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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF CITY GAS DISTRIBUTION PROJECT IN BHADRAK, BALASORE, AND MAYURBHANJ DISTRICTS, ODISHA

Client:
Adani Gas Limited

ET-05668

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1 INTRODUCTION

1.1 BACKGROUND

Adani Gas Ltd. (hereinafter referred to as "AGL) is developing and operating City Gas Distribution (CGD) networks to supply Piped Natural Gas (PNG) to industrial, commercial and domestic (residential) customers and Compressed Natural Gas (CNG) to the transport sector in Bhadrak, Balasore, and Mayurbhanj districts in the state of Odisha in India.

AGL, is a Gujarat based and Bombay Stock Exchange listed company of Adani Group, an Indian multinational conglomerate headquartered in the Ahmedabad city of Gujarat. With a global footprint in developing and operating mines, the Group has diversified interests in natural resources, logistics, and energy and infrastructure businesses. The Group manages its major businesses through its three listed entities viz., Adani Enterprises Limited (AEL), Adani Power Limited (APL) and Adani Port and Special Economic Zones Limited (APSEZ).

Adani Group is one of the largest developers of ports, power plants, and infrastructure buildings in India. With the installed capacity of 10440 MW of thermal power plants and around 5000 km of overhead transmission line, Adani group is the leading independent private power producer in India. Fortune, India's largest edible oil brand is owned by the group. The company has combined market capitalisation in excess of US $ 20 billion, a sales turnover of US $ 9.4 billion.

Headquartered in Ahmedabad, India, the company has already set up city gas distribution networks in Ahmedabad and Vadodara in Gujarat, Faridabad in Haryana and Khurja in Uttar Pradesh.

With the Government of India planning to offer additional geographical areas for gas distribution in the Xth round involving 50 (Gas Agencies) GAs comprising of 123 districts coupled with rapid urbanization, AGL is on track to become one of the largest private sector CGD companies of the world. AGL is committed to achieve approximately 23 lakh domestic piped natural gas connections and install approximately 500 CNG stations in these 13 new GAs.

List of 13 GAs (state-wise) for which Adani Gas Limited has been granted authorization to lay city gas infrastructure and supply natural gas in the IXth round of CGD bidding is as under:

1. Surendranagar District (Except areas already authorized) -Gujarat
2. Kheda (except areas already authorized), Morbi (Except areas already authorized) & Mahisagar Districts- Gujarat
3. Porbandar District-Gujarat

4. Barwala & Ranpur Talukas-Gujarat
5. Navsari (Except areas already authorized), Surat (Except areas already authorized), Tapi (Except areas already authorized) & The Dangs Districts-Gujarat
6. Nuh & Palwal Districts (Project Area) - Haryana
7. Bhiwani, Charkhi Dadri & Mahendragarh Districts- Haryana
8. Udupi District- Karnataka
9. Cuddalore, Nagapattinam & Tiruvarur Districts- Tamil Nadu
10. Tiruppur District- Tamil Nadu
11. Bhilwara & Bundi Districts- Rajasthan
12. Chittorgarh (Other than Rawatbhata Taluka) & Udaipur Districts- Rajasthan
13. **Balasore, Bhadrak & Mayurbhanj Districts- Odisha**

AGL group has been granted authorization for laying, building, operating or expanding the CGD Network in Bhadrak, Balasore, and Mayurbhanj districts in the state of Odisha. The grant has been authorized subject to the petroleum and natural gas regulatory board (authorizing entities to lay, build, operate or expand city or local natural gas distribution networks) regulations, 2008. Under this, the CGD network will be covering 17,195.30 square kilometers of area. 20 CNG Stations, 1,50,464 PNG Connections and 506 Steel Pipe (Inch-km). The activities of laying, building and operating or expansion of the CGD network had to commence immediately after signing and issuance of authority dated, 28th September 2018. Also, the activities must be completed as per the mentioned schedule in tenure of 8 contract years.

TUV SUD South Asia Pvt. Ltd. (TUV SUD) has been assigned by Adani Group for undertaking Environmental and Social Impact Assessment (ESIA) of its proposed City Gas Distribution (CGD) project at Bhadrak, Balasore, and Mayurbhanj districts in the state of Odisha in India.

1.2 PROJECT BRIEF

Adani Gas Ltd (AGL) is developing and operating City Gas Distribution (CGD) networks to supply Piped Natural Gas (PNG) to industrial, commercial and domestic (residential) customers and Compressed Natural Gas (CNG) to the transport sector.

The purpose of the assignment is to evaluate the environmental and social impacts of the proposed project in line with the project and to implement mitigation measures and design an Environmental, Health, Safety and Social Management Plan to avoid adverse impacts during the project. The aim of the study is to assess whether the project to comply with the requirements of the above-mentioned guidelines as necessitated by financial investors.

1.3 NEED & SCOPE OF EIA

The purpose of this EIA is to assess the potential environmental impacts due to the proposed project in a study area of 10 km radius around and 500 m on both sides of the pipeline. The assessment covers both construction and operation phases of the project. The EIA forecasts changes (positive and negative) that may occur as a result of key project activities to the baseline environmental conditions in the study area. Early identification of impacts and their mitigation reduces the risk of long-term adverse environmental effects.

Scope of EIA:

- Assessment of the present status of environmental components such as air, water, noise, soil, topography and drainage, traffic and socio- economic conditions based on field data/ secondary data.
- Identification of the potential impacts of various activities proposed to be undertaken during construction and operation phases of the project.
- Prediction and evaluation of the impact of activities.
- Identifying the mitigation measures, management plan and monitoring schedule, if any

1.4 TUV SUDS APPROACH & BRIEF METHODOLOGY FOR THE STUDY

The broad approach and methodology adopted for the project is described below:

a) Identified and reviewed applicable local, state, national and international environmental and social regulatory and institutional frameworks;

b) Established environmental baseline conditions of the site and surrounding area through the following:

- Detailed surveys to observe environmental and social characteristics of the project area in all three districts;
- Discussions with the local community, project affected people, panchayats and identification key issues during planning, construction and operation phase of the project;
- Primary baseline data collection of the site and study area with respect to water and soil quality, ambient air and noise quality and ecology mainly terrestrial flora & fauna and Avifauna in particular;

c) Assessed the socio-economic environment through collation of secondary information of the site, supplemented by personal and group consultations with the local communities to understand community perception with regard to the project and its activities. The approach included:

- Stakeholder identification;
- Focussed group consultations with landowners, general community, SC community and other impacted groups;
- Field surveys and data compilation;
- Group/Community Consultations: Group meetings and consultations with local and community representatives; and

d) Reviewed the current HR, Social, Environmental, Occupational Health and Safety Management System of AGL

e) Preparation of the EIA report.

The present Report has been prepared based upon the reconnaissance survey by TUV SUD team for preliminary assessment of the site. This survey included verification of location and site condition viz terrain & topography, soil & geology, vegetation cover in the project area and investigation into environmental monitoring records of Ambient Air Quality, Noise levels, Surface water and groundwater, soil in study area of 10 km radius.

1.4.1 AGENCIES CONTACTED

The following stakeholders were contacted during the EIA study:

- Project Proponents:
  - Representatives from AGL - onsite
- Local Community:
  - Residents – Bhadrak, Balasore, and Mayurbhanj district villages
  - PAP- Bhadrak, Balasore, and Mayurbhanj district village
  -

1.5 LIMITATIONS OF THE STUDY

The EIA report has been prepared based on the professional judgement to certain facts with resultant subjective interpretations. Professional judgments expressed herein are based on the facts which were available within the limits of the scope of work, information provided by the client or its representative, prevailing secondary data, budget and schedule.

The consultation undertaken during the site visit was based on the present understanding of the project and the project footprint. This assessment may slightly change in case of a change in the plant location as finalized at the time of study. The documents like land records, and management system were limited for review at the time of visit.

Also, the consultations undertaken as part of the impact assessment were restricted to the stakeholders who were available during the site visit. Also, due to the large number of the villages within the study area and the limited time in which the assessment had to be completed, the EIA team undertook consultation in a sample of the villages with a focus for coverage of maximum number of stakeholder groups.

1.6 REGULATORY FRAMEWORK

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified the Environmental Impact Assessment (EIA) Notification, 2006 under the provisions of the Environment (Protection) Act, 1986, which regulates development and their expansion/modernization of 39 sectors/activities listed in the Schedule to the EIA Notification, 2006. There are two Categories of the projects in the notification namely Category 'A' and Category 'B' projects. Category 'A' projects are appraised at the level of MoEF&CC and Category 'B' projects are appraised by the respective State Environment Impact Assessment Authority (SEIAA) following the procedure prescribed under the EIA Notification, 2006.

As per project/ Activity 6 (a) of Schedule of EIA Notification 2006, oil and gas transportation pipelines which pass through national parks, sanctuaries, coral reefs or ecologically sensitive areas sites require Environmental Clearance (EC).

A recent notification by dated 7th November 2014 by MoEF&CC (Annexure-1) accorded general approval under the Forest (Conservation) Act, 1980 (FC Act) for underground laying of optical fibre cables, telephone lines, drinking water supply pipeline and CNG/ PNG pipelines along the petroleum pipelines within existing right of way not falling in National Parks and Wildlife Sanctuaries, without felling of trees, where the maximum size of the trench is not more than 2.00 meter depth and 1.00 meter width.

The present project does not fall under any notified area in the state of Odisha hence no clearance is required. The client needs to intimate the project detail to the respective State Environment Impact Assessment Authority (SEIAA) following the procedure prescribed under the EIA Notification, 2006.

Also if the pipeline is passing through the land under the control of PWD (Building and roads) as on either side of the flowing water course of all canals, branches, distributaries, major-minor channels etc., under the control of irrigation department, the land along the railway track and station yards under the control of Indian railways, and land under the control of national or state highway – the client is advised to take permission from the concerned authority.

Table 1-1: Applicability of all Act, Laws & Rules to the project

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
1.	Environmental (Protection) Act & Rules, 1986	To protect and improve overall environment	As all environmental notifications, rules and schedules are issued under this act	MoEF&CC GoI, Forest, Ecology & Environment Department, CPCB, OSPCB	No
2.	The Irrigation Laws (Amendment) Act, 1964	To maintain the uninterrupted flow of natural water ways and canals	For using land under the Right of Way basis for laying the CNG PNG pipeline across a either side of the flowing water course of all canals, branches, distributaries, major-minor channels etc.	Water Resources Department, Govt. of Odisha (PWD)	Yes Application to be made to the Water Resources Department, Odisha
3.	The Railways Act, 1989	To manage safety of railways	For using land under the Right of Way basis for laying the CNG PNG pipeline	Indian Railways (IR)	Yes, Application for NOC to be made
4.	National Highway Authority of India (NHAI)	To manage safety National Highway, State Highway	For using land along the highway on right of way basis for laying the CNG PNG pipeline	National Highway Authority of India (NHAI)	Yes, Application for NOC to be made

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
5.	Environmental Impact Assessment (EIA) Notification, 2006	To provide environmental clearance to new development activities following environmental impact assessment	As per project/ activity 6 (a) of Schedule of EIA Notification 2006, oil and gas transportation pipelines which pass through national parks, sanctuaries, coral reefs or ecologically sensitive areas sites require Environmental Clearance (EC). The project lies in Category A of the notification.	MoEFCC	No
6.	Forest (Conservation) Act, 1980	To check deforestation by restricting conversion of forested areas into non-forested areas	The project does not lie along and in the protected forest area.	Forest Department, MoEFCC	No
7.	National Forest Policy (Revised), 1988	To maintain ecological stability through preservation and restoration of biological diversity	No eco sensitive zone exists along the project corridor, from which the pipeline passes through	Forest Department	No
8.	Wildlife Protection Act, 1972	To Protect wildlife sanctuaries and National Park	No wildlife sanctuary falls within 10 km of the project road.	NBWL, SBWL & Chief Wildlife Warden, MoEFCC	No
9.	Water (Prevention and Control of Pollution) Act, 1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	This act will be applicable during construction, for establishments of hot mix plant, construction camp, workers' camp, etc	OSPCB	Yes
10.	Air (Prevention and Control of Pollution) Act as amended in 1987	To control air pollution by controlling emission and air pollutants according to prescribed standards	This act will be applicable during construction; for obtaining NOC for establishment of hot mix plant, workers' camp, stone crusher, construction camp, & other heavy machinery.	OSPCB	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
11.	Noise Pollution (Regulation and Control) rules, 2000	Noise pollution regulation and controls	This act will be applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design.	OSPCB	Yes
12.	The Explosives Act (& Rules), 1884	An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives	For transporting and storing diesel, bitumen etc.	OSPCB	Yes
13.	Public Liability Insurance Act, 1991	Insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions etc. safely in designated locations within the construction camp	OSPCB	Yes
14.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	Storage, handling, transportation and disposal of hazardous waste	Storage and handling of hazardous waste during construction	OSPCB	Yes
15.	Solid Waste Management Rules, 2016	Management and handling of solid waste	For disposal of solid waste generated during construction	OSPCB	Yes
16.	Construction and Demolition Waste Management Rules	Management of construction and demolition waste	For disposal of solid waste generated due to construction and demolition	OSPCB	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
17.	Batteries (Management & Handling) Amendment Rules, 2016	Management and handling of used lead acid batteries	Safe disposal of used lead batteries through authorized e waste recyclers	OSPCB	Yes
19.	E-Waste (Management) Rules, 2016	Effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes	Handling of e-waste	OSPCB	Yes
20.	Central Motor Vehicles Act , 1988	To control vehicular air and noise pollution	This rule will be applicable to road users and construction machinery	Motor Vehicle Department	Yes
21.	The Petroleum Act 1934, as amended in August 1976 The Petroleum Rules 1976, as amended in March 2002.	Operation, Storage and transportation of Petroleum products	The rule is applicable for as the transportation and distribution of compressed natural gas will take place	Ministry of Petroleum & Natural Gas	Yes
22.	Petroleum and Natural Gas Rules, 1959, amended 2009	As states own the blocks found within their territory and are therefore, responsible for awarding the licenses for onshore blocks,	The rule is applicable for as the transportation and distribution of compressed natural gas will take place through the state of Odisha	Ministry of Petroleum & Natural Gas & Odisha State Govt	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
23.	The Petroleum and minerals pipeline (acquisition of right of user in land) act, 1962	Acquisition of right of user in land [for laying pipelines for the transport of petroleum and minerals] and Provision of compensation in case of any damage, loss or injury is sustained by any person interested in the land under which the pipeline is proposed to be, or is being, or has been laid	The pipeline passes through residential and commercial areas, it may even passes from or near to private property.	Ministry of Petroleum & Natural Gas	Yes
24.	NOC from Gram Panchayat	As per Odisha state Government Policy, NOC is required from the Gram Panchayat.	The Orissa Grama Panchayat Act, 1964	Village Sirpanch	Application to village Panchayat falling in the stretch is to be made

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
25.	Petroleum and Natural Gas Regulatory Board Act, 2006	Regulation of refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as to protect the interests of consumers and entities engaged in specified activities	The project is proposed under this act and is bid out by PNGRB for uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country	PNGRB	Yes

Environmental issues during pipeline laying & construction stage generally involve equity, safety and public health issues. The construction agencies require complying with laws mentioned below as well:

- **Workmen's Compensation Act 1923** (the Act provides for compensation in case of injury by accident arising out of and during the course of employment);
- **Payment of Gratuity Act, 1972** (gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years);
- **Employees PF and Miscellaneous Provision Act 1952** (the Act provides for monthly contributions by the employer plus workers);
- **Maternity Benefit Act, 1951** (the Act provides for leave and some other benefits to women employees in case of confinement or miscarriage, etc.);
- **Contact Labor (Regulation and Abolition) Act, 1970** (the Act provides for certain welfare measures to be provided by the contractor to contract labour);
- **Minimum Wages Act, 1948** (the employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions);
- **Payment of Wages Act, 1936** (it lays down as to by what date the wages are to be paid, when it will' be paid and what deductions can be made from the wages of the workers);
- **Equal Remuneration Act, 1979** (the Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees);
- **Payment of Bonus Act, 1965** (the Act provides for payments of annual bonus subject to a minimum of 83.3% of wages and maximum of 20% of wages);
- **Industrial Disputes Act, 1947** (the Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment);
- **Industrial Employment (Standing Orders) Act; 1946** (the Act provides for laying down rules governing the conditions of employment);
- **Trade Unions Act, 1926** (the Act lays down the procedure for registration of trade unions of workers and employers. The trade unions registered under the Act have been given certain immunities from civil and criminal liabilities);
- **The Child Labour (Prohibition and Regulation) Amendment Act, 2016** An Act further to amend the Child Labour (Prohibition and Regulation) Act, 1986. (the Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labour is prohibited in Building and Construction Industry);

- **Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979** (the inter-state migrant workers, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home to the establishment and back, etc.);
- **The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996** and the Cess Act of 1996 (all the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act; the employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for Workers near the workplace, etc.);
- **The Factories Act, 1948** (the Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours and rendering information-regarding accidents or dangerous occurrences to designated authorities).

1.7 STRUCTURE OF THE REPORT / CHAPTERISATION

The EIA Report will be chapterised under following heads:

Chapter 1: Introduction

This chapter provides background information of the existing pipeline, brief description and objectives of the project, scope of the study.

Chapter-2: Project Description

This chapter presents the details of the proposed project with description of the resources required and emissions, waste and wastewater anticipated to be generated.

Chapter-3: Description of Environment

This chapter describes the existing baseline status of environment components collected in a pre-defined study area based on primary and secondary data collection.

Chapter 4: Anticipated environment impacts and mitigation measures

This chapter describes the potential impacts of the proposed project and evaluates their significance based on parameters such as Intensity, Spatial extension, Temporal duration and Environmental Vulnerability. Impact avoidance and mitigation measures are delineated.

Chapter 5: Additional Studies

This chapter assesses the potential risks involved in the construction and operation of proposed facilities and presents a Disaster Management Plan (DMP).

Chapter 6: Analysis of Alternatives

The chapter entails the alternative options for the project.

Chapter 7: Project Benefits

This chapter presents the details of direct and indirect benefits due to proposed project.

Chapter 8: Environment Monitoring & Management Plan

This chapter describes the details of the monitoring schedule to be implemented for checking the effectiveness of mitigation measures. It covers the parameters, frequency and location of monitoring. If existing monitoring schedule is enough to cover the proposed development, the same has been clearly mentioned.

2 PROJECT DESCRIPTION

2.1 DESCRIPTION OF THE CITY GAS DISTRIBUTION PIPELINE

Adani group has been granted authorization for laying, building, operating or expanding the CGD Network in Bhadrak, Balasore, and Mayurbhanj districts in the state of Odisha. The authorized area for laying, building, operating, or expanding the proposed network shall cover an area of 17195.30 square kilometers.

Table 2-1: Description of Work

Sr. No	Description of Work	Numbers
1	Number of CNG stations (Online and daughter booster stations) to be installed within 8 contract years from the date of authorization	20
2	Number of domestic piped natural gas connections to be achieved within 8 years from 28th September, 2018	1,50,464
3	Inch-km of steel pipeline to be laid within 8 years from 28th September, 2018	506
4	Total Population	63,46,594
5	Total Geographical Area (Sq Km)	17195.30
6	Total Household	14,25,587
7	No. of Charge Area	45

Source: Adani Gas Limited

Adani group is responsible for designing and installation of optimal size of the infrastructure in terms of pipeline of various types including steel belting of the authorized area, online compressors of adequate capacity for compressing of natural gas into CNG, allied equipment and facilities in the CGD network depending upon the potential demand for natural gas. The infrastructure in the CGD network will be adequate to maintain uninterrupted flow of natural gas in the pipelines and will also be able to maintain supplies at adequate pressure to online CNG stations.

Adani has planned to lay 8” & 4” diameter steel pipeline, approx. 200 km for the gas distribution throughout Bhadrak, Balasore, and Mayurbhanj districts. The pipeline runs from proposed gas station at Chandabali in Bhadrak where the existing GAIL pipline passes for tap off to various Balasore district and Baripada town in Mayurbhanj district.

The proposed project will provide 20 CNG stations throughout the project. There are total 45 charge areas for the entire project. 1.5 acre of un-rrigated farmland for one LNG station has

been identified on in Chandabali village of Bhadrak district and will be acquired on willing buyer-willing seller mode.

Since the project does not lie in any notified protected forest no NOC and clearance are required to be obtained from Odisha forest department and MoEFCC, however intimation is to be sent to them detailing the project intent.

The pipeline passes along main district roads, state and national highway hence it is required to obtain clearance from the National Highway Authority of India (NHAI). It also crosses railway lines hence will be requiring clearance from Indian Railways.

The project also require permission from irrigation department Odisha associated all the rivers passing through the Bhadrak, Balasore, and Mayurbhanj districts that falls in the pipeline route.

2.2 PROJECT IMPLEMENTATION SCHEDULE

A grant of authorization was signed on 14th September 2018 by Petroleum and Natural Gas Regulatory Board (PNGRB) vide a letter of authorization to AGL group, which was accepted by them on 28th September 2018. The letter schedule D of the letter stated the year wise work program within the 8-contract year period. The details on which are given in table below:

Table 2-2: Project Implementation Schedule

Implementation Schedule					
Approximate PNG Connections (Cumulative)		**Approximate CNG Stations (Cumulative)**		**Approximate Inch-km of steel pipeline (Cumulative)**	
By the end of contract year	% of work program	By the end of contract year	% of work program	By the end of contract year	% of work program
1st	NIL	1st	NIL	1st	5
2nd	10	2nd	15	2nd	20
3rd	20	3rd	30	3rd	40
4th	30	4th	45	4th	60
5th	40	5th	60	5th	70
6th	60	6th	75	6th	80
7th	80	7th	90	7th	90
8th	100	8th	100	8th	100

Source: Adani Gas Limited

Adani group has been granted authorization for laying, building, operating or expanding the CGD Network in Bhadrak, Balasore, and Mayurbhanj districts in the state of Odisha. The

authorized area for laying, building, operating, or expanding the proposed network shall cover an area of 5,187 square kilometers.

The project is still in conceptual stage and required regulatory permits are being obtained. No work has started yet on the any stage of the project.

Bhadrak, Balasore, and Mayurbhanj districts Stretch runs within the city on the connecting National Highway (NH 45) while the four smaller stretches within two cities Bhadrak and Balasore runs along the district roads . The details of pipeline loop and charge head is given in following table:

Table 2-3: Details with Charge Area of the pipeline project

Charge Area ID	Name	Coordinates Start	Coordinates End
CA 01	Chandbali – Bhadrak	86° 46' 58.63" E 20° 54' 06.18" N	86° 30' 45.85" E 21° 04' 41.29" N
CA 02	Bhadrak – Remuna, Balasore	86° 31' 53.95" E 21° 06' 02.49" N	86° 53' 38.37" E 21° 30' 51.64" N
CA 03	Remuna, Balasore – Koliana, Mayurbhanj	86° 53' 38.37" E 21° 30' 51.64" N	86° 42' 26.52" E 21° 58' 19.41" N
CA 09 A	Bhadrak City # 1	86° 30' 26.96" E 21° 04' 19.70" N	86° 32' 01.13" E 21° 02' 54.87" N
CA 09 B	Bhadrak City # 2	86° 29' 49.77" E 21° 03' 28.31" N	86° 31' 06.00" E 21° 03' 08.89" N
CA 09 C	Bhadrak City # 3	86° 29' 38.39" E 21° 03' 15.49" N	86° 30' 11.47" E 21° 03' 59.89" N
CA 09 D	Bhadrak City # 4	86° 29' 41.90" E 21° 03' 35.18" N	86° 28' 20.40" E 21° 03' 53.64" N
CA 10 A	Balasore City # 1	86° 52' 51.67" E 21° 28' 02.04" N	86° 57' 38.51" E 21° 28' 38.54" N
CA 10 B	Balasore City # 2	86° 53' 38.37" E 21° 30' 51.64" N	86° 56' 54.23" E 21° 29' 26.38" N
CA 10 C	Balasore City # 3	86° 54' 54.07" E 21° 29' 10.06" N	86° 55' 25.26" E 21° 30' 15.12" N
CA 10 D	Balasore City # 4	86° 55' 11.13" E 21° 29' 35.94" N	86° 56' 26.02" E 21° 29' 17.17" N

A Map of Geographical Area Bhadrak, Balasore, and Mayurbhanj Districts approved by PNGRB shows the following loops of the proposed pipeline routes.

Table 2-4: Details of the loops and their length of the pipeline project

Loop Name	Road	Approximate Distance	Approximate Indication in Map
Chandbali – Bhadrak	SH -9	41.9 km	Brown Line
Bhadrak – Remuna, Balasore	NH- 16	62.8 km	Yellow Line
Remuna, Balasore – Koliana, Mayurbhanj	NH- 18	60.5 km	Green Line
Bhadrak City # 1	SH- 9	5 km	Red Line
Bhadrak City # 2	SH- 53	2.3 km	Red Line
Bhadrak City # 3	District Road	1.7 km	Red Line
Bhadrak City # 4	District Road	2.7 km	Red Line
Balasore City # 1	District Road	9.6 km	Red Line
Balasore City # 2	District Road	6.6 km	Red Line
Balasore City # 3	District Road	2.6 km	Red Line
Balasore City # 4	District Road	3.4 km	Red Line

Source: Primary Survey, TUV SUD

The proposed project was started in June-July 2019 and is expected to be completed in approximately 36 months from the date of approval environmental & other statutory clearances.

2.3 PIPELINE ROUTE & ACCESSIBILITY

Pipeline runs parallel along the man roads hence accessibility is not an issue. Project pipeline runs along major national and state highway connecting Bhadrak, Balasore, and Mayurbhanj districts. The route covers 110 villages in 15 talukas and 3 districts.

