being submitted regularly to regional office of MOEF&CC. Latest test report is attached at **Annexure-11(pg 32-39)**

(i)	Vision document specifying prospective plan for the site shall be formulated and submitted to the Regional Office of the Ministry within six months.	**Complied** Vision document submitted to MOEF&CC.
(ii)	Scheme for implementation for harnessing solar power within the premises of the plant particularly at available roof tops shall be formulated and status of implementation shall be submitted periodically to the Regional Office of the Ministry.	**Complied** 10 MW solar already installed in Arkha village. 1212.5 KWp Solar Plant at rooftop of Plant building is completed. **Annexure 13.(pg41-46)** Additionally, 7.8 MW solar roof top and ground mounted is under progress.
(iii)	Provision for installation of FGD shall be provided for future use.	**Complied** Stage IV, Unit#6 FGD installation completed. Trial operation successfully completed on 30.08.2022. FGD is under operation from 11.10.2022. Stage I FGD completed and under operation from 18.02.2025 Stage II & III FGD completed and under operation from 30.06.2025
(iv)	Coal transportation to plant site shall be undertaken by rail and no road transportation shall be permitted.	**Being Complied** Coal transportation is being undertaken through Rail only.

(v)	A long term study of radio activity and heavy metals contents on coal to be used shall be carried out through a reputed institute. Thereafter mechanism for an in-built continuous monitoring for radio activity and heavy metals in coal and fly ash (including bottom ash) shall be put in place.	Being Complied This condition has been modified vide EC amendment dated 21.10.2020 as Radioactivity and heavy metals content in coal and fly ash (including bottom ash) shall be carried out through a reputed institute once in a year and the analysis report to be submitted to the Ministry and its Regional Office. Accordingly, Radioactivity and Heavy metals contents in coal and fly ash (including bottom ash) have been carried out through a reputed institute. Radio activity contents report in coal and ash attached at **Annexure-14.(pg47-50)** Heavy metal content report in coal and ash attached at **Annexure-14**
(vi)	Utilization of 100% Fly Ash generated shall be made from 4th year of operation. Status of implementation shall be reported to the Regional Office of the Ministry from time to time.	**Being Complied** Ash being supplied to cement industries, ash bricks, to traders and for construction of roads of NHAI and UPEIDA etc. Ash utilization for FY 25-26 is 110.36 % **Annexure-15(pg-51)**
(vii)	High Efficiency Electrostatic Precipitators (ESPs) shall be installed to ensure that particulate emission does not exceed 50 mg/Nm^3.	**Complied** ESP with efficiency 99.955% has been installed. The PG test report in this regard is enclosed. **(Annexure-16)(pg-52)** Also, SPM levels at the outlet of ESP's are being continuously monitored and reported, which is again indicator of efficient functioning of ESP's. Emission level of SPM at Unit-VI is 12.6 mg/Nm3, Latest monitoring record attached at **annexure-17(pg53-59)**
(viii)	Adequate dust extraction system such as cyclones / bag filters and water spray system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	**Complied** Dust Extraction/Dust Suppression (DE/DS) system has been installed in CHP area. Cold fogging for dust suppression system is also installed. Dry fogging dust suppression system is also installed in wagon tippler. **Annexure-17A(pg60-61)**

(ix)	Fly ash shall be collected in dry from and storage facility (silos) shall be provided. Unutilized fly ash shall be disposed off in the ash pond in the form of slurry form. Mercury and other heavy metals (As, Hg, Cr, Pb etc.) will be monitored in the bottom ash as also in the effluents emanating from the existing ash pond. No ash shall be disposed off in low lying area.	**Being Complied** Dry Ash Evacuation System (DEAS) available for fly ash collection along with storage facility (silos). 100 percentage ash generated is being utilized in various avenues like Cement Industries, NHAI Road projects, Ash bricks and tiles manufacturer units etc. Mercury and Heavy metals in ash pond water and bottom ash are being regularly monitored, and reports are being submitted to MoEF and CC. Mercury and Heavy metals analysis reports in ash pond water and bottom ash attached at **Annexure-18.(pg62-63)** No ash is being disposed in low lying area.
(x)	Ash pond shall be lined with HDPE/LDPE lining or any other suitable impermeable media such that no leachate takes place at any point of time. Adequate safety measures shall also be implemented to protect the ash dyke from getting breached. Ash pond water shall be re- circulated and utilized.	**Not applicable** This condition was deleted vide EC amendment dated 25.01.2022. **Annexure-19(pg64-66)**
(xi)	Fugitive emissions shall be controlled to prevent impact on such that no agricultural/ non-agricultural land. Impact to any land shall be mitigated and suitable compensation provided in consultation with the local Panchayat.	**Being Complied** No ash pond is envisaged for Stage-IV. Existing ash dyke is being used for Stage-IV. To control fugitive emissions from ash dykes soil cover, grass cover, water blanket and water sprinkling is being done. Proposal has been initiated for installation of permanent sprinkling system.

(xii)	Hydrogeology of the area shall be reviewed annually from an institute / organization of repute to assess impact of surface water and ground regime (especially around ash dyke.) In case any deterioration is observed specific mitigation measures shall be undertaken and reports/ data of water quality monitored regularly and maintained shall be submitted to the Regional Office of the Ministry.	**Being Complied** Hydrogeology study (for 24-25) completed by Geoscience Consultancy Services Roorkee, Hydrogeological report for year 24-25, attached at **annexure-20(pg67-184)**
(xiii)	No ground water shall be extracted for use in operation of the power plant even in lean season.	**Complied.** No ground water is being extracted for operation of the plant.
(xiv)	No water bodies (including natural drainage system) in the area shall be disturbed due to activities associated with the setting up/operation of the power plant.	**Complied** No water bodies (including natural drainage system) in the area being disturbed due to activities associated with the setting up/ operation of the power plant.
(xv)	Regular monitoring of ground water level shall be carried out by establishing a network of existing wells and constructing new piezometers. Monitoring around the ash pond area shall be carried out particularly for heavy metals (Hg, Cr, As, Pb) and records maintained and submitted to the Regional Office of this Ministry. The data so obtained should be compared with the baseline data so as to ensure that the ground water quality is not adversely affected due to the project.	**Being Complied** Piezometers at ash dykes and in plant are installed and ground water levels are being monitored regularly. Analysis of Heavy metal in ground water around the ash pond area is being carried out regularly and report is being submitted. Heavy metal analysis report in ground water around the ash pond area attached at **Annexure-21 (pg185-188)**

(xvi)	Monitoring surface water quality in the area shall also be regularly conducted and records maintained. The monitored data shall be submitted to the Ministry regularly. Further, monitoring points shall be located between the plant and drainage in the direction of flow of ground water and records maintained. Monitoring for heavy metals in ground water shall be undertaken.	**Being Complied** Monitoring of surface water quality in the area is being regularly carried out and records have been maintained. Refer **Annexure-22(pg189-193)** The monitored data is being submitted to the Ministry regularly. For heavy metal, ground water hydrology report already submitted. Ground water analysis also covered in Groundwater hydrology report carried out by Geoscience Consultancy services Roorkee (**Annexure-20)(pg67-185)**
(xvii)	Minimum required environmental flow suggested by the Competent Authority of the state Govt. shall be maintained in the Channel/ Rivers (as applicable) even in lean season.	**Not applicable** Sharda Sahayak Canal is an artificial irrigation canal operated and maintained by UP Irrigation Department. The canal is closed for maintenance for about one month every year. Hence, this condition is not applicable to FGUTPP Unchahar.
(xviii)	The treated effluents conforming to the prescribed standards only shall be re- circulated and reused within the plant. Arrangements shall be made that effluents and storm water do not get mixed.	**Complied** The treated effluents conforming to the prescribed standards only are being re-circulated and reused within the plant. Arrangements have been made that effluents and storm water do not get mixed. An ETP of capacity 2400 m3/day provided for Stage-4. Effluents are being treated through Liquid Effluent Treatment Plant. Treated effluents are recycled and reused with in the plant and Zero Liquid Discharge is being ensured.

(xix)	Wastewater generated from the plant shall be treated before discharge to comply limits prescribed by the SPCB/CPCB.	**Complied** Effluents are being treated through Liquid waste treatment plant and parameters are well within limits as prescribed by SPCB/CPCB. **Annexure-23(pg194-200)**
(xx)	A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising green belt/plantation.	**Complied** 2 MLD Sewage Treatment Plant based on Moving Bed Biofilm Reactor is commissioned and kept in operation. The treated water from STP is being used in service water plant process as well as in green belt/plantation. STP treated water characteristics are attached at **annexure-24(pg201-204)**

(xxi)	The project proponent shall undertake rain water harvesting measures and shall develop water storage for use in operation of the plant. Rain water harvesting system shall be put in place which shall comprise of rain water collection from the built up and open area in the plant premises. Action plan for implementation shall be submitted to the Regional Office of the Ministry.	**Complied** ऊंचाहार/ Unchahar Requirement of rainwater harvesting(RWH) was reviewed by CGWB vide reference letter no 4(236)/CGWB/NR/S&I/04-1940 dated 02/09/2004 (**Annexure-25).(pg-205)** It is submitted that since the depth of ground water table is below 4.9 mbgl, RWH is not required. '*Contour study of ground water and recharge at NTPC Unchahar and its related area'* studied undertaken by IIT Roorkee in year 2022 It is concluded that the plant area and township area do not require an intense groundwater recharge system as the groundwater table is within a safe limit. (**Annexure-26)(pg206-247)** Rainwater harvesting system has been installed & commissioned at 05 buildings. Station has received rainfall during 25-26 is 758.55 mm. 5 No Pit has constructed at station covering an area of approximately 12316.2 m2. Rainwater harvested annually through this 5 no pit is approximately 8407.63 m3 (**Annexure-27**)(**pg-248)**
(xxii)	Additional soil for leveling of the proposed site shall be generated within the sited (to the extent possible) so that natural drainage system of the area is protected and improved.	**Not Applicable** No additional soil is required for the leveling.
(xxiii)	Common property resource falling in the vicinity of the project area shall be identified and if any common property resource (such as grazing land, pond etc.) is falling within the plant area and is unavoidable by its sheer location an equal area shall be first developed and handed over to the community.	**Not Applicable** Stage-IV constructed in the existing plant premises where no common property resources exist. Common property resources falling outside plant area has been included in CSR/CD activities under Stage-IV.

(xxiv)	Adequate safety measures shall be provided in the plant area to check/minimize spontaneous fires in coal yard, especially during summer season. Copy of these measures with full details along with location plant layout shall be submitted to the Ministry as well as to the Regional Office of the Ministry.	**Being Complied** Yard profile management, compaction with dozer and sprinkling of water is being done to avoid spontaneous fires in coal yard. Fire NOC vide ref no- यूआईडी संख्या: UPFS/2025/174495/RBL/RAEBARELI/1617/CFO dated 07.10.2025 is obtained and valid up to 14.10.2028 attached in **annexure-28(pg-249)**
(xxv)	Storage facilities for auxiliary liquid fuel such as LDO/HFO/LSHS shall be made in the plant area in consultation with department of Explosives, Nagpur; Sulphur content in the liquid fuel will not exceed 0.5%. Disaster Management Plan shall be prepared to meet any eventuality in case of an accident taking place due to storage of oil.	**Being Complied** Storage facilities for auxiliary liquid fuel such as LDO/HFO/LSHS have been made in the plant area in consultation with department of Explosives, Nagpur and License having reference no P/HQ/UP/15/563/(P7960) is valid till 31.12.2028.(**Annexure-29)(pg250-252)** Sulphur content in coal reported within prescribed limits (**Ref annexure-3**). Disaster Management Plan (DMP) prepared, reviewed and approved by management on dated 09.06.2023 to meet any eventuality in case of an accident taking place due to storage of oil. DMP attached at **Annexure-30(pg253-358)**
(xxvi)	First Aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.	**Complied** First Aid and sanitation arrangements provided to manpower involved in construction for Stage-IV.

(xxvii)	Noise levels emanating from turbines shall be limited to 85 dB (A) from source. For people working in the high noise area, shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc. shall be periodically examined to maintain audiometric record and for treatment for any hearing loss including shifting to non noisy/less noisy areas.	**Being Complied** Design specifications for the equipment's has been made to comply with the stipulations. Noise levels from turbines in work zone being maintained within prescribed limits of 85 dB (A) from source. Noise levels are being monitored regularly and are within the prescribed limit. Noise level report attached at **Annexure-31**.(**pg-359)** For people working in the generator area and other high noise area, personal protective equipment like earplugs being provided. Periodic health examination of workers also being done.
(xxviii)	Regular monitoring of ambient air ground level concentration of SO2, NOx, PM2.5 & PM10 and Hg shall be carried out in the impact zone and record maintained. If at any stage these levels are found to exceed the prescribed limits, necessary control measures shall be provide immediately. The location of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB. Periodic reports shall be submitted to the Regional office of this Ministry. The data shall also be put on the website of the company.	**Being Complied** Regular monitoring of ambient air quality of SO2, NOx, PM2.5, PM10 and Hg is being done through MOEF and CC accredited third party lab and records maintained. Adequate control measures have also been ensured to control exceedance if any. Three nos. of CAAQMS stations have been also installed at main-plant and township locations in consultation with SPCB. Ambient air monitoring data also being uploaded regularly on NTPC website under the Half yearly EC Compliance report. Ambient air monitoring reports in the impact zone attached at **annexure-32** (**pg360-365)**
(xxix)	Green Belt consisting of 3 tiers of plantations of native species around plant not less than 100m width shall be raised (except in areas not feasible). The density of trees shall not less than 2500 per ha with survival rate not less than 80%.	**Being Complied** Stage-IV unit has been established within the existing premises of Stage-I, II and III, for which green belt has already been provided. Greenbelt development in 129.08 Ha has been developed. Plantation and related promotional activity are a continuous process at NTPC Unchahar. Additionally, 49,500 number of tree plantation completed in FY 2022-23, 45,000 in FY2023-24 and 45000 in FY 2025-26 in nearby villages through Divisional Director, Social Forestry,

		Raebareli. Completion certificate of tree plantation attached at (**Annexure-33**)(**pg366-373)**
(xxx)	An Environmental Cell comprising of at least one expert in environmental science/ engineering, occupational health and a social scientist, shall be created preferably at the project site itself and shall be headed by an officer of appropriate superiority and qualification. It shall be ensured that the Head of the Cell shall directly report to the head of the organization who would be accountable for implementation of environmental regulations and social impact improvement / mitigation measures.	**Complied** An Environment Management Group (EMG) headed by Additional General Manager (EMG) reporting to the Head of Plant is already functional at site.

फिरोज गांधी ऊंचाहार थर्मल पावर प्रोजेक्ट, ऊंचाहार, जिला – राय बरेली, उ०प्र० – 229406
फ़ैक्स/ FAX: 05311-291065 तार/ Cable : THERMPOWER
Feroz Gandhi Unchahar Thermal Power Project, Unchahar, Distt. Raebareli, U.P.-229406
पंजीक्रत कार्यालय: एन०टी०पी०सी० भवन, स्कोप कॉम्प्लेक्स 7, इन्स्टीट्यूशल एरिया लोदी रोड, नई दिल्ली – 110003

(xxxi)	The project proponent shall also adequately contribute in the development of the neighbouring villages. Special package with implementation schedule for providing potable drinking water supply in the nearby villages and schools shall be undertaken in a time bound manner.	**Being Complied** ऊंचाहार/ Unchahar **Education** One of our most prominent initiative is our Flagship Program Girl Empowerment Mission (GEM) targeted for the empowerment of the girl child wherein interventions were taken to make the girls self-reliant and confident in all walks of life. Every year rural youth in the vicinity are selected and provided vocational training to enhance their employability. They are primarily trained in tailoring, cosmetology, auto repairing, computer and repair of home appliances. Agri-based training are also conducted for enhancing the livelihood opportunities. We had installed sanitary napkin vending machine and incinerator in schools. Schools were equipped by providing Dual desk cum benches and classrooms have been constructed. Bicycles were distributed to the economically weaker and disadvantaged sections of girl students to improve their physical access to school. NTPC supports the educational needs of children with disabilities from underprivileged backgrounds by selecting few students of surrounding villages every year and admitting them in the township schools with scholarship. To ensure access to separate sanitation facility for students, toilets were constructed separately for boys and girls in surrounding government schools. **Sanitation** To promote hygienic environment through prevention of open defecation and reduce the incidence of water-borne diseases, 100 household toilets were constructed in the nearby villages. In addition to this, community toilets have been also constructed. As our contribution towards our Prime Minister's Swachh Bharat Abhiyan, we distributed dustbins in affected villages and railway station Unchahar & Rae Bareilly.

		Health ऊंचाहार/ Unchahar Regular health camps were organized in nearby villages. In addition to this, specific camps such as rehabilitation camp (disable person), respiratory camp, family planning camp, dental camp, cancer awareness/detection camp etc. were conducted. We have undertaken the repair and maintenance of CHCs and have also equipped them with required medical equipment. In order to ensure nourishment to children, we distributed about 3000 protein powder packets to the needy through Anganwadi. **Water** Various activities to provide drinking water such as installation of handpumps, borewells, setting up of piped drinking water with overhead tank etc. has been taken up by the station. **Social Infrastructure** We had undertaken the construction of public utility buildings such as community centers, Panchayat Bhawan, Bharat Ghar, library etc. We have also undertaken the repair & maintenance of PHC, CHC, school buildings, ponds etc. along with the installation of solar streetlights and high mast lights in surrounding villages, construction of roads in nearby villages and railway over bridge in Unchahar station. **Activities undertaken by NTPC Unchahar with special focus on drinking water** Water is one of the focus areas for taking up NTPC CSR 's activities for bringing maximum value to the society. NTPC Unchahar has undertaken various activities to provide drinking water with an aim of ensuring accessibility of potable drinking water in

		adequate quantity on regular and sustainable basis leading to improvement in living standards of communities in the vicinity of our Projects. Since 2016, we have targeted the construction of about 110 piped drinking water structures for a period of five years with a total award value of about Rs. 450 lakhs/-. Out of these, 65 structures have been completed. The remaining works are under progress. **Ref Annexure-34(pg374-378)**
(xxxii)	CSR scheme shall be undertaken based on need based assessment in and around the villages within 5 km of the site and in constant consultation with the village Panchayat and the District Administration.	**Being Complied** CSR projects are generally formulated based on need assessment and consultation with local Panchayat/ District Administration/ Village Development Advisory Committee (VDAC)/ Community/ Public Representative.
(xxxiii)	As part of CSR employment of local youth after imparting relevant training as may be necessary shall be undertaken as committed.	**Being Complied** Every year rural youth/women in the vicinity are being provided vocational training to enhance their employability. They are being trained in tailoring, cosmetology, auto repairing, computer and repair of home appliances etc. Agri-based training are also conducted for enhancing the livelihood opportunities.

(xxxiv)	It shall be ensured that an in-built monitoring mechanism for the CSR schemes identified is in place and annual social audit shall be got done from the nearest government institute of repute in the region. The project proponent shall also submit the status of implementation of the scheme from time to time. The achievements should be put on company's website.	**Complied** There is three tier in-house monitoring mechanism for the CSR schemes. Monitoring of work by Site-RR (Headed by HOHR-AGM), RED-RR, Corporate-RR and CSR departments (Headed by ED). Social audit externally also being done once in three years. Latest Social audit report is enclosed at **Annexure-35**.**(pg379-493)**
(xxxv)	Provision shall be made for the housing of construction labor (as applicable) within the site with all necessary infrastructures and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structure to be removed after the completion of the project.	**Being Complied.** Housing with necessary infrastructure facilities had been provided for construction labour during construction phase and was kept under the scope of EPC contractor. Whereas NTPC ensures effective compliance of the said stipulations. Project is under Operational phase at present.
(xxxvi)	The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned within seven days from the date of this clearance letter, informing that the project has been accorded environmental clearance and copies of clearance letter are available with the State Pollution Control Board/Committee and may seen at Website of the Ministry of Environment and Forests at http://envfor.nic.in.	Complied. The information of Environmental Clearance was published in two newspapers widely circulated in the region. Attached at annexure-
(xxxvii)	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila parishad/ Municipal Corporation, urban local body and the Local NGO, if any, from whom suggestions/representations, if any, received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.	Complied

(xxxviii)	The proponent shall upload the status of compliance of the stipulated environmental clearance conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MOEF, the respective Zonal Office of CPCB and the SPCB. The criteria pollutant levels namely, SPM, RSPM (PM2.5 & PM10), SO2, NOx (ambient levels as well as stack emissions) shall be displayed at a convenient location near the main gate of the company in the public domain.	**Complied.** ऊंचाहार/ Unchahar The latest status report of Compliance to the stipulated Environmental Clearance (EC) conditions is regularly uploaded on NTPC website. Compliance status report also submitted to the Regional Office of the MOEF&CC and offices of CPCB and UPPCB regularly every six months. Criteria pollutant levels are being displayed on LED display system available at the main gate of the power plant.
(xxxix)	The environment statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of environmental clearance conditions and shall also be sent to the respective Regional Offices of the Ministry by e-mail.	**Complied** The environmental statements for Stage-I, II, III, IV are being regularly submitted to UPPCB. Environment statement is also uploaded at the NTPC website under the Half-yearly compliance report of environmental clearance conditions. Env statement for 24-25 has been submitted via email on your official e-mail address rocz.lko-mef@nic.in on dated 11.09.2025
(xl)	The project proponent shall submit six monthly reports on the status of the implementations of the stipulated environmental safeguards to the Ministry of Environment and Forests, its Regional Office, Central Pollution Control Board and State Pollution Control Board. The project proponent shall upload the status of compliance of the environment of the environmental clearance conditions on their website and update the same periodically and simultaneously send the same by email to Regional office, Ministry of Environment and Forests.	**Being Complied** The Six-monthly EC compliance report is being submitted regularly at PARIVESH portal of MOEFCC. Six-monthly EC compliance reports are being uploaded on the NTPC website periodically.
(xli)	Regional office of the Environment & Forests will monitor the implementation of the stipulated	**Being Complied.** All documents related to Environmental Clearance of Feroze Gandhi Unchahar

	conditions. A complete set of documents including Environmental Impact Assessment Report and Environment Management plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring. Project proponent will up-load the compliance status in their website and up-date the same from time to time at least six-monthly basis. Criteria pollutants levels including NOx (from stack & ambient air) shall be displayed at the main gate of the power plant.	Thermal Power Project, Stage-IV had already been submitted. Six-monthly EC compliance reports are being uploaded on the NTPC website periodically. Criteria pollutant levels are being displayed on LED display system available at the main gate of the power plant.
(xlii)	Separate funds shall be allocated for implementation of environmental protection measures along with item-wise break–up. These cost shall be included as part of the project cost. The funds earmarked for the environment protection measures shall not be diverted for other purpose and year-wise expenditure should be reported to the ministry.	**Complied.** Separate funds have been allocated for implementation of environmental protection measures and included as part of the project cost in Feasibility Report of the project. The funds earmarked for the environment protection has fully utilized. Expenditure of environment protection measures attached at **Annexure-36(pg-494)**
(xliii)	The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and final approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant.	**Complied.** NTPC Unchahar Stage-IV declared Commercial Operation on 30.09.2017.
(xliv)	Full cooperation shall be extended to the Scientists/officers from the Ministry / Regional Office of the Ministry/ CPCB /SPCB who would be monitoring the compliance of environmental status.	**Complied.** Full cooperation is being extended to the Scientists/officers from the Ministry / Regional Office of the Ministry/ CPCB /SPCB who would be monitoring the compliance of environmental status.
	Compliances against amendment letter dated 21.10.2020	
i	The condition No xi of EC dated 10.05.21013 regarding CSR expenditure is hereby deleted.	**Complied**
ii	The condition number v of EC dated 10.05.2013 is modified as " Bi-flue stack of 275 meter height with flue gas velocity not less than 22 meter per second shall be installed and	**Complied** Stack of 275-meter height with flue gas exit velocity not less than 22 m/s have been installed and provided with continuous online monitoring equipment's

	provided with continuous online monitoring equipment's for Sox, NOx and PM. Mercury emission from stack may also be monitored on periodic basis"	for SOx NOx and PM. Mercury emission from stack monitored on periodic basis. Ref **annexure 17(pg-53-59)** Mercury reported below detection level.
iii	The total Radioactivity in the working areas such as coal stockyard, fly ash pond shall be calculated based on the analysis results per unit weight of coal/ash. The total radioactivity in the atmosphere is to be compared with maximum permissible dosage levels of each person working in those areas. This is to be conducted once in a year	**Being Complied** This report has already submitted in your office earlier half yearly compliance period for April'22 to Sep'22 vide email dated 28.12.2022 on your official email ID: rocz.lko-mef@nic.in Radioactivity survey has been completed in June'2025 by Board of Radiation & Isotope Technology, Dept. of atomic energy-Mumbai. and report dtd June 2025 attached at **annexure-37.(pg495-504)**
iv	While commissioning the proposed unit, the compliance of revised emission norms issued vide Notification dated 07.12.2015 and as amended time to time shall be achieved along with specific water consumption as per the notification dated 28.06.2018. The FGD system and NOX control measures such as SCR/SCNR/De-NOX burners shall be installed to achieve the revised emission norms.	**Being Complied.** The efforts are under progress to achieve the emission norms. FGD successfully commissioned on date 30.08.2022 and is in operation. For NOx control measures, Combustion modification in stage-4 boiler completed in March'24.
v	As per the Revised Tariff Policy notified by Ministry of Power vide dated 28.01.2016, project proponent shall explore the use of treated sewage water from the Sewage Treatment Plant of Municipality/ local bodies/ similar organization located within 50 km radius of the proposed power project to minimize the water drawl from surface water bodies. The details of Sewage Treatment Plants located within 50 km radius along with the capacities shall be submitted.	**Being Complied.** STP of capacity 18 MLD at Raebareli is under operation. For the supply of STP treated water, matter is taken up with Jal Nagar Nagam, Raebareli. Pre-feasibility Report for the same has already been submitted by Jal Nigam (Urban). MOU in between Jal Nigam (Urban) Govt. of Uttar Pradesh and NTPC Unchahar also signed on dated 24.11.2023 for the use of 18 MLD STP treated water. NTPC has given Rs. 10.0 Lakhs to the Jal Nigam-Raebareli for preparation of Detailed Project Report (DPR). DPR submitted by Jal Nigam is under deliberation, crossing of NHAI and Irrigation canal approval is under progress from respective department. **Annexure-38**

vi	**EC Amendment Issued on 25.01.2022** (i) General Condition no. (x) Ash Pond shall be lined with HDPE/LDPE lining or any other suitable impermeable media such that no leachate takes place at any point of time. Adequate safety measures shall also be implemented to protect the ash dyke from getting breached. Ash pond water shall be re-circulated and utilized **shall not applied** to the Feroz Gandhi Unchahar Thermal Power project Stage-IV (500 MW) until new ash pond is formed.	**Noted**	ऊंचाहार/ Unchahar

Additional conditions recommended by SCNBWL dated 21.01.2015

a. Pointwise compliance status of the five conditions imposed by SWLW

S.N.	Condition	Status of implementation
i	Ash water effluent must be treated to avoid pollution.	**Complied.** The entire ash water effluent is being treated and reused in the process of ash slurry disposal. Ash water recirculation system (AWRS) employed for effluent and ash water recycle and reuse at Arkha ash dyke for Rs.21.83 crores. AWRS at Umran was already in service. However, auxiliary pipe work worth Rs 2.77 crore has been

		undertaken to bypass the open channel flow from Umran dyke to AWRS.
ii	The effluent shall not be released in Pratapgarh Branch of Sahayak canal which is connected to Samaspur Bird Sanctuary.	**Complied.** Effluent is not released into the Pratapgarh branch or any other canal. All the main plant effluent is treated in ETP and recycled. The details of various effluent treatment systems are as follows. • Effluent from coal handling area is being treated in coal slurry settling pond having capacity 2050 m3 and treated water is being reused in dust suppression system. • Entire process water effluent is being treated in lamella clarifier and treated water is used in service water. • Sewage Treatment Plant with 2 MLD capacity based on MBBR technology is under operation.
iii	A greenbelt should be developed around the plant and outside Samaspur Bird Sanctuary at the project cost to abate air pollution. Planting site for this purpose shall be identified by concerned DFO/ protected area manager.	**Complied.** A total of 15.12 lakh trees have been planted by NTPC Unchahar till the financial year 2025-26. Every year around 45000 trees are planted in the land identified by DFO Raibarelly. So far Rs 12.08 crore has been spent on plantation work. NTPC with the help of DFO Raebareli has planted 45000 trees in the area identified by DFO Raibarelly with a cost of Rs.82.22 lakh in this FY25-26. 45000 no tree plantation for FY 25-26 is completed near Arkha and around plant area.
iv	The user agency shall be responsible for any loss of flora/ fauna in the surroundings	**Noted.** However, the project and all its activities including transportation of coal/ ash/ other materials are located in Southern direction while the sanctuary is located at 7.9 km. from the project in North Eastern direction. In fact, the project and its associated activities provide employment/ self-employment opportunities to local people thereby reducing the impacts of local population on the sanctuary.

v	Any other condition prescribed by Chief Wildlife Warden from time to time in the interest of conservation, protection/ development of forest/ wildlife habitat.	Agreed and shall be complied as per CWLW directions.
	a. As recommended by SCNBWL on 21.01.2015, PAs have not submitted 2% of the project cost to CWLW till date for conservation of protected area of Samaspur Bird Sanctuary, however, the project is operational since 2017	**Under consideration with NBWL.** The matter regarding review of the condition regarding the deposition of 2% of project cost has been challenged in High Court Delhi as all of components of project are outside the eco-sensitive zone of Samaspur bird sanctuary. Matter is under sub judice at Delhi High Court and next hearing date is on 25.08.2026

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7. SOIL QUALITY

7.1 Soil Quality – Test Results

Soil sample was Collected from project site for analysis of Chemical parameters and the Parameter details were mentioned in Table 7.2

7.2 Methodology of Sampling and Analysis

The Soil samples was collected on **24/01/2026** from site with proper observations of appearance, texture, etc. as per the sampling guidelines and submitted to the Waste Water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Unit	Test Protocol
1	Arsenic	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
2	Cadmium	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
3	Chromium	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
4	Chromium	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
5	Copper	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
6	Lead	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
7	Mercury	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
8	Nickel	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
9	Zinc	mg/kg	HECS-G/INS/SOP/ 042 Issue No.:01Issue Date:01.03.2021
10	Soil Texture-Sand, Slit, Clay	%	FAO of United Nations, Rome Chapter - III 2008
11	pH Value @ 25 ° C (1 : 2.5)	-	IS 2720 (Part 26) 1987
12	Electrical conductivity @ 25 ° C (1 : 2)	µS/cm	IS 14767: 2000
13	Organic Carbon	%	IS 2720 (Part 22) Section I 1972
14	Available Potassium	mEq/100g	FAO of United Nations, Rome Chapter - III 2008
15	Chlorides	mEq/L	FAO of United Nations Rome 2007
16	Total Nitrogen as N	%	IS 14684 Clause 4 1999
17	Exchangable Magnesium as Mg	mEq/L	FAO of United Nations, Rome Chapter - III 2008
18	Available Sodium as Na	mg/kg	International Centre for Agriculture Research (ICARDA): 2013
19	Cation Exchange Capacity	mEq/100g	IS 2720 (Part 24) Clause 5 1976
20	Moisture	%	HECS-G/ENV/SSW/SOP/003 Issue No.:01 Issue Date:02:07: 2020
21	Sulphate	mg/100g	IS 2720 Part 27 Clause 4 1977
22	Phosphorous	µg/g	FAO of United Nations, Rome Chapter - III 2008

7.3 The following tables explain the test results as per the given sample description:

Sample Description No.	**HECS/PE/116/270126**
Sample Mark	**Arkha**
Type of Sample	Soil
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**ICARDA:2013**

Sample ID			**270126507**
Sampling Date			**24/01/2026**
S. No.	**Parameters**	**Unit**	**Arkha**
1	Arsenic	mg/kg	0.57
2	Cadmium	mg/kg	BLQ (LOQ: 0.1)
3	Chromium	mg/kg	5.15
4	Copper	mg/kg	84.66
5	Lead	mg/kg	6.74
6	Mercury	mg/kg	BLQ (LOQ: 0.1)
7	Nickel	mg/kg	8.91
8	Zinc	mg/kg	12.04
9	Soil Texture	-	Clay
10	Soil Texture i)Sand	%	26.3
11	Soil Texture ii)Silt	%	30.6
12	Soil Texture iii)Clay	%	43.1
13	pH Value @ 25 ° C (1 : 2.5)	-	7.28
14	Electrical conductivity @ 25 ° C (1 : 2)	µS/cm	251.0
15	Organic Carbon	%	0.52
16	Available Potassium	mEq/100g	24.32
17	Chlorides	mEq/L	9.46
18	Total Nitrogen as N	%	0.0018
19	Exchangable Magnesium as Mg	mEq/L	29.74
20	Available Sodium as Na	mg/kg	68.4
21	Cation Exchange Capacity	mEq/100g	3.2
22	Sulphate	mg/100g	20.14
23	Phosphorous	µg/g	BLQ(LOQ 5.0)
24	Moisture	%	3.62

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/kg: milligram per Kilogram, % - Percentage.

End of Report

HUBERT ENVIRO CARE SYSTEMS (I) LIMITED Chennai 600 032

Government of India
Ministry of Environment, Forests and Climate Change
(Wildlife Division)

6th Floor, Vayu Wing
Indira Paryavaran Bhawan
Jor Bag Road, Aliganj
New Delhi-110003

F.No.6-209.2014 WL-I (32nd Meeting)
Dated: 20th February 2015

To
All Members,
Standing Committee of NBWL.

Sub: Minutes of 32nd Meeting of Standing Committee of NBWL.

Sir/Madam,

Kindly find enclosed copy of the minutes of the 32nd Meeting of the Standing Committee of National Board for Wildlife held on 21st January 2015 at 3.00 P.M. in "Narmada & Satluj", Ground Floor, Jal Block, Indira Paryavaran Bhawan, Jor Bagh, New Delhi-110003 under the chairmanship of Hon'ble Minister of State (Independent Charge) for Environment, Forests and Climate Change.

Yours faithfully,

R. Rajasekhar 20/02/2015

(Rajasekhar Ratti)
Scientist 'C'/Deputy Director (WL)

Encl: As above

Distribution:

1. Secretary, MoEF & CC
2. Director General of Forests & Special Secretary, MoEF & CC.
3. Member Secretary, NTCA, New Delhi.
4. Addl. Director General of Forests (WL), MoEF&CC.
5. Director, Wildlife Institute of India, Dehradun.
6. Director, GEER Foundation, Gandhinagar, Gujarat.
7. Prof. R.Sukumar, Central for Ecological Sciences, Indian Institute of Science, Bangalore.
8. Dr. H.S. Singh, Gandhi Nagar, Gujarat.
9. Pr. Secretary (Forests), Government of Andhra Pradesh, Hyderabad.

Copy to:

1. PPS to Hon'ble MOS (I/C) E&F.
2. PPS to DGF&SS.
3. PPS to Addl.DGF(WL) and Member Secretary, Standing Committee (NBWL).
4. PPS to IGF(WL)/PS to DIG(WL)/PS to JD(WL).

32.4.2 (27). Collection of River Bed Material (RBM) from the river bed of Ganga river at Pilli (131.31 ha) distt. Haridwar, Uttarakhand.

Member Secretary briefed the committee regarding the proposals. He mentioned that the five proposals are for collection /mining of RBM may be helpful to channelize the natural course of the river and to protect river banks and adjoining forest area and habitat from floods along the Rawasal River (Part –I & Part –II), Bishanpur and river bed of Ganga at Shyampur and Pilli. Chief Wildlife Warden explained that the SBWL recommended the all five proposals in its meeting held on 16th March 2013.

In view of vulnerability of the river course where illegal sand mining and collection has an environmental concern, after discussion the Standing Committee decided to defer the proposals and also decided that a team comprising, Prof.R.Sukumar, Inspector General, NTCA and PCCF(WL) Uttarakhand will undertake a site visit to evaluate the Environment Impact Assessment, Environment Clearance related conditions and possible implications of the proposal and submit the report to the Standing Committee of NBWL.

32.4.2 (28).Clearance to expansion of existing coal based power project by adding one unit 500 MW under stage IV of NTPC Ltd Feroz Gandhi Unchahar, Uttar Pradesh. (within 10 kms from Samaspur bird Sanctuary)

The Member Secretary briefed the committee regarding proposal. He mentioned that the proposal is adding one unit of 500MW under stage –IV of NTPC Ltd and the existing plant, stages I,II & III of capacity 1050 MW (2 ×210MW +2 ×210 MW + 210 MW), located 7.9 km away from the Samaspur Bird Sanctuary.

Chief Wildlife Warden explained that application for Terms of Reference for EIA study for stage IV has been submitted to MoEF. SBWL recommended the proposal in its meeting held on 21st October 2013 with stipulated conditions:

- *Ash water effluent must be treated to avoid pollution.*
- *The effluent shall not be released in Pratapgarh Branch of Sahayak canal which is connected to Samaspur Bird Sanctuary.*
- *A greenbelt should be developed around the plant and outside Samaspur Bird Sanctuary at the project cost to abate air pollution. Planting site for this purpose shall be identified by concerned DFO/protected area manager .*

Minutes of 32nd Meeting of SC NBWL dated 21.01.2015

Annexure-2

F.No.6-209/2014 WL (32nd Meeting)
Government of India
Ministry of Environment, Forests & Climate Change
Wildlife Division
****

6th Floor, Vayu Wing
Indira Paryavaran Bhawan
Jor Bag Road, Aliganj
New Delhi-110003
Dated: 25.02.2015.

To

The Principal Secretary (Forests),
Department of Forests,
Government of Uttar Pradesh,
Secretariat, Lucknow-226001.

Sub: Minutes of the 32nd Meeting of Standing Committee of NBWL.

Sir,

During the 32nd Meeting of Standing Committee of NBWL held on 21st January 2015 under the Chairmanship of Hon'ble Minister of State (Independent Charge) for Environment, Forests and Climate Change, the following proposals pertaining to your State were considered. The relevant portion of the decision taken in respect of the proposals is reproduced below:

"1. ***Clearance to expansion of existing coal based power project by adding one unit 500 MW under stage IV of NTPC Ltd Feroz Gandhi Unchahar, Uttar Pradesh. (within 10 kms from Samaspur bird Sanctuary)***

The Member Secretary briefed the committee regarding proposal. He mentioned that the proposal is adding one unit of 500MW under stage –IV of NTPC Ltd and the existing plant, stages I,II & III of capacity 1050 MW (2 ×210MW +2 ×210 MW + 210 MW), located 7.9 km away from the Samaspur Bird Sanctuary.

Chief Wildlife Warden explained that application for Terms of Reference for EIA study for stage IV has been submitted to MoEF. SBWL recommended the proposal in its meeting held on 21st October 2013 with stipulated conditions:

- *Ash water effluent must be treated to avoid pollution.*
- *The effluent shall not be released in Pratapgarh Branch of Sahayak canal which is connected to Samaspur Bird Sanctuary.*
- *A greenbelt should be developed around the plant and outside Samaspur Bird Sanctuary at the project cost to abate air pollution. Planting site for this purpose shall be identified by concerned DFO/protected area manager.*
- *The user agency shall be responsible for any loss of flora/fauna in the surroundings.*
- *Any other condition prescribed by Chief Wildlife Warden from time to time in the interest of conservation, protection /development of forest /wildlife habitat.*

Agenda/Mr. D.P. Singh.
Ms
for DIG(WL)
2.3.15
2/3 Ms

Contd....2

DM

After discussions, the Standing Committee recommended the proposal subject to implementation of mitigation measures and the conditions stipulated by the CWLW and Environment Clearance obtained under E(P)A,1986 and EIA Notification 2006, for which an amount of 2% of the project cost shall be placed with the Chief Wild Life Warden by the user agency.

2. ***Diversion of 0.1575 ha of forestland from Chambal Wildlife Sanctuary for laying of Optical Fiber Cable for mobile phone connectivity between Udimore to Chambal river on NH-92 Etawah Gwalior River, Uttar Pradesh by Bharti Airtel Ltd.***

The Member Secretary briefed the Committee regarding the proposal. The Chief Wildlife Warden, Uttar Pradesh mentioned that the proposal involved use of 0.1575 ha. of forest land from Chambal River Sanctuary, for laying optical fibre cable for mobile connectivity along the existing NH-92. He said that the proposal was also recommended by the State Board for Wildlife.

After discussion and considering the fact that the optical fibre was being laid along the existing National Highway, the Standing Committee decided to recommend the proposal subject to the following mitigatory measures, as stipulated by the Chief Wildlife Warden:

i. *User Agency will ensure that none of their employee/worker shall indulge into any kind of illegal activities. If this happens then user agency shall be held responsible.*
ii. *Necessary measures will be taken to negate the impact relating any environmental pollution/radioactive pollution as suggested by the Chief Wildlife Warden.*
iii. *The legal status of the land shall remain unchanged.*
iv. *In reference of U.P. Govt. order no.4862/14-2/2008 dated 12.11.2008, the use agency shall take up plantation on 20 km in three lines and maintain the green cover with the project cost. Planting site and species/ planting plan for this purpose will be indicated by Chief Wildlife Warden.*
v. *The forest land shall not be used for any other purpose other than that specified in the proposal.*
vi. *No labour camp shall be established in the sanctuary area.*
vii. *No work shall be allowed after sunset till sunrise.*
viii. *No tower shall be erected without legal permission"*

The above recommendation(s) are subject to the existing directives of Hon'ble Supreme Court and provisions of Forests (Conservation).Act, 1980.

Yours faithfully

R. Raja sekhar

(Rajasekhar Ratti)
Scientist 'C'/Deputy Director (WL)

Copy to:

1. The Chief Wildlife Warden, Government of Uttar Pradesh, 17, Rana Pratap Marg, Lucknow-226001.
2. The Addl.Pr.Chief Conservator of Forests, Ministry of Environment & Forests, Regional Office(CZ), Kendriya Bhandar, 5th Floor, Sector-H, Aliganj, Lucknow-226020, U.P.
3. The Joint Secretary, I.A. Division, MoEF & CC.
4. The Inspector General of Forests, FC Division, MoEF &CC.

R. Raja sekhar

(Rajasekhar Ratti)
Scientist 'C'/Deputy Director (WL)

5. COAL ANALYSIS

5.1 Coal samples were collected from project site for Chemical and heavy metal analysis and the detailed parameter mentioned in 5.2 table.

5.2 Methodology of Sampling and Analysis for Coal

The coal samples were collected on **30/03/2026** as per the sampling guidelines and submitted to the Waste water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Unit	Test Protocol
1	Chromium	mg/kg	HECS-G/INS/SOP/042
2	Cobalt	mg/kg	HECS-G/INS/SOP/042
3	Copper	mg/kg	HECS-G/INS/SOP/042
4	Nickel	mg/kg	HECS-G/INS/SOP/042
5	Tin	mg/kg	HECS-G/INS/SOP/042
6	Titanium	mg/kg	HECS-G/INS/SOP/042
7	Antimony	mg/kg	HECS-G/INS/SOP/042
8	Arsenic	mg/kg	HECS-G/INS/SOP/042
9	Cadmium	mg/kg	HECS-G/INS/SOP/042
10	Lead	mg/kg	HECS-G/INS/SOP/042
11	Zinc	mg/kg	HECS-G/INS/SOP/042
12	Fluorine	mg/kg	Inhouse method
13	Nitrogen	mg/kg	Inhouse method
14	Ash	mg/kg	Inhouse method
15	Sulphur	%	Inhouse method
16	Sodium	mg/kg	Inhouse method
17	Gross calorific value	mg/kg	Inhouse method
18	Moisture	-	Inhouse method
19	Volatile Matter	%	Inhouse method
20	Fixed carbon	mg/kg	Inhouse method
21	Mercury	%	HECS-G/INS/SOP/042

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5.3 Coal Analysis – Test Results

The following tables explain the test results as per the given sample description:

Sample Description No.	**HECS/PE/037/010426**
Sample Mark	**R.C Feeder Unit-1**
Type of Sample	Coal Sample 1
Date of Sampling	30/03/2026
Test Parameters	As per Scope of Work
Sampling Method	**Inhouse Method**

Sample ID		**010426082**
Sampling Date		**30/03/2026**
S. No.	**Parameters**	**R.C Feeder Unit-1**
1	Chromium	8.45
2	Cobalt	2.75
3	Copper	107.35
4	Nickel	6.72
5	Tin	0.42
6	Titanium	BLQ(LOQ0.1)
7	Antimony	BLQ(LOQ0.1)
8	Arsenic	0.75
9	Cadmium	0.22
10	Lead	13.25
11	Zinc	29.87
12	Fluorine	96.8
13	Nitrogen	1.36
14	Ash	41.3
15	Sulphur	0.40
16	Sodium	0.28
17	Gross calorific value	4128.0
18	Moisture	3.42
19	Volatile Matter	31.62
20	Fixed carbon	35.76
21	Mercury	BLQ(LOQ 0.1)

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification,mg/kg-milligram per kilogram.

End of Report

HUBERT ENVIRO CARE SYSTEMS (I) P. LTD. Chennai 600 032

5.4 Coal Analysis – Test Results

The following tables explain the test results as per the given sample description:

Sample Description No.	**HECS/PE/038/010426**
Sample Mark	**PLCP Rake Unloading Area**
Type of Sample	Coal Sample 2
Date of Sampling	30/03/2026
Test Parameters	As per Scope of Work
Sampling Method	**Inhouse Method**

Sample ID		**010426083**
Sampling Date		**30/03/2026**
S. No.	**Parameters**	**PLCP Rake Unloading Area**
1	Chromium	8.73
2	Cobalt	4.00
3	Copper	89.54
4	Nickel	6.74
5	Tin	0.43
6	Titanium	BLQ(LOQ 0.1)
7	Antimony	BLQ(LOQ0.1)
8	Arsenic	1.32
9	Cadmium	0.27
10	Lead	15.63
11	Zinc	36.55
12	Fluorine	96.28
13	Nitrogen	1.42
14	Ash	39.8
15	Sulphur	0.33
16	Sodium	0.31
17	Gross calorific value	4258.0
18	Moisture	3.42
19	Volatile Matter	30.16
20	Fixed carbon	37.82
21	Mercury	BLQ(LOQ 0.1)

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification,mg/kg-milligram per kilogram.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

F.No. J-13012/50/2010-IA.II(T)
Government of India
Ministry of Environment, Forest and Climate Change

3rd Floor, Vayu Block,
Indira Paryavaran Bhawan, Jor Bagh Road,
Aliganj, New Delhi-110003

Dated: 21.10.2020

To

Dr. Vijay Prakash, General Manager
M/s NTPC Ltd., Environmental Engineering Department
Engineering Office Complex, Plot No. A-8A, Sector – 24
Noida – 201 301.

Tel. No. 0120-2410331; E-mail: environment.ntpc@gmail.com

Sub: **500 MW (Stage-IV) Coal Based Feroz Gandhi Unchahar Thermal Power Station in Villages Babhanpur & Niranjanpur, Tehsil Unchahar, Raebareli District, Uttar Pradesh by M/s NTPC Ltd.- reg. amendment in EC.**

Sir,

The undersigned is directed to refer your online application Nos. IA/UP/THE/107452/2019 dated 07.06.2019, for amendment in Environmental Clearance (EC) to waive off the recurring CSR expenditure, & to amend the conditions regarding monitoring of Radio activity and flue gas from the Stack.

1. It has been noted that the Environmental Clearance to 500 MW Unchahar Thermal Power Project was accorded vide Ministry's letter dated 10.5.2013. The specific condition Nos.v & xi and General condition No.v of the said EC are as follows:

"Specific Condition No.v: Bi-flue stack of 275 m height with flue gas velocity not less than 22 m/s shall be installed and provided with continuous online monitoring equipments for SOX, NOX, PM2.5 & PM10. Mercury emissions from stack may also monitored on periodic basis."

"Specific Condition No.xi: An amount of Rs.11.95 Crores shall be earmarked as one time capital cost for CSR programme as committed by the project proponent. Recurring expenditure of Rs.2.4 Crores per annum till the life of the plant. Social audit by a reputed University or an Institute shall be carried out annually and details to be submitted to MoEF besides putting it on Company's Website."

"General Condition No.v: A long term study of radio activity and heavy metals contents on coal to be used shall be carried out through a reputed institute. Thereafter mechanism for an in-built continuous monitoring for radio activity and heavy metals in coal and fly ash (including bottom ash) shall be put in place."

2. It has been noted that you have requested for amendment in the above mentioned conditions. It has been informed that the continuous online instruments are not available for monitoring Radio-activity and heavy metal analysis in the Coal. Further, it has been informed that there is no technology available for continuous monitoring of flue gas for PM10 and PM2.5 separately. Further, it has been informed that the recurring CSR expenditure stipulated in the EC may be aligned with the provisions of Section 135 of Companies Act, 2013 which stipulates the mandatory spending of at least two per cent of the average net profits of the company made during the three immediately preceding financial years.

3. The above proposals for amendment in EC have been considered by the EAC (Thermal Power) in its meeting held on 26.6.2019. In acceptance of the recommendations of the EAC (Thermal Power) and in view of the decision taken in the Ministry w.r.t. CSR expenditure, ***the Ministry hereby grants the amendments in ECs dated* 10.05.2013 *with the following additional conditions***:

i. The condition No.xi of EC dated 10.05.2013 regarding CSR expenditure is hereby deleted.

ii. The condition No.v of EC dated 10.05.2013 is modified as:

"Bi-flue stack of 275 m height with flue gas velocity not less than 22 m/s shall be installed and provided with continuous online monitoring equipment's for SO_X, NO_X, PM. Mercury emissions from stack may also monitored on periodic basis."

iii. The General condition No.v of EC dated 10.5.2013, is modified as:
"Radio activity and heavy metals' contents in coal and fly ash (including bottom ash) shall be carried out through a reputed institute once in a year and the analysis reports to be submitted to the Ministry and its Regional Office."

iv. The total Radio-activity in the working areas such as coal stock yard, flyash pond shall be calculated based on the analysis results per unit weight of coal/ash. The total radio-activity in the atmosphere is to be compared with the maximum permissible dosage levels of each person working in those areas. This is to be conducted once in a year.

v. While commissioning the proposed unit, the compliance of revised emission norms issued vide Notification dated 07.12.2015 and as amended time to time shall be achieved along with specific water consumption as per the notification dated 28.06.2018. The FGD System and NOX control measures such as SCR/SCNR/De-NOX burners shall be installed to achieve the revised emission norms.

vi. As per the Revised Tariff Policy notified by Ministry of Power vide dated 28.01.2016, project proponent shall explore the use of treated sewage water from the Sewage Treatment Plant of Municipality/ local bodies/ similar organization located within 50 km radius of the proposed power project to minimize the water drawl from surface water bodies. The details of Sewage Treatment Plants located within 50 km radius along with the capacities shall be submitted.

4. All other conditions stipulated in the EC letter vide No.J-13012/50/2010-IA.II(T) dated 10.05.2013 shall remain the same as applicable.

This issues with the approval of the Competent Authority.

Yours faithfully,

(Dr. S. Kerketta)
Director (IA.I)

Copy to:

1. The Chairman, Central Pollution Control Board, Parivesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032.

2. The Deputy Director General of Forests (C), Ministry of Environment Forest and Climate Change, Regional Office (Central Zone), Kendriya Bhawan, 5th Floor, Sector – H, Aliganj, Lucknow-226020.
3. The Chairman, U.P. Pollution Control Board, PICUP Bhawan, 3rd Floor, B-Block, Vibhuti Khand, Gomti Nagar, Lucknow-226010.
4. Guard file/Monitoring file.
5. Website of MoEF&CC.

Director (IA.I)

2.2 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**FDG ST-1 (Outlet)**
Type of Sample	Stack Monitoring
Date of Sampling	**27/03/2026**
Test Parameters	As per scope of work

Sample ID			**010426055**
Sampling Date			**27/03/2026**
S.No.	**Particulars**	**FDG ST-1 (Outlet)**	**FDG ST-1 (Outlet)**
1	StackHeight	Meter	180
2	StackDiameter	Meter	6.0
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	80
5	Duct Area	Meter	43.5

Discipline : Chemical				
S.No.	**Test Parameters**	**Units**	**FDG ST-1 (Outlet)**	**CPCB Standards**
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	12.4	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	20.9	-
10	Oxygen (O2)	%	7.6	-
11	Particulate matter (PM)	mg/Nm³	17.3	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	139	-
13	Nitrogen dioxide (NO2)	mg/Nm³	450.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	931745.0	-
15	Fluegas Temperature	°C	49.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

2.3 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**FDG ST-II (Outlet)**
Type of Sample	Stack Monitoring
Date of Sampling	**28/03/2026**
Test Parameters	As per scope of work

Sample ID			**010426056**
Sampling Date			**28/03/2026**
S.No.	**Particulars**	**FDG ST-II (Outlet)**	**FDG ST-II (Outlet)**
1	StackHeight	Meter	210
2	StackDiameter	Meter	6.0
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	140
5	Duct Area	Meter	65.29

Discipline : Chemical				
S.No.	**Test Parameters**	**Units**	**FDG ST-II (Outlet)**	**CPCB Standards**
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	11.7	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	19.1	-
10	Oxygen (O2)	%	7.3	-
11	Particulate matter (PM)	mg/Nm³	24.2	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	124.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	475.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	866050.0	-
15	Fluegas Temperature	°C	48.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

एनटीपीसी ने दी जल आपूर्ति योजना की सौगात

एनटीपीसी अपने मूल लक्ष्य विद्युत उत्पादन के साथ-साथ सामाजिक सरोकारों के प्रति सदैव संवेदनशील भावना से कार्य करती है। नैगम सामाजिक दायित्व के अंतर्गत निरंजनपुर गांव में पेयजल आपूर्ति योजना का लोकार्पण करते हुए मानव संसाधन प्रमुख वंदना चतुर्वेदी ने उक्त विचार व्यक्त किए। अपने उद्बोधन में श्रीमती चतुर्वेदी ने ग्रामवासियों को बताया कि एनटीपीसी आसपास के गांवों में बुनियादी सुविधाएं मुहैया करवाने की दिशा में लगातार प्रयासरत है। इसी कड़ी में निरंजनपुर गांव में नैगम सामाजिक दायित्व के तहत बनाए गए पेयजल आपूर्ति योजना को ग्रामवासियों को सौंपा जा रहा है। मुझे पूर्ण विश्वास है कि इस योजना से जहां ग्रामवासियों को शुद्ध पीने का पानी उपलब्ध होगा वहीं दूसरी ओर सबको इसका लाभ भी मिलेगा।

3.2.1 Stream Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganga UP Stream Water**
Type of Sample	Surface Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126501**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Ganga Up Stream**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	37.11	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.5	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	392.0	NA	NA
7	Fluoride as F(mg/l)	0.27	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.61	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	45.0	NA	NA
13	Temperature(°C)	26.6	NA	NA
14	Total dissolved solids (mg/l)	219.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	120.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

3.2.2 Stream Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganga DOWN Stream Water**
Type of Sample	Surface Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126502**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Ganga Down Stream**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	26.72	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.6	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	365.0	NA	NA
7	Fluoride as F(mg/l)	0.25	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.67	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	27.0	NA	NA
13	Temperature(°C)	26.1	NA	NA
14	Total dissolved solids (mg/l)	204.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	105.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

Water Conservation Activities of NTPC Unchahar

1. Water bodies rehabilitation and rejuvenation in nearby villages /villages.

A. Regeneration of water body (Pond) at Kaithwal

Water bodies form important surface water storage. The existing ponds and lakes available in the Rural Local Bodies have been silted over the years and thereby make the water bodies less functional for recharge. Apart from available rainwater and reuse of treated wastewater, waterbodies (lakes, ponds) especially in rural areas have enormous value in terms of resource provision (for drinking or irrigation), regulating services (climate mediation, flood and drought management) and cultural service (religious, historic value). However, these lakes and ponds are extremely sensitive to environmental stress caused by anthropogenic activities in the basin or catchment, which reduces the natural capacity of the waterbody to restore itself and results in its deterioration.

Benefits:

- Comprehensive improvement and restoration of water bodies thereby increasing pond storage capacity.
- Groundwater recharge.
- Increased availability of drinking water.
- Improvement in catchment areas of pond commands.
- Environmental benefits through improved water use efficiency by promotion of conjunctive use of surface and groundwater.
- Community participation and self-supporting system for sustainable management for each water body.
- Capacity building of communities, in better water management. Development of tourism, cultural activities etc

B. Regeneration of Bikai Pond

Over the years Bikai village pond depleting and getting contaminated at a rapid pace due to the development of the town and growing up weeds around the pond.

The pond has reduces his water holding capacity so ultimately the groundwater recharge is also affected. NTPC is trying to restore/recharge the groundwater by developing this pond through its capacity and enhancing its beautification for the people's benefit.

NTPC Unchahar taken up for in-situ treatment of lake/pond water through Bioremediation or equivalent technology to be taken a holistic approach that looks at the multiple facets of a waterbody: as a water storage and recharge structure in preserving and enhancing water resources and thereby enhancing water security

The pond Restoration, Renovation & beautification works are in progress include removal of fine silt and sediment that has collected in a pond in order to restore its natural capacity, de-weeding, erecting a barbed wire fencing around the pond, making a pathway for morning and evening walkers, installing benches and landscaping and plantation around those ponds.

Before

After

C. Regeneration of Murarmau Pond

The restoration, reconstruction, renovation, and beautification of the Shiv Sarovar Pond, located under Bhawanidinpur Village of Muraramau Gram Panchayat, Unchahar Tehsil, Rae Bareli District, was carried out by NTPC. The work, costing ₹74.18 lakh, was executed by the Jal Nigam as the project implementation agency under the Sustainable Development Programme.

The inauguration ceremony of this pond was held on, January 15, 2026, at 12:00 noon, with the Chief Guest being the Head of the Unchahar Project.

With the growing population, the condition of water sources is becoming increasingly critical, and it is essential that we preserve them. To tackle the challenges of drinking water scarcity and drought, groundwater recharge is extremely important. The ponds developed by us will truly prove cost-effective only when they are used for drinking water supply and drought mitigation.

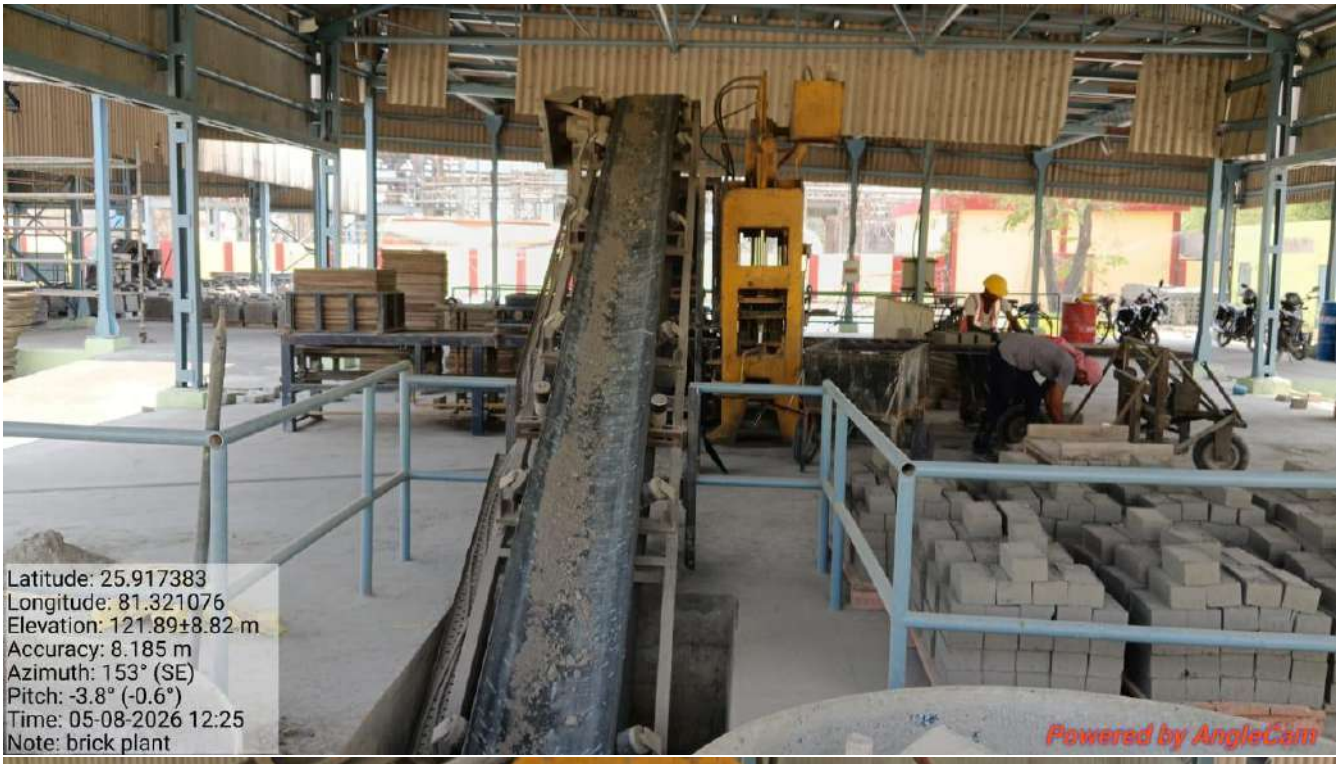
Before

After

Expenditure Status R&R / CD Activities- Stage IV Unchahar (All fig. Rs Lakhs)

SN	Name of activity	Existing Cost provisions	Award Value	Expenditure upto 31.03.2024
	1	**2**	**3**	
1	Solar lighting	**113.73**		
a	Solar street lights in surrounding villages	98.73	98.73	98.73
b	Solar street lights in village Purwara	15.00	10.00	10.00
2	Sanitation/Toilets/Drains etc.	**95.07**		
a	Girl's toilets in schools (12 No's)	35.98	35.98	31.15
b	Individual toilets in surrounding villages(300)	59.09	40.00	36.06
3	**Infrastructure Development(** Roads/Community Buildings/Bridges)	**664.29**		
a	Railway Overbridge	152.25	152.25	152.25
b	Road from gate no 5 to purwara via Biakai	227.00	227.00	227.00
c	Internal & approach road Purwara	318.02	318.02	361.00
4	Infrastructure upgradation- Medical/Crematorium/ mortuary / burn unit.	**74.16**	74.16	36.28
5	Development of suitable market place	**79.43**	**79.43**	88.00
6	Regeneration of Degraded water body	**110.52**	**110.52**	117.00
7	Provision for small fly ash brick making units.	**29.82**	**25.00**	0.00
		1200.00		**1157.47**

Annexure-8B


Latitude: 25.917383
Longitude: 81.321076
Elevation: 121.89±8.82 m
Accuracy: 8.185 m
Azimuth: 153° (SE)
Pitch: -3.8° (-0.6°)
Time: 05-08-2026 12:25
Note: brick plant
Powered by AngleCam

Latitude: 25.9173
Longitude: 81.321126
Elevation: 121.89±49.6 m
Accuracy: 2.2 m
Azimuth: 65° (NE)
Pitch: -7.2° (-1.3°)
Time: 05-08-2026 12:27
Note: brick plant
Powered by AngleCam

Latitude: 25.91723
Longitude: 81.321254
Elevation: 121.89±20.8 m
Accuracy: 2.35 m
Azimuth: 158° (S)
Pitch: -19.2°
Time: 05-08-2026 12:28
Note: brick plant
Powered by AngleCam

Latitude: 25.917256
Longitude: 81.321363
Elevation: 121.89±23.6 m
Accuracy: 1.766 m
Azimuth: 167° (S)
Pitch: -13.4° (-4.5°)
Time: 05-08-2026 12:29
Note: brick plant
Powered by AngleCam

Latitude: 25.917251
Longitude: 81.321188
Elevation: 121.89±26.6 m
Accuracy: 6.872 m
Azimuth: 348° (N)
Pitch: -9.5° (-0.7°)
Time: 05-08-2026 12:28
Note: brick plant
Powered by AngleCam

Inauguration of SABKA BAZAAR

"The growth and development of people is the highest calling of leadership"

On the occasion of 30th NTPC Unchahar Raising Day Sabka Bazar : Haat was inaugurated in village Umran which shall generate direct employment for more than 500 people from nearby communities.The Haat: Sabaka Bazar was wholeheartedly welcomed by all Gram Pradhans of 15 Gram Panchayatas as they have always shown support and reinforcement for NTPC Unchahar CSR initiatives.In the very same prodigious and gigantic Haat: Sabka Bazar,

Mega Health Camp and Eye Screening Camp was deployed which catered the health needs of about 500 community people with specially women and children to whom medicines along with cloth bags including sanitizer kit (Facemask, sanitizers and Soap) was distributed by the Dignitaries on this significant and prominent day of NTPC Unchahar. CGM Unchahar Shri Kamlesh Soni, GM (O&M) Shri Arindam Banerjee, GM (Maintenance) Shri SK Jha, GM (Project) Shri SK Mandal, GM (FM) Shri KD Yadav, GM (NSA) Shri AK Dang, HOHR Smt. Vandana Chaturvedi, President, Priyadarshini Ladies Club Smt. Anu Soni and other senior dignitaries were also present at the event.

6.14 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Manirawpur Prathamic Vidyalaya (Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126489**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Manirawpur Prathamic Vidyalaya (Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	55.42	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.6	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	841.0	NA	NA
7	Fluoride as F(mg/l)	0.43	1.0	1.5
8	Iron as Fe (mg/l)	0.064	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.60	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	70.0	NA	NA
13	Temperature(°C)	26.4	NA	NA
14	Total dissolved solids (mg/l)	471.0	500	2000
15	Total Suspended Solids (mg/l)	3.0	NA	NA
16	Total hardness as CaCO3 (mg/l)	290.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.15 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganghera Primary Path Sala(Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126490**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Ganghera Primary Path Sala(Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	56.91	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.4	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	984.0	NA	NA
7	Fluoride as F(mg/l)	0.46	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.31	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	85.0	NA	NA
13	Temperature(°C)	26.2	NA	NA
14	Total dissolved solids (mg/l)	551.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	340.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.16 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganghera Bazar Chedilal Home (Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126491**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Ganghera Bazar Chedilal Home (Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	43.54	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.7	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	525.0	NA	NA
7	Fluoride as F(mg/l)	0.31	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.61	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	71.0	NA	NA
13	Temperature(°C)	26.5	NA	NA
14	Total dissolved solids (mg/l)	294.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	210.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.17 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Madaripur (Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126492**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Madaripur (Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	17.81	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.7	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	591.0	NA	NA
7	Fluoride as F(mg/l)	0.27	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.62	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	45.0	NA	NA
13	Temperature(°C)	26.4	NA	NA
14	Total dissolved solids (mg/l)	329.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	190.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.18 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Baherwa Rajaram Mandir School (Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		270126493	IS 10500 : 2012	
Sampling Date		24/01/2026		
S. No.	**Parameters**	**Baherwa Rajaram Mandir School (Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	43.54	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.7	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	981.0	NA	NA
7	Fluoride as F(mg/l)	0.44	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.61	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	65.0	NA	NA
13	Temperature(°C)	26.8	NA	NA
14	Total dissolved solids (mg/l)	490.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	340.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYST. Chennai 600 032 LIMITED

6.19 PLANT & TOWNSHIP WATER – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Hand Pump (Village)**
Type of Sample	PLANT & TOWNSHIP WATER
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126494**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Umran Hand Pump (Village)**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	98.97	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.8	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	816.0	NA	NA
7	Fluoride as F(mg/l)	0.41	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.66	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	84.0	NA	NA
13	Temperature(°C)	26.8	NA	NA
14	Total dissolved solids (mg/l)	456.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	170.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

6.4 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Toe Drain**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**121125029**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Toe Drain**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	3.0	30	350	100
7	Chemical Oxygen Demand (COD)	20.0	250	-	-
8	Chloride as Cl-	38.7	1000	1000	600
9	Dissolved Oxygen	6.8	-	-	-
10	Electrical Conductivity @ 25 ° C	512.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.32	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	328.0	2100	2100	2100
17	Total suspended solids @ 105° C	18.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.5 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Toe Drain**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426073**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Toe Drain**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	6.0	30	350	100
7	Chemical Oxygen Demand (COD)	36.0	250	-	-
8	Chloride as Cl-	48.9	1000	1000	600
9	Dissolved Oxygen	6.4	-	-	-
10	Electrical Conductivity @ 25 ° C	436.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.18	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	302.0	2100	2100	2100
17	Total suspended solids @ 105° C	16.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT Enviro CARE SYSTEMS LIMITED Chennai 600 032

6.6 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke (AWRS)**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426074**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Dyke (AWRS)**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	4.0	30	350	100
7	Chemical Oxygen Demand (COD)	20.0	250	-	-
8	Chloride as Cl-	24.9	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	470.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.42	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	302.0	2100	2100	2100
17	Total suspended solids @ 105° C	24.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.7 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke (AWRS)**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426075**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke (AWRS)**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	5.0	30	350	100
7	Chemical Oxygen Demand (COD)	32.0	250	-	-
8	Chloride as Cl-	69.8	1000	1000	600
9	Dissolved Oxygen	6.6	-	-	-
10	Electrical Conductivity @ 25 ° C	516.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.12	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	348.0	2100	2100	2100
17	Total suspended solids @ 105° C	13.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

6.8 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke Piezometer Well-11**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426076**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke Piezometer Well-11**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	5.0	30	350	100
7	Chemical Oxygen Demand (COD)	28.0	250	-	-
8	Chloride as Cl-	34.8	1000	1000	600
9	Dissolved Oxygen	6.2	-	-	-
10	Electrical Conductivity @ 25 ° C	420.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.12	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	272.0	2100	2100	2100
17	Total suspended solids @ 105° C	10.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

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6.9 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke Piezometer Well-02**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426077**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke Piezometer Well-02**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	6.0	30	350	100
7	Chemical Oxygen Demand (COD)	36.0	250	-	-
8	Chloride as Cl-	39.9	1000	1000	600
9	Dissolved Oxygen	6.4	-	-	-
10	Electrical Conductivity @ 25 ° C	456.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.18	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	296.0	2100	2100	2100
17	Total suspended solids @ 105° C	6.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

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6.10 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke Piezometer Well-01**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426078**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Dyke Piezometer Well-01**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	3.0	30	350	100
7	Chemical Oxygen Demand (COD)	24.0	250	-	-
8	Chloride as Cl-	49.7	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	620.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.28	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	386.0	2100	2100	2100
17	Total suspended solids @ 105° C	4.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

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6.11 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke Piezometer Well-02**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426079**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Dyke Piezometer Well-02**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	3.0	30	350	100
7	Chemical Oxygen Demand (COD)	16.0	250	-	-
8	Chloride as Cl-	32.7	1000	1000	600
9	Dissolved Oxygen	6.4	-	-	-
10	Electrical Conductivity @ 25 ° C	586.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.42	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	390.0	2100	2100	2100
17	Total suspended solids @ 105° C	7.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

3.3.1. Canal Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Intake Canal Water**
Type of Sample	Surface Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126504**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Intake Canal Water**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	16.33	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.7	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	360.0	NA	NA
7	Fluoride as F(mg/l)	0.27	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.94	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	45.0	NA	NA
13	Temperature(°C)	26.4	NA	NA
14	Total dissolved solids (mg/l)	198.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	110.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ:0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ:0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
25	Salmonella (Per 100ml)	Absent	NA	NA
26	Shigella (Per 100ml)	Absent	NA	NA
27	Vibrio cholerae(Per 100ml)	Absent	NA	NA
28	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

Solar Project

A. Roof Top Solar Project - 1212.5 KWp

S.No.	Location	PV Capacity (KWp)	SPV Modules				Solar Invertors			
			Qty	Rating	Make	Model	Qty	Rating	Make	Model
1	New ADM Building	120	204	CEL	300Wp	PM300	3	20	Fronius	Symo 20.0-3 480
	Oild ADM Building		153	CEL	300Wp	PM300	2	20	Fronius	Symo 20.0-3 480
	IT Building		51	CEL	300Wp	PM300	1	20	Fronius	Symo 20.0-3 480
2	New O&M store	126.75	390	CEL	320Wp	PM320	2	60	Growatt	MAX60KTL3 LV
3	Ash Slurry Pump House Building	196.95	606	CEL	320Wp	PM320	3	60	Growatt	MAX60KTL3 LV
4	Fire Pump House Building	31.2	96	CEL	320Wp	PM320	1	30	Growatt	MAX60KTL3 LV
5	RODM Plant Building	31.2	96	CEL	320Wp	PM320	1	30	Growatt	MAX60KTL3 LV
6	PT & Chlorination Plant Building	31.2	96	CEL	320Wp	PM320	1	30	Growatt	MAX60KTL3 LV
7	Switchyard Building	21.45	66	CEL	320Wp	PM320	1	20	Growatt	MAX60KTL3 LV
8	ESP Building	30.55	94	CEL	320Wp	PM320	1	30	Growatt	MAX60KTL3 LV
9	Chemical Building	31.2	96	CEL	320Wp	PM320	1	30	Growatt	MAX60KTL3 LV
10	U-3&4 DDCIMS	32	128	Renesola	250Wp	JC250M				
11	DAV Building	360	1059	ibsolar	340Wp	Fortuner340	2	100	Deye	SUN-100K-G03
							1	60	Deye	SUN-60K-G
12	TG Building	200	589	ibsolar	340Wp	Fortuner340	1	100	Deye	SUN-100K-G03
							1	60	Deye	SUN-60K-G

Admin Building

Old Admin Building

New O&M Store Building

Latitude: 25.913687
Longitude: 81.320581
Elevation: 82.2±20 m
Accuracy: 12.9 m
Azimuth: 53° (NE)
Pitch: -2.4° (3.5°)
Time: 05-05-2023 12:30
Note: new O&M Store buildi

Stg IV Switchyard Building
Azimuth: 10° (N)
Pitch: -7.3° (2.1°)
Time: 05-05-2023 12:26
Note: stg 4 switch yard building
Powered by AngleCam

FWPH Building Stage IV
Latitude: 25.91093
Longitude: 81.318943
Elevation: 69.8±19 m
Accuracy: 8.1 m
Azimuth: 85° (E)
Pitch: -2.2° (2.6°)
Time: 05-05-2023 12:59
Note: fire water building stg 4 building
Powered by AngleCam

Ash Water Building Stg IV
Latitude: 25.911997
Longitude: 81.321648
Elevation: 82.2±22 m
Accuracy: 374.7 m
Azimuth: 71° (E)
Pitch: 2.8° (3.0°)
Time: 05-05-2023 12:43
Note: Ash water building stg4 building

Stg IV RO Building
Latitude: 25.911268
Longitude: 81.31962
Elevation: 205.3±438 m
Accuracy: 21.0 m
Azimuth: 32° (NE)
Pitch: -9.8° (7.0°)
Time: 05-05-2023 12:58
Note: RO stg 4 building
Powered by AngleCam

Ash Water Building Stg IV
Latitude: 25.911997
Longitude: 81.321648
Elevation: 82.2±22 m
Accuracy: 374.7 m
Azimuth: 71° (E)
Pitch: 2.8° (3.0°)
Time: 05-05-2023 12:43
Note: Ash water building stg4 building

B. 10 MWp Solar Plant at Arkha

5. COAL & ASH ANALYSIS

Coal samples were collected from project site for Chemical and heavy metal analysis and the detailed parameter mentioned in 5.2 table.

Ash samples were collected from project site for Chemical and heavy metal analysis and the detailed parameter mentioned in 5.3 table.

5.2 Methodology of Sampling and Analysis for Coal

The coal samples were collected on 27/12/2025 as per the sampling guidelines and submitted to the Waste water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Unit	Test Protocol
1	Chromium	mg/kg	HECS-G/INS/SOP/042
2	Cobalt	mg/kg	HECS-G/INS/SOP/042
3	Copper	mg/kg	HECS-G/INS/SOP/042
4	Nickel	mg/kg	HECS-G/INS/SOP/042
5	Tin	mg/kg	HECS-G/INS/SOP/042
6	Titanium	mg/kg	HECS-G/INS/SOP/042
7	Antimony	mg/kg	HECS-G/INS/SOP/042
8	Arsenic	mg/kg	HECS-G/INS/SOP/042
9	Cadmium	mg/kg	HECS-G/INS/SOP/042
10	Lead	mg/kg	HECS-G/INS/SOP/042
11	Zinc	mg/kg	HECS-G/INS/SOP/042
12	Mercury	mg/kg	HECS-G/INS/SOP/042
13	Alpha emitters	microcurie/ml	Inhouse method
14	Beta emitters	microcurie/ml	Inhouse method

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5.3 Methodology of Sampling and Analysis for Ash

The Ash samples were collected on **27/12/2025** as per the sampling guidelines and submitted to the Waste water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Unit	Test Protocol
1	Zinc	mg/kg	HECS-G/INS/SOP/042
2	Chromium	mg/kg	HECS-G/INS/SOP/042
3	Copper	mg/kg	HECS-G/INS/SOP/042
4	Nickel	mg/kg	HECS-G/INS/SOP/042
5	Cadmium	mg/kg	HECS-G/INS/SOP/042
6	Cobalt	mg/kg	HECS-G/INS/SOP/042
7	Arsenic	mg/kg	HECS-G/INS/SOP/042
8	Lead	mg/kg	HECS-G/INS/SOP/042
9	Mercury	mg/kg	HECS-G/INS/SOP/042
10	Tin	mg/kg	HECS-G/INS/SOP/042
11	Antimony	mg/kg	HECS-G/INS/SOP/042
12	Titanium	mg/kg	HECS-G/INS/SOP/042
13	Alpha emitters	microcurie/ml	Inhouse method
14	Beta emitters	microcurie/ml	Inhouse method

5.4 Coal and Ash Analysis For Heavy Metal– Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Coal and Ash for Heavy metal**
Type of Sample	Coal and Ash
Date of Sampling	27/12/2025
Test Parameters	As per Scope of Work
Sampling Method	**Inhouse Method**

Sample ID		**291225168**	**291225166**	**291225167**
Sampling Date		**27/12/2025**	**27/12/2025**	**27/12/2025**
S. No.	**Parameters**	**Coal Sample**	**Fly Ash**	**Bottom Ash**
1	Chromium	9.04	11.14	12.08
2	Cobalt	1.02	0.67	0.57
3	Copper	70.44	6.48	7.13
4	Nickel	6.44	6.62	7.42
5	Tin	0.21	2.01	0.57
6	Titanium	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)
7	Antimony	BLQ(LOQ 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
8	Arsenic	0.68	5.62	6.21
9	Cadmium	BLQ(LOQ 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
10	Lead	5.87	3.10	1.54
11	Zinc	21.08	4.24	3.13
12	Mercury	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification,mg/kg-milligram per kilogram.

End of Report

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5.5 Coal and Ash Analysis For Radioactive Elements– Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Coal and Ash for Radioactivity test**
Type of Sample	Coal and Ash
Date of Sampling	27/12/2025
Test Parameters	As per Scope of Work
Sampling Method	**Inhouse Method**

Sample ID		**291225163**	**291225164**	**291225165**
Sampling Date		**27/12/2025**	**27/12/2025**	**27/12/2025**
S. No.	**Parameters**	**Coal Sample**	**Fly Ash**	**Bottom Ash**
1	Alpha emitters	BLQ(LOQ 0.00000000001)	BLQ(LOQ 0.00000000001)	BLQ(LOQ 0.00000000001)
2	Beta emitters	BLQ(LOQ 0.0000000001)	BLQ(LOQ 0.0000000001)	BLQ(LOQ 0.0000000001)

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification,mg/kg-milligram per kilogram.

End of Report

Annexure-15

STATUS OF FLY ASH GENERATION AND ITS UTILIZATION

Name of Station: Feroz Gandhi Unchahar Thermal Power Station, Unchahar

S. No.	Month	Coal Consumed (Ton)	Ash Produced (Ton)	Ash Utilized (Ton)	% Ash Utilized
1	Total / Year **FY 2021-22**		**2084804**	**3318831**	**159.19**
2	Total / Year **FY 2022-23**	**5718639**	**2019459**	**2086131**	**103.30**
3	Total / Year **FY 2023-24**	**5619799**	**2093304**	**2893627**	**138.23**
4	Total / Year **FY 2024-25**	**6983988**	**2752719**	**2785220**	**101.18**
5	Total / Year **FY 2025-26**	**6483667**	**2640607**	**2914288**	**110.36**

Ash Utilization for FY 25-26

S. No.	Month	Coal Consumed (MT)	Ash Content %	Ash Produced (MT)	Ash Utilized (MT)	% Ash Utilized
1	Apr/25	617599	41.12	253957	239005	94.11
2	May/25	600010	41.66	249964	154636	61.86
3	Jun/25	625155	41.51	259502	182160	70.20
4	Jul/25	631664	40.06	253045	197320	77.98
5	Aug/25	599577	41.33	247805	184464	74.44
6	Sep/25	472475	40.59	191778	305653	159.38
7	Oct/25	471554	41.30	194752	314723	161.60
8	Nov/25	452865	39.31	178021	216447	121.58
9	Dec/25	537207	39.83	213970	257341	120.27
10	Jan/26	559965	40.69	227850	266079	116.78
11	Feb/26	490832	40.69	199720	290782	145.60
12	Mar/26	424764	40.08	170245	305678	179.55
	Total / Year	**6483667**	**40.73**	**2640607**	**2914288**	**110.36**

ESP Procedure

SECTION 2.4.0

2.4.0 SAMPLE CALCULATION

SAMPLE DATA

Sl. No	Parameters		GUARANTEE POINT VALUE	MEASURED VALUE
1.	Total flue gas flow,	m^3/s	803.1	868
		Nm^3/s	550.87	602.4
2.	Flue gas temperature	Deg.C	125	128.0
3.	Inlet dust concentration	G/Nm^3	57.9	51.37
4.	Outlet emission	$mgNm^3$	20	23
5.	Sulphur in coal	%	0.40	0.25
6.	Ambient temperature	Deg.C	27	29
7.	Theoretical gas flow calculated for test coal, V_m	m^3/s		868.0
		Nm^3/s		590.9

CALCULATION OF TEST EFFICIENCY CORRECTED TO GUARANTEE POINT CONDITION

Measured efficiency, Em = ((51.37 – 0.023) /51.37) * 100 = **99.955%.**

The procedure for correcting measured efficiency at test condition to design condition as follows:

2.4.1 CORRECTION TO GAS FLOW CALCULATED FOR TEST COAL:

The gas flow measured during the test is considered as Vm and measured efficiency is corrected to the guarantee point flow.

Corrected test efficiency to the guarantee flow, $E_g = 1 - e^Y$.

Where,

$Y = (V_m/V_g)^{0.5} \times \log_e (1 - E_m) = (868/803.1)^{0.5} \times \log_e (1 - 0.99955) = -8.017$

$E_g = 1 - e^{-8.017} = 99.967$ %.

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2. STACK MONITORING DATA

Stack monitoring data were collected and monitored at different locations of projects site for analysis of Stack Parameters.

2.1 Methodology of Sampling and analysis

Stack datas were monitored on **25/12/2025 To 27/12/2025** from site as per sampling guidelines and were submitted to the lab with in stipulated period. The brief methodology of parameters is being given below for the reference.

S. NO	Parameter	Test Method
1	Ammonia	IS 11255 (Part 6) Clause 5 2019
2	Carbon dioxide (CO2)	IS 13270 Clause 4 1992
3	CarbonMonoxide (CO)	IS 13270 Clause 4 1992
4	Flue Gas Velocity	IS 11255 (Part 3) 2008
5	Oxygen (O2)	IS 13270 Clause 4 1992
6	Particulate matter (PM)	IS 11255 Part 1 1985
7	Sulphur dioxide (SO2)	IS 11255 (Part 2) 1985
8	Nitrogen dioxide (NO2)	IS 11255 (Part 7) 2005
9	Flue Gas Discharge (Flow Rate)	IS 11255 (Part 3) 2008
10	Fluegas Temperature	IS 11255 (Part 3) 2008
11	Mercury (Hg)	USEPA Method 29: 2017

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2.2 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - I**
Type of Sample	Stack Monitoring
Date of Sampling	**26/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225142**
Sampling Date			**26/12/2025**
S.No.	**Particulars**	**Units**	**Unit - I**
1	Stack Height	Meter	165.0
2	Stack Diameter	Meter	6.0
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	20
5	Duct Area	Meter	26.22

Discipline : Chemical				
S.No.	**Test Parameters**	**Units**	**Unit - I**	**CPCB Standards**
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	12.6	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	18.9	-
10	Oxygen (O2)	%	8.3	-
11	Particulate matter (PM)	mg/Nm³	66.77	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	1132.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	463.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	1323719.0	-
15	Fluegas Temperature	°C	120.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

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2.3 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - II**
Type of Sample	Stack Monitoring
Date of Sampling	**26/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225142**
Sampling Date			**26/12/2025**
S.No.	**Particulars**	**Units**	**Unit - II**
1	Stack Height	Meter	165.0
2	Stack Diameter	Meter	6.0
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	20
5	Duct Area	Meter	26.22

Discipline : Chemical				
S.No.	**Test Parameters**	**Units**	**Unit II**	**CPCB Standards**
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	13.4	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	15.3	-
10	Oxygen (O2)	%	7.5	-
11	Particulate matter (PM)	mg/Nm³	73.43	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	1143.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	482.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	1071582.0	-
15	Fluegas Temperature	°C	120.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

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2.4 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - III**
Type of Sample	Stack Monitoring
Date of Sampling	**26/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225144**
Sampling Date			**26/12/2025**
S.No.	**Particulars**	**Units**	**Unit -III**
1	Stack Height	Meter	220.0
2	Stack Diameter	Meter	4.15
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	20
5	Duct Area	Meter	28.56

Discipline : Chemical

S.No.	Test Parameters	Units	Unit III	CPCB Standards
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	11.8	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	13.6	-
10	Oxygen (O2)	%	9.1	-
11	Particulate matter (PM)	mg/Nm³	53.84	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	1203.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	455.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	471276.0	-
15	Fluegas Temperature	°C	107.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

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2.5 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - V**
Type of Sample	Stack Monitoring
Date of Sampling	**27/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225145**
Sampling Date			**27/12/2025**
S.No.	**Particulars**	**Units**	**Unit -V**
1	Stack Height	Meter	220.0
2	Stack Diameter	Meter	4.15
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	35
5	Duct Area	Meter	19.7

Discipline : Chemical				
S.No.	**Test Parameters**	**Units**	**Unit V**	**CPCB Standards**
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	12.6	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	14.4	-
10	Oxygen (O2)	%	8.3	-
11	Particulate matter (PM)	mg/Nm³	50.72	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	1261.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	520.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	498998.0	-
15	Fluegas Temperature	°C	107.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

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2.6 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - VI**
Type of Sample	Stack Monitoring
Date of Sampling	**27/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225146**
Sampling Date			**27/12/2025**
S.No.	**Particulars**	**Units**	**Unit -VI**
1	Stack Height	Meter	275.0
2	Stack Diameter	Meter	6.75
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	80
5	Duct Area	Meter	34.8

Discipline : Chemical

S.No.	Test Parameters	Units	Unit VI	CPCB Standards
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	13.2	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	15.4	-
10	Oxygen (O2)	%	7.7	-
11	Particulate matter (PM)	mg/Nm³	12.60	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	52.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	310.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	1860188.0	-
15	Fluegas Temperature	°C	45.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

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2.7 Stack Monitoring – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Unit - IV**
Type of Sample	Stack Monitoring
Date of Sampling	**27/12/2025**
Test Parameters	As per scope of work

Sample ID			**291225147**
Sampling Date			**27/12/2025**
S.No.	**Particulars**	**Units**	**Unit -IV**
1	Stack Height	Meter	220.0
2	Stack Diameter	Meter	4.15
3	Type of Stack	-	Circular
4	Height of Sampling port	Meter	20
5	Duct Area	Meter	28.56

Discipline : Chemical

S.No.	Test Parameters	Units	Unit IV	CPCB Standards
6	Ammonia	mg/Nm³	BLQ(LOQ 2)	-
7	Carbon dioxide (CO2)	%	11.3	-
8	CarbonMonoxide (CO)	%	BLQ(LOQ 0.2)	1% Max
9	Flue Gas Velocity	m/sec	13.8	-
10	Oxygen (O2)	%	9.6	-
11	Particulate matter (PM)	mg/Nm³	45.27	CNTE 150
12	Sulphur dioxide (SO2)	mg/Nm³	1133.0	-
13	Nitrogen dioxide (NO2)	mg/Nm³	528.0	-
14	Flue Gas Discharge (Flow Rate)	Nm³/hr	465954.0	-
15	Fluegas Temperature	°C	117.0	-
16	Mercury (Hg)	mg/Nm³	BLQ(LOQ 0.1)	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, %V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

End of Report

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Annexure-17A

Dust Suppression in coal yard

Dust Suppression in Wagon Tippler area

Crusher house CF-DS

6.6 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke (AWRS)**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426074**	**Limits**		
Sampling Date		**31/03/2026**			
S. No	**Parameters**	**Umran Dyke (AWRS)**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	4.0	30	350	100
7	Chemical Oxygen Demand (COD)	20.0	250	-	-
8	Chloride as Cl-	24.9	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	470.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.42	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	302.0	2100	2100	2100
17	Total suspended solids @ 105° C	24.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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6.7 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke (AWRS)**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426075**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke (AWRS)**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ. 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	5.0	30	350	100
7	Chemical Oxygen Demand (COD)	32.0	250	-	-
8	Chloride as Cl-	69.8	1000	1000	600
9	Dissolved Oxygen	6.6	-	-	-
10	Electrical Conductivity @ 25 ° C	516.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.12	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	348.0	2100	2100	2100
17	Total suspended solids @ 105° C	13.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

F. No. J-13012/50/2010-IA. II(T)
Government of India
Ministry of Environment, Forests & Climate Change
(Impact Assessment Division)
****

Indira Paryavan Bhavan
2nd Floor, Vayu Wing, Jor Bagh Road
New Delhi – 110003
Email id: yogendra78@nic.in
Tele fax: 01120819364

Dated: 25th January, 2022

To,

Dr. Vijay Prakash,
The Head of Department Environment Engineering,
M/s NTPC Limited, NTPC Engineering Office Complex,
Sector-24, Noida, Gautam Buddha Nagar-201301,
(Uttar Pradesh)

Sub: Feroz Gandhi Unchar Thermal Power project, Stage-IV (500 MW) in an area of 2003 acres located in Village Uchahar, Tehsil Uchahar, District Raebareli, Uttar Pradesh by M/s NTPC Limited – Amendment/ Clarification in Environmental Clearance – reg.

Sir,

This has reference to your online Proposal No. IA/UP/THE/237833/2021 dated 10th November, 2021 submitted to the Ministry for amendment in Environmental Clearance to the project cited in the subject.

2 . The Ministry of Environment, Forest and Climate Change has considered the application. It is noted that the proposal is for amendment/ clarification of Environmental Clearance to Feroz Gandhi Unchar Thermal Power project, Stage-IV (500 MW) in an area of 2003 acres located in Village Uchahar, Tehsil Uchahar, District Raebareli, Uttar Pradesh by M/s NTPC Limited.

3 . The proposal was considered by the Expert Appraisal Committee (EAC) for Thermal Power Projects in its 16th EAC Meeting held on 18th November, 2021. The comments and observations of EAC on the project may be seen in the Minutes of the meeting which are available on the web-site of this Ministry.

4 . It has been noted that Environmental Clearance was accorded by MoEF&CC vide letter dated 10th May, 2013 for Feroz Gandhi Unchar Thermal Power project (FGUTPP), Stage-IV (500 MW) is located in Unchahar Tehsil of Raebareli district of Uttar Pradesh. Subsequently, amendment in EC was granted on 21st October, 2020. The project is under operation since 30th September, 2017 (Date of COD). In EC dated 10th May, 2013 mentioned that as under:

General Condition at Sr. No. (x): "*Ash pond shall be lined with HDPE/ LDPE lining or any other suitable impermeable media such that no leachate takes place at any point of time. Adequate safety measures shall also be implemented to protect the ash dyke from getting breached. Ash pond water shall be recirculated and utilised.*"

5. The project proponent has requested that the General Condition No. (x) may be deleted since no new ash dyke has been proposed to construct for FGUTPP, Stage-IV. The existing ash dykes at Arkha and Umran are under operation for more than 32 and 22 years respectively. Further, it has been informed that the ash utilisation at Feroz Gandhi Unchahar Project is very high (On an average 120% during the last five years with 113% being used in Cement, Bricks and Road Construction), which indicates the use of legacy ash also. Thus, the ash dykes are being used for temporary storage of ash only. Provision of lining at subsequent raising shall jeopardize the lifting of ash from existing dyke reducing the ash utilisation as well as increase in use of soil as substitute material

6. The sectoral Expert Appraisal Committee after detailed deliberations in its 16th meeting held on 18th November, 2021 through video conferencing on the information submitted and as presented, recommended the proposal for necessary clarification in Environmental Clearance. Based on recommendation of EAC, Ministry, hereby issues the clarification/amendment in Environment Clearance regarding no new ash dyke to be constructed for FGUTPP, Stage-IV. Therefore, General Condition No. (x) shall not applied to the Feroz Gandhi Unchar Thermal Power project, Stage-IV (500 MW) until new ash pond is formed. The PP will insure 100% ash utilization in terms of extent rules and regulations of the ministry and guidelines issued by the CPCB in this regard.

7. This issues with the approval of the Competent Authority.

Yours faithfully,

25.01.2022

(Yogendra Pal Singh)
Scientist 'E'

Copy to:

1) The Chairman, Central Electricity Authority, Sewa 1Bhawan, R.K. Puram, New Delhi-110066.
2) The Chairman, Central Pollution Control Board, Parivesh Bhawan, CBD cum-Office Complex, Last Arjun Nagar, Delhi-110032.
3) The Deputy Director General of Forests (C), Ministry of Environment, Forest and Climate Change, Regional Office (Central Zone), Kendriya Bhawan, 5th Floor, Sector-H, Lucknow-226020.
4) The Chairman, Uttar Pradesh Pollution Control Board, PICUP Bhawan, 3rd Floor, B-Bock, Vibhuti Khand, Gomti Nagar, Lucknow-226010.
5) The District Collector, Rae Bareli, Govt of Uttar Pradesh.
6) Guard file/Monitoring File.
7) Website of MoEF&CC.

25.01.2022

(Yogendra Pal Singh)
Scientist 'E'

Review of Hydro-Geology to Assess the Impact of NTPC Unchahar On Surface Water and Groundwater Regimes

FOR

NTPC UNCHAHAR Project, (1550MW)

Submitted to

NATIONAL THERMAL POWER CORPORATION

NTPC UNCHAHAR (FGUTPP)

By

GEOSCIENCE CONSULTANCY SERVICES, ROORKEE

(CGWA ACCREDITED & ISO 9001:2015)

SALEMPUR RAJUPTAN, ROORKEE – 247667 (UTTARAKHAND)

OCTOBER - 2025

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1 INTRODUCTION

1.1 GENERAL

NTPC Limited, which was set up in November 1975 with the objective of planning, promoting and organizing integrated development of thermal power in India, has been playing a key role in the power sector of the country. As on 31 December 2024, total installed capacity of the company is 76,708.18 MW (including JVs). Its own stations include 26 coal- based, 7 gas based, 1 Hydro, 1 Wind, 18 Solar and 1 Small hydro plant and under JV, NTPC has 9 coal based, 4 gas based, 8 hydro based and 4 renewable energy projects (one small hydro, two wind-powered, and one Solar PV).

The Feroze Gandhi Unchahar Thermal Power Project, located in the Raebareli district of Uttar Pradesh, was initially conceived by the Uttar Pradesh Government as a load center station to meet regional energy demands. The project's initial stage, consisting of two 210 MW units (Stage-I), was implemented by the State Government. A feasibility study for Stage-II, comprising three additional units of 210 MW each, was conducted by U.P. Rajya Vidyut Utpadan Nigam Ltd. (UPRVUNL) in November 1983. Subsequently, the project was transferred to NTPC on 13th February 1992, pursuant to an ordinance issued by the Governor of Uttar Pradesh and a government notification.

Post-acquisition, NTPC proposed a phased expansion of the project that includes two 210 MW units under Stage-II, one 210 MW unit under Stage-III, one 500 MW unit under Stage-IV, and a 10 MW solar photovoltaic plant near Arkha railway station. The power plant is strategically located at latitude 25°54′50″ N and longitude 81°19′50″ E, as per Survey of India Toposheet No. 63G/5. It is bounded by several villages, including Faridpur, Bahamanpur, Bikai, Sarai Parsu, Gosain ka Purwa, Kanpur, and Niranjanpur, and lies approximately 3 km from Mustafabad (now Unchahar) on the Allahabad Raebareli broad gauge section of Northern Railways.

The plant colony is positioned between Mustafabad town and the main plant site, south of the Unchahar Salon road. Ash management infrastructure includes disposal sites located 8–9 km from the plant along the northern bank of the River Ganga near

Arkha village, and another site approximately 6 km northeast of the plant near Umran village. The Feroze Gandhi Unchahar Thermal Power Station represents a critical component of NTPC's coal-fired generation capacity and plays a vital role in regional energy security and economic development.

Keeping in view the above, a consultancy **"Biennial contract for review of Hydro-geology to assess impact of NTPC Unchahar on surface water and ground regime"** has been to ***M/s. Geoscience Consultancy Services (GCS),*** a CGWA-accredited institute, vide PO No. 4000337031-026-1019 Date: 11.07.2024 and GEM order no. GEMC-511687785098469.

1.2 OBJECTIVES

The main objective envisaged for the present consultancy is to study the Hydro-geological Status of the Project area and the impact of ash disposal on surface water and groundwater regime (especially around Ash Dyke). The specific objectives of the study are as follows:

1.2.1 Surface Water Hydrology

1. Any change in the drainage pattern of the study area with respect to previous years.
2. Status of identified surface water bodies, if any (including degenerated water bodies) within the study area (10 km radius from the plant boundary), their exploitation and potential for development of degenerated water bodies. Recommendations by consultant to improve the condition of degenerated water bodies by NTPC.
3. Recommendation by consulted to improve the condition of degenerated water bodies by NTPC.
4. To study the surface water quality at the identified location and current sources of contamination if any.
5. To study the impact of post-construction activity and operation of thermal power plant on groundwater with respect to free construction

period /previous year.

Status of rainwater harvesting at NTPC premises and status of watershed management at the study area.

6. Recommendation/suggestion to NTPC for taking sites Pacific mitigation measures.

1.2.2 Groundwater Hydrology

1. Define the hydrogeological scenario of the study area through water table contour map.
2. Assessment of groundwater depletion if any.
3. Estimation of annual recharge and utilization of groundwater during operation of NTPC Unchahar plant
4. Status of implementation of NTPC rainwater harvesting policy. Enumerate any increase or decrease in the potential for rainwater harvesting and suggestions for augmenting groundwater recharge.
5. To study on groundwater quality at identified locations and current sources of contamination if any.
6. To study the impact of post-construction activities and operation of thermal power plant and as pond on groundwater during the year.
7. Data collection from existing monitoring network for annual review and monetary of groundwater levels and quality
8. Coordinates of tubewells of plant and township area and their location shall be provided on Geo reference map.
9. Recommendation/suggestion to NTPC for taking sites Pacific mitigation measures.

1.3 SCOPE OF WORK

1.3.1 Literature Review

A detailed literature review of documents and reports for the study area is already available, compiled by various agencies, including the Geological Survey of India, State Department of Geology and Mining, Central and State Water Boards, State Water Resources/Irrigation departments, Central Water Commission, and the India Meteorological Department, among others. The consultant will review the earlier reports/ data related to the study with all possible help from NTPC. Based on the review of the literature available, a detailed plan for the study covering all the objectives will be prepared.

1.3.2 Field Studies

The field studies will cover the following aspects:

1. The latest satellite imageries from IRS/NRSC will be used for geological mapping and to ascertain areas covered by water bodies. Any reduction/increment in area covered by water body in study area will be given.

2. Drainage patterns and surface water bodies to be identified. The satellite imageries will be used for mapping LULC and water bodies.

3. Well logging for water level measurements as well as water quality monitoring to determine hydraulic gradients and groundwater flow characteristics using flow net analysis for Pre-monsoon and Post-Monsoon Seasons.

4. Infiltration studies for determining rate of infiltration using double ring infiltrometers at 5 locations in and around the Ash Dyke, pre-monsoon and post-monsoon seasons will be carried out.

5. Monitoring the surface and groundwater quality at 40 locations within the 10 Km radius from NTPC plant, with respect to parameters like pH, TSS,

DO, BOD, COD, dissolved phosphate, nitrate and ammonia, Major ions (Na, K, Ca, Mg, HCO_3, Cl, SO_4 and F^-), Silica, oil & grease, Phenolic compound, total coliform and Heavy metals (Cd, Zn, Hg, As, Cr, Cr (iv), Pb, Cu, Se, Fe) during pre-monsoon and post-monsoon seasons.

6. Potential for rainwater harvesting will be investigated by studying the physiography of the area and identification of zones required for runoff generation, water harvesting, and recharge.

7. Suggest locations of Piezometers near-by ash ponds.

2 DESCRIPTION OF STUDY AREA

The present study is focused on the Feroze Gandhi Unchahar Thermal Power Station (FGUTPP), located in Raebareli district, Uttar Pradesh, India. This coal-based thermal power station is operated by NTPC Limited, the largest power utility in India, and plays a significant role in power generation and energy security in northern India.

Geographically, the power plant is situated at 25°54′50″ N latitude and 81°19′50″ E longitude, falling on Survey of India Toposheet No. 63G/5. The station is approximately 3 km from Mustafabad (Unchahar), situated on the Allahabad Raebareli broad gauge railway line under the Northern Railways. The site is well connected via road and rail and lies in proximity to several villages including Faridpur, Bahamanpur, Bikai, Sarai Parsu, Gosain ka Purwa, Kanpur, and Niranjanpur. The plant was initially conceptualized as a Load Centre Station by the Government of Uttar Pradesh to meet the growing energy demand of the region. The development began with Stage-I (2 × 210 MW units) implemented by the state government. Following a government ordinance, the plant was transferred to NTPC Limited on 13 February 1992. Since then, the project has undergone several expansions: Stage-II: 2 × 210 MW, Stage-III: 1 × 210 MW, Stage-IV: 1 × 500 MW. Thus, Feroze Gandhi Unchahar Thermal Power Plant has an installed capacity of 1,550MW. In addition, 10 MW Solar PV Plant has been installed near Arkha Railway Station. The residential colony for plant employees is situated midway between Unchahar town and the plant area, adjacent to the Unchahar–Salon Road. The ash disposal from the plant is managed through two sites:

Arkha Village: Located 8–9 km south of the plant on the northern bank of the River Ganga.

Umran Village: Located approximately 6 km northeast of the plant.

The area is characterized by alluvial plains, with the River Ganga flowing nearby, influencing the surface and subsurface hydrology. The location within a densely populated agricultural zone makes environmental monitoring and resource management critical. The plant is also a site of integrated energy generation with an inclusion of solar energy, indicating a shift towards hybrid energy systems. Given its large-scale operations, strategic location, and ecological setting, the NTPC Unchahar plant serves as a critical case for assessing the environmental impact of thermal power generation, ash management practices, and transition to cleaner energy sources in northern India.

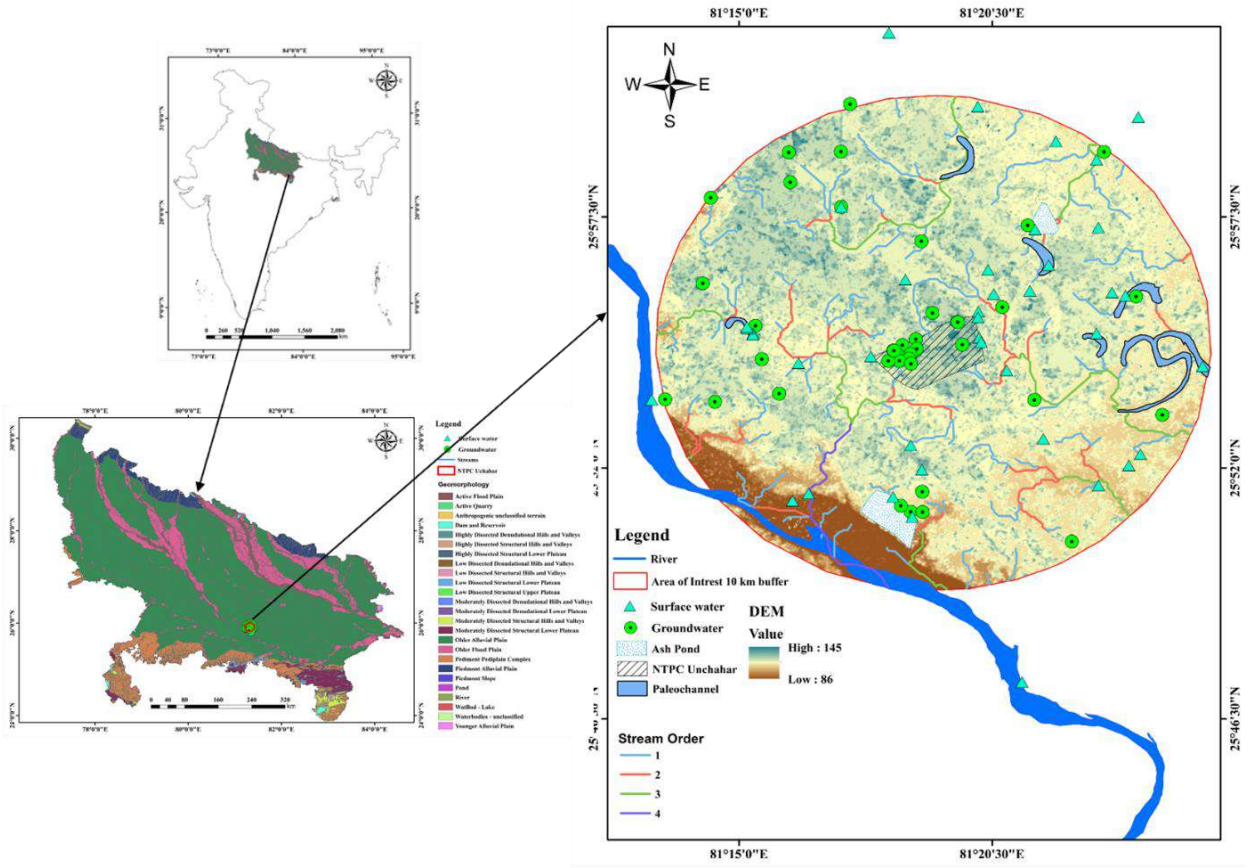


Figure 2.1: Location Map of NTPC Unchahar hydrological study in 10 Km radius.

2.1 Physiography and Geomorphology

The study area constitutes the younger flood plain, older flood plain and composite flood plain or upland interfluve area (CGWB 2023).

Younger Flood Plain- The area is identified adjacent to active river channel beds. It is formed due to flooding during monsoon and formation of terraces at different elevations. The sediments are made up of various grades of silt, sand and occasionally silty clay which has been deposited during floods. These sediments have been termed as younger/newer alluvium. The sediments are poor in calcium and no kankar pan can be seen in younger alluvium. The kankar nodules present, might be transported. The thickness of the younger alluvium is limited and maximum thickness may be restricted along the channel bed. At the junction of younger flood plain and older flood plain, a diagnostic landform present is ravenous tract, which can be seen along almost all the rivers. In this ravenous tract, which can be seen along almost all the rivers, at places Kankar beds, well cemented having up to 1m thickness can be seen.

Older Flood Plain/Intermediate Surface- The development of older flood plain of river Sai can be seen on both the banks and is characterized by a flat gently sloping surface, with breaks in slope at places as well as with in fluvial land forms, such as, ox bow lakes, cut off meanders and minor meander scars, and a number of terraces. The flood plain of river Ganga is restricted to narrow belt on its northern bank. The river Ganga shows a northward migrating trend. The absence of Usar land or alkaline soils is a diagnostic feature though salt effervescence can be seen in section through the ravines. Compositionally, it comprises sand-silt-clay sequence with occasional transported kankar.

Composite Flood Plain or Upland Interfluve Area- This unit is restricted between the major drainage systems and is almost 6-7 m higher than the adjoining younger flood plain. The natural levee is still higher and 1-2 m higher than this land surface.

The remote sensing technique has been used to delineate the geomorphological set-up of the study area. Remote Sensing (RS) data are essential input for the appraisal of natural environments as it provides valuable information for the interpretation of the

landscape. This technology has already been demonstrated to provide information on natural resources such as land use land cover, soil, vegetation and crop patterns on a periodic basis. Geographic Information System (GIS) is the latest tool available to capturing, storing, querying, analyzing, and displaying geospatial data. Thus, it plays an important role in evolving alternate scenarios for natural resources management. Combination of RS and GIS provide multi-dimensional information for mapping of an area.

The scope of work in the present study includes rectification and georeferencing of satellite images pertaining to years 2006, preparation of maps for the area including land use land cover, major streams and tributaries etc. using satellite imageries and topographic maps, marking the location of water resources projects, their area of influence and other features in the study area. The NTPC Unchahar study area lies within the Indo-Gangetic alluvial plain, characterized by flat to gently undulating terrain. The region comprises unconsolidated Quaternary deposits—mainly silt, clay, sand, and occasional Kankar shaped by fluvial processes and influenced by canal irrigation. Elevation within the 10 km buffer zone ranges from 86 to 145 meters amsl, with a gentle slope trending southwest to southeast, guiding surface runoff and drainage. Seasonal waterlogging is common during monsoons near drains and canals. The area's geology supports surface–groundwater interaction, though the flat terrain calls for careful management of drainage, flooding, and seepage from structures like ash dykes.

The topographic maps F45 and M16 (1:50,000 scale) were used as base map. It was converted to digital mode using scanning. The topographic map was georeferenced with longitude and latitudes using the Arc-GIS software and spatial analyst tools and demarcated the boundary of study area.

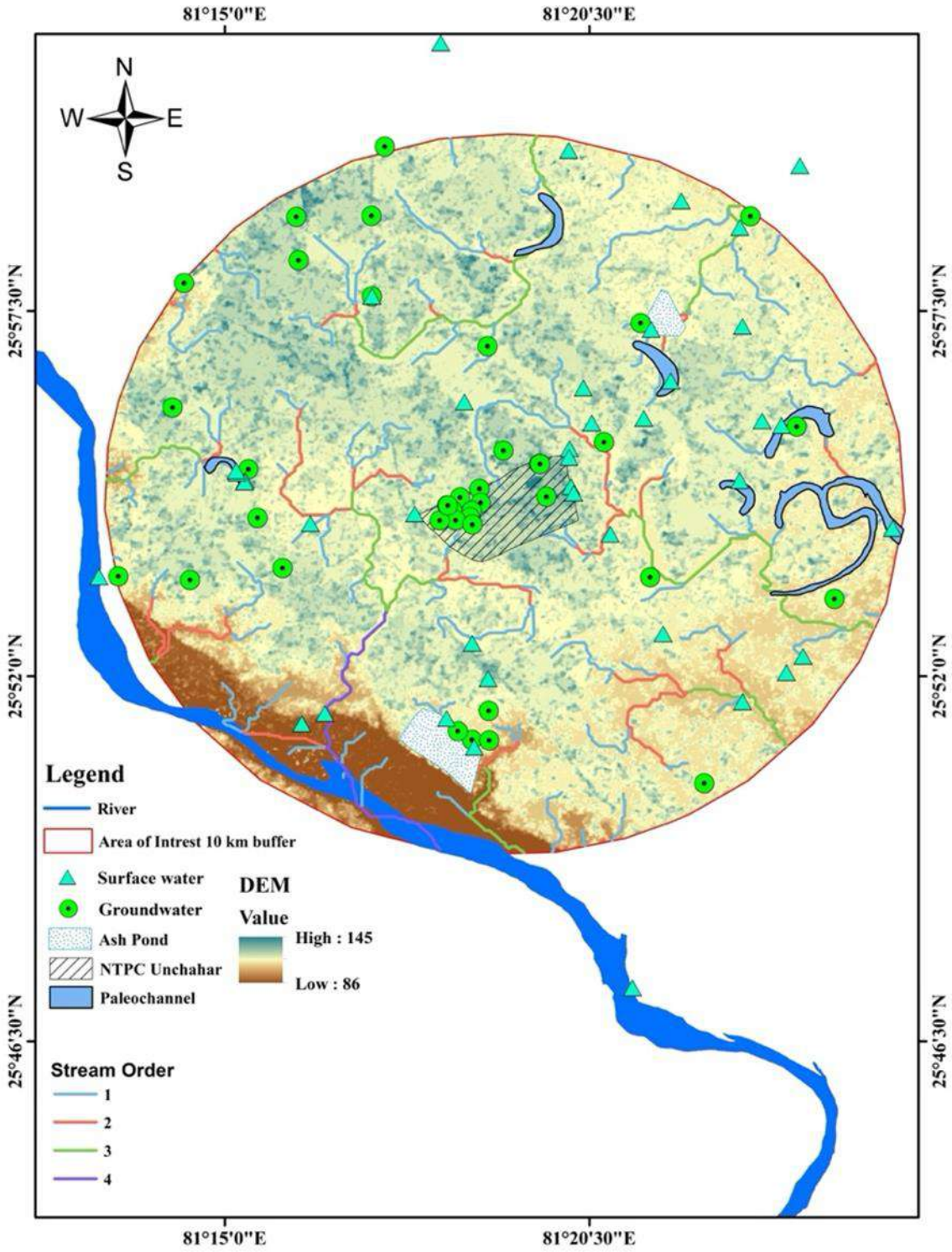


Figure 2.2: Digital elevation model of the buffer zone of NTPC Unchahar.

Landsat ETM+ images have been used for the study. Landsat ETM+ data was downloaded for the year 2006 to study land use and land cover patterns. The Enhanced Thematic Mapper Plus (ETM+) instrument is a fixed "whiskbroom", eight-band, multispectral scanning radiometer capable of providing high-resolution imaging information of the Earth's surface. It detects spectrally filtered radiation in VNIR, SWIR, LWIR and panchromatic bands from the sun/lit Earth in a 183 km wide swath when orbiting at an altitude of 705 km. The primary new features on Landsat 7 are a panchromatic band with 15 m spatial resolution, an on-board full aperture solar calibrator, 5% absolute radiometric calibration and a thermal IR channel with a four-fold improvement in spatial resolution over TM. The Enhanced Thematic Mapper Plus (ETM+) satellite data from 19 November 2006 was downloaded from Global Land Cover Facility (GLCF).

DEM of the study area has been generated using ASTER data. ASTER (Advanced Space borne Thermal Emission and Reflection Radiometer sensor) is an imaging instrument that is flying on the TERRA satellite launched in December 1999 as part of NASA's Earth Observing System (EOS). ASTER provides images with high resolution. There are 14 spectral bands all together spanning the visible and infrared spectra. Since sensor operates in visible and NIR bands, cloud cover poses problems in view of the earth and availability of the data. Because of its off-nadir sensor pointing capability, ASTER can collect the stereo pairs necessary to generate high resolution DEM (using bands 3N and 3B). The ASTER onboard the Terra satellite has produced 30 m resolution elevation data. There is a fairly complete coverage of the world at this high resolution and data are free. Japan's Ministry of Economy, Trade and industry (METI) and NASA announced the release of the ASTER Global Digital Elevation Model (GDEM) in June 2009. The GDEM was created by stereo-correlating the 1.3 million scenes from ASTER VNIR archive, covering the Earth's land surface between 83N and 83S latitudes. The GDEM is produced with 30m postings and is formatted in 1 x 1-degree tiles as Geo-TIFF files. The GDEM is referenced to the WGS84/EGM96 geoid. The GDEM's pre-production accuracy estimates were 20 meters at 95% confidence for vertical data, and 30 meters at 95% confidence for horizontal data. The digital elevation model of the study area is shown in **Figure 2.2**.

2.2 Climate and Rainfall

The average annual rainfall of the Raebareli district is 1150 mm where the Unchahar power plant is located. The climate is sub-humid and it is marked by a hot summer from March to early June with large variation of temperature and it is followed by rainy season starting from June and continuing to September. About 80% of rainfall is received during rainy season. Surplus water during the monsoon period is available for deep percolation to ground water. There is a nearest meteorological observatory at Sultanpur, so the records of it may be taken as representative for meteorological condition for Raebareli district also.

Table 2.1: Climatological Data of IMD Station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Av. Temp (ºC)	15.2	18.9	24.7	30.7	33.3	32.7	29.0	28.3	27.7	25.7	21.4	16.7
Max Temp (ºC)	21.6	25.5	32.0	38.2	37.5	32.4	31.6	31.6	31.4	31.1	27.9	23.3
Min Temp (ºC)	9.2	12.4	17.1	22.9	26.5	27.9	26.4	25.8	24.7	20.3	15.2	10.2
Relative Humidity (%)	67	60	43	29	3	52	78	82	80	67	59	64
Rainfall (mm)	21	23	11	7	12	130	309	259	175	32	3	8
Rainy days (Days)	2	2	2	2	3	8	18	18	13	2	1	1
Av. Daily Sunshine (Hrs)	8.5	9.6	10.7	11.4	11.9	10.8	8.4	7.9	8.3	9.6	9.6	9.0
Source: India Meteorological Department												

The rise in day temperature is rapid and maximum temperature exceeded 38°C in early May and minimum temperature to 10°C. Both the day and night temperature rise till May when maximum temperature reaches to 48°C. With the advance of the monsoon about middle of June there is appreciable drop in day temperature. While night temperature falls slightly. January is usually the coldest month with the mean daily maximum temperature at about 23°C and mean daily minimum at about 8°C. The mean monthly maximum temperature is 32.4°C and mean monthly minimum temperature is 19°C **(Table** 2.1**).** During monsoon season air is very humid and relative humidity is high. The mean monthly morning relative humidity is 65% and evening relative humidity is 51%. The winds are generally light except in the summer. The mean wind velocity is 4.4 km/hr. The potential evapotranspiration is 1424.5 mm.

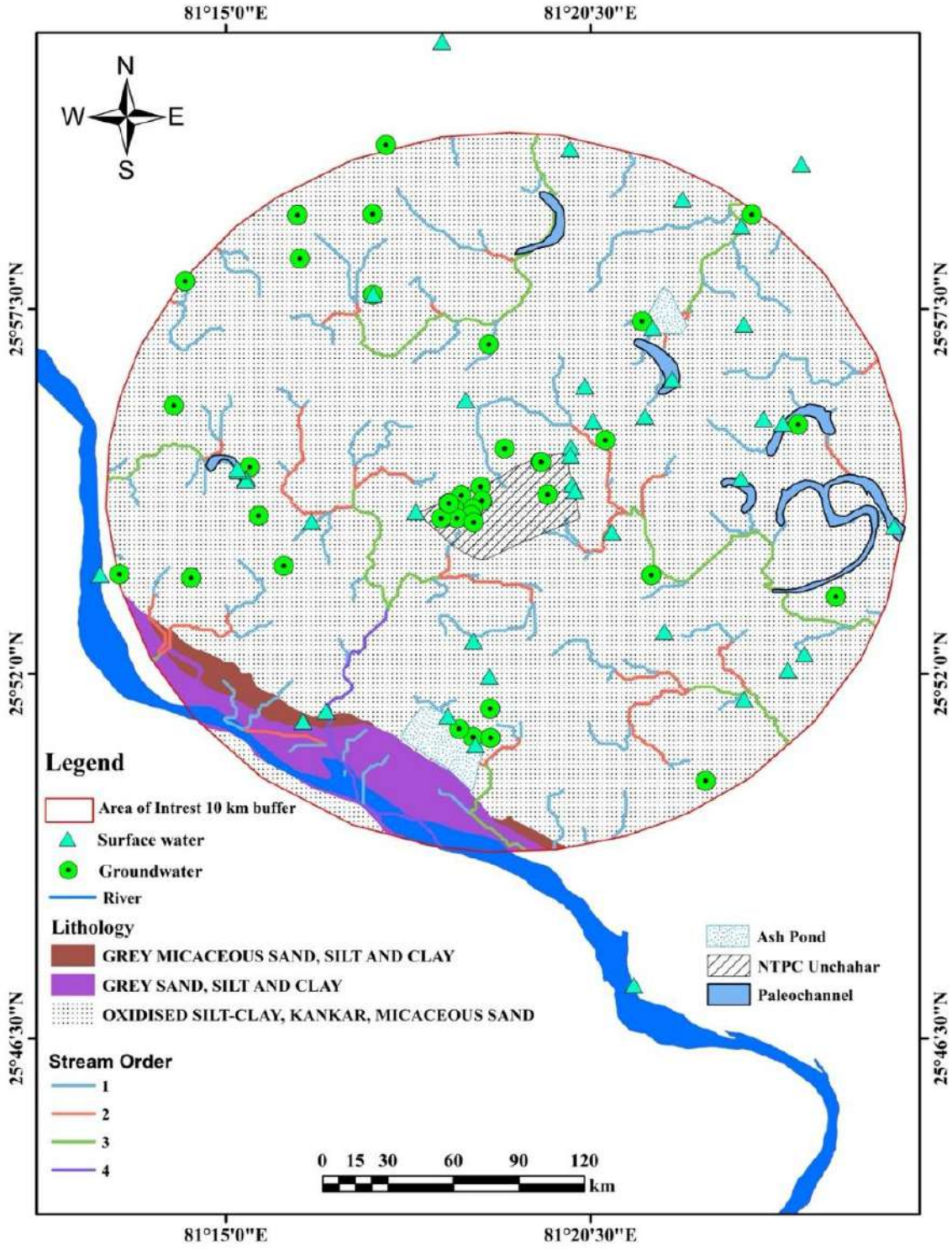


Figure 2.3: Lithological and drainage map of the buffer zone of the NTPC Unchahar

2.3 Hydrology and Drainage system

The district is divided into two equal halves by river Sai, which flows in a more or less south-easterly direction, becoming east-west and north-south stream in small segments. The area of the district falls in the drainage basin of Ganga and Sai River, a tributary of river Ganga River itself. A small northern part falls in the drainage basin of river Gomti. A major part of the district is drained by the river Sai and its tributaries, whereas southern and south-western part close to the river Ganga is drained by river Ganga and its tributaries. The drainage map of the area covering about 10 km of radius from the NTPC.

As far as the study area of NTPC Unchahar campus is concerned, the drainage area map for the area has been created using ArcGIS 10.7.1 software and SRTM 30 m DEM data (**Figure 2.3**). No major stream is present in the area, only small channels that carry water during the rainfall events are indicated.

2.4 Hydrogeology

The district is a part of Indo-Gangetic plains and is underlain by quaternary sediments consisting of sands of different grade, clays, silt, and kankar. The geomorphology of the area plays a very important role on the ground water regime. The relief, slope, depth of soil type and assemblage of different landforms hold significant importance on the occurrence and movement of ground water. Major region of the study area consists of older alluvium followed by younger alluvium. As per CGWB exploratory drilling data the depth of wells ranges from 308 m to 610 m in the district. The lithological and geophysical logs of the exploratory wells are used to compile and optimized to give the aquifer geometry of the study area; a three-tier aquifer system has been established up to the depth of 300 m bgl. (CGWB 2023).

First Aquifer Group:

This comprises clay sediments and sand beds in different proportions having kankar bed at different depths and occurs generally down to 100 m bgl sometimes occasionally down to 130 m bgl as found close to Unchahar village. The average depth to bottom of this group can be taken as 100 m bgl. Two or three fine grained sand beds

are prevalent and variable in their regional extension. They have been harnessed in shallow tube wells. The discharge of the well's ranges from 500 to 1500 lpm.

Second Aquifer Group:

The middle aquifer group exists between the depths of 120-220 m bgl. The formation encountered consists of isolated sand beds, dominantly fine grained, and lenses with interspersed kankar. The thickness of these fine-grained sand beds varies from 5 to 30m. This aquifer is not regionally extensive.

Third Aquifer Group:

This group exists below 250 m bgl and extends down to beyond 300 m bgl. The sediments are intercalated sequence of sand and clay beds. Sand is medium to coarse grained with occasional gravel beds. The sand beds are regionally extensive and form the potential aquifer. Piezometric head varies between 8-15 m bgl and yield varies between 1500-3000 lpm.

Each of the aquifer groups are separated from each other by extensive clay layers.

2.5 Groundwater Resources

Groundwater is mainly controlled by drainage, topography and lithological behavior, it occurs under phreatic condition at shallow depths and fractures and granular zones under at deeper depths. Groundwater occurs in pore spaces and interstices of unconsolidated alluvial sediments under phreatic to semi confined to confined condition in shallow aquifers. The near surface aquifer is under unconfined/water table condition. The shallow phreatic aquifer is harnessed by dug wells. Raebareli district is divided into 18 blocks (i.e., Amawan, Bachhrawan, Sataon, Dalmau, Harchandpur, Khiron, Lalganj, Maharajganj Jagatpur, Rahi, Rohaniya, Sareni, Shivgarh, Deen Shah Gaura, Unchahar, Deeh, Chatoh & Salon).

The Unchahar Block of Raebareli district exhibits a moderate groundwater availability and extraction profile**,** classified under the *"Safe"* category as per the Ground Water Resource Estimation–2022 (GWRE-2022)**.** The block spans an area of 21,862 hectares**,** with a net annual extractable groundwater resource of 3,967.74 ham and a

groundwater recharge per unit area of 0.18 m, which is among the lowest in the district, indicating relatively limited recharge potential compared to blocks like Lalganj or Dih The ground water estimates for the phreatic aquifer for the Raebareli are presented in the **Table 2.2**.

Table 2.2: Groundwater availability and stage of development for Unchahar Block

Net Annual Extractable Ground Water Resource (ham)	Ground Water Extraction for Domestic & Industrial Use (ham)	Ground Water Extraction for Irrigation Use (ham)	Total Extraction (ham	Stage of development in %	Categorization of Assessment Unit
3,967.74	372.19	2061.1	2,433.30	61.33	SAFE

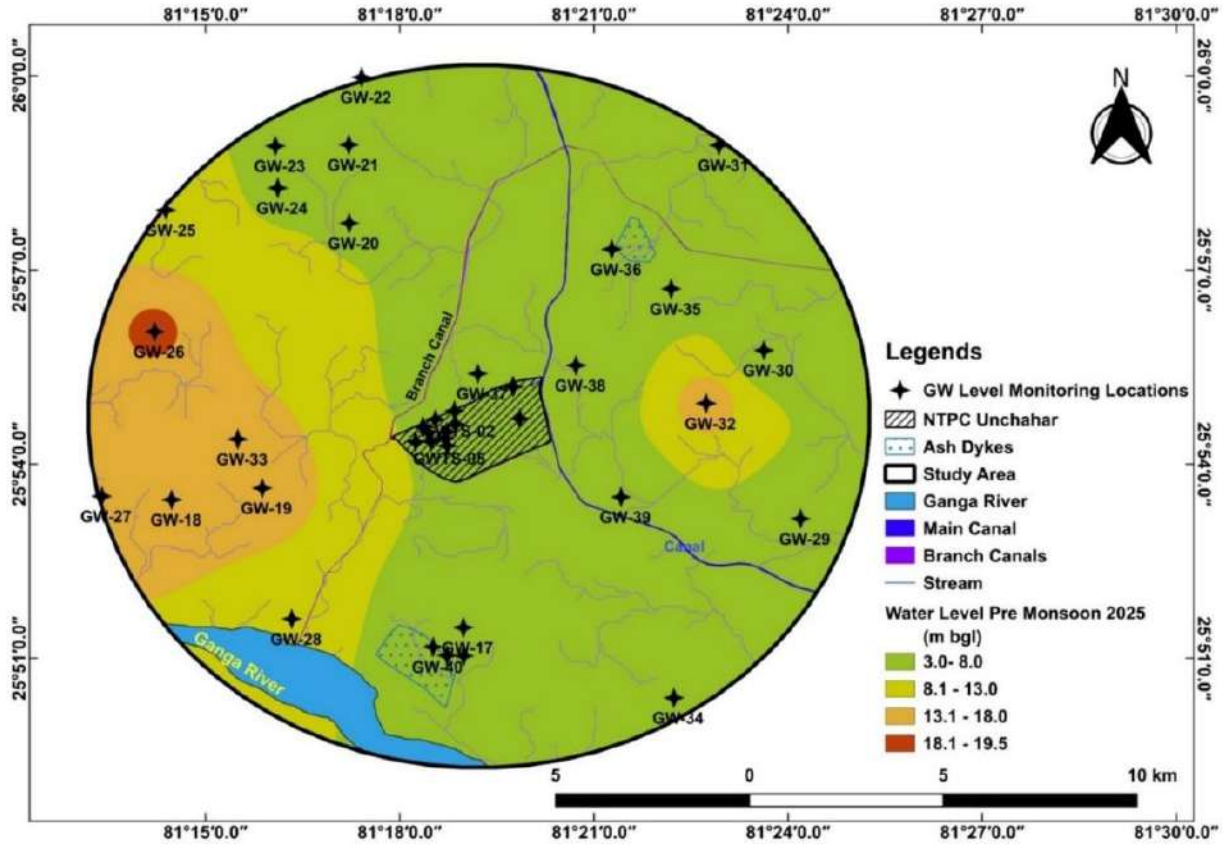


Figure 2.4: Depth to water table map of Pre-Monsoon Period 2025

Groundwater table fluctuation during pre-monsoon varies from 3.0 to 19.5 m with an average of 8.5 m bgl (**Figure** 2.4), Whereas the depth to water level in the study area varies between 0.5 m and 8.0 m bgl during the post-monsoon, with an average depth of groundwater level in the post-monsoon is 3.6 m (**Figure 2.5**).

