Draft EIA: Onshore Oil and Gas Exploration and Appraisal in Block AAONHP-2017/11 in Jorhat and Golaghat Districts of Assam

Vedanta Limited (Division: Cairn Oil & Gas)

October 2019

Quality information

Prepared/Compiled by	Checked by	Verified by	Approved by
Debsagar Das Moudipta Banerjee Consultant I	Souvik Basu Environmental Co-ordinator	Avijit Sarkar Associate Director	Chetan Zaveri Executive Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	01/10/2019	Draft EIA: Onshore Oil and Gas Exploration and Appraisal in Block AAONHP-2017/11 in Jorhat and Golaghat Districts of Assam.		Chetan Zaveri	Executive Director

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Prepared for:

Vedanta Limited

(Division: Cairn Oil & Gas)

DLF Atria, Phase 2, Jacaranda Marg,

DLF City, Gurgaon 122002

Prepared by:

AECOM India Private Limited

19th Floor, Building No.5

Tower C, Cyber City

Gurgaon 122002

Haryana, India

CIN: U74210KA2005PTC037770

T: +91 124 4682700/800

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Executive Summary

Introduction

Vedanta Ltd. (Division: Cairn Oil and Gas) has been allocated hydrocarbon Block namely AA-ONHP-2017/11 by Government of India under the revenue sharing contract (RSC) for exploration and exploitation of hydrocarbon. RSC (Revenue Sharing Contract) has been signed between Vedanta Ltd and MoP&NG on 1st October 2018 for the exploration and exploitation of hydrocarbons. Vedanta Limited (Division: Cairn Oil and Gas) proposes to drill 11 exploratory (including appraisal) wells within the Block boundary of AA-ONHP-2017/11. The Block encloses an area of 785 Sq. Km.

Vedanta Ltd. (Division: Cairn Oil & Gas) proposes to carry out exploration, and appraisal well drilling and early production of oil and gas in the Block AA-ONHP-2017/11. In case of a discovery (ies), the exploratory and appraisal well(s) would be tested for extended duration by flowing hydrocarbons to ascertain the reservoir parameters and assess the quality and commercial viability. The exploratory and appraisal wells would be drilled to explore the reservoirs in the range of 4500 m to 5500m.

The proposed exploratory and appraisal drilling activities fall under category 1(b) of the EIA Notification, 2006 and require Environmental Clearance (EC) from the Ministry of Environment and Forests and Climate Change (MoEF&CC). The Terms of Reference (ToR) for the Project have been approved by MoEF&CC vide letter F. No.IA-J-11011/132/2019-IA-II(I) dated 4th May 2019.

AECOM India Private Limited, a NABET-QCI Accredited firm has been entrusted to conduct the Environmental Impact Assessment (EIA) study for the proposed Block AA-ONHP-2017/11. The EIA study comprised of initial scoping, site visits, environmental monitoring and surveys, conduct of Public Hearing (PH) and the preparation of draft and final EIA-EMP reports.

Block location and Accessibility

The AA-ONHP-2017/11 Block is located at Deragaon, Golaghat and Sarupathar Tehsils of Golaghat and Jorhat west Tehsil of Jorhat districts, of Assam. The Block is accessible through road network. NH 37, SH 34, SH 32, SH 33 and SH 1 is present within the block. Jorhat railway station is 4.82 km east from the eastern block boundary. Jorhat Airport is 0.76 km east from the eastern block boundary.

Land Requirement

During the site selection process, all legal requirements would be considered and surface location of the exploratory well would be finalized. Once surface drilling location is finalized, short term lease of the land would be taken from concerned owners. If well location falls in agricultural lands or other private lands, land and crop compensation would be provided to the land owner, and in case of government. land, land allotment from government would be applied. Initially temporary short-term lease would be taken for 3 - 5 years for exploration purpose and in case of commercially viable discovery of hydrocarbon resources; the land lease would be converted into long term lease up to life of the project. The estimated land required per drill site is approximately 9 ha. No forest land would be used for drilling purpose, so forest clearance is not applicable for the proposed project.

Description of the project

The project includes proposed drilling of 11 onshore exploratory and appraisal wells and Setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) for produced well fluid processing and production up to 8000 BOPD crude oil and up to 1.6 MMSCFD associated natural gas in AA-ONHP-2017/11 Block located in Jorhat and Golaghat Districts of Assam. Block Location on SOI Toposheet is presented below.

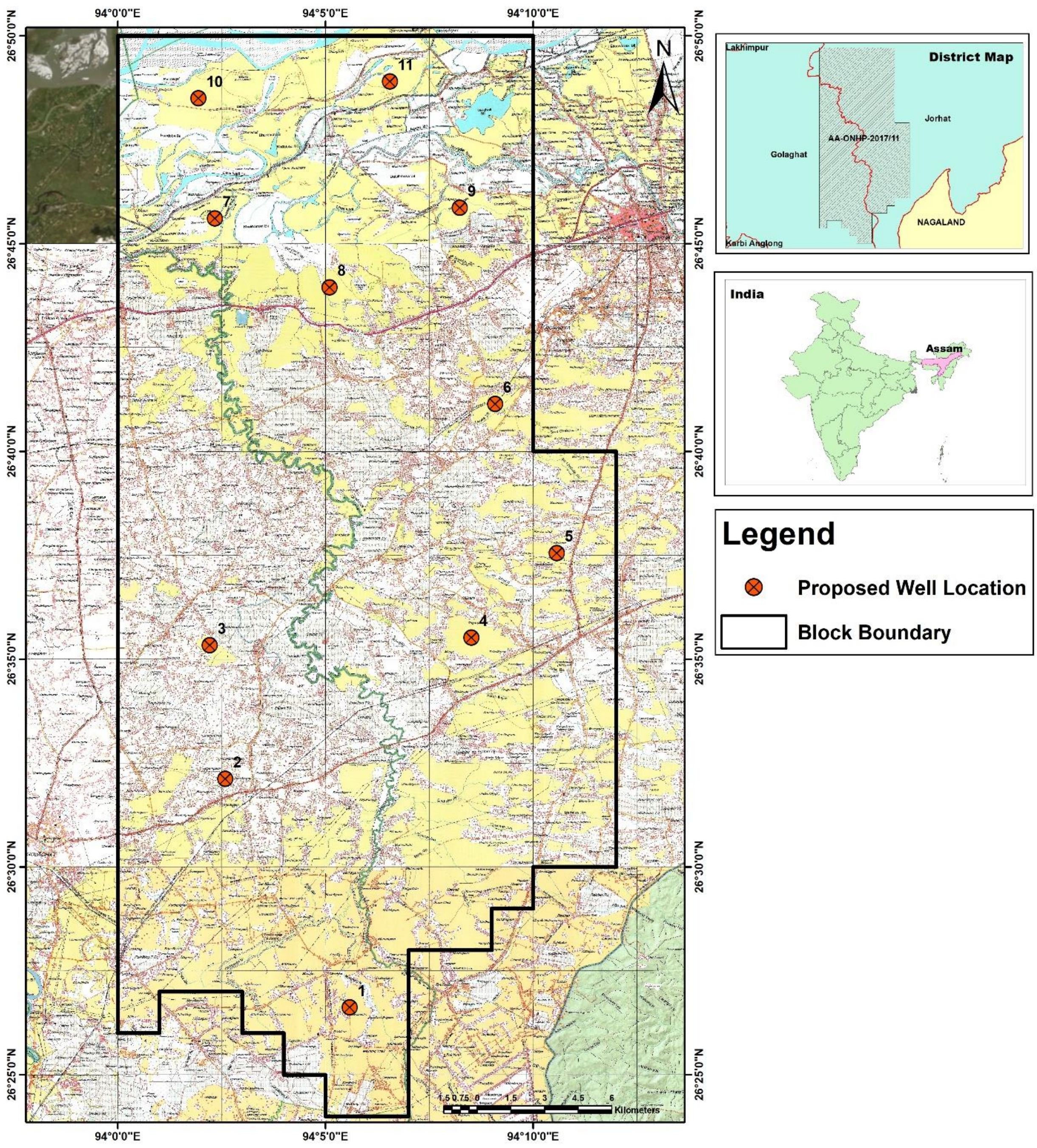

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Map Showing Block Boundary and Well Location on Toposheets	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth,Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital, Globe, GeoEye,Earthstar Geographics,CNES/ AirbusDS,USDA, USGS,AeroGRID, IGN,and theGIS User Community.	

Drill Site Preparation

Drill Site Selection

An initial assessment of the exploratory well site would be carried out through analysis of satellite imageries. Field surveys would be carried out to earmark the drill site location maintaining maximum possible distance from any settlement and sensitive receptors. Ease of accessibility to the site would also be considered.

Site Preparation

Detailed site surveys would be carried, and the boundary of the drill site earmarked. Site levelling, and excavation works would be carried out for site preparation. Individual sites would be duly fenced. New approach roads to drill sites would be constructed or existing village roads would be strengthened to provide access for the drilling equipment and machinery. If the earmarked site has vegetation cover, clearance of vegetation is the first activity that would be undertaken during drill site construction. Following this, the preparation and construction of drill site would involve top soil scraping and storage for future use, elevating the drill platform by excavated material from the drill site and authorized quarry area. Reinforced Cement Concrete (RCC) platforms would be used as foundation for drill pad and all other heavy equipment systems or machinery. Cast in-situ bored under-reamed piles of specified lengths would be used as foundation for main rig structure. Additionally, there will be other ancillary facilities of a Drilling mud system, Effluent Treatment Plant (ETP), Cuttings disposal, Drill Cementing equipment along with utilities to supply power (DG sets), water and fuel (HSD) and provision of proper garland drains for storm water with sufficient gradient.

Rig Mobilization

After completion of the construction/site preparation activities and with the provision of the basic facilities, drill rig would be transported to the site. The drill equipment is designed as standard land rig or a “Mobile Land Rig” type, which facilitates quick mobilization and demobilization. Rig essentially comprises of a Drilling mud system.

Drilling Operation

A rig would be installed at the potential site of drilling after thorough inspection for its working capability and quality standards. Well spudding would be the start of drilling activity. Wells would be drilled in sections, with the diameter of each section decreasing with increasing depth. Before commencing the actual drilling, large diameter pipe (Conductor) would be lowered into a hole and cemented/grouted. Top-hole section would be drilled to a desired depth based on well design. After drilling top-hole section, it would be cased with a pipe called “Casing”. Once each section of the well is completed, the drill string is lifted, and protective steel pipe or casing lowered into the well and cemented into place. The lengths and diameters of each section of the well would be determined prior to the starting of the drilling activities and are dependent on the geological conditions through which the well is would be drilled. This process of drilling and casing the hole section continues until the final well depth (target) is achieved.

Drill cuttings generated from the drilling activity, would be collected and separated using a solid control system and temporarily stored on-site in HDPE lined pits. Drilling and wash wastewater generated would also be stored at an onsite HDPE lined pit. The waste water would be adequately treated in a mobile ETP to ensure conformance to the S No. 72 A (ii) Schedule I - Standards for Emission or Discharge of Environmental Pollutants from Oil Drilling and Gas Extraction Industry of CPCB.

Hydraulic Fracturing Activity

Hydraulic fracking may be conducted in wells with low permeability formation and the wells with low pressure. Fracking fluid would typically be 99% water and sand (or other granulated material) and approximately 1% gelled chemicals that would be pumped at a high rate (in excess of 20 bpm) and high pressure (up to 5000 psi) to fracture the formation and improve the well deliverability. Sites for the wells with more than 2 fracs per well (multi-stage fracturing) would have provision of additional space for water storage for better continuity of operations.

Well Testing & Flaring

During the exploration and appraisal drilling, where a hydrocarbon formation is found, initial well tests (generally about one month of duration) would be carried out to establish flow rates, formation pressure and other parameters. However, depending on the need, based on nature of the reservoirs, the exploratory and appraisal wells would be tested for longer/extended durations to ascertain the reservoir parameters.

Associated Facilities

Each drill site would be provided with facilities such as drilling rig foundation and cellar pit, waste and water storage pits, chemical storage area including fuel storages, drill cutting disposal pit, flare pit and Mobile STPs. The drill cutting and spent mud disposal pits would be provided with a HDPE lining for temporary storage. Adequate drainage system for storm water and wastewater would be provided.

Liquid Mud Plant (LMP)

The Liquid Mud Plant (LMP) would be located at suitable location in the field to prepare synthetic/water-based mud for the drilling operations.

Appraisal

When, exploratory drilling is successful, more wells (termed as Appraisal wells) would be drilled to determine the size and the extent of the field. The technical procedures and activities in appraisal drilling would be the same as those employed for exploration wells deviated or directional drilling at an angle from a site adjacent to the original discovery well may be used to appraise other parts of the reservoir.

Quick Production Unit (QPU)

In case of commercially viable discovery, QPUs would be installed for the processing of produced well fluid processing and early production of up to 8000 BOPD crude oil and up to 1.6 MMSCFD associated natural gas for captive power generation. A QPU would be a packaged/ modular mobile unit and would mainly consist of a three-phase separator & production heater or heater-treater, oil storage tanks, oil tanker loading system, produced water (PW) separation and disposal system, power generation (GEG or DG), utility systems such as fuel gas, flare & Inst. Air packages, firefighting equipment, etc. Each QPU capacity would be ~2,000 BFPD (Barrels of Fluid per Day).

Accommodation and Camp Site

Temporary camp site (porta cabin) for the drilling of exploratory (including appraisal wells) are envisaged, which would be dismantled after drilling of the wells. At any point of time, it is anticipated that about 50 personnel per shift would be housed in the campsite during the well drilling campaign.

Well decommissioning

After the completion of the drilling activity, partial de-mobilization of the drilling rig and associated infrastructure would be initiated. As discussed earlier, well testing may be carried out immediately after the drilling is completed. The complete de-mobilization of the facilities at site would happen once well-testing completed successfully. In case of commercially viable discovery (s) of hydrocarbons in the Block and having established the size of the hydrocarbon field (s), proposes to immediately bring the field (s) into production using one or more of the appraisal wells for the production of crude oil by setting up of QPU (Quick Production Unit). All other equipment, materials, fuel and wastes would be removed from the drilling site and reused for other drilling activities or disposed as per the applicable regulatory requirements.

If hydrocarbons are not found, a full abandonment plan would be implemented. All concrete or steel installations would be removed to at least 1m below ground level, to ensure that there would be no protruding surface structures. All waste from the site would be removed and the pits would be closed. The drill sites and camp sites would be restored to its original conditions or as required by the landowner.

Utilities and Resource Requirement

Water: Total of 102 m^3 per day fresh water would be required per well. From the total water, 22 m^3/day water would be used for mud preparations, 50 m^3/day would be required for drilling activities and 30 m3/day freshwater would be used for domestic purposes including drinking, washings and domestic use. In case, required water could not be sourced from locally available approved sources, ground water would be extracted after obtaining permission from CGWA/ State Govt. During early production, the installation of typical EPU/QPU unit water requirement for process, domestic consumption, greenbelt and miscellaneous use will be15-18 m^3/day.

Power – For a drilling site, the power would be provided through diesel generator (DG) sets (Camp site - 2x350 KVA (including one as standby), Drilling site - 3x1000 KVA (including one as standby) or 2X1850 KVA (1 Working + 1 Standby) depending on the rig capacity / availability during E&A drilling phase(including one as standby) as per rig requirement and Radio Room -2*x100 KVA (including one as standby).

For early production power requirement will be met through the State Electricity and or installation of Diesel/Gas Engine Generator (GEG) of 1 MW output using produced natural gas and a 500 KVA DG will be used as backup in emergency conditions.

Labour - It is anticipated that, at any given time, there would be about 80 - 100 personnel working on site including technical staff, drilling crew, security staff etc.

Project Cost

The cost of the proposed project has been estimated would be about INR 352 Crores.

Pollution Sources

Air emissions: Point source air emissions would be generated from DG sets. Fugitive emissions would occur from vehicles involved in the drilling operations, resuspension and from windblown dust from storage and staging areas within the drill site.

Noise & Vibrations: Noise and vibration would be generated due to operation of drilling rig, DG sets and vehicles.

Liquid wastes: During the drilling phase, approximately 30-40 m^3 per day of waste water would be generated from the drilling activity and 15-25 m^3 per day of domestic waste water would be generated from each drill site.

Drill cuttings & spent mud: Approximately 500 - 1500 Tons/well of drill cuttings from WBM, 250 – 750 Tons/well of drill cuttings from SBM and 250-500 Tons/well of spent mud would be generated per site.

Existing Baseline Environment of the Project Area

Baseline information about the Block was collated by review of other published literature, site surveys, stakeholder interactions and primary monitoring carried out during the period of March-May 2019 by a NABL Accredited Agency.

Sub-surface Geology

The Block is situated in Jorhat and Golaghat district. Geological set-up of both the district is represented by hilly tract and alluvial flood plain of River Brahmaputra. foot hill region is marked by the older terrace deposit. Two terrace surfaces have been identified as the Harmuti and Joyhing surfaces that represent high- and low-level terraces. These terrace deposits are characterised by undulating surface comprising boulders, pebbles of quartzitic and gneissic rocks with fine sand, silt and clay. The alluvial flood plain consists of younger and older alluvial deposits. It represents various sub-features, viz., palaeochannel, swampy/marshy land, river terraces, flood plains, point bars, channel bar and river channel.

Hydrology

Drainage pattern of Jorhat district is characterized by river Brahmaputra, and its tributaries like south Dhansiri, Bhogdoi and Kakodonga drain the district. The tributaries originate in Naga-Patkai range and flow northward to join the Brahmaputra River, almost at right angles which give rise to subparallel type of drainage.

The Golaghat district is underlain by Quaternary formation followed by Archaean group of rocks. The cumulative thickness of aquifer zones has the tendency to increase towards the north and in the south eastern parts, the thickness reverses considerably. Hydro-geologically, the district is proved to be very potential. Ground water occurs under water table to confined conditions

Hydrogeology and Groundwater Quality

The Golaghat district is underlain by Quaternary formation followed by Archaean group of rocks. The cumulative thickness of aquifer zones has the tendency to increase towards the north and in the south eastern parts, the thickness reverses considerably. Hydro-geologically, the district is proved to be very potential. Ground water occurs under water table to confined conditions.

Ground water in Jorhat district mainly present in under water table to semi-confined conditions in the near surface conditions and in the deeper horizon, under semi-confined to confined conditions. Depth to water level in the water table zone varies from 0.41 to 3.07 m bgl in the pre-monsoon period and 0.56 to 3.41 m bgl during post-monsoon period.

Total of 8 ground water samples have been collected and analysed for parameters as per IS: 10500:2012 standards. Concentrations of various heavy metals like mercury, arsenic, lead, barium, cadmium and selenium were found below detectable limits at all the sampling locations. Presence of Faecal Coliforms has not been observed in any of the water sampled.

Climate and Meteorology

The temperature in Golaghat district reaches around 42.0°C during the month of June. Summer is generally wet in nature with very humidity in the air. Whereas, winter experience very low temperature. The lowest temperature recorded in the month of January which reaches up to 2.2oC. Annual mean rainfall of 1239.2 mm throughout the year

Jorhat district, climate is classified as mesothermal wet climate with forest type of vegetation. January is the coldest month with temperature of 6.1°C. July and August are the hottest period with average monthly temperature of about 29°C.Whereas, winter experience very low temperature, particularly during night time. nThe lowest temperature recorded in the month of December which reaches up to 4°C.

Ambient Air Quality

Ambient air quality was monitored at 8 locations (for a period of 12 week - March to May'19). The PM_{10} values of all monitored locations were below were NAAQS value, the average value observed would be in the range of 52.98 - 61.09 µg/m^3, which is typical of the region, due to presence of huge vegetation and rainfall. The $PM_{2.5}$, SO_2, NO_x and NH_3, Ni values were in the range of 29.07 – 32.55 µg/m^3, µg/m^3, 6.52 – 6.95 µg/m^3 , 21.21 – 24.10 µg/m^3 respectively and are well within the National Air Quality Standards (NAAQS) and Ni was found at only AAQ 2 , for a week only.

Ambient Noise Levels

Noise levels were monitored at 8 locations within the study area. The locations for the noise levels are selected on the basis of sensitive receptors such as health centre, educational centres, market place etc. The day time and night time noise levels were found would be within the permissible standards of 55 and 45 dB respectively during day and night time for rural areas.

Soil Quality

Soil samples were collected from 8 locations. The soil in general indicates slightly acidic to slightly alkaline properties in the study area. Soil texture at all locations was observed would be loam to Clay loam . pH of the soil samples ranged from 4.91 to 7.07. The concentrations of heavy metals namely cadmium, mercury, antimony was observed would be below detectable limit. The values for Zinc, Lead, Cadmium, Copper, Nickel were found would be much below soil remediation intervention values.

Ecology

Quadrat based survey was carried out across the Block and it was observed that major portion of the study area comprises of moderate vegetation. Total 66 species of trees, 27 species of shrubs, 19 species of climbers and Liana has been cited within the study area. 57 species of birds and three mammals were observed in the study area during primary survey.

Socio- Economic Conditions

A total of 11 villages are located in core area, where wells are located, and 38 villages were regarded as buffer area which are present in the close proximity of the well area. Major population in the study area are farmers by occupation. Paddy is the main crops sown in the area along with presence of some scattered tea garden. Among the core zone villages Birina Sayek has the highest population of 1780, whereas the average household number is 5. Literacy rate in core zone villages is range between 48.69 – 97.60. Male literacy is little higher than the female literacy among the core zone villages. Presence of SC and ST population has been observed in core zone villages. As a source of drinking water people depend on Tube well. The most prevailing religion in this area is Hinduism followed by Muslims. It is observed that 38 % of the villages in the core zone area has the facility of primary health centre. Governmental scheme like Pradhan Mantri Awas Yojana, grant for making pukka Toilet etc are implemented in these villages. Electricity is available and consistent in the study area villages.

Impact Assessment and Mitigation Measures

Site Selection & Land Procurement

Impact

An area of approximately 300m X 300m would be taken on temporary short-term lease basis for the construction of well pad (drill site) for exploratory and appraisal wells and for Quick Production Unit/ Early Production Unit. For the preparation of suitable access roads connecting to well pads, accommodating OHL and other utilities in future, a width of 30m (approx.) RoU would be required. The drill sites are planned would be located in agricultural land. Their procurement for project purposes would result in loss of landowner's income for the lease period. The procurement of land on lease can lead to moderate impact mainly due to expectations on compensation package.

Mitigation Measures

- During the construction of the access road adequate cross drainage structures would be provided considering the topography of the alignment.
- Consultations would be carried out with land owners for finalizing compensation packages.
- The excavated material from the drill site would be stored (temporarily /permanently) in uncultivated land and would be away from any drainage channel.

Site Clearance and Grading

Impact

The site preparation works at campsite and drill site may result in clearance of vegetation, dust generation and loss of topsoil. The earthworks to be carried would typically involve excavation, levelling / grading; and rolling and compaction.

Mitigation Measures

- Water sprinkling would be carried out, while working in proximity of agricultural fields or settlements/habitations;
- Runoff from drill sites located near natural water bodies would be channelized through silt trap;
- if any tree felling is involved, permission from the concerned department would be undertaken.

Construction of Drill Site

Impact

Construction of cellar pit, water storage pit and drilling waste storage pits would result in excavation of soil from each site. Noise from construction activity would be generated from bull dozer, DG sets and concrete-mixing plant.

Mitigation Measures

- Temporary storage sheds would be provided for storing of construction material such as cement;
- Excavated soil would be used for construction at other project sites;
- Detailed Health & Safety Plan would be provided to all civil contractors, as part of their contract with Vedanta Ltd. (Division: Cairn Oil & Gas).

Campsite Installation

Impact

The campsites would be located in the vicinity of the drill site. A typical campsite would require portable cabins to accommodate about drilling crew and the contractor personnel. Installation of porta-cabins with associated facilities would involve Health and Safety issues pertaining to transportation, loading - unloading of cabins and installation of cabins.

Mitigation Measures

- Crane would be is equipped with a legible, durable load chart that shows the manufacturer's recommended load configurations and maximum load weights; and
- Surface conditions would be examined prior to movement of crane.

Transportation of Drilling Rig and Other Components –

Impact

Transportation of drilling rig, drilling equipment, materials and manpower would involve movement of trailer through the use of existing roads till they reach the access road for each well site. The potential impacts may include congestion of roads, wear and tear of existing roads and oil leaks from vehicle maintenance areas.

Mitigation Measures

- Movement of rig & associated machinery would be avoided to the extent possible during peak traffic hours
- . All vehicles (light, medium and heavy) would be required to have valid PUC (Pollution under Check) certificate.
- Periodic maintenance of all project vehicles and machinery would be carried out

Drilling and Well Testing

Impact

During drilling operation, water for WBM preparation would be 600-1000m^3/well, for SBM preparation would be 150-300 m^3/well. For drilling, water consumption would be 30-50m^3/day/well and water for domestic use would be 20-30m^3

Mitigation Measures

Water requirement for all the project activities would be sourced locally through approved/ authorized sources of surface water and/ or ground water (e.g. PHD bore wells, privately owned bore wells, Irrigation Dept./ Water Resources Dept. of State Govt.). In case, required water could not be sourced from locally available approved sources, ground water would be extracted after obtaining permission from CGWA/ State Govt.

Handling, transport and storage of Chemicals and wastes

Impact

The drilling operations would involve generation of spent drilling mud, drill cuttings, waste oil, used containers, etc. The drill site would also involve storage of hazardous chemicals and fuels which has the potential to contaminate soil and groundwater.

Mitigation Measures

- Separate drill cutting disposal pits would be provided for WBM and SBM
- Drill pits would be provided with HDPE lining on bottom and side surfaces
- The drill cuttings from the drilling operations associated with water-based mud would be used for filling low lying areas as a sub grade construction material in construction of well pads, etc., after testing for hazardous characteristics and analysis. Synthetic base mud would be re-used in further drilling activities.
- Used hazardous chemical barrels and waste oil would be sent to SPCB authorized vendors
- Fuel tanks would be provided with secondary containment facilities and maintained as per statutory requirements.
- All mixing tanks and chemical storage area would be paved and provided with secondary containment.

Noise Generation

Impact

The noise generation sources would include DG sets, pumps for rig and other miscellaneous equipment.

Mitigation Measures

- Installation of adequate engineering control on equipment and machinery (like mufflers & noise enclosures for DG sets and mud pumps) to reduce noise levels at source.
- The DG set would be kept in an acoustic enclosure.
- Providing Personnel Protective Equipment (PPEs) like ear plugs/muffs to workers at site.
- Undertaking periodic maintenance of vehicles to reduce noise levels.

Air emissions

Impact

The drilling activities would lead to emissions from operation of diesel generator sets and flaring during well testing. Fugitive dust emissions due to the proposed project would be principally associated with emissions of dust during the site preparation. The dust generated would be primarily from the handling and transportation of fill material and re-entrainment of dust during movement of the vehicles on unpaved roads.

Mitigation Measures

- DG set emissions would be as per CPCB standards
- In case of ground flaring to minimize the effects of flaring, the flare pit would be made of RCC surrounded by a permanent wall of minimum 5m height (with refractory bricks), to reduce the radiation and glaring effects in the adjoining areas.
- In case of elevated flaring system: Elevated flare system would be adopted, and designed with proper enclosure height;
- Location of the flare stack would be decided at the design stage taking into consideration nearest habitations, vegetation, public amenities or any sensitive locations

- Flaring of crude oil would be avoided, and crude oil would be effectively separated at the drill site and stored in barrels/tankers for transportation to the nearest terminal for management; and
- No cold venting would be resorted instead flaring would be done with combustion efficient elevated flare tip; and
- Location of flare stacks would be chosen considering the sensitive receptors adjoining the site

Surface water quality

Impact

Site clearance and stripping of top soil during site construction would result in an increase in soil erosion potential leading to an increased sediment load in the surface run-off during monsoon. Also, surface run off from drilling waste (cuttings and drilling mud), hazardous waste (waste oil, used oil etc) and chemical storage areas may lead to the pollution of receiving water bodies viz. natural drainage channels etc.

Mitigation Measures

- Proper treatment of all wastewater and produced water and any water discharge from well site would comply with CPCB Inland Water Discharge Standards for Oil and Gas Industries
- Waste mud would be stored in the HDPE lined pit
- Drainage system at the well site would be provided.
- All chemical and fuel storage areas, process areas would have proper bunds so that contaminated run-off cannot escape into the storm-water drainage system.

Ground water

Impact

In absence of supply of surface water resource, the potential impacts on groundwater resource would be due to ground water abstracted for domestic needs and for Drilling activities.

Mitigation Measures

• All water storages in the drill sites would be kept covered and leakage prevented;

Soil Quality

Impact

During the site preparation stripping of soil would be happened during the construction phase. Site preparatory activities would involve the sourcing of earth-fill from borrow areas. Since in most of the cases efforts would be made to procure the fill material from nearby existing borrow areas. Storage of drill cuttings associated with WBM/SBM, spent drilling mud and sludge containing oil and other waste are likely would be generated, would be stored at HDPE lined pit. Fuels, lubricants and chemical used for the drilling operations (especially daily consumption) would be stored at site.

Mitigation Measures

- The top soil would be stored properly.
- Manage spills of contaminants on soil using spill kits;
- Storage of MSW in designated areas within drill sites/production facilities;
- Adopt best practices e.g. use pumps and dispensing nozzle for transfer of fuel, use drip trays etc.

Road and Traffic

Impact

During various phases of projects like, drilling, early production and decommissioning various types of vehicle / equipment movement would be involved. The vehicular movement is expected would be more in drilling phase due to movement of machinery & manpower.

Mitigation Measures

- Speed limits would be maintained by vehicles involved in transportation of raw material and drilling rig.
- Regular supervision would be done to control vehicular traffic movement along defined traffic routes.
- Adequate training on traffic and road safety operations would be imparted to the drivers of project vehicles.
- Entry of vehicles into the drilling site area is prohibited except for material movement.
- Adequate parking would be provided outside the drilling location.

Terrestrial Ecological environment

Impact

The Potential Impacts on the existing floral and faunal diversity may arise due to following activities

1. Vegetation Clearance.
2. Illimitation from Site.
3. Generation of noise.

Mitigation Measures

1. The working area always be kept minimum.
2. For felling of trees prior approval from concerned department would be obtained;
3. Appropriate shading of lights to prevent unwanted scattering.
4. Fencing would be done on the camp site to avoid any unfortunate encounter with faunal species.

Socio economic environment

Impact
Influx of population is anticipated in all stages of the project cycle particularly during exploratory drilling. The drill site would involve the operation of about 50 onsite workers during drilling phase. Interaction between workers with villagers of nearby areas might give rise to various issues like conflict of workers with the local population, nuisance caused by workers due to improper sanitation facilities, etc.

Mitigation

- The shortest distance as far as avoidable/feasible would be considered for access road,
- The village road identified for accessing proposed project footprints, would be strengthened and widened as per requirement
- Concerns of local panchayat regarding any impact on their common property resources (like of use of village road, water resource etc.) due to project activities, would be proactively identified and addressed;

Occupational Health & Safety Risks

Impact

The health and safety risks associated with drilling operations may include well kick or blow out, crane failure, fire Hazards and radiation hazard from well logging tool handling and storage.

Mitigation Measures

- Blowout preventers would be provided;
- Flare pit would be placed at a safe distance from the well head and fuel storage areas;
- Fire-fighting measures would be provided.

Operation of Campsites

Impact

It is anticipated that, at any given time, there would be about 80 - 100 personnel working on site including technical staff, drilling crew, security staff etc. who would be accommodated at each campsite associated with drilling. Water for domestic use would be 20-30 m^3/day/well. Each campsite is anticipated to generate 25-30 kg/day/well of domestic waste. Inadequate disposal and handling of waste would pollute the surroundings.

Mitigation Measures

- Safe drinking water would be provided at campsite.
- Segregation of waste at the source of generation would be put in practice.
- Food waste would be stored in a closed container and composted.
- The sewage from each porta-cabin would be connected to a mobile modular STP.

Demobilization and Abandonment

Impact

If hydrocarbons are not found, a full abandonment plan would be implemented. The impacts from decommissioning of drill sites may include noise generation and soil contamination due to demolition of cutting pits and chemical storage areas.

Mitigation Measures

- All the wastes would be completely removed from the site and sent to designated authorized disposal facilities prior to commencement of demolition work.
- Prior to commencement of any demolition, a planned programme of site clearance would be formulated. All pits, cellars and holes would be removed, and filled to ground level, any oil or otherwise contaminated soil would be removed and disposed properly.
- Roads and other paving would be removed to sufficient depth to allow soil replacement and revegetation.
- Any remaining topsoil that has been stocked during the site clearance would be re-spread over appropriate portions of the site. Plantation, if possible, would be commenced in and around the site.

Environment Management and Monitoring Plan

A comprehensive environmental monitoring plan has been developed for the project. Monitoring of ambient air quality, noise levels, soil and groundwater quality, etc. would be carried out by MoEF&CC/NABL/ASPCB recognized laboratories for pre and post drilling operations to assess the effectiveness of the environment management plan and adopt appropriate corrective measures if it found that those are not functioning properly.

HSE Organization Structure

Vedanta Limited (Division: Cairn Oil & gas) has an existing established Health, Safety and Environment (HSE) management system for its operations. The HSE structure comprises of a corporate HSE team based in Gurgaon office and an on-site team.

A significant portion of the project activities would be undertaken by contractors. Vedanta Limited (Division: Cairn Oil and Gas) would ensure that the contractual documentation emphasizes on the need to comply with all legal requirements and Environment Management and Monitoring Plan (EMMP). Vedanta Ltd. (Division: Cairn Oil and Gas) would either directly or through its contractors, to arrange for periodic trainings of the project crew on legal requirements and EMMP. Vedanta Limited (Division: Cairn Oil and Gas) would undertake regular inspections of the drill and camp sites and document them to ensure compliance to legal requirements and the EMMP.

Proposed CER Strategy

As per MoEF&CC office memorandum number F. No 22-65/2017-IA-III dated 1st May, 2018, Corporate Environmental Responsibility requirement would be fulfilled as per the prescribed rate.

1. Introduction

India is largely dependent on import of petroleum goods to meet its requirements and imports about 80% of crude oil demand every year. For the last 3 years including the last financial year of 2018-19, the production figures of crude oil in India is hovering about 35 MT against a total demand of 212 MT in the last year. In addition, the demand of petroleum products is poised to grow at an annual average rate of 4.8% till year 2022 (13th 5-year plan).

To enhance indigenous production of oil, Government of India has targeted reducing the country's dependency on import by 10% by the year 2022. As a lead-up to this intent, Government of India has awarded Block AA-ONHP-2017/11 in upper Assam to Vedanta Limited (Division: Cairn Oil & Gas) for exploration of hydrocarbons.

1.1 Background

Revenue Sharing Contract (RSC) for Block AA-ONHP-2017/11 has been signed between Vedanta Ltd. and MoP&NG, Govt of India on 1st October 2018 for the exploration of hydrocarbons resources. Vedanta Ltd (Division: Cairn Oil & Gas) proposes to carry out exploration including exploratory and appraisal well drilling and early production of oil and gas in the above mention Block. In case of any discovery, the exploratory appraisal well(s) would be tested for extended duration by flowing hydrocarbons to ascertain the reservoir parameters, assess the quality and commercial viability for early production.

Vedanta Limited (Division: Cairn Oil & Gas) proposes for drilling of 11 exploratory and appraisal wells and setting up of early/quick production unit in AA-ONHP-2017/11.

1.2 Objective of the EIA Study

The exploration/development of oil and gas is included under activities specified in Schedule (Activity 1b) of the EIA Notification dated 14th September 2006 and categorized as "A" level project that requires an Environmental Clearance (EC) from the Ministry of Environment, Forests and Climate Change (MoEF&CC).

AECOM India Pvt Ltd., a NABET-QCI accredited firm has been entrusted with the task of conducting an EIA study and technically assisting Vedanta Limited (Division: Cairn Oil & Gas) in obtaining environmental clearance from the MoEF&CC.

The main objectives of the EIA study are as follows:

- Establish the prevailing baseline environmental and socio-economic condition of the AA-ONHP-2017/11 Block and its surroundings along with the compliance needs for environmental approvals to carry out hydrocarbon exploration.
- Assessing environmental and socioeconomic impacts arising out of the proposed drilling activities;
- Recommend appropriate preventive and mitigation measures to eliminate or minimize pollution, environmental & social disturbances during the life-cycle of the project, ensuring compliance with environmental laws and regulations applicable;
- Identifying and proposing alternative actions in terms of technology and practices that may help in abating environmental or socio-economic impacts due to the project;

Integrating mitigative measures with environmental action plans and management systems so that they can be implemented, monitored and suitable corrective action can be taken in case of deviations;

1.3 Project Status

Vedanta Limited (Division: Cairn Oil & Gas) had submitted Form-1 of the EIA Notification, along with a draft Terms of Reference (ToR) for scoping to MoEF&CC. Ministry of Environment and Forest and Climate Change (MoEF&CC) has issued an approved ToR vide No. IA-J-11011/132/2019-IA-II(I) dated 4th May 2019. The approved ToR is attached as Annexure 1.1

The baseline monitoring and all primary data collection was conducted for the summer season (March to May) of 2019, as per the requirements of the ToR.

1.4 Brief Details of The Project

AA-ONHP-2017/11 Block is located in Golaghat, Deragaon and Sarupathar tehsils of Golaghat district; Titabor and Jorhat West tehsils of Jorhat district in Assam, which encompasses within an area of 785 sq. km. Vedanta Limited (Division: Cairn Oil & Gas) proposes to carry out drilling of 11 exploratory and appraisal wells within the Block. Apart from that, setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) for produced well fluid processing and production of up to 8000 BOPD crude oil and 1.6 MMSCFD associated natural gas has also been planned. Total estimated cost of the project is Rs. 352 crores.

1.5 Scope of The Study

The scope of the EIA study considers the impact due to drilling of 11 onshore exploratory and appraisal wells and setting up of early/ quick production unit in AA-ONHP-2017/11, on physical, biological and socioeconomic environment of the surrounding areas in compliance to the approved ToR provide by MoEF&CC. The scope of the EIA study includes the following:

- To establish the prevailing environmental and socio-economic condition of the study area;
- To assess environmental and socioeconomic impacts arising out of the proposed expansion activities;
- To recommend appropriate preventive and mitigation measures to eliminate or minimize pollution;
- To identify and propose management plans in terms of good practices that may help in abating environmental or socio-economic impacts due to the project.
- To prepare a Disaster Management Plan (DMP) based on Risk Assessment/ studies;

Environmental baseline monitoring has been carried out during March to May, 2019 representing summer season and used to identify potential significant impacts.

1.6 Layout of the EIA Report

The overall contents of the EIA report have been prepared as per the generic structure prescribed in the Appendix III of EIA Notification issued by MoEF&CC, Govt. of India on 14th September 2006 and subsequent amendments. The report consists of executive summary followed by eleven chapters the content of which is briefly described in this section in Table 1.1

Table 1.1 : Content of the project

Sl. No.	Section	Brief Description
	Executive Summary	Executive Summary of EIA report.
1.	Introduction	This section covers project background; scope of the work and overview of the project.
2.	Project Description	Presents a Description of the Existing and proposed project.
3.	Environmental Baseline Study	Baseline Environment Status: The methodology for assessing various baseline environmental components in the study area has been identified in this chapter. The various parameters of present environmental status are identified under different aspects, which include location and regional setting of the area, physical aspects such as land use, land cover and soil quality. Hydrological aspect consists of area drainage, surface water and ground water quality. Meteorological aspect contains all the climatic factors and ambient air quality existing in the study area. Ecological environment describes the flora and fauna of the region. Human aspect includes the demographical features, socio-economic environment and infrastructure facilities of the study area.
4.	Impact Assessment and Mitigation Measures	Includes impact identification through scoping, assessment of impact, mitigation measures and evaluation of significance of residual impacts.
5.	Alternative Analysis	This section includes alternatives analysis with respect to site and technology
6.	Environmental Monitoring Program	The environmental monitoring would be scheduled during construction and operation phase is provided
7.	Additional studies	A summary of the additional studies/activities conducted as per the requirements of the ToR is given in this chapter. The additional studies conducted are Risk Assessment and Disaster Management Plan. On-site disaster management

Sl. No.	Section	Brief Description
		describing the on-site and off-site emergencies commands and controls have also described in this chapter. Stakeholder assessment as per primary consultation and Public hearing related issues have been also covered in this chapter.
8.	Project Benefits	The benefits that would be accrued from the project in the locality in particular and society in general as well as development would be identified and described in this chapter.
9.	Environmental Management Plan	This section covers introduction and elements of EMP i.e. planning, implementation, checking and management review.
10.	Summary and Conclusion	Presents the overall findings of the EIA study and includes overall justification for implementation of the project and provides explanation of how, adverse effects have been mitigated.
11.	Disclosure of Consultants	Provides brief information about AECOM and professionals who were engaged for completion of this study.

Source: EIA Notification 2006

1.7 Compliance to TOR

Environment Impact Assessment (EIA) study has been undertaken for the proposed project located in Golaghat and Jorhat Districts of Assam. The EIA study has been undertaken in accordance with the Standard ToR issued by MoEF&CC vide File No. IA-J-11011/132/2019-IA-II(I) dated 4th May 2019.The point wise compliance to TOR is provided in Table 1.2.

Table 1.2 Terms of Reference (ToR) Compliance

Sl. No	Condition	Reference Section
1.	Executive summary of the project	Refer to Executive Summary
2.	Project description, project objectives and project benefits	Refer to Chapter 2, section 2.2-Objectives and Benefits Of Proposed Exploratory, Appraisal And Well Testing Activities, section 2.6 and 2.7-Well Locations And Environmental Settings, section 2.6- Project Activities And Schedule
3.	Cost of project and period of completion	Refer to Chapter 2, section 2.13- Project Cost and section 2.6 - Project Activities and Schedule
4.	Site details within 1 km of the each proposed well, any habitation, any other installation/activity, flora and fauna, approachability to site, other activities including agriculture/land, satellite imagery for 10 km area.	Refer to Chapter 2, section 2.5-Well Locations and Environmental Settings Refer to Chapter 3, section 3.10-land use/land cover
5.	All the geological details would be mentioned in the Topo sheet of 1:40000 scale, superimposing the well locations and other structures of the projects.	Refer to Chapter 2, Section 2.3 -Block Location & Description
6.	Topography of the project site.	Refer to Chapter 3, section 3.3.6-Topography
7.	Details of sensitive areas such as National Park, Wildlife sanctuary and any other eco-sensitive area along with map indicating distance	Refer chapter 3, section 3.12-Ecological Environment
8.	Approval for the forest land from the State/Central Govt. under Forest (Conservation) Act, 1980, if applicable.	Not applicable
9.	Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January 2011 (if applicable).	Not applicable
10.	Distance from nearby critically/severely polluted area as per Notification, if applicable. Status of moratorium imposed on the area.	Not applicable
11.	Does proposal involve rehabilitation and resettlement? If yes, details thereof.	No rehabilitation and resettlement would be required as such.
12.	Environmental considerations in the selection of the drilling locations for which	Refer Chapter 5- Analysis of Alternatives

Sl. No	Condition	Reference Section
	environmental clearance is being sought. Present any analysis suggested for minimizing the foot print giving details of drilling and development options considered.	
13.	Baseline data collection for air, water and soil for one season leaving the monsoon season in an area of 10 km radius with centre of Oil Field as its centre covering the area of all proposed drilling wells.	Refer Chapter 3, section 3.6-Ambient Air Quality, section 3.9 -Water Environment, section 3.11-Soil Quality
14.	Climatology and Meteorology including wind speed, wind direction, temperature rainfall relative humidity, etc.	Refer Chapter 3, section 3.3.5-Climate and Rainfall, section 3.5-Meteorology
15.	Details of Ambient Air Quality monitoring at 8 locations for PM2.5, PM10, SO2, NOx, CO, VOCs, Methane and non-methane HC.	Refer Chapter 3, section 3.6-Ambient Air Quality,
16.	Soil sample analysis (physical and chemical properties) at the areas located at 5 locations.	Refer Chapter 3, section 3.11-Soil Quality
17.	Ground and surface water quality in the vicinity of the proposed wells site.	Refer Chapter 3, section 3.9 -Water Environment,
18.	Measurement of Noise levels within 1 km radius of the proposed wells.	Refer Chapter 3, section 3.7-Ambient Noise Quality
19.	Vegetation and land use; flora/fauna in the Block area with details of endangered species, if any.	Refer Chapter 3, section 3.12-Ecological Environment
20.	Incremental GLC as a result of DG set operation, flaring etc.	Refer Chapter 4, Section 4.8
21.	Potential environmental impact envisaged during various stages of project activities such as site activation, development, operation/ maintenance and decommissioning.	Refer Chapter 4
22.	Actual source of water and 'Permission' for the drawl of water from the Competent Authority. Detailed water balance, wastewater generation and discharge.	Refer to Chapter 2, section 2.7.3-Water Requirement
23.	Noise abatement measures and measures to minimize disturbance due to light and visual intrusions	Refer Chapter 4, section 4.9-Potential Impact and Mitigation Measures on Noise quality
24.	Details on wastewater generation, treatment and utilization /discharge for produced water/ formation water, cooling waters, other wastewaters, etc. during all project phases.	Refer to Chapter 2, section 2.8.3-Wastewater
25.	Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its disposal options during all project phases.	Refer to Chapter 2, section 2.8.4-Solid and Hazardous Waste Streams
26.	Disposal of spent oil and lube.	Refer to Chapter 2, section 2.8.4-Solid and Hazardous Waste Streams
27.	Storage of chemicals and diesel at site. Hazardous material usage, storage and accounting	Refer to Chapter 2, section 2.7-Utilities & Resource Requirements
28.	Commitment for the use of water-based mud (WBM) only	Refer to Chapter 2, section 2.6.2-Drilling Activity
29.	Oil spill emergency plans for recovery/ reclamation	Refer Chapter 9, Section 9.5
30.	H_2S emissions control	Refer chapter 7, section 7.3.13.
31.	Produced oil/gas handling, processing and storage/transportation	Not applicable

Sl. No	Condition	Reference Section
32.	Details of control of air, water and noise pollution during production phase	Not Applicable
33.	Measures to protect ground water and shallow aquifers from contamination	Refer Chapter 4, section 4.11.
34.	Whether any burn pits being utilised for well test operations	Refer to Chapter 2, section 2.6.2-Drilling Activity
35.	Risk assessment and disaster management plan for independent reviews of well-designed construction etc. for prevention of blow out. Blowout preventer installation.	Refer Chapter 7, section 7.2.5
36.	Environmental Management Plan.	Refer Chapter 9.
37.	Total capital and recurring cost for environmental control measures	Refer Chapter 9, Section 9.15
38.	Emergency preparedness plan.	Refer Chapter 7, Section 7.3.4
39.	Decommissioning and restoration plans	Refer to Chapter 2, section 2.6.3-Well Decommissioning
40.	Documentary proof of membership of common disposal facilities, if any	Not applicable
41.	Details of environmental and safety related documentation within the company including documentation and proposed occupational health and safety Surveillance Safety Programme for all personnel at site. This would also include monitoring programme for the environmental	Refer to Chapter 6 - Environmental Monitoring Programme
42.	A copy of Corporate Environment Policy of the company as per the Ministry's O.M. No. J-11013/ 41/2006-IA.II(I) dated 26thApril, 2011 available on the Ministry's website	Refer Chapter 9, Section 9.1.

Source: ToR issued By MoEF&CC

1.8 Limitations

This EIA study is based on certain scientific principles and professional judgment to certain facts with resultant subjective interpretation. Professional judgment expressed herein is based on the available data and information.

This report has been developed based on the project related information provided by Vedanta Limited (Division: Cairn Oil & Gas) with the assumption that the information gathered is representative for the proposed drilling of 11 onshore exploratory and appraisal wells and early production units in Golaghat and Jorhat districts of Assam. If information to the contrary is discovered, the findings in this EIA may need would be modified accordingly. The impact assessment for the project is based on the project configuration as described in Section 2 - Description of the Project.

2. Description of the Project

The proposed project by Vedanta Limited (Division: Cairn Oil & Gas) includes, proposed drilling of 11 onshore exploratory and appraisal wells and setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) for produced well fluid processing and production of up to 8000 BOPD crude oil and up to 1.6 MMSCFD associated natural gas in AA-ONHP-2017/11 Block located in Golaghat and Jorhat districts of Assam.

In case of a discovery (ies), the exploratory and appraisal well(s) would be tested for extended duration by flowing hydrocarbons to ascertain the reservoir parameters and assess the quality and commercial viability. Moreover, in case of commercially viable discovery (s) of hydrocarbons in the Block and having established the size of the hydrocarbon field (s), field would be immediately brought into early production of crude oil and associated gas using some of the successful exploratory/ appraisal wells by setting up of temporary and mobile Early Production Units (EPUs)/ QPUs (Quick Production Units) for the processing of produced well fluids. Any associated gas would be used for captive power generation.

2.1 Objectives of Proposed Project

Specific objectives of the proposed drilling activities are summarized below:

- To develop and produce hydrocarbons safely
- To augment National Production of oil and gas

2.2 Benefits of the Proposed project

The project would ultimately cater to fulfil the energy requirement of India. The dependency of India on other countries would be lessened to an extent. Additionally, the project would benefit people living in neighbouring villages in relation to direct & indirect employment associated with various project activities and would boost the local economy. The benefits of the project are listed below;

- Provision of royalty to Assam Government and more cess to Govt. of India
- Provision of direct and indirect employment opportunity to local people
- Development of infrastructure (roads, culverts, bridges etc.) in the area
- Increase in business opportunity for the local people
- Energy security for the country

2.3 Block Location & Description

Location of Block

Block AA-ONHP-2017/11 is located in Golaghat and Jorhat districts of Assam and is circumscribed within a total area of 785 sq. km. The coordinates of the vertices of the block are presented in Figure 1. The block area is distributed across Dheragaon, Sarupathar and Golaghat tehsils in Golaghat and Titabor and Jorhat West tehsils in Jorhat district. The geographic location of the block is included as an overlay on the Survey of India's Topo-Sheet No. G46K/1, G46K/2, G46K/3, G46I/14.

The regional setting of the proposed Block is presented in Figure 2 and the location of AA-ONHP-2017/11 Block on toposheet and satellite imagery is presented in Figure 3 and Figure 4.

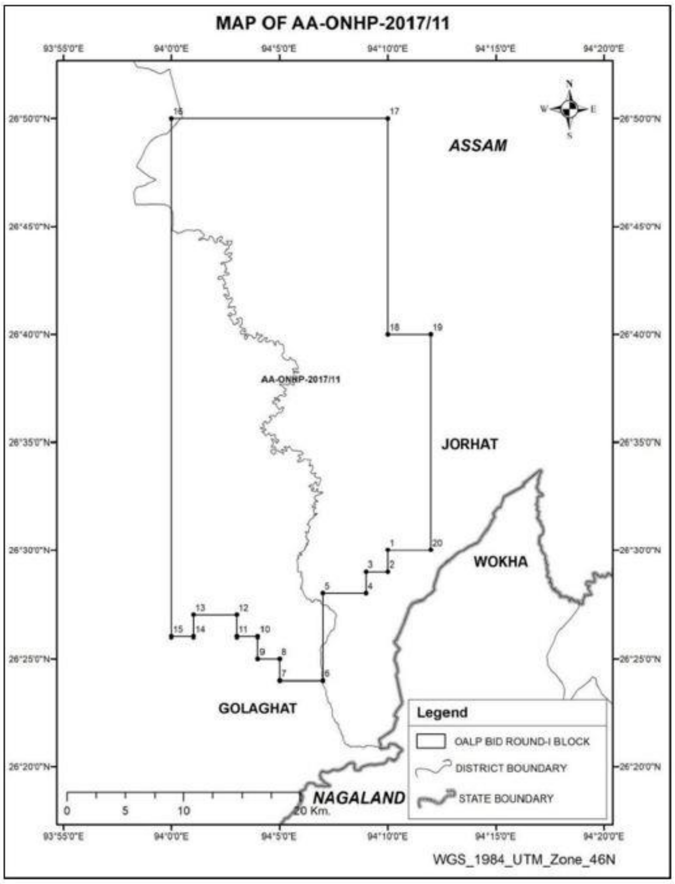

Figure 1. Block Boundary Pillar Co-ordinates of AA-ONHP-2017/11

Boundary /Pillar Points	Longitude (East)	Latitude (North)
1	94° 10'	26° 30'
2	94° 10'	26° 29'
3	94° 9'	26° 29'
4	94° 9'	26° 28'
5	94° 7'	26° 28'
6	94° 7'	26° 24'
7	94° 5'	26° 24'
8	94° 5'	26° 25'
9	94° 4'	26° 25'
10	94° 4'	26° 26'
11	94° 3'	26° 26'
12	94° 3'	26° 27'
13	94° 1'	26° 27'
14	94° 1'	26° 26'
15	94° 0'	26° 26'
16	94° 0'	26° 50'
17	94° 10'	26° 50'
18	94° 10'	26° 40'
19	94° 12'	26° 40'
20	94° 12'	26° 30'

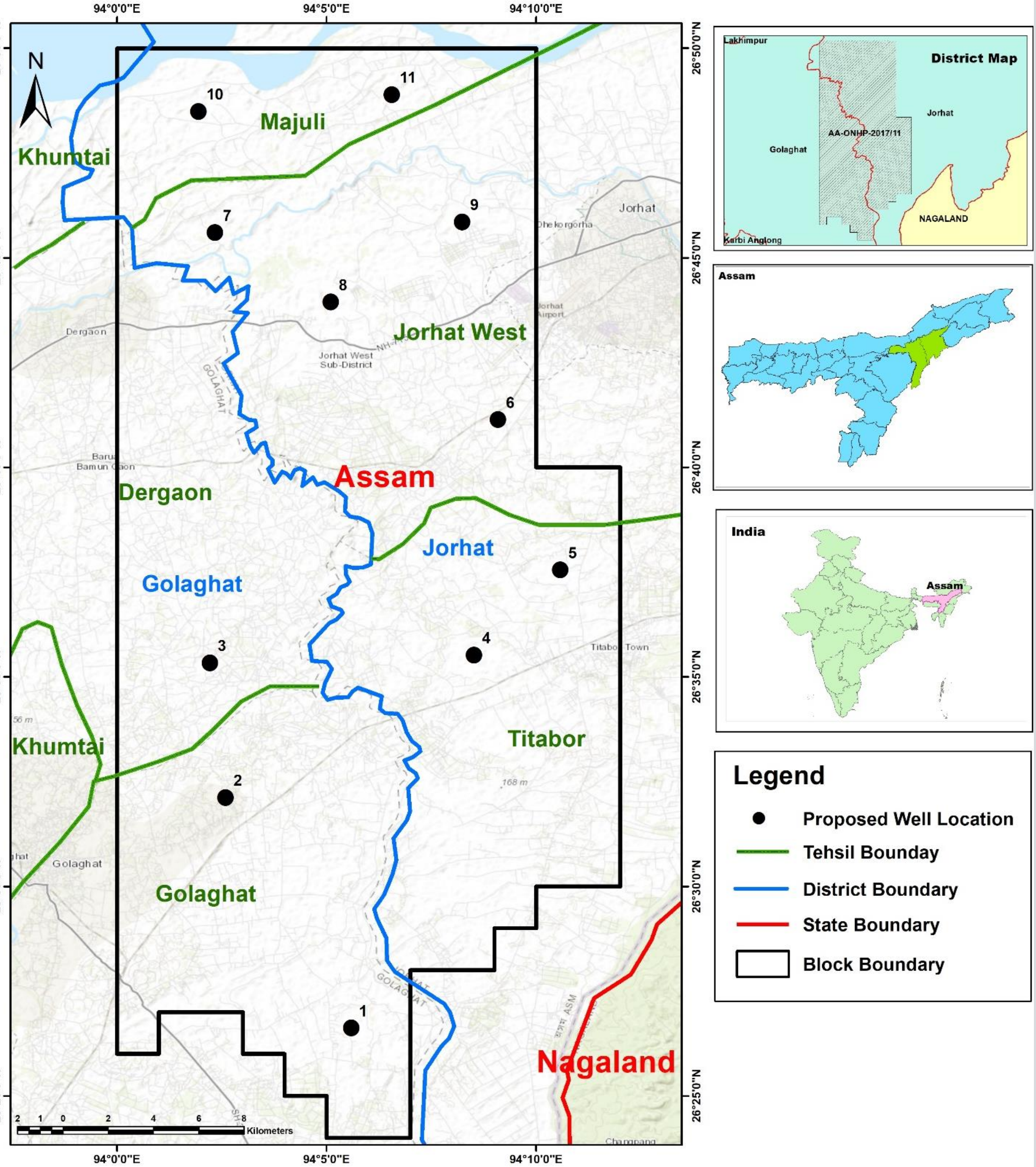

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Regional Setting Map	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth,Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital Globe, GeoEye,Earthstar Geographics, CNES/ AirbusDS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.	

Figure 2. Regional Setting of the Block AA-ONHP-2017/11

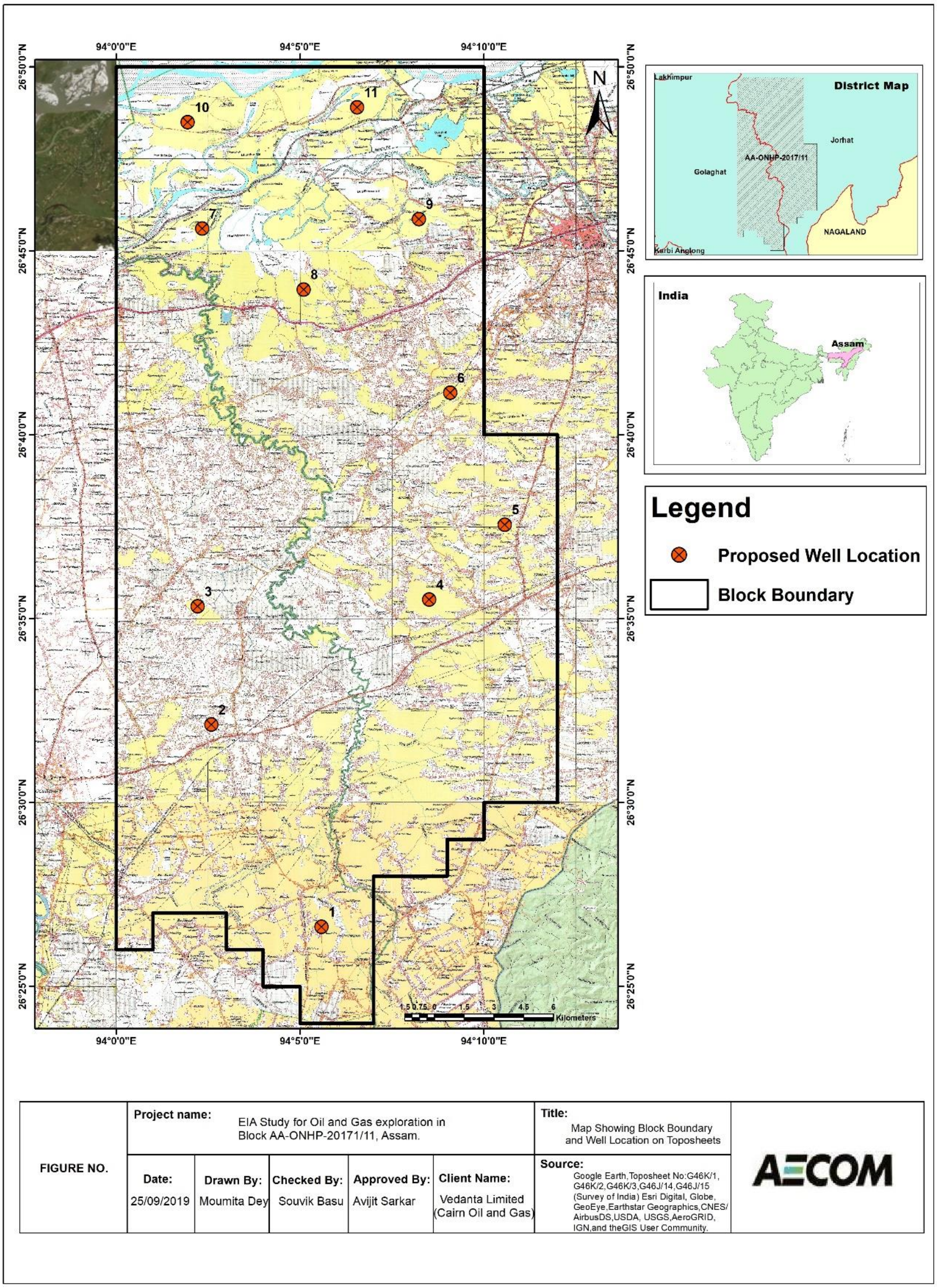

Figure 3. Block boundary of AA-ONHP-2017/11 on Survey of India Toposheet

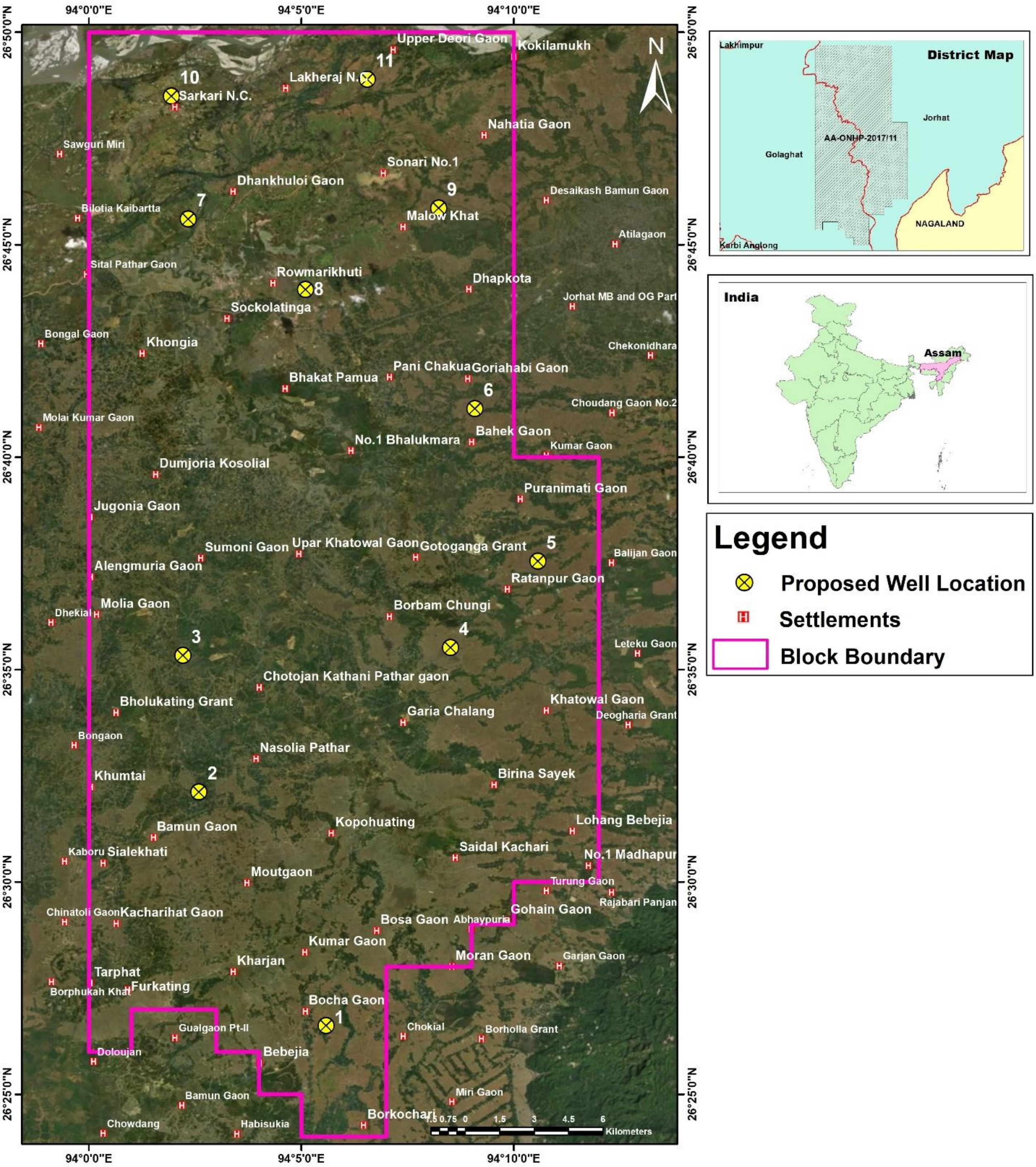

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Map Showing Block Boundary and Well Location on Satellite Imagery	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth,Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital, Globe, GeoEye,Earthstar Geographics,CNES/ AirbusDS,USDA, USGS,AeroGRID, IGN,and theGIS User Community.	

Figure 4. Boundary of Block AA-ONHP-2017/11 Block on Satellite Imagery (Google Earth)

Accessibility

Roads

The proposed block is located in Jorhat and Golaghat districts of Assam Block AA-OHNP-2017/11. The major connectivity in the block is formed by SH33 (KB Road), SH1 (Dhodar Ali Road) and SH32 (Na Ali Road). The mentioned State Highways intersects the NH 715 (Assam Trunk Road), which further connects the Jorhat City (5.58 km, NE), subsequently connecting the nearest airport, Jorhat Airport. SH1 interconnects the SH 33 and SH32 within the block boundary. Apart from the major road network of State Highways, the area within the block boundary is internally connected with motorable access roads to the proposed well sites.

Railway

The study area is well connected by the North-East Frontier Railway. The nearest major railway stations are Golaghat Railway Station (3.82km, West) and Jorhat Town Railway Station (4.98 km, East). The railway stations within the block area are Furkating Junction, Kamarbandha Ali, Chakiting Railway and Titabor Raiway Station.

Airport

Nearest airport is Jorhat Airport also known as Rowriah Airport, which is 840 m in Eastern direction from the eastern Block boundary.

Accessibility map of Block AA-ONHP-2017/11 is given in figure 5.

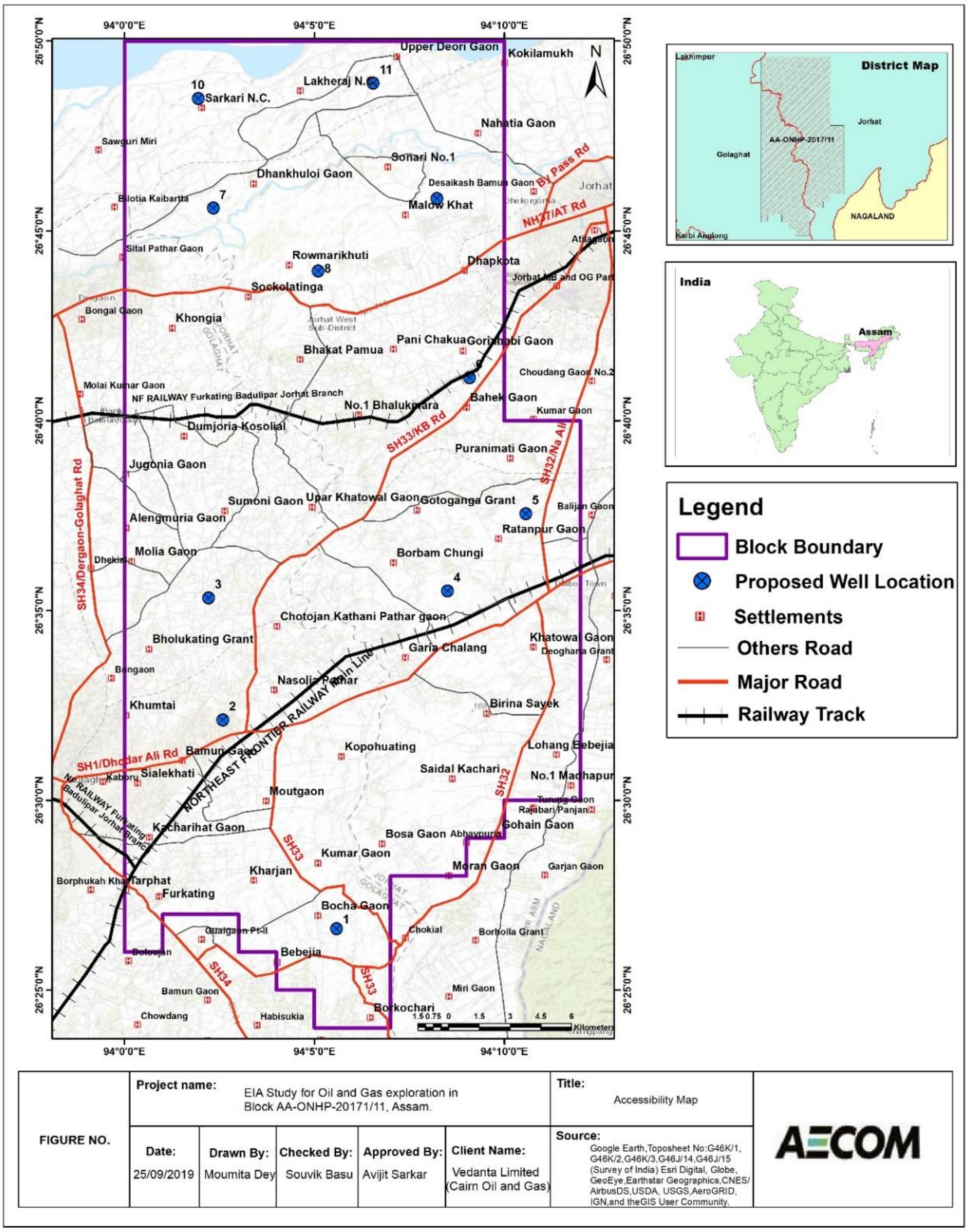

Figure 5. Accessibility Map of AA-ONHP-2017/11 Block.

2.4 Environmental Settings

Environmental Settings of AA-ONHP-2017/11 Block

- The Block spreads across the Golaghat, Dergaon, Sarupathar tehsils of Golaghat district and Jorhat West and Titabor tehsils of Jorhat District of Assam.
- On an average the length and breadth of the block are 48 km and 19.93 km respectively.
- The block is located at the flood plain of river Brahmaputra, which flows on the Northern boundary of the block area. Beside river Brahmaputra, Gelabil, Delasari Nadi, Disai and Bhogdoi rivers forms the major drainage within the block boundary, towards the Northern side of the block area.
- A considerable area inside the block is consist of swampy grassland. These areas are mostly situated at the south east portion of the block near river Brahmaputra. Bank erosion is a common phenomenon which could be seen here, near the bank of Brahmaputra.
- Dayang Reserved Forest is located towards the extreme South of the block area encompassing within an area of 44 hectares.
- The nearest WLS includes- Hoollongapar Gibbon Wildlife Sanctuary and Nambor Wildlife Sanctuary, these are located 11.23 km to the East and 4.76 km to the South-West, respectively, of the block boundary. The designated ESZ of 10 km falls within the block boundary, towards the South-West side of the block.
- Land use classes within the Block chiefly comprises agricultural land and the other forms of land use present are marshy land, tea garden, natural vegetation, water body, river, build up area and brick kiln industry.
- The block has a rural set up with agriculture as the main livelihood for the local people. Paddy is the foremost agriculture produce here, some Tea gardens are also present within the block.
- There are no major industries located within the Block except some tea processing unit.

Location of Wells

Vedanta Ltd. (Division: Cairn Oil & Gas) proposes to drill 11 exploration & appraisal wells present within the Block boundary of AA-ONHP-2017/11. The proposed well site selection is primarily based on both the geological considerations and the environmental considerations viz. location of sensitive ecological habitats, settlements, schools/ hospitals, water bodies etc. Care had been taken to locate the wells distantly from these receptors. In case, well site selection in proximity to sensitive receptors could not be avoided (due to presence of geological formations), requisite clearance/permission would be obtained as may be statutorily required. Proper environmental and safety measures would be adopted to minimize footprints on these receptors.

Tentative well coordinates are provided in **Table 2.1** and the location of the wells are shown in **Figure 6.**

Table 2.1 Details of Proposed Well Location

Well no.	Coordinates	Present Land Use	Village	Tehsils	District
1	26°26'36.54"N, 94° 5'34.94"E	Agricultural Land	Bocha Gaon	Golaghat	Golaghat
2	26°32'6.57"N, 94° 2'35.33"E	Agricultural Land	Dolakhuria	Golaghat	Golaghat
3	26°35'19.44"N, 94° 2'12.65"E	Agricultural Land	Dakhinhengera Grant No. 57	Golaghat	Golaghat
4	26°35'30.60"N, 94° 8'30.53"E	Agricultural Land	Baliporia Gaon	Titabar	Jorhat
5	26°37'32.55"N, 94°10'34.04"E	Agricultural Land	Barhoi Bari Mahajan Gaon	Titabor	Jorhat
6	26°41'7.66"N, 94° 9'5.19"E	Agricultural Land	Dhekelia Borasaikia	Jorhat West	Jorhat
7	26°48'29.08"N, 94° 1'56.44"E	Agricultural Land	Sarkari NC	Jorhat West	Jorhat
8	26°43'56.15"N, 94° 5'5.95"E	Agricultural Land	Tingtingia	Jorhat West	Jorhat
9	26°45'50.93"N, 94° 8'13.82"E	Agricultural Land	Pohumora No. 2	Jorhat West	Jorhat
10	26°48'29.08"N, 94° 1'56.44"E	Agricultural Land	Sarkari NC	Jorhat West	Jorhat
11	26°48'53.19"N, 94° 6'32.94"E	Agricultural Land	Karang Chapari	Jorhat West	Jorhat

Environmental settings around 2.5 km radius [1]area of each well site was carried out during field survey and the same has been checked with toposheet and satellite imagery.

All the proposed well locations are located in agricultural land. Settlements/houses were observed in vicinity of well locations. Villages roads are also located close to well locations. Well profile including environmental setting and environmental settings map of each well is given in **Appendix 2.3.**

[1] As per project plan well site may shift 2 kilometer around the prosed well site based on seismic data and geological formation. Considering the fact 2.5 km radius of the proposed well site is considered as the area of influence of the particular well.

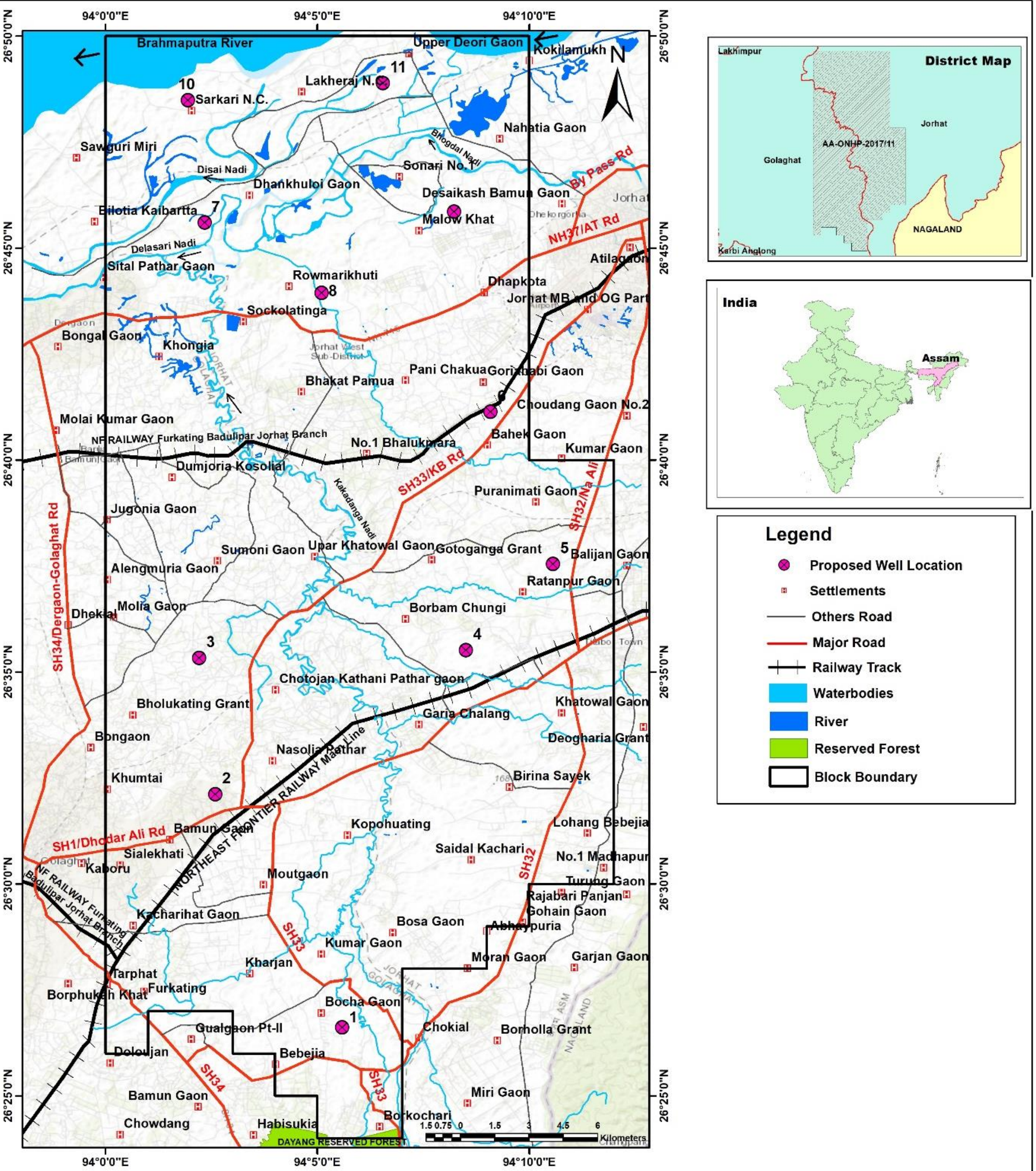

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.				Title: Environmental Settings Map	AECOM
	Date: 25/09/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth,Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital, Globe, GeoEye,Earthstar Geographics,CNES/ AirbusDS,USDA, USGS,AeroGRID, IGN,and theGIS User Community.

Figure 6. Environmental Settings Map of Block AA-ONHP-2017/11

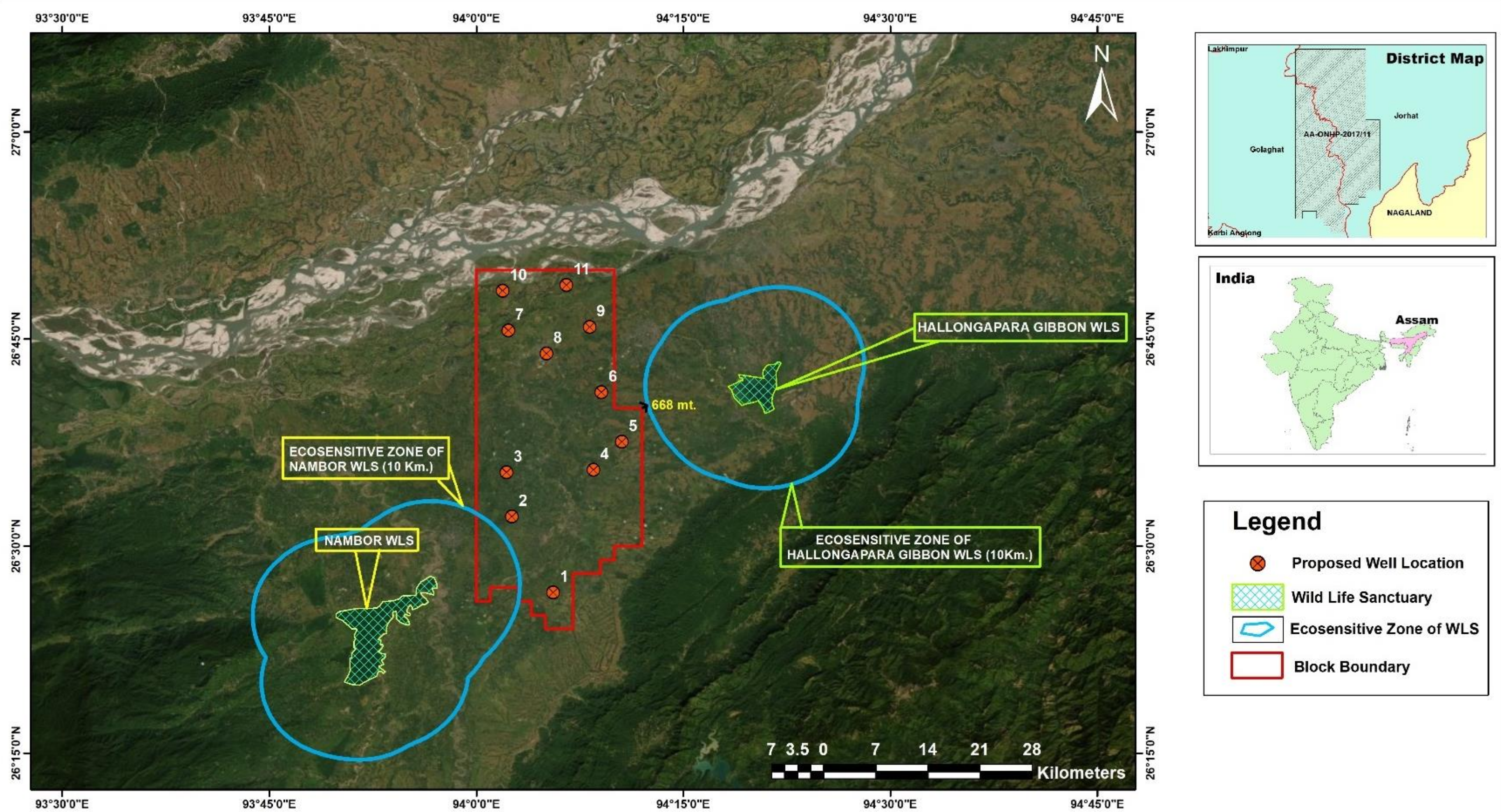

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017/11, Assam.					Title: Map Showing the Distance of Nearest Ecosensetive Zone of WLS from the Block Boundary	AECOM
	Date: 18/06/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth, Wild Life Institute of India, Esri Digital Globe, GeoEye, Earthstar Geographics,CNES/AirbusDS, USDA, USGS,AeroGRID,IGN,and the GIS User Community.	

Figure 7. WLS of Block AA_ONHP_2017/11

2.5 Well Drilling

The lifecycle of project activities for the proposed project has been divided into distinct steps and each is described in detail in the subsequent sections and would take approximately three months to complete drilling and testing activity at each well site. Vedanta Limited (Division: Cairn Oil and Gas) has planned to carry out the proposed project activities in the AA-ONHP-2017/11 Block over a period of 10-12 years.

The project lifecycle has been classified into three phases:

Pre-drilling activity

- Site selection
- Land procurement
- Site Preparation
- Site access road and drill site construction
- Pre-drilling activities, mobilization and Rigging up

Drilling activity

- Drilling of wells
- Testing of wells

Early Production- When, exploratory drilling is successful

- Drilling of Appraisal wells to quantify the hydrocarbon reserves
- Setting up of Early Production Units (EPUs)/Quick Production Units (QPUs)

Well decommissioning

- Well abandonment
- Site closure and decommissioning
- Site Restoration

Pre-drilling Activity

The pre-drilling phase would involve the following activities:

Site Selection

The exploration history of the area exhibits the potential presence of the oil and gas in the region. The seismic data interpretation of the seismic survey would decide the exact locations of the drilling well. The proposed exploratory well site have been identified based on the study and interpretation of the stratigraphy and seismic data. Within the identified location the actual well drilling site have been selected based on the following factors:

- Located at a safe distance from public road
- Ensure natural drainage channels are avoided or drainage channels rerouted to ensure
- Unhindered flow of rain / flood water. Where necessary adequate erosion control measures would be provided

Land Procurement

An area of approximately 300m X 300m would be taken on temporary short-term lease basis for the construction of well pad (drill site) for exploratory and appraisal wells. For the preparation of suitable access roads connecting to well pads, accommodating OHL and other utilities in future, a width of 30m (approx.) RoU would be required.

Site Preparation

Site preparation would involve all activities required to facilitate the operation of the drilling rig and associated equipment and machineries. At the initial stage, the drilling site would be elevated to about 2.0 m from the existing ground level with minimal clearance of existing ground vegetation. The existing trees would be retained to the extent possible. All efforts would be made during the design of the drill pad to prevent felling of any mature trees.

The loose top soil would be removed by using mechanical means like bulldozer and saved at a nearby place (away from the water channels) for later use during site restoration. Levelling and compaction would be done with the help of graders and mechanical rollers. The land filling materials and rubbles would be required for the purpose for site preparation in sufficient amount. Subsequently, the proposed well site & campsite would be duly fenced using chain link and barbed wires.

Platforms for drill pad and all other heavy equipment systems or machinery, cast in-situ Reinforced Cement Concrete (RCC) would be used for the construction of foundation system. The rig foundation would be of 20m X 20m in size and would have an elevation of 0.6 m. For making the foundations of main rig structure, cast in-situ bored under- reamed piles of specified lengths would also be used. The elevated structures would have proper garland drains for storm water with sufficient gradient, made of brick masonry, to take care of surface runoff water.

Specially designed pit of an impervious HDPE liner would be provided as part of the site development for disposal of drilling waste in the form of spent drilling mud and cuttings.

A Campsite, elevated to the height as that of the drilling site (approx.2.0 m), would be set up adjoining the well site. Local earth and rubble would be used as the fill material. Proper surface gradients and brick masonry drains would take care of the run-off water, where as separate septic tanks and soak pits would be provided along with the labour camp for disposal of domestic waste water.

Though the rig and related equipment's would be directly brought to site, spares, mud preparing chemicals and other materials would be stored at a warehouse near to the site and would be received to the site from that intermediate storage area. The rig equipment would however be transported directly to the drilling site during mobilization and would be de-mobilized directly from the site. The materials would be intermittently supplied from warehouse to the drilling site, during the operations - with some stock at the drilling site itself.

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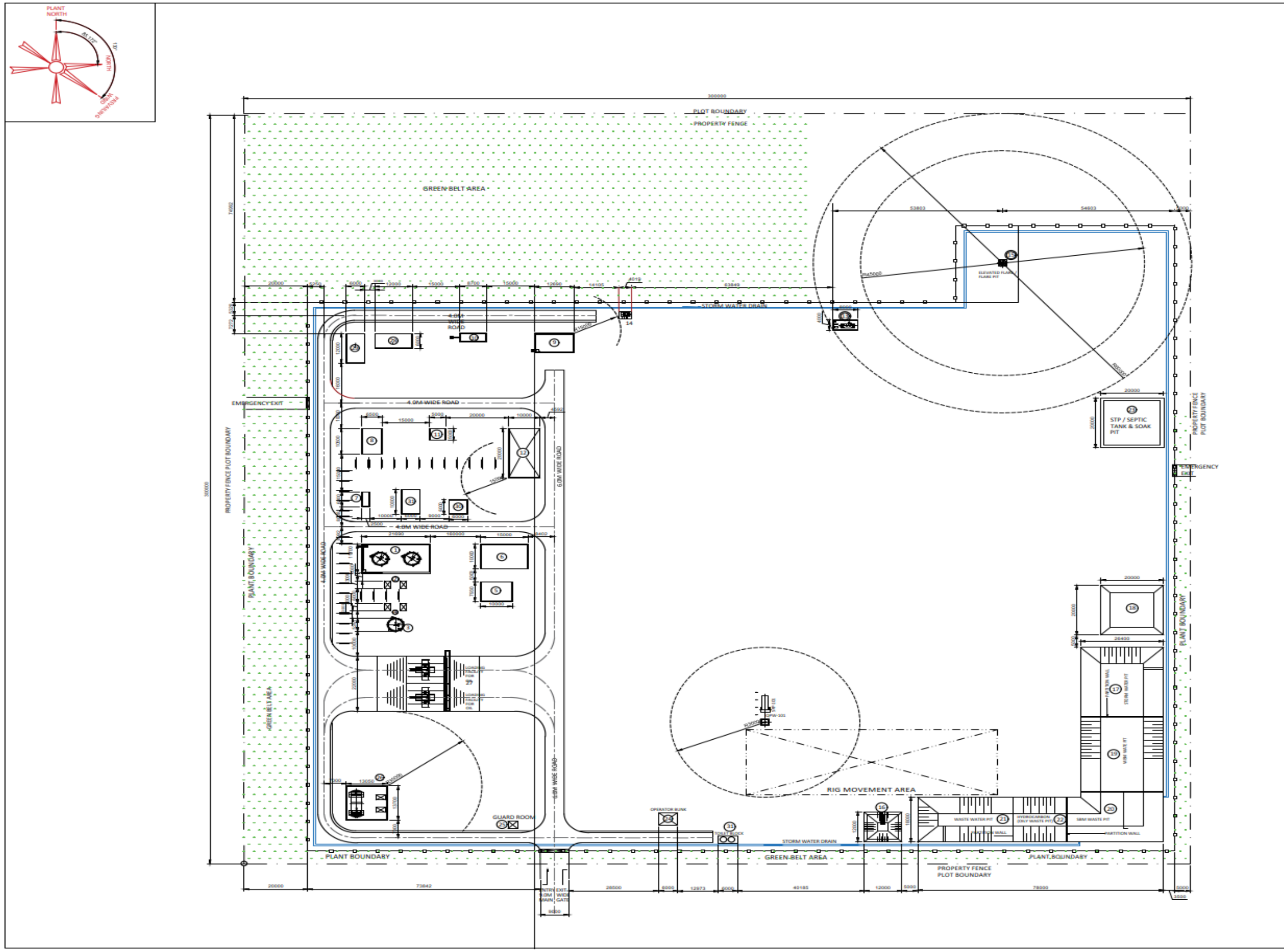

EQUIPMENT LIST			
SL NO.	EQUIPMENT	QTY.	DIMENSION
1	OIL STORAGE TANK	2	5.2 DIA
2	OIL TRANSFER PUMPS	2	-
3	WATER STORAGE TANK	1	5.2 DIA
4	WATER TRANSFER PUMPS	2	-
5	INSTRUMENT AIR PACKAGE	1	10x7.93
6	CHEMICAL INJECTION PACKAGE	1	15x10
7	ELECTROSTATIC COALESCER SEPARATOR	1	6x2.5
8	HEATER TREATER SKID	1	10.5x6.5
9	DIESEL STORAGE TANK & PUMP	1	12.96x7.95
10	DIESEL GENERATOR	1	8.7x3.5
11	FUEL GAS SYSTEM	1	10x10
12	GEG PACKAGE	1	20x20
13	FLARE KO DRUM & PUMPS	1+2	8x4
14	CLOSED DRAIN SYSTEM & PUMPS	1+2	4x4
15	ELEVATED FLARE / FLARE PIT	1	2.6x2.6
16	FRESH WATER PIT	1	12x12
17	STORM WATER PIT	1	30x20
18	MUD PIT	1	20x20
19	WBM WASTE PIT	1	27.7x26.4
20	SBM WASTE PIT	1	29.4x26.4
21	WASTE WATER PIT	1	30x18
22	HYDROCARBON (OILY WASTE PIT)	1	18x16.5
23	STP / SEPTIC TANK & SOAK PIT	1	20x20
24	OPERATOR ROOM	1	6x5
25	GUARD ROOM	1	3x3
26	FIRE FIGHTING FACILITY & FIRE PUMPS	1+2	13.7x13
27	LOADING FACILITY AREA	1	-
28	SUB-STATION	1	12x6
29	CONTROL ROOM	1	6x6
30	WELL TEST SEPARATOR	1	6x6
31	PRODUCED WATER TREATMENT SKID	1	10x6
32	TOILET BLOCK	1	-

Figure 8. Typical Layout of Drilling PAD with QPU.

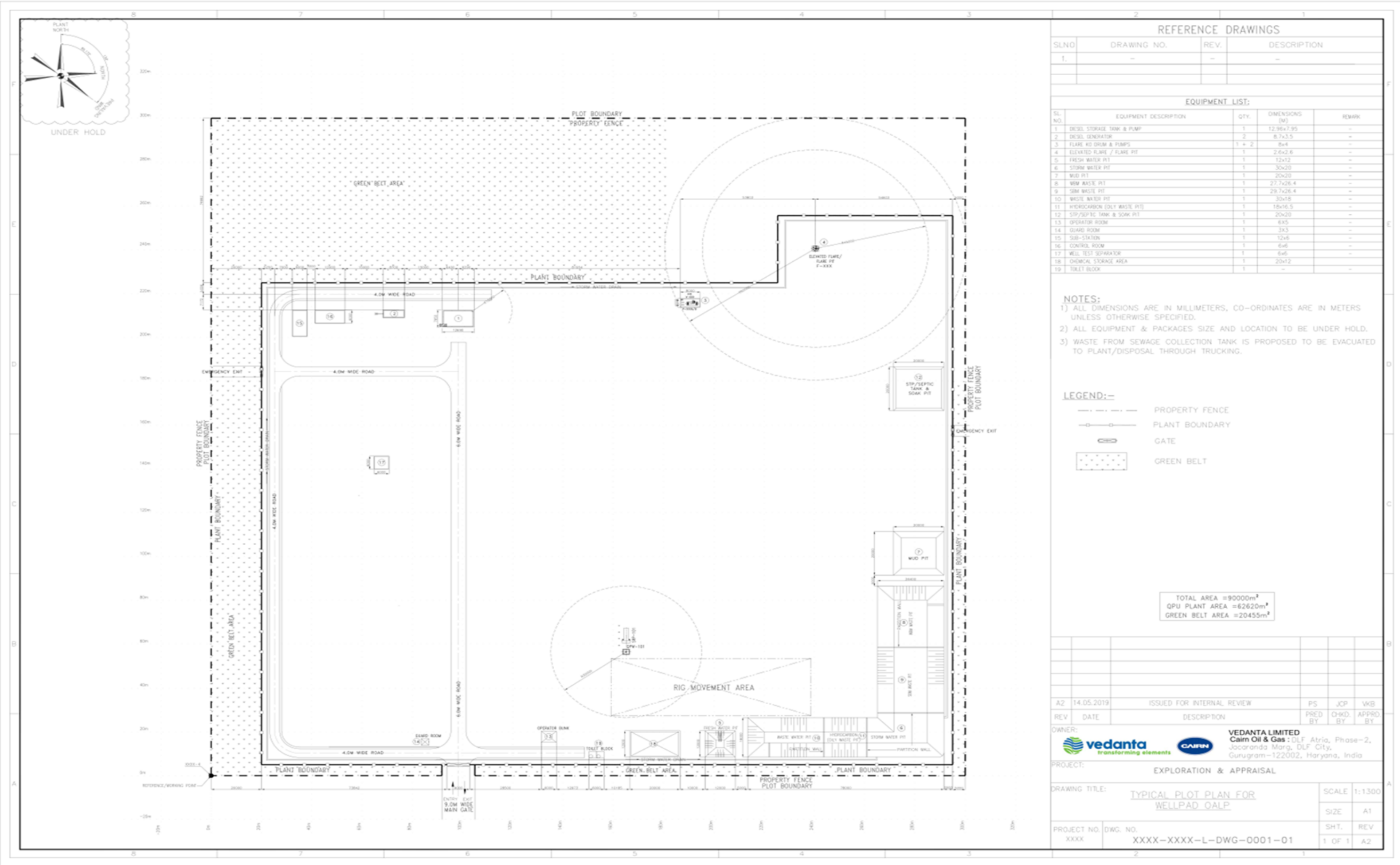

Figure 9. Schematic Diagram of A typical Well Pad

Drilling Activity

The proposed drilling would be carried out by using a standard land rig or a "Mobile Land Rig" with standard water-based drilling fluid treatment system. This rig would be suitable for deep drilling up to the desired depth of 6000 meters (TVDSS) as planned for the project. Additionally, there would be other ancillary facilities like Drilling mud system, ETP, Cuttings disposal, Drill Cementing equipment etc. and utilities to supply power (DG sets), water, fuel (HSD) to the drilling process and would be set up as a part of the Project. The details of the drilling rig is given in Table 2.2. The typical configuration of a Drilling Rig is shown in the **Figure 10** below.

Table 2.2 Specification of a drilling Rig

Type of Rig	**Electrical Rig**
Power generator type & nos.	AC – SCR Type. (03 Nos.)
Details of solids handling systems on rig	Shale Shakers - 1200 GPM Capacity Desander – 1200 GPM Capacity Desilter – 1200 GPM Capacity

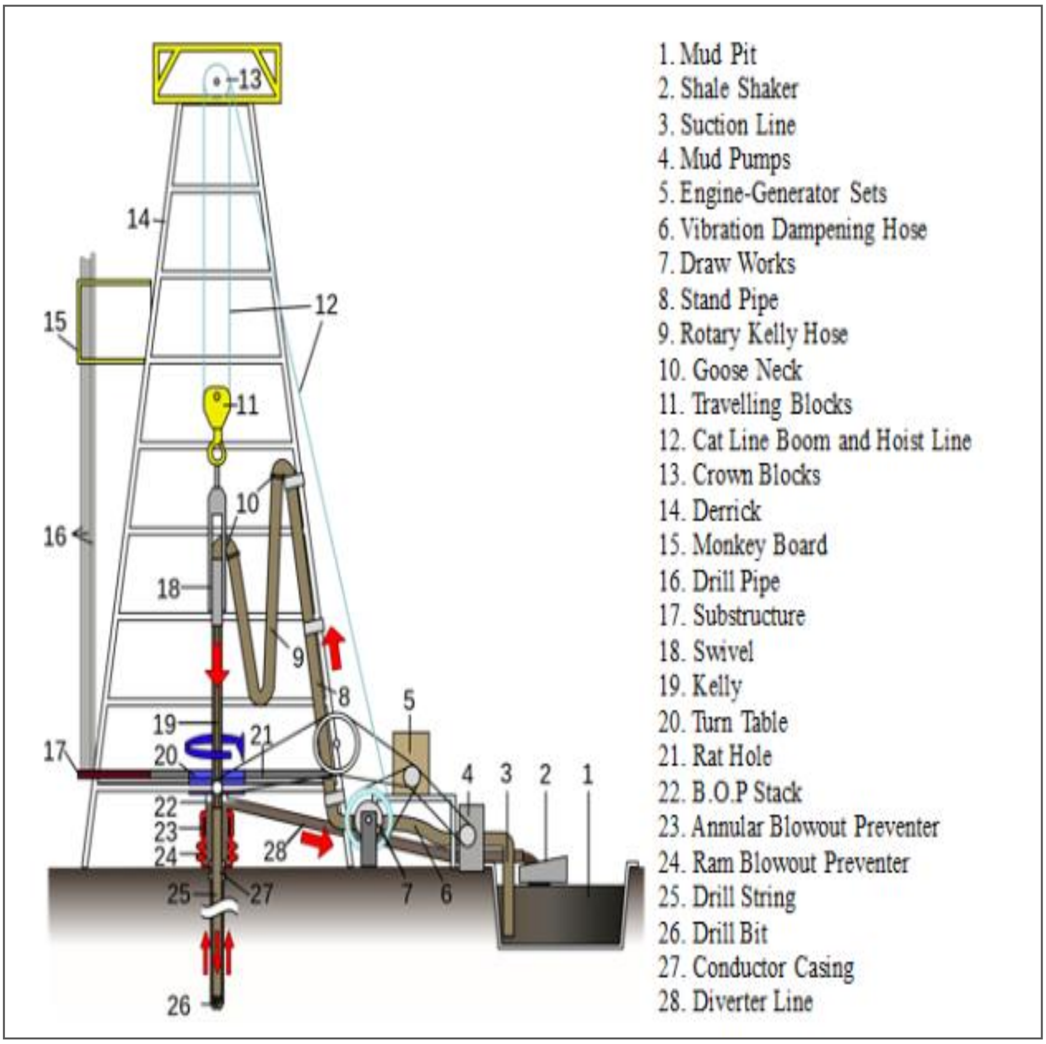

Figure 10. Typical Drilling Rig Configuration.

Drilling Operation

A rig would be installed at the potential site of drilling after thorough inspection for its working capability and quality standards. Well spudding would be the start of drilling activity. Wells would be drilled in sections, with the diameter of each section decreasing with increasing depth. Before commencing the actual drilling, large diameter pipe (Conductor) would be lowered into a hole and cemented/grouted. Top-hole section would be drilled to a desired depth based on well design. After drilling top-hole section, it would be cased with a pipe called “Casing”. Once each section of the well is completed, the drill string is lifted, and protective steel pipe or casing lowered into the well and cemented into place. The lengths and diameters of each section of the well would be determined prior to the starting of the drilling activities and are dependent on the geological conditions through which the well is would be drilled. This process of drilling and casing the hole section continues until the final well depth (target) is achieved. A typical model of onshore drilling process is presented in Figure 11.

Figure 11. Typical Model for Onshore Drilling Process

Mud System and Cuttings

During drilling operations, the drilling fluid (or mud) is pumped through the drill string down to the drilling bit and returns at the drill pipe–casing annulus up to surface back into the circulation system after separation of drill cuttings /solids through solids control equipment. The primary function of drilling fluid is to ensure that the rock cuttings generated by the drill bit are continuously removed from the wellbore. The mud must be designed such that it can carry the cuttings to surface while circulating, suspend the cuttings while not circulating and drop the cuttings out of suspension at the surface. The drilled solids are removed at the surface by mechanical devices such as shale shakers, de-sanders and de-silters. The hydrostatic pressure exerted by the mud column prevents influx of formation fluids into the wellbore. The instability caused by the pressure differential between the borehole and the pore pressure can be overcome by increasing the mud weight. Hydration of the clays can be overcome by using non-aqueous based muds, or partially addressed by treating the mud with chemicals which would reduce the ability of the water in the mud to hydrate the clays in the formation. Water based mud would be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations would be drilled using synthetic base mud (SBM). Synthetic base mud can be re-used. At the end of drilling a well almost the entire amount of the SBM is collected for re-use in next drilling operation. SBM systems promote good hole cleaning and cuttings suspension properties. They also suppress gas hydrate formation and exhibit improved conditions for well bore stability compared to most WBM. WBM typically consists of water, bentonite, polymers and barite. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation. The mud would be used would be continuously tested for its density, viscosity, yield point, water loss, pH value etc. The mud would be prepared onsite (drill location) using centrifugal pumps, hoppers and treatment tanks.

During drilling activity, cuttings would be generated due to crushing action of the drill bit. These cuttings would be removed by pumping drilling fluid into the well via triplex mud pumps. The mud used during such operation would flush out formation cuttings from the well hole. Cuttings would be then separated from drilling mud using solids-control equipment. This would comprise a stepped system of processes consisting of linear motion vibrating screens called shale shakers, hydro-cyclones (including de-sanders and de-silters), and centrifuges to mechanically separate cuttings from the mud.

Flow chart for drilling mud & solid discharge is shown in Figure 12 and a typical view of drill cutting separation & Treatment system is shown in Figure 13.

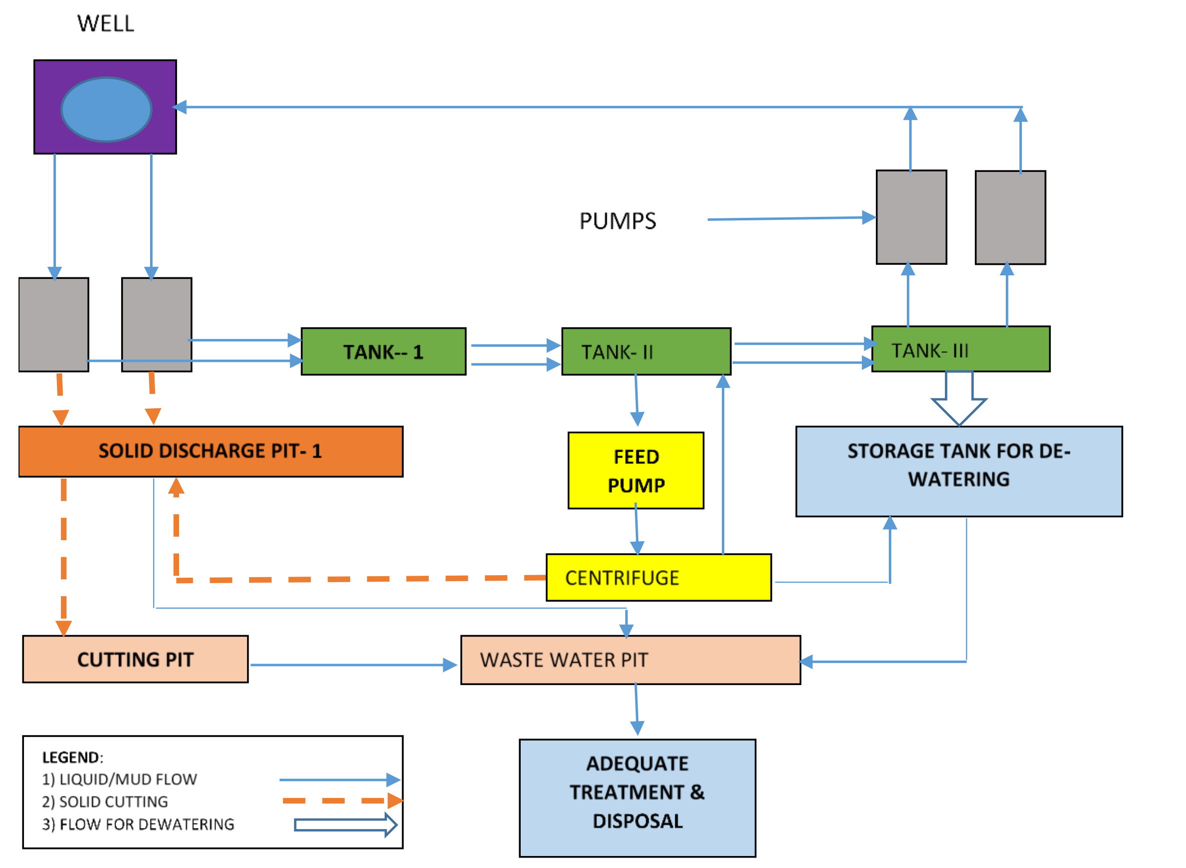

Figure 12. A Typical View of Drill Cuttings Separation & Treatment System

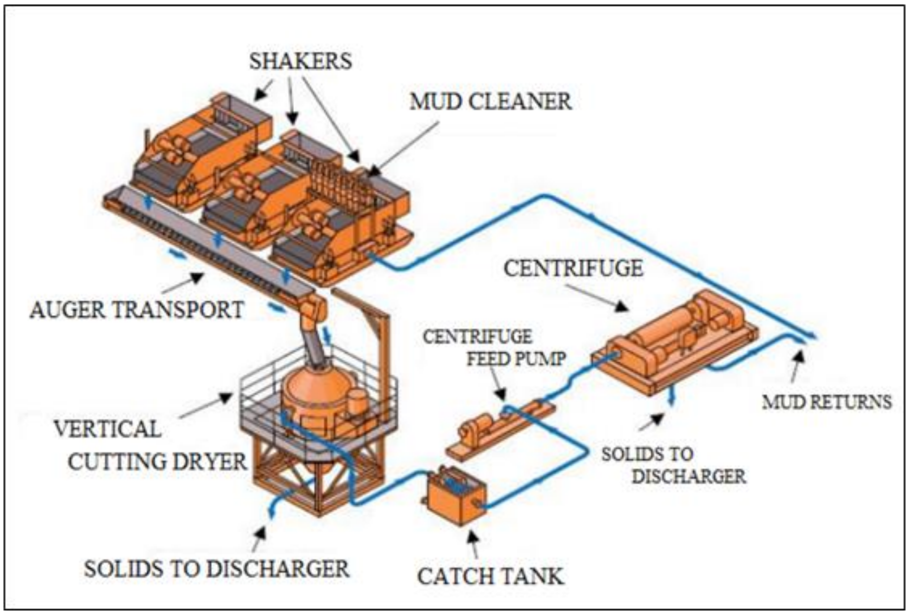

Figure 13. Typical view of Drill Cuttings Separation & Treatment System

Cementing

Cementing is a necessary aspect of exploratory drilling oil and gas wells. Cement is used to fulfil the following works:

- Secure/support casing strings
- Isolate zones for production purposes

Well Evaluation

During the drilling operations for different zones, logging operations would be undertaken to get information on the potential type and quantities of hydrocarbons present in the target formations. Technicians employed by a specialist logging Service Company do well logging by different well logging techniques including electric, sonic and radioactive techniques. Logging instruments (sensors) are attached to the bottom of a wire line and lowered to the bottom of the well and they are then slowly brought back. No emissions to the environment or any environmental harm is associated with wire line logging operations. The radioactive source required for well logging operations would be kept in specially designed container.

A drill-stem test would be frequently performed to evaluate the formation or zone from which the gas show was observed. A drill-stem test enables the exploration company to obtain a sample of the fluids and gases contained in the formation or interval being tested as well as pressure information, which is determined by special gauges within the test tool. The test tool contains a valve which may be opened and closed to allow formation fluids to enter the test tool and drill string. If there is sufficient fluid and pressure within the zone being tested, the formation fluid may rise to the surface and flow into special test tanks used for that purpose. If gas is present, it is burned at the surface as a flare.

Hydraulic Fracturing – for Tight Rock Reservoirs of Hydrocarbons

Hydraulic fracturing is used in tight rock reservoirs with low permeability, such as shale (i.e, the conductivity or ability of hydrocarbons to flow in the formation is low because of the small pore size in the rock). The goal of hydraulic fracturing in tight reservoir (shale) formations is to enable a well to produce the resource or to increase the rate at which a well is able to produce the resource. Hydraulic fracturing may be conducted in wells with low permeability formation and low pressure. Wells requiring hydraulic fracturing and numbers of stages of hydraulic fracturing per well would depend on seismic data acquired & interpreted and data acquired during the drilling phase of the project.

Hydraulic fracturing is a common technique used to stimulate the production of oil and natural gas by creating fractures or cracks that extend from the well hole into the rock formations. This is accomplished by injecting fluid, which is usually a mixture of water and high viscosity fluid additives, under extremely high pressure. The pressure of the water would then exceed the strength of the rock, causing fractures to enlarge. After the fractures take place, a “propping agent” known as proppant (which is usually sand) is injected into the fractures to keep them from closing. This allows the hydrocarbon to move more efficiently from the rock to the well. A single well may require up to 15,000 m^3 of water which may vary depending on the fracking requirements. For the hydraulic fracturing in a well, proppant mass of 150,000 – 200,000 lbs per stage and fluid volume of 2500 bbls – 4000 bbls per stage would be required.

Fracturing effluent generated would be discharged in the HDPE lined pits at the drilling well sites. The effluent would be treated for disposal and reuse to the extent possible.

Well Kick Situation & Control measures

While drilling, if the formation pressure exceeds the hydrostatic pressure exerted by the drilling fluid, formation fluids break out in to the well bore. This is called kick. Primary means of well control is to have sufficient over-balance over formation pressure. For some reason if an unexpected over-pressurized formation is encountered while drilling and if the well control situation arises, rig is equipped with equipment to control this situation. This set of equipment is called “Blowout Preventers (BOP)”. Blow Out Preventer consists of, “Annular Preventer”, which can generally close on any size or shape of tubular in the well bore and closes the annular space between drill string and casing. Another type of blowout preventer is a “Ram Preventer”. Ram preventers are of two types i.e., Pipe Rams and Shear Rams. Pipe rams also close the annulus between drill string and casing, but they have a fixed size. As such a specific pipe rams can be closed on a specific size of pipe. Shear rams are generally the last choice of preventer would be operated as they shear drill string and shut off the well bore. After determining the existing formation pressure and other geological complexities from the seismic data, appropriate BOP would be used as per standard oil field guideline for the same.

All these preventers would be stacked in a sequence and such assembly of preventers is termed as BOP stack. A typical BOP stack is illustrated in Figure 14. Blowout prevention equipment would be installed, tested and operated according to the well control procedures of Vedanta Limited (Division: Cairn Oil & Gas).

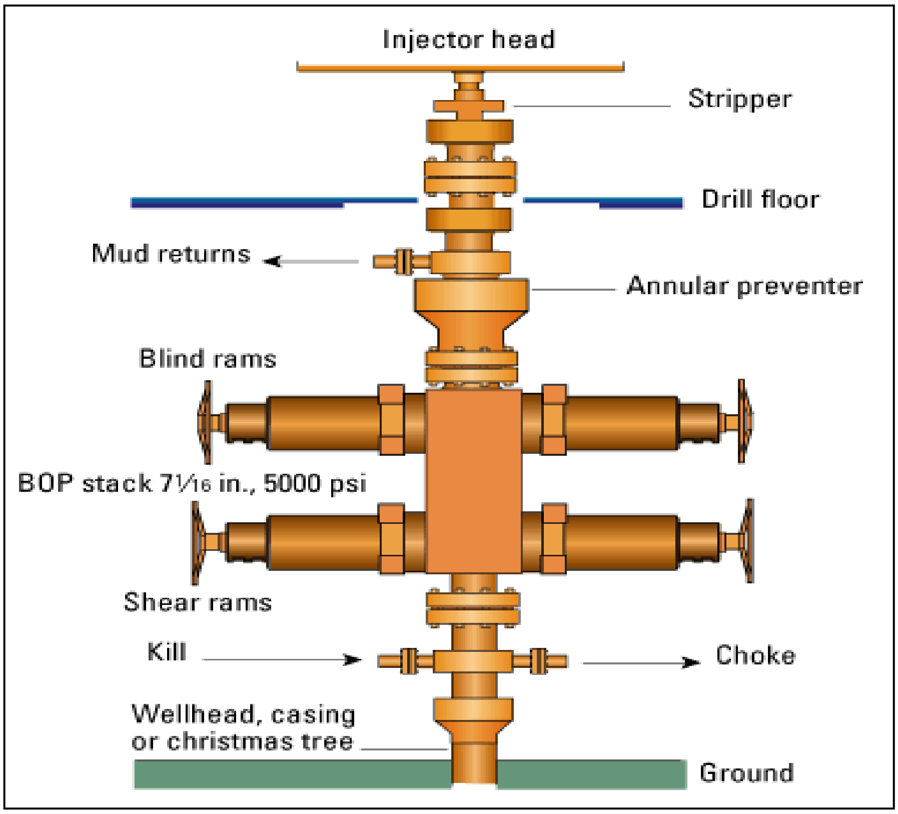

Figure 14. Schematic diagram of Blow Out Preventer

Well Testing & Flaring

During the exploration and appraisal drilling, where a hydrocarbon formation is found, initial well tests (generally about one month of duration) would be carried out to establish flow rates, formation pressure and other parameters. However, depending on the need, based on nature of the reservoirs, the exploratory and appraisal wells would be tested for longer/extended durations to ascertain the reservoir parameters. During the well testing, crude oil, natural gas and produced water could be generated and would be treated and disposed appropriately. Hydrocarbons would be flared. Efficient test flare burner would be used to minimize incomplete combustion. As an alternative option, if feasible, crude oil/ slop oil would be transferred to nearby refinery (terminals/depots) for processing or would be sent to authorized recyclers.

2.6 Early Production

Drilling of Appraisal wells to Quantify the Hydrocarbon Reserves

When, exploratory drilling is successful, more wells (termed as Appraisal wells) would be drilled to determine the size and the extent of the field. Wells drilled to quantify the hydrocarbon reserves found are called as 'appraisal' wells. The appraisal activity would be carried out with an aim to evaluate the size and nature of the reservoir, to determine the number of confirming or appraisal wells required, and whether any further seismic survey is necessary. The technical procedures and activities in appraisal drilling would be the same as those employed for exploration wells. A number of wells may be drilled from a single well pad/ drill site. Deviated or directional drilling at an angle from a site adjacent to the original discovery well may be used to appraise other parts of the reservoir, in order to reduce the land requirement.

Early Production Units (EPUs)/ Quick Production units (QPUs)

Early Production Units (EPUs) or Quick Production Units (QPUs) would be installed for the processing of produced well fluid. A EPU/ QPU would be a packaged/ modular mobile unit and would mainly consists of a heater-treater separator or a production heater followed with a three phase separator, electrostatic coalescer, oil storage tanks, oil tanker loading system, produced water separation and disposal system, power generation (GEG or DG), test separator skid, utility systems such as fuel gas, flare, Inst. Air package, diesel storage, firefighting equipment, etc. A QPF would be designed for a capacity of 2,000 BLPD (Barrels of liquid per Day) with water cut variation from 0 – 50 vol%.

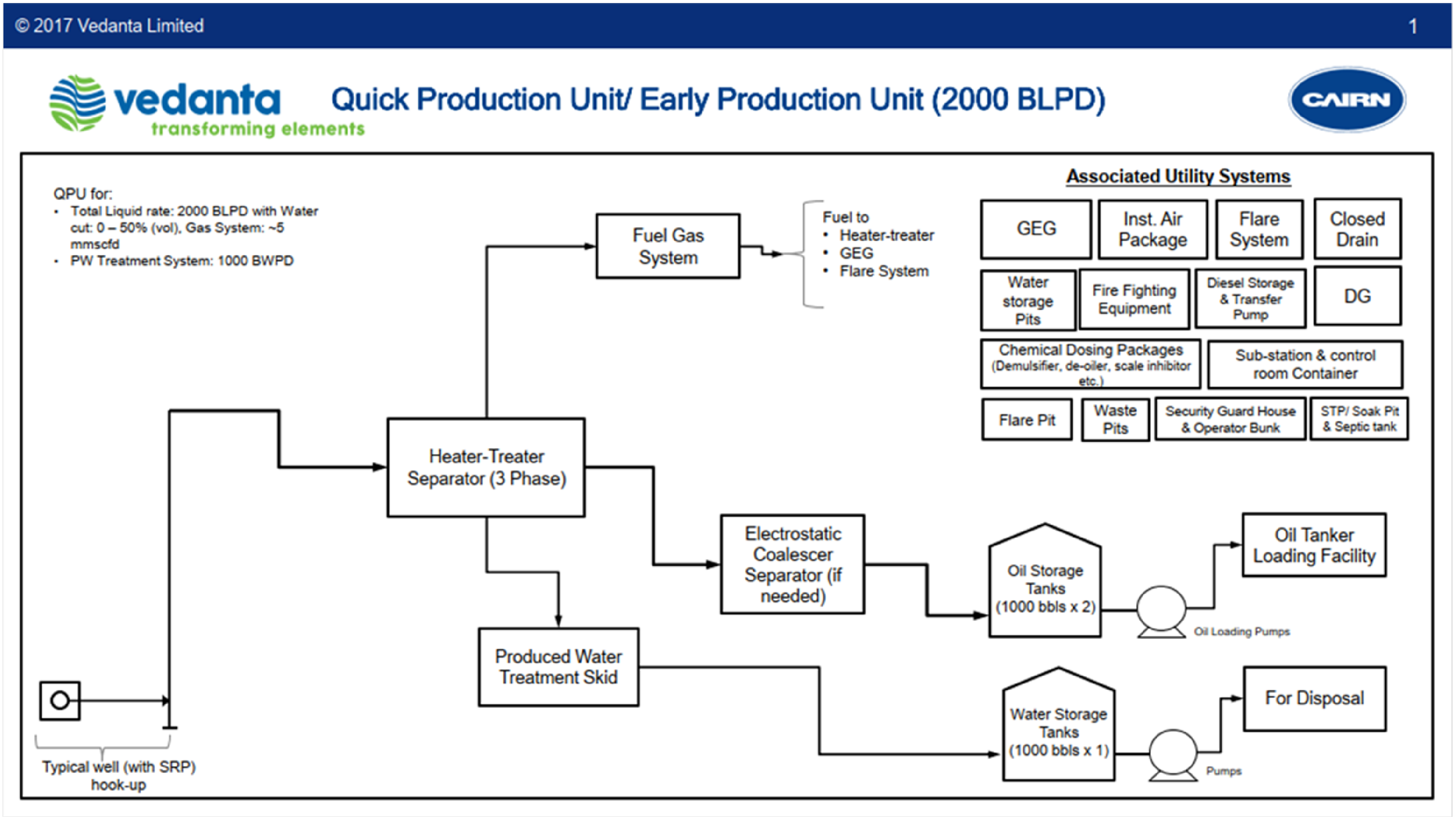

Figure 15. Early Production Units (EPUs)/Quick Production Units (QPUs)

Source: Vedanta Ltd (Division :Cairn oil and Gas)

Produced well fluid from one or more successful exploratory/ appraisal wells would be gathered & sent to heater-treater separator skid for primary separation & heating purpose. Gathered produced fluid would be heated & degassed in heater-treater separator skid operating at ~2.5 – 3 Barg and ~70 – 80 ^{0}C and separated in to gas, oil and water streams. The separated produced (associated) gas would be either routed to fuel gas system or to flare depending on the quantity and richness of produced (associated) gas. In case of sufficient quantity of produced gas, a part of the produced gas would be used for power generation using gas engine generator (GEG), for firing in heater-treater separator skid and for blanketing & purging purpose. The surplus gas post internal consumption (if any) would be routed to flare for safe atmospheric discharge.

Separated oil from heater-treater separator skid would be sent to electrostatic coalescer separator (if needed, based on oil properties) to separate the residual water and achieve BS&W specifications. The treated crude oil from electrostatic coalescer separator would be sent to oil storage tanks. From oil storage tanks, oil would be pumped & loaded in to road tanker using the tanker loading facility for evacuation of crude oil to the nearby available facilities like terminals/ depots of consumers.

Separated produced water (PW) from heater-treater separator skid would be sent to degasser vessel operating at low pressure. The evolved HC gases from degasser vessel would be routed to flare for safe disposal and the degassed water sent to PW treatment package.

The PW treatment package would consist of a compact flotation unit or other equivalent gas floatation based de-oiling (oil removal) system and a filtration system. The treated water from PW treated skid would be stored in PW storage tanks. The produced water would be treated to achieve MoEF &CC/ CPCB/ SPCB specifications (discharge standards) and would be disposed off. The treated effluent (i.e. produced water) would be disposed-off using either a nearby down hole disposal well (by reinjection in abandoned well) or other available and suitable onshore disposal medium or solar/ mechanical evaporators depending on the quantity and feasibility.

The power requirement would be met through either state electricity grid and/ or installation of Diesel/ Gas Engine Generator(s) using produced gas. If produced gas is sufficient quantity, then power generation using produced gas would be preferred.

Along with above processing facility, a well test separator skid would be installed at pad. It would be used for well testing purpose. Well under testing would be routed to test separator skid. The separated gas, oil & water would be sent back to inlet of heater-treater separator skid for further processing. Quick production set-up would have following utility systems & infrastructure for supporting the operations.

- Wells with selected artificial lift and flow lines
- Fuel gas system consisting of filters & a super-heater
- Instrument Air package or Instrument as system
- Chemical dosing packages i.e. corrosion inhibitor, de-mulsifier & scale inhibitor etc.
- Elevated flare system or enclosed ground flare or ground flare
- Closed drain system, storm water drain system
- Fresh water storage
- Diesel storage
- Power generation (GEG and / or DG)
- Firefighting equipment
- Domestic sewage treatment facility (STP or septic tank & soak pit system);

2.7 Completion of Drilling

On completion of activities, the well would be either plugged and suspended (if the well evaluations indicate commercial quantities of hydrocarbons) or would be killed and permanently abandoned. In the event of a decision to suspend the well, it would be filled with a brine solution containing very small quantities of inhibitors to protect the well. The well would be sealed with cement plugs and some of the wellhead equipment (Blind Flange) would be left on the surface (Cellar). If the well is abandoned it would be sealed with a series of cement plugs, all the wellhead equipment would be removed, by leaving the surface clear of any debris and the site would be restored.

2.8 Well Decommissioning

After the completion of the drilling activity, partial de-mobilization of the drilling rig and associated infrastructure would be initiated. As discussed earlier, well testing may be carried out immediately after the drilling is completed. The complete de-mobilization of the facilities at site would happen once well-testing completed successfully. This would involve the dismantling of the rig, all associated equipment and the residential camp, and transporting it out of the project area. It is expected that demobilization would take approximately 20-25 days and would involve the trucking away of materials, equipment and other materials from the site to bring it back to its original condition. It is estimated that about 50 truckloads would be transported out of site during this period. If no indication of any commercially viable amount of oil or gas is encountered either before or after testing, the well would be declared dry and accordingly would be plugged of and abandoned, and the site would be restored in line with regulations and good industry practice.

2.9 Utilities & Resource Requirements, Associated Facilities

Liquid Mud Plant (LMP)

The Liquid Mud Plant (LMP) would be located at suitable locations of the field to prepare drilling mud for the drilling operations. It is estimated around 3 – 5 LMP's would be set-up at any a given point of time for the proposed drilling operations. All the tanks, equipment's, civil works, pumps, mud laboratory with testing equipment along with the mud waste disposal pits would be constructed within a single location.

The entire LMP area would be provided with containment area and with facilities for fork lift movement and transportation of solid waste skips. The area would be designed to facilitate tanks for SBM mixing/ storage, tanks of base oil storage and another tanks for brine mixing/storage. These tanks are interconnected with piping and manifold with mixing hoppers, pumps connections, centrifuges connection with complete mud conditioning set-up, loading-unloading piping/hoses connections.

The Mud Plant area would be surrounded with a containment boundary wall. All the liquid transferred from the LMP to the drilling site would be through road tankers. For power supply requirement DG sets would be required with one operational and one standby.

The LMP would have water storage tanks, bunk houses for operating office and site laboratory, dry chemical storage area in paved surface, truck loading and unloading area with parking facility, cranes & forklifts maintenance and parking facility, septic tank with soak pits, DG area, diesel storage area and power distribution panel & facility.

Accommodation & Camp Site

Drilling camp sites would be set-up within the vicinity of the drilling sites to allow for easy movement of the crew between the camp and the drilling sites. The camp site would generally comprise of transportable container cabins (portable cabin) of 20 feet and 40 feet size to provide accommodation to operational crew. Each cabin would house 2 to 4 persons. A typical view of Vedanta Limited. (Division Cairn Oil & Gas)'s camp site has been presented in Figure 16 below. Toilet facilities would be built as part of the accommodation unit. The sewage lines from the units would be connected through a pipeline system to a septic tank and soak pit system. Additionally, there would be dedicated cabins to serve as kitchen, cold storage, dining area, recreation area, laundry etc.

