एनटीपीसी
NTPC
एक महारत्न कम्पनी

एन टी पी सी लिमिटेड
(भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

कुड़गी / KUDGI

Ref.: NTPC/Kudgi/EMG/2023/201

Dated: 27.05.2023

To,
The Deputy Director General of Forests (C)
Ministry of Environment, Forest and Climate Change (MoEF&CC)
Integrated Regional Office,
Kendriya Sadan, 4th Floor, E & F Wings,
17th Main Road, IInd Block, Koramangala,
Bengaluru – 560 034 (Karnataka)

Sub.: Submission of Six Monthly Compliance Report for Environmental Clearance of NTPC Ltd., Kudgi STPS, Stage-I (3 x 800 MW) – Reg.

Ref.: 1) MoEF&CC Letter No. J 13012/06/2009-IA.II (T) dated 25.01.2012.
2) MoEF&CC Letter No. J 13012/65/2008-IA.II (T) dated 11.08.2020.
3) MoEF&CC Letter No. J 13012/06/2009-IA.II (T) dated 04.07.2022.

Dear Sir,

With reference to the MoEF&CC OM dated 14.06.2022 regarding submission of six monthly compliance report through dedicated module in PARIVESH, we wish to humbly inform that NTPC Kudgi is experiencing issues regarding uploading of EC conditions under project proponent category. The issue has appropriately been brought to the knowledge of concerned NIC technical team of MoEF&CC by registering complaint *(Ticket No. PAR-TIC-891327)* in PARIVESH portal as advised by them.

In view of the above, we are constrained to submit the six monthly compliance report pertaining to NTPC Kudgi as per the regular practice. Please find enclosed herewith, the Six Monthly Compliance Status Report for the period October, 2022 - March, 2023 in respect of the Environmental Clearance conditions stipulated vide MoEF&CC letter no. J 13012/06/2009-IA.II (T) dated 25.01.2012 and subsequent amendments dated 11.08.2020 and 04.07.2022 respectively for NTPC Ltd., Kudgi Super Thermal Power Project, Stage-I (3 x 800 MW) located near village Kudgi, Tq. Basavana Bagewadi, Distt. Vijayapur, Karnataka.

Thanking you.

Yours sincerely,

(Amit More)
Dy. General Manager (EMG)

Encl.: as above.

Copy to:
1) The Member Secretary, KSPCB, Bengaluru.
2) The Environmental Officer, Regional Office - KSPCB, Vijayapura.

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कुड़गी / KUDGI

HALF-YEARLY COMPLIANCE STATUS REPORT

OF

ENVIRONMENT CLEARANCE

(MoEF&CC Letter No. J-13012/06/2009-IA.II(T) Dtd.25.12.2012)
(MoEF&CC Letter No. J-13012/65/2008-IA.II(T) Dtd.11.08.2020)
(MoEF&CC Letter No. J-13012/06/2009-IA.II(T) Dtd.04.07.2022)

SUBMITTED BY

NTPC LTD., KUDGI SUPER THERMAL POWER STATION
STAGE-I (3 X 800 MW)
KUDGI, BASAVANA BAGEWADI (TAL.), VIJAYAPURA (DIST.),
KARNATAKA – 586 121

MAY - 2023

HALF YEARLY ENVIRONMENTAL MONITORING REPORT

(PERIOD: APRIL-2022 TO SEPTEMBER-2022)

COMPLIANCE STATUS OF ENVIRONMENTAL CLEARANCE CONDITIONS
vide Letter Nos. J- 13012/06/2009-IA. II (T) dtd. 25.01.2012, J-13012/65/2008-IA.II(T) dtd.11.08.2020 and J-13012/06/2009-IA.II(T) dtd.04.07.2022.

S. NO.	STIPULATION	STATUS AS ON 31.03.2023
i	Vision document specifying prospective plan for the site shall be formulated and submitted to the Regional Office of the Ministry within six months.	Vision document has been prepared and submitted to the Regional Office (Southern Zone) MOEF&CC at Bangalore vide letter dated 11.07.2012.
ii	Land and water requirement shall be restricted as per latest CEA norms issued.	Land and water requirement for the project has been optimized and restricted as per the CEA norms.
iii	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 to Regional Office of the Ministry from time to time.	Solar panels having capacity of 1500KW have been installed at available rooftops of FWPH, Switchyard Building, Compressor House, O&M Store, TG Roof, Workshop Roof, Unit-1 IDCT, Railway Siding S&T Building, Fire Station Building in Plant and various Buildings in Township. In addition, 3.37MW of Hybrid Plant comprising of Solar and Wind project is already installed and commissioned.
iv	A study shall be undertaken through a reputed Govt. Organization/ Agriculture University on the impact on vegetation within 10 Km radius of the plant due to fly ash generated and action taken shall be submitted to the Ministry. The study shall be completed within one year of operation of the proposed plant.	The scientific study for assessment of impact on vegetation within 10 Km radius of the plant due to fly ash generated has been conducted through M/s Indian Agricultural Research Institute who is governed by Indian Council of Agricultural Research (ICAR-Govt. of India). Copy of report is enclosed as **Annex-1**.
v	A wildlife conservation plan shall be formulated in consultation with the office of the Chief Wildlife Warden and duly vetted by the concerned Chief Wildlife Warden for immediate implementation. The plan shall have an in-built monitoring mechanism.	The Deputy Conservator of Forests, Karnataka Forest Department (KFD), Vijayapur Division vide letter no. B2/DCF/BIP/NTPC/W.L/2013-14 dated 03.02.2014 has communicated that there is no Wildlife Sanctuary, National Park or Protected Area in and around 10 Km radius of Kudgi STPS. In view of the above, no wildlife conservation plan is envisaged.

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vi	Provision for installation of FGD shall be provided for future use.	Noted and compliance assured. Provision for installation of FGD was available and installation works of FGD system for controlling SOx concentration in flue gas are in progress.
vii	Coal transportation to plant site shall be undertaken by rail and no road transportation shall be permitted.	Noted and compliance assured. No coal is being transported by road. Coal transportation to plant site is being undertaken through railways only.
viii	A detailed study on chemical composition of coal used, particularly heavy metal and radioactive contents shall be carried out through a reputed institute and report shall be submitted to Regional Office of the Ministry. Only after ascertaining its radioactive level shall fly ash be supplied to end user.	In compliance to the said stipulation, a study of heavy metal analysis and radioactivity analysis of coal was carried out through CSIR-NCL & BRIT, Department of Atomic Energy respectively and the reports are submitted along with EC compliance reports dated 13.05.2017 and 19.11.2019.
ix	Fly ash shall not be used for mine void filling or for agricultural purpose.	Is being complied. Fly ash is not being used for mine void filling or for agricultural purposes.
x	The project proponent shall carry out a long term R&D on Boiler efficiency vis-à-vis large variation on ash content of coal and submit its findings to the Ministry at a later stage.	The records w.r.t. boiler efficiency and corresponding ash content are being compiled for all the 3 units. Copy of the data compiled up-to Dec-2022 is enclosed as **Annex-2**.
xi	A 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 for SO_x, NO_x, PM_{10} and $PM_{2.5}$. Mercury emissions from stack may also be monitored on periodic basis.	▪ A single flue stack for Unit-1 and bi-flue stack for Unit-2 & 3 having chimney height of 275m, is provided. ▪ Continuous Emission Monitoring System for online measurement of SO_2, NO_x, and Particulate Matter (PM) has been provided and the emissions are being monitored. Mercury emissions from stack are also monitored on periodic basis through MoEF&CC approved laboratory.
xii	High Efficiency Electrostatic Precipitators (ESPs) shall be installed to ensure that particulate emission does not exceed 50 mg/Nm^3.	High Efficiency Electrostatic Precipitators (ESP) designed for achieving guaranteed efficiency of 99.97% have been installed and the emission of Particulate Matter (PM) as per applicable norms is being complied.
xiii	Adequate dust extraction system such as cyclones/ bag filters and water spray system in dusty areas	**Ash Handling Areas:** Dry ash is being pneumatically conveyed from ash hoppers to HCSD ash silos. 04 nos. HCSD silos

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	such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	having capacity of 625MTeach are in use for supply of ash to end-users. 06 nos. of fly ash (FA) silos having capacity of 1600MT are under construction. The ash is being issued to Cement and RMC industries in closed bulkers only through HCSD silos provided with telescopic chutes. Un-utilized ash is disposed to ash dyke through High Concentration Slurry Disposal (HCSD) system through pipelines. **Coal Handling Areas:** Pre-wetting and water sprinkling arrangements are available for control of dust during unloading of coal at Wagon Tippler (WT) area. In addition, fog canons (mist canons) are also provided for mitigating the fugitive emissions in WT area. Closed coal conveyor system has been adopted for internal coal movement. The conveyors and Transfer Points (TPs) are provided with automatic Dry Fog Dust Suppression (DFDS) for controlling the fugitive dust. **Coal Stockyard:** Regular compaction of the coal stored in coal storage area (stockyard) is being carried out with the help of dozers and compactors which minimizes the potential of any fugitive dust. During reserved shutdown (RSD) periods, the stacked coal is covered with tarpaulin to avoid emanation of any fugitive dust. Dust suppression in coal stockyard by means of water spraying is being carried out on regular basis. Spontaneous combustion of coal is a common concern within the coal stockyard of thermal power plants. Therefore, water spraying becomes crucial not only for dust suppression but for quenching of fire also in the coal stockyards.
xiv	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.	Ash Utilization Plan has been prepared and all efforts are being made to achieve the targets in compliance to fly ash Gazette Notification dated 31.12.2021 and its subsequent amendment. The annual compliance status of ash utilization is being submitted to the Regional Office (SZ), MOEF&CC at Bangalore regularly.

