Environmental Impact Assessment

Project No: 51308-009
March 2022

India: Tripura Power Distribution Strengthening and Generation Efficiency Improvement Project

Rokhia 120 MW Combined-Cycle Gas Power Plant, Tripura

Prepared by Tripura Power Generation Limited, Department of Power, Government of Tripura, India for the Asian Development Bank.

CURRENCY EQUIVALENTS
(as of 21 January 2022)

Currency unit	-	Indian rupee (Rs)
Rs1.00	=	$ 0.0134
$1.00	=	INR 74.38

ABBREVIATIONS

ADB	-	Asian Development Bank
BAT	-	best available technology
CCGPP	-	combined cycle gas power plant
CO	-	carbon monoxide
CO_2	-	carbon dioxide
CPCB	-	Central Pollution Control Board
DPR	-	detailed project report
EIA	-	environmental impact assessment
EHS	-	environment, health and safety
EHSG	-	environment, health safety guidelines
EIA	-	environmental impact assessment
EMoP	-	environmental monitoring plan
EMP	-	environmental management plan
ESMS	-	environmental and social management system
GAIL	-	Gas Authority of India Ltd
GIIP	-	good international industry practice
GoI	-	Government of India
GoT	-	Government of Tripura
GRM	-	grievance redress mechanism
HRSG	-	heat recovery steam generator
IBA	-	important bird area
IBAT	-	integrated biodiversity assessment tool
IFC	-	International Finance Corporation
KBA	-	key biodiversity area
MOEF&CC	-	Ministry of Environment, Forest, and Climate Change
NAAQS	-	National Ambient Air Quality Standards
NO_x	-	oxides of nitrogen
NO_2	-	nitrogen dioxide
OCGPP	-	open cycle gas power plant
ONGC	-	Oil and Natural Gas Corporation Ltd.
PA	-	protected area
PAI	-	project area of influence
TPCB	-	Tripura Pollution Control Board
TPGL	-	Tripura Power Generation Limited
TSECL	-	Tripura State Electricity Corporation Limited

WEIGHTS AND MEASURES

km	-	kilometer (1,000 meters)
^{0}C	-	degrees Celsius
dB(A)	-	A-weighted decibel
K	-	Kelvin
g/s	-	gram per second
MW	-	megawatt (1000 kW)
km	-	kilometer (1000 meter)
ha	-	hectare (10,000 square km)
MMSCM	-	Million Metric Standard Cubic Meter
D	-	Per Day

NOTES

In this report, "$" refers to United States dollars unless otherwise stated.

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EXECUTIVE SUMMARY

The Government of India (GoI) has requested Asian Development Bank (ADB) to finance a project comprising distribution strengthening and generation efficiency improvement to help improve energy security, power quality, efficiency, and resilience of the power section in Tripura. Under Output 1 of this project, Tripura Power Generation Limited (TPGL) will develop a more efficient combined cycle gas power plant (CCGPP) at Rokhia, Manikyanagar, Tripura (the proposed plant) with a generation capacity of around 120 MW as a replacement for the existing 63 MW open cycle gas power plant (the existing plant). Doing so will allow power output to be increased using the same quantity of natural gas, allowing Tripura to reduce its dependence on central generating stations to meet its power demand whilst helping GoI meet its commitment towards its nationally determined contribution (NDC) targets under the Paris Agreement 2015 through improving energy intensity and diversification of the energy sources from existing coal-based fossil fuels.

The proposed plant will be setup on 4.5 ha of land, considering land required for green belt, within the premises of the existing Rokhia Thermal Power Station (the project site) and will be owned and operated by TPGL as the implementing agency (IA) for Output 1 of the ADB project. There is an existing gas supply to the project site which will be tapped and existing transmission infrastructure for power evacuation to which the proposed plant will be connected. Decommissioning of the existing plant will be undertaken by TPGL following commissioning of the proposed plant and will be a condition of ADB's proposed loan. Although the decommissioning works themselves are outside the scope of the ADB project, they are associated with it and essential to ensuring project benefits are realized.

Once operational, the proposed plant will be operated by TPGL and about 98 skilled, semi-skilled and unskilled workers (78 permanent TPGL staff and 20-30 contractual staff) who will be housed in TPGL staff accommodation at the Rokhia Thermal Power Station or will travel daily from Agartala and/or nearby towns. The proposed plant is designed for a life span of 25 years after which it will be decommissioned by TPGL, this is comparable with the Paris agreement to reduce GHG emissions to net zero by 2025 which GoI has pledged to achieve by 2070.

Output 1 is the most environmentally sensitive component of the ADB project, and due to the potential for significant irreversible and diverse adverse impacts including the climate change impacts of using natural gas as fuel, it has been categorized as Category A by ADB for environmental safeguards. Thus, an environmental impact assessment (EIA) was undertaken and this EIA report including an environmental management plan (EMP) prepared by TPGL for disclosure in relation to Output 1, to ensure that the potential adverse impacts and risks in relation to location, design, construction, and operation of the proposed plant are identified and appropriately addressed in compliance with national laws and regulations and ADB's Safeguard Policy Statement 2009. National Environment Clearance (EC) for the proposed plant will need to be obtained by TPGL prior to contract award. They will also need to obtain Consent to Establish (CTE) and Consent to Operate (CTO) in compliance with national laws and regulations. The EIA is based on an indicative design (already updated from the initial design of TPGL to incorporate noise mitigation) and will need to be updated following detailed design by the EPC Contractor. A separate initial environmental examination (IEE) has been undertaken and an IEE report including EMP prepared covering the potential adverse impacts and risks of Outputs 2-4 of the ADB project, which have less significant adverse impacts than the proposed plant.

The study area is rural with the main activities being agriculture, rubber plantation and brick manufacturing. Nearby villages, including Manikyanagar, have basic rural infrastructure and use ground water for domestic use. The project site is owned by TPGL and therefore no resettlement impacts are involved. The study area is well connected, although off the national highway village roads are narrow and have low traffic flows. There is a road passing through the existing Rokhia Thermal Power Station, this is a private access road of TPGL, but which is permissively used by the local communities. This will be temporarily barricaded for the 36-month construction period which will not have any impact on livelihoods. The private TPGL access road bisecting the Rokhia Thermal Power Station will be reopened to local communities after commissioning of the proposed plant.

The scope of works for construction of the proposed plant includes boundary establishment including repair/development of the existing concrete boundary wall, development of temporary facilities including construction offices, stores, repairs to the existing TPGL vacant staff quarters to be used for workers, improvements to access roads, site clearance and demolition works, dismantling unused high voltage transmission towers on the project footprint, hillock cutting and earthworks, civil works for foundations, plant assembly and erection. The 4.5 ha project footprint comprises two office buildings and an ancillary building taking up about 1% of the footprint (645m^2) which will be demolished. No asbestos was seen to be present in these buildings although this will be reconfirmed by a competent surveyor employed by the EPC Contractor prior to their demolition. There will be clearance of ground vegetation and cutting of shrubs and 249 trees across the remaining 99% of the project footprint comprising hard standing area, open ground, and degraded forest habitat. There will be an influx of about 350 construction workers for which the EPC contractor will be responsible for providing accommodation, transport etc. It is anticipated the EPC contractor will refurbish existing TPGL vacant staff quarters for the purpose of housing its workers or they may have workers reside in Agartala and/or nearby towns. There will also be about 30 TPGL staff present on site during construction works, so 380 workers in total.

The proposed plant, although it will be located within the premises of the existing Rokhia Thermal Power Station is a partly greenfield development requiring clearance of about 2.3 ha of natural, albeit degraded, forest habitat. Loss of this habitat to the project footprint is not considered significant as this is less than 0.0004% of total forest cover in Tripura. In clearing this habitat, tree loss will be compensated for by compensatory reforestation of 2,490 locally native trees (at a ratio of 10 planted to each one cut) to be planted by TPGL at the Rokhia Thermal Power Station. The project site is located 10.5 km from Sipahijila Wildlife Sanctuary (incorporating Clouded Leopard National Park) and there are no protected areas, Ramsar wetlands, key biodiversity areas, notified forest areas, or other areas of biological importance found adjacent to the project site or proposed access routes, and neither will any such areas be indirectly impacted. The study area includes critical habitat for Phayre's leaf monkey as their range extends from Sipahijila Wildlife Sanctuary up to about 2.5 km from the proposed plant. However, no species of higher conservation value (vulnerable, endangered, or critically endangered as per their IUCN conservation status) were recorded at the project site during ecological survey work, although it was reported by the Forest Department that the globally vulnerable, nationally protected capped langur (*Trachypithecus pileatus*) may visit the area around the proposed plant on occasion. The project site, existing plant site, and existing staff accommodation area were observed during site visits to be used by Rhesus macaque (*Macaca mulatta*), which are globally least concern and not a nationally protected species. Mitigation measures will be adopted during construction and operation to minimize disturbance to fauna present, including because of construction works and the presence of workers in the study area. Post-mitigation impacts on the biological environment are predicted to be not significant, but in accordance with ADB's Safeguard Policy Statement 2009 natural habitat safeguard requirements habitat loss will still be compensated for to ensure no net loss of biodiversity because of construction.

The nearest known archaeological or heritage site to the proposed plant is the Boxarnagar Buddhist Stupa at 3.15 km from the project site which is an Archaeological Survey of India (ASI) protected monument. There are no anticipated impacts on this stupa which is already secured within a locked boundary to prevent access. The only other physical cultural resources within the study area are places of worship of local cultural and religious significance although none are found inside the project site. The nearby villages house many small and medium sized temples, mosques and one church, with one small temple being found adjacent to the access route from Boxarnagar. A small temple is located adjacent to the project site for use by workers of Rokhia Thermal Power Station, another is located in the cluster of nearest residences. Mitigation measures adopted during construction will include chance find procedures to avoid unanticipated damage. Post-mitigation, the impacts on physical cultural resources are predicted to be not significant.

Construction impacts related to the physical environment that will be permanent include changes in topography and terrain with flattening of hillocks with an estimated cut volume of up to 334,092 m^3, soil structure and fertility loss, and landscape and visual aesthetics; although mitigation measures are provided to reduce the extent of the impact as far as practical these are unavoidable impacts if the 4.5 ha project site is to be developed for the proposed plant.

Disruption and disturbance to the local community and impacts and risks related to pollution, health and safety during construction are expected to be significant prior to mitigation but will be temporary in nature with adverse impacts generally restricted to within about 500 m of the project footprint, along the access routes, and immediately adjacent. The most significant impacts will be experienced by 10 private residences located close to the eastern side of the project site and an adjacent school. They arise primarily from dust and noise associated with proposed demolition and earthworks. The demolition and construction activities include excavation, compaction, foundation installation, disposal of construction waste and wastewater, temporary barricading of the access road through the existing Rokhia Thermal Power Station, and the hauling of construction materials, plant and equipment including oversized vehicles along the access routes resulting in dust, noise, vibration, traffic congestion, community safety risks, temporary relocation of street furniture etc. There are also occupational health and safety risks for the construction workforce including working at height, working with electricity etc. These impacts and risks are all commonly encountered during major construction works and well-developed management methods reflected in international good industry practices per the World Bank-International Finance Corporation (WB-IFC) Environmental, Health, and Safety (EHS) Guidelines are available to mitigate them. For the access routes the surface will be brought up to standard before the start of construction, and then left in no worse state than at present. Mitigation and monitoring plans will be included by TPGL in the construction contract to ensure that the required measures are costed for and implemented by the EPC Contractor. To elaborate on EMP implementation, a construction environmental management plan (CEMP) including construction pollution prevention plans, solid and hazardous waste management plans, chance find procedures etc. and the EPC Contractor's health and safety risk assessments and management plans addressing both occupational and community risks, including traffic management and coronavirus disease (COVID-19) provisions, will need to be approved by TPGL prior to construction. Provided the standards and measures set out in the EIA and EMP are adhered to by the EPC Contractor, the residual significance of these temporary construction related impacts will be much reduced.

The proposed plant will provide baseload power and comprise of a Gas Turbine Generator (GTG) of 77.39 MW, Heat Recovery Steam Generator (HRSG) and Steam Turbine Generator (STG) of 37.65 MW generating a total of about 120 MW power. This technology is the best available combustion technology available for a fossil fuel power plant. Renewable alternatives are not feasible for TPGL, mainly because of the large area of land take required for wind, solar or hydro requiring land acquisition whereas no land acquisition is required for the proposed plant. For hydroelectric power, the existing 15 MW Ghumti HEP is not running at its full capacity (although TPGL is looking to rehabilitate it soon) and suitable hilly terrain is absent to set up a new hydro plant. Biofuel-based thermal energy could be accommodated at Rokhia Thermal Power Station. As a carbon neutral, renewable resource its use can reduce reliance on fossil fuel whilst still providing reliable base load. However, it is not favored by TPGL, as it is not as efficient as gas, requires more space, still results in some emissions, and a local fuel source that does not cause forest impacts needs to be identified.

Pre-mitigation, the proposed plant's operation was assessed to generate some significant adverse impacts mostly in relation to use of natural gas as a fossil fuel and noise, water consumption, and occupational and community health and safety aspects. The indicative design of the proposed plant is 52.31% efficient and calculated to emit 330,704.9 tons of carbon dioxide (CO_2) emissions per annum. Due to limited availability of water, an air-cooled condenser must be used, this reduces the efficiency of the proposed plant's steam cycle compared to what can be achieved with water cooled condenser (54.7 % to 56.9%) but for the type of condenser being used the energy efficiency is in line with international good practice for a 120 MW CCGPP. As GHG emissions are very large the residual climate change impacts from the power plant alone and the use of natural gas as a non-renewable resource over 25 years of operation will remain significant post-mitigation. However, if the existing plant is decommissioned by TPGL no additional natural gas will be consumed and so there is a saving (offset) of 27,320.51 tons CO_2 per year due to the generation efficiencies of the proposed plant compared to the existing plant whilst it is fully operational. Further, replacement of the existing plant by the more efficient proposed plant which generates additional MW will support GoI in meeting its commitment towards its NDC targets through improving energy intensity and diversification of the energy sources from existing coal-based fossil fuel. This will offset additional CO_2 per year in relation to energy sourced from the grid in the short term whilst India transitions its energy generation away from coal. Longer term, as the existing plant reaches the end of its lifespan, and grid efficiency improves using a commercial market-based, nature-based solution mechanism to offset these GHG emissions is economically feasible; at current rates of \$5 to \$15 per ton of CO_2 it cost up to \$4 million per year.

An operational air quality assessment was undertaken using a nationally and internationally recognized air dispersion model. This revealed that, with an oxides of nitrogen (NO_x) emission standard of 25 parts per million (ppm), a proposed 60 m HRSG main stack (in closed cycle) and a 30 m bypass stack (in single cycle/maintenance mode), the proposed plant emissions alone (i.e., the process contribution) were predicted to contribute less than 1% of the recently revised annual mean World Health Organization (WHO) guideline level for nitrogen dioxide (NO_2) of 10 micrograms per cubic meter ($\mu g/m^3$) at relevant receptor locations, and less than 10% of the daily and hourly mean WHO NO_2 guideline levels of 25 $\mu g/m^3$ and 200 $\mu g/m^3$, respectively. Although the annual mean WHO guideline level was exceeded when considering all other local (i.e., non-project) emission sources, this exceedance is determined by contributions from other sources such as brick kilns (i.e., the airshed is already degraded with respect to NO_2 regardless of the proposed plant). All relevant national GoI NO_2 ambient air quality standards are comfortably met by the proposed plant, both in terms of the process contribution and the total concentration from all other sources. Due to the use of a more efficient, modern gas turbine there will be a reduction of approximately 635 tonnes of NO_x emitted per annum compared to the existing plant once it is decommissioned. This reduction in emissions, coupled with taller and optimized stacks for the proposed plant emission sources is predicted to reduce the annual mean process contributions of NO_2 by up to 83%, i.e., the proposed plant will facilitate a net improvement in local air quality compared to the existing plant. Other emissions to air, such as carbon monoxide, comfortably meet both national air quality standards and the WHO guideline levels. Emissions of sulfur dioxide and particulate matter from the process stacks are considered negligible/not relevant due to the use of natural gas.

Construction and operational noise and vibration was assessed using nationally and internationally recognized thresholds and calculation methodologies. The construction noise assessment indicated significant noise impacts would be likely at receptors in the absence of mitigation. Mitigation methods, such as temporary noise barriers, and considerate construction phasing are demonstrated to be able to reduce impacts to a post-mitigation level that is not significant. Construction activities with the greatest potential for producing appreciable levels of vibration were found to be located at distances sufficiently far from sensitive receptors to ensure vibration levels would be below the assessment thresholds, and therefore considered not significant. The operational noise assessment was informed by noise modelling assuming two operational scenarios; HRSG (closed cycle) and the bypass stack (open cycle during emergency and start up) operation. Pre-mitigation operational noise exceedances of the night-time noise criteria were predicted based on the initial design at six private residences, located to the east of the project site. Therefore, consideration of mitigation was required. Adopted mitigation includes a modification of the initial design developed by TPGL in terms of plant layout, and a commitment to construct a 3m noise barrier, as set out in the EMP. The post-mitigation operational noise impact of the indicative design is considered not significant. No significant vibration sources in the vicinity of sensitive receptors were identified by the assessment, therefore operational vibration is considered not significant.

The cost of the operational air quality and noise mitigation is included in the EMP budget, and, through the contract, the EPC Contactor will be required to rerun the air quality and noise modelling to demonstrate their final layout and design will comply with the standards and measures set out in the EIA and will have less or the same impact than that presented in the EIA report e.g., not significant.

TPGL will need to comply with the GoI requirement that "*new plants to be installed after 1st January 2017 shall have to meet specific water consumption up to maximum of 2.5 m^3/MWh*." Given limited surface water resources in the study area, groundwater will be used, and an air-cooled condenser adopted to limit the need for water extraction. Ground water withdrawal for the 0.2 m^3/MWh (20 m^3/hr) of water required to operate the proposed plant will be subject to a withdrawal permit to be obtained before construction from the Water Resource Investigation Division, Agartala and the Central Ground Water Board, GoI, following a detailed hydrogeological assessment. The Water Resource Investigation Department, GoT has already indicated there is adequate groundwater available in the study area, but community consultations flagged that there are very localized variations in the availability of water during the dry season. The nearest residents reported during consultation that they experience water shortages during the dry season whereas the residents of the nearest village, Manikyanagar and from the larger study area, have stated that there is no water stress. Further hydrogeological studies by TPGL will therefore collect additional baseline data on existing water supplies and groundwater levels and address potential impacts on water stress as well as the availability of water supply considering all seasons and users. Once the aquifer for abstraction has been confirmed, if there is a risk groundwater abstraction by the proposed plant could compromise local water supplies, a piped water supply will be provided to affected properties by TPGL, tapping into the same groundwater source as TPGL, before the proposed plant becomes operational. If no risk is envisaged, TPGL will monitor groundwater levels on an ongoing basis and put in place a backup plan, providing an immediate solution such as canned water, in case of an unanticipated impact. TPGL will also consider undertaking preemptive mitigation, since providing an alternative piped water supply in advance will provide the nearest residents with a community benefit. The plant will be zero discharge with the treated wastewater used for site irrigation and incorporate rainwater harvesting to reduce withdrawal intensity.

There is a fire and explosion risk associated with the use of natural gas; quantitative risk-hazard modelling has shown this risk does not extend beyond the Rokhia Thermal Power Station or put the adjacent school at risk. The EPC Contractor will be required through the contract to rerun the modelling and ensure the risk of their final layout and design is “As Low as Reasonably Practicable” (ALARP) having the same or less impact than presented in the EIA report e.g., not significant.

TPGL will hire suitably and qualified operational staff, provide capacity building and trainings, and also develop an operational environmental and social management system (ESMS) for the proposed plant with the aim of getting it ISO 14001 and ISO 45001 accredited. This ESMS will include operational pollution prevention plans, solid and hazardous waste management plans, and their health and safety risk assessments and management plans addressing both occupational and community risks and including emergency preparedness and response provisions in the event of fire, explosion, or another incident.

Though decommissioning of the existing plant is not funded by the ADB project, as this is essential to realize the project’s benefits (including GHG and air quality offsets) TPGL needs to ensure it is done in a timely and environmentally safe and sound manner. Tentatively it will be decommissioned by 2027 subject to construction of the proposed plant running to schedule. There are some minor patches of oil contamination in the existing plant area, for which remediation will be required to avoid legacy issues in the long term. These patches will be excavated, handled, and disposed of as hazardous waste according to GoI regulations before decommissioning of the existing plant commences. There are 37 employees at the existing plant, and they will be deputed to the new plant once it is operational. Labor retrenchment is not envisaged as TPGL is a government organization. Other decommissioning impacts will be like those of construction – the existing plant is further from the closest houses and can be similarly managed through a Decommissioning EMP.

There is an existing gas collecting station (GCS) which will be tapped and a switchyard to which the proposed power plant will connect. The former is operated by ONGC and the latter by TPGL. Environmental audit of these existing facilities found some non-compliances to national laws and regulations and good practice EHS guidelines including, inadequate housekeeping and waste management, oil leakage, lack of PPE, inadequate first aid and fire safety, etc. To address these a corrective action plan (CAP) is required to be implemented by TPGL and ONGC before access for works is given to the EPC contractor. There are no other existing facilities or associated facilities that are linked to the proposed plant.

The affected persons and other interested stakeholders were involved in the EIA process through face-to-face discussions on-site and public consultations with views expressed incorporated into the EIA report and in the planning and design of the proposed plant. As per ADB’s Safeguard Policy Statement 2009 requirements for Category A environment safeguards, two rounds of consultation were held, one at scoping stage (reflecting the preliminary design and potential impacts) and the other at the draft EIA stage (reflecting the assessment outcomes). The scoping stage public consultation was held on April 19, 2021, with 52 participants (17% women) at the project site. At draft EIA stage the public consultation, along with focus group discussions with the nearest residents and school, was held on October 27, 2021, with 79 participants (29% women) at the project site. In addition, other stakeholders such as Department of Forest officials were met one-to-one to discuss the proposed plant, and an Officer of Tripura Pollution Control Board was present during the public consultation. Based on feedback, there is public support for the proposed plant with the key concerns related to continued water availability due to water stress in the dry season; impact on structural stability of the nearby temporary houses, suitability and use of access routes that are in a poor state of repair with development encroaching into the road right of way for taking construction traffic especially oversized vehicles; potential community conflict with project workers; air and noise pollution; vibration impacts on mud house structures; proposed plant fire risk; and scaring away of local fauna like the Rhesus macaques. These consultations were undertaken in accordance with national restrictions and international good practice guidance for managing exposure to COVID-19 risks with virtual participation by ADB safeguards staff.

The EIA report with its executive summary translated into local Bengali language will be made available in hard copy at TGPL's Agartala Offices and at the Rokhia Thermal Power Station; it will be disclosed to a wider audience via the TPGL (TSECL) and ADB websites. The consultation process will be continued during project implementation to ensure that affected persons and other interested stakeholders are fully engaged and can participate in implementation of the proposed plant. Advance notice will be provided to local communities about the private access road closure, commencement of works, high noise activities, major periods of traffic movement, and transport of oversized vehicles. To address grievances that may arise from affected persons in the local community and workforce a Grievance Redress Mechanism (GRM) will be established by TPGL, the details of which will be disseminated during the future consultations with GRM focal points – name, designation, contact numbers, address plus the timeline and process of redressal to be displayed at the project site by the EPC contractor during construction and by TPGL in operation.

TPGL and the EPC contractor will comply with all applicable national and state environment, health, and safety (EHS) regulatory requirements, ADB's Safeguard Policy Statement 2009, the WB-IFC EHS general guidelines and the sector guidelines for Thermal Power Plant. The EMP sets out the measures to avoid, minimize, mitigate, and offset the predicted environmental impacts of the proposed plant during construction and operation, including emergency response procedures, as well as decommissioning of the existing plant and a corrective action plan for the existing facilities. Presently, TPGL does not have an existing environment, health and safety policy or procedures and they lack safeguards capacity and experience in EMP implementation. This is demonstrated by the fact environment, health and safety management at the existing plant requires significant improvement. Effective implementation of the EMP and ensuring compliance with national laws and regulations needs a suitable organizational set up and adequate safeguard capacity to be established at TPGL. Department of Power, Government of Tripura will be the executing agency (EA) and TPGL the IA for the proposed plant. TPGL will establish a project management unit (PMU) headed by an In-Charge (General Manager-Technical) at TPGL's Agartala Office and a project implementation unit (PIU) headed by a Plant Manager (Deputy General Manager level–Electrical/Mechanical) at the project site for day-to-day implementation; a project implementation consultant (PIC) will provide these units with implementation support. A Safeguard Unit will be established under the PMU and PIU to support EMP implementation, supervision, and monitoring. This will be staffed with a suitably qualified and experienced Environmental and Social Safeguard Officer at PMU level having 15+ years of environment safeguards experience, and two suitably qualified and experienced officers at PIU level with 5-7 years of experience in environment safeguards, and 7-10 years of experience together with professional certification for health and safety, respectively. The PIC will include a Senior Environment Consultant, a Senior Health and Safety Consultant with professional certification, a Senior Ecologist, a Senior Labor Consultant and on-site support. Once operational, the TPGL power plant operations team shall comprise an environment officer and a health and safety officer (with professional certification) both with 12-15 years of experience. Further, the EPC Contractor will be required to have suitably qualified and experienced, dedicated on-site counterpart staff including an Environment Manager, a Health and Safety Manager with professional certification supported by several Health and Safety Supervisors, an ecologist, a labor officer, and a community liaison officer on-site. During pre-construction and construction, capacity building by the PIC will be required for the engineering staff of the PMU and PIU and the EPC Contractor responsible for the implementation of the EMP on a day-to-day basis; they will be trained as set out in the EMP on the environmental, health and safety impacts and risks and their management. The PIC and EPC Contractor will also support capacity building and training for operational staff.

EMP implementation will be assured by a program of environmental supervision and monitoring to be conducted throughout project implementation by the TPGL PMU and PIU who will report any unanticipated impacts or requirements for corrective action during implementation to ADB. Budget of about $3.45 million is required for EMP implementation during construction, during operation the annual EMP implementation cost will be about $0.2 million. Reporting to ADB will be through quarterly project progress reports with environment monitoring reports submitted semi-annually by TPGL up until decommissioning of the existing plant has been completed or the project completion report is issued, whichever comes later. During project implementation, state regulators such as the Tripura Pollution Control Board and Department of Forests will also monitor implementation of mitigation measures as per regulatory requirements to ensure national environmental clearance and other permit and license requirements are being met by TPGL and the EPC Contractor.

Provided the mitigation measures set out in the EMP are implemented as planned, and standards and measures are adhered to the residual significance of the impacts will be much reduced. The EIA including the EMP are considered sufficient to meet the environment safeguard requirements of ADB for the proposed plant. However, the EIA report will need to be reviewed and updated following the EPC Contractor's detailed design. In case any unanticipated impact (including a scope or design change such as any deviation from the parameters presented in this EIA report) occurs during any stage in the project implementation, the EIA and EMP will be updated by TPGL and submitted to ADB for review and clearance before any related works commence or are cleared to continue.

I. INTRODUCTION

A. Project Background and Rationale

1. Electricity Generation and Supply

1. Power generation by the state of Tripura, India is extremely unreliable due to its reliance on inefficient power plants for power generation. As of January 2020, the total generation capacity available for Tripura was 604.4 megawatts (MW) including power allocation from state and central generating stations.[1] The derated capacity of the generating units of the state is 115 MW out of which approximately 21 MW is generated by Baramura Gas Thermal Power Plant (BGTPP) and has to be shared with Manipur and Mizoram states as per the financial arrangement with North-East Council (NEC). Power in Tripura is generated mainly from two types of energy sources: (a) natural gas (oil and natural gas is the most important mineral resource in Tripura) and (b) hydro. Approximately 115 MW is generated by the state-owned Tripura Power Generation Limited (TPGL) through its BGTPP (2 x 21 MW), Rokhia Gas Thermal Power Plant (RGTPP) (3 x 21 MW) and Ghumti Hydro-electric Project (GHEP) (3 x 5 MW). Out of the 3 units in GHEP only 2 units are currently operational at any one time and thus only 10 MW can be generated. The rest of the power is procured from the central generating stations of Northeastern Electric Power Company (NEEPCO), ONGC Tripura Power Corporation (OTPC), National Hydro Power Corporation (NHPC) and National Thermal Power Corporation (NTPC). Out of these central power generating stations the bulk comes from two power plants located in Tripura: a share of OTPC's Palatana 726.6 MW Combined Cycle Gas Power Plant (CCGPP) commissioned in 2013 with a third unit of 363 MW having just recently received an environmental clearance, and NEEPCO's Monarchak 101 MW CCGPP commissioned in 2015.

2. The deficiency in power across the north east of India is about 8.44% of peak demand. The peak demand of Tripura in the fiscal year (FY) 2020 was 335 MW and hence the state generating stations capacity was fully utilized with more than 70% of the state's power demand being met through power allocation from the central generating stations.[2] Of the state's contribution, about 86.3% is currently met from gas-based power stations while the balance is from hydro power.[3]

3. Tripura is already supplying power for almost 24 hours in urban areas and for approximately 22 to 24 hours in rural areas and to industries except during power shortages and/or scheduled outages such as occurs before Durga Puja, an annual Bengali festival that creates heavy power use. Based on government records of formal connections Tripura has also achieved 100% household electrification in March 2019 under Prandhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhaya), a Government of India (GoI) project that aims to attain 100% electrification of households and provides last-mile connection to all interested households with no upfront fees for the electricity connection. It also provides free electricity to households below the poverty line. In order to match the growth in generated capacity and to meet the increase in demand within Tripura, there has been a corresponding augmentation and upgradation in the

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[1] Tripura Power Generation Limited. November 2020. *Detail Project Report for Installation of 120 MW CCGT Power Plant at Rokhia, Tripura.* Development Consultant Pvt. Ltd. Tripura

[2] Tripura Power Generation Limited. November 2020. *Detail Project Report for Installation of 120 MW CCGT Power Plant at Rokhia, Tripura.* Development Consultant Pvt. Ltd. Tripura

[3] Tripura Power Generation Limited. November 2020. *Detail Project Report for Installation of 120 MW CCGT Power Plant at Rokhia, Tripura.* Development Consultant Pvt. Ltd. Tripura

transmission and distribution network. The state is well connected with the national grid through various transmission lines. The existing distribution network however remains aged, overloaded, and uses antiquated technologies which creates operation and maintenance (O&M) challenging especially during the monsoon season. The average aggregate technical and commercial (AT&C) losses of the distribution network and system interruption frequencies are four times and 300 times higher than the best performing states in India respectively. Lengthy distribution feeders, lack of modern protection and monitoring devices in the system, under sized conductors and inadequate number and capacity of distribution substations and transformers issues have been identified as major reasons behind the poor operational performance. The poor quality of power supply is one of the contributory factors to low socio-economic development in Tripura as compared to other progressive states in India.

4. Tripura State Electricity Corporation Limited (TSECL) is responsible for power sector planning, transmission, and distribution and was established or corporatized from Tripura Power Department on 1 January 2005 once the Electricity Act 2003 was enacted. Tripura Power Generation Limited (TPGL) is responsible for power generation and was carved out of its parent body TSECL in 2015. However, the organizations share a common financial and human resources function. Both TSECL and TPGL function under the oversight of the Power Department, Government of Tripura (GoT) headed by a secretary rank officer who is also the chairman (non-executive) of TSECL (ex officio). The Power Department sets the various policies and strategies related to power generation, transmission, distribution, and also rural electrification in the state along with liaison with the central government on issues related to power.

5. To meet GoT's objective of connecting the unconnected and supplying 24x7 quality, reliable and affordable power supply to domestic, commercial, agriculture and industrial consumers within a fixed time, the 24x7 Power for All (PFA) programme was launched in 2016 by GoT with active support from the Government of India (GoI).[4] The program had aspired to supply reliable electricity in the state and connect the unconnected entities in a phased manner by FY 2018-19. As of 2021, there has been a delay in achieving the targets. It is unlikely they will be achieved in the next five years. This is due to multiple reasons including poor efficiency of aged and dilapidated power plants, decommissioning of obsolete units, lack of upstream distribution strengthening, and the AT&C losses of distribution network etc. There is a lack of adequate funds within the GoT required to meet the O&M challenges exacerbated by the high maintenance and generation costs of the old inefficient power generating units using outdated technology and low revenue generation from power distribution due to high AT&C losses, power theft and inaccurate/obsolete meters.

2. Climate Change Commitments

6. India has recently announced an updated and strengthened 2030 Paris Agreement targets and a 2070 net zero target at the World Leaders Summit at Conference of Parties 26 (COP 26) in Glasgow. The updated 2030 target comprises of four elements (the details of which are yet to be published):

(i) Reducing carbon intensity of the economy to 45% below 2005 level
(ii) Increasing non-fossil capacity in power generation to 500 GW

[4] Government of India and Government of Tripura. 2016. *24x7 Power For All.* Delhi. https://powermin.gov.in/sites/default/files/uploads/joint_initiative_of_govt_of_india_and_tripura.pdf

(iii) Achieving 50% of its energy requirement from renewable energy sources by 2030
(iv) Reducing GHG emissions by 1 billion tons by 2030

7. India's Intended Nationally Determined Contribution (NDC) has a strong focus on climate change mitigation and aspires to reduce GHG emissions by 33-35% by 2030 to 2005 levels, achieve 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 and create an additional (cumulative) carbon sink of 2.5–3 $GtCO_2e$ through additional forest and tree cover by 2030.[5] Further to COP 26, India is still to submit its updated NDC to UNFCCC.

8. The GoI has provided an economic stimulus to the domestic economy deeply impacted due to the COVID 19 scenario in early 2021, which is climate-friendly, with approximately two thirds of the resources aimed towards a green recovery, including approximately $3 billion in battery development and solar photovoltaics (PV). As per a recent report, the GoI is continuing to promote a greener recovery by committing $35 billion (28.5%) of the $122 billion in energy-related funding to renewables, which is almost twice the $18 billion (15%) that is flowing to fossil fuels.[6]

9. India has also set an ambitious renewable energy capacity target of achieving 175 GW by 2022 and has achieved 98.9 GW of new capacity as of July 2021. Presently, India subsidizes both fossil fuels and renewable energy generation, including direct subsidies, fiscal incentives, price regulation and other government support. As of December 2021, the major source of energy in India is from coal-based fossil fuel powered plants. In order to meet its NDC targets, India will be required to move into from coal-based fossil fuel energy sources to renewable and noncoal-based fuel sources.[7]

10. In relation to developing renewables TPGL plans to upgrade and modernize the existing 3 x 5 MW GHEP, which as of December 2021 is operating with a subpar capacity of 2 x 5 MW. The existing reservoir has been undergoing siltation which has vastly reduced the water availability, especially during the summer seasons to run the entire 3 units. For this purpose, TPGL has already prepared the technical documents and is seeking financial assistance. GHEP rehabilitation does not seek any new land acquisition but has legacy issues associated with land acquisition for the reservoir area decades back, which TPGL are working to resolve. The Tripura Renewable Energy Development Agency (TREDA) which is a constituent organization of the Power Department, Government of Tripura is engaged in implementing a number of new renewable energy projects including solar photovoltaic power plants at primary and community health centers, hospitals and police stations across the state (varying from 1 kW – 50 kW power capacities), solar street lights (in 4001 locations), biogas plants, Solar Home Lighting Systems etc. The organization also participates in the central government schemes of setting up of

[5] Government of India. 2015. *India's Intended Nationally Determined Contribution: Working Towards Climate Justice*. UNFCCC. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf
[6] Vibhuti Garg, Max Schmidt & Christopher Beaton. March 2021. *How Green Is India's Stimulus for Economic Recovery? How India Can Raise Its Ambition for a Green Stimulus in 2021.* https://ieefa.org/wp-content/uploads/2021/03/How-Green-Is-Indias-Stimulus-for-Economic-Recovery_March-2021.pdf. International Institute for Sustainable Development (IISD) and Institute for Energy Economics and Financial Analysis (IEEFA)
[7] Climate action tracker. India https://climateactiontracker.org/countries/india/

decentralized ground/stilt mounted grid connected solar or other renewable energy-based power plants; stand-alone solar agriculture pumps; solarization of grid connected agriculture pumps; and development of solar cities. TREDA also has drawn up an action plan for the FY 2020-2021 in which it plans to install 1000 kW of Off-grid Solar power plants besides installation of 12,000 SPV Street Lighting System and others[8] These targets also contribute towards the NDC targets of the country. However, as renewable energy will take time to develop and considering the urgent need for GoI to move away from its heavy dependency on coal-based fossil fuel in the transition period it will be necessary to increase its reliance on natural gas power which has the lowest carbon intensity of any fossil fuel.

11. It is estimated that the power demand in the state shall rise over time and this shall further aggravate the dependency of Tripura on more expensive power from central generating stations. To enable Tripura to meet any increase in power demand from state generating stations, and to free up central generating station capacity to help GoI meet its commitment towards its NDC targets through diversification of the energy sources from existing coal-based fossil fuels it is imperative that the existing gas-based power plants in the state are modernized and made more energy efficient. GoT has thus planned to increase the natural gas-based generation capacity in the state through TPGL by replacing the RGTPP 's aged inefficient (26.46%) existing 63 MW Open Cycle Gas power plant (OCGPP) (the existing plant) with a new efficient (52.32%) 120 MW CCGPP (the proposed plant) whilst consuming the same amount of natural gas.

12. The replacement of the existing aged OCGPP (63 MW) with a more energy efficient CCGPP of about 120 MW utilizing the same amount of gas is in line with the stated NDC of India. Doing so will allow power output to be increased, allowing Tripura to reduce its dependence on central generating stations whilst helping GoI meet its commitment towards its NDC targets through improving energy intensity and diversification of the energy sources from existing coal-based fossil fuels. The proposed plant is designed for a life span of 25 years after which it will be decommissioned by TPGL, this is comparable with the Paris agreement to reduce GHG emissions to net zero by 2025 which the GoI pledged at COP 26 to achieve by 2070.

3. Proposed Project

13. GoI has requested Asian Development Bank (ADB) to finance a project comprising distribution strengthening and generation efficiency improvement to help improve energy security, power quality, efficiency, and resilience of the power section in Tripura. ADB will provide a loan of $220.00 million under the *Tripura Power Generation Upgradation and Distribution Strengthening Project.* It will be aligned with the following impacts: power quality, efficiency financial sustainability and resilience of power sector in Tripura improved. The project will have the following outcome: energy security in Tripura improved.

14. The proposed loan has four outputs:
- (i) Output 1: Rokhia power plant upgraded to double its capacity and its efficiency.
- (ii) Output 2: Resilience of distribution network strengthened and modernized.
- (iii) Output 3: Smart meters and advanced metering infrastructure established.
- (iv) Output 4: Institutional capacity for planning, implementation, financial

[8] Government of Tripura. Department of Power. 2020. *Action Plan For The Year 2020-21*. Tripura http://treda.nic.in/sites/default/files/action%20Plan%202020-21.pdf

management, and gender mainstreaming improved.

15. The proposed loan shall thus finance under Output 1 the construction of a new 120 MW CCGPP at Rokhia, Manikyanagar, while TPGL shall finance contingencies and project management expenses using counterpart funds. Department of Power, Government of Tripura will be the executing agency (EA) and TPGL the implementing agency (IA) for Output 1. The loan will be on-lent by GoI through GoT to TGPL (as implementing agency).

16. ADB has recently renewed its Energy Policy wherein it shall provide conditional support for natural gas-based power generation.[9] The new policy states: *"ADB's support for natural gas-based power generation will be conditional on evidence that the project employs high-efficiency and internationally best available technologies, reduces emissions by directly displacing other fossil fuel-based thermal power capacity, or results in a lower grid emission factor estimated as an average over its operational life. In addition, all projects involving natural gas must meet all of the following conditions:*

(i) No other low-carbon or zero-carbon technology, or combination thereof, can provide the same service at an equivalent or lower cost at a comparable scale.[10]

(ii) The project's operating lifetime is consistent with the carbon stabilization trajectory aiming to achieve carbon neutrality by about 2050, and by a time set by DMCs that is consistent with their NDCs. The project also avoids long-term lock-in into carbon infrastructure and the associated risk of creating stranded assets.

(iii) The project is economically viable considering the social cost of carbon and an operating lifetime consistent with condition (ii)."

17. The proposed plant will employ high-efficiency and internationally best available technologies for gas power and will result in a lower grid emission factor estimated as an average over its operational life by replacing the inefficient existing plant. The generation units of the existing plant were established in various phases from 1990 to 2013. There are 9 generation units, among which 6 (6 x 8MW) are already decommissioned. Of the remaining 3 (VII, VIII and IX) 2 x 21MW are operational and 1 x 21 MW has temporarily stopped operation under direction from the Ministry of Environment Forest and Climate Change (MoEF&CC).[11] The two in operation are under violation form MoEF&CC due to operating without prior environmental clearance.[12] The operational units have a low energy efficiency (26.46%) and consume 0.58 Million Metric Standard Cubic Meter Per Day (MMSCMD) of natural gas as fuel. Natural gas is supplied through an existing gas pipeline of Konaban Gas Field of Gas Authority of India Ltd (GAIL) and Rokhia Gas Field of Oil and Natural Gas Corporation (ONGC). ONGC maintains the gas collecting station (GCS) within the Rokhia Thermal Power Station. Power is evacuated through transmission system which constitutes both 66 kV and 132 kV transmission lines. Decommissioning of the existing plant will be undertaken by TPGL following commissioning of the proposed plant and will be a condition of ADB's proposed loan. Although

[9] ADB. 2021. Energy Policy Supporting Low-Carbon Transition in Asia and the Pacific 2021. Manila

[10] *"Same service" means that the proposed supply option must provide the same quantity of energy requirements at all times, including the ability to supply demand variations, at the same quality of voltage and frequency, and with the same reliability with respect to interruptions.*

[11] http://environmentclearance.nic.in/writereaddata/Form-1A/Minutes/2007202169965964Approved_MoMof13thEACthermalheldon13-7-2021.pdf

[12] A violation case against the existing plant is brought by MoEF&CC Committee as it was noted that 3 x 21 MW gas-based power project has been established without obtaining Environmental Clearance. Ref MoM: 36th MEETING OF THE RE-CONSTITUTED EXPERT APPRAISAL COMMITTEE (EAC) ON ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF THERMAL POWER PROJECTS HELD DURING 04th December 2019. Item no. 36.

the decommissioning works themselves are outside the scope of the ADB project, they are associated with it and ensuring that project benefits are realized.

18. The proposed plant will comprise of Gas Turbine Generator (GTG) – 77.39 MW, Heat Recovery Steam Generator (HRSG) and Steam Turbine Generator (STG) – 37.65 MW. Since it will be more energy efficient and generate a higher energy per unit of gas with lesser cost of production the additional generation of 57 MW will be achieved without increasing the quantity of gas used by the existing plant. The combination of the GTG, HRSG and STG will be finalized, based on the EPC Contractors technical assessment and whichever combination is more energy and cost efficient. The scope of works for construction of the proposed plant includes boundary establishment, development of temporary facilities including construction offices, stores and labor camps, rehabilitation of the staff quarters to be used for workers, improvements to access roads, site clearance and demolition works, dismantling unused high voltage transmission towers on the project footprint, hillock cutting and earthworks, civil works for foundations, plant assembly and erection. The existing facilities will be the existing gas collecting station (GCS) of ONGC and the existing switchyard. Both will be connected to the proposed plant. The existing plant decommissioning is an associated activity which is required to realize the benefits of the project, but it is not an “associated facility” of the proposed plant per ADB’s Safeguard Policy Statement 2009.

B. ADB Environment Safeguard Requirements

19. Safeguard requirements for all projects funded by ADB are defined under ADB’s Safeguard Policy Statement (2009) which establishes an environmental screening, assessment and management process to ensure that projects (i) avoid adverse impacts of projects on the environment and affected people, where possible; (ii) minimize, mitigate, and / or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.[13] All ADB projects must comply with the requirements of ADB’s Safeguard Policy Statement, 2009 and its Operational Manual F1, 2013 so as to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.[14]

20. For each ADB project, screening and categorization is conducted at the earliest stage of project preparation when sufficient information is available and is undertaken to (i) reflect the significance of potential impacts or risks that a project might present; (ii) identify the level of assessment and institutional resources required for the safeguard measures; and (iii) determine disclosure requirements. ADB uses a classification system to reflect the significance of a project’s potential environmental impacts. A project’s category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project’s area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. For a Category A project, an Environmental Impact Assessment (EIA) including an Environmental Management Plan (EMP) is required. For a Category B project, an Initial Environmental Examination (IEE) including an EMP is required and for a Category C project, an EIA or IEE is not required, although environmental implications need to be reviewed e.g., through preparation of a due diligence report.

[13] ADB. 2009. Safeguard Policy Statement. *Operations Manual. OMF1/BP*. Manila.
[14] ADB. 2009. Safeguard Policy Statement. *Operations Manual. OMF1/BP*. Manila.

21. Output 1 of the proposed loan (the proposed plant) is the most environmentally sensitive component of the ADB project, due to the potential for significant irreversible and diverse adverse impacts including the climate change impacts of using natural gas as fuel. The project has therefore been categorized as Category A for environmental safeguards by ADB. Thus, an EIA was undertaken, and this EIA report including EMP prepared by TPGL for disclosure in relation to Output 1, to ensure that the to ensure that the potential adverse impacts and risks in relation to location, design, construction, and operation of the proposed plant are identified and appropriately addressed in compliance with Government of India and GoT laws and regulations and ADB's Safeguard Policy Statement 2009. A separate IEE study has been undertaken and an IEE report including EMP prepared covering the potential adverse impacts and risks of Outputs 2-4 of the ADB project which have less significant impacts than the proposed plant.

C. EIA Approach and Methodology

22. The EIA has been undertaken on behalf of TPGL by a team of ADB funded environment technical assistance (TA) consultants including national environment expert and EIA team leader – Dibyendu Banerjee, national ecological expert – Arijit Choudhury, national social expert – Samarendar Narayan Jena, international air quality expert – Adam Clegg and international noise experts – James Trow supported by George Gibbs.

23. The EIA report describes the direct, indirect, cumulative, and induced impacts and risks of the proposed plant on the biological, physical, socioeconomic, and physical-cultural resources in the project area of influence (PAI) during the construction and operation phases of the proposed plant, as well as considering decommissioning of the existing plant. Direct impacts will generally be restricted to within about 500 m of the proposed plant's footprint area, along the access routes and immediately adjacent. The general PAI is taken as 10 km radius from the project site, whereas as for individual environmental domains separate PAI are selected based on potential impact.

24. The EIA process involves the scoping and assessment of potential and perceived environmental impacts and risks of the proposed plant. It also involves the identification of avoidance and mitigating measures and the preparation of an EMP that will be implemented and monitored to address those predicted impacts and risks of the proposed plant. This EIA report provides ADB with an assessment of the environmental impacts and risks to be considered in their decision-making process. This EIA report will also support the preparation of a prior Environmental Clearance (EC) application to the MoEF&CC for obtaining the national EC and other permits and licenses required before the start of construction of the proposed plant.

25. The objectives of the EIA were to:

(i) Identify the environmental impacts and risks of the proposed plant across the construction and operational phases, as well as considering decommissioning of the existing plant, in a manner consistent with ADB's Safeguard Policy Statement (SPS) 2009 and national environment, health and safety requirements and obligations under international agreements.

(ii) To scope and assess (quantitatively where appropriate) the identified environmental impacts and risks that may arise because of implementing the proposed plant, including analysis of the proposed plant design, design-engineering options, primary and secondary environmental baseline data, and consultation inputs to determine the significance of the predicted impacts.

(iii) Identify mitigation measures to avoid, minimize, and manage the predicted impacts and risks; and prepare an EMP to ensure no significant residual impacts.

(iv) Develop an environmental monitoring plan to monitor EMP implementation so that corrective actions can be taken if so required.

(v) Recognize and enhance TPGL's institutional structure and current environment safeguards implementation, supervision, and monitoring capacity.

(vi) Conduct meaningful public consultations, disclose information on the predicted impacts and risks of the proposed plant in a timely and transparent manner and plan for the setting up of a grievance redressal mechanism during project implementation.

26. The EIA has been undertaken based on an indicative design (updated from the initial design set out in the detailed project report (DPR, November 2020)[15] developed by Development Consultant Pvt. Ltd. (DCPL) as design engineers for TPGL) because the proposed plant is to be designed and built by an EPC Contractor. The EPC Contractor will be required to demonstrate their final layout and design, taking into consideration the updated noise design changes, will comply with the standards and measures set out and will have the same or less environmental impact than presented in the EIA report, prior to approval of their detailed design by TPGL. The EIA report will be reviewed and updated for clearance by ADB and disclosure following the EPC Contractor's detailed design and before TPGL approves it. The extent of the EIA update will be reviewed in consultation with ADB once the final layouts, designs and construction methods have been submitted by the EPC contractor to TPGL for approval. In case any unanticipated impact (including a scope or design change such as any deviation from those parameters presented in this EIA report) occurs during any stage in the project implementation, the EIA and EMP will be updated by TPGL and submitted to ADB for review and clearance before any related works commence or are cleared to continue.

27. The approach and methodology used to conduct the EIA is:

(i) Review of GoI and GoT policies, regulations, and guidelines and ADB's Safeguard Policy Statement (SPS) 2009 requirements. For standards and measures, international good practice guidelines, including the World Bank Group-International Finance Corporation's (IFC) Environment, Health and Safety Guidelines (EHSG) for Thermal Power Plants and other good international industry practice (GIIP) including from the EU was referred.

[15] Tripura Power Generation Limited. November 2020. *Detail Project Report for Installation of 120 MW CCGT Power Plant at Rokhia, Tripura.* Development Consultant Pvt. Ltd. Tripura

(ii) Site visit was conducted at scoping stage in March 2021 for reconnaissance survey, initial baseline data collection from the project site and surroundings, discussion with TGPL and consultees.

(iii) Identify the PAI for impact analysis and collect primary and secondary baseline data, the PAI was identified as:

 (a) Study Area: the study area is the anticipated maximum impact zone due to the proposed plant. For conducting EIA, core and buffer impact zones were identified based on the anticipated spatial extent of environmental impacts and risks and considered for collecting baseline data from primary and secondary sources. The general PAI for the baseline assessment was identified as 10 km, with the following exceptions. For noise the baseline assessment, the PAI was identified as 500 m radius from the project site. For assessment of air quality impacts, the PAI was selected as 50 km radius, while for ecological assessment the Integrated Biological Assessment Tool (IBAT) was conducted for a maximum of 50km radius from the project site in order to pick up potentially wide-ranging species.

 (b) Project Site**:** defined as the physical space where the proposed plant and related infrastructure will be located, as well as access routes and areas immediately adjacent.

(iv) Primary environmental baseline data for micrometeorology, air, water, soil, quality and noise were collected by MITCON, an MOEF&CC accredited consultants appointed by TPGL for three seasons (October 2020-June 2021) in the PAI. MITCON also collected primary data for biological, physical, and socioeconomic parameters which were supplemented by additional primary and secondary baseline data collated by the ADB TA consultants.

(v) Undertake scoping of impacts: identification of the various activities associated with the construction and operation of the proposed plant and its potential and perceived environmental impacts and risks on various environmental parameters (physical, biological, socioeconomic, and physical cultural resources) guided by professional expertise and consultations.

(vi) Detailed impact assessment: including air dispersion modelling, noise modelling and quantitative risk-hazard assessment were conducted to assess the potential impacts and risks of the proposed plant. Impact assessment was informed by field visits, analysis of primary and secondary baseline data, and discussion with different levels of stakeholders i.e., ADB project team, TPGL project team, DCPL design engineers, MITCON consultants, Tripura Power Department, Forest Department, other government departments and NGOs.

(vii) Undertake meaningful consultations: public consultations, focus group discussions, and 1-on-1 stakeholder consultations were held to receive feedback and suggestions for the proposed plant design and EIA. The scoping stage public consultation was conducted on 19th April 2021 inside the site. EIA stage public consultation was completed on 27th October 2021 to inform the community about the impact assessment outcomes, plans and activities. Outcomes of the consultations have been detailed in Chapter 8 of this EIA report.

(viii) Development of mitigation measures to address the predicted adverse impacts and risks of the proposed plant, and development of an environmental management plan (EMP) and environmental monitoring plan (EMoP) for TPGL to monitor its implementation.

D. Structure of the EIA Report

28. The following chapters have been developed based on the EIA process undertaken:

(i) **Chapter-1** Introduction: The chapter describes the general background of the proposed plant, its justification, and the objectives and methodology of the EIA.

(ii) **Chapter-2** Description of the Project: This describes the proposed plant layout, design, technology and construction and operation.

(iii) **Chapter-3** Policy, Legal and Administrative Framework: This describes the policy, legal and administrative framework applicable to the project. It describes acts and rules promulgated by GoI and GoT, ADB's Safeguard Policy Statement 2009, and GIIP guidelines and their applicability to the proposed plant.

(iv) **Chapter-4** Description of the Baseline Environment: This covers the environmental baseline description of the project site and study area. The coverage of the baseline has been reported under sections on Biological Environment, Physical Environment, Socio-Economic Environment and Physical-Cultural Resources.

(v) **Chapter-5** Anticipated Environmental Impacts and Mitigation Measures: This covers the potential environmental impacts and risks due to project implementation during the construction and operation phases and how they can be mitigated to reduce the significance of residual impacts.

(vi) **Chapter-6** Analysis of Alternatives: This section covers the various alternatives of the project, and the without project alternative. It compares alternates of project location, design, technology, transport routes, resource usage, etc.

(vii) **Chapter 7:** Risk-Hazard Assessment: This section covers the quantitative risk-hazard assessment for the proposed plant.

(viii) **Chapter-8** Consultation, Participation and Information Disclosure: this covers public consultations and information disclosures. The details of consultations undertaken, public and other stakeholders' viewpoints and their addressal by TPGL have been covered in this chapter.

(ix) **Chapter-9** Grievance Redressal Mechanism: This chapter describes the Grievance Redress Mechanism planned for the project addressing how grievances from the local community and workforce will be addressed.

(x) **Chapter-10** Environmental Management Plan: This chapter describes the institutional arrangements, capacity building, budgeting, schedule for EMP implementation, and the environmental mitigation and monitoring plan.

(xi) **Chapter-11** Conclusions and Recommendations: This chapter summarizes the findings of the EIA process, its conclusion and recommendations.

II. DESCRIPTION OF THE PROJECT

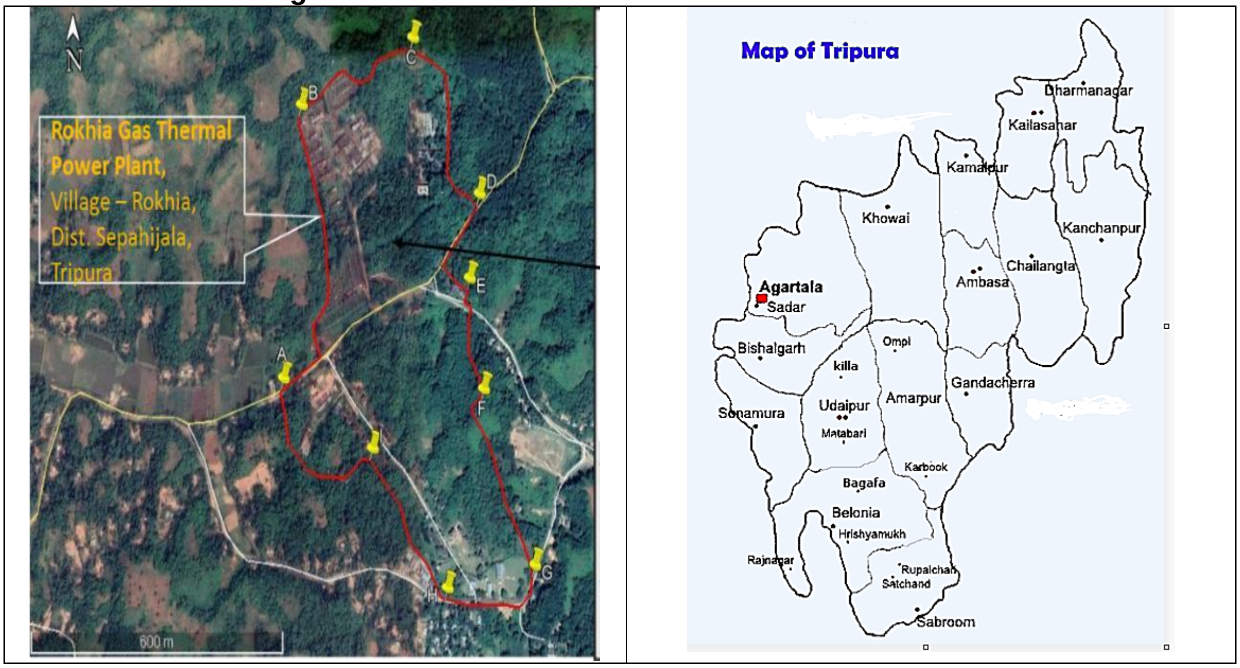
A. Project Location and Key Characteristics

29. The proposed 120 MW CCGPP (the proposed plant) as summarised in Table 2-1 is to be sited at Rokhia, Manikyanagar village, Boxarnagar Block, Bishalgarh Sub-Division, Sepahijala District of Tripura. The project footprint forms part of the existing Rokhia Thermal Power Station, owned by TPGL and housing the existing 63 MW OCGPP (the existing plant), which is being replaced by the proposed plant. Approximately 4.5 hectares of land (including land for greenbelt) within the project site will be required for constructing the proposed plant and related facilities for which no land acquisition is required.

30. The project site is about 35 km from Agartala, the state capital. It is sited in a rural area, approximately 3.25 km from the Bangladesh international border to the west. The center coordinates of the project site are 23°37'23.86"N 91°11'47.92"E. It is well connected to the National Highway 8 (NH 8) (10 km from the project site) which connects Bishalgarh town with the rest of the country the via Bishalgarh-Boxarnagar Road. State highway (SH) and major district roads (MDR)/local roads connect Bishalgarh with Rokhia. The distance from Rokhia to Guwahati in Assam, the neighbouring state, is about 540 km (about 16 hours travel time) via NH 27. The nearest broad gauge railway station, at Bishalgarh is 13 km from the project site. The nearest waterways are Ashuganj River Port (Bangladesh), Chittagong/Chattogram Port (Bangladesh) and Haldia or Kolkata Port (West Bengal, India). The Ashuganj River Port is approximately 81 km away from Rokhia via Agartala with approximately 3 hours of travel time by road. Chittagong Port is approximately 220 km, approximately 4.5 hours of travel time by road. Haldia port is approximately 1,686 km (approximately 43 hours of travel time by road) whilst the distance from Kolkata port is shorter by approximately 125 km with the journey time by road also shorter by approximately 2.5 hours.

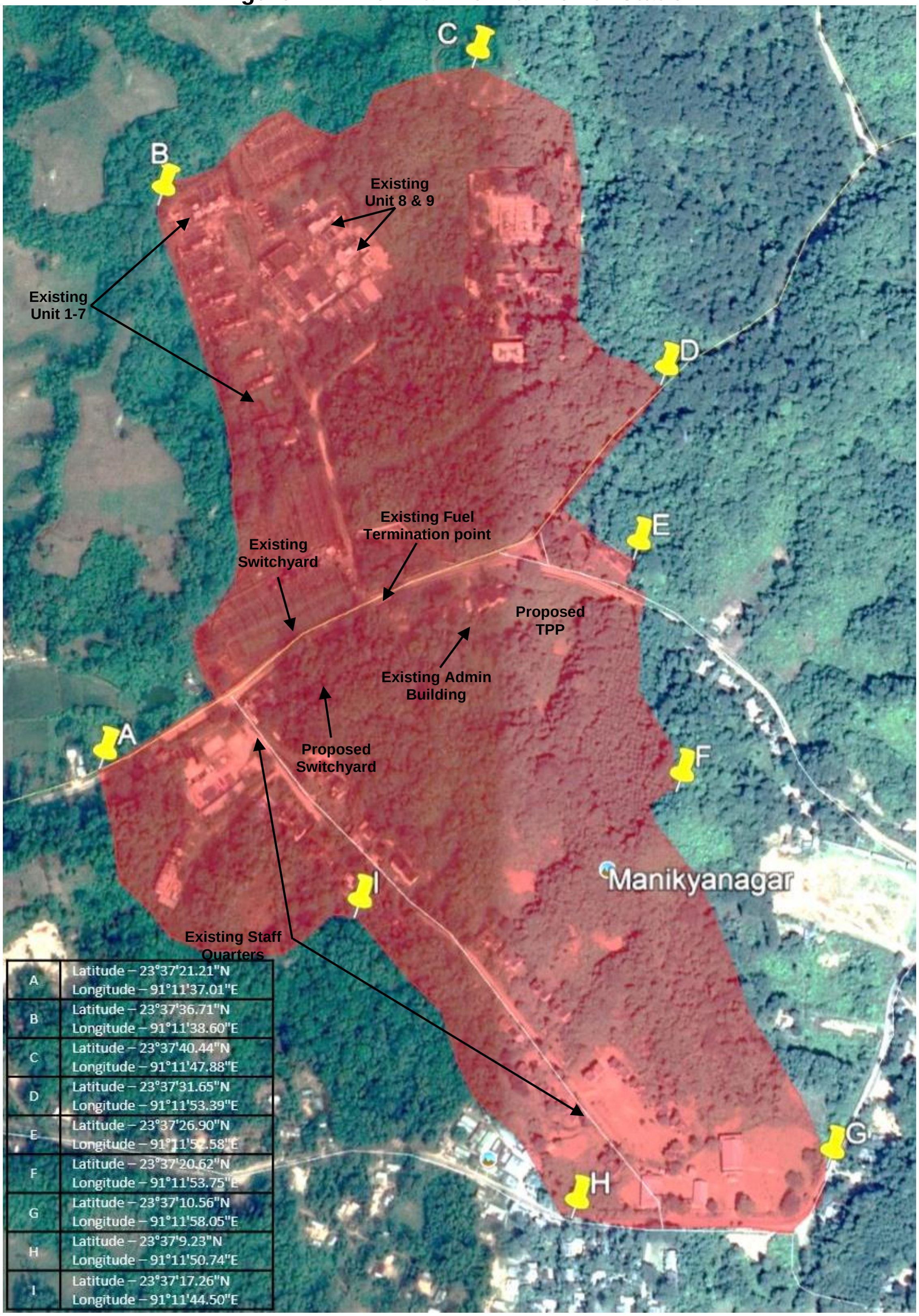
31. The location map is shown as Figure 2-1, the existing layout of Rokhia Thermal Power Station is shown in Figure 2-2 with the location of the proposed plant within it, and the project footprint is shown in Figure 2-3. Topography of the project site is variable with flatter areas of land (ranging in elevation from 30m to 49 m) being interspersed with hillocks (maximum 59 m).

Figure 2--1: Location of Rokhia Thermal Power Station



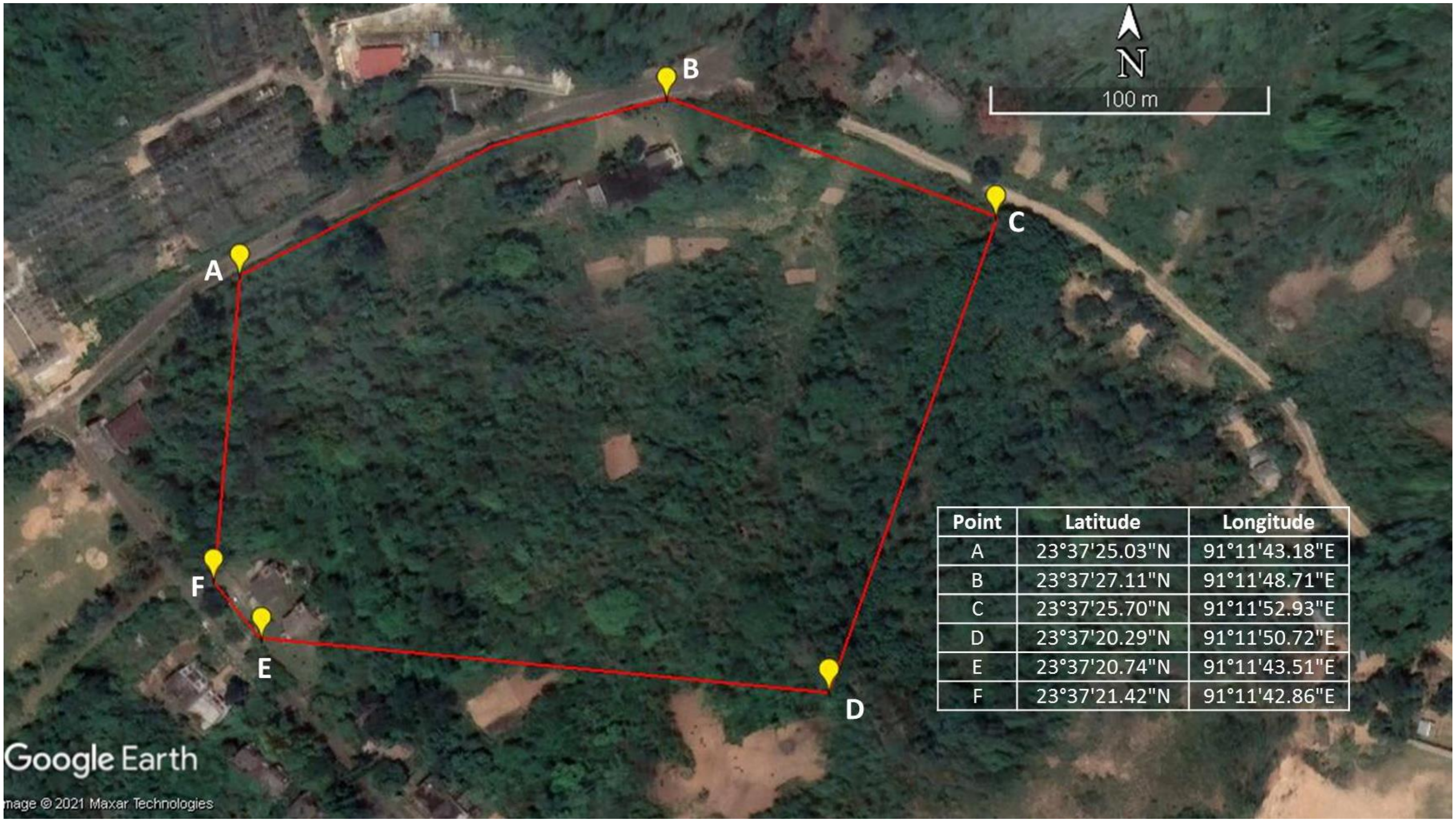
Source: ADB TA Consultant, TPGL DPR, November 2020, Google Earth

Figure 2--2: Rokhia Thermal Power Station



Source: TPGL DPR, November 2020

Figure 2-3: Plot of the Project Footprint



Point	Latitude	Longitude
A	23°37'25.03"N	91°11'43.18"E
B	23°37'27.11"N	91°11'48.71"E
C	23°37'25.70"N	91°11'52.93"E
D	23°37'20.29"N	91°11'50.72"E
E	23°37'20.74"N	91°11'43.51"E
F	23°37'21.42"N	91°11'42.86"E

Source: TPGL, December 2021

Table 2-1: Key Characteristics of Proposed Plant and Project Site

Characteristic	Description
PROPOSED PLANT	
Sector/Category	Industrial/Thermal Power Plant
Technology	Advanced F-class CCGT
No. of CCGT units	1
CCGT unit configuration	1 GT + 1 HRSG + 1 ST on separate shafts; The final configuration will be as per EPC contractor's design.
Output of CCGT unit	About 120 MW
Fuel	Natural Gas
Condenser cooling type	Air cooled condenser for steam turbine Auxiliaries for GT/ST generators, HRSG, Gas Booster Compressor and air compressor will be cooled through closed cooling water system (demineralized water) in the primary circuit and Fin Fan coolers in the secondary circuit
Water Source	Groundwater (two bore hole on project site)
HRSG stack height	60 m
Bypass stack height	30 m
Design and construction	EPC Contractor through selected bids
Operator	Tripura Power Generation Limited (TPGL)
PROJECT SITE	
Land use and status	TPGL owned land within Rokhia Thermal Power Station. No land acquisition involved
Transport/Access route	No new access is required, existing modes of access (road, railway, waterway from Kolkata / Haldia port through roads or railways of the Indian states of West Bengal, Assam, Meghalaya and Tripura for approximately 1,686km by road or 1,650km by rail, or from Chittagong/Chattogram port in Bangladesh through Sabroom in Tripura for approximately 220km by road, or from Ashuganj River Port in Bangladesh through Agartala for approximately 81km by road) are to be used with the access route to be determined by the EPC Contractor
Topography	Complex topography with flatter land varying from 30-49 m elevation and hillocks having maximum height 59m on project site

EPC = Engineering, Procurement and Construction; CCGT = Combined Cycle Gas Turbine; GT = Gas Turbine
HRSG = Heat Recovery Steam Generator; ST = Steam Turbine; MW = Megawatt
Source: ADB TA Consultant

B. Existing Plant

32. The existing plant at Rokhia Thermal Power Station was established in 6 different phases between 1990 and 2013. It is an OCGPP, using natural gas as a fuel. There are 9 open cycle gas turbines generating sets installed, of which six units – namely Units 1, 2, 3, 4, 5 and 6 have a capacity of 8 MW each while the other three units (Units 7, 8 and 9) have a capacity of 21 MW each. Out of the 9 gas turbine units, only 3 units (Units 7, 8 and 9) are operational, although one of the units is currently shut down in compliance to MoEF&CC's direction since TPGL did not obtain environmental clearance and also to keep generation under 50MW

(violation case) from MoEF&CC during its installation.[16] The other 6 units are not operational and have been either decommissioned or are in process of being decommissioned as their active life spans have expired.

33. The technical specification for the existing plant as currently operational is provided in Table 2-3. The open (or simple) cycle power generation process starts when fresh air drawn in through an inlet air filtration system enters the compressor of each unit at ambient temperature where its compressed. Heavy-duty gas turbines can operate successfully in a wide variety of climates and environments due to the use of suitably designed inlet air filtration systems that remove contaminants to levels below those that are harmful to the compressor and gas turbine. The compressed air enters the combustion chamber where natural gas is injected and ignited. The heated, compressed exhaust gases of combustion enter the gas turbine and rotate its blades as they expand to ambient pressure; the turbine blades are attached to a shaft and generator so that their rotation generates electricity which is then evacuated to the grid through a switchyard and high-voltage transmission lines.

34. The existing process has low efficiency (26.46%) as the heat generated by combustion is wasted to atmosphere along with the exhaust gases.

Table 2-2: Unit-wise Status of Existing Plant

Phase	Unit	Configuration (in MW)	Date Of	
			Commissioning	Decommissioning
I	1	8	7th Mar 1990	22nd Jan 2006
	2	8	20th Dec 1990	14th Feb 2002
II	3	8	4th Jun 1995	Not Operational, being decommissioned
	4	8	15th Dec 1995	
III	5	8	2nd Mar 1997	
	6	8	5th Aug 1997	
IV	7	21	2nd Aug 2002	Currently Operational, although one unit shut down on direction of MoEF&CC
V	8	21	31st Mar 2006	
VI	9	21	31st Aug 2013	

Source: TPGL DPR Nov 2021 and MOEF&CC MoM dated 4th December 2019

Table 2-3: Selected Technical Specifications of Existing Plant

Particulars	Details
No. of Turbine	3 (one unit shut down on direction of MOEF&CC)
Capacity of the operational units	3 x 21 MW = 63 MW Presently 2 x 21 = 42 MW
Gas Requirement	0.58 MMSCMD from ONGC and GAIL (consumption around 0.57 MMSCMD)
No. of Stacks	One per Unit (total 9, 2 operational, 1 temporarily not operational)
Stack Height	10m
Combustion and Fuel	Multi-chamber combustion system with dual retractable spark plugs and

[16] TPGL had commissioned 3 x 21 MW units without obtaining Prior EC and have applied for regularisation of EC. In pursuance of MoEF&CC's order to maintain operational capacity below 50 MW, operation of one unit was stopped and capacity reduced to 42 MW. The EAC has recommended the grant of ToR for the proposal to regularise EC for the 3 x 21 MW units vide its minutes of the 13th meeting of the re-constituted EAC on EIA of thermal power projects held on 13th July 2021. TPGL has concurrently applied for prior EC for the new 120 MW gas based thermal power plant as a category A project. The proposed plant as per its output is Category B, but it fulfils the general condition of being present within 10km of international border and has thus been upgraded to Category A and Prior Environment Clearance from MoEF&CC is required.

Particulars	Details
Injection System	sparking, flame detector, fuel nozzle for gas injection, and crossfire tubes in the gas turbine
Gas Turbine	Single shaft axial flow compressor turbine (Frame-5 GT Sets)
Auxiliary	Microprocessor based Fuel Control System to control the flow of fuel to the combustion chambers, Air Processing System, Pressure-switch Transducer, Motor-control Centre, DG set with AMF panel for auto-start in the event of failure of the main AC supply, DC motor driven Lubricant-oil Pump etc. Lubrication system to cater for running and emergency requirements is a closed system with reservoir/tank capacity of 6000 liters.
Enclosures	Turbine and generator compartments have been completely enclosed with weather protection, , and ventilation
Heating and Ventilation System	Fans fitted in the enclosure for ventilation of the turbine compartment. Heater has been provided in the enclosure; but this is only to maintain a suitable start-up temperature and for humidity protection during any shutdown and stand-by period.
Fire Detection and Protection System	Automatic fire detection and protection system installed, releases halogen/CO_2 fire-extinguishing media into the turbine and generator compartments automatically
Control Room	Vermin-proof, self-ventilated duplex type control panels lined-up together for generator control and protection, unit transformer control and protection turbine control, accessories control, complete with necessary meters, instrument recorders, etc. Fully air-conditioned with split-type air-conditioners of adequate capacity
Earthing	Earthing grid comprises a mat connecting all the equipment/metal structures through risers with suitable earth pits distributed over and around the existing plant area to limit the earth resistance below 0.5 ohms
Lighting	Outdoor lighting arrangements are provided for the existing plant area, GCS, switchyard, staff quarters, etc. Indoor lighting arrangements have been provided for illumination of control room buildings, office buildings, staff quarters, etc.

MW= Megawatt; MMSCMD= million metric standard cubic meters per day; ONGC = Oil and Natural Gas Corporation Limited; GAIL= Gas Authority of India Ltd; KVA = kilo volt ampere; DC = direct current; AC = alternating current; AMF= automatic mains failure; CO_2 = carbon dioxide; CGI = corrugated galvanized iron
Source: TPGL DPR

1. Fuel Supply

35. The existing plant operates on piped natural gas supplied from nearby Konaban Gas Field of GAIL (150m) and Rokhia Gas Field of ONGC (200m) which terminate at the metered gas collecting station (GCS) of the Rokhia Thermal Power Station (Figure 2-4) located close to the existing plant. Gas wells and the small GCS are sited within the northeast boundaries of Rokhia Thermal Power Station (Figure 2-2) – the main gas fields/wells and GCS are sited elsewhere.[17]

36. The small GCS which services only the exiting plant is operated by ONGC. As an existing facility to which the proposed plant will connect, an environmental audit for it is included later in this chapter. The allocated quantity of natural gas to the Rokhia Thermal Power Station

[17] The main gas fields of GAIL and ONGC are significantly distant from Rokhia Thermal Power Station, the main Konaban gas field terminal of GAIL is around 8 km NW from the existing plant, ONGC gas field is about 31 km north. Other gas power plants are supplied in addition to Rokhia Thermal Power Station.

is up to 0.58 MMSCMD whereas the consumption by the existing plant is currently about 0.57 MMSCMD.

37. The natural gas supplied from the Konaban gas field is mainly composed of methane (96.01%), ethane (2.321%), propane (0.458%), carbon monoxide (0.716%), nitrogen (0.184%), besides small percentages of butane, propane, and carbon. The detailed composition is given in **Annexure 1**.

38. Back-up diesel generator is provided at the existing plant in the event of failure of the main power supply.

Figure 2-4: Gas Supply Arrangement

Note: orange line shows the existing gas pipeline to existing plant GCS
Blue line is the proposed gas pipeline
Source: ADB TA Consultant

2. Water Supply

39. There is process water required to keep the lubricant oil temperature below 80ºC which is done by closed loop water circulation. This process water is supplied from groundwater through one borehole with pre-treatment through demineralization. Domestic water is also required for the workforce, which is supplied from the same bore well, supplemented by bottled water. The water requirement is shown in Table 2-4. The borehole is located within the Rokhia Thermal Power Station, southeast of the proposed plant near to the school (there is another borewell used by the school). The borehole is 30 m deep – groundwater abstraction of up to 770 liters per day is licensed by Tripura, Water Resource Department.

40. The pre-treatment plant is located within the existing plant, the pre-treatment comprises a series of clarifiers and sand filters; coagulant chemicals are used for pre-treatment. The pre-treatment plant will be decommissioned alongside the existing plant, but the borewell will remain for local supply and as a standby for the proposed plant.

Table 2-4: Water Requirement of Existing Plant

Type	**Water Requirement (liters per day)**	**Notes**
Process Water	600	Initial filling requirement is 1000 liters per unit, make-up requirement is 200 liters/day/unit
Domestic Water	170	
Total Water	770	

Note: no separate water is allocated for fire services of existing plant
Source: TPGL DPR, November 2020

3. Power Evacuation

41. Power is presently evacuated from the existing plant through the 132/66 kV transmission network of TSECL. The existing 132 kV switchyard within the Rokhia Thermal Power Station (Figure 2-5) is operated by TPGL, as an existing facility to be retained, an environmental audit for it is included later in this chapter. The existing 132 kV switchyard currently has one moose bus conductor.

Figure: 2-5: Photographs showing Facilities at the Existing Plant

Facility	**Photograph**
Switchyard (existing facility to be used for the proposed plant power evacuation)	

Facility	Photograph
Overview of existing plant showing boundary/hillocks	
GCS inside existing plant (existing facility – to be used for transporting gas from this point to proposed plant through a 90m pipeline)	
Proposed storage yard within TPGL area	

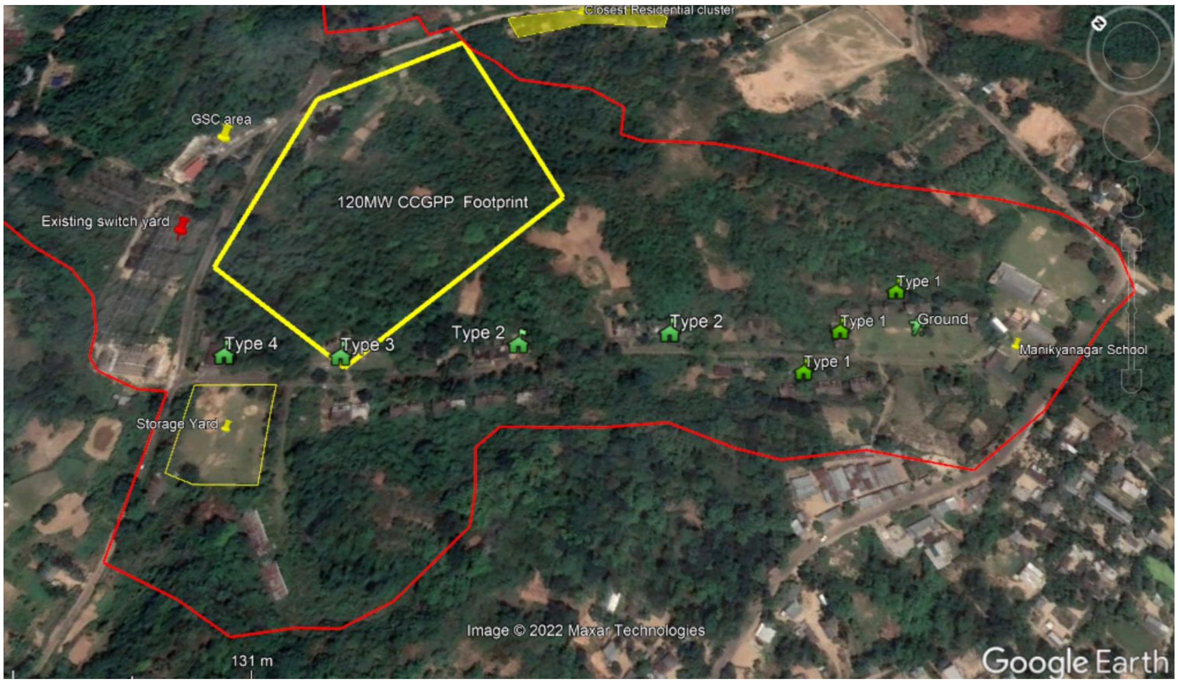
Facility	Photograph
Defunct Units	
Operational Units	

Source: ADB TA Consultant

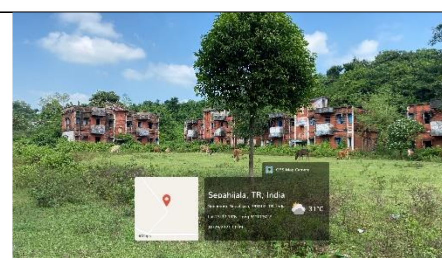
4. Manpower and Staff Accommodation

42. 37 skilled staff and 4 unskilled staff (security, peon[18]) are employed for the operation of the existing plant. There are no female staff. Most of the existing staff travel from home and very few reside in the residential staff quarters within the Rokhia Thermal Power Station. Whilst some staff quarters are being maintained by TPGL, most of the low rank officers' staff quarters are vacant and in need of repair and/or maintenance to be suitable for staff accommodation. The details of the accommodations available in the Rokhia plant area is provided in Table 2-5.

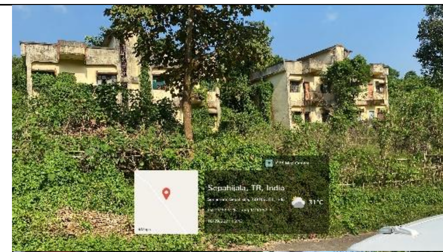
Table 2-5: TPGL Staff Accommodation Details



Google Earth Map showing locations of the TPGL staff accommodation

Sl. No.	**Type (Refer to map above)**	**Existing status**	**Reference to proposed plant**	**Photograph**
1	Type 1	2 storied small quarters for junior grade staff. Accommodated 100+ staff across various phases of existing plant units. Last use was to host Indian army officers (2009-2019). Most dilapidated and not in use.	Not to be used for proposed plant	

[18] Low ranking officer, office assistant

2	Type 2	2 storied medium sized quarters for junior/mid-level officers. These are either within a compound or standalone (see map) Some in use. Require minor repair, painting, boundary repair, and garden clearance to be habitable.	Planned use for EPC contractors' officers/TPGL officers during construction	 
3	Type 3	2 storied larger accommodation for senior TPGL officers. Vacant now. Intermittently used. Require some clean-up, painting, etc	Planned use for TPGL officers of proposed plant during construction and operation	 
4	Type 4	Two storied bachelor staff barracks. Used for single/junior level staff. Vacant now. Require clean-up, painting etc.	Planned use as construction workers accommodation	

Source: ADB TA Consultant

5. Effluent Treatment

43. Sludge from the pre-treatment plant consisting of raw water clarifier sludge, demineralized water clarifier sludge, and pressure sand filter backwash are taken to the common clarifier sludge treatment system consisting of a thickener and centrifuge located within the existing plant. Sludge from the centrifuge is disposed through ONGC in the form of sludge cakes to licensed waste disposal facility/recyclers in Assam. The treated effluent is re-circulated into the system. No process effluent is generated for discharge to surface or ground water. The system will be decommissioned alongside the existing plant. Sewage generation from domestic activity is treated in septic tanks followed by soak pits located within the existing plant.

6. Hazardous Materials, Solid and Hazardous Waste Storage and Disposal

44. The existing plant does not have dedicated hazardous materials or solid and hazardous waste storage areas. Non-Hazardous solid wastes comprise metal scraps, paper, plastic, rubber, broken glass, leaves and twigs from trees and bushes around the project site, and domestic wastes. Non-hazardous wastes are disposed, sold, or recycled through approved vendors or municipal services. Hazardous wastes include fused fluorescent lamps, used oil, oily rags (hazardous) which are taken in packed containers by ONGC and disposed to licensed waste disposal facility/recyclers in Assam. All hazardous wastes are disposed as per the provisions of the Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016 through ONGC. Tripura does not have any authorised hazardous waste handling facility. The nearest major secured landfill and incinerator facility is in Haldia, West Bengal, which is about 1700 km (or 40 hours) via NH 27 from Rokhia.

C. Combustion Technology of Proposed Plant

45. The proposed plant will use combined cycle combustion technology to generate about 120 MW of power from the same amount of natural gas used by the existing plant. The first steps in the combined cycle process are the same as the open (simple) cycle gas turbine plant with a compressor, combustion chamber, and gas turbine. Since the input temperature of gases entering the turbine is very high, the output temperature of the flue gases is also very high. Instead of being wasted this heat can be used to fuel a second cycle using steam.

46. Once the heated, compressed exhaust gases of combustion have been used to drive the turbine the waste heat is then used to generate steam by passing the exhaust gases through a heat recovery steam generator (HRSG) with a live steam temperature between 420 and 580°C. In the HRSG highly purified water flows in a network of sealed pipes with extended fins to increase the effective heat transfer area that the hot exhaust gases meet. Heat transfer causes the water to turn into steam. This steam then rotates a steam turbine and coupled generator to produce electricity. Exhaust gases leave the HRSG at around 100°C and are discharged to the atmosphere.

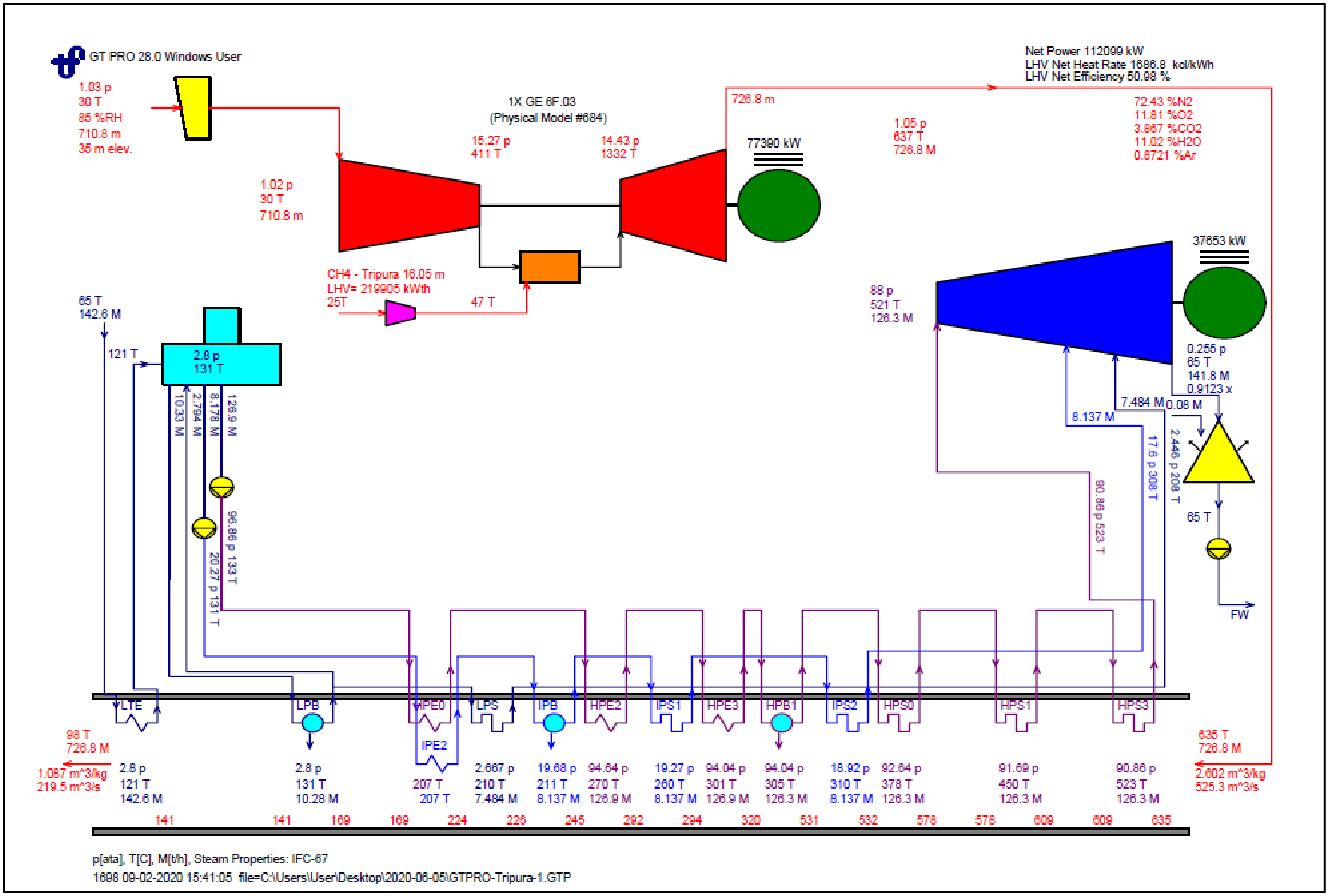
47. The boiler feed water is first passed through an economizer from where it passes through an evaporator and then to a superheater. In the HSRG the hot exhaust gases first encounter the superheater, then the evaporator and then the economizer. The temperature of the superheater is the highest in the system because it is the closest to the input of the hot exhaust gases. The temperature of the economizer is the lowest because it is farthest from the hot exhaust gases input, its function is to preheat the water before it passes to the evaporator section. The preheated water then passes to the pipes of the evaporator where enough heat exchange occurs for the water to be converted into steam. The steam may be saturated in nature hence it is passed to the superheater section where the temperature of the steam increases so much that it becomes a superheated steam. This superheated steam is then output from the HRSG to the steam turbine.

48. The steam turbine cycle produces about one third of the power and the gas turbine cycle produces about two thirds of the power output of the combined cycle process. By combining both gas and steam cycles, high input temperatures and low output temperatures can be achieved. The efficiency is increased because both cycles are powered by the same fuel source. The efficiency of a combined cycle gas power plant varies between approximately

50–60 percent, with the latest large heavy duty GT systems exceeding 60% (net, LHV).[19] Per World-Bank IFC EHS Guidelines for Thermal Power, the proposed plant must aim to be in the top quartile of the Indian/Asian average of the same fuel type and power plant size (to keep down CO_2 emissions) and suggest 54-58% as being achievable efficiency for a CCGPP. To maximize the efficiency, it is necessary to optimize the HRSG with the objective of increasing the steam turbine output. HRSG performance has a large impact on the overall performance of a combined cycle gas power plant.

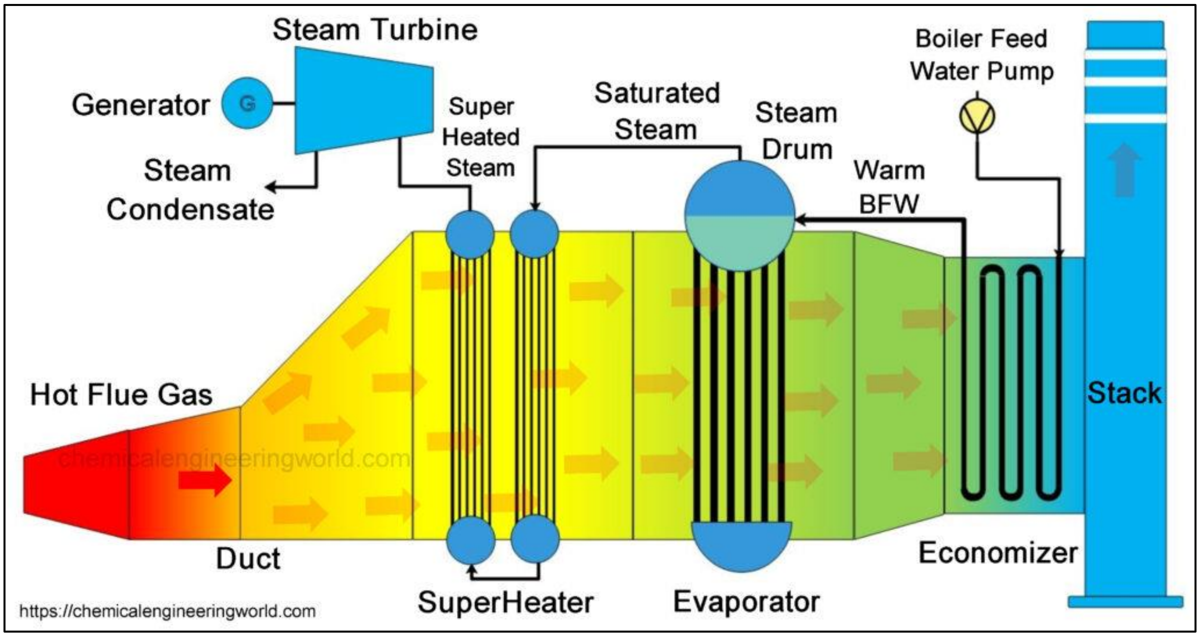
[19] Adumene, S. and Nitonye, S. 2016. *Assessment of Site Parameters and Heat Recovery Characteristics on Combined Cycle Performance in an Equatorial Environment*. World Journal of Engineering and Technology, 4, 313-324. https://www.scirp.org/journal/PaperInformation.aspx?PaperID=66877#:~:text=Many%20researchers%20focus%20on%20improving%20the%20modeling%20of,50%25%20-%2060%25%20based%20on%20the%20operating%20environment.

Figure 2-6: Operating Process Diagram of the Combined Cycle Gas Power Plant



Source: TPGL PFR, undated

Figure 2-7: Operating Principle of HRSG



Source: Chemicalengineeringworld.com

D. Details of the Proposed Plant

49. The proposed plant will be a CCGPP using natural gas as fuel. It will be operated as a base load power plant. Project footprint required for the proposed plant and related facilities is 4.5 hectares. The power generation capacity will be around 120 MW – Gas Turbine Generator (GTG) – 77.39 MW, Heat Recovery Steam Generator (HRSG) and Steam Turbine Generator (STG) – 37.65 MW. There will be one unit of 120 MW (1 x 120MW) with built-in low Nox emission control technology and closed-loop air cooling condenser system. Natural gas will be supplied by ONGC and GAIL from the existing Gas Collecting Station (GCS) through a new 90 m, 8-inch pipeline (Figure 2-4). Electricity will be exported to the grid through the existing switchyard. All other related facilities will be newly constructed for the proposed plant. The gross design efficiency of the proposed plant will be 52.31%.[20] The life span of the proposed plant is 25 years so based on the commencement of operations it will be in operation until about 2050 after which it will be decommissioned.

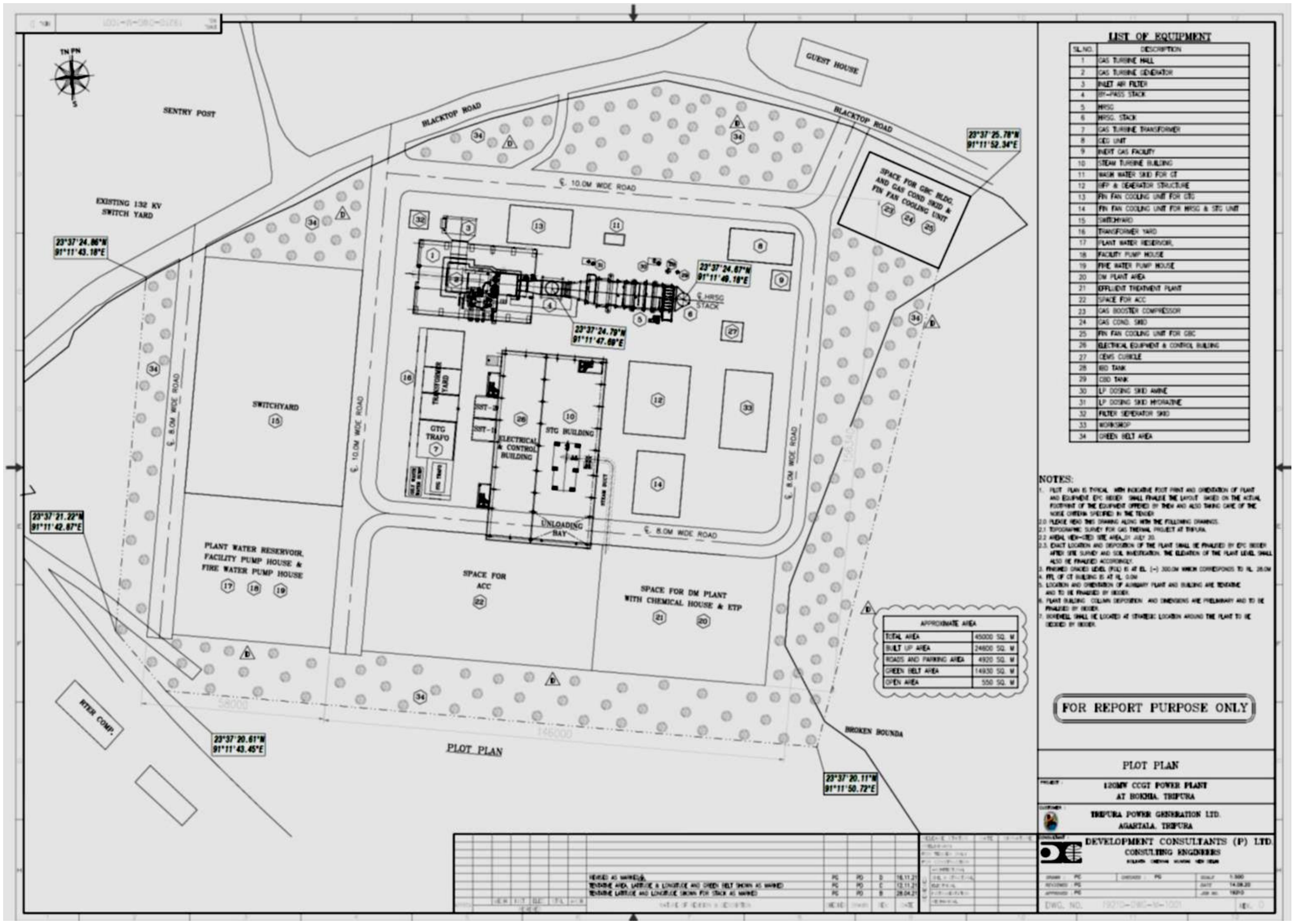
1. Indicative Design and Layout

50. The proposed plant will have one industrial type F-class Combined Cycle Gas Turbine with bypass stack of 30 m high for simple cycle operation, and a horizontal type HRSG with main stack 60 m high for combined cycle operation. The indicative layout on which this EIA is

[20] The available combined cycle plants of 120 MW capacity from reputed manufacturers have ISO condition efficiency with water cooled condenser in the order of 54.7 % to 56.9% (Chapter VI). However, due to paucity of water, air-cooled condenser must be used. This will reduce the efficiency of steam cycle. Thus, the estimated efficiency of the CCGPP at site conditions with air-cooled condenser will be in the order of 51.14%-53.86% at ISO conditions. The final efficiency of the CCGPP will be decided by EPC Contractor based on the equipment and steam cycle offered.

based is provided in Figure 2-8 and Table 2-6. Detailed plans and plots are provided in **Annexure 2.** The indicative design and layout of the proposed plant has been developed considering installation of one 120 MW multi shaft module consisting of one gas turbine, one HRSG and one steam turbine in (1+1+1) configuration. Considering paucity of surface water availability an air-cooled condenser will be provided for condensing exhaust steam from the steam turbine. The indicative layout was prepared in such a way that the available space is well utilized, process flow is maintained, adequate access for operation and maintenance is available and to minimize impacts on the nearby residents. Final unit configuration and layout is to be decided by the EPC contractor. Structures will be designed based on maximum wind / seismic loads as per the relevant IS standards.

Figure 2-8-: Indicative Layout of Proposed Plant
(considering green belt requirement and noise mitigation design)



Source: DCPL (Design Consultant)

Figure 2-6-: Indicative Breakdown of Land Take for Proposed Plant

Particulars	**Area (ha)**
Built-up Area	2.460
Parking and Road Area	0.492
Green Belt Area	1.493
Open Space	0.055
Total	**4.500**

Source: DCPL (Design Consultant)

51. The following will comprise the proposed plant and related facilities:
   (i) Gas receiving, pressure boosting and conditioning units
   (ii) Power Block including Gas Turbine (GT) and Steam Turbine (ST) Buildings or Halls
   (iii) Air Cooled Condenser (ACC)
   (iv) Black Start and Emergency Generator
   (v) Electrical Equipment come Control Building annexed to the ST Building
   (vi) Transformer Yard and New Switchyard
   (vii) Water storage reservoir, water treatment plant and effluent treatment plant blocks
   (viii) Stores and Workshop Building
   (ix) Staff Welfare Facilities[21]
   (x) Fire Station
   (xi) Boundary Wall, Service Roads and Gate House to Rokhia Thermal Power Station (currently there is gate and gate house for the existing plant, although the proposed plant has an opening onto the private TPGL access road but no gate or gate house)

52. **Gas receiving, pressure boosting and conditioning units**: incoming gas will be supplied as per the existing plant to the GCS. At the receiving point, a motorised isolation valve will be provided to interrupt the gas flow as and when required. A pressure indicator will continuously monitor the supply gas pressure and in case of any abnormality, it will generate an alarm. Downstream of the isolation motorised valve, an on-line flow meter with integrator and a pressure control valve will be provided to maintain a constant pressure downstream of the control valve. The gas will be led to a gas booster compressor (housed within a building of RCC construction with brick wall having noise attenuation panels inside) via a knock-out drum which will be provided to arrest entrained moisture or liquid hydrate droplets. Excess liquid will be drained to a drain tank through a control valve, a level controller, one level gauge and one more liquid level high alarm through a level switch will be provided on the drum. To save the knock-out drum from failure due to high pressure and subsequent fire hazards one pressure safety valve will be provided on the drum. This pressure safety valve will vent excess gas through a vent header to the atmosphere through a cold stack (no flare) when pressure inside the drum will rises above a preset value.

53. The natural gas pressure is in the order of 20 kg/cm^2. The gas turbine will require gas supply at a pressure of around 22 kg/cm^2. Hence a gas booster compressor station will be installed to supply gas at the correct pressure to the gas turbine unit. Two electrical motor driven

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[21] Some staff welfare facilities such as a canteen and medical facilities are already available at the exiting TPGL administrative buildings to which proposed plant workers will have access; the administration buildings will continue to be used for the proposed plant, but where there is inadequate provision of staff welfare facilities these will be supplemented at the proposed plant

centrifugal gas booster compressors with a capacity of approximately 25,000 Sm^3/hr will be provided to boost the available fuel gas pressure to the desired level of gas turbine manufacturer. Normally one gas compressor will be in operation and the other will be in standby in case of failure of the running compressor. A recirculation line with a control valve will be provided in the discharge line of each compressor to absorb surge in case of drop of discharge flow below a pre-set level, with a pressure relief valve provided upstream of the non-return valve. This valve will open by interlock as soon as the respective gas booster compressor trips or stops to vent off the entrapped gas to atmosphere through the vent header to stack (no flare). Each gas compressor will be provided with a forced lubrication oil system with a sealed oil supply system, each system will have two pumps and a reservoir with normally one pump running and the other in standby in case of failure. Auxiliaries for the gas booster compressor will be cooled through common closed cooling water system (demineralized water) which in turn will release heat to atmosphere through fin fan coolers.

54. To get contaminant free clean and dry fuel gas for safe and trouble-free operation of the gas turbine a gas conditioning system will be provided. From the discharge header of the gas booster compressors the gas will enter 2 x filter separators to separate moisture, liquids, and other contaminants. A constant liquid level will be maintained inside each filter separator by an automatic level control valve. The excess liquid above the pre-set level will be drained to the drain tank by this level control valve. One level gauge will also be provided. In addition, if the liquid level rises above a pre-set level one level switch will operate which in turn will trip the gas turbine unit.

~~55.~~ **Power block**: the GT generator and ST generator will be located indoors in buildings/halls and the HRSG unit outdoors. Sufficient lay down area and overhead cranes will be provided in both buildings/halls for maintenance and overhaul. The building/hall designs will be finalized based on the selected model/manufacturer of the GT and ST. They will be of steel structure with metal (insulated) cladding over brick wall up to 2.1m high while the roof shall be Reinforced Cement Concrete (RCC). The optimum height of GT and ST buildings/halls will be worked out during detailed design by the EPC Contractor but the footprint of the GT is anticipated to be 35.8 m x 21 m x 21.5 m high, and the footprint of the ST is anticipated to be 58 m x 21 x m 24 m high.

56. Performance of gas turbines is sensitive to inlet air quality because of their inherent design and the enormous amount of air they handle, filtration is necessary for protection against air borne contaminants, entry of debris and birds, ingress of ground dust which might degrade the turbine performance and life due to erosion, corrosion, fouling, plugging, etc. The air inlet system will include filter compartments, weather louvers and moisture separator, silencer, ducting, fresh screens, plenum support structure, ladders, etc. The filter element of filter compartment will be sized considering maximum air intake in the gas turbine with low intake velocity with filter elements suitable for replacement and/or cleaning without stopping the gas turbine.

57. Auxiliaries for the GT/ST generators, HRSG, and air compressor will be cooled through will be cooled through common closed cooling water system (demineralized water) which in turn will release heat to atmosphere through fin fan coolers. The closed loop cooling water system has been envisaged to cater to the requirements of various auxiliary coolers of GTG, STG and other miscellaneous coolers. The system will utilize inhibited/passivated demineralized water as a cooling medium. The cooling water system will comprise fin fan coolers/air cooled heat exchangers, closed cooling water pumps, cooling water surge tank etc.

58. **Air Cooled Condenser (ACC)** for condensing exhaust steam from the steam turbine will be located outdoors. The super structure of the ACC will be structural steel framing with RCC floor slabs and metal cladding.

59. **Black Start and Emergency Generator:** a 630 KVA Emergency Diesel Generator (DG) is to be installed for supplying power for safe shut down of the proposed plant or power during emergency condition. It is to be housed in the open (isolated) area of the proposed plant or in a structural steel frame construction clad with brick or metal with RCC or metal sheet roof and having a stack as per CPCB guidelines.[22] Fuel oil (High Speed Diesel) will be required and will be stored in a small cylindrical tank adjacent to DG enclosure; its capacity will be such that no CCOE approval is required for the oil storage. It will be of the "green" generator type (Figure 2-9) being silent or having soundproofing and vibration isolation features. The fuel tank will be periodically filled up with oil through portable/hand pump from fuel oil tanker. There will also be a 1250 KVA emergency gas engine provided.

Figure 2-9: Representative Image of a Green Generator

Source: India Mart, https://www.indiamart.com/proddetail/kirloskar-green-625-kva-generator-12601150848.html

60. **Electrical/Control Building**: all electrical distribution equipment will be in one building near the power block which is annexed to the ST Building/Hall. The plant DCS and switchyard control will be in the Control Building from where the operation of the entire plant can be controlled and monitored. This will be a multi storeyed building of RCC/Structural Steel framed construction with RCC roof and cladding with brick / pre coated metal sheet. The ground floor will locate all switchgear, motor control centers, batteries, and battery charger and first floor will house all control panels. The Electrical Room and Control Room will be air-conditioned and provided with false ceiling and false floor. The Control Room will be designed so that the internal noise level is less than 45-50 dB(A) (as per World Bank-IFC EHS Guideline 2007 Table

[22] Stack height (H) = h+0.2 x √ KVA where the h is the height of the nearest building in m

2.3.1). Space will be provided in this building for plant O&M staff (including conference room, record room, rest area, eating area, kitchen space, toilets and washrooms etc.)

61. **Transformer Yard and New Switchyard**: the GT generator will be connected to a generator transformer through a generator circuit breaker for synchronizing the generator with the grid. The generator circuit breaker will also facilitate the use of start-up power by back charging the generator transformer to feed two auxiliary transformers of voltage ratio generator voltage/6.9 kV from the existing 132 kV switchyard grid power by keeping the generator circuit breaker open. The generator transformer will be used to feed the auxiliary loads from the grid even if the gas turbine generator is not in operation. The two auxiliary transformers will be rated at 132 kVA to feed the maximum load connected to the 6.6 kV switchgear. Transformers will be located towards the new 132 kV switchyard end of the power block for ease of connection to the existing 132 kV switchyard. Generator transformers and station auxiliary transformers will be in a transformer yard. Each transformer will have its own impermeable oil pit (sump) of at least 110% capacity ~~g~~ to collect oil leak or spill. Individual oil pits will be connected to a common oil pit and finally connected to an oil water separator. In the high voltage switchyard, transformers will be separated by fire wall of adequate thickness. Galvanized steel structures will be provided to support conductors, transformers, circuit breakers, insulators, switches etc. Four-legged towers supporting the gantries for stringing of overhead conductors will have RCC foundation. A switchyard control room (local) is not currently envisaged, but if required then it will be a steel structure with masonry wall and RCC roof. The entire switch yard will be paved/concrete and having uniform elevation.

62. **Water storage reservoir, pre-treatment plant and effluent treatment plant blocks:** a water storage reservoir will be provided to store up to seven days of water supply for the proposed plant plus fire water reserve; effective capacity of 4000 m^3 of storage (two compartments having capacity of 2000 m^3 each). A plant water pump house annexed to the reservoir will house process water, domestic water, and fire water pumps. The reservoir and pump house will be constructed of RCC substructure with the superstructure being RCC or steel framed construction clad with brick/metal with RCC or metal roof.

63. The water treatment plant will be housed in a building also including a motor control centre (MCC) room, chemical house, laboratory room etc. The water treatment plant building will be of RCC framed construction with brick cladding and RCC roof. Floors of the chemical house and laboratory room will be lined with acid and alkali proof tiles. The capacity and design of the pre-treatment plant will be determined at detailed design stage with the treatment process based on borehole water quality analysis – for process water a demineralization plant is required, to remove inorganic salts that could cause corrosion by passing the water through ion exchange resins (chemical method). Chemical feed system will be provided for feeding tri-sodium phosphate in the HRSG drum and neutralizing amines and hydrazine in the condensate extraction pump discharge and boiler feed suction line to maintain the chemical concentration in the drum water and feed water within permissible limits for trouble-free operation of the plant. For potable water, filtration and chlorination of the groundwater supply will be carried out as required to meet the Indian Public Health Association (IPHA) and IS 10500 2012 Standards for potable water. Chlorination (sodium hypochlorite) will be as required, chlorine will be in powered form to be mixed in water for intermittent dosing of the potable water.

64. An effective Effluent Treatment Plant (ETP) with capacity of 5 m^3/hr (maximum) is required to limit the quality of effluent to be discharged from the proposed plant within the prescribed norms of CPCB, World Bank-IFC’s Environmental Health and Safety (EHS) General Guidelines and EHS Guidelines for Thermal Power Plants. The ETP will treat process

wastewater, at a minimum the process will include equalisation, neutralisation, and sedimentation. Continuous monitoring system, Real Time Effluent Quality Monitoring System (RT-EQMS) will be installed with provision for connection to CPCB/TPCB system.

65. Domestic wastewater is currently envisaged to be discharged to septic tank for treatment prior to discharge, although it can also be discharged to a separate package sewage treatment plant (STP) for sanitary sewage or the ETP depending on the EPC Contractor’s design.

66. **Workshop and Store Building:** workshop and store buildings for civil, electrical, and mechanical maintenance are to be constructed. A one storey building with masonry cladding and RCC roof having crane facility will be built to carry out routine plant maintenance and small site repair work. The store will house spare parts for the proposed plant.

67. **Staff Welfare Facilities:** adequate number of separate toilets for male and females will be provided. The electrical/control room will include a rest area, eating area, kitchen space, toilets and washrooms etc. It is also necessary to provide a canteen and medical/first aid room with doctors room and nurses chamber. In this respect, existing TPGL administration office, cafeteria and medical facilities can be used by proposed plant staff. It is planned to repair existing staff accommodation (outside the 4.5 ha project footprint) in line with GoI and ILO worker accommodation guidelines[23] so that it may be used to accommodate TPGL staff that do not live local to the project site.

68. **Fire Station:** a fire station will be provided with a fire tender and fire jeep with necessary accessories. The firefighting equipment provided will conform to the recommendation of Tariff Advisory Committee (TAC) of the Insurance Association of India and the standards of the United States National Fire Prevention Association (NFPA).

69. **Boundary wall, service roads and gate house**: a boundary wall of minimum 3 m height will be provided to check unauthorized entry to the proposed plant. Fencing will also be provided for safety reasons around the transformer yard, switchyard, DG set area, gas receiving station etc. Internal service roads will be constructed around the proposed plant for movement of project vehicles.

2. Resource Requirements

2.1 Fuel Supply

70. The proposed plant is to be operated on natural gas tapped from the existing metered GCS (Figure 2-4) with the existing gas supply diverted to the proposed plant through a new 90 m, 8-inch gas pipeline (blue line) crossing beneath the TPGL private access road to join the gas receiving unit. No gas storage will be required. The current allocated quantity of natural gas to the Rokhia Thermal Power Station is 0.58 MMSCMD. The daily natural gas requirement for the proposed plant at 100% Plant Load Factor operation is 0.553 MMSCMD for generation of 115.04 MW of Gross Power at annual average project site conditions. Thus, the existing allocated quantity of natural gas of 0.58 MMSCMD will be sufficient to meet the requirement of the proposed project.

[23] https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---multi/documents/publication/wcms_116344.pdf

71. Normally the auxiliary power to the proposed plant will be supplied from the terminal of GT Generator/Generator Circuit Breaker through stepdown transformers – it will be about 3% of generated power. When the GT Generator is not in operation, the auxiliary power will be taken from the new 132 kV switchyard.

72. Fuel oil (High Speed Diesel) will be required for the 630 KVA Emergency Diesel Generator. High Speed Diesel is a complex mixture of hydrocarbons and has amongst other components benzene, naphthalene, and sulphur (maximum 0.20% by mass is permissible as per IS 16861:2018).[24] Given the DG is <3MWth capacity the emission levels of the generator will conform to the national standards as provided in **Annexure 3**.

2.2. Water Supply

73. Process water, potable water, and water for the fire system is required. Process water in a CCGPP generally includes that required for condenser cooling of various GT/ST/HSRG generators/ancillaries and for production of demineralized water for power cycle make-up. The total raw water requirement of the proposed plant has been estimated as 480 m^3 per day or 20 m^3/hour (Table 2-6 provides a breakdown and Figure 2-8 the water balance diagram). Water storage of 7 days requirement plus 2 hours fire water reserve will be provided. Considering this, the effective Plant Water Reservoir Capacity will be 20 x 7 x 24 + 550 = 3,910 m^3, approximately 4,000 m^3.

Table 2-7: Water Requirement of Proposed Plant

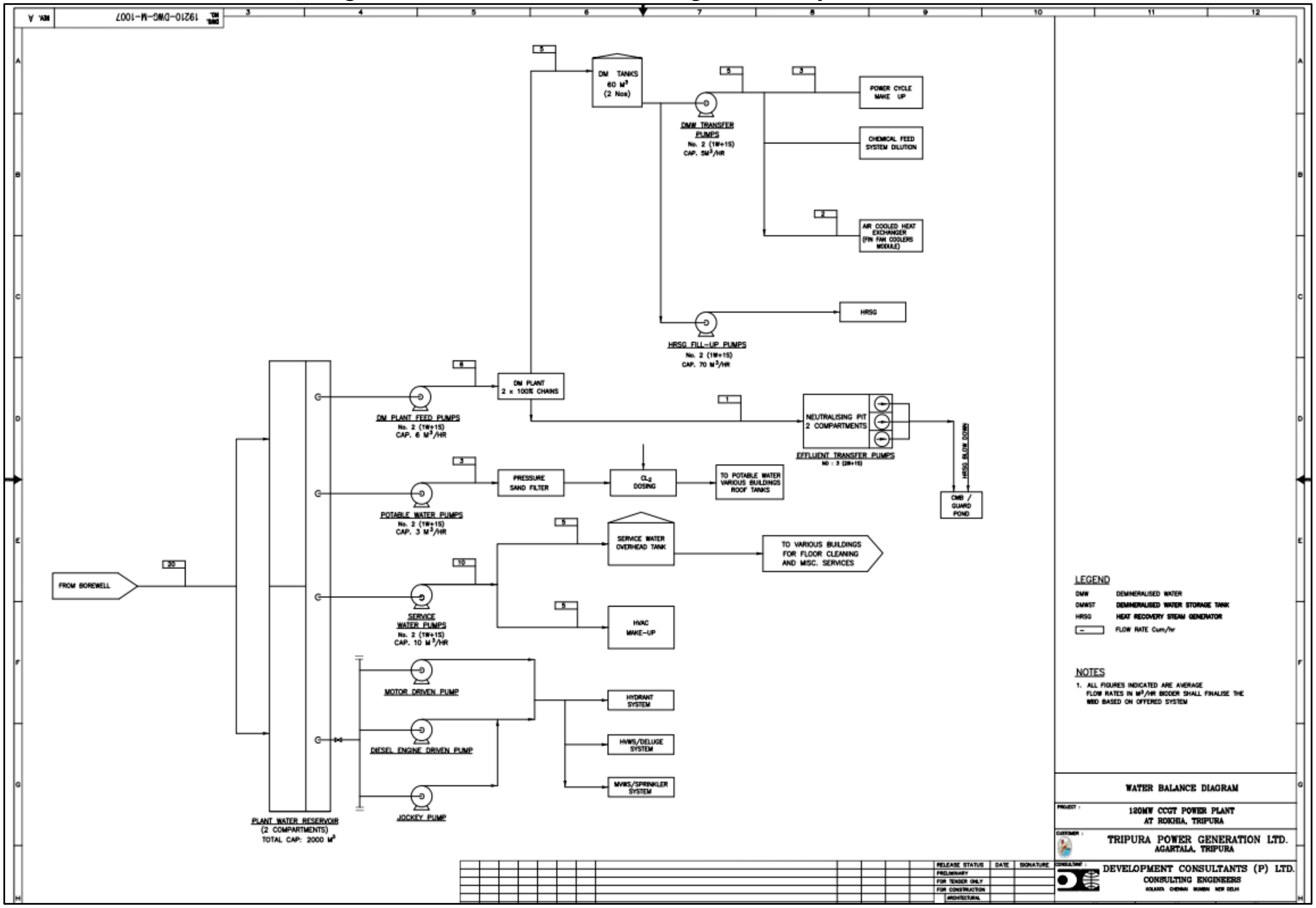
Type	**Water Requirement (liters per day)**	**Notes**
Process Water	480,000	Process water requirement about 144,000 liters/day including make-up requirement of 72,000 liters/day Domestic water is about 312,000 liters/day Fire system water is one time requirement of 550,000 liters for 2 hours
Domestic Water		
Fire System Water		
Landscaping/Green Belt Maintenance Water	48,000	Reuse from treated effluent meeting wastewater quality standards (no raw water supply needed)

Source: DCPL (Design Consultant)

74. The water demand of the proposed plant is significantly greater than the existing plant due to the second cycle involving HRSG. To meet the water requirement, groundwater will be abstracted through two new deep boreholes following permission from the Water Resource Department, GoT and CGWB. The boreholes will be located within the project footprint, these boreholes are anticipated to be sited in the pump house area near the Gas Turbine Hall and dug to a depth of 30m. Groundwater will be abstracted by pumps and stored in the water storage reservoir.

[24] https://www.bharatpetroleum.com/images/files/High%20Speed%20Diesel_MSDS.pdf

Figure 2-10: Water Balance Diagram for Operation Phase



Source: TPGL DPR Nov 2020

2.3. Power Evacuation

75. The existing 132/66 kV network will be utilized for evacuation of power from the proposed plant. The GT/ST will be connected to a new 132 kV switchyard. The new 132 kV switchyard will then be connected by the EPC Contractor to the existing 132 KV switchyard by two 132 kV overhead power lines crossing the road (about 50m in length). Two bays shall be provided in the new 132 kV switchyard for grid interconnection. In addition, the existing 132 kV switchyard bus conductor (one Moose Bus Conductor) will be upgraded by the EPC contractor with two Moose Bus Conductors to cater for additional power demand.

2.4. Manpower and Staff Accommodation

76. The proposed plant will require about 98 skilled, semi-skilled, and unskilled workers to operate; of which about 78 will be permanent TPGL staff and 20-30 contractual workers. TPGL will employ skilled and semi-skilled staff. Contractual workers will be semi-skilled and unskilled workers for outsourcing of activities like housekeeping, security services etc. As TPGL is a Government of Tripura undertaking most of the skilled personnel will be from the state while some may be from other states and directly employed by TPGL. Semi-skilled and any unskilled labourers (e.g., cleaners, gardeners) may be contractually recruited by TPGL for the operational period both locally and from the state. These staff will mostly commute from nearby town and Agartala. But some will be accommodated in the staff quarters at Rokhia Thermal Power Station.

77. Details of staff quarters to be reused are provided in Table 2-5. Most of the existing junior level officers staff quarters at present are vacant, dilapidated and will not be used for the proposed plant The two storied, standalone quarters in better condition (Type 2 and Type 3) will be renovated in line with GoI and ILO worker accommodation guidelines[25] for by O&M staff posted to the proposed plant.

3. Emissions, Discharges and Wastes

3.1. Air Emission

78. The major emissions will be NOx and CO and the emission levels to be achieved are set out in Table 2-8. One bypass stack of 30m will be provided after the GT generator and one HRSG stack of 60m will be provided for exhausting flue gas from the HRSG. Stack sensitivity analysis (Chapter 5) was conducted to check the suitability of the proposed stack heights. The lowest stack heights, beyond which no feasible emission decrease was observed, were identified for the proposed plant through this analysis.

79. The frame/structure of both stacks will be structural steel and the foundation will be of RCC. It may be noted that the foundation concept is based on soil data for the existing plant, foundation design will be finalised after site-specific geotechnical investigation is conducted by the EPC contractor during detailed design. If piling is required for the stack foundation, it will be decided during detailed design stage.

80. Continuous emission monitoring system (CEMS) devise for NO_x and CO as well as PM, SOx and unburned hydrocarbon (UHC) will be provided on both the stacks to monitor the

[25] wcms_116344.pdf (ilo.org)

emission levels. The emission monitoring system will have provision for connection to CPCB/TPCB system for real time monitoring of the emission level.

Table 2-8: Emissions Levels to be Achieved by the Proposed Plant

Parameter	Emission	Condition
NOx	25 ppm (51 mg/m^3)	Dry gas with an excess O_2 content of 15% One atm pressure Zero degrees Celsius
CO	8 ppm (10 mg/m^3)	
PM	Negligible	
SO_2	Negligible	

Note: there is no international good practice or national emission standard for CO, PM or SO_2 but the proposed plant will be designed to achieve the above emission levels so that impacts are not greater than those predicted in this EIA.
Source: ADB TA Consultant

3.2. Wastewater

81. Sources of process wastewater from the CCGPP will include:

- Effluent from condenser cooling: approximately 2m^3/hr or 48 m^3/day
- Boiler blow down process water: approximately 2.4m^3/hr or 58 m^3/day
- Water treatment plant effluent and filter backwash: 2m^3/hr or 48 m^3/day
- Plant drainage: about 15 m^3/day bunded containment and drainage system will be provided to collect all leaks, spills, floor washings, and surface water runoff from the buildings and area inside the service roads including the power block, water treatment plant and oil storage.

82. Process effluent will be treated to conform to the most stringent discharge level for each parameter of the national water quality standards as per **Annexure 3** and the IFC EHS guidelines for thermal power plant effluent[26] given in **Annexure 4** which are to be achieved without dilution i.e., before discharge to a Central Monitoring Basin (CMB/guard pond). The final design will be up to the EPC Contractor, but an indicative schematic diagram of the Effluent Treatment Plant (ETP) is shown as Figure 2-11. The indicative design assumes that process effluents (excepting HRSG blowdown and demineralization regeneration wastewater) will be collected in a suitably sized oil separator and settling tank (corrugated plate interceptor (CPI) separator splitting oil, clean water, and sediments) prior to being discharged to the CMB/guard pond which will act as a retention/balancing tank having at least 12 hours retention period. The quality of effluent will be sampled upstream of the CMB/guard pond. The effluent from the HRSG blowdown and demineralization regeneration water will be discharged to a neutralizing pit for self-neutralizatoin or any required pH dosing with acid/alkali to neutralize the effluent before its quality is sampled and it enters to the CMB/guard pond. The proposed plant will need to be zero discharge. Thus, treated effluent from the CMB/guard pond may be either be used to replenish groundwater supplies through recharge to ground, or alternatively as irrigation water for landscaping/green belt maintenance (Table 2-7) in accordance with the Central Public Health and Environmental Engineering Organisation (CPHEEO) manual[27] and public health guidance from the World Health Organization (WHO).[28]

83. Sanitary wastewater/domestic effluent of about 0.5 m^3/hr or 12 m^3/day will be treated to conform to the most stringent discharge level for each parameter of the water quality standards

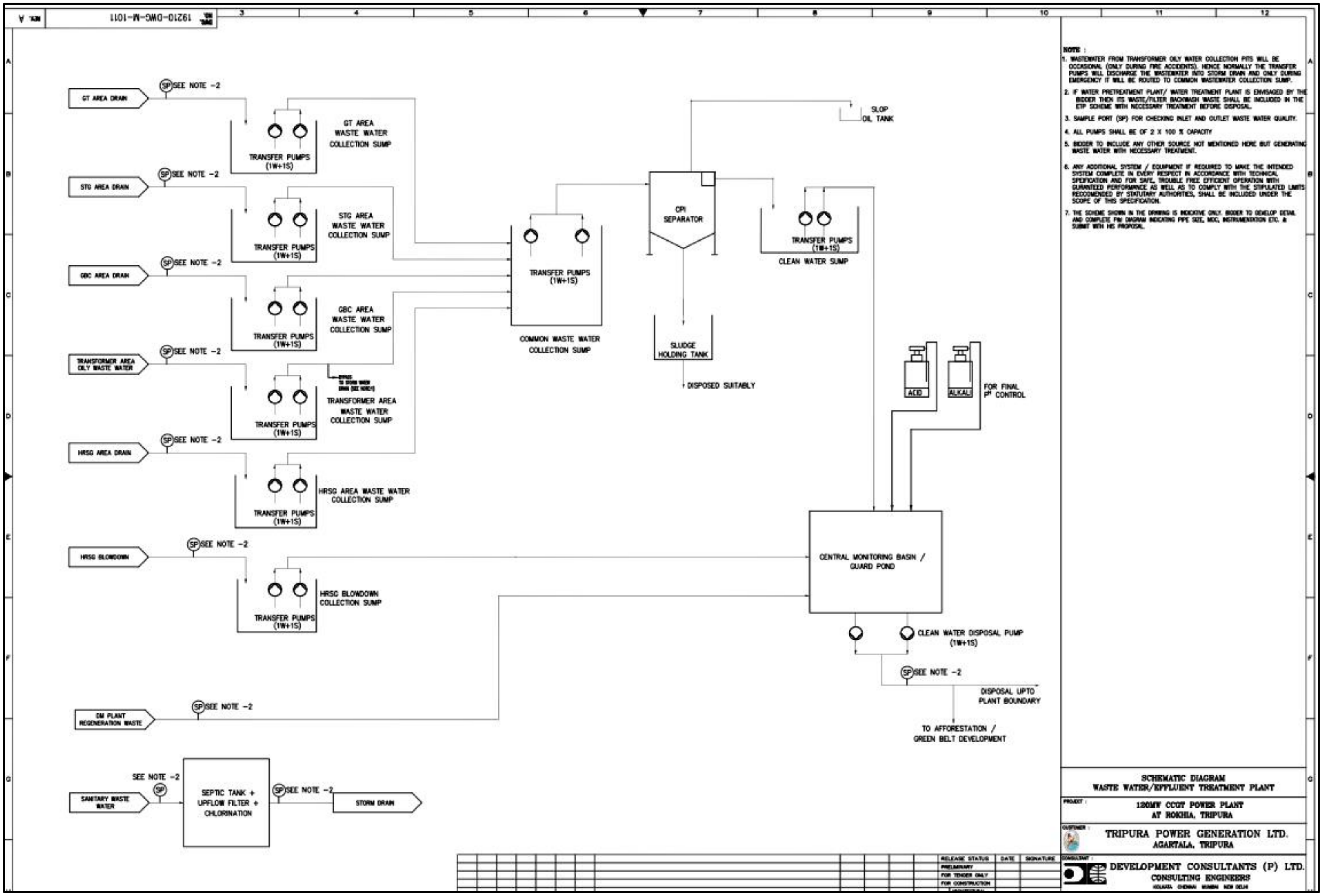
[26] https://www.ifc.org/wps/wcm/connect/9ec08f40-9bc9-4c6b-9445-b3aed5c9afad/Thermal+Power+Guideline+2017+clean.pdf?MOD=AJPERES&CVID=lNwcJZX
[27] http://www.cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
[28] WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006)

as per **Annexure 3** and to the IFC EHS general guidelines[29] given in **Annexure 4**. The EPC Contractor will decide how to treat the sanitary wastewater, for the purposes of the indicative design it is assumed that it will be sent to a septic tank, this will be followed by an up-flow filter bed to remove further TSS/BOD and chlorination. However, the EPC Contractor will also consider a package sanitary STP which would be preferable given that 98 staff will be present on-site. The proposed plant will need to be operated as a zero-discharge plant so the discharge may be used for landscaping/green belt maintenance (Table 2-7) in accordance with the CPHEEO manual and public health guidance from the WHO.

84. Sludge from the pre-treatment plant likely consisting of raw water clarifier sludge, demineralized water clarifier sludge, and pressure sand filter backwash, as well as from the ETP and any septic tank/package sanitary STP will be dewatered and thickened resulting in concentrated sludge cake for disposal. As with the existing plant, sludge cake from the water and effluent treatment will be disposed to licensed waste disposal facility in Assam although TPGL will secure its own MOU rather than disposing of it through ONGC. Sludge cake from sanitary wastewater will be organic in nature and thus may be used as manure for green belt development if its composition is in accordance with the CPHEEO manual[30] and public health guidance from the WHO.[31] Separated oil will be generally sold out to licensed vendors (Guwahati, Assam) after recovery as it finds a good local market.

[29] https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERES&CVID=ls4Xbfn
[30] http://www.cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
[31] WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006)

Figure 2-11: Schematic Diagram of Effluent Treatment for Proposed Plant



Source: TPGL DPR November 2020

3.3. Hazardous Materials

85. Diesel oil will be stored at site as an emergency generator fuel. Lubricant oil will also be stored. Chemicals like acids, alkalis, ammonia, phosphate, and chlorine may be used for water treatment. The exact chemicals used will be determined based on the raw water analysis and decided by the EPC contractor.

86. Fuel, oil, and chemical storage will be bunded as follows:

- (i) All fuel and oil drum storage areas and chemical bulk and drum storage areas must be bunded so that the capacity of each bund is sufficient to contain at least 110% of the maximum design storage capacity within storage area.
- (ii) All areas where loading/unloading of fuel, oil and chemicals takes place must be bunded to contain 120% capacity of the largest compartment/container that could be being filled.
- (iii) All petroleum product storage including diesel oil for generators must be designed, constructed, and maintained in accordance with the Explosives Act 1884 and its subsequent amendments and the Explosives Rules 1983.
- (iv) Petroleum product will be stored in a cylindrical tank located next to the emergency generator enclosure with a maximum capacity of less than 2,500 litres so that no explosive approval is required for the oil storage. The tank will be periodically filled up with oil through portable/hand pump from a fuel oil tanker. The quantity of Class A petroleum not intended for sale that can be stored without approval is thirty litres and must be kept in securely in stoppered receptacles of glass, stoneware or metal which shall not, in the case of receptacles of glass or stone ware, exceed one litre in capacity or, in the case of receptacles of metal, exceed 25 litres in capacity. For Class B petroleum, the total quantity should not exceed 2,500 litres and none of it must be contained in a receptacle exceeding 1,000 litres in capacity while for Class C petroleum the total quantity should not exceed 45,000.[32] Any amount exceeding the limits shall require clearance.
- (v) Liquid tanks and transformers must be bunded with a bund capacity of 110% of the net capacity of the largest tank to be maintained – this applies to the diesel oil tank/transformers.
- (vi) All flooring and bunding must be made of a sufficiently impervious surface to allow retention and easy recovery of material stored within the bund.
- (vii) Any pipe-works in and out of storage vessels from each bunded area must not be through the bund but shall be directed over the bund wall.

3.4. Solid and Hazardous Wastes

87. Several wastes will be produced by the proposed plant, similar to the existing plant. Designated, segregated solid and hazardous waste storage areas on undercover, bunded, impermeable hardstanding will be provided.

88. All solid and hazardous wastes will be disposed of (under an MOU to be agreed between TPGL and the waste management facility) to either Assam for recycling/solid waste and Haldia, West Bengal, which has an integrated hazardous waste treatment and management facility as per the provisions of the Hazardous and Other Wastes (Management, & Trans-

[32] https://peso.gov.in/web/petroleum-act-1934 (Para 7 & 8 of chapter 1: Control Over Petroleum)

boundary Movement) Rules, 2016 as amended through SPCB authorised waste vendors. Non-hazardous wastes will be either sold for reuse, recycled, or disposed, through approved vendors or municipal services.

4. Safety Requirements

89. **Earthquake**: the project site is situated in seismic zone V and earthquakes are quite frequent. Historically though very severe earthquakes have not been recorded in the study area. As per IS:1893 and as such all structures, buildings and related facilities will be designed to withstand the effect of earthquakes as per applicable national standards.

90. **Fire**: for fire safety the proposed plant will be constructed as per the recommendation of TAC of the Insurance Association of India and the standards of the United States NFPA. Emergency exits will be designed as per these standards and the plans will be approved by the Directorate of Fire and Emergency Services. All necessary fires safety clearances and approvals will be obtained from different agencies at various stages of the project including from the Chief Inspector of Boilers, Factory Inspector, Electrical Inspectors and Directorate of Fire and Emergency Services.

91. **Structural:** all steel structures and machines/instruments will be protected as per the Original Manufacturers design and relevant ISO codes.

92. **Electrical:** for electrical safety a grounding system comprising a combination of vertical ground electrodes approximately 3 m long and a horizontal mat with bare MS rod buried at a suitable depth (600 mm to 1000 mm) beneath equipment and structures will be required, this is essential for the safety of personnel as well as quick isolation of faulty equipment to safeguard the equipment under adverse conditions during fault. It will be designed to ensure that the ground resistance of the interconnected mat shall be less than 0.5 Ohm. Separate grounding mat will be provided for the 132 kV Switchyard, BTG area and BOP areas. However, all mats will be interconnected to achieve very low grounding resistance as well as to reduce potentials. The grounding system will be designed as per the requirement of IEEE–80 & IEEE– 142, IS-3043, Indian Electricity rules and CBIP guidelines. The grounding system will provide low impedance path to ground (earth) during high voltage surges due to lightning and leakage currents and will also maintain equipment and structures as near as possible to earth potential. A complete lightning protection system will also be provided as per IS 2309 for buildings/outdoor structures/stacks to protect them against direct lightning strikes.

93. **Lighting**: the proposed plant illumination system will include normal lighting which will be always on when grid power supply is available, and emergency lighting to selected locations. The emergency lighting will be powered in an emergency by either DG set or DC battery. The illumination levels will be maintained as per the international good practice to give a comfortable illumination level for efficient working of the personnel and, whether indoor or outdoor, will be designed in such a way that uniform illumination is achieved. As far as possible, any dark spot will be avoided. LED lighting fixtures will be provided in all indoor areas with the type used (e.g., low-high bay, well glass) depending primarily on the ceiling height. For the outdoor illumination, flood lights will be provided at suitable locations, LED lighting fixtures mounted on lighting poles installed on the internal access roads and switchyard, and bracket mounted LED lighting fixtures provided in the transformer yard. Outdoor illumination will be controlled through timer switch. Lighting panels will be installed at convenient locations for ease of operation. Use of fluorescent/HPSV lamps will be avoided since they are less energy efficiency and classed as hazardous waste for purposes of disposal.

E. Scope of Work

94. The major activities involved during pre-construction, construction, and operation phases are:

Pre-construction

(i) Hydrogeological study addressing water availability and stress to identify borehole locations and depth, and any alternative arrangements for potable water supply for those properties tapping into the same groundwater source – to be undertaken by TPGL.
(ii) Appointment of the EPC Contractor
(iii) Yield test for the selection of location and number of borewell pumps for groundwater.
(iv) Detailed topographic survey
(v) Calculation surplus material from hillock cutting and earthworks; balance of cut and fill (it is currently anticipated that all excess spoil can be accommodated on-site; if excess material is requiring disposal outside of the Rokhia Thermal Power Station the EPC Contractor will assess the suitability of disposal site options,[33] route plan, and undertake local consultations)
(vi) Dainage Risk Assessment to ensure surface water runoff from project footprint will be reduced to no more than existing (primarly greenfield) rates outside the boundaries of the internal access roads and the proposed plant is not at risk of being waterlogged
(vii) Detailed design of CCGPP by EPC Contractor
(viii) Update EIA based on detailed design and construction methods, submit to ADB for review – updated EIA is to be cleared and disclosed prior to approval of detailed design
(ix) Asbestos survey of buildings for demolition by competent surveyor, followed by risk assessment and asbestos management plan if required.[34]
(x) Tree enumeration for site development
(xi) Structural survey and photographic record of the nearest residences as baseline in case of damage claim
(xii) Detailed access route and traffic survey – road dimensions, load bearing capacity, roadside features, pavement condition, structural survey of adjacent properties, photographic record etc.
(xiii) Executing MOU with Hazardous Waste Management Facility
(xiv) Obtaining permits and clearances including:
    (a) Contest to establish (CTE): TPCB
    (b) Ground water extraction permission: DWSS and CGWB
    (c) Approval of construction activity, drainage and building plan: municipal and local authorities
(xv) Preparation of Contractor's Environmental Management Plan (CEMP) and its sub-plans (for approval of TPGL before commencement of construction)

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[33] Since the excavated material will be inert, any surplus material may be used by TPGL for its Corporate Social Responsibility activities, for example, to develop the nearby Autonomous District Council (ADC) village school playground subject to agreement with school's headteacher. Otherwise, it will need to be disposed of to a suitably licensed waste management facility for inert waste.

[34] No asbestos was seen to be present in these buildings although this will be reconfirmed by a competent surveyor employed by the EPC Contractor prior to their demolition.

Construction phase

(i) Surfacing access roads to bring them up to standard before being used for construction
(ii) Establishment of temporary construction facilities; upgrading existing staff accommodation and barracks if to be used by the EPC Contractor to house their construction workers
(iii) Importation of plant, equipment, machinery etc.
(iv) Construction/strengthening of boundary walls, temporary barricading of the private road of TPGL that passes through the existing Rokhia Thermal Power Station to the local community for safety reasons, and ensuring other security facilities in place e.g., construction gate, watch tower etc.
(v) Demolition of existing structures and disposal of demolition waste; only existing buildings falling in the project footprint are to be demolished. They comprise three buildings of 645 m^2. They are all two-story high (6m) and are of brick/concrete construction.
(vi) Clearance of ground vegetation, shrubs and trees
(vii) Dismantling of high voltage transmission towers (unstrung) within the project footprint and handover to TSECL
(viii) Hillock cutting and earthworks to create level construction platform, the existing level of the project site will be raised to contour level of 96-100 (contour level 98 corresponds to RL 30 m above MSL, the existing level of the flatter land is 30-49m) through cut and fill including levelling of the existing hillock (topsoil will be stripped and stored for gardening work post-construction)
(ix) Importation of construction materials from existing licensed sources
(x) Civil construction (e.g., service roads, foundations, drainage) to be completed before the CCGPP equipment arrives at the project site
(xi) Importation of CCGPP equipment from manufacturer/supplier
(xii) Plant assembly and erection work, as soon as the civil construction has been completed, the various equipment that constitutes the CCGPP including mechanical, electrical, and instrumental parts will be assembled.
(xiii) Post erection/assembly check
(xiv) Installation of gas pipeline from GCS
(xv) Upgrading of existing 132 kV switchyard and installation of power lines to connect new 132 kV switchyard to it
(xvi) Pre-commissioning tests: all auxiliary systems needed for commissioning of the proposed plant will need to be completed to schedule initial trial of the main equipment including the fuel system, water system, firefighting etc.
(xvii) Commissioning tests
(xviii) Obtaining permits and clearances to operate including contest to operate – TPCB
(xix) Landscaping works and demobilization of construction sites, residual waste disposal, etc.

Operation phase

(i) Commercial operation of the proposed plant

(ii) Decommissioning of existing plant (an associated activity undertaken by TPGL outside of the project scope)

1. Construction Details

1.1 Construction Programme

95. Pre-construction and construction works will require 36 months from the "zero date" which is the date of contract award/notice to proceed (**Annexure 5**). Following civil work and installation which will start about 9 months in, major commissioning activities including testing and trials of all equipment and instruments like pumps, dials, valves etc. will take place. The Electrical and Control Building will be completed within 22 months for taking-up the GT generator commissioning activities. This building will be in critical path as electrical equipment will be required to be installed in it to permit GT commissioning within 26 months from the zero date. The CCGPP is anticipated to be commissioned within 36 months from the zero date. It is not proposed to operate the proposed plant until both the GT and HRSG/ST are commissioned.

1.2. Temporary Construction Facilities

96. 0.4 ha of land, located in the southern part of the project footprint has been identified for use by temporary construction facilities. There are other open lands within the Rokhia Thermal Power Station that could also be used for material storage etc. For example, land near the existing staff accommodation buildings.

97. Temporary construction facilities will include construction site offices with space for TPGL, the EPC contractor and any sub-contractors, storage yards, vehicle bays, and a concrete batching plant area. Batching plants, hot mix plants, crushers etc. must be set up by the EPC contractor only after obtaining Consent to Establish and Consent to Operate from Tripura Pollution Control Board.

1.3. Construction Water

98. The requirement of construction water for service, domestic and fire system purposes will be drawn from the new boreholes to be set up by the EPC Contractor for supplying the proposed plant during operation. It is estimated that 15m^3/hour of water will be required during construction. In addition, emergency water will be required for a temporary fire hydrant network to be set up for the construction.

1.4. Construction Power

99. The EPC Contractor will be required to arrange DG sets to meet construction power requirements. However, after receiving appropriate permission, construction power at 11 kV can be drawn from the existing power plant. The EPC contractor will make suitable arrangements for step down to 415 V supply. A power line ring main will be constructed encompassing the construction area for feeding construction power to predetermined locations.

1.5. Construction Transportation

100. The EPC Contractor will bring construction materials, their own construction plant, equipment, and machinery and the CCGPP equipment to the project site using existing road,

railway, and waterway access routes.[35] Some of the equipment will be oversized (Figure 2-13). Shipment of the GT has been considered at 19 months after placement of order and subsequent erection will be 6 months later. Supply and erection of the HRSG and ST will be about 28 months later.

101. The EPC Contractor has the option of choosing the access route that is most feasible although from Bishalgarh road transport is the only option. For the purposes of this EIA the proposed access routes are:

(i) From West Bengal, Haldia or Kolkata Port either (a) through national highways (NH) 116, NH 16, NH12, NH 27, NH6 and NH 8 via Assam, Meghalaya, and Tripura for approximately, 1,686 km reach reaching Bishalgarh and then onto Rokhia, or (2) by railways from Kolkata to Bishalgarh station and on to Rokhia by road for approximately 1,650 km.

(ii) From Ashuganj Port in Bangladesh by road via Akhaura border post to Agartala from where it can either transported by NH8 or railways to Bishalgarh and then onto Rokhia. The total distance from Ashuganj port to the project site is approximately 81 km length.

(iii) From Chittagong/Chattogram port in Bangladesh via Sabroom border post (approximately 100 km) and then to Bishalgarh by NH 8 and onto Rokhia (approximately 120 km). Thus, the total distance of this route will be approximately 220 km.

(iv) From Bishalgarh for any of the above routes the access route will then comprise 13 km of state highway and MDR/local roads to reach Rokhia Thermal Power Station (the couple of settlements passed along the route off NH 8 are: KK Nagar, Prabharam village).

102. During pre-construction a detailed route and traffic survey will be conducted jointly by TPGL and the EPC Contractor to assess the capacity and condition of the proposed access route. The structural strength of the road/bridges in relation to the weight of loads is important as well as the width of the road/bridges. Given the volume of construction traffic, any unsurfaced or poorly surfaced road will need to be surfaced before construction to minimize impacts on adjacent properties – dust, noise, vibration etc. The scope of works for the strengthening of the short stretch of road[36] from National Highway 8 so it is of adequate standard to accommodate of 36 months of construction traffic including oversized vehicles[37] will be included in the scope of the EPC contractor. On completion of construction works the access route must be left by the EPC contractor in no poorer condition than when construction started, joint survey will be conducted by TPGL and EPC Contractor after major periods of traffic movement, after the passage of oversized vehicles, and at the end of construction to identify any areas that need to be reinstated if damage was caused. Structural survey and photographic record of the properties adjacent to the access route will also be needed to provide a baseline in case of any inadvertent damage or vibration impact.