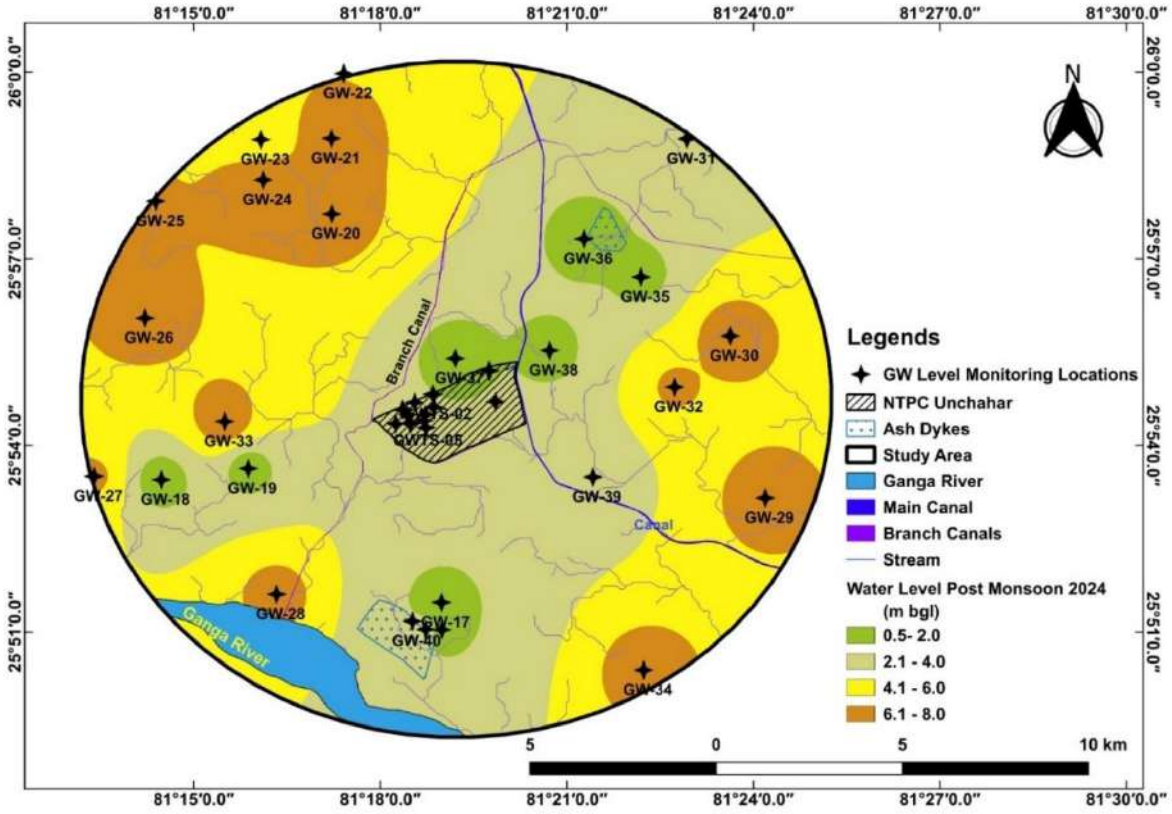


Figure 2.5: Depth to water table map Post-Monsoon period 2024

2.6 Soil Type and Land Use Land Cover

Soil in the district exhibits wide variance in composition and appearance. They can be classified into following categories. Bhur or Silty Sand- Occur on ridges, very close to river channels. Supports vegetation and is permeable. Clay- Occur in the topographic lows and depressions in upland interfluve areas and suitable for paddy cultivation. Dumat or Loam- It occurs in the interfluves and upland plains, close to old channels or river valleys. It is very fertile soil and often gets flooded, at places confined

to old flood plain which gets flooded during high floods. Usar/Alkaline Soils- It is clay dominant soils; kankar pan is also present at depth very close to the surface. The clay bed is overlain by a white salt efflorescence, which is due to capillary action within close distance to surface, unsuitable for cultivation. At places where the problem is not acute, paddy is cultivated as soils are covered with water during paddy crops (CGWB). The Land use landcover map **(Figure 2.6)** of the study area represents six classes in the region, viz., waterbody, forested area, agricultural land, built-up area, sand deposition and barren land.

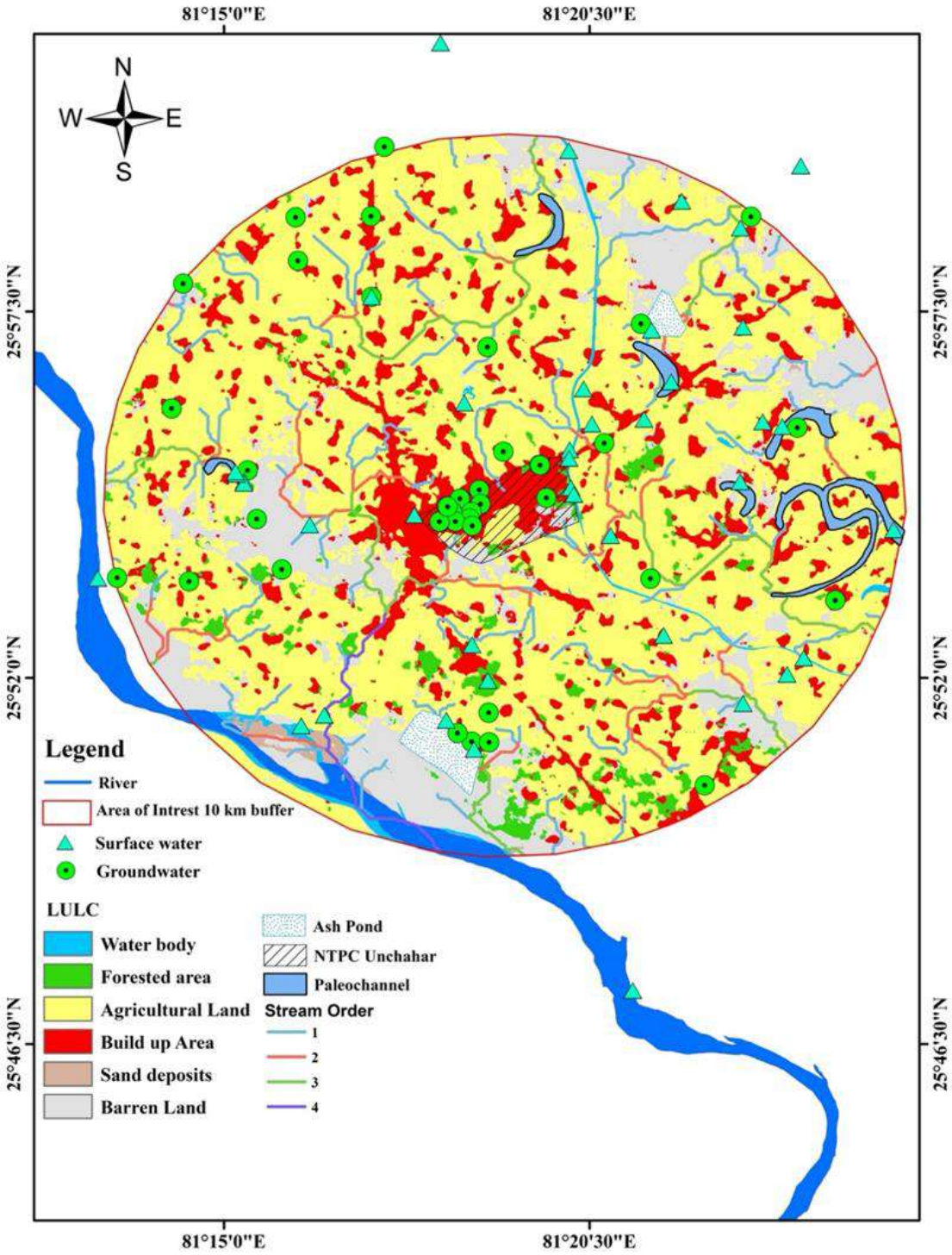


Figure 2.6: LULC map of the study area

3 METHODOLOGY

3.1 Collection of water samples

To understand the impact of ash pond on groundwater quality, pre-monsoon and post-monsoon water samples from and around the proposed ash pond of NTPC Unchahar, were collected during the field visit conducted between **09-13 Oct 2024** (Post monsoon) and **14-18 April 2025** (Pre-monsoon), respectively. The water samples were collected from surface (pond/River) as well as ground (hand pump and dug well) water sources. A total of 80 samples were collected for physicochemical and trace metal analysis in polyethylene bottles along with their GPS coordinates. Out of the total collected water samples, 40 were from groundwater (GW) sources and 40 were from surface water (SW) sources. The hand pumps were continuously pumped for at least 15 minutes prior to the sampling, to ensure the groundwater to be sampled was representative of groundwater aquifer. All the groundwater samples were collected from the sources which are being used extensively. A total number of four samples were taken from each site, two for chemical analysis (toxic or non-toxic heavy metals, cation and anion), one for bacteriological analysis and one for oil and grease analysis.

The sampling locations are selected in all directions from the ash pond area to find out the impact of ash pond on subsurface water quality. The details of SW and GW samples collected for analysis of various parameters are provided in **Table** 3.1 and **Table** 3.2**.**

Table 3.1: Details of samples collected for water quality analysis.

S. No.	Sampling Code	Latitude	Longitude	Source	Location
1	SW-01	25.85605	81.30577	Ash Dyke	Arkha Lagoon 2
2	SW-02	25.84879	81.31272	Ash Dyke	Arkha Lagoon 1
3	SW-03	25.86603	81.31622	Pond	Kumran ka purwa
4	SW-04	25.95368	81.35722	Ash Dyke	Umran Lagoon
5	SW-05	25.91572	81.37945	Pond	Danehi
6	SW-06	25.96200	81.28701	Pond	Sarayn Tularan pond
7	SW-07	25.89160	81.21840	River	Ganga River U/s
8	SW-08	25.93899	81.34017	Pond	Gagehara Gulal Ganj
9	SW-09	25.85470	81.26939	River	Ganga River middle
10	SW-10	25.99861	81.33647	Canal	Central Canal upstream
11	SW-11	25.90497	81.27152	Pond	Gauspur, Unchahar
12	SW-12	25.97926	81.37951	Pond	Amrit Sarovar Rohaniya
13	SW-13	25.87490	81.31220	Pond	Arkha Pond
14	SW-14	25.85731	81.27517	Canal	Central Canal D/s
15	SW-15	25.90743	81.29778	Canal	Naala at NTPC Road
16	SW-16	25.86754	81.39118	Pond	Raja ka purwa
17	SW-17	25.95446	81.38015	Canal	Sharda Canal
18	SW-18	25.87727	81.36021	Pond	Nigoha
19	SW-19	25.90373	81.41793	Pond	Murethi
20	SW-20	25.92957	81.38996	Pond	Parsipur
21	SW-21	25.78842	81.35252	River	Ganga River D/s
22	SW-22	25.93071	81.38510	Pond	Amrit Sarovar, Parsipur
23	SW-23	25.91584	81.25513	Pond	Hadipur
24	SW-24	25.91536	81.25503	Pond	Hadipur
25	SW-25	25.91761	81.25317	Pond	Hadipur
26	SW-26	25.91424	81.33702	Canal	Outlet drain of plant
27	SW-27	25.92374	81.33667	Canal	Thermal feeder channel
28	SW-28	26.02557	81.30433	Canal	Dalmau canal
29	SW-29	25.93019	81.34228	Pond	Gulal Ganj
30	SW-30	25.98591	81.36478	Pond	Dhamoli village
31	SW-31	25.86021	81.38017	Pond	Sherwanipur
32	SW-32	25.93137	81.35533	Pond	Murgaon
33	SW-33	25.94074	81.36214	Pond	Umaran
34	SW-34	25.91259	81.33776	Canal	Gautam Nagar
35	SW-35	25.99477	81.39459	Pond	Samaspur
36	SW-36	25.92161	81.33656	Canal	Gulal Ganj
37	SW-37	25.87165	81.39535	Canal	Asthan
38	SW-38	25.93549	81.31024	Pond	Hatwa
39	SW-39	25.90229	81.34693	Pond	Mokhara
40	SW-40	25.91817	81.25291	Pond	Amrit sarovar Gangoli

Table 3.2: Details of samples collected for water quality analysis.

S. No.	New code	Lat	long	Location
1	GWTS-01	25.89083	81.24129	Pump house 7
2	GWTS-02	25.89379	81.26457	Pump house 12
3	GWTS-03	25.85795	81.3164	Pump house 2
4	GWTS-04	25.85055	81.31651	Pump house 8
5	GWTS-05	25.85073	81.31215	Pump house 5
6	GWTS-06	25.85851	81.30481	Pump house 3
7	GWTS-07	25.90641	81.25828	Pump house 4
8	GWTS-08	25.91862	81.25596	Pump house 9
9	GWTS-09	25.91153	81.30919	Pump house 6
10	GWTS-10	25.91372	81.31405	Pump house 10
11	GWTS-11	25.91019	81.31435	Pump house 1
12	GWPL-01	25.90819	81.31208	Near SVM School
13	GWPL-02	25.90656	81.31164	Open Space Near Type II Qtr.
14	GWPL-03	25.90823	81.30727	T.W Overhead Water Tank
15	GW-15	25.90579	81.30806	T.W. TH'S Quatres
16	GW-16	25.90576	81.30408	Primary school Saray Tularm
17	GW-17	25.90957	81.30593	Primary school Babuganj
18	GW-18	25.90474	81.31229	Sankar trader
19	GW-19	25.90952	81.30612	Kamoli
20	GW-20	25.96200	81.28701	Puran Sahpur
21	GW-21	25.98220	81.2869	Purelalian
22	GW-22	25.99958	81.29023	Samar Purwa
23	GW-23	25.98193	81.268	Sangron
24	GW-24	25.97107	81.26858	Purevinda Panday
25	GW-25	25.96535	81.23979	Kharoli
26	GW-26	25.93409	81.23692	Kalyani
27	GW-27	25.89173	81.22326	Badalabaad
28	GW-28	25.85992	8.271982	Sarakpur
29	GW-29	25.83979	81.37056	Bhapora
30	GW-30	25.88605	81.40330	Romilia
31	GW-31	25.92931	81.39378	Lakshman Ganj
32	GW-32	25.98211	81.38217	Patti Pitha
33	GW-33	25.94451	81.37041	Umaran
34	GW-34	25.95529	81.35456	Raipur
35	GW-35	25.92329	81.32008	Khurampur
36	GW-36	25.92539	81.34538	Sumer bah
37	GW-37	25.8915	81.35696	Raipur
38	GW-38	25.84943	81.31510	Arkha
39	GW-39	25.91239	81.32497	Near Cooling Tower
40	GW-40	25.91172	81.33101	Near Start up Boiler

The maps showing the surface water and groundwater sampling locations are shown **Figure** 3.1 and **Figure** 3.2**.**

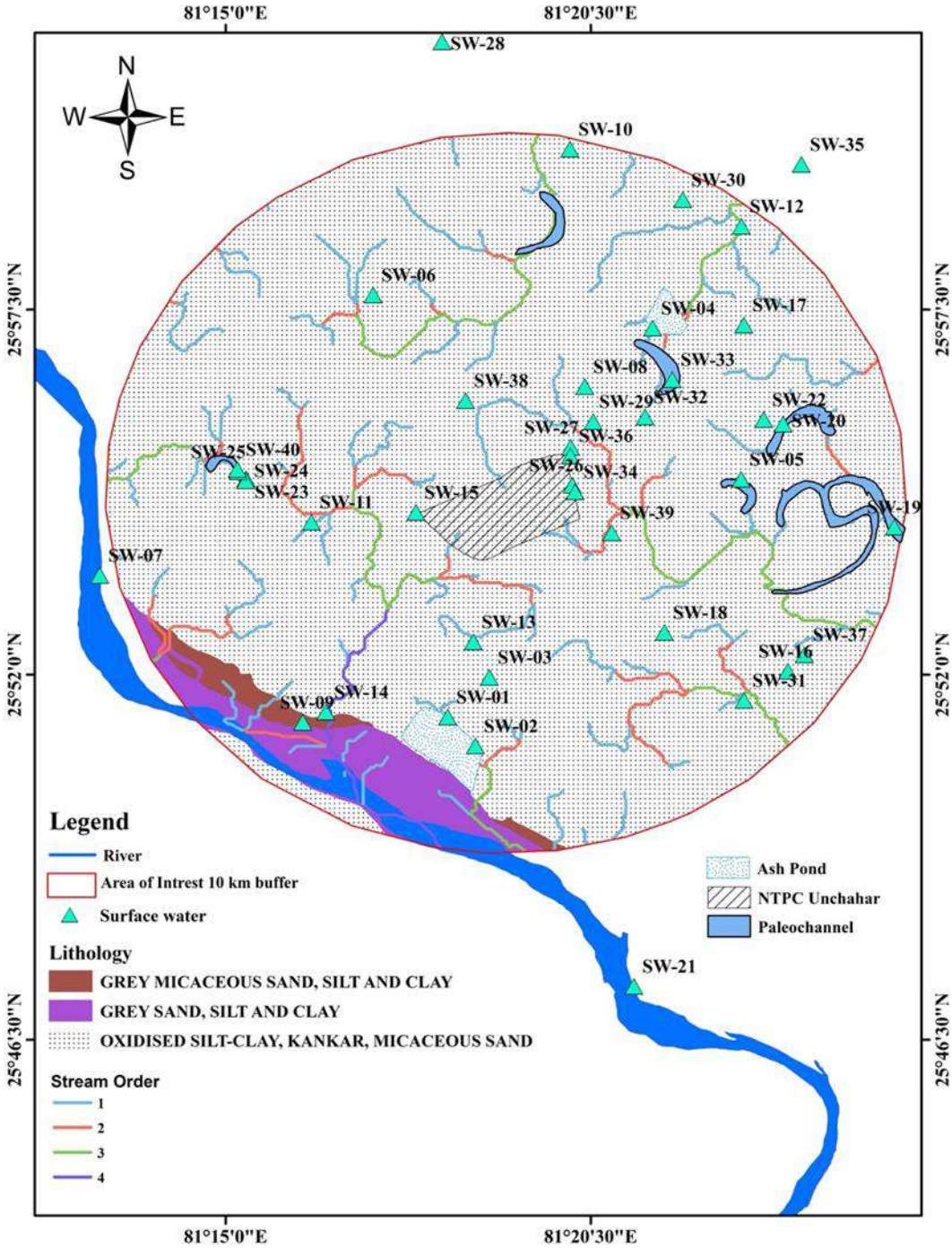


Figure 3.1: Map of Surface water sampling locations.

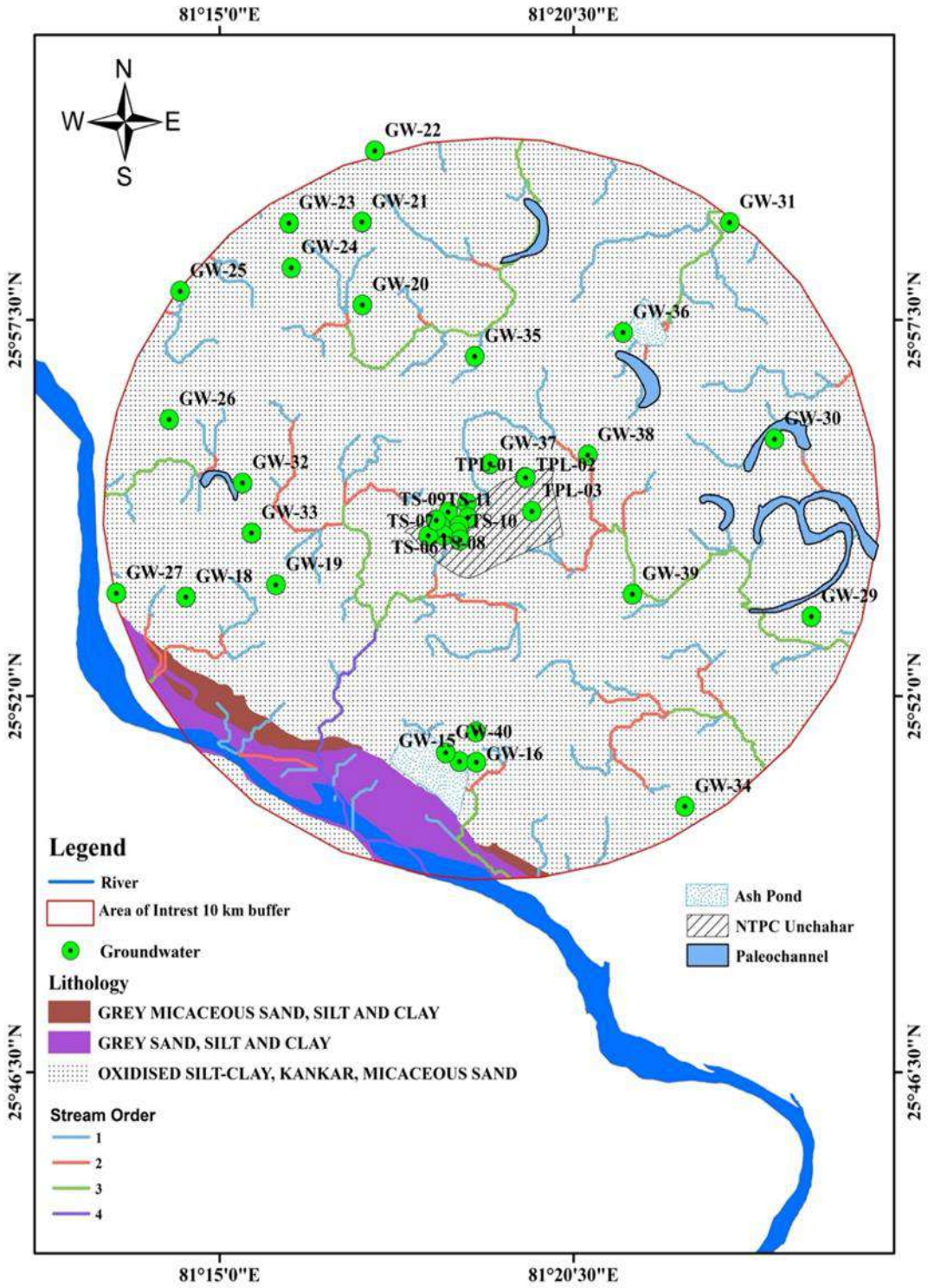


Figure 3.2: Map of Groundwater sampling locations.

To avoid any precipitation of trace elements, the samples collected for trace metals were acidified using HNO_3 to pH≈2 in the field whereas unfiltered samples were collected for analysis of anions (APHA, 2012). Water samples were collected in a wide mouth amber color bottle for oil and grease analysis. Approximately one litre of representative sample was collected in a glass bottle following conventional sampling practice, except that the bottles were not pre-rinsed with sample before collection. The samples brought to the laboratory for detailed physicochemical, trace metal, and oil and grease analysis. The physicochemical and trace metal analyses were performed following the APHA's Standard Methods for the Examination of Water and Wastewater (APHA, 2012).

Figure 3.3: Measurement of ions using Ion Chromatography
(A) heavy metals in ICPMS (B) at the Water Quality laboratory, NIH, Roorkee.

3.2 Chemicals and Reagents

All chemicals used for analysis were of analytical reagent grade (Merck-BDH). Standard solutions of metal ions were procured from Merck, Germany. De-ionized water was used throughout the analysis work. All glassware and other containers used for trace metal analysis were thoroughly cleaned by soaking in detergent, followed by soaking in 10% nitric acid for 48 hours, and finally rinsed with de-ionized water several times prior to use. All glassware and reagents used for analysis were cleaned before use. It is also important that all glassware surfaces are rinsed with n-hexane to effect a quantitative transfer of the constituents (oil and grease) in the sample prior to starting analysis.

3.3 Analytical Methodology for Water Sample

The samples were analysed as per Standard Methods for the Examination of Water and Wastewater (APHA, 2012; Jain and Bhatia, 1988). The details of analytical methods and equipment used in the study are given in **Table 3.3**. Ionic balance was calculated and the error in the ionic balance for majority of the samples was within 5%.

Table 3.3: Analytical methods and equipment used in the study

S. No.	Parameter	Unit	Method	Equipment
1.	pH		Electrometric	pH Meter
2.	Electrical Conductivity	µS/cm	Electrometric	Conductivity Meter
3.	Temperature	^{0}C		Digital Thermometer
4.	Total Dissolved Solids	mg/l	Gravimetric	Conductivity Meter
5.	Total Suspended Solids	mg/l	Gravimetric	
6.	Dissolved oxygen	mg/l	Electrometric	D.O. meter
7.	BOD	mg/l	Titration	
8.	COD	mg/l	Titration	
9.	Alkalinity	mg/l	Titration by H_2SO_4	-
10.	Hardness	mg/l		-
11.	Chloride	mg/l	Conductivity Method	Ion Chromatograph
12.	Bi-Carbonate	mg/l		
13.	Sulphate	mg/l		
14.	Nitrate	mg/l		
15.	Sodium	mg/l		
16.	Potassium	mg/l		
17.	Calcium	mg/l		
18.	Magnesium	mg/l		
19.	Fluoride	mg/l		
20.	Silica	mg/l		UV Spectrophotometer
21.	Oil and grease	mg/l	Hexane Extractable Gravimetric Method	
22.	Phenolic Compounds	mg/l		
23.	Bacteriological	MPN/100ml	Membrane filtration	Bacteriological Incubator
24.	Heavy Metals	ppb		ICP-MS

4 WATER QUALITY CHARACTERISTICS

The quality of water depends on many individual hydrological, physical, chemical and biological factors. Generally, higher proportions of dissolved constituents are found in groundwater than in surface water because of greater interaction of groundwater with various materials in geologic strata. The water used for drinking purposes should be free from any toxic elements, living and non-living organisms and excessive amounts of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, Cobalt, Copper, etc., but large quantities of them may cause physiological disorders. The contamination of groundwater by heavy metals has assumed great significance during recent years due to their toxicity and accumulative behavior. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle in which natural waters are the main pathways. The determination of the concentration levels of heavy metals in these waters, as well as the elucidation of the chemical forms in which they appear is a prime target in environmental research today.

The quality of water is also influenced by anthropogenic factors. For example, overexploitation of groundwater in coastal regions may result in sea water ingress and consequent increase in salinity of groundwater and excessive use of fertilizers and pesticides in agriculture and improper disposal of urban/industrial waste can cause contamination of groundwater resources. Groundwater contains a wide variety of dissolved inorganic chemical constituents in various concentrations, resulting from chemical and biochemical interactions between water and geological materials. Inorganic contaminants including salinity, chloride, fluoride, nitrate, iron and arsenic are important in determining the suitability of groundwater for drinking purposes.

The surface water and groundwater samples collected during pre-monsoon season were analysed for various physicochemical parameters, bacteriological parameters and heavy metals. The water quality data was analysed with reference to BIS and WHO standards. The results of analysis of pre-monsoon sampling of different water quality parameters are discussed below:

4.1 Physical and Chemical Parameters

It is essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purposes. Water must be tested with different physio-chemical parameters. Selection of parameters for testing water solely depends upon what purpose it is going to be used and the extent of quality and purity needed. Water does contain different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical tests are performed for testing its physical appearance such as temperature, pH, turbidity (TSS), TDS etc., while chemical parameters are analysed for BOD, COD, dissolved oxygen, alkalinity, hardness and other characteristics.

Results of physicochemical analysis for pre-monsoon 2025 and post-monsoon 2024 are given in **Table 4.1** to **Table 4.7** of surface water and groundwater, respectively.

Table 4.1: Physicochemical quality of SW sources during pre- and post-monsoon.

S. No.	Sample ID	pH		EC (µS/cm)		TSS (mg/l)		TDS (mg/l)		BOD (mg/l)		COD (mg/l)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	SW-01	7.9	7. 5	580.9	484.5	2	1.4	367.1	323.0	2.4	2.8	32.2	20.4
2	SW-02	7.6	6.9	664.5	463.0	2	10.3	143.0	312.8	3.9	3	36.8	26
3	SW-03	8.1	7.3	569.3	460.6	5	4.6	653.1	278.9	36.5	24.6	98	78.9
4	SW-04	6.8	7.4	757.3	675.6	4	8.5	488.3	441.6	2.8	2.5	42.8	34
5	SW-05	6.9	7.2	352.1	506.4	2	3.4	220.7	269.4	30.2	20.8	107.5	68.2
6	SW-06	Dry	7.3	Dry	549.2	Dry	4.0	Dry	302.6	Dry	4.6	Dry	56.4
7	SW-07	7.7	7.5	373.7	309.0	4	2.7	265.5	212.9	3.4	3	20	12
8	SW-08	8.3	7.8	640.1	805.6	3.4	6.1	198.2	485.4	16.6	10	72.5	44.5
9	SW-09	7.6	7.3	352.9	372.2	2.5	1.7	307.7	257.0	4.5	3.7	26.2	18.1
10	SW-10	7.9	8.1	329.6	440.3	2	1.2	158.7	284.1	4.4	3.9	21.8	17.5
11	SW-11	7.7	7.4	599.4	481.6	2	3.3	571.5	335.6	19.5	13.2	87.4	55.8
12	SW-12	Dry	8.1	Dry	1184.6	Dry	4.2	Dry	884.8	Dry	8.8	Dry	36
13	SW-13	7.5	7.4	471.6	354.4	2	3.7	242.8	237.8	21.7	17.3	78.2	69.3
14	SW-14	Dry	8.2	Dry	441.4	Dry	6.0	Dry	317.6	Dry	4.1	Dry	Dry
15	SW-15	7.7	7.6	582.0	423.3	3	4.2	333.1	267.9	8.9	5.3	41.5	26.4
16	SW-16	7.9	7.9	603.9	452.9	4.6	5.8	425.4	292.2	7.5	6.3	55.9	29
17	SW-17	8.3	8.1	569.5	592.3	3.5	4.2	165.0	423.1	2.5	3.7	11.5	16.3
18	SW-18	7.1	7.9	678.2	501.9	2	1.6	536.0	315.4	16	14.9	68.2	54.7
19	SW-19	7.1	7.8	254.8	258.5	3.1	2.6	166.8	175.9	4.2	2.6	28.3	17.6
20	SW-20	7.4	7.9	489.0	386.4	4	8.4	133.3	257.6	8.4	9.5	31	39.4
21	SW-21	8.1	7.3	464.5	324.4	2	13.7	309.8	225.6	3.8	4	38.5	18.2
22	SW-22	8.2	7.5	517.0	265.4	4	6.9	441.6	173.5	4.6	3.5	17.6	20.3
23	SW-23	7.6	7.5	627.7	494.4	2	1.2	230.2	309.0	5	6.2	35.3	28
24	SW-24	Dry	8.0	Dry	446.0	Dry	3.6	Dry	293.4	Dry	7.8	Dry	33.7
25	SW-25	8.1	7.5	286.1	278.0	6	7.8	201.3	178.2	14.7	12	66.8	51.6
26	SW-26	8.0	7.9	241.3	292.1	4.8	5.5	153.4	162.2	4.6	3.9	26.3	19.5
27	SW-27	Dry	7.4	Dry	215.3	Dry	6.4	Dry	142.8	Dry	4.9	Dry	25.9
28	SW-28	8.3	7.9	361.3	320.9	12.8	10.0	157.9	226.0	2.8	3.2	21.6	32
29	SW-29	7.5	8.0	537.5	328.3	4.6	7.4	388.5	206.5	14.6	14	60.5	73.2
30	SW-30	7.9	8.1	448.1	618.3	2	3.4	279.9	406.3	9	8.4	41.7	35.8
31	SW-31	7.4	7.4	456.2	268.1	6.9	7.6	268.1	153.0	5.9	6.5	27.4	30.1
32	SW-32	7.4	7.0	612.1	341.4	9.2	14.0	443.9	210.8	7.3	5.3	26.2	18.4
33	SW-33	7.8	8.1	287.7	430.9	5	6.4	357.4	285.3	12	11.4	69.8	48.5
34	SW-34	7.9	7.9	278.0	317.2	2	1.2	206.8	215.8	4	4.4	18.3	23
35	SW-35	7.5	7.6	427.1	478.8	32	8.0	198.5	312.9	8.9	10.4	84	90
36	SW-36	8.1	7.4	233.4	257.0	3.3	13.4	167.6	173.7	3.8	2.7	60	36
37	SW-37	8.2	7.6	262.3	318.3	2	4.5	152.6	213.6	3.1	3.9	49.5	35
38	SW-38	Dry	8.1	Dry	1422.8	Dry	3.8	Dry	871.1	Dry	5.2	Dry	23.6
39	SW-39	Dry	8.1	Dry	754.9	Dry	5.9	Dry	460.3	Dry	4.7	Dry	20.8
40	SW-40	8.3	7.9	332.5	123.4	54	42.3	264.8	87.3	3.4	4.1	26.5	32.9
BIS Acceptable Limit		**6.5-8.5**		**NS**		**NS**		**500**		**NS**		**NS**	
BIS Permissible Limit		**NR**		**NS**		**NS**		**1000**		**NS**		**NS**	

Table 4.2: Physicochemical quality of SW sources during pre and post monsoon.

S. No.	Sample ID	Oil & Grease (mg/l)		Phenolic Compound (mg/l)		Silica (mg/l)		Total Alkalinity (mg/l)		Total Hardness (mg/l)		F^- (mg/l)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	SW-01	0.2	BDL	0.001	BDL	6.3	4.0	41.8	63.9	210.2	149.5	2.7	3.4
2	SW-02	0.35	BDL	0.001	BDL	7.2	4.7	32.8	63.1	50.6	145.3	2.6	3.1
3	SW-03	0.3	0.1	BDL	BDL	9.2	8.4	343.0	118.2	162.8	104.8	0.8	0.6
4	SW-04	BDL	BDL	0.001	BDL	5.9	3.8	99.8	86.1	281.5	183.7	3.4	3.9
5	SW-05	BDL	0.2	BDL	BDL	10.2	7.9	178.8	116.4	144.2	137.3	1.5	2.6
6	SW-06	Dry	BDL	Dry	BDL	Dry	4.6	Dry	121.8	Dry	131.2	Dry	1.2
7	SW-07	0.2	BDL	BDL	BDL	12.5	10.1	123.8	111.5	143.9	140.1	0.7	0.4
8	SW-08	BDL	BDL	BDL	BDL	7.3	5.5	166.2	315.1	156.5	297.6	1.1	0.3
9	SW-09	0.25	BDL	BDL	BDL	14.1	17.2	142.8	131.8	147.5	140.3	0.6	0.5
10	SW-10	BDL	BDL	BDL	BDL	8.2	6.2	119.6	228.7	119.9	177.1	0.9	0.7
11	SW-11	0.55	0.2	BDL	BDL	31.6	15.5	357.0	290.8	237.2	225.7	0.6	0.3
12	SW-12	Dry	BDL	Dry	BDL	Dry	12	Dry	276.4	Dry	371.9	Dry	1.0
13	SW-13	BDL	BDL	BDL	BDL	2.4	1	168.2	114.3	157.3	150.4	1.1	0.6
14	SW-14	Dry	BDL	Dry	BDL	Dry	4.7	Dry	281.6	Dry	182.9	Dry	0.7
15	SW-15	0.35	BDL	BDL	BDL	1.8	2.3	236.1	166.7	230.1	171.4	0.4	0.7
16	SW-16	0.15	BDL	BDL	BDL	10.2	7.8	304.5	212.8	271.0	195.2	0.6	0.9
17	SW-17	BDL	BDL	BDL	BDL	3.4	2.9	117.0	148.5	145.7	232.0	0.6	1.1
18	SW-18	0.5	0.3	BDL	BDL	7.9	5.6	403.8	240.2	311.7	249.1	1.1	0.4
19	SW-19	BDL	BDL	BDL	BDL	4.8	4	137.6	130.3	127.0	95.8	1.3	0.9
20	SW-20	BDL	BDL	BDL	BDL	6	5.6	113.2	212.1	105.6	196.9	0.6	0.8
21	SW-21	BDL	BDL	BDL	BDL	10.6	12.3	143.6	100.5	171.5	131.4	0.6	0.4
22	SW-22	BDL	BDL	BDL	BDL	6	5.3	246.2	85.4	310.9	86.1	0.6	0.4
23	SW-23	BDL	BDL	BDL	BDL	9.2	7.8	119.2	166.4	105.6	170.0	1.4	0.4
24	SW-24	Dry	BDL	Dry	BDL	Dry	7.3	Dry	251.0	Dry	194.6	Dry	0.8
25	SW-25	BDL	BDL	BDL	BDL	12.5	10	138.7	129.3	129.8	123.3	1.2	0.5
26	SW-26	BDL	BDL	BDL	BDL	5.2	4.1	109.2	131.4	124.9	127.5	0.6	0.3
27	SW-27	Dry	BDL	Dry	BDL	Dry	5.2	Dry	75.4	Dry	81.5	Dry	0.5
28	SW-28	BDL	BDL	BDL	BDL	8.6	7.4	114.4	151.1	123.1	168.3	0.9	0.7
29	SW-29	BDL	BDL	BDL	BDL	6.9	6.6	296.4	157.2	201.9	156.0	0.4	0.6
30	SW-30	BDL	BDL	BDL	BDL	7.2	5.9	175.8	184.9	128.7	177.4	0.3	0.6
31	SW-31	BDL	BDL	BDL	BDL	2.8	1	175.0	100.6	126.1	65.3	0.8	0.6
32	SW-32	0.4	0.3	BDL	BDL	11.9	13.5	256.4	150.5	145.1	130.1	1.2	0.9
33	SW-33	0.6	0.2	BDL	BDL	16.2	20.3	118.6	181.5	117.7	150.4	0.9	1.2
34	SW-34	BDL	BDL	BDL	BDL	9.1	6.3	154.5	145.4	187.8	151.1	0.4	0.2
35	SW-35	BDL	BDL	BDL	BDL	3.2	2	112.0	183.1	127.4	178.8	1.0	0.5
36	SW-36	0.35	BDL	BDL	BDL	4	3.6	119.0	77.7	145.8	124.1	0.4	0.3
37	SW-37	0.05	BDL	BDL	BDL	12.4	9.9	93.0	104.3	118.6	156.0	0.7	0.3
38	SW-38	Dry	BDL	Dry	BDL	Dry	8.9	Dry	326.2	Dry	405.4	Dry	0.7
39	SW-39	Dry	BDL	Dry	BDL	Dry	10.7	Dry	220.2	Dry	194.0	Dry	0.8
40	SW-40	BDL	BDL	BDL	BDL	20.8	16.2	213.1	46.6	228.8	39.2	0.7	0.5
BIS Acceptable Limit		**0.5**		**0.001**		**NS**		**200**		**200**		**1**	
BIS Permissible Limit		**NR**		**0.002**		**NS**		**600**		**600**		**1.5**	

Table 4.3: Physicochemical quality of SW sources within buffer area during pre and post monsoon.

S. No.	Sample ID	DO (mg/l)		Temp (°C)		TC (MPN/100ml)		PO_4 (mg/l)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	SW-01	6.0	5.7	30.1	27.4	50	24	0.0	0
2	SW-02	6.5	5.5	31.6	27.8	68	39	0.0	0
3	SW-03	4.2	6	33.2	31.2	1450	492	0.3	0
4	SW-04	4.2	5.4	28.0	27.7	98	56	0.4	0
5	SW-05	4.7	4.3	30.1	28.4	360	136	0.4	0
6	SW-06	DRY	4.8	DRY	28.5	Dry	443	Dry	0
7	SW-07	8.1	6.9	29.8	29.1	110	76	0.5	0
8	SW-08	5.2	5.1	32.0	29.6	589	190	0.9	1.1
9	SW-09	7.8	7.6	29.0	27.6	100	185	0.0	0
10	SW-10	8	6.6	28.8	26.7	0	90	0.0	0
11	SW-11	5.4	5	34.3	28.3	264	398	0.7	0
12	SW-12	Dry	4.3	Dry	27.9	Dry	279	Dry	0
13	SW-13	4.8	4.7	31.9	28.2	250	170	1.3	2.3
14	SW-14	Dry	6.9	27.8	27.7	Dry	BDL	Dry	0
15	SW-15	4.6	6.4	28.8	28.3	340	86	0.2	0
16	SW-16	5.2	4.2	29.0	28.5	980	198	0.0	0
17	SW-17	6.8	6.8	28.2	27.9	20	8	0.0	0
18	SW-18	6.1	4.7	31.2	29.8	220	76	1.7	0
19	SW-19	4.6	6.1	29.6	29.2	215	110	0.2	0
20	SW-20	6.8	4.1	29.6	30.9	396	298	0.2	0
21	SW-21	7.7	7.4	29.2	28.1	140	98	0.3	0
22	SW-22	6.5	4.1	29.9	28.6	95	BDL	0.0	1.4
23	SW-23	5.5	5.2	33.5	28.2	176	89	2.5	0.05
24	SW-24	Dry	5	Dry	29.4	Dry	310	Dry	0
25	SW-25	5	4.5	29.7	30.6	1066	789	2.0	0
26	SW-26	5.2	6.4	31.0	29.7	4	25	0.0	0
27	SW-27	Dry	6.9	Dry	29.3	Dry	560	Dry	0
28	SW-28	7.8	6.2	28.2	28.9	92	130	0.0	0
29	SW-29	5.9	5	29.4	30.2	870	495	0.0	0
30	SW-30	5.2	4.7	31.3	30.6	481	366	1.2	0.3
31	SW-31	7	5.2	29.8	28.9	688	470	2.9	0
32	SW-32	6.1	4.8	29.3	27.8	508	335	1.7	0
33	SW-33	5.8	3.9	33.0	29.3	222	180	0.0	0
34	SW-34	7.2	6.2	30.5	27.1	0	56	0.0	0
35	SW-35	5.8	3.8	33.9	28.6	0	232	0.0	0.15
36	SW-36	6.6	6.6	31.2	28.3	93	75	0.0	0
37	SW-37	7.8	6.9	30.9	28.1	30	BDL	0.1	0
38	SW-38	Dry	4	Dry	29.7	Dry	74	Dry	0
39	SW-39	Dry	4.5	Dry	29.9	Dry	196	Dry	0
40	SW-40	7.8	6.4	33.1	30.0	192	210	0.256	0
BIS Acceptable Limit		NS		NS		Nil		NS	
BIS Permissible Limit		NS		NS		NR		NS	

Table 4.4: Major ions in Surface water sources in buffer area during pre and post monsoon (concentration in mg/l).

S. No.	Sample ID	Na		K		Ca		Mg	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	SW-01	26.8	28.8	5.1	8.5	56.3	40.5	16.9	11.8
2	SW-02	30.5	30.8	6.4	7.9	12.0	38.7	5.0	11.9
3	SW-03	117.8	23.6	54.8	38.8	33.5	19.7	19.2	13.5
4	SW-04	24.7	52.5	8.0	10.5	69.9	49.7	26.0	14.5
5	SW-05	16.0	16.8	4.8	24.2	34.6	33.4	14.1	13.1
6	SW-06	Dry	22.1	Dry	35.8	Dry	29.3	Dry	14.1
7	SW-07	43.4	12.6	4.7	4.8	40.8	38.9	10.2	10.5
8	SW-08	14.8	55.5	2.2	37.0	36.3	76.5	16.0	25.9
9	SW-09	62.4	19.2	2.0	5.1	42.2	39.6	10.3	10.0
10	SW-10	7.2	43.4	2.0	5.3	32.1	39.6	9.7	19.1
11	SW-11	132.1	28.0	6.9	2.0	69.8	62.3	15.3	17.0
12	SW-12	Dry	132.4	Dry	1.0	Dry	66.6	Dry	50.1
13	SW-13	22.2	19.2	2.8	2.1	49.6	39.9	8.1	12.4
14	SW-14	Dry	41.2	Dry	4.6	Dry	42.7	Dry	18.6
15	SW-15	32.8	24.4	4.6	11.8	51.6	40.8	24.6	16.9
16	SW-16	41.1	23.1	3.5	8.1	59.0	48.5	30.0	18.0
17	SW-17	6.9	76.6	2.0	2.0	34.3	40.8	14.6	31.7
18	SW-18	63.2	31.1	14.6	2.2	76.2	69.7	29.5	18.3
19	SW-19	17.5	31.5	0.6	0.9	28.5	23.1	13.6	9.2
20	SW-20	10.7	25.5	0.0	5.0	27.3	43.9	9.1	21.2
21	SW-21	47.5	16.7	2.5	4.4	51.2	36.5	10.6	9.8
22	SW-22	56.5	23.2	4.7	9.8	62.4	20.0	37.7	8.8
23	SW-23	41.7	38.8	15.9	10.7	20.2	47.1	13.4	12.8
24	SW-24	Dry	27.8	Dry	5.7	Dry	45.8	Dry	19.6
25	SW-25	26.2	17.8	2.2	3.4	34.8	28.3	10.4	12.8
26	SW-26	8.3	12.3	2.7	3.5	27.6	31.5	13.6	11.9
27	SW-27	Dry	10.7	Dry	2.8	Dry	21.4	Dry	6.8
28	SW-28	7.3	20.5	1.1	6.1	30.5	38.1	11.4	17.8
29	SW-29	86.3	13.6	2.1	2.7	44.5	36.4	22.0	15.8
30	SW-30	52.3	74.3	5.6	13.8	33.8	42.7	10.8	17.2
31	SW-31	59.3	45.5	6.0	3.1	26.3	16.3	14.7	6.0
32	SW-32	96.9	25.0	4.5	1.2	41.1	27.9	10.3	14.7
33	SW-33	91.0	35.6	4.0	11.5	23.2	35.4	14.5	15.1
34	SW-34	7.7	13.5	2.3	4.0	42.8	40.2	19.6	12.3
35	SW-35	27.9	39.3	4.1	10.7	32.6	49.7	11.2	13.3
36	SW-36	6.9	3.5	2.3	3.2	39.8	32.8	11.3	10.3
37	SW-37	9.7	3.3	2.1	3.8	30.7	42.2	10.2	12.3
38	SW-38	Dry	148.9	Dry	1.5	Dry	60.8	Dry	61.8
39	SW-39	Dry	88.5	Dry	14.3	Dry	46.5	Dry	19.0
40	SW-40	16.3	6.6	4.68	7.3	47.9	8.0	26.5	4.7
BIS Acceptable Limit		NS		NS		75		30	
BIS Permissible Limit		NS		NS		200		100	

Table 4.5: **Major ions in Surface water sources in buffer area during pre- and post-monsoon (concentration in mg/l).**

S. No.	Sample ID	HCO_3		Cl		SO_4		NO_3	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	SW-01	51.0	78.0	35.7	19.6	190.5	166.6	1.4	0.9
2	SW-02	40.0	77.0	32.9	25.1	21.8	151.4	4.7	0.8
3	SW-03	418.5	144.2	93.4	45.6	60.4	55.4	54.3	1.2
4	SW-04	121.8	105.0	32.5	23.3	253.5	228.3	3.2	2.6
5	SW-05	218.1	142.0	7.6	33.5	10.2	65.5	12.4	1.4
6	SW-06	Dry	148.6	Dry	42.2	Dry	77.6	Dry	1.3
7	SW-07	151.0	136.0	28.5	13.3	31.3	51.8	17.5	2.5
8	SW-08	202.8	384.4	2.8	49.9	1.3	41.6	14.1	0.0
9	SW-09	174.2	160.8	50.4	14.0	30.6	69.4	8.1	1.5
10	SW-10	145.9	279.0	1.6	7.8	21.5	21.7	2.7	0.8
11	SW-11	435.5	354.8	47.7	13.9	31.6	18.8	17.6	0.4
12	SW-12	Dry	337.2	Dry	412.2	Dry	40.3	Dry	0.5
13	SW-13	205.2	139.4	9.6	24.7	10.4	4.4	32.8	61.6
14	SW-14	Dry	343.6	Dry	9.0	Dry	16.2	Dry	8.0
15	SW-15	288.0	203.4	33.4	24.0	38.2	44.6	1.5	0.6
16	SW-16	371.4	259.6	47.5	20.0	43.1	33.5	4.5	2.5
17	SW-17	142.7	181.2	4.4	130.8	21.8	45.7	5.7	1.0
18	SW-18	492.6	293.0	33.1	18.1	32.9	23.4	29.7	0.0
19	SW-19	167.9	159.0	3.8	3.9	1.6	22.6	10.9	0.3
20	SW-20	138.1	258.8	4.4	13.8	1.8	12.1	4.2	0.3
21	SW-21	175.2	122.6	39.8	12.3	48.9	71.2	10.2	0.7
22	SW-22	300.4	104.2	111.2	30.0	6.8	20.7	5.6	1.8
23	SW-23	145.4	203.0	18.9	59.7	22.1	6.6	12.2	23.5
24	SW-24	Dry	306.2	Dry	19.3	Dry	12.9	Dry	1.1
25	SW-25	169.2	157.8	10.3	12.3	6.9	12.8	10.3	1.4
26	SW-26	133.2	160.3	4.2	6.7	17.5	11.2	7.2	0.5
27	SW-27	Dry	92.0	Dry	2.0	Dry	47.2	Dry	0.1
28	SW-28	139.6	184.4	4.4	11.9	20.3	29.9	3.7	1.3
29	SW-29	361.6	191.8	13.5	2.3	28.6	31.2	3.2	1.4
30	SW-30	214.5	225.6	15.1	94.1	19.7	31.9	26.6	12.6
31	SW-31	213.5	122.7	30.4	3.0	12.9	13.3	5.4	2.8
32	SW-32	312.8	183.6	102.0	6.2	1.8	27.2	16.1	2.2
33	SW-33	144.7	221.4	129.5	20.3	3.9	33.1	1.9	2.1
34	SW-34	188.4	177.4	0.8	1.6	29.8	48.1	0.0	0.7
35	SW-35	136.6	223.4	21.9	55.9	11.5	10.2	16.7	19.5
36	SW-36	145.2	94.8	7.4	2.1	22.0	70.0	1.0	0.4
37	SW-37	113.5	127.2	2.6	1.5	25.2	76.7	2.3	0.1
38	SW-38	Dry	398.0	Dry	299.1	Dry	90.4	Dry	0.0
39	SW-39	Dry	268.6	Dry	96.4	Dry	36.7	Dry	13.3
40	SW-40	260	56.8	5.8	6.1	4.6	7.7	7.3	1.7
BIS Acceptable Limit		**200**		**250**		**200**		**45**	
BIS Permissible Limit		**600**		**1000**		**400**		**NR**	

Table 4.6: Physicochemical quality of GW sources within buffer area during pre and post monsoon (concentration in mg/l except pH & EC).

S. No.	Sample ID	pH		EC (µS/cm)		TSS		TDS		Oil & Grease		Phenolic Compound	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	GWTS-01	6.65	7.45	486.0	569	0.1	0.3	326	379	BDL	BDL	BDL	BDL
2	GWTS-02	6.84	7.3	434.6	665	0	0.02	290	449	BDL	BDL	BDL	BDL
3	GWTS-03	6.96	7.75	350.0	651	0	0.4	246	407	BDL	BDL	BDL	BDL
4	GWTS-04	6.74	7.15	623.0	852	0.15	0	411	596	BDL	BDL	BDL	BDL
5	GWTS-05	6.78	7.15	558.4	763	0	0	372	502	BDL	BDL	BDL	BDL
6	GWTS-06	6.9	7.07	560.0	770	0.25	0.02	358	556	BDL	BDL	BDL	BDL
7	GWTS-07	6.98	7.35	594.2	679	0	0	414	468	BDL	BDL	BDL	BDL
8	GWTS-08	7.05	7.11	539.4	671	2.56	2	360	407	BDL	BDL	BDL	BDL
9	GWTS-09	7.14	7.67	280.2	259	0.42	1	171	179	BDL	BDL	BDL	BDL
10	GWTS-10	7.1	7.75	620.0	618	0	2	408	399	BDL	BDL	BDL	BDL
11	GWTS-11	7.08	7.16	455.0	664	0.456	1.4	315	463	BDL	BDL	BDL	BDL
12	GWPL-01	7.32	7.58	406.8	595	0	1	274	344	BDL	BDL	BDL	BDL
13	GWPL-02	7.4	7.73	589.4	741	0.44	1.4	400	497	BDL	BDL	BDL	BDL
14	GWPL-03	7.37	7.2	550.6	453	0	0	350	326	BDL	BDL	BDL	BDL
15	GW-15	7.23	7.05	540.2	707	1.8	6	360	448	BDL	BDL	BDL	BDL
16	GW-16	7.15	6.95	1305.2	826	0	0.04	813	533	BDL	BDL	BDL	BDL
17	GW-17	7.59	7.17	752.5	731	0	0.02	523	522	BDL	BDL	BDL	BDL
18	GW-18	7.61	6.75	651.2	809	0	0.2	434	512	BDL	BDL	BDL	BDL
19	GW-19	7.34	7.16	488.6	709	0	0.5	326	483	BDL	BDL	BDL	BDL
20	GW-20	7.26	7.35	445.6	512	1.3	3.4	263	341	BDL	BDL	BDL	BDL
21	GW-21	7.13	7.3	570.0	625	1.1	0.2	391	439	BDL	BDL	BDL	BDL
22	GW-22	7.12	6.95	703.6	648	1.4	1	469	423	BDL	BDL	BDL	BDL
23	GW-23	7.1	7.15	519.5	598	0	0	371	374	BDL	BDL	BDL	BDL
24	GW-24	7.17	7.17	561.2	504	0	0.4	390	332	BDL	BDL	BDL	BDL
25	GW-25	7.19	7.05	898.4	1075	0	0.2	642	689	BDL	BDL	BDL	BDL
26	GW-26	7.14	6.95	570.1	692	0	0.05	380	458	BDL	BDL	BDL	BDL
27	GW-27	7.08	7.06	1254.8	938	0	0.5	852	670	BDL	BDL	BDL	BDL
28	GW-28	7.2	7.25	875.1	1018	0.22	0.4	583	717	BDL	BDL	BDL	BDL
29	GW-29	7.18	7.27	510.0	797	0.27	0.4	376	501	BDL	BDL	BDL	BDL
30	GW-30	7.21	6.75	1361.3	1063	0	0.2	979	754	BDL	BDL	BDL	BDL
31	GW-31	7.11	7.25	751.5	830	1.1	0.6	501	563	BDL	BDL	BDL	BDL
32	GW-32	7.66	7.18	757.2	722	0	0.2	505	469	BDL	BDL	BDL	BDL
33	GW-33	7.27	7.95	1187.2	856	0	0.2	860	616	BDL	BDL	BDL	BDL
34	GW-34	7.16	7.35	1248.6	797	0	0.1	886	565	BDL	BDL	BDL	BDL
35	GW-35	7.52	7.15	909.1	784	0	0.02	606	513	BDL	BDL	BDL	BDL
36	GW-36	7.44	7.45	924.7	662	0.4	0.2	658	486	BDL	0.5	BDL	BDL
37	GW-37	7.39	7.45	867.3	517	0	0	631	364	BDL	0.05	BDL	BDL
38	GW-38	7.4	7.03	629.9	704	0.23	1	420	473	BDL	BDL	BDL	BDL
39	GW-39	7.45	7.35	772.1	863	0.75	0.5	477	587	BDL	BDL	BDL	BDL
40	GW-40	7.39	7.82	838.7	757	0.14	0.3	524	541	BDL	BDL	BDL	BDL
BIS Acceptable Limit		6.5-8.5		NS		NS		500		0.5		0.001	
BIS Permissible Limit		NR		NS		NS		1000		NR		0.002	

S. No.	Sample ID	Silica		Total Alkalinity		Total Hardness		F^-		TC (MPN/100ml)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	GWTS-01	10.4	12.2	292	297	198	242	0.6	0.4	Nil	Nil
2	GWTS-02	11.1	9.6	279	326	179	257	0.6	0.6	Nil	Nil
3	GWTS-03	5.7	7.08	169	279	141	226	0.2	0.5	Nil	Nil
4	GWTS-04	7	6.4	303	363	312	443	0.6	0.7	3	Nil
5	GWTS-05	6.2	8	268	344	319	290	0.5	0.9	Nil	Nil
6	GWTS-06	10.5	14.9	285	344	272	299	0.7	1.1	Nil	Nil
7	GWTS-07	6.6	8.4	301	328	335	304	0.6	0.2	Nil	Nil
8	GWTS-08	11	16.62	299	264	261	172	0.5	0.0	1	Nil
9	GWTS-09	8.2	7.5	100	122	142	150	0.2	0.3	Nil	Nil
10	GWTS-10	9.8	12.5	281	276	293	274	0.4	0.7	Nil	Nil
11	GWTS-11	8.4	10.3	305	336	246	278	0.4	1.0	Nil	Nil
12	GWPL-01	7.7	6.8	226	285	150	138	0.4	0.2	Nil	Nil
13	GWPL-02	5.3	7.9	295	322	138	125	0.5	0.8	Nil	Nil
14	GWPL-03	5.8	6.5	312	229	153	150	0.5	0.3	Nil	Nil
15	GW-15	12	10.87	272	331	231	348	0.5	1.0	Nil	Nil
16	GW-16	19.7	26.4	384	315	580	272	0.5	0.6	67	20
17	GW-17	18	20.8	412	338	280	252	0.9	0.4	275	164
18	GW-18	7.9	8	308	355	153	243	0.9	1.4	65	24
19	GW-19	10.1	12.4	281	358	226	381	0.5	0.5	2	Nil
20	GW-20	10.5	14.2	229	293	191	274	0.3	0.2	20	Nil
21	GW-21	27.8	30.9	248	270	275	294	0.9	1.3	Nil	Nil
22	GW-22	18	16.6	268	300	269	319	1.4	1.8	4	Nil
23	GW-23	5.9	8	282	301	269	290	0.7	0.2	Nil	Nil
24	GW-24	5.2	5.7	282	253	232	250	1.3	1.3	9	6
25	GW-25	7	9.8	472	487	314	330	1.1	1.8	Nil	Nil
26	GW-26	6.6	8.1	323	359	284	304	0.6	1.1	Nil	Nil
27	GW-27	21.05	24.9	316	319	430	440	0.8	0.5	198	65
28	GW-28	8.2	7	287	354	307	305	0.6	0.8	64	70
29	GW-29	5.2	4.6	317	346	189	308	0.7	0.6	Nil	Nil
30	GW-30	26.9	28.5	381	482	439	255	1.0	1.0	10	36
31	GW-31	14	17.8	289	422	341	296	1.1	1.4	Nil	Nil
32	GW-32	25.8	23.69	275	357	319	308	1.0	0.9	Nil	Nil
33	GW-33	23.6	30.5	332	391	350	152	0.9	0.9	14	32
34	GW-34	10.6	14	367	341	813	439	1.5	1.8	2	6
35	GW-35	5.2	4.6	248	309	353	278	1.0	1.2		Nil
36	GW-36	13.9	13	226	300	265	175	0.6	0.7	43	54
37	GW-37	18.4	20.4	319	200	353	173	0.8	1.0	Nil	Nil
38	GW-38	13	15.3	271	349	484	269	1.1	1.2	24	65
39	GW-39	10.3	16	243	321	330	277	0.9	1.0	13	80
40	GW-40	6.9	8	301	294	566	273	1.9	2.0	Nil	Nil
BIS Acceptable Limit		**NS**		**200**		**200**		**1**		**Nil**	
BIS Permissible Limit		**NS**		**600**		**600**		**1.5**		**NR**	

Table 4.7: **Major ions in groundwater sources in buffer area during pre- and post-monsoon (concentration in mg/l).**

S. No.	Sample ID	Na		K		Ca		Mg	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	GWTS-01	42.6	70.2	4.8	3.8	32.8	32.9	30.6	38.9
2	GWTS-02	42.3	100.2	3.8	4.3	32.7	45.7	20.6	34.9
3	GWTS-03	36.8	78.3	4.1	4.7	34.3	47.1	19.3	26.3
4	GWTS-04	48.3	89.9	4.0	6.4	57.3	58.4	28.9	72.4
5	GWTS-05	49.8	83.4	3.4	3.3	56.2	54.5	14.9	37.4
6	GWTS-06	42.9	100.3	4.4	3.4	44.7	46.5	26.2	44.4
7	GWTS-07	46.5	60.4	5.9	6.2	52.8	55.3	33.0	40.5
8	GWTS-08	58.2	85.1	4.2	3.6	41.3	24.9	19.4	26.7
9	GWTS-09	15.7	11.7	4.0	3.2	33.6	28.9	9.7	19.0
10	GWTS-10	61.0	50.6	4.5	3.2	56.1	45.7	22.2	38.9
11	GWTS-11	38.9	75.0	3.5	3.8	42.6	60.2	21.2	31.1
12	GWPL-01	51.5	69.5	2.8	3.0	32.5	31.3	11.6	14.5
13	GWPL-02	110.8	124.3	2.1	3.6	29.9	33.5	14.5	10.2
14	GWPL-03	86.4	62.8	2.2	6.4	31.7	35.8	9.5	14.7
15	GW-15	33.1	44.7	2.8	2.6	52.4	74.7	24.0	39.3
16	GW-16	156.8	90.7	27.5	14.8	136.7	53.7	21.0	33.5
17	GW-17	124.0	82.2	8.9	2.7	48.2	67.9	12.6	20.0
18	GW-18	100.6	123.8	3.4	4.2	21.4	26.9	37.4	42.8
19	GW-19	45.9	63.5	3.7	5.1	39.7	63.6	30.6	54.2
20	GW-20	27.8	35.8	5.1	2.0	39.0	47.3	23.0	37.9
21	GW-21	18.9	37.3	4.5	3.8	55.5	50.0	33.0	41.2
22	GW-22	46.6	50.9	5.0	4.8	71.0	74.7	22.0	32.4
23	GW-23	29.7	38.3	4.8	4.7	63.3	67.4	27.0	29.5
24	GW-24	40.1	46.9	5.1	5.3	48.5	40.9	27.0	36.0
25	GW-25	103.7	158.0	5.6	8.5	50.6	61.8	46.0	42.8
26	GW-26	50.0	82.3	3.4	5.1	73.2	71.1	25.0	30.7
27	GW-27	143.3	82.0	5.0	4.8	83.7	88.8	54.0	53.1
28	GW-28	89.5	158.9	3.0	5.2	61.6	58.4	28.2	38.8
29	GW-29	63.0	86.9	2.6	5.1	44.2	62.6	19.2	36.9
30	GW-30	189.4	196.3	40.5	4.6	79.9	90.5	31.6	7.0
31	GW-31	60.1	77.5	5.4	6.8	83.7	92.2	14.5	16.0
32	GW-32	67.6	80.6	4.4	5.2	76.4	44.1	28.5	48.1
33	GW-33	136.5	158.3	4.8	4.8	65.5	40.1	45.4	12.6
34	GW-34	219.8	70.1	19.9	6.3	102.0	69.4	11.0	64.9
35	GW-35	75.0	105.4	13.8	5.6	67.8	42.5	32.6	41.8
36	GW-36	156.9	125.2	4.0	5.7	54.1	28.9	31.7	25.1
37	GW-37	126.7	62.8	4.6	3.4	66.7	28.9	45.4	24.5
38	GW-38	61.3	90.9	2.4	5.0	73.3	38.5	16.0	42.1
39	GW-39	102.6	127.9	5.4	6.3	65.1	26.8	12.6	51.1
40	GW-40	73.4	80.0	12.4	4.2	80.5	70.5	17.4	23.6
Acceptable Limit		NS		NS		75		30	
Permissible Limit		NS		NS		200		100	

S. No.	Sample ID	HCO_3		Cl		SO_4		NO_3		PO_4	
		Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
1	GWTS-01	356	362	16	24	10	16	1.0	0.0	ND	ND
2	GWTS-02	340	397	5	36	4	19	0.5	0.0	ND	ND
3	GWTS-03	206	340	4	45	38	28	0.9	0.0	ND	ND
4	GWTS-04	369	442	53	98	28	43	0.0	0.0	ND	ND
5	GWTS-05	327	419	53	70	25	33	0.0	1.0	ND	ND
6	GWTS-06	348	419	37	110	17	24	0.7	0.5	ND	ND
7	GWTS-07	367	400	55	62	30	34	0.4	0.0	ND	ND
8	GWTS-08	365	322	24	61	18	24	1.4	4.2	ND	0.05
9	GWTS-09	122	149	5	12	33	21	0.6	0.0	0.8	0.04
10	GWTS-10	342	337	53	46	27	31	3.8	2.0	ND	ND
11	GWTS-11	372	410	9	65	6	11	0.0	0.5	ND	ND
12	GWPL-01	275	348	5	18	24	26	1.1	0.6	ND	ND
13	GWPL-02	359	393	15	70	41	50	1.1	0.0	0.5	0.6
14	GWPL-03	381	279	6	21	17	39	1.7	1.2	ND	ND
15	GW-15	331	404	9	24	51	34	10.6	14.3	ND	ND
16	GW-16	469	384	182	75	16	15	19.3	30.4	1.1	0.08
17	GW-17	503	412	17	56	32	51	11.7	15.3	ND	0.76
18	GW-18	376	433	40	63	5	15	30.4	10.4	ND	ND
19	GW-19	343	437	7	44	11	18	6.6	3.3	ND	ND
20	GW-20	279	357	7	11	10	15	0.5	0.0	ND	ND
21	GW-21	302	329	17	18	83	91	0.6	1.3	ND	0.08
22	GW-22	327	366	33	38	109	16	1.2	4.5	0.06	0.35
23	GW-23	345	367	22	20	45	20	1.0	2.2	ND	ND
24	GW-24	345	308	18	18	71	21	3.5	3.5	ND	ND
25	GW-25	575	594	62	52	73	43	6.0	14.3	ND	ND
26	GW-26	394	437	9	13	8	16	7.0	12.4	ND	ND
27	GW-27	385	389	166	126	119	53	67.8	42.8	0.8	0.8
28	GW-28	350	431	84	143	102	42	31.8	47.3	0.4	0.3
29	GW-29	387	422	22	32	26	60	0.0	2.5	ND	ND
30	GW-30	464	588	158	93	172	30	49.0	9.4	ND	ND
31	GW-31	353	515	45	12	91	61	10.5	20.5	ND	ND
32	GW-32	336	436	42	15	83	21	9.6	11.9	ND	ND
33	GW-33	405	477	140	56	233	67	9.4	7.4	0.8	0.8
34	GW-34	448	416	150	93	145	31	2.9	6.9	ND	ND
35	GW-35	303	377	98	29	149	67	12.9	27.3	ND	ND
36	GW-36	275	366	121	36	130	59	8.7	9.9	0.8	0.8
37	GW-37	389	244	139	72	26	12	9.3	17.9	0.6	0.54
38	GW-38	331	426	49	21	25	13	15.1	33.1	ND	ND
39	GW-39	296	391	94	94	9	28	29.3	40.3	ND	ND
40	GW-40	367	359	82	94	57	60	9.9	18.6	ND	ND
Acceptable Limit		**200**		**250**		**200**		**45**		**NS**	
Permissible Limit		**600**		**1000**		**400**		**NR**		**NS**	

4.1.1 pH

pH is defined as log[H^+] and is measured as intensity of acidity or alkalinity on a scale ranging from 0-14. In natural water, pH is governed by the equilibrium between carbon dioxide, bicarbonate and carbonates ions and in general, ranges between pH 4.5 to 8.5. Although pH has no direct impact on the health of consumers, yet it is one of the most important operational water quality parameters. BIS (2012) have prescribed pH value in the range of 6.5 to 8.5 for water used for drinking purpose.

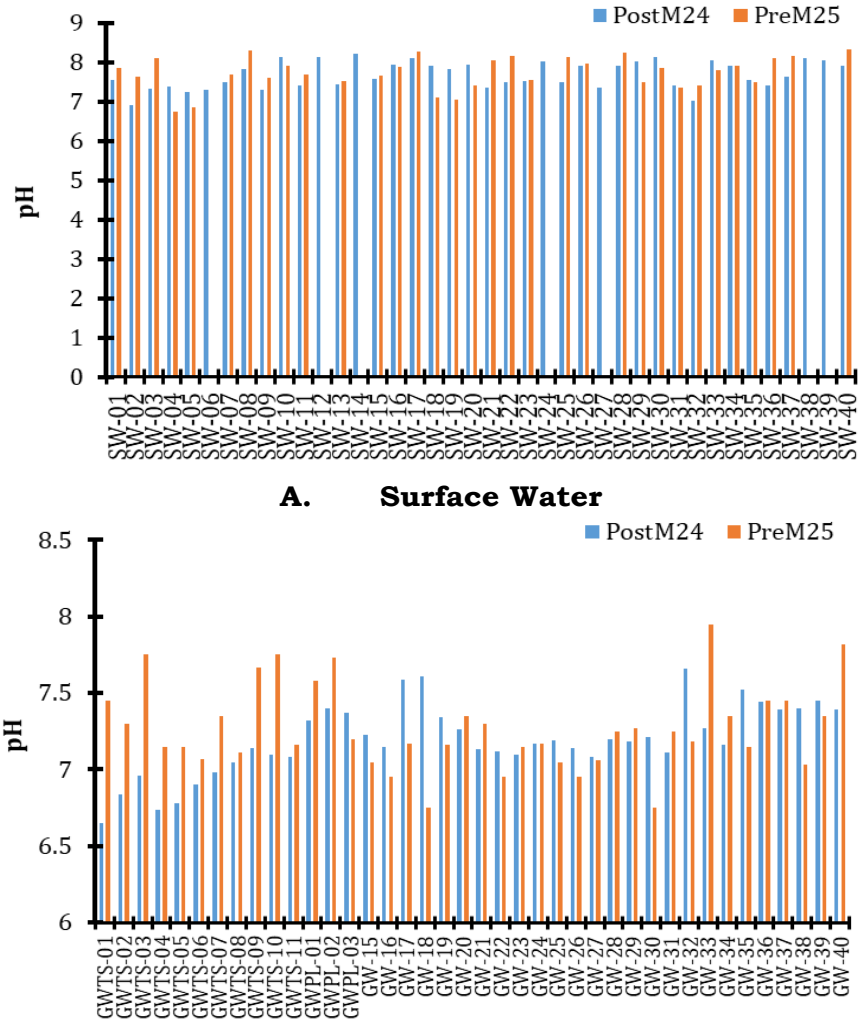


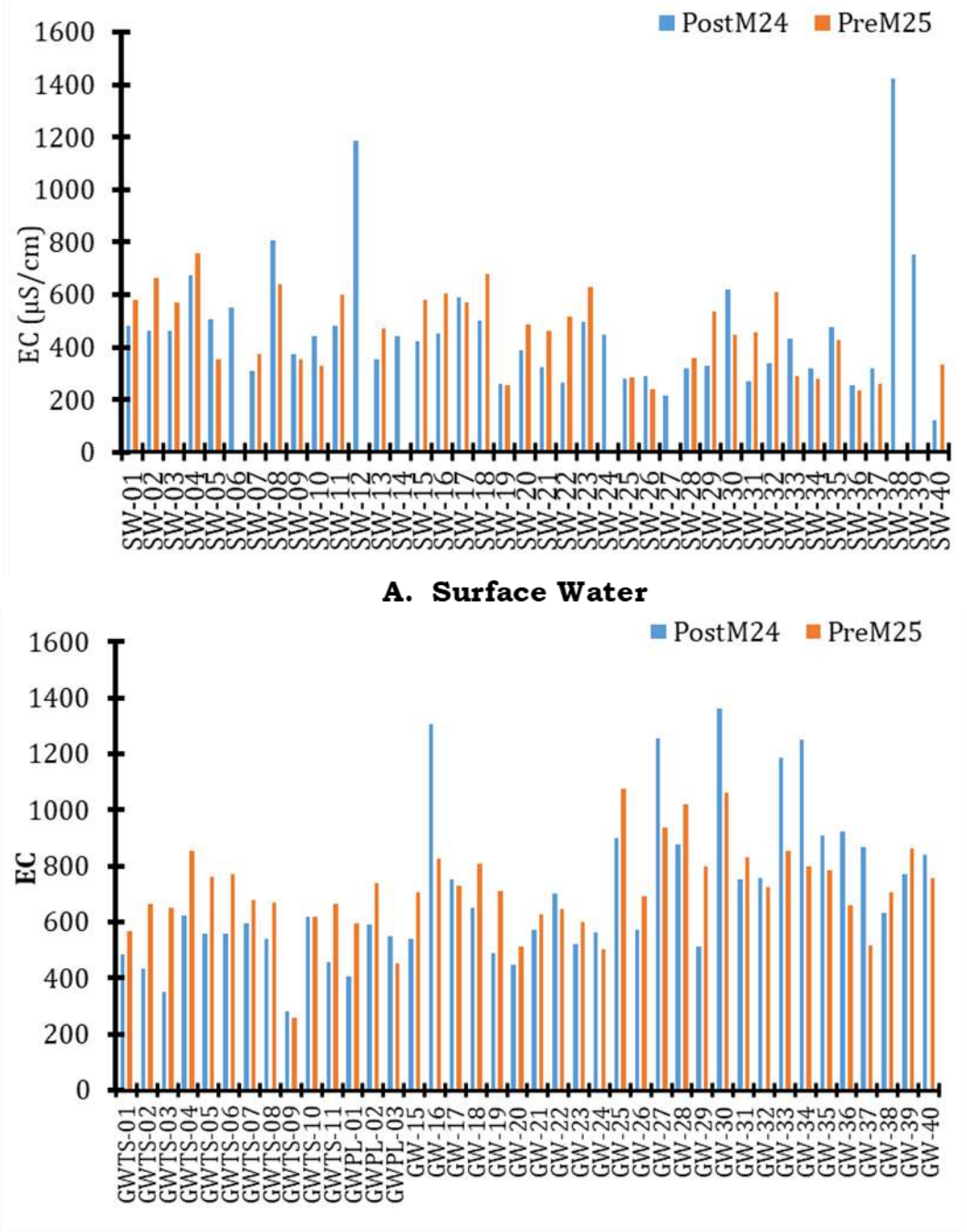
Figure 4.1: pH of SW and GW during pre and post monsoon.

The pH of the analysed surface water and groundwater samples of study area during post-monsoon varies from 6.9 to 8.2 and 6.70 to 7.7 with an average value of 7.7 and 7.2 respectively. During pre-monsoon season, pH of the analysed surface water and groundwater varies from 6.8 to 8.3 and 6.8 to 8.0 with an average value of 7.7 and 7.30 respectively. Variation of pH in surface water and groundwater is shown in **Figure 4.1** these water samples contained pH well within the desirable limits prescribed by BIS (2012) and WHO (2011) for various uses of water including drinking and other domestic supplies.

4.1.2 Electrical Conductivity (EC)

Electrical conductivity (EC) is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions; on their total concentration, mobility, and valence; and on the temperature of measurement. The electrical conductivity and dissolved salt concentrations are directly related to the concentration of ionized substance in water and may also be related to problems of excessive hardness and-or other mineral contamination.

The EC of the analysed surface water during post-monsoon and pre-monsoon varies from 123 to 1423 µS/cm with an average of 461 µS/cm and 233 to 757 µS/cm with average 462 µS/cm, respectively. EC in ground water during post-monsoon and pre-monsoon varies from 280 to 1361 µS/cm with an average of 699 µS/cm and 259 to 1075 µS/cm with average 717 µS/cm, respectively. Variation of EC in surface water and groundwater is shown in **Figure 4.2.** In the study area, groundwater shows overall higher EC than surface water samples. The waters are still suitable for drinking and for irrigation uses. The spatial differences between the EC values are due to wide variation in the activities and processes prevailing in the study area.



A. Surface Water

B. Groundwater

Figure 4.2: Electrical Conductivity (EC) of SW and GW during pre- and post-monsoon.

4.1.3 Temperature

Temperature exerts a major influence on biological activity and growth. Temperature governs the kinds of organisms that can live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are none.

Temperature is also important because of its influence on water chemistry. Warm stream water can affect the aquatic life in the stream. Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Some compounds are also more toxic to aquatic life at higher temperatures. Temperature in surface water during post-monsoon 2024 varies in a range of 26.7 to 31.2^{0}C with an average of 28.8^{0}C and during pre-monsoon 2025 it varies in a range of 27.8 to 34.3^{0}C with an average of 30.5^{0}C. Variation of temperature in surface water is shown in **Figure 4.3** Water in ponds has relatively higher temperature than that of the river/Canal. There is no BIS standard for temperature for water.

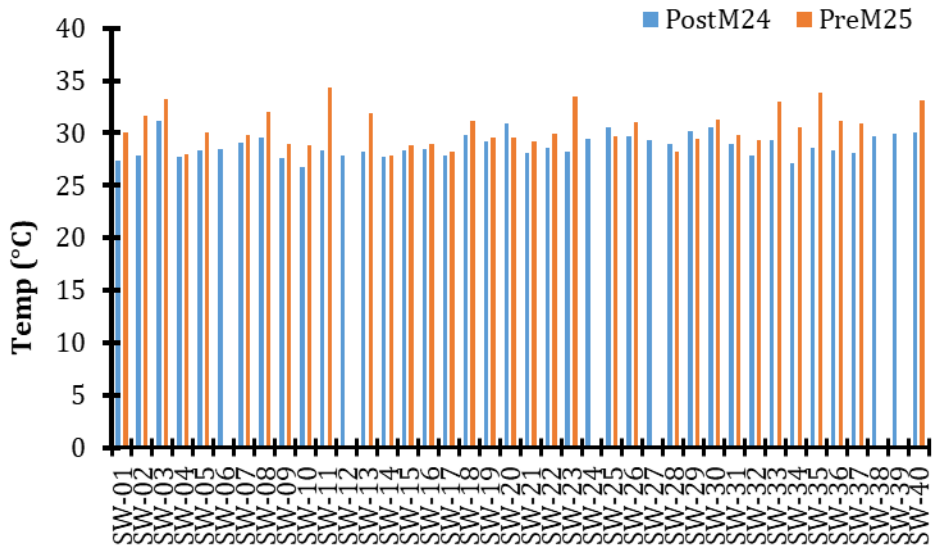


Figure 4.3: Temperature variation in SW during pre and post monsoon.

4.1.4 Dissolved Oxygen

Dissolved oxygen (DO) is the amount of oxygen that is present in water. Water bodies receive oxygen from the atmosphere and from aquatic plants. Running water, such as that of a swift moving stream, dissolves more oxygen than the still water of a pond or lake. It is an important indicator of the qualitative health of any surface water body. The higher the dissolved oxygen, the better the quality of water. Generally, water at lower temperatures has higher DO while warmer and polluted waters have lower DO. Healthy water should generally have dissolved oxygen concentrations above 6.5-8 mg/l.

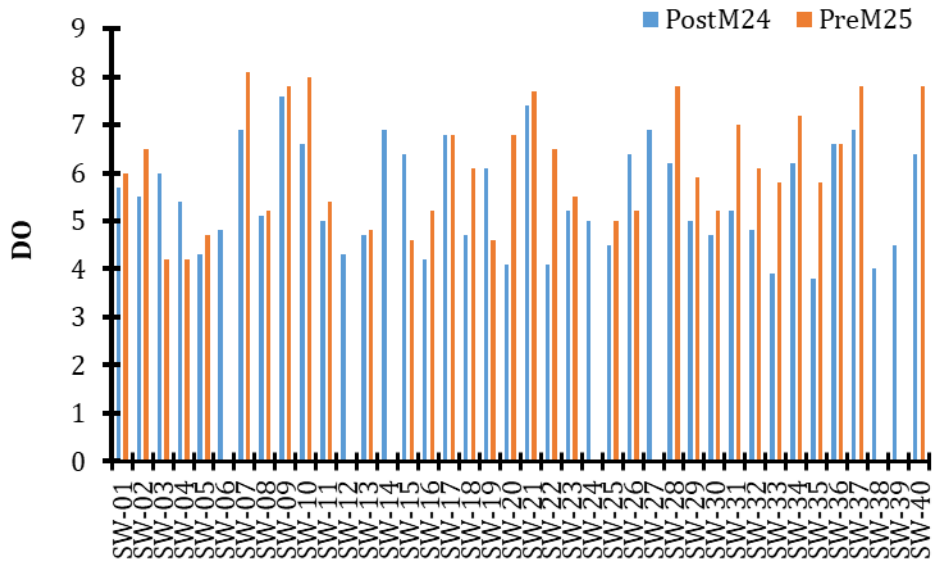


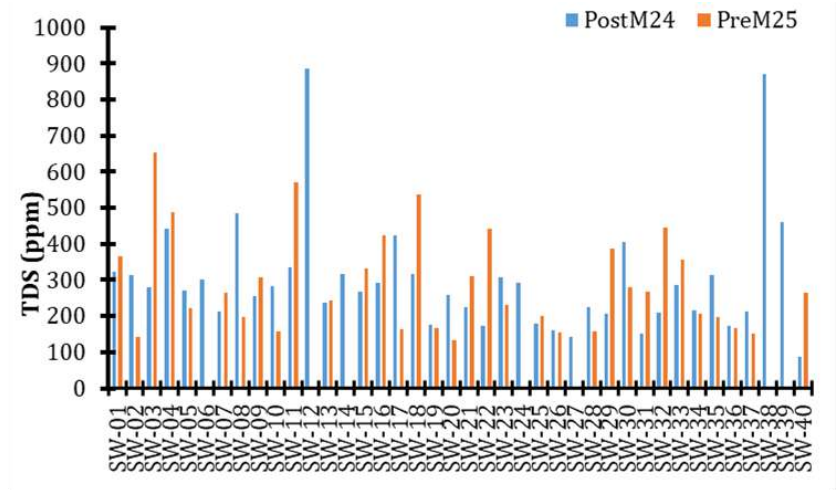
Figure 4.4: Dissolved Oxygen (DO) variation in SW and GW during pre and post monsoon.

DO in surface water during pre-monsoon 2025 varies in a range of 4.2 to 8.1 mg/l with an average of 6.1 mg/l and during post-monsoon 2024 it varies in a range of 3.8 to 7.6 mg/l with an average of 5.5 mg/l. Variation of DO in surface water is shown in **Figure 4.4**. DO of water in ponds is less than that of the river/Canal. There is no BIS standard for dissolved oxygen for water.

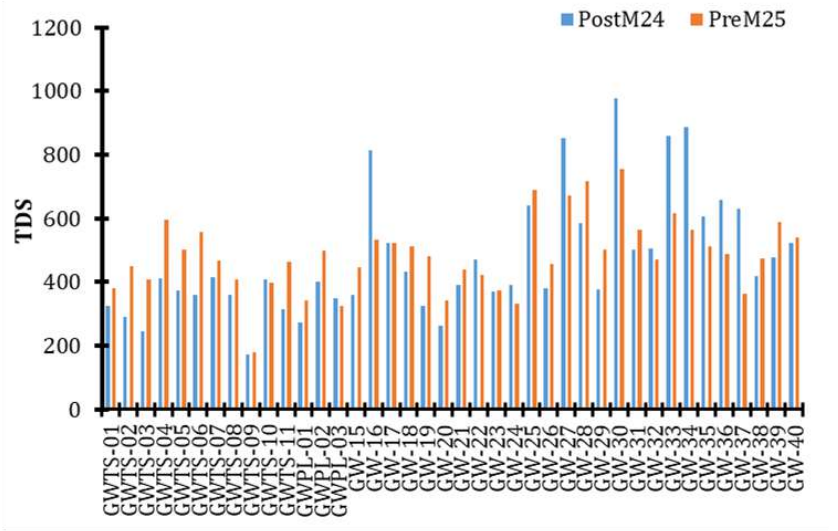
4.1.5 Total Dissolved Solids

Total Dissolved Solid (TDS) in water includes all dissolved material in solution, whether ionized or not. TDS is numerical sum of all mineral constituents dissolved in water and is expressed in mg/l. TDS in drinking-water originates from natural sources,

sewage, urban runoff and industrial wastewater. Concentrations of TDS in water vary considerably in different geological regions owing to differences in the solubility of minerals. The palatability of water with a total dissolved solids (TDS) level of less than about 600 mg/l is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/l. No health-based guideline value for TDS has been proposed (WHO, 2011). BIS (2012) have prescribed 500 mg/l as the acceptable limit and 2000 mg/l as the permissible limit in absence of alternate source for drinking and other domestic usage.



A. Surface Water



B. Groundwater

Figure 4.5 TDS variation in SW and GW during pre and post monsoon.

During the pre and post monsoon seasons, TDS in the surface water of the study area ranged from 133.4 to 653.1 mg/l (average 290.9 mg/l) and from 87.3 to 884.7 mg/l (average 299.6 mg/l) respectively. TDS in the ground water during pre-and post-monsoon ranged from 178.7 to 754.1 mg/l (average 483.6 mg/l) and from 171 to 978.6 mg/l (average 472.9 mg/l) respectively.

TDS variation in the surface water and groundwater of the study area is shown in **Figure 4.5.** Based on TDS content, water can be classified into four categories as fresh, brackish, saline and brine water (**Table 4.8**). TDS of the 100% of analysed water samples fall in the category of fresh water during both the seasons.

Table 4.8: Classification of water based on Total Dissolved Solids

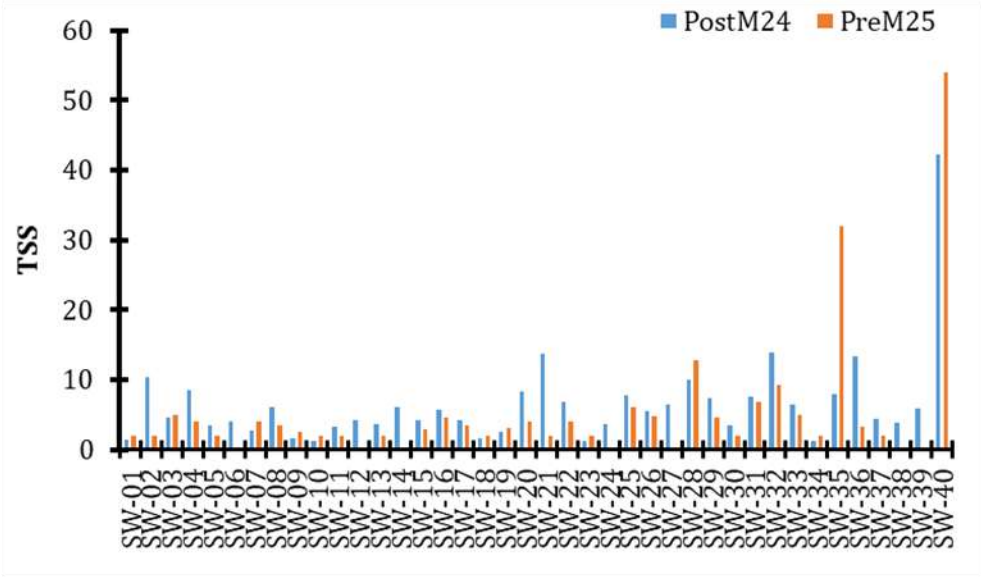
TDS (mg/l)	Water Quality	% Samples
0 – 1,000	Fresh Water	100%
1,000 – 10,000	Brackish Water	Nil
10,000 – 100,000	Saline Water	Nil
>100,000	Brine	Nil

4.1.6 Total Suspended Solids

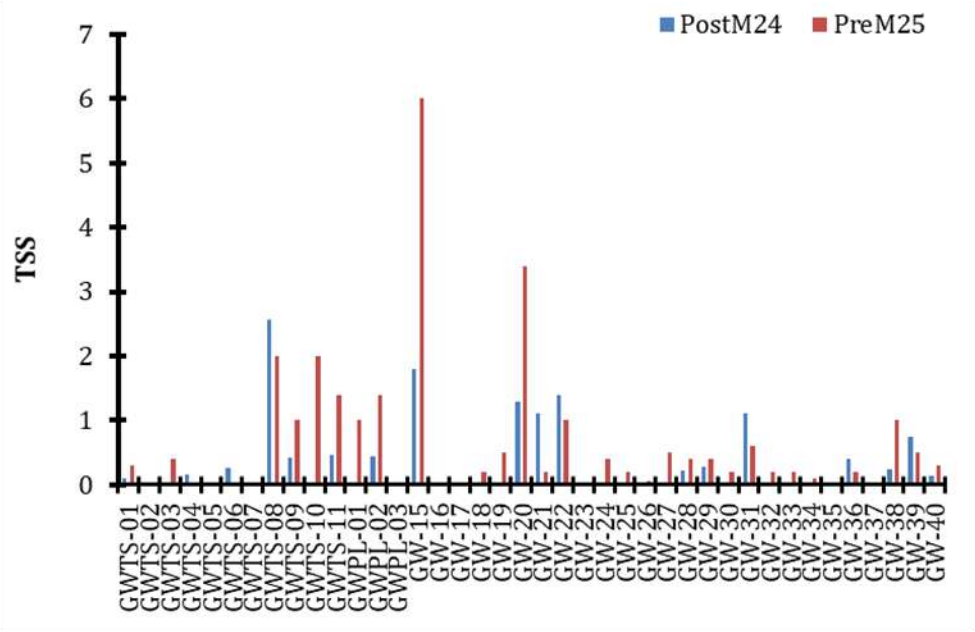
Total Suspended Solids (TSS) refers to solid particles or matter present in water that are large enough to be retained by a filter. These particles can range in size from fine clay and silt to larger organic and inorganic materials. Elevated TSS levels can cause water to appear cloudy or turbid and may have adverse effects on aquatic ecosystems and human health. Turbidity is the effect on light caused by the suspended particles (and anything else that affects light).

During the pre and post monsoon season, TSS in the surface water of the study area ranged from 2.0 to 54 mg/l (average 6.2 mg/l) and from 1.2 to 42.3 mg/l (average 6.5 mg/l) respectively. While TSS in the groundwater ranged from 0 to 6.0 mg/l (average 0.7 mg/l) and from 0 to 2.6 mg/l (average 0.33 mg/l) pre and post monsoon, respectively.

TSS variation in the surface water and groundwater of the study area is shown in **Figure 4.6.** TSS in groundwater is only seen in dug wells. No health-based guideline value for TSS has been proposed by BIS (2012) and (WHO, 2011).



A. Surface Water



B. Groundwater

Figure 4.6: Total Suspended Solids in SW and GW during pre-and post-monsoon.

4.1.7 Alkalinity

Alkalinity is a measure of the ability of water to neutralize acids. It is expressed in terms of $CaCO_3$ equivalent of the hydrogen ions neutralized. Alkalinity of water is mainly due to the presence of bicarbonates, carbonates, hydroxides of sodium, potassium, calcium and magnesium. Highly alkaline waters are usually unpalatable and impart a bitter taste to water.

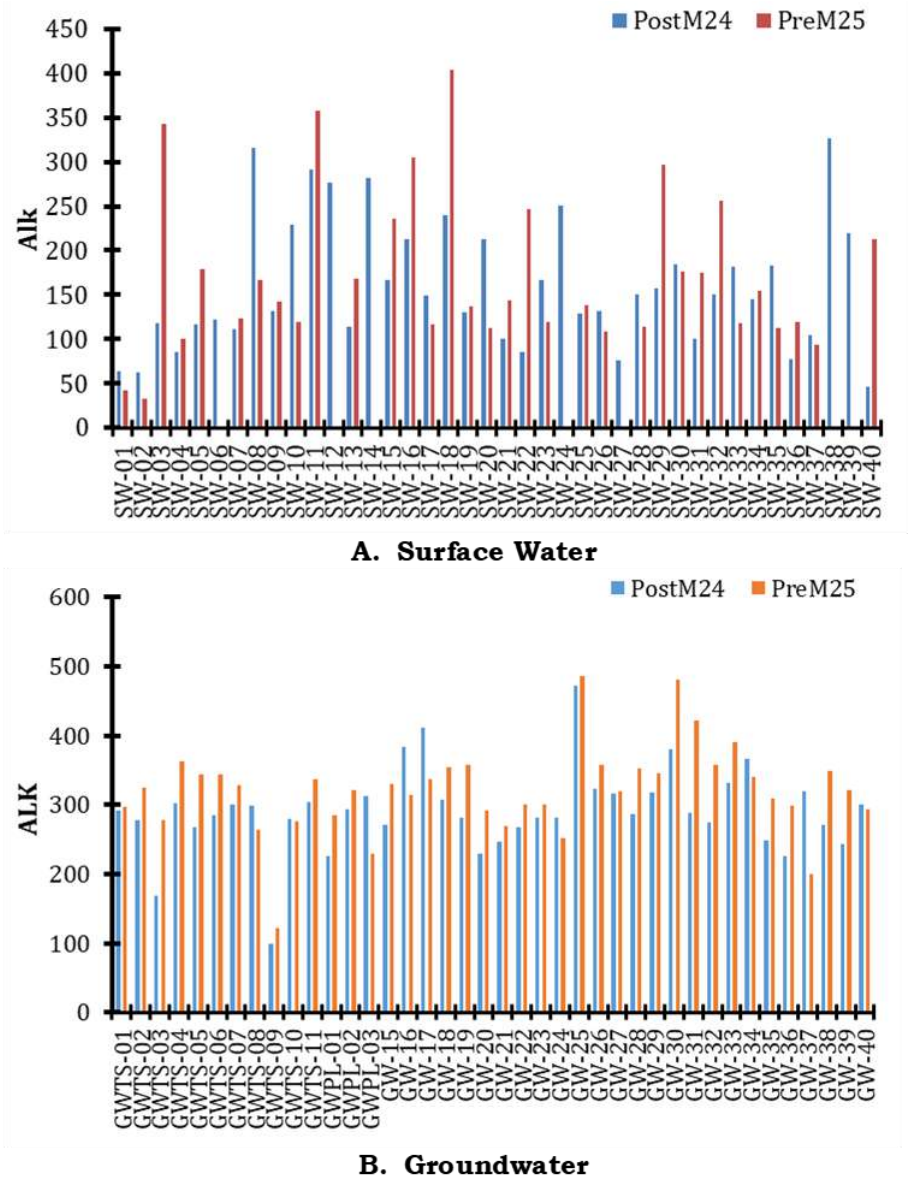


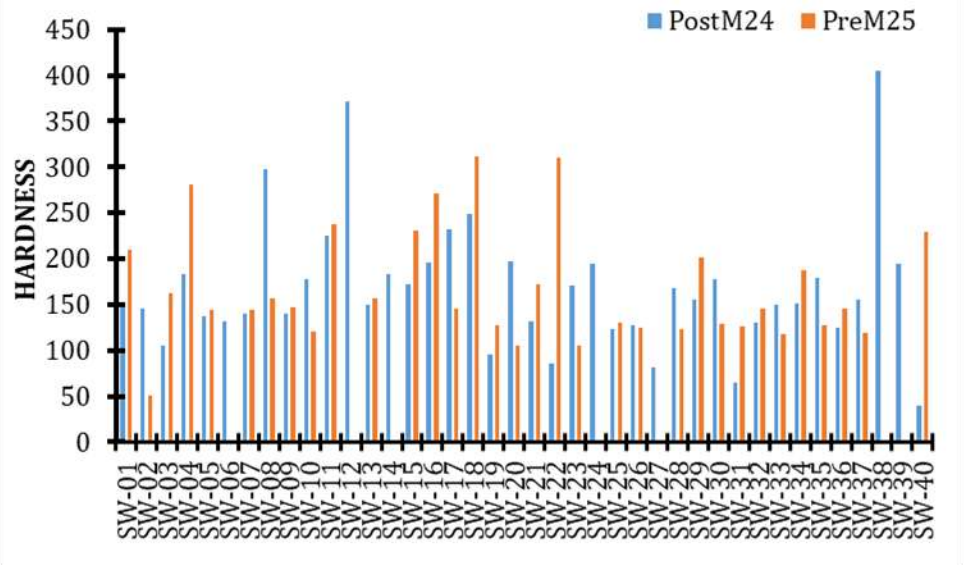
Figure 4.7: Alkalinity in SW and GW during pre and post monsoon.

Measuring alkalinity is important in determining water sources' ability to neutralize acidic pollution from rainfall or wastewater. There can be long-term changes in the alkalinity of streams and rivers in response to human disturbances. Alkalinity is related to the pH of a solution (its basicity) but measures a different property. Roughly, the pH of a solution is a measure of how "strong" the bases are in a solution, whereas the alkalinity measures the "total quantity" of chemical bases.

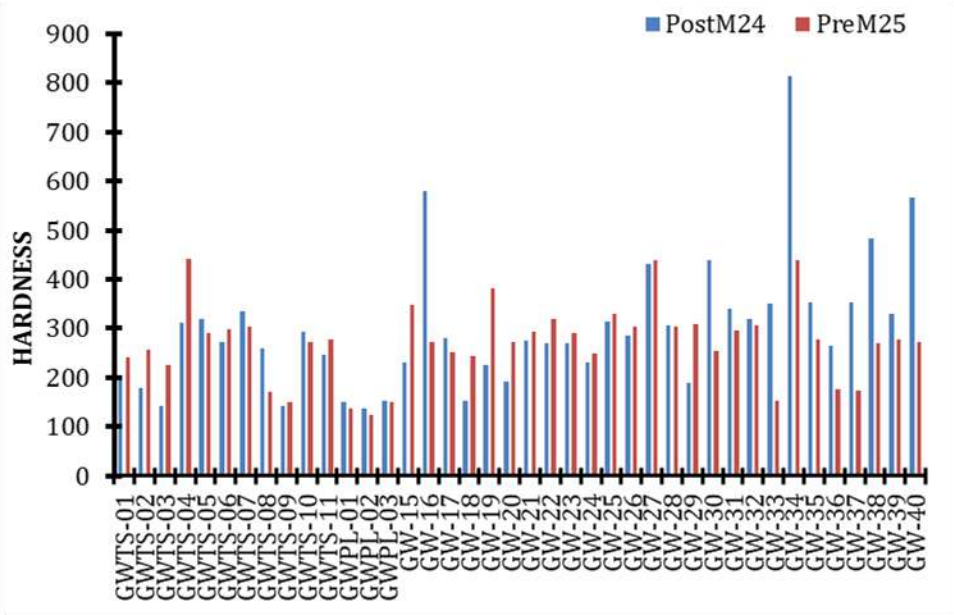
During the pre and post monsoon season, alkalinity of the surface water samples varies between 32.8 to 403.8 mg/l (average 171.9 mg/l) and 46.6 to 326 mg/l (average 160 mg/l), respectively. The alkalinity of the groundwater during pre and post monsoon season was found to vary between 122.4 to 486.8 mg/l, with an average of 321.4 mg/l and 100 to 471.6 mg/l (average 292 mg/l), respectively. Alkalinity variation in the surface water and groundwater of the study area is shown in **Figure 4.7.** Alkalinity in both surface water and groundwater is within the permissible limit prescribed by BIS for drinking water.

4.1.8 Total Hardness

Total Hardness in water is caused by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations. It is usually expressed as milligrams of calcium carbonate per liter. The degree of hardness of drinking water is important for aesthetic acceptability by consumers.



A. Surface Water



B. Groundwater

Figure 4.8: Total Hardness in SW and GW during pre and post monsoon.

Drinking-water can be a contributor to calcium and magnesium intake and could be important for those who are marginal for calcium and magnesium. Consumers are likely to notice changes in hardness. The taste threshold for the calcium ion is in the range of 100–300 mg/l, depending on the associated anion, and the taste threshold for magnesium is probably lower than that for calcium. In some instances, consumers

tolerate water hardness more than 500 mg/l. BIS (2012) has prescribed 200 mg/l as acceptable limit and 600 mg/l as permissible limit in absence of alternate source for drinking and other domestic usage. No health-based guideline value is proposed for hardness in drinking-water (WHO, 2011).

Hardness is classified in four categories as soft water, hard water, moderately hard water and very hard water **(Table 4.9).** During the pre and post monsoon, total hardness (TH) of the surface water varies between 51 to 312 mg/l (average 166.6 mg/l) and 39.2 to 405.4 mg/l (average 167.2 mg/l), respectively. The hardness of the groundwater samples ranged 125.5 to 442.9 mg/l (average 271.2 mg/l), and 138.1 to 813.1mg/l (average 299.5 mg/l), during the pre and post monsoon, respectively. Total Hardness variation in the surface water and groundwater of the study area is shown in **Figure** 4.8**.**

Table 4.9: Hardness Classification of Water

Hardness (mg/l)	Water Class	Surface water (No. of Samples)		Groundwater (No. of Samples)	
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon
0-75	Soft	2	8	-	-
75-150	Moderately hard	15	18	4	4
150-300	Hard	21	12	19	24
>300	Very hard	2	2	17	12

Total hardness in the ground water and surface water is within the BIS permissible limit. As per **Table 4.9**, none of the samples has very hard water and only 40-50% surface water samples have hard water. Generally, groundwater is soft or moderately hard water.

4.1.9 Biochemical Oxygen Demand (BOD)

The demand of oxygen from water to break down organic and inorganic waste and sewage is known as biochemical oxygen demand (BOD). The more the oxygen taken out from water, the less the content of dissolved oxygen, thus increasing the pollution in the river with a high BOD load. The amount of dissolved oxygen needed by bacteria

to decompose the waste determines the quality of wastewater. The problem arises when demand for dissolved oxygen exceeds available supply. Thus, BOD is a measure of oxygen required to sustain organisms like aerobes, protozoa etc.

During pre and post monsoon, BOD values in the surface water samples collected from the study area vary from 2.4 to 36.5 mg/l (average 9.2 mg/l) and 2.5 to 24.6 mg/l (average 7.3 mg/l) in ponds and rivers. BOD values in surface water samples are shown in**. Figure** 4.9**.**

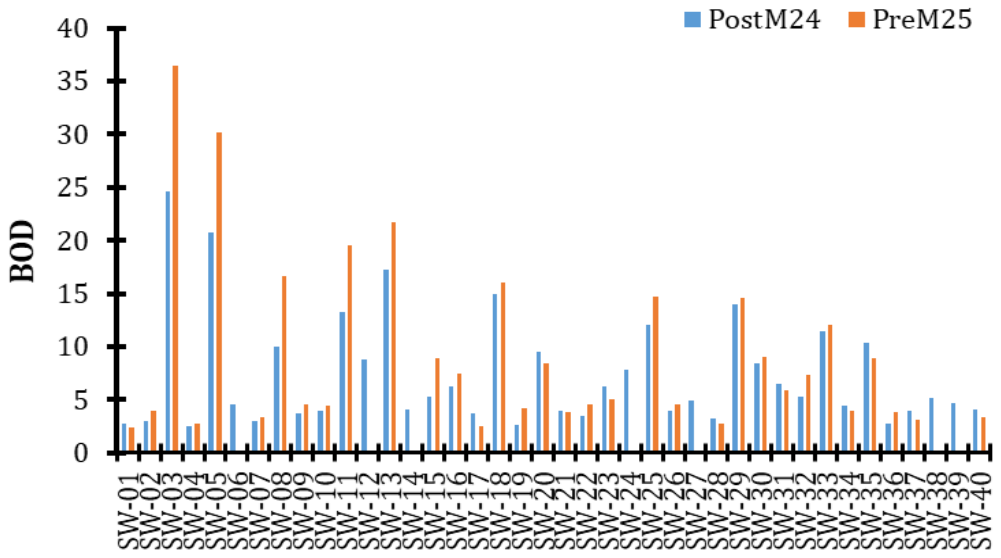


Figure 4.9: Variation of BOD in SW during pre and post monsoon.

4.1.10 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is a measurement of the oxygen requirement equivalent of organic matter that is susceptible to oxidation with the help of a strong chemical oxidant. It is an important, rapidly measured parameter as a means of measuring organic strength for streams and polluted water bodies. Chemical Oxygen Demand (COD) is a measurement of the oxygen requirement equivalent of organic matter that is susceptible to oxidation with the help of a strong chemical oxidant. It is an important, rapidly measured parameter as a means of measuring organic strength for streams and polluted water bodies. During pre and post monsoon season, COD value in the surface water varies from 11.5 to 107.5 mg/l (average 46.4 mg/l) and 12 to 90

mg/l (average 36.3 mg/l), respectively. Variation of COD in surface water is shown in **Figure** 4.10

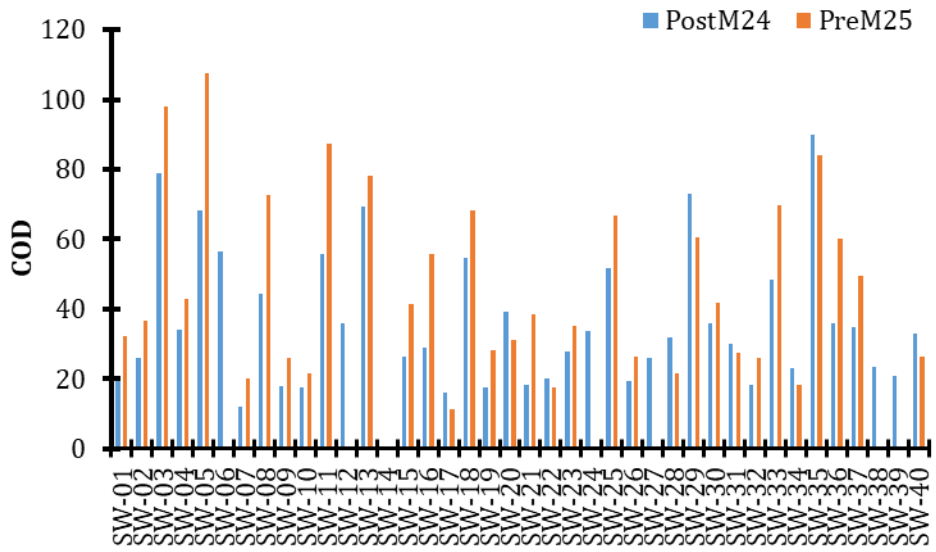


Figure 4.10: Variation of COD in SW during pre and post monsoon.

4.1.11 Fluoride

Fluorine is a common element, but it does not occur in the elemental state in nature because of its high reactivity. Fluorine is the most electronegative and reactive of all elements that occur naturally within many rock types.

Fluoride is found in all natural waters at some concentration. Seawater typically contains about 1 mg/l while rivers and lakes generally exhibit concentrations of less than 0.5 mg/l. In groundwater, however, low or high concentrations of fluoride can occur, depending on the nature of the rocks and the occurrence of fluoride-bearing minerals.

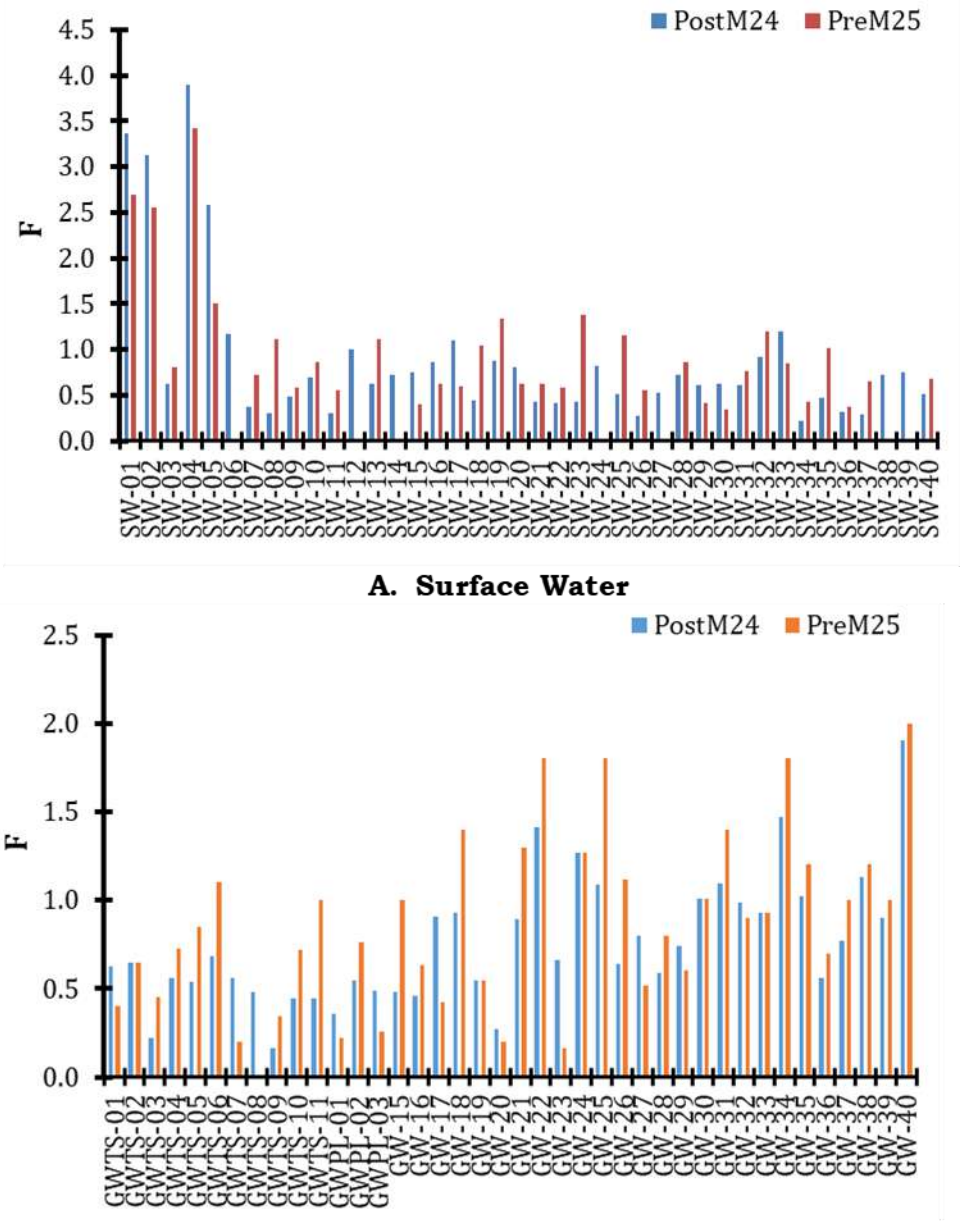


Figure 4.11: Fluoride in SW and GW during pre- and post-monsoon.

Fluoride occurs as fluorspar (fluorite), rock phosphate, phosphorite minerals etc. in nature. Among the factors, which control the concentration of fluoride includes climate of the area and the presence of accessory minerals in the rock mineral assemblage through which the groundwater is circulating. Concentrations in water are limited by

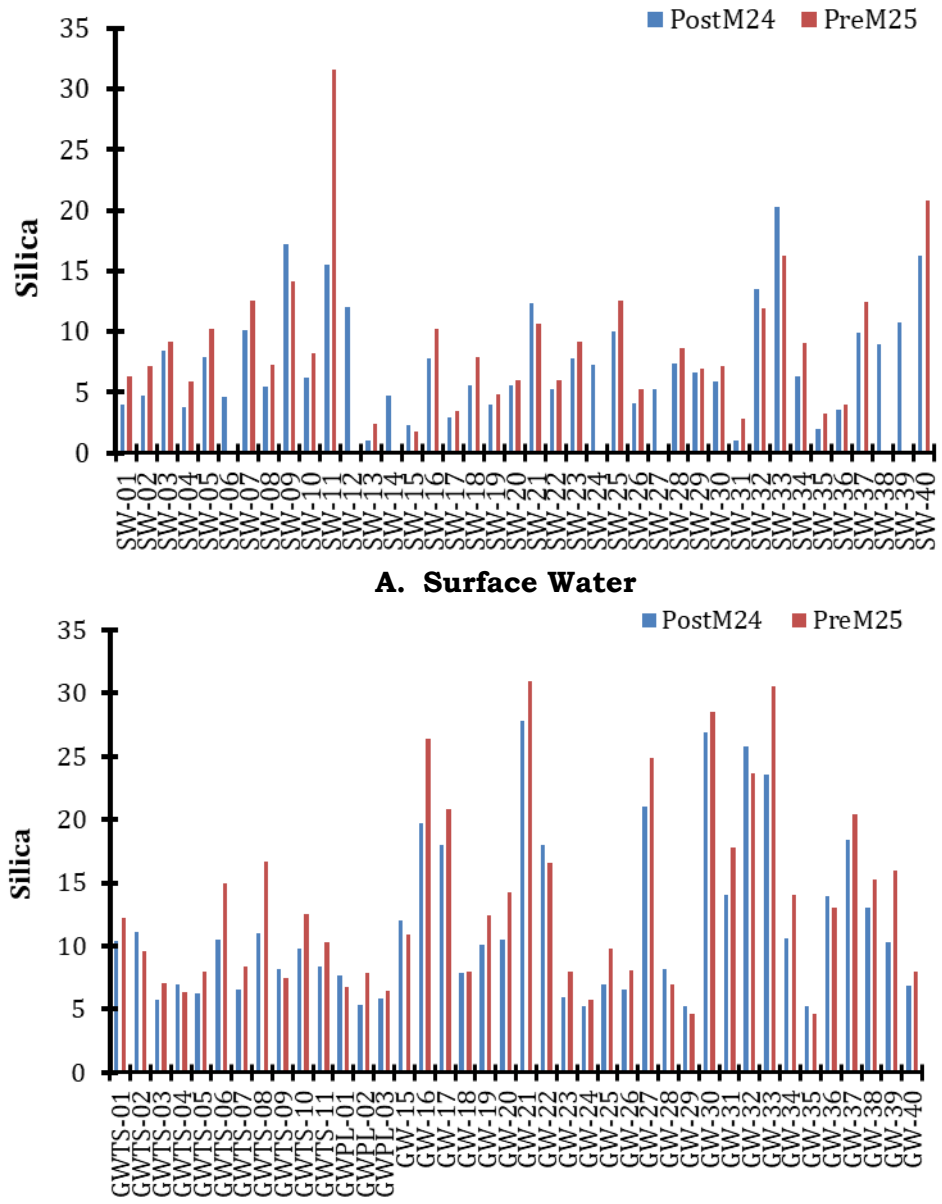
fluorite solubility. It is the absence of calcium in solution which allows higher concentrations to be stable. High fluoride concentrations may therefore be expected in groundwater from calcium-poor aquifers and in areas where fluoride-bearing minerals are common. Fluoride in drinking water has a narrow range between beneficial and detrimental health effects. During pre- and post-monsoon, concentration of fluoride in surface water varies from 0.3 to 3.4 mg/l (average 0.98) and 0.2 and 3.9 mg/l (average 0.88 mg/l), respectively. Concentration of fluoride in ground water varies from 0.0 to 2.0 mg/l (average 0.86) and between 0.16 and 1.97 mg/l (average 0.76 mg/l), respectively.

The WHO (2011) and BIS (2012) estimate the maximum allowable limit for fluoride uptake to humans in drinking water as 1.5 mg/l. Excess fluoride intake causes different types of fluorosis, primarily dental and skeletal fluorosis. Fluoride variation in the surface water and groundwater of the study area is shown in **Figure 4.11.**

4.1.12 Silica

Silica (silicon dioxide) is a compound of silicon and oxygen ($Si0_2$). It is a hard, glassy mineral substance that occurs in a variety of forms such as sand, quartz, sandstone, and granite. It is also found in the skeletal parts of various animals and plants. Silicon is the 7th most abundant element in the universe and the second most abundant element on earth after oxygen which explains why most water supplies will contain some traces of silica. All natural water supplies contain some dissolved “silica” and most will also contain suspended or colloidal silica. In solution it can exist as silicic acid or silicate ion, depending upon the pH value. Silica can also be found in certain foods including cucumbers, oats, brown rice, wheat, strawberries, onions, avocados, and root vegetables. Silica can cause water to appear cloudy or leave white, chalky deposits on glassware, showerheads, and sinks. These residues are harmless but can be unsightly and inconvenient to clean. High silica levels in water can cause scaling on industrial equipment, pipes, and appliances. This is a particular concern for businesses using boilers or cooling systems, where silica deposits can reduce efficiency and increase maintenance costs. The dissolved silica concentrations in waters samples collected

during pre-monsoon from study area are tabulated in **Table 4.1 and Table 4.2** for surface water and groundwater respectively. Variation of silica in surface water and groundwater are shown in **Figure 4.12**



A. Surface Water

B. Groundwater

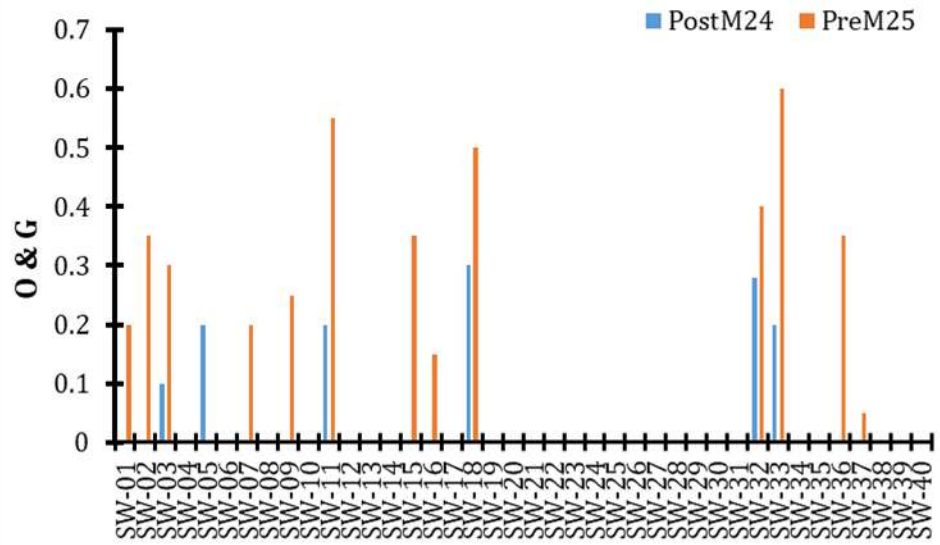
Figure 4.12: Silica in SW and GW during pre- and post-monsoon period.

Silica in surface water samples during pre- and post-monsoon varies between 1.8 to 31.6 mg/l (average 8.9 mg/l) and 1.0 to 20.3 mg/l (average 7.5 mg/l) respectively during post-monsoon season. Concentration of Silica in groundwater during pre- and post-monsoon varies between 4.6 to 30.9 mg/l (average 13.4 mg/l) and 5.2 to 27.8 mg/l (average 11.6 mg/l) respectively. BIS & WHO have not set any guidelines for silica in drinking water standards. high concentration of silica forms hard scale in pipes and boilers and may form deposits on blades of steam turbines.

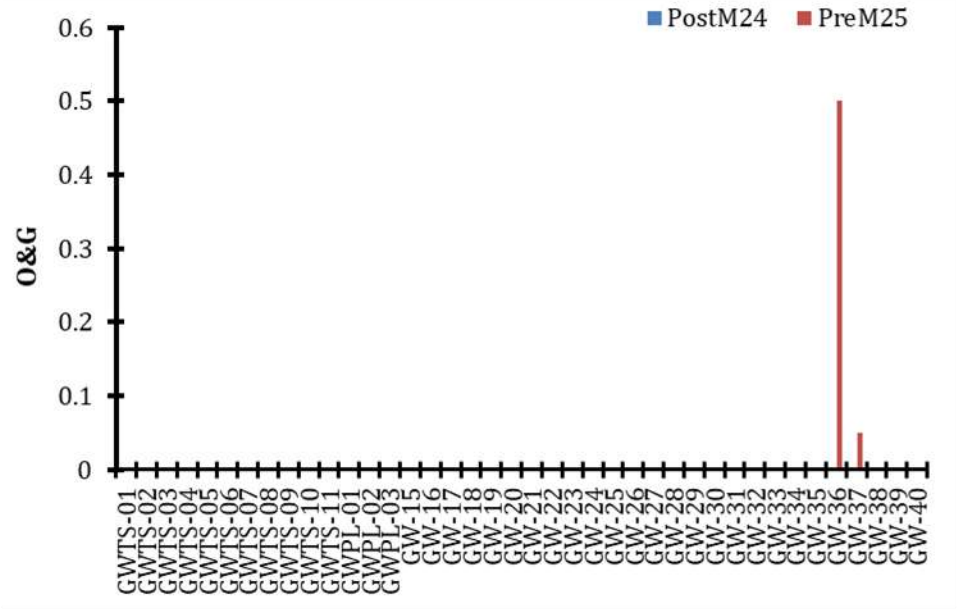
4.1.13 Oil and Grease

Oil and grease include fats, oils, waxes, and other related constituents found in water, generally wastewater. If these compounds are not removed before discharge of treated wastewater, oil and grease can interfere with biological life in surface waters and create unsightly films. Fats and oils contribute to domestic wastewater in butter, lard, margarine, and vegetable fats and oils. Fats are also commonly found in meats, in the germinal area of cereals, in seeds, in nuts, and in certain fruits. The low solubility of fats and oils reduces their rate of microbial degradation. Kerosene, lubricating, and road oils are derived from petroleum and coal tar and contain essentially carbon and hydrogen. These oils can reach sewers in considerable volume from shops, garages, and streets. The mineral oils coat surfaces to a greater extent than fats, oils, and soaps, and the particles interfere with biological action and cause maintenance problems.

Oil & Grease variation in the surface water and groundwater of the study area is shown in **Figure 4.13** Concentration of Oil and Grease in surface water samples of study area varies between 0.1 to 0.6 mg/l (average 0.3 mg/l) and 0.1 to 0.3 mg/l (average 0.2 mg/l) respectively during pre- and post-monsoon season. Oil and Grease have not been observed in any sample of groundwater during post-monsoon season, whereas during pre-monsoon GW36 and GW37 the Oil and Grease was measured around 0.5 and 0.05 mg/l, respectively. Mostly, oil and grease have been observed in surface water samples, however, two of the groundwater samples also show traces of oil and grease. The physical verification of these two dug wells shows that these are low lying wells and there may be chances of anthropogenic activities due to which Oil and grease traces are visible in the groundwater.



A. Surface Water



B. Groundwater

Figure 4.13: Oil and Grease in SW and GW during pre and post monsoon period.

4.1.14 Phenolic Compounds

Phenol, a pervasive and persistent organic pollutant, threatens natural ecosystems and human health. Phenol is non-biodegradable, efficiently absorbed through the skin, and highly toxic and mutagenic at higher concentrations. Phenolic compounds cover a vast array of substances. At lower concentrations, phenol is used as a disinfectant. Most monohydric and dihydric phenols easily succumb to oxidation and microbial breakdown, depending on the habitat.

Phenol and its derivatives are classified as potent water contaminants that cause foul odors and water taste. The effluents from the paint, pesticide, pharmaceutical, chemical, petroleum, and petrochemical sectors are the leading causes of phenol contamination in the aquatic environment. The chlorination used for water disinfectants produces chlorinated phenols that are more toxic than the parent material. The European Union (EU) and the United States Environmental Protection Agency (USEPA) have designated phenol and its derivatives as pollutants of primary concern. Since these compounds are known to be hazardous and to have negative short- and long-term impacts on both humans and animals, this enlistment is necessary. According to BIS, the phenol in drinking water should not be higher than 0.002 mg/l.

Phenolic compounds exist in water bodies due to the discharge of polluted wastewater from industrial, agricultural and domestic activities into water bodies. They also occur because of natural phenomena. These compounds are known to be toxic and inflict both severe and long-lasting effects on both humans and animals. They act as carcinogens and cause damage to the red blood cells and the liver, even at low concentrations. Interaction of these compounds with microorganisms, inorganic and other organic compounds in water can produce substituted compounds or other moieties, which may be as toxic as the original phenolic compounds.

Phenols or Phenolic compounds have not been detected in groundwater during both pre-monsoon and post monsoon seasons. Whereas, in surface water the phenolic compound traces were observed in pre-monsoon period in Ash dyke water (SW-01, 02 and 04).

4.2 Major Ions

Major ions are the positive and negatively charged ions present in water. These are the constituents that contribute to the amount of total and dissolved solids and specific conductance in waters.

Concentration of various ions in surface water and groundwater are given in **Figure** 4.14 and **Table 4.6,** respectively.

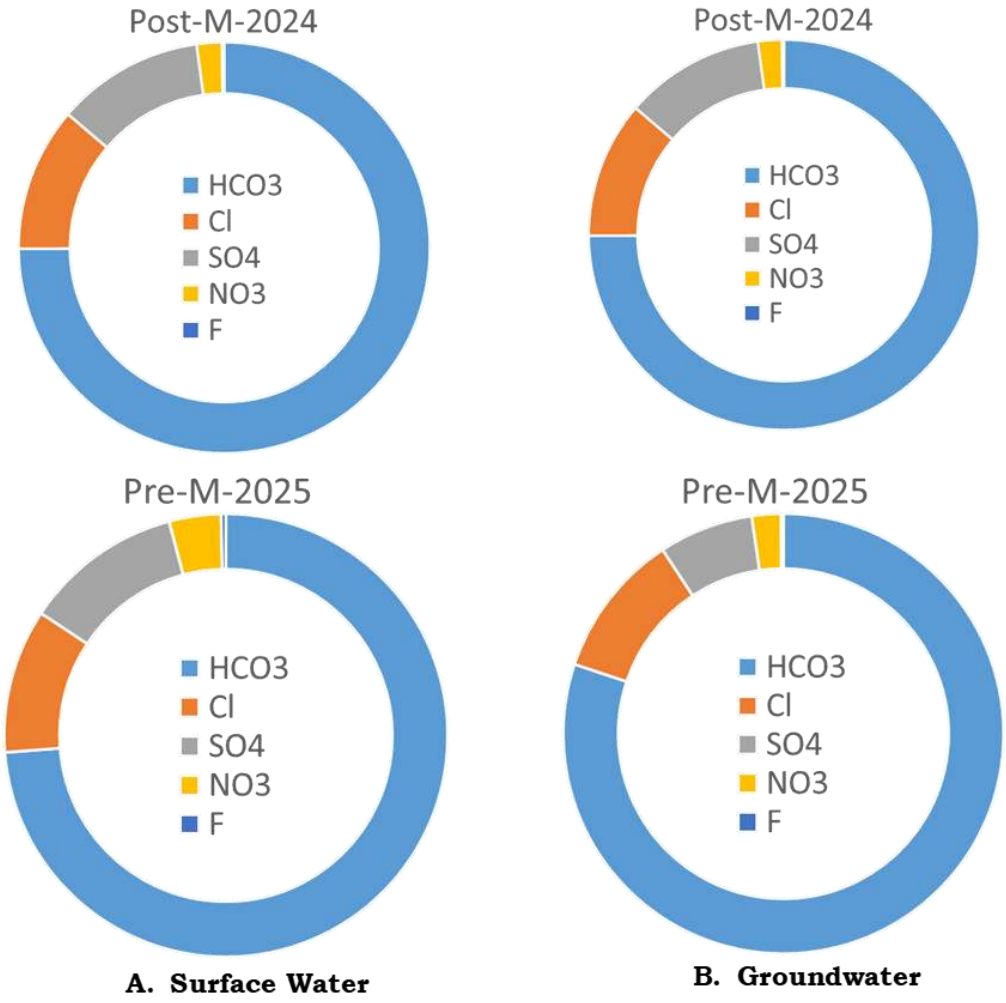
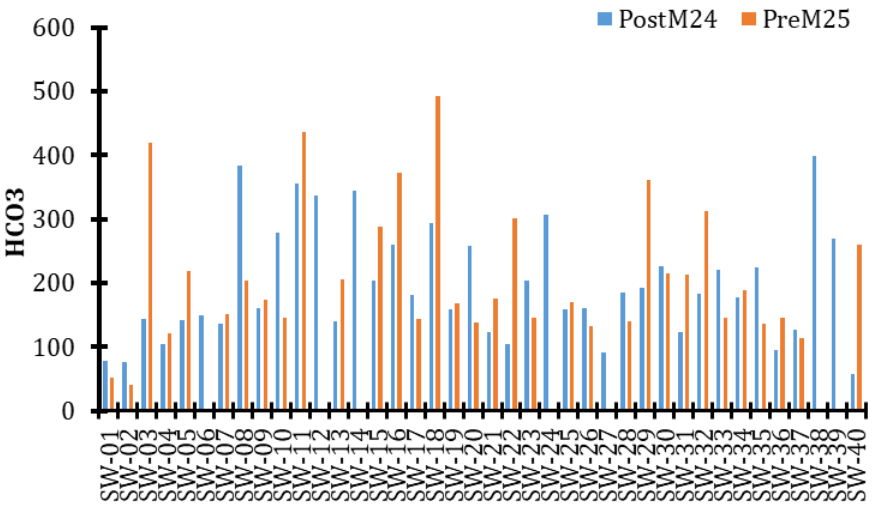


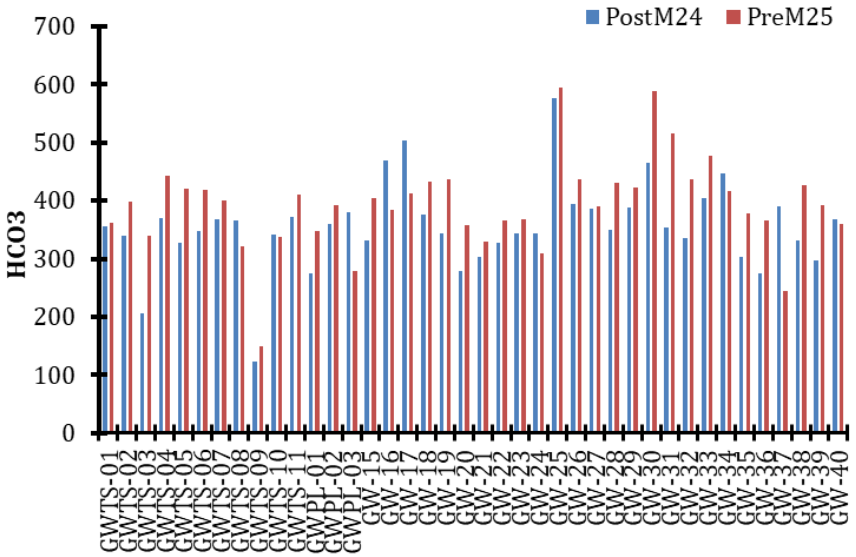
Figure 4.14: Anion distribution in SW and GW during pre and post monsoon period.