Figure 16. Typical View of Camp Site

Approach and Internal Roads

The approach road to drill sites would be constructed and/or existing roads would be strengthened for movement of construction machinery, drilling rig, material supply vehicles, passenger vehicles etc. depending on the location of drill site. In general, it is intended to make the maximum use of the existing road infrastructure.

Water Storage Pit

The water storage pit contains the water used for preparing drilling fluid and domestic purpose. Provision for additional water storage would be kept in case multi-stage fracturing is planned.

Chemical Storage Area

The chemicals would be used in preparing mud would be stored on a paved platform with kerb walls and protected against weather by an impervious covering. All the storage areas would be identified with labelling and sign boards. Material Safety Data Sheets (MSDS) would be maintained for all chemicals that are stored and handled at the drill site. The storage area would be provided with adequate number of fire extinguishers.

Spent Drilling Fluid Disposal Pits

All wastewater from the drilling operations would be collected in the drilling fluid storage pit. The wastewater in this storage pits would be recycled and reused during drilling phase. The residual wastewater would be sent to solar evaporation pit for natural solar drying. The pits would be lined with HDPE sheet and the overlaps welded together with the edges bought over the rim and tucked into the cement mortar / bund soil.

Drill Cutting Disposal (impervious lined) Pit

While recycling the mud, the drill cutting would be separated through shale shaker, which would be disposed off to cutting disposal pit. This pit would be similar in construction to the solar pit. It would be lined to avoid contamination of land and groundwater. The pit would be soil bunded and HDPE lined to prevent any overflow to the surroundings.

Flare Pit (well testing)

To conduct ground flaring, all the sites would have a flaring pit with adequate burner. The flare pit would be made up of RCC / brick lining and are located preferably 90 degrees to the predominant wind direction. The location of the pit also depends on the entry to the site from the adjacent road side, processing units or tanks.

Flare Stack

A flare system consists of the flare stack or boom and pipes which collect the gases would be flared. The flare tip at the end of the stack or boom is designed to assist entrainment of air into the flare to improve burn efficiency. Seals installed in the stack prevent flashback of the flame, and a vessel at the base of the stack removes and conserves any liquids from the gas passing to the flare.

- For effective flaring CPCB's document "Oil & Gas drilling and extraction industry" June 2006 would be followed as follows:
- Standard flare design - An efficient test flare burner head equipped with a combustion enhancement system would be selected to minimize incomplete combustion, black smoke, and hydrocarbon fallout. Volumes of hydrocarbons flared would be recorded.
- Location and height of the flare stack based on maximum ground level concentration criteria & maximum radiation intensity exposure criteria
- Flare stack- Minimum physical height of stack would be 30 m from ground level. Only in those situations and or locations where elevated flares are not technical feasible, then ground flaring/enclosed ground flaring may be resorted to, such as when there is a crop cultivation / vegetation in the vicinity of the well pad or / and where flared gas volume is <0.5 MMSCFD (due to this low volume, sometimes elevated flare gets extinguished in presence of wind).

Diesel Storage Tank

The fuel (diesel) would be received in bulk quantity through tankers and would be stored in above ground steel diesel tanks. The tank area is provided with secondary containment of adequate capacity to control any accidental leaks.

Waste Storage

Hazardous wastes generated from drilling activities such as used oil from pumps and machinery, empty chemical and fuel barrels, contaminated oil rags and soil etc would be collected and stored in a designated storage area. The storage area would have paved flooring, containment bund and roof. Waste oil from pumps and machinery would be collected and stored in used oil barrels and would be kept in a designated storage area. The contaminated soil and cotton rags would be disposed of at approved secured Land fill as per the legal provision. Used oil would be disposed off through recyclers/ re-processors registered with the Central Pollution Control Board and authorized by State Pollution Control Board.

Storm Water Drainage System

Adequate drain would be provided all around the drilling site to prevent runoff of any oil containing waste water into the nearby natural drainage area. The storm water drain would be provided with oil trap and the collected water would be sent to storm water pit.

Spill Containment System

Containment systems and oil traps would be provided to trap any spillage of oil at the drilling site. All potential sources of spillage would be equipped with drip pans in order to contain spills.

Sewage Treatment Plant (STP)

Mobile STP or septic and soak pit of capacity 30 m^3/day for treatment of sewage and sullage Water generated within the well pad limits. Each well site and camp site would have toilets which would be provided with septic tanks and soak pit arrangement. To cater to about people that would stay in the camps site, adequately sized septic tanks and soak pits would be provided.

Raw Material Requirement

Maximum care would be taken for resource optimization, wherever possible with an aim of

- Resource Conservation
- Elimination of Waste Streams
- Minimizing Waste
- Reuse/recycle of Wastes
- The drill cuttings from the drilling operations associated with water-based mud would be used for filling low lying areas as a sub grade construction material in construction of well pads, etc.
- Synthetic base mud would be re-used in further drilling activities

Raw Material Required for Drilling

During drilling activities, materials like HSD, Steel (in the form of casings & tubulars) and chemicals like barite, oil well cement and bentonite would be required. Other production equipment like tubular (Casing and tubings), wellhead assembly, packer etc, and chemicals for mud and cementing required for the drilling operations and would be procured by the company from within the country and from abroad before the commencement of operations.

Water based mud would be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations would be drilled using synthetic base mud (SBM). Synthetic based mud can be re-used. WBM typically consists of water, bentonite, polymers and barite. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation.

- Requirement WBM (approx.) 800-1000 m^3/well
- Requirement SBM (approx.) 600-800 m^3/well

The role of the mud in pressure control is especially important. If the drill bit penetrates a formation containing oil, gas or water under pressure these fluids are prevented from flowing into the borehole by ensuring that the drilling mud is of sufficient density to the natural formation pressures. The density of the mud can be increased by the addition of barite weighting material. Bentonite is employed to improve the theological properties and enable the drill cuttings would be transported from the hole while drilling and also be suspended in the fluid while the drill bit is being changed. The barite used in the drilling mud would be as per American Petroleum Institute (API) standard specifications.

Power Requirement

Drilling Operations

The power requirement in the drilling site and the campsites would be provided through diesel generator (DG) sets. The rated capacity of the DG sets required for onshore drilling site is provided in the table 2.3

Table 2.3 Details of DG Sets of Onshore Drilling Activity

Sl. No.	Location	DG Capacity
Drilling Process		
1.	Camp site	2x350 KVA (Including one as standby)
2.	Drilling site	3x1000 KVA (Including one as standby)
3.	Radio room	2x100 KVA (Including one as standby) or 2 x 1850 KVA (Including one standby) *
Early production		
1.	Gas Engine Generator (GEG)	1 MW output
2.	DG for Emergency purpose	1 x 500 KVA

Source: Vedanta Limited (Division: Cairn Oil & Gas)

** Depending on the Rig Capacity and Rig availability during E&A drilling Phase*

Water Requirement

Drilling

Wells would be drilled by using either water-based mud or synthetic based mud. The water requirement in drilling rig is mainly meant for preparation of drilling mud apart from washings and domestic use. Water consumption during drilling and testing of wells would be 102m^3/day. Total 62 m^3 /day fresh water and 10m^3/day recycled water would be required for drilling activities and 30m^3/ day fresh water would be used for domestic purpose including drinking, washing and other domestic uses. The water requirement for all the project activities would be sourced locally through approved/authorized sources of surface water and/or ground water (e.g. PHD bore wells, privately owned bore wells, irrigation Department/water resources Dept. Of State Govt.). In case, required water would be extracted after obtaining permission from CGWA/State Govt.

Quick production unit/Early production unit

Approximately, 20 m^3 per day water would be required for domestic use in QPU/EPU.
The water requirement per well is shown in Table 2.4. Water balance diagram is presented in figure 17.

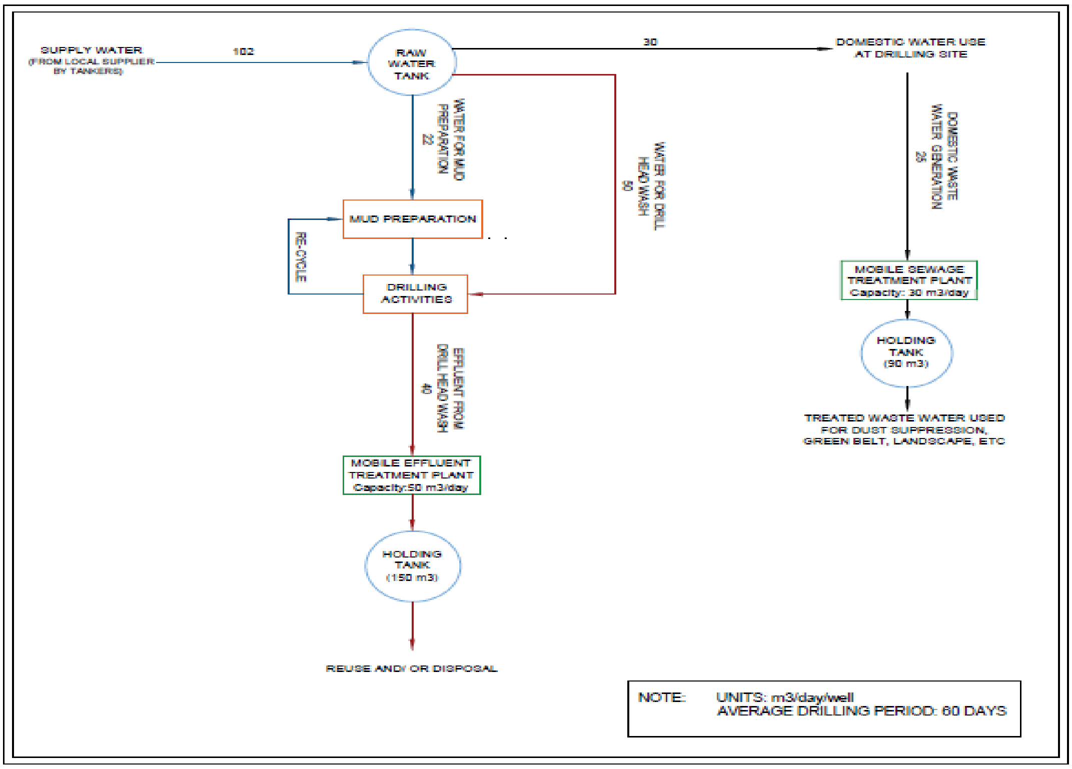

Figure 17. Water Balance for Drilling Phase of the Oil and Gas Exploration.

Table 2.4 Details of Water Requirement

Description	Quantity (m^3/day)
Total Water Requirement for Drilling	72
Total Water Requirement for Domestic Use	30
Total Water Requirement during Early Production Stage	15 – 18

Source: Vedanta Limited (Division: Cairn Oil & Gas)

Fuel Consumption

Fuel consumed during the drilling phase would mainly be diesel (HSD) used for various equipment and vehicles operating to transport goods and supplies to site.

During the drilling phase, High-Speed Diesel would be required. Fuel would be supplied onsite by local supplier through mobile tankers. Out of this, a major part approximately 85% would be consumed by the rig (also include the DG sets) and about 15% would be required for the campsite.

Manpower / Employment

Most of the workforce would be from local / nearby area. During the site preparation for drilling, approximately 30-35 workmen would be employed per drill site. During the drilling phase, about 50 workmen per shift would be working on site. This would include technical experts, who would be responsible for various drilling related activities and some technical manpower. It is anticipated that, at any given time, there would be about 80 - 100 personnel working on site including technical staff, drilling crew, security staff etc.

Drilling Hazards

Loss of well control / blow-out, fire, explosion and oil spills are the major potential hazards associated with drilling for oil and gas. Effective response plans to foreseeable emergencies would be developed by Cairn Oil and Gas and communicated to the project teams. The quantitative risk assessment would be carried out as part of this EIA would also contribute towards identification of hazards, risks and formulating management plans for emergency response, blowout, oil spills.

Pollution Sources and Characterization

The various types of pollution from the proposed exploratory drilling operations are:

- Noise and Vibration;
- Air Emission;
- Liquid waste and
- Solid and Hazardous waste generation

Exhaust gases from DG sets, noise from the drilling operations, wastewater, drilling wastes are the major types of the pollutants generated during the proposed drilling operations which is a temporary activity lasting for maximum of 4- 5 months at each of the well locations.

Noise and Vibrations

Noise would be generated during various phases of the project, site preparation, drilling and decommissioning of wells. The major noise generating operations from the proposed activity are drilling operations, diesel generators, mud circulation pumps and movement of vehicles. Noise during the site preparatory phase would primarily be contributed by heavy construction machinery operating on site and vehicular sources. The noise generation work however is transient and limited to the drilling period only. The diesel generators would be provided with acoustic enclosures to comply with the regulatory requirements. Average noise emission ranges for different types of machineries and vehicles is shown in Table 2.5 and Table 2.6 respectively.

As drilling activity is continuous, part of the noise associated with functioning of the rig and ancillaries would be generated throughout day and night.

Table 2.5 Typical Noise Emissions from Construction Machinery

Equipment	Sound Level at Operator (in decibels)	
	Average	Range
Earth Moving Equipment		
Front End Loader	88.0	85-91
Back Hoe	86.5	79-89
Bull Dozer	96.0	89-103
Roller	90.0	79-93
Truck	96.0	89-103

Equipment	Sound Level at Operator (in decibels)	
	Average	Range
Material Handling Equipment		
Concrete Mixer	<85.0	-
Crane/Hydra	<85.0	-
Derrick	100	97-102

Source: British Columbia, "Construction Noise," Workers Compensation Board of BC

Table 2.6 Drilling Rig and Equipment Noise Level

Equipment	Equivalent Noise Level in dB (A)	
	Average	Range
Drilling Rig	96.9	88.0-103.0
Mud Pumps	76.9	73.3 -80.5
Diesel Generators	72.7	71.8-73.7
Shale Shakers	76.6	-

Air Emissions

Exhaust emissions are expected from diesel generators would be used for the operation of drilling activities. Emissions are also expected from flaring of gases during testing/extended testing of exploratory and appraisal wells. Vehicular emissions are likely to occur during the transportation of materials, equipment and workforce. The principal air pollutants would comprise of Suspended Particulate Matter (SPM), Sulphur and Nitrogen oxides (SO_2 and NO_2) and other hydrocarbons (HC).

Additionally, the flaring and burning of oil during the testing of the well would also lead to the release of some pollutants including un-burnt hydrocarbons to the atmosphere. Some fugitive emissions of dust and air pollutants from vehicular exhaust would also happen during the project lifecycle, mostly during the operation and decommissioning activities. Additionally, there would be re-entrainment of dust from the approach road leading to the site mainly during the dry season.

The following pollution prevention and control measures would be adopted-

- Air emission specifications would be considered during all equipment selection and procurement.
- The associated gas stream would be routed to an efficient flare system.

Liquid Waste

The drilling operation would generate wastewater in the form of wash water due to washing of equipment, string and cuttings etc. The only other source of wastewater generated from drilling operation is sewage from sanitation facilities. Around 15 to 25 m^3/day/well of wastewater would be generated, which would be treated in modular Sewage Treatment Plant (STP) and the treated water would be used for dust suppression, green belt, etc. It is expected that wastewater in the form of Drill cutting washing + Rig washing+ cooling etc would be generated at an average rate of around 30 to 40 m^3/day/well during the drilling operations from a single well. Waste water would be discharged in HDPE lined evaporation pit for disposal. The wash water would contain variable quantities of mineral salts, solids, suspended and dissolved hydrocarbons, and other organic and inorganic components in very minor quantities. The drilling wash wastewater would be treated prior to discharge to comply with the regulatory standards. Treated effluent (PW) would be disposed off on the suitable onshore disposal medium or solar/mech. evaporators depending on feasibility. The quantity of wastewater generation and anticipated disposal methods is given in Table 2.7.

Table 2.7 Waste Water Generated During Drilling and their Disposal

Wastewater	Quantity	Disposal
Drilling wash wastewater	30-40 m^3/day/well	The wastewater would be adequately treated in an Effluent Treatment Plant (ETP) to ensure conformance to the CPCB onshore oil and gas extraction industry effluent standards
Domestic Wastewater	15-25 m^3/day/well	The domestic wastewater would be treated in mobile Sewage Treatment Plant and the treated water would be used for dust suppression, green belt, etc.

Solid and Hazardous Waste water

The different solid and hazardous waste water generated during project and their mode of disposal has been presented in Table 2.8.

Table 2.8 Waste Water Generated during and Mode of Disposal

Waste Type	Quantity	Mode of Disposal
Domestic Waste	25 – 30 kg per day/well	Would be stored in compost pits on daily basis.
Drill Cuttings associated with WBM	250-750 tons/ well	Cuttings would be washed and contained in cuttings disposal area (HDPE lined collection pit) provided per the requirement of HWMHTM, 2016 Rules
Drill Cuttings associated with SBM	500-1500 tons/well	Cuttings would be washed and contained in cuttings disposal area (HDPE lined collection pit) provided per the requirement of HWMHTM, 2016 Rules
Spent/Residual Drilling Mud	250-500 tons/ well	The mud would be tested for hazardous contaminants and would be disposed as per Hazardous Waste Rules, 2016
Sludge containing oil & other drilling wastes	250-500 tons/ well	The oil contaminated sludge would be disposed as per Hazardous Waste Rules, 2016
Used oil	1-2 tons/well	Used oil would be sent to CPCB authorized recyclers.
Non-combustible waste containing metallic residues	1000-1200 kg/well	Would be analysed for the trace/heavy metals content before disposing suitably
Left over chemicals and materials, scrap metal	250 - 500 kg/well	Scrap metal and recoverable material to the salvages before dispose of balance material the registered vendors
Cement, grit, blasting and painting wastes	500 - 600 kg/well	Would be disposed of their registered vendors on periodic basis.

Pollution Prevention Control Measures at Design Stage

Vedanta Limited. (Division: Cairn Oil & Gas) would include necessary pollution prevention control measures in the well pad designing stage. Basic provision for pollution prevention control measures would be as follows:

- **Liquid Mud Plant** - The Mud Plant area would be surrounded with a containment boundary wall. All the liquid transferred from the LMP to the drilling site would be through road tankers.
- **Chemical Storage Area** -The chemicals would be used in preparing mud would be stored on a paved platform with kerb walls and protected against weather by an impervious covering. The storage area would be provided with adequate number of fire extinguishers.
- **Spent Drilling Fluid Disposal Pits** - Spent drilling fluid would be recycled and reused during drilling phase. The residual wastewater would be sent to solar evaporation pit for natural solar drying. The pits would be lined with HDPE sheet and the overlaps welded together with the edges bought over the rim and tucked into the cement mortar / bund soil.
- **Drill Cutting Disposal** -Drill Cuttings would be disposed of in lined pits to avoid contamination of land and groundwater. The pit would be soil bunded and HDPE lined to prevent any overflow to the surroundings.
- **Flare Pit (well testing)** - To conduct ground flaring, all the sites would have a flaring pit with adequate burner. The flare pit would be made up of RCC / brick lining and are located preferably 90 degrees to the wind direction.
- **Diesel Storage Tank** - The tank area would be provided with secondary containment (dyke walls) of adequate capacity to control any accidental leaks.
- **Waste/ Lubricating Oil Storage** - The storage area would have paved flooring, containment bund and roof. Waste oil from pumps and machinery would be collected and stored in used oil barrels and would be kept in a designated storage area.

- **Storm Water Drainage System** - A garland drain would be provided all around the drilling site to prevent runoff of any oil containing waste into the nearby area. The storm water drain would be provided with oil trap and the collected water would be sent to storm water pit.
- **Spill Containment System** - Containment systems and oil traps would be provided to trap any spillage of oil at the drilling site. All potential sources of spillage would be equipped with drip pans in order to contain spills.
- **Mobile STP** - Each well site and camp site would have toilets which would be provided with modular STP for treatment of sewage generated within the well facility.

2.10 Project Cost

Vedanta Limited (Division: Cairn Oil and Gas) has planned to carry out the proposed project activities in the AA-ONHP-2017/11 Block over a period of 10-12 years.

The cost of the project is estimated is given below:

- Average drilling cost per well for exploratory & appraisal well is estimated would be INR 14 Crore.
- Average cost of each EPU (Early Production Unit)/ QPU (Quick Production Unit) is estimated would be INR 44 Crore.
- The cost of the proposed project has been estimated is about INR 352 Cr.

3. Description of the Environment

3.1 Introduction

This chapter describes the existing baseline environmental settings in study area including AA-ONHP-2017/11 Block and its immediate surroundings. This includes the physical environment comprising air, water and land components, the biological environment, and socio-economic environment. Attributes of the physical environment like air, water, soil quality and noise level in the surrounding area were assessed primarily through monitoring and analysis of samples collected from field. Baseline monitoring has been carried out during Summer season, 2019 (March to May 2019). Information about topography, geology, hydrology prevailing natural hazards risks like floods, earthquakes etc. have been collected from different available literatures and information from various government departments. Primary surveys were carried out to understand and record the biological environment prevailing in the area and the same was verified against published information and literatures. The socio-economic environment has been studied through consultations with various stakeholders in the villages within the AA-ONHP-2017/11 Block. Additionally, socio-economic data have been obtained from the Census of India 2011 reports.

3.2 Study area

The study area for determination of environmental, biological and social baseline is the entire AA-ONHP-2017/11 Block and 10km radius area from the Block boundary. The Block AA-ONHP-2017/11 is located in Golaghat and Jorhat district of Assam. The Block boundary is already defined in chapter 2 under article 2.3. The entire study area is covered by SoI Toposheet no G46K/1, G46K/2, G46K/3 and G46I/14. The hydrocarbon Blocks lie between 26°10'N to 26°30 'N Latitude and 94°10'E to 94°12'E longitude. The study area represents flat to moderately undulating terrain with ground elevation is below 100 amsl.

3.3 Physiography and Geology

The AA-ONHP-2017/11 hydrocarbon Block is located in Golaghat and Jorhat district of Assam.

Golaghat District

Golaghat district of Assam bifurcated from old Jorhat district form a part of the vast alluvial plain of Assam and covers an area of 3,502 sq. km. The district is bounded on the North by the River Brahmaputra, on the South by the Nagaland state, on the East by Jorhat and in the West by Karbi-Anglong and Nagaon districts.

Physiographically, the district shows a monotonous plain topography towards north and southeast, while the southwestern part of the area represents an undulating topography. The general elevation of the elevated area is around 100 meters above Mean Sea Level (MSL) and low-lying areas show altitude about 80 m above MSL. Maximum height of about 128 m above MSL is observed in the southern parts of the district, where it merges with the hills of the Nagaland as well as Karbi-Anglong district of Assam. The slope of the district is towards north east from south.

Geologically the district is underlain by Quaternary formation followed by Archaean group of rocks. Quaternary formation comprises younger and older alluvial deposits consisting of different grades of sand, pebbles, cobbles, gravel and clay in the area. Major parts in the north of NH-37 passing in the east-west direction in the district show younger alluvial deposits. The older alluvial deposits occur mainly towards southern parts of the NH37. The hard crystalline of Archaean age covers extreme southern boundary of the district merging with Karbi-Anglong district. The rock types are granite, granite gneiss and quartzite.

Jorhat District

The district is situated on the south bank of river Brahmaputra. It is bounded by the Naga-Patkai range at the south, Golaghat district on the west and in the south-east by the Wokha and Mokokchung districts of Nagaland. Sibsagar district lies to its northeast.

The district can be divided into five major parts, viz. flood plain of Brahmaputra river in the north, central upland area consists of younger alluvial formations, central upland area with older alluvial formation, southern undulating hill area adjacent with Naga Patkai range. The area is underlain by unconsolidated alluvial sediments of the Quaternary age, which can be differentiated into i) Older and ii) Younger alluvium. The Older alluvium present at the upland areas with sediments of oxidized and relatively compact nature, while the Younger alluvium occurs along the low-lying tracts of the area along the river courses (Plate II). The southern part of the area, adjacent to the Naga hill range is occupied by surficial blanket of clay, belonging to Younger alluvium and probably has been derived from the adjacent hills which are composed of the rocks of Tertiary age.

The elevation of the district varies from 90 – 312 (central flood plain to structural hills) metre above mean sea level. The mighty River Brahmaputra and its important tributaries like south Dhansiri, Bhogdoi and Kakodonga are the main drainage present in the district.

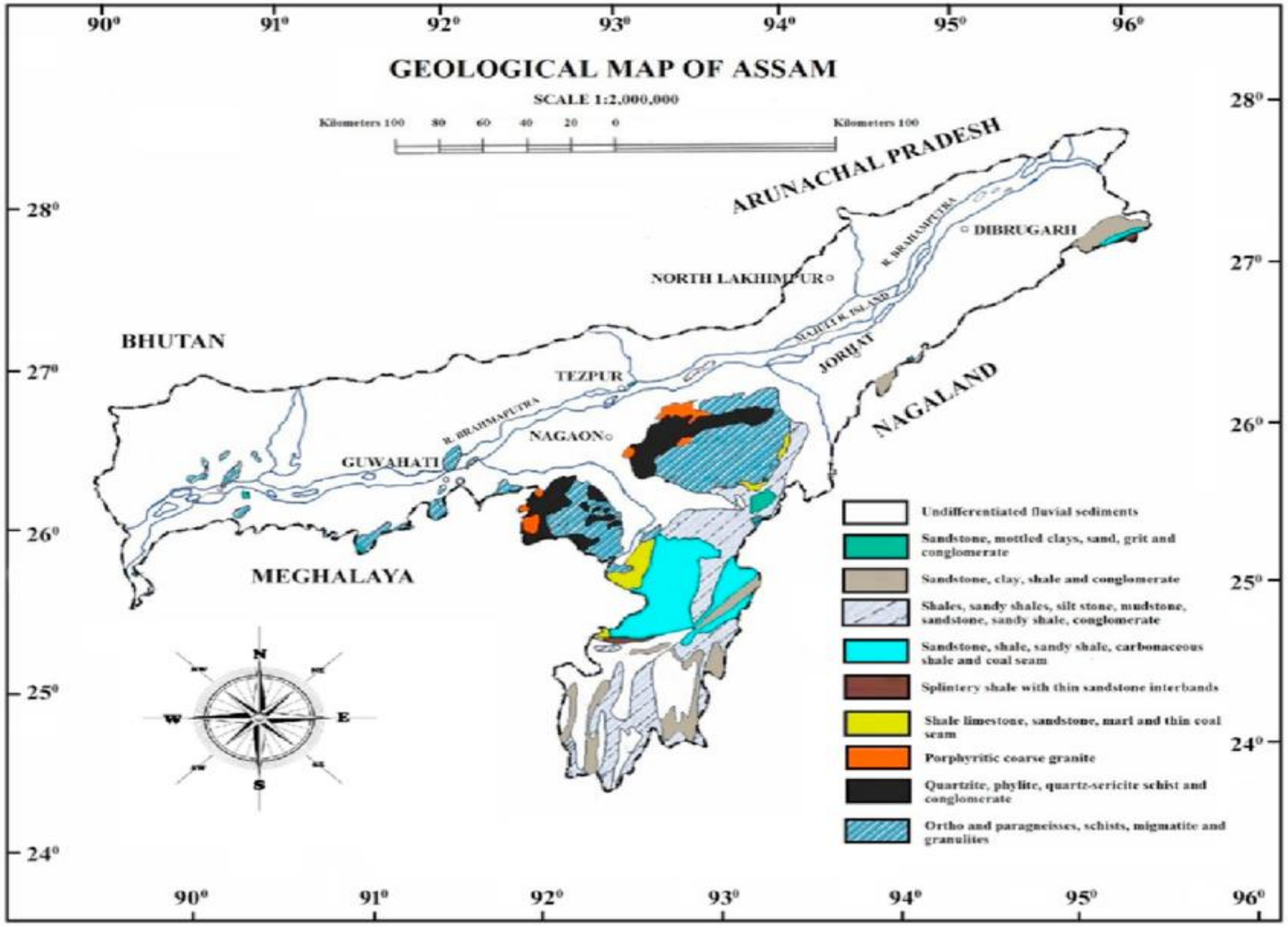

Figure **18.** Geological Map of Assam

Source: Geological Atlas of Assam

3.4 Hydrogeology

Golaghat District

As per the report of CGWB (2013), Sub-surface geology as evidenced from available data infers that the potential aquifer
pertaining to Quaternary formation exist down to the explored depth of 300 m. The cumulative thickness of aquifer zones has the tendency to increase towards the north and in the southeastern parts, the thickness reverses considerably.

Hydrogeologically, the district is proved to be very potential. Ground water occurs under water table to confined conditions. Depth to water level in major parts of the district varies from 2 to 5 m. In the extreme southern and southwestern parts close to hills, the water level is found to be deeper and generally rests within 5 to 7 m. The movement of ground water is from south to north. The water level trend shows that there is gradual rising of water level in the district.

The study of water level fluctuation by CGWB during pre and post monsoon revealed that During pre-monsoon period about water level marked up to 3.8 to 7.96 m bgl. During post-monsoon period water level marked above 3.31 – 6.89 m bgl.

Hydrogeological map of Golaghat district is given in Figure 19.

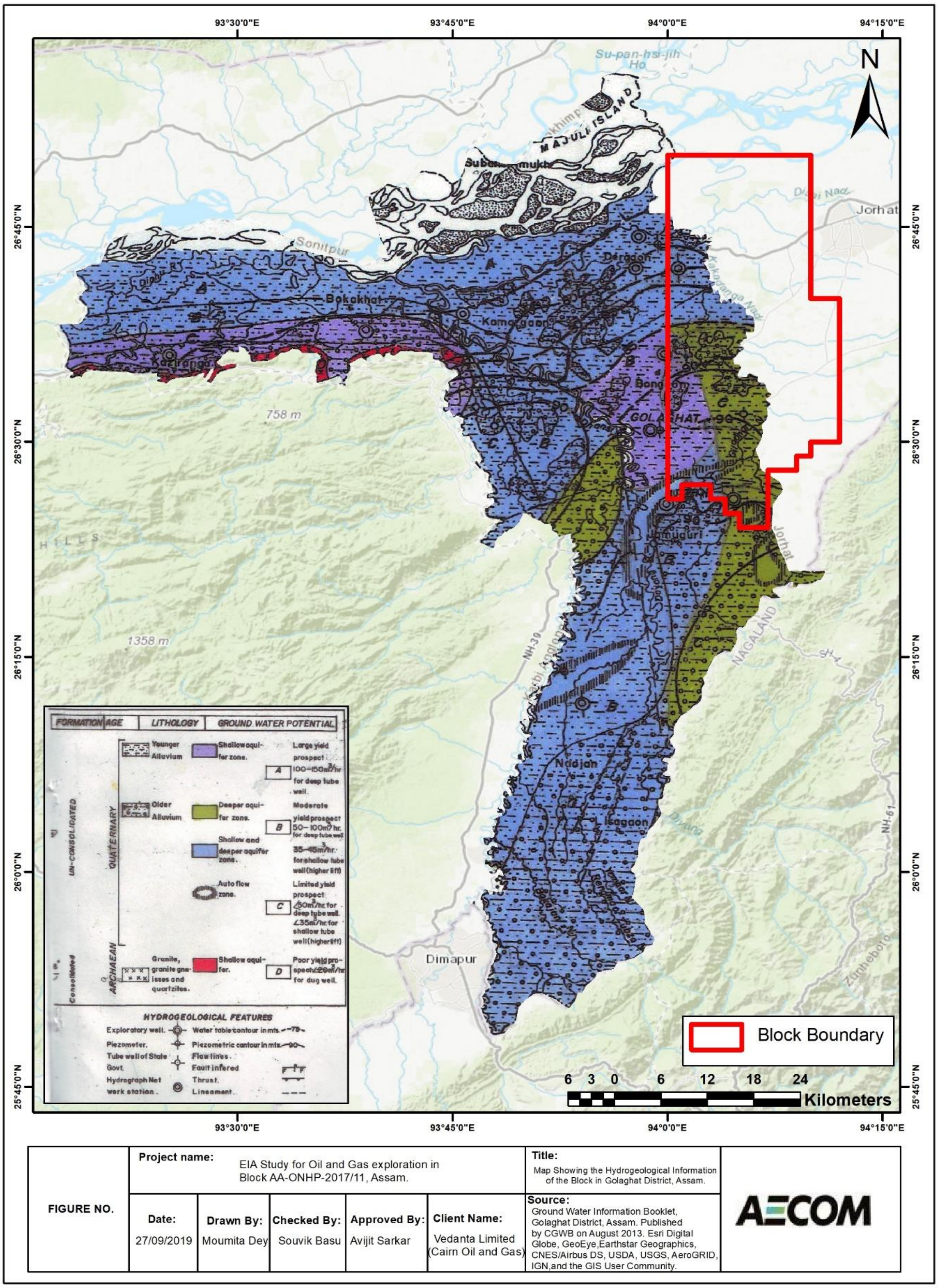

Figure 19. Hydrogeological Map of Golghat District

Source: CGWA report, Golaghat, 2013

Jorhat District

Ground water in the district mainly present in under water table to semi-confined conditions in the near surface conditions and in the deeper horizon, under semi-confined to confined conditions. Depth to water level in the water table zone varies from 0.41 to 3.07 m bgl in the pre-monsoon period and 0.56 to 3.41 m bgl during post-monsoon period.

As per the report of CGWB of Jorhat district, In the vicinity of Brahmaputra River, five to six aquifer systems with limited thickness exist within the depth range of 400 m. In the southern parts, the aquifer system fades out due to mixing of finer particles of sand and clay leading to decrease in thickness of aquifer system. The geometry of the aquifer system varies widely. In the north eastern and north western parts, the thickness of the aquifer increases, and clear sand beds exists. Throughout the district, varied thickness of clay beds overlying and underlying the aquifer system exist.

Hydrogeological map of Jorhat district is given in Figure 20

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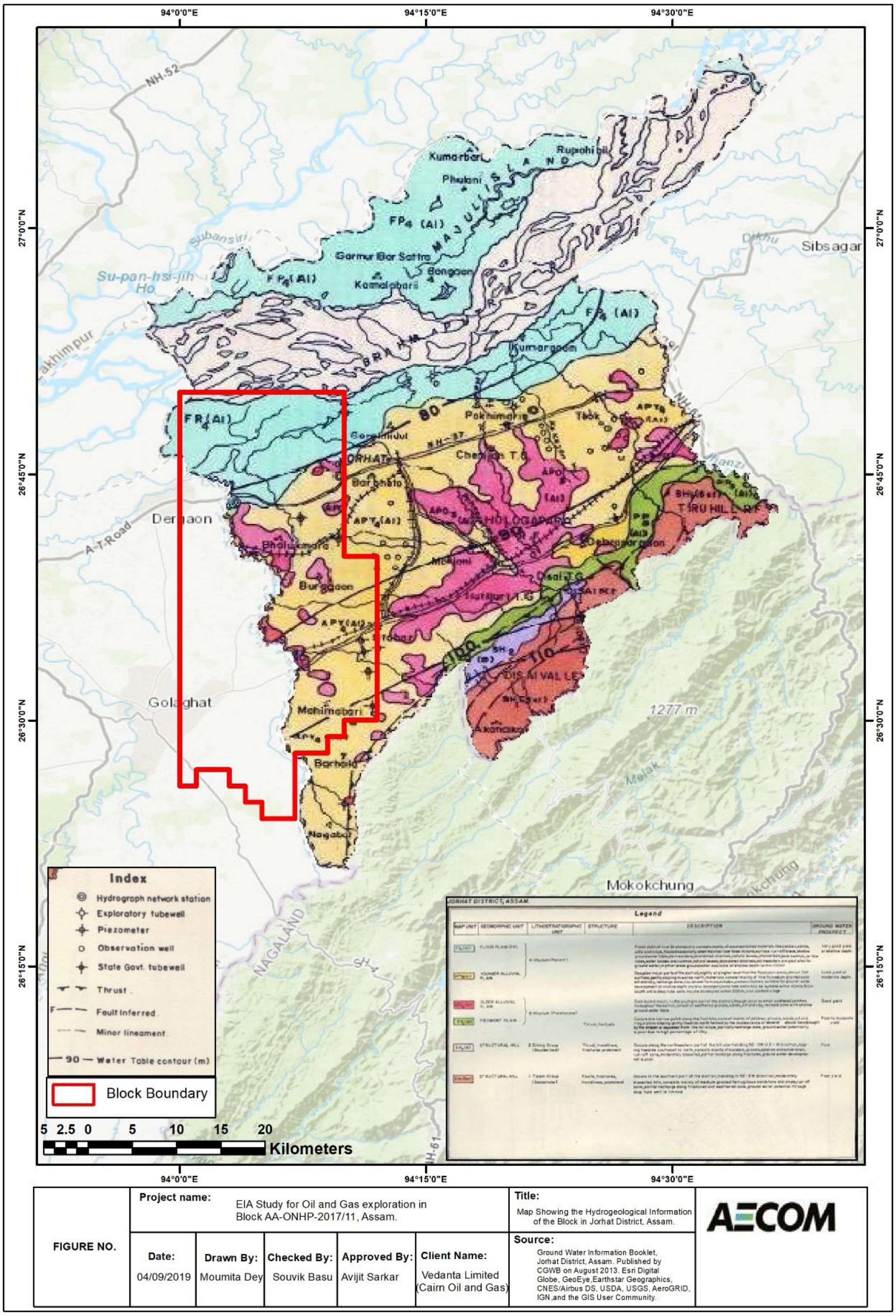

Figure 20. Hydrogeological Map of Jorhat District

Source: Central Ground Water Board, Ministry of Water Resources, Government of India

3.5 Topography

Golaghat District

Topography of Golaghat districts shows a monotonous plain topography towards northand southeast, while the southwestern part of the area represents an undulating topography. The general elevation of the elevated area is around 100 meters above Mean Sea Level (MSL).and low lying areas show altitude about 80 m above MSL. Maximum height of about 128 mabove MSL is observed in the southern parts of the district, where it merges with the hills ofthe Nagaland as well as Karbi-Anglong district of Assam. The slope of the district is towardsnorth east from south.

Jorhat District

The district topography can be described as five types of land forms:

(i) The flood plain of the Brahmaputra River in the north

(ii) The central upland area covering younger alluvial formations

(iii) The central upland area covering older alluvial formations

(iv) The southern undulating hill area running along the Naga-Patkai range covering the piedmont plain

(v) Structural hills.

The elevation of the flood plain area varies from 80 to 90 m while in the central upland area it is 95 to 110 m above Mean Sea Level. The altitude of the hills in the southern and eastern parts of the district is up to 312 m above MSL. The general trend of the hills is NE-SW and at places to N-S.

In general, the elevation of the block AA-ONHP-2017/11 is below 100 m from the mean sea level. Elevation map of the block is presented in Figure 21.

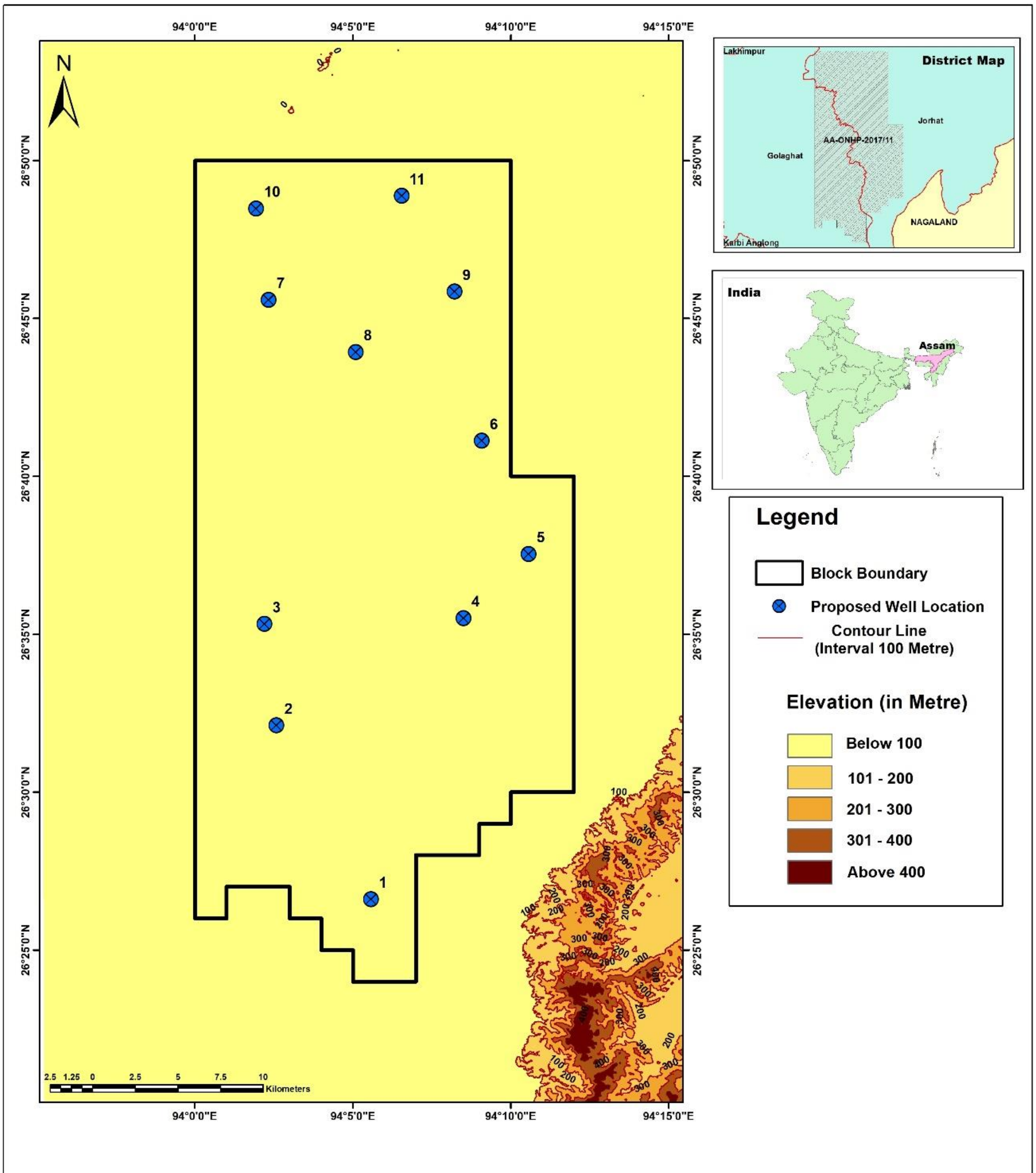

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Elevation Map	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth, Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) the GIS User Community and Indian Geo-Platform of ISRO(Bhuvan).	

Figure.21. Elevation Map of the Block AA-ONHP-2017/11.

3.6 Drainage

Golaghat District

The drainage of Golaghat district is dominated by mighty Brahmaputra river which is flowing in east-west direction in the extreme northern parts of the district and its tributaries flowing in northern direction, control the entire drainage system of the district and plays an important role in the ground water occurrence and control of the district. Important Rivers of the district are Dhansiri and Dayang. These rivers have meandering courses with abandoned channels in the form of waterbodies and ox-bow lakes along their courses.

Jorhat District

The drainage pattern of Jorhat district is characterized by river Brahmaputra, and its tributaries like south Dhansiri, Bhogdoi and Kakodonga drain the district. The tributaries originate in Naga-Patkai range and flow northward to join the Brahmaputra River, almost at right angles which give rise to subparallel type of drainage. These tributaries retain only meager base flow during the dry winter months. The rivers and streams are highly meandering in nature and sudden changes in courses of these rivers possibly due to heavy siltation and epiorogenic movements cause the flood in the district.

Drainage map of Block AA-ONHP-2017/11 is provided in Figure 22.

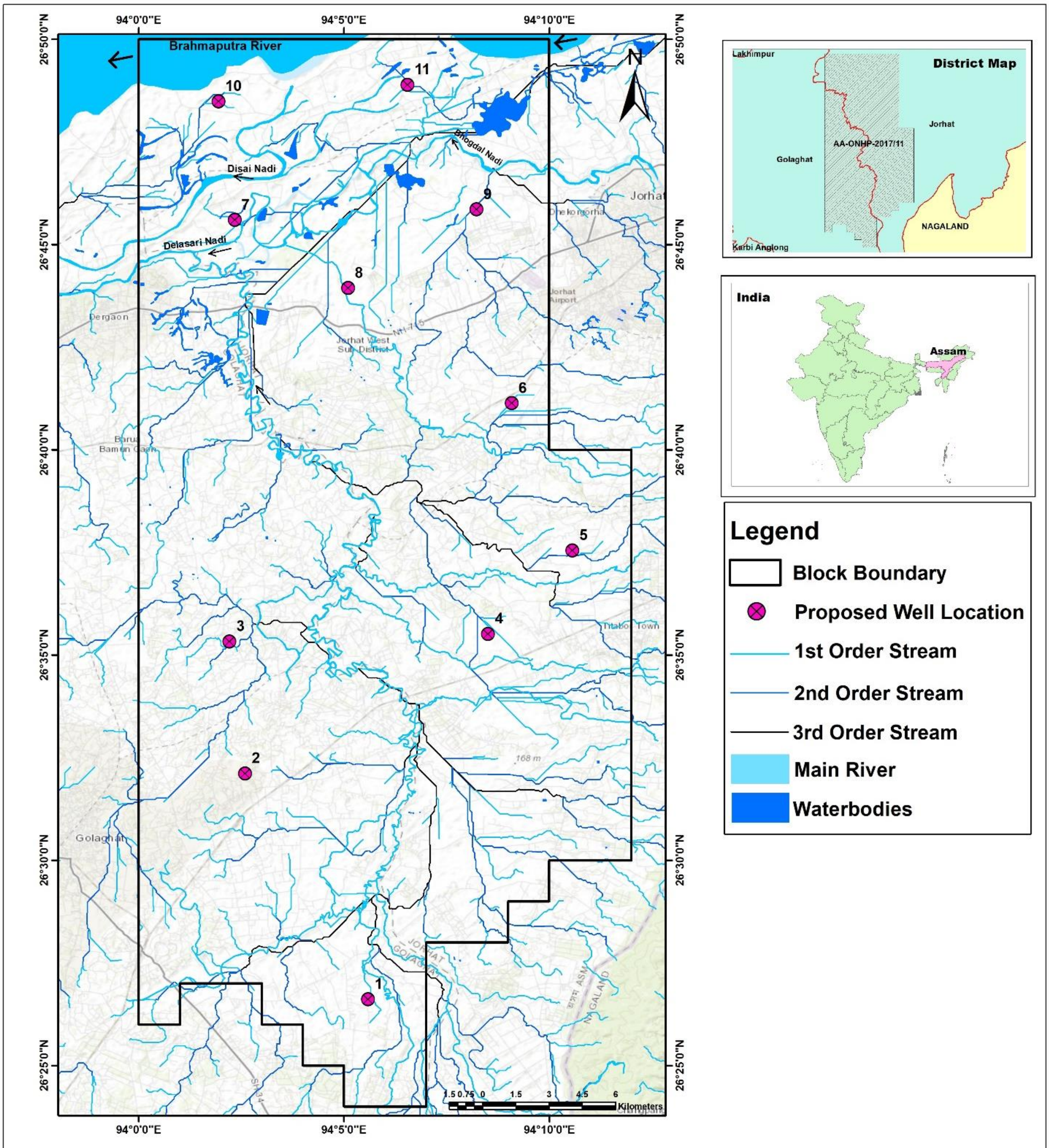

FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.				Title: Drainage Map	AECOM
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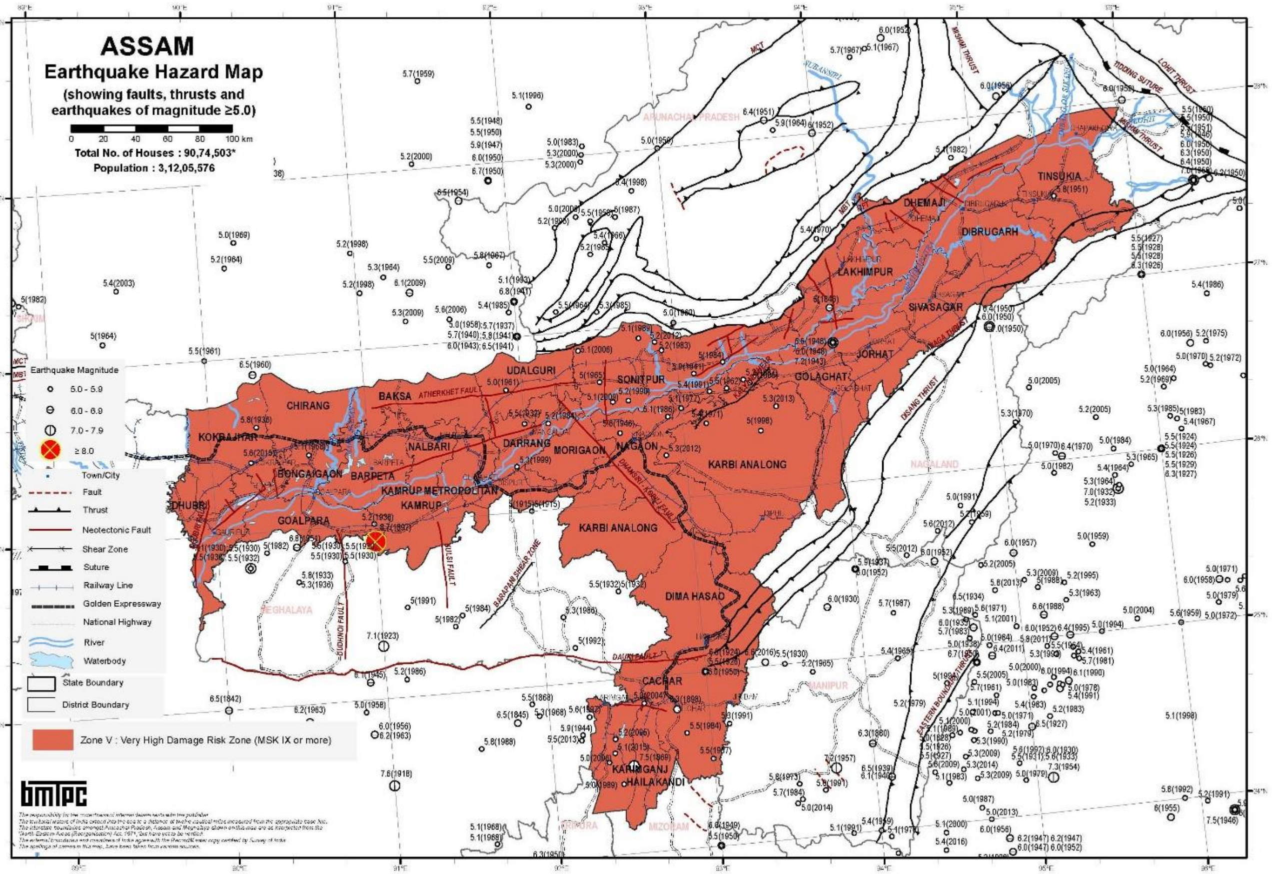
Figure 22. Drainage Map of the Block AA-ONHP-2017/11

3.7 Vulnerability of the Site

A natural disaster during the life cycle of the project can have a significant effect on the functioning of the project in addition to affecting the local environment in the area and stressing the availability of resources for the project. Such disasters also sometimes create difficulties in access through disruption of transportation links.

Seismicity

According to the study of Assam state Disaster Management Authority, the plate tectonics, Assam is in the eastern-most projection of the Indian Plate, where the plate is thrusting underneath the Eurasian Plate creating a subduction zone and the Himalayas. As per the Global Seismic hazard Assessment Program(GSHAP) DATA the state of Assam falls in the region of high to very high seismic zone. As per the 2002 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. Historically, parts of this state have experienced seismic activity greater than 6.0, in Richter scale. The State has experienced two major earthquakes in the year 1897 and 1950.



BMTPC : Vulnerability Atlas - 3rd Edition : Peer Group, MoHUA, GOI; Map is Based on digitised data of SOI; Seismic Zones of India Map IS: 1893 (Part I): 2002, BIS; Earthquake Epicentre from IMD; Seismotectonic Atlas of India and its Environs, GSI; Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Figure 23. Earthquake hazard map of Assam

Source : BMPTC: Vulnerability Atlas of India, Third Edition 2019

Floods

The entire state of Assam is affected by flood, in almost every year. River Brahmaputra, being the main drainage channel of the region, consisting of a total catchment area of 5,80,000 sq KM in Tibet , Bhutan, India and Bangladesh. The river flows for length of 918 km in India of which 720 km flows through the plains of Assam .In this valley about 20 major tributaries on its North Bank and about 30 on its South bank join the river Brahmaputra. The precipitation here is mainly due to South West Monsoon. Heavy rainfall occurs from May to September.

The causes of flood in Jorhat District are due to excessive rainfall in Assam, Arunachal Pradesh and Nagaland, melting of snow at Tibet etc. During flood the rivers get charged with enormous quantity of silt and in their movement the rivers alter the condition of flow and sometime changes the river courses causing untold miseries to the people living in its low line basin, making the district vulnerable to annual flooding. The main flood prone areas in the district are Jorhat and Titabor sub division, Majuli Subdivision. The block also comes under these two sub divisions. A major problem as bank erosion in Majuli sub division has driven due to the problematic reaches of River Bhogdoi.

Golaghat District is also regarded as the flood prone district of the state Assam. River Brahmaputra and Dhansiri are the main drainage pattern of the district and causing a heavy flood situation. Most affected areas are Golaghat and Bokhakaht subdivision of the district.

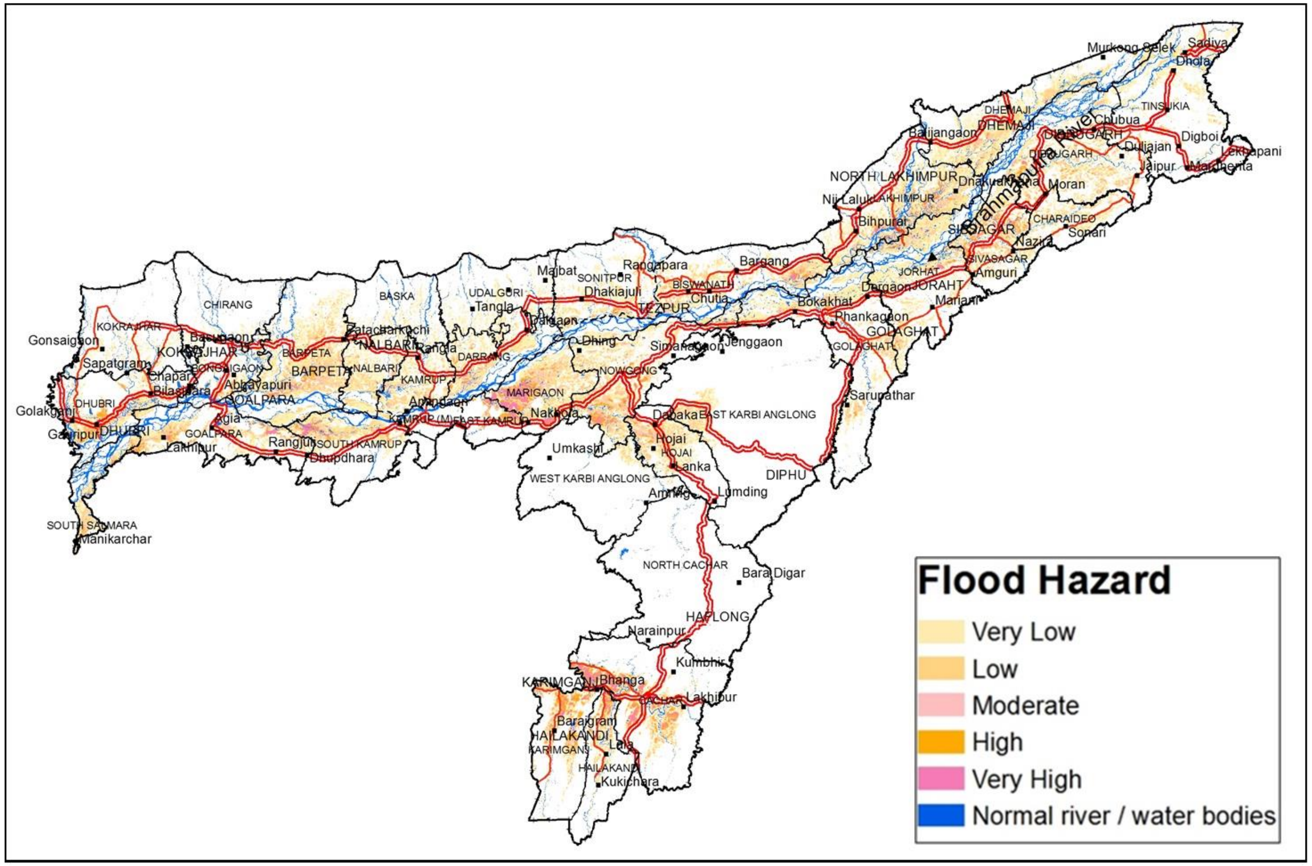


Figure 24. Flood zonation Map of Assam

Source : Assam State Disaster Management Authority

River Bank Erosion

Riverbank erosion is a serious problem in Assam leading to displacement of people due to the disappearance of villages year after year.

Total area eroded from 1954 till date is approximately 386476 Hectares which means that about 7% of the land in the state's 17 riverine districts has been lost due to river erosion in the last 50 years. Vulnerability to natural disasters combined with socio-economic vulnerability of the people living in the state pose a great challenge to the government machinery and underscores the need for a comprehensive plan for disaster preparedness and mitigation. In Golaghat district the most affected zone due to bank erosion is bank of river Dhansiri. The bank erosion protection programme of the state Assam is presented in Figure 25.

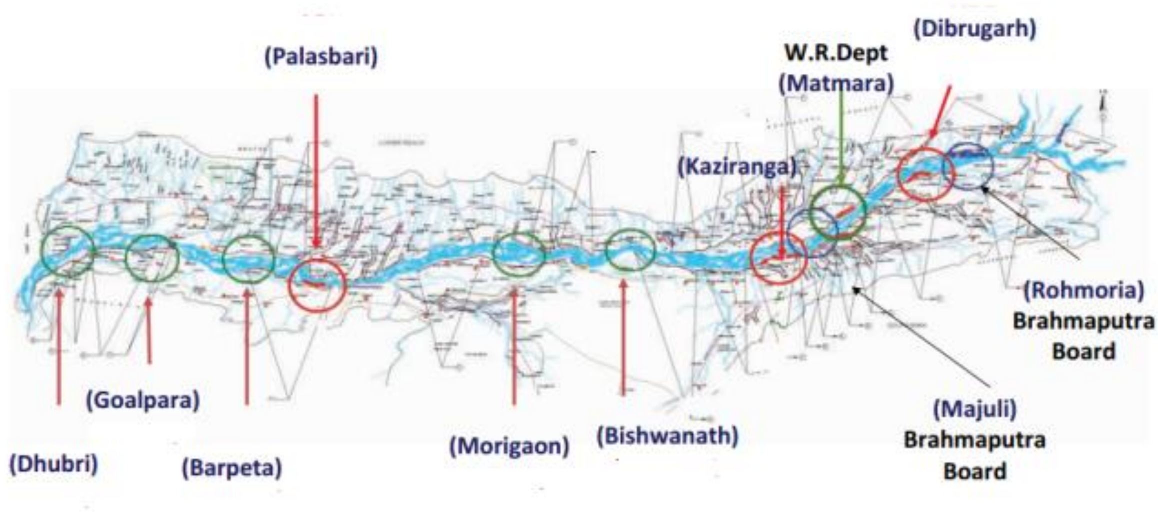


Figure 25. River bank erosion map of Assam

Source : Planning and Development Dept., Govt. of Assam

3.8 Land use/Land Cover

Objectives

The objective of assessing the land use details of the area is to know the existing land use pattern of the area and understand how the land can be used for the proposed development activities in the study area. It also enables to envisage the scenario emerging due to the increase in demand for land with increase in population and the impacts arising due to the interface with various project activities.

Land use Pattern in the Study Area

It is observed that, major land use pattern of Block AA-ONHP-2017/11 is Agricultural land, which is covering 64.04% area of the study area. Besides agricultural land, other land uses which are observed in the study area are marshy land, tea garden, natural vegetation, water body, river, build up area and brick kiln industry. The detail of land use pattern in the study area is given in **Table 3.1** and in Figure 26.

Table 3.1 . Land use Pattern in the Hydrocarbon block area

Sl. No.	Land Use Pattern	Area (in Km^2)
1	River	24.81
2	Water Body	5.94
3	Forest Land	0.43
4	Built Up	52.52
5	Industry	0.15
6	Tea Garden	54.93
7	Natural Vegetation	142.69
8	Marshy Land	0.56
9	Agricultural Land	502.17

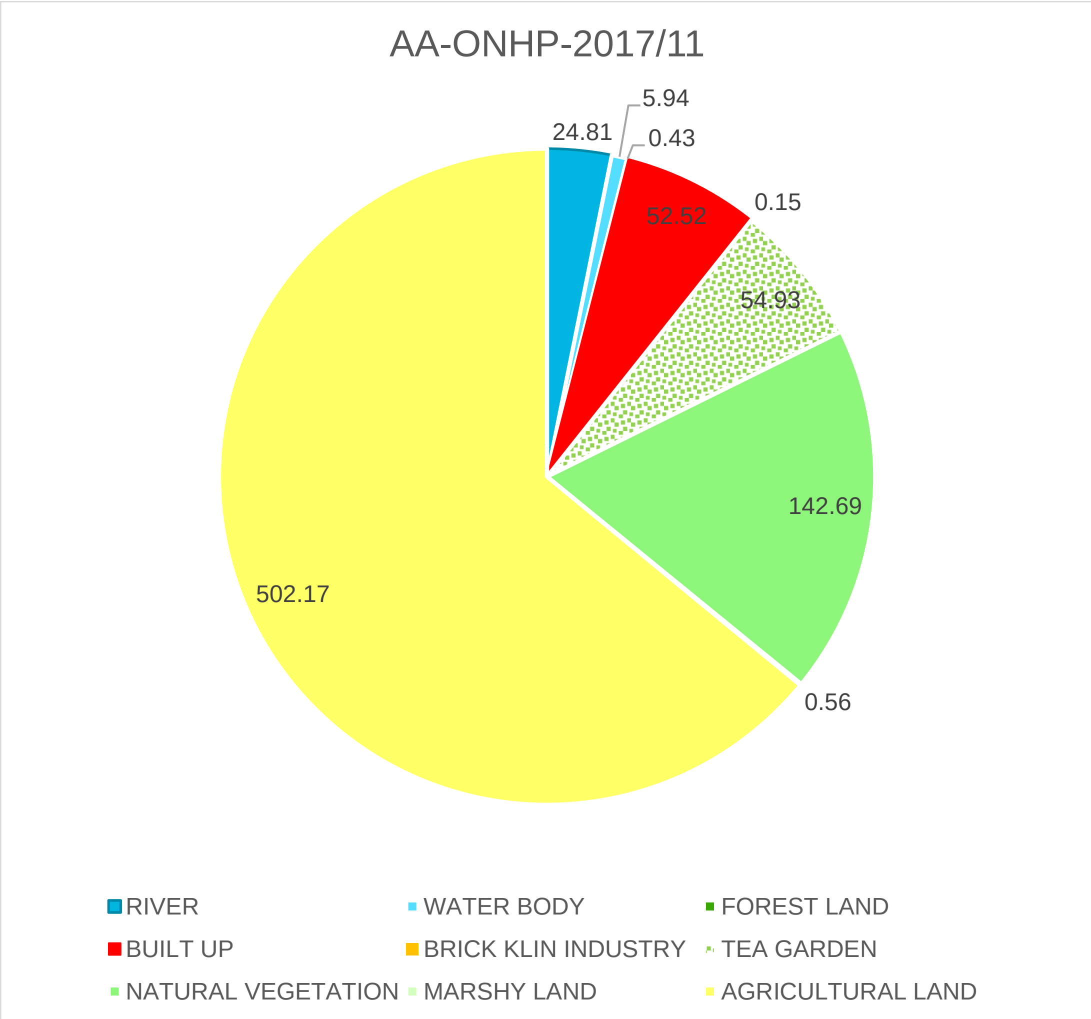


Figure 26 : Land Use Land Cover Profile of the Block Area.

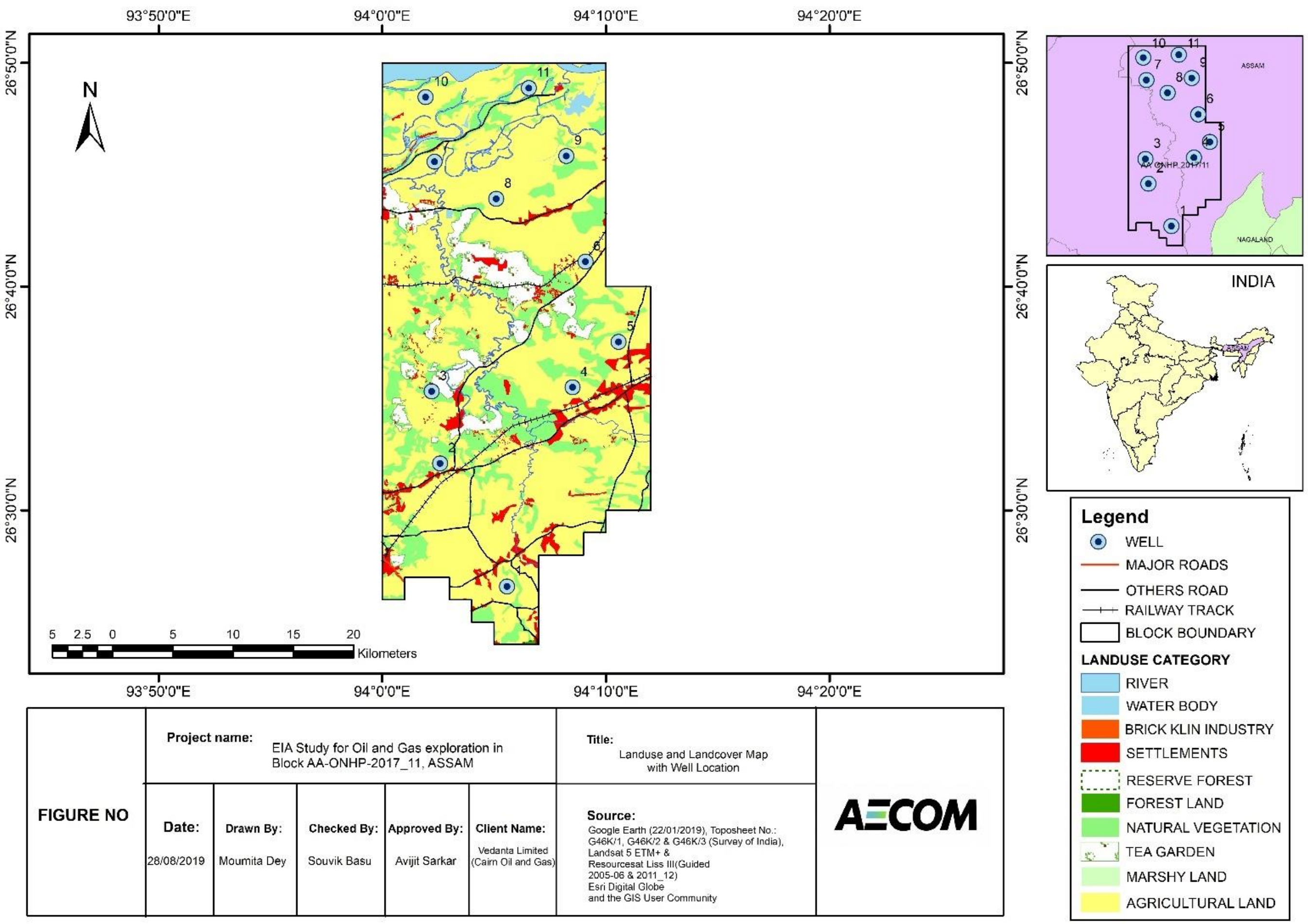


Figure 27 : Land Use and land Cover Map of the Study Area

3.9 Climate & Meteorology

Climate and meteorology of a region regarded as a significant parameter to be considered for the implementation of any development project. Meteorology (weather and climate) plays a crucial 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 Block AA -ONHP - 2017/11 falls under the humid sub-tropical climate zone, which is a normal climate profile for the whole state of Assam.

The seasons experienced by the area is described below:

Pre-monsoon : March-May
Monsoon : June- September
Post-monsoon: October- November
Winter : December- February

The meteorological data of IMD station at North Lakhimpur has been used for interpretation of longer-term temperature profile, relative humidity, wind speed and wind direction in the study area. In addition, monthly rainfall data obtained from Customized Rainfall Information System (CRIS), IMD has also been referred to understand the rainfall pattern of the area.

Temperature

Golaghat District

As per the CGWB booklet of Golaghat, the climate of the district is subtropical and humid characterized by moderate rainfall. The maximum temperature goes up to 36°C during June / July and minimum temperature falls to 6°C in December and January.

Jorhat District

The climate of the district is classified as mesothermal wet climate with forest type of vegetation. January is the coldest month with temperature of 6.1°C. July and August are the hottest period with average monthly temperature of about 29°C.Whereas, winter experience very low temperature, particularly during night time. The lowest temperature recorded in the month of December which reaches up to 4°C.

As per the Climatological Normal (1971-2000), annual daily maximum mean temperature was observed as 28.2°C with highest daily temperature as 35.7°C observed in June. The annual daily minimum mean temperature was observed as 18.4°C with lowest daily temperature as 9.1°C in January.

Relative Humidity

Golaghat District

As per the report of CGWB of Golaghat district, 93 to 95% during morning hours and during afternoon hours it varies from 53 to 75%. Which is a normal pattern of this region.

Jorhat District

As per CGWB booklet of the district Jorhat, the average relative humidity in a year is 78.7 per cent, with a mean of 75 percent.

As per the Climatological Normals (1971-2000), mean relative humidity in winter, at day time was recorded as 78%, whereas the mean night time relative humidity was 75%. In pre monsoon mean day time relative humidity accounted as 76%, and mean night time relative humidity recorded as 73% only. Day time mean relative humidity in monsoon season recorded as 87% and night time mean relative humidity recorded as 81.25%. The day time mean relative humidity of the post monsoon season recorded as 76%, and the night time mean relative humidity recorded as 81.5%.

Rainfall

Golaghat District

Golaghat district gets a south-west monsoon rainfall of around 2012 mm from the month of April and continues up to September/October. The pattern of rainfall varies in the district, from south to north, the intensity of rainfall increases, and the maximum rainfall is recorded in the north eastern parts of the district.

Jorhat District

As per the report of CGWB, the average annual rainfall in the district for last ten years from 1998 to 2007 has been computed to be 1,867.08 mm. The amount of rainfall increases from southwest to northeast.

As per the Climatological Normals (1971-2000), the mean annual rainfall was recorded as 3324.9 mm.

District wise rainfall map is presented in Figure 28

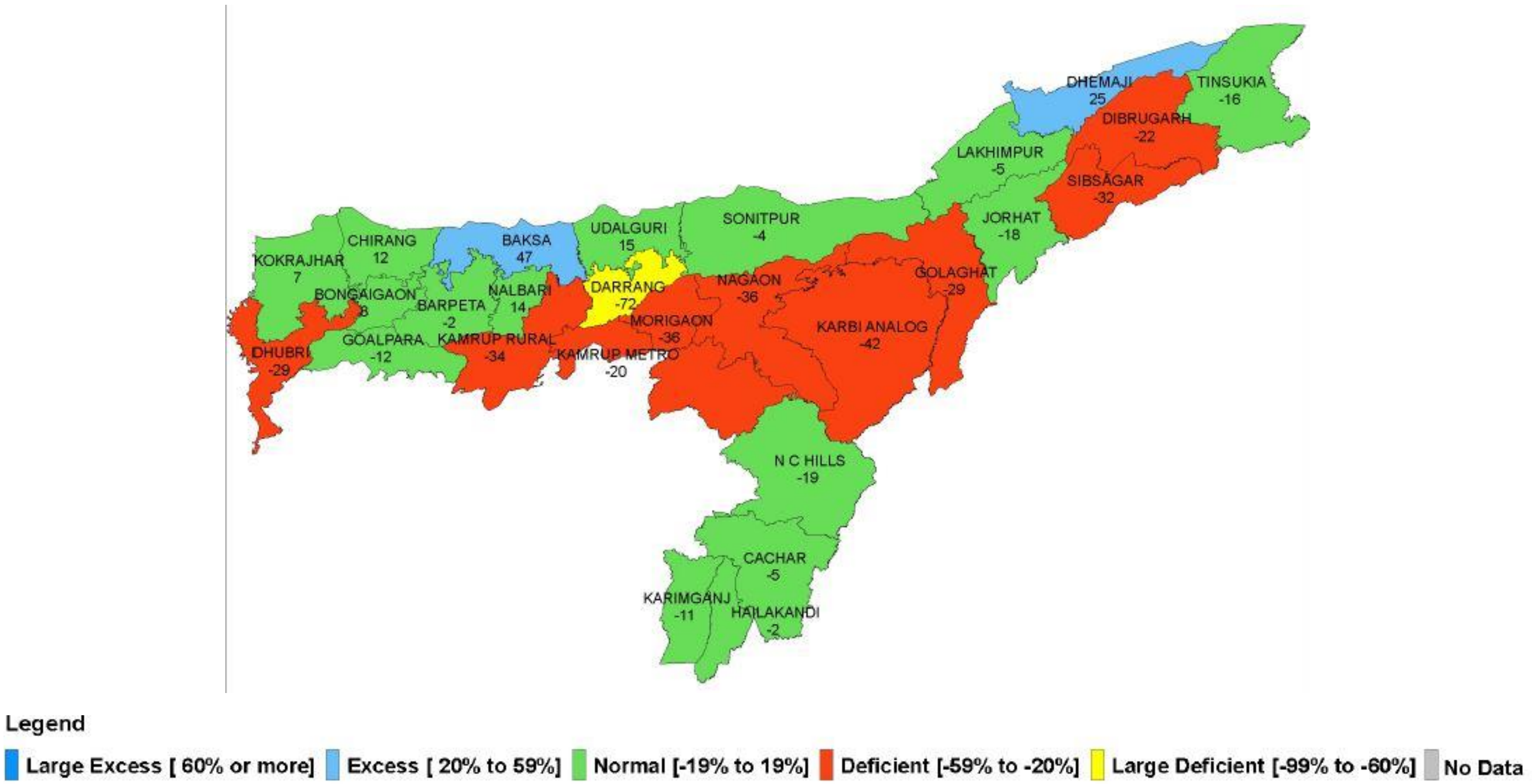


Figure 28. Rainfall distribution pattern of Assam, according to CRIS

Wind Speed and Wind Direction

As per the Atlas of Windrose (1971-2000) by Indian Meteorological Department, highest monthly mean wind speed is 6.5 m/s in the month of April and lowest monthly mean wind speed is 2.5 m/s in November. Predominant wind direction is north east (NE) direction.

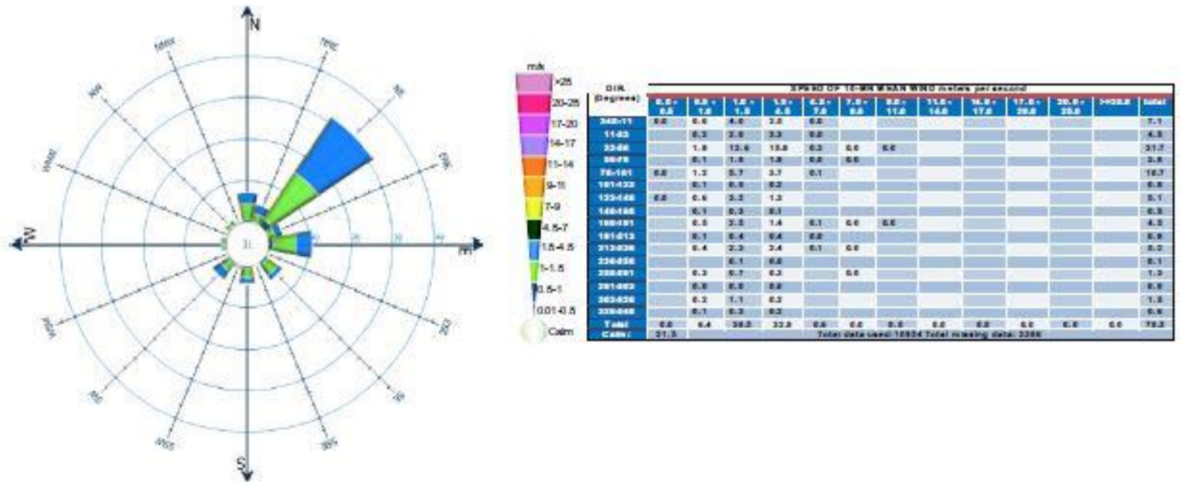


Figure 29. Windrose of North Lakhimpur.

Table 3.2 . Climatology profile of North Lakhimpur

Seasons	Temperature (°C)		Relative humidity (%)		Wind speed (kmph)	Rainfall (mm)
	Maximum	Minimum	Day time	Night time		
Winter	28.4	9.1	78	75	2.7	31.23
Premonsoon	32.4	15.03	76	73.3	5.8	224
Monsoon	35.5	22.15	87	81.2	7.4	580.45
Post Monsoon	32	8.93	76	81.5	2.9	101.05

Source: IMD Meteorological table

Micrometeorological Parameters

Block Micrometeorological parameters were observed to assess the local climatic condition of the study area. Micrometeorological setup was installed at Dhemaji, which is almost 35 km north from the nearest block boundary. The micro met monitoring stations were installed at a height of about 10 m above the ground level, ensuring that there were no obstructions to the free flow of winds. A three-monthly (March to May 2019) monitoring was conducted, and the prevailing meteorological conditions are discussed below (Table 3.2 and Table 3.3).

Meteorological profile of this region characterised by high temperature with a heavy amount of rainfall. Temperature of this region varies from, 25°C to 44°C, with an average of 34.28°C. Relative humidity accounts for 47.42%, on an average throughout the monitoring period. Average wind speed was measured as 3.5 metre/second throughout the study period with predominant wind direction from East to West.

Table 3.3 Climatological profile of the Study Area

Station name	Temperature(°C)		Relative humidity	Rainfall	Wind speed	Wind direction
	Max	Min	(Average)	(mm)	(m/s)	(Average)
Macharhat (26°46'19.00"N, 94°12'29.00"E)	36.4	16.4	82.45	60.79	3.5	E - W

Source: MET station installed at Jorhat

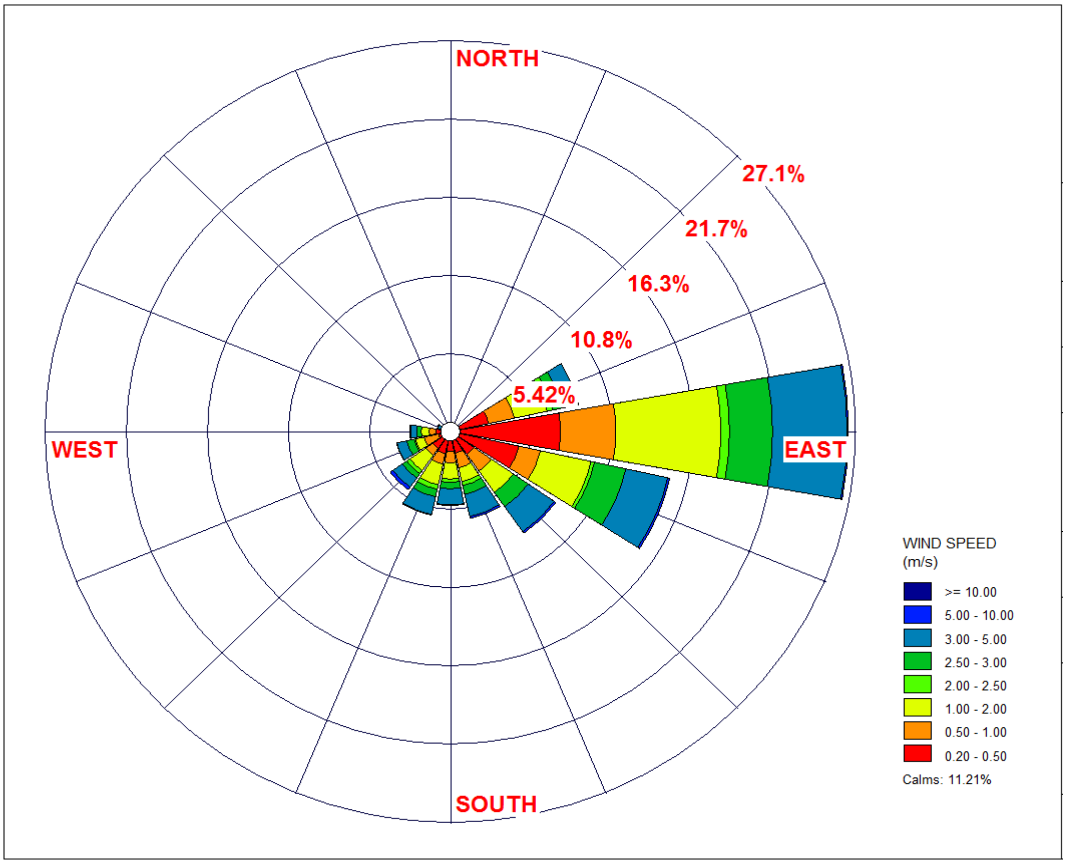


Figure 30. Windrose of Jorhat MET station.

Source: MET station installed at Jorhat

Ambient Air Quality

The baseline status of the ambient air quality was assessed through a scientifically designed ambient air quality-monitoring network. The design of monitoring network in the air quality study was based on (i) meteorological conditions on synoptic basis; (ii) topography of the study area; (iii) representatives of regional background air quality for obtaining baseline status; (iv) representatives of likely impact areas and (v) location of sensitive receptors in the study area, (vi) settlement area and (vi) accessibility and availability of infrastructure. Criteria used for designing the network were principally governed by pre-dominant wind directions obtained from the wind rose pattern for the summer season and the accessibility of the selected sites.

Ambient air quality monitoring was conducted for following parameters:(i) Particulate Matter (PM_{10} & PM $_{2.5}$), (ii) Sulphur Dioxide (SO_2), (iii) Nitrogen Dioxide (NO_2), (iv) Carbon monoxide (CO),Ozone(O_3), Benzene(C_6H_6), Benzo alpha pyrene (BaP), Lead(Pb) ,Arsenic(As), Nickel(Ni) , Ammonia(NH_3) ,Hydrocarbons(HC)- both methane and non-methane , Volatile Organic Compounds (VoC). Ambient air quality monitoring was conducted at AA-ONHP-2017/11 Block in representative locations during pre-monsoon season i.e. March to May 2019.

There are 8 locations have been selected in the study area for ambient air quality monitoring. The air monitoring activity was conducted as per the approved CPCB guidelines. The monitoring locations were selected after considering the upwind, downwind and cross wind direction of the proposed well location within the study area.

AAQ Monitoring Locations

The ambient air quality monitoring was carried out at eight (8) locations in and around the study area. The monitoring locations were selected taking into considerations factors such as predominant up & down wind directions and cross wind direction of the proposed well location, locations of the sensitive receptors in the Block area, and, any existing air pollution sources also taken into consideration during selection of monitoring location.

The Predominant wind direction (SW and NE) for the period (March to May 2019) was found from long term climatic average as available from IMD (1981-2010) station at Dhemaji. The detail ambient air quality monitoring results is given in Appendix 3-2. The location of the 15 air monitoring locations is given in **Table 3-4**.

Table 3.4 . Ambient Air Quality Monitoring Stations

Location Code	Coordinates	Justification
AAQ1	26°29'225"N, 94°03'208"E	Down wind of well no. 1, Crosswind of well no. 2
AAQ2	26°23'815"N, 94°01'296"E	Down wind of well no. 1
AAQ3	26°31'719"N, 93°58'937"E	Crosswind of well no.1 and 4, up wind of well no 2 and 3
AAQ4	26°38'04.39"N, 94°10'407"E	Downwind of well no. 3 and upwind of well no. 4
AAQ5	26°47'166"N, 94°02'808"E	Upwind of Well no 10
AAQ6	26°38'058"N, 94°10'681"E	Crosswind of well no. 5
AAQ7	26°31'17.11"N, 93°58'46.85"E	Down wind of well no 2 and 3
AAQ8	26°46’11.12”N, 94°09’10.24”E	Down wind of well no 8 and 9.

Source: Primary baseline Survey of Air Quality, AECOM

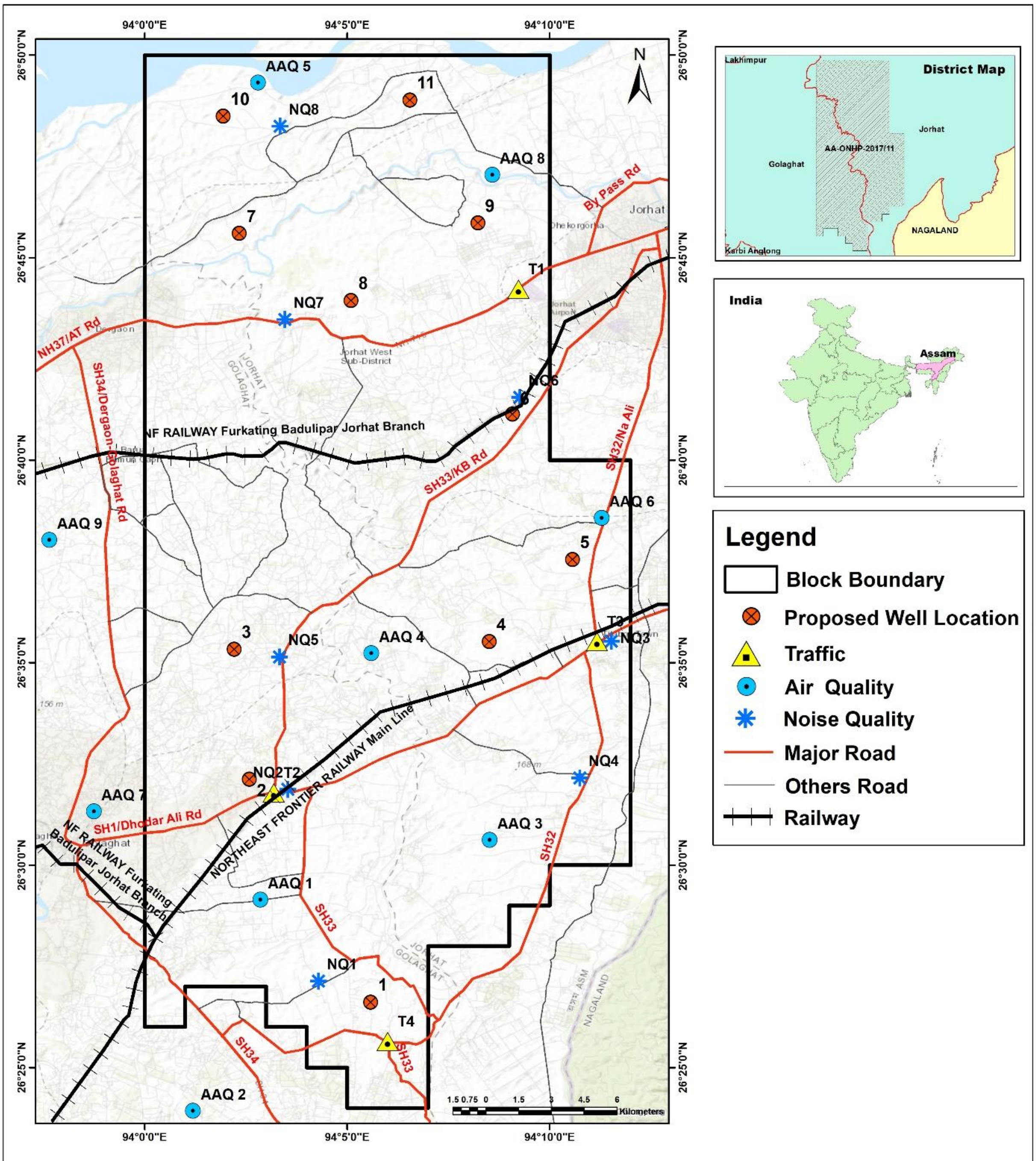


FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Monitoring Location Map (Air Quality, Noise Quality and Traffic Location)	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth, Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital, Globe, GeoEye,Earthstar Geographics,CNES/ AirbusDS,USDA, USGS,AeroGRID, IGN,and theGIS User Community.	

Figure 31. Ambient Air Quality, Noise quality and Traffic Monitoring Stations in **Block** AA-ONHP-2017/11

AAQ monitoring Results

Ambient air quality monitoring was conducted for twice a week 24 hourly for three months at eight (8) locations for each parameter as listed above in table below. Analysis of ambient air quality monitoring results for March to May'19 is presented in **Table 3-5.**

Table 3.5 . Ambient Air Quality monitoring result of Block AA-ONHP-2017/11

Parameter	Results	AAQ-1	AAQ-2	AAQ-3	AAQ-4	AAQ-5	AAQ-6	AAQ-7	AAQ-8
PM10 (µg/m^3)	NAAQS	100	100	100	100	100	100	100	100
	Max	72.2	83.5	81.2	79.9	78.3	81.6	80.5	75.5
	Min	30.2	40.7	40.2	36.2	31.2	38.7	35.3	41.2
	Average	53.0	57.8	61.1	58.4	56.1	59.9	56.7	60.5
	98th Percentile	71.1	81.0	81.0	78.9	78.3	77.2	75.9	75.5
PM2.5 (µg/m^3)	NAAQS	60	60	60	60	60	60	60	60
	Max	44.7	43.5	45.3	51.2	51.4	56.5	46.2	48.2
	Min	17.2	19.7	18.6	14.5	14.6	17.9	16.7	18.7
	Average	29.1	30.4	31.2	32.6	29.3	32.0	30.7	32.4
	98th Percentile	42.4	42.9	43.9	47.2	48.4	50.9	45.0	45.9
SO_2 (µg/m^3)	NAAQS	80	80	80	80	80	80	80	80
	Max	7.8	8.1	7.3	7.8	8.1	7.0	8.2	8.2
	Min	6.0	6.0	6.2	6.0	6.1	6.2	6.1	6.0
	Average	6.8	6.7	6.6	6.7	6.9	6.5	6.7	7.0
	98th Percentile	7.7	8.0	7.2	7.7	8.0	7.0	8.1	8.0
NO_2 (µg/m^3)	NAAQS	80	80	80	80	80	80	80	80

Parameter	Results	AAQ-1	AAQ-2	AAQ-3	AAQ-4	AAQ-5	AAQ-6	AAQ-7	AAQ-8
	Max	31.2	33.5	30.7	31.5	30.2	30.2	32.2	31.9
	Min	15.2	15.8	13.9	15.5	14.7	15.2	15.4	15.3
	Average	22.0	24.1	22.7	22.4	21.3	21.3	23.0	22.5
	98th Percentile	30.9	33.1	30.7	31.0	29.9	29.1	31.2	31.9
CO (mg/m^3)	NAAQS	4	4	4	4	4	4	4	4
	Max	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.9
	Min	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Average	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	98th Percentile	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.8
NH_3 ($\mu g/m^3$)	NAAQS	400	400	400	400	400	400	400	400
	Max	17.8	21.2	24.2	24.5	18.6	21.2	21.2	29.1
	Min	10.5	10.4	10.2	11.6	10.8	10.8	10.4	10.2
	Average	13.5	15.4	14.9	16.9	13.6	15.4	13.9	16.5
	98th Percentile	17.6	21.2	23.2	24.1	18.3	21.2	20.7	28.2
C_6H_6 ($\mu g/m^3$)	NAAQS	5	5	5	5	5	5	5	5
	Max	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Min	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Parameter	Results	AAQ-1	AAQ-2	AAQ-3	AAQ-4	AAQ-5	AAQ-6	AAQ-7	AAQ-8
	Average	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BAP (ng/m^3)	NAAQS	1	1	1	1	1	1	1	1
	Max	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Min	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Average	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
O_3 (µg/m^3)	NAAQS	100	100	100	100	100	100	100	100
	Max	29.8	24.8	26.8	26.7	28.9	27.1	25.5	25.4
	Min	20.5	20.8	20.2	20.3	20.8	20.2	20.0	20
	Average	24.8	22.3	22.5	22.2	23.7	22.6	22.2	21.9
	98th Percentile	29.5	24.8	26.5	25.9	28.4	26.8	25.3	25.4
Pb (µg/m^3)	NAAQS	1	1	1	1	1	1	1	1
	Max	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Min	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Average	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Parameter	Results	AAQ-1	AAQ-2	AAQ-3	AAQ-4	AAQ-5	AAQ-6	AAQ-7	AAQ-8
Ni (ng/m^3)	NAAQS	20	20	20	20	20	20	20	20
	Max	6.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Min	5.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Average	6.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	6.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
As (ng/m^3)	NAAQS	6	6	6	6	6	6	6	6
	Max	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Min	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Average	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
HC as Methane (µg/m^3)	NAAQS	--	--	--	--	--	--	--	--
	Max	2.6	2.9	2.6	2.5	2.4	2.7	2.7	2.3
	Min	0.9	0.8	1.0	1.0	1.1	0.7	1.1	1.0
	Average	1.6	1.7	1.6	1.6	1.6	1.5	1.7	1.6
	98th Percentile	2.5	2.7	2.5	2.3	2.3	2.5	2.6	2.2
HC as Non-Methane (µg/m^3)	NAAQS	--	--	--	--	--	--	--	--
	Max	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Parameter	Results	AAQ-1	AAQ-2	AAQ-3	AAQ-4	AAQ-5	AAQ-6	AAQ-7	AAQ-8
	Min	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	Average	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	98th Percentile	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Note: NAAQS = National Ambient Air Quality Standards; BDL = Below Detection Limit; NA = Not Available

DL = Detection Limit; DL for C6H6 = 2.0 µg/m3, DL for BAP = 0.5 µg/m3, DL for O3 = 10.0 µg/m3, DL for Pb = 0.01 µg/m3, DL for As = 0.5 ng/m3, DL for HC as Methane = 2.5 µg/m3, DL for HC as Non-Methane = 2.5 µg/m3, DL for VOC = 2.0 µg/m3.

Particulate Matter (PM_{10})

PM_{10} concentration in the study area varied from 53 µg/m³ to 61 µg/m³. The monitoring location at AAQ 2, observed the maximum concentration of PM_{10} i.e 83.5 µg/m³, whereas minimum PM_{10} concentration was observed at AAQ 1, i.e 30.2 µg/m³ . Graphical presentation of concentration of PM_{10} values is given Figure 32.

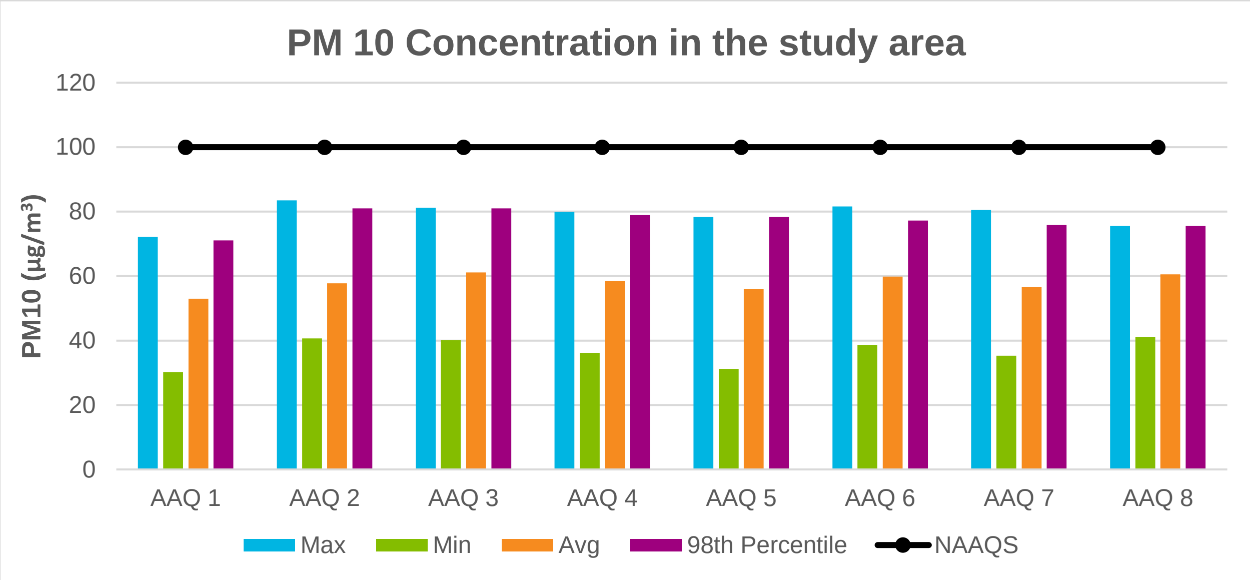


Figure 32. PM 10 Values at all Monitoring Locations.

Particulate Matter (PM2.5)

$PM_{2.5}$ concentration in the study area varied from 29 µg/m³ to 32.6 µg/m³. The highest PM 2.5 concentration was observed at monitoring location AAQ 6 which is 56.5 µg/m³ and the lowest concentration of PM 2.5 is located at monitoring location AAQ 4 which is 14.5 µg/m³. Graphical presentation of concentration of PM2.5 values is given Figure 33.

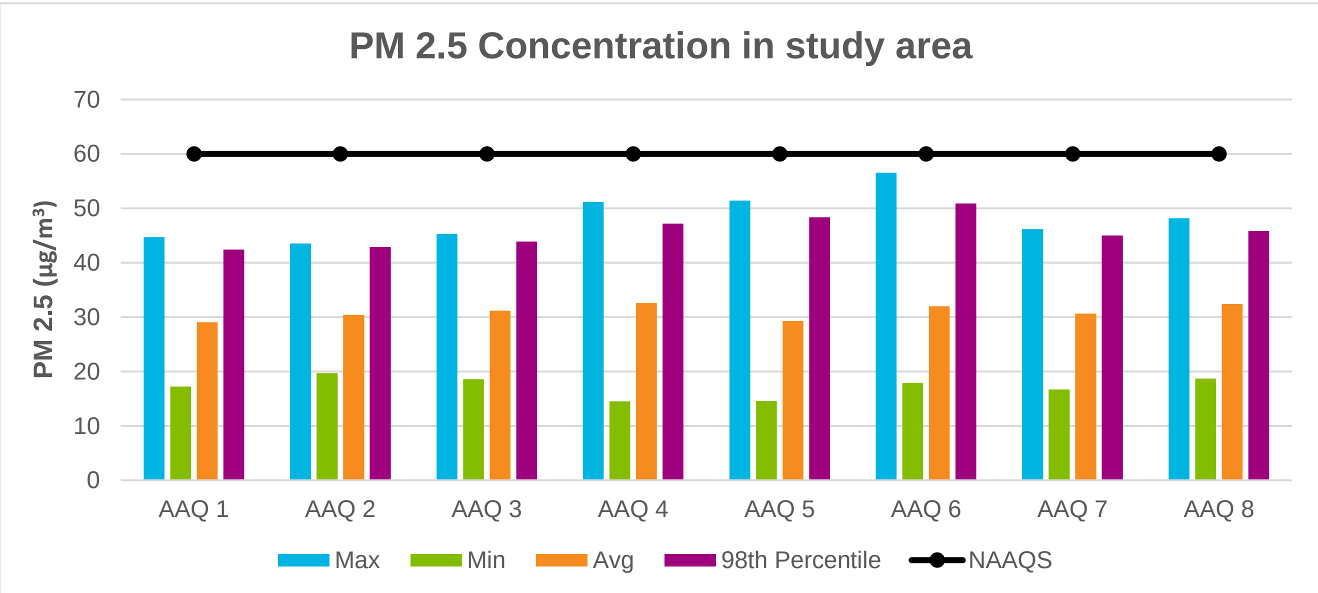


Figure 33. PM2.5 Values at all Monitoring Locations.

Nitrogen Di-Oxide (NO_2)

NO_2 concentration in the study area varied from 21.27 µg/m^3. to 24.10 µg/m^3. The highest NO_2 concentration was observed at monitoring location AAQ 2 which is 33.5 µg/m^3 and the lowest concentration of NO_2 was recorded at monitoring location AAQ 3 which is 13.9 µg/m^3. Graphical presentation of concentration of NO_2 values is given figure 34.

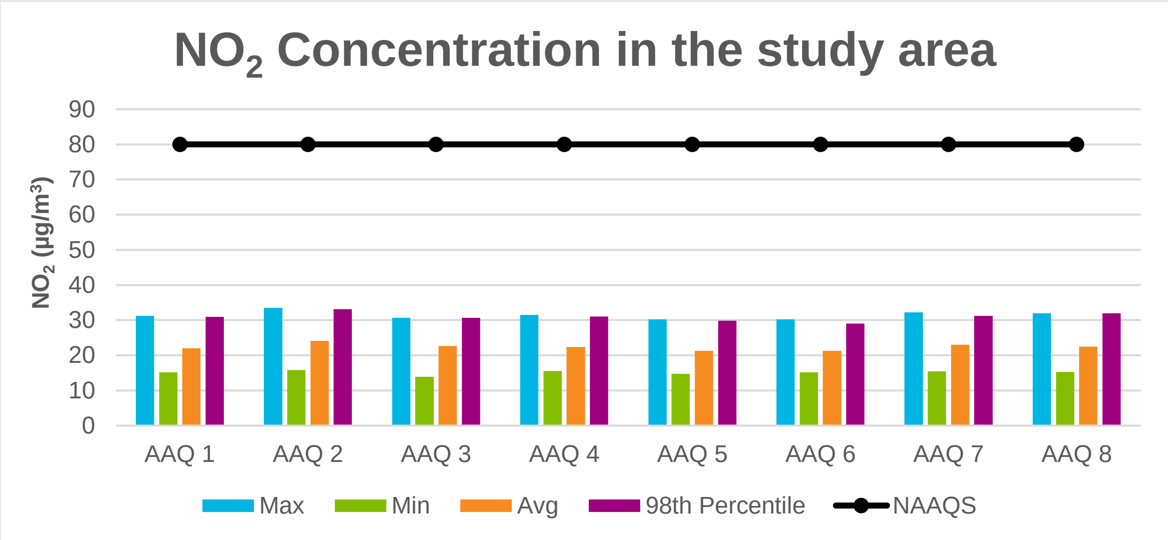


Figure 34. NO_2 Values at the Monitoring Locations

Sulphur Di-Oxide (SO_2)

SO_2 concentration in the study area varied from 6.52 to 6.95 µg/m^3. The highest SO_2 concentration was observed at monitoring location AAQ 7 & 8 which is 8.2 µg/m^3 and the lowest concentration of SO_2 was recorded at monitoring location AAQ 2 which is 6 µg/m^3. Graphical presentation of concentration of SO_2 values is given Figure 35.

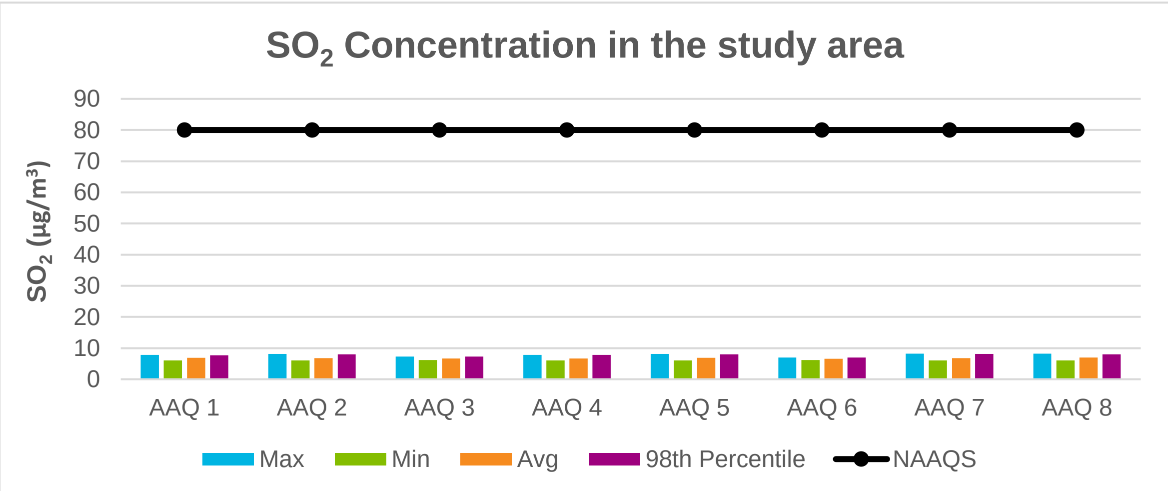


Figure 35. SO_2 Values at the Monitoring Locations

Other Parameters

The concentrations for CO ranged from 0.2 to 0.9 mg/m^3. The average concentrations for NH_3 ranged from 13.5 to 16.9 µg/m^3. The average concentration for Ni found to be below detectable limit in all location, except AAQ 1 (6.2 ng/m^3) . The seasonal average concentrations for O_3 ranged from 22.2 to 24.8 µg/m^3.

Concentration of other parameters i.e. C_6H_6 (µg/m^3), BAP (ng/m^3), Pb (µg/m^3), As (ng/m3), HC as Methane (µg/m^3), HC as Non-Methane (µg/m^3) were observed would be below detectable limit at all locations. Currently there are no ambient air quality standards for Hydrocarbon (as methane & as non-methane).

The photograph of ambient air quality sampling is shown below.

Photographs 1: AAQ 3 at Jotinagar

Photographs 2: AAQ 4 at Titabor

Photographs 3: AAQ 5 Nimati village

Photographas 4: AAQ 6 at Dholi Village

3.10 Ambient Noise Quality

Monitoring of noise levels around the study area has been carried out to assess the existing noise levels generated due to the existing operations on human settlements. Noise standards have been designed for different types of land use i.e. residential, commercial industrial areas and silence zones as per 'The Noise Pollution (Regulation and Control) Rules, 2000, Notified by Ministry of Environment and Forests, New Delhi, February 14, 2000'.

The ambient noise monitoring was carried out at eight (8) locations during baseline monitoring activity (March to May, 2019). The details of the noise monitoring locations is given in Table 3-6 . Sound pressure level (SPL) measurements in dB (A) were recorded for every hour continuously for 24 hours at 15 minutes interval for the monitoring stations and equivalent noise levels in the form of Leq day and Leq night was computed. The day noise levels have been monitored during 6.00 am to 10.00 pm and night levels during 10.00 pm to 6.00 am at all the locations. The results obtained were compared with the standard specified in Schedule III, Rule 3 of Environmental Protection Rules.

Table 3.6 . Ambient Noise Monitoring Locations

Location Code	Monitoring Location	Coordinates
NQ1	NA-Pamua	26°27'7.56"N, 94° 4'17.58"E
NQ2	Kamarbandha	26°31'51.66"N, 94° 3'25.30"E
NQ3	Bebejia Gaon	26°35'27.41"N, 94°11'20.25"E
NQ4	Madhapur	26°32'8.70"N, 94°10'45.00"E
NQ5	Dakhinhengera	26°35'8.04"N, 94° 3'19.92"E
NQ6	Kuhairbiria	26°41'32.32"N, 94° 9'15.94"E
NQ7	Rangagara Gaon	26°43'27.82"N, 94° 3'28.02"E
NQ 8	Bagmaria	26°48'14.21"N, 94° 3'20.81"E

Map showing Monitoring Locations for Noise in the study area is given in Figure 30. The details of ambient noise monitoring result is given in Appendix 3-3. The graphical representation of noise level is present in figure 36.

The summarized results of noise levels are given in table 3.7. The noise levels are compared with Ambient Air Quality Standards in respect of Noise as per The Noise Pollution (Regulation and Control) Rules, 2000 stipulated for daytime and night time for residential land use

Table 3.7 Noise level in the Study Area

Location code	Leq Day Time (dBA)	Leq Night Time (dBA)	Applicable Daytime Standards	Applicable Night-time Standards
NQ1	58.80	47.39	55	45
NQ2	59.99	42.95	55	45
NQ3	58.39	42.77	55	45
NQ4	54.90	41.97	55	45
NQ5	57.55	41.88	55	45
NQ6	54.09	43.68	55	45
NQ7	59.35	46.15	55	45
NQ 8	55.09	41.60	55	45

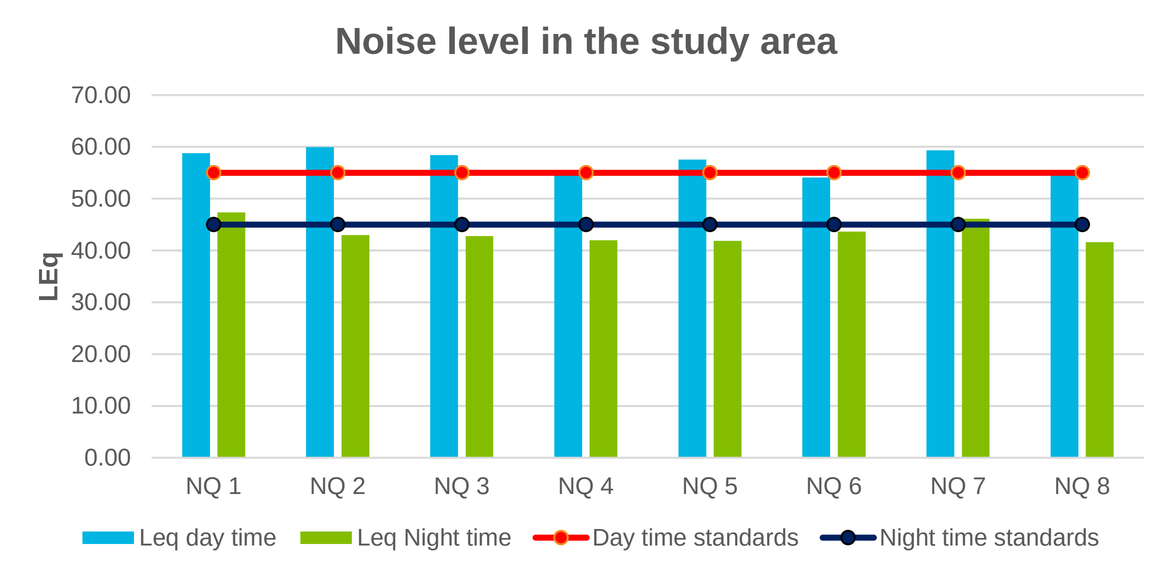


Figure 36. Day and Night Time Equivalent Noise Levels**.**

Due to movement of heavy traffic in the block the Leq day time at some locations were beyond the Day time standards of 55 dB, but in the night time most of the locations were within the limit of night time standards of 45 dB.

The photographs of the noise sampling are shown below:

Photographs 1: NQ station 2 at Kamarbandha

Photographs 2 : NQ Station 3 at Bebejia Gaon

Photographs 3: NQ station 4 Madhapur

Photographs 4: NQ Station 5 Dakhin Hengera

3.11 Water Environment

Water quality assessment of different parameters of surface and ground water resources within Block area has been carried out for assessing the surface and ground water quality. Eight (8) ground water samples covering entire Block area were examined for physico-chemical, heavy metals and bacteriological parameters. It is observed that the water holding capacity of the soil is strong, which influences higher surface water availability in this Block. Monitoring programme was occurred in the summer season during Month of May,2019.

Analyses of the water samples were carried out as per established standard methods and procedures prescribed by CPCB, IS 3025 Codes and APHA 22nd edition, 2012. Appendix 3-6 gives ground water quality monitoring results.

Ground Water Quality

Primary monitoring of ground water quality was considered important to understand the probable impacts of the proposed project activities on the sub surface aquifers. Potential pollution of subsurface and unconfined aquifers may occur due to improper casing and cementing of well leading to infiltration or seeping of drilling chemicals or mud into nearby aquifer. Contamination of aquifers may also occur from disposal of drilling waste and mud in an open/unpaved pit.

Groundwater Sampling Locations

For the purpose of baseline assessment, total 8 locations were identified for groundwater samples covering the study area and were examined for physico-chemical, heavy metals and bacteriological parameters to assess the current status of water quality in the study area during the monitoring period. The groundwater quality is likely would be variable within the Block due to spatial heterogeneity in the aquifer. These locations are spatially distributed all across the Block and its surrounding areas. The sampling locations were selected to capture both shallow as well as deeper part of aquifer. All ground water samples were collected from bore wells/tube well.

Table 3.8 Ground Water Sampling Locations

Location Code	Sampling Co-ordinate	Village	Type
GW 1	26°31'17.30"N, 94°05'41.41"E	Bokolai	Tubewell
GW 2	26°23'51.88"N, 94°01'25.43"E	Hatigarh Matikhola	Tubewell
GW 3	26°39'27.18"N, 94° 1'46.34"E	Dumjoria Kosolal	Tubewell
GW 4	26°48'14.92"N, 94° 1'56.88"E	Bahfola	Tubewell
GW 5	26°38'01.70"N, 94°10'54.53"E	Awariyagaon	Tubewell
GW 6	26°31'17.47"N, 93°58'44.39"E	Golaghat Cmmerce College	Borewell
GW 7	26°46'10.02"N, 94° 8'23.94"E	Rojakhat Gaon	Tubewell
GW 8	26°51'37.41"N, 94°27'57.00"E	Bamun Pukhuri Gaon	Tubewell

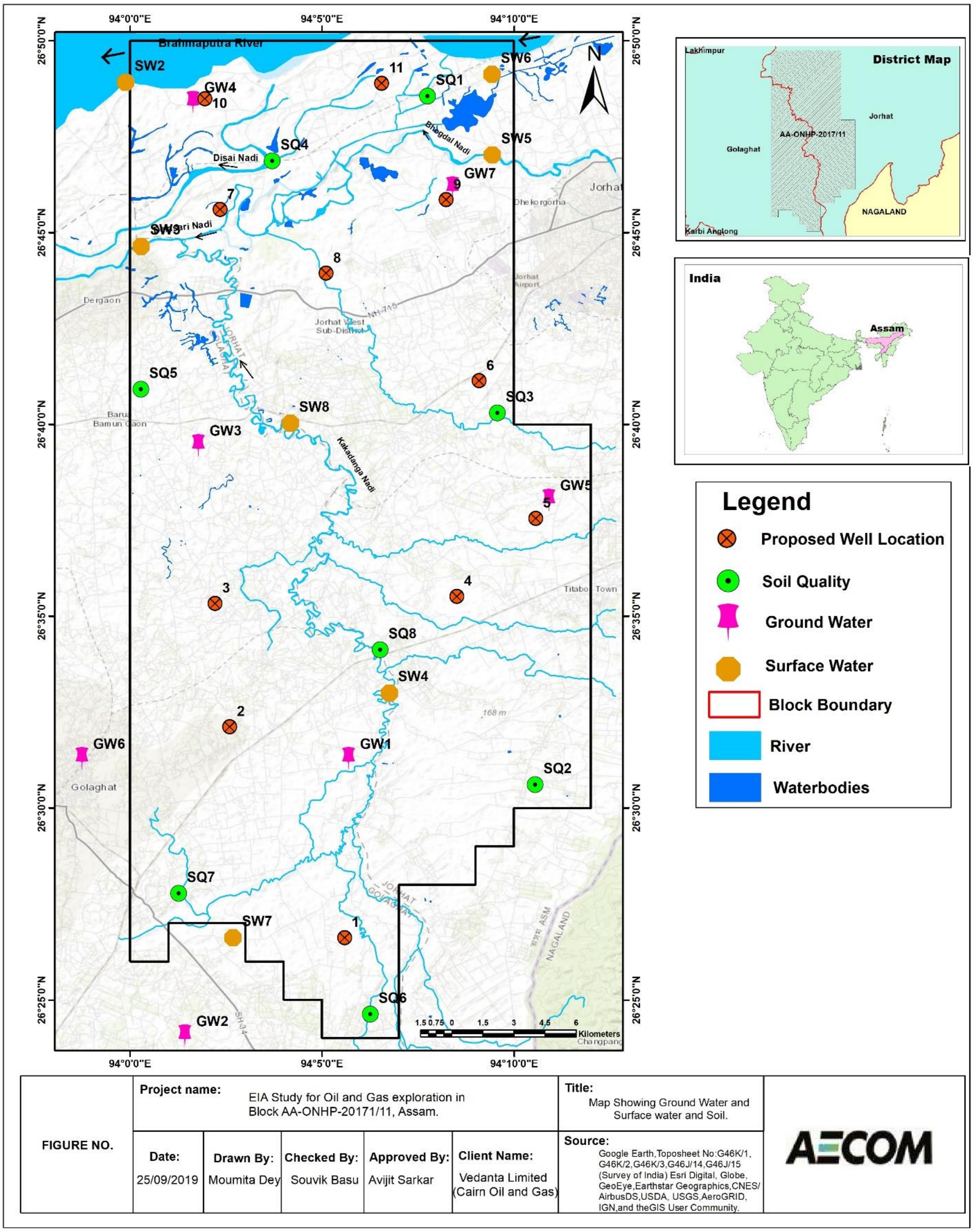


Figure 37. Surface water, Ground water and Soil monitoring Locations in Block AA-ONHP-2017/11**.**

Table 3.9 Ground Water Quality Monitoring Result

Sl. No.	Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW- 8
1	Colour	Hazen	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2	Odour	-	unobjectionable	unobjectionable	Unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	Unobjectionable
4	Temperature	°C	25.6	25	26	28.2	24.6	26	25.1	25deg C
5	pH	-	7.8 at 25.6 °C	7.8 at 25 °C	6.7 at 26 °C	7.8 at 28.2 °C	6.7 at 24.6 °C	7.8 at 26 °C	6.7 at 25.1 °C	6.54 at 25 °C
6	Turbidity	NTU	2.4	7	<1.0	<1.0	2.2	1.5	1.2	207
7	Total Dissolved Solids	mg/l	272	276	176	282	280	260	192	206
8	Electrical Conductivity	µS/Cm	502	461	324	538	436	456	326	340
9	Salinity	None	0.29	0.26	0.18	0.31	0.22	0.26	0.16	0.17
10	Dissolved oxygen	mg/l	5.1	5.2	5.1	5.0	5.3	5.3	5.4	5.2
11	Aluminium (Al)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Anionic Detergent (as MBAS)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
13	Barium (Ba)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
14	Calcium (Ca)	mg/l	34	12	22	49	23	23	17	20
15	Chloramines (as Cl2)	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
16	Chloride	mg/l	6	8	6	20	6	6	6	8
17	Copper(Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Sl. No.	Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW- 8
18	Fluoride as F	mg/l	0.23	0.42	0.15	0.25	0.35	0.32	0.28	0.17
19	Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
20	Iron (Fe)	mg/l	0.53	0.84	0.08	0.06	0.11	0.30	0.51	60
21	Maganisium(Mg)	mg/l	15	10	15	27	8.3	18	10	13
22	Manganese(Mn)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
23	Mineral Oil	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Nitrate	mg/l	3.8	7.2	0.8	24	20	2.7	0.64	9
25	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Selenium (Se)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
27	Sulphate	mg/l	<1.0	<1.0	3.0	<1.0	<1.0	<1.0	<1.0	37
28	Potassium	mg/l	1.1	0.7	1.7	2.6	1.7	1.4	1.6	1.7
29	Total Phosphorous	mg/l	4.4	1.8	0.06	2.8	3.4	1.9	4.8	0.08
30	Sodium	mg/l	65	76	32	26	48	50	30	25
31	Total Alakalinity	mg/l	190	240	125	170	250	240	160	145
32	Total Hardness	mg/l	146	73	115	234	92	131	84	104
33	Total Nitrogen	mg/l	2.7	3.0	0.36	6.0	6.5	2.0	1.0	2
34	Zinc(Zn)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Sl. No.	Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW- 8
35	Cadmium (Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
36	Cyanide (as CN)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
37	Lead (Pb)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
38	Mercury (Hg)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
39	Molybdenum (as Mo)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
40	Nickel (as Ni)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
41	Hexavalent Chromium(Cr+6)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
42	Arsenic(As)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
43	Alchor	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
44	Atrazine	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
45	Aldrin	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46	Dialdrin	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
47	α-HCH	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
48	β-HCH	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
49	Butachlore	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
50	Chlorpyrifos	µg/l	<0.02	<0.02	<0.02	<0.02	<0.0	<0.02	<0.02	<0.02
51	δ-HCH	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Sl. No.	Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW- 8
52	2,4 Dichlorophenoxyacetic acid	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
53	p,p DDT	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
54	o,p DDT	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
55	o,p DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
56	p,p DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
57	o,p DDD	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
58	p,p DDD	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
59	Endosulphan sulphate	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
60	Alpha-Endosulfan	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
61	Beta-Endosulfan	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
62	Ethion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
63	ɣ-HCH (Lindane)	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
64	Iso Protron	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
65	Malathion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
66	Methyl Parathion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
67	Monocrotphos	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
68	Phorate	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Sl. No.	Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW- 8
69	Pesticides as Lindane	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
70	Total Coliform	MPN/100 ml	NOT DETECTED	13 MPN/100 ml	NOT DETECTED	4 MPN/100 ml	NOT DETECTED	NOT DETECTED	11 MPN/100 ml	NOT DETECTED
71	Faecal Coliform	MPN/100 ml	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	2 MPN/100 ml	NOT DETECTED

Interpretation of Groundwater Quality Results

Physical Parameters

The colour of the samples was found <1 hazen units and with agreeable odour. The pH of water samples ranged from 6.54 to 7.8. Turbidity of all the samples found between <1.0 – 7, which is under the permissible limit of 5 NTU, except in one sample in Golaghat turbidity accounted as 207 NTU, the possible reason could be high iron content in that sample (60mg/l), and the CGWB report of Golaghat also reported the high iron content in the region. The TDS in the water samples varied from 176 mg/l to 282 mg/l, which is incompliance with desirable limit of 500 mg/l.

Inorganic Parameters

The total alkalinity of the samples varied from 125 to 250 mg/l which falls within their corresponding permissible limit of 600 mg/l. Total hardness of the samples varied from 73 to 146 mg/l and was within the desirable limit of 200 mg/l. The concentrations of heavy metals such as Aluminium, Manganese, Iron, Nickel, Copper, Zinc, Arsenic were below their corresponding permissible limit. Cadmium, Mercury, Lead and other parameters like Residual Chlorine, Cyanide, Hexavalent Chromium, Phenol, Total Phosphorus, Free Ammonia, Cyanide, polychlorinated bi-phenyls, PAHs were found would be below detection limit.

Coliform

Faecal coliform was detected only in one ground water sample, GW 7, near Rojakhat Gaon, accounted as 2MPN/100ml. Total Coliform was detected at GW 1, GW 4 and GW 7.

Other Parameters

No pesticides were detected in any of the samples. Most of the samples were below detectable limits for toxic substances. The groundwater quality was found to be suitable for drinking purposes in most of the locations as TDS, hardness was in compliance with the permissible limits, though primary and secondary treatment are preferable before consuming. The quality of groundwater is likely would be variable within the study area due to spatial heterogeneity in the aquifer.

Photographs of Ground water sampling is given below.

Photographs1: GW 1 sampled from Bokolai

Photographs 2: GW 2 sampled from Hatigormatikhola

Photographs 3: GW 4 sampled from Bahfalla

Photographs 3: GW 5 sampled from Awariya Gaon

3.12 Surface water quality

Surface water quality monitoring location

A monitoring network consisting of 8 locations for surface water monitoring was selected. Water sampling and analysis was done following CPCB standard guidelines for physical, chemical and bacteriological parameters. Surface Sampling Location is presented in Figure 37.

Table 3.10 Surface water sampling locations

Location Code	Sampling Location	Coordinate
SW 1	Bramahputra River Near Deomari	26°50'30.96"N, 94° 7'5.67"E
SW 2	Bramahputra River Near Neolgaon	26°48'54.70"N, 93° 59'53.20"E
SW 3	Gelabil River Near Bilotia	26°44'38.09"N, 94° 0'17.45"E
SW 4	Kakodunga River Near Bogiwai	26°32'59.29"N, 94° 6'45.41"E
SW 5	Bhogdoi River Near Gaingaon	26°47'1.08"N, 94° 9'26.39"E
SW 6	Pond Near Nojankhana	26°49'7.024"N, 94° 9'26.02"E
SW 7	Gorongajan River Near Boruahgaon	26°26'36.59"N, 94° 2'41.06"E
SW 8	Kakodonga River Near Changchowa	26°40'01.30"N, 94° 4'10.81"E

Interpretation of Surface water quality result:

Surface water quality results have been provided in in table 3-12. As discussed in the previous section the channels from which samples were taken and analyzed were primarily used for irrigation, bathing, cleaning and for catching fish. The analyzed values of the samples after comparing with the CPCB Water Use Criteria justifies their use in compliance to water use criteria.