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[35] Trip generation during construction is difficult to accurately estimate as it depends on the construction methods, the phasing of works and speed of installation, and size of vehicles used to transport materials. It is however expected that during the construction phase traffic will peak at approximately 50 one-way heavy goods vehicles per day while civil works are undertaken. It is estimated that the number of delivery trips for large oversized items of infrastructure will be twice or three times per year during the construction phase when the major equipment like the turbines and generators will be installed.

[36] Road is black top with some bad patches/breaks for total around 750m -1km. There is also narrow width in some stretches (around 1-1.5 km in total) of concern.

[37] Largest vehicles will be trailer

103. The approval from PWD-Roads will be sought by the EPC contractor for heavy equipment transport as required, the local community will also need to be consulted and notified about major periods of traffic movement or the passage of oversized vehicles which is to be done at night.

Figure 2-13: Representative Images of Transport and Assembly of CCGPP Oversized Modules

Source: Web search

1.6. Construction Materials

104. No CFCs, PCBs or asbestos containing materials will be used in construction.

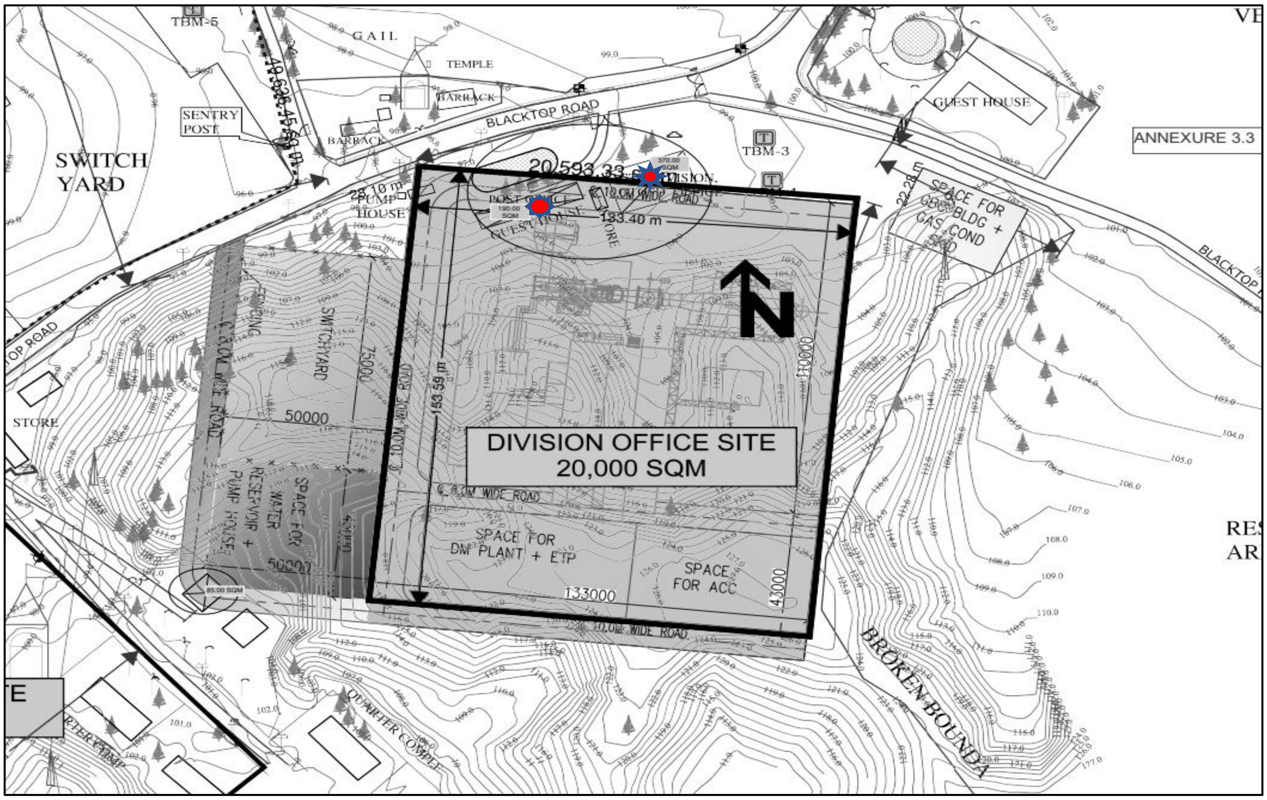
105. Cement for batching will be obtained from existing licensed sources and may be transported from across India, the nearest cement plants are operating in Assam and Meghalaya. Stone aggregates in Tripura are supplied from Assam (as stone quarries are virtually non-existent in Tripura, where brick bats are used in lieu of stone aggregates). The EPC contractor is free to source the stone aggregates from any of the approved quarries in India which hold Prior Environmental Clearance and valid crusher operating documents from TPCB. Aggregates from brick bats may also be used if they pass all laboratory tests and are approved for use in construction. Brick bats may be sourced from approved brick kilns having valid operating documents from TPCB. Sand shall be procured locally from approved quarries that have valid Prior Environmental Clearance. Steel rods will be sourced from approved steel plants. Electrical, Mechanical and Instrumentation parts will be procured as per the technical specifications from original equipment manufacturers or from approved authorised distributors.

106. Borrow pits for site levelling will not be required as ample spoil will be produced in cutting of the hillock. This needs to be cut to create a level construction platform with the adjacent flat land being raised to a contour level of 96-100 (contour line 98 corresponds to RL 30m above MSL, the existing level of the flat land is 30-49m) through cut and fill. The estimated cut volume would be up to 334,092 m^3. Based on topographic survey during detailed design, it will need to be confirmed that there is sufficient spare volume to accommodate this as fill on the project site and the final ground level may be adjusted to help ensure there is no excess spoil for disposal. The final plant level will be decided by the EPC contractor based on detailed design requirements. The topsoil shall be stored and shall be reutilised for gardening etc.

1.7. Demolition

107. To accommodate the indicative layout, the old onsite office buildings will have to be demolished to make way for the proposed plant. One main building (GTED division building) of 370 m^2 x 6m, a sub-division building (190m^2 x 6m) and a small staff quarter (85m^2 x 6m) adjacent are planned for demolition by EPC Contractor to make way for the proposed plant. These abandoned buildings are all brick buildings and no hazardous materials including asbestos are observed. Demolition will be taken up before construction works start.

Figure 2-14: Plan of Proposed Plant Showing Buildings Marked (red) for Demolition



Note: proposed plant layout is initial design (subsequently revised)
Source: TPGL

1.8. Construction Waste

108. Waste resulting from construction can be classified as hazardous and non-hazardous. Hazardous waste will mostly be used oil, empty metal or plastic containers of paints, solvent-soaked rags, containers for solvent etc. All hazardous wastes will be disposed off to Assam or West Bengal as per the provisions of the Hazardous and Other Wastes (Management, & Trans-boundary Movement) Rules, 2016 as amended in 2019 through SPCB authorised waste vendors. Non-hazardous waste includes all domestic wastes, office wastes, packaging, plastics, paper, cardboard, wood, broken concrete, brick, rubble, iron scrap etc. It will include demolition waste from demolition of buildings on the project site and any excess spoil generated from earthworks that cannot be disposed of on site. Non-hazardous wastes will be sold for use, recycled, or disposed of as approved by TPGL through the approved waste vendors or municipal authorities as authorized by the SPCB.

1.9. Construction Workforce

109. The exact size of the workforce including the number of unskilled, semiskilled, and skilled workers will be determined by the EPC contractor based on the construction schedule. However, for the purposes of this EIA is it anticipated the maximum size of the workforce at any one time will be 350 persons. Both local and external labourers will be utilised. The EPC contractor will obtain all the labour licenses and shall procure Workmen Compensation Insurances which will be further divided into skilled and unskilled category for the labourers

employed. In addition, there will be about 30 TPGL staff posted on-site to oversee the construction.

110. Construction workers will be housed by the EPC Contractor, potentially in the vacant staff quarters/barracks (Figure 2-5) of TPGL near the south-east boundary of Rokhia Thermal Power Station which will need to be repaired by the EPC contractor if they wish to utilise it. The worker accommodation will have all basic requirements in line with GoI requirements and ILO worker accommodation guidance[38] including proper beds and beddings with mosquito nets, windows, ventilation, fans, lighting, mobile charging points, emergency exits, firefighting equipment, kitchen and dining area, toilets and washrooms connected to septic tanks and soak pits, potable water storage, recreational areas, and security etc.

2. Operational Management

111. The proposed plant will be operated and maintained to optimise its output and availability whilst having safe, reliable, and efficient operations meeting all national and ADB Safeguard Policy Statement, 2009 requirements. O&M of the proposed plant will be the overall responsibility of the Plant Head (Deputy General Manager-Electrical/Mechanical) of TPGL, who will be assisted by amongst others (Figure 2-15) the:

(i) Planning and coordination department which will be responsible for performance monitoring, energy management, environmental compliance supervision, and cost control

(ii) Material management department responsible for procuring spare parts and consumables and maintenance of stores

(iii) Plant operation who will be responsible for plant operation and fuel handling including day-to-day environmental, health and safety compliance

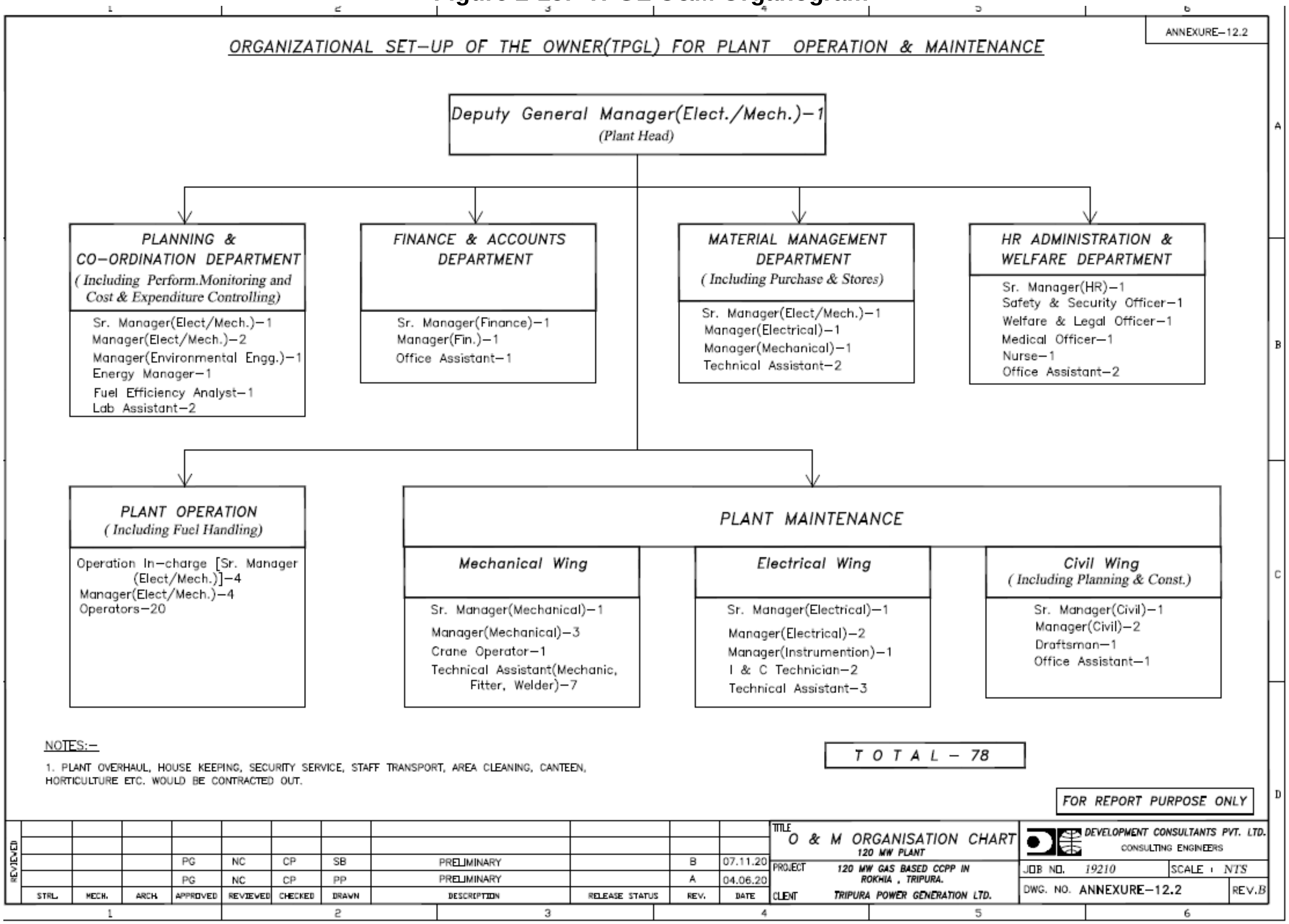
(iv) Plant maintenance department for routine and emergency maintenance of the plant including housekeeping, instrumentation, and control. Major maintenance and annual overhauls will be contracted out to manufacturers/suppliers or contractors depending on the quantum and condition of works. Odd jobs like plant cleaning, road and drainage maintenance, plant security, gardening/green belt development may be contracted out locally.

(v) HR administration and welfare department responsible for administration, the welfare of the O&M Personnel, legal aspects, safety aspects of O&M, medical facilities for the site personnel – to include safety and security officers, welfare and legal officer, medical officer, nurses, office assistants etc.

(vi) Finance and accounts department dealing with finance and accounts matters related to the plant.

[38] https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---multi/documents/publication/wcms_116344.pdf

Figure 2-15: TPGL O&M Organogram



Source: DCPL and TPGL

112. Operation of the proposed plant will be controlled using a Distributed Control System (DCS) by a limited number of experienced operating staff. Maintenance facilities for day-to-day and minor plant maintenance including a well-equipped workshop will be staffed by trained technicians – mechanical, electrical, and civil staff, tradesmen and operators including mechanics, fitters, welders, crane operators, I&C technicians etc. The power plant will run for 85% of the time (about 310 days a year) which is allowing for power failures, any emergency etc.

113. TPGL is already in the business of power generation and has existing plant operation teams in its other power plants. For the proposed plant they will set up an on-site plant O&M team by taking the experienced engineers from the existing staff of TPGL and by recruiting new engineers to work under their guidance. TPGL and the EPC Contractor (manufacturer/supplier) will provide training for plant O&M staff during the pre-commissioning and commissioning activities to enable them to develop the requisite experience for operation of the CCGPP.

F. Existing Facilities

114. The proposed plant will utilise existing 132 kV switchyard for power evacuation and the ONGC gas collection point for tapping the gas supply, both are housed within the Rokhia Thermal Power Station.

115. The existing 132 kV switchyard was visited by the ADB TA Consultant National EIA Expert and EHS aspects were recorded to evaluate compliance with national and ADB's Safeguard Policy Statement 2009 requirements and existing management practices. The observations were as follows with corrective action in Table 2-9:

(i) The existing 132 kV switchyard was established in three phases. The original switchyard which was built in 1990 (AIS type, 66 kVA, 132/66 kV step down) is not currently working. A new switchyard was built in 1995 and expanded in 2002. This is a GIS type using SF6 (2.5 kVA, 11/132 kV step up). It is currently connected to the grid with 132 kV transmission lines.

(ii) Statutory requirements: Consent to Operate permit from TPCB has expired and is not renewed.

(iii) Documentary records were requested including log of PPE status, incident reporting, repair, and maintenance logs. No other EHS documents present on-site e.g., no SOP or similar are available.

(iv) EHS permits/documentation and records need to be obtained by TPGL for the existing units and copies of these kept at the on-site site office, including – NOC, CTO, other permits, workers/staff insurance certificates, medical benefits, health check-up records etc.

(v) Although the access road is paved, vehicle movement is not possible within the switchyard itself, due to its unpaved condition and the presence of loose rocks and boulder debris.

(vi) Health and safety (H&S) wise, the switchyard is not paved, and surface is loose rocks, boulder debris causing walking hazard, risk of trip and fall. Shrubs and grass in patches are observed.

(vii) In terms of community H&S, locals are prohibited to enter premises without permission.

(viii) Located on flat topography within the gated and locked existing plant boundary with security present 24 hours.

(ix) Total transformers are eight out of which three are defunct. The working transformers include four 30 MVA and one 6.3 MVA. The transformers are oil insulated and make is Bharat Bijlee and BHEL (both 2002 manufacture) which are not at high risk of containing PCBs as per UNIDO guidance. Transformer oil test reports were not available on-site and recorded till 2018. TPGL have been unable to share the same.

(x) No spill bunds are present for the transformers with oil spills and contamination observed.

(xi) Standing water observed with algal growth, scum, and oily residues under transformers.

(xii) Housekeeping is average, with empty drums, cables, equipment stored within the compound. No dedicated empty oil drum storage area. Oil drums are stored on site under the control room and locked.

(xiii) Circuit breaker is SF6 insulated. Gas changes are done by hired specialist agency (Power Maker Ltd, Guwahati), SF6 gas was last changed and serviced in 2018. Use vacuum tubes to suck out gas, fill using cylinders. SF6 cylinders (sealed, 11 kg x 2 cylinders present) on-site. No leak detectors, no training on SF6 management provided.

(xiv) Used oil is taken by TSECL for use in distribution transformers.

(xv) End of life batteries, or those damaged, are taken back by supplier and recycled.

(xvi) No caution/hazard signages present.

(xvii) EMF level recorded in the yard was 47 uT compared to XXX guideline for occupational exposure

(xviii) Noise level was 61 dB(A[39]) compared to 70 dB(A) WHO guideline for an industrial receptor

(xix) No pest issues, although snake siting was reported in the vegetated portions of the switchyard.

(xx) Post COVID-19, attendance at the switchyard is as and when required.

(xxi) PPE available but not adequate and the staff were not wearing any PPE.

(xxii) First aid available is limited.

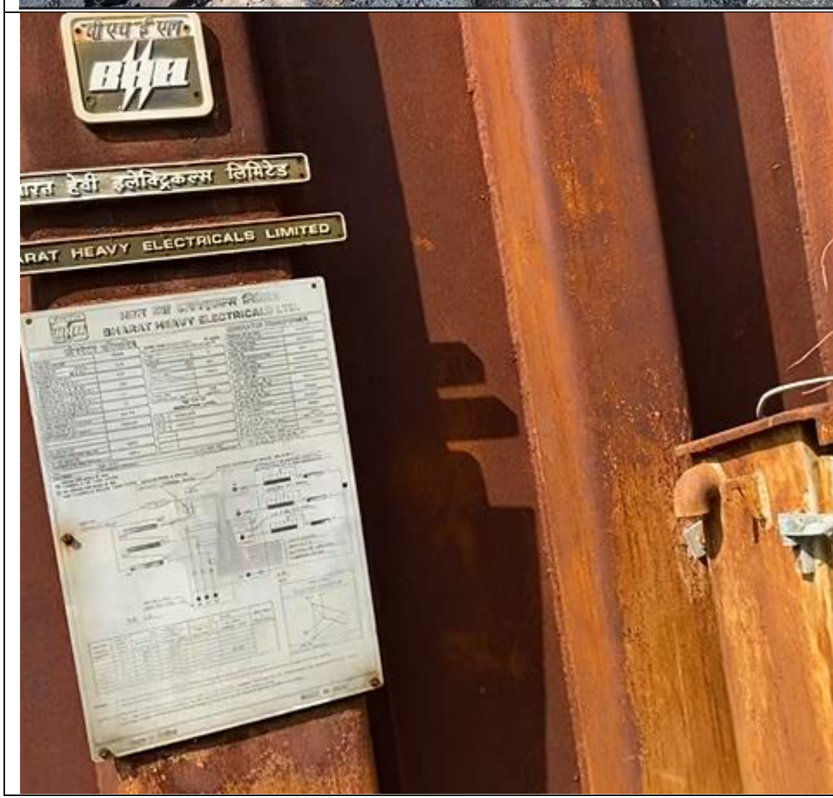
(xxiii) No automatic fire alarms are installed. Fire sensing sprinklers are not installed in control room. Sand buckets were present (5 no.) but inadequate for purpose. Chemical based fire extinguishers were available (4 no.) with two already past their expiry date.

(xxiv) 24 hours vehicle is on standby for emergency – hospital 3 km Boxarnagar, 5 minutes by road.

[39] Recorded using smartphone based third party software.

Figure 2-16: Sample Photolog of Existing 132 kV Switchyard

	Defunct circuit breaker – non SF6
	SF6 Circuit Breaker

	Oil residues on soil near main transformer
 	Defunct transformer in yard

	Stagnant water with scum/oil residues in transformer area

Source: ADB TA Consultant

116. The existing GCS was visited by the ADB TA Consultant, National Environment Expert and EHS aspects were recorded to evaluate compliance with national and ADB's Safeguard Policy Statement, 2009 requirements and existing management practices. The observations were as follows with corrective action in Table 2-9:

(i) ONGC Gas Supply Station is a locked facility with secured boundary
(ii) No non-compliance evident on-site; observed housekeeping was satisfactory and caution signs followed.
(iii) Environment, health and safety documentation was requested but not available; therefore it is unclear if the GCS has obtained Consent to Operate and other EHS permissions.
(iv) Assessment of Risk and Hazard Assessment Report was provided for GAIL gas field (**Annexure 6**) but no similar study is available for ONGC gas field/GCS thus there is no demonstration that ONGC is considering its compliance against health and safety requirements etc.
(v) It is submitted that 0.5 MMSCMD gas supply and transportation agreement with GAIL and 0.08 MMSCMD gas supply agreement with ONGC already exists for supply of gas. Same quantity of gas which is being presently used for the existing plant will be continued for the proposed plant. The agreement sample copy is provided as **Annexure 7.**

117. Other than the above and upgrading and maintenance of the staff accommodation no other existing facilities will be utilized.

Table 2-9 Existing Facilities Corrective Action Plan

Corrective Action	Date	Responsibility
Obtain Consent to Operate	Before access granted to the EPC Contractor	TPGL
Test Existing Transformer Oil for PCB	Testing before access granted to the EPC Contractor Remediation by 31.12.2025 (if this is required, as not anticipated to contain PCBs)	
Oil contamination and standing water presence within transformer area to be addressed, drainage to be maintained to prevent standing water, contaminated soil to be removed from site and disposed of as hazardous waste	Before access granted to the EPC Contractor or action item specifically included in contract requirements for EPC Contractor to address during work	
Surface switchyard to enable safe access (or require this corrective action to be done by EPC Contractor as part of works to upgrade the switchyard)		
Remove waste materials from switchyard and dispose of per national laws and regulations		
Provide dedicated oil drum storage area (or require this corrective action to be done by EPC Contractor as part of works to upgrade the switchyard, meanwhile placing drums on drip trays		
Bund transformers to contain spills/leaks (or require this corrective action to be done by EPC Contractor as part of works to upgrade the switchyard)		
Provide SF6 leak detectors (or require this corrective action to be done by EPC Contractor as part of works to upgrade the switchyard)		
Install caution/hazard signs on boundary fence and on equipment		
Obtain all EHS permits/documentation and records and keep copies at the on-site site office		
Develop switchyard SOP for PPE, ensure that appropriate PPE to be always worn by staff		
Develop switchyard SOP for first aid kit, first aid kit to be fully stocked		
Develop switchyard SOP for firefighting and ensure all firefighting equipment is serviced and in date		
Existing switchyard staff to be included in operational EHS training for new switchyard	Before operation of proposed plant	TPGL EPC Contractor
TPGL to obtain copies of Consent to Operate and other EHS permissions from ONGC, TPGL	Before access granted to the EPC Contractor/before	TPGL ONGC

Corrective Action	Date	Responsibility
to ensure ONGC is compliant with all national requirements	proposed plant/gas pipeline is connected to the existing GCS	
TPGL to require ONGC to complete a HAZOP study and implement its recommendations in respect of the existing GCS		

Source: ADB TA Consultant

G. Associated Facilities

118. There are no associated facilities of the proposed plant. Decommissioning of the existing plant is not funded by the ADB project, but as this is essential to realize the project's benefits TPGL need to ensure it is done in a timely and environmentally safe and sound manner. Tentatively it will be decommissioned by 2027 subject to construction of the proposed plant running to schedule. There are some minor patches of oil contamination in the existing plant area, for which remediation will be required to avoid legacy issues in the long term. These patches will be excavated, handled, and disposed of as hazardous waste according to GoI regulations before decommissioning of the existing plant commences. There are 37 employees at the existing plant, and they will be deputed to the new plant once it is operational. Labor retrenchment is not envisaged as TPGL is a government organization. Other decommissioning impacts will be like those of construction – the existing plant is further from the closest houses and can be similarly managed through a Decommissioning EMP.

H. Climate and Disaster Risk Vulnerability Assessment[40]

119. Climate change and disaster could affect the output, efficiency, and financial viability of the proposed plant therefore adaptation measures to withstand the local climatic conditions and to minimize risks due extreme climate events need to be incorporated to its design and operation. Improving the resiliency of electricity infrastructure involves improving its ability to withstand or minimize the impacts of climate change events and in the event of possible damage its ability to continue operating despite damage. Adaptation efforts should also increase a system's ability to return to normal operations rapidly if outages do occur.

1. Climate and Disaster Risk Screening

120. **Higher temperatures**: gas turbine output varies with temperature and thus combined cycle output will vary with temperature. Reduction in power output is proportional to temperature increase and as per a study conducted for combined cycle gas turbines by URS (2010) an increase of 5°C average temperature during summer would result in only a 0.34% efficiency drop.[41] Per the CVRA, the average temperature is expected to rise by 1.05°C by the 2030s; 1.7°C by the 2050s and 2.91°C by the 2070s, relative to the average temperature for 1986-2005 of 25.28°C. This warming is strongly biased towards the winter and pre-monsoon months and is stronger with respect to changes in the annual minimum and maximum temperatures rather than in the average. For example, the rise in annual minimum temperature is around 18%-21% higher than the rise in average temperature. As a result, more fuel usage is envisaged in the future, however, the drop in efficiency shall be negligible. The components of the powerplant that are vulnerable to reduced performance besides the GT/ST are the air compressor and the

[40] ADB CRVA Report, 2021
[41] Climate Risk and Adaptation in the Electric Power Sector, Asian Development Bank, 2012

circulating water pumps. The structural units of the power plant may experience some heat stress and thus have a shorter design life span. The CVRA considers the proposed plant has a **low** vulnerability to higher temperatures.

121. **Changing rainfall patterns, decreasing seasonal water availability and droughts**: the project site experiences tropical climate with the monsoon season normally from June to September. In terms of expected maximum 1-day rainfall with a 25-year return level, future precipitation indicates an increasing trend compared with the average from 1986 to 2005. These values are 30.5 mm for the period of 2030s; 37.6 mm 2050s and 58.1 mm for 2070s. Drought indices are used to assess future water availability, whether drier or wetter. Positive values indicate wet conditions and negative values indicate dry conditions. Using these indices, Agartala's precipitation scenario is seen to be trending on the wetter side, as the indices are seen to become increasingly positive towards the end of the 21st century relative to 1986-2005 conditions. The 20-year period projection SPI is 0.1 for the period 2030s; 0.1 for 2050s and 0.43 for 2070s thus water may remain available for the proposed plant. The CVRA considers the proposed plant has a **low** vulnerability to changing rainfall patterns etc.

122. **Increased intensity of precipitation, flooding, thunderstorms, and wind pattern**: Cyclones, flooding and landslides have increased in frequency in Tripura over recent years. Tripura state is surrounded by Bangladesh and aerial distance to Bay of Bengal is less than 100 km, thus the entire landmass of the state is prone to high wind and cyclone zone-A which is very high-risk zone. Tripura state belongs to wind zone 6 – very high damage risk zone in India where winds speeds reaching up to 55 m/s is possible. The River Flood and Urban Flood hazard for Tripura are classified as high. However, the project site is located at an elevation of average 45m above sea level and has not witnessed flooding in its recent history. Even though the area is not flood prone, poor drainage may cause waterlogging or ponding of water etc. The landslide susceptibility is classified as medium. The CVRA considers the proposed plant has a **medium** vulnerability to such extreme events.

2. Adaptation Measures

123. **Higher temperatures**: Advanced GT class technology is already being used which can withstand changes in ambient temperature. In the case of the proposed plant, its output of 115.04 MW has been calculated based on an average temperature of 30°C and performance guarantee will be obtained for that. Actual output will be more based on current average temperatures and all auxiliary equipment will be sized accordingly so that maximum output can be obtained at lower temperatures.

124. **Changing rainfall patterns, decreasing seasonal water availability and droughts**: Due to existing water constraints ACC system is already being used for cooling to reduce dependability on water sources.

125. **Increased intensity of precipitation, flooding, thunderstorms, and wind pattern**: Power plant buildings will already be designed as per the relevant IS standards and other architectural/structural guidelines to withstand storms of high intensity and wind erosion given location of proposed plant.

Table 2-11: Climate Change Risks and Additional Adaptation Measures

Climate Change Events	Impacted Component	Possible Risks	Additional Adaptation Measures

Climate Change Events	Impacted Component	Possible Risks	Additional Adaptation Measures
Higher temperatures	Power Plant	Higher temperature leads to minor loss in cooling capacity and increases in operational costs of power plant.	Use of “green building” principles using natural ventilation in construction of buildings
Changing rainfall patterns	Power Plant	Heavier rainfall events expected to contribute to moderate infrastructure damage and loss of service	For outdoor equipment like air cooled condenser design to be suitable for the rainfall conditions; rust protection design for generating plant etc.
Decreasing seasonal water availability and droughts	ACC system and generation/ancillary equipment with cooling requirement	Change in seasonal groundwater availability leads to disruptions to ACC system affecting its safe operation and increases operational costs of power plant.	i. Effluent treatment plant to treat effluent for recharge to groundwater or reuse in the proposed plant as irrigation water (zero discharge plant) ii. Rain water harvesting to conserve rain water and recharge groundwater
Increased intensity of precipitation, flooding, thunderstorms, and wind pattern	Power Plant	• Infrastructure damage and disruptions to power generation and supply due to precipitation and lightening • Damage is recoverable with maintenance and repairs	Slope stability analysis and drainage risk assessment will be done by the EPC contractor, bioengineering considered for excavated hillocks and measures included in the drainage design to ensure no waterlogging or ponding of water etc.

Source: Adapted from ADB CRVA Report, 2021 with supplementary input from ADB TA Consultant

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Introduction

126. This chapter reviews the policy, legislative and administrative set-up pertaining to environment, health and safety assessment and management for the proposed plant at the national and state levels, as well as international agreements to which India is a signatory. It sets out the various permissions required for the project from national or state authorities. It also covers the environment safeguards of ADB as set out in their Safeguards Policy Statement 2009 and the existing environment, health and safety policies and procedures of TPGL, as well as the capacity of TPGL to comply with environmental mitigation and monitoring requirements.

B. National and State Environment Regulatory Framework and Standards

127. In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. Several policies, acts and regulations aim to protect and enhance the environmental and land resources of India and Tripura, as detailed in Table 3-1. One significant environment omission is a specific regulation on contaminated land, land contamination issues must be dealt with through existing legislation and case law which is based on the polluter pays principle. The most notable legislation with respect to environmental assessment is the EIA Notification, 2006 and its subsequent amendments. This identifies projects and activities that require Prior Environmental Clearance (EC) and lays the procedure for obtaining the same.

128. Projects are categorized as Category A or B as per the EIA notification. New gas based thermal power plants are categorized based on their capacity with the threshold being those greater than or equal to 500 MW classified as a Category A project, those being greater than equal to 5 MW but less than 500 MW classified as a Category B project. Category A projects require EIA and public consultation. Category B is further sub-divided into Category B1 projects, which require an EIA and public consultation and Category B2 projects, which do not require an EIA or public consultation. Based on the threshold limits the proposed plant should be a Category B project. However, general conditions of the notification are also applicable to the proposed plant, and since it is within an aerial distance of 3.25 km from the international border between Bangladesh and India, it tiggers one of the general conditions that stipulates that any Category B projects which are located within 10km of international boundary shall become a Category A project and shall be apprised by the Expert Appraisal Committee (EAC), MoEF&CC. The proposed plant is thus Category A project, and Prior Environmental Clearance (EC) from MoEF&CC will be required.

129. The main government agencies responsible for administration of the environmental policy and legislation pertinent to the proposed plant are:

(i) **Ministry of Environment and Forests, Forest & Climate Change (MoEFCC):** responsible for the implementation of GoI’s policy with respect to environment. It formulates and regulates all country level legislation and enforces regulations in conjunction with the various autonomous organizations under MoEF&CC and the states. MoEF&CC reviews and issues Prior EC through an EAC for Category A projects besides also granting forest clearances and wildlife clearances. The EAC of MoEF&CC will accord the EC for the proposed plant. No forest or wildlife clearance will be required for the proposed plant.

(ii) **State Level Environmental Impact Assessment Authority (SEIAA):** an authority constituted by central government under sub-section (3) of section 3 of the Environment (Protection) Act, 1986 for every state and union territory. The composition of the SEIAA is published through separate gazette notifications and normally has a term of 3 years. It issues Prior EC to Category B projects. For the proposed plant, this authority is not involved.

(iii) **Central Pollution Control Board (CPCB)**: statutory authority under the MoEFCC. Its responsibilities include planning and implementing air and water pollution programs, setting air and water standards, and coordinating with state level Pollution Control Boards. The proposed plant will be required to adhere to various standards set by CPCB.

(iv) **Tripura State Pollution Control Board (TPCB):** responsible for pollution control at the state level for Tripura including planning and executing state level air and water quality initiatives, establishing standards for air and water quality based on national minimum standards, and monitoring and enforcing activities under air and water related legislation. It issues No-objection Certificates (NOC) in accordance with air and water related legislation. TPCB issues Consent to Establish (CTE) and Consent to Operate (CTO) for setting up and operating of construction plants like batching plants, hot mix plants and operation of the proposed plant.

(v) **Tripura Forest Department:** the Principal Chief Conservator of Forests (PCCF) & Head of the Forest Force (HoFF) is the senior most forest officer and is from Indian Forest Service (IFS) cadre. The department is empowered to declare protected and reserved forests. It has also been given the authority to acquire land for extension and preservation of forests. Recommendations for forest diversion accorded by the department are forwarded to MoEFCC. The Chief Wildlife Warden (CWLW) is the head of the wildlife division, reporting to the HoFF and is responsible for the protection and conservation of all protected areas (PA) in the state besides dealing with all wildlife issues. The CWLW is also a member of the State Board of Wildlife which recommends projects sited within notified ecologically sensitive zones (ESZ) and PA and forwards the same to the semi-autonomous National Board of Wildlife (NBWL) under MoEFCC. The proposed plant will require permissions from the department for felling timber and non-timber tree species on non-forest land, for which compensation is paid, and for the transit of felled trees.

(vi) **Archaeological Survey of India (ASI):** sitting under the Ministry of Culture, it is responsible for maintenance of ancient monuments and archaeological sites and remains of national importance. It also is responsible for regulating all archaeological activities in the country as per the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958 and Antiquities and Art Treasure Act, 1972. The Guwahati Circle of the ASI is responsible for maintenance of monuments in Tripura including the Boxanagar Stupa which is approximately 3.15 km away from the project site.

(vii) **Central Ground Water Board (CGWB) and Central Ground Water Authority (CGWA):** CGWB is a multi-disciplinary scientific organization under the Ministry of Jal Sakti, entrusted with providing scientific inputs for the management, exploration, monitoring, assessment, augmentation and regulation of ground water resources. Besides advising states on planning and management of ground water resources, it provides technical know-how for scientific ground water exploration, development and management. CGWA is a sister concern of CGWB engaged in various activities related to regulation of ground water development to ensure its long-term sustainability. An NOC is required to be obtained from the CGWA for withdrawal of ground water for the proposed plant.

(viii) **National Green Tribunal (NGT)**: the NGT based out of New Delhi was established in 2010 under the National Green Tribunal Act 2010. This tribunal is headed by a chairman and has both judicial and expert members (having multidisciplinary expertise). It is responsible for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources. It is also responsible for enforcement of any legal right relating to environment and giving relief and compensation for damages.

130. Environment permissions to be obtained for the proposed plant are set out in Table 3-2. The main permission required by the proposed plant is the Prior EC. Although it is located within the existing Rokhia Thermal Power Plant, MoEF&CC has confirmed that TPGL is to apply for Prior EC on the basis of the proposed plant being a new project as opposed to an extension to the existing plant.[42] The application for Prior EC has been made to MoEF&CC on Form 1 following which the EAC of MoEF&CC shall decide on the due diligence necessary including preparation of an EIA report based on approved Terms of Reference and submission of the draft report to TPCB for conducting public hearing. Post the public hearing, the minutes of the hearing will be complied, and the final EIA report submitted to MoEF&CC who shall deliberate and appraise on the report and based on a presentation will decide whether to grant environmental clearance. A flow chart of the Prior EC process is provided in **Annexure 8.**

131. Once the prior EC is obtained and the EPC contractor mobilised, the contractor will apply to TPCB through an online portal for consents to establish (CTEs) under Water Act, 1974 and Air Act, 1981 for construction plants required. The CTE is normally accorded without any inspections based on self certification unless there is any reported cases of violations. Once the CTE is obtained, the EPC contractor will establish and then apply to TPCB for Consent to Operate (CTO). TPCB normally grant CTO based on inspections whichare normally valid for a period of one year and must be renewed.

132. Besides the CTE and CTO for the construction plants, the thermal power plant will also require a CTE and CTO. Thermal Power plants have been categorized as Red category based upon their pollution potential and range of pollution index and the CTO for Red category plant is generally valid for a period of 5 years. TPGL will apply for CTE through an online portal along with all necessary supporting documents and pay the requisite fees. Normally grant of CTE is based on self certification of the user agency and the validity of the CTE is 3 years for industries having a capital investment of more than INR 10 crores, irrespective of the type of category. The CTE can be extended for a period as determined by TPCB. Once the CTE is obtained, the proposed plant will be established by the EPC contractor. TPGL will then apply again for grant of CTO along with prescribed fees, before commissioning of the proposed plant. TPCB based

[42] TPGL has applied for prior EC for the proposed plant as per the EIA Notification of 2006 and its subsequent amendments.
EC for 2 x 8 MW units were accorded in 1988 and the units were decommissioned in 2002 and 2006. Further 4 x 8 MW units were accorded EC in 1991 & these units are not in operation and in various stages of decommissioning. TPGL had commissioned 3 x 21 MW units without obtaining Prior EC and have applied for regularisation of EC.
In pursuance of MoEF&CC’s order to maintain operational capacity below 50MW, operation of one operational 21 MW unit has been stopped and capacity reduced to 42 MW. The EAC has recommended the grant of ToR for the proposal to regularise EC for 3 x 21 MW vide its minutes of the 13th meeting of the re-constituted EAC on EIA of thermal power projects held on 13th July 2021.

on inspection shall grant a CTO which normally is valid for 5 years. CTO can be renewed before the 5th year based on the submisison of mandated periodic reports.

Table 3-1: National and State Environment Policy and Legislation

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
1	National Environment Policy (NEP), 2006	Both construction and operation of the proposed plant must generally adhere to the NEP principles of conservation of environmental resources and abatement of pollution, the EIA process and implementation of the EMP will enable this.	**Responsible Authorities:** MoEF&CC
2	National Water Policy, 2012	Need to conserve and manage ground water as it is a community resources held by the state. Recognizes that water is required for thermal power and the utilization should be optimized and an awareness of water as a scarce resource should be fostered.	**Responsible Authorities:** Ministry of Jal Shakti
3	National Resource Efficiency Policy (NREP), 2019 (Draft)	Recognizes the need for efficient use of resources (natural gas, water, soil, air, etc.) with minimum negative impact on environment.	**Responsible Authority:** MOEF&CC, if it becomes final National Resource Efficiency Authority (NREA) will be constituted under the provisions of Section 3 (3) of the Environment (Protection) Act, 1986
4	Policy Statement for the Abatement of Pollution, 1992	Project should lay emphasis on pollution abatement and include best available practicable technologies (BAT) to prevent pollution. The project shall have state of the art pollution abatement mechanisms and include BAT for pollution prevention.	**Responsible Authorities:** MoEF&CC
5	National Forest Policy, 1988	Not applicable as the policy deals with increasing forest cover and its management by involving local communities in the management of forests. There are no forest areas in the project site.	**Responsible Authorities:** MoEF&CC
6	National Conservation Strategy and Policy Statement on Environment and Development, 1992	It is applicable for the project as it provides the measures to be taken for prevention and control of pollution and environmental hazards in energy generation and its uses.	**Responsible Authorities:** MoEF&CC
7	National Resettlement and Rehabilitation Policy, 2007	Not applicable as there is no land acquisition involved, all lands are owned by TPGL	**Responsible Authorities:** Ministry of Rural Development
8	The Environmental (Protection) Act, 1986 and The Environmental (Protection) Rules, 1987 & its amendments	Both construction and operation of the proposed plant must comply with the legislation issued under this act and rules, the EIA process and implementation of the EMP will enable this. Construction and operation must also comply with the environmental quality standards	Umbrella act under which environmental notifications, rules, schedules and standards applicable to the proposed project are issued. 2015 amendment requires new plants

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
		per **Annexure 3.** In operation the proposed plant must comply with water consumption restrictions per the 2015 amendment.	constructed after 2017 to limit water consumption to 2.5m^3/MW and achieve zero wastewater discharged. **Responsible Authorities:** MoEF&CC, Tripura DoF, CPCB and TPCB
9	The EIA Notification, 2006 as amended to 2016	Prior to construction, as the proposed plant has potential to generate adverse impacts on the environment it requires Prior EC from MoEFCC. Prior EC is also applicable for sourcing of raw materials during construction. No new quarries will be opened, instead materials will be sourced by the contractor from existing sources. The contractor will need to confirm any existing sand and aggregate quarries (including those involving excavation of riverbeds) used by third party vendors obtained Prior EC as per the notification schedule.	Identifies projects and activities that require Prior EC and lays the procedure for obtaining the same. **Responsible Authorities:** MoEFCC and SEIAA
10	The Right to Information Act, 2005 and its amendment of 2019	In relation to information disclosure during all stages of the proposed plant, wherein any citizen of India may request information after paying a fee from a TPGL which is a government body and which TPGL is required to respond within thirty days.	
11	The National Environmental Appellate Authority Act, 1997 National Green Tribunal Act, 2010	Proposed plant will need to comply with any NGT rulings in case of application against it.	NGT has dedicated jurisdiction in environmental matters to provide environmental justice and help reduce the burden of litigation in the higher courts. It is mandated to endeavor for disposal of applications or appeals within 6 months of them being filled. **Responsible Authorities:** NGT
12	Central Ground Water Authority (CGWA) Notification no. 21-4/Guidelines/CGWA/2009-832 dated 14th October 2009	Since the proposed plant intends to extract ground water through new bore wells prior to construction permission to abstract will be required from CGWA in accordance with this notification.	**Responsible Authorities**: CGWA
13	Comprehensive Environmental Pollution Index (CEPI) 2018	Not applicable as the project doesn't falls under any of the industrial clusters nor under the Critically Polluted Areas (CPAs) as per the CEPI	Industrial clusters are categorized under the CEPI as Polluted Industrial Areas giving weight to various pollutants, ambient pollutant concentrations, receptors (that is, the number of

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
			people affected) and additional high-risk elements; they are to be remediated seeking compensation from polluting industries, and any expansion or development of new sites in these areas will be rejected **Responsible Authorities**: CPCB, SPCB, enforced by NGT
14	The Water (Prevention and Control of Pollution) Act, 1974 The Water (Prevention and Control of Pollution) Rules, 1975 The Water (Prevention and Control of Pollution) Cess Act, 1977 & amendment in 2003	Prior to construction, CTE and CTO are required for major construction facilities and the thermal power plant to protect against pollution of surface and ground water.	Empowers central and state pollution control boards to establish and enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction and operation of certain facilities. **Responsible Authority:** TPCB
15	Thermal Power Plants - Water Consumption Limit under Environment (Protection) Amendment Rules, 2015	Ground water consumption by TPGL to be below 2.5 m3/MWh and achieve zero discharge	**Responsible Authorities**: TPCB
16	The Air (Prevention and Control of Pollution) Act, 1981 The Air (Prevention and Control of Pollution) Rules, 1982	Prior to construction, CTE and CTO are required for major construction facilities and the thermal power plant to protect against air pollution. Need to adhere to the air emission standards per **Annexure 3.**	Empowers state pollution control boards to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission. **Responsible Authority:** TPCB
17	Noise Pollution (Regulation and Control) Act, 2000 and 2010 as amended	Both construction and operation of the proposed plant must adhere to the ambient noise emission standards; any generators used must also be compliant per **Annexure 3.**	Standards for noise emission for various land uses and equipment have been issued. **Responsible Authority:** TPCB
18	The Motor Vehicle Act. 1988 and its subsequent amendments	All vehicles utilized during construction and operation mandatorily require obtaining of a "*Pollution Under Control Certificate*" (PUC) for the duration of their use to manage the vehicular emissions.	Empowers the State Transport Authority to enforce standards for vehicular pollution and issuance of PUC certificates. **Responsible Authority:** State Motor Vehicles Department
19	Indian Forest Act, 1927	No forest land is required to be diverted for the	The act defines the various forest areas and lays

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
	Forest (Conservation) Act, 1980 as amended Forest (Conservation) Rules, 2003 & its amendments	proposed plant as the land required for the project is already owned by TPGL. However, permission is required for tree felling under the rules.	down the procedure for diversion of forest land for non-forest activities. **Responsible Authorities:** MoEFCC & Tripura DoF
20	State of Tripura Guidelines for Extraction of Trees from Non-Forest Areas, 2010 Detailed Procedure for Extraction of Trees from Non-Forest Areas, 2010	Prior to construction as there will be felling of both timber and non-timber trees outside of forest land to facilitate construction, thus permissions for these activities must be sought.	Deals with the felling and transporting of both timber and non-timber trees in non-forest areas, timelines for registration and procedures for permissions for felling including service charges. It exempts registrations for fruit trees like mango, litchi, guava, and rubber trees. **Responsible Authority:** Department of Forest
21	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Rules 2007	Not applicable to the proposed plant as no land is being acquired from scheduled tribes.	Provides rights related to title, usage, relief, development and forest management including traditional and customary rights of forest-dwelling scheduled tribes. **Responsible Authorities:** Department of Forest, Department of Revenue and Department of Tribal Welfare
22	Biological Diversity Act, 1992 Biological Diversity Rules, 2004 Wildlife Protection Act, 1972 as amended	Proposed plant is not situated within a notified Protected Area such as national park or wildlife sanctuary, neither it is within the notified Ecological Sensitive Zone (ESZ) of a PA. The nearest PA is Sepahijala Wildlife Sanctuary and Clouded Leopard National Park (located within Sepahijala WLS) at 10.5 km distance – ESZ of Sepahijala WLS has been notified in the gazette, it is 10m from the WLS on all boundaries except for the eastern boundary where it is 50m from the WLS. In the event of construction works encountering any scheduled plants and animals at the project site it will need to be followed.	Provides for protection of PA from non-conservation activities. It also lists (schedules) plants and animals of which sale, trade or commerce in is prohibited. **Responsible Authorities:** National Board of Wildlife (NBWL), State Board of Wildlife (SBWL) and Chief Wildlife Warden of Tripura
23	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Not applicable as there is no land acquisition involved, all lands are owned by TPGL	Provides directions related to fair compensation of any land acquired for public works purpose. **Responsible Authorities:** Revenue Department and Sepahijala District Administration

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
24	The Provision of the Panchayats (Extension to the Scheduled Areas) Act, 1996	Not applicable as there is no land acquisition under Tripura Tribal Areas Autonomous District Council (TTAADC) areas involved, all lands are owned by TPGL	It applicable only for areas that have been declared under fifth schedule of the constitution, such as TTAADC. **Responsible Authorities:** TTADC
	Indian Treasure Trove Act 1878 (as modified up to September 1949) The Antiquities and Art Treasures Act, 1972	It shall be applicable only if there are any chance finds of physical cultural resources during excavation for construction.	Deals with treasures and other artifacts which are of antique value and origin. **Responsible Authority:** Archaeological Survey of India (ASI)
25	Ancient Monuments Preservation Act 1904 Ancient Monuments and Archaeological Sites and Remains Act 1958 and its amendments Ancient Monuments and Archaeological Sites and Remains (Framing of Heritage Bye laws and Other Functions of Competent Authority) Rules, 2011 National Monument Authority Rules, 2011 Heritage Conservation and Preservation Act, 2010	The Buddhist Stupa at Boxarnagar, 3.15 km from the project site is an ASI notified monument and must be protected from indirect impact. Further, the acts will be applicable only if there are any chance finds of physical cultural resources during excavation for construction.	Deals with activities that may be permitted and prohibited near the protected monuments. Construction works are prohibited within 100m of a protected monument. In event of any chance finds they must be notified/surrendered to the competent authority. **Responsible Authorities:** ASI, Tripura Department of Archaeology
26	The Explosives Act 1884 and its subsequent amendments. The Explosives Rules 1983	If explosives are used for blasting to level the hillocks or to facilitate construction the regulations must be followed. They must also be followed if petroleum products are stored beyond the permissible capacities at the project site.	Sets out the regulations as regards to the usage and storage of explosives including explosive fuel (diesel or petrol) at the project site and precautionary measures to be taken. **Responsible Authority:** Chief Controller of Explosives
27	Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989	Storage of hazardous chemicals, flammable gases are considered as hazardous chemical.	**Responsible Authorities**: TPCB
28	Regulation of Polychlorinated Biphenyls (PCBs) Order, 2016	New transformers provided for the proposed plant must be PCB free and any existing PCB containing	Provides guidance on the usage of PCBs and prohibits the usage of PCBs in any form by 31st

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
		transformers at the existing substation removed by the cut of date of 31st December 2025. Disposal of PCB containing equipment must be as per Hazardous and Other Wastes (Management, & Trans-boundary Movement) Rules.	December 2025. **Responsible Authority:** TPCB
29	Ozone Depleting Substances (Regulation and Control) Rules, 2000 and its amendments	Prohibition on usage of ozone depleting substances during construction and operation period e.g., for servicing of fire extinguishers	Provide direction on the regulation of ozone depleting substances. **Responsible Authorities:** TPCB
30	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Emergency response planning must involve the responsible authorities in case during construction and operation chemical accident that could impact public occurs while handling any hazardous chemicals (flammable, toxic and explosive). Flammable chemicals for the purposes of the rules also include gases	Protection of the public against chemical accident while handling any hazardous chemicals (flammable, toxic and explosive) **Responsible Authorities:** District and Local Crisis Group headed by the District Magistrate and Sub Divisional Magistrate
31	Construction and Demolition Waste Management Rules, 2016	Construction and demolition waste will be generated and will need to be managed and disposed of in accordance with these rules during construction.	Deals with safe disposal of construction wastes generated due to construction and demolition activities. **Responsible Authorities:** TPCB
32	Solid Waste Management Rules 2016 Municipal Solid Waste (Management & Handling) Rules, 2000 (MSW Rules)	Solid waste will be generated and will need to be managed and disposed of in accordance with these rules during construction and operation.	Deals with safe disposal of municipal solid wastes generated due to construction **Responsible Authorities:** TPCB, Panchayats
33	The Plastic Waste Management Rules, 2016	Plastic will be generated for disposal in the wastes from packaging materials during both construction and operation period	The rules apply to "*every waste generator, local body, Gram Panchayat, manufacturer, Importers and producer*". Wastes to be segregated and disposed as per Solid Waste Management Rules, 2016. **Responsible Authorities:** TPCB, Tripura's Urban Development Secretary and Village Panchayats
34	Hazardous and Other Wastes (Management, & Trans-boundary Movement) Rules,	In relation to the management and disposal of hazardous wastes (used transformer oils, batteries, solvent-soaked rags etc.) that are used during	Provides protection to the general public against improper handling and disposal of hazardous wastes.

Sl. No.	Name of Policy / Law / Regulation	Applicability to Proposed Plant	Remarks
	2016 as amended in 2019	construction and operation of the proposed plant.	**Responsible Authority:** TPCB
35	Batteries (Management and Handling) Rules, 2001	Use of batteries as back up in the proposed plant is envisaged. During construction and operation used batteries must be properly disposed to TPCB authorized and registered recyclers.	The rules apply "*to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer, and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof*". Half-yearly returns using the required forms are to be filed and submitted to TPCB. **Responsible Authorities:** TPCB
36	E-Waste (Management) Rules, 2016 as amended in 2018	During construction and operation used e-waste must be properly disposed to TPCB authorized and registered recyclers.	**Responsible Authorities**: TPCB
37	Bio-Medical Waste Management Rules, 2016	During construction and operation bio-medical waste from temporary or permanent clinic facilities must be managed and disposed of in accordance with these rules.	**Responsible Authorities**: TPCB

Source: ADB TA Consultant

Table 3-2: Environment Permissions Required for the Proposed Plant

Sl. No.	Clearances / Permissions / NOC	Authority	Responsible Party	Status as of February 2022
1	Prior Environmental Clearance	MoEFCC / SEIAA	TPGL	Scoping request submitted to MoEFCC on December 2021
2	Consent to Establish (Power Plant)	TPCB		To be obtained prior to construction
3	Tree Felling / trimming Permissions	State Forest Department		To be obtained prior to construction
4	NOC for ground water withdrawal	CGWA		To be obtained prior to construction
5	Consent to Operate (Power Plant)	TCPB		To be obtained prior to commissioning and operation
6	Consent to Establish (CTE) construction facilities	State Pollution Control Board	EPC Contractor	To be obtained prior to construction
7	Consent to Operate (CTO) construction facilities	State Pollution Control Board		To be obtained prior to construction
8	Pollution Under Control Certificates for construction vehicles	State Motor Vehicles Department		To be obtained prior to construction

Source: ADB TA Consultant

C. National Health and Safety (Labor) Regulatory Framework and Standards

133. Several policies, acts and regulations relate to health and safety and labour welfare as detailed in Table 3-3. One significant health and safety omission is regulation on asbestos for which regulations remain in draft. There is no ban on asbestos importation. However, the Supreme Court has previously addressed the harmful consequences of asbestos making the employer responsible for paying damages to workers whose health has been affected by exposure to it. The main government agencies responsible which are for administration of the health and safety policy and legislation pertinent to the proposed plant are:

(i) **Ministry of Labor and Employment:** Responsible for protecting and safeguarding the interests of workers with due regard to creating a healthy work environment along with promotion of welfare and providing social security to the labor force in both organized and unorganized sectors. This is achieved through enactment and implementation of various labor laws (currently 44 statutes) dealing with minimum wages, social security benefits, occupational safety and health, conditions of employment, disciplinary action, formation of trade unions, industrial relations, etc. State governments are also competent to enact legislation. Labor statutes are enforced and monitored through the Labor Commissioners.

(ii) **Central Electricity Authority (CEA):** Advises central and state governments and regulatory commissions on all policy and technical matters relating to the generation, transmission and distribution of electricity and formulates plans for the development of electricity systems. It is also responsible for prescribing the technical standards related to construction of electrical plants, lines, and connections to the grid, the installation and operation of meters, safety standards, and grid standards etc. The proposed plant will be required to adhere to the safety regulations and standards as prescribed by the CEA.

134. Health and safety permissions to be obtained for the propoosed plant are set out in Table 3-4.

Table 3-3: National and State Health and Safety (Labour) Policy Regulations

Sl. No.	Name of Policy / Law / Regulation	Applicability to Project	Remarks
1	National Policy on Safety, Health and Environment at Workplace, 2009	Proposed plant to strive for the objective of improving safety, health and environment in the workplace during both the construction and operation	**Responsible Authorities:** Ministry of Labor and Employment
2	National Policy on HIV / AIDS and the World of Work	Influx of laborers for the construction works may lead to transmission of HIV/AIDS. Policy aims to prevent transmission amongst workers and protect the rights of the infected	**Responsible Authorities:** Ministry of Labor and Employment
3	Drinking Water Standard (IS 10500:2012)	Provides the standards of drinking water in India. The drinking water provided in the proposed plant during construction and operation must adhere to the standards. The standard is given in **Annexure 3**	**Responsible Authorities:** Bureau of Indian Standards, CPCB, TPCB
4	Indian Factories Act 1948	Proposed project will follow the health and safety requirements during operation. It is applicable, as there will be more than ten full time employees during the operation till the time The Occupational Safety, Health and Working Conditions Code, 2020 comes into force.	This act along with 12 other central labor laws has been rationalized and will be replaced by The Occupational Safety, Health and Working Conditions Code, 2020. However, the code is yet to come into force through an official gazette notification. **Responsible Authorities:** Ministry of Labor and Employment, Chief Inspector of Factories, GoT and Sipahijala District Magistrate as Inspector for the district
5	The Tripura Factories (Safety Officers) Rules, 1984	The proposed plant shall qualify as a factory during operation period. The safety officer employed during the operational phase should qualify as per the rules.	Deals with the qualifications and duties of the safety officer appointed in a factory. **Responsible Authorities:** Factories Welfare Officer, GoT
6	The Building & Other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996	Proposed project will follow the requirements during construction. It is applicable, as ten or more building workers will be employed in construction work, till the time The Occupational Safety, Health and Working Conditions Code, 2020 comes into force.	This act along with 12 other central labor laws has been rationalized and will be replaced by The Occupational Safety, Health and Working Conditions Code, 2020. However, the code is yet to come into force through an official gazette notification. **Responsible Authorities:**

Sl. No.	Name of Policy / Law / Regulation	Applicability to Project	Remarks
			State Building and Other Construction Workers' Advisory Committee, Labor Commissioner
7	The Contract Labour (Regulation & Abolition) Act, 1970 The Contract Labour (Regulation & Abolition) Rules, 1971	Hiring of laborers with or without the knowledge of TPGL (the principal employer) must be done through a licensed contractor as per the act. It is applicable till the time The Occupational Safety, Health and Working Conditions Code, 2020 comes into force.	This act along with 12 other central labor laws has been rationalized and will be replaced by The Occupational Safety, Health and Working Conditions Code, 2020. However, the code is yet to come into force through an official gazette notification. **Responsible Authorities:** Labour Commissioner
8	Tripura Contract Labour (Regulation and Abolition) Rules 1978	It is applicable to construction and operation as more than 25 construction laborers will be hired for the proposed plant.	Deals with hiring of laborers by a licensed labor contractor. It also provides for provision of rest rooms, canteens, toilets (one for every 25 laborers), first aid facilities, wages etc. **Responsible Authorities:** Directorate of Labour, GoT
9	The Bonded Labour (Abolition) Act 1976	Applicable as it prevents use of bonded labor during construction	**Responsible Authorities:** Sipahijala District Magistrate as Inspector for the district or any officer delegated by them
10	The Child Labour (Prohibition and Regulation) Act, 1986 and its amendment The Tripura Child Labour (Prohibition and Regulation) Rules, 1994 as Amended up to 2018	During construction and operation prohibits the employment of children below the age of 14 by the contractor or TPGL.	Prohibits employment of children below the age of 14 in the building and construction industry. **Responsible Authority:** Ministry of Labor and Employment, Labor Inspector
11	The Trade Union Act, 1926	Applicable as it allows the formation of Trade Unions for the purpose of regulating the relations between workers and TPGL	**Responsible Authorities:** Registrar of Trade Unions, Tripura
12	Interstate Migrant Workers Act, 1979	If migrant workers are employed during construction or operation, it will be applicable for the migrant laborers, till the time The Occupational Safety, Health and Working Conditions Code, 2020 comes into force.	This act along with 12 other central labor laws has been rationalized and will be replaced by The Occupational Safety, Health and Working Conditions Code, 2020. However, the code is yet to come into force through an official gazette notification. **Responsible Authority:** Department of Labor

Sl. No.	Name of Policy / Law / Regulation	Applicability to Project	Remarks
13	The Code on Wages, 2019	During construction and operation comply with code in relation to payment of minimum stipulated wages, avoiding inequality in payment of wages etc.	The code repealed and replaced Payment of Wages Act, 1936, the Minimum Wages Act, 1948, the Payment of Bonus Act, 1965, and the Equal Remuneration Act, 1976. The Code has consolidated all the provisions of these four labor laws that have been repealed regarding wage and bonus payments and makes it mandatory for payment of minimum wages and timely payment of wages for all workers in India. **Responsible Authority:** Labor Commissioner
14	The Code on Social Security, 2020	During construction and operation comply with code in relation to provident funds, gratuities, compensation, employee insurance etc. which are to be paid to the workers employed by the labor contractors, employees of EPC contractors and TPGL.	The code repeals and consolidated the Workmen's Compensation Act, 1923, The Employees' Provident Funds and Miscellaneous Provisions Act, 1952, The Payment of Gratuity Act, 1972, The Employees' State Insurance Act, 1948 and five other acts. The act brings generation, transmission and distribution of power works under the ambit of the act. Workmen Compensation Insurance, regular Provident Fund (PF), gratuity and other insurances have to be obtained by the contractors for the project. **Responsible Authorities:** Labor Commissioner, PF Commissioner
15	Employers' Liability Act no. 24 of 1938	Deals with injuries to workers and the responsibility of the employer to maintain machinery and plant in good and safe conditions	**Responsible Authorities:** Ministry of Labor and Employment
16	Public Liability and Insurance Act, 1991	The act is applicable to protect the public from any fortuitous accidents during construction or in the operation of the proposed plant. Liability Insurances are to be obtained by the EPC contractor and TPGL for construction and operation.	The act provides for protection to the public from accidents caused from hazardous materials resulting in continuous or intermittent or repeated exposure to death of, or injury to, any person or damage to any property **Responsible Authorities:** Labor

Sl. No.	Name of Policy / Law / Regulation	Applicability to Project	Remarks
			Commissioner and District Magistrate
17	The Indian Electricity Act, 1910 and its amendments The Indian Telegraph Act, 1885	New transmission lines will be constructed to connect to the existing switchyard so the act must be complied with. Right of Way required for transmission lines which will be constructed to connect to the existing switchyard. The applicable ROW for 132 kV power line is 27m.	Safety measures to be taken in laying of electrical lines and connections. **Responsible Authorities:** Central Electricity Authority (CEA)
18	Electricity Act, 2003 and its amendments	Electric works will be carried out so the act must be complied with.	Guiding act related to electricity in India. Sections 53, 67, 73, 161 and 177 deals with safety related to electricity including power to make regulations. **Responsible Authorities:** CEA
19	Central Electricity Authority (Measures Relating to Safety and Electricity Supply) Regulations, 2010 CEA (Measures Relating to Safety and Electricity Supply) Regulations, 2018 CEA (Measures relating to Safety and Electric Supply) Amendment Regulations 2015 CEA (Measures Relating to Safety and Electric Supply) Regulations, 2019	Proposed plant deals with generation of electricity thus regulations must be followed.	Provide for safety requirements including mandatory appointment of an Electrical Safety Officer and their qualifications. **Responsible Authorities:** CEA
20	CEA (Technical Standards for Construction of Electric Plants and Electric Lines) Regulations, 2010 CEA (Safety Requirements for Construction, Operation and Maintenance of Electrical Plant and Electrical Lines) Regulations, 2011 CEA (Installation and Operation of Meters) Regulations, 2006 and its amendments CEA (Grid Standards for Operation and Maintenance of Transmission lines) Regulations, 2010	New thermal power plant will be constructed and operated thus regulations must be followed.	Pertains to the safety requirements for construction, operation and maintenance procedures of electrical plant and electrical lines **Responsible Authorities:** CEA

Sl. No.	Name of Policy / Law / Regulation	Applicability to Project	Remarks
	CEA (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2010		
21	The Petroleum Act, 1934 The Petroleum Rules 2002	Supply and storage of natural gas as fuel for the proposed plant, storage of diesel for generator set	Deals with the import, transport and storage of petroleum and petroleum products **Responsible Authorities:** Ministry of Petroleum and Natural Gas, Chief Controller of Explosives
22	Guidelines on Traffic Management in Work Zones IRC:SP:55, 2014	Need to provide for the safe and efficient movement of road users through or around the work zones while reasonably protecting the workers and equipment.	**Responsible Authorities:** Ministry of Labor and Employment, PWD

Source: ADB TA Consultant

Table 3-4: Health and Safety (Labour) Permissions Required for the Proposed Plant

Sl. No.	Clearances / Permissions / NOC	Authority	To be obtained by	Status as of February 2022
1	Certificate of Registration of Principal Employer	Labour Commissioner, Ministry of Labour and Employment	TPGL	To be obtained prior to construction
2	Labour License	Labor Commissioner, Tripura	EPC Contractor	To be obtained prior to construction
3	Workers Insurance	Ministry of Labor and Employment		

Source: ADB TA Consultant

D. International Agreements Applicable to the Proposed Plant

135. International agreements pertinent to the proposed plant include multilateral environmental agreements (MEA) and conventions of the International Labor Organization (ILO) related to worker safety and welfare. Representatives of countries can accept and sign the terms of international agreements on behalf of their government, making their country a signatory, following which they are ratified by the government to make the country's commitment binding. Table 3-5 provides the international agreements to which India is a signatory and details the applicability of these agreements to the proposed plant. Of note, in relation to the occupational health and safety of labour, India is not a signatory to Occupational Health and Safety Convention of the ILO and several other ILO conventions related to the health and safety of workers.[43]

Table 3-5: International Agreements

Sl. No.	Name	Date of Ratification	Applicability	Remarks
1	Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia	April 1988	Proposed plant will omit air pollution and is within 3.25 km of the Bangladesh border, TPGL need to ensure no transboundary air quality impact as a result	An inter-governmental network involving Bangladesh, Bhutan, India, Iran, the Republic of the Maldives, Nepal, Pakistan and Sri Lanka. It deals with air pollution in general and emissions of SO2 & NOx
2	Convention For the Protection of the World Cultural and Natural Heritage, 197[2]	14th December 1977	Some loss of natural habitat through felling of trees and clearing of the project site; but no world heritage will be impacted	Addresses nature conservation and preservation of cultural properties
3	Convention On International Trade in Endangered Species of	20th July 1976	Risk of illegal wildlife activities by workers out of hours, of note given project	Deals with protection of endangered species from illegal trade

[43] https://www.ilo.org/dyn/normlex/en/f?p=1000:11210:0::NO:11210:P11210_COUNTRY_ID:102691

Sl. No.	Name	Date of Ratification	Applicability	Remarks
	Wild Fauna and Flora, 1973		site is within 5km of the Bangladesh border	
4	Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 1971	1st February 1982	No Ramsar sites will be impacted	Deals with conservation and sustainable use of wetlands
5	Convention On the Conservation of Migratory Species of Wild Animals, 1979	1st November 1983	Some loss of natural habitat through felling of trees and clearing of the project site. . However, no migratory species falling under the convention were observed in the study area	Aims to conserve migratory species in their range
6	Rio de Janeiro Convention on Biological Diversity, 1992	18th Feb 1994	Some loss of natural habitat through felling of trees and clearing of the project site	Deals with biodiversity conservation, sustainable usage of natural resources and habitat preservation.
7	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 1998	24 May 2005	Transformers and other equipment procured must be PCB free	Promotes the sharing of responsibilities related to import of hazardous chemicals including PCBs.
8	Basel Convention on The Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989	24th June 1992	Applicable in relation to any hazardous wastes generated during construction and operation.	India has hazardous waste facilities so transboundary movement unlikely to be required.
9	Stockholm Convention on Persistent Organic Pollutants, 2001	13 January 2006	Transformers and other equipment procured must be PCB free. Existing transformers and other oil containing equipment may be contaminated with PCBs which must be removed by 31st December 2025.	Lists PCBs as one of the pollutants. Implemented in India in part by the Regulation of PCBs Order, 2016.
10	United Nations Framework Convention on Climate Change, 1992	1st November 1993	Proposed plant will emit significant GHG emissions as it burns gas as a fossil fuel. It is also applicable as Sulphur Hexafluoride (SF6) is present in gas-insulated switchgear.	Deals with reductions of greenhouse gases (GHG) to achieve 1.5°C target.
11	Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997	19 August 2002		
12	Paris Agreement under the United Nations Framework Convention on Climate Change, 2015	2nd October 2016		
13	Convention For the Protection of the Ozone Layer, 1985	18th March 1991	Servicing and refilling of fire extinguishers during construction and operation, ensure that use of ozone	Lists the various ozone depleting substances and steps for reducing their
14	Montreal Protocol on	19th June		

Sl. No.	Name	Date of Ratification	Applicability	Remarks
	Substances That Deplete the Ozone Layer, 1987	1992	depleting substances is prohibited	production
15	International Labour Organisation (ILO) Fundamental Conventions:[44] Forced Labor, Equal Renumeration, Abolition of Forced Labor, Minimum Age, Worst Forms of Child Labor	30th November 1954 25th September 1958 18th May 2000 13th June 2017	Construction and operation will involve workers	Labour laws of India are compliant to the ILO conventions that India is a signatory of.

Source: ADB TA Consultant

E. ADB Safeguards Policy Statement 2009 and International Good Practice

136. ADB's Safeguard Policy Statement, 2009 (SPS 2009)[45] broadly consists of three policy components: (i) Environment Safeguards, (ii) Involuntary Resettlement Safeguards, and (iii) Indigenous People Safeguards. The objectives of ADB's SPS 2009 are to (i) avoid adverse impacts of projects on the environment and affected people, where possible; (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

137. Under SPS 2009 projects are categorized A, B, C according to the likely significance of impacts:

- (i) Category A: Projects with potential for significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA) is required.
- (ii) Category B: Project with some adverse impacts, but of lesser degree and / or significance than category A. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination (IEE) is required.
- (iii) Category C: Projects that are likely to have minimal or no adverse impacts. No EIA or IEE required, although environmental implications are still reviewed.

138. The proposed plant is assigned as Category A for which an EIA is required. Table 3-6 presents a comparision and gap analysis of ADB's SPS 2009 requirements for Category A projects and Indian requirements.

139. The following international good practice guidelines are refered to by ADB's SPS 2009:

- (i) World Bank Group- IFC's General EHS Guidelines, April 2007; and

[44] https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:102691
[45] https://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf

(ii) World Bank Group- IFC's Thermal Power Plant sector guidelines, 2008.

140. The applicable international good practice standards and guidelines from the above mentioned guidelines are set out in **Annexure 4**. Where international good practice standards or guidelines are more stringent than national, it is the most stringent that applies to the project unless otherwise justified in this EIA.

141. ADB's prohibited investment activities list will also apply to the project. Thus any use of CFCs, PCBs, and asbestos containing materials for the proposed plant will be prohibted. In relation to child labor, taking into account capacity for supervision, no under 18s will be permitted to work on the construction site or operational areas of the power plant due to the hazardous nature of work involved and ADB is stringent in application of these conditions related to use of asbestos and child labor.

Table 3-6: Gap Analysis between ADB's SPS 2009 and National EHS Framework Applicable to the Proposed Plant

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
Screening and Categorization	• EIA Notification of 2006 and its amendments set screening criteria to classify new and expansion projects based on potential environmental impacts as either category A, B1 and/or B2 based on threshold approach. • The category of the project will determine the level of environmental assessment required, EIA is required to be carried out for Category A and B1 projects. • New gas based Thermal Power Plants with threshold limit of greater than equal to 500 MW are classified as Category A project while plants with threshold limit of greater than equal to 5 MW to <500 MW are classified as Category B project and general conditions (GC) are applicable. If Category B projects fulfils the conditions of the GC then the project is upgraded to Category A and apprised by the EAC at MoEFCC • Flow chart detailing the process is provided in **Annexure 8.**	• Screening required with categories based on potential significance of environmental impacts, the category of project shall determine the level of environmental assessment: (i) Category A - EIA required (ii) Category B – IEE required (iii) Category C – no environmental assessment required but a review of environmental implications is required	• No major gaps but differences in approach to categorization. • Per the Indian regulations, EIA is mandatory for eight types of project activities including gas based thermal power generation plants if they satisfy the defined threshold limits. Moreover, if Category B projects satisfies the requirements of the general conditions, then they are upgraded to Category A and appraised at the MoEFCC level. • The proposed plant is of 120 MW and nationally falls under Category B but it also is situated within a 5 km radius of the international boundary and thus has been upgraded as a Category A project and an EIA will be required to obtain Prior EC. • Per ADB's Safeguard Policy Statement (2009) the proposed 120 MW plant has been categorised as A and EIA is required.
Environmental Assessment	• Prior Environmental Clearance (EC) is required for Category A and B projects from MoEFCC and State Environmental Impact Assessment Authority (SEIAA) respectively	• EIA identifies potential direct, indirect, cumulative, and induced impacts and risks on physical, biological, socioeconomic, and physical cultural resources in the context of a project's area of influence (i.e., primary site and	• Some gaps persist • Indian regulations do not refer to the consideration of cumulative impact and consideration of impacts on the global climate • Requirements in relation to socioeconomic impacts do not refer to considering health and

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
	• EIA is required to be carried out for Category A and B1 projects as per approved Terms of Reference issued by the EAC / SEIAA. The EIA identifies potential direct, indirect, cumulative, and induced impacts and risks on physical, biological, socioeconomic, and physical cultural resources in the context of a project's area of influence • No consultation with neighbouring countries is undertaken, unless a project has a propensity to vitiate international relationship	facilities, associated facilities etc.) including transboundary and global impacts	safety, livelihoods, gender, or other vulnerable groups • EIA prepared for the proposed plant meets the requirements of both GoI and ADB SPS 2009
Analysis of Alternatives	• For Environmental Sensitive projects (*based on the spatial extent of potential impacts and potential impacts on human health and natural and manmade resources* and defined threshold limits, as per EIA notification, 2006) requiring Prior EC, analysis of alternatives to the proposed project's site, technology, design, and operation including the with and without project scenarios are to be carried out. The project is Environmental Sensitive	• Category A projects are required to carry out alternative analysis. Alternatives to the project's location, design, and technology are to be examined and rationale for selecting the project location, design, and technology to be documented. Also "no project" alternative must be assessed.	• No major gaps • An analysis of alternatives has been carried out as part of the EIA as per both the Indian regulations and SPS 2009
Environmental Planning and Management	• The EIA notification state that the EIA report prepared for projects seeking Prior EC (Category A and B) shall provide for an environmental	• In cases where impacts cannot be avoided or prevented, mitigation measures and actions are required to be identified so that the project is designed, constructed, and operated in compliance	• Some gaps persist • In both the cases the project proponent engages qualified and experienced experts for carrying out EIA, they prepare the EMP delineating mitigation measures and responsibilities for implementation

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
	management plan (EMP) that should delineate the description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA. • Standard TOR issued by MoEF&CC / SEIAA for conducting EIA requires that the EMP have a detailed budget of all proposed mitigative activities. Project proponents are obliged to submit six monthly compliance reports, post grant of EC, as per the specified conditions of the EC	with applicable laws and regulations and meets the requirements of the SPS 2009. • Key considerations include mitigation of potential adverse impacts to the level of "no significant harm to third parties", the polluter pays principle, the precautionary approach, and adaptive management. • SPS 2009 requires an EMP addressing the potential impacts and risks identified by the environmental assessment which should include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.	along with time schedule and budget and ensuring that relevant laws are met. • Indian regulations do not however refer to the capacity development and training measures required to ensure EMP implementation. • Normally monitoring tasks are carried out by the Pollution Control Board, who are understaffed and unable to regularly monitor the conditions of Prior EC and EMP implementation. • EIA and EMP prepared for the proposed plant meet the requirements of both GoI and ADB SPS 2009 with TPGL capacity development and training measures being included.
Meaningful Consultation	• Public consultation in the form of Public Hearing is required to be undertaken through public notice prior to the approval by the MoEFCC for Category B1 and A projects. • Consultation activities start when the Draft EIA Report is submitted by the project proponent to the State Pollution Control Board	• Starts early and continues during implementation phase. It is undertaken in a conducive atmosphere and is inclusive of gender, vulnerable and indigenous groups such that the project incorporates all relevant views and concerns of affected persons and other stakeholders	• Some gaps persist • No specific requirements for gender balance and vulnerable groups in public consultations under Indian regulations • Meaningful consultations are undertaken as part of the EIA incorporating gender, vulnerable and indigenous groups.
Information Disclosure	• Information for Category A and B1 projects only through public notice, this is required to be disclosed prior to the approval of Prior EC by the MoEFCC	• ADB will post in its website the following: a) Draft EIA report at least 120 days prior to consideration by Board b) Final or updated EIA upon receipt c) Environmental monitoring reports	• No major gaps • Category A & B1 projects need to disclose information as per Indian regulations • The documents prepared for the proposed plant shall comply with the requirements of SPS and shall be disclosed on the ADB website and locally

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
		submitted by borrowers upon receipt • Local disclosure is required	by TGPL
Grievance Redress Mechanism	• Grievance redress mechanism is not mentioned in the regulations	• Establish grievance redress mechanism to facilitate resolution of grievances or complaints received in the project	• Major gap exists • GRM to be firmed up as per the requirements of the SPS
Monitoring and Reporting	• Post environmental clearance (EC) monitoring is stipulated by the regulations, with half yearly compliance reports to be made available as public documents. Latest report to be displayed on website of the regulatory authority	• Project Proponents are required to prepare and submit regular semi-annual or annual monitoring reports on the progress of EMP implementation to ADB for review and disclosure • For Category A projects, external experts are recruited for monitoring and reporting purposes • Prepare and implement corrective action plan if non-compliance is identified	• No major gaps. • Monitoring measures in accordance with ADB's Safeguard Policy Statement (2009) are proposed for the project
Biodiversity	• EIA Notification of 2006 and its amendments requires projects that applying for Prior EC to provide information in Form 1 on ecologically sensitive areas, establish baseline data on biodiversity and then carry out an assessment on the impact of it and provide mitigation measures in the EIA report and EMP • Wildlife Protection Act, 1972 and amendments provides the procedures and guidelines for siting of projects within ESZ of protected areas (PA) and within PA. Projects within ESZ or PA require lengthy permission procedures and in exceptional cases are permitted with numerous mitigation measures. Projects	• SPS 2009 requires that the borrower assess the significance of project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process. It also requires that the assessment focus on the major threats to biodiversity including destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner and then identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity. • SPS 2009 also lays down procedures for implementing projects in natural habitats, critical habitats and Legally Protected Areas	• Some gaps persist • Both EIA under the national notifications and the SPS 2009 requires assessment of impacts of the project on biodiversity and provision of mitigation measures along with an EMP • Projects are difficult to be set up within ESZ, PA, or forest areas without prior approvals and clearances which are very difficult and time consuming to obtain as per the Indian legislations while the SPS 2009 provides necessary procedures to be followed including consultations and assessment for project activities within such areas • In some cases, critical habitat areas are found outside the PA system of the country wherein some endangered or critically endangered species may be present. Indian regulations have no provisions for protecting biodiversity in this event unless projects fall under the EIA Notification

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
	that obtain permissions are mainly linear projects of national importance. • Indian Forest Act, 1927 and the Forest (Conservation) Act, 1980 and its subsequent amendments set procedures for diversion of forest land for non-forest activities. The procedure is also time consuming especially for cases involving diversion >5 ha. Any diversion of forest land involves compensation of land and plants that shall be felled. For central government projects there are some relaxations related to compensation of land • Most, but not all, of the critical habitats or areas inhabited by endangered species (under schedules of the Wildlife Protection Act, 1972 and amendments) are protected under either the Forest Act or the Wildlife Protection Act, or the Environmental Protection Act		
Pollution	• The Environment (Protection) Rules, 1986 and various legislations addressing aspects such as air, noise, water pollution, hazardous substance management etc. • National Ambient Air Quality Standards have been specified as per (MoEF&CC notification General Statutory Rules	• Refers to IFC EHS Guidelines for environmental standards as provided in **Annexure 4**. • If national regulations differ, more stringent one will be followed • If less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification.	• Limiting value of some pollutants specified in the Indian regulatory standards are different than those specified in World Bank Group / IFC's EHS guidelines and hence gaps exist in certain situations • The values of the five pollutants under the WHO guidelines referred to by IFC are more stringent than the Indian standards. • The National Ambient Air Quality Standards list 12 pollutants along with their permissible

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
	(G.S.R) 826(E), dated 16.11.2009) in compliance with the Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982 • Noise Standards has been specified as per the Noise Pollution (Control and Regulation) Rules, 2000 (Amended 2002). • Water quality standards have been specified as per MoEF&CC notification No. GSR 742(E), Dt: 25.09.2000) and in compliance with the Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974. • Standards applicable to the project are provided in **Annexure 3.** • Technical EIA Guidance Manual for Thermal Power Plants, MoEF&CC, August 2010		concentrations. The major pollutant that is listed in the Indian standard but missing from the WHO guidelines to which the IFC refer is Carbon Monoxide (CO) although WHO introduced one in their latest 2021 update of the guidelines. Also, the Indian standards are for 2 types of land uses – (a) industrial, residential, rural and others and (b) ecological sensitive Areas notified by the Government whereas WHO make no distinction on land use. • Bharat Stage Emission Standards (BSES) which is based on European Standards is used in India. Presently BS IV standards corresponding to Euro 6 are being implemented in the country. • Ambient noise limits for industrial receptors is lower as per the WHO community noise guidelines to which IFC refer than the GoI standard, whilst at residential receptors they are similar, but differ for sesnsitive and commercial zones. The GoI introduces two additional receptor types not considered by IFC / WHO namely commercial area and silence zone (hospitals, educational institutions, courts, religious places and '*any other area which is declared as such by the competent authority*') • There are no sector specific Indian standards for effluent / water quality whereas the IFC EHS guidelines provides effluent guidelines for thermal power sectors • IFC EHS guidelines for thermal power provide energy efficiency and GHG emission guidelines while Indian environmental regulations do not provide energy efficiency standards in gas fuelled thermal power plants, except advocating the fuel for minimising GHG emissions as it produces lower CO_2 emissions per unit of energy and enhances energy efficiency. The EIA manual for Thermal Power plants advises use of heat

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
			recovery methods
Health and Safety	• Occupational health and safety standards included in various Indian labour laws and codes	• Refers to IFC EHS Guidelines for the occupational health and safety guidelines to be followed	• No major gaps as both IFC EHS guidelines and Indian regulations provide for safe work areas, the use of safety equipment and personal protective equipment (PPE)
Physical Cultural Resources	• The procedures for obtaining permissions for siting of projects in the vicinity of a protected monument are laid in the various acts related to ancient monuments • The EIA Notification of 2006 and its amendments also requires that the project proponent provides detailed information on the presence of physical cultural resources during the application for EC. Appropriate mitigation measures are to be provides in the EIA report in case of direct and indirect impact on the resources	• SPS 2009 states that the borrower is responsible for siting and designing the project to avoid significant damage to physical cultural resources. It requires that such resources that may have direct, indirect, cumulative, and induced impacts are identified and assessed by qualified and experienced experts using field-based surveys. If such resources are impacted consultations with affected communities shall take place to identify the importance and to incorporate the views of the affected communities besides consultations with relevant national or local regulatory agencies. Appropriate mitigation measures ranging from avoidance to full site protection to selective mitigation, including salvage and documentation be provided in case of impacts. • For projects that are located where physical cultural resources are expected to be found as per the environmental assessment, procedures for chance finds shall be included in the EMP and such finds shall not be disturbed until assessed by a competent specialist • Movement of physical cultural resources shall be done only when no alternatives exist, overall benefits of the	• Both EIA under the national notification and SPS 2009 requires assessment of impacts of the project and provision of mitigation measures along with an EMP. Though field-based surveys by competent experts on physical cultural resources are not generally done unless it is prescribed in the ToR of the EIA by the EAC of MoEFCC / SEIAA • National legislations prohibit projects that are within 100m of protected monuments. For projects within 500m, permissions are to be obtained from the competent authorities. • Chance finds as per Indian regulations are to be handed over to the authorities who shall inspect / assess the chance finds • Very rarely are protected physical cultural resources removed unless the project is of national importance and the resources are of minor importance and, in such cases, it is handled by the specialist from the Archaeological department. In most cases of conflicts, the project proponent is advised to relocate their project site

Project Stage	Indian Requirements	ADB's Safeguard Policy Statement (2009)	Gap Analysis
		project substantially outweigh the anticipated cultural heritage loss and the removal is in accordance with relevant national and international laws and uses the best available techniques	

Source: ADB TA Consultant

F. TPGL’s Environment, Health and Safety Policies, Procedures and Environment Safeguards Capacity

142. TPGL has not adopted its own environment or health and safety policy to date. TPGL follows national and state legislation but has no written environment or health and safety procedures to be followed during project planning, construction, operation, or maintenance works.

143. TPGL does not have any dedicated environment, health, and safety (safeguards) unit or officer. A General Manager (GM-Technical) rank officer has been deputed at the Head Quarters to liaise with the regulatory authorities for obtaining all environment, health and safety permissions that are required by TPGL.

144. Since the number of operational staff in the generation units of TPGL is small, staff running the existing plant have been given additional responsibilities of safety including designating a senior staff as the Electrical Safety Officer. Similarly, the DGM / Plant Manager (Mechanical & Electrical) at the existing plant have been given the additional charges of safety. TPGL, does not have any environment, health and safety (safeguards) staff based on the project site.

145. Presently most of the staff at the project site level have not been exposed to any capacity building or trainings on environment, health and safety (safeguards) and it is thus of utmost urgency that the line and field staff are trained on environment, health and safety (safeguards) requirements.

146. TPGL has not previously worked with any international financial institution (IFI) and so do not have experience with IFI safeguard policies. However, TSECL from which TPGL has been carved out has worked with the World Bank for North Eastern Region Power System Improvement Project.

147. To ensure capacity training and organisational capacity augmentation of TPGL will be required (Chapter 10).

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

148. Baseline data covering biological, physical, socioeconomic, and physical cultural resource aspects has been collected, analyzed, and compiled to determine the existing environmental condition at the project site and in the wider study area. Site reconnaissance for the identification of sensitive receptors, baseline surveys for air quality, noise, water quality, ecology and socioeconomics, and consultations were conducted to collect primary baseline information. Secondary baseline data collection involved identifying and collecting existing published materials and documents on geology, hydrology, hydrogeology, meteorology, ecology, population data etc. The following sections summarize the pre-project biological, physical, and socio-economic environment of the project site and study area. Further baseline details are provided in **Annexures 9 to 16.**

149. The effects of physical activities associated with construction and operation of the proposed plant on a particular environmental resource or sensitive receptor will have spatial and temporal dimensions. Some activities will impact resources or receptors in a larger radius than others whilst some resources or receptors will be more sensitive to impacts; this has been considered in defining the Project Area of Influence (PAI) in relation to each environmental parameter. The PAI established and discussed in Chapter I (Introduction) has been divided into core and buffer zones. The core zone is defined as the project site and a given radius extending from the project site which will be subject to the most impacts or the greatest magnitude of change during construction and operation. The buffer zone is the remaining part of the study area which may be subject to impacts but fewer in number or of lesser magnitude than the core zone experiences. The PAI based on core and buffer zones for the proposed plant is provided in Table 4-1. The international boundary between India and Bangladesh is around 3.25 km to the west of the proposed plant.

Table 4-2: Project Area of Influence (PAI)

Environment Parameter	Core	Buffer	Remarks
Biological	2km	10km (50km) Buffer includes Bangladesh border	PAI of 10km radius was considered for undertaking the biological data collection. Surveys provide an understanding of the project site, its immediate surroundings (core zone) and wider setting (buffer zone). For primary biological survey, both floral and faunal surveys were conducted through transects in the project footprint and within 2 km radius. For running an IBAT report a 50km buffer was used to pick up on any wide-ranging species and nearest protected / key biodiversity areas. Both primary and secondary data (including IBAT screening) was for assessment.
Physical	150m-1km (10km) For noise 150m	10km (50km) For noise 500m Buffer includes Bangladesh	PAI of 10km radius was considered for undertaking physical environment data collection. For most parameters 500m-1km radius was considered as core zone for mapping of sensitive receptors during the field surveys and for undertaking baseline monitoring. For air quality baseline, the study area was taken as 10km. Although for operational air quality modelling, the study area was extended to 50km to ensure that

Environment Parameter	Core	Buffer	Remarks
		border	the location of the maximum ground level concentration was picked up. For the noise baseline and assessment, the study area was 500m. The spatial extents are representative of the extents of likely adverse impacts associated with the noise assessment, as dictated by initial model runs.
Socio-economic	500 m	10km Buffer includes Bangladesh border	PAI of 10km radius is considered for socio-economic context, with a core zone of 500m radius for mapping of individual sensitive receptors and consultations during field surveys. The nearest residents/vulnerable people were identified at 55m from the project site east boundary.

Source: ADB TA Consultant

B. Biological Environment

1. Introduction

150. Tripura is in the bio-geographic zone of Northeast India, province 9B-North-East Hills. Situated in the Indian sub-region of the Oriental zoo-geographic region, local flora and fauna bear a very close affinity and resemblance with the floral and faunal components of the Indo-Malayan and Indo-Chinese sub-regions.

151. Its unique zoo-geographical position means it rich in biodiversity falling on the edge of the Indo-Burma biodiversity hotspot. It supports Mountain ecosystem with moderate hill ranges, Forest ecosystem, and Freshwater ecosystem comprising 10 major rivers and numerous wetlands.

152. Given the small size of the state its floral diversity is significant, but it does not exhibit any distinctive endemism trait. Most species are widely distributed across India and adjacent countries. The research on status of flora identifies 379 species of trees, 320 shrubs, 581 herbs, 165 climbers, 16 climbing shrubs, 35 ferns, 45 epiphytes and 4 parasites (a total of 1,545 taxa) with 50 plants species restricted to Tripura and its neighboring states, only 7 of which are endemic. The maximum value of Plant-Diversity Index (Shannon-Weiner) reported is 5.23, which generally ranges from 3-4, indicating presence of a variety of species uniformly. There are 90 mammalian species identified from the state, including seven primates. Apart from this rich diversity of mammalian species, Tripura is supporting many varied bird species, reptilians, amphibians, fishes, and invertebrates very similar to the entire region of Northeast India.

153. The specific objectives of biological baseline assessment were to gather information about:

(i) Floral species prevailing in the study area based on field surveys and their classification as threatened in accordance with the International Union for the Conservation of Nature [IUCN] Red List, nationally protected according to the schedules of the Wildlife (Preservation) Act 1972 and amendments, endemic, etc. In order to identify the presence of endangered and threatened species the Database on Threatened Plants of India based on the Botanical Survey of India's publication of Red Data Book Plants of India and listed out in the National Wildlife

Database of Wildlife Institute of India and the Forest Department, Government of Tripura's website were referred and analyzed with the field survey data.

(ii) Extent of modified and natural habitat supported by the project footprint, identification and enumeration of trees found within the project footprint that may need to be felled for construction.

(iii) Fauna species (specifically mammals, birds, amphibians, and reptiles since there are no waterbodies at the project site) and their classification as threatened in accordance with IUCN Red List, nationally protected according to the schedules of the Wildlife (Preservation) Act 1972 and amendments), endemic etc.

(iv) Forest resources, wetlands, protected areas, key biodiversity areas, if any, in the study area and their status.

(v) Other areas which are important and/or sensitive for ecological reasons including wildlife migratory corridors/avian migratory routes, breeding, nesting, foraging, resting, over wintering areas etc.

(vi) Potential critical habitat triggers including threatened species found in the study area, especially any associated with the project site to determine if critical habitat is supported.

154. The biological baseline assessment methodology adopted included:

(i) Desktop Review of Secondary Data: a desktop review of existing published materials and documents was conducted to help determine the floral and faunal assemblage in the study area (PAI), distribution of forest resources, protected areas etc. This included a 50km IBAT analysis, attached as **Annexure 9.**

(ii) Site Visit and Ecological Survey: following a site visit to scope requirements, seasonal ecological surveys were conducted by MITCON, supervised by ADB TA Ecological Expert through May to November 2021. Details of the surveys and methods used are attached in **Annexure 10.**

(iii) Consultation: discussion with Forest Range Officer, Beat Officer, and villagers to help determine the floral and faunal assemblage in the study area, and the presence of ecologically important/sensitive areas. The Principal Chief Conservator of Forest (PCCF) come Chief Wildlife Warden (CWLW) and Head of the Forest Force (HoFF) was met at Aranya Bhawan, Agartala on 16th March 2021.

2. Results and Observations

2.1. Forests, Wetlands, Protected and Key Biodiversity Areas

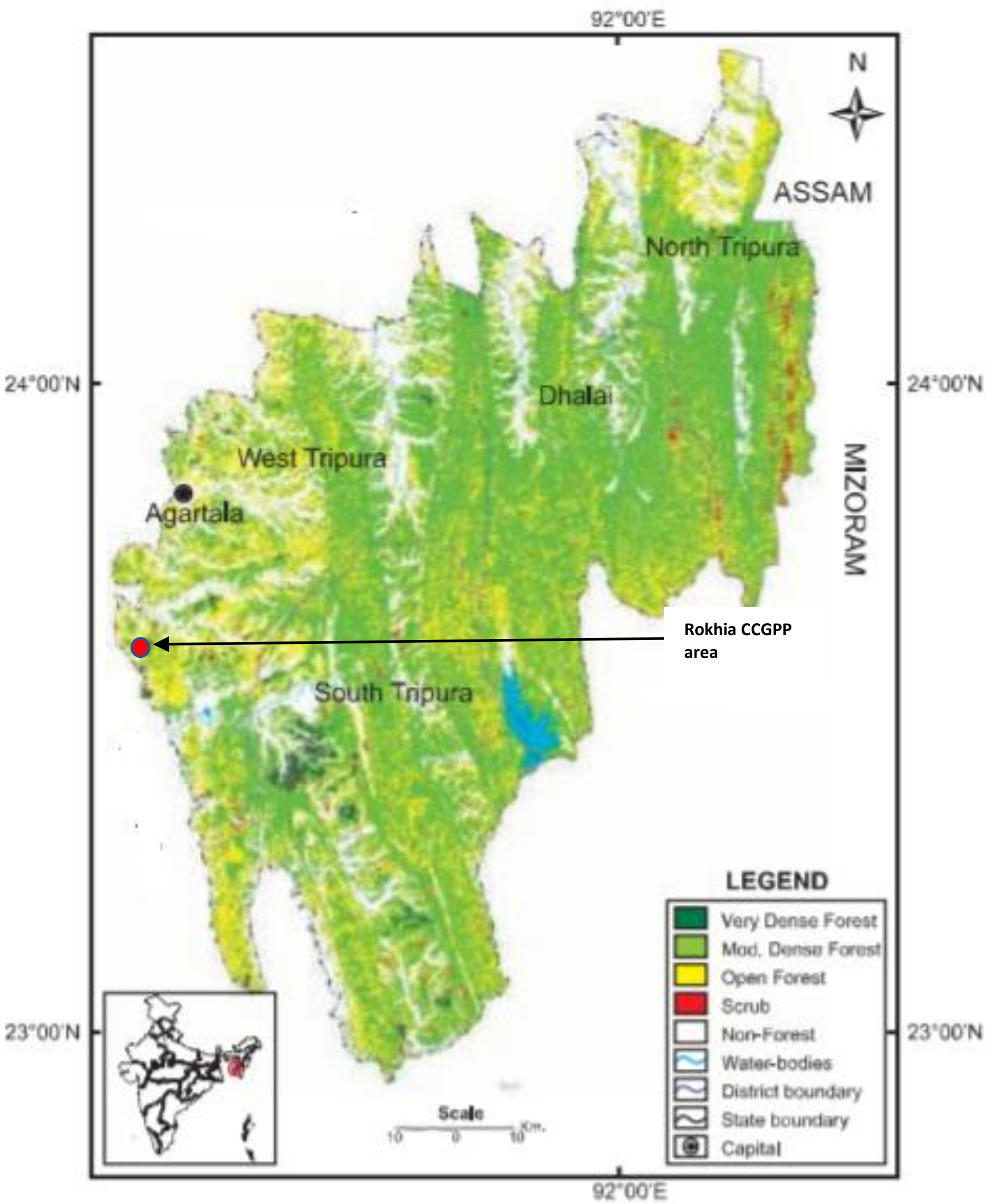
155. **Forests.** The official recorded forest area of the state of Tripura is 6294 km^2 which constitutes 60.02% of its geographical area. Of this 4,175 km^2 is Reserved Forest, 2 km^2 is Protected Forest and 2,117 km^2 is Unclassed Forest. However, 2017 satellite data interpretation shows there may be 7,725.59 km^2 of forest covering 73.68% of the geographical area with only 653.1 km2 being very dense forest, 5,235.19 km^2 being moderately dense forest, and 1,835.89 km^2 being open forest. The forests are mainly tropical evergreen, semi evergreen, and moist deciduous. As per the Champion & Seth Classification of Forest Types (1968), the forests in Tripura belong to two groups which are then further divided into five natural forest types plus plantation.

156. Natural forest habitat making up Boxanagar Range is found across the study area. It mostly supports open forest habitat which has been modified to varying degrees with the largest contiguous area of forest habitat being found to the south and southeast, about 5 km from the

project site as shown in Figure 4-1. There is a patch of social forestry near Boxanagar, at about 2.5 km from the project site.

157. The project site supports degraded natural forest habitat but is not designated as Reserve Forest, although a portion of the land was historically converted from Reserve Forest to industrial land from the forest department. TSECL originally received forest clearance for conversion of 14.0 ha Reserve Forest vide letter D.O. No. 8-66/92-FC dated 15th December 1992. The Principal Conservator of Forests - Tripura issued a letter to TSECL for use of 2.04 ha additional forest land for non-forestry purpose vide letter No. F.18-12/For-86/34790 dated 11th November 1993. Thus, TSECL historically diverted a total of 16.04 ha designated forest land under Sepahijala Forest Division, for setting up the Rokhia Thermal Power Station which is now owned and operated by TPGL. Copies of the land transfer records are attached to **Annexure 11**. Outside of the project site, there are no designated Reserve Forests within the 10km study area (PAI).

Figure: 4-1: Tripura Forest Cover Map showing Project Area



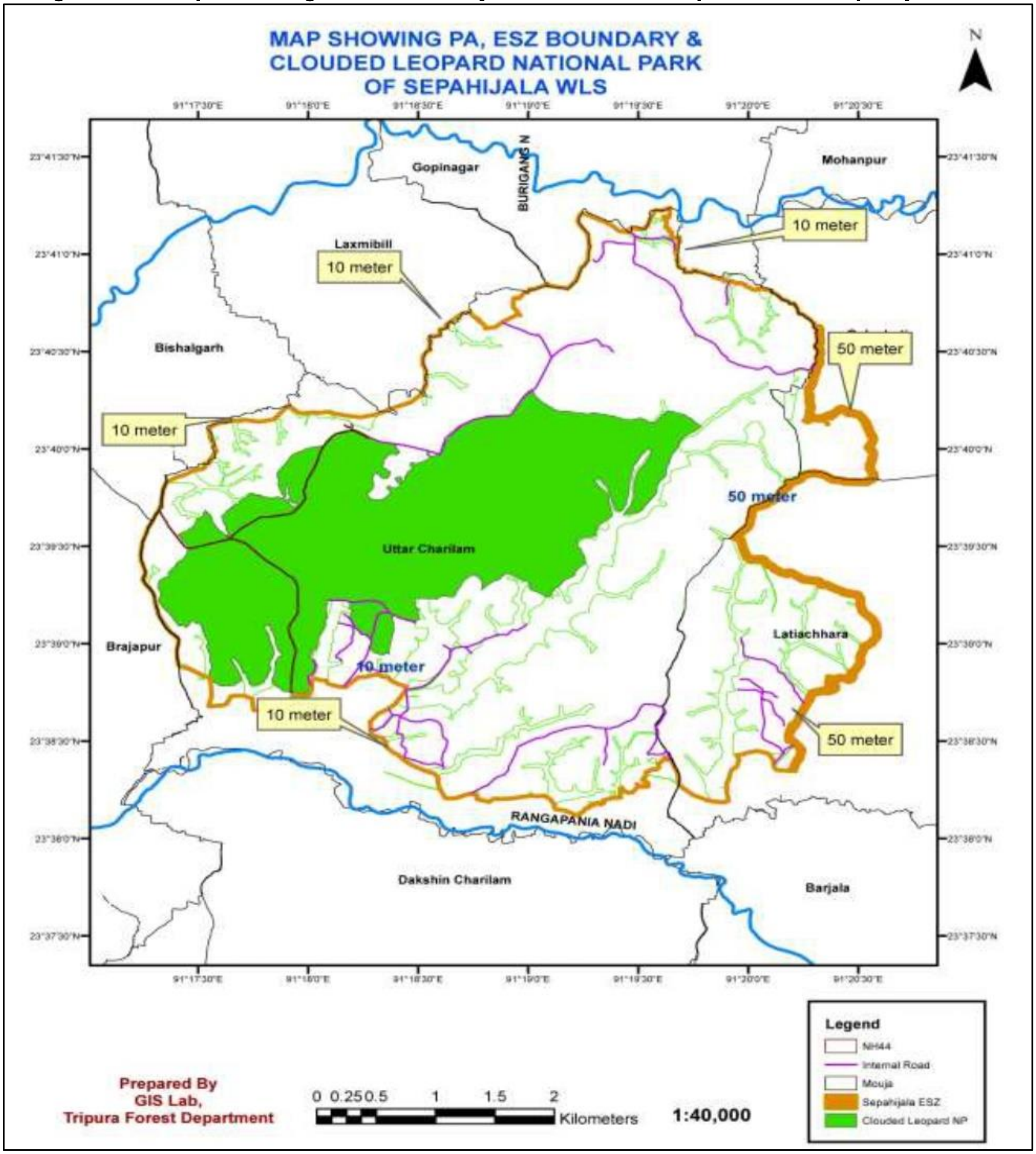
Source: https://fsi.nic.in/cover_2011/tripura.pdf

158. **Wetland.** There are numerous rivers and streams in Tripura supporting inland wetland habitat. According to the National Wetland Atlas, there are 432 wetlands covering an area of 14,559 ha. These wetlands vary in size from 2.5 ha and are categorized as: Lakes/ponds, Oxbow lakes, Waterlogged (seasonal), Reservoirs, and Tanks. Besides these there are large numbers of water harvesting structures found. Boxanagar range (which includes Rokhia) does not have any wetlands. No declared wetlands are recorded in the study area although numerous small ponds and reservoirs are found along with two lakes within 3 km of the proposed plant.

159. **Protected and Key Biodiversity Areas.**[46] Wildlife in Tripura is given protection through a network of four Wildlife Sanctuaries namely Sepahijala Wildlife Sanctuary (WLS), Trishna WLS, Gumti WLS, and Rowa WLS and two National Parks (NP), Clouded Leopard National Park and Bison / Rajbari National Park. The nearest to the project site is Sepahijala WLS at 10.5 km, within which sits the Clouded Leopard NP. The ecological sensitivity zone (ESZ) map of Sepahijala WLS and Clouded Leopard NP has been notified through a gazette notification issued by the MoEF&CC. It extends 10m from the WLS on all sides except the eastern boundary where it extends 50m (Figure 4.2). Sepahijala WLS also houses the Sepahijala Zoological Park which is engaged in conservation breeding of four endangered species, namely, Payre's langur (*Trachypithecus phayrei*), clouded leopard (*Neofelis nebulosa*), binturong (*Arctitis binturong*) and pig tailed macaque (*Macaca arctoides*).

[46] Key Biodiversity Areas (KBA) are 'sites contributing significantly to the global persistence of biodiversity', in terrestrial, freshwater and marine ecosystems. Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability. KBAs comprise an "umbrella" set of internationally-recognized priority sites for biodiversity that include Important Bird Areas (IBAs) and Alliance for Zero Extinction (AZE) sites. IBAs are priority sites for bird conservation because they regularly hold significant populations of one or more globally or regionally threatened, endemic or congregatory bird species, or highly representative bird assemblages.

Figure 4-2: Map Showing ESZ Boundary and Clouded Leopard NP of Sepahijala WLS

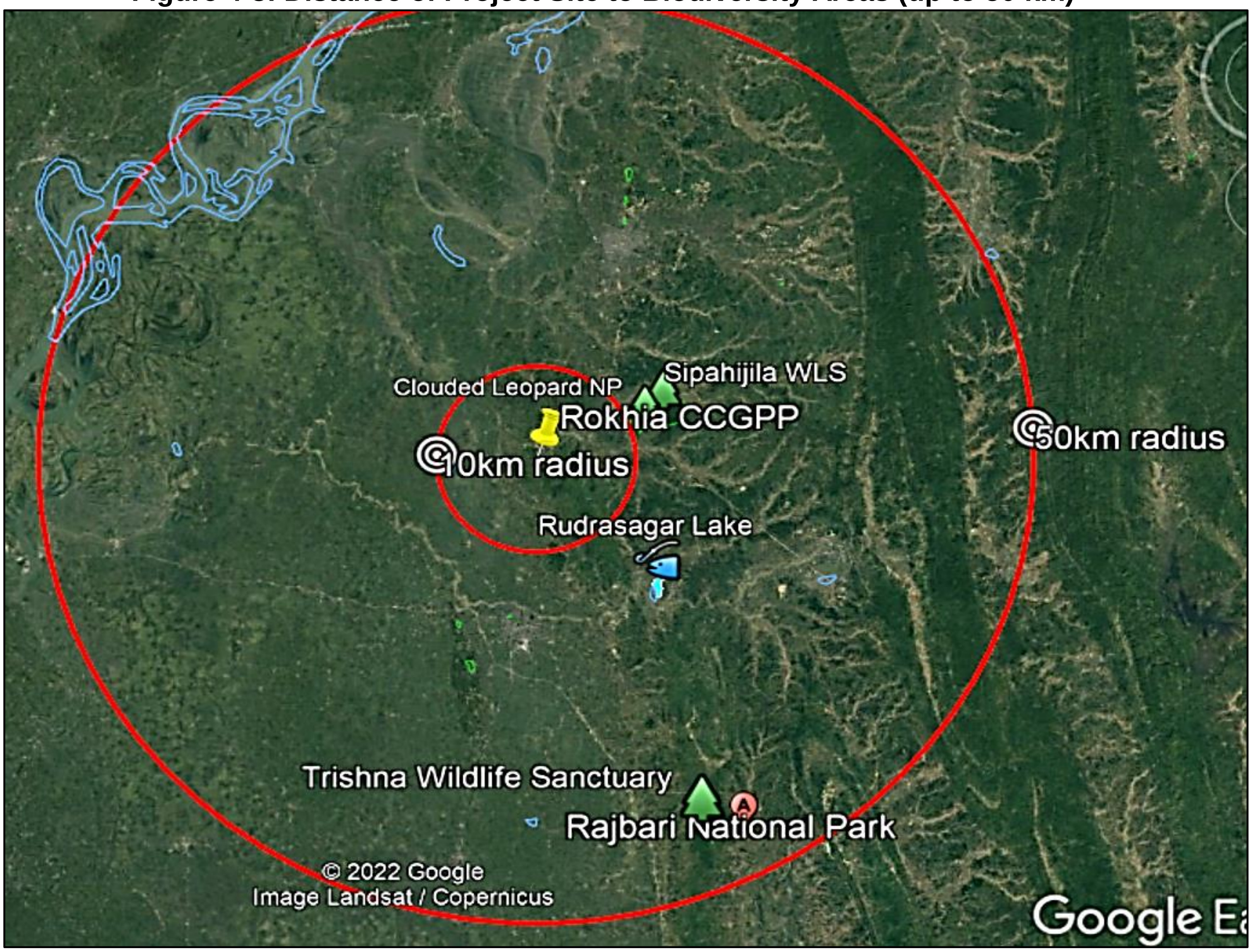


Source: Gazette Notification no. S.O.789(E) of MoEFCC dated 19th February 2021

160. There are no protected areas, declared wetlands of importance (Ramsar sites) or key biodiversity areas within 10km of the project site. This was confirmed from review of secondary data and an IBAT report run for the PAI. The map of the nearest biodiversity areas to the project site is shown as Figure 4-3, the IBAT map outputs in Figure 4-4 although not all protected areas are included in IBAT, and distances to them in Table 4-2.

161. The state of Tripura doesn't have any tiger reserves and there are no tigers reported in the state.[47] The state also does not have any elephant reserves nor are there any elephant corridors in the state.[48] Thus, there are no tiger or elephant corridors in the study area. As per records available only 59 wild elephants are said to be present in Tripura.[49] These elephants are part of two different elephant groups in Khowai and Gomati districts as per records of Forest Department Tripura.

Figure 4-3: Distance of Project Site to Biodiversity Areas (up to 50 km)



Note: Clouded Leopard National Park is within Sepahijala WLS (10.5 km from project site)

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[47] Jhala, Y.V., Qureshi, Q. and Nayak, A.K. (eds) 2020. Status of tigers, copredators and prey in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun.

[48] Right of Passage Elephant Corridors of India, Wildlife Trust of India, (Approved by the State Forest Departments of Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Orissa, Tamil Nadu, Uttaranchal and West Bengal

[49] http://www.wiienvis.nic.in/Database/ElephantReserves_8226.aspx

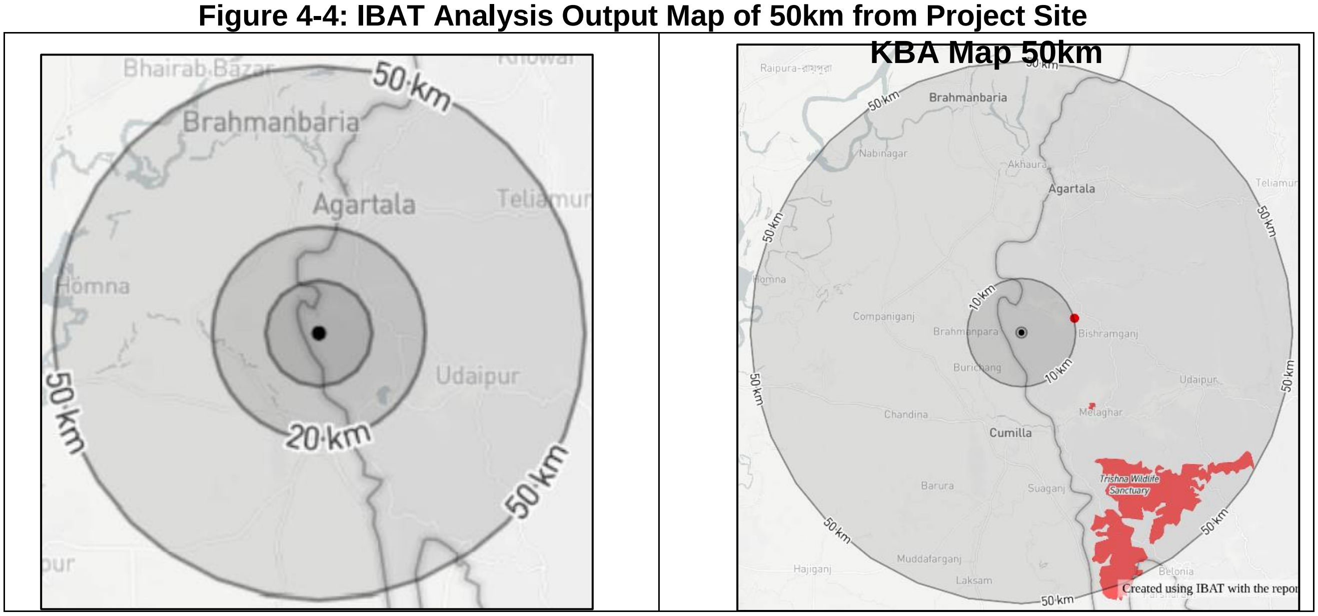
Source: ADB TA Consultant

Table 4-3: Distance of Nearest Biodiversity Areas from Project Site (50 km)

Area	National Status	Distance / Direction (approx. Km)	IUCN Status
Sepahijala WLS	Protected Area (PA) as WLS	10.5 (NE)	Not categorized
Clouded Leopard National Park (within Sepahijala WLS)	PA as NP	10.5 (NE)	Not categorized
Rudrasagar Lake	IBA (IN-TR-03), Ramsar Site	17.5 (SE)	Ramsar Site, Wetland of International Importance (IUCN Management Category Not Reported)
Trishna WLS	PA as WLS KBA, IBA	43.6 (SE)	Not categorized
Bison NP (old name Rajbari NP) (within Trishna WLS	PA as NP	44.0 (SE)	Not categorized

Source: ADB TA Consultant

Figure 4-4: IBAT Analysis Output Map of 50km from Project Site



Source: IBAT/ADB TA Consultant

2.2. Habitat

162. Predominantly four terrestrial habitats are observed within the 10km study area (PAI), which include natural forest habitat, rubber plantation, homestead plantation and agricultural land. The latter three habitats are modified habitat with agricultural land (40.26%) dominating the study area. Only 5.98% of the 10km study area comprises waterbodies – ponds with the nearest 0.8km south of the project site, reservoirs and two lakes. The nearest river is Salda River 3.25 km to the north of the project site.

163. At the project site the terrestrial habitat is mainly natural forest habitat in various states of degradation with some areas cleared, due to use of the site for Rokhia Thermal Power Station. In the immediate surroundings up to 1km, habitat also comprises agricultural land (27.18%) and waterbodies (0.96%).

164. **Habitats of Socioeconomic Value/ Ecosystem Services Provision.** Natural forest habitat in Tripura has social, economic, and cultural values as it provides ecosystem services including timber, fuel, thatch, fodder, bamboo, edible fruits and tubers, medicinal plants etc.

2.3. Flora and Fauna

2.3.1. IBAT and Flora/Fauna Screening

165. IBAT provides a basic risk screening on flora and fauna that may be of interest. It draws together globally recognized biodiversity information from several IUCN knowledge products including the IUCN Red List of Threatened Species. A detailed list of species (50 km) is provided in **Annexure 9.** Of particular note, IBAT identified 14 critically endanged and 29 endangered species who range overlaps with a 50km radius from the project site although that does not mean that they are actually supported by it. This list of species was used to inform further desk based research, surveys, and consultations to identify those species that are supported.

166. It was intimated by Boxanagar forest officer that the Rokhia Thermal Power Station houses rhesus macaque (*Macaca mulatta*) and Pallas's squirrel (*Callosciurus erythraeus*), besides various species of snakes, birds, and amphibians and records do not document the presence of any globally critically endangered/endangered or Scheduled I (under the (Protection) Act 1972) species. The available forest and wildlife records that were accessed and the officials consulted also do not suggest the presence of any globally endangered / critically endangered or Schedule I (under WL Act) species within the project site. It was clarified by the forest official that the following critically endangered / endangered species that were listed under the IBAT analysis have either not been observed or found within the wider study area (PAI):

(i) *Indotestudo elongate* (Elongated Tortoise)
(ii) *Batagur dhongoka* (Three-striped Roofed Turtle)
(iii) *Aythya baeri* (Baer's Pochard)
(iv) *Houbaropsis bengalensis* (Bengal Florican)
(v) *Emberiza aureola* (Yellow-breasted Bunting)
(vi) *Gyps bengalensis* (White-rumped Vulture)

2.3.2. Floral diversity of study area

167. **Recorded Flora.** Floral survey was undertaken in June 2021. 222 floral species were identified to be supported in the study area of 10 km. Plant diversity in the core area of 2 km was considered moderate with 30 tree and 46 herbaceous species recorded by quadrat surveys. The Plant-Diversity Index (Shannon-Weiner) reported is 2.91. Out of the total floral species in the 10 km area, 22 are invasive species and 11 of these are within the 2 km area. 15 of the total 22 species are alien while the rest 6 have a native range in India and there is no information on the distribution for 1 species. 5 species out of the 222 species are threatened as per IUCN (1 critically endangered and 4 vulnerable species). Further details of the ecology assessment and list of species in the study area is given in **Annexure 10**.

Table 4-3: List of Invasive Species within 10km

Sl. No.	Botanical Name	Common Name	Class	IUCN Status	Invasive	Range (ref to India)
1	*Abrus precatorius* L.	Rosary Pea / Burmann's Spider Flower	Herb	NE	Yes	Native
2	*Ageratum conyzoides* L	Goat weed	Herb	NE	Yes	Alien
3	*Alternanthera philoxeroides* (Mart.) Griseb.	Alligator Weed	Herb	NE	Yes	Alien
4	*Bacopa monnieri* (L.) Wettst.	*Brahmi*	Herb	LC	Yes	Native
5	*Bambusa balcooa* Roxb.	-	Grass / Bamboo	NE	Yes	Alien
6	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Siam Weed	Herb	NE	Yes	Alien
7	*Cynodon dactylon (L.) Pers.*	Bermuda grass	Herb	NE	Yes	Alien
8	*Eichhornia crassipes* (Mart.) Solms	Water Hyacinth, *Jal Kumbhi*	Herb	NE	Yes	Alien
9	*Hydrilla verticillata* (L.f.) Royle	Water Thyme	Herb	LC	Yes	Native
10	*Ipomoea aquatica* Forssk.	Water Morning Glory	Herb	LC	Yes	Native
11	*Lantana camara* L.	Lantana	Herb	NE	Yes	Alien
12	*Litsea glutinosa* (Lour.) C.B.Rob.	Indian Laurel	Tree	LC	Yes	No info
13	*Livistona chinensis* (Jacq.) R.Br. ex Mart.	Chinese fan palm	Palm	NE	Yes	Alien
14	*Melia azedarach* L.	Meliaceae	Tree	LC	Yes	Native
15	*Mimosa pudica* L.	Shameplant	Herb	LC	Yes	Alien
16	*Parthenium hysterophorus* L.	Congress grass	Herb	NE	Yes	Alien
17	*Pistia stratiotes* L.	Water Cabbage	Herb	LC	Yes	Alien
18	*Psidium guajava* L.	Guava	Tree	LC	Yes	Alien
19	*Ricinus communis* L.	The castor bean	Herb	NE	Yes	Alien
20	*Sagittaria sagittifolia* L.	Chinese Arrowhead	Herb	LC	Yes	Alien
21	*Solanum torvum Sw.*	Turkey Berry	Herb	NE	Yes	Alien
22	*Syzygium cumini* (L.) Skeels	Jamun	Tree	LC	Yes	Native

Source: ADB TA Consultant, Analysis from Primary Data

168. **Tree Enumeration**. 33 tree species are found to be directly affected in the project footprint covering 249 individuals based on enumeration at the proposed site. Among them, the most impacted species is *Shorea robusta* with 48 number of individuals followed by 36 number of *Ficus auriculata.* The least impacted species are *Acacia auriculiformis, Cassia fistula, Ficus amplissima, Gmelina arborea, Melia azedarach & Mimusops elengi* with one individual each. All tree species that shall be felled are globally of least concern. Further details of the ecology assessment and list of species in the study area is given in **Annexure 10.**

169. **Threatened and Endemic Species**. Of the 222 flora species identified, 5 threatened species 4 are vulnerable (VU) and 1 Critically Endangered (CR) as per IUCN were recorded in the study area. There are no endemic species in the study area. Even though there are 5 threatened species within the 10 km area the number of individuals will not trigger critical habitat as summarized in Table 4-4.

Table 4-4: **Threatened Species**

Species	**Global (National) Red List Status**	**Discussion**	**Recorded in Project Footprint**
Agarwood *Aquilaria malaccensis*	CR	It is widespread species in South and South-East Asia, the global population is at threat but not known. In India it is mostly found in the foothills of North-East India and West Bengal. In Tripura Agarwood is mostly confined to Kadamtala Block of North Tripura District, Khowai Subdivision of Khowai District and some pockets of South Tripura and Gomati districts. In non-forest areas total number of trees is estimated at more than 5 million covering about 2000 ha of private plantation, almost 99% of this is concentrated in North Tripura.[50] Given this statewide distribution, in terms of global population the study area is not considered likely to meet thresholds for critical habitat. No individuals were recorded within the transects and quadrats that were drawn in the project area and in 2 km radius. A few individuals were noted to be sparingly present within 10 km radius (PAI) in both private and government lands	No
Sandalwood *Santalum album*	VU	It is widespread species in South and South-East Asia, the global population is at threat but not known. In India although found across the country nearly 98% of the sandalwood area is found in Karnataka and Tamil Nadu.[51] Given this distribution, and as a VU species, the study area is not considered to meet thresholds for critical habitat. No individuals were recorded within the transects and quadrats that were drawn in the project area and in 2 km radius. A few individuals were noted to be sparingly present within the PAI	No
Sita Ashok *Saraca asoca*	VU	This is an important medicinal plant that is widespread across India and Sri Lanka, the global population is at threat but not known. In India the original range is primarily in the Deccan Plateau and south and central Western Ghats, though it is commonly found across the country. However, as a VU species that was	Yes

[50] https://jica.tripura.gov.in/jica/retreiveimg3?ids=25
[51] https://www.researchgate.net/publication/326294915_Sandalwood_farming_in_India_problems_and_prospects

Species	Global (National) Red List Status	Discussion	Recorded in Project Footprint
		infrequently encountered during surveys the study area is unlikely to meet thresholds for critical habitat. Only 1 individual of the species was identified in the quadrats that were laid in the project area	
African Mahogany *Khaya senegalensis*	VU	It is a non-native tree to India imported from Africa for plantation, thus it is not considered further in terms of critical habitat screening. 7 individuals of the species were identified in the quadrats that were laid in the project area	Yes
Garjan *Dipterocarpus turbinatus*	VU	It is widespread species in South and South-East Asia, the global population is at threat but not known. In India although found in several states including Tripura there is limited information on its distribution. However, as a VU species the study area is unlikely to meet thresholds for critical habitat. No individuals were recorded in the transects and quadrats that were laid in the project area and in 2 km radius. A few individuals were noted to be sparingly present within PAI	No

Source: ADB TA Consultant

170. **Protected Species**. Wildlife (Protection) Act 1972 prohibits picking, uprooting, damaging, destroying, acquiring, or collecting six species of plants from forest land and any area specified, by notification, by the Central Government [Clause 17A of Chapter IIIA (Protection of Specified Plants), page 346 of Handbook Vol. 1]. The six species are: Beddome's cycad (*Cycas beddomei*), Blue Vanda (*Vanda coerulea*), Kuth (*Sassurea lappa*), Ladies slipper orchids (*Paphiopedilum* spp.), Pitcher plant (*Nepenthes khasiana*), Red Vanda (*Rananthera imshootiana*). None of the six species are recorded / reported from the study area.

171. **Species of Socioeconomic Value**. Tripura has one of the oldest, richest, and most diverse cultural traditions associated with use of medical plants. There are large number of village-based herbal medicines practitioners who have traditional knowledge of herbal home remedies of ailments and nutrition. Statewide there are 266 species of medicinal plants (68 trees, 39 shrubs, 71 herbs and 88 climbers) although herbal medicines used by rural people including tribal have not yet been documented. Timber, bamboo, and cane also play a very vital role in the economy as they serve the artisan and non-artisan users. The subsidy that flows to the rural economy on account of removal of timber, fuel, thatch, fodder, and bamboo forest produce has been conservatively estimated to be Rs. 12,926 lakhs, about 5.57% of State Domestic Product, not considering edible fruits, tubers, medicinal plants, and many other non-timber forest products. Several traditional medicinal species are found in the PAI along with 6 species of bamboo and at least 2 major timber species besides a number of fruit bearing and fuel wood species.

2.3.3. Faunal diversity of study area

172. **Recorded Mammals, Birds, Amphibians and Reptiles.** Fauna survey was undertaken in the post monsoon season in 2021 (October – November 2021). 141 faunal species were identified to be supported in the study area, of these:

(i) 9 species of mammals were identified and Pallas's Squirrel *(Callosciurus erythraeus*) a globally least concern species was the most common mammalian species that was observed and heard during the surveys. The project site was observed to be used by Rhesus macaque (*Macaca mulatta*) monkeys moving across the study area, these are globally least concern as per their IUCN conservation status and,

(ii) 58 bird species were recorded & all the avian species are of globally least concern except 1 which is globally near threatened status (Red Breasted Parakeet *Psittacula alexandri)*

(iii) 10 herpetofauna species (3 amphibians and 7 reptiles) were recorded. Out of the amphibians the Asian common toad (*Duttaphrynus melanostictus*) a globally least concern species and Indian Skipping Frog (*Euphlyctis cyanophlyctis*) a globally least concern species were the most visible species while tokay gecko (*Gekko gecko*), reptilian species and a globally least concern species was the most common species

(iv) 26 butterflies, 15 species of moths and 7 dragonfly species were also recorded all of which were at most least concern.

173. Further details of the ecology assessment and list of species in the study area is given in **Annexure 10.**

Table 4-5: Class wise Faunal Species Present in the Study Area

Sl. No.	Faunal Class	Number of Species observed / recorded		
		Within 2 km radius during Transect surveys	Within 2 – 10 km radius	Total Species in Study Area
1	Insect (Butterflies)	26	-	26
2	Insect (Moths)	15	-	15
3	Insect (Dragonflies)	7	-	7
4	Insect (Others)	16	-	16
5	Herpetofauna	10	-	10
6	Aves	43	15	58
7	Mammal	8	1	9
Total Species		**125**	**16**	**141**

Source: Primary Survey by MITCON

174. **Threatened, Endemic, Migratory and Congregatory Species;** 1 Near threatened (NT) bird species and 1 vulnerable (VU) mammalian species as per IUCN have been identified from surveys of the project footprint. No critically endangered (CR) or endangered (EN) species has been recorded. However, there is potential for 1 threatened (vulnerable) species which might trigger critical habitat to be found in the wider study area, as summarized in Table 4-6 – this species is Capped Langur (*Trachypithecus pileatus*), these are mainly migrants coming in search of food from the nearby protected areas and forest habitat. There is no reported man – animal conflict in the Boxanagar range, as per official forest and wildlife reports that were accessed.

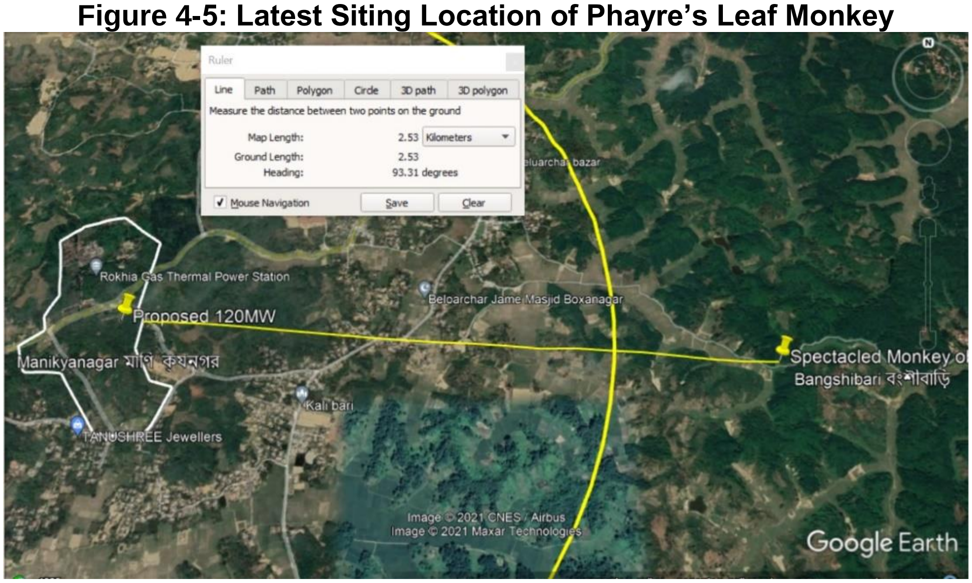
Table 4-6: Faunal Species as per Global Status present in the Study Area

Sl. No.	Faunal Class	NE	LC	NT	VU	EN	CR	Total Species in Study Area
1	Insect (Butterflies)	19	7	-	-	-	-	26
2	Insect (Moths)	15	-	-	-	-	-	15
3	Insect (Dragonflies)	-	7	-	-	-	-	7
4	Insect (Others)	15	1	-	-	-	-	16
5	Herpetofauna	1	9	-	-	-	-	10
6	Aves	3	54	1	-	-	-	58
7	Mammal	-	8	-	1	-	-	9
Total Species		**53**	**86**	**1**	**1**	**-**	**-**	**141**

Source: Primary Survey by MITCON

175. Given that the study area supports possible Critical Habitat, particular attention has been paid to the distribution of Phayre's Leaf Monkey (*Trachypithecus phayrei*) given its globally endangered status, it is also the Tripura State Animal and a Schedule 1 species under the Indian Wildlife Protection Act, 1972. According to the IUCN, Phayre's Leaf Monkey is listed as globally endangered as it is suspected to have undergone a decline of more than 50% over the last three generations (36 years, given a generation length of 12 years), due to a combination of habitat loss and hunting. As per meeting with Boxarnagar Range Forest Officer, the species is primarily restricted to Sepahijala WLS, which is one of the few locations where the species can be regularly spotted. Rarely once or twice in a year they are reported / observed outside in the rubber plantation areas seeking food. They have grown fond of and adapted to rubber as food. Troops are also sometimes reported / sited in the Boxarnagar Social Forest area, which is around 2.5 km from the project site. The latest official siting was at a location approximately 2.53 km away from the project site by the Forest Department on 23 October 2021. As discussed during the scoping public consultation and with TPGL staff, they have not seen the species since last 30 years in the immediate project site and surroundings. No siting of the Phayre's Leaf Monkey was made during the EIA survey work. Therefore, although the study area supports Critical Habitat for Phayre's Leaf Monkey the extent of this does not extend to the project footprint.

Figure 4-5: Latest Siting Location of Phayre's Leaf Monkey



Source: Tripura Forest Department Record, ADB TA Consultant

Table 4-7: Threatened Species

Species	Global (National) Red List Status	Discussion	Recorded in Project Footprint
Phayre's Langur or Phayre's leaf monkey *(Trachypithecus phayrei)*	EN (Schedule 1)	Found across North-East India, Bangladesh, and Myanmar but global population is not recorded. In India and Bangladesh populations are small and highly fragmented – estimated 1200 individuals in India and 376 in Bangladesh. There is no population information for Myanmar. The home range of the species can be up to 100 ha, depending on troop size, with little overlap between the troops. If food resources are limited larger groups will increase the size of their home range in search of food. Recorded in Sepahijala WLS (1,853 ha) just outside study area, 132 individuals who may also venture into the study area. This is 8.7% of the known population thus Sepahijala WLS would be considered a definite critical habitat for this species. Given that troops (one troop of 8-22 would be >0.5% of the known population, they are comprised of 1 male, 3-6 adult females, plus sub-adults, juveniles and infants) are occasionally using land up to 10km outside of the sanctuary the study area is considered to support possible Critical Habitat for Phayre's Leaf Monkey.	No
Capped Langur *(Trachypithecus pileatus)*	VU (Schedule 1)	Four subspecies found across India, Bangladesh, Bhutan, and Myanmar with a possible population in People's Republic of China, but global population is not recorded. It is most common in North-East India, in Assam population of 18,600 was recorded. Recorded in Sepahijala WLS just outside study area, 59 individuals (this is <0.5% of the known North-East Indian population, it will be even less of the global population). Presence has been reported in 2km range around the proposed plant as per consultations with the public and the forest officials. A solitary capped langur was observed 0.53 km from the project site. However, as a VU species that was infrequently encountered during field surveys the study area does not meet the thresholds for critical habitat.	Potentially present, the forest officials and the public reported that the troops of the capped langur are occasional visitors from nearby forest areas; but they are not resident at the project site.

Species	Global (National) Red List Status	Discussion	Recorded in Project Footprint
Northern Pig Tailed Macaque *(Macaca leonina)*	VU (Schedule II part I)[52]	Found from North-East India across Southeast Asia, but global population is not recorded. In India, the population is <1,500 individuals; the only other population estimate is <1,700 from People's Republic of China. Recorded in Sepahijala WLS just outside study area, 42 individuals (2.8% of the North-East Indian population, it will be less of the global population). As this is an important concentration of globally vulnerable species the sanctuary itself would be critical habitat. However, the species was not encountered during surveys in the study area (which does not include the sanctuary) and it is unlikely to meet thresholds for critical habitat.	No
Clouded Leopard (*Neophelis nebulosa*)	VU (Schedule 1)	Found across South and Southeast Asia, with a global population of 3,700-5,580. Population density estimates vary from 0.3-5.14 individuals per 100 km^2. The Clouded Leopard NP has been declared in 5.08 Km^2 within the core area of Sepahijala WLS in January 2008. The last census in 2013-14 reported 5 individuals in the national park. The Sepahijala Zoological Park within the Sepahijala WLS runs a breeding programmed for the species and 10 individuals were reported at the breeding center in on 31st March 2019. The animal is arboreal & nocturnal and not observed in study area. Based on the population density estimates the study area may support 3-4 individuals (<0.5% of the population), which is very unlikely given the low numbers within the protected area, itself. Considering this is a VU species the study area does not meet thresholds for critical habitat.	No

Source: ADB TA Consultant

176. At least 370 species of migratory birds from the Central, East, and West Asian flyways are reported to visit the Indian subcontinent, of which 310 predominantly use wetlands as habitats, the rest being land birds, inhabiting dispersed terrestrial areas. North-Eastern India and thus the project site falls within the outer edges of two flyways. The Central Asian Flyway (CAF) links northern most breeding grounds in Russia (Siberia) to southernmost non-breeding (wintering) grounds in West and South Asia, the Maldives, and the British Indian Ocean Territory. India has a strategic role in this flyway as it provides critical stopover sites to over 90% of the bird species known to use this migratory route. The East Asian - Australasian Flyway (EAAF) stretches from the Russian Far East and Alaska, southwards through East Asia and South-east Asia, to Australia and New Zealand. 58 bird species were recorded in the study area

[52] Schedule II Part I species are protected by the act but are not threatened or endangered

and none are reported to be migratory or congregatory species. The nearest IBA and Ramsar site is Rudrasagar Lake at 17.5 km distance and there are no wetlands within the study area that can support significant concentrations of aquatic migratory bird species.

177. **Protected Species.** A total of 2 Schedule I species, 3 Schedule II (part I) species, 4 Schedule II (part II) species, 1 Schedule III and 39 scheduled IV species were recorded during the primary surveys in the project area. As per Wildlife Protection Act, 1972, Schedule I and II (part II) species are provided the highest degree of protection and any harm to these species are severely dealt with. These species are considered to be threatened and normally are keystone species and national parks, sanctuaries reserves (Protected Areas) are declared for the conservation and protection of these species. The levels of punishment for causing harm to Schedule III and IV species are much lower but these species are also protected under the act. Capped Langur (*Trachypithecus pileatus)* a globally vulnerable animal and Common Pierrot (*Castalius rosimon)*, which is globally not evaluated species are two Schedule I species that have been recorded in the study area. Chequered keelback (*Xenochrophis piscator / Fowlea piscator)* a globally least concern snake, Dhaman or Common Rat snake (*Ptyas mucosus*) a globally not evaluated snake, Indian Cobra (*Naja naja*) another globally least concern snake, and Bushbrown (*Mycalesis* sp.) a globally least concern butterfly species which are protected under Schedule II (Part II) of the Wildlife Protection Act, 1972 have been recorded in the project area (Table 4-8).

Table 4-8: Scheduled Species in Project Area

Sl. No.	Common Name	Scientific Name	Class	Conservation Status	
				WPA	IUCN
1	Capped Langur	*Trachypithecus pileatus* (Blyth)	Mammal	Schedule I	VU
2	Common Pierrot	*Castalius rosimon* (Fabricius)	Insect (Butterflies)	Schedule I	NE
3	Rhesus Macaque	*Macaca mulatta mulatta* (Zimmermann)	Mammal	Schedule II (Part I)	LC
4	Small Indian Mongoose	*Herpestes auropunctatus birmanicus* Thomas	Mammal	Schedule II (Part I)	LC
5	Asiatic Jackal	*Canis aureus indicus* Hodgson	Mammal	Schedule II (Part I)	LC
6	Chequered keelback	*Xenochrophis piscator (Schneider) / Fowlea piscator*	Reptile	Schedule II (Part II)	LC
7	Dhaman or Common Rat snake)	*Ptyas mucosus* (Linnaeus)	Reptile	Schedule II (Part II)	NE
8	Indian Cobra	*Naja naja* (linnaeus)	Reptile	Schedule II (Part II)	LC
9	Bushbrown sp	*Mycalesis sp*	Butterfly	Schedule II (Part II)	LC
10	Wild Boar*	*Sus scrofa cristatus* Wagner	Mammal	Schedule III	LC
11	Black-hooded Oriole	*Oriolus xanthornus* (Linnaeus, 1758)	Aves	Schedule IV	LC
12	Black Drongo	*Dicrurus macrocercus* Vieillot, 1817	Aves	Schedule IV	LC
13	Lesser Racquet-tailed Drongo	*Dicrurus remifer* (Temminck, 1823)	Aves	Schedule IV	LC
14	Greater Racket-tailed Drongo*	*Dicrurus paradiseus* (Linnaeus, 1766)	Aves	Schedule IV	LC
15	Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	Aves	Schedule IV	LC

Sl. No.	Common Name	Scientific Name	Class	Conservation Status	
				WPA	IUCN
16	Lineated Barbet	*Megalaima lineata* (Vieillot, 1816) / *Psilopogon lineatus*	Aves	Schedule IV	LC
17	Spotted Dove	*Streptopelia chinensis* (Scopoli, 1786)	Aves	Schedule IV	NE
18	Oriental Turtle Dove	*Streptopelia orientalis* (Latham, 1790)	Aves	Schedule IV	LC
19	Red Collared Dove	*Streptopelia tranquebarica* (Hermann, 1804)	Aves	Schedule IV	LC
20	Eurasian Collared Dove *	*Streptopelia decaocto* (Frivaldszky, 1838)	Aves	Schedule IV	LC
21	Yellow Footed Green Pigeon	*Treron phoenicoptera* (Latham, 1790)	Aves	Schedule IV	LC
22	Rufous Treepie/ Indian Treepie	*Dendrocitta vagabunda* (Latham, 1790)	Aves	Schedule IV	LC
23	Common Myna	*Acridotheres tristis* (Linnaeus, 1766)	Aves	Schedule IV	LC
24	Jungle Myna*	*Acridotheres fuscus* (Wagler, 1827)	Aves	Schedule IV	LC
25	Chestnut Tailed Starling	*Sturnus malabaricus* (Gmelin, 1789)	Aves	Schedule IV	LC
26	Asian Pied Starling	*Sturnus contra* Linnaeus, 1758	Aves	Schedule IV	NE
27	Indian Pond-Heron	*Ardeola grayii* (Sykes, 1832)	Aves	Schedule IV	LC
28	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	Aves	Schedule IV	LC
29	Median Egret*	*Mesophoyx intermedia* (Wagler, 1829)	Aves	Schedule IV	NE
30	Little Egret*	*Egretta garzetta* (Linnaeus, 1766)	Aves	Schedule IV	LC
31	Common Indian Nightjar	*Caprimulgus asiaticus* Latham, 1790	Aves	Schedule IV	LC
32	White-breasted Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	Aves	Schedule IV	LC
33	Small Blue Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	Aves	Schedule IV	LC
34	Little Cormorant	*Phalacrocorax niger* (Vieillot, 1817) / *Microcarbo niger*	Aves	Schedule IV	LC
35	Common Iora	*Aegithina tiphia* (Linnaeus, 1758)	Aves	Schedule IV	LC
36	Fulvous Breasted Woodpecker	*Dendrocopos macei* (Vieillot, 1818)	Aves	Schedule IV	LC
37	Rufous Woodpecker	*Celeus brachyurus* (Vieillot, 1818)	Aves	Schedule IV	LC
38	Lesser Goldenback	*Dinopium benghalense* (Linnaeus, 1758)	Aves	Schedule IV	LC
39	Scally Breasted Munia / Spotted Munia	*Lonchura punctulata* (Linnaeus, 1758)	Aves	Schedule IV	LC
40	Indian Roller	*Coracias benghalensis* (Linnaeus, 1758)	Aves	Schedule IV	LC
41	Rose Ringed Parakeet	*Psittacula krameri* (Scopoli, 1769) / Alexandrinus krameri	Aves	Schedule IV	LC
42	Red Breasted Parakeet	*Psittacula alexandri* (Linnaeus, 1758)	Aves	Schedule IV	NT

Sl. No.	Common Name	Scientific Name	Class	Conservation Status	
				WPA	IUCN
43	Common Cuckoo*	*Cuculus canorus* (Linnaeus, 1758)	Aves	Schedule IV	LC
44	Purple-rumped Sunbird*	*Nectarinia zeylonica* (Linnaeus, 1766)	Aves	Schedule IV	LC
45	Rain Quail*	*Coturnix coromandelica* (Gmelin, 1789)	Aves	Schedule IV	LC
46	Indian Flying Fox	*Pteropus giganteus giganteus* (Briinnich)	Mammal	Schedule IV	LC
47	House Mouse	*Mus musculus castaneus* Waterhouse	Mammal	Schedule IV	LC
48	Common Crow	*Euploea core* (Cramer)	Butterfly	Schedule IV	LC
49	Western Stripped Albatross	*Appias libythea* Fabricius	Butterfly	Schedule IV	NE

NE: Not Evaluated, VU: Vulnerable
* Outside 2 km from project site
Source: Primary Survey by MITCON

178. **Species of Socioeconomic Value.** Phayre's leaf monkey which is the Tripura state animal is the most important species that is reported in the study area. Indian Cobra, whose poison is extracted for medicinal purpose in authorized institutes (though none in the project area) and is also used by snake charmers as a show animal is the other socially and economically important animal that is reported in the study area. Various birds whose feathers are used economically (egrets), provide scavenging services (crows, kites), are used as pets illegally in India (parakeets, mynas etc.) are also reported in the study area. Indian flying fox that serves as a pollinator besides being treated as pest as it feeds on fruits like mangoes and guavas is also reported in the study area.

2.3.4. Critical Habitat Screening

179. The Area of Analysis for screening critical habitat has been taken as the project site and study area, although impacts will generally be restricted to within 500 m of the project footprint. Table 4-9 summaries the findings of critical habitat screening considering IFC Performance Standard 6 thresholds for triggers 1-4. It is concluded that critical habitat for Phayre's Leaf Monkey is supported by the study area but that this is associated with Sepahijala WLS and does not extend to the project footprint.

Table 4-9: Critical Habitat Screening

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Rationale
1. Areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species	(a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units). (b) Areas that support globally important concentrations of an	Yes, possible for Phayre's Leaf Monkey	No protected areas found within study area. Though individuals of CR/EN/VU species may be present in the study area, except for Phayre's Leaf Monkey, concentrations are unlikely to exceed the thresholds for critical habitat as per Tables 4-4 and 4-8. For Phayre's Leaf Monkey the critical habitat is associated with Sepahijala WLS and the extent of this does not extend to the project footprint.

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Rationale
	IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a). (c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.		
2. Areas having special significance for endemic or restricted-range species	Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.	No	No endemic or restricted-range species recorded during flora and fauna surveys.
3. Sites that are critical for the survival of migratory species	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. (b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.	No	No biological corridors, IBA or migratory species found within study area.
4. Areas supporting globally significant concentrations or numbers of individuals of congregatory species		No	No IBA, congregatory species found in study area.
5. Areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services		No	Not within biodiversity hotspot, no KBA are found within study area. Ecosystems services are provided by natural forest habitat, but these are not considered to be "key" in the context of triggering critical habitat
6. Areas having biodiversity of significant social, economic, or cultural importance to local communities		Yes, possible for Phayre's Leaf Monkey	Biodiversity associated with natural forest habitat in the study area is of social, economic, and cultural importance to local communities including indigenous peoples; social safeguard specialists have confirmed that this biodiversity is not of "significant" importance to local communities. However, Phayre's Leaf Monkey is the

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Rationale
			state animal so is considered of "significant" importance at the state level.

Source: ADB TA Consultant

2.3.5. Key Biological Aspects

180. Summary of the key biological aspects in the PAI are given in Table 4-10.

Table 4-10: Key Biological features in PAI

- **Habitat type:** project site supports natural forest habitat in varying states of degradation with some area cleared for Rokhia Thermal Power Station that supports the existing plant. In the study area rubber plantation, homestead plantation and agricultural land are also found – these are modified habitat.
- **Nearest Protected Area:** Sepahijala WLS and Clouded Leopard National Park (10.5 km)
- **Nearest Key Biodiversity Area:** Sepahijala WLS (10.5 km)
- **Reserve Forest:** the project site is not designated as forest land. 16.04 ha of Reserve Forest area was diverted for Rokhia Thermal Power Station to be industrial land nearly 30 years ago. There are no recorded Reserve Forests within the 10 km study area.
- **Wetland and Surface Water:** No waterbodies on project site. Study area has ponds, reservoirs and two lakes but no declared wetlands**.** The Salda River is located 3.25 km north of the project site.
- **Trees:** 33 species, 249 trees in total
- **Flora and Fauna:** all species observed at project site of least concern. One CR and four VU tree species, one EN and three VU mammals (one VU in study area)
- **Critical Habitat**: for Phayre's Leaf Monkey is supported by the study area but this species is associated with Sepahijala WLS and does not extend to the project footprint

Source: ADB TA Consultant

C. Physical Environment

1. Introduction

181. The State of Tripura, with a geographical area of 10,491 km^2 is landlocked. It is surrounded by the deltaic basin of Bangladesh except for in the North-East which adjoins Cachar district of Assam and Mizoram. Tirpura is predominantly a hilly region with three distinct physiographic zones (i) hill ranges, (ii) undulating plateau land, and (iii) low-lying alluvial land. About 60% of its land is hilly while the remaining 40% is plain land. Five major hill ranges traverse the state in roughly north-south direction and continue southward into Chittagong Hill Tract. The highest peak lies at Bethliangchhip (Thaidawar, Shib-rangkhung) 975.36 m ASL. Narrow valleys running southeast to northwest separate these ranges generally 20 km wide, they are broad and flat being separated from the adjacent highs with domes and conical peaks. The general altitude of the state varies between 16 m to 600 m ASL.