4.2.1 Major Anions (HCO_3^-, Cl^-, SO_4^{2-}, NO_3^-)

In the surface water and groundwater, the major anions during the pre- and post-monsoon period include HCO_3^-, Cl^-, SO_4^{2-}, NO_3^- and F^-. In groundwater and surface water, the anions follow the abundance order of HCO_3^->Cl^->SO_4^{-2}>NO_3^->F^-, in both pre-monsoon and post-monsoon seasons.



A. Surface Water



B. Groundwater

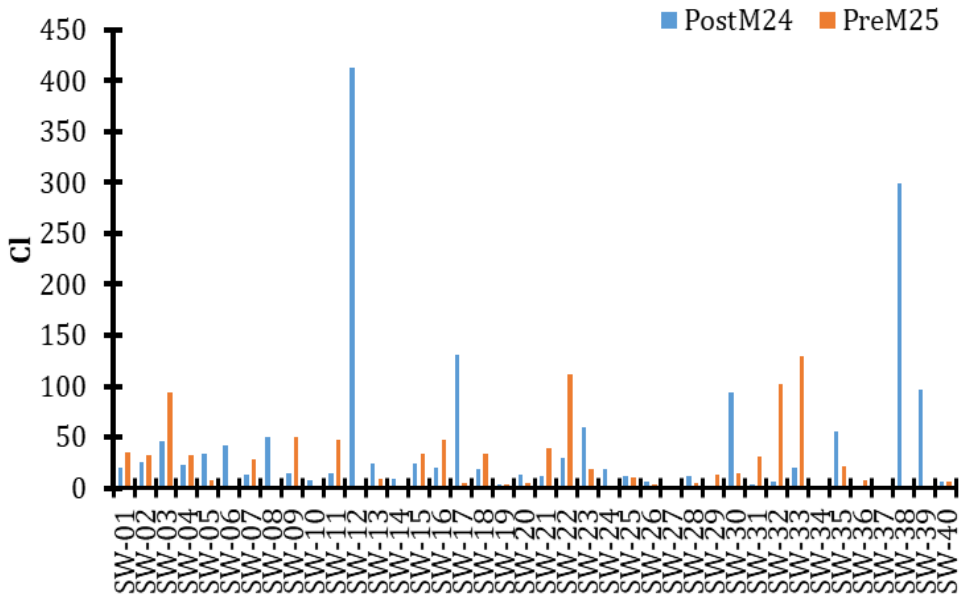
Figure 4.15: Bicarbonates in SW and GW during pre-and post-monsoon period.

Bicarbonate: The bicarbonates & carbonate are derived mainly from the soil zone CO_2 and at the time of weathering of parent minerals. The soil zone in the subsurface environment contains elevated CO_2 pressure (produce as result of decay of organic matter and root respiration), which in turn combines with rainwater to form bicarbonate. Bicarbonate may also be derived from the dissolution of carbonates and-or silicate minerals by the carbonic acid. Bicarbonates contribute to alkalinity (acid neutralizing capacity), and BIS (2012) has prescribed 200 mg/l as acceptable limit and 600 mg/l as permissible limit in absence of alternate source for drinking and other domestic usage. Bicarbonate variation in the surface water and groundwater of the study area is shown in **Figure 4.15.** During pre- and post-monsoon, HCO_3^- concentration in the surface water samples varies between 40.0 to 492.6 mg/l (average 209.6 mg/l) and 56.8 to 398 mg/l (average 195.2 mg/l) respectively. In groundwater during post-monsoon, HCO_3^- concentration in the varies between 149.3 to 593.9 mg/l (average 392.1 mg/l) and 122 to 575.4 mg/l (average 355.2 mg/l) respectively.

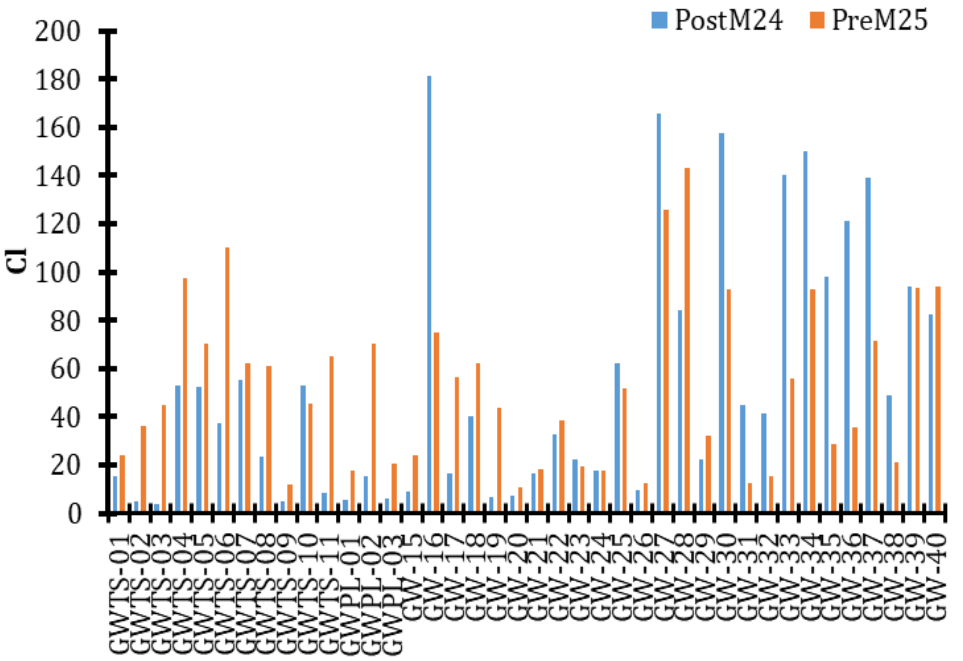
Chloride (Cl^-): All natural waters contain some dissolved solids (salinity) from contact with soils, rocks, and other natural materials. Too much, though, and dissolved solids can impair water use. Unpleasant taste, high water-treatment costs, mineral accumulation in plumbing, staining, corrosion, and restricted use for irrigation are among the problems associated with elevated concentrations of dissolved solids.

The chloride (Cl^-) concentration in the pre-and post-monsoon varies between 0.8 to 129.5 mg/l (average 29.9 mg/l) and 1.5 to 412.2 mg/l (average 42.2 mg/l) in surface water, respectively. Whereas, in the groundwater chloride (Cl^-) concentration during pre- and post-monsoon varies from 10.6 to 143.4 mg/l (average 52.1 mg/l) and 4.1 to 181.6 mg/l (average 53.8 mg/l), respectively. Chloride variation in the surface water and groundwater of the study area is shown in **Figure 4.16.**

BIS (2012) has prescribed chloride (Cl^-) concentration of 250 mg/l as acceptable limit and 1000 mg/l as permissible limit in absence of alternate source for drinking and other domestic usage. Chloride concentrations in all the analysed samples were within the acceptable limit prescribed by BIS. No health-based guideline value is proposed for chloride in drinking-water.



A. Surface Water



B. Groundwater

Figure 4.16: Chloride in SW and GW during pre-and post-monsoon period.

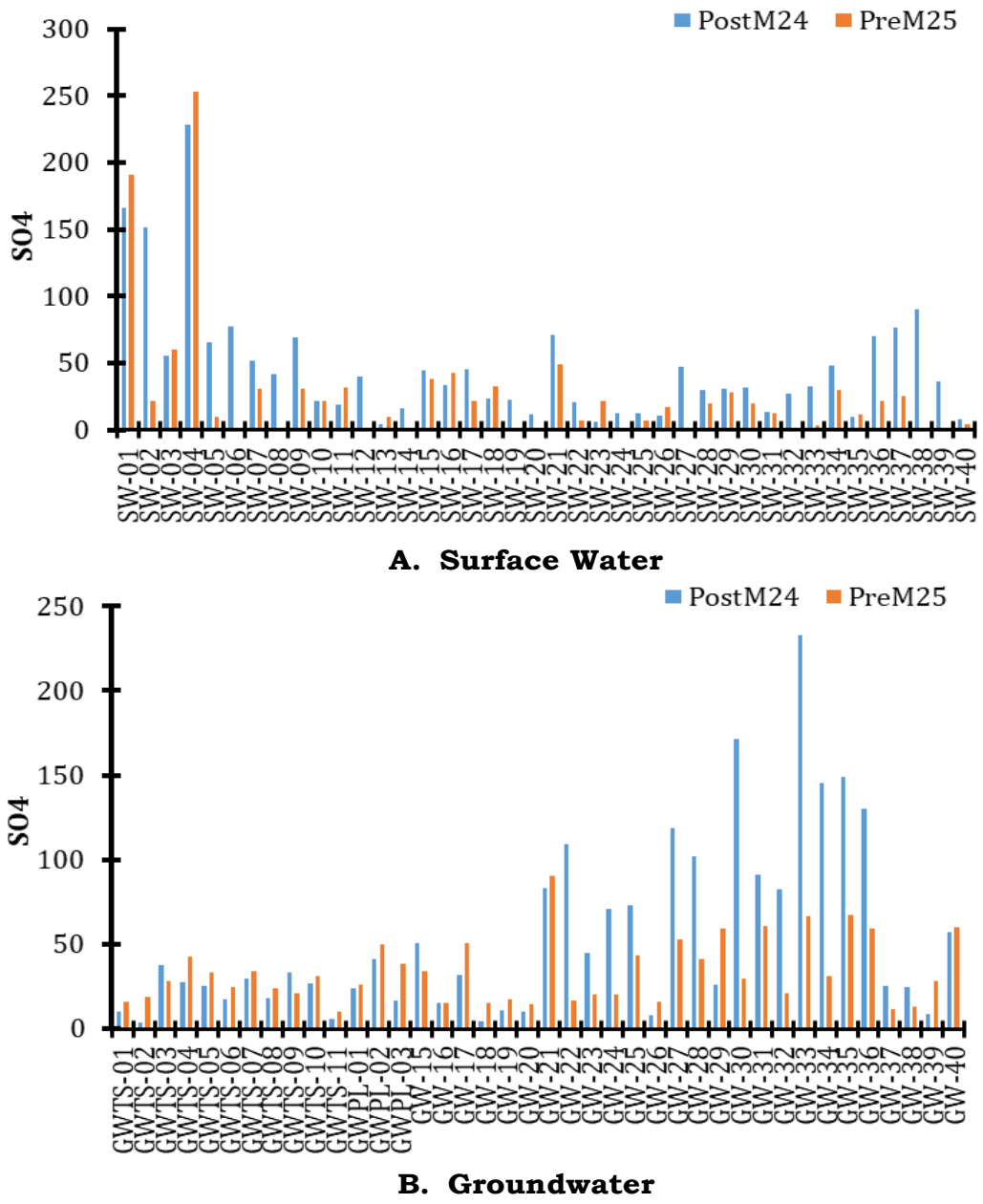


Figure 4.17: Sulphate in SW and GW during pre-and post-monsoon period.

Sulphate (SO_4^{-2}): Sulphate in drinking-water can cause noticeable taste, and very high levels might cause a laxative effect in unaccustomed consumers. Taste impairment varies with the nature of the associated cation; taste thresholds have been found to range from 250 mg/l for sodium sulfate to 1000 mg/l for calcium sulfate. High sulfate levels in drinking water results in gastro-intestinal disorders, and hence, it is

recommended that health authorities be notified of sources of drinking water that contain sulfate concentrations more than 500 mg/l (WHO, 2011). BIS (2012) has prescribed 200 mg/l as acceptable limit and 400 mg/l as permissible limit for sulfate in absence of alternate source for drinking and other domestic usage. During the pre-and post-monsoon season, SO_4^{2-} concentration in surface water varies from 1.3 to 253.5 mg/l with an average of 32.9 mg/l and 4.4 to 228.3 mg/l with an average of 47.0 mg/l, respectively. Whereas in groundwater the concentration of SO_4^{2-} during the pre-and post-monsoon season varies between 10.6 to 90.5 mg/l with an average of 33.9 mg/l and 3.8 to 232.5 mg/l with an average of 54.9 mg/l, respectively. Sulphate variation in the surface water and groundwater of the study area is shown in **Figure 4.17**. The ranges of SO_4^{2-} concentration in both the surface water and groundwater indicated that Sulphate concentration is within the stipulated permissible limit prescribed by BIS (2012).

Nitrate (NO_3^-): Nitrate is highly soluble in water. Nitrate (NO^{3-}) is found naturally in the environment and is an important plant nutrient. It is present at varying concentrations in all plants and is a part of the nitrogen cycle. Nitrate can reach both surface water and groundwater because of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater disposal and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks. Surface water nitrate concentrations can change rapidly owing to the surface runoff of fertilizer, uptake by phytoplankton and denitrification by bacteria, but groundwater concentrations generally show relatively slow changes. Some groundwater may also have nitrate contamination because of leaching from natural vegetation. The anthropogenic sources of nitrogen include (i) point source including industrial effluents, sewage, refuse dumps etc. discharged directly into the surface water, (ii) diffuse source including runoff and leaching from rural and urban land and (iii) precipitation.

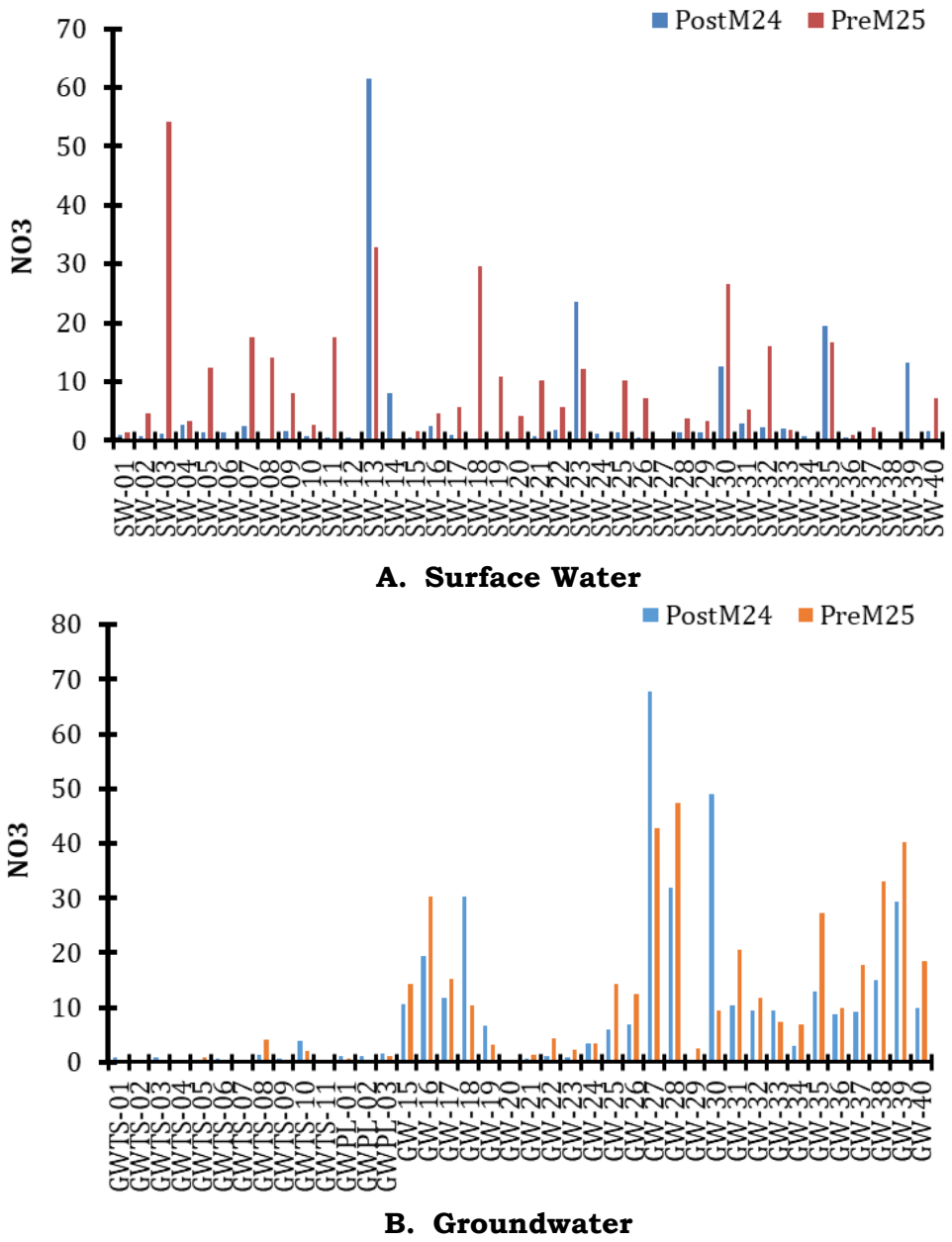
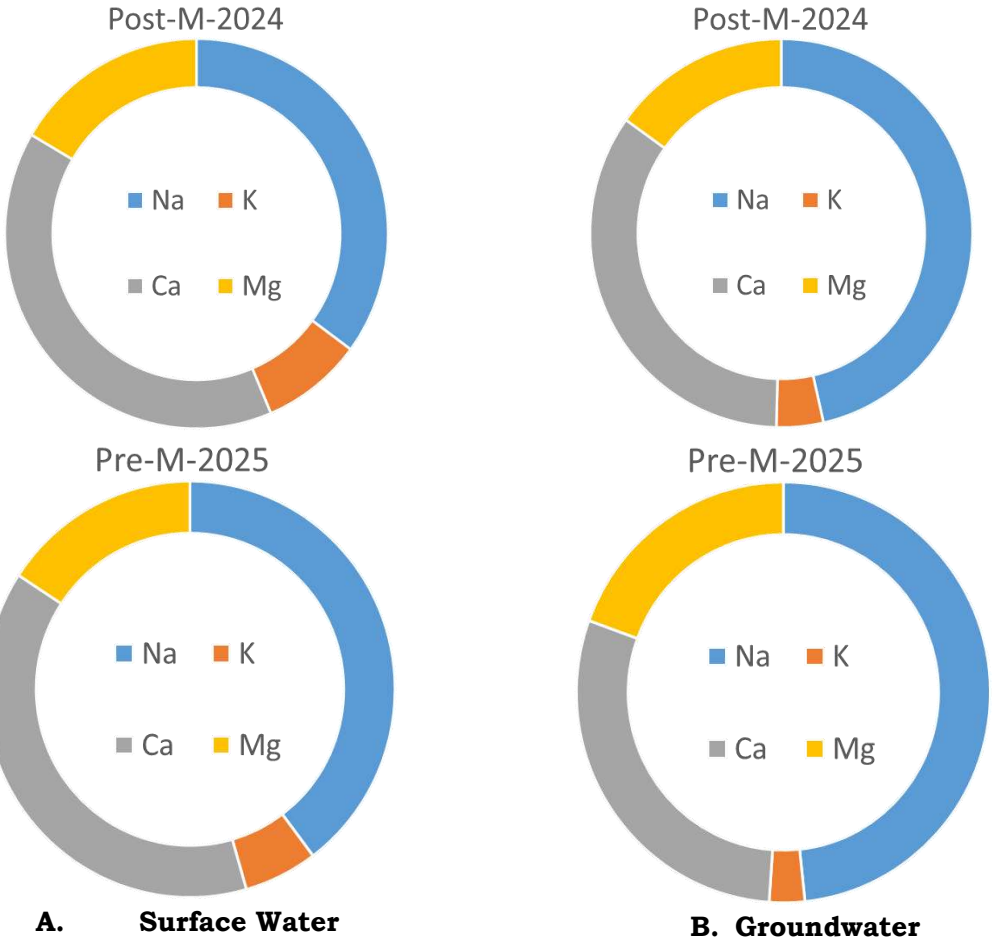


Figure 4.18: Nitrate in SW and GW during pre-and post-monsoon period.

The presence of nitrate in drinking water is a potential health hazard when present in large quantities. Nitrites are formed by reduction of nitrate in the human body, which combines with haemoglobin in the blood to form methaemoglobin that leads to methemoglobinemia (blue baby syndrome) in infants. The combination of nitrates with amines, amides, or other nitrogenous compounds through the action of bacteria in the

digestive tract results in the formation of nitrosamines, which are potentially carcinogenic. According to the Indian Standard for drinking water (IS 10500:2012), the maximum allowable nitrate concentration in drinking water is 45 mg/l as NO_3. During the pre-and post-monsoon season, NO_3 concentration in the surface water ranges from 0.0 to 54.3 (average 10.7 mg/l) and 0.0 to 61.6 mg/l (average 4.4 mg/l) respectively. NO_3 concentration in the groundwater ranges from 0.0 to 47.3 (average 10.4 mg/l), 0.0 to 67.8 mg/l (average 9.4 mg/l) during pre- and post-monsoon, respectively. Nitrate variation in the surface water and groundwater of the study area is shown in **Figure 4.18**. Nitrate concentrations in the study area are well within the acceptable limit (45.0 mg/l) in most of the analyzed surface water and groundwater samples except few locations.



A. Surface Water **B. Groundwater**

Figure 4.19: Cation distribution in SW and GW during pre and post monsoon period.

4.2.2 Major Cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+})

The major cations include Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}. Generally, Ca^{2+} and Na^{+} are the major cations, and both constitute more than 70.0% of the total cations in the analysed groundwater and surface water of the buffer area of study area. **Figure 4.19** shows that the surface water is dominated by Ca^{2+}> Na^{+}> Mg^{2+}> K^{+} and Na^{+}>Ca^{2+}> Mg^{2+} > K^{+} during post-and pre-monsoon sampling period. The dominance of these ions in groundwater is in the order Na^{+}>Ca^{2+}> Mg^{2+} > K during pre-and post-monsoon, respectively.

Calcium (Ca^{2+}): Calcium ions are among the most encountered substances in water. Calcium in water arises mostly from the dissolution of Ca bearing minerals of the aquifer formation and often it is the most abundant cation in water. Weathering and dissolution of calcium carbonate (limestone and dolomite) and calc-silicate minerals (amphiboles, pyroxenes, olivine, biotite etc.) are the most common sources of calcium in the aquatic system. The calcium in hard water results in teaming up with excess bile and its resident fats to lather up the soap like insoluble substance, which is emitted from the body during bowel movements.

BIS (2012) have prescribed 75 mg/l as an acceptable limit and 200 mg/l as permissible limit for calcium in absence of alternate source for drinking and other domestic usage. During pre-and post-monsoon monitoring, concentration of Calcium in surface water varies between 12.0 to 76.2 mg/l (average 40.7 mg/l) and 8.0 to 76.5 mg/l (average 39.8 mg/l) respectively. Whereas, in groundwater during pre- and post-monsoon monitoring, Calcium varies between 24.8 to 92.3 mg/l (average 52.1 mg/l) and 21.4 to 136.7 mg/l (average 57.1 mg/l) respectively. Calcium variation in the surface water and groundwater of the study area is shown in **Figure 4.20.**

Magnesium (Mg^{2+}): Magnesium is abundant in earth crust and is a common constituent of natural water. Olivine, clay minerals, dolomite, pyroxenes are the common source minerals for magnesium in the waters. The carbonate, chlorides, hydroxides, oxides and sulphate of the magnesium are used in the production of magnesium metal, refractories, fertilizers, ceramics, and explosives and medicines. Magnesium compounds are more soluble than their counterparts. Magnesium precipitates in its hydroxide at pH>10.

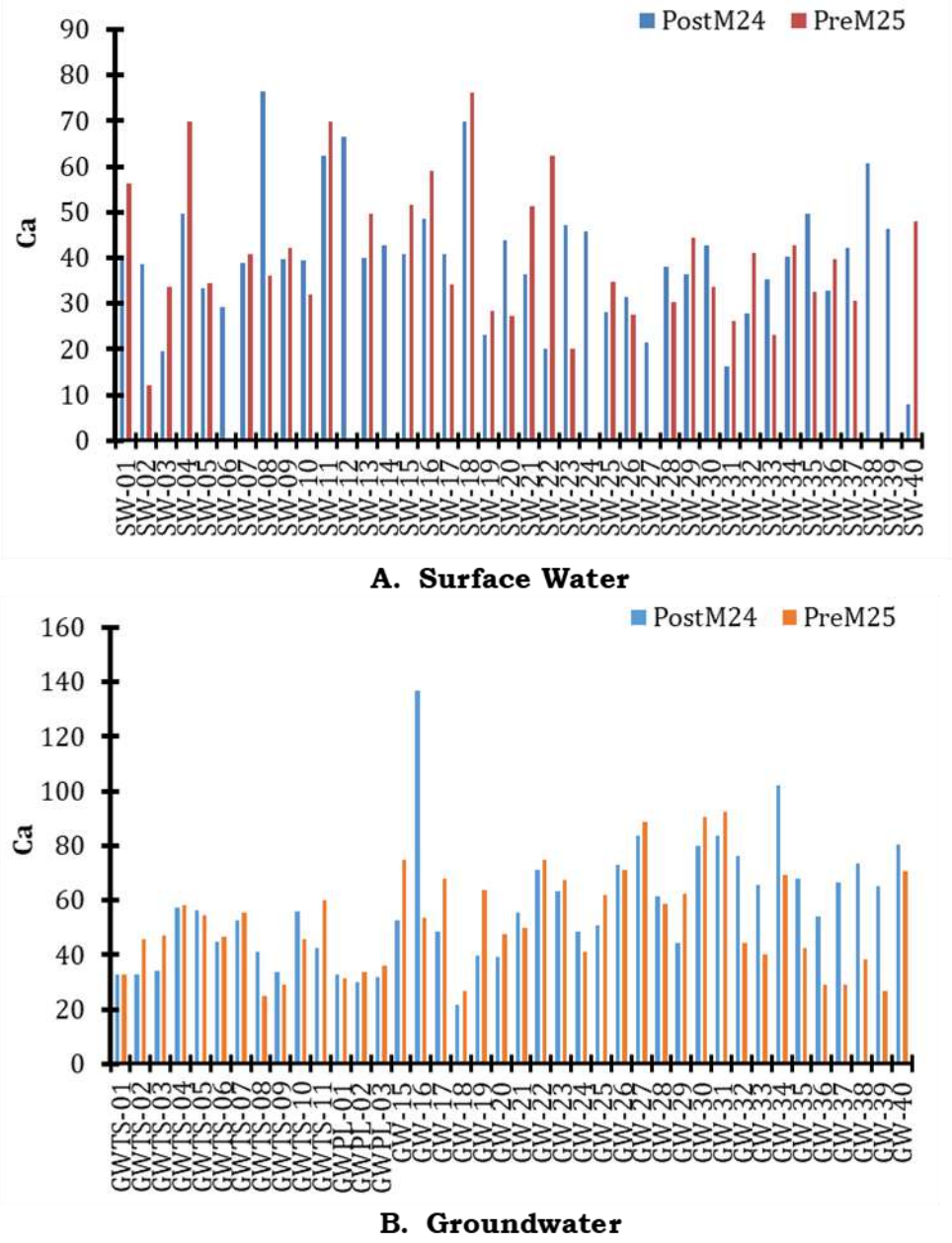
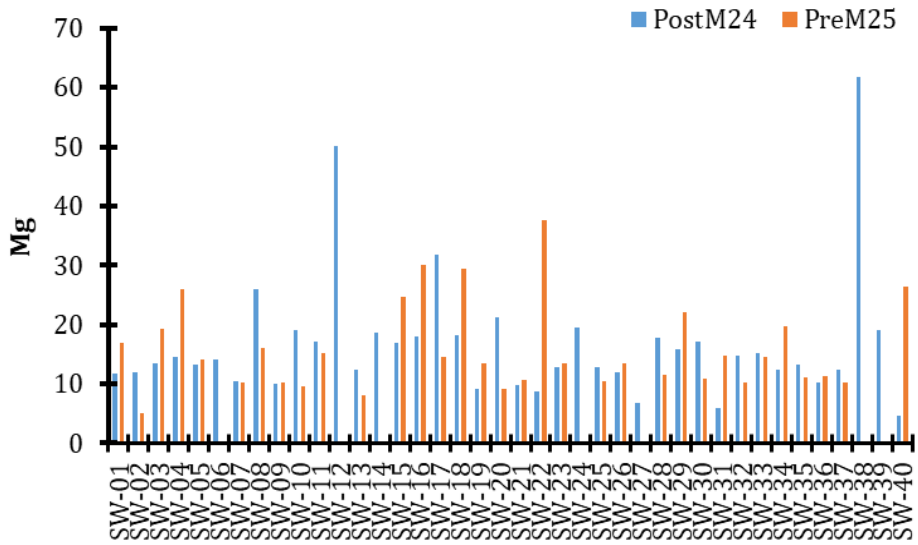


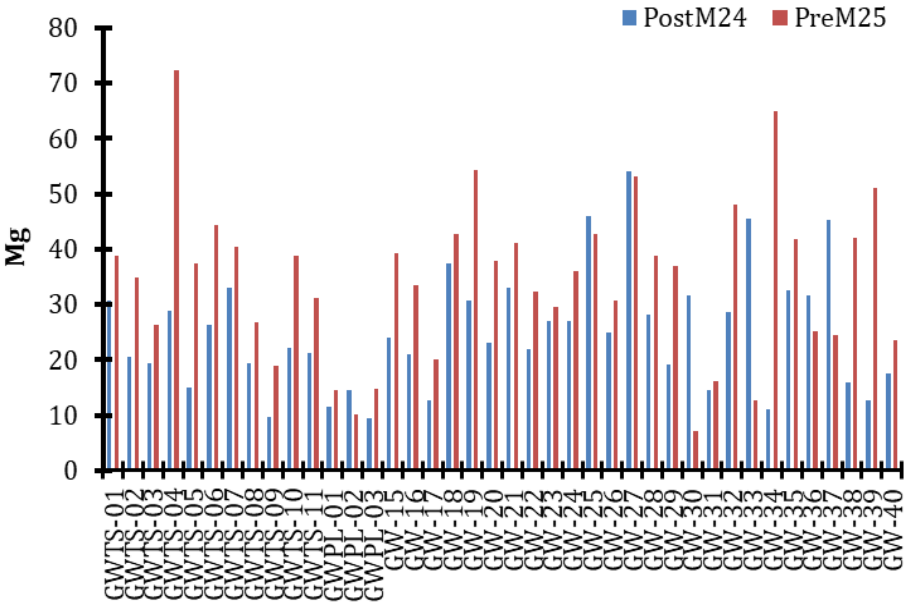
Figure 4.20: Calcium in SW and GW during pre-and post-monsoon period.

Natural sources contribute more magnesium to the environment than all anthropogenic sources. The principal source of magnesium in natural water is ferromagnesian mineral in igneous rock and magnesium carbonate in sedimentary rock. The sulphate and chloride of magnesium are very soluble. The presence of calcium and magnesium make

the water hard. BIS (2012) have prescribed 30 mg/l as acceptable limit and 100 mg/l as permissible limit for magnesium in absence of alternate source for drinking and other domestic usage.



A. Surface Water



B. Groundwater

Figure 4.21: Magnesium in SW and GW during pre-and post-monsoon period.

In the pre and post monsoon seasons, concentration of magnesium in surface water varies between 5.0 to 37.7 mg/l (average 15.8 mg/l) and 4.7 to 61.8 mg/l (average 16.5 mg/l) respectively. Where as in the ground water samples the concentration of magnesium during pre & post monsoon seasons varies between 7.0 to 72.4 mg/l (average 34.4 mg/l) and 9.5 to 54.0 mg/l (average 25.0 mg/l) respectively. Magnesium variation in the surface water and groundwater of the study area is shown in **Figure 4.21.** During pre-monsoon season, in few samples the concentration of magnesium in groundwater exceeded the acceptable limit (30 mg/l) while none of the samples exceeded the permissible limit for drinking water.

Sodium (Na): The sodium (Na) in the aquatic system is derived from the atmospheric deposition, evaporate dissolution and silicate weathering. The evaporate encrustations of sodium-potassium salts may also be developed due to cyclic wetting and drying periods leading to the formation of alkaline-saline soils, which may also serve as a source of sodium and potassium. The weathering of Na and K silicate minerals like albite, anorthite, orthoclase and microcline are the major source of the Na and K in the aquatic system.

During pre-monsoon 2024, concentration of Sodium in surface water and groundwater varies between 6.9 to 132.1 mg/l (average 39.8 mg/l) and 11.7 to 196.3 mg/l (average 85.5 mg/l) respectively. During post-monsoon 2024, concentration of Sodium in surface water and groundwater varies between 3.3 to 148.9 mg/l (average 35.1mg/l) and 15.7 to 219.8 mg/l (average 76.8 mg/l) respectively. Sodium variation in the surface water and groundwater of the study area is shown in **Figure 4.22.**

No health-based guidelines are given by BIS for drinking water for sodium. WHO (2011) has defined taste threshold for sodium in water depends on the associated anion and the temperature of the solution. At room temperature, the threshold values are about 150 mg/l for sodium chloride, 190 mg/l for sodium nitrate, 220 mg/l for sodium sulfate, and 420 mg/l for sodium bicarbonate. Based on taste threshold, the recommended concentration of sodium in the water should be less than 200 mg/l.

The concentration of sodium at all locations is within the stipulated standards recommended by BIS/ WHO, except one ground water sample during post monsoon.

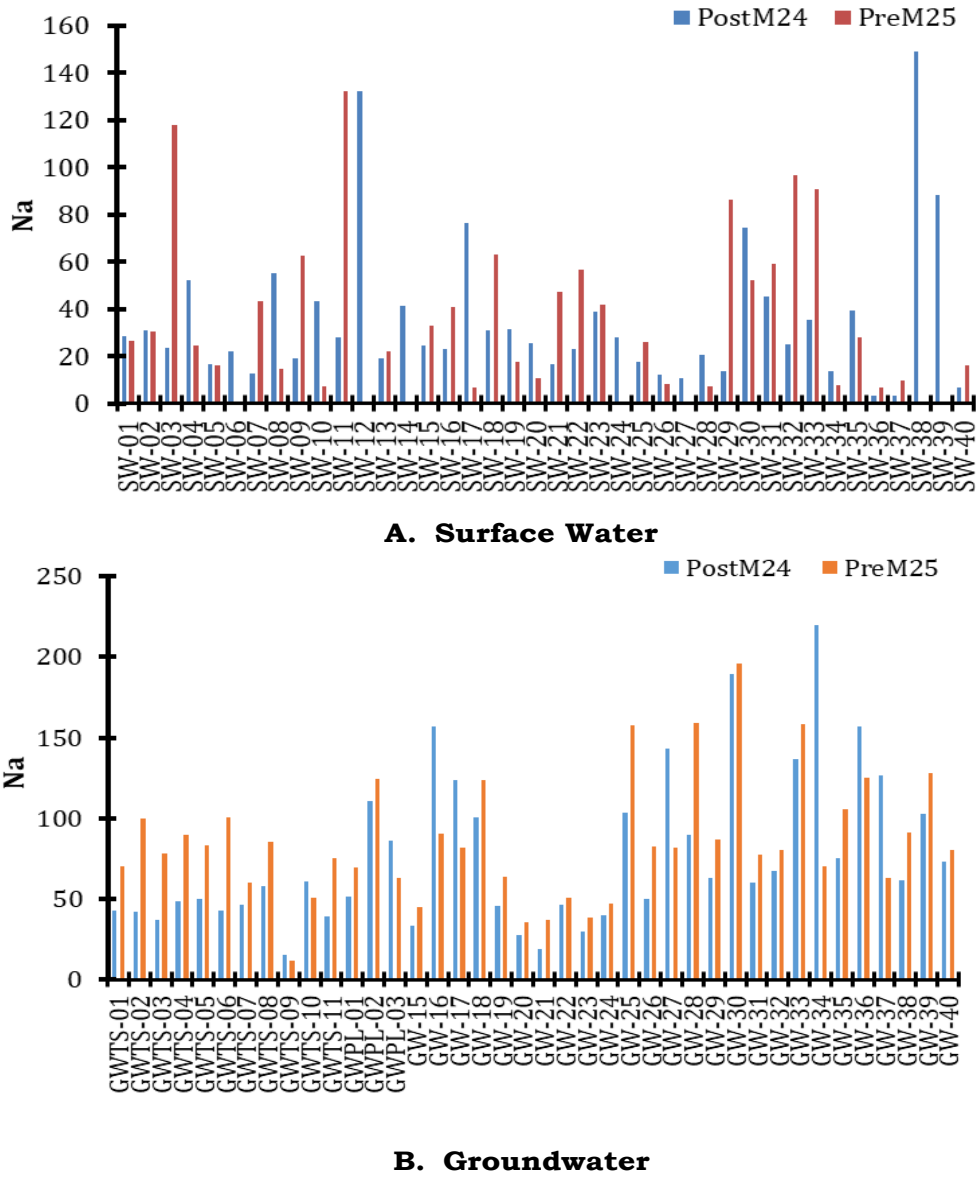
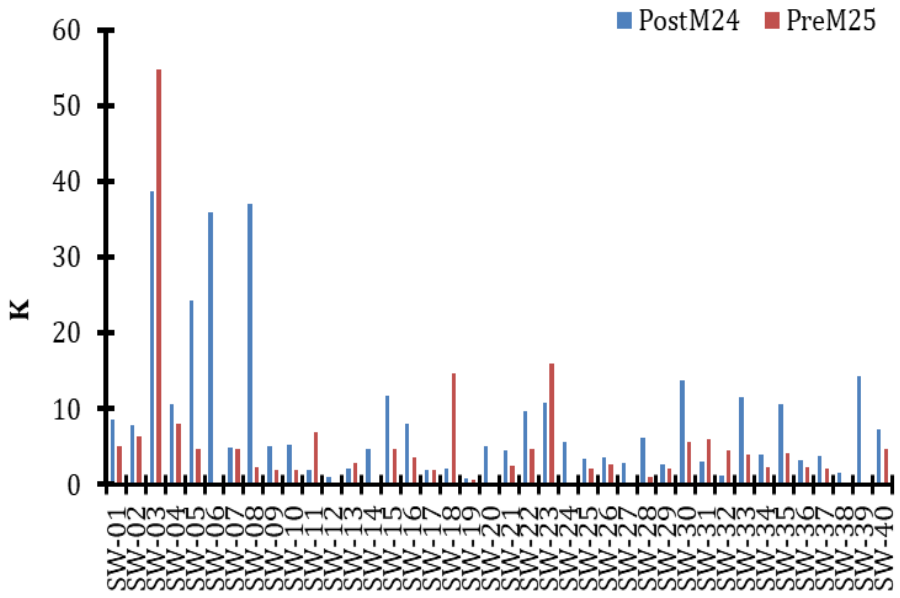
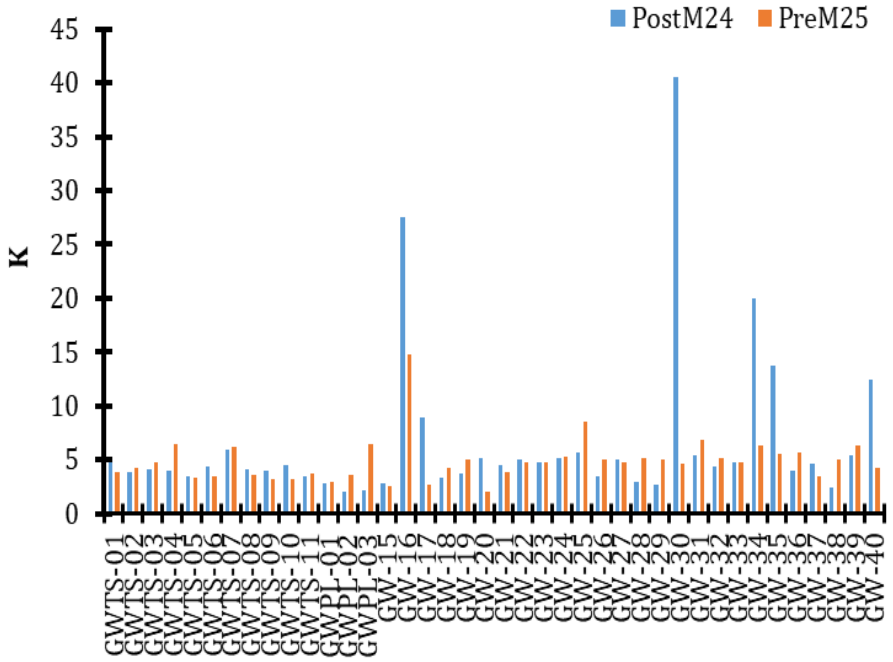


Figure 4.22: Sodium in SW and GW during pre-and post-monsoon period.



A. Surface Water



B. Groundwater

Figure 4.23: Potassium in SW and GW during pre-and post-monsoon period.

Potassium (K^+): Although potassium is nearly as abundant as sodium in igneous rocks and metamorphic rocks, its concentration in groundwater is one-tenth or even one-hundredth that of sodium. Parity in the concentration of sodium and potassium is found only in waters with low mineral content. The factors responsible for the scarcity of potassium in groundwater are the resistance of potassium minerals to weathering and fixation of potassium in clay minerals formed due to weathering.

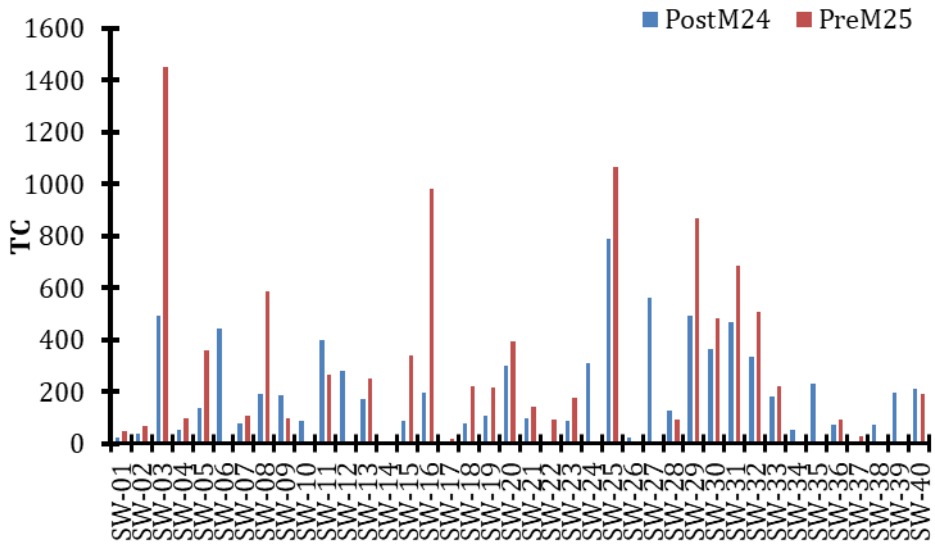
Concentration of K^+ in surface water and groundwater during pre-monsoon varies between 0.0 to 54.8 mg/l (average 5.8 mg/l) and 2.0 to 14.8 mg/l (average 4.9 mg/l) respectively. Concentration of K^+ in surface water and groundwater during post-monsoon varies between 0.9 to 38.8 mg/l (average 8.5 mg/l) and 2.1 to 40.5 mg/l (average 6.6 mg/l) respectively. Potassium variation in the surface water and groundwater of the study area is shown in **Figure 4.23.** The BIS & WHO has not included K in drinking water standards. The main sources of potassium in ground water include rainwater, weathering of potash, silicate minerals, use of potash fertilizers and use of surface water for irrigation.

4.3 Bacteriological Parameters

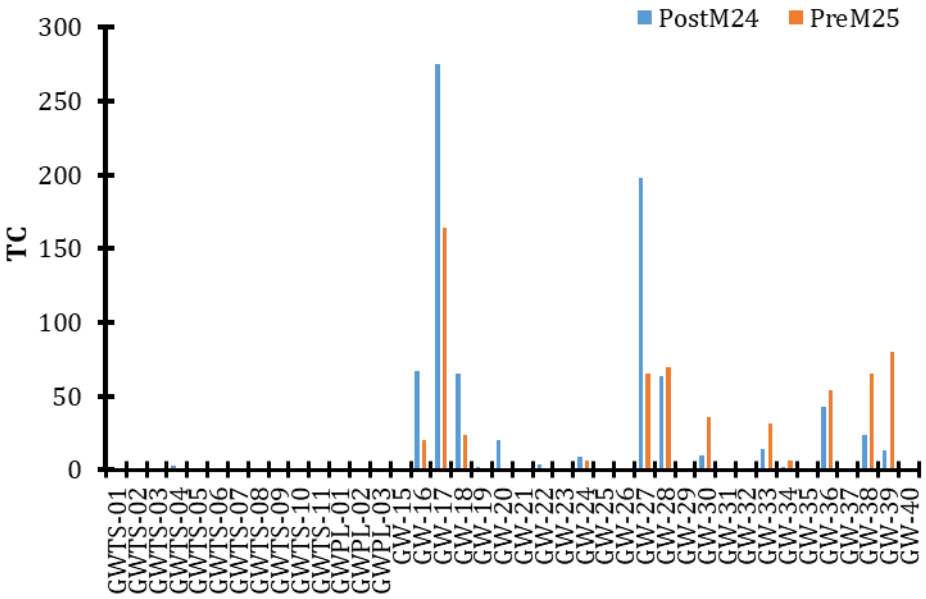
Bacteriological quality is one of the important parameters of water potability. It is measured by the presence of a pollution indicator of organisms, in particular, total germs and fecal coliforms (Escherichia coli). Total germs represent the density of the bacterial population in drinking water. This measure allows a global assessment of the pernicious nature of water, without determining the sources of contamination (Levallois 2003). E. coli is one of the most determined bacteria that indicates fecal contamination (Edberg et al. 2000). Total coliform and E. coli are used as indicators to measure pollution level and water quality.

Water quality through the presence of pathogenic enteric microorganisms may affect human health. Coliform bacteria, Escherichia coli and coliphages are normally used as indicators of water quality. However, the presence of above-mentioned indicators does not always suggest the presence of human enteric viruses. It is important to study human enteric viruses in water. Human enteric viruses can tolerate

fluctuating environmental conditions and survive in the environment for long periods of time, becoming causal agents of diarrheal diseases.



A. Surface Water



B. Groundwater

Figure 4.24: Total Coliform in SW and GW during pre-and post-monsoon period.

According to the BIS (Bureau of Indian Standards) total coliform in drinking water should not be present or "Zero/MPN" in any 100 ml sample. Though as per the Central Pollution Control Board (CPCB), water bodies in India are classified in following classes based on their intended best use and corresponding quality criteria.

Class A – Drinking Water Source without Conventional Treatment but after Disinfection: Total Coliform Organisms shall be 50 MPN/100 mL or less.

Class B – Outdoor Bathing (Organized Recreation): Total Coliform Organisms shall be 500 MPN/100 mL or less.

Class C – Drinking Water Source after Conventional Treatment and Disinfection: Total Coliform Organisms shall be 5,000 MPN/100 mL or less.

In this present study, Total coliform has been measured in all surface water and groundwater samples during pre- and post-monsoon seasons. The results of bacteriological analysis are given in **Table 4.3** and **Table 4.6**. Variation of total coliforms in surface and groundwater are shown in **Figure 4.24**.

Most of the analysed surface water sample falling under **class B category** (total coliform bacteria is ≤500 MPN/100ml) of CPCB and suitable for outdoor bathing during both the sampling seasons. However, few surface water samples comply with CPCB Class C limit (≤ 5,000 MPN/100 mL). Among the analysed ground water samples majority of the samples doesn't show any presence of the Total coliforms organism and found suitable for drinking purpose during both the seasons.

4.4 Heavy Metals

Heavy metals in groundwater have considerable significance due to their toxicity and adsorption behavior. Heavy metals are not biodegradable and enter the food chain through several pathways, causing progressive toxicity due to the accumulation in human and animal organs during their life span on long-term exposure to contaminated environments. Despite the presence of trace concentrations of Cr, Mn, Co, Cu and Zn in the aquatic environment, which are essential to several life processes, high concentrations of these metals become toxic. The major sources of heavy metals in ground and surface water include weathering of rock minerals and waste effluents on land and runoff water.

The concentration of trace metals in surface water and groundwater of the study area for pre-and post-monsoon is given in **Table 4.10** and **Table 4.11** respectively. The toxic effects of these elements and the extent of their contamination are discussed in the following sections.

Table 4.10: Heavy metals in SW sources in the buffer area during post-monsoon and pre-monsoon (concentration in ppb).

Sample code	As		Hg		Pb		Cd		Cr	Cr
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
SW-01	12.7	4.3	0.45	1.5	3.8	0.7	0.2	1.1	3.3	0.9
SW-02	16.9	7.0	0.34	2.7	1.9	1.0	0.1	1.3	1.2	0.9
SW-03	8.1	5.4	BDL	0.2	6.9	3.7	0.3	0.6	6.1	4.2
SW-04	12.2	7.6	0.22	1.3	0.7	BDL	0.1	0.3	1.2	0.5
SW-05	10.4	4.6	BDL	0.1	0.4	BDL	0.1	BDL	0.6	BDL
SW-06	7.6	Dry	BDL	Dry	1.8	Dry	0.1	Dry	1.0	Dry
SW-07	7.0	7.7	BDL	BDL	6.4	1.3	0.4	1.4	12.4	9.4
SW-08	4.6	5.0	BDL	BDL	2.3	0.6	0.1	0.1	1.5	1.0
SW-09	4.9	17.0	BDL	0.5	2.5	0.6	0.1	0.4	3.6	1.1
SW-10	3.4	3.4	BDL	0.1	5.1	2.8	0.2	0.2	5.5	1.8
SW-11	10.6	20.5	BDL	0.1	1.3	16.5	BDL	1.0	3.1	35.6
SW-12	5.7	Dry	BDL	Dry	10.3	Dry	0.1	Dry	1.0	Dry
SW-13	3.4	3.7	BDL	0.1	9.0	3.2	0.4	0.5	4.8	4.3
SW-14	3.3	Dry	BDL	Dry	2.0	Dry	BDL	Dry	2.2	Dry
SW-15	4.1	5.8	BDL	BDL	6.7	BDL	0.3	BDL	5.4	12.2
SW-16	2.0	0.7	BDL	BDL	1.8	1.2	0.1	0.4	1.4	2.3
SW-17	5.2	7.5	BDL	BDL	4.1	BDL	0.1	BDL	3.6	7.3
SW-18	10.6	6.2	BDL	BDL	0.4	4.4	BDL	1.0	1.8	2.4
SW-19	4.2	Dry	BDL	Dry	3.2	Dry	0.2	Dry	4.8	Dry
SW-20	1.7	5.3	BDL	0.1	1.8	4.6	0.1	2.1	3.3	1.9
SW-21	5.7	13.0	BDL	0.1	2.8	2.2	0.1	0.2	6.1	1.2
SW-22	12.7	6.2	BDL	0.1	3.8	1.7	0.1	1.1	7.5	1.3
SW-23	BDL	12.9	BDL	0.3	6.2	22.2	BDL	1.4	18.6	33.4
SW-24	4.0	Dry	BDL	Dry	2.9	Dry	0.3	Dry	3.4	Dry
SW-25	0.7	2.0	BDL	BDL	1.6	BDL	0.1	BDL	4.5	12.5
SW-26	BDL	1.3	BDL	0.1	BDL	1.0	BDL	BDL	BDL	1.7
SW-27	4.2	Dry	BDL	Dry	0.9	Dry	0.1	Dry	1.8	Dry
SW-28	2.0	2.7	BDL	BDL	3.2	0.7	0.2	0.2	5.0	0.6
SW-29	1.3	3.0	BDL	BDL	2.4	BDL	0.2	BDL	2.9	10.2
SW-30	BDL	4.8	BDL	0.2	3.6	4.8	BDL	0.2	BDL	0.6
SW-31	5.5	10.5	BDL	BDL	0.7	2.4	BDL	0.2	2.0	2.8
SW-32	4.4	9.2	BDL	0.2	5.1	1.6	0.2	0.1	6.4	0.7
SW-33	BDL	8.5	BDL	0.1	0.6	1.8	BDL	0.3	BDL	2.7
SW-34	5.1	3.7	BDL	BDL	6.1	2.1	0.1	0.4	8.8	2.0
SW-35	2.9	3.9	BDL	BDL	3.5	1.4	0.3	0.6	11.3	1.7
SW-36	BDL	1.8	BDL	BDL	0.7	1.1	BDL	0.4	BDL	BDL
SW-37	5.6	2.3	BDL	0.1	7.2	1.3	0.1	0.1	11.2	1.6
SW-38	4.7	Dry	BDL	Dry	1.3	Dry	0.1	Dry	4.7	Dry
SW-39	1.9	Dry	BDL	Dry	1.3	Dry	0.4	Dry	1.7	Dry
SW-40	6.1	2.4	BDL	BDL	0.7	8.4	0.1	0.4	1.9	10.9
Min	**1**	**1**	**0.2**	**0.1**	**0.4**	**0.6**	**0.1**	**0.1**	**0.6**	**0.5**
Max	**17**	**21**	**0.5**	**2.7**	**10.3**	**22.2**	**0.4**	**2.1**	**18.6**	**35.6**
Average	**6**	**6**	**0.3**	**0.4**	**3.3**	**3.6**	**0.2**	**0.6**	**4.6**	**5.7**
AL	**10**		**1.00**		**10**		**3**		**50**	
PL	**NR**		**NR**		**NR**		**NR**		**NR**	

Sample code	Cr(vi)		Cu		Zn		Se		Fe	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
SW-01	BDL	BDL	5	15	35	10	13.5	5.3	148	67
SW-02	BDL	BDL	3	1.3	94	26	16.5	15.5	140	174
SW-03	BDL	BDL	5	5	62	45	1.6	0.7	1185	2116
SW-04	BDL	BDL	2	1	9	2	4.5	5.9	209	339
SW-05	BDL	BDL	11	37	6	4	5.1	BDL	45	50
SW-06	BDL	Dry	2	Dry	9	Dry	2.0	Dry	231	Dry
SW-07	0.5	2.2	11	30	37	7	0.7	BDL	479	766
SW-08	BDL	BDL	3	1	12	5	BDL	BDL	888	578
SW-09	BDL	BDL	4	2	13	4	BDL	BDL	216	428
SW-10	BDL	BDL	3	3	28	6	BDL	BDL	1752	1537
SW-11	0.9	3.7	13	37	10	77	BDL	0.5	787	2761
SW-12	BDL	Dry	1	Dry	6	Dry	BDL	Dry	264	Dry
SW-13	BDL	BDL	5	5	49	62	BDL	BDL	1845	2435
SW-14	BDL	Dry	3	Dry	11	Dry	BDL	Dry	1568	Dry
SW-15	BDL	BDL	5	23	35	60	0.5	1.4	568	781
SW-16	BDL	BDL	4	2	13	51	BDL	BDL	539	1199
SW-17	BDL	BDL	2	9	16	30	BDL	BDL	184	645
SW-18	BDL	BDL	1	3	3	56	BDL	BDL	500	1916
SW-19	BDL	Dry	3	Dry	18	Dry	BDL	Dry	256	Dry
SW-20	BDL	BDL	5	4	14	367	BDL	BDL	953	880
SW-21	BDL	BDL	6	2	13	7	BDL	BDL	333	369
SW-22	BDL	BDL	5	3	23	670	BDL	BDL	625	850
SW-23	0.2	3.2	17	25	80	117	BDL	1.1	1650	2407
SW-24	BDL	Dry	4	Dry	15	Dry	BDL	Dry	1521	Dry
SW-25	BDL	BDL	4	6	9	35	BDL	BDL	1471	1245
SW-26	BDL	BDL	3	2	4	6	BDL	BDL	770	1041
SW-27	BDL	Dry	2	Dry	5	Dry	BDL	Dry	985	Dry
SW-28	BDL	BDL	5	2	20	2	BDL	BDL	603	399
SW-29	BDL	BDL	4	12	14	22	BDL	0.6	1330	1643
SW-30	BDL	BDL	6	1	5	3	BDL	BDL	211	135
SW-31	BDL	BDL	2	3	6	8	BDL	BDL	622	2564
SW-32	BDL	BDL	4	1	25	4	BDL	BDL	431	356
SW-33	BDL	BDL	2	3	5	10	BDL	BDL	880	850
SW-34	BDL	BDL	13	4	22	155	BDL	BDL	996	1599
SW-35	BDL	BDL	10	2	20	94	BDL	BDL	449	1164
SW-36	BDL	BDL	BDL	1	3	7	BDL	BDL	84	104
SW-37	1.60	BDL	15	3	27	5	0.7	BDL	1260	1304
SW-38	BDL	Dry	3	Dry	8	Dry	0.1	Dry	1376	Dry
SW-39	BDL	Dry	2	Dry	5	Dry	BDL	Dry	111	Dry
SW-40	BDL	2	2	12	4	39	3.5	9.2	959	757
Min	**0.2**	**1.8**	**1.3**	**1**	**3**	**2**	**0**	**0**	**45**	**50**
Max	**1.6**	**3.7**	**17.2**	**37**	**94**	**670**	**17**	**15**	**1845**	**2761**
Average	**0.8**	**2.7**	**5.1**	**8**	**20**	**62**	**4**	**4**	**736**	**1046**
BIS AL*	**NS**		**50**		**5000**		**10**		**1000**	
BIS PL+	**NS**		**1000**		**15000**		**NR**		**NR**	

***Acceptable Limit, + Permissible limit**

Table 4.11: Heavy Metals in GW sources in the buffer area during pre- and post-monsoon (concentration in ppb)

Sample Code	As		Hg		Pb		Cd		Cr	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
GWTS-01	1.0	0.7	BDL	0.19	2.5	1.3	0.1	0.20	8.0	2.3
GWTS-02	1.3	1.1	BDL	0.18	2.5	2.0	0.15	0.1	4.8	2.0
GWTS-03	1.1	2.8	BDL	0.10	9.5	0.5	0.48	BDL	3.8	1.1
GWTS-04	0.7	0.7	0.01	0.20	0.5	0.9	BDL	BDL	1.1	1.1
GWTS-05	1.0	1.1	BDL	0.11	4.1	4.7	0.1	BDL	1.4	0.9
GWTS-06	1.1	0.9	BDL	0.07	BDL	0.9	BDL	BDL	0.9	0.6
GWTS-07	0.6	BDL	BDL	BDL	BDL	0.6	BDL	BDL	1.7	3.1
GWTS-08	0.9	0.7	BDL	0.10	0.7	BDL	BDL	BDL	1.2	0.8
GWTS-09	1.0	BDL	BDL	BDL	0.8	1.2	BDL	BDL	0.8	1.0
GWTS-10	1.5	2.3	BDL	0.13	6.8	BDL	BDL	BDL	1.1	0.6
GWTS-11	0.9	1	BDL	0.05	2.4	1.0	0.1	BDL	2.8	0.6
GWPL-01	1.3	1.2	0.04	0.36	13.0	1.3	1.34	0.3	15.8	1.5
GWPL-02	BDL	1.2	0.02	0.35	BDL	0.9	BDL	BDL	BDL	2.0
GWPL-03	0.9	1.0	BDL	0.22	0.5	0.5	0.1	BDL	1.6	1.9
GW-15	BDL	BDL	BDL	0.07	2.8	4.5	BDL	BDL	BDL	1.1
GW-16	4.2	3.0	BDL	0.09	0.9	0.8	0.1	BDL	2.7	1.3
GW-17	13.8	1.1	BDL	0.03	6.9	2.2	0.7	BDL	5.7	5.5
GW-18	2.1	1	BDL	0.07	0.9	0.8	0.2	BDL	2.6	2.6
GW-19	1.5	0.7	BDL	0.11	9.1	1.6	0.1	BDL	2.4	5.3
GW-20	BDL	0.6	BDL	BDL	2.8	1.1	BDL	0.06	0.5	0.9
GW-21	1	BDL	BDL	BDL	2.8	4.2	0.11	BDL	3.6	0.9
GW-22	BDL	BDL	BDL	0.07	0.6	1.0	BDL	BDL	1.4	1.4
GW-23	1	0.6	BDL	0.07	2.5	3.7	BDL	0.1	1.0	1.9
GW-24	BDL	0.9	BDL	BDL	BDL	2.3	BDL	BDL	2.2	4.0
GW-25	0.8	BDL	BDL	0.05	3.1	0.7	0.21	BDL	3.9	0.8
GW-26	BDL	BDL	BDL	0.07	2.5	1.2	BDL	0.1	1.7	1.0
GW-27	1.1	BDL	BDL	0.07	1.4	0.6	0.1	BDL	2.9	0.9
GW-28	1	BDL	BDL	BDL	2.4	1.6	0.1	0.13	4.6	3.1
GW-29	1.9	2.6	BDL	BDL	4.4	5.8	BDL	BDL	1.8	1.7
GW-30	4.8	0.2	BDL	BDL	0.6	1.9	BDL	0.1	2.3	0.6
GW-31	1.1	2.8	BDL	BDL	2.5	2.9	0.2	0.5	3.7	3.0
GW-32	3.9	11.0	BDL	BDL	0.6	3.4	BDL	0.10	2.8	4.2
GW-33	3.1	12.3	BDL	BDL	1.0	0.9	0.1	BDL	4.7	0.7
GW-34	2.6	1.2	BDL	BDL	3.2	5.8	BDL	BDL	1.9	3.1
GW-35	1.5	8.0	BDL	BDL	1.6	4.5	BDL	BDL	9.1	5.6
GW-36	2.6	3.8	BDL	0.07	5.9	5.1	0.42	BDL	7.9	4.5
GW-37	2.4	3.7	BDL	BDL	1.4	3.2	BDL	BDL	2.1	1.3
GW-38	2.1	BDL	BDL	BDL	1.0	1.5	BDL	BDL	1.2	5.5
GW-39	1.4	4.9	BDL	BDL	0.8	1.6	0.1	BDL	2.1	3.2
GW-40	1.6	2.3	BDL	BDL	4.9	8.7	BDL	0.10	1.2	1.5
Min	**0.5**	**0.2**	**0.01**	**0.03**	**0.5**	**0.5**	**0.06**	**0.05**	**0.5**	**0.6**
Max	**13.8**	**12.3**	**0.04**	**0.36**	**13.0**	**8.7**	**1.34**	**0.50**	**15.8**	**5.6**
Average	**2**	**2**	**0**	**0**	**3**	**2**	**0**	**0**	**3**	**2**
BIS AL*	**10**		**1**		**10**		**3**		**50**	
BIS PL+	**NR**		**NR**		**NR**		**NR**		**NR**	

*Acceptable limit, + Permissible limit

Sample Code	Cr (VI)		Cu		Zn		Se		Fe	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
GWTS-01	0.55	BDL	3.4	1.0	55	48	BDL	0.2	79	122
GWTS-02	BDL	BDL	2.7	4.7	15	29	0.5	0.2	54	140
GWTS-03	BDL	BDL	6.0	2.3	49	8	0.2	BDL	150	53
GWTS-04	BDL	BDL	1.7	1.7	32	36	1.6	2.8	50	89
GWTS-05	BDL	BDL	5.5	9.4	555	1145	1.0	1.1	53	260
GWTS-06	BDL	BDL	0.5	4.7	23	50	3.5	2.3	27	34
GWTS-07	BDL	BDL	1	1.4	64	79	2.5	3.1	34	70
GWTS-08	BDL	BDL	1.4	1.9	79	27	2.7	0.7	96	46
GWTS-09	BDL	BDL	2.6	3.1	10	15	0.5	1.0	85	130
GWTS-10	BDL	BDL	94.0	1.4	33	14	0.6	BDL	173	92
GWTS-11	BDL	BDL	20.6	10.0	172	1	0.7	0.6	167	18
GWPL-01	2.1	BDL	9.6	1.6	89	11	1.8	0.5	352	20
GWPL-02	BDL	BDL	1.4	0.9	7	10	BDL	0.8	30	19
GWPL-03	BDL	BDL	BDL	BDL	4	3	0.4	0.3	32	6
GW-15	BDL	BDL	18.6	26.9	266	341	BDL	BDL	1650	1879
GW-16	BDL	BDL	3.1	3.1	11	46	2.3	0.5	159	306
GW-17	0.5	BDL	15.9	6.4	58	145	0.5	0.1	326	370
GW-18	BDL	BDL	5.0	1.3	40	36	1.7	0.6	381	399
GW-19	BDL	0.7	1.9	3.7	655	170	0.4	BDL	345	595
GW-20	BDL	BDL	1.1	1	145	204	0.1	BDL	529	249
GW-21	BDL	BDL	9.1	2.8	50	22	BDL	BDL	4665	4909
GW-22	BDL	BDL	1.7	1.4	26	17	BDL	BDL	1058	1008
GW-23	BDL	BDL	1.0	2.9	967	491	BDL	BDL	1127	1772
GW-24	BDL	BDL	2.8	4.4	46	51	BDL	BDL	520	780
GW-25	BDL	BDL	2.7	1.0	97	4	1.2	0.7	498	278
GW-26	BDL	BDL	1.7	1.7	285	185	0.7	0.3	913	1024
GW-27	BDL	BDL	3.2	1.2	114	81	BDL	BDL	664	833
GW-28	BDL	BDL	3.5	2.3	131	95	0.2	BDL	1581	1030
GW-29	BDL	BDL	30.8	44.6	1000	1200	BDL	BDL	475	310
GW-30	BDL	BDL	4.6	1.6	112	31	2.3	BDL	68	258
GW-31	BDL	BDL	3.0	5.2	319	480	0.1	BDL	6727	7670
GW-32	BDL	BDL	2.9	4.4	54	61	BDL	BDL	1431	785
GW-33	BDL	BDL	4.8	BDL	23	14	1.6	BDL	1212	231
GW-34	BDL	BDL	1.6	0.7	6	3	1.3	0.7	58	30
GW-35	BDL	0.6	10.0	0.9	71	30	1.1	BDL	1951	319
GW-36	BDL	BDL	14.3	1.2	53	37	1.4	1.0	599	208
GW-37	BDL	BDL	12.1	1.1	88	135	1.6	BDL	245	1258
GW-38	BDL	BDL	8.1	4.2	581	176	0.1	BDL	375	175
GW-39	BDL	BDL	8.3	22.5	654	722	0.1	BDL	691	464
GW-40	BDL	BDL	16.4	41.9	88	106	BDL	0.1	438	599
Min	**0.5**	**0.6**	**0.5**	**1**	**4.4**	**1.1**	**0.1**	**0.1**	**26.8**	**6.4**
Max	**2.1**	**0.7**	**94.0**	**44.6**	**1000.2**	**1200.0**	**3.5**	**3.1**	**6727.1**	**7670.0**
Average	**1**	**1**	**9**	**6**	**178**	**159**	**1**	**1**	**752**	**721**
BIS AL*	**NS**		**50**		**5000**		**10**		**1000**	
BIS PL+	**NS**		**1000**		**15000**		**NR**		**NR**	

4.4.1 Arsenic (As)

Arsenic is usually present in natural waters at concentrations of less than 1–2 µg/l. However, in waters, particularly ground waters, where there are sulfide mineral deposits and sedimentary deposits deriving from volcanic rocks, the concentrations can be significantly elevated. Arsenic has not been demonstrated to be essential in humans.

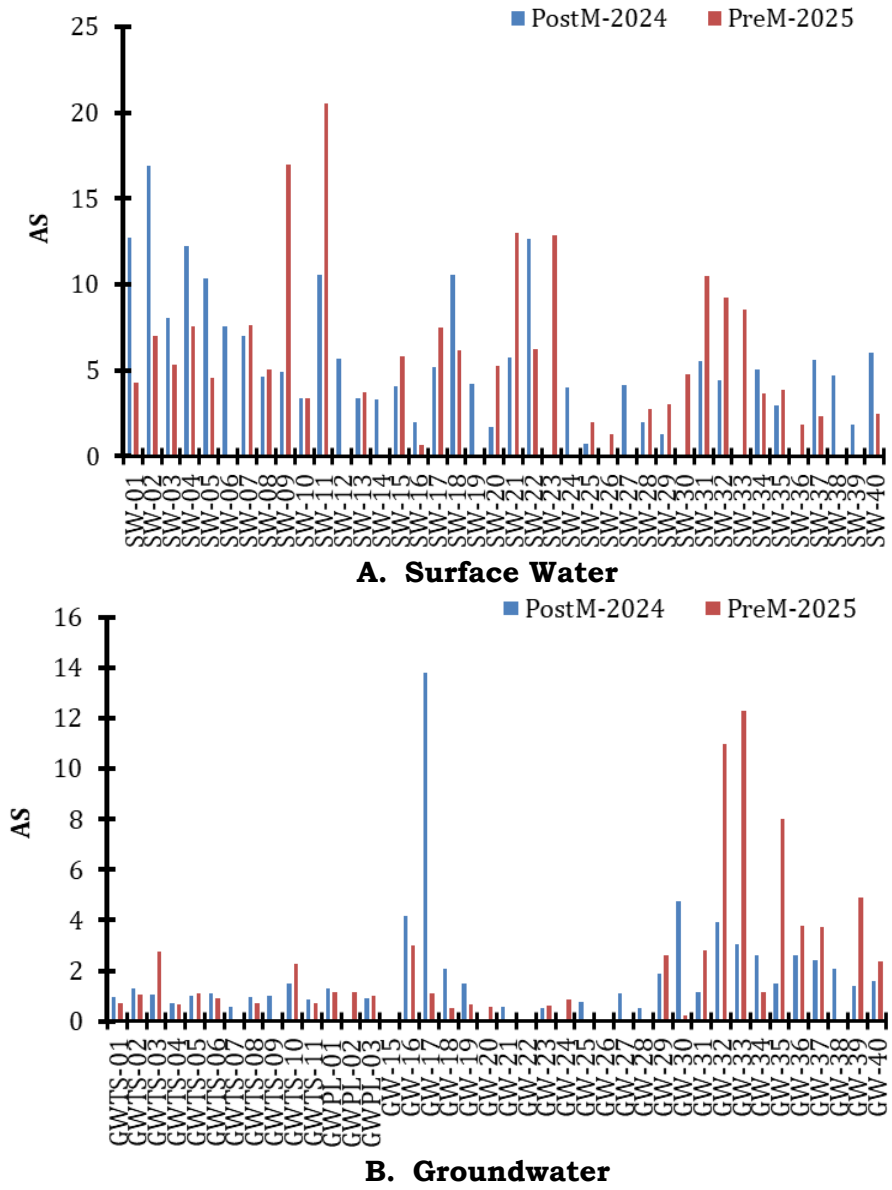


Figure 4.25: Arsenic concentration in SW and GW during pre and post monsoon.

The acute toxicity of arsenic compounds in humans is predominantly a function of their rate of removal from the body. Arsine is the most toxic form, followed by the arsenites, the arsenates and organic arsenic compounds. Signs of chronic arsenicism, including dermal lesions such as hyper-pigmentation and hypopigmentation, peripheral neuropathy, skin cancer, bladder and lung cancers and peripheral vascular disease, have been observed in populations ingesting arsenic-contaminated drinking-water.

The Bureau of Indian Standards has recommended 10 ppb as the desirable limit for arsenic in drinking water (BIS, 2012). In the pre-and post-monsoon season, concentration of Arsenic in surface water samples varies between 0.7 to 20.5 ppb (average 6.2 ppb) and 0.7 to 16.9 ppb (average 5.9 ppb) respectively. Concentration of Arsenic in groundwater samples varies between 0.2 to 12.3 ppb (average 2.5 ppb) and 0.1 to 13.8 ppb (average 2.0 ppb) respectively during pre-and post-monsoon season. Arsenic variation in the surface water and groundwater of the study area is shown in **Figure 4.25**. Most of the analysed samples are within permissible limit except 2-3 locations during both the seasons.

4.4.2 Mercury (Hg)

Mercury is a shiny, silver-white metal found in small amounts in the earth's crust. At room temperature, metallic mercury is an odorless liquid that can slowly evaporate into the air. It can combine with other elements to form inorganic and organic compounds. Mercury is a persistent, bio accumulative, toxic pollutant. When released into the environment, it accumulates in sediments laid down in water, where it converts into toxic methylmercury and enters the food chain. Mercury contamination is a significant public health and environmental problem because methylmercury easily enters the bloodstream and affects the brain.

Mercury concentrations tend to be higher in larger, older fish and in fish from tea-colored and relatively acidic waters. Mercury is introduced into the environment in three ways. First, mercury is emitted into the air naturally from volcanoes, the weathering of rocks, forest fires, and soils. Second, mercury is emitted into the air from

the burning of fossil fuels and municipal or medical waste. Also, mercury can be re-introduced into the environment through natural processes such as evaporation of ocean water.

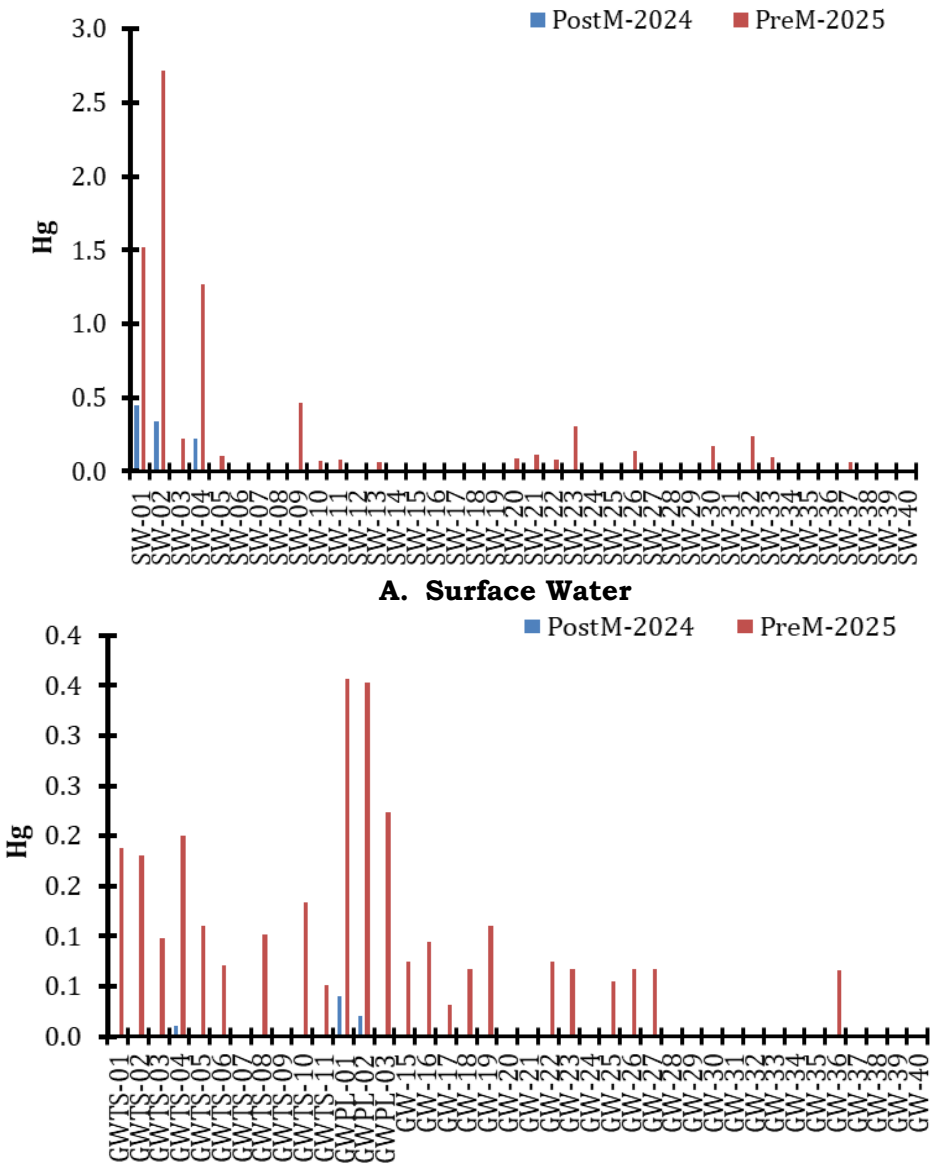


Figure 4.26: Mercury (Hg) in SW and GW during pre and post monsoon.

The Bureau of Indian Standards has recommended 1 ppb as the acceptable limit for mercury in drinking water (BIS, 2012). Mercury variation in the surface water and groundwater of the study area is shown in **Figure 4.26** In the pre-and post-monsoon season, the concentration of Mercury in surface water samples varies between 0.1 to 2.7 ppb (Lagoon water) (average 0.4 ppb) and 0.2 to 0.5 ppb (average 0.3 ppb) respectively. Whereas in groundwater during the pre-monsoon season, Mercury varies from 0.03 to 0.4 ppb and has not been detected during post-monsoon in groundwater samples except three samples which is still within permissible limit.

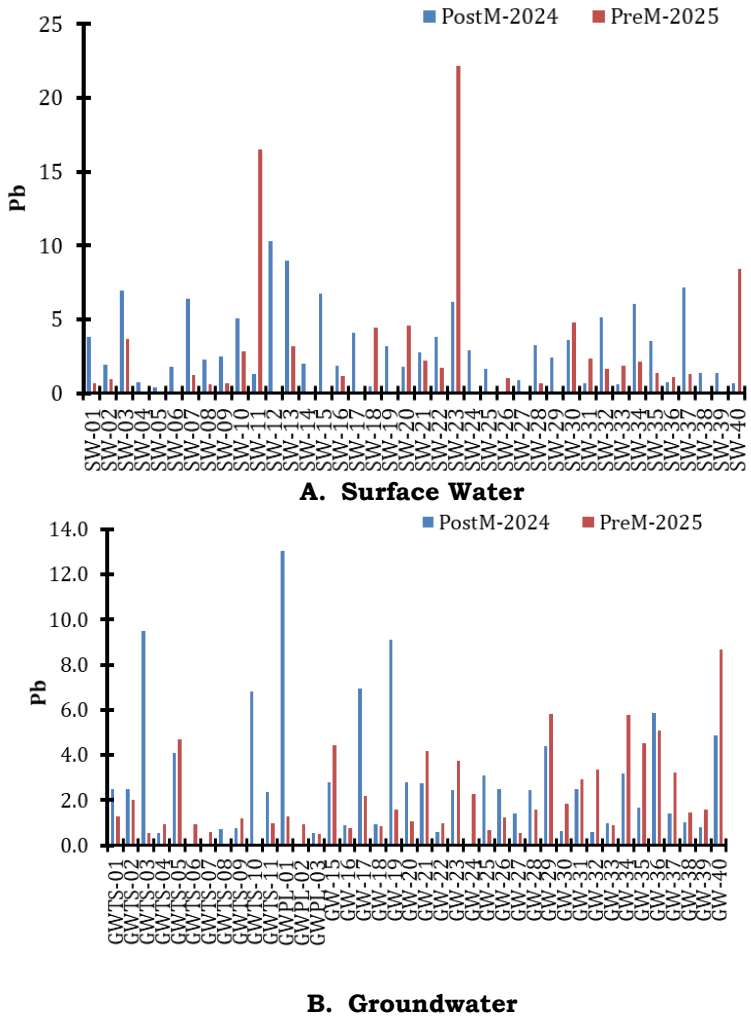


Figure 4.27: Lead (Pb) in SW and GW during pre and post monsoon.

4.4.3 Lead (Pb)

Lead is the most common of the trace metals and is mined widely throughout the world. It is used principally in the production of lead-acid batteries, solder and alloys. The lead compounds (tetraethyl and tetramethyl) are also used extensively as antiknock and lubricating agents in petrol, although their use for these purposes in many countries has largely been phased out. Lead is rarely present in drinking water because of its dissolution from natural sources; rather, its presence is primarily from corrosive water effects on household plumbing systems containing lead in pipes, solder, fittings or the service connections. Exposure to lead is associated with a wide range of effects, including various neuro developmental effects, mortality (mainly due to cardiovascular diseases), impaired renal function, hypertension, impaired fertility and adverse pregnancy outcomes.

The Bureau of Indian Standards has recommended 1 ppb as the acceptable limit for mercury in drinking water (BIS, 2012). Lead variation in the surface water and groundwater of the study area is shown in **Figure** 4.27**.** Concentration of Lead in surface water samples during pre and post-monsoon varies between 0.6 to 22.2 ppb (average 3.6 ppb) and 0.4 to 10.3 ppb (average 3.3 ppb), respectively. Concentration of Lead in groundwater varies between 0.5 to 8.7 ppb (average 2.3 ppb) and 0.5 to 13.0 ppb (average 3.1 ppb) respectively during per and post-monsoon season. The results indicate that lead exceeded the maximum permissible limit of 10 ppb in SW-11 and SW-23 during pre-monsoon. Whereas the groundwater sample GDPL-01 during post-monsoon exceeded the maximum permissible limit of 10 ppb.

4.4.4 Cadmium (Cd)

Cadmium is mainly found in the earth's crust. It always occurs in combination with zinc. Cadmium also consists in the industries as an inevitable by-product of zinc, lead and copper extraction. After being applied it enters the environment mainly through the ground, because it is found in manures and pesticides.

Naturally a very large amount of cadmium is released into the environment, about 25,000 tons a year. About half of the cadmium is released into rivers through the

weathering of rocks and some cadmium is released into air through forest fires and volcanoes. The rest of the cadmium is released through human activities, such as manufacturing.

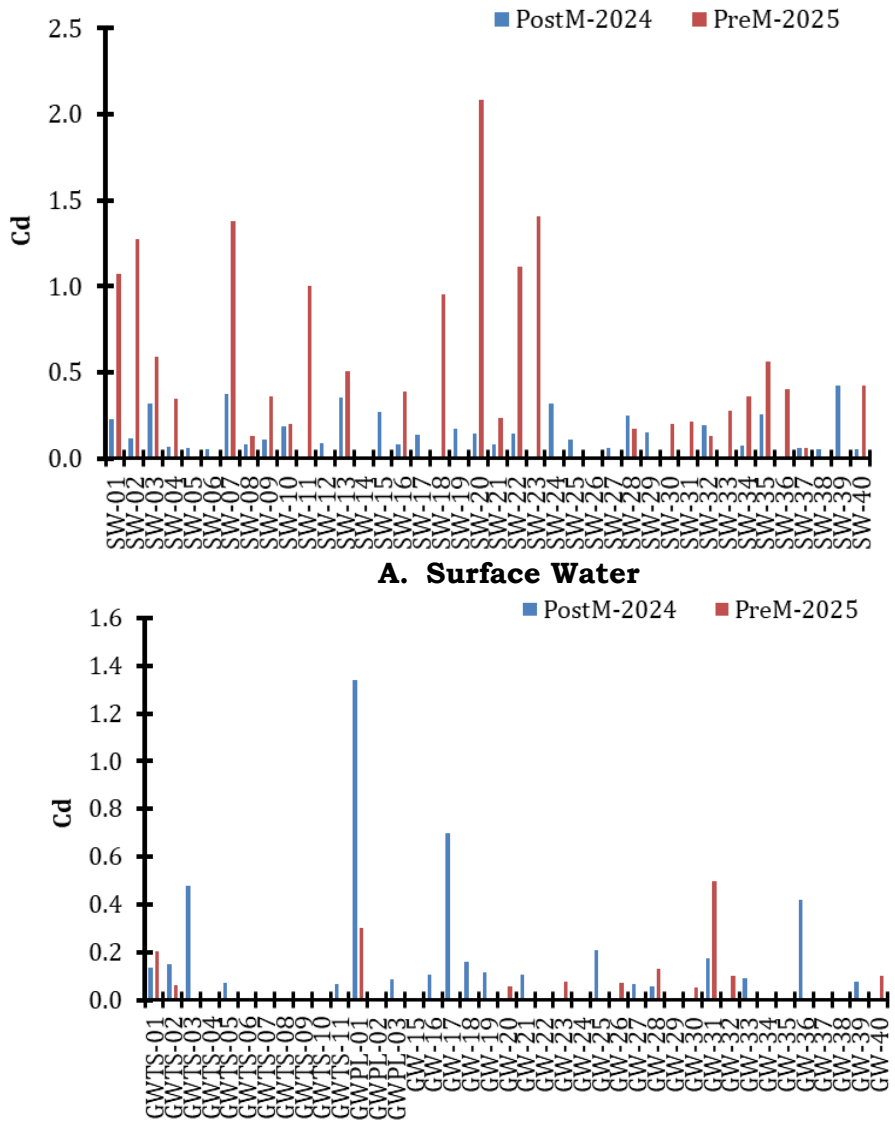


Figure 4.28: Cadmium (Cd) in SW and GW during pre and post monsoon.

Health effects that can be caused by cadmium are diarrhoea, stomach pains and severe vomiting, Bone fracture, Reproductive failure and possibly even infertility, Damage to the central nervous system, Damage to the immune system, and psychological disorders. The Bureau of Indian Standards has recommended 3 ppb as the acceptable limit for cadmium in drinking water (BIS, 2012). Cadmium variation in the surface water and groundwater of the study area is shown in **Figure 4.28.**

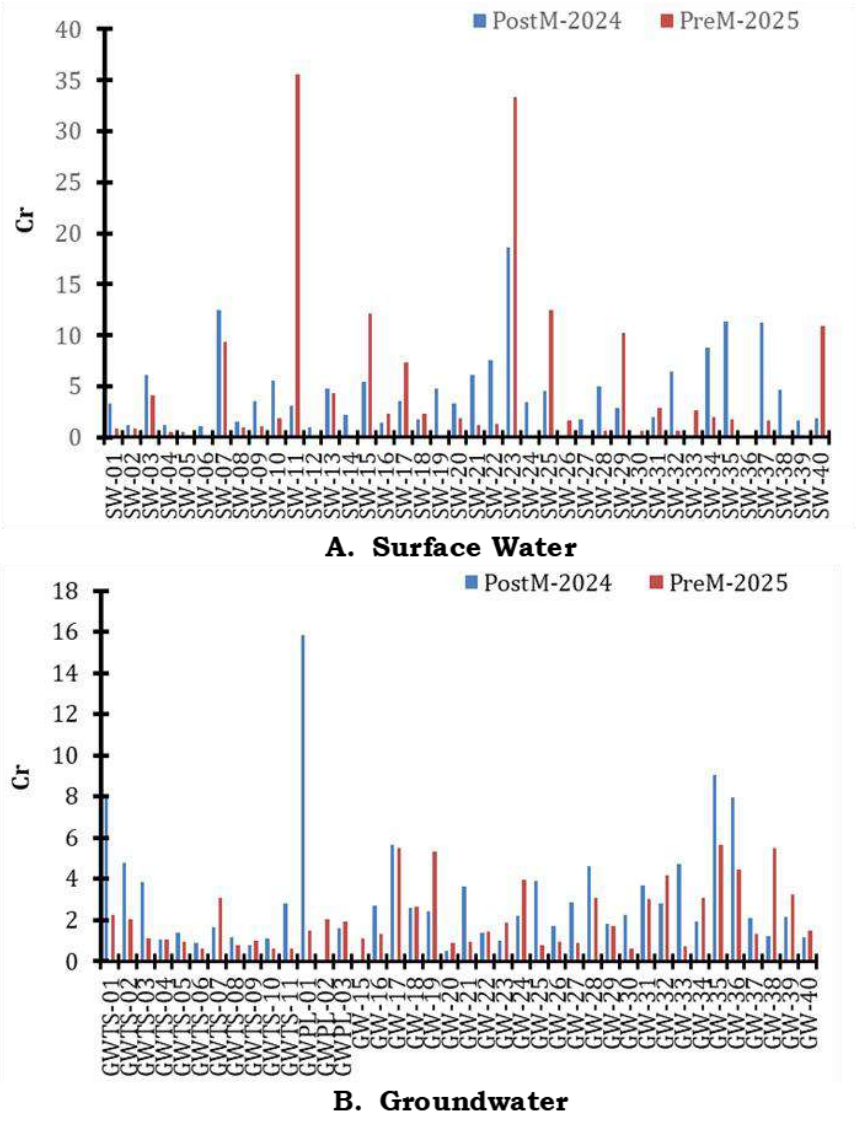


Figure 4.29: Total Chromium (Cr) in SW and GW during pre and post monsoon.

Concentration of Cadmium in surface water samples varies between 0.1 to 2.1 ppb and 0.1 to 0.4 ppb with average concentration 0.6 and 0.2 ppb respectively during pre-and post-monsoon season. Its concentration in groundwater varies between 0.05 to 0.5 ppb and 0.06 to 1.3 ppb with average concentration 0.1 and 0.2 ppb respectively during the pre-and post-monsoon season.

4.4.5 Chromium (Cr)

Chromium is a chemical element; it has symbol Cr and atomic number 24. Chromium is an essential trace mineral. There are two forms: trivalent chromium, which is safe for humans, and hexavalent chromium, which is a toxin. Environmental pollution with various forms of Cr results from its numerous uses in the chemical industry, production of dyes, wood preservation, leather tanning, chrome plating, manufacturing of various alloys, and many other applications and products.

Concentration of Chromium in surface water samples varies between 0.5 to 35.6 ppb and 0.6 to 18.6 ppb with average concentrations 5.7 and 4.6 ppb respectively during pre-and post-monsoon season. Concentration of Chromium in ground water samples varies between 0.6 to 5.6 ppb and 0.5 to 15.8 ppb with average concentration 2.1 and 3.2 ppb, respectively, during pre-and post-monsoon season. All the analysed samples were falling within the acceptable limit of BIS (50ppb) for total chromium in drinking water. Total Chromium concentration in the surface water and groundwater of the study area is shown in **Figure 4.30 .**

4.4.6 Chromium hexavalent (Cr^{6+})

In water, chromium occurs in two oxidation states, Cr^{3+} and Cr^{6+}. Cr^{3+} is an essential human dietary element and is found in many vegetables, fruits, meats, grains, and yeast, while Cr^{6+} occurs naturally in the environment from the erosion of natural chromium deposits. It can also be produced by industrial processes. There are demonstrated instances of chromium being released to the environment by leakage, poor storage, or inadequate industrial waste disposal practices.

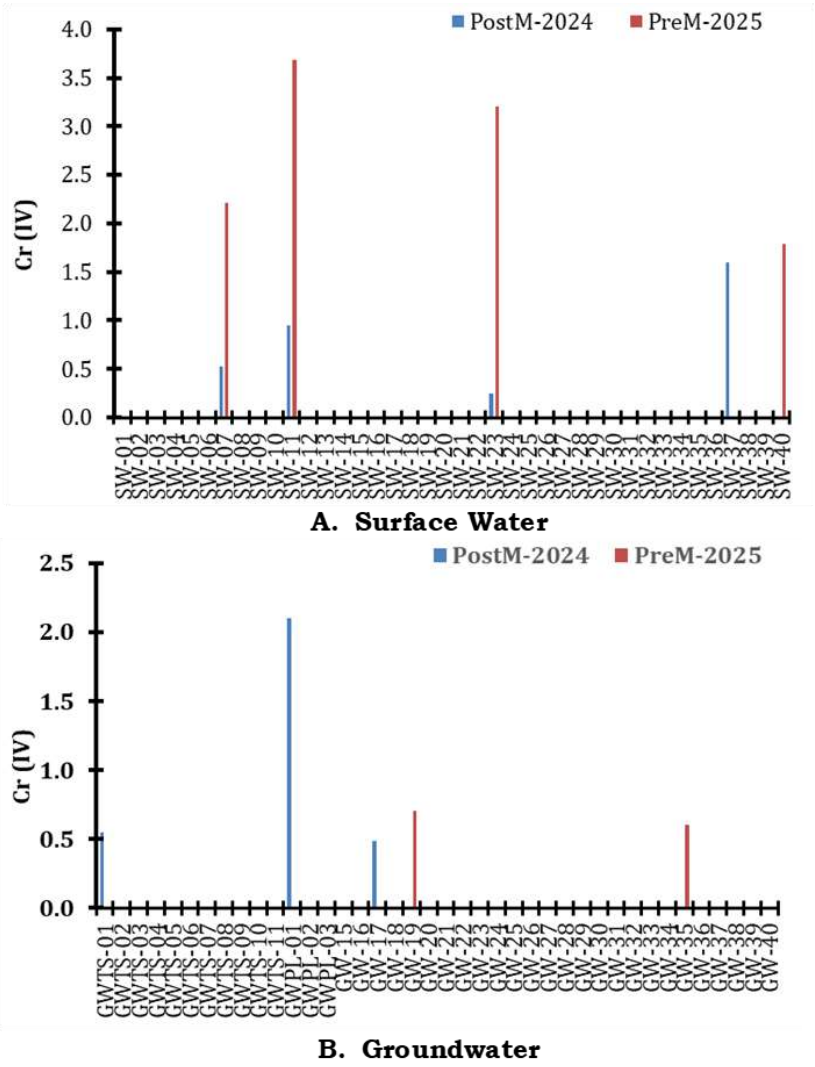


Figure 4.30:Chromium hexavalent (Cr6+) in SW and GW during pre-and post-monsoon.

The Bureau of Indian Standards has recommended 50 ppb as the acceptable limit for chromium in drinking water (BIS, 2012). The National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMMC) of Australia has recommended 50 ppb as the permissible limit for Cr^{6+} in drinking water. Total Chromium concentration in groundwater of the study area is shown in **Figure 4.30** Concentration of Chromium hexavalent (Cr^{6+}) in surface water varies between 1.8

to 3.7 ppb, with an average concentration 2.7 ppb and 0.2 to 1.6 ppb, with an average concentration 0.8 ppb during pre-and post-monsoon. Cr^{6+} has not been detected in most of the groundwater except few locations during the pre and post-monsoon season. The concentration of Cr^{6+} in the analyses surface and groundwater samples is far below the permissible limit recommended by BIS/NHMRC/NRMMC, Australia.

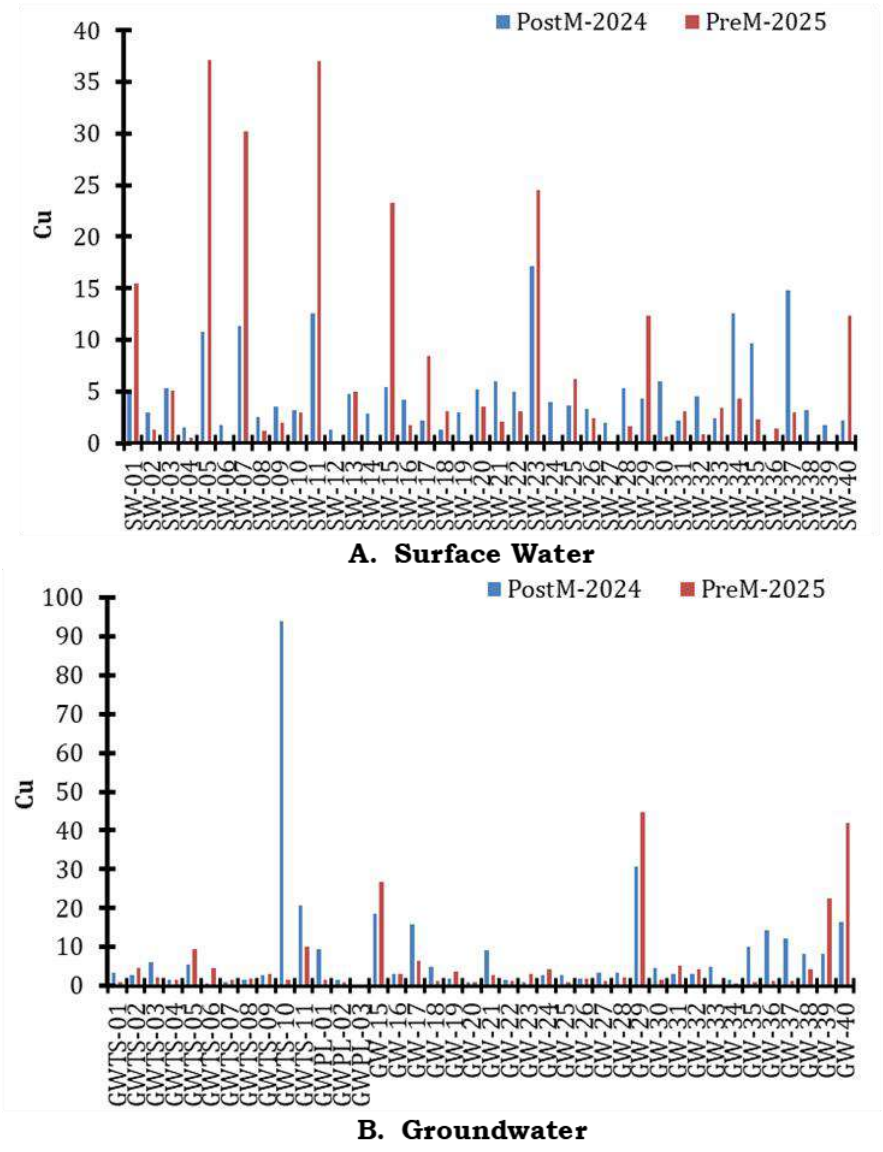


Figure 4.31: Copper (Cu) in SW and GW during pre and post monsoon.

4.4.7 Copper (Cu)

Copper is both an essential nutrient and a drinking-water contaminant. It is used to make pipes, valves and fittings and is present in alloys and coatings. Beyond 0.05 mg/l the water imparts astringent taste and cause discoloration and corrosion of pipes, fittings and utensils. Recent studies have delineated the threshold for the effects of copper in drinking-water on the gastrointestinal tract, but there is still some uncertainty regarding the long-term effects of copper on sensitive populations, such as carriers of the gene for Wilson disease and other metabolic disorders of copper homeostasis.

The Bureau of Indian Standards has recommended 50 ppb as the acceptable limit and 1000 ppb as the permissible limit for copper in drinking water (BIS, 2012). Copper concentration in the surface water and groundwater of the study area is shown in **Figure 4.31.** The concentration of copper in surface water and groundwater varies between 1.0 to 37 ppb and 1.0 to 44.6 ppb, with average concentrations 8 ppb and 6.0 ppb, respectively, during pre-monsoon season. The concentration of copper in surface water and groundwater varies between 1.3 to 17.2 ppb and 0.5 to 94.0 ppb with average concentrations 5.1 ppb and 9.0 ppb, respectively, during pre-and post-monsoon season. All the samples ranging within the acceptable limit of 50 ppb for drinking water except few samples.

4.4.8 Zinc (Zn)

Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. The solubility of zinc in water is a function of pH and total inorganic carbon concentrations; the solubility of basic zinc carbonate decreases with increase in pH and concentrations of carbonate species. In general, concentration of zinc in surface water and groundwater normally do not exceed 100 and 500 ppb, respectively. The Bureau of Indian Standards has recommended 5000 ppb as the desirable and 15000 ppb as the maximum permissible limit for drinking water (BIS,

2012). Zinc concentration in the surface water and groundwater of the study area is shown in **Figure 4.32.**

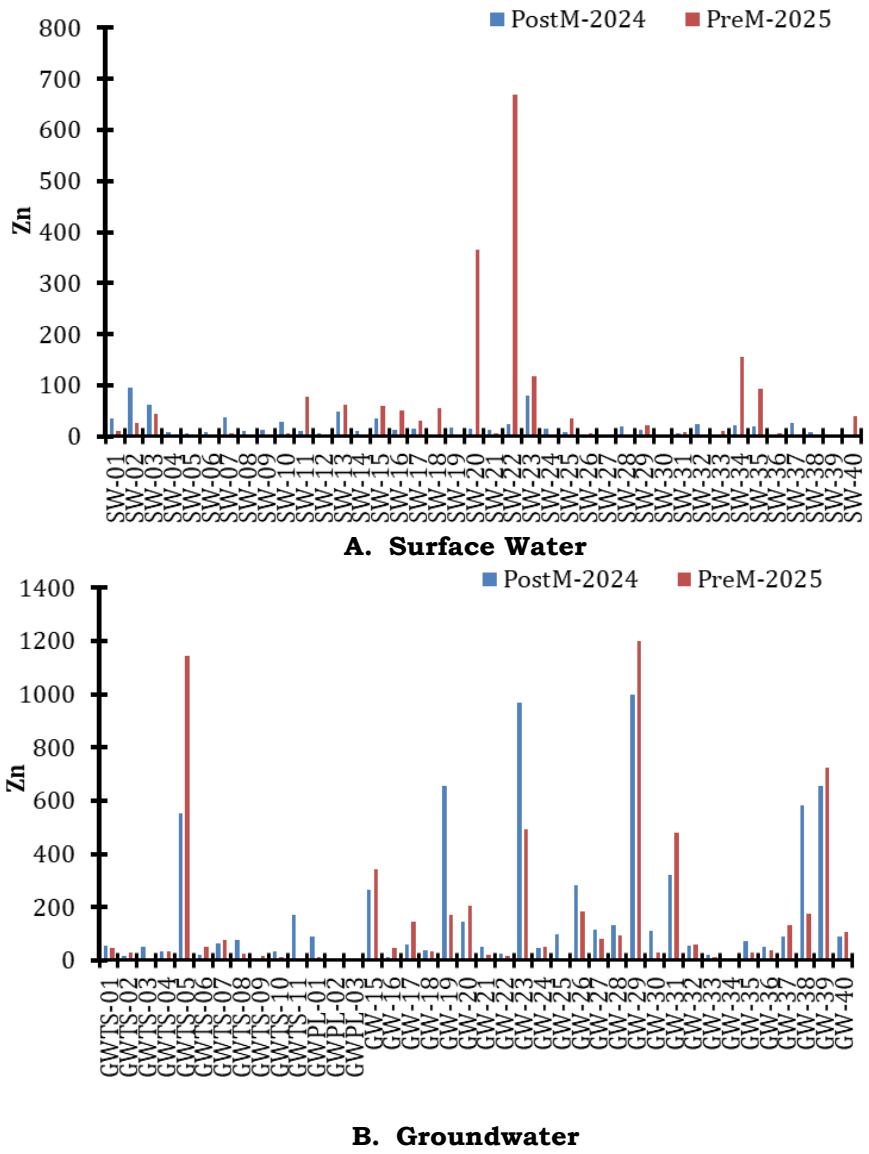


Figure 4.32: Zinc (Zn) in SW and GW during pre and post monsoon.

During the pre-and post-monsoon, the concentration of zinc in surface varies between 2.0 to 670 ppb and 3.0 to 94.0 ppb with average concentration of 62.0 and 20.0 ppb respectively. During the pre- and post-monsoon, zinc in groundwater samples varies between 1.2 to 1200 ppb and 4.4 to 1000 ppb with average concentration of 159.0 and 178.0 ppb respectively. It is evident from the results that zinc concentration was well within the acceptable limit for all the samples.

4.4.9 Selenium (Se)

Selenium is among the rarer elements on the surface of this planet and is rarer than silver. Selenium is present in the atmosphere as metyl derivatives. Uncombined selenium is occasionally found and there are around 40 known selenium-containing minerals, some of which can have as much as 30% selenium - but all are rare and generally they occur together with sulfides of metals such as copper, zinc and lead.

Selenium occurs naturally in the environment. It is released through both natural processes and human activities. Well fertilized agricultural soil generally has about 400 mg/ton since the element is naturally present in phosphate fertilizers and is often added as a trace nutrient. In its natural form as an element selenium cannot be created or destroyed, but selenium does have the ability to change form.

Selenium levels in soils and waters increase, because selenium settles from air and selenium from waste also tends to end up in the soils of disposal sites. When selenium in the soil does not react with oxygen it remains immobile. Selenium that is immobile and will not dissolve in water is less of a risk for organisms. The oxygen levels in the soil and the acidity of the soil will increase mobile forms of selenium. Higher oxygen levels and increased acidity of soils are usually caused by human activities, such as industrial and agricultural processes. Selenium exposure to humans takes place either through food or water, or when we encounter soil or air that contains high concentrations of selenium. This is not very surprising, because selenium occurs naturally in the environment extensively and it is very widespread. The health effects of various forms of selenium can vary from brittle hair and deformed nails to rashes, heat, swelling of

the skin and severe pains. When selenium ends up in the eyes people experience burning, irritation and tearing.

The Bureau of Indian Standards has recommended 10 ppb as the acceptable limit and there is no relaxation as the maximum permissible limit for drinking water (BIS, 2012). Selenium concentration in the surface water and groundwater of the study area is shown in **Figure 4.33.**

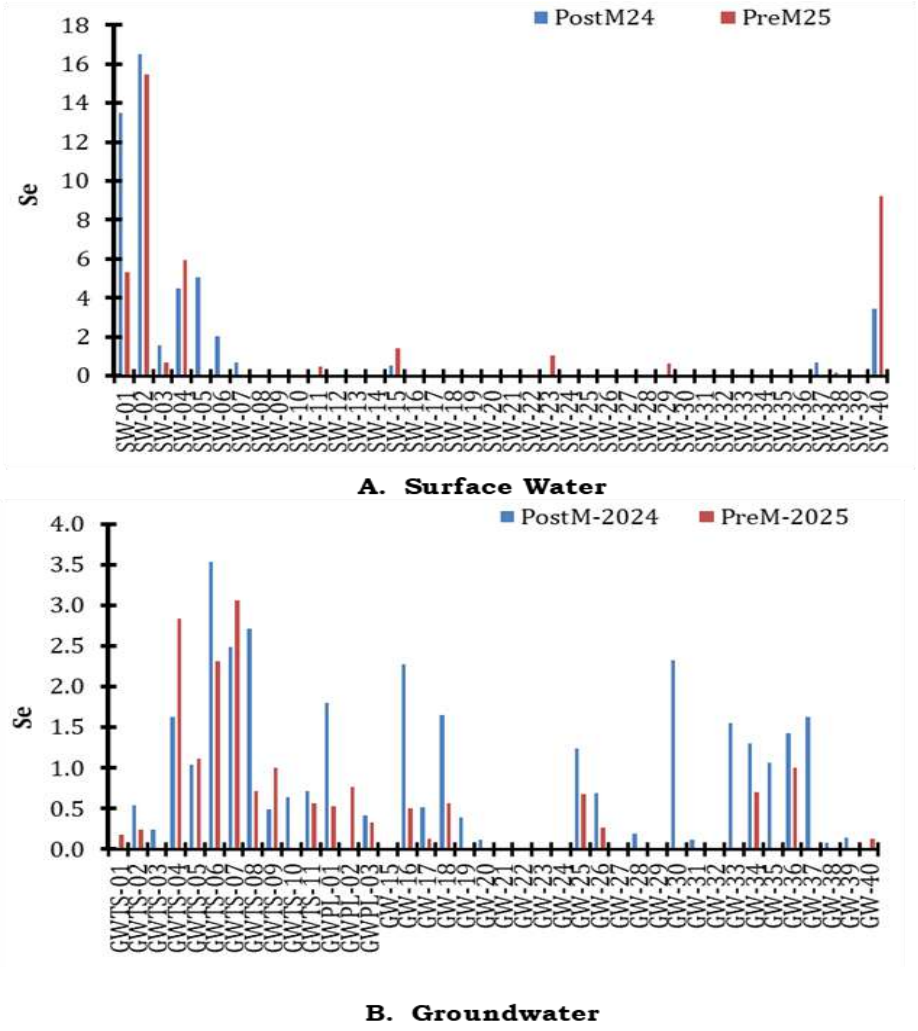


Figure 4.33: Selenium (Se) in SW and GW during pre and post monsoon.

The concentration of Selenium in surface water samples of the study area varies between 0.5 to 15.5 ppb (average 4.5 ppb) and 0.1 to 16.5 ppb (average 4.4 ppb), respectively, during pre-and post-monsoon monitoring. The concentration of Selenium in groundwater samples of the study area varies between 0.1 to 3.1 ppb (average 0.9 ppb) and 0.1 to 3.5 ppb (average 1 ppb), respectively, during pre-and post-monsoon monitoring. Selenium concentration in most of the surface water and groundwater samples was well within the acceptable limit during both seasons.

4.4.10 Iron (Fe)

Iron in trace amounts is essential for nutrition. High concentrations of iron generally cause inky flavor, bitter and astringent taste to water. Well water containing soluble iron remains clear while pumped out, but exposure to air causes precipitation of iron due to oxidation, with a consequence of rusty color and turbidity. The objection to iron in the distribution system is not due to health reasons but to staining of laundry and plumbing fixtures and appearance. Taste and odor problems may be caused by filamentous organisms that prey on iron compounds, originating from another consumer's objection (red water). The presence of iron bacteria may clog well screens or develop in the distribution system, particularly when sulfate compounds in addition to iron may be subjected to chemical reduction.

The Bureau of Indian Standards has recommended 1000 ppb as the as the maximum permissible limit for iron in drinking water (BIS, 2018). Iron concentration in the surface water and groundwater of the study area is shown in **Figure 4.34** In the pre-and post-monsoon season, the concentration of iron (Fe) in surface water samples of the study area varies between 50 to 2761 ppb and 45 to 1845 ppb with average concentrations of 1046 and 736 ppb, respectively. During the pre- and post-monsoon monitoring, the concentration of iron in groundwater varies between 6.4 to 7670 ppb and 26.8 to 6727.1 ppb, with average concentrations 720.9 and 751 ppb, respectively. It is evident from the results that ~20% groundwater samples exceeded the maximum acceptable limit of iron, whereas ~25% surface water samples are exceeding the acceptable limit for drinking water during both the seasons. The primary source of iron

in groundwater is geogenic i.e. the dissolution of iron-bearing minerals within rocks and sediments during rock-water interaction as the soil of the study area contains lateritic formations.

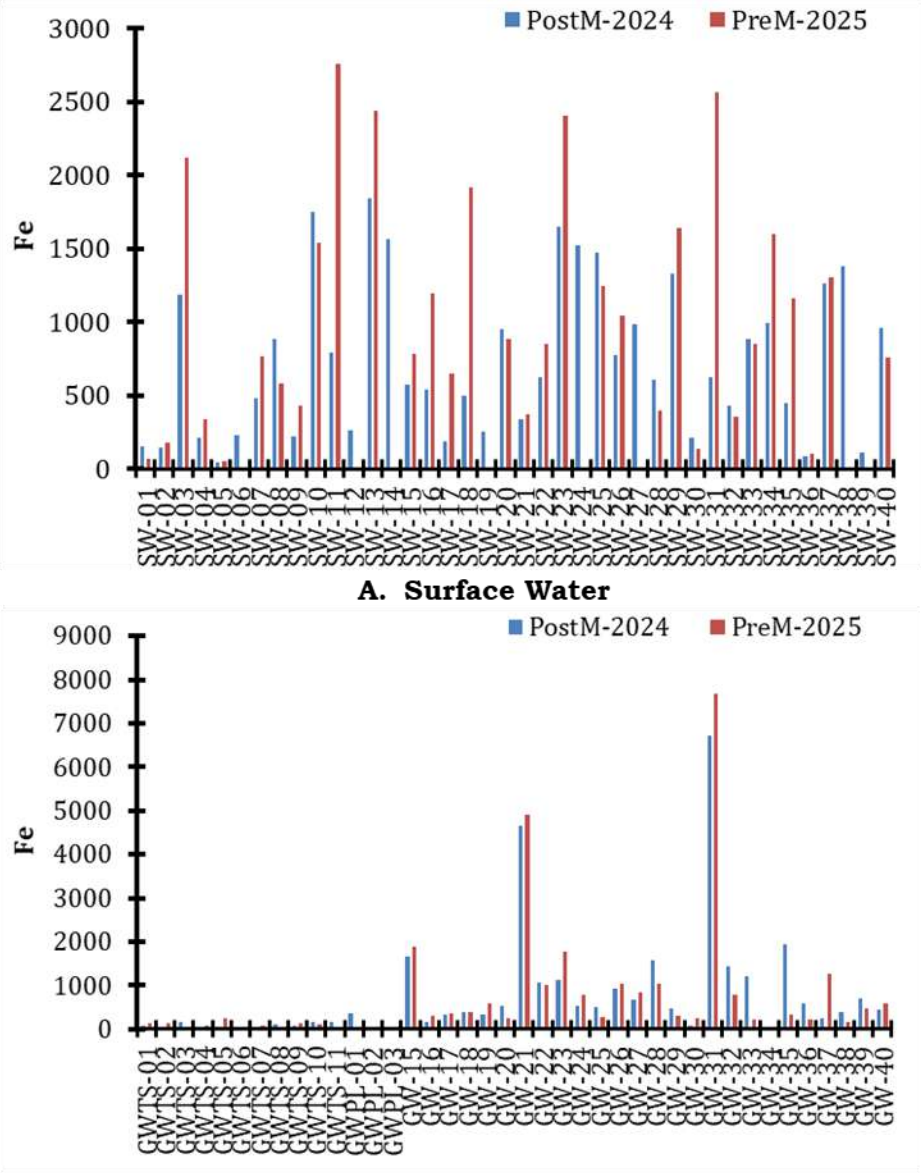


Figure 4.34: Iron (Fe) in SW and GW during pre and post monsoon.

5 INFILTRATION TEST

5.1 Basic Principle

Infiltration is the process by which water on the ground surface enters the soil. The speed at which water enters the soil is called the Infiltration rate. Infiltration is the measure of the ability with which soil can absorb water. Technically, the Infiltration rate is the volume flux of water flowing into the soil profile per unit of soil surface area. Infiltration is usually measured by the depth (generally in mm) of the water layer that can enter the soil in a specified time (generally one hour). Thus, an Infiltration rate of 15 mm/hour means that a water layer of 15 mm on the soil surface will take one hour to infiltrate.

In dry soil, water infiltrates rapidly. This is called the initial Infiltration rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady rate. The Infiltration rate decreases to a steady or quasi-steady state as the soil becomes saturated. Therefore, the Infiltration rate curve shows a sharp decline with time. The constant rate approached after a sufficiently large time is referred to as the steady-Infiltration rate. Some water that infiltrates will remain in the shallow soil layer, where it will gradually move vertically and horizontally through the soil and subsurface material. Some of the water may infiltrate deeper, recharging groundwater aquifers.

Infiltration rate is an important component of the hydrologic cycle. It helps to determine how rainfall is divided between recharging the groundwater and running off over the surface as sheet wash and in streams. Infiltration process is responsible for modifying precipitation and converting it to runoff and additions to soil moisture storage. The infiltration and other processes are interrelated through a common dependence on soil moisture conditions. In general, the lower the Infiltration rate, the greater the surface runoff, and thus the greater the potential for soil erosion. A high Infiltration rate lets most of the rainwater soak into the soil and make its way downward to the aquifer.

5.2 Variation of Infiltration Rate

Soils with low infiltration can be responsible for runoff and flooding and can become saturated during rain events. It, in turn, decreases soil strength and increases erosion potential. It can also cause nutrient deficiencies in plants and generate anaerobic conditions. Soils that have reduced infiltration have an increase in the overall amount of runoff water. This excess water can contribute to local and regional flooding of streams and rivers or result in accelerated soil erosion of fields or stream banks.

A typical variation of infiltration capacity for different soils for different initial conditions is shown in **Figure 5.1.**

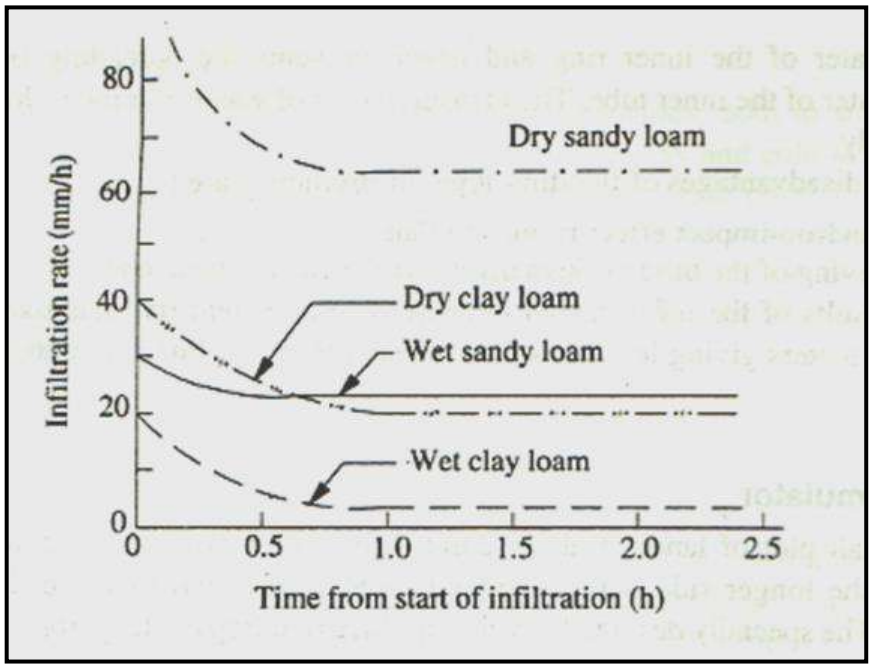


Figure 5.1: Variation of Infiltration capacity (Source: Subramanya, 1997)

It is clear from the figure that the infiltration capacity for a given soil decreases with time from the start of rainfall; it decreases with the degree of saturation and depends upon the type of soil. As discussed earlier, the infiltration capacity values of soils are subjected to wide variation depending upon many factors.

5.3 Methodology for Measurement of Infiltration Rate

There are number of available methods which can be used to measure the Infiltration rate in the field. Single Ring and Double Ring Infiltrometer, Mariotte-Double ring Infiltrometer, Disc Permeameter, Rainfall Simulator, Runoff-on-Ponding, Runoff-on-out and Percolation test are the common methods used for Infiltration rate determinations. The Percolation test is the most popular and convenient method for Infiltration rate determination because of its simple experimental setup and straightforward mathematical calculation.

In the present investigation, the double ring infiltrometer method has been used for the measurement of infiltration rates. The Double Ring infiltrometer test equipment consists of two concentric cylinders. The cylinders are usually 25 cm deep. The inner cylinder, from which the infiltration measurements are taken, is usually 30cm in diameter. The outer cylinder, which is used to form the buffer pond to minimize the lateral spreading of water, is about 60cm in diameter. The cylinders are installed about 10cm deep in the soil. The water is added in the inner and outer cylinder upto the desired level, say 10cm above the ground. After initial reading, point gauge measurements are taken at frequent intervals, say 5 minutes to determine the amount of water that has infiltered during the time interval. Water is added quickly after each measurement so that a constant average infiltration head can be maintained. The average depth of water maintained in cylinder is 7 to 12cm which is approximately equal to the expected water level in the border or basin during irrigation. The buffer pond is filled with water immediately after filling the inner cylinder to maintain the same depth in both the cylinder. The function relation between Cumulative infiltration(Y) and elapsed time(t) is represented by Kostiakov equation-($\mathbf{Y=a*t^{\alpha}}$) **Figure 5.2** shows the field setup of the double-ring infiltrometer.

As per the scope of work, Infiltration studies for determining rate of infiltration using double ring infiltrometer at 5 locations in and around ash disposal area during Pre-monsoon and Post-Monsoon Seasons needed to be carried out. Location of infiltration tests is shown in **Figure 5.3**.

Figure 5.2: Field set up of double ring infiltrometer

Figure 5.3: Infiltration Test locations in and around the Ash dyke zone

Table 5.1: Detail of the Infiltration tests carried out in and around the Ash dyke.

S. No.	Grid No.	Location	Longitude	Latitude	Post-monsoon 2024		Pre-monsoon 2025	
					Initial Infiltration rate (mm/hr)	Steady Infiltration rate (mm/hr)	Initial Infiltration rate (mm/hr)	Steady Infiltration rate (mm/hr)
1	UN-IN-01	New Ash Dyke	25.846347	81.314791	11.5	3.3	8.1	3.9
2	UN-IN-02	New Ash Dyke	25.853086	81.308693	5.9	3	25.9	3.2
3	UN-IN-03	New Ash Dyke	25.848434	81.298474	28.9	5.8	36.3	5.3
4	UN-IN-04	New Ash Dyke	25.960104	81.353049	5.6	0.4	9.3	0.4
5	UN-IN-05	New Ash Dyke	25.949871	81.361325	7	2.2	9.3	1.6
6	UN-IN-06	Gomti Bhawan	25.905089	81.305979			14.8	5

The results from the double ring infiltrometer (constant head) test sites are shown in **Table 5.1.** Infiltration rate (post-monsoon 2024) in the study area exhibits significant spatial variability, ranging from a maximum of 5.8 mm/hr to a minimum of 0.4 mm/hr, with an average infiltration rate of 2.94 mm/hr. Whereas, in pre-monsoon (2025), the steady state infiltration rate ranged from a maximum of 5.3 mm/hr to a minimum of 0.4 mm/hr, with an average infiltration rate of 3.2 mm/hr. This variation in infiltration rates can be attributed to several factors, including differences in topsoil texture, compaction, and land use practices across the region. Infiltration rate graphs are shown in **Figure 5.4** to **Figure 5.8**.

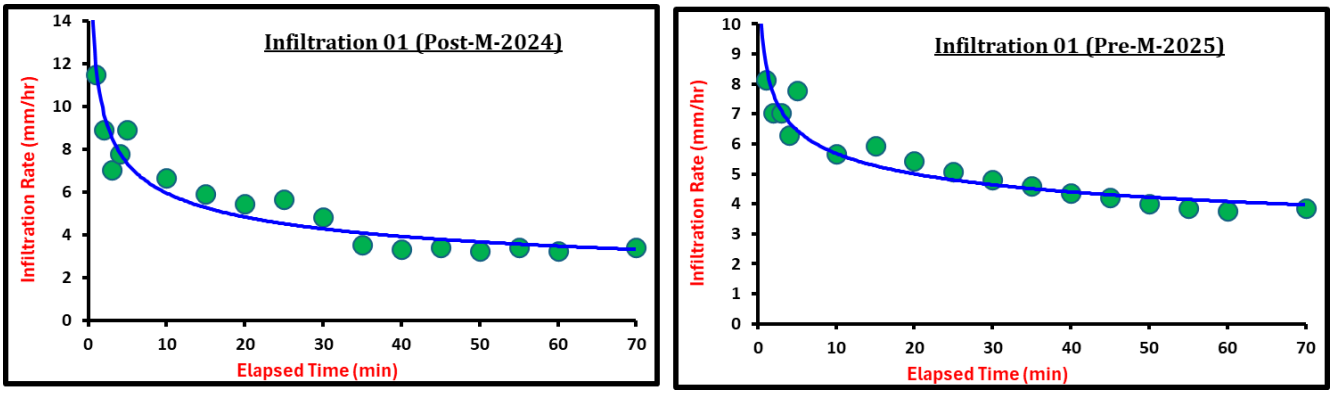


Figure 5.4: Infiltration rate graph at site-1.

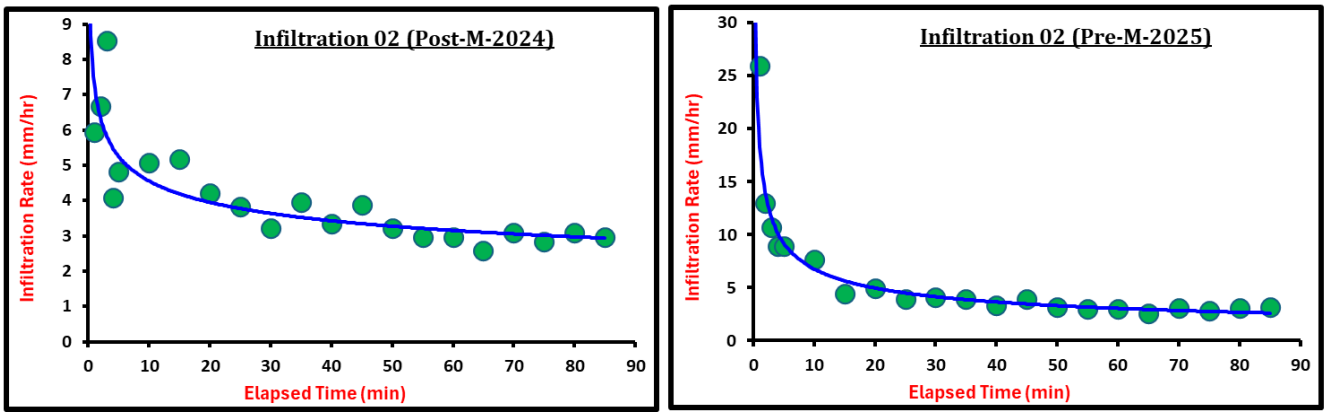


Figure 5.5: Infiltration rate graph at site-2.

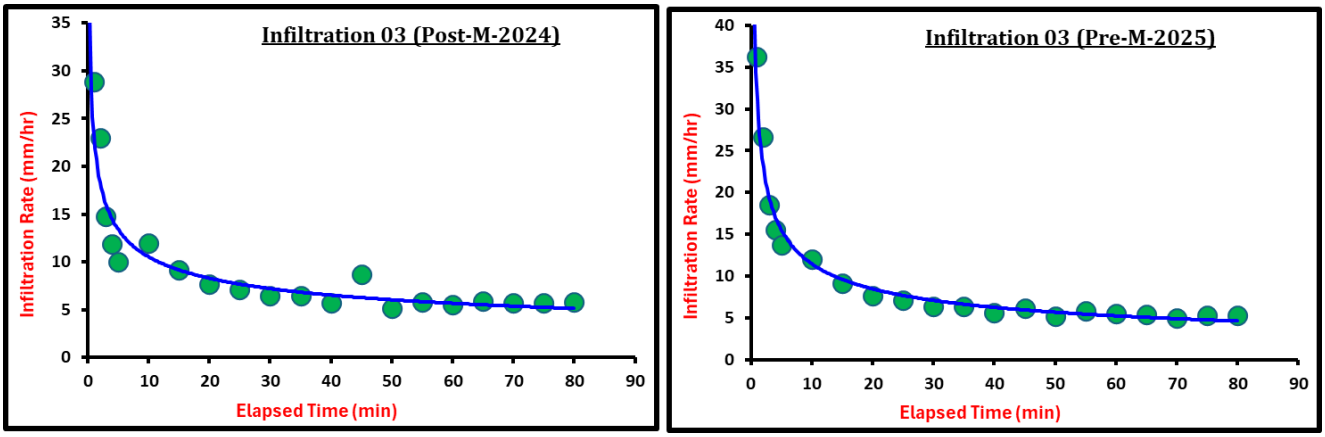


Figure 5.6: Infiltration rate graph at site-3.

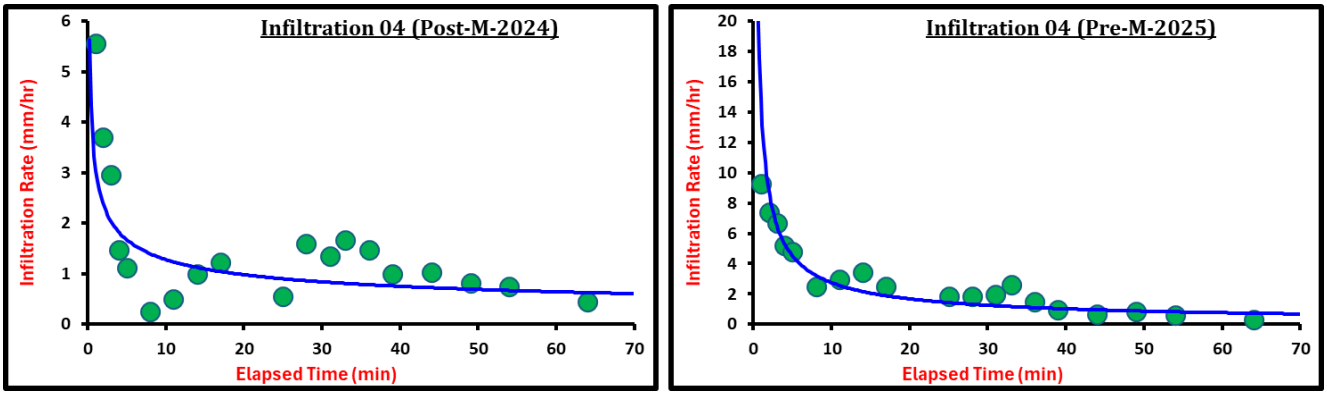


Figure 5.7: Infiltration rate graph at site-4.

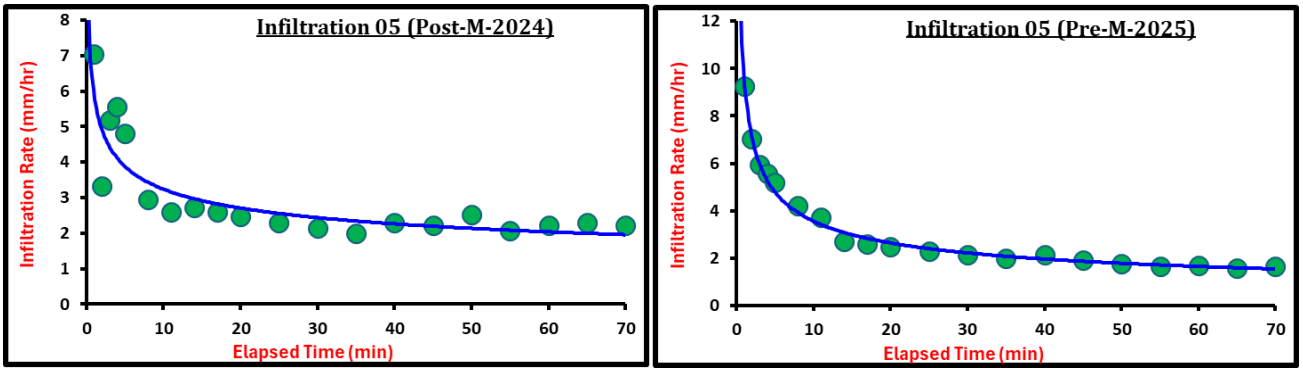


Figure 5.8: Infiltration rate graph at site-5.