Table 3.11 . Surface water quality result:

Sl. No.	Parameter	Unit	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
1	Colour	Hazen	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2	Odour	None	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
4	Temperature	°C	23.6	25.6	28.6	25.1	30.2	25.6	26.2	25
5	pH value	None	6.7 at 23.6 °C	6.7 at 25.6 °C	6.4 at 28.6 °C	5.6 at 25.1 °C	6.7 at 30.2 °C	5.6 at 25.6 °C	5.6 at 26.2 °C	6.85 at 25 °C
6	Conductivity	µS/cm	132	120	108	137	158	154	102	116
7	DO	mg/l	6.2	6.1	6.2	6.3	6.1	6.0	6.1	5.8
8	Turbidity	N.T.U.	22	20	14	69	27	29	44	24
9	Total Dissolved Solids (as TDS)	mg/l	76	65	62	72	82	80	64	74
10	Biochemical Oxygen Demand (as BOD)	mg/l	<2.0	3.4	2.8	3.8	4.2	3.0	2.1	<2.0
11	Chemical Oxygen Demand (COD)	mg/l	7.7	40	36	27	31	27	23	8
12	Total Hardness (as CaCO3)	mg/l	61	54	50	46	65	61	50	48
13	Alkalinity (as CaCO3)	mg/l	50	28	20	40	60	30	20	40
14	Sodium (as Na)	mg/l	2.7	1.8	1.4	7.1	4.5	4.8	3.9	4
15	Potassium (as K)	mg/l	2.4	2.5	2	3.3	2.5	3.9	2.6	3
16	Sodium Adsorption Ration (as SAR)	None	0.15	0.11	0.15	0.45	0.24	0.26	0.24	0.4

Sl. No.	Parameter	Unit	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
17	Free Ammonia	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
18	Phosphorus	mg/l	<0.05	<0.05	<0.05	4.9	3.2	7.2	3.5	<0.05
19	Total Nitrogen	mg/l	<0.3	0.75	0.56	1.4	0.90	0.85	1.0	1.1
20	Aluminium (as Al)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Anionic Detergents (as MBAS)	mg/l	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
22	Barium (as Ba)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Calcium (as Ca)	mg/l	15	12	9.2	7.7	17	11	12	11
24	Chloramines (as Cl2)	None	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
25	Chloride (as Cl)	mg/l	6	12	8	10	8	8	10	14
26	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
27	Fluoride (as F)	mg/l	0.17	<0.1	<0.1	0.20	0.17	0.18	0.18	0.27
28	Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
29	Iron (as Fe)	mg/l	3.7	7.7	5.1	1.7	0.15	0.74	2.5	3
30	Magnesium (as Mg)	mg/l	5.5	5.5	6.5	6.5	5.5	8.3	4.6	4.8
31	Manganese (as Mn)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
32	Mineral Oil	None	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
33	Nitrate (as NO3)	mg/l	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	5
34	Selenium (as Se)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Sl. No.	Parameter	Unit	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
35	Sulphate (as SO4)	mg/l	4.2	<1.0	<1.0	8.8	2.0	18	11	3
36	Cadmium (as Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
37	Cyanide (as CN)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
38	Lead (as Pb)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
39	Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
40	Molybdenum (as Mo)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
41	Arsenic(as As)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
42	Nickel (as Ni)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
43	Zinc (as Zn)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
44	Hexavalent Chromium (as Cr+6)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
45	Salinity	None	0.08	0.07	0.09	0.08	0.11	0.10	0.04	0.07
46	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
47	Bromoform	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
48	Dibromochloro methane	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
49	Bromodichloro methane	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
50	Chloroform	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
51	Alachlor	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
52	Atrazine	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Sl. No.	Parameter	Unit	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
53	Aldrin	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
54	Dieldrin	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
55	Alpha-HCH	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
56	Beta-HCH	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
57	Butachlor	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
58	Chlorpyrifos	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
59	Delta-HCH	µg/l	<0.01	<0.01	<0..01	<0.01	<0.01	<0.01	<0.01	<0.01
60	2,4-Dichlorophenoxyacetic acid	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
61	p,p DDD	micro gm/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
62	o,p-DDT	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
63	p,p-DDT	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
64	o,p-DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
65	p,p-DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
66	o,p-DDD	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
67	Endosulfan sulfate	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
68	Alpha - endosulfan	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
69	Beta-Endosulfan	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
70	Ethion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
71	Gama-HCH(Lindane)	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Sl. No.	Parameter	Unit	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
72	Isoproturon	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
73	Malathion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
74	Methyl parathion	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
75	Monocrotophos	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
76	Phorate	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
77	Polychlorinated biphenyls (as PCB)	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
78	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
79	Total coliform	MPN/100ml	170	70	50	90	27	70	130	50
80	Faecal coliform	/100ml	9 MPN/100 ml	7 MPN/100 ml	8 MPN/100 ml	9 MPN/100 ml	4 MPN/100 ml	7 MPN/100 ml	8 MPN/100 ml	8 MPN/100 ml

- **pH** – The pH value ranged between 5.6 to 6.85 in all monitoring locations and characterized as mild acidic to neutral .
- **Dissolved Oxygen (DO)** –DO concentrations of the collected samples was found to be 5.8 to 6.3, which is little above of the safe criteria of 5 mg/l.
- **Biochemical Oxygen Demand (BOD)** – The concentration of BOD for the water samples was found to be <2.0 to 3.8 in all the collected samples.
- **Chemical Oxygen Demand (COD)** – The concentration of COD for the water samples 7.7 to 40mg/l in the collected surface water samples.
- **Coliform bacteria**–The load of total coliform was measured as 27 MPN/100 ml and 170 MPN/100 ml at all the sampling locations. Faecal coliform was also detected at all the surface water sample which could be due to the fact that the water body may be used for bathing and release of sewage in the water bodies.
- **Total Dissolved Solids (TDS)** - The TDS concentrations of all the samples ranged between 62 – 82 mg/l.
- **Sodium Absorption Ratio (SAR)** - Sodium absorption ratio for all the samples recorded as 0.11 to 0.45.
- **Total hardness** – Total hardness in all the water samples ranged between 46 – 65 mg/l, which indicated a soft water nature of the surface water.
- Concentrations of phenol (<0.001 mg/l) found to be below detection limit for the sample, polychlorinated biphenyl was not detected in the sample.
- **Concentration of Metals -** like lead (<0.001 mg/l), mercury (<0.001 mg/l), cadmium (<0.001 mg/l), Hexavalent chromium (<0.02 mg/l) were found to be below detection limits for the only surface water sample.
- **Arsenic** – The concentration of Arsenic was found to be below detection limit.
- **Free Ammonia** - The concentration of Free Ammonia was found to be less than 0.01 mg/l.

The water samples were found to be suitable for “B” class of water, i.e. Outdoor bathing. The analysed values also reveal that all the samples complied to the CPCB Class D i.e. Propagation of Wild life and Fisheries.

Photographs1: Surface water samoling from Brahmaputra River near Deomari (SW1)

Photographs 2: Surface water sampling from Gelabili River near Bilotiya (SW3)

Photographs 3: Surface water sampling from Kakodanga River near Bogiwai (SW4)

Photographs 4: Surface water sampling from Bhogdoi River near Gaingaon (SW5)

3.13 Soil Quality

Golaghat District

The soils of district Golaghat is broadly classified in to two major groups.

Deep reddish soil, these are found in older geological formation and (ii) light grey to dark grey coloured soil covering the major parts of the district. Low nitrogen, low phosphate, medium to high potash, acidic characters of the soil are representative of the soil cover found in the hills. In the plain areas, the other type of the soil covers is found to be feebly alkaline.

Jorhat District:

The soils of the Jorhat district can be broadly divided in to three major groups.

- **New Alluvial soil:** The new alluvial soil are characterized by silt deposition by occasional flood. These are yellow to yellowish grey in colour. pH of soil is alkaline and rich in plant nutrient.
- **Older Alluvial soil:** This type of soil can be located in central upland area of the district. The soil is consisting of sand, silt and humus rich clay.

- **Hilly soil :** This particular soil type is present in the southern boundary of the district, representing the hilly region. The soils in the southern parts are residual in origin, derived from the semi-consolidated rocks underlying these areas

Samples for soil quality study were collected from eight (8) locations from the study area. Details of Soil Sampling locations, analysis results of soil samples are presented in tables 3.13.

Table 3.12 Soil sampling locations

Location Code	Co-ordinates	Sampling Location	Land-Use Pattern
SQ 1	26°48'33.29"N, 94° 7'45.21"E	Dekasatra Bhakei	Agricultural land
SQ 2	26°30'36.04"N,94°10'33.36"E	Tipomia	Agricultural land
SQ 3	26°40'17.82"N,94°09'34.33"E	Saraibahi Bamungaon	Agricultural land
SQ 4	26°46'51.91"N, 94° 3'42.40"E	Dhankhuloigaon	Agricultural land
SQ 5	26°40'54.76"N, 94° 0'17.12"E	Boruahgaon	Agricultural land
SQ 6	26°24'37.19"N,94°06'15.80"E	Simphuria	Agricultural land
SQ 7	26°27'46.09"N,94°01'16.26"E	Fatual	Agricultural land
SQ 8	26°34'07.04"N,94°06'31.28"E	Garia Chelengaon	Agricultural land

Table 3.13 . Soil Quality Result

Sl. No.	Parameters	Unit	SQ 1	SQ2	SQ 3	SQ 4	SQ 5	SQ 6	SQ 7	SQ 8
1	Alkalinity (as CaCO3)	mg/kg	180	100	60	140	160	120	100	80
2	Antimony (as Sb)	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
3	Arsenic(as As)	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
4	Available Nitrogen (as N)	mg/kg	274	162	280	308	342	162	274	364
5	Available Phosphorus (as P)	mg/kg	3.7	7	4.1	3.6	3.1	15	3.6	13
6	Available Potassium (as K)	mg/kg	30	30	49	44	50	55	91	89
7	Barium (as Ba)	mg/kg	15	27	33	22	26	37	47	55
8	Boron (as B)	None	3	6	8	5	6	9	9	11
9	Bulk Density	g/cc	1.25	1.18	1.05	1.11	1.18	1.25	1.14	1.11
10	Cadmium (as Cd)	mg/kg	<2	<2	<2.0	<2	<2	<2.0	<2	<2
11	Calcium (as Ca)	mg/kg	650	600	450	350	400	900	1350	800
12	Carbonate	mg/kg	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
13	Cation Exchange Capacity	meq/100 gm	12	7.5	6.6	9	8.6	9.0	13	8.8
14	Chloride (as Cl)	mg/kg	40	50	60	40	60	40	70	70
15	Cobalt (as Co)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2.0
16	Copper (as Cu)	mg/kg	6	7	9	8	6	17	17	16
17	Cyanide (as CN)	mg/kg	<1	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0
18	Electrical conductivity	us/cm	31.1 (1:2) at 25 °C	31 (1:2) at 25 °C	99 (1:2) at 25 °C	37.9 (1:2) at 25 °C	31.2 (1:2) at 25 °C	101(1:2) at 25 °C	218 (1:2) at 25 °C	75 (1:2) at 25 °C
19	Hexavalent Chromium (as Cr+6)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
20	Infiltration Capacity	mm/Hr	16	13	2.0	11	17	18	3.4	6.9

21	Iron (as Fe)	mg/kg	105	104	68	32	20	24	57	101
22	Lead (as Pb)	mg/kg	3	5	7	5	4	8	11	13
23	Magnesium (as Mg)	mg/kg	270	90	180	120	150	240	330	180
24	Manganese (as Mn)	mg/kg	23	180	180	60	180	140	180	160
25	Mercury (as Hg)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
26	Moisture	%	26	25	30	17	23	23.	27	19
27	Molybdenum (as Mo)	None	<2	<2.0	<2.0	<2	<2	<2.0	<2.0	<2.0
28	Nickel (as Ni)	mg/kg	13	19	18	16	18	20	21	25
29	Organic Matter	%	1.3	0.75	1.2	1.4	1.1	0.71	0.56	2.02
30	Particle Size Distribution	mg/kg	Sand:42% Silt: 34% Clay:24%	Sand:44% Silt:30% Clay:26%	sand:31% silt:%26 clay:43%	Sand:46% Silt: 29% Clay:25%	Sand:41% Silt: 36% Clay:23%	Sand: 52% Silt:28% Clay:20%	Sand: 30% Silt: 29% Clay:41%	sand:44% silt:26% clay:30%
31	Permeability	Cm/hr	2.9	1.4	0.09	2.7	2.3	2.6	0.14	0.96
32	Total Phosphorus	mg/kg	84	92	120	73	64	196	128	182
33	Sodium (as Na)	mg/kg	54	56	34	50	27	69	193	87
34	Sodium Adsorption Ration (as SAR)	None	0.25	0.17	0.14	0.31	0.17	0.30	0.71	0.33
35	Specific gravity	None	2.59	2.27	2.36	2.44	2.36	2.64	2.39	2.38
36	Sulphate (as SO4)	mg/kg	13	43	20	13	32	11	26	23
37	Texture	None	Loam	Loam	Clay	Loam	Loam	Loam	Clay	Clay loam
38	Thiocyanate	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5
39	Total Nitrogen (as N)	mg/kg	571	392	622	700	801	386	521	824
40	Total Organic Carbon	%	0.77	0.44	0.69	0.80	0.62	0.41	0.32	1.2
41	Total Porosity	%	51.7	47.9	55.5	54.5	50.1	52.6	52.3	53.4
42	Total Potassium	mg/kg	106	196	264	186	152	282	332	398
43	Trivalent Chromium as Cr-III (TCLP)	None	<2	<2	<2	<2	<2	<2	<2	<2.0

44	Water Holding capacity	%	39	33	46	33	35	30	42	37
45	Zinc (as Zn)	mg/kg	10	22	25	22	17	22	30	41
46	pH value	None	5.79 (1:2.5) at 25 deg C	5.37 (1:2.5) at 25 deg C	4.35 (1:2.5) at 25 deg C	5.32 (1:2.5) at 25 deg C	5.67 (1:2.5) at 25 deg C	5.78 (1:2.5) at 25 deg C	7.07 (1:2.5) at 25 deg C	4.91(1:2.5) at 25 deg C

ND = Not Detectable; LDL: Lower detection limit

India does not have any specific concentration-based soil contamination standards. In absence of any existing standards, Dutch standards have been considered for the purpose of analysis

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Table 3.14 . Soil Remediation Intervention Values as per Dutch Standards

S. No.	Parameter	Intervention Values (mg/kg dry matter)
1	Zinc	720
2	Arsenic	76
3	Lead	530
4	Cadmium	13
5	Copper	190
6	Mercury (inorganic)	36
7	Nickel	100

Source: Soil Remediation Circular 2009, Minister of Housing, Spatial Planning and Environment, Netherlands.

Note: Concentrations are shown for standard soil (10% organic matter and 25% clay)

The physical, chemical and heavy metal concentrations of the soil samples were determined and compared with the standard soil classification provided by the Indian Council of Agricultural Research (ICAR) and as given in table 3.15 .

Table 3.15 .Standard Soil Classification

Sl. No.	Soil Test	Classification
1.	pH	<4.5 Extremely acidic 4.51- 5.50 Very strongly acidic 5.51-6.0 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline 7.81-8.50 moderately alkaline 8.51-9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1 ppm = 640 mmho/cm)	Upto 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon	Upto 0.2: very less 0.21-0.4: less 0.41-0.5 medium, 0.51-0.8: on an average sufficient 0.81-1.00: sufficient >1.0 more than sufficient
4	Nitrogen (kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient
5	Phosphorus (kg/ha)	Upto 15 very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient

6	Potash (kg/ha)	0 -120 very less 120-180 less 181-240 medium 241-300 average 301-360 better >360 more than sufficient

Source: Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi

pH

Soil acidity has a correlation with the availability of nutrients in terms of their deficiency and toxicity. A soil having pH less than 6 is considered as acidic. The soil samples in the study area was found would be very acidic to slight alkaline in nature and it ranges from 4.35 to 7.07.

Texture and Electrical Conductivity

Texture is an expression to indicate the coarseness or fineness of the soil as determined by the relative proportion of the various sized primary particles in the soil mass. The textures of the collected soil samples were found would be loam to clay loam in the study area, and higher proportion of silt particle had been observed. The presence of clay and silt in the soil gives a better water holding capacity of the soil, hence showed a low permeability of 2.6 on an average, and the average water holding capacity is 36.5% on average.

The EC values for the soils monitored at the study area range between 31.1 and 218 µs/cm. For a productive soil, the electrical conductance (EC) would be < 100000 µs/cm.

Macronutrients and Organic Carbon

Nutrient status of the soil samples can be determined from the concentration of available N, P, K and organic carbon in soil samples. Standard rating chart for soil nutrients is provided in Table 3.16.

Nitrogen contents in the soil samples ranged between 955.8 – 2020.2 kg/ha, phosphorus content in the soil samples ranged between 18.29 – 93.75 kg/ha, and potassium contents ranges between 187.5 – 518.7 kg/ha, with comparison to the rating chart, nutrient status of the soil is medium.

Metals

Heavy metals such as copper (6 - 16 mg/kg), lead (3 - 13 mg/kg) and zinc (10 - 41 mg/kg) were detectable in the soil of the study area. The concentration of copper, lead, Zinc and the other heavy metals in the soil sample was much below the soil remediation intervention values specified in Dutch Soil Remediation Circular (Refer table 3.15).

Sodium Absorption Ratio (SAR) - Sodium absorption ratio for the samples varied between 0.14 – 0.71.

Conclusion

The soil samples were found would be loam to clay loam, with comparatively low pH, typically represents he soil of flood plain of Brahmaputra valley. The macronutrient contents viz. NPK values of the soil samples were found would be medium. Metal contamination has not been observed in the analysed soil samples.

Photographs of Soil Quality Monitoring Activity is given below.

Photographs1: Soil sampling near Dekasatra Bhakei (SQ1)

Photographs 2: Soil sampling near Tipomia (SQ2)

Photographs 3: Soil sampling near Saraibahi Bamungaon (SQ3)

Photographs 4: Soil sampling near Boruahgaon (SQ5)

3.14 Traffic Survey

In order to appreciate the traffic and transport system characteristics traffic surveys were conducted within the study area. The brief methodology adopted, location, nature and extent of data collected under each of the above-mentioned surveys is discussed below. The field data collection activities were carried out in May & June 2019.

The major roads in the study area include AT road at Dhakpota, KB road at Kamarbandha, Titabor to Golaghat road at Kamarbandha, Titabor to Golaghat road at Titabor, Titabor to Jorhat road at Titabor, Titabor to Borholla road and Titabor to Borholla – Torani Gaon road. The survey was conducted by travelling along the identified road network and by collecting details on road characteristics by visual observation, inspection and measurements.

The main objective of classified traffic volume counts was to assess the traffic characteristics in terms of average daily traffic, hourly traffic variation, peak hour traffic, traffic composition and directional distribution. The surveys were conducted manually, on a normal working day and weekend. The survey has been conducted continuously for 24 hours. In order to express the intensity of traffic, it would be convenient to express all these different vehicle types in single unit terms. For this purpose, the PCU factors (IRC 106:1990) have been adopted and are given in **Table 3-16.**

Table 3.16 . Adopted Passenger Car Units

Mode	PCU factor
Heavy Motor Vehicles	4.5
Light Motor Vehicles	1.5
Two/Three Wheelers	1.0
Non-motorized vehicle	4

Source: IRC-106:1990

These roads cater to inter and intra city travel needs of various facilities and population residing in study area. Other roads provide links connecting to various facilities inside the study area.

The hourly variation of PCUs at above mentioned road intersections are presented below.

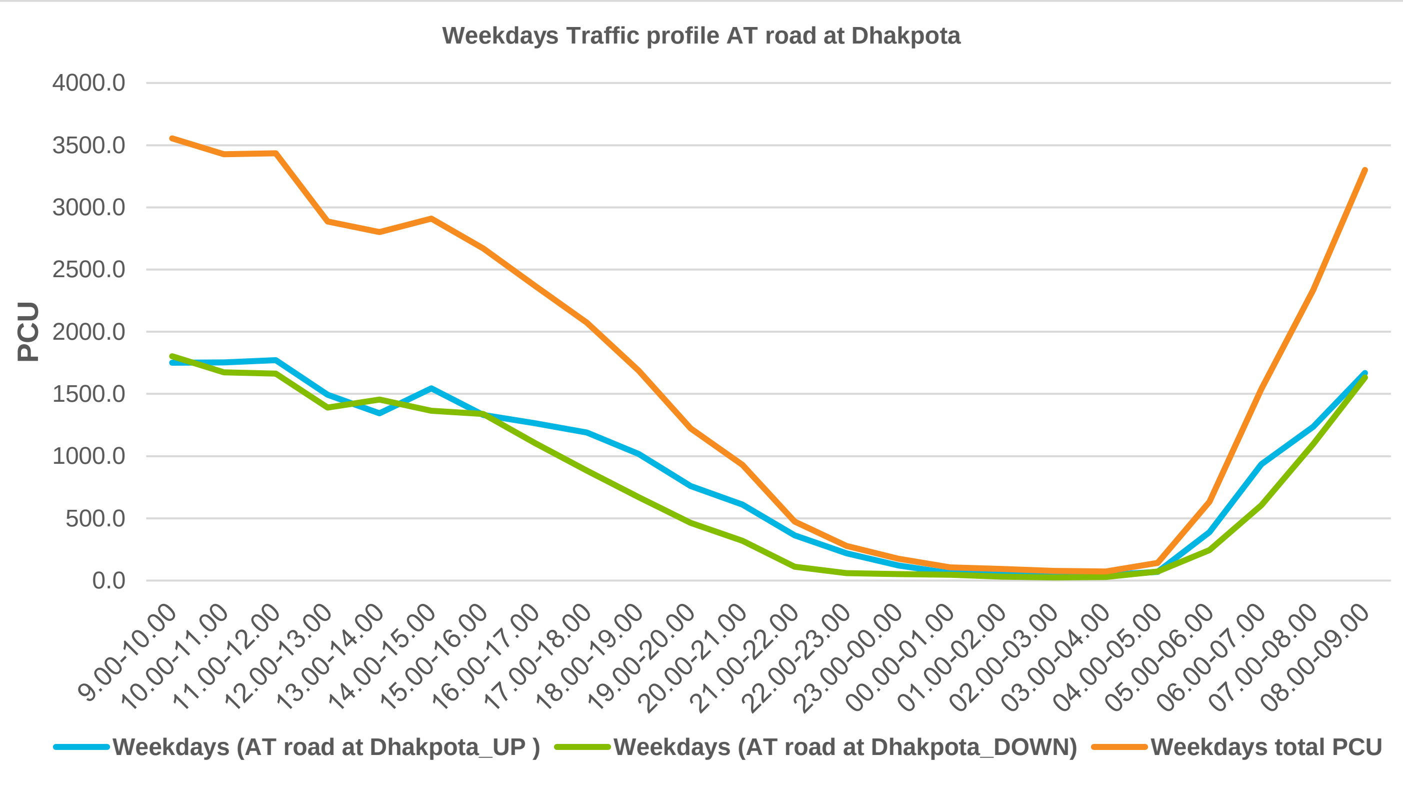


Figure 38. Hourly Traffic Profile at AT road at Dhakpota

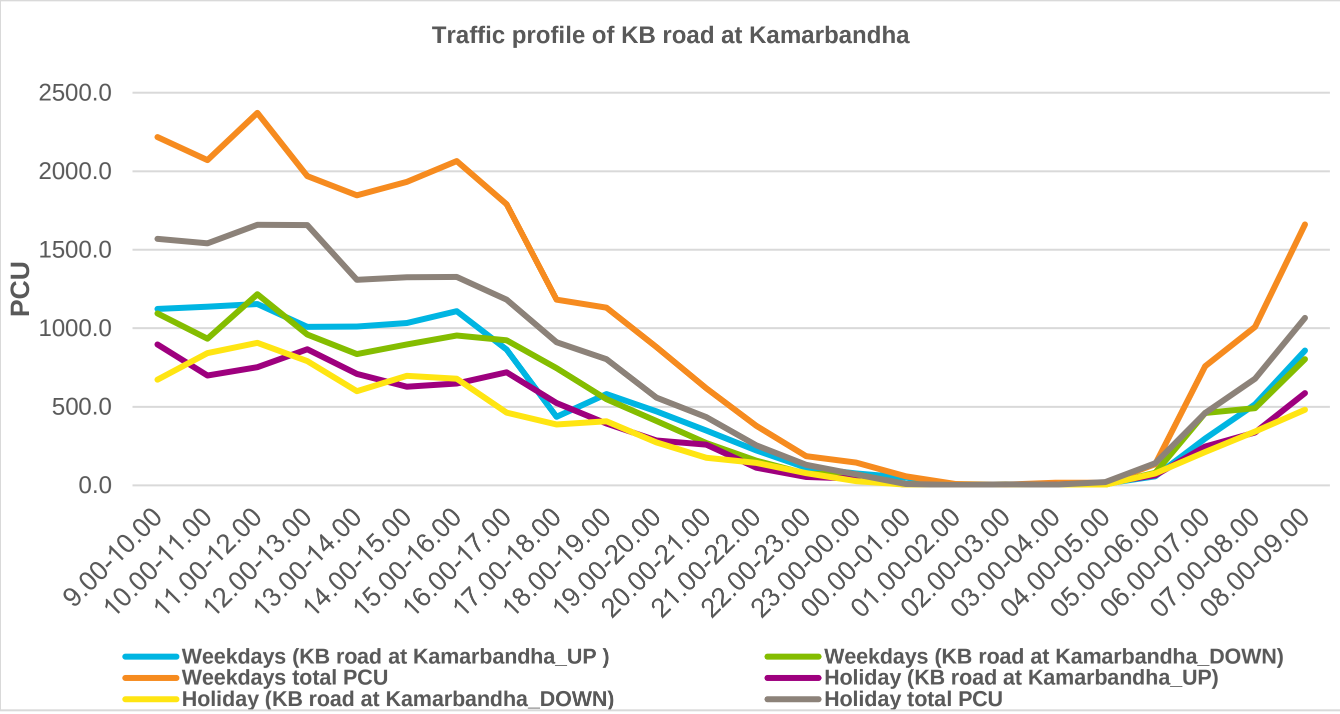


Figure 39. Hourly Traffic Profile at KB road at Kamarbandha**.**

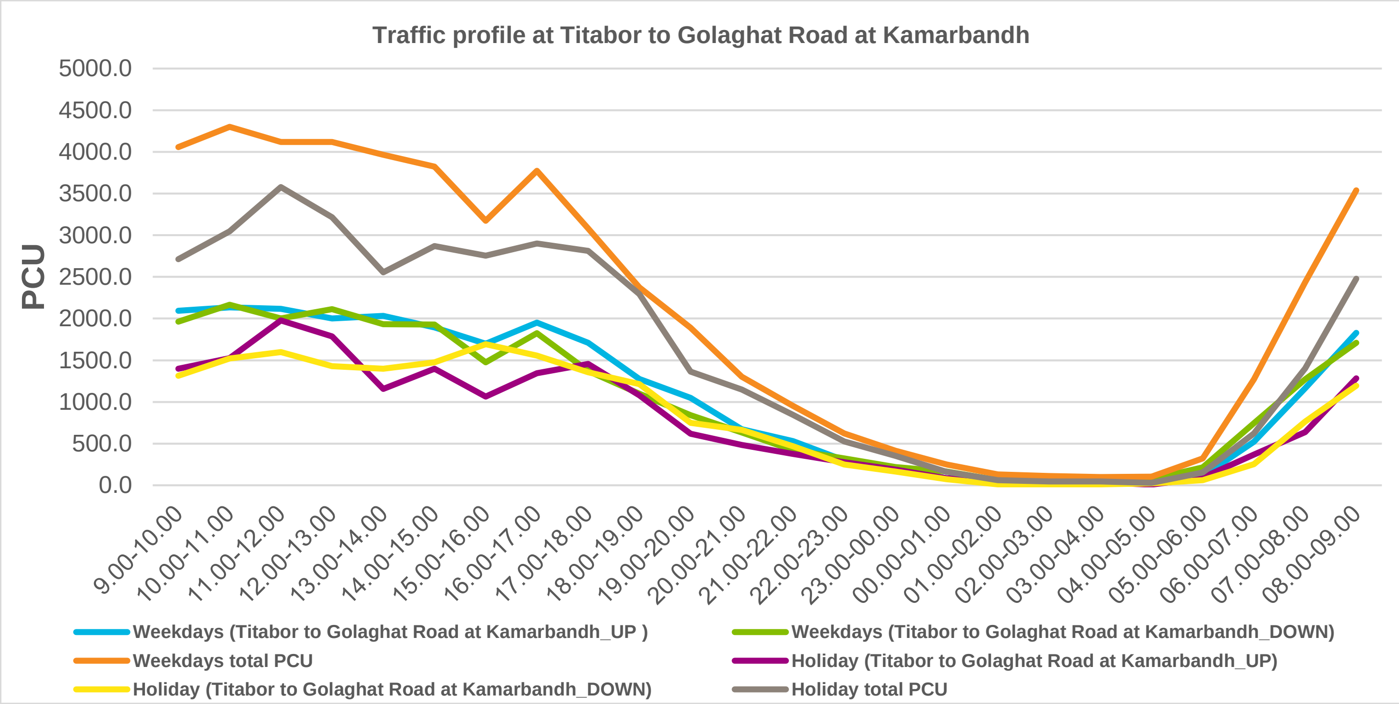


Figure 40. Hourly Traffic Profile at Titabor to Golaghat Road at Kamarbandha

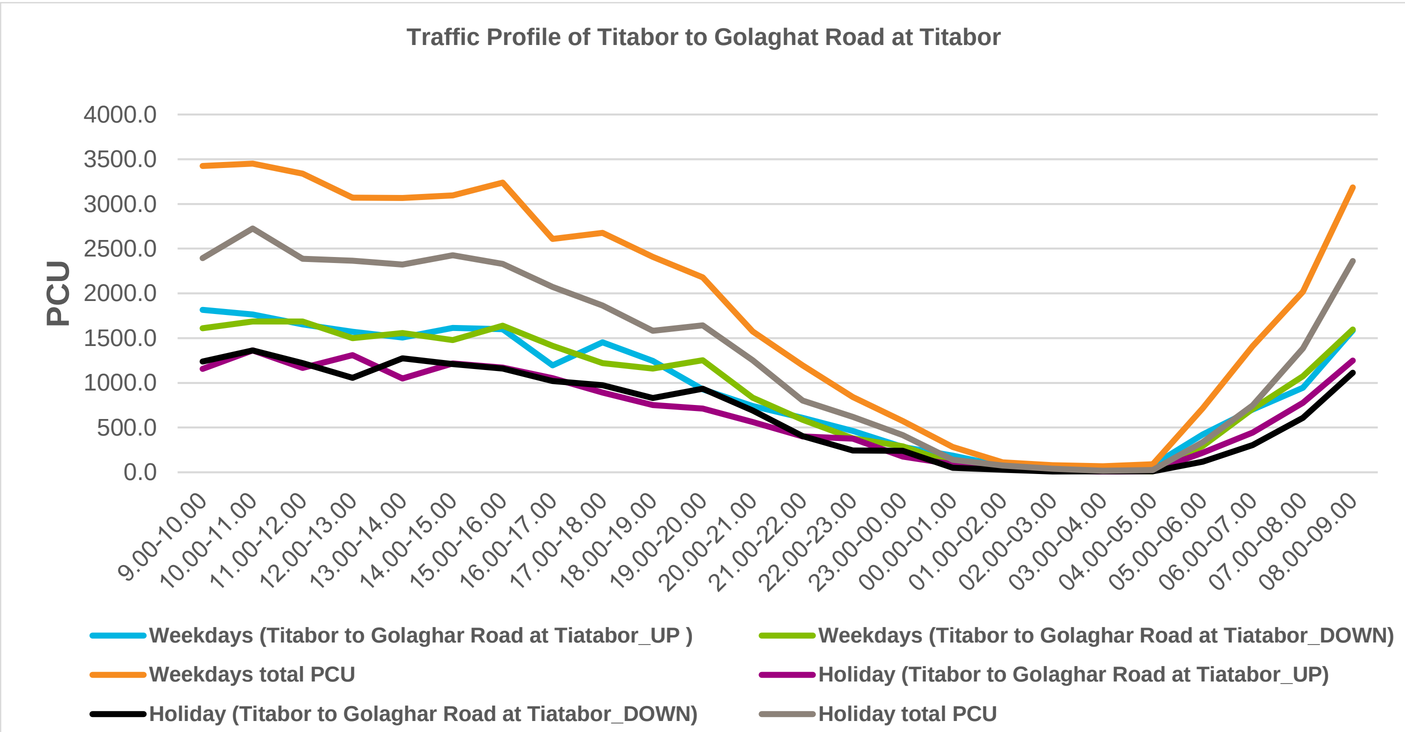


Figure 41. Hourly traffic Profile at Titabor to Golaghat Road at Titabor.

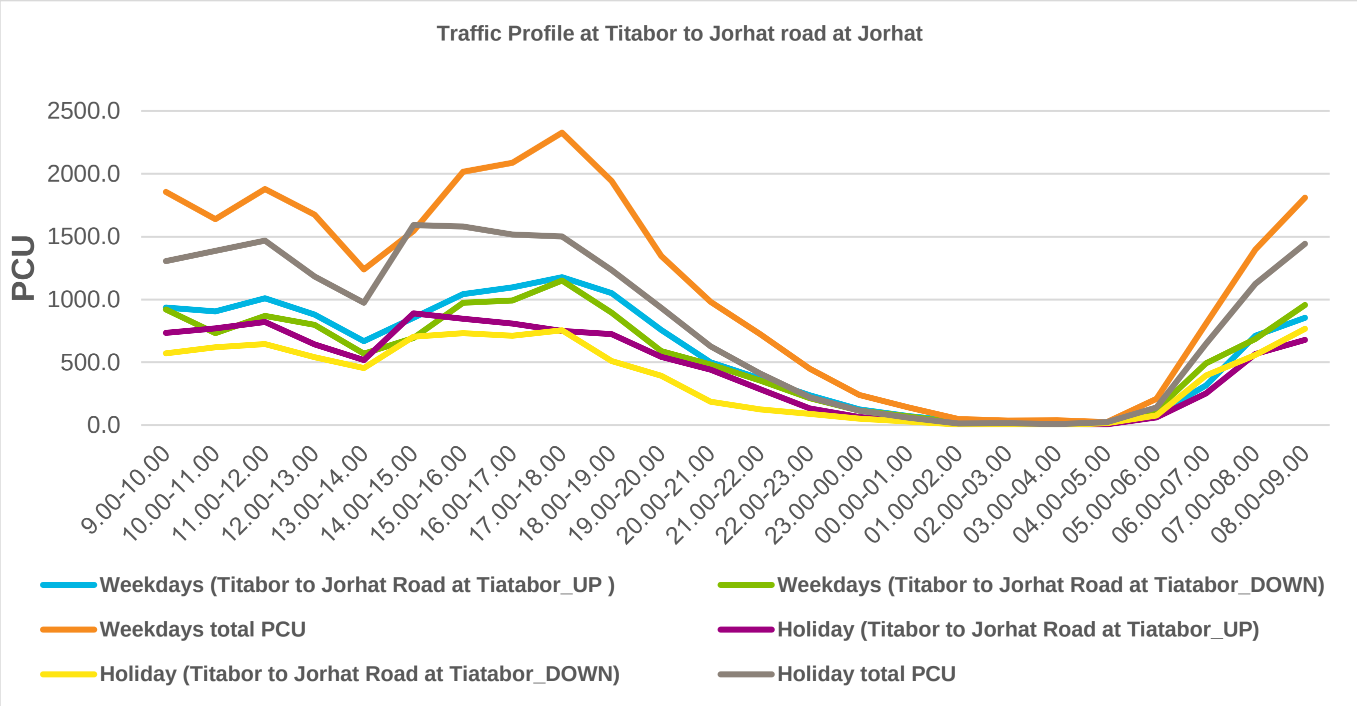


Figure 42. Hourly traffic profile at Titabor to Jorhat road at Jorhat.

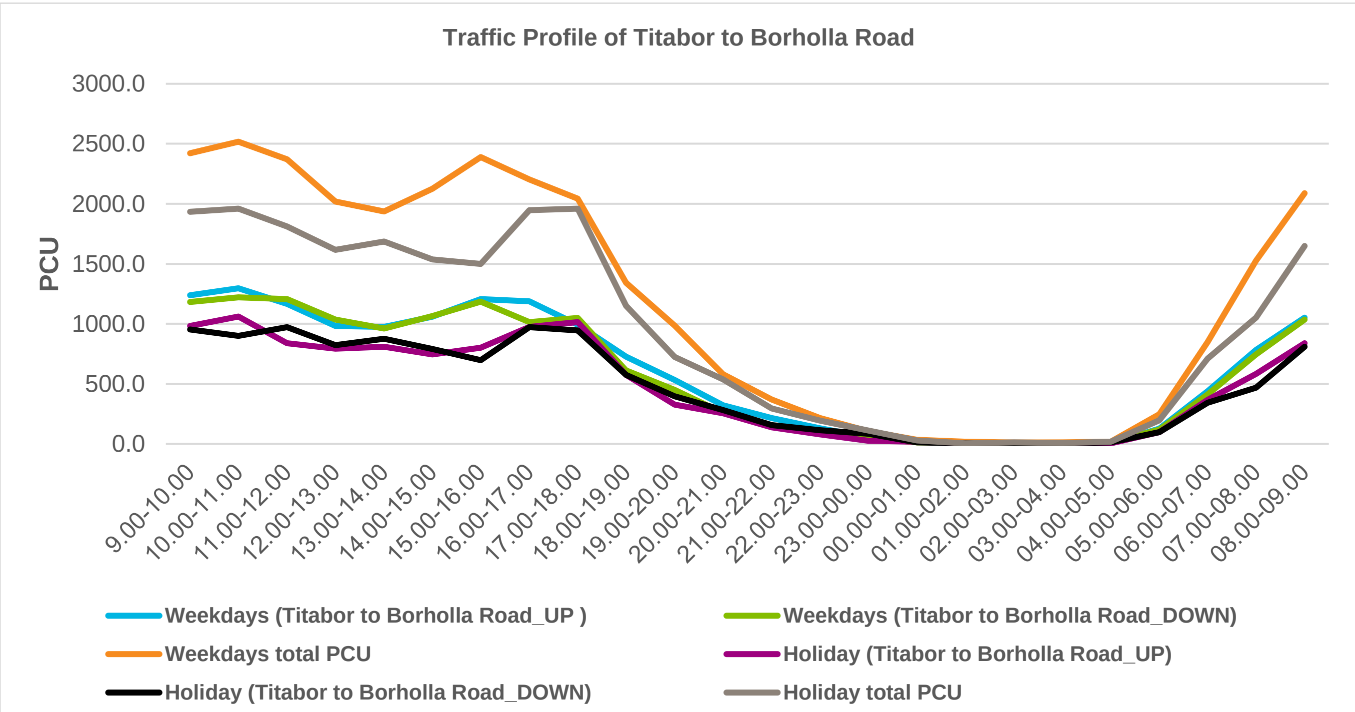


Figure 43. Hourly traffic profile at Titabor to Borholla road

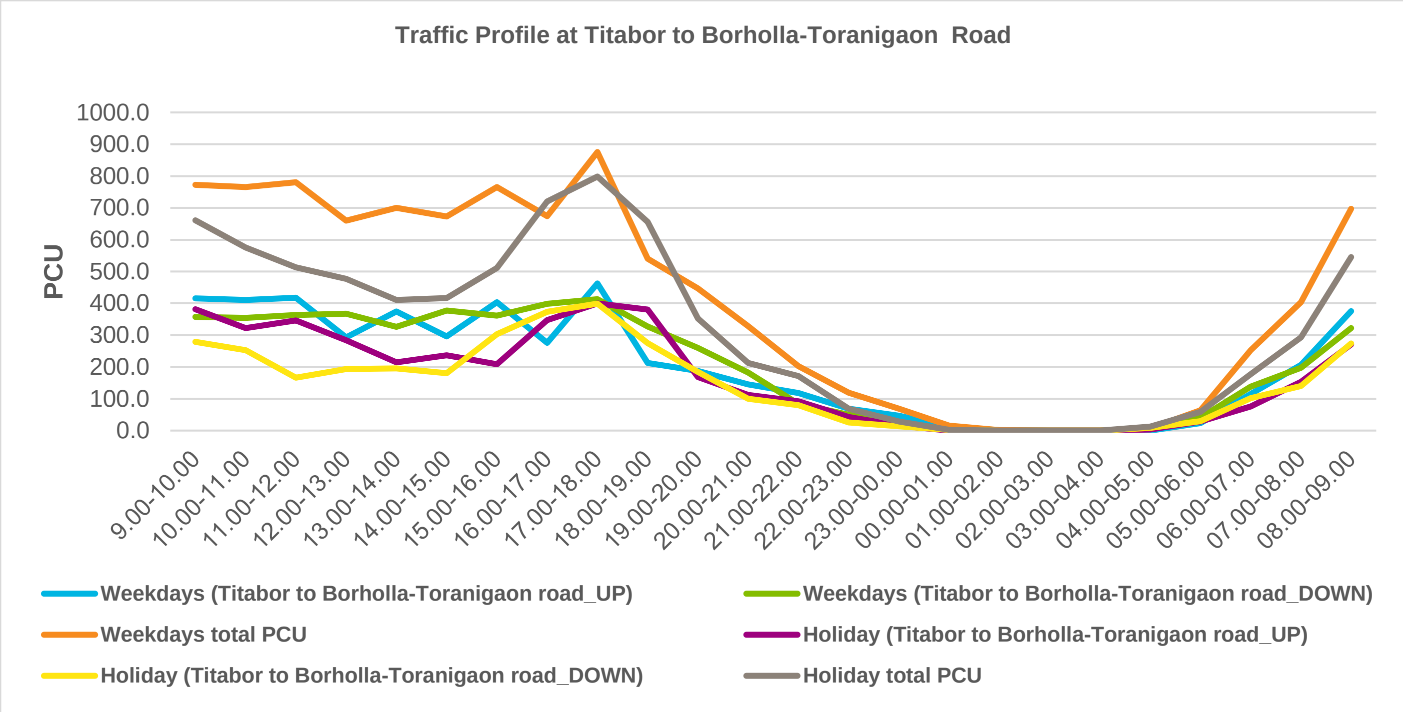


Figure 44. Hourly traffic profile at Titabor to orholla – Toranigaon road

Peak Hour Traffic

Peak hour traffic composition was also analysed for weekdays and holidays to understand the peak traffic timing and the diversity of vehicles at that time. Peak hour traffic composition has expressed through pie charts for each junction.

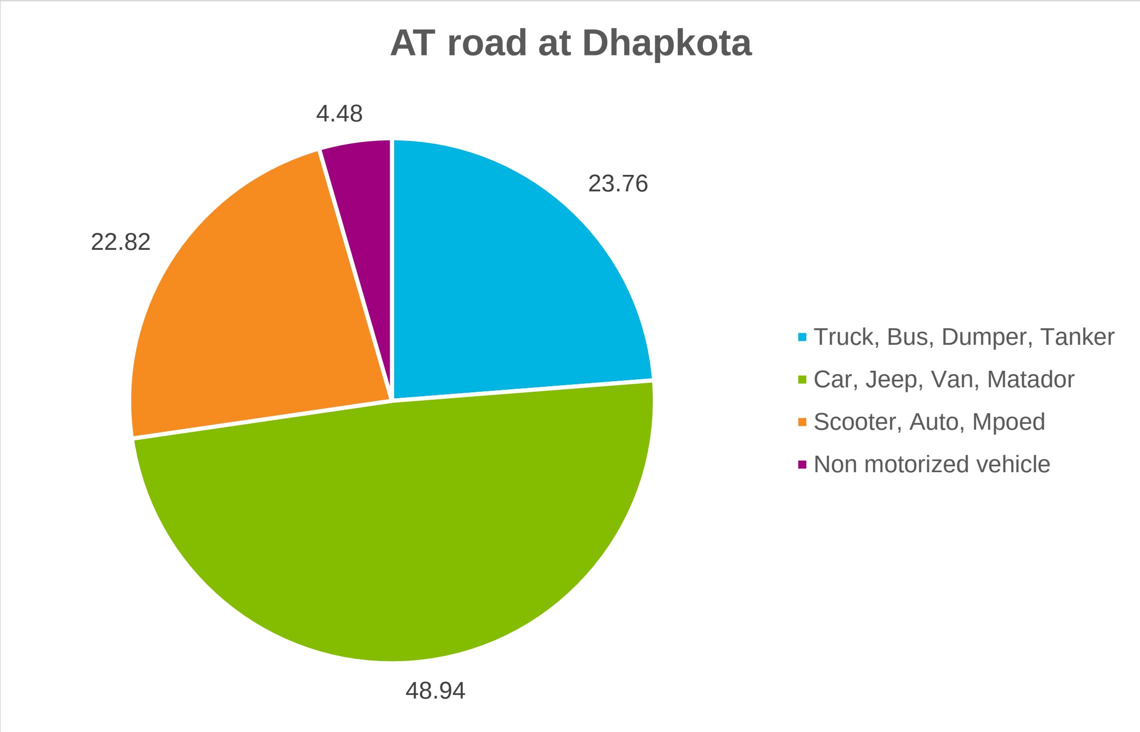


Figure 45. Peak Hour Traffic Composition (Vehicular) at AT road at Dhakpota. (weekdays)

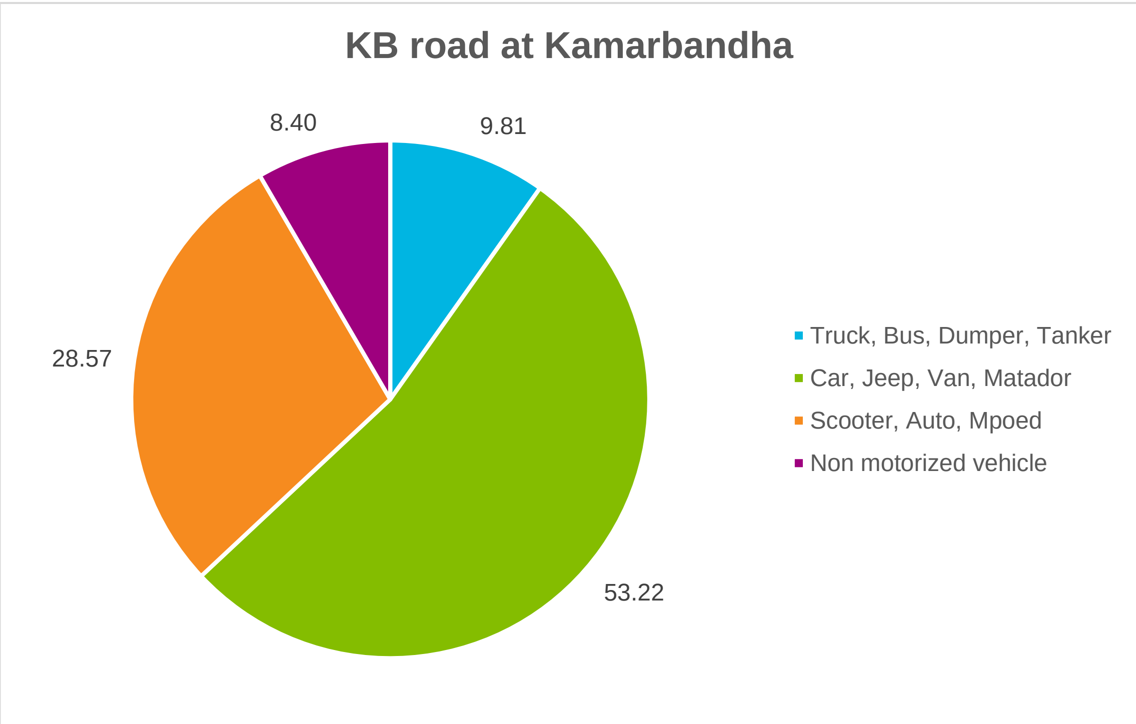


Figure 46. Peak Hour Traffic Composition (Vehicular) at KB road at Kamarbandha. (Weekdays)

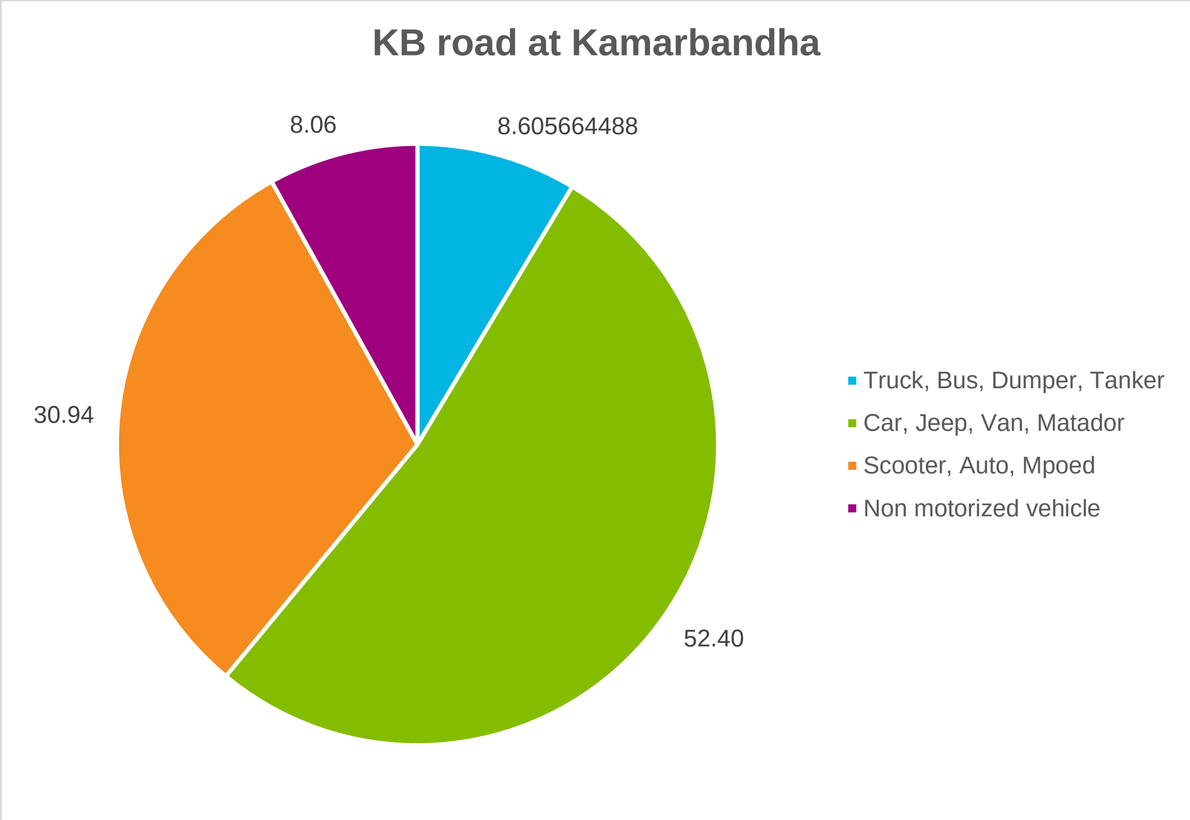


Figure 47. Peak Hour Traffic Composition (Vehicular) KB road at Kamarbandha (Holidays)

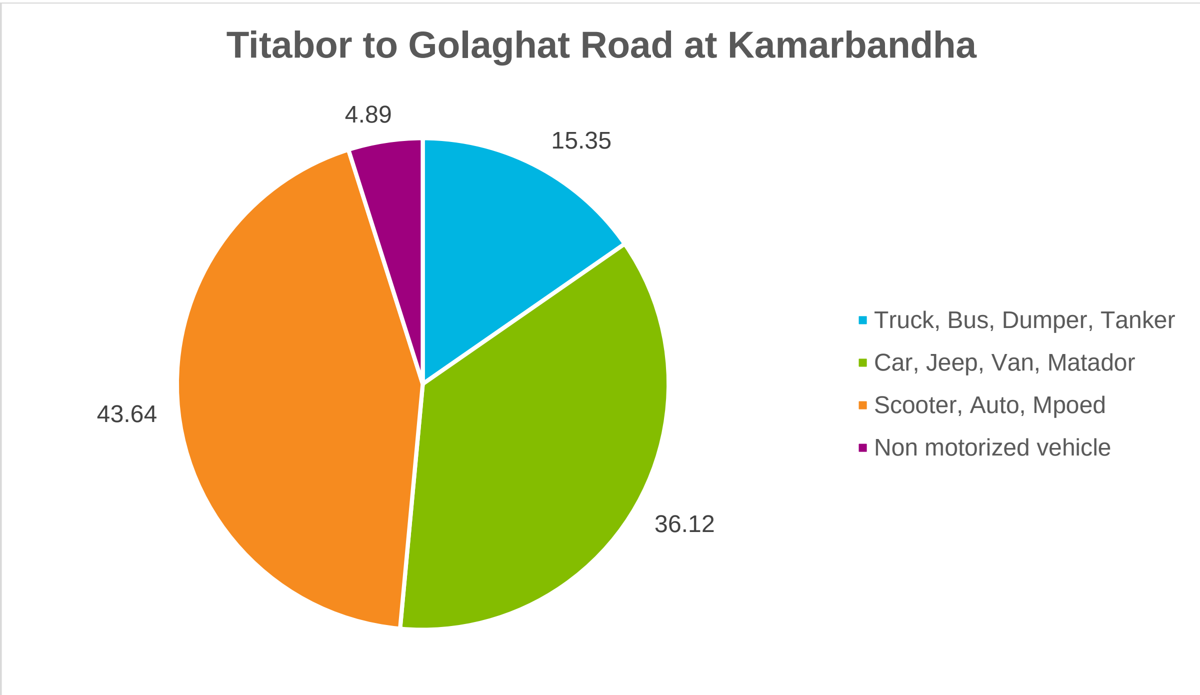


Figure 48. Peak Hour Traffic Composition (Vehicular) Titabor to Golaghat Road at Kamarbandha (Weekdays)

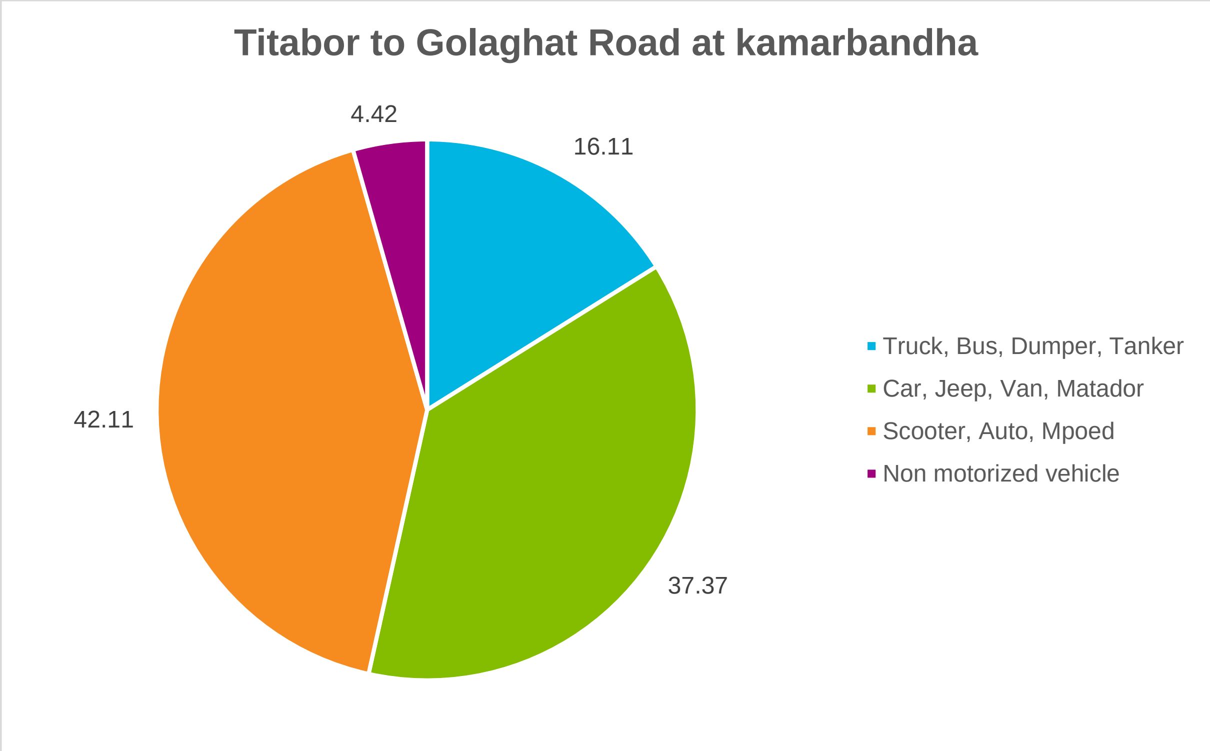


Figure 49. Peak Hour Traffic Composition (Vehicular) Titabor to Golaghat Road at Kamarbandha (holidays)

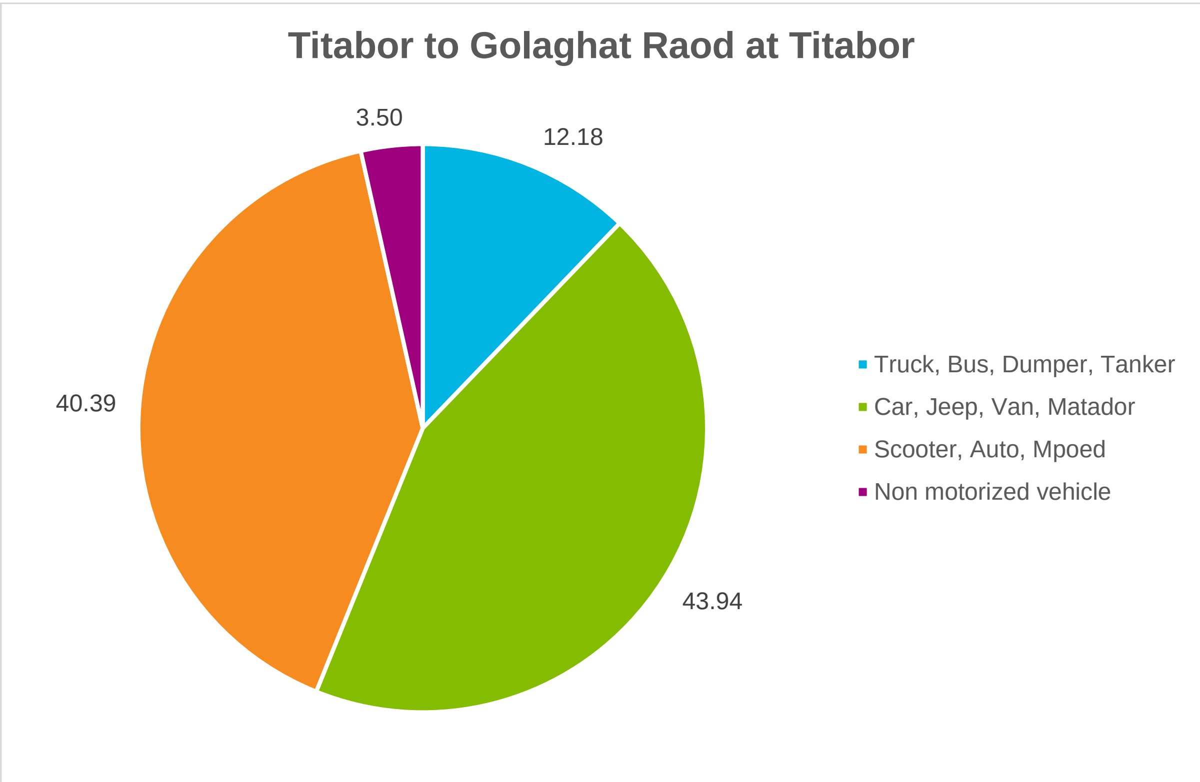


Figure 50. Peak Hour Traffic Composition (Vehicular) Titabor to Golaghat Road (Weekdays)

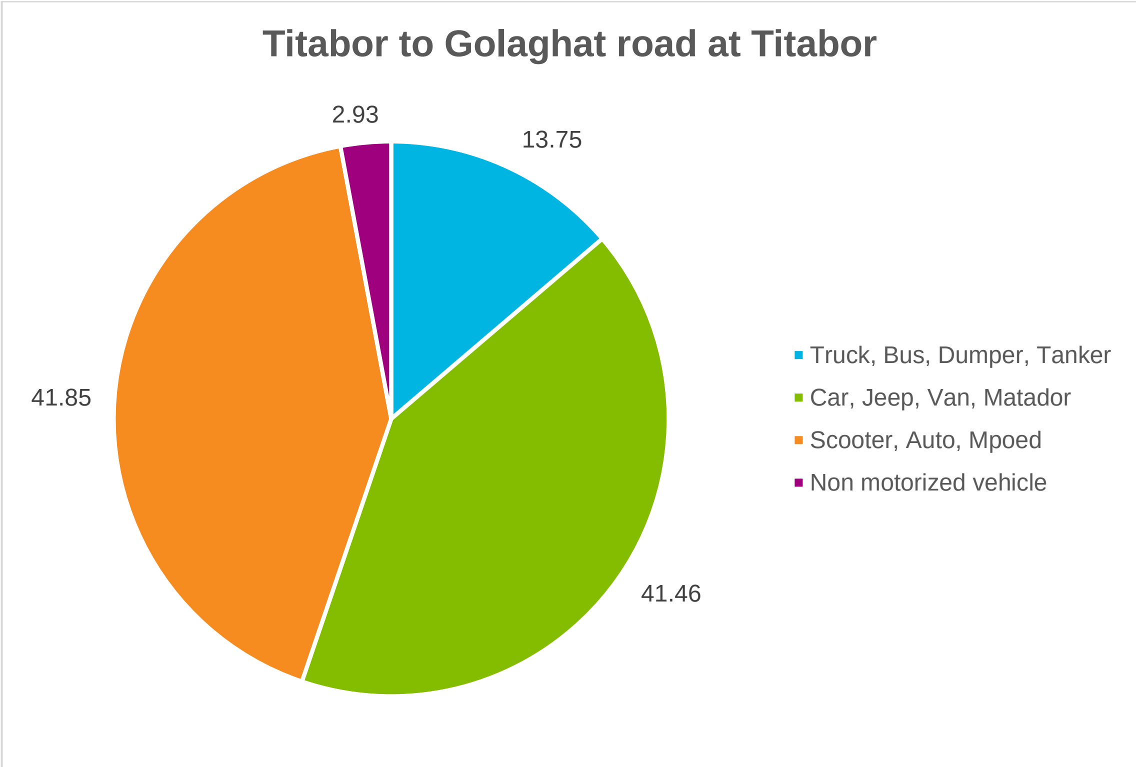


Figure 51. Peak Hour Traffic Composition (Vehicular) Titabor to Golaghat Road at Titabor (holidays)

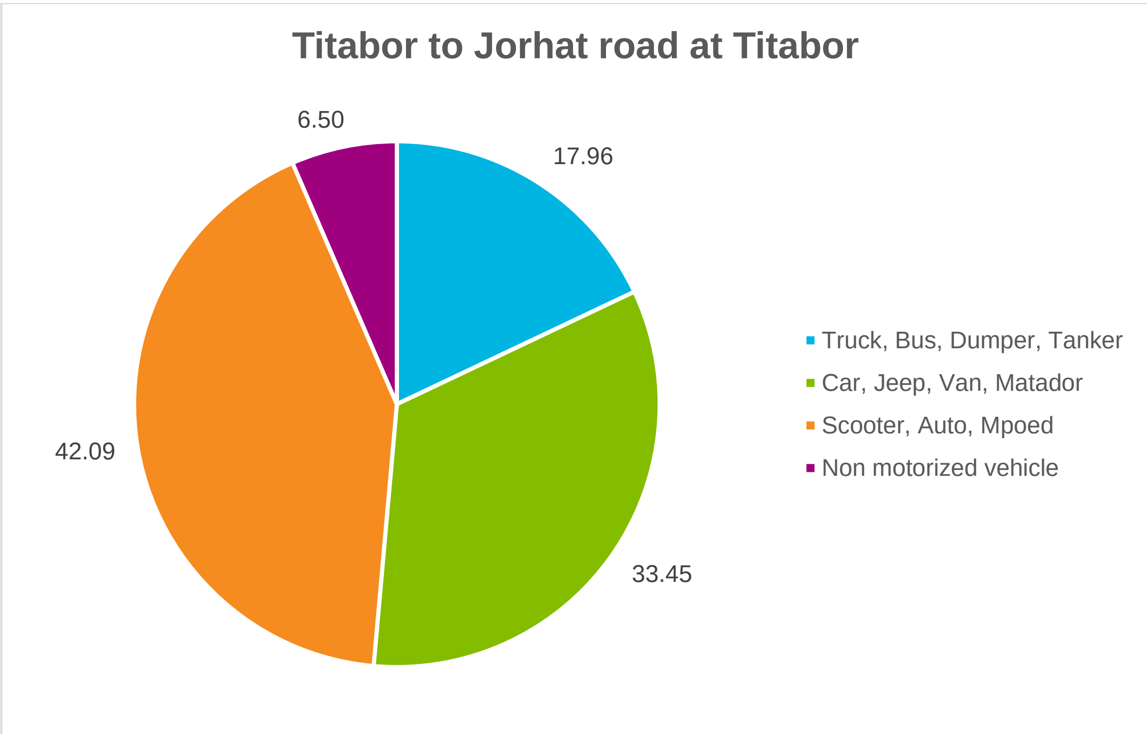


Figure 52. Peak Hour Traffic Composition (Vehicular) Titabor to Jorhat Road at Titabor (weekdays)

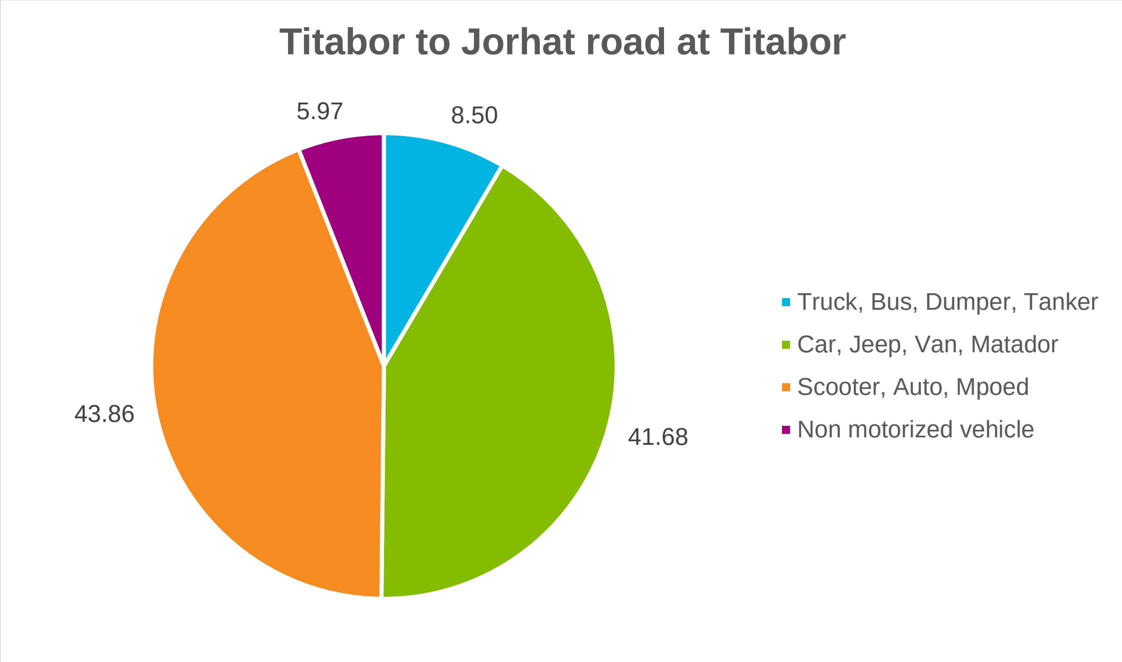


Figure 53. Peak Hour Traffic Composition (Vehicular) Titabor to Jorhat Road at Jorhat (Holidays)

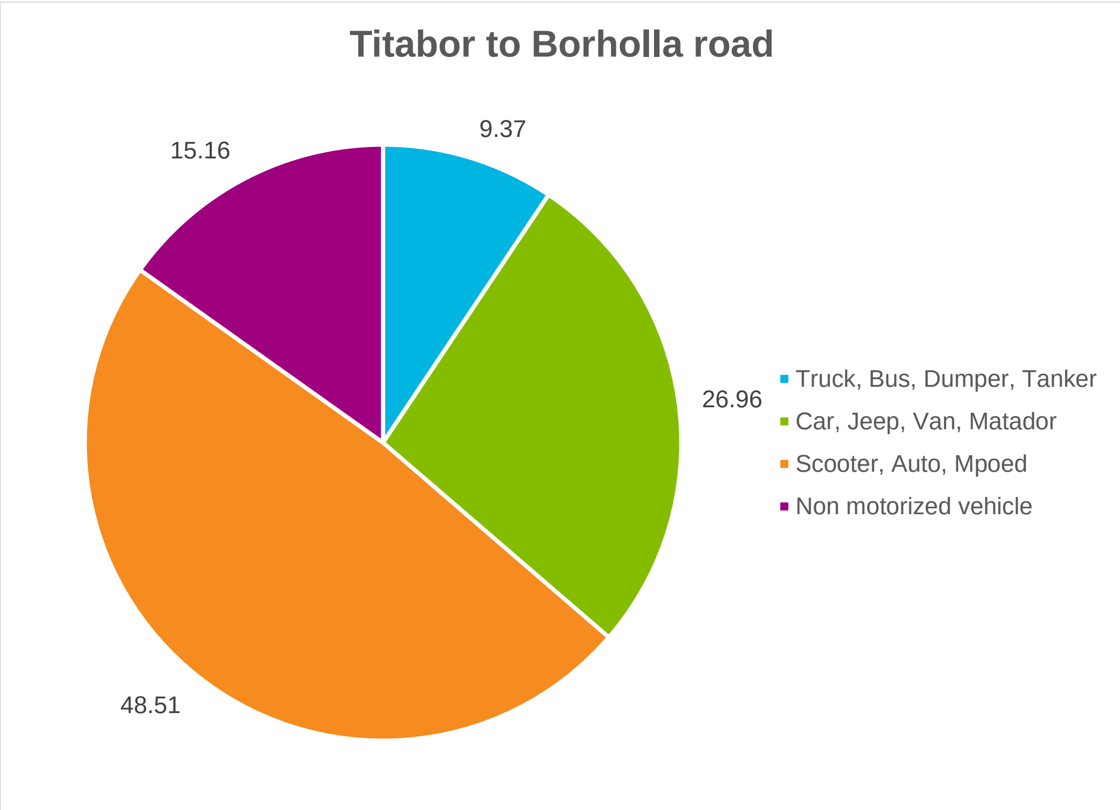


Figure 54. Peak Hour Traffic Composition (Vehicular) Titabor to Borholla road (Weekdays)

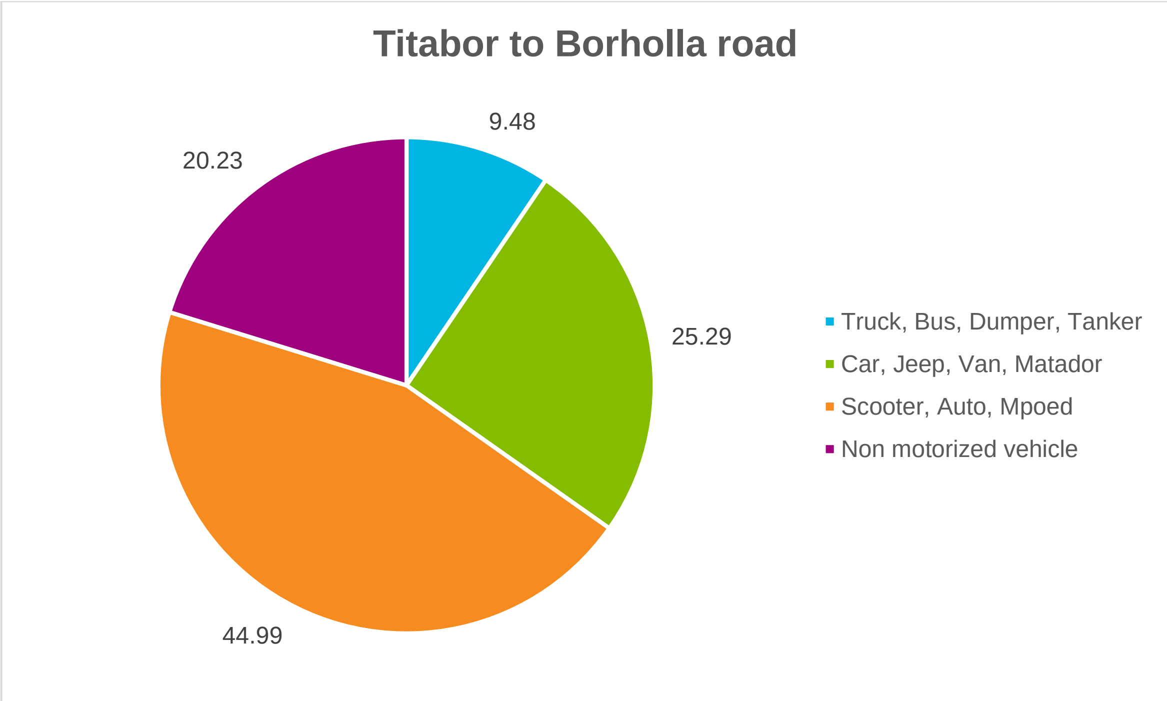


Figure 55. Peak Hour Traffic Composition (Vehicular) Titabor to Borholla Road (Holidays)

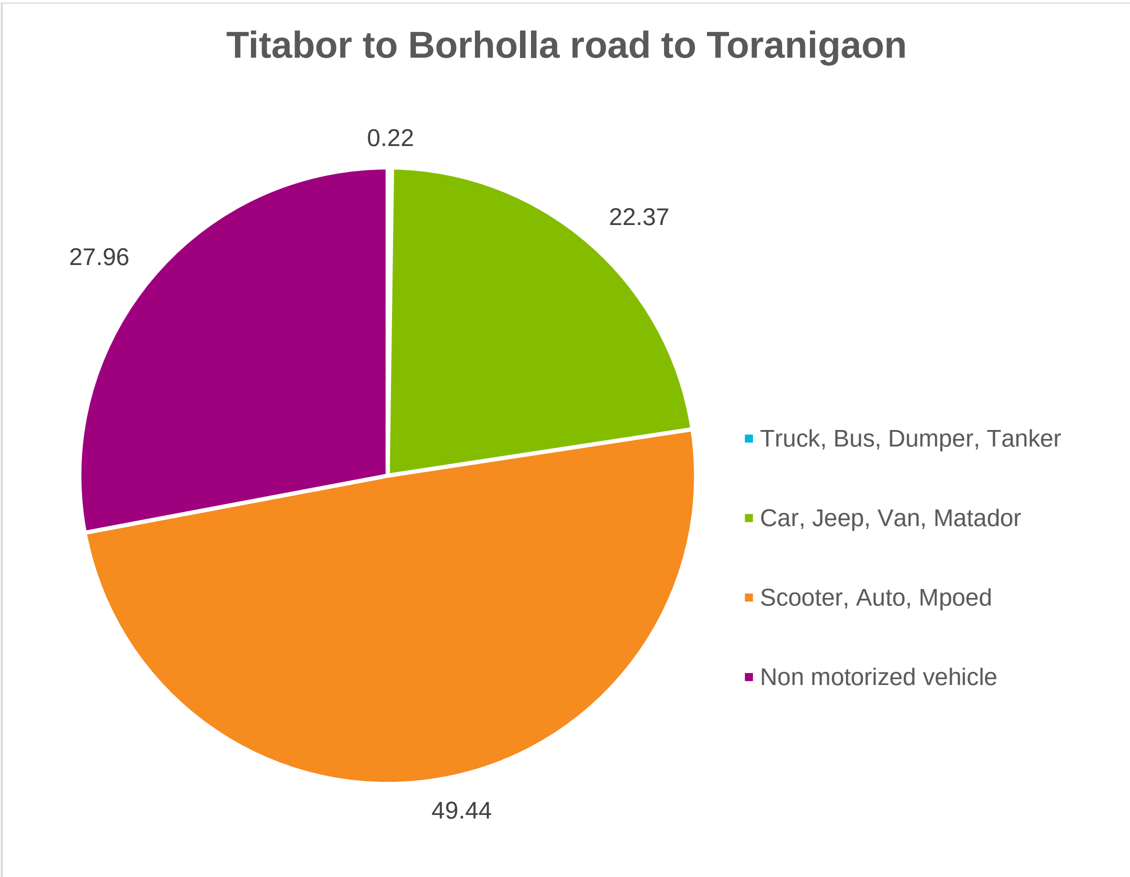


Figure 56. Peak Hour Traffic Composition (Vehicular) Titabor to Borholla Road to Toranigaon (Weekdays)

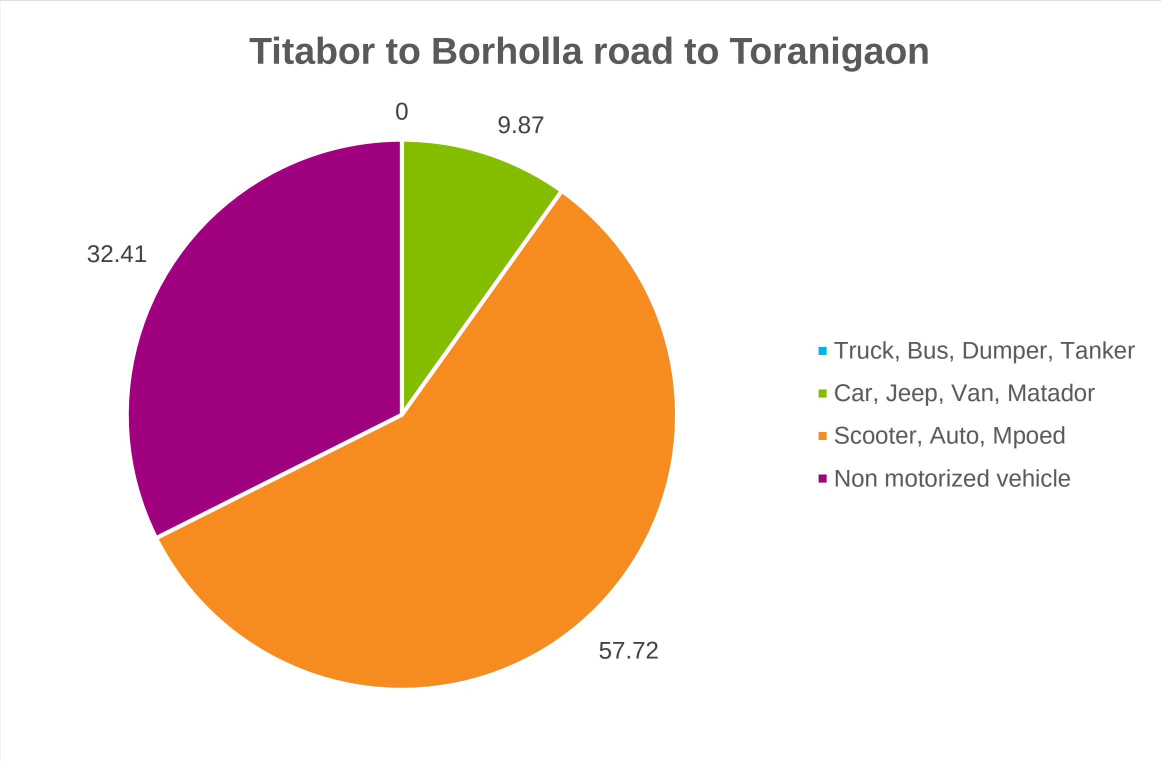


Figure 57. Peak Hour Traffic Composition (Vehicular) Titabor to Borholla Road to Torani gaon(Holidays)

The peak hours at various intersections are given in **Table 3-17**. At Assam Trunk road at Dhakpota the peak hour traffic composition was observed between 9:00 – 10:00 am during weekdays. During weekdays at KB road at Kamarbandha the peak hour traffic composition was observed between 11:00 – 12:00, whereas during holidays the peak hour traffic composition was observed at 12:00 – 13:00 noon. At Titabor to Golaghat Road at Kamarbandh the peak hour traffic composition was observed at 11:00 – 12:00 in the morning for both weekdays and holidays. At Titabor to Golaghat road at Titabor he peak hour traffic composition was observed in between 10:00 to 11:00 am in the morning for both weekdays and holidays, whereas at Titabor to Jorhat road at Jorhat, the peak hour traffic composition was observed at in the evening between 17:00 – 18:00 pm, during weekdays, and in holidays it was observed between 11:00 – 12:00 noon. For Titabor to Borholla road the peak hour traffic composition was observed at 10:00 -11:00 am in the morning for both weekdays and holidays, the same went with another location Titabor to Borholla- Torani gaon road, the peak hour traffic composition was observed at 17:00 – 18:00 in the evening for both weekdays and holidays.

Table 3.17 . Peak hour traffic at Critical intersection

SL No	Intersection	Weekdays	Holidays
1	AT road at Dhakpota	9:00 – 10:00	-
2	KB road at Kamarbandha	11:00 – 12:00	12:00 – 13:00
3	Titabor to Golaghat Road at Kamarbandh	11:00 – 12:00	11:00 – 12:00
4	Titabor to Golaghat road at Titabor	10:00 – 11:00	10:00 – 11:00
5	Titabor to Jorhat road at Jorhat	17:00 – 18:00	11:00 – 12:00
6	Titabor to Borholla road	10:00 – 11:00	10:00 – 11:00
7	Titabor to Borholla Torani Gaon road	17:00 – 18:00	17:00 – 18:00

Source: Traffic survey,2019

Traffic Composition

The composition of vehicles at these Intersections indicates that of the total vehicles observed. The traffic composition of each junction for weekdays and holidays are presented in Table 3.18 and 3.19 respectively.

Table 3.18 Classified volume Count at Major Intersection (weekdays)

SL No	Location	Heavy motor vehicles, 24 hours	Light motor vehicles, 24 hours	Two/three wheelers, 24 hours	Non-motorized vehicles, 24 hours	Total PCU in 24 hours, (To& Form)	Average PCU Flow/24 hours	Max PCU/Hr	Min PCU/Hr	MAX PCU hours	Min PCU hours
1	AT road at Dhakpota	4216	7883	4411	996	39191.5	1632.98	3554.5	73	09.00-10.00	3.00-4.00
2	KB road at Kamarbandha	1586	6170	4453	902	24453	1018.88	2371.5	4.5	11.00-12.00	2.00-3.00
3	Titabor to Golaghat Road at Kamarbandh	4720	9592	8830	1441	50222	2092.58	4300.5	99	10.00-11.00	3.00-4.00
4	Titabor to Golaghat road at Titabor	3894	10135	7460	1129	44701.5	1862.56	3451	67.5	10.00-11.00	3.00-4.00
5	Titabor to Jorhat road at Jorhat	2222	5132	5661	775	26458	1102.42	2327.5	23.5	17.00-18.00	4.00-5.00
6	Titabor to Borholla road	1328	4155	6297	2482	28433.5	1184.73	2517.5	11.5	10.00-11.00	2.00-3.00
7.	Titabor to Borholla Torani Gaon road	16	1110	2961	1278	9810	408.75	875.5	0	17.00-18.00	3.00-4.00

Table 3.19 . Classified volume Count at Major Intersection (Holidays)

SL No	Location	Heavy motor vehicles, 24 hours	Light motor vehicles, 24 hours	Two/three wheelers, 24 hours	Non-motorized vehicles, 24 hours	Total PCU in 24 hours, (To& Form)	Average PCU Flow/24 hours	Max PCU/Hr	Min PCU/Hr	MAX PCU hours	Min PCU hours
1	KB road at Kamarbandha	984	4134	3226	818	17127	713.63	1659	2.5	11.00-12.00	1.00-2.00
2	Titabor to Golaghat Road at Kamarbandh	3441	6686	7153	1326	37970.5	1582.10	3578	29	11.00-12.00	4.00-5.00
3	Titabor to Golaghat road at Titabor	2981	6498	5662	879	32339.5	1347.48	2725.5	17.5	10.00-11.00	3.00-4.00
4	Titabor to Jorhat road at Jorhat	1472	4037	4113	681	19516.5	813.19	1592	7.5	14.00-15.00	3.00-4.00

SL No	Location	Heavy motor vehicles, 24 hours	Light motor vehicles, 24 hours	Two/three wheelers, 24 hours	Non-motorized vehicles, 24 hours	Total PCU in 24 hours, (To& Form)	Average PCU Flow/24 hours	Max PCU/Hr	Min PCU/Hr	MAX PCU hours	Min PCU hours
5	Titabor to Borholla road	1056	3280	4672	2075	22644	943.5	1960	4.5	10.00-11.00	1.00-2.00
6	Titabor to Borholla Torani Gaon road	4	751	2247	1067	7659.5	319.15	798.5	0	17.00-18.00	3.00-4.00

3.15 Ecological Environment

An Ecology and Biodiversity study of Block AA-ONHP-2017/11, located in Golaghat and Jorhat districts of Assam was conducted for assessment of biological diversity of the area and to identify the probable impacts on it due to development of exploratory as well as appraisal well. The study was carried out in pre-monsoon season during month of May, 2019. A Total 13 transects, 26 quadrats, 7 PBZ locations and 7 primary productivity sampling locations were selected within the block based on topography, land use, habitat and vegetation pattern. For assessment of floral species, quadrats of size 10m x 10m for trees, 5m x 5m for shrubs and 1m x 1m for herbs were plotted and qualitative and quantitative analysis of the same was carried out. Faunal species were assessed by transect method by traversing a known distance and noting observed faunal species along the length. Assessment of faunal species was also done using indirect method, wherein searching for evidences such as scats, pug marks, prey kills, calls, nests, feathers, skin molts, road-kills etc was done. Secondary data was collected from RFO office, Jorhat and Golaghat; Freshwater Fish of Peninsular India, Birds of the Indian Sub-continent, Indian Mammals- A field guide, Indian snakes-A field guide, Book of Indian reptiles and Amphibians and academic publications were also consulted.

Methodology of the Study

Primary Data

Primary data have been collected at nine sampling sites selected by applying the stratified systematic sampling method. Table 3-21 presents details of the sampling sites, including location code, location coordinates, elevation above mean sea level (a msl), nearest village or town and habitat-profile of each site.

Table 3.20 . Details of Sampling Sites

S.No..	Quadrat	Location	Nearest well	Type of Habitat
1	Quadrat 1	26°25'45.03"N, 94°5'46.04"E	Well 1	Settlement
2	Quadrat 2	26°25'41.03"N, 94°4'25.04"E	Well 1	Settlement
3	Quadrat 3	26°27'37.97"N, 94° 1'1.00"E	Within the block	Forest land
4	Quadrat 4	26°28'49.93"N, 94°1'55.04"E	Within the block	Agricultural land
5	Quadrat 5	26°29'25.58"N, 94°9'30.68"E	Within the block	Settlement
6	Quadrat 6	26°29'17.46"N, 94°8'37.34"E	Within the block	Agricultural land
7	Quadrat 7	26°34'35.82"N, 94°9'53.43"E	Well 4	Agricultural land
8	Quadrat 8	26°33'57.90"N, 94°8'14.56"E	Well 4	Settlement

S.No..	Quadrat	Location	Nearest well	Type of Habitat
9	Quadrat 9	26°32'31.81"N, 94°4'39.39"E	Well 2	Agricultural land
10	Quadrat 10	26°33'5.34"N, 94° 4'11.13"E	Well 1	Agricultural land
11	Quadrat 11	26°33'42.03"N, 94°1'14.02"E	Well 2	Agricultural land
12	Quadrat 12	26°32'39.24"N, 94°0'40.49"E	Well 3	Settlement
13	Quadrat 13	26°37'1.89"N, 94° 5'27.28"E	Well 3	Settlement
14	Quadrat 14	26°37'23.06"N, 94° 6'9.44"E	Well 3	Settlement
15	Quadrat 15	26°41'6.10"N, 94° 7'38.24"E	Well 6	Settlement
16	Quadrat 16	26°41'50.45"N, 94°6'53.68"E	Well 8	Settlement
17	Quadrat 17	26°40'8.03"N, 94° 2'52.30"E	Within the block	Tea Garden
18	Quadrat 18	26°40'6.39"N, 94° 1'37.77"E	Within the block	Riparian
19	Quadrat 19	26°43'22.98"N, 94°1'49.13"E	Well 8	Agricultural land
20	Quadrat 20	26°43'31.59"N, 94°2'38.19"E	Well 8	Settlement
21	Quadrat 21	26°46'46.04"N, 94°3'43.01"E	Well 7	Agricultural land
22	Quadrat 22	26°47'15.93"N, 94°3'16.00"E	Well 10	Settlement
23	Quadrat 23	26°48'44.93"N, 94°5'33.98"E	Well 11	Agricultural land
24	Quadrat 24	26°49'18.93"N, 94°5'59.00"E	Well 11	Settlement
25	Quadrat 25	26°48'43.97"N, 94°8'33.00"E	Along the River Brahmaputra	Agricultural land
26	Quadrat 26	26°49'14.57"N, 94°9'55.93"E	Along the River Brahmaputra	Settlement

In case of floristic species, qualitative and quantitative data was collected at each sampling site, using the standard quadrat methodology. Quadrat sizes employed are 10m x 10m for trees, 5m x 5m for shrubs and 1m x 1m for herbs.

In case of faunal species, qualitative data have been collected mainly at each sampling site. Any species recorded outside the sampling sites have been ascribed to the nearest sampling site. Faunal records are based on direct sightings, as well as, indirect evidence, such as calls, burrows, nests, droppings or scats. Only higher faunal species, namely vertebrates, including mammals, birds, reptiles, amphibians and fishes, have been covered.

Primary data was collected through most of the diurnal period from early morning till late evening.

Faunal Survey Methodology

Faunal species were assessed by transect method by traversing a known distance and noting observed faunal species along the length. Analysis was done through direct observation or visual encounter techniques and also through observation of indirect signs such as calls, scat, pug marks and road kills. seven line transects were laid in the study area. Seven line transects were laid in the study area. GPS locations of transects laid is given in following table 3.21.

Direct observation (Visual Encounter): In this method, the species of animals observed visually were noted. Also, a count of each species observed was recorded.

Indirect observation (Searching for signs): Signs such as scat, feeding signs, pug marks, burrows and dens were recorded as evidence of the presence of mammals. For accuracy, the burrows and dens were checked to confirm whether they were active or abandoned. Notable behaviours of the bird such as calls, feeding, nesting, or breeding and the associated habits were also observed and accordingly the recorded Apart from line transects, vantage point surveys were also conducted along the village ponds for aquatic birds.

Table 3.21 . Geographic co-ordinates of Transact Location

Transect	Start point	End point	Nearest Wells
Transect 1	26°25'44.90"N, 94° 5'46.94"E	26°25'31.41"N, 94° 4'4.38"E	Well 1
Transect 2	26°27'37.83"N, 94° 0'59.59"E	26°28'51.54"N, 94° 1'54.91"E	Within the block
Transect 3	26°29'24.65"N, 94° 9'54.63"E	26°29'18.20"N, 94° 8'8.75"E	Within the block
Transect 4	26°34'35.30"N, 94° 9'56.44"E	26°33'55.00"N, 94° 8'11.68"E	Well 4
Transect 5	26°32'7.30"N, 94° 4'53.26"E	26°33'2.12"N, 94° 4'6.03"E	Well 2
Transect 6	26°32'33.46"N, 94° 0'36.69"E	26°33'47.11"N, 94° 1'9.49"E	Well 2, 3
Transect 7	26°36'24.02"N, 94° 4'40.40"E	26°37'22.83"N, 94° 6'9.86"E	Well 3, 5
Transect 8	26°40'45.18"N, 94° 7'42.44"E	26°41'55.92"N, 94° 6'47.53"E	Well 6
Transect 9	26°40'16.10"N, 94° 3'6.52"E	26°40'2.42"N, 94° 1'21.73"E	Within the block
Transect 10	26°43'17.78"N, 94° 0'51.96"E	26°43'30.17"N, 94° 2'45.41"E	Well 7
Transect 11	26°46'29.15"N, 94° 2'43.25"E	26°47'16.69"N, 94° 3'17.31"E	Well 10
Transect 12	26°48'28.69"N, 94° 4'38.45"E	26°49'21.55"N, 94° 5'59.83"E	Well 11
Transect 13	26°48'39.00"N, 94° 8'19.89"E	26°49'18.04"N, 94°10'0.09"E	Well 7

Source: <AECOM Primary Survey>

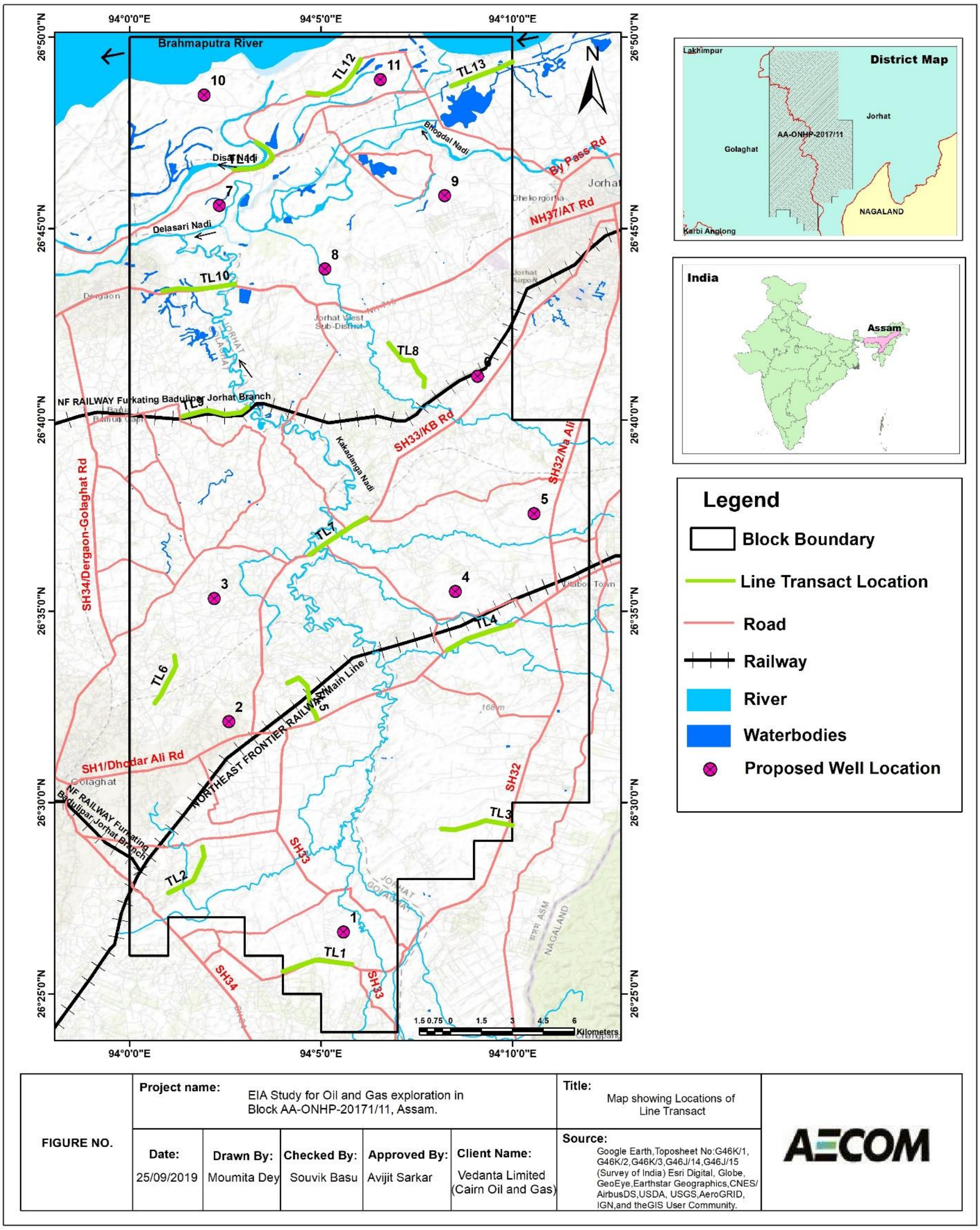


Figure 58. Geographic Co-ordinates of Transact Location

Field identification has been based on professional experience, and following , standard field guides and identification keys were made use of. Fauna was checked for their IUCN status (International Union for Conservation of Nature , Red List Version 3.1) and also their status in the Schedules of Wildlife Protection Act, 1972.

Phyto-sociological Analysis

Frequency, density and dominance were calculated following Mishra (1968) and dos Santos et al. (2015) according to the formulae –

$$Relative\ Frequency = \frac{Number\ of\ quadrats\ in\ which\ species\ occured}{Total\ number\ of\ quadrats\ studied}\ x\ 100$$

$$Relative\ Density = \frac{Total\ number\ of\ individual\ s\ of\ the\ species}{Sum\ of\ all\ individual\ s\ of\ all\ species}\ x\ 100$$

$$Relative\ dominance = \frac{Dominance\ of\ given\ species}{Total\ dominance\ of\ all\ species}\ x\ 100$$

Important value index (IVI) is used to determine the overall importance of each species in the community structure. It is used to identify the dominance of any given species in the study area which helps in getting an overall importance of any given species in the community by statistical analysis. It can be calculated by summing the values of relative frequency, relative density and relative dominance. The IVI of the individual species has been calculated as the following formula

$$\mathrm{IVI} = \mathrm{Relative\ frequency} + \mathrm{Relative\ density} + \mathrm{Relative\ dominance}$$

The rationale behind the number of transect and quadrats laid was to ensure thorough and proportionate coverage of all the habitat types observed in the study area.

Desktop review and Secondary Data Collection

A desktop review has been carried to identify the forest area, land use pattern, Vegetation type etc. information regarding sensitive ecological habitat such as Biosphere Reserve, National Park, Wild life Sanctuary , Game reserve, Conservation reserve also collected from sources such as Forest Working Plan of Jorhat, Lakhimpur and Sibsagar District, different Scientific report published in peer reviewed journals, Government reports, To identify the different classification of different forest types , report from Forest Survey Of India (SoFR, 2017) was consulted Stakeholder consultation with forest Department and local villagers was also carried out to gather the relevant information during field survey.

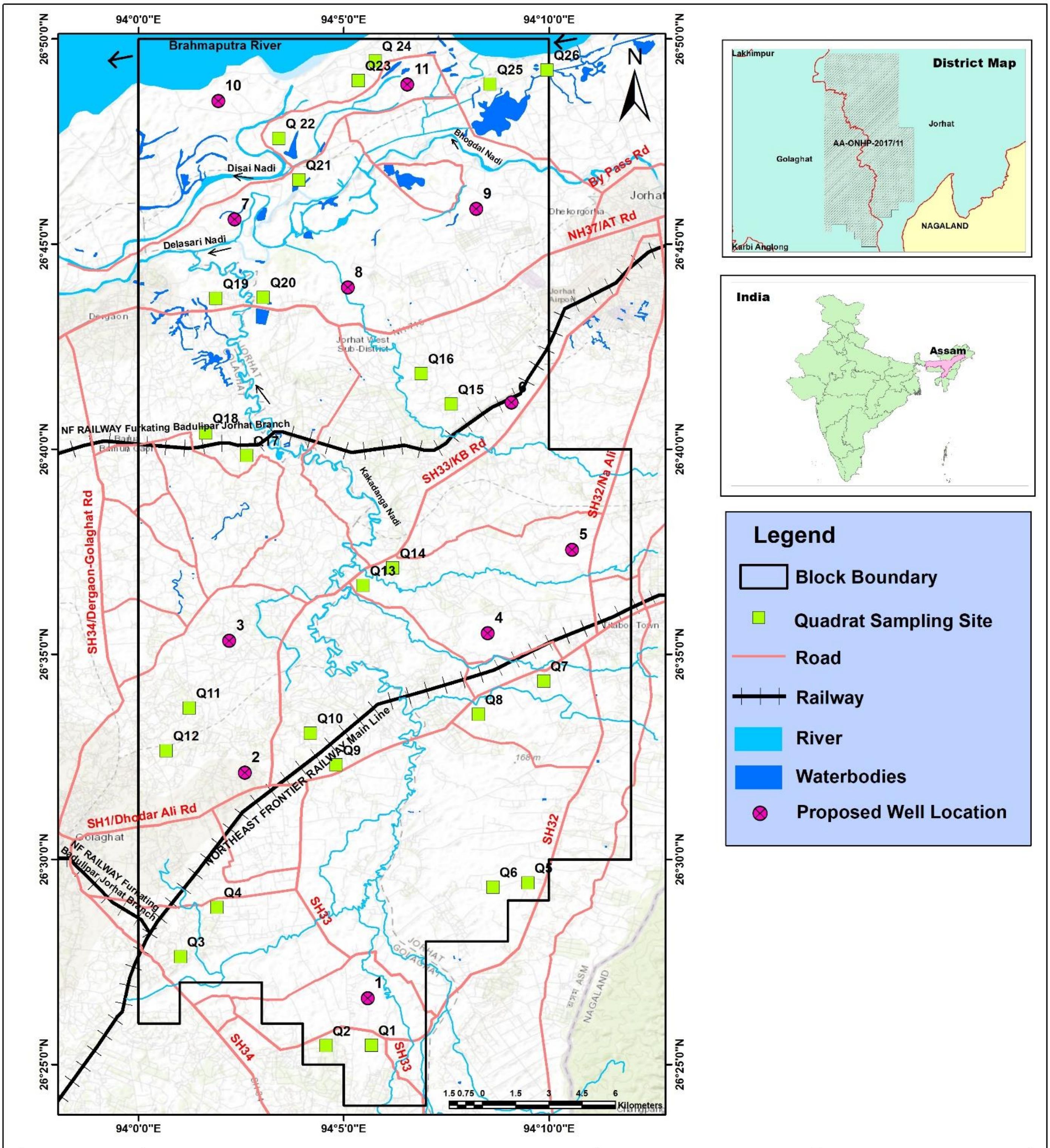


FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.					Title: Map showing Locations of Quadrat Sampling Sites	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth, Toposheet No:G46K/1, G46K/2, G46K/3, G46J/14, G46J/15 (Survey of India) Esri Digital, Globe, GeoEye, Earthstar Geographics, CNES/ AirbusDS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.	

Figure 59. Quadrat sampling location maps.

Flora of the Study Area

The floristic baseline was carried out after considering the different habitats present in the study area. Forest types are also identified as per the Champion and Seth Classification, 1967. Forest working Plans of Golaghat and Jorhat District are also consulted during identification of Forest types.

Forest Types

The Study area falls within the Jorhat and Golaghat district of Assam. Both of the district receives heavy rain fall in the monosson season and moderate to light rainfall rest the year which. This type of rainfall helps to development of forest area. In Golaghat District, 18.59 % of the Geographic area comes under forest cover whereas in Jorhat Dostrict, 19.43 % of geographic area falls in the forest area (SoFR. 2017). The Major forest types which are observed in the study area are moderately dense forest and open forest.

Floristic Species Recorded

A consolidated list of flora species observed in the study area, prepared on the basis of primary survey has been provided in following Table 3.23. Orchids such as *Cymbidium aloipholium, Dendrobium aphyllum, Rhynchostylis rhetusa, Aerides rosea, Aerides odorata, Bulbophyllum sp, Papilionanth teres, Dendrobium densiflirum and Papilionanthe* teres were observed in the study area.

Trees

The study area comprises of 65 tree species belonging to 33 families. Diversity of species belonging to Euphorbiaceae family was found to be hiher, followed by *Myrtaceae* and *Melliaceae*. Most common species were *Bambusa balcooa, Lagerstroemia speciosa, Alstonia sacholaris, Trewia nodiflora, Ficus hispida* and *Mallotus tetracoccus.* .

Table 3.22 . List of Tree species observed in the study area

S.No.	Botanical Name	Common Name/ Local Name	Family	IUCN 3.1
1	*Acacia moniliformis*	Bengali babul	Fabaceae	Not Assessed
2	*Aegle marmelos*	Bel	Rutaceae	Not Assessed
3	*Ailanthus excelsa*	Borpat	Simaroubaceae	Not Assessed
4	*Alangium begonifolia*	Chinese alangium	Cornaceae	Not Assessed
5	*Albizia lebbeck*	Sirish	Fabaceae	Not Assessed
6	*Albizia procera*	Tantari assing	Fabaceae	Not Assessed
7	*Alstonia scholaris*	Satwan	Apocynaceae	Least Concern
8	*Anthocephalus cadamba*	Kadam	Rubiaceae	Not Assessed
9	*Aphanamixis polystachya*	Hakhori bakhori	Meliaceae	Not Assessed
10	*Aquilaria agallocha*	Sasi	Thymelaeaceae	Not Assessed
11	*Artocarpus heterophyllus*	Jackfruit	Moraceae	Not Assessed
12	*Artocarpus lacucha*	Lakuch	Moraceae	Not Assessed
13	*Azadirachta indica*	Neem	Meliaceae	Not Assessed
14	*Bambusa balcooa*	Bhaluka	Poaceae	Not Assessed
15	*Bambusa tulda*	Jati-banh	Poaceae	Not Assessed
16	*Barringtonia acutangula*	Hijagal	Lecythidaceae	Not Assessed
17	*Bombax ceiba*	Dumboli	Malvaceae	Not Assessed
18	*Butea monoperma*	palash	Fabaceae	Data Deficient
19	*Canarium bengalense*	Bisjang	Burseraceae	Not Assessed
20	*Caryota urens*	Chao	Arecaceae	Least Concern

S.No.	Botanical Name	Common Name/ Local Name	Family	IUCN 3.1
21	*Cassia fistula*	Amaltas	Fabacea	Not Assessed
22	*Cedrela toona*	Toon	Meliaceae	Not Assessed
23	*Ceiba pentandra*	Safed semal	Malvaceae	Not Assessed
24	*Dalbergia sissoo*	Sissu	Fabaceae	Not Assessed
25	*Dillenia indica*	Outenga	Dilleniaceae	Threat recorded
26	*Dysoxylum indicum*		Meliaceae	Not Assessed
27	*Ficus hispida*	Black ficus	Moraceae	Not Assessed
28	*Ficus racemosa*	Goolar	Moraceae	Not Assessed
29	*Ficus religiosa*	ahot	Moraceae	Not Assessed
30	*Ficus* sp.		Moraceae	
31	*Garcinia xanthochymus*	Tepor	Clusiaceae	Not Assessed
32	*Garuga pinnata*	Pama	Burseraceae	Not Assessed
33	*Gmelina arborea*	Gamhar	Lamiaceae	Not Assessed
34	*Lagerstroemia speciosa*	Ejar	Lytheraceae	Not Assessed
35	*Litsea lancifolia*		Lauraceae	Not Assessed
36	*Litsea monopetala*	Muga	Lauraceae	Not Assessed
37	*Livistona jenkinsiana*	Toko pat	Araceae	Not Assessed
38	*Mallotus sp.*		Euphorbiaceae	
39	*Mallotus tetracoccus*	Moralia	Euphorbiaceae	Not Assessed
40	*Mangifera indica*	Aam	Anacardiaceae	Data Deficient
41	*Melia azedarach*	Bakain	Meliaceae	Not Assessed
42	*Mesua ferrea*	Dieng-ngai	Clusiaceae	Not Assessed
43	*Meyna laxiflora*	Moyna	Rubiaceae	Not Assessed
44	*Michelia champaca*	Tita-sopa	Magnoliaceae	Not Assessed
45	*Mimospos elengi*	Bokul	Sapotaceae	Not Assessed
46	*Murraya koenigii*	Bhisahari	Rutaceae	Not Assessed
47	*Oroxylum indicum*	Toguna	Bignoniaceae	Not Assessed
48	*Pandanus odoratissimus*	ketaki	Pandanaceae	Not Assessed
49	*Pandanus tectorius*		Pandanaceae	Not Assessed
50	*Phylanthus emblica*	Amloki	Euphorbiaceae	Not Assessed
51	*Pongamia pinnata*	Pongam tree	Papilionaceae	Least Concern
52	*Premna latifolia*	Gejeru	Lamiaceae	Not Assessed
53	*Prunus persica*	Nora-bogori	Rosaceae	Not Assessed
54	*Schima wallichii*	Makria	Theaceae	Not Assessed
55	*Senna siamea*	Seemia	Caesalpinaceae	Not Assessed
56	*Streblus asper*	khorua	Moraceae	Not Assessed
57	*Syzygium cumini*	Jamun	Myrtaceae	Not Assessed

S.No.	Botanical Name	Common Name/ Local Name	Family	IUCN 3.1
58	*Syzygium fruticosum*	Jamun	Myrtaceae	Not Assessed
59	*Tamarindus indica*	Imli	Fabaceae	Least Concern
60	*Tectona grandis*	Segun	Verbenaceae	Not Assessed
61	*Terminalia arjuna*	Arjun	Combrretaceae	Not Assessed
62	*Terminalia chebula*	Hilikha	Combrretaceae	Not Assessed
63	*Trewia nodiflora*	Many fruited Trevia	Euphorbiaceae	Not Assessed
64	*Wallichia oblongifolia*		Arecaceae	Not Assessed
65	*Wrightia tinctoria*	Sweet Indrajao	Apocynaceae	Least Concern

Source: *Primary Survey*

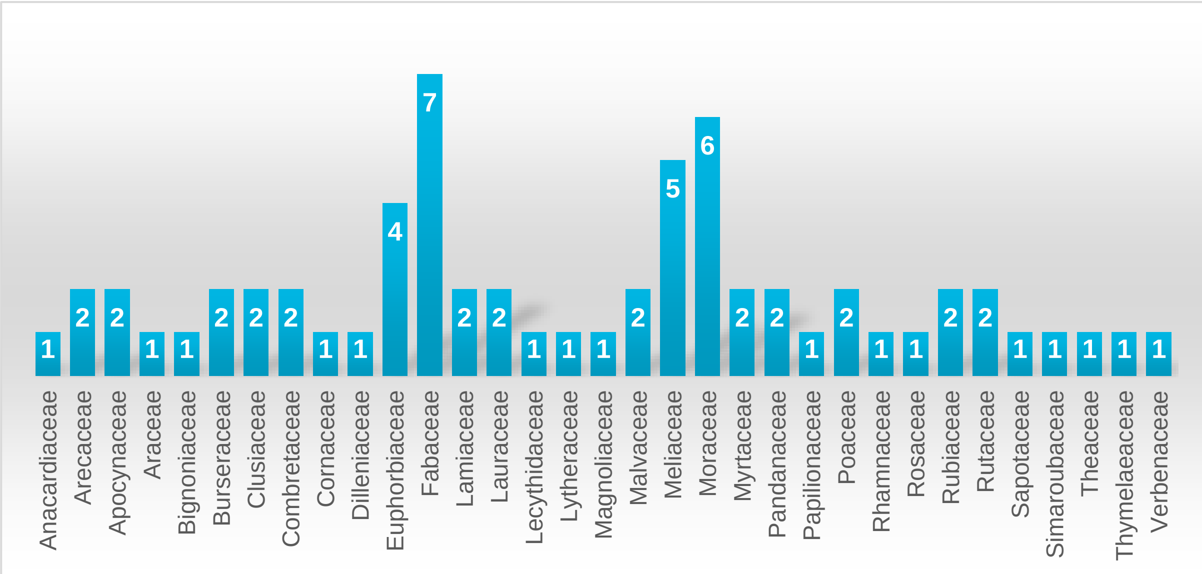


Figure 60. Tree species Diversity in Study Area

Shrubs:

Twenty-six (26) shrub species have been observed during field survey in study area. Species belonging to Lamiaceae family were found to be higher in the study area followed by Convolvuaceae and Rubiaceae. Species such *as Ricinus communis, Eupatorium odoratum, Lygodium sp. and Senna toram* were commonly observed in the study area.

Table 3.23 . List Shrub Species observed in study area

Sr.no	Botanical name	Common Name/ Local Name	Family	IUCN
1	*Melastoma malabathricum*	Shapti	Melastomaceae	Not Assessed
2	*Calotropis gigantea*	Akon	Aclepiadaceae	Not Assessed
3	*Capparis spinosa*		Capparidaceae	Not Assessed
4	*Clerodendrum colebrookianum*	vete	LamiLaceae	Not Assessed
5	*Clerodendrum infortunatum*	Vete	Lamiaceae	Not Assessed

Sr.no	Botanical name	Common Name/ Local Name	Family	IUCN
6	*Clerodendrum* sp.		Lamiaceae	Not Assessed
7	*Clerodendrum viscosum*	Vete	Lamiaceae	Not Assessed
8	*Clinogyne dichotoma*	Pati-doi	Marantaceae	Not Assessed
9	*Eupatorium odorata*	Jarmoni bon	Asteraceae	Not Assessed
10	*Eupatorium* sp.		Asteraceae	Not Assessed
11	*Glycosmis pentaphylla*	Ban nimbu	Rutaceae	Not Assessed
12	*Ipomea aquatica*	Nali	Convolvulaceae	Not Assessed
13	*Ipomea carnea*	Behaya	Convolvulaceae	Not Assessed
14	*Ixora acuminata*	Vedchi	Rubiaceae	Not Assessed
15	*Justicia gendarussa*	Tita-bahak	Acanthaceae	Not Assessed
16	*Leea asiatica*	Ahina	Vitaceae	Not Assessed
17	*Litsea lancifolia*	Baghnala	Lauraceae	Not Assessed
18	*Maesa indica*	Awuapat	Primulaceae	Not Assessed
19	*Morinda angustifolia*	Narrow-Leaf Morinda	Rubiaceae	Not Assessed
20	*Murraya* sp.		Rutaceae	Not Assessed
21	*Mussaenda roxburghii*	Soklati	Rubiaceae	Not Assessed
22	*Phlogacanthus thyrsiformis*	Bahok	Acanthaceae	Not Assessed
23	*Polygonum* sp.		Polygonaceae	Not Assessed
24	*Ricinus communis*	Era	Euphorbiaceae	Not Assessed
25	*Solanum torvum*	Bhi-tita	Solanaceae	Not Assessed
26	*Tabernaemontana divaricata*	Chandni	Apochynaceae	Not Assessed

Source: <Primary Survey,AECOM>

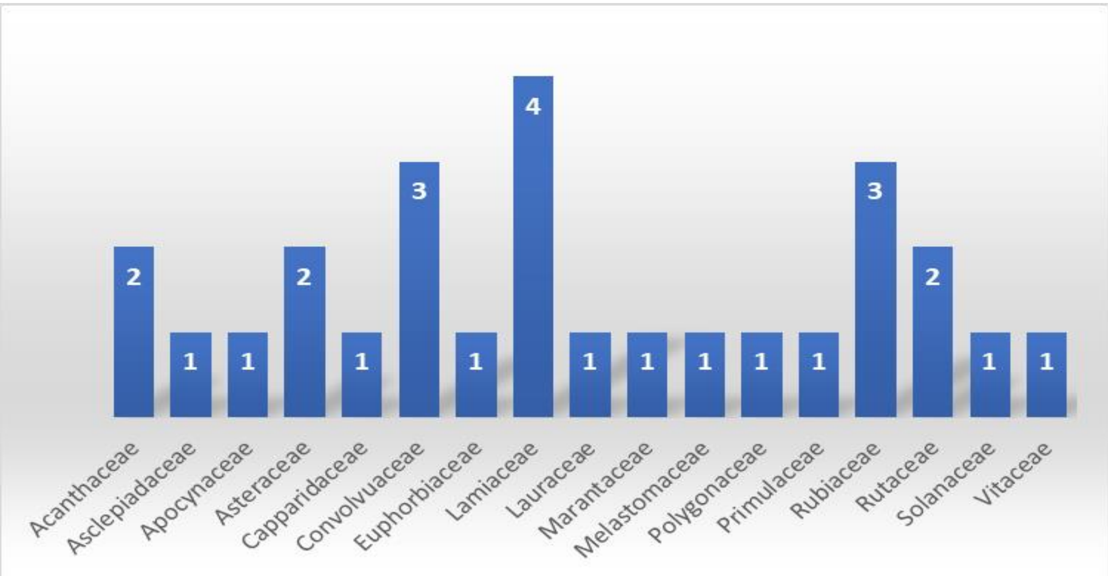


Figure 61. Shrub Species diversity in Study Area

Herbs:

There are 68 species of herbs were observed in the study area. Herbs family belonging to Arthyriaceae was found to be higher, followed by Fabaceae. Species such as *Polygonum hydropiper, Leucas aspera, Colocasia esculentum, Spilanthes paniculata* were commonly observed in the study area.

Table 3.24 . List of Herbs Species observed in Study area

S.no	Botanical name	Common Name/ Local Name	Family	IUCN Status
1	*Achyranthes aspera*	Chaff Flower	Acanthaceae	Not assessed
2	*Agave* sp.		Aspargaceae	Not assessed
3	*Ageratum conyzoides*	Jangli pudina	Asteraceae	Not assessed
4	*Alternathera philoxeroids*	Aligator weed	Amaranthaceae	Least Concern
5	*Alysicarpus vaginalis*	Alyce Clover	Fabaceae	Not assessed
6	*Amaranthus spinosus*	Kata kathura	Amaranthaceae	Not assessed
7	*Amaranthus viridis*		Amaranthaceae	Not assessed
8	*Anisomeles indica*	Kala bhangra	Lamiaceae	Not assessed
9	*Blumea lacera*	Jangli Muli	Asteraceae	Not assessed
10	*Borreria hispida*		Rubiaceae	Not assessed
11	*Cannabis sativa*	bhang	Cannabaceae	Not assessed
12	*Cassia occidentalis*	Bari kasondi	Fabaceae	Not assessed
13	*Cassia hirsuta*	Woolly Cassia	Fabaceae	Not assessed
14	*Cassia tora*	Soru-medeluwa	Fabaceae	Not assessed
15	*Cassia uniflora*		Fabaceae	Not assessed
16	*Centella asiatica*	Bar manimuni	Apiaceae	Least Concern
17	*Chenopodium ambrosioides*	bathuwa shaak	Chinopodiaceae	Not assessed
18	*Christella parasitica*		Thelypteridaceae	Not assessed
19	*Chrysopogon aciculatus*	bonguti	Poaceae	Not assessed
20	*Chrysopogon* sp.		Poaceae	Not assessed
21	*Colocasia esculenta*	Arvi	Araceae	Least Concern
22	*Crotalaria juncea*	Ghantakarana	Fabaceaee	Not assessed
23	*Croton bonplandianus*	Ban tulsi	Euphorbiaceae	Not assessed
24	*Cuphea carthagenensis*		Lytheraceae	Not assessed
25	*Cyperus rotundus*	Keyabon	Cyperaceae	Not assessed
26	*Desmodium triflorum*	Kodial	Fabaceae	Not assessed
27	*Digitaria* sp.		Poaceae	Not assessed
28	*Diplazium esculentum*	Dhekia-sak	Athyriaceae	Not assessed
29	*Diplazium* sp.		Athyriaceae	Not assessed
30	*Eclipta prostata*	Kochu	Asteraceae	Least Concern
31	*Evolvulus nummularius*	Musakarni	Convlvulaceae	Not assessed
32	*Evolvulus* sp.		Convolvulaceae	Not assessed
33	*Heliotropium indicum*	Hatisura	Boraginacea	Not assessed
34	*Houttuynia cordata*	Musundari	Saururaceae	Not assessed
35	*Hydrocotyle asiatica*		Apiaceae	Not assessed

36	*Hydrocotyle rotundifolia*		Apiaceae	Not assessed
37	*Hydrocotyle* sp.		Apiaceae	Not assessed
38	*Impatiens balsamina*	Balsam	Balsaminaceae	Not assessed
39	*Leonurus sibiricus*		Lamiaceae	Not assessed
40	*Leucas aspera*	Durun khak	Lamiaceae	Not assessed
41	*Lindernia dubia*		Linderniaceae	Not assessed
42	*Lindernia* sp.		Linderniaceae	Not assessed
43	*Ludwigia parviflora*	Paddy clove	Onagraceae	Not assessed
44	*Mimosa pudica*	Nilaji-bon	Mimosaceae	Not assessed
45	*Ophiorrhiza mungos*	Sarhati	Rubiaceae	Not assessed
46	*Oxalis corniculata*	Amrul	Oxalidaceae	Not assessed
47	*Oxalis debilis*		Oxalidaceae	Not assessed
48	*Parthenium* sp.		Asteraceae	Not assessed
49	*Polygonum hydropiper*	Patharua bihalagani	Polygonaceae	Not assessed
50	*Polygonum* sp.		Polygonaceae	Not assessed
51	*Pouzolzia* sp.		Urticaceae	Not assessed
52	*Pouzolzia zeylanica*	Borali bokua	Urticaceae	Not assessed
53	*Pteris* sp.		Pteridaceae	Not assessed
54	*Scoparia dulcis*	Mithi patti	Plantaginaceae	Not assessed
55	*Sida cordifolia*	Bor Sonborial	Malvaceae	Not assessed
56	*Solanum lycopersicum*	Bilahi bengena	Solanaceae	Not assessed
57	*Solanum melongena*		Solanaceae	Not assessed
58	*Solanum nigrum*	Mokoi	Solanaceae	Not assessed
59	*Solanum xanthocarpum*		Solanaceae	Not assessed
60	*Sonchus* sp.		Asteraceae	Not assessed
61	*Spilanthes acmella*	Pipulka	Asteraceae	Not assessed
62	*Spilanthes paniculata*	Akarkar	Asteraceae	Not assessed
63	*Stephania* sp.		Menispermaceae	Not assessed
64	*Synedrella nodiflora*	Pig grass	Asteraceae	Not assessed
65	*Urena lobata*	Bachita	Malvaceae	Not assessed
66	*Vernonia cinerea*		Asteraceae	Not assessed
67	*Vernonia* sp.		Asteraceae	Not assessed
68	*Xanthium strumarium*	chota gokhuru	Asteraceae	Not assessed

Source: Primary Survey, AECOM

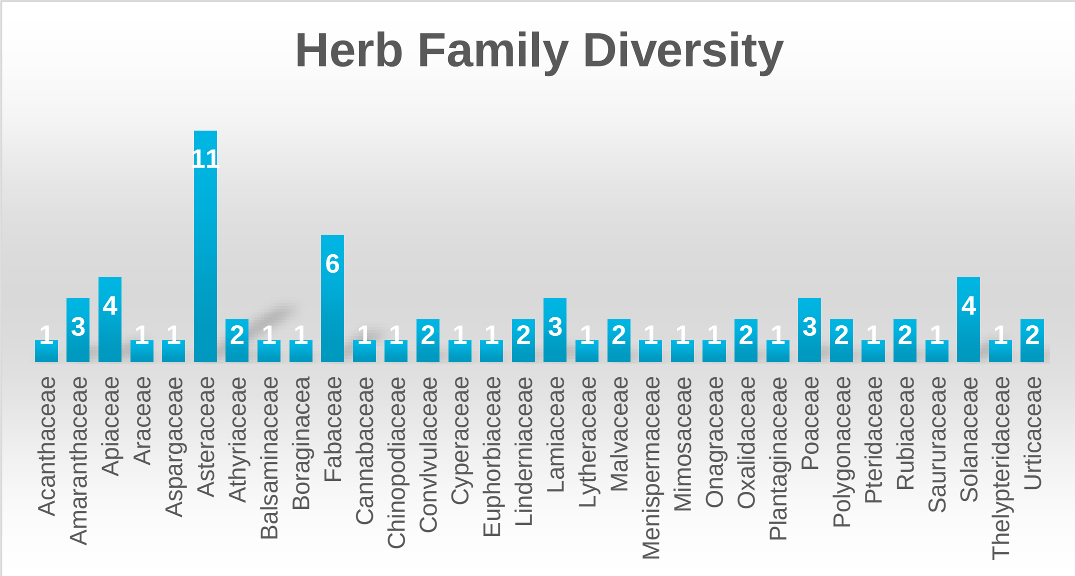


Figure 62. Herbs Species Diversity in Study Area.

Climbers:

Total 19 climber species belonging to 9 families were observed during the study. Species of Convolvuaceae and Menispermaceae family were found in higher number.

Table 3.25 List of Climbers observed in Study Area

Sr.no	Botanical name	Common Name	Family	IUCN
1	*Pothos scandens*		Araceae	Not assessed
2	*Calamus sp.*		Arecaceae	Not assessed
3	*Calamus tenuis*		Areceae	Not assessed
4	*Ipomea sp.*		Convolvuaceae	Not assessed
5	*Argyreia nervosa*	Ghav bel	Convolvulaceae	Not assessed
6	*Merremia sp.*		Convolvulaceae	Not assessed
7	*Ipomea sp.*		Convolvulaceae	Not assessed
8	*Ipomea aquatica*	Nali	Convolvulaceae	Not assessed
9	*Cucurbita maxima*	Ranga	Cucurbitaceae	Not assessed
10	*Momordica charantia*	Karela	Cucurbitaceae	Not assessed
11	*Derris elliptica*	Etam chali	Fabaceae	Not assessed
12	*Lygodium sp.*		Lygodiaceae	Not assessed
13	*Mikania micrantha*	Climbing Hempweed	Menispermaceae	Not assessed
14	*Stephania tuberosa*		Menispermaceae	Not assessed
15	*Tinospora cordifolia*	Hoguni-lot	Menispermaceae	Threat recorded
16	*Cissampelos pareira*		Menispermaceae	Not assessed
17	*Piper longum*	Pipli	Piperaceae	Not assessed
18	*Smilax perfoliata*		Smilacaceae	Not assessed
19	*Cayratia trifolia*	Chepeta-lota	Vitaceae	Not assessed

Source: Primary Survey

Phytosociological Analysis

The phytosociological analysis of the observed floral diversity has been carried out and the frequency, density and dominance of each observed species is given in following tables 3.26 to 3.27

Trees:

Among trees *Bambusa balcooa* (22.17821), *Lagerstroemia speciosa* (11.35971), *Alstonia sacholaris* (10.74216) are the dominant species observed in the study area.