182. The Tropic of Cancer passes through it, and strong seasonal rhythms are observed with a warm humid tropical climate. Tripura state is well endowed with surface water resources. 10 major rivers are reported to generate an annual flow of 793 million m^3 of water. All the major

rivers originate from hill ranges; they are generally ephemeral in nature and their flow is directly related to the rainfall.

183. The specific objectives of the baseline data analysis for the physical environment were to:

(i) Gather information on the existing geology, soil resources, soil quality, climate, air quality, noise, surface and ground water resources, and water quality of the study area as likely to be impacted by the proposed plant.
(ii) Characterize the ability of the physical environment to absorb changes because of the proposed plant.

184. The physical baseline assessment methodology adopted included:

(i) Desktop Review of Secondary Data: a desktop review of existing published materials and documents was conducted to help determine the geology, soil resources, climate, and water resources in the study area, and to identify any existing baseline data for soil quality, air quality, noise, and water quality within the 10km study area, although focused on the project site.
(ii) Site Visit: site visit to identify sensitive receptors and scope requirements
(iii) Baseline data monitoring surveys: seasonal surveys for air quality, noise, and water quality as well as soil quality surveys were conducted by MITCON, supervised by ADB TA Environment Consultant as discussed below.
(iv) Consultation: discussion with Tripura SPCB, discussions were held with local community during consultation on physical environmental quality of area, like air, noise, water quality etc.

185. MITCON, an MoEF&CC approved and National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited organization, was hired by TPGL to conduct the baseline monitoring for securing environmental clearance for the existing plant. Further their assignment included survey locations that were part of the 10km PAI of the proposed plant and requested by the ADB TA Environment Consultant to inform the EIA of the proposed plant. The proposed plant is about 350 m from the existing plant within the Rokhia Thermal Power Station. For the baseline monitoring the data on air quality and noise included the contribution from the existing plant as it remained operational continuously throughout the monitoring period.[53] Thus, this contribution is anticipated to be reflected in the ambient data. However, the contribution from the existing plant will cease once it is decommissioned on operation of the proposed plant. The baseline monitoring was conducted over three seasons: Season 1 – October 2020 to December 2020 (post-monsoon season); Season 2 – January 2021 to March 2021 (winter and pre-monsoon seasons); Season 3 – April 2021 to June 2021 (pre-monsoon and start of monsoon). July to September being monsoon seasons with heavy rainfall were not monitored, although additional noise monitoring was conducted in August 2021 at five locations under clear conditions. Not all sampling locations were sampled in every season as they were adjusted as the EIA progress progressed and more understanding was gained about sensitive receptors, the area of maximum impact etc. For example, although MITCON collected noise data for the 10 km study area and this provides baseline context, the noise monitoring undertaken at the sensitive receptors within 500m during August 2021 was used to inform the noise assessment. The

[53] TPGL had commissioned 3 x 21 MW units without obtaining Prior EC and have applied for regularisation of EC. In pursuance of MoEF&CC's order to maintain operational capacity below 50 MW, operation of one unit was stopped and capacity reduced to 42 MW. Ref MoM: 36th MEETING OF THE RE-CONSTITUTED EXPERT APPRAISAL COMMITTEE (EAC) ON ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF THERMAL POWER PROJECTS HELD DURING 04th December 2019.Item no. 36.

details of environmental sampling locations are given in Table 4-11. The location map for the ampling points are shown as Figures 4-6 to 4-12.

Table 4-11: Environmental Sampling Locations

Sample Code	Sampling Location	Latitude	Longitude	Distance (km)	Direction	Justification /Land Use	Seasons Sampled
Air Quality							
AAQ.1	Project Site	23°37'34.13"N	91°11'42.41" E	Project Site		Plant emissions	Season 1, 2 and 3.
AAQ.2	Putia	23°38'36.70"N	91°11'44.93" E	1.9	N	DW	
AAQ.3	Boxanagar	23°36'37.60"N	91°10'12.05" E	3.10	SW	CW	
AAQ.4	Manikyanagar	23°37'17.64"N	91°12'2.50"E	1.00	SE	UW, nearest village	
AAQ.5	Kamalanagar	23°33'27.84"N	91°12'54.59" E	7.90	SSE	UW	
AAQ.6	Konaban	23°42'1.37"N	91°11'4.80"E	8.30	NNW	DW	
AAQ.7	Lalsinghmura	23°37'56.89"N	91°15'46.66" E	7.00	ENE	CW	
AAQ.8	Rahimpur	23°38'44.03"N	91° 9'46.58"E	3.95	NW	DW	
AAQ.9	Ghilatali	23°35'26.88"N	91°12'1.94"E	3.95	SSE	DW	Season 2 and 3
AAQ.10	Bhaluarchar	23°37'52.75"N	91°12'47.36" E	1.95	NE	CW	
Noise Quality							
NV4	Manikyanagar	23°37'10.19"N	91°11'48.26" E	0.46	SE	Nearest village	Season 1, 2 and 3. and Aug 2021
1	Closest Houses	23°37'18.01"N	91°12'2.25"E	0.18	E	Closest residential	Aug 2021
2	School (at 100 m buffer)	23°37'24.44"N	91°11'54.08" E	0.38	SE	Sensitive receptor	Aug 2021
3	Site Boundary (E)	23°37'10.90"N	91°11'52.44" E	0.07	E	Proposed Plant Boundary	Aug 2021
4	Site Boundary (W)	23°37'24.81"N	91°11'50.46" E	0.14	S	Proposed Plant Boundary	Aug 2021
Soil							
S.1	Project Site	23°37'31.35" N	91°11'43.24" E	--	--	Existing plant condition	Season 1, 2 and 3.
S.2	Putia	23°38'30.77"N	91°11'39.49" E	1.79	N	Buffer villages	
S.3	Boxanagar	23°36'49.44"N	91°10'23.52" E	2.60	SW		
S.4	Manikyanagar	23°36'54.39"N	91°11'32.38" E	1.17	SW	Nearest village	
S.5	Ghilatali	23°36'25.22"N	91°12'11.41" E	2.20	SE	Buffer villages	
S.6	Bhaluarchar	23°38'9.70"N	91°12'47.28" E	2.17	NE		

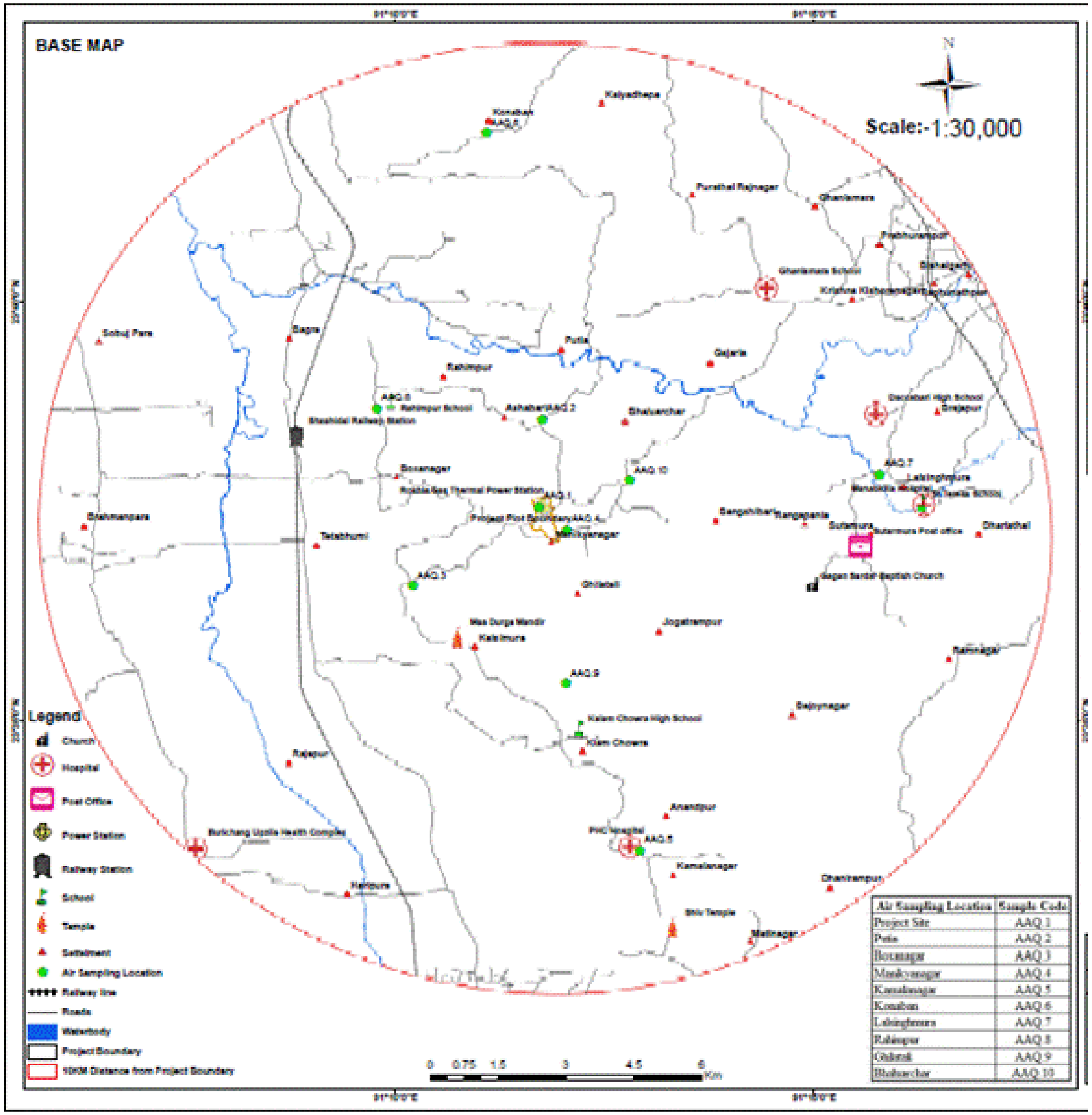
Sample Code	Sampling Location	Latitude	Longitude	Distance (km)	Direction	Justification /Land Use	Seasons Sampled
S.7	Kalsimura	23°36'17.82"N	91°10'19.93" E	3.28	SW		
S.8	Bangshibari	23°37'25.61"N	91°14'5.77"E	4.04	WNW		
S.9	Oil Spill site 1	23°37'34.30"N	91°11'41.49" E	--	--	Testing of soi at existing plant, oil contamination from spills was observed.[54]	Season 2 and 3.
S.10	Oil Spill site 2	23°37'35.06"N	91°11'40.81" E	--	--		
S.11	Oil Spill site 3	23°37'36.52"N	91°11'40.37" E	--	--		
S.12	Proposed Plant	23°37'24.63"N	91°11'50.41" E	0.30	SE		
Surface Water							
SW 1	Salda River D/S (bridge near Putia)	23°39'20.20"N	91°12'28.13" E	3.56	NE	Nearest major river	Season 1, 2 and 3.
SW 2	Pond near project site	23°37'22.34"N	91°11'16.62" E	0.8	SW	Nearest pond	
SW 3	Salda River U/S (near Lalsingmura)	23°37'57.84"N	91°15'43.17" E	6.86	E	Nearest major river	
SW 4	Lake near Manikyanagar	23°36'56.97"N	91°11'31.68" E	1.16	SW	Nearest water bodies with 3km radius	Season 2 and 3.
SW 5	Lake near project site	23°37'5.59"N	91°11'56.72" E	0.97	SE		
SW 6	Pond near Bhaluarchar	23°38'17.96"N	91°12'42.98" E	2.18	NE		
SW 7	Lake near Ashabari	23°38'13.35"N	91°11'51.11" E	1.23	NNE		
SW 8	Lake near Ghilatali	23°36'18.26"N	91°12'11.35" E	2.47	SE		
Ground Water							
GW 1	Project Site	23°37'18.57" N	91°11'44.29" E	--	--	Existing plant groundwater	Season 1, 2 and 3.
GW 2	Putia	23°38'36.75"N	91°11'45.25" E	1.90	NNE	Nearest groundwater bodies within 10 km radius and potentially drawing from the same aquifer of the proposed plant	
GW 3	Boxanagar	23°36'35.51" N	91°10'16.74" E	3.00	SW		
GW 4	Manikyanagar	23°36'56.03"N	91°11'31.80" E	0.76	SW		
GW 5	Kalamchowra	23°34'23.44" N	91°12'29.91" E	5.72	SE		Season 1
GW 6	Konaban	23°42'10.09" N	91°11'18.54" E	8.26	N		
GW 7	Lalsinghmura	23°37'56.84" N	91°15'50.92" E	6.98	E		

[54] Three sites inside the existing plant, observed to be small patches of oil contaminated soil made due to spillage of oil from existing plant operation during decanting from drums.

Sample Code	Sampling Location	Latitude	Longitude	Distance (km)	Direction	Justification /Land Use	Seasons Sampled
GW 8	Rahimpur	23°38'28.41" N	91°9'53.31" E	3.6	NW		
GW 5	Ghilatali	23°35'14.54"N	91°11'57.46" E	4.35	SSE		Season 2 and 3
GW 6	Bhaluarchar	23°38'7.53"N	91°12'47.00" E	1.99	NE		
GW 7	Kalsimura	23°36'21.77"N	91°10'29.35" E	3.04	SSW		
GW 8	Bangshibari	23°37'29.18"N	91°14'6.74"E	4.10	ESE		

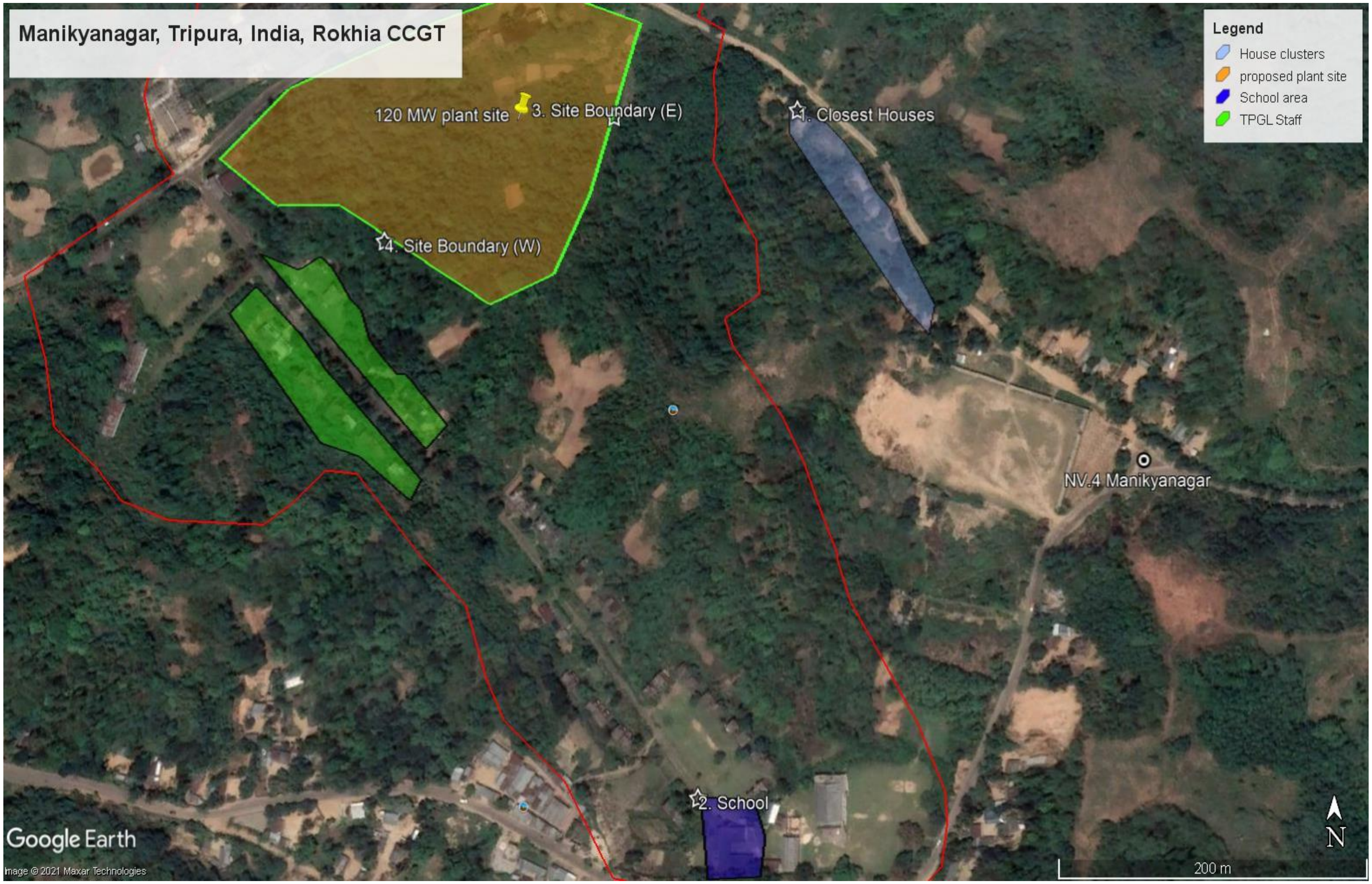
Note: UW: upwind, CW: crosswind, DW: down wind directions
Season 1: 1st October 2020 to 31st December 2020
Season 2: 1st January 2021 to 31st March 2021
Season 3: 1st April 2021 to 30th June 2021
Source: MITCON Baseline Report

Figure 4-6: Air Quality Monitoring Locations (Oct 2020-June 2021)



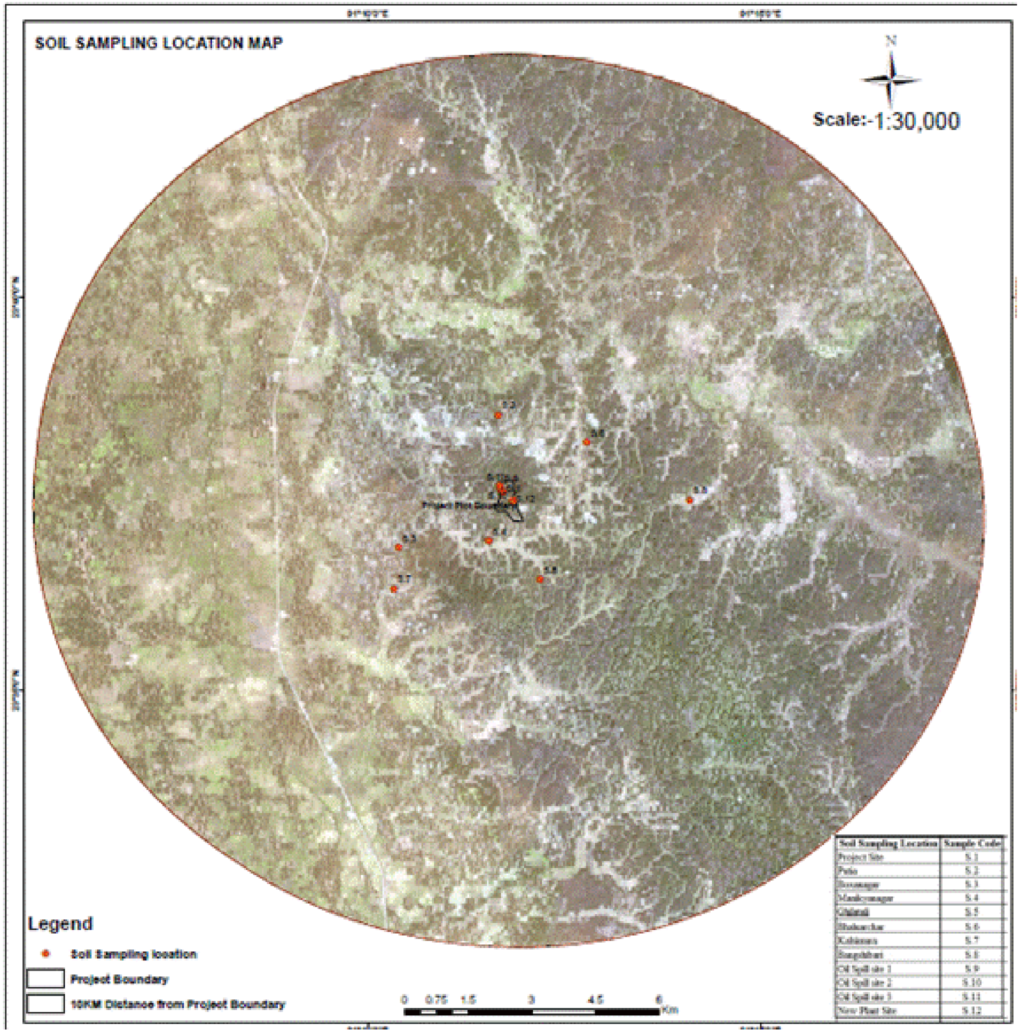
Source: MITCON Baseline Report

Figure 4-7: Noise Monitoring Locations (August 2021)



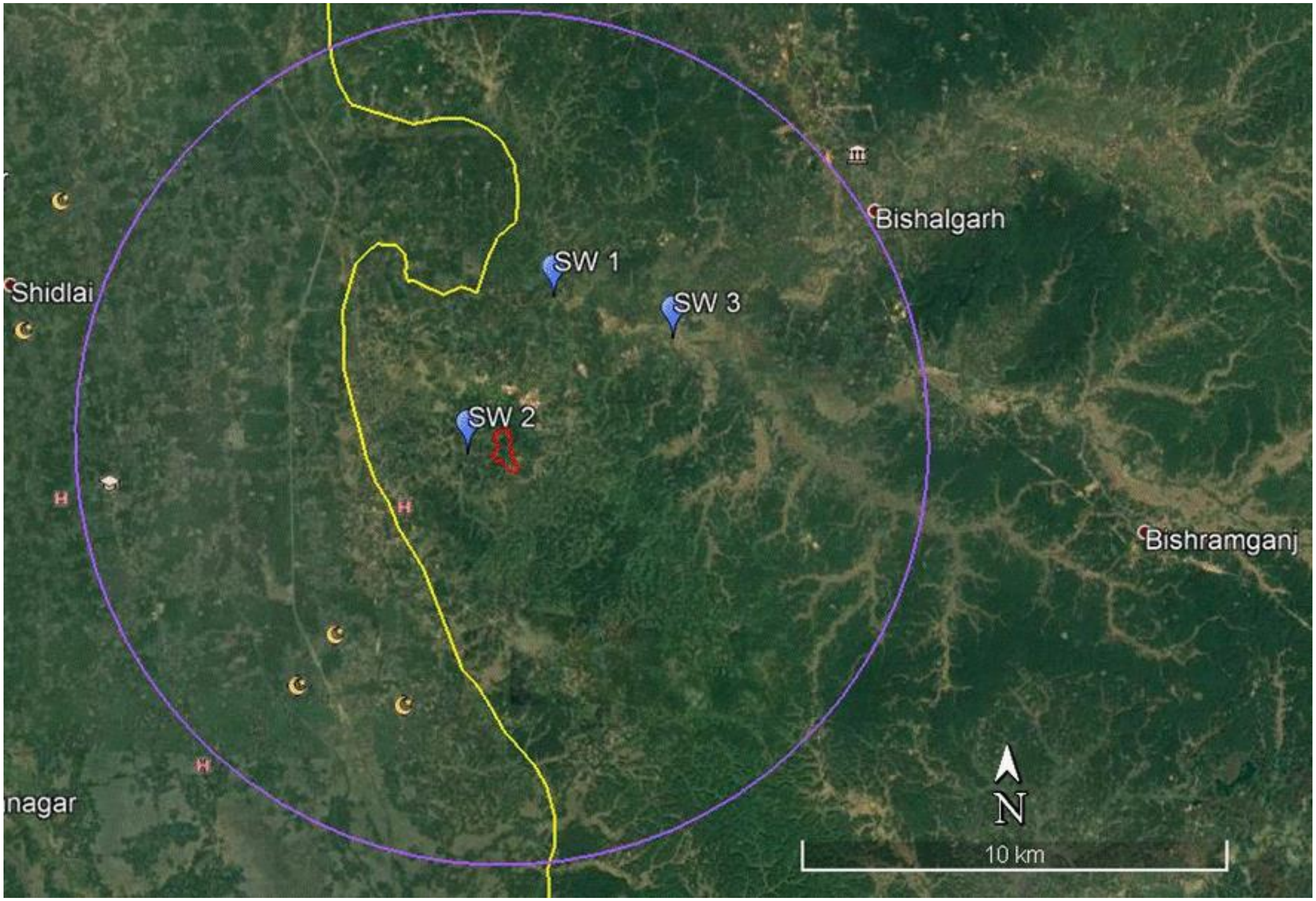
Source: ADB TA Consultant

Figure 4-8: Soil sampling locations (Oct 2020-June 2021)



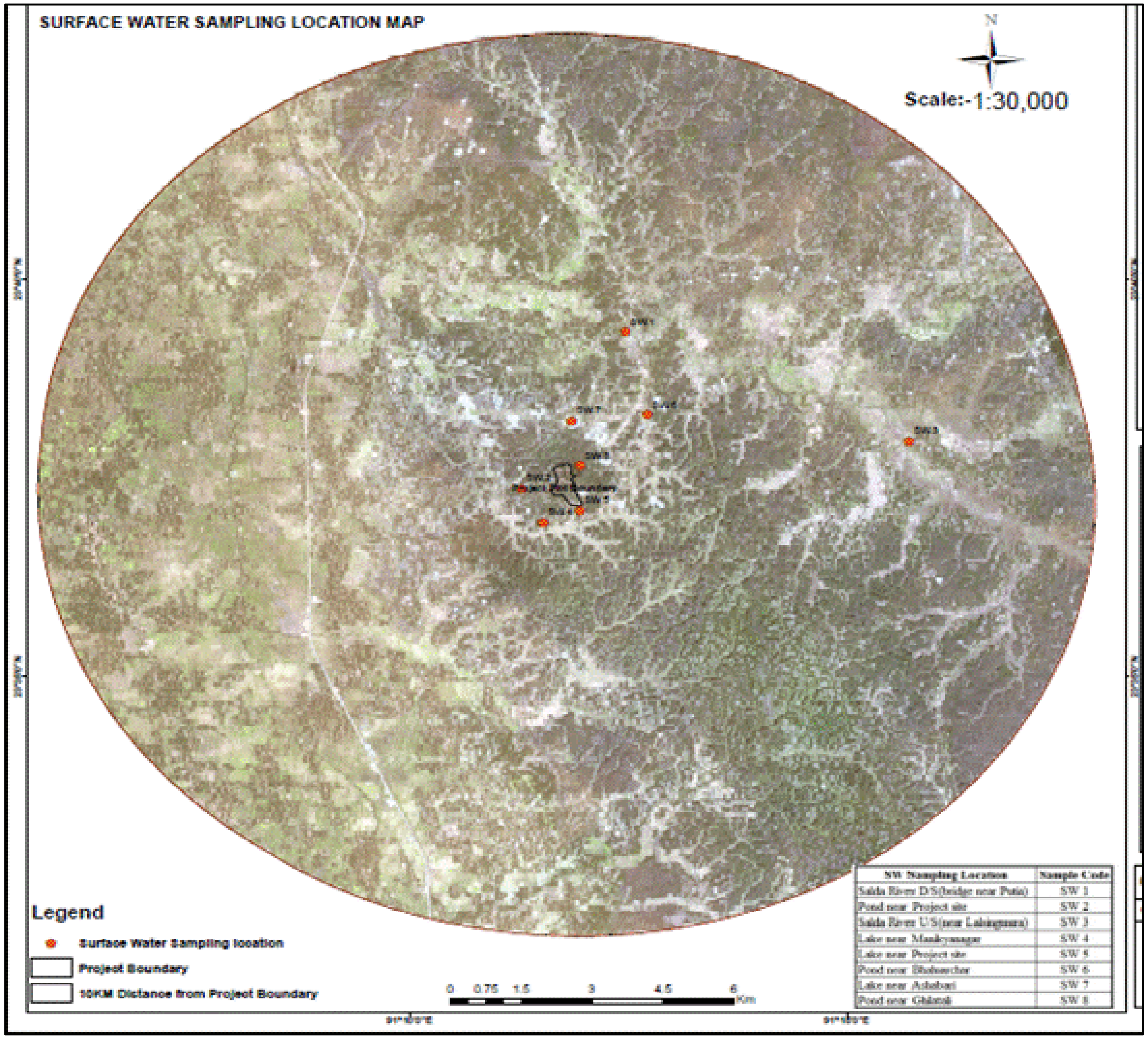
Source: MITCON Baseline Report

Figure 4-9: Surface Water Sampling Locations (Oct 2020-Dec 2021)



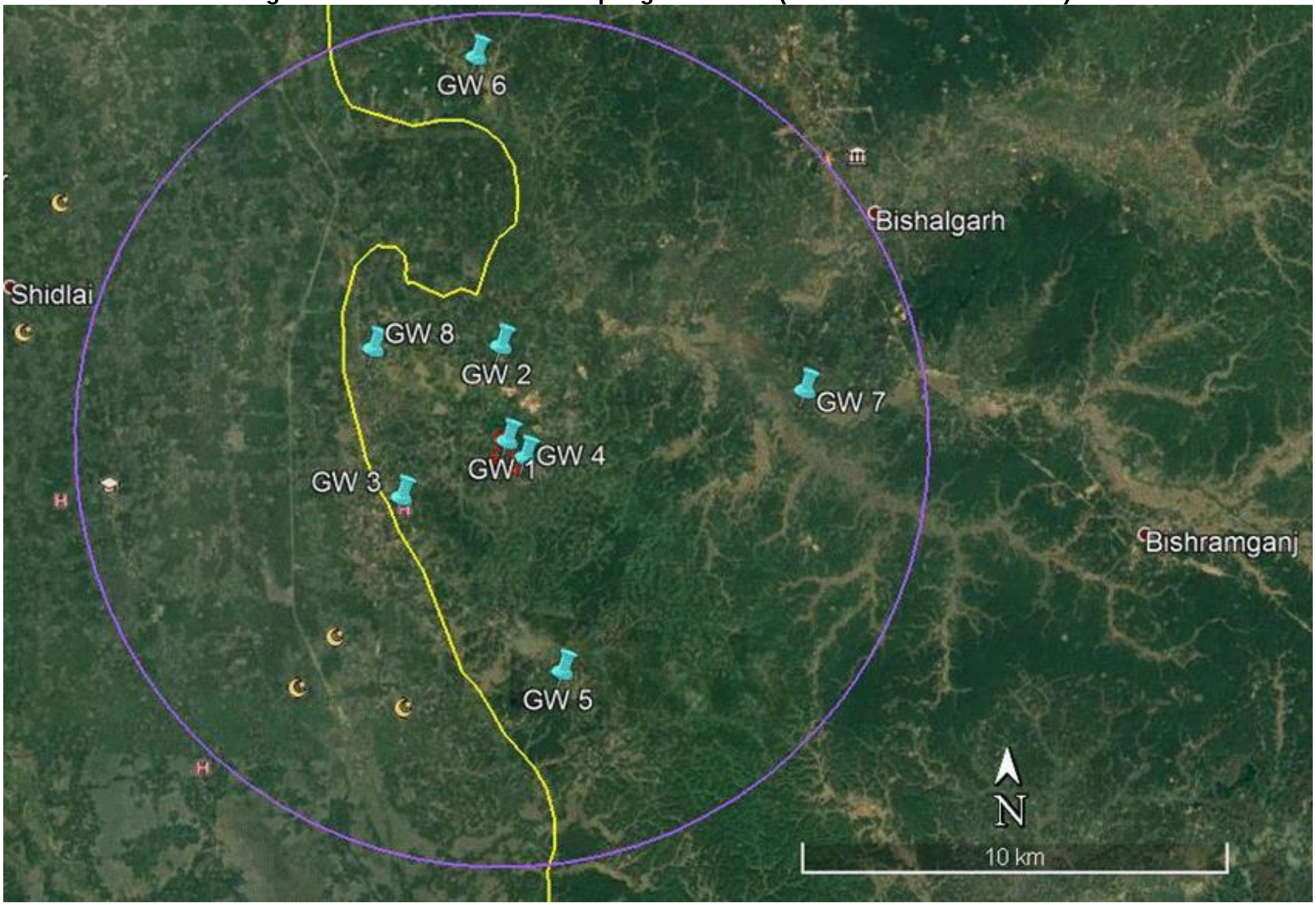
Source: MITCON Baseline Report

Figure 4-10: Surface Water Sampling Locations (January 2021 – June 2021)



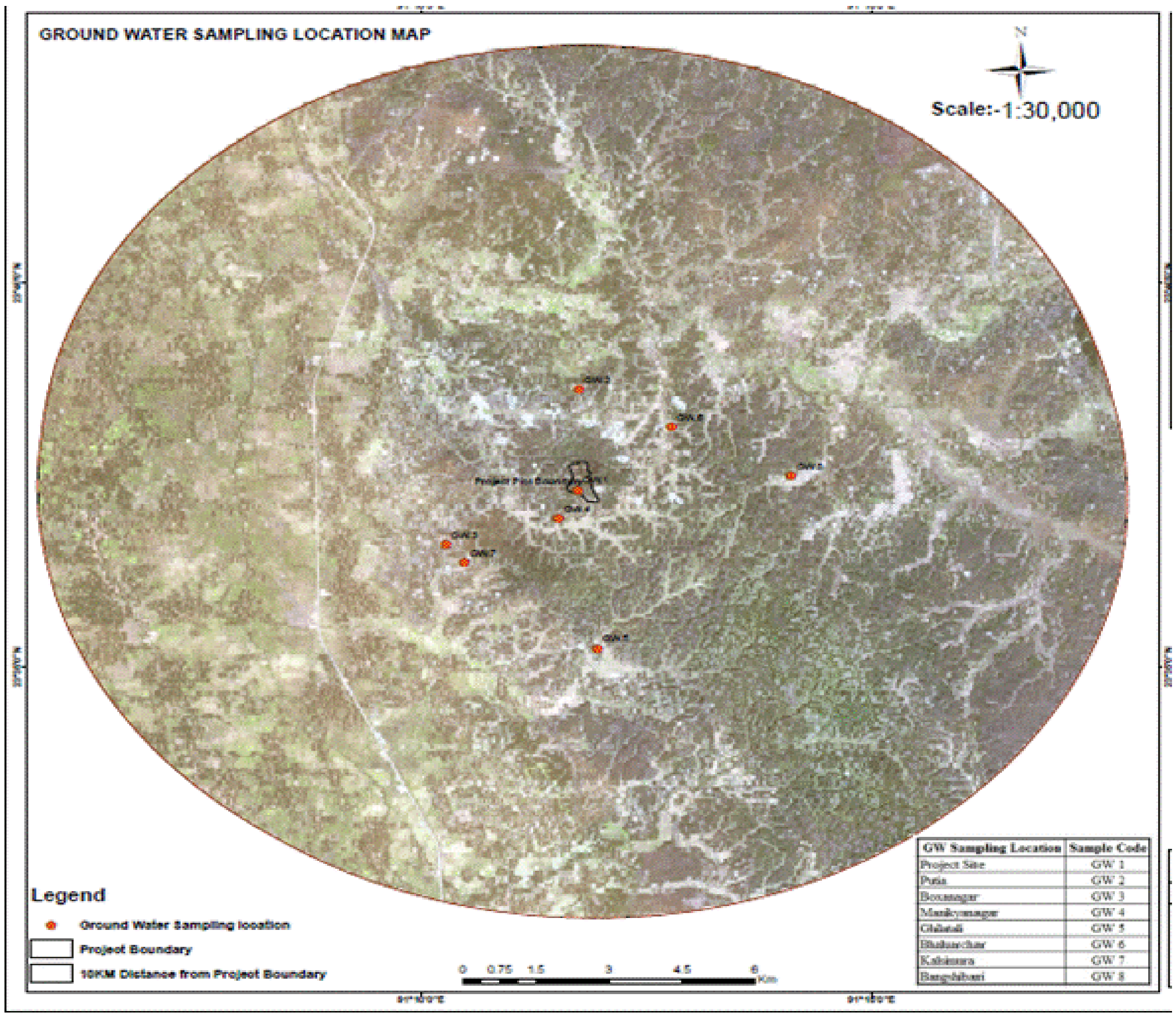
Source: MITCON Baseline Report

Figure 4-11: Ground Water Sampling Locations (October 2020 – Dec 2020)



Source: MITCON Baseline Report

Figure 4-12: Ground water sampling locations (January 2021 – June 2021)



Source: MITCON Baseline Report

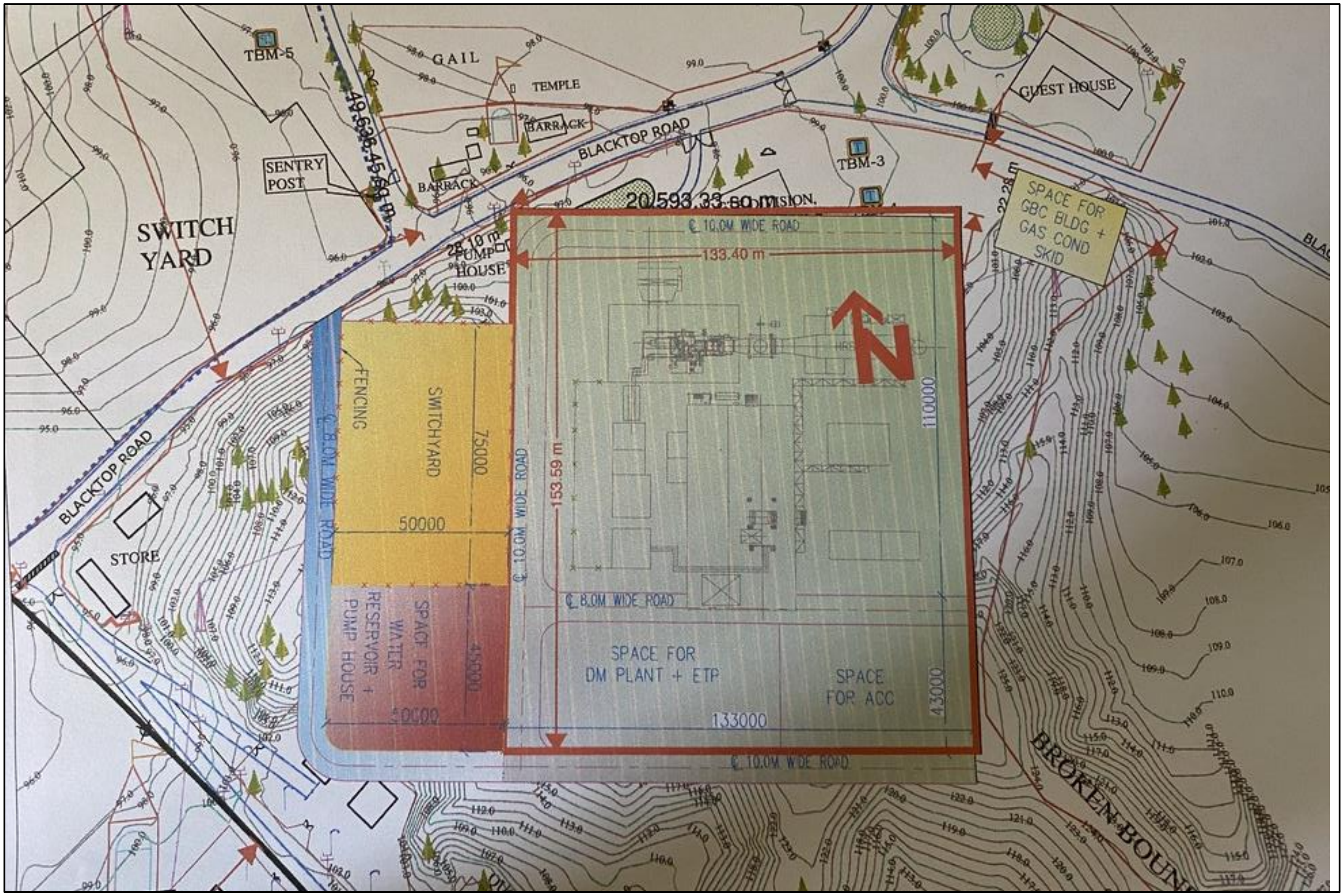
2. Elevation and Topography

186. The general elevation of the 10 km study area varies between 64m above mean sea level (AMSL) in the north and southeast up in the hills to 9m in the west on low-lying alluvial land with the foothills of the hill ranges forming chains of isolated hillocks scattered across the landscape. Plain areas with low to moderate elevations house the built-up areas by land use including roads, settlements, and agricultural lands. The project site and its immediate surrounding is found on plain to elevated terrain ranging between 30m to 49m ASL, with two hillocks with maximum elevation 59m AMSL both of which are covered with vegetation/natural forest. Of the two hillocks, the smaller one on the eastern boundary has a maximum elevation of 55m, whilst the larger one forming the southern boundary has a maximum elevation of 59m. The project site is shown as Figure 4-13. The topography of the Bisalgarh Block, which houses the project site, is shown as Figure 4-14 while the elevation profile of the project area is shown as Figure 4-15.

Figure 4-13: Panoramic View of Project Site
(from proposed plant center Looking east to south)

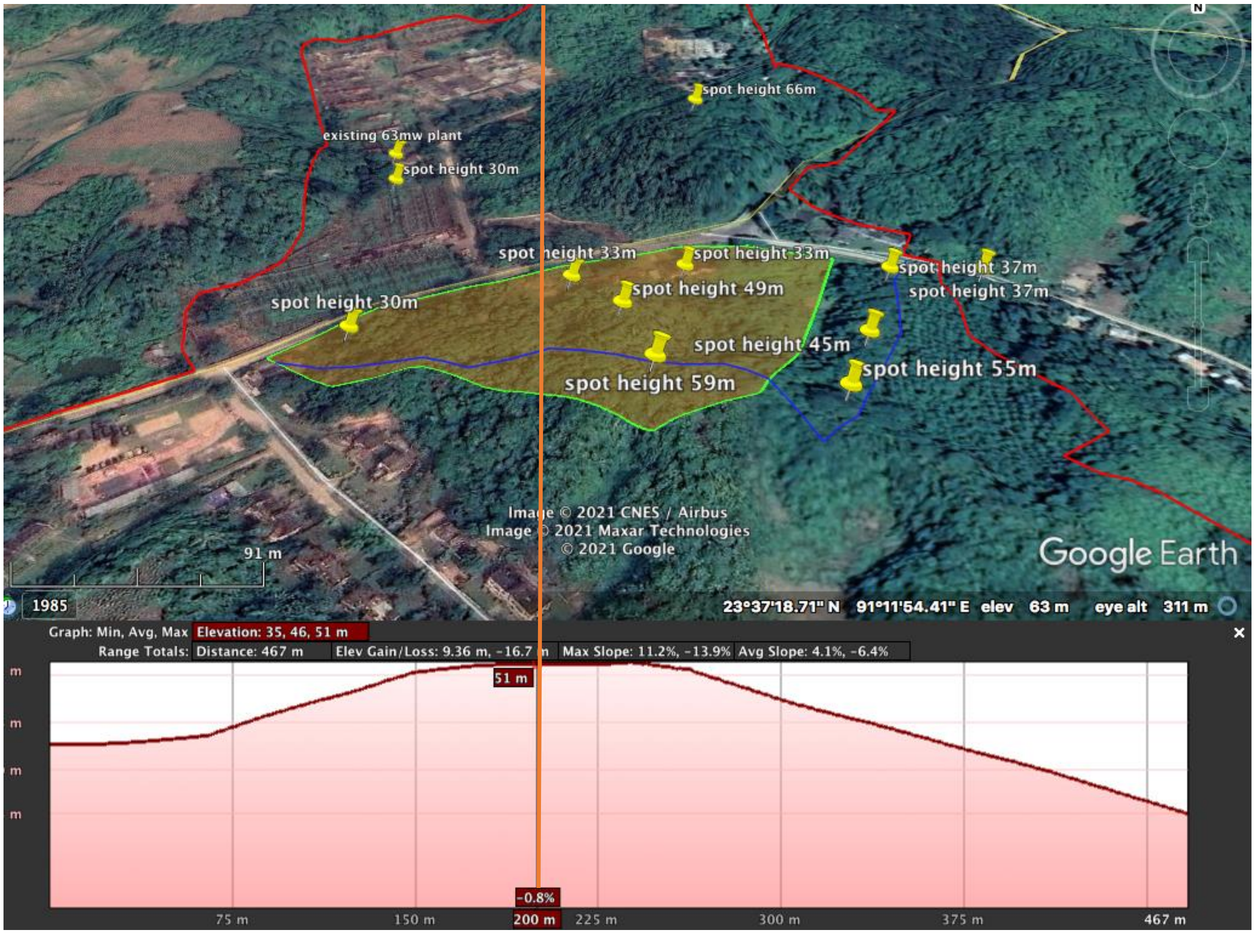
Source: ADB TA Consultant

Figure 4-14: Contour Plot of Project Site with Layout



Note: proposed plant layout is initial design (subsequently revised)
Source: TPGL

Figure 4-15: Elevation Profile of Project Site and Immediate Surroundings



Note: the red line approximately passing through the proposed plant center across the southern hillock
Source: ADB TA Consultant

3. Land Use and Land Cover

187. The land for the proposed plant is within the TPGL owned Rokhia Thermal Power Station so no land acquisition is required. Portion of the land (16.04ha) for Rokhia Thermal Power Station has been historically transferred from Reserve Forest to industrial land over 30 years ago. The remaining portion of land (6.58ha) was originally private/jote land.

3.1. Study Area

188. Land Use/Land Cover (LULC) for a 10 km radius around the existing plant was delineated by MITCON based on Landsat ETM+ satellite data, the LULC classes were categorized based on ground truthing during site visit. Land is classified as vegetation (tree patches/degraded natural forest areas), scrub, barren land, agricultural, built-up area, brick kilns, water bodies, etc. Since the proposed plant is near the existing plant, this existing plant LULC mapping is appropriate to use for the baseline and assessment. LULC in the study area varies but is predominantly agricultural as seen from Table 4-12 and Figure 4-16.

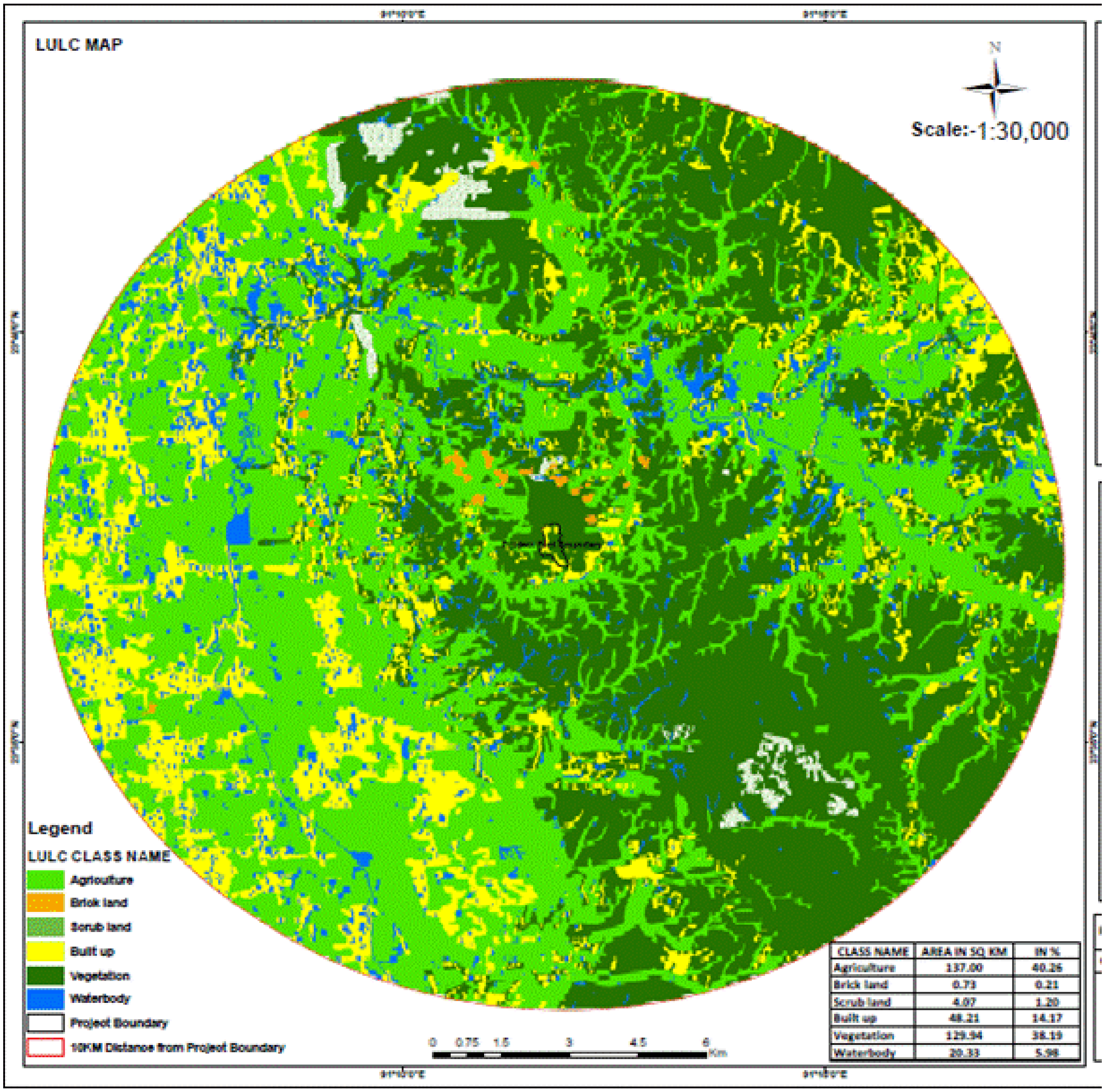
Table 4-12: Land Use in the Study Area

LULC Classes	Area in km^2	Area in %

Agricultural	137	40.26
Vegetation/Trees	120.94	38.18
Built-up	40.21	14.17
Water bodies	20.33	5.98
Scrub land/open tracts	4.07	1.2
Brickfields	0.73	0.21
Total	**314.2**	**100.00**

Source: MITCON

Figure 4-16: LULC Map of 10km Study Area

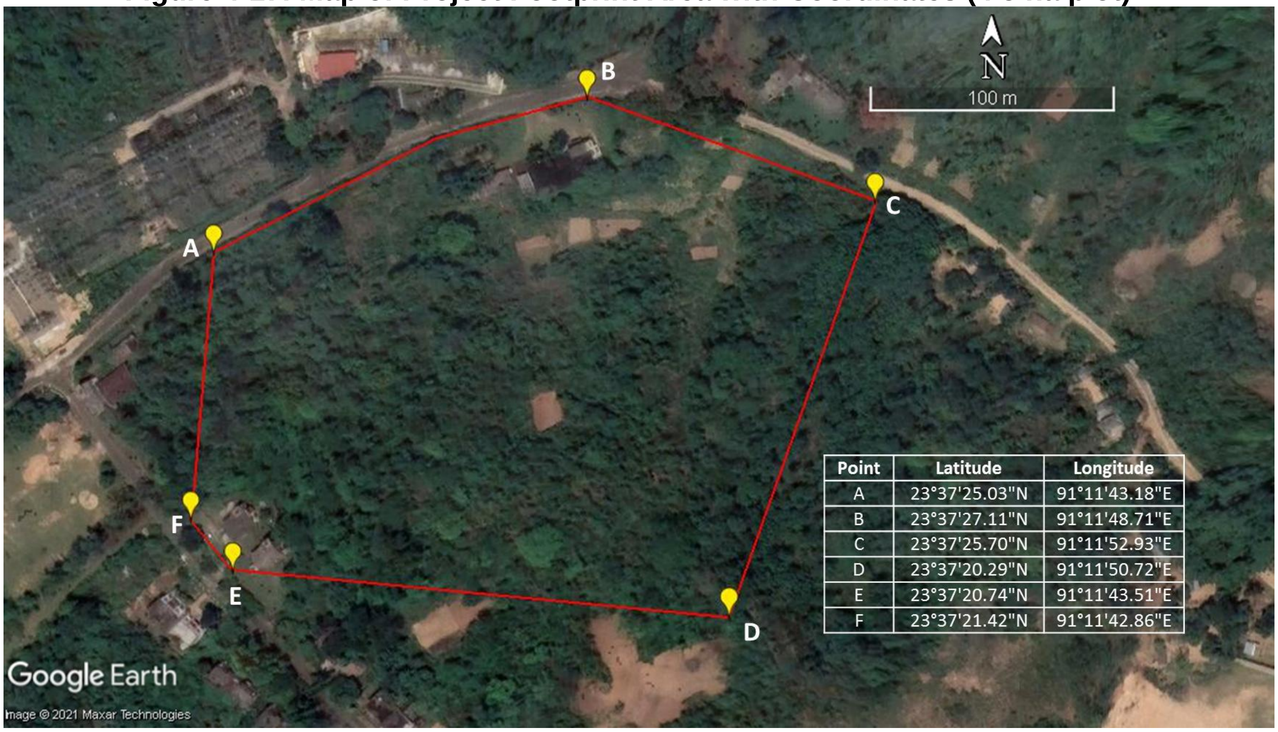


Souce: MITCON baseline report for regularization of 63MW plant

3.2. Project Site

189. The project site is about 15% built up (office building and road access) and 85% vegetated, of which 20% is cleared, open land with limited vegetation and 65% is a less disturbed vegetated area. No agricultural land or water bodies are present within the project site. LULC of the plant site is shown as Figure 4-20. Of the office buildings (Figure 4-18) on the project site no asbestos was seen to be present, although this will be reconfirmed by a competent surveyor employed by the EPC Contractor prior to their demolition.

Figure 4-17: Map of Project Footprint Area with Coordinates (4.5 ha plot)



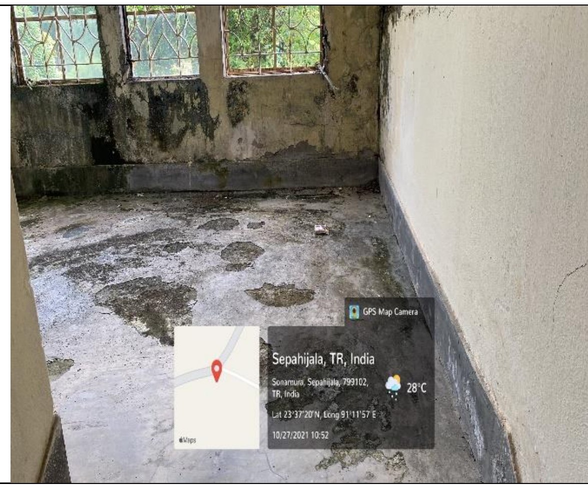
Source: TPGL

Figure 4-18: Photographs of Building to be Demolished

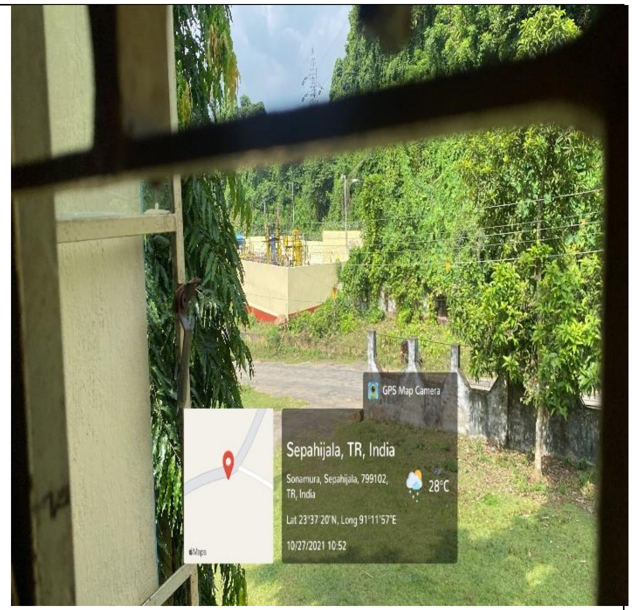
Looking from GTDL building (south) to be demolished into north (HRSG site)

Looking from north to south, showing the GTDL building to be demolished and the small office behind also marked for demolition

GTDL building marked for demolition – external view



GTDL building inside

	
Roof to GTDL building marked for demolition	View from GTDL building, looking to west, showing proposed plant gate and the GCS unit beyond the project road section, across which the gas pipeline will enter the proposed plant

Source: ADB TA Consultant

4. Geology, Soil and Geological Hazards

4.1. Geology

190. The state of Tripura is characteristically underlain by a wide range of sedimentary rocks that has origin in marine-mixed fluvial type laid down in a range of environmental conditions primarily governed by tectonic movement.[55] The age ranges from upper most Oligocene (38 million years) to Holocene (recent period). Tectonically it now comprises a series of sub-parallel arcuate, elongated doubly plunging folds arranged in north-south direction. The anticline folds are separated by wide flat synclines. The physiography of Tripura is shown as Table 4-13 and the group of sediments during different geological ages are shown in Table 4-14 on litho-stratigraphy.

Table 4-13: Physiographic unit of Tripura[10]

i.	Steeping slopping and slightly dissected high relief structural hills and ridges exemplified by areas like Kailashahar, Panisagar, Baramura, Teliamura, etc.
ii.	Moderately slopping with moderately dissected medium relief parallel ridges present in north and northeastern part of Tripura.
iii.	Moderately slopping and highly dissected, low relief structural hills and ridges found in the north-west and southern part of the state.
iv.	Moderately to gently sloping and moderately dissected flat topped denuded hill occurring in western, central and southern part of Tripura.
v.	Low lying residual hill with valley represented by Gonda charra area of south eastern part of

[55] State of Environment Report of Tripura for the year of 2002: Geomorphology, Geology and Mineral Resources

	Tripura.
vi.	Undulatory plain with low mounds and gently slopping valley situated mostly in the western and southern part of Tripura.
vii.	Moderately to gently sloping inter-hill valley with upland mostly occurring on the northern-eastern and southern part of the state.
viii.	Moderately to gently slopping inter-hill valleys with alluvial upland plains, represented by Kumarghat-Chailengta area as alluvial deposit of river Manu.
ix.	Rolling upland common in some pockets of the west and north-western part of Tripura.
x.	Flood plain constitutes an important area rornled by rivers of Tripura. Studied area Krishnakishore nagar and Jampuri fall under this group.

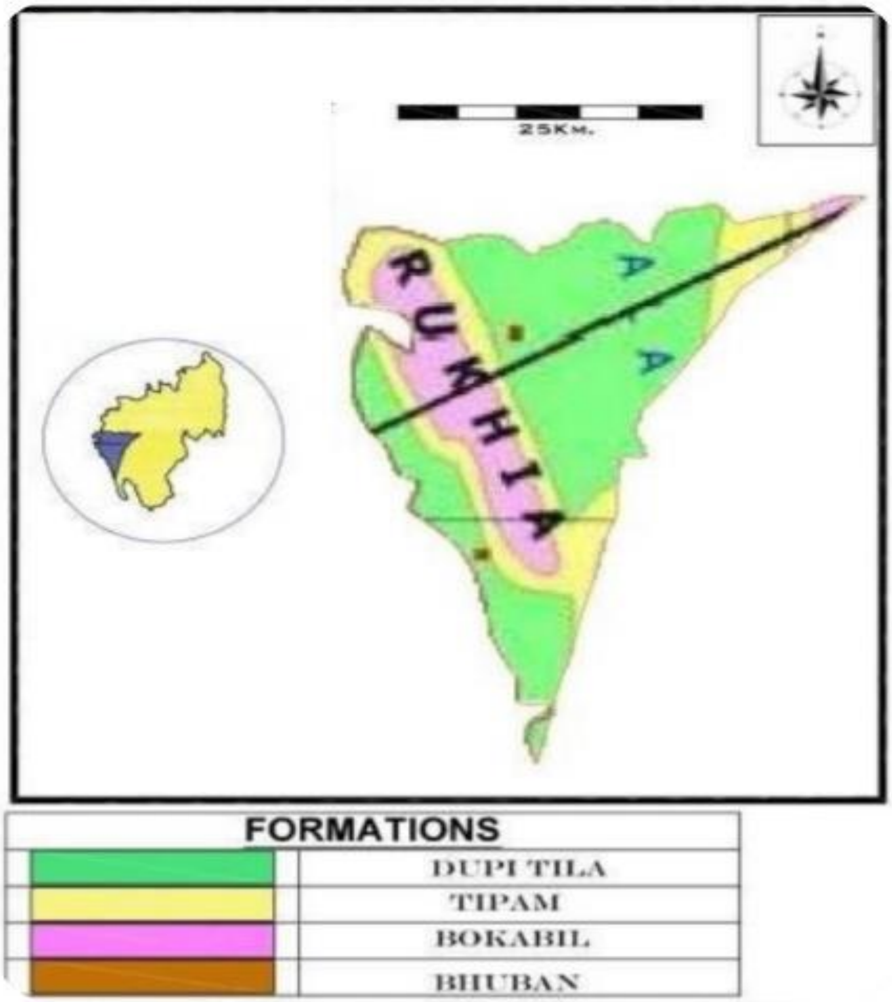
Source: Tripura ENVIS

Table-4-14: Stratigraphy of Tripura[10]

Age	Group	Sub-Group	Formation	Rock Type
Holocene	Recent	-	Khowai Formation Ghilatoli Formation Teliamura Formation Kalyanpur Formation	Unconsolidated silt, and clay with decomposed vegetable matter and gravels
Quaternary	Dupitila	-	Dupitila Formation	Sandy clays, clayey sandstone, ferruginous sandstone with pockets of plastic clay, silica and laterite.
Upper Pliocene to Pleistocene Pliocene	Tipam	Tipam	Upper Tipam Formation Lower Tipam Formation	Sandstone, occasional sandy shale and abundant lumps of fossil wood Sandstone with laminated layers and lenses of sandy shale, siltstone and mudstone.
Micocene- Lr. Pliocene Upper most Oligocene	Surma	Bokabill Bhuban	Bokabil Formation 1. Upper Bhuban Formation 2. Middle Bhuban Formation 3. Lower Bhuban Formation (Not exposed in Tripura)	Thinly bedded repetition of sandstone, siltstone/shale, mudstone and ferruginous sandstone. Hard compact sandstone, olive shale, sandy shale and siltstone repetitions

Source: Tripura ENVIS

Figure 4-19: Geological Map of Sipahijila District



Source: District Survey Report, 2019, GoT

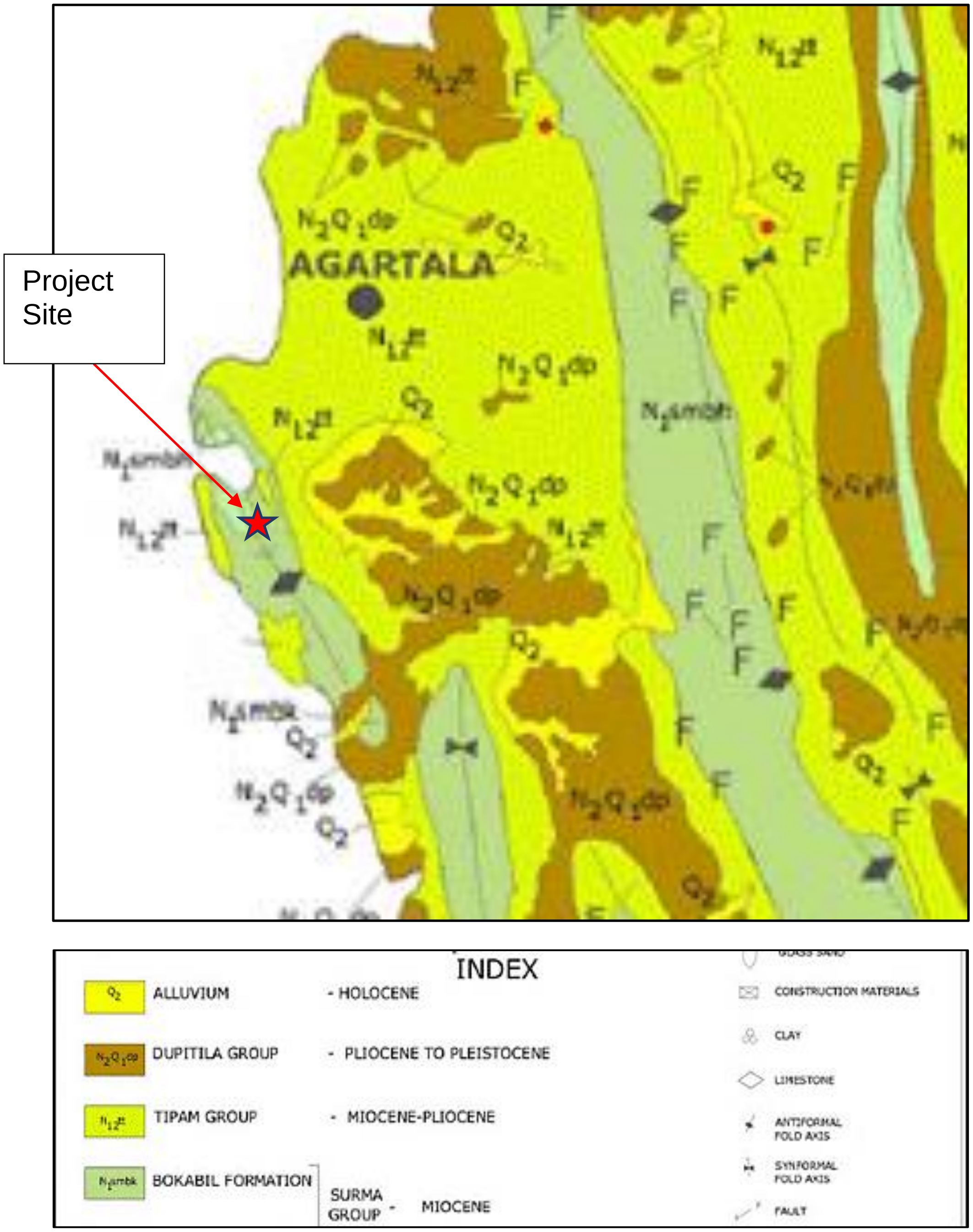
4.2. Site Geology

191. The Rokhia area covers Manikyanagar-Sonamura Field, which is southern part of the Rokhia Structure in Western Tripura, a part of the Assam-Arakan Fold Belt (AAFB). The first hydrocarbon lead in Rokhia Structure in Western Tripura Fold belt was obtained in 1983 and thereafter Gaseous hydrocarbon has been discovered in Manikyanagar area.[56] Tripura-Cachar fold belt comprises a series of sub-parallel elongated en-echelon anticlines trending NNW-SSE with slight convexity towards west. The anticlines are, in general, bounded by longitudinal reverse faults on one or either limb. Geologically, Rokhia anticline, in the same trend is the outermost frontal structure of the fold belt. It is an elongated gently folded doubly plunging, flat topped, near symmetrical anticline.

[56] Samala et al. 2017. Reservoir Characterization in Complex Geological Set-up of Fold Thrust Belt: Case study from Manikyanagar Field of Rokhia Structure in Tripura Fold Belt, India

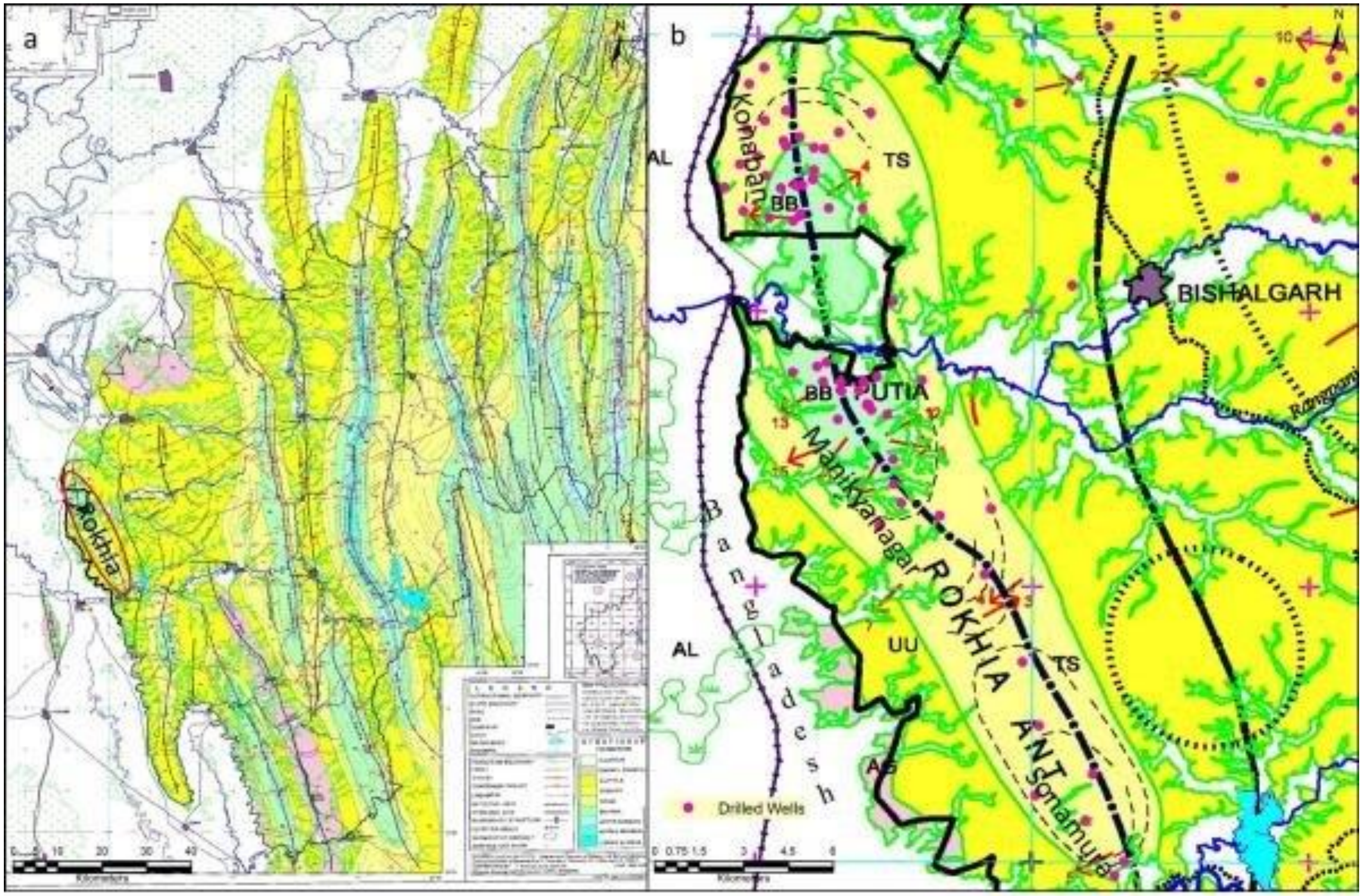
192. Based on litho-assamblage, the Surma Group is divided into two sub-groups, viz. Bhuban and Bokabil Formations. The Bhuban Formation is further divided into three units, Upper Middle and Lower Bhuban. The Bhuban Formation is mainly argillaceous in the middle part while it is relatively arenaceous in the upper and lower parts. The limited grain size analysis of sediments exposed in the folds of Tripura-Cachar area has indicated that Tripura area was located in front of a prograding delta with marine transgression during the deposition of Surma Group sediments and earlier times. Gradually the depositional environment changed to fluvial conditions during deposition of Tipam Formation. In Rokhia area mainly upper and middle Bhuban is explored in different wells. The oldest sediments exposed in the core of the Rokhia anticline are Tipam and Bokabil sediments (Figure 4-20), comprising of alternating dominantly arenaceous and moderate to thin argillaceous beds. The core of the northern culmination is occupied by older arenaceous sequence of Bokabil whereas, the core of southern culmination is occupied by comparatively younger sequence of Tipam Group. The project site itself is underlain by the Bokabil formation. This formation consists of siltstone with small interbanded sandstone and has a typical geomorphic expression manifested by linear, low lying sharp hills. Oil and natural gas are the most important mineral resource in Tripura. Current production of natural gas in estimated at one million cubic meters per day. The project site is underlain by the Bokabil petroleum mining lease (PML) Block laid down in the Surma basin. Gaseous hydrocarbon has been discovered in intermittent areas within the Upper Bhuban formation of Manikyanagar area. These PML are areas with formation of oil and natural gas formation and minerals of significance like glass sands and clays which are used particularly for building and construction purposes; limestone is available but not suitable for cement. The mineralogical map is presented in Figure 4-20 and Rokhia geology map as Figure 4-21. Soils at the project site have high shear strength and low settlement potential, they are suited to having shallow foundations for most structures except heavy equipment which may need piles.

Figure 4-20: Mineralogical Map of Project Site and Surrounding Area



Source: GSI, GoI

Figure 4-21: Geology Map of Rokhia in Manikyanagar



Source: Samala et al. 2017. Reservoir Characterization in Complex Geological Set-up of Fold Thrust Belt: Case study from Manikyanagar Field of Rokhia Structure in Tripura Fold Belt, India

4.3. Seismicity Hazard

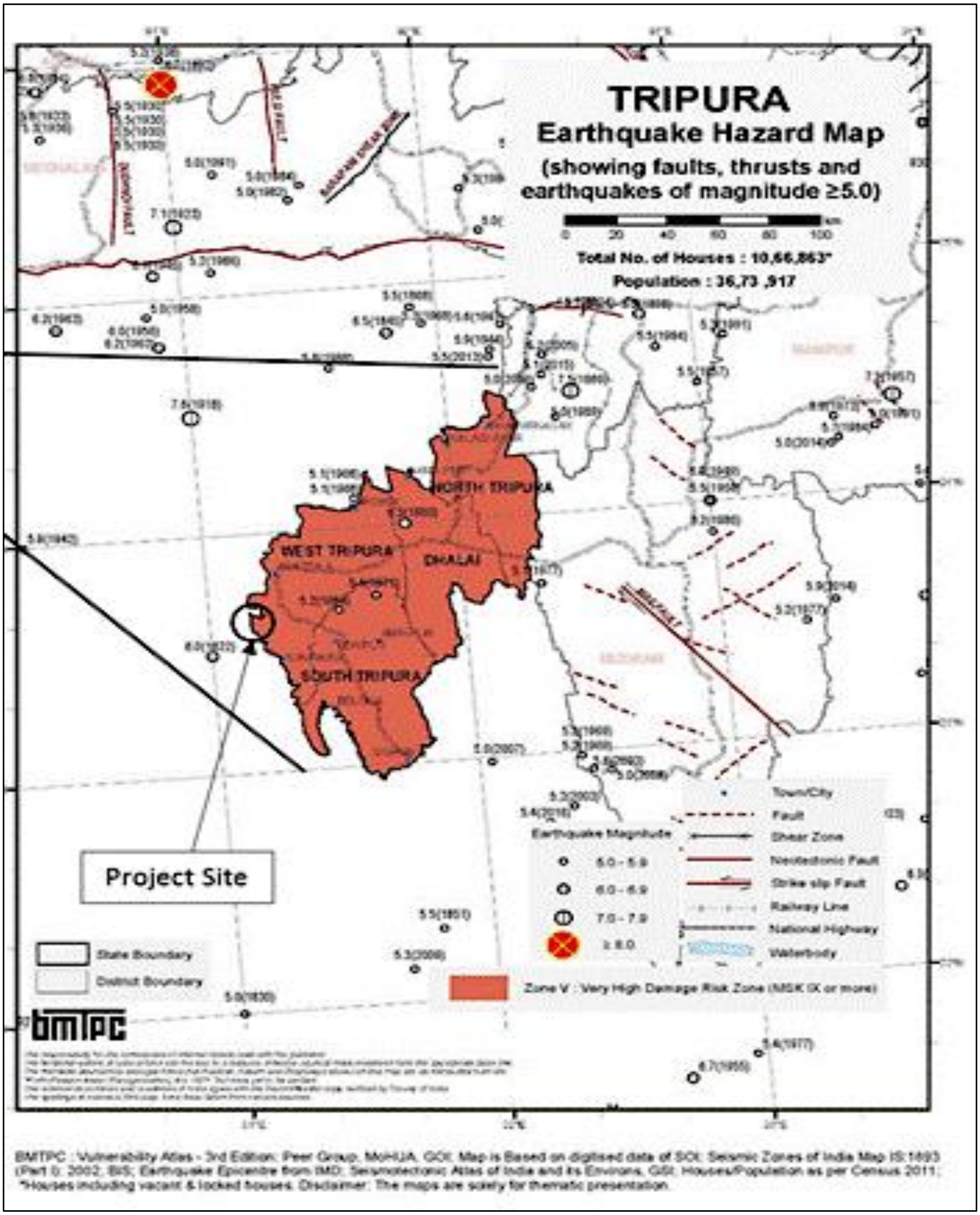
193. Tripura is situated in north-eastern India, adjacent to the Himalayan belt that is seismically very active due to the convergent boundary of the Indian plate with the Eurasian plate. The Indian plate is currently moving towards the northeast at 5 cm per year. The fault line is a reverse fault, due to which subduction and over-thrust occur. Earthquakes of small to moderate magnitude therefore occur quite often, on average it has more than seven earthquakes a year that are greater than magnitude 5 on the Richter scale.

194. The varying geology at different locations in India implies that the likelihood of damaging earthquakes taking place at different locations is different. Thus, a seismic zone map was required to identify these regions. The seismic zone maps were prepared and revised from time to time as more understanding is gained on the geology, the seismotectonic and the seismic activity in the country. The latest map was published in 2002, and has only four seismic zones – II, III, IV and V.[57] The zonation is as per the estimated seismic intensity risk (Zone Factor). The zone factor is defined as maximum horizontal acceleration experienced by structure in that zone. For example, a seismic factor of 0.10 is the maximum horizontal acceleration experienced by a structure in this zone is 10%. The entire state of Tripura including the project site, falls in the seismic zone V (magnitude 7.0 to 7.5) as per Indian Standard Code (IS 1893 2002)[58] with a zone factor of 0.36 (36% horizontal acceleration), which signifies high risk severity of earthquake hazards in the region. This is considered Very High Damage Risk Zone (MSK IX or more) as shown in Figure 4-24. There is a history of numerous earthquakes occurring in the state, following being the prominent:

(i) An earthquake occurred in 1918 with 7.6 magnitude on Richter scale.
(ii) A 5.7 magnitude earthquake occurred at Ambassa, Tripura on January 3, 2017, with a maximum observed intensity of 6-7. It struck at 2:39 pm and the estimated depth was 32 km.

[57] http://www.iitk.ac.in/nicee/EQTips/EQTip04.pdf
[58] Revised IS Code for Earthquake Resistant Design of Structures IS 1893 (Part 1): 2002

Figure 4-22: Earthquake Hazard Map Tripura

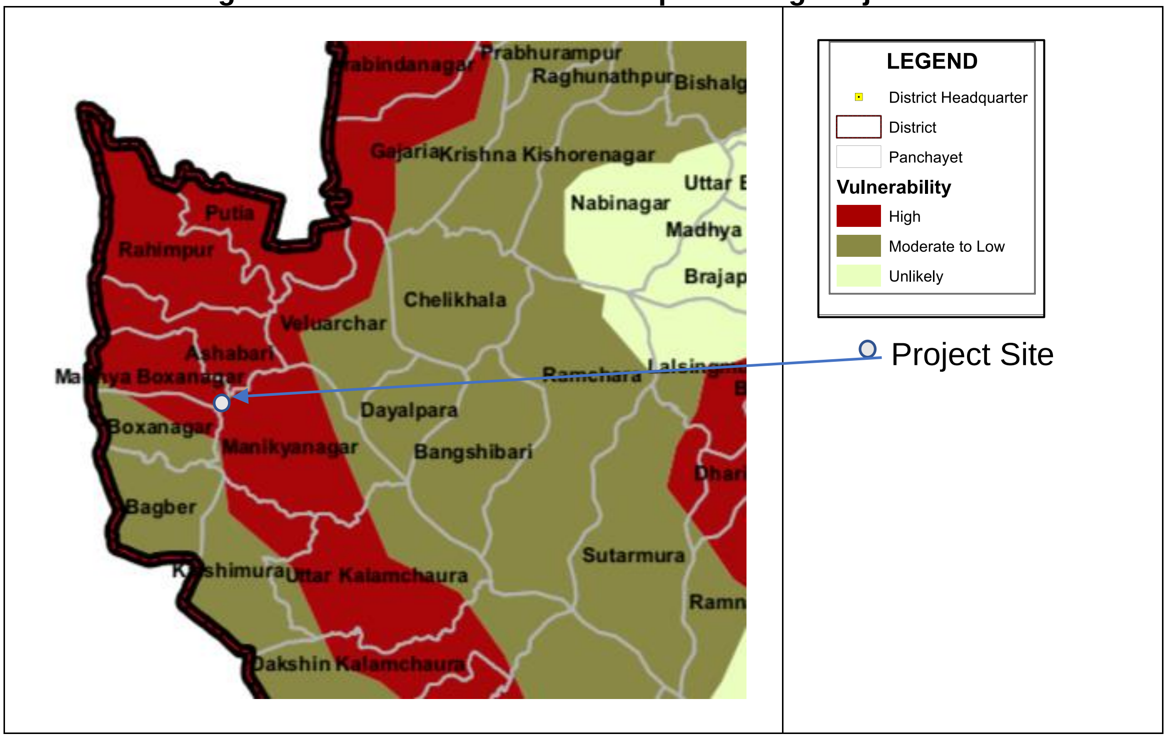


Source: BMTPC Vulnerability Maps (3rd Edition), GoI

4.4. Landslide Hazard

195. The sedimentary nature of geology and the seismic risk mean Tripura is vulnerable to landslides. The project site lies within a high-risk zone in terms of landslide vulnerability as shown in Figure 4-23.

Figure 4-23: Landslide Hazard Map Showing Project Site



Source: MITCON Baseline Report for TPGL

4.5. Soils and Soil Quality

196. The soil types of Tripura can be classified under five major groups; these are clay (red) loam, sandy loam, reddish yellow brown sandy soils, older alluvial soils, and younger alluvial soils. They are classified as per USDA Soil Taxonomy into four orders viz. Entisols, Inceptisols, Alfisols and Ultisols. The soils at the project site are clay loam but in the wider study area are mostly sandy loam type and characterized by dominant presence of Ultisols and Alfisols. In general, soils of Sepahijala district are acidic in nature. The hydrogen potential (pH) of the soil ranges from 5.5 to 6.

197. Soil quality was monitored at eight locations within the study area on agricultural land, open areas and vegetated tracts, three potentially contaminated sites inside the existing plant and one site at the proposed plant. The contamination was observed to be small patches made due to spillage of oil from existing plant operation during decanting from drums. TPGL has taken no action to manage the contamination. Soil samples were collected three times between October 2020 and June 2021 for analysis, samples of oil testing were only collected two times.

198. In terms of physical properties, the sand content was high in all samples. Moisture content varied between 1.13% and 5.4%. Potentially contaminated site samples had low moisture of 0.80%. Bulk density was between 1.59 and 2.24. The data shows that the pH varies from 6.18 – 7.14, which ranges from acidic to alkaline type soil in the area. The conductivity

varied from 1204 to 2139 us/cm. The concentrations of nitrogen, phosphorus and potassium varied from 185.2 to 214.8 kg/ha, 5.0 to 11.52 kg/ha and 188.6 to 239.6 kg/ha, respectively. The results of analysis are provided in **Annexure 12**.

Table 4-15: Summary of Inferences from Soil Quality Across all Seasons Season

Season 1	Season 2	Season 3	Inferences
pH of all samples in the range of 5.55 to 7.01	pH of all samples in the range of 6.15 to 7.14.	pH of all samples in the range of 6.25 to 7.89.	Soils in the study area are mildly acidic to neutral and adequate for growth of vegetation/agriculture
Conductivity of samples ranges between 989.6 to 2040.6 μs/cm.	Conductivity of samples ranges between 1204.6 to 2139.6 μs/cm	Conductivity of samples ranges between 1289.4 to 2118.4 μs/cm	This is less than 4000 μs/cm and nature is not saline-very less saline.[59] Suitable for vegetation/crops
N, P, K concentration in all soil samples are in the range of 197.3 to 213.8 kg/ha, < 5.0 to 9.23 kg/ha and 180.4 to 250.3 kg/ha respectively	N, P, K concentration in all soil samples are in the range of 182.3 to 214.8 kg/ha, < 5.0 to 10.12 kg/ha and 178.9 to 239.6 kg/ha respectively.	N, P, K concentration in all soil samples are in the range of 158.6 to 208.6 kg/ha, < 5.0 to 13.6 kg/ha and 174.3 to 219.6 kg/ha respectively.	N content in analyzed soil is Low (< 240 Kg/ha). P content is Low (<11 Kg/ha). K content is medium (110-280 Kg/ha)[60]
Heavy metals: zinc is in the range of 8.23 to 13.75 mg/kg and copper is in the range of 5.58 to 9.45 mg/kg while Cadmium, Lead, Chromium and Nickel are all less than 0.1 mg/kg in all the samples.	Heavy metals: zinc is present in the range 7.02 to 14.02 mg/kg and copper is present in the range 4.25 to 11.42 mg/kg while Cadmium, Lead, Chromium and Nickel are all less than 0.1 mg/kg in all the samples.	Heavy metals: zinc is present in the range 8.12 to 12.32 mg/kg and copper is present in the range 6.85 to 12.52 mg/kg while Cadmium, Lead, Chromium and Nickel are all less than 0.1 mg/kg in all the samples.	Heavy metals were all under permissible limits (Awasthi 1998)[61]
Not tested	Samples S.9, S.10 & S.11 were specifically tested for oil contamination.	Samples – S.9(3), S.10(3) & S.11(3) were specifically tested for oil contamination.	PCB contamination is unlikely to be present. Oil contamination detected from physical examination

Source: MITCON Baseline Report for TPGL

[59] https://www.researchgate.net/publication/273725294_Transformation_of_Fertile_Agricultural_Soil_into_Housing_Schemes_A_Case_of_Bahawalpur_City_Punjab_Pakistan

[60] https://www.researchgate.net/publication/337696042_Case_study_on_the_soil_physical_parameters_disparity_and_NPK_concentrations_in_regions_found_in_and_around_Pachapalayam_Coimbatore_Tamil_Nadu

[61] Awasthi, S. K. (1998). Prevention of Food Adulteration Act No 37 of 1954. Central and State Rules as Amended for 1999. Ashoka Law House.
and State Rules as Amended for 1999. Ashoka Law Hous

5. Climate and Climate Hazards

5.1. Climate and Micrometeorology

199. The climate of Tripura is characterised by a warm and humid tropical climate with five distinct seasons, namely, spring, summer, monsoon, autumn, and winter. Spring starts from late mid-February and continues till mid-March. Summer season starts from mid-March and reaches its peak in April - May and brings thunderstorms accompanied with rain to the state. Pre-monsoon rain is always experienced after Jhum harvesting (slash and burn agricultural practice) in the hills in March-April, these thunderstorms are known as 'Norwesters' or 'Kalbaisakhi' in local language. They generally move from northwest to southeast direction. Their duration may be from a few minutes to a few hours. This is the secondary rainy season of the state with nearly 30% of the annual rainfall. On average, thunderstorms occur more than 30 days in Tripura during this season. Sometimes thunderstorms are accompanied with squalls, with wind speed of more than 150 km per hour or hail. The south-west monsoon when the wind direction changes from northerly/north-westerly to southerly bringing humid air from the Bay of Bengal to the state generally breaks in the later part of May or first week of June and lasts until September. Occasionally there is no gap between the pre-monsoon and monsoon rain. Severe thunderstorm activity decreases but rainfall increases during this season. It is the main rainy season for the state with an average of more than 1300mm. It is about 60% of the annual rainfall. June is the rainiest month of the year with more than 400mm of average rainfall. The south-west monsoon is normally withdrawn from the state during mid-October. Rainfall decreases in the state from October. The temperatures also start decreasing. Winter sets in from November and is it coldest in the month of January. From November itself the weather becomes dry and light northerly surface winds are observed, but sometimes one or two cyclonic circulations in the Bay of Bengal bring some rainfall for 2-3 days during this season. Humidity is generally high throughout the year. In the summer season, due to the presence of Bay of Bengal to its south, the relative humidity varies from 50% to 74% whereas in the monsoon season it is over 85%.

200. Overall Tripura observes moderately warm temperatures during summer and moderately cold temperatures during winter. January is the coldest month of the year, average minimum temperatures are around 10 degrees Celsius in this month. Temperatures start rising from March. The average maximum temperatures are around 32-33 degrees Celsius during this season with April being the warmest month of the year. The average maximum temperatures during the monsoon are around 31-32 degrees and minimum temperatures are around 24-25 degrees Celsius. With the withdrawl of the south-west monsoon and onset of winter the average maximum and minimum temperatures fall from 31 and 22 degrees in October to 26 and 11 degrees Celsius respectively in December.

201. IMD has two full time meteorological observatories in Tripura. One Meteorological Centre (MC) located at the state capital Agartala (23° 53´ N, 91° 15´ E) in West Tripura district and one Meteorological Observatory (MO) located at Kailashahar (24° 19´ N, 92° 00´ E) in Unakoti District. Besides, it also has part-time observatories across the state from which daily rainfall data are obtained.

202. Onsite primary climatic monitoring by MITCON was conducted from October 2020 to June 2021 (post-monsoon, winter, spring and summer). Onsite meteorological data was collected using an automatic weather monitoring station, installed at 10m height in the existing plant. The parameters recorded (24 hourly data) included wind speed and direction, ambient

temperature, relative humidity, atmospheric pressure, and precipitation. The details of parameters monitored and equipment used are given in Table 4-16.
203. Long term secondary meteorological data (2015 -2020) from nearest IMD station (Agartala city) was procured by MITCON for assessment of air quality. Since the complete data set was not received for 2020 (upto May 2020), 2015-2020 was used for assessment. The summary secondary data for 2015-2020 is presented in Table 4-17.

204. Based on the long-term meteorological data, it can be said that the area follows the typical monsoon climate prevalent in the sub-continent. Meteorology of a place can play an important role in the implementation of any developmental project. Meteorology plays a key role in understanding local air quality as there is an essential relationship between meteorology and atmospheric dispersion involving the wind speed/direction, stability class and other factors. The study area falls under the humid sub-tropical climate zone with warm seasons. The highest temperature recorded from the monitoring during pre-monsoon was 35.8ºC and the minimum temperature recorded during this period was 13.2ºC. This shows intense summer in the area. The relative humidity stays at higher side throughout the year. In summer, the relative humidity lies between 57 to 82% whereas during rainy season it goes to 83%. The maximum and minimum relative humidity is 83% for both the month of July and January. Rainfall pattern is of importance since after rainfall the runoff from different areas through narrow rain-fed drainage channel, gets discharged into big streams or rivers. The area experiences very heavy rain from June to September/October from the Southwest Monsoon. Winter seasons (Nov/Jan) in the area is mostly dry (0.7-1.2 days). The annual rainfall in the area is 2057.5 mm with average 94 rainy days. The IMD data collected showed that maximum rainfall for the pre-monsoon season is in May with 363mm.

205. To visualize and interpret the wind flow pattern in a particular area the wind speed and direction are used to produce Wind rose plots. The wind rose gives very concise detailed information of how wind speed and direction are typically distributed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from a particular direction. The length of each "spoke" around the circle is related to the frequency of time that the wind blows from a particular direction. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequencies at the outer circles. The annual wind-rose for the period January 2015 to December 2020 has been obtained from the Meteorological Centre (MC) - IMD Agartala shown as Figure 4-24. The wind rose (Figure 4-25) shows that the winds at Agartala (about 30km from project site) during the period (2015-2020) blow from the south and southeast much of the time. In fact, the 2 spokes around the south-southeast direction (S and SE) comprise about 15% of all hourly wind directions. This also shows that the wind rarely blows from the north. The mean annual velocities are in the range of 4 to 6 km/h and especially high during pre-monsoon period of June to August. These wind roses also provide details on speeds from different directions. The predominant wind direction is Southeast and South, the prevailing wind direction occurs for 15% of the combined time for both directions. The wind frequency graphs for each year are shown as Figure 4-25, represent the percentage of time the wind speeds and their percentages during the period. Examining the graphs shows that annual calm conditions (no to low winds) is 18% of the time.

Table 4-16: Meteorological Parameters Monitored at Project Site

Sr. No.	Parameters	Instruments	Frequency
1.	Wind speed	Counter Cup Anemometer	Hourly / Continuous
2.	Wind direction	Wind vane	Hourly / Continuous
3.	Temperature	Thermo sensor	Hourly / Continuous

4.	Relative humidity	Thermo–hydro sensor	Hourly / Continuous

Source: MITCON Baseline Report for TPGL

Table 4-17: Summary of Long-Term Meteorological Data 2015-2020

Meteorological Centre: IMD Agartala
Location: near Maharaja Bir Bikram Airport, Agartala
Latitude: 23°53'N, Longitude: 91°15'E
Relative location: about 30 Km NNE of project site
Elevation: 15 m above MSL

Month	Temperature (°C)				Relative Humidity (%)		Rainfall (mm)		Mean Wind Speed (m/s)	Wind Direction: Predominant
	Daily Min. Mean	Daily Max. Mean	Lowest in Month	Highest in Month	Min	Max	Monthly mm	No. of Rainy Days		
January	10.5	25.2	6.6	28.8	71	83	7.6	0.8	0.5	N
February	13.9	28.2	9.0	31.6	60	75	22.1	2.1	0.8	N-S
March	18.9	31.7	13.2	35.6	57	70	69.4	3.3	1.2	S-SW
April	22.4	32.9	17.5	35.8	67	74	180.4	7.9	1.6	SE-S
May	23.4	32.6	19.6	35.8	74	78	362.9	13.3	1.3	SE-S
June	25.2	32.3	22.2	35.4	81	82	373.0	14.9	1.5	SE-S
July	25.2	31.6	23.5	34.3	82	83	344.0	15.8	1.5	SE-S
August	25.2	32.2	23.8	34.7	82	82	258.2	14.9	1.2	SE-S
September	24.6	31.8	22.8	34.4	83	84	225.1	12.2	0.9	SE-S
October	22.4	31.4	18.6	34.2	81	83	167.7	7.1	0.6	N-NE, S
November	17.1	29.6	12.8	32.2	79	81	36.2	1.2	0.5	N
December	12.1	26.6	8.8	29.8	78	82	11.0	0.7	0.4	N
Annual Mean or Total	**20.1**	**30.5**	**6.5**	**36.8**	**75**	**79**	**2057.5**	**94.3**	**3.5**	**SE-S**

Source: GOI, Ministry of Earth Sciences, IMD, Climatological Tables 1981-2010, MITCON Baseline Report for TPGL

Table 4-18: Annual Variations in Long-Term Meteorological Data 2015-2020

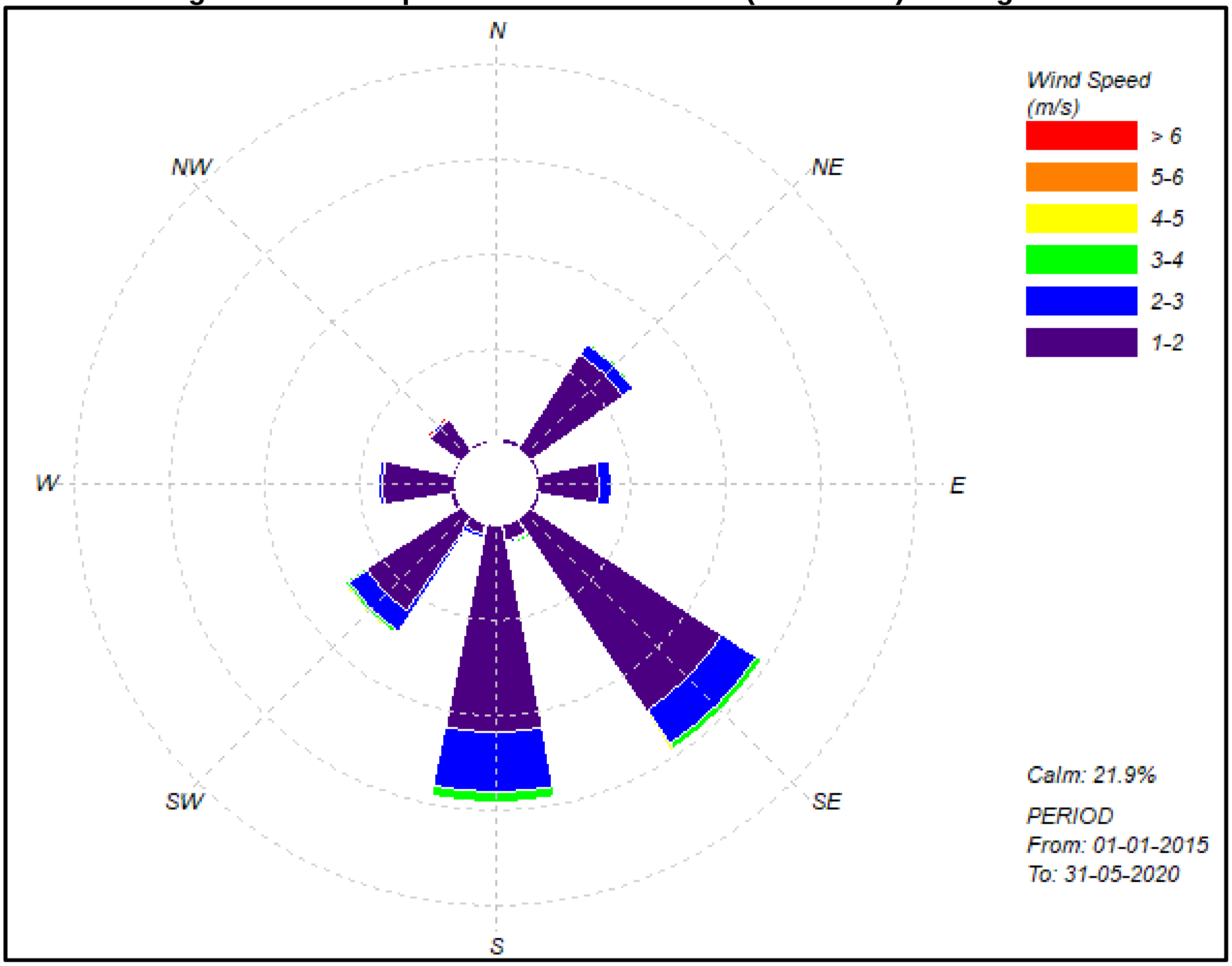
Meteorological Centre: IMD Agartala
Location: near Maharaja Bir Bikram Airport, Agartala
Latitude: 23°53'N, Longitude: 91°15'E
Relative location: about 30 Km NNE of project site
Elevation: 15 m above MSL

Year	Values	Temperature, ^0C	Relative Humidity, %	Wind Speed (km/h)	Wind Dir. (deg)	Precipitation (mm)	Atmos. Pressure	Cloud cover, octa	Mixing height, m
2015	Max	36.2	100.0	36.0	337.5	86.6	40.3	2.0	6000.0
	Mean	25.1	80.3	2.8	81.5	0.9	26.0	0.6	4507.6
	Min	8.2	0.0	0.0	0.0	0.0	8.1	0.0	1500.0
2016	Max	37.4	100.0	22.0	337.5	68.4	38.9	2.0	6600.0
	Mean	25.8	81.6	2.8	85.6	0.7	27.4	0.7	3284.9
	Min	7.6	0.0	0.0	0.0	0.0	9.8	0.0	1000.0
2017	Max	37.0	100.0	114.0	337.5	97.2	39.4	2.0	7500.0
	Mean	25.4	82.9	2.8	78.5	1.5	27.2	0.7	4400.7
	Min	6.6	24.0	0.0	0.0	0.0	8.7	0.0	0.0
2018	Max	39.4	100.0	20.0	337.5	236.2	46.9	2.0	6000.0
	Mean	25.0	81.1	1.9	71.2	1.1	26.0	0.6	4201.9
	Min	7.2	29.0	0.0	0.0	0.0	9.5	0.0	0.0
2019	Max	37.0	100.0	200.0	337.5	158.6	40.7	2.0	7500.0
	Mean	25.4	81.6	2.0	71.5	1.1	27.1	0.6	4580.0
	Min	9.0	28.0	0.0	0.0	0.0	10.5	0.0	0.0
2020 (up to May)[62]	Max	37.0	100.0	44.0	315.0	30.5	38.2	2.0	7500.0
	Mean	23.4	78.5	1.5	56.6	0.3	22.3	0.5	4371.5
	Min	8.2	17.0	0.0	0.0	0.0	8.9	0.0	1000.0

Source: MITCON Baseline Report

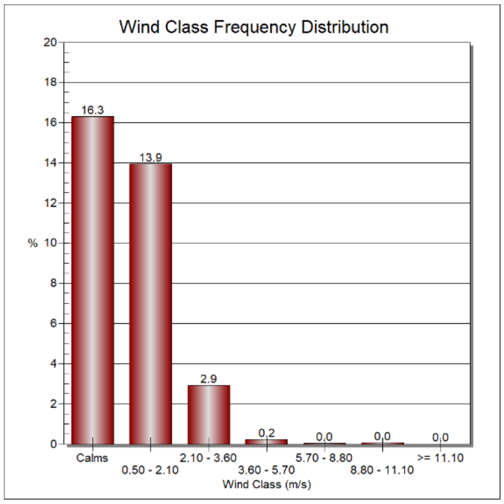
[62] Not used for assessment as complete year data not available

Figure 4-24: Composite Annual Windrose (2015-2020) IMD Agartala

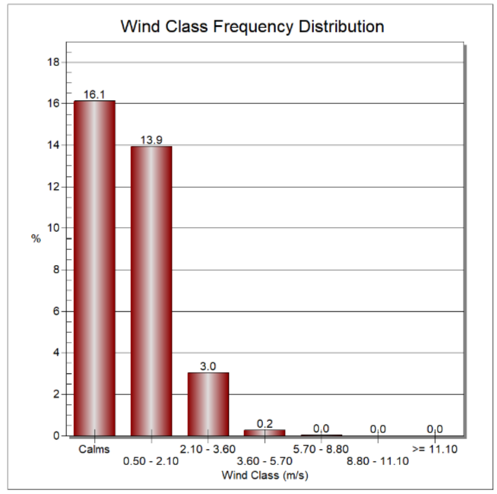


Source: ADB TA Consultant

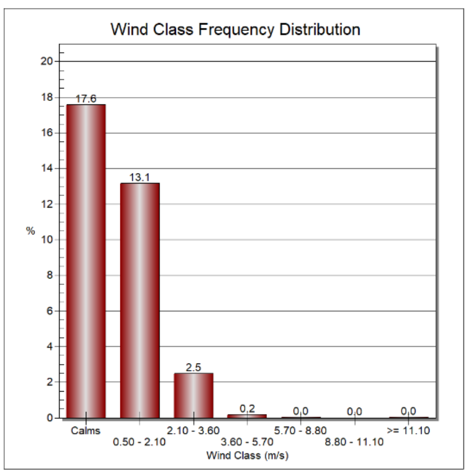
Figure 4-25: Wind Speed Frequency graphs for period 2015-2019 IMD Agartala



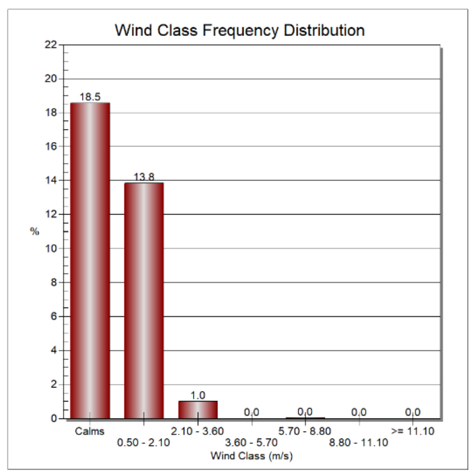
2015



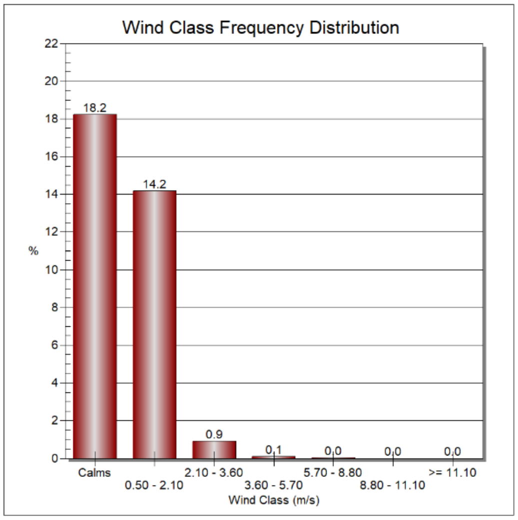
2016



2017



2018



2019

Source: ADB TA Consultant

5.2. Climatic Hazards

206. The CCGPP is vulnerable to temperature increase, heavy precipitation, droughts, and extreme weather conditions due to its location, fresh cooling water requirement, and efficiency change by heat. Power distribution network will be affected by temperature increase, and extreme weather conditions which lead to system losses and frequent maintenance and repair.[63] According to the Vulnerability Atlas of India, 2019 Tripura faces danger from heavy storms and floods.[64]

207. **Temperature:** Averaged annual mean maximum temperature time series has shown no trends in Tripura during 1951-2010 (study period). Averaged annual mean minimum temperatures have shown significantly increasing trends in Tripura and is +0.02 ^{o}C/year during the study period. Annual mean diurnal temperature range (DTR) trends have significantly decreased over Tripura and is -0.02 ^{o}C/year. Annual mean temperatures have increased significantly over all the Tripura.[65] The study indicates decreasing trend in winter mean maximum temperatures over Tripura during 1951-2010. State averaged winter mean minimum temperatures have shown significantly increasing trends over Tripura and is (+0.033) ^{o}C/year. Winter DTR has decreased significantly over Tripura and is -0.04 ^{o}C/year. State averaged summer mean maximum temperatures have decreased and is -0.02 ^{o}C/year. No trends have been observed for summer mean minimum temperatures. Summer mean temperatures have shown significant decreasing trends over Tripura -0.01 ^{o}C/year. Summer DTR showed significantly decreasing trends over Tripura and is -0.02 ^{o}C/year.

208. **Rainfall:** The highest ever temperature recorded at Agartala is 42^{0}C on 1st May 1960. Tripura is generally moderately cold, but on one occasion, the temperature recorded as 2^{0}C on

[63] ADB Climate Risk and Vulnerability Assessment, 2021
[64] https://bmtpc.org/topics.aspx?mid=56&Mid1=180
[65] State Level Climate Change Trend in India, http://environicsindia.in/wp-content/uploads/2018/09/ StateLevel ClimateChangeMonoFinal.pdf

30 December 1972. The highest one-day rainfall recorded was 257.2 mm on 22 May 1993.[66] State averaged annual rainfall trend, winter season rainfall trend and summer season rainfall trend have been increased over Tripura while decreasing trends have been observed over Tripura in monsoon and post monsoon rainfall.

209. **Wind Hazard and Cyclones**: The state is caterogorized as cyclonic as it experiences cyclonic winds at speeds up to 198 km/hour. The study area including the project site is categorized as very high damage risk zone due to wind hazard as shown in Figure 4-27. Because the Tripura state is surrounded by Bangladesh and aerial distance to Bay of Bengal is less than 100 KM, the entire landmass of the State is also prone to high wind and cyclone zone-A which is very high-risk zone.[67] Study area, located in West Tripua is not high cyclones. Based on the FGD, the nearest resdients face wind winds during monsson season and in 2019, part of tin roof was blow away by high-speed winds.

210. **Landslide:** The landslide susceptibility is classified as medium according to the information published by UNDRR. This means that Tripura has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides an infrequent hazard phenomenon. Climate change is likely to alter slope and bedrock stability through changes in precipitation and/or temperature. It is difficult to determine future locations and timing of large rock avalanches, as these depend on local geological conditions and other non-climatic factors.

211. **Drought:** Although drought is not a periodic calamity in the State, it does occur at times such as the dry spell of 1988-99. Caused by extremely low rainfall, the drought of December 1988- April 1999 had resulted in extensive damage to crops across the State. The rainfall during this period was as low as 54.6mm while the usual average for the corresponding period is 286.6mm. Summer vegetables, paddy, sesamum, maize, etc., were among the crops damaged. The damage of Rs 1397.3 million caused by debilitating drought had seriously affected the State's economy, the agricultural sector in particular.

212. **Flood:** 750 km^2 of land area of Tripura is considered to be flood prone. Nearly all the rivers are rain-fed and are prone to flood. During the past twenty-five years, two massive floods occurred in 1999 and 2004 causing huge economic cost. The 1999 floods followed incessant rain that was almost double the normal rainfall and it was extremely heavy during 8-12 of July resulting in the floods. The damage was particularly severe in South Tripura and West Tripura districts. Especially Gumti River had turned immensely destructive and the total damage caused by this flood was estimated at Rs 498.5 million. Two episodes of devastating floods occurred in June/July and September 2004, following unprecedented rainfall. For example, while the usual average rainfall in North District during the month of July was 700.9 mm, in 2004 it was 2,102.8 mm; whereas the usual average for South Tripura in the month of September is 298.4 mm, in 2004 it was as high as 1,491.8 mm.[68] In the recent past, frequent flooding has been observed, August and November 2002, May and June 2003, June 2004, September 2005, June to November 2007, March and April 2010, May 2011, May 2013.[69]

[66] https://agartala.imd.gov.in/Tripura-Climatology/#:~:text=Month%20wise%20extreme%20temperature%20and,mm%20on%2022nd%20May%201993.

[67] Tripura State Action Plan on Climate Change, Government of Tripura

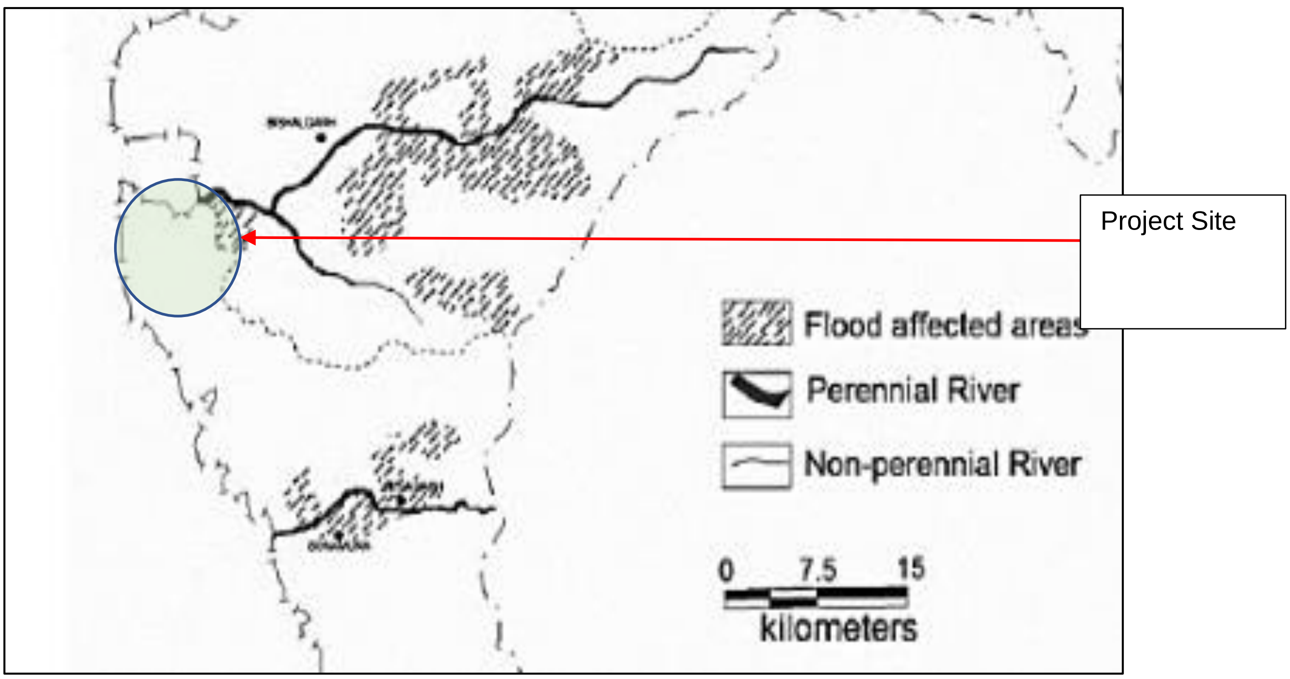
[68] Tripura State Pollution Control Board, http://trpenvis.nic.in/test/disaster.html

[69] https://www.rkvy.nic.in/static/SAP/TR/For%20this%20Period(2017-18%20to%202019-20)/SAP%20Tripura%20Report_LD.pdf

213. North, South, Dhalia and West Tripua district faces flash floods annually during the monsoon season i.e., June to September accompanied with other hazards like landslide. Flood prone areas in study area include Putia, Rahimpur, Veluarchar, Manikyanagar, Dayalpara, Boxanagar, Lakshimura, Dakshin Kalamchowra, Anandapur, Matinagar, Sonamura National Park. In June/July 2003 a one off flood event[70] damaged 4,860 ha of paddy and 5,939 ha of non-paddy in Boxaranagar around 4km from project site.

214. Figure 4-27 shows flood prone areas based on historic events including the project site status. Based on inputs during consultation, the nearest residents were of opinion that the road along the proposed site boundary and also the project road is flooded with rain water with high speed gushing water flow. The project site however is not flooded as it stands on higher ground than the road.

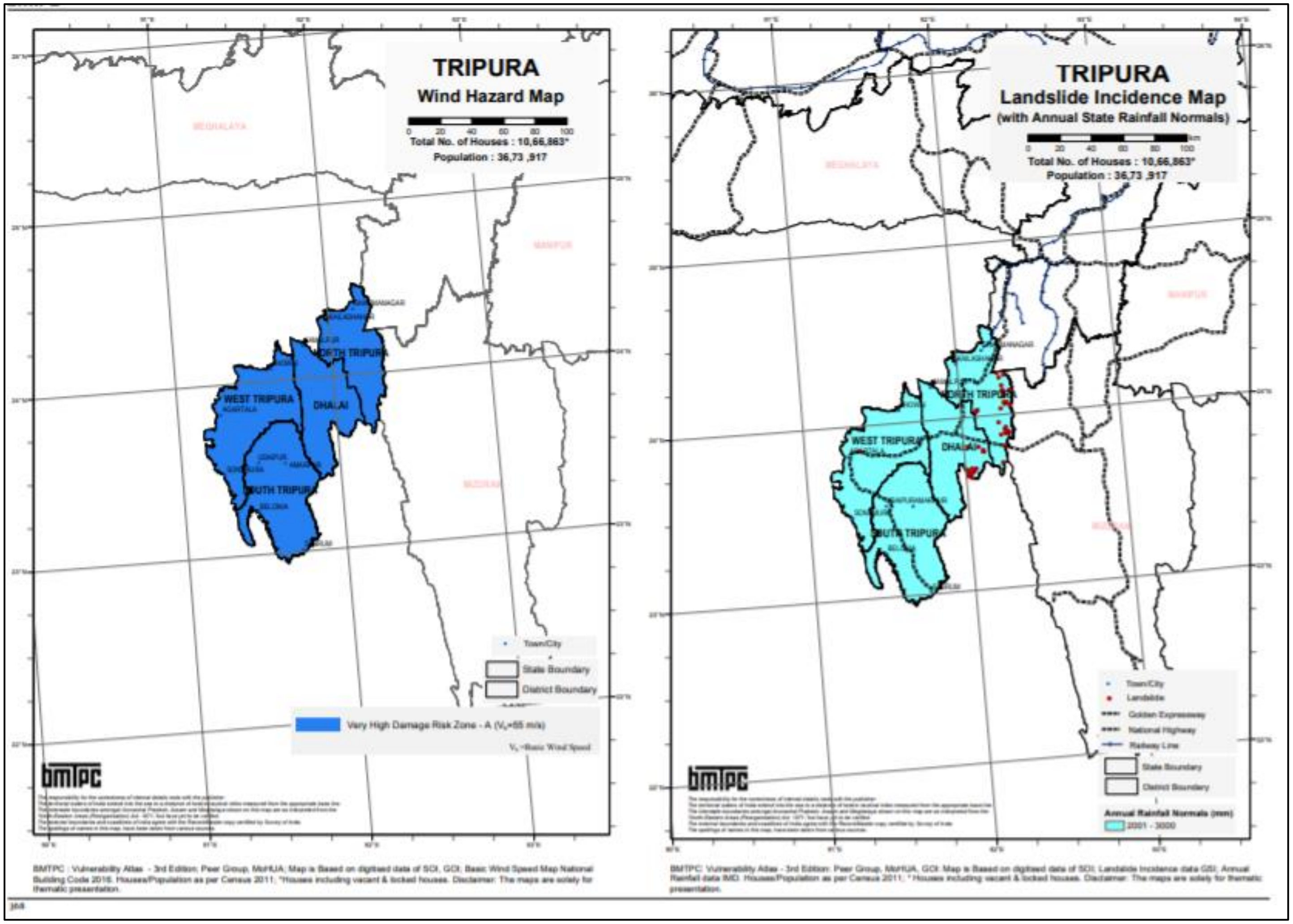
Figure 4-26: Map Showing Project Site and Surrounding Flood Affected Areas (1993-2004)



Source: Tripura State Pollution Control Board, http://trpenvis.nic.in/test/disaster.html

[70] Spatio-temporal analysis of flood and identification of flood hazard zone of West Tripura district, Tripura, India using integrated geospatial technique – 2015

Figure 4-27: Tripura Wind and Landslide Hazard Map



Source: BMTPC https://bmtpc.org/DataFiles/CMS/file/Publication/VAI_3rd2019.pdf

6. Ambient Air Quality

215. For primary data collection, air quality monitoring stations were identified based on the following:

(i) Air quality assessment objectives,
(ii) Prevailing meteorology conditions,
(iii) Location of sensitive receptors likely to be impacted,
(iv) Analysis of climatological data and wind rose,
(v) Practical site implementation factors like road approach, site condition, ease of setup of equipment and systems, availability of electricity etc.

216. The ambient air quality monitoring was initially conducted at eight sites within 10 km PAI. During the second season, an additional two sites were used to capture the potential population exposure closer to the project site. The baseline sampling was conducted with the existing plant operating. Consequently, the background data may potentially contain contributions from the existing plant emissions, which would be absent when the existing plant is decommissioned. As a result, cumulative concentrations presented in the air quality assessment will be conservative.

217. At each station sampling of PM_{10}, $PM_{2.5}$, SO_2, NO_x and CO (for CO season 2 and 3 only) was performed continuously over a 24-hour period (8-hour period for CO) to determine 24-hour average (and 8-hour average for CO) concentrations. The sampling frequency was twice a week. Sampling was conducted at a height of 3.5 m (approximately) from the ground level. Calibrated Respirable Dust Samplers with Whatman GF/A microfiber filter paper (size: 8" X 10") were used for the collection of particulate matter (PM) and analyzed using gravimetric principles separately for the two PM components. Sampling and analysis of ambient SO_2 was performed with a calibrated gas sample by adopting the Improved West and Gaeke Method using spectrophotometric principles and that of ambient NO_x was performed by adopting the Jacob Hochheister Modified (Na arsenite) Method followed by spectrometry. Concentrations of CO were determined using a non-dispersive infra-red analyser. Further details are given in Table 4-19.

Table 4-19: Methodology of Air Quality Monitoring

Parameter	Averaging Period	Monitoring Equipment	Analytical Method	Minimum Detectable limit	Technical Protocol
$PM_{2.5}$	24 hour	Fine dust sampler	CPCB Guidelines for the Measurement of Ambient Air pollutant Vol. I, 2011	10 µg/m^3	Gravimetric method
PM_{10}	24 hour	Fine dust sampler	IS 5182 (Part 23):2006, RA-2012	10 µg/m^3	Gravimetric method
SO_2	24 hour	Gaseous sampler	IS 5182 (Part II):2001, RA-2012	5 µg/m^3	Improved West and Geake method
NO_x	24 hour	Gaseous sampler	IS 5182 (Part VI):2006, RA-2012	5 µg/m^3	Modified Jacob and Hochheiser method
CO	8 hour	CO meter	IS 5182 (Part-X) and CPCB Guidelines	-	Non-Dispersive Infra-Red (NDIR) spectroscopy

Source: MITCON Baseline Monitoring Report/CPCB

218. Tables 4-20 and 4-21 present a summary of the monitored baseline air quality data along with standards for assessment. Results for CO have not been presented as they were all below the limit of detection of the method used.
219. Due to the intermittent nature of method used, although in-line with CPCB guidance and Indian standards, the data may not necessarily reflect potentially higher values that may occur in between the sampling periods. To ensure the data and subsequent assessment is robust, in the absence of continuous 24-hour monitoring, the average values from all samples collected (which were taken to represent an annual/long-term averaged dataset) were doubled to determine the short-term baseline concentrations in the air quality assessment in Chapter V. This procedure is consistent with dispersion modelling guidance in the UK.[71] The NOx monitoring method used provides concentrations of total NOx (i.e., NO + NO2), whereas the air quality guidelines are based on the NO2 component only. Consequently, a factor of 0.7 has been applied to the NOx monitoring data to derive NO2 concentrations per UK and US EPA guidance.

220. In summary, the maximum baseline data referred to in Tables 4-20 and 4-21 have not been used directly in the air quality assessment. Rather, to estimate maximum short-term concentrations which may not have been captured through the intermittent monitoring strategy used, and to account for the fact that it is highly unlikely maximum impacts from different sources will occur over the same temporal scales, the average data have been doubled for the purposes of defining hourly, 8-hourly and daily mean background data. The average data, without any additional factor applied, has been used for the long-term (annual mean) impact assessment. The long-term and short-term background data used in the assessment can be found in Table 5-16.

[71] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Table 4-20: Three Season Baseline Air Quality Assessment for PM_{10} and $PM_{2.5}$ (Oct 2020-June 2021)

Monitoring Station	PM_{10}						
	Season 1 Max	Season 2 Max	Season 3 Max	Three Season Avg.	Max as % of GoI Std.	Max as % of WHO-IFC guideline	Max as % of WHO AQG 2021
	µg/m3	µg/m3	µg/m3	µg/m3	%	%	%
AAQ1 – Existing Plant	114.8	110.8	112.2	52	114.8	229.6	255.1
AAQ2 - Putia	125.4	103.0	89.8	46	125.4	250.8	278.7
AAQ3 - Boxanagar	134.6	112.0	114.8	53	134.6	269.2	299.1
AAQ4 - Manikyanagar	123.6	102.0	108.2	49	123.6	247.2	274.7
AAQ5 - Kamalanagar	123.6	106.6	95.8	49	123.6	247.2	274.7
AAQ6 - Konaban	120.8	99.2	95.6	46	120.8	241.6	268.4
AAQ7 - Lalsingmura	118.6	112.2	112.8	52	112.2	237.2	263.6
AAQ8 - Rahimpur	102.2	118.6	103.0	47	118.6	237.2	263.6
AAQ9 - Ghilatali	-	95.8	86.8	40	95.8	191.6	212.9
AAQ10 - Bhaluarchar	-	110.8	101.8	46	110.8	221.6	246.2

Monitoring Station	$PM_{2.5}$						
	Season 1 Max	Season 2 Max	Season 3 Max	Three Season Avg.	Max as % of GoI Std.	Max as % of WHO-IFC guideline	Max as % of WHO AQG 2021
	µg/m3	µg/m3	µg/m3	µg/m3	%	%	%
AAQ1 – Existing Plant	46.6	51.0	44.8	21	85.0	204.0	340.0
AAQ2 - Putia	49.0	53.0	36.0	18	88.3	212.0	353.3
AAQ3 - Boxanagar	49.8	52.6	46.0	21	87.7	210.4	350.7
AAQ4 - Manikyanagar	51.0	49.4	43.2	20	85.0	204.0	340.0
AAQ5 - Kamalanagar	46.4	47.2	38.2	19	78.7	188.8	314.7
AAQ6 - Konaban	49.6	52.6	38.2	18	87.7	210.4	350.7
AAQ7 - Lalsingmura	49.8	52.8	45.2	22	88.0	211.2	352.0
AAQ8 - Rahimpur	40.4	45.0	41.2	18	75.0	180.0	300.0
AAQ9 - Ghilatali	-	51.6	34.8	17	86.0	206.4	344.0
AAQ10 - Bhaluarchar	-	44.4	40.8	18	74.0	177.6	296.0

* Industrial, Residential, Rural & other Areas -standard. None of the sites are Ecological Sensitive areas (notified by GoI);
PM10 Std: GoI: 100 µg/m3, WHO AQG in WB-IFC 2007: 50 µg/m3, WHO AQG 2021: 45 µg/m3;
PM2.5 Std: GoI: 60 µg/m3, WHO AQG WB-IFC 2007: 25 µg/m3, WHO AQG 2021: 15 µg/m3
Maximum value across all 3 seasons was used for establishing whether the airshed is degraded with respect to short-term concentrations. Average value used for long-term (annual mean) concentrations in the air quality assessment.

Exceeds GoI Standard	Exceeds WB IFC Guideline	Exceeds WHO AQG 2021

Source: ADB TA Consultant

Table 4-21: Three season air quality assessment of SO_2 and NO_2 (Oct 2020-June 2021)

Monitoring Station	SO_2						
	Season 1 Max	**Season 2 Max**	**Season 3 Max**	**Three Season Avg.**	**Max as % of GoI Std.**	**Max as % of WHO-IFC Guideline**	**Max as % of WHO AQG 2021**
	µg/m3	µg/m3	µg/m3	µg/m3	%	%	%
AAQ1 – Existing Plant	24.8	50.6	51.4	17	85.7	257.0	128.5
AAQ2 - Putia	29.8	31.8	22.6	10	53.0	159.0	79.5
AAQ3 - Boxanagar	36.4	34.4	45.0	14	75.0	225.0	112.5
AAQ4-Manikyanagar	31.4	31.0	31.8	12	53.0	159.0	79.5
AAQ5 - Kamalanagar	22.6	25.8	41.8	11	69.7	209.0	104.5
AAQ6 - Konaban	37.0	29.6	51.4	14	85.7	257.0	128.5
AAQ7 - Lalsingmura	36.4	32.8	43.4	14	72.3	217.0	108.5
AAQ8 - Rahimpur	15.6	29.8	41.8	11	69.7	209.0	104.5
AAQ9 - Ghilatali	-	31.0	37.4	13	62.3	187.0	93.5
AAQ10 - Bhaluarchar	-	31.0	22.6	9	51.7	155.0	77.5

Monitoring Station	NO2					
	Season 1 Max	**Season 2 Max**	**Season 3 Max**	**Three Season Avg.**	**Max as % of GoI Std.**	**Max as % of WHO AQG 2021**
	µg/m3	µg/m3	µg/m3	µg/m3	%	%
AAQ1 – Existing Plant	48.8	52.8	38.2	12	66.0	211.2
AAQ2 - Putia	46.2	53.0	51.4	15	66.3	212.0
AAQ3 - Boxanagar	50.2	48.8	36.8	12	62.8	200.8
AAQ4 - Manikyanagar	49.4	47.8	49.2	14	61.8	197.6
AAQ5 - Kamalanagar	35.6	43.2	33.6	11	54.0	172.8
AAQ6 - Konaban	48.6	48.0	37.8	12	60.8	194.4
AAQ7 - Lalsingmura	50.2	51.8	35.4	12	64.8	207.2
AAQ8 - Rahimpur	24.6	27.4	33.6	8	42.0	134.4
AAQ9 - Ghilatali	-	38.8	36.0	9	48.5	155.2
AAQ10 - Bhaluarchar	-	35.8	35.8	10	44.8	143.2

* Industrial, Residential, Rural & other Areas -standard. None of the sites are Ecological Sensitive areas (notified by GoI); **** NO_2 values from NOx (70%).**
SO2 Std: GoI: 60 µg/m3, WHO in WB-IFC 2007: 20 µg/m3, WHO AQG 2021: 40 µg/m3;
NO2 Std: GoI: 80 µg/m3, WHO in WB-IFC 2007: **no daily mean guidelines present**, WHO AQG 2021: 25 µg/m3
Maximum value across all 3 seasons was used for establishing whether the airshed is degraded with respect to short-term concentrations. Average value used for long-term (annual mean) concentrations in the air quality assessment.

Exceeds GoI Standard	**Exceeds WB IFC Guideline**	**Exceeds WHO AQG 2021**

Source: ADB TA Consultant

221. The concentration of PM_{10} exceeds the GoI Standard for nine locations (except Ghilatali) among the ten monitored locations. All the locations exceed the IFC-WB 2007 guideline and most recent WHO 2021 daily mean guideline. Monitored daily mean $PM_{2.5}$ concentrations are higher than the IFC-WB guideline and most recent WHO 2021 guideline at all locations but are compliant with the GoI standard. The SO_2 daily mean values exceed the IFC-WB guideline for all locations but are compliant with GoI standard. In comparison to the most recent WHO 2021 daily mean SO_2 guideline, four locations exceed the guidelines – Putia, Manikyanagar, Ghilatali and Bhaluarchar (the revision (increase) in the SO_2 WHO air quality guideline in the 2021 update followed more recent research on health impacts associated with SO_2). Daily mean NO_2 ambient levels exceed the recently introduced 24-hour WHO 2021 guideline at all locations but are in compliance to the GoI standards at all locations. If the three-season average concentration is considered to represent an annual mean concentration, no monitoring location would comply with the revised WHO 2021 annual mean guideline value for NO_2. CO concentrations at all locations were below detectable limits. The study area can generally be identified as a non-degraded airshed based on the GoI standard but would be considered degraded from both a long-term and short-term perspective if compared against the more conservative recently introduced WHO 2021 guidelines.

222. Major sources of pollution include suspended dust due to erosion of open areas and unpaved roads. Except for the existing plant, the only industries are brick kilns whose contributions are already accounted for in the baseline data. Other industries are absent in the study area. It may be conservatively anticipated that the existing plant may have contributed to NO_x and CO values as the plant was operational during the monitoring surveys. Open crop burning/jhum cultivation and operating brick kilns may contribute to air pollution, especially higher SO_2 values, intermittently or seasonally. Particulates and SO_2 contributions are not anticipated during operation of the existing or proposed plant as natural gas is used as fuel.

7. Ambient Noise

223. Noise and vibration in the form of undesirable and unwanted sounds can have an adverse effect on human beings and their environment, including structures, and domestic animals. It can also disturb wildlife and ecological systems. Sound undergoes absorption, reflection etc. Thus, sound propagation from a source to a receptor depends upon the properties of the atmosphere and the presence of any object in the transmission path. It is therefore necessary to measure both the quality as well as the quantity of environmental noise in and around the proposed plant.

224. MoEF&CC has notified permissible noise levels for different zones in India vide gazette notification dated February 14, 2000 under the Environment Protection Act (1986) wherein standard limits are provided in respect of time (day: 6.00am to 10.00pm and night: 10.00pm to 6.00am) and land use – Industrial, Commercial, Residential, Silence and Mixed area. As per notification, the Silence zone is defined as an area up to 100m around premises of hospitals, educational institutions, and courts. Rule 3(4) states that while planning developmental activity consideration will be taken of all aspects of noise pollution as a parameter of quality of life to avoid noise menace and to achieve the objective of maintaining the ambient air quality standards in respect of noise. It does not provide guidance on the exceedance of ambient noise due to such developmental activities.

225. In terms of ADB's SPS 2009 requirement, the IFC EHS Guidelines 2007 which in turn refer to the WHO Community Noise Guidelines are referred to along with the GoI standards and assessment is undertaken based on a more stringent threshold. The IFC EHS Guidelines sets

absolute noise thresholds, in addition to noise requirements in relation to changes in ambient noise level. The principle of the latter is that noise emissions from the proposed plant should not result in an increase in background levels of 3 dB at the nearest receptor location off site. For the purpose of this assessment, it is assumed that the terminology for background levels as defined in the IFC EHS Guidelines are equivalent to the ambient sound level i.e., the totally encompassing sound at the receptor location excluding contributions from the proposed plant, presented in terms of $L_{Aeq,\ T}$.

226. The noise limits at industrial receptors are more stringent in the IFC EHS Guidelines than the GoI Standards, whilst at residential receptors it is the same, and less stringent for silence and commercial zones. Table 4-22 presents a comparison of the GoI and IFC EHS Guideline thresholds, and the noise standards adopted in the assessment. For the noise assessment, a combination of the two sets of standard/guidelines has been adopted as being the most stringent thresholds. Consideration of the IFC EHS Guideline requirement for a change in ambient noise levels is given for scenarios where noise levels from the proposed plant exceed the assessment standard.

Table 4-22: Noise Assessment Standards in dB(A)

Receptor	GoI Standard LAeq, 24 hr		IFC EHS LAeq, 1 hr		Assessment Criterion LAeq, 24 hrT	
	Day	Night	Day	Night	Day	Night
Industrial	75	70	70	70	70	70
Commercial	65	55	70	70	65	55
Residential	55	45	55	45	55	45
Silence (at 100m buffer)						
Educational	50	40	55	45	50	40
Health/Medical	50	40	-	-	50	40
Court	50	40	-	-	50	40
Religious Places	50	40	-	-	50	40
Authority Declared	50	40	-	-	50	40

Source: ADB TA Consultant

227. Ambient noise levels were initially monitored at 8 locations within the study area through a network of monitoring stations for the 1st and 2nd season. For 3rd season only 5 locations were identified, as these are likely to be most impacted by the proposed development and assessed further. Continuous (24-hour) noise level sampling was carried out at the 5 locations in August 2021. Summary of the noise monitoring results are shown in Table 4-23 (statical analysis) and Table 4-24 (comparing with assessment standards) and detailed noise data is attached as **Annexure 15.** The ambient noise time series is presented as Figure 4-29. Since the existing plant was operational, it is likely to have contributed to the monitored data. Noise was monitoring across all seasons, except monsoon, as rainfall would contribute to higher noise levels. Although the last monitoring was done during monsoon (August 2021), but all monitoring period was dry without rainfall.

228. The overall day-night noise levels at all the five locations are lower than the assessment criterion, except school at night time. All locations are in a rural setting and major noise sources in the surroundings of the project site include neighborhood/residential noise and intermittent low volume vehicle pass. Manikyanagar itself is a rural village with residents and local commercial activities, along with some traffic movement, mostly 2-wheelers and private vehicles. The school is operation during the day. The monitored noise level at 2 is at a buffer

location 100m from the school, this is an open field and lacks any contributing noise sources except for the natural environmental noise. The school, however, is adjacent to a highway with moderate traffic flow. The monitored noise level at NV4 is likely to be the most representative of the baseline condition, as there are minimal contributions from anthropogenic sources in the location. No roads are nearby and noise from the existing plant can be ruled out. The assessment of the noise emission due to the proposed plant (Chapter 5) therefore adopts the night-time noise level of NV4 for the Closest House assessment.

Table 4-23: Summary of 48 Hour Monitored Ambient Noise in August 2021

Parameters	**Manikyanagar**	**Closest Houses**	**School (100m buffer)**	**Project Site Boundary (E)**	**Project Site Boundary (W)**
	NV.4	1	2	3	4
LA_{eq} 16 hr, Day	51.2	47.7	47.5	41.6	42.9
L_{90} Day	45.1	42.5	43.4	38.1	39.5
L_{10} Day	55.1	50.9	50.6	44.5	45.2
L_{max} Day	56.1	51.6	50.8	45.9	46.4
L_{min} Day	42.3	40.3	41.4	37.1	38.4
LA_{eq} 8 hr, Night	44.8	42.4	42.6	37.5	38.9
L_{90} Night	42.8	40.4	41.5	36.4	38.2
L_{10} Night	47.3	45.0	44.6	38.6	39.8
L_{max} Night	48.7	46.4	45.1	39.7	40.3
L_{min} Night	42.6	39.8	41.2	36.1	37.8

all values in dB(A)

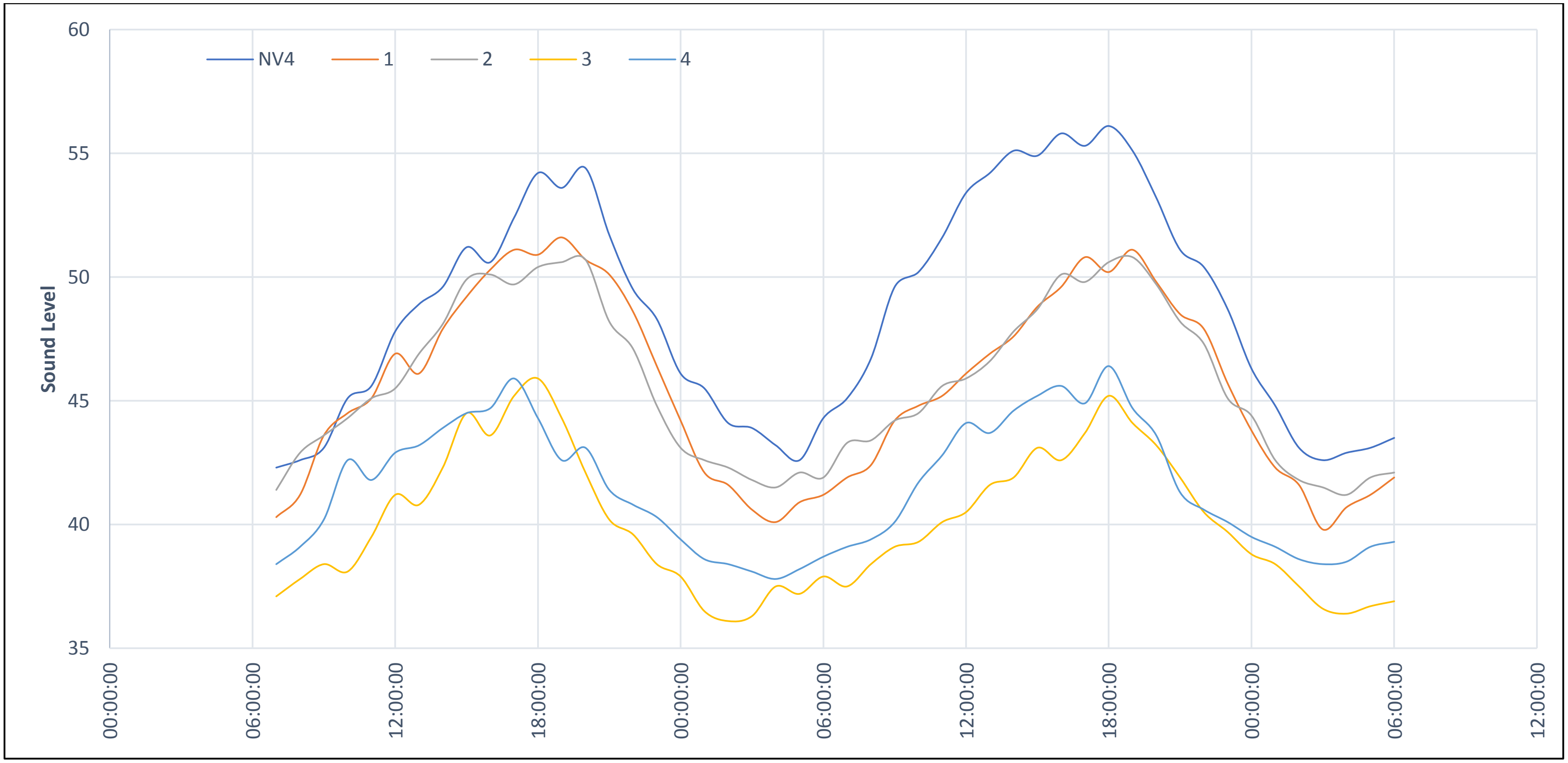
Source: ADB TA Consultant

Table 4-24: Assessment of Ambient Noise Levels, August 2021

No.	**Location**	**Noise climate**	**Zone**	**Day (6 am-10 pm) Noise Levels LAeq 24**		**Night (10 pm – 6 am) Noise Levels LAeq 24**	
				Assessment Criterion	Ambient Noise	Assessment Criterion	Ambient Noise
NV.4	Manikyanagar	Rural, open area, near field, vegetation	Residential/open	55	51.2	45	44.8
1	Closest Houses	Rural, nearest house cluster, 55m to proposed plant, buffer of 50m has trees, neighborhood noise with intermittent low flow traffic predominant	Residential	55	47.7	45	42.4
2	School (at 100m buffer)	Rural, sensitive receiver, buffer is open area/field.	Silence	50	47.5	40	**42.6**
3	Site Boundary (E)	Project site, vacant land, vegetated	Industrial	70	41.6	70	37.5
4	Site Boundary (W)	Project site, vacant land, vegetated	Industrial	70	42.9	70	38.9

*As per Table 4-13; all values in dB(A)
Non-conformers/Exceedance are highlighted
Source: ADB TA Consultant

Figure 4-29: Ambient Noise Time Series (48 hours) at the Five Noise Monitoring Locations (August 2021)



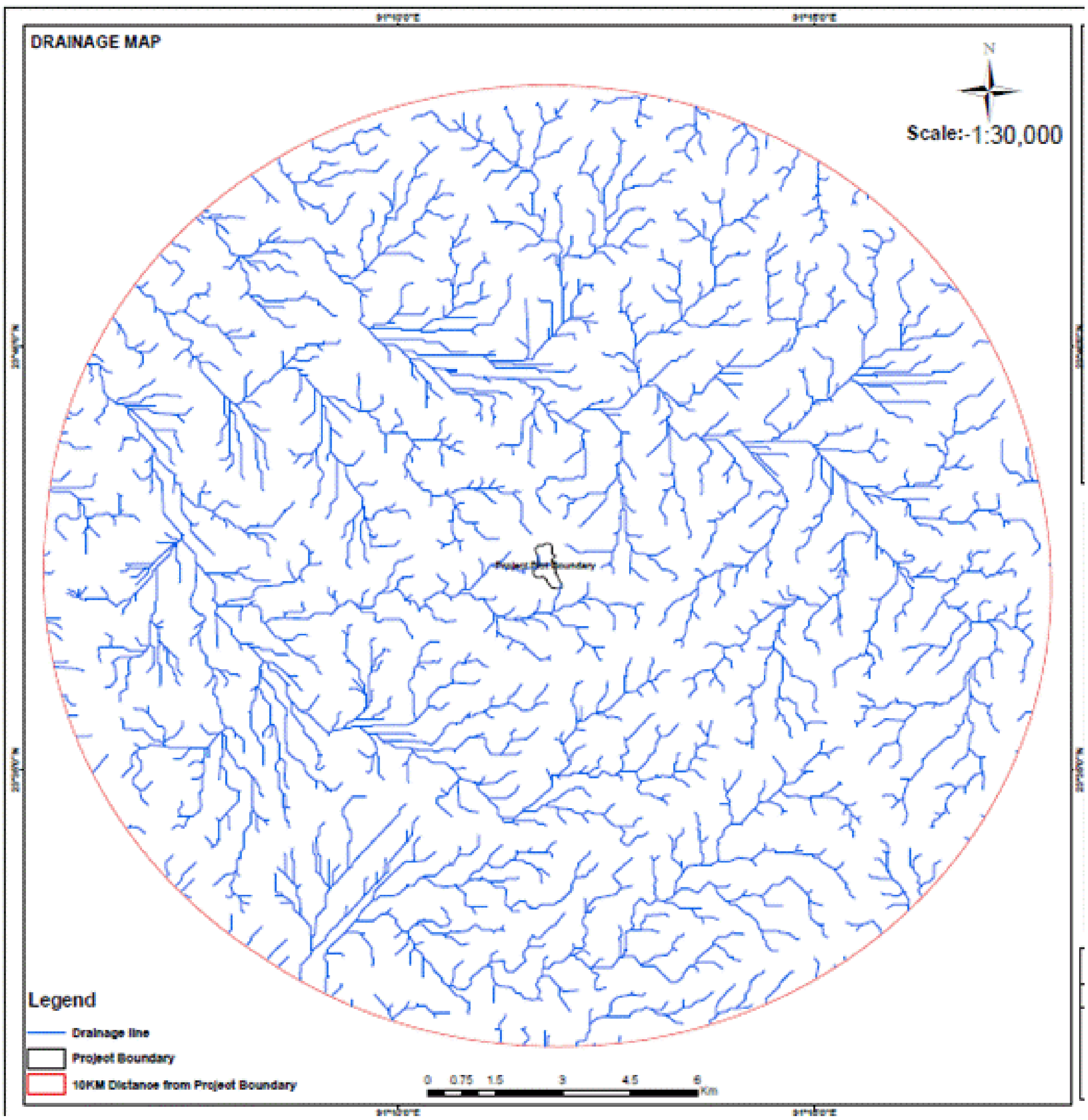
Source: ADB TA Consultant

8. Hydrology, Hydrogeology and Water Resources

8.1. Hydrology

229. Tripura state is drained by 10 major rivers which originate in the hill ranges and flow either in a northerly or westerly direction through narrow valleys. The only major rivers in the study area is the Salda river, which is rain-fed and ephemeral. None of these major rivers flow in the study area. During the dry season all the major rivers are fed by ground water and maintain certain base flow. Each valley in the study area is drained by a river with several perennial and ephemeral streams joining to produce a dendritic drainage pattern. Run-off essentially depends on various factors like intensity and duration of rainfall, its distribution, extent of the catchment area, vegetative cover, relief and slope. Figure 4-30 shows drainage pattern map of the 10 km study area around project site and Figure 4-31 shows Salda river in study area.