6 CONCLUSIONS

The present study is focused on the Feroze Gandhi Unchahar Thermal Power Station (FGUTPP), located in Raebareli district, Uttar Pradesh, India. This coal-based thermal power station is operated by NTPC Limited, the largest power utility in India, and plays a significant role in power generation and energy security in northern India.

The title of the present study is **"Biennial contract for review of Hydro-geology to assess impact of NTPC Unchahar on surface water and ground regime"** and has been carried out by ***M/s. Geoscience Consultancy Services (GCS),*** a CGWA-accredited institute, vide **PO No. 4000337031-026-1019 Date: 11.07.2024 and GEM order no. GEMC-511687785098469.** The scope of the study included literature review, identification of drainage patterns and surface water bodies, groundwater level measurements, Infiltration studies, identification of groundwater flow direction, temporal changes in aquifer characteristics, monitoring the surface and groundwater quality and estimation of rainwater harvesting potential.

As per the literature review of the study area, the main morphological and hydro-geological features are;

- **Drainage:** The area of the district falls in the drainage basin of Ganga and Sai River, a tributary of the Ganga River itself.
- As per the CGWB, Unchahar Block falls under 'Safe category', having 74.07 % of development.
- **Elevation:** The elevation in the study area varies from 86 to 145 m amsl.
- **Hydrogeology:** Raebareli district is underlain by alluvial sediments of quaternary age. The upper layer of alluvium is composed of sandy loam, silty clays and clays in varying proportions. The thickness of alluvium is more than 600 m in the northern part as per CGWB exploratory drilling data, whereas in southern part the thickness of alluvial sediment is about 487 m bgl where bed rock

(Bundelkhand Granite) was encountered at 487.8 m bgl at Sultanpur Janaul. Based on groundwater exploration by CGWB in the area, a four-tier aquifer system has been established down to the depth of 600 m bgl (CGWB).

- **Geomorphologically:** The study area constitutes the younger flood plain, older flood plain and composite flood plain or upland interfluve area in the Gangetic plain. The overview of the first-year pre- and post-monsoon period study at NTPC Unchahar (FGUTPP) is described below.

- **Depth to Water Table:** Groundwater table fluctuation during pre-monsoon varies from 3.0 to 19.5 m with an average of 8.5 m bgl. Whereas the depth to water level in the study area varies between 0.5 m and 8.0 m bgl during the post-monsoon, with an average depth of groundwater level in the post-monsoon is 3.6 m bgl.

- All these water samples contained pH well within the desirable limits prescribed by BIS (2012) and WHO (2011) for various uses of water including drinking and other domestic supplies.

- In the study area, groundwater shows overall higher EC than surface water samples. The waters are still suitable for drinking and for irrigation uses. The spatial differences between the EC values are due to wide variation in the activities and processes prevailing in the study area.
- DO in surface water during pre-monsoon 2025 varies in a range of 4.2 to 8.1 mg/l with an average of 6.1 mg/l and during post-monsoon 2024 it varies in a range of 3.8 to 7.6 mg/l with an average of 5.5 mg/l. DO of water in ponds is less than that of the river/Canal.

- TDS of the all analysed ground water and surface water samples falling in the category of fresh water (0 -1000 mg/l) during both the seasons.

- During the pre- and post-monsoon season, TSS in the surface water of the study area ranged from 2 to 54 mg/l (average 6.12 mg/l) and from 1.2 to 42.3 mg/l (average 6.5 mg/l), respectively. While TSS in the groundwater ranged from 0 to

6.0 mg/l (average 0.7 mg/l) and from 0 to 2.6 mg/l (average 0.33 mg/l) pre- and post-monsoon, respectively. TSS in groundwater is only seen in few dug wells.

- Alkalinity in both surface water and groundwater is within the permissible limit prescribed by BIS for drinking water during the both seasons and ranged from 32.8 to 486.7 mg/l.
- Total hardness in the groundwater and surface water is within the BIS permissible limit. None of the samples has very hard water, and only 40-50% surface water samples have hard water. Generally, groundwater is soft or moderately hard water.
- During pre and post monsoon, BOD values in the surface water samples collected from the study area vary from 2.4 to 36.5 mg/l (average 9.2 mg/l) and 2.5 to 24.6 mg/l (average 7.3 mg/l) in ponds and rivers.
- During pre and post monsoon season, COD value in the surface water varies from 11.5 to 107.5 mg/l (average 46.4 mg/l) and 12 to 90 mg/l (average 36.3 mg/l), respectively.
- Mostly, oil and grease have been observed in surface water samples, however, two of the groundwater samples also show traces of oil and grease. The physical verification of these two dug wells shows that these are low-lying wells and there may be chances of anthropogenic activities due to which Oil and grease traces are visible in the groundwater.
- Phenols or Phenolic compounds have not been detected in groundwater during both pre-monsoon and post-monsoon seasons. Whereas, in surface water, the phenolic compound traces were observed in the pre-monsoon period in Ash dyke water (SW-01, 02 and 04).
- During pre- and post-monsoon, HCO_3^- concentration in the surface water samples varies between 40.0 to 492.6 mg/l (average 209.6 mg/l) and 56.8 to 398 mg/l (average 195.2 mg/l) respectively. In groundwater during post-monsoon, HCO_3^- concentration in the varies between 149.3 to 593.9 mg/l (average 392.1 mg/l) and 122 to 575.4 mg/l (average 355.2 mg/l) respectively. HCO_3^-

concentration is within the stipulated permissible limit (600 mg/l) prescribed by BIS (2012) in all the analysed surface water and ground water samples.

- Chloride concentrations in all the analysed samples during both the seasons were within the acceptable limit (250 mg/l) prescribed by BIS (2012). No health-based guideline value is proposed for chloride in drinking-water.
- The ranges of SO_4^{2-} concentration in both the surface water and groundwater indicated that Sulphate concentration is within the stipulated acceptable limit (200 mg/l) in most of the sample except few samples which is still under permissible limit (1000mg/l) prescribed by BIS (2012) during both of the seasons.
- Nitrate concentrations in the study area are well within the acceptable limit (45.0 mg/l) in all the analysed surface water and groundwater samples during both of the seasons.
- During pre- and post-monsoon, concentration of fluoride in surface water varies from 0.3 to 3.4 mg/l (average 0.98) and 0.2 and 3.9 mg/l (average 0.88 mg/l), respectively. Concentration of fluoride in ground water varies from 0.0 to 2.0 mg/l (average 0.86) and between 0.16 and 1.97 mg/l (average 0.76 mg/l), respectively. Fluoride concentration is within the stipulated permissible limit (1.5 mg/l) prescribed by BIS (2012) in all the analysed surface water and ground water samples.
- The surface water is dominated by $Ca^{2+} > Na^{+} > Mg^{2+} > K^{+}$ & $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+}$ during post-and pre-monsoon sampling period, however the dominance of these ions in groundwater is in the order $Na^{+} > Ca^{2+} > Mg^{2+} > K$ during pre-and post-monsoon, respectively.
- During pre-and post-monsoon monitoring, concentration of Calcium in surface water varies between 0.0 to 76.2 mg/l (average 40.7 mg/l) and 8.0 to 76.5 mg/l (average 39.8 mg/l) respectively. Whereas, in groundwater during pre- and post-monsoon monitoring, Calcium varies between 24.8 to 92.3 mg/l (average 52.1 mg/l) and 21.4 to 136.7 mg/l (average 57.1 mg/l), respectively. Calcium concentration is within the stipulated permissible limit (200 mg/l) prescribed by BIS (2012) in all the analysed surface water and ground water samples.

- During pre-monsoon, concentration of Sodium in surface water and groundwater varies between 6.9 to 132.1 mg/l (average 39.8 mg/l) and 11.7 to 196.3 mg/l (average 85.5 mg/l) respectively. During post-monsoon, concentration of Sodium in surface water and groundwater varies between 3.3 to 148.9 mg/l (average 35.1mg/l) and 15.7 to 219.8 mg/l (average 76.8 mg/l) respectively. No health-based guidelines are given by BIS for drinking water for sodium.
- During the pre-monsoon season, in few samples the concentration of magnesium in groundwater exceeded the acceptable limit (30 mg/l) while none of the samples exceeded the permissible limit for drinking water.
- Concentration of K^+ in surface water and groundwater during pre-monsoon varies between 0.0 to 54.8 mg/l (average 5.8 mg/l) and 2.0 to 14.8 mg/l (average 4.9 mg/l) respectively. Concentration of K^+ in surface water and groundwater during post-monsoon varies between 0.9 to 38.8 mg/l (average 8.5 mg/l) and 2.1 to 40.5 mg/l (average 6.6 mg/l) respectively.
- During pre-monsoon season, total coliforms have been observed in most of the surface water samples, whereas, in groundwater samples, total coliforms have been found in 10 samples. In the post monsoon season, total coliforms have been in the same samples but in less number.
- Most of the analysed surface water sample falling under **class B category** (total coliform bacteria is ≤500 MPN/100ml) of CPCB and suitable for outdoor bathing during both the sampling seasons. However, few surface water samples comply with CPCB Class C limit (≤ 5,000 MPN/100 mL). Among the analysed ground water samples majority of the samples doesn't show any presence of the Total coliforms organism and found suitable for drinking purpose during both the seasons.
- In the pre-and post-monsoon season, concentration of Arsenic in surface water samples varies between 0.7 to 20.5 ppb (average 6.2 ppb) and 0.07 to 16.9 ppb (average 5.9 ppb), respectively. Concentration of Arsenic in groundwater samples varies between 0.2 to 12.3 ppb (average 2.5 ppb) and 0.05 to 13.8 ppb (average

2.0 ppb) respectively during pre-and post-monsoon season. Most of the analysed samples are within permissible limit except 2-3 locations during both the seasons.

- In the pre-and post-monsoon season, the concentration of Mercury in surface water samples varies between 0.1 to 2.7 ppb (Lagoon water) (average 0.4 ppb) and 0.2 to 0.5 ppb (average 0.3 ppb) respectively. Whereas in groundwater during the pre-monsoon season, Mercury varies from 0.03 to 0.4 ppb and has not been detected during post-monsoon in groundwater samples except three samples which is still within permissible limit.
- Concentration of Lead in surface water samples during pre and post-monsoon varies between 0.6 to 22.2 ppb (average 3.6 ppb) and 0.4 to 10.3 ppb (average 3.3 ppb), respectively. Concentration of Lead in groundwater varies between 0.5 to 8.7 ppb (average 2.3 ppb) and 0.5 to 13.0 ppb (average 3.1 ppb) respectively during per and post-monsoon season. The results indicate that lead exceeded the maximum permissible limit of 10 ppb in SW-11 and SW-23 during pre-monsoon. Whereas the groundwater sample GDPL-01 during post-monsoon exceeded the maximum permissible limit of 10 ppb.
- The Bureau of Indian Standards has recommended 3 ppb as the acceptable limit for cadmium in drinking water (BIS, 2012) and none of the analysed samples exceeded the acceptable limit for drinking water during both the monitoring seasons.
- Concentration of Chromium in surface water samples varies between 0.5 to 35.6 ppb and 0.6 to 18.6 ppb with average concentrations 5.7 and 4.6 ppb respectively during pre-and post-monsoon season. Concentration of Chromium in ground water samples varies between 0.6 to 5.6 ppb and 0.5 to 15.8 ppb with average concentration 2.1 and 3.2 ppb, respectively, during pre-and post-monsoon season. All the analysed samples were falling within the acceptable limit of BIS (50ppb) for total chromium in drinking water.

- The concentration of copper in surface water and groundwater varies between 1.0 to 37 ppb and 1.0 to 44.6 ppb, with average concentrations 8 ppb and 6.0 ppb, respectively, during pre-monsoon season. The concentration of copper in surface water and groundwater varies between 1.3 to 17.2 ppb and 0.5 to 94.0 ppb with average concentrations 5.1 ppb and 9.0 ppb, respectively, during pre- and post-monsoon season. All the samples ranging within the permissible limit of 1000 ppb for drinking water.
- During the pre-and post-monsoon, the concentration of zinc in surface varies between 2.0 to 670 ppb and 3.0 to 94.0 ppb with average concentration of 62.0 and 20.0 ppb respectively. During the pre- and post-monsoon, zinc in groundwater samples varies between 1.2 to 1200 ppb and 4.4 to 1000 ppb with average concentration of 159 and 178 ppb respectively. It is evident from the results that zinc concentration was well within the acceptable limit for all the samples.
- The concentration of Selenium in surface water samples of the study area varies between 0.5 to 15.5 ppb (average 4.5 ppb) and 0.1 to 16.5 ppb (average 4.4 ppb), respectively, during pre-and post-monsoon monitoring. The concentration of Selenium in groundwater samples of the study area varies between 0.1 to 3.0 ppb (average 0.9 ppb) and 0.1 to 3.5 ppb (average 1 ppb), respectively, during pre-and post-monsoon monitoring. Selenium concentration in most of the surface water and groundwater samples was well within the acceptable limit during both seasons.
- In the pre-and post-monsoon season, the concentration of iron (Fe) in surface water samples of the study area varies between 50 to 2761 ppb and 45 to 1845 ppb with average concentrations of 1046 and 736 ppb, respectively. During the pre- and post-monsoon monitoring, the concentration of iron in groundwater varies between 6.4 to 7670 ppb and 26.8 to 6727 ppb, with average concentrations 720.9 and 751 ppb, respectively. It is evident from the results that only ~20 & ~25% of groundwater samples and surface water samples exceeded

the maximum acceptable limit of iron respectively, whereas majority of the samples are within the acceptable limit for drinking water. The primary source of iron in groundwater is geogenic i.e. the dissolution of iron-bearing minerals within rocks and sediments during rock-water interaction as the soil of the study area contains lateritic formations.

- **Infiltration Characteristics:** Infiltration rate (post-monsoon 2024) in the study area exhibits significant spatial variability, ranging from a maximum of 5.8 mm/hr to a minimum of 0.4 mm/hr, with an overall average infiltration rate of 2.94 mm/hr. Whereas, in pre-monsoon (2025), the steady state infiltration rate ranged from a maximum of 5.3 mm/hr to a minimum of 0.4 mm/hr, with an average infiltration rate of 3.2 mm/hr. This variation in infiltration rates can be attributed to several factors, including differences in topsoil texture, compaction, and land use practices across the region.

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Weinstein L. H., Davison A., 2004. Fluorides in the environment: Effect on plants and animals. CABI Publishing, Cambridge, MA, USA.

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6.8 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke Piezometer Well-11**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426076**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke Piezometer Well-11**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	5.0	30	350	100
7	Chemical Oxygen Demand (COD)	28.0	250	-	-
8	Chloride as Cl-	34.8	1000	1000	600
9	Dissolved Oxygen	6.2	-	-	-
10	Electrical Conductivity @ 25 ° C	420.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.12	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	272.0	2100	2100	2100
17	Total suspended solids @ 105° C	10.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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6.9 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Arkha Ash Dyke Piezometer Well-02**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426077**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Arkha Ash Dyke Piezometer Well-02**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	6.0	30	350	100
7	Chemical Oxygen Demand (COD)	36.0	250	-	-
8	Chloride as Cl-	39.9	1000	1000	600
9	Dissolved Oxygen	6.4	-	-	-
10	Electrical Conductivity @ 25 ° C	456.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.18	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	296.0	2100	2100	2100
17	Total suspended solids @ 105° C	6.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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6.10 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke Piezometer Well-01**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426078**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Dyke Piezometer Well-01**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	3.0	30	350	100
7	Chemical Oxygen Demand (COD)	24.0	250	-	-
8	Chloride as Cl-	49.7	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	620.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.28	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	386.0	2100	2100	2100
17	Total suspended solids @ 105° C	4.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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6.11 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Umran Dyke Piezometer Well-02**
Type of Sample	Industrial Effluent Water
Date of Sampling	31/03/2026
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -10) : 2021

Sample ID		**010426079**	**Limits**		
Sampling Date		**31/03/2026**			
S. No.	**Parameters**	**Umran Dyke Piezometer Well-02**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ:0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ:0.1)	3	3	3
5	Zinc	BLQ (LOQ:0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days 27 ° C	3.0	30	350	100
7	Chemical Oxygen Demand (COD)	16.0	250	-	-
8	Chloride as Cl-	32.7	1000	1000	600
9	Dissolved Oxygen	6.4	-	-	-
10	Electrical Conductivity @ 25 ° C	586.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.42	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	390.0	2100	2100	2100
17	Total suspended solids @ 105° C	7.0	100	600	200
18	Mercury	BLQ (LOQ:0.1)	0.01	0.01	0.01
19	Lead	BLQ (LOQ:0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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4. SURFACE WATER QUALITY

Surface Water were collected from Lake, Canal and Stream and the details of the location as follows below:

4.1 Stream Water

Ganga Upstream Water
Ganga Downstream Water

4.1.1. Stream Water

Stream Water Sample were drawn for analysis of Chemical and biological Parameters and the detailed parameters mentioned in Table 4.1.2.

4.1.2. Methodology of Sampling and Analysis

Stream Water Sample were collected with proper observations of appearance, odour, etc. as per the sampling guidelines and submitted to the water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Test Protocol
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days	IS3025Part44:2023
2	Chemical Oxygen Demand(COD)	IS3025Part58:2023
3	Chloride as Cl	IS3025Part32:1988(ArgentometricMethod)
4	Hexavalent Chromium as Cr6+	IS3025Part52:2003
5	Cyanide as CN	IS3025Part27sec1:2021
6	Dissolved oxygen	IS3025Part38:1989
7	Electrical Conductivity at25°C	IS:3025Part14:2013
8	Fluoride as F	IS3025Part60Sec1:2023
9	Iron as Fe	IS3025Part53:2024
10	Oil and Grease	IS3025Part39:2021
11	pH at 25°C	IS3025Part11:2022(ElectrometricMethod)
12	Phenolic compounds asC6H5OH	IS3025Part43:Sec1:2022
13	Sodium as Na	IS3025Part45:2024
14	Temperature(°C)	IS3025Part9:2023
15	Total dissolved solids	APHA24theditionMethod2540C: 2023
16	Total Suspended Solids	IS3025Part17:2022
17	Total hardness as CaCO3	IS3025Part21:2009
18	Arsenic	USEPA200.8:1994
19	Cadmium	USEPA200.8:1994
20	Chromium	USEPA200.8:1994
21	Copper	USEPA200.8:1994
22	Lead	USEPA200.8:1994
23	Manganese	USEPA200.8:1994
24	Mercury	USEPA200.8:1994
25	Zinc	USEPA200.8:1994
26	Salmonella	IS15187:2016
27	Shigella	IS5887Part7:1999RA2022
28	Total Coliform	IS15185:2016
29	Vibrio cholerae	IS5887Part5Sec1:2023
30	Vibrio parahaemolyticus	IS5887Part5Sec1:2023

4.1.3. Stream Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganga UP Stream Water**
Type of Sample	Surface Water
Date of Sampling	**27/03/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**010426080**	**IS 10500 : 2012**	
Sampling Date		**27/03/2026**		
S. No.	**Parameters**	**Ganga Up Stream**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	25.63	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	5.9	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	477.0	NA	NA
7	Fluoride as F(mg/l)	0.26	1.0	1.5
8	Iron as Fe (mg/l)	0.098	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.81	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	45.0	NA	NA
13	Temperature(°C)	26.9	NA	NA
14	Total dissolved solids (mg/l)	258.0	500	2000
15	Total Suspended Solids (mg/l)	13.0	NA	NA
16	Total hardness as CaCO3 (mg/l)	170.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Total Coliform(Per 100ml)	Absent	Absent/100ml	NA
29	Vibrio cholerae(Per 100ml)	Absent	NA	NA
30	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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4.1.4. Stream Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ganga DOWN Stream Water**
Type of Sample	Surface Water
Date of Sampling	**27/03/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**010426081**	**IS 10500 : 2012**	
Sampling Date		**27/03/2026**		
S. No.	**Parameters**	**Ganga Down Stream**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	23.65	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.0	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	459.0	NA	NA
7	Fluoride as F(mg/l)	0.27	1.0	1.5
8	Iron as Fe (mg/l)	0.14	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.61	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	40.0	NA	NA
13	Temperature(°C)	26.9	NA	NA
14	Total dissolved solids (mg/l)	246.0	500	2000
15	Total Suspended Solids (mg/l)	9.0	NA	NA
16	Total hardness as CaCO3 (mg/l)	160.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ: 0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ: 0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Total Coliform(Per 100ml)	Absent	Absent/100ml	NA
29	Vibrio cholerae(Per 100ml)	Absent	NA	NA
30	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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3.3.1. Canal Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Intake Canal Water**
Type of Sample	Surface Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126504**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Intake Canal Water**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	16.33	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.7	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	360.0	NA	NA
7	Fluoride as F(mg/l)	0.27	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.94	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	45.0	NA	NA
13	Temperature(°C)	26.4	NA	NA
14	Total dissolved solids (mg/l)	198.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	110.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ:0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ:0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
25	Salmonella (Per 100ml)	Absent	NA	NA
26	Shigella (Per 100ml)	Absent	NA	NA
27	Vibrio cholerae(Per 100ml)	Absent	NA	NA
28	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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3.1.3. LakeWater Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Samaspur Lake Water**
Type of Sample	Surface Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	IS 17614 (Part -1) : 2025

Sample ID		**270126503**	**IS 10500 : 2012**	
Sampling Date		**24/01/2026**		
S. No.	**Parameters**	**Samaspur Lake Water**	**Acceptable Limits (Max)**	**Permissible Limits (Max)**
1	Biological Oxygen Demand (BOD)@ 27°C For 3 days (mg/l)	BLQ(LOQ:2.0)	NA	NA
2	Chemical Oxygen Demand(COD) (mg/l)	BLQ(LOQ:4.0)	NA	NA
3	Chloride as Cl (mg/l)	30.68	250	1000
4	Cyanide as CN (mg/l)	BLQ(LOQ:0.01)	0.05	No relaxation
5	Dissolved oxygen (mg/l)	6.4	NA	NA
6	Electrical Conductivity at 25°C (µS/cm)	724.0	NA	NA
7	Fluoride as F(mg/l)	0.35	1.0	1.5
8	Iron as Fe (mg/l)	BLQ(LOQ:0.01)	1.0	No relaxation
9	Oil and Grease (mg/l)	BLQ(LOQ:4.0)	NA	NA
10	pH at 25°C	7.62	6.5-8.5	No relaxation
11	Phenolic compounds as C6H5OH (mg/l)	BLQ(LOQ:0.001)	0.001	0.002
12	Sodium as Na (mg/l)	74.0	NA	NA
13	Temperature(°C)	26.2	NA	NA
14	Total dissolved solids (mg/l)	405.0	500	2000
15	Total Suspended Solids (mg/l)	BLQ(LOQ:2.0)	NA	NA
16	Total hardness as CaCO3 (mg/l)	260.0	200	600
Heavy Metals				
17	Arsenic (mg/l)	BLQ (LOQ: 0.005)	0.01	No relaxation
18	Cadmium (mg/l)	BLQ (LOQ: 0.001)	0.003	No relaxation
19	Chromium (mg/l)	BLQ (LOQ: 0.01)	0.05	No relaxation
20	Copper (mg/l)	BLQ (LOQ: 0.01)	0.05	1.5
21	Lead (mg/l)	BLQ (LOQ:0.01)	0.01	No relaxation
22	Manganese (mg/l)	BLQ (LOQ:0.005)	0.1	0.3
23	Mercury (mg/l)	BLQ (LOQ: 0.01)	0.001	No relaxation
24	Zinc (mg/l)	BLQ (LOQ: 0.0005)	5	15
25	Hexavalent Chromium as Cr6+ (mg/l)	BLQ(LOQ:0.01)	NA	NA
Discipline : Biological				
26	Salmonella (Per 100ml)	Absent	NA	NA
27	Shigella (Per 100ml)	Absent	NA	NA
28	Vibrio cholerae(Per 100ml)	Absent	NA	NA
29	Vibrio parahaemolyticus (Per 100ml)	Absent	NA	NA

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

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5. INDUSTRIAL EFFLUENT WATER QUALITY DATA

6 samples were drawn from different locations of project site for analysis of parameters such as followsArsenic, Cadmium, Chromium, Copper, Zinc, BOD, COD, Chloride as Cl-, Dissolved Oxygen, Electrical Conductivity @ 25 ° C, Free Residual Chlorine, Iron as Fe, Oil and grease, pH value @ 25 ° C, Phosphate as PO43-, Total dissolved solids @ 180° C, Total suspended solids @ 105° C, Mercury and Lead.

5.2 Methodology of Sampling and Analysis

The Industrial Effluent Water samples were collected on **24/01/2026** from site with proper observations of appearance, odour, etc. as per the sampling guidelines and submitted to the water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Test Protocol
1	Arsenic	USEPA 200.8 Revision 5.4: 1994
2	Cadmium	USEPA 200.8 Revision 5.4: 1994
3	Chromium	USEPA 200.8 Revision 5.4: 1994
4	Copper	USEPA 200.8 Revision 5.4: 1994
5	Zinc	USEPA 200.8 Revision 5.4: 1994
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	IS 3025 (Part 44) 1993
7	Chemical Oxygen Demand (COD)	IS 3025 (Part 58) 2006
8	Chloride as Cl-	IS 3025 (Part 32) Clause 2 1988
9	Dissolved Oxygen	IS 3025 (Part 38) Clause 4 1989
10	Electrical Conductivity @ 25 ° C	IS 3025(Part 14) 2013
11	Free Residual Chlorine	IS 3025 (Part 26) Clause 5 2021
12	Iron as Fe	IS 3025 (Part 53) Clause 6 2003
13	Oil and grease	IS : 3025 (Part 39) Clause 5 2021
14	pH value @ 25 ° C	IS 3025 (Part 11) Clause 2 2022
15	Phosphate as PO43-	HECS-G/ENV/WW/SOP/006 Issue No.:01 Issue Date:02:07 2020
16	Total dissolved solids @ 180° C	IS 3025 (Part 16) 1984
17	Total suspended solids @ 105° C	IS: 3025 (Part 17) 1984
18	Mercury	USEPA 200.8 Revision 5.4: 1994
19	Lead	USEPA 200.8 Revision 5.4: 1994

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

5.3 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Boiler 1**
Type of Sample	Industrial Effluent Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		**270126495**	**Limits**		
Sampling Date		**24/01/2026**			
S. No.	**Parameters**	**Boiler 1**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	BLQ (LOQ 2.0)	30	350	100
7	Chemical Oxygen Demand (COD)	BLQ (LOQ 4.0)	250	-	-
8	Chloride as Cl-	28.36	1000	1000	600
9	Dissolved Oxygen	7.0	-	-	-
10	Electrical Conductivity @ 25 ° C	92.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	8.49	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	64.0	2100	2100	2100
17	Total suspended solids @ 105° C	3.0	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

5.4 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Boiler 2**
Type of Sample	Industrial Effluent Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		**270126496**	**Limits**		
Sampling Date		**24/01/2026**			
S. No.	**Parameters**	**Boiler 2**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	BLQ (LOQ 2.0)	30	350	100
7	Chemical Oxygen Demand (COD)	BLQ (LOQ 4.0)	250	-	-
8	Chloride as Cl-	36.24	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	74.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	8.31	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	56.0	2100	2100	2100
17	Total suspended solids @ 105° C	8.0	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

5.5 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Boiler 3**
Type of Sample	Industrial Effluent Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		**270126497**	**Limits**		
Sampling Date		**24/01/2026**			
S. No.	**Parameters**	**Boiler 3**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	BLQ (LOQ 2.0)	30	350	100
7	Chemical Oxygen Demand (COD)	BLQ (LOQ 4.0)	250	-	-
8	Chloride as Cl-	19.28	1000	1000	600
9	Dissolved Oxygen	6.8	-	-	-
10	Electrical Conductivity @ 25 ° C	134.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	8.47	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	94.0	2100	2100	2100
17	Total suspended solids @ 105° C	3.0	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

5.6 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Boiler 4**
Type of Sample	Industrial Effluent Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		**270126498**	**Limits**		
Sampling Date		**24/01/2026**			
S. No.	**Parameters**	**Boiler 4**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	BLQ (LOQ 2.0)	30	350	100
7	Chemical Oxygen Demand (COD)	BLQ (LOQ 4.0)	250	-	-
8	Chloride as Cl-	26.86	1000	1000	600
9	Dissolved Oxygen	7.2	-	-	-
10	Electrical Conductivity @ 25 ° C	98.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	8.57	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	68.0	2100	2100	2100
17	Total suspended solids @ 105° C	2.0	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

5.7 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**DM Plant Effluent Water**
Type of Sample	Industrial Effluent Water
Date of Sampling	**24/01/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		**270126499**	**Limits**		
Sampling Date		**24/01/2026**			
S. No.	**Parameters**	**DM Plant Effluent Water**	**Inland Surface water**	**Public Sewer**	**Land for Irrigation**
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	6.0	30	350	100
7	Chemical Oxygen Demand (COD)	32.0	250	-	-
8	Chloride as Cl-	394.44	1000	1000	600
9	Dissolved Oxygen	6.7	-	-	-
10	Electrical Conductivity @ 25 ° C	3284.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	8.17	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	2210.0	2100	2100	2100
17	Total suspended solids @ 105° C	3.0	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

5.8 Industrial Effluent Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**CT Blowdown Stage # 4**
Type of Sample	Industrial Effluent Water
Date of Sampling	24/01/2026
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID		270126500	Limits		
Sampling Date		24/01/2026			
S. No.	Parameters	CT Blowdown Stage # 4	Inland Surface water	Public Sewer	Land for Irrigation
1	Arsenic	BLQ (LOQ: 0.005)	0.2	0.2	0.2
2	Cadmium	BLQ (LOQ: 0.01)	2	1	1
3	Chromium	BLQ (LOQ: 0.01)	2	2	2
4	Copper	BLQ (LOQ: 0.1)	3	3	3
5	Zinc	BLQ (LOQ: 0.1)	1	1.5	1.5
6	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	BLQ (LOQ 2.0)	30	350	100
7	Chemical Oxygen Demand (COD)	BLQ (LOQ 4.0)	250	-	-
8	Chloride as Cl-	46.74	1000	1000	600
9	Dissolved Oxygen	7.1	-	-	-
10	Electrical Conductivity @ 25 ° C	658.0	-	-	-
11	Free Residual Chlorine	BLQ (LOQ 0.1)	1	-	-
12	Iron as Fe	BLQ (LOQ 0.02)	-	-	-
13	Oil and grease	BLQ (LOQ 4.0)	10	20	10
14	pH value @ 25 ° C	7.59	5.5-9	5.5-9	5.5-9
15	Phosphate as PO43-	BLQ (LOQ 0.2)	5	-	-
16	Total dissolved solids @ 180° C	440.0	2100	2100	2100
17	Total suspended solids @ 105° C	BLQ (LOQ 2.0)	100	600	200
18	Mercury	BLQ (LOQ: 0.01)	0.01	0.01	0.01
19	Lead	BLQ (LOQ: 0.1)	0.1	1	1

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

THIRD PARTY ENVIRONMENT MONITORING

SEVENTEENTH VISIT REPORT

PO: Purchase Order No. : 4000332261-057-1019
Date : 30.04.2024

Period: 23/02/2026 to 26/02/2026

AT

NTPC UNCHAHAR

Submitted by

Hubert Enviro Care Systems Limited

(An ISO 9001:2008 Company)
(Accredited by NABL)

A-21, III Phase Thiru Vi Ka Industrial Estae,
Guindy, Chennai–600 032
Phone: (044)43635555 Fax: (044)42985500
Email-lab@hecs.in

6. SEWAGE WATER QUALITY DATA

2 samples were drawn from different locations of project site for analysis of parameters such as follows, Ammonical Nitrogen as NH3-N. Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C, Chemical Oxygen Demand (COD), pH value @ 25 ° C, Phosphorus as P, Temperature, Total dissolved solids @ 180° C, Total Nitrogen as N, Total suspended solids @ 105° C, Faecal Coliform

6.2 Methodology of Sampling and Analysis

The Sewage Effluent Water samples were collected on **23/02/2026** site with proper observations of appearance, odour, etc. as per the sampling guidelines and submitted to the water laboratory within the stipulated period.The brief methodology of parameters is given below for reference.

S. No.	Parameters	Test Protocol
1	Ammonical Nitrogen as NH3-N	IS 3025 (Part 34) Clause 2.5 1988
2	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	IS 3025 (Part 44) 1993
3	Chemical Oxygen Demand (COD)	IS 3025 (Part 58) 2006
4	pH value @ 25 ° C	IS 3025 (Part 11) Clause 2 2022
5	Phosphorus as P	APHA 23 rdEdn. 4500 P-B,D 2017
6	Temperature	IS:3025 (Part 09)1984
7	Total dissolved solids @ 180° C	IS 3025 (Part 16) 1984
8	Total Nitrogen as N	HECS-G/ENV/WW/SOP/004 Issue No.:01 Issue Date:02:07 1988
9	Total suspended solids @ 105° C	IS: 3025 (Part 17) 1984
10	Faecal Coliform	APHA 24th Edition Part 9221

6.3 Sewage Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**STP Inlet**
Type of Sample	Sewage Water
Date of Sampling	**23/02/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID			**270226191, 270226193**	**Limits (As per CPCB)**	
Sampling Date			**23/02/2026**		
S. No.	**Parameters**	**Unit**	**STP Inlet**	**Metropolitans Cities**	**Other**
1	Ammonical Nitrogen as NH3-N	mg/l	7.19	-	-
2	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	mg/l	28.0	20	30
3	Chemical Oxygen Demand (COD)	mg/l	96.0	-	-
4	pH value @ 25 ° C	-	7.38	6.5-9.0	6.5-9.0
5	Phosphorus as P	mg/l	BLQ (LOQ 0.1)	-	-
6	Temperature	°C	27.9	-	-
7	Total dissolved solids @ 180° C	mg/l	712.0	-	-
8	Total Nitrogen as N	mg/l	13.49	-	-
9	Total suspended solids @ 105° C	mg/l	48.0	<50	<100
10	Faecal Coliform	MPN/100ml	1600	<1000	<1000

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre, MPN-Most Probable Number.

End of Report

6.4 Sewage Water Quality – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**STPOutlet**
Type of Sample	Sewage Water
Date of Sampling	**23/02/2026**
Test Parameters	As per Scope of Work
Sampling Method	**IS 17614 (Part -10) : 2021**

Sample ID			**270226192, 270226194**	**Limits (As per CPCB)**	
Sampling Date			**23/02/2026**		
S. No.	**Parameters**	**Unit**	**STP Outlet**	**Metropolitans Cities**	**Other**
1	Ammonical Nitrogen as NH3-N	mg/l	0.12	-	-
2	Bio-Chemical Oxygen Demand(BOD) 3days @27 ° C	mg/l	4.0	20	30
3	Chemical Oxygen Demand (COD)	mg/l	24.0		
4	pH value @ 25 ° C	-	7.12	6.5-9.0	6.5-9.0
5	Phosphorus as P	mg/l	BLQ (LOQ 0.1)	-	-
6	Temperature	°C	27.2	-	-
7	Total dissolved solids @ 180° C	mg/l	390.0	-	-
8	Total Nitrogen as N	mg/l	0.94	-	-
9	Total suspended solids @ 105° C	mg/l	4.0	<50	<100
10	Faecal Coliform	MPN/100ml	94	<1000	<1000

Note:- BLQ : Below the Limit of Quantification, LOQ: Limit of Quantification, mg/l: milligram per Litre, MPN-Most Probable Number.

Remarks:-STP Outlet as above parameters meets CPCB Standards.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

Speed Post

Annexure-25

No.4(236)/CGWB/NR/S&I/04 – 1940
Government of India
Central Ground Water Board,N.R.,
Bhujal Bhawan Sector-B, ,
Sitapur Road Yojana,
Lucknow-226021.

Dated: 02 SEP 2004

To,

Sh. S.K.Singh,
Dy. General Manager (AMG),
Feroz Gandhi Unchahar Thermal Power Project,
N.T.P.C., Unchahar-229406,
District Raibareli (U.P).

Sub: Rain Water Harvesting at NTPC Unchahar Stage-III.

Sir,

Kindly refer to your letter No. UCR/AMG/Stage-III-MOEF Clearance dated 09.6.04 and discussions held during your visit to this office in the month of August, 2004 in connection with feasibility of rain water harvesting at NTPC Unchahar Stage-III.

This office has also received letter no. UCR/EMG/E-8C dated 16.8.2004 wherein it has been requested to intimate whether rain water harvesting for NTPC Unchahar Stage-III is required or not.

It is seen from the letter dated 16.8.2004 that ground water level in a dug well existing in Bhaktin Purwa (Pure Metai) village and located at a distance of 100 m approximately towards south from boundary wall of township of Unchahar N.T.P.C. rests at 4.90 metres below ground level. In view of above depth to water level in Unchahar NTPC township rain water harvesting is not required at present.

Yours faithfully,

(ABRAR HUSAIN) 02/9/04
Scientist 'D'
for Regional Director

Copy to:

Sh. T. R. Verma, Manager (EMG), Feroz Gandhi Unchahar Thermal Power Project, N.T.P.C., Unchahar-229406, District Raibareli (U.P) with reference to his letters referred to above.

(ABRAR HUSAIN)
Scientist 'D'
for Regional Director

Scanned with OKEN Scanner

Annexure-26

CONTOUR STUDY OF GROUND WATER AND RECHARGE AT NTPC UNCHAHAR AND ITS RELATED AREA

Sponsor: NTPC Limited, P.O. Unchahar, Raebareli, U.P.

Submitted by

Dr. Ashish Pandey, Professor, IIT Roorkee (PI)
Dr. Sanjay Tignath, External Consultant
Dr. Umesh C. Chaube, External Consultant

Department of Water Resources Development & Management
Indian Institute of Technology Roorkee
Roorkee 247 667, Uttarakhand, India
E-mail: ashish.pandey@wr.iitr.ac.in

July, 2022

IITR Project No. WRC/6007/21-22

CONTOUR STUDY OF GROUND WATER AND RECHARGE AT NTPC UNCHAHAR AND ITS RELATED AREA

Final Report

July 2022

Submitted to

NTPC Limited, P.O. Unchahar, Raebareli, U.P.

Submitted by

Dr. Ashish Pandey, Professor, IIT Roorkee (PI)
Dr. Sanjay Tignath, External Consultant
Dr. Umesh C. Chaube, External Consultant

Department of Water Resources Development & Management
Indian Institute of Technology Roorkee
Roorkee 247667, India
E-mail: ashish.pandey@wr.iitr.ac.in

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EXECUTIVE SUMMARY

The groundwater level contours and flow directions in the study area (plant and township area) of Feroze Gandhi Unchahar Thermal Power Project (FGUTPP) have been studied explicitly in the pre-monsoon period to evaluate the lowest status of groundwater and to suggest a groundwater recharge plan if needed.

The subsurface aquifers/lithological layering has been studied using the Vertical Electrical Sounding method (VES-Resistivity method) and observation of groundwater level in wells and piezometers(existing and newly constructed for this study).

The VES results indicate that the aquifer conditions exist close to the ground surface from a depth of about 1.75 m, and the aquifer conditions continue to exist to over 18m deep; hence the first aquifer has thickness of about 16.5 m.

The ground surface of the FGUTPP area is very gently sloping in the south direction, and there is only a two-meter elevation difference in the direction from north to south. Groundwater maps (depth of GW, RL groundwater contour map, and flow direction map) produced from the piezometer observations reveal that the generally high level of groundwater or the recharging zone is in the northwest and near the north boundary of the plant area. Groundwater table slopes towards south and south-west with linear flow direction along the western boundary and curvilinear flow direction along the central and eastern half of the area. Although, the general direction of groundwater flow is southward, there are remarkable three lows as indicated by closed contours of lower values, showing depression in the groundwater table. The three significant lows are i) near gate number 2 residential area, ii) near the stadium and the park/playground, and iii) in the central part of the southern half of the residential area (south of the central road from gate number 2).

These closed lows (as indicated by contours of lower water level values) show the deeper aquifer's recharging. Therefore, it cannot be said to be flowing away from the area in those parts. However, it is noteworthy that the groundwater levels are found within 5m depth even in the pre-monsoon month. That is quite a safe condition of existing groundwater table.

It is concluded that the plant area and township area do not require an intense groundwater recharge system as the groundwater table is within a safe limit. However, some conservative measures are recommended as discussed below.

Ground Water Recharge in Plant Area: The north-western and northern side near the IT building area and north of the old administration block is the possible recharging area. Groundwater levels are close to the surface; therefore, the plant area does not require additional recharging structures.

There is open space on the railway trackside along the boundary wall. Soak pits have been suggested along the eastern boundary wall.

Ground Water Recharge in Residential Area: The open space in township area is suitable for developing a groundwater recharge system. Two types of simple recharge structures are suggested.

a. The Beach Volley Ball Play Ground (BVB PG) type structure: Four BVB PG type recharge structures(size 20mx10m) are suggested in the existing playgrounds/open space. This type of recharge structure does not render the land out of any other use. Further, the recharge area(s) can be used for sand sports. These structures have two layers, the upper half meter of coarse sand and the lower 1.5m / 1m shaft of gravel.
b. Soak pits: Smaller in dimensions, these structures contain three layers, the upper, middle, and the lower shaft consisting of gravel, boulder, and gravel respectively. Thirty soak pits may be constructed in the first stage. The soak pits suggested near gate no. 2 residential area may be taken up first.

The recharge structures may be constructed in two or three stages in the pre-monsoon month when the water table is at its lowest. In other months, at places, it may not be possible to dig up to 3m depth due to the water table rising to less than 3m depth.

Piezometers have been constructed as part of this study. It is recommended to monitor ground water level in existing and newly constructed piezometers on monthly basis and if that is not possible then at least in the two pre monsoon months(first week of May and June) and two post monsoon season months((first week of October and November). The monitoring should be carried out over next five years period.

CHAPTER 1
INTRODUCTION

1.1 FEROZE GANDHI UNCHAHAR THERMAL POWER PROJECT (FGUTPP)

Existing Power Plant: Feroze Gandhi Unchahar Thermal Power Project (FGUTPP), a coal-based plant is located at Unchahar in Rae Bareli district of Uttar Pradesh. The FGUTPP consists of four stages. Stage-IV (1×500 MW) is located within the existing plant premises of FGUTPP stage-I, II & III. The present capacity of all the four stages of FGUTPP is 1550 MW. The total area acquired for the existing FGUTPP plant is about 2203 acres (891.55 hectares). The ash pond and township facilities are common for all the four stages of FGUTPP.

1.2 SCOPE OF STUDY

M/s NTPC Limited has issued a Purchase Order (P.O. number 4000252123-068-1006) to IIT Roorkee for the contour study of groundwater and recharge at NTPC Unchahar for the Plant area and Township area. Based on the subsequent discussion, the study period has been extended upto July,2022.

Following is the scope of the study as specified in the Purchase Order.

Study area: Area of study is the NTPC Unchahar plant area and township

I-Field survey and data collection in the study area using

a). Geophysical survey,

b). Water level observation in existing & proposed wells (Pre-monsoon April/May 2022)

c). Piezometer data (Pre-monsoon April/May 2022)

II-Report Preparation

d) Analysis of data and preparation of contour map of groundwater levels based on field observations and other available data

e) Preparation of recharge plan as required

1.3 LOCATION OF THE FGUTPP

The FGUTPP is situated at geographical coordinates with a latitude of 25o54’50”N and a longitude of 81^{o}19’50”E, respectively. Mustafabad town is located at a distance of about 3-km from the plant. Unchahar railway station on the Allahabad-Rae Bareli broad gauge (BG)

section of Northern Railway (NR) is 2 km away. Figure 1a shows the index map of the Feroze Gandhi Unchahar Thermal Power Project (FGUTPP).

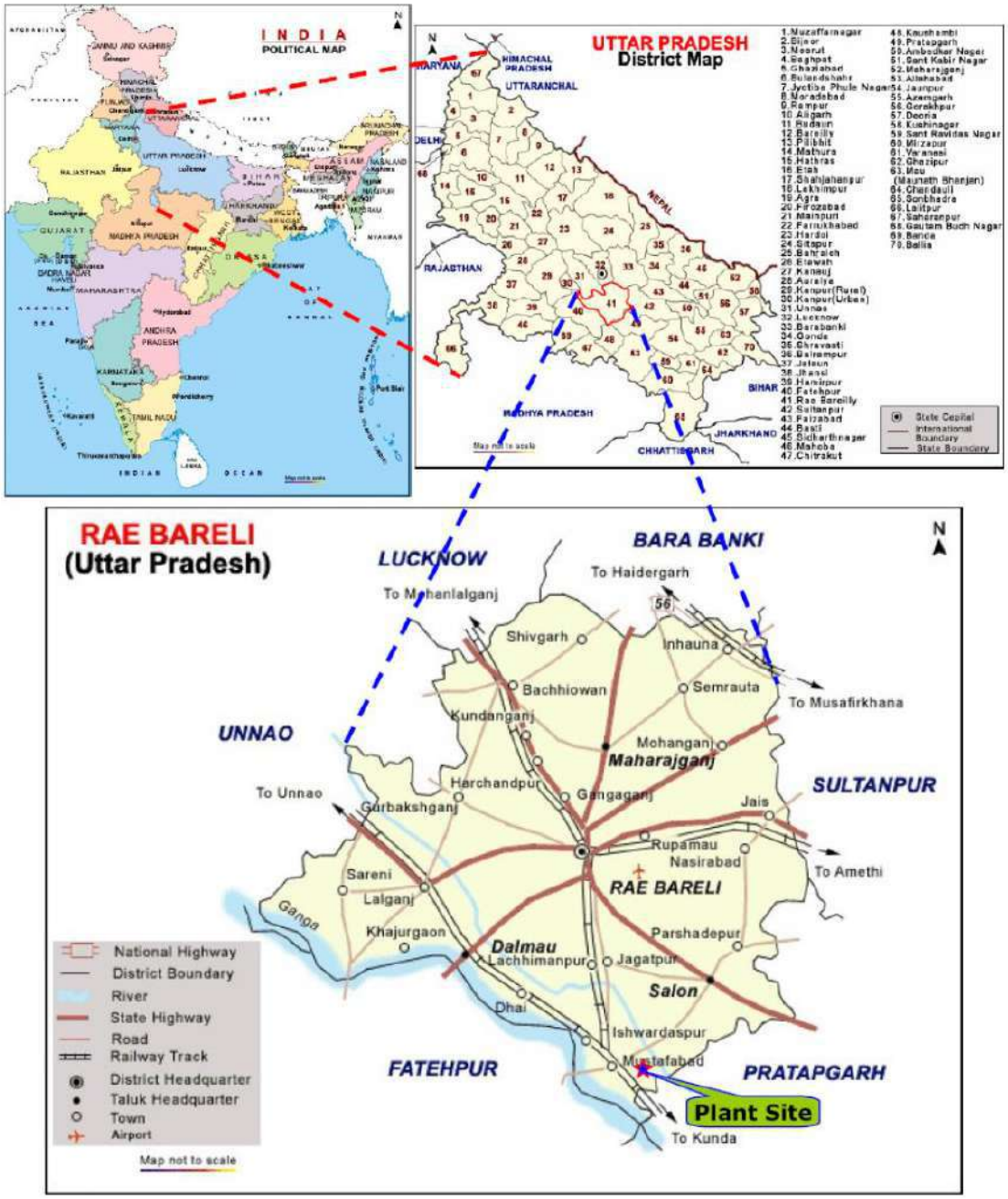

Figure 1.1a. Index map of the Feroze Gandhi Unchahar Thermal Power Project (FGUTPP)

1.4 LAYOUT PLAN OF STUDY AREA

The present study area consists of the NTPC Unchahar plant area and township. Figures 1b and 1c show the layout plan of the plant area and the township area.

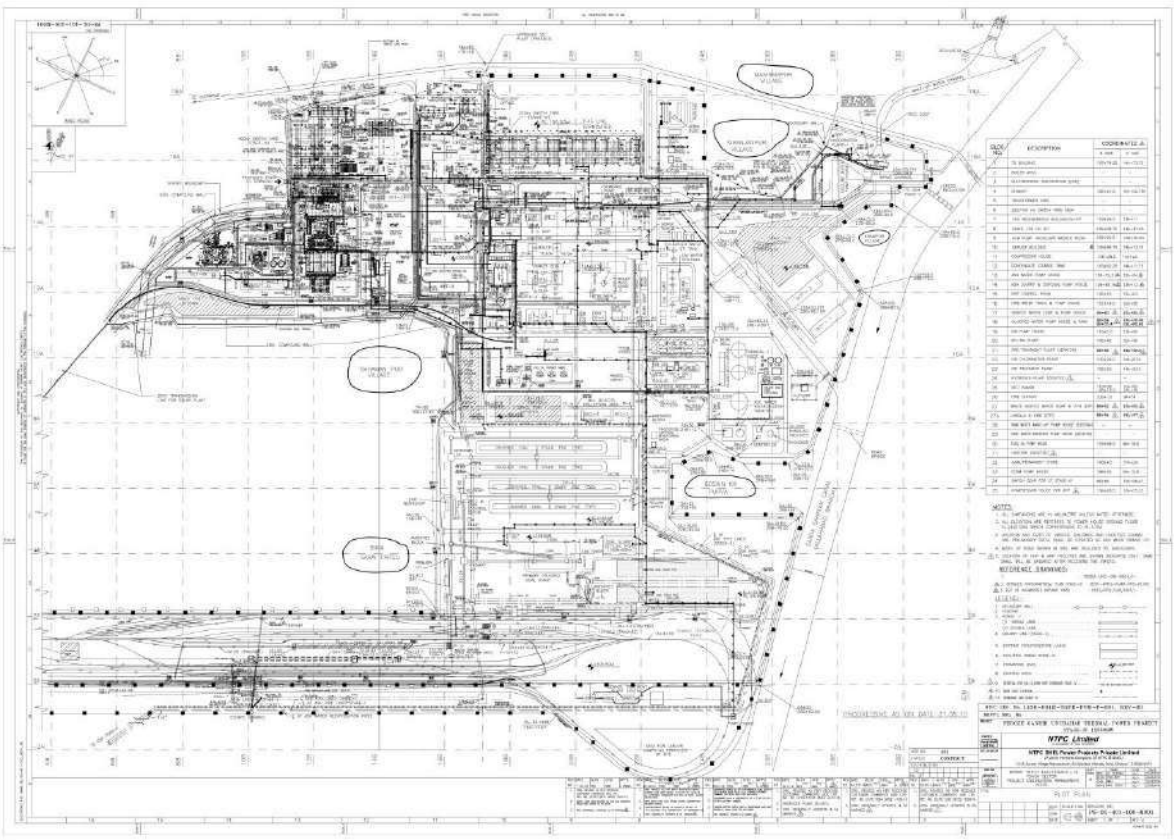

Figure 1.1b. Layout map of the plant of FGUTPP Unchahar

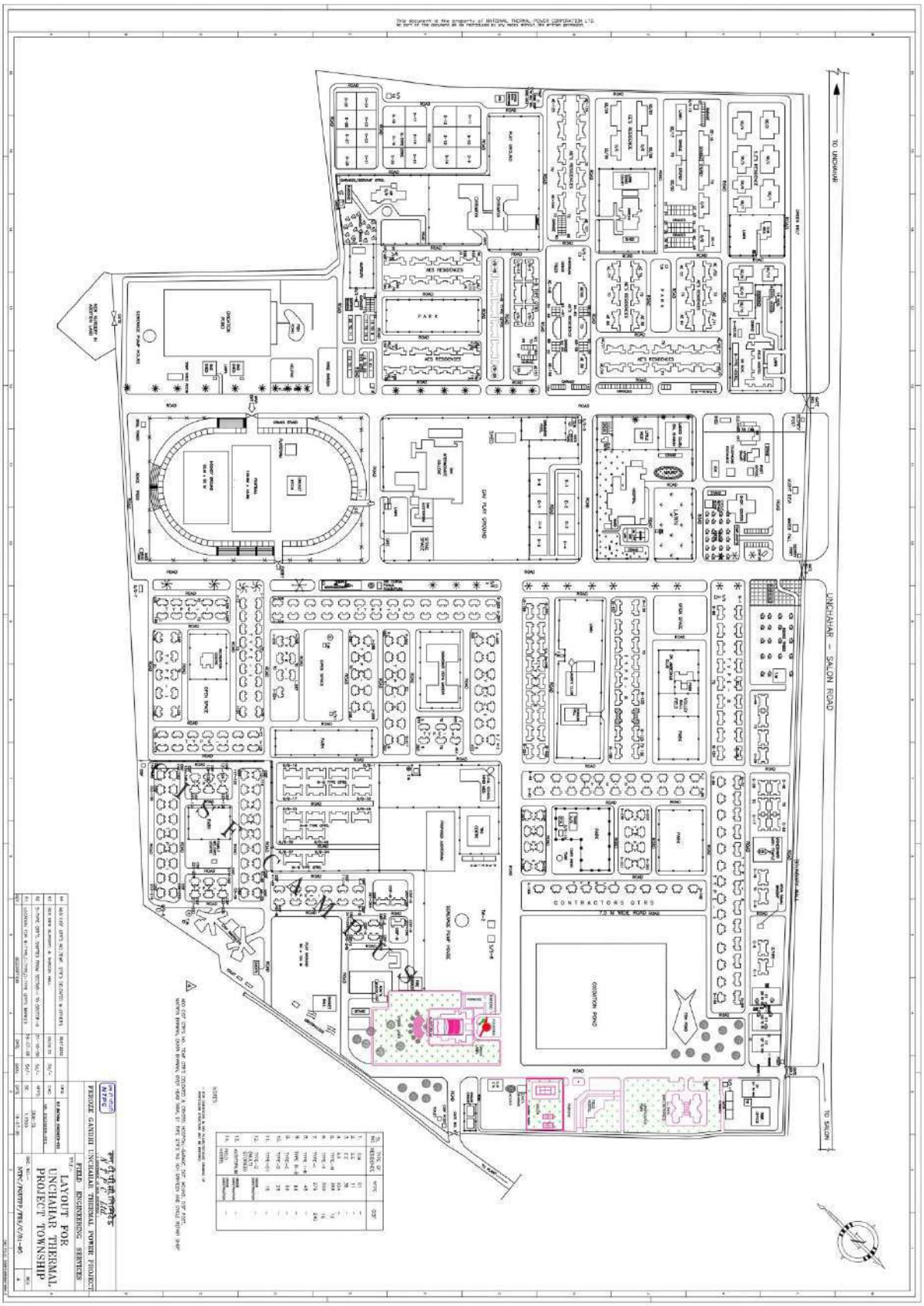

Figure 1.1c. Layout map of the township of FGUTPP Unchahar

CHAPTER 2

STUDY AREA CHARACTERISTICS

2.1 PHYSICAL CHARACTERISTICS OF VICINITY AREA

Feroze Gandhi Unchahar Thermal Power Plant is located at Unchahar in Raebareli district in the Indian state of Uttar Pradesh. Unchahar literally means high land (*uncha* means higher, *and har* means grazing land). The average elevation of the study area is 109m from MSL. The plant and township area is located at a higher elevation than the surrounding area. Therefore plants and townships do not have the problem of flooding. There is no natural drain passing through the plant area.

Ahiyari is a natural drain in the vicinity that carries municipal and agricultural effluents from a large area, including storm runoff and waste water from the FGUTPP plant and the township. The drains carrying wastewater from township and plant areas fall into Ahiyarinala near the Railway bridge. After crossing the railway bridge, the Ahiyarinala flows through Unchahar town in the south direction to join the Ganga River.

The area receives an average rainfall of about 750 - 1150mm (Source: India Meteorological Department). The climate is sub-humid, and it is marked by a hot summer from March to early June with a large variation of temperature and it is followed by the rainy season starting from June and continuing up to September. About 80% of rainfall is received during the rainy season. Surplus water during the monsoon period is available for deep percolation into groundwater. The variation in rainfall data of the Raebareli district from 2010 to 2021 is shown in Figure 2.1.

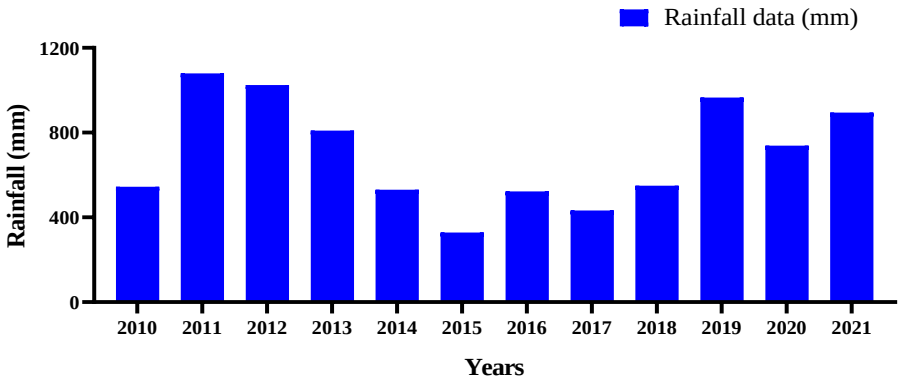

Figure 2.1: Graph of the variation of rainfall data of Raebareli district from 2010 to 2021

2.2 GEOLOGY AND GEOMORPHOLOGY OF THE VICINITY AREA

The area belongs to the great Gangetic alluviums, and the aggradational processes of flood plains control the topography at play. The area of Unchahar represents features typical of flood plains geomorphology.

The prominent geomorphic units identified in the region are mostly quaternary older-flood plain or intermediate surfaces, characterised by a flat gently sloping surface with break in slope at places and with fluvial land forms such as oxbow lakes, cut off meanders, break-in

slopes, and minor meander scrolls. The topsoil layer in most parts of the study area consists of leveled material fill. The Ganges River flows about eight to ten km south of the area.

2.3 HYDROGEOLOGY OF THE VICINITY AREA

Hydrogeologically, the area lacks any hard rock exposures, and the thick pile of alluviums rests on the granitic basement of Bundel Khand granite which lies deep down at a depth of nearly 500m or more. The thickness of alluvium is more than 600 m in the northern part as per C.G.W.B. exploratory drilling data, whereas, in the southern part, the thickness of alluvial sediment is about 487.00 mbgl, where bedrock (Bundel Khand Granite) was encountered at 487.80 mbgl at Sultanpur Janaul.

The area has fairly good Hydrogeological conditions. The flatness of the area contributes a larger contact time to rainwater before getting run-off into the Ganges. The relict drainages are good absorbers of rainwater and act as recharge structures, or so to say, soaking trenches with a natural filter of sand material. The aquifers are fundamentally sand-rich alluvial horizons below sandy-silty layers.

The upper layer of alluvium is composed of sandy loam, silty clays, and clays in varying proportions. Minor sand beds are also seen and the thickness of this zone ranges from 5 to 16 m on average. Kankar is interspersed in clay. Kankar beds, at times forming thick layers are also present at different depths. The kankar beds can be seen in the ravinous area of the Ganga and Sai rivers.

Older alluvium occupies a large part of the district in topographic high, which does not get flooded, whereas the younger alluvium occupies the area along the river courses forming their food plain and terraces.

CHAPTER 3
METHODOLOGY AND FIELDWORK

The study was carried out using i) an electrical resistivity survey and ii) observation of groundwater levels. Seven sites were selected for the electrical resistivity survey. As part of this study, five piezometers/observation wells were constructed in the study area. In addition, two existing piezometer/observation wells were also utilized for the observation of groundwater levels. Thus, a total of seven observation sites for groundwater levels were used to study the slope and pattern of the groundwater contours.

3.1 VERTICAL ELECTRICAL SOUNDING (VES) SURVEY

The sub-surface geology and hydrology of the region have been studied using the Vertical Electrical Sounding (VES) survey. VES is based on the electrical conductivity or resistivity of the medium (rock or soil horizons). For VES, the Schlumberger array method is used, where four electrodes are placed in a line around a common midpoint. Furthermore, the electrode spacing interval is changed while maintaining a fixed location for the center of the electrode spread; consequentially, in a general way, as the electrode spacing increases, the depth of investigation increases. The interpretation of the resistivity sounding dataset results is demonstrated in one-dimensional (1-D) form that includes resistivity and thicknesses of the subsurface layers. To interpret the data from such a survey, it is normally assumed that the subsurface sediments consist of horizontal layers, and the method does not take into account lateral changes in the layer resistivity. The limitation of the method to include the effect of such lateral changes can be compensated by comparing the results of the other points to decipher the continuity of behavior laterally. Thus, the results are interpreted for the layer resistivity and/or thickness. In resistivity profiling, the location of the spread is changed while maintaining a fixed electrode spacing interval, and the entire array is moved along a straight line. This does give us information about lateral changes in subsurface resistivity related to each median depth of investigation. In this case, it is assumed that resistivity does not change in the perpendicular direction to the survey line.

The measured data by using the Schlumberger is converted to apparent resistivity by applying equation (3.1):

$$\rho_a = \frac{\pi c^2}{b}\left[1 - \frac{b^2}{4c^2}\right]R \tag{3.1}$$

Where ρ_a, R, a, b and c represent apparent resistivity, measured resistance, dipole spacing, potential electrode spacing, and half of the current electrode spacing.

3.2 GROUNDWATER CONTOUR MAP GENERATION

Furthermore, for the validation of VES data and direct observation of the groundwater levels, the piezometers/observation wells were dug. The measurement of the ground water table from these observation wells was carried out with the help of installed piezometers. After the measurement, the data was geo-tagged in a GIS environment, and a spatial map for the area was prepared (Figure 3.1).

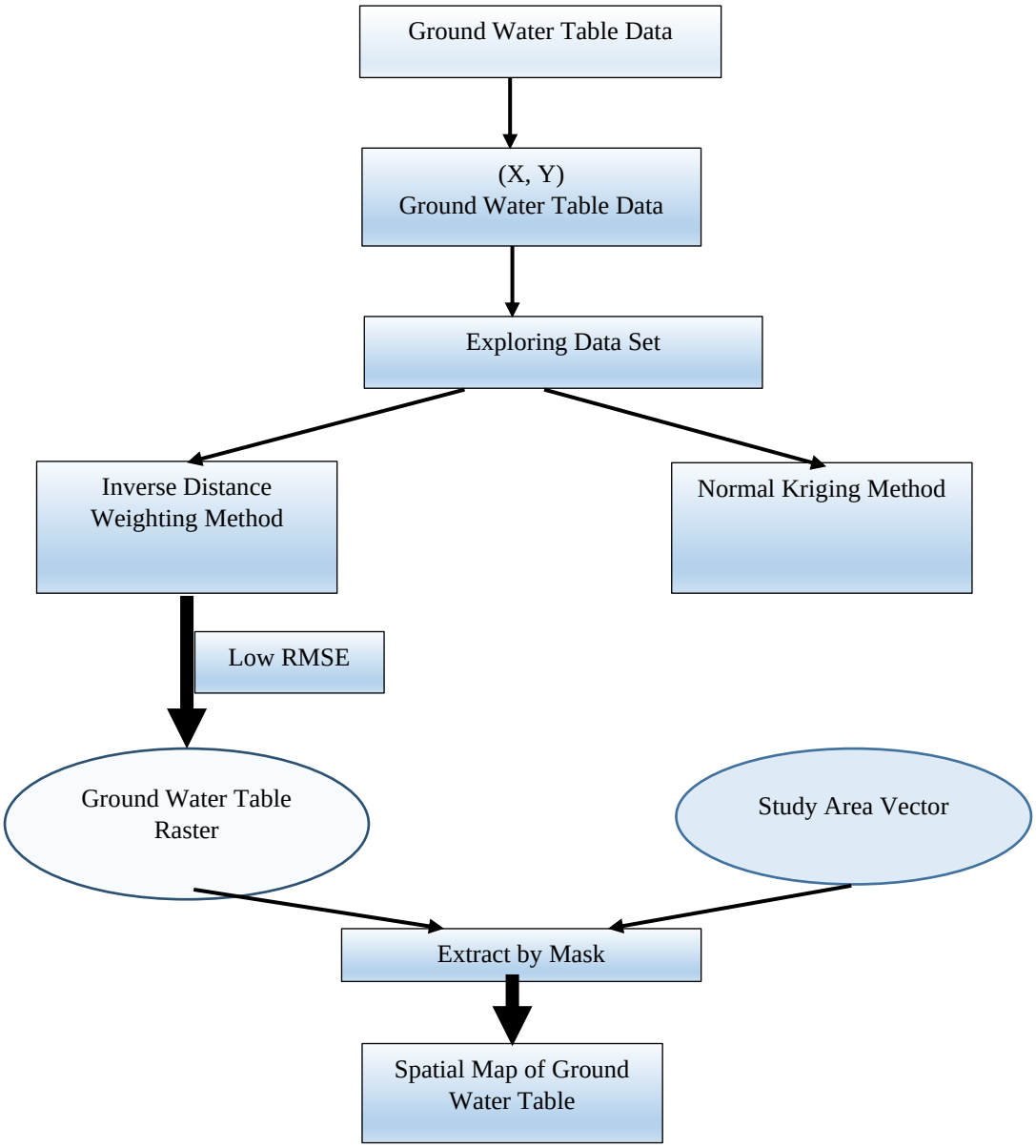

Figure 3.1 Methodological flow chart of spatial mapping: The Root Mean Square Error (RMSE) for IDW method was low and adopted for spatial mapping of GW table maps

3.3 LOCATION OF THE FIELD EXPERIMENTATION SITES FOR VES

The Vertical Electrical Sounding (VES) or resistivity experimentation to determine the subsurface layers and groundwater conditions was carried out at seven locations after a detailed survey to select the suitable points (Table 3.1). Figure 3.2 shows the location of these sites.

Table 3.1 Location of Vertical Electrical Sounding (VES) survey

Serial Number	VES points
VES-1	At the stadium
VES-2	At DAV school playground
VES-3	At the SGM school playground
VES-4	Near Railway crossing (inside plant area)
VES-5	Near IT building parking stand (inside plant area)
VES-6	Near Gate No. 5 in the township
VES-7	Behind IT building parking stand (inside plant area)

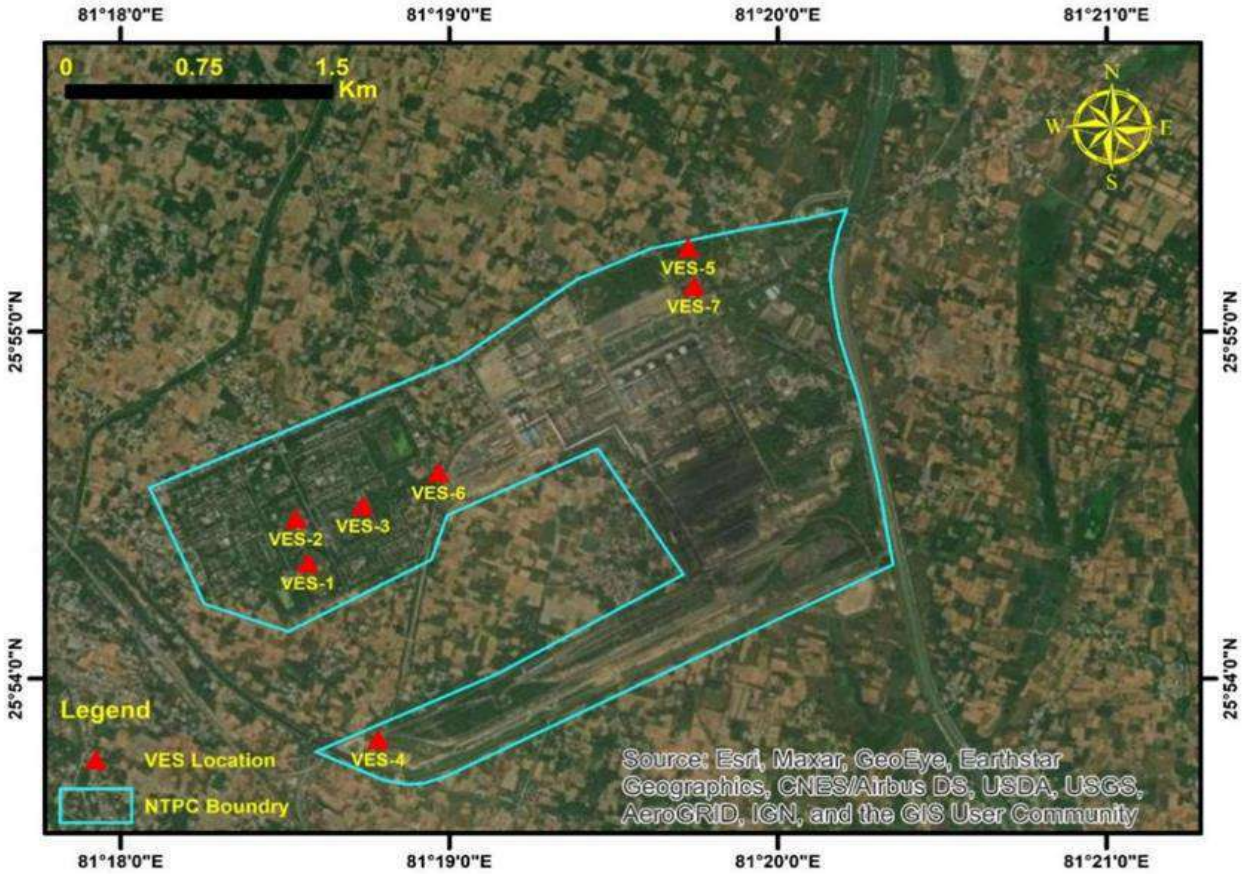

Figure 3.2 VES sites in the study area

3.4 LOCATION OF PIEZOMETERS/OBSERVATION WELLS

Based on a geological survey in the plant area and nearby surrounding area, points for drilling piezometric observation sites were decided. Two piezometers already existed in the study of the plant (Table 3.2). Figure 3.3 shows the location of the observation well/piezometers.

Table 3.2 Location of groundwater observation well/piezometers

Serial Number	Ground Water Observation Well Location
W1	Near Gate No. 2 in the township (parking stand)
W2	Near stadium
W3	Near Vidyut Upkenders No. 12 (Railway Gate No. 4)
W4	Near CISF parade ground
W5	Near IT building parking stand (inside plant area)
W6	Near Gate No. 5 in the township
W7	Behind IT building parking stand (inside plant area)

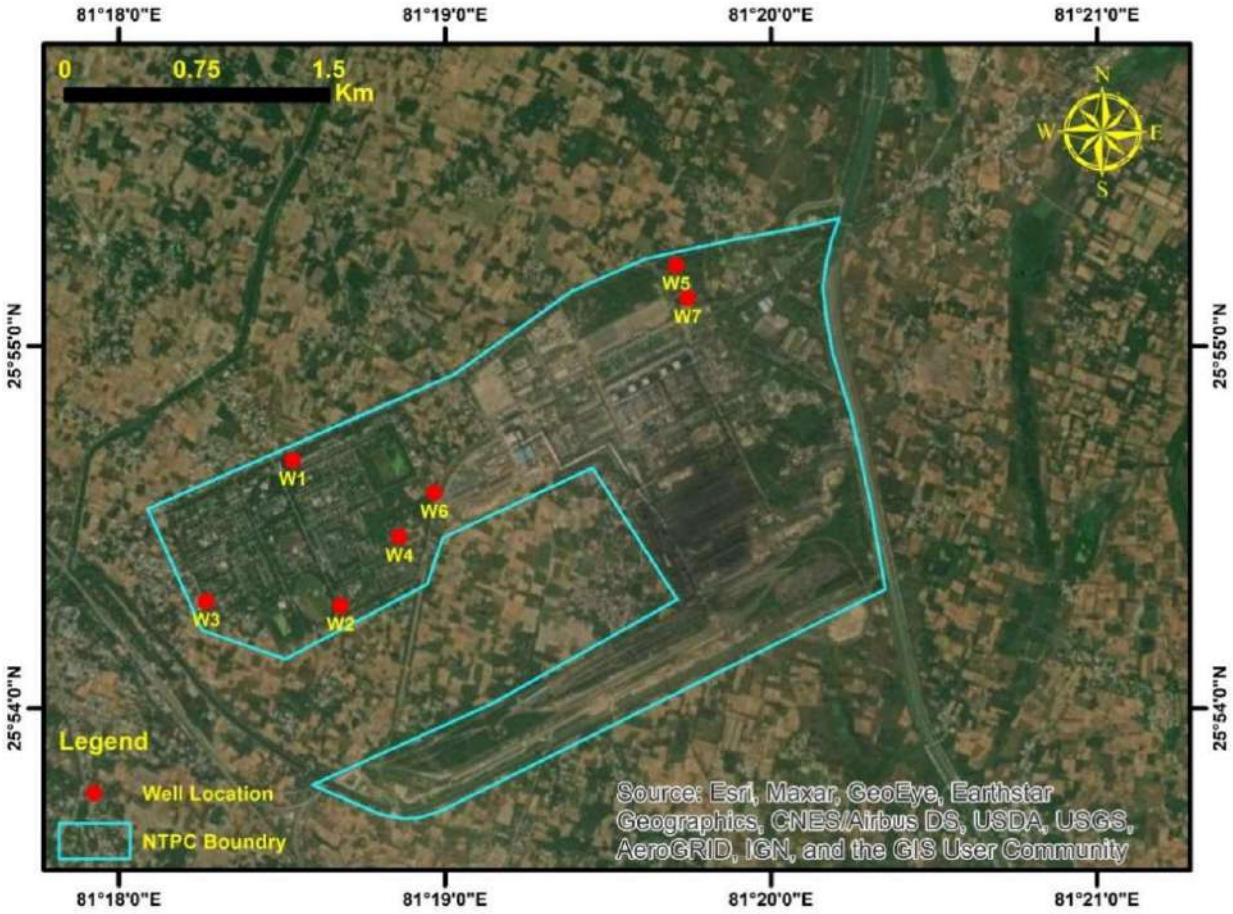

Figure 3.3 Ground water table observation well sites in the study area

Figure 3.4 Field photograph during resistivity survey at SGM school playground

CHAPTER 4

RESULTS OF VERTICAL ELECTRICAL RESISTIVITY SURVEY

4.1 ANALYSIS OF VERTICAL ELECTRICAL RESISTIVITY SURVEY (VES) DATA

The data collected from the VES survey effectively explains the sub-surface (Lithology/geology) and hydrological condition of the area. The interpretation of the VES data was carried out with the help of prior literature and the map of the area, and field survey in and around the plant area for geological and geomorphological observations. The 1-D plot of the Vertical Electrical Sounding (VES) is given in Figures 4.1 to 4.7. It shows that the soils horizons in the study area are mostly composed of silty clay, silty clay with sand, silty sand, and silty sand with clay in the section of up to 16-18m.

Descriptions of the Vertical Electrical Soundings (VES) for locations 1 to 7 are given below in terms of their resistivity in Ohm/m, indicated soil type (corroborated by field check) and groundwater aquifer:

VES-1 has portrayed a section of about 20m, where mainly two layers exist. The first layer is silty clay from the surface up to 1.7m depth, and the second layer starts from the depth of 1.7m up to 20m, composed of silty clay with sand (Figure 4.1). This layer has a low resistivity value of 18 ohm/m and shows an aquifer property.

VES-2 represents a section of three layers. At the top, there is a 2.5m thick silty clay with sand layer, followed by silty clay up to 6.3m and another layer of silty clay with sand (Figure 4.2). In this location, both top and bottom layers of silty clay with sand show 14 and 17 ohm/m resistivity value show an aquifer property.

In location 3 VES shows six layers horizon, silty sand to 1.7, followed by two very low resistive layers of 6 and 3 ohm/m and a very high resistive layer of 9999 ohm/m up to 7.9m (Figure 4.3). This is some localized anomaly that does not extend much beyond the sounding point, as confirmed by other sounding results. Below this, there are two layers of silty sand and silty sand with clay at 7.9 and 13.3m depth. At this location, the top three layers reflect aquifer property composed of silty sand and two lower resistive layers beneath the anomaly layer.

VES-4 suggests that the section up to 16m in the sub-surface is consists of silty sand of 2m thickness, followed by two layers of silty sand with cay of varied resistivity of 26 and 17 ohm/m, at a depth of 2m and 2.9m respectively (Figure 4.4). The low resistivity value of both silty sand with clay layer below 2 m depth shows an aquifer property in this section.

VES-5 portrays a layered structure of two types of soil horizons of silty sand with clay and silty sand of varied thickness and resistivity properties (Figure 4.5). Like VES-5, VES-6 also represents the intercalation of a 7.7m thick silty sand layer between two silty sand with

clay layers of 1.5 and 4.1m thick, followed by a low resistive layer at the bottom (Figure 4.6). In both the section of VES-5 and VES-6, the top layer of silty sand with clay shows an enriched water table condition.

VES-7 shows a section of seven layers, loam or mud of 1.3m thickness followed by silty sand with clay, two silty clay with sand layers, a 2.4m thick silty sand with clay layer, and at the bottom, there are two low resistive layers at 10m and 13.3m depth (Figure 4.7). At this section silty sand with clay and silty clay with sand below 1.3m depth possible forms first level aquifer.

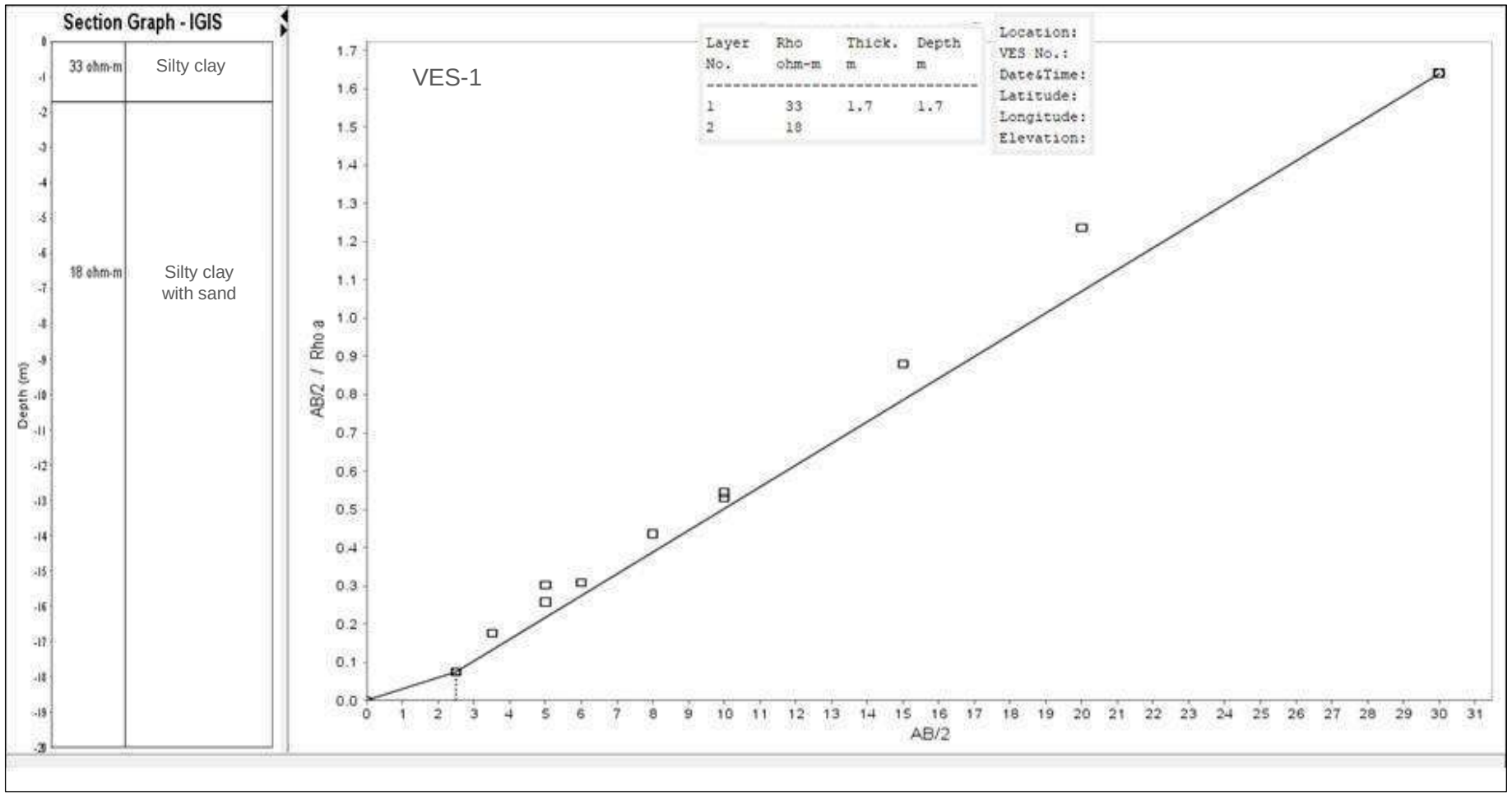

Figure 4.1. 1-D plot of Vertical Electrical Sounding (VES) survey at location 1 in the study area.

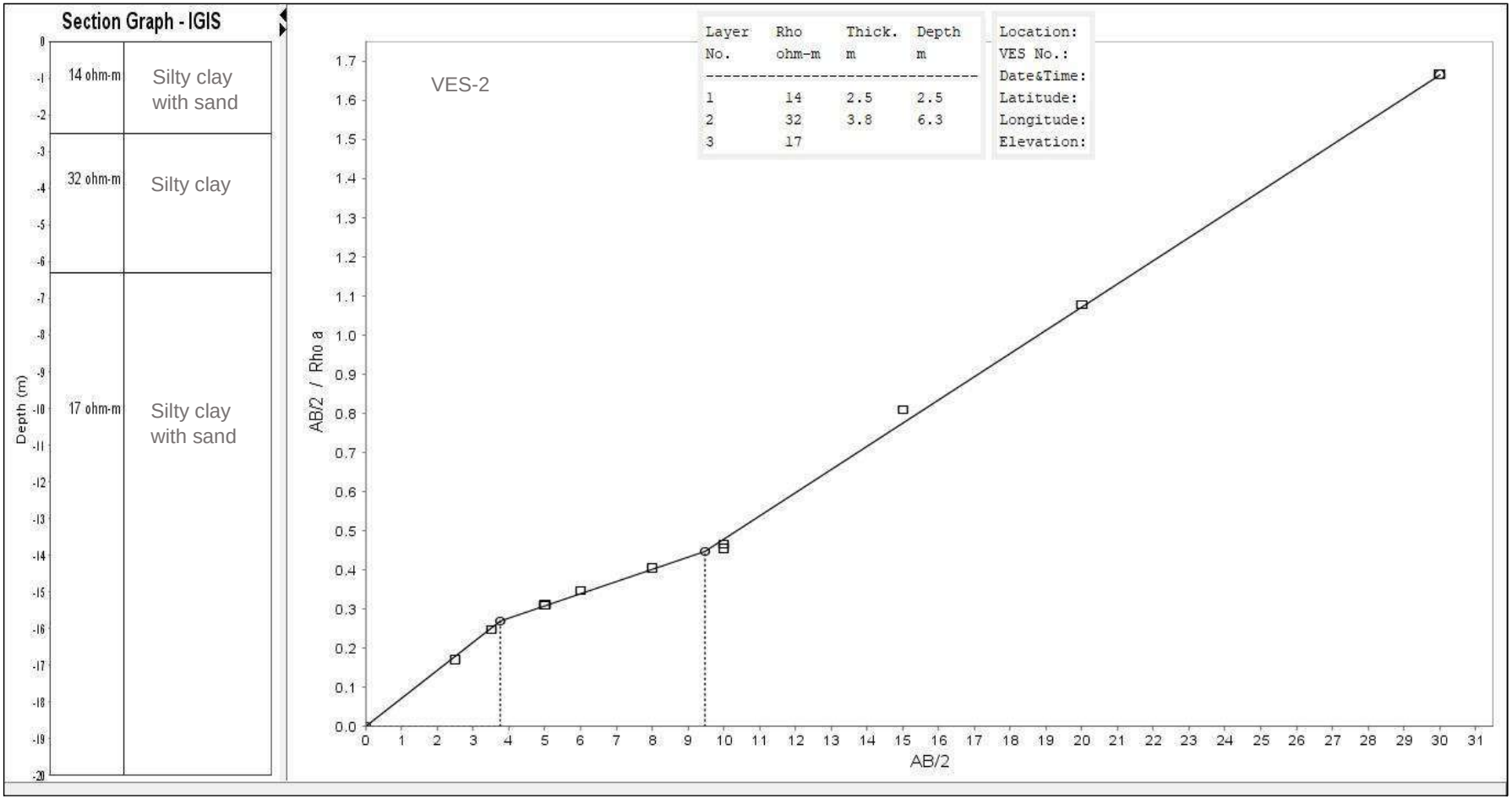

Figure 4.2. 1-D plot of Vertical Electrical Sounding (VES) survey at location 2 in the study area.

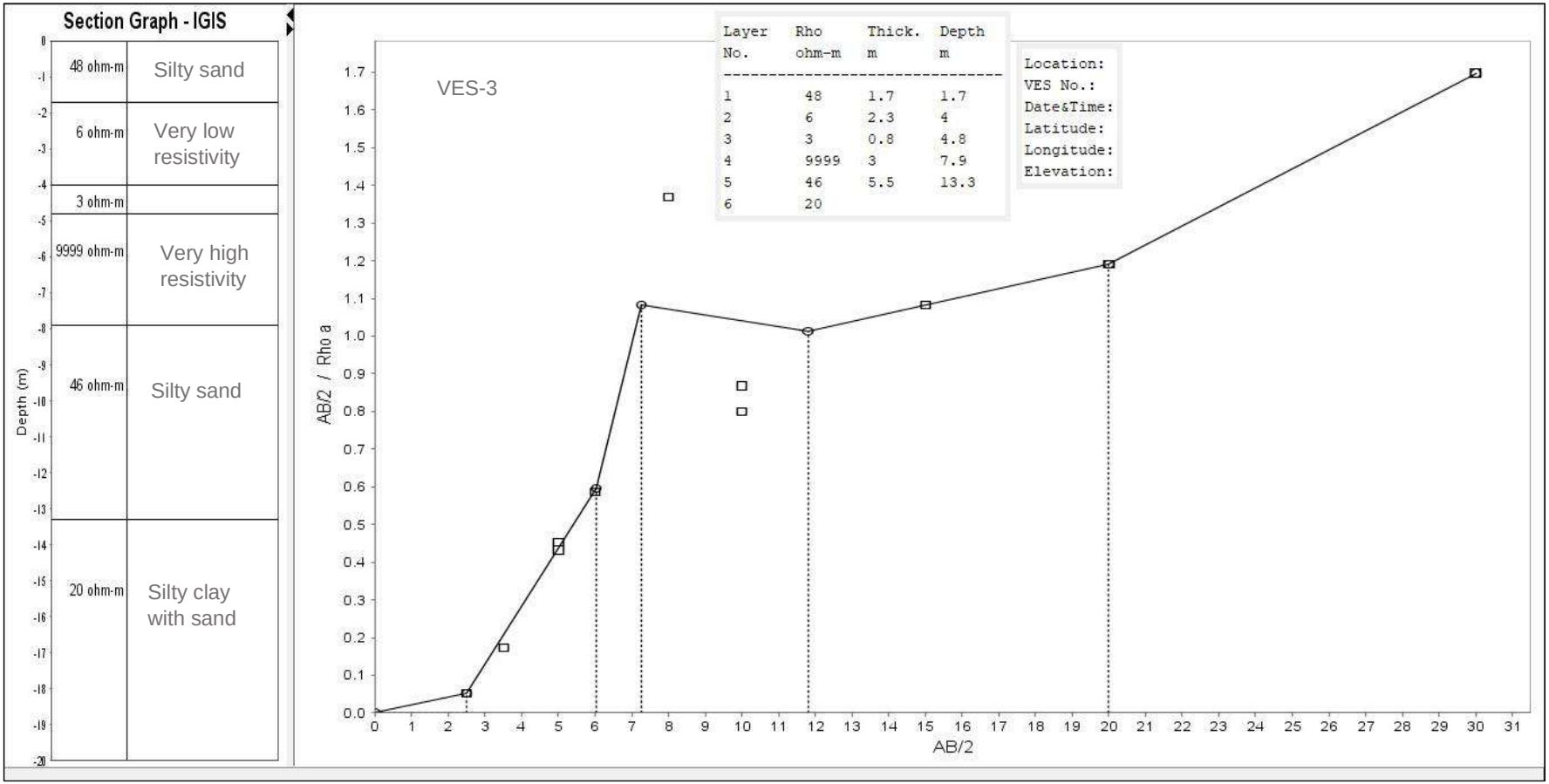

Figure 4.3. 1-D plot of Vertical Electrical Sounding (VES) survey at location 3 in the study area.

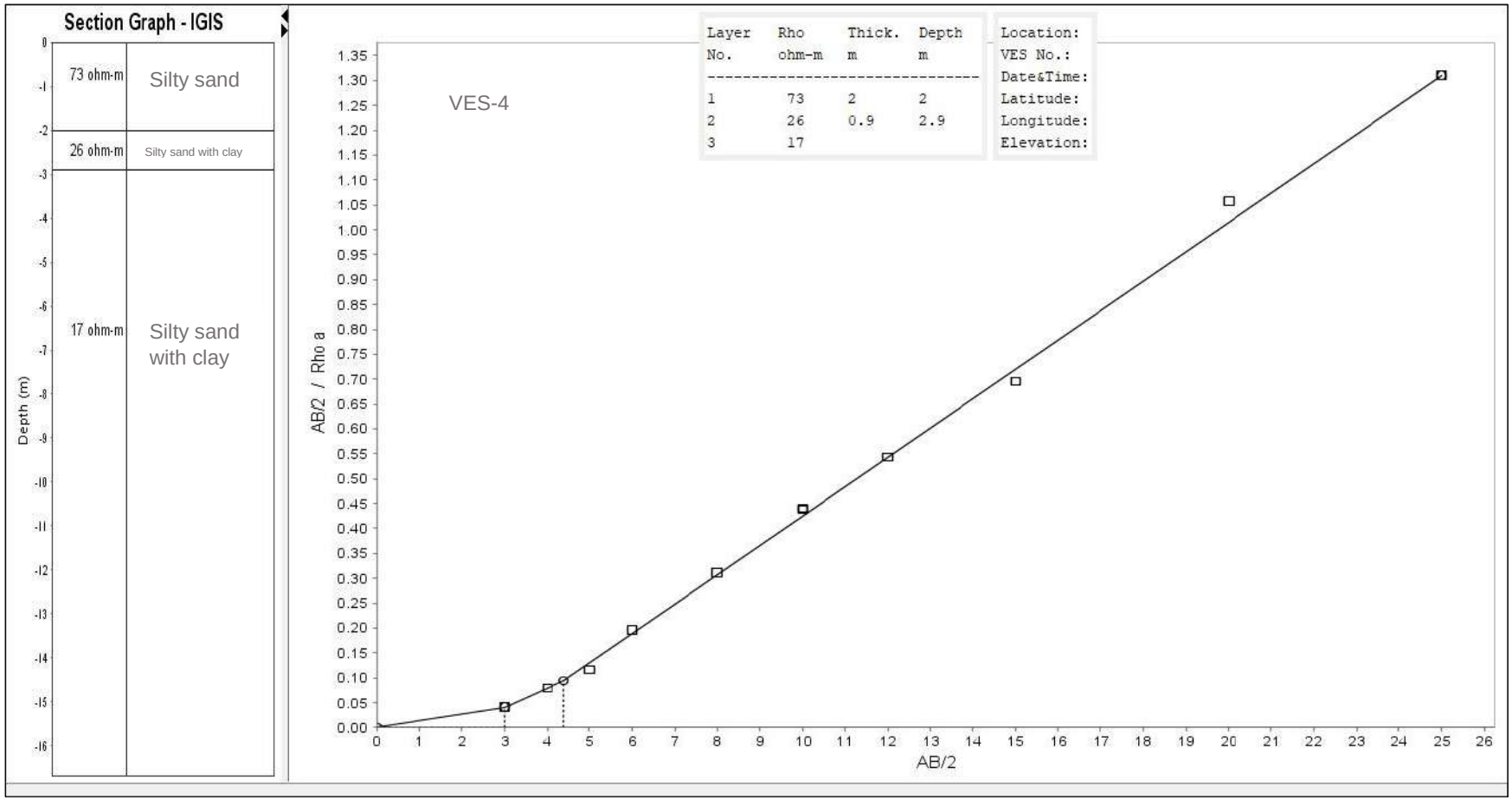

Figure 4.4. 1-D plot of Vertical Electrical Sounding (VES) survey at location 4 in the study area.

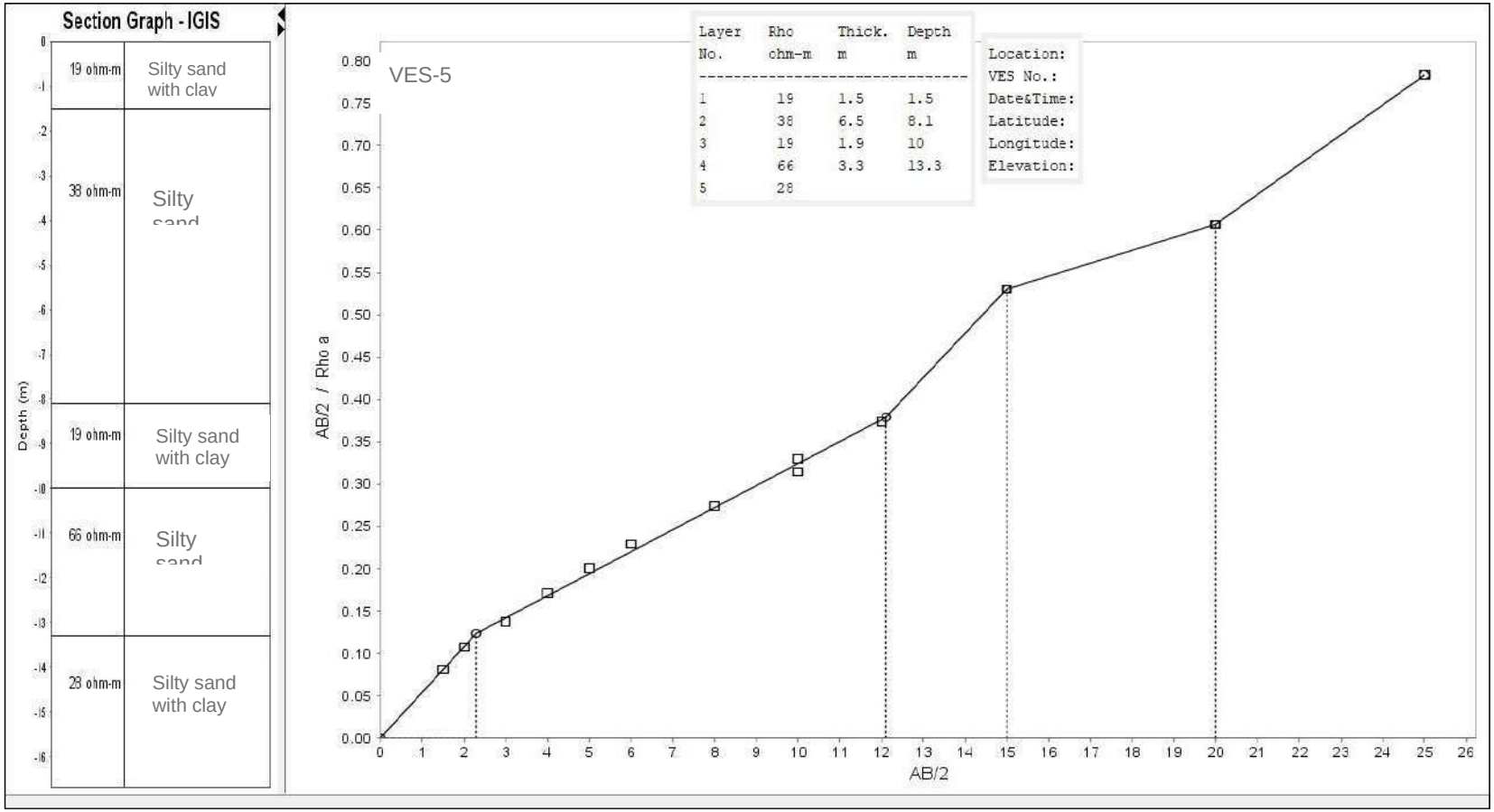

Figure 4.5 1-D plot of Vertical Electrical Sounding (VES) survey at location 5 in the study area

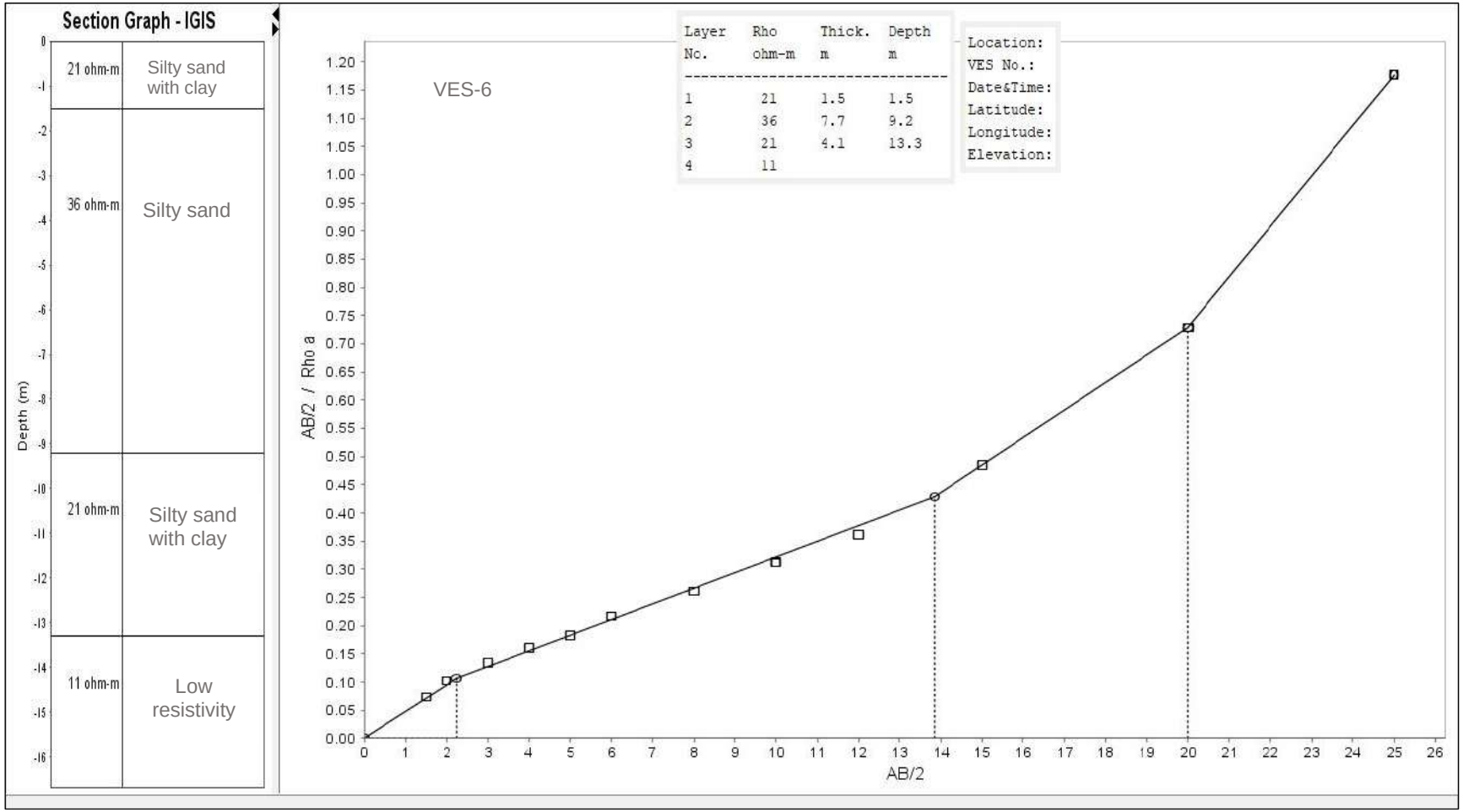

Figure 4.6 1-D plot of Vertical Electrical Sounding (VES) survey at location 6 in the study area

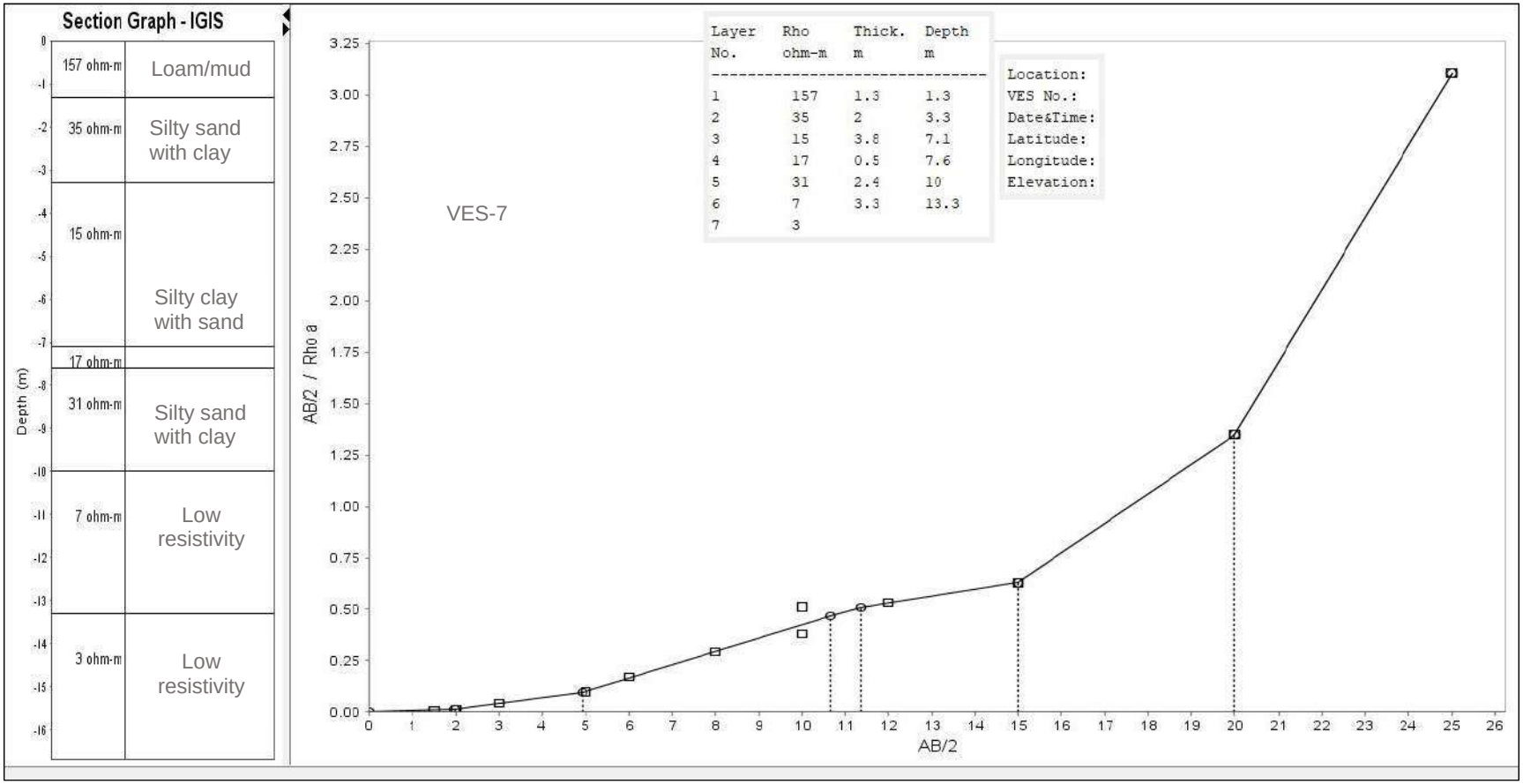

Figure 4.7 1-D plot of Vertical Electrical Sounding (VES) survey at location 7 in the study area

4.2 CONCLUSIONS OF THE VERTICAL ELECTRICAL SOUNDINGS (VES)

Based on the results of Geophysical survey by VES in the FGUTPP area it can be concluded that the soil layers up to the depth of 20m show favourable resistivity values that indicate potential aquifer conditions for groundwater availability. There are minor variations in the resistivity values which are classifying the whole 20m thick aquifer into layers of 3 to 7 types however these variations do not affect the aquifer potential as such as these values fall in the range that can be clubbed in one category of the aquifer with high potential of groundwater.

It was observed during the drilling operation that the soils contained coarse sand size or slightly bigger grains of quartz, jasper, dark colour minerals along with silt and clay fractions. This admixture of grains sizes has imparted aquifer properties to the 20 m thick horizons of alluvial soils.

CHAPTER 5

STUDY OF GROUND WATER CONTOURS

5.1 WELL /PIEZOMETERS DATA ANALYSIS FOR GROUNDWATER LEVELS

The study of spatial variation in groundwater levels and the groundwater flow directions can only be made with direct observations and measurements of groundwater levels from observation wells/piezometers at suitable location in an area. The direct observation data is then put to GIS environment in order to generate spatial data by appropriate methods as mentioned in the methodology. In order to measure the groundwater level condition of the study area, 05 observation wells / piezometers(W1, W2, W3, W4, and W5) were constructed. Two piezometers (W6 and W7) were already existing in the area. Hence total of seven piezometers was measured and used for contour analysis. The location of the wells is shown in Table 5.1.

Table 5.1 The observation wells in the study area

Serial Number	Well no.	Location	Depth of Water level
1	W1	Near Gate No. 2 in the township (parking stand)	4.75 m
2	W2	Near stadium	4.77 m
3	W3	Near Vidyut Upkendera No. 12 (Railway Gate No. 4)	4.36 m
4	W4	Near CISF parade ground	1.58 m
5	W5	Near IT building parking stand (inside plant area)	2.09 m
6	W6	Near Gate No. 5 in the township	4. 58 m
7	W7	Behind IT building parking stand (inside plant area)	3.29 m

Table 5.2 Ground elevation, depth to groundwater level, and reduced level of seven drilling wells, recharge, and discharge sites

S.No.	Longitude	Latitude	Drilling Well	Elevation, m	DGWL, m	Reduced Level, m	Site nature inferred
1	81°18'32.01"E	25°54'41.05"N	Drilling Well-W1	108.81	4.75	104.06	Discharge site
2	81°18'40.77"E	25°54'16.97"N	Drilling Well-W2	109.12	4.77	104.35	Discharge site
3	81°18'16.06"E	25°54'17.69"N	Drilling Well-W3	108.51	4.36	104.15	Discharge site
4	81°18'51.59"E	25°54'28.40"N	Drilling Well-W4	108.10	1.58	106.93	Recharge site
5	81°19'42.53"E	25°55'13.36"N	Drilling Well-W5	110.34	2.09	108.25	Recharge site
6	81°18'58.05"E	25°54'35.69"N	Drilling Well-W6	110.03	4.58	105.45	Discharge site
7	81°19'44.67"E	25°55'7.93"N	Drilling Well-W7	110.34	3.29	107.05	Recharge site

The maps depicting depth to groundwater level (Figures 5.1 and 5.2) and groundwater contour (Figures 5.3, 5.4, and 5.5) have been prepared for the study area. These maps show shallow groundwater level conditions. The possible fluctuation in depth to groundwater level is 1.58 - 4.77m in pre-monsoon conditions. There are two prime recharge sites in the study area, one is W5 and W7 (near IT building parking stand), and the other one is W4 near the CISF parade ground. The groundwater levels in the piezometers (W1, W2, W3, and W6) show discharge sites at the township area of the plant area, enveloped by the contour of 3.5m. Most of the plant area has a water table condition ranging from 2.81 - 3.72m (Table 5.2).

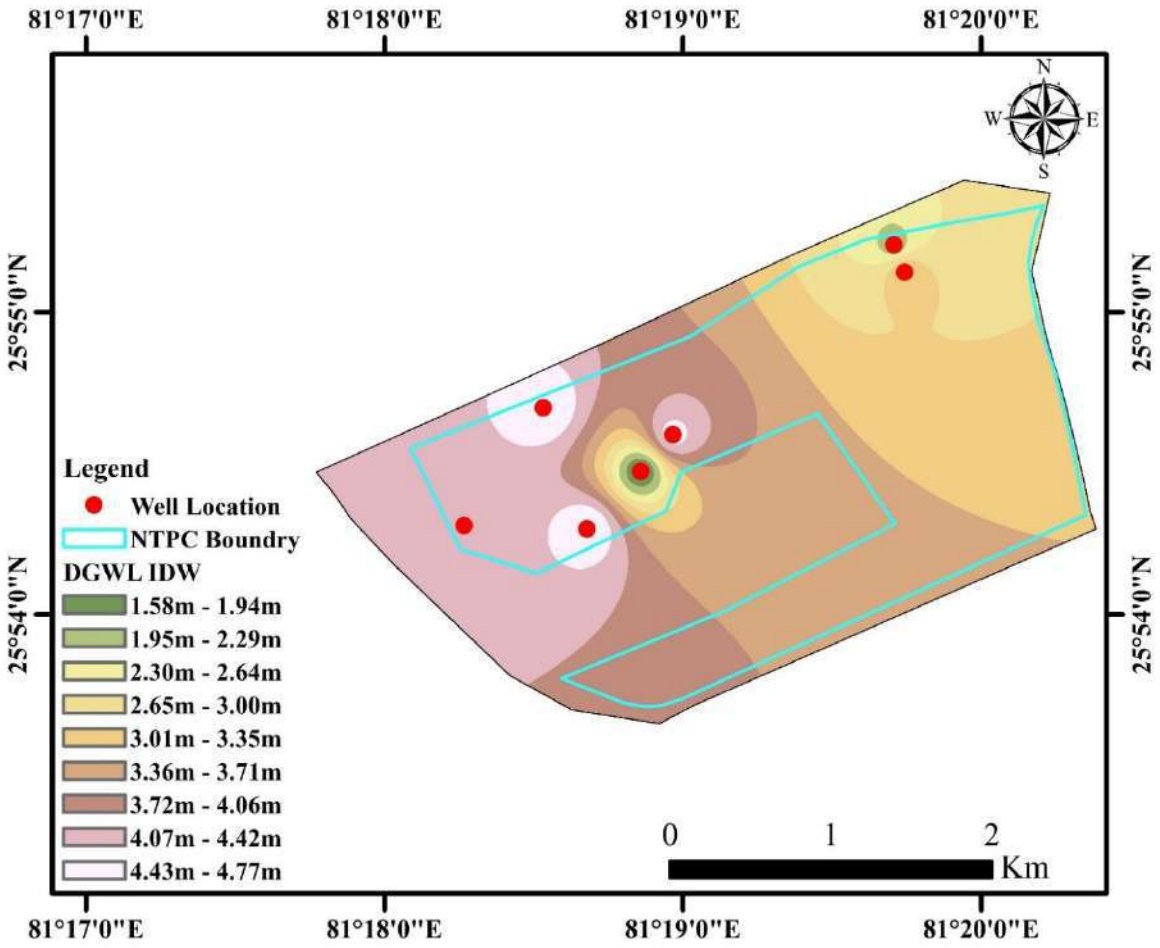

Figure 5.1 Spatial map obtained from IDW Method showing variation in depth to groundwater level (DTW) in the study area

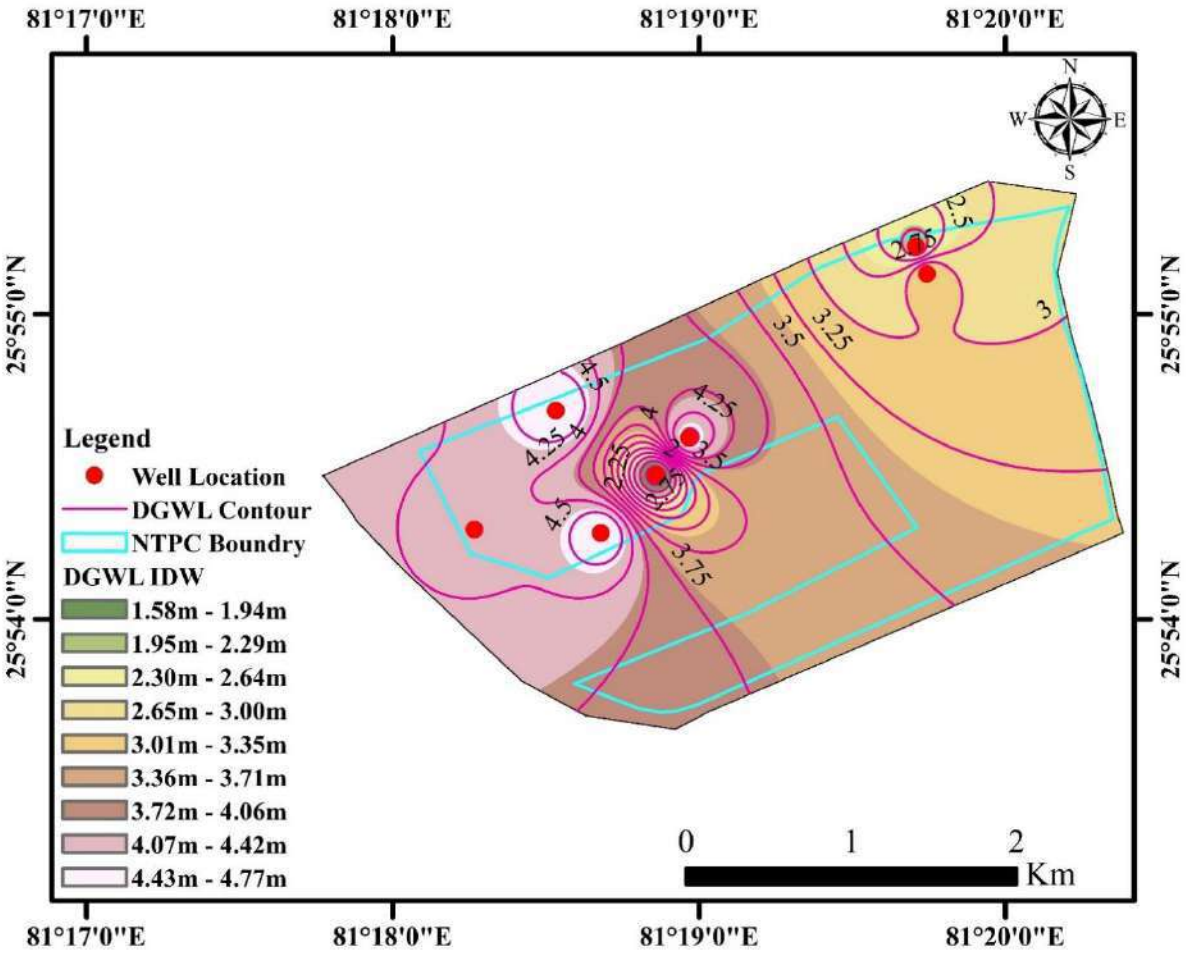

Figure 5.2 Spatial map with superimposed contours showing Depth to groundwater level (DTW) in the study area

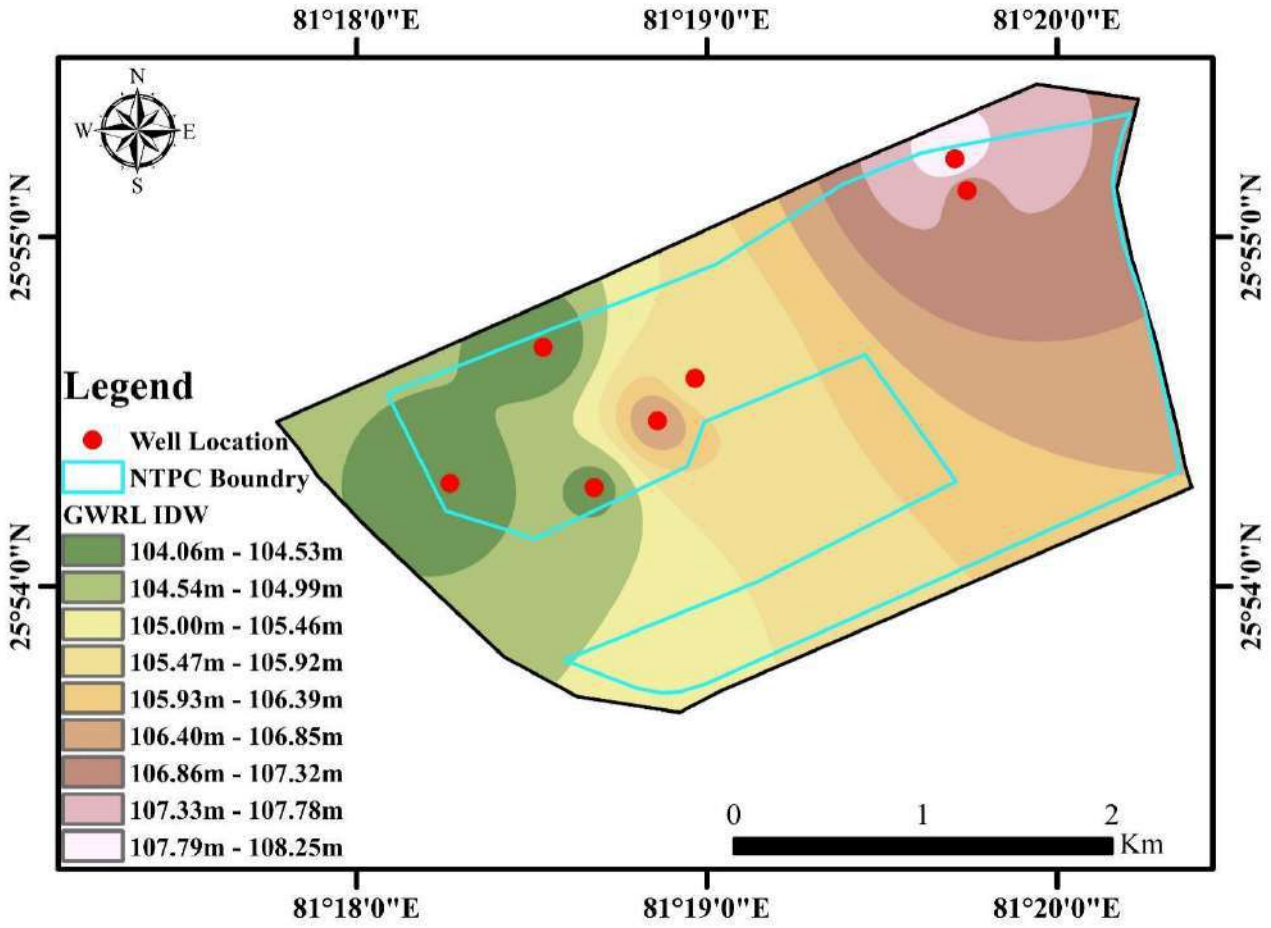

Figure 5.3 Spatial map showing variation of the Groundwater table with respect to MSL in the study area

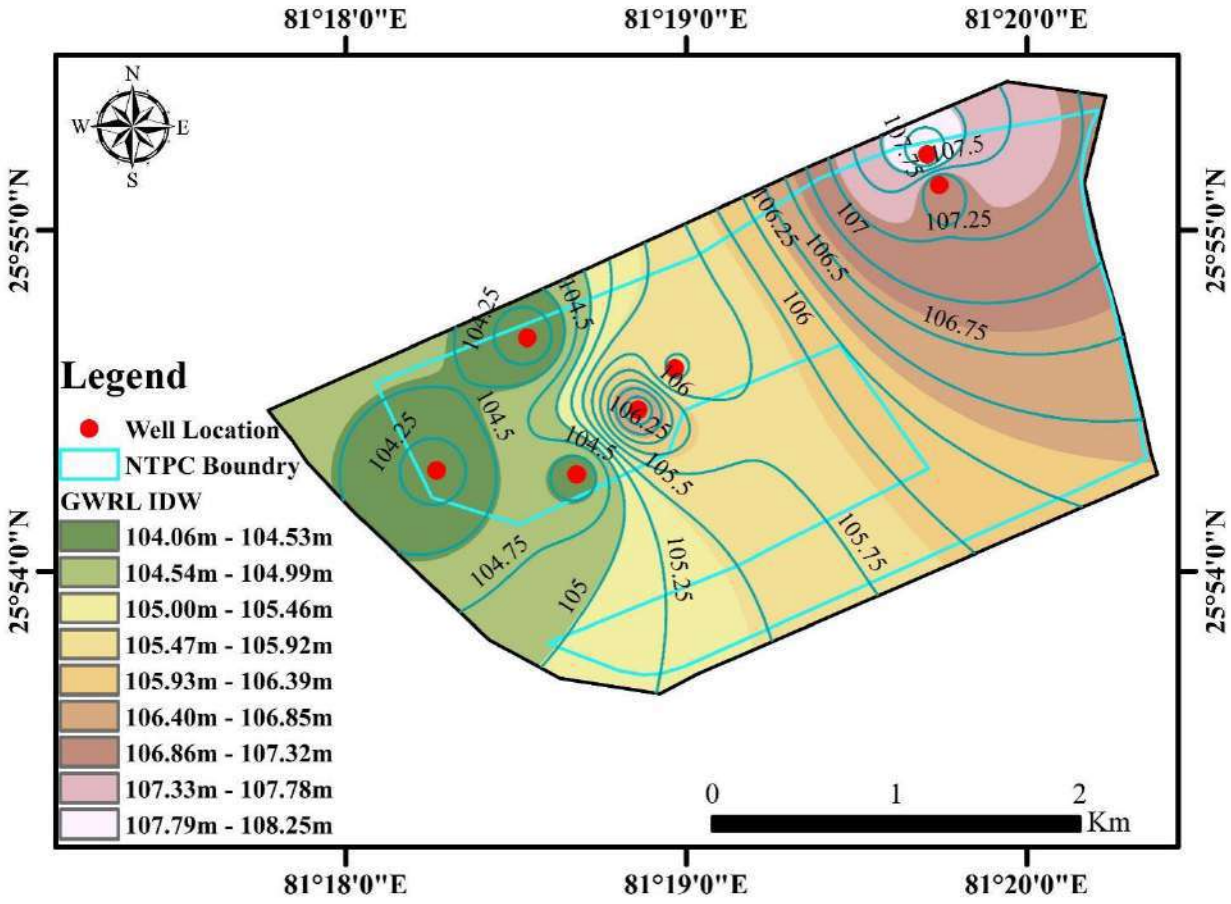

Figure 5.4 Spatial map showing the Groundwater table superimposed with the contour map (with respect to MSL) in the study area

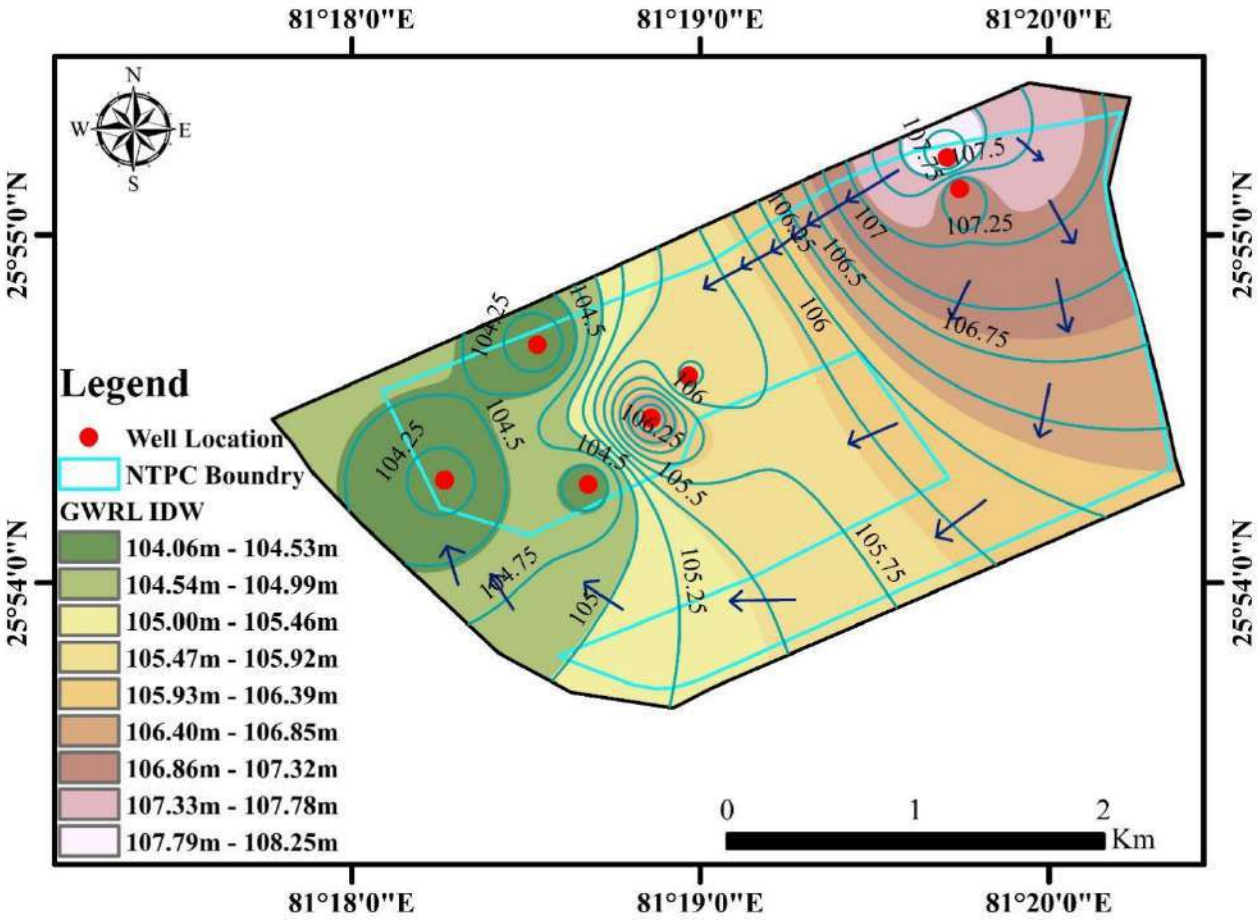

Figure 5.5 Spatial map showing direction of the Groundwater flow in the study area

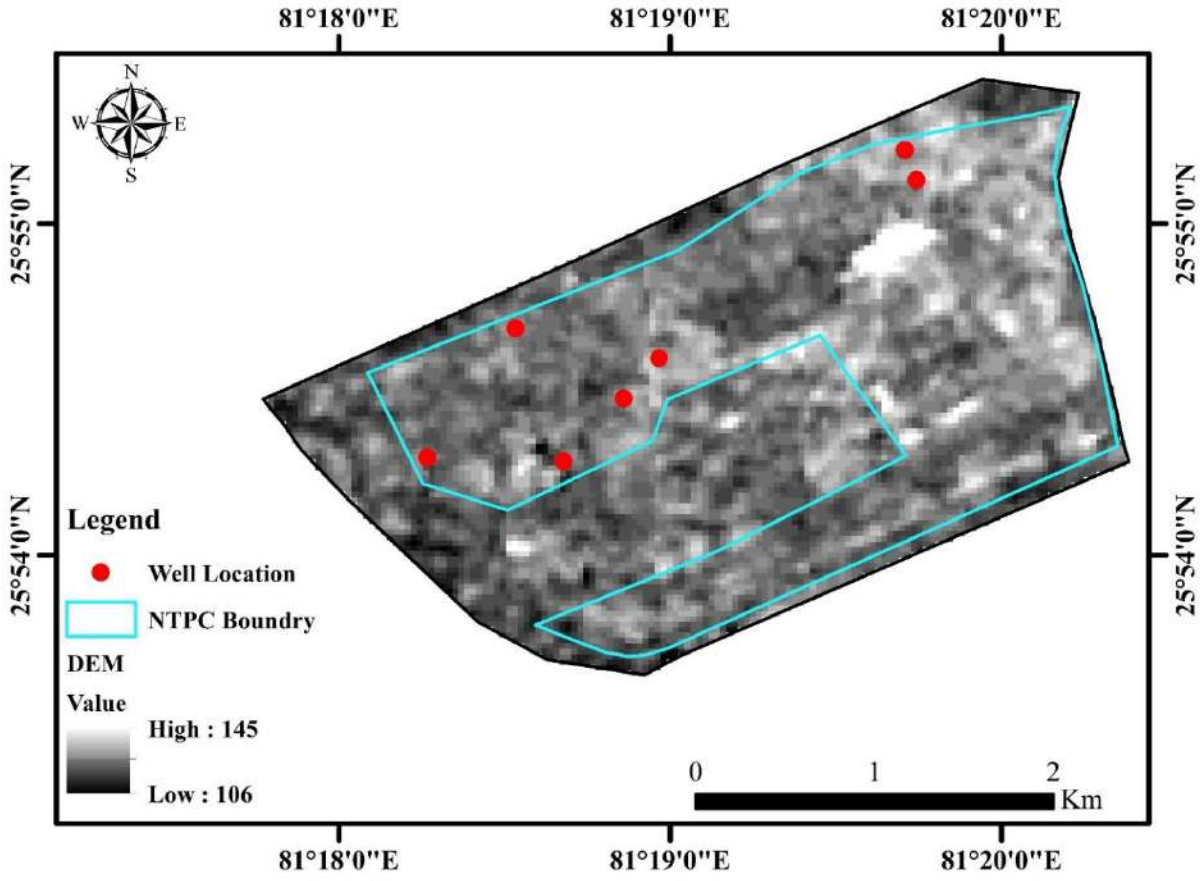

Figure 5.6 Digital Elevation Model (DEM) of the NTPC campus.