Table 2-5: List of villages, cities, talukas and districts of Bhadrak, Balasore, and Mayurbhanj falling in the project area

S. No	City/ Village		1. Taluka	District	State
1	1. Chandabali 2. Panchupada 3. Saentapanijharia 4. Samdaspur 5. Nischanta 6. Mahulia 7. Bhatapada 8. Naugoruda 9. Matto 10. Chasakhand 11. Malbad 12. Pratappur 13. Nalgunda 14. Kaupuni 15. Nuagaon 16. Khadijan 17. Baharpal 18. Laxmiprasad 19. Samantraipur 20. Harisinghpur 21. Bamana Bhinda 22. Malpur 23. Bhinda 24. Indiria 25. Sindol 26. Orada 27. Barikbhinda 28. Managrajpur 29. Tihidi 30. Bidyadharpur 31. Mukundpur 32. Jhinkiria 33. Bodhapur 34. Gadadharpur 35. Chakaagiri 36. Bahanaga 37. Daradia 38. Begunia 39. Panapana 40. Betagadia 41. Biruhan 42. Banaparia 43. Channapur	55. Agiria 56. Ghumal 57. Sridharpur 58. Harikishanpur 59. Kedarpur 60. Brahmapur 61. Purana Bazar 62. Taragana 63. Bankashi 64. Belmala 65. Charampa 66. Tisalpur 67. Asura 68. Suseiladeipur 69. Ranj 70. Sarsatia 71. Jagadalpur 72. Similia 73. Muruna 74. Bhagia 75. Markona 76. Kaniari 77. Anantpur 78. Jamujhadi 79. Bedpur 80. Radhaballavpur 81. Salampur 82. Talanagar 83. Brahmapur 84. Alipur 85. Kantipur 86. Soro 87. Brahmanshi 88. Nayakbandh 89. Sahisad 90. Dhandharipur 91. Keshpur 92. Asimilia 93. Kasbajaipur 94. Margorasahi 95. Sankua 96. Hiratikiri 97. Patarra 98. Raim	1. Saraskana 2. Bisoi 3. Betanati 4. Baripada 5. Remuna 6. Shamakhunta 7. Koliana 8. Bangiriposi 9. Chandabali 10. Dhamanagar 11. Bhadrak 12. Tihidi 13. Similia 14. Soro 15. Bahanaga	Bhadrak, Balasore, and Mayurbhanj	Odisha

	44. Geruda 45. Saraswatipur 46. Bindha 47. Dumuda 48. Gambhiria 49. Jaipuria 50. Baisinga 51. Bhatia 52. Dhanpur 53. Raghada 54. Krishnachandrapur	99. Dharampur 100. Naugan 101. Jugpura 102. Jogal 103. Agrai 104. Badachuruni 105. Sathilo 106. Purunapani 107. Naykhendukal 108. Nuanagar 109. Gholapur 110. Rangmatia			

Source: Primary Survey, TUV SUD

Figure 2-1: Location Map of Project Site

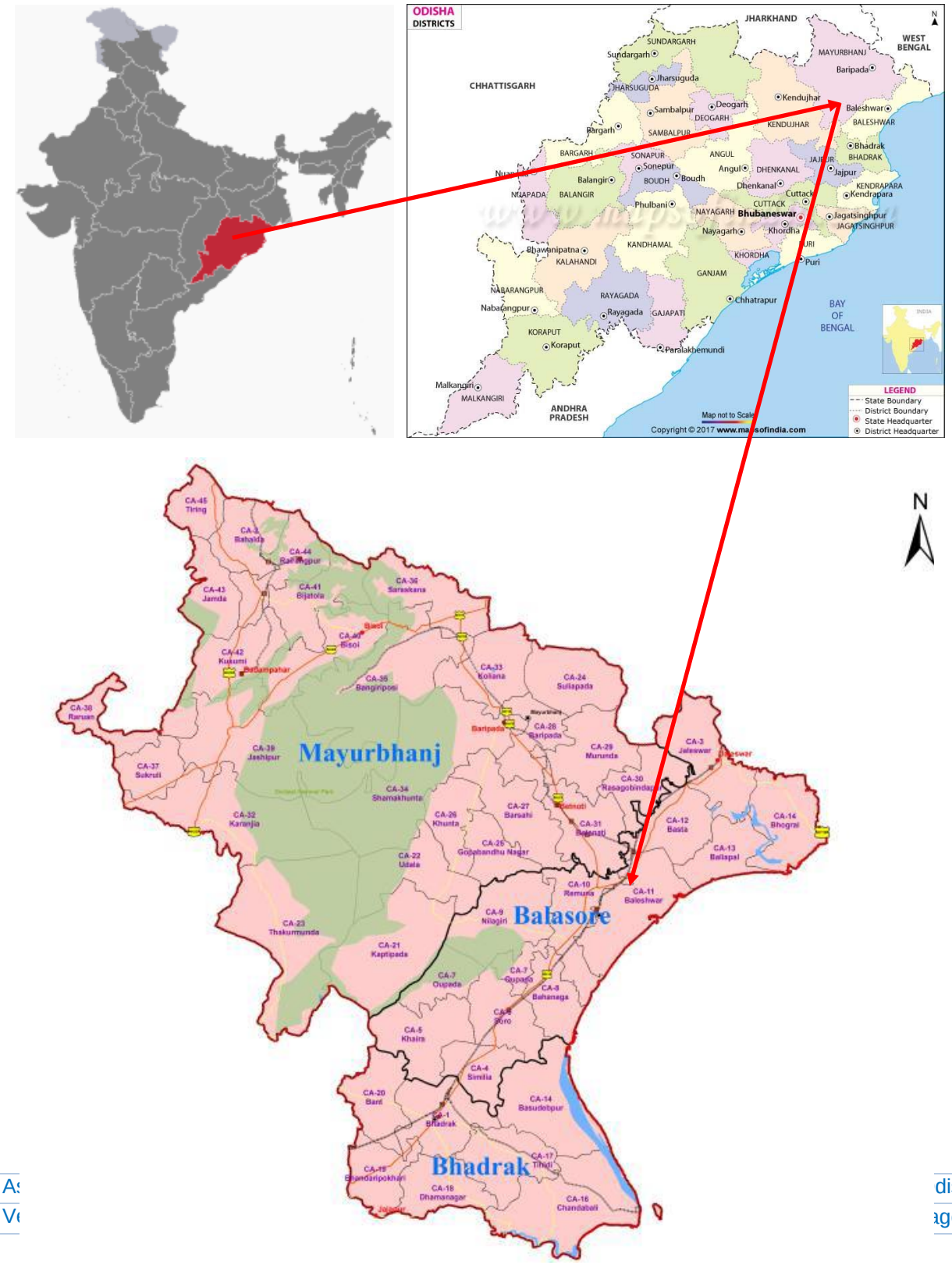
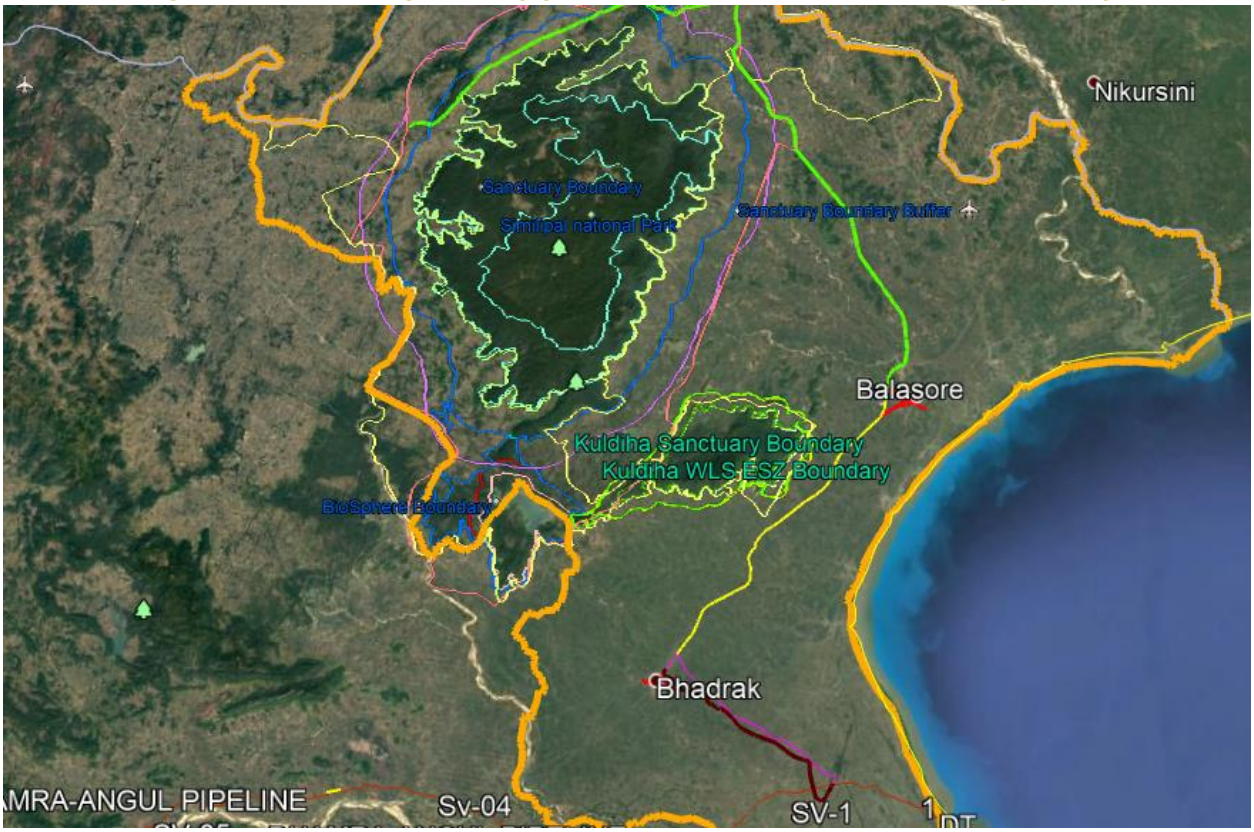


Figure 2-2: Route Map for the pipeline in Bhadrak, Balasore, and Mayurbhanj



Source: Adani Gas Limited

Salandi River Crossing on SH 9, Bhadrak

Bridge over Salandi River Crossing NH 16

Kansa Bansa River Crossing NH 16 in Bedpur

Budhabalanga River Crossing NH 16 in Balasore

Table 2-6: List of Rivers, Canal, & Ponds falling in the pipeline route in the districts of Bhadrak, Balasore, and Mayurbhanj

Sr. No	River/Canal/Rivulet	Project Phase
Bhadrak -Balarose		
1	Salindi River	Brown Line
2	Salindi River	Red Line
Balasore -Baripada		
3	Kansa Bansa River	Yellow Line
4	Budhabalanga River	Yellow Line

Source: Primary Survey, TUV SUD

Table 2-7: List of Railway crossing falling in the pipeline route in the districts of Bhadrak, Balasore, and Mayurbhanj

Sr. No	Railway Crossings	Project Phase
Balasore		
1	Railway crossing in Asha Nagar, Balasore City	Yellow Line
2	Railway crossing in Ranipatana, Balasore City	Yellow Line
3	Railway crossing in Kundipur	Red Line
Bhadrak		
1	Railway Crossing at Erei in Bhadrak	
2	Railway crossing in Alipur	

Source: Primary Survey, TUV SUD

Table 2-8: Forest falling in the pipeline route in the districts of Bhadrak, Balasore, and Mayurbhanj

Sr. No	Forest Area (Ha)	Project Phase
Baripada		
1	Reserved Forest – 8.24 Hectares	Yellow Line

2.4 PIPELINE DESIGN & CODE

As stated in PNGRB Notification 2008, the design, materials and equipment, welding, fabrication, installation, testing, operation and maintenance and corrosion control of CGD network shall be in accordance with requirements of ASME B31.8 except insofar as such

requirements are specifically cancelled, replaced or modified by the requirements specified in these regulations.

The CNG Station, CNG Mother Station, CNG On-Line Station and CNG Daughter Station shall be designed, operated and maintained in line with the requirements of the Chief Controller of Explosives as detailed in the Gas Cylinder Rules, 2004 as modified or amended from time to time. This includes compression, handling and transportation activities of compressed natural gas.

It is intended to apply these regulations to all new and such aspects of already existing networks as design, fabrication, installation, testing at the time of construction and commissioning. However, if an Adani has laid, built, constructed or expanded the CGD infrastructure based on some other standard or is not meeting the standards specified in these regulations, then it needs to carry out a detailed technical audit of its infrastructure through a Board authorized or approved third party agency by the Board. Adani thereafter shall submit the recommendations made by the third party along-with its time-based mitigation plan and implementation schedule to the Board for authorization within six months from the date of notification of these regulations.

Technical standards and specifications mentioned in PNGRB notification, 2008 including safety standards (hereinafter referred to as standards) for city or local natural gas distribution networks are as specified in Schedule–I which cover material and equipment (Schedule–1A), welding (Schedule–1B), piping system components and fabrication (Schedule– 1C), design, installation and testing (Schedule–1D), operating and maintenance procedures (Schedule–1E), corrosion control (Schedule–1F) and miscellaneous (Schedule–1G).

Table 2-9: Applicable Standards & Codes

S. No	Standards & Schedule	Applicability
1	ASME B 16.25	Butt welding Ends
2	ASME B 31.8	Gas Transmission and Distribution Piping Systems
3	ASME B 16.11	Forged Fittings, Socket Welding and Threaded
4	ASME B 31.3	Process Piping
5	ASME B 31.4	Pipeline Transportation System for Liquid Hydrocarbons and Others
6	ASME B 16.5	Pipe line flanges and flanged fittings
7	ASME B 16.9	Factory made- Wrought Steel Butt welding Fittings
8	ASME PTC 10	Performance Test Code on Compressors and Exhausters
9	PNGRB T4S	Pipeline Design & Material Selection

10	PNGRB Regulation, 2008- Schedule–I A	material and equipment
11	PNGRB Regulation, 2008- Schedule–1B	welding
12	PNGRB Regulation, 2008- Schedule–I C	piping system components and fabrication
13	PNGRB Regulation, 2008- Schedule–I D	design, installation and testing
14	PNGRB Regulation, 2008- Schedule–I E	operating and maintenance procedures
15	PNGRB Regulation, 2008- Schedule–I F	corrosion control
16	PNGRB Regulation, 2008- Schedule–I E	miscellaneous

Source: Secondary Data Survey, TUV SUD

Table 2-10: Technical details for the proposed pipeline

S.No	Description	Piping Details
1	Pipeline internal Diameter (Inches)	8” & 4”
2	Pipeline wall thickness (mm)	
3	Piping material specification	
4	Normal operating pressure	19-40 kg/cm^2
5	Maximum allowable operating pressure	40 kg/cm^2
6	External Coating type & specification	
7	Design Throughput (MMSCMD)	0.3 MMSCMD
8	Pipeline Design Life	25 years
11	Design Temperature (C)	0-60 degree centigrate
12	Rating of Piping Components	Schedule 40 (API 5L *42)
13	Mainline Valve Stations	Will be installed at every 3 kms for the complete length of the pipeline

Source: Adani Gas Limited

2.5 ASSOCIATED FACILITIES

2.5.1 SCADA, TELECOMMUNICATION & LEAK DETECTION

The Master Control Station shall be equipped with Supervisory Control and Data Acquisition (SCADA) software running under multi-programming, multitasking real time operating system environment. The SCADA software shall incorporate control & monitoring of all locations including Block valves. Leak Detection system shall be provided, and the Leak Detection Software shall run in a separate machine at Master Control Station. This package will enable the operator to take optimal control actions and thus ensure the safety and security of the pipeline network.

The CGD system should have leak detection system in position and should be operative. For pipeline network it shall be odorisation based and for enclosures such as CGS, above ground DPRS, it shall be gas leak detection based. Gas detectors shall be installed at strategic locations covering to detect any gas leakage.

2.5.2 FIRE ALARM & FIRE FIGHTING SYSTEMS

As per the Petroleum and natural gas regulatory board notification 2008, Schedule 1 D, after construction activities relevant warning signs shall be displayed in the area. A proper Emergency Response Plan shall be in place and emergency contact numbers of relevant agencies should be visible. Firefighting equipment's should be available during commissioning.

As per the PNGRB notification, 2008 AGL operating CGD Networks shall provide for an Emergency Control Room, manned round the clock and equipped with effective communication system and emergency vehicles fitted with communication facilities, first aid equipment, fire extinguishers, gas detectors, repair kits and tools, maps, plans, material safety data sheets etc. at its disposal. The CGD entity shall put in place an Emergency Response Plan, a Disaster Management Plan and a Pandemic Plan. While preparing these plans the entity shall take into confidence the various local authorities (i.e. The Fire authorities, Police authorities, Health authorities, local administration, Disaster Management authorities, Mutual aid, Factory inspectorate etc) and clearly elaborate on their role in case of an incident.

2.5.3 CORROSION PROTECTION

Underground carbon steel section beyond transition fitting is below ground, it shall be protected against corrosion by minimum 400 micron thick 2 pack high build epoxy coating. Above ground service piping shall be Galvanized Iron or copper or carbon steel protected by anti-corrosive coating.

2.6 LAYING OF PIPELINE

The pipeline construction is proposed to be carried out through deployment of 4 to 5 spreads. The sequence and methodology of construction of new pipeline is given below:

- Clearing and grading - A 30 m wide Right of Use (RoU) area will be cleared off vegetation and other obstacles such as boulders. Tree felling will not take place.
- Stringing–Pipes are transported to the site on trucks will be offloaded using side booms. Pipes are then strung adjacent to the trench. Trailers and cranes will be used for maneuvering of pipes. This activity may be done before or after trenching.

- Trenching - Trenchers and backhoe type excavators will be used to dig the trench for laying the pipeline. The topsoil in agricultural areas will be removed and stockpiled for restoration. The excavated sub-soil will be stockpiled separately for backfill.
- Bending – Pipes will be bent using a bending machine to the appropriate angle to match the vertical and horizontal alignment of the trench.
- Welding - Welding will be done using conventional manual/ semi-automatic welding involving a crew of welders and fitters. Once the pipe is strung a line-up crew will position the pipe using side booms in preparation for welding. Pipe strings to be welded will be effectively earthed. During welding, at least one end of the pipe string will be closed to prevent a forced draught effect.
- Non-Destructive Inspection - Mechanized Ultrasonic Testing (MUT) is the specified method to be applied for the execution of NDT. Each field weld will be 100% radiographed to test for soundness of the weld in compliance with specifications. NDT and its evaluation shall be performed in accordance with API Standard 1104.
- Coating: After welding at each weld joint, coating of field joints of bare pipes and the repair of coating shall be done by.
- Burial - General burial depth of the pipeline along the route will be with a minimum 1.0 m cover. Burial cover will be compacted to avoid future erosion by all weathers.
- Backfilling - The excavated sub-soil will be returned to the trench. The topsoil, which has been preserved on the side of the ROU, will be spread over the filledup trench. A crown of soil will be kept on top of the trenched portion to allow for future settlement. Backfilling will be managed so that damage from sizable rocks is not used or any other materials that may damage the pipeline.
- Crossings - The method used for the crossing of waterways and other infrastructure facilities will vary from place to place depending on the environmental setting and the geo-technical features of the area. The detail method of various types of crossings is specified below.

Table 2-11: Type of crossings required for various type of infrastructure

S.No	Type of Crossing	Method of Crossing
1	National Highway	Conventional Trenching/ Horizontal Directional Drilling (HDD)
2	State Highway	Conventional Trenching/ HDD
3	Other Roads	Conventional Trenching/ HDD
4	Railway Crossing	HDD
5	Major Lined Canal	HDD
6	Unlined Canal	HDD

Source: PNRGB Notification, 2008

- Restoration - Restoration of the ROU will be conducted progressively following the completion of construction work. This will involve removal of foreign materials such as construction debris and wastes. The ROU will be returned to its original condition by spreading the topsoil over the areas from where it was stripped, so that agricultural activities will be restored. Special focus will be given to restoration of side slopes and beds of natural water body crossings.
- Pipeline warning markers–In the final stages of construction, warning marker posts will be erected indicating the location of the pipeline and the crossing of other pipelines, cables and features. A marker tape will be placed in the trench 500 mm above the pipeline to indicate to future excavators that a pipeline is below and that they are nearing

The major construction activity involved during laying of pipeline are as follows:

- Transport of pipes from the place of availability to stock/lining yard.
- Transporting of pipes from the stock / lining yard to suitable places along the route of the pipeline.
- Application of lining and coating.
- Fabrication of fittings and special lining and coating of the same.
- Excavation and preparation of trenches for the pipes. Topsoil to be kept separately.
- Lowering the pipes into the trench.
- Jointing of pipes inside the trench.
- Welding of pipes.
- Rectification of defects and re-testing
- Finishing the coating and lining at weld joints.
- Back-filling of the trench with topsoil layer.
- Construction of valve chambers and erection of valve.
- Construction of necessary pipe supports, anchor blocks.
- Providing line markers

2.6.1 SITE PREPARATION & LAYING METHODOLOGY

The project is for laying of a Gas pipeline with open trenching. However, for the Portion passing through, train tracks, Canals, ponds bridges will be done by Horizontal Directional Drilling Method (HDD) to reduce the environmental impacts to minimum.

The usual approach to pipeline installation is to dig an open trench, place the pipeline and then bury it. Proposed pipeline is passing through commercial, industrial residential, agricultural areas, water bodies, public spaces etc. shall be laid by:

1. Horizontal Directional Drilling (HDD) method for pipeline.

2. Open cut method for remaining portion of pipeline.

Horizontal Directional Drilling (HDD) is a Trench-less methodology that provides an installation alternative that can offer a number of benefits over traditional open-cut method.

• In a sensitive wetland environment such as a river/creek crossing, wildlife habitats would be destroyed, and extensive mitigation efforts would be required while pipe laying by open cut method. As a result, trenchless or "no-dig" technology has been used extensively worldwide.

• HDD can be implemented with very little disruption to surface activities, requires less working space, and may be performed more quickly than open-cut methods.

• 8” Nominal bore, & 4” Nominal bore pipelines Steel Pipelines laid together by HDD methodology and remaining length of CRZ portion by Open Cut Method.

Open Cut Method is a usual approach to pipeline installation is to dig an open trench, place the pipeline and then bury it.

• pressure shall be between 16-40 Bar, 3 layers of PE coated steel pipes for the transportation of gas to its delivery centers.

2.6.2 PIPELINE BURIAL

As per the Petroleum and natural gas regulatory board notification 2008, all types of pipes (plastic and steel) and fittings shall be laid underground and shall not be exposed. The buried service lines are provided with a minimum cover of 1.0- 1.5 m. Where it is impractical to provide 1.0 m cover due to physical constraints, additional protective measures such as concrete slabs or high impact resistance plastic sheets shall be installed at least 300 mm above the service line. In no case the depth of cover shall be less than 600mm. For transition from plastic pipe to GI pipe, transition fittings shall be used. Plastic part of transition fitting protruding above ground shall be protected by encasing it with concrete guard.

In case carbon steel section beyond transition fitting is below ground, it shall be protected against corrosion by minimum 400 micron thick 2 pack high build epoxy coating. Above ground service piping shall be Galvanized Iron or copper or carbon steel protected by anti-corrosive coating.

In cases where HDD is used for pipeline burial, plastic or carbon steel, adequate depth of 2-2.5m shall be maintained under if the pipeline is going below from any of the listed features, i.e river/ canal beds, highways, roads, houses and industries.

Table 2-12: Minimum depth of cover for buried steel pipeline

S.No	Location	Minimum Cover (m)
1	Normal/ Rocky Terrain	1.0
2	Minor River/ unlined canal/ nala crossing/ tidal areas/ other water courses	1.5
3	Major River Crossings	2.5
4	Rivers with rocky bed	1.5
5	Lined canals/ drains/ nalahs	1.5
6	Drainage ditches at roadways and railways	1.0
7	Rocky Areas	1.0
8	Cased/ uncased road crossing	1.2
9	Cased railroad crossing	1.7

Source: PNGRB Notification, 2008

2.7 PROJECT REQUIREMENT

2.7.1 LAND

The land required for the project is only for CNG Stations and Tap off points. CNG stations have to be setup for this project and one tap off point. The land for the Tap off point has been bought near to the GAIL Tap off point, as the LPG/CNG will be bought from Gail and converted to CNG and transported further.

2.7.2 MANPOWER RESOURCES

During the construction phase, local skilled and unskilled labour will get temporary employment based on required skill sets. However, as the development will be phase wise, the total number of locals employed at any one time may not be more than 500- 600. Adani has contracted out the construction work and management of labour to shanti contractors, local skilled and unskilled workers and service providers are preferred in order to boost local employment generation. As far as operation phase is considered, guards will be employed to patrol the pipeline areas, which will be around 20-30 people for this stretch. Skilled workers will be employed for the operation and maintenance. All these will also be contracted out to the subcontractors.

2.7.3 POWER REQUIREMENT

The power requirement will be bet from DG Sets during construction phase of the project.

2.7.4 WATER REQUIREMENT

Water requirement will be minimal for the project associated only with domestic use by the workers during construction and office staff during constructions and operations period at the distribution centers. Further, one-time water shall be required for Hydro testing of pipeline. The water shall be sourced from tankers. The water requirement for construction phase will be contracted out to private tankers. During the operation phase, water requirement will only be at the CNG stations.

2.7.5 EMISSION AND DISCHARGES

Fugitive dust shall be the main air pollutant, from the small diesel engines used for the construction works & movement of vehicles for which dust suppression system will be used as relevant points. No effluent will be generated during operation of the proposed project.