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xv	Fly ash shall be collected in dry form 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 will be disposed-off in low lying area.	Ash management scheme is implemented consisting of Dry Ash Extraction System (DAES) for collection of fly ash with storage facility (silos), supply of ash to entrepreneurs for utilization and promoting ash utilization to maximum possible extent and safe disposal of unused ash in the ash pond. Dry ash is being pneumatically conveyed from ash hoppers to HCSD ash silos in dry form for supply to end-users i.e. Cement and RMC industries. Storage facility viz. 04 nos. HCSD silos having capacity of 625MT each are in use for supply of ash to end-users. 06 nos. of fly ash (FA) silos having capacity of 1600MT are under construction. The plant is equipped with two ash disposal systems, [a] conventional wet slurry disposal with ash water re-circulation for bottom ash, and [b] High Concentration Slurry Disposal system (HCSD) for disposal of unused fly ash. Periodic monitoring for mercury & heavy metals in the bottom ash and water emanating from ash pond is being carried out through MoEF&CC approved laboratory. No ash is disposed-off in the low lying areas.
xvi	Ash pond water shall be re-circulated and utilized.	Ash Water Recirculation System (AWRS) is implemented for re-circulating the ash water from the ash pond area to the plant for its complete re-utilization in the ash handling system.
xvii	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.	The ash dyke lagoons where bottom ash slurry is being discharged and Overflow lagoon, are designed and lined with impervious thick liner of 300mm with material like Bentonite blended clay and charged with impervious high concentrated slurry mainly consisting of fine fly-ash which is considered to be having low permeability coefficient. The structure of ash dykes is designed, constructed and operated as per state-of-the-art engineering practices for the design and construction of earthen dams [as per the relevant IS code (IS-7894 for stability

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		analysis of earth dams, IS-9429 for internal drainage system for earth & rock fill dams etc.)] with adequate factor of Safety. Seismic parameters have also been taken into consideration while designing of the ash dyke. Regular monitoring and inspection of ash dykes and an emergency response system ensure that there are no risks of failure.
xviii	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.	Sulphur content in the coal is checked on random basis and weighted average in the coal used is equal to or less than 0.5%. Further, MoEF&CC vide Notification no.S.O.1561(E) dated 21.05.2020 has amended and allowed use of coal by thermal power plants, without stipulations as regards ash content or distance.
xix	Hydro-geology 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.	NTPC Kudgi has carried out a Hydrogeological study of the area through National Institute of Hydrogeology (NIH), Roorkee and the study report has been submitted to MoEF&CC vide HYC report dated 02.12.2017. The surface and ground water analysis is being carried out through MoEF&CC approved laboratory and the summary report is enclosed herewith as **Annex-3**. Further, a study for review of hydro-geology of the area is in progress.
xx	No ground water shall be extracted for use in operation of the power plant even in lean season.	Noted and compliance assured. The water requirement for use in operation of the power plant is drawn from Almatti reservoir for which MoU with KBJNL, GoK dated 27.09.2014 is available for supply of 5.2TMC per annum water requirement.
xxi	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.	Noted and compliance assured.
xxii	Minimum required environmental flow suggested by the Competent Authority of the State Govt. shall be maintained in the Channel/	Noted and compliance is being ensured.The water is drawn from Almatti reservoir with the prior permission of the Competent Authority.

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	Rivers (as applicable) even in lean season.	
xxiii	COC of 4.0 shall be adopted.	Noted and compliance assured. A closed cycle cooling system has been designed and implemented for achieving minimum 4 Cycles of Concentration (COC) at NTPC Kudgi for conservation/ optimization of water requirement for the project.
xxiv	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.	Monitoring around the ash pond area is being carried out through MoEF&CC approved laboratory, particularly for heavy metals and records are maintained and submitted to Karnataka State Pollution Control Board (KSPCB) and MoEF&CC regularly. Ground water level monitoring has been carried out in and around the main plant and ash pond area by establishing a network of existing wells during the Hydro-geological study carried through M/s National Institute of Hydrology (NIH), Roorkee. A study for reviewing the hydro-geology of the area is in progress.
xxv	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.	Monitoring of surface water quality in the area is being carried out through MoEF&CC approved laboratory and the reports are submitted to the Regional Office (SZ) of MOEF&CC and KSPCB. Monitoring for heavy metals in ground water are also being carried out and its record submitted to KSPCB regularly.

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xxvi	Waste water generated from the plant shall be treated before discharge to comply limits prescribed by the SPCB/ CPCB.	An effluent management scheme has been designed and is being implemented with the objective to treat the entire wastewater as per the prescribed statutory standards of KSPCB/ CPCB. It is submitted that during normal course of project operation the feasibility of zero discharge has been adopted based on maximum recycle/ reuse of wastewater for various plant usage thereby reducing and optimizing the quantities of water requirement and effluent generation to the extent feasible.
xxvii	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.	Rainwater harvesting structures have been constructed and measures are also being undertaken as per the site conditions.
xxviii	Additional soil for levelling of the proposed site shall be generated within the sites (to the extent possible) so that natural drainage system of the area is protected and improved.	All levelling activity of the project site is being done from additional soil generated within the sites only with all necessary precautions to protect natural drainage system of the area.
xxix	At least three nearest village shall be adopted and basic amenities like development of roads, drinking water supply, primary health centre, primary school etc. shall be developed in co-ordination with the district administration.	Activities like road construction & development, providing bus shelters, development of sanitation facilities, drinking water facilities, providing medical equipment to Hospital, 24-hour ambulance facility, providing of tools and equipment to Government ITI, conducting health camps, providing additional infrastructure facilities in schools, distribution of books to students etc. have been carried out in villages near the project. Improvement of infrastructure of primary health centers of four villages & construction of additional class rooms in schools are in progress. All welfare activities under R&R scheme are being carried out in five surrounding

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		villages namely Kudgi, Telgi, Masuti, Golsangi and Muttagi. • *In Golsangi village, new Primary Health Centre (PHC) building has been constructed and handed over to Dept. of Health & Family Welfare, Govt. of Karnataka.* • *Around 38 new classrooms have been constructed in above-mentioned five villages benefitting more than 20 Government Schools.* <u>During 2019-20:</u> • *NTPC Kudgi distributed School Notebooks worth Rs.12 Lakh to about 8000 students in the above-mentioned five villages.* <u>During 2020-21:</u> • *NTPC Kudgi distributed Library furniture worth Rs.4 Lakh for Golasangi RAD School and Madhri Badawne School.* <u>During 2021-22:</u> • *NTPC Kudgi installed 06 nos. Solar High Masts at Project Affected Villages.* • *Extended financial support of Rs.43 Lakh towards COVID Doctors remuneration.* • *Distributed 40,000 notebooks to Project Affected Village School Children.* <u>During 2022-23:</u> • *Under CSR – A month long Girl Empowerment Mission (GEM) programme conducted for empowering girls by giving exposure of various activities and training including skills & self-defense to 42 girls from Project Affected Villages who are studying in 6th standard.* • *Financial support of Rs.2 Lakh for village level Sports Meet.* • *Sponsorship of ITI Training at Government ITI, Vijayapura for 9 students of Project Affected Villages.*
xxx	A special scheme for upliftment of SC & ST population in the study area shall be formulated and implemented in a time bound manner. The project proponent	Under Community Development (CD) initiatives, special scheme for up-liftment of SC & ST population in the study area is being formulated and implemented in a time bound manner.

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	shall also identify the rights of tribals under existing Laws and ensure its protection and implementation thereof.	Over a period of nine years, around 350 meritorious students (all categories including SC, ST, OBC) from neighboring villages have been awarded with Uttkarsh Scholarship along-with a solar lamp. Further, students of SC/ ST community of Govt. ITI, Vijayapura also got benefitted by the sponsorship program extended by industry. During FY 2020-21, industry have sponsored 10 students from surrounding project affected villages to Govt. ITI College as part of its skill upgradation program. Identification the rights of Under tribal – industry will support for Banjara Community for manufacturing of Banjara Dress items under Self-help group up-liftment. During 2022-23: Under CSR, a month long Girl Empowerment Mission (GEM) program conducted for empowering girls by giving exposure of various activities and training including skills & self-defense to 16 girl children from SC and 1 girl child from ST from Project Affected Villages studying in 6th standard.
xxxi	A comprehensive R&R action plan with requisite details such as details of land losers and financial budget for compensation etc. shall be submitted to the Regional Office of Ministry within four months. The R&R action plan shall also include scheme for upliftment of marginalized section who are indirectly affected on account of dependence for their sustenance on the land not owned by them.	A comprehensive R&R action plan with requisite details such as details of land losers and financial budget for compensation etc. has already been prepared and approved in consultation with representatives of PAPs, VDAC and Government of Karnataka. Implementation of the same is in progress. The Final R&R Plan has been submitted to the Regional Office (SZ) of MOEF&CC, Bangalore vide letter dated 16.10.2012.
xxxii	The project proponent shall also adequately contribute in the development of the neighboring 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.	Due to the setting up of Kudgi STPS, general facilities in the nearby areas have certainly developed. New opportunities for business and self-employment have been generated thereby increasing the cash flow in business. NTPC is making all efforts for developing infrastructural facilities and implementing various community development activities through;