5.2 CONCLUSIONS OF GROUNDWATER CONTOUR STUDY

The general slope of the water table is towards gate no. 2 for entry into the residential area. The southern and southwestern part of the residential area has lower water levels. In general, groundwater moves from the northern and north-western boundary of the plant area towards the south and south-west (gate no. 2 residential area entry). However, this depression is enclosed by higher groundwater contours. This is important in understanding the pattern of flow of the plant area. This enclosed contour of the water table surface, having altitudes of little over 104m MSL is local discharging into the deeper aquifer owing to the deep well, which has been operative since the residential area was developed. Hence it is now in equilibrium condition. Secondly, the general flow is from north to south as the water table altitude in the north-west is 108m MSL compared to the southern side where water table altitudes are slightly over 104m MSL. Owing to the effect of the pumping well near Gate number 2 residential area entry, the general slope direction to the south has been locally curved (Figures 5.5 and 5.6).

The study concludes that the area has shallow water table conditions even in the pre-monsoon conditions. The general movement of groundwater towards the south/the Ganges regime. With less than 5mbgl pre-monsoon groundwater conditions in the study area a rigorous recharging plan is *not* needed. However, some compensatory recharge structures are suggested for loss of groundwater (if any) due to temporary pumping conditions for dewatering in the foundation excavations for any construction site in the plant area.

CHAPTER 6
RECHARGE PLAN

6.1 RECHARGE PLAN

The plant and residential area, in general, have a shallow water table in the alluviums in the Unchahar area, Rae Barelli UP. The water levels vary between 1.59mbgl and 4.77 mbgl in May 2022 as per the readings.

The upper aquifer zone is sufficiently thick, and a shallow water table reveals that the area has safe groundwater conditions. However, there are two lows (although within 05 meters below the ground level) on both sides of the shallow/high water level mound at the CISF ground (~ 1.60 m.). As suggested below, the two low points should be used for the recharge structures. Apart from these two points, small recharge structures are also suggested to make a network of recharge structures.

There are several methods generally in use for developing the groundwater recharge structures (CWC report, 2007; Ministry of Rural development 2004; CGWB Manual,2007). These structures may be made hybrid as per the constraints of the locale.

The main constraints in the Residential area of the FGUTPP area are that there is lack of unutilized /unused open spaces. Therefore, certain methods cannot be used in their original format such as Trench-furrow, ditch and open percolation tanks. These structures would be highly hazardous for residential area where people, children and animal frequently move in the area. Instead, only such structure which are filled with filtering material can be constructed. The soak pits filled with gravels and boulders being smaller structure can be safely used along street sides. Another structure which is a hybrid structure of the percolation tank has been suggested here in the present case. Keeping the lack of unused area in mind this hybrid structure of percolation tank can be developed in the playground and their dimension may be kept equal to sandy(beach type) Volley Ball Playground as described below. In this manner, the recharging structure would be serving two purposes simultaneously and can be best constructed in the existing playgrounds.

Types of Recharge structures suggested for the area:

1. Beach Volley Ball Playground Type Structures:

a) The stadium
b) DAV school ground
c) Dr. Ambedkar Club Backyard ground
d) The Playground near southern boundary wall

2.Park type Structures/Recharge Pits

a) Along the road from Gate 2 Residential area (on the other side of the drains)
b) Park near Ambedkar Club

c) Near Gate no 2 (residential area) near western boundary wall
d) Park near the playground near the southern boundary wall
e) Children's Park (North of stadium)
f) Along the Railway Track and boundary
g) Along the road inside the plant

6.2 BEACH VOLLEY BALL PLAYGROUND TYPE STRUCTURES

The playground type of structure is based on the beach Volleyball and provides a usable recharge structure. The size dimension of the playground is 20m×10m. Basically, it is an excavation work that is 2m deep and has three shafts, each 2m×2m approximately 01m deep on the excavation floor along the longitudinal center line. This is a simple structure in which the upper half meter is coarse sand, and below the sand, all gravels fill the excavations (Figure 6.1).

Precipitation water should enter the ground that would infiltrate through upper half meter of unconsolidated sand and then the gravel layer with high permeability it will directly reach the ground water table.

The volume of the excavation is:

20mx10mx2m+ 2mx2mx3(no.of shafts)= 412 M^3

Generally, an excavation of one cubic meter can infiltrate about four to six cubic meter of water in the whole monsoon season of the base of the excavation touches the aquifer's upper limit (i.e. in pre-monsoon period the water table goes down much below the upper limit of the aquifer).

Accordingly, the on the lower side of assumption we get

412 M^3 x 4= 1648 M^3 of recharge

On the higher side of the assumption we get

412 M^3 x 6=2472 M^3

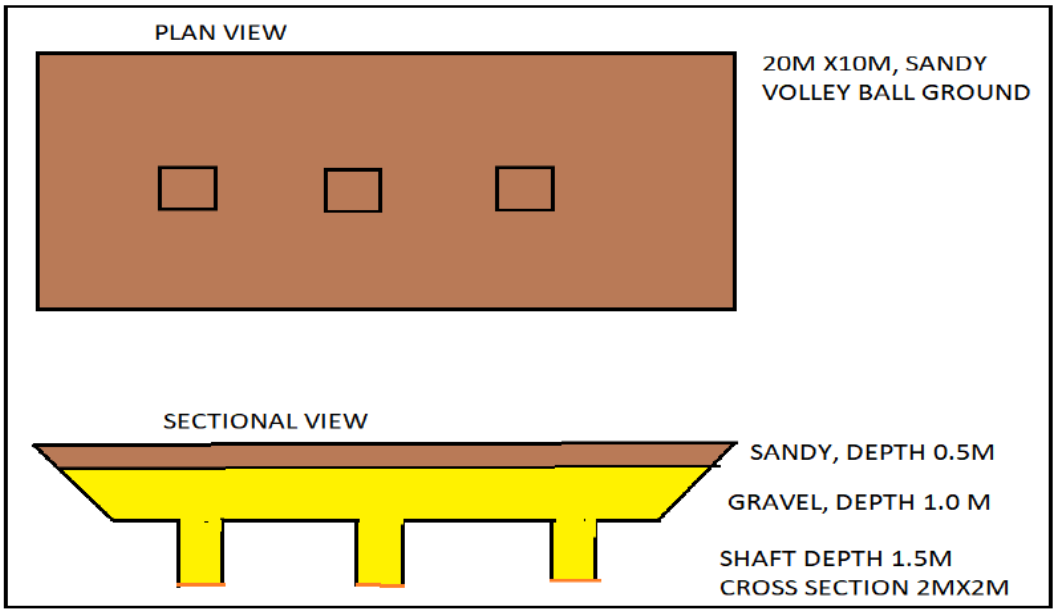

Figure 6.1 Plan and sectional view of the recharge structure in the Volley ball Ground.

Four such beach volley ball type play grounds would contribute about 1ha-m of water as recharge.

In should be noted that the fill does not lower the infiltration rate so long as the infiltration rate in the ditch material is greater than or equal to the infiltration rate of the aquifer material. Therefore, the excavation filled with permeable material is as good as unfilled one.

There are four such places where the beach Volley ball type of recharge structure may be developed.

a) The stadium
b) DAV school ground
c) Dr. Ambedkar Club Backyard ground
d) The Playground near southern boundary wall

As students would love to play on such sand pools, the space of school would not go useless, and at the same time an efficient recharge system can be developed.

It needs to be protected from waste disposal practices, and only sports activities should be performed on them. If waste material reaches the site it can contaminate recharging water.

There is no immediate need to develop all such recharge structures. One or two such beach Volleyball types of structures may be developed initially, and recharge efficiency may be monitored.

6.3 PARK TYPE/ SOAK PIT STRUCTURES

These are smaller in dimension and can be made along the main and lateral roads in the residential and plant area.

These soak pits have Length × Width × Depth as 2.5m×2m×1.5m+ 1m×1m ×1.5m shaft. The base of the pit is kept sloping into the shaft (Figure 6.2).

These recharge structures have three layers:

Upper Gravel layer

Middle Boulder layer

Lower Gravel layer in the shaft.

The dimensions may be further adjusted if narrow space is available and should then be chosen 2m ×1.5×1.5 + 1m×1m×1.5m.

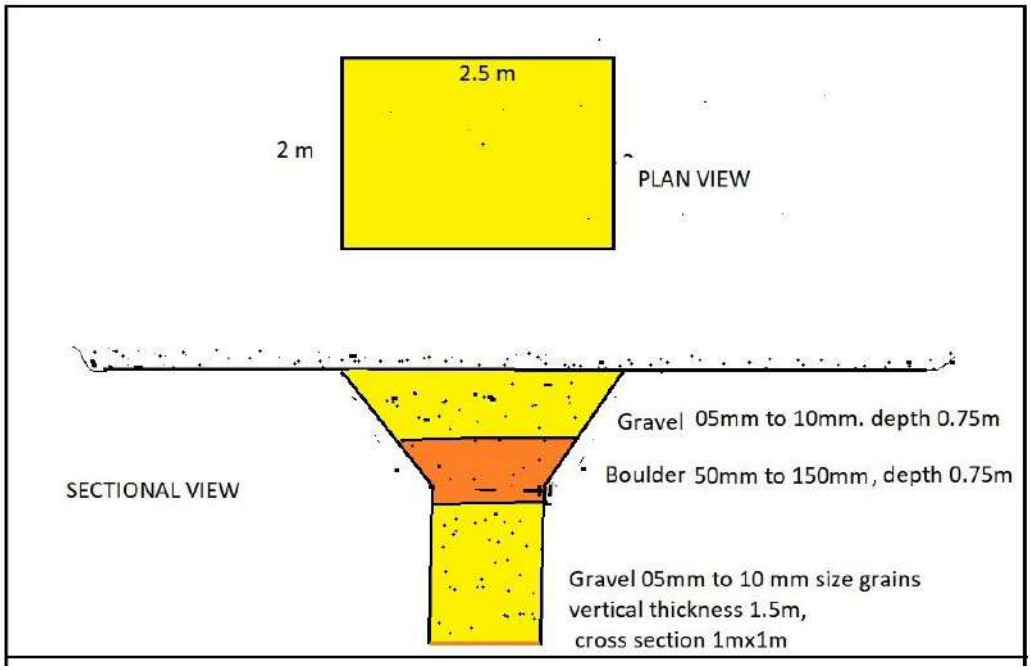

Figure 6.2 Plan and sectional view of the soak pit.

The soak pit with original dimensions has a volume of 9 M^3 that can recharge as per the above assumptions between 36 M^3 and 54 M^3

And if the dimensions are reduced as per the above suggestion, then it will have 6 M^3 areas, and it would recharge between 24 M^3 and 36 M^3.

The road from Gate No 2, entry into the residential area runs straight and provides a good opportunity for construction of such soak pits on both sides

There is runoff drainage running on both sides of the road; therefore, the soak pits should be developed between the drain line and the residential buildings and not between the road and the drain, as it may soften the ground along the margin of the road and may cause some settlement along the margins. If necessary, then it should be at least 2.0 meters away from the road. There are open spaces along the lateral roads from the central road (to Gate no.2). These open spaces may also be utilized to develop such soak pits.

About 20 such pits can be constructed in the residential area (Figure 6.3), whereas 20 such soak pits can be developed in the plant area (Figure 6.4) along the road from the gate no. 5 entry to the plant, around the old admin block, and near the IT building area.

20 pits may be developed between the boundary wall and the railway track to gate number 4. Also, along the road to the plant from the gate, no 5 from the residential area, a yellow space has been marked, but many soak pits have not been suggested as there may be other constraints that might not allow construction soak pits there. If possible, five pits may be accommodated there.

The number of soak pits initially maybe 10 in the residential area, 10 in the Plant area, and 10 on the other side of the railway track to Gate no 4.

Total sixty soak pits, as suggested above, would recharge around $54 \times 60 = 3240\ M^3$ at a fully recharging rate.

These are low-cost structures and do not require maintenance if waste material does not reach the pits. However, three monthly checkings should be made to see that no waste material is reaching the pits. If found on some pit, the gravel layer should be renewed for the particular pit.

As it is clear that the area has shallow water table conditions, which further come closer to the ground surface within 2 to 3m in the post-monsoon time, the area has safe groundwater availability.

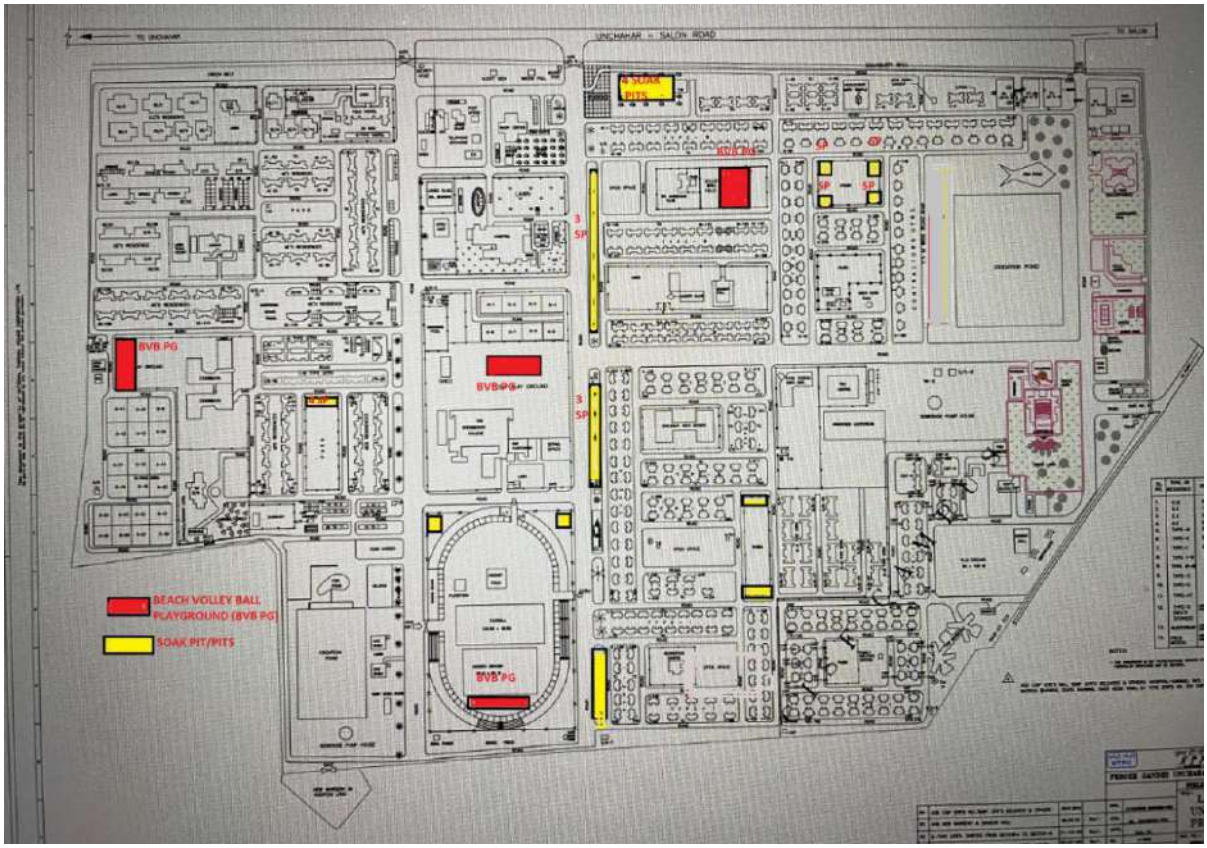

Figure 6.3 Recharge structures suggested for Residential area FGUTPP, Unchahar

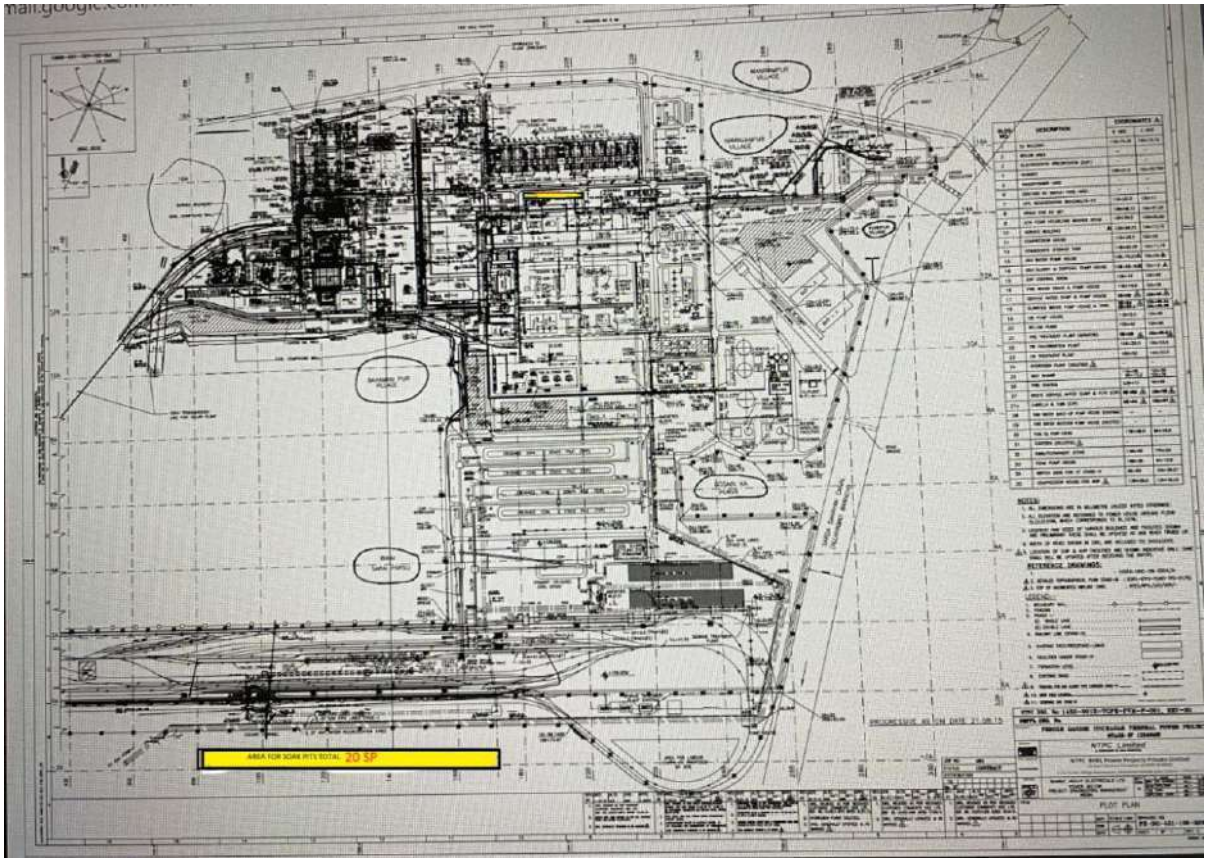

Figure 6.4 Recharge structures suggested for Plant area FGUTPP , Unchahar

References

Central Ground Water Commission : Water and related statistics , 2007, Ministry of Water resources GOI , New Delhi.

CGWB, Guide on artificial recharge to ground water, 2007.

Ministry of Rural development Water harvesting and artificial recharge, 2004

Implementation of rain water harvesting scheme at NTPC Unchahar.

Rainfall 2025-26: 758.5 mm

S.No.	Area Description	NO of Pit	Area (M2)	Type of material	Run-off coefficient	Annual average rainfall (mm)	Harvestable Qty (M3)
1	2		3	4	5	6	7=3*5*6/1000
I	**Plant Area**						
	All Roof top plant area						
	Central Work shop	1	1867.21	Roof Top	0.9	758.5	1274.65
II	**Township Area**						
1	DAV School	2	7920.79	Roof Top	0.9	758.5	5407.13
2	Ganga Bhawan guest house	1	1180.57	Roof Top	0.9	758.5	805.92
3	ADM Building						
	Office bld	1	1,347.59	Roof Top	0.9	758.5	919.93
	Total =		**12316.2**				**8407.63**

Calculation of RHW

The rain water harvesting potential of an area can be estimated through the following formula : Water captured (L) =		**Catchment area (m2) X annual average rainfall (mm) X run-off coefficient**

Run-off coefficient for different types of catchment

Catchment		Type of r	Run-off coefficient
Roof , playgroun		Tiles	0.8-0.9
		Metal	0.7-0.9
Paved area Driveway/ courtyard, roads		Concrete	0.6-0.8
		Brick	0.5-0.6
		10% sand	0.0-0.3
Unpaved area garden		Hard com	0.2-0.5
		Lawns	0.1

प्रारूप-झ (संलग्नक-9) Annexure-28

अग्नि एवं जीवन सुरक्षाप्रमाण पत्र का नवीनीकरण

यूआईडी संख्या: UPFS/2025/174495/RBL/RAEBARELI/1617/CFO

दिनांक: 07-10-2025

प्रमाणित किया जाता है कि मैसर्स **FEROZE GANDHI UNCHAHAR THERMAL POWER STATION, NTPC LTD, UNCHAHAR** (भवन/प्रतिष्ठान का नाम) पता **0,FEROZE GANDHI UNCHAHAR THERMAL POWER PROJECT, NTPC,RAEBARELI** तहसील - **UNCHAHAR** जिसमें

ब्लॉक/टावर	तलों की संख्या	बेसमेन्ट की संख्या	ऊँचाई
CHP BUILDING	1	0	17 mt.
MAIN PLANT HOUSE	1	0	17 mt.
ASH HANDLING	2	0	8 mt.
SERVICE BUILDING	1	0	6.50 mt.

तथा प्लाट एरिया **4152479.38 sq.mt** है। भवन का अधिभोग **FEROZE GANDHI UNCHAHAR THERMAL POWER STATION, NTPC LTD, UNCHAHAR** (भवन स्वामी/ अधिभोगी अथवा कम्पनी का नाम) द्वारा किया जा रहा है। इनके द्वारा भवन में अग्नि निवारण एवं अग्नि सुरक्षा व्यवस्थायें एन0बी0सी0 एवं तत्संबंधी भारतीय मानक व्यूरो के आई0एस0 के अनुसार भवन में स्थापित व्यवस्थाओं का अनुरक्षण किया जा रहा है। जिसका निरीक्षण द्वारा दिनाँक **14-10-2025** को भवन स्वामी के प्रतिनिधि श्री **GOVT OF INDIA** के साथ किया गया तथा भवन में अधिष्ठापित अग्नि एवं जीवन सुरक्षा व्यवस्थाओं को मानकों के अनुसार यथास्थिति में पाया गया। अतः प्रश्नगत भवन को अग्नि एवा जीवन सुरक्षाप्रमाण पत्र का नवीनीकरण (Renewal of Fire & Life Safety Certificate)(एन0बी0सी0 की अधिभोग श्रेणी) **Industrial** के अन्तर्गत वैधता तिथि **15-10-2025** से **14-10-2028** तक **3** वर्षों के लिये इस शर्त के साथ दिया जा रहा है कि भवन में सभी मानकों का अनुपालन किया जायेगा तथा भवन के इस प्रमाण पत्र का नवीनीकरण निर्धारित समयवधि के अन्तर्गत पुनः कराया जायेगा तथा नवीनीकरण से पूर्व भवन मं. स्थापित अग्निशमन व्यवस्थाओं को क्रियाशील रखने की जिम्मेदारी आपकी होगी ।

Note : .नोटः- यू0आई0डी0 नं0-UPFS/2022/67217/RBL/RAEBARELI/367/JD पर निर्गत अनापत्ति प्रमाण पत्र का नवीनीकरण शासनादेश संख्या- शासनादेश संख्याः- 1087357/छः पु0-8-2025-1967229 दिनांकः 12 सितम्बर, 2025 के क्रम में निर्गत किया जा रहा है।

"यह प्रमाण-पत्र आपके द्वारा प्रस्तुत अभिलेखों , सूचनाओं के आधार पर निर्गत किया जा रहा है । इनके असत्य पाए जाने पर निर्गत प्रमाण-पत्र मान्य नहीं होगा । यह प्रमाण-पत्र भूमि / भवन के स्वामित्व / अधिभोग को प्रमाणित नहीं करता है ।"

हस्ताक्षर (निर्गमन अधिकारी)

(मुख्य अग्निशमन अधिकारी)

Digitally Signed By
(SUNIL KUMAR SINGH)

[E17811BEF63913DDA8702838F65298C53358BAC7]

15-10-2025

निर्गत किये जाने का दिनांक : 15-10-2025
स्थान : RAEBARELI

Annexure-29

भारत सरकार
Government of India
वाणिज्य और उद्योग मंत्रालय
Ministry of Commerce & Industry
पेट्रोलियम तथा विस्फोटक सुरक्षा संगठन (पैसो)
Petroleum & Explosives Safety Organisation (PESO)
केंद्रीय सदन (जीपीओए), तृतीय एवं चतुर्थ तल, 34-ए, महात्मा गाँधी मार्ग, सिविल लाइन्स
इलाहाबाद- 211001
Kendraiya Sadan (GPOA), 3rd & 4th Floor,
34-A, Mahatma Gandhi Marg, Civil Lines,
Allahabad - 211001

E-mail : **dyccealahabad@explosives.gov.in**
Phone/Fax No : **0532 -2401518,2401519,2401520 Fax 2401521**

संख्या /No. : **P/HQ/UP/15/563 (P7960)** दिनांक /Dated : **01/01/2024**

सेवा में
/To,

Dy. General Manager M/S National Thermal Powwer Corporation Limited,
Firoz Ghadhi Unchahar Thermal Power,
Post Unchahar,
Unchahar,
Unchahar,
Taluka: Unchahar,
District: RAIBARELY,
State: Uttar Pradesh
PIN: 229406

विषय /Sub : **Plot No, NA, Mustafabad, UNCHAHAR, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229404** में स्थित विद्यमान पेट्रोलियम वर्ग **C** अधिष्ठापन में अनुज्ञप्ति सं **P/HQ/UP/15/563 (P7960)** के नवीकरण के संदर्भ में ।
Existing Petroleum Class **C** Installation at **Plot No, NA, Mustafabad, UNCHAHAR, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229404 -** Licence No. **P/HQ/UP/15/563 (P7960) - Renewal** regarding.

महोदय
/Sir(s),

कृपया आपके पत्र क्रमांक **OIN1504036** दिनांक **28/12/2023** का अवलोकन करें ।
Please refer to your letter No.: **OIN1504036**, dated **28/12/2023**

अनुज्ञप्ति संख्या **P/HQ/UP/15/563 (P7960)** दिनांक **20/04/1988** को दिनांक **31/12/2028** तक नवीनीकृत कर इस पत्र के साथ अग्रषित की जा रही है ।
Licence No. **P/HQ/UP/15/563 (P7960)** dated **20/04/1988** is forwarded herewith duly renewed upto **31/12/2028**.

कृपया पेट्रोलियम नियम 2002 के अधीन बनाए गए नियम 148 में दी गई प्रक्रिया का कडाई से पालन करें । अनुज्ञप्ति के नवीकरण हेतु समस्त दस्तावेजों को अनुज्ञप्ति की वैधता समाप्त होने की तिथि से कम से कम 30 दिन पूर्व कार्यालय को प्रेषित करें ।
Please follow the procedure strictly as laid down in rule 148 of the Petroleum Rules, 2002 and submit complete documents for the Renewal of the licence **so as to reach this** office on or before the date on which Licence expires.

कृपया पावती दें।
Please acknowledge the receipt.

भवदीय /Yours faithfully,

((डा. आर. आर. गुप्ता)
(Dr R R Gupta))
उप मुख्य विस्फोटक नियंत्रक
Dy. Chief Controller of Explosives
इलाहाबाद/Allahabad

Note:-This is system generated document does not require signature.

(अधिक जानकारी जैसे आवेदन की स्थिति, शुल्क तथा अन्य विवरण के लिए हमारी वेबसाइट : http://peso.gov.in देखें)
(For more information regarding status,fees and other details please visit our website: http://peso.gov.in)

Digitally signed by RANJANA RANI GUPTA
Reason: Licence No. : P/HQ/UP/15/563
Location:Allahabad [P7960]
Date:01-01-2024 17:29:54 PM

प्ररूप XV
(प्रथम अनुसूची का अनुच्छेद 6 देखिए)
FORM XV
(see Article 6 of the First Schedule)

अधिष्ठापनों में पेट्रोलियम के आयात और भंडारकरण के लिए अनुज्ञप्ति
LICENCE TO IMPORT AND STORE PETROLEUM IN AN INSTALLATION

अनुज्ञप्ति सं. (Licence No.) : **P/HQ/UP/15/563(P7960)** फीस रूपए (Fee Rs.) **50000/-** per year

Dy. General Manager M/S National Thermal Powwer Corporation Limited, Firoz Ghadhi Unchahar Thermal Power, Post Unchahar, Unchahar, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229406 को केवल इसमें यथा विनिर्दिष्टु वर्ग और मात्राओं में पेट्रोलियम **12150.00 KL** आयात करने के लिए और उसका, नीचे वर्णित और अनुमोदित नक्शा संख्या **P/HQ/UP/15/563(P7960)** तारीख **21/12/2022** जो कि इससे उपाबद्ध हैं, में दिखाए गए स्थान पर भण्डारकरण के लिए पेट्रोलियम अधिनियम, 1934 के उपबंधों या उसके अधीन बनाए गए नियमों तथा इस अनुज्ञप्ति की अतिरिक्त शर्तों के अधीन रहते हुए, यह अनुज्ञप्ति अनुदत्त की जाती हैं ।

Licence is hereby granted to **Dy. General Manager M/S National Thermal Powwer Corporation Limited, Firoz Ghadhi Unchahar Thermal Power, Post Unchahar, Unchahar, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229406** valid only for the importation and storage of **12150.00 KL** Petroleum of the class and quantities as herein specified and storage thereof in the place described below and shown on the approved plan No **P/HQ/UP/15/563(P7960)** dated **21/12/2022** attached hereto subject to the provisions of the Petroleum Act, 1934 and the rule made thereunder and to the further conditions of this Licence.

यह अनुज्ञप्ति 31st day of December **2028** तक प्रवृत रहेगी ।
The Licence shall remain in force till the 31st day of December **2028**

पेट्रोलियम का विवरण /Description of Petroleum	अनुज्ञप्त मात्रा (किलोलीटरों में) /Quantity licenced in KL
वर्ग क प्रपुंज पेट्रोलियम /Petroleum Class A in bulk	**NIL**
वर्ग क प्रपुंज पेट्रोलियम से भिन्न /Petroleum Class A, otherwise than in bulk	**NIL**
वर्ग ख प्रपुंज पेट्रोलियम /Petroleum Class B in bulk	**NIL**
वर्ग ख प्रपुंज पेट्रोलियम से भिन्न /Petroleum Class B, otherwise than in bulk	**NIL**
वर्ग ग प्रपुंज पेट्रोलियम /Petroleum Class C in bulk	**12150.00 KL**
वर्ग ग प्रपुंज पेट्रोलियम से भिन्न /Petroleum Class C,otherwise than in bulk	**NIL**
कुल क्षमता /Total Capacity	**12150.00 KL**

April 20, 1988

Chief Controller of Explosives

अनुज्ञप्त परिसरों का विवरण और अवस्थान
DESCRIPTION AND LOCATION OF THE LICENSED PREMISES

अनुज्ञप्त परिसर जिसकी विन्यास सीमाएं अन्य विशिष्टयां संलग्न अनुमोदित नक्शों में दिखाई गई हैं **Plot No: NA, Mustafabad, UNCHAHAR, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229404** स्थान पर अवस्थित है तथा उसमें निम्नलिखित **FOUR ABOVE GROUND PETROLEUM CLASS C STORAGE TANK TOGETHER WITH CONNECTED FACILITIES.** सम्मिलित हैं |

The licensed premises, the layout , boundaries and other particulars of which are shown in the attached approved plan are situated at **Plot No: NA, Mustafabad, UNCHAHAR, Unchahar, Taluka: Unchahar, District: RAIBARELY, State: Uttar Pradesh, PIN: 229404** and consists of **FOUR ABOVE GROUND PETROLEUM CLASS C STORAGE TANK TOGETHER WITH CONNECTED FACILITIES.** together with connected facilities.

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Location:Allahabad [P7960]
Date:01-01-2024 17:29:00 PM

अनुज्ञप्ति संख्या-(Licence No.) P/HQ/UP/15/563 (P7960)

नवीनीकरण के पृष्ठांकन के लिए स्थान
SPACE FOR ENDORSEMENT OF RENEWALS

पेट्रोलियम अधिनियम, १९३४ के उपबन्धों या उनके अधीन बनाए गए नियमों या इस अनुज्ञप्ति की शर्तों का उल्लंघन न होने की दशा में यह अनुज्ञप्ति फ़िस में बिना किसी छूट के दस वर्ष तक नवीकृत की जा सकेगी | This licence shall be renewable without any concession in fee for ten years in the absence of contravention of any provisions of the Petroleum Act, 1934 or of the rules framed thereunder or of any of the conditions of this licence.	नवीकरण की तारीख Date of Renewal	समाप्ति की तारीख Date of Expiry of license	अनुज्ञापन प्राधिकारी के हस्ताक्षर और स्टाम्प Signature and office stamp of the licencing authority.
1).	08/12/2005	31/12/2007	Sd/- PESO ADMIN
2).	03/03/2008	31/12/2010	Sd/- R.N.Meena
3).	21/01/2011	31/12/2013	Sd/- Mridul Kumar Pandey
4).	06/01/2014	31/12/2018	Sd/- Dr. A.P. Singh Jt. Chief Controller of Explosives For Dy. Chief Controller of Explosives Allahabad
5).	28/12/2018	31/12/2023	Sd/- Rahul Kumar Mandloi Dy. Controller of Explosives For Dy. Chief Controller of Explosives Allahabad
6).	01/01/2024	31/12/2028	Dr R R Gupta Dy. Chief Controller of Explosives Allahabad

यदि अनुज्ञप्ति परिसर इसमें उपाबद्ध विवरण और शर्तों के अनुरुप नहीं पाए जाते है और जिन नियमों और शर्तों के अधीन यह अनुज्ञप्ति मंजूर की गई है उनमे से किसी का उल्लंघन होने की दशा में यह अनुज्ञप्ति रद्द की जा सकती है और अनुज्ञप्तिधारी प्रथम अपराध के लिए साधारण कारावास से, जो एक मास तक हो सकता है, या जुर्माने से, जो एक हजार रुपये तक हो सकता है, या दोनों से, और प्रत्येक पश्चातवर्ती अपराध के लिए साधारण कारावास से जो तीन मास तक हो सकता है, या जुर्माने से, जो पांच हजार रुपये तक हो सकता है, या दोनों से, दण्डनीय होगा \|

This licence is liable to be cancelled if the licensed premises are not found conforming to the description given on the approved plan attached hereto and contravention of any of the rules and conditions under which this licence is granted and the holder of this licence is also punishable for the first offence with simple imprisonment which may be extend to one month, or with fine which may extend to one thousand rupees, or with both and for every subsequent offence with simple imprisonment which may extend to three months, or with fine which may extend to five thousand rupees or with both.

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Location:Allahabad [P7960]
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Annexure-24

NTPC UNCHAHAR
DISASTER MANAGEMENT PLAN

Doc. No.	**NTPC/UCR/DMP/01**
Revision No.	**25**
Effective from	**29.03.2025**
Copy No. (If controlled copy)	
Issued to	

NTPC - Limited
UNCHAHAR (P.O.), RAEBARELI (DISTT.)
UTTAR PRADESH – 229406, INDIA

Prepared by: **Sh. JITENDRA KUMAR** **AGM (Safety Coordinator)**	**Reviewed by:** **Sh. ASUTOSH BISWAS** **(GM - O&M)**	**Approved by:** **Sh. ABHAY KUMAR SRIVASTAVA** **(HOP)**
29.03.2025	**29.03.2025**	**29.03.2025**

EMERGENCY TELEPHONE NOS.

S. No.	Location	Ph. No. (Intercom) / P&T
01	Shift In-Charge/ Control Room	6099/ Mobile No - 9450925139
02	Fire Station	6101/ 05311-278000(P&T)
03	Emergency/ Ambulance	6102/ 05311-278761(P&T)
04	First Aid Centre (Plant)	6112
05	Medical	6112/ 05311-278001(P&T)
06	Safety	6103/ 05311-278041(P&T)
07	CISF Security	6100/ 3096/ 05311-278032 (P&T)
08	Civil Maintenance	6097
09	Electrical Maintenance	6098
10	Water Leakage/ Wastage	6106
11	Reception	6000
12	HOP	6104
13	GM (O&M)	6105

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01. DEFINITION AND GLOSSARY OF TERMS

1.1 DISASTER
As far as this document is concerned the word disaster will be synonymous with emergency which is defined below: -

1.2 EMERGENCY
An emergency occurring in the Plant is one that may affect sections within it and / or may cause serious injuries, loss of lives, extensive damage to property or serious disruption outside the works. It will require the best use of internal resources as well as outside resources to handle it effectively. Usually it is the result of a malfunction of the normal operating procedures; it may also be precipitated by the intervention of an outside force such as a cyclone, flood or deliberate acts of arson or sabotage.

1.3 ACCIDENT SITE
The location of an unexpected occurrence, failure or loss either at a facility or along transportation route, resulting in a release of hazardous materials on incident site.

1.4 AIRBORNE RELEASE
Release of any chemical into the air.

1.5 BOILING LIQUID EXPANDING VAPOUR EXPLOSIONS (BLEVE)
Boiling Liquid Expanding Vapour Explosions (BLEVE) are amongst the most feared events when containers of hazardous chemical are exposed to fire or physical damage or other events that cause excessive pressure within the tank. The pressure inside the container eventually vents itself through the weakest area of the tank. This sudden venting of pressure and vaporisation of product involves violent rupture of the container with rocketing fragments.

1.6 CHEMICAL ABSTRACT SERVICE NO (CAS NO)
The chemicals are listed by their common names and also by their Chemical Abstract (CAS) number. While chemicals may be known by several different names, the CAS number provides a unique and unambiguous identification.

1.7 CHEMICAL PROCESS
A particular method of manufacturing or making a chemical usually involving a number of steps or operations.

1.8 CHRONIC EFFECTS
Of long duration or having frequent recurrence. Chronic health effects are those that become apparent or continue for some time after exposure to hazardous chemicals.

1.9 CONTINGENCY PLAN
A document to identify and catalogue the elements responds to an emergency, to define responsibilities and specific tasks, and to serve as a response guide.

1.10 EMERGENCY
A situation created by an accidental release or spill of hazardous chemicals which poses a threat to the safety of workers, residents, the environment or property.

1.11 EVACUATION
Removal of residents and other persons from an area of danger.

1.12 EXERCISE
A simulated accident or release set up to test emergency response methods and for use as a training tool.

1.13 HAZARD
Any situation that has the potential for doing damage to life, property and or the environment.

1.14 HAZARDOUS CHEMICAL

A chemical which is explosive, flammable, poisonous, corrosive, reactive or radioactive and require special care in handling because of the hazards it poses to public health and environment.

1.15 HAZARDOUS INSTALLATION

An industry handling hazardous chemicals.

1.16 HAZARD ANALYSIS

Identification of undesired events that lead to the materialization of the hazards. The analysis of the mechanism by which those undesired events could occur and usually the estimation of the extent, magnitude and relative likelihood or any harmful effects.

1.17 HAZARD IDENTIFICATION

Provides information on available extremely hazardous substances (EHSs) on site, their nature, quantities and also on storages and conditions of storage.

1.18 IDLH

Immediately dangerous to life or health (IDLH) level means the maximum level to which a healthy worker can be exposed for 30 minutes without suffering irreversible health effects or escape impairing symptoms.

1.19 LCLO

Where acute exposure data are available (30 Minutes to 4 hours exposure), the lowest exposure concentration causing death or irreversible health effects in any species is used as the IDLH concentration. These data are often reported as lethal concentration low (LCLO).

1.20 LETHAL

Causing or capable of causing death.

1.21 LEVEL OF CONCERN (LOC)

The concentration of an extremely hazardous substances (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

1.22 ON SITE EMERGENCY

An accident which takes place in an industry and its effects are confined to the factory premises involving only the people working in the factory.

1.23 OFF-SITE EMERGENCY

If an accident takes place in an industry and its effects are felt outside the factory premises, the situation thus generated is called an off-site emergency.

1.24 OCCUPIER

Occupier in relation to NTPC Plant is Head of the Plant i.e. General Manager.

1.25 PROBABILITY

A number of expressing the likelihood of occurrence of a specific event, such as the ratio of the bumper of outcomes that will produce given event to the total number of possible outcomes.

1.26 RADIUS OF VULNERABLE ZONE

The maximum distance from the point of release of a hazardous substance at which the airborne concentration could reach the level of concern (LOC) or LCLO under specified weather conditions.

1.27 RESPONSE

The efforts to minimize the risks created in an emergency by protecting the people, the environment or the property, and the efforts to return the scene to normal pre-emergency conditions.

1.28 RISK

The predicted or actual frequency of occurrence of an adverse effect of a chemical or other hazard.

1.29 RISK ANALYSIS

It is a relative measure of the likelihood of various possible hazardous events and enable the emergency plan to focus on the greatest potential risk.

1.30 SITE / FACILITY

Any location where actually toxic chemicals are processed, stored, handled, used or disposed in short any place where these chemical any be found.

1.31 STORAGE

Methods of keeping raw materials, finished goods or products while awaiting use or consumption.

1.32 TRANSFER

Loading unloading of chemicals between transport vehicles and storage place.

1.33 TRANSPORT

To carry or convey goods from the place to another using any type of vehicle.

1.34 THRESHOLD PLANNING QUANTITY (TPQ)

A quantity designated for each chemical which requires the occupier to take various steps in preparation of emergency planning like preparation of on-site plans, submission of information for preparation of off-site plan or making a safety report as per manufacture, storage and import of Hazards Chemicals Rules, 1989.

1.35 VULNERABLE ZONE

It is an estimated geographical area that may be affected by the toxic release at levels that could cause irreversible acute health effects or death to human population within the area following an accidental release.

02. OBJECTIVE OF "ON SITE EMERGENCY PLAN"

An "On site Emergency" is caused by an accident that takes place in a hazardous installation and the effects are confined to the factory premises involving only the people working in the factory. On Site Emergency Plan to deal with such eventualities is the responsibility of the occupier and is mandatory.

Apart from the provisions in the Hazardous Chemicals Rules, Section 14-B (4) of the Factories Act, 1948 (as amended) also requires that every occupier is to draw up an On Site Emergency Plan with detailed disaster control measures for the factory and to educate the workers employed in the factory premises. The obligation of an occupier of hazardous chemicals to prepare an emergency plan is stipulated in Rule 13 of the Manufacture, Storage and Import of Hazardous Chemicals Rules 1989. The general public living in the vicinity is also to be informed and educated about safety measures and actions required to be taken in the event of an accident.

The preparation of an On Site Emergency Plan and furnishing relevant information to the District Emergency Authority for the preparation of the Off Site Emergency Plan are statutory responsibilities of the occupier of every industry and other units handling hazardous substances. An On site Emergency Plan should contain the following key elements effect of rescue and treatment of causalities:-

(1) Safeguard other personnel in the premises.

(2) Minimize damage to property and environment.

(3) Initially contain and ultimately bring the incident under control.

(4) Identify any deeds.

(5) Provide to the needs of relatives.

(6) Provide authoritative information to the news media concerned officials.

(7) Secure the safe rehabilitation of affected persons.

(8) Preserve relevant records and equipment for the subsequent enquiry into the cause and circumstances of emergency.

03 BRIEF DESCRIPTION OF THE PLANT

Feroze Gandhi Unchahar Thermal Power Project is a power generation plant presently having an installed capacity of Thermal (5 X 210 MW +1 X 500 MW) + Solar (10 MW) = 1560 MW. The process details of Thermal power are given below: -

INDUSTRIAL ACTIVITIES AND PROCESSES

PRODUCTION OF STEAM

Coal from the coal wagons is unloaded in the Coal Handling Plant. This coal is transported upto the raw coal bunkers with the help of belt conveyors. Coal from coal bunkers conveyed to pulverized mills (Bowl & Tube mills) by coal feeders where it is pulverized to powder from. This pulverized coal is taken away to the furnace through coal pipes with the help of hot and cold air mixture from Primary Air – fan. PA fan takes atmospheric air, a part of which is sent to Air-preheaters for heating while a part goes directly to the mill for temperature control. Atmospheric air from FD fan is heated in the Air Heaters and sent to the furnace as combustion air.

Water from deaerator / feed storage tank is pumped the boiler feed pumps passes through economizer and reaches the boiler drum and from there it passes through down comers and goes to bottom ring header. Water from the bottom ring header is divided to all four sides of the furnace. Due to heat and density difference the water rises up in the water wall tubes. Water is partly converted to steam as it rises up in the furnace. This steam and water mixture is again taken to the boiler drum where the steam is separated from water. Water follows the same path while the steam is sent to super-heaters for super-heating. The super heaters are located inside the furnace and the steam is superheated to 540° C and finally it goes to turbine.

A flue gas from the furnace is extracted by Induced Draft Plan which maintains balance draft in the furnace with forced draft fan. These flue gases emit their heat energy to various super heaters in the boiler and finally pass through air pre-heaters and goes to electrostatic precipitator consists of metal plates which are electrically charged. Ash particles are attracted on to plates, so that they do not pass through the chimney to pollute the atmosphere. Regular mechanical hammer blows cause the accumulation of ash to fall to the bottom of precipitator where they are collected in a hopper for disposal. This ash is mixed with water to form slurry, and each pumped to ash pond.

The dry ash directly collected from ESP hoppers is transported by the air to the ash silo for its use to different utilities. The flue gas desulfurization (FGD) plant installed in Stage-4 & being installed in other Stages to remove sulfur dioxides (SO2) from flue gas.

STEAM TO POWER

From the boiler steam pipes convey steam to the turbine through stop valves and through control valves that automatically regulate the supply of steam to the turbine. Stop valves and control valves are located in a steam chest and a governor driven from main turbine shaft operates the control valves to regulate the amount of steam used.
Steam from the control valves enters the high-pressure cylinders of the turbine, where it passes through a ring of stationery blades fixed to the cylinder wall. These act as nozzles and direct the steam into a second ring of moving blades mounted on a disc secured to the turbine shaft. This second ring turns the shafts as a result of the force of the steam. The stationery and moving blades together constitute a stage of the turbine and in practice many stages are necessary. So, the cylinder contains a number of rings of stationery blades with rings of moving blades arranged between them. The steam passes through each stage in turn until it reaches the end of the high-pressure cylinder and in its passage some of its heat energy is changed into mechanical energy.
The steam leaving the high-pressure cylinder goes back to the boiler for reheating and returns to intermediate pressure cylinder. Here, it passes through another series of stationery and moving blades.
Finally, the steam is taken to the low-pressure cylinder which enters at the centre flowing outwards in opposite directions through the rows of turbine blades as double flow to the extremities of the cylinder. As the steam gives up its heat energy to drive the turbine, its temperature and pressure reduces and it expands. Because of this expansion the blades are much large and longer towards the low pressure ends of the turbine.
The turbine shaft usually rotates at 3,000 revolutions per minute (RPM). This speed is determined by the frequency of the electrical system used in this country and is the speed at which a 2 – pole generator must be driven to generate alternating current at a frequency of 50 cycles per second.
When as much energy as possible has been extracted from the steam it is exhausted directly to the condenser. The condenser consists of a large vessel containing large number of tubes. Cold water is circulated through these tubes and as the steam from the turbine passes round them it is rapidly condensed into water condensate. Since water has a much smaller comparative volume than steam, a vacuum is created in the condenser. This allows the steam to reduce down to pressure below that of the normal atmosphere and more energy can be utilized.
From the condenser the condensate is pumped through low pressure heaters by the extraction pumps, after which its pressure is raised to boiler pressure by the boiler feed pump. It is passed through further feed heaters to the economizer and the boiler for re conversion into steam.

Where the cooling water for power stations is drawn from large rivers, estuaries or sea it can be returned directly to the source after use. Power stations situated on smaller rivers and inland like ours do not have such vast water resources available the cooling water is passed through cooling towers and reused.
Source of water for Unchahar Power Station is Sharada Sahayak/ Dalmau canal.

SWITCHING AND TRANSMISSION

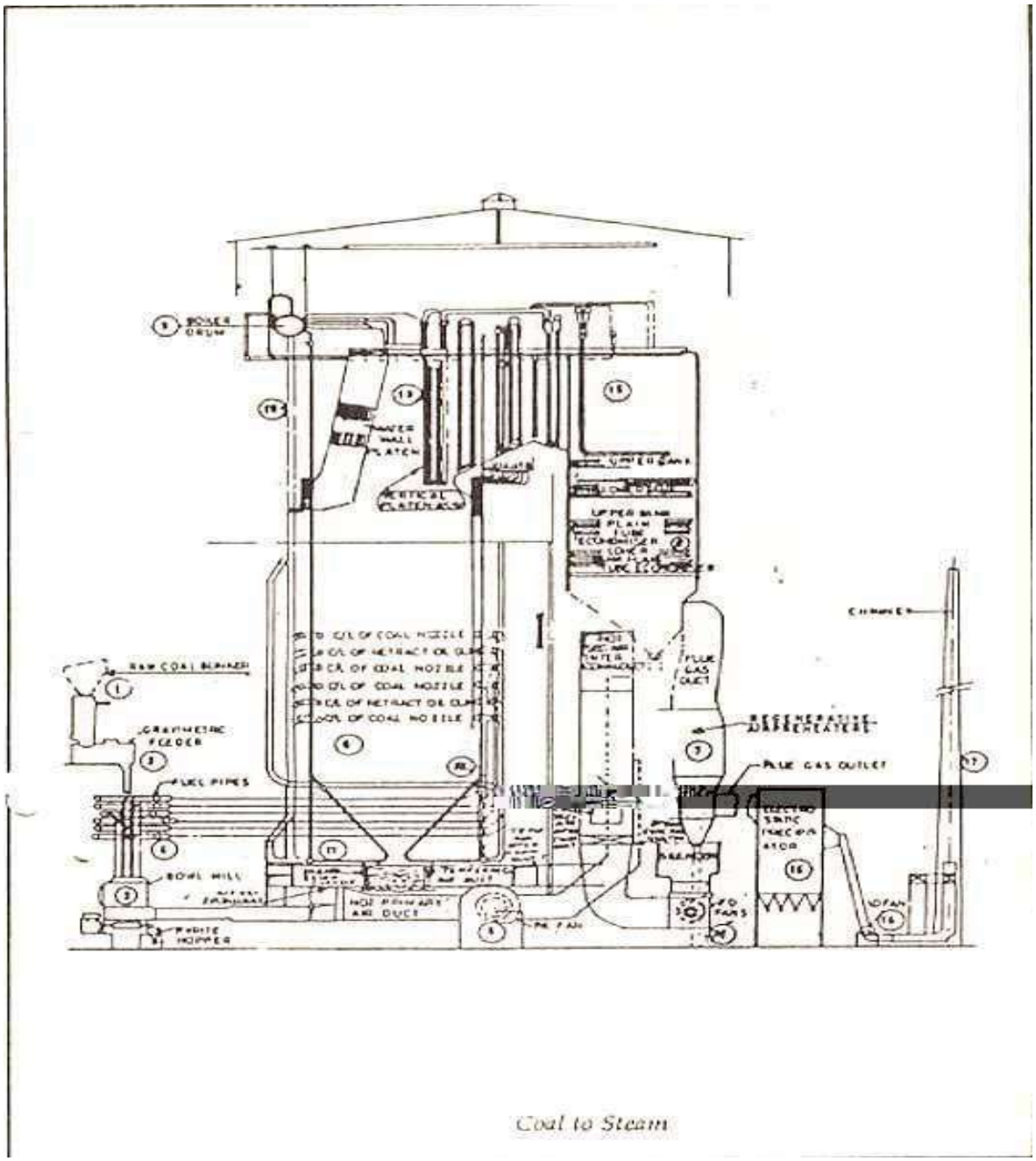
Electricity is produced in the stator windings of large generator at 15750 volts and is fed through terminal connections to one side of a generator transformer that step up the voltage

to 220000 Volts (220 KV) . From here conductors carry it to a series of three switches comprising an isolator, circuit breaker and another isolator.
The circuit breaker which is a heavy duty switch capable of operating in a fraction of a second is used to switch off the current flowing to the transmission lines. Once the current has been interrupted the isolators can be opened. These isolated the circuit breaker from all outside electrical sources to that there is no chance of any high voltages being applied to its terminals which ensures safety of maintenance personnel. The breakers used for 220 KV switching operations are of SF_6 type in which Sulphur-Hexafluoride gas is used as quenching media. Sulphur-Hexafluoride gas is inert thermally stable non-inflammable and nonpoisonous which makes it ideally suitable for high voltage are quenching in circuit breakers.
The center of the Power station is the control room. Here engineers monitor the output of electricity, supervise and control the operation of generating Plant and high Voltage switchgear directing the power to the grid system as required. Instruments on the control panels show the output and power flow conditions and miniature diagrams given on control panels indicate the precise state of the electrical system.

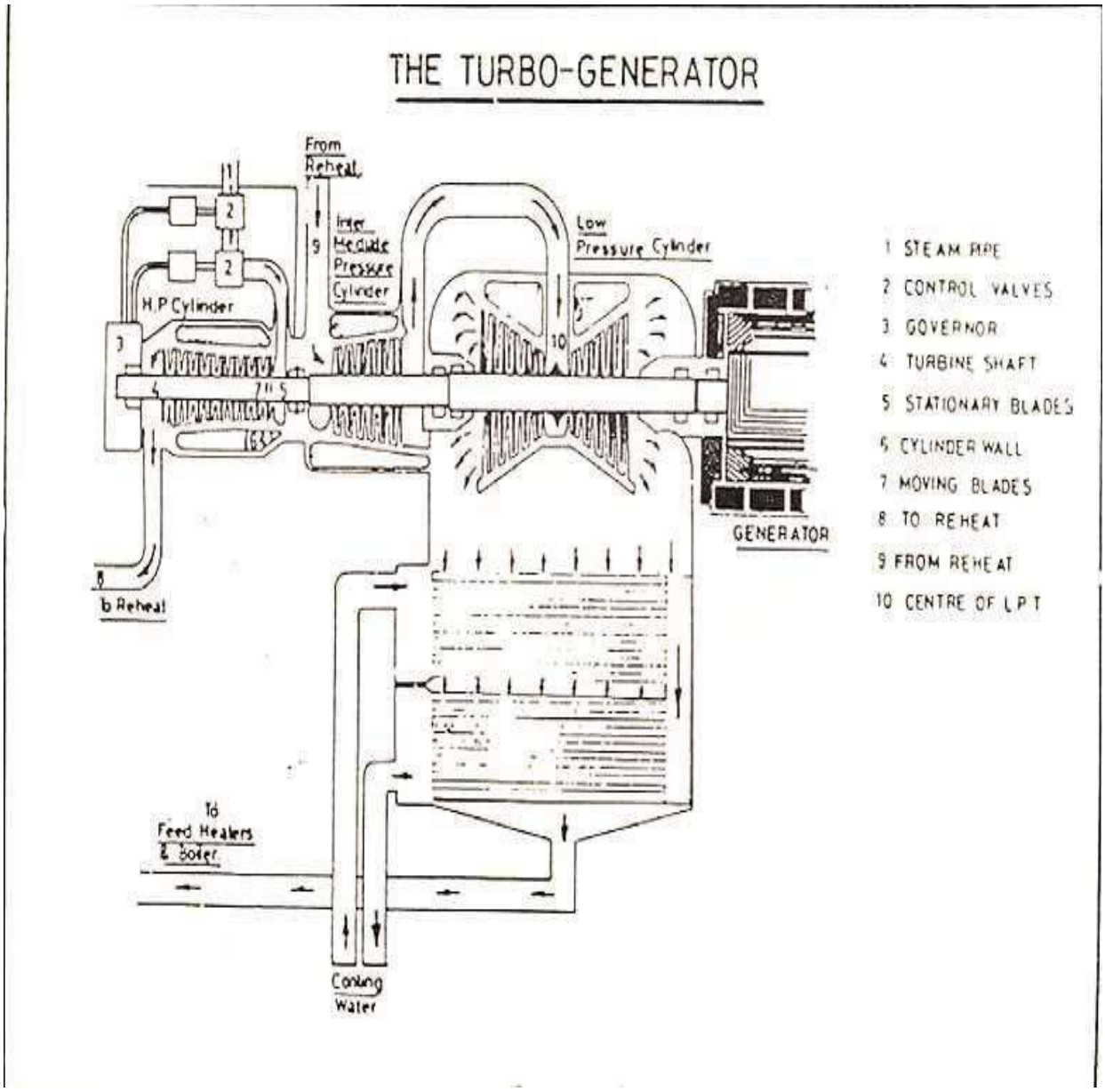
4. ABOUT NTPC, UNCHAHAR PLAN AND ITS MODIFICATION

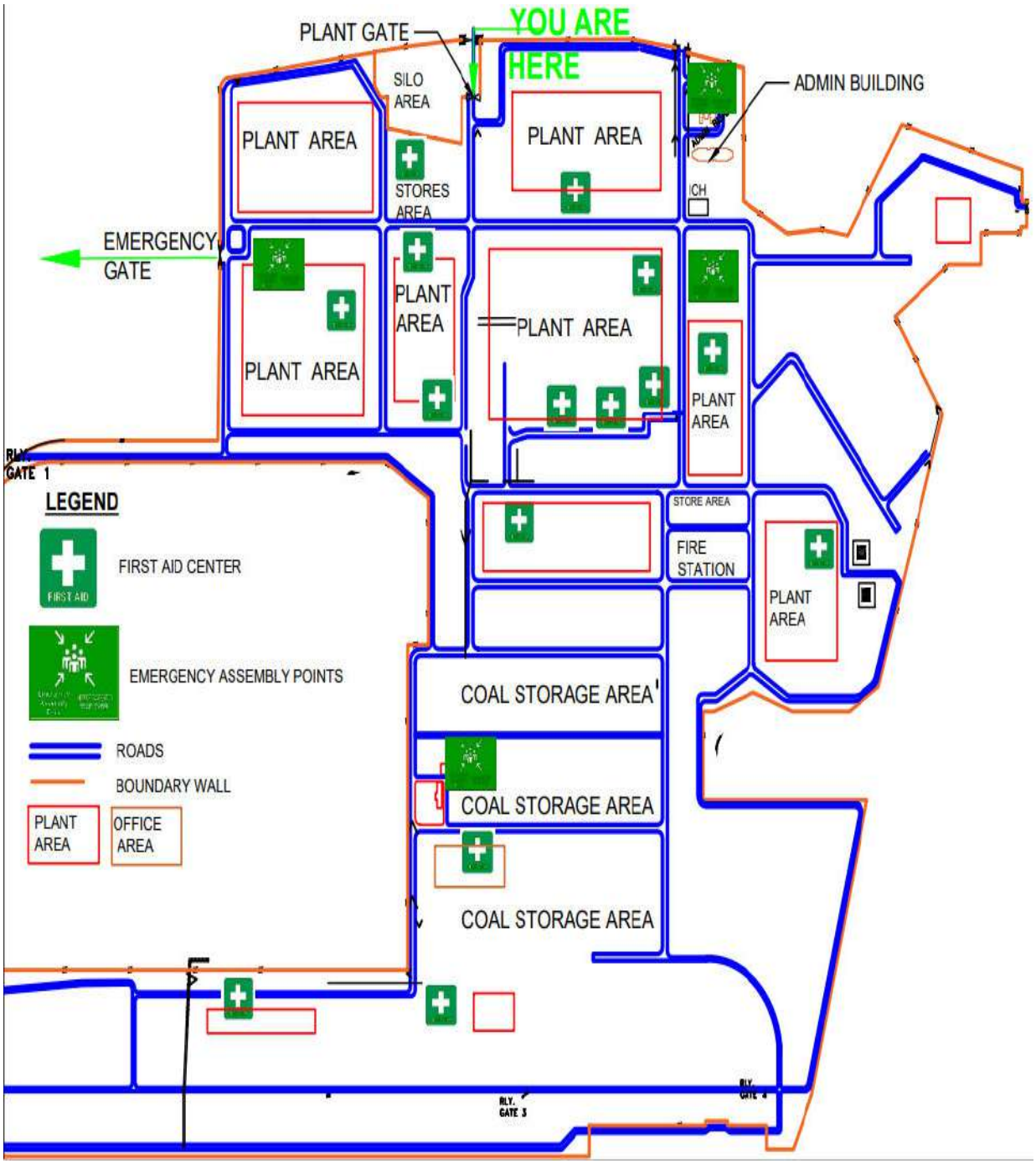
At Unchahar, all efforts, right from the take over from Uttar Pradesh Rajya Vidut Utpadan Nigam (A U.P. Govt. undertaking) in Feb' 1992 itself have been emphasized to run the plant safely. Initially the location management instructions to handle the emergencies arising out of Operation and Maintenance prepared and implemented. On site Emergency Plan for Unchahar had been worked out on the guidelines provided by World Bank for protecting the property and life in and around the Unchahar Thermal Power Station, in the event of disaster such as earthquake, cyclone, flood, fire and explosion, toxic release, terrorist activities and due to malfunctioning in standard working system. In the past, no. of times plan has been modified and upgraded based on the practical experiences, actual practices and for the compliance of Rule-13 of the Manufacture, Storage and Import of Hazardous Chemical Rules 1989 and Section 41-B (4) of the Factories Act 1948 (as amended).
The modifications of plan in 2000 have been done taking into consideration various inputs requirement of district administration and the guidelines which are applicable to NTPC, Unchahar have been incorporated in the plan. This document includes all such information about NTPC, Unchahar which District Emergency Authority requested from the occupier for the preparation of Off-Site Emergency Plan for the district, Raebareli (U.P.)

COAL TO STEAM



TURBO-GENERATOR




PLANT GATE
YOU ARE HERE
SILO AREA
ADMIN BUILDING
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EMERGENCY GATE
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RLY. GATE 1
LEGEND
FIRST AID CENTER
EMERGENCY ASSEMBLY POINTS
ROADS
BOUNDARY WALL
PLANT AREA
OFFICE AREA
STORE AREA
FIRE STATION
PLANT AREA
COAL STORAGE AREA
COAL STORAGE AREA
COAL STORAGE AREA
RLY. GATE 3

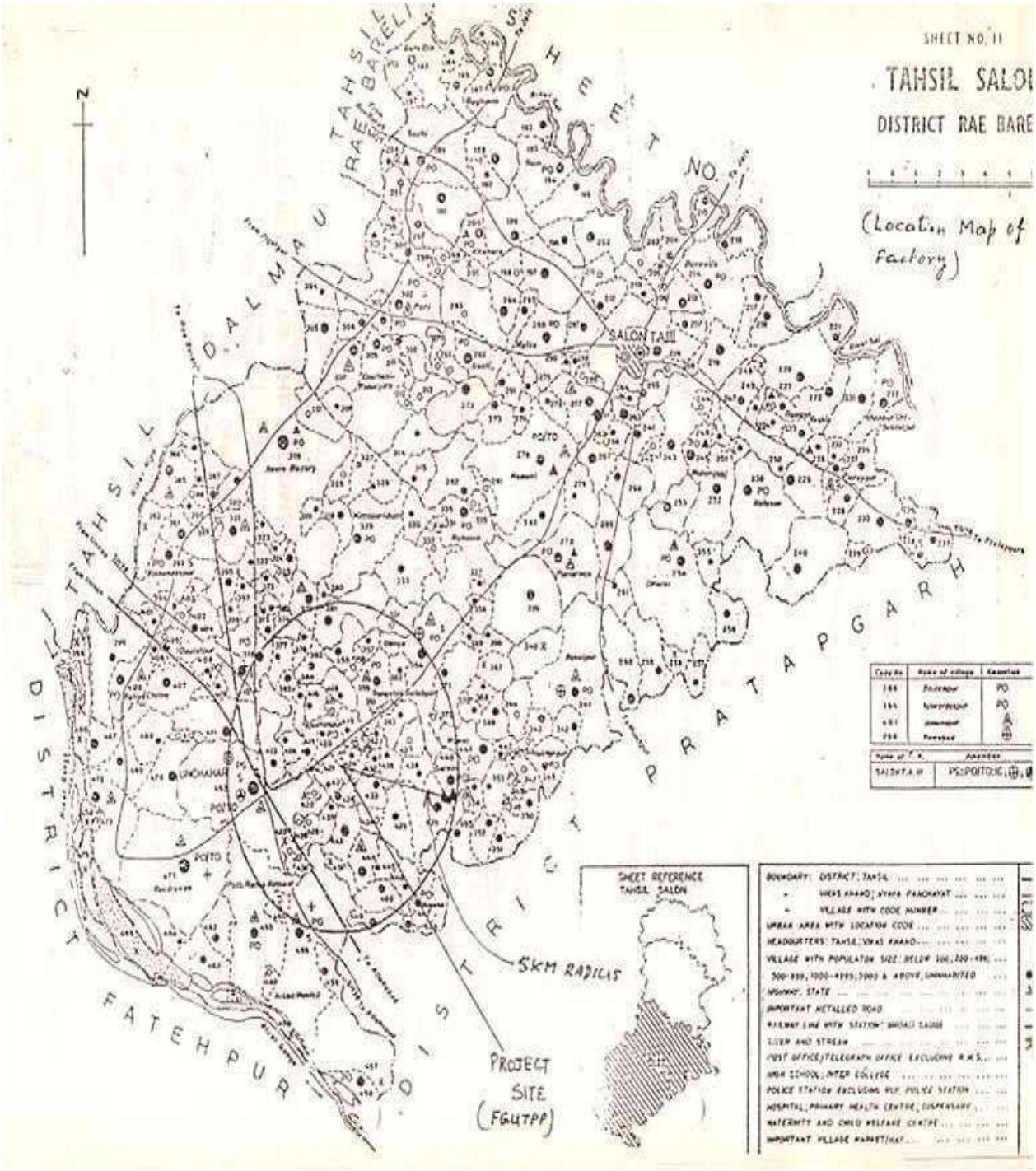
5. GENERAL INFORMATION & DEMOGRAPHIC FEATURES WITH VICINITY / SITE PLAN OF NTPC, UNCHAHAR

Demographic features of the plant are tabulated as below: -

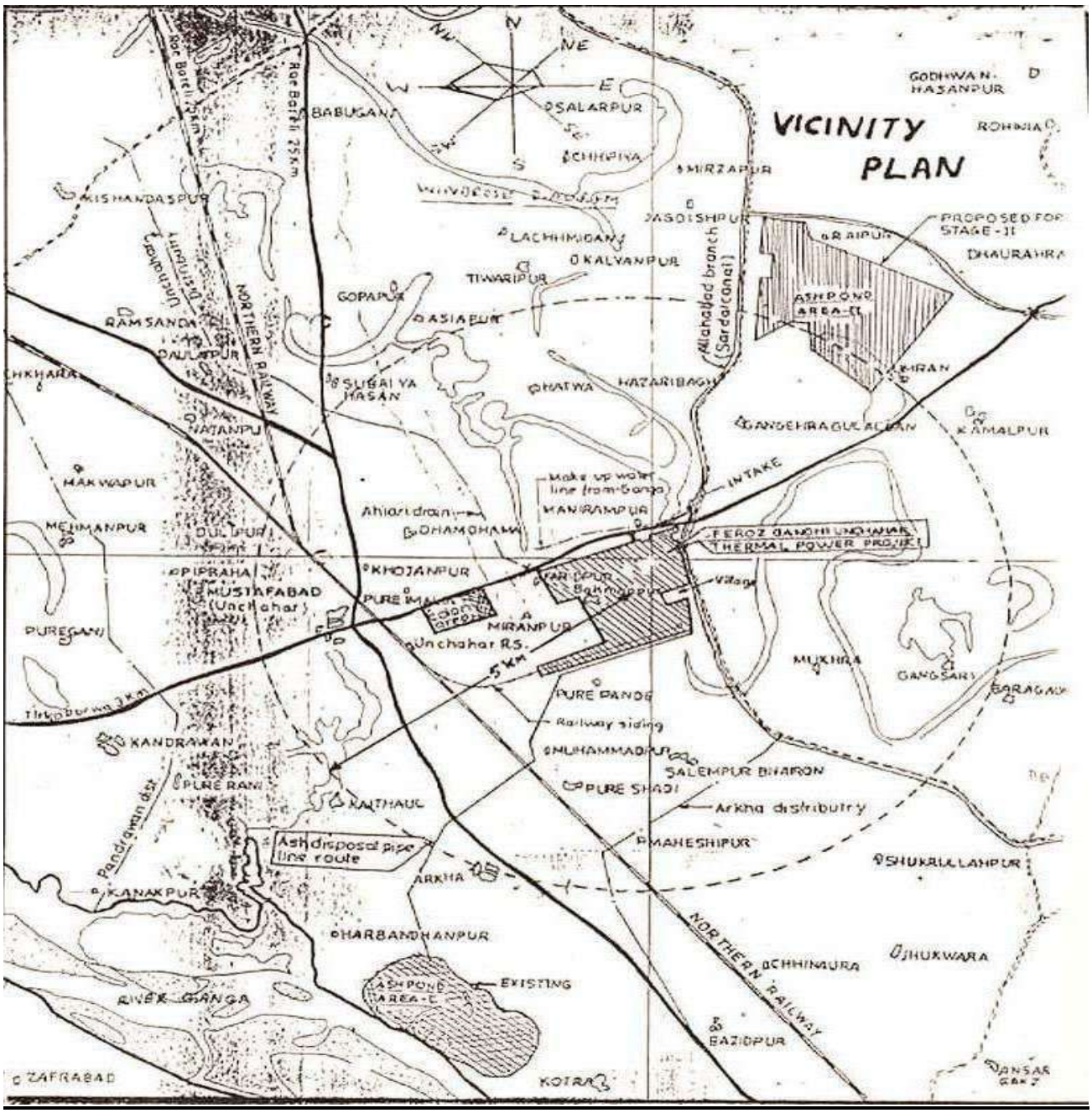
1	NAME AND ADDRESS OF THE FACTORY	NTPC Limited FEROZ GANDHI UNCHAHAR THERMAL POWER PROJECT (FGUTPP) P.O. UNCHAHAR, DISTT: RAEBARELI UTTAR PRADESH, PIN CODE – 229 406 FAX NO. (05311) 278065
2	LOCATION	FGUTPP is located in Raebareli District of Uttar Pradesh at a distance of approximately 3 KM from Unchahar town on Allahabad – Raebareli Broad gauge section of Northern Railway and Allahabad Lucknow State Highway
3	PRODUCTS MANUFACTURED PHYSICAL STATE MODE OF STORAGE	POWER GENERATION N.A. N.A.
4	INTERMEDIATE PRODUCTS	NIL
5	NO. OF PERSONS EMPLOYED	500 (APPROX.)
6	NAME OF OCCUPIER AND TEL. NO.	Sh. ABHAY KUMAR SRIVASTAVA HEAD OF PROJECT TEL # (OFF) (05311) 278010 TEL # (RES) (05311) 278004 Mob. No.: 9650990866 E Mail: aksrivastav@ntpc.co.in
7	NAME, ADDRESS & TEL.NO. OF FACTORY MANAGER	Sh. ASUTOSH BISWAS GENERAL MANAGER (O&M) TEL # (OFF) (05311) 278105 TEL # (RES) (05311) 278105 Mob. No. 8004940332 E Mail: asutoshbiswas@ntpc.co.in
8	NAME OF MEDICAL OFFICER AND SAFETY OFFICER	Dr MADHU SINGH, C.M.O. TEL # (OFF) 2308 TEL # (RES) 2309 Mob. No. 9437966880, E Mail: madhusingh@ntpc.co.in (1) Sh. Jitendra Kumar, AGM (Safety Coordinator) TEL # (OFF.) (05311) 278041 Mob. No. 8210201926 E Mail: jitendrakumar02@ntpc.co.in (2) Sh. Rakesh Kumar Sahu, Sr. Manager (Safety) Mob. No. 9109179822 E Mail: rakeshsahu@ntpc.co.in
9	INSTALLED HP / MW	2107413 HP / 1560 MW
10	GENERAL WIND DIRECTION	WEST TO EAST
11	LOCATION OF HAZARDOUS	AS LOCATED IN SITE PLAN (Page. 12 to 14)

	STORAGE & PROCESS	
12	EMERGENCY CONTROL CENTRE, ADDRESS & PHONE NO.	Adjacent to HOP Office room, New Admn. Bldg. Block, Inside plant premises.
13	ASSEMBLY POINTS	1. In front of Service Building 2. Near Administrative Building 3. In front of CHP Control Room 4. In front of Stage-IV Park
14	LOCATION OF NEARBY HOSPITAL, RELIEF PLACES, FIRE AND POLICE STATIONS	Primary health centre, Unchahar, Fire station – Salon (20 km) & Raebareli (41 km) Police station - Unchahar

LOCATION MAP OF THE FACTORY



SITE / VICINITY PLAN

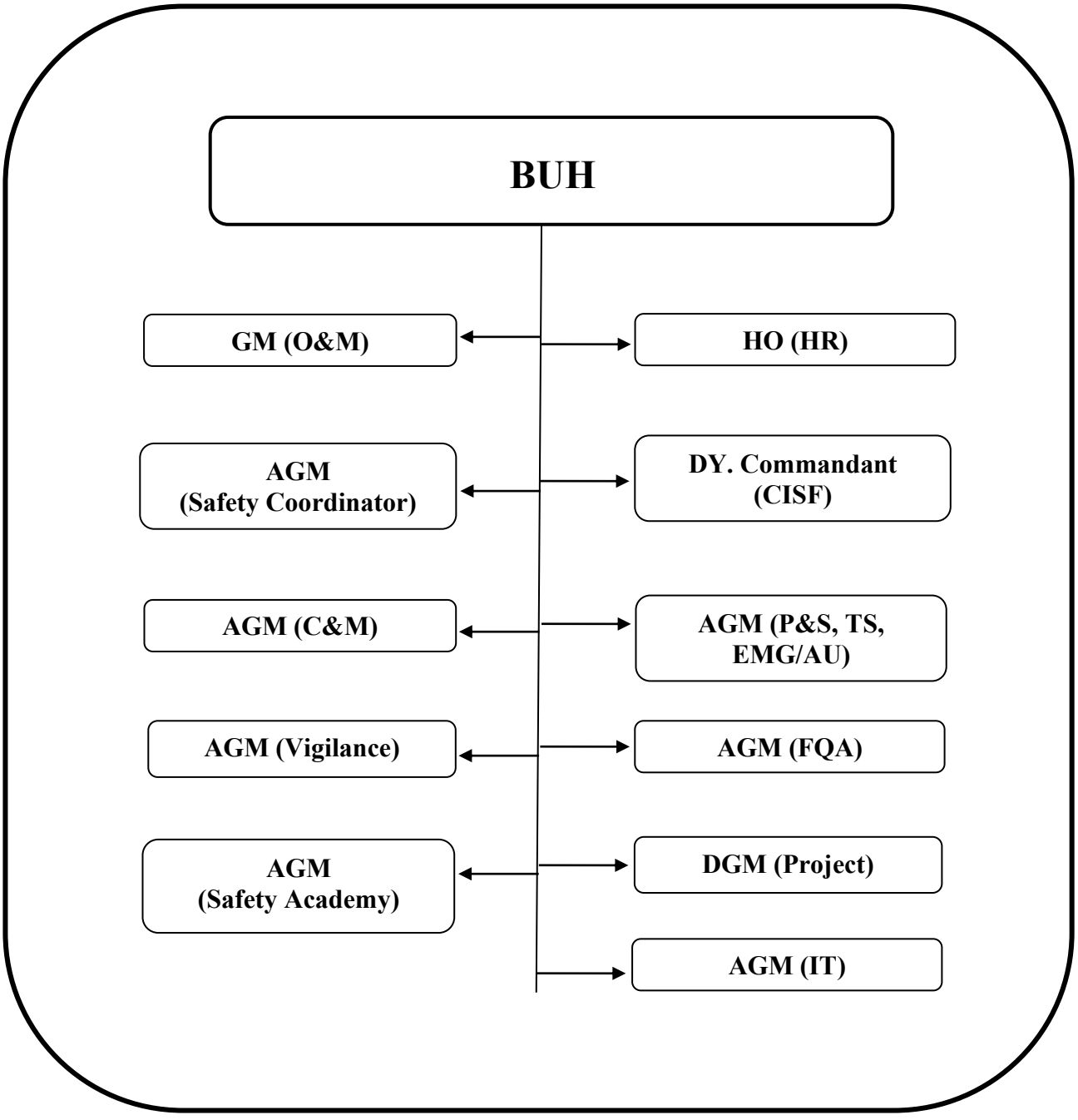


06. POPULATION DETAILS AROUND FGUTPP

S.No	NAME OF VILLAGE	AREA OF VILLAGE (HECTARE)	TOTAL POPULATION
1	Sonerbagh	53.70	78
2	Chhatauna Mariyani	142.33	1775
3	Reghunathpur labehdawa	65.15	400
4	Hazaribagh	31.56	342
5	Gongehara Gulalganj	290.52	2361
6	Bhawanidinpur	83.37	699
7	Raghunathpur Paterawa	65.16	381
8	Bikargarh	42.90	482
9	Murar nau	105.22	669
10	Umaran	390.00	4786
11	Kanalpur	86.00	193
12	Dakpur	66.77	293
13	Gopapur	24.68	670
14	Sawaiya Hasanpur	71.10	377
15	Sawaiya Mira	133.14	945
16	Paindapur	76.89	593
17	Prayagpur Nadura	43.25	1862
18	Detaule	237.72	824
19	Hatwa	163.89	1062
20	Sawaiya Raje	82.86	1178
21	Jamalpur Maufi	65.15	618
22	Sawaiya Dhani	24.90	2577
23	Samapur Nevada	209.00	722
24	Khojanpur	169.15	2127
25	Dhandama	61.91	788
26	Baherawa	146.90	1891
27	Hisampur	78.10	805
28	Khargsenpur	28.33	123
29	Gopalpur	131.53	913
30	Manirampur	78.10	659
31	Khurranpur	99.15	963
32	Faridpur	39.66	574
33	Mirapur Dangani	29.14	91
34	Bhamanpur	90.24	330
35	Niranjapur	27.52	336
36	Khanpur	54.23	120
37	Bikai	77.30	673
38	Saral Parsu	74.46	326
39	Khallikpur Khurd	40.47	150

40	Malkna	72.02	154
41	Jairampur	82.90	102
42	Gauraiyapur Maafi	12.90	46
43	Kaleh	73.25	241
44	Saraisahihjan	180.89	671
45	Madhopur Hardopad	56.66	177
46	Mikhara	227.03	886
47	Madaripur	112.49	322
48	Bhuwalpur	114.52	343
49	Lalchandra Chhania	142.85	429
50	Gangesari	300.28	1108
51	Sareni	100.28	533
52	Mawai	58.80	217
53	Purbara	332.65	1110
54	Saleempur Bhairon	235.53	1094
55	Narainpur	125.46	275
56	Hariharpur	100.68	323
57	Madhopur Sultan	78.30	261

07. ORGANISATION CHART



8. NEAR BY HOSPITALS

30 Bedded upgraded Primary Health Centre, Unchahar: 3 KM

Primary Health Centre, Salon: 20 KM

I.T.I. Hospital, Raebareli: 40 KM

Distt: Hospital, Raebareli: 40 KM

Medical College Hospital, Lucknow: 130 KM

Central: Command Hospital, Lucknow: 130 KM

Sanjay Gandhi Post Graduate Hospital, Lucknow: 120 KM

Medical College Hospital, Allahabad: 90 KM

Medical College Hospital, Kanpur: 140 KM

Shyama Prasad Mukherjee Civil Hospital , LKO

9. EMERGENCY CONTROL CENTRE (ECC)

Emergency Control Centre will be adjacent to Group General Manager's office and equipped with adequate means of communication to areas inside and outside the work together with relevant data of Personal Protective equipment to assist those manning the centre and to enable them to plan accordingly.

The Emergency Control Room will be occupied by the Chief Incident Controller, the officials nominated as key personnel and Sr. Executives of outside Services called in for assistance. No other person shall have access to the Emergency Control Centre.
ECC will also contain the following data:

Safety data pertaining to all hazardous materials likely in emergency etc.

Procedure of major and special firefighting rescue operations and First Aid etc.

Emergency call out list of persons drafted for emergency control center, key personnel, fire safety, First Aid, medical, P&IR, Security and District Administrative Authorities.

The following minimum facilities should be available in Emergency control Centers:

1) 2 nos. of Intercoms.
2) 2 nos. of P&T Telephones
3) Telex and Fax
4) Wireless/ Walkie Talkie
5) Emergency manuals

6) Blown up area maps
7) District phone directories
8) Emergency lights
9) Wind direction and speed indicator

10. EVACUATION AND ASSEMBLY POINTS

In an emergency, it would certainly be necessary to evacuate Personnel from affected areas and as precautionary measure, to further evacuate non-essential workers, in the first instance, from areas likely to be affected should the emergency escalate. The evacuation will be affected on getting necessary message from WIC. On evacuate employees shall assemble at Assembly Points.
The following areas are identified as assembly points and employees shall assemble at any of the assembly points depending on the area of emergency.

- Near Administrative Building
- In front of Service building (Unit#1)
- In front of CHP Control Room
- Park Near Stage 4 (In Front of ACW Pump House Unit#6)

11. MUTUAL AID SCHEME

Feroze Gandhi Unchahar Thermal Power Project is located about 35 KM from District Headquarters, Raebareli and 20 KM from Tehsil Headquarters, Salon. There are no industries around 35 KM radius which could give immediate help to NTPC Unchahar. Hence, efforts are being made to establish possible infrastructural facilities at the Project itself. In the event of extreme emergency, help through District Magistrate, Raebareli and Tehsil authorities, Salon can be obtained for which requisite line up is existing at NTPC Unchahar.

12. FLAMMABLE & HAZARDOUS CHEMICALS

(Details of Chemicals and Flammables / Combustible Materials Stored)

TOXIC CHEMICAL STORED

S. No.	CHEMICAL STORED	TYPE OF CONTAINER	NUMBERS	MAXIMUM STORAGE CAPACITY
1	Liquid Chlorine	Chlorine Tonner	6	Chlorination plant erected / commissioned

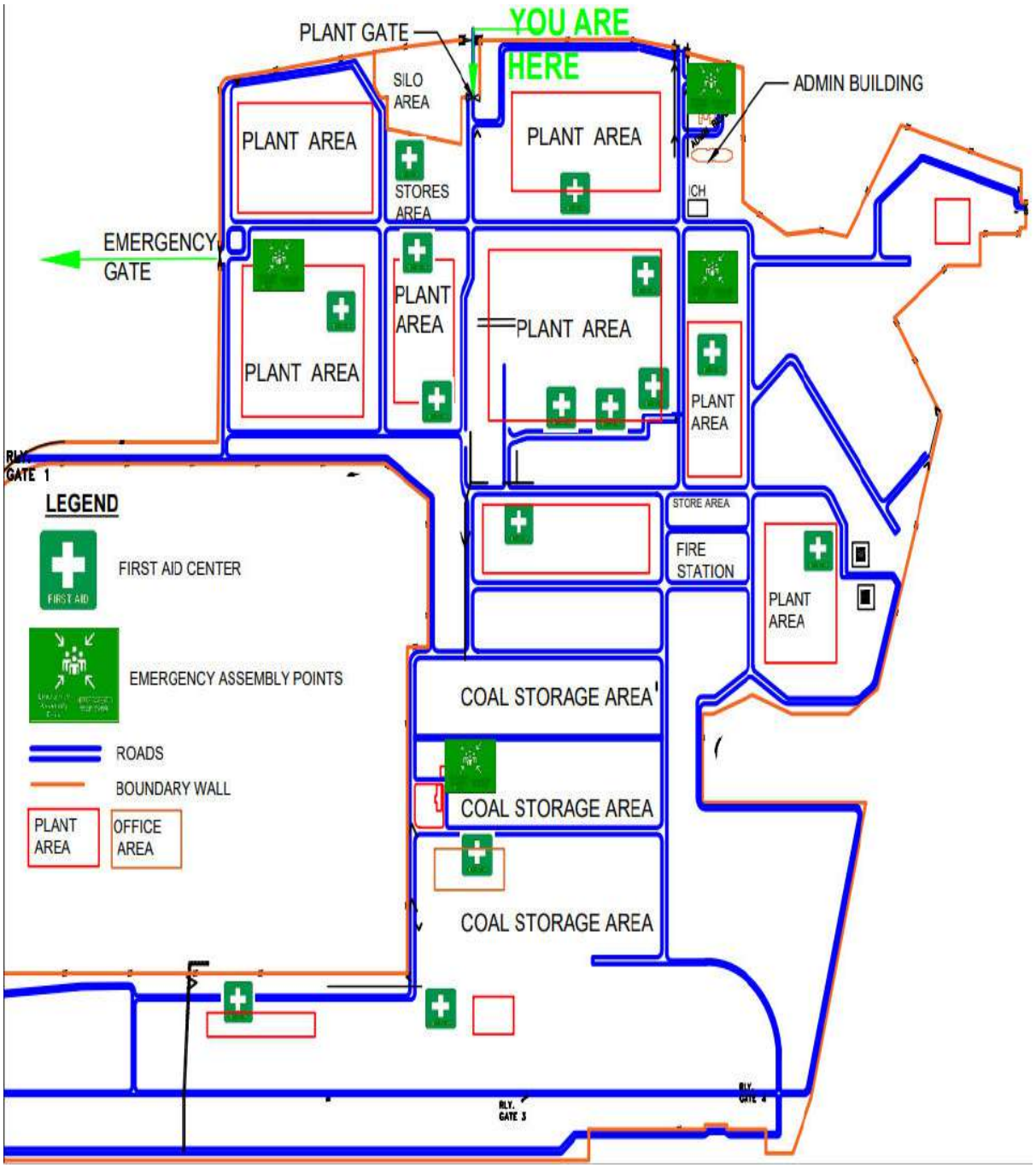
2	Hydrochloric Acid	Tank	4	240 MT
3	Sodium Hydroxide (Caustic)	Tank	3	180 MT
4	Ammonium Hydroxide	HDPE Drums (50 Liter capacity)	40	2 MT
5	Hydrazine	HDPE Drums (50 Liter capacity)	60	3 MT
6	Sulphuric Acid	Tank	2	100 MT

13. HAZARDOUS PLANT / LOCATIONS

I) FLAMMABLE / COMBUSTIBLES STORED

S. No.	CHEMICALS USED	TYPE OF CONTAINER	NOS.	CAPACITY
1	Furnace Oil	Tank	1	4,000 KL
2	Light Diesel Oil	Tanks	2	4,000 KL
3	Light Diesel Oil	Tank	1	500 KL
4	DOT	Tank	1	150 KL
5	Coal	Open Yard	3	5,00,000 MT
6	Hydrogen	Gas Holders	4	10 x 2 = 20, 3.5 x 2 = 7 = 27M3

EVACUATION LOCATIONS MATERIAL & STORES



II) EVACUATION LOCATIONS & MATERIAL STORES

(1) Considering the process and the material to be used at Thermal Power Station the following can be considered as major sections.

(2) Coal Handling Plant.

(3) Main Plant (Boiler, Turbo Generator etc.).

(4) Water Treatment Plant (Cl2 dozing, Chemicals etc.)

(5) Hydrogen Generation Plant.

(6) Switchyard including sub-stations.

(7) Fuel Oil Handling Plant.

(8) Chemicals and Lubricants stores.

(9) FGD Area

III) NATURE OF HAZARDS AND OCCURRENCES

(1) Slow isolated fires.

(2) Fast spreading fires.

(3) Explosions.

(4) Bursting of pipelines / vessels.

(5) Uncontrolled release of toxic / corrosive / flammable liquids.

(6) Uncontrolled release of toxic flammable gases / dusts.

Depending upon the nature, scale, speed, and impact on environment, these may constitute an emergency. The hazard potential of various plant sections is identified.

IV) FIRE HAZARD

(1) In Coal Handling Plant and at Conveyor.

(2) Cables in galleries and on trays in all plant sections.

(3) Fuel oil handling and oil tanks in main plant.

(4) Transformer oil and lub oil.

(5) Boiler area.

(6) FGD Area

(7) Switchgears and Switchyards

V) EXPLOSION HAZARD

(1) Hydrogen generation plant

(2) Turbo generator where Hydrogen is used for cooling

(3) Transformers.

(4) Boiler.

(5) Coal dust in mills and boilers.

VI) BURSTING OF PIPELINES & VESSELS

(1) Steam pipes due to high pressure / temperature.

(2) H2 gas lines, acid lines and oil lines.

VII) RELEASE OF GASES / DUST

(1) Chlorine in Water Treatment Plant.

(2) Hydrogen in Turbo Generator area of main plant and H2 plant.

(3) Pulverized coal dust from mills and associated piping.

(4) Fly Ash from chimneys and ash ponds, ESP hoppers and bottom ash system.

(5) Coal dust in transfer points, CHP Crusher & Mill area.

(6) Flue Gas transfer duct

VIII) RELEASE OF LIQUID

(1) Chemicals tanks in Water Treatment Plant.

(2) Fuel Oil tanks in Fuel oil handling section.

IX) CHLORINE LEAKAGE

Chlorine plant at NTPC Unchahar has been commissioned and presently chlorine is being used. The requirement of Cl_2 at NTPC Unchahar is less. Only the minimum required number of tonners is used.

Hence in anticipation of any emergency following necessary steps have been taken.

(1) Chlorine cylinders are stored at site i.e. always less than five.

(2) Automatic chlorine detection system with the provision of Alarm/ Siren at local and also at control room is installed in Chlorine usage area.

(3) Neutralizing pit with necessary arrangement is available. to put the leakage chlorine cylinders.

(4) Automatic chlorine gas absorption system is available. It is to suck Cl2 from leaking cylinder and neutralize with sodium hydroxide. It consists of blowers and

caustic recalculation pumps.

(5) For arresting the leakage from Toners, 2 Nos. chlorine sealing kits are available. Sufficient no. of persons is trained to use these kits.

(6) For personal protection 08 nos. breathing apparatus sets and two nos. compressed air breathing sets are available.

(7) Sufficient no. of the local operators/ executives are trained to use personal protective equipment, sealing kits, neutralizing system for leakage toners.

(8) Mock drills are being conducted at regular intervals (six month) as per Factories Act.

14. CAPABILITY ANALYSIS (EXISTING STRUCTURE)

Plant has adequate capability to protect its property and manpower in the event of emergency arising due to its operation and maintenance failure. Existing capability of plant have been given as below:

(1) FIRE FIGHTING CAPABILITY

The Plant is protected against fire hazards, and it is well equipped with fire protection systems. The Plant has its own "Fire Station" also. The details of the firefighting facilities available at FGUTPP is as under: -

(2) CISF FIRE WING AT FGUTPP

FGUTPP has full-fledged fire station operated by CISF (Fire Wing) personnel. The fire station is equipped with the following facilities to handle the fire promptly and actively:

(1) Asst. Commandant - 01

(2) Inspector - 00

(3) Sub-Inspector - 01

(4) Asst. Sub-Inspector - 06

(5) Head Constable - 14

(6) Naiks / LNC / Constable - 26

(7) Drivers - 8

(8) Motorcycle - 01

(9) Bicycle - 04

(10) Follower - 01

The fire control room is manned in 3 shifts round the clock. The minimum strength in each shift available is

Sub-Inspector / Asst. Sub-Inspector - 01

Head constable – 02 / Constable - 06

Driver – 02

15. FIRE FIGHTING EQUIPMENT AVAILABLE

S.No.	EQUIPMENT	AVAILABILITY	CAPACITY
A	Combined Foam Tender	1 no.	500
B	DCP Tender	1 no.	1000KG+1000KG
C	Foam Tender	1 no.	3000 Lts water 500 Lts foam
D	Water Tender	1 no.	4500 Lts
E	Fire Jeep	1 no.	
F	High Pressure Portable Pump	1 no.	1640 Lpm
G	Portable Pumps	6 nos.	275 Lpm
H	Blower Exhauster	1 no.	2.2 Kw
I	High & Medium Exhauster/ Foam Generator	2 Nos	
J	B.A. Set	17 nos.	-

*** HAYDRANT LANDING VALVES / YARD HYDRANT**

There are altogether 881 hydrants landing valves/ yard hydrant fitted at various locations of the plant which are manually operated, whenever water is required for first fighting work. Their distribution is as under:-
Single hydrant = 866
Double hydrant = 15
Water monitor = 59

Type	Quantity
Single hydrant	881
Double hydrant	15
Water monitor	59

*** PUMPS USED FOR WATER SUPPLY FOR FIRE FIGHTING HYDRANT SYSTEM AND FOR SPRINKLER SYSTEM**

S. No.	TYPE OF NAME	NO. OF PUMPS	CAPACITY
1	Electrically Driven pumps	11 nos.	410 M3/Hr
2	Diesel Driven pumps	6 nos.	410 M3/Hr
3	Booster pumps (4 Elec. + 4 Diesel)	04 nos. (02 El.+02Diesel) 04 nos. (02 El.+02Diesel)	70 M3/Hr 132 M3/Hr

4	Jockey pumps. (4 Elec. + 4 Diesel)	4 nos. (02 El.+02Diesel) 4 nos. (02 El.+02Diesel)	22M3/Hr 30M3/Hr

Diesel pumps come on Auto in case of power failure. These are tested by operation deptt. in daily morning.

*** PORTABLE FIRE EXTINGUISHERS**

In addition to firefighting equipments, portable and Mobile fire extinguishers have been installed at prominent locations of the Plant including Main Plant, Control rooms, Switch Gears, Laboratories, Off Sites, Administration building etc., details are tabulated below: -

*** NUMBER OF EXTINGUISHERS**

TYPE	50 KG	45 KG	25 KG	22.5 KG	10 KG	9 KG	5/6 KG	6.8 KG	4.5 KG	2 KG
CO_2 Type	-	-	-	85	-	40	-	297	478	32
DCP	48	-	20	-	122	-	525	-	-	-
FOAM TYPE	14	-	-	-	-	361	-	-	-	-
WATER	-	-	-	-	-	324	-	-	-	-

*** FIXED FIRE DETECTION AND PROTECTION SYSTEM**

HFO and LDO tanks have been provided with fixed foam systems. The foam station is situated near HFO tanks where foam concentration has been kept in tanks. The mixture of water and foam concentrate goes to HFO tanks, thrown on to the top surface of oil and converts into foam to extinguish the fire.

*** AUTOMATIC FIRE DETECTION SYSTEM**

1-Main plant area UCB I, II, III, IV, V & VI
2-Service building
3-Switch yard
4-CHP area
5-DM Plant/ CW switchgear room
6-FGD Control Room

*** AUTOMATIC SPRINKLER SYSTEM**

1-All conveyor belts
2-All cable vaults of unit I&II

*** AUTOMATIC EMULSIFIRE SYSTEM**

1-All types of transformers (Temperature Detection Quartzoid Bulb operated)

*** AUTOMATIC MVW SYSTEM**

1-All cable galleries in unit III, IV & V
3-Boiler area
4-MOT area
5-Dirty and clear oil tank and seal oil pumps in Turbine area

*** MEDIUM VELOCITY SPRAY SYSTEM FOR HFO TANKS**

In addition to the foam system HFO tanks have been provided with medium velocity spray system to cool down the oil vapours which develop due to heating of the oil in case of fire incident.

16. MEDICAL ASSISTANCE AVAILABLE

FGUTPP Hospital is situated in the central place in township about one KM away from the main entrance gate (Township end). It is equipped with all necessary facilities leading to medium size hospital. It has following facilities: -

1. Ambulance: 1 nos. (Round the clock),
2. Bed capacity: 30 nos. / ICU Facility bed available – 02 nos.
3. Doctors: 09 nos.

Specialists Available: Medicine, Gynecology, Anesthesia, Pathologist

4. Medical Staff: 14 (Other than Doctors)

Facilities for management of general diseases and emergencies including Industrial Accidents are available.

17. COMMUNICATION SYSTEM

Public Address System has been provided in the Plants. Telephone and Intercom facilities are available at all required desks and with officials. The officers have been given Intercom telephone connections with facilities of incoming P&T calls at their residences.
P&T (STD) telephone, Mobile phones, Fax, facilities are available within the project and Township.

18. EMERGENCY POWER SUPPLY

Emergency lights are provided at all vulnerable points for lighting arrangements as well as to operate basic minimum equipment for operating the plant safely. All units are provided with DG sets and Battery system which come on Auto in case of Power failure. More than one supply through different transmission systems is also provided to ensure electric supply without fail.

19. EMERGENCY SAFETY EQUIPMENT

The following emergency Safety equipments are made available in areas like Water Treatment Plant, UCBs, Fuel Oil Pump House, Shift Charge Engineer Office, Safety office and Fire Station.

Self-contained breathing apparatus.
Full / Half Face Piece Respirators
Emergency Suits.
Gum Boots.
Face Shield.
Hand gloves.
Aprons etc.
Chlorine Sealing Kit.

20. ALARMS FOR VARIOUS / EMERGENCIES

ALARM

The emergency alarm will be sounded by the control room on instruction from the chief incident controller.

21. EMERGENCY SIREN

The emergency siren is installed on the service building and operating switch is located in UCB -1 (Unit Control Board). That is under the control of Shift charge engineer and can be sounded at the time of emergency.

S. No	TYPE	DURATION
1	Normal factory siren	Continuous 1 minute
2	In case of fire /Hydrogen leakage cum fire	10 seconds on 5 seconds off 3 times
3	Emergency siren for heavy chlorine leak	20 seconds on 15 seconds off 3 times
4	Any Major Emergency that requires evacuation of work area & reach to Assembly Points	20 seconds ON and 15 seconds OFF – 5 times.
5	All clear signal	Continuous siren for 2 minutes only once

22. T E A M S

A.	TASK FORCE		*INTERCOM Nos.*			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Sh. ABHAY KUMAR SRIVASTAVA	HOP (U)	6104		9650990866-M 05311-278010 (B)	HOP BUNGALOW
2	Sh. ASUTOSH BISWAS	GM (O&M)	6105		8004940332-M 05311-278107(B)	
3	Sh. SANTOSH KUMAR	AGM (O)	3467		9650990412	AE-44
4	Sh. ANURAG GOURAHA	AGM (FM)	3300	2037	9424141584	BH-23
5	Mrs. RUMA DE SHARMA	AGM (HR)	3093	2148	9650999329 05311-278022(B)	AE-43
6	Mrs. PRITI SINHA	AGM (TS/EMG/AU)	3216	2010	9451212012	D-01
7	Sh. HRIDAYA NAND PANDEY	AGM (CHEMISTRY)	3722		9650991039	
8	Sh. Jitendra Kumar	AGM (SAFETY)	3259	2358	8210201926, 05311-278055(B)	SE-03
9	DR. MADHU SINGH	CMO	2308	2309	9437966880-M 05311-278001(B)	D-18
10	Sh. TIRUMALA MURALI MOHAN	AGM (C&M)	3118	2606	9437960509	TD-02
11	Sh. SATYAWAN GUPTA	AGM (IT)	3331	2331	9650992368	AE-42
12	Sh. ASHISH GAIROLA	DGM (PROJECT)	3538	2413	7300714713	AE-180-A
13	Sh. AJAY KUMAR TRIPATHI	Dy. COMDT. (CISF)	2299		8130419611-M 05311-278009	
B.	**MAINTENANCE TEAM**		*INTERCOM Nos.*			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Sh. RAJIB GHOSH	AGM (TMD)	3223	2106	9434049625	SE-09
2	Sh. ALEKH SINHA	AGM (C&I)	3727	2224	9450916631	D-09
3	Sh. PANKAJ KUMAR	AGM (OFF SITE)	3128	2551	9415701114	BH-10
4	Sh. K VISHNU MURTHY	AGM (EMD)	3430	2073	9440918679	D-08
5	Sh. TRIYUGI NARAYAN YADAV	AGM (AHD)	3316	2640	9450962712	SE-05

6	Sh. SHAMSHUDDIN KHAN	AGM (BMD)	3294	2047	9650995255	TD-10
7	Sh. VIKAS VASHIST	Sr. Manager (PLANT CIVIL MAINT.)	3342	2450	8004916521	AE-75
C.	**FIRE FIGHTING TEAM**		*INTERCOM Nos.*			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Sh. AJAY KUMAR TRIPATHI	Dy. COMDT. (CISF)	2299		8130419611-M 05311-278009	
2	Sh. R. S. SHIROHI	ASST. COMDT. (CISF) FIRE	3011	2252	9453044313	
3	Sh. PANKAJ KUMAR	AGM (OFF SITE)	3128	2551	9415701114	BH-10
4	Sh. BRIJ LAL	SUB INSP. (CISF) FIRE	3001		7908345565	SOs Barrick-1
D.	**AUTO BASE TEAM**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence. No.**
1	Sh. SHAMSHUDDIN KHAN	AGM (BMD)	3294	2047	9650995255	TD-10
2.	Sh. SURESH KUMAR	Sr. MANAGER (A/B)	3390	2145	9415246714	AE-13
E.	**COMMUNICATION TEAM**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1.	Sh. SATYAWAN GUPTA	AGM (IT)	3331	2331	9650992368	AE-42
2.	Sh. ABDUL QUADIR	DGM (IT)	3333	2786	9437565331	EE-12
3.	Sh. IMRAN KHAN	SR.MGR (IT)	3332	2125	9927922677	EE-16
F.	**SECURITY TEAM**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Mrs. RUMA DE SHARMA	AGM (HR)	3093	2148	9650999329 05311-278022(B)	AE-43
2	Sh. DISHA AWASTHI	DGM (HR)	3699	2615	9426563694	D-23
3	Sh. AJAY KUMAR TRIPATHI	Dy. COMDT. (CISF)	2299		8130419611-M 05311-278009	
G.	**ADMINISTRATION TEAM**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Mrs. RUMA DE	AGM (HR)	3093	2148	9650999329	AE-43

	SHARMA				05311-278022(B)	
2	Sh. VIJAY KUMAR	DGM (HR)	3278	2101	7369000350	D-4
H. SAFETY TEAM			***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Sh. Jitendra Kumar	AGM (SAFETY)	3259	2358	8210201926, 05311-278055(B)	SE-03
2	Sh. R K Sahu	Mgr. (SAFETY)	3037	2128	9109179822	AE-143
3.	Sh. SAMAI DIN	Asst. Manager (SAFETY)	3707	2063	8004948158	III-238
I. MEDICAL TEAM			***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	DR. MADHU SINGH	CMO	2308	2309	9437966880-M 05311-278001(B)	D-18
2.	Dr. RANJANA KERKETTA	SR. SPECIALIST	2305	2350	9427107438	AE-11
3	Dr. BABITA	SR. SPECIALIST	2304	2471	8004916165	AE-03
4.	Dr. MARY B JOSEPH	SR. SPECIALIST	2328	2187	9424141714	D-19
J. MONITORING TEAM			***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1.	Sh. HRIDAYA NAND PANDEY	AGM (CHEMISTRY)	3722		9650991039	
2.	Mrs. MANISHA RAJPUT	Sr. MANAGER (CHEMISTRY)	3472	2034	9650994979	AE-90
3.	Sh. Munish Thakur	MANAGER (CHEMISTRY)	3252	2180	9425219156	AE-192 A
K. ENVIRONMENTAL IMPACT/ MITIGATION TEAM			***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1.	Sh. B.S. Bhartiya	AGM (EMG/AU)	3683	2199	8004916004	D-14
2.	Sh. HRIDAYA NAND PANDEY	AGM (CHEMISTRY)	3722		9650991039	
3.	Sh. ANAND C LOHAKARE	DGM (EMG/AU)	3193	2603	9405437293	D-7
4.	Mrs. MANISHA	MANAGER	3472	2034	9650994979	AE-90

	RAJPUT	(CHEMISTRY)				
L.	**SUPPORT TEAM TO CIC**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Mrs. RUMA DE SHARMA	AGM (HR)	3093	2148	9650999329 05311-278022(B)	AE-43
2	Sh. TIRUMALA MURALI MOHAN	AGM (C&M)	3118	2606	9437960509	TD-02
3	Sh. KHEVENDER KUMAR	DGM (C&M)	3475	2076	9650994225	D-28
4	Sh. NARESH KUMAR KANDPAL	DGM (STORES)	3225		9650995113	
M	**SUPPORT TEAM TO WIC**		***INTERCOM Nos.***			
S. NO	**NAME**	**Designation**	**OFFICE**	**RESI.**	**MOBILE / P&T**	**Residence No.**
1	Sh. K VISHNU MURTHY	AGM (EMD)	3430	2073	9440918679	D-08
2	Sh. SANTOSH KUMAR	AGM (O)	3467		9650990412	AE-44
3	Sh. ALEKH SINHA	AGM (C&I)	3727	2224	9450916631	D-09
4	Sh. RAJIB GHOSH	AGM (TMD)	3223	2106	9434049625	SE-09
5	Sh. PANKAJ KUMAR	AGM (OFF SITE)	3128	2551	9415701114	BH-10

23. COMMUNICATION CHART (EXTERNAL)

S.No.	AUTHORITY	ADDRESS	P&T TELEPHONE Nos.	
			OFFICE	RESIDENCE
1	Director Of Factories (U.P.)	Kanpur	0512- 223886	(0512) 294614 / 275718
2	Dy. Director of Factories (U.P.) Lucknow Zone	Lucknow	0522- 2637609	M0BILE NO. 9557346762
3	District Magistrate, Raebareli	Raebareli	0535-2202302/ 9454417559	0535-2703301 - 2703401
4	Addl. D M (F&R)	Raebareli	0535-2203097/ 9454417630	0535-2701423
5.	Supdt. of Police	Raebareli	0535-2202315/ 9454402471	0535-2701736
6	Fire Service, Raebareli	Raebareli	0535- 203493/ 9454418353	
7	S D M	Unchahar	05311-277265/ 9454416631	9415118948
8	Police Station, Unchahar	Unchahar	(05311) 277024	9415189237

24. COMMUNICATION CHART (INTERNAL)

I) CORPORATE & REGIONAL OFFICE

S.N.	AUTHORITY	ADDRESS	P&T TELEPHONE Nos.	
			OFFICE	RESIDENCE
1	Chairman & Managing Director, NTPC	New Delhi	011- 24360044 4363050(FAX)	011- 26967009
2	Director (Operation), NTPC	New Delhi	011-24360232 24363478	011-26896439
3	Director (HR), NTPC	New Delhi	011-24360950 24363478	011-26493757
4	Executive Director (North),	Lucknow	0522-2720738 2720854	5222720738

II) STATION / PROJECT

S. NO	NAME	Designation	OFFICE NO	RESIDENCE NO	MOBILE/ PH.NO
1	Sh. ABHAY KUMAR SRIVASTAVA	HOP (U)	6104		9650990866-M 05311-278010 (B)
2	Sh. ASUTOSH BISWAS	GM (O&M)	6105		8004940332-M 05311-278107(B)
3	Sh. SANTOSH KUMAR	AGM (O)	3467		9650990412
4	Sh. ANURAG GOURAHA	AGM (FM)	3300	2037	9424141584
5	Mrs. RUMA DE SHARMA	AGM (HR)	3093	2148	9650999329 05311-278022(B)
6	Mrs. PRITI SINHA	AGM (TS/EMG/AU)	3216	2010	9451212012
7	Sh. HRIDAYA NAND PANDEY	AGM (CHEMISTRY)	3722		9650991039
8	Sh. Jitendra Kumar	AGM (SAFETY)	3259	2358	8210201926, 05311-278055(B)
9	DR. MADHU SINGH	CMO	2308	2309	9437966880-M 05311-278001(B)
10	Sh. TIRUMALA MURALI MOHAN	AGM (C&M)	3118	2606	9437960509
11	Sh. SATYAWAN GUPTA	AGM (IT)	3331	2331	9650992368
12	Sh. ASHISH GAIROLA	DGM (PROJECT)	3538	2413	7300714713
13	Sh. AJAY KUMAR TRIPATHI	Dy. COMDT. (CISF)	2299		8130419611-M 05311-278009

25. RESPONSIBILITY OF CORPORATE CENTRE

In case of receipt of any information by Chairman and Managing Director, he shall co-ordinate with Ministry of Energy Deptt. of Power and other higher authorities in Government
Chairman & Managing Director shall constitute Enquiry Committee and conduct of enquiries or as felt necessary by him.
Chairman & Managing Director directly or through P.R. Deptt. Shall issue the press statement and deal with the Press / Media for any enquiries raised by them.

TASK FORCE

A task force consisting of the following shall immediately proceed to the Disaster site to study the circumstances relating to the mishap.

General Manager (OS), General Manager (PE), Medical Consultant, Head of Safety

If the Task Force feels necessary, it may invite any other official to help the Task Force.

CONTROL ROOM

A control room shall be set up at Corporate Centre, which shall be controlled by General Manager (IR). Information shall be collected regularly and given to the Chairman & Managing Director, Executive Director (HR) and other concerned officials to deal with the situation.

SERVICE OF NTPC HELICOPTER

If requested by the Head of Project for handling of injured persons, the Service of helicopter shall be immediately made available. For this purpose, General Manager of the Project shall talk on SATCOM or other such quick means of communication to Executive Director (CP) who will be the in-charge of helicopter in such emergencies.

26. ON SITE DISASTER MANAGEMENT PLAN

Emergencies may occur due to many reasons. It may occur due to natural causes like earthquake, cyclone, flood etc. It may occur due to terrorist activity or it may be due to malfunction of standard working systems of practices.
In the industry handling hazardous materials large scale emergencies will be essentially those of a major release of flammable or toxic material and of event which have significant environmental impact.
The factory management in the "On site Emergency Plan" must make a judgement concerning the nature and scale of the events which should realistically be taken into account based upon all relevant information including, most importantly practical operating experience.

AIM OF ON-SITE DISASTER MANAGEMENT

The Emergency Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in this same order of priorities.
For effective implementation of the Emergency Plan, it will be widely circulated and personnel trained through rehearsals / drills.
The Emergency Plan should reflect that probable consequential severities of the undesired event due to deteriorating conditions or through "Knock on" effects. Further the management should be able to demonstrate that their assessment of the consequences uses good

supporting evidence and is based on currently available and reliable information. Incident data from internal and external sources and if necessary the report of outside consultancies.

To tackle the consequence of a major emergency inside the factory (Power Plant) a major emergency planning has to be formulated and this planned emergency document is called On Site Disaster Management Plan which has been termed as On-Site Emergency Plan in Factories Act 1948 and other statutory provisions. The objective of the major emergency plan is to make use of the combined resources of the Plant and the outside services to achieve the following: Effect the rescue and medical treatment of casualties.

Safeguard other people.

Minimise damage to property and the environment.

Initially contain and ultimately bring the incident under control.

Identify the affected.

Provide for the needs of relative.

Provide authoritative information to the news media.

Secure the safe rehabilitation of affected area.

Preserve relevant records and equipments for the subsequent enquiry into the cause and circumstances of Emergency.

27. ACTION PLAN & RESPONSIBILITIES

THE ACTION PLAN CONSISTS OF:

Responsibilities of Chief incident Controller.

Responsibilities of Work incident Controller.

Responsibilities of Designated Emergency Control Centre Key Personnel.

Responsibilities of Declaration of Emergency.

Responsibilities for all Clear Signal.

RESPONSIBILITIES OF CHIEF INCIDENT CONTROLLER

The HOP, who is the Chief Incident Controller, will assume over all responsibilities for the factory / storage site and its personnel in case of any emergency. His responsibilities are to: -

Assess the magnitude of the situation and decide whether staff need to be evacuated from their assembly points to be identified safer places: Declare ON-SITE / OFF-SITE EMERGENCY.

Exercise direct operational control over areas other than those affected.

Undertake a continuous review of possible developments and assess in consultation with key personnel as to whether shutting down of the plant of any section of the Plant and evacuation of personnel are required.

Liaise with senior officials of police, Fire Brigade, Medical and Factory Directorate and provide advice on possible effects on areas outside the factory premises.

Look after rehabilitation of affected persons on discontinuation of emergency.

Issue authorised statements to news media and ensure that evidence is preserved for enquiries to be conducted by the statutory authorities.

RESPONSIBILITIES OF WORKS INCIDENT CONTROLLER

The Work Incident Controller on knowing about an emergency, immediately will rush to the incident site and take overall charge and report to the Site Controller. On arrival, he will assess the extent of emergency and decide if major emergency exists and inform the communication officer accordingly. His responsibilities will be to: -

Direct all operations to stop within the affected area taking into consideration priorities for safety of personnel, minimise damage to the plant, property and environment and minimise loss of materials.

Provide advice and information to the Fire and Security Officers and the local fire service.

Ensure that all non-essential workers / staff of the areas affected are evacuated to the appropriate assembly points and the areas are searched for casualties.

Set up communication points and establish contact with the emergency Control Centre in the event of failure of electric supply and thereby Public Address System (PAS) and internal telephones.

Report on all significant an developments to the communication officer and

Have regard to the need to preserve the evidence so as to facilitate any enquiry into the cause and circumstances which caused or escalated the emergency.

28. KEY PERSONNEL

Apart from Works Incident Controller and Chief Incident Controller, other works personnel will have key role to play in providing advice and in implementing the decisions made by the Chief Incident Controller.

THE KEY PERSONNEL INCLUDE:

GMs / AGMs / Engineer – In charge responsible for

Operation

Electrical Maintenance

Mechanical Maintenance

C&I

Chemical

Head of HR and Officers connected with IR and Labour Welfare.

AGM (Technical Services)

Head of Safety

Chief Medical Officer

Dy. Commandant / Asst. Commandant

CISF Fire Officer

Transport: Auto Base Engr. (I/c)

Public Relation Officer (PRO)

As necessary they will decide the actions needed to shut down plants, evacuate personnel, carry out emergency repair works, arrange of supplies of equipment, personnel etc. Carry out atmosphere tests, provide catering facilities, liaison with police, informing relative of the victims, press media etc.

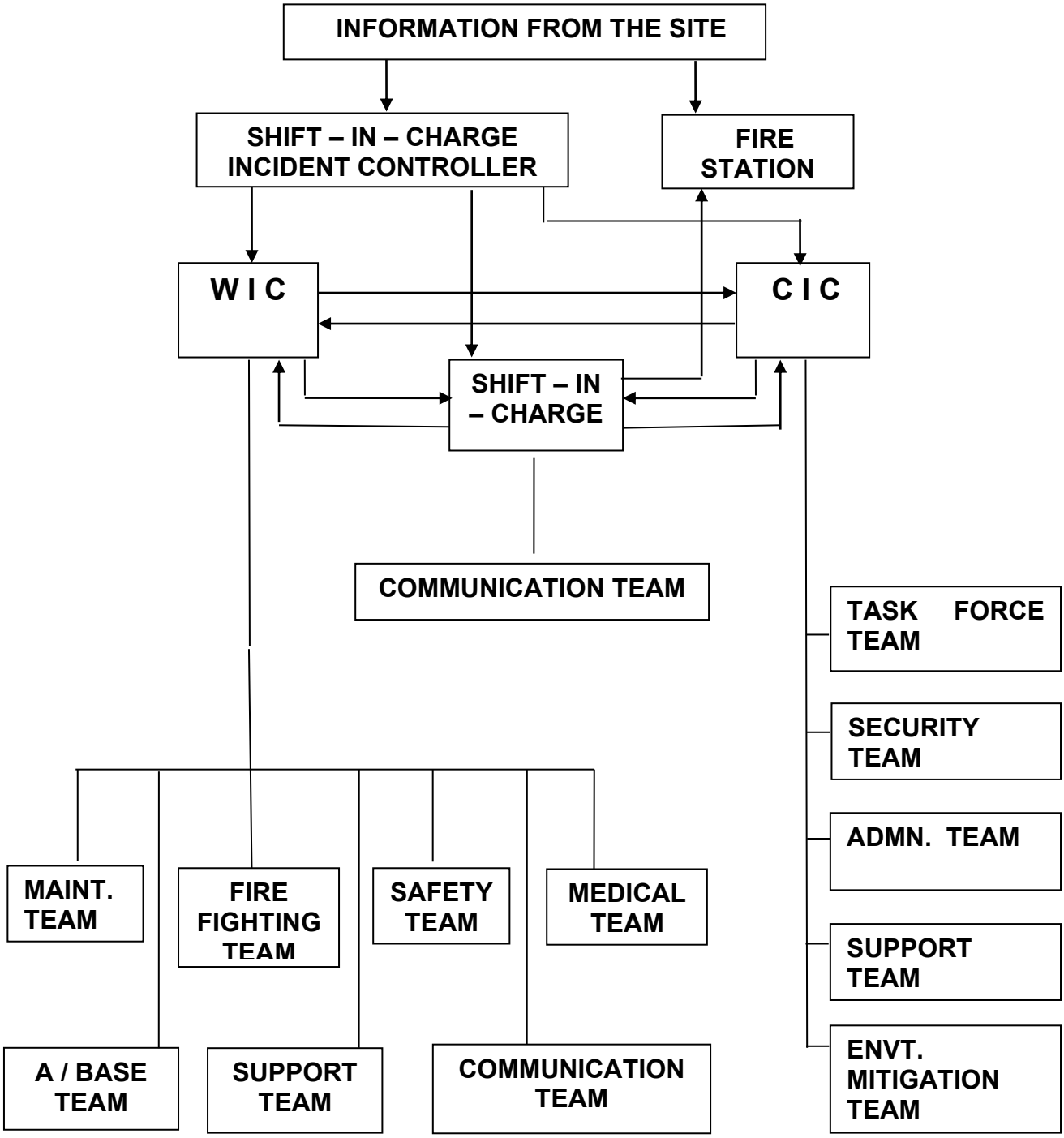
29. ESSENTIAL STAFF

In plant immediately affected or likely to be affected as decided by the Chief Incident Controller, efforts will be needed to make shut down and make process units safe. This work will be carried out by plant supervisors and essential operators provided they can do it without exposing themselves to undue risk. Some workers / supervisors will also be required to help the above works for example Attendants, Messengers, Drivers, First Aiders, Steno-Typists etc. These will be, Essential Staff and it is the responsibility of the Works Incident Controllers to identify the essential staff from a task force report at defined plant control centres so that they can be readily contacted. It is the responsibility of the Work incident Controller to remove all non-essential staff to assembly points.

30 A. FIRST INFORMATION

The first person who observes / identifies the emergencies shall inform by shouting and by telephone to the shift engineer and fire station about the hazard. The shift engineer will inform to works incident controller, Chief Incident Controller and also telephone operator, who shall communicate it to all key officers about the emergency.

30 B. EMERGENCY MANAGEMENT INFORMATION FLOW DIAGRAM



31. RESPONSIBILITIES OF TEAMS

I. Task Force

To identify source of hazard and try to neutralise / contain it.

To isolate remaining plant and keep that in safe conditions.

To organise safe shutdown of plant, if necessary.

To organise all support services like operation of the fire pumps, sprinkler system etc.

II. Maintenance Team

Attend to all emergency maintenance jobs on top priority.

To take steps to contain or reduce the level of hazard created due to disaster.

To organise additional facilities as desired.

III. Fire Fighting Team

To rush to fire sport and extinguish fire.

To seek help from outside firefighting agencies.

To evacuate persons effected.

IV. Auto Base Team

To make the auto base vehicles ready to proceed for evacuation or other duties, when asked for,

To send at least one mechanic at the site of incidence where he may help in attending minor defects in ambulance, fire tenders or other vehicles.

To arrange petrol / diesel supply.

Make all arrangements regarding transportation.

V. Communication Team

To maintain the communication network in working condition.

To attend urgent repairs in the communication system, if required.

To arrange messengers for conveying urgent messages when needed.

To help NTPC Authorities to communicate with external or internal authorities / officials.

To prepare the press release about the emergency in consultation with Chief Incident Controller

VI. Security Team

To man all gates.

To ban entry of unauthorised persons.

To permit, with minimum delay, the entry of authorised personnel and outside agencies, vehicles etc. who have come to help.

To allow the ambulance / evacuation vehicles etc. to go through the gates without normal checks.

VII. Administration Team

To rescue the casualties on priority basis.

To transport casualties to first aid post, safe places or medical centers.

To account the personnel.

To help in search for missing personnel.

To pass information to the kith and kin of fatal or serious injured persons.

VIII. Safety Team

To arrange required safety equipment.

To record accidents.

To collect and preserve evidences in connection with accident injuries.

To guide authorities on all safety related issues.

IX. Medical Team

To arrange first aid material / stretchers immediately and reach to site of incident.

To arrange for immediate medical attention.

To arrange for sending the casualties to various hospitals and nursing homes etc.

To ask specific medical assistance from outside including through Medial Specialist in consultation with CIC / WIC.

X. Monitoring Team

To measure gas concentrations, in case of gas leakage at various places.

XI. Environmental Impact Mitigation Team

To ensure mitigation Environmental impact after handling of departmental emergency.

32. SUPPORT TEAMS

In addition to the teams already mentioned there will be two additional teams known as Support Teams:

Support Team to CIC:

This team will assist CIC: (Chief Incident Controller) during an emergency to execute his functioning in consultation with CIC. The members of the Team and their responsibilities are given below:

Head of HR (Alternative–Next below Head of Personnel)

Contacting statutory authorities.

Arranging for relievers and catering facilities.

Giving information to media.

Contacting medical centers and nursing homes.

Providing all other support, as necessary.

Head of Materials (Alternative – Next below Head of Materials)

Arranging for urgently required materials through cash purchase or whatever means.

Head of Finance (Alternative – Next below Head of Finance)

Arranging funds for various relief measures as well as emergency purchase of materials, sending his representative for emergency purchase.

Support Team to WIC:

The Support Team to WIC (Works Incident Controller) will consist of:

AGM (O)

AGM /AGM (Elect. Maintenance / Mechanical Maintenance.)

HO (HR) (Alternative–Next below AGM HR)

The Team may call any more persons depending upon the need. This team will assist the WIC in manning communication and passing instructions to the teams.

One Steno Secretary shall always be available with WIC for recording all information coming in and instructions going out.

33. ALL CLEAR SIGNAL

After cessation of emergency, WIC will communicate to CIC about it. After verification of status, CIC will communicate and will announce all clear by instruction to sound all clear signal.

34. PREPAREDNESS APPARATUS EVALUATION OF FUNCTIONING OF DISASTER PLAN

Full Mock Drill Monitoring Committee

(To be conducted at least once in 6 months)

Plant Head - Chairman of Committee

Head of O&M - Vice Chairman (Alternative to Chairman in his absence)

Head of Operation - Member

Head of Maintenance - Member

Head of Medical - Member

Head of HR - Member

Head of CISF - Member

Head of Auto Base - Member

Head of Materials - Member

Head of Safety - Convenor

The Committee may invite any other Official / Expert, if considered necessary.
The Committee shall supervise the following activities.
Functioning of Emergency Control Centre, very specifically availability of all facilities etc as mentioned in the Plan and its functional healthiness.
To evaluate communication of the Disaster Plan to all segments of employees, to familiarize them about their responsibilities in case of any disaster including evaluation of behavior of employees and others.
To ensure that all facilities as required under the plan from within or from nearby industries / aid center under mutual assistance scheme or otherwise are available.
To ensure that the necessities under the material assistance scheme is properly documented and the concerned employees are fully aware in this regard.
To ensure that employees are fully aware to fight any emergency like sealing of chlorine leakage, firefighting other such cause.

35. DISASTER MANAGEMENT EFFICACY DRILL MONITORING COMMITTEE (To be conducted at least once in every 3 months)

Head of (O&M) - Chairman

Head of HR - Member

Head of Communication - Member

Head of CISF - Member

Head of Medical - Member

Head of Safety - Convener

The Committee may invite any other Official / Expert to assist its functioning.
The following activities shall be necessarily supervised for its being effectiveness.

All employees are trained about their responsibilities / duties. They all are aware about evacuation routes, direction of evacuation of equipments to be used during evacuation or the method of evacuation.

All employees are fully trained to rescue their colleagues, who are affected due to cause of disaster. In case they are unable to rescue their colleagues, they should know to whom they have to inform about such persons.

All employees are fully trained in first aid use of desired equipments including breathing apparatus. First Aid box etc. are available at the desired location.

All warning alarms are functional. Public Address System is in healthy condition.

All telephone lines / communication systems are provided in control rooms and there is no removal of the facilities (as prescribed) for the control rooms.

It is very clear amongst the concerned managers who shall call for assistance under the mutual aid scheme or the facilities from within.

It is clear at the plant, who shall declare emergency.

It is clear at the plant, who shall inform the District Authorities, State Authorities and Corporate Centre.

36. MOCK DRILLS

It is imperative that the procedures laid in this plan are put to the test by conducting Mock drills. The Mock drills should be carried out step by step as stated below:

FIRST STEP

Test the effectiveness of communication system.

SECOND STEP

Test the speed of mobilization of the Plant emergency teams.

THIRD STEP

Test the effectiveness of search, rescue, and treatment of casualties.

FOURTH STEP

Test Emergency isolation and shut down and remedial measures taken on the system.

FIFTH STEP

Conduct a full rehearsal of all the actions to be taken during an emergency.

The Disaster Management Plan should be periodically revised based on experiences gained from the mock drills.

A SAMPLE EMERGENCY MESSAGE

On getting the message that emergency has been declared, CIC / WIC will rush to the affected / likely to be affected areas and announce through P.A. system the following message like

" HEAVY CHLORINE LEAK HAS TAKEN PLACE IN FGUTPP AND AS A RESULT OF WHICH CHLORINE CONTENT IN THE ATMOSPHERE MAY BECOME HIGH"

Steps to control the situation is in progress. In the meantime you are advised:

Not to get panic.

Close the doors and windows tightly.

Don't try to come out from closed doors, if you find an irritating smell outside, the concentration of chlorine may be much more.

If, found necessary we may evacuate you to the nearest evacuation centre, be prepared for it.

Announcement to be made by the concerned official in Hindi, similarly announcement of termination of the emergency also should be made.

37. BACKGROUND INFORMATION OF THE INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES TABLES

The modeling of accident scenarios carried out to support the table was based on arrange of package sizes used to transport each chemical. A small spill refers to an incident with container size equal to or smaller than 0.55 gallon drum (e.g. a small cylinder) a large spill refers to a larger container size (e.g. , a one ton cylinder a tank truck or rail car).

The release from a given container could be of three types of evaporation from a liquid pool, direct release of gaseous vapors into the air or a combination of both for evaporating liquid pools. The evaporation rates were calculated assuming a sunny day with 35° C (95° F) air passing over the liquid pool. The maximal pool size for a small spill that forms a liquid pool was assumed to be 48 feet. A large spill was assumed to come from a maximal liquid pool 60 feet diameter.

A Gaussian dispersion model was used to predict vapor dispersion distances. For vapor dispersion calculations, a neutral stability (Class D) overcast night with light variable winds of 16 Km/h (10 Mile/h) and a temperature of 35° C (95° F) was assumed. Use of the class D stability is conservative for daytime releases because diffusion is more rapid on sunny and unstable days. Shifts in wind direction are assumed to keep the plume confined to an area surrounding 30 degrees on either side of the predominant wind direction. This permits the crosswind dispersion to equal the downwind dispersion distance.

A 30 minutes period following the start of a release was used to compute distances in the table.

HOW TO USE THE TABLE OF INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

You should already have:

Identified the material by its ID Number and Name.

Read the Guide for that material and take the emergency actions it recommends.

Note the wind direction.

Now you should look in this table for the ID number and Name of the Material in this incident. Some ID numbers have more than one shipping name listed. Look for the specific name of the material.

If you find a matching entry in the table, use the following steps (c through f) to determine the area requiring immediate protective actions.

Determine if the incident involves a SMALL or LARGE spill. Generally, a SMALL SPILL is one which involves a single, small package (i.e. up to a 55-gallon drum), small cylinder or a small leak from a large package. A LARGE SPILL is one which involves a big spill from on opening in a large package or spills from many small packages.

Look up the initial ISOLATION distance direct that all persons move in a crosswind direction away from the spill to that distance.

Next look up the initial PROTECTIVE ACTION DISTANCE shown in the Table. For a given hazardous material and spill size, the table gives the distance in miles downwind in which protective actions should be considered. For practical purposes the Protective Action Zone (i.e. the area in which people are at risk of harmful exposure) is a square whose length and width are the same as the downwind distance shown in the table.

Initial Protective Action to the extent you can, beginning with those closest to the spill site and working away from the site in the down wind direction.

The shape of the area in which protective actions should be taken (Protective Action Zone) is shown in the vicinity plan.