Table 3.26 . List of Trees

Sl. No	Botanical Name	Relative Frequency	Relative Density	Relative dominance	IVI
1	Acacia moniliformis	0.65	1.23	0.93	2.82
2	Aegle marmelos	0.65	0.21	0.53	1.39
3	Ailanthus excelsa	0.65	0.21	0.40	1.25
4	Alangium begonifolia	2.60	2.26	1.39	6.25
5	Albizia lebbeck	1.30	0.41	0.34	2.05
6	Albizia procera	1.30	0.62	0.52	2.43
7	Alstonia scholaris	6.49	4.12	4.12	14.73
8	Anthocephalus cadamba	0.65	0.21	0.35	1.21
9	Aphanamixis polystachya	1.30	0.62	0.52	2.43
10	Aquilaria agallocha	0.65	2.26	1.71	4.63
11	Artocarpus heterophyllus	0.65	0.21	0.40	1.25
12	Artocarpus lacucha	0.65	0.21	0.53	1.39
13	Azadirachta indica	0.65	0.21	0.21	1.06
14	Bambusa balcooa	1.95	34.98	19.13	56.05
15	Bambusa tulda	2.60	1.65	0.80	5.04
16	Barringtonia acutangula	0.65	0.41	0.45	1.51
17	Bombax ceiba	1.95	1.44	3.94	7.32
18	Butea monoperma	0.65	0.21	0.31	1.16
19	Canarium bengalense	0.65	1.65	2.27	4.57
20	Caryota urens	2.60	4.32	3.96	10.88
21	Cassia fistula	1.30	1.44	1.09	3.83
22	Cedrela toona	0.65	0.21	0.33	1.18
23	Ceiba pentandra	0.65	0.21	0.35	1.21
24	Dalbergia sissoo	1.30	0.41	0.41	2.12
25	Dillenia indica	1.30	1.65	3.19	6.13
26	Dysoxylum indicum	2.60	0.82	0.62	4.04
27	Ficus hispida	5.19	1.85	2.75	9.79
28	Ficus racemosa	0.65	0.41	0.38	1.44
29	Ficus religiosa	1.95	0.62	1.05	3.62
30	Ficus sp.	0.65	0.21	0.45	1.31
31	Garcinia xanthochymus	1.95	0.62	0.42	2.99
32	Garuga pinnata	1.30	0.41	0.45	2.16
33	Gmelina arborea	1.95	1.65	3.19	6.78
34	Lagerstroemia speciosa	5.84	3.91	5.39	15.15

Sl. No	Botanical Name	Relative Frequency	Relative Density	Relative dominance	IVI
35	Litsea lancifolia	0.65	2.67	2.23	5.56
36	Litsea monopetala	2.60	1.23	1.35	5.18
37	Livistona jenkinsiana	0.65	0.41	0.31	1.37
38	Mallotus sp.	1.95	0.62	0.47	3.03
39	Mallotus tetracoccus	4.55	1.44	2.45	8.44
40	Mangifera indica	3.25	1.03	2.96	7.24
41	Melia azediaracha	0.65	0.21	0.16	1.01
42	Messua ferrea	1.30	1.85	1.85	5.00
43	Meyna laxiflora	1.30	0.82	0.50	2.63
44	Michalia champaca	0.65	0.62	1.96	3.23
45	Mimospos elengi	0.65	0.21	0.45	1.31
46	Murraya koenigii	1.30	1.23	0.34	2.87
47	Oroxylum indicum	0.65	0.41	0.38	1.44
48	Pandanus odoratissimus	0.65	0.62	0.34	1.60
49	Pandanus tectorius	0.65	0.21	0.13	0.98
50	Phylanthus emblica	0.65	0.21	0.28	1.14
51	Pongamia pinnata	2.60	1.85	2.95	7.40
52	Premna latifolia	0.65	0.21	0.16	1.01
53	Prunus persica	0.65	0.21	0.16	1.01
54	Schima wallichii	0.65	1.23	2.10	3.99
55	Senna siamea	0.65	0.41	0.31	1.37
56	Streblus asper	3.25	2.26	3.60	9.11
57	Syzygium cumini	0.65	0.21	0.45	1.31
58	Syzygium fruticosum	1.30	0.62	1.20	3.11
59	Tamarindus indica	0.65	0.21	0.35	1.21
60	Tectona grandis	0.65	1.44	1.57	3.66
61	Terminalia arjuna	1.30	0.41	0.70	2.41
62	Terminalia chebula	0.65	0.21	0.40	1.25
63	Trewia nodiflora	4.55	2.67	5.18	12.40
64	Wallichia oblongifolia	0.65	1.44	1.09	3.18
65	Wrightia tinctoria	0.65	0.21	0.16	1.01
66	Ziziphus jujuba	1.95	0.82	0.62	3.39

Source: <Primary Survey, >

Shrubs:

Among Shrub, *Clerodendrum viscosum (65.68174) and Ricinus communis (31.73627), are the dominant species.*

Table 3.27 . Phyto sociological Analysis of Shrub Species

Sr.No	Botanical Name	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Melastoma malabathricum*	12.57	12.57	3.43	28.57
2	*Calotrois gigantea*	0.55	0.55	1.83	2.92
3	*Capparis spinosa*	0.55	0.55	0.60	1.69

Sr.No	Botanical Name	Relative Frequency	Relative Density	Relative Dominance	IVI
4	*Clerodendrum colebrookianum*	0.55	0.55	0.34	1.43
5	*Clerodendrum infortunatum*	1.09	1.09	0.67	2.86
6	*Clerodendrum* sp.	0.55	0.55	0.04	1.13
7	*Clerodendrum viscosum*	29.51	29.51	32.25	91.27
8	*Clinogyne dichotoma*	1.09	1.09	1.19	3.38
9	*Eupatorium odorata*	10.38	10.38	2.84	23.60
10	*Eupatrorium* sp.	4.37	4.37	4.78	13.52
11	*Glycosmis pentaphylla*	7.65	7.65	2.09	17.39
12	*Ipomea carnea*	1.09	1.09	0.67	2.86
13	*Ixora aciminata*	1.64	1.64	1.01	4.29
14	*Justicia gendarussa*	4.37	4.37	1.19	9.94
15	*Leea asiatica*	0.55	0.55	0.60	1.69
16	*Litsea lancifolia*	0.55	0.55	0.60	1.69
17	*Maesa indica*	2.73	2.73	2.99	8.45
18	*Morinda angustifolia*	2.19	2.19	1.34	5.72
19	*Murraya* sp.	1.64	1.64	1.79	5.07
20	*Mussaenda roxburghii*	1.64	1.64	5.49	8.77
21	*Phlogacanthus thyrsiformis*	2.73	2.73	4.67	10.13
22	*Polygonum* sp.	1.09	1.09	0.30	2.48
23	*Ricinus communis*	6.01	6.01	26.28	38.30
24	*Smilax glabra*	1.09	1.09	0.67	2.86
25	*Solanum torvum*	1.09	1.09	0.67	2.86
26	*Tabernaemontana divaricata*	2.73	2.73	1.68	7.14

Source: Primary Survey, AECOM

Herbs:

Among herbs, *Cassia tora* (14.32046) showed higher diversity followed by, *Polygonum hydropiper (13.08772) and Leucas aspera (11.01549)* were the dominant species observed in the study area.

Table 3.28 . Phyto sociological Analysis of Herbs Species

Sr.No	Botanical Name	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Achyranthes aspera*	1.74	1.14	1.00	3.89
2	*Agave* sp.	0.58	0.13	0.33	1.04
3	*Ageratum conyzoides*	2.91	2.66	1.40	6.97
4	*Alternathera philoxeroids*	0.58	0.89	2.33	3.80
5	*Alysicarpus vaginalis*	0.58	0.63	1.67	2.88
6	*Amaranthus spinosus*	2.91	1.14	0.60	4.65
7	*Amaranthus viridis*	0.58	0.51	1.33	2.42
8	*Anisomeles indica*	1.16	0.76	1.00	2.92
9	*Blumea lacera*	2.91	2.41	1.27	6.58
10	*Borreria hispida*	0.58	0.76	2.00	3.34
11	*Cannabis sativa*	0.58	2.03	5.33	7.94

Sr.No	Botanical Name	Relative Frequency	Relative Density	Relative Dominance	IVI
12	*Cassia occidentalis*	0.58	0.25	0.67	1.50
13	*Cassia hirsuta*	1.74	0.38	0.33	2.46
14	*Cassia tora*	4.65	8.50	2.79	15.94
15	*Cassia uniflora*	0.58	0.13	0.33	1.04
16	*Centella asiatica*	1.16	2.54	3.33	7.03
17	*Chenopodium ambrosioides*	0.58	0.13	0.33	1.04
18	*Christella parasitica*	1.74	3.05	2.66	7.45
19	*Chrysopogon aciculatus*	1.74	2.03	1.78	5.55
20	*Chrysopogon* sp.	1.16	1.27	1.67	4.10
21	*Colocasia esculentum*	5.23	6.60	1.92	13.76
22	*Crotalaria juncea*	0.58	0.63	1.67	2.88
23	*Croton bonplandianum*	1.16	0.51	0.67	2.34
24	*Cuphea carthagenensis*	1.16	2.54	3.33	7.03
25	*Cyperus rotundus*	0.58	0.13	0.33	1.04
26	*Desmodium triflorum*	0.58	1.65	4.33	6.56
27	*Digitaria* sp.	0.58	0.13	0.33	1.04
28	*Diplazium esculentum*	4.07	2.66	1.00	7.73
29	*Diplazium* sp.	1.16	0.51	0.67	2.34
30	*Eclipta prostata*	2.33	1.14	0.75	4.22
31	*Evolvulus numularus*	0.58	0.76	2.00	3.34
32	*Evolvulus* sp.	1.74	0.76	0.67	3.17
33	*Heliotropium indicum*	1.16	1.78	2.33	5.27
34	*Houttuynia cordata*	1.16	0.51	0.67	2.34
35	*Hydrocotyl rotundifolia*	2.33	2.92	1.92	7.16
36	*Hydrocotyle asiatica*	1.16	0.51	0.67	2.34
37	*Hydrocotyle* sp.	0.58	0.38	1.00	1.96
38	*Impatiens balsamina*	2.91	1.40	0.73	5.04
39	*Leonurus sibiricus*	1.16	1.78	2.33	5.27
40	*Leucas aspera*	4.65	5.71	1.87	12.24
41	*Lindernia dubia*	0.58	0.13	0.33	1.04
42	*Lindernia* sp.	0.58	0.25	0.67	1.50
43	*Ludwigia parviflora*	0.58	0.76	2.00	3.34
44	*Mimosa pudica*	1.16	1.14	1.50	3.80
45	*Ophiorrhiza mungos*	0.58	0.25	0.67	1.50
46	*Oxalis corniculata*	2.91	2.54	1.33	6.78
47	*Oxalis debilis*	1.16	0.38	0.50	2.04
48	*Parthenium* sp.	0.58	0.13	0.33	1.04
49	*Polygonum hydropiper*	2.33	9.64	6.33	18.30
50	*Polygonum* sp.	0.58	2.41	6.33	9.32
51	*Pouzolzia* sp.	0.58	0.38	1.00	1.96
52	*Pouzolzia zeylanica*	1.74	1.27	1.11	4.12

Sr.No	Botanical Name	Relative Frequency	Relative Density	Relative Dominance	IVI
53	*Pteris* sp.	0.58	0.25	0.67	1.50
54	*Scoparia dulcis*	0.58	0.89	2.33	3.80
55	*Sida cordifolia*	2.91	2.03	1.07	6.00
56	*Solanum lycopersicum*	0.58	0.25	0.67	1.50
57	*Solanum melongena*	0.58	0.38	1.00	1.96
58	*Solanum nigrum*	1.16	1.02	1.33	3.51
59	*Solanum xanthocarpum*	4.07	2.79	1.05	7.91
60	*Sonchus* sp.	0.58	0.63	1.67	2.88
61	*Spilanthes acmella*	0.58	0.38	1.00	1.96
62	*Spilanthes paniculata*	4.07	3.93	1.48	9.48
63	*Stephania* sp.	0.58	0.25	0.67	1.50
64	*Synendrella nodiflora*	1.16	0.89	1.17	3.22
65	*Urena lobota*	0.58	0.13	0.33	1.04
66	*Vernonia cinerea*	1.74	1.14	1.00	3.89
67	*Vernonia sp.*	0.58	0.13	0.33	1.04
68	*Xanthium strumarium*	2.33	1.27	0.83	4.43

Source: <AECOM Primary Survey>

Biodiversity Indices

The diversity measurement reflect as to how many diverse species are present, the density measurement indicates number of individuals of a species in the study area. Species diversity is the best measure of community structure and it is sensitive to various environmental stresses. Smaller value of Simpson's Diversity Index shows healthy ecosystem and the higher value shows that an ecosystem is under environmental stress. The floral diversity was found to be medium to high as Shannon's index value varied from 1.10-2.76, whereas Simpson's indices value varied from 0.125 - 0.952. Quadrat wise value of Shannon's and Simpson's index is given in following Table 3.29

Table 3.29 . Quadrat wise Diversity indices

Sr. no.	Quadrat	Shannon's index	Simpson's index
1	Quadrat 1	2.688	0.9501
2	Quadrat 2	2.291	0.9051
3	Quadrat 3	1.101	0.4096
4	Quadrat 4	1.647	0.754
5	Quadrat 5	2.598	0.914
6	Quadrat 6	2.712	0.9308
7	Quadrat 7	1.895	0.8439
8	Quadrat 8	1.523	0.6886
9	Quadrat 9	2.713	0.9501
10	Quadrat 10	2.579	0.9529
11	Quadrat 11	2.02	0.9455
12	Quadrat 12	2.084	0.8918
13	Quadrat 13	2.567	0.125
14	Quadrat 14	2.753	0.9441
15	Quadrat 15	1.925	0.8974
16	Quadrat 16	1.95	0.8347
17	Quadrat 17	2.592	0.9231

Sr. no.	Quadrat	Shannon's index	Simpson's index
18	Quadrat 18	2.754	0.9323
19	Quadrat 19	2.736	0.9355
20	Quadrat 20	2.39	0.9007
21	Quadrat 21	2.764	0.9358
22	Quadrat 22	2.56	0.9395
23	Quadrat 23	1.915	0.7323
24	Quadrat 24	2.334	0.9017
25	Quadrat 25	2.228	0.909
26	Quadrat 26	1.43	0.7029

Source: AECOM Primary Survey

Fauna of the Study Area

The faunal baseline of the study area is based on the species having recorded ranges that include the study area, supported by the primary faunal data recorded during field visit. The following sub-sections provide details of the faunal species reported from or recorded in the study area.

Mammals

Among Mammals, only Rhesus Macaque, Hoary - bellied Squirrel, Indian Flying Fox was observed in the study area during field visit. The IUCN status of this species is Least concern (LC) and as per Wild life protection Act, 1972, this species is enlisted in Schedule II and V. However, 62 mammalian species have been reported from the Lakhimpur and Jorhat district from different secondary sources such as forest working Plan, peoples Biodiversity registrar, scientific literatures etc. The list of mammalian species which is observed in the study area is given in table 3.30 And recorded mammalian species from this area are given Appendix 3.8

Table 3.30 .Mammalian Species observed in the Study Area

Sr. No.	Common Name	Scientific Name	Family	IUCN, 3.1 Status	WPA 1972 Schedule
1	Hoary - bellied Squirrel	*Callosciurus pygerythrus*	Sciuridae	LC	-
2	Rhesus Macaque	*Macaca mulatta*	*Cercopithecidae*	LC	Sch. II
3	Indian Flying Fox	*Pteropus giganteus*	*Pteropodidae*	LC	Sch. V

Source: Primary Survey, AECOM

Avifauna

57 avian species have been observed in the study area. Among the avian species Alexandrian parakeet (*Psittacula eupatria)*, Blossom Headed parakeet (*Psittacula roseate)* and Red Breasted parakeet (*Psittacula alexandri)* are Near Threatened species according to IUCN red data Book. No other globally threatened avian species has been observed in the study area. Detailed checklist of birds observed in the study area is given in Table 3.31

Table 3.31 . List of Avifauna observed in the Study Area

S. No.	Common Name	Scientific Name	Order	Family	IUCN Status	Schedule as per WPA, 1972
1	*Accipiter Badius*	Shikra	Accipitriformes	Accipitridae	LC	Not Evaluated
2	*Acridotheres fuscus*	Jungle Myna	Passeriformes	Sturnidae	LC	Sch.IV
3	*Acridotheres ginginianus*	Bank Myna	Passeriformes	Sturnidae	LC	Sch.IV
4	*Acridotheres tristis*	Common Myna	Passeriformes	Sturnidae	LC	Sch.IV
5	*Aegithina tiphia*	Common Iora	Passeriformes	Aegithinidae	LC	Sch.IV
6	*Aethopyga siparaja*	Crimson Sunbird	Passeriformes	Nectariniidae	LC	Sch.IV

S. No.	Common Name	Scientific Name	Order	Family	IUCN Status	Schedule as per WPA, 1972
7	*Alcedo meninting*	Common Kingfisher	Coraciiformes	Alcedinidae	LC	Sch.IV
8	*Amaurornis phoenicurus*	White-breasted waterhen	Gruiformes	Rallidae	LC	Not Evaluated
9	*Anastomus oscitans*	Asian Openbill	Ciconiiformes	Ciconiidae	LC	Sch.IV
10	*Ardeola grayii*	Indian Pond heron	Pelecaniformes	Ardeidae	LC	Sch.IV
11	*Bubulcus ibis*	Cattle Egret	Pelecaniformes	Ardeidae	LC	Sch.IV
12	*Casmerodius albus*	Great Egret	Pelecaniformes	Ardeidae	LC	Sch.IV
13	*Ceryle rudis*	Pied Kingisher	Coraciiformes	Alcedinidae	LC	Sch.IV
14	*Cinnyris asiaticus*	Purple Sunbird	Passeriformes	Nectariniidae	LC	Sch.IV
15	*Columba livia*	Common Pigeon	Columbiformes	Columbidae	LC	Not Evaluated
16	*Copsychus saularis*	Oriental Magpie Robin	Passeriformes	Muscicapidae	LC	Not Evaluated
17	*Coracias benghalensis*	Indian Roller	Coraciiformes	Coraciidae	LC	Sch.IV
18	*Corvus levaillantii*	Eastern Jungle Crow	Passeriformes	Corvidae	Not Evaluated	Sch.IV
19	*Corvus splendens*	House Crow	Passeriformes	Corvidae	LC	Sch.IV
20	*Cypsiurus balasiensis*	Asian Palm Swift	Caprimulgiformes	Apodidae	LC	Sch.IV
21	*Dendrocitta vagabunda*	Rufous Treepie	Passeriformes	Corvidae	LC	Sch.IV
22	*Dendrocygna javanica*	Lesser whistling - Duck	Anseriformes	Anatidae	LC	Sch.IV
23	*Dicrurus hottetottus*	Spangled Drongo	Passeriformes	Dicruridae	LC	Sch.IV
24	*Dicrurus macrocercus*	Black Drongo	Passeriformes	Dicruridae	LC	Sch.IV
25	*Eudynamys Scolopaceus*	Asian Koel	Cuculiformes	Cuculidae	LC	Sch.IV
27	*Gracupica contra*	Asian Pied Starling	Passeriformes	Sturnidae	LC	Sch.IV
28	*Halcyon smyrnensis*	White throated Kingfisher	Coraciiformes	Alcedinidae	LC	Sch.IV
29	*Hierococcyx varius*	Common Hawk Cuckoo	Cuculiformes	Cuculidae	LC	Sch.IV
30	*lanius schach*	Long tailed Shrike	Passeriformes	Laniidae	LC	Not Evaluated
31	*Leptoptilos javanicus*	Lesser Adjutant	Ciconiiformes	Ciconiidae	VU	Not Evaluated
32	*Lonchura malacca*	Chestnut Munia	Passeriformes	Estrildidae	LC	Sch.IV
33	*Motacilla flava*	Yellow Wagtail	Passeriformes	Motacillidae	LC	Not Evaluated
34	*Nycticorax nycticorax*	Black Crowned Night heron	Pelecaniformes	Ardeidae	LC	Sch.IV
35	*Oriolus Xanthornus*	Black Hooded oriole	Passeriformes	Oriolidae	LC	Sch.IV
36	*Orthotomus sutorius*	Common Tailorbird	Passeriformes	Cisticolidae	LC	Not Evaluated
37	*Parus major*	Great Tit	Passeriformes	Paridae	LC	Sch.IV
38	*Passer montanus*	Eurasian Tree Sparrow	Passeriformes	Passeridae	LC	Not Evaluated
39	*Pelargopsis capensis*	Stork Billed Kingfisher	Coraciiformes	Alcedinidae	LC	Sch.IV

S. No.	Common Name	Scientific Name	Order	Family	IUCN Status	Schedule as per WPA, 1972
40	*Ploceus philippinus*	Baya Weaver	Passeriformes	Ploceidae	LC	Sch.IV
41	*Prinia inornata*	Plain Prinia	Passeriformes	Cisticolidae	LC	Not Evaluated
42	*Pycnonotus cafer*	Red Vented Bulbul	Passeriformes	Pycnonotidae	LC	Sch.IV
43	*Pycnonotus jocosus*	Red-whiskered Bulbul	Passeriformes	Pycnonotidae	LC	Sch.IV
44	*Stigmatopelia Chinensis*	Spotted Dove	Columbiformes	Columbidae	LC	Sch.IV
45	*Treron phoenicopterus*	Yellow footed green pigeon	Columbiformes	Columbidae	LC	Sch.IV
46	*Vanellus indicus*	Red-wattled lapwing	Charadriiformes	Charadriidae	LC	Not Evaluated

Source: Primary Survey, AECOM

** LC- Least Concerned*

Maximum diversity of birds belonging to order Passeriformes were found in the study area. *Passeriformes* are also known as perching birds. These birds are commonly observed in the Study area.

Reptiles

No reptile species observed during the site visit. Although, a list of reptiles' species which have reported from the study area has been given in Annexure 3.9

Amphibians

A list of Amphibians species that are reported from the study area is given in Annexure 3.10

Eco-sensitive Areas

There is no protected area i.e National park, wildlife sanctuary is falling inside the block boundary. The Nearest protected area is Nambor Wildlife sanctuary which is located at a distance of 4.76 km from the block boundary in west direction. A small portion of block area is coming inside the present Eco sensitive zone of Nambor Wildlife Sanctuary. Although, no exploratory or appraisal drilling work is planned inside the eco sensitive Zone. The nearest well i.e.Well No 1 is located at a distance of 2.4 km from buffer zone boundary of Nambor Wildlife Sanctuary.

Aquatic Ecology

In an aquatic ecosystem, the environment is water, and all the system's plants and animals live either in or on that water. Aquatic ecosystems include wetlands, rivers, lakes, and coastal estuaries. Kakodonga, River Gelabil, and River Brahmaputra, apart from several ponds, wetlands and paddy fields is the major river in the area providing a huge aquatic habitat in the block. Small canals, ponds were also found in the study area.

Total seven locations were selected in the study area for plankton and benthic diversity studies, GPS coordinates of locations selected for phytoplankton, zooplankton and benthic sampling are given in Table 3.32 and Figure 64.

Table 3.32 . Geographic Co-ordinates of Plankton and Benthic study location

Sr. no.	Sample	GPS Coordinate	Name of the River
1	Sample I	26°43'29.00"N, 94° 2'48.80"E	Kakodonga
2	Sample II	26°40'42.70"N, 94° 2'39.60"E	Kakodonga
3	Sample III	26°49'8.98"N, 94° 2'56.99"E	Brahmaputra
4	Sample IV	26°34'12.20"N, 94° 6'24.40"E	Kakodonga
5	Sample V	26°32'54.83"N, 94° 6'35.46"E	Gelabil
6	Sample VI	26°49'3.41"N, 94° 9'35.91"E	Brahmaputra
7	Sample VII	26°42'33.60"N, 94° 0'27.72"E	Pond

Source: AECOM Primary Survey

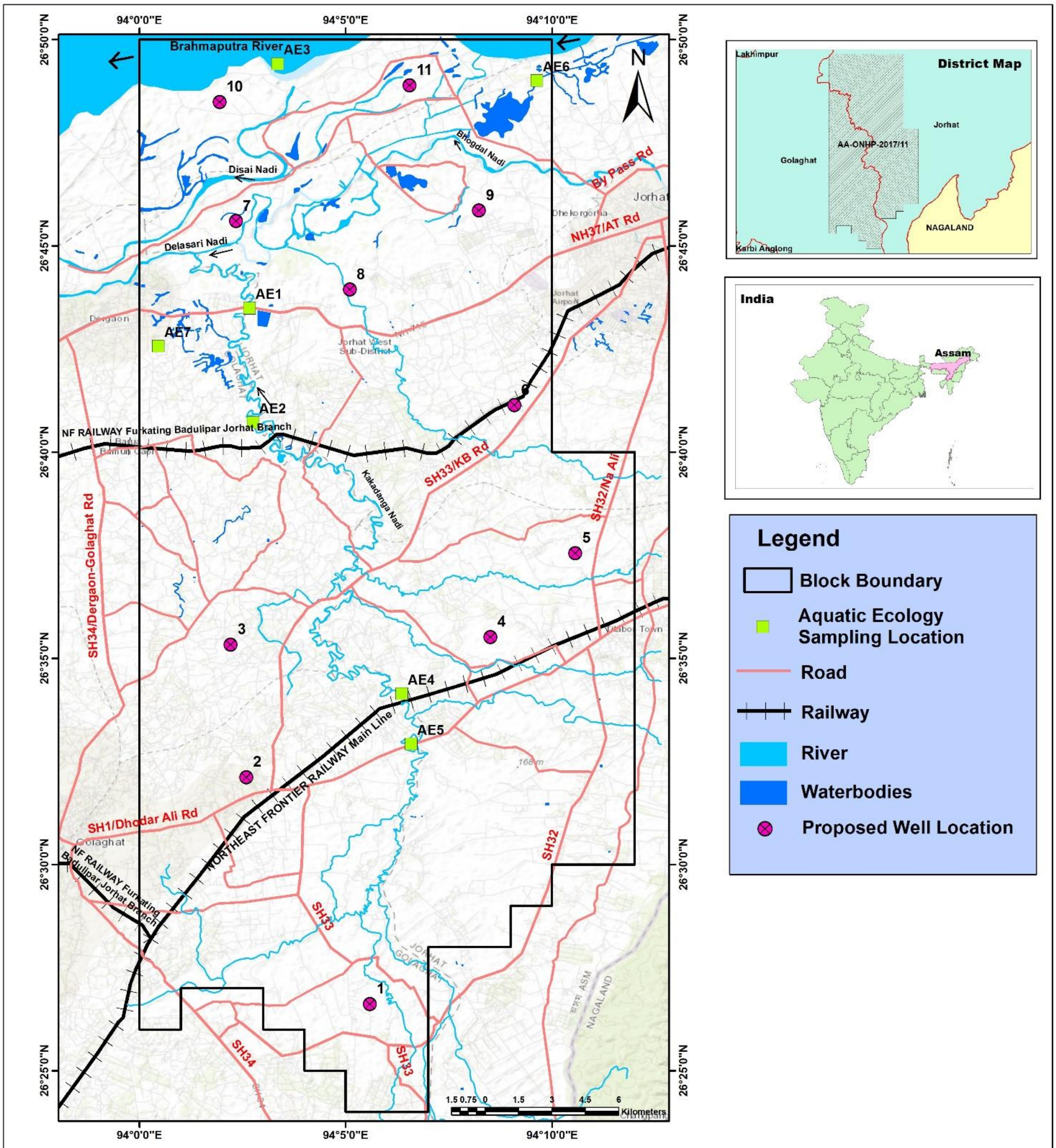


FIGURE NO.	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-20171/11, Assam.				Title: Map showing Locations of Aquatic Ecology	AECOM
	Date: 25/09/2019	Drawn By: Moumita Dey	Checked By: Souvik Basu	Approved By: Avijit Sarkar	Client Name: Vedanta Limited (Cairn Oil and Gas)	Source: Google Earth,Toposheet No:G46K/1, G46K/2,G46K/3,G46J/14,G46J/15 (Survey of India) Esri Digital, Globe, GeoEye,Earthstar Geographics,CNES/ AirbusDS,USDA, USGS,AeroGRID, IGN,and theGIS User Community.

Figure 63. PBZ Sampling Location

Plankton

Phyto plankton

For phytoplankton analysis, composite samples were collected at each sampling location till the euphotic depth. Sample preservation was done with Lugol's iodine (final concentration 1 part to 100 parts water sample). Phytoplankton were viewed under a 40X lens in a compound microscope using a Sedgewick rafter cell. The protocol was as per NIO field manual (2004).

Table 3.33 . Plankton in the study area

Sr. No.	Name of the species	L1 (Kakodanga River)	L2 (Kakodanga River)	L3 (Brahmaputra)	L4 (Kakodanga)	L5 (Gelabil)	L6 (Brahmaputra)	L7 (Pond)
				DIATOMS				
1	*Gyrosigma sp.*	-	3	1	1	-	2	3
2	*Melosira granulata*	8	5	9	2	-	-	1
3	*Melosira varians*	-	-	3	1	3	-	-
4	*Cymbella ehrenbergii*	-	-	-	-	2	-	3
5	*Cymbella sp.*	1	3	-	2	6	-	2
6	*Navicula sp.*	10	7	4	8	-	5	6
7	*Amphora ovalis*	2	-	1	-	-	-	-
8	*Synedra sp.*	4	6	8	5	-	-	2
9	*Synedra ulna*	-	-	-	-	5	3	-
10	*Nitzschia sp.*	8	5	8	10	-	5	5
11	*Pinnularia sp.*	3	2	-	6	-	2	-
12	*Gomphonema olivaceum*	-	-	2	3	-	-	-
13	*Fragilaria sp.*	-	3	-	1	-	-	2
				CHLOROPHYTA				
14	*Scenedesmus quadricuada*	-	-	-	2	-	-	-
15	*Schroederia spiralis*	1	-	3	-	-	-	-
16	*Cladophora glomerata*	-	-	-	-	1	-	-
17	*Monoraphidium arcuatum*	-	-	-	2	-	-	-
				EUGLENDOIS				
18	Trachelomonas sp.	6	5	9	3	-	2	1
19	Trachelomonas bacilifera	-	-	2	1	-	-	-

Sr. No.	Name of the species	L1 (Kakodanga River)	L2 (Kakodanga River)	L3 (Brahmaputra)	L4 (Kakodanga)	L5 (Gelabil)	L6 (Brahmaputra)	L7 (Pond)
20	Euglena acus	3	-	5	2	-	2	-
				DINOFLAGELLATA				
21	*Ceratium* sp.	-	-	1	-	2		
				CYANOBACTERIA				
22	*Planktolyngbya circumcreta*	-	-	-	-	2	-	-
23	*Pseudoanabaena cartenata*	-	-	-	-	-	1	-
24	*Oscillatoria*	-	-	3	-	-	-	-
25	*Microcystis wesenbergii*	-	-	-	-	-	1	-

Of the 25 species of phytoplankton observed in the Block 11 samples, 13 were diatoms. Plankton react rapidly to ecological changes and are viewed as excellent indicators of water quality and trophic conditions due to their short time and rapid rate of reproduction.

As per a study conducted by Singh et al. (2013), Fragilaria sp., Navicula cryptocephala, Gomphonema sp., Nitzschia palea, Synedra ulna, Scenedesmus sp. were reported to be tolerant to pollution. Surirella robusta, Pinnularia biceps, and Gomphonema sphaerophorum indicate mild pollution or mixed conditions, as per a study conducted in the River Ganges by Dwivedi and Srivastava (2017). Biodiversity indices were calculated for the phytoplankton details of the same are given in Table 3.34

Table 3.34 . Plankton diversity indices

S.No..	Location	Shannon's Index	Simpson's index
1	Location I	2.077	0.8754
2	Location II	2.131	0.8974
3	Location III	2.352	0.9062
4	Location IV	2.423	0.9073
5	Location V	1.898	0.8658
6	Location VI	2.051	0.8933
7	Location VII	2.037	0.8867

Source: AECOM Primary Survey

Zoo Plankton

Zoo plankton were sampled using a standard zooplankton net of mesh size 75 µm. The samples were collected with a horizontal haul. After collection sample was rinsed thoroughly and then concentrated. Fixing was done with 4-5% formalin (1-part formalin and 9 parts sample) within 2-3 minutes of sample collection. 4-5% formalin also works as preservative. Few drops of Rose Bengal solution were used for sample staining. Zooplankton were viewed under a 20X lens in a stereo microscope. The protocol was as per NIO field manual (2004).

Table 3.35 List of Zoo Plankton

List of Group	Mayfly	Copepod			Cladocerans			Rotifer Larvae	
	Larve of Ephemeroptera	Cyclopoida	Calanoida	Nauplius larvae	Sida sp.	Diaphanosoma Sp.	Daphnia sp.	Trichotria sp.	Brachionus calyciforus
Location I	-	6	2	5	1	-	3	-	-
Location II	-	7	-	2	-	2	5	3	1
Location III	1	-	-	5	-	1	3	-	-
Location IV	2	6	1	2	-	-	-	1	-
Location V	1	3	-	2	-	1	4	-	2
Location VI	-	-	-	3	-	-	2	3	-
Location VII	1	-	-	-	-	-	-	4	-

Zooplanktons belonging to Mayfly, Copepod, Cladocrans and Rotifer group were observed in the study area. Higher diversity was observed at Location II at a water body. More diversity of Nauplius Larvae was observed in the study area.

Benthic Organism

For analysis of benthic organisms, the sediment has been collected using a scoop or grab sampler. The samples were mixed with water to have a slurry-like consistency and a mesh of size 500µm was used with low pressure rinsing to ensure sample concentration. Residue were fixed with 4% (v/v) formalin. Benthic biodiversity was viewed using a hand-held lens as well as under a 20X lens in a stereo microscope. The protocol was as per NIO field manual (2004).

Table 3.36 . List of Benthic Organism

	Macrobenthos					Meiobenthos			
List of Group	Amphipoda	Insecta		Gastropoda		Cladocera	Calanoida	Harpacticoida	Cyclopoida
		May fly	Glass-worm	Pilla sp.	Paludomus Sp.	Cladocera	Calanoida	Harpacticoida	Cyclopoida
Location I		May fly	Glass-worm	Pila sp.	Paludomus sp.	Daphnia sp.			Trichotria sp
Location II	-	1	-	1	-	2	-	-	3
Location III	-	-	3	-	1	2	-	-	-
Location IV	3	-	-	-	-	-	-	3	2
Location V	-	3	-	4	-	-	-	-	-
Location VI	-	1	-	-	-	1	1	4	-
Location VII	-	-	2	-	4	-	-	-	-

Among benthos, three groups of Macrobenthos and four group of meiobenthic were reported in the study area.

Primary Productivity

Primary productivity is a term used to describe the rate at which plants and other photosynthetic organisms produce organic compounds in an ecosystem. There are two aspects of primary productivity:

Gross productivity is the entire photosynthetic production of organic compounds in an ecosystem.

Net productivity is the organic materials that remain after photosynthetic organisms in the ecosystem have used some of these compounds for their cellular energy needs (cellular respiration).

Primary productivity will be calculated using Winkler's light and dark bottle method. The technique developed by Gaarder and Gran uses variations in the concentration of oxygen under different experimental conditions to infer gross primary production. Typically, three identical transparent vessels are filled with sample water and stoppered. The first is analysed immediately and used to determine the initial oxygen concentration; this is done by performing a Winkler titration. The other two vessels are incubated, one each in under light and darkened. After a fixed period of time (usually 24 hrs), the experiment ends, and the oxygen concentration in both vessels is measured. As photosynthesis has not taken place in the dark vessel, it provides a measure of ecosystem respiration. The light vessel permits both photosynthesis and respiration, so provides a measure of net photosynthesis (i.e. oxygen production via photosynthesis subtract oxygen consumption by respiration). Gross primary production is then obtained by adding oxygen consumption in the dark vessel to net oxygen production in the light vessel.

Table 3.37 . Geographic Co-ordinates of primary productivity sampling site

Sr. no.	Sample	GPS Coordinate	Name of the River
1	Sample I	26°43'29.00"N, 94° 2'48.80"E	Kakodonga
2	Sample II	26°40'42.70"N, 94° 2'39.60"E	Kakodonga
3	Sample III	26°49'8.98"N, 94° 2'56.99"E	Brahmaputra
4	Sample IV	26°34'12.20"N, 94° 6'24.40"E	Kakodonga

Sr. no.	Sample	GPS Coordinate	Name of the River
5	Sample V	26°32'54.83"N, 94° 6'35.46"E	Gelabil
6	Sample VI	26°49'3.41"N, 94° 9'35.91"E	Brahmaputra
7	Sample VII	26°42'33.60"N, 94° 0'27.72"E	Pond

Source: AECOM Primary Survey

Primary productivity for five locations were calculated and the results are given in **Table3.37**

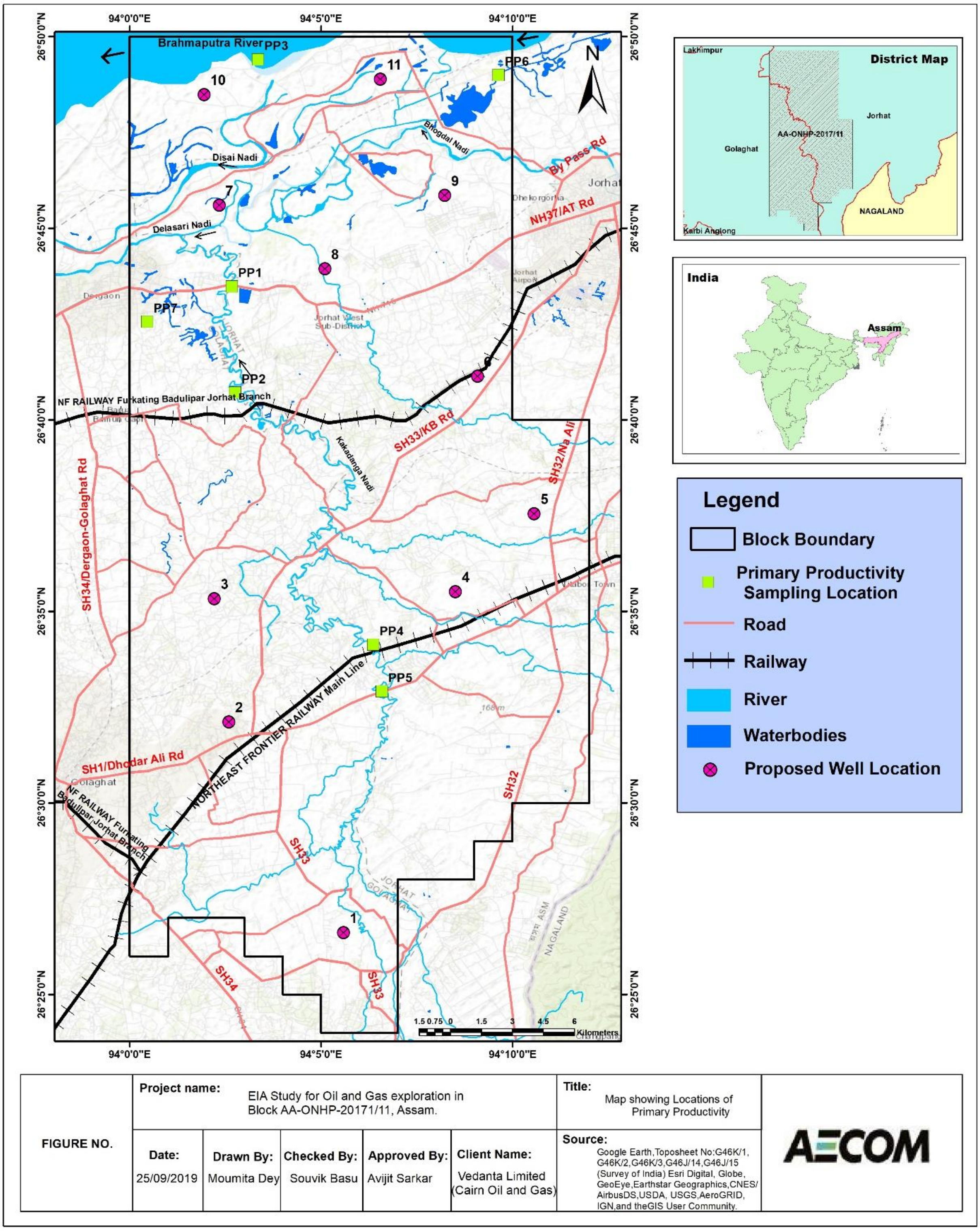


Figure 64. Primary Productivity Sampling Location

Table 3.38 . Primary Productivity of Different sites

Sr.no.	Sample	GPP	NPP
1	Sample I	15.625	10.9375
2	Sample II	15.625	9.375
3	Sample III	7.8125	6.25
4	Sample IV	26.5625	20.3125
5	Sample V	28.125	18.75
6	Sample VI	20.3125	18.75
7	Sample VII	26.5625	18.75

Source: AECOM Primary Survey

Photographs of Ecological Survey

Photographs1: PBZ sampling in Gelabili River

Photographs 2: PBZ sampling in Diroi river

3.16 Socio economic Environment

A socio-economic assessment is a procedure, in which the positive and negative impacts on the people likely would be directly and indirectly affected by the project was conducted along with other studies during the EIA. The assessment facilitated an understanding of the needs, demands, preferences, capacities and constraints of the people in the vicinity of the project operation. It was undertaken primarily to enhance the understanding of other relevant factors such as social organizations and networks, livelihood patterns, social infrastructure etc. The assessment attempts to predict and evaluate future impacts of project upon people, their physical and psychological health and well-being, their economic facilities, cultural heritage, lifestyle and other value system and helped in prioritizing Vedanta's commitment towards the CER initiatives. Inputs from the social assessment into the design phase facilitated in:

- Tracking potential adverse effects over different time frames and different activities
- Reviewing options to eliminate such negative impacts through design changes or mitigate them through specific social protection or mitigation measures
- Reviewing options to extend or enhance benefits for the population in the vicinity of the project site.

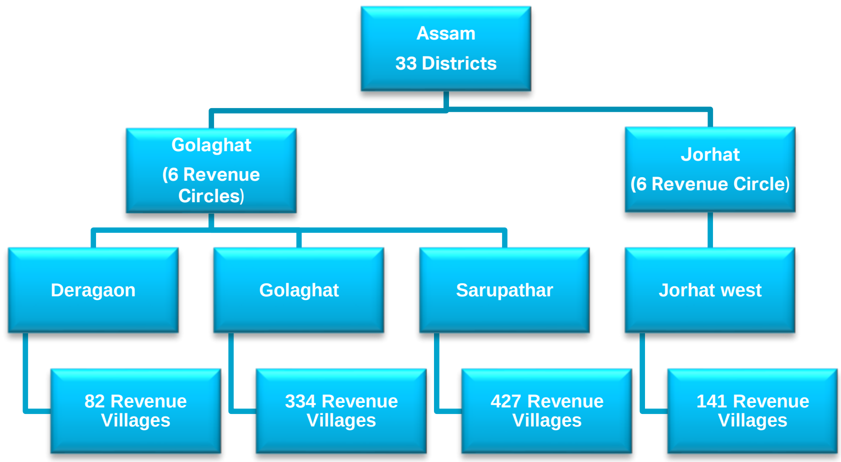


Figure 65. Administrative set up of the Block AA-ONHP-2017/11

Area of Influence

Study area for present study has been divided in two part i.e. Core area and Buffer Area based on the impact type direct and indirect. Core area means the area where the local community and villages are mostly impacted both negative and positive impact. Buffer area is just outside (within .5 km radius of the proposed well location) the core area where local community and villages might be impacted due to spill over of impact outside the core area.

The villages, where the proposed well sites are located are considered as core area, and the villages within 2.5 km radius of the core zone villages are regarded as buffer area villages, for the present project.

These villages are primarily selected based on reconnaissance surveys, census data information, topo sheet maps, understanding of the project and professional judgment. The villages falling under the Core area and the Buffer area for which socio-economic baseline assessment has been undertaken have been mentioned in Table 3.39 and 3.40.

Table 3.39 . Villages within proposed well area

Villages	Well No.	Block	District
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	1	Jorhat	Jorhat
Bhojkhati	2	North West Jorhat	Jorhat
Dakhinhengera Grant No.57	3	Golaghat Central	Golaghat
Dhekalia Borsaikia	4	North West Jorhat	Jorhat

Karang Chapari	5	North West Jorhat	Jorhat
Kawrichuk	6	Golaghat East	Golaghat
No.2 Sokalani Habi (No2 Sokolating Habi Gaon)	7	North West Jorhat	Jorhat
Pohumora No.2	8	Jorhat	Jorhat
Raidangia Gaon	9	Kaliapani	Jorhat
Sarkari N.C.	10	Jorhat West	Jorhat
Tingtingia	11	North West Jorhat	Jorhat

Table 3.40 . List of villages located within 2.5 km Buffer of Proposed Well Location

Villages within2.5 km	CD Block	District
Bahek Gaon	Jorhat	Jorhat
Bahfalla Gaon	North West Jorhat	Jorhat
Balijan	Golaghat West	Golaghat
Baliporia Gaon	Titabor	Jorhat
Bamun Gaon	Golaghat West	Golaghat
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	Jorhat	Jorhat
Bhojkhati	North West Jorhat	Jorhat
Birina Sayek	Titabor	Jorhat
Bocha Gaon	Golaghat East	Golaghat
Borteng Nowholia	Golaghat Central	Golaghat
Bosa Gaon	Titabor	Jorhat
Chakial Gaon	Titabor	Jorhat
Dahutia Baruah	Jorhat	Jorhat
Dakhinhengera Grant	Golaghat Central	Golaghat
Dangdhora Grant	North West Jorhat	Jorhat
Dolakhuria	Golaghat Central	Golaghat
Dumjoria Kosolial	Gamariguri	Golaghat
Ekorani	Golaghat East	Golaghat
Forkating	North West Jorhat	Jorhat
Garumorakoibortra	North West Jorhat	Jorhat
Gayan Gaon	Golaghat South	Golaghat
Gohain Gaon	Golaghat West	Golaghat
Hatiyekhowa	Golaghat Central	Golaghat
Kacharihat Gaon	North West Jorhat	Jorhat
Karang Chapari	North West Jorhat	Jorhat
Kawrichuk	Golaghat East	Golaghat
Kharjan	Kakodonga	Golaghat
Madhapur	Golaghat South	Golaghat
Malow Khat	Golaghat South	Golaghat
Mokreng Habi	Titabor	Jorhat
Moria Sayek(Mariasayek)	North West Jorhat	Jorhat
Namsonia	Jorhat	Jorhat
Neul Gaon	Jorhat	Jorhat

Villages within2.5 km	CD Block	District
Pohumora No.2	Jorhat	Jorhat
Raidangia Gaon	Kaliapani	Jorhat
Rowmarikhuti	Kakodonga	Golaghat
Sarukachari	Golaghat Central	Golaghat
Tingtingia	North West Jorhat	Jorhat

Methodology for Socio-economic Study

The socio-economic assessment was primarily based on the analysis of the secondary data obtained from the census survey 2011 and Community consultations. Following tools have been used for gathering information and validating secondary data after considering nature of project operation and understanding the demographic characteristic of the area.

Secondary Data Analysis

To evaluate socio-economic environment in the study area, secondary information from the 2011 Census handbook has been referred to and details pertaining to habitations in the study area have been extracted and assessed. Apart from that district level secondary information has also been collected for district statistical hand book, Year 2011.

Stakeholder Consultation

At the beginning of the EIA process, the AECOM team conducted a preliminary identification of probable stakeholders. An inventory of potential stakeholders, including local groups and individuals, local institutions like panchayats which may be directly or indirectly affected by the project or with interest in the development activities of the region was made at preliminary.

Consultations with community are a continuous process that was carried in the EIA process and would be continued during the construction and operation phases of the project. Issues like land and resource damage, social disturbance, severance and increased congestion, noise and air pollution, employment opportunities, need for development of basic infrastructure, safe drinking water, sanitation facilities in the villages located in 2.5 km periphery have been discussed during the consultations so that they can be adequately addressed through the environment management plans. The consultations also helped in developing preliminary understanding of the requirement of social development initiatives, which are required in the project village and may be undertaken as part of the Vedanta's CER activity.

Socio-Economic Profile

Demographic Profile

Demographic details are details related to statistical and dynamic aspects of a population. Data related to households, population, sex ratio, caste, literacy rate was obtained from Census, 2011 that is conducted every 10 year since 1872.

Population and Household

Population and households are basis units of demography. A population in statistics can be defined as a discrete group of people that are identical with at least one common characteristic whereas a household is majorly composed of two or more persons who are occupying a single housing unit. Details of the population and households was obtained from District Census, 2011 handbook of Jorhat and Golaghat district.

Population and Household Size of Villages in the Study Area

As per the census data 2011, maximum number of households were found in village Chaliha Gaon (1368), Goria Gaon (898), followed by Balijan (795), Dhodang goria Gaon (780) and Jugonia Gaon (268). Least number of households were found in Borghop Chapari (5), Koharpar (5), Mojia Bheti (20).

Also, the population largest population was reported in Chaliha Gaon (6597) followed by Goria Gaon (4307), Balijan (3949). Lowest population was observed in Koharpar (16) followed by Borghop Chapari(17), Miri Gaon No.2 (101). The average household size was found to be 5. The average sex ratio in the villages in the block was 969 females per 1000 males

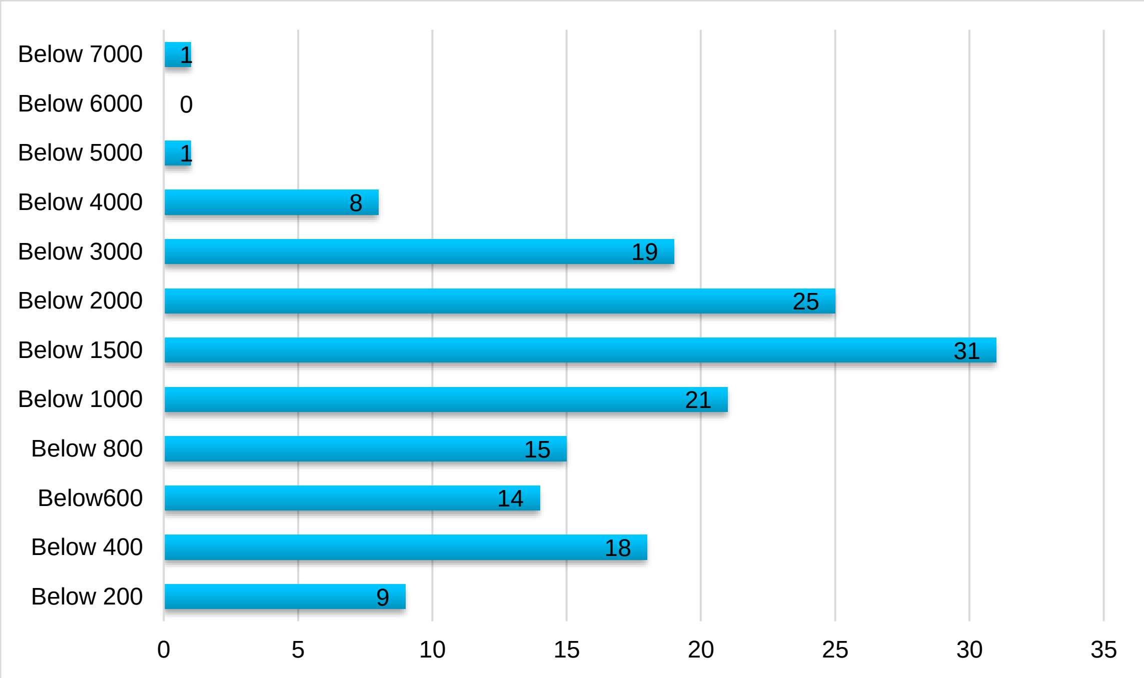


Figure 66. Population in villages within the Study Area

Source: Census of India, 2011 (Golaghat and Jorhat districts)

Villages where Proposed Well Area Located

As per census data 2011, among the villages located near well the village with maximum number of households was found to be Dhekalia Borsaikia. (389) followed by Raidangia Gaon (374) and Karang Chapari (255).Least number of households were found in Pohumora No.2.(21) followed by Sarkari N.C. (63).

The most populated village was found to be Dhekalia Borsaikia. (1739), followed by Raidangia Gaon (1705) and Karang Chapari (1500). Lowest population was observed in Pohumora No.2. (104) followed by Tingtingia (346).

The average household size was found to be 5. The average sex ratio in the villages, where wells are located was 1009 females per 1000 males

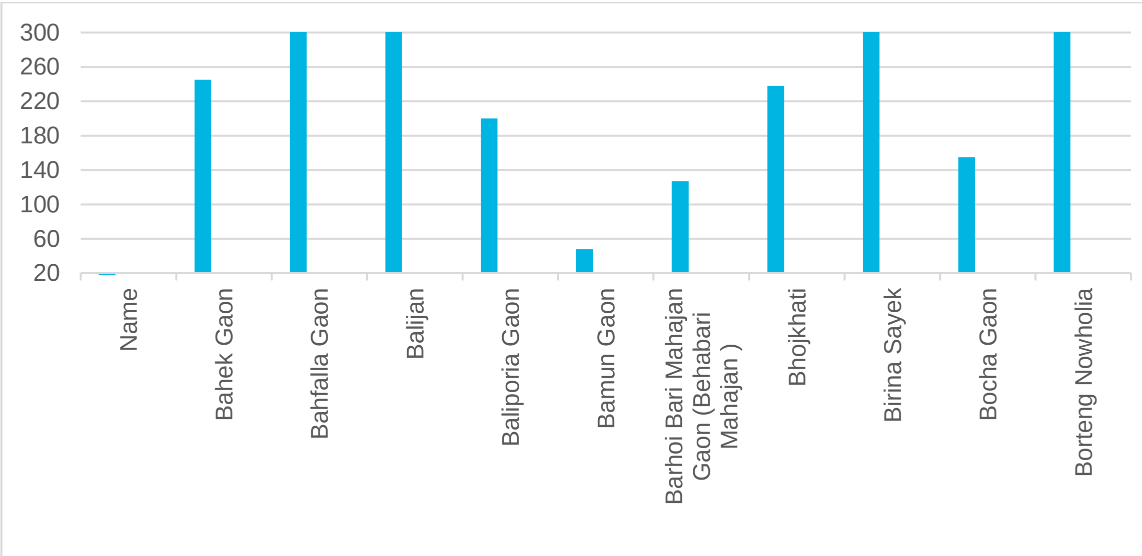


Figure 67. No. of Households in the Villages in which Wells are Located

Villages Located within 2.5 km Buffer of the Proposed Well Location

As per Census data 2011, the villages with maximum number of households was found to be Balijan (795) followed by Dakhinhengera Grant (676), Forkating (533). Least number of households were found in Pohumora No.2 (21), follwed by Rowmarikhuti(37) and Bamun Gaon (48). The Census 2011 data showed maximum population in village Balijan (3949), followed by Dakhinhengera Grant (3434) and Bahfalla Gaon (2436). The average household size was found to be 5. The average sex ratio in the villages within 500 m buffer of the well locations was 984 females per 1000 males.

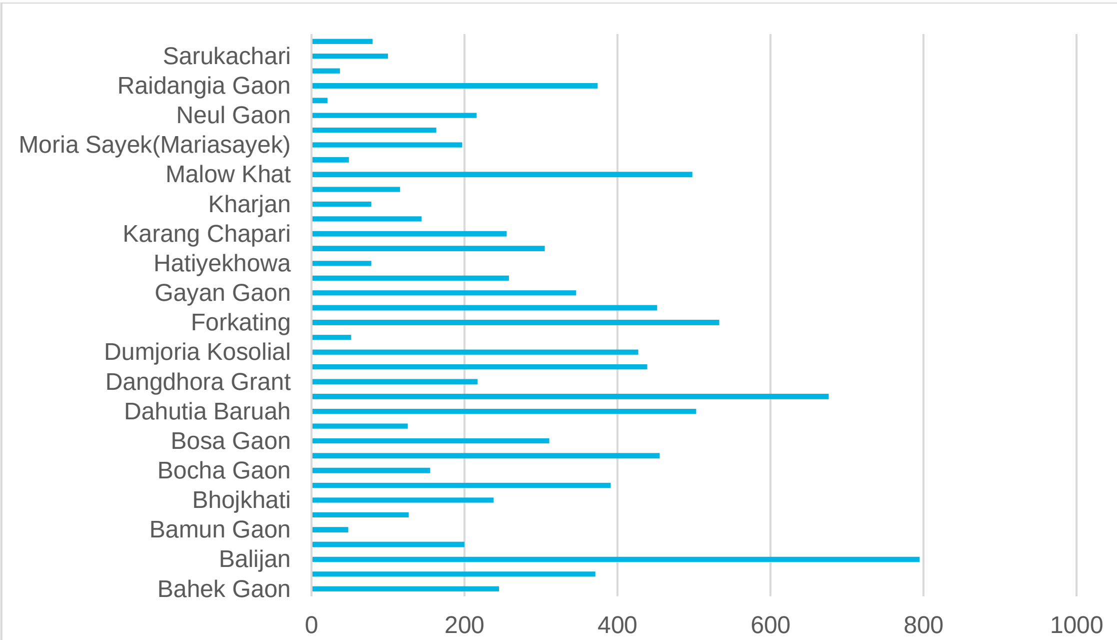


Figure 68: Households in the 500m Buffer of Well Locations

SC and ST Population

The Scheduled Castes and Scheduled Tribes are officially designated groups of people who are historically disadvantaged in India. The terms were derived in the Constitution of India and the groups are designated in one or other of the categories.

Villages Located within the Study Area

According to Census 2011, 8 villages in Block 11 had more than 50% SC population and 23 Villages in Block 11 had more than 50% ST Population. The main communities of the districts are the Miri, Mikir, Rabha, Kachari (i.e. Sonowal Kachari), Boro, Dimasa, Deori,and Lalung comprises the STs of the region (*http://censusindia.gov.in/Tables_Published/SCST/ST%20Lists.pdf*). Bansphor, Bhuinmali, Mali, Patni, Sutradhar, Mehtar, Bhangi, Namasudra, Kaibartta, Jaliya, Lalbegi and Jalkeot are among the SCs (*http://censusindia.gov.in/Tables_Published/SCST/SC%20Lists.pdf*)

Villages where Proposed Wells Are Located

According to Census 2011, only 1 village (Baliporia Gaon) in Proposed Well Area had more than 50% SC population and 3 Villages Sarkari N.C., Karang Chapari & Bhojkhati in the Proposed Well Area had more than 50% ST Population

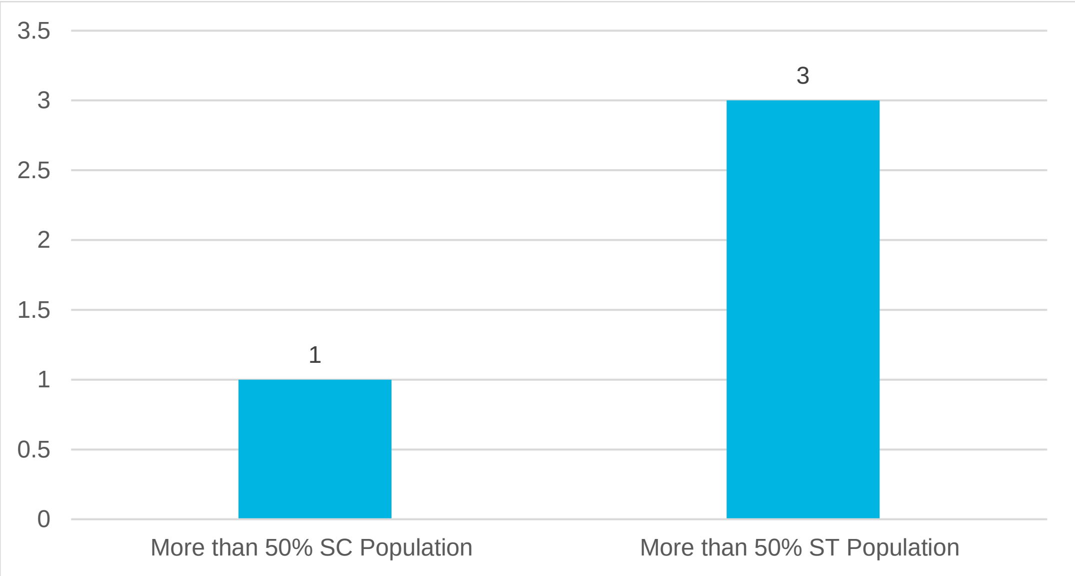


Figure 69. SC and ST population of villages, where proposed wells are located

Villages Located within 2.5 km Buffer of the Proposed Well Location

As per the Census 2011, none of the villages in the buffer area had any Scheduled caste population. However, Scheduled Tribe population was high in almost all the buffer area villages (87.95%-100%). Kekuri Bebejia, Balijan, Polongani and Ratanpur Gabharumelia had neither SC not ST population.

Literacy Rate

Literacy, as defined in Census data, is the ability to read and write with understanding in any language and literacy rate is a key indicator of the level of education prevalent amongst the sample population. It is also considered as one of the key factors of socioeconomic progress. All children of age below 7 years are treated as illiterate. People who are blind and could read in Braille are also treated as literates.

Villages Located within Block

According to Census 2011, village Sarukachari Gaon (99.51%) had maximum literacy rate, followed by Kumar Gaon (99.11%), Chakial Gaon (99.08%). Lower literacy rate was observed in Borghop Chapari (28.57%) and Bamun Gaon (36.25%). Male literacy was maximum in Ratanpur Gabharumelia (98.15) followed by Sephkati (91.74%) and Sumdirimukh N.C. (86.89%). Female literacy was highest in Bebejia Gaon (100%) and Sarukachari(100%) followed by Chakial Gaon (99.64%) and Kumar Gaon (99.58%).More than 65% of the villages showed more than 80% literacy. Mean literacy rate was 80.21%. While 77.43% is the mean literacy rate of

Golaghat district, 82.15% is the average literacy rate of Jorhat. In comparison, 73.18% is Assam state literacy rate.

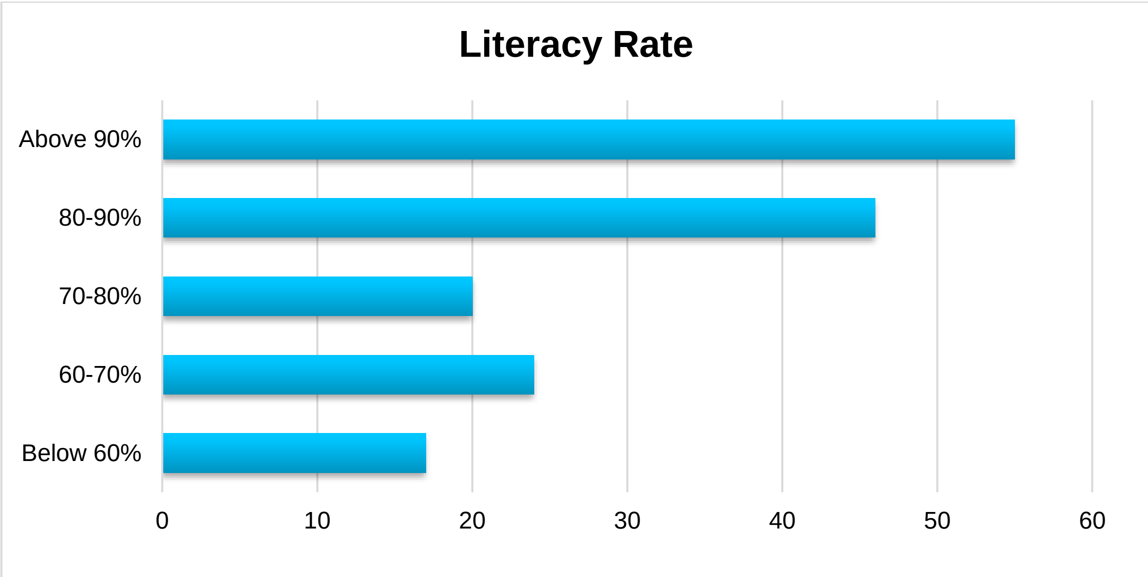


Figure 70. Literacy Rate in the Villages in the Study Area

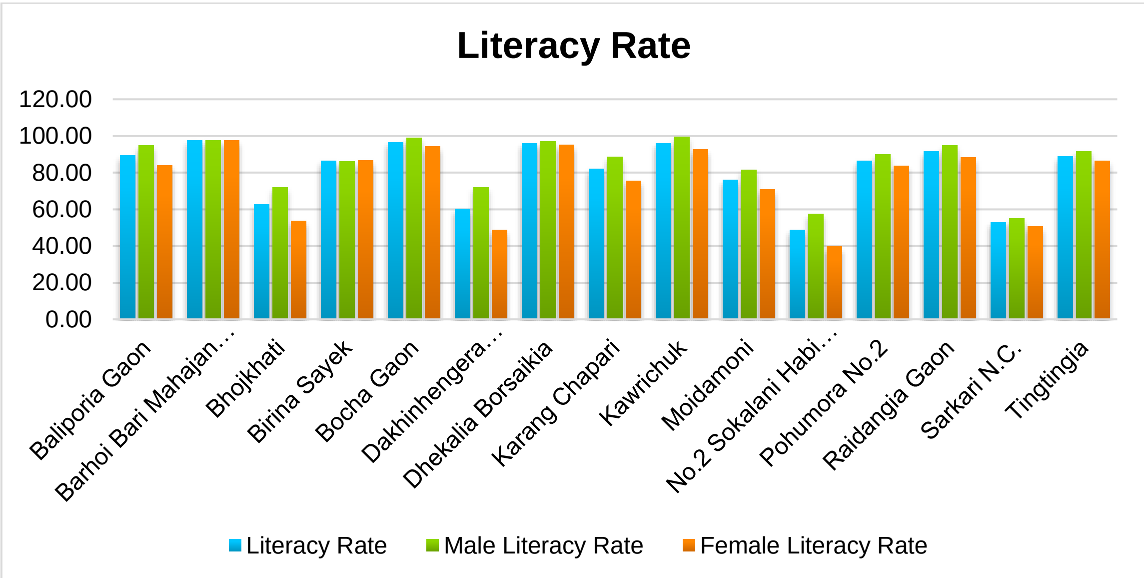


Figure 71. Literacy rate in the Villages in which Proposed Wells are Located

Among the wells located near the well, village Barhoi Bari Mahajan Gaon (97.60%) had maximum literacy rate, followed by Bocha Gaon (96.59%), Dhekalia Borsaikia (96.05%). Lower literacy rate was observed in No.2 Sokalani Habi (48.69%) and Sarkari N.C. (52.89%). Male literacy was maximum in Kawrichuk (99.38%) followed by Bocha Gaon (98.88%) and Barhoi Bari Mahajan Gaon. (97.6%). Female literacy was high in Barhoi Bari Mahajan Gaon (97.54%) followed by Dhekalia Borsaikia (95.17%) and Bocha Gaon (94.2%). While 77.43% is the mean literacy rate of Golaghat district, 82.15% is the average literacy rate of Jorhat. In comparison, 73.18% is Assam state literacy rate.

Villages Located within 2.5 km Buffer of the Proposed Well Location

As per census 2011, among the villages located near the well, village Sarukachari (99.51%) had maximum literacy rate, followed by Chakial Gaon (99.08%), Bahek Gaon (98.62%).Low literacy rate was observed in Bamun Gaon

(36.25%) Highest male literacy rate was observed in Sarukachari (100%) followed by Chakial Gaon (99.08), Kawrichuk (99.38%). Female literacy rate was highest in Sarukachari (99.06%), Mahani Bari (98.51%).

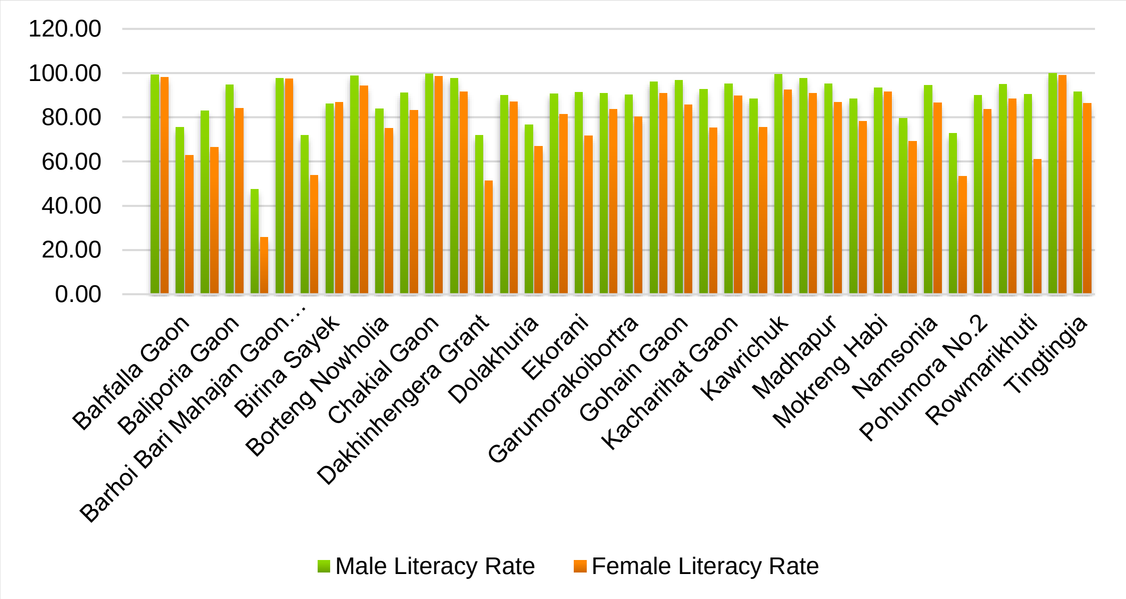


Figure 72. Literacy Rate in Villages in the 500m Buffer of the Proposed Well Locations

Economic Condition of Study Area Villages

Villages Located within Block

As per census 2011, About half the population, 50.6% constituted the working population while remaining were non-working. A majority of the workers (66.37%) were main workers, and among them, a majority (81%) was that of cultivators. Bahfalla Gaon, Chakial Gaon, Gohain Gaon had a substantial number of marginal workers.

Villages where Proposed Well Area Located

Only 44.18% of the population constituted the working population while 56.6% of the population was non-working. A majority of the workers (73%) were main workers, and among them, a majority (71%) was that of cultivators. Bhojkhati and Bocha Gaon had a substantial number of marginal workers.

Villages Located within 2.5 km Buffer of the Proposed Well Location

About half the population, 55.05% constituted the working population while remaining were non-working. A majority of the workers (70.08%) were main workers, and among them, a majority (85.96%) was that of cultivators.

Details of Amenities Present in Study Area Villages

Drinking Water

Tap water availability in the study area villages was scarce, as per Census 2011, with a little under 25% villages getting access to treated tap water and 11.11% villages getting untreated tap water. More than 90% and 70% of the villages relied on handpumps and tubewells/borwells, respectively, for their water supply.

Educational Facility

As per Census 2011, in most of the villages in the study area (nearly 62 percent), government primary schools were present. However, Secondary and Senior Secondary Government schools were present in only 36.70 and 5.69 percent of the villages, respectively.

Sanitation Condition

Less than one fourth of the villages in the study area were covered under the Total Sanitation Campaign. Also, nearly none of the villages had access to a community toilet complex, whether without a bath. Slightly more than one third of the buffer area villages were covered under the Total Sanitation Campaign. Also, none of the villages had access to a community toilet complex, whether without a bath.

Villages in which Proposed Wells are Located

Only one fourth of the villages in which proposed wells are located were covered under the Total Sanitation Campaign. Also, none of the villages had access to a community toilet complex, whether without a bath.

Health Facility

Health is an important aspect concerned with wellbeing of an individual physically and mentally. Health of the people affects socio-economic condition of a community and is also linked with the environment. The healthcare facility is divided into a three-tier system in rural area, which is given as follows:

Sub-centre: The Sub Centre is the most peripheral and first contact point between the primary health care system and the community. The major task sub-centres are assigned are to provide service associated with maternal and child health, nutrition, family welfare, immunization, diarrhoea control and control of various communicable diseases programmes.

Primary Health Centre (PHC): PHC is the first point of contact between village community and the medical officers. The Centre was envisaged to provide facilities integrated with curative and preventive health care to the rural population, majorly focusing on various preventive and promotive aspects of health.

Community Health Centres (CHCs): CHCs are maintained by the State government under MNP/ BMS programme. As per norms, a CHC is required to be managed by 4 medical specialists (surgeon, physician, gynaecologist and paediatrician) including 21 paramedical and other required staff. It has 30 in-door beds with one OT, X-ray, labour room and laboratory facilities.

The standards set by the national health policy are given below:

Table 3.41 . National Health Policy Standards

Population	Infrastructure	Personnel
3000- 5000	1 Sub-centre	1 ANM (Auxiliary Nurse Midwives)
25,000- 30,000	1 PHC, 6 Beds	2 Medical Officers
1,00,00	Rural Hospital	Medical Superintendent

A Primary health subcentre was within five km for 37% villages in the study area. For 21 % villages this facility was available within 10km while for 15 %, it was beyond 10km. A Primary Health centre was within five km for 13 % villages, and within 10km for 37 % villages. A community health centre was more than 10km away for 48% of the villages.

Electricity

Villages in the Study Area:

According to Census 2011, 64.2% villages had power supply for domestic use, as many as 71% of these villages had less than 99 hours of electricity supply in the summer and winter months.

Villages in 2.5 km Buffer of the Proposed Wells

According to Census 2011, 82.4% villages had power supply for domestic use, as many as 70% of these villages had less than 99 hours of electricity supply in the summer and winter months.

Villages in which Proposed Wells are Located

While 87% villages had power supply for domestic use, as many as 87% of these villages had less than 99 hours of electricity supply in the summer and winter months.

Photographs of Social Survey conducting during Month of April-May, 2019.

Stakeholder Consultation

Key stakeholder groups who were consulted during the site visit include Village head (Panchayet Pradhan), Headmaster of schools, Doctors, if available in PHC, administrative officers and local people. Details of stakeholder consultations undertaken during the site visit have been mentioned in table below.

Key points of stakeholder consultation:

Consultation with several group of stake holders, reveal the socio-economic issues, of the targeted villages:

- Most of the villages are facing the problem river bank erosion.
- Communication facility via road is not in well condition.
- Several losses of property and lives are happening due to heavy rain and bank erosion, every year.
- Water borne disease pulls out epidemic condition often.

Photographs of social survey

Photographs1: Interaction with Hospital stuff

Photographs 2: Consultation with Gaon Burha

Photograph 3 : Consultation with School stuff

Photograph 4 Consultation in Health Care unit

4. Environmental Impact Assessment and Mitigation Measures

This chapter is based on the systematic identification, characterization and evaluation of the potential environmental impacts arising of the proposed project and prioritizing them through a semi-quantitative system so that the impacts can be effectively addressed by Environment Management Plans. This section outlines mitigation measures alongwith the impacts, which will effectively combat the addressed the adverse impacts arising from various sequential activities to be undertaken as part of the proposed project.

4.1 Impact Assessment Methodology

An environmental impact identification matrix has been developed to present an overview of possible interactions between project aspects and components of the environment which may get affected. The matrix considers physical, biological and socio-economic components of the environment on abscissa (X-axis) and activities of the proposed drilling project on the ordinate (Y-axis). Aspects and impacts on environmental components which would be relevant to the different phases of the project e.g. pre-drilling activities, drilling, early production decommissioning have been addressed in the matrix. Environmental and socio-economic components were identified based on reviewing of applicable legislations project specific features and baseline environment, site reconnaissance visits, discussions with stakeholders.

Potential environmental impacts that may result from any of the identified project activity has been identified in a matrix based on activity-component interaction and is presented in **Table 4.3**. The impacts which has been identified in the matrix have been assessed for its significance based on significance criteria delineated in **Table 4.1 and 4. 2.**

4.2 Impact Criteria and Ranking

Once all project environmental aspects were comprehensively identified for the different activities of the project, the level of impact that may result from each of the activity-component interactions has been assessed based on subjective criteria.

For this, three key elements have been taken into consideration based on standard environmental assessment methodologies:

- **Severity of Impact:** Degree of damage that may be caused to the environmental components concerned;
- **Extent of Impact:** Geographical spread of impact around project location and corridors of activities; and
- **Duration of Impact:** Time for which impact lasts taking project life-cycle into account.

These elements have been ranked in three levels viz. 1 (low), 2 (moderate) and 3 (high) based on the following criteria provided in Table 4.1.

Table 4.1 Impact Prediction Criteria

Impact Elements	Criteria	Ranking
Severity	• Regional impact resulting in long term and/ or medium damage to the natural environment. • Major impact on community and occupational health (e.g. serious injury, loss of life) on account of accidental events *viz*. well blow-outs and related operational activities.	3
	• Local scale impact resulting in short term change and / or damage to the natural environment. • Temporary loss of land, source of livelihood for affected communities • Local scale impact on terrestrial habitat, endangered species, drainage pattern and community resources. • Moderate impact on occupation and community health &well being (e.g. noise, light, odour, dust, injuries to individuals)	2

Impact Elements	Criteria	Ranking
	• Limited local scale impact causing temporary loss of some species etc. • Limited impact on human health and well-being (e.g. occasional dust, odour, light, and traffic noise).	1
Extent	• Regional scale impact and including impacts to physical, biological and socio-economic environment of the Block	3
	• Largely local level impact limited to immediate vicinity of the proposed well sites	2
	• Impact not discernible on a local scale and is limited within the boundaries of the drill site	1
Duration	• The impact is always likely to occur during the entire project life cycle .	3
	• The impact is likely to occur in some phases of project life under normal operating conditions.	2
	• The impact is very unlikely to occur at all during project life cycle but may occur in exceptional circumstances.	1

A positive or beneficial impact that may result from this project has not been ranked and has been depicted in the form of ++.

4.3 Impact Significance

The significance of impact has been determined based on a multiplicative factor of three element rankings. The **Table 4.2** depicts impact significance in a scale of LOW-MEDIUM-HIGH and would be used for delineation of preventive actions, if any, and management plans for mitigation of impacts.

Impact significance has been determined considering measures which have been factored in the design and planning phase of the project. Legal issues have been taken into account, wherever appropriate in the criterion sets, to aid in Cairn Oil & Gas effort to comply with all relevant legislation and project HSE requirements. Additionally, the results of quantitative impact prediction exercise, wherever undertaken, have also been fed into the process.

Table 4.2 Criteria Based Significance of Impacts

Severity of Impact (A)	Extent of Impact (B)	Duration of Impact (C)	Impact Significance (A X B X C)	
1	1	1	1	**Low**
1	1	2	2	
1	2	1	2	
1	1	2	2	
2	1	2	4	**Medium**
1	2	2	4	
3	1	2	6	
1	3	2	6	
2	2	2	8	
3	2	2	12	**High**
2	3	2	12	
2	2	3	12	
3	3	2	18	
3	2	3	18	
2	3	3	18	
3	3	3	27	
- Beneficial Impact -			**++**	**Positive**

To assist in determining and presenting significance of an impact, an impact evaluation matrix (**Table 4.3**) has been developed based on the one developed for the impact identification exercise. In addition to ranked weights, significance of impacts has been depicted using colour codes for easy understanding. In case an environmental component is impacted by more than one project activity or the activity would impact a sensitive receptor e.g. settlement, school, hospitals, forest etc. a high significance ranking of ">12" has been considered. A second evaluation matrix presents significance of impacts after considering that proposed mitigation measures would be implemented

The impacts on each of the environmental components and its significance during the different stages of the project have been discussed in detail in the following section. This is followed by a point wise outline of mitigation measures recommended.

Table 4.3. Impact Identification Matrix

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Pre-Drilling Activities																													
Site selection and land acquisition				x	x														x			x							
Site Preparation	x	x	x			x	x					x	x	X									x	x			+	x	
Well site & access road construction	x	x	x	x	x		x																x				+	x	x
Sourcing & transportation of borrow material etc	x	x	x	x		x	x					x	x							x	x		x				+	x	x
Storage and handling of construction debris	x	x																										x	

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Transportation of drilling rig and ancillaries		x	x	x												x					x		x					x	x
Operation of DG set		x	x																										
Consumption of water for construction & domestic use for labourer											x											x							
Generation of domestic solid waste & disposal	x					x					x						x												x
Generation of waste water & discharge from construction									x		x							x											x

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
activity & labour camp																													
Surface run-off from construction site						x	x		x		x						x					x							
Drilling & Testing																													
Physical Presence of drill site	x												x																
Operation of DG sets and machinery		x	x										x															x	x
Operation of drilling rig			x											x									x					x	
Storage and disposal of drill cuttings and mud	x					x			x x		x																		

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Generation of process waste water & discharge									x								x												
Surface run-off from drill site						x					x						x												
Generation of domestic waste water & discharge						x					x						x												
Generation of Municipal waste & disposal	x					x					x																		
Workforce engagement & accommodation at drill site																				x		x			x		+		x
Flaring during well testing		x	x																									x	x

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Accidental events – blow out		x				x			x		x	x		x			x											x	x
Accidental events- spillage of chemical & oil						x			x		x																		
Early Production																													
Flaring of Gas		x	x															x											
GEG/DG Set of Emission		x																											
Produced Water						x	x	x	x																				
Decommissioning and Reinstatement																													
Dismantling of rig and associated facilities		x	x																									x	X

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & rout	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Transportation of drilling rig and ancillaries		x	x	x																									X
Removal of well site construction materials & disposal		x	x				x																						

4.4 Impact Assessment

This section discusses the impacts of the project activities on the environmental receptors It discusses probable impacts during various phases of the project lifecycle on the environmental and socio-economic components. Rankings for every activity – component interaction is based on the criterion set earlier and resulting environmental significance with necessary justification that has been recorded below for every set of impacts and the same has been represented in evaluation matrices. In broader context, it is however important to remember that operations related to drilling, testing and early production activities also include positive socio-economic impacts in terms of increase in local business opportunities and on a larger perspective, by providing potential energy security at a national level.

4.5 Potential Impact and Mitigation Measures on Visual Environment & Aesthetics

Source of Impact: Aesthetics and visual environment impacts due to setting up of the proposed project would be of low scale and temporary in nature. There would be no significant change in land use. Only the drilling rig boom with associated facilities including one flare stack and DG sets would be visible from the adjoining road and settlement area. The land area of disturbance is also very less of the order of not more than 9 Ha and only the elevated rig would be visible from a distance.

Mitigation Measures:

If no hydro-carbon is found from the well for economic recovery, then same would be closed and all supporting facilities would be demobilized. The surface of earth after any unsuccessful attempts of oil exploration would be restored back to normalcy in line with the prevailing land use status of the area.

4.6 Potential Impact and Mitigation Measures on Land Use

***Source of impact*:** Land would be required for the drilling operations. The land would be procured from private owners. In case of QPU the same drill site would be used, and no new area would be procured.

Assessment of Impact

Site preparation

Land will be required for exploration activities of exploratory and appraisal wells and setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs). As mentioned in Section 2.4.1, the proposed drill sites are located in tea gardens, agricultural lands and homestead plantation areas. With the commencement of activities, existing land use comprising of tea gardens, homestead plantations and agriculture would be converted to industrial land. This may lead to both positive and negative impacts on income and livelihood.

Potential impact on drainage is primarily anticipated in the form of disruption of natural drainage pattern during site preparation and approach road construction. The site preparation involves raising of acquired land to about 2 m above ground level, which may lead to alteration of onsite micro-drainage pattern leading to potential problems of obstruction of natural flow of water. The block is situated in the flood plains of the river Brahmaputra and the soil comprises of impermeable alluvium deposits, this may produce impacts due to the obstruction in the natural flow and which may subsequently be exaggerated during heavy rainfall in monsoons.

The access to majority of the drill sites in AA-ONHP-2017/11 is characterized by paved and unpaved rural roads. Well specific environmental setting study shows that most of the wells can be approached by an existing road. However, for site approach a road needs to be constructed. Widening and strengthening of existing paved/unpaved road will be required for transportation of drilling rig and heavy equipment to the well site. Widening/ new construction of roads could result in the alteration of drainage unless proper cross drainage structures are provided and may lead to water-logging of adjacent lands.

Well Site Restoration

Site restoration would be initiated for well site not indicative of any commercially exploitable hydrocarbon reserves. Unplanned restoration may lead to the long-term disruption in natural drainage pattern and water logging in neighbouring agricultural land abutting the site. However, adequate care would be taken by Vedanta Limited. (Division: Cairn Oil & Gas) to restore the site back to its original condition based on the originally existing contours and predominant slope to prevent any such adverse drainage impacts. The impact is considered would be of medium significance with onsite drainage being dependent on the proper site restoration.

Considering total area of block, the scale on impact significance is considered to be low. The impact will be limited to the local, since the land belongs to people living in and around the proposed sites, however the duration will be limited to some phases in the life of the project so, the magnitude will be small. The resource sensitivity is low since the maximum land impacted will be of homestead plantation, tea garden and agricultural land. The impact on land use is assessed to be low.

Severity of Impact	2	Extent of Impact	1	Duration of Impact	2
Impact Significance = 4 i.e. Low					

Mitigation Measure

- During the construction of the access road adequate cross drainage structures would be provided considering the topography of the alignment.
- The excavated material from the drill site would be stored (temporarily /permanently) in uncultivated land and would be away from any drainage channel.

4.7 Potential impact and Mitigation Measures on Topography & Drainage

Potential impact on drainage and topography *viz.* alteration of drainage pattern are anticipated during well site preparation, widening/strengthening of access roads and restoration of well facilities. The impact details have been discussed in the section below.

Impacts during road & site development

The strengthening of the access road would require some earth works especially at the sharp bends. The existing access road, culverts would not be disturbed. Thus, no change in the micro-drainage pattern along the access roads is expected.

For drilling operations approximately 9 ha. land site would be required. The site would be selected taking considering drainage pattern, thus during site preparation the cutting and filling would be limited. No change in the micro-drainage pattern and slope of the areas in the vicinity of the site is expected. In case of unplanned disposal of soils and other waste Blockage of local drainage channels can happen. Considering the above factors all these impacts would be temporary (in construction phase only) are largely at local level.

Severity of Impact	2	Extent of Impact	1	Duration of Impact	2
Impact Significance = 8 i.e. Medium					

Mitigation Measure

- Leveling and grading operations would be undertaken with minimal disturbance to the existing contour, thereby maintaining the general slope of site;
- Provision of drainage system would be made for surface run-off.

4.8 Potential Impact and Mitigation Measures on Air Quality

Source of Pollution: The probable sources of impact on ambient air quality during different phase of the project are listed below.

- Pre-drilling phase
    - Site development/preparation;
    - Operation of vehicles and construction machinery;
    - Transportation, storage, handling of construction material, disposal of construction waste;
    - Operation of diesel generator (DG) sets.

- Drilling phase
    - Operation of DG sets;
    - Emissions from flare stack;
    - Transport of drilling chemical and manpower etc.
- Early Production phase
    - GEG combustion stack \ DG set
- De-commissioning phase
    - Decommissioning of rig and connected facilities;
    - Transport of de-mobilised rigs and machineries.

Control Measures: Project design stage control measures are as follows:

- Vehicle, equipment and machinery used for drilling would conform to applicable emission norms;
- Drilling chemical and materials would be stored in covered areas to prevent fugitive emissions;
- GEG/DG set stacks would have adequate height, as per statutory requirements, would be able to adequately disperse exhaust gases; and
- Flare stacks of adequate height would be provided.

Assessment of Impact: The potential impact due to above mentioned activities has been discussed in the following section.

Fugitive emission: Fugitive dust emissions due to the proposed project would be principally associated with emissions of dust during the site preparation. The dust generated would be primarily from the handling and transportation of fill material and re-entrainment of dust during movement of the vehicles on unpaved roads. The generation of such fugitive dust is likely would be governed by micro-meteorological conditions (wind speed and direction). Effects of dust emissions are heightened by dry weather and high wind speeds and effectively reduced to zero when soils and/or ambient conditions are wet. However, dust generated from the site development and construction activity would be generally settle down on the adjacent areas within a short period due to its larger particle size.

Emissions from Vehicles/Equipment: The pre-drilling, drilling and decommissioning operations would involve movement of diesel operated vehicles and operation of machineries and equipment. Heavy vehicles would be particularly intense during site preparation and decommissioning phases. Gaseous pollutants such as NO_2, SO_2, are likely would be emitted from operation of vehicles and machineries.

Impact during the Drilling Phase

Flaring of gases primarily during the drilling testing phase will contribute to additional air pollution. Flaring involves high temperature oxidation process to burn combustible gases that may be generated from the proposed well sites.

In order to predict the Ground Level Concentrations (GLCs) at various distances from the source, of the above-mentioned pollutants, an air modelling exercise has been undertaken and is discussed in the impact prediction section below.

The input parameters considered in the impact prediction modelling undertaken using AERMOD is given in *Table 4.4*. Prediction of impacts on air environment has been carried out by AERMOD.

Table 4.4 : Input Parameters Considered for Dispersion Modelling

Emission sources	Stack height (m)	Stack dia. (m)	Stack gas temp. (K)	Stack gas velocity m/s)	Emission Rate (g/s)		
					NO_2	SO_2	PM_{10}
1000 KVA DG*	10	0.305	573.0	4.52	2.04	0.006	0.07
1000 KVA DG*	10	0.305	573.0	4.52	2.04	0.006	0.07
Flaring Stack (testing)	30	0.078	1273.0	20.0	0.0325	0.00085	-

** Source: DG book*

Presentation of Results

The predicted ground level concentrations (GLC) have been estimated at various receptor locations at 500 m interval in a grid of 20*20 km around the project site. The 24-hrly incremental concentrations have been predicted for the entire year. The results for SO_2, NO_2 and PM_{10} are presented in Table-2. The isopleths for SO_2, NO_2 and PM_{10} ground level concentrations are depicted in *Figure*- 74, 75, 76, 77 and 78 respectively.

Resultant Concentrations after implementation of the Project

The maximum incremental 24 hourly GLCs due to the proposed project for SO_2, NO_2 and PM_{10} are superimposed on the maximum baseline SO_2, NO_2 and PM_{10} concentrations recorded during the primary study. The resultant concentrations (baseline + incremental) after implementation of the project are tabulated below in *Table-4.5*

Table 4.5 : Resultant Consideration for SO_2, NO_2 and PM_{10}

Pollutant Maximum	Distance	AAQ Highest Concentration Recorded During the Study (µg/m^3)	Incremental 24 hourly Concentration due to Drilling (µg/m^3)	Resultant Concentration (µg/m^3)
SO_2	0-2 km	8.2	0.08	8.28
	2-5 km	8.2	0.06	8.26
	5-10 km	8.2	0.03	8.23
NO_2	0-2 km	33.5	28.0	61.5
	2-5 km	33.5	16.0	49.5
	5-10 km	33.5	4.0	37.5
PM_{10}	0-2 km	83.5	0.9	84.4
	2-5 km	83.5	0.6	84.1
	5-10 km	83.5	0.15	83.65

The rise in ground level concentrations would be practically negligible and the fallout would be mostly occurring within a radius of 500 m. The maximum GLCs for SO_2, NO_2 and PM_{10} after implementation of the proposed project would be well within the prescribed standards for rural and residential areas. Based on the above details, it can be inferred that proposed project would have an insignificant impact on the prevailing ambient air quality status.

Impacts during the Early Production (EP) Stage

During the EP phase there would be only one point source emission from GEG combustion stack. There would be no other point sources except a standby DG set which would be operated as backup power source when the GEG is not operating. The flue gases from the GEG would be vent out through a stack of 30 m in to the atmosphere. The emission of flue gas from GEG stack has been modelled with the following emission details.

Input Details

Table 4.6 : Input Parameters Considered for Early production

Emission sources	Stack height (m)	Stack dia. (m)	Stack gas temp. (K)	Stack gas velocity (m/s)	Emission Rate (g/s)	
					NO_2	SO_2
Flaring Stack (EPU)	30	0.3	1273	1.23	0.13	0.0034

Results During the GEG Operation

At the time of early production, due to the GEG operation, the incremental GLCs of SO_2 and NO_2 are 0.007 µg/m^{3}and 0.24 µg/m^3, therefore the incremental GLC of NO_2 and SO_2 would be again practically negligible. There would be no adverse impact in the site surrounding air environment.

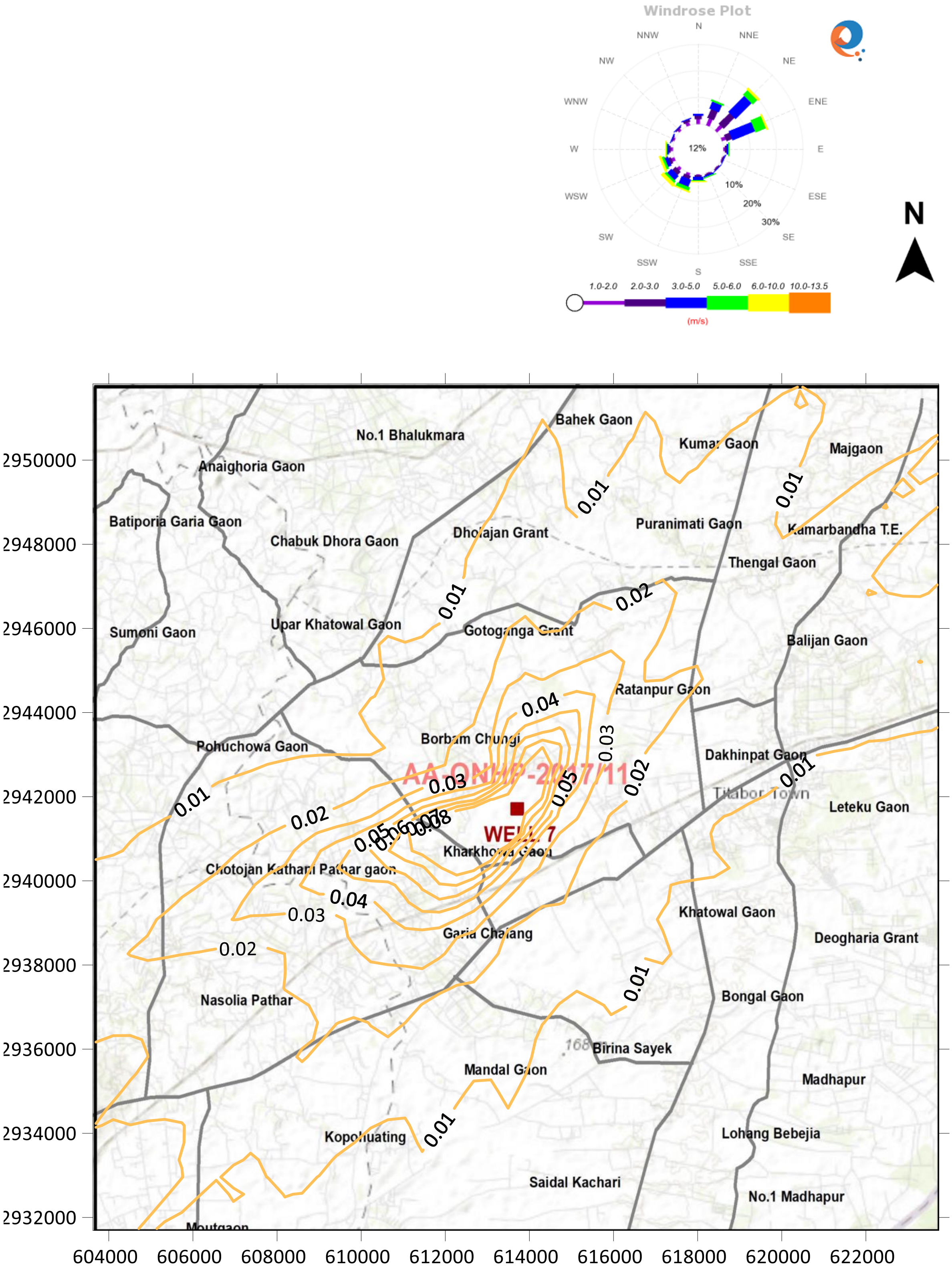
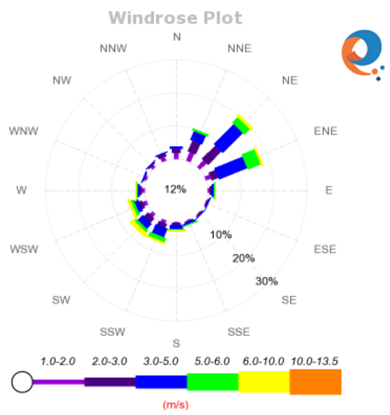


Figure 73. 24 Hourly GLCs OF SO_2 during Exploration and Drilling Phase



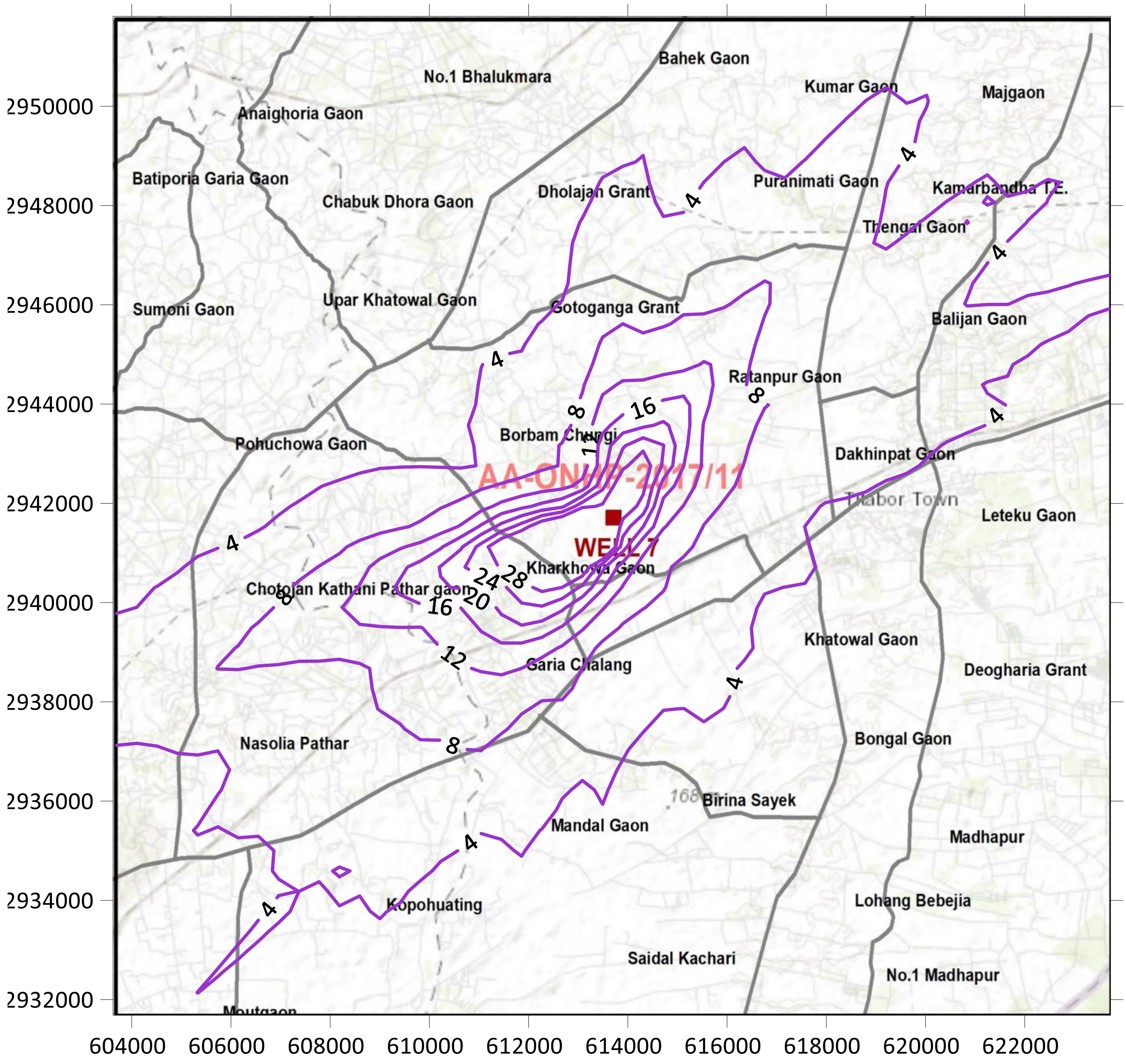


Figure 74. 24 Hourly GLCs OF NO_2 during Exploration and Drilling Phase

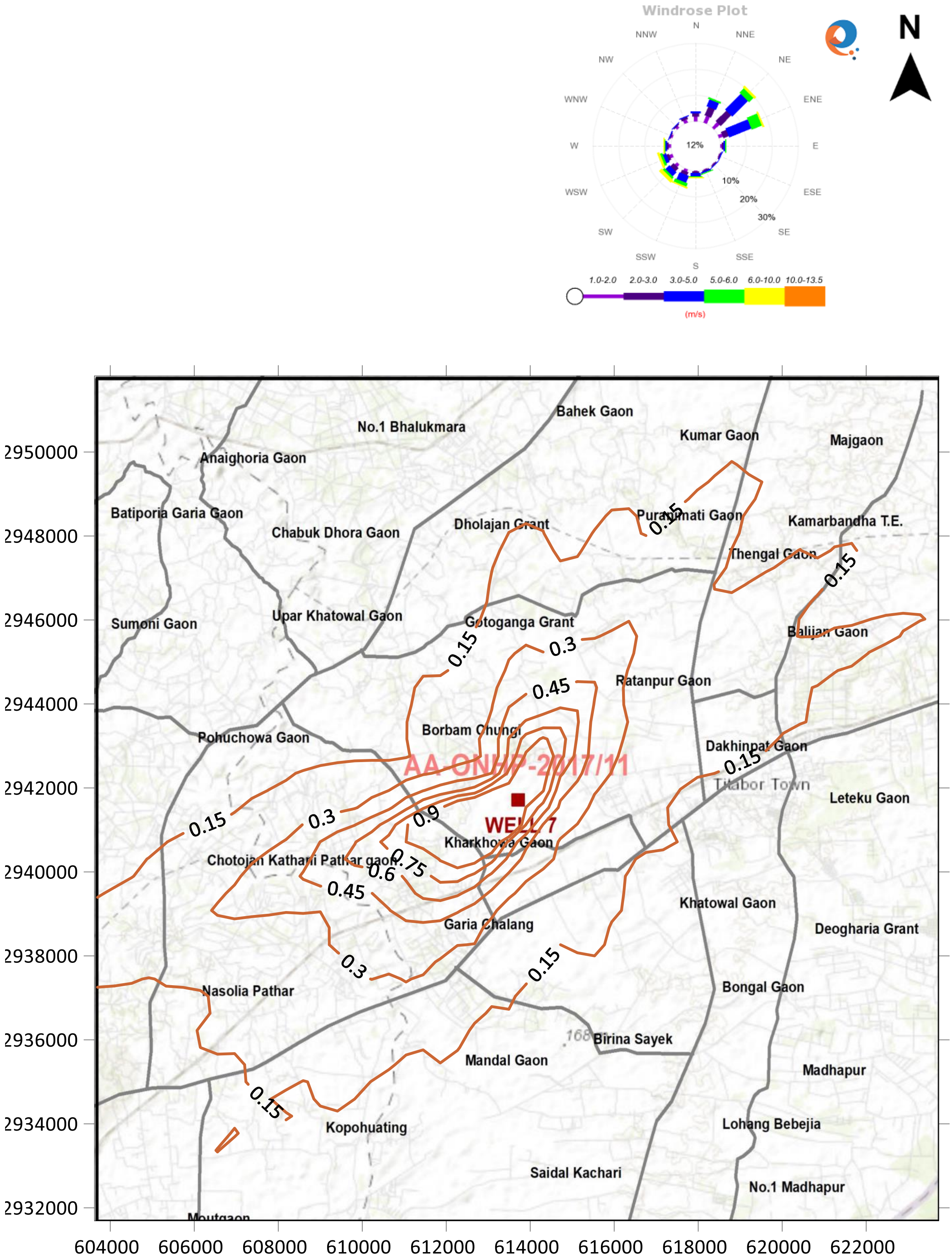
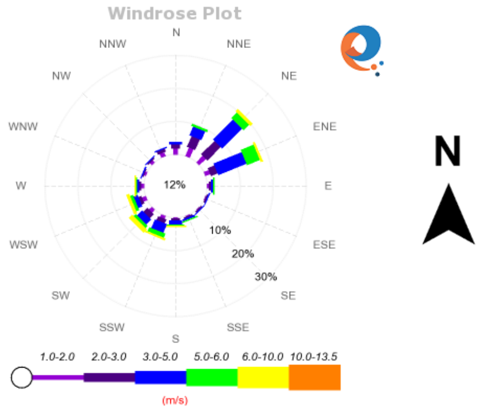


Figure 75. 24 Hourly GLCs OF PM_{10} during Exploration and Drilling Phase



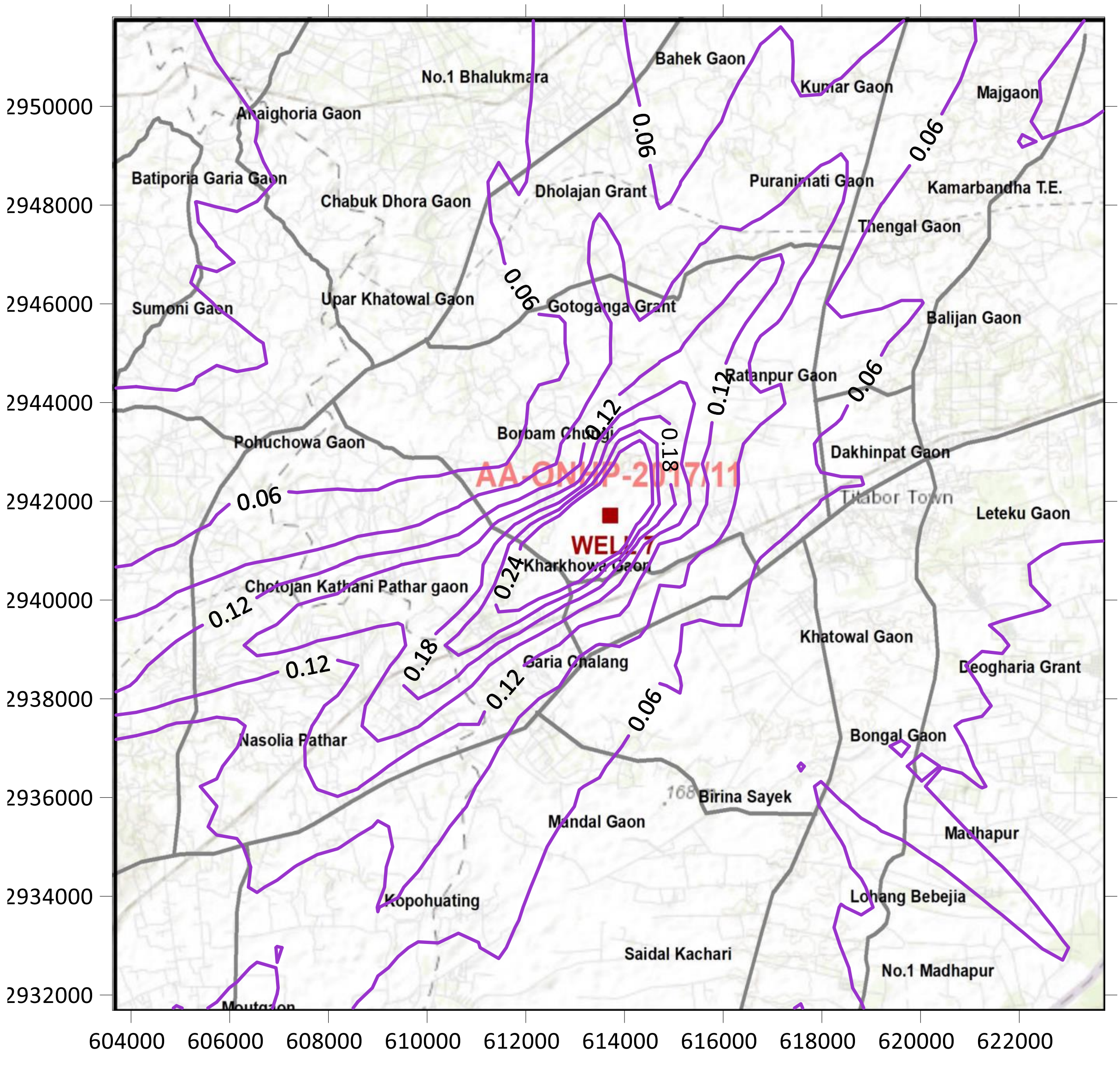


Figure 76. 24 HOURLY GLCs OF NO_2 during the early production phase

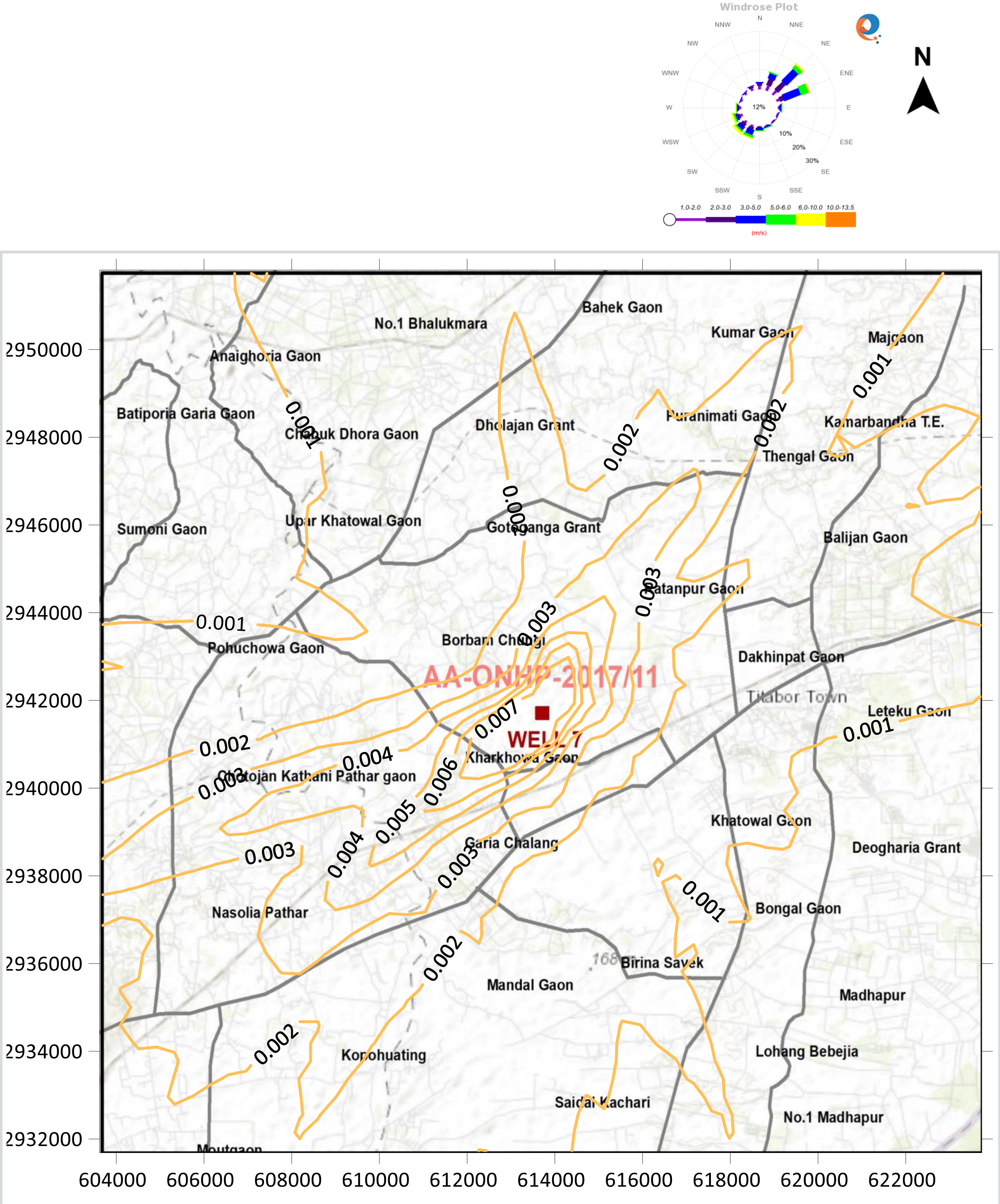


Figure 77. 24 HOURLY GLCs OF SO_2 during the early production phase

Mitigation Measures:

The proposed mitigation measures are as follows:

To minimize emission of fugitive dusts the following measures would be adopted:

- Carry out regular water sprinkling at the site during dry season especially during the construction and decommissioning activities;
- Location of construction materials will be away from nearby worker's camps;
- Proper handling of materials to ensure minimal emission of dust.

To minimise emission from the vehicles, equipment and machinery the following measures would be adopted:

- Movement of construction vehicles will be minimised and minimum speed will be enforced along the access and approach roads;
- All diesel-powered equipment will be regularly maintained, and idling time reduced to minimise emissions;
- Low sulphur diesel will be used in diesel powered equipment and best management practices would be adhered to;
- Vehicle / equipment air emissions will be controlled by good practice procedures.

To minimise the adverse impacts of flaring the following measures should be adopted:

- Proper engineering controls to ensure complete combustion of gas;
- No cold venting will be resorted instead flaring will be done with combustion efficient elevated flare tip; and
- Location of flare stacks to be chosen considering the sensitive receptors adjoining the site.

4.9 Potential Impact and Mitigation Measures on Noise Quality

Potential impact on noise quality is anticipated from vehicular movement, operation of construction machinery, access road strengthening during well site preparation and operation of drilling rig and ancillary equipment during drilling operation and Early production.

Source of Impact:

The potential impacts on noise quality may arise out of the following:

- Pre-drilling phase:
  - Site development/preparation;
  - Operation of vehicles and construction machinery;
  - Transportation, storage, handling of construction material, disposal of construction waste;
  - Operation of DG sets.
- Drilling phase:
  - Operation of DG sets and drilling rig
  - Operation of machineries & equipment;
  - Vehicular traffic.
- Decommissioning phase:
  - Demobilization activity
  - Vehicular traffic.
- Quick/Early Production:
  - Flaring of the Gas.
  - Operation of GEG/DG sets

Assessment of Noise Impacts due to Site Activities

Driller rotors and the power generators and pumps would be the main sources of noise pollution during the drilling activity. Noise due to vehicular movement would be intermittent but would also add to the background noise levels.

The well site during excavation phase of the site preparation where heavy earth moving machinery would be in operation, noise level of the vehicle would not be more than the 90 dB (A).

Typically, the noise generating sources for the onshore drilling activity are provided below (in the immediate vicinity)

- GEG/Diesel Generator: 75 dB(A)
- Pumps at the Rig: 85 to 90 dB(A)
- Mud pumps: 73.3-80.5 dB(A)
- Control Room & Quarters: 50 to 60 dB(A)
- Drilling: 85-90 dB(A)
- Flaring: 86.0 dB(A)

In order to predict ambient noise levels due to the proposed drilling of exploratory wells the preparative modelling has been done. For computing the noise levels at various distances with respect to the proposed site, noise levels are predicted using a user-friendly model the details of which is elaborated below.

Mathematical Model for Sound Wave Propagation During Operational phase

For an approximate estimation of dispersion of noise in the ambient from the source point, a standard mathematical model for sound wave propagation is used. The sound pressure level generated by noise sources decreases with increasing distance from the source due to wave divergence. An additional decrease in sound pressure level with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

For hemispherical sound wave propagation through homogenous loss free medium, one can estimate noise levels at various locations, due to different sources using model based on first principles, as per the following equation

$$Lp2 = Lp1 - 20\log(r2/r1) \qquad (1)$$

Where Lp2 and Lp1 are Sound Pressure Levels (SPLs) at points located at distances r2 and r1 from the source. The combined effect of all the sources then can be determined at various locations by the following equation.

$$Lp(total) = 10 \times LOG10(SUM[10^{(L1/10)} + 10^{(L2/10)}) \qquad (2)$$

Where, Lp1, Lp2, Lp3 are noise pressure levels at a point due to different sources. Based on the above equations, a user-friendly model has been developed. The details of the model are as follows:

- Noise levels can be predicted at any distance specified from the source;
- Model is designed to take topography or flat terrain;
- Coordinates of the sources in meters;
- Maximum and Minimum levels are calculated by the model;
- Output of the model in the form of isopleths; and
- Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured Leq levels.

Input for the Model

The incremental increase in noise levels due to the operation/site preparation phase of the exploratory drilling has been done. Noise levels are mainly generated from DG sets, air compressors, pumps and transformers. The noise sources have been defined with respect to centre of drill site. The input data pertaining to corresponding noise level are tabulated in Table 4.7.

Table 4.7. Input Data for Noise Modelling

Sr. No.	Location	Noise Levels dB(A) at 1m distance from source
1	Diesel Generator (4 DG set)	75
2	Pumps at the Rig	85
3	Mud pumps	70
4	Control Room & Quarters	50
5	Drilling	85
6	Flaring	86

Source:
https://www.cpcb.nic.in/displaypdf.php?id=SW5kdXN0cnktU3BlY2lmaWMtU3RhbmRhcmRzL0VmZmx1ZW50LzUwMS5wZGY=
www.vurup.sk/petroleum-coal

Presentation of Results

The model results are discussed below and are represented through line chart in Figure 54. The predicted noise level at 500 m distance from the boundary of well site is 43dB (A) and are tabulated in Table 4.8 and 4.9.

Table 4.8. Predicted Noise Levels

Name of Source	Noise Levels at 1m distance	X (Distance in m)	L2 [dB(A)]
Diesel Generator	75	50	56
		100	50
		200	44
		500	16
Diesel Generator	75	50	56
		100	50
		200	44
		500	16
Pumps at the Rig	85	50	61
		100	55
		200	49
		500	41
Mud pumps	70	50	46
		100	40
		200	34
		500	26
Control Room & Quarters	50	50	26
		100	20
		200	14
		500	6
Drilling	85	50	61
		100	55
		200	49
		500	41

Name of Source	Noise Levels at 1m distance	X (Distance in m)	L2 [dB(A)]
Flaring	86	50	62
		100	56
		200	50
		500	42

Table 4.9. Attenuated Noise levels from well boundary

Distance	Predicted Noise Levels dB (A)	Prescribed Noise levels at Day time of the Residential Area	Prescribed Noise levels at Night time of the Residential Area
50	62.98	55	45
100	56.96	55	45
200	50.94	55	45
500	42.98	55	45

Further, considering drilling would be a continuous operation, noise generated from aforesaid equipment has the potential to cause discomfort to the local community residing in proximity of the rig facility. So, settlements located close to majority of the wells would face discomfort due to drilling operation. Vedanta Limited. (Division: Cairn Oil & Gas) would ensure that well location is located as far as possible from the nearest human habitation.

Occupational health and safety impacts viz. Noise Induced Hearing Loss (NIHL) is also anticipated on personnel working close to such noise generating equipment. However, drilling activities would be undertaken for short duration and necessary noise prevention and control measures viz. use of acoustic barriers, provisions for proper PPEs, regular preventive maintenance of equipment etc. would be implemented by the proponent to reduce the noise impact on the communities residing in proximity to the well sites.

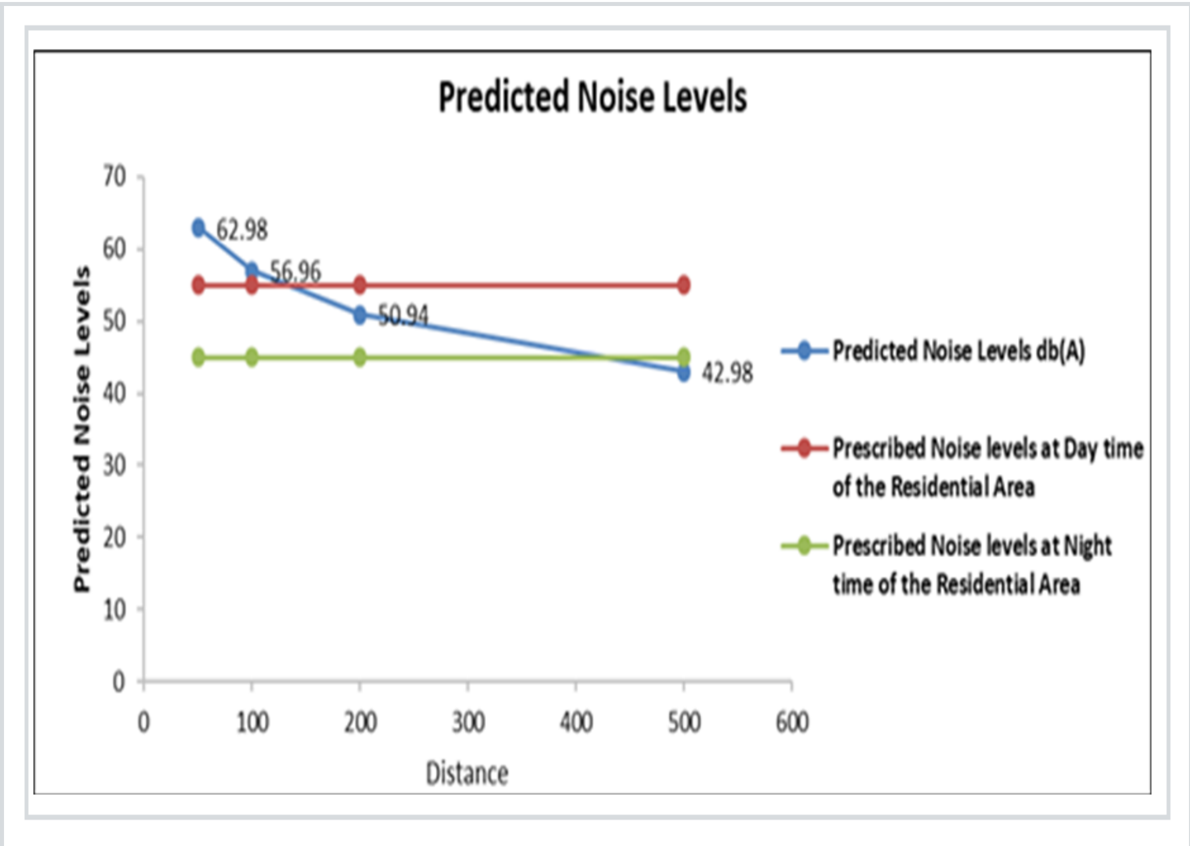


Figure 78. Predicted Noise Levels

Severity of Impact	2	Extent of Impact	2	Duration of Impact	1
Impact Significance = 4 i.e. Medium					

Mitigation Measures:

Typical mitigation measures for noise would include the following:

- Installation of adequate engineering control on equipment and machinery (like mufflers & noise enclosures for DG sets and mud pumps) to reduce noise levels at source, carrying out proper maintenance and subjecting them to rigid noise control procedures.
- Providing Personnel Protective Equipment (PPEs) like ear plugs/muffs to workers at site.
- The DG set would be kept in an acoustic enclosure with noise conformance labelling as per CPCB standards.
- Undertaking preventive maintenance of vehicles to reduce noise levels

4.10 Potential Impact and Mitigation Measures on Surface Water Quality

Surface run-off discharge

Site clearance and stripping of top soil during site construction/site preparation would result in an increase in soil erosion potential leading to an increased sediment load in the surface run-off during monsoon. Also, surface run off from drilling waste (cuttings and drilling mud), hazardous waste (waste oil, used oil etc) and chemical storage areas may lead to the pollution of receiving water bodies viz. natural drainage channels etc unless precautionary measures are adopted. However, taking into account the provision of onsite drainage system, sediment control measures, provision of oil water separator would aid discharging of surface run off in compliance with the CPCB Inland Water Discharge Standards, the impact is considered would be of low significance.

Discharge of drilling mud and process wash water

Severity of Impact	2	Extent of Impact	1	Duration of Impact	2
Impact Significance = 4 i.e. Medium					

Mitigation Measures

- Proper treatment of all wastewater and produced water and any water discharge from well site would comply with CPCB Discharge Standards for Oil and Gas Industries
- Waste mud would be stored in the HDPE lined pit
- Drainage and sediment control systems at the well site would be efficiently designed
- All chemical and fuel storage areas, process areas would have proper bunds so that contaminated run-off cannot escape into the storm-water drainage system.

4.11 Potential Impact and Mitigation Measures on Ground Water Resource

Source of Impacts: In absence of supply of surface water resource, the potential impacts on groundwater resource would be due to ground water abstracted for domestic needs and for civil construction activities. Potential impact on ground water resource could arise due to:

- Pre-drilling phase,
    - Water required for construction of drill sites
- Drilling phase

Embedded Control Measures

- Water requirement would be sourced locally through approved authorised process.
- Potential impacts on groundwater resources that could arise as a result of the proposed drilling activities include the following:

Ground Water Extraction

The field area is located on the flood plains of the River Brahmaputra and its tributaries. As per the Ground Water Information of Golaghat and Jorhat Districts of Assam, the stage of ground water development in the districts are 17% and 13% respectively, which is categorized as Safe. There are no major changes in the long-term water level so the districts, where AA-OHNP-2017/11 is located, may be considered as Safe.

The water requirement for all project activities would be sourced locally through approved / authorized sources of surface water and/or ground water (e.g. PHD bore wells, privately owned bore wells, irrigation Dept./Water Resources Dept. of State Govt.). In case, required water could not be sources from locally available approved sources, ground water would be extracted after obtaining permission from CGWA/State Govt.

Considering drilling would be a temporary activity (approx. 90 days) the impact on ground water resource is considered would be low. In case of QPU the water requirement would reduce and thus the impacts would reduce even though the duration of the activity would be longer.

Severity of Impact	**2**	**Extent of Impact**	**2**	**Duration of Impact**	**1**
Impact Significance = 4 i.e. Medium					

Mitigation Measures

All water storages in the drill sites would be kept covered and leakage prevented.

4.12 Potential Impact and Mitigation Measures on Soil Quality

Potential impact on soil quality is envisaged in the form of increase in soil erosion and loss of soil fertility resulting from site clearance and top soil stripping during well site preparation. The impact from accidental spillage resulting from storage and handling of mud chemicals is also envisaged.

Source of Impact: Soil quality impacts can result from:

- Pre-drilling Phase
    - Removal of top soil from the land procured;
    - Compaction of soil;
    - Disposal of construction waste/ MSW in non-designated area;
    - Spillage of chemical/oil on open soil;
    - Surface runoff from material & waste storage areas and oil spillage area.
- Drilling Phase/Operation of Production facilities:
    - Spillage of chemical, spent mud, hazardous waste, etc.;
    - Surface runoff from waste storage area and spillage area.
- Decommissioning Phase:
    - Disposal of decommissioning waste materials in open soil.

Embedded Control Measures: The project embedded control measures are as follows:

- The drill cuttings and spent drilling mud would be generated at site per well during drilling operations. This would be stored in well-designed HDPE line pit. And would be disposed as per the guideline of GSR & HWM rules.
- Topsoil would be removed and stored separately.
- Soil quality impacts so identified have been assessed and evaluated in the section below.