3 ENVIRONMENTAL DESCRIPTION

3.1 STUDY AREA

This chapter summarises the available baseline data on physical and biological resources within the principal area of interest i.e. the project area that would comprise of project components and associated facilities. Key existing sources of information used for this section comprises of government departments, analysis of available research papers and secondary data review from established sources such as Indian Meteorological Department, etc. Reconnaissance visits and physical, social and biological field surveys were carried out in November 2019 to supplement the existing baseline data.

The scope of environmental assessment, existing features of the project and proposed improvement, methodology and regulations applicable to environmental assessment is highlighted in the previous sections. In this chapter, an attempt has been made to prepare a baseline environmental setting to meet out the applicability of Government of India (GoI) regulatory requirements. Considering the existing environmental scenario, potential impacts of road improvement will be identified and accordingly management plan will be proposed in forthcoming sections. The baseline environmental conditions will help in comparing and to monitor the predicted negative and positive impacts resulting from the project during construction and operation phases.

The area falling within 10 km radius from the project boundary has been considered as “Study Area” for the purpose of conducting EIA Study. The baseline data generation includes site visits, ecological surveys, social surveys and interviews, and secondary data review from established sources such as Indian Meteorological Department, Census of India.

The details pertaining to both the project taluka and district, from authentic government sources, have been presented where project area / project site specific information was not available in public domain.

3.2 TOPOGRAPHY

The Bhadrak, Balasore, and Mayurbhanj Districts lies on the eastern part of Odisha bordering Bay of Bengal and is surrounded by Jajapur District in the south, Kendujhar district in west and West Bengal in North.

The Bhadrak sub-division of erstwhile Balasore district of Orissa State was conferred upon the status of an individual district in the year 1992-93 during reorganization process of different districts of the state. The district is situated in the north-eastern part of Orissa and lies between

north latitudes 200 45' & 210 14' and east longitudes 860 17' & 860 59'. It is bounded in the north by Balasore, in the south by Kendrapara and Jajpur, in the west by Keonjhar districts and in the east by Bay of Bengal. The geographical area of the district is 2788 sq km and is divided into 7 administrative blocks with district head quarter at Bhadrak. It is having 3 urban areas, viz; Bhadark Municipal area, Basudevpur (NAC) and Chandbali (NAC).

Balasore district has a geographic area of 3806 Sq Kms and is divided into 12 Community Development Blocks, which in turn are further subdivided into 289 Gram Panchayats comprising of 2953 villages in the rural front and on the urban side it comprises of 1 Municipal Corporation of Balasore and 4 Notified Area Councils. As per the Census Data of 2011, the total population of the District is 23,20,529. Of this the Male population is 11,85,787 and the female population is 11,34,742. This gives a over all sex ratio of 957 females per 1000 males. The decadal growth rate is pegged at 14.62 % with a population density of 610 persons per square kilometres.

The Mayurbhanj district lies between north latitudes 210 17' and 220 34' and east longitudes 850 40' and 870 10' falling in the survey of India toposheet nos 73F, 73G, 73J and 73K. It is bounded on the north by the district Singbhum of Jharkhand and Midnapur district of West Bengal, on the south by Balasore and Keonjhar districts and on the west by Keonjhar and Singhbhum districts and on the east Midnapur and Balasore districts.The district comprises of 4 subdivisions namely sadar sub-division with headquarter at Baripada,Bamanghaty sub-division with headquarter at Rairangpur, Pancpir with headquarter at Karangia and Kaptipda sub-division with headquretr at Udala. (Plate 1). There are 9 Thehsils. The geographical area of the district is 10418 sq km. There are 26 blocks and 3945 villages out of which 227 villages are uninhabited.

3.3 GEOMORPHOLOGY

Bhadrak
Geomorphology & Soil Types

The district presents gently undulating to flat topography with the altitude varying from 37m in the North-Western part to around 3m, in the extreme eastern part along the coastline. The general slope is towards east and south-east which varies from 5 to 1.1 metre per kilometre from north west to south east. The district can broadly be divided into four distinct geomorphic units (1) Tidal flat (2) Coastal plain (3) Alluvial plain (4) Flood plain.

The fine sediments carried by the rivers get deposited along the coast because of tidal action, as tidal flat / mud flat. The width of this tidal flat varies from 2 to 5 Kms. Tidal flats and mud flats support growth of varieties of mangrove.

The coastal plain is a gently sloping plain occurring parallel to the coast and mainly formed by fluvio–marine action and is intersected by network of creeks, which are mainly saline due to tidal action. The area is marshy with shrubby vegetation. The width of this coastal plain varies from 5 to 25 Kms. The coastal plain encompasses a series of beach ridges characterized by sand dunes of varied relief and extends for kilometers, almost parallel to the coast.

The gently sloping alluvial plain occurs to the west of the coastal plain and forms the most fertile part of the district. The alluvial plain can be further divided into two i.e. (i) Older alluvial plain (ii) Younger alluvial plain

The North-western part of the district constitute the older alluvial plain. This is attributed mainly due to earlier cycle of deposition of sediments carried by rivers / streams and constitutes gravel, sand, and clay. At places, lateritisation at the top down to a depth of few meters has also occurred.

The younger alluvial plain spreads over a large area and it represents major part of the district. This has developed due to depositional activities of the major river systems in a fluviatile environment. It also encompasses geomorphic units like palaeo channels, meander scars, ox-bow lakes of smaller dimensions.

Soils

Three types of soils, viz. Alfisols, Aridisols and Entisols occur in the district. As per agro-climatic classification, the district falls under North Eastern Coastal plain.

Alfisols: These include deltaic and older alluvial soils. The deltaic soils are found along the course of Baitarani River while the older alluvial soils occur in the extreme north-western part. The deltaic alluvial soils are generally deficient in phosphate (P2O5) and nitrogen (N). Both the total and available potassium (K2O) are fairly adequate and pH varies between 6.5 and 7.3.

Aridisols: These are saline and saline alkali soils, occurring along the coastal area and are rich in calcium, magnesium and also consist of half decomposed organic matter.

Entisols: These soils include coastal alluvial soils, which are deficient in nitrogen, phosphoric acid and humus, but not in potash and lime. The soil texture varies from loam to clayey loam. It is alkaline in nature and the most fertile soil in the area.

Balasore

Geomorphology: Hydrogeomorphological features of Balasore district are mainly attributed to fluviomarine, erosional, denudational and depositional processes. The coastal plain has been

developed due to fluviomarine processes. The alluvial plains owe their origin due to various fluviatile actions of major rivers. The details of the geomorphic unit as identified are as below:

Coastal Plain: Coastal plain predominantly consist of sand silt and clay is developed all along the coast of Balasore district. It is developed all along the coast of Balasore district. It is gently slopping plain occurring parallel to the coast. The saline marshy tract with shrubby vegetation comes under this coastal plain. Tidal streams are very active during high tide time. Ground water prospect is good but salinity is a major problem in this tract.

Beach: Beach is mainly formed by marine action. Beach ridges are very common, and these are formed due to sea waves. They are mainly consisting of sand mixed with silt etc. Ground water prospect is good within a depth of 30-40 m, where fresh ground water pockets are available. Deep tube wells in these areas may lead to sea water ingress.

Mud flat: This is an relatively marshy area covered with fine silt and mud along the shore. Mangroves vegetation is very common. Ground water quality is mostly saline.

Paleo mud flat: These are the ancient mud flat consisting of fine sand and mud. These are mostly converted to agricultural land in due course of time. Due to marine regression ground water quality is saline. Hydrogeological Framework, Ground Water Development Prospects & Aquifer Management Plan of Balasore District, Odisha

Offshore Bar: Offshore bar is an elongated bar of sand occurring in the sea parallel with the coastline. These comprises of sand. Ground water quality is saline.

Channel Bar: It is a depositional fluvial landform developed inside the channel due to the recession of the velocity of water. It is mainly consisting of alluvial deposits. Ground water prospect is good.

Meander Deposits: This is an abandoned river course mostly filled with alluvial deposits. Ground water prospects are good to excellent.

Oxbow Lake: This is a cut off meander filled with alluvial material. The shape of the landform looks like an oxbow. Ground water prospect is excellent.

Paleo Channel: This includes buried as well as abandoned channels. These are mostly comprised of fluvial deposits of varying grain size. Ground water prospect is good to excellent.

Flood Plain: This is an area adjacent to the river and mostly built up by river borne deposits during high floods. Flood plains primarily consist of unconsolidated materials like sand, gravel and silt. Groundwater prospect is good to very good.

Younger Alluvial Plain: This is a flat to gently undulating plain of large extent formed by river action. The area encompasses various fluvial landforms in the latter stage of deposition in the fluvial cycle. This constitutes unconsolidated Hydrogeological Framework, Ground Water Development Prospects & Aquifer Management Plan of Balasore District, Odisha materials like gravel, sand and clay of varying size and forms prolific aquifers. Ground water prospects is good to excellent.

Older Alluvial Plain: These landforms have been developed during earlier cycle of deposition in a fluviatile environment. The lithology and ground water prospect is similar to that of younger alluvial plain.

Lateritic Upland: These are mostly formed on the highland areas and over early Pleistocene sediments. The lateritic appears to form in the surfacial decomposition zone of iron rich rocks where the seasonal rainfall regime causes considerable water table fluctuation, where the rainfall is heavy enough to cause leaching and deep weathering. Lateritic uplands are occurring in the western hilly tact in Nilgiri and northern tertiary tract bordering Mayurbhanj district. The thickness of this lateritic crust varies from 10 to 12 m. The depth to water level is deeper in these formations.

Denudational Hills: These are the hills, which have undergone the processes of weathering and denudation and are still under active process of denudation. Nilgiri granites form these landforms. These are traversed by joints, fractures and lineaments etc. These acts mainly as runoff zone. Ground water prospect is poor and limited along fractures and fissures.

Residual Hills: These are isolated hills of height 10-15m above ground level. These are the residual masses left out after weathering and denudation. These are occurring in the western part of the district in Nilgiri, Oupada sector. These units act as runoff zones and are poor in ground water potential. Hydrogeological Framework, Ground Water Development Prospects & Aquifer Management Plan of Balasore District, Odisha

Pediments: These are erosional rocky surfaces having thin soil cover. This geomorphic unitis found bordering the hilly terrain and also localized patches in the western part of the district. These are sometimes traversed by fractures and joints especially in the granitic area. Groundwater potential is poor and limited.

Deeply Weathered Buried Pedi plain: This is a moderately undulating plain with a thick weathered soil profile. The thickness of weathered mantle varies from 10 to 20m, depending on the nature of topography. This unit occurs in the Nilgiri-Oupada-Khaira, with good ground Water prospect.

Mayurbhanj

Physiography: The Mayurbhanj district shows conspicuous physiographic variations and mainly represented by high hills/ isolated hillocks/ domal granitic outcrops, vast undulating plains and alluvial tract.

Lateritic Upland: It occupy the eastern part of Baripada. The hard crust of the laterite in the region is followed downward by litho-margic clay and highly weathered bed rock. The general topography is characterized by gently undulating plain.

Alluvial Plain: It occurs along a narrow stretch in the south-eastern and southern part of the district lying adjacent to the river Budhabalanga.

Flood Plain: This hydromorphic unit has been mapped in the southern part and south eastern part of the district and in the northern part, of Bangiriposi block. In this unit buried channel and migrated river courses from hydrogeologically significant units.

Intermontane Valleys: These valleys are restricted mainly to the north western part and sporadically to the central part of the district and consist of phyllite and other Iron ore group of rocks. Groundwater potential is moderately good.

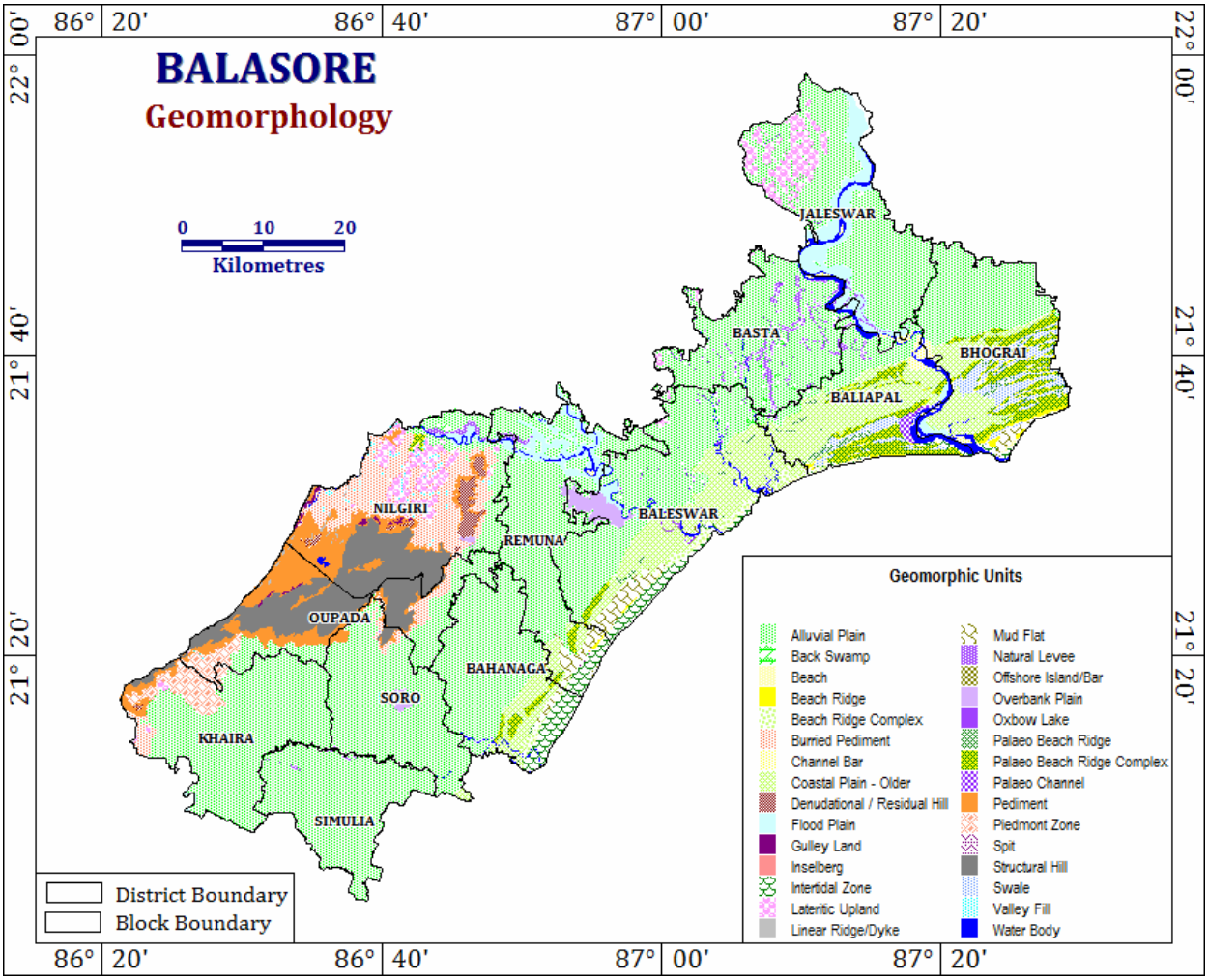
Denudational Hills: These hills are identified by their high relief. Granitic hills represent this geomorphic land form in the area. Rate of infiltration is very poor except along fractures/joints. These generally act as runoff zones.

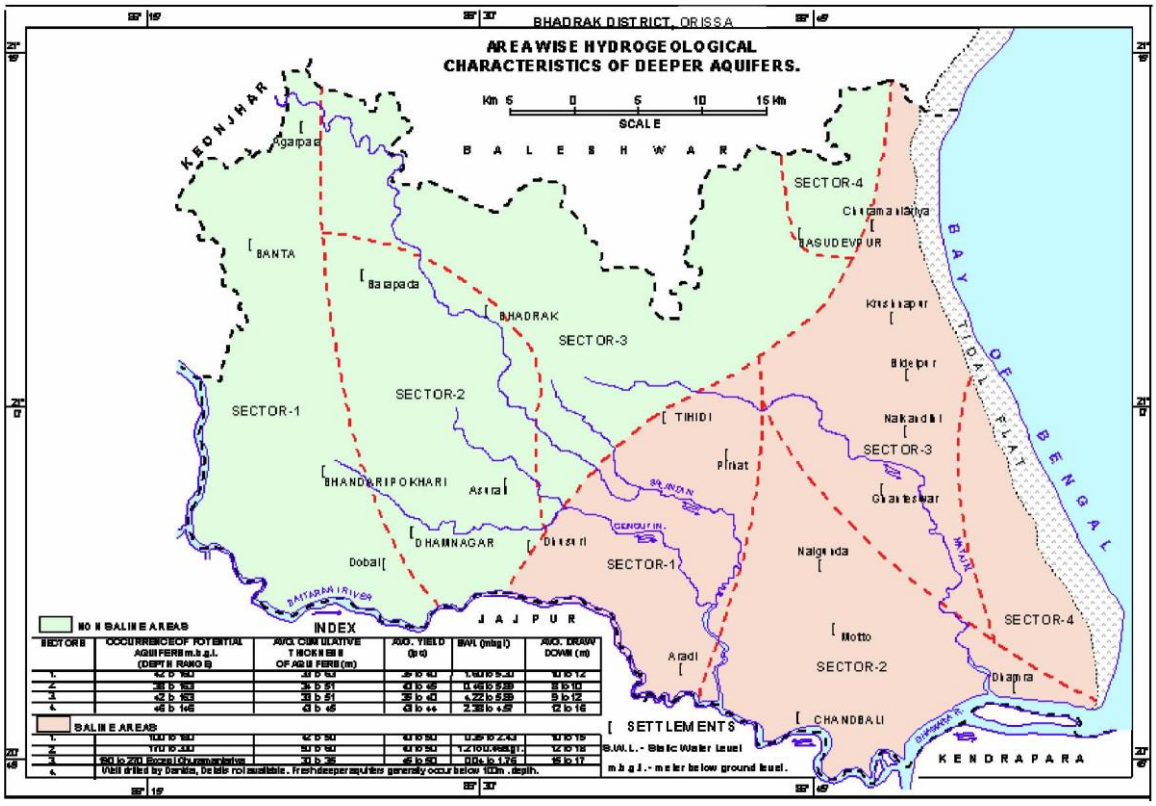
Shallow and Deeply weathered Pediplain: These geomorphic units occur throughout the area except in the extreme eastern part of the district and consists of Singhbhum granite. Occurance of ground water in these unit are moderate to good.

Soil Types: The soils of the district may be broadly grouped into two categories depending upon their occurrence physical and chemical properties e.g. Alfisols, Ultisols.

Alfisols: It is distributed throughout the district,these include older alluvial soil and red earth soil. These soils are generally deficient in P O and N, pH varies between 6.5-7.3.

Ultisols: These soils include laterite, lateritic soil, red and yellow soil. These soils are poor in nitrogen, phosphate, potassium and organic matter. The pH ranges from 4.5-6.0.


BALASORE
Geomorphology
0 10 20
Kilometres
86° 20'
86° 40'
87° 00'
87° 20'
22° 00'
21° 40'
21° 20'
JALESWAR
BASTA
BHOGRAI
BALIAPAL
BALESWAR
NILGIRI
REMUNA
OUPADA
BAHANAGA
SORO
KHAIRA
SIMULIA
District Boundary
Block Boundary
Geomorphic Units
Alluvial Plain
Back Swamp
Beach
Beach Ridge
Beach Ridge Complex
Burried Pediment
Channel Bar
Coastal Plain - Older
Denudational / Residual Hill
Flood Plain
Gulley Land
Inselberg
Intertidal Zone
Lateritic Upland
Linear Ridge/Dyke
Mud Flat
Natural Levee
Offshore Island/Bar
Overbank Plain
Oxbow Lake
Palaeo Beach Ridge
Palaeo Beach Ridge Complex
Palaeo Channel
Pediment
Piedmont Zone
Spit
Structural Hill
Swale
Valley Fill
Water Body


BHADRAK DISTRICT, ORISSA
AREA WISE HYDROGEOLOGICAL CHARACTERISTICS OF DEEPER AQUIFERS.
SCALE
B A L E S H W A R
KEONJHAR
BAY OF BENGAL
TIDAL FLAT
SECTOR-1
SECTOR-2
SECTOR-3
SECTOR-4
BANTA
Barapada
BHADRAK
BASUDEVPUR
Krushnapur
Bidelpur
TIHIDI
Pirhat
Nalkandhi
Ghanteswar
BHANDARIPOKHARI
Asura
DHAMNAGAR
Dobai
Dhusuri
Nalgunda
Motto
Aradi
CHANDBALI
Dhamra
BAITARANI RIVER
J A J P U R
K E N D R A P A R A
INDEX
NON SALINE AREAS
SALINE AREAS
SETTLEMENTS
S.W.L. - Static Water Level
m.b.g.l. - meter below ground level.

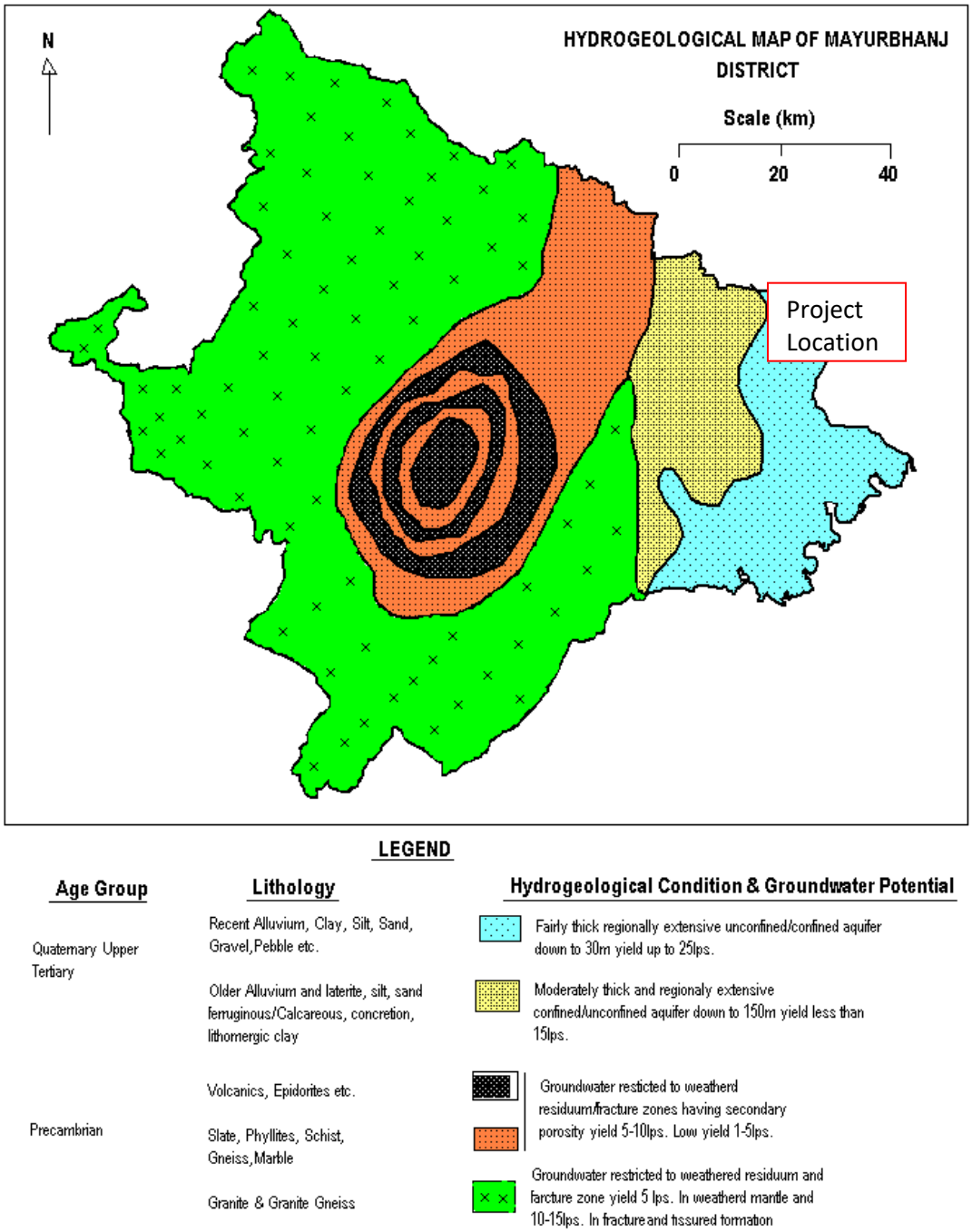


Figure 3-1 : Geomorphology Map of Bhadrak, Balasore and Mayurbhanj Districts

3.4 HYDROGEOLOGY

Bhadrak

The district is underlain by unconsolidated formations belonging to Quaternary and Tertiary periods down to a depth varying from 165 m in the northwestern part to more than 600m in the eastern part along the coast line and are composed of sand, gravel, clay, laterites and lateritic gravel, silt, mud stone, shale, lime stones

Balasore

The geological formations in the district spans in age from Archean to Recent (Quaternary). The Tertiary and Quaternary formations are covering major part of the district while Archeans occupy the hilly areas and the areas under higher altitude in the west. The crystalline are devoid of primary porosity but possess secondary porosity on being weathered and fractured. However, the unconsolidated sand and gravel layers of Tertiary and Quaternary age, form good repository of ground water. Ground water occurs under water table conditions in shallow aquifers and under semi confined to confined conditions in deeper aquifers.