USE THIS TABLE WHEN THE MATERIAL IS NOT ON FIRE

ID No.	Name of Material	SMALL PILLS (leak of spill from a small package or small leak from a large package)		LARGE SPILLS (leak of spill from a large package or spill from many small packages)	
		First ISOLATE In all directions (feet)	Then PROJECT those persons in the downward direction (miles)	First ISOLATE in all directions (feet)	Then PROJECT those persons in the downward direction (miles)
1005	AMMONIA	150	0.2	300	1
1005	Ammonia, Anhydrous, Liquefied	150	0.2	300	1
1005	Ammonia Solution With 50% Ammonia	150	0.2	300	1

1005	Anhydrous Ammonia	150	0.2	300	1
1008	Boron Trifluoride	1500	5	1500	5
1016	Carbon Monoxide	150	0.4	150	0.8
1017	Chlorine	900	3	1500	5
1023	Coal Gas	300	1	1500	5
1041	Carbon Dioxide, Ethylene Oxide Mixture, With 6% Ethylene Oxide	150	0.8	1200	4
1050	Hydrochloric Acid Anhydrous	600	2	1200	4
1050	Hydrogen Chloride Anhydrous	600	2	1200	4

38. DISASTER PREVENTION AND REDUCTION

1.0	NTPC recognise and accept its responsibility for establishing and maintaining a safe working environment for all its employees. This responsibility arises from:
a.	Company's moral responsibility to its employees, to provide the best practicable conditions of work from the point of view of health and safety.
b.	The obligation to consult with its staff and their representative to implement policies and procedures developed as a result of discussions.
c.	Statutory responsibility in respect of the health, safety and welfare of employees emanating from relevant legislations such as the Factories Act. The Indian Electricity Act. The Explosive Act, the Boiler Act etc.
2.0	**COMPANY'S RESPONSIBILITY**
	The Company shall take all such steps which are reasonably practicable to ensure best possible conditions of work, and with this end in view the company shall do the following:-
2.1	To allocate sufficient resources to provide and maintain safe and healthy conditions of work:-
2.2	To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
2.3	To ensure that adequate safety instructions are given to all employees.
2.4	To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
2.5	To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety.
2.6	To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge.
2.7	To provide appropriate facilities for first aid prompt treatment of injuries and illness at work.
2.8	To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters.
2.9	To ensure proper implementation of fire prevention and an appropriate firefighting service, together with training facilities for personnel involved in this service.
2.10	To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise.

2.11	To organise collection, analysis, and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.	
2.12	To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.	
2.13	To publish/notify regulations, instructions, and notices in the common language of employees.	
2.14	To prepare separate safety rules for each type of occupation/process involved in a project.	
2.15	To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, workplaces and operations.	
2.16	To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe systems of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.	
3.0	**THE RESPONSIBILITY OF THE EMPLOYEE**	
	The establishment and maintenance of the best possible conditions of work is, no doubt, the responsibility of Management, it is also necessary that each employees follows prescribed safe methods of work. He should take reasonable care for the health and safety of himself, or his fellow employees and of other persons who may be affected by his action at work. With this in mind, employees should be health and safety conscious and:-	
	REPORT	Potential hazards
	OBSERVE	Safety rules, procedures and codes of practice.
	USE	With all reasonable care the tools, equipment, safety equipment and protective clothing provided by the Company; these items should be kept in good condition.
	PARTICIPATE	In safety training courses when called upon to do so.
	MAKE USE	Of safety suggestions schemes.
	TAKE	An active and personal interest in promoting health and safety at work.
4.0	**RESPONSIBILITY FOR IMPLEMENTATION**	
4.1	The ultimate responsibility for ensuring the implementation of the policy on health and safety at work rests on the NTPC Management, the Corporate Personnel Division at the Corporate level, and the concerned General Managers at the Project/Station level. The Officers in charge of safety will be functionally responsible to the Corporate headquarter for ensuring that the policy is promulgated, interpreted, and carried out in the manner expected.	
4.2	Immediate responsibility for safety at work is that of the Management/Executives of each department/section who are primarily responsible for preventing accidents involving members of their staff and other persons. It is their responsibili8ty to issue clear and explicit working instructions, compliance with which will ensure safe working and to require the effective use of approved equipment.	
4.3	Accepted rules, procedures and Codes of practice which are formulated with proper regard to health and safety consideration must be strictly observed by all concerned. Contracting Agencies executing works should be made responsible, through various measures including appropriate provisions in the contract, for discharging their safety obligations.	
4.4	In designated areas of particular hazard, the appropriate Executives are required to authorise, in writing, the commencement of any work and, before doing so, personally to satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorised, in writing as competent to perform these duties.	
4.5	Safety Officers are appointed to advise Management on questions of safety at work including advice on the application in particular local situations of the system of work, implementation of	

	Company's Rules and Relevant Codes of Practices in consultation with Area Engineer. They will be consulted in the interpretation of rules and codes being formulated by the Corporate Management and shall advise Management in the investigation and analysis of accidents and circulation of appropriate statistics.
4.6	MAJOR SITE INCIDENTS The General Manager at each Project/Station is required to ensure that plans are devised for action in the event of fire, major site incident or necessity for evacuation procedure. These plans must be communicated to all staff and rehearsed from time to time.
4.7	Firefighting training and the formation of fire-fighting team on a voluntary basis will be encourage by the Project/Station Management.
4.8	All accidents and dangerous occurrences will be reported immediately to the General Manager who will implement an established procedure to ensure that an investigation takes places and recommendations are made to prevent recurrence.

39. PROCEDURE FOR REPORTING OF ACCIDENTS/ DANGEROUS OCCURRENCES IN NTPC

With a view to ensuring prompt report of accidents and dangerous occurrences to comply with requirements/obligations under different statues; and to inform the concerned authorities within the organisation for keeping complete information of accidents for record and analysis and to take necessary preventive actions, a procedure for reporting of accidents dangerous occurrences has been framed.

1.0	**OBJECTIVE**
	In order to make prompt report of accidents and dangerous occurrences to comply with requirements/obligations under different statues; and to inform the concerned authorities within the organisation for keeping complete information of accidents for record and analysis, which will be of help in taking remedial measures for accident prevention in future; it has been decided to introduce a procedure for reporting of accidents/dangerous occurrences in NTPC.
2.0	**PROCEDURE IN CASE OF ACCIDENTS CAUSING INJURIES/FATALITIES:**
2.1	An officer of the Section will immediately refer the injured to Corporation's Hospital/Dispensary/First-aid unit with a preliminary report on Form-I. In addition, he will inform about the accident to Departmental Head, Personnel Head and Safety Office to telephone with full description of accident.
2.2	In case of injury to Contractor's employee, the contractor will immediately inform accident/dangerous occurrence to NTPC Officer In-charge and Safety Officer himself on telephone or thorough special messenger. Officer In-charge of NTPC will submit information of accident as in Para 2.1 above.
2.3	In case the injured has come/is taken directly to hospital/dispensary/first-aid unit, the in-charge of unit will inform about the injury to Departmental Head in Form-II with a copy to Plant Personnel Head and Plant Safety Officer. He will immediately inform of serious cases by telephone also to Departmental Head, Personnel Head and Safety Officer.
2.4	Subsequently the concerned department/section In-charge will prepare a detailed report of accident within 4 hours of the accident in Form-III and will submit one copy each to the General Manager and Personnel Head. Third and fourth copy of the report will be sent to Safety Officer and fifty copies will be retained by him for departmental record.
2.5	The Safety Officer will intimate the accident to concerned Statutory Authorities as per the provisions of relevant Act/Rules enclosed contains a list of such authorities. However, the

	State Rules concerned should be referred to for additional provisions, if any.
2.6	The Safety Officer will also submit a copy of Form-III along with his comments to Corporate Centre Safety Section within one week of occurrence of accident.
2.7	The Safety Officer will send accident report of each calendar month of Corporate Centre Safety Section in Form-V before fifth day of every succeeding month. In case of no accident, a 'Nil' report should be sent.
2.8	In case of fatal accident, information of accident will immediately be intimated to Corporate Centre Personnel by telegram/telex/wireless.
3.0	**PROCEDURE IN CASE OF DANGEROUS OCCURRENCES:**
	As prescribed under the relevant rules made by the State Government with reference to the provision of Section 88-A of the Factories Act.
3.1	In case of a dangerous occurrence, the same will be informed by Section In-charge to Safety Officer, Department Head and Personnel Head on Form VII within 4 hours.

40. OFF SITE EMERGENCY PLAN

If an accident takes place in an NTPC unit and its effects are felt outside its premises, the situation thus created is called an 'off site' emergency. It no longer remains the concern of the factory management alone but also becomes a concern for the general public living outside or passing by the premises of the factory or storage site involved. To meet such situations. Offsite emergency plans are to be prepared as stipulated and put into operations as and when required.

Offsite emergency plan is to be prepared by the government authorities, not by the occupiers of NTPC unit. It is mandatory under Rule 14 of the Hazardous Chemical Rules for District authorities to prepare an off-site emergency plan in respect of industry employing hazardous chemicals or at locations where accidents are likely to have an offsite adverse effect.

The off-site emergency plan shall detail how emergency related to major accidents on the site will be dealt with. For preparing the plan, concerned District authorities should consult the industries and other persons who would be concerned with its execution should such an emergency arise. The following points should be noted by all concerned in respect of an off-site emergency plan:

The industrial or storage units to be covered under the plan should provide all the necessary information related to industrial activities under their respective control to the concerned authorities.

In case of any new industrial activity proposed or being set up in the area, an onsite emergency plan shall be prepared before the activity is commenced.

WHAT CAN ORDINARILY CONSTITUTE AN OFF-SITE EMERGENCY IN NTPC

The following conditions can constitute an off-site emergency in NTPC.

Heavy release of chlorine, resulting in it spread to neighboring areas.

Major fires involving combustible materials like oil, and other facilities.

EMERGENCY DUE TO CHLORINE TONNER FAILURE

There can be two types of chlorine toner failure rupture of value or rupture of the shell.
Other major cause of off-site emergency may be explosion in chlorine cylinder due to terrorist activities or otherwise.
It is not uncommon for a valve of chlorine toner to rupture. It is assumed that a rupture would release approximately 250 kgs of chlorine into the atmosphere instantaneously. Remaining chlorine could come out relatively slowly and in about 20 minutes the Cylinder may empty out. If the chlorine supplier overfills the tonner and if such toner is kept in the open, the pressure inside tonner can increase with heat due to the Sun. Due to this increase in pressure, tonner can rupture. It is not possible to predict the nature of rupture and its size. At the minimum it can be assumed to be equivalent to the complete breaking of valve of tonner. At the worst total failure of tonner can be taken. In this case the whole of its contents will get released instantaneously to the atmosphere.
Another very extreme case could be sudden rupture of all or most of the stored full chlorine tonners due to fire explosion. In this case it can be assumed there will be a maximum release of 10-20 tons of chlorine into the atmosphere.

RESPONSIBILITY FOR PLANNING AN OFF-SITE EMERGENCY

The planning for emergency response to chemical disaster requires cooperation among the responders to know the persons responsible for various activities. This understanding is facilitated through personal interaction and close working in devising and updating a plan. Therefore, the pre-requisition of the planning team is given below.
Under the Environmental Protection Act, the responsibility of preparation of OFF-SITE Emergency Plan lies with the State Government. The Collector / Deputy Collector are ordinarily nominated by the State Government to plan OFF-SITE Emergency Plan.

FOLLOWING MEMBERS SHOULD BE PART OF THE TEAM

Planning Team – Members

Collector / Deputy Collector

District Authorities In-charge of Fire Services, Police

Medical Services

Factory Inspectorate

Pollution Control Board

Industries and

Transport

Co-opted Members on need basis

District authorities concerned.
Civil Defense
Publicity Department
Municipal Corporation, and
Non-Officials such as elected representative. MPs / MLAs and Voluntary Organisation.
The District Collector or his nominated representative would be the team leader who shall conduct the planning task in a systematic manner.

NUMBER AND TYPE OF INDUSTRIES TO BE COVERED UNDER THIS PLAN

A list of chemicals with the threshold quantities for which off-site emergency plan is required to be prepared is given in Schedules 2 and 3 of Management, Storage & Import of Hazardous Chemicals Rules, 1989. The off-site plan is also to be prepared in case of Transit Depots, Warehousing Corporation and during transportation of Hazardous Chemicals.

COMPILATION OF GEOGRAPHIC, DEMOGRAPHIC, METEOROLOGICAL AND SEISMIC INFORMATION

Details of public transport network including information and local conditions around the hazardous industries are required for preparation of off-site plan. The information required includes:

Geographic Information

Public transportation network, details of road network including conditions of road, with traffic load and connecting road with industries and the rail network are to be collected and shown on map.

Pipeline network

Details of pipeline network carrying flammable and toxic materials are to be shown in the map to indicate possible impact.

Land use (actual and future use)

Land use plan in the vicinity of the hazardous industries would require in-depth analysis to determine the likely effect of any spill in the area.

Water supply

Demographic Information

The population of the industry as well as the neighboring areas is a key factor for this type of planning. The information to be collected in this regard is:

Neighboring population

Housing colonies of industries

Sensitive institutions i.e. schools, hospitals

Type of housing

Cattle / livestock

Meteorological Information

Meteorological data for a period of 10 years related to wind speed / direction, humidity and temperature inversion is essential for preparation of dispersion models for toxic gas release.

Seismic Data

Information regarding seismic zone and record of earthquake is considered to be an important input in off-site planning.

ELEMENTS OF OFF-SITE PLANNING

A typical off-site emergency plan should have the following important components:
Plan Pre-requisite (Background information as given earlier)

Plan requirement (Aims & Objectives of the Plan)

Planning Team

Hazard analysis and Quantification

Scenario development

Assessment of Capabilities

Plan Development

Incident information

Authority for responding.

Basic Assumption

Operation of the Plan

Coordination with other plans

Emergency Assistance

Name and addresses of the key personnel.

Telephone numbers

Response Functions

Initial Notification

Control Room

Access

Direction and control

Communication amongst responders

Warning System / Emergency Notification

Public information

Resources Mobilization and Management

Health and Medical Response

Public protection including evacuation

Fire and Rescue

Law and Order

On-going Incident Assessment

Besides the above, other elements of off-site planning are containment, clean up and disposal, Documentation and Investigation, Plan Testing and Updating and Community Awareness, Preparedness and Training.

For developing an offsite plan of a particular locality, the elements of relevance to the plan should be carefully selected, the elements would be based on locational situations, hazards present, existence of vulnerable area in the vicinity and resource availability etc.
The main pre-requisite of an off-site emergency plan is to define and lay down the clear-cut objectives and requirements. As stated earlier, a planning team representing local industries, response agencies and other bodies should be formed, the plan should be based on a systematic hazard analysis of the units in the area and scenarios based thereon. This should be done by the units and made available for updating the plan. Resource planning has to be based on an assessment of capabilities in the area.
Plan development should clearly indicate the format to be used for reporting information related to accidents, basic assumptions preparing the plans, plan operation and dove tailing with other plans. The plan should include the names and contact telephone numbers of the persons responsible for emergency part of the plan. The plan should cover details about Central Control Room, access to and from the incident area, direction and control of emergency, public information, resource management, communication during emergencies, response personnel safety, ongoing incident assessment etc.
Specific roles of the police, fire fighting and medical personnel should be worked out in the plan. The aspect of containment clean up and disposal should also be covered in the plan. If it is not done properly, there could be secondary effect from the accident. Testing and updating of the plan needs lot of preparatory work in the form of training of teams, developing assessment mechanisms using observers and mobilization of resources. The role of adjacent communities during emergencies and building community awareness are also important aspects of the plan.

OFF-SITE CONTROL ROOM

The control of crisis during major accidents is to be exercised through a Control Room to be established by government at an easily accessible central location in the area. This Control Room should be capable of functioning on being required to be activated at any time. The Control Room for Off-site plan is thus over and above the Control Room set up by each unit for its on-site plan. The Control Room shall: -

Act as a focal point of emergency management.

Keep records of all messages

Inform the operation officer on receipt of first information relating to accident.

Monitor implementation of mutual aid.

Serve as the focal point for meeting of the Crisis Management Group (CMG).

In order to operate the Control Room round the clock manpower and transport are required on a shift basis. The Control Room should be equipped with proper communication system, data processing network and should be a storehouse of information to combat emergencies.

KEY PERSONNEL AND THEIR DUTIES

The ultimate responsibility for the management of the major emergencies rests on the District Collector. He will be assisted by representatives from all concerned organisations, departments and services at the district level. This group of officials forms the District **Crisis Management Group (CMG)**

C M G (Crisis Management Group)

The members of the group may vary according to the District and local conditions. The CMG will: -

Control all emergency operations.

Guide on matters related to policy issues.

Provide official information and instructions to the general public.

An **Operation Response Group (ORG)** will have to be put up to implement the directions of the CMG.

The duties of the **ORG** are under:-

To develop an integrated response strategy based on the available information.

To plan deployment of field units to ensure the availability of appropriate force to deal with the situation.

To coordinate the functioning of the various agencies.

To deal with crisis and implement decisions of CMG.

To Monitor the progress till the crisis ends and keep the CMG posted with the development.

41. COMMUNICATION SYSTEM NETWORK

An efficient and reliable Communication System is required for the success of the off-site emergency plan. The efficient communication system is required to alert: -

Off-site Emergency Authorities and Services.

Neighboring factories in the area and public in the vulnerable zone.

A communication network of the following type may be helpful:

Radio communication between the Control Room to Unit Control Room of the industrial unit and respondents outside the area.

Hotlines between Control Room to industrial units, Emergency Services.

Meteorological Station and the Media.

P&T Telephone Lines.

Data Processing Network hooked to the Computers.

A communication flow chart is prepared and kept in the Control Room and up-to-date Telephone Directory of key personnel concerned with the emergency is made available at all times.

In coordinating the communication system efficiently, there would be a communication officer in Control Room to ensure that all modes of communication are functional round the clock, all communication operators shall maintain a Logbook for the messages received in / out and actions taken.

42. WARNING SYSTEM

In an off-site Management Plan, one of the most important pre-requisite is a good "Warning System Efficient warning system will save lives, prevent injuries and reduce losses. Emergency Commander will decide the appropriate Warning System and implement it. The Commissioner of Police will be responsible for implementation of the Warning System.
The Warning System are of the following types: -

Disaster Warning (Maximum Credible Loss Scenario)

Shall be decided by state Govt. authorities.

Fire / Toxic Release:

Shall be decided by state Govt. authorities.

All Clear:

Shall be decided by state govt. authorities.

Depending upon the nature of hazards and the area affected other methods of warning may be used by state govt. as follows:

Outdoor Warning Sirens.

Public Address System with Police.

ARP Sirens.

Mass Media.

Door to door visit by Civil Defense Personnel.

Telephonic contact with schools and other organisations / Public institutions.

Information to be provided at common gathering places such as Canteens, Shops etc.

43. PUBLIC INFORMATION SYSTEM

During a crisis following an accident, the people of the area and large number of media representatives would like to know about the situation from time to time and the response of the District Authority to the crisis. It is important to give timely information to the public in order to prevent panic and rumor mongering. Ther emergency public information could be carried out in three phases.

Before the Crisis

This will include the safety procedure to be followed during an emergency through posters, talks and mass media in different languages including local languages. Leaflets containing do's/don'ts should be circulated to educate the people in the vicinity. Under the Factories Act 1948, this responsibility lies with the government.

During the Crisis

Dissemination of information about the nature of the incidents, actions taken and instructions to the public about protective measures to be taken, evacuation etc, are the important steps during this phase.

After the Crisis

Attention should be focused on information concerning restoration of essential services, travel restrictions etc.

Various tasks of the public information system could include:

Quick dissemination of emergency instructions to the public.

To receive all calls from media / public regarding emergency situations and respond meticulously.

Obtain current information from the Central Control Room.

Prepare news release.

Maintain contact with hospital and get information about the casualties.

44. FIRE FIGHTING SYSTEM

The industrial areas having major accident-prone hazardous installations should have special firefighting arrangements. There shall be an Emergency control centre to have control all firefighting resources in the affected areas under the overall charge of the CISF Fire Officer. The operational response will be coordinated from the Central Control Room, the planning for firefighting should be done by government as follows:

Before the Crisis

The proper road and means of escape are to be identified.

Considering the possible hazards, is maintained adequate water supply.

Training of the personnel in firefighting duties in the industry is organised regularly.

Provision of adequate and proper arrangement of fire fighting vehicles is made.

Immediate response to an emergency should be coordinated by the Govt. Control Room by matching all the resources. In a major emergency having wide off-site implications, more than one industry may be affected necessitating concurrent firefighting operations at a number of places. In this case, the whole area may be divided in different fire zones. The task of the fire zone commanders should be as under: -

Command and control of all firefighting resources in the respective fire zones.

Deployment of additional fire resources allocated by Control Room.

Coordination of firefighting institutes.

45. SERVICES SUPPORT SYSTEM

- **HEALTH AND MEDICAL**

A major off-site emergency in an area may affect a number of units and the surrounding colonies resulting in more casualties. The medical resources and provide emergency medical treatment to the victims of the incident a Coordinate utilisation of all available local medical resources in the incident areas as well as the additional resources should be

mobilised under the overall charge of the District Health Department. The operational response should be coordinated by the Chief Medical Officer from the Control Room. Before the crisis, the following actions should be carried out: -
Specialized training of doctors relating to chemicals hazards.
Block grouping of all employees working in the industrial union.
Maintenance of list of blood donors groupwise.
Arrangement of adequate buffer stock of essential medicines.
Stocking of anti-dotes and special medicines for hazardous substances.
Planning of additional capacity in the base hospital for large-scale casualties.
During the crisis, medical plan in terms of manpower, transport, and equipment as per organizational response be implemented.
The organisational response structure should be set up as under: -

Fire Aid Post

Casualty Response Centre

Base Hospital

It is essential to guide medical relief and establish public health measures like sanitation, immunization etc. In the absence of proper information about the chemical exposure, their symptoms, first aid and treatment, the physicians attending such emergencies are generally faced with great problems.

*** TRANSPORTATION**

A large number of ambulances would be necessary to transport casualties to the casualty response centre and base hospital. For this purpose, all types of vehicles which can be converted as ambulances at short notice should be kept at the Unit Control Room and other places as deemed necessary by government.

*** SECURITY AND POLICE**

Security, protection of life and property and traffic control and maintenance of law and order are the traditional and statutory functions of the police. During an emergency, duties and responsibilities of the police may be: -

Cordoning of the incident area.

Warning public about the hazards.

Traffic Control.

Assist firefighting services.

Assist first aid and medical teams.

Assist evacuation and ensure protection of property in evacuated areas.

Control of security operations in the area should be exercised by the Deputy Commissioner of Police. Different phases of emergency management practices would be as under: -

***Before the Crisis**

Contingency plan of manpower, transport, and communication network to coordinate possible incident areas and to regulate traffic should be made for each industry in the area.

*** During the Crisis**

The Security Commander of the area will set in motion the relevant contingency plan to control the operation.

*** After the Crisis**

Protect property in the affected area.

*** Media**

The Control Room should release up-to-date information to the media.

46. EVACUATION

In a disaster situation, evacuation is the movement of people from the place of danger to places of relative safety. It is the most effective action to protect people. A comprehensive and coordinated planning is necessary to implement orderly evacuation of population.

The process of evacuation should be based on the nature of threat, possibility of spreading of toxic gases and weather conditions. In this case the hazard analysis in maximum credible loss scenario would help in planning of evacuation. The people of the area should be advised to leave the threatened area and to take shelter in the nearest reception centres. The command and control of the evacuation process should be carried out in three phrases.

Before the Crisis

The public should be informed and educated properly for chemical hazards. Local police should warn the people in this regard and install sirens in vulnerable places.

The probable affected areas should be divided in several evacuation centres which are entirely site specific.

Detailed contingency plan of evacuation of various sites should be prepared.

Availability of all transport resources needs to be ensured. Planning of adequate reception centres including accommodation, food, water supply and sanitary arrangements for the affected population should be done.

During the Crisis

Implementation of the plan should be done in the quickest possible time.

After the Crisis

Once the crisis is over, the affected people should be rehabilitate, and the follow up measures should be taken up.

Relief to the victims

Post emergency activities include relief to the victims

The Public Liability Insurance Act (PLI Act.) 1991 provides for the owner who has control over handling hazardous substances to pay specified amount of money to the victims as interim relief by taking insurance policy for this purpose. The District Collector has definite role in implementation of the PLI act, 1991. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.

47. DETAILED INFORMATION ABOUT CHLORINE

Chemical Name & Synonyms	**: CHLORINE**
Chemical Formula	**: Cl2**
U.N. Number	**: 1017**
C.A.S No.	**:7762.50.5**
U.N. Classification	**: Class 2**
Characteristic Nature	**: Liquid in cylinders. Gas at atmospheric Temperature and pressure.**
Boiling Point C	**: (-) 34.05 at 1 atm.**
Vapour Pressure (mmHg)	**: 6.3 atm at 20° C**
Vapour Density (Gas)	**: 2.5 atm 20° C (gm/lr)**
Solubility in H2O	**: Slightly soluble**
Appearance & Odour	**:Greenish yellow (Gas). Clear amber liquid. Suffocating and pungent.**
Specific Gravity (liquid Cl2)	**: 1.468 at 0° C and 3.617 atm.**
Threshold Limit Value	**: 1 ppm**
Melting Point ° C	**: (-) 101 at 1 atm.**

Fire & Exploding Hazard Data: Neither liquid nor gaseous chlorine is explosive or flammable by itself, but both react readily with many organic substances, usually with the evolution of heat and in some cases resulting in explosion.

Health Hazard Data Nature: Corrosive Liquid

Effects of over Exposure: Causes headache retrosternal burning, nausea, painful breathing, sweating, eyes nose, throat irritation, coughing, vomiting, increase in respiratory and pulse rate. Massive inhalation causes pulmonary oedema, fall of blood pressure and in a few minutes cardiac arrest.

Emergency & First Aid: For eye and skin contact flush with plenty of water. Apply artificial respiration only if he is not breathing. Consult a physician.

Spill or Leak

Steps to be taken if Chlorine is Released: If a leak occurs keep the leaking valve on on the upper side by rolling the cylinder to prevent discharge of liquid. No water to be splashed at any point of time on the cylinder. Keep other containers cool by spraying with water.

Special protection :

Respiratory Protection: Self-contained breathing apparatus**.**

Protective Gloves: Rubber or PVC

Eye Protection: Goggles giving complete protection to Eyes

Other Protective equipments: Rubber aprons and boots. Eyewash showers should be with clean water.

Precautions to be taken:

During Handling and Storage: Keep containers and valves closed when not in use. Store cylinders in a covered shed only. Use protective equipments as indicated above.

Toxicity of Chlorine

HEALTH HAZARD

Chlorine is a mucous membrane and respiratory system irritant. It reacts with body moisture to form acids and at high concentration, it acts as an asphyxiant by causing cramps in the muscles of larynx and swelling of the mucous membranes. The presence of chlorine in the atmosphere is, to some extent, detectable by its characteristic odour and irritant properties. Consequently in the event of leakage workers usually have sufficient warning to escape and avoid excessive exposure.

ACUTE EXPOSURE

First symptoms of exposure to chlorine are irritation to mucous membranes of eyes, nose and throat, which increases to smarting and burning pain. This irritation spreads to the chest.

A reflex cough develops, which may be intense and often associated with pain behind the breastbone, the cough may lead to vomiting.

Cellular damage may occur with excretion of fluid in the alveoli which may prove fatal if adequate treatment is not given immediately (complete rest, O2 therapy, immediate transfer to hospital). Vomit frequently contains blood due to lesions of the mucous membrane caused by the gas.

Other common symptoms include headache, general indisposition, anxiety and feeling of suffocation.

Massive inhalation produces pulmonary odema, fall of blood pressure and in a few minutes cardiac arrest.

CHLORINE EXPOSURE

Chlorine concentration considerably higher than current threshold values may occur with out being immediately noticeable, men rapidly looses their ability to detect the odour of chlorine in small concentrations.

Prolonged exposure to atmospheric Cl2 concentration of 5 PPM results in the disease of bronchi and predisposition to tuberculosis.

Lung studies have indicated that concentration of 0.8 to 1.0 ppm causes permanent, although moderate reduction in pulmonary function.

Acne is not unusual in persons for long period of time to low concentration of Cl2 and is commonly known as chlorancne.

HAZARD OF CHLORINE AT DIFFERENT ATMOSPHERIC CONCENTRATIONS

(As given in International Labour Organisation Encyclopedia of Occupational Health and Safety)

CHLORINE CONCENTRATION IN AIR		DEGREE OF HAZARD
ppm	mg/m3	
0.1-0.5	0.3-1.5	No noxious long-term effect

0.5	1.5	Slight odour (tentative limit)
1-3	3-6	Definite odour, irritation of eyes and nose
30	90	Intense coughing, fits
40-60	120-180	Exposure without effective respiration for 30-60 minutes or more may cause serious damage
100	300	May cause lethal damage
1000	3000	Danger to life even after few deep inhalations

FIRST AID FOR CHLORINE EXPOSURE

General

Caution – Proper personal protective equipment should be worn to ensure safety.

Remove exposed persons to uncontaminated areas as quickly as possible.

Remove contaminated clothing.

Wash contaminated parts of the body with running water.

Give nothing by mouth if the person is unconscious or convulsing.

Call a physician at the earliest.

Give assurance to the victim to alleviate his anxiety.

Chlorine Gas Inhalation

In case the victim is not breathing

Remove him to fresh air.

Give artificial respiration immediately.

Administer oxygen by inhalation as soon as possible utilising the services of trained personnel.

If the victim is breathing

Place patient in a comfortable position.

Encourage him to have slow deep regular breathing.

Administer oxygen by inhalation as soon as possible, utilising the services of trained personnel.

Keep the victim warm, keep him at rest.

Render any other necessary first aid, if needed.

Give assurance to the victim to alleviate his anxiety and obtain his co-operation.

In severe cases position victim in chair. Have the victim lie down the head and trunk elevated to 45–60-degree position.

Liquid Chlorine Eye contact

Flush eyes immediately with copious amounts of running water for a minimum of 15 minutes.

Hold eyelids apart to ensure complete irrigation of all eye and lid tissues.

Do not attempt chemical neutralisation of any kind.

Refer to a physician.

Liquid Chlorine Skin contact

Flush contaminated skin with copious amounts of running water for a minimum of 15 minutes. Remove clothes from the victim's body. While in the shower to ensure irrigation of all affected skin.

Do not try chemical neutralisation or apply any ointments to damaged skin.

Refer to a physician if irritation persists after irrigation or if skin is broken or blistered.

CHLORINE EXPOSURE – MEDICAL RELIEF MEASURES

For Mild cases give the following:

Cough syrup –2 Teaspoon (10 ml)

Erasma – Chloroppced + Strepsil Tablets.

Hot tea or water to drink.

NOTE: Only trained persons should give the above treatment.

For Severe cases (who are conscious):

Give the treatment as in above PLUS

Injection Deriphyllin / Periphyllin 2 ml IM

Injection Decadron 2 ml IM

Tablet Lasix or Injection Lasix

Oxygen inhalation

NOTE: Only doctors / nurses / compounders / trained persons shall give the treatment.

For Unconscious cases

Doctor to give the following and send the victims to the hospitals where they will be attended by specialists:

Injection Coromine

Injection Decadron

Injection Lasix

Injection Deriphyllin

Oxygen by mask / catheter

MEDICAL TREATMENT OF CHLORINE EXPOSURES
GENERAL PRINCIPLES

All individuals who have been exposed to acute over exposure to chlorine gas by inhalation should be sent for medical treatment.

For acute chlorine exposure no specific antidote is known. Prompt supportive

measures can be taken to obtain good therapeutic results.

Victim's anxiety should be alleviated by communication with him the various procedures undertaken and elicit his co-operation, especially in breathing exercise.

Position victim in chair. In severe cases the victim should lie down with the head and trunk elevated to 45–60-degree position.

Encourage the victim to take slow, regular respirations.

Use of intermittent positive pressure breathing apparatus helps in minimising the risk of pulmonary edema.

Humidify air.

Therapy for specific physiological disturbances
Pulmonary Edema

Administer 60 to 100% oxygen, 6 liters per minute.
Intermittent positive pressure breathing apparatus helps in reducing edema. Caution is required if there is co-existing peripheral circulatory collapse.
Steroid therapy given early may be effective in preventing or alleviating pulmonary edema. If steroids are used a loading dose should be given promptly and the dose then gradually tapered off over a one to two week period, in keeping with clinical findings.
The use of antibiotics should be considered to protect against secondary pulmonary infection.

Branchospasm

Broncho dilators nebulised into the inspiratory air may be beneficial when spasm is present.

An effective drug is ventrolin.

Increased Mucus Secretion

Positive pressure treatment and nebulised detergents may be beneficial. Care should be taken to maintain the patient's hydration and to humidify the inspired air.

Coughing is not harmful but a cough suppressant may be helpful for a persistent, nonproductive and irritating cough.

Excitement Phenomenon

This occurs as a result of a central stimulation and emotional disturbance.

Mild sedation with the diazepam is usually effective. In the more severe cases, heavier sedation may be employed with close supervision of respiratory function.

Some patients may require special sedation for the first night following over exposure.

MEDICINES AND FACILITIES TO BE KEPT IN THE HOSPITALS

Oxygen cylinders

Injection Deriphyllin

Injection Periphyllin

Injection Lasix

Injection Decadron

Injection Coramine

Erasma Tablets

Calropred Tablets

Lasix Tablets

Strepsils / Lozenges

Glucose Saline

I.V. Sets5 ml syringes

2 ml syringes

Injection Needles

Stretchers

PREDICTING THE AREAS WHICH WILL BE AFFECTED BY THE CHLORINE CLOUD

When a massive chlorine leak takes place in the Plant, the escaping gas will spread to the neighboring areas. The spreading of chlorine cloud will depend upon the wind direction and speed and the amount of chlorine escaped.

48. EMERGENCY PLAN FOR CONSTRUCTION /ERECTION WORK

The following emergencies are likely to be occurred during major construction & erection work in expansion of project.

1. Fire & Explosion
2. Collapse of Lifting appliances and transport equipments
3. Collapse of Building, sheds or structures etc.
4. Gas leakage or spillage of dangerous goods or chemicals
5. Landslides getting building worker buried and other natural calamities.

List of Key person for Emergency in Construction /Erection work

The Key Personnel include:

DGMs / Engineer – In charge responsible for

Project Civil

Mechanical Erection

Electrical Erection

C&I Erection

Head of Personnel and Officers connected with IR and Labour Welfare.

DGM (Technical Services)

Head of Safety

Chief Medical Officer

Commandant / Asst. Commandant

CISF Fire Officer

Transport: Auto Base Engr. (I/c)

Public Relation Officer (PRO)

The rescue operation Teams of above-mentioned emergencies have already been covered vide Point no.22 i.e. Teams (A to L),

49. MATERIAL SAFETY DATA SHEETS
CHLORINE

1. CHEMICAL IDENTITY

Chemical Name: CHLORINE : Chemical Classification : *Inorganic gas or liquid*

Synonyms : None : Trade Name

Formula: Cl_2 C.A.S. No. : *7782-50-5* U.N No. *1017*

Regulated Identification: Shipping Name: *Chlorine* Hazchem Code : 2 X E

Codes/ label: *Nonflammable gas, Poison, Class 2*

Hazardous Waste ID No.: *17*

HAZARDOUS INGREDIENTS : CAS No.: HAZARDOUS INGREDIENTS : CAS No.

1. *Chlorine* : *7782-50-5* 2.

2. PHYSICAL/CHEMICAL DATA

Boiling Pt./ Range *-34^0 C* : Physical State : *Liquefied Copr. Gas*: Appearance: *Greenish Yellow*

Melting/Freezing Point *-101.0^0 C* : Vapour Pressure: Odour : *Irritating, chocking*

@ 35^0 C 4800 mm Hg at 20^0 C:

Vapour Density (Air =1) *2.49* : Solubility In water at 30^0 C *Not soluble*: Others *Soluble in alkalies*

Specific Gravity : pH *Not pertinent*

3. FIRE/EXPLOSION HAZARD DATA

Flammability (OC) *No* : LEL *Not pertinent* % : Flash Point ^{0} C *Not pertinent*

TDG Flammability *NA* : UEL *Not pertinent* % : Flash Point ^{0} C *Not pertinent*

Auto ignition Temperature ^{0} C : *Not pertinent*

Explosion sensitivity to impact : *Stable*

Explosion sensitivity to Static Electricity: : *Stable*

Hazardous Combustion Products : *Toxic products are generated when combustibles burn in Cl_2*

Hazardous Polymerization : *Will not occur*

Combustible Liquid *No* : Explosive Material *No* : Corrosive Material *Yes*

Flammable Material *No* : Oxidizer *Yes* : Others

Pyrophoric Material *No* : Organic Peroxide *No*

4. REACTIVITY DATA

Chemical Stability : *Stable*

Incompatibility with other material : *Combustible substances, finely divided metals*

Reactivity :*Violent reaction with alcohols , explosive reaction with metals , potentially dangerous with Sulfides, Trialkyl Boranes , . At normal temperatures dry Chlorine does not attack steels, copper, bronze etc. Moist Chlorine is corrosive*.

Hazardous reaction Products : *Toxic Products are generated when combustibles burn in Cl_2*

5. HEALTH HAZARD DATA

Routes of Entry :*Inhalation, Ingestion, skin and eyes*

Effect of Exposures /Symptoms :*Causes eye irritation, sneezing, copious salivation, general excitement, restlessness. High concentration causes respiratory distress and violent coughing often with retching. Death may result from suffocation.*

Emergency Treatment : Inhalation : *Remove the victim to fresh air area , support respiration, give Oxygen, if necessary.*

: Eyes : *Flush with large amounts of water for at least 15 minutes . seek medical aid immediately.*

LD $_{50}$ (Oral/ Rat) : *Not listed* *mg/ kg* :

STEL *3* *ppm* *9mg/m^3*

Permissible Exposure Limit ppm *3 mg/m^3* : Odour Threshold *3.5 ppm* *10.2 mg/m^3*

TLV (ACGIH) /

NEPA Hazard	: Health	:Flammability	: Reactivity	: Special
Signals	*3*	*0*	*0*	

6. PREVENTIVE MEASURES

Personal : *Avoid contact with liquid or vapours*.

Protective Equipments : *Provide PVC gloves , gumboots, rubber overcoat, Head mask, self contained breathing apparatus*

Handling & Storage Precautions : *Store in a cool place, dry, relatively isolated, well ventilated place. Store in a cylinders, pressure vassals or pipe lines.* :

7. EMERGENCY / FIRST AID MEASURES

FIRE :Fire Extinguishing :Media :*Not combustible*

:Special Procedure : *Keep the containers cool by spraying water if exposed in heat or flame.*

:Unusual Hazard : *Poisonous gases are produced in fire.*

EXPOSURE :First Aid Measures: *If inhaled, move the victim to fresh air area. If Chlorine comes in contact with eyes or skin , wash with plenty of water under quick opening safety shower and eye wash fountain. Seek medical aid immediately.*

:Antidotes / Dosages : *Not available*

SPILLS : Steps to be taken : *: Shut off leaks if without risk . Contain liquid with sand or earth.. Prevent the liquid from entering the sewer. Vapours create toxic atmosphere. Knock down vapours with water spray*.

: Waste Disposal Method: : *Neutralizes small liquid spillage's with soda ash and drain with abundant water. Cover pool with protein Foam, so that the release of vapour to atmosphere is and under control.*

8. ADDITIONAL INFORMATION / REFERENCES

In case of large gas escapes , the presence of cloud can be marked with ammonia with which it will turn into a mist. Run away from the gas clouds in a direction perpendicular to the wind direction. Avoid liquid chlorine leaking and body contact . persons with pulmonary diseases should avoid the exposure. A concentration of 3.5 ppm produces a detectable odour; 15 ppm causes immediate irritation of the throat . Conc. of 50 ppm are dangerous for even short exposures . 1000 ppm is Fatal. Can react to cause fire/ explosion on contact with Turpentine, illuminating gas, Polypropylene, rubber, sulfuric acid ,Acetaldehyde, alcohol's. Bring the leaking portion of the cylinder to the uppermost position, so that only the gas escapes and not the liquid.

9. MANUFACTURERS / SUPPLIERS DATA

NAME OF FIRM	Contact person
MAILING ADDRESS	in emergency
TELEPHONE / TALEX NO.	Local Bodies Involved
TELEGRAPHIC ADDRESS	Standard Packing
	Trem Card Details/Ref.

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HYDROGEN

1. CHEMICAL IDENTITY

Chemical Name : *HYDROGEN* : Chemical Classification : *Inorganic Gas*

Synonyms : *Liquid Hydrogen, para Hydrogen*, *Hydrogen Compressed* : Trade Name

Formula : H_2 C.A.S. No. : *1333-74-0* U.N No. *2015/2014*

Regulated Identification: Shipping Name :*Hydrogen, Compressed*

Hazchem Code *2 S E*

Codes/ label :*Flammable Gas, Class 2*

Hazardous Waste ID No. :17

HAZARDOUS INGREDIENTS	: CAS No. :	HAZARDOUS INGREDIENTS	: CAS No.
1. Hydrogen	*1333-74-0*	2.	

2. PHYSICAL/CHEMICAL DATA

Boiling Pt./ Range *-252.8 ^{0} C* : Physical State *Gas* : Appearance *Colourless*

Melting / Freezing Point –259.18^0 *C* : Vapour Pressure : Odour *Odourless*

@35^0 C *Not pertinent* mmHg

Vapour Density (Air=1) *0.069* : Solubility In water at 30^0 C *Slightly soluble:* Others *not available*

Specific Gravity (Water=1) 0.0899 g/l : pH *Not pertinent*

3. FIRE/EXPLOSION HAZARD DATA

Flammability *Yes* : LEL *4.1% :* Flash Point ^{0} C *Not pertinent* (OC)

TDG Flammability *2* : UEL *74.2% :* Flash Point ^{0} C *Not pertinent* (OC)

Auto ignition Temperature ^{0} C : *400.0*

Explosion sensitivity to impact : *Stable*

Explosion sensitivity to Static Electricity : *Exploders*

Hazardous Combustion Products : *Not available*

Hazardous Polymerization : *Will Not Occur*

Combustible Liquid *No* : Explosive Material *Yes* : Corrosive Material *No*

Flammable Material *Yes* : Oxidizer *No* : Others

Pyrophoric Material *No* : Organic Peroxide *No*

4. REACTIVITY DATA

Chemical Stability *: Stable*

Incompatibility : *Water, No chemical reaction with common materials but low temperature causes*

With other material *most materials to become very brittle*.

Reactivity :*Violent reaction or ignition with air + catalyst (Platinum and similar metals*

containing absorbed Oxygen or Hydrogen), Bromine,

Iodine, Dioxane+ Nickel,

Lithium, Nitrogen trifluoride, Nickle + Oxygen diflouride , Pd +Isopropyl alcohal

Hazardous reaction :*If forms sensitive explosive mixtures withBromine, Chlorine, Iodine Heptaflouride,*

Products *: Chlorine Dioxide, Dichloride Oxide, Dinitrogen Oxide*

5. HEALTH HAZARD DATA

Routes of Entry *:Skin, Ingestion*

Effect of Exposures /Symptoms :*It is an inert, non toxic gas. In high concentration acts as a simple asphyxiant. If atmosphere does not contain enough oxygen, inhalation can cause dizziness, unconsciousness or even death. Contact of liquid with eyes or skin causes freezing similar to burn.*

Emergency : Inhalation: *If victim is consciousness (due to oxygen deficiency), move him to fresh area and apply resuscitation.*

Treatment : *Eyes & Skin: Treat for frostbite, soak the skin in the warm water. Seek medical aid.*

LD $_{50}$ (Oral/ Rat) N*ot listed* mg/ kg : STEL N*ot listed* ppm N*ot listed* mg/m^3

Permissible Exposure ASPHYXIANT ppm *ASPHYXIANT* mg/m^3 Odour Threshold: *Odourless* ppm *Odourless* mg/m^3 *Limit*

TLV (ACGIH) : *ASPHYXIANT* ppm *ASPHYXIANT* mg/m^3

NEPA Hazard	: Health	:Flammability	: Reactivity	: Special
Signals	: 0	: 4	:0	:

6. PREVENTIVE MEASURES

Personal : *Avid contact with liquid or gas*

Protective Equipments :*Provide safety goggles face shield, insulated gloves and long sleeved, trousers worn outside boots or over high-top shoes, self contained breathing apparatus containing air (never use oxygen)*

Handling & Storage : *Store in a cool , FIRE-PROOF, well ventilated area, separated from other cylinders,*

Precautions : *preferably in open air*

7. EMERGENCY/FIRST AID MEASURES

FIRE :Fire Extinguishing :*Stop flow of gas , let fire burn under control.*
:Media :
:Special Procedure : *Keep the containers cool by spraying water if exposed to heat or flame*
:Unusual Hazard : *flash back along gas trail may occur*

EXPOSURE :First Aid Measures : *Inhalation : If victim is unconscious (due to oxygen deficiency) , move him to fresh air area and apply resuscitation.*
: *Eyes & Skin: Treat for frostbite, soak the skin in lukewarm water. Seek medical aid.*

:Antidotes / Dosages : *Not available*

SPILLS :Steps to be taken : *Shut off leaks if without risk. Warn ever body ~Explosion Hazard*

:Waste Disposal Method: : *To be burnt under control condition.*

8. ADDITIONAL INFORMATION / REFERENCES

Practically no toxicity , except that it is an asphyxiant. Highly dangerous fire and severe explosion hazard when exposed to heat, flame and oxidizers, flammable or explosive when mixed with air , O_2, Cl_2 *. Vigorous exothermic* reaction with Benzene+ Raney Nickel catalysts, metals(like Strontium, Sodium, Potassium, barium , 300^0 C) Ventilate at points.

9 MANUFACTURERS / SUPPLIERS DATA

NAME OF FIRM	Contact person
MAILING ADDRESS	in emergency
TELEPHONE / TALEX NO.	Local Bodies Involved
TELEGRAPHIC ADDRESS	Standard Packing
	Trem Card Details/Ref.

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HYDROCHLORIC ACID

1. CHEMICAL IDENTITY

Chemical Name : HYDROCHLORIC ACID : Chemical Classification : *Inorganic Compound*

Synonyms : *Muriatic Acid, Hydrogen Chloride, chlorohydric acid , Sprits of Salts*

Trade Name

Formula : HCl C.A.S. No. : *7647-01-0* U.N No. *1789*

Regulated Identification: Shipping Name : Hydrochloric Acid Hazchem Code

: Codes/ label : *Corrosive Class 8* Hazardous Waste ID No. : 16

HAZARDOUS INGREDIENTS : CAS No. : HAZARDOUS INGREDIENTS : CAS No.

1. Hydrochloric Acid : *7647-01-0* 2.

2. PHYSICAL/CHEMICAL DATA

Boiling Pt./ Range –84.8^0 C : Physical State *Liquid* : Appearance *Colourless*

Melting / Freezing Point 114.3^0 C : Vapour Pressure : Odour *Sharp irritating odour*

@35^0 C 3040 mmHg at 17.8^0 C

Vapour Density (Air=1) *Not pertinent* : Solubility In water at 30^0 C *Soluble* : Others : *Soluble in Ethyl*

Specific Gravity (Water=1*) 1.19 at 20^0 C (Liquid*) : pH >1 : *Alcohol& Ethyl Ether*

3. FIRE/EXPLOSION HAZARD DATA

Flammability *No* : LEL *Not Pertinent* % : Flash Point *Not Pertinent* ^{0} C (OC)

TDG Flammability *Na* : UEL *Not Pertinent* % : Flash Point *Not Pertinent* ^{0} C (OC)

Auto ignition Temperature ^{0} C : *Not Pertinent*
Explosion sensitivity to impact : *Stable*
Explosion sensitivity to Static Electricity : *Stable*
Hazardous Combustion Products : *Emits toxic fumes of Cl*
Hazardous Polymerization : *Will not occur*

Combustible Liquid *No* : Explosive Material *No* : Corrosive Material *Yes*

Flammable Material *No* : Oxidizer *No* : Others

Pyrophoric Material *No* : Organic Peroxide *No*

4. REACTIVITY DATA

Chemical Stability : *Stable*

Incompatibility with other material *: With Alkali and Active metals*

Reactivity : *Violent reaction with acetic Anhydride, 2-Aminoethanol, NH_4OH Chloro sullonic Acid*

1.1 Dilluroethylene, Ethlene Diamine, Ethylene, Oleum, $HClO_2$ Propylene Oxide

Hazardous reaction Products : *Potentially dangerous reaction with sulfuric acid release HCl gas*

5. HEALTH HAZARD DATA

Routes of Entry : *Inhalation , Ingestion & eyes*

Effect of Exposures /Symptoms : *Inhalation of vapours result in coughing chocking sensation, irritation to nose and lungs . Ingestion causes burns, can burn mouth and the digestive track.*

Emergency : *Inhalation: Remove the victim to fresh air areas , keep him warm, start artificial respiration if*

Treatment for : *breathing stops.*

: *Ingestion: Have the victim drink water or milk. Do not induce vomiting.*

: *Eyes and Skin : Flush with plenty of water 15 mins. Remove contaminated clothing's.*

Seek medical aid immediately

LD $_{50}$ (Oral/Rat) *not listed* mg/ kg : STEL *not listed* ppm *not listed* mg/m^3

Permissible Exposure Limit 5(Ceiling) ppm *7(Ceiling)*mg/m^3: Odour Threshold 1-5 ppm 47-7-36 mg/m^3

TLV (ACGIH) /5(Ceiling) 5(Ceiling) *7(Ceiling)* mg/m^3

NEPA Hazard Signals	: Health	:Flammability	: Reactivity	: Special
	3	0	0	

6. PREVENTIVE MEASURES

Personal : *Avoid contact with liquid or vapours*

Protective Equipments : *Provide chemical protective suit with self contained breathing apparatus, air line mask*, *rubber hand glove , face shield and shoes*

Handling & Storage Precautions : *Store in a rubber lined or FRP coated steel tanks away from oxidizers, in a well ventilated area.*

7. EMERGENCY / FIRST AID MEASURES

FIRE :Fire Extinguishing :Media : *Not combustible*

:Special Procedure :*Keep the containers cool by spraying water if exposed to fire.*

:Unusual Hazard :*Flammable gas may be produced on contact with metals*

EXPOSURE :First Aid Measures: *Inhalation: Remove the victim to fresh air areas , start artificial respiration if breathing stops. Keep him warm and quiet. Ingestion: Have the victim drink water and milk. Do not induce vomiting.*

: *Eyes and Skin : Flush with plenty of water 15 mins. Seek medical aid immediately*

:Antidotes / Dosages : *Not available*

SPILLS :Steps to be taken : *Collect leaking liquid in seated containers. Neutralise the spilled liquid*

Liquid and wash away with plenty of water. O not use metal containers for spilled liquid.

:Waste Disposal Method : *Seat all waste in vapour tight plastic bags for eventual disposal.*

8. ADDITIONAL INFORMATION / REFERENCES

A Concentration of 35 ppm causes irritation of the throat after short exposure. Vigorous reaction with Aluminum, Chlorine + Dinitroailines

9 MANUFACTURERS / SUPPLIERS DATA

NAME OF FIRM	Contact person
MAILING ADDRESS	in emergency
TELEPHONE / TALEX NO.	Local Bodies Involved
TELEGRAPHIC ADDRESS	Standard Packing
	Trem Card Details/Ref.

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SULFURIC ACID

1. CHEMICAL IDENTITY

Product Name : Hydrogen Sulfate, Fertilizer Acid, Battery Acid, Dipping acid Oil of Vitriol Trade Name: Sulfuric Acid Label / Class: White & Black label – CORROSIVE/s, Group 11

Formula : H_2SO_4 U.N No.: 1832 C.A.S. No. : 7664-93-9
HAZCHEM Code : 2P

2. PHYSICAL AND CHEMICAL PROPERTIES :

Physical State :Liquid 1 ATM, 20c) Boiling Pt./Range C: 290
Vapour Pressure
Appearance :Colourless/Brown Melting/Freezing Point.C 10.49 (at 20 deg C. mm Hg)
Odour :Sharp/Penetrating Vapour Density (Air=1) 2.8(20C SO_3)
Evaporation Rate
Solubility in water :Soluble Specific Gravity,25 C :
1.84(66deg Be) (at 30 deg C)
Dyn. Viscosity Heat of
Vaporisation
Calorific Valve (PAS deg C) (Kcal/Kg)
(Kcal/Kg) Molecular weight: 98.1 Cp/Cv

3. FIRE AND EXPLOSIVE HAZARDS DATA:

Explosivity Not combustible: Auto ignition Temperature C Flash Point, C, CC/OC: Not combustible
Flammability : Not combustible : Explosive limit Burning Rate Not combustible
Extinguish Media :Use Dry chemical to fight adjacent fires. Avid use of water :
Special Procedure :Not flammable but highly reactive and capable of igniting finely divided combustible
materials in contact. Fire involving small amount of combustible may be smothered with
suitable DCP. Use water on combustibles burning in vicinity of this material but with care
as water applied directly to this acid. Results in evolution of heat and causes splattering..
Unusual Hazards :React violently with water and organic materials with evolution of heat release of toxic fumes.

4. REACTIVE HAZARD

Stability : Stable Conditions to avoid : Keep away from oxidizing & reducing materials
Hazardous Poly: : Organic Materials (Chlorates, Carbides fulminates& picrates) Metals, combustible materials
Hazardous Combustion/ Decomposition Products : Sulfuric Acid , Sulfur di-Oxide, Sulfur tri-oxide & Carbon Monoxide Fumes

5. HEALTH HAZARD DATA

Entry Route :Inhalation Odour threshold: 1.0mg/m^3
TLV, PPM mg/cu.m :1 STEL: PPM mg/cu.m LC50,Guinea pig mg/$m^{3:}$ 18.0

PEL, PPM mg/cu.m : LD $_{50}$ Oral, Rat g/kg 2.14 LDL, Human, mg/kg

Sign/ Symptoms of Exposure: LDL, Human inhalation:

INHALATION : Damage to upper respiratory tract and lung tissues sore throat coughing labored breathing

INGESTION : Sore throat , abdominal pain, nausea and vomiting

CONTACT EYES : Highly destructive to tissue, Skin- Dermatitis, burns

Emergency Treatment : Rapidly causes severe damage and possible loss of sight

INHALATION : Remove victim to fresh air, give artificial respiration, (Not mouth to mouth) if breathing has stopped oxygen if breathing is laboured. Seek prompt medical assistance.

CONTACT : Flush with plenty of water and remove contaminated clothing

EYES : Irrigate eyes with plenty of water immediately

INGESTION : Do not induce vomiting give milk mixed with white of eggs (or plenty of water) to drink to conscious victim If shock symptoms develop in case of extensive/ severe burns put the patient on his back and keep him warm but not hot until physician arrives. Do not apply ointment to burn areas without instruction from doctor.

6. HAZARD SPECIFICATION :

NEPA RATING Health: 3 Flammability: 0

Material Factor Water H azard : : Stability : 2

Special Signals

7. KNOWN HAZARDS :

Combustible Liquid: Flammable Material : Pyrophoric Material :

Explosive material : Unstable material; Water reactive mat: Reacts/

Soluble

Oxydizer: Organic peroxide Corrosive material : Corrosive

Compressed gas : Irritant :

Sensitizer:

Carcinogen Mutagen: Others

8. SAFE USAGE DATA

VENTILATION :

PROTECTIVE EQUIP. :

Eyes :Tight fitting chemical goggles

Respiratory : Self contained breathing apparatus

Gloves : Gauntlet type rubber vinyl

Clothing : Boots- High rubber or neoprene (Pants worn outside)

Others :

9. PRECAUTIONS :

Handling /Storage : Protect against physical damage and water. Separate from carbides chlorates fulminates, nitrates picrates powered metals and combustible materials

Others : H_2SO_4 pipe lines should be located above ground for safety , as leaks will be more apparent and inspection easier. Unprotected lights and fire should be kept away from H_2SO_4 lines or storage tanks as hydrogen may be evolved from action of the acid on certain metals closed vessels should be vented periodically to release Hydrogen, if found.

10. EMERGENCY RESPONSE DATA

Release / Spill :Person not wearing equipment and clothings should be restricted from area of spills/ leaks

Waste Disposal : Ventilate area of spill. Collect spilled material with aid of vermiculate dry sand earth or similar material.. It may also be diluted and neutralized.

11. ADDITIONAL INFORMATION

MANUFACTURER / SUPPLIER ;
Name & address :
Telephone No. :
Contact person :
Ref. : Environment Canada: Fire protection guide for Hazardous materials : OPHG for chemical Hazards: API Toxicology reviews Sulfuric Acid

SODIUM HYDROXIDE

1. CHEMICAL IDENTITY

Chemical Name : *SODIUM HYDROXIDE* : Chemical Classification : *Alkaline inorganic compound*

Synonyms *: Soda Lye Lye* : Trade Name

Formula : *NaOH* C.A.S. No. : *1310-73-2* U.N No.

Regulated Identification: Shipping Name :*Sodium , Hydroxide Solid/Solution*

Hazchem Code : *2 R*

Codes/ label : *Corrosive Class 8* Hazardous Waste ID No. : *16*

HAZARDOUS INGREDIENTS : CAS No. : HAZARDOUS INGREDIENTS : CAS No.

1. Sodium Hydroxide : *1310-73-2* 2.

2. PHYSICAL/CHEMICAL DATA

Boiling Pt./ Range 1390^0 C : Physical State *Solid* : Appearance *White flakes / pellets*

Melting / Freezing Point 318.4^{0}C : Vapour Pressure : Odour *Odourless*

@35^0 C */ 3040 mmHg at 730^0 C*

Vapour Density (Air=1) *Not pertinent* : Solubility In water at 30^0 *Soluble*

Specific Gravity (Water=1) : *2.12 at 24 ^{0} C / 4 ^{0} C* : pH *13-14 (soln)*

3. FIRE/EXPLOSION HAZARD DATA

Flammability No : LEL *Not pertinent* % : Flash Point ^{0} C *Not pertinent (OC)*

TDG Flammability NA : UEL *Not pertinent* % : Flash Point ^{0} C *Not pertinent (OC)*

Auto ignition Temperature ^{0} C : *Not pertinent*

Explosion sensitivity to impact : *Stable*

Explosion sensitivity to Static Electricity : *Stable*

Hazardous Combustion Products : *Emits toxic fumes of Na_2O*

Hazardous Polymerization : will not occur

Combustible Liquid *No* : Explosive Material *No* : Corrosive Material *Yes*

Flammable Material *No* : Oxidizer *No* : Others

Pyrophoric Material *No* : Organic Peroxide *No*

4. REACTIVITY DATA

Chemical Stability : *Stable*

Incompatibility : *Water Acids, Flammable liquids, Organic Halides metals, All Sn , nitromethane and*

With other material *compound*

Reactivity : *Vigorous reaction with organic halides, metals, nitro compounds*

Hazardous reaction : *Not Available*

Products

5. HEALTH HAZARD DATA

Routes of Entry : *Inhalation , Skin, Ingestion & eyes*

Effect of Exposures /Symptoms : *Inhalation : Causes small burns to upper respiratory track and lungs, mild irritation. Ingestion : Causes severe damage to mucous membrane , severe scaring or perforation may occur Eyes, Severe Damage Skin : Causes severe burns*

Emergency Treatment *Inhalation: Remove the victim from exposure, Support respiration, give oxygen, if necessary. Ingestion: Water or milk. followed by dilute vinegar or fruit juice. Do not induce vomiting. Skin : Wash the affected area with plenty of water and soap. Eyes : Wash with plenty of water for 15 minutes. Seek medical Aid immediately.*

LD $_{50}$ (Oral/ Rat) *Not listed* mg/ kg : STEL Not listed ppm Not listed mg/m^3

Permissible Exposure Limit --- ppm 2 (Ceiling) mg/m^3 : Odour Threshold *Odourless* ppm *Odourless* mg/m^3

TLV (ACGIH) / --- ppm 2 (Ceiling) mg/m^3

NEPA Hazard	: Health	:Flammability	: Reactivity	: Special
Signals	: 3	: 0	: 1	:

6. PREVENTIVE MEASURES

Personal : *Avoid contact with solid or liquid*

Protective Equipments : *Provide side covered safety goggles , face shield, dust type respirator, rubber shoes and rubber : hand gloves*

Handling & Storage Precautions : *Keep in cool , dry, well ventilated places..*

7. EMERGENCY / FIRST AID MEASURES

FIRE :Fire Extinguishing :Media :Special Procedure :Unusual Hazard : *Not combustible : : Keep the containers cool by spraying water if exposed to heat or flame. : Toxic gases are produced..*

EXPOSURE :First Aid Measures : *If eyes are affected , flush with plenty of water for 15 mins. Skin : Remove contaminated clothes & shoes. Wash the affected area with plenty of water . If inhaled , remove the victim to fresh air area Support respiration . Seek medical aid immediately*

:Antidotes / Dosages : *Not available*

SPILLS :Steps to be taken : *Sweep and collect without making dust. Wash the surface with plenty of water and soap*

:Waste Disposal Method: : *Seal all waste in vapour tight plastic bags for eventual disposal.*

8. ADDITIONAL INFORMATION / REFERENCES

Vigorous reaction with 1,2,4,5 – Tetrachlorobenzene has caused many industrial explosion and forms extremely toxic 2,3,7,8,Tetrachlorodibenzodioxin, acetic anhydride, acrolein , acrylonitrile, allyl alcohol, allyl chloride.

9 MANUFACTURERS / SUPPLIERS DATA

NAME OF FIRM	Contact person
MAILING ADDRESS	in emergency
TELEPHONE / TALEX NO.	Local Bodies Involved
TELEGRAPHIC ADDRESS	Standard Packing
	Term Card Details/Ref.

10. DISCLAIMER

Information contained in this material data sheet is believed to be reliable but no representation, guarantee or warranties of any kind are made as to its accuracy, sustainability for a particular application or results to be obtained from them. It is up to the manufacturer / shelter to ensure that the information contained in the material safety data sheet is relevant to the product manufactured / handled or sold by him as the case may be. The I.C.M.A makes no warranties expressed or implied in respect of the adequacy of this document for any particular purpose.

AMMONIUM HYDROXIDE

1. CHEMICAL IDENTITY

Chemical Name : *AMMONIUM HYDROXIDE* : Chemical Classification : *Alkaline inorganic compound*

Synonyms : Ammonia Aquous, Ammonia solution : Trade Name

Formula : NH_4OH C.A.S. No. : *1336-21-6* U.N No. 2672

Regulated Identification: Shipping Name :A*mmonium Hydroxide* Hazchem Code: *Not isted*

Codes/ label :*Corrosive Class 8* Hazardous Waste ID No. *: 16*

HAZARDOUS INGREDIENTS	CAS No.	HAZARDOUS INGREDIENTS	CAS No.
1. Ammonium Hydroxide	1336-21-6	2.	

2. PHYSICAL/CHEMICAL DATA

Boiling Pt./ Range 36^0 C : Physical State : Liquid : Appearance: *Colourless, watery*

Melting / Freezing Point -77^0 C : Vapour Pressure : Odour *Pungent odour*

@35^0 C 0.5 mm Hg

Vapour Density (Air=1) 0.6 : Solubility In water at 30^0 *Soluble* : Other : *Soluble in chloroform and either*

Specific Gravity (Water=1) 0.89 at 204 ^{0} C : pH : *Alkaline* : *Methanol and glycerol*

3. FIRE/EXPLOSION HAZARD DATA

Flammability *: No* : LEL Not Pertinent % : Flash Point ^{0} C Not Pertinent (OC)

TDG Flammability : *N.A* : UEL Not Pertinent % : Flash Point ^{0} C Not Pertinent (OC)

Auto ignition Temperature ^{0} C	: *Not Pertinent*
Explosion sensitivity to impact	: *Stable*
Explosion sensitivity to Static Electricity	*: Stable*
Hazardous Combustion Products	: *Emits toxic fumes of NH_3 and NOx*
Hazardous Polymerization	: *Will not occur*

Combustible Liquid	*No*	: Explosive Material	*No*	: Corrosive Material	*Yes*
Flammable Material	*No*	: Oxidizer	*No*	: Others	
Pyrophoric Material	*No*	: Organic Peroxide	*No*		

4. REACTIVITY DATA

Chemical Stability :*Stable*

Incompatibility : *Acrolein, Nitromethane, Acrylic Acid, Chlorosulphonic Acid, dimethylesuphfate, Halogens, HCl, HF*

With other material : HNO_3, $AgNO_3$, Ag_2O

Reactivity : *Reacts with H_2 SO_4 strong material Acids exothermally, Corrosive to copper, Copper Alloys, Aluminum alloys, galvanized surfaces*

Hazardous reaction Products : *Not Available*

5. HEALTH HAZARD DATA

Routes of Entry : *Inhalation , Skin, Ingestion & eyes*

Effect of Exposures /Symptoms : *Causes burning pain in mouth , throat, stomach, constriction of throat and coughing, followed by vomiting of blood, severe eye and skin irritation.*

Emergency Treatment : *Inhalation: Remove the victim to fresh air area, give artificial respiration and oxygen if needed from exposure, Support respiration, give oxygen, if necessary.*
Ingestion: Do not induce vomiting , lavage stomach with water or lemon Juice, milk .
Delay may cause perforation of oesophagus or stomach swelling of glottis may necessitate tracheotomy. : Eyes: wash with plenty of water for 15mins.
Skin : Wash the affected area with plenty of water. Seek medical aid immediately.

LD_{50} (Oral/ Rat) 350 mg/ kg : STEL 35 (NH_3) ppm 27 (NH_3) mg/m^3

Permissible Exposure Limit 25 (NH_3)ppm 18 (NH_3)mg/m^3 : Odour Threshold 50 ppm 36 mg/m^3

TLV (ACGIH) 25 (NH_3) 18 (NH_3) mg/m^3

NEPA Hazard : Health :Flammability : Reactivity : Special Signals Not Listed

6. PREVENTIVE MEASURES

Personal : Avoid contact with solid or liquid

Protective : Use rubber boots , gloves apron, safety goggles. Se of protective oil will reduce skin irritation.

Equipments :

Handling & Storage : Keep in a cool , strong glass , plastic or rubber stopered bottles , not completely filled

Precautions :

7. EMERGENCY / FIRST AID MEASURES

FIRE :Fire Extinguishing :Not flammable
:Media :

:Special Procedure : Keep the containers cool by spraying water if exposed to fire or heat

:Unusual Hazard : Poisonous gases are produced in fire.

EXPOSURE	:First Aid Measures	:Inhalation Remove victim to fresh air area and provide artificial Respiration. Ingestion : Do not induce vomiting , lagave stomach with water, lemon juice or milk . Eyes: Wash with plenty of water for 15 mints. Skin : Wash the affected area with plenty of water and soap.Seek medical aid immediately
	:Antidotes / Dosages	: Not available
SPILLS	:Steps to be taken	:Collect leaking liquid in sealable container, wash away remainder with large amount of water.
	:Waste Disposal Method:	: Seal all waste in vapour tight plastic bags for eventual disposal.

8. ADDITIONAL INFORMATION / REFERENCES

9 MANUFACTURERS / SUPPLIERS DATA

NAME OF FIRM	Contact person
MAILING ADDRESS	in emergency
TELEPHONE / TALEX NO.	Local Bodies Involved
TELEGRAPHIC ADDRESS	Standard Packing
	Trem Card Details/Ref.

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DIESEL OIL- GAS OIL

1. CHEMICAL IDENTITY

Product Name : Diesel Oil, Gas Oil

Trade Name : HSD Label / Class: White – POISONOUS GAS: class 2.3

Formula : HSD Complex mixture of Hydrocarbons: U.N No:1202 C.A.S. No : 7647-01-0 HAZCHEM Code : 3V

2. PHYSICAL AND CHEMICAL PROPERTIES :

Physical State :Liquid Boiling Pt./Range C: 150-400 Vapour Pressure <1

Appearance : Light Brown Melting/Freezing Point.C 18 to -46 (at 138 deg C. mm Hg)

Odour : Diesel Vapour Density (Air=1) 3-5

Evaporation Rate

Solubility in water : Insoluble (30ppm) Specific Gravity,20 C : 0.81 to 0.19(at 30 deg C)

Dyn. Viscosity : 6.76E-05 Liq 25C Heat of Vaporization

Calorific Valve : 4.34E+0.7 (PAS deg C) 2.71E +05 (J/Kg)

(Kcal/Kg) Molecular weight: Sp heat liq. J/Kg : 2.34 E+03

3. FIRE AND EXPLOSIVE HAZARDS DATA:

Explosivity : Moderate : Auto ignition Temp. C: 256.6 Flash Point, C, CC/OC: 32 to 96

Flammability : Moderate : Explosive limit % 0.7-5 Burning Rate 4mm/mm

Extinguish Media :Foam CO_2 DCP water may be ineffective and cause fire to spread may be used to cool fire Special Procedure : exposed

Unusual Hazards : Flash back may occur along vapour trail

4. REACTIVE HAZARD

Stability : Stable Conditions to avoid : Keep away from heat and open flame

Hazardous Poly: : Conditions to avoid :

Incompatibility : Oxidizing agents

Hazardous Combustion/ Decomposition Products : Toxic gases/ vapours (CO)

5. HEALTH HAZARD DATA

Entry Route : Inhalation / skin absorption Odour threshold PPM: 0.1

TLV, PPM mg/cu.m :5, ppm/mg/cu.m (Inhalation) STEL: PPM mg/cu.m 10mg/m^3 LC50, Rabbit g/kg: 0.2

PEL, PPM mg/cu.m : $LD_{50\ Oral}$, Rat g/kg 28 LDL, Mammal, mg/kg

Sign/ Symptoms of Exposure: Delay Toxicity

INHALATION : Dizziness, headache, ASPIRATION rapidly developing potential fatal chemical pneumonitis

INGESTION : Nausea, vomiting

CONTACT : Skin- irritation: Eyes irritation, Dermatitis may result on

prolonged contact.

Emergency Treatment : (IMMEDIATE MEDICAL ATTENTION REQUIRED)

INHALATION : Remove victim to fresh air, give artificial respiration, if necessary. If unconscious but Breathing, Place in the unconscious (recovery) position. Give external cardiac message If Necessary. Do not induce vomiting.

INGESTION :

CONTACT : Remove contaminated clothings and wash affected part (skin/eyes) with plenty of water.

6. HAZARD SPECIFICATION:

NEPA RATING Health: 0 Flammability: 2 Material Factor : 10 : : Stability : 0 Special Signals

7. KNOWN HAZARDS:

Combustible Liquid: Flammable Material: Flammable liquid Pyrophoric Material:

Explosive material: Unstable material; Water reactive mat:

Oxidizer: Organic peroxide Corrosive material:

Compressed gas: Irritant:

Sensitizer:

Carcinogen Mutagen: Others

8. SAFE USAGE DATA

VENTILATION: : Adequate ventilation

PROTECTIVE EQUIP. :

Eyes : Goggles / face shield

Respiratory : Self contained breathing apparatus for containment/ cleanup operations

Gloves : Rubber

Clothing : Rubber

Others :

9 PRECAUTIONS :

Handling /Storage : Diesel should be stored in well ventilated properly labeled and approved containers. Sniffing, Siphoning and use as solvent and cleaning agent should be avoided. Do not transfer to unlabelled unsuitable or incorrectly labeled containers all containers Should be kept out of reach of children and kept fully closed when not in use. Cleaning and inspection / maintenance of storage tanks should be done according to Proper procedures and precautions (work permit system, gas freeing of tanks. using Lifeline and wearing air supplied breathing apparatus.

Others :

10. EMERGENCY RESPONSE DATA

Release / Spill : Avoid spillages should they occur sand or earth are useful means of containment and absorption

Waste Disposal :.

11. ADDITIONAL INFORMATION

Gastric lavage should be done after endotracheal intubation in view of risk of aspiration which can cause chemical pneumonitis.

MANUFACTURER / SUPPLIER ;
Name & address :
Telephone No. :
Contact person :
Ref. : Environment Canada: Chemical Hazards of the workplace OPHG for chemical Hazards: CONCWE report 2/83

50. SOPs FOR DIFFERENT EMERGENCIES

1. SOP FOR HANDLING OF TRANSFORMER FIRES (EMD)

A Purpose:

This document is prepared to guide the operating personnel / Firefighting team in case of fire in Oil filled transformers.

B Scope:

This shall be applicable to all transformers of NTPC-Unchahar including Switchyard, GT Area, offsites, township and CHP.

C Introduction:

In Unchahar station oil filled transformer is used with various ratings. This document is prepared with intend to case of fire, prevention of fire and action plan after fire in transformer

D Causes of Transformer Fire

How do fires start in transformers?

Normally there are two ways of getting high temperatures inside the transformer: Internal arcing (flashover) or external arcing (flashover). Delayed fault clearance may aggravate the situation leading to major fires.

1. Internal Faults

An internal arcing in an oil immersed transformer will cause a high temperature in the arcing gases and the surrounding oil, but it will not cause a fire inside the tank without access to oxygen. The oxygen dissolved in the oil is not accessible to start a fire. If the current feeding a high energy arc is not disconnected rapidly, then the tank may rupture and high temperature gases and oil then gets access to oxygen and will combust if the temperature is high enough for auto ignition, or if it is exposed to an arc or makes contact with metal with sufficiently high temperature to cause ignition.

2. External Faults

A too high current through the transformer leads, terminals and windings can cause localized or even widespread overheating within the transformer. Normally there is not sufficient oxygen to cause a fire inside the transformer tank and not sufficient fuel at the external terminals to cause a fire there because the electrical protections would normally interrupt the current independently of the temperature before any fire will start. If excessive over-current is not interrupted and sufficient heating occurs, then it can cause overflowing and possibly boiling of oil, which may cause spilling from the conservator, pressure relief valves or damaged gaskets. However, to start the fire there still must be a source to ignite the oil.

3. Tank Rupture Process

Due to arcing and heating, oil pressure increases inside the transformer leading to tank rupture.

4. Transformer Bushing Fire Scenarios

OIP bushings are the single largest cause of transformer fires. The insulation in bushings is highly stressed and there are inherent fire risks in their design.

Regular testing of bushings are done for OIP bushings and results are closely monitored.

5. Transformer Cable Box and Cable Termination Failures Fire Scenarios

Cable terminations failures of often causes a transformer fire which can develop into a major fire where an cable box is connected to the main tank and the oil from the main tank feeds the fire, which then can burn gasket on inspection and access covers and cause a major spill of oil from the main tank.

6. Fires Initiated by OLTC Failures

OLTCs failures is the cause of 10-15% of fires, however these fires are often minor fires as the volume of oil exposed to air is only a few hundred liters at the most, unless there has been a rupture of the barrier between the main tank and the OLTC diverter/arcing contact oil compartment. A low arc energy fault may only initiate a small oil fire, as the oil surface exposed in the OLTC and the amount of oil in the OLTC conservator relative small. If the fault cleared quickly by the protection before the fire escalates, then it may or may not developed into a major oil fire. However, if the arc energy is high it is more likely that the OLTC cover or its tank may rupture and the barrier board to the main tank may be broken. If this occurs then the oil will spill from the main tank, the conservator and the fire will quickly cover a much bigger surface and be fed by much larger oil volume.

E. Protections measures against fire in transformers.

All Transformers are provided with various types of protection devices to quickly identify any faults/abnormal conditions and isolate the transformer from both HV/LV sides. Electrical protection devices include over current/Earth fault protection, Differential protection, Overload alarms etc. Transformers are provided with High Oil temperature/Winding temperature protection also. Additionally transformers are provided with Buchholz relay, PRD/SPR devices to trip the transformer in case of abnormal pressure build-up inside the transformer due to internal faults.

Large transformers are provided with fire separation wall between transformers to prevent spread of fire from one transformer to another near-by.

Oil soak pits filled with gravel are provided below the transformer for drainage of oil in case of major leak/fire to contain spread of fire. Oil spilled from the fire source (one transformer) will not be able to travel along cable trenches or conduit or other means where it can potentially spread the fire to building or other plant items as separate oil pit is used to collect oil in case of rapture of transformer.

High velocity fire water sprinkler system complete with detection bulbs and deluge valve is provided for transformers of capacity more than 10 MVA as per CEA guidelines. Sprinkler system will operate in case of fire in transformer

F. Handling of Transformer Fires:

Despite the protection measures employed, Transformers may catch fire due to failure of Eqpt/Protection devices, Lightning etc.

When a transformer failure has developed into a transformer fire, the transformer is in most cases destroyed beyond economic repair. The aim of fire protection control measures is therefore directed to minimize the damage to the fire “victims” generally in the following in the order of priorities:

- Minimize risk of loss of life and injury to humans.
- Minimize the risk of the fire spreading or causing damage to adjacent transformers, control building, structures and other items of plant and equipment.
- Minimize contamination and damage to the environment.
- Minimize overall economic loss in the event of a transformer fire.

Before applying any method of fire extinguishing it is to be remembered that there exist a risk of electrocution:

CISF will generally not attempt any firefighting efforts until they are assured that the electrical hazards have been removed and it is safe to enter the transformer yard.

It is the responsibility of Shift-In charge of main plant operation to assure that equipment under fire is electrically isolated.

The following steps may be followed in case of in case of transformer fire.

1. Ensure that the transformer under fire is isolated from both HV/LV sides. Hand trip the transformer, if not tripped already. If any breaker fails to trip, isolate the connected bus. Hand trip the unit in case of fire in GT/UT.
2. Stop all cooling fans and pumps of transformer to prevent spread of fire. Isolate cooler control cabinet power supplies.
3. Ensure operation of transformer fire sprinkler system. Operate deluge valve manually if required. Ensure running of fire water pumps with sufficient pressure.
4. In case of fire with oil spillage, ensure that oil drainage is contained to oil soak pit only.
5. CISF team with fire tender/Foam tender may be deployed as per the situation. Foam tenders may be more effective for quenching of fire inside the transformer. Manual firefighting efforts by the trained CISF personnel may be continued to contain the fire and quench it completely.
6. Continue operation of fire sprinkler system till the fire is completely quenched.
7. Ensure that there is no spread of fire thorough cable trenches and plant drains due to oil spillage.

2. SOP FOR FIRE PROTECTION AT FOPH AREA (OPERATION)

SOP for fire protection at FOPH area			
SL. NO.	**AREA**	**FIRE HAZARD**	**FIRE PREVENTION**
1	Fuel Oil Storage Tanks	1. Greater risk during venting, gassing and filling operations of light fuel oil. 2. Leakage of tank. 3. Dry grass around tanks. 4. Oil spillage. 5. Unclean surroundings. 6. Soaked insulation. 7. Electrical tracing.	1. Precautions to be taken during tank emptying, cleaning, tank inspections, vent inspections, other maintenance works (including electrical / lighting works). Welding/cutting to be avoided; if carried out, all precautions to be taken. 2. Entry to bunded area to be restricted to authorized persons only. 3. Filling lines to be purged and road tanker connections should be kept secure when not in use. 4. Recycled oil to be cooled to below the flash point before returning to storage tanks. 5. Excess temperature safety systems and alarms to be installed on heater banks. 6. All areas within the bund walls must be free of vegetation and other combustible materials. 7. Periodic checking of foam protection system.
2	Fuel Oil Unloading and Transfer Pump House	1. Oil spillage or leakage due to failure of joints or of venting due to overheating or restrictions in system. 2. Heaters. 3. Loosely laid electrical cables/welding cables. 4. Drain oil stagnant in unloading pipe trenches and surface drains.	1. Adequate ventilation in the enclosed pump house to keep the concentration of oil vapours within safe levels. 2. Proper smoke vents and adjustable louvers at high and low level. 3. Proper earthing of all electrical systems. 4. Use of flame proof lighting/electrical appliances only in the pump house. 5. Trenches to be filled with sand and PCC on top to prevent contamination with oil. 6. Oil waste, rag, other combustible materials not to be allowed to accumulate. 7. No spillage of oil. 8. Prompt attention to defects on oil pipes heaters etc. 9. Oil absorbing granules if used, should be removed immediately after use. Wood dust not to be used as it is an oil absorbing medium. 10. Checking of fire protection system as per schedule.

3. SOP FOR SAFE HANDLING OF CHLORINE (CHEMISTRY)

1. PURPOSE : To establish a procedure for safe handling of chlorine.

2. SCOPE : PT/CW Chlorination plant (Chlorination Plant (WCP stage II, III, CW stage II, IV)

3. RESPONSIBILITY: HOD (Chemistry) is overall responsible for the implementation of this procedure. The area executive / operator working in the Chlorination Plant (WCP stage II, III, CW stage II, IV) are responsible for following up of this procedure in respective area of operations / activity.

4. PROCEDURE :

a. Safe start up procedure of Chlorine

b. Safe shut down procedure of chlorine.

c. Safe loading & unloading of chlorine tonners

d. Safe handling of chlorine in case of leakage: As described below

- On initiation of the on-line chlorine detector alarm or smelling the pungent odor of the chlorine, immediately wear the self-breathing apparatus.
- Close the Chlorine Main Toner Valve.
- Observe that auto chlorine scrubbing system start immediately.
- Identify the source of leakage by ammonia torch. Use the emergency kit.
- Rotate container until leak is from uppermost position so that gas, not liquid leak through it.
- Use Wrench, Hood for fusible plug, Hood for valves and Patch for side leak.
- Inform HOD Chemistry / Shift in-Charge UCB/ Hospital, depending upon the severity of the chlorine leakage.
- Depending upon the exposure to chlorine and its affect, use safety shower and remove the person away from the leak area.
- Take medical advice immediately.
- Inform the mechanical maint. /C&I/Electrical Departments for taking remedial actions to repair /replace the source of leakage.
- Record the leakage details in the logbook and Surksha AP.
- Dial Chlorine Emergency Response Number (CERN) 1800-11-1735

5. REFERENCE : MSDS of Chlorine/ DMP

4. SOP FOR SAFE HANDLING OF CHLORINE LEAKAGE (CHEMISTRY)

CHEM/ OCP /04

1. PURPOSE : To establish a procedure for safe handling of Chlorine leakage.

2. SCOPE : WCP St-II/III PT chlorination Plant, CW St-I&II.

3. DEFINITION : PPEs- Personal protective Equipments, WCP-Water Clarification Plant, CW- Cooling water.

4. RESPONSIBILITY : The overall responsibility lies with AGM Chemistry Section.

5. PROCEDURE :

SL. No.	DESCRIPTION	RESPONSIBILITY	REF. DOC.
5.1	Usage of suitable PPEs during handling of Chlorine	Manager (Chemistry)	
5.2	On initiation of online chlorine detector alarm or smelling the pungent smelling of odour of the chlorine, immediately ensure the usage of relevant PPEs.	Manager (Chemistry)	
5.3	Try to approach the source of leakage from the opposite direction of the air flow.	Manager (Chemistry)	
5.4	Close the Chlorine Tonner valve immediately and use Emergency Kit to plug the leakage.	Manager (Chemistry)	
5.5	Identify the source of leakage by the Ammonia Torch. If required, turn the Tonner so that gaseous phase comes upward and liquid phase turned down ward.	Manager (Chemistry)	
5.6	Use wrench, hood for fusible plug and hood for valves and patch for arresting side leak.	Manager (Chemistry)	
5.7	Empty the remaining chlorine in the process, if it is not possible it may be absorbed in alkali solution tank.	Manager (Chemistry)	
5.8	Informed shift chemist/ UCB/Hospital depending upon the severity of chlorine leakage.	Manager (Chemistry)	
5.9	Depending upon the exposure to Chlorine and its effect, use safety shower and remove the person from leak area. Take medical help immediately.	Manager (Chemistry)	
5.10	Inform the mechanical maintenance /C&I /electrical dept. For taking remedial actions to repair / replace the source of leakage.	Manager (Chemistry)	
5.11	Record the leakage details in the logbook.	Manager (Chemistry)	

5. SOP FOR THE EMERGENCY PROCEDURE AND RESPONSE IN CASE OF HAZARDOUS CHEMICAL (CHLORINE) ACCIDENT (CHEMISTRY)

CHEM/ EPR /01

1. PURPOSE **:To establish a system for the emergency procedure and response in case of hazardous chemical (Chlorine) accident..**

2. SCOPE **:CCW treatment area/PT chlorination Plant.**

3. DEFINITION **:PPEs- Personal protective Equipments, CCW-Condenser Cooling water , PT-Pre-treatment.**

4. RESPONSIBILITY **:The overall responsibility lies with AGM Chemistry Section.**

5. PROCEDURE **:**

SL. No.	DESCRIPTION	RESPONSIBILITY	REF. DOC.
5.1	Usage of PPEs during handling of Chlorine	Manager (Chemistry)	
5.2	On initiation of online chlorine detector alarm or smelling the pungent smelling of odour of the chlorine, immediately ensure the usage of relevant PPEs.	Manager (Chemistry)	
5.3	Immediately Close the Chlorine Tonner valve which is in service. Ensure automatic leak absorption system is in service.	Manager (Chemistry)	
5.4	Identify the source of leakage by the Ammonia Torch. Use suitable emergency kit to arrest leak.	Manager (Chemistry)	
5.5	Inform Shift Chemist/UCB/Hospital , depending upon severity of the chlorine leakage.	Manager (Chemistry)	
5.6	Depending upon the exposure to Chlorine and its effect, use safety shower and remove the person from leak area. Take medical help immediately.	Manager (Chemistry)	
5.7	Inform the mechanical maintenance /C&I /Electrical dept. For taking remedial actions to repair / replace the source of leakage.	Manager (Chemistry)	
5.8	To call Ambulance on emergency phone 2000 for Medical help/ Plant Ambulance no.3375.	Manager (Chemistry)	

6. SOP FOR HANDLING EMERGENCY SITUATION ARISING OUT OF BOILER EXPLOSION. (BMD)

1.0 PURPOSE:

1.1 To define operational control procedure for handling emergency situation arising out of Boiler explosion.

2.0 SCOPE:

2.1 Actions to be taken in case of emergency situation arising out of Boiler explosion.

3.0 RESPONSIBILITY:

S. No.	Description	Responsibility
3.1	Overall	GM (O&M)
3.2	Boiler Area	AGM (BMD) / AGM (Operation) / AGM (AHD) / AGM (C&I) / AGM (CHP) / AGM (EMD) / AGM (HR) / AGM (Safety)
3.3	Hospital Area	CMO
3.4	Disaster Management Control Room	As per DMP Unchahar

4.0 Types of explosions in Boiler:

4.1 Furnace Explosion

The major fire hazard associated with a boiler is a furnace explosion which are the result of the ignition of combustible mixtures of fuel and air that have accumulated in the confined spaces of the boiler. Generally, such accumulations are the result of malfunction in combustion control and safeguard system or operator error associated with an inadequate or improper purge or incorrect operation of the burner equipment.

Insufficient Combustion Air

Inadequate supply of combustion air inside furnace can result in loss of flame in a portion of the boiler and improper combustion causes deposition of unburnt fuel on surfaces in different zones of the boiler. This leads to flame failure and tripping of boiler. But if combustion controls are tampered, it can result in furnace explosion.

Inadequate Ignition

Low oil pressure at pilot or gun may not ignite the main flame but continues to accumulate fuel inside the furnace. This delayed ignition during start-up can lead to furnace explosion in the furnace. In multi-burner units, the loss of flame at one or more burners may allow an explosive mixture to accumulate, only to be ignited by other burners, either while operating normally or while being lighted.

Fuel Safety Shutoff Valves

Leaks in fuel safety shut-off valve can cause fuel to flow and deposit inside the idle furnace. During re-start operation when burners are ignited can lead to uncontrollable ignition of fuel resulting in furnace explosion.

Faulty Draft Controls

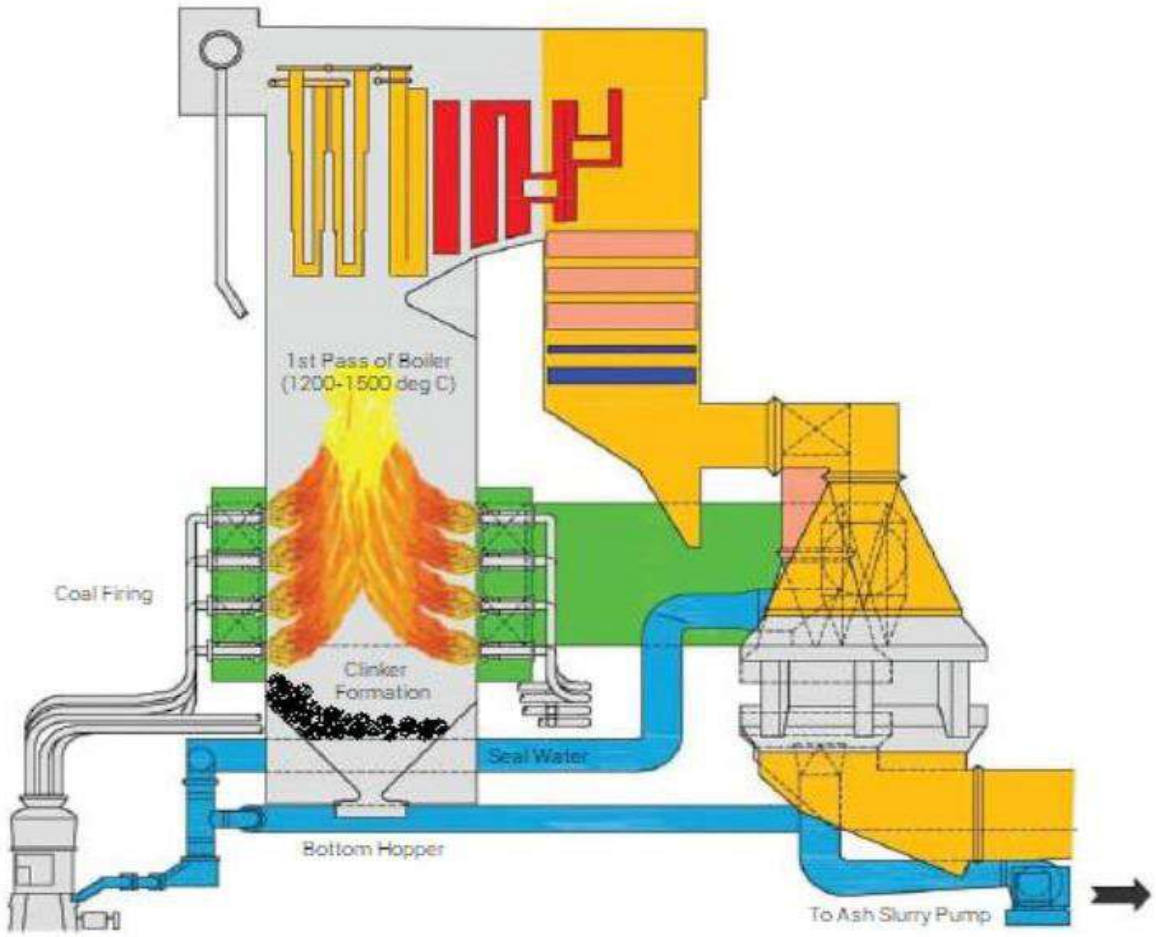
Total loss of flame or substantial changes in airflow may cause negative pressure excursions known as furnace implosions which can be extremely damaging.

Failing to Purge during Restart

An example for operator can be the failure to purge the furnace of combustible mixtures between repeatedly unsuccessful attempts to light off the burner. Total loss of flame or substantial changes in airflow may cause negative pressure excursions known as furnace implosions which can be extremely damaging.

Carryover of unburnt fuel particles from the boiler combustion chamber may result from poor or inadequate fuel/air ratio control, malfunction of a inlet fuel valve, or the loss of a forced-draft fan. This carryover presents a hazard to equipment, such as air preheaters, electrostatic precipitators, and baghouse filters, in the downstream flue gas train. Flue gas scrubbers, which are also located in the flue gas train, generally operate wet and are not normally affected by carryover. However, they usually have combustible linings which are a hazard whenever the scrubber is not in operation, or if the water spray system fails during operation.

Furnace Explosion while dislodging Clinker



Two coal fire thermal power stations of India have witnessed catastrophic boiler explosions in consecutive years of 2016 and 2017 that have caused severe damage to life and property. Investigations of incidents revealed that both the incidents could have been avoided.

Clinker formation is a complex series of mineralogical transformations and phase changes that occur as coal burns. They are formed in the high temperature zones of the boiler, which is mainly the furnace with operating temperature between 1200-1500 deg. Celsius, when non-combustible elements contained in coal such as iron, calcium, silicon, aluminium and sodium interact with sulfur and carbon at high temperatures.

These elements melt together with clays and alkalis to form a glassy slag that eventually hardens into clinkers. Small clinkers can fuse together to form large ones that can physically damage boilers. The illustration shown above represents furnace with clinker formation around the bottom most panel of the furnace water wall tubes.

In both the explosion events, manual poking of clinkers along with spray of fire hydrant jets on the clinker surface was carried out from the manhole at the furnace bottom. This eventually led to dislodging of clinker at higher elevation into the bottom ash hopper resulting in sudden pressurization of boiler and explosion.

4.2 Steam Explosion

Overheating of Tubes

Contaminants present in the makeup water, corrosion products formed with steam cycle and contaminants resulting from condenser tube leakage are the principal contributing factors to the formation of heat deterrent scale or deposits in boiler tubes. These deposits are found in tube coils which are horizontally placed at different zones of the boiler i.e. where sludge or scale particles may settle on the lower part of the tube.

This may form a porous coating, restricting the access of water to the tube wall, eventually allowing the tube wall temperature to increase to a level permitting corrosion attack due to steam pockets. As the temperature of the tube wall increases, it becomes weak, and the internal pressure causes a bulge to develop. If the bulge extends far enough, cracking will occur resulting in steam explosion.

Low Water Level

Absence of water (which acts as cooling media) in the evaporator surface results in abrupt rise in tube metal temperature reducing the strength of the tube and thus causing rupture. Prolonged operation at low water levels could cause catastrophic damage to the steam and water circuit.

The principal factors contributing to low water level in boilers are defective low water level cut-off / low water cut-off protection being bypassed, Improper blowdown procedure, tampering with low water control, feedwater pump failure, control valve failure, loss of water to the deaerator or make-up water system, drum level controller failure, Drum level controller inadvertently left in the manual position, loss of plant air pressure to control the valve actuator, safety valve lifting, large and sudden change in steam load.

Failure to Operate Safety Valve

This is either due to valve being damaged or valve being corroded, or valve left in gagged condition after hydro test. Sudden over-pressurization at boiler due to load throw-off scenario can result in pressurization of boiler. Operation failure of the safety valve can lead to rupture of tubes.

5.0 Loss Prevention

Boilers are one of the critical and high hazard equipment being used across many industries. However, with diligent inspection and maintenance by trained professionals, boilers can be operated safely and with high efficiency. The following are best practices followed in terms of inspection to be carried out during outage or overhaul to minimize the hazards associated with boiler.

■ Ensure Static Interlocks and protections of all critical systems and equipment are tested at least once a year or during overhauls i.e. by incorporating periodic checks by simulating or relevant procedures. (At the end of the outage simulating scenarios / faults & checking MFT and checking healthy working of protection).

■ Conduct conditioning monitoring of the boiler by using Non-Destructive Testing (NDT) Techniques like inspection of deposits in tubes of different sections, hardness testing, Dye penetrate and ultrasonic testing of weld joints.

■ Conduct destructive testing of sample tubes during overhaul of boiler. If defects are found, or a tube cracks or ruptures, repairs should be made by replacing all or part of the tube. It is sometimes necessary to plug a tube as a temporary repair until a regular maintenance shutdown occurs.

■ Follow OEM recommendations for inspecting and maintaining Emergency Stop Valves (ESVs), Control Valves (CVs) and Non-Return Valves (NRVs).

■ Boiler Tube Assessment – Conduct Ultrasonic, Metallographic Studies, Random Thickness measurement, Tube deposit analysis.

■ Burners – Conduct visual inspection of nozzle assembly tips and clean if needed; replace nozzle tips and coal pipe bends as required.

■ Internal inspection of Drum should include as a minimum the following: — Tightness of all drum internal parts should be checked.

— Scrubbers and separators must be checked and be firmly in place to ensure the proper water/steam separation will take place.

— Separators should be examined for any sign of erosion or corrosion.

— Screens above the cyclone separators should be firmly in place.

— The entire drum should be examined for deposits of any kind. Copper deposits, for example, could come from the feedwater heaters, condenser or other proud metal components in the water/steam cycle. Heavy copper concentration can lead to hydrogen embrittlement in the steam generator water walls or other high heat input areas.

— Any unusual deposits found should be analyzed, and follow-up inspections should determine that corrective action is being taken by the utility along with the feedwater treatment specialist

■ Inspection and testing of the safety valves using Trevi test.

■ Rotary Fans – Conduct inspection and replace blades if required.

■ Conduct Boiler Hydro as per IBR: 1.25 working pressure once in a year and overhaul at least biannually

■ Conduct regular monitoring of tube thickness, tube scanning using LFED (Low Frequency Electrodynamics Device).

■ Conduct Remnant Life Assessment (RLA) of boiler as per OEM guideline.

■ Always check for the leakages of steam, water, air and flue gases from any suspicious place.

■ All instruments used for various critical measurements w.r.t temperature, pressure, flow must be calibrated at specified intervals of time.

■ Ensure cleaning of boiler tubes during shutdown to prevent any ash deposition or scaling inside or outside the tubes. Failing to do so will affect boiler efficiency and will eventually overheat the tubes leading to tube leakage problems.

■ Maintain the ratio of primary and secondary air in accordance with fuel feed as specified by OEM.

■ Periodically check burner operation back pressure and line pressure to prevent any thermal hazard.

Handling of Emergency Situation

In case of boiler explosion, following actions are required.

1. Safe Shutdown of the Unit including Fuel Supply
2. Bunker Area isolation
3. Notification /Intimation to the concerned persons as per DMP
4. Activation of Emergency Control room as per DMP
5. Activation of Security team
6. Activation of Firefighting team
7. Activation of Safety Team for Safety announcements.
8. Cordoning of the affected area and enforcement of restricted access to the affected area
9. Activation of the Trained Team to Handle to handle Boiler Emergency
10. Readiness of Hospital to Handle Burn injuries if any Human injuries
11. Activation Tie-up with nearby hospital if Hospital capacity if not sufficient such as AIIMS Raebareli/CHC/Govt Hospital
12. Activation of PR team to Handle outer agencies

7. SOP FOR Lightning and Thunderstorm preparedness. (MTP)

Most thunderstorms come and go uneventfully. However, any thunderstorm can become severe, and all thunderstorms, by definition, present the danger of lightning. Therefore, thunderstorm preparedness refers to taking steps before, during, and after a thunderstorm to minimize injury and damage.

A) Routine activities to avoid disaster during Thunderstorm

Sl. No.	Activity	Details of activity	Responsibility
1.	Checking of Lightning arresters of buildings, F.O. tanks etc.	All high rise & critical buildings, Chimney, F.O. tanks etc. must be checked regularly for healthiness of Lightning arresters installed. Earth resistance should be checked regularly & readings be recorded.	Electrical Maint. Dept.
2.	Checking of Switchyard Lightning Masts, Lighting towers, earth wires etc.	Structures of Switchyard Gantry, Lightning Masts, Lighting towers, earth wires etc. must be checked for integrity as these are most vulnerable to create station Contingencies.	Electrical Maint. Dept.
3.	Removal of Loose metallic sheets, trees, branches, tarpaulin sheets etc.	Remove all metallic sheets which could cause disaster to Electrical equipment nearby. Remove dead or rotting trees and branches that could fall and cause injury or damage during a severe thunderstorm. Secure outdoor objects that could blow away or cause damage.	All concerned Depts.
4.	Clear station drainage system	All peripheral/ storm water drains, switchyard drainage system etc. shall be maintained to have proper flow of rain water.	Civil Maint. Dept.
5.	Availability of normal/ emergency dewatering pumps	All dewatering pumps at critical locations should be available to meet contingency.	Mech./ Offsite/ Civil/ Opn./CHP Maint. Dept.
6.	Checking of level switches of Drain pits	Ensure that Level Switches of all drain pits are working properly for auto start of dewatering pumps.	C&I Dept
7.	Availability of DC/ Emergency Lighting	Regular checking of auto operation of DC lighting at all locations must be ensured.	Operation/ Elect. Maint. Dept.

B) Readiness before Thunderstorm & Lightning

Sl. No.	Activity	Details of activity	Responsibility
1.	Checking of Lightning arresters of buildings, F.O. tanks etc.	All high rise & critical buildings, Chimney, F.O. tanks etc. must be checked regularly for healthiness of Lightning arresters installed. Earth resistance should be checked regularly & readings be recorded.	Electrical Maint. Dept.
2.	Checking of Switchyard Lightning Masts, Lighting towers, earth wires etc.	Structures of Switchyard Gantry, Lightning Masts, Lighting towers, earth wires etc. must be checked for integrity as these are most vulnerable to create station Contingencies.	Electrical Maint. Dept.
3.	Removal of Loose metallic sheets, trees, branches, tarpaulin sheets etc.	Remove all metallic sheets which could cause disaster to Electrical equipment nearby. Remove dead or rotting trees and branches that could fall and cause injury or damage during a severe thunderstorm. Secure outdoor objects that could blow away or cause damage.	All concerned Depts.
4.	Clear station drainage system	All peripheral/ storm water drains, switchyard drainage system etc. shall be maintained to have proper flow of rain water.	Civil Maint. Dept.
5.	Readiness of Battery operated equipment (Trolley, Search lights, UPS etc.)	Batteries to be in fully charged condition. Float/ Boost Charging of all batteries to be ensured.	All concerned Depts.
6.	Dewatering Pumps	All Dewatering Pumps / Diesel Dewatering Pumps at critical locations e.g. CW Pump Houses, CHP, TG Hall areas etc. to be kept in Ready-to-start mode.	All concerned Depts.
7.	Rain Coats, Gum Boots, Torches	Availability/readiness of these items at all critical locations may be ensured.	All concerned Depts.
8.	Emergency Lights / search lights	Emergency Lights to be checked physically & made ready at all locations. Additional torches along with cells can be made available at all operational locations and to maintenance personnel. Search lights to be made available.	All concerned Depts.

9.	Availability of Condenser diaphragms	Condenser diaphragms may be kept ready for all units	Turbine Maint. Dept.
10.	Switchyard Control Room & Main Unit Control Room	A group of Sr. executives from Operation, Electrical, C&I and Turbine maint. to remain present in Main Plant control room. Similarly, Sr. executives from Operation & Switchyard maint. Group to remain present at Switchyard Control Room to handle any emergency. Groups to work in close association with SCE. No Work Permits shall be planned for EHV System or major auxiliaries. SCE to remain in touch with Grid officials. All MCCs Doors and windows to be ensured for tight closure.	All concerned Depts.
11.	Bunker Level	Bunker levels in running units to be made full. Conveyors to be stopped before Thunderstorm.	Main plant, CHP Operation & CHP Maint.
12.	Coal Handling Plant Track Hopper	All persons to be asked to come out of conveyor gallery, Track hopper areas. Stacker Reclaimer should be parked with its boom properly anchored. Track Hoppers should be evacuated fully to avoid overflowing of Slurry Coal	CHP Operation & Maint. CHP Operation & Maint.
13.	MGR System	Manual brakes should be applied to the loose Railways/ MGR wagons to avoid rolling down of wagons.	MGR Operation & Maint.
14.	Shift Operations	Station should be ready to quickly reduce load as per the prevailing grid frequency. As the reduced demand during storms is of short duration, Generating station must pick up load immediately as per grid frequency when load starts getting connected to the grid. All these may be done under intimation to respective RLDCs.	Operation Dept.
15.	Parking of Lifts	Boiler lift to be parked at zero meter. Lift Pit dewatering facility to be kept ready.	Concerned Dept.
16.	Medical Aid	Medical Team along with Ambulance to be on duty round-the-clock at Main Plant.	Medical Cell
17.	Fire & Safety	Fire and Safety Personnel to be available Round-the-clock at Main Plant.	CISF

18.	Availability of food stuff, Drinking water	Adequate stock of snacks/ food material/ Drinking water at Control rooms & different manned locations to be arranged.	HR Dept.
19.	Ambulance preparedness	Ambulance at safe plant location to urgently take care of casualties.	SCE
20.	Safety of personnel	No manpower movement at outdoor locations during Thunderstorm. No person shall stand near trees / tall masts. A team should be ready for removal of road & MGR track blockage caused by possible uprooting of trees and poles.	All Concerned Dept.
21.	EOT/ Gantry Cranes	Locking of EOT/ Gantry Cranes must be ensured.	Mech. Maint.
22.	Hydra, JCB, Portable DG Set, Power Saw	Availability/readiness of these equipment along with operators may be ensured.	All concerned Depts.
23.	Big trees/ poles/ towers on approach road from Township to Plant & within plant premises	Identify all big trees/ poles/ towers which may uproot due to high velocity winds during thunderstorm & take precautionary measures.	Civil Maint.

C) During Thunderstorm & Lightning

Sl. No.	Activity	Details of activity	Responsibility
1.	Stay informed	To remain in touch with IMD, news sources, weather information center etc. for latest updates & conveying the same thro' SMS	Cyclone/ Thunderstorm Nodal Group members
2.	Safety of personnel	Avoid contact with corded phones and devices including those plugged into electric for recharging. Cordless and wireless phones not connected to wall outlets are OK to use. Avoid contact with plumbing. Avoid washing hands, dishes, taking a shower as plumbing and bathroom fixtures can conduct electricity during lightning. Do not touch materials or surfaces that can	All concerned

		conduct electricity, including metal scaffolding, metal equipment, utility lines, water, water pipes and plumbing. Stay away from windows, doors and porches. Take shelter in a sturdy building. Avoid isolated sheds or other small structures in open areas.	
3.	Check for water ingress	Check for water ingress in control rooms/ on Electrical & Electronic panels and take immediate action to prevent it.	Elect./ C&I Dept.
4.	**Treatment of lightning victim**	**Follow these steps if someone has been struck by lightning:** Call for Emergency Medical help. Anyone who has sustained a lightning strike requires professional medical care. Check the person for burns and other injuries. If the person is breathing normally, look for other possible injuries and care for them as necessary. People who have been struck by lightning do not retain an electrical charge and can be handled safely.	All concerned

D) After a Thunderstorm & Lightning

Sl. No.	Activity	Details of activity	Responsibility
1.	Updating of information	Listen to the news sources about the improvement in situation & communicate to all.	Cyclone/ Thunderstorm Nodal Group
2.	Assessment of the situation	Survey the outside and inside of all the plant buildings, EOT/ Gantry cranes, Chimney, FO Storage tanks, Ash Dyke, outdoor Equipment, like, Boilers, Switchyard, transmission towers, Transformers, OH traction lines etc. for structural damage. Look for sharp objects, downed power lines, damaged pipe lines, or other hazards. Intimate concerned department for quick restoration/ repair.	All concerned Depts.
3.	Clean up safely	All the debris, flying objects, unwanted material, and access to blocked roads may be cleared quickly. Persons involved in this exercise must wear proper PPE before taking up the job.	All concerned Depts.

8.2 Noise Monitoring – Test Results

The following tables explain the test results as per the given sample description:

Sample Mark	**Ambient Noise, Indoor Noise**
Type of Sample	Noise Data
Date of Sampling	10/11/2025
Locations	As per Scope of Work
Sampling Method	IS 9989 : 1981

Sample ID		**121125020**
Sampling Date		11/11/2025
S. No.	**Locations**	**Noise Level in dB(A)**
1	AAQMS-01 (Township)	56.2
2	AAQMS-02(Railway gate)	53.2
3	AAQMS-03 (Intake gate)	51.4

Note :- Day time-06.00AM to 10.00PM, Night time-10.00PM to 06.00AM

Limits set by CPCB:

Sample ID		**121125022**
Sampling Date		10/11/2025 to 11/11/2025
S. No.	**Locations**	**Noise Level in dB(A)**
1	Compressor House	78.2
2	FD Fan Unit No. 4	85.0
3	PA Fan Unit No. 3	82.7
4	TG Floor Unit No. 4	82.3
5	Mill Area Unit No. 2	80.6
6	Raw water Pump House Stage No.01	70.6
7	BFP Area Unit No. 6	78.3
8	Wagon Trippler No. 3	64.8
9	WCP Stage No. 2	62.6
10	ESP Area Unit No. 2	71.8
11	Unit Control Room Unit No. 1	56.9

i. Industrial Area : Day Time-75 dB (A); Night Time-70 dB (A).

Note :- Day time-06.00AM to 10.00PM, Night time-10.00PM to 06.00AM

Limits set by Tamilnadu Factories Rules,1950 Permissible Limit of Exposure(8 hrs):

i. Work Zone : 90 dB (A)

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2. AMBIENT AIR QUALITY DATA

Air samples were collected and monitored at 5 different locations of projects site for analysis of Lead, Arsenic, Nickel, Benzene, Benzo (a) pyrene, Ammonia as NH_3, Carbon Monoxide (CO), Ozone as O3, PM10, PM2.5, NO2, SO2 and Mercury respectively.

2.1 Methodology of Sampling and analysis

Ambient air quality samples were monitored on **24/01/2026** from site as per sampling guidelines and were submitted to the lab with in stipulated period. The brief methodology of parameters is being given below for the reference.

S. NO	Parameter	Test Method
1	Lead	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021
2	Arsenic	HECS-G/INS/SOP/ 041 IssueNo.:01 Issue Date:01.03.2021
3	Nickel	HECS-G/INS/SOP/ 041 IssueNo.:01 Issue Date:01.03.2021
4	Benzene	IS 5182 Part 11: 2006
5	Benzo (a) pyrene	IS : 5182 Part 12: 2004
6	Ammonia as NH3	IS 5182 (Part 25) 2018
7	Carbon Monoxide (CO)	IS 5182 (Part 10) Clause 41999
8	Nitrogen dioxides as NO2	IS 5182 (Part 6) 2006
9	Ozone as O3	IS 5182 (Part 9) 1974
10	Particulate matter (Size less than 10µm)	IS 5182 (Part 23) 2006
11	Particulate matter (Size less than 2.5µm)	IS 5182 (Part 24) 2019
12	Sulphur dioxide as SO2	IS 5182 (Part 2) 2001
13	Mercury	HECS-G/INS/SOP/ 041 Issue No.:01Issue Date:01.03.2021

2.2 Ambient Air Quality – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Station No.01**
Type of Sample	Ambient Air
Date of Sampling	**24/01/2026**
Test Parameters	As per scope of work

Sample ID			**270126467**	**NAAQ Standards:2009**	
Sampling Date			**24/01/2026**		
S.No.	**Parameter**	**Units**	**Station No.01**		
1	Lead	µg/m³	BLQ (LOQ: 0.002)	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m³	BLQ (LOQ: 2.0)	6 (Annual)	6 (Annual)
3	Nickel	ng/m³	BLQ (LOQ: 2.0)	20 (Annual)	20 (Annual)
4	Benzene	µg/m³	BLQ (LOQ: 0.1)	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	8.10	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	BLQ(LOQ 0.05)	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	18.49	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	BLQ(LOQ 10.0)	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10µm)	µg/m³	45.72	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5 µm)	µg/m³	21.36	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	10.54	80 (24 hours)	50 (Annual)
13	Mercury	µg/m³	BLQ (LOQ: 0.002)	NA	NA

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³-Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.
Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End of Report

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2.3 Ambient Air Quality – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Station No.02**
Type of Sample	Ambient Air
Date of Sampling	**24/01/2026**
Test Parameters	As per scope of work

Sample ID			**270126469**	**NAAQ Standards:2009**	
Sampling Date			**24/01/2026**		
S.No.	**Parameter**	**Units**	**Station No.02**		
1	Lead	µg/m³	BLQ (LOQ: 0.002)	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m³	BLQ (LOQ: 2.0)	6 (Annual)	6 (Annual)
3	Nickel	ng/m³	BLQ (LOQ: 2.0)	20 (Annual)	20 (Annual)
4	Benzene	µg/m³	BLQ (LOQ: 0.1)	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	6.63	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	BLQ(LOQ 0.05)	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	22.60	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	BLQ(LOQ 10.0)	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10µm)	µg/m³	49.83	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5	µg/m³	24.29	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	14.75	80 (24 hours)	50 (Annual)
13	Mercury	µg/m³	BLQ (LOQ: 0.002)	NA	NA

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³-Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.
Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End of Report

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2.4 Ambient Air Quality – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Station No.03**
Type of Sample	Ambient Air
Date of Sampling	**24/01/2026**
Test Parameters	As per scope of work

Sample ID			**270126470**	**NAAQ Standards:2009**	
Sampling Date			**24/01/2026**		
S.No.	**Parameter**	**Units**	**Station No.03**		
1	Lead	µg/m³	BLQ (LOQ: 0.002)	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m³	BLQ (LOQ: 2.0)	6 (Annual)	6 (Annual)
3	Nickel	ng/m³	BLQ (LOQ: 2.0)	20 (Annual)	20 (Annual)
4	Benzene	µg/m³	BLQ (LOQ: 0.1)	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	10.35	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	BLQ(LOQ 0.05)	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	20.72	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	BLQ(LOQ 10.0)	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10µm)	µg/m³	42.91	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5	µg/m³	18.45	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	8.16	80 (24 hours)	50 (Annual)
13	Mercury	µg/m³	BLQ (LOQ: 0.002)	NA	NA

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³-Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.
Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End of Report

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2.5 Ambient Air Quality – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Samaspur Village**
Type of Sample	Ambient Air
Date of Sampling	**24/01/2026**
Test Parameters	As per scope of work

Sample ID			**270126473**	**NAAQ Standards:2009**	
Sampling Date			**24/01/2026**		
S.No.	**Parameter**	**Units**	**Samaspur Village**		
1	Lead	µg/m3	BLQ (LOQ: 0.002)	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	7.58	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	BLQ(LOQ 0.05)	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	19.07	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	BLQ(LOQ 10.0)	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10µm)	µg/m³	51.84	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5µm)	µg/m³	20.60	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	12.52	80 (24 hours)	50 (Annual)
13	Mercury	µg/m³	BLQ (LOQ: 0.002)	NA	NA

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³-Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End of Report

HUBERT ENVIRO CARE SYSTEMS (I) PVT. LTD. Chennai 600 032

2.6 Ambient Air Quality – Test Results

Following tables explains the test results as per the given sample description.

Sample Location	**Bikai Village**
Type of Sample	Ambient Air
Date of Sampling	**24/01/2026**
Test Parameters	As per scope of work

Sample ID			**270126476**	**NAAQ Standards:2009**	
Sampling Date			**24/01/2026**		
S.No.	**Parameter**	**Units**	**Bikai Village**		
1	Lead	µg/m3	BLQ (LOQ: 0.002)	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	9.44	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	BLQ(LOQ 0.05)	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	21.63	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	BLQ(LOQ 10.0)	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10µm)	µg/m³	44.27	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5µm)	µg/m³	22.82	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	9.40	80 (24 hours)	50 (Annual)
13	Mercury	µg/m³	BLQ (LOQ: 0.002)	NA	NA

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³-Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End of Report

HUBERT ENVIRO CARE SYSTEMS LIMITED Chennai 600 032

PO -

Annexure-33

कार्यालय प्रभागीय निदेशक, सामाजिक वानिकी प्रभाग रायबरेली।
पत्रांक–3959 /5–1 रायबरेली, दिनॉक, 27-2- .2026

Utilization Certificate

This is to certify that the first instalment payment of Rs 5707013.00 (Fifty seven lakh seven thousand thirteen only) has been received from NTPC limited, Unchahar for Block, Miyawaki and bamboo plantation in year 2025-26 and amount of rupees Rs 5707013.00 has been utilized for the purpose of Block, Miyawaki and bamboo plantation work during the year 2025-26.

Place-Raebareli.

Divisional Director
Social Forestry Department
Raebareli.

कार्यालय- क्षेत्रीय वन अधिकारी, एन.टी.पी.सी. ऊँचाहार, रायबरेली

पत्रांक : 33/29-1 दिनांक : 21.01.2026

सेवा में,

प्रभागीय निदेशक
पर्यावरण वन एवम् जलवायु परिवर्तन
प्रभाग, रायबरेली

द्वारा - उचित माध्यम।

विषय- एन. टी० पी० सी० द्वारा वर्षाकाल 2022, 2023, 2024 एवम् 2025 में वृक्षारोपण पूर्णता प्रमाण पत्र।

सन्दर्भ- आपर मुख्य प्रबन्धक (वानिकी की सेवायें) का पत्र सं० एन-टी-पी-सी (ई एन जी / ई-9 / ऊँचाहार / 2026 दिनांक 19-01-2026।

महोदय,

सादर अवगत कराना है कि सुपरोक्त सन्दर्भित पत्र के अनुक्रम में वन विभाग द्वारा वर्ष 2022, 2023, 2024 व 2025 में प्राप्त समस्त लक्ष्यों / कार्यों को पूर्ण कर लिया गया तथा प्राप्त धनराशि का उपभोग भी कर लिया गया है।

अतः रिपोर्ट श्रीमान् जी की सेवा में सूचनार्थ एवम् इस आशय सहित कि कृपया आगे के स्तर से अपेक्षित मध्यम प्रबन्धक (वानिकी की सेवायें) एन.टी.पी.सी. ऊँचाहार को भेजने की कृपा करें।

भवदीय

(रामबिहारी शुक्ला)
क्षेत्रीय वन अधिकारी
एन.टी.पी.सी. (वानिकी), ऊँचाहार

Ajay
DFO
04/02/2026

कार्यालय उप प्रभागीय वनाधिकारी उप वन प्रभाग-रायबरेली
पत्रांक- 276 /29-1 रायबरेली दि० 04/02/2026

प्रेषित महोदय,

क्षे०व०अ०- N.T.P.C (वानिकी), ऊँचाहार द्वारा प्रेषित उपरोक्त अय संलग्नकों सहित मूल को अग्रेत्तर कार्यवाही हेतु प्रेषित।

उप प्रभागीय वनाधिकारी
रायबरेली

कार्यालय- क्षेत्रीय वन अधिकारी, एन.टी.पी.सी. ऊँचाहार, रायबरेली

32/29-1

दिनांक : 20-01-2026

सेवा में,

प्रभागीय निदेशक
पर्यावरण वन एवम् जलवायु परिवर्तन
प्रभाग, रायबरेली

विषय- वर्ष 2024 व 2025 वृक्षारोपणों की जीवितता प्रतिशत।
सन्दर्भ- एन. टी. पी. सी. ऊँचाहार की पत्र सं-NTPC/ईएम जी/ई-9 अंश का पत्र दिनांक 19.1.2026।

महोदय,

उपरोक्त विषयांकित सन्दर्भित पत्र के अनुक्रम में सूचना निम्न प्रकार है —

वर्ष-2024

क्र०सं.	वृक्षारोपण क्षेत्र का नाम	क्षेत्रफल हे.	रोपित पौधे	जीवित पौ०	जीवितता %
①	पूरे तुला ग्रामीणों की भूमि-I 2024	5.0 हे.	10,000 पौधे	9536	95.36%
②	पूरे तुला ग्रामीणों की भूमि-II 2024	5.0 हे.	10,000 पौधे	9496	94.96%
③	पूरे सभार मजरे आरखा ग्रा० भूमि-I 2024	5.0 हे.	10,000 पौ०	9502	95.02%
④	पूरे सभार मजरे आरखा ग्रा० भूमि-II 2024	5.0 हे.	10,000 पौ०	9563	95.63%
	योग-	40.0 हे.	40,000	38097	95.24% औसत

नोट- उक्त वृक्षारोपणों के I-II व III चरणों का समस्त कार्य प्रगति पर किया गया/घनत्व गणना का कार्य गतिमान है।

वर्ष-2025

①	आरखा ग्रामीणों की भूमि-I-2025	5.125 हे.	10250 पौ.	9895	96.53%
②	आरखा ग्रामीणों की भूमि-II 2025	5.0 हे.	10,000 पौ.	9804	98.04%
③	एन० टी० पी० सी० भूमि	2.34 हे.	3450 पौ.	3382	97.65%
	योग-	12.465 हे.	24000 पौ.	23361	97.33% औसत

वृक्षारोपण 2025 के प्रथम व द्वितीय चरण का समस्त कार्य पूर्ण कर लिया गया है तथा घनत्व गणना का कार्य प्रगति पर है।

अतः रिपोर्ट श्री मान् जी की सेवा में सूचनार्थ एवम् आवश्यक कार्यवाही हेतु प्रेषित है।

भवदीय

क्षेत्रीय वन अधिकारी
एन.टी.पी.सी. (वानिकी), ऊँचाहार

क्षेत्रीय वन अधिकारी, एन.टी.पी.सी. ऊँचाहार, रायबरेली

31/294

दिनांक :20-01-2026

सेवा में,

प्रभागीय निदेशक,
पर्यावरण वन एवम् जलवायु परिवर्तन
प्रयागराज, रायबरेली

विषय- वर्षा कालीन 2022 में रोपित पौधों की सकलता/जीवितता प्रतिशत।

सन्दर्भ- एन0टी0पी0सी0 ऊँचाहार का पत्रांक HP(ऊँ एम ज)E-9 कैलाहार 2026 दि0 19-1-2026।

महोदय,

विषयांकित सूचना निम्न प्रकार है वर्ष-2022

क्र0सं0	वृक्षारोपण सेंव का नाम	क्षेत्रफल	रोपित पौध	जीवित पौ.	जीविकता प्रतिशत
1	2	3	4	5	6
①	कोटरा बहादुर गंज ग्राम समाज 2022	7.0 है.	14,000	11991	85.65%
②	आखा ग्राम समाज-2022	9.5 है.	19000	16386	86.24%
③	पट्टी रहम कृषकवत ग्राम समाज-22	6.0 है.	12000	10373	86.44%
	योग-	22.5है.	45000	38750	86.11 औसत
				वर्ष-	2023
①	आखा ग्राम समाज-2023	5.0 है.	10,000	8673	86.73%
②	कोटरा बहादुर गंज ग्राम समाज 22	5.0 है.	10000	8593	85.93%
③	कोटरा बहादुर गंज ग्रामीणों की सभा	6.0	12000	10569	88.07%
④	कोटरा बहादुर गंज ग्रामीणों की सभा	4.0 है.	8000	6961	87.01%
	योग-	20.0 है.	40,000	34796	86.99 औसत

नोट- वर्ष 2023 में 5000 बिंगा बाकी पड़ती से वृक्षारोपण रामकैलाहार हल्दीचापा गया है।

उक्त वृक्षारोपणों का समस्त कार्य श्रम बूंद लिपा गया है समस्त धनराशि का व्ययभोग का लिपा गया है रिपोर्ट वीडियो जी लेख में सूचनार्थ एवम् इस आशय सहित कि, हमारा आगे कार्य एन.टी.पी.सी. को अवगत कराने की कृपा करें।

भवदीय

क्षेत्रीय वन अधिकारी

PO – 4600070162

कार्यालय प्रभागीय निदेशक, सामाजिक वानिकी प्रभाग रायबरेली।
पत्रांक– /5–1 रायबरेली, दिनॉक, 27/02/2026

Utilization Certificate

This is to certify that the third instalment payment of Rs 204680.00 (Two lakh four thousand six hundred eighty only) has been received from NTPC limited, Unchahar for Miyawaki plantation maintenance in year 2025-26 and amount of rupees Rs 204680.00 has been utilized for the purpose of miyawaki plantation maintenance work during the year 2025-26.

Place-Raebareli.

Divisional Director
Social Forestry Department
Raebareli.

SES – 1003962854

कार्यालय क्षेत्रीय वन अधिकारी रेंज रायबरेली।

पत्रांक– 400/29-1 रायबरेली दिनांक 30-01-2026

सेवा में,

प्रभागीय निदेशक
पर्यावरण वन एवं जलवायु परिवर्तन प्रभाग,
रायबरेली।

द्वारा - उचित माध्यम।

विषय– **मियावाकी वृक्षारोपण की सफलता के सम्बन्ध में।**

महोदय,

उक्त विषयक पत्र के क्रम में मियावाकी वृक्षारोपण की सफलता रिपोर्ट।

अतः रिपोर्ट श्रीमान जी की सेवा में सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

संलग्नक– उपरोक्तानुसार।

भवदीय

क्षेत्रीय वन अधिकारी
रेंज रायबरेली।

कार्यालय उप प्रभागीय वनाधिकारी उप वन प्रभाग - रायबरेली
पत्रांक - 298 / 29-1 रायबरेली दिनांक - 27/02/2026

प्र० निम्नलेख

क्षेत्र० अ० अ० - रायबरेली द्वारा प्रेषित उपरोक्त रिपोर्ट अग्र संलग्नक सहित (संस्तुति सहित) मूल में प्रेषित।

उप प्रभागीय वनाधिकारी
रायबरेली

मियावांकी वृक्षारोपण

क्र.सं.	रेंज का नाम	रोपण वर्ष	.स्थल का नाम	हे0	रोपित पौधों की संख्या	जीवित पौधों की संख्या	जीवितता प्रतिशत
1	3	2	5	6	7	8	9
1	रायबरेली	2023	शहीद स्मारक वृक्षा0–2023	0.17	5950	5813	97.7
[redacted]							
3	रायबरेली	2025	अहमदपुर नजूल वृक्षा0–2025	0.6	21000	20838	99.2
4	रायबरेली	2025	अहमदपुर नजूल वृक्षा0–2025	0.143	5000	4966	99.3

प्रतिहस्ताक्षरित

उप प्रभागीय वनाधिकारी
रायबरेली

क्षेत्रीय वन अधिकारी
रायबरेली

कार्यालय प्रभागीय निदेशक, सामाजिक वानिकी प्रभाग – रायबरेली

पत्रांक–3950 /5–1 रायबरेली, दिनांक, 27-02-.2026.

सेवा में,

अपर महाप्रबन्धक (तकनीकि सेवाएं),
एन0टी0पी0सी0, ऊँचाहार।

विषय– एनटीपीसी द्वारा वर्षाकाल 2022, 2023, 2024 तथा 2025 में पौधरोपण पूर्णता प्रमाण पत्र एवं जीवित सफलता प्रतिशत के सम्बन्ध में।

संदर्भ– आपके कार्यालय का पत्रांक–एनटीपीसी/ईएमजी/ई–9 ऊंचाहार/2026, दिनांक 19.01.2026.

महोदया,

उपरोक्त संदर्भित पत्र के क्रम में आप द्वारा मांगी गयी सूचनाएं निम्न प्रकार संलग्न कर प्रेषित हैं–

1. वर्षाकाल 2022, 2023, 2024 तथा 2025 हेतु उपलब्ध करायी गयी धनराशि के सापेक्ष वृक्षारोपण कार्य पूर्ण कर लिये गये हैं, जिसकी जीवित सफलता प्रतिशत रिपोर्ट बिन्दु संख्या–2 के अनुसार संलग्न है।
2. वर्षाकाल 2022, 2023, 2024 तथा 2025 पौधरोपण उत्तर जीवित सफलता प्रतिशत।
3. वर्षाकाल 2025 में दिये गये अग्रिम भुगतान का यूटिलाइजेशन प्रमाण पत्र।
4. वर्षाकाल 2023 में किये गये मियावाकी वृक्षारोपण का उत्तर जीवित सफलता प्रतिशत।
5. वर्ष 2025 के लिये मियावाकी वृक्षारोपण के लिये दिये गये अग्रिम भुगतान का यूटिलाइजेशन प्रमाण पत्र।

साथ ही पी0ओ0 संख्या–4600086574 द्वारा स्वीकृत परियोजना के प्रथम चरण हेतु वांछित धनराशि रू0 48.45 लाख यथाशीघ्र इस कार्यालय को उपलब्ध कराने की कृपा करें, जिससे ससमय कार्य प्रारम्भ कराये जा सकें।

प्रभागीय निदेशक,
सामाजिक वानिकी प्रभाग,
रायबरेली।

पत्रांक– / 5–1 उक्तदिनांकित

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित–

1. उप प्रभागीय वनाधिकारी, रायबरेली।
2. क्षेत्रीय वन अधिकारी, एन0टी0पी0सी0 यूनिट।

प्रभागीय निदेशक,
सामाजिक वानिकी प्रभाग,
रायबरेली।

Mitigation of water and sanitation challenges in the communities in line with NTPC's Policy for "Providing Potable Drinking Water " and "NTPC Jal Jyoti Mission Guidelines".

SANITATION:

Under sanitation intervention, NTPC Unchahar has provided a grant for cleaning and construction of drainages, built household and community toilets, undertook dustbin distribution drive in the villages and public spaces, gave financial assistance to district authority under Swachh Bharat Mission, conducted awareness drives on sanitation and open defecation free communities through Nukkad Natak. Below is the list for number of activities done in the PAP for improving the sanitation condition:

S. No.	Activity	Beneficiaries (in numbers)
1	Cleaning of existing drain (Umran jheel and Arkha Station)	2194
2	Construction of drain at Umran	1694
3	Construction of 200 Individual Household Toilets	1600
4	Construction of Community Toilets (2017-18, 2019-20)	43000
5	Construction of Sanitary Toilets	540
6	Distribution of dustbins (2018-19, 2019-20)	24000
7	Organised Nukkad natak (2017-18, 2018-19, 2019-20)	6000
8	Distribution of mosquito net in surrounding area	1000

Table: List of CSR interventions under them Sanitation

Sanitation has been a core of CSR initiatives. During regular interaction with schools & village institutions, problem of improper infrastructure related to toilets was raised. Some of the villagers particularly parents of the students shared that lack of improper sanitation infrastructure is a serious concern. It was brought to notice that without access to proper sanitation facilities girls are often forced to stay home from school during their periods. Lack of sufficient and functional toilets is the main health concerns for parents of school going children. Also NTPC Unchahar has provided a grant for cleaning and construction of drainages, built household and community toilets, undertook dustbin distribution drive in the villages and public spaces, gave financial assistance to district authority under Swachh Bharat Mission, conducted awareness drives on sanitation and open defecation free communities through Nukkad Natak. Key focus is to propagate the idea that 'Sanitation is not a choice but necessity for a healthy life'. Salient Objectives of this program are listed below:

- Inculcate habit of not defecating in open by promoting sanitation practices.
- To reduce the incidence of human waste borne diseases to improve the health of school students
- To create a healthy ambience at schools as facilitator to environment for education
- To establish NTPC's credential as an organization that believes in all-round development of society
- Focus on Schools and formation of "Sanitation Clubs"

Fig: Images related to dustbin distribution, School toilets and community toilets

Benefits:

- Habit of not defecating in open has improved due to availability of more no. of toilets
- Sanitation scenario has improved due to improved habits
- General attendance of girl's students has improved hence improving the enrollment number in the school. This has also motivated the other girls in the community to pursue education.
- Girls and boys feel safe while using closed toilets and privacy is maintained.
- Program has been very well taken by local community especially parents

Piped Drinking Water:

Water is most essential requirement for survival of living being. Access to safe water for drinking and other domestic needs still continues to be a problem in many parts of India. Below are the CSR interventions for easy accessibility of water in nearby villages which have benefitted more than forty thousand people:

S. No.	Activity	Beneficiaries (in numbers)
1	RO at PHC, Unchahar (2018-19)	20000
2	Installation of hand pumps (2016-17, 2019-20)	9750
3	Piped water system with overhead tanks (2019-20)	2550
4	Installation of piped drinking water (2019-20)	7320
	Total	**40620**

Table: List of CSR interventions under them water

About 160 million do not have access to clean drinking water in India. The water borne diseases are the most common health threats, that's why water is focus area for NTPC's CSR. 95% of community people of 15 villages access water either through handpumps (India Mark hand Pumps) or Overhead tank / Bore wells (installed under Jal Jyoti Mission).This have made availability of drinking water during the summer easily accessible to the community members. During COVID-19 pandemic, mobility to access water was reduced hence the risk of covid infection was also less. Girls and women of community had to travel long and carry heavy vessels to store drinking water which made them double burdened. Due to installments of hand pumps and water system, burden to collect water is minimized and they feel safe due to easy access.