Figure 4-30: Drainage Pattern of Study Area



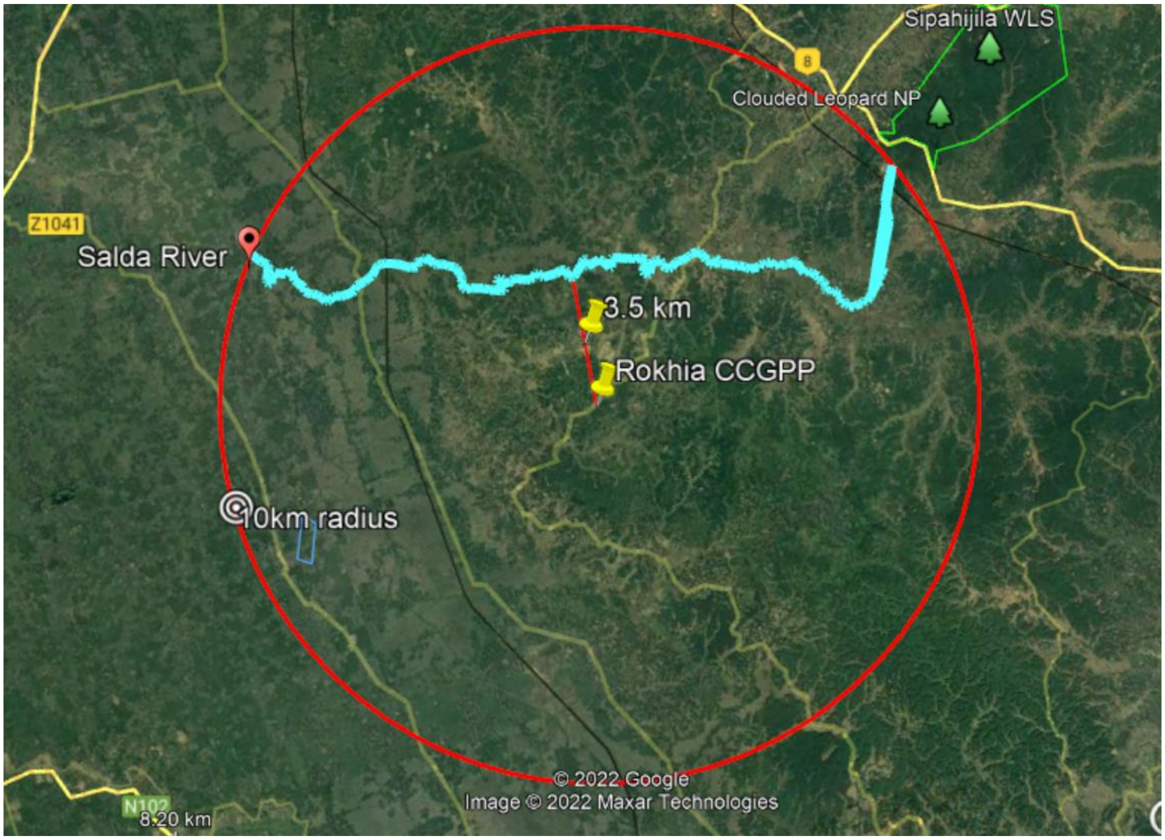
Source: MITCON

230. The are no rivers/streams on or adjacent to the project site. The Salda River, is about 3.5 km N of the project site. The river originates in the Baramura Hills and flows in Bangladesh traversing the north of the study area. In the Sipahijila district the area drained is 0.030 sq km and area drained is 15%. The river is rainfed and becomes dry during the summers. Abstractions include for river bed sand mining, fishery, agriculture, bathing, washing, etc. There are two moderate sized ponds in the surroundings of the project site; one located at 1 km near Manikyanagar, while the other is near the existing plant at 1 km. No other water bodies are present either on site or in the immediate surroundings.

231. In the wider study area, there is one major water, the Rudrasgar lake, an IBA and Ramsar Wetland, located 17.5km, SE of project site. The lake area is 240 ha. Rudrasagar Lake, a lowland sedimentation reservoir in the northeast hills, is fed by three perennial streams discharging to the River Gomti. The lake is abundant in commercially important freshwater fishes like *Botia* spp*, Notopterus Chitala, Mystus spp., Ompok pabda, Labeo bata*, and freshwater scampi, with annual production of 26 metric-tons. Owing to high rainfall (2500mm) and downstream topography, the wetland is regularly flooded with 4-5 times annual peak, assisting in groundwater recharge. Lands are owned by the state with perennial water areas leased out to the subsistent fishers' cooperative, and surrounding seasonal waterbodies are cultivated for paddy. Main threats are increasing silt loads due to deforestation, expansion of agricultural land and intensive farming, and land conversion for population pressure. Vijaya Dashami, one of the most important Hindu festivals with various sports events, attracts at least 50,000 tourists and devotees every year. A management plan is underway by the MoEF&CC.[72]

[72] Ramsar site no. 1572. Most recent RIS information: 2005

Figure 4-31: Map showing Salda River within Study Area



Source: ADB TA Consultant

8.2. Hydrogeology

232. The existence of tappable aquifers is the combined effect of the topography, lithology, and soil types. Semi-consolidated tertiary formations form the main hydrogeological unit of the study area. These formations consist of friable sand stones, clayey sandstone, sandy shales and shales. The semi-consolidated formations can then be further subdivided into three principal zones, out of which the first zone is present in West of Tripura, which houses the study area. The artesian belt has been delineated and the yield of such wells are found to be in the order of 1 to 3 m^3/hr. High auto-flow discharge of 54 m^3/hr is observed in Khowai valley.

233. Tipam formation: This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. Tipam formation is found in most of the valleys. Sandstone of Tipam formation constitutes the principal aquifer in the area. The permeability of this sandstone is much higher than that of Dupitila sandstone or Surma sandstone. The recharge area of the sandstone is in the anticlinal hills. Ground water occurs under semi-confined to confined conditions. This sandstone is developed by deep tubewells and shallow tubewells.

234. Aquifers in the study area are generally of two types: shallow aquifers (upto 30m) and deep aquifers (> 30m). Shallow aquifers are unconfined or semi-confined. Shallow aquifers can be contaminated by the seepage of polluted water and leaching of waste. Deep aquifers are under confined conditions and are tapped by deep bore wells for domestic and industrial

purposes like brick fields. Water tables are sub-parallel to land surface and follow the topographic slopes.

235. In Boxanagar block, which is located under Manikyanagar village and the project site, five subsurface layers (of the three principle zones) can be seen, out of which the top layer is generally formed with clay, the second layer is generally formed with clay mixed with fine sand particles, the third layer is generally formed with impervious type clay, the fourth layer is generally formed with clay mixed with very fine sand particles and the bottom layer is generally formed with clay with conserved moisture contents.[73] At Sepahijala district, the subsurface formations are highly variable. Hard impervious type clay, clay with conserved moisture contents, clay mixed with fine sand particles, very coarse sand particles, silty clay, clayey soil are the main subsurface formations of this area. Survey yields that to obtain a water quantity of 8000 - 10000 gallon per hour in the Boxanagar location, drilling up to 175 m is recommended.

236. Based on assessment is can be said the ground water formations are deep aquifers with impervious clayey layers on top. It can also be assessed that heavy clay soils are regarded as less permeable due to their low saturated hydraulic conductivities. This will minimize the percolation of any pollution from the proposed plant as the top layer in clay.

237. The main source of ground water recharge in the study area is rainfall infiltration, the other source being seepage from drains. The soil type of the area is sandy loam. This type of soil allows moderate percolation into the subsoil and subsequently to the groundwater. A decadal (1999 to 2009) study conducted by CGWB shows that ground water depth varies during pre-monsoon and post monsoon period. The groundwater table in the study area/Bisalgarh Block was below 3.25 - 4.08 mbgl which is of the shallow aquifer type.[74]

8.3. Status of Water Resources

238. Water from the surface water bodies in the study area is used for bathing, washing, catching fish and irrigation. The Salda river is mainly used for fisheries, sand mining, domestic uses, agriculture during the monsoon, etc. Groundwater in the state of Tripura is primarily used for agriculture, drinking and other domestic purposes. No groundwater exploitation is being reported by Water Resource Investigation Dept. Govt. of Tripura at state level (Table 4-16).

239. Details of water resource stress in the study area are (footnote 32):

- (i) Water Stress which measures total water withdrawals to available renewable surface and groundwater supplies – Low (<10%)
- (ii) Water Depletion, which measures the baseline water depletion, ratio of total water consumption to available renewable water supplies – Low (<5%)
- (iii) Seasonal Variability which measures the average within-year variability of available water supply, including both renewable surface and groundwater supplies. Higher values indicate wider variations of available supply within a year – Medium High (0.66-1.00)
- (iv) Drought risk measures where droughts are likely to occur, the population and assets exposed, and the vulnerability of the population and assets to adverse effects. Higher values indicate higher risk of drought – Medium High (0.6-0.8)

[73] Debedma et al. Study of Identification of Effective Sand Bed in Aquifer Zones using Resistivity Survey in Tripura: Case Studies, 2016

[74] State of Environment Report in Tripura, 1989

240. The study area is included under Sepahijila district (formerly West Tripura). Details of groundwater resources at the district level are given in Table 4-32. There is an annual net groundwater draft of 10,415-hectare meter (ham) and the stage of groundwater development is 10%. At block level, hydrogeological data was obtained from the Office of the Executive Engineer, Water Resource Investigation Division – Kunjaban, Agartala and is provided in Table 4-18. Bishalrgarh block, is at 12.3% groundwater extraction stage, while in Boxarnagar block (plant area), ground water extraction is 11.24%.

Figure 4-32: Location of Nearby Ground Water Bore Wells

Source: ADB TA Consultant

241. The local population, including the nearest village Manikyanagar, have confirmed they extensively use ground water. It is primarily tapped by tube wells from depths ranging mostly between 35-70 m. For the existing plant the source of water is deep tube well within the Rokhia Thermal Power Station. Since the source is deep tube well, it can be presumed that the aquifer tapped is confined type. TPGL has confirmed that they had to fracture rocks to get to water, making it more likely to be confined type. Initial top up water is 3000 litres and after that 600 liters are required per day for the closed water cycle system. The borehole for the existing plant is located near the abandoned staff quarters within the Rokhia Thermal Power Station and to a depth of 30m, TPGL has not reported any water stress in relation to their existing abstraction. Local communities reported they are currently abstracting water from levels of 60m below

ground at the nearest residences, and 30m below ground at the nearest major settlement, Manikyanagar. The local population of the Manikyanagar village, has advised there has not been any contains of stress in the area, although stress was reported by the nearest residents, situated 55m outside plant boundary. These nearest residents to the east of the project site have one borehole (deep aquifer, about 60m bgl) between 2 properties reported to a depth of 60m and have opined that there is water stress mainly during dry season affecting their groundwater supplies. Those properties that do not have boreholes import their water supplies by road as they are not connected to piped water system. This water stress appears to be highly localized since TPGL and the inhabitants of the nearest village, Manikyanagar, also use ground water from a depth of about 30m and during the consultation have stated that there is no water stress on their boreholes.

Table 4-25: Ground Water Resources of Tripura (2018)

Parameter	
Annual Replenishable Ground Water Resource	2.19 BCM
Net Annual Ground Water Availability	1.97 BCM
Annual Ground Water Draft	0.17 BCM
Stage of Ground Water Development	9 %
Ground Water Development and Management	
Over Exploited	NIL
Critical	NIL
Semi- critical	NIL
Ground water User Maps	4
Artificial Recharge to Ground Water (AR)	Feasible AR structures: 300 check dams, 500 weirs, 1000 gabion structures, 240 roof top harvesting, 100 developments of springs
Ground Water Quality Problems	
Iron (>1.0 mg/l)	Districts affected (in part) = Dhalai, North Tripura, South Tripura, West Tripura.

BCM: Billion cubic metres
Source: CGWB, GoI http://cgwb.gov.in/AQM/NAQUIM_REPORT/Tripura/NAQUIM%20Report-West%20Tripura.pdf

Table 4-26: Groundwater Resources in West Tripura (2018)

Parameters	**West Tripura (HAM : Hectare meters)**
Annual replenishable ground water resources	113,095
Net ground water available	101,785
Net annual ground water draft	10,415
Stage of ground water development	10%
Projected demand (up to 2025) for use of ground water in domestic and irrigation sector	10,526
Projected demand (up to 2025) for use of ground water for irrigation purpose	84,125

Souce: CGWB, GoI

Table 4-27: District and Study Area Groundwater Information (2021)

Assessment Unit	Recharge from Rainfall during Monsoon Season	Recharge from other Sources during Monsoon Season	Recharge from Rainfall during Non-monsoon Season	Recharge from Other Sources during Non-monsoon Season	Resultant Flow	Total Annual Groundwater Recharge	Provision for Natural Discharges	Actual Extractable Groundwater Resources	Existing Gross Groundwater Draft for Irrigation	Existing Gross Groundwater Draft for Domestic and Industrial water supply	Stage of Groundwater Extraction (%)
Units	mm	mm	mm	mm	mm	Ham	Ham	Ham	Ham	Ham	%
Bishalgarh Block	1480.29	311.06	919.33	1170.85	174.02	3707.50	370.75	3336.75	241.20	169.10	12.30
Boxanagar Block	1191.39	61.26	739.91	250.61	498.80	1744.37	174.44	1569.93	66.60	109.85	11.24
Sepahijhala District	11043.64	872.91	5144.18	3548.44	2158.96	18450.21	1658.49	16791.73	704.05	950.89	9.86

Source: TPGL

8.4. Water Quality

242. The surface and ground water quality of the study area may get affected due to various contaminants from point or non-point sources. Point sources contribute contaminants from a discrete location, such as, the outflow from a pipe, storage of solid waste, etc. These sources can be controlled by treatment at or before the point of discharge. Non-point sources, on the other hand, include the atmosphere, agricultural runoff, roads, residential developments, parking lots, and contributions from groundwater.

243. Water quality sampling was carried out in the months of October and December 2020 for Season 1. During Season 1, few surface water bodies were found within the study area and sampled including the Salda River. In Season 2, additional small private lakes used by locals to cultivate fish for consumption and sale were identified and samples were collected to get a better idea of the surface water quality in the study area. Season 3 (April-June 2021) monitored for the same sources as used in season 2. The samples were analyzed for selected physicochemical parameters to establish the existing water quality of the study area. Parameters tested were pH residual chlorine, colour, temperature, conductivity, turbidity, total dissolved solids, suspended solids, alkalinity, hardness, chloride, sulphate, nitrates, phosphate, calcium, magnesium, sodium, potassium, heavy metals, silica, ammoniacal nitrogen, dissolved oxygen, fluoride, BOD, COD, oil and grease and coliforms. Samples were collected, preserved and analyzed as per methods given in the Standard Methods for the Examination of Water and Wastewater.[75] The samples for bacteriological quality of water analysis were collected in the

[75] APHA, 23rd Edn https://yabesh.ir/wp-content/uploads/2018/02/Standard-Methods-23rd-Perv.pdf

sterilized bottles and samples were analyzed for bacteriological quality of water for coliforms. The samples were analyzed for heavy metals by atomic absorption spectrophotometer.

244. Surface water quality observations:

(i) pH of the surface water samples varied from 7.23-7.84, which is within the standards of 6.5-8.5.

(ii) Dissolved oxygen (DO) levels at all locations exhibited values ranging from 4.2-5.9 mg/l. Out of the 8 monitored water bodies, SW1-SW2 (Salda River) and SW3 (pond near site) had DO levels below the prescribed minimum of 5 mg/l required to support aquatic life and indicating a good aquatic ecosystem.

(iii) Biochemical Oxygen Demand (BOD) values of all the sample was found to be <1 mg/l indicating minimal pollution in comparison to < 3 mg/l standard.

(iv) Electrical conductivity of the water quality samples ranged between 118.4-488.1 µS/cm.

(v) Ammoniacal nitrogen contents of all the samples was found to be less than 0.1 mg/l, indicating absence of sewage pollution in the surface waterbodies.

(vi) The presence of contaminants in the form of oil and grease in all surface water samples was found to be low (<5 mg/l) in comparison to standards of 10mg/l.

(vii) Total Coliform count in the Salda River upstream station was 70 MPN/100 ml and downstream station 90 MPN/100 which is higher than the prescribed Class B (Bathing Water, CPCB Criteria[76]) as well as IS 10500 drinking water standards. The pond near the existing plant had coliform levels of 110 MPN/100 ml (it is near residential area and may have possible septic tank leakage leading to high levels). The rest of the sampling locations had coliforms count < 2 MPN/110 ml. The IS: 10500 (2012) requires absence of coliform to be fit for drinking.

(viii) Concentrations of heavy metal like lead, chromium and cadmium were found to be within the prescribed drinking water limits in the surface water samples.

(ix) The results of surface water analysis indicated compliance to CPCB Class D (Propagation of Wildlife and Fisheries) and Class E (Irrigation, Industrial Cooling, Controlled Waste Disposal)

245. Ground water quality observations:

(i) pH of the groundwater samples was found in the range of 7.01-7.73. The water samples were found to be within the IS:10500 (2012) drinking water standard limit of 6.5-8.5.

(ii) The concentration of total dissolved solids (TDS) in ground water is a measure of its suitability for domestic use. In general, TDS values at 500 mg/l or below are acceptable for such purpose being specified under IS:10500 drinking water standard. The level of dissolved solids in the groundwater samples (72-114 mg/l) were found to be below the acceptable limit of IS 10500 standards.

(iii) With respect to IS: 10500 standards, acceptable limit of chloride is 250 mg/l while the permissible limit (in absence of alternate source) is 1000 mg/l. At concentration above 250 mg/l chlorides renders a salty taste to water which may be objectionable in terms of human consumption. The chloride concentration in the ground water samples (<5 – 9.85 mg/l) was found to comply to the acceptable limit.

(iv) Hardness of water is an important parameter in determining the suitability of water for domestic uses particularly washing. Total hardness of water is correlated to the presence of bivalent metallic ions *viz*. calcium and magnesium.

[76] https://cpcb.nic.in/water-quality-criteria/

Total hardness in the groundwater samples was observed to be very low and varied from 8.16 mg/l to 19.39 mg/l and within the acceptable limit of 200 mg/l.

(v) Iron is an important ground water parameter since at higher concentration it interferes with laundering operations and imparts objectionable stains. As per CGWB, GoI, March 2008 report, iron is found in significant amount in the study area, including Boxarnagar Block, under which the project site falls. The CGWB reported iron content is 1.38 mg/l which is much higher than ISO 10500 standard of ≤ 0.3 mg/l in ground water. It is present in water either as soluble ferrous iron or the insoluble ferric iron. Water containing ferrous iron is clear and colorless because the iron is completely dissolved. When exposed to air, the water turns cloudy due to oxidation of ferrous iron into reddish brown ferric oxide. However, the concentration of iron in ground water samples was <0.05 mg/l. Iron concentration in all the samples complied to the acceptable limit (0.3 mg/l) of IS:10500.

(vi) Fluoride concentration of the samples were below 0.1 mg/l, which complies to the acceptable limit of IS:10500 standards (1.0 mg/l).

(vii) Nitrate contents of the groundwater samples varied between 1.61- 4.99 mg/l and sulphate in all samples was below 10 mg/l were in compliance to the acceptable limits of IS:10500 for nitrate (45 mg/l) and sulphate (200 mg/l).

(viii) Mercury, cadmium, lead, zinc, and chromium contents in all ground water samples were found to be below standard limits in compliance to the acceptable limits of IS:10500.

(ix) Arsenic levels were observed to be lower than prescribed standard in all monitored water bodies.

(x) Coliforms are indicators of contamination from sewage and faecal matter. Total coliforms contents of all the samples were found to be <2 MPN/100 ml. Faecal coliform were also found to be <2 MPN/100 ml.

246. Based on the analyzed results the ground water tested can be used for drinking purpose as parameters were reported as below prescribed standards. Results of the surface water analyses are given in Table 4-28. Results of the ground water analyses are summarized in Table 4-29.

Table 4-28: CPCB Water quality criteria

Designated-Best-Use	Class of water	Criteria
Drinking WaterSource without conventional treatment but after disinfection	A	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20C 2mg/l or less
Outdoor bathing (Organised)	B	• Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial	E	• pH betwwn 6.0 to 8.5

Designated-Best-Use	Class of water	Criteria
Cooling, Controlled Waste disposal		• Electrical Conductivity at 25C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
•	Below-E	Not Meeting A, B, C, D & E Criteria

Source: CPCB, 2019 https://cpcb.nic.in/water-quality-criteria/

Table 4-29: Sample Surface Water Quality Analysis Results (Full Results in Annexure 16)

Parameters	Units	Surface Water Quality Standards IS: 2296 (the criteria table is shown as Table 4-29)		SW.1		SW.2	SW.3	SW.4	SW.5	SW.6	SW.7	SW.8
		Class B	Class C									
pH at 25^{o}C	-	6.5 - 8.5	6.5 - 8.5	7.70		7.84	7.51	7.23	7.55	7.59	7.60	7.58
Electrical Conductivity	µS/cm	-	-	144.1		119.2	118.4	467.1	196.7	488.1	383.3	364.4
Colour	Hazen	10	300	< 5		< 5	< 5	< 5	< 5	< 5	< 5	< 5
TSS	mg/l	-	-	07		06	08	09	<5	10	05	06
Temperature	^{0}C	-	-	26		26	26	26	26	26	26	26
TDS	mg/l	500	1500	82		76	72	190	112	248	220	225
Total Hardness ($CaCO_3$)	mg/l	300	-	13.27		9.18	12.24	23.47	10.20	29.60	27.56	25.52
Calcium as Ca	mg/l	80.10	-	< 5		< 5	< 5	7.35	< 5	7.35	6.13	6.94
Magnesium as Mg	mg/l	24.28	-	< 1		< 1	< 1	1.23	< 1	2.72	3.71	1.98
Nitrates as NO_3	mg/l	20	50	< 1		< 1	< 1	< 1	< 1	< 1	< 1	< 1
Fluoride as F	mg/l	1.5	1.5	< 0.1		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Phosphorous	mg/l	-	-	< 1		< 1	< 1	< 1	< 1	< 1	< 1	< 1
Turbidity	mg/l	-	-	< 1		< 1	1.3	1.5	< 1	1.7	1.4	< 1
Sodium as Na	mg/l	-	-	3		02	04	10	5	08	09	07
Potassium as K	mg/l	-	-	< 1		< 1	< 5	2	< 1	< 5	< 1	< 1
Iron (as Fe)	mg/l	0.3	50	< 0.05		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Copper (as Cu)	mg/l	1.5	1.5	< 0.04		< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Nickel	mg/l	-	-	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zinc as Zn	mg/l	1.5	1.5	< 0.05		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Manganese	mg/l	0.5	-	< 0.1		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chromium as 6^{+}	mg/l	0.05	0.05	<0.03		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	mg/l	0.1	0.1	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium	mg/l	0.01	0.01	< 0.003		< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Mercury	mg/l	0.001	-	< 0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
BOD	mg/l	2	3	< 1		< 1	< 1	< 1	< 1	< 1	< 1	< 1
COD	mg/l	-	-	< 5		< 5	< 5	< 5	< 5	< 5	< 5	< 5

Parameters	Units	Surface Water Quality Standards IS: 2296 (the criteria table is shown as Table 4-29)		SW.1		SW.2	SW.3	SW.4	SW.5	SW.6	SW.7	SW.8
DO (min)	mg/l	6	4	4.9		4.7	4.8	5.7	4.2	5.7	5.2	5.9
Oil & Grease	mg/l	-	0.1	<5		<5	<5	<5	<5	<5	<5	<5
Alkalinity	mg/l	-	-	12.3		10.25	13.32	21.52	11.27	31.77	30.75	29.72
Salinity	mg/l	-	-	0.008		0.007	0.009	0.016	0.006	0.03	0.03	0.02
Silica	mg/l	-	-	1.98		1.89	1.75	5.0	1.35	5.98	6.48	6.08
Phenol	mg/l	0.002	0.005	< 0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Total Coliforms	MPN. /100 ml	50	5000	70		110	90	< 2	< 2	< 2	< 2	< 2
Faecal coliform	MPN. /100 ml	-	-	50		50	30	< 2	< 2	< 2	< 2	< 2

Surface Water Quality Standards (as per IS: 2296).
Non-conformers/Exceedance are highlighted
Class A – Drinking water without conventional treatment but after disinfection. Class B – Water for outdoor bathing. Class C – Drinking water with conventional treatment followed by disinfection. Class D – Water for fish culture and wildlife propagation. Class E – Water for irrigation, industrial cooling and controlled waste disposal. (Unobj = Unobjectionable).
Source: MITCON baseline report

Table 4-30: Sample Ground Water Quality Analysis Results (Full Results in Annexure 16)

Parameters	Units	GW.1	GW.2	GW.3	GW.4	GW.5	GW.6	GW.7	GW.8
pH	pH Scale	7.73	7.11	7.15	7.08	7.01	7.13	7.21	7.66
Electrical Conductivity	µS/cm	165.9	131.3	120.5	93.9	153.6	169.0	122.5	99.27
TDS	mg/l	114	92	88	72	108	122	82	78
Total Hardness	mg/l	17.35	13.27	11.22	9.18	13.27	19.39	11.22	8.16
Ca^{2+} Hardness	mg/l	4.49	< 5	< 5	< 5	< 5	5.31	< 5	< 5
Mg^{2+} Hardness	mg/l	1.48	< 1	< 1	< 1	< 1	1.48	< 1	< 1
Total Solids	mg/l	116	95	90	74	110	125	84	80
Turbidity	NTU	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Acidity	mg/l	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Total Alkalinity	mg/l	19.47	15.37	13.32	10.25	14.35	21.52	11.22	9.22
Salinity	mg/l	0.017	0.016	0.013	0.008	0.016	0.011	0.005	0.004
Total Nitrogen	mg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Silica	mg/l	7.14	7.58	7.06	6.48	7.72	7.91	8.68	5.98
Phenol	mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chlorides	mg/l	9.85	8.86	7.39	<5	<5	10.34	5.42	<5
Sulphate	mg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Nitrate	mg/l	2.99	2.19	1.97	1.61	3.77	4.66	4.99	1.49
Ammoniacal Nitrogen	mg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoride	mg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Phosphorous	mg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sodium	mg/l	10	< 5	12	9	13	14	15	8
Potassium	mg/l	1	< 5	3	1	4	5	4	3
Iron (as Fe)	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Copper (as Cu)	mg/l	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Nickel	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zinc as Zn	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Manganese	mg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Chromium	mg/l	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

Parameters	Units	GW.1	GW.2	GW.3	GW.4	GW.5	GW.6	GW.7	GW.8
Hexavalent)6^{+})	mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Lead	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium	mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Arsenic	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Total Coliform	MPN	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Faecal coliform	MPN	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2

NA – Not Applicable, NR – No Relaxation, NS – Not Specified

Source: MITCON Baseline Report

9. Key Physical Aspects

247. Summary of the key physical aspects in the PAI are given in Table 4-29.

Table: 4-31: Summary of Key Physical Environmental setting in PAI

Particulars	Description
Project Site Location	Latitude – 23°37'24.32"N Longitude – 91°11'48.50"E
Elevation and Topography	• On higher ground elevation on flatter land is 30m - 49 m • Project site is plain to elevated and bounded by two hillocks, one near the east boundary and the other to the south • The maximum hillock height in the east is 55m, whereas the hillock in the south side is 59m. It is planned to excavate/reduce to a suitable height the hillocks and then use the earth to elevate the plain area to bring to the same level. • Hillock height beyond the existing plant boundary is 65m, which is outside the proposed project footprint in the NW. • Overall, the study area can be identified as complex terrain.
Land Use and Land Cover – Study Area	• Agricultural 41 % • Vegetation 38 % • Built-up 15 %
Land Use and Land Cover – Project Site	• Scattered grass, vegetation, and trees cover the project site. • Three buildings in the proposed plant area are marked for demolition. • No site contamination observed, existing plant area had three oil contaminated spots.
Microclimatic condition	• Nearest IMD station, Meteorological Centre (MC) – IMD Agartala, about 30 km towards NNE. • Highest and lowest recorded temperatures are Maximum 35.8 ^{0}C Minimum 6.6^{0}C (2015-2020 data) • Total annual average rainfall of Sepahijala district: 2392.7 mm • Low to moderate wind velocities. The mean annual velocities are in the range of 4 to 6 km/h and especially high during pre-monsoon period of June to August.
Geological and Climatic Risks	• Zone-V i.e., Very High Damage Risk Zone • Landslides-Medium Risk area • Storms and cyclones – High Risk area • Surface Water Flooding – Medium Risk area
General environmental conditions – soils, air quality, noise, water	• Rural dusty roads due to lose soil along roads. • Soil is not contaminated and no solid or hazardous wastes observed at the project site, except some municipal debris like polythene bags and plastic bottles discarded near the project site boundary. • Within the existing plant area some oil contaminated spots were identified. The contaminated soil was analyzed for organic content. Hydrocarbon was not found although presence of oil was confirmed by visual inspection and texture/smell. • Vehicular movement very low within project site and villages. • Industrial activities, except existing plant and brick kiln are not observed in the study area. • Ambient air quality data was inclusive of existing plant and brick kilns. • Seasonal jhum cultivation is also likely to contribute to air pollution, especially SO_2 • PM_{10} values exceed the GoI Standard in three locations including the

Particulars	Description
	existing plant, whereas all locations exceed the WB-IFC EHS guideline 2007 and WHO 2021 guidelines. $PM_{2.5}$ concentrations were within GoI Standards but exceeded the WB-IFC EHS guideline 2007 and WHO 2021 guidelines across all locations. • SO_2 values were all within GoI Standards but exceeded WB-IFC EHS guideline 2007; whereas only 60% of locations exceeded the latest WHO AQG 2021 because as per the latest guideline, the limit has increased from 20 to 40 µg/m3. • NO_2 ambient levels in all locations are with in GoI Standards but exceed the latest WHO 2021 guidelines. • In the short term, project area air quality can be categorized as degraded airshed per WHO guidelines • Background day and night-time noise levels are lower than assessment standards at all monitored sites except nighttime noise at nearest school located at the boundary of the TPGL plant area and adjacent to the main road. • There are no surface water bodies in the project site and up to 500m radius • Salda River – 3.25 km N • Neatest waterbody is pond at 0.8 km SW of proposed plant • Bore well is present with TPGL plant area, and two additional wells/pumps are proposed at new plant site. No natural springs in area. • As per consultation, locals in nearest village Manikyanagar use ground water for domestic purposes. • Ground water in the area is deep aquifer (> 30m depth), deep aquifer is being used by existing plant. • Although the nearest residents (55m east of plant) have reported that they are under water stress during dry seasons, The opinion of the community in the larger study area and the TPGL and GoT data shows that adequate water is available.

Source: ADB TA Consultant

D. Socio-Economic Environment

1. Introduction

248. The baseline socio-economic study covered villages 10 km radial distance from the proposed plant. The study area is mostly rural. It covers a total of 25 major and minor human settlements including villages and towns of Tripura. These fell into 2 zones, namely the Core Zone (0 up to 3 km radius) which is the main impact area and a Buffer Zone (3 km to 10 km). The distance of 3 km radius has been considered as the core zone based on the assumption that the magnitude of socio-economic impacts is likely to be more visible here than the remaining portion of the study area; an area from 3 km radius to 10 km radius is considered as the buffer zone based on the assumption that the magnitude of socio-economic impacts here is likely to be limited.

249. The study adopted a two-fold methodology for data collection, namely, review and analysis of published secondary data sources and collection and analysis of primary data. Secondary data was collected from District Census statistics of 2011, including demography,

occupational structure, literacy profile and social structure etc. Census 2011: the District Census Handbook (DCHB) is an important publication of the Indian Census Organization[77] since 1951. It contains both Census and non-Census data of urban and rural areas for each District. The Census data provides information on demographic and socio-economic characteristics of population at the lowest administrative unit i.e., of each Town/Village and ward of the district. The non-Census data presented in the DCHB is in the form of a Town Directory and Village Directory containing information on various infrastructure facilities available in the village or town viz. education, medical, drinking water, communication and transport, post and telegraph, electricity, banking, and other miscellaneous facilities. Review and analysis of the available secondary data helped to identify key socio-economic parameters and trends allowing for a comparative assessment of the study area vis-à- vis the block and district level socio-economic baseline.

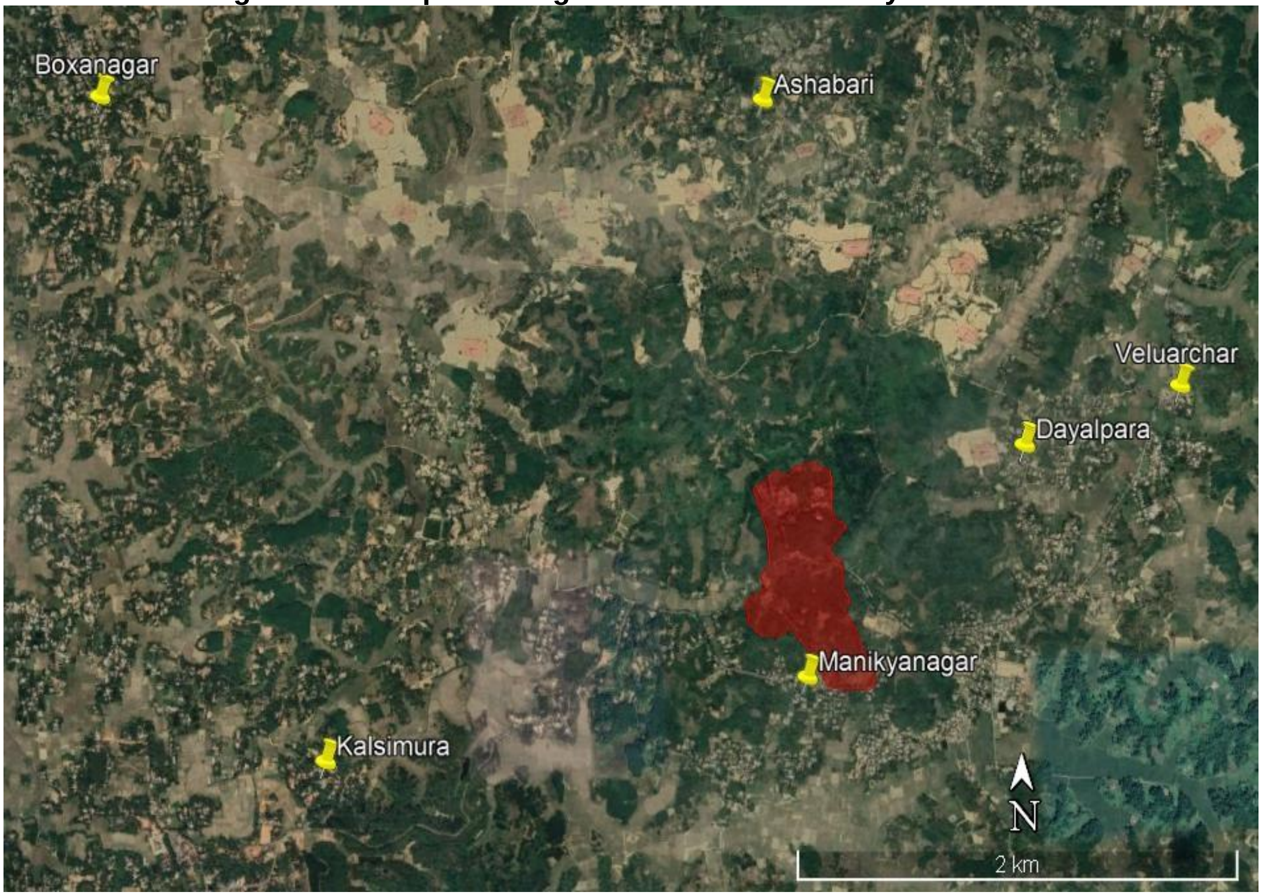
250. The primary data was collected by MITCON under supervision of ADB TA consultants. The primary data was collected through random household survey covering a sample of households in the core and buffer zone villages in June 2021. To collect primary site-specific data a questionnaire was prepared based on discussion with TPGL, ADB TA consultants and safeguard experts from ADB. The next step was to identify a random sample of villages around the project site (500m core zone), and the following villages were identified for carrying out the surveys:

(i) Manikyanagar (core zone)
(ii) Veluarchar (buffer zone)
(iii) Dayalpara (buffer zone)- TTAADC village
(iv) Ashabari (buffer zone)
(v) Boxanagar (buffer zone)
(vi) Kalsimura (buffer zone)

251. While the summary data are discussed in these sections, additional detailed data from socioeconomic survey conducted by MITCON is provided in **Annexure 17**. ADB TA environment and social consultants supported the primary data collection team and reviewed the field data collection formats, questionnaires, reviewed the socioeconomic report and extracted/analyzed the baseline scenario for assessment purpose. Secondary Census data 2011 was also reviewed and used in the baseline by ADB TA social consultant. Additional socioeconomic details were obtained during public consultations and key stakeholder interactions.

[77] Office of the Registrar General and Census Commissioner, India under Ministry of Home Affairs, Government of India. ffice of the Registrar General and Census Commissioner, India under Ministry of Home Affairs, Government of India.

Figure 4-33: Map Showing Socioeconomic Survey Locations



Source: MITCON

2. Results and Observations

2.1. Administrative Set Up and Demographics

252. Tripura State has eight Districts, which are divided into Sub-divisions and further into Blocks. Blocks have administrative units like Tehsils (group of villages) and Panchayats (village council). The proposed plant is located in the Sipahijila District. Carved out of West Tripura District, Sepahijala District is one of the most recent (January 2012) demarked districts of Tripura with a total geographical area of 1043.58 km^2.

253. **Sipahijila District**: There are three Sub-Divisions in the district, namely Bishalgarh subdivision, Sonamura subdivision and Jampaijala subdivisions. The Subdivions are further divided into 7 blocks. The Boxarnagar Block is under Bisalgarh subdivision, where the project site is located. Further Tehsils are also recorded as administrative units comprising of some villages. In Sipahijila there are 37 Tehsils. Panchayats, an elected village council/governing body for development of a village are 169 in Sipahijila District.

254. Demography in Sepahijala District is controlled by its socio-economic and environmental condition. According to the provisional estimates of Census 2011,[78] the total population of the district was 327,564. The population of males was at 167,401 whereas the population of females was 160,163 which stands at 957 females per 1,000 males. Further in Tripura, there are a total of 587 TTAADC (Tripura Tribal Areas Autonomous District Council) has also been created post 2012 for Tribal dominated villages. Sipahijila has 85 TTAADC.

255. The district is accessible from the rest of Tripura including the capital city Agartala through National Highway 44 and NH 8, and other district roads. The principal towns in the district are Bishalgarh, Bishramganj, Melaghar and Sonamura, and the district headquarters is located at Bishramganj town. A.

256. There are 25 villages and one town (Boxarnagar) located within the 10 km radius of the proposed plant. The location details of these villages are provided in Table 4-33. The details of demographic data from the census are given in Table 4-34.

257. The main settlement of Manikyanagar village is located within 500 km from the project site and is the nearest major habitation from the proposed plant. The village has all basic amenities including water, electricity, and cooking gas, local markets, primary health facility, and school. Water supply is through bore wells. Main occupations are agriculture and business/commercial. The village has two high schools, of which, the Manikyanagar High Secondary school is located within Rokhia Thermal Power Station. No colleges are available in the village. College students must travel to Agartala city for higher education. Government health centers are available but there is no major hospital and surgical facilities can only be availed by traveling to Agartala city which takes around 2 hours by road. The population characteristics from the Census are given in Table 4-35.

258. Mr. Subhash Chandra Saha is the Mandal (Boxarnagar Block) President and is the main leader and decision maker in the community. Mr. Saha is liked and revered by everyone who was interviewed during the survey. He resides in Manikyanagar village, but he did not wish to be interviewed for the socioeconomic survey.

Table 4-33: List of the Villages Located Within the 10 km Study Area (Census 2011)

Name	Sub District	Distance from project site	Type	Total Households	Total Population	Total male	Total female
Core village (up to 500m)							
Manikyanagar	**Boxanagar**	**1**	**Rural**	**666**	**3027**	**1661**	**1366**
Buffer villages (500m - 3km)							
Bhaluarchar	Boxanagar	2.5	Rural	1000	3787	1989	1798
Ghilatali	Boxanagar	2.5	Rural	488	2461	1224	1237
Ashabari	Boxanagar	3	Rural	536	2870	1471	1399
Kalsimura	Boxanagar	3	Rural	1064	5272	2702	2570
Jogatrampur	Boxanagar	3	Rural	105	474	239	235
SUBTOTAL				**3193**	**14864**	**7625**	**7239**

[78] Directorate of Economic & statistics, Govt. of Tripura https://www.yumpu.com/en/document/read/50505962/economic-review-of-tripura-2010-11-directorate-of-

Name	Sub District	Distance from project site	Type	Total Households	Total Population	Total male	Total female
Buffer villages (3-10 km)							
Bangshibari	Bishalgarh	3.5	Rural	418	1790	924	866
Rahimpur	Boxanagar	3.5	Rural	698	3888	2003	1885
Boxanagar Town	Boxanagar	3.5	Rural	1128	5414	2730	2684
Putia	Boxanagar	4	Rural	543	3290	1750	1540
Gajaria	Bishalgarh	4.5	Rural	875	3668	1870	1798
Rangapania	Bishalgarh	4.5	Rural	569	2494	1289	1205
Kalamchaura	Boxanagar	5	Rural	767	3647	1933	1714
Anandapur	Boxanagar	5.5	Rural	474	2471	1284	1187
Sutamura	Bishalgarh	6.5	Rural	702	3104	1544	1560
Bejoynagar	Boxanagar	6.8	Rural	222	1064	530	534
Purathal Rajnagar	Bishalgarh	7.5	Rural	1009	4293	2208	2085
Krishna Kishorenagar	Bishalgarh	7.5	Rural	1960	8146	4173	3973
Ramnagar	Bishalgarh	8	Rural	502	2272	1136	1136
Kamalanagar	Boxanagar	8	Rural	728	3110	1586	1524
Konaban	Bishalgarh	8.5	Rural	862	3792	1968	1824
Ghaniamara	Bishalgarh	8.5	Rural	1833	7469	3836	3633
Brajapur	Bishalgarh	8.5	Rural	2599	10515	5278	5237
Dhariathal	Bishalgarh	8.5	Rural	282	1217	587	630
Kaiyadhepa	Bishalgarh	9	Rural	757	3457	1804	1653
Dhanirampur	Boxanagar	10	Rural	376	1809	907	902
SUB TOTAL				**17304**	**76910**	**39340**	**37570**
TOTAL (CORE+BUFFER)				**21163**	**94801**	**48626**	**46175**

Source: CENSUS REPORT 2011, GoI

Table 4-34: Demographic Details of Villages within 10 km Radius

No.	Name	No. of Households	Total Population	Total Males	Total Females	Total SC	Total ST	Total Literate	Total Illiterate	Total Work Force	Main Work Force
Core village (up to 500m)											
1	**Manikyanagar**	**666**	**3027**	**1661**	**1366**	**744**	**28**	**2496**	**531**	**1162**	**1034**
Buffer villages (500m - 3km)											
2	Bhaluarchar	1000	3787	1989	1798	1307	892	2662	1125	1528	1209
3	Ghilatali	488	2461	1224	1237	637	0	1562	899	705	667
4	Ashabari	536	2870	1471	1399	45	0	2016	854	719	675
5	Kalsimura	1064	5272	**2702**	2570	2258	0	4309	963	1516	1325
6	Jogatrampur	105	474	239	235	148	0	332	142	131	131
	Sub total	**3193**	**14864**	**7625**	**7239**	**4395**	**892**	**10881**	**3983**	**4599**	**4007**
Buffer villages (3km – 10km)											
7	Konaban	862	3792	1968	1824	1120	2110	2477	1315	1613	1054
8	Kaiyadhepa	757	3457	1804	1653	1077	127	2492	965	1189	994
9	Purathal Rajnagar	1009	4293	2208	2085	458	2	3145	1148	1425	1118
10	Ghaniamara	1833	7469	3836	3633	1420	14	5661	1808	2636	2004
11	Krishna Kishorenagar	1960	8146	4173	3973	1042	5	6108	2038	2891	2265
12	Gajaria	875	3668	1870	1798	813	1797	2631	1037	1314	1176
13	Putia	543	3290	1750	1540	4	98	2166	1124	1163	1091
14	Rahimpur	698	3888	2003	1885	63	0	2812	1076	1074	865
15	Brajapur	2599	10515	5278	5237	1878	1830	7997	2518	4561	3281
16	Boxanagar	1128	5414	2730	2684	483	4	4138	1276	1738	1215
17	Bangshibari	418	1790	924	866	0	1786	1451	339	1072	780
18	Rangapania	569	2494	1289	1205	808	5	1938	556	901	772
19	Sutamura	702	3104	1544	1560	0	2956	2492	612	1100	773
20	Dhariathal	282	1217	587	630	0	1026	883	334	378	285
21	Ramnagar	502	2272	1136	1136	0	2268	1702	570	1284	594
22	Kalamchaura	767	3647	1933	1714	2263	0	2640	1007	1123	917
23	Bejoynagar	222	1064	530	534	0	1062	635	429	360	297
24	Anandapur	474	2471	1284	1187	572	4	1829	642	752	566
25	Kamalanagar	728	3110	1586	1524	1538	2	2418	692	1038	763
26	Dhanirampur	376	1809	907	902	0	1764	1011	798	547	537
	Sub total	**17304**	**76910**	**39340**	**37570**	**13539**	**16860**	**56626**	**20284**	**28159**	**20584**
	TOTAL	**21163**	**94801**	**48626**	**46175**	**18678**	**17780**	**70003**	**24798**	**33920**	**25625**

Source: MITCON

Table 4-35: Population Characteristics of Manikyanagar

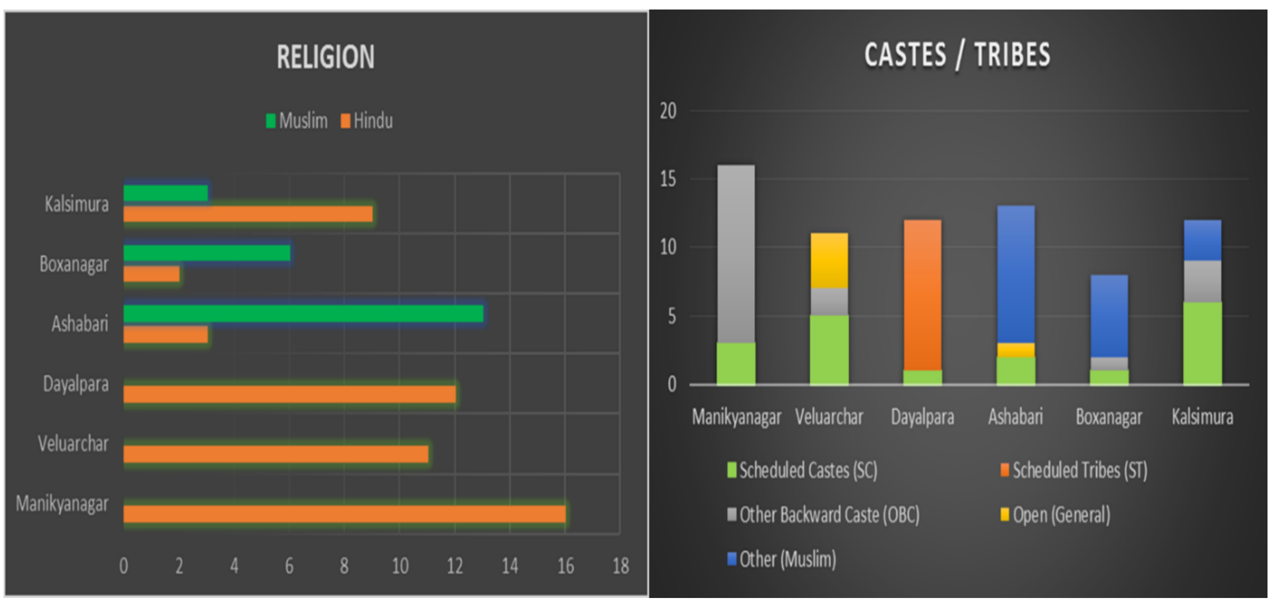
Census Parameter	Census 2011 Data
Total Population	3027
Total No. of Households	666
Female Population %	45.1 % (1366)
Total Literacy rate %	82.5 % (2496)
Female Literacy rate	35.6 % (1077)
Scheduled Tribes Population %	0.9 % (28)
Scheduled Caste Population %	24.6 % (744)
Working Population %	38.4 %
Child (0-6) Population by 2011	400
Female Child (0-6) Population % by 2011	51.2 % (205)

Source: Census of India Report, 2011

2.2. Religion and Caste/Tribes

259. In all three villages surveyed in Veluarchar tehsil (revenue division at block level),[79] all the correspondents were found to follow Hindu religion. No Nomadic Tribes were found in any of the villages surveyed. Populations of other castes are varied, with Other Backward Clases (OBC) and Schedule Caste (SC) population being most dominant. In Boxanagar tehsil majority of the people were found to be Muslim. Ashabari village had the most dominant Muslim population. Figure 4-34 shows details of Religion and Castes/Tribes in the villages surveyed.

Figure 4-34: Graph Showing Caste and Religion Structure In Study Area



Source: MITCON

2.3. Language and Literacy

260. As per Census 2011, literacy rate in Tripura is 87.22 percent against all India figures of 74.04 percent. The corresponding figure in 2011 for male literacy and female literacy in Tripura

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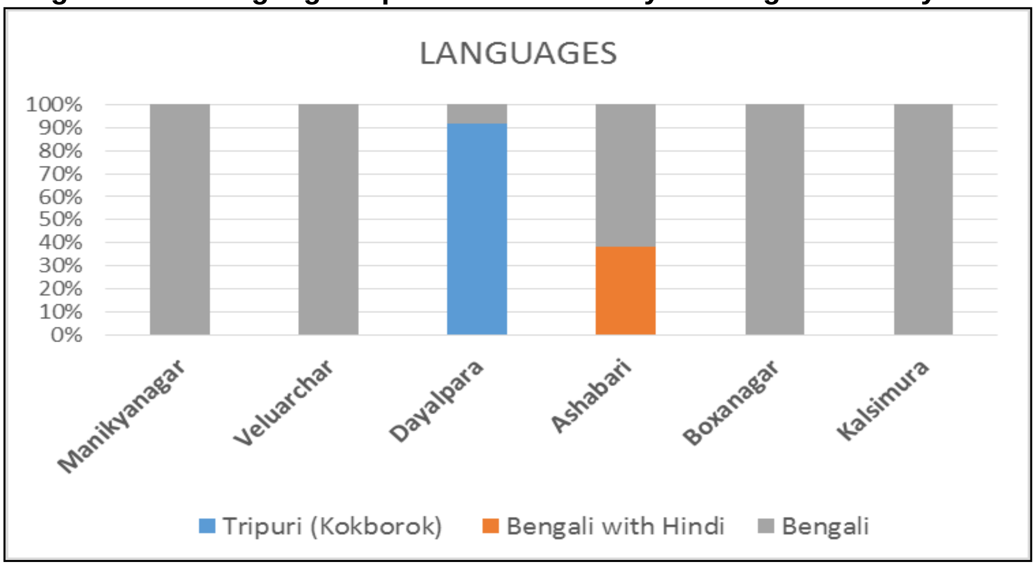
[79] A group of attached villages constitute a Tehsil

was 92.91 percent and 84.76 percent. The Literacy of Sipahijila District is 98%, which is highest in the country. At the State level, gap in male-female ratio with respect to literacy has been reduced to 8.8 percent in 2011 as against 17.01 percent in 2001.

261. Of the villages surveyed in Veluarchar tehsil, namely Manikyanagar, Veluarchar and Dayalpara, most of the population is Bengali speaking. In Manikyanagar, 16 households were questioned as per the socio-economic questionnaire prepared, and all these households were Bengali speaking. Similar case was observed in Veluarchar village, where of the 11 households questioned, all 11 were Bengali speaking. Contraily, the Dayalpara village lies in the Tripura Tribal Areas Autonomous District Council (TTAADC) area, and of the 12 households interviewed, 11 households are Tripuri (Kokborok) speaking, and 1 is Bengali speaking households. Similarly, in the 3 villages surveyed in Boxanagar tehsil, most of the population is Bengali speaking, while some Muslim households speak Hindi along with Bengali. Languages spoken in all households interviewed (village-wise) is shown in Figure 4-35.

Figure 4-35: Languages Spoken in the Surveyed Villages in Study Area



Source: MITCON

262. The overall literacy rate for the state was 87.22 %. The male literacy rate was 92.17 % whereas the female literacy rate is 83.17%. The majority of the households interviewed in all the villages surveyed in the study area are literate. Percentage of Male literacy is around 87.4%, while female literacy is around 83.2%. Literacy and level of education in the surveyed villages is given in Table 3-33 and Table 4-36 respectively.

Table 4-36: Literacy in Villages Surveyed

Village	Male Literate	Male Illiterate	Female Literate	Female Illiterate
Manikyanagar	35	0	27	0
Veluarchar	21	0	21	0
Dayalpara	29	6	19	10
Ashabari	22	11	21	5
Boxanagar	27	3	16	4
Kalsimura	25	0	27	3
Total	**159**	**20**	**131**	**22**

Source: MITCON

Table 4-37: Village-wise Level of Education in Study Area

Name of Village	Pre-primary to Primary	5^{th} to 10^{th} (Secondary)	11^{th} to 12^{th} (Higher Secondary)	Graduate	PG	Diploma	No Education
Manikyanagar	33	17	12	0	0	0	0
Veluarchar	8	16	12	3	2	1	0
Dayalpara	14	26	10	1	0	0	13
Ashabari	8	22	12	1	0	0	16
Boxanagar	6	22	15	0	0	0	7
Kalsimura	6	29	12	6	0	0	3
Total	**75**	**132**	**73**	**11**	**2**	**1**	**39**

Source: MITCON

2.4. Household Composition, Occupation and Income Sources

263. The workforce data based on Census-2011 has been released by the Registrar General of India, New Delhi shows that the total number of workers (main & marginal) in the State was 14,69,521. Out of these total workers, 10,77,091 were the main workers and 3,92,502 were the marginal workers in 2011. The total male workers (main & marginal) were 10,45,326 and remaining 4,24,195 were the female workers in 2011. Out of the total worker (main & marginal), 11,16,076 (75.95 percent) were in rural areas and 3,53,445 (24.05 percent) were in the urban area in 2011, respectively. The proportion of total workers (main & marginal) in total population of the State was 40 percent in 2011, which was 36.24 percent in 2001. The total main workers were 10,77,019 in 2011, out of which 8,87,881 (83.44 percent) were male main workers and 1,89,138 (17.56 percent) were female main workers.

264. **Work participation rate:** The work participation rate (WPR) stood at 39.99 percent in 2011 which were 36.2 percent in 2001 and 31.1 percent in 1991, respectively. The work participation rate among the rural population of the State was 41.15 percent in 2011. The similar work participation rate among the urban population was 36.76 percent in 2011.

265. **Male work participation rate:** Male work participation rate for State as a whole increased from 47.6 percent in 1991 to 50.6 percent in 2001 Census and further to 55.77 percent in 2011.

266. **Female work participation rate**: Female work participation rate increased from only 13.8 percent to 21.1 percent in 2001 and further to 23.57 percent in 2011.

267. Among the workers about 20 % are cultivators and 24 % are working as agricultural laborers. Thus 44.2 % are directly engaged in agriculture and allied activities. Similarly, 2.8 % are household industrial workers and majority about 53 % are classified as other workers.

268. **Per-Capita Income:** The per capita income of the state was Rs. 47,155 in 2011-12 and it increased to 1,25,191 by 2019-20. The state stands at 21st position among the 33 states in term of per-capita income. The state per-capita income is less than the national average of 1,34,226 according to the Economic review of Tripura for the year 2019-20. The Per Capita

Income (PCI) is derived by dividing the Net State Domestic Product at current prices by the mid-year's total population of the State. The Per Capita Income (PCI) is a pointer for standard of living and the well-being of people.

269. **Poverty:** The erstwhile Planning Commission has periodically estimated poverty lines and poverty ratios on the basis of large sample surveys on 'Household Consumer Expenditure' conducted quinquennially (once every 5 years) by the National Sample Survey Office, Ministry of Statistics & Programme Implementation, Government of India. Based on NSS 68th round data of 'Household Consumer Expenditure' survey, poverty estimates for the year 2004-05 and 2011-12 have been estimated as per recommendations of Tendulkar Committee. The final poverty line for Tripura was Rs. 450.49 for rural areas and Rs. 555.79 for urban areas as against Rs. 446.68 for rural areas and Rs.578.8 for all India in 2004-05. About 40.6 % of the population was under poverty in the year 2005-05, which significantly dropped to 14 %, the rural poverty ratio was 16.5 whereas the urban poverty ratio was 7.42 in the year 2011-12.

270. **Livestock:** The Animal Resources Development Department of the State has been implementing various socio-economic programmes to create gainful employment opportunities in the rural areas through various developmental schemes with the objectives: To provide health coverage to all the livestock and poultry of any breed in respect of contagious and non-contagious diseases and to improve livestock generating production viz; Milk, Egg and Meat as well as to improve socio-economic status of the farmers and enhance contribution to the Gross Domestic Product of the State. To achieve the goal, the Animal Resources Development Department of the State has been providing animal health care service and breed improvement facilities through 16 Veterinary Hospitals, 60 Dispensaries, 11 Artificial Insemination Centres, 2 ICDP Centre, 4 Frozen Semen Banks, 458 Veterinary Sub-Centres, 4 Veterinary Medicine Store, 4 Disease Investigation Laboratories, 5 Hatcheries, 4 Poultry Breeding Farms, 10 Pig breeding Farms, 2 Goat breeding Farms, 2 Duck Farms, 1 Cattle farm, 2 Rabbit Farms and 7 Fodder multiplication Farms etc.

271. **Industry:** Tripura is industrially backward and main reason for its backwardness is geographical isolation. Low availability of infrastructure has made the process of economic development and decentralization extremely difficult in the State. The un-organised manufacturing and service activities are only dominant and high in the State.[80] The Industry Sector has remained undeveloped so far, despite the vast potential. The secondary sector contributes only about 5% of total employment and about 7% of the total income (SDP) of the state at present.[81] Tourism has been declared as an Industry in the state since 1987. Handicraft is emerging as a potential industry in Tripura. The Handloom Industry also plays an important role in rural Industry of Tripura. According to the economic review of 2019-20, the State has 5-industrial Estates, 1-Industrial area, Public Sector Undertaking-4, 2-growth centre, Value of export Rs 30.34 crore and value of import Rs 644.78 crore in 2019-20.

272. The State has the potentiality for industrial opportunities and improvement, which in turn will increase employment generation in the State. The main thrust areas of the State Industries & Commerce Department are to promote and develop the rural, micro, small and medium enterprises, agri based food processing industries and promoting export and import business with the neighboring country of Bangladesh. Tea and rubber-based industries are taken into consideration for the development of industrial base in Tripura. Although the State is backward

[80] Economic Review of Tripura. 2019-20
[81] https://tripura.gov.in/demographic-features

in industrialization but it has the potentiality for industrial opportunities and improvement, which will increase employment generation in the State. The provisional result of 7th Economic Census-2019 reveals that there were 4,82,269 establishments in Tripura engaged in different economic activities other than crop production and plantation in the State. Out of them, 3,67,866 (76.28 percent) establishments were in rural areas and remaining 1,14,403 (23.72 percent) establishments in urban areas. Around 5,16,109 (65.86 percent) persons engaged in the establishments as hired workers and remaining 2,67,585 (34.14 percent) persons engaged in the establishment as a non-hired workers in the State.

273. In most of the villages surveyed, majority of the households were male headed. Education levels are up to high school. Women-headed Households (WHH) amounted to around 12.5% of the total 72 households interviewed. Dayalpara village had most amount of female headed households (3 of the 12 interviewed). number of males and females in the interviewed HH is shown in Table 4-38. In total 5 women from all 6 villages were interviewed in the Study Area.

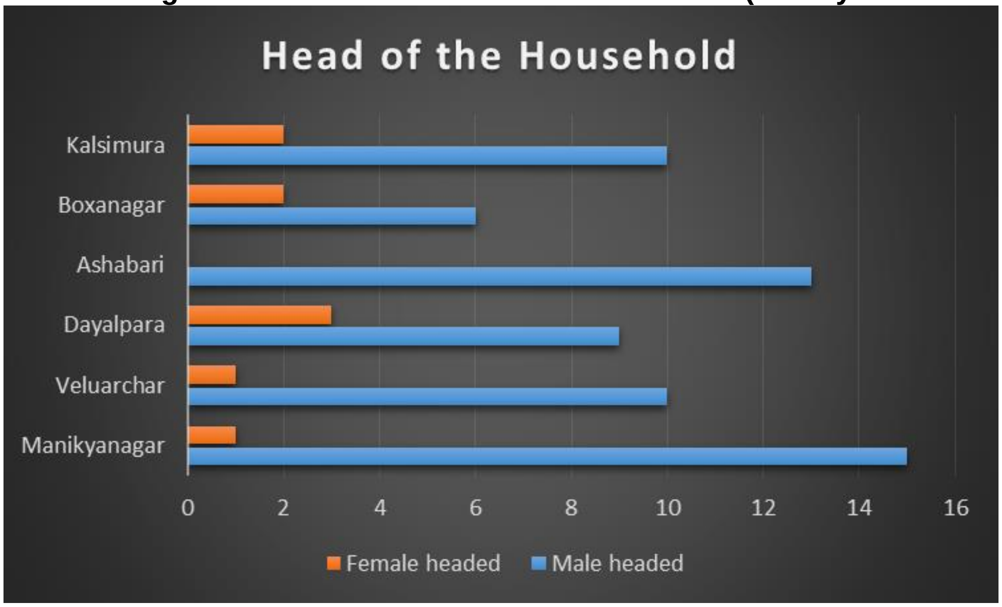
Table 4-38: Total Males to Total Females in Surveyed Households

Village	No of Males	No. of Females
Manikyanagar	35	27
Veluarchar	21	21
Dayalpara	35	29
Ashabari	33	26
Boxanagar	29	21
Kalsimura	26	30
Total	**179**	**154**

Source: MITCON

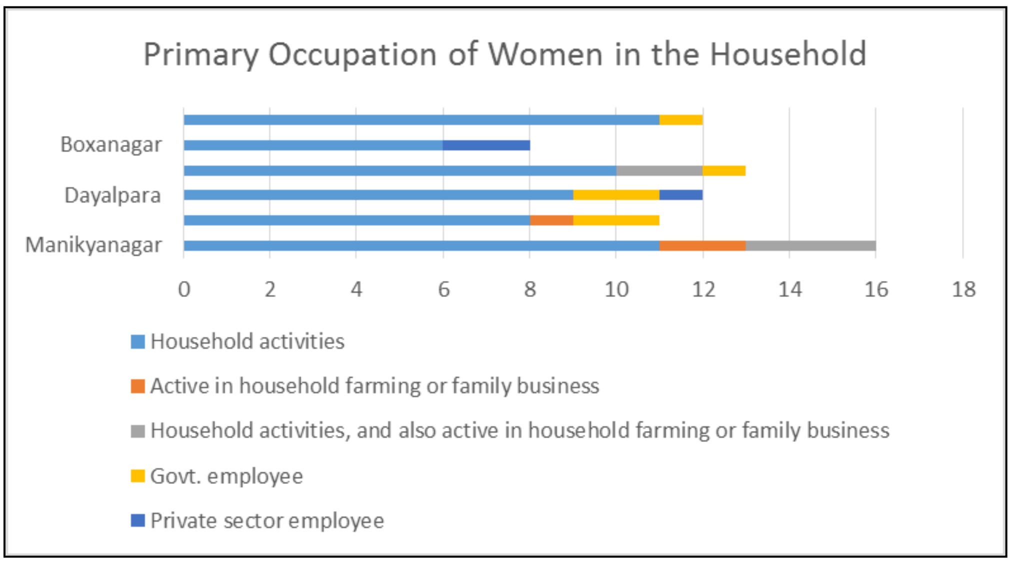
274. Women in most households of all villages surveyed are involved in household activities. Some women are also active in household farming or family business. Government employees and private sector employees are the other prominent occupations of women in the households. Details of head of the households and the primary occupations of women in the households, are shown below in Figure 4-36 and Figure 4-37 respectively.

Figure 4-36: Village-wise Details of Head of the Household (Surveyed Households)



Source: MITCON

Figure 4-37: Primary Occupations of Women in the Households Surveyed



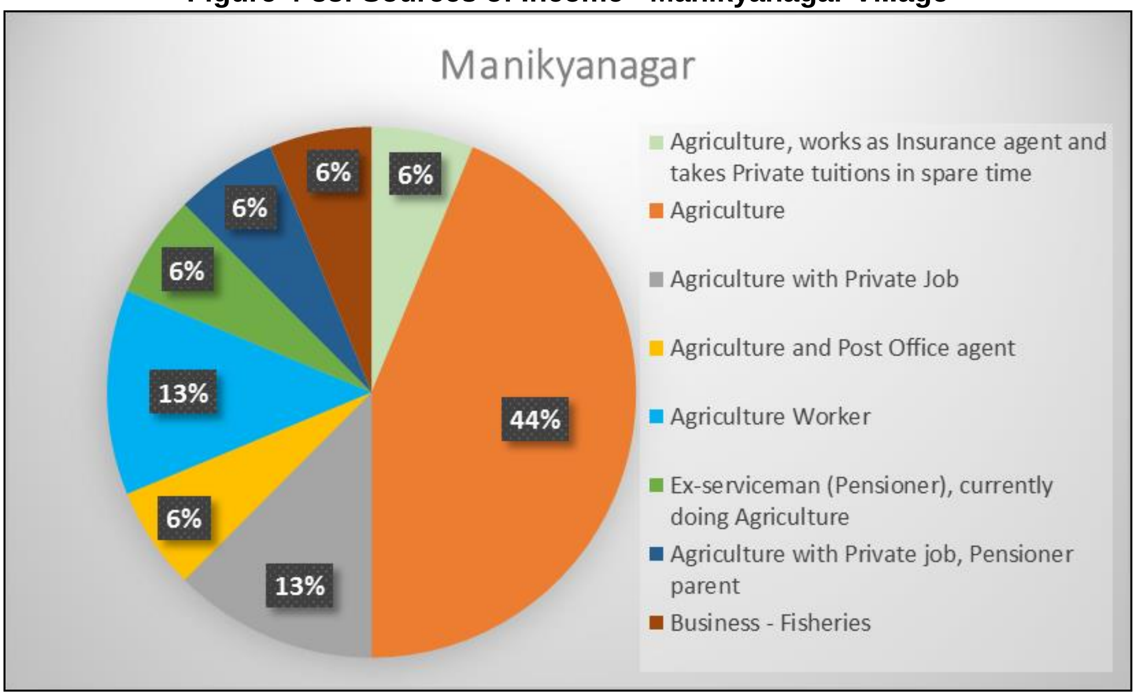
Source: MITCON

275. Of all the households surveyed, women from 1 household in Manikyanagar village, and from 2 households each in Dayalpara, Ashabari and Kalsimura villages are part of Self-Help Group (SHG). Some of the SHGs in the area include Joyram SHG, Asha SHG, and Nutan Dighanta SHG.

276. The main source of household income in all villages surveyed seems to come from agriculture or related activities. Almost every household has agricultural land and carry out farming, either for personal use or as an income source. Many people in the surveyed villages carry out agriculture along with other businesses such as private tuitions, shops, private sector jobs, government jobs, post office/general insurance agents, etc. Few people own fish farms or

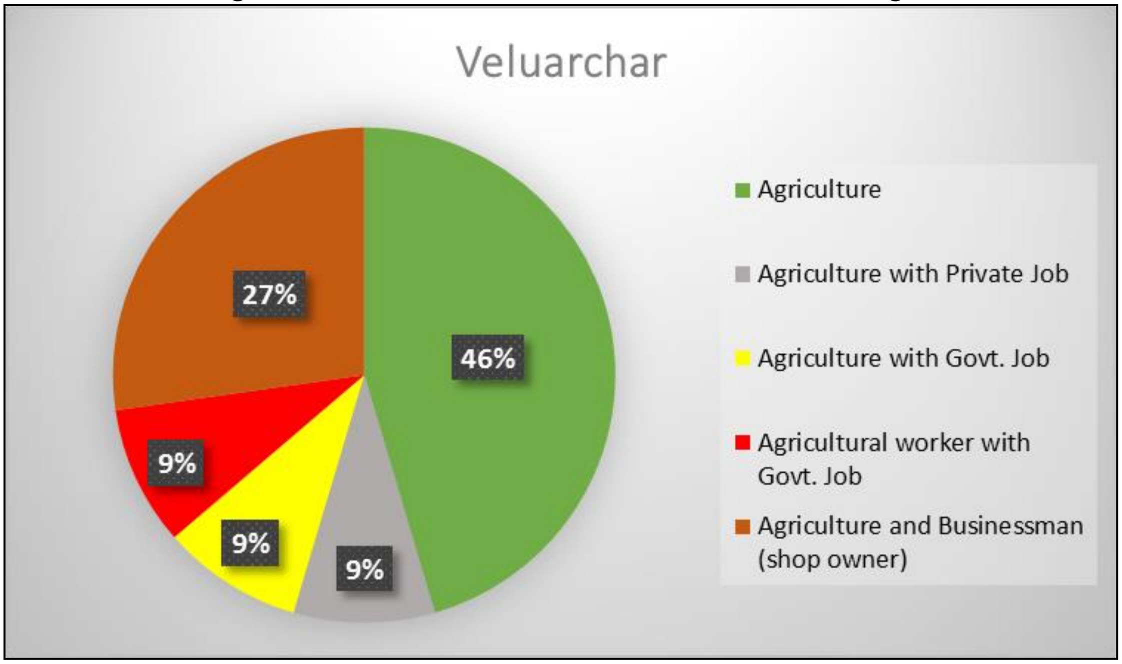
poultry farms. Village-wise business details of those surveyed are represented as pie charts in Figures 4-38 to 4-43.

Figure 4-38: Sources of Income - Manikyanagar Village



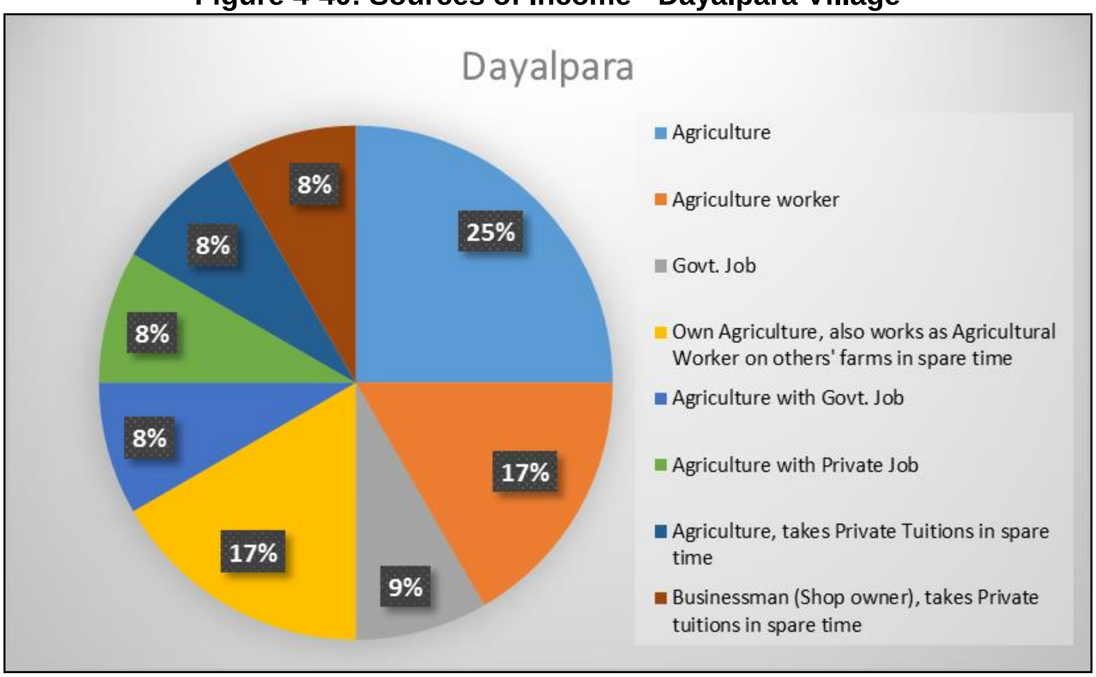
Source: MITCON

Figure 4-39: Sources of Income - Veluarchar Village



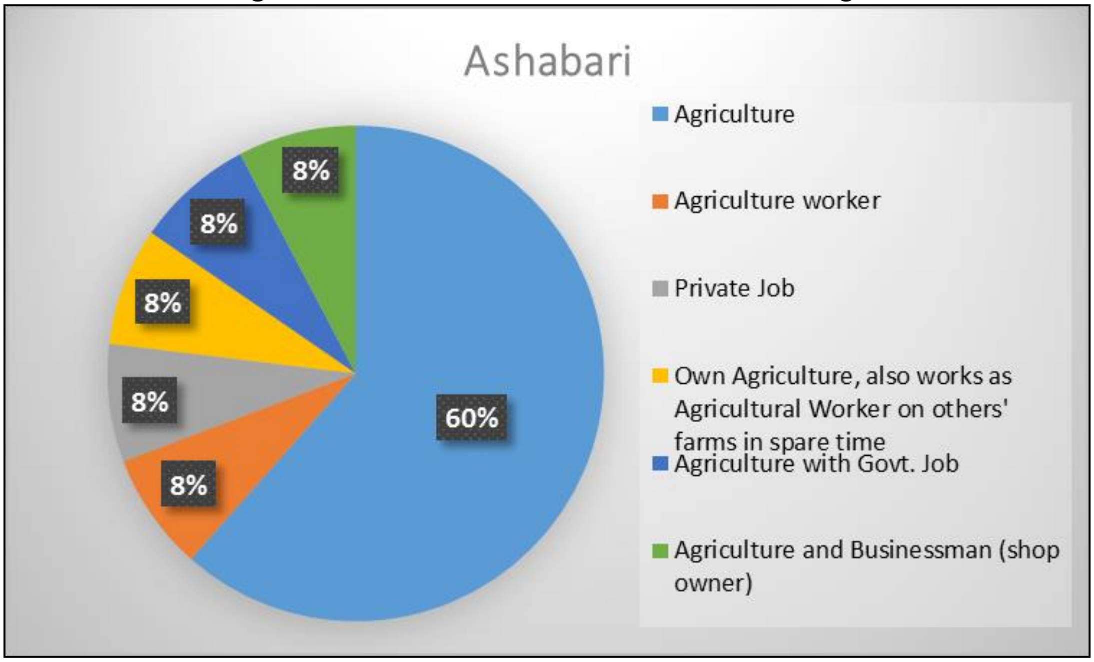
Source: MITCON

Figure 4-40: Sources of Income - Dayalpara Village



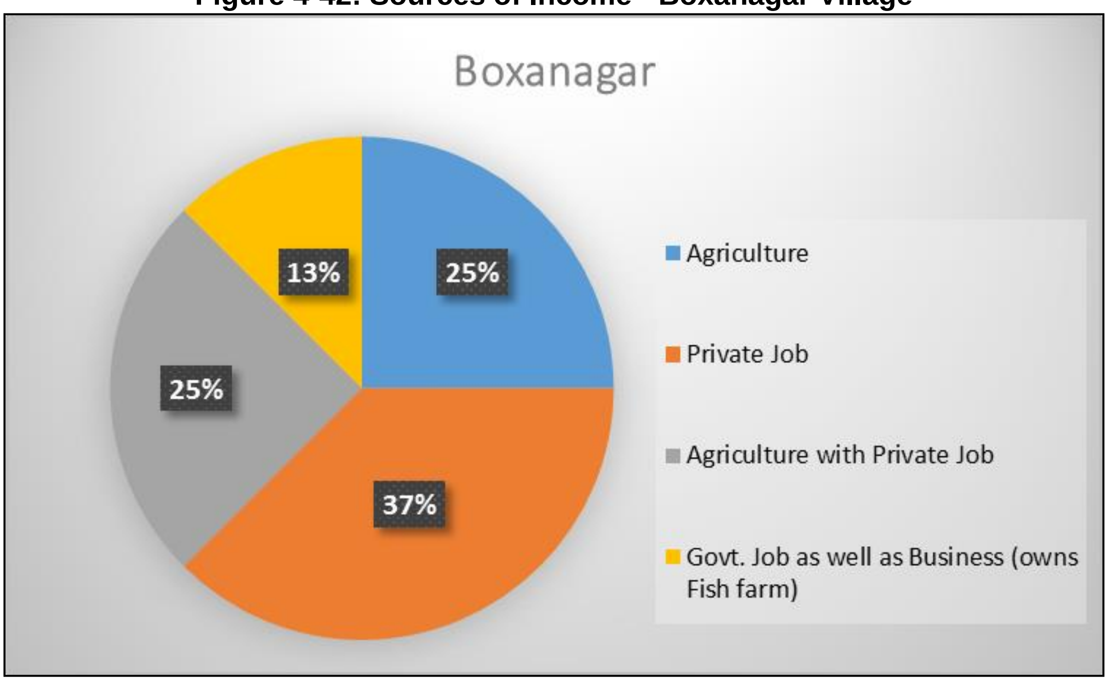
Source: MITCON

Figure 3: Sources of Income - Ashabari Village



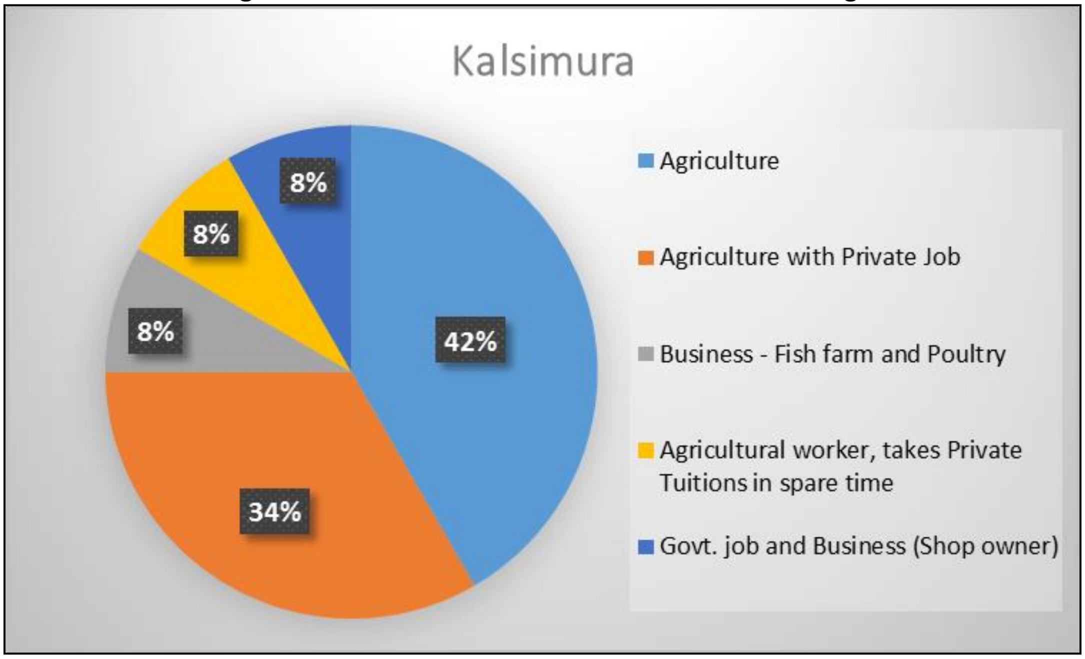
Source: MITCON

Figure 4-42: Sources of Income - Boxanagar Village



Source: MITCON

Figure 4: Sources of Income - Kalsimura Village

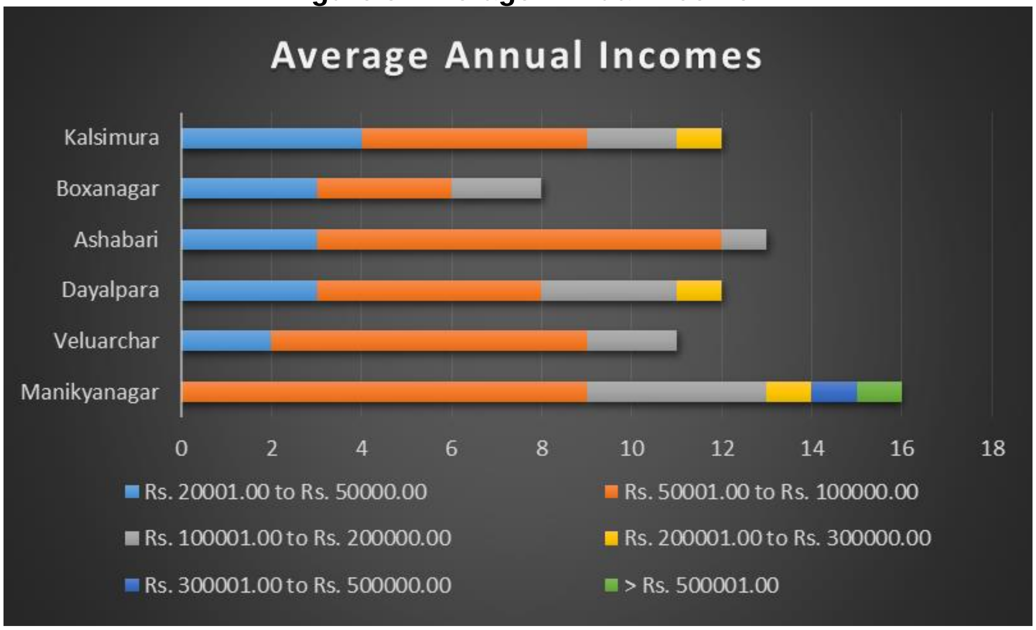


Source: MITCON

277. The average yearly income in the surveyed villages varies as shown in Figure 4-44. In its Ninth Five-Year Plan (1995–2002), BPL for rural areas was set at annual family income less than Rs. 20,000, less than two hectares land, and no television or refrigerator. Of the total 72 households surveyed in 6 villages around the study area, about 62% HH are Above Poverty Line (APL) as shown in Figure 4-45.

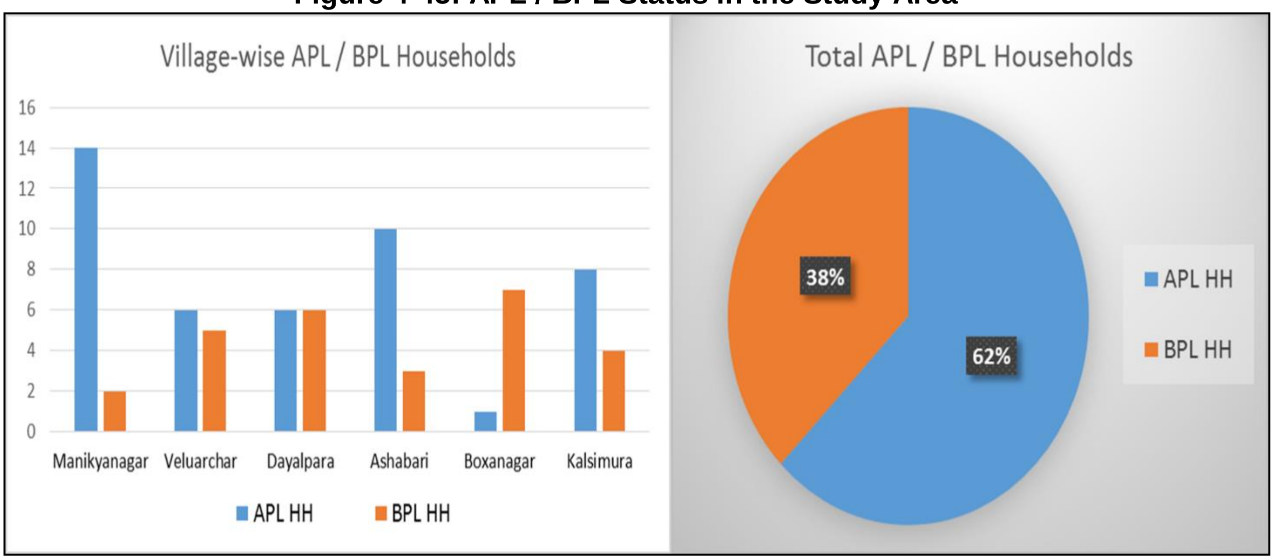
278. The existing project is beneficial to all and none of the people were affected with the construction of the project. No land was affected and hence no compensation was required. All the households interviewed seemed to be aware about the upcoming proposed plant, none had any objections to it.

Figure 5: Average Annual Income



Source: MITCON

Figure 4-45: APL / BPL Status in the Study Area



Source: MITCON

279. Almost all the households interviewed have accounts in the Tripura Gramin Bank (TGB), which is a state-run Bank in Tripura, and is recently taken over by the Punjab National Bank (PNB). Other banks include State Bank of India (SBI) and UCO bank. No other options other than these banks are used by any of the household interviewed.

2.5. Land Use and Agricultural Practices

280. The majority of land use in the surveyed villages comprises forest, followed by agricultural land as shown in Table 4-39. Tripura has one of the oldest, richest, and most diverse cultural traditions associated with use of medical plants. There are large number of

villages based herbal medicines practitioners who have traditional knowledge of herbal home remedies of ailments and nutrition. Besides the above registered medical practitioners of modified system of Indian Medicine (such as Ayurveda) use medical plants. The herbal medicines used by rural people including tribal have not yet been documented. Compiling an exhaustive inventory of medicinal plants in the State is the need of the hour. So far about 266 species of medicinal plants (68 trees, 39 shrubs, 71 herbs and 88 climbers) have been identified and documented. Bamboo plays a very vital role in the economy of the State as it serves the artisan & non-artisan users of the state. The productivity of bamboo at present is only 0.70 MT per ha /yr.[82] Research studies in various forest divisions show that the productivity of bamboo can be increased to 5MT per ha/year in natural conditions with timely plantation and protection measures.

281. While the annual revenue from forests in the State is around Rs. 300 lakhs, the subsidy that flows to the rural economy on account of free removal of only five items of forest produce has been conservatively estimated to be Rs. 12,926 lakhs, which is about 5.57% of State Domestic Product (SDP). This does not take into account edible fruits, tubers, medicinal plants and many other non-timber forest produce. Recorded/unrecorded removal/use of aforesaid five categories of forest produce is estimated as per Table 4-40. Except bamboo, the supply of other forest produce is not at all commensurate with the sustainable yield. The supply also includes timber from settled and private land as can be seen from the following Table 4-41.

[82] https://forest.tripura.gov.in/forest-of-tripura#:~:text=Tripura%20has%20one%20of%20the,home%20remedies%20of%20ailments%20%26%20nutrition.

Table 4-39: Area under Different Types of Land Use

(in hectares rounded up to one decimal place)

Name village	Forests	Area under Non-agricultural Uses	Barren and Un-cultivable land	t Pastures and Other Grazing	Under Miscellaneous Tree	Fallow lands other than current fallows	Current Fallows
Rahimpur	115	32.6	8.8	0	1.6	2.4	6.8
Putia	177	5	2.4	0	2.3	1.2	1.5
Bhaluarchar	601	0.6	0	0	3.2	0	0
Ashabari	159	1.3	0.4	1.1	1.6	0.8	0.8
Boxanagar	159	1.3	0.4	1.1	1.6	0.8	0.8
Kalsimura	168	38.6	4.1	2.1	6.1	2.1	4.1
Manikyanagar	518	1.8	1.5	0	2.4	0	0.1
Ghilatali	340	23.1	0.6	0.9	0.8	2	0.8
Jogatrampur	324	52	1	0.9	1.8	4.5	1.6
Kalamchaura	36.8	669.3	9	1.2	1.3	4	6.1
Anandapur	538	38.2	0	0.5	1.5	0	0
Kamalanagar	437	15	0	1.8	3	0	0
Bejoynagar	797	22.1	0	1.3	0.2	0	0
Dhanirampur	962	10.2	0	0.8	1.2	0	0
Matinagar	1173	12.3	0	2	2	0	0
Kulubari	274	9.7	0	1	1	0	0
	6778	**933.1**	**28.2**	**14.7**	**31.6**	**17.8**	**22.6**

Source: MITCON

Table 4-40: Recorded/unrecorded removal/use of aforesaid five categories of forest produce

Produce	Recorded removal (million units)	Unrecorded removal (million units)	Actual removal (million units)	Value per unit (Rs.)	Value (in Rs. Lakhs)
Timber	0.012	0.034	0.046	2000/m^3	680
Fuelwood	0.043	2.194	2.236	200/m^3	4388
Thatch	0.13	0.213	0.343	80/ton	170
Fodder		1.53	1.53	500/ton	7650
Bamboo	109.76	75.50	184.26	50000/million	38
Total					12926

Source: MITCON

Table 4-41: Supply-demand timber

Forest produce	Average Demand/ capita	Total users (in million)	Extraction/ annum (million units)	Sustainable yield (million units)	Gap (million units)
Timber	0.022 m^3	2.76	0.061	0.041	0.02
Fuelwood	0.806 m^3	2.57	2.07	1.485	0.585
Bamboo	42.76 No.	2.57	109.82	142.60	-
Thatch	0.124 ton	2.57	0.32	0.0127	0.32

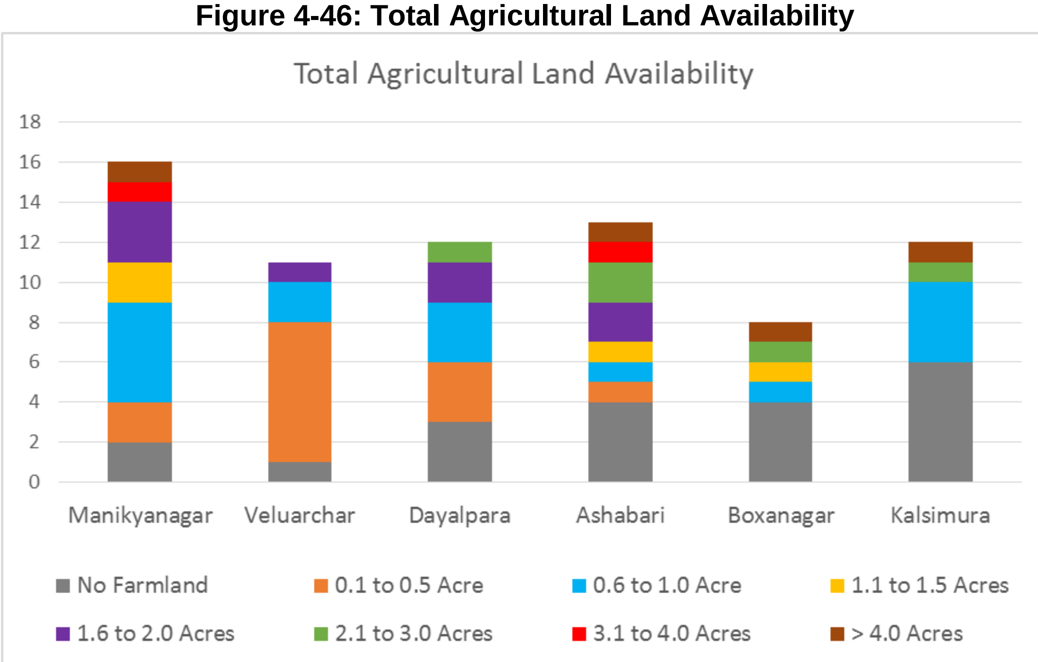
Source: MITCON

282. The cropping pattern in Tripura is characterized by two distinct farming systems i.e., settled cultivation in the plains and shifting cultivation in the hills. Paddy, pulses and oilseeds are the major crops grown in the state. Paddy is grown in 55% of gross cropped area in three seasons viz. *Aush* (pre-Kharif), *Aman* (Kharif) and *Boro* (summer) whereas pulses and oilseeds cover about 5% of area. Kharif is the autmn crops sown at the beginning of the monsoon season. Fruits and vegetables are grown in 21% of gross cropped area, 10% area is under rubber cultivation and 9% under other miscellaneous crops like tea, medicinal plants etc. The major Kharif crops are rice, maize, pigeon pea, black gram, green gram, cowpea, ground nut, sesame, jute, Mesta, cotton, and Kharif vegetables. Different crops taken during Rabi season (crops sown around mid-November, preferably after monsoon rains) are rice, wheat, pea, green gram, lentil, rapeseed-mustard, potato, and Rabi vegetables. The state has favorable climatic conditions for cultivating various fruit and horticultural crops including rice, jackfruit, pineapple, potato, sugarcane, chili, and natural rubber. Rice is the major crop of the state and is cultivated in 55% of the cropped area.

283. Availability of total farmland in all the households surveyed is shown graphically in Figure 4-46. Almost all the households in the study area cultivate rice as the main crop, while few use their uncultivable farmland for fisheries business or poultry farms. Rubber cultivation is also undertaken by one or two of the households interviewed. Most of the households depend on rain as a source of water for agriculture. Bore-wells and river/stream water are also used by some households as a source of water for agriculture. It is a practice in most households to convert a small part of their uncultivable farmland into a pond. This pond is generally used to cultivate fish for personal consumption and for raising ducks.

284. Livestock owned by most households include 1-4 cows, a few hens, ducks and goats. Pigs are also reared for consumption by some of the households, especially in the Tripura Tribal Area Autonomous District Council (TTAADC) and non-Muslim dominated areas.

Figure 4-46: Total Agricultural Land Availability

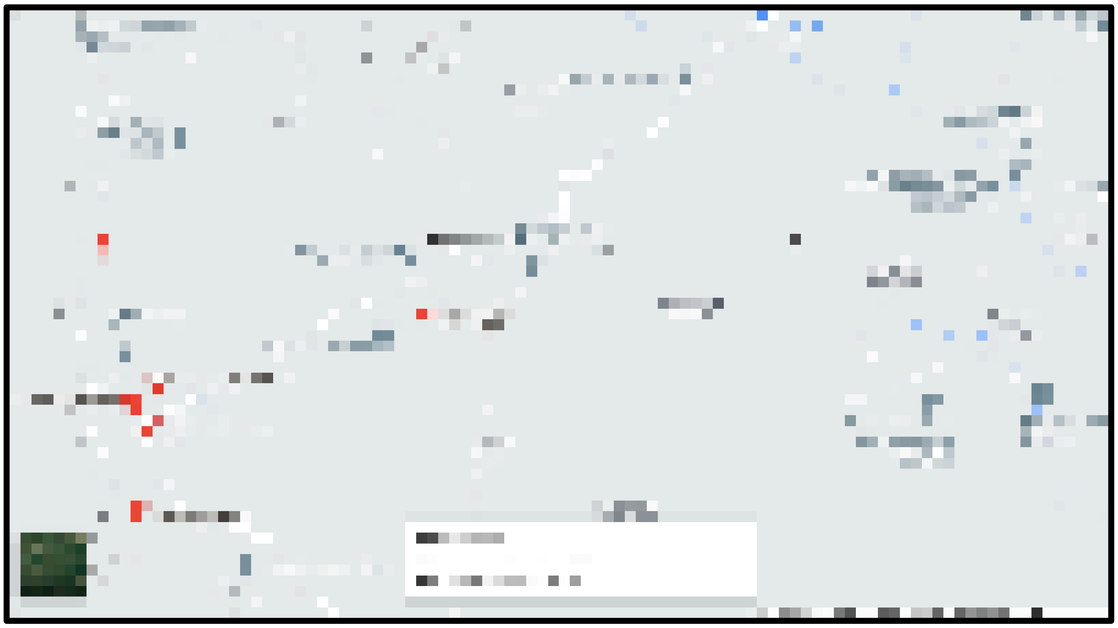


Source: MITCON

3. Basic Amenities and Infrastructure

285. The rural areas falling under the radius of study area has the necessary civic and other basic amenities although further development in infrastructure especially for health care and education is required. Key facilities, including education and religious, within 3 km are shown in Figure 4-47.

Figure 4-47: Map Showing Key Facilities Within a Radius of 3 km of Project Site



Source: ADB TA Consultant

3.1. Access to Drinking Water

286. In Tripura tap water is access by one third of the households. This is about 54 % in urban area and 25 % in rural area. This is significantly less than the national average of 43.5 %. Uncovered well, and hand pumps are also important source for another 43 % of the households in Tripura, more in rural areas than in urban areas. The other sources of water is as shown in Table 4-42.

Table 4-42: Number and Percentage of Source of Water by Different Types

House list Item	India	Tripura					
		Absolute Number			Percentage		
		Total	Rural	Urban	Total	Rural	Urban
Tap water	43.5	2,79,789	1,52,888	1,26,901	33.20	25.2	54
Tap water from treated source	32.0	1,71,167	69,003	1,02,164	20.30	11.4	43.5
Tap water from un-treated source	11.6	1,08,622	83,885	24,737	12.90	13.8	10.5
Well	11.0	2,30,576	2,15,219	15,357	27.40	35.4	6.5
Covered well	1.6	24,343	21,196	3,147	2.90	3.5	1.3
Uncovered well	9.4	2,06,233	1,94,023	12,210	24.50	31.9	5.2
Hand pump	33.5	1,52,365	1,02,071	50,294	18.10	16.8	21.4
Tube-well / Borehole	8.5	1,36,980	98,270	38,710	16.30	16.2	16.5
Spring	0.5	15,960	15,769	191	1.90	2.6	0.1

House list Item	India	Tripura					
River / Canal	0.6	15,414	14,954	460	1.80	2.5	0.2
Tank / Pond /Lake	0.8	4,075	3,772	303	0.50	0.6	0.1
Other sources	1.5	7,622	4,836	2,786	0.90	0.8	1.2

Source: Census of India Report, 2011

3.2. Cooking Fuel

287. For cooking majority about 80.5 % of the households use firewood in Tripura which is significantly much higher than the national average of 49 % according to the 2011 census. Besides firewood, about 18 % uses LPG / PNG in the state as cooking fuel. The details of sources of lighting are given in Table 4-43.

Table 4-43: Fuel Used for Cooking

#	Households by fuel used for cooking	India	Tripura					
		% age	Absolute Number			Percentage		
			Total	Rural	Urban	Total	Rural	Urban
1	Fire - wood	49	6,78,178	5,66,977	1,11,201	80.5	93.3	47.3
2	Crop residue	8.9	6,573	5,105	1,468	0.8	0.8	0.6
3	Cowdung cake	7.9	1,173	763	410	0.1	0.1	0.2
4	Coal, Lignite, Charcoal	1.4	694	528	166	0.1	0.1	0.1
5	Kerosene	2.9	5,294	1,100	4,194	0.6	0.2	1.8
6	LPG / PNG	28.5	1,48,637	31,920	1,19,717	17.6	5.3	50.9
7	Electricity	0.1	299	223	76	0.0	0.0	0.0
8	Bio-gas	0.4	589	264	325	0.1	0.0	0.1
9	Any other	0.5	705	559	146	0.1	0.1	0.1
10	No cooking	0.3	639	340	299	0.1	0.1	0.1
	Total number of households	24,66,92,667	8,42,781	6,07,779	2,35,002	100.0	100.0	100.0

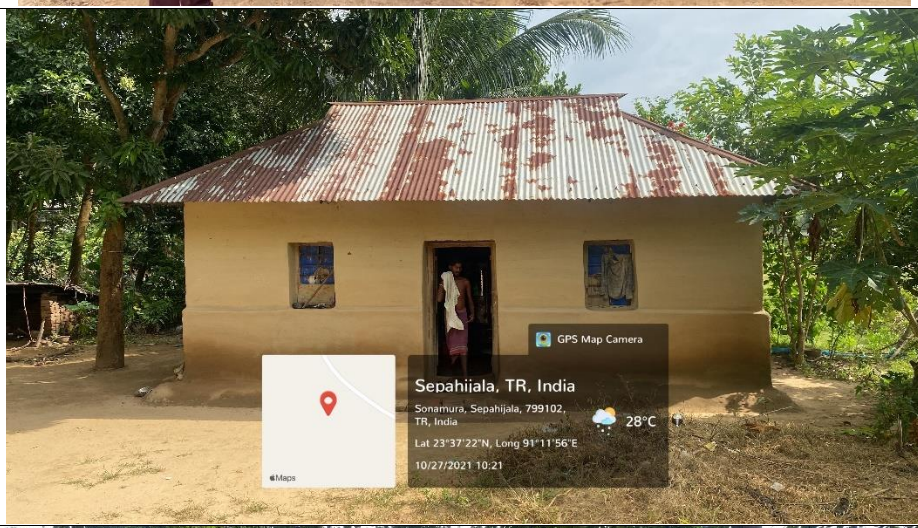
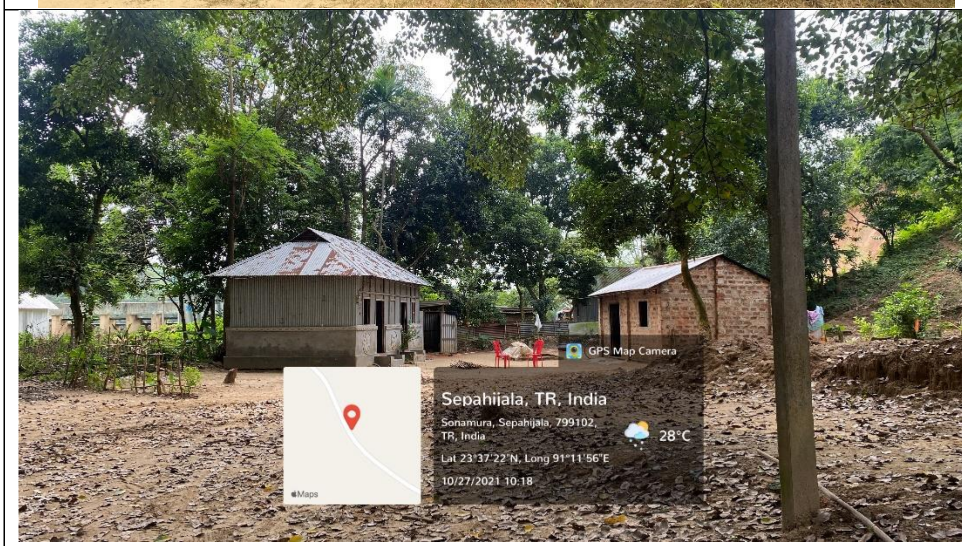
Source: Census of India Report, 2011

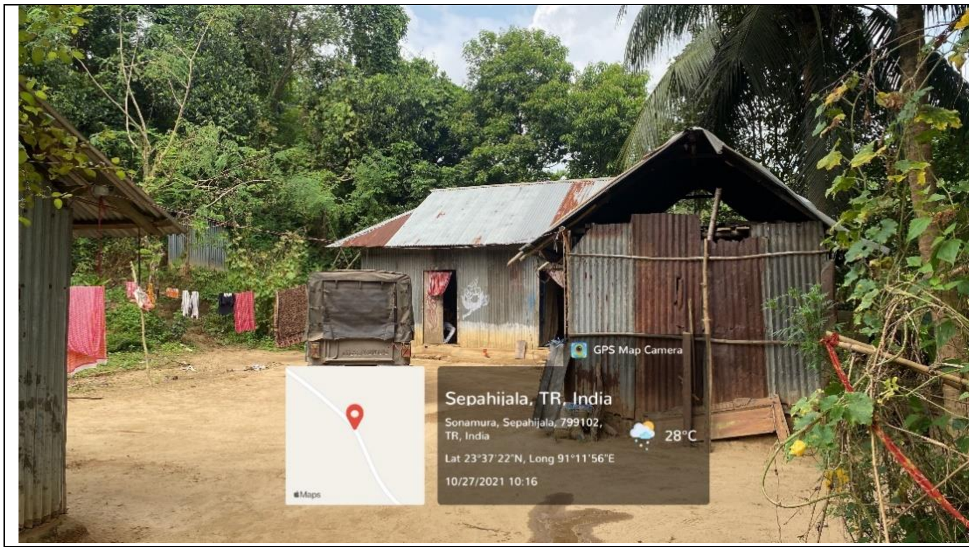
3.3. Housing Condition and Structural Integrity

288. Residences in the study area typically comprise multiple smaller house-buildings in a common compound. Each building has a different purpose and is used accordingly. The unit of measurement used to measure land is called a *Gonda.* One *Gonda* is around 100 square feet. Most of the houses in the study area do not have designated area for cattle sheds or have cattle sheds smaller than 50 square feet. None of the households interviewed is a landless household. According to the National Sample Survey Organization (NSSO), landlessness is defined as possessing land below 0.002 hectares, or 215 square feet. Village-wise comparison of areas of residences in the study area as well as the percentage of cattle sheds owned in all the 72 households interviewed is shown if Figure 4-50.

289. Majority of the houses are made up of mud/tin sheets and/or bricks and concrete. Most of the houses have roofs made of steel sheets, RCC and cement and/or a combination of these. The nearest residences are of mud walls and tin roofs and their structural integrity is weak. Consultations revealed that the houses are impacts by monsoon winds/cyclone, flash floods along the residences. Roofs have been blown away during heavy winds in 2019. Photographs of the residents are shown in Figure 4-49. A graphical representation of the type of materials used for construction of walls and roofs in the Study Area is shown in Figure 4-51.

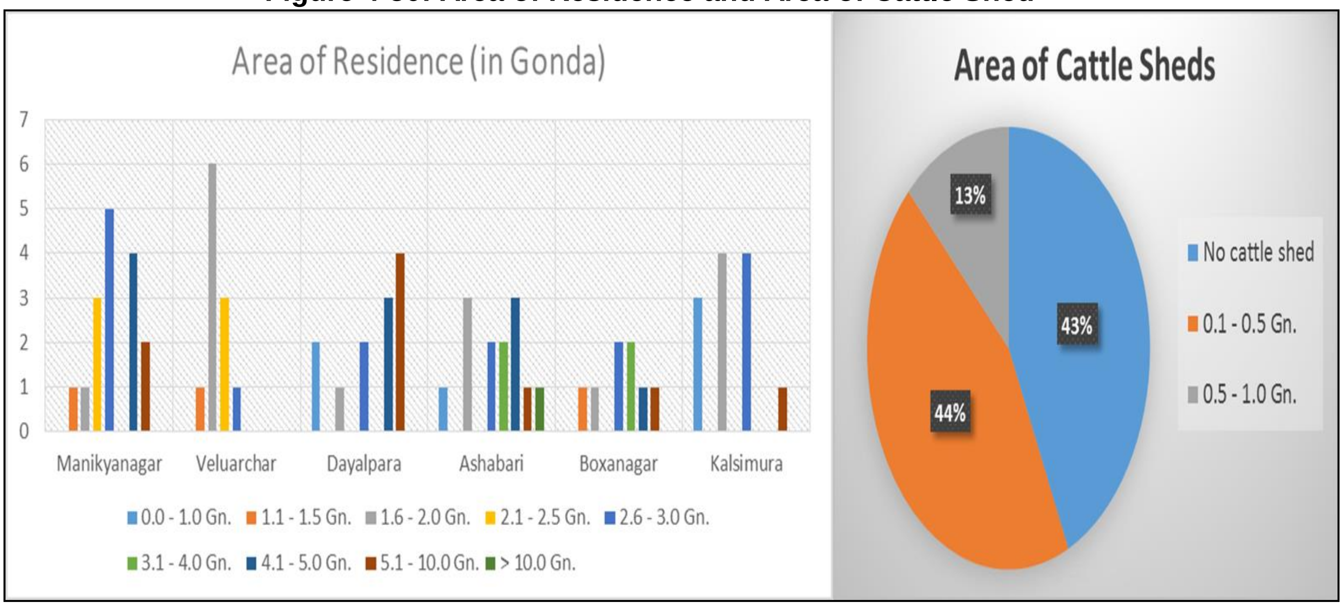
Figure 4-49: Condition of Houses Located Nearest to Proposed Plant

	Tin walled and tin roof house near proposed plant
	Mud hut with tin roof - residence close to plant
	Huts made of stone and concrete, the 10th residence from the plant area

	One of the damaged houses near the plant

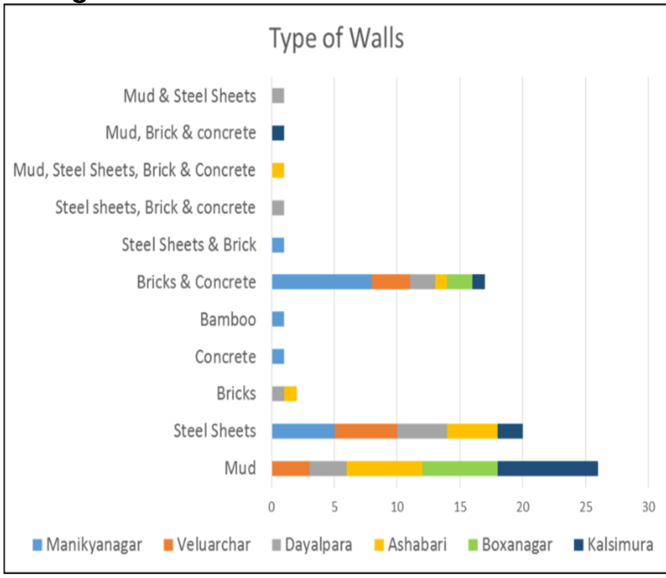
Source: ADB TA Consultant

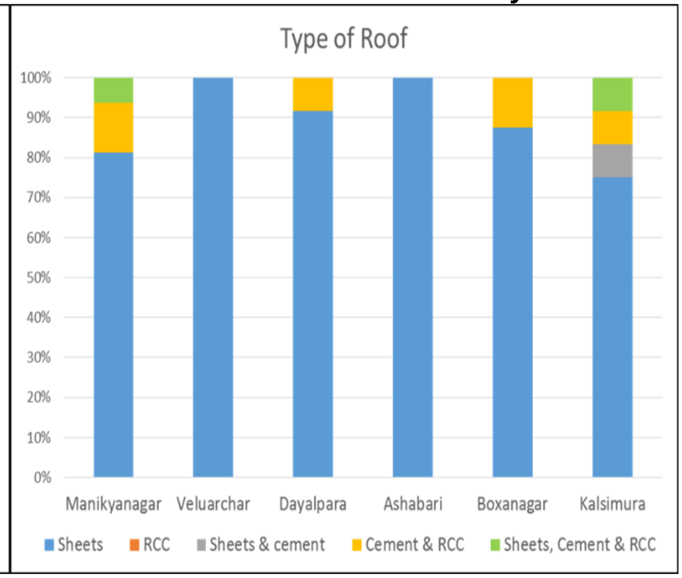
Figure 4-50: Area of Residence and Area of Cattle Shed



Source: MITCON

Figure 6: Construction Materials used for Walls and Roofs of Residences in Study Area



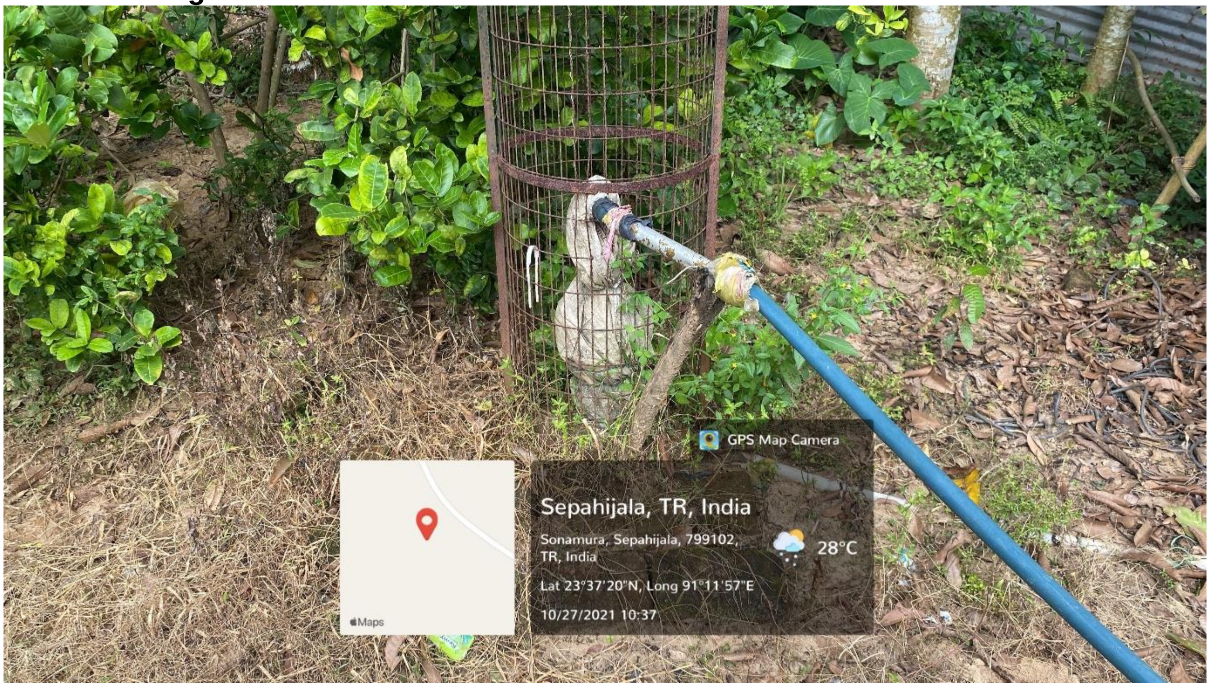


Source: MITCON

3.4. Water Resource and Usage

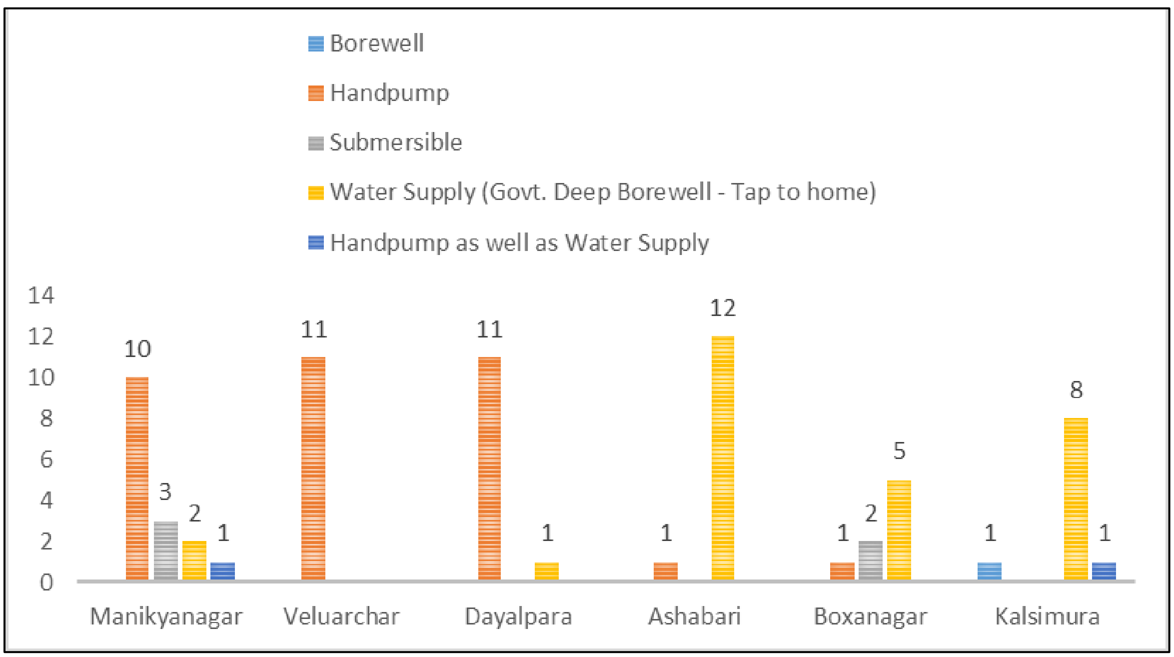
290. The Census 2011 data reveals that drinking water facilities of different types exit in all the villages in the study area. As, in general across Tripura, the iron content in ground water is high. People collect drinking water from tube wells, earthen ring wells or from mini deep tube wells installed by the local administration. Most households in Veluarchar *tehsil* own personal hand-pumps for drinking/domestic water, while most households in Boxanagar tehsil, have water supply to their homes. Government has dug deep borewells with up to 5000 LPS drawdown and has provided water supply lines straight to end users in Veluarchar *tehsil*. Other water sources found in the study area include submersible pumps and borewells. Some of the households have water supply as well as hand-pumps.

Figure 4-52: Bore Well Located at One of the Nearest Residence



Source: ADB TA Consultant

Figure 4-53: Graph Showing Drinking Water Resources in the Study Area



Source: ADB TA Consultant

3.5. Sanitation and Sewerage Facilities

291. The sewerage scheme (Swachh Bharat Mission, GoI) in Manikyanagar has been designed to provide the individual house connection in almost all the cases. Each individual household is to be connected to the nearest manhole of the sewer network through an

inspection chamber. However, in some isolated cases, the sewers particularly in upstream stretches of the network may be above the outlet pipe of the toilets of the individual's houses. In such cases, the toilets are to be lifted for connection to the sewers or lifting station arrangements are to be provided with.

Figure 4-54: Toilet at the Compound Of Nearest Residences
(Outlet Connected to Soak Pit)

Source: ADB TA Consultant

292. All the households surveyed have private sanitation facilities. Private sewage treatment in the form of septic tanks, is available with all the households surveyed. Government of Tripura has taken extensive Information, Education and Communication (IEC) activities for bringing behavioral change along with construction of Individual House Hold Latrines (IHHLs) for achieving Open Defecation Free (ODF) Status of all Gram Panchayats and Village Councils of the State. On 02.03.2019, the entire state of Tripura attained ODF status. A total of 214,488 IHHLs have been constructed so far and construction of 40,254 toilets is in process in different parts of the state. As per the Swachh Bharat Mission website [https://sbm.gov.in/sbmdashboard/ODF.aspx] a total of 1178 villages (Gram Panchayats) are Declared ODF, of which 743 are verified ODF villages.

3.6. Solid and Hazardous Waste Management

293. **Solid Waste**: Tripura has no masterplan for solid waste management even in major urban centers including the capital city of Agartala. According to the Agartala Municipal Council, about 90-95 metric tonnes of solid waste is generated per day. Of which approximately 50-60 metric tonnes are collected through NGO collaboration and dumped in Haphama Dumping Ground – it is and open dump and not an engineered sanitary landfill. In a recently held meeting (August 2001) Agartala Municipal Council has proposed improvement of the same through additional deployment of dumper, dozer, payloader and house to house collection, besides cleaning up of major roads and 10 markets, at a cost of nearly Rs. 453.0 lakh. A local NGO has

also proposed to undertake work for conversion of organic wastes into compost, vermicomposting, pelletization etc.

294. **Hazardous Waste:** Due to lack of infrastructure and communication, Tripura is still an industrially backward state. The main livelihood of this state is agriculture. Most of the production units in Tripura are small-scale in nature and most of them do not have available the Material Safety Data Sheet (MSDS). Therefore, inventorization of hazardous waste for this state can only be done based on medium-scale and large-scale industrial units. Based on the available information an inventory of hazardous waste generating units has been prepared by the National Productivity Council in 2001, Delhi to the State Pollution Control Board, Tripura. Highest quantum of hazardous waste i.e., 88,000 m^3/year is generated from processing of latex. Out of total 88,000 m^3/year, 67 % is generated from West district only and balance 33 % is spread in remaining three districts. About 0.8 MT/year of waste developing and fixer residue is generated from photo printing units in Tripura. This is at present being drained to the municipal drains. However, some units claim that they generally collect them in a drain and then send them to Assam for recovery of silver from it. About 240 MT of spent acid is being generated per year from lead acid battery reconditioning process which is presently being discharged into municipal drains from all the small shops of battery reconditioning spread all over Tripura. The waste has to be neutralized and the lead has to be removed before discharge. In addition, approximately 1,200 MT of lead scrap is generated which is presently being sold out to traders for reclamation of lead outside Tripura. About 198 MT of oil containing sludge and about 13.2 MT of cloth contaminated with oil are being generated per year from repairing and servicing of automobile The oil containing sludge is presently being sold out while cloth contaminated will oil is being burnt. The small shops for repairing of automobiles are spread all over the Tripura. There are clusters of textile and handloom weaving units in West district of Tripura. However, dyeing of cotton yarns & printing of textile (bed sheets) is been carried out in co-operative societies only. The azo-dyes are being used for dyeing and printing. The wastewater containing spent dyes is being discharged into groundwater without any treatment through digging the wells right up to aquifer. However, it is estimated that after installation of Effluent Treatment Plant (ETP) about 4.3 MT of sludge containing dyes will be generated per year at existing capacity of dyeing and printing. There is only one tannery unit in West district of Tripura, which is not having any wastewater treatment plant. However, it is estimated that after installation of Effluent Treatment Plant (ETP), about 159 MT of sludge containing chromium will be generated per year at existing capacity of tanning i.e., 20,000 skins per month. Remaining hazardous wastes are in very small quantity. In summary, it is apparent that at present no proper systems of hazardous waste management exist in Tripura. A summary of hazardous waste generation and management within the Sipahijila district, housing the proposed plant is provided in in Table 4-44. There are no hazardous waste management facilities in Tripura.

Table 4-44: District Hazardous Waste Details

Name of District	No. of HW Generating Units	Quantity of HW as per authorization (MTA)	Quantity of HW generated as per annual return (MTA)	Quantity sent to recyclers of Schedule-IV HW (MT)	Quantity of HW stored at occupier premises at the end of year (MT)
Sepahijala	22	87.60	87.60	79.46	7.10

Source: Tripura ENVIS, TPCB

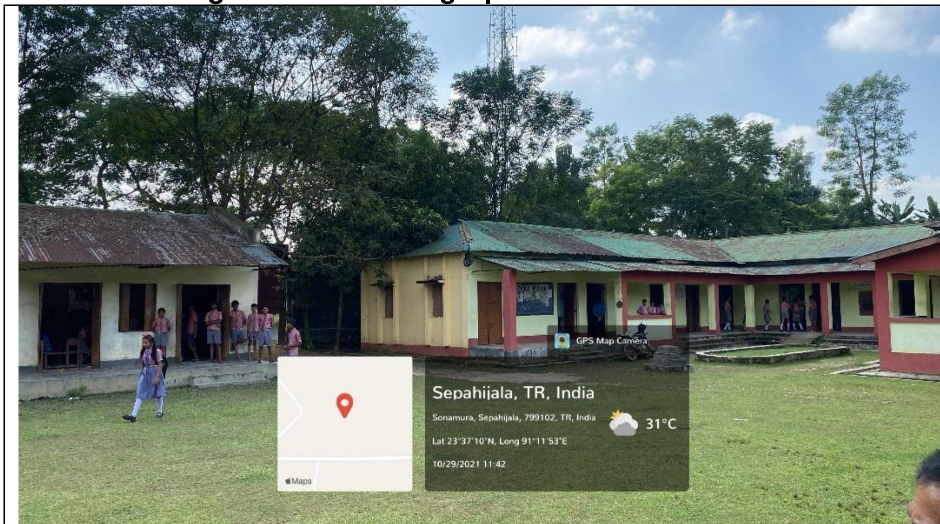
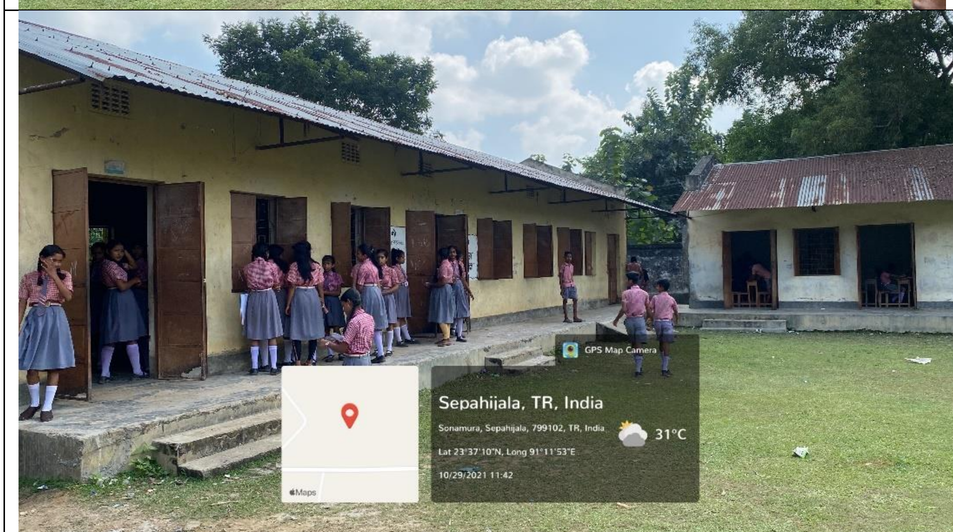
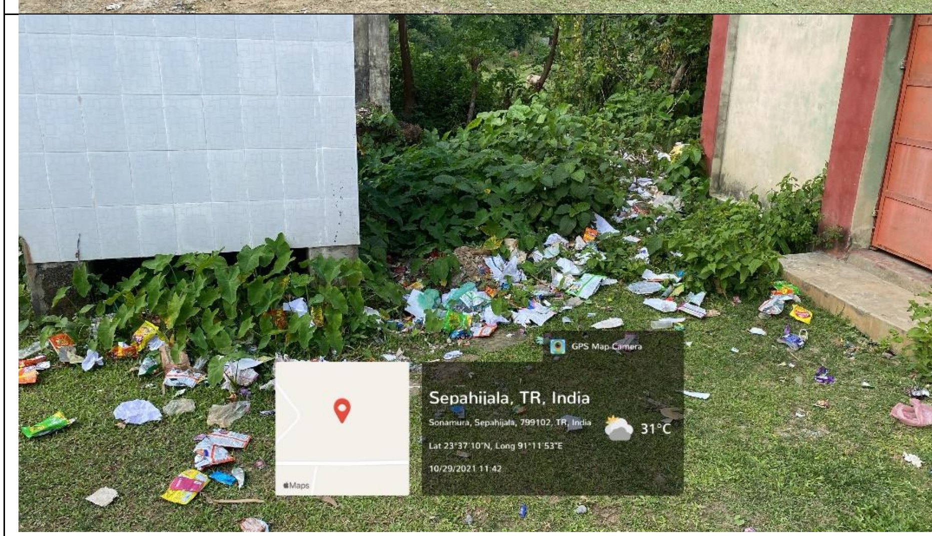
3.7. Educational Facilities

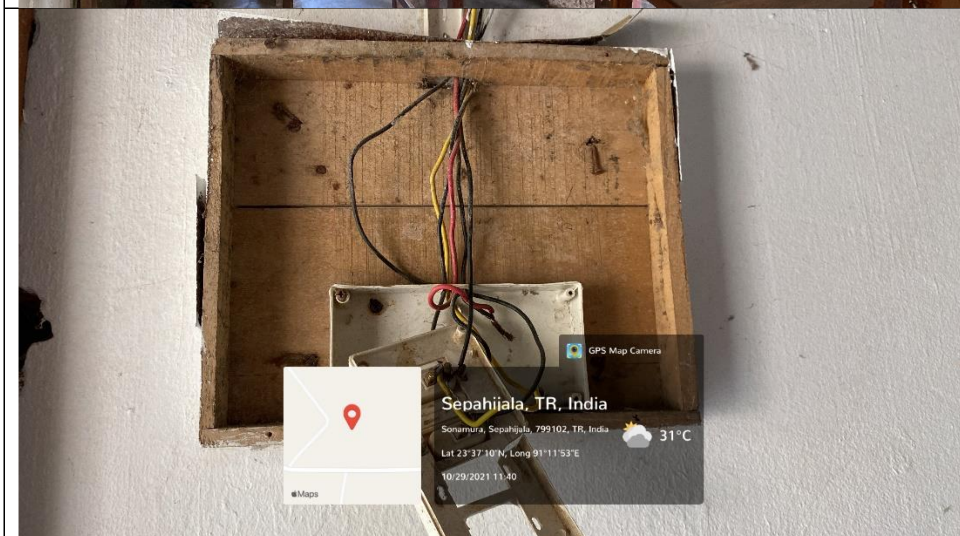
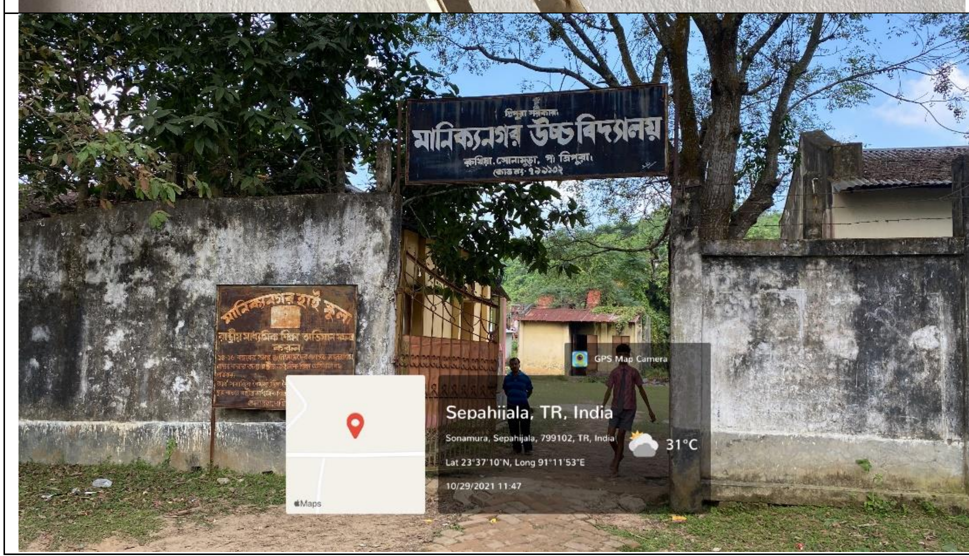
The study area possesses necessary educational infrastructure (high schools) cater to the educational needs of rural population. In the study area junior basic, secondary, and high schools are present in every panchayet and ADC. For higher education students must go to Agartala.

295. The nearest school to the proposed plant is the Manikyangar High school (Figure 4-55). There is total of 321 students, out of which 170 are girls. There are 10 teaching faculty, out of which 4 are women. The compound wall is not present in the backside and can be entered from TPGL plant side. No security present. The front side, which is adjacent to the main road has a compound and gated. Building is brick and concrete with tin wall. It is a one-story building. Front compound is present. Toilets are not separate from boys and girls and even teaching faculty uses the same toilet. Water was not available, even for drinking as the pump (located within school compound) could not be operated due to power outage. The school offers free school to students under Government Mid-Day Meal Scheme. Unfortunately cooking and distribution is hampered due to power outage. The school being adjacent to the main road is highly risk prone and previous road fatalities with two guardians have occurred. Electrical hazards were observed as the switch boxes have been open for repair exposing wires and connection, which are within reach of the students.

296. Of all the villages surveyed, Boxanagar being a tehsil place has most amount of infrastructure facilities for education. Boxanagar has few private pre-primary and primary schools along with government Primary school. Government Secondary and higher secondary school is also located at Boxanagar. Apart from this Boxanagar also has ITI training institute for Diploma courses. Graduation and post-graduation colleges are not present in any of the surveyed villages. Nearest graduation college is situated at Bishalgarh. Post-graduation facilities are only situated in state capital of Agartala. Manikyanagar and Veluarchar also have private pre-primary schools and government primary schools. Government secondary school is also located at Manikyanagar.

Figure 4-55: Photographs of The Nearest School to The Plant Area

	School compound
	Building structure – brick and concrete walls, tin roofed
	Waste disposal in school compound

	Class room
	Electrical health and safety
	Main school entrance

Source: ADB TA Consultant

3.8. Health Condition and Prevalent Diseases

297. Medical facilities are one of the basic service indicators which need to be studied to know the quality of life in the study area. In the 26 study area villages, all villages have a health sub center at panchayat or TTAADC level. Other than that, villagers must go to nearest town and/or Agartala to avail the medical facility.

298. Hospital and healthcare facilities in the study area are poor. The nearest major government facility is the Public Health Centre (PHC) situated at Boxanagar, which lies at approximately 1 to 8 km from all surveyed villages. People in the study area do not prefer visiting private hospitals which are expensive and situated even further away from their respective villages. Good healthcare facilities are available in the state capital Agartala, but it is situated far from the study area. Nearly all the villages have requested the Government opening of a hospital and other healthcare facilities like ambulances, pathology labs, pharmacies, closer to their village. A list of all public (non-private) hospitals in Sepahijala district is given in **Annexure 17**.

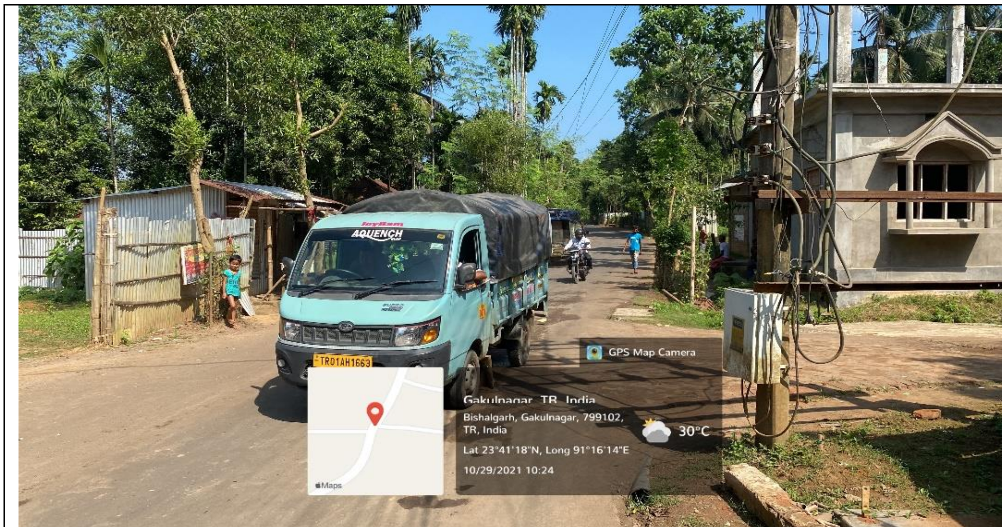
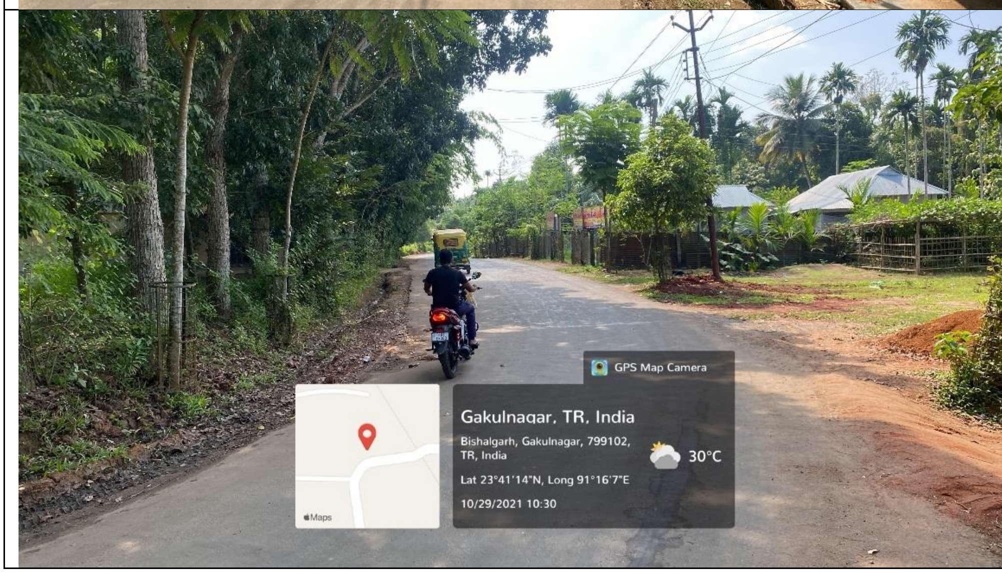
299. Commonly occurring diseases in the study area include cough, cold and fever. No major illnesses were disclosed during the socioeconomic survey. Underlying health of most of the households interviewed is generally good. None of the households have any major respiratory illnesses.

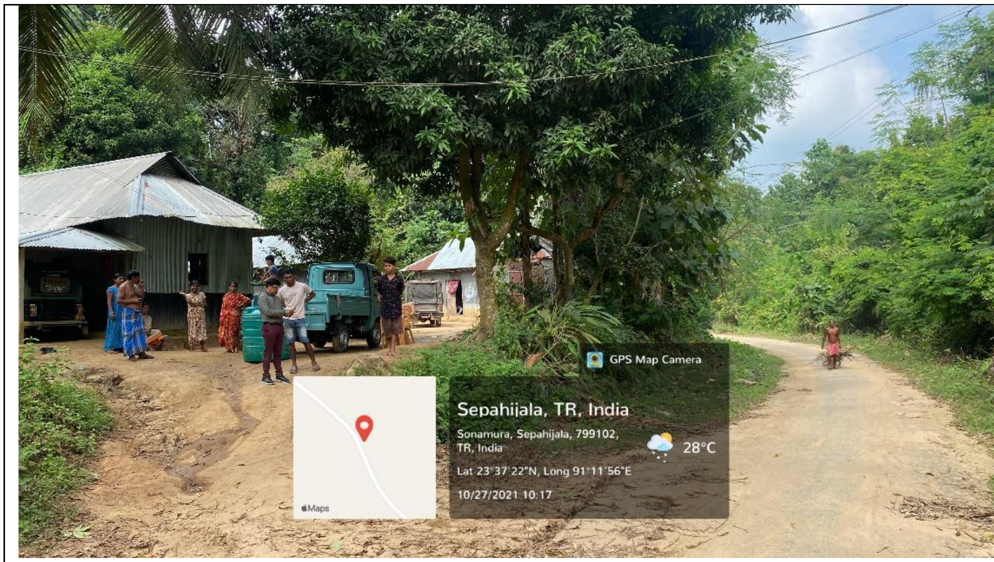
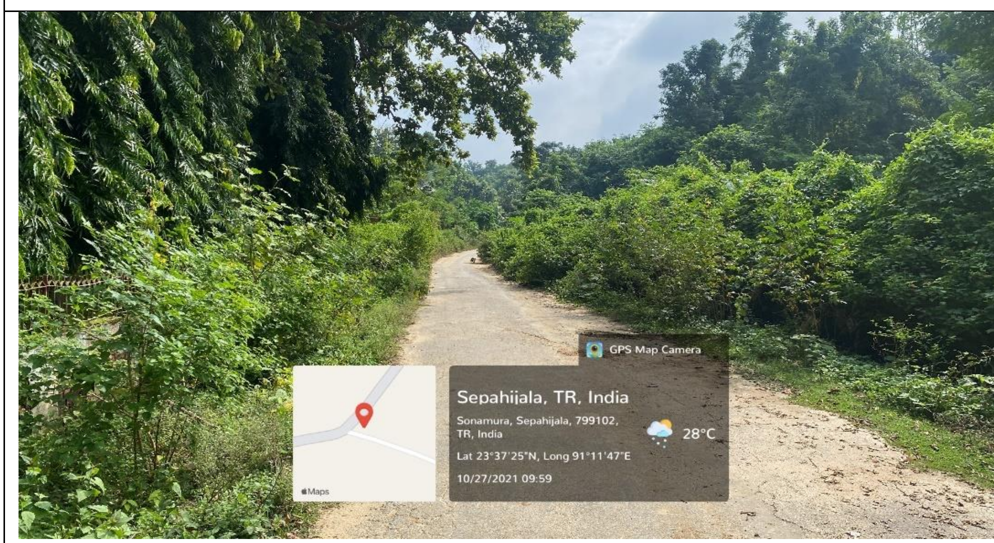
3.9. Transport and Communication

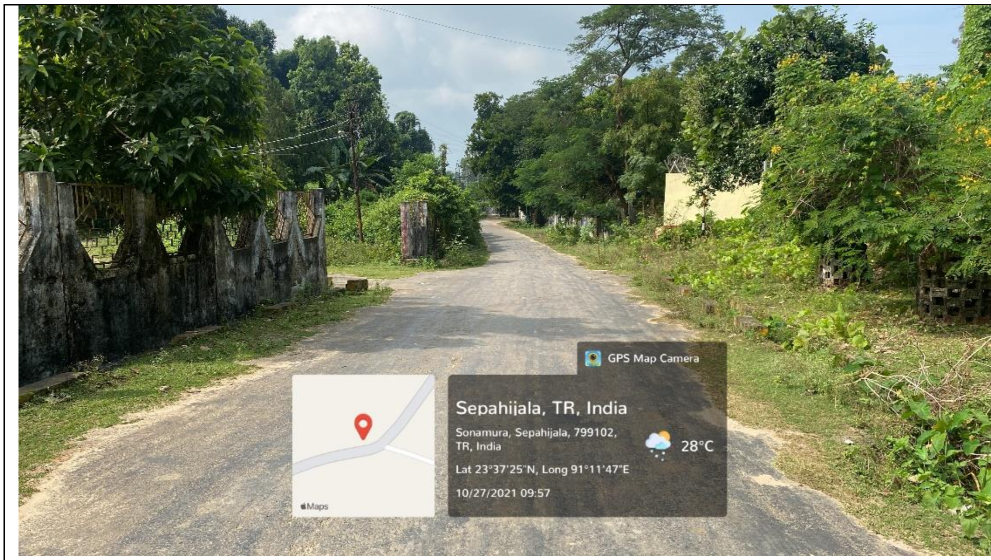
300. Shilong-Agartala-Sabroom National Highway 44, National Highway 8 and State Highway are the major roads connecting the study area with Agartala and are being used by the local people as a route of transportation. There are also some major district roads which connect the study area with the nearest towns. Concrete/black top, paved road is present in almost every village. The public transport system is yet to reach its highest efficacy however there is public bus transport system present in some of the core area villages. Other than that, villagers depend on the private auto or jeep. Bus/cab servce is not available throughout the study area.

301. Rokhia Thermal Power Station has the TPGL private access road owned by them which lies in between the existing plant and the proposed project area. This road is also accessible to the local community and used as a bypass since the main road around the Rokhia Thermal Power Station is almost triple the length of this section. Some locals use 2-wheelers and light motor vehicles/cars to reach the main road as this is a short cut, through the Rokhia Thermal Power Station. The vehicle movement was based on visual observation by TA consultants as well as feedback from TPGL and local community, it is found to be very low. Figure 4-56 shows the road condition.

Figure 4-56: Access Roads and TPGL Private Access Road Condition

	Road connecting from Agartala to site (Boxarnagar-Bisalgarh Road access road)
	Road connecting from Agartala to site (Boxarnagar-Bisalgarh Road access road)

	Road used by the locals/nearest residents (nearest houses visible). This road is damaged as heavy trucks (ONGC, private) were seen and local pointed out that this cause for damage. This would not be used for TPGL vehicle movements as per TPGL.
	Same road as above



TPGL (private) access road that is used by locals as shortcut, and to be closed off during construction. The existing/GCS yellow boundary is on the right and the existing boundary and gate of the proposed plant area is seen in the left.

Source: ADB TA Consultant

3.10. Power Supply

302. Electricity is available in all study area villages through a stable 220V electricity supply adequate for domestic, agricultural, and other purposes. All the villages surveyed have electricity connections provided by Tripura State Electricity Corporation Ltd. (TSECL), i.e., they are connected to the National Grid. None of the households use any off-grid electricity sources. It was also noted during FGD with nearest residences that they do not have electrical connections.

303. The main source of lighting is electricity in Tripura. About 68 % of the households uses electricity for lighting and this comparable the national average of 67 %. As usual the urban areas are more electrified than the rural areas according to the 2011 census. Kerosene oil is used as another major source of light for the households in Tripura. The use of solar energy is higher in the rural area of Tripura which is higher than the national average. The details of sources of lighting are given in Table 4-45.

Table 4-45: Number and percentage of household by main source of lighting

#	Household by main source of lighting	India	Tripura					
		% age	Absolute Number			Percentage		
			Total	Rural	Urban	Total	Rural	Urban
1	Electricity	67.2	5,76,787	3,61,573	2,15,214	68.44	59.49	91.58
2	Kerosene	31.4	2,45,373	2,28,953	16,420	29.11	37.67	6.99
3	Solar	0.4	15,868	13,368	2,500	1.88	2.20	1.06
4	Other oil	0.2	1,798	1,470	328	0.21	0.24	0.14
5	Any other	0.2	349	268	81	0.04	0.04	0.03
6	No lighting	0.5	2,606	2,147	459	0.31	0.35	0.20
	Total number of households	24,66,92,667	8,42,781	6,07,779	2,35,002	100.00	100.00	100.00

Source: Census of India Report 2011.

3.11. Household assets and communication

304. According to the 2011 census only about 45 % of the households possesses a television significantly more households in urban areas than the rural areas. This is comparable to all India average of 47 % in 2011. Only 7 % possesses a computer in Tripura against the national average of 19 %. About 94 % were having either a landline or a mobile in the state which is higher than the national average of 82 %. Four wheelers were there with only 2 % of the households and 8 % were having a two wheelers. All villages from the sample have access to telecommunications, a post office, and other private courier services although internet connectivity is mostly poor in the rural areas. The post office facility is available within 5 to 10 km of most of the study area villages. Most of the Households interviewed own television sets and mobile phones which are the only means of entertainment. The detail on assets possessed by households is given in Table 4-46.