Hydrogeologically all the formations encountered in the district can be broadly divided into three subgroups viz. 1 - Crystalline formations 2- Sedimentary formations and 3 - Laterites. The crystalline formations are mainly constituted by granite gneisses (Nilgiri Granites) while the sedimentaries are constituted by younger and older alluvium and Tertiary formations.

Mayurbhanj

The water bearing formation of the area can be divided into (a) areas underlain by fractured, fissured and consolidated basement rock formations (b) areas underlain by recent unconsolidated alluvial formations.

(a) Consolidated Formation- These are most predominant rock types occurring in the undulating plains of the ditrict. Groundwater occur under unconfined condition in the shallow weathered zone and circulates through fractures and joints. The thickness of the weathered zone varies from 3 to 35 m. Depth of open wells in these formations varies from 5 to 14 m below ground level.

(b) Unconsolidated alluvial formations-The unconsolidated formations consist of laterite and alluvium. Laterites at places are highly consolidated and used as building stones. The laterites have high degree of effective porosity and form potential aquifers commonly tapped in dug wells.

The alluvium comprises an admixture of clay, silt, sand and calcareous concretions in varying proportions. The coarse sediments like sand and gravel form the main repository of ground water. Ground water occurs under both unconfined condition in shallow aquifers and in confined condition in deeper parts.

3.5 DEPTH TO WATER LEVELS

Bhadrak

This freshwater zone in pheratic zone generally extends upto 5 to 12 mbgl. The deeper fresh water bearing aquifers generally occur at depths from 84 to 292 mbgl. The overall cumulative thickness of freshwater aquifer generally varies from 50 to 55 meters.

Balasore

Based on extensive analysis of historical data, micro level hydrogeological survey data generated and ground water exploration carried out in the area,

the following three types of aquifers can be demarcated and the details are given below:

Aquifer – I: These are the unconfined aquifer comprising the top weathered and phreatic aquifer and occurring upto a depth of 50 metres below ground level.

Aquifer – II: These are semi-confined to confined aquifers which are represented as fractured aquifers in the Consolidated formation in the north western part of the district and as porous and pervious zones in the unconsolidated sedimentary formations in the rest of the district. These aquifers are presumably classified to occur between the depth range of 50 – 150 metres below ground level.

Aquifer – III: These are confined aquifers occurring in the depth range of 150 – 300 metres below ground level. They are more pronounced in the eastern part of the district with thick pile of sediments.

Mayurbhanj

The depth of the wells in hard rocks varied from 59 to 200.4m and yield varied from negligible to 10.83 lps. In the hard rock terrain in Rangamatia-Jamda-Rairangpur-bisoi-Jamsola tract the yield varied from negligible to 10.83 lps. In Jamkeswar-Raruan tract in the Western part of the district the yield varied from 0.16 to maximum of 11 lps at Raruan. In the southeastern part, the well at Udala yielded 8.84lps. The saturated fractures in the hard rocks are generally restricted within 100 m depth.

The depth of the exploratory wells in semi-consolidated Tertiary formation varied from 131.16 to 303.0m and the yield varied from 5.47 to 18 lps. Two to seven aquifer zones with a cumulative thickness of 10 to 48m occurs within this depth. The static water levels varied from 8.33 to 14.70 m bgl.

3.6 GEOLOGY

Bhadrak

Three types of soils, viz. Alfisols, Aridisols and Entisols occur in the district. As per agro-climatic classification, the district falls under North Eastern Coastal plain.

Balasore

The major parts of the district are underlain by Tertiary & Quarternary Alluvium(including Recent Alluvium). The north western part is underlain by the Archaeo-Proterozoic Basement Granites and Granite Gneisses with minor Pegmatites and vein Quartz.

The recent alluvium occurs in limited patches along the river courses. The Tertiary deposits comprise of lower marine fossiliferous sequence of Miocene' age and an upper estuarine sequence of Mio-Pliocene age.

Mayurbhanj

The Mayurbhanj district shows conspicuous physiographic variations and mainly represented by high hills/ isolated hillocks/ domal granitic outcrops, vast undulating plains and alluvial tract.

3.6.1 SURFACE WATER

Bhadrak

The district forms the outfall area of the Baitarani river. The Baitarani river along with its tributaries form the drainage system of the area and flows along the Southern boundary of the district. Main tributaries of the Baitarani river are Salandi and Matai. The rivers and streams are mostly effluent in nature. The Baitarani and the Salandi rivers have developed extensive flood plains comprising unconsolidated materials. A large number of creeks have been developed before the river debouches with the river Brahmani.

Balasore

The drainage in the area is controlled by Subarnarekha, Panchpara, Burhabalang, Jamira, Kansbans, Sono rivers and their tributaries and distributaries. All these rivers are having south

easterly flow direction. Hydrogeomorphological features of Balasore district are mainly attributed to fluviomarine, erosional, denudational and depositional processes. The coastal plain has been developed due to fluviomarine processes. The alluvial plains owe their origin due to various fluviatile actions of major rivers.

Mayurbhanj

The district is mainly drained by the Budhabalanga, Kharkai, Jamira and several other tributaries originate from Similipal hills. All these rivers exhibit dendritic type of drainage pattern and are structurally controlled.

3.6.2 GROUND WATER

Bhadrak

The dynamic ground water resource of the district was estimated during 2009 jointly by Central Ground Water Board and Ground water Survey and Investigation Deptt. of Govt.of Orissa, adopting the norms recommended by Ground Water Estimation Committee (2003) and found to be 45409 ham. The annual draft is only 25197 ham and the balance ground water resource available for irrigation is 19786 ham. The level of ground water development is only 55.49%.

Balasore

Most of the blocks of the district have already high levels of resource utilization. Bhograi is the block with highest ground water utilization of 68.77% in the district. Nilgiri is the block with lowest ground water utilization of 32.42% in the district. Net ground water availability of the district is assessed to be 1,10,063 HM and the gross annual draft for domestic, industrial, and irrigation uses is 58,651.12 HM. The average stage of ground water development in the district is 53.29%. All the 12 blocks have been classified as SAFE. The fresh in-storage resource in hard rock area is 36,771 HM and the same in alluvial area is 1,52,109 HM, thus the total fresh in storage resource is 1,88,880 HM. The saline in-storage resource in hard rock area is NIL and the same in alluvial area is 26,560 HM, thus the total saline in storage resource is 26,560 HM. Thus the total in storage resource including both the fresh and the saline water for the entire district is 2,15,440 HM. The total Fresh water resource for the entire district combining both the dynamic and the in-storage component is 2,98,943 HM.

Mayurbhanj

As per the ground water resources assessed during 2009, the net ground water resources availability in the district are 148194 ham. 6365 ham of the total ground water is used in domestic and industrial water supply. The existing gross ground water draft for irrigation in net

terms is 33963 ham. The Net ground water availability for future irrigation development 106150 ham. Overall the present level of ground water development is only 27.21 percent in the district with the maximum in Badasahi block viz. 64.65% and minimum in Bijatala block (9.79%). Hence the district as well as all the blocks come under the white category.

Summarized block wise estimate of dynamic groundwater resources is given in Table 3-1.

Table 3-1: Ground Water Potential of the Districts

Block	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for domestic & Industrial Supply	Existing Gross Ground Water Draft for all uses	Provision for domestic & industrial requirement supply for next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development	Category
Bhadra	45409.00	22571.00	2625.00	25197.00	3053.00	19786.00	55.49	Safe
Balasore	116485.00	110063.00	52556.23	6094.89	58651.12	10072.06	53.29	Safe
Mayurbhanj	148194.00	33963.07	6365.90	40329.00	8080.00	106150.00	27.21	Safe

Source: Groundwater Information Booklet, Bhadrak, Balasore, and Mayurbhanj Districts, Odisha

3.7 CLIMATE

Bhadrak

The average lowest and the highest temperatures (1992-99) for the district are 13.80C and 38.70C respectively. The normal annual rainfall is 1568.4 mm (1950 – 1991). The average annual rainfall for the last 8 years (1997-05) is 1528 mm and out of which 1242 mm is monsoon rainfall. During the 2005 the annual rainfall was recorded as 1618.7 mm.

The mean annual wind velocity at Chandbali (IMD observatory) is 9.3 km/hr. The wind speed during cyclonic storms becomes very high and ranges from 70 to 100 km/hr or even more. Major direction of wind is from south and south-west.

The relative humidity, on an average, varies from 40 to 90% during the year and during monsoon it is much more. The mean monthly potential evapotranspiration varies from 4.51 cm during January to 27.68 cm during May.

Balasore

The district enjoys Humid subtropical climate where the temperature of the warmest month is over 22 °C and at least 4 months the temperature remains over 10° C. Southwest monsoon is

the principal source of precipitation in the district. The normal annual rainfall of the district is 1568.4, out of which about 85% is received during monsoon season (mid- June to mid-October).

Month	Daily Mean Temperature (°C)		
	Minimum	Maximum	Average
January	14.4	27.1	20.8
February	17.5	29.5	23.5
March	21.4	33.4	27.4
April	24.4	35.9	30.2
May	25.7	35.7	30.7
June	26.0	33.9	30.0
July	25.7	32.2	29.0
August	25.6	31.7	28.7
September	25.2	32.1	28.7
October	23.1	31.9	27.5
November	18.7	30.1	24.4
December	14.5	27.4	21.0
ANNUAL	**21.9**	**31.7**	**26.8**

Mayurbhanj

The district is characterized by tropical to subtropical climate with hot summer, high and well distributed rainfall during the monsoon and a cold winter. The summer season lasts from March to Middle of June followed by rainy season from June to September and post monsoon period from October and November. May is the hottest month with maximum temperature of 47^{0}C and December is the coldest month with minimum temperature of 6^{0}C.

Table 3-2: Temperature details of IMD Odisha (1995 - 2014)

Bhadrak

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.8	23.5	27.8	30.9	31.9	30.4	28.5	28.6	28.5	26.9	23.4	20.6
Min. Temperature (°C)	14.4	17.1	21.4	24.9	26.7	26.3	25.7	25.9	25.6	23.4	18	14.3
Max. Temperature (°C)	27.2	30	34.3	36.9	37.1	34.6	31.4	31.3	31.5	30.5	28.9	27

Balasore

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.6	23.1	27.5	30.6	31.6	30.4	28.7	28.6	28.6	27.1	23.2	20.5
Min. Temperature (°C)	14.1	16.8	21.3	24.9	26.7	26.6	26.1	26.1	25.8	23.4	17.7	14.1
Max. Temperature (°C)	27.1	29.5	33.8	36.3	36.5	34.3	31.3	31.2	31.4	30.8	28.8	26.9

Mayurbhanj

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.2	23	27.7	31.1	32.4	31	28.8	28.7	28.7	27.1	23	20.2
Min. Temperature (°C)	13.4	16.2	20.8	24.7	26.8	26.7	26	25.9	25.7	23.1	17.1	13.4
Max. Temperature (°C)	27.1	29.8	34.6	37.6	38	35.3	31.7	31.6	31.7	31.1	29	27

Source: Climatological Normals (1981-2010)

3.7.1 RAINFALL

Bhadrak

The district is characterized by tropical monsoon climate having three distinct seasons in the year, viz. winter, summer and rainy seasons. The Bay of Bengal, which forms the eastern boundary of the district, plays a prominent role in controlling the climate of the district.

The winter commences from late November and continues till end of February. The winter is followed by the summer season, which extends up to mid-June. During the period between April and May 3 to 4 cyclonic storms accompanied with rains generally occur in the district. The rainy season sets-in at the advent of the southwest monsoon, generally from the middle of June and continues till end of September.

Balasore

The month of July and August gets the heaviest rainfall of the year, though rainfall is not very regular throughout the season but fairly uniform throughout the district. There are on the

average 60 – 85 rainy days in a year. Besides, the relative humidity varies between 30 % to 86 %.

The year-wise rain data for Balasore is given below

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Year	(Rainfall in mm)												
1995	12	50	39	15	423	193	228	426	306	265	213	0	2170
1996	13	12	0	21	51	215	346	534	77	141	4	0	1414
1997	18	25	108	182	95	330	346	584	362	61	36	54	2201
1998	29	31	95	113	101	170	199	156	458	182	72	0	1606
1999	0	0	0	9	224	300	240	352	445	530	110	0	2210
2000	8	87	0	72	166	291	246	220	332	53	2	0	1477
2001	0	10	68	49	167	366	397	385	152	211	33	0	1838
2002	28	0	46	80	57	232	121	272	373	52	60	0	1321
2003	0	12	50	26	76	287	340	213	184	538	34	16	1776
2004	0	0	4	37	78	260	326	388	231	266	0	0	1590
2005	16	0	63	71	88	227	403	222	549	432	0	0	2071
2006	0	0	25	27	112	240	370	524	429	25	22	0	1774
2007	3	93	0	19	97	296	452	544	603	44	35	0	2186
2008	67	18	4	23	98	633	263	287	304	10	35	0	1742
2009	0	0	9	0	171	90	430	303	336	199	42	0	1580
2010	0	0	2	2	201	93	254	177	306	199	6	27	1267
2011	0	16	3	33	109	348	112	374	472	20	0	0	1487
2012	71	0	0	80	30	97	147	291	233	28	33	18	1028
2013	1	2	5	50	192	241	252	0	346	697	0	0	1786
2014	0	42	44	24	225	177	479	490	316	134	0	0	1931
Average	13.3	19.9	28.25	46.65	138.05	254.3	297.6	337.1	340.7	204.35	36.9	5.75	1723

Mayurbhanj

The average annual rain fall in the district is 1500mm. The mean monthly potential evapotranspiration values range from 40mm in January to 347 mm in May.

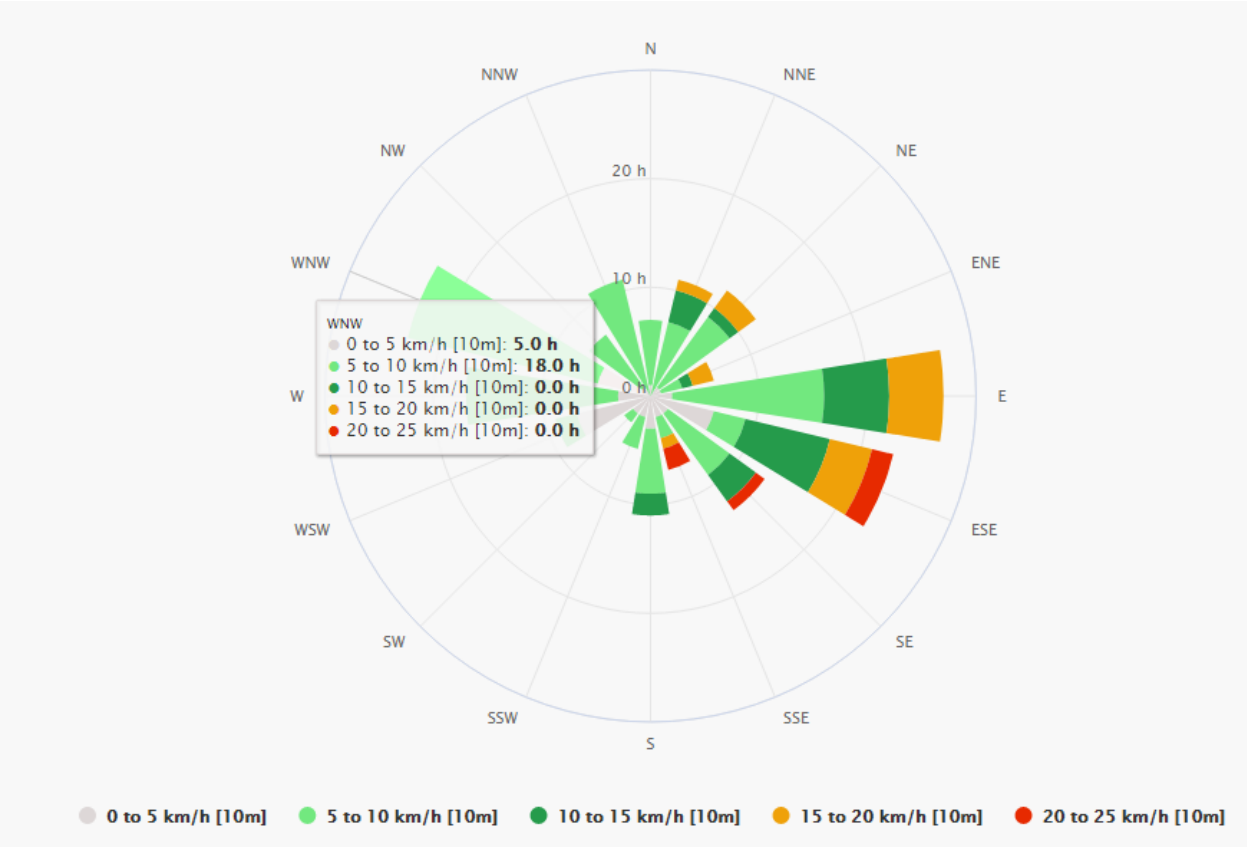
Month wise rainfall data of the district is given below:

3.7.2 WIND

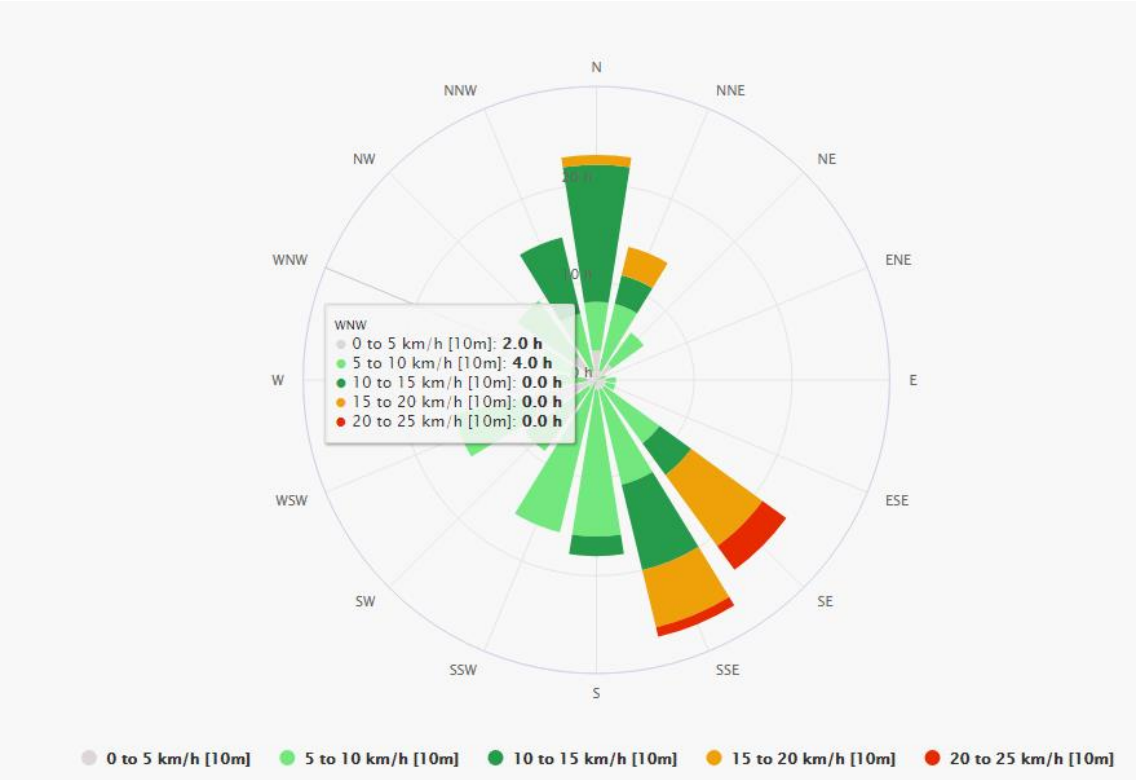
Balasore

Wind is generally light to moderate. During summer and southwest monsoon season, wind velocity increases. In the post-monsoon months and in winter, wind is mainly from the north and east. During summer wind direction is variable and in rainy season wind from southwest direction is very common. The southern part of the district is prone to cyclonic storms.

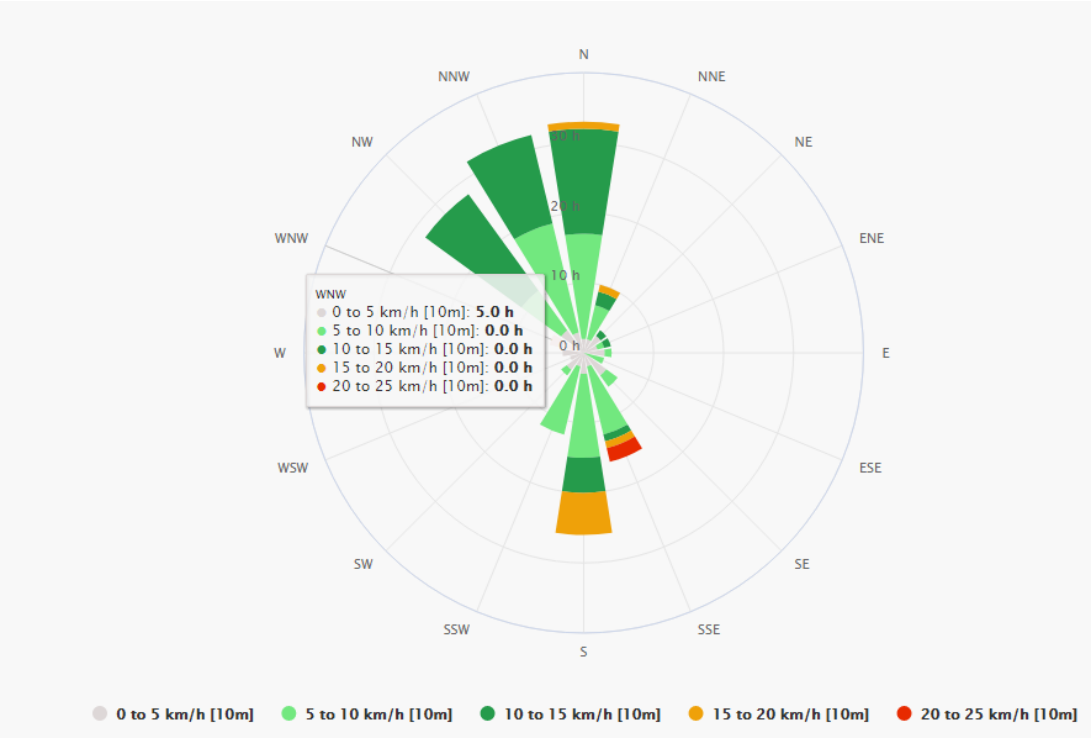
Wind Rose Diagram of Bhadrak



Wind Rose Diagram of Balasore

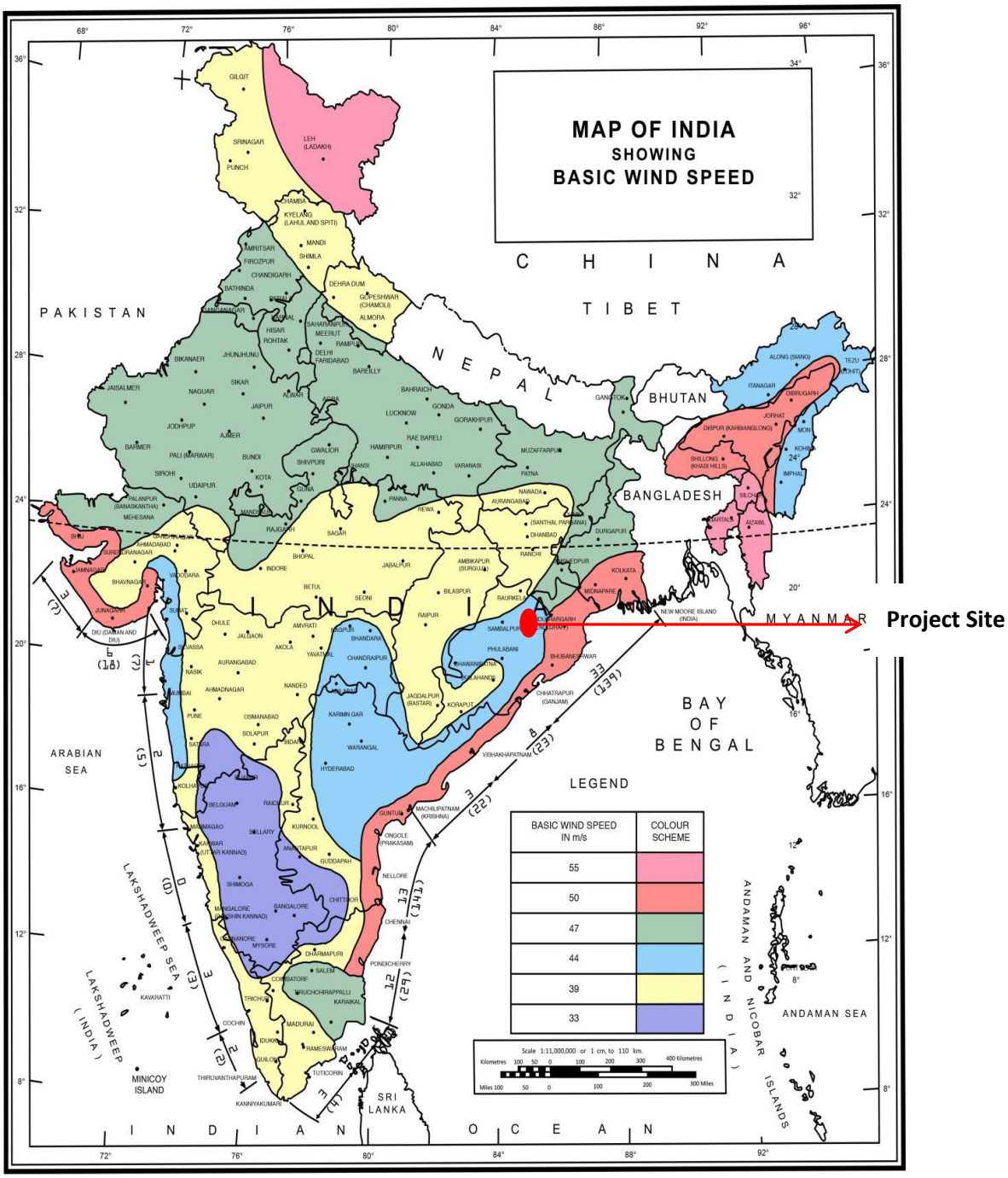


Wind Rose Diagram of Mayurbhanj



Source: Climatological Normals (1981-2010)

Figure 3-2: Wind Hazard Map showing Project Site



Source: Climatological Normals (1981-2010)

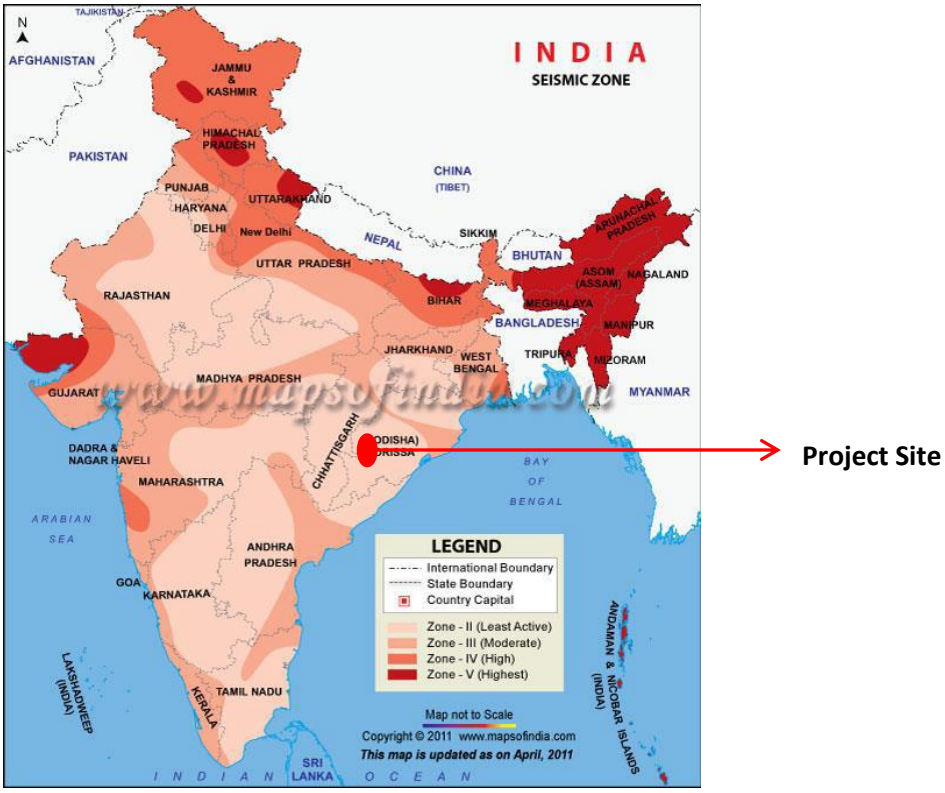
3.7.3 NATURAL HAZARDS

Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (floods), climatological (droughts, etc.), meteorological (cyclones and storms/wave surges) or biological (disease epidemics and insect/animal plagues). Natural hazards can have impacts on the developments; hence assessment of the natural hazards in the area is important for any development.