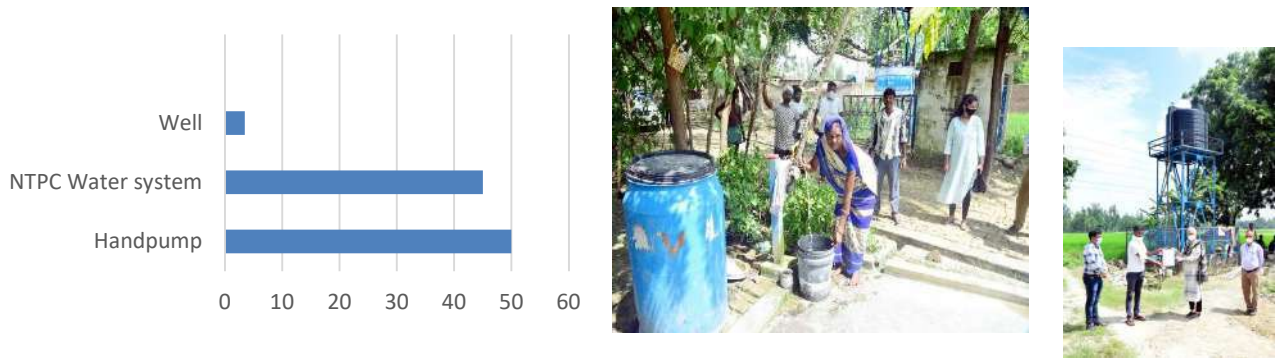

Fig: *Source of drinking water in PAP and Images of Over head tanks in nearby village*

Benefits:

- The interventions in water have resulted in the reduced distance the people travel for accessing water for household purpose.
- More quality time for economic activities for women
- Reduced need for water storage methods.
- Many women and girls expressed that they don't have to walk long to get water and, they get saved from various forms of sexual harassment.
- Improvement in the overall quality of life

Education

One of our most prominent initiative is our Flagship Program Girl Empowerment Mission (GEM) targeted for the empowerment of the girl child wherein interventions were taken to make the girls self-reliant and confident in all walks of life. Every year rural youth in the vicinity are selected and provided vocational training to enhance their employability. They are primarily trained in tailoring, cosmetology, auto repairing, computer and repair of home appliances. Agri-based training are also conducted for enhancing the livelihood opportunities.

We had installed sanitary napkin vending machine and incinerator in schools. Schools were equipped by providing Dual desk cum benches and classrooms have been constructed. Bicycles were distributed to the economically weaker and disadvantaged sections of girl students to improve their physical access to school. NTPC supports the educational needs of children with disabilities from underprivileged backgrounds by selecting few students of surrounding villages every year and admitting them in the township schools with scholarship. To ensure access to separate sanitation facility for students, toilets were constructed separately for boys and girls in surrounding government schools.

Sanitation

To promote hygienic environment through prevention of open defecation and reduce the incidence of water-borne diseases, 100 household toilets were constructed in the nearby villages. In addition to this, community toilets have been also constructed. As our contribution towards our Prime Minister's Swachh Bharat Abhiyan, we distributed dustbins in affected villages and railway station Unchahar & Rae Bareilly.

Health

Regular health camps were organized in nearby villages. In addition to this, specific camps such as rehabilitation camp (disable person), respiratory camp, family planning camp, dental camp, cancer awareness/detection camp etc. were conducted. We have undertaken the repair and maintenance of CHCs and have also equipped them with required medical equipment. In order to ensure nourishment to children, we distributed about 3000 protein powder packets to the needy through Anganwadi.

Water

Various activities to provide drinking water such as installation of handpumps, borewells, setting up of piped drinking water with overhead tank etc. has been taken up by the station.

Social Infrastructure

We had undertaken the construction of public utility buildings such as community centers, Panchayat Bhawan, Bharat Ghar, library etc. We have also undertaken the repair & maintenance of PHC, CHC, school buildings, ponds etc. along with the installation of solar streetlights and high mast lights in surrounding villages, construction of roads in nearby villages and railway over bridge in Unchahar station.

Activities undertaken by NTPC Unchahar with special focus on drinking water

Water is one of the focus areas for taking up NTPC CSR's activities for bringing maximum value to the society. NTPC Unchahar has undertaken various activities to provide drinking water with an aim of ensuring accessibility of potable drinking water in adequate quantity on regular and sustainable basis leading to improvement in living standards of communities in the vicinity of our Projects.

Since 2016, we have targeted the construction of about 110 piped drinking water structures for a period of five years with a total award value of about Rs. 450 lakhs/-. Out of these, 65 structures have been completed. The remaining works are under progress. **Ref Annexure-12A**

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Social Impact Evaluation and SROI
NTPC Unchahar
Uttar Pradesh
2021

Disclaimer

This report is an evaluation of the impact of the CSR programmes of the area as gathered through the survey. The information contained in the report is of general nature and will not be intended to address the circumstances of any particular individual or entity. Recommendations and Comments in our report are not intended, nor should they be interpreted to be a binding opinion. IICA does not undertake any responsibility arising in any way whatsoever, to any person other than NTPC Ltd. in respect of the matters dealt with in this report, including any errors or omissions therein, arising through negligence or otherwise, howsoever caused.

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Acknowledgements

Social, economic and spatial aspects of developments are interrelated and physical growth must be in harmony with well-defined social and economic goals. This is only possible when the three essential and complementary aspects of development - the social, economic and physical, are considered together and coordinated from the very beginning. This requires local solutions implemented with the knowledge and engagement of local people and supported by the CSR funds of companies with light oversight. The trust we place in local communities leads to the IICA edge.

This report is an outcome of the Impact Assessment Study undertaken by the Centre for End-to-End Advisory in CSR, Indian Institute of Corporate Affairs. The study was undertaken in the Raebareli district of Uttar Pradesh with cooperation and support from the National Thermal Power Corporation Limited (NTPC), Unchahar officials. We would like to extend our sincere thanks to NTPC and all their functionaries involved in the study at different levels and for their insightful inputs and support. We are grateful to Dr Sameer Sharma, IAS (former Director General, IICA) to guide the Evaluation team throughout this process. We are also thankful to Field coordinators and enumerators for conducting this study efficiently by visiting the field and conducting meetings with all the stakeholders of the projects.

Evaluation Team

Mr. Mukesh Kumar
(Head-Centre for End-to-End Advisory in CSR)

Dr. Shivangi Sharma
(Senior Research Associate)

Mr. Waseem Ahmad
(Research Associate)

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List of Acronyms and Terms

AWW KII	Anganwadi Worker Key Informant Interview
BPL	Below Poverty Line
CII	Confederation of Indian Industries
CSR	Corporate Social Responsibility
CSR-CD	Corporate Social responsibility- Community Development
E2E in CSR	End-to-End Advisory Services in CSR
FGD	Focus Group Discussion
FICCI	Federation of Indian Chambers of Commerce and Industry
IMR	Infant Mortality Rate
KII	Key Informant Interview
MMR	Maternal Mortality Rate
NA	Data not available
NSO	National Statistical Organisation
PHC	Primary Health Centre
RGI	Registrar General of India
SAI	Sports Authority of India
SHG	Self-Help Group
SRS	Sample Registration System
VDAC	Village Development Advisory Committee
WASH	Water, Sanitation and Hygiene

Attribution: It is an assessment of how much of the outcome was caused by the contribution of other organizations or people. Attribution is calculated as a percentage.

Deadweight: Deadweight is the part of change or outcome which would have happened anyway in absence of the project which is implemented. It is calculated as percentage.

Displacement: Displacement is the part of outcome which displaces other outcomes of the project. Every project does not displace other outcomes. It is calculated as percentage.

Drop off: In future years, the amount of outcome is likely to be less or, if the same will be more likely to be influenced by other factors, so attribution to the organization's intervention is lower. Drop-off is only calculated for outcomes that last more than one year.

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EXECUTIVE SUMMARY

The present study entitled: 'Social Impact Evaluation of Feroz Gandhi Unchahar Thermal Power Corporation' presents the findings of social impact evaluation of Corporate Social Responsibility (CSR) activities undertaken during 2015-2020. Unchahar Super Thermal Power Project is located at Rae Bareli district in the state of Uttar Pradesh.

The National Thermal Power Corporation (NTPC) Unchahar has invested 7.91 crores in Financial Year 2015-16, 2016-17, 2017-18, 2018-19, 2019-20 towards its Corporate Social Responsibility (CSR) activity as required under The Companies Act, 2013. After the conclusion of financial year 2019-20, Indian Institute of Corporate Affairs (IICA) was assigned to undertake CSR impact evaluation of NTPC.

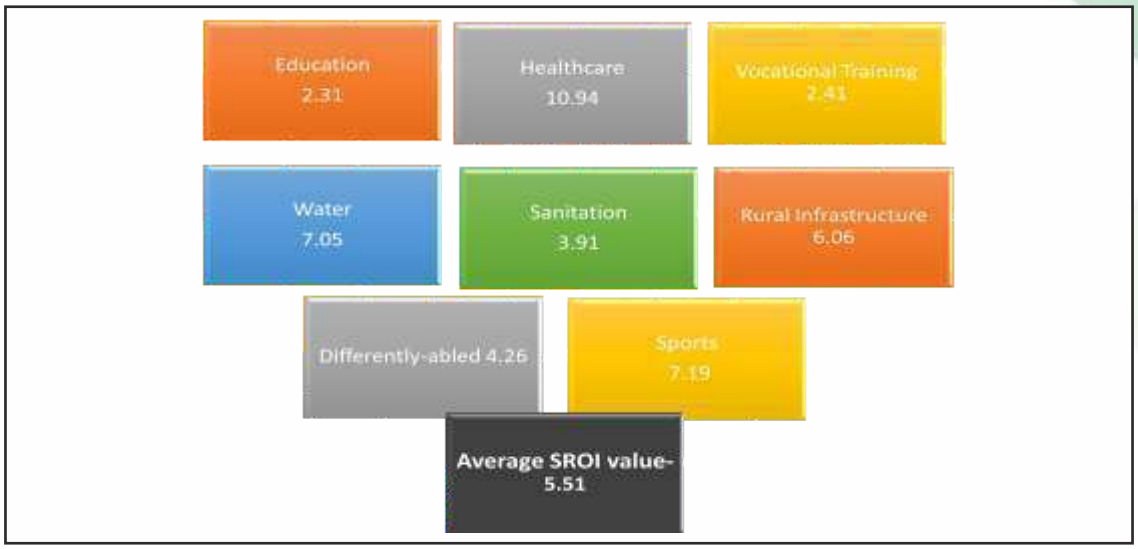
The area is primarily dependent upon agriculture and allied activities. In the study area, 84.05 per cent of respondents are engaged in agriculture and allied activities as their primary occupation, 4.81 per cent work as casual labourers and 3.04 per cent own small businesses.

The CSR activities implemented by NTPC Unchahar are grouped together and classified under nine categories in accordance with its CSR policy. The broad areas are Education, Healthcare, Vocational training initiative, Drinking-Water, Sanitation, Differently-abled, Rural Infrastructure and Promotion of Sports and games.

The study used both primary and secondary research methods and follows a mixed method approach. Primary data was collected by conducting extensive fieldwork in all the 15 project affected villages of NTPC Unchahar in Rae Bareli district of Uttar Pradesh. Primary data collection exercise covered 395 households, 28 focus groups discussions, and 42 interviews with key informants. The total number of households benefitted were 10010. The IICA used a sample size of 395 households. Out of the total household survey respondents, 39.49 percent were females and 60.25 percent, males. The majority of the population in these villages speaks Hindi, Urdu and local dialect (Awadhi). The selection of villages was appropriate for the intervention as these villages have a high percentage of the marginalised population belonging to underserved sections of society. Overall, 44.30 per cent of the population belongs to the Scheduled Caste (SC) and Scheduled Tribe (ST) category. Thus, the respondent's sample was representative of different socio-economic groups in the villages.

It was observed that the NTPC Unchahar's CSR activities and the interventions are in line with the Sustainable Development Goals and Schedule VII of the Companies Act, 2013. In doing so, NTPC Unchahar spent more than half of the budget (58.1%) was allocated to education projects. Rural Infrastructure is another important area where allocation of budget was around 19 per cent. Intervention in sanitation were allocated 10.2 per cent

budget of total CSR budget of NTPC Unchahar. Budget allocated for thematic areas like healthcare, vocational training, sports and differently-abled was less than 5 percent.



To compute the Social Return on Investment (SROI), IICA deployed the Social Value UK International methodology to measure the social value of CSR-CD projects. The Theory of Change was utilised to know the outcomes and impacts on ground. Deadweight, attribution and drop off factors were considered to avoid the overclaim of benefits due to the projects. The SROI was calculated in close consultation with the key stakeholders.

The mean SROI value of the projects is 5.51. It shows a monetary value created or value of the social impact (the benefit) of CSR-CD interventions of NTPC Unchahar. It expresses material project outcomes as equivalent monetary values so that they can be compared with the cost of inputs. There are some strategic and specific recommendation suggested in the report that can be considered to gain higher SROI while implementing the projects in future. Thus, to further improve the social impact and social return on investment prior to starting any CSR-CD intervention, it is recommended that need assessment, baseline studies are conducted. Once the needs are assessed, the objectives of interventions must be decided and on the basis of objectives indicators must be agreed upon. As next steps, stakeholder consultations should be done so that their needs and concerns are included in the projects at the beginning itself. Moreover, interventions should be thoroughly discussed in the Gram Sabha and suggestions coming out of Gram Sabha should be taken into consideration. A record of the consultations should also be maintained. Theme-wise findings and recommendations are given below:

Education: The IICA survey suggests that 15 villages of the study area have a literacy rate of 67.09 per cent, which is lower than the national average of 76.9 per cent. Moreover, in the study area 82.01 per cent males were literate while 44.23 per cent females were literate. The problem in transportation, coupled with schools located at a great distance in the study area, compelled parents not to send their kids to the schools, thus keeping them devoid of education. Thus, the interventions in education particularly, supporting female education, are suited to the study area.

It is observed that a lot of stress has been placed on building infrastructures. As next steps, NTPC Unchahar must focus its CSR-CD activities in education, that involves construction of infrastructures in school aimed at improving learning outcomes. NTPC Unchahar can provide schools with smart classes so that students are motivated to come to school and it improves their learning outcomes. The coverage of bicycle support should be extended to more girl students in consultation with school authorities as the distance of school is one of the main reasons children drop out in the area, and the intervention has potential to improve the average years of schooling and consequently the marriage age.

Healthcare: To understand the status of general health in the region, the population was questioned about the prevalent diseases like water-borne diseases, mosquito-borne diseases and common diseases to men, women and elderly. Overall 13.92 per cent population was affected by water borne diseases like Jaundice, Typhoid etc. which is higher than the national average (9.20%) and lower than the state average (15%) of water borne diseases. Overall, 34.68 per cent population reported some diseases, those who reported among them 4.38 per cent population reported diseases like Malaria during the survey, while majority (68.62%) reported having respiratory issues and pneumonia in children as a health problem. However, 65 per cent population did not report any disease, which is a positive sign of status of health in the study villages. However, it is suggested that local health workers like ANMs and ASHAs should be involved and used as resource persons in creating awareness vis-a-vis Mobile medical units and health awareness camps of NTPC Unchahar. The database of patients who use Mobile Medical Units should be used for diagnosis and referral in future health camps. Health Camps should be organized in community spaces like Panchayat Bhawans, *Ajeevika Bhawans* , schools, Anganwadi centres etc

Water and Sanitation: In the rural areas of Uttar Pradesh the coverage of piped water is 2.3 per cent[1]. In the survey area the coverage of piped water was found to be 6.4 per cent. There was a piped water intervention by NTPC Unchahar in the study area, however its coverage has not been wide as it was started in the year 2019-20. It is suggested that NTPC Unchahar should try to expand the network of piped drinking water in the villages as per the decided timeline with effective monitoring framework.

[1]ibid

In sanitation, the access to toilet within the household in India (rural) is 63.2 per cent and Uttar Pradesh (rural) is 46.1 per cent. Baherwa (55.56%) and Murrar Mau (56.25%) are the top performers compared to other villages in the study area. Rest all other villages in the area have less than 50 percent households which have access to toilet (within the house). Babhanpur (25.00%), Mokhara (23.53%), and Unchahar Dehat (25.26%) have the least percentage of households having toilet within the house. The point to notice is that all the villages are poor performers when compared with the national average of access to toilet within the house. It is suggested that while building household toilets NTPC Unchahar must ensure that there is availability of water source nearby the toilets as our survey suggest 4.56 per cent toilets are not functional because of unavailability of water. Nukkad Nataks should be run with involvement of school students to have a multiplier effect. Besides organization of Nukkad Nataks, NTPC Unchahar should also run innovative campaigns like " *Shauchalaye nahi toh bahu nahi*".

Rural Infrastructure: Road construction projects are required in Purwara, Mokhara and Ganghera Gulalganj as expressed by community members during focus group discussions. The survey suggests that only 42.78 per cent respondents across the study villages had pukka and kharanja road in their neighbourhood. Before undertaking the construction of community assets, NTPC Unchahar must ensure community and panchayat engagement. Installation of solar street lights are an effective and relevant intervention that have its long term impact on the community. However, sometimes they are not found functional, the reason for their non-functionality is the lack of ownership in the community. Thus, NTPC Unchahar, must explore the Public-Private-Community Partnership that has proved a model to replicate in rural areas.

Promotion of games and sports: To improve the sports ecosystem in the study villages, NTPC Unchahar has provided sports equipment like sports kits and provided grant to District Magistrate for open gym. The study area's significant challenges are the lack of sports infrastructure and family support to continue sports as a career. Thus, such initiatives have encouraged sports activities and improved community interaction in the area. However, regarding the grant provided to District Magistrate, there is not much information available, and the field survey team could not find the open gym. It is suggested that besides distributing sports kits, NTPC Unchahar should also provide training to aspiring athletes and sports person from the neighboring villages. NTPC Unchahar can search, identify, and groom sportspersons through National Sports Academy set up by Sports Authority of India (SAI). NTPC can also facilitate the training of the local sportspersons at Guru Gobind Singh Sports College, Lucknow which is not too far (110km) from the village.

The Indian Institute of Corporate Affairs (IICA) is a think tank, under the aegis of Ministry of Corporate Affairs to deliver opportunities for research, education and advocacy. Its work enables corporate growth, reforms and regulation through synergized knowledge management and global partnerships, thereby offering real-time solutions. National Foundation for Corporate Social Responsibility (NFCSR) is an apex National Institution being housed at IICA, Ministry of Corporate Affairs, providing a favourable environment for the corporate sector to work in tandem with the Government, Non-Government, Civil Society Organizations and Local Community Organizations in the field of rapidly emerging concept of CSR. The NFCSR has been successfully bridging the gap between businesses and communities by helping them develop value-based, sustainable, and SMART corporate social responsibility (CSR) programmes. In order to propagate and facilitate compliance of Section 135 of Companies Act-2013, Centre for End-to-End advisory services in CSR (NFCSR) has been handholding the corporate and is having the cutting edge to extend the following services:

The Centre for E2E in CSR at IICA has followed sound methodology and tools for conducting the Impact Assessment of this project. The study analyses all the stakeholders involved in the implementation process of the CSR projects, and has a holistic approach from commencement to the impact of the projects and identifies gaps which can be filled. The study looks at acquiring and assessing information about the CSR-CD activities implemented by NTPC Unchahar in creating long-term social and community impact.

The report consists of seven sections and the structure of the report is as follows:

Section 1: Comprehensive Profile of all the villages and activities done by NTPC

Section 2: The impact of various CSR-CD projects on the social/cultural/education/health and economic conditions of the people

Section 3: Assessment of the changes brought in the quality of life among village communities

Section 4: Objective description of social impacts rather than what people might tell publicly

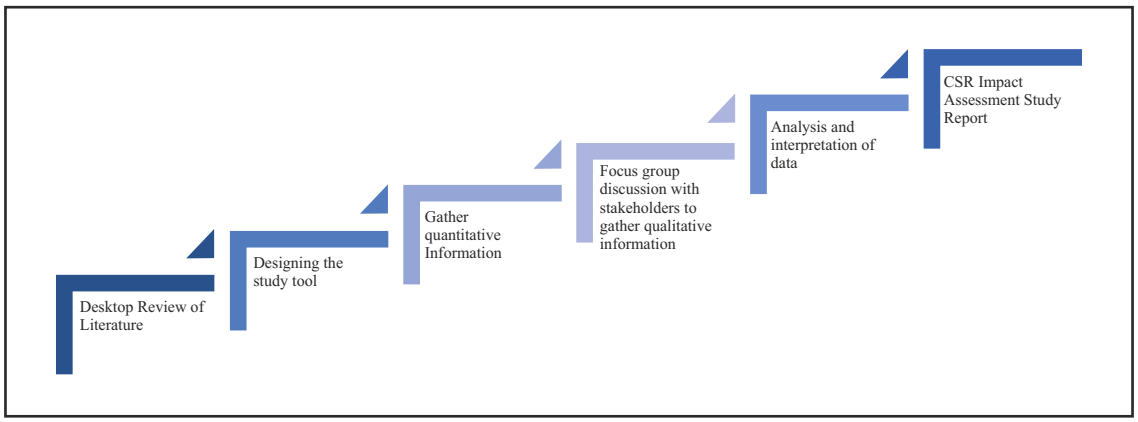
Section 5: Identification of requirement of modifications in the existing CSR-CD activities

Section 6: Assessment of the level of community participation and consultation through CSR-CD activities

Section 7: Evaluation of the nature of communication and consultation between the stakeholders for the various CSR-CD projects.

To conduct the impact study, IICA adopted the five-step approach, as explained in Figure 1. After enlisting the CSR-CD activities undertaken by NTPC Unchahar during the five financial years, i.e. 2015-16, 2016-17, 2017-18, 2018-19 and 2019-20. The first step was to collect secondary data from different government offices and websites. A data collection exercise, meeting and exchanging information with the NTPC project management officials in Unchahar to discuss the evaluation objectives and the evaluation timetable. The second step was to prepare, pre-testing and finalization of Research Tools for the field survey. The third step was to forming the survey team and preparing them for field survey. Fieldwork in all the 15 villages and collection of primary data covered 395 households, 28 focus groups discussions (men and women), and 42 interviews with key informants (school officials, health workers, Gram Panchayat member, Anganwadi workers). In the fourth step, focus group discussion (FGD) were held for the collection of qualitative information regarding the village. Fifth, data analysis of findings and preparation of the preliminary evaluation was done. The last step is the finalisation of the report and reporting of conclusions and recommendations.

Figure 1: *Research Steps*



The study used both primary and secondary research methods and is based on quantitative and qualitative data. Primary data was collected by conducting extensive fieldwork in all 15 villages.

Household Survey	• The study adopted household survey method, guided through structured questionnaire as primary tool for collecting data. The questionnaires have been employed during face - to - face consultations with community members and beneficiaries of various programmes at the identified field locations in the selected villages.
Focus Group Discussions (FGDs)	• Focus Group Discussions (FGDs) have been conducted in many locations as a supplement to the formal questionnaires of sample survey. The FGDs were primarily conducted among the Male and female members of the villages to obtain additional data from community and beneficiaries on broader issues and challenges and collectively perceived impacts of the targeted interventions.
Key Informant Interview (KIIs)	• The Key informant interviews were conducted with Gram Pradhans/ Parshads, health workers, anganwadi workers and school officials. This has been conducted in a Semi-Structured Interviewing/Conversational Interviewing method. Besides, the survey team also made observations on different activities undertaken by NTPC Unchahar.

The research team collected secondary data at IICA from the Census of India (2011) and official records of various offices like Primary Health Centres (PHC), Anganwadi Centres and Schools, apart from the data received from the NTPC office.

Quantitative data are put in different tables and graphs, and the analysis is done based on using percentage and ratio techniques. Data collected through qualitative methods like FGD and KII are analyzed through description and explanation

OBJECTIVES OF THE STUDY

The purpose of the study is to evaluate the short- and long-term impact of the CSR-CD projects in 15 villages, the sustainability of those projects after their completion and suggestions for improvement or changes. The specific objectives are -

- To prepare a comprehensive profile of all the activities done by NTPC Unchahar (vis a vis all the individual activities, village-wise, in all the broad areas like Education, Health, Sanitation, Rural Infrastructure, Drinking Water, Vocational Training, Differently-abled, Sports, quality of life, etc. are to be included as per the requirement/demand of community;
- To determine the impact of various CSR-CD projects on the social/ cultural/education/health and economic conditions of the people in communities;
- To assess the changes brought in the quality of life among village communities through CSR project interventions;
- To get an objective description of social impacts rather than what people might tell publicly.
- To identify the requirement of modifications in the existing CSR-CD activities in order to take care of the changing needs of the communities;
- To assess the level of community participation and consultation through CSR-CD activities.
- Evaluate the nature of communication and consultation between the stakeholders for the various CSR-CD projects.
- To document all the findings in a systematic manner as may be required later for collaborating with other project activities or for the purpose of extending further funding of the project.

COMPREHENSIVE PROFILE OF ALL THE VILLAGES AND ACTIVITIES

This section deals with the brief demographic profiles of the 15 study villages analysed on the basis of the available secondary data from Census of India, 2011. Further, it enlists all community development activities undertaken by the Unchahar Station of NTPC during the last five financial years, i.e. 2015-16, 2016-17, 2017- 2018, 2018-2019 and 2019-2020. Table 1 enlists the total population, male-female population, sex ratio and scheduled caste and scheduled tribe population of the 15 villages.

Table 1: *Comprehensive Profile of 15 villages*[2]

SNo	Name of village	Total population	Male	Female	Sex Ratio	Scheduled Caste population	Scheduled Tribe population
1	Unchahar Dehat	13365	7021	6344	895	2302	0
2	Arkha	10531	5484	5074	922	3785	25
3	Sarai Parsoo	2136	1103	1033	985	80	0
4	Purwara	2269	1150	1119	973	538	0
5	Babhan Pur	2026	238	222	980	91	0
6	Sarai Sahijan	1674	839	835	1035	596	0
7	Baherwa	2679	1397	1282	980	646	0
8	Gopalpur Dudhwan	1695	872	823	980	204	0
9	Khurram Pur	2422	1285	1138	803	269	0
10	Murrar Mau	1850	957	893	956	444	0
11	Raipur	1593	815	778	918	336	0
12	Umran	5083	4786	2508	980	1577	0
13	Gangehra	3484	1720	1764	1055	640	0
14	Jasauli	1128	533	595	980	498	0
15	Mokhara	2010	1024	986	986	1025	0

[2]Based on the Census of India, 2011

CSR-CD ACTIVITIES UNDERTAKEN BY NTPC UNCHAHAR

All the CSR activities implemented by NTPC Unchahar are grouped together and classified under nine categories as listed below. These categories are in accordance with the CSR policy of NTPC.

1. Education
2. Healthcare
3. Vocational training initiatives
4. Water
5. Sanitation
6. Differently-abled
7. Rural Infrastructure
8. Promotion of sports and games
9. Other CSR activities

Table 2 describes the budget utilised against each CSR activity undertaken in the last five financial years (2015-16, 2016-17, 2017-18, 2018-19, 2019-20), provided by NTPC Unchahar.

Table 2: *List of Activities Undertaken by NTPC Unchahar Station*

Education			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	Furniture (Dual desk cum bench) to village Schools	17.47	1100
2	Construction of Boundary wall & pathway at schools	20.78	268
3	Construction of Classroom	6.5	225
4	Construction of Cycle Stand at Harnarayan Inter Collage Unchahar	9.31	1700
5	Distribution of Basic supplies (Pullover, woolen cap, School bag kit) to surrounding village schools	32.2	9000
6	Earth filling in ground of Primary School, Umran	0.58	140
7	Education Scholarship & prize to Meritorious Students	1.75	65
8	Inclusive Education for PCP Students of surrounding village	3.99	24
9	Girl Empowerment Mission (2019-20)	50	103
10	Distribution of Bi-cycle to the economically weaker and disadvantaged sections of girl students (2018-19)	1.56	27
11	Toilet Construction in schools	18.24	125
12	Provided computer to ITI schools	NA	NA
13	Solar Lighting System for Kasturba Gandhi Residential Girls	26.48	128
	Collage		
	Total	**188.86**	**12905**

Healthcare			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries(in number)**
1	Awareness creation for mother & child health and adolescence health, Awareness about malnutrition/Good nutrition- protein powder distribution	2.74	600
2	Cancer awareness/Detection camp (2018-19)	1.65	426
3	Cataract Surgery (Under National Blindness Programme) 2015-16	7.03	3
4	Dental check-up & awareness camp (2018-19, 2019-20)	0.46	1375
5	Eye Camps (2015-16)	7.03	1029
6	Family Planning camp (2015-16, 2016-17, 2017-18, 2018-19, 2019-20)	4.73	926
7	Mobile Health Clinic (2015-16, 2016-17, 2017-18, 2018-19, 2019-20)	6.2	21295
8	Providing training for First Aid Services & provision of Kits (2017-18)	0.33	45
9	Annual Respiratory Camps (2015-16, 2016-17, 2017-18, 2018-19, 2019-20)	1.23	719
	Total	**31.4**	**26418**

Vocational Training			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	Auto Repairing Training for 25 youth (2015-16)	1.9	25
2	Basic of Beauty and Hair Dressing to girls (2018-19)	1.301	25
3	Beautician and hair dressing (2019-20)	3.56	25
4	Computer Tally (e-Billing) to girls & youth (2018-19)	1.301	25
5	Computer training for 50 youth (2015-16)	1.751	50
6	Home appliance training to 30 candidates (2016-17)	Data not available	30
7	Solar electric System Installer and service Provider training to youth (2018-19)	1.735	25
8	Tailoring Training to women/girls including procurement/ distribution Sewing Machine (2017-18)	9.34	40
9	Tailoring Training to 40 women/girls of surrounding village (2015-16)	2.42	40
10	Tailoring Training to 40 women/girls of surrounding village (2019-20)	4.17	50
	Total	**27.478**	**335**

Water			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	RO at PHC, Unchahar (2018-19)	0.99	20000
2	Installation of hand pumps (2016-17, 2019-20)	24.49	9750
3	Piped water system with overhead tanks (2019-20)	125	2550
4	Installation of piped drinking water (2019-20)	66.2	7320
5	Beautification & development of Pond in Town area Ward no. 8. (2015-16)	8.87	1000
	Total	**225.55**	**40620**

Sanitation			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	Cleaning of existing drain (Umran jheel and Arkha Station)	12.1	2194
2	Construction of drain at Umran	18.12	1694
3	Construction of 200 Individual Household Toilets	46.39	1600
4	Construction of Community Toilets (2017-18, 2019-20)	133.68	43000
5	Construction of Sanitary Toilets	9.26	540
6	Distribution of dustbins (2018-19, 2019-20)	14.28	24000
8	Financial assistance given to Distt. authority under Swachh Bharat Abhiyan	1.2	Data not available
9	Organised Nukkad natak (2017-18, 2018-19, 2019-20)	4.57	6000
10	Distribution of mosquito net in surrounding area	2.05	1000
	Total	**241.65**	**80028**

Differently-abled			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	Distribution of Tri-Cycle to disabled persons on World Disability Day	0.568	8
2	Procurement & distribution of Hearing Aid	0.47	17
3	Rehabilitation camp (Disable Person)	4.72	222
	Total	**5.758**	**247**

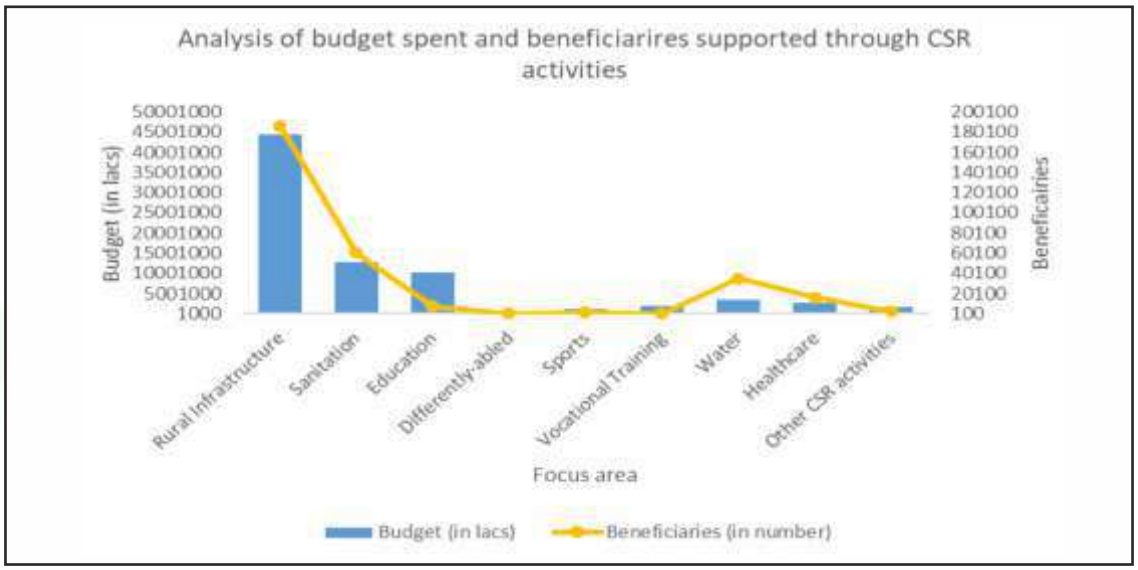
Rural Infrastructure			
S. No.	**Activity**	**Budget**	**Beneficiaries (in numbers)**
1	Consruction of 1.1Km. RCC Road with drain from Unchahar-Salon to railway station (2018-19)	48.34	25000
2	Construction of WBM Road (0.6 Kms) Sarai Parsu to Bhaktin ka Purwa.	9.8	1500
3	Installation of solar street lights in surrounding villages.	34.47	2500
4	Installation of stand-alone Solar light	32.91	5000
5	Installation of 4 Nos. Semi-High Mast Light	27.5	3000
6	Installation of 50 no Standalone Solar light	12	25000
7	Installation of CCTV Camera	4.46	4000
8	Installation of High Mast Light	27.5	5000
9	Installation of Stand-alone Solar Light in Rural area.	41.78	11000
10	Maintenance of high mast light at Town area Unchahar	0.6	5000
11	R&M of 0.4 KM road from Unchahar Bus Station to Railway Station.	16.12	1000
12	R&M of 0.45 Km road of village Manirampur from Unchahar-Salon road	Data not available	1500
13	R&M of 0.6 Km. road to village Malkana From Rly. Station road	Data not available	1000
14	R&M of 1.5Km. road from village Bhakhri to Labedwa.	Data not available	2500
15	R&M of Community Health Centre at Arkha (2018-19)	1	20000
16	R&M of Panchayat Bhawan, Purwara (2018-19)	1.53	2269
17	Solar lighting system at PHC- Unchahar (2017-18)	26.48	20000
18	Railway Overbridge	152.25	50000
	Total Budget	**445.61**	**186269**

Sports			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in numbers)**
1	Financial assistance to DM Raebareli for open Gym equipment (2018-19)	4.26	Data not available
2	Rural Sports & Distribution of Kit (2015-16, 2016-17, 2017-18, 2018-19, 2019-20)	10.29	1500
	Total	**14.55**	**1500**

Other CSR Activities			
S. No.	**Activity**	**Budget (in lacs)**	**Beneficiaries (in number)**
1	Distribution of blankets for needy and poor people (2018-19)	2.25	560
2	Procurement of blanket & distribution to weaker section (2017-18)	2.01	500
	Total	**4.26**	**1060**

Further, Figure 2 presents the budget utilisation pattern in various broad areas and suggests that the budget's largest share has been utilised for activities in rural infrastructure, sanitation, and education activities. Similarly, the number of beneficiaries supported are also higher in rural infrastructure and sanitation project. However, the number of beneficiaries is not as high in education as the budget spent on related activities. Water related activities have more number of beneficiaries vis-a-vis the amount spent on water related interventions.

Figure 2: *Analysis of budget spent and beneficiaries supported through CSR activities*



(Source: NTPC Unchahar)

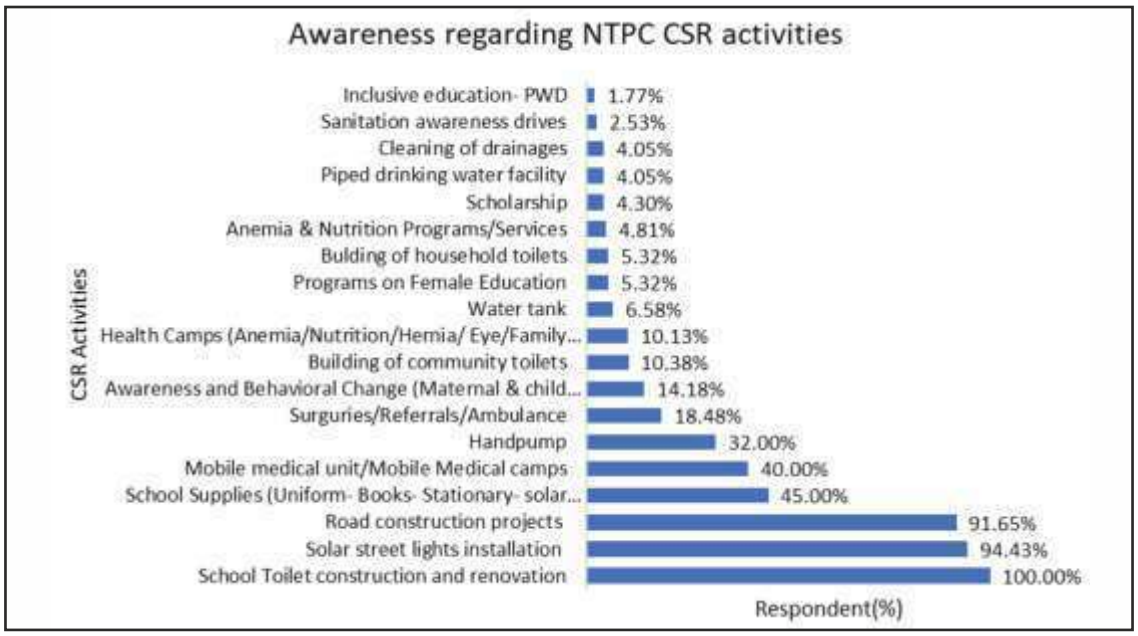
Additionally, Objective 1 of NTPC Terms of Reference (ToR)[3] also deals with awareness and perception. The focus here is on an objective evaluation of social impacts on the community for whom the projects are designed and implemented.

[3]Wide Purchase Order No. : 4600062870-017-1012 Dated : 02.09.2020

AWARENESS AND PERCEPTIONS OF CSR INTERVENTIONS

All respondents surveyed in these villages were interviewed to determine their awareness and perceptions of CSR-CD interventions based on the focus areas of NTPC Unchahar. In order to assess their awareness and perception, various questions around the CSR-VD interventions were asked from the community and the key stakeholders. Such information is collected and further analysed by considering the responses received as High/ Medium /Low in case of awareness about the projects. Figure 3 summarises the level of awareness about CSR activities undertaken by NTPC Unchahar.

Figure3: *Level of awareness about NTPC CSR Projects*



(Source: IICA survey, 2020)

Findings and observations

Respondents in the study area were reached out through households surveys and focus group discussions. It was found that the respondents were aware of the various NTPC programmes and projects running in the villages. The survey reported a high level of awareness (nearly 90%) about projects undertaken in infrastructure like renovation of educational institutes, building of toilets, road construction projects and installation of street lights. A medium level of awareness (30%-50%) was found for handpumps, basic school supplies and Mobile medical unit provided by NTPC. A low level of awareness (less than 30%) was observed regarding the sanitation projects, water tank, health camps, programmes on female education, inclusive education and other educational initiatives.

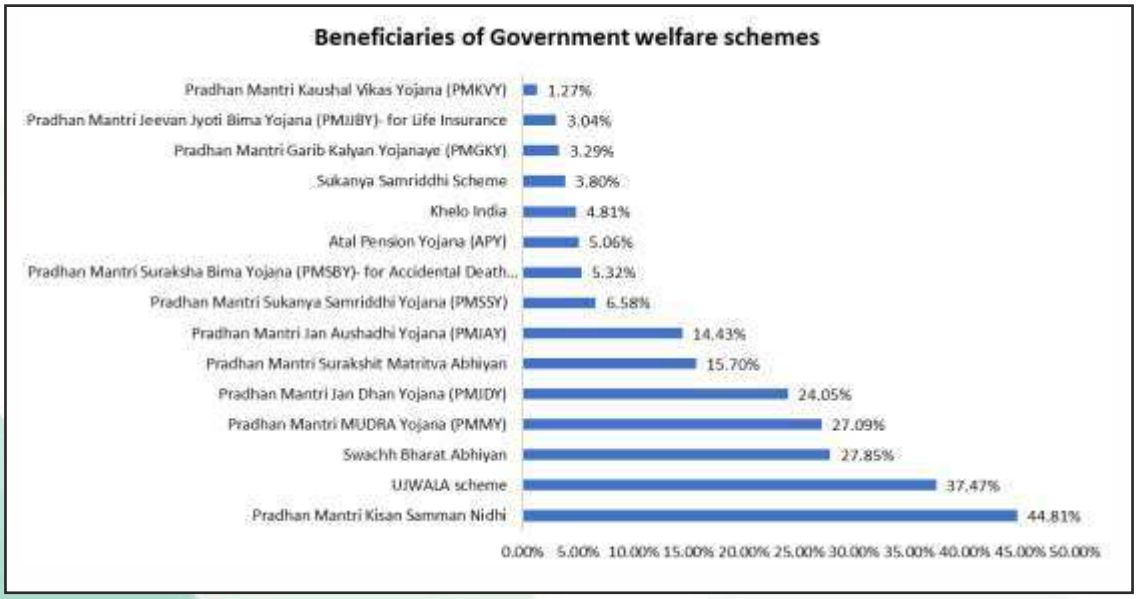
The reason for high level of awareness about the road construction and toilet construction in schools can be owed to the NTPC branding in these projects where visibility is high. The medium and low level of awareness is found in programmes where the intervention is strategic in nature. One of the primary reasons for low level of awareness in majority of CSR activities, is the community's lack of engagement before designing the project and during the implementation, as expressed by the community members during FGDs.

To understand community's perception regarding the CSR-CD projects undertaken by NTPC Unchahar, the focus group discussions were held with the male and female community members from the villages. The majority of the participants had stated that they were aware of the various interventions in health, education, drinking water and rural infrastructure. The perception was positive about the hand pump initiatives and infrastructure projects as their visibility was high, and the number of beneficiaries was higher in these interventions. It was observed that the majority of project interventions are aligned with community needs, which is why the perception has been positive.

AWARENESS OF GOVERNMENT WELFARE PROGRAMMES

The NTPC places a great emphasis on increasing the awareness and align their CSR-CD activities with government welfare programmes. The NTPC ToR mentioned about the awareness level of the respondents regarding these programmes, hence Figure 4 illustrates the percentage of respondents who are beneficiaries of various government schemes and programmes.

Figure4: *Percentage of Beneficiaries of Government Operational Welfare Programmes*



(Source: IICA survey, 2020)

From Figure 4 it is evident that the majority of the population in the study area are unaware of government welfare schemes and programmes. The highest awareness in the study area (44.81%) was regarding Pradhan Mantri Kisan Samman Nidhi. The flagships schemes like Swachh Bharat Abhiyaan (27.85%), Ujjwala scheme (37.47%) and Pradhan Mantri Jan Dhan Yojna (24.05%) also recorded a high number of beneficiaries than the other programmes like Pradhan Mantri Kaushal Vikas Yojna (1.27%), Pradhan Mantri Jeevan Jyoti Yojna (3.04%) and Atal Pension Yojna (5.06%).

Further, the NTPC officials informed that the majority of their programs are aligned with centre and state government programmes and policies. The road construction programs are linked to Pradhan Mantri Gram Sadak Yojna, Sanitation programs with Swachh Bharat Mission, health initiatives are linked to National Rural Health Mission, skill training initiatives with Pradhan Mantri Kaushal Vikas Yojana, Sports initiative with Khelo India. However, NTPC must ensure that the CSR activities should play the role of facilitators wherever possible so that government efforts are not replicated.

DETERMINING THE IMPACT OF VARIOUS CSR-CD PROJECTS ON THE SOCIAL/CULTURAL/ EDUCATION/ HEALTH AND ECONOMIC CONDITIONS OF THE PEOPLE IN COMMUNITIES

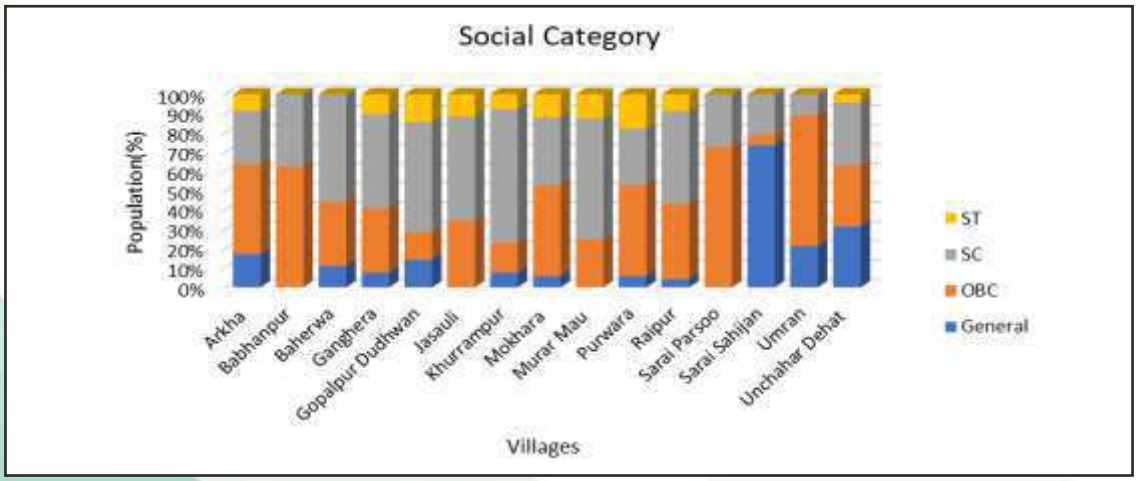
Socio-economic factors play a vital role in the process of proper allocation to various CSR activities for achieving benefit maximization. Therefore, this chapter deals with the assessment of socio-economical background. The survey for social impact evaluation was carried out in 15 project-affected villages of NTPC Unchahar. The total number of beneficiary households are 10010. A sample size of 395 households was calculated using confidence interval of 95% and 5% of margin of error. Random sampling was used, to select the respondents among the beneficiaries.

Socio-Cultural Condition

IICA survey covered total 395 households in 15 study villages. Out of the total survey respondents, 39.49 per cent were females and 60.25 per cent, males. The majority of the population in these villages speaks Hindi, Urdu and local dialect (Awadhi). The average age of the respondent population is between 35 to 50 years.

Figure 5 shows that out of the total number of respondents, 17.72 per cent belonged to the General category, 37.97 per cent to Other Backward Classes, 37.47 per cent to Scheduled Castes and 6.84 per cent to Scheduled Tribes. Overall, 44.30 per cent of the population belongs to the Scheduled Caste (SC) and Scheduled Tribe (ST) category. Moreover, Figure 5 shows that the respondent's sample was representative of different socio-economic groups in the villages.

Figure5: *Social Category of the Respondents*

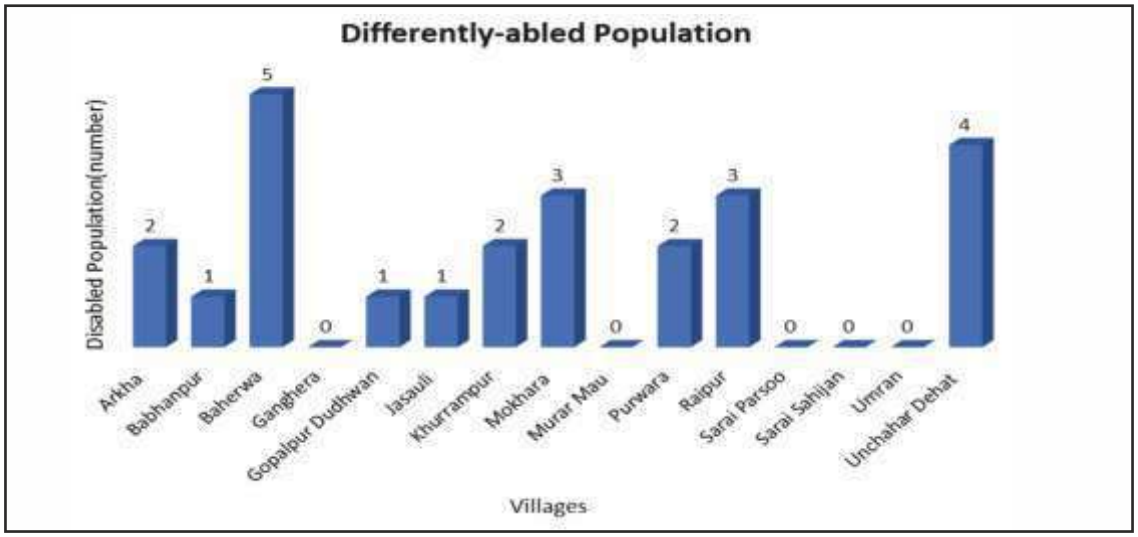


(Source: IICA survey, 2020)

The selection of villages for conducting CSR activities was appropriate for the intervention as these villages have a high percentage of the marginalised population belonging to underserved sections of society.

Further, Figure 6 shows that out of the total population surveyed, 6.08 per cent were differently-abled. The highest percentage of the differently-abled population was found in Baherwa (1.27%) and Unchahar Dehat (1.01%), followed by Mokhara (0.76%). It was observed that the majority of persons with disabilities had either auditory, visual or locomotor disability. Thus the interventions aimed at inclusion and empowerment of differently-abled appropriately cater to the needs of the community.

Figure 6: *Differently-abled Population in numbers (village-wise)*

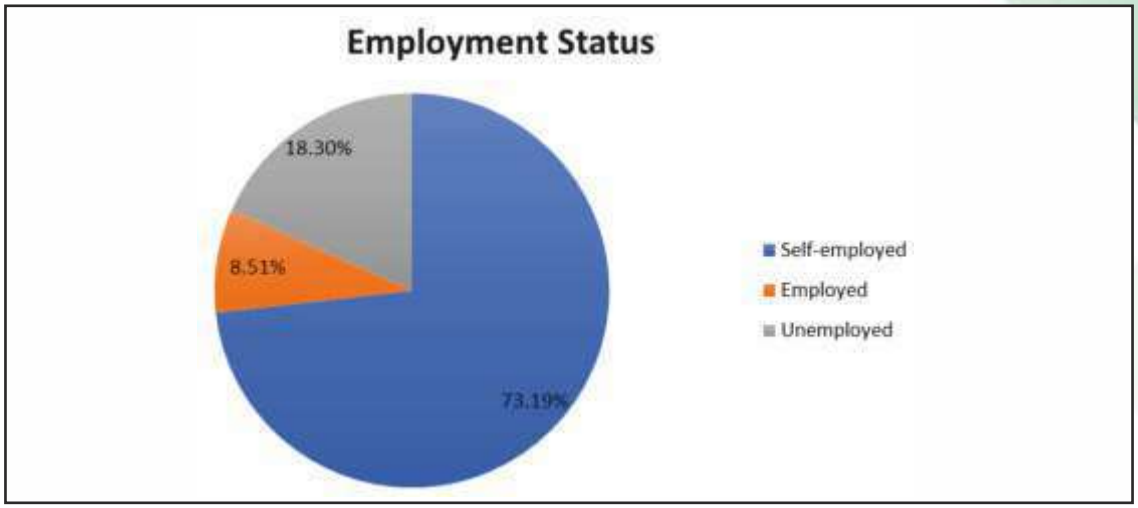


(Source: IICA survey, 2020)

In India, during 2017-18, about 52.2 percent of rural households had a major source of income from self-employment[4]. Figure 7 states that the 73.19 per cent population in the study villages is self-employed as farmers, casual labourers in agriculture and non-agricultural workers, daily wage workers such as drivers, plumbers, electrician, rikshawpuller, mason etc. and own small business and shops. 18.30 per cent population is unemployed. Those involved in regular employment are 8.51 per cent. Among the regular employed, majority are those who work in the NTPC Unchahar as contract labourers.

[4]Annual report, Periodic Labour Force Survey (2017-18)

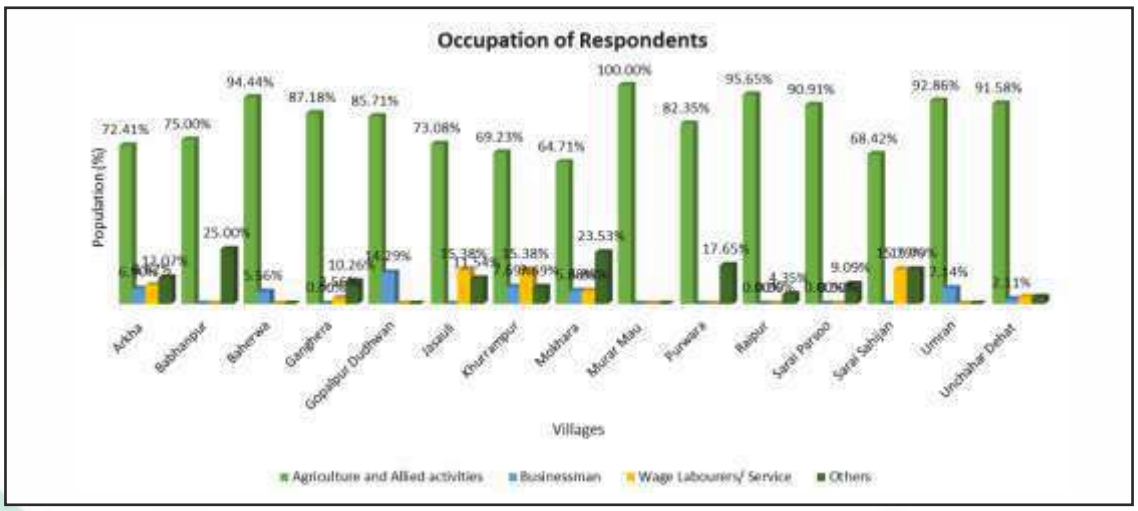
Figure 7: *Employment Status of the respondents*



(Source: IICA survey, 2020)

Further, Figure 8 clarifies that the study area is primarily dependent upon agriculture and allied activities. Nearly 84.05 per cent of respondents are engaged in agriculture and allied activities as their primary occupation. 4.81 per cent work as casual labourers and 3.04 per cent own small businesses. The majority of the population in Murrar Mau (100%), Raipur (95.65%) and Baherwa (94.44%) are primarily engaged in agriculture. The major crops people grow in this area are paddy and wheat. Recently farmers have started menthol mint farming in the district, as being the terai region it is ideal for mint cultivation.

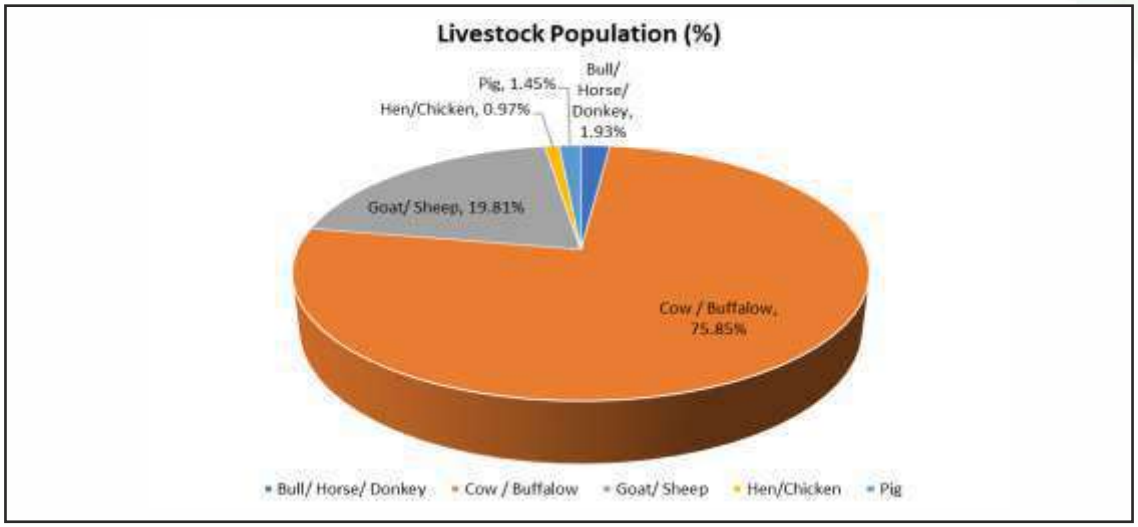
Figure 8: *Occupational Status of the respondents (village wise)*



(Source: IICA survey, 2020)

Additionally, animal husbandry is one of the subsidiary activities in the rural or agricultural sector as it supplements employment and income to the farming households. IICA survey suggests that 52.41 per cent of the population owns livestock in the survey area. Cow or Buffalo (75.85%) are the most common animals found in people's houses, followed by goats and sheep (19.81%). 1.93 per cent of the population owns bull, donkey or horses and 1.45 per cent population owns pig and 0.97 per cent also own hen and chicken as livestocks.

Figure 9: *Livestock population(%)*



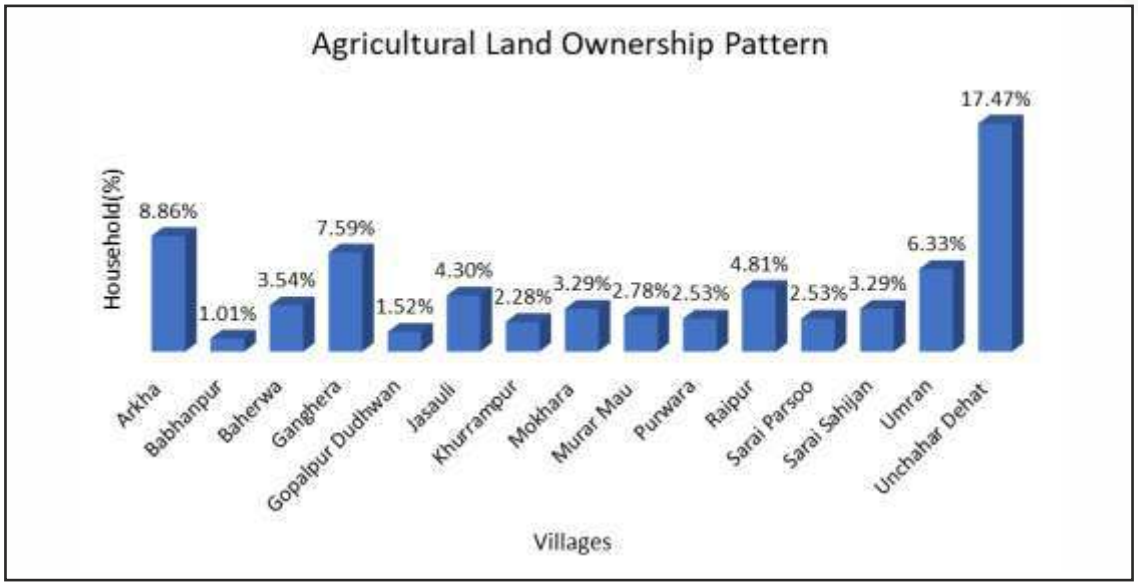
(Source: IICA survey, 2020)

However, there is a lack of understanding of cattle rearing method among the inhabitants in the study area. Respondents leave their livestock to move around places for grazing without bothering crop damages, thus indicating improper maintenance of livestock. Out of the total households who owned livestock, 25.12 per cent use them for generating livelihood while 74.88 per cent use the products obtained from them for self-consumption. The lowest number of animals were found in Babhanpur, while in Unchahar Dehat and Arkha the livestock population was high.

Land Ownership Pattern

The pattern of land ownership plays a vital role in land use and agricultural development. Figure 10 suggests that in all the studied villages the percentage of household who own agricultural land is higher in Unchahar Dehat (17.47%) followed by Arkha (8.86%) and Ganghera (7.59%). A lower percentage of agricultural land ownership was found in Babhanpur (1.01%), Gopalpur Dudhwan (1.52%) and Khurrampur (2.28%) and Purwara (2.53%).

Figure 10: *Land ownership status of the respondents (village wise)*



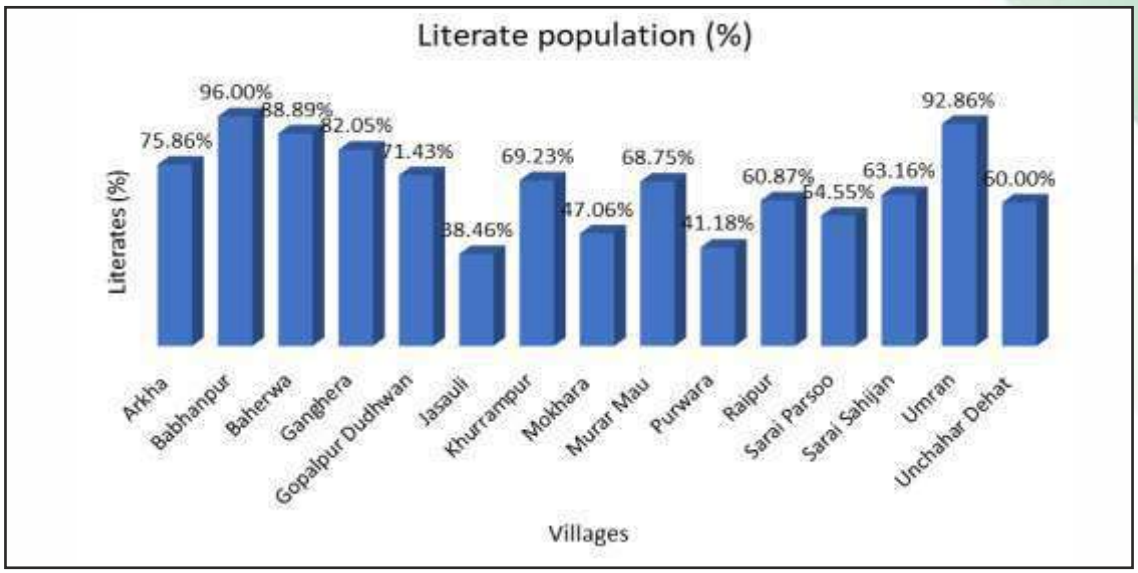
(Source: IICA survey, 2020)

Educational Conditions

Education plays a significant role in an individual's day-to-day life, as it enhances the ability to understand and comprehend things. In India, the literacy rate[5] (among persons of age 7 years and above) during 2017-18 was 76.9 per cent. The IICA survey suggests that 15 villages of the study area have a literacy rate of 67.09 per cent, which is lower than the national average. Figure 11 presents the literacy level in the study villages and shows that the lowest percentage of literates were found in Jasauli (38.46%) while the highest were found in Babhanpur (96%).

[5]Annual report, Periodic Labour Force Survey (2017-18)

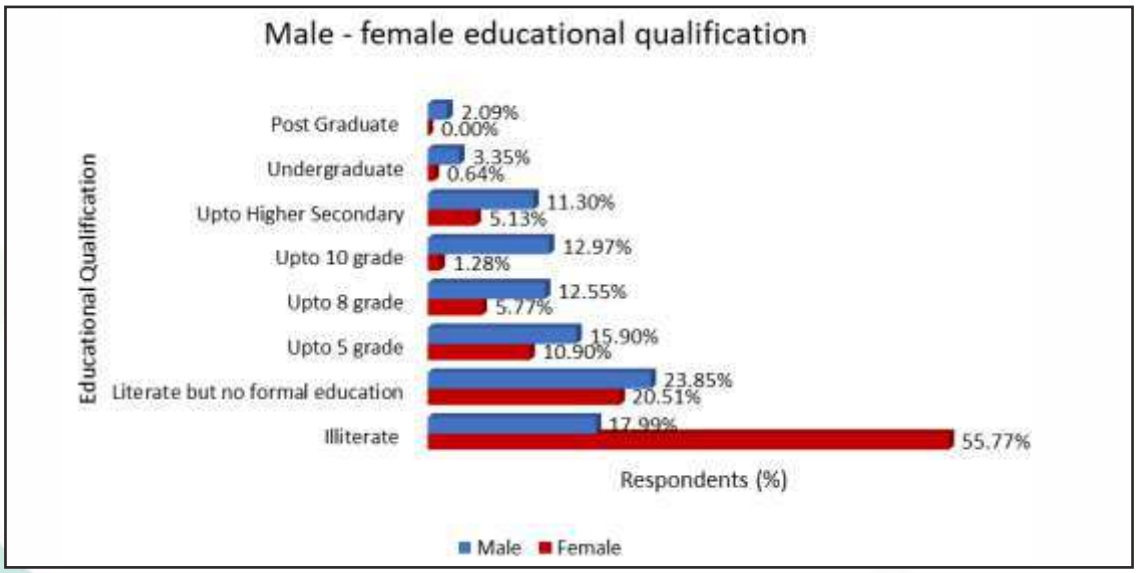
Figure 11: *Percentage of Literate Population (village-wise)*



(Source: IICA survey, 2020)

In India, the literacy rate in both rural and urban is higher among males than females[6]. In rural areas, the literacy rate was 80.7 per cent among males compared to 64.5 per cent among females. As Figure 12 shows, in the study area 82.01 per cent males were literate while 44.23 per cent females were literate.

Figure 12: *Male-female educational qualification*



(Source: IICA survey, 2020)

[6]Annual report, Periodic Labour Force Survey (2017-18)

The trends regarding literacy of males vis-a-vis females in the village are similar to the national trends where males' literacy rate is higher than females. Further, figure 12 suggests that only 10.90 per cent female respondents were educated till primary schools. The figures are poorer in upper primary (5.77 %) and higher secondary education (5.13%).

The problem in transportation, coupled with schools located at a great distance in the study area, compelled parents not to send their kids to the schools, thus keeping them devoid of education. Thus, the interventions in education particularly, supporting female education, are suited to the study area.

The major activities organized by NTPC in the thematic area of education can be classified into two categories

1. Activities that bring tangible results
2. Activities that bring non-tangible results

For instance, in FGDs, participants were asked to discuss various educational interventions by NTPC, the respondents mentioned the Girl Empowerment Mission that enhanced their personality development, made them more confident and helped them to acquire new skills. Activities like augmenting school infrastructure, making provisions for school stationery, providing solar panels to educational institutes are some of the interventions that brought immediate results.

Health Conditions

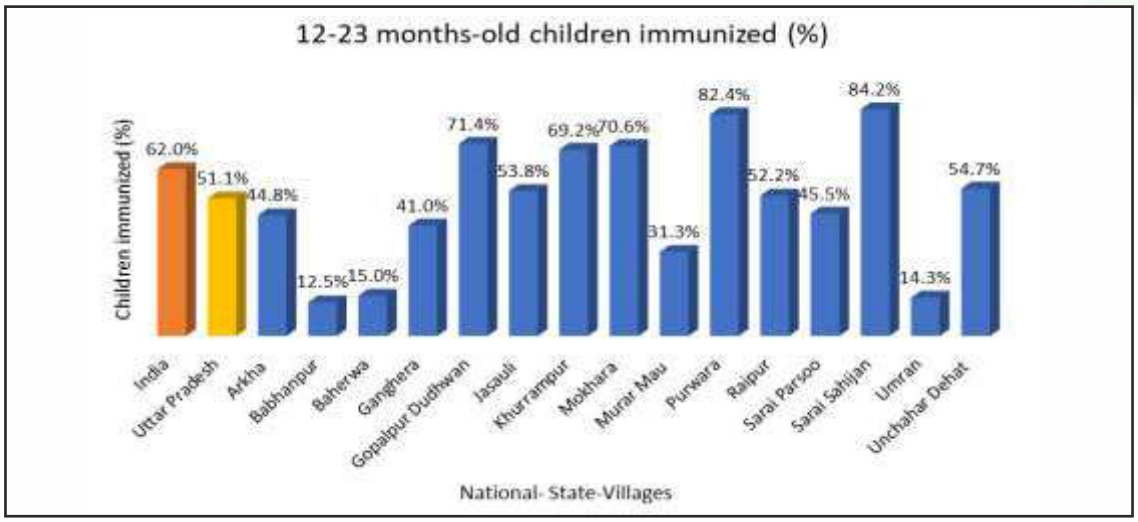
The NTPC Unchahar, as part of its health intervention, has conducted health awareness camps and runs a mobile medical unit. To understand the general health conditions of the people of the area, it is important to take note of the status of institutional births in the area, status of immunisation of children in the area, infant mortality rate and maternal mortality rate in the study area and also prevalent diseases among the community members.

An important indicator to understand the health of the children, the percentage of 12-23 months-old children immunized measures the extent of coverage and the quality of the child health care system in the area. Immunization is an essential component for reducing under-five mortality rates. Besides reducing mortality and morbidity, there is reduction in disability burden by 9 million cases and 960 million disability adjusted life years have been saved from 2001 due to this protective measure. The national average for full immunisation is 61.30 per cent in India[7]. Figure 13 presents that there are only two villages (Purwara (82.4%) and Sarai Sahijan (84.2%) among studied villages which have more than 80 per cent immunisation coverage. While the ten villages have immunisation

[7]NFHS 4, 2015-16

coverage less than national average (61.30%). The status of immunisation is poorer in Bhabhanpur (12.5%), Baherwa (15.0%), and Umran (14.3%). The low percentage of 12-23 months-old children immunized can be also be owed to high percentage of marginalised population in the survey area. NTPC Unchahar can work towards expanding access to immunization that is crucial to achieve the Sustainable Development Goals (SDGs).

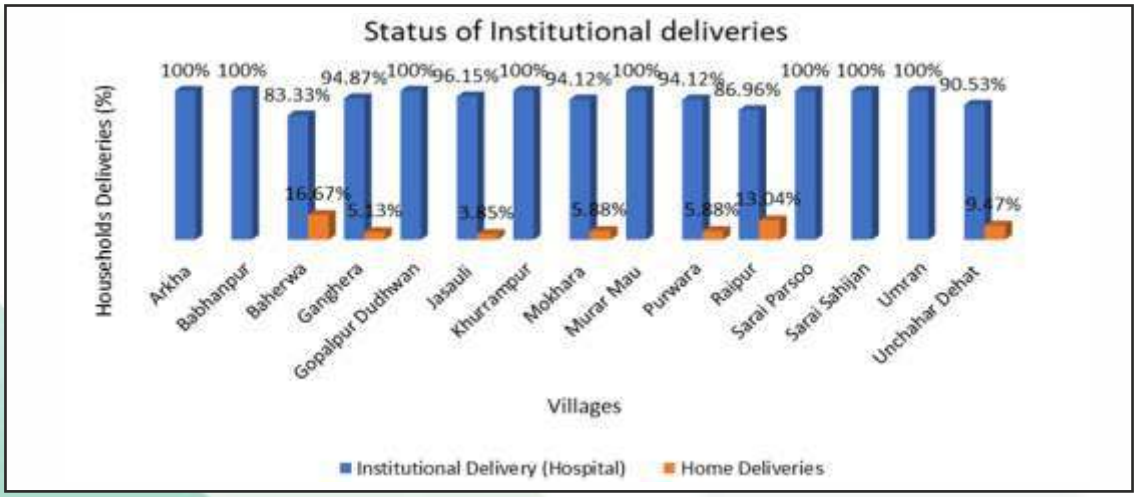
Figure13: *Percentage of 12-23 months-old children immunized (village wise)*



(Source: IICA survey, 2020)

Various studies suggest that increased institutional births leads to lower deaths related to pregnancy and births. Figure 14 suggests that in terms of institutional deliveries, many villages in the study area performed remarkably better with percentage of institutional births more than 90 per cent.

Figure14: *Status of Institutional Deliveries*



(Source: IICA survey, 2020)

Maternal Mortality Rate[8] and Infant Mortality Rate (MMR and IMR) are regarded as important and sensitive indicators of the health status, general standard of living and effectiveness of interventions for improving maternal and child health in an area. As per the latest report (2016-18) of Sample Registration System (SRS) released by Registrar General of India (RGI), Maternal Mortality Ratio (MMR) of India per 100,000 live births declined to 113 in 2016-18. The MMR in Uttar Pradesh is 197, which is higher than the national average. Since the data for finding the rate was not available, the team conducted KII with Anganwadi workers and ANMs in the villages. Table 3 states the number of Infant mortality, the Maternal mortality and mortality number of children under 5 as shared by Anganwadi workers[9].

Table 3: *Infant mortality, Maternal mortality and mortality number of children under 5 (in numbers)*

Village	Children born in the span of last five years	Children born in the span of last one year	Children under the age of five years have died in last one year	Children under the age of 1 year have died in last one year	Pregnant women registered in the last one year	Maternal deaths recorded in AWC in the last one year
Baherwa	130	26	2	1	30	1
Gopalpur	235	47	4	2	47	1
Raipur	42	8	10	1	45	1
Umran	120	22	8	3	25	1
Gangehra	75	15	2	2	16	1
Arkha	110	22	1	1	25	1
Jasauli	125	36	1	1	30	1
Sarai Parsoo	110	22	2	1	22	1
Unchahar dehat	120	24	0	0	24	11
Mokhara	106	28	0	0	28	0
Murrar Mau	125	24	1	1	24	1

(Source: Register of Anganwadi workers, 2020)

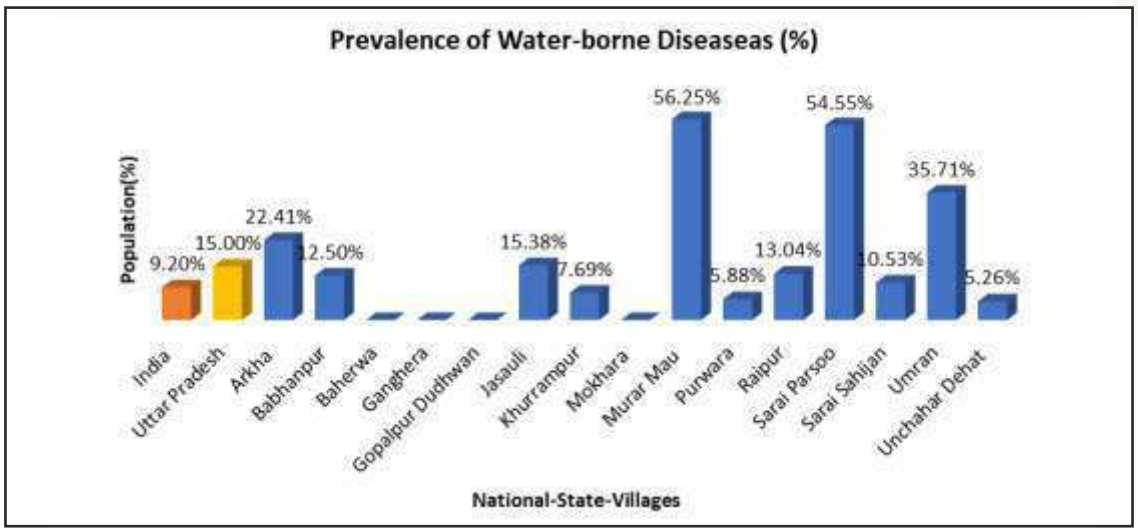
Regarding the health of women in the area, common diseases were asked to assess their overall health conditions. Some women reported about the prevalence of the diseases like Leucorrhoea. NTPC Unchahar may consider to increase the cover of health camps conducted. Sexual health and hygiene should be made one of the major interventions to improve the health of adolescent girls and women in the area. Awareness campaigns on women general and menstrual health could be organised with the help of ASHAs and ANMs on Village Health and Nutrition Day.

Additionally, to understand the status of general health in the region, the population was questioned about the prevalent diseases like water-borne diseases, mosquito-borne diseases and common diseases to men, women and elderly.

[8] Number of maternal deaths per 1,00,000 live births.
[9] There can be bias in the data since this was told by Anganwadi workers from their registers.

Water-borne diseases are a severe problem from the public health point of view as they can spread rapidly affecting large sections of the population. These diseases have a very high disease burden and a significant impact on the economy in countries such as India where water pollution and open defecation, coupled with poor sanitation and hygiene practices lead to high incidence of water-borne diseases. Figure 15 represents the prevalence of water-borne diseases among the villages. Overall 13.92 per cent population was affected by water borne diseases like Jaundice, Typhoid etc. which is higher than the national average (9.20%) and lower than the state average (15%) of water borne diseases.

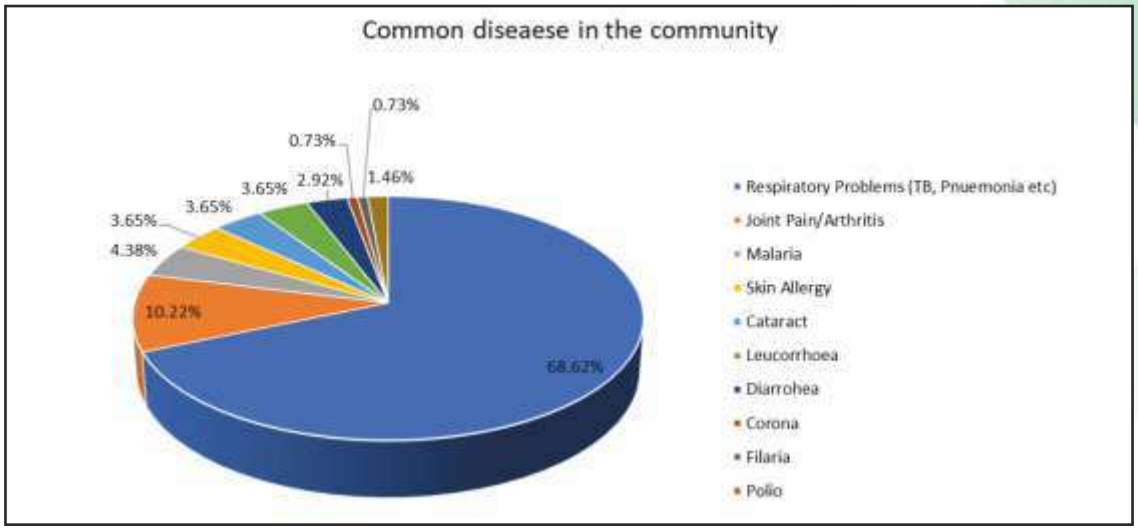
Figure15: *Prevalence of Water-borne Diseases(village-wise)*



(Source: IICA survey, 2020)

The highest percentage of water-borne diseases was found in Murar Mau (56.25%), Sarai Parsoo (54.55%) and Umran (35.71%) which is higher than the national average of nine percent. Some villages like Khurrampur (7.69%), Purwara (5.88%) and Unchahar Dehat (5.26%) reported few cases of water borne diseases. Baherwa, Ganghera, Gopalpur Dudhwan and Mokhara were found to have nil occurrences of water borne diseases. Further, Figure 16 shows the bifurcation of existing common diseases in the community. Additionally it shows that majority of health camps conducted by NTPC Unchahar were relevant interventions.

Figure 16: *Common diseases in the community*



(Source: IICA survey, 2020)

Overall, 34.68 per cent population reported some diseases, those who reported among them 4.38 per cent population reported diseases like Malaria during the survey, while majority (68.62%) reported having respiratory issues and pneumonia in children as a health problem. However, 65 per cent population did not report any disease, which is a positive sign of status of health in the study villages, which can be owed to the mobile medical and general health awareness and diagnosis through health camp interventions of NTPC Unchahar.

Economic Conditions

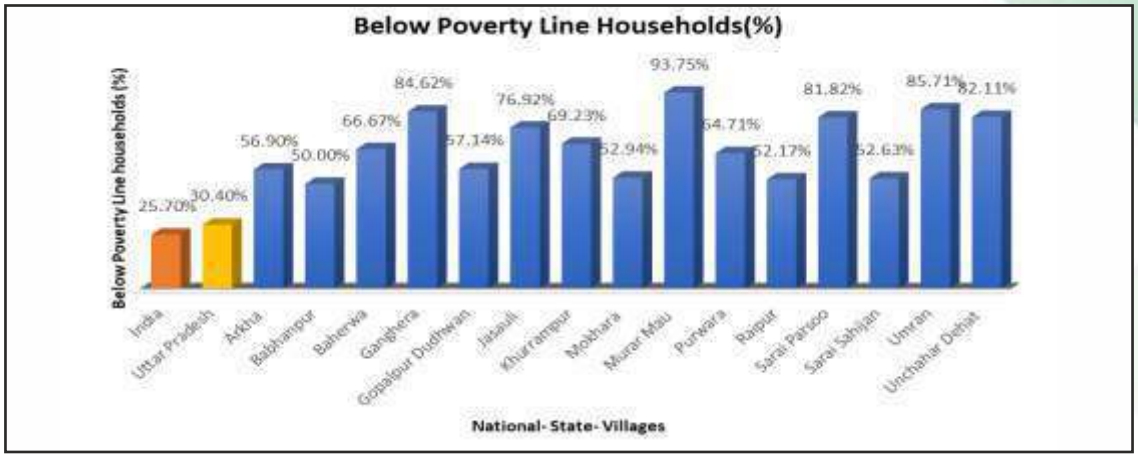
To understand the economic conditions of the respondents, the two most important indicators are percentage of population Below Poverty Line (BPL) and per capita annual income.

Out of the total population living in the rural India, 25.7 per cent of them is living below the poverty line while in Uttar Pradesh it is 30.40 per cent[10].

Figure 17, suggests that the economic conditions of the people in the study area is relatively poor when compared with the national and state average. The field survey suggests that all the villages in the study area have a very high percentage of people living below poverty line. Villages like Murrar Mau (93.75%), Umran (85.71%), Ganghera (84.62%), Unchahar Dehat (82.11%) and Sarai Parsoo (81.82%) have a very high percentage of population who have BPL cards.

[10]https://www.rbi.org.in/scripts/PublicationsView.aspx?id=16603

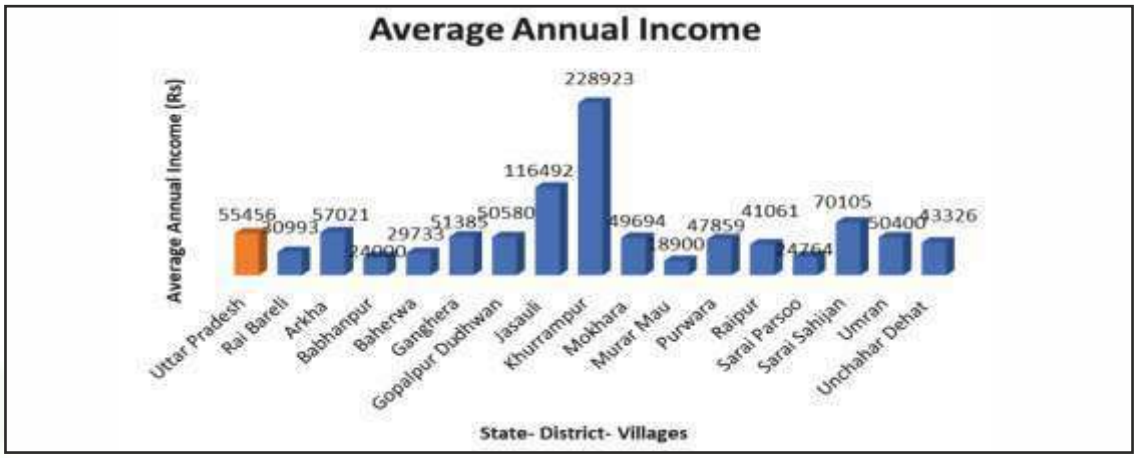
Figure 17: *Percentage of Population Below Poverty Line*



(Source: IICA survey, 2020)

Further, insights into the economic conditions are provided by considering average annual income. The per capita net income of Uttar Pradesh is Rs 55,456 and Rae Bareli is Rs 30,993 (at current price)[11]. In terms of average annual income, Figure 16 suggests that the lowest was found in Murrar Mau (INR 18,900) and Babhanpur (INR 24,000) and highest was reported in Khurrampur (INR 2,28,923) and Jasauli (INR 1,16,492).

Figure 18: *Average Income of the Respondents (annually)*



(Source: IICA survey, 2020)

From the Figure 17 and 18 it is inferred that Murrar Mau is economically poorest when compared with other villages. To understand the reasons behind the poor economic performance of the villages, the percentage of Self-Help Groups (SHGs) in the area was also analysed, and the findings suggest that just 8.86 per cent respondents were part of SHGs. The majority of population in the area was unaware of SHGs and thus wasn't a part. The next section analyses the changes brought in the quality of life of people in the study area through CSR interventions conducted by NTPC Unchahar.

[11]Statistical Diary, Uttar Pradesh (2018)

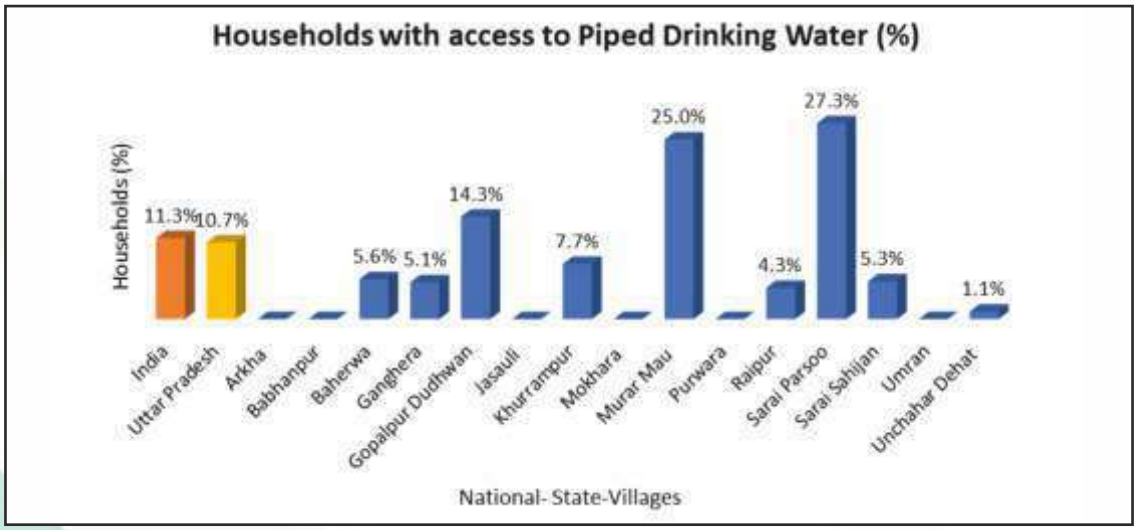
ASSESSMENT OF THE CHANGES BROUGHT IN THE QUALITY OF LIFE AMONG VILLAGE COMMUNITIES THROUGH CSR PROJECT INTERVENTIONS

In order to understand the changes brought in the quality of life by the CSR-CD interventions by NTPC Unchahar, prescribed indicators are compared and benchmarked at national, state, district and village level.

Households with piped drinking water

Around 21.4 per cent households in India have piped drinking water connections[12]. The situation is worse in rural India, where just 11.3 per cent households receive potable water directly at homes. In the rural areas of Uttar Pradesh the coverage of piped water is 2.3 per cent[13]. In the survey area the coverage of piped water was found to be 6.4 per cent. There was a piped water intervention by NTPC Unchahar in the study area, however its coverage has not been wide as it was started in the year 2019-20. Figure 19 shows that Sarai Parsoo (27.3%), Murrar Mau (25%) and Gopalpur Dudhwan (14.3%) have a high percentage of households with piped drinking water compared to national and state average, which can be owed to NTPC's piped water intervention. In seven study villages namely, Arkha, Babhanpur, Jasauli, Mokhara, Purwara, Umran and Unchahar Dehat survey team did not find households with access to piped drinking water.

Figure 19: *Percentage of households with access to piped Drinking-water*



(Source: IICA Survey, 2020)

[12]NSSO, 76th Round report on Drinking Water, Sanitation, Hygiene and Housing Condition'
[13]ibid

Population with sustainable access to an improved water source (within their premises and near to their premises)

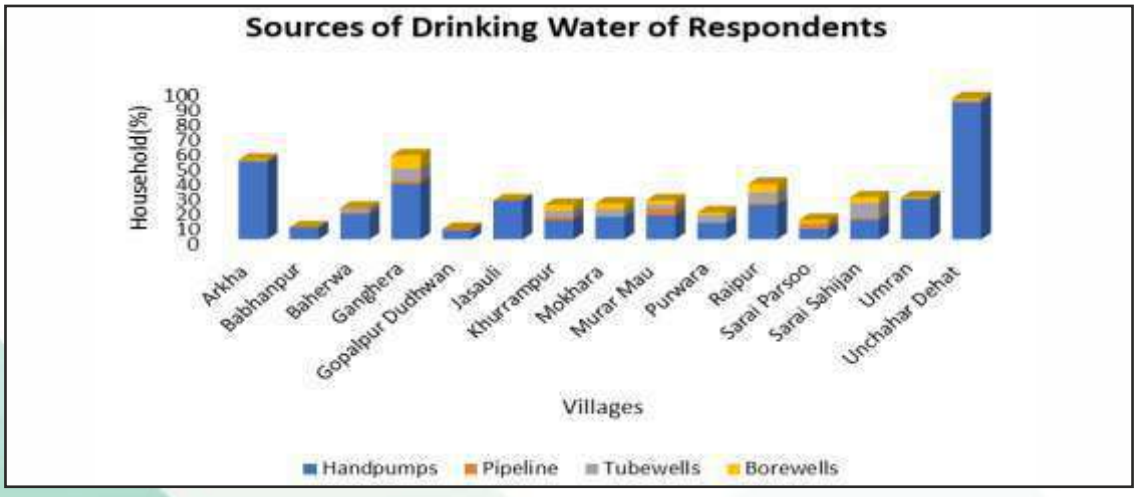
In India, about 94.5 per cent of the households in the rural areas used 'improved source of drinking water' viz. bottled water, piped water into dwelling, piped water to yard/plot, piped water from neighbour, public tap/standpipe, tube well, hand pump, protected well, public tanker truck, private tanker truck, protected spring and rainwater collection. The major source of drinking water is hand pump (42.9%) for the households in the rural areas[14].

S. No	Sources	2001	2011	Changed (in per cent)
1	Tap Water	24.3	30.8	+26.74
2	Hand Pump/ Tube Well	48.9	51.9	+6.13
3	Well Water	22.2	13.3	(-)40.09
4	Other Sources	4.5	4.0	(-)11.11
5	**Total**	**100**	**100**	

Figure 20, summarises the sustainable access to improved water source in the study area. Most of the population in the study villages get their water from handpumps (91.6%) followed by tube wells (11.90%), wells/borewells (9.37%). To improve the sustainable access to an improved water source within or near their premises, NTPC Unchahar undertook installation of hand pumps and piped drinking water in nearby villages. The NTPC intervention of handpumps has provided sustainable access to water to people in the study villages while piped drinking water coverage is limited to few villages.

Availability of Sources of Water	Within Premises		Near the Premises		Away	
	2001	2011	2001	2011	2001	2011
Rural Area	28.7	35	51.8	42.9	19.5	22.1
All India level	39	46.6	44.3	35.8	16.7	17.6

Figure 20: *Sources of Drinking Water of Respondents (village-wise)*



(Source: IICA survey, 2020)

[14] ibid

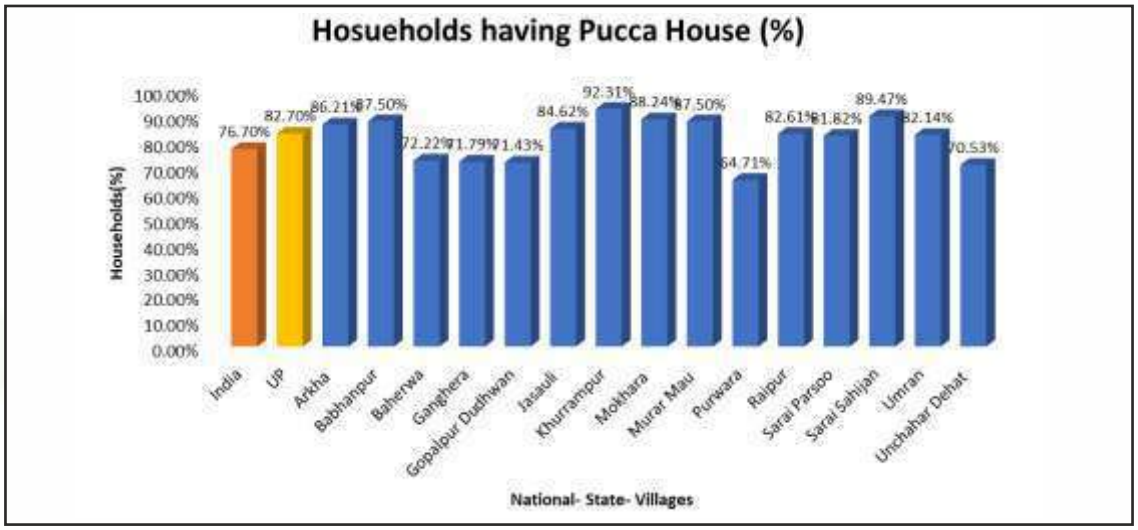
In 2018, about 58.2 per cent of the households in the rural areas in India had drinking water facilities within the household premises[15]. However, in the study area 25.3 per cent households had water source within their premises, thus the interventions in improving access to sustainable water source are relevant.

Population having pucca house (type of house)

Housing has a positive impact on the overall standard of living of rural people. However, there has been no direct intervention with regards to pucca houses in the villages by NTPC Unchahar. In the rural India, about 76.7 per cent households had the pucca structure, while in Uttar Pradesh 82.7 per cent have the pucca house structure[16]. Figure 21 shows that majority of the villages in the study area have a higher percentage of households that live in pucca house.

However, some villages like Baherwa (72.22%), Ganghera (71.79%), Gopalpur Dudhwan (71.43%) and Purwara (64.71%) have less percentage of pucca house when compared with national and state average. Thus, it is clear that there is a need for an exclusive housing scheme for the rural households, preferably low-cost houses or cost-effective houses such as under the Pradhan Mantri Awas Yojana- Rural.

Figure21: *Households having Pucca House (%)*



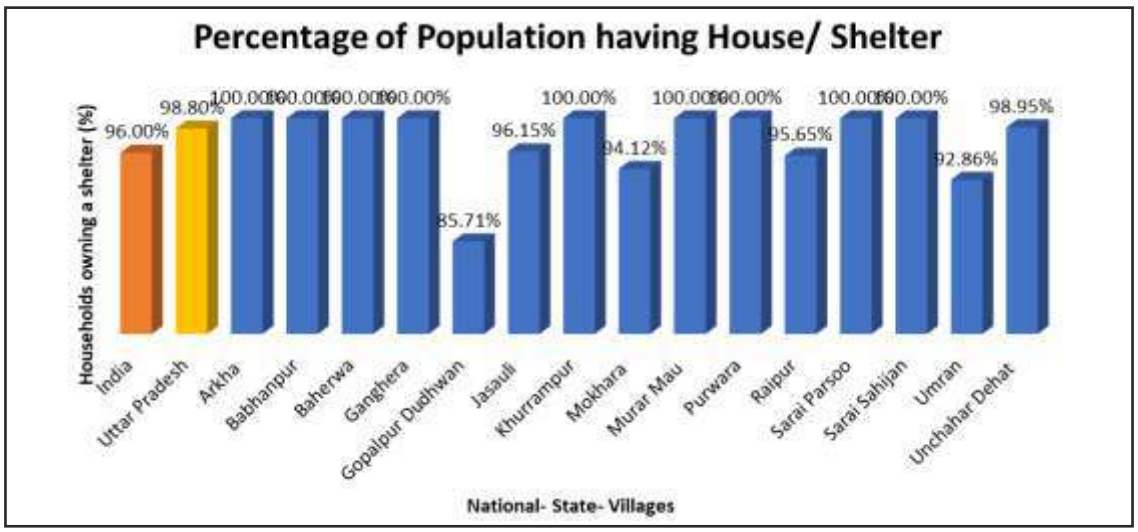
(Source: IICA survey, 2020)

[15]NSSO, 76th Round report on Drinking Water, Sanitation, Hygiene and Housing Condition'
[16]NSSO, 76th Round report on Drinking Water, Sanitation, Hygiene and Housing Condition'

Population having house/ shelter (owning a house)

In India (rural), about 96 per cent of the households in the rural areas had their own dwelling unit[17]. In Uttar Pradesh (rural), 98.8 per cent households were living in their own shelters. The IICA survey reveals that 96.30 per cent of the households in the study area lived in their own dwellings. The total population having a house or shelter is slightly higher than the national average and lower than the state average, as represented in Figure 22. 100 percent households in Arkha, Babhanpur, Ganghera Gulalganj, Khurrampur, Murrar Mau, Purwara, Sarai Parsoo and Sarai Sahijan, reported ownership of housing units. On the contrary, in Gopalpur Dudhwan (85.71%), Jasauli (96.15%), Mokhara (94.12%), Raipur (95.65%), Umran (92.86%), and Unchahar Dehat (98.95%) population reported having their own house.

Figure 22: *Percentage of Population having house/ shelter*



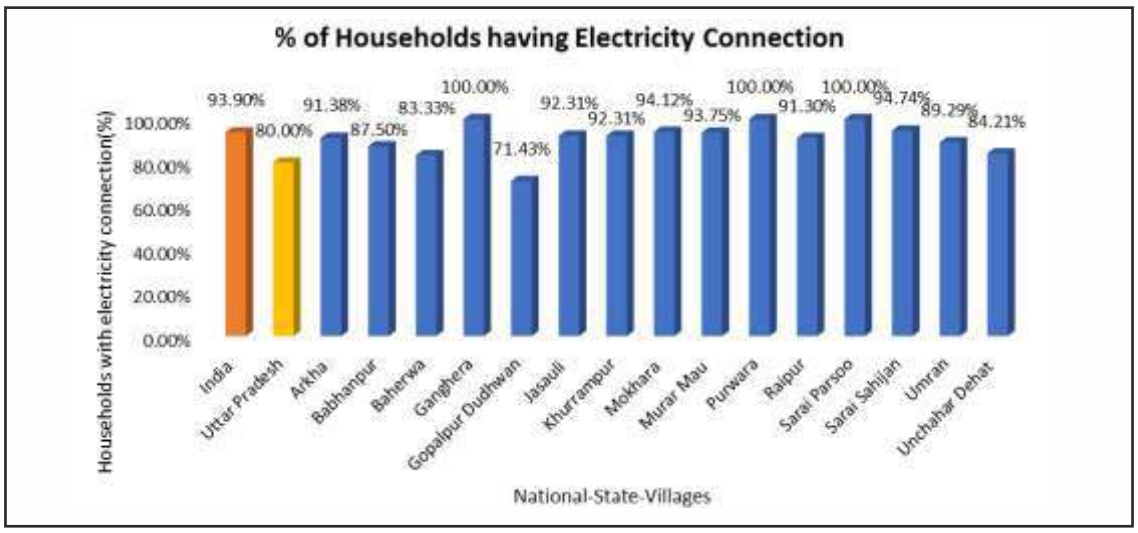
(Source: IICA survey, 2020)

[17]NSSO, 76th Round report on Drinking Water, Sanitation, Hygiene and Housing Condition'

Households having electricity connection

In terms of rural electrification in India, about 93.9 per cent of the households have electricity for domestic use while in Uttar Pradesh 80 per cent houses in rural areas have electricity connection[18]. Figure 23 reveals that all the villages have better average in terms of household electricity connections except Gopalpur Dudhwan (71.43%). The three villages (Ganghera Gulalganj, Purwara, Sarai Parsoo) out of 15 villages surveyed have 100 per cent households with electricity connection. Thus, all the villages in the study area are electrified. Moreover, survey found that 75 per cent villages get more than 6 hours of electricity supply while 25 per cent (Purwara, Raipur and Sarai Sahijan) get irregular supply of electricity. However, NTPC Unchahar does not have any direct intervention in providing electricity to the households in the survey villages.

Figure23: *Percentage of households having electricity connection*



(Source: IICA survey, 2020)

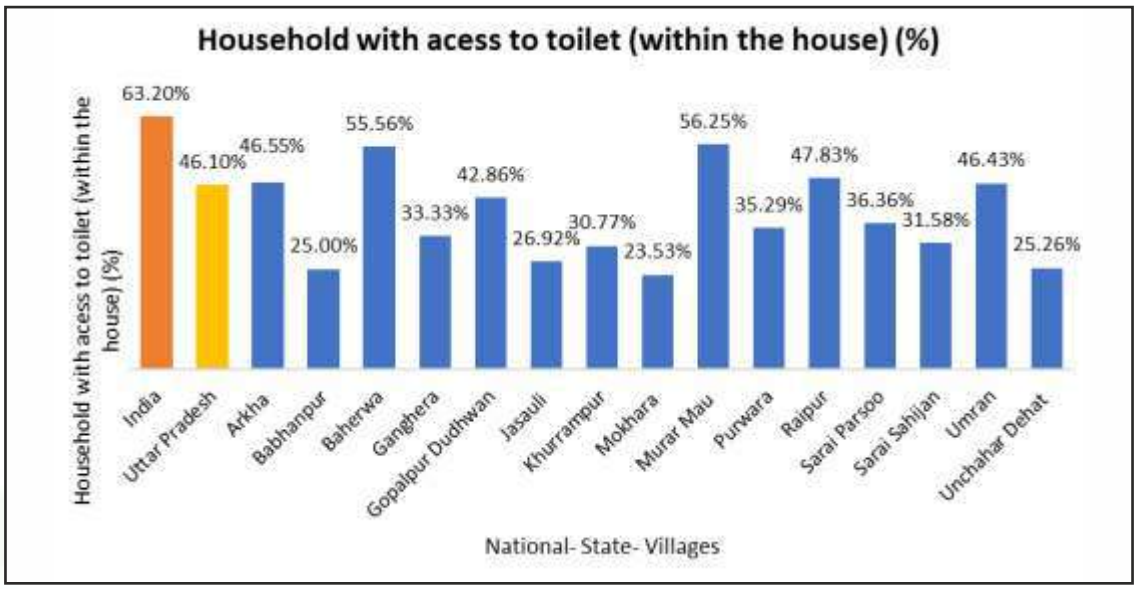
[18]NSSO, 76th Round report on Drinking Water, Sanitation, Hygiene and Housing Condition'

Population having toilet facilities

In India, about 71.3 per cent of the households in rural areas had access to latrine, while in Uttar Pradesh it is 52 per cent. In the study villages 51.90 per cent households have toilet facilities within the house, or shared between two or more than two houses and community toilets.

In terms of access to toilet within the household in India (rural) is 63.2 per cent and Uttar Pradesh (rural) is 46.1 per cent. Figure 24 shows that Baherwa (55.56%) and Murrar Mau (56.25%) are the top performers compared to other villages in the study area. Rest all other villages in the area have less than 50 percent households which have access to toilet (within the house). Babhanpur (25.00%), Mokhara (23.53%), and Unchahar Dehat (25.26%) have the least percentage of households having toilet within the house. The point to notice is that all the villages are poor performers when compared with the national average of access to toilet within the house.

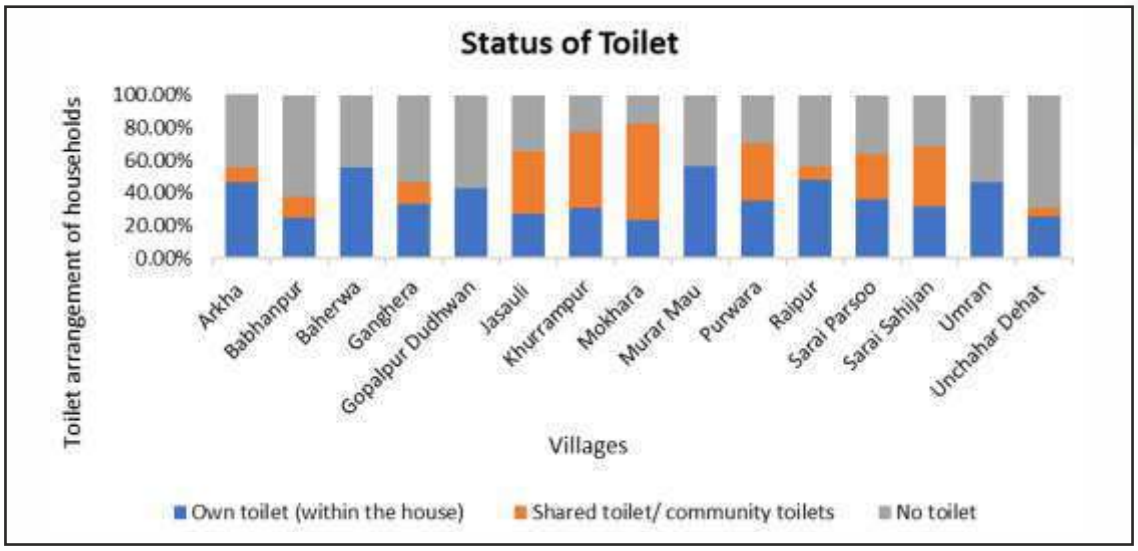
Figure24: *Percentage of Population having Toilet (within the house)*



(Source: IICA survey, 2020)

Figure 25 clarifies that people in these villages either have own toilets, shared toilets between two or more than two houses and community toilets. In India, among the households which had access to toilet, about 3.5 per cent of the household members in the rural areas do not use them. In the study area, 4.56 per cent people have toilets but they are not functional.

Figure25: *Status of Toilets (village wise)*



(Source: IICA survey, 2020)

In the study area, 32.41 per cent respondents shared that they practice open defecation. In Baherwa, Babhanpur, Unchahar Dehat, Gopalpur Dudhwan and Umran a majority of people either do not have access to toilet or don't have functional toilets owing to lack of water and thus they practice open defecation.

The next section focuses on objective description of social impacts arising out of the logical framework analysis.

AN OBJECTIVE DESCRIPTION OF SOCIAL IMPACTS

This section comprises the impact analysis of all the activities both in the short-term and long-term across thematic areas such as education, healthcare, vocational training, Water, sanitation, rural infrastructure, sports and assistance to the differently-abled persons.

Impact of education projects

The NTPC Unchahar, under its educational intervention, provided infrastructural support like dual desk cum bench furniture, constructed and raised boundary wall, pathways, cycle stand, earth filling work of ground. It installed a solar lighting system and constructed toilets for girls in a residential girls school. It also offered scholarships to meritorious students, conducted Girl Empowerment Mission and provided basic supplies like school bags, sweaters, water bottles etc. It also provided bicycles to girl students from low-income families.

Impact:

The most impactful educational initiative by NTPC Unchahar was Girl Empowerment Mission. Out of the total respondents who attended the Girl Empowerment Mission, 60 per cent agreed that it helped them improve academic performance. All the girls who participated in the GEM training were motivated to study well and expressed that they got great exposure during their one month programme, where they learned various skills and enjoyed their time being with girls from different backgrounds.

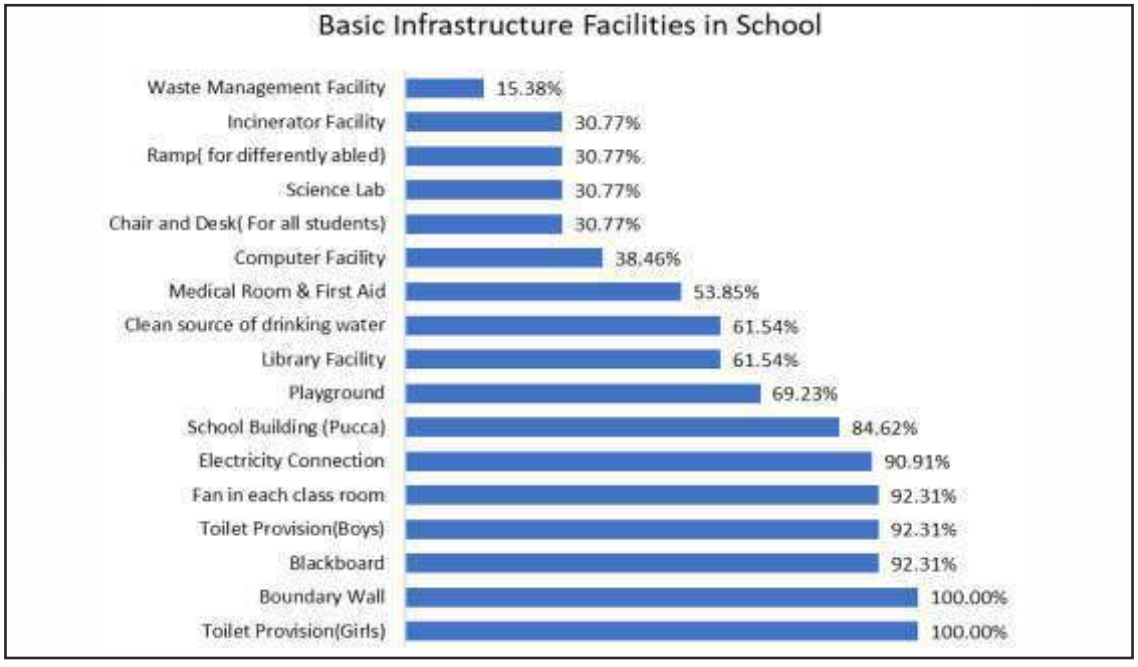
Another impactful intervention was the provision of bicycles to girl students belonging to low income households. The need of providing bicycle to girls was also highlighted through Needs Assessment Survey (2019). It is a crucial and relevant intervention since 47.50 per cent households responded schools being outside the village between 3-5 kms. The bicycles provided to girls of secondary classes have had a great impact in terms of motivation to continue the education. It was found that girls who were provided bicycles had 100 per cent attendance in school. This initiative further raised awareness towards education amongst the children in the villages as they are called "NTPC-Bicycle girls" in their neighbourhood.

> *"The parents of the girls who were provided bicycles were motivated to send their girls to schools. As schools were far and they were scared to send girls to school by foot earlier. The intervention has impacted the beneficiaries immensely. It should be scaled and replicated."*
>
> **-School Principal**

Through the IICA survey, it was observed that most interventions aim to improve the infrastructure in schools. As a result of NTPC Unchahar's educational interventions, there is a visible up-gradation of education institutions. Figure 26 presents the availability of infrastructures in the schools. All the surveyed schools had proper boundary wall and had separate toilets for girls. More than 90 per cent of schools had electricity connection, fan and blackboard in each classroom. More than 80 per cent of schools in the study area were running in the pucca building. More than 60 per cent had a playground (69.23%), library facility (61.54%) and clean source of drinking water (61.54%). However, just 30.77 percent schools had chair and desk for all the students. Thus, NTPC Unchahar support to educational institutes built an efficient, effective and quality education system in the survey area.

Image 1: Girls toilet in a school, built by NTPC Unchahar

Figure26: *Availability of Infrastructure in Schools*



(Source: IICA survey, 2020)

Additionally, it also provided timely and crucial support of Rs 2,000 to differently-abled and meritorious students for continuing education. Since most students leave school in the study area due to financial constraints and thus scholarship initiative resulted in the inclusion of at-risk children (girls, differently-abled and other vulnerable and marginalised groups).

Impact of healthcare projects

The NTPC Unchahar, under its healthcare intervention, conducted cataract surgeries, organised various health camps- eye, family planning, dental camps, cancer awareness, respiratory camps, general health awareness campaigns, awareness creation for mother and child health, distributed nutrition powder, provided first aid training and kits and a grant for running Mobile Medical Unit in the neighbouring villages.

Impact: The NTPC healthcare interventions, particularly MMU, are crucial and relevant because there is a lack of healthcare facilities in the area. When health facilities happen to be available, most villagers can neither pay the doctor nor pay for the medicines. Most villages in the study area do not have a Primary Health Centre, government dispensary and private clinic within the village. Rural populations are particularly disadvantaged as they often lack reliable means of transportation. Thus, the provision of MMU led to the use and awareness of healthcare services in the village, which resulted in improved health education and the adoption of better sanitation practices and hygiene behaviours. However, the level of awareness about the mobile medical unit is low, and people do not know about its time of visit in the villages. Thus, there is an immediate need to communicate about this intervention through various channels like local newspaper.

The initiative focused on improving the awareness about mother and child health impacts that 94.94 per cent of respondents reported institutional deliveries of their children in the survey area.

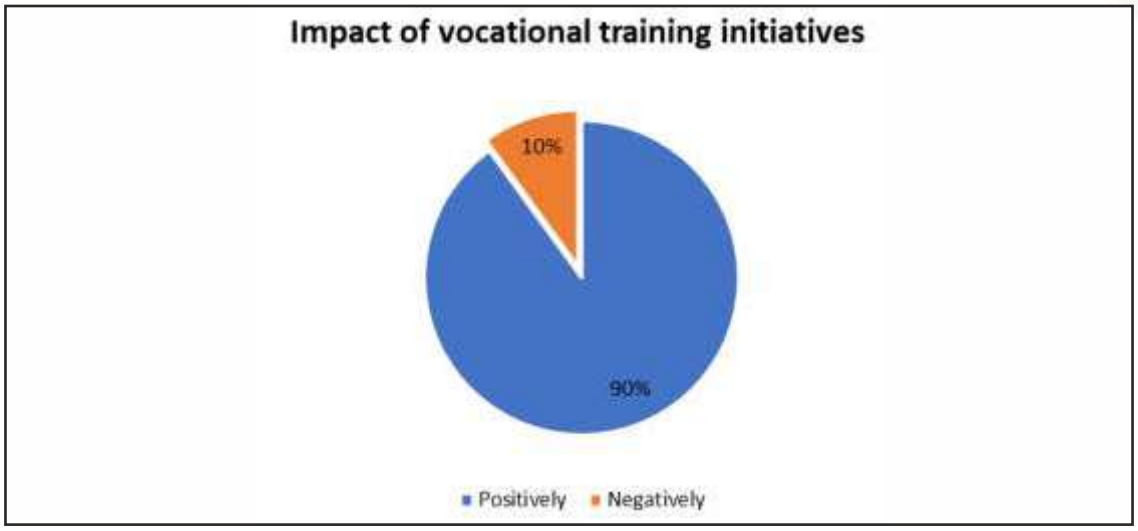
Regarding the health camps, the awareness has been low. During FGDs it was found that health camps are organised inside the NTPC Unchahar township and many villagers are not aware of them or cannot attend due to entry restrictions. However, those who attended health camps have rated slightly helpful to moderately helpful by 82 per cent of the beneficiaries. In addition, NTPC Unchahar has sponsored cataract surgery of three people leading to dignity, respect and safety of the elderly. Therefore, health interventions increased health coverage and positively impacted the health of the villagers.

Impact of vocational training projects

Under its vocational training intervention, NTPC Unchahar has trained 335 beneficiaries by providing vocational training programmes like auto repair, basic beauty and hair dressing, computer tally, computer training, home appliance training, tailoring training, and provided sewing machines to trainees from surrounding villages.

Impact: The interventions in vocational training were majorly focussed at creating self-employment. During the interactions with skill training beneficiaries, most of them agreed that the training led to enhancements in their skill level. Beneficiaries were satisfied with the trainer and the training conducted. Survey suggests that nearly 50 per cent of the beneficiaries got placement support post the training. Figure 26 shows the impact of the skill training programmes, 90 per cent of beneficiaries shared that it has impacted them positively. In comparison, 10 per cent reported it negatively as they felt it did not add any value.

Figure 27: *Impact of Vocational Training initiatives*



(Source: IICA Survey, 2020)

Thus, the training programme has positively impacted the lives of those who attended the vocational training conducted by NTPC Unchahar. As majority of them were able to restore their jobs post the training or were able to start their own work like beauty parlour and tailoring services at home. Some trainees of tailoring programme were also provided with sewing machines which brought significant change in their monthly income.

> *"The parents of the girls who were provided bicycles were motivated to send their girls to schools. As schools were far and they were scared to send girls to school by foot earlier. The intervention has impacted the beneficiaries immensely. It should be scaled and replicated."*
>
> **-School Principal**

Impact of water projects

Under water projects, NTPC Unchahar provided grant for installing the hand pumps and piped water supply in the neighbouring villages.

Impact: Provision of drinking water through handpumps and piped drinking water is a relevant intervention. The data suggest that the percentage of households with access to piped drinking water in the area is low. Hence handpumps are long term solutions.

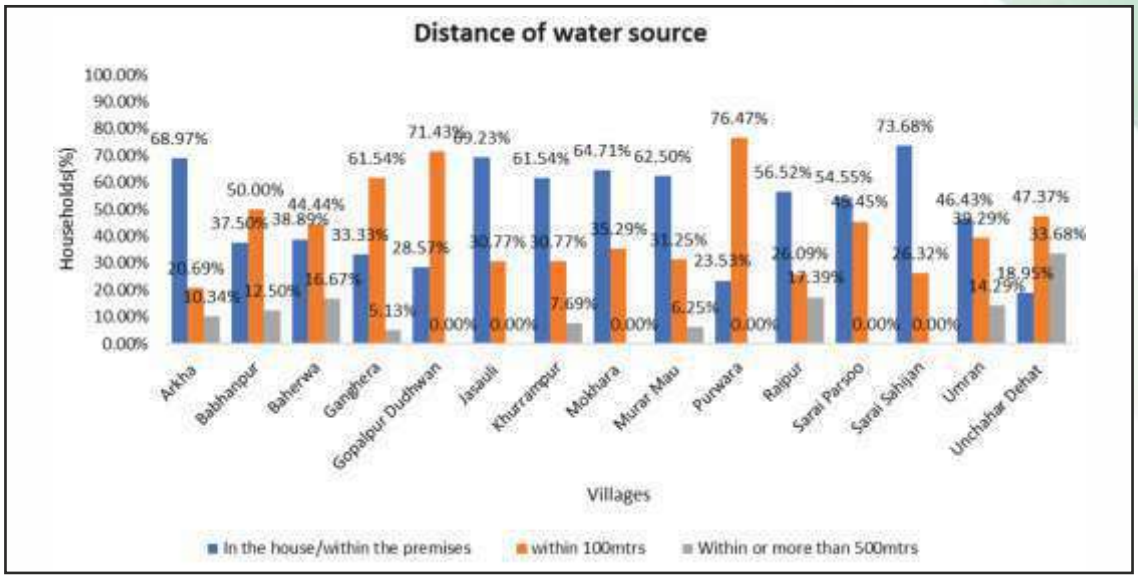
Image 2: Piped water supply

The interventions in water have resulted in the reduced distance the people travel for accessing water for household purpose. As observed from FGDs in the community, this has resulted in the availability of more quality time for economic activities for women, and they get an improved quantity of water, feel a reduced need for water storage methods.

Many women and girls expressed that they don't have to walk long to get water and, they get saved from various forms of sexual harassment. Therefore, the intervention in drinking water has resulted in an improvement in the overall quality of life.

Further, Figure 28 analyses the data from the survey and reveals that the modal distance to get the water is within 100 metres for Babhanpur, Ganghera, Gopalpur Dudhwan, Purwara and Unchahar Dehat. The majority of households in Arkha, Baherwa, Jasauli, Khurrampur, Mokhara, Murrar Mau, Raipur, Sarai Parsoo, Sarai Sahijan and Umran have water facility within the premise. The reduced distance to get water in these villages can be attributed to NTPC's handpump and piped water intervention.

Figure 28: *Distance of water source (village wise)*



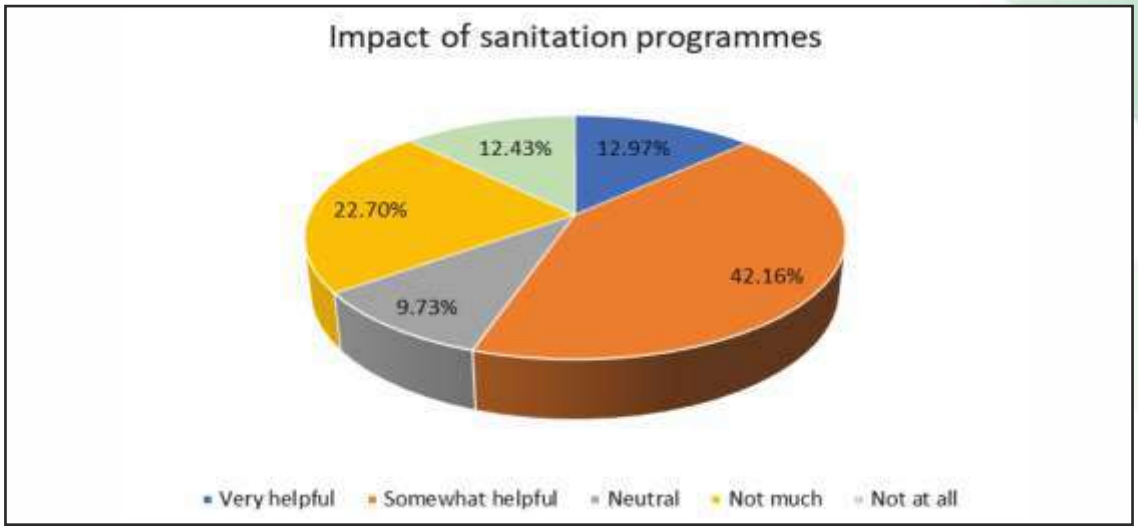
(Source: IICA survey, 2020)

Impact of sanitation projects

Under its sanitation intervention, NTPC Unchahar has provided a grant for cleaning and construction of drainages, built household and community toilets, undertook dustbin distribution drive in the villages and public spaces, gave financial assistance to district authority under Swachh Bharat Mission, conducted awareness drives on sanitation and open defecation free communities through Nukkad Natak.

Impact: The sanitation interventions aimed at behaviour change in the community regarding health and sanitation practices, increased awareness of hygiene and sanitation among the community members. The overall impact of sanitation programmes was found very helpful by 12.97 per cent of the population, 42.16 per cent rated them somewhat beneficial. 9.73 per cent population in the study villages had neutral views about sanitation interventions. On the contrary, the interventions were not found much helpful by 22.70 per cent and not at all helpful 12.43 per cent population in the survey area.

Figure 29: *Impact of sanitation programmes*



(Source: IICA survey, 2020)

All the interventions undertaken in sanitation are in alignment with the Swachh Bharat Mission of the Government of India.

Impact of rural infrastructure projects

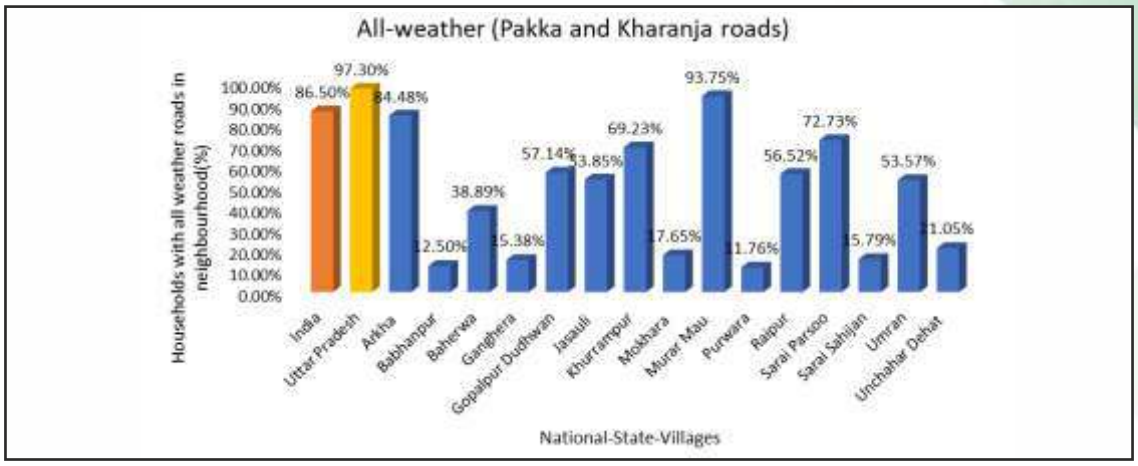
NTPC Unchahar has provided grant for construction of roads, installation of street lights and CCTV Camera, repair and maintenance of community spaces and construction of railway bridge as part of its rural infrastructure intervention.

Impact: The CSR interventions focussing on rural infrastructure development like construction and repair of village roads provided easy and quick access to nearby village areas and public spaces. This improved connectivity within and outside of village.

Image 3: Street light in a village

Figure 30 shows the status of all-weather connectivity in the study area. Majority of villages in the area do not have access to pakka and Kharanja all-weather roads. Road connectivity is good in Murrar Mau, Sarai parsoo and Khurrampur. Baherwa, Gopalpur Dudhwan, Jasauli, Raipur and Umran have moderate coverage of all-weather roads connectivity. The coverage of roads in these villages can be owed to the road construction intervention by NTPC Unchahar. The condition of roads in Babhanpur, Ganghera Gulalganj, Mokhara, Purwara, Sarai Sahijan and Unchahar Dehat is poor, needs attention since it impacts people's overall quality of life in these villages.

Figure 30: *Percentage of Respondents with Access to All-weather Roads*



(Source: IICA Survey, 2020)

Street lights were demanded during VDAC meeting with NTPC Unchahar officials. Therefore, solar street lights were provided based on the needs of the community. After sunset, the village roads were engulfed in pitch darkness, exposing inhabitants to various nuisances like snake bites, insect bites, theft etc.

During FGDs, the community members expressed that there was a feeling of insecurity among the villages while going out during the night before installing of solar lights. In absence of electricity in the evening hours (most useful hours for villagers), the households were completely dependent on kerosene. Many households being very poor could not afford to buy kerosene and they prefer to stay in dark instead. Illumination of streets at night through solar powered street lights has helped in reduced insecurity and assaults on women.

Impact of project to promote games and sports

To improve the sports ecosystem in the study villages, NTPC Unchahar has provided sports equipment like sports kits and provided grant to District Magistrate for open gym.

Impact: Activities relating to sports are essential components of human resource development. It helps promote good health, comradeship, and a spirit of friendly competition, which has a positive impact on personality development. To promote games and sports in the neighbouring villages, NTPC Unchahar has provided sports kits to students. The study area's significant challenges are the lack of sports infrastructure and family support to continue sports as a career. Thus, such initiatives have encouraged sports activities and improved community interaction in the area. However, regarding the grant provided to District Magistrate for Open Gym, there is not much information available, and the field survey team could not find the open gym. The Needs Assessments Survey conducted in 2019 has also highlighted the lack of availability of playgrounds in the area, hence the intervention is relevant.

Impact of projects for the differently-abled

To empower the persons with disability, NTPC Unchahar provided a grant for procuring aids and appliances like tricycles, hearing aids. It also organised rehabilitation camp thereby impacted the lives of 247 beneficiaries with its interventions.

Impact: Persons with disability need special attention. There are 62,230 persons with disability in Rae Bareli, out of which 7478 are hearing impaired, and 12786 have Locomotor disability[19]. Out of the total respondents interviewed in the study area, most of them had a locomotor disability. It was found that the general issues of concern among them are the lack of awareness of the government schemes and the inability to procure appropriate equipment.

The NTPC Unchahar's initiative of distributing assistive aids like hearing aids, rollator, tricycle and prosthetic leg was relevant. The intervention was aimed at mainstreaming physically challenged persons by providing them with aids and appliances. Differently-abled persons and their caretakers shared during focus group discussions that the provision of equipment increased their social functioning/capabilities, increased their access and mobility, and brought a change in social attitude towards them to a certain extent. During the survey, beneficiaries also expressed concerns that the quality of distributed tricycles was not good as it did not last long and the belt for the artificial limb is not easily available in the area. Thus, NTPC Unchahar should provide good quality assistive aids and also train the persons with disability and their caretakers regarding their use, at the time of distribution.

[19]Census of India, 2011

REQUIREMENT OF MODIFICATIONS IN THE EXISTING CSR-CD ACTIVITIES IN ORDER TO TAKE CARE OF THE CHANGING NEEDS OF THE COMMUNITIES

The previous section, Objective 4 analysed the impact of CSR activities, and Objective 5 analyses the sustainability of the activities undertaken and suggests the scope for improvement.

Sustainable development and CSR are moving targets that cannot be fully "achieved" by one-time activities and decisions. NTPC should approach CSR as a process of continual improvement, being constantly alert to new issues and considerations. All the activities in following tables analyse the sustainability and scope for improvement for each activity (Annexure 3).