Table 4-46: Possession of Household Assets Tripura

Assets	Numbers			Percentage		
	Total	Rural	Urban	Total	Rural	Urban
Radio/Transistor	1,07,995	80,746	27,249	12.8	13.3	11.6
Television	3,77,988	2,05,683	1,72,305	44.9	33.8	73.3
Computer/Laptop with internet	8,612	2,489	6,123	1	0.4	2.6
Computer / Laptop without internet	53,344	1,989	21,355	6.3	5.3	9.1
Landline only	4,05,115	2,33,957	1,71,158	48.1	38.5	72.8
Mobile only	3,60,143	2,14,022	1,46,121	42.7	35.2	62.2
Both	27,481	9,956	17,525	3.3	1.6	7.5
Bi-cycle	3,31,560	2,23,872	1,07,688	39.3	36.8	45.8
Scooter/ Motorcycle / Moped	69,463	28,451	41,012	8.2	4.7	17.5
Car/Jeep/Van	18,443	7,839	10,604	2.2	1.3	4.5
Total number of households	8,42,781	6,07,779	2,35,002	100	100	100

Source: Census of India Report 2011

3.12. Market Facilities

305. The study on availability of marketplace not only tells the buying power of the population but also gives an insight of services it provides for quality of life. Market facility is present in Manikyanagar. Other than the local market, large marketplace is present in Bisalgarh. There are only some basic amenities shops present with each village. Weekly markets are in Veluarchar and Boxanagar villages, and both are organized twice a week. The weekly market in Veluarchar is organized on Saturdays and Tuesdays, while that in Boxanagar is organized each week on Sundays and Thursdays. People from Manikyanagar, Veluarchar and Dayalpara prefer going to the Veluarchar weekly market, while those from Boxanagar, Ashabari and Kalsimura villages prefer the Boxanagar weekly market

4. Indigenous Peoples/Scheduled Tribe in Tripura

4.1. Tripura Tribal Area Autonomous District Council Area

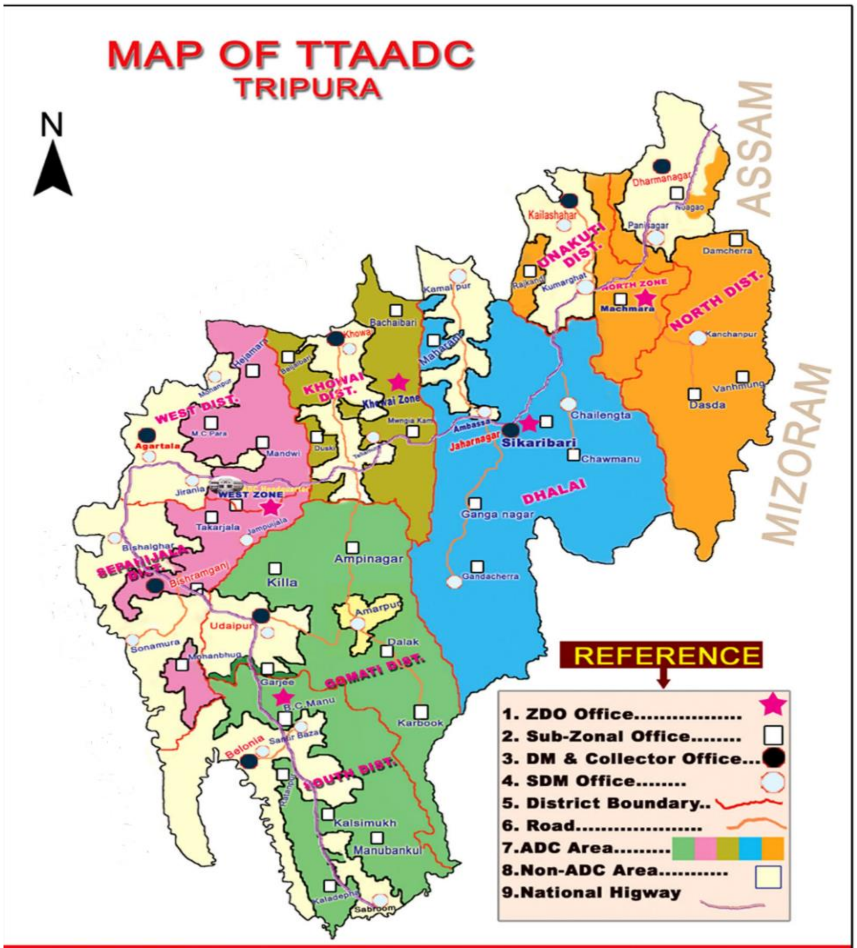
306. With a view to fulfil the aspirations of the Tribal to have autonomy to administer them, the Tripura Tribal Areas Autonomous District Council (TTAADC) was set up in January 1982 under the Seventh Schedule of the Constitution of India. Later, the council was brought under

the provisions of the Sixth Schedule of Indian Constitution to entrust more responsibilities and power from 1st April 1985.

307. The activities of the Council range from primary education to maintenance of roads and bridges etc. The rehabilitation of the landless tribal, creation of employment opportunities, agricultural development, soil conservation, flood control, supply of drinking water, education, transport and communication, setting up of village industries are some of the important tasks under taken by the TTAADC. Special drive to bring high lands under horticultural corps, establishment of small farms to supply inputs of agriculture, horticulture, pisci-culture, and animal husbandry to the Tribal families, extension of medical facilities in interior areas through mobile unit, supply of safe drinking water will also be geared up and arranged for the S.T. villages in TTAADC.

308. The total area of the TTAADC is 7,132.56 km^2, which covers about 68% of the total area (10,491 km^2) of the state. About 70% of land under TTAADC is covered by hilly forest, whereas all the plain cultivable land including all the districts and sub-divisional headquarters are outside the purview of TTAADC. The population of the TTAADC area is 12,16,465 out of which the Scheduled Tribes are 10,21,560, i.e., 83.4% of the population in the TTAADC area. In the total population of 3,673,917 of Tripura (as per 2011 census) the total population of Scheduled Tribes is 11,66,813 (31.76%). Therefore, the number of Scheduled Tribes of the state who reside in the TTAADC area is 87.55% of the total Indigenous population of Tripura. TTADC area is depicted in Figure 4-57.

Figure 4-57: TTADC Area



Source: TTAADC Council Website, GoT

4.2. Demography

309. According to the Census of India 2011, 8.2 percent of the Indian population is classified as ST. In comparison to the national figure, Tripura has 32% percent of its state populations classified as ST. Around one-third of the population belongs to the Scheduled Tribes. Tripura is a Tribal Area and autonomous administrative division under the Sixth Schedule of the Constitution of India, and the project therefore affects territories of Indigenous People. Roughly one-third (31.8%) of the population of Tripura are recognized as belonging to Scheduled Tribes. Collectively these Scheduled Tribes govern approximately two-thirds (68%) of the state's land area. Tripura has rich cultural heritage of 19 different tribal communities. These communities are - Tripura/Tripuri, Riang, Jamatia, Noatia, Uchai, Chakma, Mog, Lushai, Kuki, Halam, Munda, Kaur, Orang, Santal, Bhil, Bhutia, Chaimal, Garo, Khasia, and Lepcha.

310. The population of Tripura is characterized by diversity. The people of the Scheduled Tribes (ST) comprise of about one-third of the total population of the State. As per Census-2011, ST population of the State was 11,66,893 which is 31.8 percent of the total population of the State. The composition of ST population is maximum in Dhalai district (55.7%), followed by Gomati (42.7%) and Khowai district (42.6%). In south Tripura district ST population comprises

of 35.5% of the total population. The composition of ST population less at 19.23% in west Tripura district however the district has the second largest number of STs in terms of absolute numbers. District wise detail on ST population is given in Table 4-47.

Table 4-47: Scheduled Tribe Population in Tripura

#	Districts	Total Population	ST Population	% of ST Population
1	West Tripura	9,18,200	1,76,596	19.23
2	Khowai	3,27,564	1,39,537	42.60
3	Sepahijala	4,83,687	1,19,401	24.69
4	Gomati	4,41,538	1,88,554	42.70
5	South Tripura	4,30,751	1,52,691	35.45
6	Unakoti	2,76,506	62,320	22.54
7	North Tripura	4,17,441	1,17,106	28.05
8	Dhalai	3,78,230	2,10,688	55.70
	Total	36,73,917	11,66,893	31.76

Source: Census of India Report 2011

311. There are various types of Scheduled tribes living in the state. Population composition of each tribe is described in Table 4-48.

Table 4-48: ST Communities and their Detailed Demography

#	Name of the tribes	Population (Census Years)			
		1981	1991	2001	2011
1	Tripuri / Tripura	3,30,872	4,61,531	5,43,848	5,92,255
2	Reang	84,003	1,11,606	1,65,103	1,88,220
3	Jamatia	44,501	60,824	74,949	83,347
4	Noatia	7,182	4,158	6,655	14,298
5	Uchai	1,306	1,637	2,103	2,447
6	Kuki	5,501	10,628	11,674	10,965
7	Halam	28,969	36,499	47,245	57,210
8	Lushai	3,734	4,910	4,777	5,384
9	Bhutia	22	47	29	28
10	Lepcha	106	111	105	157
11	Khashia	457	358	630	366
12	Chakma	34,797	96,096	64,293	79,813
13	Mog	18,231	31,612	30,385	37,893
14	Garo	7,297	9,360	11,180	12,952
15	Munda / Kaur	7,993	11,547	12,416	14,544
16	Santhal	2,726	2,736	2,151	2,913
17	Orang	5,217	6,751	6,223	12,011
18	Bhil	838	1,754	2,336	3,105
19	Chamal	18	26	226	549
20	Generic	0	0	7,098	48,356
	Total	**5,83,770**	**8,52,191**	**9,93,426**	**11,66,813**

Source: Census of India Report 2011

4.3. Literacy among ST population

312. The Census- 2011 data reveals that the literacy rate of the state was 87.22 percent and the similar literacy rate for the tribal population was 79.05 percent, which was 56.50 percent in 2001. The Scheduled Tribe literacy rate has significantly increased during intra census period of 2001-2011.

4.4. Scheduled Tribe Welfare

313. The Department of Welfare for Scheduled Tribes and Scheduled Castes established on 24th October 1970 with the objective of socioeconomic development as well as over all development of the most under-privileged sections of the society namely, the Scheduled Tribes (STs) & Scheduled Castes (SCs). In 1982, the Tribal Welfare Department started functioning as a separate Department with a view to give more focused attention on the integrated socio-economic development of Scheduled Tribes people.

4.5. Economic Development:

314. To ensure economic development, up gradation of livelihood and self-dependency of scheduled tribes is the main objective of this scheme. Various schemes like assistance to ARDD Activities (Duckery and Poultry), Horticulture activities (Vermi compost, exotic flower, Mushroom, Arecanut, Banana & Pineapple) Pisci-culture activities (integrated Pig cum fish culture) are being implemented for economic development of Scheduled Tribes. During the year 2019-20, total 3,528 beneficiaries have been provided Rs. 458.73 lakh financial assistance for the above-mentioned purpose.

4.6. Pradhan Mantri Van Dhan Yojana:

315. The Honorable Chief Minister has launched the Pradhan Mantri Van Dhan Yojana in Tripura on 11 January 2020 with the aim of promoting entrepreneurship among Minor Forest Produces (MFP) gatherers and artisans. An amount of Rs. 2.26 crore has been sanctioned by the Government of India for setting up of 17 Van Dhan Vikas Kendra (VDVK) involving 4256 beneficiaries of 249 SHGs for procurement and value addition of Minor Forest Produces like Broom Grass, Amla, tamarind, Gandhaki etc. In the 1st Phase VDVKs will be provided support for tool kits, training and raw materials etc. In the 2nd phase fund of Rs.20.00 lakhs will be provided to each VDVKs for up gradation of Pucca House, warehouse, storage, add-on equipment etc.

4.7. Skill Development

316. The main objective of this scheme is to upgrade the skills of the tribal youths in various traditional/ modern vocations depending upon their educational qualifications, present economic trends and the market potential. Under this scheme training, support and guidance for all occupations like carpentry, motor driving, beautician, mason, bar binder, plumber, plastic engineering, Spoken English & communication skill, Terracotta Leather and Rexene goods marker, Bag maker, Toy maker etc. are provided. In the year, 2019-2020, there was a financial achievement of INR 36.68 lakhs and there was physical achievement here 436 trainees were enrolled and trained.

4.8. Implementation of Schedule Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

317. The Scheduled Tribes and Other Traditional Forest Dwellers (ROFR) Act, 2006 had been successfully implemented in the State. Under this Act, so far 1,30,903 forest dwellers have been vested with forest rights out of 2,00,696 applications filed by the Forest Dwellers. Details of implementation of RoFR Act, 2006 are given in Table 4-49 (as on 30 April 2020).

Table 4-49: Recognition of Different Forest Rights

#	Particulars	Details of implementation of RoFR Act 2006
1	Total no of forest rights so far vested	1,30,903
2	Total no of forest rights so far vested to S.T families	1, 30,901
3	Total no of forest rights so far vested to OFD	2
4	Quantum of land involved (ha.)	1,86,229.50
5	Quantum of land involved (for ST families) (ha)	1,86,229.02
6	Quantum of land involved for OFD (ha)	0.48
7	Demarcation of land completed through GPS(Nos.)	1,24,985
8	Pillaring completed (Nos.)	1,22,422

Source: Tribal Welfare Department, Tripura.

5. Key Socioeconomic Aspects

318. Summary of the key physical aspects in the PAI are given in Table 4-50.

Table 4-50 – Key Socio-economic Features in PAI

Particulars	Description
Location	Rokhia, Manikyanagar Village, Boxarnagar Block, Sepahijala District
Indegeneous People	• The composition of ST population less at 19.23 % in west Tripura district however the district has the second largest number of STs in terms of absolute numbers. • According to the Census of India 2011, 8.2 percent of the Indian population is classified as ST. In comparison to the national figure, Tripura has 32 % percent of its state populations classified as ST. • The Department of Welfare for Scheduled Tribes and Scheduled Castes established on 24th October 1970 with the objective of socioeconomic development as well as overall development of the most under-privileged sections of the society namely, the Scheduled Tribes (STs) & Scheduled Castes (SCs). In 1982, the Tribal Welfare Department started functioning as a separate Department with a view to give more focused attention on the integrated socio-economic development of Scheduled Tribes people
Economic Landownership and individual properties	• No private land or property in the project site. • Part of the Rokhia Thermal Power Station owned by TPGL. • To ensure economic development, up gradation of livelihood and self-dependency of scheduled tribes is the main objective of this scheme. Various schemes like assistance to ARDD Activities (Duckery & Poultry), Horticulture activities (Vermi compost, exotic flower, Mushroom, Arecanut, Banana & Pineapple) Pisci-culture activities (integrated Pig cum fish culture) are being implemented for economic development of Scheduled Tribes. During the year 2019-20, total 3,528 beneficiaries have been provided Rs. 458.73 lakh financial assistance for the above-mentioned purpose.
Nearest Habitation	• Nearby cluster of 10 houses – 55m E from proposed plant boundary. These houses are mud/tin/stone walled, and tin roofed. • TPGL existing staff quarters at 200 m S. These are officers quarters and occupied. A majority of the other staff quarters are unoccupied and locked. • School – Manikyangar High School, about 485m from the project site and within TPGL area • Manikyanagar village main settlement – around 1 km SE. • Nearest major town is Bishalgarh – 9.5 km NE
Road Access	• Shillong - Agartala - Sabrum (NH-8) – 10.2 km in NE • Road from NH-8 to project site is two-way narrow road. • Footpaths are not available along most roads.
Human use of surface and groundwater	• No surface water at project site (see physical environment) • Groundwater is used by local communities • Local community in PAI uses tube/pumped well water for domestic purposes
Nearest educational facilities	• Manikyanagar High School - 485m • Mainkyanagar Purba Para Junior Board (10 years) School – 850 m • Veluarchar High School -1.15 km • Jharajala Senior Board School (12 years) – 1.5 km
Nearest health facilities	• Veluarchar Integrated Child Development Centre -2 km • Boxarnagar Community Health Centre – 2.5 km • Bisalgarh Sub-Divisional Hospital – 9.5 km

Source: ADB TA Consultant

E. Physical Cultural Resources

319. There is one designated site (Archaeological Survey of India, GoI) of archaeological or heritage value of international or national importance within study area. This is the nationally designated Boxanagar Stupa located 3.15 km from the project site (Figure 4-58). The brick-built stupa exposed through archaeological excavation is of square plan having a dimension of 15.4m x 15.4m. The basement of the stupa is arrayed in eight mouldings in diminishing order over which tapering medhi is set with mud mortar and burnt bricks of different sizes. The ruin of the chaityagriha has been exposed on the eastern side of the stupa which is rectangular on plan and is aligned in east-west direction. The superstructure of the chaityagriha is completely damaged except the side walls which have survived up to 1.60m. The brick-built monastery has a long corridor between rows of five cells on each side. Although not identified yet, there are chances that archaeological remains including historical and/or paleontological sites may be excavated in the future in the study area as the terrain is hilly and chances are it may be hiding sites of archaeological importance.

320. As is typical of rural India settlements, each village in the study area has some places of local cultural or religious significance, like temples, mosques, graveyards etc. Some of them are of significance for the community. Sometimes their significance is related to specific seasons and/or time of the year. There are several places of worship in the study area, although not of archaeological or heritage value, with the nearest detailed in Table 4-51.

321. The nearest hindu temple is located within the Rokhia Thermal Power Station (Figure 4-59). The temple is permanent with brick concrete built and access controlled. It is also intermittently visited by locals. The temple is along the TPGL private access road and across from the proposed plant footprint.

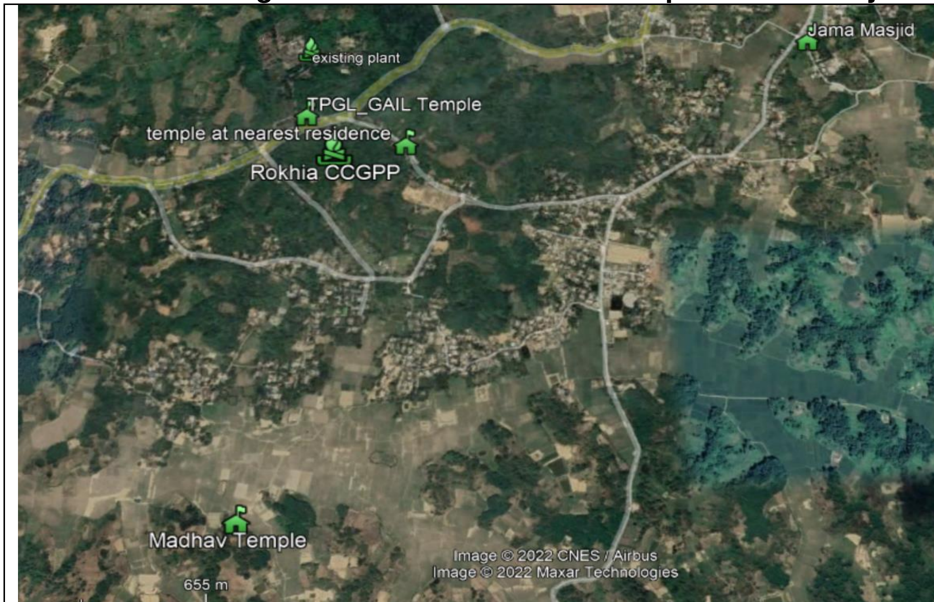
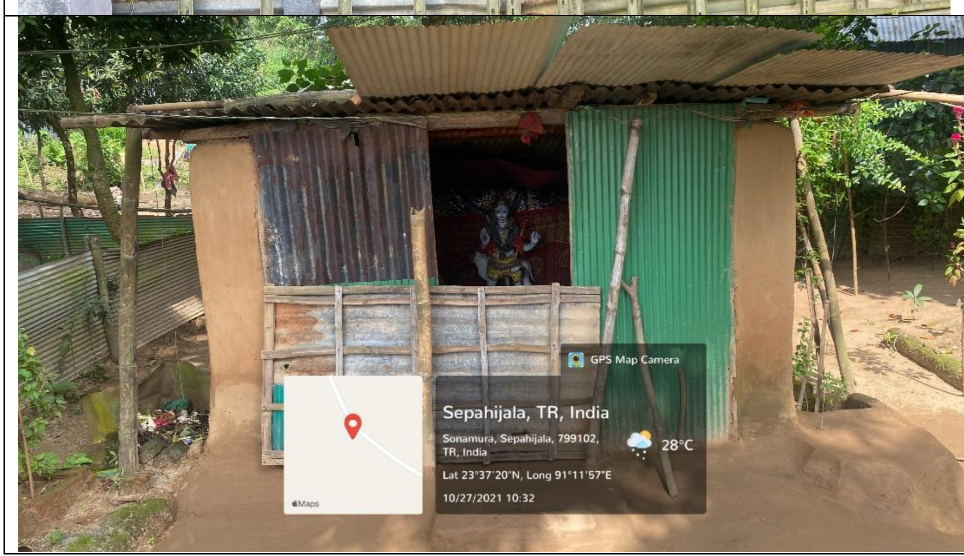
322. Since Hinduism is predominant in this region, common festivals of Hindus like Holi, Rath yatra, Durga puja, Kali puja, Diwali are quite common to be celebrated. In majority of the interviewed villages the main God is Shri Krishna and Durga Maa. *Durga Puja*, which is celebrated during October-November of each year, is the most important festival in all villages, including TTAADC village of Dayalpara, and is celebrated by everyone including the Muslim population. Main festival for the Muslim population is *Eid* which is celebrated during April-May every year. Other cultural practices in the area include attending *Kirtans* and other festive gatherings. Apart from these, many tribal festivals such as Kharchi Puja, Ker Festival, Garia Puja, Ganga Puja are celebrated in this region. In the TTAADC administered village of Dayalpara, Goria festival is an important annual celebration, which is celebrated in the months of March/April.

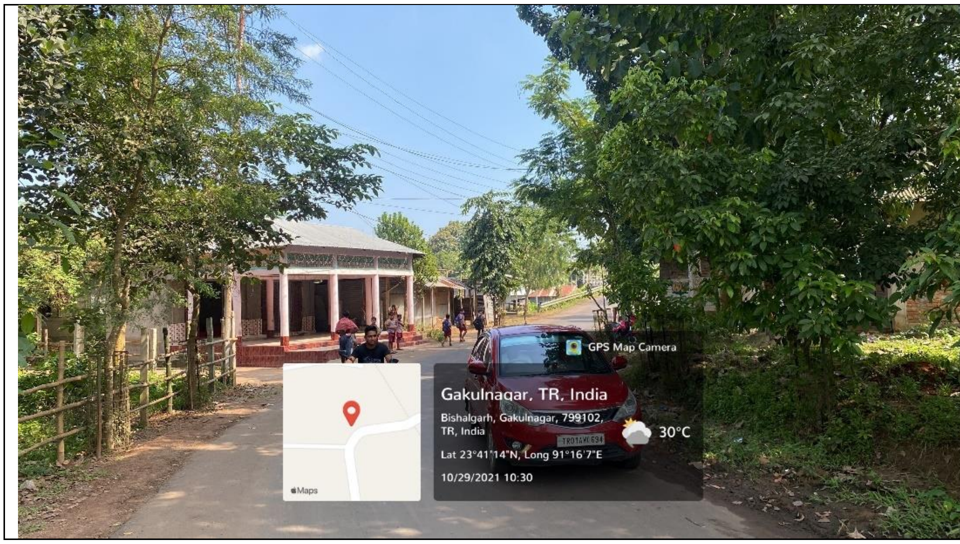
Table 4-51: Nearest Places of Worship (3km radius and Access Road)

Description	Distance and Direction
GAIL GCS Private Temple	0 km (within Rokhia Thermal Power Station) W
Temple at nearest residence	125 m E
Madhab Temple	1.4 km, S
Belochar Jama Masjid (mosque)	1.5 km, NE
Gakulnagar Temple along Boxarnagar-Bisalgarh access road	5m along Boxarnagar-Bisalgarh road, N

Source: ADB TA Consultant

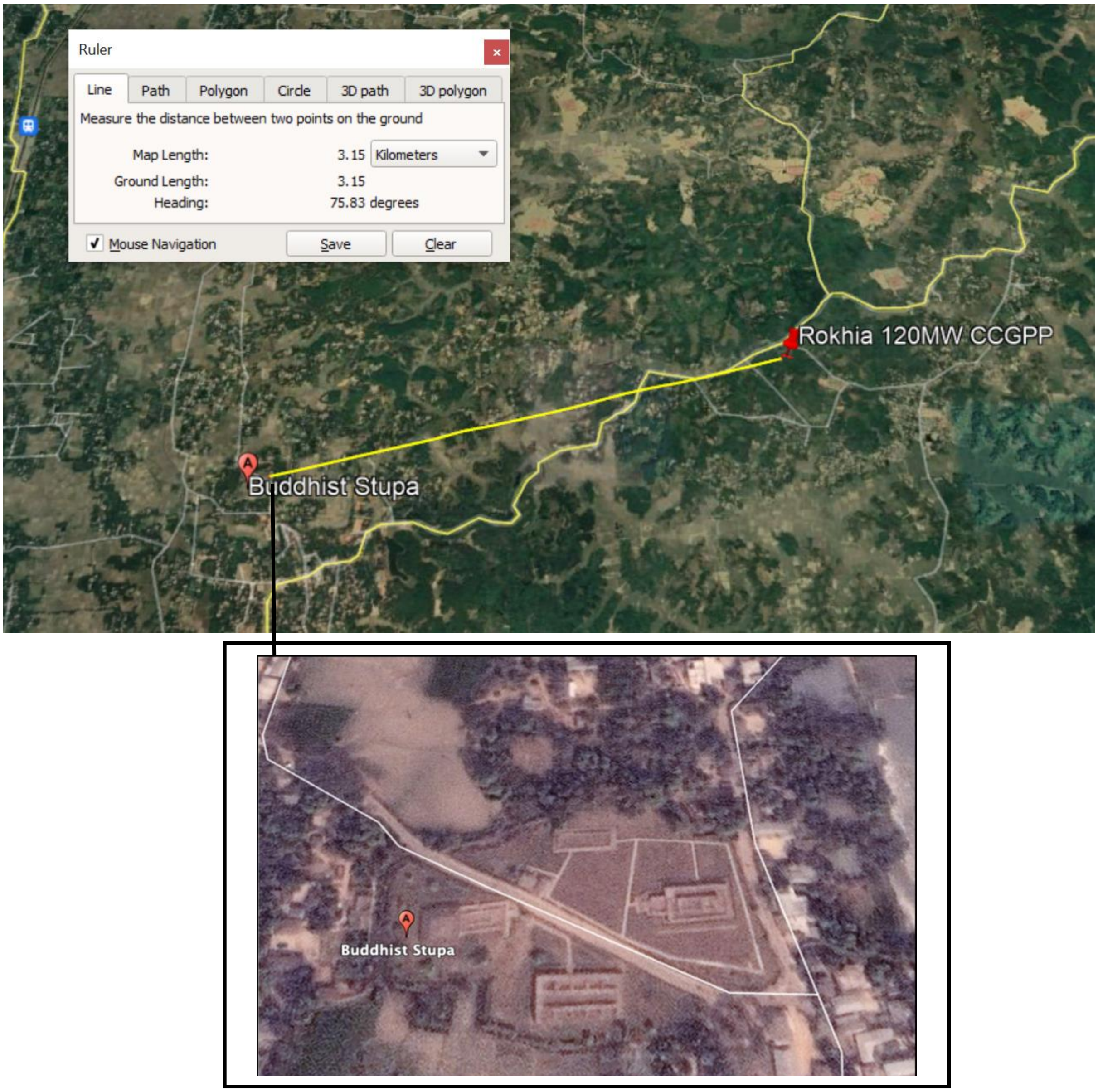
Figure 4-52: Nearest Local Temples to the Project Site

<table>
<tr><td>
</td><td>Map showing nearest places of worship</td></tr>
<tr><td>
</td><td>GAIL Temple, within the TPGL area beside the private road</td></tr>
<tr><td>
</td><td>Temporary temple in one of the compounds of the nearest residences</td></tr>
</table>

	Temple beside access road (Boxarnagar-Bisalgarh Road)

Source: ADB TA Consultant

Figure 4-59: Map Showing Boxarnagar Buddhist Stupa 3.15km from Project Site



Source: ADB TA Consultant

323. Summary of the key physical aspects in the PAI are given in Table 4-53.

Table 4-53: Key Physical Cultural Resources in PAI

Particulars	Description
Archaeological monuments	• Boxanagar Stupa at 3.15 km towards WSW • No access road for the proposed plant is passing through/near this area • No other archeological site, paleontological sites are recorded in the study area • Potential for chance finds exists where there is undisturbed land
Cultural and Religious Places	• Locally important cultural and religious places like temples, churches and mosques are located throughout the study area. • Private temple in the GAIL GCS is present beside the TPGL private road, across from the project footprint and within Rokhia Thermal Power Station boundaries • Next nearest religious site is a local temple within the compounds of the nearest residence compound–125m from boundary of TPGL • One major temple and 3-5 smaller temples are located alongside the access road to be used for project vehicles

Source: ADB TA Consultant

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

324. This section identifies and assesses the potential and perceived environmental impacts and risks that can be expected from the development of the proposed plant that will replace the existing plant which is currently operating within the Rokhia Thermal Power Station. Environmental impacts and risks on the physical, biological, and socioeconomic (including occupational health and safety, community health and safety, vulnerable groups, and gender issues, and impacts on livelihoods through environmental interventions) and physical cultural resources in the project's area of influence are considered. The proposed plant will have a diverse range of impacts on the environment in two distinct phases: (a) Construction, including demolition of office buildings and site clearance, and (b) Operation, including maintenance works (O&M) as described in the project description (Chapter 2).

325. The plant is designed for a life span of 25 years after which it will be decommissioned by TPGL, the existing plant is to also be decommissioned by TPGL upon operation of the proposed plant. Since potential decommissioning impacts of the existing plant, and the proposed plant in 25 years, will be similar in nature to those of the construction phase and thus can be similarly managed, they have not been separately evaluated in this chapter.

326. Prior to construction, activities undertaken during the detailed design and pre-construction phase will influence the subsequent impacts of the proposed plant, but this stage is not separately evaluated as it will have minimal or impact being mostly desk based with some site investigation. Mitigation for construction and operation will, however, need to be considered upfront during these stages. Preparations for construction include establishing the EPC contractor’s environment, health and safety management arrangements (including a contractor’s environmental management plan (CEMP)) to ensure mitigation of construction related impacts in accordance with the EMP and relevant parts of the World Bank-IFC EHS Guidelines on Construction and Demolition will occur during pre-construction.

327. Potential and perceived environmental impacts related to major maintenance activities are similar but of lesser magnitude that those during construction and are not discussed under the operational phase which concentrates on the operational impacts of the project infrastructure.

328. The impacts and risks were identified and if necessary scoped into the assessment based on professional judgement following review of project documents, site visits, meaningful consultations, and, with reference to international good practice guidance, primary data collection and analysis, and available secondary data. They have been evaluated considering baseline information (Chapter IV) and consultation feedback (Chapter VIII) with respect to the nature of impact (i.e., positive, negative, direct, or indirect, cumulative, or induced), spatial nature (i.e., site-specific, localized, or widespread), temporal nature and reversibility (i.e., temporary during construction, permanent, short term, or long term), and likelihood amongst other factors that influence significance. This section summarizes the impacts and risks identified, mitigation to address those impacts, which are incorporated into the project level Environmental Management Plan (EMP), and the residual impacts which will remain post-mitigation.

B. Scoping and Impact Assessment Methodology

329. Environmental impacts and risks will be influenced by the location, design, and technology of the proposed plant. Prediction of impacts and risks is essentially a process in which the interactions between the proposed plant and the existing baseline environment are identified. Prediction methods used include quantitative, semi-quantitative and qualitative techniques. The significance of potential impacts and risks is then arrived at using the criteria and methodology given in this section.

330. In the first instance the severity of the impacts and risks has been considered in terms of the predicted magnitude of change (or for risks, the consequences) that will be experienced. The importance or sensitivity of receptors including workers, local communities, and the surrounding environment has also been considered, and the initial significance determined as a function of severity and importance using the impact significance matrix shown in Table 5-2. The matrix applies universally to all resources/receptors, and for all impacts and risks to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations that enter the matrix. However, significance also considers the likelihood, frequency or duration of the impact and parameters such as: (i) spatial extent; (ii) reversibility; (iii) opportunities for mitigation; and (vi) legal standards and established international good practice guidelines – i.e., the eventual significance (**Error! Reference source not found.**) may not directly correspond to a function of severity and importance in all cases.

331. In scoping the assessment, potential and perceived environmental impacts and risks that would occur pre-mitigation but including the standard design features that would be incorporated by TPGL in accordance with national legislation have been identified, qualitatively assessed, and are summarized in Table 5-3**Error! Reference source not found.**. These impacts and risks have been categorized as being of Maximum, High, Medium, Low or Minimal significance based on Figure 5-1 and Tables 5-1 and 5-2. Impacts of Maximum or High significance pre-mitigation have been scoped into detailed assessment and/or quantification where possible.[83] Impacts of Medium significance also require a thorough understanding to define suitable mitigation measures. However, mitigation is required for all potential impacts to ensure residual significance is reduced to the extent possible. Sections 5-7 provide detailed assessment and/or quantification to the extent possible of the impacts of High significance pre-mitigation per Table 5-3.

332. Sections 5-7 also discuss other impacts and risks on the biological, physical, socioeconomic, and physical cultural resources in the project's area of influence in relation to identifying the mitigation measures warranted and if there are any residual adverse impacts that cannot be mitigated. While the importance factors cannot be influenced, mitigation measures can be put in place to decrease the severity or likelihood of impacts to decrease the overall significance of the risk. For the purposes of this EIA, the following mitigation hierarchy is adopted, the priority being to first avoid or reduce the source of impacts and then to address the impacts that do occur via mitigation to reduce the significance of the impact, and then as a last

[83] Impacts of Maximum or High significance are those that are likely to trigger Category A under ADB's SPS 2009 therefore requiring an EIA, conducting detailed assessment of these impacts pre-mitigation is therefore crucial in confirming the categorization of the project.

resort using compensatory or offset measures. Mitigation measures required are summarized in this chapter but are set out in full within the EMP mitigation plan in **Annexure 28.**

(i) Avoid or Reduce at Source: avoiding or reducing the source of impacts through the design, construction, and operation of the solar power plants.

(ii) Abate on Site: if the source cannot be removed, adding something to the design or into the construction method to abate the impact.

(iii) Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site.

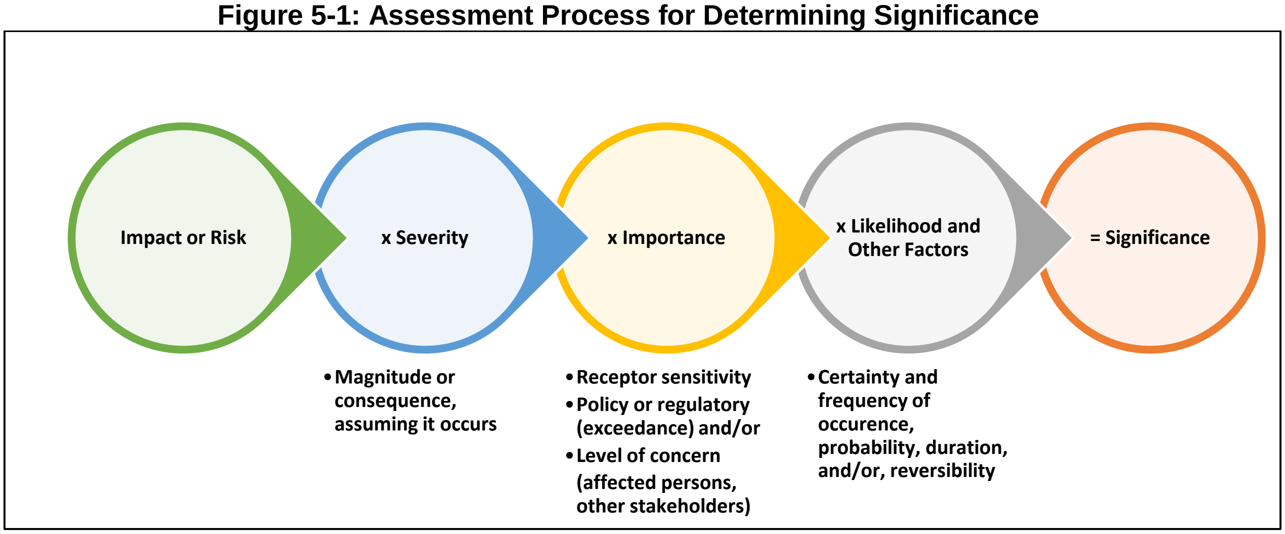
(iv) Repair or Restore: some impacts involve unavoidable damage to a resource (e.g., use of habitat for temporary construction facilities) and these impacts can be addressed once they have occurred through use of repair or restoration measures.

(v) Compensate or Offset: where other mitigation approaches are not possible or fully effective, then compensation of offset for loss, damage and disturbance might be appropriate (e.g., planting of trees off-site to offset for loss of vegetation on-site).

333. Considering the mitigation measures proposed in the following sections, impacts and risks have then been re-assessed in the last section (Table 5-40) to reflect the residual impacts that can be expected post-mitigation.

334. The impact assessment is structured by the two development phases: (i) construction; and (iii) operation. This structure is carried forward and used to structure the environmental management plan (EMP) for the proposed plant.

Figure 5-1: Assessment Process for Determining Significance



Source: ADB Project Team/TA Consultant

Table 5-1: Parameters for Determining Significance Factors

	Maximum	**High**	**Medium**	**Low**	**Minimal**
Severity Factors:					
Magnitude Change (quantified amount)	Very Large	Large	Medium	Small	Very Small (negligible)
Consequence	Critical	Major	Moderate	Minor	Minimal

	Maximum (catastrophic)	High	Medium	Low	Minimal (negligible)
Importance Factors:					
Receptor Sensitivity	International	National/State	District	Local/ Community (Block)	Individual
Receptor Resilience and Adaptability	No capacity to absorb proposed changes	Minimal capacity to absorb changes	Some capacity to absorb changes	Good capacity to absorb changes	Very good capacity to absorb changes
Receptor Vulnerability	Far above average vulnerability	Above average vulnerability	Average vulnerability	Below average vulnerability	Far below average vulnerability
Policy or Regulatory (exceedance)	Large	Medium	Small	None	Not Regulated
Level of Concern	Global/ National	Regional/ State	District	Local/ Community (Block)	Individual
Having considering severity x importance per Table 5-2 significance may be increased or decreased depending on:					
Likelihood Factors:					
Frequency of Occurrence	Continuous	Frequent	Occasional	Infrequent	Rare
Probability	Certain	Likely	Possible	Unlikely	Improbable
Duration (temporal extent)	Very long term, > 3 years	Long term, > 1 year	Medium term, < 1 year	Short term, < 1 month	Very short term, < 1 week
Other Factors:					
Spatial extent	Far beyond project site boundaries (>500m)	Beyond project site boundaries (<500m)	Immediately adjacent to project site (<50m)	In project site	Confined location in project site
Reversibility	Irreversible	Reversible with effort in long term	Reversible with ease in long term	Reversible with effort in short term	Reversible with ease in short term
Opportunities for mitigation	No or minimal opportunities for mitigation	Few opportunities for mitigation	Some opportunities for mitigation	Several opportunities for mitigation	Numerous opportunities for full mitigation
Legal standards	Breaches national standards and international good practice guidelines	Complies with international good practice guidelines but breaches more stringent national standards	Complies with national standards but breaches more stringent international good practice guidelines	Meets national standards and international good practice guidelines	Not applicable

Source: ADB TA Consultant

Table 5-2: Risk Matrix for Significance Determination

Severity Importance	Maximum	High	Medium	Low	Minimal
Maximum	Maximum	Maximum	High	Medium	Medium
High	Maximum	High	Medium	Medium	Low
Medium	High	High	Medium	Low	Low
Low	High	Medium	Low	Low	Minimal
Minimal	Medium	Medium	Low	Minimal	Minimal

Source: ADB TA Consultant

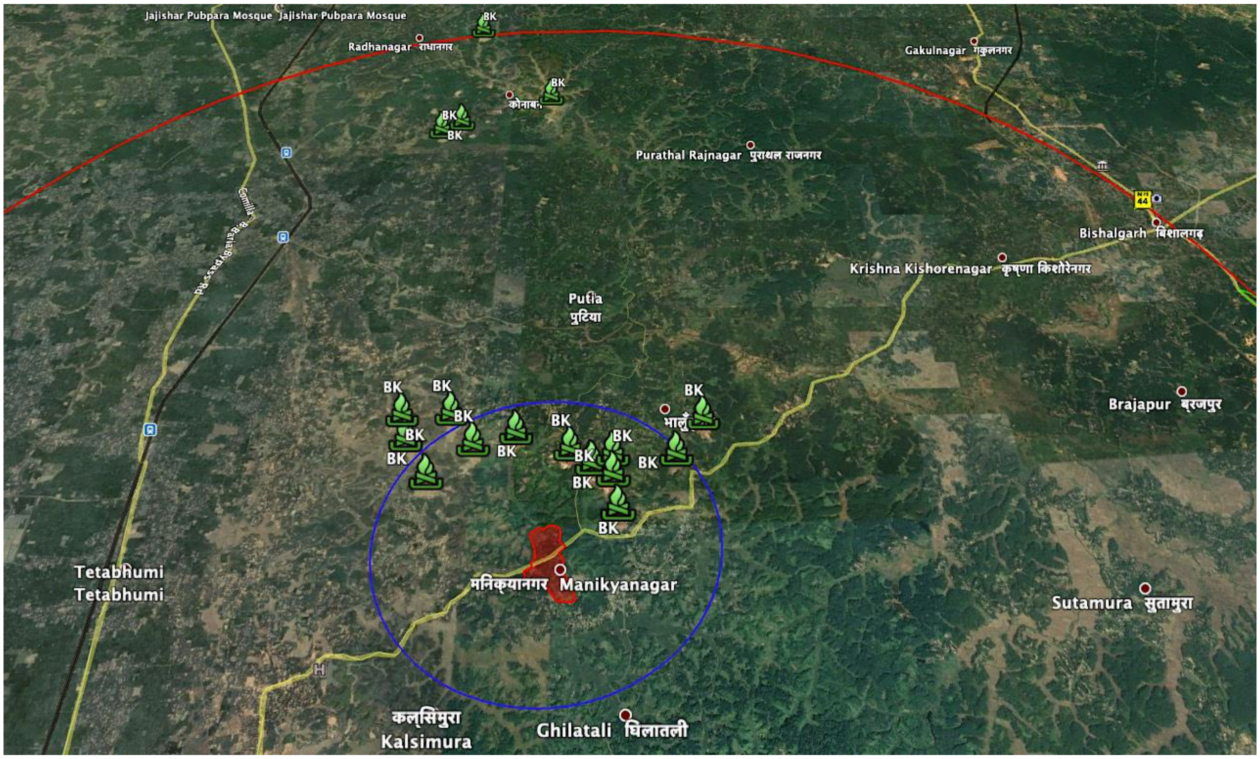
C. Cumulative and Induced Impacts

335. Cumulative impacts[84] are defined as the combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that cannot be expected in the case of a stand-alone project. The existing plant contributes GHG emissions, air pollution and noise whilst abstracting water etc. The existing plant will not be operational once the proposed plant is constructed, but any impacts would be cumulative if they were to operate in parallel. The cumulative impact of its decommissioning has been considered for those parameters where it is relevant. Overall replacing the existing plant with the proposed will be cumulatively beneficial for climate change and air pollution. However, since decommissioning will come after construction it will extend the duration of predicted construction impacts related to disruption and disturbance to the local community due to increased traffic etc.

336. There are no anticipated/planned future projects in the vicinity of the proposed plant that would result in cumulative impacts. In terms of other existing industries, brick fields (manufacturing) are in operation in the study area, contribute to air pollution, abstract large volumes of groundwater and use local roads for transportation of final products. Out of the seventeen brick fields identified in study area, nine are within 2km radius and the nearest is 800m from the project site (Figure 5-2). However, there may be other brick fields not identified. During site visits, some of the brick fields were seen to be functional with emissions from stacks visible. The ambient air quality results reported in Chapter 4 were based on sampling when the 63 MW existing plant and the brick fields were in operation, thus, likely cumulative contributions is reflected in the assessment. The baseline ground water status report from GoT considers existing water users and suggests that the study area is not under water stress. Other than the GAIL/ONGC gas field including drilling/development of wells located within the land boundaries of the Rokhia Thermal Power Station, but not under the control of TPGL, other major industries are not present in the study area.

[84] ADB. 2012. *Environment Safeguards: A Good Practice Sourcebook Draft Working Document*. Manila

Figure 5-2: Map Showing Existing Brick Kilns Within Study Area



Source: ADB TA Consultant

337. Induced impacts are the adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur later or at a different location. There may be some induced economic development because of construction of the proposed plant e.g., small businesses could be set up and rental income could be generated by leasing or renting house to staff working at the power plant. In turn this may encourage the development of new properties etc. However, as the Rokhia Thermal Power Station already exists such impacts are anticipated to be minor. Any such induced development will need to be in accordance with the national laws and regulations of India. It should also be noted that any such future development is entirely independent of the proposed plant.

D. Pre-Mitigation Impacts due to Proposed Plant

338. The potential and perceived impacts and risks and their significance based on the indicative design, its construction and operation as descriped in Chapter 2 have been assessed using the methodology described above and are summarized in Table 5-3 with respect to the resources/receptors affected, which can also be referred to as important environmental and social components.

Table 5-3: Pre-Mitigation Impacts and their Significance

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
BIOLOGICAL ENVIRONMENT						
Vegetation/ trees	Project site is not designated forest land but supports natural forest habitat. Out of 4.5ha project site 2.3ha is degraded natural forest habitat supporting ground cover, shrubs, herbs and trees. This portion of the project site is a mix of planted trees and natural vegetation. Site clearance activities will result in the removal of most, if not all, this vegetation, and the felling of about 249 trees (33 species, girth size 10-200 cm) in the project site. None of these trees are a threatened species. Terrestrial vegetation/ trees not intentionally cleared for construction may be accidentally damaged due to demolition, earthworks, or truck movements.	Construction	**Medium –** forest habitat at and surrounding project site of district importance as not designated All trees to be felled are globally of least concern (LC) Open forest so not of high ecological value but as degraded natural forest habitat it has minimal capacity to absorb changes, above average vulnerability	**Low** Small magnitude: irreversible impact, confined to project site so no impact on threatened trees	**Low Adverse**	Yes
	Damage to remaining natural forest habitat including that in wider Rokhia Thermal Power Station complex and beyond due to risk of forest fire especially due to operational hazards, gas leaks, fire, and explosion hazard etc. Forest habitat is not contiguous with Sipahijila WLS at 10.5km distant and agricultural land/settlement can provide a fire break. Potential for cutting trees or collection of non-timber forest products by project workers. There are some threatened trees found in the study area. These risks are already present due to the existing plant, although construction will bring an influx of activity long term impacts will be similar.	Construction, Operation		**Medium** Moderate consequence if forest fire was to occur, risk beyond site boundaries especially from forest fire, but impact is unlikely and rare occurrence, reversible with effort in long term, several opportunities for mitigation	**Medium Adverse**	Yes
	Risk of spread of invasive flora species	Construction,		**Low**	**Low Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	to/from the project site because of site clearance, earthworks, and truck movements. 22 invasive species are recorded in the PAI of 10 km radius with 11 invasive species (3 native and 8 alien) identified within 2km. Invasive species can be transferred in / out of the project area during vehicle movement; these risks are already present due to the existing plant, although construction will bring an influx of activity long term the impacts will be similar.	to a lesser extent during O&M		Minor consequence if occurred: risk of impact beyond site boundaries, but several opportunities for mitigation		
	Emission of NOx affecting vegetation that is sensitive to air pollution	Operation		**Minimal** Very small magnitude and within emission standards: permanent impact, some opportunities for mitigation.	**Low Adverse**	Yes
Wildlife	Loss of critical habitat for Pharyre's leaf monkey (EN) and habitat regularly used by other threatened species is not envisaged, the project site itself does not support critical habitat with Sipahijila WLS at 10.5km distant. Capped langurs (*Trachypithecus pileatus*) (VU) occasionally visits the wider study area around the project site but do not reside there. Potential human-wildlife conflicts; poaching, hunting, fishing, of wild animals by workers; increased risk of road-related accident due to additional traffic, disturbance to wildlife due to construction etc. These risks are already present due to the existing plant, although construction will	Construction, Operation	**High to Maximum –** Pharye's leaf monkey of international importance with VU species of national importance, minimal capacity to absorb changes, above average vulnerability	**Minimal** Very small magnitude in relation to habitat loss, given distribution of threatened species impact from conflict unlikely and infrequent occurrence: irreversible impact on individual but several opportunities for mitigation and magnitude of any loss unlikely to affect population	**Medium to Low Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	bring an influx of activity.					
	Loss of terrestrial habitat for other non-threated wildlife species supported by the Rokhia Thermal Power Station. The project site provides habitat for variety of Rhesus macaque (*Macaca mulatta*), small mammals birds, frogs, lizards, snakes, insects all of LC or NE species	Construction	**Medium –** some capacity to absorb changes, average vulnerability	**Low** Small magnitude: irreversible impact, confined to project site	**Low Adverse**	Yes
	Potential disturbance to non-threated wildlife including Rhesus macaque (*Macaca mulatta*), globally LC species utilizing / moving across terrestrial habitat within and adjacent to the project site due to construction dust from demolition and earthworks, noise, illumination at night; potential human-wildlife conflicts; poaching, hunting, fishing, of wild animals by workers; increased risk of road-related accident due to additional traffic; collision with stack etc. These risks are already present due to the existing plant, although construction will bring an influx of activity.	Construction, Operation		**Low** Minor consequence if wildlife killed: irreversible impact on individual, but several opportunities for mitigation and magnitude of any loss unlikely to affect population	**Low Adverse**	Yes
PHYSICAL ENVIRONMENT						
Climate change	Emission of greenhouse gases (GHG) from construction and operation of the proposed plant due to combustion of natural gas as fossil fuel contributing to global climate change impact. There will be cumulative impact from the more efficient 120 MW proposed plant replacing the 63 MW existing plant, for which no additional gas supply is required. However, in relation to achievement of the Paris agreement the proposed plant will extend use of fossil fuel and thus climate change impacts for a further 25 year period. There will also be fugitive emission	Construction, Operation	**Maximum** Global/national concern, no capacity to absorb changes	**Maximum** Very large magnitude: permanent impact from operational plant, few opportunities for mitigation of gas power plant, impact may felt be far beyond site boundaries	**Maximum Adverse (although considered to be Beneficial with respect to short-term cumulative effects)**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	from use of SF6, a potent GHG in switchgear.					
Ambient air quality	Generation of dust during site clearance, demolition of office buildings, earthworks including leveling of hillocks, track out, material mobilization etc.	Construction	**High** Locally sensitive receptors with scattered rural communities. The closest properties are 55m from the proposed plant boundary; with a school located 300m from the boundary. Existing baseline concentrations largely meet national standards but exceed the latest WHO 2021 guidelines and the airshed is degraded, individual/local concern	**High** Large magnitude from dust emissions related to demolition, earthworks, construction activities and vehicle movement (track out). Temporary impact during construction, with opportunities for mitigation. Unlikely to impact communities beyond 350m of the project site, or within 20 m of access roads up to 500 m from the site related to track out	**High Adverse**	Yes
	Emissions from diesel fueled vehicles – mainly PM, SO_2, NO_x and CO	Construction, to a lesser extent during O&M		**Minimal** Very small magnitude, temporary impact during construction, reversible with ease in short term	**Low Adverse**	Yes
	Stack emission of NO_x during power plant operation adopting 25 ppm emission standard, cumulative impact with other major sources of NO_x in airshed. Impact considers proposed plant alone but there will also be beneficial cumulative impact from the proposed plant replacing the 63 MW existing plant, as there would be a net improvement in the baseline situation. The existing plant has less efficient turbines with a lower stack height	Operation		**Minimal** Very small magnitude NO_2 impacts from the new plant in isolation represent less than 1% of the WHO 2021 guidelines) with a permanent impact. Some opportunities for mitigation.	**Low Adverse (although considered to be Beneficial with respect to cumulative effects)**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	and consequently, existing impacts are higher than those predicted for the new plant.					
	Other stack and fugitive emissions, such as CO, PM and SO_2 during normal power plant operation, and infrequent operation of the standby diesel generator during emergency.	Operation		**Minimal** Emission of PM and SO_2 not envisaged as natural gas will be used as a fuel. CO emissions will occur but these impacts are predicted to be negligible. Emissions will occur when as the emergency gas engine and diesel generator are operated. However, their use will be infrequent and limited to emergency scenarios only so is not included in model.	**Low Adverse**	Yes
Noise and Vibration	Presence of project workers generating noise; noise from demolition, crushing, breaking works, earthworks, operation of mechanical equipment and machinery, material mobilization, traffic movements etc. Ground borne noise due to high energy construction activities, etc.	Construction	**High** Locally sensitive receptor–scattered rural communities; closest at 55m from plant boundary, vulnerable groups present, some capacity to absorb change, exceedance noise/vibration standards may occur, community concern	**Maximum to High** Maximum to major magnitude: temporary impact during construction, some opportunities for mitigation, other than for piling unlikely to impact communities beyond 500m project site and access roads although some residences are present at 55 m from plant boundary and are the most vulnerable to	**Maximum to High Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
				noise impacts		
	Noise from power plant operation including start up and shut down, stack operations (HRSG, Bypass when used), HRSG, air inlet system, Air Cooled Condenser and infrequent (emergency) use of diesel generator are sources	Operation		**Medium** Medium impact, operational noise exceedances of the noise limits at the closest houses to the development during the night-time period. The diesel generator used will be "green" generator type which is silent or sound proofed with air cooling. Also, diesel generator operation will be limited only during emergencies.	**Medium Adverse**	Yes
	Ground borne vibrations due to high energy construction activities, earthwork, large vehicle movement, demolition, material handling, etc.	Construction		**Minimal** Levels of vibration significantly below the lower vibration threshold at the closest dwellings.	**Medium Adverse**	Yes
	Vibrations from power plant operation including start up and shut down	Operation		**Minimal** No operations with likely appreciable levels of vibration proposed as part of the development.	**Low Adverse**	Yes
Topography and landscape/ terrain, surface water drainage	Change in topography and landscape/terrain due to cutting and levelling of two hillocks in the project footprint involving up to 334,092 m^3 of earthworks to create a level construction platform at about 30 m AMSL when the existing elevation ranges from 30-49m	Construction	**Medium** Highly complex terrain. Some capacity to absorb changes, above average vulnerability as in area of high	**High** Large magnitude of earthworks: irreversible impact, change in terrain confined to the project footprint, existing	**High Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	with the two hillocks up to 59m. Due to extensive earthworks site elevation and its natural drainage flow pattern will be altered.		landslide risk	power plant means landscape already industrialized but some topographic screening will be lost		
Geology and Soils	Excavation and compaction of topsoil and subsoil to create level construction platform and install foundations; including cutting of two hillocks with an estimated cut volume of up to 334,092 m^3 to create a level construction platform at about 30 m AMSL	Construction	**Medium** Forest soils, some capacity to absorb changes, above average vulnerability as in area of high landslide risk	**High** Large magnitude due to extent of earthworks: irreversible impact, confined to project site unless excess spoil to dispose of off site	**High Adverse**	Yes
	Erosion of the exposed soils due to surface water runoff, especially during the monsoon season with risk of construction induced landslide	Construction		**Medium** Medium magnitude: confined to project site but soil will be exposed and landslide risk due to cutting of hillocks	**Medium Adverse**	Yes
	Inadequate storage and spills or leaks of fuel, oil, or chemicals stored on site causing soil contamination including transformer oil for new switchyard and diesel fuel for emergency diesel gen set. Disturbance of legacy soil contamination from spills and leaks at the existing plant which will be decommissioned (decommissioning is outside of scope of ADB funded but essential to realize project benefits).	Construction, Operation		**Medium** Moderate consequence as limited volume (up to 2500 liters) be stored and unlikely to impact soils beyond immediate storage location; reversible with effort in long term, several opportunities for mitigation	**Medium Adverse**	Yes
Water	Alternation of surface water drainage patterns due to extensive earthworks and construction of impermeable surfaces in place of vegetated land use; no drains or surface water bodies found at the project site	Construction	**Low** Some capacity to absorb changes, average vulnerability as outside of floodplain, community	**Low** Low magnitude: irreversible, change in drainage patterns may affect area immediately adjacent	**Low Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
			concern			
	Use of groundwater for construction, including potable water supply for workers. Although GoT groundwater studies indicate there is plenty of water availability risk of compromising the supply of existing water users especially the nearest residents who reported water stress, mostly during the summer (March-June)	Construction	**High to Medium** In an area of low groundwater stress, but limited availability of surface water. Only 10 adjacent properties are reporting water stress, nearby village has no water stress. Some capacity to absorb changes, community concern for nearest residents	**Low** Low magnitude: temporary impact during construction period, some opportunities for mitigation	**Medium to Low Adverse**	Yes
	Use of groundwater for power plant operation, including potable water supply. Cumulative impact from 120 MW replacing 63 MW power plant. Higher water requirement in comparison to existing plant, but less water than usual for power plant as air cooled condensers are used. Although GoT groundwater studies indicate there is plenty of water availability risk of compromising the supply of existing water users especially the nearest residents who reported water stress, mostly during the summer (March-June)	Operation		**Medium** Medium magnitude but especially during summer season may affect groundwater resources beyond project site; few opportunities for mitigation including rainwater harvesting and use of air-cooled condenser	**Medium Adverse**	Yes
	Surface water runoff leading to sediment laden runoff entering surface water, affecting water quality and aquatic ecology	Construction	**Low** Locally sensitive receptors – small ponds, below average vulnerability, exceedance of national water quality standards may occur, community concern	**Minimal** Due to distance involved no impacts are envisaged	**Minimal Adverse**	Yes
	Untreated effluent or inadequate storage and spills or leaks of fuel, oil, or chemicals stored on site causing surface water contamination including transformer oil for new switchyard and diesel fuel for emergency diesel gen set.	Construction, Operation		**Minimal** Due to distance involved no impacts are envisaged	**Minimal Adverse**	Yes
	Inadequate storage and spills or leak of fuel, oil, or chemicals stored on site causing groundwater contamination	Construction, Operation	**High** Some capacity to absorb change,	**Medium** Medium magnitude: may affect	**Medium Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	including transformer oil for new switchyard and diesel fuel for emergency diesel gen set.		average vulnerability but above average as used for drinking water, exceedance of national water quality standards may occur, community concern	groundwater beneath and connected to project site		
	Disposal of untreated process and sanitary wastewater to land for watering the project site. Higher water requirement in comparison to existing plant results in a greater volume of effluent, but less water than usual for power plant as air cooled condensers are used	Construction, Operation		**Medium** Medium magnitude: may affect groundwater beneath and connected to project site	**Medium Adverse**	Yes
Natural resource use and waste generation	Use of raw materials from existing licensed sources: sand, gravel, fuel, oil, chemicals etc.	Construction, Operation	**Low** No policy or regulatory concerns as existing licensed sources will be used	**Medium** Medium magnitude in relation to construction materials: several opportunities for mitigation, impact may be beyond site boundaries	**Medium Adverse**	Yes
	Use of natural gas as a non-renewable fossil fuel for combustion. There will be cumulative impact from the more efficient 120 MW proposed plant replacing the 63 MW existing plant, for which no additional gas supply is required. However, the proposed plant will extend use of fossil fuel for a further 25-year period.	Operation	**High** No policy or regulatory concerns as existing licensed sources will be used, but natural gas is a non-renewable resource of importance to the economy of Tripura	**Maximum** Maximum magnitude: natural gas available in Tripura but it permanent impact on India and state's natural gas supplies	**Maximum Adverse**	Yes
	Generation of inert spoil, inappropriately disposed of in the landscape surrounding the project site; it is currently anticipated that cut and fill can be balanced at the project site	Construction	**Medium** District/State level concern since may be disposed of outside of project site	**Medium** Medium magnitude due to anticipated balance of cut and fill: some opportunities for mitigation, impact may be beyond site boundaries	**Medium Adverse**	Yes
	Generation of solid waste including	Construction,	**High**	**High**	**High Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	construction offcuts, packaging and food waste, sludge from water pre-treatment and effluent treatment, air filters etc. inappropriately disposed of in the landscape surrounding the project site	Operation	State/National level concern as no engineered solid waste management facilities in Tripura	Large magnitude in terms of volumes generated but minimal opportunities for mitigation, impact may be far beyond site boundaries		
	Generation of hazardous waste e.g., oily rags, empty drums, etc. inappropriately disposed of in the landscape surrounding the project site	Construction, Operation	**High** State/National level concern as no hazardous waste management facilities in Tripura	**High** Large magnitude: several opportunities for mitigation, impact may be beyond site boundaries	**High Adverse**	Yes
Socioeconomic Environment						
Occupational (workers) H&S	Risks related to unsanitary working conditions and sanitation and welfare facilities including overnight accommodation provided by employer, spread of communicable diseases, ponding of water for mosquitoes – malaria is a major health problem in Tripura, COVID-19 and HIV/AIDS, snake bites etc.	Construction, Operation	**High to Medium** Individual receptors/concern; average vulnerability although any under 18 and foreign migrant workers may be above average	**High to Low** Major consequence if fatality occurs, large number of workers involved during construction, rare occurrence, in most cases moderate to low consequences will occur, and several opportunities for mitigation	**High to Medium Adverse**	Yes
	Risks related to unsafe working conditions leading to H&S incidents/accidents e.g., slips, trips, falls from height due to inadequate protection, collapse of excavations, confined spaces, road traffic accidents, unloading of materials, electrical hazards etc.	Construction, Operation		**High to Low** Major consequence if fatality occurs, large number of workers involved during construction, fatality a rare occurrence, in most cases moderate to low consequences will occur, and several	**High to Medium Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
				opportunities for mitigation		
	Human health impacts on project workers from dust, noise, handling wastes, water pollution etc.	Construction, Operation		**High to Low** Major consequence if fatality occurs, large number of workers involved during construction, fatality a rare occurrence, in most cases moderate to low consequences will occur, and several opportunities for mitigation	**High to Medium Adverse**	Yes
	Power plant operational hazard, including fire and explosion risk due to use of natural gas. Including incidents with anthropogenic cause and because of any natural hazards e.g., earthquakes. These risks are already present in study area from existing plant.	Operation		**High to Low** Major consequence if fatality occurs, large number of workers at proposed plant, fatality a rare occurrence in most cases moderate to low consequences will occur, and some opportunities for mitigation; risk of gas pipeline fire/explosion confined within a small area of the project site although fire may spread to adjacent areas if it is not controlled	**High to Medium Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
Community H&S	Community access to hazards present on construction site or operational power	Construction, Operation	**High** Locally sensitive	**High to Low** Major consequence if	**High to Medium Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	plant. Operational risks are already present in study area from existing plant – security present and no unauthorized access inside existing plant area is allowed.		receptors– scattered rural communities; community concern, average vulnerability although children of above average vulnerability noting school sited within Rokhia Thermal Power Station at 300m, as well as elderly and those in ill at health for indirect impacts	fatality occurs, but rare occurrence, in most cases moderate to low consequences will occur, and several opportunities for mitigation as discrete site that can be easily secured		
	Human health impacts on community members from dust, gaseous emissions including NOx, noise, vibration, water pollution etc. Operational risks are already present in study area from existing plant – see also physical impacts on air, noise, water etc.	Construction, Operation		**Maximum to High** Maximum to major magnitude in relation to construction dust and noise: permanent impact, some opportunities for mitigation, improved baseline condition for air pollution as the air emissions from proposed plant will be lower than existing plant	**Maximum to High Adverse (although considered to be Beneficial with respect to cumulative air quality effects)**	Yes
	Power plant operational hazard, including fire and explosion risk due to use of natural gas. Including incidents with anthropogenic cause and because of any natural hazards e.g., earthquakes. These risks are already present in study area from existing plant.	Operation		**High to Low** Major consequence if fatality occurs, but rare occurrence, in most cases moderate to low consequences will occur, and some opportunities for mitigation; risk of gas pipeline fire/explosion confined within a small area of the project site although fire may spread to adjacent areas if it is not controlled	**High to Medium Adverse**	Yes
	Traffic congestion, pedestrian and driver delay on local roads due to construction vehicle movements including transportation of oversized power plant equipment along rural access roads with	Construction		**High** Large magnitude, temporary impact during construction period, some opportunities for mitigation	**High Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	tight curves passing through etc. Risk of traffic accidents due to additional vehicle movements on local roads, concern over safety of driving on, living adjacent to or having to cross busier roads etc. Road from Bisalgarh to Rokhia is on average 6m (4.5m-7.6m) in width, whereas the diameter of stack is about 7.5-8m diameter.					
	Spread of communicable diseases including COVID-19, HIV/AIDS, and other STDs from presence of migrant workers in rural area	Construction, Operation		**High to Low** Major consequence if fatality or permanent disability occurs as a result, rare occurrence, in most cases moderate to low consequences will occur, several opportunities for mitigation	**High to Medium Adverse**	Yes
	Community interactions and conflict with workers and any security personnel deployed, especially for nearest residents/ Manikyanagar village, including sexual exploitation, abuse, and harassment from presence of migrant workers in rural area, disruptions of religious festivals etc. These risks are already present in study area from existing plant and community has not raised any concerns in that respect but there will be more workers including migrant workers present during construction.	Construction, Operation	**High** Community concern, scattered settlements in rural area; average vulnerability although women, IPs and children with school at 300m are of above average vulnerability	**High to Low** Major consequence if fatality or permanent disability occurs as a result, rare occurrence and unlikely to occur as TPGL existing plant, in most cases moderate to low consequences will occur, several opportunities for mitigation	**High to Medium Adverse**	Yes
Land use and livelihoods	Private land take is not required as site is already part of TPGL land holding and the forest and private land historically diverted for industrial land use.	Construction	**Low** Locally sensitive receptors, community level	**Low** Some impact to roadside assets along roads to be used for project vehicle	**Low Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
	There may be some temporary short-term disturbance to existing utility or roadside assets within the right of way along the access roads during transport of oversized vehicles.		concern	movement		
	Loss of access due to temporary closure of TPGL private road, currently allowed to be used by local communities; alternative/actual route of 1-2 km additional travel is available	Construction	**Low** Locally sensitive receptors, community level concern	**Medium** Medium magnitude, temporary during construction period. No livelihood impact due to temporary road closure	**Low Adverse**	Yes
	Damage to private property – the nearest residences (mud/tin construction) to the project site due to dust deposition and vibrations caused by construction work, and increased traffic movements along access roads	Construction	**Medium** Local roads affected, some capacity to absorb change, division/district level concern with communities immediately adjacent to roads most vulnerable	**Medium to Minimal** Minimal consequences related to the project site, but moderate risk of private property encroaching into road ROW along access roads due to narrow width and oversized vehiles etc. Several opportunities for mitigation	**Medium to Low Adverse**	Yes
	Unused transmission towers in the project site are planned for dismantling Potential damage to other public utilities along roads, e.g., gas pipes, power lines, telephone lines, water pipelines or sewers along project vehicle transport route	Construction	**Low** Local/community receptors, community concern	**High** Major consequence if damage/breakage to power lines occurs as a result of construction traffic, supply to community hampered until supply restored, rare occurrence, several opportunities for mitigation	**Medium Adverse**	Yes
	Stress on use of community resources and services e.g., health services, water supplies. These risks are already present in study area from existing plant but will be more workers present during construction.	Construction, Operation	**Medium** District/local receptors, minimal capacity to absorb changes, district/	**Maximum to Medium** Maximum magnitude in relation to local health services in relation to construction impacts; reducing to major	**High to Medium Adverse**	Yes

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
			community concern	magnitude during operation with some TPGL staff and workers already using resources; moderate risk to local water supplies		
	Employment and micro level economic development opportunities from provision of accommodation for construction workers etc. Skilled and unskilled workers required, former likely to come from outside study area due to requirement for specialist training etc. Cumulative impact from replacing existing plant means no additional opportunities during operation, no labor retrenchment of the existing TPGL employees as they will be employed at the proposed plant	Construction	**Low** Local/community receptors, community concern	**Beneficial** Small magnitude of employment during construction	**Beneficial**	Yes
	Energy supply and security	Operation	**High** State/national importance	**Beneficial** 57 MW additional generation capacity available from same use of natural gas	**Beneficial**	n/a
Landscape and visual	Landscape and visual impact on adjacent residents of construction / new industrial setup, change from vegetated land to industrial land, demolition of hillock, etc. Stacks will be visible for a large distance.	Construction, Operation	**Medium** District sensitive receptors, some capacity to absorb change, district level concern	**High** High magnitude: irreversible impact, already designated as industrial land but supports forest habitat	**High Adverse**	Yes
Physical Cultural Resources						
Physical cultural resources	Risk of damage to local physical cultural resources due to construction and traffic movements along access roads; impact on the visual setting of local physical cultural resource	Construction, Operation	**Low** Local/community receptors, community concern	**Low** Small magnitude: irreversible, may affect area immediately adjacent to project site and access roads, setting of physical	**Low Adverse**	Yes (for operation mitigation see landscape and visual impacts)

Receptor (IEC/ISC)	Environment Impacts/Risks	Phases of Project	Importance	Severity	Significance Prior to Mitigation	Mitigation Incorporated into EMP
				cultural resources not specifically impacted by changes in the landscape		
	Risk of damage due to construction on project site to undiscovered physical cultural resources / chance finds e.g., archaeological / paleontological remains within the hillocks which will be excavated	Construction	**Low** Unknown but likely if any encountered will be at most local/community receptor	**Low** If encountered risk of minor damage before work halted, some opportunities for mitigation but any damage would be irreversible, confined to project footprint, rare occurrence and unlikely to occur at project site	**Low Adverse**	Yes

Source: ADB TA Consultant

E. Assessment of Potential Biological Impacts and Mitigation

1. Impacts of Construction including Demolition

339. The proposed plant will be constructed within the premises of the Rokhia Thermal Power Station. No direct impacts on protected areas, key biodiversity areas, designated forest land, or Critical Habitat are predicted because of construction works, as none are present at or immediately adjacent to the project site. Sipahijila Wildlife Sanctuary (WLS), incorporating the Clouded Leopard National Park is the nearest protected area (PA) at 10.5 km distance. The project site was historically transferred from designated Reserve Forest (RF) to TPGL for industrial use nearly 30 years ago, even though it still supports degraded natural forest habitat. The project site of 4.5 ha supports 2.2ha of modified habitat supporting office buildings and open ground, and 2.3 ha of degraded forest habitat including ground vegetation, shrub and tree cover which will need to be cleared to create a level construction platform resulting in direct habitat loss. This forest is a “natural habitat” but loss of this habitat to the project footprint is not considered significant as this is 0.0004% of forest cover in Tripura and 0.009% of forest cover in Sepahijala District. The habitat in the PAI is approximately 38.18% vegetated/forest. The project site houses various floral species including timber, bamboos, firewood, flowering and fruiting plants besides some traditional medicinal and some invasive species but none of the floral species within the forest habitat are endemic to the project site and all are commonly found across the PAI in general. The forest habitat within Rokhia Thermal Power Station also has limited socioeconomic value to the local community since the land is already owned by TPGL and entry within it by the public is restricted.

340. Trees and vegetation are an essential component of a healthy environment. In addition to maintaining the oxygen-carbon dioxide balance in the atmosphere through photosynthesis, they help to control air and noise pollution, soil erosion, provide food and shelter to domestic and wild animals, and improve the aesthetic value of the environment. Tree felling for the proposed project will require a permit from the Forest Department, GoT. It is estimated that 249 secondary growth trees (including horticultural species planted by TPGL) having a girth size more than 30cm (Table 5-4) will need to be cut, although this will be reconfirmed by EPC Contactor based on the detailed design. None of these trees are a threatened or endemic species, and none are nationally protected. Direct habitat loss will be irreversible / permanent, but of small magnitude and unlikely to affect the ecological integrity of the study area, thus **not significant.** It will however be required to offset the loss of natural habitat and trees through compensatory reforestation to achieve no net loss of biodiversity or net gain.

341. Other trees not earmarked for cutting may be accidentally damaged due to construction works and the photosynthesis of vegetation may be temporarily affected by dust deposition. However, the greatest threat to vegetation, trees and habitat comes from accidental forest fires because of hot works which could spread to adjacent forest habitat if not controlled. There may also be cutting of trees or collection of NTFP by construction workers, poaching, hunting, fishing, road-related accident due to traffic movements, and, spread of invasive flora (there are 11 invasive species within 2km of the project site, mainly grasses and herbs out of which 3 are native and rest 8 are alien species; these species are commonly found within the PAI). These risks already exist from the existing plant, but the magnitude of impact or risk will temporarily increase for the 36-month construction period because of up to 350 construction workers being present at the project site. There will also be about 30 TPGL staff on site during construction works, so 380 workers in total. This influx of workers as well as construction activities will mean more dust, noise, illumination at night-time, and human activity at the project site disturbing

fauna using the project site and immediate surroundings. Periods of greatest disturbance will be demolition of the existing buildings, cutting of trees for tree dwelling species including birds and Palla's squirrel, earthworks including cutting of the hillocks which will also impact soil micro and macro fauna, and piling work. Species found at the project site that may be directly disturbed are small mammals including Rhesus macaques (*Macaca mulatta*) and Pallas's squirrel, birds, frogs, lizards, insects all of which are either least concern (LC) or not evaluated (NE) and are not nationally protected.

342. In terms of indirect disturbance Pharye's leaf monkey (CR) is the most sensitive species found in the study area but as the nearest sighting is 2.5km from the proposed plant in Boxarnagar Community Forest area it is unlikely it will be disturbed, impacts from dust and noise will be confined to a maximum 500m radius and construction workers are also unlikely to venture this far. Though capped langur (VU) may occasionally use the project site it does not reside there so during periods of disturbance it is likely to make more use of the rest of its habitat range. Their foraging habitat, movement tracts and territory will however be slightly reduced, they and other primate species including Rhesus macaques may also be attacked by construction workers or get trapped in construction machinery and equipment. Indirect biodiversity impacts and risks to vegetation/trees and wildlife during construction will need to be mitigated with particular attention towards protecting threatened and nationally protected species, but are temporary for the duration of construction, of medium to minimal magnitude / moderate to minor consequence and **not significant**.

Table 5-4: Trees to be Felled

Species	Girth Size (cm)					Grand Total
	<30	31-60	61-90	91-120	121-200	
Acacia auriculiformis	0	0	0	1	0	**1**
Albizia procera	1	0	0	1	0	**2**
Aphanamixis polystachya	1	1	0	0	0	**2**
Artocarpus heterophyllus	2	2	0	0	0	**4**
Bombax ceiba	0	1	0	1	0	**2**
Callicarpa arborea	1	1	3	0	0	**5**
Cassia fistula	1	0	0	0	0	**1**
Chukrasia tabularis.	1	5	1	2	0	**9**
Cupressus sempervirens.	4	3	0	0	0	**7**
Dead unknown tree	0	0	1	0	1	**2**
Delonix regia	1	3	0	0	0	**4**
Ficus amplissima	0	0	0	0	1	**1**
Ficus auriculata	16	8	10	2	0	**36**
Garuga pinnata	2	6	9	1	0	**18**
Gmelina arborea	0	0	0	1	0	**1**
Holarrhena pubescens	2	0	0	0	0	**2**
Lannea coromandelica	1	2	3	2	0	**8**
Magnolia champaca	0	1	0	0	1	**2**
Melia azedarach	0	1	0	0	0	**1**
Microcos paniculate	3	4	0	0	0	**7**
Mimusops elengi	0	1	0	0	0	**1**
Moringa oleifera	4	2	0	0	0	**6**
Oroxylum indicum	12	2	0	0	0	**14**
Polyalthia longifolia	0	0	0	10	1	**11**
Pterospermum acerifolium	1	3	3	0	0	**7**

Species	Girth Size (cm)					Grand Total
	<30	31-60	61-90	91-120	121-200	
Senna siamea	4	2	2	0	0	**8**
Shorea robusta	1	4	12	19	12	**48**
Syzygium cumini	3	0	0	0	2	**5**
Tectona grandis	2	3	1	1	0	**7**
Terminalia bellirica	5	3	0	0	1	**9**
Trema orientalis	1	6	3	2	0	**12**
Unknown	0	0	1	0	0	**1**
Ziziphus xylopyrus	3	0	1	1	0	**5**
Grand Total	**72**	**64**	**50**	**44**	**19**	**249**

Source: MITCON baseline survey

1.2. Mitigation during construction including demolition

343. The CEMP to prepared by the EPC contractors before construction commences will incorporate mitigation measures for biodiversity elaborating on those included in the EIA/EMP. The EPC Contractor will employ a suitably experience and qualified ecologist full time on-site to supervise and monitor their construction, they will also provide awareness raising on wildlife conservation to management, construction workers, local community etc. This ecologist will have both flora and fauna identification skills as well as experience in wildlife management. The PIC will also include a part-time consultant ecologist to support TPGL EMP supervision and monitoring team with respect to ecological matters. PMU E&S Safeguards Officer will be delegated authority under the contract to be able to halt construction works if any wildlife of conservation value or which needs to be rescued is observed.

344. Clearance of vegetation / trees will only take place within the 4.5 ha project footprint with trees to be retained in the 33% of the project site which is to be retained as green belt clearly marked or fenced to prevent them being damaged. The EPC contractors will also strictly locate all temporary construction facilities within the project footprint, or if they need additional space then they will only use allocated bare ground / modified habitat within the confines of Rokhia Thermal Power Station, subject to ecology survey and agreement of the PMC ecologist. 0.4ha of bare ground that would be suitable has already been identified by TPGL. Prior to clearance the EPC Contractor will undertake a detailed inventory of the number, location, size, and species of tree that they will need to cut. Under GoT legislation the cutting of trees will require permission from the Forest Department who will verify the trees to be felled and then accord permission for felling. Trees will be marked and felled under the supervision of the EPC Contractor's ecologist. Cleared vegetation will be composted on site and used for soil conditioning works (gardening) whilst cut trees will be transferred to the Forest Department for disposal as timber or firewood. Use of herbicides or burning to clear vegetation or burning of vegetation trimmings is strictly prohibited.

345. It is an MoEF&CC requirement that 33% of the proposed plant (1.49 ha) is developed as green belt – vegetated area. Therefore, a green belt will be retained/provided around the project site to cover all the vacant areas not occupied by hard infrastructure. Although the availability of land within the premises is limited, in addition to providing the compensatory payment to Department of Forests, if legally mandated, tree loss will also be directly compensated by TPGL through the planting of non-invasive, native trees (floral, timber, fruit bearing and other species to be determined by the ecologist of the EPC contractor and approved TPGL with the support of the PMC ecologist) at ten times the trees felled (2,490 trees) locally within the Rokhia Thermal Power Station, as part of establishing the requisite green belt (on bare ground / modified

habitat) and improving habitat elsewhere with the TPGL land holding at a density of about 2,000-2,500 trees per hectare. The remaining vacant areas of the project site will be landscaped with avenue plantation/lawn/garden. The utility of the green belt predominantly lies in its capacity to attenuate fugitive emissions and spillage. Systematic screening of plants for their ability to tolerate pollutants is to be undertaken following CPCB guidance on greenbelt plantation. For pollution abatement purposes tree species would be fast growing, wind firm, unpalatable to animals, hardy and pollutant tolerant/resistant. But the general approach for selection of locally native species for green belt development is as follows:

- (i) Potential for attenuation of fugitive emissions, act as barrier to dust emissions and improve microclimate
- (ii) Potential for attenuation of noise
- (iii) Diversity of vegetation
- (iv) Introduction of trees providing food or habitat for animals

346. There will be strict prohibition on construction workers to enter nearby forest land, Reserved Forest, and Protected Areas whilst working at the proposed plant, and they will also be prohibited from cutting timber / firewood, poaching, trapping, hunting, fishing etc. Regular, compulsory awareness raising activities will be undertaken to reinforce these prohibitions with strict penalties as well as how to interact with wildlife encountered on site. Drivers employed should be skilled and receive training to how to avoid traffic collisions with wildlife especially when driving at night on rural roads.

347. Demolition, site clearance, tree cutting and cutting of the hillock will be conducted cautiously under supervision of the EPC Contractor’s ecologist to minimize impacts on wildlife. In the first instance these works will be scheduled outside the breeding season of animals found on site especially during and immediately after the monsoon season. Demolition and tree cutting will only be conducted after being surveyed by the EPC Contractor’s ecologist and confirmed by the PIC ecologist that no nesting or roosting fauna is present. Site clearance and cutting of the hillock will only be conducted after occupancy of all burrows has been checked by the EPC Contractor’s ecologist and it is confirmed by the PIC ecologist that works can proceed. If nesting, roosting, or burrowing animals are observed then construction works will be postponed until the young are confirmed to have left the nest/burrow and adequate time has been given for adult animals to depart. In the interim they will be demarked to avoid accidental damage or disturbance being caused. The CEMP will include a wildlife rescue plan (including liaison and intimation to Forest and Wildlife Department) with any wild animals accidentally injured being taken for treatment by the nearest wildlife veterinarian (at the Sipahijila WLS) with assistance from the Forest and Wildlife Department. A written record, supported by photographs, of any animal casualties at the project site or in traffic collision, including a cause of death if known, is to be kept by the EPC Contractor’s ecologist.

1.3. Impacts of Operation

348. Operational impacts relate to the presence of project workers in the study area, the risk of forest fire, emergency incident, noise, light, and air pollution all of which already occur with the presence of the existing plant. No direct impacts on protected areas, key biodiversity areas, designated forest land, or Critical Habitat are predicted because of operation. There will also be no impacts on aquatic habitat, as no surface water will be abstracted. Groundwater abstraction that is proposed will not affect wetlands which are not present in the study area. Due to the use of air-cooled condensing there will be no thermal discharge for disposal, and as the proposed

plant will be zero discharge there will be no effluent disposal to surface water and impact on aquatic ecology.

349. Quantitative risk-hazard assessment (Chapter 7) was undertaken to demonstrate that in the unlikely event of a fire or explosion the direct effect of this will be contained within the project site. There will be a fire station on site with fire truck and fire-fighting equipment to quickly respond to any incidents that occur. However, if not quickly controlled by TPGL such a fire could spread to forest habitat surrounding the power plant resulting in loss of habitat. Forest habitat is not contiguous with Sipahijila WLS and Clouded Leopard NP at 10.5km distant and agricultural land/settlement can provide a fire break. This means major or catastrophic loss would be avoided, in a worst-case 3-5 ha of forest habitat within approximately 1 km of the project site could be lost.

350. Species using the project site will be disturbed by the presence of workers, noise, and illumination including high power floodlight (for nocturnal species) from the power plant operation, although given the existing plant most will be habituated. These impacts will generally be confined to a 500m radius. The presence of the two stacks (HRSG and Bypass) will not affect overflying birds; there will be no intermittent flare or flames coming from the stacks. Collision of birds with the stacks (the HRSG is tallest at 60m compared to the existing plant's 10m stack height) and other elevated structures including about 50m of overhead power line to connect the new and existing switchyard is a possible risk to consider. Due to the stack's size most birds should be able to detect it and avoid collision, the use of white or yellow lighting has been shown to increase collision risk with red lighting reducing it so will be favored if it needs to be lit.[85] The project site and surroundings are not part of any migratory route or flyway so any collision impacts on bird species will be minimal.

351. Due to the use of natural gas as fuel, the major emission of concern from the proposed plant is NO_x. Nitrogen-containing air pollutants can affect vegetation indirectly via chemical reactions in the atmosphere or directly after being deposited on vegetation, soil and water. The direct impact of airborne nitrogen is due to toxic effects, eutrophication, and acidification. Two different types of effect threshold exist: critical levels and critical loads. Critical level (CLE) is the concentration in the atmosphere above which there can be direct impacts on biological receptors, which is 30ug/m^3, whereas Critical Load is the amount deposited from air to the ground (10-20 KgN/ha/year). With respect to the critical level of NO_x value in ambient air during project operation, it will be within this guideline set by WHO,[86] as assessed in the air quality impacts section. Based on the quantitative air quality assessment, the long-term incremental ground level concentration and thus the critical load of NO_x in the study area due to the proposed plant operation will be very low and a small percent of the GoI and WHO 2021 guidelines. The baseline will also be improving because the air emissions from the proposed plant will be lower than those from the existing plant.

352. Overall, the impacts of operation on biodiversity are of medium to very small magnitude/moderate to minor consequence and unlikely to affect the conservation status of the species supported, thus **not significant**.

1.3. Mitigation during operation

[85] https://core.ac.uk/download/pdf/188123064.pdf
[86] https://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf

353. The ESMS developed by TPGL will incorporate mitigation measures for biodiversity elaborating on those included in the EIA/EMP which will be supervised by their Environment Officer. There will be strict prohibition on construction workers to enter any nearby forest land, Reserved Forest and Protected Areas whilst working at the proposed plant, and they will also be prohibited from cutting timber/firewood, poaching, hunting, fishing etc. Training followed by regular, compulsory awareness raising activities will be undertaken as part of worker orientation to reinforce these prohibitions with strict penalties as well as how to interact with wildlife encountered on site such that wildlife visiting the project site is not disturbed or attacked by them.

354. The ESMS will include a disaster and risk management system to be implemented in the event of a fire, explosion, or any other plant operational hazard which may impact the local ecology. Training followed by regular, compulsory awareness raising activities on identifying and reporting wildlife incidents and dealing with the risk of forest fire will be part of worker orientation. TPGL will also provide awareness raising to the local community on avoiding and managing forest fires.

355. Mitigation measures set out in the physical environment section will be followed to control emissions to air, noise etc. If the stacks are to be lit, they will use red LED lighting with other illumination within the proposed plant directed downwards and avoiding spill onto the adjacent forest habitat.

356. For major maintenance works and decommissioning same biodiversity mitigation as for the construction works is to be adopted.

F. Assessment of Potential Physical Environment Impacts and Mitigation

1. Climate change

357. The Kyoto Protocol – United Nations Framework Convention on Climate Change (UNFCCC) has identified the following six categories of Greenhouse Gases (GHGs) that may have climate change impact:

(i) Carbon dioxide (CO_2);
(ii) Methane (CH_4);
(iii) Nitrous Oxide (N_2O);
(iv) Hydrofluorocarbons (HFCs);
(v) Perfluorocarbons (PFCs); and
(vi) Sulfur Hexafluoride (SF6).

358. Inventories of GHG emissions can be calculated using published emission factors. Emission factors consider the global warming potentials (GWP) of the GHGs created during combustion which vary by gas. Typically, GHG emissions are reported in units of carbon dioxide equivalent (CO_2e). The GHG emissions are converted to CO_2e by multiplying by the emissions by the global warming potential (GWP). GWP was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period, relative to the emissions of 1 ton of CO_2. The GWP of selected GHGs are given in Table 5-5.

Table: 5-5: Global Warming Potentials

GHG	Lifetime (years)	100-year time period (Values based on Assessment Reports (AR))		
		AR4 2007	AR5 2014	AR6 2021
CO_2	Variable	1	1	1
CH_4	12	25	28	29.8
N_2O	114	298	265	273
SF6	3200	22800	23500	23500

Source: IPCC Sixth Assessment Report, 2021[87]

1.1. Construction including Demolition

359. During construction, GHG emissions mostly in the form of CO_2 and N_2O will arise from the operation of plant and equipment such as diesel generator sets and construction vehicles and well as the use of materials such as concrete and steel. These GHG emissions will be temporary although dispersed GHG emissions over the 36-month construction period will contribute to long term global/regional climate change impacts. In the context of global emissions climate change impacts due to the proposed plant construction are anticipated to be of low magnitude and **Not Significant.**

1.2. Operation

360. In terms of efficiency the World Bank-IFC EHS guidelines on thermal power recommended that new power plants should be in the top quartile for Asia/India, typically they give the efficiency value for a combined cycle gas turbine as 54-58% Net LHV emitting 348-374 g CO_2e/kWh. The gross design efficiency of the proposed plant will be 52.31% emitting 386 g CO_2/kWh. The available combined cycle plants of 120 MW capacity from reputed manufacturers have ISO condition efficiency with water cooled condenser in the order of 54.7% to 56.9% (Chapter 6). However, due to paucity of water, air-cooled condenser must be used. This will reduce the efficiency of steam cycle. Thus, the estimated efficiency of the proposed plant at site conditions with air-cooled condenser will be in the order of 51.14%-53.86%. Considering the type of condenser that must be used the design efficiency of 52.31% emitting 386 g CO_2/kWh is in line with international good practice.

361. Most GHG emissions associated with the life cycle of a gas fired power plant will come from the use of natural gas (about 25%) and its combustion (about 75%).[88] GHG emissions are one of the key environmental issues associated with gas fired power plants although these emissions are less compared to use of coal or oil as fuel. Since natural gas consists mainly of methane (i.e., natural gas itself is a GHG) leakages in the process of extraction and transportation can contribute significantly to the total GHG emissions. The proposed plant will be using the natural gas supply from ONGC and GAIL to the existing plant which will be routed to the proposed plant through a short pipeline (about 90 m in length). Therefore, there will be negligible additional impacts from the extraction and transportation of natural gas although the proposed plant will extend this for a further 25 years. The dominant contributor to GHG emissions is CO_2 from the power plant. There will also be no additional impacts from its combustion, although again these impacts are extended for a further 25 years and contributing

[87] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change
[88] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC21207/EUR%2019754%20EN.pdf

to long term global/regional climate change impacts. In that respect, alignment with the Paris Agreement is required. The Paris Agreement's (12th December 2015) central aim is to strengthen the global response to the global threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

362. The amount of GHGs emitted by the power plant is a measure of its contribution to climate change and can be estimated based on fuel consumption. The GHG emissions are estimated using ADB methodology (based on energy efficiency and fuel consumption, the latter fuel consumption method will be used for monitoring during operation)[89] as shown in Table 5-6. The proposed power plant will contribute about 28% of Tripura's GHG emissions based on unofficial 2013 data,[90] 0.01% of India's GHG emissions and < 0.001% of global GHG emissions based on unofficial 2018 data.[91] Therefore, taking into consideration the Paris agreement and the urgent need to reduce global emissions to meet the 1.5 degrees Celsius target, the magnitude of GHG contribution of the proposed plant at 330,704.9 tCO_2/year is Maximum Adverse and **Significant**.

Table 5-6: GHG Estimation from Proposed Plant

	Description	Unit	Value	Source
1	**Greenhouse Gas Emissions from Proposed Plant Using Energy Efficiency Method**			
a	Capacity of the Proposed Plant	MW	115.04	TPGL
b		hours/year	8760	
c	Plant Load	%	85	TPGL
d	Annual energy generated (a x b x c)	MWhrs/year	856587.84	
e	Plant Efficiency	%	52.31	TPGL
f	Fuel Consumption (Mf) (d x 3.6 x e)	GJ/year	5894918	
g	Fuel Emission Factor	tCO_2/GJ	0.0561	ADB Methodology
h	**CO_2 Emission (f x g)**	**tCO2/year**	**330,704.90**	
2	**Greenhouse Gas Emissions from Proposed Plant Using Fuel Consumption Method**			

89 https://www.adb.org/sites/default/files/institutional-document/296466/guidelines-estimating-ghg.pdf

90 Tripura – 1.02 MtCO2e in 2013 from http://www.ghgplatform-india.org/Images/Publications/GHGPI-PhaseIII-Trend%20Analysis%20State-Tripura-Dec%2719.pdf, the most recent state data from earlier years is not totalled but is available from https://dste.tripura.gov.in/documents/state_action_plan.pdf. The 2013 data does not consider that new gas power plants have come online since 2014, therefore the current contribution to state emissions is anticipated to be lower than that calculated, based on GHG emissions of the state having increased in recent years.

91 India – 3.35 Gt CO2e (2018) and Global – 48.9 Gt CO2e (2018) from https://www.climatewatchdata.org/ghg-emissions?chartType=area&end_year=2018&regions=IND&start_year=1990

	Description	Unit	Value	Source
a	Fuel consumed per day	MMSCMD	0.553	TPGL
b	Plant Efficiency	%	52.31	TPGL
c	Annual fuel consumed (a x 365 x b)	m^3/year	171,568,250	
d	NCV	kcal/m^3	8317.9	Gas Analysis
e	Annual energy generated (c x d x 4.1868 x 0.000000001)	TJ/yr	5974.93	
f	Fuel Emission Factor	tCO_2/TJ	56.1	ADB Methodology
g	**CO_2 Emission (e x f)**	**tCO2/year**	**335,193.61**	

Source: ADB TA Consultants

363. India's current 2030 Nationally Determined Contributions (NDC) target will be well overachieved with current policies. As per the latest report (December 2015) on GHG emissions submitted by India to the United Nations Framework Convention on Climate Change (UNFCCC) electricity generation sector contribution to GHG emission in year 2010 was 1,510,120.76 Gg CO2e. The emission intensity of GDP has reduced by 12% from 2005 to 2010, on course to meeting the voluntary target of 20-25% reduction in emission intensity of GDP by 2020. India has yet to submit updated 2030 targets to the UNFCCC having missed the deadline of October 12, 2021. But it did announce updated and strengthened 2030 targets at COP 26 including reducing the carbon intensity of the economy to 45% below 2005 level and reducing GHG emissions by 1 billion tons by 2030. India considers natural gas as a transition fuel in that it should be used until other alternatives become available as it is less polluting than coal but not as clean as other renewables.

364. Provided the proposed plant replaces the existing plant which has an efficiency of about 26.46%, emitting 1310.24 g CO_2/kWh whilst the total amount of GHG emissions is significant, there will be a benefit from reducing the emission intensity of the power plant. Using the ADB methodology[92] (Table 5-7) if the existing plant operating on 3 units is decommissioned by TPGL, no additional natural gas will be consumed and so there is a saving (offset) of 27,320.51 tons per year due to the generation efficiencies of the proposed plant compared to the existing plant. If only considering two units are in operation[93] the GHG emissions would not be fully offset by decommissioning of the existing plant, a further 92,021.29 tons per year would need to be offset. If only considering only one unit[94] is operational, a further 211,363.10 tons per year would need to be offset.

365. Replacement of the existing plant by the more efficient proposed plant which generates additional MW will support GoI in meeting its commitment towards its NDC targets through

92 https://www.adb.org/sites/default/files/institutional-document/296466/guidelines-estimating-ghg.pdf

93 Only two units are currently in operation due to MoEF&CC order, further in 2027 the 25 year lifespan of the first existing plant units would be reached requiring it to be decommissioned, thus it can no longer be counted as part of the annual offset post-2027

94 In 2031 the 25 year lifespan of the second of the existing plant units would be reached requiring it to be decommissioned, thus it can no longer be counted as part of the annual offset post-2031

improving energy intensity and diversification of the energy sources from existing coal-based fossil fuel. This will offset an additional CO_2 per year in relation to energy which would need to be sourced from the grid. Based on the current (2020-2021) CEA grid factor[95] the total offset (existing plant + grid savings) will be 333,437.5 tons per year if all existing plant units were operational such that the balance of 57.4 MW was sourced from the grid. The total offset would be greater if fewer existing plant units were in operation, due to the grid factor reflecting India's current energy mix. It would be 345,999.2 tons per year if the full 115.04 MW had to be sourced from the grid.[96]

Table 5-7: GHG Offset from Decommissioning Existing Plant

	Item Description	Unit	Value				Source
1	**Greenhouse Gas Emissions from Proposed Plant**						
a	**Total Green House Gas Emissions from Proposed Plant**	**tCO2/year**	**330,704.90**				**Refer Table 5-6**
2	**Baseline Greenhouse Gas Emissions**		Existing plant 3 units	Existing plant 2 units (2027)	Existing plant 1 unit (2031)	No existing plant (2038)	
a	Capacity of Existing Open Cycle Project in Rokhia	MW	63	42	21	0	TPGL 3 units to operate when EC for existing plant is received
b		hours/year	8760				
c	Plant Load	%	85				TPGL
d	Annual energy generated (a x b x c)	MWhrs/year	469,098	312,732	156,366	0	
e	Plant Efficiency	%	26.46				TPGL
f	Fuel Consumption (Mf) (d x 3.6 x e)	GJ/year	6,381,914	4,254,609	2,127,305	0	Calculation
g	**Fuel emission factor**	**tCO2/GJ**	**0.0561**				ADB Methodology
h	CO_2 emission (f x g)	tCO2/year	358,025.41	238,683.61	119,341.80	0	

[95] https://cea.nic.in/cdm-co2-baseline-database/?lang=en

[96] In 2038 the 25-year lifespan of the third and final of the existing plant units would be reached requiring it to be decommissioned, thus at this point the existing plant can no longer be counted as part of the annual offset post-2038

	Item Description	Unit	Value				Source
3	**Offset from Exiting Plant (1a-2h)**	**tCO2/year**	**-27320.51**	**92021.29**	**211363.10**	**0**	
4	**Grid Offset**						
a	Balance from Grid (115.04-2a)	MW	52.04	73.04	94.04	115.04	
b	Grid Emission Factor	tCO2/MWh	0.79				CEA
c	Grid CO_2 emission (a x b)	tCO2/year	306,116.97	429,646.11	553,175.25	676,704.39	
d	**Total CO_2 Emission Existing Plant plus Grid (2h+4c)**	**tCO2/year**	664,142.39	668,329.72	672,517.06	676,704.39	
5	**Total Offset (1a-4d)**	**tCO2/year**	**-333,437.5**	**-337,624.8**	**-341,812.2**	**-345,999.2**	

Source: ADB TA Consultants

366. GHG emissions will also be associated with the use of SF6 in switchgear. SF6 is a non-toxic but potent greenhouse gas with a long atmospheric lifetime contributing to climate change. 1kg has a global warming potential of 22,800 CO2e. Although research is ongoing the power industry has yet to develop a widely accepted alternative to SF6. SF6 emissions to atmosphere will only result from leaks and inappropriate handling of end-of-life equipment, in the context of global emissions climate change impacts due to the SF6 use are anticipated to be of low magnitude and **Not Significant**.

1.3. Mitigation

367. Since the GHG emissions are >100,000 tCO2/y TPGL will maintain a GHG inventory during construction and operation. Since the CEA grid factor will improve over time as India becomes less dependent on coal and increases its renewable energy capacity – the lifespan of the existing plant and improvements in the grid factor will need to be factored in to annual offset calculations during operation.

368. Having pre-determined the fuel source and efficiency of the power plant there are few options for mitigation of construction and operation GHG emissions thus residual impacts will remain **Significant.** However, the following mitigation can be adopted by the EPC Contractor and TPGL respectively as follows:

(i) Detailed design to maximise the energy efficiency of the proposed plant at site conditions with air-cooled condenser, aiming to achieve the upper limit of 51.14%-53.86%.

(ii) Take a life-cycle approach to detailed design, considering the use of construction materials and the energy and water efficiency of buildings during operation adopting the "green building" concept e.g., using natural ventilation for reducing the need for air conditioners.

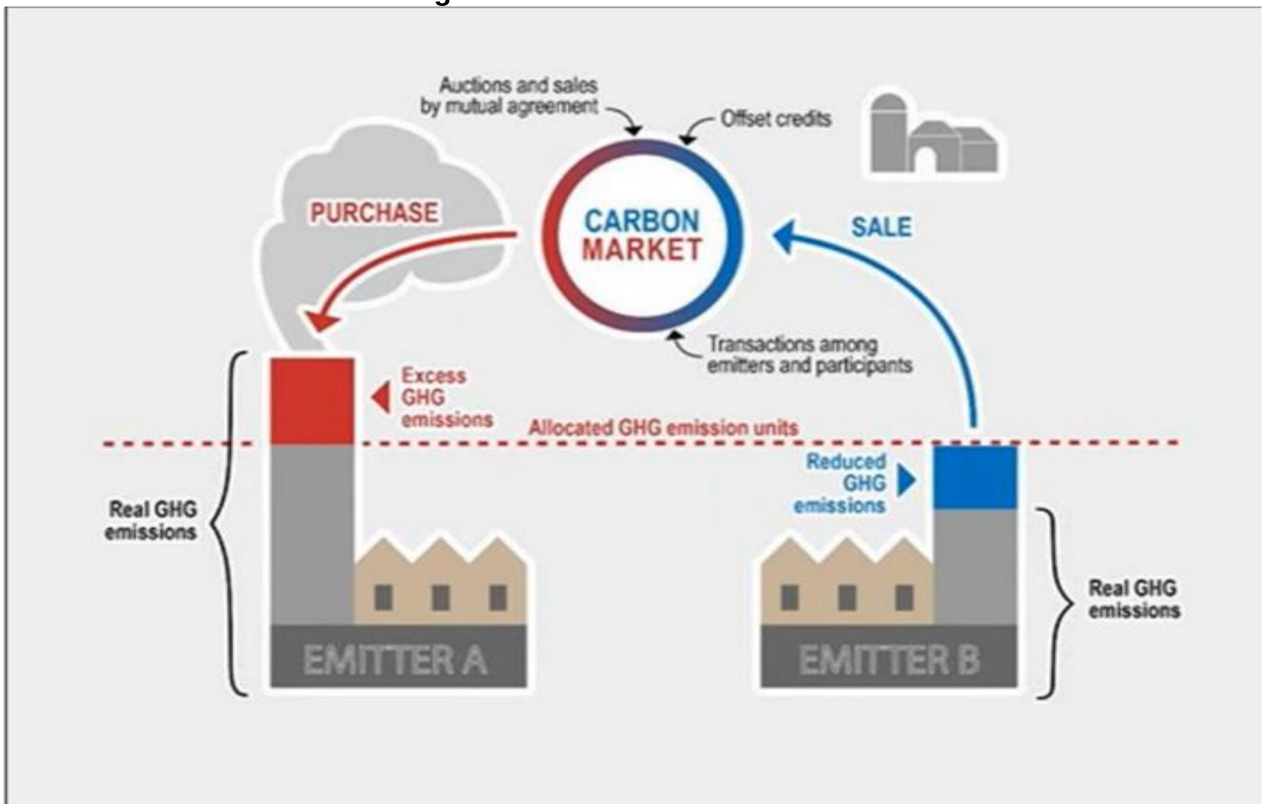
(iii) Use of energy efficient lighting systems (LEDs)
(iv) Minimize tree cutting as far as practicable and maintain green belt trees during operation.
(v) Use locally sourced materials to reduce transportation.
(vi) Use of modern and well-maintained plant, equipment, and construction vehicles during construction work – any vehicles used must have Pollution Under Control (PUC) permits, be of the latest engine emission design (BS-IV/VI) and be maintained to a good standard in accordance with the manufacturer's specifications.
(vii) Installation of modern leak detection and monitoring system on the gas pipeline from the GCS to the proposed plant and maintain the gas pipeline in good condition during operation.
(viii) Maintain power plant equipment in good condition in accordance with the manufacturer's specifications to maintain efficiency.
(ix) Use switchgear that has been tested and guaranteed by the supplier at less than 0.1% leakage rate with leak detection equipment installed, and adoption of good SF6 management during operation.
(x) During maintenance or decommissioning as part of the ESMS a safe SF6 retrieval arrangement will be defined by TPGL, with appropriate handling, storage, disposal process for end-of-life equipment by a certified industrial waste management company who will need to remove SF6 and treat the equipment prior to disposal in accordance international good practice e.g., International Electrotechnical Commission (IEC) standard 61634 to ensure that the SF6 is not released to atmosphere.

369. Decommissioning of the existing plant will offset GHG emissions in the short term, fully in 2027 and then to varying degrees as units reach the end of their lifespan, other offsets options considered by TPGL are:

(i) Reforestation, 2,490 trees will be planted as biodiversity offset but this will have minimal impact in terms of offsetting the GHG emissions and TPGL would need to purchase a commercial market-based nature-based solution offset on an annual basis; this is economically feasible and at current rates of $5 to $15 per ton of CO_2 could cost up to $4 million per year.
(ii) Renewable energy (RE) generation: there is limited space (about 0.5 ha) at the project site for installation of RE however roof top solar system can be installed (later, separate to the ADB funded project) on all buildings to offset some GHG emissions. Further, TPGL has plans to install a solar power system in the existing plant area after its decommissioning which will further help India meet its NDC targets.
(iii) Carbon capture and storage; this is feasible for natural gas but as the focus to date has been on coal there are few examples where it has been proven at scale for natural gas thus it is not currently technically feasible for TPGL to adopt. However, the proposed plant should be designed so CCS can be retrofitted later years if India tightens its NDC targets.

370. Longer term, as the existing plant units reach the end of their lifespan, and Indian grid efficiency improves using a commercial market-based, a nature-based solution mechanism to offset these GHG emissions is an economically feasible option. This will be taken up by TPGL in future years to enable the proposed plant to fully offset its GHG emissions when the Indian grid factor has been much improved, and/or India tightens its NDC targets for net zero to be achieved.

Figure 5-3: GHG Offset Process



Source: cecinc.com https://www.cecinc.com/blog/2019/05/09/pa-greenhouse-gas-cap-and-trade-program-gets-a-green-light/

2. Ambient air quality

2.1. Construction including demolition

371. Construction works will give rise to a potential risk of dust impacts during demolition, site clearance, earthworks, foundation construction, erection, as well as from trackout of dust and dirt by vehicles onto the public highway. Consequently, an assessment of the dust risk has been made and mitigation measures identified using guidance developed by the United Kingdom Institute of Air Quality Management (IAQM).[97] The detailed methodology and guideline used for the assessment are provided as **Annexure 19**. Step 1 of the assessment procedure is to screen the need for a detailed assessment. There are receptors within the distances set out in the

[97] IAQM, 2016, Guidance on the assessment of dust from demolition and construction

guidance and, therefore, a detailed assessment is required. The following section sets out Step 2 of the assessment procedure.

2.1.1. Potential dust emission magnitude

372. **Demolition.** There will be a requirement to demolish two mid-sized building ($370m^2$ x 6m and $190m^2$ x 6m) and one small staff quarter ($85m^2$ x 6m). For demolition, based on the example definitions set out in **Annexure 19** Table A19-1, although the total building volume to be demolished is much less than 20,000 m^2, the construction material is dusty (concrete and brick), thus the dust emission class for demolition is conservatively taken as medium.

373. **Earthworks.** The characteristics of the soil at the project site have been defined using information provided by the ENVIS Centre. Soils within Tripura consist predominantly of alluvial deposits, sand, and loam. Soil in the area is anticipated to be deep. Overall, it is considered that, when dry, this soil has the potential to be moderately dusty. The disturbed areas including storage areas and staff accommodation outside the project footprint ($45,000m^2$) covers some $60,000m^2$ and a large proportion of this will be subject to earthworks, involving excavation of large amounts of material for levelling of two hillocks. Dust will arise mainly from vehicles travelling over unpaved ground and from the handling of dusty materials (such as dry soil). Based on the example definitions set out in **Annexure 19**, Table A19-2, the dust emission class for earthworks is taken as large.

374. **Construction.** Construction will involve predominantly metal structures, but some concrete buildings will be required. Furthermore, concrete is likely to be used to form the foundations for the proposed plant. Dust will arise from vehicles travelling over unpaved ground, the handling and storage of dusty materials, on-site concrete batching and from the cutting of concrete. Based on the example definitions set out in Table 5-5, the dust emission class for construction is taken as large.

375. **Trackout**. The number of heavy vehicles accessing the project site, which may track out dust and dirt, is currently unknown, but given the size of the proposed plant it has been assumed as a conservative basis for the dust assessment only that there could be over 50 outward heavy vehicle movements per day during peak construction. Based on the example definitions set out in Table A19-2, the dust emission class for trackout is taken as large.

376. Table 5-8 summarizes the dust emission magnitude for the different activities of constructing the proposed plant.

Table 5-8: Summary of Dust Emission Magnitude

Source	Dust Emission Magnitude
Demolition	Medium
Earthworks	Large
Construction	Large
Trackout	Large

Source: ADB TA Consultant

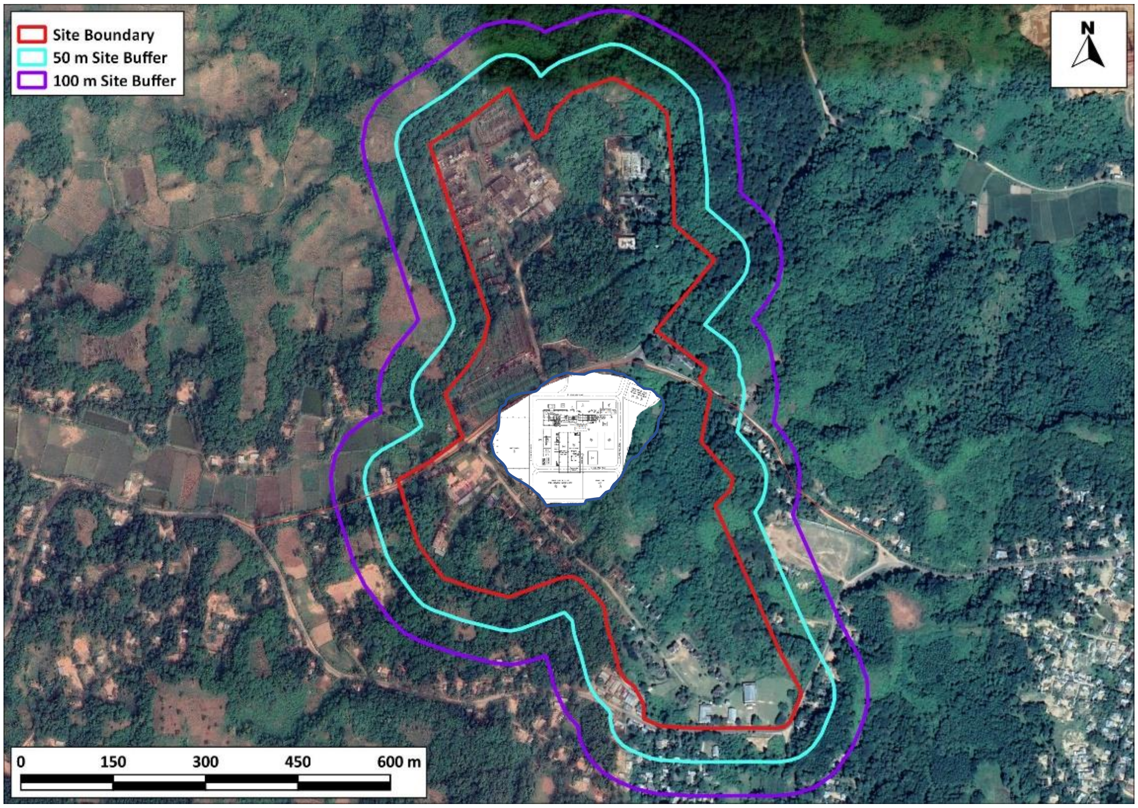
2.1.2. Sensitivity of the area

377. This assessment step combines the sensitivity of individual receptors to dust effects with the number of receptors in the assessment area and their proximity to the project site. It also

considers additional site-specific factors such as topography and screening, and in the case of sensitivity to human health effects, baseline PM_{10} concentrations.

378. The IAQM guidance explains that residential properties are 'high' sensitivity receptors to dust soiling, while schools are also a 'high' sensitivity receptor (**Annexure 19**, Table A19-3). Residential properties are also classified as being of 'high' sensitivity to human health effects, while places of work are classified as being of 'medium' sensitivity. The proposed plant is planned within the Rokhia Thermal Power Station, adjacent to the existing plant. There are approximately 10 residential properties starting at 55 m from the project site's east boundary and the nearest school is located at 375m from project site (Figure 5-4).

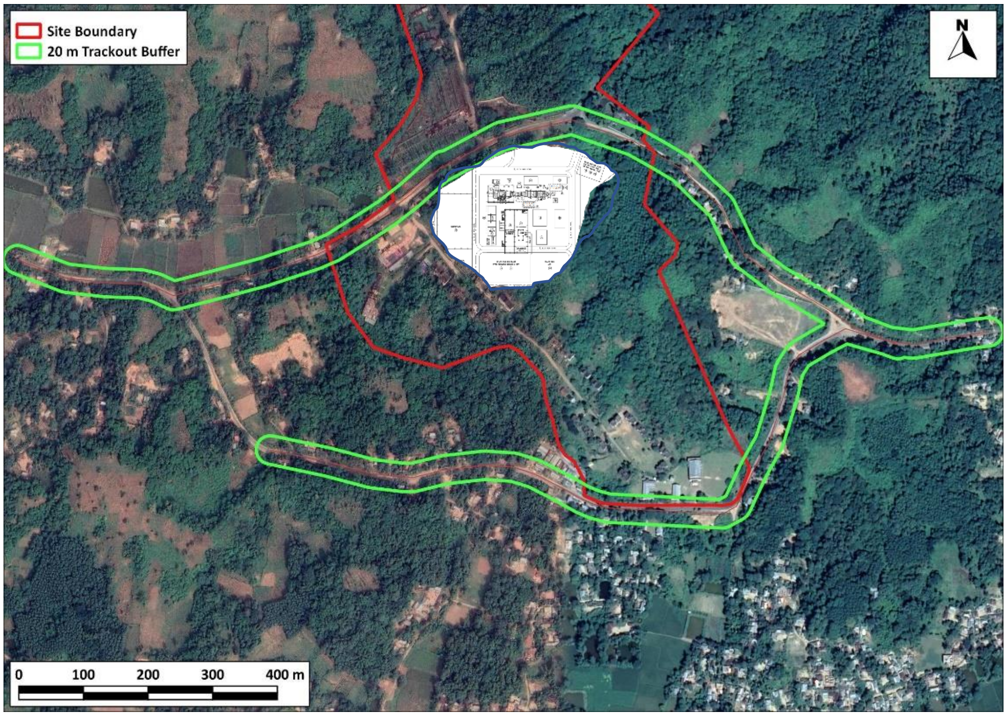
Figure 5-4: 50 m and 100 m Distance Bands around Rokhia Thermal Power Station and the Project Site (in white)



Source: ADB TA Consultant

379. Table 5-8 shows that the dust emission magnitude for trackout is large and **Annexure 19,** Table A19-4 explains that there is a risk of material being tracked 500 m from the project site exit. The construction vehicles will use the Bisalgarh-Boxarnagar road (as per Chapters 2 and 6) to and from the project site, it has been assumed that all possible access routes including this road could be affected. There are approximately 30 residential properties within 20 m of the access roads along which material could be tracked (Figure 5-5).

Figure 5-5: 20 m Trackout Distance Bands



Source: ADB TA Consultant

380. *Sensitivity of the area to effects from dust soiling*. Using the information set out in Figure 5-3 alongside the matrix set out in **Annexure 19**, Table A19-4, the area surrounding the works is of 'medium' sensitivity to dust soiling. Using the information set out in Figure 5-4 alongside the same matrix, the area is of 'high' sensitivity to dust soiling due to trackout.

381. *Sensitivity of the area to human health effects.* The matrix in **Annexure 19,** Table A19-5 requires information on the baseline annual mean PM_{10} concentration in the study area. Baseline monitoring has indicated that PM_{10} concentrations just after the monsoon season, i.e., a period of the year when ambient concentrations may be expected to be at their lowest because of less dry soil conditions, exceeded the 32 µg/m^3 threshold in the IAQM guidance. In other seasons, daily mean PM_{10} concentrations were found to exceed 100 µg/m^3. Due to the use of some unpaved roads and high level of soil erosion in the study area, it is likely that the annual mean baseline PM_{10} concentrations will exceed 32 µg/m^3 at all receptors in the study area. Using the information set out in the IAQM guidance, the area surrounding the project site is of 'high' sensitivity to human health effects. The area surrounding roads along which material may be tracked from the project site is also of 'high' sensitivity.

382. *Sensitivity of the area to ecological effects.* The guidance only considers designated ecological sites within 50 m to have the potential to be impacted by the construction works. There are no designated ecological sites within 50 m of the project site boundary or those access roads along which material may be tracked. Therefore, there is no requirement to consider ecological impacts related to construction dust.

383. *Summary of area sensitivity.* Table 5-9 summarizes the sensitivity of the area around the proposed plant construction.

Table 5-9: Summary of Area Sensitivity

Effects Associated With:	Sensitivity of the Surrounding Area	
	On-site Works	Trackout
Dust Soiling	Medium Sensitivity	High Sensitivity
Human Health	High Sensitivity	High Sensitivity
Ecological	None	None

Source: ADB TA Consultant

2.1.3. Risk and Significance of Effects

384. The dust emission magnitude in Table 5-8 has been combined with the sensitivity of the area in Table 5-9 using the matrix in **Annexure 19,** Table A19-5 to assign a risk category to each activity. The resulting risk categories for the four construction activities, without mitigation, are set out in Table 5-10. These risk categories have been used to determine the appropriate level of mitigation set out in Table 5-11 (step 3 of the assessment procedure).

Table 5-10: Summary of Dust Risk

Source	Dust Soiling	Human Health
Demolition	Medium Risk	High Risk
Earthworks	Medium Risk	High Risk
Construction	Medium Risk	High Risk
Trackout	High Risk	High Risk

Source: ADB TA Consultant

385. The IAQM guidance does not provide a method for assessing the significance of effects before mitigation and advises that pre-mitigation significance should not be determined. With the appropriate mitigation defined in Table 5-11 in place, the IAQM guidance is clear that the residual effect will normally be **Not Significant**.

2.2. Mitigation for Construction including Demolition

386. The CEMP to prepared by the EPC contractors before construction commences will incorporate mitigation measures for dust elaborating on those included in the EIA/EMP. The mitigation measures in Table 5-11 reflect the recommendations of the IAQM guidance for the specific level of risk identified in Table 5-10. Implementation of all measures identified as 'mandatory' will be required to ensure dust effects are not significant.

387. During construction, quantitative monitoring of ambient air quality will be undertaken as prescribed in the EMoP in **Annexure 30.**

Table 5-11: Mitigation Measures for Construction Dust

Measure	Recommended	Mandatory
Communications		
Develop and implement a stakeholder communications plan that includes community engagement before and during work on site		✓
Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary – the EPC Contractor's GRM Focal		✓
Display the TPGL GRM Focal's name and contact details		✓

Measure	Recommended	Mandatory
Dust Management Plan		
Develop and implement a Dust Management Plan (DMP) approved which documents the mitigation measures to be applied, and the procedures for their implementation and management		✓
Site Management		
Record all dust and air quality complaints in the GRM register, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken		✓
Make the GRM register available when asked		✓
Record any exceptional incidents that cause dust and/or air emissions, either on- or off- site, and the action taken to resolve the situation in a logbook		✓
If applicable, hold regular liaison meetings with other high risk construction sites within 500 m of the site boundary (e.g., works at gas fields) to ensure plans are coordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes		✓
Monitoring		
Undertake daily on-site and off-site inspections of nearby receptors (including roads) to monitor dust. Record inspection results and make the log available to regulatory authorities/ADB when asked. This should include regular dust soiling checks of surfaces such as street infrastructure, cars and windows within 100 m of the site boundary, with cleaning to be provided if necessary		✓
Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to regulatory authorities/ADB when asked		✓
Increase the frequency of site inspections by the EPC contractor and TPGL safeguard staff on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions		✓
Agree dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations (EMoP). Where possible, commence baseline monitoring at least three months before work on the earthworks phase commences.		✓
Preparing and Maintaining the Site		
Plan the site layout so that machinery and dust-causing activities are located away from receptors, as far as is possible		✓
Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site		✓
Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period		✓
Avoid site runoff of water or mud		✓

Measure	Recommended	Mandatory
Keep site fencing, barriers and scaffolding clean using wet methods where a suitable supply of water is available		✓
Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below		✓
Cover, seed, or fence stockpiles to prevent wind whipping		✓
Operating Vehicle/Machinery and Sustainable Travel		
Ensure all vehicles switch off their engines when stationary – no idling vehicles		✓
Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery-powered equipment where practicable		✓
Impose and signpost a maximum-speed-limit of 25 kmph or less on surfaced and 15 kmph or less on un-surfaced internal access roads and work areas, (on off-site access roads, beyond 500m these speeds may be increased on surfaced roads with suitable additional control measures provided)		✓
Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials		✓
Implement a Travel Plan that supports and encourages sustainable staff travel (e.g., cycling, walking, employer provided buses and ride-sharing)		✓
Construction Operations		
Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems		✓
Where water supplies allow, use water for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate		✓
Use enclosed chutes, conveyors and covered skips		✓
Minimize drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate		✓
Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods		✓
Waste Management		
Avoid bonfires and burning of waste materials		✓
Measures Specific to Demolition		
Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust)		✓
Where water supplies allow, ensure effective water suppression is used during demolition operations. Hand held sprays are more effective		✓

Measure	Recommended	Mandatory
than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground		
Avoid explosive blasting, using appropriate manual or mechanical alternatives		✓
Bag and remove any biological debris or damp down such material before demolition		✓
Measures Specific to Earthworks		
Re-vegetate earthworks and exposed areas/soil stockpiles to stabilize surfaces as soon as practicable		✓
Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable		✓
Only remove the vegetation cover from small areas during work, not all at once		✓
Measures Specific to Construction		
Avoid scabbling (roughening of concrete surfaces), if possible		✓
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place		✓
Ensure any bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery		✓
Ensure any concrete batching plant is located away from the site boundary		✓
For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust	✓	
Measures Specific to Trackout		
Avoid dry sweeping of large areas		✓
Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport		✓
Access gates should be located at least 10 m from receptors		✓
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable)		✓
Ensure there is an adequate area of hard surface between the wheel wash facility and site exit, wherever the site size and layout permits		✓

Source: ADB TA Consultant

3. Operation

388. The proposed plant will comprise an advanced class Gas Turbine Generator, three pressure Heat Recovery Steam Generator, Steam Turbine Generator, and auxiliary plant. Natural gas will be used as the fuel source. The estimated consumption of fuel (annual average) will be in the order of 0.58 MMSCMD. The pollutants of concern released from the proposed plant will include oxides of nitrogen (NO_x) and carbon monoxide (CO). With the use of natural gas, PM emissions are not a concern as natural gas does not have any ash content responsible for generating PM_{10} and $PM_{2.5}$. Additionally, the sulphur content of natural gas is negligible and, consequently, SO_2 will not be emitted. Volatile Organic Compounds (VOCs) can be emitted during combustion, either as unburnt hydrocarbons from the fuel, as combustion products, or as fugitive emissions from leaks in pipelines/valves etc. The main VOC component of natural gas is methane and this would be the primary VOC in the emission from the plant. Methane is not associated with human health impacts and consequently, VOC emissions have not been considered further. Emissions, in any case, are expected to be negligible due to the automated systems that will be in place to monitor and control the combustion process, ensuring combustion is optimized at all times. Emissions from the emergency gas engine and diesel generator have been scoped out from further detailed assessment. They would only ever be used in an emergency scenario to allow the safe shutdown of the plant and would represent an infrequent, very short-term source of emissions.[98]

389. The primary pollutants for further assessment are therefore NOx and CO emissions, which may cause significant impacts if not monitored and controlled efficiently. Baseline ambient air quality monitoring undertaken (Chapter 4) shows that the levels of NO_2 (the component of NOx associated with health effects) and CO are within GoI standards but ambient NO_2 concentrations exceeds the recently introduced WHO 2021 guidelines. The air quality impacts of these emissions during operation have been assessed in a quantitative manner following WB-IFC EHS Guidelines and based on available information. To evaluate the impact of air emissions from operation of the proposed plant on the study area, air quality modelling was conducted. The air quality assessment also considers the impact on the baseline, and whether replacing the existing plant with the proposed plant will beneficial or adverse. To enable this comparison, modelling of the existing plant was also conducted. The study also comprised a stack height assessment to identify the ideal stack height for the proposed plant for optimal dispersal. The details of the modelling and the results are discussed in the following sections.

3.1. Air quality modelling

390. The air dispersion model provides an assessment of the potential effects of the proposed plant on local air quality. This assessment has been conducted in accordance with GoI national requirements, IFC EHS Guidelines for Thermal Power 2008 and the IFC General EHS Guidelines for Air Emissions and Ambient Air Quality and addresses the operational impacts resulting from emissions to air from the proposed plant. The assessment has been undertaken based on the layout, design, technology and process as described in Chapter II, the TPGL DRP and the ambient air quality data provided through MITCON in this EIA.

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[98] The diesel generator may be tested periodically as a safety requirement to demonstrate it can still operate and connect to provide the required emergency load. Typically, this testing may involve no more than 1 hour run every month. From an air quality perspective, testing of up to 1 hour per month would be less than 20 hours of operation in a year. This is below a commonly applied threshold used by the UK Environment Agency for determining whether a detailed assessment of emissions to air is required. Consequently, emissions to air from the limited use of the generator have been scoped out of the assessment.

3.2. Modeling framework

391. The Gaussian Dispersion Modelling (GDM) is used for prediction of dispersion of air emissions and the computation of Ground Level Concentration (GLC) up to a specified distance from source. The fundamental model is given below:

$$c\left(x,y,z\right)=\frac{Q}{2\pi\sigma_y\sigma_z u}\exp\left(\frac{-y^2}{2\sigma_y{}^2}\right)\left(\exp\left(\frac{-\left(z-h\right)^2}{2\sigma_z{}^2}\right)+\exp\left(\frac{-\left(z+h\right)^2}{2\sigma_z{}^2}\right)\right),$$

392. Where c is a concentration at a given position, Q is the source term, x is the downwind, y is the crosswind and z is the vertical direction and u is the wind speed at the h height of the release. The σ_y, σ_z deviations describe the crosswind and vertical mixing of the pollutant. The model describes a mixing process that results in a Gaussian concentration distribution both in crosswind and in vertical direction, centered at the line downwind from the source. Gravitational settling and chemical or radioactive decays are neglected. The model computes the pollutant concentration dispersed in microgram per cubic meter (ug/m^3) for any point source with the location coordinate x, y and z.

393. **Ambient Air Standards/Guidelines**: Ambient air quality standards and guidelines are developed with the primary aim to provide a basis for protecting public health from the adverse effects of air pollution and for eliminating, or reducing to a minimum, those pollutants in air that are known or likely to be hazardous to human health and wellbeing. GoI has developed a system of ambient air quality standards applicable to all regions across the country and are referred to as the National Ambient Air Quality Standards 2009 (NAAQS). The NAAQS define the amount of pollutant in ambient air which will prevent an impact on human health or the environment because of direct contact or exposure. The World Health Organization also provides global air quality guidelines for certain air pollutants, including PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2. These guidelines are intended to support actions for air quality at the optimal achievable level for public health protection in different contexts. The WHO does not formally prescribe how guidelines should be used in air quality management, but they are often adopted by countries outright or are modified to reflect the countries' national requirements as legislated through national ambient air quality standards. Interim targets have been provided by the WHO in recognition of the need for a staged approach to achieving the recommended guidelines. As recognized international guidance, the WHO ambient air quality guidelines need to be considered in assessing the impacts of the emissions from the proposed plant. The WHO originally introduced global air quality guidelines in 2005. However, it recently released an update to its global guidelines in 2021 which, for certain pollutants, included revised guidelines or different averaging periods. However, some guidelines and averaging periods were not altered and remain consistent with those introduced in 2005 e.g., the hourly mean guideline for NO_2.[99] The GoI NAAQS and WHO air quality guidelines are set out in Table 5-12. In accordance with IFC and ADB guidance, the more stringent guidelines have been assessed against.

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[99] WHO 2005 ambient air quality guidelines are reflected in the World Bank Group Environmental, Health and Safety General Guidelines (WGB, 2007) but have since been updated. For purposes of the assessment both the 2006 and 2021 guidelines have been reflected.

Table 5-12: Air Quality Assessment Standards/Guidelines

Criteria Pollutants	Averaging period	GoI Standards		WB-IFC EHS Guideline WHO 2005	WHO 2021	Assessment Criteria Used
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Areas (notified by Central Government)			
NO_2	1 hour	-	200 µg/m^3	-	200 µg/m^3	200 µg/m^3
	24 hour	80 µg/m^3	-	25 µg/m^3	25 µg/m^3	25 µg/m^3
	Annual	40 µg/m^3	40 µg/m^3	10 µg/m^3	10 µg/m^3	10 µg/m^3
CO	1 hour	-	35 mg/m^3	-	35 mg/m^3	35 mg/m^3
	8 hour	2 mg/m^3	10 mg/m^3	-	2 mg/m^3	2 mg/m^3
	24 hour	-	-	4 mg/m^3	4 mg/m^3	4 mg/m^3

Source: Table compiled from CPCB National Ambient Air Quality Standards, WB/IFC EHS Guidelines for Air Emissions and Air Quality, and the 2021 WHO Global Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide

394. **Emission standards and other design considerations:** GoI industry specific emissions standards are prescribed via Maximum Permissible Limits of Central Pollution Control Boards (CPCB).[100] Relevant WB-IFC guidelines for emissions to air applicable for the proposed plant are presented in the WB-IFC EHS Guidelines for Thermal Power Plants. The EHS Guidelines advise that, with respect to emission limits, where the host country regulations differ from the levels presented, projects are expected to achieve whichever is more stringent as does ADB's Safeguard Policy Statement (Table 5-10). The WB-IFC EHS Guideline emission limits distinguish between degraded (i.e., polluted) and non-degraded airsheds. However, for natural gas combustion turbines the emission limits are the same for both degraded airsheds (DAs) and non-degraded airsheds (NDAs). The proposed plant will meet the WB-IFC Emission Guidelines for NO_X of 25 ppm.

395. The ADB SPS 2009 has the principle to "*apply pollution prevention and control technologies consistent with international good practices as reflected in internationally recognized standards such as the WB/IFC EHS Guidelines*". The policy statement requires that if host countries standards differ from values set out within such documents a project is expected to achieve the most stringent. The policy statement requires that "*when the project has the potential to constitute a significant source of emissions in an already degraded airshed, strategies that help improve ambient conditions, such as evaluating alternative project locations and considering emissions offsets, will be introduced*". The general approach of the WBG/IFC EHS General Guidelines is to prevent or minimize impacts so that: "*Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources*; *Emissions do not contribute a significant*

[100] CPCB. 2000. Emission standards for ambient air, automobiles, fuels, industries and noise

portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed." (WBG, 2007).[101] For facilities or projects located within degraded airsheds (an airshed is considered as having degraded if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded), and within or next to areas established as ecologically sensitive (e.g. national parks), the WB/IFC EHS Guidelines clarifies that any increase in pollution levels should be as small as feasible, and amount to a fraction of the applicable short-term and annual average air quality guidelines, or standards, as established in the project-specific environmental assessment.

Table 5-13: NOx Emission Standards for Gas-based Power Plants

Pollutant	**IFC Guideline, 2008**	**GoI Standard, 2000**	**Emission Standard Used in Assessment**
	Natural Gas (Unit ≥ 50MWth)	**Natural gas/naphtha (Unit ≥ 100 MW - < 400 MW**	
	Non-Degraded Airshed (NDA) and Degraded Airshed (DA)		
NO_X	25ppm (51 mg/Nm^3)	75ppm	25 ppm (51.3 mg/Nm^3)
CO	-	-	8 ppm (10 mg/Nm^3)*
Excess Dry Gas O_2 Content of 15%vol * Emission standards are not prescribed for CO in the GOI or WB / IFC Guidelines. In the absence of an applicable standard, manufacturer supplied emissions data has been used for the proposed turbines, whilst an emission concentration of 40 mg/Nm3 has been assumed for the existing turbines based on typical data in the EU BAT Reference Document for Large Combustion Plants			

Source: Table derived from CPCB Environmental Standards for Gas/Naphtha Based Thermal Power Plants and WB/IFC EHS Guidelines for Thermal Power Plants

3.3. Inputs and model run

396. The Project will be designed to operate continuously throughout the year. During combined cycle operation, the heat of exhaust gas will be admitted to the HRSG where superheated steam will be produced which will then drive the steam turbine to generate additional electrical power. Use of the HRSG will not result in additional contaminants in the stack emissions as it operates to recover heat only without supplementary firing. During certain periods of the year, e.g., to allow maintenance on the HRSG, the HRSG can be bypassed with emissions from the gas turbine discharged through a bypass stack. Both normal and bypass operation have been considered in this assessment. The GDM formed the basic framework of the software used for the computations of concentration of air pollutants at ground level for this assessment. The model makes certain assumptions such as:

(i) Steady State Condition - ideal gas, continuous uniform emission rate, homogenous horizontal wind field, representative wind velocity, no directional wind shear in the vertical, infinite plume, no plume history and normal distribution of eddy turbulences.

(ii) Pollutant Characteristics - the pollutants emitted are stable gases or particulates which remain suspended in the air and turbulent movement of the atmosphere.

[101] https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdf

None of the material is removed as the plume advances and diffuses down wind and there is complete reflection at the ground.

(iii) Gaussian distribution - the pollutant material within the plume takes on a Gaussian distribution in both the horizontal cross wind and vertical directions described by empirical dispersion parameters σ_y, and σ_z. However, as an advanced Gaussian model, the model that has been used in the assessment is able to account for the heterogeneous nature of the vertical velocity distribution in convective conditions by applying a skewed Gaussian distribution to vertical dispersion during such conditions.

(iv) It has been assumed that the pollutants do not undergo any transformations.

(v) Gravitational settling of pollutants has not been considered.

(vi) Reflection factor from any surface has not been considered.

397. US EPA AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model) based software, AERMOD Cloud Ver 18 (2021) was used for the predictive modelling of emission from the proposed plant. The software uses the Briggs Plume Rise equations for effective plume height, while boundary layer parameterization techniques are used to determine the values of horizontal and vertical dispersion coefficient i.e., σy, and σz. AERMOD is considered an advanced dispersion model because of the way it characterises the atmosphere. AERMOD is designed to treat both surface and elevated emission sources in simple and complex terrain. Special features of AERMOD include its ability to treat the vertical heterogeneity nature of the planetary boundary layer, special treatment of surface releases, irregularly shaped area sources and limitation of vertical mixing in the stable boundary layer. AERMOD is a modelling system with three separate components, and these are as follows:

(i) AERMOD (AERMIC Dispersion Model) – version 19191

(ii) AERMAP (AERMOD Terrain Pre-processor) – version 18081

(iii) AERMET (AERMOD Meteorological Pre-processor) – version 19191

398. AERMOD is classed by the US EPA as their “preferred model” for regulatory dispersion applications. The model is used and recognized by regulators worldwide, and is acknowledged by IFC’s Environmental, Health, and Safety (EHS) Guidelines as an appropriate tool for predicting potential impacts from air emission sources. The model inputs are discussed in this section.

399. **Study Area**: An impact area of 50 km radius, centered on the proposed plant, was selected for the air quality impact prediction and analysis. For the existing plant, the centre of the plant was used for assessment. The coordinates are given below:

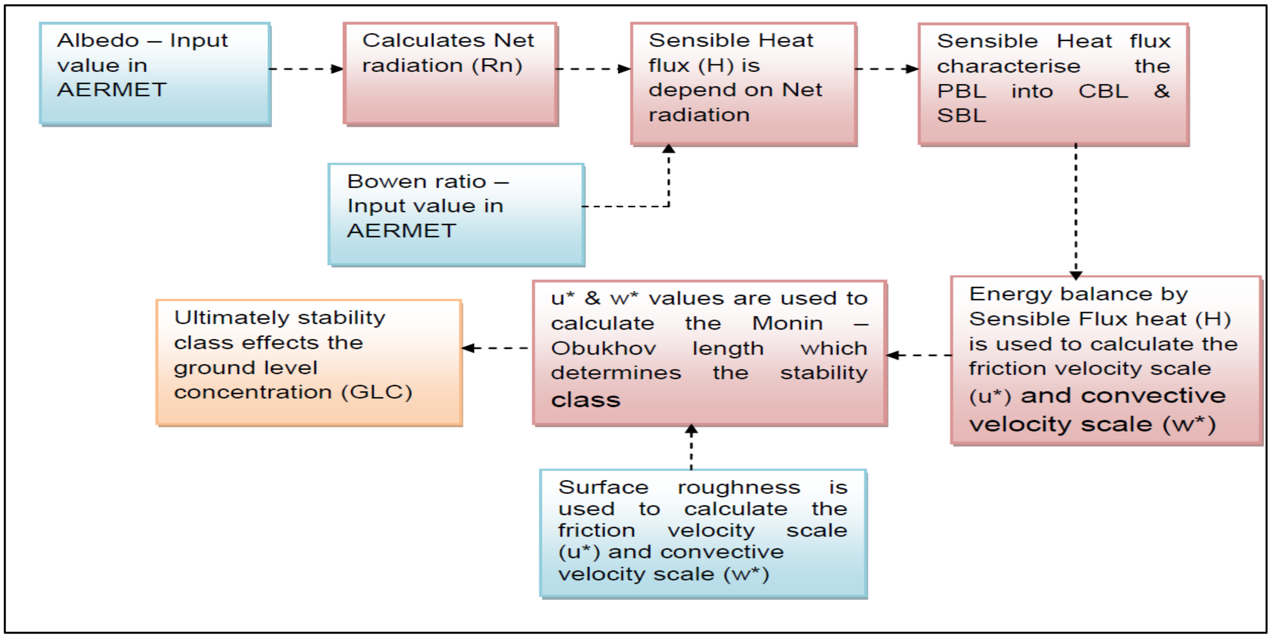
(i) Existing plant central coordinates:
- Q46 315864.03 E 2614000.35N
- Latitude: 23.626155 deg, or 23 deg 37 min 34.158 sec
- Longitude: 91.194998 deg, or 91 deg 11 min 41.993 sec

(ii) Proposed plant central coordinates:
- Q46 316024.21E 2613697.88N
- Latitude: 23.623442 deg, or 23 deg 37 min 24.3912 sec
- Longitude: 91.196605 deg, or 91 deg 11 min 47.778 sec

400. The base map along with terrain data was downloaded within the software system along with the digital elevation model (DEM) data using the coordinates of the plant centers. The presence of elevated terrain can significantly affect (usually increase) ground level concentrations of pollutants emitted from elevated sources, such as stacks, by reducing the distance between the plume centre line and ground level. Conversely, terrain can increase turbulence and plume mixing, which may reduce ground level concentrations. Terrain data has

been included in the dispersion model as the area surrounding the plants can be described as elevated/complex as there are hillocks with gradients greater than 1-10 in and around the project site. Roughness of terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height and the degree of atmospheric turbulence. Surface parameters have been accounted for within the processing of the meteorological data for land use around the meteorological station used in the assessment. The influence of these parameters on the GLC is summarized in Figure 5-6.

Figure 5-6: Impact of Albedo, Bowen Ratio and Surface Roughness on GLC[102]



Source: Dobariya et al. (2016)

401. **Building and layouts**: The movement of air over and around buildings generates areas of recirculating flow, which can lead to increased ground level concentrations in the building wakes. For the proposed plant, the buildings likely to have the dominant effect (i.e., with the greatest dimensions likely to promote turbulence) are the GT Hall, the Steam Turbine Hall/Control Building and the HRSG. The existing plant's main control building has also been incorporated into the building module along with building dimensions and details provided by TPGL and their design consultant. The details of the building considered are provided in Table 5-14 and shown as Figure 5-7.

Table 5-14: Building Details Used for Air Quality Assessment

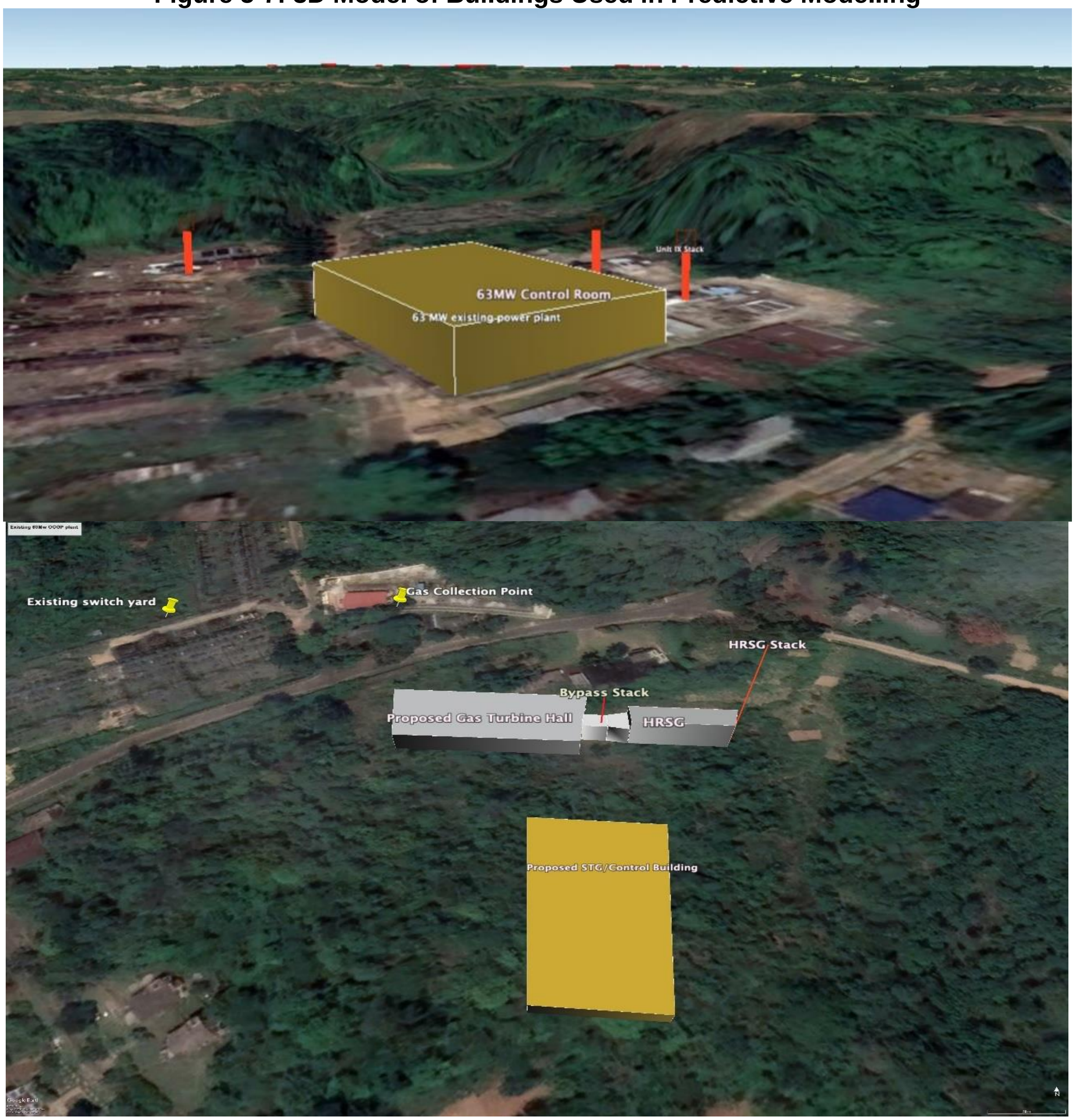
Building	Height	Width	Length
Existing Plant			
Control Room (BULD00)	10m	40m	60m

[102] STUDY OF IMPACT OF SURFACE CHARACTERSTICS ON AMBIENT AIR CONCENTRATION BY USING AERMOD: A REVIEW : 2016

Proposed Plant			
ST Hall/Control Building (BULD01)	10m	45m	75m
Gas Turbine Hall (BULD02)	10m	25m	65m
HRSG (BULD03)	15m	12m	32m

Source: ADB TA Consultant

Figure 5-7: 3D Model of Buildings Used in Predictive Modelling



Source: ADB TA Consultant

402. **Meteorological data**: The AERMET module inside the AERMOD system uses the meteorological data for estimating dispersion across the study area. The most important meteorological parameters governing atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability:

(i) Wind direction determines the sector of the compass into which the plume is dispersed

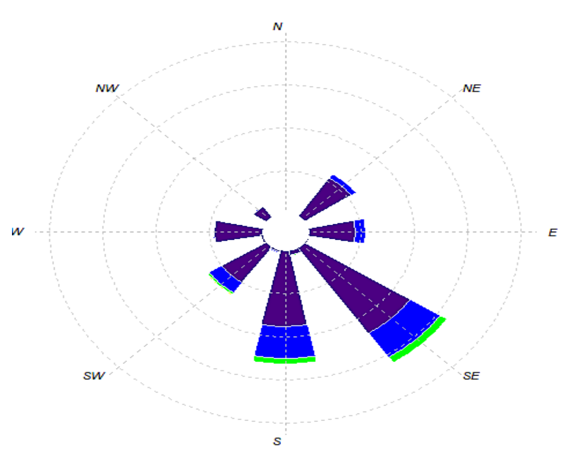
(ii) Wind speed affects the distance which the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

(iii) Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. New generation dispersion models, such as AERMOD, use a parameter known as the Monin-Obukhov length that, together with the boundary layer height, describes the stability of the atmosphere.