Site clearance and stripping of top soil

As discussed in the baseline section, the soil of AA-ONHP-2017/11 Block is characterized by fertile unconsolidated alluvial sediments. However, to preserve the topsoil, stripping of topsoil has been planned before the start of construction activity at the drill site to reduce the impact on the fertility of the land. It is estimated that about 15-20% of topsoil would be removed per well site having an area of 9.0 ha considering 15 cm topsoil. However, such impact is considered would be temporary as the proper reinstatement of site would be undertaken by Vedanta Limited (Division: Cairn Oil & Gas) in case the wells are not indicative of any commercially exploitable hydrocarbon reserves. Necessary surface run-off control measures would be adopted by the proponent during construction phase to prevent sediment flow to abutting agricultural land. Further specific mitigation measures would be implemented by Vedanta Limited (Division: Cairn Oil & Gas) to stabilize the topsoil and to preserve their fertility characteristics during site restoration. The impact is therefore considered would be of medium significance.

Sourcing of borrow material

The drill sites would also be raised. Site preparatory activities would involve the sourcing of earth-fill from borrow areas. Since in most of the cases efforts would be made to procure the fill material from nearby existing borrow areas/ quarries the impact is considered would be of low significance.

Storage and disposal of drill cuttings and drilling mud

As an embedded mitigation measures HDPE lined impervious pits would be constructed at each of the drill sites for temporary storage of drill cuttings and drilling fluid. The disposal of the drill cuttings and the drilling mud would be carried out in accordance with “CPCB Oil & Extraction Industry Standard – Guidelines for Disposal of Solid Wastes” no significant impact to this regard is envisaged.

Storage and handling of fuel and chemicals

Fuels, lubricants and chemical used for the drilling operations (especially daily consumption) would be stored at site. In addition to spent lube, and waste oil would also be stored temporarily at site before it is disposed as per the regulatory requirements. Improper storage and handling of the chemicals and fuels spent lubricants can lead to contamination of soil. Accidentally, spillage of chemicals, oil and lubricants, either during transportation or handling, on soil may contribute to soil contamination. Considering the accidental nature of the event the impact is considered would be of low significance.

Embedded controls have been considered in the project design to reduce the impact on soil. Also, most of these impacts on the soil fertility is reversible as the drill sites would be reinstated after the drilling. The contamination of soil due to spillage of chemical and fuel is likely to happen only in case of accidents. Thus, the significance of the impact is medium.

Severity of Impact	**2**	**Extent of Impact**	**2**	**Duration of Impact**	**2**
Impact Significance = 8 i.e. Medium					

Mitigation Measures:

The following mitigation measures are proposed for reducing impact on soil quality:

- The top soil would be stored properly.
- Manage spills of contaminants on soil using spill kits;
- Storage of construction waste/ MSW in designated areas within drill sites/production facilities;
- Adopt best practices e.g. use pumps and dispensing nozzle for transfer of fuel, use drip trays etc.

4.13 Potential Impact and Mitigation Measures on Road & Traffic

During various phases of projects like construction, drilling, early production and decommissioning various types of vehicle / equipment movement would be involved. The vehicular movement is expected would be more in construction/site preparation phase due to movement of machinery & manpower.

Vedanta Limited (Division: Cairn Oil & Gas) would ensure that traffic management plan is implemented so that proper vehicular movement is done with minimal disturbance to nearby communities. The impacts would be for limited duration. Thus, the impacts are temporary in nature and limited mostly within the drill site.

Severity of Impact	2	Extent of Impact	1	Duration of Impact	2
Impact Significance = 4 i.e. Medium					

Mitigation Measures

- Speed limits would be maintained by vehicles involved in transportation of raw material and drilling rig.
- Road safety awareness programs/campaign would be organized in coordination with concerned authorities
- Entry of vehicles into the drilling site area is prohibited except for material movement.
- Adequate parking would be provided outside the drilling location.

4.14 Potential Impact and mitigation Measures on Terrestrial Ecological Environment

Potential impact on Ecological environment i.e. impacts on existing Floral and faunal diversity is envisaged particularly during Site preparation phase and operation phase. The potential impacts on terrestrial Ecology in Site preparation and operational phase is given below.

Source of Impact:

The Potential Impacts on the existing floral and faunal diversity may arise due to following activities:

1. Vegetation Clearance.
2. Illumination from Site.
3. Generation of Noise

Impact Assessment:

Vegetation Clearance

It is proposed to carryout drilling of 11 exploratory and appraisal well in Block AA-ONHP-2017/11, which is primarily located on land of with agricultural fields. During primary survey, it has been observed that removal of ground vegetation is required for site preparation.
The vegetation observed in the study area is common to these climatological conditions and no endangered floral species is observed in the study area. Further the distribution of vegetation is scattered in nature and no well is located inside any forest land. Clearance of vegetation for site preparation would not require cutting of any mature trees. It is observed that approximately 9 ha land is required for each drill site and clearance of only shrubs and herbs are required. Therefore, the scale of Impact can be considered as low, extent of impact would be limited within site. The clearance of vegetation would initiate the change in land use. So, overall impacts would be low.

Generation of Noise and Illumination from site

It is anticipated that noise would be generated particularly during the construction/site preparation period and various operational activities from the drilling site. It is expected to get attenuated to baseline level of noise within 200-300 m from the proposed drilling locations. During the field visit and as confirmed by the Forest Department of Government of Assam, the nearest WLS includes the designated ESZ of 10 km of Nambor Reserve Forest, which is located within the block boundary, towards the South-Western side of the block. The nearest proposed exploratory well location is situated approx. 4.94 km from the Reserve Forest boundary. Therefore, no activity is planned inside the protected area. According to the proposed drilling activities, the well sites are located outside the protected area, the potential impacts on existing wildlife due to generation of noise can be considered as low.

the potential impacts on existing wildlife due to generation of noise can be considered as low.

The drill site would be illuminated during both construction and operational phase as drilling would be conducted continuously for 24 hrs and thus may cause significant disturbance to local faunal population particularly avifauna.

Severity of Impact	2	Extent of Impact	1	Duration of Impact	2
Impact Significance = 4 i.e. Low					

Mitigation Measures

A range of measures would be adopted during construction and drilling phase to mitigate the potential impacts of terrestrial ecology and biodiversity which are described below:

- The working area would always be kept minimum.
- For felling of trees prior approval from concerned department would be obtained;
- Appropriate shading of lights would be ensured to prevent unwanted scattering.
- Plantation of local trees would be undertaken;
- Fencing would be done on the camp site to avoid any unfortunate encounter with faunal species.

4.15 Potential Impact and Mitigation Measures on Socio-Economic Environment

The impacts on the socio-economic environment are both adverse as well as positive in nature. The adverse impacts are primarily due to: Inconvenience due to dust and noise. Disruption or damage to public infrastructure due to construction related activities

Assessment of Impact

The impact on different aspects of the socio-economic environment is discussed as under.

Additional Demand on Infrastructure

The width of some of the access and approach roads are not wide enough to support the movement of heavy vehicles to drill site, hence they have would be widened and strengthened. Transportation of drilling rig and associated facilities to drill and decommissioning of rig and associated structure would increase traffic movement. Increase in vehicular fleet may cause damage to road infrastructure if not properly maintained. The strengthening and widening of the existing road would reduce the significance of impact from medium to low.

Influx of labour Population

Influx of population is anticipated in all stages of the project cycle particularly during exploratory drilling. The drill site would involve the operation of about 50 onsite workers during drilling phase. Interaction between workers with villagers of nearby areas might give rise to various issues like conflict of workers with the local population, nuisance caused by workers due to improper sanitation facilities, etc. However, considering that majority of the workforce during construction phase is likely would be sourced from local villages chances of such conflicts are negligible.

Employment opportunities

Project would benefit people living in the neighbouring villages temporarily by creating opportunity for direct & indirect employment associated with the various project activities. Site preparation phase would involve certain number of laborers and there is a possibility that local people can be engaged for this purpose. Drilling process would involve a number of skilled and unskilled workers. Generation of short time employment opportunities during the project phase would improve the employment scenario of the area.

Cultural & Heritage Site

Impact on cultural environment may occur due to site preparation, operation of drilling rig and also during vehicular movement with respect to the proposed exploration activities. There are no designated historical or cultural spots close to the well sites or access roads hence; no impact in this regard is envisaged.

Corporate Social Responsibility

Vedanta Limited (Division: Cairn Oil & Gas) has taken up various CSR initiatives in and around present operational areas for the benefit of the residents as per the CSR Act and Rules, Govt. of India.
CSR measures will be taken up by Vedanta Limited. (Division: Cairn Oil & Gas) in case of commercially viable hydrocarbon discovery & further full-fledged development of the fields and production and associated facilities.

Mitigation Measures

- The shortest distance as far as available/feasible would be considered for access road, with additional care to avoid division of land parcels into agriculturally unviable fractions;
- The village road identified for accessing proposed project footprints, would be strengthened and widened as per requirement
- Appropriate awareness program on grievance redressal mechanism, would be designed and implemented for local community around proposed project footprints;

Impact Significance = ++ i.e. POSITIVE

4.16 Potential Impact and Mitigation Measures on Occupational Health and Safety

Construction/site preparation

Source of Impact Occupational health and safety impacts during construction/site preparation phase are anticipated primarily from:

- Operation of construction machineries/equipment;
- Exposure to high noise generation areas.

Embedded Control Measures The project embedded control measures are as follows:

- Provision of proper PPEs for the contractor workers onsite;
- Provision of drinking water facility, sanitation and cooking facilities.

Assessment of Impact

Impact on occupational health and safety of contractor workers is anticipated from exposure to high noise generated from operation of heavy machinery/equipment and fugitive dust generated from material stockpiles, earth works and vehicular emission. It is estimated that about 50-60 workers would be deployed by the contractor at each drill site and 10-20 workers in the production facility. The outstation project workforce would be housed in labour camp located within the drill site. Continuous exposure of workers to high noise levels and fugitive dust and inadequate facilities and unhygienic conditions at such camps may lead to adverse health impacts *viz*. headache, asthma, allergy, hearing loss etc. indicating a *high* receptor sensitivity. However, extent of the impact would be limited to the well site and production facility only hence the impact would be *localized only*. Also considering the temporary nature of the construction phase activities, operation of machinery/equipment would be *short term* and with provision of proper PPEs and training for the workers scale of the impact would be *low*. Hence, the impact magnitude for occupation health and safety due to above mentioned construction activities have been assessed would be of *medium and* significance would be *moderate*.

Operational Phase

Source of Impact: The source of occupational health and safety could arise from:

- Operation of rig and machineries,
- Exposure in high noise generation area.

Embedded control measures: The control measures are as follows:

- All potential occupational health hazards would be identified;
- Permit to work system would be in place;
- Provision of PPEs to all workers.

Assessment of Impact:

Major occupational health hazards encountered in proposed drilling activity would include noise from drilling activity, operation of heavy vehicles and machinery, handling of chemicals etc. both in drill site and production facility.

Drilling Activity

Continuous exposure of workers involved in drill activity to high noise levels may lead to adverse health impacts viz. headache, hearing loss etc. which indicates a ***high*** receptor sensitivity. It is under stood that extent of the impact would be limited to the well site only hence the impact would be ***local***. As the drilling activity would be continuous of maximum period of up to 3 months and intermittent operation of machinery/equipment duration would be ***short term*** and with provision of proper PPEs and training of the workers scale of the impact would be ***low*** and magnitude of the impact would be small. Hence, the impact significance of occupation health and safety due to above mentioned construction activities is assessed would be ***moderate***

Quick Production Unit/Early Production Unit

Main impact on occupational health safety in production facility would limit to operation of heavy vehicles and machinery, handing of chemicals etc. However, involved of the personal in a production facility per shift is maximum up to 10 persons and it is understood that they would be trained. Hence, the resource sensitivity would be ***medium***. As all the activity of production facility would be carried out within secure premises extent of impact would be ***local***. As the risk level of a production facility is high as it is handling highly inflammable hydrocodone embedded control of any production facility is very strong, so the scale of the impact would be ***medium***. Hence, the magnitude of the impact would be ***medium*** and significant of the impact is assessed would be ***Medium.***

Severity of Impact	2	Extent of Impact	2	Duration of Impact	2
Impact Significance = 8 i.e. Medium					

Mitigation measures: The mitigation measures are as follows:

- Periodic onsite surveillance would be conducted so that the workers use the designated PPEs all the time;
- Health surveillance would be conducted of personnel working in the aforesaid areas;
- Regular health and safety training would be provided to workers.
- Exposure of workers operating near high noise generating sources would be reduced to the extent possible;

4.17 Potential Impact and mitigation Measures on Community Health & Safety

Community health and safety of inhabitants residing close to the drilling site stands to get affected from frequent heavy vehicular movement along village access roads and due to noise from drilling rig operations.

Ensuring Public Safety

Since the project involves the movement of heavy vehicles and machinery in the area, the issue of public safety of the villagers, especially children, is an important concern. During the drilling phase and for the rest of the project activities proper safety measures would be undertaken both for transportation as well as the other operations. The drill site would be fenced, and gates would be constructed so that the local people are refrained from straying into the site.

The movement of traffic is also likely to access conditions of the inhabitants residing close to the access road. The increase in traffic would have implications on their safety too, as well as create congestion, potential delays and inconvenience for pedestrians.

Health and safety impact arising from technological emergencies viz. well blow outs, explosions would be dealt separately in the Quantitative Risk Assessment (QRA) section.

Although the aforesaid activities are temporary in nature it may not adversely affect community health and safety in the long term. Mitigation measures would be taken as outlined in environmental management plan to reduce the impacts arising out of project activities.

Severity of Impact	2	Extent of Impact	2	Duration of Impact	2

Impact Significance = 8 i.e. Medium

Mitigation Measures:

- Drilling activities would be under proper fencing
- Proper hoardings in English and local language would be displayed during construction and operation phase to prevent people from encroaching the fenced area or to make them aware of the danger associated with the project activities.
- Traffic management plan would be developed and implemented at site.

Table 4.10 Impact Significance Matrix (with mitigation)

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & Route	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Pre-Drilling Activities																													
Site selection and land acquisition					M														M			L							
Site preparation	L	L	L			M						M		M									L	L			+	L	
Well site& access road construction	L	L	L	M			M																L				+	L	L
Sourcing & transportation of borrow material etc	L	L	L	M		L	L					M								M	M		L				+	L	L
Storage and handling of construction debris	L	L																										L	
Transportation of drilling rig and ancillaries		L	L	M																	M		L					L	L

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & Route	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Operation DG set		L	L											M	M														
Workforce engagement & accommodation at construction site																				M		L			M		+		L
Consumption of water for construction & domestic use for labourer										L												L							
Generation of domestic solid waste & disposal	L					L			L		L																		L
Generation of waste water & discharge from construction activity &labour camp									L		L																		L

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment											
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & Route	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Surface run-off from construction site						L			M		L											L							
Drilling & Testing																													
Physical Presence at drill site	L													M	M														
Operation of DG sets and machinery		L	M									L		L	L													M	M
Operation of drilling rig			M									L		L	L								M					M	
Storage and disposal of drill cuttings and mud	L					L			L		L																		
Generation of process waste water & discharge									M		L						M	M											

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment											
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & Route	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Surface run-off from drill site						L			L								M	M											
Generation of domestic waste water & discharge						L			L		L						M	M											
Generation of Municipal waste & disposal	L					L			L		L																		
Workforce engagement & accommodation at drill site																				M		L			M		+		M
Flaring during well testing		L	M									M		L	L													M	M
Accidental events - blow out		L				M			M		M	M		L	L													M	M

Environment / Activity	Physical Environment											Biological Environment							Socio-economic Environment										
	Aesthetics & Visuals	Air Quality	Noise Quality	Transport & Traffic	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground Water Resources	Ground water quality	Flora & Floral Habitat	Wildlife Habitat	Fauna	Threatened & Endangered species	Migratory corridor & Route	Aquatic Habitat	Aquatic Flora & Fauna	Loss of Livelihood	Conflict on Job opportunity	Disruption of Infrastructure	Common Property Resources	Dust & Noise Discomfort	Loss of Agricultural Productivity	Influx of Population	Cultural & Heritage Site	Job & Economic Opportunity	Occupational Health & Safety	Community Health & Safety
Accidental events-spillage of chemical & oil						M			M		M						M	M											
Decommissioning and Reinstatement																													
Dismantling of rig and associated facilities		L	L																									M	M
Transportation of drilling rig and ancillaries		L	L	M																									M
Removal of well site construction materials & disposal		L	L				M																						
Site Restoration						+						+															+		

5. Analysis of Alternative

Consideration of alternatives to a project proposal is a requirement of the EIA process. During the scoping process, alternatives to a proposal can be considered or refined, either directly or by reference to the key issues identified. A comparison of alternatives helps to determine the best method of achieving the project objectives with minimum environmental impacts or indicate the most environmentally friendly and cost-effective options. The consideration of alternatives is most useful when the EIA is undertaken early in the projects cycle. The type and range of alternatives open for consideration include:

- Site alternatives (e.g. advantage of proposed site, details of any other sites, if explored, etc)
- Input or supply alternatives (e.g. use of raw materials, sourcing, etc)
- Technology alternatives (e.g. feasibility of different technologies available and advantage of proposed technology, etc)
- After analysis of the various factors the most environmentally compatible alternative is selected. Reference may be made to available technologies, policy objectives, social attitudes, environmental and site constraints, projects economic etc.

This section provides an analysis of alternatives in relation to the conception and planning phase of the project. This includes the following:

5.1 No Project Scenario

The no project scenario has been analysed to understand what would be reasonably expected to occur in near future if the proposed development drilling of hydrocarbons and production of hydrocarbon are not conducted in the area. In such a scenario, there would not be any pressure on use of local resources and infrastructure, and no adverse effect on local ecology or incremental pollution to baseline environmental Aspects viz. air, water and noise levels. At the same time, there would not be any positive or beneficial impact on socioeconomic status of the area resulting from direct/ indirect employment and economic benefits that such a project can provide. With no project scenario, dependence of the Nation on import of crude oil and demand for foreign exchange would continue undesirably.

5.2 Alternatives for Project Site

The Block is allocated by the Government of India under the Revenue Sharing Contract (RSC). Vedanta Limited (Division: Cairn Oil & Gas) would be the Operator for this Block. Drilling locations are proposed based on geo-scientific information of the specific Block sites available with MoPNG and alternate sites cannot be considered for the proposed project facilities due to the following reasons:

The location is within the existing RSC boundary of the Block. The surface locations of all wells have been tentatively selected considering the drilling configuration (reach to potential reservoirs).

5.3 Alternatives for Well Location

The seismic data interpretation of the seismic survey would decide the exact locations of the drilling well. The proposed exploratory well site have been identified based on the study and interpretation of the stratigraphy and already available seismic data. Within the identified location the actual well drilling site would be selected based on the following factors:

- Located as far as possible from the nearest human habitation or sensitive receptors
- Located at a safe distance from public road
- Ensure natural drainage channels are avoided or drainage channels rerouted along the periphery to ensure unhindered flow of rain / flood water. Wherever necessary adequate erosion control measures would be provided.

5.4 Alternative of Technology

The technical and process related alternatives are discussed in the following section.

Use of Water Based and Synthetic Based Mud

During drilling operation, drilling mud would be used, which is essential to lubricate and cool drill bits, removal of drilled rock (i.e. cuttings) from the bottom of the hole and transporting it to the surface and maintaining hydrostatic head in the well to counter natural formation pressures.

Drilling mud is basically a suspension / mixture of solids suspended in a liquid phase, which is blended with clays, polymers, salts and weighting agents. The main component/ solvent of drilling fluid are water, oil or synthetic and accordingly they are called as oil-based, water-based, and synthetic-based muds (OBMs, WBMs, and SBMs). All the three types of muds have certain advantages and disadvantages as discussed below.

Though the WBMs is a least cost option and widely used but is not found efficient in high temperature and also for water sensitive substrata, i.e., shales and mud. To overcome these limitations, OBM and SBM are used and of the two, SBM is preferred choice and it may be used in different set of environments like high temperatures, hydratable shales, high-angle, extended-reach wells, high-density mud and drilling through salt.

Table 5.1. Ranks/Comparison of Different Types of Mud

Aspects	Water Based Mud	Oil Based Mud	Synthetic Based Mud
Least Cost	1	2	3
Quantity of Waste discharge	3	2	1
Least Quantity of Water Required for Preparation	3	2	1
Toxicity	1	3	2
Reduced drill time	3	2	1

Note:- 1: Preferable, 2: Less Preferable, 3: Least Preferable

The WBM produces large quantity of drill waste as the mud is not recyclable. Moreover, the clay in WBM absorbs water and expands to disperse into the drilling fluid. These fine clay particles increase mud viscosity and inhibit its upward flow. To lower the mud viscosity, water is added to lower the concentration of fine solids and mud products are added to give the drilling fluid the correct density and flow properties. As a result, large volumes of mud are produced and would be discharged as waste. On the other hand, the OBM and SBM are recycled several times and only drill cutting are disposed off.

The water requirement of SBM is highest as compared to OBM and WBM. Though, OBM are considered more efficient and has wider application in different conditions but recently their use is restricted due to environmental considerations. OBM are considered toxic due to the use of hydrocarbons as solvents and need a proper disposal through land fill. The water-based muds are considered safest in this regard followed by SBM.

If all the three types of mud are compared on the drill time, SBM is far superior then OBM and WBM. The less drill time mean shorter operation and hence less emissions from various drilling equipment and limited engagement of workforce.

The SBMs have the potential to drill wells more quickly and efficiently than WBMs, while avoiding some of the disposal costs and environmental difficulties associated with OBMs.

Water based mud would be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations would be drilled using synthetic base mud (SBM). Synthetic base mud can be re-used. At the end of drilling a well almost the entire amount of the SBM is collected for re-use in next drilling operation. SBM systems promote good hole cleaning and cuttings suspension properties.

5.5 Conclusion

This proposed project is of national importance as it has potential to achieve enhanced fuel security and save on FOREX reserve expenditure. The proposed project would have positive benefits in terms of revenue generation to state and central government as well as increase in job opportunities of primary and secondary types.

Site selection would be carried out taking into consideration the nearest habitation, proximity to any sensitive receptor and natural drainage.

In addition, Vedanta Limited (Division: Cairn Oil & Gas) would ensure that the final site selection is made after due consideration to all environmental conditions as mentioned earlier. Also, use of alternate technology to avoid sensitive locations would be made to the extent possible. Consideration of these alternatives with strict compliance to the Environment Management and Monitoring Plans suggested in the next chapter would ensure minimal adverse impact on the Environment.

6. Environmental Monitoring Programme

Periodic monitoring of environmental parameters is of immense importance to assess the status of environment during pre-drilling, drilling and post drilling stages. With the knowledge of baseline conditions, the monitoring programme would serve as an indicator for any deterioration in environmental conditions due to operation of the project, to enable taking up suitable mitigatory steps in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by monitoring.

Usually, as in the case of the study, an Impact Assessment study is carried over short period of time and the data cannot bring out all variations induced by the natural or human activities. Therefore, periodic monitoring programme of the environmental parameters is essential to consider the seasonal variation and changes in the environmental quality due to project operations.

6.1 Object of Monitoring

The objectives of monitoring are to:

- Verify effectiveness of planning decisions;
- Measure effectiveness of operational procedures;
- Confirm statutory and corporate compliance; and
- Identify unexpected changes.

6.2 Monitoring Schedule

Periodic environmental monitoring schedules are prepared covering various phases of project advancement. This comprises the duration of proposed exploratory drilling as well as post-drilling phase, when the hydrocarbon is established in the wells and production program is undertaken as well as the Decommissioning/Closure Phase. In order to assess the extent and nature of impacts on environment due to drilling operations, the monitoring on various attributes of environment would be carried out during various phases of drilling as under:

Monitoring requirements have been described in the following **Table 6.1.** Frequency of monitoring and responsibility of carrying out the monitoring have also been presented in the table below.

Table 6.1 Proposed Environmental Monitoring Program

Monitoring	Locations	Frequency	Parameters
Ambient Air Quality (AAQ) monitoring	Adequate number of representative locations.	Pre-drilling, during drilling and post-drilling	As per NAAQS and HC, NMHC, H_2S and VOC
D.G. Stack		Once during operation	As per GSR 771 (E) or as specified by Consent to operate issued by State pollution control board (SPCB)
Ambient Noise Level at Fence/ Boundary	Adequate number of representative locations	Pre-drilling, during drilling and post-drilling	Leq (night), Leq (day), Leq (24 hourly)
Work Place noise Monitoring	Monitoring at point sources of noise emissions	During drilling	8 Hourly (TWA)
Sewage Water Quality Monitoring	Treated domestic waste water	Once during operation	pH, TSS, TDS, BOD, COD, oil & grease, faecal coliform (MPN per 100 millilitre, MPN/100ml or as per CTE/CTO issued by SPCB
Ground water monitoring	Adequate number of representative locations.	Pre-drilling and post-drilling	As per IS 10500: 2012
Soil Quality	Adequate number of representative locations.	Pre-drilling and post-drilling	pH, conductivity, texture, bulk density, Ca, Mg, Na, K, P, N, organic matter, organic

Monitoring	Locations	Frequency	Parameters
			carbon, Cl, SO4, sodium absorption ratio, Al, Fe, Mn, Boron, Zn, Hg and PAH
Fresh Synthetic Based Mud (SOBM)	During drilling	One sample / well during drilling	Aromatic content, Toxicity, (LC_{50}, 96 hours)
Fresh Water Based Mud (WBM)	During drilling	One sample / well during drilling	(LC_{50}, 96 hours), Mercury
Barite used for mud preparation	During drilling	One sample / well during drilling	Hg, Cd
Drill cuttings associated with WBM	During drilling	One sample / well during drilling	Oil and grease, (LC_{50}, 96 hours), Hg and parameters for disposal of waste
Drill cuttings associated with SBM	During drilling	One sample / well during drilling	Oil and grease, (LC_{50}, 96 hours), Hg and parameters for disposal of waste
Spent WBM before disposal	During drilling	One sample / well during drilling	(LC_{50}, 96 hours), Hg and parameters for disposal of waste

7. Additional Studies

Based on the TOR specified by the Ministry of Environment & Forest and Climate Change (MoEF&CC) issued vide letter No.IA-J-11011/132/2019-IA-II(I) dated 4th May 2019 for preparation of EIA/EMP Report for proposed Greenfield project, several studies were conducted and planned would be conducted to provide a clear picture of the project area. The studies and activities suggested in EIA Notification includes: -

- Public Hearing and Consultation
- Risk Assessment Study including Disaster Management Plan
- Disaster Management plan

7.1 Public Hearing and Consultation

Public Hearing

As per the Environment Impact Assessment Notification, 2006, and subsequent amendment, a public hearing will be carried out by Assam PCB. This draft EIA report is prepared and submitted to Assam PCB for public hearing.

After completion of the Public Hearing, the applicant shall address all the environmental concerns expressed during this process and make appropriate changes in the draft EIA and EMP Report. The final EIA report, so prepared, shall be submitted by the applicant to MoEF&CC for appraisal.

7.2 Risk Assessment

The objective of the RA study is to identify major risk contributing events, demarcate vulnerable zones and evaluate the nature of risk posed to nearby areas due to proposed drilling activity, in addition to ensure compliance to statutory rules and regulations. The scope of work for the study is described below:

- Identify potential risk scenarios that may arise from the proposed drilling and other associated activities
- Analyse the possible likelihood and frequency of such risk scenarios by reviewing historical accident related data.
- Predict the consequences of such potential risk scenarios and if consequences are high, establish the same by through application of quantitative simulations.
- Recommend feasible preventive and risk mitigation measures as well as provide inputs for drawing up of Emergency Response Plan (ERP) for the project.
- The assessments would be based on various existing documents including Emergency Response Plan (ERP), Disaster Management Plan (DMP).

Quantitative Risk Assessment

"Risk" is defined as the combination of the expected frequency and consequence of accidents that could occur as a result of an activity. Risk assessment is a formal process of increasing one understands of the risk associated with an activity. The process of risk assessment includes answering three questions:

- What can go wrong?
- How likely is it?
- What are the impacts?

Qualitative answers to one or more of these questions are often sufficient for making good decisions about the allocation of resources for safety improvements. But, as managers seek quantitative cost/benefit information upon which to base their decisions, they increasingly turn their attention to the use of QRA. Figure 81 depicts the overall RA process.

QRA is the art and science of developing and understanding numerical estimates of the risk (i.e., combinations of the expected frequency and consequences of potential accidents) associated with a facility or operation. It uses a set of highly sophisticated, but approximate tools for acquiring risk understanding. The Overall approach for the Risk Assessment in brief has been given here with details in the further chapters.

The various steps in the QRA process are described below.

- Hazard Identification
- Consequence Analysis
- Initial Failure Frequency assessment
- Construction of Event Trees
- Calculation of Average Individual Risk
- Risk Assessment and preparation of Risk reduction recommendations

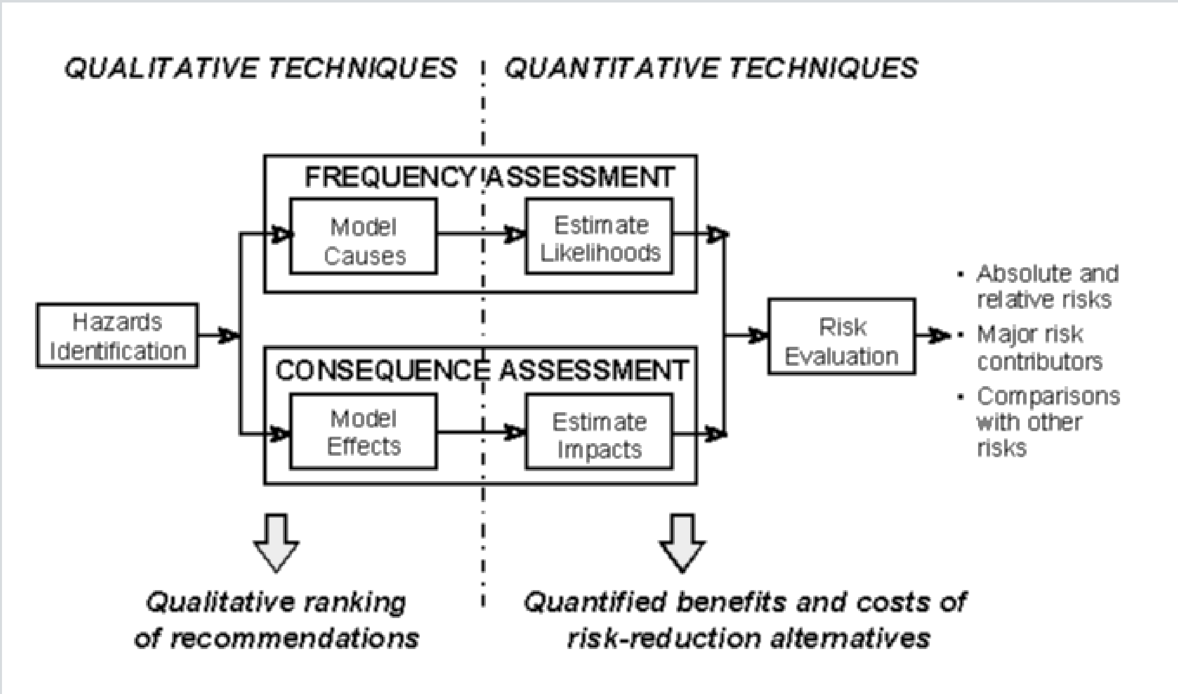


Figure 79. Risk Assessment.

Hazard Identification

This most important section looks into all incidents, which could result in possible fatalities. For drilling, such incidents typically include the following:

- Well fluid releases - small, medium and large well fluid releases from exploratory/appraisal drilling wells. Possibilities include blowouts (due to either downhole or surface abnormality or possible cratering (a basin like opening in the Earth surface surrounding a well caused by erupted action of gas, oil or water flowing uncontrolled)) or other incidents involving drilling fluids, leakage from mud degassing stacks/ vents and others- these are the major category and are deliberated later.
- Possibility of dropped objects on the drilling platform due to lifting of heavy equipment including components like draw works, drilling pipe, tubing, drill bits, Kelly, mud equipment, shale shakers, BOP components, power generating equipment and others.
- Single fatality occupational incidents such as trips and falls. These are more likely in drilling rigs due to the hazardous nature of operations and general high congestion and large extent of the manual operation involved.
- Structural failure of the drilling rig due to excessive static or rotating loads, earthquake, design defect, construction defect etc. It may be noted that rotating loads are induced due to the specific rotating actions of the rotary drilling mechanism (Drill string rotated by means of rotary table etc.).

- Loss of containment of fuels (HSD) and consequent pool fire on encountering an ignition source

The HAZID would select the Scenarios for further modelling in the next sections. The HAZID is derived mainly from incidents in Similar drilling installations based on worldwide experience and includes generic data sources.

Table 7.1. Identification the Accident Event in Oil Well Drilling Activity

Type of Hazardous Event	Specific Accident Events included in QRA
Hydrocarbon Release	Uncontrolled Blow out-medium, large, small
	Release from diesel tanks- Catastrophic failure, medium and small risks
Occupational accidents	Single fatality accidents such as slips, trips, falls, dropped objectives etc.
Structural failure	Structural collapse of drilling rig due to static or rotating load, fatigue, construction defect, design defect, earthquakes etc

Source: Vedanta Ltd.(Division: Cairn Oil and Gas)

Hydrocarbon Release

The events of blow-outs during drilling are divided in the databases according to the consequences and well control success. Such blow outs can be ignited or un-ignited. Blow outs are uncontrolled sudden expulsions of oil, gas, water or drilling fluids from wells to the surface which result in loss of control of the well.

Sources of hydrocarbon release during the drilling phase include the following:

- Dissolved gas which comes out of solution under reduced pressure often while drilling at near balance or under balance hydrostatically or as trip gas during a round trip to pull the drill string around from the hole. Such sources could include releases at bell nipple and around mud return flow line outlet, shale shakers and active mud pits.
- As a “kick”, which occurs as the down hole formation pressure unexpectedly exceeds the hydrostatic head of the circulating mud column. Significant releases can occur from the vent lines of the mud /gas separator and other locations.
- From residual mud on the surface of the drill pipe being racked in the derrick during the round trip, or on production of coil tubing being withdrawn from the hole, or from core samples laid out for inspection. Usually any liquid hydrocarbon system entering the down hole under normal circumstances are very much diluted by the mud system. However, under conditions of under balanced drilling, the proportion of hydrocarbons in mud returns may be significant with a potential for continuous release.
- Small hydrocarbon release from rotating equipment, pipes and pump work occurring during normal operations/ maintenance during drilling. These are not likely would be significant in open derrick or mast structures.
- Possible shallow gas blowout – these may occur at sumps or drainage tanks and be conveyed by vents or drains to areas of potential ignition sources resulting in fire/ explosion.
- Vapour present in oily drainage systems, vents, and ducting.
- Flammable materials used in drilling operations (oil-based drilling fluids)- release points could include high pressure mud points, mud degassing equipment, shale shaker, mud pits and active tanks etc.

Protection against Blowouts

The primary protections against blow outs during drilling are the BOPs or Blow out Preventers. These are used to shut in and control the well in the event of gas or oil being encountered at pressures higher than those exerted by the column of mud in the hole.

BOPs typically consist of 2-3 ram preventers designed at high pressures- (ram preventer is basically a double operated valve with one ram or gate on each side of the bore hole). The BOPs are hydraulically operated with a second remote control panel situated someway away from the rig for use in emergencies when the rig is unapproachable. Connected to the side of the ram type preventers (usually below the blind rams) are the kill and choke lines which are used to control the well in the event of any imbalance between the drilling fluid column pressure and the formation pressure. Both lines are high pressure 2-3-inch hydraulic pipes, the kill line being connected to the mud circulation system and the high-pressure cement pumps and the choke line leading to a back pressure control Manifold and the mud degasser unit.

In the event of the high-pressure kick with the drill string in the hole, the BOP is closed around the drill pipe and the mud is circulated down the drill string and back to the mud tanks through the choke line and back pressure manifold. The manifold consists of a series of valves and chokes - the choke can be adjusted to give the orifice opening required such as to give a back pressure on the well in order to control it. There would be two chokes in order to allow maintenance on one.

If a kick or blow out occurs with the drill string out of the hole, the blind rams are closed, and heavy mud is pumped into the well through the kill line. Any gas can be bled off through the choke line and fluids are usually squeezed back into the formation.

The correct installation of the drilling equipment and the operational reliability of the BOPs are essential for the safety of well drilling operation. In addition, initial and periodic testing of the BOPs, choke and kill manifolds, high pressure/ heavy mud system etc. before installation and periodically is absolutely essential. Most important is the presence of highly trained skilled personnel on the rig! In addition, the use of the correct drilling fluid in the circulatory system is extremely vital.

- The drilling fluid basically does the following:
- To cool and lubricate the drilling bit and the drill string
- To remove drill solids and allowing the release at their surface.
- To form a gel to suspend the drill cuttings and any fluid material when the column is static
- To control sub surface pressures
- To prevent squeezing and caving if formations
- To plaster the sides of the borehole
- To minimize the damage to any potential production zone.

Pressures associated with the sub surface oil, gas or water can be controlled by increasing the specific gravity of the fluid and thereby by reducing the hydrostatic head of the drilling fluid column. The squeezing of formations in the drilled hole can be checked by increasing the hydrostatic head of the drilling fluid. Special additives for the drilling fluid for controlling viscosity, lubricating properties, gelling properties etc. play an important role in the drilling fluid integrity. Sealing agents such as cellulose, mica can also be added to make up the drilling fluid loss into the porous and fractured formations.

The historical records show that the drilling of an exploration well has a higher chance of blow out occurring than does drilling a development well. A blow out can be expected for about 400 exploration wells drilled. As a well takes about 20-25 days to drill this equates to one blow out approximately every 50 years if drilling was continuous. Historically, ignited blowouts have caused an average of three deaths per blow out.

Release of the other flammable material

HSD is used in the mobile generators at the drill sites to cater to the power requirement of the drill equipment, area lighting, etc. The material would be stored in 180 MT vertical cylindrical tank. Spill containment system in the form of 1.2m high bund wall is envisaged to contain 110% of the tank volume. Storage of fuels would primarily pose fire hazard. The credible accident scenarios include:

- Catastrophic tank rupture (Large Leak)
- Leak from a 4” pipeline (Medium Leak)
- A 2” leak from the tank/pipe/flange (Small Leak)

The catastrophic Rupture (CR) of the tank would involve a large leak/big hole in the tank or disengagement of a joint/large leak from a flange sufficient enough to discharge tank inventory in a short time. The spilled material shall get contained within the dyke area. In presence of an ignition source, it may catch fire and result in Pool fire of the dyke area.

A 4” leak from a pipeline or a flange shall have similar consequences as to CR, only the time for loss of containment may be more. Fire being a surface phenomenon, the pool fire in the dyke area would pose similar heat radiation to the surrounding area.

A 2" leak from the tank or the pipeline would result in the loss of inventory at a much-reduced rate. Counter-measures shall be available to arrest the leak within reasonable time. With a limited loss of inventory, the damage distances in such case would be less in comparison to the above two cases.

The tank design and construction take into account the possible stress loads imposed due to exploration and appraisal activities at the drill site. Dyke with adequate capacity (110%) is being provided to contain the spill, if any. Standard well area inspection and maintenance procedures of Vedanta Limited (Division: Cairn Oil and Gas) would be implemented at the exploratory and appraisal wells to identify any abnormalities.

Consequence Analysis/Calculations

Consequence analysis involves the calculation of the initial "release rate" and then predicting the consequence of the release through computer modelling- it forms an important ingredient in the QRA approach. Consequence analysis is a complex procedure involving numerous calculations. It must also be noted that a single starting incident could have numerous outcomes depending upon factors such as escalation, ignition and others.

The various factors of importance in this drilling rig study with respect to consequence analysis are described below.

Loss of Containment- leak sizes

It must be understood that there are an infinite range of possible releases of flammable material on the facilities for example, a hole could appear at any point in a well, at any time of the year and the hole could have any size (right from pinhole to catastrophic line guillotine rupture) and also possibly any shape! In order to allow management of the study, it is per force necessary to divide the infinite range into a number of smaller ranges through representation as a single event or a failure case.

In the study, only small, medium and large well fluid blowouts were considered.

Hydrocarbon Leaks due to Loss of Containment (Leak during Well Testing) were not taken into consideration since they are likely would be controlled about 95% of the time. The category includes releases that may be isolated from the reservoir fluids, typically release from the well testing equipment and mud line.

Inventory

Inventory can get discharged to Environment due to Loss of Containment. Inventory Analysis is commonly used in understanding the relative hazards and short listing of release scenarios and plays an important role in regard to the potential hazard. The larger the inventory of a vessel or a "system", the larger the quantity of potential release. The potential release depends upon the quantity of release, the properties of the materials and the operating conditions (pressure, temperature etc. described later).

Blowouts

A blowout on the topsides may take one of several forms and release locations. Any release not immediately ignited would give a flammable vapour cloud, which could cause a vapour cloud explosion in the drill floor or the mud pit areas.

A pressurized jet release could lead to a very large jet fire, producing high levels of thermal radiation. The flame could impinge on structural members in the derrick. These could then fail as they lose their mechanical properties at high temperature. This may lead to objects falling from the derrick and causing more damage below, especially if the derrick has already been weakened by the blast from a vapour cloud explosion. If the fire continues for a long period (say one to two hours) then the derrick may collapse causing serious damage to surrounding areas. However, evacuation is expected to have occurred by any available means before this time.

This scenario is a worst-case scenario, which is unlikely to happen in this situation as the bottom hole pressure is low.

Unburnt oil from a potential blowout would typically form running or evaporating pools, which could create a hazard from heat and smoke in all areas that the pools reach. If the blow out originates on the drill floor, then the burning oil would run over the side of the drill floor.

Consequence Analysis for Blowouts

Blowout release rate is taken as 0.12 kg/s assuming 5 times the normal rate from the well. It is expected that the uncontrolled release of fluids on the drill floor would ignite almost immediately and that the resulting fire would engulf the drill floor. Higher ignition probabilities are expected for large releases compared to smaller releases. The flames are likely to impinge on structural members on the drill floor. These may fail as they lose their mechanical properties at high temperature. This may lead to objects falling from the derrick and causing more damage below. If the fire continues for a long period.

Weather Conditions

The weather stability class is normally Class D on sunny days and Class F for Night time. The average wind speed most of the time is 5 m/s for day time and 1.5 m/s. combining this with stability class D and F, consequence modelling is done for both the weather cases 5 D and 1.5 F. The ambient condition considered in this study is as under:

Average Ambient Temperature = 24˚C

Average Humidity = 80 %

The six representative weather classes on which the analysis is based are detailed in Table 7.3 below

Table 7.2. Pasquill Stability Class

Surface Wind Speed (m/s)	Daytime Conditions Strength of Sunlight			Night Sky	
	Strong	Moderate	Slight	Thin Overcast ≥ 4/8 Cloudiness**	≤3/8 Cloudiness
< 2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
> 6	C	D	D	D	D

*Applicable to heavy overcast conditions day or night

**Degree of Cloudiness = Fraction of sky above horizon covered by clouds.

A- Extremely Unstable Conditions

B- Moderately Unstable Conditions

C- Slightly Unstable Conditions

D- Neutral Conditions*

E- Slightly Stable Conditions

F- Moderately Stable Conditions

In its original form, the Pasquill system contains seven categories (A to F) but joint categories are also common. Categories A (Very Unstable), D (Neutral) and F (Very Stable) are discussed next.

Category A (very unstable) occurs typically on a warm sunny day with light winds and almost cloudless skies when there is a strong solar heating of the ground and the air immediately above the surface. Bubbles of warm air rise from the ground in thermals. The rate of change (decline) of temperature with height (lapse rate) is very high.

Category D (neutral) occurs in cloudy conditions or whenever there is a strong surface wind to cause vigorous mechanical mixing of the lower atmosphere.

Category F (very stable) occurs typically on a clear, calm night when there is a strong cooling of the ground and the lowest layers of the atmosphere by long wave radiation. There is a strong inversion of temperature (i.e. warm air over cold air).

Table 7.3. Representative Weather Class 5D and 1F

Weather Class	Wind Speed(m/s)	Pasquill Stability
I	3	B
II	1.5	D
III	5	D (used for modelling)
IV	9	D

Weather Class	Wind Speed(m/s)	Pasquill Stability
V	5	E
VI	1.5	F (used for Modelling)

Source: Handbook of Chemical Hazard Analysis Procedure by FEMA, USEPA and USDOT

Damage Criteria

Jet Fire

The consequence caused by exposure to heat radiation is a function of:

- The radiation energy onto the human body [kW/m^2];
- The exposure duration [sec];
- The protection of the skin tissue (clothed or naked body).

It can be assumed that people would be able to find a cover or a shield against thermal radiation in 20 seconds time. Furthermore, 100% lethality may be assumed for all people suffering from direct contact with flames, such as the pool fire, a flash fire or a jet flame. The effects due to relatively lesser incident radiation intensity are given below.

In the study, the following criteria were used for estimation of heat radiation due to fire fatalities:

Heat Radiation Selection Criteria:

- 4.73 kW/m^2: Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding but with appropriate clothing. Corresponds to of painful burns and blistering after 20 second exposure (0% lethality)
- 6.31 kW/m^2: Indicative of second degree burns after 20 second exposure (1% fatality)
- 12.5 kW/m^2: Indicative of piloted ignition for susceptible structures (50% fatality)
- 37.5 kW/m^2: Indicative of total asset loss (100% fatality

Flash Fire Selection Criteria:

The consequence distances would be identified for the following Lower Explosive Limit:

- 50 % Lower Explosive Limit
- 100 % Lower Explosive Limit

Toxic Gas Dispersion Criteria:

No Toxic gas dispersion scenarios envisaged for this project.

Explosion Criteria:

Blast peak overpressure from explosion for buildings would not exceed the following levels provided in Table-7-5. Internationally recognized and globally accepted TNO Multi energy model was used for the explosion modelling for this Project.

Table 7.4 Overpressure Criteria

Level of Concern	TYPE OF DAMAGE
0.02068 bar	"Safe distance" (probability 0.95 of no serious damage1 below this value); projectile limit; some damage to house ceilings; 10% window glass broken.
0.070 bar	General buildings, offices
0.1379 bar	Partial collapse of wells, concreate Block wells, not reinforced, shattered
0.2068	bar
1 bar	Range for 1-99% fatalities among exposed population due to direct blast effects

Source: Report Number : 434 International Association of Oil & Gas Producers (OGP)- March 2010- Table 2.8 and PHL-S-100

Failure Frequency Analysis

Selection of Failure Scenarios

Potential release rates for a material from containment depend significantly on the initial operating conditions. Factors affecting the “release rate” include the initial pressure, temperature, hole size, hole roughness, hole orientation, gas properties, atmospheric conditions and many other parameters.

Both, the complexity of study and the number of incident outcome cases are affected by the range of initiating events and incidents covered. This not only reflects the inclusion of accidents and / or non-accident-initiated events, but also the size of those events. The following four scenarios have been quantitatively evaluated in the study:

- Small and medium size holes - these typically represent failures such as gasket leaks, flange leaks etc. This scenario has been considered as 2” leak for HSD
- Medium leaks – these typically represent disengagement of flanges, full bore failure of pipelines, large leaks from flanged joints, etc. This scenario has been considered as a 4” leak of HSD.
- Large holes– these typically represent “catastrophic” or “guillotine” rupture scenarios, possibly on account of factors such as soil inundation, earthquakes etc. This scenario has been considered as a Catastrophic Failure of HSD Tank.
- Well Blow out case. This has been considered as Well Blow out scenario involving crude oil

The selection of initiating events and incidents would take into account the goals or objectives of the study. The main reasons for including release sizes other than the catastrophic are to reduce the conservatism in an analysis and would better understand the relative contributions to risk of small versus large releases. Only leakage events leading to possibility of serious injury are considered in the study.

Calculation of Individual & Societal Risk

Individual Risk or IR represents the geographical distribution of risk to any individual.

Societal Risk is representing the risk the project poses to society as a whole. The Societal Risk or Group risk (F-N) curves indicate the cumulative frequency (F) of (N) number of fatalities. Society is typically not willing to accept industrial installations that result in many fatalities, even with a low frequency rate!

The estimation of risks in the software is done through estimation of “risks” attributed to each failure case by determining the impact in terms of fatalities. In this step, the hazard or effect zone information, ignition source, population distribution, meteorological data and other relevant details are combined to determine risks.

In order to estimate risks (IR or SR), the number of fatalities for each incident outcome case is calculated and the frequencies of outcomes with equal fatalities summed up.

Comparison to Risk Acceptance Criteria

This penultimate step compares the estimated risk with respect to the Company’s internal risk acceptability criteria or specific legislative or regulatory (as applicable in the country of operation) risk acceptability criteria. In this step, the risk “band” is determined- typically, the project risk band is determined would be negligible, acceptable, not acceptable are the risk assessment stage determines whether the risks are “Broadly Acceptable”, “Intolerable” or “Tolerable if ALARP”.

Vedanta Limited (Division: Cairn Oil & Gas) Risk Acceptability Criteria

Vedanta Limited (Division: Cairn Oil & Gas) risk acceptability criteria are derived from interpretation of the risk acceptability criteria published by UK HSE-92 and is applied when assessing the tolerability of risk to persons for Vedanta Limited (Division: Cairn Oil & Gas) facilities, sites, combined operations or activities. It broadly indicates as follows:

- Individual risk to any worker above 10^{-3} per annum shall be considered intolerable and fundamental risk reduction improvements are required.
- Individual risk below 10^{-3} for but above 10^{-6} per annum for any worker shall be considered tolerable if it can be demonstrated that the risks are As Low As Reasonably Practicable (ALARP).

- Individual risk below 10^{-6} per annum for any worker shall be considered as broadly acceptable and no further improvements are considered necessary provided documented control measures are in place and maintained.
- Individual risk to any member of the general public as a result of Vedanta Limited (Division Cairn Oil & Gas) Businesses activities shall be considered as intolerable if greater than10-4 per annum, broadly acceptable if less than 10-6 per annum and shall be reduced to As Low As Reasonably Practicable (ALARP) between these limits.
- For new facilities, Vedanta Limited (Division Cairn Oil & Gas) shall strive to achieve lower risks compared with that typical for existing facilities, down at least to an individual risk to any worker of 10-4 per annum, by the appropriate use of best practice including technology and management techniques.
- For existing facilities, higher risk levels may be tolerated provided that they are As Low As Reasonably Practicable (ALARP) and meet the minimum standards given herein. As facilities under Vedanta Limited (Division Cairn Oil & Gas) expansion may be considered as “new” facilities; it is proposed that individual risk to any worker above 10-4 per annum shall be considered intolerable.

The risk acceptability criteria are indicated in the following pages.

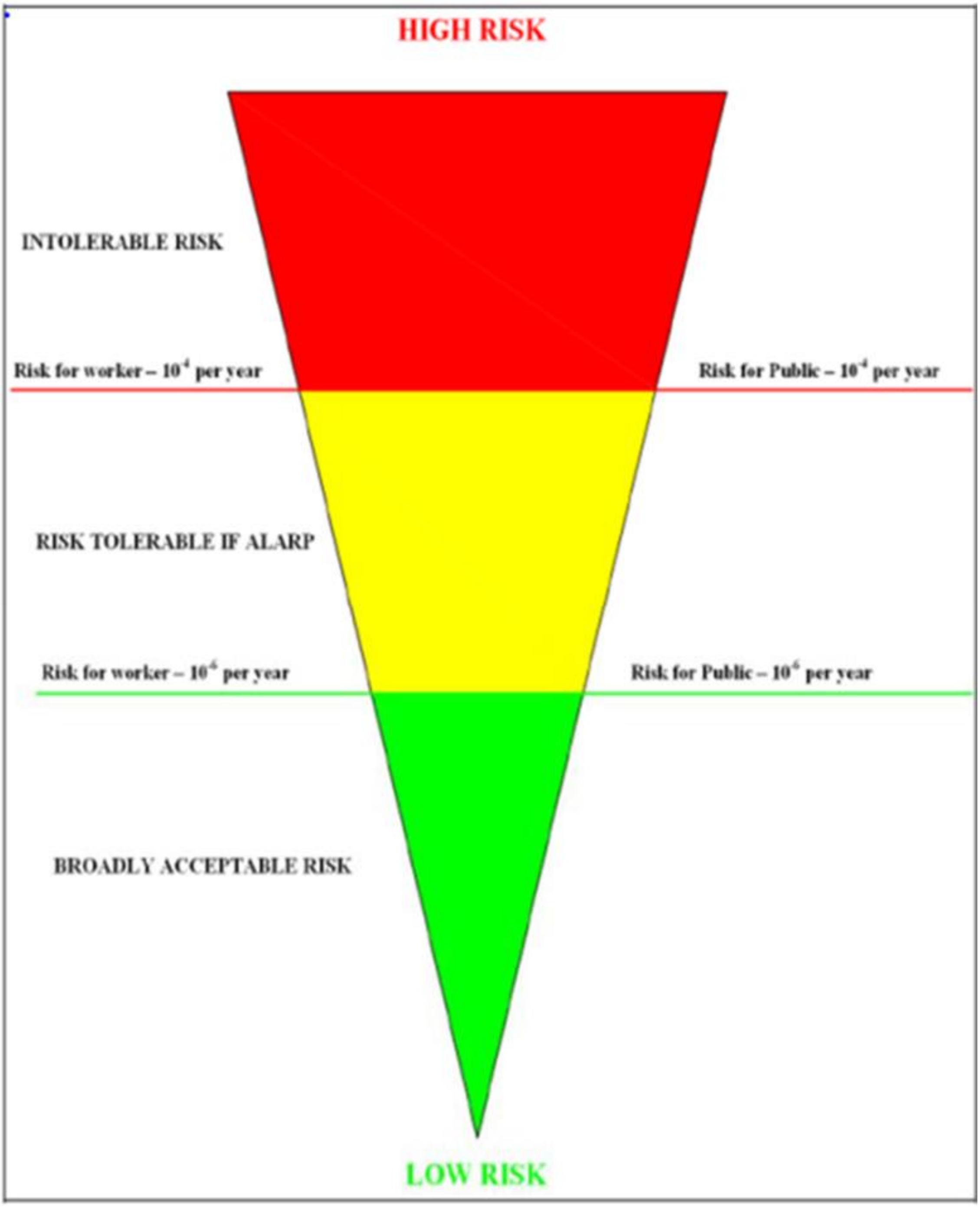


Figure 80. UK HSE-Individual Risk Criteria

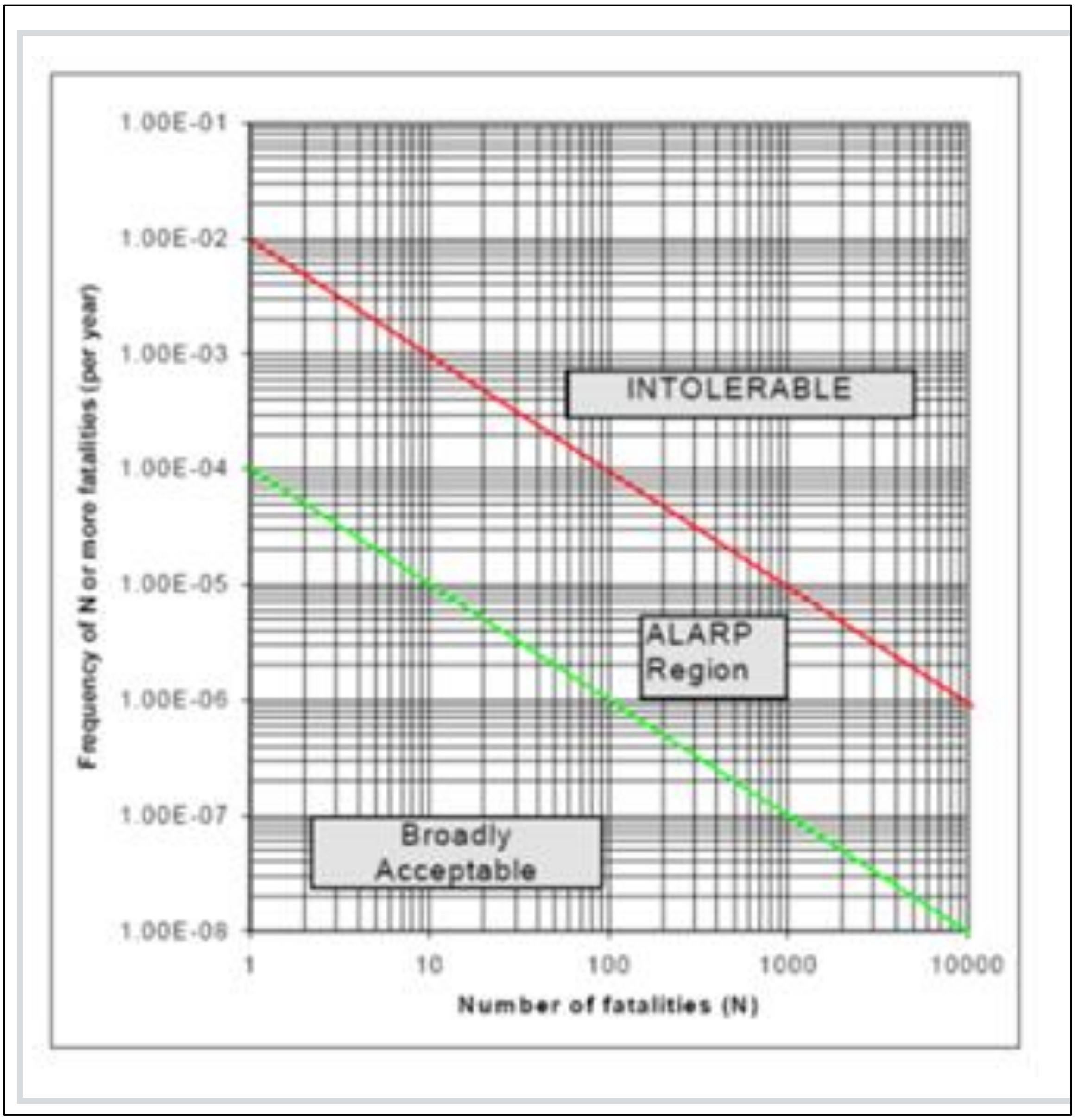


Figure 81. UK HSE-Offsite Group Risk Criteria.

ALARP Demonstration

Wherever risks are found to lie in the ALARP region, this suggests existing risk mitigating measures must be sustained and Best Industry Practices used. Any specific new risk reduction options may be evaluated through Cost Benefit Analysis (CBA).

Risk Reduction Recommendations

This step analyses the risks estimated, their tolerability with respect to the risk acceptability criteria.

In case risks are found to fall in the "Unacceptable" region, risk reduction recommendations aimed at bringing risks to within the "Tolerable region if ALARP" are proposed. In such conditions, the Cost Benefit Analysis (CBA) is also carried out for specific risk reduction measures in order to "quantify" them or any other mitigative measures shall be recommended.

In case risks have been found would be the ALARP or Broadly Acceptable region, recommendations may still be suggested for generic risk reduction based on industry best practice. Such risk reduction recommendations are not "quantified" or mandatory but are nevertheless proposed for safer operation of the facilities.

Software Used

The Software, DNV PHAST was used for the study for assessing the Risk and Consequence calculations.

Population

Table 7.5 Population

S. No	Area	Population (Day)	Population (Night)
1	Process Area (Heater Treater, Fuel Gas, Coalesing Fiilter etc.)	25	25
2	Process Area (Oil Storage Area, Instrument Air etc.)	5	5
3	Loading, Unloading Area	2	2
4	Operator Bunker	2	2
5	Diesel Storage Area	2	2
6	Waster Area (Water, SBM etc.)	15	15
7	Toilet Block	2	2
8	Drilling/ Well Area	40	40

Hazard Identification (HAZID), Consequence Analysis and Risk Results for the Project

Hazard Identification is a very important and critical first step in the QRA process. The HAZID identifies process and non-process hazards affecting the project execution and operational stage. The main objective of the HAZID is to identify potential major accident events- it is important to ensure scenarios identified in the HAZID are factored into the QRA.

Shortlisting of Release Scenarios

The range of incidents possible in the facility is established through identification of “Isolatable sections”, from which the different categories of leakages/ releases may occur. The Isolatable Sections comprise those where Emergency Shutdown Valves are in place isolating the section, even in emergency. Assumption Meeting for the purpose of identifying such sections and estimating inventories, release rates and other details relevant to the quantitative analysis. Guideline was utilized for deriving failure scenarios, release rates, inventories etc. Isolatable Sections are identified as follows:

- The initial step is the identification of sources and their physical location
- Calculation of the hold-up volumes within isolatable sections with respect to fluid within equipment and associated piping.

The process isolation times, inventory release times etc. for the various leak sizes considered were taken at 5 minutes for small leaks (5 mm), 3 minutes for minor leaks (25 mm)- safe distance can be used for layout purpose 2 minutes for large leaks and 1 minute for catastrophic rupture.

Appendix 7.1 shown provides information on leak sizes, inventories and hazardous chemicals within the isolatable sections.

Consequence Analysis Results

Events originating from within the facility may, depending upon the nature and quantity of hazardous chemical and the location of accident have the potential of affecting personnel within the installation or at times the general population in the surrounding area.

Table 7.6 Pool Fire Results

SECTION	LEAK SIZE	Weather Class	Incident Heat Radiation (KW/m2)			
			4.73	6.31	12.5	37.5
			Distance in Meter (m)			
IS-01 - From Well Fluid from Well to Inlet of Heater Separator	5mm	DAY TIME (5/D)	19	18.5	17.4	-
		NIGHT TIME (1.5/F)	18.5	17	13.5	-
	25mm	DAY TIME (5/D)	79	76	71	65
		NIGHT TIME (1.5/F)	88	80	65	47
	100mm	DAY TIME (5/D)	282	270	243	218
		NIGHT TIME (1.5/F)	310	232	222	160
	CR	DAY TIME (5/D)	545	505	455	395
		NIGHT TIME (1.5/F)	590	530	415	308
IS-02 Heater Treater Separator – Oil Case	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	37	36.5	36	26
		NIGHT TIME (1.5/F)	25	24.8	23	11
	100 mm	DAY TIME (5/D)	96	93	89	83
		NIGHT TIME (1.5/F)	72	69	65	59
	CR	DAY TIME (5/D)	150	145	135	120
		NIGHT TIME (1.5/F)	112	110	98	86
IS-03 Heater Treater Separator – Gas Case	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	100mm	DAY TIME (5/D)	22.1	21.1	17.9	-
		NIGHT TIME (1.5/F)	20.4	18.4	14.3	-
	CR	DAY TIME (5/D)	42	41.2	39	35.2
		NIGHT TIME (1.5/F)	38.8	36.2	28.9	13.8
IS-04 Oil from Heater Treater Separator to inlet of Oil Storage Tanks including coaleser separator	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	32.8	32	31	-
		NIGHT TIME (1.5/F)	24.2	23.5	22.5	20.5
	100mm	DAY TIME (5/D)	95	93	88	83
		NIGHT TIME (1.5/F)	70	67	63	58
	CR	DAY TIME (5/D)	110	107	102	97
		NIGHT TIME (1.5/F)	85	81.5	76.5	71
IS-05- From XSV of tank inlet to pump inlet including oil storage tank	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	30.6	32	30.6	28.4
		NIGHT TIME (1.5/F)	23	22	-	-
	50mm	DAY TIME (5/D)	50	49.5	47	43.2
		NIGHT TIME (1.5/F)	38	37	35	31.2
	CR	DAY TIME (5/D)	103	100	96	90
		NIGHT TIME (1.5/F)	78	74	70	64
	5mm	DAY TIME (5/D)	-	-	-	-

SECTION	LEAK SIZE	Weather Class	Incident Heat Radiation (KW/m2)			
			4.73	6.31	12.5	37.5
			Distance in Meter (m)			
IS-06 From Oil Transfer pump outlet to tanker loading Facility		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	60	58	55	52
		NIGHT TIME (1.5/F)	39.2	37.5	33	23.5
	100mm	DAY TIME (5/D)	135	132	124	116
		NIGHT TIME (1.5/F)	112	107	92	78
IS-07 Tanker Failure	CR	DAY TIME (5/D)	60	58	56	55
		NIGHT TIME (1.5/F)	46	45	43	41
IS-08 Diesel Storage Tank	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	50mm	DAY TIME (5/D)	15.7	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	CR	DAY TIME (5/D)	24.3	23.3	-	-
		NIGHT TIME (1.5/F)	16.2	14.4	-	-
IS-09 Fuel Gas System	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	100mm	DAY TIME (5/D)	22.1	21	17.7	-
		NIGHT TIME (1.5/F)	20.4	18.4	14.3	-
	CR	DAY TIME (5/D)	42.8	41.2	39.1	36.2
		NIGHT TIME (1.5/F)	38.9	35.2	29	13.8
IS-10-Flare System	5mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	25mm	DAY TIME (5/D)	-	-	-	-
		NIGHT TIME (1.5/F)	-	-	-	-
	100mm	DAY TIME (5/D)	14.6	-	-	-
		NIGHT TIME (1.5/F)	13.8	12.1	-	-
	CR	DAY TIME (5/D)	31	30.2	28.5	-
		NIGHT TIME (1.5/F)	29	26.5	21	-

Table 7.7 Flash Fire Result

Section	Leak Size	Level of Concern	Weather Class	
			(5/D)	(1.5/F)
IS-1 - From Well Fluid from Well to Inlet of Heater Separator	**5mm**	50% LEL-5102 ppm	12.2	25
		100 % LEL- 1.02e+004ppm	8.5	11
	25 mm	50% LEL-5102 ppm	145	259
		100 % LEL- 1.02e+004ppm	88	100
	100 mm	50% LEL-5102 ppm	400	420
		100 % LEL- 1.02e+004ppm	320	320
	CR	50% LEL-5102 ppm	475	478
		100 % LEL- 1.02e+004ppm	390	380

Section	Leak Size	Level of Concern	Weather Class	
			(5/D)	(1.5/F)
IS-2 - Heater Treater Separator – Oil Case	5mm	50% LEL-3123 ppm	6.5	6.5
		100 % LEL- 6245 ppm	5	6.4
	25 mm	50% LEL-3123 ppm	20	26
		100% LEL- 6245 ppm	19	14
	100 mm	50% LEL-3123 ppm	70	65
		100 % LEL- 6245 ppm	40	42
	CR	50% LEL-3123 ppm	102	90
		100 % LEL- 6245 ppm	68	60
IS-03-Heater Treater Separator – Gas Case	5mm	50% LEL-1.769e+004 ppm	1.25	1.72
		100% LEL- 3.538e+004 ppm	0.82	0.98
	25 mm	50% LEL-1.769e+004 ppm	4.8	6.9
		100% LEL- 3.538e+004 ppm	3.3	4.4
	100mm	50% LEL-1.769e+004 ppm	14.5	22.2
		100% LEL- 3.538e+004 ppm	10	14.4
	CR	50% LEL-1.769e+004 ppm	29	43
		100% LEL- 3.538e+004 ppm	17.5	27.5
IS-04 - Oil from Heater Treater Separator to inlet of Oil Storage Tanks including coalescer separator	5mm	50% LEL-3123 ppm	6.3	6.6
		100 % LEL- 6245 ppm	5	6.4
	25 mm	50% LEL-3123 ppm	14	23.9
		100% LEL- 6245 ppm	13.9	12.2
	100mm	50% LEL-3123 ppm	58	55
		100 % LEL- 6245 ppm	27	31
	CR	50% LEL-3123 ppm	73	64
		100 % LEL- 6245 ppm	44	44
IS-05 - From XSV of tank inlet to pump inlet including Oil Storage Tank	5mm	50% LEL-3123 ppm	7	7.6
		100 % LEL- 6245 ppm	5.3	6.9
	25 mm	50% LEL-3123 ppm	15.2	21
		100 % LEL- 6245 ppm	15	12.3
	50 mm	50% LEL-3123 ppm	35	44
		100 % LEL- 6245 ppm	15	25.8
	CR	50% LEL-3123 ppm	70	64
		100% LEL- 6245 ppm	43	46
IS-06 - From Oil Transfer pump outlet to tanker loading Facility	5mm	50% LEL-3123 ppm	9.5	13.2
		100% LEL- 6245 ppm	7.2	9.5
	25 mm	50% LEL-3123 ppm	58	35
		100% LEL- 6245 ppm	44	34.5
	100 mm	50% LEL-3123 ppm	73	75
		100% LEL- 6245 ppm	71	58
	CR	50% LEL-3123 ppm	191	0.57
		100% LEL- 6245 ppm	165	0.57
IS-07 - Oil Tanker Failure	CR	50% LEL-3123 ppm	42	32.5
		100% LEL- 6245 ppm	24	22
	5mm	50% LEL-3500 ppm	6.6	5.9

Section	Leak Size	Level of Concern	Weather Class	
			(5/D)	(1.5/F)
IS-08 - Diesel Storage Tank		100 % LEL- 7000ppm	5	5.4
	25 mm	50% LEL-3500 ppm	10.4	9.5
		100% LEL- 7000ppm	10.3	9.5
	50 mm	50% LEL-3500 ppm	11.8	12.2
		100 % LEL- 7000ppm	11.8	11.8
	CR	50% LEL-3500 ppm	13.9	13
		100 % LEL- 7000ppm	13.9	13
IS-09 - Fuel Gas System	5mm	50% LEL-1.769e+004 ppm	1.25	1.71
		100 % LEL- 3.538e+004ppm	0.82	0.98
	25 mm	50% LEL-1.769e+004 ppm	4.9	6.8
		100% LEL- 3.538e+004ppm	3.3	4.4
	100mm	50% LEL-1.769e+004 ppm	14.5	22.4
		100% LEL- 3.538e+004ppm	10	14.3
	CR	50% LEL-1.769e+004 ppm	29	43
		100 % LEL- 3.538e+004ppm	17	27.5
IS-10 - Flare System	5mm	50% LEL-1.769e+004 ppm	1.04	1.2
		100 % LEL- 3.538e+004ppm	0.56	0.62
	25 mm	50% LEL-1.769e+004 ppm	3.7	5
		100 % LEL- 3.538e+004ppm	2.48	3.2
	100mm	50% LEL-1.769e+004 ppm	11.3	16.5
		100 % LEL- 3.538e+004ppm	8.4	10.8
	CR	50% LEL-1.769e+004 ppm	19.2	32
		100% LEL- 3.538e+004ppm	13.9	20

Table 7.8 Fireball Result

SECTION	LEAK SIZE	Weather Class	Incident Heat Radiation (KW/m2)			
			4.73	6.31	12.5	37.5
			Distance in Meter (m)			
IS-02	CR	DAY TIME (5/D)	365	312	215	95
		NIGHT TIME (1.5/F)	365	312	215	95

TNO Multi energy model has been used for the study and explosion is not envisaged for the desired overpressure levels (0.0268, 0.070, 0.1379,0.2068 and 1 bar)

Risk Calculation

Risk Calculation is done by combining the Consequence Analysis results given vide section 7.2.15 with the estimated failure frequency and estimates of population within and outside the facility. However, other key study assumptions were discussed with Vedanta Limited (Division: Cairn Oil & Gas).

Population

The following plant population has been assumed for the study:

Table 7.9 Population

S. No	Area	Population (Day)	Population (Night)
1	Process Area (Heater Treater, Fuel Gas, Coalesing Fiilter etc.)	25	15

S. No	Area	Population (Day)	Population (Night)
2	Process Area (Oil Storage Area, Instrument Air etc.)	5	2
3	Loading, Unloading Area	2	1
4	Operator Bunker	2	1
5	Diesel Storage Area	2	1
6	Waster Area (Water, SBM etc.)	15	7
7	Toilet Block	2	0
8	Drilling/ Well Area	40	10

FN Curve

The FN Curve drawn for this project is presented below. The FN Curve represents combined risk (during 5/D and 1.5 F) covering all the identified scenarios.

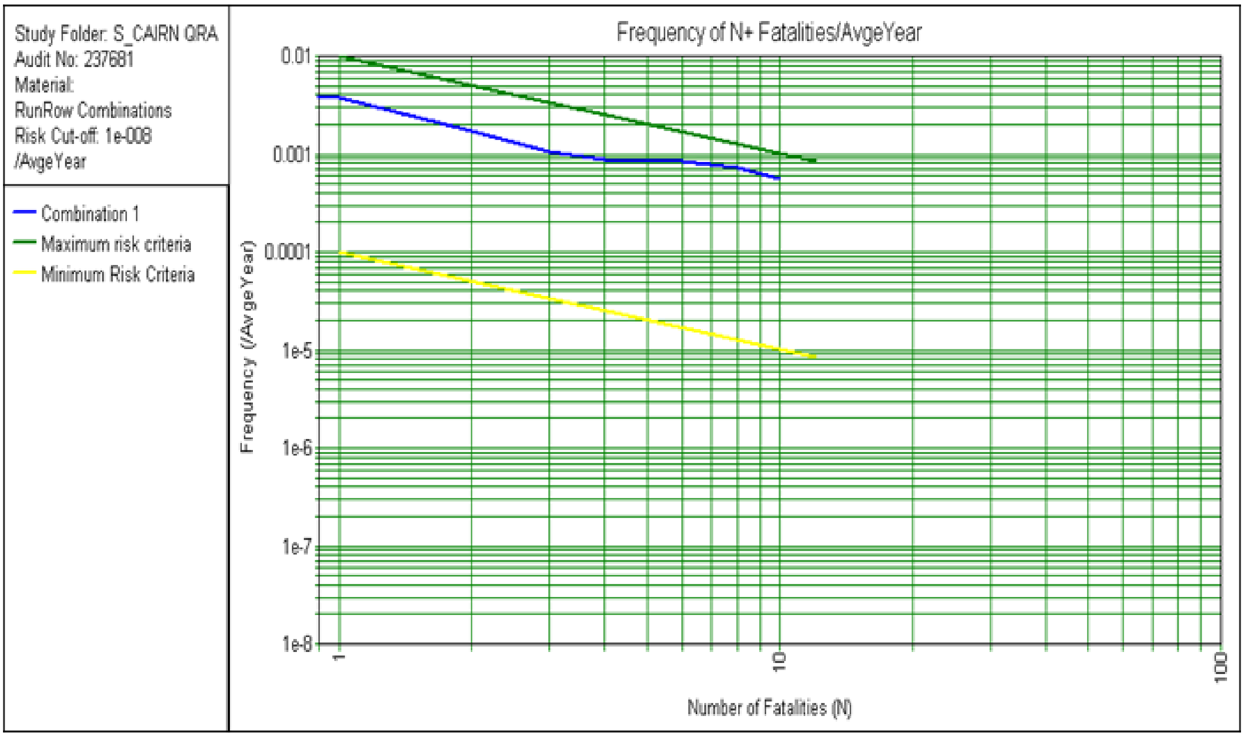


Figure 82. . FN Curve

From the above F-N Curve, it may be seen that the maximum line starts at 1E-02 and 1E-04 and it is observed that the integrated risks lie within the 1E-02 and 1E-04, Hence the risk is in “ALARP” range. -this suggests that existing risk mitigating measures must be sustained and other Best Industry Practices shall be used. Any specific new risk reduction options may be evaluated through Cost Benefit Analysis (CBA) or any other suitable means.

Location Specific Individual Risk (LSIR)

LSIR is the risk for a hypothetical individual who is positioned at that location for 24 hours a day 365 days per year. Since in reality people do not remain continuously at one location, LSIR is a notional risk measure.

From the below figure (combined during 5/D and 1.5 F) it can be seen that the maximum risk level lies in the band of 1E-003 /Avg year (within the fence) and 1E-004 /Avg year –this risk band extends towards the west for a distance of approx. 20 meters from the plot boundary. It may be noted that this risk level is on the higher side for public areas (normally acceptable risk level is 1E-006/Avg year). It is suggested that either heater treater unit, Coalescing filter skid and Fuel gas unit may be shifted 20 meters towards east to prevent any outside risk or to ensure there are no vegetating in this area.

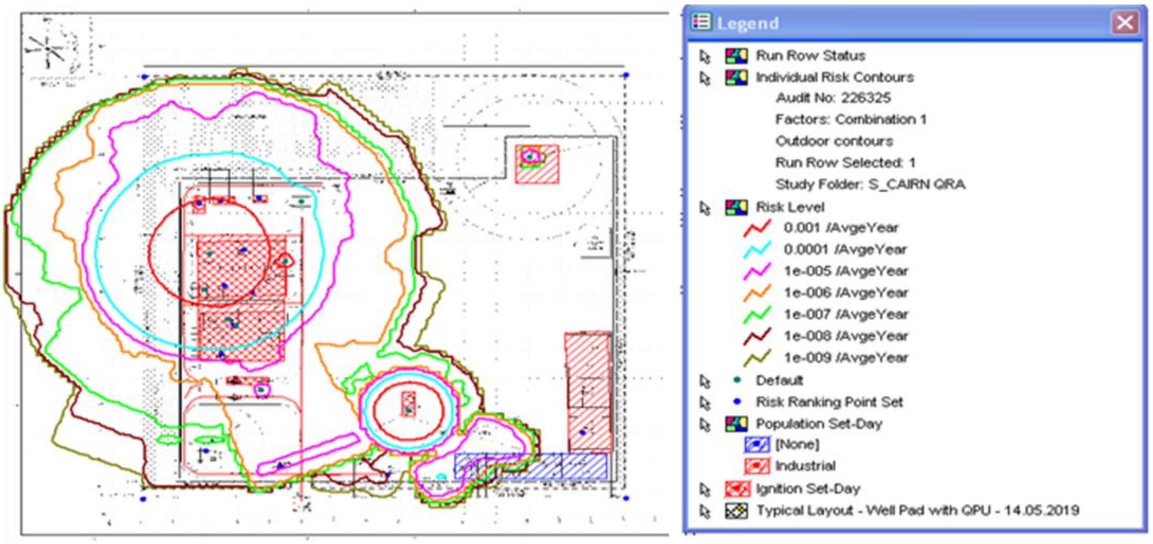


Figure 83. Overall ISO Risk Contour.

Location Specific Individual Risk (ISIR)

The Location Specific Individual Risk is the risk to a person who is assumed would be at the specific location 365 days a year and 24 hours a day. A more representative risk measure is the "Individual Specific Individual Risk (ISIR). This is the risk estimated accounting for the time fraction a person actually spent at a specific location. The calculation for this is done based on the consideration of Personnel working. An average working period of 12 hours per day are considered and the results are presented below in table 7.10.

- ISIR= LSIR×1/2×1/2×Time Spent/12

Table 7.10 Total ISIR Operations/Maintenance Staff

S. No	Area	LSIR	Time Spent in hrs	ISIR
1	Coalescer Area	2.12E-03	6	2.65E-04
2	Control Room	1.14E-03	9	2.14E-04
3	DG Area	7.12E-04	1	1.48E-05
4	Diesel Area	3.87E-04	3	2.42E-05
5	Flare Area	1.12E-04	0.5	1.17E-06
6	Heater Treater Area	5.64E-03	6	7.05E-04
7	Loading Area	1.99E-05	2	8.28E-07
8	Oil Storage Area	6.71E-04	5	6.99E-05
9	Well Area	5.86E-03	4	4.88E-04
10	Fuel Gas Area	2.02E-03	5	2.10E-04
	Total			3.44E-06

Table 7.11 Total ISIR Non-Operation/ Maintenance Staff

S. No	Area	LSIR	Time Spent in hrs	ISIR
1	Fire Water Area	1.29E-08	2	5.38E-10
2	Toilet Block	1.29E-08	1	2.69E-10
3	Security Cabin	1.00E-07	10	2.08E-08
4	Operator Block	1.00E-07	4	8.33E-09
	Total	3.00E-08		

From the above values it is seen that the operation/maintenance ISIR value is in ALARP range for operation person and broadly acceptable for Non-operation. The following measures are available to address the same.

- Safeguarding of human life is Cairn Oil & Gas top most priority. To this effect, Vedanta Limited (Division Cairn Oil & Gas) has issued and implemented a comprehensive HSE POLICY backed up with appropriate safety management systems and procedures.
- Vedanta Limited (Division Cairn Oil & Gas) operating procedures lay a strong focus on hazard identification and risk assessment covering each and every hazardous operation, procedure and equipment. Risks and mitigating measures for each are clearly carried out and measures implemented and monitored. This ensures risk minimisation to the worker group.
- The facility to be built based on the applicable National / International codes and best practice. Individual equipment is of highest quality, certified and of highest safety integrity. This ensures risk minimisation to the worker group through operational and maintenance periods. In addition, equipment hazard identification has would be carried out for each of the equipment time to time.
- Mock drills would be carried out periodically to ensure the highest state of emergency response in case of any incident.

Risk Reduction Measures

The main conclusions drawn from the Consequence Analysis and Risk calculations are given below- critical actions for safeguarding against the incidents are also mentioned below: -

- From the F-N Curve, it is observed that the integrated risks lie within the “ALARP” range. -this suggests existing risk mitigating measures must be sustained and Best Industry Practices be used. Any specific new risk reduction options may be evaluated through Cost Benefit Analysis (CBA).
- From the below figure it can be seen that the maximum risk level lies in the band of 1E-003 /Avg year (within the fence) and 1E-004 /Avg year –this risk band extends towards the west for a distance of approx. 20 meters from the plot boundary. It may be noted that this risk level is on the higher side for public areas (normally acceptable risk level is 1E-006/Avg year). It is suggested that either heater treater unit, Coalescing filter skid and Fuel gas unit may be shifted 20 meters towards east to prevent any outside risk or to ensure there are no vegetating in this area.
- It is seen that the control room is falls under 1E-03 /Avg year it advised to shift the Control room to a safe location.
- As Living area are likely would be affected due to large incidents on the Rig Floor, it is essential to ensure the upkeep of the safety devices (Smoke Detection, Fast Rescue Craft (FRC), escape routes and it must be ensured that Mock evacuation drills are carried out periodically.
- Escape routes for personnel on the Drill Floor towards the LQ must be properly protected and kept free of any debris/obstructions etc. to ensure minimum loss of life.
- The correct installation of Safety Critical Equipment and their operational reliability are essential for the safety of the facility. In addition, initial and periodic testing of the Safety Critical Equipment before installation and periodically is absolutely essential and the same must be ensured.
- Storage tank enclosures must be drained periodically during the rainy season in particular.
- As hydrocarbon related risks exist at the facility, ignition source control must be ensured during routine and non-routine operations.
- Ensuring that the public in vicinity of the facility is made aware of the hazards and also the hazards of unplanned and irregular third-party activities- this may be done through frequent safety awareness programmes, warning signage, explicit display of Do’s and Don’ts etc.
- Emergency Response Drills must be carried out frequently both internally within Vedanta Limited (Division Cairn Oil & Gas) and also involving external authorities. Lessons learnt must be assimilated and disseminated to concerned persons.
- The correct installation of the Safety Critical Equipment and their operational reliability are essential for the safety of the facility. In addition, initial and periodic testing of the Safety Critical Equipment before installation and periodically is essential and the same must be ensured.

- For Jet fire scenarios for small leaks may be safeguarded against through proper fire protection means (Fire and gas Detectors, Passive and Active firefighting systems, etc). Proper firefighting system design and implementation and fire drills, training etc. are essential and must be sustained through the project life cycle.
- The damage distance arises due to the Flash Fire mitigated by ensuring the that the area must be kept free of ignition sources to the extent possible and the same must be ensured even during maintenance activity. Non-sparking tools must be used and personnel entering the area must be “de-earthed” before entering. A hazardous area classification study is suggested for placement of electrical equipment in the classified area.
- The damage distance for pool fire arising due the pool fire for small leaks shall be safeguarded against through proper fire protection means
- Key non-routine activities must be preceded by a Job Safety Analysis and Job or Task Risk Assessment involving key personnel that would be working on the facility.
- Work Permit System must be implemented during the construction and operational phases of the project to safeguard against any accidents. It must subsequently also cover the operational phase.
- Trips and falls hazard, electrical hazards etc. must be minimized through periodic safety audits and site inspections using third party and Internal audit teams. Actions arising out of the audits must be implemented in a time bound manner and followed up for closure.
- Vedanta Limited (Division: Cairn Oil & Gas) must ensure suitable training to all personnel (Company as well as Contractor personnel) to help prevent incidents/ accidents- such training must be refreshed periodically, and a list of trained personnel must be maintained by Vedanta Limited (Division Cairn Oil & Gas)
- As ignition related risks exist at the facility, ignition source control must be ensured during routine and non-routine operations.
- Apart from the process risks assessed, another very important category of incidents possible are those associated with well operations. These risks could include uncontrolled blowouts, incidents associated with rig movement/rig walk, wireline risks during wireline operations, well bore clean out risks, risks associated with specific chemicals during drilling/well repair/ activation/other activities. On-site personnel are subject to standard occupational risks and Vedanta Limited (Division Cairn Oil & Gas) must direct effort and resources into reducing these risks. Incidents connected with well operations, dropped objects, personnel falls from height, electrocution incidents etc. are top priorities which Vedanta Limited (Division Cairn Oil & Gas) would concentrate significant effort to prevent, prepare for and respond to. This must be implemented through the Vedanta Limited (Division Cairn Oil & Gas) HSE Management System.
- HAZOP would be undertaken once design is reasonably complete and before start up. In addition, a basic safeguarding must be in place during the testing/early production phase- well shut/ surface facilities basic shut down must be possible. A basic functioning F&G system too must be put in place with well shut down in case of F&G activation. Initial phase well behaviour could be unpredictable and necessary safeguarding must be in place- essentially, the EPU must be equipped with basic shutdown facilities, typically “fit for purpose”. It is also necessary that initial well operations are manned continuously- this of course, would be the case, since data logging/monitoring would also be taking place.
- Storage Tank vents would be routed at safe height and location to avoid toxic/sudden vapour egress with toxic/flammable hazard.
- Heater Treater BMS would be checked thoroughly before being put on line and necessary leak and performance tests would be ensured properly. Burner light up sequences would be properly established and necessary site verification tests etc. carried out
- Specific procedures to address sanding operations/ sand flush out must be in place.
- It must be ensured that Storage Tanks and Road Tankers are NOT overfilled (not more than 80%)- set points/ SOP to capture the same
- Road Tanker Bottom filling option is preferred- in case of top loading, OISD 157 (https://oilweb.oilindia.in/OISD_Standard/oisd%20standard_old/Std-157.doc) guidelines would be followed for critical points
- Ensure proper (metallic/ metal braided) hoses, gaskets etc. and Road tanker earthing is properly executed.
- F&G system periodic testing and maintenance would be ensured to prevent major escalation scenario.

- Periodic cleaning would be ensured for flame arrestors of storage tanks to prevent any Blockage/LOC scenario.

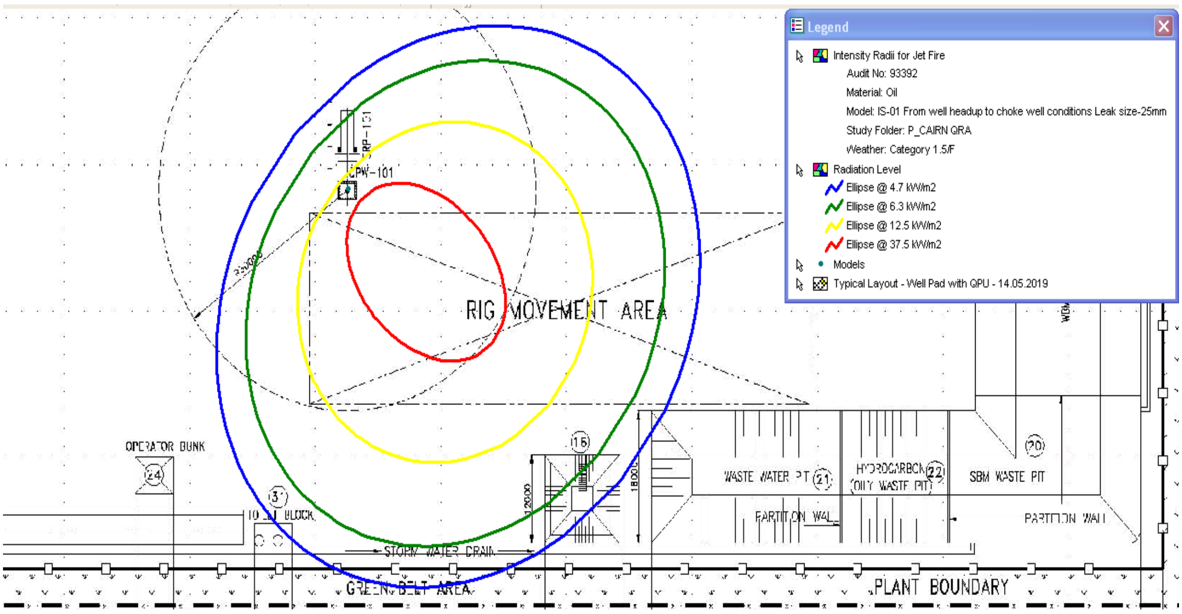


Figure 84. Jet fire Results (1.5/F) – IS-01 -25 mm Leak Size.

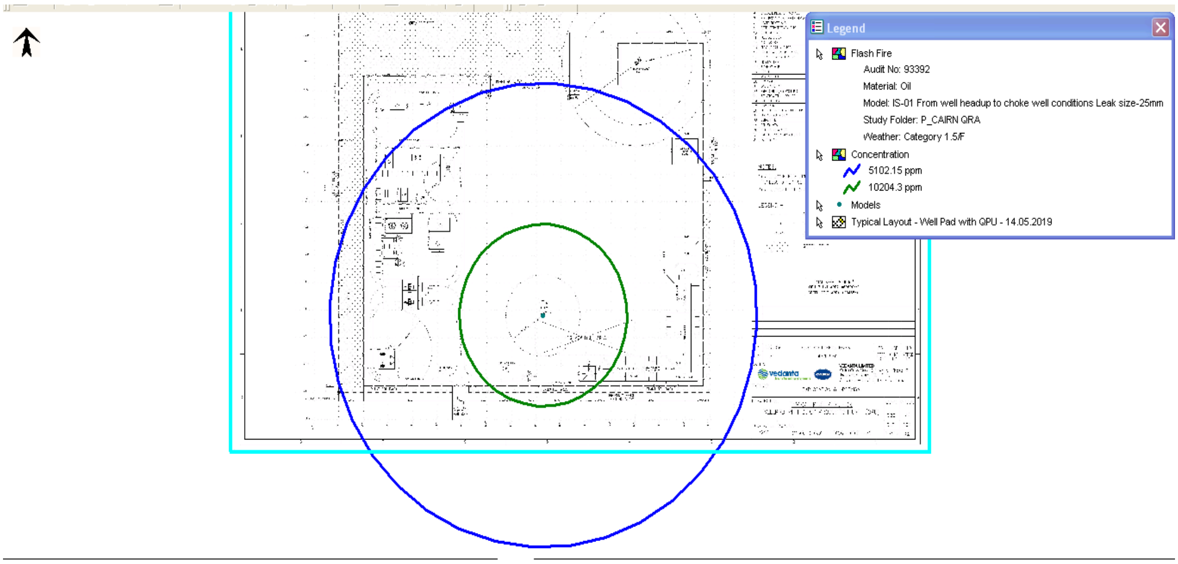


Figure 85. Flash Fire Result (1.5/F-IS-01-255 mm Leak Size).

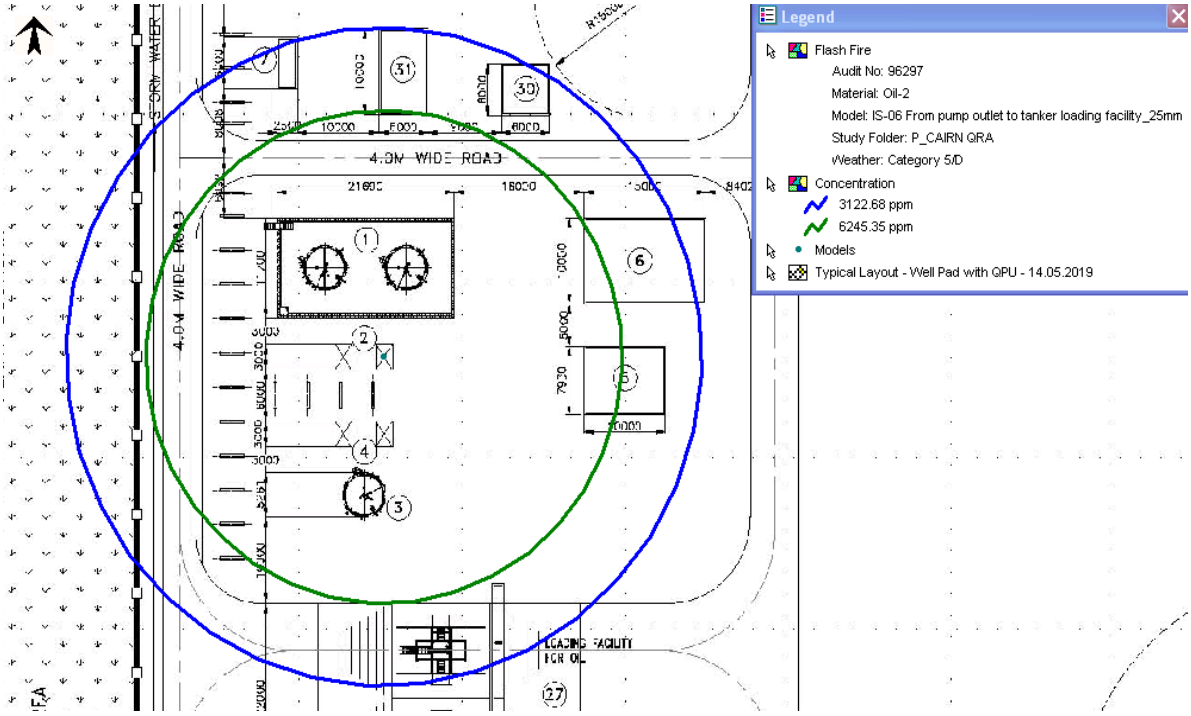


Figure 86. Flash Fire Results (%/D0-IS-06-25 mm Leak Size

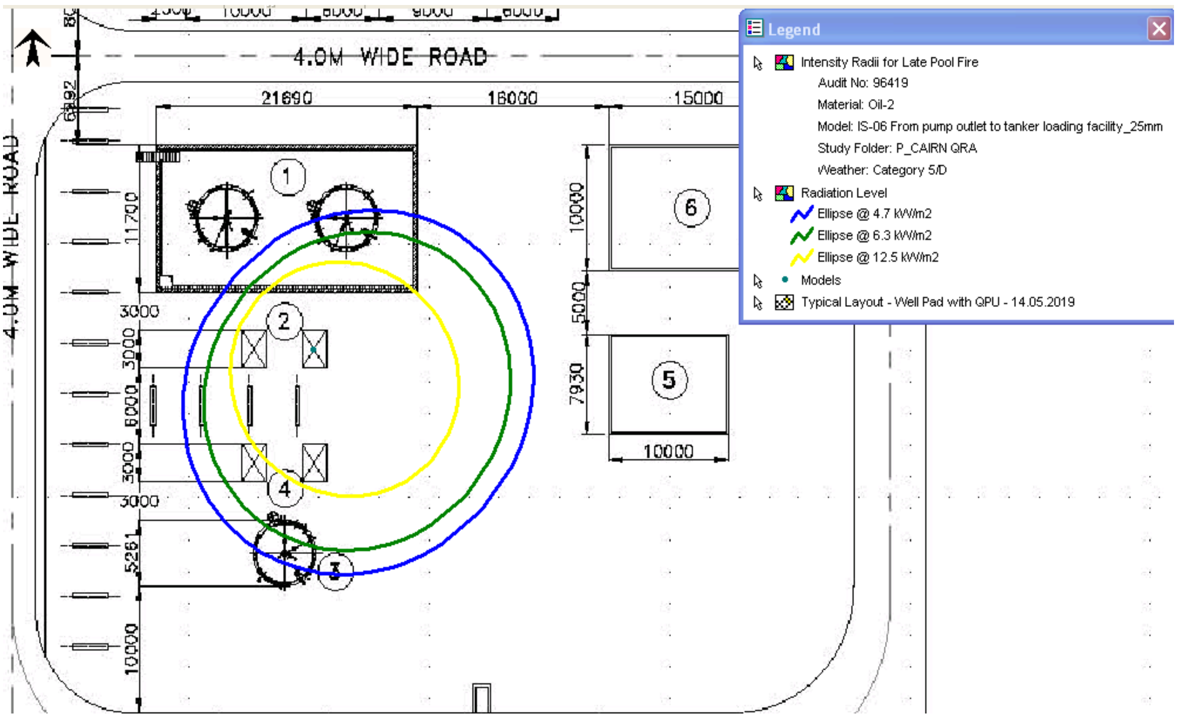


Figure 87. Pool fire Results (5/D) – IS-06 -25 mm Leak Size.

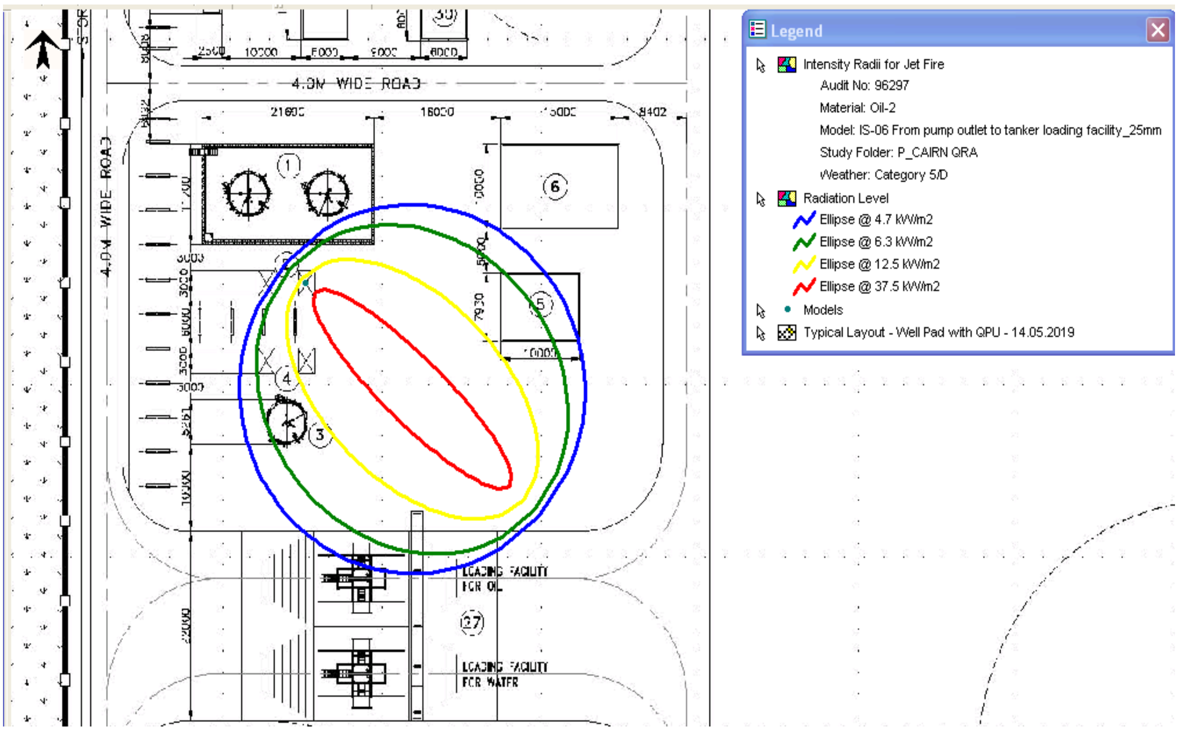


Figure 88. Jet fire Results (5/D) – IS-06 -25 mm Leak Size

7.3 Disaster Management Plan

In view of the hazardous nature of products / process handled in the project, Disaster Management Plans (DMPs) has been prepared. These plans are based on various probable scenarios like Well Blow Out, Fire, Explosion, Natural Calamities, etc. The consequence arising out of such incidents are accurately predicted with the help of latest technique available by various Risk Analysis Studies. To minimize the extent of damage consequent to any disaster and restoration of normalcy is the main purpose of DMP. The onsite Emergency Plans would deal with handling of the emergency within boundary of the plants mainly with the help of industry's own resources. Also, when the damage extends to the neighbouring areas, affecting local population beyond boundaries of plant, Off-site Emergency plans would be put into action in which quick response and services of many agencies are involved e.g. District Authorities, Fire Services, Civil Defence, Medical, Police, Voluntary Organizations etc.

Objective of DMP

The following are the main objective of Disaster Management Plan:

- Safeguarding lives both at installations and in neighbourhood.
- Containing the incident & bringing it under control.
- Minimizing damage to property & environment.
- Resuscitation & treatment of causalities.
- Evacuating people to safe area.
- Identifying persons and to extend necessary welfare assistance to causalities.
- Finally, when situation is controlled, efforts are would be made to return to normal or near normal conditions.

Emergency Identified

Typical emergency situations which the Vedanta Ltd. (Division: Cairn Oil & gas) business has identified that could occur within its field of operations are:

- Well Blowout

- Fire / Explosion
- Gas Leakage (H2S, Natural Gas, etc.)
- Natural disaster such as earthquake, floods, storms, etc.
- Human injuries from accidents, falls, etc.
- Motor vehicle, road incidents
- Security incidents such as hold-ups, kidnapping, bomb threats, etc

Emergency Classification - Tiers of Emergency Response

Response strategies shall be commensurate with the nature, scale and associated hazards and risks for relevant emergency event.

The emergencies are classified as Tier 1, 2 & 3. The examples of Tier 1, 2 and 3 incidents are given in table 7.12.

Table 7.12 Emergency Classification & Response Team

Emergency Levels	Category	Response	Health & Safety	Environment	Security / Community
Tier 1 Local Reactive	– A minor Incident where site / location team requires no external assistance and can control the incident with local resources – Incident Controller must notify the leader of the ERT or EMT as applicable	– Emergency Response Teams – (IRT)/(ERT)	– Minor medical or injury case requiring no external support – Equipment damage with loss of production – Minor fire with minor injury or plant damage – Rescue of trapped and injured personnel	– Minor oil spill < 100T(700b bls) – Onsite environmental Exposure contained with internal efforts e.g. chemical spill – Notification of cyclone within 72 hrs	– Minor security breach – Theft from site – Local unrest
Tier 2 Tactical	– Substantial Incident – EMT leader decides to activate EMT – EMT leader must notify CMT Leader	– Emergency Management Team – (EMT)	– Any incident requiring additional / external resources – Fire or Explosion – Injury or illness requires evacuation – Traffic accident requires external assistance – Well blow out	– Oil spill from >100T but <1000T (700–7000bbls) – Environmental exposure requiring outside help – Earthquake – Flood or Cyclone warning Yellow alert – within 12 hours	– Community protest or security breach – Major criminal activity
Tier 3 Strategic	– Crisis situation – CMT leader decides to activate CMT leader must notify the Chief Executive Officer	– Crisis Management Team (CMT)	– Incident leading to loss of facility – Incident leading to significant financial loss – Incident leading to multiple injuries or fatality – Total loss of marine vessel / vessel hitting platform – Helicopter crash – Well blowout – Incident which could lead to international media interest – Major traffic incident with multiple casualties	– Oil spill more than 1000T (7000bbls) – Major Earthquake	– Terrorist activities /bomb threat – Kidnap or extortion /threat – Major civil unrest /community protest

On-site Emergency Response Plan

The Onsite & Offsite Disaster Management Plan (DMP) and Emergency Response Plan (ERP) are planned for facilities, which are also extended to proposed activities. The scope of the DMP On-site Emergency Preparedness Plan is to evaluate the various types of emergencies that can occur at rig installations and processing/production facilities (Drilling and Production activities) and to formulate emergency plans, procedures that can be implemented by Vedanta Ltd. (Division Cairn Oil & Gas) in house. In case the contingency exceeds in dimension or geographical coverage beyond Vedanta Ltd. (Division Cairn Oil & Gas)'s capability, the offsite Emergency plan shall be activated concurrently with the help of District administration

Based on the incident classification and response team matrix mentioned above, Incident Response Team, Emergency Response Team and Emergency Management Team gets involved.

Tier 1 Incident Response Team (IRT):

- The emergency or incident can be effectively and safely managed, and contained within the site, location or facility by local staff.
- Emergency or incident has no impact outside the site, location or facility. IRT may provide support through effective interaction with local stakeholders.
- Loss of life or severe environmental damage or material loss of asset or organisation's reputation is not a consequence of event / emergency.

Tier 1 incidents are managed by Site IRT, each site has own IRT.

Tier 1 Emergency Response Team (ERT):

- The ERT provide assistance and local support to the IRT's in relevant area.
- The ERT have access to local outside site / external emergency services.
- For tier 2 emergency events.

Tier 2 Emergency Management Team (EMT)

- The incident cannot be effectively and safely managed or contained at the site location or facility by operational local staff and additional support is required.
- The incident is having or has potential of impact beyond the site, location or facility and external support may be required.
- Loss of life or severe environment damage or loss of asset or organisation's reputation is possible consequence of event / emergency.
- IRT may provide support through effective interactions with local stakeholders.
- ERT acts as interface between EMT and IRT for Midstream pipeline operations.

Tier 2 EMT is primarily for tactical response to the incident but may on occasions required to act in reactive mode.

Tier 3 Crisis Management Team (CMT):

- The incident has escalated to a level having potential of loss of life, adverse effect on public or company's operations / reputation.
- Incident may have requirement of immediate action / guidance from Top Management.

Tier 3 incidents are incident escalating to the point requiring involvement of CMT

Responsibilities of the Individual Response Organisations

The Incident Response Team is responsibility for managing all incidents and emergencies which may occur at or in close proximity to their operational area. For emergencies where additional / external support is required the person in charge of the incident response, the Incident Controller at a remote location, site or facility must notify and request support and assistance from the next level in the emergency management organisation. The ERT / EMT would be notified of all incidents within 30 minutes of the IRT activation at a remote location, site or facility.

The key role and responsibilities of the IRT Leader would be

- To manage the response to any and all incident or emergencies at the Site, Plant or Field Location

- To Control the incident by preventing escalation and minimizing risk to personnel
- Direct and coordinate the activities of the Incident Control and Forward Response Teams.
- Ensuring sufficient trained and competent personnel are available to support the Response Teams.
- Ensuring the safety of all personnel working at the Site, Plant or Field location
- Evaluate and initiate immediate actions, to contain and mitigate effects of the incident or emergency. Monitor the situation & determine need for evacuation.
- Establish head count and potential whereabouts of any missing personnel and if necessary prepare search, rescue and recovery plan.
- Follow Incident Response Plan and if required develop a plan of action to deal with the incident or emergency and communicating this plan to the IRT members

Emergency Response Team (ERT) – Pipeline (Reactive/Tactical)

This is Emergency Response Team, responsible for coordinating overall incident and emergency response for pipeline incident at any of midstream pipeline locations.

The role and responsibilities of the ERT Leader would be:

- Co-ordination and Support of responses for all incident and emergency situations for the pipeline;
- Reporting all incident and emergency situations in the pipeline operations to the EMT Leader in line with notification requirements;
- Provide and deploy additional resources as needed by the Incident Controller;
- Ensure all direct communications with the EMT;
- Determine the actual and possible impact of the incident;
- Ensure that information associated with the incident is promptly considered by the Support Team;

Emergency Management Team (EMT) – Tactical/Strategic Response

In the event of an incident or emergency the Emergency Management Team Leader would make a decision whether or not to mobilise the EMT. If the decision is taken to mobilise the EMT then all EMT duty personnel are required to proceed promptly to the Emergency Management Team Room and manage emergency in accordance with their role, responsibility and as directed by the duty EMT Leader. DOA shall be nominated for absence.

The EMT organisation has following roles and responsibilities:

- EMT Leader – In overall in-charge / team leader, responsible for Company's tactical response to all emergency situations in respective SBU. They are also responsible for reporting incidents to the regulating authorities.
- Human Resources Coordinator – Responsible for providing HR services advice and support
- Logistics Co-ordinator – Responsible for providing transport and logistics support as required
- Operation and Technical Coordinator – Responsible for providing operational and technical support and advice
- Finance – Responsible for providing financial support and advice.
- HSE Coordinator – Responsible for providing health, safety, environmental support and response.
- Recorder – Responsible for maintaining a timed log of key events and actions
- Security Coordinator – Responsible for providing security support advice and assisting others as required by EMT Leader

The above list identifies a number of key EMT roles, following additional supporting roles may be called on when as and when required, typical roles being:

- Air Medevac Nodal Officer – Responsible for facilitating air medevac.
- IT/Telecommunication Co-ordinator – Responsible for providing the EMT with technical support associated with the communications hardware and software

- Company Medical Officer – Responsible for providing advice and assistance on health and medical issues.
- Legal – Responsible for providing support on legal / regulatory aspects.
- Public Relation / Corp Com – Responsible for communication with media and external stake holders.
- Contractor's representatives – who may be called in to assist the EMT would the incident involve members of their organisation

Crisis Management Team (CMT) Roles

The Crisis Management Team is comprised of small core of senior executives. The CMT would collectively have responsibility for all major actions taken before; during, and after the crisis situation has occurred.

The role and responsibilities of the CMT would be:

- Select additional specialist resources to join the CMT or to advise the CMT during a crisis, depending on the nature of the crisis
- Develop and implement crisis management strategy
- Develop and communicate the operating mandate of the CMT to those with responsibility for the on-scene activities
- Nominate spokesperson to cover media interviews
- Establish contact and communicate with appropriate government or other agencies
- Prepare to coordinate business continuity and recovery strategy

Emergency Response Strategies / Evacuation Plan

Emergency response strategies (ERS) are the documented decisions on required emergency response measures for identified emergencies, based on risk evaluation and assessment process. It shall consider all statutory requirements applicable to the installations.

The objective of ERS is to identify the means would be used to secure adequate emergency response. It provides basis for monitoring of the adequacy of the emergency response measures so that they can be modified when essential. ERS would include appropriate standard of performance for response measures associated with each type of identified major accident hazard and installation specific factors.

ERS would include the following elements:

- Organisation
- Procedures
- Equipment
- Information
- Competency building measures (Training & refresher courses and Drills & exercises)
- The role of any other measure essential for achieving successful emergency response

Emergency response measures shall consider the available resources as below:

- Installation resources: They are immediately available on the installation and are under control of installation Manager / In-charge. These include personnel and equipment that can be assigned emergency role.
- Area resources: These resources are available on the installations in the vicinity, within same area and are not under control of Installation In-charge. The resources may be available within the Vedanta Ltd. (Cairn Oil & Gas) or available by a mutual aid or cooperation agreement.
- External resources: These resources are available by a mutual aid or cooperation agreement at regional, national or international level and include organisations, professional bodies and resource persons.

The general requirements as per Vedanta Technical Standard VED/CORP/SUST/TS 13 on Emergency and Crisis Management are:

- Crisis situations shall be managed centrally by Vedanta Ltd. (Division: Cairn Oil and Gas) business, in accordance with the requirements outlined in the standard.
- SBU operations shall also have procedures in place to ensure crisis situations are escalated to Cairn Oil and Gas business and Vedanta Group as appropriate.

- Emergency situations shall be managed by SBU operations and reported to Cairn Oil and Gas business and Vedanta Group as appropriate.
- Incidents shall be managed at the SBU operation level and reported in accordance with SBU operations, Vedanta limited (Division: Cairn Oil and Gas) and regulatory reporting requirements. Also refer Management Standard MS11 on Incident Reporting, Escalation and Investigation.
- Emergency Preparedness and Response Plans shall be developed, implemented and maintained at the SBU operation, Vedanta limited (Division: Cairn Oil and Gas) to deal with incidents, emergencies and crisis situations.

Additional Vedanta Ltd. (Division Cairn Oil and Gas) requirements are:

- The objective of emergency response planning is to have clear written procedures for expected actions during anticipated emergencies. Emergency response plan includes operational and procedural requirements for various emergency scenarios that are relevant for the installation.
- Ensure that appropriate resources and incident / emergency response plans are prepared, practiced and available. The procedures shall include provision for emergency arrangements with contractors.
- Critical resources of emergency response would include:
  - Emergency power systems
  - Fire and gas detection systems
  - Active fire protection
  - Passive fire protection
  - Shutdown system
  - Explosion mitigation and protection systems
  - Evacuation escape and rescue arrangements
- Every Cairn business unit (including projects and offices) shall be covered by trained Incident and Emergency Management Teams who would manage and execute the emergency plans.
- All members of the emergency organisations would be trained and competent to perform their assigned role within the incident response (IRT) / emergency response (ERT) / emergency management (EMT).
- Arrangements for emergency medical treatment shall consider injuries to persons as a result of minor accidents & major accidental events, illness of persons on installation, transportation & evacuation of sick and injured personnel.
- Controlled medicines shall be stored in a secure place accessible only to those who are trained to administer these.
- The level of medical facilities and trained personnel provided would be in line with the requirements identified in emergency response strategy. Key points would be considered is identification of medical facilities / hospitals
- Emergency response plans shall comply with all relevant legislative and regulatory requirements to ensure emergency capabilities are maintained and achieved.
- Procedure for designing emergency response measures would be based on:
- Integration of emergency response with / into design and operations
- Automatic or remotely operated safety systems to mitigate the effects of an incident
- Emergency response organisation structure
- Wherever applicable offsite emergency response / disaster management plans shall be ensured.
- Essential safety system (such as control stations, temporary refuge, muster areas, fire pumps) shall be located where they are least likely would be affected by fires and explosions.
- Emergency shut down (ESD) system shall be designed such, that it is capable of fulfilling its function under the conditions of incident. If installation is in operation, the essential shutdown functions shall be available during maintenance activities, which affect the operation of the ESD system. ESD system shall contain facilities for testing of both input / output devices and internal functions.

- Evacuation and escape routes shall be provided from all areas of an installation where personnel may be expected would be present during their normal activities. Alternative means to allow persons to safely leave the installation in an emergency shall be provided.
- Evacuation and escape routes shall have adequate illumination with emergency lighting and shall be marked to ensure that 'they can be used during emergency conditions. All escape routes shall be unobstructed (including vertical clearance) and readily accessible.
- Personal protective equipment for use in major accident hazards would be suitable for the circumstances in which it may have would be used and the individuals who may have to use it.
- PPE for use in an emergency would be for all persons on the installation for use in condition of fire, heat, gas release or smoke to enable them to reach muster areas, temporary refuges and evacuation or escape points. Those with specific emergency duties shall also be provided appropriate PPE for use like fire suits and breathing apparatus etc.
- During an emergency, security arrangements shall ensure that unauthorised persons do not enter the incident site by controlling assess and if need arises the area around the site can be evacuated and cordoned to ensure safety of the persons.
- Environmental emergency response would consider:
  - Oil-pollution control equipment that would be located on the installation
  - Environmental conditions that may be present when the equipment is deployed
  - Capacity of the oil recovery system
  - Characteristics of the oil / emulsion would be recovered
  - Means to identify the extent of the spill
  - Facilities to handle any recovered oil.
- International conventions have introduced the requirements to develop national plans for oil-spill response in offshore, and Offshore Assets / SBUs / Operations would ensure that their installations' emergency response plans are aligned with the national requirements.

Responsibilities of the Employees

The establishment and maintenance of best possible conditions of work is, no doubt, the responsibility of the Project Management. It is also necessary that each employee follows prescribed safe methods of work. He would take reasonable care for the health and safety of himself, or his fellow employees and of other persons who may be affected by his action at work. With this in mind, employees shall be trained would be health and safety conscious in the following aspects:

Table 7.13. Health and Safety Aspects

Report	Potential Hazards
Observe	Safety rules, procedures and codes of practice
Use	Tools and equipment with all care and responsibility
Participate	In safety training course when called upon to do so.
Make	Use Of safety suggestion schemes.
Take	An active and personal interest in promoting health and safety

Each unit shall identify and document the resources required to ensure the effective implementation of the emergency and crisis management procedures. Resource requirements shall meet the requirements of the Vedanta Management Standard MS01 on Leadership, Responsibilities and Resources. The following resources shall be considered and made available as necessary:

- Trained and competent personnel;
- Equipment and other materials including Personal Protective Equipment (PPE);
- Warning devices;
- Medical services, including personnel trained in first aid, and medical equipment that is appropriate to the type of operation;

- Emergency services support; and
- Emergency funding, along with an appropriate mechanism for delivering funds.

The capacity of external resources, such as local firefighting capacity, shall be assessed, and additional resources acquired and maintained at the operation where external resources are deemed insufficient.

The resources identified shall be maintained and tested on a regular basis, and their adequacy reviewed periodically.

Communication Systems

Emergency response relies upon effective and reliable communication between all personnel involved in response. Communication systems shall:

- Provide sufficient reliable information / alarm to personnel on the installation to enable them to take the appropriate emergency actions.
- Provide means for those on the installation to communicate with the person in overall charge.
- Provide reliable arrangements to allow the person in overall charge to communicate with all personnel on the installation regarding the nature of any emergency and the actions they are required to take.
- Provide reliable means to allow the person in overall charge to communicate with area and external resources who have a role in emergency response.
- Suitable equipment, information processing and procedures shall be in place to enable effective communications. The means of communication shall be selected based on the need for communication in likely scenarios including operational conditions under which they are to function like, noise, ambient conditions and susceptibility to damage. So far as reasonable, communication arrangements would remain available throughout the emergency
- Alarm signals used, and their meanings would be described in the emergency response plan along with the procedures would be followed in the event of an alarm. Persons would be provided with adequate information to allow them to, initiate alarms where necessary, distinguish between alarms and respond to alarms.
- Adequate alarms and warning devices, along with other forms of communication, shall be maintained to reliably alert persons across the whole site in the event of an emergency.
- Independent secondary / back-up communications systems shall be provided in case the emergency incident makes the normal communication system inoperable.
- Ensure that the means are in place to alert to the connected installations, the local community / neighbouring businesses in the event of an emergency that has the potential interface with them.

Training and Emergency Response Drills

All persons on the installation or in connected activities (including contractor's personnel) shall be trained periodically for emergency response and evacuation procedures. Training for employees having assigned roles in emergency response shall be completed before they are called upon to perform in real emergencies. Emergency response organisation structure (IRT/ERT/EMT/CMT) shall ensure command by competent persons, which can be maintained, so far as is practicable, throughout an emergency.

- Key persons such as the Installation In-charge and Shift In-charge / control room operator shall be assessed for required competence to perform emergencies duties before assigning of duties. As far as possible, assessment would be under simulated emergency conditions.
- Competency and training needs shall meet the requirements of the Vedanta management Standard MS06 on Competency, Training and Awareness
- An emergency response table top exercise / emergency response drill is a focused activity that places the participants in a simulated situation requiring them to function in the capacity that would be expected of them in a real event. Its purpose is to ensure preparedness by testing policies and plans and by training personnel. One objective of an exercise is would be able to identify problem areas for resolution/ corrective action before an actual emergency occurs.

- The drills need to address the readiness of personnel and their familiarity / proficiency with emergency equipment and procedures. All personnel on the installation involved including contractor's employees would participate in the drills.
- The drills and table top exercises shall be carried out as often as appropriate, against documented schedule. Would be scheduled regularly, at least once a year for full drills and six monthly for desk-based exercises, although the exact frequency and type of drills may depend on the nature and scale of the operations, and the associated risks.
- Emergency response plan shall be reviewed and revised as appropriate in line with the findings from drills and table top exercises.
- Involve external emergency response agencies and other external stakeholders, where appropriate.

Performance Measures

- Key elements of functionality, survivability, reliability and availability shall be included in performance standards. Achievability of performance standards would be validated.
- Effective operations, inspection, testing and maintenance procedures shall be established to ensure that the functional requirements of the equipment and systems provided for emergency escape, evacuation and rescue response are maintained.
- A written scheme shall be prepared, detailing the inspection, testing and maintenance routines and frequencies would be followed. All emergency equipment and systems shall be thoroughly inspected, following established procedures. Adequate records of the results of the inspection, testing and maintenance shall be kept and shall be periodically reviewed to confirm that the written scheme is appropriate and is being adequately implemented.

Monitoring, Evaluation and Review

Documented reviews would be carried out after all drills and actual emergency responses to determine the effectiveness of the Emergency Preparedness and Response Plans, with a full debrief to identify what worked well and what aspects require improvement.

Lessons learned following exercises or actual emergency situations/incidents shall be documented, and any gaps in planning and implementation shall be addressed in revised versions of the Emergency Preparedness and Response Plans. Lessons learned shall be shared across Vedanta's operations where appropriate.

All Emergency Preparedness and Response Plans shall be reviewed and updated periodically, at least on an annual basis, to ensure they remain appropriate and relevant. Reviews shall also meet the requirements of the Vedanta Management Standard MS14 on Management Review and Continual Improvement.

Preventive and Mitigation Measures for Well Blow out

Blow-out (uncontrolled gushing of oil & gas) is the worst situation, which may arise at oil wells during drilling, work-over operations, perforation, and reservoir studies at active wells, etc. or due to some unforeseen reasons.

A blow out, though rare, in a drilling operation is often accompanied by fire and explosion exposing workers to serious danger to their lives, burns and poisoning. To understand the failure modes resulting to formation of kick and subsequent blow outs, one has to understand the safety systems installed for blow out prevention.

Prevention of blow outs rests primarily on control of any kick in the well bore. A kick means entry of formation fluids into well bore in large enough quantity to require shutting in the well under pressure. Once a kick is detected, steps can be taken to control entry of formation fluids into the well bore by over balancing the expected bottom hole pressure with properly conditioned mud and operation of safety valves i.e. Blow Out Preventer (BOP), whereby the space between the drill pipes and the casings can be closed and well itself shut off completely. Several instruments are provided on a drilling rig for detection of kicks.

Instrumentation in Mud System

Continuous monitoring of condition of mud in the well provides information useful for well control. The following processes are used in the drilling mud system for this purpose:

- A pit level indicator registering increase or decrease in drilling mud volume. It is connected with an audio-visual alarm near the drillers control panel.

- A trip with float-marking device to accurately measure the volume of mud going in to the well. This is useful to keep the well fed with required quantity of mud at all times.
- A gas detector or explosive meter installed at the primary shale shaker together with an audio-visual alarm at the drillers control panel to indicate the well presence of gas-cut mud in the well.
- The kick in the well is prevented by keeping the hydrostatic head of the drilling fluid greater than the formation pressure. The primary control can be lost in the following situations:
- If there is reduction in hydrostatic pressure in the well due to swabbing, which maybe caused if the drilling string is pulled out too fast or by a balled-up or clogged bit, which is indicated by insufficient filling of mud.

Preventive Measures for Handling Natural Gas

The natural gas is a colourless, odourless, flammable gas, mainly methane which may cause flash fire. Electrostatic charge may be generated by flow, agitation etc. No occupational exposure limits have been established for natural gas. The preventive measures would be taken to avoid impact due to leakages are

- Provide local exhaust ventilation system: Ventilation equipment would be explosion-resistant if explosive concentrations of material are present.
- Gloves: Wear appropriate chemical resistant gloves.
- Respirator: Under conditions of frequent use or heavy exposure, respiratory protection may be needed.

Leakage of H_2S Gas

Hydrogen sulphide is a colourless, flammable, extremely hazardous gas with “rotten egg” smell. Low concentrations of H_2S irritate the eyes, nose, throat and respiratory system e.g. burning / tearing of eyes, cough, and shortness of breath. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances and weight loss.

The preventive measures would be taken up in case of leakages are:

- Stop the source of leakage (i.e. close the well)
- Remove victim, if any to fresh air, if breathing, maintain victim at rest & administer oxygen, if available, if person is not breathing, start artificial respiration immediately or start mechanical/ automatic resuscitator. Call ambulance and sent victim to hospital or doctor.
- Avoid & extinguish all naked flames
- Pull out all inflammable material i.e. HSD, Gas Cylinders, Chemicals etc. from the premises of well / installation.
- Pull out all possible equipment to safe distances.
- Call for fire tender and start spraying water on the sources of leakage to dissolve H2S in water.
- Evacuate personnel in 500 m area from down wind direction.
- Warn nearby inhabitants, if required.
- Cordon off the area & do not allow entry of any unauthorized person.

Vedanta Ltd. (Division: Cairn Oil & Gas)’s operations in the Block have indicated that there is no naturally occurring H_2S in the reservoir and therefore release of H_2S during drilling operations is not expected.

Preventing Fire and Explosion Hazards

Fire is one of the major hazards, related to oil and natural gas well. Fire prevention and code enforcement is the area of responsibility of the fire service. Safe operating practices reduce the probability of an accidental fire on a platform. Personnel would understand their duties and responsibilities and be attentive to conditions that might lead to fire. The following precautions are recommended:

- Fire control cannot be achieved until the source of fuel and ignition is isolated. Fire control cannot be achieved until the source of fuel and ignition is isolated. An emergency shut down (ESD) system shall be provided to isolate the installation from the major hydrocarbon inventories within pipelines and reservoirs, which if released on failure, would pose an intolerable risk to personnel, environment and the equipment / assets.

- There would be provision for safe handling and storage of dirty rags, trash and waste oil. Flammable liquids and chemicals spilled on platform would be immediately cleaned.
- Containers of paints and HC samples, gas cylinders would be stored properly. Gas cylinders would be transported in hand-carts
- Cutting and welding operations would be conducted in accordance with safe procedures
- Smoking would be restricted to designated platform areas and “no smoking” areas would be clearly identified by warning signs
- Platform equipment would be maintained in good operating condition and kept free from external accumulation of dust and hydrocarbons. Particular attention would be given to crude oil pump, seals, diesel and gas engines which could be potential source of ignition in the event of a failure
- The Disaster Management Plan would address the issue of a fire event at any location on the well and the procedure would be adopted in the very unlikely event of this occurring. If a fire starts in any well, that section of the well would be isolated by closing the section (Block) valves, as quickly as possible and surrounding facilities would be cooled with water.