Making education projects sustainable

The Objective 4 outlined the impact of educational interventions on the project affected villages. Table 5 analyses the sustainability aspect of various educational activities undertaken by NTPC Unchahar.

Table 4: *Sustainability Aspect of the Activities on Education*

S. No.	Activity	Mode of sustainability after completion
1	Furniture (Dual desk-cum-bench), Construction of Boundary wall & pathway, Construction of Cycle Stand, Earth filling in ground, Toilet Construction, Raising of Boundary wall Brick soling work, Solar Lighting System	Before providing such assets NTPC Unchahar must ensure that the responsibility for their maintenance and upkeep lies with the school administration. The responsibility of its functionality must lie with the school and should be taken as a consent before undertaking the installation.
2	Distribution of Pullover & woolen cap, School bag kit of surrounding village schools	Such basic supplies should be given once in 2-3 years.
3	Education Scholarship & prize to Meritorious Students	Scholarships should also be given on the need-based criteria apart from merit criteria.
4	Inclusive Education for PCP Students of surrounding village.	
5	Distribution of Bi-cycle to the economically weaker and disadvantaged sections of girl students	The selection of girls who are provided bicycle should be based on two criteria one is that the beneficiaries must belong to lower income families and other is the distance of home from school.

Scope for improvement: The scope for improvement in education is as follows:

- While distributing basic educational supplies, it must be ensured that these are given in the interval of 2-3 years so that continuity and quality can be maintained.
- While speaking about the benefits of scholarship initiatives of NTPC Unchahar, school officials suggested that scholarships are an important initiative that helps students continue their education, their coverage should be increased to include need-based beneficiaries apart from the meritorious students.
- Personality/ skill development session should be conducted every six months. More such special workshops for children should be organised at regular intervals.
- The coverage of bicycle support should be extended to more girl students after consultation with school authorities as the distance of school is one of the main reasons for children drop out in the area.
- Career counselling must be done once in six months so that students are encouraged to continue the education.
- On asking about suggestions to improve the quality of education, school officials informed that schools must be equipped with smart classes so that students are motivated to come to school. Some schools expressed the need for an RO water system. Once such assets are created, there should be an asset audit every three years to evaluate their conditions.

Making healthcare projects sustainable

The Objective 4 outlined the impact of healthcare facilities provided by NTPC Unchahar on the community. Table 6 analyses the aspect of sustainability against each activity.

Table 5: *Sustainability Aspect of the Activities on Healthcare*

S.No	Activity	Sustainability/ Mode of sustainability after completion
1	Organisation of various health Camps (eye, family planning, respiratory camp, dental, cancer awareness, cataract surgery, general health awareness campaigns)	Local village development advisory committees should also be involved along with ASHA workers and ANMs for creating awareness about the health camps. Focus must also be put on follow-up treatments after diagnosis and corrective surgery. Health camps must be conducted at community spaces like community centre or school during holidays. Database of health camps should also be maintained to be used in referral and diagnosis during future camps.
2	Mobile Medical Unit	NTPC Unchahar must maintain a database of patients visiting MMU to assess the health of the public and patterns of illness and injury in the area.
3	Awareness creation for mother & child health and adolescence health, Awareness about malnutrition	Involvement of ASHA's and ANMs and organising such awareness sessions during Village Health and Nutrition Day will bring better results every three months.

Scope for improvement:

- Since the level of awareness about health camps in the community is relatively low (40%), efforts must be made to make people aware about conducting such activities well in advance through newspapers, pamphlets and audio announcements. Focus group discussions revealed that health camps are useful for the beneficiaries, and they suggested that NTPC Unchahar increases the frequency of such camps and they should be organised at a community place which is easily accessible for the people of the area.
- Special camps for assessing women and adolescent girl's health should also be organised as many women from the villages reported to have Leukorrhea and expressed the need for an ambulance in the local health facility for pregnant ladies.
- It is suggested that MMU run by NTPC Unchahar must be enabled with GPS technology so that their movement can be tracked for better effectiveness and real time monitoring of the intervention on daily basis.
- Moreover, NTPC Unchahar must maintain a database of patients who attend healthcare services to assess the health of the public and patterns of illness and injury in the area. It will further provide an important way of monitoring and improving the value of healthcare services it provides.

Making Vocational training projects sustainable

Table 6: *Sustainability Aspect of the Activities on Vocational training*

S.N	Activity	Sustainability/ Mode of sustainability after completion
1	Organisation of various vocational training programmes	1. Local MSMEs should be consulted or surveyed in determining the skills that are required as a workforce in the area. 2. Trained women should be encouraged to form SHGs. 3. Trained youths should be provided support to connect with government programmes that provide support to young entrepreneurs.

Scope for improvement: NTPC Unchahar conducted various vocational training programmes in to improve the livelihood of youth and women in the area.

- The training programmes must be in accordance with Market driven demand, such industry response driven courses enhance the opportunities for employment and self-employment. To further improve the skilling programmes NTPC Unchahar should ensure that local MSMEs should be consulted or surveyed in determining the skills that are required as a workforce in the area.
- The trainees of vocational programme who neither got placement support nor could start their own employment should either be provided with seed capital to start their self-employment or should be connected with government schemes like Prime Minister Employment Generation Programme (PMEGP), Credit Guarantee Scheme for Micro & Small Enterprises (CGTMSE), MUDRA and other schemes that provide similar support.
- NTPC Unchahar should adopt Cluster-based training approach through government or community owned infrastructures to increase the access to vocational training. Soft skills training component must be a part of each vocational training programme.
- Programmes aimed at women beneficiaries should be created with market linkages and industry tie-ups for creating self-employment opportunities. NTPC Unchahar should also ensure to connect the youth and women with schemes like Procurement and Marketing Support Schemes[20] that provide support to small businesses. Women who are provided trainings should be mobilised to form SHGs so that they can together generate livelihood.

Table 7: *Sustainability Aspect of the Activities on Drinking Water*

S.N	Activity	Sustainability/ Mode of sustainability after completion
1	Installation of Hand Pump	Post implementation, no further investment is required from any agency for continued usage of the facility. However, at the time of installation an orientation session with community can be organised to increase the outreach of community development efforts by NTPC.
2	Installation of RO water pump	A maintenance committee may be formed before installation that will be responsible to look after their functionality.
3	Piped water supply	Providing piped water supply is the most efficient and a long term solution. However, many a times pipes get blocked due to garbage etc hence it must be ensured that they are leakproof.

[20]https://my.msme.gov.in/mymsme/reg/COM_Matu.aspx

Scope for improvement: To provide safe and potable drinking water in adequate quantity and within a minimum distance to all at all times and to bring about an improvement in the general quality of life in the vicinity villages, NTPC Unchahar should design a focussed intervention in Bhabhanpur, Ganghera Gulalganj, Gopalpur Dudhwan, Purwara and Unchahar Dehat where people have to walk nearly 100 metres to get water for daily use.

- To increase the piped water coverage in the area, NTPC Unchahar should expedite the implementation of piped water project as per its CSR policy. To make a measurable impact, the monitoring and evaluation of the project should be done annually. NTPC Unchahar can also support 'Har Ghar Jal Scheme' of Government of India by providing drinking water supply through pipe line to each household through elevated storage reservoirs in villages. NTPC Unchahar should sign an MoU with the village panchayat regarding the implementation and maintenance of the plant for a period of five years. Once this period is over, NTPC can either hand over the plant to the community if they want to maintain it themselves or renew the agreement for another five years.
- Second, Solar water pumps are long term solutions, since the electricity is a cause of concern in some villages, that can be installed to store water in overhead tanks in villages where there is scarcity of water. Since the Unchahar and Rohania block's water resources availability is adequate, it would be safe to install the solar water pumps to reach to larger population with written consent from Gram Panchayat for its effective usage and maintenance.
- Third, as observed, installation of hand pumps has reduced the distance to fetch water in the villages in Unchahar and Rohania block. NTPC Unchahar should ensure the regular (every 3 years) check-up of the installed handpumps to impact the beneficiaries positively.
- Fourth, nearly 55 per cent of the respondents feel that there is a need for revitalization and conservation of water resources in the survey area as they are polluted, NTPC Unchahar may undertake their rejuvenation while ensuring the participation of the local community particularly women and the youth.

Making sanitation projects sustainable

As outlined in objective 4, sanitation intervention helps keep the village neat and clean and prevents mosquito breeding. Table 8 explains the mode to ensure the sustainability of these interventions.

Table 8: *Sustainability Aspect of the Activities on Sanitation*

S.No.	Activity	Sustainability/ Mode of sustainability after completion
1	Construction, cleaning and repairing of Drains	Develop a system of community-led management of constructed and modified drains. The involvement of sanitation workers and the village development committee will make such activities more sustainable. Sensitisation of community to take care of them as their own property.
2	Construction of household toilets	While constructing toilets it must be ensured that there is availability of water in the vicinity.
3	Construction of community toilets	Before undertaking construction of community toilets, a consent must be obtained from local authority regarding its maintenance and cleanliness.
4	Organisation of Nukkad Natak	Involvement of school children in conducting Nukkad Natak will have a long term impact in the community. Such sessions around various issues affecting health and sanitation should be organised once in six months.
5	Distribution of dustbins	Apart from distribution, a behavioural change has to be brought about waste management. The efforts must also focus on creating frameworks for community-led initiatives by roping in waste workers, scrap dealers and the local administration.

Scope for improvement:

- While conducting sanitation intervention, the focus should be on behaviour change programmes that either seek to create a demand for the construction of individual toilets or influence attitudes to enhance the usage of toilets. Under Swachh Bharat Mission, the focus is on collective behaviour change in rural communities through massive campaigning, and the NTPC Unchahar can facilitate similar campaigns.
- To make the villages open defecation free, NTPC Unchahar must undertake initiatives that increase the population's access to toilets. While building household toilets NTPC Unchahar must ensure that there is availability of water source nearby the toilets as our survey suggest 4.56 per cent toilets are not functional because of the unavailability of water.

- NTPC Unchahar can also explore and provide ecological sanitation toilets based on the liquid separation systems, an innovative approach to the promotion of sanitation and hygiene. However, this would require a strong foundation of behaviour change among local communities. Such kind of toilets are a great way of promoting good sanitation behaviour in areas that face water crisis.
- Further, the survey reveals that 64.81 per cent of respondents reported that either there are no drains in villages or they are open. This need was also highlighted by Needs Assessment Survey (2019). Apart from construction and modifications, stress must be placed on cleaning drainages. NTPC Unchahar can conduct drainage cleaning drives once a month in the rainy season and once in three months otherwise.
- NTPC Unchahar can also conduct initiative focussing on segregation and waste management in collaboration with State Pollution Control Board, as the survey reports a lack of awareness regarding this pertinent issue. While doing so, NTPC Unchahar should engage and conduct capacity building session of sanitation workers as they are major stakeholders in the sanitation intervention.
- Finally, NTPC Unchahar should ensure an integrated solution where behavioural change programmes are implemented along with other complementary interventions such as the construction and maintenance of toilets.

Making rural infrastructure projects sustainable

The rural infrastructure development program of NTPC Unchahar are divided into three major categories: construction of community structures, construction, renovation and maintenance of roads, and third is the installation of street lights. Table 9 suggests the mode of ensuring sustainability of the projects.

Table 9: *Sustainability Aspect of the Activities on Rural Infrastructure*

S.No.	Activity	Sustainability
1	Construction of roads	Villages that do not have access to all-weather roads, NTPC should work with VDAC to prioritise road construction in those villages. People from local community must be involved in the construction of such projects.
2	Installation of street lights	Before installing street lights, NTPC Unchahar must ensure their repair and maintenance. Their functionality should be checked once a year.
3	Repair and maintenance of community assets	Before undertaking new asset creation, NTPC must ensure their repair and maintenance. Their condition should be checked once a year.

Scope for improvement:

- Road construction projects are required in Purwara, Mokhara and Ganghera Gulalganj as observed during data collection activity. The survey suggests that only 42.78 per cent respondents across the study villages had pukka and kharanja road in their neighbourhood. Before undertaking the construction of community assets, NTPC Unchahar must ensure community and panchayat engagement.
- Installation of solar street lights are an effective and relevant intervention that have its long term impact on the community. However, sometimes they are not found functional, the reason for their non-functionality is the lack of ownership in the community. Thus, NTPC Unchahar, must explore the Public-Private-Community Partnership that has proved a model to replicate in rural areas.
- Moreover, It is evident from the survey that the domestic electricity connection challenge may have been met, but the electricity supply challenge remains. To improve the quality of life and to aid economic activities, it is essential to ensure affordable, reliable electricity supply. The literature review from various agencies like FICCI and CII reveals that CSR programmes in clean energy are reported under community and rural infrastructure. Companies in Power, and Oil and Gas sectors are more likely to support clean energy projects. NTPC Unchahar can support innovations to promote renewable energy and other technologies for the rural India.
- For long term, a supply-focussed rural electrification drive is required to overcome the problem. As part of its CSR activity, NTPC Unchahar can establish renewable solar micro grids providing electricity to households in villages for lighting and appliances.

This will also ensure lowering elective electricity costs and carbon emissions, thus providing clean energy and improving quality of life of people in the villages. Additionally, it will amplify the Government of India's ongoing campaign to provide electricity to rural areas. This will result in increased awareness about renewable sources of energy and will improve their overall quality of life.

Making sports projects sustainable

As objective 4 outlined the impact of sports activity, Table 11 presents the sustainability of CSR activities conducted to promote sports and games in the area.

Table 10: *Sustainability Aspect of the Activities on Sports*

S.No.	Activity	Sustainability
1	Financial assistance to District Magistrate for open gym equipment	NTPC Unchahar should try and build the sports infrastructure on its own, based on the assessed needs of the area, to effectively monitor and evaluate the progress of the intervention.
2	Distribution of sports kits	Distribution of sports kits are an important intervention. However, the stress must be placed on building sports infrastructure in the villages. NTPC Unchahar should organise talent scouting programmes and support the young talent for the district and state level events.

Scope for improvement: Sports are essential for the development of children and youth. It can play a transformative role in achieving value for NTPC Unchahar and its neighboring communities.

- IICA survey suggest that a majority of people in the study villages play Cricket. As a matter of fact, most of the youngsters in these rural areas lack a platform to showcase their skills and grow in their respective disciplines. Through the organisation of sports leagues NTPC Unchahar can provide them with a platform, the efforts should be towards building rural sports ecosystem. Moreover, NTPC Unchahar can provide community playgrounds, which are great options to engage community members.
- Additionally, IICA survey suggests that only 30.77 per cent of schools in the area do not have a playground or sports facility. NTPC Unchahar can build playgrounds or sports facility as they provide children the opportunity to practice and improve their key social, emotional, cognitive and physical skills.
- Moreover, community members expressed need to have better sports infrastructure, training and sports scholarships to potential talents from the village. NTPC Unchahar can search, identify, and groom sportspersons through National Sports Academy[21] set up by Sports Authority of India (SAI). NTPC Unchahar can also facilitate the training of the local sportspersons at Guru Gobind Singh Sports College, Lucknow which is not too far from the village.

[21] https://sportsauthorityofindia.nic.in/showfile.asp?link_temp_id=2446

Making projects for differently-abled sustainable

As outlined in Section 4, that the disability activities have been beneficial for its beneficiaries, Table 10 indicates the mode of sustainability of such activities.

Table 11: *Sustainability Aspect of the Activities on differently-abled*

S.No.	Activity	Sustainability
1	Provision of aids and appliances	The quality of aids and appliances should be good and these should be checked every 3-4 years for their functional status. Identification of PwDs through District Disability Rehabilitation Centre.
2	Disability Rehabilitation Camp	Such camps should be organised once a year and database of people who attend the camps must be maintained for future reference.

Scope for improvement: The beneficiaries of initiatives in differently-abled programme and their caretakers expressed that they have been benefited through assistive devices.

- As the next steps, differently-abled should also be helped with livelihood creation programmes, ensuring that Persons with Disabilities have the opportunity for a better future and dignified life.
- 70.3 per cent schools in the area have do not have ramp facilities for differently-abled children, NTPC Unchahar can build ramps in schools to allow barrier-free access to education. It can further identify children with special needs who have special talent at school level and facilitate and promote their skills.
- Additionally, NTPC Unchahar can provide smart and interactive TVs to be installed in primary and nursery classes, while at secondary level, integrated digital devices or Braille friendly mobiles and laptops can be installed to promote inclusive education and create a long term impact in the life of differently-abled.
- Taking cue from 2021 Disability day theme 'NOT ALL DISABILITIES ARE VISIBLE', NTPC can spread awareness about disabilities that are not immediately apparent, such as mental illness, sight or hearing impairments, brain injuries, neurological disorders, learning disability and cognitive dysfunctions as part of its CSR intervention.

SATISFACTION INDEX

In order to understand the satisfaction of the community with regard to CSR-CD activities undertaken by NTPC Unchahar a satisfaction index was prepared.

BOX 1

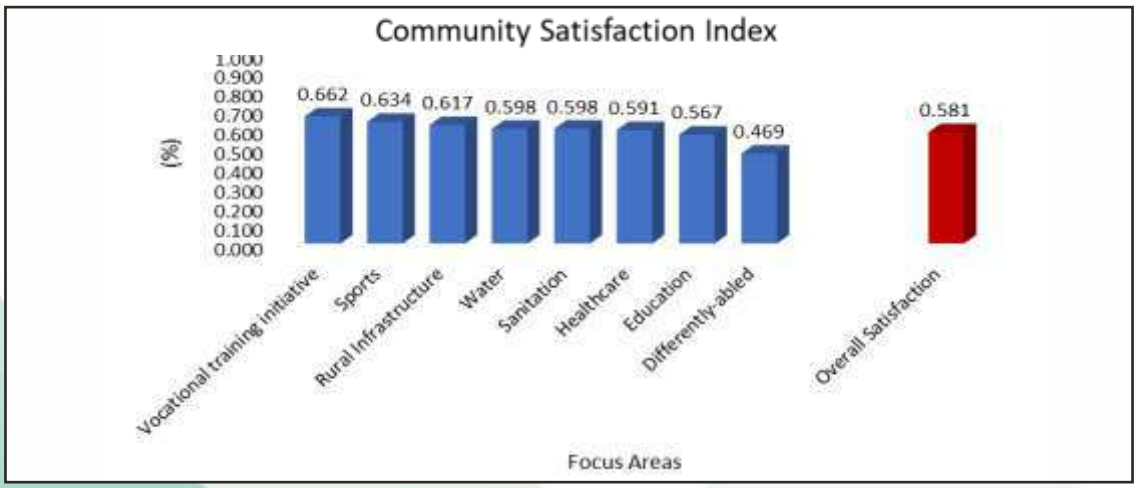
Steps for Calculation of Satisfaction Index

Calculation of Satisfaction Index

- Level of satisfaction would be measured in 5-point Likert scale
- Satisfaction level under 5-point Likert scale – Highly satisfied(5), Satisfied(4), Indifferent(3), Dissatisfied(2), Extremely dissatisfied(1)
- Mark satisfaction level according to the above mentioned scale for each question under every Thematic Area (TA)
- Calculate Xi for every respondent based on Likert scale marking
- Calculate possible X maximum value for every respondent based on Likert scale marking
- Calculate ratio of Xi to X maximum value
- Satisfaction Index for each thematic area would be summation of (Xi to X maximum) for all outcome under the particular thematic area
- After calculation of satisfaction index of each TA, Overall Satisfaction Index SI (O) would be weighted summation of all SI (TA) under the study with equal weights to each thematic area.

The value of the satisfaction index ranges between 0 and 1. 0 represents complete dissatisfaction, and 1 means highest level of satisfaction. Figure 30 shows that sports (0.63), rural infrastructure (0.61), water and sanitation (0.59), healthcare (0.59), education (0.56), and differently abled (0.46) programmes are rated on the level of satisfaction.

Figure 31: *Community Satisfaction Index*



(Source: IICA Survey 2020)

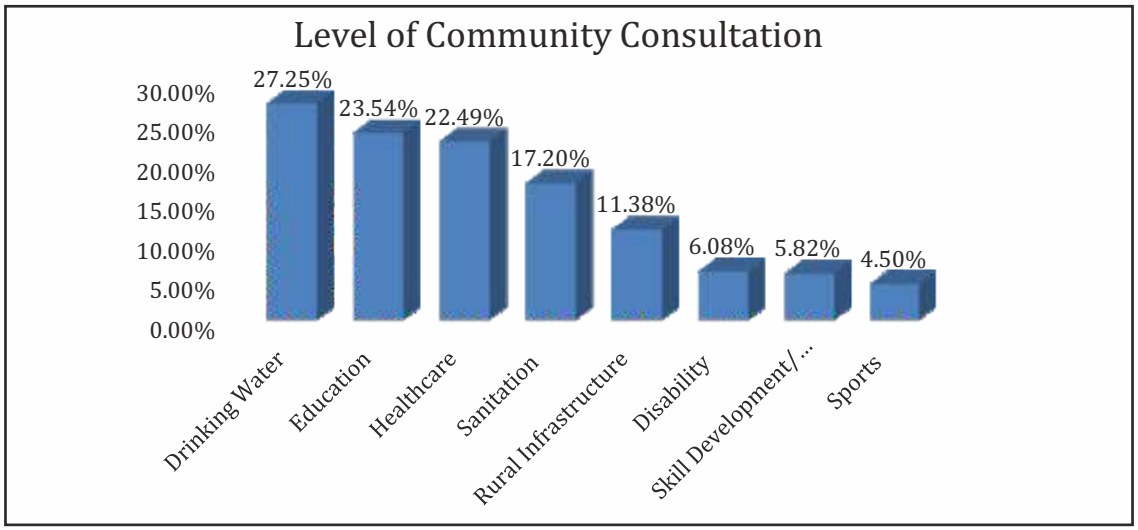
The mean of the satisfaction index is 0.581, whereas the standard deviation is 0.059. Only satisfaction with education is beyond one standard deviation. As no activity has satisfaction below one standard deviation, it may be inferred that satisfaction across different activities is neither too high nor too low. The reason for a higher level of satisfaction in sports, rural infra and water and sanitation projects is the direct benefits in the form of sports kits, visibility of roads and street lights, hand pumps and household toilets that were directly accrued to beneficiaries. The healthcare and education initiatives have not been rated very high on level of satisfaction by its beneficiaries, since the awareness about health camps and educational programmes is not very high. It was further observed that there was no stakeholder consultation was done in the thematic areas where satisfaction is low. NTPC Unchahar needs to work on stakeholder engagement, as suggested in the next section.

ASSESSMENT OF THE LEVEL OF COMMUNITY PARTICIPATION AND CONSULTATION THROUGH CSR-CD ACTIVITIES

This section evaluates the nature of community participation and consultation regarding CSR-CD projects. To do so, household sample surveys and focus group discussions with community members were carried out, and the team also interacted with some selected direct and indirect beneficiaries of various CSR projects.

Figure 32 details the level of consultation that NTPC Unchahar conducted with various stakeholders.

Figure 32: *Level of Community Consultation*



(Source: IICA survey, 2020)

As Figure 32 shows, many respondents felt that their needs were met with regards to the overall development of the community. The NTPC consulted the community, particularly in areas of education (23.54%), healthcare (22.49%), drinking water (27.25%), sanitation (17.20%), and rural infrastructure development (11.38%). Whereas in initiatives for differently-abled (6.08%), vocational training (5.82%) and promotion of sports (4.50%), the consultation and engagement level has been very low. The low level of consultation and engagement also affects the degree of beneficiary satisfaction with the activities in these thematic areas.

There are various reasons for the low level of engagement in projects connected to differently-abled, skill training and sports programmes:

1. Due to 'one-time' activities like provision of aids and appliances and sports kits, distribution activities are undertaken in CSR.

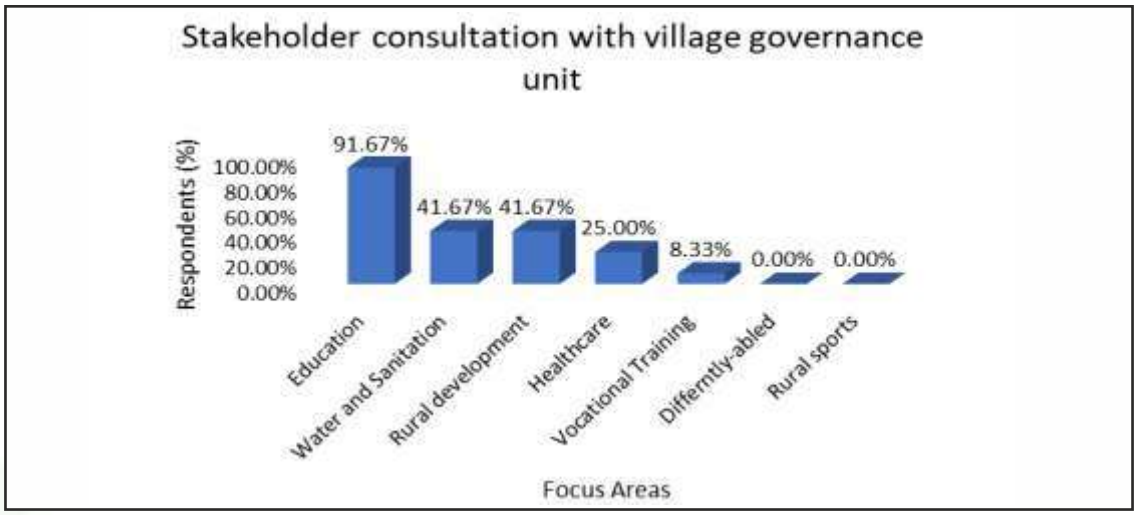
2. The amunt of budget disbursed in education, healthcare, drinking water, sanitation and rural infrastructure is high compared to initiatives for differently-abled, vocational training and sports, as stated in objective one.
3. Initiatives for differently-abled, vocational training and sports are not as highly ranked vis-a-vis initiatives in healthcare and education in NTPC's focus areas as observed from NTPC policy.

Recommendation: Stakeholder engagement is required to ensure sustainability and is a critical tool that provides a comprehensive approach in carrying out responsible business. Further, building stakeholder interlinkages between stakeholders helps in increasing transparency and accountability. The interventions should focus on regular engagements between the stakeholders where problems are raised, addressed, and solutions are talked about collectively. As pointed out in objective 6, one-off events such as sports kit distribution, appliances distribution, sweet distribution, etc., do not lead to long term meaningful impacts. NTPC should focus on designing a CSR activity more efficiently and gives better results both in terms of output and outcome, and gives ample scope to exploit the provision for their benefits. The next chapter delves deeper into providing an insight into the nature of communication and consultation between various stakeholders.

EVALUATING THE NATURE OF COMMUNICATION AND CONSULTATION BETWEEN THE STAKEHOLDERS FOR THE VARIOUS CSR-CD PROJECTS

To evaluate the nature of communication and consultation between various stakeholders, IICA followed a step-wise process. The first meeting was held with NTPC officials, and then the interactions with local governance units like Gram Pradhans was held. After that, the key informants like school principals, teachers, health workers and Anganwadi workers were contacted for the information regarding the project. Theme-based structured and unstructured interviews were carried out with each stakeholder. This process helped to get a clear and detailed picture of the perceptions regarding CSR-CD interventions. The discussion with health workers/ Anganwadi workers/ school officials revolved around service delivery processes and the challenges faced at each stage. Figure 33 demonstrates the level of consultation with the village-level governance unit regarding every development project.

Figure 33: *Stakeholder Consultation with Village-level Governance Unit*



(Source: IICA survey, 2020)

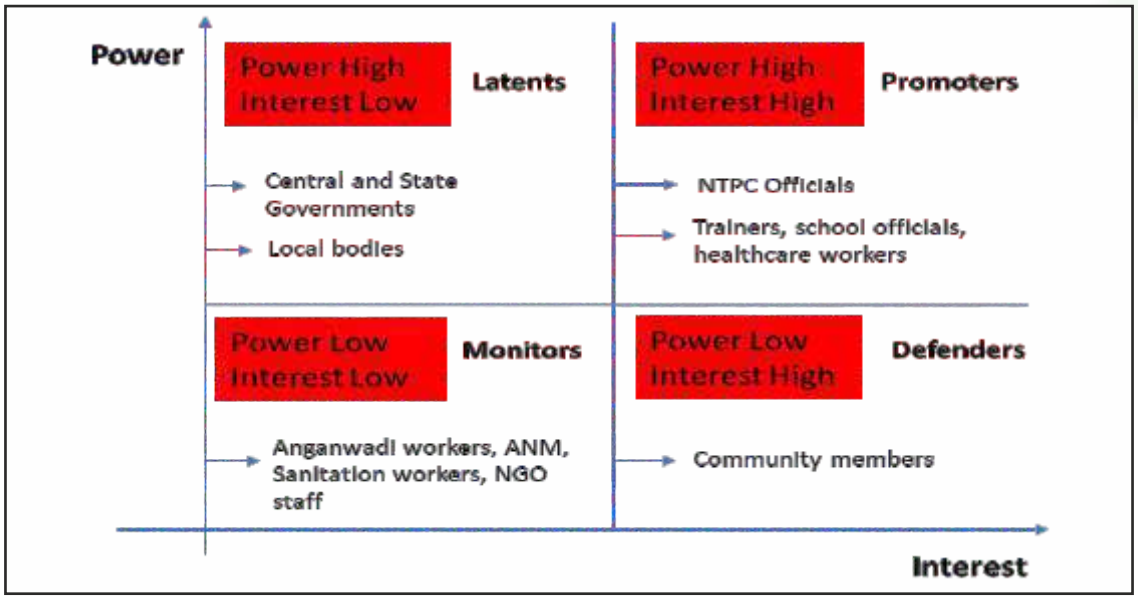
During conversation with Gram Pradhans, it was noted that the consultation with Panchayat members was high in the case of education intervention. A medium level of engagement was observed in drinking water, sanitation and rural development/ infrastructure activities. There was low level of consultation with regards to healthcare activities. And, there was no consultation regarding the projects in differently-abled interventions, sports and vocational programmes.

School officials were also interviewed to understand the challenges and effectiveness of educational interventions undertaken by NTPC, and the team observed that school

officials were apprised of the interventions and have found them useful. They further shared the challenges they faced, which such developmental initiatives can improve, affecting the village's overall educational level.

Figure 34 describes the stakeholder analysis used to figure out the key stakeholders and their relevance in the implementation of various CSR activities.

Figure 34: *Stakeholder Engagement Analysis*



(Source: adapted from Mendelow, A. L. (1981). Environmental Scanning- the Impact of the Stakeholder Concept)

Figure 34 explains the role of all the key stakeholders while categorising them into four categories. First, those who need to be satisfied by the project's outcome but who may not require regular attention during the project itself are called Latent. Latent should be kept wholly informed e.g., Central and state government and local bodies. Second are the Promoters, on which the project manager must devote their attention to manage them closely. These are the stakeholders with the largest capacity to promote the project and have the most extensive ability to derail the NTPC CSR activities if not carefully handled, e.g., the NTPC project management team, school officials, healthcare workers skill trainers. Third are the Monitors, stakeholders monitored by the project manager if their interest or power changes but require almost no attention otherwise, e.g., Anganwadi workers, ANMs, sanitation workers, NGOs staff working on the ground. Fourth is the Defenders who support the project and its aims. Defenders should be given regular updates to keep them included and motivated, e.g., community members. The active participation of local stakeholders inculcates a sense of ownership among the community and ensures the sustainability of CSR activities. For the successful execution of a CSR initiative, different stakeholders need to be consulted and engaged systematically. Below is the representation of stakeholder engagement in the activities conducted by NTPC Unchahar.

STAKEHOLDER ENGAGEMENT

Education

Stakeholders in an educational intervention are Gram Panchayat as it would have observed the changes in childhood development due to educational intervention. The NTPC Officials are the ones who have provided the community with school intervention projects and are primarily responsible for their implementation. Students are the direct stakeholders who reap the benefits of educational interventions. School officials (principals and teachers) would have seen changes in attendance and learning outcomes due to the construction of girls toilets, provision of books, study material and scholarship. Parents of students are indirect beneficiaries as they directly observe the benefits of CSR interventions of increase in learning outcome of their ward without much investment in private tuitions or increased safety of their children. It was observed that the community was not directly engaged in the designing of the project activity. However, NTPC consulted the school authority, village head, and the implementation agency obtained their consent prior to initiation of implementation of the intervention. The impact thus ascertained to be high.

Healthcare

Stakeholders in a healthcare initiative are members of Gram Panchayats, as he observes changes in the general health status of the people, is aware of the prevalence of various health conditions and would be able to inform how effective the health services by NTPC has been in responding to health demands of the community. The major responsibility of effective implementation of the healthcare project lies with NTPC Officials. The local PHC officials (Doctors and staff), health services providers like ASHA workers, and Anganwadi workers promote healthy practices, provide on-ground support, and spread awareness about various health programmes conducted by the government and other agencies. The community was directly not engaged in the project activity. Therefore the impact ascertained is average.

Water and Sanitation

Major stakeholders in water and sanitation activities are members of the Gram Panchayat/ Village Water & Sanitation Committee as they observe the changes in the behaviour of the villagers and increased awareness towards hygiene due to NTPC's drinking-water and sanitation initiatives. NTPC Officials, as they implement the project. Community members (Men, women, Girls and elderly) as the interventions directly impact the community's overall health. WASH interventions must take into consideration women & girls as the influencing stakeholder. Health and sanitation workers are also the key stakeholders who witness the value created by the construction of toilets and sanitation drives because the village would be progressing towards better hygiene and sanitation.

However, we found that apart from Gram Pradhan, no other stakeholder has been engaged in this intervention. The community, and sanitation workers play a major role, and they have not been engaged. Therefore the impact ascertained would not be too high.

Rural infrastructure

Major stakeholders in rural infrastructure initiatives are members of Gram Panchayat. They observe the community participation changes, improved accessibility, sense of safety amongst the women in the village, and reduction in road accidents and other benefits arising out of NTPC interventions. NTPC officials, as they authorise and are the key agency in assessing and devising major rural development/infrastructure interventions that need to be carried for rural development/infrastructure projects. Rural initiatives directly impact community members, as they are the primary users. Local businessmen/businesswomen, owing to the developed rural infrastructure, are the key beneficiaries as it provides easy access and reduces travel time and adversities. The Gram Pradhan has been consulted regarding rural infrastructure development, so the impact ascertained would be high. However, for having a very high impact, NTPC should also plan the engagement of the community.

Vocational training

Major stakeholders in vocational training programmes are members of Gram Panchayat, as they are aware of the skills and jobs available for youth in the area. NTPC officials, as the vocational training interventions are to be carried out by NTPC, have a greater say in assessing, approving vocational skill training that would be imparted in the community for various targeted groups. Community Members (particularly women &youth) participate in the vocational training sessions. Specifically, youth, women and farmers are the direct beneficiaries of the skilling initiative. Family members of the trainees as the beneficiary undergoes the skilling training, he/ she can get a job. Hence the family members are indirect beneficiaries of the skilling program. It was found that the majority of stakeholders were not consulted before and during the program. Therefore the impact would not be ascertained too high.

Differently-abled

Major stakeholders in disability initiatives are Gram Panchayat members, as they know about the number of disabled people in the area and their needs. NTPC Officials, as the intervention is carried out with support from them, their key responsibilities are, its effective implementation. Persons with Disability (PwDs) are direct beneficiaries, as they get aids and appliances to improve their quality of life. PHC officials/Health officials are aware of the health issues faced by PwDs, any change in their life due to the provision of aids and equipment will be closely observed by them. NTPC also give some of the aids and appliances to students with disabilities. Thus school officials are in a position to call out the

difference they make to their lives. For families/care providers of PwDs, the change in the mobility of PwDs will directly impact their relationship with their family members/ care providers. During a consultation with the community, we found that none of the stakeholders has been engaged before and during the project. Hence, the ascertained impact of such initiatives won't be too high.

Sports

Major stakeholders in the sports initiatives are members of Gram Panchayat, who are responsible for the improvement in sports infrastructure and the promotion of sports at the village level with technical support from the Youth Affairs Department at the District level. NTPC officials are responsible for the effective implementation of the intervention of the sports. Sportspersons are directly impacted by the provision of sports infrastructure and other resources provided by NTPC under the 'sports for change initiative'. During the consultation with the community, we found that sports intervention did not engage any stakeholder before and during the project. Hence, such initiatives' ascertained impact would not be too high.

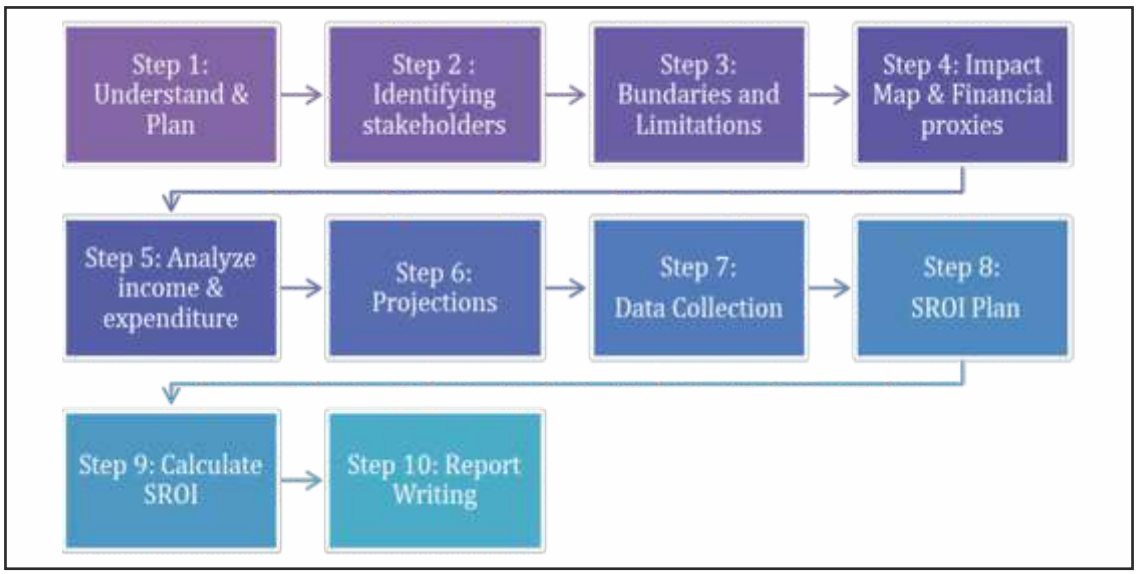
NTPC officials expressed that the conflict among the stakeholders is one of the major challenge faced by them while implementing CSR-CD projects. The solution for this challenge lies in sensitisation and awareness creation among implementers (Government functionaries/ political representatives/PRIs/NGOs/community etc.) at all levels through various communication channels about the programme. This will create a long term impact and will result in building a positive brand image of the company.

SOCIAL RETURN ON INVESTMENT

Step 1: SROI Process and Methodology

The objective is to measure SROI value of CSR-CD projects implemented by NTPC near its thermal plant in Unchahar, Rae Bareli. The study will help NTPC Unchahar in strategic planning and compare the social value generated for different projects. The projects were analyzed based on secondary information provided by NTPC corporate office and field office as primary data collected from the field visit in December 2020, and the scope of study was established. The SROI study was carried out for 2017-20. The IICA follows a 10-step strategy given in Figure 35.

Figure 35: *Steps in SROI Computation-IICA's Approach*



(Source: IICA)

1. **Understand and Plan:** The first step is the understanding the stages of the SROI study and planning the details of the SROI process. IICA accessed all the vital material information on the nature and design of CSR projects, details of beneficiaries and implementing agencies and chalked out a plan to conduct the SROI analysis. A kick-off meeting was also done with the managers of the NTPC and the record of discussion is given in Annexure 1. The plan was also reviewed by external experts and the feedback of the experts is given in Annexure 3.
2. **Identification of Stakeholders:** After understanding and planning, the stakeholders involved in the projects were identified. The identification of the stakeholders is a key step in the calculation of the SROI. Much care and attention was given in the identification of stakeholders. Only those stakeholders were included who had materially benefitted from the projects or had been associated in the project.

3. **Boundaries and Exclusions:** This step has two sub steps:
   a. **Materiality analysis:** The way of defining project 'materiality' to the SROI analysis is to evaluate whether a piece of information, if excluded, would significantly misrepresent the conclusions of CSR activities implemented by NTPC. In order to understand the biggest impact created, various factors were be assessed such as Safety and wellness of school going children, toilet usage in the community, awareness of hygiene and sanitation in households, hygiene and sanitation and community support for hygiene and sanitation, Usage of Mobile Medical Units, provision and usefulness of skill development programs, Usage of roads and its maintenance, usage of other infrastructure such as crematorium etc. These criteria were used to assess the impact created under CSR interventions of NTPC Unchahar. Rest of the projects were excluded from SROI analysis.
   b. **Inclusion and Exclusion criteria:** Based on the materiality analysis, the inclusion and exclusion criteria was applied to the CSR projects of NTPC Unchahar and a short list of projects was developed, The concerned stakeholders of the selected projects only were consulted for the SROI study.
4. **Impact mapping& financial proxies:** Once the CSR projects were shortlisted and stakeholders had been identified, the next step was creating an impact map. Project objectives, impact areas and nature of activities undertaken for projects were identified. Inputs, outputs, outcomes and impact were also outlined and a Theory of Change was formulated. The Theory of change shows the inputs, outputs and outcomes as stated by different stakeholders. The nature of change that each stakeholder group undergoes was identified based on the theory of change to establish the relationship between inputs, outputs and outcomes for each project.
5. **Analyze Income & expenditure:** The materiality of the projects and the stakeholders is analyzed by the amounts of expenditure incurred on the projects and the number of beneficiaries benefitted from the project. Hence, some projects like construction of crematorium, renovation of homeopathy center and construction of boundary wall have very less number of beneficiaries and there are no indicators on which these projects could be measured
6. **Projections:** From the income and expenditure data, it was ascertained whether the costs and benefits of the CSR projects may be projected over the future years. As advised by SROI experts, for the purpose of this study, projections of social values were taken for next 5 years.
7. **Data collection:** Relevant data needed to calculate material change were identified and requested from NTPC. This involved developing outcomes, collecting relevant data, knowing duration of outcomes and weighing outcomes and then valuing them. Site visits of fifteen villages near NTPC Unchahar were also made to understand the impacts, determine proxy values and the perspective of various stakeholders for better estimation. This included one-on-one interactions, semi-structured interviews and focus group discussions with beneficiary and government officials of CSR projects of NTPC Unchahar.

8. **SROI plan:** The IICA team collected evidence on outcomes and monetized them, eliminating from consideration those aspects of change happening anyway or as a result of other factors. For example, mushroom cultivation and milk production can also be attributed to government and development of the region in the last decade. In cases where accurate data was not available, estimates were made by using proxies such as Doctor's consultation fees and fee of a school with good learning environment By considering quantity of change and proxy values for each outcome, social value created was calculated and the value of deadweight and attribution was also deducted from it
9. **Calculating SROI:** In the last step, all project outcomes were added and various factors such as deadweight and attribution were subtracted and then the remaining value was divided by the total investment of NTPC on the projects in the last three years. The contribution of Govt. was also subtracted from NTPC Unchahar investments to calculate the actual social value or SROI ratio. After the computation of the ratio, a sensitivity analysis was done to verify the results and their veracity. The aim of such an analysis is to test which assumptions have the greatest effect on the model. This allows us to report the amount of change necessary to make the ratio change from positive to negative or vice versa

Once these calculations are done, the social value generated from the projects is calculated. The Social value is calculated by multiplying the financial value of outcomes with the total number of beneficiaries and then subtracting from it the deadweight, displacement, drop-off and attribution. The formula for the calculation of Social value created is expressed as follows:

Social Value Created= Outcomes x Number of Beneficiaries-(minus) (Deadweight+ Displacement+ Attribution+ Drop-off)

After calculating the Social value created through the projects, the next step is to compute the SROI ratio. The SROI ratio is computed by dividing the total social value created by the total amount of expenditure on the CSR projects. The formulae for calculating the SROI us expressed as follows:

SROI= Social Value Created/ NTPC Unchahar CSR budget

The formulae stated above gives the SROI ratio for each project/thematic area which is the unit of analysis. The SROI value can then be analysed and suggestions and recommendations can be drawn from the resultant SROI. The SROI ratio shows the value of the impact which has been generated through CSR projects.

10. **Report writing:** The reporting of the SROI value is done through standardized SROI reports which details the process and methods of calculation of the SROI. The reporting is done so that all the stakeholders can understand and verify the results. The draft report containing the findings and recommendations was again discussed with the NTPC managers in an Exit Conference. In the end the draft report was again reviewed by the experts.

Step 2: Scope of the study

The present study is the analysis of the Social Return on Investment of the CSR-CD projects of NTPC Unchahar. The scope of this SROI study includes the projects which have been implemented under CSR commitments of NTPC in the villages near Unchahar Super Thermal Power Station. The CSR projects have been implemented in 15 villages of Rae Bareli district of Uttar Pradesh. The interventions have been categorized in eight thematic areas like Education, Healthcare, Water, Sanitation, Vocational Training, Rural Infrastructure, Differently abled and Sports. The study analyses in detail the social return accrued because of CSR-CD projects. The study was done in consultation with the relevant key stakeholders.

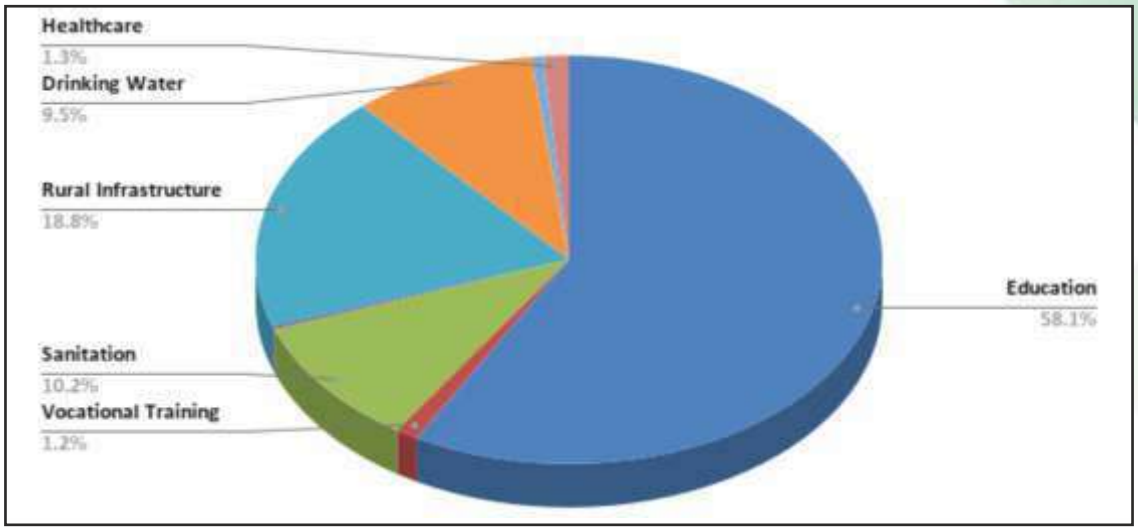
Project Details and Budgets

All the CSR activities implemented by NTPC Unchahar are specified in section one of the report.

Budget Allocation

Figure 36 shows the percentage of budget allocated to different thematic areas. It is observed that more than half of the budget (58.1%) was allocated to education projects. Rural Infrastructure is another important area where allocation of budget was around 19 per cent. Intervention in sanitation were allocated 10.2 per cent budget of total CSR budget of NTPC Unchahar. Budget allocated for thematic areas like healthcare, vocational training, sports and differently-abled was less than 5 percent.

Figure 36: *Budget (in percentage)*



Step 3: Identifying Stakeholders

The stakeholders are key to the SROI study. The consultation and engagement with all stakeholders is needed to assess the impact of the study. Key stakeholders of the CSR-CD projects are identified and given theme-wise in Table 5.

Table 5: *Key Stakeholders*

Thematic Areas	Key Stakeholders
Education	Students, Parents, NTPC, Government, Teachers
Health	Community (Beneficiaries), NTPC , Gram Panchayat, Health Workers
Vocational Training	Trainees, Training Agency, NTPC, MSMEs, Government
Water	Community (Beneficiaries), Gram Panchayat, NTPC
Rural Infrastructure	Community, Gram Panchayat and NTPC
Sports	Sportsperson, Community (families of beneficiaries) and NTPC
Differently-Abled	Differently-Abled, Care-givers of Differently-Abled and NTPC
Sanitation	Community (Beneficiaries), Gram Panchayat, Sanitation workers, NTPC

Rationale for Identification of Stakeholders

Educational Interventions

The stakeholders in the area of educational interventions are Students, their parents and NTPC. These stakeholders are included in the study as they are major stakeholders. Students are direct beneficiaries of the program. The entire project has been designed for them. The parents have been included as a stakeholder because they are indirect beneficiaries as well as they also provide input in the form of the sending their kids to schools and putting effort in educating them. They benefit from the education of the children because it provides them a sense of pride as well as a promising future for the household. NTPC remains a stakeholder because it provides the input cost required for the implementation of the project and also makes effort to implement the project in coordination with the school officials. The government has not been included as a stakeholder because it is not involved in the projects at any point. The basic infrastructure has been provided but their input is not as such that it should be considered for the study.

Healthcare Interventions

In the area of health Interventions, the community is the direct beneficiary of the interventions and hence a major stakeholder. NTPC remains a stakeholder in this intervention as they are providing the input cost and also implementing the project. Government has been included as a stakeholder because the projects have been implemented in coordination with them and the existing infrastructure has been used to implement the project. The healthcare workers have not been included as a stakeholder because they don't benefit from the projects in any manner whatsoever.

Vocational Training

The stakeholders in vocational training interventions are trainees and their parents as they benefit from the project. Trainees benefit directly while their parents and families are indirect beneficiaries. The implementing agency is also a stakeholder as they also benefit from the projects and make the training beneficial for others. They provide the training and are responsible for the placement of the trainees in the domain of their training. NTPC remains a key stakeholder here also because it has designed and funded the project.

Water and Sanitation

In this area of intervention, the major stakeholders include Community/beneficiaries who benefit from these projects. NTPC is another stakeholder which funds and implements the project. Implementing agency is another stakeholder in these projects which carry the construction work.

Rural Infrastructure

The stakeholders in the rural infrastructure projects are community, NTPC and the implementing agency. The community or people of the villages are direct beneficiaries of these projects. NTPC Unchahar remains a stakeholder as they are funding the project and getting the objectives of development achieved. In these projects contactors or the construction companies are also a stakeholder as they implement the project and make the design a reality.

Sports

The stakeholders in sports intervention are sportspersons and community. The community is an indirect stakeholder in such programmes. NTPC Unchahar has provided sports kits to encourage sports activities and improved the community interaction in the area.

Differently-abled

Differently-abled and their care-givers are direct stakeholders for the intervention in the programmes related to inclusion of differently-abled. The emotional well-being of care-givers is often neglected in the society. Improved well-being and mobility of differently abled will have direct consequence on the psychological and financial well-being of care-givers.

Step 4: Boundaries and Exclusions

It is important to assess and be clear about the boundaries and limitations of the study. At this stage it is ensured that only those stakeholders and projects are considered for the study which are highly important and will impact the findings of the study, if left out.

Project stakeholders were consulted through focus group discussions and one-to-one meetings in the study area villages to understand the direct and indirect impact of the projects. Direct and indirect stakeholders comprehensively mentioned the change they have gone through in last three years due to NTPC Unchahar's intervention in health, Education, Water & Sanitation, vocational training, rural infrastructure, sports and differently-abled.

Consulting with various stakeholders through primary data collection exercise covered 395 households, 28 focus groups discussions, and 42 interviews with key informants for monetizing outcomes. These were major primary stakeholders who were selected because they have undergone the material changes as per the objectives of the projects. Many outcomes emerged during the discussions but most relevant and significant outcomes which were experienced by most stakeholders were selected and monetized in the study.
In this stage, IICA determined the following:

- What is 'material' or important to include for decision-making purposes?
- Which stakeholders are we going to include and exclude?
- Which activities are we going to include and exclude?
- What data do we have available?

Materiality analysis: The way of defining project 'materiality' to the SROI analysis is to evaluate whether a piece of information, if excluded, would significantly misrepresent the conclusions of CSR activities implemented by NTPC. The materiality of the projects and the stakeholders is analysed by the amounts of expenditure incurred on the projects and the number of beneficiaries benefitted from the project. The excluded stakeholders of each thematic area are given in Table 6 and excluded activities are mentioned in Table 7.

Table 6: *List of excluded stakeholders*

S. No.	Focus Area	Excluded stakeholders	Reason(s) for exclusion
1	Education	Company or firms that provided basic supplies	Due to the limited scope of the study
		Watchman of School	Beyond the scope of the study
		Construction workers	List of construction workers and their contact details are not available.
2	Rural Infrastructure	Construction Workers	List and contact details of construction workers who constructed roads and community structures are not available.
		Electricians	List and contact details of electricians who installed solar lights are not available.
3	Water	Local Government Officials	Due to limited Scope of study
		Worker and technicians who installed hand pumps and solar pumps	List and contact details of technicians who installed solar and hand pumps is not available
4	Sanitation	Local Government Officials	Due to the limited scope of the study
		VHSNC committee members	Due to the limited scope of the study
		Health workers	Due to the limited scope of the study
		Construction workers	Due to the limited scope of the study
6	Sports	Families of sports person	Due to limited scope of the study
7	Vocational Training	MSMEs	Due to limited scope of the study
		Krishi Vigyan Kendra Officials	Due to limited scope of the study
8	Healthcare	HelpAge India (NGO that runs Mobile Medical Units)	Due to the limited scope of the study
		VHSNC committee members	Due to the limited scope of the study
		Local Health Workers	Due to the limited scope of the study
		Doctors who provided their services in mobile medical units	Due to the limited scope of the study
		Quacks	Due to the limited scope of the study.

Other stakeholders like local Government officials have been excluded due to limited scope of the study. However, in certain cases, the real behind exclusion of stakeholder is non-availability of data.

Table 7: *List of excluded activities*

S. No.	Focus Area	Excluded activities	Reasons for exclusion
1	Education	Provided computer to ITI schools	Details and objectives of the activity is not available
		Earth filling ground in	Difficult to extrapolate the benefits of activity that led to
		school	quantitative or qualitative improvement in educational outcomes of children
		Inclusive Education for PCP Students of surrounding village	Details and objectives of the activity is not available
2	Sanitation	Financial assistance given to Distt. authority under Swachh Bharat Abhiyan	Details and objectives of the activity is not available
		Distribution of mosquito net in surrounding area	Data vis-a-vis reduced water borne and mosquito borne diseases is not available
3	Rural Infrastructure	Construction of Railway Overbridge	Details and objectives of the activity is not available
		Installation of CCTV Camera	Beyond the scope of the study
4	Water	Rejuvenation of Pond	Details of beneficiaries and objectives of activity is not available
5	Sports	Financial assistance to DM Raebareli for open Gym equipment	Details and objectives of activity is not available
6	Healthcare	Training provided for First Aid Services & provision of Kits	Details and objectives of activity is not available
7	Other CSR activities	Blanket Distribution etc.	Details and objectives of activity is not available

Step 5: Impact Mapping and Financial Proxies

Impact mapping is one of the most important elements of a Social Return on Investment Study. A theory of change is made through logical framework analysis to determine the impact of the interventions. At this stage, the inputs, outputs and outcomes are linked to visualize the impacts of the interventions. The details regarding the outputs, outcomes and impacts have been arrived at by consulting and communicating with the stakeholders identified in the previous section.

Household surveys[22], FGDs with beneficiaries of the project, Key informant interviews are used to quantify outcomes and anchor studies are used to assign financial proxy to each outcome.

Impact Map and Financial Proxies of Educational Interventions

The outcomes of educational interventions lead to outcomes like improvement in academic performance of children, improvement in confidence of children, increased access to education and motivation to continue education because of interventions like GEM and scholarships. Better learning experience because of renovation of school infrastructure and increased sense of security among students. Table 8 summarizes the inputs, outputs and outcomes of educational interventions.

Table 8: *Impact Map for Educational Interventions*

Stakeholder	Input	Output	Outcome	Financial Proxy
Students	Time & Energy	No. of students who received basic supplies	Increased motivation and savings to continue their studies	Average cost of raised motivation to go to school
Students	Time & Energy	No. of beneficiaries of GEM Scholarship and scholarships to meritorious students	Increased access to financial resource to continue their studies and increased self-reliance	Average cost of summer camp by Private schools
Students	Time & Energy	No. of Economically weaker students and disadvantaged girl students who received bicycle	Increased mobility and motivation to continue their education	Average of yearly commute and cost of motivation to attend school
Students	Time & Energy	No. of classrooms, toilets, cycle stands and boundary wall constructed and furniture provided	Qualitative improvement in educational institute	Cost of studying in private school
Students	Time & Energy	Installation of solar lights in Kasturba Gandhi College	Improved safety and security of girls studying in college	Yearly salary of 2 security guards
NTPC	Financial and Monetary Resources	NTPC branding on basic supplies and toilets constructed	Improved NTPC Brand Image	Cost of brand improving exercises

[22] IICA-2020

The outcomes from educational projects for the parents are that it leads to an increase in confidence in their children and an increase in self-esteem of parents. The monetization of educational outcomes is done on indicators like the cost of raising motivation, the cost of life-skills sessions and the cost of therapy sessions as financial proxies for increased self-confidence and self-esteem. The personality development, skill enhancement and basic educational supplies led to improvement in academic performance of participants, improved decision making skills and emotional skills by giving them workshops on life-skills. It also led to improvement in creativity and artistic expression of children by providing sessions on performative and creative arts and crafts. This led to the savings on part of children and their parents for a life-skills session and of engaging a private school tutor. Hence, the financial proxy for this outcome can be the cost of attending motivation increasing workshops. This cost is calculated and multiplied with the total number of beneficiaries to arrive at the social value of this project.

The SROI of the most impactful educational project Girl Empowerment Mission comes out to be 3.81 as 103 girls spent one month in residential camp organised by NTPC Unchahar.

Table 9: *Impact Map for GEM Intervention*

Stakeholder	Input	Output	Outcome	Financial Proxy
Students	Time & Energy	No. of beneficiaries of GEM Scholarship	Improvement in exposure of 100 per cent students	Average cost of a residential 1 month summer camp by Private schools
Students	Time & Energy	No. of beneficiaries of GEM Scholarship	Improvement in academic performance of 60 per cent students	Average cost of attending private tuition
Students	Time & Energy	No. of beneficiaries of GEM Scholarship	Improvement in self-confidence / self-reliance of 100 per cent students	Average cost of personality development workshops
Parents	Time & Energy	No. of Parents whose children attended GEM Scholarship	Increased confidence in their children and motivation to continue schooling	Average cost of workshop of teaching parents about the importance of education
Parents	Time & Energy	No. of Parents whose children attended GEM Scholarship	Saving of parents in improving educational outcomes of children	Average cost saved by parents on improving education of their children
NTPC	Financial and Monetary Resources	NTPC branding through parents and children	Improved NTPC Brand Image	Cost of brand improving exercises

And the SROI was found to be 3.81 which means 1 Rs spent on GEM workshops will bring 3 times the amount of money spent. However, this could have been higher if the amount spent per beneficiary is optimised.

Impact Map and Financial Proxies of Healthcare Interventions

The outcomes of health interventions as reported by Community are: easy accessibility to health care services due to MMU and health camps in the villages and medicines available to people. By organizing health camps and providing the facility of mobile medical units, NTPC's reputation in the community improved and their brand value also increased. Table 10 summarizes the inputs, outputs, outcomes and financial proxies of health interventions.

Table 10: *Impact Map for Health Interventions*

Stakeholder	Input	Output	Outcome	Financial Proxy
Community members	Time & Energy	No. of beneficiaries who received health care facility in health camps and MMU	Improved physical health of beneficiaries	Average cost of basic health check up
Community members	Time & Energy	No. of beneficiaries received preventive healthcare check-up	Saving on healthcare expenditure	Cost saving on health expenditure
Cataract Surgery Beneficiaries	Time & Energy	No. of beneficiaries prevented blindness due to cataract	Saving on cataract surgery expenditure	Average cost saving on cataract surgery expenditure
NTPC	Financial and Monetary Resources	Amount spent on improving brand image	Improved Brand Image	Cost of brand improving exercises

The financial proxies for the easy accessibility of healthcare facilities in villages and improved health infrastructure are taken equivalent to the consultation fee charged by a doctor in the rural areas and the average cost of medicines disbursed in a public hospital. The financial proxies for health interventions are the average consultation fee charged by a doctor in a rural area. NTPC Unchahar as a stakeholder will also benefit from the project, so the financial proxy for this outcome is the 0.01 percent of total advertisement budget of NTPC.

Impact Map and Financial Proxies of Vocational Training projects

The vocational training led to employment of people and improvement in their livelihood conditions. The trainees reported to have improved self-esteem as a gainful employment because of the training provided by NTPC Unchahar. For the families of the trainees who are indirect beneficiaries of training interventions, the major outcomes reported was increased confidence in their children and increased sense of dignity, due to improved quality of life because of earnings. Table 11 summarizes the inputs, outputs, outcomes and financial proxies of vocational training interventions.

Table 11: *Impact Map for Vocational Training Projects*

Stakeholder	Input	Output	Outcome	Financial Proxy
Youth and women Beneficiaries	Energy & Time	No. of participants in vocational trainings in various activities	Improved skills level for employment/ Self employment	Cost of certificate course paid by participant for similar skill development course
Youth and women Beneficiaries	Energy & Time	No. of participants in vocational trainings in various activities	Improved self-confidence, self-esteem and well being	Cost of attending seminar
Families of beneficiaries	Energy & Time	Improved quality of life	Improved confidence in the capability of their son or daughter	Cost of wellbeing session
Salary of trainers	Energy & Time	No. of training programmes conducted	Earned livelihood through training programme	Salaries earned for training
NTPC	Financial and	No. of Vocational	Improved Brand Image	0.01 % Cost of brand
	Human Resources	training programmes conducted	through Training completion Certificate	improving exercises

The vocational training initiative lead to many social benefits for the families of the trainees. The training also provided employment to the trainers and the implementation agency gained income through its engagement with the project. Financial proxy for the improved skills for the employment of trainees is the average cost of similar certificate course or skill enhancement training. The employment of the youth will lead to many benefits to the household which will reduce the stress levels in parents. Hence the cost of a therapy or a wellbeing session has been taken as a financial proxy for these outcomes. The average income of the trainers has been taken from the training fees as determined by PMKVY[23].

[23] https://pmkvyofficial.org/App_Documents/News/PMKVY%20Guidelines%20(2016-2020).pdf

Impact Map and Financial Proxies of Water

Installation of hand pumps, piped water through overhead tanks, installation of RO plant at PHC have been undertaken by NTPC Unchahar as part of their water intervention. It led to an increase in the quantity of water available to households and also saving time which was earlier spent in carrying water from far-off places. Table 16 shows the inputs, outputs, outcomes and financial proxies of water interventions.

Table 12: *Impact Map of Water*

Stakeholder	Input	Output	Outcome	Financial Proxy
Community Members	Time & Energy	No. of hand pumps and overhead tanks and piped water installations	Improved quantity of water	Average cost incurred on buying water
Community Members	Time and efforts	No. of RO plants installed at PHC	Improved health and hygiene of the community	Average cost of medicines for water-borne diseases
NTPC	Financial and Human Resources	No. of people benefitted with water interventions	Improved Brand Image	Cost of brand improving exercises

The outcomes of the water interventions have been monetized by using the financial proxy of average cost of per litre water available and time saved due to the availability of the water near the household. NTPC's name is visible on installed overhead tanks and solar pumps. It led to the upliftment of the brand image of NTPC. 0.01% of annual advertisement cost of NTPC has been used as a financial proxy of enhanced brand image of NTPC.

Impact Map and Financial Proxies of Sanitation Interventions

The major outcomes of the sanitation projects are improved sanitation in the villages and overall improvement in quality of life of people. The major outcomes of these projects are increased awareness regarding hygiene and health related issues; it also helped them in reducing the expenditure on curative health and led to cleaner surrounding around households. As far as NTPC is concerned, It led to improvement in their brand image. Table 12 shows the inputs, outputs, outcomes and financial proxies of the sanitation interventions.

Table *13:* *Impact Map for Sanitation Interventions*

Stakeholder	Input	Output	Outcome	Financial Proxy
Beneficiaries (Community)	Time & Energy	No. of people reached / awareness created through Nukkad Nataks	Increased Awareness vis-a-vis hygiene and sanitation	Average cost of generating awareness per person through Swachh Bharat Mission
Beneficiaries	Time & Energy	No. of Individual household/community toilets constructed	Reduced expenditure on health due to improved hygiene	Average expenditure on health per person per year
Beneficiaries (Community)	Time & Energy	No. of drainages cleaned and constructed and dustbins distributed	Cleaner surroundings	Average cost of treating water borne diseases (per patient)
NTPC	Financial and Monetary Resources	Increased awareness about sanitation through drives and community toilets NTPC	Improved NTPC Brand Image	Cost of brand improving exercises

Increased awareness vis-a-vis WASH, reduced expenditure on health, average cost of generating awareness, expenditure on treatment of water borne diseases and brand improving exercise due to improved sanitation conditions are the major outcomes for this project. Quantification of reduced expenditure on health, average cost of generating awareness has been used as financial proxies to monetize the outcomes of this project.

Impact Map and Financial Proxies of Rural Infrastructure Interventions

The interventions in rural development like construction of roads, community structures and installation of solar street lights lead to outcomes such as easy and improved access to markets, schools, hospitals and towns/cities. This leads to employment and other facilities to the people. Better community infrastructure leads to general welfare and well-being. Other important outcomes are availability of community space for public gatherings, increased solidarity among community members, reduced accidents during night time. Table 13 shows the input, output, outcomes and financial proxies of the rural development interventions.

Table 14: *Impact Map for Rural Infrastructure Projects*

Stakeholder	Input	Output	Outcome	Financial Proxy
Community Members	Time and Efforts	Kms of roads constructed	Easy access to markets, school, hospitals etc.	Average cost of vehicle maintenance and fuel saving
Community members	Time and Efforts	Number of community buildings created	Availability of community space for public gatherings and meetings	Average cost of renting a public space (Banquet, lawn etc.)
Community members	Time and Efforts	Number of community buildings created	Increased solidarity among community members	Average annual salary of community mobiliser.
Community members	Time and Effort	Street lights installed	Reduced accidents during night time	Average Medical expense of treating injury due to accident.
NTPC	Time, Energy, Human Resource and Money	No. of rural-Infra Projects completed	Improved Brand Image	Advertisement Cost (.01% of total Budget)

The outcomes of the rural infrastructure interventions have been monetized by using the financial proxies- average cost of vehicle maintenance and average cost of fuel savings, average cost of renting a public space, and average annual salary of a community mobiliser in bringing solidarity in the community, average expenditure on treating injury due to accident and 0.01 percent of advertisement budget of NTPC.

Impact Map and Financial Proxies of Differently-abled

Intervention in this thematic area led to increased mobility of differently abled and their improved well-being. Consequently, Table 14 shows the inputs, outputs, outcomes and financial proxies of interventions for differently abled.

Table 15: *Impact Map of Differently-abled*

Stakeholder	Input	Output	Outcome	Financial Proxy
Beneficiaries	Time & Energy	No. of beneficiaries who received tri-cycle and hearing aids	Improved mobility and social access	Average cost spent by differently-abled on basic aids
Beneficiaries	Time & Energy	No. of beneficiaries who received tri-cycle and hearing aids	Improved Economic Potential	Current MGNREGA wage rate
Beneficiaries	Time & Energy	No. of beneficiaries attended rehabilitation camp	Saving on diagnostic health expenditure	Average cost of health-check up
Beneficiaries	Time & Energy	No. of beneficiaries who received tri-cycle	Improved physical and social well being	Average cost of attending Cognitive Behaviour therapy
				Session
Family of beneficiaries	Time & Energy	No. of caretakers who saved money on caretaker cost	Reduction in care-cost of persons with disability	Average Care cost

Improved mobility, enhanced economic potential, improved well-being, reduction in care cost are the major outcomes in this area of intervention. Average cost of basic aid provided, average 100 days wage of MGNREGA in the area, average cost of attending a health camp and economic value of care taking time are the financial proxies used to calculate SROI in the intervention area. Since, the quality of assistive aids provided are not good, the intervention did not bring very high social return.

Impact Map and Financial Proxies of Sports

Intervention in this thematic area led provision of sports kits to sportspersons. Sport persons, Families of sportspersons and NTPC are key stakeholders in this intervention. Table 15 shows the inputs, outputs, outcomes and financial proxies of sports interventions.

Table 16: *Impact Map of Sports*

Stakeholder	Input	Output	Outcome	Financial Proxy
Sportspersons	Time & Energy	No. of sportsperson who received kits	Improved motivation for pursuing career towards sports	Average cost of attending sports events and leagues
Sportspersons	Time & Energy	No. of sportsperson who received kits	Improved overall wellbeing of sportspersons	Average cost spent on physical and mental well-being
Parents of sports person	Time & Energy	No. of Parents of children who received sports kits	Saving on expenditure for buying sports kits	Average cost of buying sports kits
NTPC	Financial and Human Resources	Completion of CSR project for promotion of sports	Improved Brand Image	0.01 % Cost of brand improving exercises

Provision of sports equipment is the major outcome in this thematic area. Improved motivation for pursuing career towards sports and overall wellbeing of sportsperson; financial savings of the parents of sportsperson are the major outcomes of this intervention. NTPC's brand image enhanced as a part of the outcome and thus 0.01% of annual advertisement, cost of sports kit and cost of attending sports event or league are considered as financial proxies for calculating SROI for the thematic area.

Once the impact maps are created and financial proxies are assigned, the next step is to establish the impact.

Step 6: Establishing impact

After ascertaining the outcomes and monetizing them based on financial proxies, valuation filters are used to adjust the return on investment against any impact which is not the outcome of the interventions under study. To ascertain the actual social value of the impacts, valuation filters like deadweight, attribution, drop-off and displacement are calculated and deducted from the total value of the impacts. Since we have calculated the SROI thematic area wise, the average deductions are presented in the table below. This presents the correct view of the social value created through interventions. Table 17 gives the summary of the valuation filters used in the SROI.

Table 17: *Valuation Filters for various thematic areas*

Thematic Area	Average Deadweight	Average Attribution	Average Displacement	Average Drop off
Education	5.83%	5%	0%	13.33%
Healthcare	15%	15%	0%	25%
Vocational Training	6%	6%	0%	10%
Rural Infrastructure	22%	13%	13%	20%
Water	10%	13.33%	3.33%	20%
Sanitation	12.5%	12.5%	2.5%	12.5%
Differently- Abled	13.33%	10%	0%	26.66%
Sports	12.5%	10%	0%	20%

DEADWEIGHT

To ascertain the deadweight, during the field survey questions were designed to ask the beneficiaries about the likelihood of the existence of outcomes, if these projects were not implemented.

- **Educational Interventions**

For educational interventions, the deadweight ascertained was 5.83% because the government would have put some effort and there are government projects in the region which function through government schools. The deadweight on strengthening and augmenting government school infrastructure is 30% as the government could have renovated the school. Since, the government has not intervened for such a long time the deadweight was lessened in this case. There is no deadweight for special workshops for girl student programs as there is no other agency with this intervention. Scholarship to meritorious and specially abled students does not have any deadweight as this is a unique programme.

- **Healthcare interventions**

The overall deadweight for the health care interventions was found out to be 15% as the basic health infrastructure is minimal and unresponsive to the immediate needs of the people. The government has the infrastructure which is used by CSR projects to work upon. Hence, the 15% deadweight is justified.

- **Vocational Training**

There was 6 per cent deadweight for vocational training interventions as there are not many training facility in the nearby areas. The nearest training facility is 110 kms away from the target area. This does not lead to any deadweight on the project interventions.

- **Water and Sanitation interventions**

The deadweight on hand pumps is 10% as there is no such government initiative to provide handpumps in villages as the NTPC has done. There is no deadweight on RO plants as they are not installed by anyone. On sanitation interventions, the calculated deadweight is 25% as sanitation drives are sometimes facilitated by local officials or small organisations. There is 10% deadweight on renovation of community toilets. The chances of renovation is very little by any other organisation.

- **Rural Infrastructure Interventions**

The calculated deadweight on roads and drainages is 22% as there are interventions which are focused on rural roads and drainages. Other infrastructures like construction of boundary wall near canal, construction of solar powered water storage etc have no deadweight as these interventions are not covered in any interventions.

- **Interventions for Differently-abled**

The calculated dead weight for differently abled intervention is 13.33%. As there are government schemes which provide assistance to disabled persons for purchase/fitting of aids and appliances.

ATTRIBUTION

If the outcomes and impacts generated are solely to be attributed to the efforts of these CSR projects, it was assessed in consultation with Gram Panchayat officials and people in the beneficiary villages. After analysis of the data from FGDs,25% impact was attributed to the government efforts, as the government schools would have contributed to some increase in the educational indicators. Impact generated in Healthcare, Water and Sanitation and Rural Infrastructure Interventions 25% was attributed to government interventions. In vocational training interventions, 100% of the impact was attributed to NTPC.

DISPLACEMENT

Through stakeholder consultations, it was assessed if there was any displacement in the outcomes. It was found that there is 0 per cent displacement in case of education, healthcare, vocational training, sports and initiatives for differently abled any of the outcomes in these thematic areas. However, there was displacement reported in water (3.33%), sanitation (2.5%) and rural infrastructure (13%) interventions.

DROP-OFF

The depreciation rates on roads, building and boundary walls is 10% as per government norms. Hence, the drop-off rates on Rural infrastructure projects and water and sanitation projects is 10%. In the Education and vocational training interventions, there can be loss of job or loss of academic interest. Hence, 10% drop-off is assigned to these interventions. In Health care interventions, no drop-off is assigned.

Step 7: The SROI Computation

The final stage in the process is the computation of the SROI ratio and analysis of the outcomes. The SROI ratio is calculated by multiplying the quantity of outputs with the value of the financial proxies. After this, the value of the deadweight, attribution, displacement and drop off are subtracted from it. This brings us the value of outcomes of the interventions. The next step is to calculate the net present value of outcomes which gives us the clear picture of the value generated. The formula for the calculation of net-present value is as follows:

Net Present Value = [Present value of benefits]- (minus) [Value of investments]

Once the net present value of the outcomes is calculated, the SROI ratio is calculated by dividing the net present value by the value of total inputs.

Net SROI ratio = Net Present Value of Outcomes/Value of inputs

Table 18 gives a theme-wise summary of the SROI of various interventions made by NTPC, Unchahar.

Table 18: *SROI of various thematic areas vis-à-vis their budget (%)*

Thematic Area	Budget (in percentage)	SROI Value
Healthcare	7.55%	10.94
Vocational Training	4.43%	2.41
Sports	1.60%	7.19
Water	10.34%	7.05
Education	8.32%	2.31
Differently- Abled	1.87%	4.26
Sanitation	1.75%	3.91
Rural Infrastructure	64.14%	6.06
		Mean SROI Value-5.51

The average SROI is 5.51. This means that for every rupee spent by NTPC Unchahar, benefits worth rupee 5.51 are generated for society. For detailed computation of every thematic area is annexed in annexure 1.

Step 8: Sensitivity analysis

The results presented in this SROI evaluation are based on variables according to available evidence including qualitative data on the experience of stakeholders. Despite rigorous data collection, analysis and calculation, the SROI ratio is still an estimate of true value to the community and is thus prone to error. The sensitivity analysis explores and tests these assumptions and variables to verify the results of the analysis.

A theme-wise sensitivity analysis has been done to verify the results of the SROI. For each theme, the most important areas have been taken up for the study.

In these interventions, the deadweight, attribution and drop-off will be tested along with values and number of beneficiaries.

Educational Interventions

In Education interventions, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 19.

Table 19: *Sensitivity Analysis for Education interventions*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming deadweight of 25% instead of 5.83%	2.22
Attribution	Assuming 0% attribution instead of 5%	2.56
Drop-off	Assuming 0% drop-off instead of 13.33	2.34

The original calculated SROI value for the educational interventions is 2.31. After changing the value of assumptions, it was found that the SROI values changed to a very limited extent. There were no huge fluctuations in the value of the SROI by changes in the assumptions. This proves that the initial assumptions and valuations are reasonable.

Healthcare Interventions

In healthcare interventions, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 20.

Table 20: *Sensitivity Analysis for Healthcare interventions*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 15%	11.07
Attribution	Assuming 0% attribution instead of 15%	11.07
Drop-off	Assuming 0% drop-off instead of 25%	11.19

In healthcare interventions, the SROI value is 10.94. After making modifications in rate of deadweight, attribution, and drop off, the change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Vocational Training Interventions

In vocational training interventions, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 21.

Table 21: *Sensitivity Analysis for Vocational Training Intervention*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 6%	2.76
Attribution	Assuming 0% attribution instead of 6%	2.57
Drop-off	Assuming 0% drop-off instead of 10%	2.41

In vocational training interventions, the SROI value is 2.41. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Interventions for Water

In interventions for differently-abled, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 22.

Table 22: *Sensitivity Analysis of interventions for Water*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 10%	7.13
Attribution	Assuming 0% attribution instead of 13.33%	7.27
Displacement	Assuming 0% attribution instead of 3.33%	7.07
Drop-off	Assuming 0% drop-off instead of 20%	7.28

In water interventions, the SROI value is 7.05. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Sanitation Interventions

In sanitation interventions, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 23.

Table 23: *Sensitivity Analysis for Sanitation Intervention*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 12.5%	4.02
Attribution	Assuming 0% attribution instead of 12.5%	4.01
Displacement	Assuming 0% displacement instead of 2.5%	4.13
Drop-off	Assuming 0% drop-off instead of 12.5%	4.09

In Sanitation interventions, the SROI value is 3.91. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Rural Infrastructure Interventions

In rural infrastructure interventions, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 24.

Table 24: *Sensitivity Analysis for Rural Infrastructure Interventions*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 22%	6.87
Attribution	Assuming 0% attribution instead of 13%	6.22
Displacement	Assuming 0% displacement instead of 13%	6.23
Drop-off	Assuming 0% drop-off instead of 20%	6.30

In Rural infrastructure interventions, the SROI value is 6.06. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Interventions for differently-abled

In interventions for differently-abled, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 25.

Table 25: *Sensitivity Analysis of Interventions for differently-abled*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 13.33%	4.53
Attribution	Assuming 0% attribution instead of 10%	4.51
Drop-off	Assuming 0% drop-off instead of 26.66%	5.01

In interventions for differently-abled, the SROI value is 4.26. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Interventions for Promotion of Sports

In interventions for differently-abled, the deadweight, attribution and drop-off are tested along with values and number of beneficiaries in Table 26.

Table 26: *Sensitivity Analysis for Sports Interventions*

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 12.5%	7.34
Attribution	Assuming 0% attribution instead of 10%	7.31
Drop-off	Assuming 0% drop-off instead of 20%	7.94

In sports interventions, the SROI value is 7.19. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

The sensitivity analysis explored how robust the SROI ratio is by adjusting variables in the calculation to establish how much change would reduce the ratio of return to 1:1. In conclusion, regardless of the extent to which the discounting factors or value propositions of major components are reinterpreted, the SROI of various thematic areas remains robust.

Step 9: Analysis and Recommendations

The mean SROI value of the projects is 5.51. It shows a monetary value created or value of the social impact (the benefit) of CSR-CD interventions of NTPC Unchahar. It expresses material project outcomes as equivalent monetary values so that they can be compared with the cost of inputs. There are some strategic and specific recommendation suggested below that can be considered to gain higher SROI while implementing the projects in future.

Strategic Recommendations

- SROI calculations are contingent upon stated objectives and goals of the project. In some activities, the objectives of the project aren't very clear. It is suggested that before starting any CSR-CD project, it is always beneficial to clearly state the objectives and goals of the project.
- Besides mandatory legal compliance of CSR law, NTPC Unchahar should also take CSR activities as a brand building exercise among the neighbouring communities of NTPC plants.
- NTPC Unchahar should plan and formulate clear logic model about Outcomes/Impacts (Short term, medium term and long term), before implementing the CSR-CD activities.
- NTPC Unchahar should try to optimize the amount spent per unit beneficiary vis a vis the socio-economic impact on beneficiaries. Thus, NTPC Unchahar will create the maximum meaningful impact from the available CSR budgets.
- There is positive association between the percentage of budget spent and corresponding SROI ratio,r (15)=0.016.The value of correlation coefficient can be interpreted in a way that there are thematic areas where the percentage of budget spent is disproportionate compared to Social Value created by that project. For instance, projects in the area of disability. The objective of CSR projects is to create maximum impact upon stakeholders in the available financial resources. Had more financial resources been utilized in areas of higher SROI, the impact would have been much larger. It is prescribed for future interventions that agency should relatively spend more money on those thematic areas which are generating more social value compared to other projects.
- There is positive association between the SROI ratio and corresponding satisfaction index, r (15)=0.37. It shows that there is conspicuous link between how much community is satisfied and amount of social value is created. Stakeholder engagement and consultation prior to starting a CSR project is one of the way of increasing satisfaction vis-à-vis project. Consequently, it is expected to create better social value.

Theme-wise recommendations

Education

- It is observed that a lot of stress has been placed on building infrastructures. As next steps, NTPC Unchahar must focus its CSR-CD activities in education, that involves construction of infrastructures in school aimed at improving learning outcomes. NTPC Unchahar can provide schools with smart classes so that students are motivated to come to school and it improves their learning outcomes.
- The coverage of bicycle support should be extended to more girl students in consultation with school authorities as the distance of school is one of the main reasons children drop out in the area, and the intervention has potential to improve the average years of schooling and consequently the marriage age.

Healthcare

- Village Health Sanitation Nutrition Committee (VHSNC) members should be consulted and involved in organizing health camps.
- Local health workers like ANMs and ASHAs should be involved and used as a resource person in creating awareness vis-a-vis Mobile medical units and health awareness camps.
- Database of patients who use Mobile Medical Units should be used for diagnosis and referral in future health camps.
- Health Camps should be organized in community spaces like Panchayat Bhawans, *Ajeevika Bhawans* , schools, Anganwadi centres etc
- NTPC Unchahar has spent 7 lacs for cataract surgeries of 3 beneficiaries, which is much higher than the average cost of treatment in government facilities. Thus, budget for CSR activities should be planned in advance with clear objectives to have larger meaningful impact.

Water

- It is suggested that NTPC Unchahar should try to expand the network of piped drinking water in the villages as per the decided timeline with effective monitoring framework.
- NTPC should sign an MoU with the village panchayat which says that they will take care of the implementation and maintenance of the plant for a period of five years. Once this period is over, NTPC can either hand over the plant to the community if they want to maintain it themselves or renew the agreement for another five years.
- Before installation of handpumps and overhead water tanks, a buy-in from the community must be ensured so that they are responsible for its upkeep and maintenance.
- At the time of installation of water assets like handpumps and overhead water tanks, an orientation session with the community must be held so that the community is aware of such developmental programmes by NTPC Unchahar.

Sanitation

- It is suggested that VHSNC members and Lok Nirman Samiti should be consulted in prioritising the location of community toilets.
- While building household toilets NTPC Unchahar must ensure that there is availability of water source nearby the toilets as our survey suggest 4.56 per cent toilets are not functional because of unavailability of water.
- Nukkad Nataks should be run with involvement of school students to have a multiplier effect. Besides organization of Nukkad Nataks, NTPC Unchahar should also run innovative campaigns like " *Shauchalaye nahi toh bahu nahi*"
- The IICA survey reveals that 64.81 per cent of respondents reported that either there are no drains in villages or they are open. Apart from construction and modifications, stress must be placed on cleaning drainages.
- NTPC Unchahar can also conduct initiative focussing on segregation and waste management in collaboration with State Pollution Control Board, as the survey reports a lack of awareness regarding this pertinent issue.

Vocational Training

- Local MSMEs should be consulted in determining the skills that are required as a workforce in the area.
- All the vocational training programme must be market linked.
- It is suggested that NTPC Unchahar should provide placement assistance to all the candidates.
- To create self-employment among the trainees of vocational training, NTPC Unchahar should connect the youth and women with schemes like MUDRA that provide support to small businesses.
- Women who are provided trainings should be mobilised to form SHGs so that they can together generate livelihood.

Rural Infrastructure

- Members of Lok Nirman Samiti of Gram Panchayat should be consulted in prioritizing the infrastructure projects in the village.
- It is suggested that local workers who don't have MGNREGS card should be given priority in the construction for infra projects.
- It is further suggested water related infrastructure projects should be given priority where piped water penetration is less than the national average.
- Jal samitis should be treated as important stakeholder in water related infrastructure projects and maintenance of such project projects should be responsibility of Jal samitis.

Differently-abled

- Differently-abled and caregivers should be given training regarding the usage of assistive aids, so that they last longer.
- Number of differently-abled in Raebareli are 62,230 (Census, 2011), Hearing-7478. Locomotor 12786(loco-motor). However, Hearing aids and tricycles are distributed only to 25 differently-abled beneficiaries. It is suggested that number of beneficiaries should be increased.
- As the next steps, differently-abled should also be helped with livelihood creation programmes, ensuring that Persons with Disabilities have the opportunity for a better future and a dignified life.
- It can further identify children with special needs who have special talent at school level and facilitate and promote their skills.

Promotion of games and sports

- It is suggested that besides distributing sports kits, NTPC Unchahar should also provide training to aspiring athletes and sports person from the neighboring villages.
- As a matter of fact, most of the youngsters in these rural areas lack a platform to showcase their skills and grow in their respective disciplines. Through the organisation of sports leagues NTPC Unchahar can provide them with a platform, the efforts should be towards building rural sports ecosystem.
- NTPC Unchahar can provide community playgrounds, which are great options to engage community members and creating sports ecosystem in the villages.
- NTPC Unchahar can search, identify, and groom sportspersons through National Sports Academy set up by Sports Authority of India (SAI). NTPC can also facilitate the training of the local sportspersons at Guru Gobind Singh Sports College, Lucknow which is not too far (110km) from the village.

Limitations of SROI study

One of the major limitations of SROI is that it is difficult to compare results between organizations. Many organizations adopt different ways of analysis and reporting of the SROI study. There is also issues of focusing on certain aspects of the study which increase the SROI values and downplaying those areas which diminish the SROI score. This SROI study also had specific some limitation which are discussed below:

(a) Unavailability of baseline data;

(b) Lack of appropriate indicators to assess return on investment for specific projects;

(c) High attribution overlap since most beneficiaries get these benefits from multiple sources like government and NTPC Unchahar, that contribute to returns;

(d) Limited scope within the evaluation scope of work to undertake a full return on investment assessment and address attribution through in-depth qualitative analysis;

(e) Challenge to engage beneficiaries to discuss sensitive and often proprietary financial data; and

(f) Lastly, the development outcomes and return on investment are not always applicable, especially in remote areas where implementation costs are high and development results are slow.

Annexure 1: *Village-wise status on relevant indicators* (B- Better, L-Lacking)

Nature of intervention/Objective	Indicator to measure keeping objective	Source of Information (Secondary data, survey, FGDs, KII)	India	Uttar Pradesh	Rae Bareli	Arkha	Babhan Pur	Baherwa	Gangehra	Gopalpur Dudhwan
Demographic profile	Total Population	Census of India-2011	1,210,854,977	199,812,341	3405559	10337	460	1891	2361	913
	Female Population	Census of India-2011	586,469,294	953,318,31	1,653,017	4958	222	895	1212	452
	Male Population	Census of India-2011	623724568	104480510	1752542	5379	238	996	1149	461
	Total Child Population (0-6 Age)	Census of India-2011	15,87,89,287	3,07,91,331	482517	1476	57	272	360	133
	Sex Ratio (per thousand males)	Census of India-2011,	940 females	912 females	943 females	922 females	980 females	980 females	1055 females	980 females
	Number of SC	Census of India-2011	166635700	41357608	1030367	3,785	91	646	640	204
	Number of ST	Census of India-2011	104545716	1134273	1756	25	0	0	0	0
	Language	Census of India-2011, Panchayat KII	Hindi & English	Hindi, English and Urdu	Hindi and Awadhi	Hindi and Awadhi	Hindi and Awadhi	Hindi and Awadhi	Hindi and Awadhi	Hindi and Awadhi
Economy	% of population below BPL (% of household with BPL Ration Cards)	(Antyodaya Dashboard-2019-20), HH Survey	42% (Antyodaya Dashboard-2019-20)	48% (Antyodaya Dashboard-2019-20)	62% (Antyodaya Dashboard-2019-20)	56.9% (HH Survey) Status-Lacking	50.00% (HH Survey) Status-Lacking	66.67% (HH Survey) Status-Lacking	84.62% (HH Survey) Status-Lacking	57.14% (HH Survey) Status-Lacking
	Per capita income (Annually)	MoSPI (2018-19), HH Survey	Rs 126,406, (MoSPI 2018-19)	Rs. 461351, (MoSPI 2018-19)	Data Not Available	57021 (HH Survey)	24000 (HH Survey)	29733 (HH Survey)	51385 (HH Survey)	50580 (HH Survey)

[24]The benchmarking has been done against the national data

Education and Vocational Skills status	% of children (6-14 years) attending the school (Primary)	ASER report (2018-19), School Officials KII, Attendance register	65.6% (ASER, 2018-19)	44.3% (ASER, 2018-19)	Data Not Available	87.5% (HH Survey) Status-Better	82% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better
	% of children (15-18 years) attending the high school	ASER report (2018), School Officials KII, Attendance register	57.4% (ASER, 2018)	27.5% (ASER, 2018-19)	Data Not Available	12.50% (HH Survey) Status-Lacking	13.15% (HH Survey) Status-Lacking	50% (HH Survey) Status-Lacking	0% (HH Survey) Status-Lacking	0% (HH Survey) Status-Lacking
	% of girl child (15-18 years) attending the high school	ASER report (2018), School Officials KII, Attendance register	13.5% (ASER, 2018)	25.8% (ASER, 2018-19)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	Literacy rate of 7 plus years old (Average literacy rate)	Census of India-2011, HH Survey	73% (Census of India 2011)	67.7% (Census of India 2011)	79.02% (Census of India 2011)	75.86 (HH Survey) Status-Better	96.00% (HH Survey) Status-Better	88.89% (HH Survey) Status-Better	82.05% (HH Survey) Status-Better	71.43% (HH Survey) Status-Lacking
	% of children drop out after grade 5	(NITI Ayog SDG Dashboard, 2019-20)	19.89% (NITI Ayog SDG Dashboard, 2019-20)	12.71% (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	9.38% (HH Survey) Status-Better	9% (HH Survey) Status-Better	50% (HH Survey) Status-Lacking	14.% (HH Survey) Status-Better	0% (HH Survey) Status-Better
	% of population having higher education i.e graduation, post graduation, technical education (GER in Higher education)	MHRD (2015-16), HH Survey	24.5% (MHRD 2015-16)	24.5% (MHRD 2015-16)	Data Not Available	3.45% (HH Survey) Status-Lacking	25% (HH Survey) Status-Better	5.56% (HH Survey) Status-Lacking	5.13% (HH Survey) Status-Lacking	14.29% (HH Survey) Status-Lacking
	% of youth (15-35 years) provided training/ vocational training for employment/ placement and/or self employment	Antyodaya Dashboard 2019-20	4% (Antyodaya Dashboard)	2% (Antyodaya Dashboard)	2% (Antyodaya Dashboard)	0% (Antyodaya Dashboard)	0% (Antyodaya Dashboard)	0% (Antyodaya Dashboard)	0% (Antyodaya Dashboard)	0% (Antyodaya Dashboard)

	(Vocational Training Centre/ITI/ Polytechnic/DDUGKY)									
	Number of primary school /thousand population and Average distance to nearest school	NSSO (2014),National Institute of Educational Planning & Administration, U-DISE DATA 2016-17	936 schools per thousand populations	1,13,249(Total Primary Schools in State) As per District U-DISE DATA 2016-17	8,66,361(Total Primary Schools in district) As per District U-DISE DATA 2016-17	Within the Village	Within the Village	Within the Village	Within the Village	Within the Village
Quality of Life	% of households provided with piped drinking water	(NSSO , 76th round survey), HH Survey	11.3% NSSO Survey, 2018-19 (76th round)	10.7% NSSO Survey, 2018-19 (76th round)	Data Not Available	0% (HH Survey) Status-Lacking	0% (HH Survey) Status-Lacking	5.6% (HH Survey) Status-Lacking	5.1% (HH Survey) Status-Lacking	14.3% (HH Survey) Status-Better
	% of population with sustainable access to an improved water source (within their premises & near to their premises), types of facility that is handpump. tap water, well etc.	(NSSO , 76th round survey), HH Survey	94.5% NSSO Survey, 2018-19 (76th round)	87.7% NSSO Survey, 2018-19 (76th round)	Data Not Available	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better
	% of population having Pucca House	(NSSO , 76th round survey), HH Survey	76.7% (NSSO , 76th round survey)	82.7% (NSSO , 76th round survey)	Data Not Available	86.21% (HH Survey) Status-Better	87.5% (HH Survey) Status-Better	72.22% (HH Survey) Status-Lacking	71.79% (HH Survey) Status-Lacking	71.43% (HH Survey) Status-Lacking
	% of population having house/ shelter (owning a house)	(NSSO , 76th round survey), HH Survey	96% (NSSO , 76th round survey)	89.4% (NSSO , 76th round survey)	Data Not Available	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	85.71% (HH Survey) Status-Lacking

	% of households having electricity connection	(NSSO , 76th round survey), HH Survey	88.2% (NSSO , 76th round survey)	80% (NSSO , 76th round survey)	Data Not Available	91.38% (HH Survey) Status-Better	87.5% (HH Survey) Status-Lacking	83.33% (HH Survey) Status-Lacking	100% (HH Survey) Status-Better	71.43% (HH Survey) Status-Better
	% of population having toilet facility	(NSSO , 76th round survey), HH Survey	63.2% (NSSO , 76th round survey)	46.1% (NSSO , 76th round survey)	Data Not Available	46.55% (HH Survey) Status-Lacking	25% (HH Survey) Status-Lacking	55.56% (HH Survey) Status-Lacking	33.33% (HH Survey) Status-Lacking	42.86% (HH Survey) Status-Lacking
Health	Prevalence of underweight children under 05 years of age (No. of malnourished children)	NFHS-4 (2015-16), AWW KII	35.8% (NFHS, 2015-16)	39.5% (NFHS, 2015-16)	41.3% (NFHS, 2015-16)	27 (AWW KII)	Data Not Available	2 (AWW KII)	6 (AWW KII)	15 (AWW KII)
	Under-five mortality rate per 1000 live birth (Village wise numbers)	NFHS-4 (2015-16), AWW KII	56 (NFHS, 2015-16)	78 (NFHS, 2015-16)	62 (AHS, Census 2011)	1 (AWW KII)	Data Not Available	2 (AWW KII)	2 (AWW KII)	4 (AWW KII)
	Infant Mortality Rate per thousand live birth (Village wise numbers)	NFHS-4 (2015-16), AHS, 2011), AWW KII	41 (NFHS, 2015-16)	64 (NFHS, 2015-16)	55 (AHS, Census 2011)	1 (AWW KII)	Data Not Available	1 (AWW KII)	2 (AWW KII)	2 (AWW KII)
	% of children immunized (0-6 year age group) (0-6 years children immunized)	Antyodaya Dashboard, 2019-20, HH Survey	84% (Antyodaya Dashboard 2019-20)	80.8% (Antyodaya Dashboard)	85.1% (Antyodaya Dashboard)	48.28% (HH Survey) Status-Lacking	12.5% (HH Survey) Status-Lacking	5.56% (HH Survey) Status-Lacking	43.59% (HH Survey) Status-Lacking	85.71% (HH Survey) Status-Better
	% of 1 year-old children immunized	NFHS (2015-16), HH Survey	61.3% (NFHS, 2015-16)	51.1% (NFHS, 2015-16)	65.8% (NFHS, 2015-16)	44.83% (HH Survey) Status-Lacking	12.5% (HH Survey) Status-Lacking	0% (HH Survey) Status-Lacking	41.03% (HH Survey) Status-Lacking	71.43% (HH Survey) Status-Better
	Maternal Mortality Rate per lakh (Village wise numbers)	NFHS (2015-16), AHS (2010-11), AWW KII	122 (NFHS, 2015-16)	216 (NFHS, 2015-16)	210	1 (AWW KII)	Data Not Available	1 (AWW KII)	1 (AWW KII)	1 (AWW KII)

	% of births attended by skilled health personnel	NFHS (2015-16), HH Survey	81.4% (NFHS, 2015-16)	70.4% (NFHS, 2015-16)	82.0% (NFHS, 2015-16)	100% (HH Survey) Status-Better	100% (HH Survey) Status-Better	83.33% (HH Survey) Status-Better	94.87% (HH Survey) Status-Better	100% (HH Survey) Status-Better
	1. Tuberculosis (Total patients registered for treatment)	NITI Ayog SDG Dashboard (2019-20), HH Survey	187 per lakh populations, (NITI Ayog SDG Dashboard, 2019-20)	160 per lakh populations, (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	10.52% (HH Survey)	Nil	11.11% (HH Survey)	10.25% (HH Survey)	14.28% (HH Survey)
	2. Malaria	PHC officials KII	-	-	-	Data Not Available	Data Not Available	5.55% (HH Survey)	2.56% (HH Survey)	Data Not Available
	3. Measles (% estimated based on substracting 100-Children age 12-23 months who have received measles vaccine)	NFHS-4 (2015-16), PHC KII	19.4% (NFHS, 2015-16)	38% (NFHS, 2015-16)	23.1 % (NFHS-4, 2015-16)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	4. Water-borne diseases (Prevalence of diarrhoea (reported) in the last 2 weeks preceding the survey (%) (children under age 5 years)	NFHS-4 (2015-16), HH Survey	9.2% (NFHS-4, 2015-16)	15.0% (NFHS-4, 2015-16)	10.8% (NFHS-4, 2015-16)	22.41% (HH Survey) Status-Lacking	12.5% (HH Survey) Status-Lacking	Nil (HH Survey) Status-Better	Nil (HH Survey) Status-Better	Nil (HH Survey) Status-Better
	5. HIV (per 1000 population)	NITI Ayog SDG Dashboard (2019-20),PHC officials KII	0.07 (NITI Ayog SDG Dashboard, 2019-20)	0.03 (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	6. Disability (% of disabled person)	Census of India 2011, HH Survey	2.21% (Census 2011)	2.08% (Census 2011)	62,230 (Census 2011)	0.51% (HH Survey)	0.25% (HH Survey)	1.27% (HH Survey)	0% (HH Survey)	0.25% (HH Survey)

	7. Cancer	National Health Profile- 2019, PHC Officials KII	168122 (National Health Profile- 2019)	2155 (National Health Profile- 2019)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	8. No. of beds per thousand population	National Health Profile- 2019, PHC Officials KII	265275 (National Health Profile- 2019)	39104 (National Health Profile- 2019)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	9. The distance of nearest hospital/PHC	HH Survey, Panchayat KII	-	-	-	Within the Village	-	Upto 5Kms	Up to 5Kms	-
Disabilities	Number of people benefitted from distribution of aids and appliances (No. of Physically challenged received Implants/appliances)	Antyodaya Dashboard 2019-20	2140357 (Antyodaya Dashboard)	275313 (Antyodaya Dashboard)	6660 (Antyodaya Dashboard)	5 (Antyodaya Dashboard)	4 (Antyodaya Dashboard)	3 (Antyodaya Dashboard)	6 (Antyodaya Dashboard)	6 (Antyodaya Dashboard)
	No. of disabled people enrolled in schools (Inclusive education)	NITI Ayog SDG Dashboard, 2019-20, School officials KII	61.18 % (NITI Ayog SDG Dashboard, 2019-20)	59.19 % (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	Number of disabled people engaged in self-employment/income generation activities after attending vocational training course	Panchayat KII	-	-	-	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	Number of disabled people undergone surgeries etc.	PHC officials KII	-	-	-	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
Vocational Training	Number of people attending vocational training program (number of trainees trained under skill	Antyodaya Dashboard 2019-20	5564689 (Antyodaya Dashboard)	630058 (Antyodaya Dashboard)	12006 (Antyodaya Dashboard)	2 (Antyodaya Dashboard)	0 (Antyodaya Dashboard)	0 (Antyodaya Dashboard)	20 (Antyodaya Dashboard)	0 (Antyodaya Dashboard)

	development programs)									
Gender Equality and Women Empowerment	Ratio of girls to boys in primary, secondary and tertiary education.	Gender Parity Index based on GER (GPI): 2015-16	103/100	108/100	TBO	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	Ratio of literate women to men	NFHS-4 (2015-16), HH Survey	61.5% (F), 82.6% (M) (NFHS-4, 2015-16)	61.0% (F): 82.4% (M) (NFHS-4, 2015-16)	62.2 % (F): 87.1 % (M) (NFHS-4, 2015-16)	27.27% (F): 72.73%(M)	0%(F): 100% (M)	66.67%(F): 33.33%(M)	43.75% (F):56.25% (M)	20%(F): 80%(M)
	% of women in wage employment in the non-agricultural sector.	Census of India- 2011, Panchayat KII	28.2% (Census, 2011)	39.36% (Census, 2011)	39.4% (Census, 2011)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	% of seats held by women in government decision-making bodies (Seats held by women in legislative assemblies)	(NITI Ayog SDG Dashboard, 2019-20), Panchayat KII	8.32% (NITI Ayog SDG Dashboard, 2019-20)	10.55% (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
	% of women brought/ are into SHG fold. (% of households mobilised into SHGs)	Antyodaya Dashboard 2019-20, HH Survey	25% (Antyodaya Dashboard)	5.4% (Antyodaya Dashboard)	6% (Antyodaya Dashboard)	13.79% (HH Survey)	0% (HH Survey)	5.56% (HH Survey)	0% (HH Survey)	0% (HH Survey)
Occupation & Employment Status	Level of employment and agriculture development	Panchayat KII	-	-	-	Explained in detail in SIE report				
Occupation & Employment Status	Kinds of occupations prevalent	Community Members FGD, Panchayat KII, HH Survey	-	-	-	Farmer Casual labourers	Farmer Casual labourers	Farmer Casual labourers	Farmer Casual labourers	Farmer Casual labourers
Others	% of children (0-6 age group) receiving ICDS services. (% children in ICDS CAS)	(Antyodaya Dashboard-2019-20), HH Survey	43% (Antyodaya Dashboard-2019-20)	40% (Antyodaya Dashboard-2019-20)	33.2% (Antyodaya Dashboard-2019-20)	39.66% (HH Survey)	12.5% (HH Survey)	16.67% (HH Survey)	17.95% (HH Survey)	57.14% (HH Survey)
	% of eligible persons	HH Survey	15.47 crore	1,62,64,264	Data Not	0% (HH	0% (HH	0% (HH	0% (HH	0% (HH

covered under Pradhan Mantri Suraksha Bima Yojana.		number of enrollments (in crore) and 32,176 claims disbursed till 01.04.2019		Available	Survey)	Survey)	Survey)	Survey)	Survey)
% of eligible persons covered under Pradhan Mantri Jan Dhan Yojana. (No. of households with Jan Dhan Accounts)	Antyodaya Dashboard-2019-20, HH Survey	71410117 (Antyodaya Dashboard-2019-20)	11194902 (Antyodaya Dashboard-2019-20)	176338 (Antyodaya Dashboard-2019-20)	17.24% (HH Survey)	0% (HH Survey)	0% (HH Survey)	2.7% (HH Survey)	0% (HH Survey)
% of eligible persons covered under Atal Pension Yojana.	HH Survey	154.18 Lakh people have enrolled as on as on 31.03.2019 under this scheme	Data not available	Data Not Available	10.53% (HH Survey)	0%(HH Survey)	10.53% (HH Survey)	5.26%(HH Survey)	0% (HH Survey)
% of eligible persons covered under Pradhan Mantri Jeevan Jyoti Bima Yojana.	Panchayat KII	5.91 crore number of enrollments (in crore) and 1,35,212 claims disbursed till 01.04.2019	Data not available	Data Not Available	0% (HH Survey)	0% (HH Survey)	0% (HH Survey)	7.69% (HH Survey)	0% (HH Survey)
% of households provided food grains under PDS (% of households recieving foodgrains from FPS)	Antyodaya Dashboard-2019-20	34% (Antyodaya Dashboard-2019-20)	53 % (Antyodaya Dashboard-2019-20)	68 % (Antyodaya Dashboard-2019-20)	50% (Antyodaya Dashboard-2019-20)	25% (Antyodaya Dashboard-2019-20)	50% (Antyodaya Dashboard-2019-20)	25% (Antyodaya Dashboard-2019-20)	33.3% (Antyodaya Dashboard-2019-20)
% of eligible persons enrolled under AADHAR	NITI Ayog SDG Dashboard (2019-20), HH Survey	88.8 % (NITI Ayog SDG Dashboard, 2019-20)	86.41 %, (NITI Ayog SDG Dashboard, 2019-20)	Data Not Available	96.55% (HH Survey)	87.5% (HH Survey)	100% (HH Survey	100% (HH Survey	85.71% (HH Survey)
% of any other governemnt scheme like Ujjwala Yojna etc	Antyodaya Dashboard-2019-20, HH Survey	49723081 (Antyodaya Dashboard-2019-20)	9702705 (Antyodaya Dashboard-2019-20)	169437 (Antyodaya Dashboard-2019-20)	24.31% (HH Survey)	0% (HH Survey)	0.69% (HH Survey)	8.33% (HH Survey)	1.39% (HH Survey)

Annexure 2: *Social Return on Investment*

Thematic Area	SROI Value
Healthcare	10.94
Vocational Training	2.41
Sports	7.19
Water	7.05
Education	2.31
Differently- Abled	4.26
Sanitation	3.91
Rural Infrastructure	6.06
	Mean SROI Value-5.51

Annexure 3: *Calculation of Social Return on Investment*

Educational Projects

Deadweight %	Displacement %	Attribution %	Drop off %	Impact		Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution		Discount rate		3.5%			
						Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
20%	0%	20%	20%	2,880,000.00		0.00	2,880,000.00	2,304,000.00	1,843,200.00	1,474,560.00	1,179,648.00
5%	0%	0%	10%	1,596,000.00		0.00	1,596,000.00	1,436,400.00	1,292,760.00	1,163,484.00	1,047,135.60
10%	0%	10%	10%	109,350.00		0.00	109,350.00	98,415.00	88,573.50	79,716.15	71,744.54
0%	0%	0%	10%	6,836,000.00		0.00	6,836,000.00	6,152,400.00	5,537,160.00	4,983,444.00	4,485,099.60
0%	0%	0%	20%	300,000.00		0.00	300,000.00	240,000.00	192,000.00	153,600.00	122,880.00
0%	0%	0%	10%	240,000.00		0.00	240,000.00	216,000.00	194,400.00	174,960.00	157,464.00
10%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
			Total	11,961,350.00		0.00	11,961,350.00	10,447,215.00	8,148,093.50	8,028,764.15	7,063,971.74
			Present value of each year			0.00	11,556,859.90	9,752,586.99	8,251,058.20	6,897,475.56	5,947,674.65
			Total Present Value (PV)								42,505,653.31
			Net Present Value (PV minus the investment)								24,076,653.31
			Social Return Value per amount invested								2.31

Healthcare Projects

Stage 4

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
20%	0%	20%	20%	3,298,560.00	0.00	3,298,560.00	2,638,848.00	2,111,078.40	1,688,862.72	1,351,090.18
10%	0%	20%	40%	9,277,200.00	0.00	9,277,200.00	5,566,320.00	3,339,792.00	2,003,875.20	1,202,325.12
0%	0%	0%	20%	120,000.00	0.00	120,000.00	96,000.00	76,800.00	61,440.00	49,152.00
30%	0%	20%	20%	168,000.00	0.00	168,000.00	134,400.00	107,520.00	86,016.00	68,812.80
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Total	12,863,760.00	0.00	12,863,760.00	8,435,568.00	5,635,190.40	3,840,193.92	2,671,380.10
			Present value of each year		0.00	12,428,753.62	7,874,682.99	5,082,618.88	3,346,927.14	2,249,230.36
			Total Present Value (PV)							30,981,802.99
			Net Present Value (PV minus the investment)							28,148,802.99
			Social Return Value per amount invested							10.94

Vocational Training

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
20%	0%	10%	10%	723,600.00	0.00	723,600.00	651,240.00	586,116.00	527,504.40	474,753.96
0%	0%	10%	10%	225,000.00	0.00	225,000.00	202,500.00	182,250.00	164,025.00	147,622.50
10%	0%	10%	10%	135,675.00	0.00	135,675.00	122,107.50	109,896.75	98,907.08	89,016.37
0%	0%	0%	10%	300,000.00	0.00	300,000.00	270,000.00	243,000.00	218,700.00	196,830.00
0%	0%	0%	10%	390,000.00	0.00	390,000.00	351,000.00	315,900.00	284,310.00	255,879.00
0%	0%	0%	10%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Total	1,774,275.00	0.00	1,774,275.00	1,596,847.50	1,437,162.75	1,293,446.48	1,164,101.83
			Present value of each year		0.00	1,714,275.36	1,490,674.23	1,296,238.46	1,127,163.88	980,142.50
			Total Present Value (PV)							6,608,494.43
			Net Present Value (PV minus the investment)							3,860,694.43
			Social Return Value per amount invested							2.41

Rural Infrastructure Projects

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
50%	25%	25%	20%	13,710,937.50	0.00	13,710,937.50	10,968,750.00	8,775,000.00	7,020,000.00	5,616,000.00
20%	20%	10%	20%	16,032,960.00	0.00	16,032,960.00	12,826,368.00	10,261,094.40	8,208,875.52	6,567,100.42
20%	20%	10%	20%	138,240.00	0.00	138,240.00	110,592.00	88,473.60	70,778.88	56,623.10
20%	0%	20%	20%	25,760,000.00	0.00	25,760,000.00	20,608,000.00	16,486,400.00	13,189,120.00	10,551,296.00
0%	0%	0%	20%	300,000.00	0.00	300,000.00	240,000.00	192,000.00	153,600.00	122,880.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total				55,942,137.50	0.00	55,942,137.50	44,753,710.00	35,802,968.00	28,642,374.40	22,913,899.52
Present value of each year					0.00	54,050,374.40	41,776,067.17	32,292,225.83	24,960,174.55	19,292,868.54
Total Present Value (PV)										172,373,730.4
Net Present Value (PV minus the investment)										143,924,730.4
Social Return Value per amount invested										6.06

Water

Stage 4

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
10%	10%	20%	20%	46,405,224.00	0.00	46,405,224.00	37,124,179.20	29,699,343.36	23,759,474.69	19,007,579.75
10%	0%	20%	20%	2,880,000.00	0.00	2,880,000.00	2,304,000.00	1,843,200.00	1,474,560.00	1,179,648.00
10%	0%	0%	20%	270,000.00	0.00	270,000.00	216,000.00	172,800.00	138,240.00	110,592.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total				49,555,224.00	0.00	49,555,224.00	39,644,179.20	31,715,343.36	25,372,274.69	20,297,819.75
Present value of each year					0.00	47,879,443.48	37,008,265.49	28,606,422.60	22,110,471.58	17,090,219.58
Total Present Value (PV)										152,693,822.7
Net Present Value (PV minus the investment)										131,025,822.7
Social Return										7.05

Sanitation

Stage 4

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
20%	0%	20%	20%	118,118.40	0.00	118,118.40	94,494.72	75,595.78	60,476.62	48,381.30
20%	0%	20%	10%	14,444,800.00	0.00	14,444,800.00	13,000,320.00	11,700,288.00	10,530,259.20	9,477,233.28
10%	10%	10%	10%	10,165,176.00	0.00	10,165,176.00	9,148,658.40	8,233,792.56	7,410,413.30	6,669,371.97
0%	0%	0%	10%	300,000.00	0.00	300,000.00	270,000.00	243,000.00	218,700.00	196,830.00
0%	0%	0%	10%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	10%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total				25,028,094.40	0.00	25,028,094.40	22,513,473.12	20,252,676.34	18,219,649.12	16,391,816.55
Present value of each year					0.00	24,181,733.72	21,016,568.06	18,266,753.69	15,877,545.91	13,801,469.69
Total Present Value (PV)										93,144,071.07
Net Present Value (PV minus the investment)										68,304,071.07
Social Return										3.91

Differently-abled

Stage 4

Deadweight %	Displacement %	Attribution %	Drop off %	Impact	Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight,displacement and attribution	Discount rate		3.5%			
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
10%	0%	20%	20%	90,000.00	0.00	90,000.00	72,000.00	57,600.00	46,080.00	36,864.00
10%	0%	20%	20%	361,800.00	0.00	361,800.00	289,440.00	231,552.00	185,241.60	148,193.28
10%	0%	0%	20%	112,500.00	0.00	112,500.00	90,000.00	72,000.00	57,600.00	46,080.00
10%	0%	20%	40%	36,000.00	0.00	36,000.00	21,600.00	12,960.00	7,776.00	4,665.60
10%	0%	0%	20%	59,940.00	0.00	59,940.00	47,952.00	38,361.60	30,689.28	24,551.42
30%	0%	0%	40%	210,000.00	0.00	210,000.00	126,000.00	75,600.00	45,360.00	27,216.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total				870,240.00	0.00	870,240.00	646,992.00	488,073.60	372,746.88	287,570.30
Present value of each year					0.00	840,811.59	603,973.96	440,214.42	324,827.37	242,126.48
Total Present Value (PV)										2,451,953.82
Net Present Value (PV minus the investment)										1,676,953.82
Social Return Value per amount invested										4.20

Sports Interventions

Deadweight %	Displacement %	Attribution %	Drop off %	Impact		Calculating Social Return					
What would have happened without the activity?	What activity did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy less deadweight,displacement and attribution		Discount rate		3.5%			
						Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
10%	0%	20%	20%	540,000.00		0.00	540,000.00	432,000.00	345,600.00	276,480.00	221,184.00
20%	0%	20%	20%	960,000.00		0.00	960,000.00	768,000.00	614,400.00	491,520.00	393,216.00
20%	0%	0%	20%	600,000.00		0.00	600,000.00	480,000.00	384,000.00	307,200.00	245,760.00
0%	0%	0%	20%	300,000.00		0.00	300,000.00	240,000.00	192,000.00	153,600.00	122,880.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
0%	0%	0%	0%	0.00		0.00	0.00	0.00	0.00	0.00	0.00
			Total	2,400,000.00		0.00	2,400,000.00	1,920,000.00	1,536,000.00	1,228,800.00	983,040.00
			Present value of each year			0.00	2,318,840.58	1,792,340.54	1,385,384.00	1,070,828.21	827,693.30
			Total Present Value (PV)								7,395,086.63
			Net Present Value (PV minus the investment)								6,395,086.63
			Social Return Value per amount invested								7.19

Social Impact Evaluation and SROI NTPC Unchahar Uttar Pradesh (2021)

Sec. 5, IMT Manesar, Distt. Gurgaon (Haryana), Pin Code - 122052
Ph:- 0124-2640000, Email:- contactus@iica.in

Design & Printed by SMC : 9811117587

Environment Management Plan

Sr. No.	Description of item	Cost (Rs in Crores)
1	Electrostatic Precipitators	68.64
2	Chimney	32.10
3	Cooling towers	44.92
4	Ash Handling	131.82
5	Ash Dyke-First 9 years	0.00
6	Ash Water Recirculation Incl. ETP	21.83
7	Dust extraction and suppression system	1.5
8	DM plant waste treatment systems	1.5
9	Sewerage collection, treatment & disposal	0.5
10	Environmental lab. Equipment	0.5
11	Green Belt, Afforestation & Landscaping	1.0
	Total	**304.32**

Report

on

Radioactivity Assessment Study

at

NTPC, Unchahar

by

Isotope Application Services

Board of Radiation & Isotope Technology

Navi Mumbai

June-2025

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BRIT
ATOMS IN THE SERVICE OF THE NATION

1. INTRODUCTION

1.1 Introduction to BRIT

Board of Radiation and Isotope Technology (BRIT) was separated from Bhabha Atomic Research Centre, Department of Atomic Energy, Government of India to undertake commercial activities of radioisotope and radiation applications in 1989. In other words, it is a commercial wing of Department of Atomic Energy. Few of the industrial applications of radioisotopes like Gamma column scanning, blockage, void, corrosion detection in pipelines, identification of location of leakage in underground pipelines, residence time distribution analysis in reactor vessels of any kind, flow rate estimation and flow-meter calibration, effluent dispersion studies in surface waters and sediment transport studies on river/sea bed, bore-well interconnection studies for groundwater, studies for the enhanced recovery of oil from the oil wells, reservoir development, interconnection between oil wells, monitoring secondary recovery of oil and its effectiveness, etc are undertaken by BRIT. BRIT also supplies industrial irradiators for the irradiation of surgical items for sterilization, food grains for removal of pests and enhancement of their shelf life, etc. Gamma chambers of various capacities are supplied for research purposes. Indigenous radiography cameras (Industrial gamma radiography exposure device) are supplied for industrial radiography and the radioisotopes are provided for the imported radiography camera. For diagnosis and therapy, radiopharmaceuticals are produced and supplied to the hospitals in India and abroad. BRIT has laboratories for radiopharmaceutical distribution at various locations throughout India.

1.2 What is Radiation Survey?

A survey is an assessment of work areas, equipment & tools, floors in a laboratory or outdoor places for the radioactivity level and contamination. The following procedures are adopted to perform a survey:

- Radiation Field Survey
- Sample Analysis at Laboratory

Survey results should be documented and records should be kept so that all the information is readily available by laboratory staff or members of the Radiation Safety Office.

1.3 Radiation Exposure

People are getting exposed to the radiation emitted by naturally occurring atomic species like uranium, thorium and potassium. As the growth of science and technology has created additional sources of exposures, such as X-rays, TV monitors, radioactive releases from nuclear reactor operations and accidents, fallout from weapon tests, exposure due to radioactive waste disposal and other industrial, medical and agricultural uses of radioisotopes, Still, the major contribution to the background radiation exposure arises from the natural sources. Natural sources of exposures are due to (a) external source of extra-terrestrial origin (cosmic rays), (b) source of terrestrial origin (radioactive nuclides present in earth's crust, in atmosphere and in building materials etc.), (c) internal source of exposure from naturally occurring radionuclides taken into the body through ingestion of food materials etc, and (d) lung irradiation due to radon and thoron and their daughter products inhaled through air. Extent of exposure to natural radiation depends on the occupation, type of dwelling, location of habitation and life style of the population. Total annual effective doses from natural radiation sources to the Indian population residing in normal background areas is approximately 2.3 mSv/year.

Radiation exposure refers to the situation where the body is in the presence of radiation. There are two types of radiation exposure, "internal exposure" and "external exposure." External exposure means to receive radiation that comes from radioactive materials existing on the ground, suspended in the air, or attached to clothes or the surface of the body i.e., radiation from outside of the body. Conversely, internal exposure is caused (i) when a person has a meal and takes in radioactive materials in the food or drink (ingestion); (ii) when a person breathes in radioactive materials in the air (inhalation); (iii) when radioactive materials are absorbed through the skin (percutaneous absorption); (iv) when radioactive materials enter the body from a wound (wound contamination); and (v) when radiopharmaceuticals containing radioactive materials are administered for the purpose of medical treatment. Once radioactive materials enter the body, the body will continue to be exposed to radiation until the radioactive materials are excreted in the urine or feces (biological half-life) or as the radioactivity weakens over time (physical half-life).

In general, criteria of time, distance and shielding needs to be observed while handling radiation of any kind i.e., alpha, beta and gamma. Time taken to handle the radioisotope or when in vicinity should be minimum, the radioisotope should be handled from a distance as far as possible or one should keep away from the source and the radioisotope needs to be

adequately shielded for handling. This ionising radiation may cause biological changes in the exposed person hence the doses to the occupational workers shall be kept As Low As Reasonably Achievable (ALARA) and doses to patients shall be optimized. The normal exposure of individuals resulting from all relevant practices should be subject to dose limits to ensure that no individual is exposed to a risk that is judged to be unacceptable. The permissible effective whole body dose limit to the occupational worker is 20 mSv/yr averaged over 5 consecutive years (30 mSv in any single year). This limit for general public is 1 mSv/yr.

2. RADIATION SURVEY JOB AT NTPC, UNCHAHAR

Coal is largely composed of organic matter, but it is the inorganic matter in coal such as heavy metals and other trace elements etc. that have been cited as possible causes of health, environmental, and technological problems associated with the use of coal. Some trace elements in coal are naturally radioactive. These radioactive elements include uranium (U), thorium (Th), and their numerous decay products, including radium (Ra) and radon (Rn). Although these elements are less chemically toxic than other coal constituents such as arsenic, selenium, or mercury, the possibility of radiation hazard from these radioactive elements are matter of study.

At NTPC, Unchahar, huge coal and fly ash storage yards are present as they generate electricity by burning coal. During environmental audit, they were asked to get assessment of the amount of radiation dose from coal and fly ash stacks affecting the workers around it and whether it is in safe levels.

In this regard, purchase order was placed as **Order No. 40003271720571035 dt. 13/04/24** for "**Radioactivity Assessment Study in coal and ash storage areas and Analysis of 7 nos. samples at NTPC Unchahar**".

To carry out this job, it was decided to monitor the radiation levels at the site by using MIRION contamination monitor (Sr. No. 820776) and RADEYE survey meters (Sr. No. 31477 & 10354).

The samples collected at the site was analysed for its radioactivity content at Radioanalytical Laboratory (RAL, NABL accredited), BRIT, Vashi.

Daily work progress for Radiation survey are as follows:

Sr. No.	Date	Work
1	17/06/25	Arrival of BRIT team at Unchahar
2	18/06/25	Radiation survey of the specified areas
3	19/06/25	Radiation survey of the specified areas
4	20/06/25	Radiation survey of the specified areas

3.OBSERVATION

- Background radiation level: 6-10 µR/hr

S.No.	Name of Area/ Location	Description of Dimension/ Capacity	Max. Dose rate(µR/hr)
1	Primary Coal Yard area	245mtr X 133 mtr x 5.5mtr	**14**
2	Secondary yard Area	i) Zone A: 380 mtr x 38.3 mtr x 9.0mtr	**11**
		ii) Zone B: 380 mtr x 38.3 mtr x 9.0mtr	**13**
		iii) Zone C: 280 mtr x 54.2mtr x 10.0mtr	**14**
		iv) Zone D: 280 mtr x 54.2 mtr x 10.0mtr	**12**
3	Coal Handling Plant	04 Crusher Areas each of dimension = 25x25 mtr	**19**
4	Bunkers (Coal Holding Capacity)	i) Unit#1 bunkers: 6 (400 MT)	**09**
		ii) Unit#2 bunkers: 6 (400 MT)	**11**
		iii) Unit#3 bunkers: 6 (750 MT)	**10**
		iv) Unit#4 bunkers: 6 (750 MT)	**12**
		v) Unit#5 bunkers: 6 (750 MT)	**13**
		vi) Unit#6 bunkers: 9 (1200 MT)	**13**
5	Ash Dyke Area	i) Arkha (including AWRS system): 730 Acre	**28**
		Umran (including AWRS system): 230 Acre	**29**
6	Ash handling Plant: Stage wise Capacity of Ash handling system	i) Stage-I: 03 (900m^3/hr)	**18**
		ii) Stage –II: 03 (700 m^3/hr)	**14**
		iii) Stage-III: 03 (400 m^3/hr)	**11**
		iv) Stage-IV: 03(765 m^3/hr)	**12**
7	Ash Silo (Ash Holding Capacity):	i) Stage-I: 700 Ton	**18**
		ii) Stage-II: 700 Ton	**14**
		iii) Stage-III: 350 Ton	**22**
8	ESP Area: Stage wise number of hoppers	i) Stage-I: 72 Hoppers	**16**
		ii) Stage-II: 64 hoppers	**18**
		iii) Stage-III: 64 hoppers	**27**
		iv) Stage-IV: 144 hoppers	**15**

Table 1: Maximum Dose rates Observed at the survey locations

Dose Calculation:

Note: 1 Sv = 100 R

1. **Primary Coal Yard Area: -**

   Number of working hours in a day: - 8 hrs
   Number of working days in a week: - 5 days
   Number of working weeks in a year: - 52 weeks
   Therefore total no. of working hours in a year: - 2080 hrs
   Maximum dose rate in the area: - 14 µR/hr

   Dose received by a person in a year: - 2080 × 14 = 29120 µR = **0.29 mSv**

2. **Secondary yard Area: -**

   Number of working hours in a day: - 8 hrs
   Number of working days in a week: - 5 days
   Number of working weeks in a year: - 52 weeks
   Therefore total no. of working hours in a year: - 2080 hrs
   Maximum dose rate in the area is in Zone B: - 14 µR/hr

   Dose received in a year: - 2080 × 14 = 29120 µR = **0.29 mSv**

3. **Coal Handling Plant: -**

   Number of working hours in a day: - 8 hrs
   Number of working days in a week: - 5 days
   Number of working weeks in a year: - 52 weeks
   Therefore total no. of working hours in a year: - 2080 hrs
   Maximum dose rate in the area: - 20 µR/hr

   Dose received in a year: - 2080 × 20 =39520 µR = **0.39 mSv**

4. **Bunkers:**

   Number of working hours in a day: - 8 hrs
   Number of working days in a week: - 5 days
   Number of working weeks in a year: - 52 weeks
   Therefore total no. of working hours in a year: - 2080 hrs
   Maximum dose rate in the area is in Unit#4 bunkers: - 13 µR/hr

   Dose received in a year: - 2080 × 13 = 27040 µR = **0.27 mSv**

5. **Ash Dyke Area: -**

Number of working hours in a day: - 8 hrs
Number of working days in a week: - 5 days
Number of working weeks in a year: - 52 weeks
Therefore total no. of working hours in a year: - 2080 hrs
Maximum dose rate in the area is in Umran (including AWRS system): - 29 µR/hr

Dose received in a year: - 2080 × 29 =60320 µR = **0.60 mSv**

6. **Ash handling Plant:**

Number of working hours in a day: - 8 hrs
Number of working days in a week: - 5 days
Number of working weeks in a year: - 52 weeks
Therefore total no. of working hours in a year: - 2080 hrs
Maximum dose rate in the area is in Stage-IV: - 18 µR/hr

Dose received in a year: - 2080 × 18 = 37440 µR = **0.37 mSv**

7. **Ash Silo:**

Number of working hours in a day: - 8 hrs
Number of working days in a week: - 5 days
Number of working weeks in a year: - 52 weeks
Therefore total no. of working hours in a year: - 2080 hrs
Maximum dose rate in the area is in Stage-III: - 22 µR/hr

Dose received in a year: - 2080 × 22 = 45760 µR = **0.45 mSv**

8. **ESP Area:**

Number of working hours in a day: - 8 hrs
Number of working days in a week: - 5 days
Number of working weeks in a year: - 52 weeks
Therefore total no. of working hours in a year: - 2080 hrs
Maximum dose rate in the area is in Stage-IV: - 20 µR/hr

Dose received in a year: - 2080 × 27 = 56160 µR = **0.56 mSv**

The analysis of the samples collected from the above locations were analysed at Radioanalytical Laboratory, BRIT, Vashi. The radioactivity present in the samples has been tabulated in Bq/Kg.

Sr.No.	Sample Name & ID	U-238 (Bq/Kg)	Ra-226 (Bq/Kg)	Th-232 (Bq/Kg)	K-40 (Bq/Kg)
1	1	52.9±2.4	49±5.8	72.6±6.1	185.8±12.9
2	2	56.1±2.8	49±5.8	72.6±6.1	185.8±12.9
3	3	44.4±2.4	29.5±4.1	69.6±3.9	213.3±14.3
4	4	95.2±3.7	76.0±7.0	145.0±5.3	564.4±28.4
5	5	113±3.6	97.7±8.1	162±3.2	708±33
6	6	93.4±3.9	77.2±7.4	141.0±3.1	741±35.2
7	7	110.0±4.1	79.5±7.3	167±3.3	796±35.8
	Activity concentration for exempt material (as per IAEA SSR-6 Rev.1 2018, Regulations for the safe transport of radioactive material)	**10^4**	**10^4**	**10^4**	**10^5**
*mdl is the lowest activity of the isotope that can be detected					

Table 2: Sample analysis for radioactivity content

4. RESULTS AND DISCUSSION

- No significant rise from the background radiation level was observed at the coal and fly ash storage yards.
- The maximum permissible effective whole-body dose for occupational exposure is **30 mSv/year** (20 mSv/year averaged over 5 consecutive years) and the general public exposure limit is **1 mSv/year** as per the **AERB directive No. 01/2011.**
- It may be noted that the readings in table-1 are the maximum readings observed over the entire area. The maximum readings were found at very few and isolated spaces and do not represent the average field observed in those areas. Still to be on conservative

side, the maximum readings are considered for calculation. Considering the maximum recorded dose rate of **29 µR/hr** (Ash Dyke Area Umran including AWRS system), A person may receive **0.60 mSv/year** of radiation dose (working 8 hours per day and 5 days in a week) which is very less than the general public exposure limit.

- The activity concentration (Bq/kg) of the radioactive elements in the coal / ash samples were very less than the limit for material exemption as prescribed by **IAEA SSR-6 Rev.1/2018.**

5. RECOMMENDATIONS

- The radioactivity assessment study should be conducted as per the regulatory requirements to avoid the potential radiation hazard.

C.B.Tiwari
Radiation Safety Officer, BRIT

Vinay Bhave
DGM, BRIT

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