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		• Alternate employment opportunities to PAPs and local people, • Periodic health checkup program for the nearby villagers, • Opportunities to local people to enhance their businesses, • Development of infrastructure facilities viz. improvement in roads, bus shelters, public facilities, solar street lamps, sanitation, toilets, medical, schools, sport facilities etc. are being implemented.
xxxiii	CSR schemes 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. As part of CSR employment of local youth after imparting relevant training, as may be necessary shall be undertaken as committed.	Various CSR schemes are being implemented based on need based survey within 5Km and in consultation with the Village Panchayat and the District Administration; • Infrastructural development i.e. improvement in roads, electricity, supply of drinking water, sanitation, educational institutions, and transportation facilities etc. • Scholarships to students and facilitation for sports, training for self-employment (computer, welding, bar-bending, carpentry, stitching, embroidery) etc. • Training/ financing facilitation for development of rural small scale industries i.e. Bee-keeping, Poultry, Dairy Farming etc. Further, as part of Corporate Social Responsibility, NTPC Kudgi distributed 620 Nos. of desks to Schools at Dharwad worth Rs.12.5 Lakh during FY 2020-21. During Covid-19 pandemic in FY 2020-21, NTPC Kudgi committed Rs.15 Lakh to District Administration towards relief material and other essential items for distribution among stranded laborer. In addition, with the support of RIO, Bengaluru, NTPC Kudgi team has extended supporting hands for the distribution of Ration Kits worth of Rs.5 Lakh to needy and vulnerable group of people at Bengaluru.
xxxiv	An amount of Rs.52.80 Crores shall be earmarked as one capital	Out of Rs.52.95 Crore earmarked for R&R expenditure, an amount of Rs.52.95 Crore

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	cost for CSR programme as committed by the project proponent. Subsequently a recurring expenditure of Rs. 10.60 Crores per annum till the life of the plant shall be earmarked as recurring expenditure for CSR activities. Details of the activities to be undertaken shall be submitted within six month along with road map for implementation.	(approx.) have been spent for R&R activities and the remaining is committed by NTPC Kudgi towards activities such as Tools and Equipment to Govt. ITI, Vijayapur, new classrooms for schools, improvement of infrastructure and medical equipment at nearby Primary Health Centers and construction of individual toilets etc. as decided in the Village Development Advisory Committee meeting chaired by Dy. Commissioner, Vijayapur. The condition has been deleted vide MoEF&CC amendment letter no.J-13012/65/2008-IA.II(T) dated 11.08.2020.
xxxv	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.	Need Assessment Survey and Social Audit for community development program for nearby areas of NTPC Kudgi has been carried out through Department of Social Work, Karnataka State Akkamahadevi Women's University, Vijayapur. The said stipulation will be complied regarding implementation of an in-built monitoring mechanism for the CSR schemes and annual social audit from the reputed Government institute in the region. Recently, Need Assessment Survey and Social Impact Evaluation Survey completed through Indian Institute of Corporate Affairs, final report is under review.
xxxvi	Green Belt consisting of 3 tiers of plantations of native species around the plant and 100 m width shall be raised (except in areas not feasible). The density of trees shall not be less than 2500 per ha with survival rate not less than 80%.	MoU is signed with Vijayapura Forest Division of Karnataka Forest Department for mass Greenbelt development (including maintenance for subsequent 4 years) at the plant with plantation density not less than 2500 per ha and survival rate not less than 90% against the stipulated survival rate of 80%. A total tree plantation of more than 3.25 Lakh consisting of 3 tiers is done with native species of plants (such as *Azadirachta indica, Aegle marmelos, Ficus benghalensis, Ficus racemosa, Ficus religiosa, Gliricidia sepium, Mangifera indica, Motinga oleifera, Pithecolobium dulce, Phyllanthus emblica, Syzygium cumini, Tamarindus indica, Ziziphus jujube etc.*) in and around the plant and 50m-100m width wherever feasible till date through

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		Karnataka Forest Department in an area of more than 230 acres out of stipulated 300 acres having survival rate of more than 90%. In addition, tree plantation of more than 5 Lakh saplings (including maintenance for subsequent 5 years) with an expenditure of Rs.3.5 Crore has been carried out through Karnataka Forest Department (KFD) in the four forest divisions namely Shivamogga, Sagara, Hunsur and Mandya forest divisions in an area of 323 Ha. During FY 2022-23, about 20,000 saplings have also been planted in Mamadapur forest land in 124 acres.
xxxvii	An Environmental Cell shall be created at the project site itself and shall be headed by an officer of appropriate seniority and qualification. It shall be ensured that the Head of the Cell shall directly report to the Head of the organization.	An Environment Management Group (EMG) with qualified team headed by Deputy General Manager (EMG) is functional at Kudgi STPS and is reporting to the Head of the Project.
B. GENERAL CONDITIONS:		
i.	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.	Noted and compliance assured. Treated effluent conforming to standards is being re-circulated and reused within the plant only. An independent plant effluent drainage system is being provided to ensure that plant effluents do not mix with storm water drainage.
ii.	A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising greenbelt/ plantation.	Noted and compliance assured. All domestic sewage is treated in STP and treated sewage conforming to prescribed standards is utilized for plantation & raising greenbelt to the extent possible through a treated water network.
iii.	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.	Noted and compliance assured. Adequate number of fire spray & hydrant system for covering the entire power station including coal yard, all the auxiliaries and buildings in the plant area have been designed and being implemented. The system includes piping system, hydrants, valves, instrumentation, hoses, nozzles, hose boxes/ stations etc.

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		Copy of fire safety measures details for CHP area and fire hydrant system has been submitted to Regional Office (SZ) of MOEF&CC at Bangalore vide HYC report dated 02.12.2017.
iv.	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.	License no.P/HQ/KA/15/2820(P359942) dated 06.11.2015 is available from Department of Explosives, Nagpur for importation and storage of Petroleum Class C in bulk. The sulphur content in the liquid fuel is not exceeding 0.5%. A detailed Disaster Management Plan (DMP) is prepared and finalized in consultation with Department of Factories, Boilers, Industrial Safety and Health, Govt. of Karnataka and regular mock drills are being conducted as per plan in order to address any eventuality in case of an accident.
v.	First Aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.	All arrangements related to first aid, health & safety and sanitation for contract workers during construction phase of the project are kept under the EPC contract and compliance is ensured by NTPC. NTPC Kudgi is in its operation stage and therefore various measures implemented are as follows: • Adequate infrastructure facilities, such as sanitation, medical facilities, safety, and suitable water supply are provided. • Safety equipment such as earplugs and earmuffs, helmets, face shields, safety goggles etc. is being provided to personnel engaged in high risk areas. • A First Aid Centre is established to provide immediate medical aid to the workers and their family members. A 24x7 hour ambulance is in service at site to transport injured workers to nearby hospitals.
vi	Noise levels emanating from turbines shall be so controlled such that the noise in the work zone shall be limited to 85 dB (A) from source. For people working in high noise area, protective requisite personal protective equipment like ear plugs/ ear	Noted and compliance assured. Equipment are designed as per the specifications for complying with the stipulation. In addition, Personal Protective Equipment are also being provided to personnel working in high noise areas.

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	muffs etc. 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.	Examination of workers engaged in noisy areas has been conducted as stipulated. The workers of generator halls and other high noise areas are being provided with appropriate ear protection devices.
vii	Regular monitoring of ambient air ground level concentration of SO_2, NO_x, $PM_{2.5}$ & PM_{10} and Hg shall be carried out in the impact zone and records maintained. If at any stage these levels are found to exceed the prescribed limits, necessary control measures shall be provided 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.	Four numbers of CAAQM Stations have been provided and locations of these CAAQMS were finalized in consultation with KSPCB. In addition, one of the AAQMS (18^{th} Cross AAQMS) is equipped with metrological station for monitoring the weather parameters such as wind speed & direction, temperature, rel. humidity, rainfall etc. Regular monitoring of ambient air ground level concentration of SO_2, NOx and $PM_{2.5}$ & PM_{10} is being carried out through MoEF&CC approved laboratory and records are being maintained. Online data connectivity arrangements for CAAQMS data to CPCB/ KSPCB have been provided. Periodic report along with the monitored AAQ data is being submitted at regular interval to the Regional Office (SZ) of MOEF&CC at Bangalore and the compliance report is being updated on the website of the company.
viii	Provision shall be made for the housing of construction labour (as applicable) within the site with all necessary infrastructure 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 structures to be removed after the completion of the project.	NTPC Kudgi is in its operation stage and therefore necessary facilities such as sanitation facilities, First Aid Center, ambulance, provision of drinking water, canteen etc. have been made for the labour force working within the Plant.
ix	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	The information of Environmental Clearance was published in Two newspapers. 1. “Deccan Herald” on 31.01.2012 in English.