Off-site Emergency Plan

The Off-Site Emergency Plan is a compilation of various emergency scenarios and also includes the probable impact off-site locations due to emergency and the action plan to combat / mitigate the consequences of a disaster situation. Emergency is a sudden unexpected event, which can cause serious damage to personnel life, property and environment as a whole, which necessitate evolving off-site emergency plan to combat any such eventuality. Emergencies can be handled by an organized multi-disciplinary approach. If it becomes necessary to evacuate people, then this can be done in orderly way.

Under the Environmental (Protection) Act 1986, the responsibility of preparation of Off-Site Emergency Plan lies with the State Government. The Collector/ Deputy Collector by virtue of their occupation are normally nominated by the concerned State Government to plan Off-Site Emergency Plan. The different agencies involved in evacuation of people are civil administration (both state and central) and police authorities.

Purpose

- To save life and prevent/reduce loss of properties
- To make explicit inter related set of actions would be undertaken in the event of an accident posing hazards to the community
- To plan for rescue and recuperation of casualties and injuries. To plan for relief and rehabilitation
- To plan for prevention of harms, total loss and recurrence of disaster. It would be ensured that absolute safety and security is achieved within the shortest time

The activities of the government, Non-Government organizations and concerned personnel involved in off-site disaster management plan are as follows:

These would include the safety procedures would be followed during emergencies such as posters, talks and mass media in different languages including local language. Leaflets containing do’s/ don’ts would be circulated to educate the people in vicinity

Medical Help consisted of doctors and supporting staff for medical help to the injured persons because of disaster would be formed. Functions and duties of the committee include, providing first Said treatment for injured at the spot or at some convenient place and shift those to nearby hospitals for further treatment if required

The police would assist in controlling of the accident site, organizing evacuation and shifting of injured people to nearby hospitals.

The fire brigade shall organize to put out fires other than gas fires and provide assistance as required. Approach roads to accident site and means of escape would be properly identified. Chief fire officer would co-ordinate entire fire control measures. Routine training of firefighting equipment and special rescue equipment would be carried out. Concerned officer would ensure adequate supply of fire water and firefighting agents at the site of emergency. Maintenance of standby equipment / personnel for firefighting would be ready at any given time.

Mutual Aid

Disaster / emergency / risk, when becomes difficult to control by in house team / management, help from nearby industries, institutions, etc. can be taken. A group of mutual aid can be formed where emergency control systems like ambulance, firefighting equipment, medical & fire-fighting team, etc. can be shared in the event of need.

Post Emergency Relief to the Victims

The Public Liability Insurance (PLI) Act, 1991 provides for the owner who has control over handling hazardous substances to pay specified amount of money to the victims as interim relief by taking insurance policy for this purpose. The District Collector has definite role in implementation of this act. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.

General Health and Safety

The project would adhere to health & safety norms of The Factories Act, 1948 and Assam Factories Rules, 1950, as applicable along with Best Industry Practices.

General health and safety issues during various project activities are similar to those of most large infrastructure and industrial facilities and their prevention and control. These issues include among others, exposure to dust and hazardous materials, hazardous materials components, and physical hazards associated with the use of heavy equipment, etc.

Specific health and safety issues primarily include the following:

- Physical hazards
- Chemical hazards
- Confined spaces

Physical Hazards - The main sources of physical hazards are associated with machinery and vehicles. General electrical equipment safety, working in confined spaces, hot work, high temperature areas are expected would be present.

Chemical Hazards - workers may be exposed to chemical hazards especially if their work entails direct contact with fuels or chemicals, flare & DG set emission or depending on the nature of activities. Work with fuels may present a risk of exposure to volatile organic compounds (VOC) via inhalation or skin contact during normal use or in the case of spills.

Noise - Noise sources include drilling, DG operations, including vehicular traffic, and boats. In order to evaluate the impacts of proposed project on the health of workers, baseline health studies would be carried out on every worker before joining their duties.

The hierarchy of control specific for health & safety (in order of priority):

- Eliminate the use of a harmful product or substance and use a safer one;
- Substituting wherever reasonably practicable, a non-hazardous material which presents no risk to health, where a hazardous material is used intentionally, i.e. use a safer form of the product;
- Modifying a process to eliminate the use of risk, the production of a hazardous by-product or waste product, including reducing the quantities of the hazardous material which are used & stored, i.e. change the process to emit less of the substance;
- Enclose the process so that the product does not escape;
- Extract emissions of the substance near the source;
- Provide personal protective equipment (PPE) such as gloves, coveralls and a respirator. PPE must fit the wearer.

Personal Protective Equipment

Often it is not possible, or practicable, to eliminate exposure to materials hazardous to health completely. In such cases, operations would consider how to prevent employees being exposed and the prevention of exposure would be achieved by measures other than the use of PPE or Respiratory Protective Equipment (RPE), which is the last line of defence.

Situations where PPE/RPE would normally be necessary include:

- where adequate control of exposure cannot be achieved solely by good practice and the application of operational or engineering measures;
- where new or revised assessment shows that PPE/RPE is necessary until adequate control is achieved by other means;
- where there is temporary failure to achieve adequate control of the process, e.g. because of plant failure, and the only practicable solution to maintain adequate control in the time available may be the provision and use of suitable PPE/RPE; and
- where maintenance operations have would be carried out.

Key personal protective equipment would include:

- Body suit
- Hand gloves
- Helmet
- Safety shoes
- Safety harness
- Breathing apparatus
- Eye shield
- Ear muffs

First Aid

Medical services, including personnel trained in first aid, and medical equipment that is appropriate to the type of operation would be provided at project.

All persons on an installation would have at least basic training in emergency response, basic first aid, use of life saving appliances and firefighting. Individual competencies shall be periodically tested to identify further requirement of training and knowledge to perform emergency duties.

It would be ensured that any auxiliary medical teams e.g. nurses and first aid personnel are fully trained and conversant with their roles and responsibilities.

Contact details & capacities of nearby medical facilities and medical experts would be made available at strategic locations.

Disaster Management Plan for Natural Hazard

Key natural hazards that occur in Assam are earthquake, flash flood etc.

- **Earthquake** - According to the study of Assam state Disaster Management Authority, the plate tectonics, Assam is in the eastern-most projection of the Indian Plate, where the plate is thrusting underneath the Eurasian Plate creating a subduction zone and the Himalayas. As per the GSHAP DATA the state of Assam falls in the region of high to very high seismic zone. As per the 2002 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. Historically, parts of this state have experienced seismic activity greater than 6.0, in Richter scale. The State has experienced two major earthquakes in the year 1897 and 1950. General awareness and wide dissemination of do’s and don’ts through electronic and print media issued by state disaster management agency would be followed.
- **Flood** - The entire state of Assam is affected by flood, in almost every year. River Brahmaputra, being the main drainage channel of the region, consisting of a total catchment area of 5,80,000 sq KM in Tibet , Bhutan, India and Bangladesh. The river flows for length of 918 km in India of which 720 km flows through the plains of Assam .In this valley about 20 major tributaries on its North Bank and about 30 on its South bank join the river Brahmaputra. The precipitation here is mainly due to South West Monsoon. Heavy rainfall occurs from May to September. IMD and other government department warnings would be monitored and in case of any such warning, relevant steps as guided by on site disaster management plan would be followed. Instruction given by key departments like IMD, district disaster management centre, etc. would be followed.

- **Erosion** - Riverbank erosion is a serious problem in Assam leading to displacement of people due to the disappearance of villages year after year. The guidelines from the District Disaster Management Department would be followed.
- **Human Epidemics** - Although, Assam has a history of disease outbreaks such as Cholera, Acute Diarrhoea/ Dysentery, Japanese Encephalitis, Typhoid and recently H1NI; the State is particularly prone to Malaria. Conduct regular hygiene awareness and conduct targeted vaccination drives as required. Workers would be trained for hygienic work environment, sanitation & living conditions.

It has been observed that natural hazards can be minimized by the presence of a well-functioning communication / warning system. A well-prepared administration needs to have its communication/early warning system in place to enable precautionary & mitigation measures on receiving warning for impending disasters and in the process minimise loss of life & property.

Data from different reliable sources would collect and monitored in real or near real time and analysed to generate a warning alert in the event of likelihood of a disaster.

- The Indian Meteorological Department (IMD) would be the nodal agency for the monitoring of seismic activity, flood, etc.
- Tie up / contacts / communication with State Disaster Response Force (SDRF), district disaster management centre would be maintained SDRF has been constituted in the State with stations at locations Jorhat and Dibrugarh.
- Local Search and Rescue Team at the local level comprising of retired Army and Police personnel, Civil Defence and Home Guard, volunteers can be identified and trained to perform initial Search and Rescue operations.
- Apart from the above, Community volunteers/ representatives would be identified and trained on search and rescue operations through community Based Disaster Management programme.
- Disaster Management and Relief Department website/ communication along with other line departments like fire, police, health, etc. would be checked

8. Project Benefits

The proposed project would establish the potential of hydrocarbons in the Block. The development of the oil Block would result in considerable growth of service sector and would also generate direct/indirect employment and business opportunities in the area. The major benefits of the project include reduction of the oil import bill of the nation as well as reduction of the imbalance in oil production and consumption.

The commercial development would also lead to investment in Assam, bringing oil and gas revenues both to the State and to the Central Government. The presence of Vedanta Limited (Division: Cairn Oil & Gas in the region would substantially improve the socio-economic conditions of the region. Employment opportunity for local people as contract/daily wages in nearby areas.

8.1 Revenue Earning of Central & State Government

Vedanta Limited (Division: Cairn Oil & Gas) has been allotted with an exploration Block in Assam Arakan basin, namely AA-ONHP-2017/11 by Government of India under the Revenue Sharing Contract (RSC) for exploration and exploitation of hydrocarbon. A Revenue Sharing Contract (RSC) was signed between the Government of India (GoI) and Vedanta Limited (Division: Cairn Oil and Gas) on 1st October, 2018.

Due to hydrocarbon discovery and then its production, use & sell, central as well as state government would get benefited through revenue earning and sharing.

8.2 Employment Potential

The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. This in-turn would improve the socio-economic conditions of the area.

- Direct and indirect employment opportunities to many unskilled and semiskilled labour in nearby villages.
- In case the hydrocarbon is established in the Block, considerable number of people would be benefited by provision of services to the residents including hotels, restaurants, transport services etc. Thus, the direct and indirect employment generation by this project.

8.3 Corporate Social Responsibility

Vedanta Limited (Division: Cairn Oil & Gas) has taken up various CSR initiatives in and around present operational areas as per the CSR Act and Rules, Govt. of India.

CSR measures would be taken up by Vedanta Limited (Division: Cairn Oil & Gas) in case of commercially viable hydrocarbon discovery & further full-fledged development of the hydrocarbon block and production and associated facilities.

8.4 Proposed CER Strategy

The company would comply with the 1st May 2018 OM of Government of India w.r.t. CER and the cost would be assessed on actual project capex expenditure of that particular financial year Environmental Management Plan.

9. Environmental Management Plan

This section describes the Environmental Management Plan (EMP) for the proposed project.

The EMP is aimed at managing the environmental parameters in a sustainable manner. The EMP section is organized as follows:

- Organizational structure for HSE management– This subsection describes the current HSE organization in Vedanta Limited (Division: Cairn oil and Gas) which would be responsible for implementing this EMP.
- Proposed Environmental Management Plan – This Plan consists of a detailed description of the positive and negative environmental impacts anticipated from the proposed project, mitigation/ management measures and the persons/ parties responsible for ensuring implementation of such measures.
- Additional Plans - Additional plans such as Waste Management Plan, Oil Spill Response Plan have also been provided.
- EMP implementation review process – This subsection describes the requirements for periodic review and updating of the EMP to address any new impacts due to change or modification of the project.
- Budgetary allocation for EMP implementation – Provides the details of budget allocation for the various mitigation measures proposed for the Project.

9.1 Organization Structure for HSE Management

Vedanta Limited (Division Cairn Oil & Gas) has formulated a Health, Safety and Environment (HSE) Policy for its operations. Through the HSE Policy, Vedanta Limited (Division: Cairn Oil and Gas) is committed to protect the health and safety of everyone involved in its operations, and the sustainability of the environment in which it operates. Vedanta Limited (Division: Cairn Oil & Gas) strives for continual improvement and the adoption of international codes and standards. Vedanta Limited (Division: Cairn Oil & Gas) aims at ensuring that all its operations comply with applicable health, safety and environmental laws, regulations and other requirements. HSE Policy of Vedanta Limited is presented in Figure 90 and The HSE policy of Vedanta Limited (Division: Cairn Oil and Gas) is presented in figure 91.

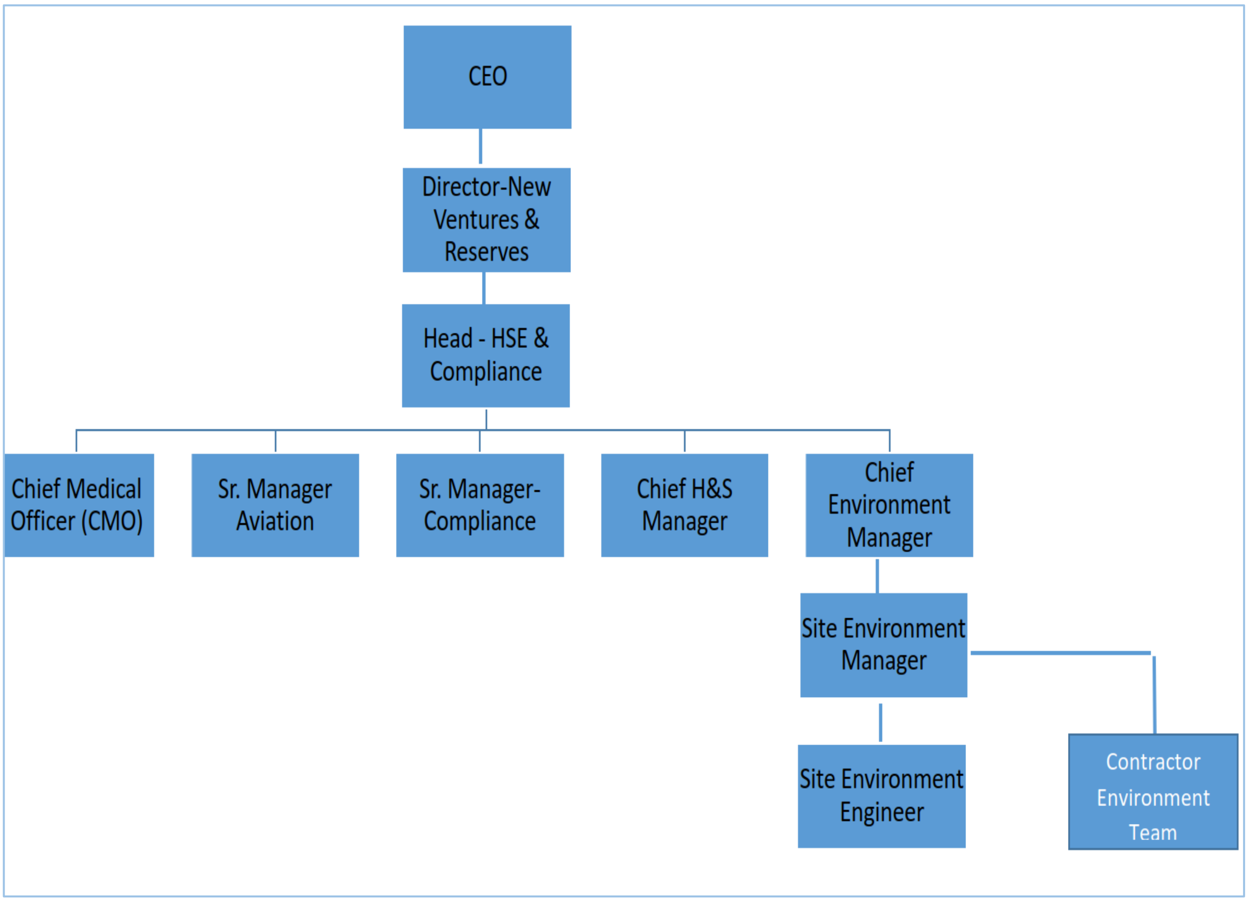


Figure 89. Vedanta Limited (Division: Cairn Oil and Gas) HSE Organizational Structure for Implementation of EMP.

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HSE Policy

At Vedanta Resources Plc, we believe in sustainable development and are committed to effective management of health, safety and the environment as an integral part of our business. The health and safety of our employees and stakeholders who may be impacted by the company's operations is of paramount importance and our aim is zero harm to people and to the environment.

Vedanta Resources and its subsidiaries strive to:

- Comply with applicable national, regional and local Health, Safety and Environment ('HSE') regulations and statutory obligations and other requirements as appropriate. The company develops, implements and maintains HSE management systems aligned with our sustainable commitments and beliefs and consistent with world-class standards. We will drive continuous improvement in HSE through setting and reviewing targets, assessing and reporting HSE performance, using appropriate best available practices and providing all employees with appropriate training;
- Prevent injury and ill health to the company's employees and contractor' s employee's by providing a safe and healthy work environment and by minimising risks associated with occupational hazards;
- Improve and enhance environmental conditions and avoid, reduce, mitigate or compensate the environmental impacts to neighbouring communities in which we operate including air, water emissions and noise;
- Conserve natural resources, through adopting environmentally friendly and energy efficient technology and process improvements. The Company is committed to managing waste of our operations and we adopt the principles of waste avoidance, reuse, recycling and beneficial utilisation to minimise discharge and disposal to the environment;
- Promote a positive HSE culture within our organisation through effective communication, participation and consultation with employees in the workplace;
- Implement regular health surveillance and risk-based monitoring of all employees;
- Influence our contractors and suppliers to adopt principles and practices adopted by us and in accordance with our own policies;
- Communicate with all our stakeholders on the progress and performance of HSE management.

Vedanta Ltd. and Konkola Copper Mines (KCM) the wholly owned subsidiaries of Vedanta Resources sign this policy, which is implemented throughout their businesses. The content and robustness of implementation of this policy will be reviewed periodically and revised accordingly, and includes sharing best practices throughout the group.

We will also measure progress against this policy and review performance on a periodic basis to ensure ongoing management of Health, Safety and Environment.

Signed by:

Tom Albanese
Group CEO, Vedanta Resources plc

Date: *1st April 2014*

Figure 90. HSE Policy of Vedanta Limited

Ensure effective implementation of the Environmental Management Plan (EMP) through review and periodic up-dation;

Vedanta Limited (Division: Cairn Oil and Gas) would have the ultimate responsibility of implementing the environment management plan along with drilling contractor. The drilling contractor would have an HSE management system, which would be reviewed by Vedanta Limited (Division: Cairn oil and Gas) prior to implementation.

9.2 Air Quality Management Plan:

The Air Quality Management Plan (AQMP) encompasses both constructions, drilling and early production phase activities for the proposed project that has the potential to adversely affect ambient air quality due to the proposed project.

The AQMP establishes specific measures and guidelines aimed at effectively addressing and mitigating the air quality impacts that may arise as result of construction of well sites, production facilities and pipelines, drilling operations, operation of production facilities and decommissioning/site closure of well sites. The plan also details out roles and responsibilities of Vedanta Limited (Division: Cairn Oil & Gas) and the contractors to ensure effective implementation of the plan.

Mitigation Measures:

Phase	Mitigation Measures
Construction/ drill Site Preparation	**Designing, Planning & Procurement** • Storage and handling of construction material and debris would be carefully managed to prevent generation of fugitive dust; • All vehicles use in transportation of raw material and personnel would have valid Pollution under Control Certificate (PUC). Vehicular exhaust would be complying with the CPCB specified emission norms for vehicular Emission; • The top soil would be preserved suitably; • Adequate stack height would be provided to DG sets in accordance with CPCB standards. **Dust Suppression** • Sprinkling of water on earthworks, material haulage and transportation routes on a regular basis, especially in dry season.
Drilling and early production	**Operation of Machineries, Vehicle & Drilling Rig** • Exhausts of diesel/Gas generators would be positioned at a sufficient height to ensure dispersal of exhaust emissions; engines would not be left running unnecessarily; • Vehicles involved in the transportation of project personnel would have valid PUC Certificate and would be subjected to periodic preventive maintenance; **Periodic Maintenance of Machinery and Vehicles** • Preventive maintenance of GEG/DG sets would be undertaken; • Flaring would be undertaken in accordance with the CPCB Guidelines for Gaseous Emissions for Oil & Gas;

9.3 Waste Management Plan

The Waste Management Plan (WMP) is applicable for all process and non-process waste streams which are generated during various phases of Vedanta Limited (Division: Cairn Oil & Gas) proposed drilling and testing of hydrocarbons in this Block. The major waste streams covered under this plan includes drill cuttings, waste drilling mud, drilling wash water, kitchen waste and sewage. In addition, waste oil and lead acid batteries generated from the proposed project operations have also been dealt in this plan.

The WMP establishes specific measures to ensure proper collection, storage, treatment and disposal of the identified process and non-process waste streams in accordance with the applicable national regulations and guidelines and also to ensure compliance with Vedanta Limited (Division: Cairn Oil & Gas) corporate HSE Policy. The plan also outlines roles and responsibilities of both Vedanta Limited (Division: Cairn Oil & Gas) and the contractors involved in the implementation of the plan.

Mitigation Measures

The following mitigation measures need would be adopted and implemented by Vedanta Limited (Division: Cairn Oil & Gas) and its contractors for the major waste streams identified in the plan.

Waste	Quantity	Mitigation Measure
Drill Cuttings	Drill cuttings associated with WBM: 250-750 tons/well, Drill Cuttings associated with SBM (500-1500 tons/well)	• Drill cuttings separated from drilling fluid would be adequately washed and temporarily stored and disposed in an impervious pit lined by High Density Poly Ethelyn (HDPE) • All drill cuttings would be disposed as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016;
Spent WBM	250–500 tons/well	• The mud will be disposed as per CPCB standard prescribed for Oil and Gas industry or as specified by ASPCB
Waste oil/ Used oil	1-2 tons/well	• Hazardous waste (waste and used oil) would be managed in accordance with Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008. • This oil would be sent to authorized recyclers.
Municipal Solid Waste	25-30 kg/well	• The waste would be segregated at source (organic/inorganic) and disposed accordingly. • All kinds of waste would be disposed in accordance with the requirement of CPCB/ASPCB.
Sewage	16-25 m^3/day per well	• Sewage generated from campsite would be treated through mobile STP. • Treated waste water would be used for dust suppression, green belt, landscape, etc
Recyclables *viz*. paper, plastic, packaging waste etc.	Depending on usage	• Proper segregation and storage of recyclable waste in designated bins. • Recyclables would be periodically sold to local waste recyclers.
Non-combustible waste containing metallic residues	1000-1200 kg/well	• To be analysed for the trace/heavy metals content before disposing suitably
Left over chemicals and materials, scrap metal	250 - 500 kg/well	• Scrap metal and recoverable material to the salvages before dispose of balance material through the registered vendors
Cement, grit, blasting and painting wastes	500 - 600 kg/well	• To be disposed of their registered vendors on periodic basis.

9.4 Soil Quality Management Plan

Soil Quality Management Plan is applicable for construction of well sites, drilling operations, operation of early production facilities and decommissioning/site closure that has the potential to adversely impact the soil quality.

Mitigation Measures

Project Phase	Mitigation measures
Construction/Site Preparation	• Site preparation and road strengthening/widening activities would be restricted within defined boundaries. • Use appropriate machinery and/or protective boarding during top soil stripping to ensure minimum compaction. • Top soil will be stored properly for preservation. • Drip trays would be used during vehicular/equipment maintenance and during refueling operations.
Drilling	• Fuel and chemical storage areas would be paved and properly bunded. • Spill kits would be made available at all fuel and chemical storage areas. All spills/leaks contained, reported and cleaned up immediately. • Drip pans/trays would be used in areas identified having spillage potential but not limited to drill rig engine; electric generator engine; pumps or other motors; maintenance areas; fuel transfer areas. • In case of a spill, the spilled soil is would be removed and stored properly. • Management of drill cuttings, waste drilling mud, waste oil and domestic waste would be made in accordance with "*Waste Management Plan*"
Decommissioning/Site Closure	• Decommissioning at the end of project life/drilling would have some adverse impacts in terms of increase in soil erosion and would require adequate mitigation measures to minimize any adverse impacts. The mitigation measures would be similar to those outlined for construction phase activities as discussed earlier.

9.5 Spill / Release Management Plan

<u>Potential spill / release scenarios</u>

The following section details the potential spill scenarios associated with the drilling activities as well as the oil spill incident responses. Spill incidents from drilling activities can be classified into three types based on the level of response required. A description of the three types are as follows:

<u>Type 1</u>

A small oil or chemical spill incident which can respond to and can be controlled with the existing resources, equipment and resources at the site and without any further escalation. Most of the potential drill stage spill risks are Type 1. As the spill / release incident as the volumes involved are limited due to the extent of hydrocarbons or chemicals used or stored at site. Such possible incidents are likely to include:

- Diesel spills from refuelling i.e., drill rig - hose leaks, overfilling or connection/disconnection incidents.
- The use of liquid chemicals i.e., during drilling the volumes are limited by the storage containers used, drums etc.
- Hydraulic oil spill resulting from a split hydraulic hose or failed connector (moderate pressure, low volume lines).
- Drilling fluid leaks from tanks, pumps or other associated equipment within the closed loop recirculation system.

<u>Type 2</u>

Type 2 spill / release incidents are those that are beyond capability of the immediate resources on-site to effectively manage and contain, requiring additional external resources to assist with the response to the spill incident. Type 2 spill incidents may require initiate Emergency operations and would involve call out of the Fire Service (in the event of danger to people) and/or regional resources. For such potential spill incidents, the resources of the local administration or suppliers may be required. Such possible incidents are likely to include:

- Transportation incidents associated with the delivery of diesel or drilling fluids to site i.e., truck rollover or collision from external suppliers (drilling fluids and diesel).

- Complete failure of an on-site drilling fluid (base oil) storage tank(s).

Type 3

Type 3 spill / release incidents are significant spill incidents that escalate from a Type 1 or 2 and exceed the capabilities of the on-site and local administrative resources to respond, requiring a State /National response. An uncontrollable well blow out scenario would fall into this category.

Spill / Release Response Strategies

Spill / release response strategies for combating spill / release incidents include:

- Prevent or reduce further spillage.
- Monitoring and evaluation (no active intervention but the spill is under observation).
- Mechanical containment and recovery.
- Any combination of the above strategies.

A brief explanation of these various response strategies is provided in the following sections.

Prevent or reduce a spill / release incident

One of the first response actions, if safe to do so, is the isolation or prevention of the source of the spill / release in an attempt to limit any further discharge. Such first response actions can involve an emergency shutdown of the particular equipment, isolation of a valve or line causing the spill or providing some immediate containment to prevent the further spread of a spill / release. Such measures are only a first immediate response prior to a more coordinate effort being planned and undertaken.

Monitoring and Evaluation

Knowing the position of spillage / release source and having the ability to forecast its movement or direction is an essential component of spill response. Monitoring and evaluation is used to:

- Determine the location and movement of the spill / release (if any).
- Describe its appearance.
- Estimate the size and quantity of the spill / release
- Note changes in the appearance and distribution of the spill over time.
- Assess the potential threat to the environment and the resources required to combat the spill / release (more effective and coordinate response)

Mechanical Containment and Recovery

Mechanical containment and recovery is the restriction of a spill / release movement through the use of booms or some other form of physical barriers and its subsequent removal using skimmers and other mechanical means. These operations may be required for large spills or spills / release which may impact environmentally sensitive areas. This response option would be used if the spill / release:

- Threatens environmental sensitive areas, or
- The spill is unlikely would be removed by natural processes.

The feasibility of a containment and recovery response is dependent upon having surface pollution that is capable of being contained and recovered and having suitable conditions for equipment deployment. The spill containment plan shall be addressed in line with the recommendation of QRA analysis as prescribed in chapter 7.

Clean-up

Oil or chemical spills may be allowed to collect or strand on a specific location in order to assist with clean-up operations. Regardless of land type the spill impacts on, the method of clean-up is usually labour intensive. Once a spill is controlled in terms of isolating the source, a response to a spill normally changes from an emergency to a project and needs would be managed as such. This may involve earthmoving equipment used to recover the absorbed spill and contaminated soil. Such operations usually involve the collection of significantly greater volumes of material than was originally spilt.

Waste Management

Solid waste due to clean up operation would be collected and treated and disposed in line with the Hazardous Waste Guideline.

9.6 Noise Quality Management Plan

The noise control plan is applicable for construction of well sites, early production system, drilling operations and decommissioning/site closure of well sites.

The noise control plan to ensure specific measures to minimize noise levels in the project site as 75 dB(A) per CPCB noise rules. The plan also outlines roles and responsibilities of both Vedanta Limited (Division: Cairn Oil & Gas) and the contractors involved in the implementation of the plan.

Mitigation Measures

Project Phase	Mitigation measures
Construction/ Site Preparation	• Selection and use of low noise generating equipment equipped with engineering controls *viz*. mufflers, silencers etc. • All vehicles utilized in transportation of raw material and personnel would have valid Pollution under Control (PUC) Certificate • Periodic preventive maintenance of vehicles • Periodic preventive maintenance of equipment. • Engines of vehicles and construction equipment would be turned off when not in use for long periods.
Drilling	• Siting of drilling rig and facilities at safe distance from sensitive receptors *viz*. schools, settlements etc. • Installing acoustic enclosures and muffler on engine exhaust of DG sets to ensure compliance with generator noise limits specified by CPCB.
Decommissioning/Site Closure	• Management measures to address noise impacts with respect to operation of heavy equipment/machinery and movement of vehicles during decommissioning/site closure phase are similar to those discussed in the “Construction/site preparation Phase” of this section

9.7 Surface Water Quality Management

The Surface Water Quality Management Plan is applicable during construction of well sites, early production system, drilling operations, operation of early production facilities and decommissioning/site closure of well sites that has the potential to adversely affect the surface water quality.

The Surface Water Quality Management Plan establishes specific measures and guidelines aimed at addressing and mitigation of surface water quality impacts that may arise at different phases of the project.

Project Phase	Mitigation measures
Construction/Site Preparation	• During site preparation, surface water run-off would be managed through implementation of proper drainage system,
Drilling	• Drip trays would be used during preventive maintenance of rig installations, vehicles and machinery. • Hazardous chemicals and fuel container would be stored in bunded and lined area equipped with proper spill control equipment and secondary containment.
Decommissioning/Site Closure	No significant impacts to surface water quality can be associated with activities during decommissioning/site closure phase. Any possible impacts that may arise due to surface run-off would be mitigated in manner similar to that discussed during construction/site preparation phase activities.

9.8 Ground Water Quality Management Plan

Ground Water Quality Management Plan is applicable for construction of well sites and drilling operations, operation of early production facilities and decommissioning/site closure of well sites that has the potential to adversely affect the ground water quality.

Project Phase	Mitigation measures
Construction/ Site Preparation	• No significant impact on the ground water quality can be associated with the construction phase activities
Drilling	• Proper casing and cementing of well would be done to prevent contamination of aquifers. • Periodic monitoring of ground water quality would be carried out for surrounding wells located outside the project boundary to assess the level of ground water contamination, if any. • Storage and disposal of drill cutting, and waste mud would be planned in accordance with "*Solid & Hazardous Waste Management Plan*"
Decommissioning/Site Closure	No significant impacts to ground water quality can be associated with activities during decommissioning/site closure phase

9.9 Storm Water Management Plan

The following mitigation measures need would be adopted and implemented by Vedanta Limited (Division: Cairn Oil & Gas) and its contractors in construction, operation and decommissioning phase.

- Necessary measures would be undertaken during construction/site preparation phase to prevent earth and stone material from Blocking cross drainage structures.
- Periodic cleaning would be undertaken to cross drainage structures and road drainage system to maintain uninterrupted storm water flow.

9.10 Road Safety & Traffic Management Plan

Road Safety & Traffic Management Plan outlines specific measures would be adopted and implemented by Vedanta Limited (Division: Cairn Oil & Gas) to mitigate any potential impact on community health and safety that may arise out of movement of vehicles and transportation of drilling rig and other heavy equipment during construction, drilling and decommissioning of well sites.

Mitigation Measure

- Proper signage would be displayed at important traffic junctions along the predefined access routes.
- Traffic flows would be scheduled wherever practicable during period of increased commuter movement;
- Adequate training on traffic and road safety operations would be imparted to the drivers of project vehicles.

9.11 Occupational Health & Safety Management Plan

The Occupation Health & Safety Management Plan (OHSMP) has been formulated to address the occupational health and safety related impacts that may arise from proposed project activities viz. drilling and testing, operation of construction machinery/equipment, storage and handling of fuel and chemicals, and decommissioning/site closure.

Mitigation Measures

The following mitigation measure need would be adopted and implemented by Vedanta Limited (Division: Cairn Oil & Gas) and its contractors in construction, drilling, and early production and decommissioning phase.

- All workers would be provided with proper PPEs viz. safety boots, masks, protected glass etc.
- Provision of ear plugs/ear muffs etc. and rotation of workers operating near high noise generating areas, would be ensured.
- Hazardous and risk prone areas, installations, materials, safety measures, emergency exits, etc. would be appropriately marked in every conspicuous location.
- All chemicals and hazardous materials storage container would be properly labelled and marked according to national and internationally recognized requirements and standards. Materials Safety Data Sheets (MSDS) or equivalent data/information in an easily understood language must be readily available to exposed workers and first-aid personnel.
- Workplace to be equipped with fire detectors, alarm systems and fire-fighting equipment as per the requirement. Equipment shall be periodically inspected and maintained to keep in good working condition.
- Adequate sanitation facilities would be provided.
- Garbage bins would be provided in the camp and regularly removed, and the garbage disposed off in a hygienic manner.
- Training programs would be organized for the operational workforce regarding proper usage of PPEs, handling and storage of fuels and chemicals etc.

9.12 Flare & Illumination Management Plan

The glare from the flare and illumination not only cause visual impacts but also causes ecological impacts.

Work Zone Illumination

Low height, sodium vapour lamp that are most energy efficient can help to reduce the ecological impacts. Further, illumination would be provided only in required locations and has placed UV filters on lamps. Such UV filtered lights have been found would be less distractive to migrating birds.

9.13 Site Closure Plan

The site closure plan would identify all the activities which would be performed during the restoration of a well site in case the well is not economically viable, and no further use of that particular well bore is envisaged. Along with the well site the approach road connecting the well would be restored accordingly.

The following activities would be considered in the closure plan:

- Plugging & Abandonment of well: Close the well head properly to prevent any further leakage
- Decommissioning Phase: Removal of the materials form the site
- Waste/mud pit closure and reclamation
- Reinstatement Phase: regeneration of the land
- Handover Phase: Returning the land to the original owner

Plugging & Abandonment of well

As and when the well would be declared as unsuccessful / to be suspended /non-productive, plugging of the well would be performed to close and abandon the well to prevent any leakage of oil or gas.

Decommissioning

The decommissioning phase includes activities dismantling and removal of surface facilities from the well site and storage in the Material Dumping Area. The activities which are envisaged during this phase are:

- Waste Management: clean up the site and remove all waste materials e.g. HDPE liners, any waste material etc. The waste would be dumped in the designated area as per the guidelines of Assam State pollution control board.
- Road Restoration: The fill materials would be removed, and the site would be restored to previous conditions or as per recommendation of administrative department of Tehsil.

Waste and Mud Pit Closure and Reclamation

Following decommissioning and abandonment of the well site the waste and mud pits would be subject to closure through onsite burial of solids in accordance with lease and obligations and with local, state and national regulations. Reclamation of closed pits or any other temporary retaining pits, including reserve pits, would be carried out within a period of one year from well closure/abandonment. All such reclamation activities would be carried out based on the climatic conditions.

Reinstatement

The reinstatement phase includes all activities for preparation of the soil for plantation of trees at the concerned site. The preparation of topsoil and fertility regeneration of topsoil would be same as referred earlier. Site restoration shall be taken up matching to the surrounding land use pattern. Selection of plants for plantation would be undertaken based on the species that were cut down at the time of site preparation activities.

Table 9.1 Environmental Management Plan

Sl. No	Activity	Potential Impact	Management / Mitigation Measures	Responsibility
1	Land Procurement	• Loss of Income • Issues pertaining to compensation	If the identified lands are of private landowners then land lease mode would be applied and in case of govt. land, land allotment from Govt. would be applied. Initially temporary and short-term lease would be taken for 3 - 5 years for exploration purpose and in case of commercially viable discovery of hydrocarbon resources, the land lease would be converted into long term lease up till life of the project. For sites selected are having any settlements, Resettlement & rehabilitation (R&R) plan would be developed and implemented as per the applicable State/ Central Govt. policy. Compensation to affected landowners for any loss of land would be ensured by Vedanta Limited. (Division Cairn Oil & Gas). Vedanta Limited (Division Cairn Oil & Gas) would ensure the livelihood of local community, if any affected by the proposed land take, are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities.	Vedanta Limited (Division: Cairn Oil & Gas)
2	Site Clearance and Grading	• Dust Generation • Loss of top soil • Increased runoff • Loss of vegetation	• The final site selection would be done for site with minimum trees, and involving minimum cutting; • Top soil would be properly stored for future use. • Water sprinkling would be carried out while working in proximity of agricultural fields or settlements/habitations;	Vedanta Limited (Division: Cairn Oil & Gas)
3	Construction of Drill Site	• Handling of excess earth material; • Noise generation • Increase in traffic volumes • Health & Safety risks	• Temporary storage sheds would be provided for construction material such as cement; • Excavated soil would be used during site preparation; • Provision and usage of adequate PPEs to workers as applicable and identified for the respective activity.	• Vedanta Limited (Division: Cairn Oil & Gas) • Civil Contractors
4	Constriction Camp of Site	• Crane overturning/Collapse • Falling Objects • Health & Safety risks	• Surface conditions would be examined prior to movement of crane; • Provision and usage of adequate PPEs to workers as applicable and identified for the respective activity.	• Vedanta Limited (Division: Cairn Oil & Gas) • Civil Contractors
5	Transportation of Drilling Components and Rig	• Congestion of roads • Road accidents • Vehicular emissions • Damage to road conditions • Oil leaks	• Only trained drivers with knowledge of on defensive driving would be involved in the movement of rigs. • All movement of major equipment would be scheduled in the lee hours keeping consideration of the traffic movement in the connecting major arterial road. • Local administration and village administration as applicable would be informed during movement of rigs through village roads;	• Contractor - HSE • Vedanta Limited (Division: Cairn Oil & Gas)
6	Drilling and Well Testing	• Additional stress on the local water resources;	• Water would be sourced from the locally approved source or ground water would be withdrawn prior approval of CGWA	• Vedanta Limited (Division: Cairn Oil & Gas)
		• Potential for contamination due to handling, storage and transportation of wastes	• Two separate Drill cutting disposal pits would be provided for WBM and SBM cuttings; • Drill waste pits would be provided with HDPE lining on bottom and side surfaces; • Used hazardous chemical barrels, used oil and other hazardous waste would be sent to ASPCB authorized recyclers;	• Vedanta Limited (Division: Cairn Oil & Gas) • Drilling contractor- HSE

Sl. No	Activity	Potential Impact	Management / Mitigation Measures	Responsibility
			• Vedanta Limited (Division: Cairn Oil & Gas) to also explore disposing drill cuttings containing for co-processing as alternate fuel and or raw material (AFR) in cement industry based on suitability and availability.	
		• Generation of noise	• Equipment upkeep and regular maintenance to minimise noise generation from all rotary equipment; • PPE's such as ear plugs, muffs would be provided to workers at site; • Periodic maintenance of vehicles and machinery would be undertaken; • DG sets would be provided with acoustic enclosures as per requirements under CPCB guideline.	• Vedanta Limited (Cairn Oil & Gas) • Drilling contractor- HSE
		• Air emissions	• All the emitting stacks including the flare pit shall be positioned orthogonal direction to the prevailing wind direction; • Cold venting of gas not would be carried out. • Adequate stack heights would be provided for generators, adhering to the CPCB standards for diesel generators;	• Vedanta Limited (Division: Cairn Oil & Gas) • Drilling contractor- HSE
		• Influx of migrant labour • Conflict with local community	• Migrant labour would be sensitized towards customs and traditions of the local population;	• Vedanta Limited (Division: Cairn Oil & Gas) • Drilling contractor- HSE
		• Occupational Health & Safety Risks	• Blowout preventers would be provided; • Flare pit would be placed at a safe distance from the well head and fuel storage areas; • Firefighting measures would be provided near all welding operations;	• Vedanta Limited (Division: Cairn Oil & Gas) Project Team Drilling contractor- HSE
7	Operation of Campsites	• Stress on water resources; • Potential contamination from generation of biomedical waste • Wastewater generation • Waste generation	• Safe drinking water to be provided at campsites; • All waste would be collected in bins located near each set of porta cabins. Segregation of waste at the source of generation would be put in practice. • All hazardous waste would be collected and stored on secure and paved area, and subsequently sent to authorised recyclers • Food waste would be stored in a closed container; • STP would be provided for campsites. • Waste generation would be separated and disposed of as per the regulatory requirements.	• Vedanta Limited (Division: Cairn Oil & Gas) • Drilling contractor- HSE
8	Operation of WMB and SBM mud plant and warehouses	• Waste generation • Potential contamination due to mud preparation • Dust due to stacking of the materials • Emission due to the forklifts and crane usages	• Effective stacking of the materials would be followed to protect from the environmental situations such as wind, rain and sunlight • If area not paved, then periodic sprinkling shall be carried out • All diesel operated generators shall have acoustic enclosures and effective stack heights • Waste shall be effectively segregated at the source of generation and disposed as per the waste management plan • All the vehicles would be operated inside the mud plant and warehouse shall follow all the HSE requirements to protect environment and have safety operations such as load test, proper maintenance etc.	• Drilling Warehouse Manager • Drilling Logistics Manager

Sl. No	Activity	Potential Impact	Management / Mitigation Measures	Responsibility
9	Decommissioning and Abandonment	• Demolition of drill cutting pits;	• A site restoration approved plan shall be prepared with the detailed checklist; • All drill cuttings, spent mud, waste oil and other waste would be completely removed from the site and sent to designated disposal place prior to commencement of demolition work; • All concrete or steel installations would be removed to at least 1 m below ground level, so as to ensure that there would be no protruding surface structures. The casing wellhead and the top joint of the casings would be cut below the ground level and capped with a cement plug. • Prior to commencement of any demolition, a planned programme of site clearance would be formulated. All pits, cellars and holes would be removed and filled to ground level, any oil or otherwise contaminated soil would be removed and disposed to suitably.	• Vedanta Limited (Division: Cairn Oil & Gas) • Drilling contractor- HSE

9.14 Corporate Environment Responsibility

The company would comply with the 1st May 2018 OM of Government of India w.r.t. CER and the cost would be assessed on actual project capex expenditure of that particular financial year.

9.15 EMP Budget

Table 9.2 EMP Budget

Sl. No.	Particulars of Work	Budget (in lakh Rs.)
1	**Air Quality Management Plan**	
a.	Dust suppression through water sprinkling in the internal unpaved roads (@Rs. 10000 per month x 6 months)	0.6
b.	Ambient Air Quality Monitoring -4 monitoring location x 2 weeks per location x 2 times during drilling (@ Rs.7500 x 16 samples)	1.2
c.	Stack emission monitoring (@ 5000 per sample x 3 DG sets x twice during drilling) @5000 X 6 samples	0.3
2	**Noise Monitoring**	
a.	Ambient Noise Monitoring – 3 locations, 2 times during drilling (@Rs. 2500 X 6 samples)	0.15
b.	Workplace noise monitoring -5 locations per well, twice during drilling (@Rs.2500 per location x 5 locations x 2 times)	0.25
3	**Water Quality**	
a.	Surface Water Quality Monitoring (@ Rs. 5000 x 3 samples from natural drainages once during drilling)	0.15
b.	Ground Water Quality Monitoring (@ Rs. 5000 x 3 sites once during drilling)	0.15
4	**Soil Quality Monitoring (@ Rs. 5000 x 3 samples x once during site construction and drilling)**	0.3
5	**Road Safety & Traffic Management**	
a.	Signage in the transport route & its maintenance (Rs. 100,000 + Rs. 10,000)	1.1
b.	Deployment of traffic personnel in sensitive area – 10 persons (@ Rs. 6000 per month x 6 months)	3.6
6	**Municipal Solid Waste**	
a.	Provision of collection bins at well site – 2 nos	0.2
b.	Transport arrangement of waste from well sites to dumping area	0.25
7	**Hazardous waste management**	
a.	Construction of dedicated hazardous storage area and record maintenance (construction included under project cost; only maintenance included in this budget)	0.1
b.	Drill Cutting, waste mud and wash water pits; HDPE lined (budgetary provision in operation cost of drilling)	0
8	**Surface and Ground Water Protection and Management**	
a.	Surface runoff control measures for chemical storage area, fuel storage area (budgetary provision is already taken care in earlier section)	0

Sl. No.	Particulars of Work	Budget (in lakh Rs.)
b.	Paved /impervious storage area for chemical storage area, fuel & lubricant storage area (Budgetary provision is already included in the infrastructure development cost)	0
c.	Domestic waste water treatment facility through septic tank & soak pits at the drill sites (budgetary provision in operation cost of drilling)	0
9	**Occupational Health & Safety Management**	
a.	Provision of appropriate PPE to all workers and its maintenance (budgetary provision is included in operational cost of drilling)	0
b.	Provision of drinking water, sanitation facility for all workers (budgetary provision is included in operational cost of drilling)	0
c	Provision First aid facility (budgetary provision is included in operational cost of drilling)	0
d	Regular occupational health & safety training	0.5
	Total Cost of Implementation of EMP	**8.85**

10. Conclusion and Recommendation

AA-ONHP-2017/11 Block is located in Golaghat and Jorhat districts in the state of Assam and covers a total area of 785 Sq. Km. Vedanta Limited (Division: Cairn Oil & Gas) propose to carry out Exploration and Appraisal Drilling activities in the Block, wherein 11 drilling (exploratory and appraisal) wells are proposed would be drilled over 10-12 years. In case of successful discovery of crude oil, setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) for produced well fluid processing and production of up to 8000 BOPD crude oil and 1.6 MMSCFD of associated natural gas for captive power generation.

ToR has been approved by MoEF&CC dated on 4th May, 2019 and MoEF&CC vide File No..IA-J-11011/132/2019-IA-II(I)..The baseline monitoring and all primary data collection was conducted for the summer season (from March to May), of 2019, as per the requirements of the ToR. Draft EIA report has been prepared for conducting the public hearing. After Public hearing concern and suggestion of local people would be incorporated and Final EIA report would be prepared.

The Final EIA report has assessed the overall significance of environmental impacts likely to arise from drilling of proposed exploratory and appraisal wells and addressed the concerns and suggestions of the community during the public hearing. The overall impacts from the individual drilling sites have been assessed and are found to be of moderate to minor in nature when appropriate mitigation measures would be implemented with proper planning and design.

To adequately address the impacts, mitigation measures and management plans suggested are as per the best practices followed in the Oil & Gas exploration Industry. These plans include environmental management plan, monitoring plan, labour management plan, traffic management plan. Vedanta Limited (Division: Cairn Oil & Gas) shall put in place a robust mechanism with adequate resources to implement the suggested mitigation measures and management plans. The measures would help to prevent any deterioration of quality of air, soil, groundwater and surface water beyond the prevailing status. Adequate safety measures would be adopted along with suitable emergency response and disaster management plan to safeguard against all man-made and natural disasters. Environmental monitoring of ambient air quality, noise levels, surface & groundwater etc. would be carried out at regular intervals to monitor and prevent any deterioration of baseline environmental quality due to the proposed project.

Compliance to all legal requirements and adherence to the suggested mitigation measures and plans would also enable Vedanta Limited (Division: Cairn Oil & Gas) in minimizing its impact on environmental and social parameter. This Report in the final form is being submitted to MoEF&CC for obtaining Environmental Clearance (EC) of the proposed project before commencement of site activity.

11. Disclosure of Consultants

AECOM has been accredited as EIA consultant for various sectors including Offshore and Onshore Oil and Gas Exploration and Development Projects from the National Accreditation Board for Education and Training (NABET) of Quality Council of India (QCI) under the Accreditation Scheme for EIA Consultant Organisations as per MoEF&CC requirements.

The following approved consultants and experts were engaged for preparation of the EIA report for the proposed study.

Table 11.1 EIA Team

S. No.	EIA Coordinator/ Functional Area	Professionals Environment Coordinator/FAE	FAA and Team Members	Signature
1	EIA Coordinator –Onshore Oil and Gas Exploration and Development Projects	Souvik Basu	Avijit Sarkar (Associate EIA Coordiantor)	
Core Functional Areas				
2	Water Pollution Monitoring, Prevention & Control (WP)	Avijit Sarkar	Swagata Mukherjee Aziz Hasan Moudipta Banerjee	
3	Ecology & Biodiversity (EB)	Mainak Majumder		
4	Socio- Economic Aspects (SE)	Souvik Basu		
Significant functional areas				
5	Solid and Hazardous Waste Management (SHW)	Chetan Zaveri	Moudipta Banerjee Vandana Singh	
6	Meteorology, Air Quality Modelling & prediction (AQ)	Shunvangi Jadavr	Swagata Mukherjee Shweta Chahar	

S. No.	EIA Coordinator/ Functional Area	Professionals Environment Coordinator/FAE	FAA and Team Members	Signature
7	Risk and Hazards Management (RH)	Akhilesh Prasad	Debsagar Das	Debsagar Das
8	Air Pollution Monitoring, Prevention & Control (AP)	Avijit Sarkar	Shivnath Chalka Aziz Hasan Swagata Mukherjee	Aziz Hasan Swagata Mukherjee
9	Hydrology, Ground Water & Water Conservation (HG)	Shiv Pratap Unya		
10	Noise &Vibration (NV)	Atul Kumar	Swagata Mukherjee Debsagar Das Aziz Hasan	Atul Kumar Swagata Mukherjee Debsagar Das Aziz Hasan
11	Land Use (LU)	Laxmi Reddy	Moumita Dey	Moumita Dey
12	Soil Conservation (SC)	Chetan Zaveri	Moumita Dey	Moumita Dey

Quality Council of India

National Accreditation Board for Education & Training

CERTIFICATE OF ACCREDITATION

AECOM India Private Limited

9/F, Infinity Tower – 'C', DLF Cyber City, DLF Phase – II,
Gurgaon – 122002

Accredited as **Category - A** organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA-EMP reports in the following Sectors:

Sl. No.	Sector Description	Sector (as per) NABET	MoEFCC	Cat.
1	Mining of minerals including Open cast/ Underground mining	1	1 (a) (i)	A
2	Offshore and onshore oil and gas exploration, development & productions	2	1 (b)	A
3	River Valley projects	3	1 (c)	A
4	Thermal power plants	4	1 (d)	A
5	Metallurgical industries - ferrous only	8	3 (a)	A
6	Cement plants	9	3 (b)	A
7	Coke oven plants	11	4 (b)	A
8	Chemical Fertilizers	16	5 (a)	A
9	Synthetic organic chemicals industry	21	5 (f)	A
10	Oil & gas transportation pipeline	27	6 (a)	A
11	Air ports	29	7 (a)	A
12	Industrial estates/ parks/ complexes/ Areas, (EPZs),	31	7 (c)	B
13	Ports, harbours, break waters and dredging	33	7 (e)	A
14	Highways	34	7 (f)	A
15	Common municipal solid waste management facility (CMSWMF)	37	7 (i)	B
16	Building and construction projects	38	8 (a)	B
17	Townships and Area development projects	39	8 (b)	A

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated October 05, 2018 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/18/0799 dated November 19, 2018.The accreditation needs to be renewed before the expiry date by AECOM India Private Limited, Gurgaon, following due process of assessment.

Sr. Director, NABET
Dated: Nov. 19, 2018

Certificate No.
NABET/ EIA/1821/ RA 0108

Valid till
13.01.2021

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

Figure 91. QCI-NABET Certificate

APPENDIX

List of Appendix

Appendix 1.1:
ToR Letter

No.IA-J-11011/93/2019-IA-II(I)

Goverment of India

Minister of Enviroment,Forest and Climate Change

Impact Assessment Division

***

Indira Paryavaran Bhavan,
Vayu Wing,3rd Floor,Aliganj,
Jor Bagh Road,New Delhi-110003
18 Apr 2019

To,

M/s Cairn India Limited
Cairn Oil & Gas, Vedanta Limited, DLF Atria, DLF Phase-2, DLF City, Gurgaon, Haryana - 122002Gurgaon,
Gurgaon-122002
Haryana

Tel.No.124-4594176; Email:dilipkumar.bera@cairnindia.com

Sir/Madam,

This has reference to the proposal submitted in the Ministry of Environment, Forest and Climate Change to prescribe the Terms of Reference (TOR) for undertaking detailed EIA study for the purpose of obtaining Environmental Clearance in accordance with the provisions of the EIA Notification, 2006. For this purpose, the proponent had submitted online information in the prescribed format (Form-1) along with a Pre-feasibility Report. The details of the proposal are given below:

1. Proposal No.:	IA/AS/IND2/99398/2019
2. Name of the Proposal:	Onshore Oil and Gas Exploration and Appraisal in AA-ONHP-2017/4 block in Jorhat District, Assam, Wokha & Mokokchung Districts, Nagaland
3. Category of the Proposal:	Industrial Projects - 2
4. Project/Activity applied for:	1(b) Offshore and onshore oil and gas exploration, development & production
5. Date of submission for TOR:	15 Mar 2019

In this regard, under the provisions of the EIA Notification 2006 as amended, the Standard TOR for the purpose of preparing environment impact assessment report and environment management plan for obtaining prior environment clearance is prescribed with public consultation as follows:

1(b):STANDARD TERMS OF REFERENCE FOR CONDUCTING ENVIRONMENT IMPACT ASSESSMENT STUDY FOR OFFSHORE AND ONSHORE OIL AND GAS EXPLORATION, DEVELOPMENT AND PRODUCTION PROJECTS AND INFORMATION TO BE INCLUDED IN EIA/EMP REPORT

B. STANDARD TOR FOR ONSHORE OIL AND GAS EXPLORATION, DEVELOPMENT & PRODUCTION

1. Executive summary of a project.
2. Project description, project objectives and project benefits.
3. Cost of project and period of completion.
4. Site details within 1 km of the each proposed well, any habitation, any other installation/activity, flora and fauna, approachability to site, other activities including agriculture/land, satellite imagery for 10 km area. All the geological details shall be mentioned in the Topo sheet of 1:40000 scale, superimposing the well locations and other structures of the projects. Topography of the project site.
5. Details of sensitive areas such as National Park, Wildlife sanctuary and any other eco-sensitive area alongwith map indicating distance.
6. Approval for the forest land from the State/Central Govt. under Forest (Conservation) Act, 1980, if applicable.
7. Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).
8. Distance from nearby critically/severely polluted area as per Notification, if applicable. Status of moratorium imposed on the area.
9. Does proposal involve rehabilitation and resettlement? If yes, details thereof.
10. Environmental considerations in the selection of the drilling locations for which environmental clearance is being sought. Present any analysis suggested for minimizing the foot print giving details of drilling and development options considered.
11. Baseline data collection for air, water and soil for one season leaving the monsoon season in an area of 10 km radius with centre of Oil Field as its centre covering the area of all proposed drilling wells.
12. Climatology and Meteorology including wind speed, wind direction, temperature rainfall relative humidity etc.
13. Details of Ambient Air Quality monitoring at 8 locations for PM2.5, PM10, SO2, NOx, CO, VOCs, Methane and non-methane HC.
14. Soil sample analysis (physical and chemical properties) at the areas located at 5 locations.
15. Ground and surface water quality in the vicinity of the proposed wells site.

16. Measurement of Noise levels within 1 km radius of the proposed wells.
17. Vegetation and land use; flora/fauna in the block area with details of endangered species, if any.
18. Incremental GLC as a result of DG set operation, flaring etc.
19. Potential environmental impact envisaged during various stages of project activities such as site activation, development, operation/ maintenance and decommissioning.
20. Actual source of water and 'Permission' for the drawl of water from the Competent Authority. Detailed water balance, wastewater generation and discharge.
21. Noise abatement measures and measures to minimize disturbance due to light and visual intrusions.
22. Details on wastewater generation, treatment and utilization /discharge for produced water/ formation water, cooling waters, other wastewaters, etc. duringallprojectphases.
23. Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radio activematerials, other hazardous materials, etc. including its disposal options during all project phases.
24. Disposal of spent oil and lube.
25. Storage of chemicals and diesel at site. Hazardous material usage, storage and accounting.
26. Commitment for the use of water based mud (WBM) only
27. Oil spill emergency plans for recovery/ reclamation.
28. H2S emissions control.
29. Produced oil/gas handling, processing and storage/transportation.
30. Details of control of air, water and noise pollution during production phase.
31. Measures to protect ground water and shallow aquifers from contamination.
32. Whether any burn pits being utilised for well test operations.
33. Risk assessment and disaster management plan for independent reviews of well designed construction etc. for prevention of blow out. Blowout preventer installation.
34. Environmental management plan.
35. Total capital and recurring cost for environmental control measures.
36. Emergency preparedness plan.
37. Decommissioning and restoration plans.
38. Documentary proof of membership of common disposal facilities, if any.
39. Details of environmental and safety related documentation within the company including documentation and proposed occupational health and safety Surveillance Safety Programme for all personnel at site. This shall also include monitoring programme for the environmental.
40. A copy of Corporate Environment Policy of the company as per the Ministry's O.M. No. J-11013/ 41/2006-IA.II(I) dated 26th April, 2011 available on the Ministry's website.
41. Any litigation pending against the project and or any direction/order passed by any court of law against the project. If so details thereof.

***

Appendix 2.1: Revenue Sharing Contract

REVENUE SHARING CONTRACT

BETWEEN

THE GOVERNMENT OF INDIA

AND

VEDANTA LIMITED

UNDER

HYDROCARBON EXPLORATION AND LICENSING POLICY

WITH RESPECT TO CONTRACT AREA IDENTIFIED

AS BLOCK

AA-ONHP-2017/11

(K.K. Asokan)
US(E-II), MoPNG

Rama Shankar Kotatheya
DGH

(SEEMA TANDON)
VEDANTA LTD.

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APPENDICES

REVENUE SHARING CONTRACT
FOR ONLAND AREAS

This Contract made on this 1st October, Two thousand and Eighteen between:
The President of India, acting through the Joint Secretary (E) Ministry of Petroleum and Natural Gas (hereinafter referred to as "the Government") of the FIRST PART;

AND

Vedanta Limited, a company incorporated under the laws of India (hereinafter referred to as "**Vedanta**" or "**Contractor**") having its registered office at 1st Floor, C wing, Unit 103, Corporate Avenue Atul Projects, Chakala, Andheri (East) Mumbai, Mumbai City Maharashtra-400093 India which expression shall include its successors and such assigns as are permitted under Article 26 hereof, of the SECOND PART;

WITNESSETH:

WHEREAS

(1) The Oilfields (Regulation and Development) Act, 1948 (53 of 1948) (hereinafter referred to as "the Act") and the Petroleum and Natural Gas Rules, 1959, made there under (hereinafter referred to as "the Rules") make provisions, inter alia, for the regulation of Petroleum Operations and grant of Licenses and Leases for exploration, development and production of Petroleum in India;

(2) The Rules provide for the grant of Licenses and Leases in respect of land vested in a State Government by that State Government with the previous approval of the Central Government;

(3) Rule 5 of the Rules provides for an agreement between the Government and the Licensee or Lessee containing additional terms and conditions with respect to the License or Lease;

(4) The Government desires that all types of Petroleum resources which may exist in India, whether within territorial waters (ultra-deep, deep or shallow water), exclusive economic zone, the continental shelf of India, or Onland, be discovered and exploited in accordance with Good International Petroleum Industry Practices (GIPIP) with utmost expedition in the overall interests of India;

(5) The Government has formulated and approved a new exploration and licensing policy named 'Hydrocarbon Exploration and Licensing Policy' ("HELP") vide Resolution dated 30.03.2016, whereby it has been determined to provide a uniform license to enable E&P operators to explore and extract all hydrocarbon resources including conventional and unconventional oil and gas resources including CBM, Shale Gas/Oil, Tight Gas, Gas Hydrates and any other resource to be identified in future which fall within the definition of 'Petroleum" and "Natural Gas" under the Rules;

(6) The Government, pursuant to HELP, invited companies to submit competitive bids to obtain the right to undertake exploration, discovery and commercial production of Petroleum resources within India, which would also be governed by Applicable Laws governing Petroleum Operations within India formulated by the Government;

(7) **Vedanta** has committed that it has, or will acquire and make available, the necessary financial and technical resources and the technical and industrial competence and experience necessary for proper discharge and / or performance of all obligations required to be performed under this Contract in accordance with Good International Petroleum Industry Practices (GIPIP) and will provide guarantees as required in Article 27 for the due performance of its obligations hereunder; and

(8) As a result of discussions between representatives of the Government and **Vedanta** on the bid submitted by **Vedanta**, the Government has agreed to enter into this Contract with **Vedanta** with respect to the Contract Area identified as Block **AA-ONHP-2017/11** and detailed in Appendix A and Appendix B (hereinafter referred to as "the Block") on the terms and conditions herein set forth.

NOW, THEREFORE, in consideration of the premises and covenants and conditions herein contained, IT IS HERE BY AGREED between the Parties as follows

ST

IN WITNESS WHEREOF, the representatives of the Parties to this Contract being duly authorized have hereunto set their hands and have executed these presents this 1st October, Two thousand and Eighteen.

Signed for and on behalf of the President of India

By: Amarnath

अमर नाथ / AMAR NATH
संयुक्त सचिव/Joint Secretary
पेट्रोलियम एव प्राकृतिक गैस मंत्रालय
Ministry of Petroleum & Natural Gas
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

In presence of

संजय कुमार जैन / SANJAY KUMAR JAIN
निदेशक / Director
पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय
Ministry of Petroleum & Natural Gas
भारत सरकार / Govt. of India
नई दिल्ली / New Delhi

Signed for and on behalf of Vedanta Limited

By:

In presence of

APPENDIX A

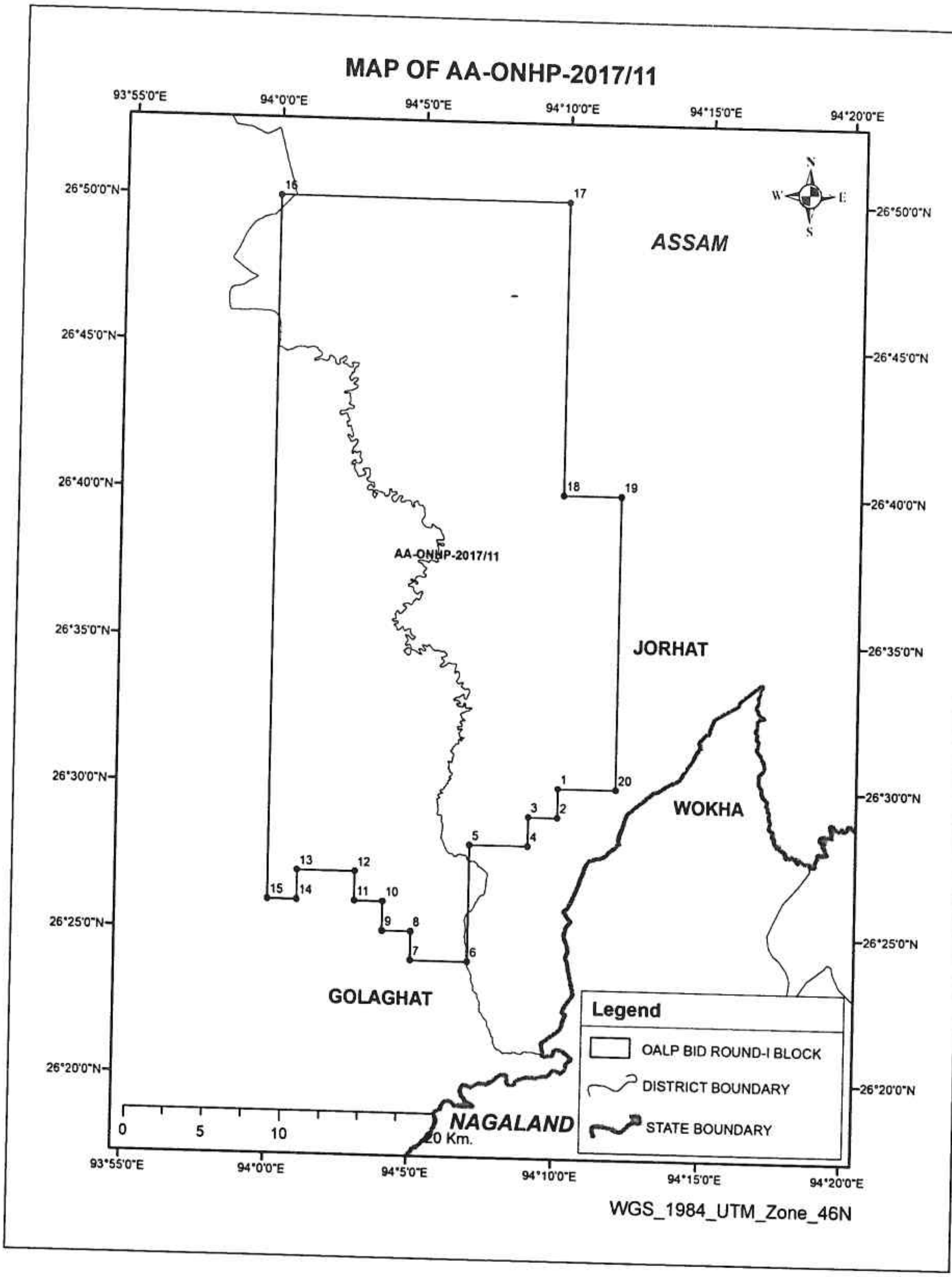
DESCRIPTION OF THE CONTRACT AREA

The area comprising approximately 785 Sq. km. onshore/offshore India identified as block AA-ONHP-2017/11 described herein and shown on the map attached as Appendix B ("Map of the Contract Area"). Longitude and latitude measurements commence at points 1, 2, 3...,20 are given below:

Points	Longitude	Latitude
1	94° 10'	26° 30'
2	94° 10'	26° 29'
3	94° 9'	26° 29'
4	94° 9'	26° 28'
5	94° 7'	26° 28'
6	94° 7'	26° 24'
7	94° 5'	26° 24'
8	94° 5'	26° 25'
9	94° 4'	26° 25'
10	94° 4'	26° 26'
11	94° 3'	26° 26'
12	94° 3'	26° 27'
13	94° 1'	26° 27'
14	94° 1'	26° 26'
15	94° 0'	26° 26'
16	94° 0'	26° 50'
17	94° 10'	26° 50'
18	94° 10'	26° 40'
19	94° 12'	26° 40'
20	94° 12'	26° 30'

APPENDIX B

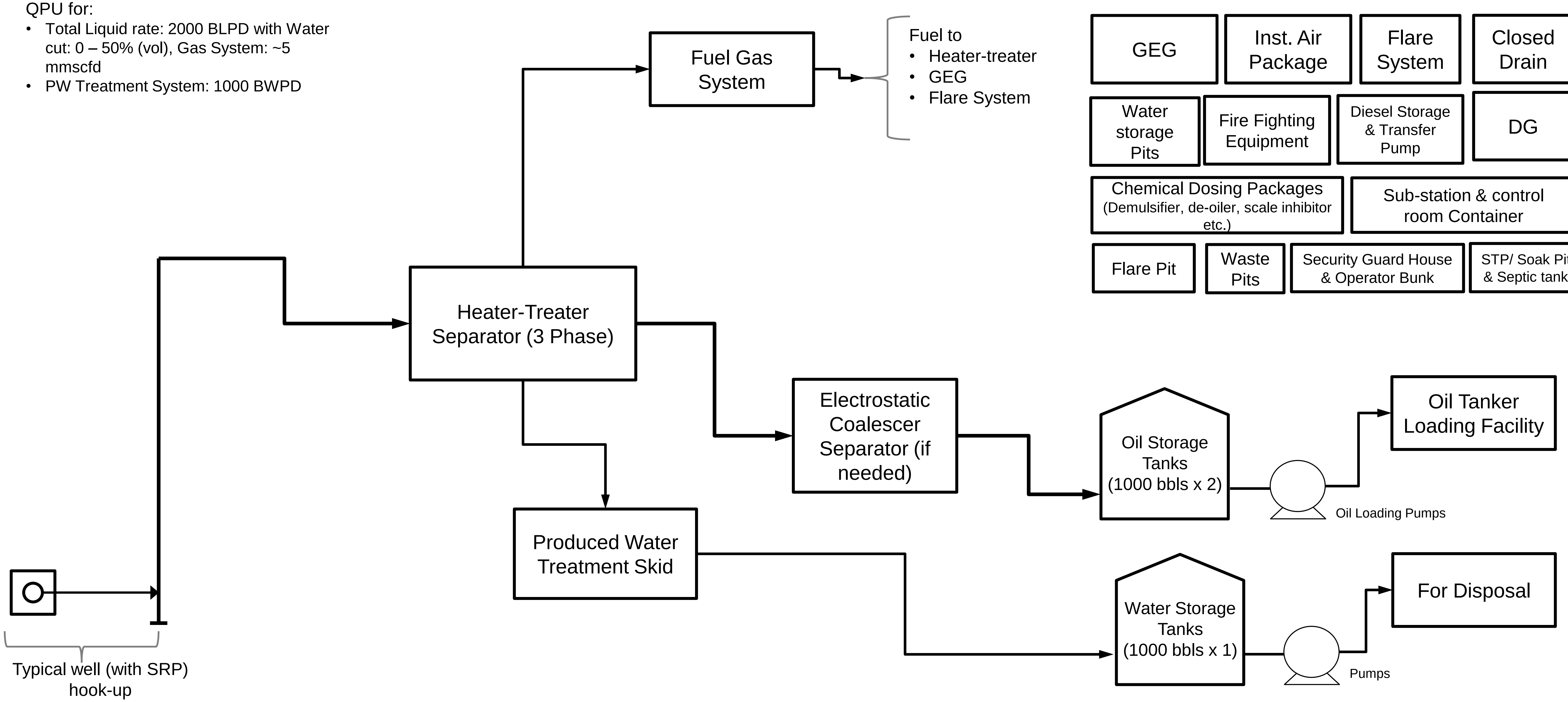
MAP OF THE CONTRACT AREA



Appendix 2.2: Process Flow Diagram

Quick Production Unit/ Early Production Unit (2000 BLPD)

QPU for:
- Total Liquid rate: 2000 BLPD with Water cut: 0 – 50% (vol), Gas System: ~5 mmscfd
- PW Treatment System: 1000 BWPD



Associated Utility Systems

GEG	Inst. Air Package	Flare System	Closed Drain
Water storage Pits	Fire Fighting Equipment	Diesel Storage & Transfer Pump	DG
Chemical Dosing Packages (Demulsifier, de-oiler, scale inhibitor etc.)	Sub-station & control room Container		
Flare Pit	Waste Pits	Security Guard House & Operator Bunk	STP/ Soak Pit & Septic tank

Appendix 2.3: Well Wise Environmental Settings

Sl. No	Well Name	Geographical Coordinates	HC Block	Admiration Setting			Existing Land cover of wells	Accessibility (in approx.)	Environmental Setting of Wells		Ecological Sensitivity		Settlement/ School within 1kms	Existing Industry	Existing facility	Map Reference (Annex 2.1)
				Village	Tehsil	District			Terrain Type	Stream / River	Forest	WLS/ ESZ				
1	1	26°26'36.54"N 94° 5'34.94"E		Bocha Gaon	Golaghat	Golaghat	Agricultural land	An unnamed road is 0.82 km west from the well location, which is connected with SH 33 towards north and SH 32 towards south. Some patch of settlement is present on the both sides of the primary approach road.	Flat land	NA	NA	NA	A small patch of settlement is present within .5 km radius of the well location, towards south. Mukoli Barichuwa LP school is present 1.34 km north west from the well location. Mokreng Habi, Sarukachari, Bebejia are the villages present within the 2.5 km radius of the well location.	NA	Athkhelia MPHC is present, 2.15 km north from the well location.	
2	2	26°32'6.57"N 94° 2'35.33"E		Dolakhuria	Golaghat	Golaghat	Agricultural land	An unnamed road is 0.39 km east from the well	Flat land	NA	NA	NA	Some scattered patch of settlement is present within	NA	Kamarbandha PHC is	

								location, which is connected to SH 33.					the .5 km radius of the well location. Bamun Gaon Jatiyo Vidyalay is present 1 km south from the well location. Bamun Gaon, Moida Moni, No. 2 Borjan are the villages present within the 2.5 km radius of the well location.		1.48 km south east from the well location. Kamarbandha Ali railway station is 1.75 km south west from the well location.	
3	3	26°35'19.44"N 94° 2'12.65"E		Dakhinhengera Grant No. 57	Golaghat	Golaghat	Agricultural land	An unnamed road is 0.26 km west from the well location, which has met with rhe connecting road of SH 34 and 33.	Flat land	NA	NA	NA	No such settlement is present within the .5 km radius of the well location and A dense patch of settlement is present at 1.73 km east from the well location. Borkhatoni high school is 1.74 km north	NA	Borkatonee Tea estate hospital is 1.83 km away from the well location towards north west.	

													west from the well location. And very near to the approach road. Borteng Nowholia, Dakhinhengra Grant, Hatiakhowa Gaon are the villages present within the 2.5 km radius of the well location.			
4	4	26°35'30.60"N 94° 8'30.53"E		Balipori a Gaon	Titabar	Jorha t	Agricultu ral land	An unnamed road is 1.14 south from the well location, which is connected with Dhodar Ali road.	Flat land	NA	NA	NA	No settlement is present within the .5 km radius of the well location, but moderate patch of settlements is present within around the well location, within 2.5 km	NA	Borbam Chungi Mini PHC is almost 3 km north west from he well location.	

													radius of the well location. Chakial Junction Basic School is 0.80 km south from the well location, and it is also very near to the approach road. Chakial Gaon, Bogar Gaon, Kharkhowa Gaon, Baliporia Gaon are the villages present within 2.5 km radius of the well location.			
5	5	26°37'32.55''N 94°10'34.04''E		Barhoi Bari Mahajan Gaon	Titabor	Jorhat	Agricultural Land	SH 32 is 0.81 km east from the well location.	Flat land	NA	NA	NA	No settlement is present within the .5 km radius of the well location, but there are	A small brick field is present almost 2.14 km south	No health care facility is present within 2.5 km	

													several clusters of settlements is present within 2.5 km radius of the well location. Jawahar Navodaya Vidyalaya is 2.37 km east from the well location. Kachari Gaon, Aoria Gaon, Ratanpur Gaon, Gajpuria Gaon are the villages present within the 2.5 km radius of the well location.	from the well location.	radius of the well location, A helipad is also present almost 2.5 km north of the well location.	
6	6	26°41'7.66''N 94° 9'5.19''E		Dhekelia Borasaikia	Jorhat West	Jorhat	Agricultural Land	A village road is 0.11 km south from the well location, which is connected	Flat land	NA	NA	NA	A little patch of settlement is present within the 0.27 km south from the well location.	NA	Chungi Kahargaon Model hospital is 2.50 km south east from the	

								with the SH 33. A rail track has crossed at a distance of 0.34 km north from the well location.					Bahek gaon LP school is 0.93 km north from the well location. Chaliha Gaon, Bahek Gaon, Dahotia Baruah are the villages present within 2.5 km radius of the well location.		well location.	
7	7	26°48'29.08"N 94° 1'56.44"E		Sarkari NC	Jorhat West	Jorhat	Agricultural Land	An unnamed road is 0.41 km south from the well location, which is connected with AT road.	Flat land	NA	NA	NA	Some settlements is present 0.18 km south west from the well location. Jonaki LP school and Namgorumora BB high school both are 1.17 km north from the well location, and very near to the approach road.	NA	Gorumara Hospital is 2 km away from the well location, which is also very near to the approach road.	

													Bhojkhati, Chari gaon, Dhankhuloi Gaon are the villages present within 2.5 km radius of the well location.			
8	8	26°43'56.15"N 94° 5'5.95"E		Tingtingia	Jorhat West	Jorhat	Agricultural land	Junction of AT road and Mohabondha road is 1.73 km south from the well location.	Flat land	NA	NA	NA	No settlement is present within .5 km radius of the well location. Some scattered settlement is present at the east and southern site of the well location, within 2.5 km radius of the well location. Kaziranga university is only 1 km away from the well location.	NA	Puranimati Subsidiary health centre is 2.28 km south east from the well location.	

													Rowmarikhuti, Bhurakala No.1, Randhanijan are the villages present within the 2.5 km radius of the well location.			
9	9	26°45'50.93"N 94° 8'13.82"E		Pohumora No. 2	Jorhat West	Jorhat	Agricultural land	A road through tea garden is present 1.19 km west frm the well location, which connects with NH 37.	Flat land	NA	NA	NA	Some tea tribe labour quarter of Sarusarai tea estate is present within .5 km radius of the well location, towards south. Malow Pathar Jatiya Vidyalaya is 1.47 km west from the well location, which is also very near to the approach road. Malow Khat, No.2	NA	A civil hospital is present almost 2 km south from the well location.	

													Sarucharai Gharfalia are the villages present within the 2.5 km radius of the well location.			
10	10	26°48'29.08"N 94° 1'56.44"E		Sarkari NC	Jorhat West	Jorhat	Agricultural land	An unnamed road is 0.41 km south from the well location, which is connected with AT road.	Flat land	A part of Brahmaputra river is present 1.88 km north from the well location.	NA	NA	No such settlement is present within the .5 km radius of the well location.But there are some cluster of settlement present at the south and eastern part of the well location. Jonaki LP school and Namgorumora BB high school both are 1.17 km north from the well location, and very near to	NA	Gorumara Hospital is 2 km away from the well location, which is also very near to the approach road.	

													the approach road. Bhojkhati, Chari gaon, Dhankhuloi Gaon are the villages present within 2.5 km radius of the well location.			
11	11	26°48'53.19"N 94° 6'32.94"E		Karang Chapari	Jorhat West	Jorhat	Agricultural land	Malow ali Road is 1.54 km east from the well location, which is connected with AT road.	Flat land	NA	NA	NA	No such settlements is present within the .5 km radius of the well location, but there are some clusters of settlements is present within the 2.5 km radius of the well location, towards north and south direction.	NA	New Deuri Sub centre is 1.53 km west from the well location.	

													Beloguri High school Kareng Gaon is present almost 1 km south from the well location. Upper Deori Gaon, Baghmaria, Lakheraj NC are the villages present within 2.5 km radius of the well location.			

Appendix 2.4: Environment Settings of Well (1km Buffer Map for Each Well)

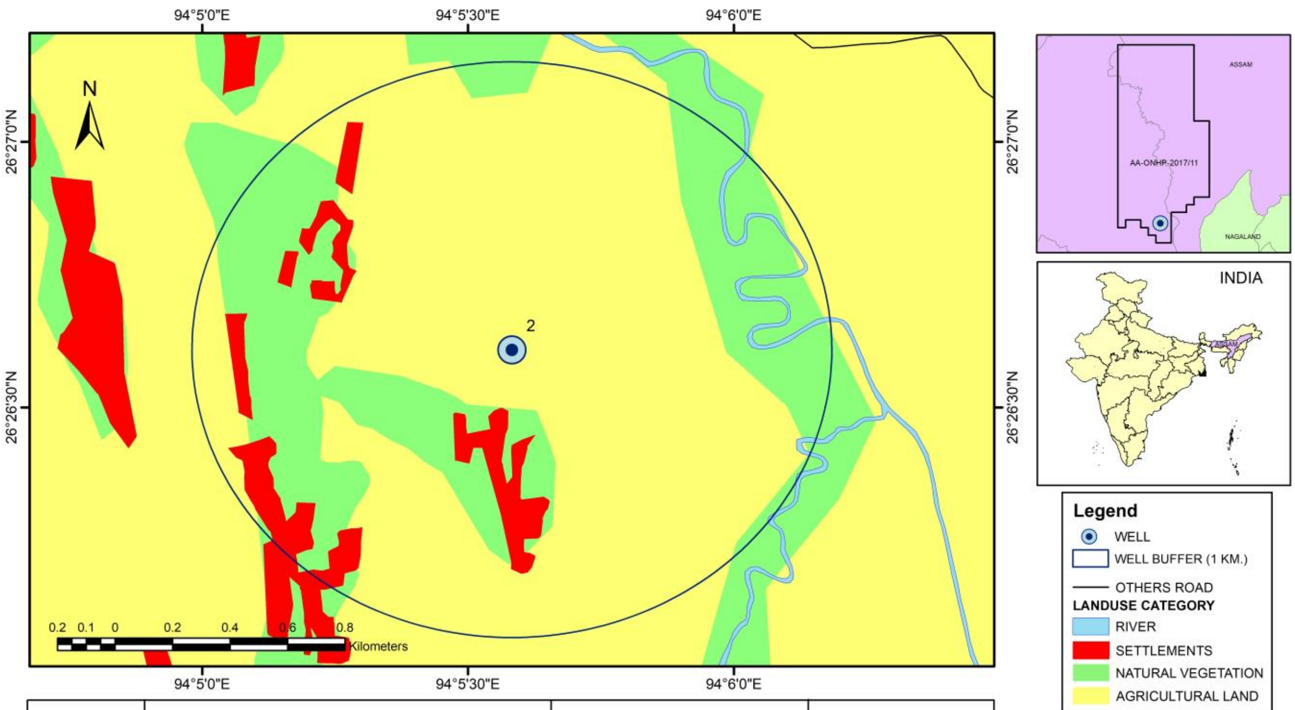


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 2	AECOM
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community

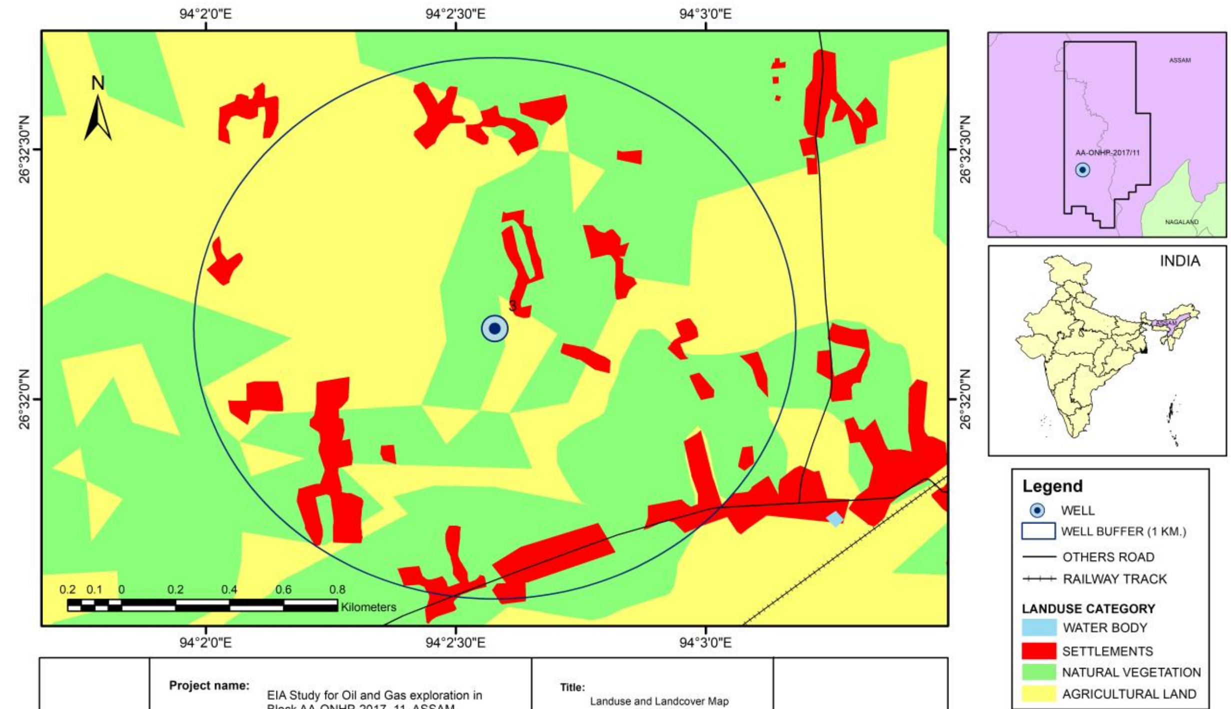


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM					Title: Landuse and Landcover Map of Well No. 3	AECOM
	Date:	Drawn By:	Checked By:	Approved By:	Client Name:	Source: Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community	
	28/08/2019	Moumita Dey	Souvik Basu	Avijit Sarkar	Vedanta Limited (Cairn Oil and Gas)		

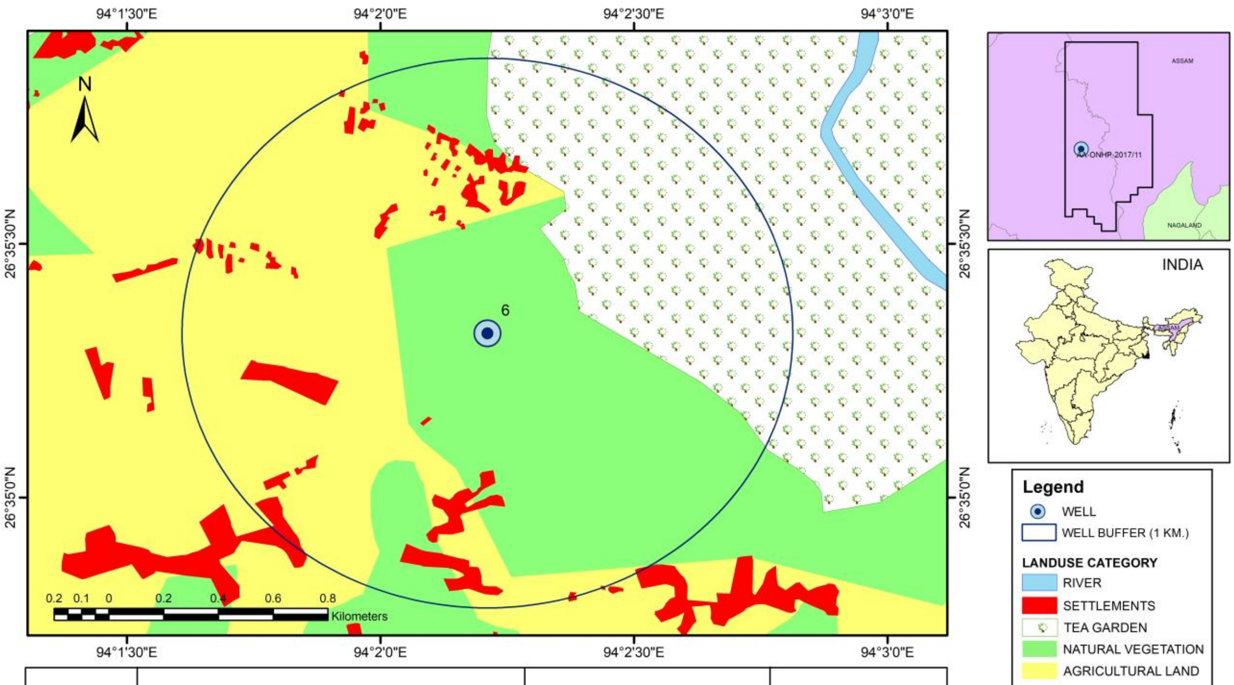


FIGURE NO	**Project name:** EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM					**Title:** Landuse and Landcover Map of Well No. 6	AECOM
	Date:	**Drawn By:**	**Checked By:**	**Approved By:**	**Client Name:**	**Source:**	
	28/08/2019	Moumita Dey	Souvik Basu	Avijit Sarkar	Vedanta Limited (Cairn Oil and Gas)	Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community	

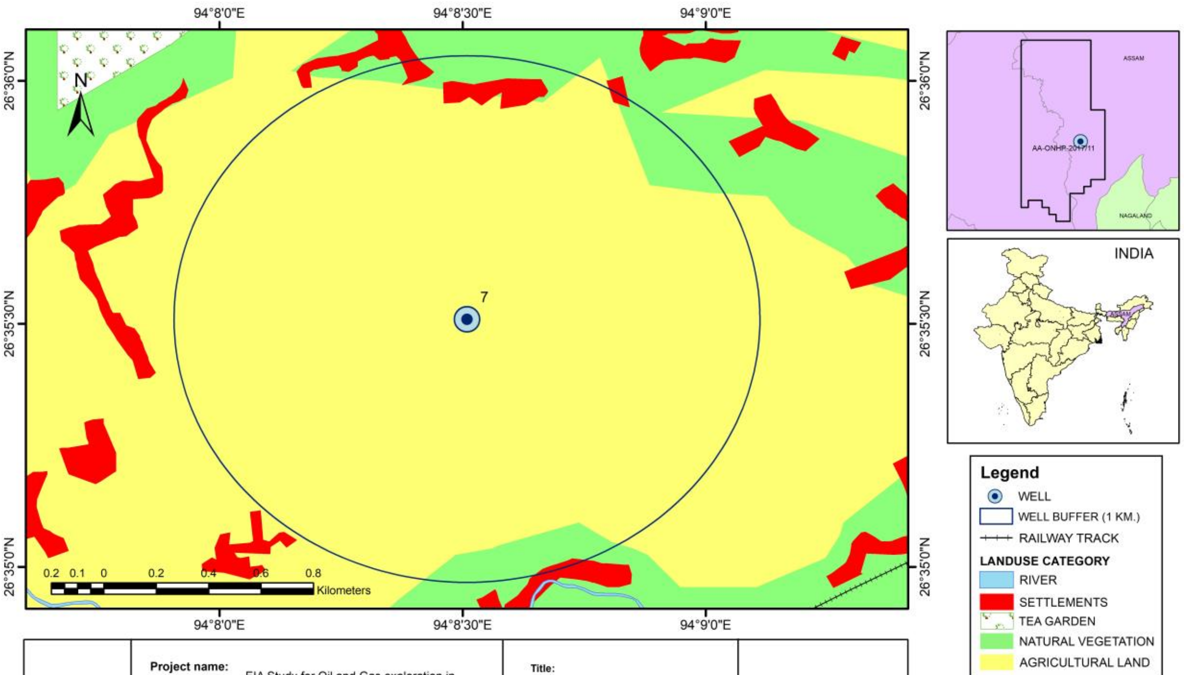
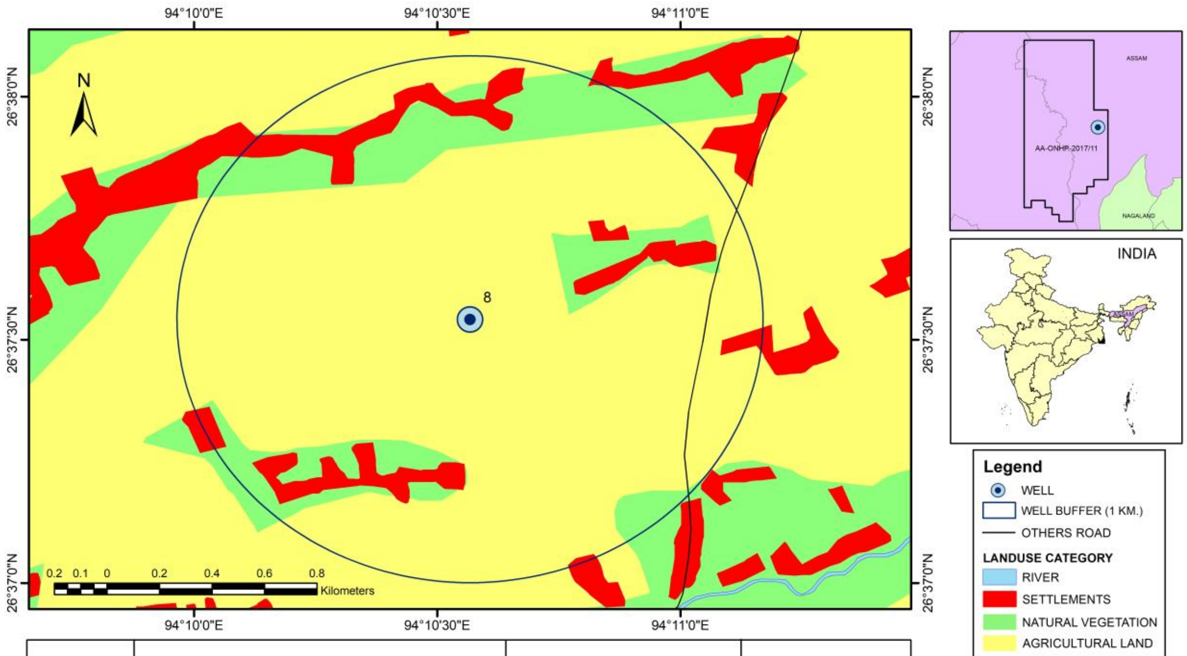


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 7	AECOM
	Date:	**Drawn By:**	**Checked By:**	**Approved By:**	**Client Name:**	**Source:**
	28/08/2019	Moumita Dey	Souvik Basu	Avijit Sarkar	Vedanta Limited (Cairn Oil and Gas)	Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community



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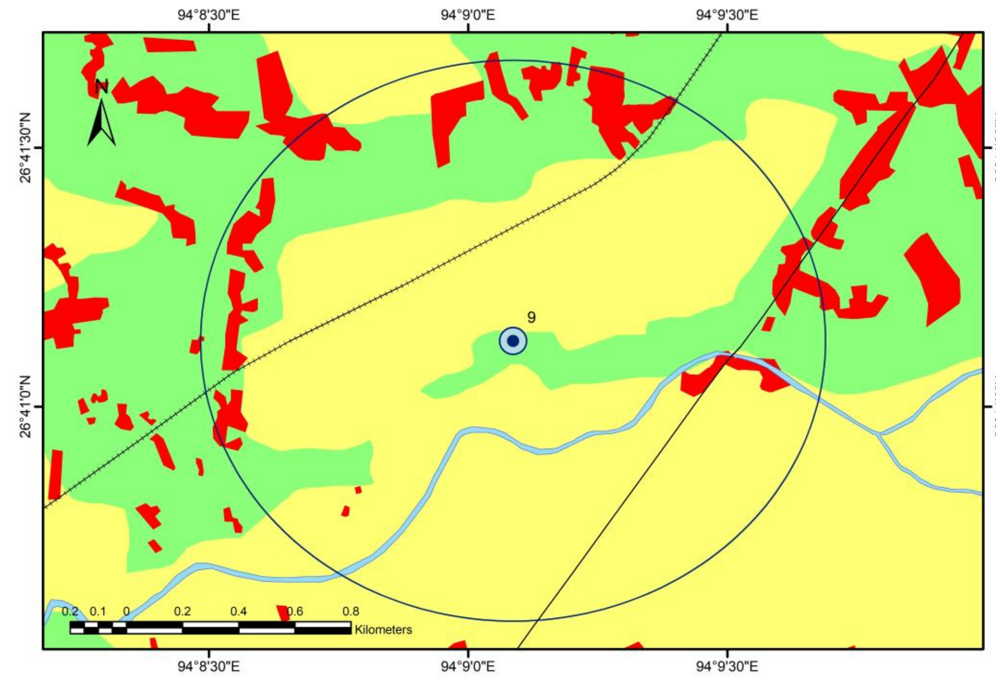
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community	



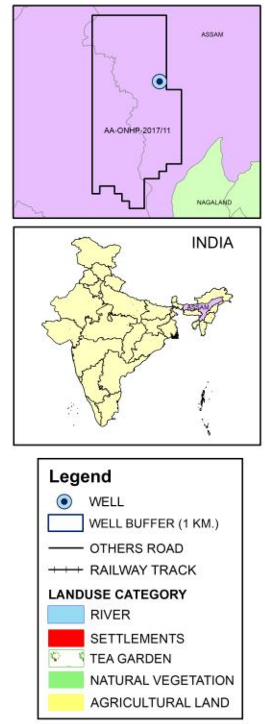


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 9	AECOM
	Date:	**Drawn By:**	**Checked By:**	**Approved By:**	**Client Name:**	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community
	28/08/2019	Moumita Dey	Souvik Basu	Avijit Sarkar	Vedanta Limited (Cairn Oil and Gas)	

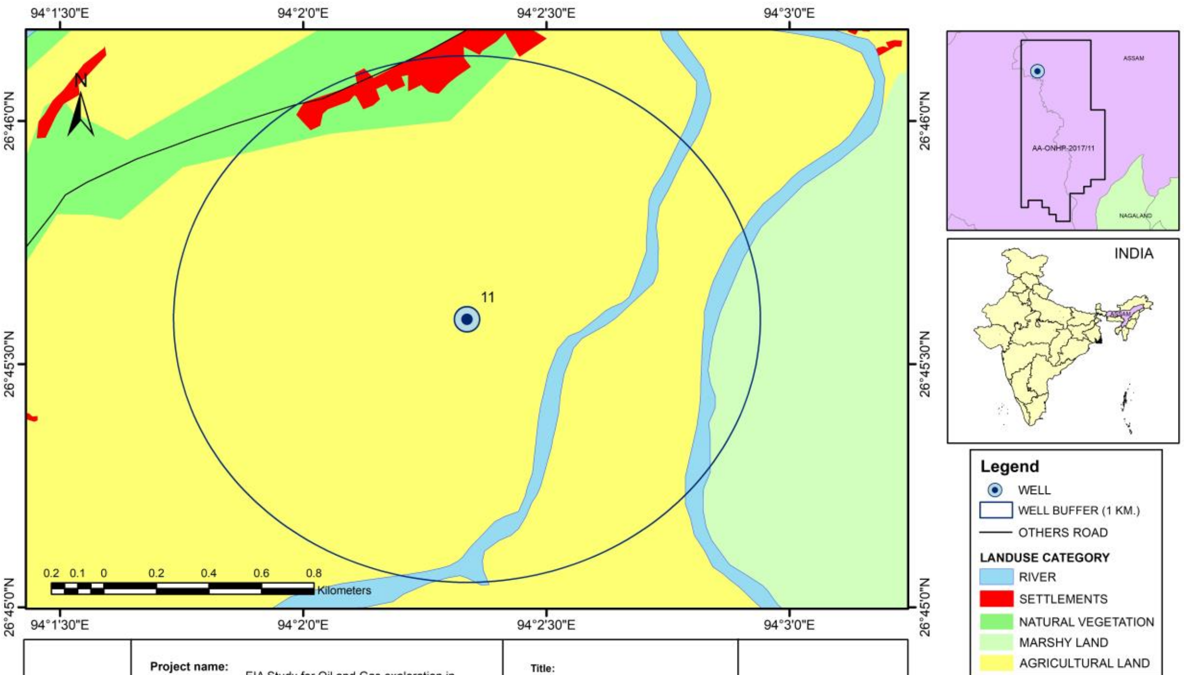


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 11	AECOM
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community

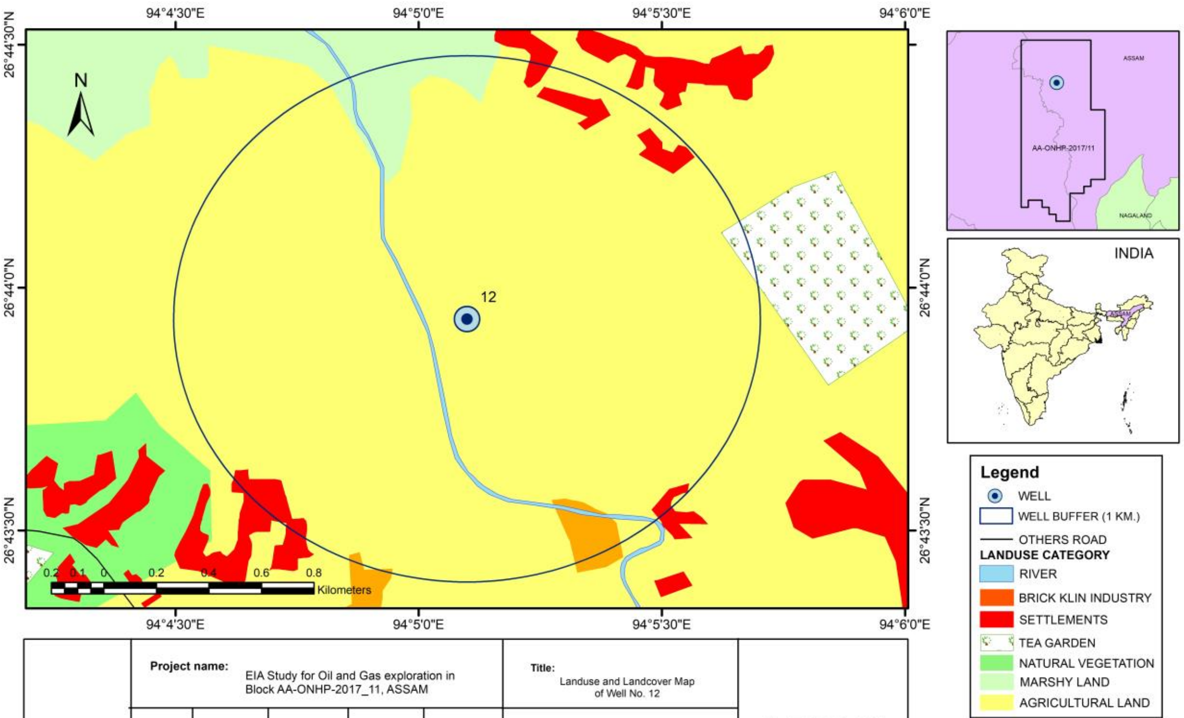


FIGURE NO	**Project name:** EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM					**Title:** Landuse and Landcover Map of Well No. 12	AECOM
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community	

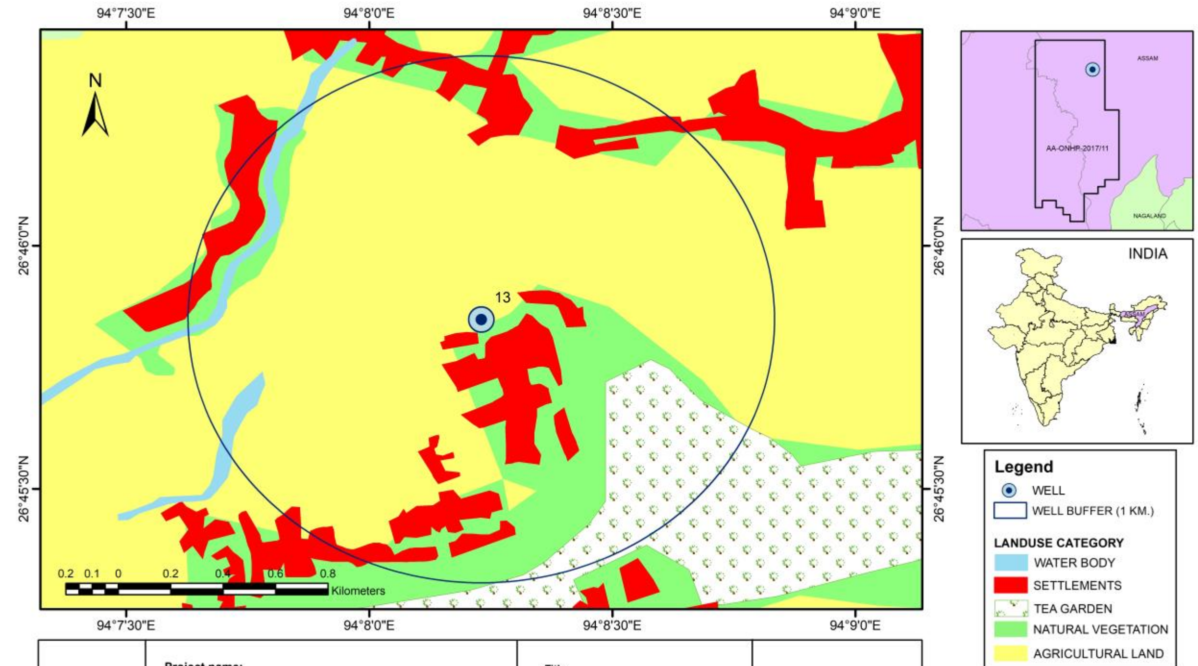
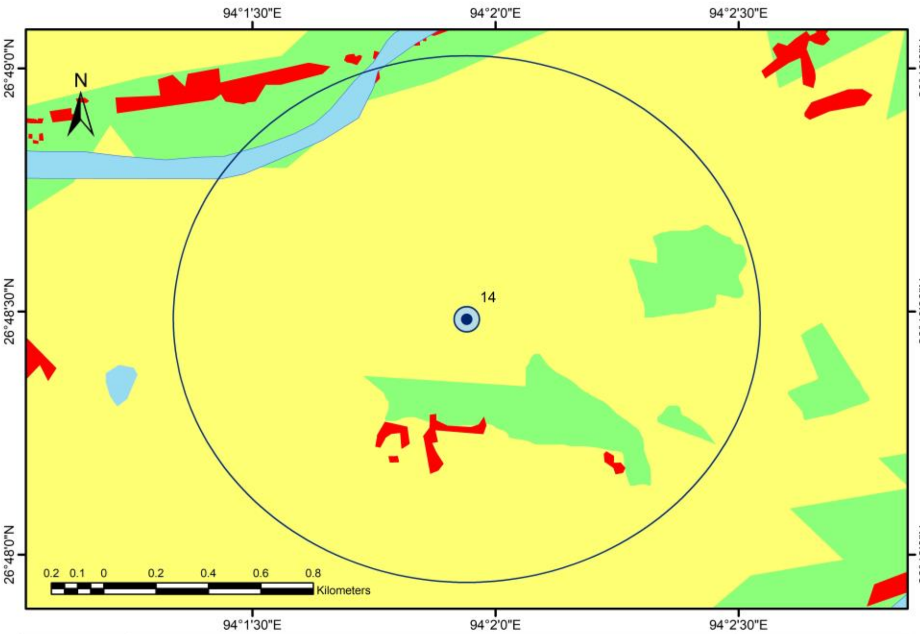
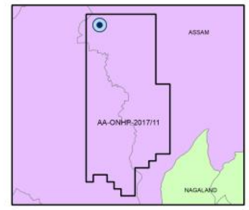


FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 13	AECOM
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community





Legend

- WELL
- WELL BUFFER (1 KM.)

LANDUSE CATEGORY

- RIVER
- WATER BODY
- SETTLEMENTS
- NATURAL VEGETATION
- AGRICULTURAL LAND

FIGURE NO	Project name: EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM				Title: Landuse and Landcover Map of Well No. 14	AECOM
	Date:	Drawn By:	Checked By:	Approved By:	Client Name:	Source:
	28/08/2019	Moumita Dey	Souvik Basu	Avijit Sarkar	Vedanta Limited (Cairn Oil and Gas)	Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community

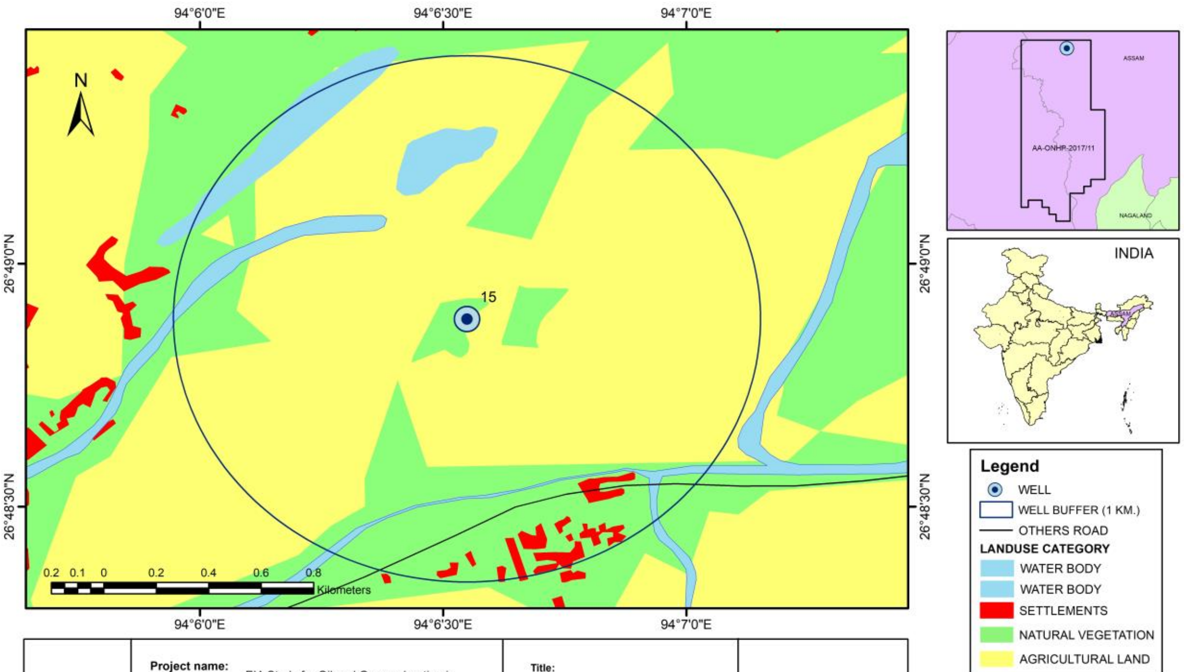


FIGURE NO	**Project name:** EIA Study for Oil and Gas exploration in Block AA-ONHP-2017_11, ASSAM					**Title:** Landuse and Landcover Map of Well No. 15	AECOM
	Date: 28/08/2019	**Drawn By:** Moumita Dey	**Checked By:** Souvik Basu	**Approved By:** Avijit Sarkar	**Client Name:** Vedanta Limited (Cairn Oil and Gas)	**Source:** Google Earth (22/01/2019), Toposheet No.: G46K/1, G46K/2 & G46K/3 (Survey of India), Landsat 5 ETM+ & Resourcesat Liss III(Guided 2005-06 & 2011_12) Esri Digital Globe and the GIS User Community	

Appendix 2.5:
List of Chemicals
to be
Used During Drilling

LIST OF CHEMICALS TO BE USED DURING DRILLING

Function	Chemicals
A. WBM Formulation	
Water /Base fluid	
Viscosifier	Biopolymer
Fluid Loss Agent	Drispac/CMC
Alkalinity Agent	Caustic Potash
Salinity	Potassium Sulphate
Lubricant	Torque Reducer/Blend of vegetable oil, Surfactant and Food Grade Paraffin Oil
Gelling agent	Bentonite
Biocide	Gluteraldehyde
Weighting Agent	Barite
B. SBM Formulation	
Base oil/Base Fluid	Synthetic Biodegradable Base Fluid
Water	-
Emulsifier	Polyamide, Petroleum Distillate, Dipropylene Glycol Methyl Ether
Viscosifier	Bentonite
Fluid Loss Agent	Gilsonite
Brine Phase	Sodium Formate
Alkalinity	Calcium Hydroxide
Bridging Agent	Calcium Carbonate Graded
Weighting Agent	Barite

Mitra S. K. Private Limited

MSK
TESTING • INSPECTION

Shivam (2nd Floor)

House No-9, Arunachal Path

Guwahati-781024
Assam

No. AA/MAR-MAY/2019

Date: 26/09/2019:

TO WHOM IT MAY CONCERN

Sub: Environmental Baseline Monitoringfor the EIA Study in Golahat and Jorhat Districts, Assam for Block - AA-ONHP-2017/11

This is to certify that Mitra S.K. Pvt. Ltd. has conducted environmental monitoring programme in Golaghat and Jorhat Districtsof Assam, from March to May, 2019.

Further it is to certify that, Ambient Air Quality has been monitored twice a week during the above-mentioned period.

It is also being hereby certified that Soil quality, Noise levels, Traffic count survey and surface & ground Water Quality monitoring have been carried out once in the monitoring period.

D Bhagabati

Debajit Bhagabati

Branch Manager

Mitra S.K. Pvt. Ltd.