Seismicity

As per the seismic zoning map of India (given in the earthquake resistant design code of India [IS:1893, Part 1, 2002], the project site area falls in seismic Zone II, i.e the least active seismic zone. The IS code assigns zone factor of 0.16 for Zone II. The project under the Bhadrak Balasore and Mayurbhanj Districts of Odisha hence lies in seismic zone II (Least Damage Risk Zone (MSK VI) as shown in Figure 3-7 below.

Figure 3-3: Geological Map of India with Seismic Zonation showing Project Site



Source: Map of India, Secondary Research, TUV SUD

3.8 AMBIENT AIR QUALITY

Ambient Air Quality Monitoring (AAQM) was carried out at 3 locations by a NABL and MoEF&CC accredited laboratory. The air samples were analysed as per standard method specified by Central Pollution Control Board (CPCB), IS: 5184, and American Public Health Association. The monitored parameters, sampling frequency, code of practice and methods of measurement are given in **Table 3-3** below.

Table 3-3: Monitored Parameter, Sampling Frequency, Code of Practice and Method of Measurement

Sr. No.	Parameter	Sampling Frequency	Code of Practice	Method of Measurement
1.	Particulate Matter (PM10)	24 hours once a week	IS-5182 (PART-23):2006 & CPCB Guidelines	Gravimetric
2.	Particulate Matter (PM2.5)			
3.	Sulphur Dioxide (SO_2)	24 hours once a week	IS-5182 (Part-II):2001 & CPCB Guidelines	Improved West and Geake
4.	Oxides of Nitrogen (NOx)	24 hours once a week	IS-5182 (Part-VI): 2006 & CPCB Guidelines	Modified Jacob & Hochheiser (Na-Arsenite)
5.	Carbon Monoxide (CO)	8 hourly for 24 hours once a week	IS: 5182 (Part-X) & CPCB Guidelines	Non Dispersive Infra-Red (NDIR) spectroscopy

Table 3-4: Details of Ambient Air Quality Stations

Sr. No.	Monitoring Location	Geographical Coordinates	Location
1	AAQM1	21°04'26.4"N 86°30'28.1"E	Bhadrak City, Chandabali Road
2	AAQM2	21°30'51.3"N 86°53'45.8"E	Balasore, Janugunj
3	AAQM3	21°55'12.3"N 86°44'44.9"E	Baripada Labour Colony

Table 3-5: Ambient Air Quality Monitoring Results

Parameter	Unit		AAQ1	AAQ2	AAQ3
PM_{10}	µg/m³	NAAQS (24 hrs)	100	100	100
		Minimum	41	44	43
		Maximum	48	57	51
		Average	44.5	50.5	47

		98 Percentile	47.86	56.74	50.84
$PM_{2.5}$	µg/m^3	NAAQS (24 hrs)	60	60	60
		Minimum	18	21	24
		Maximum	37	31	33
		Average	27.5	26	28.5
		98 Percentile	36.62	30.8	32.82
SO_2	µg/m^3	NAAQS (24 hrs)	80	80	80
		Minimum	16	18	12
		Maximum	19	22	15
		Average	17.5	20	13.5
		98 Percentile	18.94	21.92	14.94
NOx	µg/m^3	NAAQS (24 hrs)	80	80	80
		Minimum	12	16	14
		Maximum	14	19	16
		Average	13	17.5	15
		98 Percentile	13.96	18.94	15.96
CO	mg/m^3	NAAQS (8 hrs)	2	2	2
		Minimum	<1.5	<1.5	<1.5
		Maximum	<1.5	<1.5	<1.5
		Average	<1.5	<1.5	<1.5
		98 Percentile	<1.5	<1.5	<1.5

NAAQS: Revised National Ambient Air Quality Standards dated 18th November 2009
ND: Not Detectable

Particulate Matter (PM_{10})

The Particulate Matter (**PM_{10}**) concentrations varied from 41 µg/m3 to 57 µg/m3 in all the three monitoring locations. The highest concentration of 41 µg/m^3 was observed at Bhadrak location and the lowest concentration of 57 µg/m3 was observed at Balasore. However, the **PM_{10}** concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Particulate Matter ($PM_{2.5}$)

The Particulate Matter ($PM_{2.5}$) concentrations varied from 18 µg/m^3 to 37 µg/m^3 in all the three monitoring locations. The highest and lowest concentration both were observed at Bhadrak

location. However, the **$PM_{2.5}$** concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Sulphur Dioxide (SO_2)

The Sulphur Dioxide (SO_2) concentrations varied from 12 µg/m^3 to 22 µg/m^3 in all the three monitoring locations. The highest concentration of 22 µg/m^3 was observed at Balasore location and the lowest concentration of12 µg/m3 was observed at Baripada. However, the SO_2 concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Oxides of Nitrogen (NOx)

The concentrations of oxides of Nitrogen (NOx) concentrations varied from 12 µg/m^3 to 19 \µg/m^3 in three monitoring locations. The highest concentration of 19 µg/m^3 was observed at Balasore location and the lowest concentration of 12 µg/m3 was observed at Bhadrak. The NOx concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Carbon Monoxide (CO)

The Carbon monoxide (CO) concentrations at all locations were found to be below 1.5 mg/m^3 at all locations.

Inferences:

The ambient air quality observed in the area is good as all the parameters observed are considerably below National Ambient Air Quality Standards (NAAQS). The site and surrounding is predominantly rural with no identified major sources of pollution in the area. The movement of traffic was also observed to be limited in the area.

3.9 WATER QUALITY

In general, the quality of ground water at certain depths in the sandy aquifer are found good and potable and in the adjoining areas covered by lateritic/weathered gneissic rocks, it is sweet to alkaline. The dug wells in the alluvial area generally yield saline water during summer months and get fresh water during monsoon periods. The water samples collected from the dug wells /shallower zones during May-06 indicate the EC value as 500 to 10430µ/cm at 25°c in the higher order and 200 to 500µ/cm in the lower order. The EC in some of the deeper bore well located at places recorded as high as 18830µ/cm at 25°C are saline. Some parts of Bhadrak have chloride concentration up to 4000 mg/l.

Some groundwater in the area is contaminated from the salinity of tidal recharge. This contamination is more pronounced in wells along the stream courses up to the distance where tidal effect extends. Further, Ground water in proximity to stream course is contaminated with seepage of domestic waste.

As a general rule, pumpage must be distributed in time and space and there should not be any concentration of wells to avoid saline water ingress.

3.9.1 GROUND WATER QUALITY MONITORING &ANALYSIS

Two groundwater sample and two surface water sample were collected to evaluate the water quality in the study area. Details of the sampling locations are given in the Table 3-9 and 3-10 below.

Table 3-6: Ground Water Quality Sampling Locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	GW1	21°04'26.4"N 86°30'28.1"E	Bhadrak City, Chandabali Road
2	GW2	21°30'51.3"N 86°53'45.8"E	Balasore, Janugunj
3	GW2	21°55'12.3"N 86°44'44.9"E	Baripada Labour Colony

The ground water sample was analyzed for parameters as mentioned in IS: 10500:2012 standards and the analysis was undertaken as per IS 10500 and relevant American Public Health Association (APHA) standard methods. The results of the analysis are presented in **Table 3-10** below.

Table 3-7: Results of Ground Water Quality Analysis

Sr. No.	Parameter	IS: 10500 (Drinking Water Standards), 2012*	Unit	Ground Water		
				GW-1	GW-2	GW-3
1	Color	--	Hazen	2	1	3
2	Electrical Conductivity	--	uS /cm	324	345	523
3	Turbidity	1 (5)	NTU	3	2	5
4	pH	6.5-8.5	-	7.3	7.4	7.6
5	TDS	500 (2000)	mg/l	566	589	624
6	Total hardness	200 (600)	mg/l	341	512	465
7	Alkalinity	200 (600)	mg/l	243	189	178

8	Chlorides	200 (600)	mg/l	35.6	41.2	22.5
9	Sulphate	200 (400)	mg/l	3.7	3.1	4.1
10	Fluoride	1 (1.5)	mg/l	0.2	0.4	0.3
11	Boron	0.5 (1)	mg/l	0.1	0.3	0.5
12	Manganese	0.01 (0.03)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
13	Residual Chlorine	0.2 (1)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
14	Calcium	75 (200)	mg/l	33	56	45
15	Magnesium	30 (100)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
16	Iron	0.3	mg/l	0.03	0.02	0.06
17	Cadmium	0.003	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
18	Arsenic	0.001 (0.05)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
19	Lead	0.01	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
20	Zinc	5 (15)	mg/l	0.1	0.1	0.1
21	Chromium Hexavalent	--	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
22	Copper	0.05 (1.5)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
23	Selenium	0.01	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
24	Total Coliform	Shall not be detectable in any 100 ml sample	MPN	0	0	0

** Values in () indicate permissible limits*
ND: Not Detected
BDL: Below Detectable Limit

Inferences:

- The pH of groundwater samples is alkaline and is 7.3-7.6
- The total Coliform content was not detected in any of groundwater samples.

3.9.2 SURFACE WATER QUALITY ANALYSIS

The surface water sample was analyzed for parameters as mentioned in IS: 2296-1982 standards and the analysis was undertaken as per IS 12296 and relevant American Public Health Association (APHA) standard methods. The results of Surface Water Quality analysis are given below in Table 3-8.

Table 3-8: Surface Water Quality Sampling Locations

S. No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	SW1	21°04'02.6"N 86°30'09.2"E	Salandi River Naripur, Bhadrak
2	SW2	21°30'46.4"N 86°55'47.4"E	Gopal Gaon Nala, Balasore
3	SW3	21°55'01.9"N 86°43'33.5"E	Burha Balang River

Table 3-9: Results of Water Quality Analysis

Sr. No.	Parameter	IS: 2296 (Class C)	Unit	Surface Water		
				SW1	**SW2**	**SW2**
1	Color	300	Hazen	2	4	2
2	Electrical Conductivity	--	uS/cm	189	95	145
3	pH	6.5-8.5	-	7.1	7.9	7.2
4	DO	4	mg/l	7.2	5.6	7.0
5	BOD (27^0C for 3 days)	3.0	mg/l	3	14	3
6	Total Dissolved Solids		mg/l	989	341	1231
7	Total hardness	200 (600)	mg/l	898	324	645
8	Alkalinity	200 (600)	mg/l	321	98	189
9	Chlorides	600	mg/l	98.1	22.1	341
10	Sulphate	200 (400)	mg/l	5.8	8.8	11.9
11	Fluoride	1.5	mg/l	0.1	0.1	0.5
12	Nitrate (as NO_3^-)	50	mg/l	98.5	33.4	12.2
13	Potassium (as K)		mg/l	77.3	23.2	18.9
14	Sodium (as Na)		mg/l	343	89	122
16	Calcium	75 (200)	mg/l	125	111	213
17	Magnesium	30 (100)	mg/l	44.1	12.4	32.4
18	Cadmium	0.01	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
19	Cyanides	0.05	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
20	Arsenic	0.001 (0.05)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)

21	Chromium (as Cr)		mg/l	BDL (<1)	BDL (<1)	BDL (<1)
22	Copper	0.05 (1.5)	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
23	Selenium	0.01	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
24	Mercury		mg/l	BDL (<1)	BDL (<1)	BDL (<1)
25	Lead		mg/l	BDL (<1)	BDL (<1)	BDL (<1)
26	Aluminium (as Al)			BDL (<1)	BDL (<1)	BDL (<1)
27	Total Coliform	5000	MPN/1000 ml	NIL	16	NIL
28	Phenolic Compounds (as C_6H_5OH)	0.005	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
29	Anionic detergents (as MBAS)	1.0	mg/l	BDL (<1)	BDL (<1)	BDL (<1)
30	Oils and grease		mg/l	BDL (<1)	BDL (<1)	BDL (<1)
31	Aluminium (as Al)		mg/l	BDL (<1)	BDL (<1)	BDL (<1)
32	Zinc (as Zn)		mg/l	BDL (<1)	BDL (<1)	BDL (<1)

** Values in () indicate permissible limits*
ND: Not Detected
BDL: Below Detectable Limit

Inferences:

The summary of the analysis of water samples results is as follows:

- pH was observed to be ranging from 7.1-7.9.
- The coliform count in SW-1 and SW-3 was observed as NIL while in SW-2 it was 16 as the surface water sample collection was carried out from flowing river which may contained some fecal waste due to open defecation and animal waste. Further, runoff from surface soil area during rainy season might have attributed to fecal contamination of the waterbodies.

3.10 SOIL QUALITY

The district is covered with three types of soils i) sandy soil covering the beaches and the adjoining stretches ii) yellow loamy soil and iii) red lateritic soil. The sandy soils are confined to a narrow strip of the coast having width ranging from less than 100 m to as much as a kilometer. These fine to medium texture sands are characterized by their extremely high rate of infiltration and act as a good recharge media for ground water. Yellow loamy soils are transported from origin and are found mostly along riverbanks and lower reaches of valleys. They are mostly used for tile industries. This soil type is very well suited for irrigation and shows good response to irrigation practices. Red lateritic soil is the most dominant soil type in the area. The texture of these soils varies from fine to coarse. The soil in the valleys and immediate slopes are rich in loam whereas in upper slopes and pediplanes are much coarser in nature. The degree of leaching undergone by this soil type is also variable.

Table 3-10: Details of the Soil sampling locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	S1	21°04'26.4"N 86°30'28.1"E	Bhadrak City, Chandabali Road
2	S2	21°30'51.3"N 86°53'45.8"E	Balasore, Janugunj
3	S3	21°55'12.3"N 86°44'44.9"E	Baripada Labour Colony

The soil samples were analyzed for various physical and chemical parameters of soil and the results of the soil quality analysis are given in Table 3-11 below:

Table 3-11: Results of Soil Quality Analysis

S. No.	Parameter	Unit	S1	S2	S3
1	Soil Type		Sandy Loam	Sandy Loam	Sandy Loam
2	pH	---	7.1	7.9	7.5
3	Electrical Conductivity	µS/cm	341	378	189
4	Potassium (as K)	mg/kg	545	341	389
5	Sodium (as Na)	mg/kg	98.4	45.6	67
6	Organic Matter	%	2.21	1.98	1.32
7	Sodium Absorption Ratio	meq/kg	2.0	1.1	1. 2
8	Carbonate (as CO_3)	mg/kg	<20.0	<20.0	<20.0
9	Chloride (as Cl-)	mg/kg	119	88	89

10	Phosphorus (as P)	mg/kg	4.5	11.2	8.9
11	Sulphate	mg/kg	33.2	26.9	41.0
12	Bulk Density	gm/cc	1.4	1.9	2.1
13	Moisture	%	0.55	0.32	0.40
14	Total N	mg/kg	45.1	52.9	56.6
15	Iron (as Fe)	mg/kg	7443	4390	5671
16	Boron [as B]	mg/kg	3.8	3.1	5.2
17	Copper (as Cu)	mg/kg	15.9	22.5	11.8
18	Zinc (as Zn)	mg/kg	12.9	6.9	8.2

The results of the soil quality analysis were compared with the standard soil classification provided by the Indian Council of Agricultural Research (ICAR) and as given in Table 3-12 below.

Table 3-12: Standard Soil Classification

Soil Parameters	Classification	
pH	Normal to saline	6.0 to 8.5
	Tending to become alkaline	8.5-9.0
	Alkaline	Above 9.0
Electrical conductivity (mmhos/cm)	Up to 1.00 – Normal	
	1.01- 2.00 - Critical to germination	
	2.01-4.00 - Critical for growth of the sensitive crops	
	Above 4.00 – Injurious to most crops	

Source: Indian Council of Agricultural Research, New Delhi

Inference

- pH of the soil samples ranged from 7.6 -7.3, showing normal to saline in nature;
- Electrical conductivity of SW-1 was observed in the level of 100-300 mmhos/cm which indicates low EC values may be good to crops

3.11 NOISE ENVIRONMENT

Primary noise monitoring was carried out for continuous 24 hours at the three (03) identified receptor locations to evaluate the baseline noise levels at the project site. The ambient noise monitoring has been undertaken, taking into consideration factors like wind induced noise and human activities such as movement of vehicles. The baseline ambient noise levels represent

the background noise levels that would be present in the absence of the proposed Wind power plant.

Ambient noise level was monitored continuously for 24 hours using Sound Level Meter. Sound pressure levels were recorded at every 10 minutes to calculate the Leq (hourly) values. The relevant statistic measured was the LA90 (10min) (The A-weighted sound pressure level exceeded for 90 % of the 10minute interval). The noise levels obtained were analyzed to arrive at the equivalent continuous noise level (Leq) for day and nighttime. The day and nighttime hours ranged from 06:00 to 22:00 hrs and 22:00 to 06:00 hrs respectively. The noise monitoring locations are given below in Table 3-13.

For noise levels measured over a given period of time it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels exceeds the time interval. The notation for the statistical quantities of noise levels is described below:

- Hourly Leq values have been computed by integrating sound level meter.
- Lday: As per the CPCB guidelines the daytime limit is between 06:00 hours to 22.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.
- Lnight: As per the CPCB guidelines the nighttime limit is between 22:00 hours to 06.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.

Table 3-13: Details of Noise Level Monitoring Locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	N1	21°04'26.4"N 86°30'28.1"E	Bhadrak City, Chandabali Road
2	N2	21°30'51.3"N 86°53'45.8"E	Balasore, Janugunj
3	N3	21°55'12.3"N 86°44'44.9"E	Baripada Labour Colony

It was observed that the baseline noise levels ranged from 50.9-58 dB (A) during daytime and 61.7 to 62.5 dB (A) during nighttime. The noise monitoring analysis results are given in Table 3-18.

Table 3-14: Results of Noise Level Monitoring- Residential Areas

S.No.	Parameters	Unit	N1	N2	N3
1	L10	dB(A)	44.3	46.4	44.5

2	L50	dB(A)	39.5	41.1	39.0
3	L90	dB(A)	38.3	37.5	35.6
4	LEQ	dB(A)	42.4	41.5	39.8
5	Ambient Noise Level- Leq day	dB(A)	43.2	42.1	41.2
6	Ambient Noise Level- Leq Night	dB(A)	39.4	38.5	37.4
7	Day-Night Sound Level (Ldn)	dB(A)	41.9	42.1	40.1

3.12 BIOLOGICAL ENVIRONMENT

3.12.1 FOREST AREA/ RESERVED FOREST/ NATIONAL PARKS & SANCTAURIES

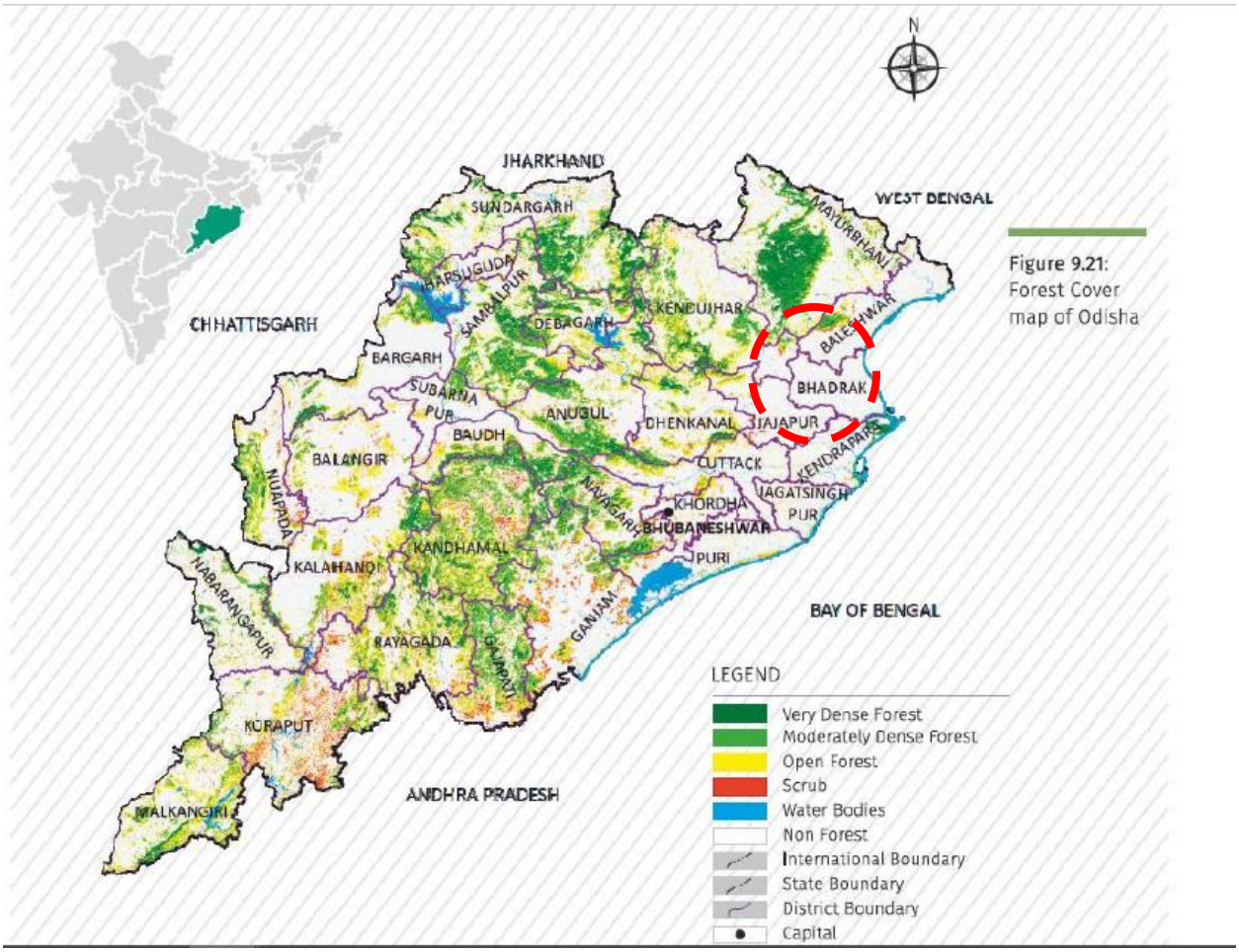
Forest Cover of the State is 51,354 sq.km which is (32.98 % of the State's geographical area. In terms of forest canopy density classes, the State has 6,967 sq.km (4.47 % of GA) very dense forest, 21,370 sq.km (13.72% of GA) moderately dense forest and open forest and 23,008 sq.km (14.77 % of GA) respectively. The comparative details between the Project Districts & State forest Cover have been presented in below

Table 3-15: Forest Cover in Project District and State

District / State	Area in Km^2					% of Geographical Area
	Geographical Area	**Very Dense Forest**	**Moderately Dense Forest**	**Open Forest**	**Total**	
Odisha	1,55,707	6,967	21,370	23,008	51,354	32.98

Source: India State of Forest Report, 2017

Figure 3-4: Forest Cover Map of Odisha State showing project location



Source: *The Odisha Forest Department*

Ecological studies are one of the important aspects of Environmental Impact Assessment (EIA) with a view to conserve biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities, which interact not only within and between themselves but also with the biotic components viz. physical and chemical components of the environment. Generally, biological communities are good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important for safety of flora and fauna. The biological environment includes terrestrial and aquatic ecosystems.