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	within seven days from the date of this clearance letters informing that the project has been accorded environmental clearance letter, informing that the project has been accorded environmental clearance and copies of clearance letters are available with the State Pollution Control Board/ Committee and may also be seen at website of the Ministry of Environment and Forests at http:/www.envfor.nic.in.	2. "Vijaya Karnataka" on 31.01.2012 in vernacular (Kannada) language.
x	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.	NTPC vide letter dated 30.01.2012 has forwarded the copy of Environmental Clearance to the Tahsildar, Basavana Bagewadi Taluka. The Environmental Clearance is also uploaded on the NTPC website.
xi	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 pollutants levels namely SPM, RSPM, ($PM_{2.5}$ & PM_{10}), SO_2, NO_x (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.	The latest and updated Half Yearly Compliance (HYC) report of EC conditions is regularly being submitted to the Regional Office (SZ) of MOEF&CC at Bangalore and at the same time also uploaded on the NTPC website as per stipulations The pollutant levels are also being displayed near the Main Gate of NTPC Kudgi.
xii	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	The Environment Statement for financial year ending 31st March, 2022 (FY 2021-22) in prescribed Form-V has been submitted to KSPCB vide letter dated 29.08.2022. Submission of Environment Statement for FY 2022-23 will also be complied as per regulation.

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	(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.	
xiii	The project proponent shall submit six monthly reports on the status of the implementation of the stipulated environmental safeguards to the Ministry of Environment & 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 e-mail to the Regional Office, Ministry of Environment & Forests.	The half yearly compliance report is being regularly submitted to the concerned statutory authority. The latest six-monthly progress report for the period of October, 2022 to March, 2023 is submitted herewith.
xiv	Regional Office of the Ministry of Environment & Forests will monitor the implementation of the stipulated 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 upload the compliance status in their website and update the same from time to time at least six monthly basis. Criteria pollutants levels including NOx (from stack and ambient air) shall be displayed at the main gate of the power plant.	A complete set of documents including Environmental impact Assessment Report and Environment Management Plan along with the additional information/ clarifications as submitted to MOEF&CC have been forwarded on 13.02.2012 to the Regional Office (SZ) of MOEF&CC at Bangalore.

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xv	Separate funds should 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 should not be diverted for other purposes and year-wise expenditure should be reported to the Ministry.	The requisite funds for environmental mitigation measures have been included in the project cost. Financial provision stipulated towards environmental mitigation measures shall not be diverted for other purposes.
xvi	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 the plant.	The Regional Office, KSPCB has been informed regarding commercial power production from Unit-I, II and III vide letters dated 01.08.2017, 30.12.2017 and 14.09.2018 respectively.
xvii	Full cooperation should 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.	Noted and compliance is being ensured.
5	The Ministry of Environment and Forests reserves the right to revoke the clearance if conditions stipulated are not implemented to the satisfaction of the Ministry. The Ministry may also impose additional environmental conditions or modify the existing ones, if necessary.	Noted.
6	The environmental clearance accorded shall be valid for a period of 5 years to start of operations by the power plant.	Noted.
7	Concealing factual data or submission of false/ fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract under	Noted.

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	the provisions of Environmental (Protection) Act, 1986.	
8	In case of any deviation or alteration in the project proposed including coal transportation system from those submitted to this Ministry for clearance, a afresh reference should be made to the Ministry to assess the adequacy of the condition(s) imposed and to add additional environmental protection measures required, if any.	Noted.
9	The above stipulations would be enforced among others under the Water (Prevention and Control Pollution) Act, 1947, the Air (Prevention and Control of Pollution) Act. 1981, the Environment (Protection) Act, 1986 and rules there under, Hazardous Wastes (Management, Handling & Trans boundary Movement) Rules, 2008 and its amendments, the Public Liability Insurance Act, 1991 and its amendments.	Noted.
Compliance status of conditions stipulated in amendment to Environmental Clearance issued by MoEF&CC vide Letter No. J-13012/65/2008-IA.II(T) dtd.11.08.2020		
1	The undersigned is directed to refer your online application No.IA/OR/THE/105399/2019 dated 14.5.2019, IA/MH/THE/105566/2019 dated 16.5.2019, IA/KA/THE/105615/2019 dated 16.5.2019, IA/MP/THE/105718/2019 dated 17.5.2019 and IA/MH/THE/105652/2019 dated 17.6.2019 regarding amendment of EC conditions pertaining to implementation of Corporate Social Responsibility (CSR) activities.	-

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4	The specific condition no. xxxiv of the EC (Kudgi TPP) dated 25.1.2012 is as follows: *"An amount of Rs.52.80 Crores shall be earmarked as one-time capital cost for CSR programme as committed by the project proponent. Subsequently, a recurring expenditure of Rs.10.6 Crores per annum till the life of the plant shall be earmarked as recurring expenditure for CSR activities. Details of the activities to be undertaken shall be submitted within six month along with road map for implementation."*	-
7	It has been noted that you have requested for aligning the conditions w.r.t. CSR activities inline with the Section 135 of the Companies Act, 2013. The proposal was appraised by the EAC (Thermal Power) in its meeting held on 28.5.2019 and the EAC recommended to align the existing conditions inline with the Companies Act, 2013. The EAC also recommended to report the amount of 2% on profits to be spent under CSR, and the implementation of activities thereof.	-
8	The Ministry has examined the matter. It has been noted that the CSR is in the domain of Ministry of Corporate Affairs under Companies Act, 2013. The stipulation of conditions pertaining to CSR by MoEF&CC will create ambiguity in multiple reporting and duplication.	-
9	In view of the above, **the Ministry hereby deletes the above mentioned conditions related to CSR in the Environmental Clearance *dated 17.2.2014, 27.12.2010, 25.1.2012, 22.3.2013***	Noted w.r.t. condition no.xxxiv stipulated vide Environmental clearance dated 25.01.2012 for Kudgi STPP.

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	and 30.12.2010 with immediate effect.	
10	All other conditions mentioned in this Ministry's letter no.J-13012/65/2008-IA.II(T) dated 17.2.2014, J-13012/95/2008-IA.II(T) dated 27.12.2010, J-13012/06/2009-IA.II(T) dated 25.1.2012, J-13012/125/2009-IA.II(T) dated 22.3.2013, and J-13012/65/2009-IA.II(T) dated 30.12.2010, shall remain the same, as applicable.	Noted and compliance is being ensured.
Compliance status of conditions stipulated in amendment to Environmental Clearance issued by MoEF&CC vide Letter No. J-13012/06/2009-IA.II(T) dtd.04.07.2022.		
(i)	Increase plantation area to 33% in periphery of the plant boundary.	A total tree plantation of more than 3.25 Lakh consisting of 3 tiers is done with native species of plants (such as *Azadirachta indica, Aegle marmelos, Ficus benghalensis, Ficus racemosa, Ficus religiosa, Gliricidia sepium, Mangifera indica, Motinga oleifera, Pithecolobium dulce, Phyllanthus emblica, Syzygium cumini, Tamarindus indica, Ziziphus jujube etc.*) in and around the plant and 50m width wherever feasible till date through Karnataka Forest Department in an area of more than 230 acres out of stipulated 300 acres vide initial EC dated 25.12.2012 having survival rate of more than 90%. Since, the condition of 33% plantation area was not stipulated in the initial EC dated 25.12.2012, space is being explored to increase the plantation area to maximum extent in the periphery of plant boundary. However, industry has proactively taken up massive afforestation through KFD in forest land in four forest divisions i.e. Sagar, Hunsur, Mandya and Shivamogga by planting more than 5 Lakh saplings in an area of approx. 800 acres during FY 2016-17. In addition, about 20,000 saplings have also been planted in forest land (124 acres) during FY 2022-23 and nearly 30,000 is planned for plantation next year i.e. 2023-24 in an area of 185 acres. All these above

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		afforestation works may also be considered under 33% plantation area.
(ii)	Improve the soil quality in consultation with reputed institute so that plants can survive in the region.	Greenbelt development/ afforestation activities at NTPC Kudgi are being carried out through Karnataka Forest Department (KFD), Govt. of Karnataka, who are considered to be the experts in afforestation works. KFD has managed to maintain the survival percentage of plantation above 90% against 80% which is stipulated vide condition no.xxxvi of EC dated 25.01.2012, by adopting various measures including improvement of soil quality.
(iii)	Three row plantation along the boundary of 390 acres of land proposed to be diverted for development of Industrial Park. The plantation work will be completed prior to diversion of land.	Noted and compliance will be ensured.
(iv)	24X7 online Continuous monitoring system for ambient air quality parameters SOx, NOx and PM shall be established with connected server to CPCB and SPCB.	Noted and compliance will be ensured.
(v)	Other conditions of the EC letter dated 25.01.2012 shall remain unchanged.	Noted and compliance is being ensured.
5	All other terms and conditions stipulated in the environmental clearance dated 25th January, 2012 and its amendment dated 11th August, 2020 shall remain unchanged.	Noted and compliance is being ensured.