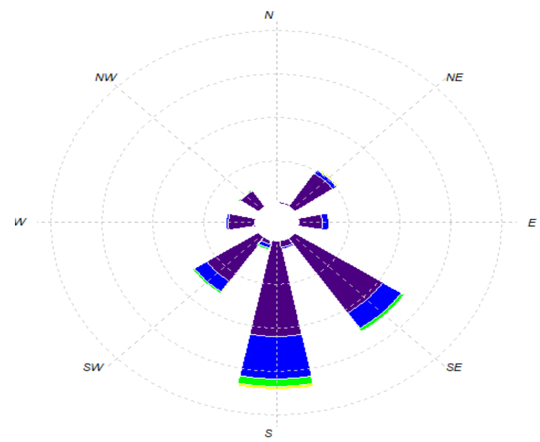
(iv) AERMET pre-processor also requires three site specific land use parameters, albedo, Bowen ratio, and surface roughness length to properly calculate the turbulent dispersion of pollutants. For the modelling, the surface albedo was taken in the range of 0.22 – 1.00 and Bowen Ratio as 1.62. The surface roughness was assumed as 1 m which takes account of the nature of the terrain and heavily vegetated/forested areas in the model domain.

(v) Complete, pre-processed hourly 3D meteorological data of the year 2015 to 2019 was procured by MITCON from the Indian Meteorological Department (IMD) (AERMOD – Ready data, for location Agartala, which is around 29km NNE from the project site). This includes surface and upper atmospheric data which is used in the air dispersion model. The parameters include wind speed, wind direction, cloud cover and temperature and other factors. The hourly primary data for the period October 2020 to June 2021 was also collected by installing a meteorological station inside the existing plant and using automatic equipment. While the data for 2015-2019 were complete and annual, 2020-2021 data were incomplete and not used for modelling. The wind roses illustrate that the predominant wind directions are from the south and south-east. Figure 5-8 presents wind roses for all the monitoring periods.

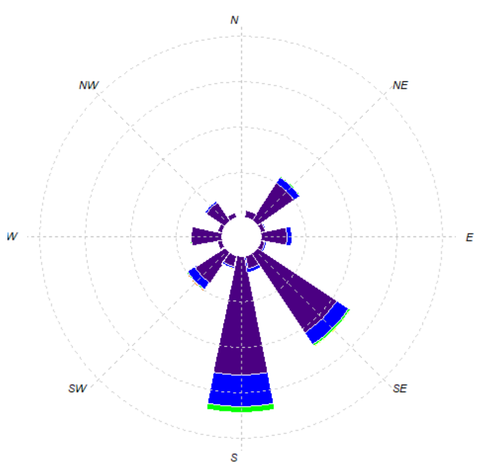
Figure 5-8: Wind Roses for Period 2015-2019 (used in the modelling) and incomplete 2020-2021 data



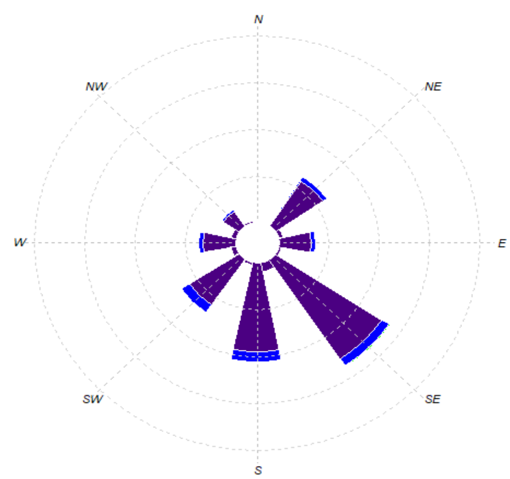
2015



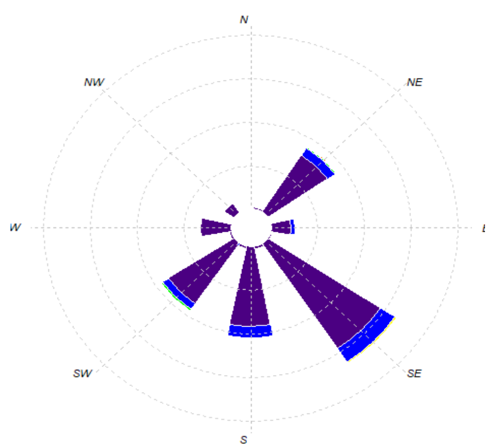
2016

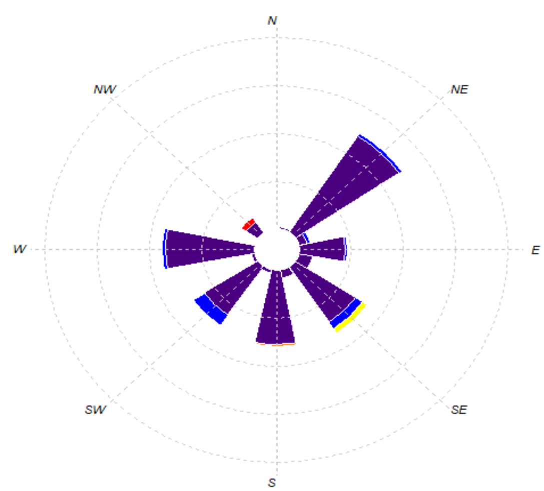


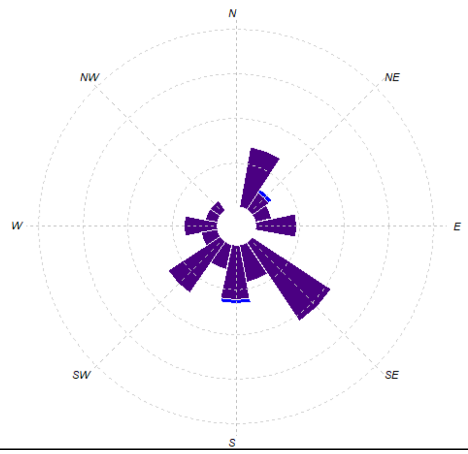
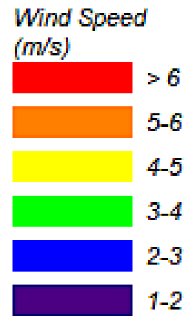
2017



2018





2019	2020
	
2021	Scale

Source: ADB TA Consultant

403. **Stack Height:** The purpose of a stack height determination is to calculate the height necessary to ensure that emissions from a stack do not result in excessive ground level concentrations of air pollutants because of atmospheric downwash, eddies or wakes which may be created by nearby structures or terrain. Nearby structures are normally the dominant cause of any atmospheric downwash, eddies, or wake effects. For proper dispersion to occur it is necessary for the emissions to be released well above the top of nearby structures. Dispersion of emissions from a stack will also be determined by the emission characteristics of the source, particularly their temperature and speed when they exit the stack.

404. Several methods are available to determine an appropriate stack height, including simple equations and dispersion modelling. Keeping in mind the sensitivity of the location and the complex terrain, including hillock and elevated areas ranging from 30m – 49m in the project site, the stack height assessment was completed using dispersion modelling, where modelling for different stack heights was conducted to estimate the appropriate height for both the stacks. In all operating situations, it has been conservatively assumed that the HRSG or bypass stack will discharge emissions equivalent to the plant operating at 100% load for 330 days per year to account for the worst-case short-term impacts. However, it is likely that, at various intervals, individual components or the whole plant will not operate due to periods of shut down (planned or unplanned). The HRSG and bypass stack scenarios have been modelled separately.

405. **Emission data and assumptions**: Stack emission data from DPR and TPGL's design consultants were considered for modeling air emissions from the existing and proposed plant. The proposed stack height used in the predictive modelling was identified based on the stack sensitivity analysis. The results of this are discussed in the model output section. The two proposed stacks have been represented in the modelling and two separate model scenarios were considered, i.e., one scenario with the HRSG stack discharging and a second with the bypass stack operating. The existing plant stacks were modelled separately as a third scenario, as they will not be operational once the proposed plant has been commissioned, thus the impact will not be cumulative. The emissions details used for the assessment are given in Table 5-15.

Table 5-15: Emission data used for modelling

Emission parameters	Proposed Plant		Existing Plant		
	HRSG	Bypass	Stack VII	Stack VIII	Stack IX

Stack co-ordinates (UTM X)	316073	316030	315810	315909	315927
Stack co-ordinates (UTM Y)	2613706	2613710	2614075	2614065	2614041
Stack height (m)	60	30	10	10	10
Stack internal diameter at exit point (m)	7.46	8	7	7	7
Stack discharge temperature (K)	375	906	773	773	773
Stack discharge velocity (m/s)	22	46.2	11.2	11.2	11.2
Stack volumetric flow at STP (Nm^3/s)	897	897	209	209	209
NOx emission concentration (mg/Nm^3)	51.3	51.3	105.6	106.0	105.3
NOx emission rate (g/s)	46.1	46.1	22.1	22.1	22.0
CO emission concentration (mg/Nm^3)	10.0	10.0	40.0	40.0	40.0
CO emission rate (g/s)	9.0	9.0	8.4	8.4	8.4

Source: TPGL/ADB TA Consultant

406. **Receptors:** Two types of receptors are defined within the model domain. These were: A) Radial/Polar Grid Points, and B) Discrete Receptors.

(i) The Radial/Polar grids are nested to capture more precise pollutant concentration in the near field after dispersion. The Radial/Polar receptor network around the plant included 36 directional radials, each representing a 10° quadrant, with a total number of 150 rings extending from the origin. The total number of grid receptor points was 5,400.
The Grid domain includes:
- An area, 50 km x 50 km centred on the proposed plant
- An area, 50 km x 50 km centred on the existing plant

407. In addition, discrete locations corresponding to the ten ambient air quality monitoring stations were included in the assessment. These receptors are in and around the core and buffer up to a radius of 10 km from the project site. Due to the proximity of certain other isolated properties to the site boundary that do not represent the location of these monitoring stations, it is considered more appropriate to estimate impacts at these locations with reference to data obtained from the Radial/Polar grid points (an individual receptor point may not necessarily reflect the highest prediction in these areas due to the large downwind gradient in ground level concentrations in the near field).

408. **Background data:** Ambient air quality monitoring data was conducted by MITCON in the study area for three seasons between October 2020 to June 2021. The air quality monitoring was conducted for ten locations for parameters including NO_2 and CO. 24-hourly averaged samples were collected twice a week at each location. Continuous monitoring data were not recorded. The data provided was not considered sufficient to robustly determine background concentrations in the study area and the protocol was not fully in alignment with the World Bank-IFC EHS Guidelines, although was consistent with GoI guidelines. MITCON started collecting data for 1st season before TA consultants were appointed. Guidance was provided during 2nd and 3rd season, post evaluation, that sampling locations and data may not necessarily be as robust as possible. Since the monitored data was discontinuous, to account for periods where higher concentrations could have occurred but which were not captured by the monitoring, the baseline data was converted using a UK based approach[103] to determine short-term concentrations from longer-term data. Here, the average monitored data from all samples across the three seasons were multiplied by a factor of 2 to derive maximum 1-hour, 8-

[103] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#calculate-pec

hour and 24-hour data to be used for the assessment. This approach also reflects that it is highly unlikely that the maximum short-term contributions from different emissions sources coincide both spatially and temporally. The three season average data was used to represent long-term, annual mean concentrations. Monitored CO data was below detectable levels (BDL) for all monitoring periods. Table 5-16 shows the converted long term background concentration for NO_2.

Table 5-16: NO_2 Background Data Used for Assessment

Site	Name	Long-term	Short-term
		µg/m³	µg/m³
AAQ1	Existing Plant	12	24
AAQ2	Putia	15	30
AAQ3	Boxanagar	12	24
AAQ4	Manikyanagar	14	28
AAQ5	Kamalanagar	11	22
AAQ6	Konaban	12	24
AAQ7	Lalsinghmura	12	24
AAQ8	Rahimpur	8	16
AAQ9	Ghilatali	9	18
AAQ10	Bhaluarchar	10	20

409. Source: ADB TA Consultant **Output Option:** The modelling for NO_2 was conducted for three averaging periods - 1 hour, 24-hours and annual, whereas for CO this was a 1-hour and 8-hour period to ensure consistency with the averaging periods for the assessment standards. Model output parameters included Highest Short-Term Values by Receptor, Overall Maximum Short-Term Values and High Values for Plotting. Results tables and time-based pollutant isopleths were generated to assess the spatial extent of the dispersion and location specific GLCs. The modelling was conducted separately for each year (2015-2019), and for three scenarios- 1. Only existing stacks, 2. Only HRSG stack, and 3. Only Bypass stack

410. NOx emissions associated with combustion sources such as gas turbines usually comprise approximately 90-95% nitric oxide (NO) and 5-10% NO_2 at source. The NO oxidizes in the atmosphere in the presence of sunlight, ozone (O_3), and volatile organic compounds (VOC) to form NO_2, which is the principal pollutant of concern with respect to environmental and human health effects. The approach considered for this assessment is based on guidance document United States Environmental Protection Agency (USEPA), Part 3, 40 CFR Part 51, 2005, which provided various techniques available for estimating the proportion of NO_x that is converted to NO_2. A 70% conversion of NO_x to NO_2 has been assumed for both short-term averaging periods (1 hour), and long-term averages (24 hour and annual).

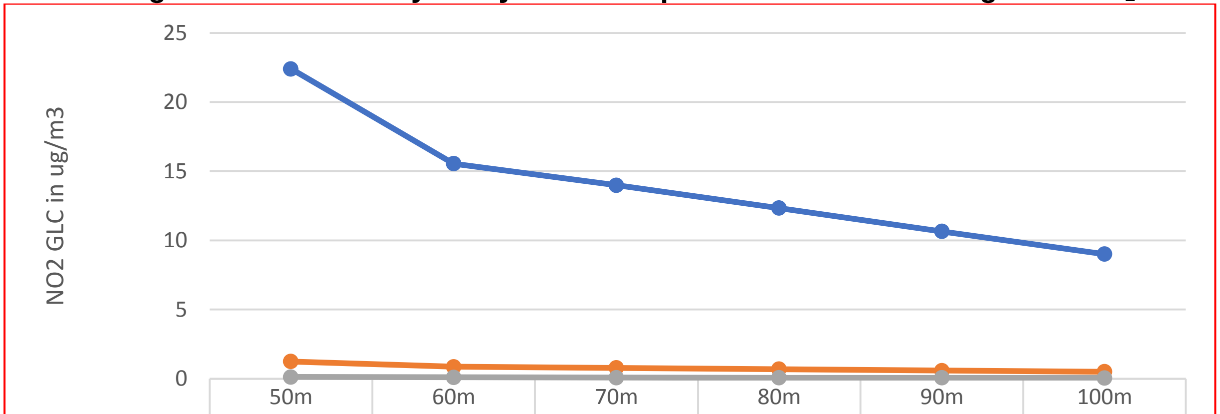
3.4. Model Output and Results

411. The modelling was run on a preliminary basis to identify the met data (among 2015-2019) which will potentially generate the highest GLC at in the study area. This was identified as the 2015 met data and this data set was used for the stack sensitivity analysis. However, the subsequent final modeling using the identified stack height was conducted with a full 5-year dataset. Further isopleths and outputs details are provided in the **Annexure 20.**

3.4.1 Stack height sensitivity analysis

412. Figure 5-9 and Figure 5-10 present the results of the stack height determination for the proposed HRSG and Bypass stacks and show the sensitivity graphs. The results of the stack height determination are based on one unit operating at full load continuously using the 2015 annual meteorological data. These results have been used to determine the appropriate stack height based on maximum GLC process contributions and how these change with increased stack height. The proposed plant is not expected to operate with the bypass stack for long periods of time. However, an appropriate stack height analysis for open cycle operation was conducted to check sensitivity. Modelling has been undertaken with a bypass stack height in the range of 30m to 60m and HRSG stack height in the range of 50 m to 100 m.

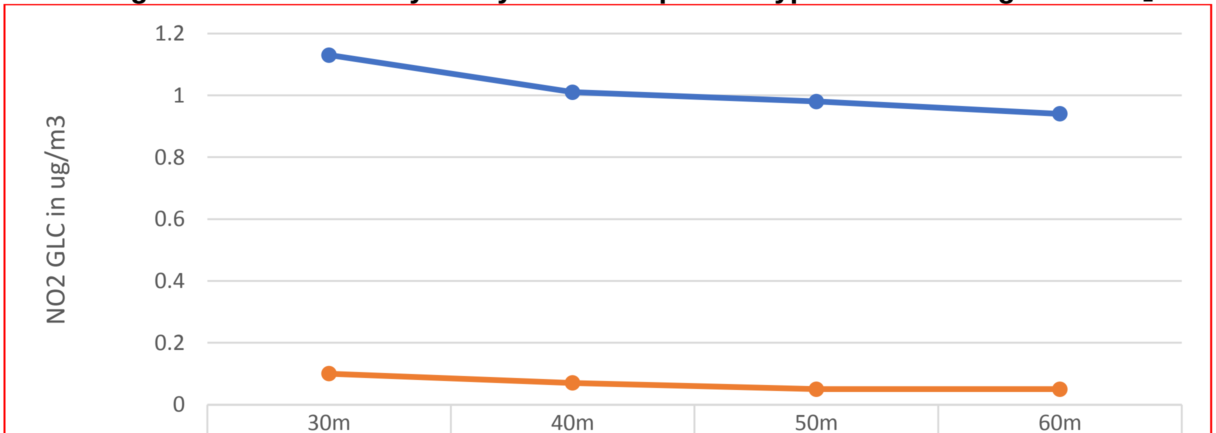
Figure 5-9: Sensitivity Analysis for Proposed HRSG Stack Height for NO_2



	50m	60m	70m	80m	90m	100m
1 Hour	22.4	15.55	13.99	12.33	10.65	9.01
24 Hours	1.24	0.86	0.78	0.69	0.59	0.5
Annual	0.12	0.1	0.08	0.07	0.06	0.05

Source: ADB TA Consultant

Figure 5-10: Sensitivity Analysis for Proposed Bypass Stack Height for NO_2



	30m	40m	50m	60m
1 hour	1.13	1.01	0.98	0.94
24 hours	0.1	0.07	0.05	0.05

Source: ADB TA Consultant

413. TPGL's design for HRSG stack height is 60m and 30m for the bypass. In the case of the HRSG stack, whilst there are further notable decreases in GLCs beyond 60m (at 100 m the predicted hourly mean process contribution is about 40% lower than the process contribution at 60m), both long-term and short-term (hourly mean) process contributions can be classed as 'insignificant' using criteria applied in other jurisdictions (e.g., in the UK, this is where a long-term (annual mean) process contribution is less than 1% of a standard, and short-term process contributions less than 10% of a standard[104]) Consequently, it would be considered disproportionate to increase the HRSG stack height beyond 60 m. For the bypass stack,

[104]https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#screen-out-insignificant-pcs

sensitivity analysis indicates that there is no significant reduction in maximum GLC with increased height. Therefore, the proposed stack height of 30m is considered appropriate for the bypass scenario. Although there is a further 50% reduction in daily mean NO_2 process contributions over the range of stack heights considered, the process contribution at 30 m is less than 1% of the applicable standard and considered insignificant. As such, any further increase in cost associated with a stack taller than 30 m would be considered disproportionate. Long-term impacts during bypass operation have not been assessed as this would be a short-term operating scenario only.

3.4.2. Air quality assessment

414. Following stack height determination, the main dispersion modelling has been undertaken, using the selected stack heights of 60m for HRSG and 30m for bypass. The contribution from the existing plant with three stacks of 10m was also modelled. The predicted maximum GLC process contributions, cumulative of background concentration, have been compared against assessment criteria. The assessment was conducted using 5 years hourly meteorological data (2005-2019) separately for each scenario and two pollutants. For the simulations, the concentration was estimated at around 5,400 receptors to demonstrate the variation in concentration in the 50 km PAI using the polar gridding method. The highest maximum GLCs predicted by the AERMOD dispersion model for the proposed and existing power plant per year is presented in Table 5-17 for NO_2 and Table 5-18 for CO.

Table 5-17: Predicted Maximum Ground Level Concentration NO_2

Averaging period	2015	2016	2017	2018	2019	Assessment criteria	Max % of criteria with Highest GLC
Existing Plant							
1hr	41.82	26.58	21.28	10.15	17.60	200	20.91 %
24hr	2.32	1.48	1.40	0.79	1.01	25	9.28 %
Annual	0.56	0.58	0.42	-	-	10	5.6 %
Proposed HRSG							
1hr	15.55	13.31	10.15	3.96	9.81	200	7.76 %
24hr	0.86	0.74	0.56	0.26	0.54	25	3.44 %
Annual	0.10	0.10	0.09	0.11	0.08	10	1.0 %
Proposed Bypass							
1hr	1.13	1.17	1.06	0.66	0.91	200	0.57 %
24hr	0.10	0.11	0.09	0.14	0.13	25	0.40 %
Annual	-	-	-	-	-	10	-

All conc. in ug/m^3
Source: ADB TA Consultant

Table 5-18: Predicted Maximum Ground Level Contribution CO

Averaging period	2015	2016	2017	2018	2019	Assessment criteria	Max % of criteria with Highest GLC
Existing Plant							
1hr	15.90	10.10	8.09	3.86	6.69	35000	0.05%
8hr	2.65	1.68	1.35	0.78	1.11	2000	0.13 %
24hr	0.88	0.56	0.53	0.30	0.38	4000	0.02 %
Proposed HRSG							
1hr	3.04	2.60	1.98	0.77	1.91	35000	0.01 %
8hr	0.51	0.43	0.33	0.13	0.32	2000	0.03 %
24hr	0.33	0.28	0.21	0.10	0.21	4000	< 0.01 %
Proposed BYPASS							
1hr	0.22	0.23	0.21	0.13	0.18	35000	< 0.01 %
8hr	0.05	0.05	0.04	0.04	0.05	2000	< 0.01 %
24hr	0.04	0.04	0.03	0.05	0.05	4000	< 0.01 %

All conc. in ug/m^3
Source: ADB TA Consultant

415. The results of the assessment using 2015 met data (which represents the ‘worst-case’ year of meteorological data) for each averaging periods and discrete receptor are provided in the Tables 5-19 – Table 5-24. The assessment standards and guidelines are provided for comparison. Maximum GLC including the existing background concentrations as derived from the ambient monitoring data are also provided. The data are representative of a rural setting but include contributions from nearby brick works and the existing power plant. Using these data to represent existing background conditions for the assessment of the effects of discharges from the proposed CCGPP will therefore provide a conservative assessment as there will be a certain amount of ‘double-counting’ of contributions from the existing power plant. Isopleths of NO_2 and CO using 2015 data are given in Figure 5-11 to Figure 5-16 for all averaging periods. The supplementary air quality modelling outputs are provided in **Annexure 20.**

Table 5-19: Air Quality Assessment of NO_2 – 1 hour Averaging Period

Baseline locations	Predicted Concentration 1-hour, 2015 NO_2, ug/m^3			Short-term Background NO_2, ug/m^3	Cumulative NO_2, ug/m^3			1-hour Assessment Criteria ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max GLC (% of standard)	41.8 (21%)	15.6 (8%)	1.1 (1%)	30.0 (15%)	71.8 (36%)	45.6 (23%)	31.1 (16%)	200
Existing plant	2.3	0.1	0.5	24	26	24	25	
Putia	3.6	0.1	0.1	30	34	30	30	
Boxanagar	8.5	2.6	0.1	24	33	27	24	
Manikyanagar	1.3	0.0	0.3	28	29	28	28	
Kamalanagar	0.0	0.0	0.0	22	22	22	22	
Konaban	5.4	1.0	0.1	24	29	25	24	
Lalsinghmura	2.5	1.6	0.5	24	27	26	25	
Rahimpur	1.5	0.2	0.0	16	18	16	16	
Ghilatali	1.1	0.4	0.1	18	19	18	18	
Bhaluarchar	2.5	0.1	0.1	20	23	20	20	

Source: ADB TA Consultant

Table 5-20: Air Quality Assessment NO_2 – 24 hour Averaging Period

Baseline locations	Predicted Concentration 24-hour, 2015, NO_2 , ug/m^3			Short-term Background NO_2, ug/m^3	Cumulative NO_2 , ug/m^3			24-hour Assessment Criteria ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max. GLC (% of standard)	2.3 (9%)	0.90 (4%)	0.10 (0.4%)	30.0 (120%)	32.3 (129%)	30.9 (124%)	30.1 (120 %)	25
Existing plant	0.34	0.01	0.07	24	24	24	24	
Putia	0.30	0.01	0.03	30	30	30	30	
Boxanagar	0.47	0.14	0.01	24	24	24	24	
Manikyanagar	0.07	0.00	0.02	28	28	28	28	
Kamalanagar	0.00	0.00	0.00	22	22	22	22	
Konaban	0.30	0.06	0.01	24	24	24	24	
Lalsinghmura	0.14	0.09	0.03	24	24	24	24	
Rahimpur	0.01	0.01	0.01	16	16	16	16	
Ghilatali	0.14	0.01	0.00	18	18	18	18	
Bhaluarchar	0.28	0.01	0.00	20	20	20	20	

NM: not monitored
Source: ADB TA Consultant

Table 5-21: Air Quality Assessment of NO_2 – Annual

Baseline locations	Predicted Concentration Annual, 2015, NO_2, ug/m^3			Long-term Background NO_2, ug/m^3	Cumulative NO_2, ug/m^3			Annual Assessment Criteria ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max. GLC (% of standard)	0.56 (7%)	0.10 (1%)	-	15 (150%)	15.6 (156%)	15.1 (151%)	-	10
Existing plant	0.3	0.01	-	12	12	12	-	
Putia	0.1	<0.01	-	15	15	15	-	
Boxanagar	<0.01	0.01	-	12	12	12	-	
Manikyanagar	<0.01	<0.01	-	14	14	14	-	
Kamalanagar	<0.01	<0.01	-	11	11	11	-	
Konaban	0.1	0.01	-	12	12	12	-	
Lalsinghmura	<0.01	<0.01	-	12	12	12	-	
Rahimpur	<0.01	<0.01	-	8	8	8	-	
Ghilatali	<0.01	<0.01	-	9	9	9	-	
Bhaluarchar	<0.01	<0.01	-	10	10	10	-	

Notes: the bypass stack would only operate for short periods of time so has not been included in the assessment of annual mean impacts
Source: ADB TA Consultant

Table 5-22: Air Quality Assessment for CO– 1 hour Averaging Period

Name	Predicted Concentration 1-hour, 2015 CO, ug/m^3			Background CO ug/m^3	Cumulative CO ug/m^3			Assessment Criteria 1-hour ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max. GLC (% of standard)	15.90 (0.05%)	3.04 (<0.01%)	0.22 (<0.01%)					35,000
Existing plant	1.27	0.03	0.13	BDL	1.27	0.03	0.13	
Putia	1.98	0.02	0.04	BDL	1.98	0.02	0.04	
Boxanagar	4.59	0.72	0.02	BDL	4.59	0.72	0.02	
Manikyanagar	0.70	0.01	0.07	BDL	0.70	0.01	0.07	
Kamalanagar	0.01	< 0.01	< 0.01	BDL	0.01	0.00	0.00	
Konaban	2.92	0.27	0.02	BDL	2.92	0.27	0.02	
Lalsinghmura	1.37	0.45	0.15	BDL	1.37	0.45	0.15	
Rahimpur	0.82	0.05	0.01	BDL	0.82	0.05	0.01	
Ghilatali	0.71	0.01	0.08	BDL	0.71	0.01	0.08	
Bhaluarchar	1.21	< 0.01	< 0.01	BDL	1.21	< 0.01	< 0.01	

Source: ADB TA Consultant

Table 5-23: Air Quality Assessment for CO– 8 hour Averaging Period

Name	Predicted Concentration 8-hour, 2015, CO , ug/m^3			Background CO ug/m^3	Cumulative CO ug/m^3			Assessment Criteria 8-hour ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max. GLC (% of standard)	2.65 (0.13%)	0.51 (0.03%)	0.05 (<0.01%)					2000
Existing plant	0.35	0.01	0.05	BDL	0.35	0.01	0.05	
Putia	0.33	0.00	0.01	BDL	0.33	0.00	0.01	
Boxanagar	0.77	0.12	0.00	BDL	0.77	0.12	0.00	
Manikyanagar	0.12	0.00	0.01	BDL	0.12	0.00	0.01	
Kamalanagar	0.00	0.00	0.00	BDL	0.00	0.00	0.00	
Konaban	0.49	0.04	0.00	BDL	0.49	0.04	0.00	
Lalsinghmura	0.23	0.08	0.02	BDL	0.23	0.08	0.02	
Rahimpur	0.14	0.01	0.00	BDL	0.14	0.01	0.00	
Ghilatali	0.13	0.01	0.00	BDL	0.13	0.01	0.00	
Bhaluarchar	0.30	0.00	0.01	BDL	0.30	0.00	0.01	

Source: ADB TA Consultant

Table 5-24: Air Quality Assessment for CO– 24 hour Averaging Period

Name	Predicted Concentration 24 hour,[105] 2015, CO , ug/m^3			Background CO ug/m^3	Cumulative CO ug/m^3			Assessment Criteria 8-hour ug/m^3
	Existing	Proposed			Existing	Proposed		
	3 stacks	HRSG	Bypass		3 stacks	HRSG	Bypass	
Max. GLC (% of standard)	0.88 (0.22%)	0.33 (<0.01%)	0.04 (<0.01%)					4000
Existing plant	0.13	0.00	0.03	BDL	0.13	0.00	0.03	
Putia	0.11	0.00	0.01	BDL	0.11	0.00	0.01	
Boxanagar	0.18	0.05	0.00	BDL	0.18	0.05	0.00	
Manikyanagar	0.03	0.00	0.01	BDL	0.03	0.00	0.01	
Kamalanagar	0.00	0.00	0.00	BDL	0.00	0.00	0.00	
Konaban	0.11	0.02	0.00	BDL	0.11	0.02	0.00	
Lalsinghmura	0.05	0.03	0.01	BDL	0.05	0.03	0.01	
Rahimpur	0.00	0.00	0.00	BDL	0.00	0.00	0.00	
Ghilatali	0.05	0.00	0.00	BDL	0.05	0.00	0.00	
Bhaluarchar	0.11	0.00	0.00	BDL	0.11	0.00	0.00	

Source: ADB TA Consultant

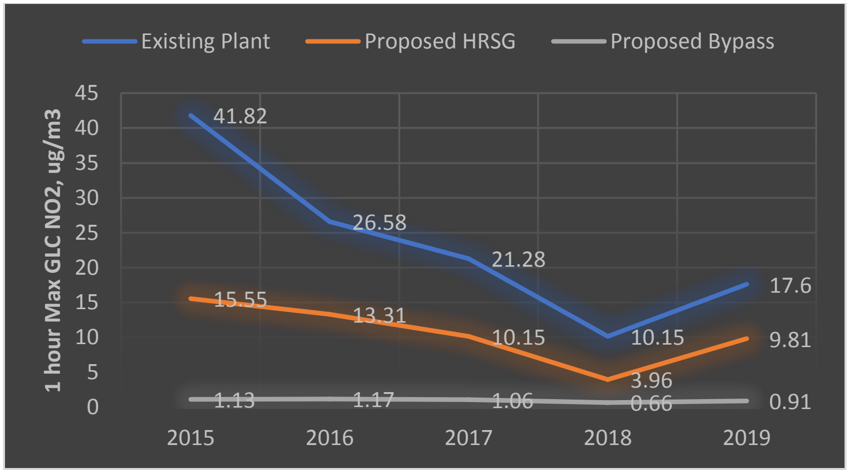
[105] 24 hour CO estimated as: (24 Hour NO2) x (CO emission rate/NOx emission rate)

416. It is evident from Tables 5-19 to 5-24 that the cumulative ground level concentration (i.e., average background concentration + predicted maximum GLC) for NO_2 from the proposed 120MW CCGPP, in the 50km PAI with natural gas as fuel, will be well within the hourly mean WHO guideline but exceed the recently revised (2021) annual and daily mean guideline levels. However, the contribution from the proposed 120MW CCGPP accounts for only 1% of the annual mean WHO guideline at the location of maximum GLC, and less than 1% of the annual mean WHO guideline at other receptor locations away from the maxima. For daily mean considerations, the contribution is less than 10%. In guidance in other jurisdictions, such as the UK, this magnitude of process contribution would be considered insignificant and would not require further assessment of options to reduce emissions further. Cumulative concentrations of CO are well within the assessment standards.

417. In terms of emission from the existing 63MW OCGPP, it is observed that impacts are greater than the impact of the proposed plant. This is a combination of lower release heights and less efficient turbines. Figures 5-11 through Figure 5-13 present the results of comparative impacts from the proposed and existing power plant. The assessment demonstrates that the maximum NO_2 GLC (all averaging periods) from the proposed plant using long term (5 years) meteorological data are much less than then those from the existing plant. The maximum reduction across any modelled year is more than 99% (annual, 2015). Based on this it can be said that the proposed project would be beneficial for local air quality, as there would be reduction in impacts following the replacement of the existing 63MW plant. As such, the impact from the proposed project will not cause an increase in the existing baseline conditions and, in isolation, can be considered insignificant. The emissions from the plant will however be long term, i.e., will occur for entire life of the plant and be transboundary. On the other hand, this project will be replacing the more pollution 63MW plant, which is beneficial. With this, the magnitude of impacts on air quality due to operational emissions from the proposed plant is assessed to be low adverse in isolation and **Not Significant**. With respect to the overall change from the existing baseline, impacts are beneficial.

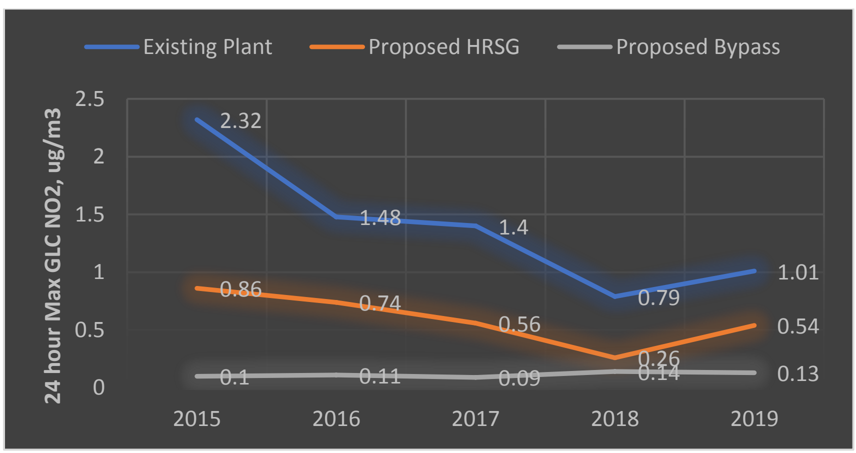
418. There will be no transboundary air quality impact on Bangladesh that would be considered to be significant.

Figure 5-11: Comparative Analysis of NO_2 Process Contributions – 1 hour



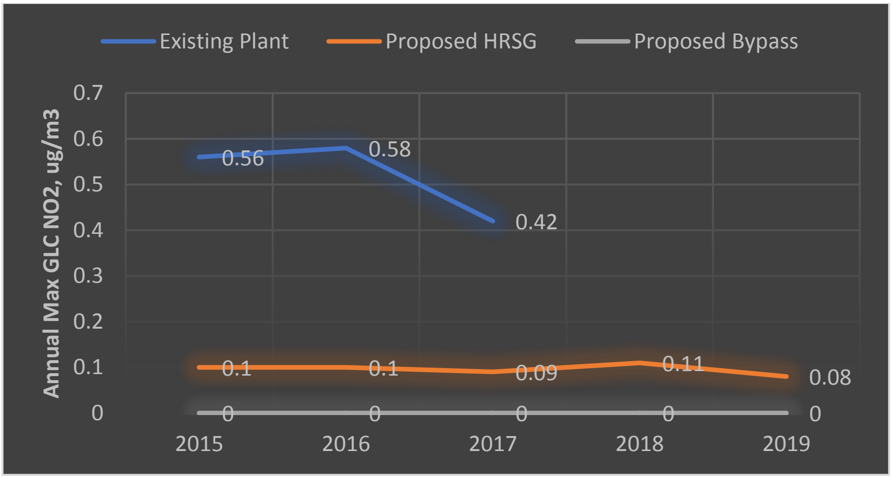
Source: ADB TA Consultant

Figure 5-12: Comparative Analysis of NO_2 Process Contributions – 24 hours



Source: ADB TA Consultant

Figure 5-13: Comparative Analysis of NO_2 Process Contributions – Annual mean



Source: ADB TA Consultant

3.5. Mitigation for Operation

419. The EPC Contractor will ensure that the detailed design complies with the air emission standards/ambient air assessment criteria and includes (i) built-in low-NOx burners in the gas turbine to reduce the NOx emission below 25 ppm (ii) stack height of 60m for HRSG and 30m for Bypass, and (iii) the installation of a continuous emission monitoring system (CEMS) (Ref CPCB 2018 guidelines)[106] for recording of NOx and CO emissions from the HRSG and Bypass (whenever operational) stacks. Since only an indicative design has been modelled to assess the air quality impact for this EIA, which may change if e.g., the building design or stack locations change during detailed design, it will be necessary for the EPC Contractor to rerun the air quality modelling and reassess the air quality impact based on their final design. They will need to demonstrate that the impact on the air assessment criteria will be less or the same impact than presented in the EIA report before their detailed design is approved by TPGL.

420. The ESMS developed by TPGL will incorporate mitigation measures for air quality elaborating on those included in the EIA/EMP as follows. Implementation will be supervised by their Environment Officer to ensure compliance with the air emission standards for the flue gas stacks.

(i) Maintain power plant equipment in a good condition in accordance with the manufacturer's specifications to maintain compliance with the air emission criteria.

(ii) Use the CEMS for the measurement of air emission levels of NO_x and CO in the exhaust of HRSG and Bypass stack whenever they are in operation. Should emissions exceed the standards, procedures will be developed to report such an event and investigate the root cause, returning the plant to compliant operation in the shortest possible timeframe.

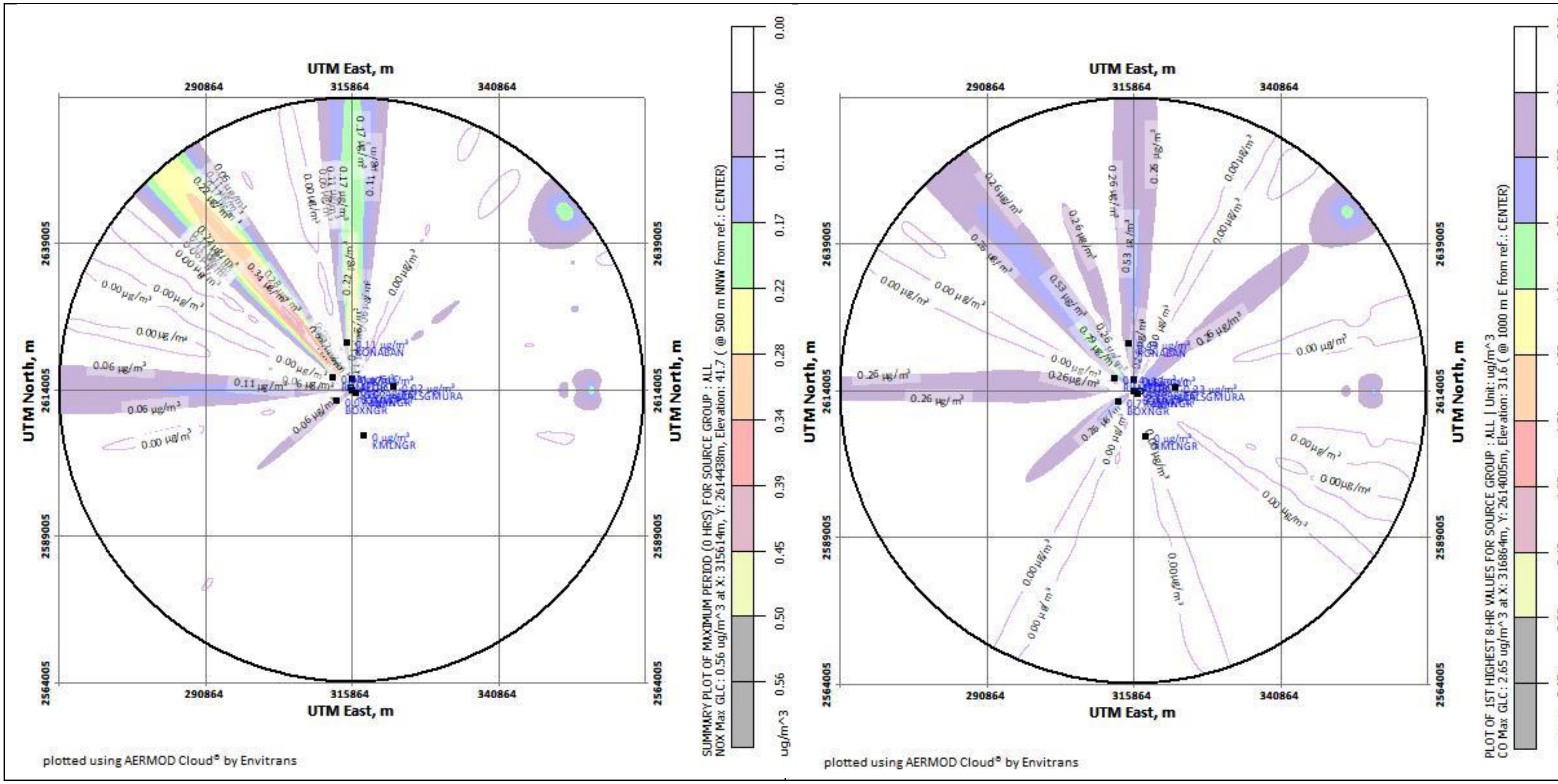
(iii) NO_x and CO as well as VOCs to be monitored periodically using third party accredited stack testing organizations, using stack monitoring kit/system (compliant with CPCB guidelines) to ensure that these emissions are not

[106] https://cpcb.nic.in/openpdffile.php?id=TGF0ZXN0RmlsZS9fMTUzNTUzMzAyMl9tZWRpYXBob3RvMzAyNDUucGRm

occurring at elevated levels because of the incomplete combustion of the natural gas fuel.

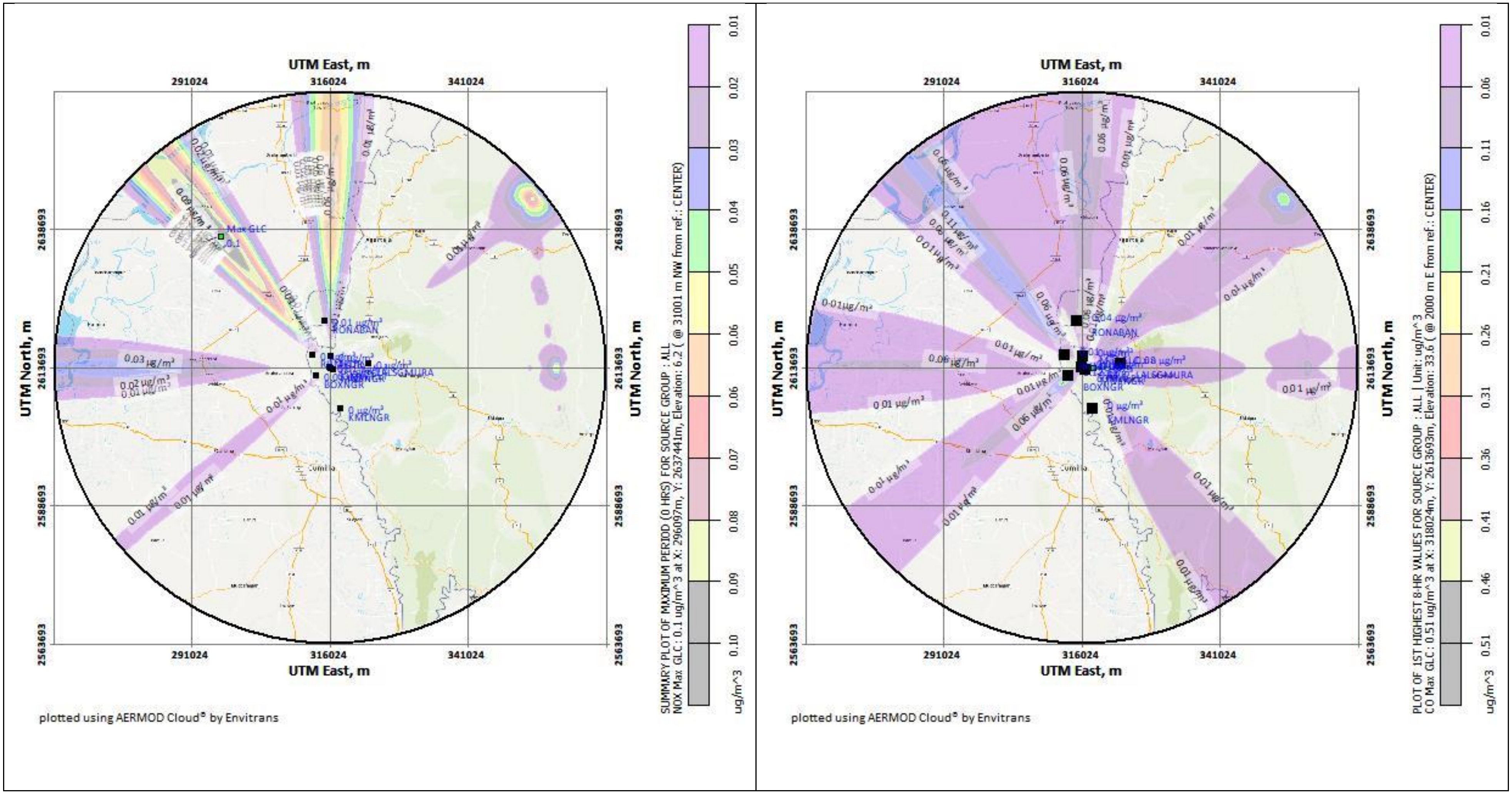
421. During operation quantitative monitoring of ambient air quality will be undertaken at selected baseline monitoring locations as prescribed in the EMoP in Annexure 35, these monitoring requirements will be incorporated into the ESMS.

Figure 5-14: Isopleth of NO_2 (annual) and CO (8 hours) GLC from the Existing Plant



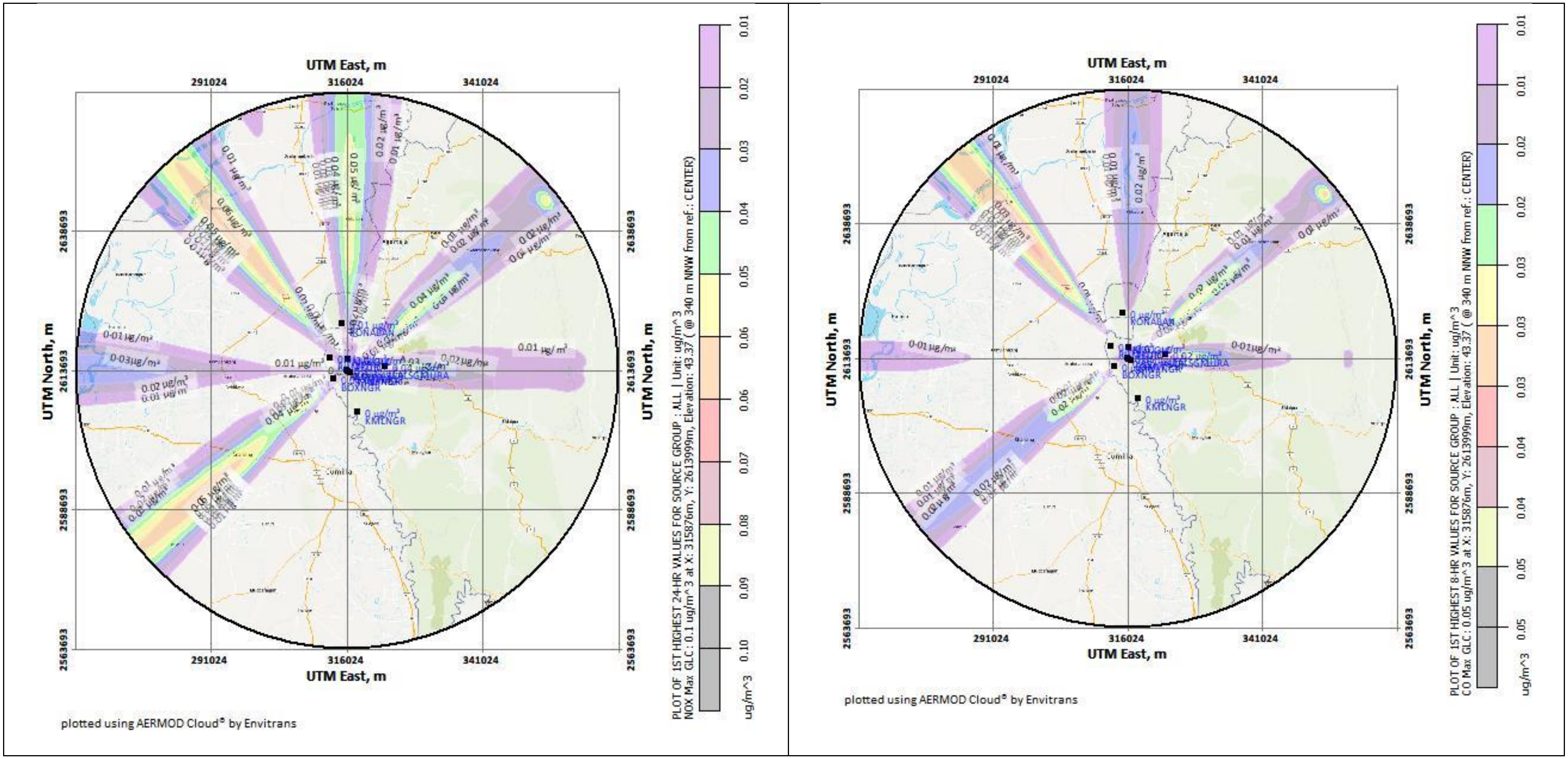
Source: ADB TA Consultant

Figure 5-15: Isopleth of NO_2 (annual) and CO (8 hours) GLC from the Proposed HRSG Stack



Source: ADB TA Consultant

Figure 5-16: Isopleth of NO_2 (24 hour) and CO (8 hour) GLC from the Proposed Bypass Stack



Source: ADB TA Consultant

4. Noise and Vibration

422. The noise sensitive receptors identified in the vicinity of the proposed development which will be considered in the noise assessment are summarized in Table 5-25. With reference to the risk matrix for significance determination set out in Table 5-3, these receptors are considered to have a high importance.

Table 5-25: Noise Sensitive Receptors

Receptor	Distance (From plant E boundary)	Latitude	Longitude
Closest Houses 1	55 m	23°37'24.42"N	91°11'54.62"E
Closest Houses 2	69 m	23°37'24.30"N	91°11'55.11"E
Closest Houses 3	81 m	23°37'24.13"N	91°11'55.30"E
Closest Houses 4	90 m	23°37'23.79"N	91°11'55.63"E
Closest Houses 5	115 m	23°37'23.60"N	91°11'55.98"E
Closest Houses 6	122 m	23°37'23.23"N	91°11'56.26"E
Closest Houses 7	137 m	23°37'22.91"N	91°11'56.45"E
Closest Houses 8	150 m	23°37'22.58"N	91°11'56.52"E
Closest Houses 9	162 m	23°37'22.32"N	91°11'56.70"E
Closest Houses 10	178 m	23°37'21.92"N	91°11'57.00"E
School (at 100 m buffer)	375 m	23°37'10.99"N	91°11'52.35"E
NV4 (Main Manikyanagar Village)	400 m	23°37'17.53"N	91°12'2.59"E
Plant boundary (East)	0 m	23°37'24.90"N	91°11'50.42"E
Plant boundary (West)	0 m	23°37'20.35"N	91°11'44.10"E

Source: ADB TA Consultant

Figure 5-17: Map showing receptors distance to plant
(CH: Closest houses)

Source: ADB TA Consultant

423. The inputs for predictive noise modelling included:
- (i) Base map of PAI - map of the assessment area
- (ii) Grid setting - coordinates of the sources and receptors
- (iii) Ground conditions – hard / soft – exposed soil, or vegetation, etc
- (iv) Receivers mapped on base map
- (v) Source locations mapped on base map - plant layout showing the location of construction and operational noise sources
- (vi) Sources sound power level at Octave band (Lw) – equipment specific sound power level from manufacturer, design engineer and/or country specification/guidelines
- (vii) Contour and results settings – output display and results setting, resultant noise levels, noise contour intervals.

424. **Noise propagation model:** Noise impact due to construction and operation of the proposed plant was analyzed using propagation model ISO 9613-2 General Noise, which considers frequency dependent attenuation due to geometric divergence, atmospheric absorption, and ground effect. ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure L_{eq} (Lp) level under meteorological conditions favorable to propagation from sources of known sound emission. It can predict long-term sound pressure levels on an A-weighted scale and octave-bands. The model predicts noise levels through spherical spreading and includes the effect of atmospheric absorption, reflection, geometrical divergence, and sound barriers attenuation. Geometrical divergence is the spherical spreading of the sound from a

point sound source in a free field. The attenuation due to geometrical divergence is dependent on the distance between the source and receiver, in meters (ISO, 1996).[107] Therefore, the geometry and characteristics of the ground are essential for the calculations. The basic model equation is:

$$Lp = Lw + K + D_C - A \qquad (2)$$

Where,
Lp is the equivalent sound pressure level at the receiver, for octave-bands,
Lw is sound power level at source,
K is pure tone,
D_C is the directivity correction that describes the deviation of the sound pressure level in a specific direction from the sound power level,
A is the attenuation of the sound propagation. It is a sum of the attenuation due to the geometrical divergence, the atmospheric absorption, the ground effect, the barriers, and miscellaneous other effects (ISO, 1996)[16] and,

$$A = (Adiv + Aatm + Agr + Abar + Amisc) - Cmet – Cscreen \qquad (3)$$

Adiv: the attenuation due to geometrical divergence
Aatm: the attenuation due to atmospheric absorption
Agr: the attenuation due to ground effect
Abar: the attenuation due to a barrier
Amisc: the attenuation due to miscellaneous other effects
Cmet: Meteorological correction
Cscreen: Topographic screening

425. **Assessment criteria:** the following assessment criteria was used to derive the noise severity ('noise impact'), which is used to inform the risk matrix for signification determination summarised in Table 5-26.

Table 5-26: Noise Impact Assessment Criteria

Maximum	High	Medium	Low	Minimal
Predicted noise levels are more than 10 dB above the relevant limits / thresholds.	Predicted noise levels are between 5 and 10 dB above the relevant limits / thresholds.	Predicted noise levels are between 0 and 5 dB above the relevant limits / thresholds.	Predicted noise levels are below the relevant limits / thresholds but >3 dBA above baseline if specific levels not already exceeded.	Predicted noise levels are below the relevant limits / thresholds and <3 dBA above baseline if specific levels not already exceeded.

Source: ADB TA Consultant

[107] https://www.iso.org/standard/59765.html#:~:text=ISO%201996%2D1%3A2016%20defines,and%20describes%20basic%20assessment%20procedures.&text=Community%20response%20to%20noise%20can,have%20the%20same%20acoustic%20levels.

4.1. Construction Including Demolition

426. Development of the proposed plant will require demolition of site buildings, site preparation, mobilization of works, material, and equipment, followed by construction activities like flattening of the two hillocks, earthworks, trenching, foundation making, piling, erection of turbine and ancillaries and construction of buildings and office, which will generate noise and increase ambient level, leading to potential community disturbance. The greatest construction noise and vibration risks are in relation to the residents of the cluster houses 55 m from the plant boundary and outside the plant area up to 500m. Most of the construction activities will be conducted within the planned area, which is close to the row of closest houses beyond settlements eastern boundary (the cluster settlements are 150m from proposed plant center). TPGL residential staff quarters are located close to western boundary. The GAIL staff quarter are located around 50m from the project site, across the TPGL private access road. Increased noise levels may pose health risks to workers as well as to the residents living near the construction site.

427. **Construction sources, and assumptions:** The equipment and machinery used for construction and demolition will produce cumulative noise depending on source type, sound power, number, weather condition, distance, and duration of working period. The model presents a ‘worst-case scenario’ as it does not consider factors like topography, ground absorption, large obstructions in the propagation path, e.g., barriers etc., refraction of noise, wind speed or direction effects and changing frequencies. Without any facility boundary or other barrier/obstructions, the noise level will propagate and attenuate significantly with distance. The details of sources are given in Table 5-27.

Table 5-27: Construction noise sources (receiver at 1.5m) and distance to monitored locations

Source	Distance to sources (m)					Octave Frequency (Hz)	Source height, m	Lw (sound power level, dB(Z)
	Site Boundary (E)	Site Boundary (W)	Closest Houses	School at 100m Buffer	Manikyanagar (NV.4)			
Backhoe	54	173	124	403	418	500	1.5	112
Bulldozer-2	109	122	213	426	496	500	1.5	117
Excavator	53	179	114	399	409	500	2	117
Dump truck	37	143	137	383	422	500	1.5	116
Compactor	43	170	115	391	408	500	1.5	112
Batching Plan	102	48	200	312	431	500	2	115
Water Truck	46	158	131	395	422	500	1.5	110
Piling	76	122	180	404	463	500	2	120
DG	146	54	256	387	510	500	1.5	110
Demolition Noise	104	122	207	422	491	500	1.5	115
Vehicle Bay	199	114	309	449	574	500	1.5	100
Storage Yard	35	108	142	340	406	500	1.5	105
Truck	100	93	209	399	483	500	1.5	105
Bulldozer	48	172	119	397	412	500	2	117

Source: ADB TA Consultant

4.1.1. Construction noise assessment results (pre-mitigation)

428. The pre-mitigation construction noise assessment results are provided in Table 5-28 for the identified noise sensitive receptors and show there is a Maximum impact at each of the closest residential receptors, and a High impact at the school, and a Medium impact at Manikyanagar. With reference to the risk matrix for significance determination set out in Table 5-2, these receptors are considered to have a High importance, therefore Maximum-High magnitude of impacts pre-mitigation are considered to be **Significant**, significant impacts do not extend to Manikyanagar village.

Table 5-28: Construction noise assessment (pre-mitigation)

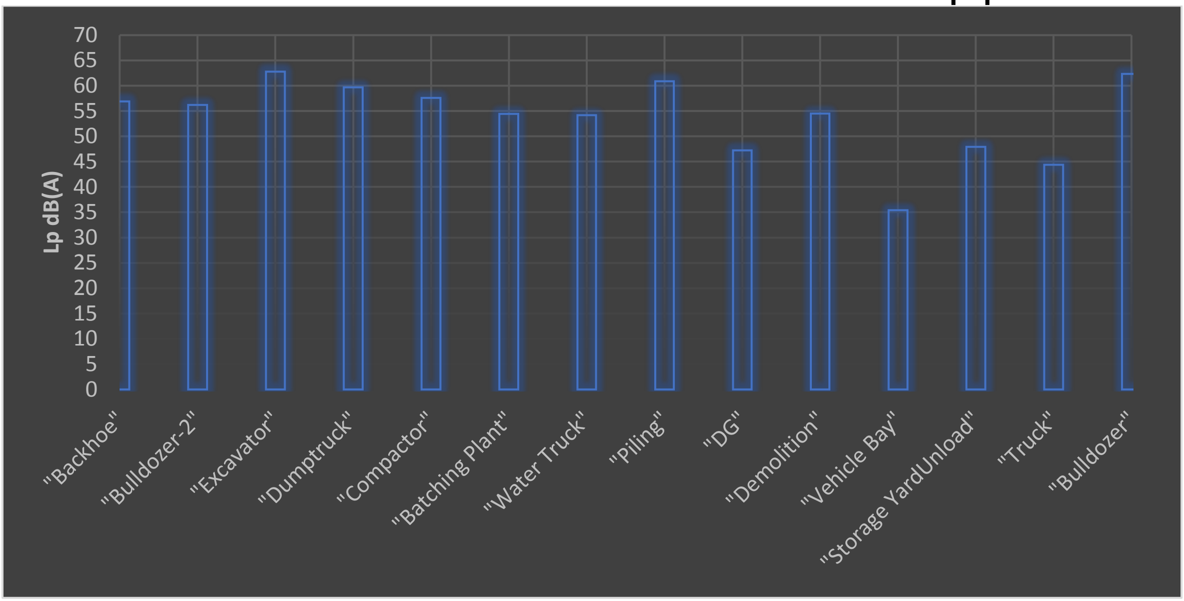
Receptor	Baseline dB(A)	Calculated dB(A)	Assessment Criterion, dB(A)	Exceedance, dB(A)	Impact
Site Boundary (E)	41.6	76.4	70	6.4	High
Site Boundary (W)	42.9	71.2	70	1.2	Medium
School at 100m Buffer	47.5	58.9	50	8.9	High
Manikyanagar (NV.4)	51.2	57.7	55	2.7	Medium
Closest House 1	47.7	68.1	55	13.1	Maximum
Closest House 2	47.7	67.6	55	12.6	Maximum
Closest House 3	47.7	67.1	55	12.1	Maximum
Closest House 4	47.7	66.8	55	11.8	Maximum
Closest House 5	47.7	66.3	55	11.3	Maximum
Closest House 6	47.7	65.7	55	10.7	Maximum
Closest House 7	47.7	65.4	55	10.4	Maximum
Closest House 8	47.7	65.1	55	10.1	Maximum
Closest House 9	47.7	64.8	55	9.8	High
Closest House 10	47.7	64.5	55	9.5	High

Source: ADB TA Consultant

4.1.2. Construction noise assessment results (on-site barriers)

429. The assessment presented in Table 5-28 is considered conservative given the modelling assumes all activities summarized in Table 5-27 are occurring concurrently, and at worst-case positions with respect to the identified noise sensitive receptors. This is unlikely to be the case, and individual contributions of the construction equipment is shown in Figure 5-18. As shown, at the closest houses, the construction noise source with the greatest noise emissions is Piling (>60 dB), the Bulldozer (>60 dB) and Excavator (>60 dB).

Table 5-18: Individual noise contributions of construction equipment



Source: ADB TA Consultant

430. The precise nature and methodology for the construction phasing is yet to be finalized. However, as a working approximation, where there is a barrier or other topographical feature between a source and noise sensitive receptor an assumed attenuation of 5 dB can be applied when the top of the plant is just visible to the receiver, and 10 dB when the noise source is completely screened. It can therefore be assumed that with the appropriate location of temporary noise barriers the noise levels could be effectively reduced at noise sensitive receptors in the order of 10 dB.

431. Adopting an assumed 10 dB reduction in noise levels due to the appropriate and effective use of on-site noise barriers during the construction works results in a reduction in the noise levels at assessed receptors. The indicative post-mitigation construction noise assessment results are provided in Table 5-29.

Table 5-29: Construction noise assessment (post-mitigation)

Receptor	Baseline dB(A)	Calculated dB(A) with Barrier Correction	Assessment Criterion, dB(A)	Exceedance, dB(A)	Impact
Site Boundary (E)	41.6	66.4	70	-3.6	Low
Site Boundary (W)	42.9	61.2	70	-8.8	Low
School at 100m Buffer	47.5	48.9	50	-1.1	Minimal
Manikyanagar (NV.4)	51.2	47.7	55	-7.3	Minimal
Closest House 1	47.7	58.1	55	3.1	Medium
Closest House 2	47.7	57.6	55	2.6	Medium
Closest House 3	47.7	57.1	55	2.1	Medium
Closest House 4	47.7	56.8	55	1.8	Medium
Closest House 5	47.7	56.3	55	1.3	Medium
Closest House 6	47.7	55.7	55	0.7	Medium
Closest House 7	47.7	55.4	55	0.4	Medium
Closest House 8	47.7	55.1	55	0.1	Medium
Closest House 9	47.7	54.8	55	-0.2	Low

Receptor	Baseline dB(A)	Calculated dB(A) with Barrier Correction	Assessment Criterion, dB(A)	Exceedance, dB(A)	Impact
Closest House 10	47.7	54.5	55	-0.5	Low

Source: ADB TA Consultant

432. As shown in Table 5-29 the level of impact has reduced to Medium at most receptors because of on-site barriers. The maximum exceedance of the assessment criterion is 3.1dBA at Closest House 1 which can be managed with the adoption of other best practices. With reference to the risk matrix for significance determination set out in Table 5-2, these receptors are considered to have a High importance, therefore post-mitigation Medium magnitude impacts will be **Not Significant.**

4.1.3. Construction noise mitigation

433. It is noted that the level of impact which has been modelled is considered worst-case, as the activities summarized in Table 5-23 will not occur concurrently, and therefore the associated noise level at receptors will likely be lower. In addition to constructing the temporary acoustic boundary wall or piles of excavated materials between noisy activities and the noise sensitive receptors/outside of the site boundary to reduce noise levels by at least 10 dB, other best practice measures associated with the control of construction noise, that should be applied, include:

(i) Construction activity will take place only between the hours of 7 am - 7 pm, no work on Sundays, Holidays and Religious Festivals, and avoid noisy works during school exam periods.

(ii) Prior 1-on-1 consultation and disclosure of the schedule of all high noise work/activities (especially bulldozing/excavation/soil compaction/piling/blasting works) planned to take place with the adjacent school and 10 affected residential properties.

(iii) Residents within 500m will also be informed well in advance of the construction schedule for noisy activities.

(iv) Restriction on use of hydraulic horn in project vehicles.

(v) Construction related traffic movements will be limited to the construction activity periods noted above. Construction traffic access routes to the site will minimize the extent of settlement areas that have to be passed through. Residents located in the vicinity of construction traffic routes will be informed in advance of any peak or oversized vehicle movements. Signage and traffic management will be used at settlements and pinch points.

(vi) Ensuring all construction vehicles are regularly serviced and maintained in good working order in accordance with manufacturer instructions and have emission certificates for operating within GoI standards; keep log of maintenance work undertaken.

(vii) Sound levels received by workers should not be over 85 dB(A) during continuation of 8 working hours or hearing protection must be provided to them.

434. During construction quantitative monitoring of ambient noise will be undertaken as prescribed in the EMoP in **Annexure 30.**

435. A worst-case assessment is shown in Table 5-28, the pre-mitigation construction noise impacts are Maximum at the closest noise sensitive receptors. However, with the adoption of

on-site noise barriers the construction noise impacts reduce to Medium. Whilst the precise nature and methodology for the construction phasing is yet to be determined, with the adoption of on-site noise barriers, and the adoption of other best practice measures, it can be concluded that construction noise can be appropriately controlled, and the associated magnitude of impacts would be Medium to Low. On this basis, the post-mitigation noise will be Medium Adverse and **Not Significant.**

4.1.4. Construction Vibration Impacts (pre-mitigation)

436. Demolition of the existing buildings[108] and flattening of the hillocks will generate vibration at the project site mainly arising from the use of heavy construction equipment. The effects of ground-borne vibration include discernible movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. The vibration from the construction-related activity agitates the ground, create vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. The damage of the buildings depends on the intensity of the sources, transmitting media and vulnerability of the structures. Thus, it is necessary to assess and manage vibration on the eastern side of the power plant to prevent cosmetic damage to dwellings, and the potential to cause disturbance.

437. To a lesser extent than the potential for adverse impacts from on-site construction plant, discernable ground-borne vibration impacts can also occur associated with heavy goods vehicles on the local road network. However, these impacts are reduced when the roads ae well maintained and free of significant irregularities. The focus of the vibration assessment is therefore emissions from on-site plant.

438. Construction vibration is generally assessed in terms of peak particle velocity (PPV). The commonly adopted threshold criterion is a PPV of 1.0 mms^{-1}. The effect associated with an exceedance of this criterion is stated as: '*it is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents'*.[109]

439. With reference to the site layout, major construction activities will be located at least 20m from the site boundary. As per Table 5-25, the nearest receptors are the cluster of closest houses, and the nearest construction equipment, the excavator, will be at distance of 114m. There is no standardized method for predicting vibration from a majority of construction activities, including excavation. However, BS 5228-2 (2014)[110] does include historic case history data for vibration measurements, largely measured in the UK, and during high impact construction activities such as piling. It does not include data on vibration levels during excavation.

440. Significant piling activities are not proposed for the proposed development; however, vibration magnitudes would be greater than those associated with excavation. Historical data associated with piling activities have therefore been considered as a worst-case with respect to vibration levels during excavation. With reference to BS 5228-2 (2014) piling activities such as

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108 Demolition works are anticipated to be done both manually and mechanically to minimize the generation of vibration, no blasting is anticipated to be required.

109 BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. Table B.1

110 BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. Table B.1

auger piling (recorded in Central London) indicate when the auger hits the base of the hole, which is expected to generate a short but higher level of vibration, the level of vibration is approximately 0.3 mms^{-1} at 14 m from the activity. This is well below the 1.0 mms^{-1} threshold set out above.

441. Due to the relatively large distance to the closest dwellings the impact is low, and the pre-mitigation significance of construction vibration at the nearest receptors is **Not Significant**.

4.1.5. Construction Vibration Mitigation

442. Demolition works are anticipated to be done both manually and mechanically to minimize the generation of vibration. The demolition plan will be prepared by the contractor with requirements and specifications included in the Bid documents and contracts. Demolition works will be part of the environmental monitoring.

443. Mitigation for noise will also help to address vibration impact. The EPC contractors will identify adjacent properties at risk of occupant disturbance and potential cosmetic damage, undertake an appropriate pre-construction structural survey, supported by photographic evidence, and determine whether on-going monitoring, using vibration monitoring, is required. If a risk of occupant disturbance or cosmetic damage is determined then the EPC contractor shall consider mitigation options. These include: consideration of an alternative construction working method; and where necessary, temporary relocation of occupants during works. Structural or cosmetic damage is to be repaired by contractors to at least pre-project condition at their own cost.

444. The post-mitigation impacts of the construction vibration at the nearest receptors are likely to be Minimal, and **Not Significant.**

4.2. Operational Noise Impact

445. This assessment of operational noise impacts is based on an assumed 120 MW CCG power plant inventory, technology, design, layout and type of equipment and systems. Should there be significant differences between the assumed plant inventory in the latest DPR and that used on site, additional assessments informed by updated noise modelling, may be needed, and the proposed noise mitigation measures should be updated and implemented accordingly. For the operational noise assessment, the propagation model is based on ISO 9613-2 (1996) advocated methodologies, and receptor and ambient noise considerations commensurate with those used for construction noise assessment.

446. ***Operational sources and assumptions:*** The assessment of operational noise impacts is based on the indicative layout, design, technology, and processes as described in Chapter 2 and an assumed inventory of power plant equipment and systems used.

447. The operational plant turbines and systems will produce cumulative noise depending on source type, sound strength, distance, and duration of working period. The assessment is based on noise contributions from external sources only. Contributions from any internal noise sources (enclosed within buildings) will be controlled through appropriate design considerations at the detailed design stage by requiring 85 dBA to be achieved externally at 1m. Contributions from internal noise sources (enclosed within buildings) will be controlled through appropriate design considerations at the detailed design stage. The proposed noise modelling methodology is conservative, as sound propagation reductions due to topography have not been considered,

and therefore the noise levels at receptors may be lower than those presented. The project site and its immediate surroundings is found on plain to elevated terrain ranging between 30m to 49m above sea level (ASL), with two isolated hillocks with maximum elevation 59m ASL both of which are covered with vegetation. Of the two hillocks, the smaller one on the eastern boundary has a maximum elevation of 55m, whilst the larger one forming the southern boundary has a maximum elevation of 59m. The ground condition is a mix of open soil and vegetation. The gap between the plant boundary and nearest house is open soil.
448. Since the bypass stacks will be working in the single cycle operation, thus two sub-scenarios are considered: (1) the HRSG scenario; and (2) the Single Cycle scenario. For the noise modelling, an ambient temperature of 10^{0}C and the relative humidity as 75% has been considered. All receiver heights were at 1.5m from ground level. A summary of the operational noise sources considered in the model for the assessed scenarios is presented in Table 5-25 and Table 5-26. Octave spectral noise, building and plant dimensions were provided by TPGL's design consultant in consultation with one possible turbine manufacturer – General Electric of the United States.

4.2.1. Operational Noise - Assessment results (pre-mitigation)

449. The proposed plant is anticipated to generate noise levels with an associated impact of Medium at identified noise sensitive receptors without noise mitigation. The major noise sources during base load operation are the air-cooled condenser (ACC) or cooling tower, start-up and shutdown, fans, steam turbine generator (STG), combustion inlet filter house, and the HRSG and HRSG Stack, and, when operational, the Bypass stack. During start-up or other transient conditions in combined cycle configurations, the high-pressure steam piping and condenser is a major noise producer, with steam bypassing the STG. Turbine and generator compartments have been completely enclosed with weather protection, sound attenuation, and ventilation, thereby dropping their respective noise source ranking. Other balance-of-plant (BOP) equipment also generates noise.

450. There is an existing concrete wall surrounding the proposed development, which is in poor condition, and will be redeveloped into a 3m height concrete wall. This wall will act as a noise barrier between noise sources within the site and noise sensitive receptors. The 3m noise barrier is inherent in the design of the proposed development, and therefore its noise attenuation properties have been considered within the 'pre-mitigation' noise results. The results of the pre-mitigation operational noise assessment are provided in Table 5-31 and Table 5-32 and shows there are exceedances of the night-time assessment criterion at the closest houses to the proposed development.

451. The magnitude of impact at the identified noise sensitive receptors is Medium. With reference to the risk matrix for significance determination set out in Table 5-2, these receptors are considered to have a High importance, therefore pre-mitigation Medium magnitude impacts will be Medium Adverse and, although **Not Significant,** consideration of appropriate mitigation is required.

452. There are no significant sources of vibration associated with the operation of the plant.

Table 5-30: Operation Pre-mitigation Noise Source Details for Proposed Plant

Assumptions for Combined Cycle – Pre-Mitigation

Ref.to plot plan (CHp 2: Fig 2-5) (project plan equipment ID)	Noise Source	Source Height, m	Latitude	Longitude	Octave Band Sound Power Level, Lw, dB								Sound Power Level, dB	Sound Power Level, dB(A)
					63	125	250	500	1000	2000	4000	8000		
3.1	Inlet filter house face	10	23°37'25.68"N	91°11'46.85"E	102	98	90	89	86	88	90	95	104.6	97.5
3.2	Inlet filter house and duct	10	23°37'25.78"N	91°11'46.81"E	102	90	81	83	83	87	83	78	102.6	91.3
5	HRSG	2.8	23°37'24.67"N	91°11'48.23"E	114	107	103	102	100	89	75	56	115.3	103.7
6	HRSG Stack - Exit	60	23°37'24.53"N	91°11'48.76"E	103	99	93	92	83	73	69	63	105.0	91.8
7	Gas Turbine Transformer - Main	20	23°37'23.93"N	91°11'46.62"E	97	100	99	94	90	86	81	72	104.3	96.3
11	Wash Water Skid for GT	3	23°37'25.39"N	91°11'47.63"E	83	88	87	89	91	89	84	79	96.5	95
13	Fin Fan Cooling Unit for GTG	3	23°37'25.68"N	91°11'47.57"E	98	97	97	96	93	89	85	79	103.7	98
22	Space for ACC	15	23°37'22.12"N	91°11'46.56"E	95	95	90	88	85	81	74	68	99.3	90.2

Source: ADB TA Consultant

Assumptions for Single Cycle – Pre-Mitigation

Ref.to plot plan (CHp 2: Fig 2-5) (project plan equipment ID) n .	Noise Source	Source Height, m	Latitude	Longitude	Octave Band Sound Power Level, Lw, dB								Sound Power Level, dB	Sound Power Level, dB(A)
					63	125	250	500	1000	2000	4000	8000		
3.1	Inlet filter house face	10	23°37'25.68"N	91°11'46.85"E	102	98	90	89	86	88	90	95	104.6	97.5
3.2	Inlet filter house and duct	10	23°37'25.78"N	91°11'46.81"E	102	90	81	83	83	87	83	78	102.6	91.3
4	By-Pass Stack - Exit	30	23°37'24.97"N	91°11'47.32"E	125	112	102	96	93	87	83	74	125.2	102.7
7	Gas Turbine Transformer - Main	20	23°37'23.93"N	91°11'46.62"E	97	100	99	94	90	86	81	72	104.3	96.3
11	Wash Water Skid for GT	3	23°37'25.39"N	91°11'47.63"E	83	88	87	89	91	89	84	79	96.5	95
13	Fin Fan Cooling Unit for GTG	3	23°37'25.68"N	91°11'47.57"E	98	97	97	96	93	89	85	79	103.7	98
22	Space for ACC	15	23°37'22.12"N	91°11'46.56"E	95	95	90	88	85	81	74	68	99.3	90.2

Source: ADB TA Consultant

Table 5-31: Operational (Combined cycle HRSG) Pre-mitigation Noise Assessment

LAeq, T	Calculated		Assessment Standard		Exceedance Level		Exceedance Level		Impact (Severity)	
	Emission from Operation		GoI and IFC stringent		Specific - IFC EHS		Baseline, LAeq, dB			
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Site Boundary (E)	58.6	58.6	70	70	-11.4	-11.4	17	21.1	Low	Low
Site Boundary (W)	43.9	43.9	70	70	-26.1	-26.1	1	5	Low	Low
Manikyanagar (NV4)	38.0	38.0	55	45	-17	-7	-13.2	-6.8	Minimal	Minimal
School (100m buffer)	39.5	n/a	50	n/a	-10.5	n/a	-8	n/a	Minimal	n/a
Closest House 1	46.8	46.8	55	45	-8.2	1.8	-0.9	4.4	Minimal	Medium
Closest House 2	46.0	46.0	55	45	-9	1	-1.7	3.6	Minimal	Medium
Closest House 3	46.1	46.1	55	45	-8.9	1.1	-1.6	3.7	Minimal	Medium
Closest House 4	45.8	45.8	55	45	-9.2	0.8	-1.9	3.4	Minimal	Medium
Closest House 5	45.3	45.3	55	45	-9.7	0.3	-2.4	2.9	Minimal	Medium
Closest House 6	45.0	45.0	55	45	-10	0	-2.7	2.6	Minimal	Medium
Closest House 7	44.7	44.7	55	45	-10.3	-0.3	-3	2.3	Minimal	Low
Closest House 8	44.5	44.5	55	45	-10.5	-0.5	-3.2	2.1	Minimal	Low
Closest House 9	43.9	43.9	55	45	-11.1	-1.1	-3.8	1.5	Minimal	Low
Closest House 10	43.4	43.4	55	45	-11.6	-1.6	-4.3	1	Minimal	Low

Source: ADB TA Consultant

Table 5-32: Operational (single cycle) pre-mitigation assessment

LAeq, T	Calculated		Assessment Standard		Exceedance level		Exceedance Level		Impact (Severity)	
	Emission from Operation		GoI and IFC stringent		Specific - IFC EHS		Baseline, LAeq, dB			
	Day	Night	Day	Night	Day	Night			Day	Night
Site Boundary (E)	58.3	58.3	70	70	-11.7	-11.7	16.7	20.8	Low	Low
Site Boundary (W)	44.7	44.7	70	70	-25.3	-25.3	1.8	5.8	Low	Low
Manikyanagar (NV4)	39.6	39.6	55	45	-15.4	-5.4	-11.6	-5.2	Minimal	Minimal
School (100m buffer)	40.6	n/a	50	n/a	-9.4	n/a	-6.9	n/a	Minimal	n/a
Closest House 1	47.7	47.7	55	45	-7.3	2.7	0	5.3	Minimal	Medium
Closest House 2	47.1	47.1	55	45	-7.9	2.1	-0.6	4.7	Minimal	Medium
Closest House 3	47.1	47.1	55	45	-7.9	2.1	-0.6	4.7	Minimal	Medium
Closest House 4	46.7	46.7	55	45	-8.3	1.7	-1	4.3	Minimal	Medium
Closest House 5	46.3	46.3	55	45	-8.7	1.3	-1.4	3.9	Minimal	Medium
Closest House 6	45.9	45.9	55	45	-9.1	0.9	-1.8	3.5	Minimal	Medium

LAeq, T	Calculated		Assessment Standard		Exceedance level		Exceedance Level		Impact (Severity)	
Closest House 7	45.7	45.7	55	45	-9.3	0.7	-2	3.3	Minimal	Medium
Closest House 8	45.5	45.5	55	45	-9.5	0.5	-2.2	3.1	Minimal	Medium
Closest House 9	45	45	55	45	-10	0	-2.7	2.6	Minimal	Medium
Closest House 10	44.5	44.5	55	45	-10.5	-0.5	-3.2	2.1	Minimal	Low

Source: ADB TA Consultant

4.2.2. Operational Noise - Assessment results (post-mitigation)

453. The greatest contributors to the overall noise level at noise sensitive receptors for the combined-cycle HRSG and singe cycle scenarios is the HRSG and By-Pass Stack-Exit, respectively. Additional noise mitigation measures for these sources were agreed with TPGL/design consultants, in consultation with one possible manufacturer (General Electric, United States), and the associated sound emission levels are summarized in Table 5-28.

454. An updated operational noise assessment post-mitigation, including consideration of the reduced noise emissions, is presented in Table 5-34 and Table 5-35. As shown, the daytime and night-time noise operational noise criterion is met at each of the assessed noise sensitive receptors.

455. During the Combined cycle HRSG operations at the ‘Closest House 1’, the calculated emission level is equal to the noise limit, therefore an impact that is Medium/Low. The impact is considered Low as the exceedance of the baseline level is less than 3 dB, as advocated in IFC guidelines.

456. During the single cycle operations the greatest impact is Maximum at east plant boundary. Outside Plant the greatest impact is Low.

457. With reference to the risk matrix for significance determination set out in Table 5-2, these receptors are considered to have a High importance, therefore post-mitigation Low magnitude of impacts will be Medium Adverse.

Table 5-33: Operation Post-mitigation Noise Source Details for the Proposed Plant

Assumptions for Combined Cycle – Post Mitigation

Ref. **Ref.to plot plan (CHp 2: Fig 2-5) (project plan equipment ID)**	Noise Source	Source Height, m	Latitude	Longitude	Octave Band Sound Power Level, Lw, dB								Sound Power Level, dB	Sound Power Level, dB(A)
					63	125	250	500	1000	2000	4000	8000		
3.1	Inlet filter house face	10	23°37'25.68"N	91°11'46.85"E	102	98	90	89	86	88	90	95	104.6	97.5
3.2	Inlet filter house and duct	10	23°37'25.78"N	91°11'46.81"E	102	90	81	83	83	87	83	78	102.6	91.3
5	HRSG	2.8	23°37'24.67"N	91°11'48.23"E	111	104	100	99	97	86	72	53	112.4	100.7
6	HRSG Stack - Exit	60	23°37'24.53"N	91°11'48.76"E	103	99	93	92	83	73	69	63	105.0	91.8
7	Gas Turbine Transformer - Main	20	23°37'23.93"N	91°11'46.62"E	97	100	99	94	90	86	81	72	104.3	96.3
11	Wash Water Skid for GT	3	23°37'25.39"N	91°11'47.63"E	83	88	87	89	91	89	84	79	96.5	95
13	Fin Fan Cooling Unit for GTG	3	23°37'25.68"N	91°11'47.57"E	98	97	97	96	93	89	85	79	103.7	98
22	Space for ACC	15	23°37'22.12"N	91°11'46.56"E	95	95	90	88	85	81	74	68	99.3	90.2

Source: ADB TA Consultant

Assumptions for Single Cycle – Post Mitigation

Ref. **Ref.to plot plan (CHp 2: Fig 2-5) (project plan equipment ID)**	Noise Source	Source Height, m	Latitude	Longitude	Octave Band Sound Power Level, Lw, dB								Sound Power Level, dB	Sound Power Level, dB(A)
					63	125	250	500	1000	2000	4000	8000		
3.1	Inlet filter house face	10	23°37'25.68"N	91°11'46.85"E	102	98	90	89	86	88	90	95	104.6	97.5
3.2	Inlet filter house and duct	10	23°37'25.78"N	91°11'46.81"E	102	90	81	83	83	87	83	78	102.6	91.3
4	By-Pass Stack - Exit	30	23°37'24.97"N	91°11'47.32"E	121	108	98	92	89	83	79	70	121.2	98.7
7	Gas Turbine Transformer - Main	20	23°37'23.93"N	91°11'46.62"E	97	100	99	94	90	86	81	72	104.3	96.3
11	Wash Water Skid for GT	3	23°37'25.39"N	91°11'47.63"E	83	88	87	89	91	89	84	79	96.5	95
13	Fin Fan Cooling Unit for GTG	3	23°37'25.68"N	91°11'47.57"E	98	97	97	96	93	89	85	79	103.7	98
22	Space for ACC	15	23°37'22.12"N	91°11'46.56"E	95	95	90	88	85	81	74	68	99.3	90.2

Source: ADB TA Consultant

Table 5-34: Operational (combined cycle HRSG) Post-mitigation Noise Assessment

LAeq, T	Calculated Emission from Operation		Assessment Standard GoI and IFC stringent		Exceedance level Specific - IFC EHS		Exceedance Level Baseline, LAeq, dB		Impact (Severity)	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Site Boundary (E)	57.3	57.3	70	70	-12.7	-12.7	15.7	19.8	Low	Low
Site Boundary (W)	41.7	41.7	70	70	-28.3	-28.3	-1.2	2.8	Minimal	Low
Manikyanagar (NV4)	36.2	36.2	55	45	-18.8	-8.8	-15	-8.6	Minimal	Minimal
School (100m buffer)	36.1	n/a	50	n/a	-13.9	n/a	-11.4	n/a	Minimal	n/a
Closest House 1	45.0	45.0	55	45	-10	0	-2.7	2.6	Minimal	Low*
Closest House 2	44.3	44.3	55	45	-10.7	-0.7	-3.4	1.9	Minimal	Low
Closest House 3	44.5	44.5	55	45	-10.5	-0.5	-3.2	2.1	Minimal	Low
Closest House 4	44.2	44.2	55	45	-10.8	-0.8	-3.5	1.8	Minimal	Low
Closest House 5	43.7	43.7	55	45	-11.3	-1.3	-4	1.3	Minimal	Low
Closest House 6	43.4	43.4	55	45	-11.6	-1.6	-4.3	1	Minimal	Low
Closest House 7	43.1	43.1	55	45	-11.9	-1.9	-4.6	0.7	Minimal	Low
Closest House 8	42.9	42.9	55	45	-12.1	-2.1	-4.8	0.5	Minimal	Low
Closest House 9	42.2	42.2	55	45	-12.8	-2.8	-5.5	-0.2	Minimal	Minimal
Closest House 10	41.6	41.6	55	45	-13.4	-3.4	-6.1	-0.8	Minimal	Minimal

*The calculated emission level is equal to the noise limit therefore an impact that is Medium/Low. The impact is considered Low as the exceedance of the baseline level is less than 3 dB, as advocated in IFC guidelines.
Source: ADB TA Consultant

Table 5-35: Operational (single cycle) Post-mitigation Noise Assessment

LAeq, T	Calculated Emission from Operation		Assessment Standard GoI and IFC stringent		Exceedance level Specific - IFC EHS		Exceedance Level Baseline, LAeq, dB		Impact (Severity)	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Site Boundary (E)	59.2	59.2	70	70	-10.8	-10.8	17.6	21.7	Low	Low
Site Boundary (W)	42.3	42.3	70	70	-27.7	-27.7	-0.6	3.4	Minimal	Low
Manikyanagar (NV4)	36.6	36.6	55	45	-18.4	-8.4	-14.6	-8.2	Minimal	Minimal
School (100m buffer)	37.7	n/a	50	n/a	-12.3	n/a	-9.8	n/a	Minimal	n/a
Closest House 1	44.9	44.9	55	45	-10.1	-0.1	-2.8	2.5	Minimal	Low
Closest House 2	44.3	44.3	55	45	-10.7	-0.7	-3.4	1.9	Minimal	Low
Closest House 3	44.5	44.5	55	45	-10.5	-0.5	-3.2	2.1	Minimal	Low
Closest House 4	44.1	44.1	55	45	-10.9	-0.9	-3.6	1.7	Minimal	Low
Closest House 5	43.7	43.7	55	45	-11.3	-1.3	-4	1.3	Minimal	Low
Closest House 6	43.3	43.3	55	45	-11.7	-1.7	-4.4	0.9	Minimal	Low
Closest House 7	43	43	55	45	-12	-2	-4.7	0.6	Minimal	Low
Closest House 8	42.9	42.9	55	45	-12.1	-2.1	-4.8	0.5	Minimal	Low

LAeq, T	Calculated		Assessment Standard		Exceedance level		Exceedance Level		Impact (Severity)	
Closest House 9	42.2	42.2	55	45	-12.8	-2.8	-5.5	-0.2	Minimal	Minimal
Closest House 10	41.6	41.6	55	45	-13.4	-3.4	-6.1	-0.8	Minimal	Minimal

Source: ADB TA Consultant

4.2.3. Operational Noise - Mitigation

458. The EPC Contractor will ensure that the detailed design complies with the fixed limit criterion (Table 4-23) and that any increase above background levels within those limits is as small as practical. Since only an indicative design has been modelled to assess the noise impact, which may change if the building designs or locations change, it will be necessary for the EPC Contractor to rerun the noise modelling and reassess the noise impact based on their final design. They will need to demonstrate that the impact on the noise assessment criteria will be less or the same impact as presented in the EIA report before their detailed design is approved by TPGL.

459. To achieve the fixed limit criterion during operation, the additional design specification in **Annexure 21** is to be followed plus the following mitigation during detailed design and construction:

- (i) The proposed plant will be designed and constructed to minimize generation of excessive noise from the operation of the plant and turbine.
- (ii) Rotating machinery, such as turbines, pumps, fans etc. to be covered with noise-proof hood to reduce noise emissions, as far as practicable.
- (iii) 3m barrier construction of a material with a surface mass density of at least 10 kg/m^2 so as to be sufficiently imperforate to sound
- (iv) Where possible, appropriate vibration isolation will be provided for all plant items such as turbines, generators, pumps, compressors, and fans from foundations or other structures and from connecting vents, ducts and pipes that might transmit the vibrations to the ground or to the other plant items.
- (v) Units will operate on an auto-start up and auto-shut down sequence to ensure the fastest, most efficient plant start-up and shutdowns. The plant will run through operating checklists, and ensuring all doors, vents, louvers are closed as required during operation to limit the releases of noise from the generator/turbine enclosures.
- (vi) The diesel generators used for emergency power back up will be a “green” generator type – a silent or soundproofed generator housed within enclosure[111]

460. The ESMS developed by TPGL will incorporate mitigation measures for noise (a noise management plan) elaborating on those measures included in the EIA/EMP as follows. Implementation will be supervised by their Environment Officer to ensure compliance with the fixed limit criterion at the site boundary and receptors:

- (i) Maintain power plant equipment in a good condition in accordance with the manufacturer’s specifications as proper maintenance can decrease the level of noise significantly.
- (ii) Ensure power plant equipment is maintained in balance to reduce the generation of vibration at its source.
- (iii) Units to always operate on an auto-start up and auto-shut down sequence to ensure the fastest, most efficient plant start-up and shutdowns. The plant staff will run through operating checklists, and ensuring all doors, vents, louvres are

[111] The diesel generator may be tested periodically as a safety requirement to demonstrate it can still operate and connect to provide the required emergency load. Typically, this testing may involve a 1 hour run every month. Noise mitigation associated with diesel generator noise, in the form of sensitive siting, noise barriers and/ or enclosures, is a well-developed practice, and will be considered as part of the detailed design. Additionally, any testing of the diesel generators will be undertaken during less-sensitive periods of the day.

closed as required during the operation to limit the releases of noise from the generator/turbine enclosures.

(iv) Residents within 500m will be informed well in advance of any noisy maintenance works.

(v) Sound levels received by workers should not be over 85 dB(A) during continuation of 8 working hours or hearing protection must be provided to them.

During operation quantitative monitoring of ambient noise will be undertaken as prescribed in the EMoP in **Annexure 30**, these monitoring requirements will be incorporated into the ESMS.

5. Topography and Landscape /Terrain

461. The project site of 4.5 ha and study area comprises a complex terrain with a series of elevated ridges/hillocks (known as Tilla in local language). According to the topographical contour lines, the existing plant is located on graded land at contour line 98-100. The western side of the Rokhia Thermal Power Station is gradually rising to contour lines of around 110-112. The northern area is also gradually rising to contour lines of around 116-117. The northeastern part of the complex supports the ONGC gas field. The southwestern part of the complex has a raised area at contour lines of around 112-120. In the eastern part of the complex there exists a Tilla identified for installation of proposed plant.

462. To create a level construction platform to accommodate the proposed plant, two hillocks found on the project site will be reduced and overall elevation of the site graded to a uniform level. There will be an estimated cut volume of up to 334,092 m^3 but it is currently anticipated cut and fill can be balanced within the project site by raising its lower areas. The elevation of the project site currently varies between 30 to 49 m and the proposed construction level will raise/lower it to a contour level of 30-31 m. Contour line 98 corresponds to reference level (RL) 30 m AMSL.

463. No changes to topography will occur outside the project site although there is a risk, given the project site is in an area of high landslide risk, that earthworks on site could locally alter the natural drainage flow pattern, affect slope stability, and indirectly affect the adjacent terrain if not well executed. There will also be a change to the landscape to more industrial use as although the Rokhia Thermal Power Station is designated industrial land and the existing power plant is already present, the project site itself still supports degraded forest habitat which will become industrialized with construction. Further the hillocks currently offer screening of the project site to the adjacent properties which will be lost. Impacts are irreversible/permanent and having a large magnitude of change are **Significant.**

5.1. Mitigation

464. There are very few options for mitigation and if the project site is to be developed for a power plant these impacts are unavoidable and thus residual impacts remain High Adverse. However, during detailed design the EPC Contractor can seek to maintain the topography of the project site as it provides screening of the existing and proposed plants to adjacent properties as far as practical. Slope stability including bioengineering techniques and the drainage design will also need to be adequately addressed in line with international engineering best practice; pre-construction activities will include conducting geotechnical investigation and drainage risk assessment to inform the detailed design.

6. Geology and Soils

465. The geology of the project site is unlikely to be impacted because of construction. Construction site preparation including cutting of the hillock and earthworks will however involve the removal of fertile topsoil currently supporting vegetation and tree growth from across the 4.5 ha project site, a cut volume of topsoil and subsoil, and soil compaction to create a level construction platform and from the passage of construction vehicles etc. The soil that will be cut from the hillock is planned to be reused on the project site as fill to raise lower areas; this is preferable to disposing of it off-site. Baseline monitoring of soil quality shows that there is no contamination of heavy metals or similar, so reuse is a suitable option reducing impacts associated with off-site transportation and disposal. Though it is anticipated that all soil will be retained on the project site its soil structure and fertility will be irreversibly/permanently lost affecting the future productivity of the land if brought out of industrial use, the impact will be a large magnitude of change and **Significant.**

466. Once the project site is cleared of vegetation and trees, soils will be exposed for the 36 month construction period. Since there will be no vegetation left to bind the soil, it will be easily eroded by rainfall especially heavy rainfall during the monsoon. Since a level construction platform will be created, although surface water drainage will be altered, this should help slow down runoff. There is also a risk, given the project site is in an area of high landslide risk, that earthworks on site could locally alter the natural drainage flow pattern, affect slope stability, and result in soil erosion. Since these impacts are confined to the project site and immediately adjacent land they are **Not Significant.**

467. During both construction and operation inadequate storage, handling and transport of fuels, oils, lubricants, and chemicals as well as wastes could lead to contamination of soils. Spills are most likely to be of small volume and occur accidentally around storage areas and during transfer of fuels, oils, lubricants and chemicals into store and into equipment. In most cases leaks would also be of small volume around equipment, but there will be 6,000 liters of lubricant in the closed system, and 2,500 liters of diesel fuel for emergency generation which in a worst-case could potentially leak to soil. If wastes are disposed of on-site either intentionally or due to poor housekeeping leading to debris being left around this could also result in soil degradation. Discharge of untreated effluent to land is another potential source of soil contamination but as the design includes an Effluent Treatment Plant and sanitary sewage will also be treated any effluent used for gardening (irrigation) will comply with standards and not cause contamination. There is a moderate risk of soil contamination during construction and operation, but this is **Not Significant**.

6.1. Mitigation

468. There are very few options for mitigation related to soil structure and fertility and if the project site is to be developed for a power plant these impacts are unavoidable and thus residual impacts remain. However, during construction the EPC Contractor will be responsible for minimizing soil erosion through the preparation of a soil management plan as part of its CEMP incorporating mitigation measures from the EMP (**Annexure 28**) such as:

(i) Minimizing the removal of existing vegetation and topsoil within the project footprint to only that which is necessary for construction.

(ii) Scheduling all earthworks during the dry season to minimize exposed areas subject to erosion by surface water runoff.

(iii) Topsoil disturbed during earthworks and foundation excavations will be separately stripped and stored and used to create green belt and for gardening on completion.

(iv) Topsoil will be stored in a designated area in low level spoil heaps to reduce compaction and retain soil structure and fertility to the extent possible; spoil heaps to be covered to prevent soil erosion by wind blow and surface water runoff.
(v) Cut and fill in the construction area will be balanced as much as possible, if suitable options for use of inert fill as a CSR activity cannot be found excess spoil must be taken off-site it will be disposed of at a licensed landfill which is appropriate for the accepting of inert wastes.

469. For operational impacts in relation to soil contamination risk, the detailed design of all equipment containing liquid hazardous materials (e.g., transformers, diesel fueled generators) and fuel, oil chemical, and waste storage areas will need to incorporate impermeable concrete surface bunded area to at least 110% volume (Chapter 2) which is not connected to the drainage system to collect spills and leaks. The detailed design will also need to provide the covered storage area of sufficient size to accommodate all anticipated storage requirements etc.

470. During construction the EPC Contractor will also be responsible for the preparation of a pollution prevention plan including spill and leak response procedures and part of its CEMP. During operation TPGL will be responsible for the same and a spill and leak response plan is to form part of its ESMS with implementation supervised by their Environment Officer. These plans will incorporate mitigation measures from the EMP (**Annexure 28)** for the environmentally safe and sound transportation, storage and handling of fuel, oil, lubricants, and chemicals and how to response to spills and leaks such as:

(i) All fuel, oil, lubricants, and chemicals are to be stored in clearly labelled, sealed containers, tanks or drums which are kept in a secured (fenced) area under lock and key on an undercover impermeable bunded surface to at 110% volume.
(ii) Fuel, oil, lubricants, and chemicals actively in use to also be stored in clearly labelled, sealed containers and, if temporarily not kept on an impermeable bunded area, to be kept on drip trays to provide a secondary containment. There should be no full or empty containers, tanks or drums that are left on open ground.
(iii) Refueling operations, equipment servicing and washdown to take place on an impermeable surface with drainage directed through oil and grease interceptors before being discharged into settling pond prior to discharge. No vehicle or equipment maintenance activities will be permitted to take place on open ground.
(iv) Drip pans will be used during all filling or fueling activities to catch any spills or leaks.
(v) Store and dispose of waste in designated areas to prevent soil degradation.

7. Water

7.1. Construction including Demolition

471. There will be no direct or indirect impacts on surface water since the nearest major surface watercourse is the Silda River located at 3.5 km from the project site and the nearest other waterbody a pond at 0.3 km. Due to the distance of the construction activities and the proposed plant from this river and pond, discharge of untreated effluent to land, sediment laden runoff or spills or leaks of liquids used during the construction phase will be unlikely to reach them. Further due to the use of air-cooled condensing there will be no thermal discharge for disposal, and as the proposed plant will be zero discharge no effluent disposal to surface water.

472. The project site is vegetated land which acts as natural recharge area for below aquifers. Due to the construction of up to 3.75 ha of impermeable surface and converting to industrial development, there will be potential reduction in local ground water recharge and on the other hand and increase in water logging, surface water runoff and flood risk to the adjacent land. However, given the setting of the project site these impacts are of low magnitude and **Not Significant.**

473. Groundwater resources required for the construction, and effluent for disposal also need to be considered. During the construction phase up to 350 laborers would be engaged. There will also be about 30 TPGL staff on site during construction works, so 380 workers in total. These workers will require drinking water. Given the baseline water quality testing undertaken it will be possible to provide the drinking water required from on-site groundwater subject to basic treatment/disinfection. Water will also be required for construction works, for example, for sprinkling of water for dust suppression, washing of vehicles etc. It is calculated that around 15 m3/hour of water up to 80 m^3/day will be required during construction. Overall, the water stress is low in the study area. However, some localized water stress has been reported by residents to the east of the project site during the dry season and so water abstraction will need to be carefully managed. The requirement for construction water will be short term and of medium magnitude; it is **Not Significant**.

474. There will be increased risk of ground contamination from discharge of untreated effluent to land, leaks, and spills. Inadequate storage, handling and transport of fuels, oils, lubricants, and chemicals as well as wastes could lead to contamination of groundwater. Spills are most likely to be of small volume and occur accidentally around storage areas and during the transfer of fuels, oils, lubricants, and chemicals into store and into equipment. The use of water resources will result in wastewater generation from various activities with treated water reused for groundwater recharge and landscaping/green belt. Disposal of untreated effluent from sanitation and welfare facilities but also, for example, because of washing of vehicles direct to ground would cause groundwater pollution. There is a moderate risk of ground contamination during construction phase and although there is no ecology relying on groundwater given the moderate permeability of the sandy loam soils (so any contamination could but will not readily reach below groundwater) and that below aquifers (confined by low permeability clayey formation) are used by drinking water for the local community impacts could be of medium magnitude but **Not Significant.**

7.2. Construction Mitigation

475. If the project site is to be developed for a power plant the creation of impermeable surfaces is unavoidable. However, through detailed design several measures can be taken to reduce the impact on groundwater recharge and flood risk. To inform the detailed design a drainage risk assessment will be undertaken with adequate drainage design, on-site storage (e.g., retention ponds) and Green Belt creation to ensure that surface water runoff from the project footprint will be no more than greenfield runoff rates and will not exacerbate waterlogging or flood risk on adjacent land.

476. For construction water, the EPC Contractor will be required to adopt rainwater harvesting which can be used to help replenish groundwater that is abstracted. The requirement of construction water for service, domestic and fire system purposes will be drawn from the new boreholes which are to be set up by the EPC Contractor for supplying the proposed plant during operation. The permission will be sought by TPGL from CGWB before establishing the borewells.

477. During construction the EPC Contractor will also be responsible for the preparation of a pollution prevention plan including spill and leak response procedures and part of its CEMP. This will incorporate mitigation measures from the EMP (**Annexure 28**) for the environmentally safe and sound transportation, storage and handling of fuel, oil, lubricants, and chemicals, how to response to spills and leaks and deal with sanitation and welfare facility wastewater such as:

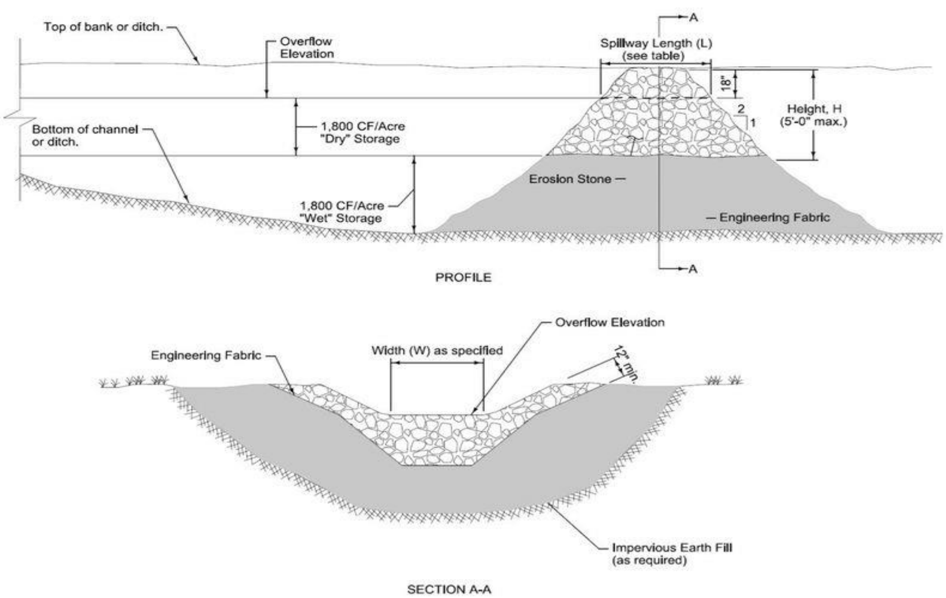
(i) Sanitation facilities to be connected to septic tanks with soak-away located 100 m from any groundwater well (existing bore well is about 250m from proposed plant) or a package sewage treatment plant, or alternatively sanitary facilities that do not allow the untreated disposal of sewage direct to adjacent water bodies will be used e.g., mobile toilets for disposal of wastewater off-site to the nearest municipal sewage treatment works; same requirement applies to any staff accommodation provided by contractor.

(ii) No untreated wastewater is to be discharged direct to surface water or the ground.

(iii) Strict prohibition on open defecation and urination by construction workers; use of pit latrines is not permitted.

(iv) Contractors to schedule all earthworks during the dry season to minimize exposed areas subject to erosion by surface water runoff and install cut-off drains across the project footprint to minimize volumes of sediment laden runoff from the construction site requiring treatment via a sedimentation pond. Construction of three-stage sedimentation ponds/tanks (Figure 5-19) with an inlet, mid, and outlet section is required to allow sediment to settle out of surface water runoff before release of water to ground. Silt fences will be used to channel surface water runoff to the sedimentation pond/tank. The working volume of the sedimentation pond/tank must be sufficient to allow for a minimum hydraulic retention time of at least 120 minutes under the peak surface water runoff conditions. If runoff rates exceed the capacity of a sedimentation pond/tank, one or more additional sedimentation ponds/tanks will be needed in parallel to accommodate the higher flow rates. Maximum sediment accumulation in the sedimentation pond/tank must be 25% or less.

Figure 5-19: Plan for Sedimentation Pond

	**Section and profile of typical sedimentation pond/tank**
	**Illustrations of actual sedimentation ponds/tanks**

Source: Minnesota Strom Water Manual, https://www.eng.auburn.edu/research/centers/hrc-temp/news/erosion-control.html, https://cals.ncsu.edu/crop-and-soil-sciences/extension/training-programs/workshops/erosion-and-sediment-control/

(v) Spraying of water on-site and along access roads will be done using just the right quantity of water to suppress the dust whilst avoiding excess surface water runoff or the ponding up of water.

(vi) All fuel, oil, lubricants, and chemicals are to be stored in clearly labelled, sealed containers, tanks or drums which are kept in a secured (fenced) area under lock and key on an undercover impermeable bunded surface to at 110% volume.

(vii) Fuel, oil, lubricants, and chemicals actively in use to also be stored in clearly labelled, sealed containers and, if temporarily not kept on an impermeable bunded area, to be kept on drip trays to provide a secondary containment. There should be no full or empty containers, tanks or drums that are left on open ground.

(viii) Refuelling operations, equipment servicing and washdown to take place on an impermeable surface located at least 100 m from any groundwater well with drainage directed through oil and grease interceptors before being discharged into settling pond prior to discharge. No vehicle or equipment maintenance activities will be permitted to take place on open ground.

(ix) Drip pans will be used during all filling or fuelling activities to catch any spills or leaks.

(x) Maintain adequate supplies of spill containment equipment/absorbents such as sand immediately on-hand in the event of an incident.

478. During construction quantitative monitoring of effluent being discharged from sedimentation ponds and septic tanks as well as ambient water quality will be undertaken as prescribed in the EMoP in **Annexure 30.**

7.3. Operation

479. As with construction, there will be no direct or indirect impacts on surface water from the discharge of untreated effluent to land, sediment laden runoff or spills or leaks of liquids used. Further due to the use of air-cooled condensing there will be no thermal discharge for disposal, and as the proposed plant will be zero discharge there will be no effluent disposal to surface water.

480. During operation the proposed plant would be staffed by about 98 persons. These staff will require drinking water. Given the baseline water quality testing undertaken it will be possible to provide the drinking water required from on-site groundwater subject to basic treatment/disinfection.

481. Water will also be required for process water and fire system as discussed in Chapter 2. Given limited surface water resources in the study area, groundwater will be used and an air-cooled condenser at an additional cost of $50,000 (INR 372 million) will be used to limit the need for water extraction. The amount of water required has already been significantly reduced by the adoption of air-cooled condenser as a design requirement. It is calculated that with the ACC around 20 m^3/h of water will be required (480 m^3 per day) during the operational phase – this is around 0.2 m^3/MWh so compliant with the Gazette notification of MoEF&CC dated 15.12.2015 which states that "*new plants to be installed after 1st January 2017 shall have to meet specific water consumption up to maximum of 2.5 m3/MWh and achieve zero wastewater discharged.*"

482. . The proposed plant will consume more water than the existing plant and hence additional deep tube wells will be required for capacity enhancement. Two new boreholes will be dug at the proposed plant, and seven days of storage, plus 2-hour fire water reserve, planned to meet the operational water requirements with the water supply going through pre-treatment as discussed in Chapter 2. Some localized water stress has been reported by residents to the east of the project site during the dry season, but overall groundwater resources are not in short supply and the community from the larger study area did not report any water stress. Government of Tripura and various secondary sources also confirm that there is sufficient ground water in the study area. It can be assumed that the based on the topography of the land on which the nearest houses are built, the water stress is possible, as the ground is elevated from the rest of the area.

483. In terms of future water availability, Agartala's precipitation scenario is seen to be trending on the wetter side, as the indices (positive-wet, negative-dry) are seen to become increasingly positive towards the end of the 21st century relative to 1986-2005 conditions. The 20-year period projection SPI is 0.1 for the period 2030s; 0.1 for 2050s and 0.43 for 2070s. There have been no incidences of drought in the Sipahijila district which will house the proposed plant. The operational ground water requirement of the proposed plant is therefore of medium magnitude in the long-term, although water abstraction will need to be carefully managed it is **Not Significant.**

484. The increased risk of ground contamination from discharge of untreated effluent to land, leaks, and spills will continue during operation. Inadequate storage, handling and transport of fuels, oils, lubricants, and chemicals as well as wastes could lead to contamination of groundwater. Hazardous solids and liquid materials will be used during the operational phase, process chemicals possibly including acids, alkalis, chlorine, hydrazine, and phosphate tri-sodium phosphate will be stored in a chemical dosing building as well as smaller quantities of materials like transformer oils, paints, etc. Spills are most likely to be of small volume and occur accidentally around storage areas which will need to be suitably designed to minimize risk, and

during the transfer of fuels, oils, lubricants, and chemicals into store and into equipment. In most cases leaks during operation would also be of small volume around equipment, but there will be 6,000 liters of lubricant in the closed system, and 2,500 liters of diesel fuel for emergency generation brought to the project site which in a worst-case could potentially leak to soil and thus percolate down into the groundwater.

485. The use of water resources will result in about 169 m^3/day process wastewater generation per day from various activities; plus domestic sanitary wastewater of about 13 m^3/day. Disposal of this untreated effluent direct to ground or indirectly through its use in gardening (irrigation) would potentially cause groundwater pollution. Process effluent will be contaminated with demineralizers, oils, lubricants, and chemicals which are added to manage the quality of water, and particular attention needs to be paid to ensuring that the pH, residual chlorine, and any toxic chemicals used as additives to treat the water are adequately treated.

486. There is a moderate risk of ground contamination during operation phase and although there is no ecology relying on groundwater given the moderate permeability of the sandy loam soils (so any contamination could but will not readily reach below groundwater) and that below aquifers are used by drinking water for the local community impacts could be of medium magnitude but **Not Significant.**

7.4. Operational Mitigation

487. Gazette notification of MoEF&CC dated 15.12.2015 states that "*new plants to be installed after 1st January 2017 shall have to meet specific water consumption up to maximum of 2.5 m3/MWh and achieve zero wastewater discharged*" – this is to be complied with by the proposed plant. Ground water withdrawal for the 0.2 m3/MWh (20 m3/hr) of water required to operate the proposed plant will be subject to a withdrawal permit to be obtained for appropriate volume to be drawn before construction from the Water Resource Investigation Division, Agartala and the Central Ground Water Board, GoI, and included in the conditional Content to Operate (CTO) license from the Tripura State Pollution Control Board following a detailed hydrogeological assessment. As per CGWA all applications for permission/NOC are to include an **impact assessment report/comprehensive hydrogeological report/water audit report for renewal cases and other mandatory documents including the Consent to Establish (CTE) from TPCB, as per the notified CGWA guidelines**.

488. The Water Resource Investigation Department, GoT has already indicated there is adequate groundwater available in the study area, but community consultations flagged that there are very localized variations in the availability of water during the dry season. The nearest residents reported during consultation that they experience water shortages during the dry season whereas the residents of the nearest village, Manikyanagar and from the larger study area, have stated that there is no water stress. Further hydrogeological studies by TPGL will therefore collect additional baseline data on existing water supplies and groundwater levels and address potential impacts on water stress as well as the availability of water supply considering all seasons and users. The aquifer which currently experiences water shortages during the dry season is to be avoided unless it is demonstrated that adequate yield is available to meet the demands of all users.

489. Since the aquifer to be tapped for operational supply and its yield will not be finally determined until detailed design TPGL will need to ensure that abstraction of groundwater for the proposed plant does not compromise the existing local water supplies where the same aquifer is being tapped. Once the aquifer for abstraction and its yield has been confirmed, if

there is a risk groundwater abstraction by the proposed plant could compromise local water supplies, a piped water supply will be provided to affected properties by TPGL, tapping into the same groundwater source as TPGL, before the proposed plant becomes operational. If no risk is envisaged, TPGL will monitor groundwater levels on an ongoing basis to determine if water stress experienced by local communities may be due to their abstraction and put in place a backup plan, providing an immediate solution such as canned water, in case of an unanticipated impact. TPGL will also consider undertaking preemptive mitigation, since providing an alternative piped water supply in advance will provide the nearest residents with a community benefit. Preemptive mitigation by TPGL to provide an alternative piped water supply to the adjacent residents to the east in advance of abstraction is preferred and could be undertaken by TPGL as a CSR activity even if there is limited risk of exacerbating water stress.

490. The plant will be zero discharge with the treated wastewater used for site irrigation and incorporate rainwater harvesting to reduce withdrawal intensity. Developing the detailed design to enable treated effluent and harvested rainwater to be recharged to groundwater and for use in gardening (irrigation) will enable TPGL to meet the mandated GoI zero-discharge requirement.

491. Detailed design of the proposed plant will include the containment measures discussed in Chapter 2 with hazardous materials stored according to the requirements of their material safety data sheets. During operation TPGL will be responsible for pollution prevention measures and a spill and leak response plan is to form part of its ESMS with implementation supervised by their Environment Officer. The ESMS will incorporate mitigation measures from the EMP (**Annexure 28**) for the environmentally safe and sound transportation, storage and handling of fuel, oil, lubricants, and chemicals and how to response to spills and leaks as with construction.

492. For treatment of process wastewater an Effluent Treatment Plant (ETP) as described in Chapter 2 but subject to detailed design by the contractor will be installed to limit the quality of effluent to be discharged from the proposed plant within the prescribed norms and guidelines as set out in Table 5-36. Effluent streams must be sampled using continuous automated sampling and the water quality levels achieved as 95%iles upstream of the discharge to the CMB/guard pond. The final effluent treatment process will be subject to detailed design by the EPC Contractor, but at a minimum must include oil separator, settlement, and for all acidic streams such as demineralization regeneration wastewater to be neutralized (self-neutralization of dosing for pH correction) before discharge to the CMB/guard pond. Continuous automatic monitoring system for pH, TSS, BOD, COD, TOC, NH_3 plus temperature, flow and conductivity will need to be installed on all effluent streams.

Table 5-36: Process Wastewater Standards

Parameter	Maximum Concentration (mg/l, except pH and temperature)
pH	6.5-8.5
Total Suspended Solids	50
Oil and grease	10
Free available chlorine or total residual chlorine	0.2
Chromium - total (Cr)	0.2
Copper – total (Cu)	0.5
Iron – total (Fe)	1.0
Zinc (Zn)	1.0

Parameter	Maximum Concentration (mg/l, except pH and temperature)
Lead (Pb)	0.5
Cadmium (Cd)	0.1
Mercury (Hg)	0.005
Arsenic (As) 0.5	0.5
Phosphorous	0.5
Other corrosion inhibiting materials	Guideline value to be established on a case-by-case basis through the EIA process
Temperature increases by thermal discharge from cooling system	• The effluent should result in a temperature change of no more than 3°C at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors, and assimilative capacity. The EIA for a specific project may specify a more stringent temperature change guideline • Elevated temperature areas due to discharge of once-through cooling should be minimized by adjusting intake and outfall design through the project specific EIA depending on the sensitive aquatic ecosystems around the discharge point • The mixing zone may be established by local regulatory agencies or through the project's EIA process. It should also be minimized as far as practicable.

Source: GoI and WB IFC EHS Guidelines 2007 https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERES&CVID=ls4Xbfn (most stringent)

493. For treatment of sanitary wastewater septic tank with up-flow filter and chlorination is proposed by the DPR for a workforce of 98 persons. Given the volume to be treated other wastewater treatment processes, such as package sewage treatment plant, may be more space efficient and are preferred, but the detailed design of sanitary wastewater treatment will be determined by the EPC Contractor. The treated sanitary sewage must meet the standards in Table 5-37. Continuous automatic monitoring system for pH, TSS, BOD, COD, TOC plus temperature, flow and conductivity will need to be installed to monitor the treated effluent's water quality. Soak ways for discharge to ground will need to be located 100m from any groundwater well.

Table 5-37: Indicative Values for Treated Sanitary Sewage Discharges

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD mg/l 30	mg/l	30
COD mg/l 125	mg/l	125
Total nitrogen mg/l 10	mg/l	10
Total phosphorus mg/l 2	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400

Arsenic	mg/l	0.2
Cyanide	mg/l	0.2

b MPN = Most Probable Number
Source: GoI, land for irrigation standards http://ismenvis.nic.in/Database/Environmental_Standards_7391.aspx and WB IFC EHS Guidelines 2007 https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERES&CVID=ls4Xbfn (most stringent)

494. During operation TPGL will be responsible for pollution prevention measures and a process and sanitary wastewater treatment plan is to form part of its ESMS with implementation supervised by their Environment Officer. The ESMS will incorporate mitigation measures from the EMP (**Annexure 28)** including:

(i) No untreated wastewater is to be discharged.
(ii) Septage from any septic tanks will need to be tankered off-site and disposed of at the nearest municipal wastewater treatment works with capacity – given limited capacity an alternative wastewater treatment process like package STP is recommended to be installed.[112]
(iii) Use of corrosion inhibiting chemicals containing zinc and chromium and brominated biocides in the proposed plant is prohibited.
(iv) Use of minimal quantities of chlorinated biocides or alternatively shock dosing of chlorine (instead of a continuous low-level feed) are the preferred means of water treatment.

495. During operation quantitative monitoring of effluent being discharged (using continuous automatic monitoring system with periodic sampling for the full suite of water quality parameters) as well as ambient water quality will be undertaken as prescribed in the EMoP in **Annexure 30.**

[112] Only one MWTP at Agartala, about 30km from site. Septage: only two functioning cess-pools which can cater only 6-8 orders per day. https://agartalacity.tripura.gov.in/sites/default/files/Presentation_Plan_0.ppt

8. Natural Resource Use and Waste Generation

8.1. Construction including Demolition

496. For construction of the proposed plant various raw materials would need to be used including gravel, sand, cement, steel, hazardous and non-hazardous chemicals, fuels, oil, lubricants etc. Extraction of natural resources may have a negative impact on the local environment where they are extracted. Procurements of construction materials would be done by the EPC Contactor from existing licensed sources, TPGL registered persons/vendors and/or local market. No new sources (e.g., borrow pits, quarries) will need to be opened for construction, although due to the large scale of construction a large volume of material will be required for it. The impact of raw natural resource use for the construction is therefore considered Medium Adverse and **Not Significant**.

497. The construction phase will generate significant volumes of inert spoil from demolition, cutting of the hillock, earthworks, and excavations. As much inert spoil as possible will be reused on-site through balancing cut and fill to reduce the need for transportation off-site with its associated impacts. No asbestos was found present in the existing buildings so demolition rubble should be inert and suitable for reuse without affecting the soil quality or human health, although this will be confirmed following survey by competent person employed by the EPC Contractor. However, any excess spoil, that is not managed and reused/disposed of off-site properly may impact on the landscape and soil quality of local communities where it is indiscriminately dumped. If disposed of near waterbodies surface water runoff across loose spoil may also result in sediment pollution, especially since the study area is undulating and gentle rolling terrain. Since it is anticipated most spoil can be reused on-site the impact will be Medium Adverse and **Not Significant.**

498. Construction generated solid wastes will include cleared vegetation, concrete wastes, damaged and unused equipment parts, timber and metal offcuts, packaging materials (e.g., cardboard, wood, plastic, polystyrene), food wastes, etc. This includes domestic waste from any offices, canteens or worker camps including food waste, waste vegetable oils, plastic, glass, cans/metal, and wastepaper. 350 construction workers (EPC) and 30 TPGL staff are expected to be present. Domestic garbage per person is estimated at 400 grams per day per person. This would result in generation of such waste of about 152 kg by 380 people in a day. Poor handling, storage, transport, and indiscriminate disposal of solid waste in and around the project site will affect the landscape/visual aesthetics, soil, and water quality as well as human health due spreading of disease by vermin etc. The impact is reversible with remediation, but if not properly managed, impacts of waste inappropriately disposed during construction would remain during the life of the project, potentially spreading across the project site and beyond. This is very likely to take place if proper management is not adopted. Given the large volume of solid waste to be generated during construction and disposed off-site and the lack of engineered sanitary landfill in Tripura to dispose of the generated waste at, the impact is considered High Adverse and **Significant.**

499. Hazardous wastes will also be generated from construction, including fuels, oils, lubricants, empty drums and containers, paint cans, oily materials, rags, etc. There may also be e-waste from broken computers used at the construction offices etc. Inappropriate handling, storage, transportation, and disposal of hazardous wastes could significantly impact the environment, contaminating soil or water sources, and human health of workers and local communities due to risks of toxic exposure etc. Considering the amount and type of waste likely to be generated, the impact maybe reversible but it may take some time for the conditions to

return to normal and would require active intervention for remediation. Given no hazardous waste facilities exist in Tripura, the amount and type of waste generated the impact is considered High Adverse and **Significant**.

8.2. Construction Mitigation

500. The CEMP prepared by the EPC Contractor before construction commences will include a Solid and Hazardous Waste Management sub-plan dealing with all inert, solid, and hazardous waste generated in an environmentally sound and safe manner, as per GoI regulations and the IFC EHS General Guidelines section on Waste Management. Further details of the required mitigation measures to be reflected in the CEMP are given in the EMP mitigation plan (**Annexure 28**) but measures will include:

(i) Construction materials (especially sand and gravel) will be sourced from existing approved sources with operating licenses, and records kept of all the materials used and their source.

(ii) Prior to the start of works the contractors will ensure an appropriate waste management collection, storage and disposal system for domestic solid waste and construction waste is established at the construction sites and any temporary workers camps/overnight accommodation. Separate waste containers (drums, bins, skips or bags) will be provided for different types of waste. Collect and segregate construction wastes including scrap metal, oil, and solid waste; provide regular toolbox talks and ensure all workers are familiar with the need for waste management, segregation and arrange colour marked garbage bins to collect these different wastes so they are not thrown on the floor.

(iii) Waste shall be managed according to the waste management hierarchy of reduce waste generated, reuse waste materials where possible, recycle materials and finally safely and soundly dispose of residual waste material. Encourage recovery of recyclable wastes that could be reused or sold to recyclers, rather than disposing of it.

(iv) Store all the wastes produced in an environmentally sound manner in designated, clearly labelled bunded area with separate waste containers (drums, bins, skips or bags) clearly labelled for each distinct type of waste. E.g., solid waste within enclosed bins to contain odours, leachate and avoid vermin, hazardous waste storage must incorporate impermeable concrete surface bunded to 110% volume which is not connected to the drainage system to collect spills and leaks.

(v) Ensure stored wastes are regularly removed from site and not allowed to build up in excess quantities.

(vi) Prohibit open burning of construction wastes.

(vii) Prohibit dumping of construction wastes on-site, adjacent to roads, in drains, agricultural fields, disposing of them at unlicensed waste management facilities, unsanitary open dumps etc.

(viii) Prohibit use of waste (e.g., empty cement bags and containers, plastic, wooden planks) for backfilling – only inert spoil may be used for backfilling to avoid need for off-site disposal

(ix) Document all wastes generated and removed off site using transfer notes, to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste according to type to suitably licensed and engineered waste management facilities.

(x) Any plant equipment that is rejected during installation and commissioning due to damage or failure shall immediately be removed from the site and returned to the supplier.

501. Licensed engineered solid waste landfill do not exist in Tripura (only open dump sites at present, which must not be used by the contractor since they are not an environmentally safe and sound. The nearest suitable waste management facilities are at Assam (reusers/recyclers) and West Bengal (where this is a solid and hazardous waste engineered landfill site). Using municipal waste collection systems may mean waste is open dumped (and will put pressure on those waste management facilities that are available to the local community given disposal volumes) so the EPC contractor through TPGL will need to make their own arrangements for disposal. MOU with authorized waste facility to be executed by TPGL. Hazardous waste including waste oils will need to be safety stored for recycling or disposal in neighboring Assam or West Bengal where suitably licensed hazardous waste management facilities exist.

8.3. Operation

502. The power plant will use natural gas which is a non-renewable fossil fuel. Based on current global reserves natural gas resources will be depleted in around 45-55 years. Natural gas contributes to about a quarter of global energy consumption. In India, however, it constitutes only 6% of the energy consumed, while crude oil and coal dominate energy generation. Long term use can deplete the domestic reserves of natural gas requiring remaining reserves to be extracted using the process of fracking with its associated environmental impacts. Besides the extraction of natural gas also releases methane into the air. Though the proposed plant will not use any more natural gas than the existing plant does it will extend the period of natural gas extraction by 25 years. Use of natural gas to generate power is therefore considered Maximum Adverse and **Significant** in terms of natural resource depletion.

503. Solid and hazardous wastes generated during operation will include damaged equipment parts, scrap metal, oils, paints, solvents and grease, or packaging materials from undertaking maintenance works; domestic waste created from offices, canteens, and accommodation including spent office consumables like printer cartridges, food waste, waste vegetable oils, plastic, glass, cans/metal, and wastepaper; and e-waste from broken computers used at the construction offices etc. About 98 (20-30 vendors and 78 TPGL staff) workers are expected to be employed. Domestic garbage per person is estimated at 400 grams per day per person. This would result in generation of such waste of about 39 kg by 98 people in a day. It will also include the following process waste streams:

(i) Used generator and turbine lubricant oil – to be collected in a tank on site and then removed off-site in drums for disposal.
(ii) Spent gas turbine fabric air filter cartridges.
(iii) Spent gas turbine lube-oil filter cartridges.
(iv) Sludge from water treatment plant.
(v) Dry solids (mineral salts) and spent resins recovered from water demineralization;
(vi) Spent laboratory chemicals from water testing and water treatment.
(vii) Sludge from water, process effluent and sanitary wastewater treatment – about $96m^3$/day, 12m3/day and 39 m3/day respectively, separated oil will be generally sold out after recovery as it finds a good local market.

504. Poor handling, storage, transport, and indiscriminate disposal of solid waste in and around the project site will affect the landscape/visual aesthetics, soil, and water quality as well

as human health. This is very likely to take place if proper management is not adopted. Considering the amount and type of waste likely to be generated, the impact maybe reversible but it may take some time for the conditions to return to normal and would require active intervention for remediation. Especially given no hazardous waste facilities exist in Tripura, the impact of the amount and type of solid and hazardous waste generated is considered High Adverse and **Significant**.

8.4. Operational Mitigation

505. Implementation of mitigation will need to start at detailed design to ensure adequate waste management facilities are available including dedicated waste segregation and bunded storage areas for solid and hazardous waste. Separate waste containers (drums, bins, skips or bags) will be provided for different types of waste for temporary storage before selling to vendors or disposing of them using licensed waste contractors who should reuse/recycle or dispose of the waste according to type to suitably licensed and engineered waste management facilities. Composting of biodegradable wastes can take place on site if adequate facilities are included in the detailed design, the resulting compost generated can be used for gardening of the Green Belt.

506. During operation TPGL will be responsible for wase management and a Solid and Hazardous Waste Management Plan dealing with all solid and hazardous waste generated in an environmentally sound and safe manner, as per GoI regulations and the IFC EHS General Guidelines section on Waste Management, is to form part of its ESMS with implementation supervised by their Environment Officer. Per construction priority is to be given to reduction, reuse, composting of biodegradable (e.g., food waste) and recycling of non-biodegradable wastes (e.g., plastics, cans, e-wastes) but any residual solid and hazardous waste will need to be disposed of as per construction waste by TPGL. TPGL will provide regular toolbox talks and ensure all workers are familiar with the need for waste management, segregation and arrange color marked garbage bins in offices and accommodation to collect different wastes (e.g., degradable, or non-degradable) so that the wastes are not thrown on the floor by the workers. Logbook will be maintained by TPGL of all the waste generated and its disposal route during operation.

G. Potential Socio-economic Impacts and Mitigation

507. The assessment of socio-economic impacts has considered the following context and project activities:

- (i) The proposed plant will not entail any additional land requirement or expansion of the existing Rokhia Thermal Power Station owned by TPGL. No land acquisition or resettlement is envisaged.
- (ii) Existing access road infrastructure will be utilized for transportation.
- (iii) During the operational phase the major raw material - natural gas - will be transported from the GCS through short length of new pipeline with water from two new boreholes on the project site; however, the manpower and other materials will be transported using the existing access roads.
- (iv) There will be a very large change in the workforce during construction, but less change in the workforce during the operation phase. Most of the workforce is likely to be from Tripura.
- (v) Though the project site is designated as industrial land it is currently occupied by couple of buildings and forest habitat.

508. Taking into account the socio-economic baseline and resources/receptors the socio-economic impacts are considered to be minimal adverse or beneficial, except for the following which are assessed in this section:

(i) Occupational Health and Safety of all workers
(ii) Community Health and Safety for adjacent residents/along access roads including unauthorized access, dust, noise, vibration, traffic safety, fire, explosion, etc.
(iii) Land use and livelihoods – loss of access due to closure of TPGL private road, damage to property and utilities, pressure on community infrastructure and services
(iv) Landscape and visual impact

1. Occupational Health and Safety

509. The proposed plant is expected to create about 380 (350 EPC workers and 30 direct workers hired by TPGL) direct employment opportunities during the peak of the construction period, which will be approximately 36 months in duration. Most workers will be engaged by the EPC contractor and their subcontractors and will consist of a semi-skilled to skilled workforce. Both local and external laborers will be utilized by the EPC contractor.

510. The operation phase is planned for a lifespan of 25 years and will involve around 98 including 78 permanent TPGL site employees and estimated 20-30 workers hired by operation and maintenance vendors (temporary) including mix of skilled, semi-skilled and unskilled staff. As TPGL is a Government of Tripura undertaking most of the skilled personnel will be from the state while some may be from other states and directly employed by TPGL. Semi-skilled and any unskilled laborers (e.g., cleaners, gardeners) may be contractually recruited by TPGL for the operational period both locally and from the state.

511. Construction and operational worker’s rights need to be respected in accordance with GoI laws and regulations to avoid accident and injury as well as abuse, discrimination, and gender-based violence whilst ensuring fair treatment, renumeration and safe working and living conditions. This is applicable not only for workers who are directly employed, either formally or informally by the EPC Contractor and TPGL but also their contractors (including sub-contractors) and workers within the supply chain. The main risks in relation to worker’s management and rights are associated with the use of contractors and subcontractors and the supply chain.

512. In terms of ensuring occupational H&S the risks to be managed will be greatest during construction when there will be most workers on the project site, traffic movements, manual handling, operation of heavy construction machinery and plant such as excavators and pile drivers, use of handheld power tools such as angle grinders, welding tools etc., open trenches, working at height, working in confined spaces, as well as work with electricity including live power when connected to the grid with the dangers of electric shock and electrocution. Construction workers will be required to handle hazardous materials such as cement, chemicals, fuels, etc. which will increase health risks if personal protective equipment is not used. They will be exposed to environmental conditions that may be hazardous to their health, such as, elevated levels of noise from the operation of heavy machinery or equipment, earthworks dust, vehicular emissions, or standing water creating a breeding ground for mosquitoes carrying communicable diseases. Continuous exposure to workers to such environmental conditions without personal protected equipment may lead to health impacts

such as hearing loss, respiratory illness, etc. The major hazards and risk during construction are set out in Table 5-38.

513. Emergency scenarios may also occur related to life and fire safety either because of human error or due to natural hazard, e.g., earthquake considering the project site is in seismic zone V. Operational quantitative risk-hazard assessment in the event an emergency scenario is undertaken in Chapter VII which shows that the risk of a fire or explosion is restricted to the project site; but such an event would seriously impact all those working in the blast zone.

514. During construction, the outstation project works will be advised to be housed by the EPC Contractor in the vacant TPGL staff quarters within the Rokhia Thermal Power Station. The EPC Contractor under supervision and permission from TPGL will need to provide these workers with housing facility that has adequate space, ventilation, electricity, food preparation facilities, solid waste collection, potable drinking water, toilets and washing facilities, etc. Inadequate standard of rest area/worker camp/overnight accommodation (Figure 5-20) and sanitation and welfare facilities or allowing unhygienic conditions to prevail may pose a health threat to the workers with uncontrolled vending of food and untreated drinking water posing a risk with respect to illness like diarrhea. During operation, existing TPGL staff, who are mostly commuting from nearest villages/town and Agartala will continue to do so. Some staff also use the staff quarters overnight accommodation.

Figure 5-20: Residential staff building identified by TPGL within plant area for workers accommodation

Source: ADB TA Consultant

515. Similar hazards especially related to working with machinery and electricity will also be present during operation of the proposed plant, although there will be fewer persons on-site so the consequences may be less significant. Project workers will be exposed to high noise levels generated by the compressors, turbines, HRSG, pumps etc. The major hazards and risk during operation are set out in Table 5-39. There will also be the risk of fire and explosion associated with gas during the operational period, for which quantitative risk-hazard assessment has been undertaken in Chapter 7.

516. These hazards create potential for accidents that may result in minor injuries, major injuries resulting in lost time, permanent disability, or in the worse-case fatality. Injuries may be physical (e.g., cuts, bruises, burns, broken bones) or health related (e.g., respiratory health, auditory health, mental health etc.) Overall, the risks of occupational health and safety during all phases are evaluated to be High to Medium Adverse and **Significant** considering the number of persons on-site and the worst-case consequences of an incident, but with adoption of the "As Low As Reasonably Practicable" (ALARP) principle for the GCS and gas pipelines and adoption of good safety protocols and enforcement the residual risk can be reduced such it is likely to be **Not Significant** following mitigation measures.

Table 5-38: Major Hazards and Risk During Construction including Demolition

Potentially Hazardous Activities	Major Hazards	Cause Analysis	Consequences

Potentially Hazardous Activities	**Major Hazards**	**Cause Analysis**	**Consequences**
Demolition of existing building/structures involving breaking and pulling down structure	Uncontrolled collapse of structure, trapped in or under rubble. Hit by flying debris/chunks of concrete. Dust, noise, and vibration. Exposure to asbestos.	Lack of safety protocols and enforcement (e.g., not putting up barricades and warning signs, worker fatigue, not providing PPE, demolition workers not skilled/untrained, lack of supervision, not checking for presence of asbestos, not working as per an approved demolition plan etc.)	Physical Injury -- cuts and bruises etc. Health Injury – respiratory or auditory etc. Disability Life Loss
Machinery and equipment, movement of vehicles for construction	Limbs trapped in machinery and equipment. Electric shocks. Collision with moving vehicles. Noise and vibration, emissions to air. Dust from track out.	Use of old, outdated machinery and equipment lacking the latest safety features available on the market. Use of vehicles that are not maintained to meet the emission standards etc. Lack of safety protocols and enforcement (e.g., not providing guards on machinery and equipment, not checking mechanical and electrical safety before use, no segregation of pedestrian and vehicles, worker fatigue, not providing PPE, construction workers not skilled/untrained, lack of supervision etc.)	Physical Injury cuts and bruises, burns etc. Health Injury Disability Life Loss
Loading and unloading	Manual handling Slips, trips, and falls due to debris lying around Falling objects or debris	Lack of safety protocols and enforcement (e.g., construction workers not skilled/untrained in manual handling, lack of supervision etc.)	Physical Injury Disability Life Loss
Earth works including trenches	Slips, trips, and falls due to uneven ground Falls from height into open trenches Collapse of trenches, trapped beneath debris Inhalation of dust etc.	Lack of safety protocols and enforcement (e.g., not putting up barricades and warning signs, poor lighting, not maintaining designated storage areas for excess spoil, worker fatigue, not providing PPE, construction workers not skilled/untrained, lack of supervision etc.)	Physical Injury – cuts and bruises, broken bones etc. Health Injury Disability Life Loss

Potentially Hazardous Activities	Major Hazards	Cause Analysis	Consequences
Working at height on scaffold Lifting of machinery and equipment from heights, during the assembly of proposed plant	Falls from height Hit by objects falling from height	Lack of safety protocols and enforcement (e.g., not using safety harnesses, not putting up barricades and warning signs, poor lighting, not providing scaffold protection boards, not checking scaffolding before use, scaffolders not skilled/untrained, crane drivers not skilled/untrained, no use of banksman to guide lifts, worker fatigue, not providing PPE, construction workers not skilled/untrained including on working at height, lack of supervision etc.)	Physical Injury Health Injury Disability Life Loss
Working in confined spaces (e.g., in trenches or during assembly of plant units)	Suffocation/asphyxiation Collapse of trenches on workers Release of toxic fumes Fire/explosion	Lack of safety protocols and enforcement (e.g., not putting up barricades and warning signs, poor lighting, poor ventilation, lack of oxygen monitoring, not using shoring for trenches, storing materials or allowing vehicle movement to close to edge of trenches, not providing PPE, construction workers not skilled/untrained in confined spaces work, lack of supervision etc.)	Physical Injury Health Injury Disability Life Loss
Use of oxyacetylene cylinders (used for welding purposes) and other flammable or explosive materials e.g., fuel, oils etc.	Fire and explosion	Use of faulty cylinders Lack of proper maintenance and servicing of oxyacetylene cylinders, fuel, oil storage etc. Lack of safety protocols and enforcement (e.g., no designated storage area, no smoking areas, not checking equipment condition before use, construction workers not skilled/untrained in using oxyacetylene cylinders, lack of supervision etc.)	Physical Injury Health Injury Disability Life Loss

Potentially Hazardous Activities	Major Hazards	Cause Analysis	Consequences
Handling and storage of hazardous chemicals	Chemical spillage Slips and falls Release of toxic fumes Acute/chronic toxicity from exposure Fire and explosion	Lack of ventilation in storage areas. Storing flammable and volatile materials in the same area. Faulty electric connections. Improper storage containers used e.g., damaged or faulty containers causing leakage. No bunding around storage areas. Not providing clear labelling/MSDS. Lack of safety protocols and enforcement (e.g., no smoking areas around storge areas, chemical handlers/workers not skilled/untrained, lack of supervision etc.)	Physical Injury Health Injury Disability Life Loss (suffocation/ asphyxiation) Environmental pollution

Source: ADB TA Consultant

Table 5-39: Major Hazards and Risks during Operation

Potentially Hazardous Activities	**Potential hazard**	**Root Causes**	**Consequences**
Regulation of gas pressure and its quantity at GCS of ONGC/GAIL to supply to proposed plant, located inside the Rokhia Thermal Power Station.	Gas leakage to the atmosphere. Flash fire/jet fire/explosion (if gas comes in contact with an ignition source)	Mechanical failure Faulty connections/weld failure/cracks/shear stress on pipelines Improper coating on pipelines Failure of maintenance activities creating ingress of air into natural gas piping and vessels and subsequent start-up without adequate purging. Corrosion Sabotage	Ecological damage Property damage Physical Injury Disabilities Fatalities (see Chapter VII)
Transmission of gas via pipeline from existing GCS to project site (about 90m)	Toxic Vapor Cloud Formation. Vapor Cloud Explosion. Jet Fire (if gas meets an ignition source) Limited Space Explosion. Over Pressure Explosion.	Mechanical failure Faulty connections/weld failure/cracks/shear stress on pipelines Improper coating on pipelines Corrosion Sabotage	Ecological damage Property damage Physical Injury Disabilities Fatalities – including Suffocation/Asphyxia tion (Chapter VII)
Operation of Steam/Gas turbines, HRSG and ancillary components for electricity generation	Mechanical hazard, trapping of limbs, flying debris etc. Leakage of natural gas; Fire hazard/explosion (if gas meets an ignition source) Electrical hazard, electrical shock Noise generation	Engineering design fault Mechanical failure (due to failure of rotating machineries or failure of gas/steam pipelines) Electric short circuit Lack of sound protection Lack of safety protocols and enforcement (e.g., not providing guards on machinery and equipment, not maintaining mechanical and electrical safety, worker fatigue, not providing PPE, power plant workers not skilled/untrained, lack of supervision etc.)	Physical Injury Health Injury – auditory health Disabilities Fatalities
Compressed air system and pipeline Boiler and pressure system, air circulating system Steam generation Live steam pipeline at high pressure from boiler to turbine	Fire (near burner) Release of high pressurized steam Explosion	Failure of the pumps Mechanical failure of safety switches and safety and bypass valves Presence of contaminant in fuel Incomplete combustion Non-functional air circulating system Busting of boiler and pressurized pipes Lack of heat sink for combustion	Physical Injury Disabilities Fatalities

Potentially Hazardous Activities	Potential hazard	Root Causes	Consequences
		process Lack of safety protocols and enforcement (e.g., not maintaining safety systems, not providing PPE, power plant workers not skilled/untrained, lack of supervision etc.)	
Transmitting electricity from generator to transformer and high voltage (230 kV) transmission network via switchyard (open air)	Fire due to arc flash/arc blast Electric shock and other electric hazards due to unprotected cables Slips and trips from unorganized/loose cables lying on the floor	Short circuit in control room and switch gear Faulty or poorly maintained cables and connections No safe connection to earth Using cables with different voltage and current ratings Lack of safety protocols and enforcement (e.g., not providing barriers and warning signs, not maintaining electrical safety, not isolating electricity prior to works, not providing PPE, workers not skilled/untrained in working with electricity, lack of supervision etc.)	Physical Injury Disabilities Fatalities
Use of chemicals for water and wastewater treatment	Chemical spillage Slips and falls Release of toxic fumes Acute/chronic toxicity from exposure Fire and explosion	Lack of ventilation in storage areas. Storing flammable and volatile materials in the same area. Faulty electric connections. Improper storage containers used e.g., damaged, or faulty containers causing leakage. No bunding around storage areas. Not providing clear labelling/MSDS. Lack of safety protocols and enforcement (e.g., no smoking areas around storge areas, chemical handlers/workers not skilled/untrained, lack of supervision etc.)	Physical Injury Health Injury Disability Life Loss (suffocation/ asphyxiation) Environmental pollution

Source: ADB TA Consultant

1.1. Mitigation

517. The CEMP to be prepared by the EPC contractors before demolition or construction commences will incorporate a Construction Health and Safety Plan. The EPC Contractor will employ a suitably experience and qualified health and safety manager full time on-site to supervise and monitor their construction, they will also provide awareness raising on health and safety to construction workers as well as local communities. This H&S manager will have

IOSH/NEBOSH qualification. They will be supported by sufficient health and safety supervisors to ensure each working area is supervised, and in each working area there is at least one supervisor to 50 workers regardless directly or indirectly, formally or informally employed, by the EPC Contractor or subcontractors.

518. The requirement to comply with this health and plan during construction sits with the EPC Contractor. TPGL will be required to approve it and then ensure its own staff on-site follow the EPC Contractors OHS Plan. PIU TPGL will also have a full-time health and safety consultant with IOSH/NEBOSH qualification to be based on-site as part of its EMP supervision and monitoring team. All health and safety persons on-site will be delegated authority under the contract to be able to halt construction works if any dangerous situation or a non-compliance is observed.

519. The ESMS developed by TPGL will also incorporate an Operational Health and Safety Management Plan which will be supervised by their Health and Safety Manager with IOSH/NEBOSH qualification.

520. Development of both plans will be preceded by a facilitated risk assessment to identify and therefore be able to manage all potential hazards. The risk assessment process for both construction and operation will start at the detailed design stage to ensure that as much risk as possible is designed out. Risk assessment workshops will be facilitated during detailed design, prior to the commencement of construction, and prior to the start of operations by the TPGL health and safety consultant and will involve the design team of the EPC Contractor, manufacturer/supplier, construction team of the EPC Contractor, TPGL, and operational staff.