This section of report describes, the methodology adopted for secondary data collection, diversity of higher flora and fauna recorded through primary field studies and the secondary data sourced from published scientific literature, habitat profile and ecosystem services profile and nearest designated areas of the project site.

Review of Secondary Data

The great plant wealth and diversity of Odisha is due to immense variety of climate, altitude and edaphic factors. Vegetation of the state can be broadly divided into four categories.

- Coastal vegetation
- Island vegetation
- Vegetation of the interior plains
- Vegetation of the hills and mountains

Littoral Vegetation

The soil is sea sand often blown and accumulating in low dunes with adequate time, but poor in nitrogen and mineral nutrient. Most of these have been converted into Casuarina plantation. The forest type occurs in reserve forest of Pichavaram, the littoral forests consists of plant species Borasus flabellifer,Anacardium occidentale, Lannia coromandalica, Pandanus tectorius, Opuntia dillenii, Cassia auriculata, Sesuvium portulacastrum, Cyperus arenarius.

Plantation

The division contains plantations of cashes, Eucalyptus sp, Casuarina, Bambusa arundanacea, Prosopis juliflora and other miscellaneous species.

Vegetation of the Interior plains

The vegetation of the plains at the foot or on the undulating slopes of hills and hillocks in the rocky area bordering the coastal plain comes under Southern tropical thorn forests of Champion and Seth (1968). These are often called as Scrub jungles. They are found in Chengalpattu, North and South Arcot, Pudukottai, Tiruchirapalli, Tirunelveli and less so in Salem, Periyar and Coimbatore districts. In these scattered forests, trees hardly reach 10 m in height and area often armed with spines and prickles. Most of the plants manifest several xeromorphic features. The common trees are Acacia chundra, A. horrida, A leucophloe, A nilotica ssp. Indica, Albzia amara, Azadirachta indica, Chloroxylon sweitenia, Dalbergia spinosa, Dichrostachys cineraria, Limonia acidissima, Plecospermum spinarum, Strychnos nux-vomica, Strychnos potatorum, Wrightia tinctoria and Zizyphus spp. The shrubs commonly met with are Cadaba fruticosa, Capparis zeylanica, Carissa congesta, Cassia auriculata, Flacourtia indica, Maytenus

emerginata, Pisonia aculeate, Scutia myrtina, Securegenia leucopyrus and Toddalia asiatica. The common climbers are cardiospermum canescens, C.halacacabum, Ceropegia candelabrum, C. juncea, Cissus quadrangularis, C. rependa, Cissampelos pareira var hirsute, Diosoria sp, Leptadenia reticulate, Pergularia daemia and Ventilago madraspatna. During rainy season, a variety of herbaceous plants like Achyranthes aspera, Allamania nodiflora, Apluda mutica, Aristida setacea, Blumea mollis, Cleome angustifolia and species of Cymbopogon, Glinus, Indigofera, Leucas, Mollugo and Oldenlandia are seen.

Tropical thorn forest of Tamilnadu are differentiated into southern thorn forest, Carnatic umbrella thorn forest, Southern Euphorbia scrubs and southern thorn scrubs (Champion and Seth 1968). In southern thorn forest, species of Acacia, Mimosa and Zizyphus are predominantly met with. In Carnatic umbrella thorn forest Acacia planifrons is common. These forests are found in Kanyakumari, Madurai, Ramanathapuram and Tirunelveli.

Southern Euphorbia scrub is full of fleshy euphorbias. Barleria buxifolia, Calotropis gigantea, Euphorbia antiquorum, E.tricalli and Opuntia dillenii are common. Southern thorn scrubs are found in the plains like Chennai and its environs. Sandal bearing scrubs are met within Sirur reserve of Niligiris.

Vegetation of Hills and Mountains

Dry Deciduous forest

These forests are found at about 400 m and above. The canopy is closed. Most of the species are deciduous. The undergrowth is usually dense. The common trees are Albizia amara, A.odorattissima, Anogeissus latifolia, Butea monosperma, Chloroxylon sweitenia, Dalbergia sp, Pterocarpus marsupium, Shorea roxburghii, Strychnos nuxvomica, Terminalia so. The bamoboo, Dendrocalamus stictus is often found. Dodonea viscose, Securinega virosa, Strobilanthes sp are some of the shrubs found in these forests. The common climbers are Combretum madraspatana, Cycas circinalis is occasional. Species of Abutilon, Achyranthes, Aristida, Bulbostylis, Cleome, Cymbopogon, Cyperus Digitaria, Heracleum, Hetropogon, Themeda, Tribulus etc form the ground layer.

South Indian Moist Deciduous forest

This type is below the zone of semi-evergreen forest. The trees reach a height 30-36 m and are deciduous. Bamboos are common. Epiphytes are rare. Bombax ceiba, Dillenia pentagyna, Mitragyna parviflora, Tectona grandis, Terminalia sp, Vitex sp, and Zizyphus xylophorus are the common trees. Cycas circinalis is occasional. Helictris isora, Lantana camara and Zizyphus oenoplia are common shrubs. Common climber is Ipomea sp. Common grass is Imperata sp

Semi-evergreen forest

This type occurs on slopes of hills and mountains usually upto 1000m. Canopy is of 2 or 3 storeys. Epiphytis orchids are present. Climbers and canes are common. Top canopy consists of Artocarpus sp, Dalbergia latifolia, Hopea sp. The second storey consists of species of Actinodaphne, Aglaia, Bischofia, Drypetes and Symplocos. Species of Glycosmis, Ixora, Lasianthus, Leea, Memecylon, Pavetta etc. form the shrubby vegetation. The common climbers are Butea parviflora, Cynanchum tunicatum, Entada pursaetha and species of Calycopteris, Dioscoria, Strychnos etc. Bambusa arundanacea and Ochlandra travencorica are also common.

Primary and Secondary Survey

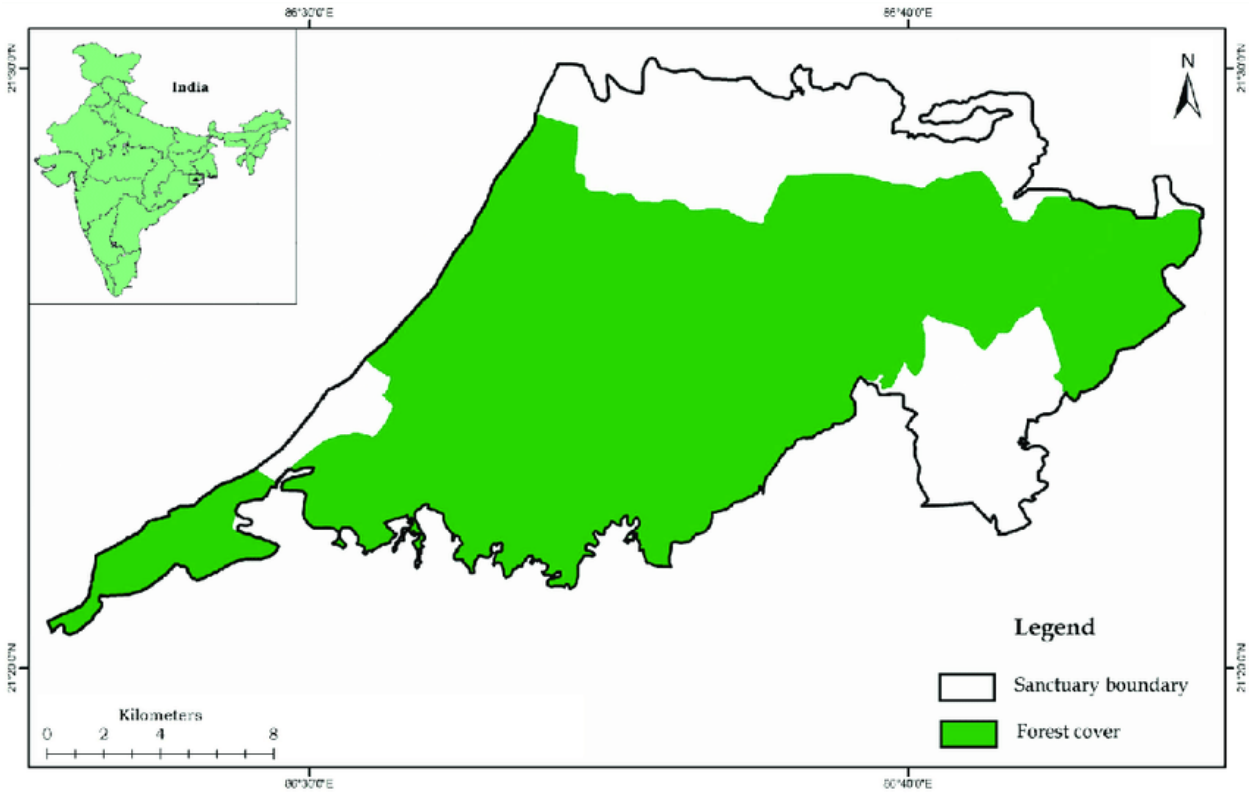
The primary surveys were undertaken to identify the ecological features of the area with particular reference to identify and quantify any sensitive ecological communities in the study area within 10 km radius of the proposed project. Secondary surveys Literature surveys were conducted to identify Rare, Endangered, Endemic and Threatened species (REET) and/or habitats within the study area. The reference has been taken from The Wildlife (Protection) Act, 1972 and Red Data Book.

The field study was undertaken and relevant, observations noted in that assessment have been included in the current assessment and referenced accordingly.

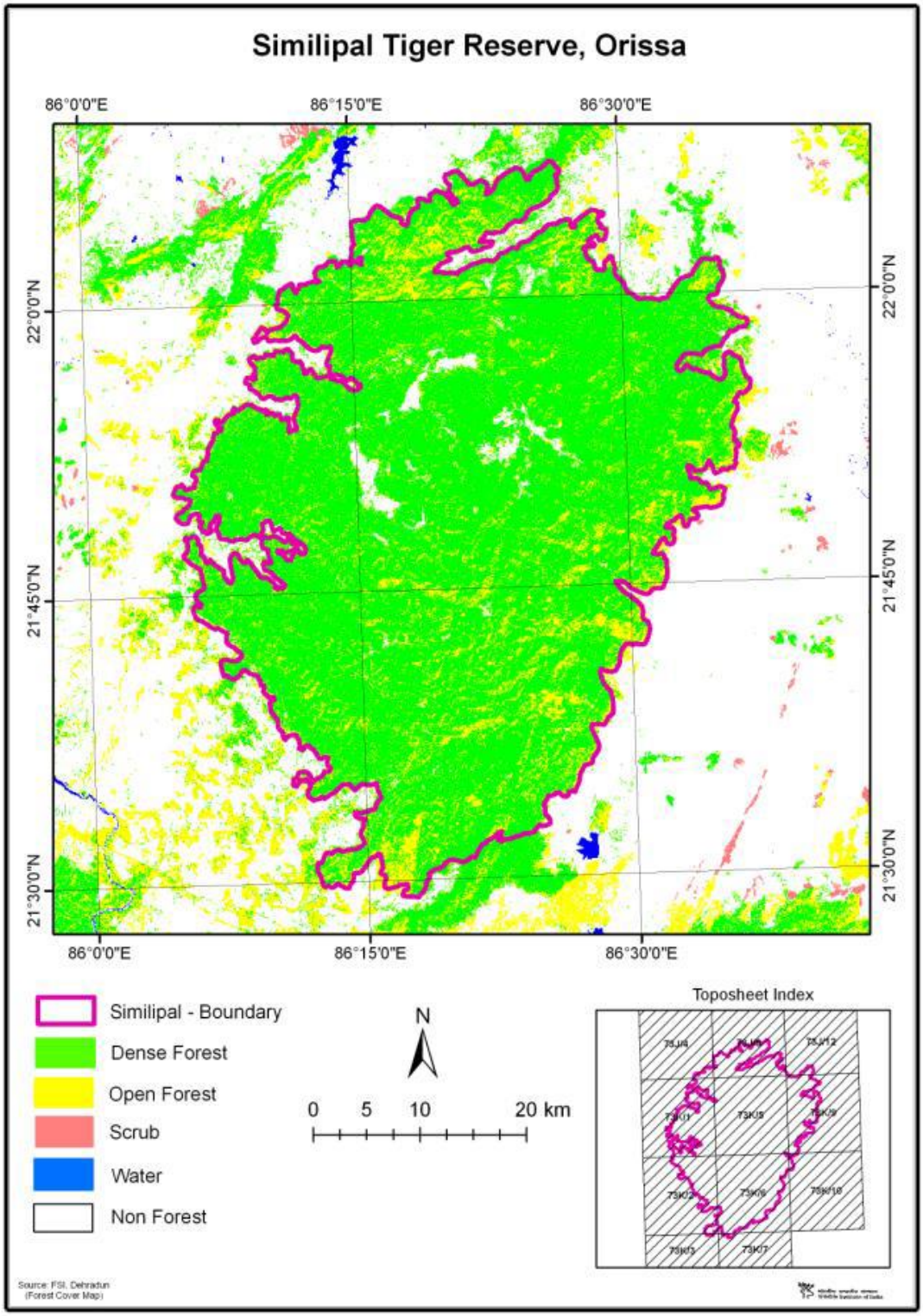
National Park/Sanctuary

As per literature survey in various departments of Forest reveal that there are Wildlife sanctuaries or National Parks or Biosphere or Hotspots in 10 km and 25 km radius from the proposed project site. Also, there is a reserve forest patch within which NH-16 passes in Mayurbhanj districts near Baripada city.

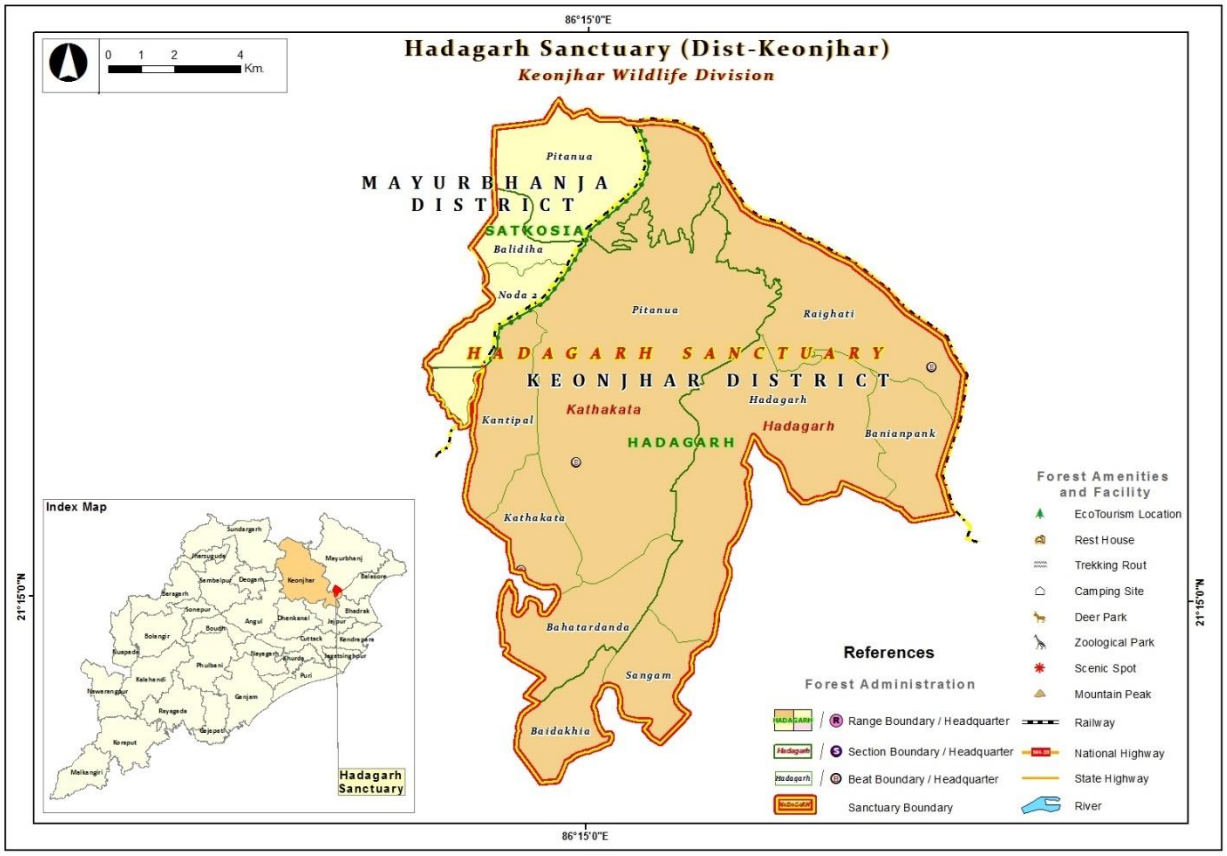
Kuldiha Wildlife Sanctuary: The Kuldiha Wildlife Sanctuary is situated in the Balasore district of Odisha, India. The sanctuary is spread across 272.75 km2 (105 sq mi) in the Chota Nagpur Plateau region. It is linked with Simlipal National Park via the Sukhupada and Nato hill ranges. It is classified as an Eastern Highlands moist deciduous forests ecoregion. The Map has been referred from The Gazette of India, Ministry of Environment, Forest and Climate Changenotification S.O. 2539(E).



Simlipal National Park: The Mayurbhanj district is home to the Simlipal National Park, which is a protected wildlife area and tiger reserve spread over 2750 km2 of the northern part of the district. It has 1078 species of plants, 55 species of mammals, 304 species of birds and also has 60 species of reptiles. Along with the Simlipal National Park, various other forests in the district collectively results into around 45% of district land area covered by forest or wildlife sanctuary. Figure 3 shows the map of Similipal Tiger Reserve as obtained from Protected Area Gazette Notification Database through ENVIS Centre on Wildlife & Protected areas.


Similipal Tiger Reserve, Orissa
86°0'0"E
86°15'0"E
86°30'0"E
22°0'0"N
21°45'0"N
21°30'0"N
Similipal - Boundary
Dense Forest
Open Forest
Scrub
Water
Non Forest
N
0 5 10 20 km
Toposheet Index
Source: FSI, Dehradun
(Forest Cover Map)

Hadgarh Wildlife Sanctuary: Hadgarh Wildlife Sanctuary wildlife sanctuary situated Keonjhar district in Odisha, India, covering an area of 191 sq. km was established in 1978. The map has been referred from The Gazette of India, Ministry of Environment, Forest and Climate Change notification S.O. 505(E). The sanctuary lies in the catchment of Salandi river, a major tributary of the river Baitarani. Besides the Salandi river, the other perennial and seasonal streams are Mukta stream, Ghagara stream, Pitanau stream, Andheri stream, Suranga stream, Chakratirtha stream and Bentokholi stream. A large stagnant water body (31.83 km2) of river Salandi, called as Hadagarh reservoir is found inside the Sanctuary and is the important wetlands of this Sanctuary that attracts variety of water birds both migratory and resident. Hadgarh sanctuary is linked to Similipal tiger reserve and Kuladiha wildlife sanctuary. It is located on the Chota Nagpur Plateau in northeastern Odisha. The primary plant community is mixed deciduous forests, including Sal (Shorea robusta). It is in the Eastern Highlands moist deciduous forests ecoregion.



Bhitarkanika Wildlife Sanctuary: The map has been referred from The Gazette of India, Ministry of Environment, Forest and Climate Change notification S.O. 1601(E). Bhitarkanika National Park is the core area of Bhitarkanika Wildlife Sanctuary located in the north-east region of Kendrapara district in the state of Odisha in eastern India. It spreads over 145 km2 (56 sq mi) and is surrounded by the Bhitarkanika Wildlife Sanctuary spread over 672 km2 (259 sq mi). It was designated as national park on 16 September 1998 and as a Ramsar site by UNESCO on 19 August 2002. Gahirmatha Beach and Marine Sanctuary lies to the east and separates swamp region cover with canopy of mangroves from the Bay of Bengal.

The national park is home to Saltwater crocodile (Crocodylus porosus), Indian python, King cobra, black ibis, darters and many other species of flora and fauna. It hosts a large number of mangroves species and is the second largest mangrove ecosystem in India. The national park and wildlife sanctuary are inundated by the rivers Brahmani, Baitarani, Dhamra, Pathsala.

Bhitarkanika Sanctuary & National park
Gahirmatha Marine Sanctuary

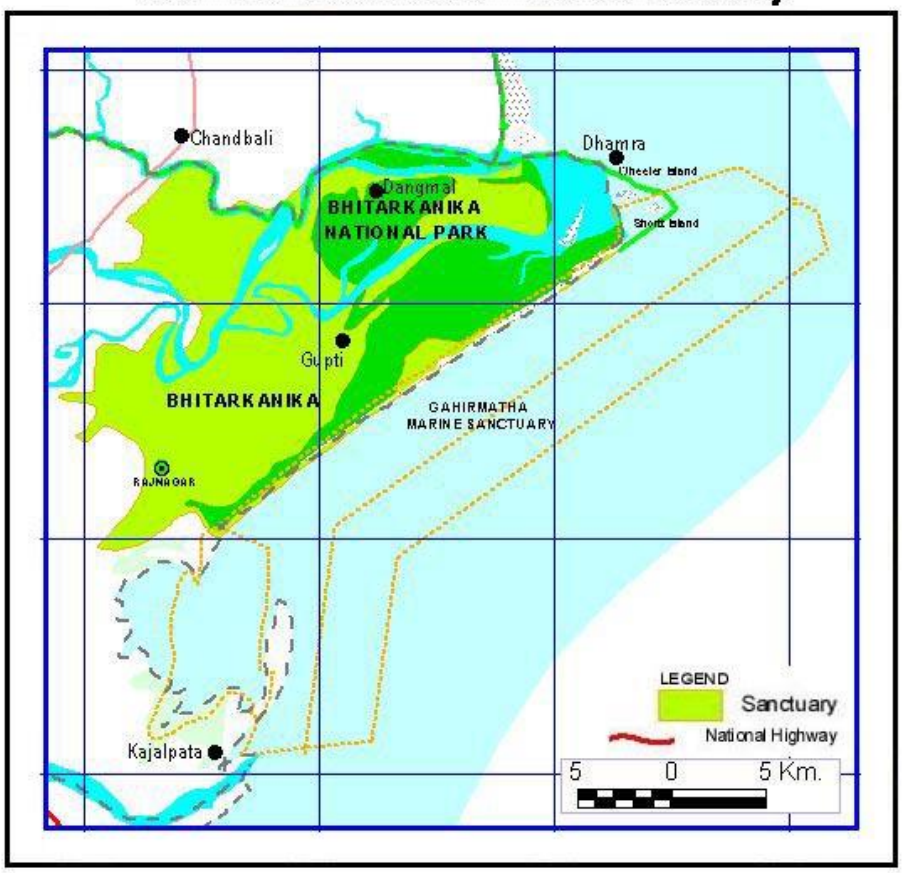
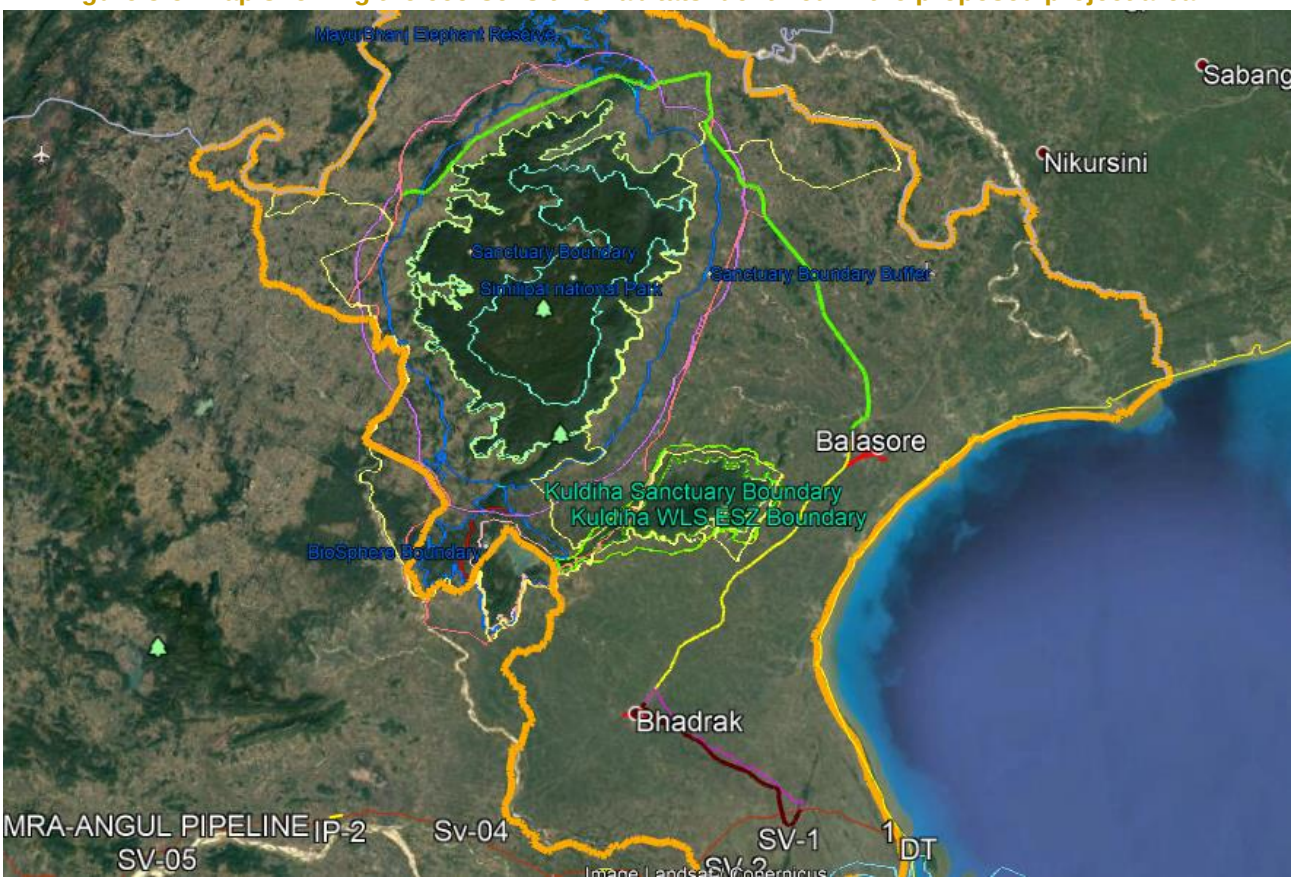