Guwahati

Appendix 3.1: Micro-Meteorological Data

Met Station Location : Macharhat, Jorhat District					Coordinates: 26°46'19.00"N, 94°12'29.00"E					
Year	Month	Day	Time	Air Temperature	Relative Humidity	Wind Direction	Wind Speed	Rainfall	Cloud Cover	Solar radiation
			Hour	℃	%	° (Deg)	m / h	In	%	W/m2
2019	3	10	1	23.1	65.4	62	5	0	0	0
2019	3	10	2	23.1	65.8	62	6	0	0	0
2019	3	10	3	23	66	63.2	5	0	0	0
2019	3	10	4	23	66.1	62.7	4	0	0	0
2019	3	10	5	22.9	66.2	64.4	1	0	0	0
2019	3	10	6	22.9	66.3	64.4	1	0	0	0
2019	3	10	7	22.9	66.5	65.3	1	0	0	20
2019	3	10	8	22.9	66.6	72.7	2	0	0	186
2019	3	10	9	22.9	66.7	111.6	3	0	0	367
2019	3	10	10	22.9	66.7	170.6	3	0	0	510
2019	3	10	11	22.9	66.7	202.9	1	0	0	607
2019	3	10	12	22.8	66.6	211.4	2	0	0	646
2019	3	10	13	22.8	66.5	218.5	4	0	10	624
2019	3	10	14	22.9	66.6	220	1	0	20	547
2019	3	10	15	22.9	66.7	218.2	1	0	30	419
2019	3	10	16	22.9	66.9	212.6	1	0	30	249
2019	3	10	17	22.9	67.1	208.7	1	0	60	57
2019	3	10	18	23	67.3	65.4	4	0	70	0
2019	3	10	19	23	67.5	63.6	0	0	40	0
2019	3	10	20	23	67.6	60.9	0	0	30	0
2019	3	10	21	23.1	67.8	60.4	2	0	20	0
2019	3	10	22	23.1	68	60.3	1	0	0	0
2019	3	10	23	23.1	68.2	60.9	0	0	0	0
2019	3	10	24	23.1	68.3	62	0	0	0	0
2019	3	11	1	23.1	68.5	62	3	0	0	0
2019	3	11	2	23.2	68.8	62	4	0	0	0
2019	3	11	3	23.2	69	63.2	0	0	0	0
2019	3	11	4	23.2	69.4	62	0	0	0	0
2019	3	11	5	23.2	69.6	63.2	1	0	0	0
2019	3	11	6	23.2	69.9	63.7	0	0	0	0
2019	3	11	7	23.2	70.1	64	1	0	0	20
2019	3	11	8	23.2	70.3	70.4	2	0	0	185
2019	3	11	9	23.3	70.5	124.8	1	0	0	368
2019	3	11	10	23.3	71	175	1	0	0	513
2019	3	11	11	23.4	72.9	199.2	0	0	0	610
2019	3	11	12	23.5	73.9	207.5	0	0	0	651
2019	3	11	13	23.7	75.2	211	0	0	0	630
2019	3	11	14	23.7	76.1	212.3	2	0	30	550
2019	3	11	15	23.7	76.9	211.9	1	0	32	418
2019	3	11	16	23.9	78.3	211.3	5	0	40	248
2019	3	11	17	25	77.5	193.4	3	0.1	80	59
2019	3	11	18	28.1	73.4	81.6	3	0	60	0
2019	3	11	19	26.9	70.9	70.4	0	0.02	70	0
2019	3	11	20	25.6	71.4	67.2	0	0	0	0
2019	3	11	21	25.3	72.1	65.6	0	0	0	0
2019	3	11	22	25.2	72.4	64.8	5	0	0	0

2019	3	11	23	25.2	72.6	64.4	2	0	0	0
2019	3	11	24	25.1	72.7	63.7	1	0	0	0
2019	3	12	1	25	72.9	63	1	0	0	0
2019	3	12	2	24.9	73	63	1	0	10	0
2019	3	12	3	24.9	73.1	63	1	0	10	0
2019	3	12	4	24.8	74.1	64.2	2	0	10	0
2019	3	12	5	24.9	76.9	65.4	3	0	10	0
2019	3	12	6	24.9	77.6	66.2	0	0	30	0
2019	3	12	7	24.9	77.5	54.4	0	0	30	18
2019	3	12	8	24.9	78.1	61.4	0	0	30	110
2019	3	12	9	24.9	77.6	109	0	0	60	106
2019	3	12	10	25	77.2	192.1	0	0	70	120
2019	3	12	11	25.1	77.3	206.4	1	0	80	192
2019	3	12	12	25.1	77.3	214.5	1	0	80	326
2019	3	12	13	25.2	77.8	214.1	2	0.05	80	625
2019	3	12	14	25.6	77.7	204.4	3	0.05	60	549
2019	3	12	15	25.6	76.4	194.7	4	0	40	413
2019	3	12	16	25.5	75.3	206	7	0	30	249
2019	3	12	17	25.4	75.8	206	6	0	0	24
2019	3	12	18	25.4	76	148.4	7	0	0	0
2019	3	12	19	25.3	76.1	116	6	0	0	0
2019	3	12	20	25.3	76.2	106.8	4	0	0	0
2019	3	12	21	25.4	76.4	111.6	4	0	0	0
2019	3	12	22	25.4	76.6	101	4	0	0	0
2019	3	12	23	25.4	76.6	91.3	5	0	0	0
2019	3	12	24	25.5	77.2	79.3	4	0	0	0
2019	3	13	1	25.5	78	55.5	1	0	0	0
2019	3	13	2	25.4	78.2	54.3	2	0	0	0
2019	3	13	3	25.4	78.7	57.8	5	0	0	0
2019	3	13	4	25.4	78.8	59	2	0	0	0
2019	3	13	5	25.4	78.8	60.8	2	0	0	0
2019	3	13	6	25.3	79.3	63.2	6	0	0	0
2019	3	13	7	25.2	79.5	63.5	7	0	0	27
2019	3	13	8	25.2	79.5	69.1	5	0	0	194
2019	3	13	9	25.2	79.4	154.4	5	0	0	370
2019	3	13	10	25.2	79.4	203.3	6	0	0	505
2019	3	13	11	25.3	79	218	5	0	0	596
2019	3	13	12	25.3	78	220	8	0	10	630
2019	3	13	13	25.3	76.3	220	2	0	15	603
2019	3	13	14	25.3	73.4	218	4	0	0	520
2019	3	13	15	25.3	72.2	215.2	3	0	0	386
2019	3	13	16	25.4	72.6	210	1	0.01	50	218
2019	3	13	17	25.7	71.3	201.6	2	0.01	90	40
2019	3	13	18	25.1	71.9	96.3	1	0	40	0
2019	3	13	19	24.7	70.3	89.4	1	0	30	0
2019	3	13	20	23.7	69.9	85	1	0	10	0
2019	3	13	21	23.4	70.4	85	1	0	0	0
2019	3	13	22	23.2	70.2	85	1	0	0	0
2019	3	13	23	23.1	70.3	81.4	1	0	0	0
2019	3	13	24	23.1	70.4	74.1	0	0	0	0

2019	3	14	1	23.1	70.4	70.5	0	0	0	0
2019	3	14	2	23.2	70.9	69.3	0	0	0	0
2019	3	14	3	23.5	70.9	67.6	0	0	0	0
2019	3	14	4	23.7	70.9	68.4	0	0	0	0
2019	3	14	5	23.9	70.9	67	0	0	0	0
2019	3	14	6	24.1	71	67.8	0	0	0	0
2019	3	14	7	24.1	71.1	66.6	2	0	0	29
2019	3	14	8	24.1	71.1	79.3	1	0	30	202
2019	3	14	9	24.1	71.1	144	1	0	50	374
2019	3	14	10	24.1	71	191.4	2	0	70	506
2019	3	14	11	24.1	70.9	210	3	0.02	80	592
2019	3	14	12	24.2	71	220	1	0.01	40	625
2019	3	14	13	24.3	70.7	223.2	3	0	60	601
2019	3	14	14	25.3	66.2	218.2	2	0.12	80	522
2019	3	14	15	25.3	72.2	209.5	4	0	70	390
2019	3	14	16	25.3	72.6	201.6	2	0	40	223
2019	3	14	17	25.4	71.3	191.7	3	0	30	41
2019	3	14	18	25.7	71.9	85	5	0	0	0
2019	3	14	19	25.1	70.3	85	3	0	0	0
2019	3	14	20	24.7	69.9	80.6	3	0	0	0
2019	3	14	21	23.7	70.4	72.7	0	0	0	0
2019	3	14	22	23.4	70.2	70.6	3	0	0	0
2019	3	14	23	23.2	70.3	71.3	3	0	0	0
2019	3	14	24	23.1	70.4	68.9	2	0	0	0
2019	3	15	1	23.1	70.4	69.3	2	0	0	0
2019	3	15	2	23.1	70.9	69.3	0	0	0	0
2019	3	15	3	23.2	70.9	69.6	3	0	0	0
2019	3	15	4	23.5	70.9	71.3	0	0	0	0
2019	3	15	5	23.7	70.9	71.3	0	0	0	0
2019	3	15	6	23.9	71	71.6	2	0	0	0
2019	3	15	7	24.1	71.1	71.7	1	0	40	28
2019	3	15	8	24.1	76	80	0	0.04	30	193
2019	3	15	9	25	69.2	117.5	0	0	20	370
2019	3	15	10	26.1	65.7	175	0	0	0	507
2019	3	15	11	27	62.4	206.6	3	0	0	598
2019	3	15	12	28.3	57.8	215.9	3	0	0	631
2019	3	15	13	29.7	53.9	218.3	6	0	0	607
2019	3	15	14	30	52.8	218.3	5	0	0	526
2019	3	15	15	30.1	53.8	218.2	6	0	0	396
2019	3	15	16	29.6	55.3	215.6	8	0	0	230
2019	3	15	17	28.4	60.5	214.8	4	0	0	47
2019	3	15	18	26.4	67.1	73.7	6	0	0	0
2019	3	15	19	24.9	73.5	72.5	1	0	0	0
2019	3	15	20	24.1	74.4	66.6	1	0	0	0
2019	3	15	21	22.9	79.3	65.3	1	0	0	0
2019	3	15	22	22.7	78.9	64.2	3	0	0	0
2019	3	15	23	22	82.1	63.2	2	0	40	0
2019	3	15	24	21.6	83.7	62.6	3	0	50	0
2019	3	16	1	20.5	88.3	63	4	0	90	0
2019	3	16	2	19.9	90.3	62.4	1	0	40	0

2019	3	16	3	20.3	88	62.2	5	0	30	0
2019	3	16	4	19.2	91.4	62.2	4	0	0	0
2019	3	16	5	18.6	93.9	62.6	3	0	0	0
2019	3	16	6	19.4	90.9	62.6	1	0	0	0
2019	3	16	7	20.3	87.2	62.4	3	0	0	25
2019	3	16	8	22.4	78.7	70.5	2	0	0	194
2019	3	16	9	24.8	69.7	117.5	3	0	30	374
2019	3	16	10	27	64.8	175	4	0	80	514
2019	3	16	11	29.3	55.7	201.6	3	0	70	607
2019	3	16	12	30.3	52.5	211.4	3	0	90	642
2019	3	16	13	32.3	46.6	215.1	1	0	65	616
2019	3	16	14	32.3	46.1	218.3	0	0	55	534
2019	3	16	15	33.2	39.8	220	1	0	35	398
2019	3	16	16	33.3	33.9	220	4	0	50	227
2019	3	16	17	31.6	33.8	175	1	0	0	45
2019	3	16	18	29.6	42.2	85	4	0	0	0
2019	3	16	19	28.3	46.2	79.3	6	0	0	0
2019	3	16	20	27.9	47.9	69.5	1	0	0	0
2019	3	16	21	26.8	51.2	64.9	0	0	0	0
2019	3	16	22	26.2	54	65.4	4	0	0	0
2019	3	16	23	25.4	57.4	64	1	0	0	0
2019	3	16	24	24.4	60.6	64	4	0	0	0
2019	3	17	1	23.3	65.4	64.4	4	0	0	0
2019	3	17	2	20.9	76.6	64.4	6	0	0	0
2019	3	17	3	20.4	75.4	64.8	2	0	0	0
2019	3	17	4	20.1	76.1	65.9	2	0	0	0
2019	3	17	5	19.2	80.1	65.5	1	0	0	0
2019	3	17	6	18.6	83.7	65.1	1	0	0	0
2019	3	17	7	19.3	82.7	66.2	4	0	0	24
2019	3	17	8	21.8	73.7	76.9	4	0	0	194
2019	3	17	9	23.8	67.4	135.7	4	0	0	372
2019	3	17	10	25.3	62.9	185	1	0	0	513
2019	3	17	11	26.7	58.4	202.7	4	0	0	606
2019	3	17	12	27.7	54.5	206.3	4	0	0	641
2019	3	17	13	28.3	49.5	208.1	7	0	0	616
2019	3	17	14	28.6	47.4	204.5	4	0	0	534
2019	3	17	15	28.7	46.6	204.7	4	0	0	399
2019	3	17	16	28.2	47	207.7	5	0	0	228
2019	3	17	17	26.8	51.5	175	4	0	0	46
2019	3	17	18	24.7	58.9	80.9	3	0	0	0
2019	3	17	19	23.3	65.9	71.6	1	0	78	0
2019	3	17	20	22.4	70.4	68.7	1	0	16	0
2019	3	17	21	21.9	74	67.2	3	0	11	0
2019	3	17	22	20.9	79.5	64.4	1	0	19	0
2019	3	17	23	20.7	80.3	63.2	0	0	29	0
2019	3	17	24	20.3	82.9	63.2	0	0	45	0
2019	3	18	1	20.3	83.6	63.8	2	0	13	0
2019	3	18	2	20.1	85.6	63.8	2	0	5	0
2019	3	18	3	19.2	90.1	64.3	1	0	10	0
2019	3	18	4	18.9	90.4	64.3	1	0	60	0

2019	3	18	5	19.6	87.9	64.3	2	0	64	0
2019	3	18	6	19.2	90.6	62.9	2	0	38	0
2019	3	18	7	20.1	86.2	65.1	0	0	66	24
2019	3	18	8	22.1	78.5	73.1	1	0	16	191
2019	3	18	9	23.9	71.3	140	0	0	74	370
2019	3	18	10	25.5	63.7	195.6	2	0	85	510
2019	3	18	11	27.3	56.3	210.8	1	0	78	603
2019	3	18	12	27.4	53.5	216.8	1	0	26	639
2019	3	18	13	28.8	50.2	218.5	3	0	14	615
2019	3	18	14	29.5	46.9	220	3	0	24	533
2019	3	18	15	29.2	46	218.3	2	0	25	399
2019	3	18	16	28.8	46.2	220	0	0	21	229
2019	3	18	17	27.7	51.9	220	0	0	14	47
2019	3	18	18	26.2	58.1	208.7	0	0.06	21	0
2019	3	18	19	20.1	88.9	130	0	0.5	17	0
2019	3	18	20	21.2	85.8	85	2	0	21	0
2019	3	18	21	20.9	81.6	85	3	0	13	0
2019	3	18	22	20.4	80.3	85	6	0	24	0
2019	3	18	23	19.9	81.1	85	3	0	32	0
2019	3	18	24	19.4	83	77.4	2	0	37	0
2019	3	19	1	18.8	86.6	68.6	1	0	18	0
2019	3	19	2	18	89.4	65.7	0	0	26	0
2019	3	19	3	18.3	88.4	66.6	0	0	29	0
2019	3	19	4	18.4	89.1	65.2	0	0.03	35	0
2019	3	19	5	17.6	93	65.9	0	0	14	0
2019	3	19	6	17.3	92.7	64.7	0	0	83	0
2019	3	19	7	17.5	93.6	64.7	1	0	100	23
2019	3	19	8	18.6	90	85	1	0	100	190
2019	3	19	9	19.6	83.6	167.9	5	0	100	364
2019	3	19	10	20.7	80	193.4	8	0	100	504
2019	3	19	11	21.7	75.9	207.9	9	0	8	597
2019	3	19	12	22.3	73	213.3	3	0	0	632
2019	3	19	13	21.7	75.6	215.1	0	0	0	525
2019	3	19	14	21.6	75.1	214.8	0	0	30	217
2019	3	19	15	21.8	72.9	210.2	2	0	100	230
2019	3	19	16	21.6	72.2	204.7	7	0	46	236
2019	3	19	17	21.1	74.5	201.6	4	0	15	51
2019	3	19	18	20	79.7	175	2	0	15	0
2019	3	19	19	19.2	84.5	92.1	2	0.07	23	0
2019	3	19	20	18.2	92.4	88.8	2	0.04	27	0
2019	3	19	21	17.8	93.4	85	4	0	14	0
2019	3	19	22	17.6	93.6	82	2	0.01	0	0
2019	3	19	23	17.7	93.6	75.5	2	0.01	0	0
2019	3	19	24	17.5	94.4	72	1	0	0	0
2019	3	20	1	17.1	96.1	82.3	1	0	0	0
2019	3	20	2	16.8	96.6	79.8	1	0	0	0
2019	3	20	3	16.5	97.8	118.6	4	0	0	0
2019	3	20	4	16.4	98.2	106.6	3	0	0	0
2019	3	20	5	16.7	97.3	130.7	1	0	0	0
2019	3	20	6	16.8	97.5	106	0	0	0	0

2019	3	20	7	17.1	95.7	116.1	0	0	10	20
2019	3	20	8	18.4	89.9	110	1	0	10	185
2019	3	20	9	20.3	83	158.2	2	0	0	367
2019	3	20	10	21.2	80.8	193.4	2	0	0	510
2019	3	20	11	22.9	75.8	187.3	2	0	0	606
2019	3	20	12	24.6	69.6	82.5	4	0	0	645
2019	3	20	13	25.7	65.1	82	3	0	0	624
2019	3	20	14	26.7	62	91.3	4	0	10	547
2019	3	20	15	26	65.8	197.6	8	0	25	419
2019	3	20	16	25.4	64.6	115.7	6	0	10	249
2019	3	20	17	23.8	68.4	154.2	3	0	0	56
2019	3	20	18	21.8	73.5	161.5	1	0	0	0
2019	3	20	19	20.9	77.8	69.4	0	0	0	0
2019	3	20	20	20.4	78.6	67.6	0	0	0	0
2019	3	20	21	20	80.7	76.3	0	0.01	0	0
2019	3	20	22	19.1	83.7	97	0	0.03	0	0
2019	3	20	23	18.5	83.1	93	0	0.03	0	0
2019	3	20	24	17.7	85.7	148	1	0.04	0	0
2019	3	21	1	17.3	87.4	131.2	1	0	0	0
2019	3	21	2	16.9	89.9	106.4	1	0	0	0
2019	3	21	3	16.9	89.9	94.8	1	0	0	0
2019	3	21	4	16.7	90.8	90.5	1	0	0	0
2019	3	21	5	16.6	91.3	79.9	1	0	0	0
2019	3	21	6	16.4	92.5	77	2	0	0	0
2019	3	21	7	17.3	89.6	87.4	2	0	0	20
2019	3	21	8	19	80.6	77.5	2	0	0	184
2019	3	21	9	20.6	77	68	1	0	0	368
2019	3	21	10	21.9	72.6	78.8	4	0	0	513
2019	3	21	11	23.5	68.2	82.4	3	0	0	610
2019	3	21	12	24.4	65.6	73.2	5	0	0	651
2019	3	21	13	24.5	64.6	74.3	7	0	0	629
2019	3	21	14	25.3	60.7	78.1	6	0	0	550
2019	3	21	15	25	59	87.6	3	0	0	418
2019	3	21	16	24.6	58.4	77.2	1	0	0	248
2019	3	21	17	22.9	60.4	89.9	9	0	0	59
2019	3	21	18	21.7	64.5	113.6	2	0	15	0
2019	3	21	19	20.4	70.6	138.8	3	0	25	0
2019	3	21	20	19.6	74.8	96.8	1	0	20	0
2019	3	21	21	19.4	76.7	86	4	0	15	0
2019	3	21	22	19.1	79.5	72.2	3	0	10	0
2019	3	21	23	18.8	81.7	87.6	3	0	15	0
2019	3	21	24	18.7	82.9	90	3	0	20	0
2019	3	22	1	18.6	82.6	147.2	2	0	10	0
2019	3	22	2	18.3	84.4	199.6	2	0.07	10	0
2019	3	22	3	17.3	91.6	94.1	2	0.08	0	0
2019	3	22	4	17.2	89.6	91.1	1	0.01	0	0
2019	3	22	5	17.1	89.6	95.8	3	0.11	0	0
2019	3	22	6	16.5	94.9	88.6	2	0.01	5	0
2019	3	22	7	16.8	94.1	74.7	4	0	10	18
2019	3	22	8	18.7	85.7	80.3	0	0	15	110

2019	3	22	9	20.6	76.4	82.3	0	0	0	106
2019	3	22	10	22.2	70.9	94.1	0	0	0	120
2019	3	22	11	22.9	66.2	67.7	3	0	0	192
2019	3	22	12	23.8	61.8	81.2	3	0	0	326
2019	3	22	13	24.4	59.7	90.5	2	0	0	625
2019	3	22	14	24.2	59.3	80.2	4	0	0	548
2019	3	22	15	24	58.7	75.7	1	0	0	413
2019	3	22	16	22.9	62.6	75.7	0	0	0	249
2019	3	22	17	21.6	68.5	83.8	0	0	0	24
2019	3	22	18	20.3	77	77.9	2	0	10	0
2019	3	22	19	19.5	81.5	169.4	3	0	17	0
2019	3	22	20	19.1	84.7	83.7	1	0	23	0
2019	3	22	21	18.5	87.8	115.9	6	0	7	0
2019	3	22	22	18.5	88.7	103.3	1	0.01	0	0
2019	3	22	23	18.1	91.7	83.3	3	0	0	0
2019	3	22	24	17.8	92.1	101.4	3	0	0	0
2019	3	23	1	17.6	93.5	94.1	6	0.02	0	0
2019	3	23	2	17.3	95.1	85	5	0.02	0	0
2019	3	23	3	17.1	95.2	85.2	4	0	10	0
2019	3	23	4	16.8	96	82.5	3	0	0	0
2019	3	23	5	16.7	96.6	84	3	0	7	0
2019	3	23	6	17	96	91	2	0	6	0
2019	3	23	7	17.3	95.4	89.7	2	0	10	27
2019	3	23	8	18.1	90.8	90.7	4	0	10	194
2019	3	23	9	19.1	87	79.4	5	0	10	370
2019	3	23	10	20.1	84.8	85	6	0	0	505
2019	3	23	11	20.9	82.4	74.3	6	0	0	596
2019	3	23	12	22.1	78	88.9	2	0	0	629
2019	3	23	13	22.2	78.5	80.5	3	0	0	603
2019	3	23	14	23.4	73.8	92.7	2	0	8	520
2019	3	23	15	23.3	74.8	94.3	2	0	0	386
2019	3	23	16	23.3	76.1	85.6	2	0	0	217
2019	3	23	17	22.8	78.2	103.8	3	0	0	39
2019	3	23	18	21.6	81.5	80.3	3	0	5	0
2019	3	23	19	20.8	86.2	105.5	3	0	12	0
2019	3	23	20	20.3	88.1	83.1	2	0	14	0
2019	3	23	21	20.2	87.1	104.3	2	0.02	10	0
2019	3	23	22	19.7	91.8	132.6	2	0.01	12	0
2019	3	23	23	19.7	92.6	117	5	0	26	0
2019	3	23	24	18.7	95.5	100.7	6	0	32	0
2019	3	24	1	18.1	94.8	81.6	6	0	14	0
2019	3	24	2	17.8	95.1	116	1	0	80	0
2019	3	24	3	17.7	95.3	112.1	1	0	96	0
2019	3	24	4	17.3	96.8	106.6	6	0	10	0
2019	3	24	5	17	97.9	167.3	1	0	14	0
2019	3	24	6	16.8	98.2	102.7	3	0	12	0
2019	3	24	7	17.5	96.3	88.3	1	0	79	29
2019	3	24	8	19.2	89.8	108.6	0	0	61	201
2019	3	24	9	21.3	79.3	118.3	0	0	61	374
2019	3	24	10	23.8	68.9	95.7	6	0	0	506

2019	3	24	11	25.5	61.9	98.3	4	0	0	592
2019	3	24	12	26.8	57.3	121.8	7	0	0	625
2019	3	24	13	27.2	56	149.9	9	0	0	601
2019	3	24	14	27.4	56.2	112.2	6	0	3	522
2019	3	24	15	27.1	55.7	110.4	6	0	0	390
2019	3	24	16	26.7	56.3	144.1	8	0	0	223
2019	3	24	17	25.9	60.6	139.7	6	0	0	41
2019	3	24	18	24.5	65.7	174.5	8	0	2	0
2019	3	24	19	23.8	70.3	227.7	6	0	18	0
2019	3	24	20	22.9	74.1	87	7	0	49	0
2019	3	24	21	21.7	80.9	186.9	6	0	14	0
2019	3	24	22	20.8	85	231.9	1	0	26	0
2019	3	24	23	20.6	86.9	112.4	1	0	40	0
2019	3	24	24	20.3	87	185.6	0	0	38	0
2019	3	25	1	19.7	87.9	195	0	0	55	0
2019	3	25	2	18.8	91.5	227.1	0	0	25	0
2019	3	25	3	18.3	93.7	238.6	1	0	5	0
2019	3	25	4	17.9	94.3	228.1	1	0	4	0
2019	3	25	5	17.7	95	217.7	1	0	10	0
2019	3	25	6	17.9	93.7	152.4	1	0	54	0
2019	3	25	7	18.9	90.9	75.3	2	0	51	28
2019	3	25	8	22.3	78.2	86.5	3	0	2	192
2019	3	25	9	24.7	72.1	84.8	2	0	0	370
2019	3	25	10	26.9	63.5	88.8	3	0	25	507
2019	3	25	11	27.9	59.2	75.6	3	0	55	597
2019	3	25	12	28.8	55	89.1	4	0	0	630
2019	3	25	13	29.8	51.9	84.1	4	0	2	606
2019	3	25	14	29.9	48.5	86.7	4	0	12	526
2019	3	25	15	30.3	46.9	121.2	6	0	17	396
2019	3	25	16	29.7	49.7	152.8	4	0	19	230
2019	3	25	17	28.5	52.2	86.6	1	0	0	47
2019	3	25	18	26.4	58.3	141.8	4	0	0	0
2019	3	25	19	25.2	60.7	146.3	4	0	0	0
2019	3	25	20	23.9	65.4	89.4	7	0	0	0
2019	3	25	21	22.4	73.8	140.7	1	0	0	0
2019	3	25	22	22.2	75.5	153.9	4	0	0	0
2019	3	25	23	20.6	82.5	155.7	1	0	0	0
2019	3	25	24	20.1	86.1	123.3	0	0	2	0
2019	3	26	1	20.4	85	100	0	0	0	0
2019	3	26	2	19.8	87.6	183.4	0	0	0	0
2019	3	26	3	18.9	90.8	156.5	4	0	0	0
2019	3	26	4	19.2	89.4	98.8	1	0	5	0
2019	3	26	5	18.4	92.2	66.3	7	0	83	0
2019	3	26	6	18.1	94	94.4	6	0	92	0
2019	3	26	7	19.3	90.5	87.6	4	0	70	25
2019	3	26	8	22.9	77.1	93.3	8	0	4	194
2019	3	26	9	24.9	72.1	75.6	3	0	0	374
2019	3	26	10	26.6	66.9	66.5	3	0	0	514
2019	3	26	11	28.3	60.1	81.7	4	0	0	606
2019	3	26	12	29.5	53.6	79.8	4	0	0	642

2019	3	26	13	30.5	49	97.4	1	0	7	616
2019	3	26	14	30.9	45.3	81.5	1	0	11	533
2019	3	26	15	31.8	42.8	79.1	9	0	10	398
2019	3	26	16	30.3	47.3	86.6	4	0	2	227
2019	3	26	17	28.2	57.8	84	1	0.01	0	45
2019	3	26	18	23.7	73.9	93.4	1	0.1	0	0
2019	3	26	19	22.4	82.4	93.2	1	0.01	13	0
2019	3	26	20	21.7	82.9	88	1	0	19	0
2019	3	26	21	20.6	86.7	92.1	4	0	20	0
2019	3	26	22	20.3	87.6	95.7	2	0	18	0
2019	3	26	23	20.1	88.9	158.5	2	0	35	0
2019	3	26	24	20.7	85.9	77.7	2	0	57	0
2019	3	27	1	20.3	88.3	97.5	1	0.02	63	0
2019	3	27	2	19.8	91.4	99.4	1	0.06	82	0
2019	3	27	3	19.7	90.4	87.4	1	0	100	0
2019	3	27	4	18.6	94.6	158.3	1	0	100	0
2019	3	27	5	18.5	96	93.8	2	0	100	0
2019	3	27	6	18.6	97.3	221.6	3	0	100	0
2019	3	27	7	19.3	97.2	180.8	2	0	100	24
2019	3	27	8	20.7	91.5	104.4	1	0	11	193
2019	3	27	9	23.4	79.6	241.3	1	0	10	372
2019	3	27	10	25.6	70.4	71.7	1	0	10	513
2019	3	27	11	26.9	63.8	79.3	1	0	10	605
2019	3	27	12	28.1	53.5	91.6	6	0	0	641
2019	3	27	13	29.2	49.1	105.6	6	0	0	616
2019	3	27	14	29.9	46	90.9	7	0	0	533
2019	3	27	15	29.9	45.3	89.1	9	0	66	399
2019	3	27	16	28.3	48.7	123.7	6	0	10	228
2019	3	27	17	27.3	54.4	105.8	6	0	69	46
2019	3	27	18	25.4	64.8	96.1	6	0	83	0
2019	3	27	19	24.2	67.7	114.1	4	0.11	23	0
2019	3	27	20	20.6	77.8	84.2	4	0.02	13	0
2019	3	27	21	20.2	80.4	117.3	1	0.02	12	0
2019	3	27	22	19.6	84.8	88	1	0	16	0
2019	3	27	23	19.6	83.3	190	0	0	21	0
2019	3	27	24	19.1	87.3	132.1	0	0	17	0
2019	3	28	1	18.9	89.2	92.8	0	0	12	0
2019	3	28	2	18.5	91.7	113.6	0	0	11	0
2019	3	28	3	18.2	93	88.6	0	0	3	0
2019	3	28	4	17.7	94	106.5	0	0	14	0
2019	3	28	5	17	96	173.9	6	0	12	0
2019	3	28	6	16.9	96.8	149.1	7	0	10	0
2019	3	28	7	18.8	90.8	122.8	1	0	10	23
2019	3	28	8	21.7	79	134.5	1	0	10	191
2019	3	28	9	23.7	66.6	68.6	1	0	10	370
2019	3	28	10	25.4	58.8	108.9	4	0	11	510
2019	3	28	11	26.7	54.9	122.8	6	0	0	603
2019	3	28	12	27.8	53.6	133.6	8	0	0	638
2019	3	28	13	28.3	52.4	115.2	4	0	0	614
2019	3	28	14	29.1	47.1	102.3	6	0	7	532

2019	3	28	15	29.9	44.9	85.9	7	0	10	399
2019	3	28	16	30.1	44.7	80.2	9	0	0	229
2019	3	28	17	29.3	47.2	165.5	8	0.01	10	47
2019	3	28	18	26.5	57.5	148	8	0	10	0
2019	3	28	19	24.3	67.9	84	4	0	0	0
2019	3	28	20	23.7	68.8	121.3	7	0	0	0
2019	3	28	21	23.2	69	95	1	0	0	0
2019	3	28	22	22.3	72.4	87	8	0	0	0
2019	3	28	23	21.9	74.4	79.5	1	0	1	0
2019	3	28	24	20.4	82.2	82	2	0	15	0
2019	3	29	1	19.7	86.2	110.8	2	0	6	0
2019	3	29	2	19.3	87.3	98.3	1	0	3	0
2019	3	29	3	18.9	87.8	79.3	1	0	10	0
2019	3	29	4	18.3	90.8	127.6	1	0	10	0
2019	3	29	5	18.1	91.5	148.1	1	0	10	0
2019	3	29	6	18.5	89	130.4	2	0	10	0
2019	3	29	7	19.5	84.8	105	2	0	10	22
2019	3	29	8	22.6	74.4	128.2	3	0	10	190
2019	3	29	9	25.5	63.7	89.6	3	0	0	364
2019	3	29	10	27.1	58	115.5	4	0	0	504
2019	3	29	11	28.8	52.1	136.9	8	0	0	597
2019	3	29	12	30.4	46.8	259.4	6	0	0	632
2019	3	29	13	31.1	46.2	117.9	1	0	5	524
2019	3	29	14	31.8	42.4	107	1	0	0	217
2019	3	29	15	33	39.5	120.6	1	0	10	230
2019	3	29	16	32.3	41.6	128.8	4	0	0	236
2019	3	29	17	31.1	45.9	172.9	7	0	0	51
2019	3	29	18	29.2	53.3	105	9	0	81	0
2019	3	29	19	26.6	64	94.3	7	0	56	0
2019	3	29	20	25.7	67.1	85.1	6	0	0	0
2019	3	29	21	24.4	72.6	185.4	3	0	0	0
2019	3	29	22	23.4	74.6	127.2	2	0	0	0
2019	3	29	23	21.8	82.7	119	2	0	0	0
2019	3	29	24	21.5	84.7	101.2	1	0	2	0
2019	3	30	1	21.5	83	145.7	1	0	3	0
2019	3	30	2	21.4	83.1	154.2	0	0	2	0
2019	3	30	3	21.7	81.8	130	0	0	100	0
2019	3	30	4	21.5	84.2	95.8	0	0	100	0
2019	3	30	5	21.6	83.8	95.4	0	0	85	0
2019	3	30	6	21.1	86.1	96.7	0	0	11	0
2019	3	30	7	21.5	85.6	95.9	0	0	18	20
2019	3	30	8	22.7	77.9	92.4	0	0	37	186
2019	3	30	9	24.1	72.5	125.3	0	0	100	367
2019	3	30	10	26.4	65.6	151.1	0	0	100	511
2019	3	30	11	28.5	59.4	120.4	0	0	100	607
2019	3	30	12	29.5	53.8	143	1	0	60	646
2019	3	30	13	30	51.7	110.3	1	0	30	625
2019	3	30	14	30.9	48	80.3	1	0	15	547
2019	3	30	15	30.4	47.6	131.9	1	0	14	419
2019	3	30	16	29.4	52.1	201	1	0	30	249

2019	3	30	17	28.6	60.8	157.1	9	0	0	57
2019	3	30	18	26.9	68.5	165.7	6	0	0	0
2019	3	30	19	26	69.9	132.2	3	0	0	0
2019	3	30	20	25.1	70.6	110.3	4	0	0	0
2019	3	30	21	23.7	73.2	65.4	1	0	0	0
2019	3	30	22	23.8	73.3	168.9	1	0	0	0
2019	3	30	23	23.6	77	97.7	4	0	20	0
2019	3	30	24	22.9	78	144.9	1	0	20	0
2019	3	31	1	22.3	82.3	158.2	1	0	50	0
2019	3	31	2	22.1	82.5	81.5	2	0	60	0
2019	3	31	3	21.9	82.6	157.8	2	0	80	0
2019	3	31	4	20.9	88.8	165.8	1	0.01	80	0
2019	3	31	5	20.4	92.6	251.2	1	0.19	95	0
2019	3	31	6	20	94.1	248.3	1	0.07	90	0
2019	3	31	7	19.7	95.2	251.7	1	0.09	100	20
2019	3	31	8	19.8	95.1	129.4	2	0.05	100	185
2019	3	31	9	19.9	94.4	233.8	1	0	70	368
2019	3	31	10	20.7	90.9	210.3	1	0	60	513
2019	3	31	11	21.1	89.6	153.4	5	0	0	610
2019	3	31	12	22.2	86.5	141.4	7	0.01	0	651
2019	3	31	13	22.9	82.8	130.3	8	0	0	630
2019	3	31	14	23.1	80.1	202.9	7	0	0	551
2019	3	31	15	22.3	83.3	181.2	8	0.05	0	418
2019	3	31	16	21.8	88	183.9	11	0	0	248
2019	3	31	17	19.8	90	181.2	6	0.04	20	59
2019	3	31	18	18.7	92.1	179.3	5	0	0	0
2019	3	31	19	18.7	91.2	186.3	2	0	0	0
2019	3	31	20	19	90.2	212.8	0	0	0	0
2019	3	31	21	18.7	91.9	167.7	0	0	0	0
2019	3	31	22	18.5	94.4	122.7	0	0	0	0
2019	3	31	23	18.4	94.7	142.5	0	0	0	0
2019	3	31	24	18.4	95	103.3	0	0.01	30	0
2019	4	1	1	18.4	94.2	91.8	1	0.01	20	0
2019	4	1	2	18.4	94.6	112.6	1	0	8	0
2019	4	1	3	18.1	96	103.6	2	0	60	0
2019	4	1	4	18.1	96.3	129.2	2	0	70	0
2019	4	1	5	18.2	95.9	169.9	2	0.01	30	0
2019	4	1	6	18.4	95.8	249.7	1	0	20	0
2019	4	1	7	18.8	94.2	112.7	1	0	12	18
2019	4	1	8	20.3	88.8	136.8	2	0	10	110
2019	4	1	9	21.3	85.1	72.2	1	0	10	107
2019	4	1	10	23	80.1	86	1	0	5	120
2019	4	1	11	23.7	76.7	82.5	3	0	5	192
2019	4	1	12	24.3	72.9	88.8	6	0	5	326
2019	4	1	13	25	71.5	125.3	4	0	5	625
2019	4	1	14	25.8	68.6	68.4	3	0	0	549
2019	4	1	15	25.5	71.2	95.2	6	0	0	414
2019	4	1	16	24.4	74.6	84	4	0	0	249
2019	4	1	17	23.8	77.2	88.6	3	0	0	25
2019	4	1	18	23.2	79.3	82.1	1	0	0	0

2019	4	1	19	22.6	82	97.7	1	0	0	0
2019	4	1	20	22.1	84.2	150.7	1	0	0	0
2019	4	1	21	21.6	85.5	95.2	3	0	0	0
2019	4	1	22	20.9	88.6	212.1	2	0	0	0
2019	4	1	23	20.6	91.2	145.4	1	0	0	0
2019	4	1	24	20.2	93.2	138.3	1	0	0	0
2019	4	2	1	19.9	94.2	68.9	1	0	0	0
2019	4	2	2	19.8	94.7	75.3	3	0	0	0
2019	4	2	3	20	94.2	69.6	2	0	0	0
2019	4	2	4	19.4	96.2	152.8	2	0	0	0
2019	4	2	5	19.1	97.2	219.4	2	0.01	20	0
2019	4	2	6	19.1	97.1	138.3	1	0	30	0
2019	4	2	7	20.2	92.8	89.6	1	0	40	27
2019	4	2	8	22.4	83.9	74.8	0	0	55	195
2019	4	2	9	24	78.7	74	0	0	30	370
2019	4	2	10	25.6	73	86.4	0	0	0	505
2019	4	2	11	26.6	70.8	79.8	0	0	0	596
2019	4	2	12	27.2	69.1	116.3	0	0	0	630
2019	4	2	13	27.9	64.5	112.3	6	0	0	603
2019	4	2	14	28.1	63.9	132.7	6	0	0	520
2019	4	2	15	27.7	64	132.9	4	0	15	386
2019	4	2	16	26.4	69.9	115.8	5	0	20	218
2019	4	2	17	25.4	72.6	127.9	9	0	21	40
2019	4	2	18	23.7	71.4	131.6	4	0	0	0
2019	4	2	19	22.8	75.9	150.3	1	0	60	0
2019	4	2	20	22.2	78.6	187.8	1	0.01	75	0
2019	4	2	21	19.2	87.9	183.3	1	0.07	80	0
2019	4	2	22	18.8	89.6	104.8	1	0.02	60	0
2019	4	2	23	18.2	93.2	97.3	3	0	30	0
2019	4	2	24	18.1	92.4	87.7	2	0	20	0
2019	4	3	1	18.2	91.9	102.7	1	0.01	12	0
2019	4	3	2	18.1	91.6	98.2	1	0	0	0
2019	4	3	3	17.8	93.4	148.8	2	0.02	0	0
2019	4	3	4	17.7	95.6	156.6	2	0.04	30	0
2019	4	3	5	17.8	94.6	65.8	2	0	65	0
2019	4	3	6	17.8	94.6	90.4	2	0	0	0
2019	4	3	7	18.2	93.7	106.3	1	0.01	0	29
2019	4	3	8	19.6	87.4	90.3	1	0	0	202
2019	4	3	9	21.3	77.5	114.2	1	0	0	374
2019	4	3	10	22.2	73.3	120.9	1	0	0	506
2019	4	3	11	23.4	69.7	65.5	4	0	0	592
2019	4	3	12	24.6	64.8	89.2	4	0	0	625
2019	4	3	13	25.8	59.4	70.8	1	0	0	601
2019	4	3	14	26.7	56	83.3	1	0	0	522
2019	4	3	15	26.7	56.3	86.9	1	0	0	390
2019	4	3	16	25.2	60.9	78	6	0	0	223
2019	4	3	17	24.3	63.8	74.9	8	0	0	42
2019	4	3	18	23.4	65.7	83.8	4	0	0	0
2019	4	3	19	22.8	70.1	115.5	2	0	0	0
2019	4	3	20	22.4	72.4	107.1	1	0.02	10	0

2019	4	3	21	21.7	73.8	118.1	1	0	30	0
2019	4	3	22	20.8	78.1	125.3	1	0	0	0
2019	4	3	23	20	82.5	108.9	6	0	0	0
2019	4	3	24	20.3	81.9	193.5	1	0	0	0
2019	4	4	1	19.8	86	203.1	1	0	0	0
2019	4	4	2	19.5	88.1	199.7	4	0	0	0
2019	4	4	3	19.2	90.1	155.1	1	0	0	0
2019	4	4	4	19.6	87.4	118.3	1	0	0	0
2019	4	4	5	19.4	87.2	88.6	0	0	0	0
2019	4	4	6	19.5	86.1	162.4	0	0	0	0
2019	4	4	7	20.4	83.8	158.3	0	0	0	28
2019	4	4	8	20.8	85	150.3	0	0	0	193
2019	4	4	9	21.9	79.3	192.7	3	0	0	370
2019	4	4	10	22.9	73.4	203.8	2	0	0	507
2019	4	4	11	22.4	72.6	293.6	4	0	0	598
2019	4	4	12	22.2	77.5	112.7	7	0	0	631
2019	4	4	13	21.8	81	119.8	4	0	0	607
2019	4	4	14	22.2	78	94.4	6	0	0	527
2019	4	4	15	22.3	74.8	118.9	4	0	30	397
2019	4	4	16	21.9	75.1	215.7	4	0	20	230
2019	4	4	17	21.3	79.2	123.1	4	0	10	47
2019	4	4	18	20.3	83.8	99	1	0	10	0
2019	4	4	19	19.8	87.2	224.7	1	0	10	0
2019	4	4	20	19.5	88.8	92.3	4	0	80	0
2019	4	4	21	19.6	89.4	117	4	0	85	0
2019	4	4	22	19.3	90.7	109	1	0	80	0
2019	4	4	23	18.8	92.1	175.7	0	0.02	60	0
2019	4	4	24	18.6	95.5	144.5	0	0.05	70	0
2019	4	5	1	18.6	95.1	188	3	0.02	90	0
2019	4	5	2	18.6	95.6	247.6	2	0.12	10	0
2019	4	5	3	18.5	95.4	229.3	1	0	100	0
2019	4	5	4	18.6	95.6	239.1	1	0.01	100	0
2019	4	5	5	18.5	96.8	262	1	0.04	60	0
2019	4	5	6	18.5	97.6	273.9	3	0.02	95	0
2019	4	5	7	18.6	97.4	251.1	4	0	40	26
2019	4	5	8	19.1	95.9	258.2	2	0	30	195
2019	4	5	9	20.2	91.7	247.3	2	0	0	374
2019	4	5	10	21.8	85.5	247.7	2	0	0	514
2019	4	5	11	23.3	79.4	242.5	2	0	0	607
2019	4	5	12	25.5	69.8	278.1	6	0	0	642
2019	4	5	13	27	63.9	280.9	3	0	0	617
2019	4	5	14	28.3	58.4	232.7	2	0	0	534
2019	4	5	15	28.4	59.6	172.5	7	0	0	398
2019	4	5	16	28.3	61.1	207.9	6	0	0	228
2019	4	5	17	27.4	64.2	201	6	0	0	45
2019	4	5	18	25	73.3	201.9	5	0	0	0
2019	4	5	19	23.6	80.9	227.5	1	0	0	0
2019	4	5	20	22.7	85.1	119.7	1	0	0	0
2019	4	5	21	22.1	87.5	82.1	2	0	0	0
2019	4	5	22	21.4	91.1	96.7	6	0	0	0

2019	4	5	23	21.6	90.4	155.1	3	0	0	0
2019	4	5	24	20.8	93.1	161.2	2	0	0	0
2019	4	6	1	20.4	93.8	180.7	7	0	0	0
2019	4	6	2	19.8	95.5	265.8	1	0	0	0
2019	4	6	3	19.5	96	219.9	1	0	0	0
2019	4	6	4	19	96.5	263.9	0	0	5	0
2019	4	6	5	18.6	97.4	178.5	0	0	5	0
2019	4	6	6	19.1	97.8	249.3	0	0	5	0
2019	4	6	7	20.2	95.7	237.8	0	0	10	25
2019	4	6	8	23.2	83.9	268.1	0	0	10	194
2019	4	6	9	25.4	75.5	252.5	2	0	10	373
2019	4	6	10	27.7	65.7	257.1	1	0	10	513
2019	4	6	11	28.7	61.8	276.4	1	0	5	606
2019	4	6	12	29.7	59.3	273.2	6	0	0	641
2019	4	6	13	30	58.8	243.4	6	0	0	617
2019	4	6	14	30.4	56.7	190.6	4	0	0	534
2019	4	6	15	31	52.5	206.5	8	0	0	399
2019	4	6	16	31.5	48.2	131.2	7	0	0	228
2019	4	6	17	30.1	53.5	69.5	4	0	0	46
2019	4	6	18	27.7	66.6	99.9	4	0	30	0
2019	4	6	19	26.1	74.2	174.2	7	0	30	0
2019	4	6	20	24.7	80.8	103.5	3	0	32	0
2019	4	6	21	23.8	85.6	131.9	2	0	100	0
2019	4	6	22	23.9	82.9	117	2	0	100	0
2019	4	6	23	22.8	86.5	95.5	2	0	100	0
2019	4	6	24	21.6	90.5	111.8	1	0	100	0
2019	4	7	1	21.6	90.1	150.9	1	0	100	0
2019	4	7	2	21.6	91.3	131.1	1	0	100	0
2019	4	7	3	21.3	91.4	143.5	1	0	100	0
2019	4	7	4	20.9	92.4	167.1	1	0	100	0
2019	4	7	5	20.4	93.1	213.8	2	0	30	0
2019	4	7	6	20.6	92.8	193	3	0	40	0
2019	4	7	7	21.8	87.8	261	3	0	10	24
2019	4	7	8	22.1	86.9	192.9	2	0	10	191
2019	4	7	9	22.2	84.3	161.1	1	0	10	370
2019	4	7	10	21.3	90.3	148.1	1	0.04	10	511
2019	4	7	11	20.6	91.4	179.4	1	0.16	15	603
2019	4	7	12	20.6	92.5	168.4	1	0.08	80	639
2019	4	7	13	20.9	90.8	95.1	1	0.01	80	615
2019	4	7	14	21.2	90.7	81.7	5	0.01	100	533
2019	4	7	15	20.6	91.3	114.3	9	0.01	100	399
2019	4	7	16	20.2	92.4	98.2	8	0.02	10	229
2019	4	7	17	20.1	92.7	117.3	4	0.02	10	47
2019	4	7	18	20	93.9	97.2	6	0	30	0
2019	4	7	19	19.8	94.9	139.8	7	0	30	0
2019	4	7	20	19.5	95.6	101.4	3	0	6	0
2019	4	7	21	19.4	95.8	88.3	2	0	79	0
2019	4	7	22	19.4	95.9	142.1	2	0	100	0
2019	4	7	23	19.3	96.4	137.9	1	0	100	0
2019	4	7	24	19.1	96.2	221.9	1	0	100	0

2019	4	8	1	19.1	94.6	97.8	1	0	100	0
2019	4	8	2	19.1	95.1	120.5	3	0	78	0
2019	4	8	3	19	95	88.9	1	0	16	0
2019	4	8	4	18.7	96.7	106.8	4	0.01	11	0
2019	4	8	5	18.8	97.2	113.5	0	0.01	19	0
2019	4	8	6	18.9	97.5	74.4	0	0	29	0
2019	4	8	7	19.8	94.4	89	4	0	45	23
2019	4	8	8	20.7	89.8	84.1	1	0	13	190
2019	4	8	9	21.2	87.6	94.3	2	0	5	365
2019	4	8	10	20.7	91.9	88.5	2	0.04	10	504
2019	4	8	11	21.2	88.9	84.8	3	0	60	597
2019	4	8	12	22.8	79.9	103	2	0	64	633
2019	4	8	13	22.7	77.9	84.6	1	0	38	525
2019	4	8	14	24.1	73.2	150	2	0	66	217
2019	4	8	15	25.4	68.2	143.9	2	0	16	230
2019	4	8	16	25.8	68.3	151.3	10	0	74	236
2019	4	8	17	24.8	72.6	96.9	9	0	85	51
2019	4	8	18	23.6	77.8	95.5	7	0	78	0
2019	4	8	19	22.4	84.4	112.6	8	0	26	0
2019	4	8	20	22	87.6	173.2	3	0	14	0
2019	4	8	21	21.8	87.8	175.6	2	0	24	0
2019	4	8	22	22	87.7	137.1	2	0	25	0
2019	4	8	23	21.1	91.4	71.6	1	0	21	0
2019	4	8	24	20.8	92	109.2	1	0	14	0
2019	4	9	1	20.4	93.3	135.3	3	0	21	0
2019	4	9	2	20.2	94.5	99.5	2	0	17	0
2019	4	9	3	20.2	95	95.7	1	0	21	0
2019	4	9	4	20	95.6	79.2	1	0	13	0
2019	4	9	5	19.9	95.8	110.3	4	0	24	0
2019	4	9	6	20.2	95.3	146.2	1	0	32	0
2019	4	9	7	21.2	90.9	100.8	7	0	37	20
2019	4	9	8	22.6	85.8	106	1	0	18	186
2019	4	9	9	24.6	79.3	98.1	4	0	26	367
2019	4	9	10	25.7	74.6	88.4	6	0	29	510
2019	4	9	11	27.3	67.7	85.6	8	0	35	607
2019	4	9	12	28.2	62	87.8	6	0	14	646
2019	4	9	13	28.9	59.8	83.8	4	0	83	624
2019	4	9	14	28.5	59.2	81.1	5	0	100	547
2019	4	9	15	26.9	66.5	174.9	6	0.04	100	419
2019	4	9	16	23.4	82.5	107.3	9	0	100	249
2019	4	9	17	22.3	83.8	90.2	7	0	100	57
2019	4	9	18	22.1	86.3	93.7	8	0	8	0
2019	4	9	19	22	88	99.3	7	0	0	0
2019	4	9	20	21.9	87.3	87.1	4	0	0	0
2019	4	9	21	21.6	88.2	101.5	1	0	30	0
2019	4	9	22	20.9	92.1	112.3	4	0	100	0
2019	4	9	23	20.7	93.6	122.1	1	0	46	0
2019	4	9	24	20.4	94.8	125.8	6	0	15	0
2019	4	10	1	20.2	96.6	139.1	1	0	15	0
2019	4	10	2	20.6	96	78.6	4	0	23	0

2019	4	10	3	20.2	96.3	110.7	1	0	27	0
2019	4	10	4	20	94.5	95.9	4	0	14	0
2019	4	10	5	19.9	94.6	112.5	1	0.02	0	0
2019	4	10	6	19.9	95.6	87.3	1	0.01	0	0
2019	4	10	7	20.3	95.3	118.5	6	0.02	0	20
2019	4	10	8	20.7	95.5	130.9	3	0.04	0	185
2019	4	10	9	21.6	93	121.7	1	0.01	0	368
2019	4	10	10	23.1	87.7	116.6	2	0	0	513
2019	4	10	11	25.4	76.8	100.1	1	0	0	610
2019	4	10	12	26.9	69.3	77.5	4	0	0	651
2019	4	10	13	28.3	62.6	78.2	1	0	0	630
2019	4	10	14	28.7	61.9	108.1	1	0	10	550
2019	4	10	15	29.2	59.4	94.7	0	0	10	418
2019	4	10	16	28.9	57.2	96.3	2	0	0	248
2019	4	10	17	28.5	56.6	115.5	2	0	0	59
2019	4	10	18	26.4	68	84.9	3	0	0	0
2019	4	10	19	24.7	76.3	90.8	1	0	0	0
2019	4	10	20	23.6	81.2	109	1	0	0	0
2019	4	10	21	22.6	88	99	0	0	10	0
2019	4	10	22	22.3	88.5	110.9	3	0	25	0
2019	4	10	23	21.8	87.5	95.6	2	0	10	0
2019	4	10	24	20.7	92.5	122	6	0	0	0
2019	4	11	1	20.3	94.1	141.2	4	0	0	0
2019	4	11	2	20.2	95.2	120.9	4	0	0	0
2019	4	11	3	19.9	95.2	139.7	6	0	0	0
2019	4	11	4	19.5	96.3	172.1	6	0	0	0
2019	4	11	5	19	97.4	121.3	4	0	0	0
2019	4	11	6	19.7	96.5	107.5	4	0	0	0
2019	4	11	7	22.6	85.3	88.2	4	0	0	18
2019	4	11	8	23.8	82.1	91.6	2	0	0	110
2019	4	11	9	26.6	72.9	121.7	2	0	0	106
2019	4	11	10	28.7	63.6	84.8	3	0	0	120
2019	4	11	11	29.8	56.8	102	2	0	0	192
2019	4	11	12	31.4	52.6	274.3	1	0	0	326
2019	4	11	13	32	48.3	121.9	1	0	0	625
2019	4	11	14	32.1	48.4	119.7	0	0	0	549
2019	4	11	15	32.2	48.2	80.7	1	0	0	413
2019	4	11	16	31.9	48.1	98	1	0	0	249
2019	4	11	17	31.3	50.3	80.6	2	0	0	24
2019	4	11	18	29.3	55.7	81.8	3	0	0	0
2019	4	11	19	27.2	65	104.4	1	0	0	0
2019	4	11	20	26.4	67.6	83.9	1	0	0	0
2019	4	11	21	25.1	72.6	77.8	0	0	0	0
2019	4	11	22	23.7	80.7	91.2	3	0	0	0
2019	4	11	23	22.9	85.4	83	6	0	0	0
2019	4	11	24	22.2	89.1	150.5	4	0	0	0
2019	4	12	1	22.1	89.2	174.7	1	0	15	0
2019	4	12	2	21.6	90.1	170.9	9	0	25	0
2019	4	12	3	21.2	91.9	144.1	7	0	20	0
2019	4	12	4	20.8	92.7	138.5	10	0	15	0

2019	4	12	5	20.6	92.7	156.9	2	0	10	0
2019	4	12	6	21.3	90.4	135	3	0	15	0
2019	4	12	7	23.4	83.2	177.3	4	0	20	27
2019	4	12	8	26.3	71.8	156	1	0	10	194
2019	4	12	9	27.7	67.4	133.6	2	0	10	370
2019	4	12	10	29.6	62.1	176.5	2	0	0	505
2019	4	12	11	31.1	56.1	152	1	0	0	596
2019	4	12	12	32.5	51.5	243.9	2	0	0	630
2019	4	12	13	33.4	48.7	198.6	3	0	5	603
2019	4	12	14	33.6	48.8	169.7	2	0	10	520
2019	4	12	15	34.4	44.6	138.2	2	0	15	386
2019	4	12	16	34.3	45.1	111.9	2	0	0	218
2019	4	12	17	32.5	51.8	77.1	9	0	0	40
2019	4	12	18	30.7	58.2	79.9	1	0	0	0
2019	4	12	19	28.8	66.9	89.1	3	0	0	0
2019	4	12	20	27.6	73	82	1	0	0	0
2019	4	12	21	27.3	74	85.3	2	0	0	0
2019	4	12	22	26.7	74.1	92.7	1	0	0	0
2019	4	12	23	25.5	78.4	117.1	1	0	0	0
2019	4	12	24	24.2	84.7	130.8	7	0	0	0
2019	4	13	1	23.7	87.8	185.8	4	0	10	0
2019	4	13	2	23.3	90.9	160.6	1	0	17	0
2019	4	13	3	23.1	90.9	267.4	4	0	23	0
2019	4	13	4	23.1	90.3	231.4	6	0	7	0
2019	4	13	5	22.4	92.9	200.3	6	0	0	0
2019	4	13	6	23.3	90	267.9	4	0	0	0
2019	4	13	7	24.7	82.3	252.1	1	0	0	29
2019	4	13	8	27.3	74	262.3	7	0	0	202
2019	4	13	9	29.1	66	248.2	3	0	0	374
2019	4	13	10	30.7	60.5	257.5	4	0	10	506
2019	4	13	11	32.3	56.6	172.2	4	0	0	592
2019	4	13	12	33.1	50.1	175	7	0	7	625
2019	4	13	13	34	47.2	165.6	8	0	6	601
2019	4	13	14	34.7	46.1	176.5	9	0	10	522
2019	4	13	15	35.1	45.1	167.5	10	0	10	390
2019	4	13	16	34.2	47.2	163.9	9	0	10	223
2019	4	13	17	32.8	52.3	170.4	5	0	0	41
2019	4	13	18	31.4	61	78.8	4	0	0	0
2019	4	13	19	29.4	71.9	78.3	7	0	0	0
2019	4	13	20	28.9	75	76.1	7	0	0	0
2019	4	13	21	28.2	77.1	96.4	6	0	8	0
2019	4	13	22	28.4	75.6	151.3	1	0	0	0
2019	4	13	23	27.6	79.6	89	1	0	0	0
2019	4	13	24	27.5	76.3	108.1	0	0	0	0
2019	4	14	1	26.1	78.5	93	0	0	5	0
2019	4	14	2	24.2	83	105.9	0	0.05	12	0
2019	4	14	3	22.7	83.1	102	0	0	14	0
2019	4	14	4	22.9	80.9	101.7	0	0.05	10	0
2019	4	14	5	21.6	88.9	101.1	0	0.32	12	0
2019	4	14	6	21.6	91	172	0	0	26	0

2019	4	14	7	22.3	90.5	63.4	0	0	32	28
2019	4	14	8	23.2	88.5	107.3	6	0	14	193
2019	4	14	9	23.8	85.2	75.4	1	0	80	370
2019	4	14	10	24	85	84.3	8	0.01	96	507
2019	4	14	11	23.8	87.6	81.1	4	0	10	598
2019	4	14	12	24.8	83	89.5	3	0	14	631
2019	4	14	13	25	82	85.5	7	0	12	607
2019	4	14	14	26.3	74.1	85.4	6	0	79	526
2019	4	14	15	27.3	73.3	109.2	5	0	61	396
2019	4	14	16	28.7	66.6	115.9	11	0	61	230
2019	4	14	17	27.5	71.3	111.1	10	0	0	47
2019	4	14	18	26.1	78.7	40.4	11	0	0	0
2019	4	14	19	24.4	88.1	117.3	11	0	0	0
2019	4	14	20	24.1	90.4	176.1	8	0	0	0
2019	4	14	21	23.8	92.2	192.6	6	0	3	0
2019	4	14	22	23.9	91.5	156.9	9	0	0	0
2019	4	14	23	23.7	92.7	113.8	8	0	0	0
2019	4	14	24	23.8	92.4	74	7	0	0	0
2019	4	15	1	23.6	93.6	117	7	0	2	0
2019	4	15	2	23.2	95.2	85.7	6	0	18	0
2019	4	15	3	22.9	95.6	88.8	8	0	49	0
2019	4	15	4	22.7	95.7	75	8	0	14	0
2019	4	15	5	22.6	95.2	125.6	6	0	26	0
2019	4	15	6	22.7	94.9	235.5	6	0	40	0
2019	4	15	7	23.5	90.9	155.3	8	0	38	25
2019	4	15	8	24	89.7	109.9	1	0	55	194
2019	4	15	9	26	80.5	85.8	8	0	25	374
2019	4	15	10	27.2	67.9	95.7	6	0	5	514
2019	4	15	11	26.9	68.9	82	10	0	4	607
2019	4	15	12	27.9	67.4	71.1	11	0	10	642
2019	4	15	13	28.4	65.6	81.4	13	0	54	616
2019	4	15	14	27.1	71.8	79.6	10	0	51	534
2019	4	15	15	27.3	72.2	105.7	10	0	2	398
2019	4	15	16	27	75.1	105.4	10	0	0	227
2019	4	15	17	26.3	79.1	82.8	11	0	25	45
2019	4	15	18	25.6	83	97.6	7	0	55	0
2019	4	15	19	25.1	85.7	113.1	10	0	0	0
2019	4	15	20	24.6	87.5	102	11	0	2	0
2019	4	15	21	24.4	86.9	136.1	10	0	12	0
2019	4	15	22	23.8	88.8	212.2	8	0	17	0
2019	4	15	23	23.1	92.1	85.8	4	0	19	0
2019	4	15	24	22.4	94.3	128.5	1	0	0	0
2019	4	16	1	22.2	94.5	71	4	0	0	0
2019	4	16	2	22.4	94.2	90.1	1	0	0	0
2019	4	16	3	22.4	94.6	69.3	8	0	0	0
2019	4	16	4	22.4	94.8	114.7	4	0	0	0
2019	4	16	5	22.4	94.7	76.9	8	0	0	0
2019	4	16	6	22.5	94.7	132.9	8	0	0	0
2019	4	16	7	23.2	92	96.6	4	0	2	24
2019	4	16	8	24.3	89	95.8	6	0	0	194

2019	4	16	9	25.4	83.8	87.5	3	0	0	372
2019	4	16	10	26.6	79.3	93.2	4	0	0	513
2019	4	16	11	25.2	86.6	90.2	6	0.06	5	606
2019	4	16	12	20.4	93.7	80.3	4	0.1	83	641
2019	4	16	13	20.8	91.9	72.6	3	0	92	616
2019	4	16	14	23.3	84.4	82.5	4	0	70	534
2019	4	16	15	25.4	75	86.9	9	0	4	399
2019	4	16	16	27.3	68.6	86.6	2	0	0	228
2019	4	16	17	26.4	72.9	96	2	0	0	46
2019	4	16	18	24.2	83.8	72.7	2	0	0	0
2019	4	16	19	23.2	87.1	88.8	1	0.01	0	0
2019	4	16	20	22.9	88.2	88	1	0	7	0
2019	4	16	21	22.7	88.5	110	3	0.12	11	0
2019	4	16	22	22.1	93.1	78.3	2	0.12	10	0
2019	4	16	23	21.8	94.7	81.4	8	0.08	2	0
2019	4	16	24	21.7	95.8	89.1	9	0.01	0	0
2019	4	17	1	21.6	96.7	145.5	9	0.01	0	0
2019	4	17	2	21.4	96.7	71.6	6	0.03	13	0
2019	4	17	3	21	96.9	76.4	8	0.16	19	0
2019	4	17	4	20.9	97.6	86.2	6	0.68	20	0
2019	4	17	5	21	98	64.2	6	0	18	0
2019	4	17	6	21.3	98	79.2	8	0.01	35	0
2019	4	17	7	21.4	93.4	103.6	6	0.01	57	24
2019	4	17	8	21.1	92.5	96.8	1	0	63	191
2019	4	17	9	22.1	89.7	84.2	8	0	82	370
2019	4	17	10	22.8	88.1	104.6	9	0	100	510
2019	4	17	11	24.6	80.1	77.1	5	0	100	603
2019	4	17	12	26.2	74.6	66.1	4	0	100	639
2019	4	17	13	27.4	69.2	133.7	3	0	100	615
2019	4	17	14	28.6	64.6	80.8	6	0	100	533
2019	4	17	15	29.1	62.6	121.5	9	0	11	399
2019	4	17	16	28.7	64.6	107.6	1	0	10	229
2019	4	17	17	28.1	63.9	175.4	1	0	10	47
2019	4	17	18	26.6	72	130.9	1	0	10	0
2019	4	17	19	24.8	82.6	86	1	0	0	0
2019	4	17	20	23.8	87.3	129.2	2	0	0	0
2019	4	17	21	23.3	89.4	134.5	2	0	0	0
2019	4	17	22	23.1	89.8	126	1	0	66	0
2019	4	17	23	22.5	93.2	88.8	8	0	10	0
2019	4	17	24	22	94.9	66.4	7	0	69	0
2019	4	18	1	21.7	95	83.3	9	0	83	0
2019	4	18	2	21.8	94.4	88.4	7	0	23	0
2019	4	18	3	21.8	94.6	100.1	6	0	13	0
2019	4	18	4	21.7	94.7	88.3	6	0	12	0
2019	4	18	5	21.5	95.6	93.4	7	0	16	0
2019	4	18	6	21.7	95.5	98.3	5	0	21	0
2019	4	18	7	23.1	91.2	87.1	3	0	17	23
2019	4	18	8	25.1	82.8	105.5	1	0	12	190
2019	4	18	9	27.7	74.6	175.3	1	0	11	364
2019	4	18	10	28.4	71.2	84.6	0	0	3	504

2019	4	18	11	30.1	63.4	76.7	1	0	14	597
2019	4	18	12	30.6	63.4	90.6	0	0	12	632
2019	4	18	13	31.9	59.3	78.8	0	0	10	525
2019	4	18	14	32.2	58.8	73.4	1	0	10	217
2019	4	18	15	31.8	60.7	75.8	1	0	10	230
2019	4	18	16	31.7	60.2	110.4	1	0	10	236
2019	4	18	17	30.6	63.1	189.5	1	0	11	51
2019	4	18	18	29.2	68.6	160	3	0	0	0
2019	4	18	19	27.9	73.3	198.5	3	0	0	0
2019	4	18	20	26.3	78.8	128.4	2	0	0	0
2019	4	18	21	25.1	84.7	93.9	2	0	7	0
2019	4	18	22	24.6	86.1	108.1	2	0	10	0
2019	4	18	23	24.1	87.4	166.6	2	0	0	0
2019	4	18	24	23.6	89.1	143.8	2	0	10	0
2019	4	19	1	22.9	91.8	89.1	2	0	10	0
2019	4	19	2	22.9	91.7	92.7	9	0	0	0
2019	4	19	3	22.7	91.8	97.5	8	0	0	0
2019	4	19	4	22.3	93.7	119.8	9	0	0	0
2019	4	19	5	22.2	94	143.2	8	0	0	0
2019	4	19	6	22.4	94.1	156.8	4	0	1	0
2019	4	19	7	24.5	87	181.1	2	0	15	19
2019	4	19	8	25.9	81.7	178.4	1	0	6	185
2019	4	19	9	27.6	74.9	215.2	1	0	3	366
2019	4	19	10	28.7	72	195.6	1	0	10	509
2019	4	19	11	29.7	68.7	244.2	2	0	10	606
2019	4	19	12	31	64.4	179.1	1	0	10	645
2019	4	19	13	31.4	63.5	116.2	1	0	10	623
2019	4	19	14	32.1	61.4	84.4	1	0	10	546
2019	4	19	15	32.4	60.6	99.6	2	0	10	418
2019	4	19	16	30.3	67.7	78.8	2	0	0	248
2019	4	19	17	28.7	67.8	76.6	1	0	0	55
2019	4	19	18	27.2	66.9	79.8	2	0	0	0
2019	4	19	19	26.4	67.2	78.7	1	0	0	0
2019	4	19	20	25.8	69.8	84.9	1	0	5	0
2019	4	19	21	24.8	76	81.6	2	0	0	0
2019	4	19	22	24.2	79.4	99.8	3	0	10	0
2019	4	19	23	23.2	85.6	95.5	1	0	0	0
2019	4	19	24	22.8	85.3	150.3	5	0	0	0
2019	4	20	1	22.6	85.2	103.7	9	0	81	0
2019	4	20	2	21.9	88.4	123.8	8	0	56	0
2019	4	20	3	21.6	89.7	152.6	10	0	0	0
2019	4	20	4	21.4	88.8	102.6	9	0	0	0
2019	4	20	5	21	90.5	131.8	7	0	0	0
2019	4	20	6	21.4	89.8	167.8	8	0	0	0
2019	4	20	7	22.8	85.7	164.4	7	0	2	19
2019	4	20	8	25.1	79.7	183.7	9	0	3	184
2019	4	20	9	26.8	71.5	225.4	2	0	2	367
2019	4	20	10	28.7	62.8	229.2	3	0	100	512
2019	4	20	11	29.9	58.8	264.6	3	0	100	609
2019	4	20	12	31.2	55.2	260.1	3	0	85	650

2019	4	20	13	31.5	55.2	267.6	2	0	11	629
2019	4	20	14	29.3	62	200.4	3	0	18	549
2019	4	20	15	28.9	62.6	102.7	2	0	37	417
2019	4	20	16	30	60.5	161	2	0	100	247
2019	4	20	17	27.4	60.5	106.4	2	0	100	58
2019	4	20	18	26.3	60.9	89	3	0	100	0
2019	4	20	19	24.7	67.2	83.2	3	0	60	0
2019	4	20	20	23.8	69.1	88.2	2	0	26	0
2019	4	20	21	23.1	71.2	90.4	1	0	20	0
2019	4	20	22	22.2	77	87.1	7	0	10	0
2019	4	20	23	22.1	79.2	93	2	0	2	0
2019	4	20	24	21.6	81.6	95.9	2	0	0	0
2019	4	21	1	20.9	85.7	120.3	4	0	0	0
2019	4	21	2	19.9	91.5	99.2	7	0	0	0
2019	4	21	3	19.9	92.5	95.8	4	0	4	0
2019	4	21	4	19.8	92.1	87.3	1	0	0	0
2019	4	21	5	19.2	94.5	121	1	0	0	0
2019	4	21	6	19.5	93.6	139.6	7	0	0	0
2019	4	21	7	21.9	85	250.5	6	0	1	17
2019	4	21	8	24.4	73.7	153.9	8	0	0	109
2019	4	21	9	26.1	66.9	181.6	4	0	0	105
2019	4	21	10	28.2	55.9	177.5	3	0	0	119
2019	4	21	11	29.2	53.8	257	2	0	0	191
2019	4	21	12	29.3	51.6	296.9	3	0	0	325
2019	4	21	13	30.7	47.1	309.8	1	0	0	624
2019	4	21	14	31.5	47.4	162.2	2	0	0	548
2019	4	21	15	29.9	54.7	151.1	2	0	0	412
2019	4	21	16	30.6	51.6	105.3	2	0	0	248
2019	4	21	17	28.9	54.3	86.2	2	0	0	23
2019	4	21	18	28.1	59.6	99.8	1	0	0	0
2019	4	21	19	26.2	72.2	95	1	0	0	0
2019	4	21	20	25.2	78.1	106	0	0	0	0
2019	4	21	21	24.8	81.9	92.9	0	0	3	0
2019	4	21	22	23.9	85.6	146.7	0	0	0	0
2019	4	21	23	24.1	84.7	188.9	1	0	0	0
2019	4	21	24	23.2	87.9	86.5	1	0	0	0
2019	4	22	1	22.9	89.7	92.6	4	0.01	0	0
2019	4	22	2	22.2	90.9	129.7	4	0.01	0	0
2019	4	22	3	21.8	92.3	268.8	7	0	0	0
2019	4	22	4	22.2	90.7	112	1	0	0	0
2019	4	22	5	21.9	92.7	134.7	0	0	0	0
2019	4	22	6	22.1	91.4	105.7	1	0	3.9	0
2019	4	22	7	22.7	88.7	107.9	1	0	30	26
2019	4	22	8	23.4	87	121.2	0	0	30	193
2019	4	22	9	25.6	76	108	4	0	23	369
2019	4	22	10	27.2	68	98.8	8	0	4	504
2019	4	22	11	27.1	65.5	108.4	4	0	73	595
2019	4	22	12	27.8	65.6	90	6	0	100	629
2019	4	22	13	28.9	60	111.3	9	0	100	602
2019	4	22	14	30.6	52.3	130.4	2	0	100	519

2019	4	22	15	30	52.6	255.3	2	0	100	385
2019	4	22	16	29.1	58.6	96.6	2	0	100	217
2019	4	22	17	28.8	57.9	79.2	3	0	100	39
2019	4	22	18	28	64.1	87.8	2	0	100	0
2019	4	22	19	26.6	72.5	99.5	8	0	76	0
2019	4	22	20	25.2	79.4	134.3	4	0	51	0
2019	4	22	21	24.9	79.5	120.6	3	0	26	0
2019	4	22	22	24.2	82.6	84.6	1	0	2	0
2019	4	22	23	23.8	80.7	84.6	1	0	3	0
2019	4	22	24	23.6	76.6	83.1	0	0	1	0
2019	4	23	1	22.8	78.6	99	2	0	2	0
2019	4	23	2	21.9	80.5	94.6	2	0	2	0
2019	4	23	3	21	84.1	85	2	0	3	0
2019	4	23	4	20.2	88.1	79.7	2	0	1	0
2019	4	23	5	19.8	91	75.8	1	0	1	0
2019	4	23	6	20.2	90.9	77.4	0	0	1	0
2019	4	23	7	22.1	84.2	85.6	4	0	0	28
2019	4	23	8	24.4	74.6	179.8	1	0	0	201
2019	4	23	9	27.2	60.4	123	1	0	0	373
2019	4	23	10	28.8	53.2	100.6	0	0	0	505
2019	4	23	11	30.1	53.9	132.9	2	0	0	591
2019	4	23	12	30.9	52.5	135.1	2	0	0	624
2019	4	23	13	31.9	49.4	82.2	3	0	0	600
2019	4	23	14	32.2	48.9	83.8	4	0	10	521
2019	4	23	15	32.4	48.4	82.7	2	0	1	389
2019	4	23	16	31.6	51	80.5	1	0	0	222
2019	4	23	17	31	51.8	96.6	0	0	0	40
2019	4	23	18	29.7	57.6	85.2	1	0	0	0
2019	4	23	19	27.4	68.3	89.9	1	0	0	0
2019	4	23	20	26.3	74.4	80	1	0	0	0
2019	4	23	21	25.4	79.8	89.6	0	0	0	0
2019	4	23	22	24.4	84.7	163.6	1	0	0	0
2019	4	23	23	23.8	86.7	131.5	0	0	0	0
2019	4	23	24	23.3	87.9	82.8	1	0	0	0
2019	4	24	1	22.8	88.1	93.2	0	0	0	0
2019	4	24	2	22.9	86	104.1	1	0	0	0
2019	4	24	3	22.3	89.1	103.7	1	0	0	0
2019	4	24	4	21.2	93.4	142.5	1	0	0	0
2019	4	24	5	21.1	94.2	151.5	0	0	0	0
2019	4	24	6	21.6	92.4	146.3	3	0	0	0
2019	4	24	7	23.8	85.8	126.1	1	0	0	27
2019	4	24	8	25.9	77.5	97.3	1	0	0	192
2019	4	24	9	28.1	68.4	106.7	6	0	0	369
2019	4	24	10	30.3	60.6	116.5	2	0	0	506
2019	4	24	11	31.7	54.1	78.4	2	0	0	597
2019	4	24	12	32.8	47.3	76.8	2	0	0	630
2019	4	24	13	33.7	44.6	99.3	1	0	0	606
2019	4	24	14	34.8	39.7	105.7	1	0	0	525
2019	4	24	15	35.3	37.8	133.6	3	0	0	395
2019	4	24	16	34.8	39.3	114.6	1	0	0	229

2019	4	24	17	34.2	41.1	141.9	0	0	0	46
2019	4	24	18	31.3	54.4	134.4	0	0	0	0
2019	4	24	19	29.1	65.5	92	1	0	0	0
2019	4	24	20	28.6	68.6	119.5	0	0	0	0
2019	4	24	21	26.8	75.2	174.2	1	0	0	0
2019	4	24	22	25.6	80.9	129.2	4	0	0	0
2019	4	24	23	25.1	82	82.3	2	0	0	0
2019	4	24	24	23.9	84.6	79.8	1	0	0	0
2019	4	25	1	23.4	87.1	118.6	1	0	0	0
2019	4	25	2	23.3	87.8	106.6	1	0	0	0
2019	4	25	3	22.8	89.9	130.7	3	0	0	0
2019	4	25	4	22.1	93.7	106	4	0	0	0
2019	4	25	5	22	92.7	116.1	5	0	0	0
2019	4	25	6	22.9	89.1	110	4	0	0	0
2019	4	25	7	25	81.3	158.2	1	0	0	24
2019	4	25	8	26.7	74.8	193.4	4	0	0	193
2019	4	25	9	29.2	67.1	187.3	1	0	0	373
2019	4	25	10	31.2	59.4	82.5	4	0	0	513
2019	4	25	11	33.1	53.7	82	3	0	0	606
2019	4	25	12	34.2	49.3	91.3	8	0	14	641
2019	4	25	13	35.3	45	197.6	8	0	39	615
2019	4	25	14	36	40.8	115.7	1	0	62	533
2019	4	25	15	36.3	38.5	154.2	1	0	10	397
2019	4	25	16	36.1	38.9	161.5	0	0	2	226
2019	4	25	17	34.8	45.3	69.4	0	0	0	44
2019	4	25	18	32.9	50.5	67.6	2	0	0	0
2019	4	25	19	31.3	60.4	76.3	3	0	9	0
2019	4	25	20	30.2	66.6	97	2	0	3	0
2019	4	25	21	29.3	69.8	93	1	0	2	0
2019	4	25	22	28.8	68	148	1	0	0	0
2019	4	25	23	26.9	78.9	131.2	4	0	0	0
2019	4	25	24	26.1	83.4	106.4	6	0	0	0
2019	4	26	1	25.4	86.3	94.8	1	0	0	0
2019	4	26	2	26.1	81.2	90.5	1	0	0	0
2019	4	26	3	25.8	79.9	79.9	1	0	0	0
2019	4	26	4	24.5	87.1	77	1	0	0	0
2019	4	26	5	24.6	87.7	87.4	0	0	0	0
2019	4	26	6	24.7	88.1	77.5	1	0	0	0
2019	4	26	7	25.8	84.6	68	6	0	2	23
2019	4	26	8	28	78.1	78.8	2	0	5	193
2019	4	26	9	30.3	70.5	82.4	2	0	2	371
2019	4	26	10	32.3	59.9	73.2	1	0	0	512
2019	4	26	11	33.5	55.6	74.3	1	0	10	605
2019	4	26	12	34.9	50.5	78.1	0	0	10	640
2019	4	26	13	35.9	46.9	87.6	4	0	10	615
2019	4	26	14	36.2	45.5	77.2	2	0	10	533
2019	4	26	15	36.4	45.6	89.9	2	0	11	398
2019	4	26	16	35.6	47.8	113.6	2	0	0	227
2019	4	26	17	34.8	50.5	138.8	2	0	0	45
2019	4	26	18	33.1	56.1	96.8	1	0	0	0

2019	4	26	19	30.9	65.6	86	1	0	12	0
2019	4	26	20	30	72.8	72.2	3	0	10	0
2019	4	26	21	26.7	69.4	87.6	4	0	67	0
2019	4	26	22	26	65.5	90	1	0	64	0
2019	4	26	23	26.3	67.5	147.2	4	0	0	0
2019	4	26	24	26.3	70	199.6	6	0	0	0
2019	4	27	1	25.5	74.8	94.1	4	0	21	0
2019	4	27	2	24.8	80.1	91.1	4	0	23	0
2019	4	27	3	24.4	83	95.8	4	0	37	0
2019	4	27	4	23.6	88.4	88.6	1	0	11	0
2019	4	27	5	24.1	84.5	74.7	1	0	32	0
2019	4	27	6	24.6	83.7	80.3	7	0	30	0
2019	4	27	7	26.2	78.8	82.3	4	0	100	23
2019	4	27	8	27.8	74.5	94.1	7	0	100	190
2019	4	27	9	30.1	65	67.7	3	0	82	369
2019	4	27	10	29.5	67.8	81.2	7	0	91	509
2019	4	27	11	25.8	86.4	90.5	8	0	31	602
2019	4	27	12	25.9	83.1	80.2	7	0	77	638
2019	4	27	13	26.5	81.8	75.7	3	0	100	614
2019	4	27	14	26.8	81.7	75.7	1	0	59	532
2019	4	27	15	27.1	80.7	83.8	1	0	15	398
2019	4	27	16	27.1	80.6	77.9	1	0	6	228
2019	4	27	17	26.7	83.1	169.4	2	0	9	46
2019	4	27	18	25.9	84.7	83.7	1	0	12	0
2019	4	27	19	25.3	89.8	115.9	1	0	7	0
2019	4	27	20	24.6	92.9	103.3	2	0	3	0
2019	4	27	21	24.4	92.7	110.5	3	0	15	0
2019	4	27	22	24.3	92.5	97.4	7	0	25	0
2019	4	27	23	24.6	91.2	98	6	0	15	0
2019	4	27	24	24.4	91.4	83.7	1	0	0	0
2019	4	28	1	24.1	93.1	85.1	4	0	0	0
2019	4	28	2	23.8	94.6	104.1	6	0	38	0
2019	4	28	3	23.7	94.1	101.5	1	0	59	0
2019	4	28	4	24	92.8	94.8	7	0	19	0
2019	4	28	5	24	93.4	130.1	4	0	10	0
2019	4	28	6	23.9	95.3	109.8	6	0	4	0
2019	4	28	7	24.1	94.6	116.3	1	0	6	22
2019	4	28	8	24.5	92.7	104.2	6	0	0	189
2019	4	28	9	24.4	94.3	119.3	6	0.02	87	363
2019	4	28	10	24	95.9	94	9	0.24	93	503
2019	4	28	11	23.7	97.1	109.1	1	0.4	72	596
2019	4	28	12	24.5	93.1	97.6	1	0.04	86	631
2019	4	28	13	24.6	93.2	166.9	1	0.02	74	524
2019	4	28	14	24.8	91.7	110.8	1	0	73	216
2019	4	28	15	24.9	90.9	93	1	0	35	229
2019	4	28	16	24.3	92.9	83.3	1	0	14	235
2019	4	28	17	23.9	94.6	80.7	1	0	10	50
2019	4	28	18	23.6	97.3	87.6	2	0.5	100	0
2019	4	28	19	23.3	98.1	172.5	2	0.02	100	0
2019	4	28	20	23.4	98.2	153.6	6	0.01	100	0

2019	4	28	21	23.2	98.2	147.7	8	0.01	22	0
2019	4	28	22	23.1	98.8	102.7	4	0	34	0
2019	4	28	23	23.1	99	81	8	0	45	0
2019	4	28	24	22.9	98.7	83.2	6	0	26	0
2019	4	29	1	22.8	98.9	90.4	4	0	25	0
2019	4	29	2	22.9	98.9	111.6	4	0	34	0
2019	4	29	3	22.8	98.5	147.1	4	0	33	0
2019	4	29	4	22.9	98.5	97.3	7	0	77	0
2019	4	29	5	22.8	98.6	127.9	4	0	34	0
2019	4	29	6	22.9	98.9	92.5	4	0	42	0
2019	4	29	7	23.1	98.3	107.8	4	0	81	19
2019	4	29	8	23.2	97.5	106.5	7	0	81	184
2019	4	29	9	22.9	97.8	98.5	1	0.35	100	366
2019	4	29	10	22.6	98.2	93.9	1	0.29	100	509
2019	4	29	11	22.5	96	88.2	0	0.12	16	605
2019	4	29	12	22.9	94.8	90.8	0	0.02	82	644
2019	4	29	13	23.3	95.3	93.5	1	0	92	623
2019	4	29	14	22.8	96.1	104.3	1	0	90	546
2019	4	29	15	23.8	93.2	94.1	2	0	19	418
2019	4	29	16	24.1	91.8	105.7	1	0	11	248
2019	4	29	17	23.7	91.6	107.9	2	0	11	55
2019	4	29	18	22.8	94.9	121.2	1	0	10	0
2019	4	29	19	22	96.2	108	3	0.01	15	0
2019	4	29	20	21.6	97.5	98.8	4	0.3	11	0
2019	4	29	21	21	99.1	108.4	8	0.11	23	0
2019	4	29	22	21	98.5	90	8	0	37	0
2019	4	29	23	21.1	98.6	111.3	8	0	43	0
2019	4	29	24	21	98.9	130.4	6	0.26	100	0
2019	4	30	1	20.8	99.5	255.3	7	0.14	100	0
2019	4	30	2	20.9	99.2	96.6	1	0.13	52	0
2019	4	30	3	20.9	99.3	79.2	7	0.07	52	0
2019	4	30	4	20.9	99.3	87.8	6	0.05	27	0
2019	4	30	5	21.1	99.1	99.5	4	0	25	0
2019	4	30	6	21.1	99.5	134.3	8	0.07	36	0
2019	4	30	7	21.2	99.7	120.6	9	0.17	42	19
2019	4	30	8	21.3	99.6	84.6	6	0.12	20	183
2019	4	30	9	21.4	99.6	84.6	1	0.16	78	367
2019	4	30	10	21.9	99.2	83.1	1	0.07	91	512
2019	4	30	11	22	98.6	99	8	0.01	37	609
2019	4	30	12	22.8	95.6	94.6	9	0	91	650
2019	4	30	13	23.2	93.7	85	4	0	100	628
2019	4	30	14	23.1	93.9	79.7	3	0	100	549
2019	4	30	15	22.5	95.1	75.8	3	0	6	417
2019	4	30	16	22.1	96.2	77.4	2	0	3	247
2019	4	30	17	21.6	97.3	85.6	2	0	1	58
2019	4	30	18	21.1	98.5	179.8	2	0.43	0	0
2019	4	30	19	20.8	99.4	123	8	0.13	10	0
2019	4	30	20	20.9	99.2	100.6	6	0.13	64	0
2019	4	30	21	20.7	99.4	132.9	9	0.3	75	0
2019	4	30	22	20.6	99.4	135.1	9	0	81	0

2019	4	30	23	20.6	98.9	82.2	8	0.01	76	0
2019	4	30	24	20.4	98.5	83.8	9	0.05	25	0
2019	5	1	1	20.2	99.1	82.7	6	0.08	100	0
2019	5	1	2	20.3	99.4	80.5	1	0.06	100	0
2019	5	1	3	20.3	99.7	96.6	4	0	36	0
2019	5	1	4	20.3	100	85.2	8	0.21	100	0
2019	5	1	5	20.3	100	89.9	8	0.02	100	0
2019	5	1	6	20.3	99.7	80	4	0.02	100	0
2019	5	1	7	20.6	98.8	89.6	6	0.02	100	17
2019	5	1	8	20.8	98.5	163.6	8	0.02	65	109
2019	5	1	9	21.5	96.8	131.5	1	0	17	105
2019	5	1	10	21.6	96.3	82.8	1	0.01	81	118
2019	5	1	11	22	96	93.2	2	0.05	85	191
2019	5	1	12	21.8	97.5	104.1	1	0.24	99	325
2019	5	1	13	22.9	93.2	103.7	2	0	100	624
2019	5	1	14	22.6	94.6	142.5	2	0.01	100	547
2019	5	1	15	22.6	95.6	151.5	2	0.03	80	412
2019	5	1	16	21.8	98.7	146.3	2	0.23	91	248
2019	5	1	17	21.9	98.6	126.1	1	0.05	83	23
2019	5	1	18	21.7	99.1	97.3	1	0.01	100	0
2019	5	1	19	21.4	99.5	106.7	9	0.09	100	0
2019	5	1	20	21.3	99.8	116.5	8	0.49	100	0
2019	5	1	21	21.3	99.9	78.4	4	0.02	100	0
2019	5	1	22	21.2	99.9	76.8	1	0.28	100	0
2019	5	1	23	21.3	100	99.3	1	0.17	100	0
2019	5	1	24	21.2	100	105.7	1	0.19	100	0
2019	5	2	1	21.2	100	133.6	7	0.21	100	0
2019	5	2	2	21.1	100	114.6	6	0.01	100	0
2019	5	2	3	21.1	100	141.9	6	0.05	100	0
2019	5	2	4	21.2	100	134.4	4	0.09	100	0
2019	5	2	5	21.2	100	92	3	0.01	100	0
2019	5	2	6	21.3	100	119.5	4	0	100	0
2019	5	2	7	21.8	99.9	174.2	3	0	100	26
2019	5	2	8	22.8	96.5	129.2	6	0	100	193
2019	5	2	9	23.7	93.3	122.8	7	0	100	369
2019	5	2	10	24.1	91.7	78.8	8	0	100	504
2019	5	2	11	25.2	88.4	120.5	7	0	100	595
2019	5	2	12	26.3	84.2	84.7	8	0	100	628
2019	5	2	13	27.8	78.2	103.9	7	0	95	602
2019	5	2	14	28.6	75.6	95.6	6	0	35	519
2019	5	2	15	28.1	77	85.5	5	0	40	385
2019	5	2	16	27.4	78.2	81.4	1	0.01	20	216
2019	5	2	17	25.6	87.8	84.3	4	0	69	38
2019	5	2	18	24.8	92.5	81.3	3	0.01	10	0
2019	5	2	19	24.6	92.1	132.7	6	0	27	0
2019	5	2	20	24.1	93.8	130.5	8	0	22	0
2019	5	2	21	23.7	94.8	117.6	6	0	100	0
2019	5	2	22	23.7	94	94.9	1	0	100	0
2019	5	2	23	23.6	93.8	91.6	1	0	15	0
2019	5	2	24	22.7	93.5	96.1	1	0	20	0

2019	5	3	1	22.7	92.7	83.4	1	0	100	0
2019	5	3	2	22.6	94.3	105	6	0	97	0
2019	5	3	3	22.5	95.5	144.2	1	0	53	0
2019	5	3	4	22.3	96.7	85.4	4	0	23	0
2019	5	3	5	22.1	96.2	134.9	1	0	20	0
2019	5	3	6	22.4	94.8	175.4	0	0	25	0
2019	5	3	7	22.4	95.2	105.4	6	0	24	28
2019	5	3	8	22.7	94.3	78.1	7	0	100	200
2019	5	3	9	23.4	91.8	188.6	4	0	100	373
2019	5	3	10	23.8	90.5	252.6	4	0.01	100	505
2019	5	3	11	25.7	83.9	245.6	8	0	100	591
2019	5	3	12	26.3	82.3	210.4	8	0	100	624
2019	5	3	13	26.6	81.6	235.9	4	0	100	600
2019	5	3	14	27.2	79.7	244.3	3	0	100	521
2019	5	3	15	26.6	81.9	253.7	2	0	100	389
2019	5	3	16	26.2	85.3	110.6	2	0.01	100	222
2019	5	3	17	25.5	90.4	116.5	4	0	100	40
2019	5	3	18	25.1	92.7	237.5	9	0	30	0
2019	5	3	19	24.7	95.6	240.8	6	0	100	0
2019	5	3	20	24.2	97.3	263.7	6	0	100	0
2019	5	3	21	24.2	98.1	240.8	6	0	100	0
2019	5	3	22	24.1	98	254	6	0	15	0
2019	5	3	23	24.1	98.2	218.6	4	0	25	0
2019	5	3	24	23.9	98.7	262.4	1	0	16	0
2019	5	4	1	23.7	98.7	267.4	4	0	33	0
2019	5	4	2	23.7	99.2	279.5	1	0	45	0
2019	5	4	3	23.6	99.7	269.2	1	0.02	80	0
2019	5	4	4	23.5	100	263.7	6	0.03	90	0
2019	5	4	5	23.2	100	254.3	1	0.01	100	0
2019	5	4	6	23.2	99.9	250.4	1	0	43	0
2019	5	4	7	23.7	98.6	240.7	1	0	100	27
2019	5	4	8	24.3	95.2	237.1	7	0	100	191
2019	5	4	9	25.5	88	193.5	7	0	23	369
2019	5	4	10	27.1	82.1	190.6	8	0	0	506
2019	5	4	11	28.4	79.1	208.5	1	0	0	596
2019	5	4	12	28.9	76.4	262	4	0	0	629
2019	5	4	13	28.3	77.5	202.4	3	0	5	605
2019	5	4	14	27.2	82.5	188.8	2	0.05	90	525
2019	5	4	15	25.3	91.6	207.9	1	0.08	80	395
2019	5	4	16	24.8	94.3	215.6	1	0.09	100	229
2019	5	4	17	24.2	94.5	245.9	8	0.04	100	46
2019	5	4	18	24.3	88.2	194.4	7	0	100	0
2019	5	4	19	23.7	92.7	121.3	4	0.01	100	0
2019	5	4	20	23.3	94.5	111	6	0.01	100	0
2019	5	4	21	23.3	95.6	115	1	0.01	100	0
2019	5	4	22	22.8	94.5	122.9	4	0	100	0
2019	5	4	23	22.5	95.9	97.3	6	0.17	100	0
2019	5	4	24	22.2	98	80.9	1	0.22	100	0
2019	5	5	1	21.9	98.7	155.8	4	0.19	100	0
2019	5	5	2	21.6	98.7	221.9	1	0.15	100	0

2019	5	5	3	21.5	99.3	126.3	0	0.1	100	0
2019	5	5	4	21.6	99.9	126.6	0	0.15	100	0
2019	5	5	5	21.7	100	207.7	6	0.1	100	0
2019	5	5	6	21.8	100	163.6	1	0.06	100	0
2019	5	5	7	21.7	100	145.7	6	0.06	100	24
2019	5	5	8	21.8	99.5	199.3	1	0.02	100	193
2019	5	5	9	22.6	96.8	145	0	0	100	373
2019	5	5	10	23.6	93.9	221.5	6	0	100	513
2019	5	5	11	24.8	88.9	222.7	1	0	100	605
2019	5	5	12	25.7	84.5	191.9	15	0	100	641
2019	5	5	13	26.8	79.1	231	16	0	100	615
2019	5	5	14	25.4	86.1	221	11	0.04	78	532
2019	5	5	15	25.2	90.9	247.3	10	0.03	56	397
2019	5	5	16	26.6	84.4	246.4	10	0	10	226
2019	5	5	17	26.4	84.3	250.4	10	0	100	44
2019	5	5	18	25.7	89	234.5	9	0	40	0
2019	5	5	19	25.1	92.5	263.3	10	0	75	0
2019	5	5	20	24.7	94.4	143.3	9	0	14	0
2019	5	5	21	24.3	96.4	130.2	8	0	7	0
2019	5	5	22	23.7	98.1	109.4	6	0	10	0
2019	5	5	23	23.5	98.1	144.8	9	0	11	0
2019	5	5	24	23.2	98.8	101.6	7	0	73	0
2019	5	6	1	23.1	99.5	106.6	13	0	21	0
2019	5	6	2	22.8	99.9	147.9	6	0	24	0
2019	5	6	3	22.8	100	171.3	6	0	29	0
2019	5	6	4	22.7	99.9	142	1	0	56	0
2019	5	6	5	22.7	99.8	237.9	4	0	16	0
2019	5	6	6	22.9	99.5	156	1	0	10	0
2019	5	6	7	23.9	95.8	143.8	6	0	10	23
2019	5	6	8	25.2	89.7	157.4	1	0	0	192
2019	5	6	9	26.3	86.2	136	1	0	2	371
2019	5	6	10	28	80.9	136.5	10	0	10	512
2019	5	6	11	30.1	73.7	148.9	9	0.01	11	604
2019	5	6	12	30.1	74.6	121.1	13	0	14	640
2019	5	6	13	30.7	72.8	82.9	13	0	10	615
2019	5	6	14	31.2	70.2	220.2	15	0	10	532
2019	5	6	15	30.6	73.5	153.8	15	0	10	398
2019	5	6	16	29.6	78.3	142	13	0	10	227
2019	5	6	17	28.3	79.4	114.2	11	0	10	45
2019	5	6	18	26.7	80.8	122.6	10	0	0	0
2019	5	6	19	25.4	82.9	132.5	8	0	2	0
2019	5	6	20	24.9	82.9	107.6	8	0	5	0
2019	5	6	21	24	84.2	86.6	8	0	8	0
2019	5	6	22	23.9	85	149.1	6	0	10	0
2019	5	6	23	23.5	86.9	80.6	1	0	0	0
2019	5	6	24	23.2	89	169.4	1	0	0	0
2019	5	7	1	22.5	91.6	216.6	6	0	0	0
2019	5	7	2	22.7	89.6	250.5	6	0	19	0
2019	5	7	3	22.8	88.2	157.8	7	0	37	0
2019	5	7	4	21.9	93.3	155	6	0	66	0

2019	5	7	5	21.8	93.3	212.7	7	0	74	0
2019	5	7	6	21.7	93.3	179.7	7	0	100	0
2019	5	7	7	21.8	91.4	145.8	4	0	76	22
2019	5	7	8	21.6	93.6	148.2	8	0.03	80	190
2019	5	7	9	21.7	93.3	81	11	0.01	85	369
2019	5	7	10	22.6	90.1	123.1	11	0	0	509
2019	5	7	11	22.6	90.9	111	10	0	0	602
2019	5	7	12	21.9	93.8	231.7	7	0	0	637
2019	5	7	13	23.4	85.1	236.1	13	0	0	613
2019	5	7	14	23.7	83.9	295.5	17	0	74	531
2019	5	7	15	23.9	84.6	184.6	13	0	0	398
2019	5	7	16	24.1	83.4	149.1	13	0	0	228
2019	5	7	17	23.8	85.3	225	8	0	0	46
2019	5	7	18	23.3	86.9	143.9	11	0	0	0
2019	5	7	19	22.9	89.3	139.3	9	0	0	0
2019	5	7	20	22.3	92.9	163.6	7	0	0	0
2019	5	7	21	21.8	95.6	147.7	7	0	1	0
2019	5	7	22	21.9	95.5	195.3	8	0	0	0
2019	5	7	23	21.8	96.8	235	4	0	0	0
2019	5	7	24	21.7	97	251.1	1	0	0	0
2019	5	8	1	21.6	96.2	254.7	6	0	10	0
2019	5	8	2	21.6	95.9	234.8	1	0.01	50	0
2019	5	8	3	21.2	96.5	148.8	4	0	0	0
2019	5	8	4	21.1	97.6	241.4	7	0	0	0
2019	5	8	5	21	97.4	229.1	7	0	3	0
2019	5	8	6	21.2	97.4	220.9	4	0.12	80	0
2019	5	8	7	21	97.5	148	4	0.39	90	21
2019	5	8	8	20.7	97.2	180.2	4	0.13	100	189
2019	5	8	9	20.9	96.5	191.5	8	0.03	90	363
2019	5	8	10	21.2	97	114	7	0.31	80	503
2019	5	8	11	21.7	96.2	163.4	7	0	8	596
2019	5	8	12	22.6	92.2	223.8	7	0	76	631
2019	5	8	13	22.7	92.7	247.3	13	0.01	80	523
2019	5	8	14	23.3	89.6	265.8	14	0	75	215
2019	5	8	15	23.6	87.8	220.9	14	0	3	229
2019	5	8	16	23.1	88.1	266.7	11	0	70	235
2019	5	8	17	22.3	91.4	278.4	11	0	1	50
2019	5	8	18	21.7	94.6	179.8	9	0	19	0
2019	5	8	19	21.7	94.3	99	7	0	75	0
2019	5	8	20	21.5	95.2	173.5	7	0	50	0
2019	5	8	21	21.3	95.1	96.8	4	0	25	0
2019	5	8	22	21.3	95.3	157.5	7	0	0	0
2019	5	8	23	21.6	94.1	133.2	7	0	81	0
2019	5	8	24	21.7	92.4	124.5	6	0	88	0
2019	5	9	1	20.8	97.5	137.3	4	0.17	100	0
2019	5	9	2	20.8	98.4	166.4	1	0	100	0
2019	5	9	3	20.7	97.6	155.2	4	0	100	0
2019	5	9	4	20.6	98.2	186.2	1	0.05	100	0
2019	5	9	5	20.6	98.9	178.9	4	0.01	100	0
2019	5	9	6	20.6	99.1	119.6	7	0.08	90	0

2019	5	9	7	20.7	99.1	138.7	4	0.07	46	19
2019	5	9	8	20.8	99.2	146.7	1	0.21	85	185
2019	5	9	9	20.9	99.2	140.7	6	0.08	100	366
2019	5	9	10	21.2	98.1	122.6	8	0.02	100	510
2019	5	9	11	21.4	97.3	107.4	4	0	40	606
2019	5	9	12	22.1	95.7	151.6	11	0	26	645
2019	5	9	13	22.9	91.8	137.6	14	0	14	624
2019	5	9	14	22.9	90.8	109.4	10	0	80	546
2019	5	9	15	23.8	87.8	88	10	0	0	418
2019	5	9	16	24.1	86.8	105.5	15	0	0	248
2019	5	9	17	23.8	85.6	76.3	10	0	7	56
2019	5	9	18	22.8	89	90.1	8	0	28	0
2019	5	9	19	22.2	91.5	95.7	8	0	23	0
2019	5	9	20	22.2	92.9	96.8	6	0	5	0
2019	5	9	21	21.8	95.2	84.4	7	0	1	0
2019	5	9	22	21.6	95.5	101.7	6	0	12	0
2019	5	9	23	21.3	97.2	89.6	1	0	43	0
2019	5	9	24	21.1	97.9	151.2	1	0	21	0
2019	5	10	1	21	97.5	111.7	4	0	32	0
2019	5	10	2	21	97.2	205.2	4	0	33	0
2019	5	10	3	21.1	97.1	83.6	4	0	35	0
2019	5	10	4	21.2	97.8	202.5	1	0	90	0
2019	5	10	5	21.2	98.2	90.4	4	0.01	100	0
2019	5	10	6	21	98.7	109.2	1	0.04	100	0
2019	5	10	7	20.8	99.3	89.3	0	0.15	100	19
2019	5	10	8	20.8	99.2	163	0	0.22	100	184
2019	5	10	9	20.8	99.4	95.2	4	0.18	100	367
2019	5	10	10	20.8	99	84.1	8	0.03	100	512
2019	5	10	11	20.9	96	110.3	4	0	100	609
2019	5	10	12	21.1	93	139.3	0	0	28	650
2019	5	10	13	22.1	90.4	123.4	9	0	29	629
2019	5	10	14	23.1	88.7	153.3	13	0	19	550
2019	5	10	15	23.8	84.6	241.8	0	0	100	417
2019	5	10	16	23.8	84	132.1	0	0	4	247
2019	5	10	17	22.9	87	191.2	0	0	1	58
2019	5	10	18	22.2	91.7	280.4	0	0	32	0
2019	5	10	19	22	93.6	149	8	0	35	0
2019	5	10	20	21.7	95.4	96.1	6	0	92	0
2019	5	10	21	21.6	95.9	133.1	4	0	100	0
2019	5	10	22	21.6	95.5	128.2	7	0	100	0
2019	5	10	23	21.4	95	108.1	6	0	53	0
2019	5	10	24	21.2	96.9	119.5	6	0.01	23	0
2019	5	11	1	21.2	98.4	131	1	0	25	0
2019	5	11	2	20.9	99	135.3	4	0.07	29	0
2019	5	11	3	20.9	99.5	145	1	0	41	0
2019	5	11	4	21.1	99.7	129.1	6	0	69	0
2019	5	11	5	20.9	99.9	138.3	6	0	77	0
2019	5	11	6	20.9	99.3	129	6	0.07	78	0
2019	5	11	7	21.4	98.2	100.6	1	0	100	17
2019	5	11	8	21.9	95.6	127.2	4	0	100	109

2019	5	11	9	21.7	95.9	235.2	7	0	100	106
2019	5	11	10	22.3	94.3	242.2	9	0	37	119
2019	5	11	11	23.5	89	212.4	7	0	54	191
2019	5	11	12	24.3	85.9	242.2	7	0	100	325
2019	5	11	13	24.4	85.7	227.5	0	0	100	624
2019	5	11	14	24	87.4	227.7	0	0	89	548
2019	5	11	15	23.8	88.1	265.5	0	0	29	413
2019	5	11	16	23.9	88.3	248.7	0	0	14	248
2019	5	11	17	23.4	90.2	140.8	9	0	14	24
2019	5	11	18	22.8	92.5	98.3	8	0	11	0
2019	5	11	19	22.8	92.5	70.1	6	0	100	0
2019	5	11	20	22.5	94.5	83.8	6	0	100	0
2019	5	11	21	22	95.7	81.2	1	0	100	0
2019	5	11	22	22.2	95.9	98.9	1	0	100	0
2019	5	11	23	22.1	96.4	88.3	7	0	100	0
2019	5	11	24	21.9	94.9	82.9	4	0	27	0
2019	5	12	1	21.6	95.2	99.1	4	0	21	0
2019	5	12	2	21.4	96.6	102.6	4	0.02	31	0
2019	5	12	3	21.2	98.6	103.3	4	0	33	0
2019	5	12	4	21.3	99.1	101.8	1	0	83	0
2019	5	12	5	21.2	99.8	166	1	0	81	0
2019	5	12	6	21.6	100	116.9	1	0.01	70	0
2019	5	12	7	21.8	99.4	101.9	1	0	28	26
2019	5	12	8	22.7	94.2	94.6	1	0	100	194
2019	5	12	9	23.9	89.5	86.7	1	0	100	369
2019	5	12	10	25.1	85.4	99.6	4	0	68	504
2019	5	12	11	25.9	83.6	104.8	7	0	100	595
2019	5	12	12	27.7	78.3	90	0	0	84	629
2019	5	12	13	28.2	77.4	117.9	0	0	10	602
2019	5	12	14	28.9	76.1	104	1	0	10	519
2019	5	12	15	29.4	75.2	124	2	0	11	385
2019	5	12	16	29.6	73.2	162.1	5	0	10	217
2019	5	12	17	28.3	79.8	120.3	4	0	10	39
2019	5	12	18	27.4	85.3	154.3	6	0	0	0
2019	5	12	19	26.8	88.4	121.2	0	0	4	0
2019	5	12	20	25.9	92.8	221.5	8	0	6	0
2019	5	12	21	25.6	94.2	137.7	8	0	19	0
2019	5	12	22	24.9	96.5	110.5	6	0	34	0
2019	5	12	23	24.4	95.6	128.6	1	0	30	0
2019	5	12	24	24.1	96.2	184.3	6	0	100	0
2019	5	13	1	24.1	95.6	225.9	4	0	100	0
2019	5	13	2	21.8	96.2	136.5	1	0.31	100	0
2019	5	13	3	22	96.5	167.1	6	0	7	0
2019	5	13	4	22.1	97.6	158.6	6	0	30	0
2019	5	13	5	22	98.6	188.9	4	0.01	59	0
2019	5	13	6	22.6	96.7	204.3	7	0	43	0
2019	5	13	7	23.7	91.5	107.4	1	0	62	28
2019	5	13	8	24.6	88.9	86.3	4	0	89	201
2019	5	13	9	24.9	87.6	72.9	1	0	28	373
2019	5	13	10	25.7	85.5	95.1	1	0	69	505

2019	5	13	11	27.2	80.9	101.4	1	0	100	591
2019	5	13	12	28.1	77.5	103	0	0	100	624
2019	5	13	13	29.1	75	123	1	0	100	600
2019	5	13	14	29.6	69.5	110.2	2	0	25	521
2019	5	13	15	29.9	66.5	81.9	3	0	17	389
2019	5	13	16	30.1	65.5	131.3	4	0	71	222
2019	5	13	17	28.8	74.1	86	6	0	40	41
2019	5	13	18	27.2	83.5	89.7	9	0.09	90	0
2019	5	13	19	25.2	89.4	125.8	4	0	45	0
2019	5	13	20	25	91.1	78.6	7	0	0	0
2019	5	13	21	23.5	89.7	109.7	6	0	1	0
2019	5	13	22	22.8	90.9	110	4	0	14	0
2019	5	13	23	22.6	92.5	104.5	4	0	16	0
2019	5	13	24	22.2	95	87.4	6	0	30	0
2019	5	14	1	22.3	95.5	149.5	9	0	100	0
2019	5	14	2	22.1	96	87.8	6	0	100	0
2019	5	14	3	22	96.7	169	5	0	100	0
2019	5	14	4	22.3	95.6	224.9	9	0	100	0
2019	5	14	5	22.5	98	187.5	7	0.45	100	0
2019	5	14	6	22.2	98.6	128.3	8	0.08	100	0
2019	5	14	7	21.9	98	105.4	7	0.07	100	27
2019	5	14	8	22.4	97	111.4	7	0.01	100	192
2019	5	14	9	23.7	92.1	132.1	6	0	100	369
2019	5	14	10	24.4	90.4	90.7	4	0	100	506
2019	5	14	11	24.3	89.8	63.3	6	0	100	597
2019	5	14	12	25.3	85.8	105.6	4	0	82	630
2019	5	14	13	25.2	84.6	142.8	8	0	64	606
2019	5	14	14	25.4	84.1	203	9	0	38	526
2019	5	14	15	25.7	83.4	266.1	9	0	3	396
2019	5	14	16	25.7	82.9	282	9	0	68	229
2019	5	14	17	25.3	83.9	219.4	3	0	100	46
2019	5	14	18	24.1	87.9	152.4	2	0	0	0
2019	5	14	19	23.4	89.3	92.5	0	0	0	0
2019	5	14	20	23.2	88	88.7	0	0	0	0
2019	5	14	21	23.1	88.5	90.5	0	0	13	0
2019	5	14	22	22.8	92.2	106.1	0	0	26	0
2019	5	14	23	22.1	95	118	2	0	37	0
2019	5	14	24	21.6	97.3	127.4	1	0	4	0
2019	5	15	1	21.4	98.3	115.4	1	0	31	0
2019	5	15	2	21.8	98	138.7	1	0	24	0
2019	5	15	3	21.9	97.9	130.6	0	0	28	0
2019	5	15	4	21.9	98.2	138.8	0	0.01	85	0
2019	5	15	5	21.8	99	204.3	1	0.05	100	0
2019	5	15	6	21.7	99.2	94.5	4	0.1	100	0
2019	5	15	7	21.9	98.5	113.5	1	0.01	75	25
2019	5	15	8	22.8	94.3	126.3	1	0	7	194
2019	5	15	9	23.2	92.7	74.9	7	0	11	373
2019	5	15	10	24.3	89.3	72.9	6	0	61	513
2019	5	15	11	24.4	88.6	181.7	0	0	64	606
2019	5	15	12	24.4	88.1	161.6	4	0	100	641

2019	5	15	13	24.6	88.3	219.4	14	0	91	616
2019	5	15	14	24.6	90.3	230.5	8	0	82	533
2019	5	15	15	25.7	85.6	252.8	4	0	71	397
2019	5	15	16	26.1	83.6	219.4	5	0	2	227
2019	5	15	17	25.6	84.5	255.3	6	0	0	44
2019	5	15	18	24.7	88	260.5	7	0	14	0
2019	5	15	19	24.1	92.7	179.1	7	0	5	0
2019	5	15	20	23.9	94.6	98	4	0	0	0
2019	5	15	21	23.7	95.5	142.5	6	0	0	0
2019	5	15	22	23.2	97.4	94.4	4	0	0	0
2019	5	15	23	23	97.4	97.3	4	0	3	0
2019	5	15	24	22.7	97.8	113.2	6	0	0	0
2019	5	16	1	22.7	97.8	107.1	7	0.01	85	0
2019	5	16	2	22.6	98.2	120.1	4	0.03	75	0
2019	5	16	3	22.4	98.5	116.3	6	0.04	90	0
2019	5	16	4	22.2	98.8	145.6	4	0.01	65	0
2019	5	16	5	22.1	99.4	87.5	7	0	29	0
2019	5	16	6	22	97.7	142.3	8	0	35	0
2019	5	16	7	23.1	94.1	195.4	7	0	39	24
2019	5	16	8	23.9	92.2	174.4	4	0	26	193
2019	5	16	9	25.4	85.5	195.6	1	0	30	372
2019	5	16	10	25.8	83	170.5	6	0	27	512
2019	5	16	11	26.8	77.2	240.4	8	0	23	605
2019	5	16	12	28.3	70.3	236	7	0	10	640
2019	5	16	13	28.2	67.6	232.3	3	0	45	616
2019	5	16	14	29.2	67.7	254.8	2	0	68	533
2019	5	16	15	29.9	65.6	251	4	0	10	398
2019	5	16	16	29.9	66.6	245.1	2	0	10	227
2019	5	16	17	29.2	70.1	197.2	7	0	0	45
2019	5	16	18	28	76.1	283.6	7	0	0	0
2019	5	16	19	26.4	84.7	98.1	6	0	0	0
2019	5	16	20	25.7	87.5	100	6	0	2	0
2019	5	16	21	24.9	92.9	99.3	4	0	7	0
2019	5	16	22	24.5	95.5	141.1	9	0	0	0
2019	5	16	23	24.2	96.7	94.1	4	0	0	0
2019	5	16	24	24.1	95.7	156.5	4	0	0	0
2019	5	17	1	23.6	97.7	141.1	4	0	0	0
2019	5	17	2	23.7	98.4	186.9	1	0	14	0
2019	5	17	3	23.6	99	158.5	7	0	34	0
2019	5	17	4	23.5	98.4	110	6	0.19	86	0
2019	5	17	5	22.8	99.4	182.3	1	0.14	95	0
2019	5	17	6	22.8	98.6	125.4	6	0	26	0
2019	5	17	7	23.4	97.4	111.6	6	0	37	23
2019	5	17	8	24.1	94.3	148.2	7	0	82	190
2019	5	17	9	24.6	93	90.3	4	0	82	369
2019	5	17	10	25.1	90.4	63.3	6	0	98	510
2019	5	17	11	25.1	90.1	78.8	6	0	81	602
2019	5	17	12	26.1	87	93.3	3	0	75	638
2019	5	17	13	26.4	84.9	79.9	2	0	94	614
2019	5	17	14	27	83.3	90.5	1	0	38	532

2019	5	17	15	27.4	82.8	79.6	0	0	27	398
2019	5	17	16	27.1	83.9	84.7	0	0	91	228
2019	5	17	17	26.1	88	88.6	0	0	94	46
2019	5	17	18	25.1	91.4	85	0	0	65	0
2019	5	17	19	24.3	92.8	85.3	0	0	0	0
2019	5	17	20	24	92.2	99.8	2	0	13	0
2019	5	17	21	23.8	90.8	105.5	4	0	21	0
2019	5	17	22	23.3	91.6	107.8	4	0	27	0
2019	5	17	23	23.1	91.5	96.8	4	0	42	0
2019	5	17	24	22.8	92.8	136	6	0	24	0
2019	5	18	1	22.4	95.4	132.8	7	0	28	0
2019	5	18	2	22.6	95.6	96.1	7	0	86	0
2019	5	18	3	22.7	95.5	111.5	8	0	100	0
2019	5	18	4	22.6	96	118.7	4	0	100	0
2019	5	18	5	22.2	98.3	74.3	4	0	100	0
2019	5	18	6	22.5	98.3	138.9	1	0	100	0
2019	5	18	7	22.9	97.7	76.7	4	0.01	100	22
2019	5	18	8	23.2	97.2	152.4	7	0	100	189
2019	5	18	9	23.1	98.2	91.9	8	0.08	87	364
2019	5	18	10	23.7	96.7	114.3	7	0	100	503
2019	5	18	11	24.2	94.6	75.7	1	0	100	596
2019	5	18	12	24.1	95.5	89.8	1	0.02	24	632
2019	5	18	13	24.6	93.7	91.5	1	0	28	524
2019	5	18	14	25.7	89.3	104.2	0	0	30	216
2019	5	18	15	26.6	85.7	89.4	0	0	39	229
2019	5	18	16	26.7	85.9	103.4	0	0	84	235
2019	5	18	17	26.2	88.3	87.8	2	0	81	50
2019	5	18	18	25.7	90.9	81.9	1	0.05	72	0
2019	5	18	19	24.6	95.3	95.3	3	0.02	55	0
2019	5	18	20	24.4	95.5	106.9	7	0	12	0
2019	5	18	21	23.8	96.6	96.3	7	0	9	0
2019	5	18	22	23.7	97.7	86.1	7	0	0	0
2019	5	18	23	23.7	98.1	95.7	7	0	0	0
2019	5	18	24	23.4	98.2	103.6	7	0	64	0
2019	5	19	1	23.2	99.3	89.9	6	0.03	73	0
2019	5	19	2	23.2	99.9	99.3	4	0	77	0
2019	5	19	3	23.1	99.6	93.6	4	0	28	0
2019	5	19	4	23.2	99.6	152	7	0	19	0
2019	5	19	5	23.3	99.5	98.9	4	0	20	0
2019	5	19	6	23.3	99.6	146.3	6	0	26	0
2019	5	19	7	23.8	97.9	106	1	0	13	19
2019	5	19	8	24.6	94.5	151.2	1	0	40	185
2019	5	19	9	25.4	92.2	141.8	7	0	28	366
2019	5	19	10	26.7	87.2	75.2	3	0	10	509
2019	5	19	11	27.9	83.6	74.3	8	0	20	606
2019	5	19	12	29.1	79.7	114.2	3	0	100	645
2019	5	19	13	29.6	77.5	101.7	3	0	100	623
2019	5	19	14	29.7	76.7	127.7	2	0	100	546
2019	5	19	15	30.2	77	253	2	0	10	418
2019	5	19	16	29.9	78.7	151.6	2	0	13	248

2019	5	19	17	29.3	80.5	74	2	0	24	55
2019	5	19	18	28.3	83.7	87.1	8	0	0	0
2019	5	19	19	27.5	87.4	86.9	7	0	5	0
2019	5	19	20	27	88.5	80.8	7	0	12	0
2019	5	19	21	26.1	86.4	115.1	7	0	3	0
2019	5	19	22	25.3	85.4	89.1	4	0	0	0
2019	5	19	23	24.8	87.4	89.1	4	0	10	0
2019	5	19	24	24.2	91.1	78.9	1	0	10	0
2019	5	20	1	23.7	88.9	83.3	6	0	10	0
2019	5	20	2	23.8	87.3	86.6	4	0	0	0
2019	5	20	3	23.2	90.5	109.7	4	0.17	56	0
2019	5	20	4	21.8	95.9	83.9	6	0	10	0
2019	5	20	5	21.7	96.8	120.9	4	0	6	0
2019	5	20	6	22.9	93.8	145.6	6	0	15	0
2019	5	20	7	23.9	92.5	173.2	8	0.01	67	19
2019	5	20	8	25.1	89.2	101.9	8	0	0	184
2019	5	20	9	24.7	91.5	98.8	10	0	56	367
2019	5	20	10	26.3	83	90.1	8	0	92	512
2019	5	20	11	27.9	78.3	87.5	6	0	10	609
2019	5	20	12	29	74.6	78.2	8	0	10	650
2019	5	20	13	29.4	73.9	89.9	8	0	10	629
2019	5	20	14	29.4	74.1	112.2	5	0	10	549
2019	5	20	15	30.2	68.5	194.4	4	0	10	417
2019	5	20	16	29.9	69.6	118.7	3	0	10	247
2019	5	20	17	29	75.7	89.7	6	0	10	58
2019	5	20	18	27.7	78	87.5	7	0	0	0
2019	5	20	19	26.9	79.8	95.3	2	0	0	0
2019	5	20	20	26.6	81.3	123.2	0	0	0	0
2019	5	20	21	26.1	83	90.7	0	0	0	0
2019	5	20	22	25.6	86.7	180.7	1	0	0	0
2019	5	20	23	24.8	92.1	107.8	2	0	0	0
2019	5	20	24	24.4	94.9	82.4	5	0	0	0
2019	5	21	1	24.1	96	80.6	1	0	0	0
2019	5	21	2	23.7	95.9	85.6	1	0	0	0
2019	5	21	3	23.7	94.2	155.3	4	0	1	0
2019	5	21	4	23.4	96	117.2	1	0	0	0
2019	5	21	5	23.5	97	106.2	6	0	0	0
2019	5	21	6	24.1	96	117	4	0	0	0
2019	5	21	7	25.2	91.7	108.3	6	0	0	17
2019	5	21	8	26.4	84.5	113.9	1	0	0	109
2019	5	21	9	25.8	82.4	145.4	7	0	0	105
2019	5	21	10	25.4	85.4	101.4	8	0	74	119
2019	5	21	11	27.2	78.9	117.6	4	0	81	191
2019	5	21	12	29.8	66.3	172.2	10	0	82	325
2019	5	21	13	30.5	62.2	137	13	0	61	624
2019	5	21	14	31.5	58.8	140	4	0	0	548
2019	5	21	15	31.3	58.1	159.4	7	0	0	412
2019	5	21	16	31.2	61	151	9	0	0	248
2019	5	21	17	30.3	65	105.5	3	0	0	23
2019	5	21	18	29.1	73.1	74.8	5	0	0	0

2019	5	21	19	28	79.4	88.2	3	0	0	0
2019	5	21	20	27.7	81.9	75.7	7	0	0	0
2019	5	21	21	27.7	82.4	86.4	1	0	2	0
2019	5	21	22	27	87.3	89	6	0	0	0
2019	5	21	23	26.8	87.4	107.8	1	0	0	0
2019	5	21	24	26.7	85.1	115.6	1	0	0	0
2019	5	22	1	23.9	96.4	112.1	4	0.64	86	0
2019	5	22	2	23.6	98.3	101	7	0.03	75	0
2019	5	22	3	23.6	98.3	92	4	0.27	82	0
2019	5	22	4	23.2	98.9	119.1	7	0.24	65	0
2019	5	22	5	23.1	98.9	98	4	0.03	55	0
2019	5	22	6	23.2	98.8	138.7	6	0	0	0
2019	5	22	7	23.4	98.3	105.2	6	0.01	59	26
2019	5	22	8	23.3	96.9	169.9	6	0.01	10	193
2019	5	22	9	24.3	91.5	152	6	0	19	369
2019	5	22	10	24.3	92.5	152.2	2	0.04	74	504
2019	5	22	11	24.4	94.7	122.1	4	0	100	595
2019	5	22	12	24.9	92.8	243.2	7	0	100	629
2019	5	22	13	25	91.6	243.8	9	0	100	602
2019	5	22	14	25.8	88.3	245.1	6	0	10	519
2019	5	22	15	27.1	81.7	271.1	9	0	0	385
2019	5	22	16	26.9	82.3	255.6	3	0	0	217
2019	5	22	17	26	87.3	271.3	2	0	0	39
2019	5	22	18	25.1	89.7	262.3	1	0	0	0
2019	5	22	19	24.3	91.3	247.6	3	0	0	0
2019	5	22	20	23.9	91.6	235.6	2	0	0	0
2019	5	22	21	23.6	94.4	240.1	2	0	1	0
2019	5	22	22	23.3	95.3	193.8	3	0	0	0
2019	5	22	23	23.2	95.5	180.4	4	0	0	0
2019	5	22	24	23.2	96.4	107.7	7	0	0	0
2019	5	23	1	23.2	96.9	184.1	6	0	29	0
2019	5	23	2	23.2	98.2	117.4	4	0.18	76	0
2019	5	23	3	23	99.5	85	4	0.07	80	0
2019	5	23	4	22.7	99.2	80.9	8	0.05	75	0
2019	5	23	5	22.5	99	113	4	0.04	65	0
2019	5	23	6	22.6	99.1	116	7	0.01	55	0
2019	5	23	7	22.8	98.4	141.8	1	0	40	28
2019	5	23	8	23.1	96.3	208.9	7	0	100	201
2019	5	23	9	22.7	98	248.7	6	0.71	100	373
2019	5	23	10	22.8	99.1	263.6	6	0.05	100	505
2019	5	23	11	24.1	93.8	260.1	6	0	100	591
2019	5	23	12	25.1	89.6	256.3	2	0	100	624
2019	5	23	13	25.3	89.5	260.8	2	0	100	600
2019	5	23	14	25.8	84.9	243.9	2	0	100	521
2019	5	23	15	25.7	84.8	251.5	2	0	81	389
2019	5	23	16	25.5	85.6	268.8	2	0	100	222
2019	5	23	17	25.4	87.2	252.5	2	0	100	40
2019	5	23	18	24.8	90.5	252.3	2	0	0	0
2019	5	23	19	24.2	94.4	237.1	6	0	4	0
2019	5	23	20	23.8	97.3	242	7	0.01	14	0

2019	5	23	21	23.6	97.6	233.4	4	0	34	0
2019	5	23	22	23.6	97.1	241.5	4	0	100	0
2019	5	23	23	23.6	97.9	240.7	1	0	100	0
2019	5	23	24	23.3	99.1	231.3	2	0	100	0
2019	5	24	1	23.2	99.5	229.6	0	0	100	0
2019	5	24	2	23.1	99.9	232.7	0	0	26	0
2019	5	24	3	23.2	100	226.6	3	0	22	0
2019	5	24	4	23.1	100	142.1	2	0	16	0
2019	5	24	5	23	100	92.2	5	0	14	0
2019	5	24	6	23	99.1	88.5	3	0.01	77	0
2019	5	24	7	23.1	98.2	84.7	1	0	63	27
2019	5	24	8	23.4	96.2	106.9	1	0	87	192
2019	5	24	9	23.9	95	71.1	1	0.06	99	369
2019	5	24	10	23.9	96.8	81.7	6	0	100	506
2019	5	24	11	24.9	91.4	125.2	3	0	14	597
2019	5	24	12	25.7	86.7	149.1	2	0	93	630
2019	5	24	13	26.6	79.5	262.3	2	0	87	606
2019	5	24	14	26.8	80.4	271.4	1	0	68	525
2019	5	24	15	27.9	74	261.7	1	0	0	395
2019	5	24	16	27.1	78.7	287	1	0	0	229
2019	5	24	17	26.3	83.6	303	1	0	0	46
2019	5	24	18	25.8	86.9	167.8	2	0	43	0
2019	5	24	19	25.3	91	221	1	0	41	0
2019	5	24	20	25.1	92.8	87.9	1	0	24	0
2019	5	24	21	24.9	94	78.3	2	0	34	0
2019	5	24	22	24.7	94.4	83.3	2	0	37	0
2019	5	24	23	24.4	93.5	97.4	1	0	46	0
2019	5	24	24	24.4	92.6	102.8	1	0	21	0
2019	5	25	1	24.3	93.2	96.6	8	0	35	0
2019	5	25	2	24.2	94.7	85.1	5	0	42	0
2019	5	25	3	23.9	97	87.1	2	0	52	0
2019	5	25	4	23.8	98	160.3	3	0	27	0
2019	5	25	5	23.8	98.2	167.7	6	0	33	0
2019	5	25	6	24	97.3	96	1	0	43	0
2019	5	25	7	24.6	95.6	121.7	1	0	47	24
2019	5	25	8	25.2	92.5	126.9	7	0	24	193
2019	5	25	9	25.8	90	94.6	7	0	42	373
2019	5	25	10	25.8	90.3	74.9	7	0	47	513
2019	5	25	11	26.1	88.8	179	3	0	100	606
2019	5	25	12	28.6	78.8	155.7	3	0	100	641
2019	5	25	13	29.5	73.9	271.9	2	0	100	615
2019	5	25	14	30.2	69.3	254.1	1	0	100	533
2019	5	25	15	30.1	71.6	265.9	1	0	100	397
2019	5	25	16	29.9	72.9	247.4	1	0	100	226
2019	5	25	17	28.6	79.2	261.5	2	0	100	44
2019	5	25	18	27.7	81.5	161.8	3	0	29	0
2019	5	25	19	27.3	83.5	95.7	2	0	40	0
2019	5	25	20	27.1	85.1	81.1	2	0	100	0
2019	5	25	21	26.9	86.4	98.3	4	0	100	0
2019	5	25	22	26.3	90.5	116.9	1	0.01	100	0

2019	5	25	23	24.7	96	80.8	1	0	100	0
2019	5	25	24	24.5	94.8	132.3	1	0	100	0
2019	5	26	1	24.6	94.4	140.5	1	0.01	100	0
2019	5	26	2	24.3	96.5	203.3	4	0.02	100	0
2019	5	26	3	24.3	96.4	206	7	0.01	100	0
2019	5	26	4	24	95.4	225.1	6	0	100	0
2019	5	26	5	23.5	94.4	130.9	7	0	90	0
2019	5	26	6	24.5	90.5	192.2	6	0	44	0
2019	5	26	7	25.1	88.9	181.4	7	0.01	41	23
2019	5	26	8	25.8	87.5	144.7	7	0	19	193
2019	5	26	9	27.1	82.6	96.7	2	0	39	371
2019	5	26	10	29.4	73.5	86.9	2	0	32	512
2019	5	26	11	25.7	90.6	110.5	1	0.33	100	605
2019	5	26	12	27.9	83.5	109.1	3	0	100	640
2019	5	26	13	29.6	76.9	122.7	3	0	84	615
2019	5	26	14	31.2	72	96	2	0	100	533
2019	5	26	15	32.3	68.3	190.5	2	0	77	398
2019	5	26	16	32.2	71	168.5	1	0	80	227
2019	5	26	17	31.3	74.4	105.5	1	0	79	45
2019	5	26	18	29.9	78	98.6	1	0	10	0
2019	5	26	19	28.8	84.6	106.2	1	0	0	0
2019	5	26	20	28.1	88.2	76.6	9	0	16	0
2019	5	26	21	27.4	91.5	96	7	0	28	0
2019	5	26	22	24.2	91.3	70.6	7	0.13	34	0
2019	5	26	23	24.1	94.5	83.8	8	0	34	0
2019	5	26	24	23.5	90.3	94	6	0	18	0
2019	5	27	1	23.1	90.7	151.9	6	0	10	0
2019	5	27	2	22.9	94	95.7	4	0	14	0
2019	5	27	3	23.2	94.6	162.6	4	0	16	0
2019	5	27	4	23.3	92.9	100.1	9	0	7	0
2019	5	27	5	23.9	90.5	115.1	7	0	11	0
2019	5	27	6	24.1	92.5	97.4	6	0	2	0
2019	5	27	7	24.4	92.1	87.1	4	0	23	23
2019	5	27	8	25.3	89	75.1	4	0	75	190
2019	5	27	9	26.4	83	73.6	6	0	88	369
2019	5	27	10	26.2	84.8	121.8	8	0	84	509
2019	5	27	11	27.1	79.7	97	8	0	33	602
2019	5	27	12	27.2	82.3	92.2	4	0	16	638
2019	5	27	13	28.1	78.9	111.3	8	0	55	614
2019	5	27	14	27.2	83.4	189.8	3	0.02	39	532
2019	5	27	15	26	91.9	253.5	2	0.02	98	398
2019	5	27	16	26.2	88.4	130.6	2	0	0	228
2019	5	27	17	26.6	89.1	91.6	2	0	0	46
2019	5	27	18	26.6	88.9	76.6	3	0	0	0
2019	5	27	19	25.7	94.6	97.5	1	0	0	0
2019	5	27	20	25.3	96.7	105.8	1	0	0	0
2019	5	27	21	25.1	95.8	96.1	1	0	0	0
2019	5	27	22	24.6	98.1	89.6	2	0	0	0
2019	5	27	23	24.4	99	103.9	3	0	0	0
2019	5	27	24	24.1	99.4	87.7	6	0	0	0

2019	5	28	1	24.1	99.8	75.5	4	0	0	0
2019	5	28	2	23.9	100	94.5	4	0	70	0
2019	5	28	3	24	100	96.5	7	0.07	65	0
2019	5	28	4	24.1	100	91.5	7	0.03	50	0
2019	5	28	5	24.1	100	118.6	6	0	30	0
2019	5	28	6	24.3	100	96.9	8	0	15	0
2019	5	28	7	24.7	99.6	88.4	1	0	3	22
2019	5	28	8	25.3	96.7	92.8	6	0	0	189
2019	5	28	9	26.1	93	92.2	4	0	1	363
2019	5	28	10	27.4	87	67.3	8	0	12	503
2019	5	28	11	29.1	79.5	105	8	0	61	596
2019	5	28	12	30.3	71.4	85.7	10	0	68	631
2019	5	28	13	31.3	66.1	102.5	10	0	10	524
2019	5	28	14	32.1	64.6	126.5	3	0	23	216
2019	5	28	15	32.4	66.6	120.1	2	0	38	229
2019	5	28	16	32.1	66.2	183.5	2	0	10	235
2019	5	28	17	31.6	66.7	104.7	1	0	22	50
2019	5	28	18	30.4	71.3	87.6	1	0	0	0
2019	5	28	19	28.8	82.9	81.1	3	0	0	0
2019	5	28	20	27.9	86.5	110.8	2	0	0	0
2019	5	28	21	27.3	90.3	108.1	1	0	0	0
2019	5	28	22	26.8	90.5	95.4	4	0	0	0
2019	5	28	23	26.5	88.1	79.3	4	0	0	0
2019	5	28	24	26.2	88.9	84.1	1	0	0	0
2019	5	29	1	25.8	89.4	94.8	1	0	0	0
2019	5	29	2	25.4	90.8	82.4	6	0	0	0
2019	5	29	3	25.1	92.4	104.6	7	0	0	0
2019	5	29	4	24.6	94.9	124.7	6	0	0	0
2019	5	29	5	24.2	97.4	135.4	8	0	2	0
2019	5	29	6	25.3	93.6	106.1	6	0	3	0
2019	5	29	7	26.9	85.4	127.6	4	0	31	23
2019	5	29	8	28.9	78.4	114.1	1	0	17	255
2019	5	29	9	30.2	75.9	108.7	4	0	25	433
2019	5	29	10	31.4	73.3	79	7	0	20	599
2019	5	29	11	32.7	69	75.7	2	0	20	709
2019	5	29	12	33.4	66.2	72.6	2	0	10	753
2019	5	29	13	33.2	66.1	114	3	0	12	729
2019	5	29	14	33.5	64.1	96.6	2	0	86	625
2019	5	29	15	33.9	60.9	142.2	2	0	72	467
2019	5	29	16	34.3	58	100.2	1	0	81	265
2019	5	29	17	33.4	59.6	73.1	3	0	77	90
2019	5	29	18	32.7	60.6	89.4	2	0	0	0
2019	5	29	19	31	72.8	83	2	0	0	0
2019	5	29	20	29.4	81.4	86	2	0	0	0
2019	5	29	21	28.8	89.2	90.8	1	0	0	0
2019	5	29	22	28.9	88.4	80.3	1	0	0	0
2019	5	29	23	29.1	82.1	83.2	1	0	0	0
2019	5	29	24	27.9	88.7	86.1	4	0	0	0
2019	5	30	1	27.2	92.4	84.5	1	0	0	0
2019	5	30	2	26.9	93.1	103.3	7	0	0	0

2019	5	30	3	26.7	91.6	140.6	1	0	23	0
2019	5	30	4	25.8	93.8	136.6	6	0.32	80	0
2019	5	30	5	23.2	98	100	6	0	30	0
2019	5	30	6	23.7	94.6	106.3	6	0	33	0
2019	5	30	7	25.5	87.5	87.4	6	0	0	24
2019	5	30	8	27.4	79.6	84.2	7	0	0	194
2019	5	30	9	28.6	76.3	87.7	3	0	0	372
2019	5	30	10	29.2	75.9	117.2	6	0	10	513
2019	5	30	11	29.8	72.6	96	4	0	14	606
2019	5	30	12	28.2	78.7	102	3	0	10	641
2019	5	30	13	27.3	79.8	154.8	2	0	12	616
2019	5	30	14	28.7	74.2	143.4	2	0	35	534
2019	5	30	15	28.7	72.9	249.9	1	0	35	399
2019	5	30	16	28.2	75.9	278.1	1	0	42	228
2019	5	30	17	28.4	76.7	295.7	1	0	65	46
2019	5	30	18	28.3	77.7	172	10	0	8	0
2019	5	30	19	26.9	86.9	195	9	0	12	0
2019	5	30	20	26.2	90.1	151	6	0	7	0
2019	5	30	21	25.9	92.6	153.9	4	0	3	0
2019	5	30	22	26.2	92.2	88.9	1	0	0	0
2019	5	30	23	25.8	93.6	76.9	4	0	0	0
2019	5	30	24	25.7	94	83.1	7	0	0	0
2019	5	31	1	25.6	94.5	91	7	0	0	0
2019	5	31	2	24.8	97.1	119.9	6	0	0	0
2019	5	31	3	24.7	98.3	94.1	4	0	2	0
2019	5	31	4	25	98.7	99.3	4	0	0	0
2019	5	31	5	24.8	96.4	162.9	6	0	1	0
2019	5	31	6	24.6	95.6	114.3	4	0.01	77	0
2019	5	31	7	25.3	89.1	90.4	4	0	49	24
2019	5	31	8	25.8	86.8	86.6	6	0	94	191
2019	5	31	9	26.9	84.4	83.8	9	0	100	370
2019	5	31	10	26.9	84.8	96.6	10	0.01	100	510
2019	5	31	11	23.2	96.4	142.2	9	0.72	100	603
2019	5	31	12	23.8	94.2	90.7	2	0.03	100	639
2019	5	31	13	25.8	84.7	103	1	0	100	615
2019	5	31	14	27.1	79.3	123.8	2	0	100	533
2019	5	31	15	27.3	79.7	162	1	0	100	399
2019	5	31	16	26.5	84.4	104.6	1	0	100	229
2019	5	31	17	25.8	86.2	110.9	1	0	100	47
2019	5	31	18	25.5	89.4	76.9	3	0	100	0
2019	5	31	19	25.1	89.6	102.3	1	0	75	0
2019	5	31	20	24.8	91.8	87.6	1	0	50	0
2019	5	31	21	24.5	93.9	83.5	3	0	28	0
2019	5	31	22	24.1	96	87.4	1	0	19	0
2019	5	31	23	23.7	97.7	97.9	1	0	25	0
2019	5	31	24	23.7	98.6	83.5	7	0	12	0
2019	6	1	1	23.4	99.2	86.8	8	0	24	0
2019	6	1	2	23.2	99.6	82.3	7	0	37	0
2019	6	1	3	22.9	99.7	102.7	8	0	47	0
2019	6	1	4	22.7	99.8	153.3	7	0	24	0

2019	6	1	5	22.7	100	119.5	6	0	35	0
2019	6	1	6	23.7	98.4	92.8	7	0	41	0
2019	6	1	7	25.6	91.2	136	6	0	27	23
2019	6	1	8	27.3	80.7	132.5	9	0	6	190
2019	6	1	9	28.5	73.9	103.1	1	0	1	364
2019	6	1	10	29.9	67.6	66.5	1	0	9	504
2019	6	1	11	30.6	67.1	123.3	2	0	19.8	597
2019	6	1	12	32	62.6	108.7	2	0	30	632
2019	6	1	13	32.8	59.3	152.9	2	0	71	525
2019	6	1	14	33.9	55.1	139.2	2	0	100	217
2019	6	1	15	34	53.3	111.5	2	0	83	230
2019	6	1	16	33.1	59.3	166.5	2	0	76	236
2019	6	1	17	32.7	60.4	119.3	1	0	54	51
2019	6	1	18	31.2	65.6	102.6	1	0	93	0
2019	6	1	19	29.7	71.5	78.5	1	0	66	0
2019	6	1	20	28.4	80	84.5	2	0	50	0
2019	6	1	21	28.1	83.1	109.6	1	0	25	0
2019	6	1	22	27.4	88.2	100.7	1	0	3	0
2019	6	1	23	27.3	88.3	89.3	0	0	5	0
2019	6	1	24	26.4	92.7	159.4	0	0	51	0
2019	6	2	1	26.1	94.1	81.8	0	0	68	0
2019	6	2	2	25.9	89.9	99.3	1	0	63	0
2019	6	2	3	26.1	90.9	77.2	1	0	50	0
2019	6	2	4	25.4	94.4	88.2	1	0	33	0
2019	6	2	5	25.2	95.6	120.7	1	0	16.5	0
2019	6	2	6	26.3	92.4	98.4	1	0	21	0
2019	6	2	7	28.3	83.3	118.7	2	0	16.5	23
2019	6	2	8	29	80.1	96.6	5	0	17.1	255
2019	6	2	9	30.1	76.3	96.9	4	0	13.5	432
2019	6	2	10	31.2	71.4	73.5	3	0	12	599
2019	6	2	11	32.6	64	100.6	2	0	15	709
2019	6	2	12	33.2	61.1	98	0	0	41	753
2019	6	2	13	33.7	62.1	125.6	0	0	100	728
2019	6	2	14	34.3	58.4	187.6	0	0	100	625
2019	6	2	15	34.5	57.2	214.3	4	0	100	466
2019	6	2	16	34.5	57.3	190.9	7	0	100	265
2019	6	2	17	33.6	59.3	176.3	8	0	82	90
2019	6	2	18	32.3	65.5	192.3	6	0	100	0
2019	6	2	19	31.2	71.8	180.8	5	0	75	0
2019	6	2	20	30.2	77.9	235.1	3	0	50	0
2019	6	2	21	29.2	86.3	178.2	0	0	27	0
2019	6	2	22	29.3	86.6	149.5	0	0	62	0
2019	6	2	23	28.9	85	90.8	2	0	100	0
2019	6	2	24	28.5	85.8	83.2	1	0	100	0
2019	6	3	1	28.3	87.3	202	0	0	100	0
2019	6	3	2	27.9	89	202	1	0	100	0
2019	6	3	3	27.7	90.6	202	1	0	75	0
2019	6	3	4	27.4	92.7	202	1	0	62	0
2019	6	3	5	27.2	91.1	202	1	0.01	62	0
2019	6	3	6	27.1	87.7	202	0	0	51	0