521. During detailed design attention needs to be given to life and fire safety during operation, including ensuring structural safety especially in the event of an earthquake by following GoI seismic codes and having the structural design reviewed by an independent engineer separate to the EPC contractor who undertakes the detailed design, providing adequate firefighting equipment, first aid box etc. Use of PCBs in transformer oil and asbestos containing materials including asbestos cement sheeting is prohibited. EMF levels to be kept within international good practice levels as per ICNRP (reference and peak values) for the occupational and community exposure. In relation to demolition, no asbestos has been identified in the existing office buildings, but this is to be confirmed following an asbestos survey by a competent person employed by the EPC Contractor. Detailed design will also need to incorporate adequate sanitation and welfare facilities for all O&M workers to be posted at or visiting the proposed plant

522. Full details of occupational health and safety mitigation are given in the EMP mitigation plan (**Annexure 28**) but occupational H&S mitigation measures to be implemented through these H&S plans will include:

(i) For workers, through the GRM (Chapter 9) they will be allowed to complain without reprisal about anything they consider to be unfair treatment or unsafe living or working conditions provided by their employees.

(ii) No child will be employed, and no under 18s will be engaged to work at the proposed plant (hazardous work).

(iii) H&S plans will include a labor management plan, addressing migrant workers from intra- and inter-state, sanitation and welfare, rest areas/worker camps/overnight accommodation etc.

(iv) If asbestos is found in the existing office buildings an asbestos removal sub-plant is to be included detailing how asbestos will be safely removed from site by a competent contractor, and safely and soundly disposed of as hazardous waste in accordance with GoI regulations and the IFC EHS guidelines 2007[113]

(v) No blasting to be undertaken.

(vi) H&S plan will include an emergency preparedness and response plan[114] in the event of an incident caused by human error or due to natural hazard during construction or operation. It will need to be developed in consultation with local emergency services although adequate fire and first-aid first-responders will need to be based on site. During construction and operation, doctor will be on call and medical officer and nurses will be available. Regular drills will be required involving all workers to prepare for an incident.

(vii) Safety Training Program. To be delivered to all managers, supervisors, and workers on-site regardless of level or whether they are directly or indirectly, formally or informally employed is required to be delivered by the EPC Contractor in relation to construction, and TPGL for their own staff during construction and during operation. The Safety Training Program will consist of:

- Initial Safety Orientation and Induction Course: all project workers and visitors to the project site will be required to attend a safety orientation before they enter the working area. All project workers will also be required to attend a safety induction course within their first week, before they are engaged in any construction works. This is to raise awareness of risks at the construction site, measures as set out in the OHS plan, and its enforcement. All visitors and project workers who have not attended the safety induction course must be always accompanied by inducted workers when within the working area.
- Periodic Safety Training Refreshers to run not less than once every six months – all project workers are to attend a six-monthly refresher covering similar topics to induction.
- Specialist Training Courses: since they have heightened risk only trained workers must undertake certain activities e.g., working at height, working in confined spaces, working with electricity etc. The EPC Contractor and TPGL must ensure all project workers have attended such training before they are involved in relevant works and either offer an internal training course or organize for attendance at an external training course. Workers must have a training record of attending a suitable training course. Untrained workers will not be permitted to work at height, enter confined spaces, work with live electricity etc.

(viii) Safety Meetings. To be conducted monthly by the EPC Contractor during construction and TPGL during operation. During construction the meetings will require attendance by the safety representatives of all subcontractors on-site and TPGL will be notified of the date of all safety meetings in advance so they (health

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[113] Page 71 https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final+-+General+EHS+Guidelines.pdf?MOD=AJPERES&CVID=jOWim3p

Training of specialized personnel and the maintenance and removal methods applied should be equivalent to those required under applicable regulations in the United States and Europe (examples of North American training standards are available at: http://www.osha.gov/SLTC/asbestos/training.html)

American Society for Testing and Materials (ASTM) E 1368 - Standard Practice for Visual Inspection of Asbestos Abatement Projects; E 2356 - Standard Practice for Comprehensive Building Asbestos Surveys; and E 2394 - Standard Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products.

[114] That addresses the training, resources, responsibilities, communications, procedures, and other aspects required to respond effectively to emergencies

and safety consultant) can also attend. The minutes of all safety meetings including actions agreed will be taken and sent to TPGL within seven days of the meeting for subsequent inclusion in semi-annual EMR.

(ix) Safety Inspections. The EPC Contractor during construction and TPGL during operation will regularly inspect, test, and maintain all safety equipment, scaffolds, guardrails, working platforms, ladders and other means of access, hoists and other lifting equipment, guards, lighting and signage, firefighting equipment, first aid kit, stock take and condition of PPE etc. Lighting will meet illumination guidelines for the working area as per IFC EHS Guidelines on OHS.[115] Signs will be graphic and in the languages of workers, kept clear of obstructions and legible to read. Equipment, which is damaged, dirty, incorrectly positioned or not in working order, will be immediately repaired or replaced.

(x) Site Audit. During construction the EPC contractor's health and safety manager and TPGL health and safety consultant will undertake monthly audits of compliance with the health and safety plan. During operation internal audits will be undertaken by the Health and Safety Manager with external audits annually by a third party employed by TPGL.

(xi) Conduct medical check-up/health surveillance of workers fitness, eyesight and hearing abilities and communicable and non-communicable diseases before works commence; and then every six months by the EPC Contractor during construction and every year by TPGL during operation. Only workers who have passed their fitness test and have the requisite medical clearance must undertake certain activities e.g., working with electricity etc.

(xii) The EPC contractor during construction and TPGL during operation will put in place a referral healthcare facility to deal with medical aspects of HIV/AIDS treatment with specialized services. Their in-house medical facility will be capable to diagnose for STD/STI, COVID-19 and TB infection among the workers and provide initial treatment if required.

(xiii) Provide ambulance on site during construction, to be retained on site during operation. Such facility will also be extended to the locals during emergencies

(xiv) Follow all national COVID-19 restrictions and international WHO good practice (Annexure 22) and maintain adequate sanitation and welfare facilities and hygienic conditions on-site to avoid spread of this and similarly transmitted communicable diseases. COVID-19 vaccination program to be completed for all workers before works commencement and kept up to date with booster vaccinations on schedule as recommended by national requirements.

(xv) Required and valid permits including a labor license and the labor insurance must be obtained by the EPC Contractor and TPGL before work commences and be maintained throughout implementation.

(xvi) Provide adequate stock of PPE for all workers in compliance with specific provision on PPE of the Factories Act 1948[116] and Table 2.7.1, page 74 of the IFC EHS Guidelines on OHS[117] including safety shoes, helmets, goggles, earmuffs, and face masks and ensure that this is worn by them at all times with a strict disciplinary system being enforced for any non-compliance.

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[115] https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final+-+General+EHS+Guidelines.pdf?MOD=AJPERES&CVID=jOWim3p

[116] https://dgfasli.gov.in/sites/default/files/2020-02/model_rules_80_81.pdf

[117] https://www.ifc.org/wps/wcm/connect/1d19c1ab-3ef8-42d4-bd6b-cb79648af3fe/2%2BOccupational%2BHealth%2Band%2BSafety.pdf?MOD=AJPERES&CVID=nPtgxyx

(xvii) Work Zone Noise Levels: during construction and operation protective measures need to be provided to the operators and workers working near the high noise generating machinery. As per Occupational Safety and Health Administration (OSHA) Standards, the maximum allowable noise level for the workers is 90 dB (A) for 8 hours exposure a day. However, IFC EHS Guidelines on OHS,[118] Table 2.3.1. sets the level at 85 dB (A) for 8 hours exposure therefore as the most stringent this will be adopted, as well as 140 dB(C) peak/instantaneous noise exposure. High noise work areas must be adequately signposted. In these high noise work areas PPE in the form of sound reducing earmuffs/ear plugs to the workers are to be provided. In the first instance however, reduction in noise levels to the lowest practical level must be achieved by adoption of suitable preventive measures, such as, use of enclosures with suitable absorption material, etc. Workers operating in the high noise work areas will be given auditory tests as part of health surveillance.

(xviii) Energy Generation and Electricity: IFC EHS Guideline on Thermal Power and Electric Power Transmission and Distribution requirements for working with electricity will be observed with only licensed electricians that meet the requirements set out in them allowed to work on live electricity with strict adherence to safety standards including those listed in said guidelines

(xix) Provide healthy and hygienic conditions at both the site and rest area/worker accommodation by TPGL as per the National Policy on Safety, Health & Environment at Workplace[119] and the IFC EHS Guidelines on OHS.

(xx) Provide adequate sanitation and welfare facilities. To ensure their welfare workers will need to have access to a clean source of drinking water that meets GoI drinking water standards, toilet and hand washing facilities, a clean eating area, and shaded rest area etc. Sufficient toilet and washing facilities should be provided for the number of workers on site with about 1 toilet per 6 workers; male and female facilities to be provided. The drinking water source used must be regularly tested (weekly) to confirm that it meets the drinking water standards.

(xxi) Overnight accommodation. For workers not local to the area, suitable overnight accommodation (refer to ILO guidance and EBRD guidance note on workers' accommodation)[120] must be provided by the EPC Contractor (and their subcontractors) during construction and TPGL during operation or an allowance given for the employees to find their own accommodation. Any employer provided accommodation must be adequately equipped with sufficient toilets, hand washing facilities, showers or baths, food preparation and clean eating area, drinking water meeting WHO drinking water standards etc.

523. For all phases of work an accident recording system will be set up and log of all occupational health and safety incidents, near-misses and accidents will be kept.

2. Community Health and Safety

2.1. Construction including Demolition

[118] https://www.ifc.org/wps/wcm/connect/1d19c1ab-3ef8-42d4-bd6b-cb79648af3fe/2%2BOccupational%2BHealth%2Band%2BSafety.pdf?MOD=AJPERES&CVID=nPtgxyx
[119] https://labour.gov.in/sites/default/files/SafetyHealthandEnvironmentatWorkPlace.pdf
[120] Workers' accommodation: processes and standards (ebrd.com)

524. Though workers are most exposed to health and safety risks the adjacent community's health, safety and security may also be affected by the presence of the proposed plant project because of worker-community interactions, traffic movements, risk of injury, pollution, spread of non-communicable diseases and communicable diseases including COVID-19 and HIV/AIDS, increased pressure on community health care facilities, public utilities and other resources.
525. There will be an influx of about 380 persons into the study area during the peak of construction. Since a lot of the positions are skilled or semi-skilled the immediate local population will not be able to provide the necessary workers for the proposed plant although for unskilled workers they will be tapped. In such cases workers from other towns/states/countries may be employed by the EPC contractor. This could lead to potential conflict with locals, especially if the incoming workers are not aware of local culture, customs, and practices. The spending habitats and behavior of the migrant workers as well as an increase in disposable income within the study area may result in incidents associated with alcohol and drug abuse, prostitution, casual sexual relations and STD transmission, discrimination, and gender-based violence which may threat the local community's health and safety. Women would be particularly at risk given most construction workers will be male. Risks associated with unhealthy and unhygienic conditions at the project site could also spill over into the local community for example waterlogging or poor sanitation and waste disposal facilities can create a breeding ground for vectors resulting in vector borne disease in the study area. These risks are assessed to be High to Low Adverse and as potentially **Significant** during construction will be a cause for concern to community health and safety without mitigation.

526. Traffic movements will increase on the local road network with movements of workers, plant, machinery, equipment, and materials including oversized vehicles per Figure 2-10 in Chapter 2. Construction will increase the traffic load, congestion, slow-moving vehicles encouraging unsafe overtaking, and risk of accidents and injury especially to pedestrians and livestock. Once off the national highway which is already well trafficked, the access route currently has moderate traffic flow with majority being private vehicles. It has around 9 settlements and 5 schools located adjacent to it with pedestrians sharing the road with vehicles as there is no separate footpath provided. This creates a road traffic public safety risk. Children, persons with disabilities, and the elderly will be at greatest risk from the increase in road traffic due to being less aware or less mobile. Presently the road condition and width will be inadequate for transportation of large equipment like the stacks (about 7 m diameter), HRSG units, cranes, etc. Transportation risks are assessed to be High to Medium Adverse and **Significant** during construction and would be cause for concern to community health and safety without mitigation.

527. Demolition of the existing buildings, site clearance, flattening of the hillocks, earthworks, civil works, erection, and traffic movements will generate dust, noise, vibration and waste during construction will impact the local community, especially those residing close to the proposed plant. Construction dust may occur with 100 m of the project site and along the access route impacting habitations along a buffer of 20 m from the road. As well as being a nuisance dust can affect human health. Noise and vibration impacts would be restricted to 100 m. As well as disturbing people excessive noise can be a health risk, whilst excess vibration could cause properties to collapse resulting in fatalities if they are not structurally sound. These impacts have been assessed and are discussed further in the Physical Environment section. They are Maximum to High Adverse and **Significant** during construction and would be cause for concern to community health and safety without mitigation.

2.2. Mitigation during Construction

528. The health and safety risk assessment and plan prepared by the EPC Contractor for construction will cover both occupational as well community health and safety. Full details of community health and safety mitigation are given in the EMP mitigation plan (Annexure 28) but community H&S mitigation measures to be implemented through the H&S plan will include the following in addition to the pollution mitigation that is already detailed in the Physical Environment section:

(i) Establishment of a GRM (Chapter 9) to receive community concerns and immediate rectification of any grievances raised.

(ii) Continuous consultations with affected persons to be conducted, to keep them informed, especially during high noise activities, peaks in transportation, and the movement of oversized vehicles.

(iii) EPC Contractor will familiarize themselves with the dates of religious festivals (Chapter 4) and ensure that high noise activities, peaks in transportation, and the movement of oversized vehicles are timed to avoid them.

(iv) OHS plan will include an emergency preparedness and response plan in the event of an incident caused by human error or due to natural hazard during construction or operation, the plan will be communicated to the local community within the core zone (500m) and the school so that they know the signals/siren noise and how to respond in the event of incident. They will also be actively involved in drills run by TPGL to simulate the event of an incident.

(v) EPC Contractors' insurance is to include a community liability clause for payment of compensation in case of any accidents because of construction of the proposed plant.

(vi) Construction works to be restricted to the project site including storage areas etc. Barricading and signage in and around the project site with graphic and written warnings in local language(s) to warn and prevent locals from entering the project site during construction – the EPC Contractor will also provide a boundary wall/fence to the school to ensure that the school grounds are clearly segregated from the Rokhia Thermal Power Station.

(vii) Do not leave hazardous conditions (e.g., unlit open excavations without a means of escape) overnight unless absolutely no access by public can be ensured. Signboards on site boundary fences are to include key emergency contact details in case of local community accident at the project site (EPC contractor, ambulance, doctor, hospital, etc.)

(viii) Prevent standing water and dumping of waste as it may become a breeding habitat for mosquitoes etc.

(ix) OHS plan will include a traffic management plan, addressing the existing road condition and H&S measures to minimize the risk from the increase in traffic movement.

(x) For entry and exit to site and for any road blockages flag men are to be utilized during works to control the traffic flow and protect construction workers and the road users.

(xi) The road running in front of the nearest residents will not be used for construction traffic.

(xii) Any unsurfaced or poorly surfaced road will need to be surfaced before construction to minimize impacts on adjacent properties – dust, noise, vibration etc. On leaving road must be in no poorer condition than when construction started. Roads will be reinstated if damage was caused.

(xiii) EPC contractors will identify public utilities and adjacent properties at risk of accidental damage and undertake a through pre-construction structural survey of them, supported by photographic evidence. Structural or cosmetic damage is to be repaired by contractors to at least pre-project condition at their own cost.

(xiv) Community health and safety awareness raising for all members of the local community within the core zone (500m) but with a particular emphasis on providing awareness raising for the adjacent school and ensuring the children are well-aware of the dangers of construction sites, and awareness raising in relation to preventing the spread of COVID-19, HIV/AIDS and other communicable diseases, and sexual, exploitation, abuse, and harassment.

(xv) Free of charge health surveillance by the in-house medical facility will be provided by the EPC Contractor for residents in the core zone (500m) for the duration of the construction works.

(xvi) Construction workers will be given awareness raising in relation to preventing the spread of COVID-19, HIV/AIDS and other communicable diseases, local cultures and heritage, religious festivals that need to respected, and sexual, exploitation, abuse, and harassment with workers having strict penalties (e.g., immediate removal from site) for any non-compliance of workers to an agreed code of conduct including setting limitations on worker movement from the construction sites and temporary worker camps/overnight accommodation.

(xvii) EPC Contractor will employ security guards to maintain security at the project site but also to oversee the respective behavior of construction workers in the local community.

(xviii) For unskilled jobs preference will be given to local employment, locally skilled and semi-skilled persons to also be prioritized providing they are suitably qualified and experienced.

529. During construction an accident recording system will be set up and log of all community health and safety incidents, near-misses and accidents will be kept.

2.3. Operation

530. The local community have been living in the presence of the existing plant and no concerns have been reported by TPGL or reported during consultation regarding worker-community interactions etc. In the long term the situation will be much the same for the proposed plant, although worker-community interactions will need to be managed at the start of operations to ensure the 98 staff are integrated. The proposed plant will be securely fenced with security to ensure no unauthorized access. Therefore, risks to the community are considered Medium Adverse and **Not Significant**.

531. Quantitative risk-hazard assessment is undertaken in Chapter 7 which shows the risk of a fire or explosion is restricted to the project site; but such an event would seriously impact any members of the community who happened to be travelling along the TPGL private access road at that time and could through forest fire pose a risk to the local community. The project road will reopen after completion of construction. Therefore, in worst-case risks are High to Medium Adverse and **Significant**.

532. In terms of pollution, the major air pollutant from the proposed plant will be NO_x including NO_2 for which the WHO AQG 2021, set guidelines in terms of the protection of human health. The air quality modelling assessment shows that although the WHO 2021 NOx guidelines are exceeded, the replacement of the existing plant will be beneficial. Emission of PM and SO_2 is not envisaged from the use of natural gas as fuel. CO emissions from the proposed plant will be significantly low than WHO 2021 guidelines and much lower than from exiting plant. Therefore, there will be a low adverse impact at most on human health during operation. For noise the noise assessment shows that there will be a Medium Adverse and **Not Significant** impact e.g., the operation of the proposed plant will slightly exceed the noise assessment criteria which adopt the most stringent of GoI standards and WHO IFC guidelines at night. Impacts on the quality of community water resources are not envisaged as the proposed plant will be a zero-discharge operation, but community water stress will need to be considered as discussed in the Physical Environment section.

2.4. Mitigation for Operation

533. The health and safety risk assessment and plan for operation prepared by TPGL as part of their ESMS will cover both occupational as well community health and safety. Full details of community health and safety mitigation are given in the EMP mitigation plan (Annexure 30) but community H&S mitigation measures to be implemented through this H&S plan will include the following in addition to the pollution mitigation that is already detailed in the Physical Environment section:

(i) Establishment of a GRM (Chapter 9) to receive community concerns and immediate rectification of any grievances raised.

(ii) TPGL insurance is to include a community liability clause for payment of compensation in case of any accidents because of operation of the proposed plant.

(iii) Boundary wall with security and signage in and around the project site with graphic and written warnings in local language (Bengali) to warn and prevent locals from entering the project site during operation.

(iv) TPGL will undertake community health and safety awareness raising with particular emphasis on providing awareness raising for the adjacent school and ensuring the children are well-aware of the dangers of the proposed plant.

(v) TPGL operational staff will be given awareness raising in relation to preventing the spread of COVID-19, HIV/AIDS and other communicable diseases, local cultures and heritage, and sexual, exploitation, abuse, and harassment with workers having strict penalties (e.g., immediate removal from site) for any non-compliance of workers to an agreed code of conduct.

(vi) For unskilled jobs preference will be given to local employment, locally skilled and semi-skilled persons to also be prioritized providing they are suitably qualified and experienced.

(vii) Provision for the training of the workers by TPGL to ensure that they are suitably qualified and experienced to work in the proposed plant.

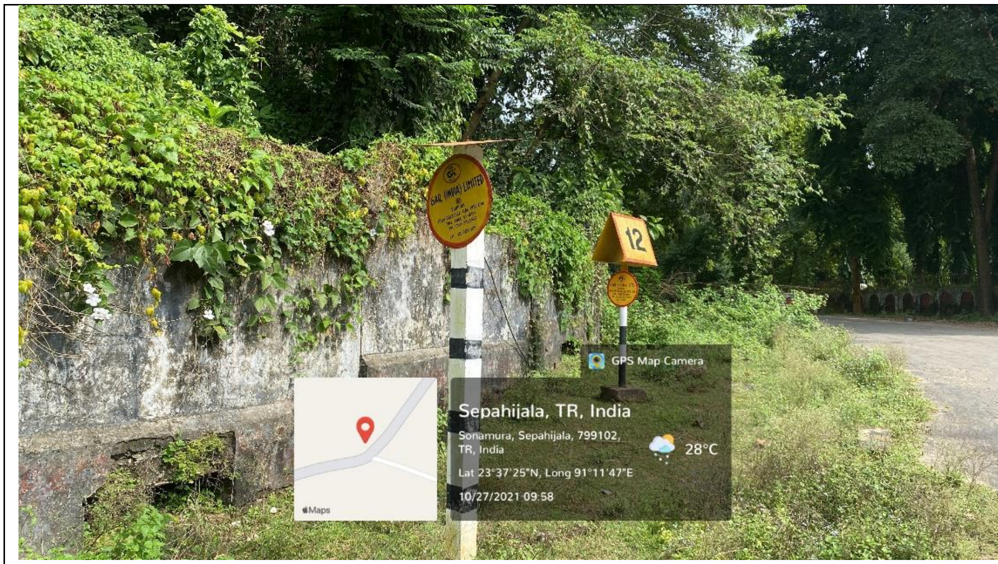
534. During operation an accident recording system will be set up and log of all community health and safety incidents, near-misses and accidents will be kept.

3. Land Use and Livelihoods

535. There is a private access road owned by TPGL that passes through the Rokhia Thermal Power Station that the local community has been allowed to use since 1998. They use it as a short cut to reach the main road. During project implementation this would be closed, and locals would have to use the longer 1.5 km route instead. Temporary closure of the private access road which is within the TPGL campus and has been used informally for many years as a path and as a shortcut to the designated road. However, no such economic activities or livelihood related activities are practiced by the local people using the access road. The alternate route even though slightly longer will mitigate any such negative impacts. Also, the villagers do not have any such complain regarding closure of the access road which we found during the consultation.

Figure 5-21: Transmission Line at the project site and Gas UG pipeline along project road

	Transmission tower at site, on eastern hillock



GAIL UG gas pipeline marker pole at project road. Existing plant boundary at left.

Source: ADB TA Consultant

536. There is an existing transmission tower in the project site, that is not connected to the grid. This will be dismantled and handed over to TSECL by TPGL before construction starts. Other than that, there is no private property or public utilities found at the project site which could be damaged. Although GAIL high pressure underground gas pipeline is found along the access road.

537. However, the pavement of the access road used by construction traffic may be damaged due to the volume of construction vehicles passing by it. Some fixed assets such as trees or fences along the access road or public utilities along the Boxarnagar-Bisalgarh part of the access route may be accidentally damaged especially when oversized vehicles are required to pass given there may be some encroachment or extension of fences etc. into that right of way. However, no involuntary resettlement will be required and no relocation will be required. As a standard practice, large, oversized vehicles will be allowed to travel only at night time with due coordination from the PWD, TSECL and local people. Damage to property is usually avoided, however, in case of unavoidable impacts, the same will be repaired, restored or compensated as per the provision made under the entitlement matrix of the RIPP. Risks of accidental property damage due to vibration because of the passage of construction traffic are discussed under the section on Physical Environment.

538. Through the proposed plant may have beneficial impacts on the local economy by supporting local shops, restaurants, accommodation etc. but it will also put pressure on the community infrastructure and services available to the rural community in Sipahijila District. This includes the existing road network and community health facilities which are limited. Impacts will be particularly acute during construction when there will be a lot of construction traffic along the access route and an influx of 380 workers. No new medical[121] or educational facilities are proposed. Impacts on groundwater resources and in relation to waste management are

[121] For primary treatment at Manikyangar, 1km from site primary health centre, Higher capability health centre at Bisalgarh, 3-4 km and major treatment, surgery at Agartala, 30km

discussed in the section on Physical Environment, but also relate to community resources. Potable water will be from existing supply lines utilizing ground water. Pressure on community infrastructure and services is High to Medium Adverse and **Significant.**

3.1. Mitigation

539. Grievance Redressal Mechanism will be put in place on site to capture any grievances linked to access, property damage or conflict between the proposed plant and community infrastructure and services as discussed in Chapter 9. The EPC Contractor and TPGL will also need to undertake community consultation throughout, as detailed in Chapter 8. They can also undertake CSR activities within the local community in consultation with the local community, Panchayat/local administration, district level authorities and NGOs. Key community needs that could be met by TPGL include access to potable drinking water by connecting those residents that currently suffer water stress and better access to community health facilities through the inclusion of a medical facility at Rokhia Thermal Power Station that the community can access which can all be considered for take up by TPGL.

540. Local community will be notified of the TGPL private access road closure at least one month before work starts through notices/signs on either end of the access road.

541. Drivers will be given a specific orientation/sensitization on the need to avoid damage to private property and public utilities during transportation. Oversized vehicle will only be allowed to travel at nighttime to limit the risk of damage due to traffic congestion on the road. The pavement of the access route, adjacent private property, and public utilities (water, electric, gas, telephone cables, sewer lines, lampposts etc.) will be mapped and surveyed (including photographic evidence) by the EPC Contractor once the access route is finalized. The pavement will be brought up to an adequate standard to allow the passage of construction vehicles by the EPC Contractor before the start of construction. If passage of oversized vehicles requires any private property or utilities along roadsides to be temporarily affected, this will either be compensated as per the entitlement matrix of the RIPP or shall be restored which shall be done in close consultation with the owner, users, or utility and written agreement obtained. Damage that is caused is to be repaired by the EPC contractor to at least pre-project condition at their own cost.

542. The EPC Contractor will be required to provide their own medical facilities at the project site sufficient for 350 persons staffed by at least one medical doctor, supported by at least one nurse. During operation, TPGL will ensure adequate medical facilities are provided on site for the 98 works of the proposed plant including a medical/first aid room with doctor's room and nurse's chamber. During operation the proposed plant will be staffed by at least one medical doctor, supported by at least one nurse, who may also offer their services to the local community.

4. Landscape and Visual

543. Examination of the environmental setting of the project site reveals that there are no other industries adjacent except the existing plant. The proposed plant will be within the TPGL Rokhia Thermal Power Station. The nearest properties are 10 houses (at 55m from the eastern boundary) and Manikyanagar settlement area to the south. The landscape is rural, elevated with undulating topography and patches of vegetation and trees. The project site houses a couple of building and vegetated hillocks. The hillocks will be levelled, and the landscape altered from vegetated open forest to industrial. Flattening of the hillocks will dramatically change the local

landscape at the project site and views in and out of it. The existing boundary to the Rokhia Thermal Power Station is a low wall that is damaged, and the project site is visible from outside.

544. During construction the presence of the construction site itself, movement of heavy vehicles, storage areas for material and equipment, storage or inappropriate disposal of waste materials, worker onsite rest rooms which will be in temporary sheds in the project site Workers accommodation within vacant TPGL staff quarters, will impact on the existing landscape and visual aesthetics although impacts will be short term for 36 months. Based on scope of work, the local environment (only residences are 10 houses at 55 m), these construction activities will only be directly visible to those moving around the project site (about 100 m) and along the access roads and will be less noticeable if they are well managed.

545. In terms of operational impact, landscape and visual aesthetics impacts will result from the physical presence of large industrial units including turbine halls, HRSG and two stacks of 30m and 60m. As provided in Figure 5-23, the visual impact would be up to a 10km radius with maximum influence experienced with 1km radius from the center point. During night-time illumination from the proposed plant may impact on the nearest receptors, although illumination lights (red light is to be used for ecological reasons) if required on the stacks will be much higher than normal line of vision. This will be a permanent setup for 25-year lifespan of the proposed plant.

546. The proposed plant will be constructed within the Rokhia Thermal Power Station. Local residents have been living alongside the existing plant, although this is well located and bounded from visual inspection from the outside. Physical presence of proposed plant, and additional illumination in much closer proximity and being more visible to the local residents is assessed as having a **High Adverse** landscape and visual impact in the immediate proximity which is **Significant.**

4.1. Mitigation

547. Following are examples of the mitigation measures that will be adopted to address the above impacts with full details given in the EMP mitigation plan (Annexure 28):

(i) Detailed design to minimize visual impact and clutter – during detailed design EPC contractors to consult with local communities within 500m of the project site boundaries to get their views and input into the plant layout and boundary treatment.

(ii) Minimal outdoor lighting to be installed to minimize disturbance; if required it must be of low intensity with little or no blue wavelength and operated using passive infra-red (PIR) technology movement sensors set at person height so as not to be kept permanently on overnight, it must be directional and shielded, so light does not fall outside the allocated land plots.

(iii) If lit externally buildings will be designed with non-reflective dark-coloured cladding materials to avoid reflecting light.

(iv) Landscaping should be used to temporary barricading of the construction site and to screen the permanent security fencing that is required for health and safety purposes – development of Green Belt planted with trees around the project site with a focus on plantation to the east and south to maximise screening of views in.

(v) EPC contractors to keep all the construction activities restricted to within the project site. The exception is the storage yard (Figure 5-22) which has been planned outside the project footprint, but within the Rokhia Thermal Power

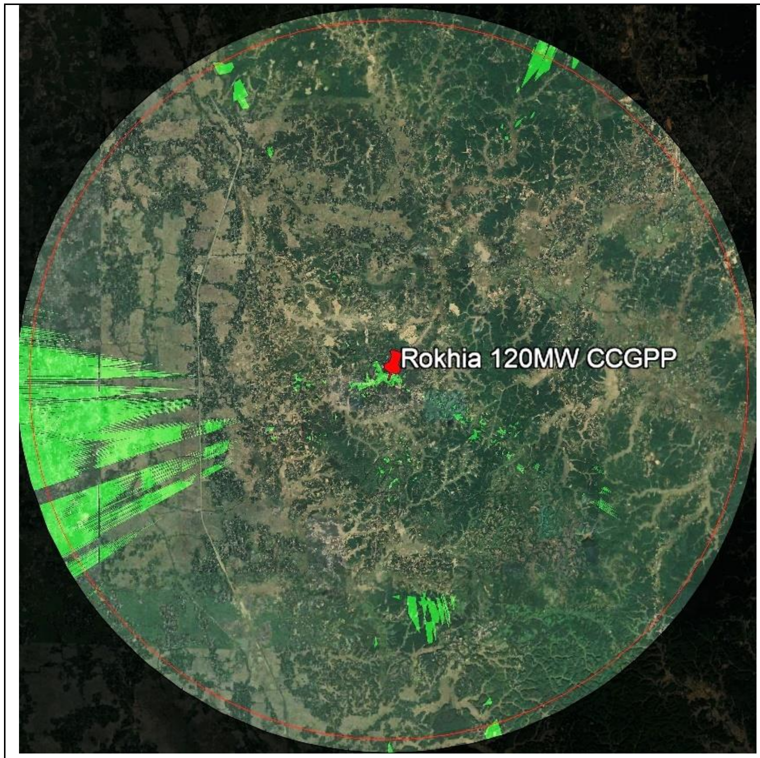
Station (south). This site, an open ground, is presently used as storage yard and will continue to do so. Similarly works to staff accommodation will occur outside the project footprint.

(vi) On completion of work all temporary structures, surplus materials and wastes will be completely removed from site.

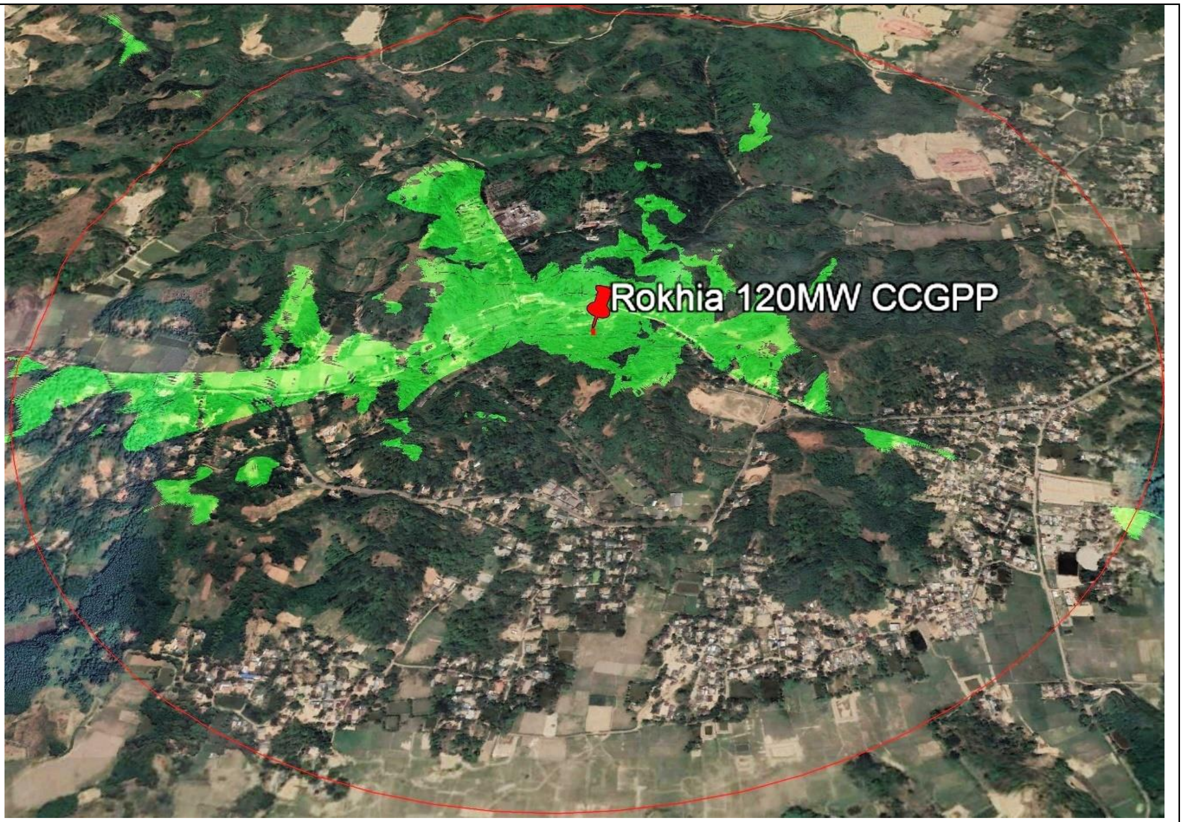
Figure 5-22: Planned storage yard area within TPGL project area

Source: ADB TA Consultant

Figure 5-23: Zonal Visual Aspects of Proposed Plant
(green highlighted areas show areas where at least the stacks will be visible from)



10km viewshed

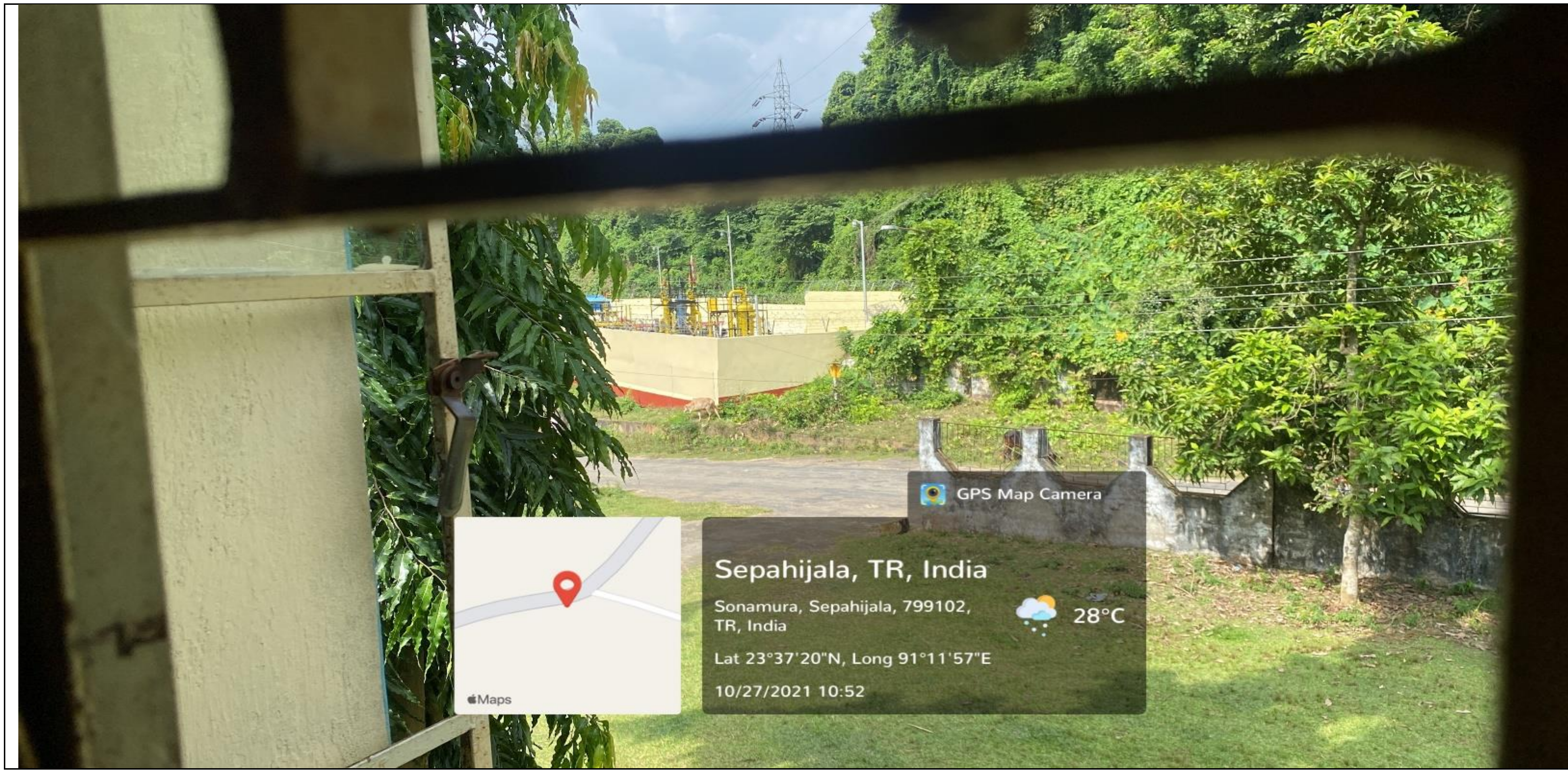


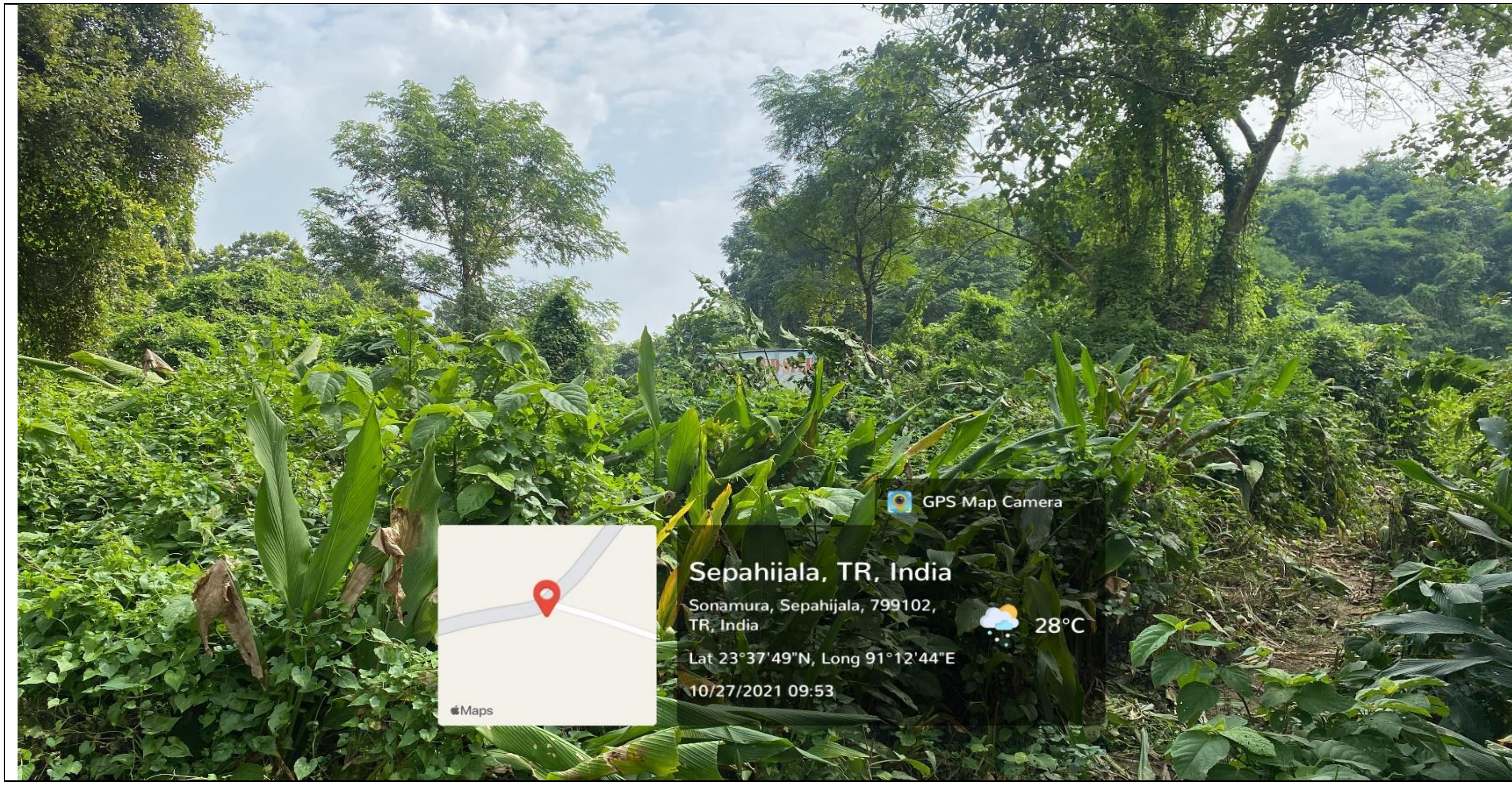
1km viewshed

Source: ADB TA Consultant

Figure 5-24: Photos of project footprint from looking to it

View from the access road into hillocks

	**View from window of to be demolished GTDL building looking to the GCS unit and the UG gas pipeline route entering the site**

	**View from west boundary to the plant centre**

	**View from boundary close to access road into the proposed GT and HRSG area**

	**View into the north boundary and site for GT**

Source: ADB TA Consultant

H. Impacts on Physical Cultural Resources and Mitigation

548. No physical or cultural resources have been identified within the project site and its immediate surroundings that can be directly or indirectly impacted by work taking place within the project footprint. The nearest place of worship is a small temple that is part of the existing plant, but outside the GCS area (Figure 5-25) so there is no risk of damage during pipeline construction. Although considered unlikely due to the volume of earthworks required and the complex terrain, a chance find of archaeological or planetological importance cannot be ruled out during excavation. However, the main risk of damage/dust/waste deposition caused to physical cultural resources relates to use of the access road during construction especially when oversized vehicles must pass through settlement areas. Where access roads house locally important cultural or religious places (5 no. identified, main one being at Gokalnagar village) along roadsides there is a chance these may be accidentally damaged, such damage may be irrevocable and may give rise to community conflict.

Figure 5-25: Map showing locations of project area temple (red line is proposed 90 m gas pipeline route)

Source: ADB TA Consultant

549. Given the sensitivity of physical cultural resources, the impact pre-mitigation is anticipated to be **Low Adverse** and **Not Significant.**

1. Mitigation

550. The CEMP prepared by the EPC Contractor before construction commences will include a chance find procedure with procedures for checking for, reporting/notifying authorities of, and dealing with any chance finds governed by the requirements of Indian legislation and ADB’s Safeguard Policy Statement. Orientation/sensitization of construction workers on the chance find procedure will be undertaken.

551. Drivers will be given a specific orientation/sensitization on the need to avoid damage to cultural or religious places during transportation. Such resources will be mapped and surveyed (including photographic evidence) by the EPC Contractor once the access route is finalized. If passage of oversized vehicles requires any locally important cultural or religious places along roadsides to be temporarily moved out of the road width or protected with fencing this will be done in close consultation with the local community following the appropriate Annexure 34 guideline. Damage that is caused is to be repaired by the EPC contractor to at least pre-project condition at their own cost.

I. Summary of Post-Mitigation Impacts

552. Post-mitigation residual impacts are summarized in Table 5-29 with a few remaining significant post-mitigation. Excepting global climate change impacts are confined to Tripura. The buffer zone of the study area contains part of Bangladesh, as the border is approximately 3.25 km from the project site, the EIA has demonstrated there will be low to minimal post-mitigation transboundary impacts due to the operational air emission from the proposed plant.

553. Significant residual impacts remain in relation to the following for which compensation/offset is required as discussed in the earlier sections.

(i) climate change and natural gas use, as although no additional natural gas is being required for the proposed plant with it being a more energy efficient replacement for the existing plant, the latter will still result in the burning of fossil fuel, as a non-renewable resource contributing to climate change impacts for its anticipated lifespan of 25 years.

(ii) changes in the topography and terrain, soil structure and fertility, and landscape and visual aesthetics of the project site that currently supports forest soils; although mitigation measures are provided to reduce the extent of the impact as far as practical these are unavoidable impacts if the 4.5 ha project site is to be developed for the proposed plant.

554. Compensation/offsets for residual impacts include:

(i) Decommissioning of the existing plant upon operation of the proposed plant to offset GHG emissions in the short term.

(ii) Compensatory reforestation as offset to ensure no net loss of biodiversity will help to offset loss of forest soils and if planted as Green Belt can help to screen the proposed plant.

(iii) In the rare event of significant health and safety incidents occurring insurance will have been secured and compensation per the Public Liability Insurance Act 1991 and compensation will be paid out in event of a disability or fatality. The 1991 Public Liability Law regulates mandatory liability insurance for potential personal injury and property damage in surrounding communities. Compensation for liability is due (Section 3) if the death or injury occurs or property damage due to an accident has occurred. In a claim for compensation under Section 1, the victim does not need to declare and prove that the death, injury, or damage on which the claim is based on an action, neglecting or not showing one's performance. Amounts must be paid to the extent specified in Section 4, sub-section (2B) within **thirty days** from the date of notification. In case of death of main earner of the household, compensation and providing job to the next of kin based on his/her skill level is required.

Table 5-40: Summary of Post-Mitigation Impact Significance

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
BIOLOGICAL ENVIRONMENT						
Vegetation / trees	Project site is not designated forest land but supports natural forest habitat. Out of 4.5ha project site 2.3ha is degraded natural forest	Construction	**Low Adverse**	**Yes**	**Low Adverse**	Compensatory reforestation required as offset to ensure no

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	habitat supporting ground cover, shrubs, herbs and trees. This portion of the project site is a mix of planted trees and natural vegetation. Site clearance activities will result in the removal of most, if not all, this vegetation, and the felling of about 249 trees (33 species, girth size 10-200 cm) in the project site. None of these trees are a threatened species. Terrestrial vegetation/ trees not intentionally cleared for construction may be accidentally damaged due to demolition, earthworks, or truck movements.					net loss of biodiversity
	Damage to remaining natural forest habitat including that in wider Rokhia Thermal Power Station complex and beyond due to risk of forest fire especially due to operational hazards, gas leaks, fire, and explosion hazard etc. Forest habitat is not contiguous with Sipahijila WLS at 10.5km distant and agricultural land/settlement can provide a fire break. Potential for cutting trees or collection of non-timber forest products by project workers. There are some threatened trees found in the study area. These risks are already present due to the existing plant, although construction will bring an influx of activity long term impacts will be similar.	Construction, Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
	Risk of spread of invasive flora species to/from the project site because of site clearance, earthworks, and truck movements. 22 invasive species are recorded in the PAI of 10 km radius with 11 invasive species (3 native and 8 alien) identified within 2km. Invasive species can	Construction, to a lesser extent during O&M	**Low Adverse**	**Yes**	**Low Adverse**	Magnitude remains the same in the worst case scenario but it is much less likely to occur

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	be transferred in / out of the project area during vehicle movement; these risks are already present due to the existing plant, although construction will bring an influx of activity long term the impacts will be similar.					
	Emission of NOx affecting vegetation that is sensitive to air pollution	Operation	**Low Adverse**	**Yes**	**Low Adverse**	
Wildlife	Loss of critical habitat for Pharyre's leaf monkey (EN) and habitat regularly used by other threatened species is not envisaged, the project site itself does not support critical habitat with Sipahijila WLS at 10.5km distant. Capped langurs (*Trachypithecus pileatus*) (VU) occasionally visits the wider study area around the project site but do not reside there. Potential human-wildlife conflicts; poaching, hunting, fishing, of wild animals by workers; increased risk of road-related accident due to additional traffic, disturbance to wildlife due to construction etc. These risks are already present due to the existing plant, although construction will bring an influx of activity.	Construction, Operation	**Medium to Low Adverse**	**Yes**	**Medium to Low Adverse**	Magnitude remains the same in the worst case scenario but it is much less likely to occur
	Loss of terrestrial habitat for other non-threated wildlife species supported by the Rokhia Thermal Power Station. The project site provides habitat for variety of Rhesus macaque (*Macaca mulatta*), small mammals birds, frogs, lizards, snakes, insects all of LC or NE species	Construction	**Low Adverse**	**Yes**	**Low Adverse**	Compensatory reforestation required as offset to ensure no net loss of biodiversity
	Potential disturbance to non-threated wildlife including Rhesus macaque (*Macaca mulatta*), globally LC species utilizing / moving across terrestrial habitat within and adjacent to the project site due to construction dust from demolition and	Construction, Operation	**Low Adverse**	**Yes**	**Low Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	earthworks, noise, illumination at night; potential human-wildlife conflicts; poaching, hunting, fishing, of wild animals by workers; increased risk of road-related accident due to additional traffic; collision with stack etc. These risks are already present due to the existing plant, although construction will bring an influx of activity.					
PHYSICAL ENVIRONMENT						
Climate change	Emission of greenhouse gases (GHG) from construction and operation of the proposed plant due to combustion of natural gas as fossil fuel contributing to global climate change impact. There will be cumulative impact from the more efficient 120 MW proposed plant replacing the 63 MW existing plant, for which no additional gas supply is required. However, in relation to achievement of the Paris agreement the proposed plant will extend use of fossil fuel and thus climate change impacts for a further 25 year period. There will also be fugitive emission from use of SF6, a potent GHG in switchgear.	Construction, Operation	**Maximum Adverse (although considered to be Beneficial with respect to short-term cumulative effects)**	**Yes**	**Maximum Adverse (although considered to be Beneficial with respect to short-term cumulative effects)**	Decommissioning of the existing plant will offset GHG emissions in the short term, TPGL will further offset emissions (after the ADB funded project) by developing roof top solar in the proposed plant area and utilizing the decommissioned plant area for extensive land based solar power, long-term a market-based instrument is economically viable to offset GHG emissions
Ambient air quality	Generation of dust during site clearance, demolition of office buildings, earthworks including leveling of hillocks, track out, material mobilization etc.	Construction	**High Adverse**	**Yes**	**Medium Adverse**	
	Emissions from diesel fueled vehicles – mainly PM, SO_2, NO_x and CO	Construction, to a lesser extent during O&M	**Low Adverse**	**Yes**	**Low Adverse**	
	Stack emission of NO_x during power plant operation adopting 25 ppm emission	Operation	**Low Adverse (although**	**Yes**	**Low Adverse (although**	

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	standard, cumulative impact with other major sources of NO_x in airshed. Impact considers proposed plant alone but there will also be beneficial cumulative impact from the proposed plant replacing the 63 MW existing plant, as there would be a net improvement in the baseline situation. The existing plant has less efficient turbines with a lower stack height and consequently, existing impacts are higher than those predicted for the new plant.		**considered to be Beneficial with respect to cumulative effects)**		**considered to be Beneficial with respect to cumulative effects)**	
	Other stack and fugitive emissions, such as CO, PM and SO_2 during normal power plant operation, and infrequent operation of the standby diesel generator during emergency.	Operation	**Low Adverse**	**Yes**	**Low Adverse**	
Noise and Vibration	Presence of project workers generating noise; noise from demolition, crushing, breaking works, earthworks, operation of mechanical equipment and machinery, material mobilization, traffic movements etc. Ground borne noise due to high energy construction activities, etc.	Construction	**Maximum to High Adverse**	**Yes**	**Medium Adverse**	
	Noise from power plant operation including start up and shut down, stack operations (HRSG, Bypass when used), HRSG, air inlet system, Air Cooled Condenser and infrequent (emergency) use of diesel generator are sources	Operation	**Medium Adverse**	**Yes**	**Low Adverse**	
	Ground borne vibrations due to high energy construction activities, earthwork, large vehicle movement, demolition, material handling, etc.	Construction	**Medium Adverse**	**No**	**Medium Adverse**	
	Vibrations from power plant operation including start up and shut down		**Low Adverse**	**No**	**Low Adverse**	
Topography and landscape/	Change in topography and landscape/terrain due to cutting and levelling of two hillocks in the project footprint involving up to 334,092	Construction	**High Adverse**	**Yes**	**High Adverse**	The area already houses a power plant which was constructed

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
terrain, surface water drainage	m^3 of earthworks to create a level construction platform at about 30 m AMSL when the existing elevation ranges from 30-49m with the two hillocks up to 59m. Due to extensive earthworks site elevation and its natural drainage flow pattern will be altered.					post levelling of the site; compensatory tree plantation/greenbelt around boundary area/landscaping during pre-construction phase will provide screening to the nearest properties but residual impact will remain
Geology and Soils	Excavation and compaction of topsoil and subsoil to create level construction platform and install foundations; including cutting of two hillocks with an estimated cut volume of up to 334,092 m^3 to create a level construction platform at about 30 m AMSL	Construction	**High Adverse**	**Yes**	**High Adverse**	Compensatory reforestation required as offset to ensure no net loss of biodiversity will help to offset loss of forest soils
	Erosion of the exposed soils due to surface water runoff, especially during the monsoon season with risk of construction induced landslide	Construction	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
	Inadequate storage and spills or leaks of fuel, oil, or chemicals stored on site causing soil contamination including transformer oil for new switchyard and diesel fuel for emergency diesel gen set. Disturbance of legacy soil contamination from spills and leaks at the existing plant which will be decommissioned (decommissioning is outside of scope of ADB funded but essential to realize project benefits).	Construction, Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
Water	Alternation of surface water drainage patterns due to extensive earthworks and construction of impermeable surfaces in	Construction	**Low Adverse**	**Yes**	**Low Adverse**	

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	place of vegetated land use; no drains or surface water bodies found at the project site					
	Use of groundwater for construction, including potable water supply for workers. Although GoT groundwater studies indicate there is plenty of water availability risk of compromising the supply of existing water users especially the nearest residents who reported water stress, mostly during the summer (March-June)	Construction	**Medium to Low Adverse**	**Yes**	**Medium to Low Adverse**	Subject to further hydrogeological assessment and securing water abstraction permit
	Use of groundwater for power plant operation, including potable water supply. Cumulative impact from 120 MW replacing 63 MW power plant. Higher water requirement in comparison to existing plant, but less water than usual for power plant as air cooled condensers are used. Although GoT groundwater studies indicate there is plenty of water availability risk of compromising the supply of existing water users especially the nearest residents who reported water stress, mostly during the summer (March-June)	Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	Subject to further hydrogeological assessment and securing water abstraction permit
	Surface water runoff leading to sediment laden runoff entering surface water, affecting water quality and aquatic ecology	Construction	**Minimal Adverse**	**Yes**	**Minimal Adverse**	
	Untreated effluent or inadequate storage and spills or leaks of fuel, oil, or chemicals stored on site causing surface water contamination including transformer oil for new switchyard and diesel fuel for emergency diesel gen set.	Construction, Operation	**Minimal Adverse**	**Yes**	**Minimal Adverse**	
	Inadequate storage and spills or leak of fuel, oil, or chemicals stored on site causing groundwater contamination including transformer oil for new switchyard and	Construction, Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	diesel fuel for emergency diesel gen set.					
	Disposal of untreated process and sanitary wastewater to land for watering the project site. Higher water requirement in comparison to existing plant results in a greater volume of effluent, but less water than usual for power plant as air cooled condensers are used	Construction, Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
Natural resource use and waste generation	Use of raw materials from existing licensed sources: sand, gravel, fuel, oil, chemicals etc.	Construction, Operation	**Medium Adverse**	**Yes**	**Medium Adverse**	
	Use of natural gas as a non-renewable fossil fuel for combustion. There will be cumulative impact from the more efficient 120 MW proposed plant replacing the 63 MW existing plant, for which no additional gas supply is required. However, the proposed plant will extend use of fossil fuel for a further 25-year period.	Operation	**Maximum Adverse**	**Yes**	**Maximum Adverse**	Non-renewable resource no mitigation is possible however, developing roof top solar in the proposed plant area and utilizing the decommissioned plant area for extensive land based solar power (after the ADB funded project) can reduce gas fired power consumption by the proposed plant itself
	Generation of inert spoil, inappropriately disposed of in the landscape surrounding the project site; it is currently anticipated that cut and fill can be balanced at the project site	Construction	**Medium Adverse**	**Yes**	**Low Adverse**	
	Generation of solid waste including construction offcuts, packaging and food waste, sludge from water pre-treatment and effluent treatment, air filters etc. inappropriately disposed of in the landscape surrounding the project site	Construction, Operation	**High Adverse**	**Yes**	**High Adverse**	Magnitude remains the same but waste will be safely and soundly disposed of to Assam or West Bengal

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	Generation of hazardous waste e.g., oily rags, empty drums, etc. inappropriately disposed of in the landscape surrounding the project site	Construction, Operation	**High Adverse**	**Yes**	**High Adverse**	
Socioeconomic Environment						
Occupational (workers) H&S	Risks related to unsanitary working conditions and sanitation and welfare facilities including overnight accommodation provided by employer, spread of communicable diseases, ponding of water for mosquitoes – malaria is a major health problem in Tripura, COVID-19 and HIV/AIDS, snake bites etc.	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur Third party Public Liability Insurance will be secured and (Public Liability Insurance Act, 1991) compensation per the national requirements paid in event of disability or fatality, with 30 days of verification of loss because of a health and safety incident Job offer in proposed plant – technical/office based for next of kin in case of death/permanent disability of main earner of the household
	Risks related to unsafe working conditions leading to H&S incidents/accidents e.g., slips, trips, falls from height due to inadequate protection, collapse of excavations, confined spaces, road traffic accidents, unloading of materials, electrical hazards etc.	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	
	Human health impacts on project workers from dust, noise, handling wastes, water pollution etc.	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	
	Power plant operational hazard, including fire and explosion risk due to use of natural gas. Including incidents with anthropogenic cause and because of any natural hazards e.g., earthquakes. These risks are already present in study area from existing plant.	Operation	**High Adverse**	**Yes**	**High Adverse**	
Community H&S	Community access to hazards present on construction site or operational power plant. Operational risks are already present in study area from existing plant – security present and no unauthorized access inside existing plant area is allowed.	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	In most cases magnitude remains the same in the worst-case scenario but it is much less likely to occur

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	Human health impacts on community members from dust, gaseous emissions including NOx, noise, vibration, water pollution etc. Operational risks are already present in study area from existing plant – see also physical impacts on air, noise, water etc.	Construction, Operation	**Maximum to High Adverse**	**Yes**	**Medium to Low Adverse**	Third party Public Liability Insurance will be secured and (Public Liability Insurance Act, 1991) compensation per the national requirements paid in event of disability or fatality, with 30 days of verification of loss because of a health and safety incident Job offer in proposed plant – technical/office based for next of kin in case of death/permanent disability of main earner of the household
	Power plant operational hazard, including fire and explosion risk due to use of natural gas. Including incidents with anthropogenic cause and because of any natural hazards e.g., earthquakes. These risks are already present in study area from existing plant.	Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	
	Traffic congestion, pedestrian and driver delay on local roads due to construction vehicle movements including transportation of oversized power plant equipment along rural access roads with tight curves passing through etc. Risk of traffic accidents due to additional vehicle movements on local roads, concern over safety of driving on, living adjacent to or having to cross busier roads etc. Road from Bisalgarh to Rokhia is on average 6m (4.5m-7.6m) in width, whereas the diameter of stack is about 7.5-8m diameter.	Construction	**High Adverse**	**Yes**	**High Adverse**	
	Spread of communicable diseases including COVID-19, HIV/AIDS, and other STDs from presence of migrant workers in rural area	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	
	Community interactions and conflict with workers and any security personnel deployed, especially for nearest residents/ Manikyanagar village, including sexual exploitation, abuse, and harassment from presence of migrant workers in rural area,	Construction, Operation	**High to Medium Adverse**	**Yes**	**High to Medium Adverse**	

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	disruptions of religious festivals etc. These risks are already present in study area from existing plant and community has not raised any concerns in that respect but there will be more workers including migrant workers present during construction.					
Land use and livelihoods	Private land take is not required as site is already part of TPGL land holding and the forest and private land historically diverted for industrial land use. There may be some temporary short-term disturbance to existing utility or roadside assets within the right of way along the access roads during transport of oversized vehicles.	Construction	**Low Adverse**	**Yes**	**Low Adverse**	
	Loss of access due to temporary closure of TPGL private road, currently allowed to be used by local communities; alternative/actual route of 1-2 km additional travel is available	Construction	**Low Adverse**	**Yes**	**Low Adverse**	
	Damage to private property – the nearest residences (mud/tin construction) to the project site due to dust deposition and vibrations caused by construction work, and increased traffic movements along access roads	Construction	**Medium to Low Adverse**	**Yes**	**Medium to Low Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
	Unused transmission towers in the project site are planned for dismantling Potential damage to other public utilities along roads, e.g., gas pipes, power lines, telephone lines, water pipelines or sewers along project vehicle transport route	Construction	**Medium Adverse**	**Yes**	**Medium Adverse**	Magnitude remains the same in the worst-case scenario but it is much less likely to occur
	Stress on use of community resources and services e.g., health services, water supplies. These risks are already present in study area from existing plant but will be more workers present during construction.	Construction, Operation	**High to Medium Adverse**	**Yes**	**Medium Adverse**	

Receptor (IEC/ISC)	Rationale for Potential Environment Impacts/Risks	Phases of Project	Significance Pre-Mitigation	Mitigation Incorporated into EMP	Significance Post-Mitigation (Residual)	Remarks/ Compensation/ Offset Measures
	Employment and micro level economic development opportunities from provision of accommodation for construction workers etc. Skilled and unskilled workers required, former likely to come from outside study area due to requirement for specialist training etc. Cumulative impact from replacing existing plant means no additional opportunities during operation, no labor retrenchment of the existing TPGL employees as they will be employed at the proposed plant	Construction	**Beneficial**	**Yes**	**Beneficial**	
	Energy supply and security	Operation	**Beneficial**	**n/a**	**Beneficial**	
Landscape and visual	Landscape and visual impact on adjacent residents of construction / new industrial setup, change from vegetated land to industrial land, demolition of hillock, etc. Stacks will be visible for a large distance.	Construction, Operation	**High Adverse**	**Yes**	**High Adverse**	The area already houses a power plant which was constructed post levelling of the site; compensatory tree plantation/greenbelt around boundary area/landscaping during pre-construction phase; consider CSR activities
Physical Cultural Resources						
Physical cultural resources	Risk of damage to local physical cultural resources due to construction and traffic movements along access roads; impact on the visual setting of local physical cultural resource	Construction, Operation	**Low Adverse**	**Yes**	**Low Adverse**	
	Risk of damage due to construction on project site to undiscovered physical cultural resources / chance finds e.g., archaeological / paleontological remains within the hillocks which will be excavated	Construction	**Low Adverse**	**Yes**	**Low Adverse**	

Source: ADB TA Consultant

VI. ANALYSIS OF ALTERNATIVES

A. Introduction

555. Under ADB's SPS 2009 for Category A environment project the analysis of alternative locations, designs, and technologies as well as the "do nothing" option needs to be considered in terms of technical, economic/financial, environmental and social cost-benefits. These are discussed in this chapter and were considered by TPGL in determining their preferred option presented in Chapter 2.

B. Do Nothing Scenario

556. The "do nothing" option will mean the proposed plant will not be constructed. This option means that the existing environment of the project site within the Rokhia Thermal Power Station will remain the same as the current condition, as described in Chapter 4 with the existing plant in operation. There would be no additional 57 MW of power generation to meet the projected future energy demands in Tripura. The operating units of the existing plant would also continue to consume natural gas and emit air pollutants at the current level, until such time as it reached the end of its lifespan (anticipated to be in the next 5-6 years) and/or alternative generation capacity was provided. The "do nothing" option is not favored by government because (a) the existing plant units are nearing the end of their life and are not energy efficient as compared to the proposed plant, (b) there is the opportunity to make use of Best Available Technologies (BAT) in the proposed plant to increase efficiency and reduce pollutant load, and (c) generation of more electricity will help the government to achieve its objectives to provide adequate power. The do-nothing scenario does serve as a basis for comparison to the 'with project scenario' and the benefits that may be lost and adverse impacts avoided. Table 6-1 presents a comparison of the 'with project' (including mitigation, residual impacts as per Chapter V) and the 'without project' scenarios.

Table 6-1: Comparison of 'Without-project' and 'With-project' Scenarios

Significant aspects	With-Project (including mitigation, residual impacts)	Without-project
Energy supply and security	Increased energy supply and security due to provision of additional 57 MW of power generation as a base load.	No change to existing situation, beneficial impacts not realized
Climate change	Proposed plant will extend the use of natural gas by its 25-year lifespan contributing to global climate change impacts over that period. Total Green House Gas Emissions from Proposed Plant: 288,327 tCO_2-eq-per year However, energy intensity will be reduced as additional 57 MW of power will be generated using the same amount of natural gas with beneficial impacts for climate change in the short term whilst India/Tripura transitions. Closed cycle technology is more efficient. Estimated Total Greenhouse Gas Emission Reduction: 364,959 tCO2-eq-per year	No change in existing situation; existing plant is not as energy efficient as CCGPP due to open cycle technology and any shortfall to meet energy demand comes from gas fired central generation stations. Baseline: Total Greenhouse Gas Emission under existing scenario: 653,286 tCO2-eq-per year. Beneficial impacts (56% GHG emission reduction) of improved energy efficiency not realized in the short term.

Significant aspects	With-Project (including mitigation, residual impacts)	Without-project
Natural resource use	No change to existing situation, although proposed plant will extend use of natural gas by its 25-year lifespan	No change to existing situation
Emissions to air	NO_x and CO emission will be lower than existing plant due to more efficient technology involved, opportunity to improve air quality baseline due to its reduced emissions	No change to existing situation, beneficial impacts of improving air quality are not realized
Water resource use	Increased volume of water will be required for the proposed plant impacting on groundwater supplies also used by the local community	No change to existing situation
Development of project site/loss of open forest habitat	Significant impacts on topography, terrain, soil structure and fertility, landscape and visual aesthetics of project site are unavoidable if it is to be developed. Loss of vegetation and trees supported by the project site.	No change to existing situation
Local communities	Disruption to local community due to construction. Temporary (construction period) restriction in using the TPGL private access road by locals as a short route alternate to reach the main road. Opportunities for employment during construction and operation, some induced socioeconomic impacts. Existing staff of TPGL working in the existing plant will be transferred to the proposed plant so retain their jobs for a further 25 years.	No change to existing situation, beneficial impacts not realized

Source: ADB TA Consultant

557. The “with project” scenario is preferred since the proposed plant will be new and more efficient that the existing plant (3 x 21 MW) whose units are already 9, 16 and 20 years old, enabling an additional 57 MW of power to be generated. From a purely theoretical environmental and social point of view considering the importance of meeting the Paris agreement, the ‘without project’ scenario is generally preferable to a ‘with project’ scenario as firstly it does not lock-in the use of fossil fuel for a further 25 years and secondly, although less significant, would avoid all project site level impacts. However, in the short term it will not help India to transition as the existing plant is inefficient and the shortfall of 57 MW (and a further 21 MW since 1 x 21 MW has recently had to stop operation under direction from MOEF&CC[122]) will need to be met from the grid which also has a higher energy intensity. In Tripura energy is from gas but in India 51.7% of energy generation is from coal with only 6.3% from natural gas and 38.5% from renewables.[123] The existing plant also generates more air pollutants (NO_x and CO) compared to the proposed plant. The ‘without project’ scenario would mean these benefits as well as minimal local benefits such as employment would also not be realized in the short term.

[122] http://environmentclearance.nic.in/writereaddata/Form-1A/Minutes/2007202169965964Approved_MoMof13thEACthermalheldon13-7-2021.pdf

[123] https://powermin.gov.in/en/content/power-sector-glance-all-india

C. With Project Scenario

558. The with-project scenarios were evaluated through alternative analysis of various with project locations, designs, and technologies.

1. Analysis of Project Locations

559. Since the proposed plant is a replacement for the existing plant and the required 4.5 ha land area for the proposed plant is available within the TPGL Rokhia Thermal Power Station which is already under their ownership no additional land acquisition is required. Further the Rokhia Thermal Power Station is already supplied with natural gas and has the transmission infrastructure for power export. Since alternative sites outside the Rokhia Thermal Power Station would require land acquisition and resettlement having social impact, as well as new gas pipeline and transmission line connections these were not examined further. Possible project sites within the confines of the Rokhia Thermal Power Station were explored.

560. For a 120 MW CCGPP of configuration 1+1+1 plus ancillaries the estimated minimum plot size requirement is an area of around 4.5 ha (comprising in the indicative design 2.46 ha for the proposed plant with a green belt of 1.493 ha. and 0.547 ha for related facilities). Since the existing plant will be required to operate to supply electricity to Tripura until the start of operations at the proposed plant it is not feasible to construct the proposed plant after demolishing the existing plant. The vacant area of the existing plant site is also too small to accommodate the proposed plant. Therefore, it was necessary to examine alternative locations within Rokhia Thermal Power Station. In conformation with the minimum plot size requirement, three available vacant lands were explored (Plots A, B, C) as shown in Figure 6-1.

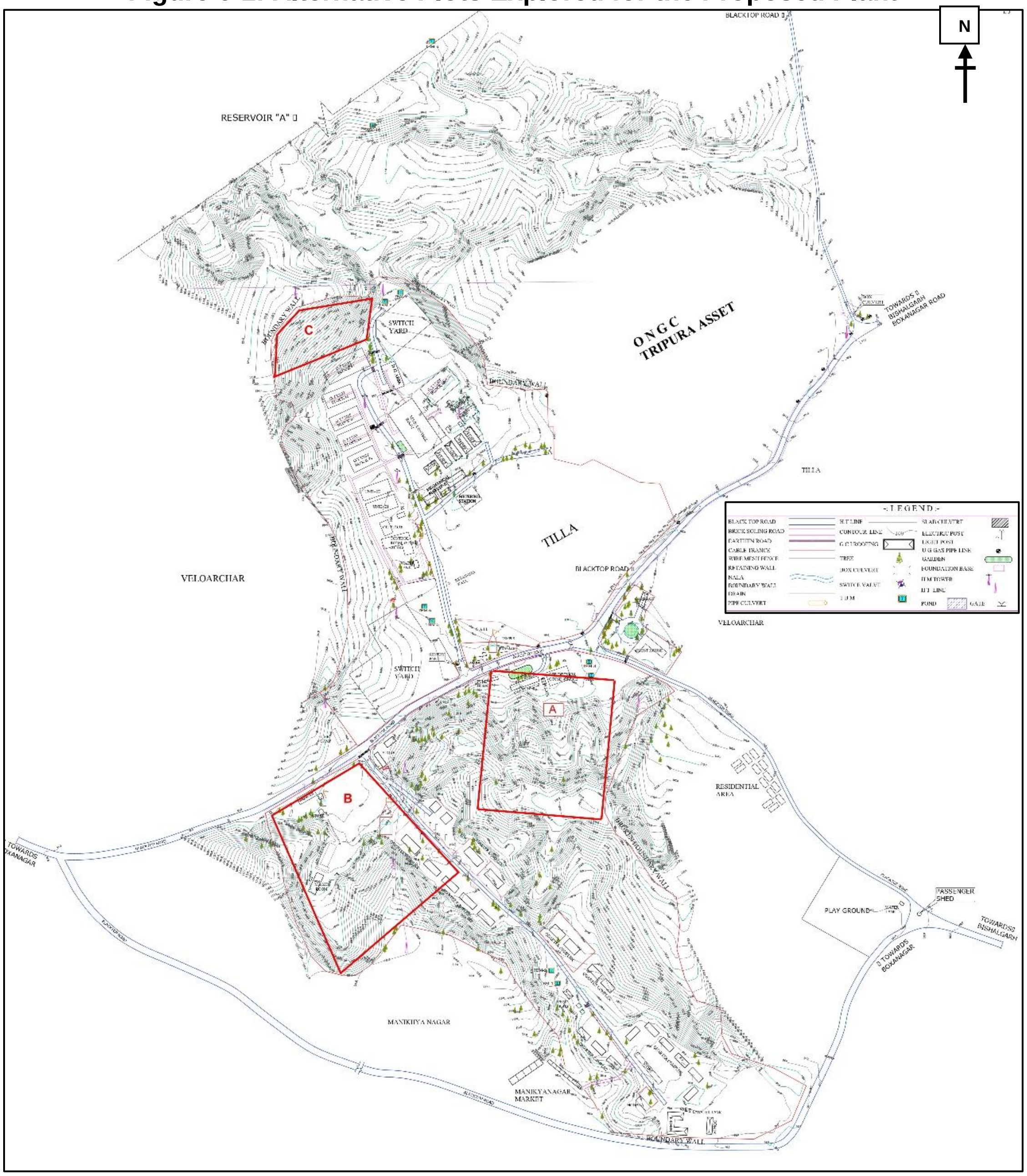
1.1. Plot A (about 153 m x 133 m + additional space on west and south periphery)

(i) Plot is vegetated with ground cover, shrubs, and trees/open forest habitat.
(ii) As is evident from the contour plot (Figure 6-1) the topography is undulating and extensive grading will be required to provide a level construction platform.
(iii) The available land meets the required area for installation of the proposed plant.
(iv) The plot has additional space for expansion to the west and south if more land is found to be required during the detailed design.
(v) To the southwest of the plot, there is an existing TPGL staff quarters, housing the engineers and employees of TPGL, which can be demolished in case additional space is required.
(vi) It has a couple of existing office buildings which need to be demolished.
(vii) There are two High Tension (HT) transmission line towers on east and west side of the plot, but the wires are not strung. If this transmission line is required by TSECL, then the transmission line will be required to be rerouted clearing the plot considered for the proposed plant. Based on current understanding it was installed for TPGL and not used, as it is no longer required the towers can just be dismantled and handed over to TSECL.

(viii) The existing 132 kV switchyard to which the proposed plant will be connected for power evacuation is next to the plot separated by the existing road. Thus, it will be easier to connect to the 132 kV switchyard by locating the 132 kV switchyard of the CCGPP to the west of this plot.

(ix) This plot is technically the most suitable and identified by TPGL for the proposed plant.

Figure 6-1: Alternative Plots Explored for the Proposed Plant



Source: TPGL

Figure 6-2: Alternate Plots Overlaid on Satellite Imagery

Source: ADB TA Consultant

1.2. Plot B (approximate perimeter dimensions in meters starting from north side – 113 x 192 x 173 x 164)

(i) Ground cover of the plot is overgrown grasses and shrubs, there are a few trees that were planted by TPGL along the existing plant boundaries and an office present that would need to be demolished.

(ii) Site is slightly undulating with contour line varying from 94-121m, some grading will be required to provide a level construction platform

(iii) The plot is bounded by existing roads and the boundary of Rokhia Thermal Power Station thus it does not have any space for expansion if required during the detailed design.
(iv) If distance has to be maintained from the existing road, the available land may fall short of the land requirement considering the restriction that there is no additional available space.
(v) It has existing structures which are required to be demolished.
(vi) The existing 132 kV switchyard to which the proposed plant will be connected for power evacuation is next to the plot separated by the existing road. Thus, it will be easier to connect to the 132 kV switchyard by locating the 132 kV switchyard of the CCGPP to the north of this plot.

1.3. Plot C. (approximate perimeter dimension in meters starting from north side – 83 x 37 x 48 x 111 x 47)

(i) The plot is in the north of existing GT Block #7 of the existing plant, no existing buildings to be demolished.
(ii) Ground cover of the plot is vegetated with grasses, dense shrubs, bamboo, and trees.
(iii) As is evident from the contour plot (Figure 6-1) the topography is undulating and extensive grading will be required to provide a level construction platform.
(iv) The available space may fall short of requirement with the restriction that there is no additional available space since it is up against the northern boundary of Rokhia Thermal Power Station.

561. It is evident from the above that the available plot area under Plot B and Plot C may fall short of the requirement. Thus, on technical grounds these plots were not considered suitable for the proposed plant.

562. Plot A has the required plot area for accommodating the proposed plant with the additional peripheral space for flexibility during detailed design. It is relatively free from the existing buildings to reduce the extent of demolition activities. Plot A is also close to existing switchyard, so power transmission and hook up arrangements will be easier. In view of the above, Plot A is considered most suitable by TPGL for installation of the proposed plant and thus it was the project site considered in detail by the EIA.

2. Analysis of Energy Generation Technologies (fuel source)

563. The following alternative energy generation technologies (fuel sources) were considered.

2.1. Generation by coal-fired power

564. Coal fired power plants currently contribute 51.7% of energy generation in India, although there is no coal fired power plant in Tripura. They are a major source of GHG emissions contributing to global climate change. The atmospheric emissions due to coal combustion, even after air pollution control, are the highest amongst fossil fuels with coal producing significantly more CO_2, NO_x, PM, and SO_2 than natural gas. Generation using a coal fired power plant will require more expenditure to implement pollution control measures to meet emissions standards as well as requiring land take for the disposal of fly ash and bottom ash, storage of coal etc. This would require a larger project site than is available at Rokhia Thermal

Power Station. Further, there are no sources of coal / coal mines in Tripura and the coal will have to be transported from the nearest coal mines (Eastern Coalfield) in Eastern India, if available, which will also increase the project cost. Since the existing coal fields are already supplying coal to the existing thermal power plants in India, issues with coal linkage (i.e., establishing an assured, and guaranteed supply of coal from an identified coal field) will persist leading to delay in implementing the proposed power plant. In all respects, not least climate change, generation by coal fired power is not considered a suitable option.

2.2. Generation by oil-fired power

565. Oil fired power plants use fuel oil obtained from refining petroleum for the generation of power and currently contribute 0.1% of energy generation in India, although there is no oil-fired power plant in Tripura. They are also a major source of GHG emissions contributing to global climate change. The quantity of CO_2, NO_x, PM, and SO_2 emissions is significantly higher as compared to natural gas due to incomplete combustion. Generation using a coal fired power plant will require more expenditure to implement pollution control measures to meet emissions standards. Further, there are no oil refineries in Tripura (nearest is in Assam) and the cost for transportation including laying of oil pipelines or transport logistics will increase cost. In all respects generation by oil fired power is not considered a suitable option.

2.3. Generation by natural gas fired power

566. As methane (CH_4) is the major component of natural gas, it is the cleanest fossil fuel available for producing energy. Removal of all other contaminants except methane in natural gas is done prior to it being used as fuel. Thus, emissions of PM and SO_2, are negligible. The combustion of natural gas only produces $NO_{X,}$ CO, and GHG emissions. Different technology is available for natural gas fired power as discussed in the next section. Of the fossil fuel options available, natural gas is the preferred option in all respects.

2.4. Generation by bio-fueled power

567. Biofuel energy is produced from non-fossilized materials derived from plants such as wood or crop wastes. As a carbon neutral, renewable resource its use can reduce reliance on fossil fuel whilst still providing reliable base load. Approximately 2.6% of total energy produced in India is from biomass power/cogeneration.[124] Presently there are 535 household biogas plants in Tripura (size of digester varies from 1-2 m^3) subsidised by Tripura Renewable Energy Development Agency (TREDA) under New National Biogas and Organic Manure Programme (NNBOMP) which uses cattle dung mass to provide mainly cooking gas. These small-scale biogas plants can also provide electricity to the households.

568. Tripura does not have any other biofuel fired power plants. Thus, TPGL does not have any experience of designing, constructing, or operating a large-scale biofuel power plant, and there is limited such expertise in India. It is also not favoured as a thermal fuel source by TPGL, as it is not as efficient as gas generation, requires more space, still results in some emissions including dust, and a continuous local fuel source that does not cause forest impacts needs to be identified. It has thus not been considered further by TPGL.

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[124] Power Sector at a Glance All India, https://powermin.gov.in/en/content/power-sector-glance-all-india

2.5. Generation by wind power

569. Wind power is the conversion of energy from the wind into electricity using wind turbines. Generation of wind power is a renewable energy that does not produce significant GHG emissions thus is preferable from an environmental sustainability/climate change perspective. However, although wind power does not result in air pollution, require water consumption for cooling systems, or result in process wastewater wind turbines are not without their environmental and social impacts. For example, sited in the wrong location they can result in bird and bat mortality or cause noise impacts to adjacent receptors. Wind energy is an inexpensive source of electric power and competitive with thermal power plants. However, due to the large area required to set up the wind turbines to generate 120 MW power (approximately 60 x 2 MW wind turbines) additional land acquisition will be required, incurring additional costs for this acquisition, land acquisition and resettlement impacts and given 59.98%[125] of land in Tripura is forest, biodiversity impacts. Further, wind is an intermittent energy source due to variability in wind patterns (low wind speeds in comparisons to other states in India) which cannot be dispatched on demand to provide base load. To provide a reliable electricity supply wind power needs to be used with other power generating sources. Thus, TPGL is not supportive of this source as an alternative to gas-powered power for generating base load. Per GoI, no wind power generation is presently found in Tripura or Northeast India.

2.6. Generation by solar power

570. Solar power is the conversion of energy from sunlight into electricity either directly using photovoltaics (PV) or indirectly using concentrated solar power or a combination. Generation of solar power is a renewable energy that does not produce significant GHG emissions thus is preferable from an environmental sustainability/climate change perspective. Minimal water consumption is required for washing of PV panels. Concentrating solar power plants with wet-cooling systems, on the other hand, have the highest water-consumption intensities of any conventional type of power plant except fossil-fuel plants with carbon-capture and storage. Solar PV is rapidly becoming inexpensive. However, it requires a much larger amount of land surface; about 1 km^2 for every 40–60 MW generated. Thus, to generate 120 MW the land required will be 200-300 ha, far larger than the Rokhia Thermal Power Station requiring additional land acquisition incurring additional costs for this acquisition, land acquisition and resettlement impacts and given 59.98% of land in Tripura is forest, biodiversity impacts. Further, solar is an intermittent energy source available during the day which without battery storage cannot be dispatched on demand to provide base load. NE India (including Tripura) in general has a long monsoon climate where the sun is obstructed by clouds and thus solar power in the state may also not be feasible at a large scale. TREDA though has installed approximately 1.6 MW solar power plant cells at 103 locations[126] and numerous streetlights operated through solar cells. Even though TPGL is not supportive of this source presently as an alternative to gas-powered power for generating base load, it is considering using its available area at the Rokhia Thermal Power Station for solar plants soon. It may also consider setting up of floating solar power plant in the Dumboor lake in Gomati district, if found to be feasible.

2.7. Generation by hydropower

[125] http://trpenvis.nic.in/test/forest.html
[126] http://treda.nic.in/sites/default/files/spv-power-plantf.pdf

571. Though generation of hydropower is a clean source of energy and thus is preferable from an environmental sustainability/climate change perspective, it can have major social and environmental/biodiversity impacts due to the submergence of land and forests and dewatering of downstream sections. Since hydropower utilises the height of the water head to run the turbines, optimal areas for hydropower are in hilly and mountainous areas. Even though Tripura has a hilly terrain, suitable locations for setting up of new hydropower may be limited due to biodiversity impacts, social constraints etc. Gumti HEP is the only hydropower plant in Tripura with a capacity to produce 15 MW (its present capacity is of 10 MW only) which has legacy social issues associated with it, as the reservoir displaced a large population a majority of whom were indigenous persons; any other hydropower plant in Tripura will have similar impacts given the ethnic distribution. Even if a suitable hydropower site were available the costs involved, including engineering cost, the social cost for resettlement and rehabilitation of affected people, and the compensatory afforestation requiring minimum twice the forest area lost will be quite prohibitive. Thus, to develop hydropower as an alternative source to generate 120 MW in Tripura is not feasible.

3. Analysis of Power Plant Technology - Best Available Technology (BAT) Assessment

572. Having identified the preferred plot and source of energy (natural gas) the indicative design of the new CCGT power plant has been compared to indicative sectoral BAT requirements as defined in the World Bank-IFC Environmental, Health and Safety (EHS) Guidelines for Thermal Power Plants and the various BAT Reference (BREF) documents and implementing decisions on BAT Conclusions by the European Commission. BAT can generally be demonstrated by comparing the design and proposed operation of an installation against indicative BAT requirements and/or BAT conclusions. However, where there is a range of techniques available and referenced as BAT, it is necessary to perform an options appraisal to identify which technique or combination of techniques represents BAT for the specific site context. Accordingly, in addition to a comparison against the indicative BAT and BAT Conclusions in the WB/IFC EHS Guidelines and European Commission BREFs, options appraisals of the following key areas have been performed:

(i) Selection of combustion technology
(ii) Options for the control of emissions of oxides of nitrogen (NOx)
(iii) Options for cooling systems

573. A detailed BAT analysis is provided in **Annexure 23** from which the following conclusions are drawn. The assessment against the indicative BAT in the WB/IFC EHS Guidelines for Thermal Power Plants and the BAT Conclusions for Large Combustion Plants indicates compliance with these requirements.

3.1. Selection of combustion technology

574. The design basis and rationale for the proposed plant involves using the existing natural gas supply network at its existing supply capacity to generate additional electrical power. Consequently, whilst there are other fuels and options for generating electricity, such as coal, oil, or renewables (as discussed above) it is only relevant to the BAT assessment to review options for selecting combustion appliances capable of operating on natural gas. Natural gas is identified by the WB/IFC EHS Guidelines for Thermal Power Plants has having the lowest environmental impact of any available fossil fuels. Four options for generating electrical power from natural gas were assessed:

(i) Combustion of natural gas in a boiler with an integrated steam turbine.

(ii) Combustion of natural gas in a spark ignition reciprocating engine.
(iii) Combustion on natural gas in an OCGPP; and
(iv) Combustion of natural gas in a CCGPP

575. Following the options appraisal, the design of the proposed plant using CCGPP technology is the BAT option. CCGPP offers the highest levels of efficiency with the lowest levels of NOx emissions. Although the load matching capability of CCGPP is much lower than that of a spark ignition engine or OCGPP, the proposed plant is principally designed to provide base-load power, not to act as peaking or balancing plant. Whilst maintenance requirements of CCGPP are more extensive than the other types of combustion plant, the operational experience with CCGPP is strong, with many such plants operating worldwide, in India and Tripura (two plants).

3.2. Options for Control of NOx Emissions

576. The options for reducing NO_x emissions from the CCGPP were informed by the measures highlighted in the WB-IFC EHS Guidelines for Thermal Power Plants and the Large Combustion Plant BREF. They included the following primary and secondary control measures:
(i) Primary measures
  (a) Dry low-NOx (DLN) burners
  (b) Steam/water injection
(ii) Secondary measures
  (a) Selective catalytic reduction

577. Steam/water injection was initially screened from further consideration since this option requires a substantial quantity of water to provide the level of emission reduction required. As the proposed plant is in an area with constraints on available water supply, this option is not considered to be technically viable. The GoI has also capped water usage by power plants at 2.5 MWh/day with zero water discharge. Based on appraisal of DLN burners and SCR, it is considered that the use of DLN burners would represent BAT for the proposed plant based on the following factors:
(i) DLN burners are a more cost-effective technique than SCR for reducing NOx emissions i.e., the cost to reduce each tonne of NOx is lower for DLN burners than SCR.
(ii) SCR has potential adverse cross media effects in terms of ammonia slip and the requirement to periodically dispose of additional waste streams (spent catalyst).
(iii) Incorporation of DLN burners will result in compliance with the emission guideline level for NOx in the WB-IFC EHS Guidelines for Thermal Power Plants.
(iv) With DLN burners, process contributions are less than 1% of the relevant local and most recently revised WHO guidelines.

3.3. Options for Cooling System

578. The cooling system options for the proposed plant were informed by the measures highlighted in the WB-IFC EHS Guidelines for Thermal Power Plants and the European Commission Industrial Cooling Systems BREF. These options included:
(i) Once-through cooling system
(ii) Closed circuit wet evaporative cooling system
(iii) Closed circuit dry cooling system

579. As the proposed plant is in an area where available water from the nearest river is only reliably available during monsoon season, the use of once-through cooling systems is not considered suitable for this location due to the substantial, year-round water requirement. Based on further options appraisal, a closed-circuit dry cooling system is considered BAT for this location despite higher costs than a closed circuit wet evaporative system and greater reduction in plant efficiency due to the following factors:

(i) The closed circuit wet evaporative system, whilst significantly reducing the water requirement compared to a once-through cooling system, still requires a year-round water supply in an area where the supply is significantly constrained for large periods of the year; and

(ii) Dry cooling systems have fewer cross media effects than a closed circuit wet evaporative system

4. Analysis of CCGPP Configurations

580. Various possible configurations of a CCGPP considering the availability of natural gas have been studied and the predicted heat rate and efficiency at ISO condition compared. It has been noted that a CCGPP utilizing advanced class heavy duty gas turbines with three pressure non reheat steam cycle would be suitable for this project. Heavy Duty Gas Turbines are normally referenced by class. The classes that are presently available are D, E, F, G, H and J. Presently, F class of GT which are typically in the 170-230 MW range are the dominant GT and commercially and technologically proven as compared to D and E class GT which are in the 75-110 MW range. All major GT Original Equipment Manufacturers (OEM) have well proven F class units. The advanced class turbines (G, H, and J frames) are normally in the 275-350 MW range. Since the proposed production output is 120 MW, an F class GT is proposed.

581. Two possible alternatives for the CCGPP configuration emerge for 120 MW capacity:

(i) One unit comprising 1 Gas Turbine, 1 Heat Recovery Steam Generators (HRSG) and 1 Steam Turbine using steam from the HRSG. This is known as a 1+1+1 configuration of the CCGPP unit. The steam cycle will be of three pressures non reheat type for this configuration.

(ii) One unit comprising 2 Gas Turbines-industrial type, 2 Heat Recovery Steam Generators (HRSG) connected to 1 common Steam Turbine using steam from both the HRSGs. This is known as 2+2+1 configuration of the CCGPP unit. The steam cycle in this configuration will be two pressure type.

582. Based on above module configurations, a study of the Combined Cycle Performance Specifications published in Gas Turbine World Handbook-2019 has been carried out under ISO conditions assuming conventional water-cooled condenser firing with natural gas as fuel.[127]

Table 6-4: Comparison of Power Output and Efficiency from Manufacturers

Original Equipment Manufacturer (OEM)	Model	GT Type	Configuration	GT Model	Net Power MW	Net Efficiency (%)
BHEL	CC206B	Industrial	2+2+1	MS-6001(B)	127.51	49.1
Siemens	SCC8002	Industrial	2+2+1	SGT-800	135.4	54.7

[127] TPGL DPR November 2020

	X1					
BHEL	CC106FA	Advanced	1+1+1	MS-6001(FA)	116.72	53.8
GE	6F.03	Advanced	1+1+1	6F.03	135	56.9

Note: the net efficiencies are reduced when air cooled condensing is used
Source: DPR by TPGL

583. From the Table 6-2 it is revealed that a CCGPP with 1 +1+1 configuration with GE 6F.03 GT model (advanced class heavy duty gas turbine) is expected to provide the most desirable technical benefits which establishes it as the preferred option of TPGL for the proposed plant.

584. The CCGPP turbines can be configured in either single shaft or multi- shaft configurations:

(i) Single shaft: the Gas Turbines and Steam Turbines (ST) are connected through a solid shaft to a common generator

(ii) Multi shaft (1 on 1 or 2 on 1): the GT and ST (1 on 1) have their own dedicated generators and are often installed in separate buildings, or the GT (2 on 1) may have a dedicated HRSG which raises steam for use in a common ST.

585. The capital and operational costs for single shaft configurations are lower compared to multi shaft configurations which involves more equipment etc. The commissioning time is also less in a single shaft configuration. Since the number of parts are fewer in the single shaft configuration, the efficiency is also slightly higher than multi shaft. Multi shaft however allows for more flexibility in the placement of the plant and is easier to maintain, and the larger ST used in 2 on 1 configuration has a better full load performance than the 1 on 1 configuration. However, a fault on the ST will stop both GTs unless bypass stacks are provided, while a fault on the ST in a single shaft unit shall not lead to complete shutdown. Since the proposed plant is not intended to run in open cycle mode, commissioning of the GT and ST will be done at the same time, TPGL prefers a multi-shaft system. However, for the proposed plant, the final configuration will be as per the EPC Contractor’s design.

5. Analysis of Stack Height for Pollution Control

586. The stack sensitivity analysis provided in Chapter 5 identified that the optimum HRSG height to be 60m and Bypass Stack as 30 m.

6. Analysis of transport routes

587. Delivery of plant, machinery, equipment, and materials to the project site on time is an important factor in ensuring the construction and installation schedule can be met. The proposed plant is well connected by National Highway 8 (NH 8) with Bisalgarh and Agartala. The distance of Agartala is around 35km and from Bisalgarh is about 13km. The movement of heavy equipment and machinery may be planned either from Ashuganj River Port (Bangladesh), Chittagong/Chattogram Port (Bangladesh) or Haldia/Kolkata Port (in West Bengal, India). From Ashuganj Port, it will have to travel via road via Akhaura border post to Agartala from where it can either transported by NH8 or railways to Bishalgarh and then to the project site. The total distance from Ashuganj port to the project site is approximately 81 km. From Chittagong port, it can be transported via Sabroom border (approximately 100 km) and then to Bishalgarh by NH 8 to the project site (approximately 120 km) for a total distance of approximately 220 km. Travel from Haldia port can be through either road or rail through the Indian states of West Bengal, Assam, Meghalaya (no railways) and Tripura for a total distance of approximately 1,686 km by roads and 1,650 km by railways.

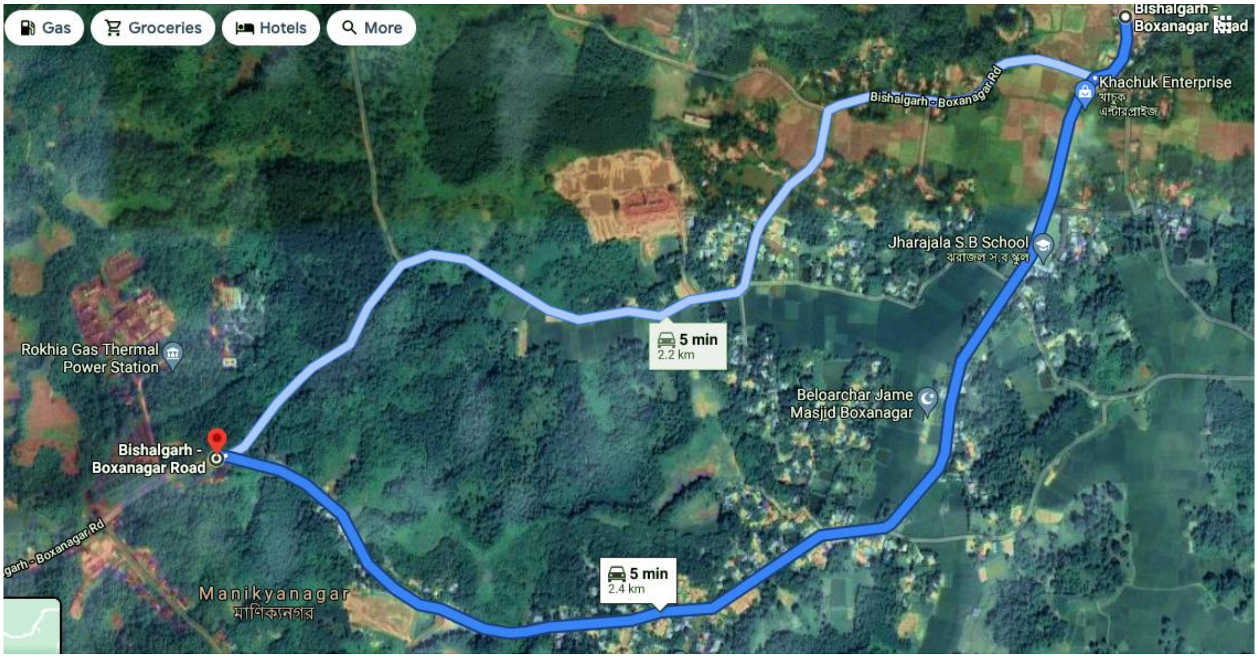
588. Figure 6-3 shows alternate routes which run along existing major district roads (MDR)/local roads from Bisalgarh to Rokhia. Route one is 14.5 km via Bishalgarh – Boxanagar Rd (Dark Blue). Route two is 16.4 km via Border Rd and Bishalgarh - Boxanagar Rd (Light Blue). Both routes pass across the Bijoy River. Both routes have settlements along the access road, although the density of them is lower in the Bisalgarh-Boxargarh Road, which is also the shortest route among the two and so is preferred for use by the EPC contractor.

589. For the final section of route one (above) there are two possible route options that could be taken (Figure 6-4). Route one is 2.4 km via Road A (Dark Blue) and route two is 2.2 km via Road B (Light Blue). Both routes pass through narrow stretches and moderate undulating terrain. Route B has two main schools (30-50m from main road) and more settlement area to pass through. Whereas Route B passes through low density settlement area in the initial section only and so is preferred subject to route assessment by the EPC Contractor. Due to concerns of the nearest residents who will already be most affected due to works at the project site Route A will not be used by the EPC Contractor for construction traffic.

Figure 6-3: Transportation Routes from Bisalgarh (about 38 km from project site)

Source: ADB TA Consultant

Figure 6-4: Transportation Route Options for Final 2.4 km from Project Site



Source: ADB TA Consultant

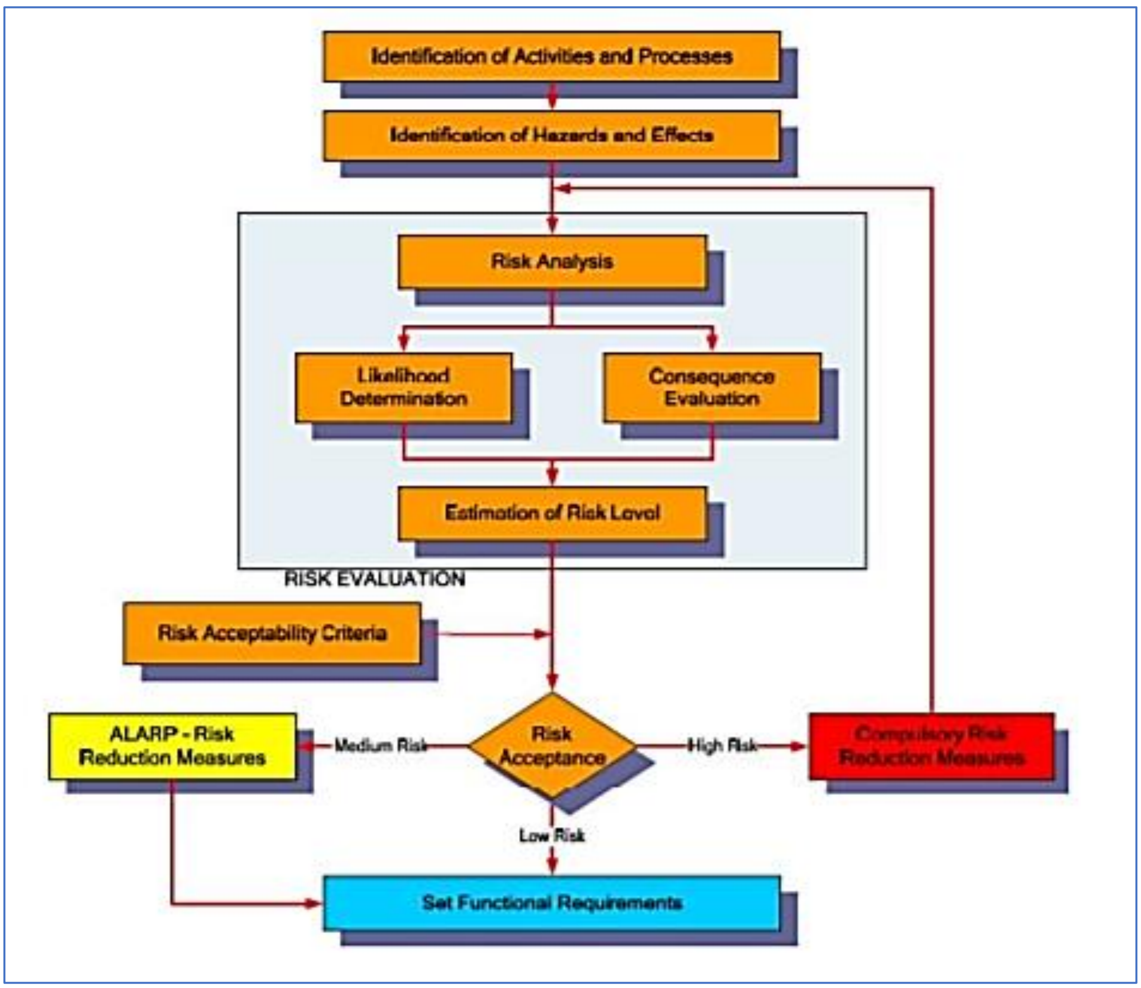
VII. OPERATIONAL QUANTITATIVE RISK-HAZARD ASSESSMENT

A. Introduction

590. A hazard is something that can cause harm or has the potential to cause harm whereas risk is a function of the likelihood of a hazard occurring and its consequences. For the proposed plant, an operational quantitative risk-hazard assessment has been conducted to examine the potential hazards present due to the use of natural gas on-site, their consequences, and measures to manage the risks considering a worse-case scenario. The quantitative risk-hazard assessment (QRA) includes several steps as per Figure 7-1:

(i) Hazard Identification and Cause Analysis
(ii) Exposure Modelling
(iii) Risk Assessment
(iv) Identification of Risk Reduction Measures
(v) Hazard Identification, Causes and Consequences

Figure 7-1: Risk Assessment Methodology

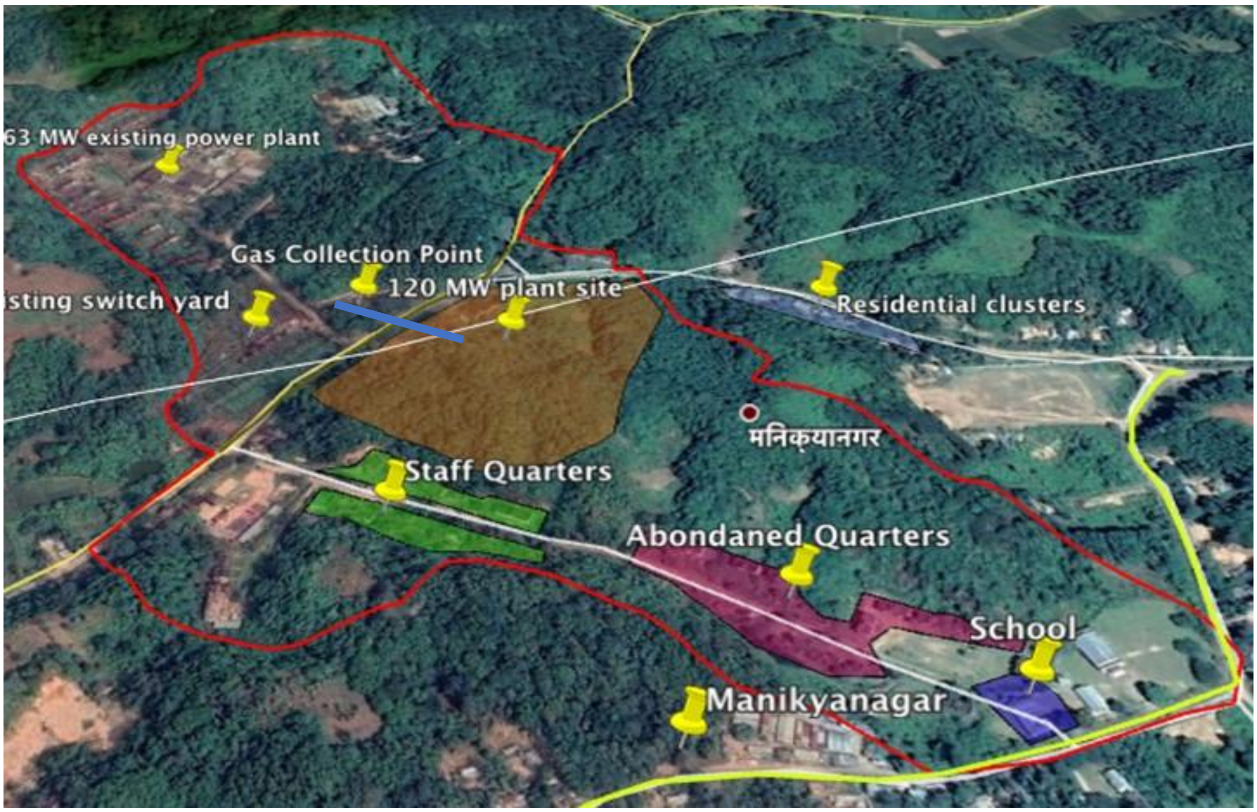


Source: ADB TA Consultant

591. The proposed gas pipeline route is shown in Figure 7-2. Gas will be supplied from within the boundaries of the existing Rokhia Thermal Power Station from the GCS via this gas pipeline

which will run under the TPGL private access road to the proposed plant. Leakage from the GCS and the approximately 90m long gas pipeline may lead to series of hazards that may ultimately result in damage to property, ecological damage, physical injuries, disabilities, or loss of human life. The area surrounding the proposed plant does not have any dense settlement. A cluster of houses is located outside the project site boundary at about 150m from the proposed plant centre. Volume of traffic flow is very low along the nearest roads. No community gathering areas, shops, businesses, or offices (other than those associated with the existing Rokhia Thermal Power Station) are present with 1 km radius although a high school is present about 450m from the proposed plant. The temple associated with the GCS is adjacent to the proposed gas pipeline route.

Figure 7-2: Map of the Proposed Gas Pipeline Route



Note: blue line shows the proposed gas pipeline route from GCS to the CCGPP
Source: ADB TA Consultant

592. Natural gas is a flammable chemical consisting of mostly of methane (96% by volume), ethane, propane, butane, and other alkanes. Though methane is highly flammable gas, its explosion limit is low and ranges between 5% and 15% (by volume of air). Natural gas release can cause jet fire as well as explosion. In case of partial failure of pressurized pipelines, natural gas will be released in the form of an unignited jet, but this will lead to jet fire when the gas encounters a naked flame or hot material. Explosion may also occur due to release of natural gas through leakage. Natural gas leaks out and mixes with the air to form an explosive vapor cloud which may explode on contact with a naked flame or hot material. Table 7-1 shows the hazard source points and major potential hazards related to natural gas during proposed plant operation.

Table 7-1: Potential Hazard Points and Possible Consequences

Hazard Points	Potential Hazards	Consequences
Gas collecting station (GCS)	Gas leak will lead to: • Toxic Vapor Cloud Formation • Vapor Cloud Explosion • Jet Fire • Limited Space Explosion • Over Pressure Explosion	Fire Explosion Physical Injury – Burns Health Injury - Poisoning Fatalities including Suffocation Damage to power plant/property Ecological Damage
8" Gas Pipeline (90m length)		

Source: ADB TA Consultant

593. The gas pipeline may be prone to small hole leakage, large hole leakage, or fracture. The operation of the gas pipeline will be almost unaffected when the small hole leakage occurs, whereas a large hole or fracture leakage would affect its operation. Some major reasons (root causes) which will increase the likelihood of hazards associated with the transmission of natural gas through the gas collecting station (GCS) and gas pipeline occurring are:

(i) Mechanical or material fracture or failure (incorrect design or faults in manufacture; faulty installation, weld failures; cracks due to shear stresses placed on on pipeline)
(ii) Corrosion-internal or external to pipeline (it may be due to use of improper coatings);
(iii) Human error or intentional damage (e.g., accidental dig-ins during excavation works, sabotage)
(iv) Natural forces or hazards (i.e., ground movement, shaking during an earthquake) etc.

594. The QRA describes and assesses the consequences and risk of these unplanned events that could potentially cause risks to occupational and public health and safety and harm to the environment.

B. Risk-Hazard (Exposure) Modelling

1. Modelling Approach

595. ALOHA (Areal Locations of Hazardous Atmospheres) software has been used to simulate the consequences of gas leakage or pipeline failure. ALOHA is a modelling tool to estimate threat zones associated with hazardous chemical releases, including toxic gas clouds, fires, and explosions. The simulation considers that it is possible to close off the gas supply connection through an automatic valve installed at the GCS (such as valve is already installed at the GCS and the existing plant with a response time of 1 minute; same is to be installed at the proposed plant). ALOHA has been applied to simulate the following sequential hazards:

(i) Thermal radiation from jet fire
(ii) Toxic Area of Vapor Cloud Formation
(iii) Flammable Area of Vapor Cloud Formation
(iv) Blast Area of Vapor Cloud Formation

596. ALOHA evaluates the risk depending on whether the natural gas (as a flammable chemical) is burning:

(i) **Burning (Jet Fire) Scenario:** if the natural gas catches fire as it escapes the gas pipeline, it will result in a jet fie. Potential hazards associated with a jet fire include thermal radiation, smoke, and toxic byproducts from the fire. ALOHA models the thermal radiation hazard.

(ii) **Not Burning Scenario**: if the natural gas escapes, but does not immediately catch on fire, it forms a vapor cloud. The hazards associated with the vapor cloud will depend on the release conditions, using ALOHA three hazards can be modelled:

a) Toxic Area of Vapor Cloud: the predicted area where the ground-level toxic vapor concentration may be hazardous.

b) Flammable Area of Vapor Cloud: the predicted area where the ground-level vapor (fuel) concentration in the air is within the flammable range and can be ignited.

c) Blast Area of Vapor Cloud Explosion: the predicted area where the blast force (overpressure) from any explosion is hazardous.

2. Model Assumptions

597. The basic assumptions include climatic condition, site condition and release conditions. One of the key assumptions is wind direction. The wind rose indicates that the predominant wind direction is south. However, the wind direction used in the model has been taken (considering potential impacts on the nearest receptor outside the project site) as flow from the west to east. Maximum wind speed has been considered as 2 m/s for modelling purposes. Most of the year wind speed remains 1-2 m/s at 10 m height. The proposed gas pipeline route is also surrounded by the foot of a hillock located to the north of the proposed plant, so will be retained post-construction, and this terrain and vegetation/trees may obstruct free flow of wind. Both ends of the gas pipe between the GCS and proposed plant and GCS will be regulated by automatic valves. Details of model inputs and assumptions are provided in this section.

SITE DATA:

(i) Location: ROKHIA, TRIPURA, INDIA
(ii) Building Air Exchanges Per Hour: 0.44 (unsheltered single storied)

CHEMICAL DATA: (ALOHA CHEMICAL DIRECTORY)

- Chemical Name: METHANE

(i) CAS Number: 74-82-8
(ii) Lower Explosive Limit (LEL): 50000 ppm
(iii) Upper Explosive Limit (UEL): 150000 ppm
(iv) Ambient Boiling Point: -161.5° C
(v) Vapor Pressure at Ambient Temperature: greater than 1 atm
(vi) Ambient Saturation Concentration: 1,000,000 ppm or 100.0%
(vii) Specific Gravity: 0.422 at -256°F[128]
(viii) Molecular Weight: 16.04[129]
(ix) Water Solubility: 3.5 ml/100 ml at 63°F[130]

ATMOSPHERIC DATA: (informed by baseline primary data by MITCON)

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[128] USCG, 1999
[129] NTP, 1992
[130] NTP, 1992

(i) Wind: 2.0 m/s from West at 10 meters
(ii) Ground Roughness: urban or forest (due to vegetation/tree cover and existing plant)
(iii) Cloud Cover: 3 tenths (predominantly clear sky)
(iv) Air Temperature: 32° C
(v) Stability Class: B (moderately unstable, worst case)
(vi) No Inversion Height
(vii) Relative Humidity: 75%

SOURCE STRENGTH: (Source: TPGL)
(i) Flammable gas escaping from pipe (not burning and burning scenario)
(ii) Pipe Diameter: 8 inches
(iii) Pipe Length: 90 meters
(iv) Unbroken end of the pipe is closed off
(v) Pipe Roughness: smooth
(vi) Hole Area: 50.3 square inches (using pipe diameter)
(vii) Pipe Pressure: 19.36 atmospheres (20 kg/cm^2)
(viii) Pipe Temperature: 30° C
(ix) Release Duration: 1 minute
(x) Max Average Sustained Release Rate: 544 g/s (averaged over a minute or more)
(xi) Total Amount Released: 32.6 kg

3. Model Results

598. In ALOHA, the Level of Concern (LOC) is a threshold value of a hazard (toxicity, flammability, thermal radiation, or overpressure) and can be taken as the value above which a threat to people or property may exist. For each LOC, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins. These zones are displayed on a single threat zone plot. If results are negligible and no or minimal hazard will result, then plots are not produced. Modelling results for the LOC for the hazards modeled are presented in Tables 7-2 to 7-6 and Figures 7-3 to 7-6.

3.1. Gas burning scenario: thermal heat radiation from jet fire

599. A jet fire, also referred to as a flame jet, will occurs when the natural gas is rapidly released from an opening/leak and immediately catches on fire—much like the flame from a blowtorch. ALOHA assumes the jet fire release is oriented vertically, although the wind can tilt the flames in the downwind direction. The red, orange, and yellow threat zones of the ALOHA output plot in Table 7-2 and Figure 7-3 indicate the areas where the thermal radiation is predicted to exceed the corresponding LOC at some time in the hour after a release begins at the project site. The direct impact will remain well within the Rokhia Thermal Power Station.

600. No well-defined guidelines or standards exist to evaluate the thermal radiation hazard. So, ALOHA uses default thermal radiation values (in kilowatts per square meter) that are based on a review of several widely accepted sources on thermal radiation to define three LOC:
(i) 10 kW/m^2 (potentially lethal within 60 seconds)
(ii) 5 kW/m^2 (second-degree burns within 60 seconds)
(iii) 2 kW/m^2 (pain within 60 seconds)

601. The thermal radiation effects that people would experience because of exposure to a jet fire hazard depends upon the length of time they are exposed to a specific thermal radiation

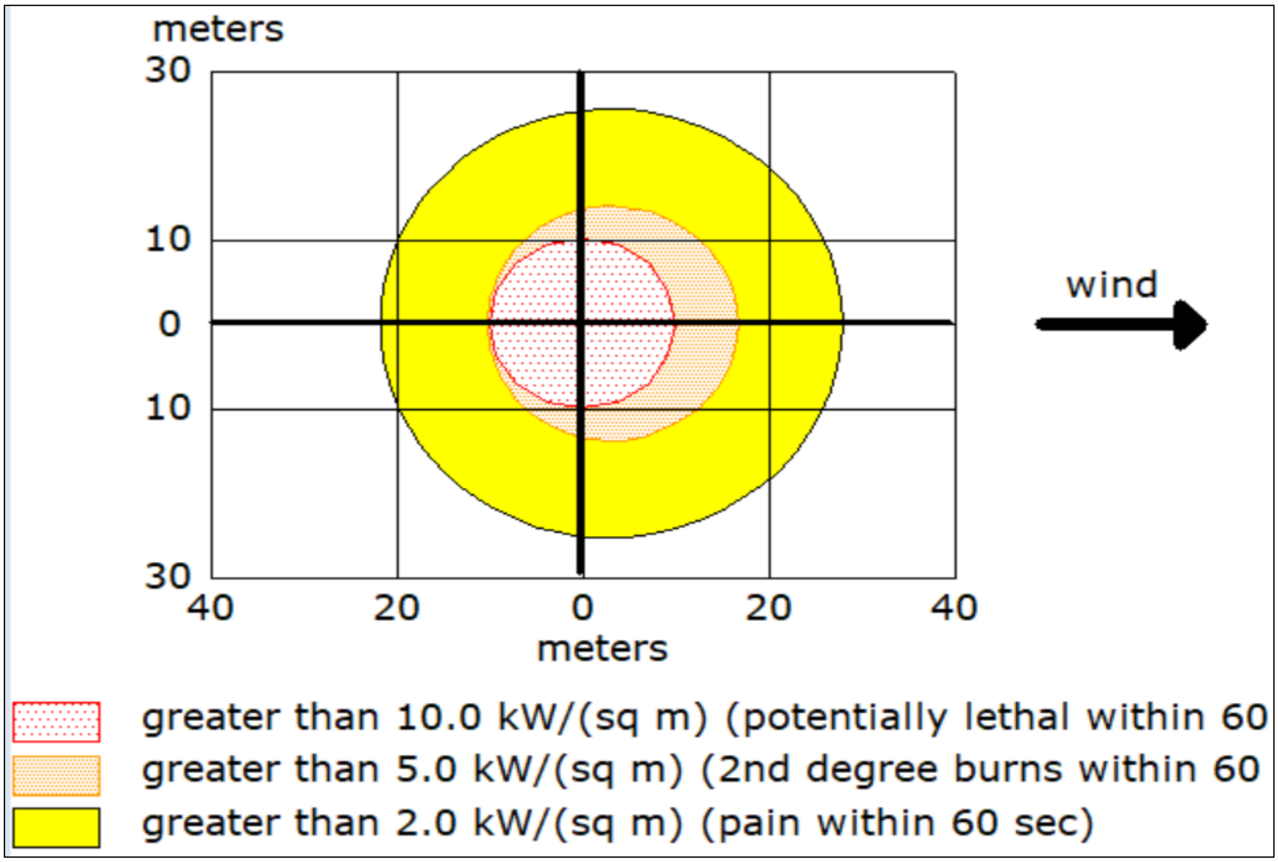
level. The possible effects used in the definition are on people who are exposed to thermal radiation levels but can seek shelter within one minute. Longer exposure durations, even at a lower thermal radiation level, can produce serious physiological effects.

Table 7-2: Threat Zone of Thermal Heat Radiation of a Jet Fire from Gas Leak

	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Definition	LOC: 10 kw/m^2 Potentially lethal within 60 seconds exposure	LOC: 5 kw/m^2 Second degree burns within 60 seconds of exposure	LOC: 2 kW/m^2 Pain within 60 seconds of exposure
Heat radiation from jetfire	10 m	17 m	28 m

LOC = Level of Concern
Source = ADB TA Consultant

Figure 7-3: Threat Zone Plot of Thermal Heat Radiation of a Jet Fire from Gas Leak



Source = ADB TA Consultant

Figure 7-3: Location Map of Threat Zone of Thermal Heat Radiation of a Jet Fire from Gas Leak

Source = ADB TA Consultant

3.2. Escaping gas not burning scenario: toxic area of vapor cloud formation

602. ALOHA estimates that for natural gas toxicity will remain only within 10m from the source. The impact will remain well within the Rokhia Thermal Power Station. Table 7-3 shows the summary of the output, and Figure 7-4 presents the extent of the impact. The LOC is based on the Protective Action Criteria for Chemicals (PACs) dataset which is a hierarchy-based system of three common public exposure guideline systems: Acute Exposure Guideline Levels (AEGL), Emergency Response Planning Guidelines (ERPG) and TEEL. A hazardous substance may have values in any—or all—of these systems. A hierarchical system is helpful for choosing a LOC for chemicals that are defined under two or more of the public exposure guidelines. PACs dataset implements the following hierarchy when choosing which values to use:

(i) Final, 60-minute AEGL values (preferred)
(ii) Interim, 60-minute AEGL values
(iii) ERPG values
(iv) TEEL values

603. PACs dataset has a single set of values (PAC-1, PAC-2, and PAC-3) for each chemical, the source of those values will vary. For methane (74-82-8) as no AEGL or ERPG values are available TEEL values are used. The Lower Explosive Limit (LEL) for methane is 50000 ppm.[131] 100% LEL denotes an atmosphere in which gas is at its lower flammable limit.

[131] DOE, 2016

Table 7-3: Threat Zone/Toxic Area of Vapor Cloud Formation

	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Definition	PAC 3: concentration <400000 ppm More than one-hour exposure to this concentration = threats of adverse health effect or death	PAC 2: concentration < 230000 ppm More than one-hour exposure to this concentration = threats of irreversible or other serious, long- lasting adverse health effects or an impaired ability to escape	PAC 1: concentration <65000 ppm Exposure to this concentration = threats of discomfort, irritation, or certain asymptomatic, non-sensory effects
Toxic Area	< 10 m	< 10 m	< 10 m

Note: indicates value is 100% or more of LEL
PAC: Protective Action Criteria
Source: ADB TA Consultant

Figure 7-4: Location Map of Threat Zone (< 10m) of Vapor Cloud Formation from Gas Pipeline Failure

Source: ADB TA Consultant

3.3. Escaping gas not burning scenario: flammable area of vapor cloud formation

604. The vapor cloud formed from a natural gas leak is flammable. The flammable area is bounded by the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL) of the vapor cloud representing the concentration of the fuel—that is, the chemical vapor—in the air. If the

chemical vapor encounters an ignition source, it will burn only if its fuel-air concentration is between the LEL and the UEL, because that portion of the cloud is already pre-mixed to the right mixture of fuel and air for burning to occur. If the fuel-air concentration is below the LEL, there is not enough fuel in the air to sustain a fire or an explosion—it is too lean. If the fuel-air concentration is above the UEL, there is not enough oxygen to sustain a fire or an explosion because there is too much fuel—it is too rich. If a flash fire occurs, the part of the cloud where the fuel-air concentration is above the UEL may continue to slowly burn as air mixes with the cloud.

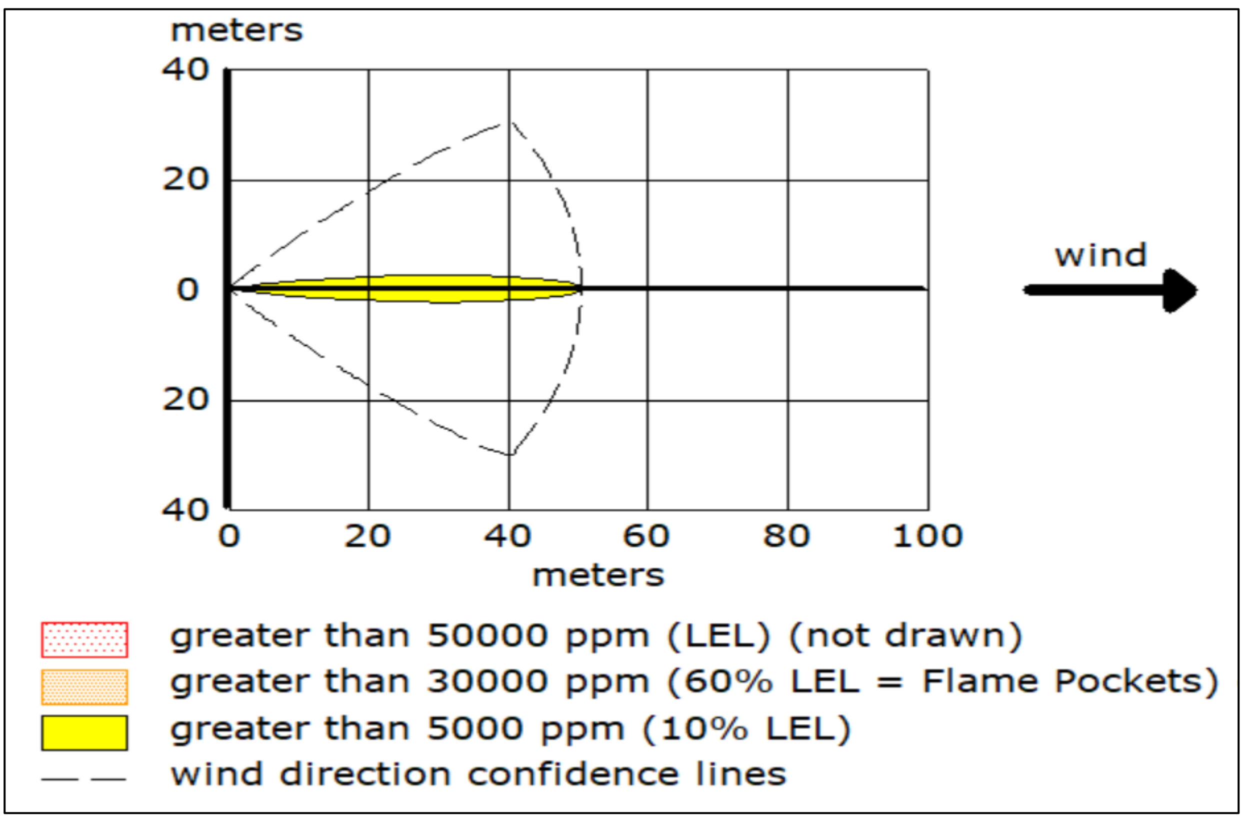
605. ALOHA has been applied to estimate the possible flammable area of the vapor cloud. The explosion limit of methane is low, only 5% (LEL) to 15% (UEL) (by volume of air). However, risk of flame exists even if the concentration is below the LEL. ALOHA considers 60% of the LEL to be at risk of flame. 60% of the LEL i.e., 30,000 ppm has been considered as the high threat zone (red) of flame occurring and 10% of the LEL i.e., 5,000 ppm is considered as the low threat zone (yellow) of flame occurring. The model estimated the high threat zone might spread up to 16m. Extent of threat (low threat zone) was estimated as downwind 57.1m and crosswind 0.71m with the maximum concentration outdoor being 5,100 ppm and indoor being 36 ppm. The flammable area of vapor cloud formation will remain well within the Rokhia Thermal Power Station. The results of the modelling are shown in Table 7-4 and Figure 7-6.

Table 7-4: Threat Zone for Flammable Area of Vapor Cloud Formation

	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Definition	50000 ppm = LEL of methane	LOC > 30,000 ppm 60% of the LEL of methane	LOC: > 5,000 ppm 10% of the LEL of methane
Flammable area of vapor cloud formation	16 m	20 m	51 m

LEL = Lowest Explosion Limit
Source: ADB TA Consultant

Figure 7-5: Plot of Threat Zone of Flammable Area of Vapor Cloud Formation



Note: Red and orange threat zone was not plotted by ALOHA because effects of near-field patchiness make dispersion predictions less reliable for short distances.
Source: ADB TA Consultant

Figure 7-6: Location Map of Flammable Area of Vapor Cloud Formation – Yellow Zone

Source: ADB TA Consultant

3.4. Escaping gas not burning scenario: blast area of vapor cloud formation

606. When a flammable chemical is released into the atmosphere, it forms a vapor cloud that will disperse as it travels downwind. If the cloud encounters an ignition source, the parts of the cloud where the concentration is within the flammable range (between the LEL and UEL) will burn. The speed at which the flame front moves through the vapor cloud determines whether there will be deflagration or a detonation. In some situations, the vapor cloud will burn so fast that it creates an explosive force (or pressure wave) -- the greater the speed of the flame front, the more intense the pressure wave (overpressure) and the greater the destructive force of the explosion. As a pressure wave spreads out into the surrounding area it can cause damage to people and property. ALOHA models the overpressure hazard. There is also the risk of hazardous fragments being thrown by the blast which is not modelled.

607. The severity of a vapor cloud explosion depends on the chemical, the cloud size at the time of ignition, the type of ignition, and the congestion level inside the cloud. ALOHA predicts that the potential blast caused by vapor cloud formation will be of low impact, only enough to shatter window glass within 19m. The results of the modelling are shown in Table 7-5 and Figure 7-7.

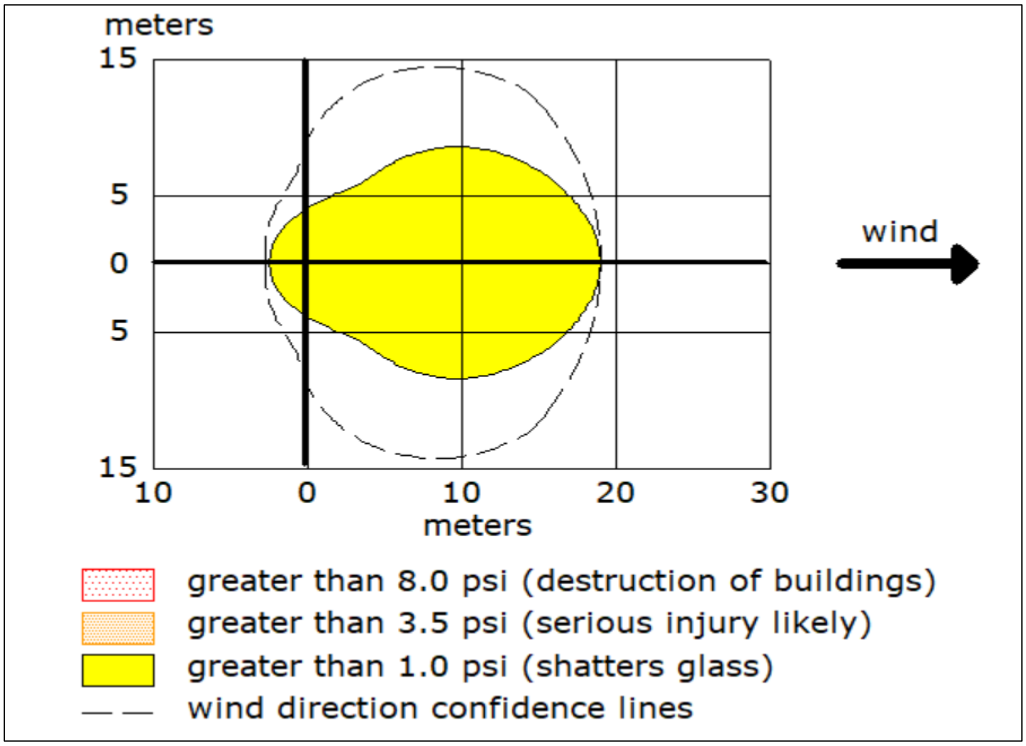
Table 7-5: Blast Area of Vapor Cloud Formation

Items	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Definition	High Threat Zone, 8 psi pressure which is destructive for buildings	Moderate Threat Zone, 3.5 psi pressure, serious injury likely	Low Threat Zone, 1 psi pressure, enough to shatter window glass

Blast pressure formation,	LOC never exceeded	LOC never exceeded	19m

LOC never exceeded means the values were all < 1 psi
Source: ADB TA Consultant

Figure 7-7: Plot of Threat Zone of Blast Area of Vapor Cloud Formation



Source: ADB TA Consultant

Figure 7-8: Location Map of Threat Zone of Blast Area of Vapor Cloud Formation

Source: ADB TA Consultant

C. Risk Assessment

1. Consequence Analysis

608. Severity analysis was undertaken to assess the likely impact of the hazards on Rokhia Thermal Power Station personnel or members of the public using the TPGL private access road (reopened following construction) as well as the wider environment and property. Consequences have been ranked as per Table 7-6. The ranking has been informed by the exposure modeling and professional judgment. It considers aspects like health injuries, environmental or property damage, timelines for recovery or restoration, and restoration costs.

Table 7-6: Severity Categories and Criteria

Parameter	1 (Minimal)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Extent of injuries to people caused	Minor pain, scratch, discomfort requiring nomedical attention	Injuries can be treated with first aid and/or some medical attention; no lost time or hospitalization	Injury requires hospitalization; requires recuperation time or absence from work to recover	Injury caused may lead to a permanent disability or inability to work Fatalities; less than (5) workers or one (1) member of the public	Fatalities; five or more (5) workers or two (2) or more members of the public
Extent of damage caused to environment, assets, buildings, structures, or other property	No detectable damage	Damage evident but not requiring repair e.g., cosmetic cracks	Damage requiring limited or easy repairs or restoration e.g., few broken windows to repair, trees to be replanted	Damage requiring major repairs or restoration e.g., numerous broken windows to repair, trees to be replanted	Damage affecting operation of asset, complete destruction e.g., building, or structural collapse
Duration, restoration implication of damage caused	Recovers naturally or restored with limited or easy intervention to pre-incident levels within a few weeks	Short term, recovers naturally or restored with limited or easy intervention to pre-incident levels in a few months	Requires up to a year to recover naturally or requires some effort or intervention to be restored to pre-incident levels	Long-term, requires more than a year to recover naturally or requires major effort or intervention to be restored to pre-incident levels	Effectively permanent, little or no chance of restoration to pre-incident levels
Financial implication of damage caused	None	<$1000	$1000 to <$50,000	$50,000 to <$250,000	>$250,000

Source: ADB TA Consultant

2. Likelihood Analysis

609. Frequency of occurrence per year during the operational lifespan of the proposed plant was estimated for the hazards identified based on the analysis of historical accident frequency data, experience from the existing plant, during whose operation no such incidents have occurred, and using professional judgment. Based on the range of probabilities for hazards that may be encountered, the frequency class and thus likelihood was ranked as per Table 7-7.

610. In the case of a natural gas pipeline of 8" diameter designed following GIIP the likelihood of failure occurring ranges from 1.5 x 10^{-4} pinhole to 10^{-8} rupture failures per km per year.[132] This equates to a possibility of between 1.35 x 10^{-5} pinhole and 9^{-10} rupture failures per year for the proposed 90m gas pipeline. Likelihood of failure resulting in consequences of any magnitude is a rare event.

Table 7-7: Frequency Classes and Definitions

Likelihood Ranking	Frequency Class	Definition
1	Rare	Rare chance of occurrence e.g., 1 in 100,000 years of operation
2	Low	Minimal chance of occurring, 1 in 10,000 years of operation
3	Medium	May occur if the conditions are abnormal or exceptional, e.g., 1 in 1,000 years of operation
4	High	Occurs more frequently, without any prior warning e.g., 1 in 100 years
5	Almost certain	Occurs under typical conditions, e.g., 1 in 10 years of operation

Source: ADB TA Consultant

3. Risk Evaluation

611. The risk resulting from the identified hazards have been evaluated considering the magnitude of consequences and the likelihood of occurrence of those consequences. The significance of the risk is expressed as the product of likelihood and the consequence of the risk event, as follows: Significance = Likelihood x Consequence. Table 7-8 illustrates the resulting significance of risk, while Table 7-9 assigns risk significance criteria in relation to the limit of risk acceptability.

Table 7-8: Risk Matrix

Frequency of Hazard (Likelihood)	Hazard Magnitude (Consequence)				
	1 (Minimal)	**2 (Minor)**	**3 (Moderate)**	**4 (Major)**	**5 (Catastrophic)**
1 (Rare)	1	2	3	4	5
2 (Low)	2	4	6	8	10
3 (Medium)	3	6	9	12	15
4 (High)	4	8	12	16	20
5 (Almost Certain)	5	10	15	20	25

Source: ADB TA Consultant

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[132] Table 72 of Microsoft Word - Final pipelines report_public_final.doc (hse.gov.uk)

Table 7-9: Risk Significance Criteria and Action Requirements

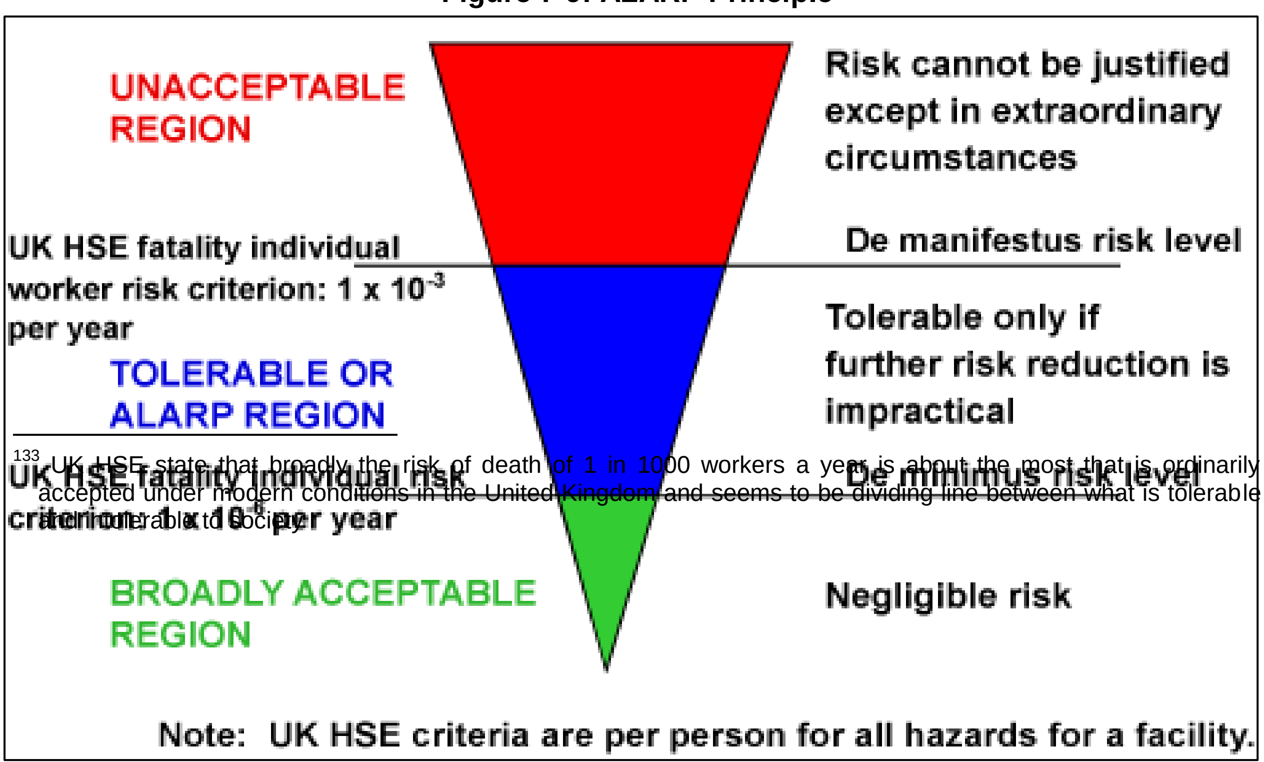
Risk Significance	Criteria Definition and Action Requirements
Maximum (16-25)	**"Risk requires attention"** Risk cannot be tolerated; operator must introduce additional controls to bring risk level down
High (10-15)	**"Risk is tolerable"** If Risk is As Low as Reasonably Practical (ALARP) it can be tolerated, operator must adopt ALARP risk reduction measures and monitoring to ensure the risk is well controlled
Medium (5-9)	"**Risk is acceptable**" Risk is within an acceptable level; implementation of additional controls to further reduce level of risk and monitoring by the operator to ensure risk is well controlled
Low (1-4)	"**Risk is acceptable**" Risk is within an acceptable level; additional controls above and beyond routine processes/procedures need not to be considered by the operator

Source: ADB TA Consultant

612. The risk significance criteria introduce the principle of As Low as Reasonably Practicable (ALARP) which has been defined by the United Kingdom Health and Safety Executive (UK HSE) to depict the concept that efforts to reduce risk need to be continued until the incremental sacrifice in doing so is grossly disproportionate to the value of the incremental risk reduction achieved (Figure 7-9). Incremental sacrifice is defined in terms of time, effort, cost, or other expenditure of resources and each incremental reduction in risk will usually require a greater expenditure of resources. The process of ALARP involves adopting all reasonably practicable measures unless they have been ruled out because the cost is grossly disproportionate to the benefit. This approach allows higher levels of safety to be provided where feasible; decisions are to be weighed in favor of protecting health and safety, but ALARP does not mean zero risk.

613. Ideally risks will be broadly acceptable. Tolerable risks (e.g., in the case of fatalities between 1 in 100,000 and 1 in 1,000 workers killed a year)[133] can be justified only if every effort has already been taken by the operator to reduce risk and the benefit is seen to outweigh the impact, whilst unacceptable risks cannot be justified except under extraordinary circumstances.

Figure 7-9: ALARP Principle



[133] UK HSE state that broadly the risk of death of 1 in 1000 workers a year is about the most that is ordinarily accepted under modern conditions in the United Kingdom and seems to be dividing line between what is tolerable and intolerable to society.

Source: Reducing Risks, Protecting People, HSE's Decision-Making Process, HSE Books, 2001.

614. For the various scenarios considered using the ALOHA model, the direct impact will be restricted entirely within the Rokhia Thermal Power Station, up to 51.7 m from around the GCS and proposed gas pipeline. Hazards will not directly affect the local community and private property but do pose a risk to the proposed plant and workers health and safety. However, given the project site supports good tree cover/forest habitat there is a risk once a fire has started forest fire will spread having indirect impact on the environment and property outside the project site. The risk ranking is assessed as acceptable (low-medium significance) based on a score of 4-5 (likelihood score 1 x consequence score 4-5 depending on if fire is contained or forest fire results) (Table 7-11) and is considered to fall within the broadly acceptable region. TPGL will adopt ALARP and implement additional health and safety controls and monitoring above and beyond routine processes/procedures to control the risk during operation and maintenance works including having an emergency preparedness and response plan and on-site firefighting provision.

615. The risk assessment was based on the initial design information supplied by TPGL and any changes in the planned configuration or parameters after the detailed design is complete are to be reassessed to ensure the impacts are the same or less than predicted.

D. Identification of Risk Reduction Measures

616. Hazards which may result from the loss of containment of natural gas being transferred (during operation) to the proposed plant have been identified. In cases where there is wide experience of a risk, such as gas pipeline operations, there are established methods of reducing the risk to an acceptable level as set out in Government of India and international good practice.

617. The natural gas supply to the proposed plant will be from the existing GCS (connected to ONGC and GAIL gas supplies) located within the Rokhia Thermal Power Plant. The HAZOP study reports for the GCS along with recommendations are provided in Annex 32, these will need to continue to be followed by ONGC during connection of the gas supply and operation of the proposed plant.

618. For the proposed plant the EPC Contractor will be required to reduce the risk to ALARP through their detailed design of the gas pipeline. The following GIIP engineering design features that reduce risk must be implemented through the detailed design to ensure this:

(i) Completing recognized processes of hazard analysis (HAZOP, HIRA, etc.) as part of the facilitated risk assessment (Chapter VI) for the proposed power plant, to be commenced during detailed design and to be reconsidered prior to commissioning and operation;
(ii) Ensuring compliance with all GoI and GoT statutory requirements;
(iii) Gas pipelines must be designed to an international standard such as: BS EN 14161: Petroleum and natural gas industries – Pipeline transportation systems; ASME B31.8 Gas Transmission and Distribution Piping Systems; or other internationally recognized standards agreed with TPGL;
(iv) Gas pipeline design must take account of the seismic risk and ground movement as a result of earthquake;
(v) Leak prevention systems such as cathodic protection and pipeline coatings suitable for the ground conditions must be adopted;

(vi) Depth of burial of the gas pipeline along its length must be equal to, or greater than the minimum depth of burial which is specified in the internationally recognized standards;
(vii) The wall thickness of the gas pipeline must be designed to accommodate the maximum operating pressure with an appropriate safety factor;
(viii) TPGL's private access road (under which, the gas pipeline will pass) is used by the local community and the gas pipeline will include specific protection measures to account for the weight from road traffic;
(ix) Adopt other risk reduction measures including concrete sheathing, tiles or marker tape above the pipeline, route marker posts or signposts to prevent damage from excavations;
(x) Installation of non-return valves on the pipelines is required;
(xi) Leak detection system must be installed on the gas pipeline;
(xii) Automatically operating isolation valves with a response time of one minute which also allow safe depressurization must be located at least at either end of the gas pipeline but ideally at intervals such that in the event of a leak only small amounts of natural gas will be released;
(xiii) All natural gas processing areas must be equipped with gas detectors with appropriate logic that can initiate emergency shutdown of operations and the gas pipeline if required;
(xiv) All the automatic safety systems will be designed so that they can also be manually activated and are fail safe;
(xv) Manually operated shut off and isolation values will be signed with clear access available at all times;
(xvi) No flammable materials are to be stored within the modelled threat zones of the gas pipeline;
(xvii) No continuous tree cover to be retained in the modelled threat zones to reduce the risk of fire spreading to adjacent forest habitat;
(xviii) Provision of fire hydrant to allow firefighting along the gas pipeline;
(xix) Post no smoking or naked flame signs within the modelled threat zones including on the TPGL private access road;
(xx) TPGL to regularly inspect and maintain the gas pipeline with immediate shut down and maintenance if any faults are observed; and
(xxi) Emergency preparedness and response plan for the GCS and gas pipeline must be compiled by TPGL (Chapter 5).

619. The emergency preparedness and response plan must include isolation and evacuation distances, as well as recommendations for firefighting, non-fire response, protective clothing and first aid. In the event of a leak being detected, as an immediate precaution, 100m around the leak location is to be isolated in all directions; for a large leak or fracture initial downwind evacuation within at least 800m is to be considered.[134] Evacuation routes planned will have alternatives in case a route is blocked. Given the presence of a cluster of houses and a high school within Rokhia Thermal Power Station preparation of the emergency preparedness and response plan must involve local government. The local community and school headteacher is to be informed of the risks and the planned response; they must also be involved in emergency drills so they may act in case a fire cannot be controlled. In respect of firefighting leaking gas fires must not be extinguished unless the leak can be stopped, firefighting procedures are to be set out for dealing with small fires limited to the threat zone and the case of the fire spreading

[134] CAMEO: ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]

beyond the threat zone. Firefighting distance will be from a minimum distance of 10 m with fire resistant clothing as PPE. In case of leaks not involving fire, all ignition sources must be removed from the threat zone and smoking avoided, a water spray can be used to reduce the vapor cloud or divert its drift. Self-contained breathing apparatus must be immediately available for emergency responders dealing with high concentrations of natural gas.[135] First aid must consider that for natural gas the first route of exposure will be inhalation which may cause symptoms to develop such as wheezing, coughing, or shortness of breath, for this a doctor must be on call and an ambulance immediately available to transport any casualties to hospital.