Table 3-16: GPS coordinates of the critical habitats around the project site

GPS point	Latitude	Longitude	Remarks	Distance
F1	21° 45.984'N	86° 20.221'E	Simlipal Tiger Rserve	14 Km from Balasore- Baripada Loop
F2	21° 25.933'N	86° 37.556'E	Kuldinha Wildlife Sanctuary	9 Km from Bhadrak-Balasore loop
F3	20°41'44.1"N	86°50'51.4"E	Bhitarkanika Wildlife Sanctuary	70 Km from Bhadrak Loop
F4	21°16'44.6"N	86°17'02.3"E	Hadgarh Wildlife Sanctuary	40 Km from Bhadrak Loop
F5	21° 49.956'N	86° 46.621'E	Krishnachandrapur Betonati Forest	Balasore- Baripada Loop on NH 16 passes through
F6	21° 49.983'	86° 52.063'E	Forest (Aforestation Scheme)	Balasore- Baripada Loop on NH 16 passes through

Figure 3-5: Map showing the eco-sensitive habitats identified in the proposed project area



Ecological sensitive habitat	Direction and Distance from the project site.
National Parks/ Wildlife Sanctuary/ Biosphere reserves/ Elephant Reserve/ Any Other Reserve	• Simlipal Tiger Rserve, 14 Km from Balasore-Baripada Loop • Kuldinha Wildlife Sanctuary, 9 Km from Bhadrak-Balasore loop • Hadgarh Wildlife Sanctuary, 70 Km from Bhadrak Loop • Bhitarkanika Wildlife Sanctuary, 40 Km from Bhadrak Loop
Reserved Forests	• Krishnachandrapur Betonati Forest, Balasore- Baripada Loop on NH 16 passes through • Forest (Aforestation Scheme), Balasore-Baripada Loop on NH 16 passes through
Wildlife Corridors & Routes	No notified wildlife corridors are present in 10 km vicinity.
Wetlands / Water bodies	Salandi River, Kansa Bansa River, Budhabalang River, and few natural nalas
Ramsar Site	NIL
Important Bird Habitats	Nil
Breeding/nesting areas of endangered species	Not present
Mangroves	Bhitarkanika Wildlife Sanctuary and Mangrove, 40 Km from Bhadrak Loop

3.12.2 FLORA

The dry tropical vegetation is observed within the study area. The experimental finding of the pre monsoon season shows the dominance of grasse like Cyanodondactylon followed by Parthenium hysterophorus, Croton sparsiflorus and trees like Acacia nilotica, Azadirachta indica, Annona squamosa, Delonix regia, Ficus benghalensis within the study area. List of flora reported/observed in the study area is given in Table 3-19

Table 3-17: List of Flora within the project Area

Sl. No.	Common name	Scientific Name
1.	Sal	*Shorea robusta*
2.	Mahua	*Madhuca indica*
3.	Baro	*Ficus bengalensis*
4.	Kendu	*Diospyros melanoxylon*
5.	Neem	*Azadirachta indica*
6.	Amba	*Mangifera indica*
7.	Sisso	*Dalbergia sisoo*
8.	Gangasiuli	*Nyctanthes arbotristis*
9.	Kanchan	*Bauhinia spp.*
10.	Tal	*Borassus flabellifer*
11.	Khajura	*Phoenix spp.*
12.	Jamu	*Syzigium cumini*
13.	Barokoli	*Zizyphus spp.*
14.	Palaso	*Butea frondosa*
15.	Khair	*Acacia catechu*
16.	Korai	*Hollarhena antidyssentrica*
17.	Kangra	*Xylia xylocarpa*
18.	Krishnachuda	*Delonix regia*
19.	Chankunda	*Cassia siamea*
20.	Babul	*Acacia arabica*
21.	Bans	*Dendrocalamus strictus*
22.	Arjun	*Terminalia arjuna*
23.	Simuli	*Bombax ceiba*
24.	Dhaura	*Anogeissus latifolia*
25.	Radha chuda	*Peltophorum feruginium*
26.	Asan	*Terminalia tomentosa*
27.	Sonari	*Cassia fistula*
28.	Tentuli	*Tamarindus indica*
29.	Panasa	*Artocarpus heterophylla*
30.	Kadamba	*Anthocephalus cadamba*
31.	Bel	*Aegele marmelos*
32.	Water Hyacinth	*Eicchornia crassipes*
33.	Kalama	*Ipomea spp.*
34.	Poksunga	*Lantana camara*

3.12.3 FAUNA

List of Amphibians either spotted or reported from the study area

Sr. No.	Technical Name	English Name / Local Name	Wildlife Act (1972)
	Reptiles		
1	*Hemidactylus sp*	House Lizard	Sch-IV
2	*Calotes versicolor*	Garden Lizard	Sch-IV
3	*Sitana pondiceriana*	Green Lizard	Sch-IV
4	*Chameleon zeylanicus*	Lizard	Sch-IV
5	*Draco sps*	Draco	Sch-IV
6	*Varanus benghalensis*	Monitor Lizard	Sch-IV
7	*Nerodia piscator*	Fresh water snake	Sch-III
8	*Dendrophis sps*	Tree snake	Sch-III
9	*Dendrolaphis sps*	Green tree snake	Sch-III
10	*Naja naja*	Cobra	Sch-II
11	*Hemibungarussps*	Indian coral snake	Sch-II
	Bungarus candidus	Krait	Sch-III
12	*Vipera russeli*	Viper	Sch-II
13	*Trimeresurus meacrolepis*	Pit viper	Sch-II
14	*Groemyda bijuga*	Fresh water tortoise	Sch-III
15	*Testudo travencoriana*	Land tortoise	Sch-III
16	**Butterflies**		
17	*Triodes minos*	Southern Birdwing	Sch-IV
18	*Papilo demoleus*	Lime butterfly	Sch-IV
19	*Graphium agamemnos*	Tailed jay	Sch-IV
20	*Papilo polymnstor*	Blue Mormon	Sch-IV
21	*Neptis hylas*	Common sailor	Sch-IV
	Amphibians		
22	*Rana hexadactyla*	Frog	Sch-IV
23	*Rana tigrina*	Bull frog	Sch-IV
24	*Cocopus sps*	Burrowing frog	Sch-IV
25	**Mammals**		
26	*Lepus nigricollis*	Hare	Sch-III
	Hyaena hyaena	Hyaena	Sch-III
27	*Canis auries*	Jackal	Sch-III
28	*Funambulus spp.*	Squirrel	Sch-IV
29	*Sus sucrofa*	Wild pig	Sch-III
30	*Rattus norvegicus*	Field mouse	Sch-IV
31	*Herpestes edwardii*	Common mongoose	Sch-IV
32	*Bandicota indica*	Bandicoot	Sch-IV

LC-Least Concern, DD-Data deficient, CR-Critically Endangered, VU-Vulnerable, NE-Not Evaluated, NA-Not
assessed, EN- Endangered, NT-Near Threatened, EW- Extinct in the Wild

3.12.4 BIRDS

Sr. No.	Technical Name	English Name / Local Name	Wildlife Act (1972)
1	*Milyus migrans*	Common Kite	Sch-IV
2	*Quills contronix*	Grey quail	Sch-IV
3	*Corvus splendens*	House crow	Sch-IV
4	*Turdoides striatus*	White headed babbler	Sch-IV
5	*Aegithina tiphia*	Iora	Sch-IV
6	*Pycnonotus cafer*	Red vented bulbul	Sch-IV
7	*Pycnonotus jokokus*	White browed Bulbul	Sch-IV
8	*Saxicoloides fulicata*	Indian robin	Sch-IV
9	*Columbus livibus*	Rock Pigeon	Sch-IV
10	*Copsychus saularis*	Magpie Robin	Sch-IV
11	*Tchitrea paradisi*	Paradise Fly catcher	Sch-IV
12	*Tephrodornis pondiceraianus*	Common Wood shrike	Sch-IV
13	*Lalage sykesi*	Black headed cuckoo Shrike	Sch-IV
14	*Artamus fuscus*	Ashy Swallow Shrike	Sch-IV
15	*Dicrurus macrocerus*	Black Drongo	Sch-IV
16	*Dicrurus longicaudatus*	Grey Drongo	Sch-IV
17	*Dissemurus paradiseus*	Rackete tailed Drongo	Sch-IV
18	*Oriolus oriolus*	Indian Oriole	Sch-IV
19	*Black Headed Oriole*	Oriolus xanthornus	Sch-IV
20	*Temenuchus pagodarum*	Brahmny Myna	Sch-IV
21	*Acridotheres tristicus*	Common myna	Sch-IV
22	*Ploceus philippines*	Weaver bird	Sch-IV
23	*Uroloncha striata*	Spotted munia	Sch-IV
24	*Passer domisticus*	House Sparrow	Sch-IV
25	*Redrumped Swallow*	Hirundo daurica	Sch-IV

26	*Cinnyris asiatica*	Purple Sunbird	Sch-IV
27	*Brachypternus bengalensis*	Malabar Golden backed wood	Sch-IV
28	*Megalaima merulinus*	Indian Cuckoo	Sch-IV
29	*Hierococys varius*	Common Hawk Cuckoo	Sch-IV
30	*Eudynamis scolopaceus*	Koel	Sch-V
31	*Centropus sinensis*	Crow Pheasant	Sch-IV
32	*Psittacula Krammeri*	Rose ringed parakeet	Sch-IV
33	*Coryllis vaeralis*	Lorikeet	Sch-V
34	*Coracias benghalensis*	Indian Roller	Sch-IV
35	*Merops orinetalis*	Common Bee Eater	Sch-IV
36	*Alcedo atthis*	Common Kingfisher	Sch-IV
37	*Halcyon smyrensis*	White breasted kingfisher	Sch-IV
38	*Microfus affinis*	House swift	Sch-IV
39	*Cyprirus parvus*	Palm swift	Sch-IV
40	*Caprimulgus asiaticus*	Common Indian jar	Sch-IV
41	*Tylo alba*	Barn Owl	Sch-IV
42	*Haliastur indus*	Brahmny kite	Sch-IV
43	*Milvus migrans*	Pariah kite	Sch-IV
44	*Circus aeruginosus*	Marsh harrier	Sch-IV
45	*Chalcophaps indica*	Emerald Dove	Sch-IV
46	*Lobvanella indicus*	Redwattled Lapwing	Sch-IV
47	*Lobpluvia malabaraica*	Yellow wattled lapwing	Sch-IV
48	*Anhinga melanogaster*	Darter	Sch-V
49	*Egretta garzetta*	Little Egret	Sch-IV
50	*Bubulcus ibis*	Cattle Egret	Sch-IV
51	*Ardeola grayii*	Pond Heron	Sch-IV
52	*Anas querquedula*	Gangney Teal	Sch-IV
53	*Anas acuta*	Common Teal	Sch-IV
54	*Aythya feroma*	White eyed Pochard	Sch-IV
55	*Gallinula chlorpus*	Moorhen	Sch-IV
56	*Sterna albifrons*	Indian River Tern	Sch-IV
57	*Galerida malabarica*	Malabar Crested Lark	Sch-IV

LC-Least Concern, DD-Data deficient, CR-Critically Endangered, VU-Vulnerable, NE-Not Evaluated, NA Not Assessed, EN- Endangered, NT-Near Threatened, EW- Extinct in the Wild

3.12.5 LIST OF ZOOPLANKTONS

Sr. No	Phytoplankton	Zooplankton
1	*Gyrosigma* sp.	*Keratella monospina*
2	*Achananthes affinis*	*Brachirous caudatus*
3	*Gyrosigma accuminatus*	*Asplancha brighwell*
4	*Pandorina* sp.	*Colpidium colpoda*
5	*Ankistrodesmus falcatus*	*Daphnia* sp.
6	*Ankistrodesmus* sp.	*Ceriodaphnia reticulate*
7	*Pediastrum boryanum*	*Mesocyclops leuckarti*
8	*Scenedesmus bijuga*	*Mesocyclops hyalinus*
9	*Melosira granulate*	*Coleps hirsutus*
10	*Cyclotella meneghiana*	*Arcella* sp.
11	*Microcystis* sp.	*Actinophyros* sp.
12	*Navicula gracilis*	*Asplancha* sp.
13	*Nitzschia gracilis*	*Ceriodaphnia* sp.
14	*Chroococcus minutes*	*Mesocyclops* sp.
15	*Spirulina princepes*	
16	*Pinnularia braunii*	
17	*Synedra tabulate*	
18	*Ophora* sp.	
19	*Cymbella* sp.	
20	*Navicula radiosa*	

3.13 DEMOGRAPHY & SOCIO-ECONOMICS

A meeting with the project proponent was initially conducted to develop a common understanding of the project activities, land acquisition for tap off point and status of payment of compensation to the affected PAP, and to identify a continuous point of contact for all future correspondence.

The baseline information included aspects like demographic information, economic activities, literacy profile, land use, infrastructure resource, economic facilities, cultural heritage, lifestyle and other value system.

The following methods were used as a benchmark to collate the baseline information:

- Stakeholders consultation meeting which included the Project Influenced and benefitted Population in Bhadrak, Balasore, and Mayurbhanj;
- Consultations with along the pipeline route to understand the socio-economic status, education facilities and the literacy levels.

The delineation of Preliminary Stakeholders was based on the following points,

- The type of stakeholders, and;
- Their connection and influence levels on the project.

An open ended questionnaire was prepared for the focus group discussions prior to the start of the consultation process to obtain the information from the population. Different stakeholder groups were consulted to understand the concerns/ issues, expectations/ benefits and other advantages that they have on the project.

3.13.1 BHADRAK, BALASORE, AND MAYURBHANJ DISTRICT PROFILE

Bhadrak

The district has an area of 2,505 km². Salandi River passes by this district. According to 2011 census Bhadrak district has a population of 15,06,522. Its population growth rate over the decade 2001-2011 was 12.95% with a population density of 601 inhabitants per square kilometer.

Balasore

It is one of the coastal Districts of Odisha and covers an area of 3,634 km2 having total population of 23,17,419 as per 2011 census. The district has a population density of 609 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 14.47%. Industries, Agriculture, Fishing and Tourism are the four major revenue sources of Balasore District. Birla Tyres, Balasore Alloys Limited, Emami Paper Mills Limited and Polar Pharma India Limited are some of the large–scale industries functioning in this district. There is an abundance of alluvium soil in the district and intersected by the perennial rivers, has collectively provided a conducive infrastructure for the growth of agriculture in the region.

Mayurbhanj

It is land-locked with a geographical area of 10,418 km2 and is in the northern boundary of Odisha. According to the 2011 census Mayurbhanj district has a population of 25,13,895. The district has a population density of 241 inhabitants per square kilometer with a population growth rate of 13.06% over the decade, 2001-2011.

3.13.2 VILLAGES FALLING UNDER STUDY AREA

Pipeline runs parallel along the man roads hence accessibility is not an issue. Project pipeline runs along major national and state highway connecting Bhadrak, Balasore, and Mayurbhanj districts. The route covers 110 villages in 15 talukas and 3 districts.

Table 3-18: List of villages, cities, talukas and districts of Bhadrak, Balasore, and Mayurbhanj falling in the project area

City/ Village		Taluka	District	State
1. Chandabali 2. Panchupada 3. Saentapanijharia 4. Samdaspur 5. Nischanta 6. Mahulia 7. Bhatapada 8. Naugoruda 9. Matto 10. Chasakhand 11. Malbad 12. Pratappur 13. Nalgunda 14. Kaupuni 15. Nuagaon 16. Khadijan 17. Baharpal 18. Laxmiprasad 19. Samantraipur 20. Harisinghpur 21. Bamana Bhinda 22. Malpur 23. Bhinda 24. Indiria 25. Sindol 26. Orada 27. Barikbhinda 28. Managrajpur 29. Tihidi 30. Bidyadharpur 31. Mukundpur 32. Jhinkiria 33. Bodhapur 34. Gadadharpur 35. Chakaagiri 36. Bahanaga 37. Daradia 38. Begunia 39. Panapana 40. Betagadia 41. Biruhan 42. Banaparia 43. Channapur 44. Geruda	55. Agiria 56. Ghumal 57. Sridharpur 58. Harikishanpur 59. Kedarpur 60. Brahmapur 61. Purana Bazar 62. Taragana 63. Bankashi 64. Belmala 65. Charampa 66. Tisalpur 67. Asura 68. Suseiladeipur 69. Ranj 70. Sarsatia 71. Jagadalpur 72. Similia 73. Muruna 74. Bhagia 75. Markona 76. Kaniari 77. Anantpur 78. Jamujhadi 79. Bedpur 80. Radhaballavpur 81. Salampur 82. Talanagar 83. Brahmapur 84. Alipur 85. Kantipur 86. Soro 87. Brahmanshi 88. Nayakbandh 89. Sahisad 90. Dhandharipur 91. Keshpur 92. Asimilia 93. Kasbajaipur 94. Margorasahi 95. Sankua 96. Hiratikiri 97. Patarra 98. Raim 99. Dharampur	1. Saraskana 2. Bisoi 3. Betanati 4. Baripada 5. Remuna 6. Shamakhunta 7. Koliana 8. Bangiriposi 9. Chandabali 10. Dhamanagar 11. Bhadrak 12. Tihidi 13. Similia 14. Soro 15. Bahanaga	Bhadrak, Balasore, and Mayurbhanj	Odisha

45. Saraswatipur 46. Bindha 47. Dumuda 48. Gambhiria 49. Jaipuria 50. Baisinga 51. Bhatia 52. Dhanpur 53. Raghada 54. Krishnachandrapur	100. Naugan 101. Jugpura 102. Jogal 103. Agrai 104. Badachuruni 105. Sathilo 106. Purunapani 107. Naykhendukal 108. Nuanagar 109. Gholapur 110. Rangmatia			

Source: Primary Survey, TUV SUD

3.13.3 DEMOGRAPHIC DETAILS

Bhadrak

An official Census 2011 detail of Bhadrak, a district of Orissa has been released by Directorate of Census Operations in Orissa. Enumeration of key persons was also done by census officials in Bhadrak District of Orissa.

In 2011, Bhadrak had population of 1,506,337 of which male and female were 760,260 and 746,077 respectively. In 2001 census, Bhadrak had a population of 1,333,749 of which males were 675,642 and remaining 658,107 were females. Bhadrak District population constituted 3.59 percent of total Maharashtra population. In 2001 census, this figure for Bhadrak District was at 3.62 percent of Maharashtra population.

There was change of 12.94 percent in the population compared to population as per 2001. In the previous census of India 2001, Bhadrak District recorded increase of 20.61 percent to its population compared to 1991.

Table 3-19: Demographic Profile of Bhadrak Districts

Bhadrak /Description	2011	2001
Population	15.06 Lakhs	13.34 Lakhs
Actual Population	1,506,337	1,333,749
Male	760,260	675,642
Female	746,077	658,107
Population Growth	12.94%	20.61%
Area Sq. Km	2,505	2,505
Density/km2	601	532
Proportion to Orissa Population	3.59%	3.62%

Sex Ratio (Per 1000)	981	974
Child Sex Ratio (0-6 Age)	942	943
Average Literacy	82.78	73.86
Male Literacy	89.64	84.65
Female Literacy	75.83	62.85
Total Child Population (0-6 Age)	184,560	192,647
Male Population (0-6 Age)	95,048	99,164
Female Population (0-6 Age)	89,512	93,483
Literates	1,094,140	842,855
Male Literates	596,269	487,993
Female Literates	497,871	354,862
Child Proportion (0-6 Age)	12.25%	14.44%
Boys Proportion (0-6 Age)	12.50%	14.68%
Girls Proportion (0-6 Age)	12.00%	14.20%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (93%) followed by Muslims (7.00%) in all three districts and Christians (.05%). The details of religion-wise demography status o are given below in Table 3-20.

Table 3-20: Religion-wise demographic Profile as per Census data, 2011

District/ Bhadrak	Total	Percentage
Hindu	1,398,543	92.84 %
Muslims	104,202	6.92 %
Christian	745	0.05 %
Sikh	169	0.01 %
Buddhist	81	0.01 %
Jain	111	0.01 %
Others	61	0.00 %
Not Stated	2,425	0.16 %

Source: Census of India, 2011

Balasore

An official Census 2011 detail of Baleshwar, a district of Orissa has been released by Directorate of Census Operations in Orissa. Enumeration of key persons was also done by census officials in Baleshwar District of Orissa.

In 2011, Baleshwar had population of 2,320,529 of which male and female were 1,185,787 and 1,134,742 respectively. In 2001 census, Baleshwar had a population of 2,024,508 of which males were 1,036,511 and remaining 987,997 were females. Baleshwar District population constituted 5.53 percent of total Maharashtra population. In 2001 census, this figure for Baleshwar District was at 5.50 percent of Maharashtra population.

There was change of 14.62 percent in the population compared to population as per 2001. In the previous census of India 2001, Baleshwar District recorded increase of 19.33 percent to its population compared to 1991.

Table 3-21: Demographic Profile of Balasore Districts

Balasore /Description	2011	2001
Population	23.21 Lakhs	20.25 Lakhs
Actual Population	2,320,529	2,024,508
Male	1,185,787	1,036,511
Female	1,134,742	987,997
Population Growth	14.62%	19.33%
Area Sq. Km	3,806	3,806
Density/km2	610	532
Proportion to Orissa Population	5.53%	5.50%
Sex Ratio (Per 1000)	957	953
Child Sex Ratio (0-6 Age)	943	944
Average Literacy	79.79	70.56
Male Literacy	87.00	81.69
Female Literacy	72.28	58.90
Total Child Population (0-6 Age)	288,672	296,087
Male Population (0-6 Age)	148,565	152,338
Female Population (0-6 Age)	140,107	143,749
Literates	1,621,232	1,219,495
Male Literates	902,359	722,244

Female Literates	718,873	497,251
Child Proportion (0-6 Age)	12.44%	14.63%
Boys Proportion (0-6 Age)	12.53%	14.70%
Girls Proportion (0-6 Age)	12.35%	14.55%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (95%) followed by Muslims (4.00%) in all three districts and Christians (0.3%). The details of religion-wise demography status o are given below in Table 3-24.

Table 3-22: Religion-wise demographic Profile as per Census data, 2011

District/ Balasore	Total	Percentage
Hindu	2,197,709	94.71 %
Muslims	94,254	4.06 %
Christian	6,434	0.28 %
Sikh	237	0.01 %
Buddhist	111	0.00 %
Jain	201	0.01 %
Others	18,345	0.79 %
Not Stated	3,238	0.14 %

Source: Census of India, 2011

Mayurbhanj

An official Census 2011 detail of Mayurbhanj, a district of Orissa has been released by Directorate of Census Operations in Orissa. Enumeration of key persons was also done by census officials in Mayurbhanj District of Orissa.

In 2011, Mayurbhanj had population of 2,519,738 of which male and female were 1,256,213 and 1,263,525 respectively. In 2001 census, Mayurbhanj had a population of 2,223,456 of which males were 1,123,200 and remaining 1,100,256 were females. Mayurbhanj District population constituted 6.00 percent of total Maharashtra population. In 2001 census, this figure for Mayurbhanj District was at 6.04 percent of Maharashtra population.

There was change of 13.33 percent in the population compared to population as per 2001. In the previous census of India 2001, Mayurbhanj District recorded increase of 17.98 percent to its population compared to 1991.

Table 3-23: Demographic Profile of Mayurbhanj Districts

Mayurbhanj /Description	2011	2001
Population	25.20 Lakhs	22.23 Lakhs
Actual Population	2,519,738	2,223,456
Male	1,256,213	1,123,200
Female	1,263,525	1,100,256
Population Growth	13.33%	17.98%
Area Sq. Km	10,418	10,418
Density/km2	242	213
Proportion to Orissa Population	6.00%	6.04%
Sex Ratio (Per 1000)	1006	980
Child Sex Ratio (0-6 Age)	960	956
Average Literacy	63.17	51.91
Male Literacy	73.76	65.76
Female Literacy	52.71	37.84
Total Child Population (0-6 Age)	351,834	364,717
Male Population (0-6 Age)	179,536	186,464
Female Population (0-6 Age)	172,298	178,253
Literates	1,369,397	964,860
Male Literates	794,171	616,003
Female Literates	575,226	348,857
Child Proportion (0-6 Age)	13.96%	16.40%
Boys Proportion (0-6 Age)	14.29%	16.60%
Girls Proportion (0-6 Age)	13.64%	16.20%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (84%) followed by Muslims (1.00%) in all three districts and Christians (0.6%). The details of religion-wise demography status o are given below in Table 3-24.