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EXECUTIVE SUMMARY

IARI-NTPC Kudgi
Contract Research Project (2020-22)
Study on the Impact on Vegetation within 10 km Radius of the Plant due to Flyash Generated and Primary and Secondary Pollutants on Crop around NTPC Kudgi

(NTPC-PO No.: 4000226319-037-1046 Dated 27.08.2019)
(IARI Project Code: 79-122 TG 5142)

Submitted To:
NTPC Limited
Kudgi Super Thermal Power Station
Distt:- Vijayapura (Bijapur), Karnataka, India-586121

Submitted by:
Dr. D.S. Gurjar
Senior Scientist & Principal Investigator (PI)

WATER TECHNOLOGY CENTRE
ICAR-Indian Agricultural Research Institute
New Delhi -110 012

EXECUTIVE SUMMARY OF THE REPORT

NTPC Limited (NTPC) is an Indian Central Public Sector Undertaking, engaged in the business of generation of electricity and allied activities. It is a company incorporated under the Companies Act 1956 and is promoted by the Government of India. Kudgi Super Thermal Power Station (NTPC Kudgi) is coal based thermal power plant located near Kudgi village of Basavana Bagewadi Taluq in Bijapur (now officially known as Vijayapur from 1st November 2014) district, Karnataka, India. It is the first super-critical coal-fired power project to be undertaken by India's state-owned electricity generator NTPC Ltd. NTPC Kudgi is having the total capacity of 2400 MW. It has 3 Units of 800 MW each. Ash is generated as a by-product of burning of coal in the furnace. Ash is disposed off in dry form and wet form. In dry form it is pneumatically conveyed to ash silos from where it is issued to various ash users such as cement industries, ready mix concrete units, ash brick plants etc. in closed bulkers. Bottom ash and unutilized fly ash is conveyed to ash pond in lean slurry and high concentrated slurry form (HCSD) respectively.

Besides the flyash production, coal based thermal power plants also emits primary pollutants (NOx, SOx, TSP and CO) and secondary pollutant (sulphates, nitrates, O_3, paroxyacetyle nitrate (PAN) etc.) during the coal combustion process. Hence, the fly-ash, primary and secondary pollutants generated from coal based thermal power plants may cause adverse impacts on human health, environment (soil, water and air) and agricultural production in surrounding areas. Hence, the NTPC Kudgi plant is a Category-A project (as per EIA Notification 2006) and got environmental clearance in the year 2012 from Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India. As per the Environment Clearance (vide MoEF&CC Letter No. J 13012/06/2009-IA. II (T) dated 25.01.2012), granted to NTPC Kudgi, specific condition no. (iv) "A study shall be undertaken through a reputed Govt. Organization / Agriculture University on the impact on vegetation within 10 km radius of the plant due to fly ash generated and action taken shall be submitted to the Ministry."

In compliance to this specific condition, study has been awarded to ICAR-Indian Agricultural Research Institute, New Delhi-110012 with the objectives as (1) Assessment of impacts on vegetation within 10 km radius of the plant boundary due to fly ash generated from NTPC Kudgi plant, (2) Assessment of impacts of primary and secondary pollutants on crops in the vicinity of NTPC Kudgi plant in terms of yield (quality and quantity) and (3) Recommendations for preventive and mitigative measures to minimize the adverse impact, if any, due to operation of NTPC Kudgi plant.

ICAR-Indian Agricultural Research Institute, New Delhi, a constituent unit of the Indian Council of Agricultural Research (ICAR), is fully central government funded autonomous body/registered society responsible for coordinating agricultural education research and extension in India. It reports to the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. The Union Minister of Agriculture serves as its president. It has the largest network of agricultural research and education institutes. ICAR head quarter is located at 1, Rajendra Prasad Road,

Krishi Bhawan, New Delhi, having its administrative office at Pusa Campus, New Delhi – 110 012 (INDIA). ICAR-Indian Agricultural Research Institute (IARI) is a premier center for agricultural research, education and extension in the country. Institute's research includes environmental aspects such as water quality, soil health and air quality management, crop improvement, production and crop quality research etc. Institute is also playing instrumental role for developing several technologies, machines, tools, high-yielding varieties of almost all the major crops, promoting agriculture mechanization in the country.

Data/information on project and study area description were collected through reconnaissance survey or visits conducted by the scientific team of IARI. Based on reconnaissance survey considering upwind & downwind and windward and leeward directions of the power plant areas, and wind rose maps for the area, crops and vegetation grown in the study area, the 10+1=11 sampling locations were finalized in consultation with Engineer In-charge (EIC) of NTPC Kudgi for collection of soil, water, air and plant samples. Hence, the villages such as Kudgi, Takkalki, Golsangi, Mukarthial, Telgi, Cheraladeni, Kaulgi, Nagardenni, Masuti, Telewad and Kalgurki (Control) were selected as sampling locations/sites for the present study.

Reviewed the literature to know the physico-chemical characteristics of fly-ash and air pollutants (primary and secondary) and its impacts on vegetation and crops. Meteorological data were collected from Meteorological Observatory of the University of Agricultural Sciences, Dharwad (UASD)–Regional Agricultural Research Institute (RARS), Vijayapur/ Bijapur. Water, soil, crop plant, vegetation, fly-ash, pond-ash, pond effluent and air samples were collected from the selected sampling sites as per time period mentioned in the ToR/PO given by NTPC Kudgi.

The daily rainfall data of the study area were collected from January 2020 to June 2022 from the study area (Bijapur District, Karnataka). Data revealed that the maximum mean monthly rainfall was observed as 267.3 mm and 161.7 mm in the month of September in both the years (2020 & 2021). Minimum mean monthly rainfall was observed as 0.4 mm to 10.2 mm in the winter months of November to February for both the years (2020 -21). Total annual rainfall of the years of 2020 and 2021 in Bijapur/Vijayapur, Karnataka was occurred as 862.2 mm and 632.8 mm, respectively. Mean monthly maximum air temperature was varied from 28.8 to 39.5^{0}C while mean monthly minimum air temperature was varied from 13.5 to 24.2^{0}C in the study years for the years (2020-2022). The relative humidity (RH) was observed in the forenoon (AM) and afternoon (PM) in a day. The mean monthly maximum relative humidity was observed as 85.0 % - 91.9% in forenoon (AM) and 48.0% -68.0% in afternoon (PM) in years of 2020-22 while mean monthly minimum relative humidity were observed as 53.0% - 60.4% in forenoon (AM) and 19.4% -23.6% in afternoon (PM) in the study years during 2020-22. The highest wind speed observed as 11.3 to 12.4 kmph and lowest wind speed as 3.0 - 4.24 kmph were recorded during the year 2020-22. The mean annual wind speed in Bijapur, Karnataka was observed as 7.0 to 7.5 kmph during 2020-22. The dominant wind direction was observed as west (W) and south east (SE) in the year in the year 2020 and west (W), southeast (SE) and north-west (NW) in the year 2021. The mean monthly minimum and maximum bright sunshine hours were observed as 3.3 hours and 9.4 hours, respectively in the year of 2020-22

in Bijapur, Karnataka. The mean monthly minimum and maximum pan evaporation were observed 2.6 mm and as 9.2 mm, respectively in the years of 2020-22. It can be concluded that the climatic/weather condition of the study area is pleasant and good for operation of thermal power plant. Dominant wind directions of the study area were west, north-west and south-west.

Parameters of water quality (pH, EC, Ca, Mg, CO_3^{2-}, HCO_3^-, Na^+, SAR, RSC, BOD, COD, Oil and grease, F. coliform, Cu, Fe, Mn, Zn, B, Ni, Cd, Pb, As, Al, Hg, Co, Cr^{6+} and total Cr were analysed from collected water samples by standard methods as mentioned in the methodology chapter. Analytical results showed that the average pH values were ranging from 7.12 to 7.95. The minimum and maximum values of EC ranged from 0.52 to 2.28 dS/m. The average CO_3^{2-} + HCO_3^- values were ranging from 1.4 to 4.6meq/L. The Ca^{2+} + Mg^{2+}values were ranging from 2.4 to 16.2meq/L. The values of Na^+ were ranging from 2.3 to 15.8 meq/L. SAR values of water samples were varied from 1.31 to 8.22. The RSC values were varied from -14.6 to 1.40 meq/L. The biochemical oxygen demand (BOD) was not observed at all the locations. The minimum and maximum values of COD were found as 4.0 and 10 mg/L, respectively. The oil and grease, Al and Hg concent were not observed at all the locations. Feacal coliform content was observed below 2 MPN/100ml in the sampling sites. Cu and As content minimum and maximum values were observed as 0.75 to 10.76 ppb and 0.41 to 6.58 ppb, respectively. The maximum values of Mn, Pb, Cr^{6+} and total Cr content observed were as 0.59, 0.92, 5.36 and 6.78 ppb, respectively which were well within the prescribed limits or maximum permissible limits (MPLs) for drinking as well as irrigation purposes. The maximum values of Fe, Ni and Co content were observed as 5382, 22.77 and 2.26 ppb respectively. Maximum Cd, and B content were observed as 0.96 and 337 ppb, respectively. All the water quality parameters were found below the maximum permissible limits (MPLs) for drinking water as well as irrigation water except Fe content which was slightly higher than the MPL. This is may be due to geogenic reasons. It can be concluded that the overall water quality of the study area was normal and safe for drinking and irrigation purposes. There were no adverse impacts of fly-ash and air pollutants (primary and secondary), generated/emitted from NTPC Kudgi, on groundwater quality observed in the study area during whole period of the project study (2020-22).