[135] USCG, 1999

Table 7-10: Risk Assessment and Risk Reduction Plan

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
Gas collecting station 8" gas pipeline	Transmission of gas to proposed plant	Gas leak will lead to: • Toxic Vapor Cloud Formation • Vapor • Jet Fire • Limited • Over	▪ Mechanical or material fracture or failure ▪ Corrosion-internal or external to pipeline • Improper coating on pipelines ▪ Human error or intentional damage ▪ Natural forces or hazards	4-5	1	**5**	• Completing recognized processes of hazard analysis (HAZOP, HIRA, etc.) as part of the facilitated risk assessment (Chapter VI) for the proposed power plant, to be commenced during detailed design and to be reconsidered prior to commissioning and operation; • Ensuring compliance with all GoI and GoT statutory requirements; • Gas pipelines must be designed to an international standard such as: BS EN 14161: Petroleum and natural gas industries - Pipeline transportation systems; ASME B31.8 Gas Transmission and Distribution Piping Systems; or other internationally recognized standards agreed with TPGL; • Gas pipeline design must take account of the seismic risk and ground movement as a result of earthquake; • Leak prevention systems such as cathodic protection and pipeline coatings suitable for the ground conditions must be adopted; • Depth of burial of the gas pipeline along its length must be equal to, or greater than the minimum depth of burial which is specified in the internationally recognized standards; • The wall thickness of the gas pipeline must be designed to accommodate the maximum operating pressure with an appropriate safety factor; • TPGL's private access road (under which, the gas pipeline will pass) is used by the local community and the gas pipeline will include specific protection measures to account for the weight from road traffic; • Adopt other risk reduction measures including concrete sheathing,	2-3	1	**4**

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
							tiles or marker tape above the pipeline, route marker posts or signposts to prevent damage from excavations; • Installation of non-return valves on the pipelines is required; • Leak detection system must be installed on the gas pipeline; • Automatically operating isolation valves with a response time of one minute which also allow safe depressurization must be located at least at either end of the gas pipeline but ideally at intervals such that in the event of a leak only small amounts of natural gas will be released; • All natural gas processing areas must be equipped with gas detectors with appropriate logic that can initiate emergency shutdown of operations and the gas pipeline if required; • All the automatic safety systems will be designed so that they can also be manually activated and are fail safe; • Manually operated shut off and isolation values will be signed with clear access available at all times; • No flammable materials are to be stored within the modelled threat zones of the gas pipeline; • No continuous tree cover to be retained in the modelled threat zones to reduce the risk of fire spreading to adjacent forest habitat; • Provision of fire hydrant to allow firefighting along the gas pipeline; • Post no smoking or naked flame signs within the modelled threat zones including on the TPGL private access road; • TPGL to regularly inspect and maintain the gas pipeline with immediate shut down and maintenance if any faults are observed; and			

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
							• Emergency preparedness and response plan for the GCS and gas pipeline must be compiled by TPGL including isolation and evacuation distances, as well as recommendations for firefighting, non-fire response, protective clothing and first aid.			

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
Gas collecting station 8" gas pipeline	Transmission of gas to proposed plant	Gas leak will lead to: • Toxic Vapor Cloud Formation • Vapor • Jet Fire • Limited • Over	▪ Mechanical or material fracture or failure ▪ Corrosion-internal or external to pipeline • Improper coatingon pipelines ▪ Human error or intentional damage ▪ Natural forces or hazards	4-5	1	**5**	• Completing recognized processes of hazard analysis (HAZOP, HIRA, etc.) as part of the facilitated risk assessment (Chapter VI) for the proposed power plant, to be commenced during detailed design and to be reconsidered prior to commissioning and operation; • Ensuring compliance with all GoI and GoT statutory requirements; • Gas pipelines must be designed to an international standard such as: BS EN 14161: Petroleum and natural gas industries - Pipeline transportation systems; ASME B31.8 Gas Transmission and Distribution Piping Systems; or other internationally recognized standards agreed with TPGL; • Gas pipeline design must take account of the seismic risk and ground movement as a result of earthquake; • Leak prevention systems such as cathodic protection and pipeline coatings suitable for the ground conditions must be adopted; • Depth of burial of the gas pipeline along its length must be equal to, or greater than the minimum depth of burial which is specified in the internationally recognized standards; • The wall thickness of the gas pipeline must be designed to accommodate the maximum operating pressure with an appropriate safety factor; • TPGL's private access road (under which, the gas pipeline will pass) is used by the local community and the gas pipeline will include specific protection measures to account for the weight from road traffic; • Adopt other risk reduction measures including concrete sheathing, tiles or marker tape above the pipeline, route marker posts or signposts to prevent damage from excavations;	2-3	1	**4**

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
							• Installation of non-return valves on the pipelines is required; • Leak detection system must be installed on the gas pipeline; • Automatically operating isolation valves with a response time of one minute which also allow safe depressurization must be located at least at either end of the gas pipeline but ideally at intervals such that in the event of a leak only small amounts of natural gas will be released; • All natural gas processing areas must be equipped with gas detectors with appropriate logic that can initiate emergency shutdown of operations and the gas pipeline if required; • All the automatic safety systems will be designed so that they can also be manually activated and are fail safe; • Manually operated shut off and isolation values will be signed with clear access available at all times; • No flammable materials are to be stored within the modelled threat zones of the gas pipeline; • No continuous tree cover to be retained in the modelled threat zones to reduce the risk of fire spreading to adjacent forest habitat; • Provision of fire hydrant to allow firefighting along the gas pipeline; • Post no smoking or naked flame signs within the modelled threat zones including on the TPGL private access road; • TPGL to regularly inspect and maintain the gas pipeline with immediate shut down and maintenance if any faults are observed; and • Emergency preparedness and response plan for the GCS and gas pipeline must be compiled by TPGL including isolation and			

Hazard points	Activities	Potential hazards	Root causes	Hazard Consequence (Before)	Hazard Frequency (Before)	Risk Ranking (Before)	Risk Reduction Plan	Hazard Consequence (After)	Hazard Frequency (After)	Risk Ranking (After)
							evacuation distances, as well as recommendations for firefighting, non-fire response, protective clothing and first aid.			

Source: ADB TA Consultant

VIII. CONSULTATION, PARTICIPATION, AND INFORMATION DISCLOSURE

A. Introduction

620. The purpose of the stakeholder consultation and public participation process is to ensure that interested or affected stakeholders as well as the public are informed about TPGL's plan for and to solicit their views and opinions about the proposed plant. Consultation is required as per the national EIA Notification 2006 for developmental projects in India whilst according to ADB's Safeguard Policy Statement (2009): "*The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. Meaningful consultation is a process that*:

- (i) Begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle;
- (ii) Provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people;
- (iii) Is undertaken in an atmosphere free of intimidation or coercion;
- (iv) Is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and
- (v) Enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.
- (vi) Consultation will be carried out in a manner commensurate with the impacts on affected communities.
- (vii) The consultation process and its results are to be documented and reflected in the environmental assessment report."

621. As per the ADB's SPS 2009, for projects categorized as Category A for environment, at least two rounds of consultations are to be held, one at Scoping Stage (preliminary design and impacts during the early stages of the EIA process) and the other at the Draft EIA stage (to disseminate and obtain feedback on the assessment outcomes) prior to ADB's funding determination. This chapter summarizes public/stakeholder consultations conducted as part of EIA for the proposed plant. The first round of formal public consultations was conducted on 19th April 2021, while the second round of formal public consultations was conducted on 27th October 2021. In addition to disseminating information, consultations were undertaken with communities/households/individuals, women, Elected/Panchayat members, NGOs, and others to collect detailed information relevant to inform the EIA. Primary socio-economic surveys in identified villages were completed by MITCON in the study area.

B. Consultations Undertaken

1. Identification of Stakeholders

622. Stakeholders were classified into primary and secondary stakeholders who are characterized as follows:

- (i) Primary stakeholders: those that may be directly affected by environmental impacts during the different phases of the proposed plant. These are people living near the project site (being more vulnerable if within the core zone) and in the study area with respect to impacts such as air quality that extend beyond the site boundaries, settlements through which access routes passes and are likely to be used for transportation.

(ii) Secondary stakeholders: these are individuals or organizations that will not be directly affected but who may have interests that mean they can contribute to the design/EIA process or influence the decision-making process. Secondary stakeholders include the natural gas suppliers (GAIL and ONGC), Local Development Authority/Block Members (from Boxarnagar, Bisalgarh, etc.), relevant government agencies like Tripura Pollution Control Board (TPCB), Forest and Wildlife Officials, Department of Water Supply and Sanitation (DWSS), Central Ground Water Board Tripura, Public Works Department (PWD) Roads, Rural Development Officials, Tripura Tribal Areas Autonomous District Council (ADC) Representatives, Public Representative (elected Panchayat members of Manikyanagar and other villages), NGOs, and other interested individuals or groups.

2. Scoping Stage Public Consultation

623. The Scoping Stage/first round of consultation for the proposed plant was conducted on 19t April 2021 in Rokhia and was facilitated by TPGL and the ADB TA Consultants to meet the requirements of ADB's SPS 2009. This consultation was planned and conducted as per prevailing COVID-19 GoI/GoT restrictions and WHO guidelines, including limiting the total public gathering to 20 persons in each batch. Due to the ongoing COVID-19 pandemic ADB participated virtually in the consultation via What's App chat/video call. The public consultation was advertised through by using mobile (moving vehicle) public address system. Government departments were informed of the consultation through official letters.

624. The objective of this public consultation was to let interested or affected stakeholders and the public from the study area know about the proposed plant and its potential impacts so they are well informed, and allow them to share their perceptions or raise their concerns about it early on in the design and EIA process. More specifically the objectives of the public consultation were to:

(i) Ensure stakeholders were given an early opportunity to participate in the design and EIA process;
(ii) Inform about TPGL's plans for the proposed plant, the need for it, and benefits that might arise;
(iii) Inform about its potential environmental impacts and possible mitigation measures;
(iv) Understand and create awareness of any existing environmental issues in the study area;
(v) Determine perceptions about the existing plant run by TPGL and allow stakeholders to share their experiences of the environmental impacts of the existing plant/similar projects;
(vi) Identify concerns and through this identify potential impacts to inform the EIA scope/ impacts and risks requiring detailed assessment;
(vii) Discuss and propose possible solutions to address those concerns raised;
(viii) Describe that a mechanism for recording, handling, processing potential grievances related to the proposed plant will be available during project implementation; and,
(ix) Inform stakeholders how they can access further information about the proposed plant.

3. Draft EIA Stage Public Consultation

625. The Draft EIA Stage/second round consultation was facilitated by TPGL and the ADB TA Consultants to meet the requirements of ADB's SPS 2009. This consultation was planned and conducted as per prevailing COVID-19 GoI/GoT restrictions and WHO guidelines, including limiting the total public gathering to 20 persons in each batch. Due to the ongoing COVID-19 pandemic ADB participated virtually in the consultation via What's App chat/video call. The public consultation was advertised one week before the event through two locally circulated newspapers and by using mobile (moving vehicle) public address system. The newspaper advertisements are provided in **Annexure 24.** Government departments were informed of the consultation through official letters.

626. This public consultation took place after the EIA process had largely been completed and the EIA Report was in draft stage. The public consultation disclosed further details about the proposed plant design, baseline situation, predicted impacts, and risks pre-mitigation and post-mitigation, how they would be managed, monitored etc. The GRM and opportunity for future consultation during project implementation were also discussed. Based on the consultation outcomes, the draft EIA was subsequently revised to include the details of the consultation and its outcomes as well as to update the assessments to respond to any concerns that were not previously raised.

4. Focus Group Discussions

627. During October 2021, in addition to the public consultations focus group discussions (FGD) were undertaken with two groups. One with the nearest residents to the proposed plant who will be most affected by its construction (as the most vulnerable receptors) and operation and the other with the teachers at the adjacent school, given school children are a vulnerable group. The FGD with the nearest residents took place on the 27th October 2021 specifically to convey the impacts and risk to them, whilst the FGD within the school campus took place on 29 October 2021 specially to discuss impacts and risks in relation to the school.

5. 1-on-1 Stakeholder Interviews

628. Stakeholder interviews, including with Forest Officers working in the study area, were undertaken by MITCON and the ADB TA Consultants to collect detailed information relevant to inform the EIA.

C. Information Disclosure

629. This EIA Report is the main vehicle for information disclosure but during both public consultations detailed information on the proposed plant's location, design, and technology, resource requirements, environmental impacts and risks were disclosed. During the Draft EIA Stage more details were provided on aspects that were not available for disclosure during the Scoping Stage. Copies of presentations made, and leaflets shared are included in **Annexure 25.**

630. This EIA Report, after endorsement by TPGL and clearance by ADB will be disclosed on ADB's website as well on TPGL's website (when available or on TSECL's website[136]) upon project approval. It will also be made available/displayed for public scrutiny in hard copy at places easily accessible to the local community and other interested parties, including but not limited to the TPGL Rokhia Thermal Power Station Office and TPGL's Agartala Head Office with the executive summary being translated into the local Bengali language. If requested of TPGL by the primary stakeholders a hard/soft copy of the full EIA report will be provided to them and, if required, an oral or written translation provided free of charge.

631. Its availability on TPGL's website will be advertised through local print and social media. Brochures/leaflets/posters, on the main findings of the EIA and where the full version can be accessed, based on a translation of the executive summary of the EIA into the local Bengali language will be printed. These will be posted directly to the 10 residents to the east of the proposed plant who will be most affected and placed in each of the villages in the study area.

D. Methodology for Consultation

632. Public consultation and FGDs were conducted with support of a power point presentation. This was followed by requesting public perceptions, feedback, and opinion about the existing and proposed plants, as well as asking targeted questions about existing environmental and socio-economic conditions. Responses to public comments were provided by TPGL and ADB TA Consultants during the discussion. All consultations were documented, photographed and the public consultations video-graphed. The detailed record of the two consultations including paper advertisements, leaflet copies, attendance register copy and presentations materials are given in **Annexure 24.** The photo documentation of the two events is provided in **Annexure 24.** Table 8-1 details consultations undertaken. Figure 8-1 shows the project site and public consultation venue.

[136] TPGL is currently developing its website; meanwhile TSECL website hosts generation and transmission as well as distribution information: https://tsecl.in/irj/go/km/docs/internet/TRIPURA/webpage/pages/Generation.html

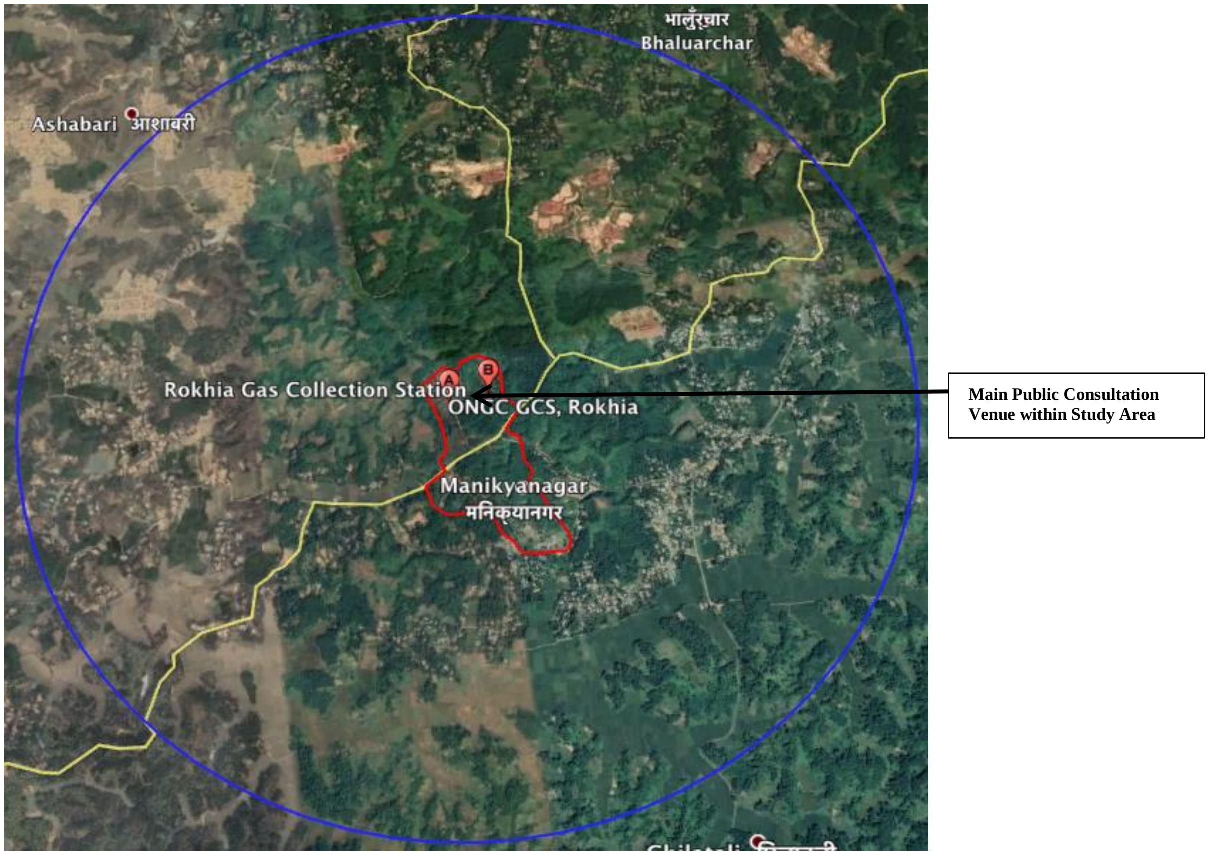
Table 8-1: Stakeholder Consultation Details

Stage/Type	Conducted By	Purpose and Key Activities	Target Stakeholders	Date	Location	Male	Female	Total
Preliminary Consultations - Socioeconomic Survey	MITCON	• To gain a preliminary understanding of the demography and socio-economic baseline for the EIA • 1-on-1 interviews with villagers/farmers/fishers etc. • Socioeconomic Survey	• Government agencies • Local/tribal communities • Villagers from study area • Vulnerable/disadvantaged groups	December 2020 to July 2021	Study area, core and buffer villages, tribal areas (see Chapter 4 for more details of the survey work)	69	3 (4%)	72
1 to 1 consultation	MITCON and ADB TA Consultants	• 1-on-1 interviews • To gain knowledge on ecology baseline/physical environment	• Forest Officials • Wildlife Officials • TPCB (Table 8-2 provides details)	March 2021 to November 2021	Study area, Wildlife/ Forest offices in range	4	-	4
First/Scoping Stage Public Consultation-group public consultation	TPGL, ADB TA Consultants	• To meet the stakeholders and introduce them to the proposed plant and EIA process and gather perceptions and concerns • Public meetings in compliance to COVID-19 protocols/restrictions, consultation was held in two batches in the afternoon and evening.	• Elected/Panchayat and ADC leaders • Local/tribal communities • Villagers from study area • Vulnerable/disadvantaged groups like women headed households, below poverty line, those likely to be most impacted form the development	19 April 2021	TPGL Office, Rokhia Thermal Power Station	43	9 (17%)	52
Second/EIA Stage Public Consultation - group public consultation	TPGL, ADB TA consultants	• To discuss the findings of the draft EIA, provide stakeholders including nearest residences with an opportunity to comment and identify	• Administrative Officers-Block and Sub-Division level Elected/Panchayat and ADC village heads • Local/tribal communities • Villagers from study area	27 October 2021	TPGL Office, Rokhia Thermal Power Station	41	20 (33%)	61

Stage/Type	Conducted By	Purpose and Key Activities	Target Stakeholders	Date	Location	Male	Female	Total
		were revisions or additions to the EIA Report are needed • Public meetings in compliance to COVID-19 protocols/restrictions, consultation was held in two batches in the morning (a formal FGD in consultation venue for nearest ten residences) and in the afternoon (with participants from the larger study area)	• Vulnerable/disadvantaged groups like women headed households, below poverty line, those likely to be most impacted form the development (nearest 10 household), those using access roads including the shorter TPGL private access road which will be temporarily closed • Business community • Non-government organizations (NGOs) • Pollution Control Board					
Nearest Houses FGD – small group consultation	TPGL, ADB TA Consultants	• To discuss the findings of the draft EIA, provide nearest residents with an opportunity to comment and identify were revisions or additions to the EIA Report are needed	• Nearest residents (who will be most impacted, as the most vulnerable receptors)	27 October 2021	Individual house visit, Rokhia	15	3 (17%)	18
School FGD – small group consultation	ADB TA EIA Team leader and Social Consultant	• To discuss the findings of the draft EIA, provide the adjacent school with an opportunity to comment and identify were revisions or additions to the EIA Report are needed	• School Faculty (school children are a vulnerable group)	29 October 2021	School campus, Rokhia Thermal Power Station	3	3 (50%)	6

Source: ADB TA Consultant

Figure 8-1: Map Showing Public Consultation Venue, Proposed Plant and 2km Buffer



Source: ADB TA Consultant

E. Socioeconomic Survey Consultation Findings

633. Primary data collection and socio-economic survey was conducted by MITCON during December 2020 to July 2021, as part of detailed socio-economic analysis for the proposed plant. Their consultation outcomes are:

(i) At present good educational facilities like English-medium schools, higher secondary schools, colleges, and post-graduation facilities are in Agartala city. Villagers residing in the study area have suggested that educational facilities should be made available to them nearer to their villages.

(ii) People feel that if TSECL/TPGL can conduct ITI trainings, computer training, electrical maintenance training, etc. in the villages close to the proposed plant, they will have a better chance at employment.

(iii) Better healthcare facilities nearer to their villages will also help them, since at present such facilities are situated far from most of the villages surveyed. If that is not possible, people have requested that an ambulance service can be made available to them to use.

(iv) Fire safety is another important concern for the villages, as no fire brigade and related services are available to them currently.

(v) People from almost all villages surveyed have also requested ATM / Cash Deposit Machine (CDM) nearer to their village as no such facilities are available at present.

(vi) Many households from Manikyanagar village, which is the closest major settlement to the project site have requested that as part of the Corporate Environmental Responsibility (CER), a temple or hall be constructed in the village. Most of the people in the village are elderly, who have settled there after retirement, and they would like a place to gather in the evenings (an existing community hall is present adjacent to the school, but it is needing repairs).

1. 1 to 1 Consultation Findings

634. Tables 8-2 and 8-3 detail the 1 to 1 consultation undertaken during the EIA, and matters discussed.

Table 8-2: 1 to 1 Consultation Details by MITCON

Name/Occupation	Date and Time	Location [Distance / Direction from Project Site]	Discussion
Mr. Bulbul Dash, RFO, Boxanagar Range (Sonamura sub-division)	29.06.2021 15.30 Hrs.	Boxanagar Range Forest Office [1.95 km / SW]	• Discussed common floral species observed in the Boxanagar Range of Sonamura Forest Sub-division. RFO orally dictated list of common tree species, which were later translated into English and botanical names to be added in primary baseline data. Information received was very basic. • Forest officials asked about sightings of Phayre's Leaf Monkey in the Range. RFO informed that the monkey does not venture much outside the Sepahijhala Wildlife Sanctuary (WLS) area. Rare occasional sightings are seen in rubber plantations nearby the WLS area (which lies at >10 km away from the project site). This was also confirmed later by interaction with local residents around the project site. • Apart from this, officials of forest department could not furnish any other information about important faunal or avi-fauna species found in the study area.

	25.10.2021 13.40 Hrs.		• Discussed about presence and absence of various faunal species in Boxanagar range. Asked the RFO about presence/ absence of following species picked up from IBAT assessment,
			  • Elongated Tortoise - *Indotestudo elongate*
			  • Three-striped Roofed Turtle - *Batagur dhongoka*
			  • Baer's Pochard - *Aythya baeri*
			  • Bengal Florican - *Houbaropsis bengalensis*
			  • White-rumped Vulture - *Gyps bengalensis*
			As informed by RFO these species were not observed in the study area.
			• However, RFO informed that Capped Langur (locally called Hanuman or Golden Monkey) is seen in the study area.
			• RFO informed that forest guard maintains a logbook about all the wildlife sighting in his range and promised to provide the same for our information. Few of these log entries are attached with the ecology report (**Annexure-10**)

Name/Occupation	Date and Time	Location [Distance / Direction from Project Site]	Discussion
Mr. Mujaheed Rehman, farmer	26.10.2021 16.20 Hrs.	Manikyanagar [1 km / SW]	• Discussed various faunal species seen around the village. He informed about occasional sighting of Monocellate Cobra, Spectacled Cobra, Jackal, and Capped Langur in rubber plantations.
Mr. Priyalal Dash, farmer	26.10.2021 07.35 Hrs.	Veluarchar [2.3 km / NE]	• He informed that, Capped Langur and Indian Fox are common in rubber plantation around village. Asked about Phayre's Leaf Monkey, he informed that it is not seen/present.
Mr. Udai Dash, farmer	27.10.2021 16.35 Hrs.	Ghilatali [1.9 km / SE]	• He informed that Capped Langur is the nuisance in their village causing lot of ruckus and destruction.
Mr. Md. Abdul Kalam	28.10.2021 17.40 Hrs.	Putia [2.0 km / NNW]	• He was employed with Tripura State Riffles (TSR) as well as Tripura Forest Department. He informed that, he had planted *Jatropha* for biofuel as well as participated in National Bamboo Mission and Medicinal Plant Mission initiatives of Government of India-Government of Tripura. • Five years back Jungle cat and Phayre's Leaf Monkey was observed near their village. Now a days Indian Fox, Capped Langur, Wild Boar, Jungle Fowl and snakes like Monocellate Cobra and Spectacled Cobra are frequently observed in the rubber plantations near village Putia
Mr. Jahir Miya and Mr. Maman Miya, local labourers	29.10.2021 07.10	Naljala [0.8 km / NW]	• Snakes like Cobra, Earth Boa and Checkered Keelback are commonly seen in the study area. Apart from that fox / jackal are also observed occasionally.
Mr. Aktar Miya, farmer	30.10.2021 08.35	Veluarchar [2.3 km / NE]	• He informed Rhesus Macaque and Capped Langur was observed very frequently near their village. Also Indian fox or Jackal is frequently seen. When asked about Phayre's Leaf Monkey, he informed that it is not seen/present.
Interaction with Fisherman Communities. Mr. Md. Rafique (Veluarchar weekly Market), Mr. Ajit Nama (Manikyanagar), Mr. Miton Dash (Veluarchar) and others	30.10.2021 01.11.2021	Veluarchar market [2.3 km / NE] Manikyanagar [0.3 km / SSW]	• Common local fish species, bred throughout the year in private / community pond for personal consumption as well as sale in local markets, are: Rui / Rohu, Mrigala / Mrigal, Catla, Mirror Carp, Scale Carp and Leather Carp, etc.

Source: MITCON

Table 8-3: 1 to 1 Consultation details by ADB TA National Ecology Consultant

Date	Name	Designation	Location	Discussions
16th March 2021	Dr. DK Sharma, IFS	Chief Wildlife Warden (CWLW) and PCCF (Head of	Agartala	1. Wildlife maps requested – shared maps showing wildlife reporting in Tripura. 2. Presence of elephants and other big mammals in project area – no elephants present in

Date	Name	Designation	Location	Discussions
		the Forest Force)		project area. Two population groups of elephants present in Gomoti and Khowai districts. Presence of Bisons in South Tripura especially within Krishna Wildlife Sanctuary (WLS) who may disturb power line poles and get injured. 3. Population of elephants and elephant corridors in Tripura – no specific corridors identified in Tripura. 4. Man-animal conflicts – officially intimated through letter of 4 cases that resulted in 2 deaths. 1 case of injury was inside forests, while the others were outside forest areas. 5. There have been no reported cases of electrocution of wild animals in the last 5 years. 6. Any mitigation measures suggested by Wildlife Department? – underground distribution lines in wildlife areas and other measures as per Wildlife Institute of India guidelines which recommend are to be followed. 7. CWLW requested that the final list of distribution lines to be shared with department.
25th October 2021	Bulbul Das	Range Forest Officer	Boxanagar	1. Presence of threatened species (as per IUCN and nationally protected) in the study area (especially within Rokhia Thermal Power Station) – reported total absence of following endangered species: • *Indotestudo elongate* (Elongated Tortoise) • *Batagur dhongoka* (Three-striped Roofed Turtle) • *Aythya baeri* (Baer's Pochard) • *Houbaropsis bengalensis* (Bengal Florican) • *Emberiza aureola* (Yellow-breasted Bunting) • *Gyps bengalensis* (White-rumped Vulture) *Trachypithecus phayrei* (Phayre's Leaf Monkey) isn't reported within Rokhia Thermal Power Station and they rarely venture out of Sipahijhala WLS. The last siting was in Veluachar area which is approximately 2.53 km away from the Rokhia Thermal Power Station. *Trachypithecus pileatus (*Capped Langur) is also not reported within the Rokhia Thermal Power Station. 2. Presence of animals within Rokhia Thermal Power Station – Rhesus Monkeys (*Macaca mulatta)*, Cobra (*Naja naja*), Small Indian Mongoose (*Herpestes auropunctatus)* reported. 3. Impact on Wetlands – there are no wetlands in Boxanagar range and hence no impacts envisaged. Also ground water level in the area (Manikyanagar – Veluachar) is at a high level. 4. Migratory animals in the study area – none
	Amiya Sutradhar	Beat Officer		

Date	Name	Designation	Location	Discussions
				reported. 5. Man-animal conflicts in the study area – none reported, including road kills. 6. Felling permission for all trees are required to be obtained. Application to be made to SDFO through the RFO and to include tree details and land ownership details. Applications are normally given within 15 days post site verification. 7. Reports for sightings of wild animals within the area requested – e.g., official sighting reports for last 6 months collected by MITCON.

Source: ADB TA Consultant

F. Outcome from Scoping and Draft EIA Stage Consultations

635. Even during the Scoping Stage, the local community within the study area have already learned about proposed plant from designated staff of TPGL. Thus, they were already aware of some of the potential impacts and generally showed neutral or positive attitude towards its implementation. There were some concerns raised, primarily by those residents most impacted by the proposed plant. Table 8-4 to Table 8-7 present the outcome of consultations held.

Table 8-4: Outcome of Scoping Stage Public Consultation 19.04.2021

Questions, comments, concerns, feedback	TPGL's Response
Employment generation for locals?	• TPGL advised that as far as practical, local unskilled labor will be given preference during construction and operation of proposed plant, but a lot of the positions that will be available are skilled and semi-skilled • TPGL disclosed that there has been some awareness raising on the general functioning of gas power plants within the local community • Skills development for the local community will be considered by TPGL
Will proposed plant improve power supply in the study area?	• TPGL responded that development of the proposed 120 MW plant will match power demand and bridge the demand-supply gap as far as possible
Will there be reduction in energy bills?	• TPGL noted tariff will be potentially reduced, although this be decided by Power Department not TPGL
Shortage and/or non-availability of phone and internet facility due to lack of mobile towers. Banks and Post Office are also not available in the Manikyanagar village.	• Proposal for these will be submitted to concerned Tripura Government telecommunication offices
Noise levels are low in Manikyanagar	• TPGL observed that noise emission level from proposed plant will be lower than existing plant.
No earthquake, flood events or other natural disasters recorded in the study area	• TPGL has also not experienced any natural hazards in the study area.
No issues or concerns raised regarding ground water/usage/shortage in the nearby villages	• TPGL noted the proposed plant will be using ground water during construction and operation from deep bore-well. TPGL observed that there is no water stress/shortage of ground water in the study area
Health issues in the study area: although	• Proposed plant will include health facilities and

Questions, comments, concerns, feedback	TPGL's Response
cardiovascular illness is low, hypertension diabetes is more prevalent in the study area	improvement of existing power plant infrastructure, local access to health center is part of the CER of TPGL.
New/improvement in health facilities are required	• This will be taken up by TPGL under CSR and placed before Government Health department.
Female safety is not cause of concern in the study area	• Streetlights have been provided by TPGL in study area and contractors will install necessary lights at all crucial areas during construction near construction camps to avoid any inconveniences to local people.
No issues regarding the existing plant	• TPGL observed that no complaints have been raised due to existing plant
Wastes from existing plant are not being dumped	• TPGL confirmed there is no waste dumping outside of existing plant. • Hazardous wastes are disposed by ONGC
Industrial hazards from the existing plant	• TPGL confirmed no fire accident has occurred in existing plant • For fire incidents/emergencies in the study area, ONGC fire trucks are used
Request for construction of fire station	• Proposal for a new fire-station will be taken up with Tripura Fire and Emergency Services department by TPGL within the proposed plant and to be used for emergencies in the adjacent villages • Proposed plant has allowed for fire trucks and fire detection system
Chances of increase in air pollution due to proposed plant? TPCB monitoring brick kilns in the study area which are the main source of air pollution	• Proposed plant will be provided with high efficiency and low NO_x burner to limit emissions below the air quality standards.
Concern due to increase in traffic due to proposed plant	• TPGL observed that no change in traffic flow/volume will take place due to the proposed plant once it is operational
Socio-economic development of study area, business/commercial	• There may be induced development in the study area due to improvement in power generation, lowering of demand-supply gap, lower tariff, and reduction in power failures.
Other development/facilities in the study area	• High School has been built and maintained by TPGL, it can be further developed if required
Wildlife sittings/observation – monkey is regularly observed in the study area, Rhesus species only	• TPGL confirmed monkey seen in the study area, Rhesus species only.
Reforestation	• Plantation is done yearly by TPGL in and around the Rokhia Thermal Power Station

Source: ADB TA Consultant

Table 8-5: Outcome of Draft EIA Stage Public Consultation – 27.10.2021

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
Project road will be	The local community will be notified	Road closure addressed in

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
temporarily closed during construction, but it will not cause concern as per attendees	of road closure before work starts.	Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Various religious festivals in the study area. May cause conflict with workers in the study area	TPGL will supervise EPC Contractor accordingly to ensure they follow EMP and their CEMP	Community H&S (worker conflicts) addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
One of the women participant's house is on the Manikyanagar main highway. Have witnessed ONGC drilling rigs for their oil well development transported on the same highway	Route survey will be done before transportation to ensure road is suitable and the pavement will be improved/maintained to allow the safe passage of the large trucks	Community H&S (transportation) addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Self-help group (SHG), those informal groups of people, mostly women who come together to address their common problems, requested work. Among them Mayabati village federation is the main SHG. There are 16 active SHGs. SHG are funded through bank loans. Mainly animal husbandry activities. Handloom / agriculture training required. Otherwise, they are interested in clerical jobs.	TPGL advised that suggestion will be considered as far as practical.	Local employment addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Ground water is the main source of water in the study area. For the nearest 10 residents, there is ground water stress during the dry seasons, although as per participants of the larger study area no stress or water shortage was reported There may be lots of ground water required in the proposed plant. What is to be done?	Existing plant already uses groundwater without any community impacts. Rainwater harvesting is planned with site storage in underground reservoirs within proposed plant area. No wastage of ground water.	Taking a conservative stance, since the proposed plant will be using significant amount of ground water for construction and operation compared to the existing plant this issue has been addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Air pollution during operation	NO2 will be the main pollutant, to be controlled with use of low NOx technology.	Air quality addressed in Impact Assessment (Chapter 5) with quantitative modelling for criteria pollutants using long term meteorological data, mitigation measures for all phases are addressed in EMP (Chapter 10) of EIA Report
Monkey will not visit if trees are removed	Only those trees required to be felled will be cut.	Ecological impacts addressed in Impact Assessment (Chapter 5)

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
	Minimum damage to other trees at Rokhia Thermal Power Station.	and EMP (Chapter 10) of EIA Report with evaluation of the baseline condition in terms of species supported based on detailed ecology survey and report (Chapter 4 and **Annexure 10**)

Source: ADB TA Consultant

Table 8-6: Outcome of Nearest Resident FGD at Rokhia – 27.10.2021

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
Water usage stress, especially during dry seasons. New borewell / submersible for proposed plant may lead to further shortage. Some residents are transporting water using vehicles from next nearest water supply/borewell for self-consumption as the borewell they have is not adequate for supply.	Government will install deep tube well near the location of the nearest 10 properties and supply water through pipeline. Rainwater harvesting structure will be used if required. Water and sanitation department to supply.	Taking a conservative stance, since the proposed plant will be using significant amount of ground water for construction and operation compared to the existing plant this issue has been addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
If water drought happens in future, then please consider to supply water from Rokhia Thermal Power Station and not from government supply.		
Electricity supply not available in all the houses	Consumers to approach TPGL for connection	No mitigation measures for this item.
High noise during construction and operation. Suggested to shift high noise operations, heavy vehicles/equipment towards center of proposed plant	Design has been changed prior to consultation to mitigate the noise generated. Further consideration will be taken to move heavy vehicles/equipment away from nearest houses	Noise was considered as one of the potentially significant issues in the EIA, it is addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report with evaluation of the pre-project baseline condition based on quantitative noise monitoring (Chapter 4)
Can hear noise from existing plant sometimes during night, requesting to reduce noise levels	Existing plant is Open Cycle and old technology and is planned for replacement by the CCGPP which will be housed inside hall and acoustically insulated to reduce noise. No works during night during construction. Day time 55dB(A) and 45dB(A) during night to be ensured by Contractor/O&M/TPGL	
Concerned about emissions/flames from stacks	HRSG stack will be 60m and Bypass stack 30m. There will be no flare/flame from the stack.	The air quality assessment and stack sensitivity analysis did not identify the need for any changes to stack heights proposed by TPGL. Air quality addressed in

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
		Impact Assessment (Chapter 5) with quantitative modelling for criteria pollutants using long term meteorological data. Mitigation for all phases is addressed in EMP (Chapter 10) of EIA Report.
Road will be damaged due to truck movement and must be developed	The road in front of the nearest residents will not be used.	Impacts due to traffic movements have been addressed in Impact Assessment (Chapter 5) and in the EMP (Chapter 10) of EIA Report
Vibration may happen which may demolish the houses. Mud house structures and hence impact on the houses may happen.	Pre-construction structural survey of nearby houses will be undertaken in case any unanticipated issue occurs; TPGL will factor mud house construction into noise and vibration assessment as they are more at risk than structurally designed house	Impacts due to noise and vibration been addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report. Structural assessment is needed for the nearest houses. For proposed access routes most houses along the main Boxarnagar-Bisalgarh and NH8 are concrete and brick. Main issue is the inadequate width of the access road.
Nearest residents do not use the road that is planned for closure during construction. ONGC uses the road in front of nearest residents and the road had deteriorated Brick trucks also use the road	For proposed plant, the road in front of the nearest residents will not be used. Regarding existing bad road condition TPGL will forward suggestion to concerned PWD office/authority	
Presence of macaque monkey in around the project site, occasional and rare visit by capped langur	Only those trees required to be felled will be cut, both on the project site and staff accommodation areas. Minimum damage to other trees at Rokhia Thermal Power Station.	Ecological impacts addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report with evaluation of the baseline condition in terms of species supported based on detailed ecology survey and report (Chapter 5 and **Annexure 10**)
Proposed plant fire risk	Presence of fire trucks and detection system in the proposed plant. Proposal for a new fire-station will be taken up TPGL with Tripura Fire and Emergency Services department.	Quantitative risk-hazard assessment has been included (Chapter 7) and mitigation included in the EMP (Chapter 10) of EIA
Earthquake - last one was 2 to 2.5 years ago. Some cracks in mud horses happened due to earthquake.	Pre-construction structural survey of nearby houses will be undertaken in case any unanticipated issue occurs; TPGL will factor mud house construction into noise and vibration assessment as they are more at risk than structurally designed house	Impacts due to noise and vibration been addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report. Structural assessment is needed for the nearest houses. For proposed access routes most houses along the main Boxarnagar-Bisalgarh and NH8 are concrete and brick. Main issue is the inadequate width of the

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
		access road.
Strong storm in 2020 year resulted in roof blown away. Sometimes heavy wind/storm during April to May	Compensation given by GoT through panchayat at the time.	No mitigation measures for this item.
Pollution from traffic dust and smoke	TPGL will ensure EPC Contractor will strictly implement the EMP, ECOP and their CEMP. Minimal emission from traffic during operation.	The air quality assessment for construction is addressed in Impact Assessment (Chapter 5) with mitigation for all phases addressed in EMP (Chapter 10) of EIA Report
Increase of road levels may cause rainwater to flow into the houses. So, no increase in road level and no water stagnation is requested.	Road levels not to be increased.	No mitigation measures for this item.
Improve health facility	Medical unit was present earlier at existing plant. Any medical help is at Boxanagar including the Primary Health Unit.	Health facility capacity evaluated based on primary and secondary information (Chapter 4) and addressed in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Influx of outside laborers may lead to some impact. Security guards in the evening to avoid confrontation with outside laborers requested	No such incidents report previously for the existing plant.	Addressed under Community H&S (worker conflicts) in Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Asking about whether similar vehicles used in 326 MW plant in Udaipur will be used? If yes, then the present road will not support it	Vehicles will be smaller for the proposed plant. Diversion road will be prepared approaching the proposed plant. Route survey will be done before transportation	Impacts due to traffic movement has been addressed in Community H&S Section of Impact Assessment (Chapter 5) and EMP (Chapter 10) of EIA Report
Concerns about condition of smaller road in front houses or bigger road off national highway	Oversize vehicle movement at night. Pre check on road conditions and utilities along the road will be undertaken and existing infrastructure protected accordingly. A pre-work survey to be conducted and after completion the road condition to be same or better as existing condition.	
Drivers, masons are available locally	Proposal for these will be submitted to Tripura Government - Power Department and TPGL head office	No mitigation measures for this item.
Street lightings requested	Proposal for these will be submitted to Tripura Government – Power and PWD offices	No mitigation measures for this item.
Frequency of consultations: once in	As per EMP and by TPGL	Ongoing consultation addressed

Questions, comments, concerns, feedback	TPGL's Response	EIA Report Status
a quarter requested	offices – ongoing consultation is committed	in this section (Chapter 8)

Source: ADB TA Consultant

Table 8-7: Outcome of School Teachers FGD at Manikyangar High School, Rokhia – 29.10.2021

Questions, comments, concerns, feedback	TPGL's Response
Separate toilets for students and staff, no separate boys/girls toilet is available	Suggestion to be considered by TPGL and forwarded to Department of Education, GoT. TPGL suggests that it is the responsibility of the education department, however, they will assist in sending such request to the education department and can assist through interdepartmental channel.
Boundary wall is not present on two sides. School can be accessed by anyone from TPGL.	TPGL will develop a boundary wall to close off the school from the backside of the proposed plant, so that it cannot be assessed by project workers
No separate teachers rest/staff room present	Suggestion to be forwarded to Department of Education, GoT and it has been conveyed that the said suggestion is not under the purview of TPGL's operation.
No separate water supply for school, there is a borewell close to school compound and this is used by them (it is separate to one used by TPGL)	Suggestion to be considered by TPGL and forwarded to Department of Education, GoT
Water supply to school hampered during power failure. Using purchased water.	Suggestion to be considered by TPGL, power failure issues will be addressed on priority by TPGL
Speeding vehicles in front of school gate. Speed breakers to be provided. The main gate opens to the State Highway. Fatality have occurred two years back near the gate.	Suggestion to be considered by TPGL and will be initiated by TPGL following which the same will be forwarded to concerned PWD – Roads, for necessary action.
Free meals for students (government scheme) not available when power failure occurs as cooking hampered during power outages	Suggestion to be considered by TPGL in response to power failure, power failure issues will be addressed on priority by TPGL
Accident in the ONGC oil/gas well area, student died Note: this is the oil well development site, which is 150m from the existing plant and from where ONGC supplies gas to TPGL through the GCS located in the Rokhia Thermal Power Station. Incident is of 2018. The well is part of the ONGC rig and is outside the Rokhia Thermal Power Station.	Ensure security in proposed plant area
Electricity/wiring exposed in switchboards in classrooms – potential high risk	Suggestion to be considered by TPGL and forwarded to Department of Education, GoT

Source: ADB TA Consultant

Figure 8-2: Summary Consultations at Rokhia

	
Nearest Houses Formal FGD	**Nearest Houses Site Visit and Informal FGD**
	
School Teachers FGD	**Discussion with Forest Range Officer**

Source: ADB TA Consultant

G. Future Consultation and Information Disclosure

636. Future meaningful consultation and information disclosure by TPGL and the EPC Contractor must continue on a regular basis to keep stakeholders and the public informed throughout project implementation. In the context of the COVID-19 pandemic all consultations will be carried out following latest national COVID-19 requirements and WHO social distancing and hygiene guidelines as detailed in **Annexure 22**. If group meetings are not possible then individual one-on-one interviews will be conducted. If travel within state is not possible due to COVID-19 restricting the involvement of TPGL Agartala Headquarters based staff, then it will be for site-level representatives to facilitate their virtual involvement in the ongoing consultations.

637. TPGL and the EPC Contractor will need to undertake a further round of public consultation and FGDs with the nearest residences/school to involve stakeholders in the detailed design and inform them of any changes in predicted impacts as a result. This will also be used to disseminate final arrangements for the grievance redress mechanism. The EIA Report will be updated by TPGL during detailed design and after clearance by ADB the update will be disclosed on the ADB and TPGL websites and locally the same as discussed earlier in this section. The same applies to any subsequent updates to the EIA during project implementation.

638. TPGL and the EPC Contractor will subsequently need to disseminate information on the outcome of pre-construction surveys ahead of the start of works. Local communities will need to be given at least one-month prior notice prior to the start of works at the project site. Advance notice will also be provided to local communities about the private access road closure, commencement of works, high noise activities, major periods of traffic movement, and transport

of oversized vehicles. Once construction has commenced FGDs with the nearest residences/school and the residents along the final access route will need to be organized by TPGL and the EPC Contractor once per quarter with a public consultation undertaken on a semi-annual basis. This will not preclude one-on-one consultations being undertaken in between to keep residents informed and/or if concerns are raised. Site notice boards will be maintained in Manikyanagar and at either end of the temporarily closed TPGL private access road to keep the local community informed of progress with construction in the interim.

639. Once the proposed plant is operational TPGL will continue to hold FGDs with the nearest residences/school once per quarter and public consultations annually for the first year, so that any teething problems related to operation of the proposed plant can be promptly addressed.

640. The EMR to be produced semi-annually for submission to ADB during construction and operation will be disclosed on the ADB and TPGL websites; the draft EMR will be locally disclosed at the same time it is submitted to ADB by posting a copy of the executive summary in local Bengali on the site notice boards and updated when the final is cleared by ADB. If requested of TPGL by the primary stakeholders a printed/soft copy of the full EMR report will be provided and, if required, an oral or written translation provided free of charge.

IX. GRIEVANCE REDRESS MECHANISM

A. Introduction

641. Grievances, within the context of EIA, are actual or perceived concerns about the implementation of the proposed plant with respect to the environment, health, and safety. TPGL will take relevant concerns of affected persons and other stakeholders seriously and ensure that they are actively able to raise and discuss their concerns throughout the project cycle.

642. A grievance redress mechanism (GRM) will be set up upon loan effectiveness and be operationalized prior to the commencement of any civil works, including enabling works. TPGL will appoint a GRM (community liaison) focal for the proposed plant. Their GRM (community liaison) focal may be a different person during the construction and operation period. The contractor will appoint one full-time GRM (community liaison) focal under the contract. All staff of TPGL and the contractor, as well as local government and other entities directly involved in the GRM process will receive a training from the safeguard specialists under the project management/implementation consultant (PMC/PIC) prior to the start of works so that they fully grasp their roles and responsibilities within the GRM as well as approaches to constructively resolve any project-related grievances. Upon commissioning of the power plant, similar training will be provided to the TPGL operations as part of the handover process.

643. The GRM will aim to provide affected persons and other stakeholders with a clear and simple way of filing a suggestion or complaint on the environmental, health and safety performance of the project. For the proposed plant, the GRM will also cover social safeguards. According to ADB's SPS 2009, the GRM must address complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to the affected persons at no costs and without retribution. Given these requirements, handling of grievances on the implementation of the proposed plant will be as follows.

644. Recourse to the GRM does not impede access to the country's judicial or administrative remedies. A grievant can approach the court of law at any time and independently of the grievance redress process. They may (subject to eligibility criteria) also access ADB's Accountability Mechanism[137] whereby people adversely aggrieved by ADB-financed projects can express their grievances, seek solutions, and report alleged violations of ADB's operational policies and procedures, including ADB's Safeguard Policy Statement 2009.

B. Grievance Redress Mechanism

1. Grievance Uptake Points and Disclosure

645. There will be specified grievance uptake points where grievances can be lodged. TPGL and the contractor's GRM focals will actively engage with the adjacent communities and construction workers throughout pre-construction and construction, with TPGL's GRM focal doing the same at the onset of operation, providing an opportunity for members of the public or

[137] There are two parts to ADB's Accountability Mechanism, problem solving led by ADB's special project facilitator can assist the complainant in finding solutions to their problems, while compliance review, led by a three-member panel, can investigate alleged violations of ADB's operational policies and procedures, including safeguard policies, and recommend corrective actions to ensure project compliance.

workers to approach them with any grievance. Any concerned person or group of people can also file a complaint through the GRM, at any time and at no cost. Affected persons and other stakeholders will have the flexibility of conveying grievances by sending them in writing, by email, through telephone call, mobile phone text, suggestion box kept on-site, paper-based grievance form, or online grievance form in TPGL's website to the GRM focal persons. All TPGL staff and the staff of its representatives, contractors, and subcontractors, must be made aware of the existence of the GRM and who to direct a grievant to if they are approached. Local government representatives will also be briefed by TPGL on the GRM and so be able to take up complaints and pass them onto TPGL or the contractor to be addressed.

646. The time frame for receiving a response will be made known to the grievant. Investigations and deliberations on the grievances will be communicated to the grievant and outcomes publicly disclosed.

647. Communities within the project's area of influence will be made aware of the GRM as well as how to access it, including communication channels/mode/reporting lines, through (i) community awareness raising during community or one-on-one meetings; (ii) pamphlets distributed to the general public in the direct vicinity of the project site, in local languages, and maximizing use of graphics to convey messages for the illiterate, and (iii) notices on the radio, social media and/or local newspaper, as well as notice boards at all the entrances to the project site, at the offices of the Rokhia Thermal Power Plant, at the contractor's site office, in local government offices, and on TPGL's website with details of the GRM together with details of the proposed plant and where the EIA report can be obtained to capture a wider audience.

648. Pre-construction and once operational, TPGL will be responsible to post clearly visible signboards at the entrances to the proposed plant with contact details including the name and phone number of their GRM focal person, together with a suggestion box that will be regularly checked for any grievances received. During construction, the contractor will be responsible for posting these signboards, including contact details with the names and phone numbers of both the TPGL and contractor's GRM focal persons as well as the suggestion box to be regularly checked.

2. Record Keeping and Disclosure

649. Careful documentation of the name of the grievant, date of receipt of the complaint, address/contact details of the person, location of the area to which the grievance relates, dates of subsequent communications with the grievant, copies of investigation reports, minutes of deliberations, and how the grievance was resolved will be undertaken. TPGL's management will have overall responsibility for timely grievance redressal on safeguard issues with the support of their GRM focal for ensuring disclosure, registration of grievances, and communication with the grievant.

650. All entries to the grievance register, no matter how minor or whether resolved at an initial informal level on site or at any of the formal levels of the GRM, along with updates on ongoing or completed actions taken to address the grievance will be included in monthly reports by the contractor to TPGL and detailed in the quarterly project reports and environmental monitoring reports to be submitted by TPGL to ADB. TPGL will also notify ADB immediately of any grievances that enter the third stage (GRC) of the GRM or are related to immediate risk to human life, or impending damage to structures, flora or fauna, or physical cultural resources.

651. The PSC safeguard specialists will monitor the operationalization of the GRM and the effectiveness of the grievance resolution process along with TPGL PMU and both will recommend any improvements to increase the efficiency, timeliness, and fairness of the process. The number of grievances registered and resolved, and summary outcomes will be disclosed on noticeboards at all the entrances to the project site, at the offices of the Rokhia Thermal Power Plant, at the contractor's site office, in local government offices, and on TPGL's website.

3. Grievance Analysis and Resolution

652. In grievance redress it is important for grievance handlers to be clear on the issues involved and why the grievant is dissatisfied. The first step is an honest appraisal of whether the grievance received is proactive or reactive to a situation, how it is relevant to the proposed plant, and if it falls under the national and ADB policy and legal framework as described in Chapter III. This will enable ineligible grievances to be identified.[138] For those that are eligible the facts must then be established in full through soliciting information and observations in the field, in communication with the grievant and others to clearly define the problem to be resolved. The grievance handlers need to be able to clearly appraise the grievant of their grievance's relevance to the proposed plant, and the applicable national and ADB policy and legal framework so that both sides have common understanding of the context. Once the problem is clear, options for resolution can then be analyzed, and a time bound grievance resolution action plan agreed with the grievant for implementation by TPGL or their contractor.[139]

653. Once a resolution has been reached, the grievant will be asked to sign a form (**Annexure 25**) acknowledging receipt of the time bound grievance resolution action plan and providing their approval or refusal, as applicable.

654. Implementation of the actions must then be monitored by the TPGL GRM focal with regular follow-ups. Whilst resolution may be quickly reached, the grievance can only be fully closed out once all actions have been completed and the grievant has confirmed their satisfaction. Implementation of the actions must therefore be undertaken by TPGL as promptly as is possible and ideally within 15 days of being agreed, though this will depend on the nature of grievances involved.

4. Budget

655. TPGL and the contractor will need to provide staff for and allocate budget for the GRM that will sufficiently cover the costs of its operations including initial awareness-raising, capacity development training, support services, field inspections, meetings, documentation, supplies, etc.

C. Procedure for Grievance Resolution

656. Following an initial informal site level, the formal GRM will provide three-tiers for grievance redress as illustrated in Figure 9.1.

[138] If the grievance is not eligible, the grievant should be informed of the reasons in writing and directed onto other appropriate mechanisms if applicable.
[139] https://www.adb.org/sites/default/files/institutional-document/180614/problem-solving-guidebook.pdf

1. Informal Stage – Site Level

657. Site level grievances may be informally redressed by the contractor staff during construction or TPGL operations staff once operational. In such cases the grievance, however minor, will still be reported to the TPGL GRM focal who will record the date, nature, and type of grievance and its resolution in the GRM register. A template for recording grievances is provided in **Annexure 25**. In case grievances that are immediate and urgent (e.g., dust, noise, spills, leaks, inappropriate behavior, worker conflict, etc.) cannot be readily resolved at the contractor's level, the on-site field officers of TPGL will provide the most easily accessible first level of contact. If workers wish to file a complaint and are not comfortable logging it informally with the contractor, then they can also raise it informally with the on-site field officers of TPGL.

658. It is anticipated that the TPGL will be able to respond to and resolve all informal, minor grievances received, in conjunction with the contractors if required, within 3 working days of the grievance first being raised. In case of a grievance relating to immediate risk to human life, or impending damage to structures, flora or fauna, or physical cultural resources, the contractor or TPGL field staff will get in immediate contact with the PMU E&S Safeguard Officer who shall have the power to halt works until required corrective action is taken.

2. First Formal Stage - PIU Level

659. If no resolution or understanding on the grievance is informally reached after 3 working days, the grievant chooses to direct their grievance directly to the formal GRM process, or an informal grievance is deemed more than minor, the grievance will be formally filed and taken up by the PIU for it to be resolved within 7 working days of being filed. The first formal level of the GRM will be headed by the PIU Plant Head/Operation In-Charge supported by the TPGL GRM focal. All grievances will be sorted by eligibility and level of urgency and by nature (suggestions or comments, complaints related to adverse impacts on an individual or group, violations of national law, etc.).

660. Just as for the informal stage, all grievances will be recorded, and the grievant will be informed formally of receipt; timeline; and resolution. TPGL's GRM focal will send within 3 working days of the grievance being filed with the first stage a letter to the complainant acknowledging receipt, and what to do if they are unsatisfied with progress including contact details for raising it to the second stage; within 7 working days the facts should have been established, a meeting held, and a time bound grievance resolution action plan agreed upon with the grievant.

3. Second Formal Stage – PMU Level

661. If no resolution or understanding on the grievance is reached at PIU level after 7 working days, or earlier if the PIU feel they are unable to resolve it themselves, the grievance will be formally filed with the second stage and taken up by the PMU for it to be resolved within 15 working days of being filed. The second formal level of the GRM will be headed by the PMU Overall In-Charge/Operation Plant Head supported by the TPGL GRM focal. All grievances will be sorted by eligibility and level of urgency and by nature (suggestions or comments, complaints related to adverse impacts on an individual or group, violations of national law, etc.).

662. Just as for the first level, all grievances will be recorded, and the grievant will be informed formally of receipt; timeline; and resolution. TPGL's GRM focal will send within 3 working days of the grievance being field with the second stage a letter to the complainant

acknowledging receipt, and what to do if they are unsatisfied with progress including contact details for raising it to the third stage; within 15 working days a meeting should have been held, and a time bound grievance resolution action plan agreed upon with the grievant.

4. Third Stage - Grievance Redressal Committee (GRC)

663. The highest GRM level will be the GRC. The GRC will be constituted by the PMU Overall In-Charge/Operation Plant Head who will also convene and chair the GRC meetings during construction/operation. The GRC will be made up of the PIU Plant Head/Operation In-Charge, safeguards staff, up to two representatives of the complainant including a female and/or indigenous peoples' representative if applicable,[140] as well as, a representative of the contractor if applicable, and, government representatives for environment or social issues (such as, but not limited to, survey officials, forest officials, pollution control board officials, water department officials, municipality representatives etc.). The GRC will be convened and meet at short intervals subject to the number of grievances to resolve.

664. Just as for the first level, all grievances will be recorded, and the grievant will be informed formally of receipt; timeline; and resolution. TPGL's GRM focal will send within 3 working days of the grievance being field with third stage (GRC) a letter to the complainant acknowledging receipt, and what to do if they are unsatisfied with progress including contact details of ADB's India Resident Mission. Within 15 days of filing with the third stage (GRC) the committee should have met, and a time bound grievance resolution action plan agreed upon with the grievant.

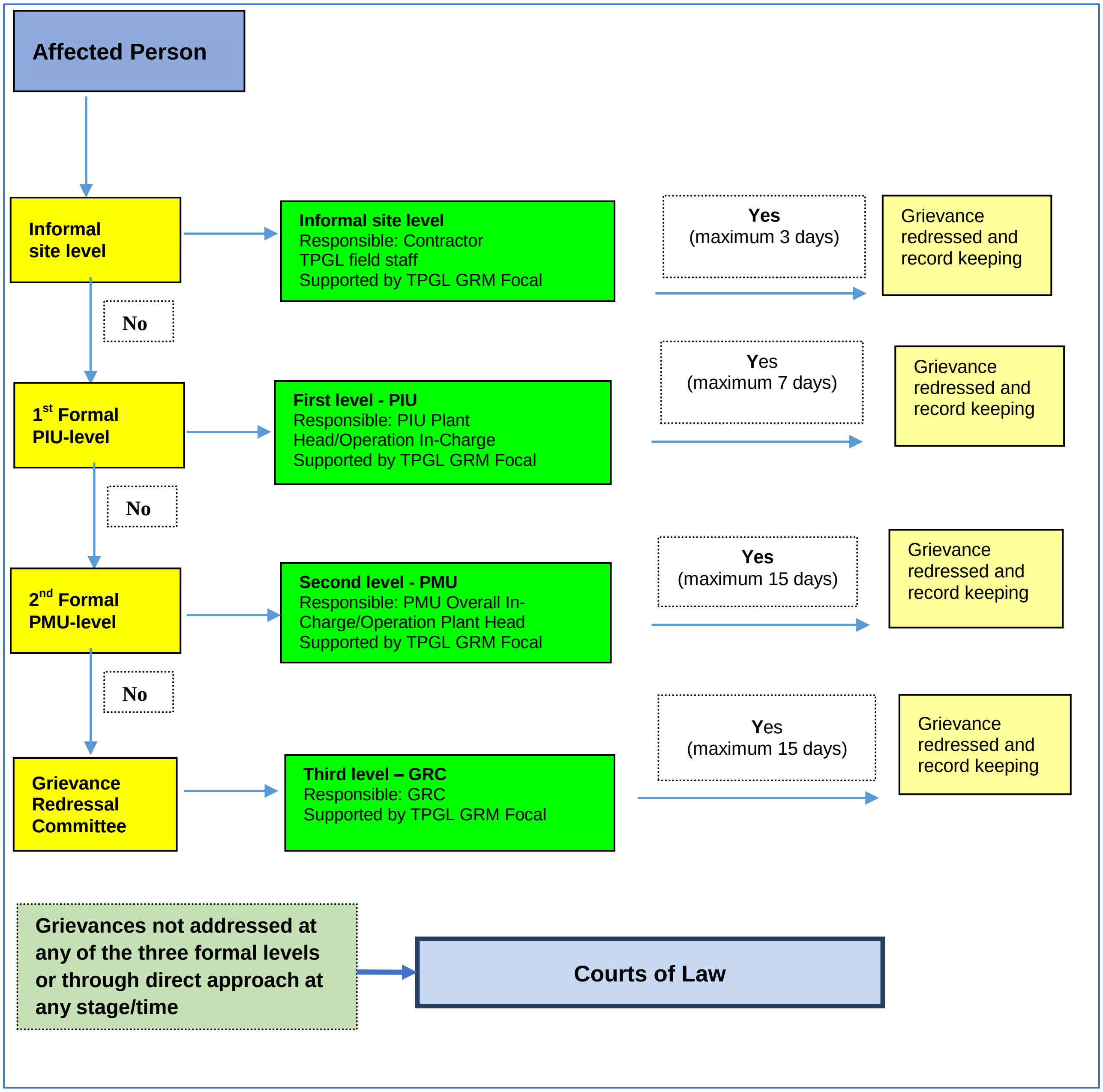
5. Unresolved Grievances

665. If the established GRM is not able to resolve the issue, then it must pass to the courts of law or alternatively an affected person can use the ADB Accountability Mechanism through directly contacting (in writing) the Complaint Receiving Officer (CRO) at ADB headquarters or ADB India Resident Mission. A complaint can be submitted in any of the official languages of ADB's developing member countries. The ADB Accountability Mechanism information will be included in the project-relevant information to be distributed to the affected communities, as part of disclosing the GRM.

666. Despite the GRM, a grievant shall have access to the country's legal system at any stage and accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the outcome of the GRM resolution.

[140] Representatives can include local government representatives or NGOs as requested by the grievant, the grievant may also choose to represent themselves during the GRC.

Figure 9-1: Structure of GRM for the Proposed Plant



Source: ADB TA Consultant

X. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

667. ADB's Safeguard Policy Statement (SPS) 2009 requires that an Environmental Management Plan (EMP) be prepared to ensure construction and operation of the proposed plant are implemented in accordance with applicable environmental, health and safety requirements of the Government of India (GoI) and Government of Tripura (GoT) including international agreements India is a signatory to, as well as international good practice as set out in the related World Bank-IFC Environment, Health and Safety (EHS) general and sector guidelines. The EMP sets out the project specific environmental measures that will be undertaken to avoid, reduce, mitigate, and manage impacts and risks associated with the proposed plant. The EMP focuses on potential impact and risks to the physical, biological, and socioeconomic environment that have been identified as part of the EIA process. It is an overarching document that will guide environmental management implementation, supervision and monitoring of all aspects of TPGL and their contractor's activities i.e., detailed design, pre-construction preparatory work, construction including site establishment, site preparation, demolition and earthworks, and operation and maintenance of the proposed plant.

B. Structure of the EMP

668. The EMP for the proposed plant describes the anticipated adverse environmental impacts and risks, the mitigation and offset measures required to address them, and the monitoring requirements to be adopted with respect to:

(i) National Environment, Health and Safety Legislative Framework as discussed in Chapter III,
(ii) Tripura State's Environment, Health and Safety Legislative Framework, as per Chapter III,
(iii) ADB's Safeguard Policy Statement 2009 requirements,[141]
(iv) International Good Practices Guidelines as per the World Bank-IFC EHS guidelines,[142] and
(v) Local environmental and social sensitivities.

669. Detailed mitigation and monitoring plans are developed and will be implemented by TPGL and their contractor. The EMP also addresses the corrective action required for the existing 132 kV switchyard for power evacuation and the ONGC gas collection point, TGPL will be required to collaborate with ONGC as a third party to ensure the EMP requirements are followed. It also covers the requirement for decommissioning the existing plant, to be undertaken by TPGL following commissioning of the proposed plant. To ensure these mitigation and monitoring plans are implemented, TPGL will undertake a program of environmental supervision and monitoring and report their compliance with the EMP and the conditions of their Environmental Clearance and Consent to Operate to Tripura State Pollution Control Board (and MoEF&CC if required by the Environmental Clearance) and ADB.

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[141] Safeguard Policy Statement (June 2009) (adb.org)

[142] https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES&CVID=nPtguVM and Guide for Preparation of Draft Industry Sector EHS Guidelines (ifc.org)

670. The EMP contains several components crucial to effective environmental management of the proposed plant, these include:

(i) Mitigation plan including performance standards to be implemented during detailed design, pre-construction preparatory work, construction including site establishment, site preparation, demolition and earthworks, and operation and maintenance (**Annexure 28**);

(ii) EHS codes of practice elaborating on the mitigation measures for pollution prevention, health, and safety to be implemented during the construction and operation phases (**Annexure 29**);

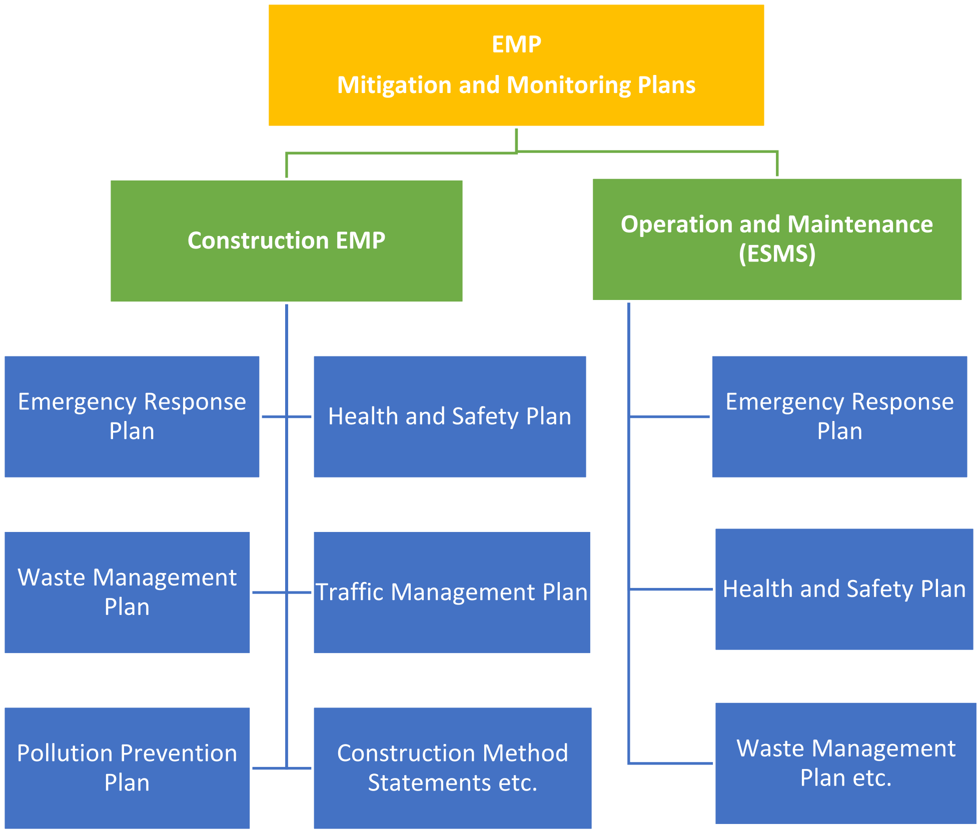
(iii) Procedures that elaborate on the mitigation measures set out in the mitigation plan in relation to specific topics and which will form the basis for the preparation of certain EMP sub-plans (**Annexures 31 onwards**). Various EMP sub-plans including those on pollution prevention, waste management, health and safety, and emergency response will be prepared by TPGL and the contractor prior to construction and operation. These will set out in detail how they intend to comply with the EMP and will sit beneath the mitigation and monitoring plans as shown in Figure 10-1;

(iv) Monitoring plan including performance standards for quantitative monitoring to be undertaken during the construction and operation phases of the proposed plant (**Annexure 30**)

(v) Implementation arrangements, including organizational roles and responsibilities for mitigation, supervision, monitoring and reporting on EMP implementation, capacity development and training requirements for TPGL and their contractors on various aspects of EMP implementation (Table 10-1**Error! Reference source not found.**) and, an indicative budget cost (**Error! Reference source not found.**).

(vi) Grievance redress mechanism (GRM) – Chapter 9 of the EIA report sets out the GRM for the project with roles and responsibilities for TPGL and their contractors.

Figure 10-1: Structure of the Mitigation and Monitoring Plans for the Proposed Plant



Source: ADB TA Consultant

671. The definitive version of the EMP cleared by ADB is the version disclosed on its website. The EMP is dynamic and can be updated as appropriate during the project implementation. However, any update to the EMP will first need to be cleared by ADB. In addition, any unanticipated impacts, or requirements for corrective action due to non-compliance identified during project implementation will be reported by TPGL to ADB, appropriate action will be agreed and taken by TPGL and their contractors to address them and bring the project implementation back on track.

672. The EMP will form part of all bidding and contract documents for construction of the proposed plant and during detailed design, pre-construction, and construction the contractors will be responsible for implementing all relevant measures under the supervision of the TPGL. The contractors must always follow the definite version of the EMP which is the version disclosed on ADB's website.

673. For operation, TPGL will develop an operational environmental and social management system (ESMS) for the proposed plant with the aim of getting it ISO 14001 and ISO 45001 accredited. This ESMS will include operational pollution prevention plans, solid and hazardous waste management plans, and their health and safety risk assessments and management plans addressing both occupational and community risks and including emergency preparedness and response provisions in the event of fire, explosion, or another incident.

C. Impacts, Mitigation and Monitoring

1. Potentially Significant Impacts to be Mitigated or Offset

674. The principal purpose of formulating the EMP is to ensure commitments made in the EIA report are translated into implementation. Potentially significant impacts are summarized as follows:

(i) Clearance of 2.3 ha of natural, albeit degraded, forest habitat including cutting of 249 trees. Disturbance to fauna present, including because of construction works and the presence of workers. In accordance with natural habitat safeguard requirements habitat loss will need to be compensated for to ensure no net loss of biodiversity because of construction.

(ii) Disturbance to nearby places of worship of local religious significance because of construction, chance find procedures for physical cultural resources are required**.**

(iii) Disruption and disturbance to the local community and impacts and risks related to pollution, health, and safety during construction. The most significant impacts will be experienced by 10 private residences located close to the eastern side of the project site and an adjacent school. They arise mainly from demolition and earthworks dust, noise and vibration including because of foundation piling works, disposal of construction waste and wastewater, barricading of the road through the existing Rokhia Thermal Power Station, and the hauling of construction materials, plant and equipment including oversized vehicles along the access routes resulting in dust, noise, vibration, traffic congestion, community safety risks, temporary relocation of street furniture etc. There are also various occupational health and safety risks that will be faced by the construction workforce including working at height, working with electricity etc.

(iv) Operational impacts mostly in relation to use of natural gas as a fossil fuel, noise and vibration, water consumption, and occupational and community health and safety aspects including:
   (a) Emission GHG emissions contributing to global climate change
   (b) Stack emissions of NOx and CO affecting local air quality
   (c) Noise emissions affecting the closest houses mainly due to operation of the heat recovery steam generator (HRSG) and the bypass stack (single cycle operation) during nighttime
   (d) Ground water abstraction impacting on other groundwater users
   (e) Fire and explosion risk associated with the use of natural gas

2. Mitigation Plan

675. **Annexure 28** set out the mitigation plan for the proposed plant including corrective action for the existing 132 kV switchyard for power evacuation and the ONGC gas collection station. The mitigation plan identifies feasible and cost-effective mitigation and offset measures to be taken to avoid and/or reduce potentially significant, adverse environmental impacts and risks to acceptable levels and generally ensure international good practice, and national or state environmental, health and safety requirements are followed. Here, mitigation and offset measures are proposed for each potential impact and risk identified by the environmental assessment, including details of responsible parties for implementation, monitoring and supervision, budget source for implementation, and the associated performance standards to be achieved. The EHS Codes of Practice (**Annexure 29**) further elaborate on the measures for pollution prevention, health, and safety to be adopted and are to be implemented as an integral part of the mitigation plan. Procedures elaborating on the mitigation measures to be

implemented in relation to specific topics and which will form the basis for the preparation of certain EMP sub-plans are also provided (**Annexures 31 onwards**).

3. Monitoring Plan

676. The Environmental Monitoring Plan (EMoP) sets out the minimum provisions for quantitative environmental monitoring and performance standards to be achieved (**Annexure 30**). Monitoring activities including laboratory analysis for air quality, noise, surface water and groundwater quality, and soil contamination are to be carried out by the National Accreditation Board for Testing and Calibration Laboratories (NABL)[143] and/or MoEF&CC accredited/recognized, third-party laboratories. Quantitative monitoring activities may be modified during implementation, depending on the contractor and power plant's performance and analytical results obtained. If performance is worse than expected, corrective action will be identified, and the environmental monitoring activities will be adjusted accordingly by TPGL to help resolve any unsatisfactory performance.

D. Institutional Arrangements and Implementation Responsibilities

1. Institutional Arrangement

677. The proposed institutional structure to implement the proposed plant by TPGL is shown in Figures 10-2 to 10-4. Reporting, instructions, liaison/consultation, and advice/inspection channels are also shown.

678. The main parties that will be involved in environmental management and monitoring are as follows with more detailed roles and responsibilities of key players being set out in Table 10-1:

(i) **Government of Tripura, Power Department –** the main project coordinating body on behalf of government.

(ii) **TPGL Management** -- as the executing and implementing agency for the proposed plant, the management of TPGL will be ultimately responsible for environmental, health and safety management and ensuring all concerned parties follow GoI and GoT requirements, ADB's SPS 2009, ADB loan covenants and EMP requirements during all phases of implementation.

(iii) **TPGL Project Management Unit (PMU) -** will be set up at TPGL's Head Office at Agartala and headed by a General Manager–Technical (GM) as Overall In-Charge during the pre-construction and construction phases. PMU will be responsible for the overall day-to-day management, and coordination of the technical, environment, health, and safety aspects of implementation and thus compliance with all requirements, reporting to TPGL Management. PMU will contain a senior E&S safeguard officer as part of a Safeguards Unit as detailed in the capacity building section.

(iv) **TPGL Project Implementation Unit (PIU)** -- will be set up at the project site at Rokhia and headed by a Deputy General Manager-Electrical/Mechanical (DGM) as the Plant Head assisting the Overall In-Charge during the pre-construction and construction phases. PIU will report to PMU and be responsible for EMP implementation during pre-construction and construction, day-to-day on-site management, and supervision and monitoring of the contractor with respect to

[143] NABL is an accreditation body, with its accreditation system established in accordance with ISO/IEC 17011.

the technical, environment, and health and safety aspects of implementation and thus compliance with all requirements. They will delegate relevant detailed design, pre-construction, and construction measures to their contractor through the contract. PIU will contain on-site environment, health and safety safeguard officers as part of a Safeguards Unit as detailed in the capacity building section.

(v) **TPGL Operation and Maintenance** – headed by the DGM as the Plant Head, supported by the Operation In-Charge TPGL operations staff will take over operation and maintenance (O&M) of the proposed plant from the contractor following its construction ─ there will be a handover period from the contractor during commissioning following which TPGL O&M will be fully responsible for EMP implementation during operation, overall day-to-day management of the technical, environment, and health and safety aspects and thus compliance with requirements. They will work towards getting the ESMS which is adopted for operation ISO 14001 and ISO 45001 accredited. O&M team will include environment, health and safety safeguard officers as part of a Safeguards Unit as detailed in the capacity building section.

(vi) **Project Management/Implementation Consultant (PMC/PIC) ─** consulting firm to support PMU and PIU in overseeing day-to-day implementation, including safeguards. PMC/PIC will contain safeguard staff as detailed later in the capacity building section.

(vii) **Contractor for construction works and their subcontractors (if any)** - through the contract, TPGL will delegate responsibility for implementing all relevant measures during detailed design, pre-construction, and construction. The contractor will be required to comply with the EMP during the detailed design, pre-construction, and construction phases, closely supervised and monitored by TPGL. There will be a handover period during commissioning when operation of the proposed plant will transfer from being the responsibility of the contractor to TPGL. The contractor will be responsible for reporting environmental safeguards progress and performance at least monthly to TPGL including record data required by the EMoP and providing necessary inputs to the quarterly progress reports and semi-annual EMRs for the duration of their contract. The requirement to undertake relevant mitigation and monitoring actions as set out in this EMP applies to the construction site as well as at any temporary workers camps or overnight accommodation provided by them. The contractor is required to ensure that the EMP requirements are cascaded down to all sub-contractors undertaking works relating to the proposed plant, regardless they are formally or informally employed. The contractors are to employ suitably qualified and experienced environment, health and safety safeguards officers as part of their team, as detailed later in this section, including a GRM (community liaison) focal to keep affected persons informed of works and be available to receive and deal with any grievances at the site level. To contractor will be required to have a corporate EHS policy and environmental management certification such as ISO 14001 and health and safety management certification such as ISO 45001 or equivalents to demonstrate their commitment and capacity for EMP implementation.

(viii) **Construction workers employed formally or informally by the contractor and any subcontractors** – these workers will need to abide, in their behavior and work, to directives issued by their employer with regards to environmental, health and safety management.

(ix) **O&M workers employed formally or informally by TPGL, O&M contractors and their workers** – these workers/contractors will need to abide, in their behavior and work, to directives issued by their employer with regards to environmental, health and safety management.

(x) **ONGC** – responsible for management of the gas collection station, as a third party to the EMP TPGL will need to collaborate with them to ensure the EMP requirements are followed.

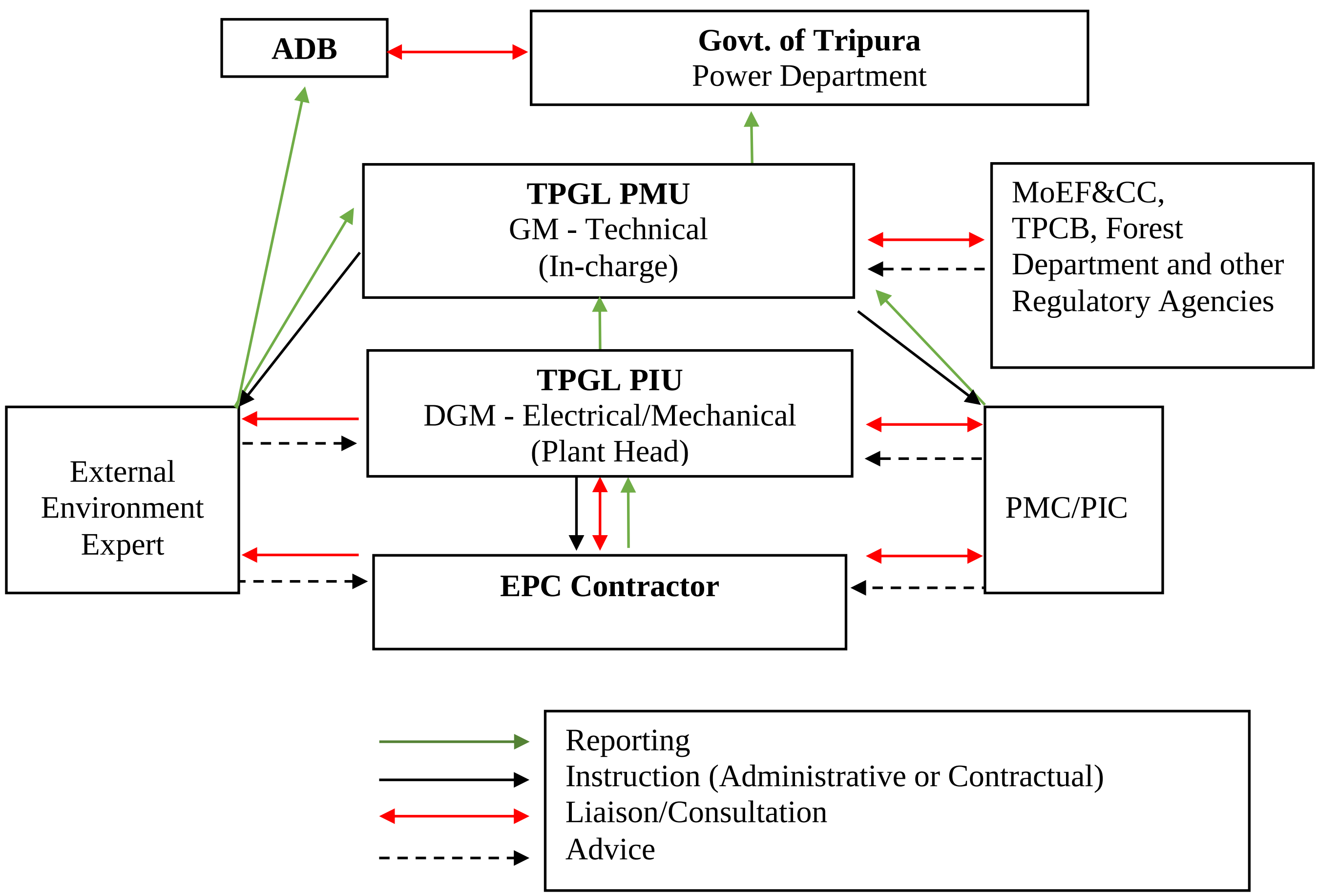
(xi) **External Environmental Monitor** – independent environmental consultant appointed by TPGL in accordance with TOR agreed with ADB to verify environmental monitoring information, they are not involved with the day-to-day management of implementation.

(xii) **MOEF&CC, TPCB, Forest Department and Other Regulatory Agencies** - responsible for enforcing all national environmental clearance requirements required for the proposed power plant.

(xiii) **Project Financiers** – ADB.

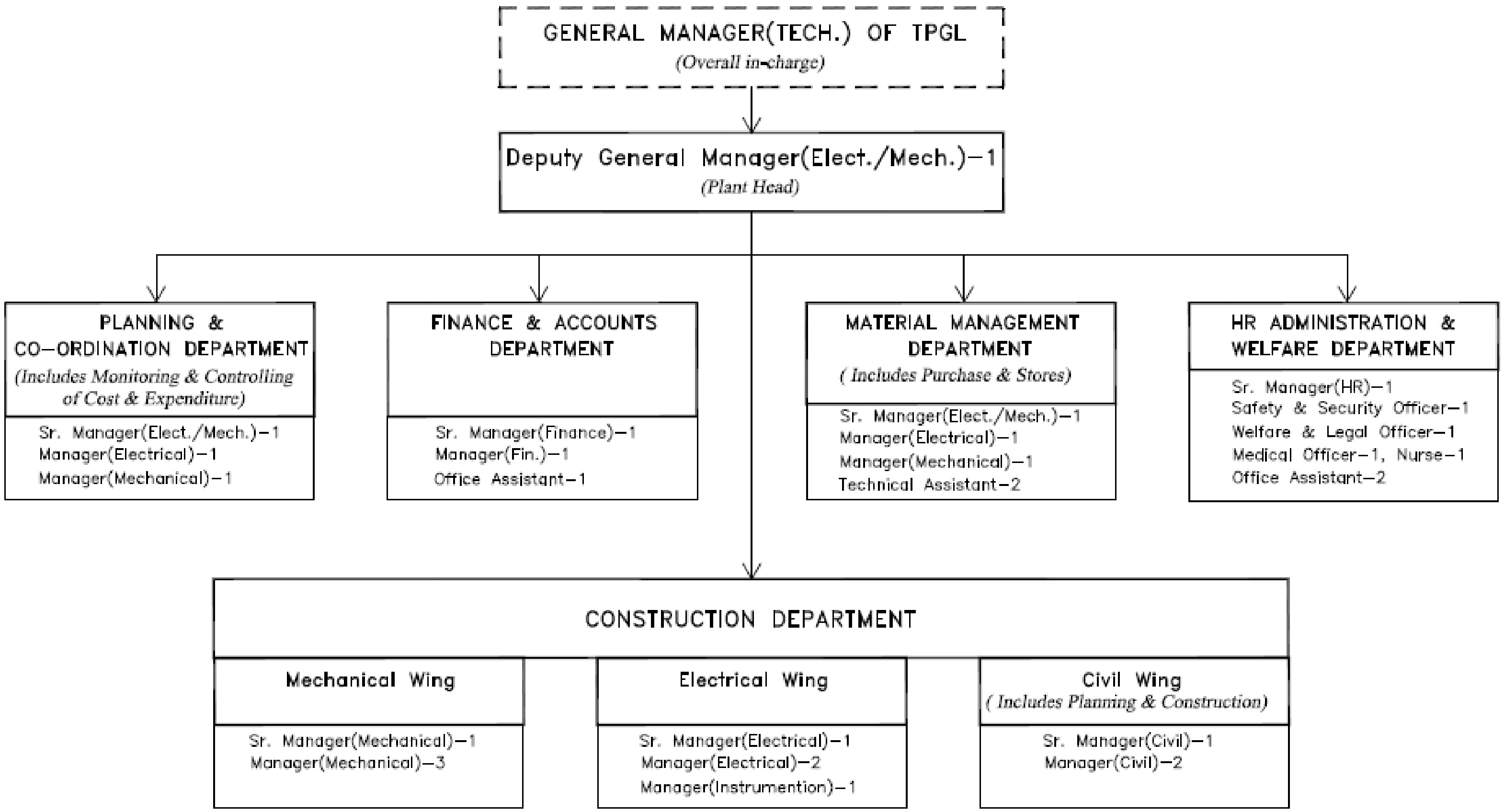
(xiv) **ADB TA Consultants** – to provide environment safeguards capacity development support, in particular supporting TPGL to develop and implement an operational ESMS building on the EMP and reflecting operation and maintenance-related measures to be followed by TPGL operations team with a view to securing ISO 14001 and ISO 45001 or equivalents.

Figure 10-2: Overall Institutional Arrangement for Environmental Management



Source: ADB TA Consultant

Figure 10-3: Organisational Set Up for Construction Phase



NOTES:–

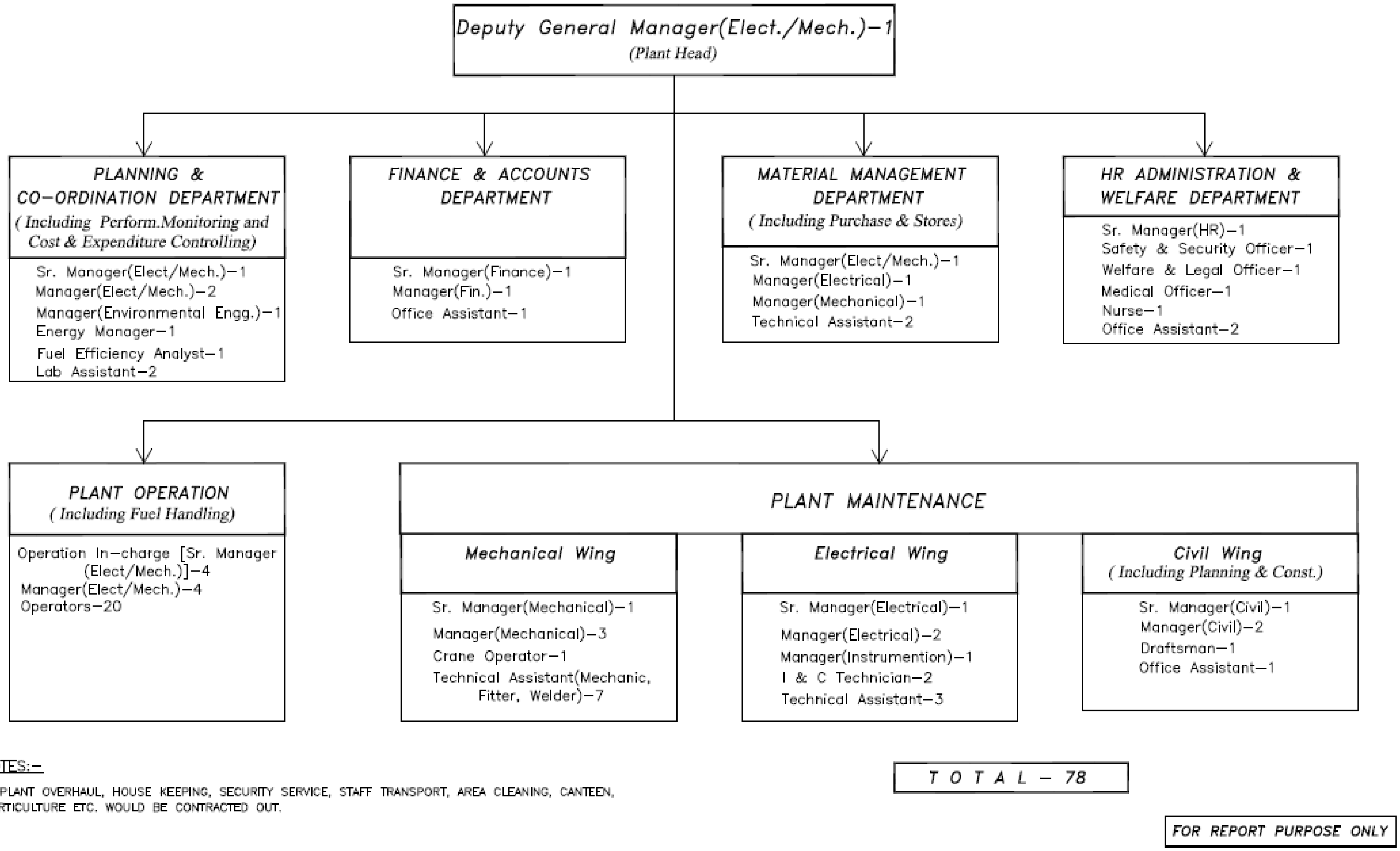
1. ASSUMING PROJECT EXECUTION BY EPC CONTRACTOR AND OVERALL SUPERVISION TO BE DONE THROUGH PROJECT CONSULTANT.
2. SECURITY, AREA CLEANING, CANTEEN, HORTICULTURE ETC. WOULD BE CONTRACTED OUT.

T O T A L – 30

FOR REPORT PURPOSE ONLY

Source: TPGL

Figure 10-4: Project Organisation for Operation Phase



Source: TPGL

Table 10-1: Detailed Implementation Roles and Responsibilities

Party	**Responsibilities (Not an Exhaustive List)**
TPGL Management /PMU/PIU/ O&M	• Ensuring adherence to all applicable national and state environment, health, safety, and labor laws and regulations in force at the time. • Ensuring adherence to ADB's Safeguard Policy Statement (2009) and the related IFC Environment, Health and Safety (EHS) general and thermal power plant guidelines (2007). • Ensuring adequate management support, budget, staff, and other resources are allocated to satisfactorily implement, supervise, and monitor implementation of the EMP during all phases. • Appointing suitably qualified and experienced safeguard officers to the Safeguards Unit to support EMP implementation during construction and operation, as per the EMP capacity building requirements. • Appointing an external environmental monitor in accordance with TOR agreed with ADB (**Annexure 27**). • Preparing a detailed training plan, providing training venues, and providing with support of PMC/PIC a suite of training activities for TPGL staff and contractors in relation awareness raising on EMP implementation. • Ensuring that all PMU/PIU/O&M staff support and attend all capacity development and training activities provided for them. • Adopting a zero-tolerance approach to OHS and enforcing all TPGL staff to comply with OHS requirements of the EMP including wearing of appropriate PPE on site to set a good example to the contractor and their workers. • Securing national environmental clearances for the proposed plant before contract award and complying with any requirements set. • Securing CTE and CTO the proposed plant before the start of construction and the start of the operation and complying with any requirements set. • Implementing the EMP throughout all phases or, if responsibilities are delegated, supervising, and monitoring its implementation by the contractor. • Collaborating with ONGC as third-party to ensure EMP implementation with respect to the gas collection station. • Incorporating the EMP into the bidding and contract documents before issuing tenders and contract awards. • Reviewing bids to ensure they are in accordance with the EMP requirements prior to contract award. • Ensuring the contractor secures all necessary CTE, CTO and other permissions before the commencement of related work, maintain records with copies of all the clearances, permits, licenses, and insurances obtained. • Ensuring the contractor provides adequate training to their subcontractors and all workers including daily EHS toolbox talks and emergency response drills; suggesting topics for the trainings based on site observations. • Reviewing and approving in a timely manner the contractor's detailed designs as well as any additional environmental safeguard assessments, their CEMP and EMP sub-plans to ensure they incorporate and are in accordance with the EMP requirements. • Updating the EIA/EMP as required in consultation with ADB prior to approval of the detailed designs to reflect any national environment clearance conditions and any changes from the indicative designs assessed by the EIA. Obtaining ADB's clearance for the EIA/EMP update prior to the commencement of any work, including site establishment, site preparation, demolition, and earthworks. Once cleared, ADB will disclose the updated EIA on its website whilst TPGL will locally disclose it. • Preparing a community liaison plan to elaborate on ongoing consultation and information disclosure in relation to EMP implementation considering gender, vulnerable groups, and indigenous peoples; preparing consultation materials for distribution to affected communities. • Locally disclosing the EIA and other environmental safeguards documents, including publication on TPGL's website. Help with translation of the EIA into local languages or an explanation of its content will be extended free of charge to affected persons on request.

Party	Responsibilities (Not an Exhaustive List)
	• Undertaking and documenting all ongoing consultation, details of consultations such as minutes of the meetings, photographs to be documented in the EMRs submitted to ADB. • Establishing and operationalizing the GRM for affected persons (construction workers and local community members) in line with Chapter IX of the EIA report, including appointing a GRM (community liaison) Focal and establishing a GRC headed by the Overall In-Charge/Operation Plant Head, disseminating contacts, recording and promptly resolving grievances received. All ongoing grievance-related information will be documented in the EMRs submitted to ADB. • Ensuring that prior to connecting the proposed plant to the ONGC gas collection station and existing substation all EMP requirements (including corrective actions) have been complied with. • Ensuring that prior to operation all pre-construction and construction measures have been closed out, and the proposed plant as constructed will enable TPGL to comply with all the operational measures. • Developing and implementing an operational ESMS building on the EMP and reflecting operation and maintenance-related measures to be followed by TPGL operations team, working towards getting it ISO 14001 and ISO 45001 accredited. • Once operational, any contractors hired for maintenance works or decommissioning will be supervised and monitored by TPGL with roles and responsibilities the same as those of the contractor for construction • Decommissioning the existing plant, developing and implementing a Decommissioning EMP reflecting construction-related measures in relation to dismantling equipment at the existing plant site and site restoration. • Undertaking environmental monitoring as set out in the EMoP during all phases, documenting quantitative and qualitative monitoring results; for quantitative monitoring hire accredited, and quality assured, third party laboratories. • Following the formal systems and templates developed for supervision and monitoring undertake day-to-day supervision to ensure that contractors adhere to all the provisions in the EMP as well as their CEMPs and sub-plans as approved by TPGL. • Keep daily records and photo logs of site observations to inform preparation of the semi-annual EMRs. • Undertaking with the support of PMC/PIC monthly EHS meetings including site walkover inspection to determine the status of EMP implementation by the contractor during construction as well as random “spot check” site visits to audit their EMP implementation. Minutes of meetings and findings of site walkover inspections will be attached to the EMRs to be submitted to ADB. • Identifying areas for improvement, unsafe acts, and any non-compliances with the EMP by the contractor and/or TPGL staff and instructing for corrective actions to be taken by them to bring implementation back on track. • Thoroughly investigating all unanticipated impacts, near-misses, accidents, and chance finds; preparing a detailed incident report where applicable, identifying and instructing on corrective actions particularly to avoid any repetition of near-misses and accidents. • Monitoring and reporting on EMP implementation including reporting on EMP implementation in quarterly progress reports and preparing semi-annual EMRs for submission to ADB up until the project completion report, or longer period if required by the PCR. • Reporting any unanticipated impacts, accidents, and chance finds to ADB within 48 hours of them occurring along with a corrective action plan. • Reporting to ADB any grievances submitted to the third formal stage of the GRM upon receipt. • Further updating the EIA/EMP as necessary and locally disclosing any updates if any unanticipated impacts (including project scope or design changes) occur during implementation; any such updates must be submitted to ADB for clearance and disclosure on the ADB website before any related works commence or are cleared by TPGL to continue. • Developing and taking all requisite corrective action in case of any non-compliance with the

Party	Responsibilities (Not an Exhaustive List)
	EMP including repair of any property damages and financial compensation (insurance) for health and safety incidents.
PMC/PIC	• Support TPGL in preparing a detailed training plan. • Support delivery of safeguard training and capacity building activities and provide on-the-job guidance to TPGL safeguards staff and the contractors on ensuring compliance with the EMP requirements. • Guiding TPGL on the implementation of the EMP during the pre-construction and construction. • Supporting TPGL in ensuring that their contractors secure all necessary CTE, CTO and other permissions before the commencement of related work, maintain records with copies of all the clearances, permits, licenses, and insurances obtained. • Supporting TPGL in ensuring the contractor provides adequate training to their subcontractors and all workers including daily EHS toolbox talks and emergency response drills; topics for the trainings to be suggested based on site observations. • Supporting TPGL in reviewing the contractor's detailed designs for compliance with the EMP as well as any additional environmental safeguard assessments, their CEMP and EMP sub-plans to ensure these documents incorporate and are in accordance with EMP requirements. • Supporting TPGL in updating the EIA/EMP as required in consultation with ADB prior to approval of the detailed designs to reflect any national environment clearance conditions and any changes from the indicative designs assessed by the EIA. • Supporting TPGL in preparing a community liaison plan. • Supporting TPGL to undertake ongoing meaningful consultation with affected communities to keep them informed of progress and with local disclosure of the findings of the EIA report and EMRs etc. • Supporting operationalization of the GRM and assist TPGL in resolving grievances received. • Developing formal systems and templates for TPGL staff, contractor, and PMC/PIC safeguard staff to supervise, monitor and report on day-to-day implementation all aspects of EMP implementation, including the immediate reporting of non-compliances, unanticipated impacts, accidents, chance finds, third stage grievances etc. • Following the formal systems and templates developed for supervision and monitoring support TPGL safeguards staff to undertake day-to-day supervision to ensure that contractors adhere to all the provisions in the EMP as well as their CEMPs and sub-plans as approved by TPGL. • Keep daily records and photo logs of site observations to inform preparation of the semi-annual EMRs. • Supporting monthly EHS meetings including site walkover inspection to determine the status of EMP implementation by the contractor during construction as well as random "spot check" site visits to audit their EMP implementation. • Reporting any unanticipated impacts, grievances, unsafe acts, or EMP violations to TPGL, identifying areas for improvement, and assist them in implementing solutions and remedial measures. • Supporting TPGL in reporting on EMP implementation within the quarterly progress reports and preparing semi-annual EMRs for submission to ADB. • Supporting TPGL with updating of the EIA/EMP as necessary if any unanticipated impacts (including project scope or design changes) occur during implementation
EPC Contractor	• Implementing all measures and responsibilities allocated to the contractor under the EMP for the full duration of the contractor's involvement in the proposed plant. • Ensuring adherence to all applicable national and state environment, health, safety, and labor laws and regulations in force at the time. • Ensuring adherence to ADB's Safeguard Policy Statement (2009) and the related IFC Environment, Health and Safety (EHS) general and thermal power plant guidelines (2007). • Ensuring the detailed design reflects the EMP requirements; seeking to ensure it has the same or no worse impact than the indicative design which was assessed in the EIA. • Supporting TPGL to update (as required) the EIA in respect of the detailed design by

Party	Responsibilities (Not an Exhaustive List)
	undertaking further assessment as required by the EMP and providing sufficient details to inform a revised project description and any subsequent reassessment of impacts and risks. • Undertaking and documenting a facilitated health and safety (H&S) risk assessment considering for all phases and including consideration of COVID-19 risks amongst others. • Preparing a Construction Environment Management Plan (CEMP) and sub-plans as specified in the EMP for review and approval by TPGL prior to the commencement of works including site establishment, site preparation, demolition, and earthworks. • Ensuring adequate budget, staff and other resources are allocated to comply with and implement the contractor’s responsibilities under the EMP and to supervise and monitor the active construction site to protect the environment and ensure the health and safety of all workers and affected communities. • Ensuring a suitably qualified and experienced environment, health and safety safeguards officers, as per the EMP capacity building requirements, have been appointed to undertake regular on-site supervision and monitoring activities before the commencement of works. • Adopting a zero-tolerance approach to OHS on the project, enforce all workers to comply with the OHS requirements of the EMP including the wearing of appropriate PPE on the construction site. • Obtaining all necessary CTE, CTO and other permissions before the commencement of related work, share copies of all clearances, permits, licenses, and insurances obtained. • Providing and ensuring attendance at EHS trainings for formal and informal construction workers and other personnel as required. • Ensuring that all construction workers including all formal and informal employees and subcontractors understand their responsibilities to implement the EMP and mitigate environmental impacts and risks associated with pre-construction and construction activities. • Supporting TPGL in undertaking ongoing consultation and implementing the site-level GRM; in particular, the contractor’s GRM Focal shall thoroughly document details of complaints and make its best efforts to resolve the complaints at project site level; all this information is to be included in the contractor’s monthly reports to TPGL. • Undertaking environmental monitoring as set out in the EMoP during pre-construction and construction and documenting qualitative and quantitative monitoring results; for quantitative monitoring the contractor is to hire accredited, and quality assured, third party laboratories. • Submitting monthly environmental management reports to TPGL (monthly EMP reports will be included as part of the contractors’ monthly progress reports) relating to the work undertaken over the reporting period and documenting the environmental measures including monitoring activities that have been carried out, problems encountered, record data including near misses and accidents, grievances received, and follow-up actions that were taken (or will be taken) to correct the problems. • Informing TPGL immediately in case of any approved detailed design changes or unanticipated environmental impacts occurring during implementation, and as required, provide any information needed to TPGL to enable them to promptly update the EIA/EMP for clearance by ADB before any changes are implemented. • Informing TPGL within 24 hours in case of chance find or accident on site and providing within 48 hours an incident report with corrective action detailing how reoccurrence will be prevented. • Informing TPGL immediately in case of any non-compliance and help them to prepare as necessary a corrective action plan for clearance by ADB, the contractor is required to implement all necessary corrective action requested by TPGL to ensure the project remains in compliance with national and state regulatory requirements, ADB’s SPS 2009, the project’s loan covenants and EMP requirements.

Source: ADB TA Consultant

2. Implementation Monitoring and Reporting

679. In addition to quantitative monitoring (**Annexure 30**) there will also be supervision and monitoring of EMP implementation by the contractor and O&M staff -- the performance standard being that all EMP measures will be implemented in full at the appropriate time. Further as a Category A project under ADB's SPS 2009, TPGL will be required to appoint an external environmental monitor under a TOR (**Annexure 27**) agreed with ADB to verify their EMRs.

680. If any performance standards are breached or any of the safeguard requirements that are covenanted in the legal agreements, are found not to be satisfactorily complied by TPGL and/or their contractors, an appropriate, time bound, budgeted, corrective action plan (CAP) will be developed and implemented as agreed upon with ADB to rectify unsatisfactory performance or safeguard noncompliance. TPGL will carry out the following actions to supervise and monitor EMP implementation (not an exclusive list) and ensure intended environmental safeguard outcomes are being achieved by the proposed plant:

- (i) Safeguard Unit officers with support of PMU/PIC are to convene monthly EHS meetings with contractor/O&M team including site walkover inspections to determine the status of EMP implementation and random "spot check" site visits to audit in more depth EMP implementation by the contractors and upon operation TPGL's O&M team.
- (ii) Obtaining monthly reports from contractors and TPGL O&M team and reviewing qualitative and quantitative monitoring results to identify any issues of concern.
- (iii) Identifying areas for improvement, unsafe acts, and any non-compliances with the EMP and instructing corrective action to be taken by them to bring implementation back on track.
- (iv) Keeping records of all monthly reports, meetings, inspections and audits and time-bound corrective actions instructed.
- (v) Supervising and monitoring the implementation of any corrective actions alongside EMP implementation to ensure they are implemented in a timely manner.

681. In addition to standard contract monitoring systems established by the PMU for the pre-construction and construction stages, the Safeguards Unit officers with support of PMU/PIC will introduce formal systems and templates for monitoring and reporting on EMP implementation, with the following reporting lines. Those responsible shall ensure monitoring is well documented and the timely submissions of monitoring reports with an acceptable level of detail:

- (i) Contractor will establish their own internal systems for monitoring and reporting their EMP implementation.
- (ii) Contractor as the main executor of the EMP will formally submit monthly and quarterly environmental management reports per an agreed template to the PIU Plant Head who will share the report with the PMU/PIU safeguards officers.
- (iii) Once works commence on site the PIU safeguards officers under the direction of the PMU E&S safeguard officer will keep daily records and photo logs of site observations reporting their findings at least weekly to them with written monthly summaries of progress submitted – the monthly summary reports will be attached to the EMRs submitted to ADB.
- (iv) Complete photographic records will be kept by both the contractor and PIU safeguards officers, covering all activities on site as well as key locations such as the construction site, receptors surrounding the proposed plant, off-site access roads, stores, sanitation and welfare facilities, temporary worker camps or overnight accommodation etc. Photographs of key areas will be taken prior to construction activities begin, to provide the environmental baseline. Copies of all geo-referenced photographs will be submitted to the PMU E&S Safeguards

Officer along with the contractor's monthly report and PIU safeguard officers written monthly summaries.

(v) PMU E&S Safeguards Officer to convene monthly EHS meetings to be attended by PIU Plant Head, PIU safeguards officers, PMC/PIU safeguards specialists, and contractor's management and safeguard team to discuss progress; initially progress will be discussed in relation to detailed design actions and as the project progresses will move onto pre-construction and contraction actions.

(vi) During the monthly EHS meetings areas for improvement, unsafe acts, and any non-compliances, time-bound corrective actions and responsibilities to address them will be discussed, agreed, and documented – minutes of monthly EHS meetings will be attached to EMRs submitted to ADB.

(vii) PMU E&S Safeguards Officer will be able to instruct the PIU Plant Head and be given delegated authority to instruct the contractor to take corrective action at any time in relation to EMP implementation.

(viii) PMU E&S Safeguards Officer will maintain the time-bound corrective action plan, monitoring and reporting of corrective actions will be undertaken alongside monitoring and reporting of EMP implementation.

682. For the operational stages, TPGL will establish an internal system to monitor and report on EMP implementation along the same lines as that established for construction, this will form part of their ESMS. They will work towards getting it ISO 14001 and ISO 45001 accredited, such accreditation will involve regular environmental audit of the power plant operation.

683. TPGL will be responsible for obtaining and maintaining documentation and ensuring document control with access by and distribution to relevant personnel. Documentation and records to be kept by all parties in hard copy as well as electronic format are as follows (not an exclusive list):

(i) Definitive EIA and EMP (as disclosed on the ADB website)
(ii) Legal register (of applicable national and state legislation)
(iii) National environmental clearance (EC) documentation
(iv) CTE and CTO – for construction plant, proposed plant itself, and ancillary facilities like DG
(v) Tree felling permits, vehicle emission test certificates etc.
(vi) Training plan and training records
(vii) Community liaison plan and records of all consultations undertaken
(viii) Records of emergency preparedness and response drills
(ix) Document review and approval records
(x) Contractor's CEMP and sub-plans and copies of approval records
(xi) Contractor's certifications and insurances
(xii) Completed site checklists and photographic records
(xiii) Corrective action instructions
(xiv) Contractor's and operational accident record and incident reports
(xv) GRM register

684. Environmental monitoring reports (EMRs) (**template in Annexure 26**) will be submitted to ADB on a semi-annual basis by TPGL during both construction and operation, with safeguard inputs provided to monthly progress reports by the contractor and quarterly progress reports to ADB. Following loan effectiveness, semi-annual EMRs will be due for submission to ADB at the end of Q2 and Q4 within 15 days of period end, e.g., before 15th July and 15th January each year. EMRs will be submitted until the ADB Project Completion Report is issued, or later if required therein.

685. The EMRs will describe project implementation progress, any scope or design changes, compliance against safeguard requirements that are covenanted in the legal agreements, progress with environment mitigation and offset implementation, quantitative monitoring results in accordance with the EMoP, corrective action plans for non-compliances and grievances received and their status. EMRs, CAP and updated EIA or addendum report, if any, submitted by TPGL during project implementation will first be reviewed by ADB to ensure quality and acceptability and then, once cleared by ADB, are to be disclosed locally (in the same places as the EIA report was originally disclosed) by TPGL and on the ADB website upon receipt.

686. TGPL will also ensure that their external environmental monitor submits their verification reports within 15 days of their semi-annual EMR being due, these reports are to be submitted concurrently to TPGL and ADB to maintain the independence of the external environmental monitor.

687. TPGL will facilitate ADB to carry out the following monitoring actions to supervise project implementation:

(i) Conduct periodic site visits during the project implementation to confirm compliance with ADB's Safeguard Policy Statement 2009, the project's loan covenants and EMP requirements.
(ii) Conduct Category A supervision missions with detailed review by ADB's safeguard specialists/officers or consultants.
(iii) Review and comment on the periodic EMRs submitted TPGL to ensure that adverse impacts and risks of the project are mitigated as was planned and agreed with ADB, that any corrective actions have been duly implemented, and that the GRM is fully functional.
(iv) Work with TPGL to rectify to the extent possible any failures to comply with their safeguard commitments, as covenanted in the loan agreement, and exercise remedies to re-establish compliance as appropriate.
(v) Prepare a project completion report that assesses whether the objective and desired outcomes of the EMP have been achieved, considering the baseline conditions, and monitoring results.

688. For this purpose, TPGL and their contractors will provide ADB with access to the project site and all requested information on the project. For any ADB supervision missions TPGL or their contractors will provide all ADB staff with a project site health and safety induction and adequate PPE in accordance with Table 2.7.1 of the IFC EHS General Guidelines - Occupational Health and Safety Section.

3. Implementation Schedule

689. During the pre-construction period, national environmental clearance will be obtained before any contract is awarded. Strictly no contracts will be awarded before the EMP has been incorporated into the contract documentation. Further, no site establishment or construction activity is to take place before TPGL has received and approved the requisite contractor's CEMP including all EMP sub-plans. The pre-construction and construction phase of the proposed plant is planned for 36 months after the contract award. The key EMP implementation milestones are provided in Table 10-2 and a tentative outline implementation schedule in Table 10-3, a more detailed schedule is in **Annexure 5**. The contractors will submit a more detailed implementation schedule for the detailed design and construction once the contract is awarded.

Table 10-2: Key EMP Implementation Milestones

Description of Milestone	Implementation Timeline
Implementation of mitigation measures and conduct environmental monitoring for which TPGL is responsible	Immediate implementation, noting EMP requirements must be reflected in contract for which bidding documents may be issued prior to ADB project approval
Procurement	April 2022, bidding process September 2022, tentative date for award of contract subject to receipt of environmental clearance
Prior environmental clearance (EC)	December 2021, scoping request submitted August 2022, tentative date to receive EC
Establishment of GRM	Immediate implementation, latest within one month of loan effectiveness
Appointment of TPGL safeguards officers (Safeguard Unit)	Latest within one month of loan effectiveness for the PMU safeguard support, before start of works on site including site establishment for the PIU safeguard support, and before start of operation for O&M safeguard support
Appointment of PMC/PIC	PMC/PIC must be appointed within three months of loan effectiveness and prior to the approval of detailed design, CEMP approval, site establishment, site preparation, etc.
Appointment external environmental monitor	External expert must be appointed within three months of loan effectiveness and prior to the approval of detailed design, CEMP approval, site establishment, site preparation, etc.
Implementation of mitigation measures and conduct environmental monitoring for which contractor is responsible	Upon award of the contract
Updating the EIA/EMP to reflect any national environment clearance conditions and any changes from the indicative designs assessed by the EIA and obtaining ADB clearance of update	Prior to approval of the detailed design
Detailed design approval	February 2023 (tentative)
Submission and approval of the Contractor's Construction Environmental Management Plan (CEMP)	One month before the start of works including any site establishment, site preparation, demolition, and earthworks
Contractor's Monthly Progress Report	5^{th} day of each month (covering the month prior)
Construction completion	June 2025 (tentative)
Restoration of construction site and surroundings	Before demobilization of contractor

Description of Milestone	Implementation Timeline
Defects Liability Period	August 2026 (tentative)
Adoption of ESMS for operation of proposed plant	One month before operations including commissioning
Implementation of mitigation measures and conduct environmental monitoring for operational period	Upon commissioning
Shut down of remaining units at existing plant	Upon operation
Decommissioning of existing plant	January 2027
Semi Annual EMR for submission to ADB	Before 15th January and 15th July each year following loan effectiveness
External monitor verification	Before 30th January and 30th July each year following loan effectiveness

Source: ADB TA Consultant

Table 10-3: Indicative Timeline

Construction Phase

Activity	Timeline (Quarter)															
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	2022				2023				2024				2025			
Implementation of EMP and EMoP by TPGL																
Procurement – Bidding Process																
Prior Environmental Clearance																
Procurement – Contract Award																
Training as per Training Plan																
Ongoing Consultation/GRM																
Implementation of EMP and EMoP by Contractor																
CEMP Approval																
Detailed Design, Updating EIA/EMP																
Detailed Design Approval																
Site Establishment																
Site Preparation, Demolition and Earthworks																
Procurement of Plant (Manufacture and Ship)																
Civil Works, Roads and Drainage																
Installation Works																
Adoption of Operational ESMS																
Testing and Commissioning of GT and HRSG																
Final shut down of existing plant																
Submission of EMR/External Verification																

Operation Phase

Activity	Timeline (Months)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12…**
Implementation of EMP and EMoP (ESMS)												
Training as per Training Plan												
Ongoing Consultation/GRM												
Submission of EMR/External Verification												

Source: ADB TA Consultant

4. Capacity Building

4.1. Safeguard Staffing Requirements

690. There is currently no clearly defined institutional setup for EHS at TPGL to supervise, monitor and report on EMP implementation. There is also no dedicated EHS staff or unit for managing and monitoring environmental impacts of their activities. Currently the DGM Electrical/Mechanical who is the Plant Head, is responsible for EHS aspects and other issues with support from junior engineers or staff. This set-up has led to lapses in compliance with national laws and regulations in relation to the existing plant. Thus, the appointment of suitably qualified and experienced safeguard staff is an essential requirement to support the PMU/PIU/O&M team. The safeguard staff will be responsible together with the PMU/PIU/O&M team for successful EMP implementation and will supervise and monitor EMP implementation by TPGL and their contractor. They will be tasked to obtain permissions, prepare the training plan, community liaison plan, consultations material, operationalize the GRM, update the EIA, prepare the operational ESMS, prepare semi-annual EMRs, and so on, in addition to undertaking day-to-day on-site supervision and monitoring activities. They will help strengthen the public images of TPGL in respect of safeguard aspects and maintain a good relationship with adjacent communities.

691. TPGL will appoint the following full-time, dedicated, suitably qualified and experienced safeguard staff – environment specialists must have at least a bachelor's degree in environmental management or similar, health and safety specialists must have IOSH/NEBOSH certification or equivalent:

- (i) DGM Level Environment and Social Safeguards Officer, having 15+ years of environment safeguards experience, based in HQ (PMU) reporting to PMU In-Charge
- (ii) Environment Safeguard Officer, with 5-7 years of experience in environment safeguards, based on site during construction (PIU) reporting to PIU Plant Head and E&S Safeguards Officer – TPGL may appoint this officer to take on the role of GRM (community liaison) focal during construction or a separate officer may be appointed into that role.
- (iii) Health and Safety Officer, 7-10 years of experience with NEBOSH/IOSH certification for health and safety, based on site during construction (PIU) reporting to PIU Plant Head and E&S Safeguards Officer.
- (iv) AGM Level Environment and Social Safeguards Officer, with 12-15 years of experience in environment safeguards, based on site during operation (Operational Team) reporting to Plant Head– TPGL may appoint this officer to take on the role of GRM (community liaison) focal during operation, or they may choose to appoint a separate officer into that role.
- (v) AGM Level Health and Safety Officer, 12-15 years of experience with NEBOSH/IOSH certification for health and safety, based on site during operation (Operational Team) reporting to Plant Head.
- (vi) Supporting environmental laboratory, environmental engineering, and administration staff during operation

692. Given TPGL safeguard officers will be new to the role they will be supported by suitably qualified PIC's Safeguard Specialists having at least 20 years (senior posts) and minimum 10 years (other posts) experience of environmental, health and safety management in the power sector. Environment specialists must have at least a master's degree in environmental science / environmental management / environmental engineering or equivalent, health and safety

specialists must have IOSH / NEBOSH certification or equivalent. The following full-time, dedicated safeguard specialists will be appointed to the PIC:

(i) Senior Environment Safeguard Specialist
(ii) Senior Health and Safety Specialist
(iii) Senior Ecologist with intermittent inputs
(iv) Senior Labour Specialist
(v) Environment Safeguard Specialist to be based full time at Rokhia and support the Senior Environment Safeguard Specialist
(vi) Health and Safety/Labour Specialist to be based full time at Rokhia and support the Senior Health and Safety and Labour specialists
(vii) Ecology Specialist to be based full time at Rokhia during demolition, earthworks, and vegetation clearance to support the Senior Ecologist (once the site is cleared their inputs will be intermittent)

693. The EPC contractor will also be required to appoint the following full-time, dedicated, suitably qualified and experienced safeguard officers having at least 15+ years (senior posts) or 7-10 years (other posts) experience who will all be based at the construction site once it is established:

(i) Senior Environment Safeguard Officer
(ii) Senior Health and Safety Officer
(iii) Ecologist
(iv) Labour Officer
(v) Community Liaison Officer/GRM Focal
(vi) Supporting administration staff

694. Further, the active construction site is to have adequate health and safety supervision to ensure the health and safety of all workers and local communities; the senior health and safety officer will be supported by full-time on-site Health and Safety steward(s) with at least one steward to each team of up to 50 persons.

4.2. Training Program

695. To build capacity in the PMU/PIU and contractors for implementation of the EMP and other safeguard requirements, a training programme will be delivered. The training programme will be implemented as per training modules provided in Table 10-4, training needs will be further determined by TPGL and elaborated in a training plan. Delivery of these training programmes is part of the project cost that includes institutional strengthening, capacity building and training whilst TPGL attendance will be from counterpart support, and the contractor will factor in their attendance within the contract amount.

Table 10-4: Training Modules for Proposed Plant

Session/Theme	Required Attendees/Recipients	Delivery Mode/Duration	Training Delivered by	Estimated Cost ($)	Budget Source
Introduction to ADB's Safeguard Policy Statement (2009), IFC EHS Guidelines, GoI/GoT requirements, and Project EMP including EMoP	PMU, PIU, Contractors Management and Environment Safeguards Staff	In Person/1 day	International Environment and H&S Experts of PMC/PIC	2000	PMC/PIC Budget
EMP implementation for detailed design	PMU, PIU, Contractors Management, Detailed Design, and Environment Safeguards	In Person/1 day	International Environment and H&S	4000	PMC/PIC Budget

Session/Theme	Required Attendees/Recipients	Delivery Mode/Duration	Training Delivered by	Estimated Cost ($)	Budget Source
	Staff		Expert of PMC/PIC ADB TA Air Quality and Noise Specialists		ADB TA Budget
Facilitated H&S Workshop (Design Stage)	PMU, PIU, Contractors Management, Detailed Design, and Environment Safeguards Staff	In Person/1 day	International H&S Expert of PMC/PIC	1000	PMC/PIC Budget
GRM operation (initial run at start of project, and then again on handover to operational staff)	All GRM levels-GRC, PMU, PIU, Contractors Management and Environment Safeguards Staff, GRM Focal Points, Local Government Representatives	In Person/1 day (Two sessions)	International Environment Expert of PMC/PIC	4000	PMC/PIC Budget
EMP implementation for pre-construction and construction, including workshop on CEMP preparation	PMU, PIU, Contractors Management, Site Engineers and Environment Safeguards Staff	In Person/2 days	International Environment and H&S Experts of PMC/PIC	4000	PMC/PIC Budget
Facilitated H&S Workshop (Construction Stage)	PMU, PIU, Contractors Management, Site Engineers and Environment Safeguards Staff	In Person/1 day	International H&S Expert of PMC/PIC	1000	PMC/PIC Budget
Biodiversity awareness training	PIU, Contractors Site Staff, Environment Safeguards Staff	In Person/0.5 day	International Environment Expert of PMC/PIC	500	PMC/PIC Budget
Site supervision and monitoring including use of detailed monitoring framework (checklists) and preparing period Environmental Monitoring Reports (initial run at start of project, and then again on handover to operational staff)	PMU, PIU, Contractors Management and Environment Safeguards Staff	In Person/2 day (Two sessions)	International Environment and H&S Experts of PMC/PIC	8000	PMC/PIC Budget
Site restoration	PMU, PIU, Contractors Site Staff, Environment Safeguards Staff	In Person/0.5 day	International Environment Expert of PMC/PIC	500	PMC/PIC Budget
EMP implementation for O&M, including workshop on ESMS preparation	TPGL Operational Staff	In Person/2 days	International Environment and H&S Experts of PMC/PIC ADB TA	8000	PMC/PIC Budget ADB TA Budget

Session/Theme	Required Attendees/Recipients	Delivery Mode/Duration	Training Delivered by	Estimated Cost ($)	Budget Source
			Power Plant ESMS Consultants		
Facilitated H&S Workshop (Operation Stage)	PMU, PIU, Contractors Management, TPGL Operational Staff	In Person/1 day	International H&S Expert of PMC/PIC	1000	PMC/PIC Budget
		Total Training Budget		**34,000**	

Source: ADB TA Consultant

5. EMP Implementation Budget

696. Costs will be associated with implementation of the mitigation plan, EMoP and capacity building and so necessary budget provisions need to be planned and allocated by TPGL to ensure satisfactory implementation of the EMP. The main EMP budget items have been identified for implementing the environmental management and monitoring and capacity building activities required, and an indicative budget allocated for each. The breakdown is shown in Table 10-5 supported by Table 10-4 in relation to training activities and Table 10-6 in relation to quantitative EMoP activities.

697. The budget in Table 10-6 will be refined during implementation, but the indicative budget enables financial requirements to be prepared. For contract related costs these are only an estimate based on an estimate of the construction and installation cost, since the contracts are subject to competitive bidding it will be for the contractor/consultants to reflect in their BOQ and ensure adequate budget is provided in their bids for the EMP implementation.

698. The EMoP budget is provided in relation to the quantitative monitoring activities required to assess the effectiveness of EMP implementation as per **Annexure 30**. The construction EMoP will be part of the Contractor's contract, whereas the operational EMoP will be the responsibility of TPGL O&M team. EMoP costs are provided in Table 10-6. If the construction period extends beyond 36 months, then the budget will need to be increased prorate. Operational cost is an annual cost, it will be incurred annually for each year the proposed plant is in operation.

Table 10-5: Indicative budget for EMP Implementation

Item	Quantity	Estimated Rate ($)	Estimated Cost ($)	Budget Source
Construction Phase				
TPGL Safeguard Unit during construction for 36 person months full-time	x 3 safeguard officers	65,000 per officer	195,000	TPGL Counterpart
PIC Safeguard Specialists	12 person months x 4 senior specialists plus logistics	96,000 per person	384,000	PMC/PIC Budget
	36 person months x 2.25 specialists full time on site	108,000 per person	243,000	
External Environmental Monitor 36 months construction	x 1 external expert plus logistics	40,000 per year	160,000	TPGL Counterpart
ADB TA Consultant Support (Noise Expert, Air Quality Expert, ESMS Expert etc.)	4 person months input	Lump sum	80,000	ADB TA
Contractors Safeguard Officers for 36 person months	x 2 senior safeguard officers	252,000 per person	504,000	Construction Contract/BOQ
	x 3 safeguard officers	108,000 per person	324,000	
Hydrogeological assessment	Once before approval of detailed design	Lump sum	60,000	TPGL Counterpart
Revised assessment for detailed design (noise, air quality etc.)	Once before approval of detailed design	Lump sum	30,000	Construction Contract/BOQ
Contractor's general EMP implementation cost (including PPE provision, blacktopping of access road etc.)	Estimated as 2.5% of the contractor's civil works[144]	Lump sum	453,750	Construction Contract/BOQ
Air quality mitigation	Increase in stack height above GOI requirements to meet SPS 2009 requirements	Lump sum	200,000	Construction Contract/BOQ
Noise mitigation	Additional design reuirements to meet SPS 2009 requirements	Lump sum	210,000	Construction Contract/BOQ
Continuous stack emission monitoring system installation	HRSG and Bypass (when operated)	20,000	40,000	Construction Contract/BOQ
Continuous wastewater monitoring system installation	Process water and sanitary sewage effluent	20,000	40,000	Construction Contract/BOQ
Compensatory reforestation	249 to be felled. To replant 2490 (10:1)	Lump sum	50,000	TPGL Counterpart
Construction environmental monitoring/laboratory tests	36 months	Refer Table 10-6	113,000	Construction Contract/BOQ
Training and capacity building	Training program	Refer to	34,000	PMC/PIC Budget

[144] Estimated Construction Cost from DPR Rs. 1,362 million ($18.15 million) including Rs. 10 million ($132,585) for environmental engineering and Rs. 15 million ($198,878) for greenbelt plantation and landscaping of the proposed plant

Item	Quantity	Estimated Rate ($)	Estimated Cost ($)	Budget Source
		Table 10-4		ADB TA Budget
Ongoing Consultation, GRM Implementation, including COVID-19 Precautions for Consultation or GRC Meetings to cover ad hoc cost of printing leaflets, purchasing masks and hand sanitizers for consultees, hire of venue or food purchase etc.	Estimated lump sum	3,000	3,000	TPGL Counterpart Fund
		Construction Sub Total	**3,123,750**	
		Contingency @ 10%	**312,375**	
		Total Budget	**3,436,125**	
Operation Phase (annual cost)				
TPGL Safeguard Unit during operation for 12 person months full-time (annual cost repeats)	x 2 safeguard officer	35,000 per officer	70,000	TPGL Operational Cost (annual)
External Environmental Monitor	x 1 external expert	40,000 per year	40,000	TPGL Counterpart (annual until completion of decommissioning of existing plant)
Operational environmental monitoring/laboratory tests (annual cost repeats)	12 months; quarterly	Refer to Table 9-6	60,200	TPGL Operational Cost (annual)
		Operation Sub Total per Year of Operation	**170,200**	
		Contingency @ 10%	**17,020**	
		Total Budget per Year of Operation	**187,220**	

Note: conversion at 1$ = INR 73.00
Source: ADB TA Consultant

Table 10-6: Environmental Monitoring Budget

Parameters as per EMoP (Annexure 30)	Monitoring Locations	Rate $	Quantity	No. of Quarters	Total in $
Construction Phase (Contractor)					
Noise 48 hourly monitoring of LAeq1hr, LAmax Quarterly for 36 months construction period	5no. per baseline locations: 1. Nearest House 2. Manikyanagar (NV4) 3. Boundary East 4. Boundary West 5. School	200	5	12	12,000
Ambient air quality PM_{10}, $PM_{2.5,}$ NOx, SO_2 and CO as 24-hourly Quarterly for 36 months construction period (dust monitoring at nearby properies is also required)	4no. per baseline locations: 1. Existing Plant (AAQ1) 2. Manikyanagar (AAQ4) 3. Nearest House (PM10 and PM2.5 only) 4. School (PM10 and PM2.5 only)	400	4	12	19,200
Stack emission tests: manual using stack monitoring kit pr CBCP guideline for stack parameters and NO_x Semiannually for 36 months construction period	DG stacks For purposes of costing assume 1no.	300	1	6	1,800
Drinking water quality for potability – parameters as per ISO 10500 2012 quarterly for 36 months construction period	Supply water used for workers (unless purchased from licensed vendor) For purposes of costing assume 1no. water supply point tested before and after treatment	500	2	12	12,000
Effluent discharge (sedimentation and septic tanks etc.) - pH, TSS, DO, BOD, COD, total coliforms, oil and grease, total nitrogen, phosphorus, sodium absorption ratio, boron	Discharge point of sedimentation and septic tanks etc. For purposes of	400	3	12	14,400

Parameters as per EMoP (Annexure 30)	**Monitoring Locations**	**Rate $**	**Quantity**	**No. of Quarters**	**Total in $**
quarterly for 36 months construction period	costing assumed 1no. sedimentation tank for surface runoff and 2no. septic tank used				
Ground water depth and quality – parameters as per ISO 10500: 2012 quarterly for 36 months construction period	4no. location 1. Borewell for existing plant 2. New borewells for proposed plant 3. Manikyanagar borewell (used for the school) 4. Nearest House borewell	500	4	12	24,000
Soil quality as per baseline parameters including hydrocarbons Semiannually for 36 months construction period	4no. locations in construction site (related to storage areas etc.)	400	4	6	9,600
Ecology surveys on completion of construction	Rokhia Thermal Power Station	20,000	1	1	20,000
			Construction Phase Budget		**113,000**
Operation Phase (TPGL)					
Noise 48 hourly monitoring of LAeq1hr, LAmax Monthly for first year, then revert to quarterly	5no. per baseline locations: 1. Nearest House 2. Manikyanagar (NV4) 3. Boundary East 4. Boundary West 5. School	200	5	12	12,000
Ambient air quality Costed for continuous air quality (real time) monitoring system (CAMS) for NOx Minimum is seasonal monitoring (4no. seasons with 1 week per season) for NO_2 using continuous monitoring methods or, alternatively,	3no. per baseline locations: 1. Existing Plant (AAQ1) 2. Manikyanagar 1 (AAQ4)	10,000	3	n/a as continuous	30,000

Parameters as per EMoP (Annexure 30)	**Monitoring Locations**	**Rate $**	**Quantity**	**No. of Quarters**	**Total in $**
the use of passive techniques (diffusion tubes) with tubes deployed and changed monthly	3. Manikyanagar 2				
Continuous Emission Monitoring System (CEMS) (NO_x and CO required plus PM, SO_2 and UHC)*	HRSG stack and Bypass stack when operational	20,000 Installation cost	2	n/a as continuous	40,000 Included in contract cost
Stack emission tests: manual using stack monitoring kit pr CBCP guideline for operational stack parameters, NO_x and CO and VOCs Semiannual testing	HRSG stack, Bypass when operational, Back up DG stack	300	3	2	1,800
Drinking water quality for potability quarterly – parameters as per baseline (ISO 10500 2012) Quarterly testing	Supply water used for workers; assume 1no. source tested before and after treatment	500	2	4	2,000
Effluent discharge Process water (real time effluent quality monitoring system (RT EQMS) as per CPCB Guidelines 2014 - continuous monitoring)* – pH, TSS, BOD, COD, TOC, NH3 plus temperature, flow and conductivity) Sanitary sewage effluent (RT EQMS – continuous monitoring)* - pH, TSS, BOD, COD, TOC plus temperature, flow and conductivity)	Inline continuous monitor on process water and sanitary sewage effluent streams For purposes of costing assume 1no. process stream and 1no. sanitary sewage stream	20,000 Installation cost	2	n/a as continuous daily recording	40,000 Included in contract cost
Effluent discharge Process water (quarterly sampling) – temperature, pH, TSS, BOD, COD, residual chlorine, oil and grease, Cr, Cu, Fe, Zn, Pb, Cd, Hg, As Sanitary sewage effluent (quarterly sampling) - pH, TSS, DO, BOD, COD, total coliforms, fecal coliforms, oil and grease, total nitrogen, phosphorus	For purposes of costing assume 1no. process stream and 1no. sanitary sewage stream	400	2	4	3,200
Ground water depth and quality – parameters as per ISO 10500: 2012 quarterly for 36 months construction period	4no. locations 1. Borewell for existing plant 2. New borewells for proposed	500	4	4	8,000

Parameters as per EMoP (Annexure 30)	Monitoring Locations	Rate $	Quantity	No. of Quarters	Total in $
	plant 3. Manikyanagar borewell (used for the school) 4. Nearest House borewell				
Soil quality as per baseline parameters including hydrocarbons Semiannually	4no. locations in Rokhia Thermal Power Station (related to storage areas, transformer yard, existing plant upon decommissioning etc.)	400	4	2	3,200
		Operation Phase Budget			**140,200 Of which 80,000 is installation cost for contract 60,200 is recurring annual cost**

* Environmental data of proposed plant to go directly online to Tripura Pollution Control Board/MoEF&CC
Source: ADB TA Consultant

XI. CONCLUSION AND RECOMMENDATIONS

A. Conclusions

699. TPGL will develop a more efficient CCGPP at Rokhia, Manikyanagar, Tripura (the proposed plant) with a net generation capacity of about 120 MW as a replacement for the existing 63 MW OCGPP (the existing plant). Decommissioning of the existing plant will be undertaken by TPGL following commissioning of the proposed plant and will be a condition of ADB's proposed loan. Although the decommissioning works themselves are outside the scope of the ADB project, they are associated with it and ensuring project benefits are realized. TPGL need to ensure it is done in a timely and environmentally safe and sound manner. Tentatively it will be decommissioned by 2027 subject to construction of the proposed plant running to schedule. There is an existing GCS which will be tapped and a switchyard to which the proposed power plant will connect, the former is operated by ONGC and the latter by TPGL. Environmental audit of these existing facilities found some non-compliances to national laws and regulations and good practice EHS guidelines -- inadequate housekeeping and waste management, oil leakage, lack of PPE, inadequate first aid and fire safety, etc.

700. EIA was conducted by analysis of the initial design of the proposed plant, baseline data analysis, impact scoping, qualitative and quantitative assessment and evaluation of severity, importance, and significance. Modelling was undertaken to inform the air quality, noise, and risk-hazard assessment. The EIA was also informed by two rounds of consultation held, one at scoping stage (reflecting the preliminary design and potential impacts) and the other at the draft EIA stage (reflecting the assessment outcomes). The process documented in this EIA and its outcomes enable the following conclusions and recommendations to be reached in respect of the environmental impacts and risks of the proposed plant based on an indicative design, already updated from the initial design of TPGL to incorporate noise mitigation. Mitigation measures have been identified for adoption during construction and operation to minimize those that were predicted to be significant. The EIA will need to be updated following detailed design by the EPC Contractor to demonstrate their final layout and design will comply with the standards and measures set out in the EIA and will not have less or the same impact than presented in the EIA report.

701. The study area is rural with main occupation being agriculture, rubber plantation and brick manufacturing. Nearby villages, including Manikyanagar, have basic rural infrastructure and use ground water for domestic use. The project site is owned by TPGL and therefore no resettlement impacts are involved. The study area is well connected with highways although off the national highway village roads are narrow and have low traffic flows. There is a road passing through the existing Rokhia Thermal Power Station, this is a private access road of TPGL, but which is permissively used by the local communities. This will be temporarily barricaded for the 36-month construction period but will not have any impacts on livelihoods.

702. The 4.5 ha project footprint comprises two offices buildings and an ancillary building taking up less than 1% (645m^2) which will be demolished. No asbestos was seen to be present in these buildings although this will be reconfirmed by a competent surveyor employed by the EPC Contractor prior to their demolition. There will be clearance of ground vegetation and cutting of shrubs and 249 trees across the remaining 99% of the project footprint. The project site is located at about 10.5 km from Sipahijila Wildlife Sanctuary (incorporating Clouded Leopard National Park) and there are no protected areas, Ramsar wetlands, key biodiversity areas, notified forest areas, or other areas of biological importance found adjacent to the project site or proposed access routes, and neither will any such areas be indirectly impacted. The

study area includes critical habitat for Phayre's leaf monkey as their range extends from Sipahijila Wildlife Sanctuary up to about 2.5km from the proposed plant. However, no species of higher conservation value (vulnerable, endangered, or critically endangered as per their IUCN conservation status) were recorded at the project site during ecological survey work, although it was reported by the Forest Department that the globally vulnerable, nationally protected capped langur (*Trachypithecus pileatus*) may use the area around the proposed plant on occasion. The project site, existing plant site, and existing staff accommodation area was observed during site visits to be used by Rhesus macaque (*Macaca mulatta*), which are globally least concern and not a nationally protected species. The nearest known archaeological or heritage site is the Boxarnagar Buddhist Stupa at a distance of 3.15 km from the project site which is an Archaeological Survey of India protected monument. Post-mitigation impacts on the biological environment and physical cultural resources are predicted to be not significant. In accordance with ADB's Safeguard Policy Statement 2009 natural habitat safeguard requirements habitat loss will still be compensated for to ensure no net loss of biodiversity because of construction and chance find procedures will be adopted to avoid unanticipated damage to any physical cultural resources.

703. Disruption and disturbance to the local community and impacts and risks related to pollution, health and safety during construction are expected to be significant prior to mitigation but will be temporary in nature with adverse impacts generally restricted to within about 500 m of the project footprint, along the access routes, and immediately adjacent. The residual significance of these temporary construction related impacts will be much reduced. However, construction impacts related to the physical environment that will be permanent include changes in topography and terrain with levelling of hillocks with an estimated cut volume of up to 334,092 m^3, soil structure and fertility loss, and landscape and visual aesthetics; although mitigation measures are provided to reduce the extent of the impact as far as practical these are unavoidable significant impacts if the 4.5 ha project site is to be developed for the proposed plant.

704. Pre-mitigation, the proposed plant's operation was assessed to generate some significant adverse impacts mostly in relation to use of natural gas as a fossil fuel, noise and vibration, water consumption, and occupational and community health and safety aspects. Through mitigation measures incorporated into the design of the proposed plants the residual significance of operational impacts will be much reduced. With a NO_x emission standard of 25 ppm, and a proposed 60 m HRSG main stack (combined cycle) and 30 m Bypass stack (open cycle), the proposed plant emissions alone (i.e., the process contribution) were predicted to contribute less than 1% of the recently revised annual mean WHO guideline (2021) level for nitrogen dioxide (NO_2) of 10 $\mu g/m^3$ at relevant receptor locations, and less than 10% of the daily and hourly mean WHO NO_2 guideline levels of 25 $\mu g/m^3$ and 200 µg/m3, respectively. Mitigation methods, such as temporary noise barriers, and considerate construction phasing are demonstrated to be able to reduce construction noise impacts to a post-mitigation level that is not significant. Post mitigation, the operational noise level from the proposed plant alone will comply with the GOI standard and WHO guidelines of 45dB(A) and is anticipated to be no more than 2.7 dB(A) above the ambient levels at the nearest receptors. TPGL will ensure that its abstraction of ground water for the proposed plant does not compromise the local water supply so that impacts are not significant. The plant will generate process effluence and sanitary sewage but will be zero discharge with the treated wastewater used for site irrigation. There is a fire and explosion risk associated with the use of natural gas; quantitative risk-hazard modelling has shown this risk does not extend beyond the Rokhia Thermal Power Station or put the adjacent school at risk.

705. The proposed plant is 52.31% efficient (gross) and calculated to emit 330,704.9 tons CO_2 emissions per annum. Due to limited availability of water, an air-cooled condenser must be used, this reduces the efficiency of the proposed plant's steam cycle compared to what can be achieved with water cooled condenser (54.7 % to 56.9%) but for the type of condenser being used the efficiency is in line with international good practice for a 120 MW CCGPP. As GHG emissions are very large the residual climate change impacts from the power plant alone and the use of natural gas as a non-renewable resource over 25 years of operation will remain significant post-mitigation. However, if the existing plant is decommissioned by TPGL no additional natural gas will be consumed and so there is a saving (offset) of 27,320.51 tons CO_2 per year due to the generation efficiencies of the proposed plant compared to the existing plant. Further, replacement of the existing plant by the more efficient proposed plant which generates additional MW will support GoI in meeting its commitment towards its NDC targets through improving energy intensity and diversification of the energy sources from existing coal-based fossil fuel. This will offset additional CO_2 per year in relation to energy sourced from the grid in the short term whilst India transitions its energy generation away from coal. Longer term, as the existing plant reaches the end of its lifespan, and grid efficiency improves using a commercial market-based, nature-based solution mechanism to offset these GHG emissions is economically feasible; at current rates of \$5 to \$15 per ton of CO_2 it cost up to \$4 million per year.

706. Provided the mitigation measures set out in the EMP are implemented as planned, and standards and measures are adhered to the residual significance of the impacts will be much reduced. The EIA including the EMP are considered sufficient to meet the environment safeguard requirements of ADB for the proposed plant.

B. Recommendations

707. The EIA report with its executive summary translated into local Bengali language will be made available in hard copy at TGPL's Agartala Offices and at the Rokhia Thermal Power Station; it will be disclosed to a wider audience via the TPGL (TSECL) and ADB websites. The consultation process commenced during the EIA will be continued during project implementation to ensure that affected persons and other interested stakeholders are fully engaged and can participate in implementation of the proposed plant. Advance notice will be provided to local communities about the private access road closure, commencement of works, high noise activities, major periods of traffic movement, and transport of oversized vehicles. To address grievances that may arise from affected persons in the local community and workforce a Grievance Redress Mechanism will be established by TPGL, the details of which will be disseminated during the future consultations with GRM focal points – name, designation, contact numbers, address plus the timeline and process of redressal to be displayed at the project site by the EPC contractor/TPGL.

708. TPGL and the EPC contractor will comply with all applicable national and state environment, health, and safety (EHS) regulatory requirements, ADB's SPS 2009, the World Bank-IFC EHS general guidelines and the sector guidelines for Thermal Power Plant. The EMP sets out the measures to avoid, minimize, mitigate, and offset the predicted environmental impacts of the proposed plant during construction and operation, including emergency response procedures, as well as decommissioning of the existing plant and a corrective action plan for the existing facilities. Presently, TPGL does not have an existing environment, health and safety policy or procedures and they lack safeguards capacity and experience in EMP implementation. Environment, health and safety management at the existing plant requires significant improvement. Effective implementation of the EMP and ensuring compliance with national laws

and regulations needs a suitable organizational set up and adequate safeguards capacity to be established at TPGL. Department of Power, Government of Tripura will be the executing agency (EA) and TPGL the implementing agency (IA) for the plant. TPGL will establish a project management unit (PMU) headed by an In-Charge (General Manager-Technical) at TPGL's Agartala Office and a project implementation unit (PIU) headed by a Plant Manager (Deputy General Manager level–Electrical/Mechanical) at the project site for day-to-day implementation; a project implementation consultant (PIC) will provide these units with implementation support. A Safeguard Unit will be established as part of the PMU and PIU to support EMP implementation, supervision, and monitoring. This will be staffed with a suitably qualified and experienced Environmental and Social Safeguard Officer at PMU level having 15+ years of environment safeguards experience, and two suitably qualified and experienced officers at PIU level with 5-7 years of experience in environment safeguards, and 7-10 years of experience together with professional certification for health and safety, respectively. The PMC will include a Senior Environment Consultant, a Senior Health and Safety Consultant with professional certification, a Senior Ecologist, a Senior Labor Consultant and on-site support. Once operational, the TPGL power plant operations team shall comprise an environment officer and a health and safety officer (with professional certification) both with 12-15 years of experience. Further, the EPC Contractor will be required to have suitably qualified and experienced, dedicated on-site counterpart staff including an Environment Manager, a Health and Safety Manager with professional certification supported by several Health and Safety Supervisors, an ecologist, a labor officer, and a community liaison officer. During pre-construction and construction capacity building by the PIC will be required for the engineering staff of the PMU and PIU and the EPC Contractor responsible for the implementation of the EMP on a day-to-day basis; they will be trained as set out in the EMP on the environmental, health and safety (EHS) impacts and risks and their management. The PIC and EPC Contractor will also support capacity building and training for operational staff.

709. EMP implementation will be assured by a program of environmental supervision and monitoring to be conducted throughout project implementation by the TPGL PMU/PIU who will report any unanticipated impacts or requirements for corrective action during implementation to ADB. Budget of about $3.45 million is required for EMP implementation during construction, during operation the annual EMP implementation cost will be about $0.2 million. Reporting to ADB will be through quarterly project progress reports with environment monitoring reports submitted semi-annually by TPGL up until decommissioning of the existing plant has been completed or the project completion report is issued, whichever comes later. During project implementation, state regulators such as the Tripura Pollution Control Board will also monitor implementation of mitigation measures as per regulatory requirements to ensure national environmental clearance and other permit and license requirements are being met by TPGL and the EPC Contractor.

710. Finally, the EIA report will need to be reviewed and updated following the EPC Contractor's detailed design. In case any unanticipated impact (including a scope or design change such as any deviation from those parameters presented in this EIA report) occurs during any stage in the project implementation, the EIA and EMP will be updated by TPGL and submitted to ADB for review and clearance before any related works commence or are cleared to continue.