2019	6	3	7	27	83.9	202	0	0	40	23
2019	6	3	8	27.4	81.4	202	0	0	45	256
2019	6	3	9	25.9	86.6	202	4	0.09	98	433
2019	6	3	10	27.7	84.9	202	3	0	100	599
2019	6	3	11	30.1	75.1	202	2	0	62	709
2019	6	3	12	30.6	76.7	202	1	0	12	753
2019	6	3	13	32.7	66	202	0	0	16	729
2019	6	3	14	33.3	63.8	202	0	0	78	625
2019	6	3	15	29.7	65.8	202	0	0	100	467
2019	6	3	16	28.6	73	202	0	0	100	266
2019	6	3	17	26.6	86.1	202	3	0.03	94	91
2019	6	3	18	25.9	89.7	202	1	0	71	0
2019	6	3	19	25.8	91	202	9	0	75	0
2019	6	3	20	25.8	91.3	202	7	0	48	0
2019	6	3	21	25.6	92.1	210	6	0	10	0
2019	6	3	22	25.6	88.6	230	4	0	0	0
2019	6	3	23	25.5	90	245	2	0	0	0
2019	6	3	24	25.2	90.5	198	0	0.01	0	0
2019	6	4	1	24.9	92.6	195	0	0	0	0
2019	6	4	2	24.9	92.5	202	0	0	0	0
2019	6	4	3	24.7	94.9	202	0	0	0	0
2019	6	4	4	24.4	95.3	156	0	0	0	0
2019	6	4	5	24.6	95.5	210	1	0	0	0
2019	6	4	6	24.9	96.3	202	1	0	0	0
2019	6	4	7	24.7	94.7	104.3	1	0	25	23
2019	6	4	8	25.1	91.1	82.2	1	0	91	255
2019	6	4	9	25.9	89	93.2	5	0.01	22	433
2019	6	4	10	27.8	82	125.7	4	0	67	599
2019	6	4	11	27.3	82.9	103.4	6	0	66	709
2019	6	4	12	27.3	82.5	123.7	2	0	0	753
2019	6	4	13	27.2	83.2	101.6	1	0	0	729
2019	6	4	14	27.6	83.4	101.9	1	0	0	625
2019	6	4	15	28.1	78.2	78.5	1	0	10	467
2019	6	4	16	28.5	75	105.6	1	0	42	265
2019	6	4	17	29.5	68.8	103	1	0	69	90
2019	6	4	18	28.4	73.3	130.6	1	0	61	0
2019	6	4	19	27	81.9	192.6	0	0	0	0
2019	6	4	20	26.3	87	219.3	0	0	0	0
2019	6	4	21	25.8	90.5	195.9	0	0	0	0
2019	6	4	22	25.3	94.5	181.3	0	0	0	0
2019	6	4	23	25.3	93.6	197.3	0	0	0	0
2019	6	4	24	25.1	94.7	185.8	3	0	0	0
2019	6	5	1	25	94.4	240.1	5	0	0	0
2019	6	5	2	24.8	95.5	183.2	8	0	0	0
2019	6	5	3	24.6	95.4	154.5	0	0	0	0
2019	6	5	4	24.7	95.4	95.8	0	0	0	0
2019	6	5	5	24.7	96.6	88.2	6	0	0	0
2019	6	5	6	25.1	95.4	270	1	0	60	0
2019	6	5	7	25.7	92.7	188	1	0	70	22
2019	6	5	8	25	93.7	247	3	0.14	80	255

2019	6	5	9	24.3	96.5	260	4	0.05	76	432
2019	6	5	10	25.7	91	272	1	0	55	598
2019	6	5	11	27.6	84.2	278	1	0	45	708
2019	6	5	12	29	80.3	292	8	0	0	752
2019	6	5	13	29.6	79.5	199	7	0	0	728
2019	6	5	14	30.9	72.9	285	5	0	0	624
2019	6	5	15	32.6	65.1	294	4	0	0	466
2019	6	5	16	32.7	63.5	282	2	0	0	265
2019	6	5	17	32.9	61.6	272	2	0	0	90
2019	6	5	18	30.9	68.3	195	1	0	0	0
2019	6	5	19	29.8	76.5	285	1	0	0	0
2019	6	5	20	29.1	80.5	212	1	0	0	0
2019	6	5	21	28.1	86.6	220	1	0	0	0
2019	6	5	22	28.2	86.1	223	1	0	0	0
2019	6	5	23	27.2	91.3	247	0	0	20	0
2019	6	5	24	26.9	93.3	253	0	0	40	0
2019	6	6	1	26.8	94.3	218	0	0	60	0
2019	6	6	2	26.8	93.5	251	0	0	70	0
2019	6	6	3	26.4	94.8	256	5	0	55	0
2019	6	6	4	26.2	96.1	274	2	0	45	0
2019	6	6	5	26.3	96.2	278	1	0	40	0
2019	6	6	6	28	89.3	273	1	0	30	0
2019	6	6	7	28.3	88.9	264	1	0	0	22
2019	6	6	8	28.6	86.5	260	0	0	0	254
2019	6	6	9	30.6	76.4	233	0	0	0	431
2019	6	6	10	32.4	67.9	216	0	0	0	598
2019	6	6	11	32.9	65.9	260	0	0	0	708
2019	6	6	12	33.9	63.2	246	3	0	0	752
2019	6	6	13	34.5	59.4	288	7	0	0	727
2019	6	6	14	35.1	56	196	5	0	0	624
2019	6	6	15	35.6	54.3	284	2	0	0	465
2019	6	6	16	36.3	51.2	287	9	0	0	264
2019	6	6	17	36.2	49.5	284	6	0	0	89
2019	6	6	18	34.7	53.6	195	3	0	0	0
2019	6	6	19	32.3	67.9	196	5	0	0	0
2019	6	6	20	30.8	76.1	205	2	0	0	0
2019	6	6	21	30.4	79.2	205	0	0	0	0
2019	6	6	22	29.8	83.8	220	0	0	40	0
2019	6	6	23	29.6	85.9	215	0	0	30	0
2019	6	6	24	29.5	84.6	216	0	0	70	0
2019	6	7	1	29	87.1	227	3	0	80	0
2019	6	7	2	28.4	89.5	270	4	0.01	95	0
2019	6	7	3	27.2	93.3	270	7	0.02	100	0
2019	6	7	4	26.2	95.9	283	1	0.05	100	0
2019	6	7	5	26.1	96.6	257	1	0.01	95	0
2019	6	7	6	26.6	95.4	247	1	0	42	0
2019	6	7	7	27.5	91.9	268	1	0	30	25
2019	6	7	8	28.1	88.7	278	1	0	10	258
2019	6	7	9	29.4	82.8	244	0	0	10	435
2019	6	7	10	31	78.1	284	0	0	0	601

2019	6	7	11	32.2	74.1	311	0	0	0	711
2019	6	7	12	32.2	74.8	264	1	0	0	755
2019	6	7	13	32.3	74	185	1	0	0	731
2019	6	7	14	33	70	206	1	0	0	627
2019	6	7	15	29.2	73	218	1	0	0	469
2019	6	7	16	27.9	78.8	208	1	0	0	268
2019	6	7	17	27.6	83.6	208	1	0	0	93
2019	6	7	18	27.6	87.1	206	6	0	0	0
2019	6	7	19	27.4	87.6	205	5	0	0	0
2019	6	7	20	27.1	90	220	1	0	0	0
2019	6	7	21	26.8	90.2	264	1	0	0	0
2019	6	7	22	26.6	89.9	277	3	0	30	0
2019	6	7	23	26.4	90.5	210	2	0	80	0
2019	6	7	24	26.2	91.7	210	0	0.03	85	0
2019	6	8	1	25.2	97.4	210	0	0.33	75	0
2019	6	8	2	25.2	98	210	0	0	65	0
2019	6	8	3	25.3	97.4	210	7	0	40	0
2019	6	8	4	25.3	98.3	210	5	0.01	30	0
2019	6	8	5	25.2	99.2	202	4	0	0	0
2019	6	8	6	25.5	98	202	2	0	20	0
2019	6	8	7	26.7	93	202	0	0	45	22
2019	6	8	8	27.9	86.1	202	0	0	65	255
2019	6	8	9	28.9	82.3	202	0	0	80	432
2019	6	8	10	30.3	77.4	202	1	0	85	599
2019	6	8	11	31.1	74.3	202	1	0	65	709
2019	6	8	12	31.5	73.8	202	1	0	50	753
2019	6	8	13	32.2	72.1	202	2	0	40	728
2019	6	8	14	31.4	73.6	202	1	0	30	625
2019	6	8	15	29.6	84.1	202	1	0.08	20	466
2019	6	8	16	30.8	82.9	202	3	0	80	265
2019	6	8	17	31.7	78.1	256	0	0.17	90	90
2019	6	8	18	31.8	78.1	298	0	0	0	0
2019	6	8	19	31.6	77.9	298	1	0	0	0
2019	6	8	20	31.3	78.2	298	1	0	0	0
2019	6	8	21	31.2	78.2	298	0	0	0	0
2019	6	8	22	30.9	78	295	1	2.05	30	0
2019	6	8	23	29.3	82.3	275	2	19.5	59	0
2019	6	8	24	28.6	82.5	230	7	0.37	60	0
2019	6	9	1	27.9	83.5	230	5	0.11	75	0
2019	6	9	2	27.6	83.8	230	1	0.23	100	0
2019	6	9	3	27.3	84.1	232	1	0.07	100	0
2019	6	9	4	26.9	83.7	232	4	0.01	80	0
2019	6	9	5	26.4	83.3	232	3	0.01	60	0
2019	6	9	6	26.4	83.9	232	0	0.14	75	0
2019	6	9	7	26.5	83.8	232	0	0.6	80	23
2019	6	9	8	26.6	83.6	232	9	0	60	255
2019	6	9	9	26.7	84.2	232	5	0.44	30	433
2019	6	9	10	27.2	85.4	232	7	0.34	100	599
2019	6	9	11	28.3	86	232	5	0.47	100	709
2019	6	9	12	29.6	86	232	2	0	50	753

2019	6	9	13	30.6	85.4	232	1	0.34	40	729
2019	6	9	14	31.2	84.2	232	1	0.38	69	625
2019	6	9	15	31.3	84.7	232	0	0.88	100	467
2019	6	9	16	31.7	84.8	232	0	0.31	80	265
2019	6	9	17	31.6	83.7	232	0	0	60	90
2019	6	9	18	31.3	83.4	232	0	0.34	80	0
2019	6	9	19	30.9	82.6	232	0	0.02	90	0
2019	6	9	20	30.3	82.6	232	1	0.59	100	0
2019	6	9	21	29.9	82.9	232	0	1.02	100	0
2019	6	9	22	29.8	83	232	1	0	10	0
2019	6	9	23	29.6	82.9	232	0	0.12	10	0
2019	6	9	24	29.4	83.1	232	0	0.05	20	0
2019	6	10	1	29.7	83	232	0	0.15	20	0
2019	6	10	2	29.8	81.7	232	0	0	20	0
2019	6	10	3	29.9	81.2	232	1	0.01	50	0
2019	6	10	4	29.9	81.4	232	4	0.12	80	0
2019	6	10	5	29.8	81	232	2	0.05	90	0
2019	6	10	6	29.4	80.4	233	3	0	75	0
2019	6	10	7	29.1	81.1	232	7	0.26	64	24
2019	6	10	8	30.3	85.4	164	6	3.81	55	257
2019	6	10	9	32.1	85.2	168	5	3.47	45	434
2019	6	10	10	31.6	82.7	170	4	0	40	600
2019	6	10	11	30.7	81.1	170	0	0	20	710
2019	6	10	12	29.6	80.8	170	0	0	30	754
2019	6	10	13	28.6	80.8	170	0	0	0	730
2019	6	10	14	28.1	81.3	170	2	0	0	626
2019	6	10	15	27.8	81.5	170	1	0	0	468
2019	6	10	16	27.6	81.4	170	1	0.03	0	267
2019	6	10	17	27.3	81.4	170	1	0.12	0	92
2019	6	10	18	27.2	81.6	170	4	0	30	0
2019	6	10	19	27.2	81.6	170	5	0	40	0
2019	6	10	20	27.2	81.2	170	2	0	0	0
2019	6	10	21	27.2	80.9	170	1	0.05	0	0
2019	6	10	22	27.8	82.8	170	1	0	0	0
2019	6	10	23	28.8	82.6	170	1	0	0	0

Appendix 3.2: Ambient Air quality Monitoring Results

Location Code: AAQ 1				Monitoring Location : Dhodar Ali, Golaghat						GPS Coordinate : 26°29'225"N, 94°03'208"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
12/03/2019	68.5	36.4	7.3	26.5	<20.0	<10.0	0.34	<1.0	10.9	0.02	<4.2	<0.5	1.22	<0.1
15/03/2019	67.8	35.2	7.2	16.7	<20.0	<10.0	0.51	<1.0	<5.0	0.02	<4.2	<0.5	1.4	<0.1
19/03/2019	63.2	30.7	6.5	21.7	<20.0	<10.0	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	0.92	<0.1
22/03/2019	58.2	31.5	<6.0	18.9	<20.0	<10.0	0.25	<1.0	<5.0	<0.01	<4.2	<0.5	2.01	<0.1
26/03/2019	68.5	35	7.3	26.5	<20.0	<10.0	0.41	<1.0	<5.0	<0.01	<4.2	<0.5	1.85	<0.1
29/03/2019	42.2	22.7	<6.0	15.2	<20.0	<10.0	0.55	<1.0	<5.0	<0.01	<4.2	<0.5	1.06	<0.1
02/04/2019	70	40.1	<6.0	20.6	<20.0	<10.0	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.21	<0.1
05/04/2019	68.2	34.4	7.4	19.4	<20.0	<10.0	0.15	<1.0	<5.0	<0.01	<4.2	<0.5	1.42	<0.1
09/04/2019	31.2	24.3	6.2	28.5	<20.0	<10.0	0.22	<1.0	<5.0	<0.01	<4.2	<0.5	2.11	<0.1
12/04/2019	46.1	28.6	7.1	31.2	<20.0	16.7	0.18	<1.0	<5.0	<0.01	<4.2	<0.5	1.96	<0.1
16/04/2019	40.2	26.3	7.8	20.7	<20.0	14.1	0.35	<1.0	<5.0	<0.01	<4.2	<0.5	1.77	<0.1
19/04/2019	72.2	44.7	6.5	25.5	23.9	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	2.04	<0.1
23/04/2019	45.6	27.3	6.9	16.3	<20.0	<10.0	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	2.62	<0.1
26/04/2019	30.2	17.2	<6.0	29.2	27.4	17.8	0.57	<1.0	<5.0	<0.01	<4.2	<0.5	1.29	<0.1
30/04/2019	56.2	33.4	<6.0	20.7	29.8	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.8	<0.1
03/05/2019	60.5	28.9	6.5	26.6	24.4	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
07/05/2019	40.6	18.9	<6.0	17.2	<20.0	10.8	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.42	<0.1
10/05/2019	50.1	28.5	6	20.5	20.5	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.69	<0.1
14/05/2019	35.7	22.4	7.2	30.6	<20.0	11.2	0.54	<1.0	<5.0	<0.01	<4.2	<0.5	1.14	<0.1
17/05/2019	60.1	28.5	6.3	21.4	22.5	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.57	<0.1
21/05/2019	55.2	30.2	<6.0	15.3	<20.0	13.8	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.3	<0.1
24/05/2019	69.7	38.4	<6.0	27.4	<20.0	<10.0	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.98	<0.1
28/05/2019	41.2	19.5	6.7	19.9	<20.0	<10.0	0.56	<1.0	<5.0	<0.01	<4.2	<0.5	2.38	<0.1
31/05/2019	52.2	30.4	<6.0	17.5	23.6	12.9	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	2.22	<0.1
04/06/2019	48.1	21.9	6.5	20.2	<20.0	<10.0	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.22	<0.1
07/06/2019	35.7	20.3	<6.0	17.3	26.4	10.5	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.52	<0.1

Location Code: AAQ 2				Monitoring Location : Titabor						GPS Coordinate : 26°23'815"N, 94°01'296"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
11/03/2019	63.5	34.3	6.3	30.2	<20.0	<10.0	0.25	<1.0	9	0.01	<4.2	<0.5	1.84	<0.1
14/03/2019	78.5	42.3	<6.0	23.8	<20.0	11.4	0.49	<1.0	6.4	0.02	<4.2	<0.5	2.46	<0.1
18/03/2019	62.2	32.4	6.2	24.5	<20.0	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.01	<0.1
21/03/2019	43.7	21.4	6.2	17.3	<20.0	<10.0	0.33	<1.0	<5.0	0.01	<4.2	<0.5	1.74	<0.1
25/03/2019	50.2	26.3	6.3	31.2	<20.0	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	0.79	<0.1
28/03/2019	70.6	35.2	6.4	28.4	<20.0	15.5	0.25	<1.0	<5.0	<0.01	<4.2	<0.5	1.7	<0.1
01/04/2019	83.5	40.2	<6.0	20.1	22.2	21.2	0.42	<1.0	<5.0	<0.01	<4.2	<0.5	2.25	<0.1
04/04/2019	72	33.2	6.2	25.4	20.8	11.4	0.39	<1.0	<5.0	<0.01	<4.2	<0.5	1.55	<0.1
08/04/2019	50.8	22.7	6.3	24.4	<20.0	<10.0	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.56	<0.1
13/04/2019	47.6	28.2	6.9	29.1	<20.0	21.2	0.55	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
15/04/2019	62.6	42.3	<6.0	32.7	<20.0	18.5	0.19	<1.0	<5.0	<0.01	<4.2	<0.5	1.67	<0.1
18/04/2019	51.8	30.4	7.8	23.7	<20.0	<10.0	0.27	<1.0	<5.0	<0.01	<4.2	<0.5	2.89	<0.1
22/04/2019	50.5	22.7	8.1	33.5	24.8	<10.0	0.64	<1.0	<5.0	<0.01	<4.2	<0.5	2.21	<0.1
25/04/2019	63.8	38.6	6.7	16.3	<20.0	19.6	0.43	<1.0	<5.0	<0.01	<4.2	<0.5	1.71	<0.1
29/04/2019	77.4	43.5	<6.0	26.9	20.8	15.7	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.93	<0.1
02/05/2019	42.8	19.7	<6.0	19.2	<20.0	<10.0	0.24	<1.0	<5.0	<0.01	<4.2	<0.5	1.76	<0.1
06/05/2019	64.9	30.6	7.2	30.6	<20.0	14.7	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.23	<0.1
09/05/2019	48.6	27.4	6.3	23.4	21	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.26	<0.1
13/05/2019	55.5	25.1	6	18.3	<20.0	15.8	0.38	<1.0	<5.0	<0.01	<4.2	<0.5	1.19	<0.1
16/05/2019	40.7	26.3	<6.0	24.1	20.9	12.9	0.48	<1.0	<5.0	<0.01	<4.2	<0.5	1.81	<0.1
20/05/2019	60.1	28.7	<6.0	15.8	<20.0	<10.0	0.74	<1.0	<5.0	<0.01	<4.2	<0.5	1.73	<0.1
23/05/2019	56.6	32.4	7.8	26.3	24.7	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.53	<0.1
27/05/2019	47.7	21.2	<6.0	17.5	<20.0	10.4	0.54	<1.0	<5.0	<0.01	<4.2	<0.5	1.22	<0.1
30/05/2019	50.1	31.4	<6.0	20.7	23.3	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
03/06/2019	46.8	26.3	6.8	27.4	<20.0	11.8	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.42	<0.1
06/06/2019	59.9	27.7	<6.0	15.9	<20.0	<10.0	0.48	<1.0	<5.0	<0.01	<4.2	<0.5	1.18	<0.1

Location Code: AAQ 3				Monitoring Location : Jotinagar						GPS Coordinate : 26°31'719"N, 93°58'937"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
12/03/2019	59.6	32.2	<6.0	24.8	20.2	<10.0	0.33	<1.0	6.5	<0.01	<4.2	<0.5	1.1	<0.1
15/03/2019	70.5	28.7	<6.0	25.4	20.6	<10.0	0.48	<1.0	7.8	<0.01	<4.2	<0.5	1.86	<0.1
19/03/2019	56.7	27.4	<6.0	17.3	<20.0	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.26	<0.1
22/03/2019	72.4	29.6	6.5	28.6	<20.0	<10.0	0.51	<1.0	<5.0	<0.01	<4.2	<0.5	2.56	<0.1
26/03/2019	59.6	29.1	<6.0	24.8	20.2	<10.0	0.23	<1.0	<5.0	<0.01	<4.2	<0.5	0.98	<0.1
29/03/2019	81.2	39.6	6.5	20.5	<20.0	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.733	<0.1
02/04/2019	69.8	37.8	<6.0	18.2	<20.0	18.2	0.51	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
05/04/2019	75.6	30.1	<6.0	26.3	21.4	10.8	0.43	<1.0	<5.0	<0.01	<4.2	<0.5	1.27	<0.1
09/04/2019	54.9	33.4	6.2	17.9	<20.0	24.2	0.16	<1.0	<5.0	<0.01	<4.2	<0.5	1.47	<0.1
12/04/2019	67.8	40.6	<6.0	25.6	25.6	16.6	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.28	<0.1
16/04/2019	48.1	30.4	6.5	27.8	<20.0	<10.0	0.64	<1.0	<5.0	<0.01	<4.2	<0.5	1.59	<0.1
19/04/2019	60.6	38.4	7	30.6	22.3	<10.0	0.48	<1.0	<5.0	<0.01	<4.2	<0.5	2.42	<0.1
23/04/2019	40.2	18.6	<6.0	23.6	23.5	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.53	<0.1
26/04/2019	47.5	21.8	6.7	20.2	24.7	<10.0	0.51	<1.0	<5.0	<0.01	<4.2	<0.5	1.62	<0.1
30/04/2019	45.8	21.6	<6.0	21.1	26.8	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	2.13	<0.1
03/05/2019	77.5	42.4	6.9	23.1	<20.0	16.3	0.39	<1.0	<5.0	<0.01	<4.2	<0.5	1.34	<0.1
07/05/2019	65.6	29.9	<6.0	13.9	<20.0	<10.0	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.2	<0.1
10/05/2019	59.3	34.5	6.2	21.7	21.8	11.2	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.35	<0.1
14/05/2019	46.3	25.3	<6.0	17.9	20.6	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.54	<0.1
17/05/2019	52.2	24.1	6.5	27.1	<20.0	10.2	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.06	<0.1
21/05/2019	68.6	30.7	<6.0	16.8	<20.0	<10.0	0.33	<1.0	<5.0	<0.01	<4.2	,0.5	1.41	<0.1
24/05/2019	70.4	41.2	<6.0	21.3	<20.0	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.59	<0.1
28/05/2019	80.8	45.3	<6.0	20.9	21.6	12.9	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.91	<0.1
31/05/2019	60.4	27.1	7.3	30.7	<20.0	<10.0	0.22	<1.0	<5.0	<0.01	<4.2	<0.5	1.8	<0.1
04/06/2019	51.5	30.2	<6.0	23.5	23.8	13.8	0.66	<1.0	<5.0	<0.01	<4.2	<0.5	1.96	<0.1
07/06/2019	45.5	20.7	<6.0	19.8	<20.0	<10.0	0.49	<1.0	<5.0	<0.01	<4.2	<0.5	1.51	<0.1

Location Code: AAQ 4				Monitoring Location : Gohaingaon						GPS Coordinate : 26°38'04.39"N, 94°10'40.57"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
11/03/2019	75.4	38.5	6.8	30.5	<20.0	<10.0	0.37	<1.0	7.9	<0.01	<4.2	<0.5	1.05	<0.1
14/03/2019	66.9	35.6	6.6	31.5	22.5	<10.0	0.3	<1.0	10	0.06	<4.2	<0.5	2.2	<0.1
18/03/2019	50.7	27.5	7.3	15.8	21.7	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.91	<0.1
21/03/2019	57.2	32.5	<6.0	16.9	<20.0	<10.0	0.2	<1.0	<5.0	<0.01	<4.2	<0.5	1.77	<0.1
25/03/2019	73.6	36.6	<6.0	22.7	22.4	<10.0	0.16	<1.0	<5.0	<0.01	<4.2	<0.5	1.39	<0.1
28/03/2019	55.6	29.8	6.2	19.3	<20.0	<10.0	0.27	<1.0	<5.0	<0.01	<4.2	<0.5	1	<0.1
01/04/2019	65.7	32.2	<6.0	21.9	<20.0	<10.0	0.69	<1.0	<5.0	<0.01	<4.2	<0.5	1.62	<0.1
04/04/2019	48.5	23.3	7	28.8	21.9	16.6	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.14	<0.1
08/04/2019	79.9	51.2	6.5	22.9	21.4	<10.0	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.2	<0.1
13/04/2019	53.7	32.4	<6.0	16.1	<20.0	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	2.03	<0.1
15/04/2019	51.8	34.7	7.6	18.7	<20.0	21.5	0.43	<1.0	<5.0	<0.01	<4.2	<0.5	1.69	<0.1
18/04/2019	36.2	14.5	<6.0	17.4	<20.0	<10.0	0.56	<1.0	<5.0	<0.01	<4.2	<0.5	2.18	<0.1
22/04/2019	61.7	39.8	6.8	27.2	26.7	<10.0	0.21	<1.0	<5.0	<0.01	<4.2	<0.5	2.47	<0.1
25/04/2019	71.9	43.2	<6.0	28.3	<20.0	16.7	0.51	<1.0	<5.0	<0.01	<4.2	<0.5	1.68	<0.1
29/04/2019	37.5	24.7	6.1	30.5	22.3	<10.0	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.3	<0.1
02/05/2019	77.9	42.5	<6.0	26.8	<20.0	24.5	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.55	<0.1
06/05/2019	56.5	32.5	7.8	26.8	<20.0	<10.0	0.52	<1.0	<5.0	<0.01	<4.2	<0.5	1.45	<0.1
09/05/2019	47.7	21.8	<6.0	15.9	<20.0	11.6	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.25	<0.1
13/05/2019	68.6	37.2	<6.0	22.5	20.3	15.5	0.17	<1.0	<5.0	<0.01	<4.2	<0.5	2.2	<0.1
16/05/2019	70.4	33.6	6.2	24.3	<20.0	<10.0	0.55	<1.0	<5.0	<0.01	<4.2	<0.5	1.53	<0.1
20/05/2019	47.3	28.4	<6.0	21.7	21.7	<10.0	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.48	<0.1
23/05/2019	63.3	36.5	6	16.3	22.9	13.9	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.2	<0.1
27/05/2019	54.2	32.2	<6.0	24.2	20.8	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.56	<0.1
30/05/2019	49.8	28.5	6.2	17.4	<20.0	14.7	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.78	<0.1
03/06/2019	39.6	24.3	6.4	21.7	<20.0	<10.0	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	2.03	<0.1
06/06/2019	57.5	32.4	<6.0	15.5	<20.0	<10.0	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.36	<0.1

Location Code: AAQ 5				Monitoring Location : Nimati Village						GPS Coordinate : 26°47'166"N 94°02'808"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
10/03/2019	66.5	38.6	6.4	23.5	<20.0	<10.0	0.36	<1.0	8.8	0.01	<4.2	<0.5	1.38	<0.1
13/03/2019	52.7	23.8	<6.0	21.6	<20.0	<10.0	0.43	<1.0	9.1	0.05	<4.2	<0.5	1.22	<0.1
17/03/2019	65.7	36.2	<6.0	21.7	<20.0	<10.0	0.42	<1.0	<5.0	<0.01	<4.2	<0.5	1.44	<0.1
20/03/2019	68.4	36.4	6.8	29.5	<20.0	<10.0	0.57	<1.0	<5.0	<0.01	<4.2	<0.5	1.14	<0.1
24/03/2019	66.5	37.5	6.6	23.5	25.6	<10.0	0.18	<1.0	<5.0	<0.01	<4.2	<0.5	1.52	<0.1
27/03/2019	48.9	23.8	<6.0	21.6	<20.0	<10.0	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	1.79	<0.1
31/03/2019	42.5	20.4	<6.0	17.4	<20.0	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.55	<0.1
03/04/2019	56.6	24.7	7.2	28.9	<20.0	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.33	<0.1
07/04/2019	70.1	42.6	6.2	17.8	<20.0	18.6	0.21	<1.0	<5.0	<0.01	<4.2	<0.5	1.46	<0.1
10/04/2019	67.2	28.6	<6.0	23.5	28.9	<10.0	0.32	<1.0	<5.0	<0.01	<4.2	<0.5	1.45	<0.1
14/04/2019	31.2	14.6	7	19.9	22.1	16.8	0.51	<1.0	<5.0	<0.01	<4.2	<0.5	1.48	<0.1
17/04/2019	54.4	21.3	<6.0	16.7	24.3	<10.0	0.42	<1.0	<5.0	<0.01	<4.2	<0.5	1.77	<0.1
21/04/2019	48.5	29.6	7.2	27.3	<20.0	13.7	0.62	<1.0	<5.0	<0.01	<4.2	<0.5	2.38	<0.1
24/04/2019	78.3	51.4	8.1	16.3	<20.0	16.6	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.6	<0.1
28/04/2019	39.8	16.6	6.2	30.2	<20.0	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
01/05/2019	52.9	23.2	6.9	17.6	<20.0	<10.0	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	2.27	<0.1
05/05/2019	47.8	21.2	<6.0	18.6	20.8	<10.0	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.72	<0.1
08/05/2019	54.5	32.7	7.4	21.8	21.2	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	2.02	<0.1
12/05/2019	39.7	17.6	<6.0	19.7	<20.0	10.8	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	2	<0.1
15/05/2019	55.3	30.4	<6.0	17.4	23.3	11.7	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.98	<0.1
19/05/2019	78.3	45.3	7.6	26.3	<20.0	<10.0	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	2.01	<0.1
22/05/2019	57.4	33.2	<6.0	14.7	<20.0	11.6	0.5	<1.0	<5.0	<0.01	<4.2	<0.5	1.72	<0.1
26/05/2019	65.5	30.1	6.6	22.1	21.7	<10.0	0.54	<1.0	<5.0	<0.01	<4.2	<0.5	1.19	<0.1
29/05/2019	48.3	22.4	<6.0	15.5	<20.0	<10.0	0.22	<1.0	<5.0	<0.01	<4.2	<0.5	1.17	<0.1
02/06/2019	60.9	33.6	<6.0	18.3	25.4	11.3	0.19	<1.0	<5.0	<0.01	<4.2	<0.5	1.12	<0.1
05/06/2019	39.5	25.3	6.1	22.5	<20.0	11.2	0.65	<1.0	<5.0	<0.01	<4.2	<0.5	1.46	<0.1

Location Code: AAQ 6				Monitoring Location : Dholi Village						GPS Coordinate : 26°38'058"N 94°10'681"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
12/03/2019	70.3	33.8	6.2	19.6	22.5	11.2	0.26	<1.0	6.9	0.03	<4.2	<0.5	1.59	<0.1
15/03/2019	54.7	31.2	6.2	18.9	<20.0	<10.0	0.2	<1.0	7.5	<0.01	<4.2	<0.5	1.4	<0.1
19/03/2019	66.4	35.2	<6.0	27.4	20.2	10.8	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	0.67	<0.1
22/03/2019	61.8	33.5	6.4	24.3	<20.0	<10.0	0.44	<1.0	<5.0	<0.01	<4.2	<0.5	0.87	<0.1
26/03/2019	70.3	38.2	6.2	19.6	22.5	11.2	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.07	<0.1
29/03/2019	66.1	32.6	<6.0	25.5	<20.0	18.6	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	0.88	<0.1
02/04/2019	72.5	40.1	<6.0	17.3	21.5	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	0.78	<0.1
05/04/2019	58.6	29.3	6.8	21.5	20.8	<10.0	0.54	<1.0	<5.0	<0.01	<4.2	<0.5	1.21	<0.1
09/04/2019	81.6	56.5	<6.0	23.4	22.7	<10.0	0.61	<1.0	<5.0	<0.01	<4.2	<0.5	1.46	<0.1
12/04/2019	70.2	29.4	7	17.4	<20.0	<10.0	0.48	<1.0	<5.0	<0.01	<4.2	<0.5	1.51	<0.1
16/04/2019	61.6	40.7	6.9	18.6	<20.0	21.2	0.24	<1.0	<5.0	<0.01	<4.2	<0.5	2.27	<0.1
19/04/2019	72.8	45.3	<6.0	30.2	21.3	16.6	0.31	<1.0	<5.0	<0.01	<4.2	<0.5	1.78	<0.1
23/04/2019	40.2	18.6	<6.0	23.6	23.5	<10.0	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.53	<0.1
26/04/2019	69.9	40.2	6.8	19.7	<20.0	21.2	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.61	<0.1
30/04/2019	63.5	26.6	<6.0	24.8	20.8	15.9	0.44	<1.0	<5.0	<0.01	<4.2	<0.5	1.73	<0.1
03/05/2019	38.7	17.9	6.2	18.1	27.1	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.61	<0.1
07/05/2019	56.9	25.7	6.2	24.2	<20.0	<10.0	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.2	<0.1
10/05/2019	45.2	21.3	<6.0	16.3	<20.0	12.8	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	1.22	<0.1
14/05/2019	57.7	33.5	<6.0	21.4	<20.0	13.4	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.77	<0.1
17/05/2019	60.9	33.8	<6.0	18.7	21.8	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.23	<0.1
21/05/2019	41.5	28.7	6.5	27.9	22.4	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.44	<0.1
24/05/2019	39.7	17.9	<6.0	16.2	<20.0	13.7	0.47	<1.0	<5.0	<0.01	<4.2	<0.5	1.04	<0.1
28/05/2019	66.6	30.3	6.3	23.7	23.6	17.2	0.63	<1.0	<5.0	<0.01	<4.2	<0.5	1.79	<0.1
31/05/2019	58.6	34.2	<6.0	17.4	<20.0	<10.0	0.57	<1.0	<5.0	<0.01	<4.2	<0.5	2.38	<0.1
04/06/2019	42.7	26.7	7	22.1	<20.0	16.6	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.35	<0.1
07/06/2019	67.9	31.4	<6.0	15.2	26.1	<10.0	0.27	<1.0	<5.0	<0.01	<4.2	<0.5	2.65	<0.1

itoring Agency : Mitra S.K.

Location Code: AAQ 7				Monitoring Location : Golaghat Commorce Collage						GPS Coordinate : 26°31'17.11"N, 93°58'46.85"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
10/03/2019	80.5	46.2	6.2	27.6	<20	<10	0.28	<1.0	<5.0	0.04	<4.2	<0.5	1.22	<0.1
13/03/2019	57.6	30.3	6.4	28.8	20.2	10.4	0.39	<1.0	8.8	0.01	<4.2	<0.5	2.44	<0.1
17/03/2019	57.6	32.4	6.3	19.3	20.4	10.6	0.47	<1.0	<5.0	<0.01	<4.2	<0.5	1.1	<0.1
20/03/2019	59.6	24.8	<6.0	32.2	20.6	10.4	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	1.14	<0.1
24/03/2019	64.2	28.7	8.2	17.3	23.3	11.2	0.47	<1.0	<5.0	<0.01	<4.2	<0.5	1.39	<0.1
27/03/2019	71.2	37.2	6.4	28.8	20.2	19.3	0.33	<1.0	<5.0	<0.01	<4.2	<0.5	1.62	<0.1
31/03/2019	55.6	23.8	7.1	15.6	<20.0	<10.0	0.31	<1.0	<5.0	<0.01	<4.2	<0.5	1.98	<0.1
03/04/2019	70.2	33.6	6.3	26.2	<20.0	16.3	0.23	<1.0	<5.0	<0.01	<4.2	<0.5	1.66	<0.1
07/04/2019	52.1	23.8	<6.0	21.8	20.9	<10.0	0.16	<1.0	<5.0	<0.01	<4.2	<0.5	1.25	<0.1
10/04/2019	55.4	33.3	6.5	30.2	<20.0	16.6	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	1.44	<0.1
14/04/2019	40.2	28.7	<6.0	19.6	22.8	<10.0	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	1.78	<0.1
17/04/2019	62.2	43.8	7.5	27.9	<20.0	18.2	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	2.25	<0.1
21/04/2019	57.3	34.2	<6.0	19.3	<20.0	<10.0	0.21	<1.0	<5.0	<0.01	<4.2	<0.5	2.3	<0.1
24/04/2019	65.6	42.2	6.6	27.3	24.5	21.2	0.27	<1.0	<5.0	<0.01	<4.2	<0.5	1.26	<0.1
28/04/2019	45.5	27.4	<6.0	26.9	<20.0	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.47	<0.1
01/05/2019	70.1	43.8	6.1	17.6	25.5	16.6	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.62	<0.1
05/05/2019	35.3	16.7	6.9	19.2	<20.0	11.3	0.48	<1.0	<5.0	<0.01	<4.2	<0.5	2.29	<0.1
08/05/2019	62.6	35.4	<6.0	20.2	<20.0	11.2	0.26	<1.0	<5.0	<0.01	<4.2	<0.5	2.31	<0.1
12/05/2019	53.5	24.5	6.2	18.6	21.9	<10.0	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	2.7	<0.1
15/05/2019	46.4	28.6	<6.0	24.9	22.5	<10.0	0.38	<1.0	<5.0	<0.01	<4.2	<0.5	1.26	<0.1
19/05/2019	69.5	32.5	<6.0	15.4	<20.0	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	2.24	<0.1
22/05/2019	55.3	31.2	7.7	27.6	24.6	12.8	0.49	<1.0	<5.0	<0.01	<4.2	<0.5	1.47	<0.1
26/05/2019	47.7	21.1	<6.0	16.8	<20.0	11.7	0.66	<1.0	<5.0	<0.01	<4.2	<0.5	1.1	<0.1
29/05/2019	50.2	28.6	<6.0	22.5	20	<10.0	0.38	<1.0	<5.0	<0.01	<4.2	<0.5	1.14	<0.1
02/06/2019	48.7	26.8	<6.0	19.2	22.8	10.5	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	1.94	<0.1
05/06/2019	39.9	17.5	6.7	26.4	<20.0	<10.0	0.28	<1.0	<5.0	<0.01	<4.2	<0.5	2.14	<0.1

Location Code: AAQ 8				Monitoring Location : Gharphalia						GPS Coordinate : 26°46'11.12"N,94°09'10.24"E				
Parameters	PM_{10}	$PM_{2.5}$	SO_2	NO_2	O3	NH3	CO	As	Ni	Pb	C6H6	BaP	HC as methane	HC as non-methane
Unit	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	mg/m3	ng/m3	ng/m3	µg/m3	µg/m3	ng/m3	ppm	ppm
10/03/2019	75.5	39.9	7.5	31.9	<20.0	<10.0	0.48	<1.0	7.6	0.03	<4.2	<0.5	1.26	<0.1
13/03/2019	68.5	35.4	7	17.9	21.4	<10.0	0.34	<1.0	9	0.02	<4.2	<0.5	1.81	<0.1
17/03/2019	41.8	23.8	<6.0	19.7	20.3	10.2	0.64	<1.0	<5.0	0.01	<4.2	<0.5	1.15	<0.1
20/03/2019	67.3	35.7	7.4	26.8	<20.0	<10.0	0.23	<1.0	<5.0	<0.01	<4.2	<0.5	1.63	<0.1
24/03/2019	75.5	33.9	7.5	31.9	<20.0	<10.0	0.66	<1.0	<5.0	<0.01	<4.2	<0.5	1.37	<0.1
27/03/2019	68.5	30.9	7	17.9	21.4	<10.0	0.22	<1.0	<5.0	<0.01	<4.2	<0.5	1.1	<0.1
31/03/2019	70.2	37.2	6.1	26.3	<20.0	16.6	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.85	<0.1
03/04/2019	66.3	26.9	<6.0	19.9	<20.0	<10.0	0.45	<1.0	<5.0	<0.01	<4.2	<0.5	0.99	<0.1
07/04/2019	63.9	38.3	7.2	15.3	21.5	<10.0	0.47	<1.0	<5.0	<0.01	<4.2	<0.5	1.24	<0.1
10/04/2019	70.9	48.2	7.6	30.2	<20.0	24.6	0.25	<1.0	<5.0	<0.01	<4.2	<0.5	1.49	<0.1
14/04/2019	66.1	43.5	<6.0	22.7	25.4	29.1	0.36	<1.0	<5.0	<0.01	<4.2	<0.5	1.61	<0.1
17/04/2019	43.3	32.5	6.2	18.3	20.5	<10.0	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	2.03	<0.1
21/04/2019	72.4	41.3	<6.0	25.6	<20.0	16.6	0.15	<1.0	<5.0	<0.01	<4.2	<0.5	2.28	<0.1
24/04/2019	54.3	21.8	8.2	24.7	<20.0	17.8	0.29	<1.0	<5.0	<0.01	<4.2	<0.5	2.03	<0.1
28/04/2019	59.7	32.6	<6.0	16.3	<20.0	<10.0	0.34	<1.0	<5.0	<0.01	<4.2	<0.5	1.61	<0.1
01/05/2019	56.3	35.6	<6.0	20.3	21.9	21.2	0.56	<1.0	<5.0	<0.01	<4.2	<0.5	1.33	<0.1
05/05/2019	66.7	29.3	6	21.3	22.6	<10.0	0.37	<1.0	<5.0	<0.01	<4.2	<0.5	1.71	<0.1
08/05/2019	49.4	28.5	<6.0	15.7	<20.0	11.2	0.46	<1.0	<5.0	<0.01	<4.2	<0.5	2.08	<0.1
12/05/2019	53.3	32.4	<6.0	23.4	21.4	10.9	0.55	<1.0	<5.0	<0.01	<4.2	<0.5	1.89	<0.1
15/05/2019	67.7	31.5	6.6	30.2	<20.0	<10.0	0.64	<1.0	<5.0	<0.01	<4.2	<0.5	1.44	<0.1
19/05/2019	41.2	18.7	<6.0	19.3	20	<10.0	0.85	<1.0	<5.0	<0.01	<4.2	<0.5	1.52	<0.1
22/05/2019	59.6	22.2	7.2	22.5	<20.0	13.3	0.25	<1.0	<5.0	<0.01	<4.2	<0.5	1.54	<0.1
26/05/2019	45.7	26.8	<6.0	17.8	20.8	<10.0	0.35	<1.0	<5.0	<0.01	<4.2	<0.5	1.74	<0.1
29/05/2019	67.6	38.9	6.3	25.4	<20.0	<10.0	0.27	<1.0	<5.0	<0.01	<4.2	<0.5	1.28	<0.1
02/06/2019	42.3	29.1	<6.0	16.3	25.3	10.4	0.78	<1.0	<5.0	<0.01	<4.2	<0.5	1.61	<0.1
05/06/2019	58.8	27.5	6.5	27.2	<20.0	<10.0	0.65	<1.0	<5.0	<0.01	<4.2	<0.5	1.74	<0.1

Appendix 3.3: Ambient Noise Monitoring Results

Sl. No.	Location	Date	Day Time			Night Time		
			Avg. Leq	Max Leq	Min Leq	Avg. Leq	Max Leq	Min Leq
1	NQ1 26°27'7.56"N, 94° 4'17.58"E	12/05/2019-13/05/2019	58.80	61.80	49.50	47.39	50.80	41.40
2	NQ2 26°31'51.66"N, 94° 3'25.30"E	20/05/2019-21/05/2019	59.99	68.20	43.60	42.95	46.70	39.90
3	NQ3 26°35'27.41"N, 94°11'20.25"E	13/05/2019-14/05/2019	58.39	63.60	44.60	42.77	46.70	39.10
4	NQ4 26°32'8.70"N, 94°10'45.00"E	21/05/2019-22/05/2019	54.90	59.00	43.00	41.97	44.40	39.40
5	NQ5 26°35'8.04"N, 94° 3'19.92"E	16/05/2019-17/05/2019	57.55	61.40	44.10	41.88	44.10	39.00
6	NQ6 26°41'32.32"N, 94° 9'15.94"E	14/05/2019-15/05/2019	54.09	58.00	46.20	43.68	46.20	40.80
7	NQ7 26°43'27.82"N, 94° 3'28.02"E	17/05/2019-18/05/2019	59.35	64.80	48.10	46.15	48.10	42.40
8	NQ8 26°48'14.21"N, 94° 3'20.81"E	15/05/2019-16/05/2019	55.09	59.00	42.70	41.60	43.50	39.20

Appendix 3.4: Ground Water Quality Monitoring Results

S.N.	Parameters	Unit	Method Used	Desirable limit	Permissible limit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
(I)	Organoleptic Physical Parameters												
1	Colour	Hazen	APHA (23rd Edition) 2120B, 2017	5	15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2	Odour	-	APHA(23rd Edition) 2150B, 2017	Agreeable	Agreeable	unobjectiona ble	unobjectionable	Unobjectio nable	unobjectio nable	unobjectio nable	unobjectio nable	unobjection able	Unobjectio nable
3	Taste	None	IS 3025 (Part 8)-1983 Rffm:2012	-	-	25.6	25	26	28.2	24.6	26	25.1	25deg C
4	Temperature	°C	APHA 23rd EDITION, 2550 B, 2017	-	-	7.8 at 25.6 °C	7.8 at 25 °C	6.7 at 26 °C	7.8 at 28.2 °C	6.7 at 24.6 °C	7.8 at 26 °C	6.7 at 25.1 °C	6.54 at 25 °C
5	pH	-	APHA(23rd Edition) 4500-H+-B, 2017	6.5-8.5	6.5-8.5	2.4	7	<1.0	<1.0	2.2	1.5	1.2	207
6	Turbidity	NTU	APHA (23rd Edition) 2130B, 2017	1	5	272	276	176	282	280	260	192	206
7	Total Dissolved Solids	mg/l	APHA(23rd Edition) 2540C, 2017	500	2000	502	461	324	538	436	456	326	340
8	Electrical Conductivity	µS/Cm	APHA (23rd Edition) 2510B, 2017	-	-	0.29	0.26	0.18	0.31	0.22	0.26	0.16	0.17
9	Salinity (In respect to KCl equivalent salinity 35)	None	APHA (23rd Edition)2520B, 2017	-	-	5.1	5.2	5.1	5.0	5.3	5.3	5.4	5.2
10	Dissolved oxygen	mg/l	APHA (23rd Edition) 4500-O-C/G, 2017	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
(II)	General Parameters												
11	Aluminium (Al)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	0.03	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Anionic Detergent (as MBAS)	mg/l	APHA (23rd Edition)5540 C,2017	0.2	0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
13	Barium (Ba)	mg/l	APHA (23rd Edition) 3120B, 2017	0.7	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
14	Calcium (Ca)	mg/l	APHA (23rd Edition) 3500 Ca B,2017	75	200	34	12	22	49	23	23	17	20
15	Chloramines (as Cl2)	mg/l	IS 3025 (Part 26)-1986	4	-	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
16	Chloride	mg/l	APHA (23rd Edition)4500-Cl B 2017	250	1000	6	8	6	20	6	6	6	8
17	Copper (Cu)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	0.05	1.5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

S.N.	Parameters	Unit	Method Used	Desirable limit	Permissible limit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
18	Fluoride as F	mg/l	APHA (23rd Edition)4500 - F C/D, 2017	1	1.5	0.23	0.42	0.15	0.25	0.35	0.32	0.28	0.17
19	Free Residual Chlorine	mg/l	IS 3025 (Part 26)-1986	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
20	Iron (Fe)	mg/l	APHA (23rd Edition)3500 Fe B 2017	---	0.3	0.53	0.84	0.08	0.06	0.11	0.30	0.51	60
21	Magnesium (Mg)	mg/l	APHA (23rd Edition) 3500 Mg B,2017	30	100	15	10	15	27	8.3	18	10	13
22	Manganese (Mn)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	0.1	0.3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
23	Mineral Oil	mg/l	IS 3025 (Part 39)1991	0.5	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Nitrate	mg/l	APHA (23rd Edition) 4500- NO3-E, 2017	45	45	3.8	7.2	0.8	24	20	2.7	0.64	9
25	Phenol	mg/l	APHA (23rd Edition)5530C 2017 (Chloroform Extraction)	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Selenium (Se)	mg/l	APHA (23rd Edition) 3120 B, 2017	0.01	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
27	Sulphate	mg/l	APHA (23rd Edition) 4500-SO4 E 2017	200	400	<1.0	<1.0	3.0	<1.0	<1.0	<1.0	<1.0	37
28	Potassium	mg/l	APHA (23rd Edition) 3500 K B 2017	-	-	1.1	0.7	1.7	2.6	1.7	1.4	1.6	1.7
29	Total Phosphorous	mg/l	APHA (23rd Edition) 4500- P B, D 2017	-	-	4.4	1.8	0.06	2.8	3.4	1.9	4.8	0.08
30	Sodium	mg/l	APHA (23rd Edition) 3500 Na B 2017	-	-	65	76	32	26	48	50	30	25
31	Total Alkalinity	mg/l	APHA (23rd Edition), 2320B, 2017	200	600	190	240	125	170	250	240	160	145
32	Total Hardness	mg/l	APHA (23rd Edition) 2340 C 2017	200	600	146	73	115	234	92	131	84	104
33	Total Nitrogen	mg/l	IS 14684 (1999)	-	-	2.7	3.0	0.36	6.0	6.5	2.0	1.0	2
34	Zinc (Zn)	mg/l	APHA (23rd Edition)3120B 2017	5	15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
(III)	Toxic Substances												

S.N.	Parameters	Unit	Method Used	Desirable limit	Permissible limit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
35	Cadmium (Cd)	mg/l	APHA (23rd Edition)3120B 2017	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
36	Cyanide (as CN)	mg/l	APHA (23rd Edition)4500 CN- F 2017	0.05		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
37	Lead (Pb)	mg/l	APHA (23rd Edition)3120B 2017	0.01	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
38	Mercury (Hg)	mg/l	IS 3025(Part 48)-1994; Rffm:2014	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
39	Molybdenum (as Mo)	mg/l	APHA (23rd Edition), 3120 B, 2017	0.07		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
40	Nickel (as Ni)	mg/l	APHA (23rd Edition), 3120 B, 2017	0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
41	Hexavalent Chromium (Cr+6)	mg/l	APHA 23rd Edtn-2017, 3500 Cr B	0.05	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
42	Arsenic (As)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	0.01	0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
(IV)	Pesticides Residues												
43	Alchor	µg/l	AOAC 990.06	20	20	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
44	Atrazine	µg/l	AOAC 990.06	2	2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
45	Aldrin	µg/l	AOAC 990.06	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46	Dialdrin	µg/l	AOAC 990.06			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
47	**α**-HCH	µg/l	AOAC 990.06	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
48	**β**-HCH	µg/l	AOAC 990.06	0.04	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
49	Butachlore	µg/l	AOAC 990.06	125	125	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
50	Chlorpyrifos	µg/l	AOAC 990.06	30	30	<0.02	<0.02	<0.02	<0.02	<0.0	<0.02	<0.02	<0.02
51	**δ**-HCH	µg/l	AOAC 990.06	2	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
52	2,4 Dichlorophenoxyacetic acid	µg/l	US EPA 515	30	30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
53	p,p DDT	µg/l	AOAC 990.06	1	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
54	o,p DDT	µg/l	AOAC 990.06	1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
55	o,p DDE	µg/l	AOAC 990.06	1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
56	p,p DDE	µg/l	AOAC 990.06	1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

S.N.	Parameters	Unit	Method Used	Desirable limit	Permissible limit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
57	o,p DDD	µg/l	AOAC 990.06	1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
58	p,p DDD	µg/l	AOAC 990.06	1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
59	Endosulphan sulphate	µg/l	AOAC 990.06	0.4	0.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
60	Alpha-Endosulfan	µg/l	AOAC 990.06	0.4		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
61	Beta-Endosulfan	µg/l	AOAC 990.06	0.4		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
62	Ethion	µg/l	AOAC 990.06	3	3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
63	**γ**-HCH (Lindane)	µg/l	AOAC 990.06	2	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
64	Iso Protron	µg/l	US EPA 532	9	9	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
65	Malathion	µg/l	AOAC 990.06	190	190	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
66	Methyl Parathion	µg/l	AOAC 990.06	0.3	0.3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
67	Monocrotphos	µg/l	AOAC 990.06	1	1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
68	Phorate	µg/l	AOAC 990.06	2	2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
69	Pesticides as Lindane	mg/l	AOAC 990.06	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	(V) Bacteriological Parameters												
70	Total Coliform	MPN/100 ml	AOAC 990.06	Not Detectable	Absent	NOT DETECTED	13 MPN/100 ml	NOT DETECTED	4 MPN/100 ml	NOT DETECTED	NOT DETECTED	11MPN/100 ml	NOT DETECTED
71	Faecal Coliform	MPN/100 ml	AOAC 990.06	Not Detectable	Absent	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	2 MPN/100 ml	NOT DETECTED

Appendix 3.5: Surface Water QualityMonitoring Results

S.N.	Parameters	Unit	Method	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
1	Colour	Hazen	APHA (23rd Edition) 2120B, 2017	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2	Odour	None	APHA(23rd Edition) 2150B, 2017	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
3	pH	None	IS 3025 (Part 8)-1983 Rffm:2012	23.6	25.6	28.6	25.1	30.2	25.6	26.2	25
4	Turbidity	N.T.U.	APHA 23rd EDITION, 2550 B, 2017	6.7 at 23.6 °C	6.7 at 25.6 °C	6.4 at 28.6 °C	5.6 at 25.1 °C	6.7 at 30.2 °C	5.6 at 25.6 °C	5.6 at 26.2 °C	6.85 at 25 °C
5	Total Dissolved Solids (as TDS)	mg/l	APHA(23rd Edition) 4500-H^+-B, 2017	132	120	108	137	158	154	102	116
6	Aluminium (as Al)	mg/l	APHA (23rd Edition) 2510B, 2017	6.2	6.1	6.2	6.3	6.1	6.0	6.1	5.8
7	Anionic Detergents (as MBAS)	mg/l	APHA (23rd Edition)-4500-O, 2017	22	20	14	69	27	29	44	24
8	Barium (as Ba)	mg/l	APHA (23rd Edition) 2130B, 2017	76	65	62	72	82	80	64	74
9	Calcium (as Ca)	mg/l	APHA(23rd Edition) 2540C, 20017	<2.0	3.4	2.8	3.8	4.2	3.0	2.1	<2.0
10	Chloramines (as Cl2)	mg/l	APHA (23rd Edition) 5210B, 2017	7.7	40	36	27	31	27	23	8
11	Chloride (as Cl)	mg/l	APHA (23rd Edition) 5220B, 2017	61	54	50	46	65	61	50	48
12	Copper (as Cu)	mg/l	APHA (23rd Edition) 2340 C, 2017	50	28	20	40	60	30	20	40
13	Fluoride (as F)	mg/l	APHA (23rd Edition) 2320B, 2017	2.7	1.8	1.4	7.1	4.5	4.8	3.9	4
14	Free Residual Chlorine	mg/l	APHA (23rd Edition) 3500 Na B, 2017	2.4	2.5	2	3.3	2.5	3.9	2.6	3
15	Iron (as Fe)	mg/l	APHA (23rd Edition) 3500 K B, 2017	0.15	0.11	0.15	0.45	0.24	0.26	0.24	0.4
16	Magnesium (as Mg)	mg/l	IS 11624, 1986, RA2015	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17	Manganese (as Mn)	mg/l	APHA (23rd Edition) 4500NH3-B, 2017	<0.05	<0.05	<0.05	4.9	3.2	7.2	3.5	<0.05
18	Mineral Oil	mg/l	APHA (23rd Edition), 4500P-D, 2017	<0.3	0.75	0.56	1.4	0.90	0.85	1.0	1.1
19	Nitrate (as NO3)	mg/l	APHA (23rd Edition) 4500N C, 2017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

20	Selenium (as Se)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
21	Sulphate (as SO4)	mg/l	APHA (23rd Edition)5540 C,2017	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
22	Alkalinity (as CaCO3)	mg/l	APHA (23rd Edition) 3120 B, 2017	15	12	9.2	7.7	17	11	12	11
23	Total Hardness (as CaCO3)	mg/l	APHA (23rd Edition) 3500 Ca B,2017	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
24	Cadmium (as Cd)	mg/l	IS 3025 (Part 26)-1986	6	12	8	10	8	8	10	14
25	Cyanide (as CN)	mg/l	APHA (23rd Edition) 4500-Cl B, 2017	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
26	Lead (as Pb)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	0.17	<0.1	<0.1	0.20	0.17	0.18	0.18	0.27
27	Mercury (as Hg)	mg/l	APHA (23rd Edition)4500 - F C/D, 2017	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
28	Molybdenum (as Mo)	mg/l	IS 3025 (Part 26)-1986	3.7	7.7	5.1	1.7	0.15	0.74	2.5	3
29	Nickel (as Ni)	mg/l	APHA (23rd Edition)3500 Fe B, 2017	5.5	5.5	6.5	6.5	5.5	8.3	4.6	4.8
30	Polychlorinated biphenyls (as PCB)	mg/l	APHA (23rd Edition) 3500 Mg B, 2017	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
31	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
32	Arsenic (as As)	mg/l	IS 3025 (Part 39)1991	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	5
33	Bromoform	µg/l	APHA (23rd Edition) 4500- NO3-E, 2017	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
34	Dibromochlorometha ne	µg/l	APHA (23rd Edition) 3120 B, 2017	4.2	<1.0	<1.0	8.8	2.0	18	11	3
35	Bromodichlorometha ne	µg/l	APHA (23rd Edition) 4500-SO4 E 2017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
36	Chloroform	µg/l	APHA (23rd Edition)3120B 2017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
37	Alachlor	µg/l	APHA (23rd Edition)4500 CN- F 2017	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
38	Atrazine	µg/l	APHA (23rd Edition) 3120B, 2017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

39	Aldrin	µg/l	IS 3025(Part 48)-1994; Rffm:2014	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
40	Dieldrin	µg/l	APHA (23rd Edition) 3120B, 2017	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
41	Alpha-HCH	µg/l	APHA (23rd Edition)3120B 2017 (ICP OES)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
42	Beta-HCH	µg/l	APHA (23rd Edition) 3120B, 2017	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
43	Butachlor	µg/l	APHA (23rd Edition) 3120B, 2017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
44	Chlorpyrifos	µg/l	APHA 23rd Edtn-2017, 3500 Cr B	0.08	0.07	0.09	0.08	0.11	0.10	0.04	0.07
45	Delta-HCH	µg/l	APHA (23rd Edition) 2520B, 2017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
46	2,4-Dichlorophenoxyacetic acid	µg/l	APHA (23rd Edition)5530C 2017 (Chloroform Extraction)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
47	o,p-DDT	µg/l	APHA (23rd Edition) 6232 B	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
48	p,p-DDT	µg/l	APHA (23rd Edition) 6232 B	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
49	o,p-DDE	µg/l	APHA (23rd Edition) 6232 B	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
50	p,p-DDE	µg/l	APHA (23rd Edition) 6232 B	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
51	o,p-DDD	µg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
52	Beta-Endosulfan	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
53	Ethion	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
54	Gama-HCH(Lindane)	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
55	Isoproturon	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
56	Malathion	µg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
57	Methyl parathion	µg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
58	Monocrotophos	µg/l	AOAC 990.06	<0.01	<0.01	<0..01	<0.01	<0.01	<0.01	<0.01	<0.01
59	Taste	none	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
60	Phorate	µg/l	US EPA 515	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
61	Sodium (as Na)	mg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
62	Endosulfan sulfate	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
63	Alpha -endosulfan	µg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
64	Potassium (as K)	mg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

65	Sodium Adsorption Ration (as SAR)	None	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
66	Zinc (as Zn)	mg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
67	Hexavalent Chromium (as Cr+6)	mg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
68	Temperature	°C	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
69	Conductivity	us/cm	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
70	Biochemical Oxygen Demand (as BOD)	mg/l	AOAC 990.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
71	Chemical Oxygen Demand (COD)	mg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
72	Salinity (In respect to KCl equivalent salinity 35)	None	US EPA 532	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
73	Phenol	mg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
74	Free Ammonia	mg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
75	Phosphorus	mg/l	AOAC 990.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
76	DO	mg/l	AOAC 990.06	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
77	Total Nitrogen	mg/l	US EPA 8082	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
78	pp DDD	µg/l	APHA 6440C	170	70	50	90	27	70	130	50
79	Faecal coliform	/100ml	APHA (23rd Edition) 9221 B	9 MPN/100 ml	7 MPN/100 ml	8 MPN/100 ml	9 MPN/100 ml	4 MPN/100 ml	7 MPN/100 ml	8 MPN/100 ml	8 MPN/100 ml
80	Total coliform	MPN/100ml	APHA (23rd Edition) 9221 E	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Appendix 3.6:
Soil Quality Monitoring Results

Sl. No.	Parameters	Unit	LDL	SQ 1	SQ 2	SQ 3	SQ 4	SQ 5	SQ 6	SQ 7	SQ 8
1	Alkalinity (as $CaCO_3$)	mg/kg	180	100	60	140	160	120	100	80	80
2	Antimony (as Sb)	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
3	Arsenic(as As)	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
4	Available Nitrogen (as N)	mg/kg	274	162	280	308	342	162	274	364	364
5	Available Phosphorus (as P)	mg/kg	3.7	7	4.1	3.6	3.1	15	3.6	13	13
6	Available Potassium (as K)	mg/kg	30	30	49	44	50	55	91	89	89
7	Barium (as Ba)	mg/kg	15	27	33	22	26	37	47	55	55
8	Boron (as B)	None	3	6	8	5	6	9	9	11	11
9	Bulk Density	g/cc	1.25	1.18	1.05	1.11	1.18	1.25	1.14	1.11	1.11
10	Cadmium (as Cd)	mg/kg	<2	<2	<2.0	<2	<2	<2.0	<2	<2	<2
11	Calcium (as Ca)	mg/kg	650	600	450	350	400	900	1350	800	800
12	Carbonate	mg/kg	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
13	Cation Exchange Capacity	meq/100 gm	12	7.5	6.6	9	8.6	9.0	13	8.8	8.8
14	Chloride (as Cl)	mg/kg	40	50	60	40	60	40	70	70	70
15	Cobalt (as Co)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2.0	<2.0
16	Copper (as Cu)	mg/kg	6	7	9	8	6	17	17	16	16
17	Cyanide (as CN)	mg/kg	<1	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0
18	Electrical conductivity	us/cm	31.1 (1:2) at 25 ℃	31 (1:2) at 25 ℃	99 (1:2) at 25 ℃	37.9 (1:2) at 25 ℃	31.2 (1:2) at 25 ℃	101(1:2) at 25 ℃	218 (1:2) at 25 ℃	75 (1:2) at 25 ℃	75 (1:2) at 25 ℃

Sl. No.	Parameters	Unit	LDL	SQ 1	SQ 2	SQ 3	SQ 4	SQ 5	SQ 6	SQ 7	SQ 8
19	Hexavalent Chromium (as Cr+6)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2
20	Infiltration Capacity	mm/Hr	16	13	2.0	11	17	18	3.4	6.9	6.9
21	Iron (as Fe)	mg/kg	105	104	68	32	20	24	57	101	101
22	Lead (as Pb)	mg/kg	3	5	7	5	4	8	11	13	13
23	Magnesium (as Mg)	mg/kg	270	90	180	120	150	240	330	180	180
24	Manganese (as Mn)	mg/kg	23	180	180	60	180	140	180	160	160
25	Mercury (as Hg)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
26	Moisture	%	26	25	30	17	23	23.	27	19	19
27	Molybdenum (as Mo)	None	<2	<2.0	<2.0	<2	<2	<2.0	<2.0	<2.0	<2.0
28	Nickel (as Ni)	mg/kg	13	19	18	16	18	20	21	25	25
29	Organic Matter	%	1.3	0.75	1.2	1.4	1.1	0.71	0.56	2.02	2.02
30	Particle Size Distribution	mg/kg	Sand:42% Silt: 34% Clay:24%	Sand:44% Silt:30% Clay:26%	sand:31% silt:%26 clay:43%	Sand:46% Silt: 29% Clay:25%	Sand:41% Silt: 36% Clay:23%	Sand: 52% Silt:28% Clay:20%	Sand: 30% Silt: 29% Clay:41%	sand:44% silt:26% clay:30%	sand:44% silt:26% clay:30%
31	Permeability	Cm/hr	2.9	1.4	0.09	2.7	2.3	2.6	0.14	0.96	0.96
32	Total Phosphorus	mg/kg	84	92	120	73	64	196	128	182	182
	Sodium (as Na)	mg/kg	54	56	34	50	27	69	193	87	87
34	Sodium Adsorption Ration (as SAR)	None	0.25	0.17	0.14	0.31	0.17	0.30	0.71	0.33	0.33
35	Specific gravity	None	2.59	2.27	2.36	2.44	2.36	2.64	2.39	2.38	2.38

Sl. No.	Parameters	Unit	LDL	SQ 1	SQ 2	SQ 3	SQ 4	SQ 5	SQ 6	SQ 7	SQ 8
36	Sulphate (as SO4)	mg/kg	13	43	20	13	32	11	26	23	23
37	Texture	None	Loam	Loam	Clay	Loam	Loam	Loam	Clay	Clay loam	Clay loam
38	Thiocyanate	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5	<5
39	Total Nitrogen (as N)	mg/kg	571	392	622	700	801	386	521	824	824
40	Total Organic Carbon	%	0.77	0.44	0.69	0.80	0.62	0.41	0.32	1.2	1.2
41	Total Porosity	%	51.7	47.9	55.5	54.5	50.1	52.6	52.3	53.4	53.4
42	Total Potassium	mg/kg	106	196	264	186	152	282	332	398	398
43	Trivalent Chromium as Cr-III (TCLP)	None	<2	<2	<2	<2	<2	<2	<2	<2.0	<2.0
44	Water Holding capacity	%	39	33	46	33	35	30	42	37	37
45	Zinc (as Zn)	mg/kg	10	22	25	22	17	22	30	41	41
46	pH value	None	5.79 (1:2.5) at 25 deg C	5.37 (1:2.5) at 25 deg C	4.35 (1:2.5) at 25 deg C	5.32 (1:2.5) at 25 deg C	5.67 (1:2.5) at 25 deg C	5.78 (1:2.5) at 25 deg C	7.07 (1:2.5) at 25 deg C	4.91(1:2.5) at 25 deg C	4.91(1:2.5) at 25 deg C

Appendix 3.7: Traffic Survey Results

TRAFFIC DENSITY - DATA							
Date of Monitoring: 08.06.2019							
LOCATION: T1- AT ROAD AT DHAPKOTA UP & DOWN (UP & DOWN COMBINED)					WORKING DAY		
Sl. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED VEHICLES	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers			
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	382	787	367	72	1608	3554.5
2	10.00-11.00	375	660	402	87	1524	3427.5
3	11.00-12.00	339	785	344	97	1565	3435
4	12.00-13.00	310	569	369	67	1315	2885.5
5	13.00-14.00	263	579	345	101	1288	2801
6	14.00-15.00	281	603	433	77	1394	2910
7	15.00-16.00	255	550	430	67	1302	2670.5
8	16.00-17.00	239	474	282	75	1070	2368.5
9	17.00-18.00	231	376	288	45	940	2071.5
10	18.00-19.00	202	282	198	39	721	1686
11	19.00-20.00	138	244	148	22	552	1223
12	20.00-21.00	132	138	53	19	342	930
13	21.00-22.00	71	47	20	16	154	474
14	22.00-23.00	50	29	2	2	83	278.5
15	23.00-00.00	31	21	4	0	56	175
16	00.00-1.00	17	17	3	0	37	105
17	1.00-2.00	17	10	2	0	29	93.5
18	2.00-3.00	12	10	4	1	27	77
19	3.00-4.00	12	10	4	0	26	73
20	4.00-5.00	17	23	11	5	56	142
21	5.00-6.00	67	122	65	21	275	633.5
22	6.00-7.00	161	389	121	28	699	1541
23	7.00-8.00	272	438	214	60	984	2335
24	8.00-9.00	342	720	302	95	1459	3301
Total Numbers		1179	8760	7875	2547	20361	36508.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 04.06.2019							
LOCATION : T2- KB ROAD AT KAMARBANDHA UP & DOWN (UP & DOWN COMBINED)					WORKDAY		
SI.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	140	600	432	64	1236	2218
2	10.00-11.00	142	473	363	90	1068	2071.5
3	11.00-12.00	125	678	364	107	1274	2371.5
4	12.00-13.00	102	570	339	79	1090	1969
5	13.00-14.00	89	491	446	66	1092	1847
6	14.00-15.00	68	559	427	90	1144	1931.5
7	15.00-16.00	71	634	354	110	1169	2064.5
8	16.00-17.00	133	389	331	69	922	1789
9	17.00-18.00	95	302	222	20	639	1182.5
10	18.00-19.00	106	276	148	23	553	1131
11	19.00-20.00	95	180	112	18	405	881.5
12	20.00-21.00	76	89	78	16	259	617.5
13	21.00-22.00	52	47	23	13	135	379.5
14	22.00-23.00	28	22	19	2	71	186
15	23.00-00.00	21	18	16	2	57	145.5
16	00.00-1.00	10	3	8	0	21	57.5
17	1.00-2.00	1	2	2	0	5	9.5
18	2.00-3.00	1	0	0	0	1	4.5
19	3.00-4.00	3	2	0	0	5	16.5
20	4.00-5.00	3	1	1	0	5	16
21	5.00-6.00	19	22	5	3	49	135.5
22	6.00-7.00	40	165	243	22	470	758.5
23	7.00-8.00	72	262	160	33	527	1009
24	8.00-9.00	94	385	360	75	914	1660.5
Total Numbers		1586	6170	4453	902	13111	24453

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 02.06.2019							
LOCATION : T2- KB ROAD AT KAMARBANDHA (UP & DOWN COMBINED)					HOLIDAY		
Sl. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	82	443	284	63	872	1569.5
2	10.00-11.00	122	362	265	46	795	1541
3	11.00-12.00	100	410	330	66	906	1659
4	12.00-13.00	79	481	284	74	918	1657
5	13.00-14.00	47	356	316	62	781	1309.5
6	14.00-15.00	52	300	314	82	748	1326
7	15.00-16.00	44	313	260	100	717	1327.5
8	16.00-17.00	64	241	253	70	628	1182.5
9	17.00-18.00	44	167	203	65	479	911.5
10	18.00-19.00	46	221	160	26	453	802.5
11	19.00-20.00	41	124	97	23	285	559.5
12	20.00-21.00	50	74	51	12	187	435
13	21.00-22.00	21	43	32	16	112	255
14	22.00-23.00	15	27	15	2	59	131
15	23.00-00.00	10	11	9	0	30	70.5
16	00.00-1.00	1	2	2	0	5	9.5
17	1.00-2.00	0	1	1	0	2	2.5
18	2.00-3.00	1	1	0	0	2	6
19	3.00-4.00	1	0	0	0	1	4.5
20	4.00-5.00	3	1	2	1	7	21
21	5.00-6.00	17	22	7	6	52	140.5
22	6.00-7.00	34	117	24	27	202	460.5
23	7.00-8.00	42	189	106	25	362	678.5
24	8.00-9.00	68	228	211	52	559	1067
Total Numbers		984	4134	3226	818	9162	17127

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 04.06.2019							
LOCATION : T2-TITABAR TO GOLAGHAT ROAD AT KAMARBANDHA (UP & DOWN COMBINED)					WORKINGDAY		
Sl. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	378	806	685	116	1985	4059
2	10.00-11.00	379	794	908	124	2205	4300.5
3	11.00-12.00	339	798	964	108	2209	4118.5
4	12.00-13.00	367	802	715	137	2021	4117.5
5	13.00-14.00	326	856	865	87	2134	3964
6	14.00-15.00	296	821	843	104	2064	3822.5
7	15.00-16.00	227	676	657	120	1680	3172.5
8	16.00-17.00	349	741	548	136	1774	3774
9	17.00-18.00	365	452	294	117	1228	3082.5
10	18.00-19.00	329	271	209	70	879	2376
11	19.00-20.00	280	170	198	44	692	1889
12	20.00-21.00	179	142	173	28	522	1303.5
13	21.00-22.00	139	113	92	16	360	951
14	22.00-23.00	92	61	59	14	226	620.5
15	23.00-00.00	65	44	28	7	144	414.5
16	00.00-1.00	43	23	19	1	86	251
17	1.00-2.00	19	22	10	0	51	128.5
18	2.00-3.00	19	12	3	1	35	110.5
19	3.00-4.00	17	11	6	0	34	99
20	4.00-5.00	10	35	4	0	49	101.5
21	5.00-6.00	21	127	22	4	174	323
22	6.00-7.00	56	403	262	38	759	1270.5
23	7.00-8.00	141	658	554	65	1418	2435.5
24	8.00-9.00	284	754	712	104	1854	3537
Total Numbers		4720	9592	8830	1441	24583	50222

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 02.06.2019							
LOCATION : T2-TITABAR TO GOLAGHAT ROAD AT KAMARBANDHA (UP & DOWN COMBINED)					HOLIDAY		
SI.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	220	599	395	107	1321	2711.5
2	10.00-11.00	344	454	451	92	1341	3048
3	11.00-12.00	306	710	800	84	1900	3578
4	12.00-13.00	242	682	575	132	1631	3215
5	13.00-14.00	218	507	529	71	1325	2554.5
6	14.00-15.00	257	486	666	80	1489	2871.5
7	15.00-16.00	219	490	672	91	1472	2756.5
8	16.00-17.00	247	395	656	135	1433	2900
9	17.00-18.00	268	340	527	142	1277	2811
10	18.00-19.00	213	339	406	105	1063	2293
11	19.00-20.00	123	226	225	62	636	1365.5
12	20.00-21.00	127	187	167	32	513	1147
13	21.00-22.00	106	134	94	18	352	844
14	22.00-23.00	73	70	66	7	216	527.5
15	23.00-00.00	54	49	33	1	137	353.5
16	00.00-1.00	24	19	19	1	63	159.5
17	1.00-2.00	11	1	10	0	22	61
18	2.00-3.00	9	2	3	0	14	46.5
19	3.00-4.00	9	1	2	0	12	44
20	4.00-5.00	4	2	0	2	8	29
21	5.00-6.00	16	31	13	5	65	151.5
22	6.00-7.00	35	174	115	22	346	621.5
23	7.00-8.00	116	295	259	45	715	1403.5
24	8.00-9.00	200	493	470	92	1255	2477.5
Total Numbers		3441	6686	7153	1326	18606	37970.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 03.06.2019)							
LOCATION :T3 -TITABAR TO GOLAGHAT ROAD AT TITABAR (UP & DOWN COMBINED)					WORKINGDAY		
Sl.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	VEHICLES		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	239	944	602	83	1868	3425.5
2	10.00-11.00	240	866	796	69	1971	3451
3	11.00-12.00	237	721	831	90	1879	3339
4	12.00-13.00	245	686	660	70	1661	3071.5
5	13.00-14.00	197	831	601	83	1712	3066
6	14.00-15.00	201	949	378	97	1625	3094
7	15.00-16.00	199	931	499	112	1741	3239
8	16.00-17.00	232	609	307	86	1234	2608.5
9	17.00-18.00	267	522	383	77	1249	2675.5
10	18.00-19.00	266	439	308	61	1074	2407.5
11	19.00-20.00	280	343	189	54	866	2179.5
12	20.00-21.00	215	230	150	28	623	1574.5
13	21.00-22.00	176	118	124	26	444	1197
14	22.00-23.00	148	78	28	8	262	843
15	23.00-00.00	107	44	17	2	170	572.5
16	00.00-1.00	56	15	7	0	78	281.5
17	1.00-2.00	19	11	8	0	38	110
18	2.00-3.00	13	8	8	0	29	78.5
19	3.00-4.00	11	10	3	0	24	67.5
20	4.00-5.00	11	22	4	1	38	90.5
21	5.00-6.00	56	166	140	19	381	717
22	6.00-7.00	81	368	373	30	852	1409.5
23	7.00-8.00	133	509	445	53	1140	2019
24	8.00-9.00	265	715	599	80	1659	3184
Total Numbers		**3894**	**10135**	**7460**	**1129**	**22618**	**44701.5**

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 02.06.2019							
LOCATION: T3 - TITABAR TO GOLAGHAT ROAD AT TITABAR (UP & DOWN COMBINED)					HOLIDAY		
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	220	463	463	62	1208	2395.5
2	10.00-11.00	211	636	642	45	1534	2725.5
3	11.00-12.00	189	508	610	41	1348	2386.5
4	12.00-13.00	219	431	499	59	1208	2367
5	13.00-14.00	164	568	447	71	1250	2321
6	14.00-15.00	190	623	382	64	1259	2427.5
7	15.00-16.00	142	614	467	76	1299	2331
8	16.00-17.00	150	483	272	100	1005	2071.5
9	17.00-18.00	173	225	282	117	797	1866
10	18.00-19.00	176	212	261	53	702	1583
11	19.00-20.00	221	220	156	41	638	1644.5
12	20.00-21.00	176	170	131	19	496	1254
13	21.00-22.00	114	90	91	16	311	803
14	22.00-23.00	118	32	36	1	187	619
15	23.00-00.00	85	16	9	0	110	415.5
16	00.00-1.00	28	8	1	0	37	139
17	1.00-2.00	16	2	1	0	19	76
18	2.00-3.00	7	5	0	0	12	39
19	3.00-4.00	3	2	1	0	6	17.5
20	4.00-5.00	3	3	2	1	9	24
21	5.00-6.00	21	86	68	11	186	335.5
22	6.00-7.00	53	223	115	15	406	748
23	7.00-8.00	82	390	325	27	824	1387
24	8.00-9.00	220	488	401	60	1169	2363
Total Numbers		2981	6498	5662	879	16020	32339.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 03.05.2019							
LOCATION: T3 TITABAR TO JORHAT ROAD AT TITABAR (UP & DOWN COMBINED				WORKINGDAY			
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	121	401	554	39	1115	1856
2	10.00-11.00	135	365	307	44	851	1638
3	11.00-12.00	99	488	437	66	1090	1878.5
4	12.00-13.00	123	374	373	47	917	1675.5
5	13.00-14.00	82	206	268	73	629	1238
6	14.00-15.00	142	281	249	59	731	1545.5
7	15.00-16.00	181	359	360	76	976	2017
8	16.00-17.00	183	328	392	95	998	2087.5
9	17.00-18.00	210	391	492	76	1169	2327.5
10	18.00-19.00	183	374	446	28	1031	1942.5
11	19.00-20.00	141	206	299	26	672	1346.5
12	20.00-21.00	120	141	179	13	453	982.5
13	21.00-22.00	83	125	139	6	353	724
14	22.00-23.00	63	72	54	1	190	449.5
15	23.00-00.00	39	24	28	0	91	239.5
16	00.00-1.00	23	11	20	0	54	140
17	1.00-2.00	4	11	14	0	29	48.5
18	2.00-3.00	5	7	2	0	14	35
19	3.00-4.00	6	8	0	0	14	39
20	4.00-5.00	2	3	2	2	9	23.5
21	5.00-6.00	29	25	20	5	79	208
22	6.00-7.00	40	220	199	25	484	809
23	7.00-8.00	100	270	387	39	796	1398
24	8.00-9.00	108	442	440	55	1045	1809
Total Numbers		2222	5132	5661	775	13790	26458

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring: 02.05.2019							
LOCATION: T3 TITABAR TO JORHAT ROAD AT TITABAR (UP & DOWN COMBINED					HOLIDAY		
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	93	294	317	32	736	1304.5
2	10.00-11.00	109	330	274	32	745	1387.5
3	11.00-12.00	74	363	382	52	871	1467.5
4	12.00-13.00	71	289	298	33	691	1183
5	13.00-14.00	37	209	229	66	541	973
6	14.00-15.00	126	288	361	58	833	1592
7	15.00-16.00	116	284	316	79	795	1580
8	16.00-17.00	104	252	243	107	706	1517
9	17.00-18.00	112	329	225	70	736	1502.5
10	18.00-19.00	106	282	234	25	647	1234
11	19.00-20.00	114	116	155	23	408	934
12	20.00-21.00	76	92	108	10	286	628
13	21.00-22.00	47	52	80	10	189	409.5
14	22.00-23.00	32	33	23	1	89	220.5
15	23.00-00.00	19	7	18	0	44	114
16	00.00-1.00	12	1	3	0	16	58.5
17	1.00-2.00	2	1	1	0	4	11.5
18	2.00-3.00	3	1	0	0	4	15
19	3.00-4.00	1	2	0	0	3	7.5
20	4.00-5.00	3	3	0	1	7	22
21	5.00-6.00	21	14	20	1	56	139.5
22	6.00-7.00	34	197	119	20	370	647.5
23	7.00-8.00	77	241	320	24	662	1124
24	8.00-9.00	83	357	387	37	864	1444
Total Numbers		1472	4037	4113	681	10303	19516.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring: 01.06.2019							
LOCATION :T4 -TITABAR TO BORHOLLA ROAD (UP & DOWN COMBINED)					WORKINGDAY		
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	100	346	603	212	1261	2420
2	10.00-11.00	123	354	637	199	1313	2517.5
3	11.00-12.00	106	334	570	206	1216	2372
4	12.00-13.00	94	239	553	171	1057	2018.5
5	13.00-14.00	82	239	361	212	894	1936.5
6	14.00-15.00	63	264	478	242	1047	2125.5
7	15.00-16.00	98	343	579	214	1234	2390.5
8	16.00-17.00	118	325	525	165	1133	2203.5
9	17.00-18.00	141	294	340	157	932	2043.5
10	18.00-19.00	76	264	227	94	661	1341
11	19.00-20.00	52	242	203	46	543	984
12	20.00-21.00	22	206	100	18	346	580
13	21.00-22.00	19	125	40	14	198	369
14	22.00-23.00	17	51	23	10	101	216
15	23.00-00.00	13	19	16	1	49	107
16	00.00-1.00	4	6	8	0	18	35
17	1.00-2.00	2	2	7	0	11	19
18	2.00-3.00	2	1	1	0	4	11.5
19	3.00-4.00	3	0	0	0	3	13.5
20	4.00-5.00	2	0	0	2	4	17
21	5.00-6.00	22	9	34	25	90	246.5
22	6.00-7.00	39	42	140	118	339	850.5
23	7.00-8.00	52	185	307	177	721	1526.5
24	8.00-9.00	78	265	545	199	1087	2089.5
Total Numbers		1328	4155	6297	2482	14262	28433.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 09.06.2019							
LOCATION : T4 TITABAR TO BORHOLLA ROAD (UP & DOWN COMBINED)					HOLIDAY		
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	84	322	361	178	945	1934
2	10.00-11.00	90	240	427	192	949	1960
3	11.00-12.00	76	292	416	154	938	1812
4	12.00-13.00	52	229	411	157	849	1616.5
5	13.00-14.00	74	216	280	187	757	1685
6	14.00-15.00	46	230	412	143	831	1536
7	15.00-16.00	74	279	388	90	831	1499.5
8	16.00-17.00	113	198	398	186	895	1947.5
9	17.00-18.00	120	250	329	179	878	1960
10	18.00-19.00	61	216	195	89	561	1149.5
11	19.00-20.00	29	158	156	50	393	723.5
12	20.00-21.00	26	133	94	32	285	538.5
13	21.00-22.00	22	69	36	14	141	294.5
14	22.00-23.00	19	33	20	10	82	195
15	23.00-00.00	11	11	5	10	37	111
16	00.00-1.00	4	4	2	1	11	30
17	1.00-2.00	1	0	0	0	1	4.5
18	2.00-3.00	2	0	0	1	3	13
19	3.00-4.00	1	0	0	1	2	8.5
20	4.00-5.00	3	0	1	1	5	18.5
21	5.00-6.00	21	3	30	17	71	197
22	6.00-7.00	34	26	104	104	268	712
23	7.00-8.00	32	153	233	111	529	1050.5
24	8.00-9.00	61	218	374	168	821	1647.5
Total Numbers		1056	3280	4672	2075	11083	22644

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring : 01.06.2019							
LOCATION :T4 - TITABAR TO BORHOLLA ROAD TO TORANIGAON ROAD (UP & DOWN COMBINED)					WORKINGDAY		
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	1	122	205	95	423	772.5
2	10.00-11.00	1	100	239	93	433	765.5
3	11.00-12.00	1	56	244	112	413	780.5
4	12.00-13.00	1	64	231	82	378	659.5
5	13.00-14.00	1	64	200	100	365	700.5
6	14.00-15.00	2	81	194	87	364	672.5
7	15.00-16.00	3	60	190	118	371	765.5
8	16.00-17.00	0	68	208	91	367	674
9	17.00-18.00	1	100	221	125	447	875.5
10	18.00-19.00	0	76	186	60	322	540
11	19.00-20.00	0	65	165	46	276	446.5
12	20.00-21.00	0	44	138	31	213	328
13	21.00-22.00	0	22	85	21	128	202
14	22.00-23.00	0	19	34	14	67	118.5
15	23.00-00.00	0	17	15	7	39	68.5
16	00.00-1.00	0	2	8	1	11	15
17	1.00-2.00	0	0	1	0	1	1
18	2.00-3.00	0	0	0	0	0	0
19	3.00-4.00	0	0	0	0	0	0
20	4.00-5.00	0	1	2	1	4	7.5
21	5.00-6.00	2	12	13	6	33	64
22	6.00-7.00	0	25	67	37	129	252.5
23	7.00-8.00	1	44	109	56	210	403.5
24	8.00-9.00	2	68	206	95	371	697
Total Numbers		16	1110	2961	1278	5365	9810

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

TRAFFIC DENSITY - DATA							
Date of Monitoring: 09.06.2019							
LOCATION :T4 - TITABAR TO BORHOLLA ROAD TO TORANIGAON ROAD (UP & DOWN COMBINED)				HOLIDAY			
S.NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	TOTAL NUMBERS	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/ Three Wheelers	Vehicles		
	(Hours)	(Truck, Bus, Dumper, Tanker, Trailer)	(Car, Jeep, Van, Metador, Tractor, Tempo)	(Scooter, M.Cycle, Auto, Moped)	Bicycle, Tricycle		
1	09.00-10.00	0	93	165	89	347	660.5
2	10.00-11.00	0	55	125	92	272	575.5
3	11.00-12.00	0	62	180	60	302	513
4	12.00-13.00	1	47	186	54	288	477
5	13.00-14.00	0	49	141	49	239	410.5
6	14.00-15.00	0	62	124	50	236	417
7	15.00-16.00	0	38	174	70	282	511
8	16.00-17.00	0	48	160	122	330	720
9	17.00-18.00	0	39	228	128	395	798.5
10	18.00-19.00	0	47	157	107	311	655.5
11	19.00-20.00	0	43	112	44	199	352.5
12	20.00-21.00	0	26	93	20	139	212
13	21.00-22.00	0	18	72	18	108	171
14	22.00-23.00	0	12	23	7	42	69
15	23.00-00.00	0	3	16	2	21	28.5
16	00.00-1.00	0	0	2	0	2	2
17	1.00-2.00	0	0	0	0	0	0
18	2.00-3.00	0	0	0	0	0	0
19	3.00-4.00	0	0	0	0	0	0
20	4.00-5.00	0	2	5	1	8	12
21	5.00-6.00	1	8	22	5	36	58.5
22	6.00-7.00	1	22	48	23	94	177.5
23	7.00-8.00	0	22	84	44	150	293
24	8.00-9.00	1	55	130	82	268	545
Total Numbers		4	751	2247	1067	4069	7659.5

PCU	Two / Three Wheeler	1.0	Light Motor Vehicles	1.5
	Bicycle, Tricycle	4.0	Heavy Motor Vehicles	4.5

Appendix 3.8:
List of Mammals

List of Mammals Species Recorded from the Study Area

Sr No	Common Name	Scientific Name	IUCN Status	WPA,1972 Schedule
1	Little spadefoot toad	Megophrys parva	LC	Not Evaluated
2	Common Indian Toad	Duttaphrynus melanostictus	LC	Not Evaluated
3	Painted kaloula	Kaloula taprobanica	LC	Not Evaluated
4	Ornate microhylid	Microhyla ornata	LC	Not Evaluated
5	Red microhylid	Microhyla rubra	LC	Not Evaluated
6	East Himalqyan Bush Frog	Raorchestes annandalii	LC	Not Evaluated
7	East Asian Tree Frog	Polypedates leucomystax	LC	Not Evaluated
8	Giant Tree Frog	Rhacophorus maximus	LC	Not Evaluated
9	Himalayan torrent Frog	Amolops marmoratus	LC	Not Evaluated
10	No popular common name	Amolops assamensis	DD	Not Evaluated
11	Indian bullfrog	Hoplobatrachus tigerinus	LC	Not Evaluated
12	Jerdon's bullfrog	Hoplobatrachus crassus	LC	Not Evaluated
13	Indian cricket frog	Fejervarya limnocharis	LC	Not Evaluated
14	Terai Cricket Frog	Fejervarya teraiensis	LC	Not Evaluated
15	Nepal Cricket Frog	Fejervarya nepalensis	LC	Not Evaluated
16	Pierre's wart frog	Fejarya pierrei	LC	Not Evaluated
17	Indian burrowing Frog	Sphaerotheca breviceps	LC	Not Evaluated
18	Long –tounged Frog	Hylarana leptoglossa	LC	Not Evaluated
19	Bhamo Frog	Humerana humeralis	LC	Not Evaluated
20	Green Mountain Frog	Odorrana livida	DD	Not Evaluated
21	Indian Flying Frog	Pterorana khare	VU	Not Evaluated
22	Rivulet Frog	Limnonectes laticeps	LC	Not Evaluated
23	Skittering Frog	Euphlyctis cyanophlyctis	LC	Not Evaluated
24	No local name reported	Philautus namdaphaensis	DD	Not Evaluated
25	Terai Tree Frog	Polypedates teraiensis	DD	Not Evaluated
26	Hongkong Whipping Frog	Polypedates megacephalus	LC	Not Evaluated
27	Nepal Flying Frog	Rhacophorus maximus	LC	Not Evaluated
28	Suffry Red webbed Tree Frog	Rhacophorus suffry	LC	Not Evaluated
29	Pied Warty Frog	Theloderma asperum	LC	Not Evaluated
30	Wuliangshan horned toad	Xenophrys wuliangshanensis	DD	Not Evaluated
31	No popular common name	Xenophrys major	LC	Not Evaluated

Note :

- LC : Least Concerned (IUCN 3.1)
- NT : Near Threatened (IUCN 3.1)
- VU : Vulnerable (IUCN 3.1)
- I : Wildlife protection Act, 1972 –Schedule I
- II: Wildlife protection Act, 1972 –Schedule II
- III: Wildlife protection Act, 1972 –Schedule III
- IV: Wildlife protection Act, 1972 –Schedule IV
- V : Wildlife protection Act, 1972 –Schedule V

Appendix 3.9:
List of Reptiles

List of Reptiles species recorded from the study area

Sr. No.	Common Name	Scientific Name	IUCN Status	Schedule (as per WPA, 1972)
1	Brahminy Worm Snake	Indotyphlops braminus	Not Evaluated	IV
2	Common Indian Trinket Snake	Coelognathus helena	Not Evaluated	IV
3	Banded Trinket Snake	Oreocryptophis porphyraceus	Not Evaluated	IV
4	Green Rat Snake	Ptyas nigromarginata	Not Evaluated	IV
5	Indian Rat Snake	Ptyas mucosa	Not Evaluated	II
6	Common Wolf Snake	Lycodon capucinus	LC	IV
7	Checkered Keelback Water Snake	Xenochrophis piscator	Not Evaluated	II
8	Buff-striped Keelback	Amphiesma stolatum	Not Evaluated	IV
9	Ornamental Flying Snake	Chrysopelea ornata	Not Evaluated	IV
10	Common Indian Cat Snake	Boiga trigonata	LC	IV
11	Common Indian Krait	Bungarus caeruleus	Not Evaluated	IV
12	King Cobra	Ophiophagus hannah	VU	II
13	Monocellate Cobra	Naja kaouthia	LC	II
14	Russell’s Viper	Daboia russelii	Not Evaluated	II
15	Flat-tailed House Gecko	Hemidactylus platyurus	Not Evaluated	Not Evaluated
16	Common House Gecko	Hemidactylus frenatus	LC	Not Evaluated
17	Brooke’s House Gecko/Spotted House Gecko	Hemidactylus brookii	Not Evaluated	Not Evaluated
18	Indo –Pacific Gecko	Hemidactylus garnotii	Not Evaluated	Not Evaluated
19	Khasi Hills Bent-toed Gecko	Cyrtodactylus khasiensis	Not Evaluated	Not Evaluated
20	Tokay Gecko	Gekko gecko	LC	Not Evaluated
21	Oriental Garden Lizard	Calotes versicolor	Not Evaluated	Not Evaluated
22	Green Fan- throated Lizard	Ptyctolaemus gularis	Not Evaluated	Not Evaluated
23	Norvill’s Flying Lizard	Draco norvillii	Not Evaluated	Not Evaluated
24	White - spotted Supple Skink	Lygosoma albopunctata	Not Evaluated	Not Evaluated
25	East Indian Brown Mabuya/Sun Skink	Eutropis multifasciata	LC	Not Evaluated
26	Spotted Forest Skink	Sphenomorphus maculatus	Not Evaluated	Not Evaluated
27	Indian Forest Skink	Sphenomorphus indicus	Not Evaluated	Not Evaluated
28	Khasi Hills Long -tailed Lizard	Takydromus khasiensis	Not Evaluated	Not Evaluated
29	Bengal Monitor	Varanus bengalensis	LC	I
30	Asian Water Monitor	Varanus salvator	LC	I
31	Yellow Monitor	Varanus flavescens	LC	I
32	Brahminy terrapin	Hardella thurjii	VU	Not Evaluated
33	Eastern hill terrapin	Melanochelys tricarinata	VU	Not Evaluated
34	Malayan box turtle	Cuora amboinensis	VU	Not Evaluated
35	Asian leaf turtle	Cyclemys dentata	NT	Not Evaluated
36	Keeled box turtle	Cuora mouhotii	EN	Not Evaluated
37	Elongated Tortoise	Indotestudo elongata	CR	Not Evaluated
38	Asian Brown tortoise	Manouria emys	CR	Not Evaluated
39	Roofed terrapin	Pangshura tecta	LC	Not Evaluated

Note :

- LC : Least Concerned (IUCN 3.1)
- NT : Near Threatened (IUCN 3.1)
- VU : Vulnerable (IUCN 3.1)
- CR: Critically Endangered
- I : Wildlife protection Act, 1972 –Schedule I
- II: Wildlife protection Act, 1972 –Schedule II
- III: Wildlife protection Act, 1972 –Schedule III
- IV: Wildlife protection Act, 1972 –Schedule IV
- V : Wildlife protection Act, 1972 –Schedule V

Appendix 3.10:
List of Amphibians

List of Amphibian Species recorded from the study area

Sr No	Common Name	Scientific Name	IUCN Status	WPA,1972 Schedule
1	Little spadefoot toad	Megophrys parva	LC	Not Evaluated
2	Common Indian Toad	Duttaphrynus melanostictus	LC	Not Evaluated
3	Painted kaloula	Kaloula taprobanica	LC	Not Evaluated
4	Ornate microhylid	Microhyla ornata	LC	Not Evaluated
5	Red microhylid	Microhyla rubra	LC	Not Evaluated
6	East Himalqyan Bush Frog	Raorchestes annandalii	LC	Not Evaluated
7	East Asian Tree Frog	Polypedates leucomystax	LC	Not Evaluated
8	Giant Tree Frog	Rhacophorus maximus	LC	Not Evaluated
9	Himalayan torrent Frog	Amolops marmoratus	LC	Not Evaluated
10	No popular common name	Amolops assamensis	DD	Not Evaluated
11	Indian bullfrog	Hoplobatrachus tigerinus	LC	Not Evaluated
12	Jerdon's bullfrog	Hoplobatrachus crassus	LC	Not Evaluated
13	Indian cricket frog	Fejervarya limnocharis	LC	Not Evaluated
14	Terai Cricket Frog	Fejervarya teraiensis	LC	Not Evaluated
15	Nepal Cricket Frog	Fejervarya nepalensis	LC	Not Evaluated
16	Pierre's wart frog	Fejarya pierrei	LC	Not Evaluated
17	Indian burrowing Frog	Sphaerotheca breviceps	LC	Not Evaluated
18	Long –tounged Frog	Hylarana leptoglossa	LC	Not Evaluated
19	Bhamo Frog	Humerana humeralis	LC	Not Evaluated
20	Green Mountain Frog	Odorrana livida	DD	Not Evaluated
21	Indian Flying Frog	Pterorana khare	VU	Not Evaluated
22	Rivulet Frog	Limnonectes laticeps	LC	Not Evaluated
23	Skittering Frog	Euphlyctis cyanophlyctis	LC	Not Evaluated
24	No local name reported	Philautus namdaphaensis	DD	Not Evaluated
25	Terai Tree Frog	Polypedates teraiensis	DD	Not Evaluated
26	Hongkong Whipping Frog	Polypedates megacephalus	LC	Not Evaluated
27	Nepal Flying Frog	Rhacophorus maximus	LC	Not Evaluated
28	Suffry Red webbed Tree Frog	Rhacophorus suffry	LC	Not Evaluated
29	Pied Warty Frog	Theloderma asperum	LC	Not Evaluated
30	Wuliangshan horned toad	Xenophrys wuliangshanensis	DD	Not Evaluated
31	No popular common name	Xenophrys major	LC	Not Evaluated

Note :

- LC : Least Concerned (IUCN 3.1)
- NT : Near Threatened (IUCN 3.1)
- VU : Vulnerable (IUCN 3.1)
- I : Wildlife protection Act, 1972 –Schedule I
- II: Wildlife protection Act, 1972 –Schedule II
- III: Wildlife protection Act, 1972 –Schedule III
- IV: Wildlife protection Act, 1972 –Schedule IV
- V : Wildlife protection Act, 1972 –Schedule V

Appendix 3.11: Demographic Profile of the Study Area

CORE ZONE VILLAGE

Table 1: Core Zone Village: Demographic Profile

Name	No of Household	Total Population Person	Household Size	Total Population Male	Total Population Female	Sex Ratio	Scheduled Castes Population Person	Scheduled Castes Population %	Scheduled Tribes Population Person	Scheduled Tribes Population %
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	127	549	4.32	278	271	975	0	0.0	11	2.0
Bhojkhati	238	1241	5.21	613	628	1024	213	17.2	719	57.9
Dakhinhengera Grant No.57	114	534	4.68	269	265	985	0	0.0	0	0.0
Dhekalia Borsaikia	389	1739	4.47	877	862	983	0	0.0	0	0.0
Karang Chapari	255	1500	5.88	762	738	969	182	12.1	1035	69.0
Kawrichuk	144	709	4.92	366	343	937	0	0.0	181	25.5
No.2 Sokalani Habi (No2 Sokolating Habi Gaon)	182	831	4.57	432	399	924	0	0.0	0	0.0
Pohumora No.2	21	104	4.95	48	56	1167	0	0.0	0	0.0
Raidangia Gaon	374	1705	4.56	856	849	992	1	0.1	1	0.1
Sarkari N.C.	63	423	6.71	217	206	949	0	0.0	422	99.8
Tingtingia	80	346	4.33	151	195	1291	128	37.0	2	0.6

Table 2: Core Zone Village: Literacy

Name	Literate Population Person	Literacy Rate	Male Literacy Rate	Female Literacy Rate
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	488.0	97.60	97.66	97.54
Bhojkhati	672.0	62.69	71.80	53.70

Name	Literate Population Person	Literacy Rate	Male Literacy Rate	Female Literacy Rate
Dakhinhengera Grant No.57	281.0	60.30	71.98	48.72
Dhekalia Borsaikia	1530.0	96.05	96.90	95.17
Karang Chapari	1014.0	82.11	88.50	75.53
Kawrichuk	607.0	96.04	99.38	92.53
No.2 Sokalani Habi (No2 Sokolating Habi Gaon)	335.0	48.69	57.43	39.64
Pohumora No.2	77.0	86.52	90.00	83.67
Raidangia Gaon	1434.0	91.57	94.87	88.31
Sarkari N.C.	183.0	52.89	55.00	50.60
Tingtingia	268.0	88.74	91.67	86.47

Table 3: Core Zone Village: Livelihood

Name	No of Households	Total Population Person	Total Workers (%)	Main Workers (%)	Marginal Workers (%)	Non workers (%)	Total Cultivators (%)	Total Agricultural Workers (%)	Household	Other
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	127	549	37.89	89.42	10.58	62.11	37.02	23.56	1	78
Bhojkhati	238	1241	55.76	86.71	13.29	44.24	84.39	11.71	10	13
Dakhinhengera Grant No.57	114	534	53.37	88.07	11.93	46.63	4.33	16.51	2	223
Dhekalia Borsaikia	389	1739	30.02	93.30	6.70	69.98	18.97	0.77	28	380
Karang Chapari	255	1500	43.27	48.38	51.62	56.73	45.76	1.69	94	210
Kawrichuk	144	709	59.24	28.57	71.43	40.76	48.33	29.05	7	56
No.2 Sokalani Habi (No2 Sokolating Habi Gaon)	182	831	49.22	87.04	12.96	50.78	2.44	0.73	10	365
Pohumora No.2	21	104	36.54	92.11	7.89	63.46	47.37	2.63	1	17

Name	No of Households	Total Population Person	Total Workers (%)	Main Workers (%)	Marginal Workers (%)	Non workers (%)	Total Cultivators (%)	Total Agricultural Workers (%)	Household	Other
Raidangia Gaon	374	1705	45.10	49.80	50.20	54.90	45.90	10.01	15	281
Sarkari N.C.	63	423	37.59	56.60	43.40	62.41	89.31	9.43	0	2
Tingtingia	80	346	39.31	53.68	46.32	60.69	27.94	42.65	3	31

BUFFER ZONE VILLAGES

Table 1: Buffer Zone Village: Demographic Profile

Name	No of Household	Total Population Person	Household Size	Total Population Male	Total Population Female	Sex Ratio	Scheduled Castes Population Person	Scheduled Castes Population %	Scheduled Tribes Population Person	Scheduled Tribes Population %
Bahek Gaon	245	1123	4.58	557	566	1016	0	0.0	0	0.0
Bahfalla Gaon	371	2436	6.57	1206	1230	1020	6	0.2	2346	96.3
Balijan	795	3949	4.97	1987	1962	987	84	2.1	1980	50.1
Baliporia Gaon	200	886	4.43	436	450	1032	455	51.4	76	8.6
Bamun Gaon	48	319	6.65	153	166	1085	0	0.0	310	97.2
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	127	549	4.32	278	271	975	0	0.0	11	2.0
Bhojkhati	238	1241	5.21	613	628	1024	213	17.2	719	57.9
Birina Sayek	391	1780	4.55	950	830	874	22	1.2	6	0.3
Bocha Gaon	155	782	5.05	396	386	975	0	0.0	0	0.0
Borteng Nowholia	455	2118	4.65	1089	1029	945	12	0.6	33	1.6
Bosa Gaon	311	1484	4.77	756	728	963	1	0.1	314	21.2

Name	No of Household	Total Population Person	Household Size	Total Population Male	Total Population Female	Sex Ratio	Scheduled Castes Population Person	Scheduled Castes Population %	Scheduled Tribes Population Person	Scheduled Tribes Population %
Chakial Gaon	126	582	4.62	296	286	966	0	0.0	0	0.0
Dahutia Baruah	503	2312	4.60	1145	1167	1019	0	0.0	0	0.0
Dakhinhengera Grant	676	3434	5.08	1760	1674	951	0	0.0	0	0.0
Dangdhora Grant	217	994	4.58	490	504	1029	28	2.8	321	32.3
Dolakhuria	439	2031	4.63	1036	995	960	0	0.0	0	0.0
Dumjoria Kosolial	427	1935	4.53	1009	926	918	121	6.3	4	0.2
Ekorani	52	236	4.54	123	113	919	0	0.0	0	0.0
Forkating	533	2093	3.93	1081	1012	936	166	7.9	114	5.4
Garumorakoibortra	452	2086	4.62	1073	1013	944	609	29.2	11	0.5
Gayan Gaon	346	1605	4.64	793	812	1024	0	0.0	0	0.0
Gohain Gaon	258	1066	4.13	542	524	967	143	13.4	6	0.6
Hatiyekhowa	78	377	4.83	198	179	904	0	0.0	110	29.2
Kacharihat Gaon	305	1356	4.45	688	668	971	16	1.2	0	0.0
Karang Chapari	255	1500	5.88	762	738	969	182	12.1	1035	69.0
Kawrichuk	144	709	4.92	366	343	937	0	0.0	181	25.5
Kharjan	78	363	4.65	187	176	941	0	0.0	0	0.0
Madhapur	116	583	5.03	313	270	863	23	3.9	0	0.0
Malow Khat	498	2355	4.73	1168	1187	1016	391	16.6	11	0.5
Mokreng Habi	49	248	5.06	131	117	893	0	0.0	0	0.0
Moria Sayek(Mariasayek)	197	827	4.20	427	400	937	4	0.5	0	0.0
Namsonia	163	703	4.31	339	364	1074	0	0.0	0	0.0

Name	No of Household	Total Population Person	Household Size	Total Population Male	Total Population Female	Sex Ratio	Scheduled Castes Population Person	Scheduled Castes Population %	Scheduled Tribes Population Person	Scheduled Tribes Population %
Neul Gaon	216	1466	6.79	751	715	952	0	0.0	1447	98.7
Pohumora No.2	21	104	4.95	48	56	1167	0	0.0	0	0.0
Raidangia Gaon	374	1705	4.56	856	849	992	1	0.1	1	0.1
Rowmarikhuti	37	154	4.16	83	71	855	97	63.0	1	0.6
Sarukachari	100	447	4.47	211	236	1118	0	0.0	0	0.0
Tingtingia	80	346	4.33	151	195	1291	128	37.0	2	0.6

Table 2: Buffer Zone Village: Literacy

Name	Literate Population Person	Literacy Rate	Male Lit %	Female Lit %
Bahek Gaon	1004.0	98.62	99.21	98.05
Bahfalla Gaon	1431.0	69.06	75.41	62.75
Balijan	2601.0	74.83	82.94	66.57
Baliporia Gaon	710.0	89.31	94.85	84.03
Bamun Gaon	87.0	36.25	47.41	25.81
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	488.0	97.60	97.66	97.54
Bhojkhati	672.0	62.69	71.80	53.70
Birina Sayek	1375.0	86.48	86.24	86.75
Bocha Gaon	679.0	96.59	98.88	94.20
Borteng Nowholia	1522.0	79.56	83.95	75.03
Bosa Gaon	1183.0	87.18	91.08	83.21
Chakial Gaon	540.0	99.08	99.64	98.51

Name	Literate Population Person	Literacy Rate	Male Lit %	Female Lit %
Dahutia Baruah	2007.0	94.58	97.64	91.53
Dakhinhengera Grant	1825.0	61.91	71.91	51.36
Dangdhora Grant	805.0	88.46	89.91	87.07
Dolakhuria	1271.0	71.93	76.70	66.82
Dumjoria Kosolial	1494.0	86.21	90.71	81.30
Ekorani	169.0	81.64	91.43	71.57
Forkating	1654.0	87.42	90.92	83.66
Garumorakoibortra	1601.0	85.43	90.33	80.26
Gayan Gaon	1332.0	93.41	96.02	90.86
Gohain Gaon	870.0	91.29	96.85	85.74
Hatiyekhowa	285.0	84.32	92.61	75.31
Kacharihat Gaon	1137.0	92.51	95.17	89.80
Karang Chapari	1014.0	82.11	88.50	75.53
Kawrichuk	607.0	96.04	99.38	92.53
Kharjan	315.0	94.31	97.66	90.80
Madhapur	478.0	91.22	95.27	86.75
Malow Khat	1718.0	83.32	88.52	78.14
Mokreng Habi	208.0	92.44	93.28	91.51
Moria Sayek (Mariasayek)	552.0	74.59	79.59	69.12
Namsonia	580.0	90.48	94.57	86.59
Neul Gaon	772.0	63.33	72.76	53.45
Pohumora No.2	77.0	86.52	90.00	83.67
Raidangia Gaon	1434.0	91.57	94.87	88.31

Name	Literate Population Person	Literacy Rate	Male Lit %	Female Lit %
Rowmarikhuti	105.0	76.64	90.41	60.94
Sarukachari	404.0	99.51	100.00	99.06
Tingtingia	268.0	88.74	91.67	86.47

Table 3: Buffer Zone Village: Livelihood

Name	No of Households	Total Population Person	Total Workers (%)	Main Workers (%)	Marginal Workers (%)	Non workers (%)	Total Cultivators (%)	Total Agricultural Workers (%)	Household	Other
Bahek Gaon	245	1123	34.28	65.19	34.81	65.72	17.92	3.12	52	190
Bahfalla Gaon	371	2436	48.15	70.76	29.24	51.85	89.60	3.67	8	58
Balijan	795	3949	41.40	65.63	34.37	58.60	30.28	13.46	162	703
Baliporia Gaon	200	886	35.55	51.11	48.89	64.45	33.97	14.60	34	111
Bamun Gaon	48	319	46.39	41.22	58.78	53.61	39.86	18.92	10	47
Barhoi Bari Mahajan Gaon (Behabari Mahajan)	127	549	37.89	89.42	10.58	62.11	37.02	23.56	1	78
Bhojkhati	238	1241	55.76	86.71	13.29	44.24	84.39	11.71	10	13
Birina Sayek	391	1780	44.38	78.35	21.65	55.62	39.62	27.34	11	235
Bocha Gaon	155	782	31.71	71.37	28.63	68.29	62.90	14.11	2	45
Borteng Nowholia	455	2118	39.80	77.34	22.66	60.20	23.13	32.03	61	260
Bosa Gaon	311	1484	73.79	24.75	75.25	26.21	80.00	8.86	4	110
Chakial Gaon	126	582	38.49	60.71	39.29	61.51	27.68	46.88	2	32
Dahutia Baruah	503	2312	41.18	60.40	39.60	58.82	14.71	20.69	101	481
Dakhinhengera Grant	676	3434	36.34	67.87	32.13	63.66	4.33	16.51	64	785
Dangdhora Grant	217	994	38.73	72.99	27.01	61.27	17.66	21.30	20	186

Dolakhuria	439	2031	50.47	77.46	22.54	49.53	35.80	39.02	20	233
Dumjoria Kosolial	427	1935	51.01	74.47	25.53	48.99	56.03	20.06	87	132
Ekorani	52	236	34.32	82.72	17.28	65.68	75.31	4.94	5	11
Forkating	533	2093	39.56	86.35	13.65	60.44	13.53	3.38	54	573
Garumorakoibortra	452	2086	52.44	54.20	45.80	47.56	56.12	12.98	13	284
Gayan Gaon	346	1605	46.04	65.90	34.10	53.96	27.60	18.40	142	231
Gohain Gaon	258	1066	54.97	99.66	0.34	45.03	89.25	1.71	6	47
Hatiyekhowa	78	377	66.05	41.77	58.23	33.95	4.42	52.21	60	32
Kacharihat Gaon	305	1356	36.43	89.27	10.73	63.57	35.22	13.36	19	218
Karang Chapari	255	1500	43.27	48.38	51.62	56.73	45.76	1.69	94	210
Kawrichuk	144	709	59.24	28.57	71.43	40.76	48.33	29.05	7	56
Kharjan	78	363	29.48	88.79	11.21	70.52	89.72	0.00	2	4
Madhapur	116	583	57.98	48.82	51.18	42.02	66.27	25.15	0	24
Malow Khat	498	2355	50.40	53.66	46.34	49.60	20.56	28.39	303	273
Mokreng Habi	49	248	59.27	98.64	1.36	40.73	78.91	2.72	3	23
Moria Sayek(Mariasayek)	197	827	58.40	62.73	37.27	41.60	19.88	14.08	47	221
Namsonia	163	703	39.26	40.94	59.06	60.74	35.51	0.36	20	126
Neul Gaon	216	1466	49.73	99.04	0.96	50.27	96.43	0.27	2	20
Pohumora No.2	21	104	36.54	92.11	7.89	63.46	47.37	2.63	1	17
Raidangia Gaon	374	1705	45.10	49.80	50.20	54.90	45.90	10.01	15	281
Rowmarikhuti	37	154	66.88	99.03	0.97	33.12	93.20	1.94	0	5
Sarukachari	100	447	63.98	40.56	59.44	36.02	56.64	23.78	6	49
Tingtingia	80	346	39.31	53.68	46.32	60.69	27.94	42.65	3	31

Appendix 3.12 Consultation of the Socio-Economic

Consultation with Administrative Body

<table>
<tr><td>A</td><td colspan="2">Project Title:</td><td colspan="2">Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.</td></tr>
<tr><td>B</td><td colspan="2">Stakeholder Title:</td><td colspan="2">ACS Circle Officer, Golaghat Revenue Circle.</td></tr>
<tr><td rowspan="3">C</td><td colspan="4">Basic details: The person is an officer in the Golaghat Revenue Circle</td></tr>
<tr><td colspan="2">Location:</td><td colspan="2">Golaghat</td></tr>
<tr><td colspan="2">Date</td><td colspan="2">May 2nd 2019</td></tr>
<tr><td rowspan="5">D</td><td colspan="4">Attended By</td></tr>
<tr><td>Sr.</td><td colspan="2">Name</td><td>Designation</td></tr>
<tr><td>1.</td><td colspan="2">Mr. Lakhimi Dutta</td><td>ACS Circle Officer</td></tr>
<tr><td>2.</td><td colspan="2">Dr.Deepti Sharma</td><td>Project Head</td></tr>
<tr><td>3.</td><td colspan="2">Mr. Utpal Goswami</td><td>Project Manager</td></tr>
<tr><td rowspan="2">E</td><td colspan="4">Purpose of Consultation</td></tr>
<tr><td colspan="4">Understanding the Baseline Socio Economic Conditions of the Village</td></tr>
<tr><td>F</td><td colspan="4">Key Points Inferred:
• He had given us a prospective of overall administration of the Revenue Office.
• He has shard that most of the people comes to the revenue department for land related records, Land related agreement dispute queries.
• The revenue officer also gave us an understanding of the land cost of the vicinity areas.</td></tr>
</table>

Consultation with School Community

<table>
<tr><td>A</td><td colspan="2">Project Title:</td><td colspan="2">Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells</td></tr>
<tr><td>B</td><td colspan="2">Stakeholder Title:</td><td colspan="2">Students</td></tr>
<tr><td rowspan="3">C</td><td colspan="4">Basic details: The interaction was with a group of students.</td></tr>
<tr><td colspan="2">Location:</td><td colspan="2">Bahfalla Village</td></tr>
<tr><td colspan="2">Date</td><td colspan="2">May 2nd 2019</td></tr>
<tr><td rowspan="5">D</td><td colspan="4">Attended By</td></tr>
<tr><td>Sr.</td><td colspan="2">Name</td><td>Designation</td></tr>
<tr><td>1.</td><td colspan="2">Ms.Rani & other students</td><td>Students</td></tr>
<tr><td>2.</td><td colspan="2">Dr.Deepti Sharma</td><td>Project Director</td></tr>
<tr><td>3.</td><td colspan="2">Mr. Utpal Goswami</td><td>Project Manager</td></tr>
<tr><td rowspan="2">E</td><td colspan="4">Purpose of Consultation</td></tr>
<tr><td colspan="4">Understanding the Baseline Socio Economic Conditions of the Village</td></tr>
<tr><td>F</td><td colspan="4">Key Points Inferred:
• Discussed the importance of festival and cultural celebration like Bihu in Assamese villages.
• Discussed on the overall quality and the availability of the colleges like Janajati College and other nearest college Kaziranga University which is located near Sockolatinga. Students felt that they have to travel a lot for accessing better higher education which they feel should be easily accessible close to village.</td></tr>
</table>

Consultation with Health Institution

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.	
B	*Stakeholder Title:*	PHC Assistant	
C	*Basic details:* The person is PHC assistant at the Primary Health Center		
	Location:	Bhojkhati	
	Date	May 2nd 2019	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Mr.Utpal Bora	PHC Asst
	2.	Dr.Deepti Sharma	Project Director
	3.	Mr. Utpal Goswami	Project Manager
E	*Purpose of Consultation*		
	Understanding the Baseline Socio Economic Conditions of the Village		
F	***Key Points Inferred:*** • The population have issues related to medical facilities. Immediate emergency service is not available to the people in the area. • Ensuring supply of clean drinking water will help improve quality of life • Most of the admissions are for pregnancy cases.		

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.	
B	*Stakeholder Title:*	PHC Assistant	
C	*Basic details: The person is PHC assistant at the Primary Health Center*		
	Location:	Hatiyekhowa	
	Date	April 29th 2019	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Mr. Lakshmi Baruah	PHC Asst
	2.	Dr.Deepti Sharma	Project Director
	3.	Mr. Lalit Sharma	Project Director
E	*Purpose of Consultation*		
	• Understanding the Baseline Socio Economic Conditions of the Village		
F	***Key Points Inferred:*** • Ensuring supply of clean drinking water will help improve quality of life • Poor drinking water quality (due to arsenic) • No other major problem reported in the Village.		

Consultation with Village Head

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	Gaon Burah
C	*Basic details:* The person is the head of the Village.	
	Location:	Bahfalla Village
	Date	May 2nd 2019
D	*Attended By*	

Sr.	Name	Designation
1.	Mr. Trinayan Pegu	Gaon Burha
2.	Dr.Deepti Sharma	Project Head
3.	Mr. Utpal Goswami	Project Manager

E	*Purpose of Consultation*
	Understanding the Baseline Socio Economic Conditions of the Village
F	***Key Points Inferred:*** • Mising tribe members are deeply traditional, a quality reflected in their lifestyle, home architecture and gusto of festival celebration. • Their vegetable growing agricultural fields and nearness to Jorhat ensures a good source of income from vegetable sale. • Despite being close to the Brahmaputra, there has been no floods since 1998.

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	Gaon Burha
C	*Basic details: The person is the head of the village*	
	Location:	Karang Chapari Village
	Date	May 2nd 2019
D	*Attended By:*	

Sr.	Name	Designation
1.	Mr. Lilaram Pegu	Gaon Burha
2.	Dr.Deepti Sharma	Project Head
3.	Mr. Utpal Goswami	Project Manager

E	*Purpose of Consultation*
	Understanding the Baseline Socio Economic Conditions of the Village
F	***Key Points Inferred:*** • Their vegetable growing agricultural fields and nearness to Jorhat ensures a good source of income from vegetable sale. • Household level Swine rearing was observed in most of the households along with small water pond in each of the house. Very few of them had cattle's.

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	Gaon Burha
C	*Basic details: The person is the head of the village*	
	Location:	Birina Sayek Village
	Date	May 2nd 2019
D	*Attended By*	
	Sr. / Name / Designation	
	1. Mr. Jiten Saikia	Gaon Burha
	2. Dr.Deepti Sharma	Project Head
	3. Mr. Utpal Goswami	Project Manager
E	*Purpose of Consultation*	
	Understanding the Baseline Socio Economic Conditions of the Village	
F	***Key Points Inferred:*** • Missing tribe members are deeply traditional, a quality reflected in their lifestyle, home architecture and gusto of festival celebration. • Their vegetable growing agricultural fields and nearness to Jorhat ensures a good source of income from vegetable sale. • Despite being close to the Brahmaputra, there has been no floods since 1998.	

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	The person is the head of the Village.
C	*Basic details:*	
	Location:	Kawrichuk Village
	Date	May 2nd 2019
D	*Attended By*	
	Sr. / Name / Designation	
	1. Mr. Hiron Saikia	Gaon Burha
	2. Dr.Deepti Sharma	Project Head
	3. Mr. Utpal Goswami	Project Manager
E	*Purpose of Consultation*	
	Understanding the Baseline Socio Economic Conditions of the Village	
F	***Key Points Inferred:*** • Missing tribe members are deeply traditional, a quality reflected in their lifestyle, home architecture and gusto of festival celebration. • Their vegetable growing agricultural fields and nearness to Jorhat ensures a good source of income from vegetable sale. • Despite being close to the Brahmaputra, there has been no floods since 1998.	

Consultation with Village Community

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	Villagers
C	*Basic details: The Person is in charge of the tea estate.*	
	Location:	Borteng Nowkholia
	Date	April 29th 2019
D	*Attended By*	

Sr.	Name	Designation
1.	Heronjyoti Gogoi & Village People	Village People
2.	Dr.Deepti Sharma	Project Director
3.	Mr. Lalit Sharma	Project Director

E	Purpose of Consultation
	Understanding the Baseline Socio Economic Conditions of the Village
F	***Key Points Inferred:*** • The village folk reported about leopard human conflict. • The Villagers shared their concern over low wages of the tea estate worker's and overall conditions of the workers. The wages are getting paid as per very old government norms. • Poor road conditions and not so good schools facilities were reported.

A	*Project Title:*	Socio-economic studies for studying the impact of the upcoming proposed development of exploratory and appraisal wells.
B	*Stakeholder Title:*	Tea Estate Manager
C	*Basic details: The Person is in charge of the tea estate.*	
	Location:	Borteng Nowkholia
	Date	April 29^{th} 2019
D	*Attended By*	

Sr.	Name	Designation
1.	Mr.Partha Sarath Gagoi & Tea Estate Workers	Tea Estate Manager
2.	Dr.Deepti Sharma	Project Director
3.	Mr. Lalit Sharma	Project Director

E	*Purpose of Consultation*
	Understanding the Baseline Socio Economic Conditions of the Village
F	***Key Points Inferred:*** • Improved access to safe drinking water. • The tea estate workers complaint of absence of Storm resistant housing • The issue of inadequate facility of sanitation and toilet was also raised. • The Tea estate manager shared his concern over the government focus and policy for Teas Estate Business. As per him government focus and policy should be updated to take care of the need and business of today's time and current challenges and business dynamics.

Appendix 7.1 Leak Sizes, Inventories and Hazardous Chemicals within the Isolatable Sections

Appendix 7.1- information on leak sizes, inventories and hazardous chemicals within the isolatable sections.

Table 1: Inventory used, Time Assumptions, Leak Sizes, & Flow Rate Etc.

Sl. No	Isolatable Section	Line Size	Flow rate / Capacity	Temperature (deg C)	Pressure (bar)	Physical State	Leak Sizes (mm)	ESDV closure time utilized for inventory (in min)	Remark / Comments
1	From Well Fluid from Well to Inlet of Heater Separator	200 mm	2000 BOPD	25	55	2 Phase- Liquid and Gas	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 200 mm	5 minute 3 minute 2 minute 1 minute	
2	Heater Treater Separator – Oil Case	200 mm	2000 BOPD (10.5 * 6.5 m)	75	3	Liquid	Small Leak : 5 mm Medium Leak : 25 m Large Leak : 100 mm Catastrophic : 200 mm	5 minute 3 minute 2 minute 1 minute	This section is modelled (100% as oil)
3	Heater Treater Separator – Gas Case	200 mm	5 mmscfd (10.5 * 6.5 m)	75	3	Gas	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 200 mm	5 minute 3 minute 2 minute 1 minute	1. This section is modelled (100% as Gas) 2. Dimensions are taken from Layout Block
4	Oil from Heater Treater Separator to inlet of Oil Storage Tanks including coaleser separator	150	6* 2.5	75	3	Liquid	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 150mm	5 minute 3 minute 2 minute 1 minute	Dimensions are taken from Layout Block

Sl. No	Isolatable Section	Line Size	Flow rate / Capacity	Temperature (deg C)	Pressure (bar)	Physical State	Leak Sizes (mm)	ESDV closure time utilized for inventory (in min)	Remark / Comments
5	From XSV of tank inlet to pump inlet including Oil Storage Tank	150	1000 bbls	75	Atm	Liquid	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 150 mm	5 minute 3 minute 2 minute 1 minute	
6	From Oil Transfer pump outlet to tanker loading Facility	150	1000 bbls	75	10	Liquid	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 150 mm	5 minute 3 minute 2 minute 1 minute	10 bar is considered as per best practice
7	Oil Tanker Failure	-	10 KL	Amb	Atm	Liquid	Catastrophic Rupture	-	
8	Diesel Storage Tank	100	60 KL	Amb	Atm	Liquid	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 50 mm Catastrophic : 100 mm	5 minute 3 minute 2 minute 1 minute	
9	Fuel Gas System	200	5 mmscfd	75	3	Gas	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 200 mm	5 minute 3 minute 2 minute 1 minute	
10	Flare System	200	5 mmscfd	75	1.2	Gas	Small Leak : 5 mm Medium Leak : 25 mm Large Leak : 100 mm Catastrophic : 200 mm	5 minute 3 minute 2 minute 1 minute	