Soil health parameters such as pH, EC, CEC, SOC, WHC, Available N, P, K, and DTPA extractable Cu, Fe, Mn, Zn, B, Ni, Cd, Pb, Cr, Co, Hg, Al and As were analysed from collected soil samples in the laboratory as per standard methods and protocols. Results indicated that the pH of soil samples of selected sites ranged from 7.65 to 8.45 (alkaline in nature) whereas values of EC were varied from 0.10 to 0.66 dS/m (quite normal) at selected sites. Cation exchange capacity (CEC) and water holding capacity (WHC) of soil samples collected from sampling sites were varied from 42.41 to 85.42% and 42.45 to 68.11%, respectively in all the seasons. The organic carbon content was varied from 0.35 to 1.18%. Available nitrogen varied from low to medium (175.6 to 420.5 kg/ha) whereas both available P and K content ranged from low to high level (7.78 to 51.2 kg/ha P and 62.1 to 761 kg/ha K). DTPA Cu content ranges from 0.21 to 6.58 ppm. The maximum Fe content observed was 78.81 ppm. DTPA extractable Mn was varied from 3.22 to 38.38 ppm. The minimum and maximum Zn contents were observed as 0.38 and 6.15 ppm, respectively. B content was ranged from 0.53 to 1.56 ppm at selected sites. DTPA Ni content was varied from 0.31 to 0.96 ppm. The maximum values of Co and Al

contents were observed as 0.49 and 3.85 ppm, respectively. It can be concluded that soil quality/health of the study area were normal for agriculture. All the soil health parameters were found normal in range which indicates a medium to high fertile soil. Adverse impacts of fly-ash and air pollutants (primary and secondary), generated from NTPC Kudgi, on soil health/quality have not been observed in the study area during whole period of the project study (2020-22).

Flyash pond effluent samples were collected periodically from the pond E1, E2, E3 and analysed in the laboratory for different physico-chemical parameters of effluent as per standard methods and protocols. The mean pH values were ranging from 7.42 to 7.48. The mean minimum and maximum values of EC were found ranged from 1.62 to 1.67 dS/m. The average CO_3^{2-} + HCO_3^- values were ranging from 2.80 to 2.93meq/L. The mean Ca^{2+} + Mg^{2+} values were ranging from 6.67 to 6.87 meq/L. The values of Na^+ were ranging from 9.53 to 9.90 meq/L. Mean SAR values of water samples were varied from 1.39 to 5.35. The mean RSC values were varied from -3.93 to -3.87 meq/L. The oil and grease was ranged from 1.33 to 2.0 ppm. Mean Cu ranged from 3.47 to 3.58 ppb. Mean Fe was ranged from 2846.67 to 3186.33 ppb. Mean Mn was ranged from 0.03 to 0.04 ppb. Mean Zn was ranged from 6.20 to 6.27 ppb. Mean B was ranged from 302.67 to 309.67 ppb. Mean Cd was ranged from 0.18 to 0.20 ppb. Mean As was ranged from 5.56 to 5.69 ppb. Mean Ni was ranged from 13.88 to 14.66 ppb. Mean Co was ranged from 0.65 to 0.66 ppb. Mean Al was ranged from 9.10 to 9.13 ppb. Mean Cr was ranged from 1.71 to 1.75 ppb. Mean Total Cr was ranged from 12.02 to 13.29 ppb. Pb and Hg concent were not observed in all the samples. It can be said that basic physico-chemical parameters, mineral nutrients and toxic heavy metals contents in pond ash effluents were found below the maximum permissible limits (MPLs) as given by CPCB/FAO for industrial effluents discharged on inland surface water or land for irrigation during the period of project study (2020-22). Moreover, no specific trend was observed in the above parameters during the project period.

Flyash and pond ash samples were collected periodically from the selected sites and analysed in the laboratory for different physico-chemical parameters as per standard methods and protocols. The pH of flyash and pond ash samples were ranged from 6.22 to 6.32 and 8.45 to 8.72, respectively whereas values of EC were varied from 0.27 to 0.29 dS/m and 0.32 to 0.36 dS/m, respectively. Cation exchange capacity (CEC) and water holding capacity (WHC) of flyash and pond ash samples were varied from 1.32 to 1.38 meq/100g & 2.51 to 2.77 meq/100g and 36.52 to 38.67% & 44.25 to 48.43%, respectively in all the seasons. The organic carbon contents in flyash and pond ash samples were varied from 0.10 to 0.13% and 0.07 to 0.09%, respectively. Available nitrogen in flyash and pond ash samples were varied from 18.6 to 23.2 kg/ha and 14.3 to 16.8 kg/ha, respectively. whereas both available P and K content were ranged from 7.16 to 7.38 kg/ha P & 32.5 to 39.9 kg/ha P and 33.4 to 38.8 kg/ha K & 45.4 to 50.8 kg/ha K, respectively. DTPA Cu content was ranges from 1.44 to 1.48 ppm and 0.50 to 0.55 ppm, respectively. Fe content was observed minimum and maximum as 48.72 to 50.75 ppm & 2.70 to 2.76 ppm, respectively. DTPA extractable Mn was varied from 12.24 to 13.56 ppm and 0.82 to 0.88 ppm, respectively. The Zn content was ranged from 1.01 ppm and 1.08 ppm and 0.33 to 0.42 ppm, respectively. The Cd content was ranged from 0.003 ppm and 0.006 ppm and 0.005 to 0.008 ppm, respectively. The Pb content was ranged from 0.05 ppm and 0.08 ppm and

0.08 to 0.09 ppm, respectively. Ni content was varied from 0.42 to 0.46 ppm and 0.14 to 0.17 ppm, respectively. The maximum values of Co and Al contents in flyash and pond ash samples were observed as 0.22 & 0.04 and 0.18 & 5.77 ppm, respectively. The maximum values of As, Cr^{+6} and total Cr contents in flyash and pond ash samples were observed as 0.01, 0.09 and 0.38 & 0.01, 0.06 & 0.28 ppm, respectively. B content ranged from 1.13 to 1.23 ppm and 1.82 to 1.96 ppm, respectively in all the seasons. Overall it can be said that flyash and pond ash having good water holding capacity, optimum soil reaction and salinity whereas cation exchange capcity, organic carbon content, NPK contents were observed very low in Flyash and pond ash during the project study period (2020-22). Heavy metals content in flyash and pond ash were observed in a very less amount as compared to the range of heavy metals concentration in uncontaminated soil (Bowen, 1966) and also observed less as compared to the permissible limits of heavy metals concentrations in soils as per Indian standards (Awashthi, 2000) during project period (2020-22) which may show the possibility of flyash use in agriculture.

Air samples were collected periodically from the selected sites and analysed in the laboratory for different air quality parameters (SO_2, NO_2, CO, PM_{10}, $PM_{2.5}$, O_3, NH3, C_6H_6, Bap, Pb, Ni, As, SO_4^{-2}, NO_3^- and PAN) as per standard methods and protocols during study period (2020-22). The SO_2 values were ranging from 7 to 29 µg/m^3. NO_2 values were ranged from 12 to 36 µg/m^3. CO values were ranged from 0.25 to 0.65 mg/m^3. PM_{10} and $PM_{2.5}$ values were ranged from 45 to 86 µg/m^3 and 20 to 58 µg/m^3, respectively. O_3 values were ranged from 8 to 27 µg/m^3. NH_3 values were ranged from 4 to 13 µg/m^3. The SO_4^{2-} values were ranged from 5.0 to 7.9 µg/m^3. NO_3^- values were ranged from 2.2 to 4.8 µg/m^3. C_6H_6, Bap, Pb, Ni, As and PAN were obesrved as below detection limit (BDL). All the values of air quality parameters were found below the standard limits given by CPCB (NAAQS, 2009). Adverse impacts of fly-ash and air pollutants (primary and secondary), generated from NTPC Kudgi, on air quality have not been observed in the study area during whole period of the project study (2020-22).

Impact of flyash and air pollutants (primary and secondary) on vegetation/crops grown in the study area were studied on the selected vegetation/crop/plant species such as *Piper betle* (Betel leaves), *Zea mays* (maize), *Pennisetum glaucum* (Bajra), *Psidium guajava* (Guava), *Saccharum officinarum* (sugarcane), *Curcuma longa* (turmeric), *Antonius Musa* (banana) and *Cajanus cajan (*pigeon pea) from selceted villages in the study area during 2022-22. Mean total chlrophyll content in the selected plant samples was varied from 1.46 to 2.36 mg/g. Mean relative water content (RWC) was varied from 81.66 to 84.37 %. Mean leaf extract pH was varied from 6.72 to 7.13. Mean ascorbic acid was varied from 0.04 to 0.06 mg/g. Based on above parameters, mean APTI values were calculated and varied from 8.18 to 8.49. Mean photosynthetic rate of seleceted plant samples were ranged from 14.54 to 17.81 µmol/m^2/sec. Mean transpiration rate value within these plant species was varied from 3.43 to 4.28 MmolH_2O/m^2/sec, while mean stomatal conductance was varied from 0.24 to 0.29 mol/m^2/sec. Mean pollen viability was varied from 93.0 to 93.6%. Mean dust deposition was varied from 1.64 to 2.82 mg/kg. Mean pest incidence was varied from 2.0 to 2.55 %. Mean disease incidence was varied from 2.0 to 2.27%. Mean physical leaf injury was varied from 1.45 to 1.73%. There was no ozone impact observed on any plant species. Mean leaf sulphate was varied from 509.45 to 575.45 ppm. Mean leaf nitrate was varied from 432.18 to 487.82 ppm.

Mean economic yield of seleceted plant species was varied from 9.99 to 24.17 t/ha. In general, it can be said that the vegetation and agricultural crops grown in the study area were quite normal in study area even some of the farmers were taking very high yield of agricultural crops and maitaing orchard of high value horticultural crops nearby areas of NTPC Kudgi. All the selected vegetation/agricultural crops and plant parameters have not been showed any specific trend during project study period. Hence, no adverse impacts of fly-ash and air pollutants (primary and secondary), generated from NTPC Kudgi, on the quality and quantity (yield)/ productivity of vegetation and agricultural crops grown in the study area were observed during whole period of the project study (2020-22).

As per visual observation during the visits of NTPC Kudgi Super Thermal Power Station (STPS), it is observed that NTPC Kudgi is a well organized and systematically planned thermal power plant with adequate facilities for operation, maintenance and management of plant alongwith excellent township/residential facilities for accommodation of plant staff and outside visitors. NTPC Kudgi is playing a great role for enhacing the socio-economical, environmental and educational standards of nearby living rural population by providing livelihood as indirect employment opportunities, school, hospital, developing degraded land by planting trees, improving atmospheric environment by developing green belts and many doing other CSR activities for improving the living standards of nearby rural/village population. It was also observed that NTPC Kudgi plant is having adequate pollution control measures and developing an excellent green belt nearby areas of plant and township premises.

In general, it may be concluded from the present study that flyash and primary and secondary air pollutants generated/emitted from NTPC Kudgi does not have any adverse impacts on water, soil and air quality as well as the quality and quantity (yield) of vegetation and agricultural crops grown around 10 km radius from the boundary of NTPC Kudgi Super Thermal Power Plant as well as the operation of plant at present. However, the impacts of flyash and air pollutants generated/emitted from NTPC Kudgi on the quality of water, soil, air, vegetation and productivity of agricultural crops needs to be monitored from time to time to avoid any adverse effects, if any, on human health and agriculture in future.

We, undersigned, scientist members of project team, are hereby submitting the EXECUTIVE SUMMARY of the final report of the NTPC funded Contract Research Project (IARI Project Code: 79-122 TG 5142) entitled "Study on the Impact on Vegetation within 10 km Radius of the Plant due to Flyash Generated and Primary and Secondary Pollutants on Crop around NTPC Kudgi" (NTPC-PO No.: 4000226319-037-1046) for approval please.

23/3/2023

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ANNEX-2

BOILER EFFICIENCY VIS-À-VIS ASH CONTENT

Date	Unit No.	Boiler Efficiency (%)	Ash (%)
15.02.2019	1	84.58	36.32
29.05.2019	1	84.93	30.42
25.07.2019	1	84.82	23.62
22.08.2019	1	84.99	24.85
26.02.2021	1	85.27	45.42
18.03.2021	1	84.91	33.73
13.04.2021	1	84.68	42.66
10.07.2021	1	85.19	39.07
17.01.2022	1	85.36	33.32
14.02.2022	1	85.52	40.83
28.03.2022	1	85.61	36.25
26.04.2022	1	85.49	29.49
30.05.2022	1	85.44	28.50
24.06.2022	1	85.84	32.56
05.07.2022	1	85.41	35.60
27.08.2022	1	84.75	29.49
15.09.2022	1	85.04	37.17
12.10.2022	1	85.58	38.36
05.11.2022	1	85.18	40.63
15.12.2022	1	85.17	40.63

Date	Unit No.	Boiler Efficiency (%)	Ash (%)
02.07.2019	2	84.54	30.42
20.12.2019	2	84.64	30.15
16.01.2020	2	84.91	29.13
26.02.2021	2	85.01	36.98
26.03.2021	2	84.91	33.73
11.04.2021	2	84.92	45.04
29.06.2021	2	85.31	39.02
19.08.2021	2	85.19	39.10
24.09.2021	2	85.09	42.96
13.10.2021	2	85.59	39.11
09.12.2021	2	85.33	36.06
18.01.2022	2	85.03	37.42
12.02.2022	2	85.16	40.93
30.03.2022	2	85.34	34.79
29.04.2022	2	85.60	37.04
10.05.2022	2	85.18	38.23
07.06.2022	2	85.24	38.45
06.07.2022	2	85.18	35.04
13.08.2022	2	84.74	34.52
15.09.2022	2	84.79	40.18
14.11.2022	2	85.17	40.00
21.12.2022	2	85.04	40.00

Date	Unit No.	Boiler Efficiency (%)	Ash (%)
06.04.2019	3	84.57	33
10.06.2019	3	84.49	30.42
27.07.2019	3	84.62	31.61
23.04.2020	3	84.87	36.41
01.07.2020	3	85.34	37.05
01.08.2020	3	85.33	43.11
09.09.2020	3	84.82	45.77
21.12.2020	3	85.09	41.51
26.02.2021	3	86.02	41.54
18.03.2021	3	85.92	43.22
10.04.2021	3	86.18	40.62
20.08.2021	3	85.17	39.10
25.09.2021	3	85.36	38.63
13.10.2021	3	85.41	42.34
17.12.2021	3	85.01	41.89
12.01.2022	3	85.13	35.05
10.02.2022	3	85.29	37.00
29.03.2022	3	85.15	37.29
21.04.2022	3	85.46	32.22
11.05.2022	3	85.15	36.41
27.06.2022	3	85.53	36.40
11.07.2022	3	85.02	38.45
04.08.2022	3	85.31	44.68
27.09.2022	3	85.30	41.13
13.10.2022	3	85.37	40.81
03.01.2023	3	85.34	40.81

ANNEX-3

Parameters	Unit	Station AAQM Values (Period Oct-2022 - Mar-2023)			NAAQM Limits
		Minimum	Maximum	Average	
PM_{10}	µg/m³	38.3	77.9	59.4	**100**
$PM_{2.5}$	µg/m³	16.2	45.3	28.6	**60**
Sulphur Dioxide (SO_2)	µg/m³	9.8	18.1	14.2	**80**
Oxides of Nitrogen (NOx)	µg/m³	11.3	15.4	13.4	**80**
Carbon Monoxide (CO)	mg/m³	0.16	0.52	0.34	**2**
Ozone (O_3)	µg/m³	8.3	18.3	13.7	**100**
Lead (Pb)	µg/m³	<0.01	<0.01	-	**1**
Ammonia (NH_3)	µg/m³	<20	<20	-	**400**
Benzene (C_6H_6)	µg/m³	<0.5	<0.5	-	**5**
Benzo(a) Pyrene [B(a)P]	ng/m³	<0.5	<0.5	-	**1**
Arsenic (As)	ng/m³	<0.5	<0.5	-	**6**
Nickel (Ni)	ng/m³	<5.0	<5.0	-	**20**

Parameters	Stack of	Unit	Unit-wise Stack Emission Values (Period Oct-2022 - Mar-2023)			CPCB Standards
			Minimum	Maximum	Average	
Particulate Matter (PM)	Unit-1	mg/Nm3	21.4	26.8	23.9	**30***
	Unit-2	mg/Nm3	23.6	28.6	25.9	
	Unit-3	mg/Nm3	21.4	25.4	24.0	
Sulphur Dioxide (SO2)	Unit-1	mg/Nm3	1153	1208	1182	**100***
	Unit-2	mg/Nm3	1208	1284	1236	
	Unit-3	mg/Nm3	1134	1246	1168	
Oxides of Nitrogen (NOx)	Unit-1	mg/Nm3	316	378	339	**100***
	Unit-2	mg/Nm3	339	389	360	
	Unit-3	mg/Nm3	317	384	359	

Note: ** Standards are applicable from 31.12.2024 for NOx emission and 31.12.2026 for SO_2 emissions as per MoEF&CC Noitification dated 05.09.2022.*

Parameters	Unit	Station Ambient Noise Levels (Period Oct-2022 - Mar-2023)			Standards [dB(A)]
		Minimum	Maximum	Average	
Industrial					
Day	[dB(A)]	60.9	70.9	66.0	**75**
Night	[dB(A)]	56.4	67.7	62.1	**70**
Residential					
Day	[dB(A)]	48.5	50.7	49.5	**55**
Night	[dB(A)]	39.4	41.8	40.6	**45**
Silence					
Day	[dB(A)]	44.1	46.4	45.1	**50**
Night	[dB(A)]	36.5	38.9	37.7	**40**

ANNEX-3 (Contd..)

Parameters	Unit	Treated Effluent (Main Plant) (Period Oct-2022 - Mar-2023)			Standards
		Minimum	Maximum	Average	
pH at 25°C	-	7.2	7.6	7.3	**5.5 - 9**
Temperature	°C	29.0	30.2	29.7	**-**
Colour	Hazen	2.0	2.5	2.2	**-**
Odour	-	Agreeable	Agreeable	-	**-**
Conductivity at 25 °C	µS/cm	1612	1896	1729	**-**
Total Dissolved Solids	mg/l	950	1224	1046	**2100**
Total Suspended Solids	mg/l	10	21	15	**200**
Oil & Grease	mg/l	<1.0	<1.0	-	**10**
Phenolic Compound as as C_6H_5OH	mg/l	<0.001	<0.001	-	**-**
Biochemical Oxygen Demand at 27 °C for 3 days	mg/l	19	28	22	**100**
Chemical Oxygen demand	mg/l	50.9	88.6	67.5	**-**
Chloride as Cl-	mg/l	123	183	152	**1000**
Sulphate as SO_4	mg/l	332	387	360	**1000**
Zinc as Zn	mg/l	0.03	0.11	0.07	**-**
Fluoride as F	mg/l	0.06	0.59	0.17	**2**
Bio-assay test	-	95% survival	95% survival	-	**90% survival of fish after 96 hours in 100% effluent.**
Sodium Absorption Ratio	mg/l	1.22	1.46	1.31	**-**
Residual Sodium Carbonate	mg/l	Nil	Nil	Nil	**5**
Free Residual Chlorine	mg/l	<0.01	<0.01	-	**-**
Dissolved Phosphate as P	mg/l	0.20	0.35	0.27	**-**
Total Chromium as Cr	mg/l	<0.01	<0.01	-	**-**
Dissolved Oxygen as O_2	mg/l	6.0	6.9	6.4	**-**
Total Copper as Cu	mg/l	0.19	0.29	0.23	**-**
Total Iron as Fe	mg/l	0.05	0.80	0.26	**-**
Mercury as Hg	mg/l	<0.001	<0.001	-	**-**
Cadmium as Cd	mg/l	<0.001	<0.001	-	**-**
Lead as Pb	mg/l	<0.01	<0.01	-	**-**
Arsenic as As	mg/l	<0.01	<0.01	-	**0.2**

ANNEX-3 (Contd..)

Parameters	Unit	Ash Pond Effluent (Period Oct-2022 - Mar-2023)			Standards
		Minimum	Maximum	Average	
pH at 25 °C	-	7.8	8.3	7.9	**6.5 - 8.5**
Oil & Grease	mg/l	<1.0	<1.0	-	**20**
Total Suspended Solids	mg/l	24	37	27	**100**
Temperature	°C	29.5	30.3	29.8	**-**
Conductivity at 25 °C	µS/cm	2098	2452	2238	**-**
Total Dissolved Solids	mg/l	1314	1521	1367	**-**
Dissolved Phosphate as P	mg/l	1.67	1.98	1.76	**-**
Chloride as Cl-	mg/l	106	142	120	**-**
Sulphate as SO_4	mg/l	259	340	293	**-**
Mercury	mg/l	<0.001	<0.001	-	**-**
Arsenic	mg/l	<0.01	<0.01	-	**-**
Chromium	mg/l	<0.01	<0.01	-	**-**
Lead	mg/l	<0.01	<0.01	-	**-**

Parameters	Unit	STP Effluent (Period Oct-2022 - Mar-2023)			Standards
		Minimum	Maximum	Average	
pH at 25 °C	-	7.3	7.6	7.4	**6.5 - 9.0**
Temperature	°C	29.8	30.2	30.0	**-**
Total Suspended Solids	mg/l	5	17	9	**<20**
Conductivity at 25 °C	µS/cm	1180	1374	1261	**-**
Total Dissolved Solids	mg/l	738	882	800	**-**
Chloride as Cl-	mg/l	104	138	121	**-**
Sulphate as SO_4	mg/l	38.6	51.6	44.2	**-**
Sulphide as S_2-	mg/l	<0.01	<0.01	-	**-**
Phosphate as P	mg/l	1.62	1.95	1.79	**-**
Phenolic Compound as C_6H_5OH	mg/l	<0.001	<0.001	-	**-**
Ammoniacal Nitrogen as N	mg/l	0.14	0.22	0.18	**5**
Biochemical Oxygen Demand at 27 °C for 3 days	mg/l	4	8	6	**<10**
Chemical Oxygen demand	mg/l	20.9	47.2	35.0	**50**
Total Nitrogen as N	mg/l	12.3	15.8	13.9	**-**
Oil & Grease	mg/l	<1	<1	-	**-**
Faecal Coliform	MPN/100ml	36	57	45	**<100**

ANNEX-3 (Contd..)

Parameters	Unit	Surface Water (Period Oct-2022 - Mar-2023)			Standards
		Minimum	Maximum	Average	
pH at 25 °C	-	7.2	7.7	7.4	**6.5-8.5**
Temperature	°C	29.6	30.3	30.0	**-**
Colour	Hazen	2.0	3.6	2.6	**Max 300**
Odour	-	Agreeable	Agreeable	-	**-**
Conductivity at 25 °C	µS/cm	316	616	458	**-**
Turbidity	NTU	0.26	0.80	0.53	**-**
Total Dissolved Solids	mg/l	192	372	274	**Max 1500**
Nitrate Nitrogen	mg/l	2.62	6.72	4.52	**50**
Nitrite Nitrogen	mg/l	0.013	0.019	0.015	**-**
Calcium as Ca	mg/l	21.9	34.1	27.8	**-**
Magnesium as Mg	mg/l	7.4	14.0	10.5	**-**
Biochemical Oxygen Demand at 27 °C for 3 days	mg/l	<1.0	<1.0	-	**Max 3**
Chemical Oxygen Demand	mg/l	<10	<10	-	**-**
Chloride as Cl-	mg/l	37.5	88.6	60.1	**Max 600**
Sulphate as SO_4	mg/l	25.7	98.4	59.0	**Max 400**
Zinc as Zn	mg/l	0.029	0.047	0.036	**Max 15**
Fluoride as F	mg/l	0.13	0.19	0.16	**Max 1.5**
Ammonical Nitrogen as N	mg/l	<0.01	<0.01	-	**-**
Sodium as Na	mg/l	13.0	45.3	27.7	**-**
Potassium as K	mg/l	1.23	3.54	2.08	**-**
Carbonate Alkalinity as $CaCO_3$	mg/l	29.8	42.8	35.3	**-**
Bicarbonate Alkalinity as $CaCO_3$	mg/l	17.4	132.0	73.7	**-**
Total Phosphate as P	mg/l	0.21	1.42	0.79	**-**
Total Chromium as Cr	mg/l	<0.01	<0.01	-	**Max 0.05**
Dissolved Oxygen as O_2	mg/l	5.6	6.4	6.0	**Min 4**
Total Copper as Cu	mg/l	<0.01	<0.01	-	**1.5**
Total Iron as Fe	mg/l	0.013	0.150	0.071	**0.5**
Mercury as Hg	mg/l	<0.001	<0.001	-	**-**
Cadmium as Cd	mg/l	<0.001	<0.001	-	**Max 0.01**
Lead as Pb	mg/l	<0.01	<0.01	-	**Max 0.1**
Nickel as Ni	mg/l	<0.01	<0.01	-	**-**
Arsenic as As	mg/l	<0.01	<0.01	-	**Max 0.2**
Boron as B	mg/l	<0.01	<0.01	-	**-**
Total Coliforms	MPN/100 ml	44	94	71	**Max 5000**
Faecal Coliforms	MPN/100 ml	ND	ND	-	**-**

ANNEX-3 (Contd..)

Parameters	Unit	Ground Water (Period Oct-2022 - Mar-2023)			Standards
		Minimum	Maximum	Average	
pH at 25C	-	7.0	7.6	7.3	**6.5-8.5**
Temperature	oC	29.2	30.4	29.8	**-**
Colour	Hazen	<1.0	<1.0	-	**Max 5**
Odour	-	Agreeable	Agreeable	-	**Agreeable**
Conductivity at 25oC	µS/cm	334	853	575	**Not specified**
Total Dissolved Solids	mg/l	202	528	352	**Max 500**
Nitrate Nitrogen	mg/l	3.8	19.2	9.9	**45**
Nitrite Nitrogen	mg/l	0.04	0.08	0.06	**-**
Orthophosphate as P	mg/l	<0.2	<0.2	-	**Not specified**
Chemical Oxygen demand	mg/l	<10	<10	-	**Not specified**
Sodium as Na	mg/l	18.7	53.1	30.2	**Not specified**
Potassium as K	mg/l	0.18	3.49	1.57	**Not specified**
Calcium as Ca	mg/l	21.8	51.6	33.1	**Max 75**
Magnesium as Mg	mg/l	3.64	16.70	8.79	**Max 30**
Carbonate Alkalinity as CaCO3	mg/l	Nil	Nil	-	**Not specified**
Bicarbonate Alkalinity as CaCO3	mg/l	82.5	269.0	183.2	**Not specified**
Chloride as Cl-	mg/l	39.2	145.0	90.2	**Max 250**
Sulphate as SO4	mg/l	22.9	54.7	34.4	**Max 200**
Percent Sodium	mg/l	34.9	43.8	40.4	**Not specified**
Sodium Absorption Ratio	mg/l	0.57	1.63	0.92	**Not specified**
Fluoride as F	mg/l	0.04	0.11	0.07	**Max 1**
Boron as B	mg/l	<0.01	<0.01	-	**Max 0.5**
Mercury as Hg	mg/l	<0.001	<0.001	-	**Max 0.001**
Cadmium as Cd	mg/l	<0.001	<0.001	-	**Max 0.003**
Lead as Pb	mg/l	<0.01	<0.01	-	**Max 0.01**
Arsenic as As	mg/l	<0.01	<0.01	-	**Max 0.01**
Zinc as Zn	mg/l	0.016	0.054	0.035	**Max 5**
Chromium as Cr	mg/l	<0.01	<0.01	-	**Max 0.05**
Nickel as Ni	mg/l	<0.01	<0.01	-	**Max 0.02**
Iron as Fe	mg/l	<0.01	<0.01	-	**Max 0.3**
Total Coliform	MPN/100ml	ND	ND	-	**-**
Fecal Coliform	MPN/100ml	ND	ND	-	**-**

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