Table 3-24: Religion-wise demographic Profile as per Census data, 2011

District/ Mayurbhanj	Total	Percentage
Hindu	2,113,079	83.86 %
Muslims	33,706	1.34 %
Christian	15,008	0.60 %
Sikh	661	0.03 %
Buddhist	162	0.01 %
Jain	109	0.00 %
Others	351,714	13.96 %
Not Stated	5,299	0.21 %

Source: Census of India, 2011

4 ANTICIPATED ENVIRONEMENTAL IMPACTS & MITIGATION MEASURES

This section of the report provides an assessment of the potential impacts on different identified environmental components, which are likely to occur during the laying of pipeline and supply of Petroleum products through the pipeline. However, by adopting appropriate management measures, the majority of the assessed impacts can be mitigated.

The major potential impacts associated with the proposed project are impact on soil, impact on water resources and area drainage, air quality degradation, noise impacts, impact on ecological environment, impact on agriculture, land use changes, impact on health and safety, impact on socio-economic features, impact on community activities, impact on cultural heritage and impact on aesthetics. These impacts can occur at any one of the three stages i.e. planning or design stage, the construction stage and the operation stage.

The identified impacts due to the proposed project can be mitigated through the incorporation of appropriate measures at different stages of the project. This will ensure the best design with minimal damage to or loss of significant or sensitive features such as roadside vegetation, local water resources, etc.

4.1 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impacts associated with the proposed project on various environmental components such as air, water, noise, soil, flora, fauna, land, socioeconomic, etc. has been identified using Impact Identification Matrix.

Table 4-1: Impact Identification matrix for the proposed pipeline route and the CNG stations

	Physical				Biological		Socio-Economic		
	Ambient Air Quality	Ground/Surface Water (Quantity/Quality)	Ambient Noise	Land (Land use, Topography, drainage, soil)	Flora	Fauna	Livelihood and Occupation	Infrastructure	Health & Safety
Augmentation of Facilities									
Construction Phase									
Civil and mechanical works	●	●	●	●	●	●	●	●	
Movement of vehicles	●		●			●		●	●

Hydro testing									●
Waste generation, handling and disposal				●					●
Operation Phase									
Operation of pumps and compressors	●	●	●						
Storage of Gas/ Crude	●								
Cleaning & maintenance		●		●					
Movement of vehicles	●		●			●		●	●
Waste generation, handling and disposal		●		●					
Laying of New Pipeline									
Construction Phase									
Preparation of Right of way	●		●	●		●	●	●	●
Pipe laying	●			●					●
Chemical use/handling		●		●					
Movement of vehicles	●		●			●		●	●
Hydro testing		●							●
Waste generation, handling and disposal				●					●
Operation Phase									
Operation of compressors	●		●						
Cleaning & maintenance		●		●					
Waste generation, handling and disposal			●						
Movement of vehicles	●		●			●		●	●
CNG Stations									
Construction Phase									
Civil and mechanical works	●		●	●	●		●		●
Movement of vehicles	●	●	●			●			●
Waste generation, handling and disposal		●		●	●			●	●
Operation Phase									
Movement of vehicles	●		●						●
Waste generation, handling and disposal		●	●						●
Waste generation, handling and disposal	●	●							
Leakage from Pipeline	●	●							

4.2 IMPACT AND MITIGATION MEASURES- CONSTRUCTION PHASE

4.2.1 AIR ENVIRONMENT

The air quality along the project stretch may get affected during the construction period. Particulate matter will be the predominant pollutant affecting the air quality during the

construction phase. As the construction activities are likely to generate dust. Mostly the additional automobile traffic and construction machineries involved during construction activities will generate petroleum pollutants. However, this will not lead to any tangible effect, as the additional traffic volume related to construction activities will be low.

a. Impacts

Potential emissions sources during construction phase include the following:

- Deterioration of air quality due to fugitive dust emissions from construction activities (especially during dry season) like excavation, back-filling and dumping of earth materials, from construction spoils, vehicular movements along unpaved roads, loading / unloading and transportation of construction materials
- Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter
- Operation of equipment and machinery for earth-moving, grading, pipeline laying and civil works at pipeline ROW and other sites
- Operation of temporary Diesel Generator (DG) sets, emission of PM, CO, NOx, & SOx

b. Mitigation Measures

During construction phase of the proposed project appropriate mitigative measures have to be implemented to ameliorate the anticipated air quality problems. The following mitigative measures will be employed during construction period to reduce the pollution level to acceptable limits

- Proper and prior planning, appropriate sequencing and scheduling of all major construction activities have to be done, and timely availability of infrastructure supports needed for construction to be ensured to shorten the construction period vis-à-vis reduce pollution.
- Construction materials to be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Stringent construction material handling / overhauling procedures to be followed.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads, at vulnerable areas of construction sites to be undertaken to control fugitive dust during material handling and hauling activities particularly near habitations especially in dry seasons.
- The construction material delivering vehicles to be covered in order to reduce spills.

- Low emission construction equipment, vehicles and generator sets to be used
- It has to be ensured that all construction equipment and vehicles are in good working conditions, properly tuned and maintained to keep emission within the permissible limits and engines tuned off when not in use to reduce pollution
- Vehicles and machineries to be regularly maintained so that emissions confirm to standards of Central Pollution Control Board (CPCB)
- Monitoring of air quality at regular intervals to be conducted during construction phase
- Construction workers to be provided with masks to protect them from inhaling dust.

4.2.2 NOISE ENVIRONMENT

During construction phase, noise will be generated due to movement of vehicles, and operation of light and heavy construction machineries including pneumatic tools (hot mixer, dozer, tipper, loader, excavator, grader, scrapper, roller, concrete mixer, generator, pump, vibrator, crane, compressor, HDD etc.). During construction the noise generating range will be approximately between 55-70 dB(A). The main sources of noise during construction period are:

- Movement of vehicles during the construction period for procurement of construction material.
- During site preparation, surface preparation, pipeline laying etc.

Noise generated from sources mentioned above will be mostly during daytime. Moreover, villages / settlements being near to the route, significant impact on local people is apprehended (as a few congested human habitations are along the site), as the noise generated will be a problem. However, the workers are likely to be exposed to high noise levels that may affect them.

a. Impacts

- Increase in noise level due to construction activities like operation of construction equipment and vehicular traffic
- Operation of construction machinery will lead to rise in noise level to the range between 80-100 dB(A). The magnitude of impact from noise will depend upon types of equipment used, construction methods and also on work scheduling.
- Since there is a mix of residential, commercial and industrial area in the vicinity of the project, noise have to be kept in check.
- The impacts will be significant on construction workers, working close to the machinery.

b. Mitigation Measures

- Construction camp and temporary labour sheds will be located away from the immediate vicinity of construction sites and major road traffic.
- Protective gears such as earplugs, etc. will be provided to construction personnel exposed to high noise levels as preventive measures.
- It will be ensured that all the construction equipment and vehicles used are in good working condition, properly lubricated and maintained to keep noise within the permissible limits and engines tuned off when not in use to reduce noise.
- Construction activities carried out near residential locations will be scheduled to the daytime (i.e. from 10.00 a.m. to 6.00 p.m.) only so as to have minimum disturbance to the residents.
- Whenever possible static noisy machinery will be placed on vibration isolators or temporary sheeting will be provided to check noise propagation.

Noise level will be monitored at regular intervals during construction phase, which will help in taking appropriate action to maintain it within the prescribed limit

4.2.3 WATER ENVIRONMENT

Small quantity of water will be used during construction process and hydro testing of the pipeline. Wastewater from construction activities would mostly contain suspended impurities. Other pollutants, which may find their way to it, will be insignificant concentrations and may not cause significant impact on the receiving water bodies. The deterioration of water quality during construction phase is expected due to wastewater disposal from the workers camp and sludge generated from construction sites. If adequate arrangements are not made to ensure proper drainage of wastewater from construction sites, such waters may form stagnant pools and aggravate soil erosion. Stagnant pools of water promote breeding of mosquitoes and create generally unsanitary conditions.

a. Impacts

- Increase of sediment / silt load in the runoff from construction sites / earth moving activities and increase in turbidity in receiving stream / water bodies.
- Erosion of soil into the water bodies due to removal of vegetation.
- Contamination by fuel and lubricants by spills from machineries.
- Contamination of water bodies due to improper sanitation and disposal of wastes at the construction Camps.
- Contamination of water bodies due to water from Hydrotesting of the pipeline.
- Impact on ground water quality due to leachates from the solid waste dumpsites.

b. Mitigation measures

- Quality of construction wastewater emanating from the construction site to be controlled through suitable drainage system with sediment traps (silting basin as water intercepting ditch) for arresting the silt / sediment load before its disposal into the main natural drainage system around the site.
- The trench shall be excavated only so far in advance of pipe laying that it do not causes increased soil erosion and silting of water bodies.
- The discharge of the trench de-watering pumps shall be conveyed either to drainage channel or to natural drains after passing through a catch pit for settling the silt.
- The trench shall be excavated to the exact gradient specified so that no making of the sub-grade by back filling is required and the concrete bed, where required, may be prepared with greatest ease giving a uniform and continuous bearing and support for the pipe.
- All the construction and preparatory activities to be carried out during dry seasons only.
- Construction materials to be stacked together by fencing it with brick or earth in order to prevent spillage into the water bodies, also these materials to be stacked away from the water bodies.
- Proper sanitation facilities to be provided at the construction site to prevent health related problems due to water contamination.
- Waste disposal and sanitation to workers in the construction camp to be properly maintained or taken care off in order to check their entry into the water bodies like ponds, streams etc.
- Vehicle maintenance and refueling to be confined to areas near construction camps designed to trap discarded lubricants and fuel spills from entering into the water bodies;
- Drinking water supply for the workers in the construction camps to meet the Indian National Standards. In order to assess the portability of the supplied water to the construction labour camps water quality to be periodically monitored.
- Garbage to be collected in tanks and disposed off daily in order to check the solid wastes entering into the ponds, streams etc

4.2.4 LAND & SOIL ENVIRONMENT

The construction activities such as earth moving may lead to reduction in vegetal cover on ground thus leading to soil erosion. During the construction period the movement of heavy vehicles will result in compaction of soil by making it hard and impermeable. The erosion at construction stretches will result in increased sediment load in recipient streams. Any leakage of lubricants in equipment yard will cause soil contamination. Solid waste disposal along roadside also adds to impact on the land environment during the construction. During construction activity

for laying of pipeline cutting of existing land will be done and the dug material generated will be replaced back after laying of the pipes.

a. Impacts

- Loss of topsoil from excavation areas.
- Loosening of topsoil and loss of vegetative cover (land clearing) along the route and construction areas due to excavation and back filling which lead to enhance soil erosion.
- Compaction of alluvial soils by earth moving equipment.
- Solid waste disposal along the route also adds to impact on the land environment during the construction phase.

b. Mitigation measures

- During excavation, care will be taken to see that the topsoil and the subsoil are stored separately. Topsoil (50cm) of route pits will be conserved and restored after excavation is over and will be replaced back for filling of the pit areas. Whereas the top soil (25cm) stripped from agricultural field and forest area will be stacked separately as top soil dump of not more than 1m in height and the same will be redistributed to the pit after laying of pipeline. During refilling, care will be taken to see that the topsoil is replaced back at the top while refilling after laying of pipeline. This will help grasses growing earlier on the surface, to grow back. Also, the less fertile soil of lower horizon will not be placed on the top thus avoiding degradation of land.
- Back filling shall be carried out immediately after the pipeline has been laid in the trench. On no account the topsoil from ROW shall be used for this purpose. The backfill material shall not contain any extraneous material and/or hard lumps of the soil. After the initial backfill has been placed into the trench to a level slightly above the surrounding ground, the backfill material shall be compacted.
- When the trench has been dug through driveways or roads all backfills shall be executed with sand or a suitable material and shall be thoroughly compacted
- Trench excavated in dykes which are the property of the railways or which is part of main road shall be graded and backfilled in their original profile and condition
- Also necessary contour bunding, gully plugging and staggered trenching shall be carried out wherever required in the pipeline corridor and in areas where excavated soil will be dumped to check soil erosion
- Stone pitching will be provided at the slopes near the irrigation and natural drainage / rivers to prevent silting of soil into these water bodies.

4.2.5 ECOLOGICAL ENVIRONMENT

The initial construction work at the pipeline route involves land clearance, but it would not include clearing of trees. However, the pipeline runs along/ in the protected forest area as well as the ecologically sensitive region.

All the construction work will be carried out in the premises of the pipeline boundary and the CNG station boundary only. Development of Green belt all around the stations will be started along with the construction activities to contain the dust and noise due to construction activities within the boundary. Therefore, no impact on the ecological environment is proposed due to the construction activity of the project.

a. Impacts

- The proposed pipeline passes through notified protected forest land, but no vegetation clearance will be undertaken as part of the pipeline route laying activity.
- The proposed project may not cause any impacts on fauna and wildlife of the study area during construction phase.
- No wildlife corridor and migratory routes comes in the pipeline route. Construction activity during monsoon and post monsoon period may not cause any impact on the movement of wildlife.

b. Mitigation measures

- No vegetation clearance will be undertaken in the pipeline route as well as the CNG stations plot boundary
- While planning / selection of route care to be taken to route the pipeline alignment in such a way to avoid areas with trees and shrubs and thus no major impact of loss of vegetation is anticipated.

4.2.6 SOCIO-ECONOMIC ENVIRONMENT

The project will provide either direct or indirect job opportunities to the local population as far as possible. There will be some migration of skilled labor force from outside the project area during construction phase, which may put some pressure on the local settlements and resources. Considering the size and type of construction activities envisaged the immigration of work force for construction phase (including contractor' labours) would have marginal impact on demography (e.g. changes in total population, sex ratio, literacy level, main workers etc.) of the immediate vicinity area.

In addition, Traffic volume might will increase on nearby roads and the project roads due to movement of heavy vehicles during the construction phase, which may cause public inconvenience. This will have minimal affect considering the size and nature of the Project.

a. Impacts

- Strain on civic amenities (like road, transport, communication, water supply and sanitation, health care and recreational utilities etc.) due to increase in floating population.
- Increase in traffic volume and congestion in the areas and roads.
- Increase in employment opportunity to non-workers in the project area as nonskilled and semi-skilled workers.

b. Mitigation Measures

- It is difficult to assess the above impacts quantitatively on a measurable scale. However, most of these impacts will be short term and limited to the construction period only.
- Development of traffic management plan to ease the situation.
- Transport of construction materials and machineries shall be carried out during lean traffic period of the day or during night.
-

4.3 IMPACTS & MITIGATION MEASURES- OPERATION PHASE

The impact during the operation phase will be continuous in nature. For a gas-based pipeline and CNG station the potentials for imparting adverse impacts is not high. However whatever impact on environment is present will be minimized through incorporation of efficient technologies for pollution control measures.

4.3.1 AIR ENVIRONMENT

a. Impacts

- The pipeline will be 1.2-2 m below the ground and thus no air pollution due to operation of the project is anticipated.
- Some vehicular emission from maintenance is anticipated during maintenance phase, which will be temporary
- The impacts of the operational CNG station would not have any impacts on Air pollution of the area. The increased frequency of the vehicles at the station would not lead to any increased air pollution.

b. Mitigation Measures

Not Required

4.3.2 NOISE ENVIRONMENT

a. Impacts

- The pipeline will be 1.2 m below the ground and thus no noise pollution due to operation of the project is anticipated

- The residents / staff may be exposed to high noise levels during maintenance phase, which will be temporary.
- Noise and vibration during operations will be gas engine, various major and large compressors, air compressor, ventilation fans and miscellaneous equipment's for the CNG stations

b. Mitigation Measures

- In the stations, a closely spaced green belt to be planted all around the premises to attenuate noise
- Machinery to be maintained and lubricated as per manufacturers' guidelines to reduce noise generation.
- Personnel deployed in compressor stations will be issued personal noise protection equipment (ear plugs, ear muffs)
- If necessary, their duty hours will be regulated to keep noise exposure levels within standards.
- All equipment in the station would be designed / operated to have a noise level not exceeding 85dB, as per the requirement of Operational and Safety and Health Administration Standard (OSHA).
- Adopting modern design and the use of sound-absorbing materials will minimize noise and vibration from the station.

4.3.3 WATER ENVIRONMENT

a. Impacts

- The material/product to be transported is compressed gas, so during the operation period, the expected impacts on the water resources are not anticipated.
- The aquatic biological environment in the vicinity of the proposed project pipeline will not be affected, as no discharge is proposed form the CNG stations. Hence, there will be no impact on aquatic ecosystem due to operation of the project.

b. Mitigation Measures

- The discharge from the toilets from the stations will be routed to through the sewage pipelines to the nearest treatment plant, No open discharge will be done.

4.3.4 ENVIRONMENT, HEALTH AND SAFETY

a. Impacts

There could be impacts on environment, health and safety due to leakage from pipelines from likely external physical forces, e.g. seismicity, floods, landslides, permafrost, vegetation;

Mitigation Measures

- Leak Detection and Control System shall be in place
- SCADA monitoring shall be carried out by AGL
- Mock Drills shall be conducted at regular intervals in line with Emergency Response and Disaster Management Plan of AGL

Prevent leaks by

- Installing positive pipe corrosion control measures, for example, coatings, cathodic protection, chemical additives, heaters;
- Ensuring that the SCADA is well maintained and used correctly to control flow and pressure.
- Detect leaks by installing leak detection equipment, e.g. monitoring the flow in the pipe through pressure sensors connected to alarms and automatic pump shutdown systems;
- Continuous metering to provide a comparison between input and output for leak detection;

- **Emergency response**

- Introduce accident, fire and explosion precautions and emergency response procedures;
- These should be tested and drills should occur regularly with appropriate reporting on response times etc.;
- Introduce environment, health and safety training for all employees and contractors;
- Plan the route of the pipeline to reduce the impact on the surrounding area;
- Bury pipelines along the entire length to a minimum of 1m to the top wherever possible;
- Schedule periodic inspection and maintenance to avoid disturbance/disruption of sensitive habitats;
- Good housekeeping should be maintained at all times in all areas of the site; and
- Prevent unauthorised or unintentional intrusion to protected areas through fencing or flagging

5 ADDITIONAL STUDIES

5.1 QUANTITATIVE RISK ASSESSMENT

Quantitative Risk Assessment (QRA) study should be undertaken for the proposed 8”& 4” diameter underground pipeline for the transfer of compressed natural gas. The aim of QRA study will be to identify potential hazards, assess the consequences and frequency of hazards and evaluate the risk to personnel, property and public. To assess the relative level of risk posed by the proposed project, a comparison will be made with risk criteria that is considered tolerable (ALARP) for similar operations

The overall approach and methodology employed for the study will be based on the guidelines given in IS 15656 : 2006, Indian Standard – Hazard Identification and Risk Analysis – Code of Practice, May 2006, using PHAST Software/Correlations.

The pipeline system will be provided with state of the art safety systems like protection system, SCADA, leak detection system / pipeline application software, Fire and gas detection systems, etc. The proposed transfer of gas will be examined for inherent hazards or the potential to result in an unplanned event or sequence of events at different sections along the pipeline route. Several hazards that can cause failure of pipelines will be identified. These included loss of integrity/ damage due to interference from third parties, corrosion, accidents, human error, sabotage, etc., during normal operation. Analysis of past accidents are to be used to establish the credibility of accident scenarios.

5.2 GUIDELINES FOR EMERGENCY RESPONSE PLAN

Emergency response plan will be developed with the resources available within the company. The important stages of the response plan are declaration of an emergency, identification of resources & manpower, ending of an emergency and rehearsal of the plan. Declaration of an emergency would involve recognizing a leak and reporting to Station in charge of nearest compressor station.

Other features are summarized below:

Emergency Response Structure: An emergency response structure will be developed for effective response to the emergency. The structure defines the main functions of the decision makers and the individual roles as well.

Roles & Responsibilities of Team: Emergency response team (ERT) to respond to fire, accidents and technical emergencies will be constituted from operations personnel, who can be

called upon 24 hours a day, supported by senior management field personnel as and when required. The ERT will receive specific training for their roles and exercised on a regular basis. The proposed functions of employees that are planned to be deployed will be finalized prior to commissioning.

Operations Control: The pipeline operation will be monitored and controlled through Local control system and POC in command which will have the provision for emergency shut down or isolation of Pipeline. Security: Surveillance of the entire pipeline will be held periodically through ground patrolling. Using operators with knowledge of local area will be deployed for ground patrolling of the pipeline route.

Medical and First Aid: All arrangements will be made available at SHPPL site offices and camps for medical and first-aid. First–Aid facility will be provided at compressor stations, master pipeline operation center/ local control center, MLVs and M&Rs. Adequate first-aid training will be provided to employees at these locations.

Communication: Responsibility for external and internal communication will be assigned at each station. Dedicated fiber optic cable based communication system will be provided for quick communication between the control stations, dispatch and delivery station(s) of the pipeline. The backup system will consist of appropriate combination of fixed telephone lines/data-bandwidth of the local service provider, mobile phones, VHF sets etc.

Emergency control room: A safe location will be designated as emergency control room (ECR) within the compressor stations.

Emergency Procedures: SHPPL will evolve easy-to-follow procedures for responding to the identified situation. The plan will be rehearsed once in three months.

Ending of an emergency: After controlling an emergency, the site ERT Leader will declare as “All Clear”. The siren will be sounded for 2 minutes to indicate that the Emergency is over.

The basic elements for an effective plan have been included in the development. Prior to the commissioning of the project, copies of the plan are to be given to the authorities.

5.3 STAKEHOLDER CONSULTATIONS

Stakeholder Consultation" refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate.

Consultations were done at all districts of the projects, along the pipeline route. These meeting included the Project Influenced and benefitted Population in three districts. This was undertaken to understand the socio-economic status, education facilities and the literacy levels of the population as well as their interest in the upcoming project in their area.
The delineation of Preliminary Stakeholders were based on the following points,

- The type of stakeholders, and;
- Their connection and influence levels on the project.

An open-ended questionnaire was prepared for the focus group discussions prior to the start of the consultation process to obtain the information from the population. Different stakeholder groups were consulted to understand the concerns/ issues, expectations/ benefits and other advantages that they have on the project.

Representatives of AGL

Sr. No.	Name	Project Site/Corporate Office	Department
1	Mr. Saurabh Chaudhary	Project Site	Project
2	Mr. Ray	Project Site	Project

Discussions with Local Inhabitants Village 1

Name of the village	:	Baripada	Date	: 21st Jan 2020
Panchayat	:	Baripada	Tehsil/Taluka	: Baripdada
District	:	Mayurbhanj		

Participants:

S.No.	Name	Village	Occupation	Land ownership/Local Inhabitants in vicinity of Project Site
1	Tutu Panda	Baripda Town	Farmer/ Business	--

2	Ranjan Dash	Baripda Town	Farmer/Shop Owner	--
3	Pratik Rath	Baripda Town	Salaried Employee	--
4	Chnadrakant Pradhan	Baripda Town	NGO Worker	--

Sr.No.	Questions	Responses
1	Total population of the area:	116,849
2	Average Household Size:	5-6
3	Literacy rate:	87.26 %
4	Caste/tribe details:	There is no population of Schedule Caste (SC) and Schedule Tribe (ST) in Balasore town
5	Religion:	92 % Hindu, 4 % Muslim, 4 % Christian
6	Ethnic Group	South Asians
7	Major Occupation:	Farming, Service, Business
8	Crops Grown:	Main crop is paddy, G. nut, mustard, Mung, Biri & vegetables
9	Land Holding details:	1-10 Acres
10	Type and number of livestock per household:	Cows, Bulls, Goat
11	BPL Holders/Other government scheme:	10%
12	Educational facilities:	Higher Secondary School
13	Transport facilities:	State Bus
14	Health care facilities:	Hospital
15	Water Supply facilities:	Tap and handpump
16	Electricity facilities:	24 Hrs
17	Role of Women:	Household work
18	Veterinary facility	Yes
19	Fertilizer shop	Yes
20	Fair price shop	Yes
21	NGO working in the area	None
22	Government scheme	MNREGA
23	Cultural Site	None

Summary of Responses received from locals residing in area

Questions	Summary of responses received from affected parties
What is the present mode of cooking (Fuelwood/ LPG/Kerosene Stove)	Fuelwood/ LPG Cylinder
Is there any piped gas supply in the vicinity?	No
Any apprehensions/concerns/odour/safety issues w.r.t. present project in the area	Yes, about fire and explosion safety. Suggests that a demo to be given to the village about the safety aspects of gas pipeline
Are people contended with fuel switchover from present mode to Piped Gas Supply?	Yes, very much willing. Had heard of the project and are eagerly waiting as it will help in business and residential proliferation.
Are the people contended with the present upcoming project in the area?	No
Have any of the locals objected so far/raised Grievance related to similar projects/proposed project?	No
What is the general perception about CGD projects?	Very positive
Other projects nearby or any other industry	--

Summary of Responses received from land sellers (near to Tap Off Station in case of Pvt. Land Parcel)

Questions	Summary of responses received from affected parties
What is the Land Use of the project site?	Non irrigated farmland. Exact land is not yet decided.
Has any land from local villages been acquired for the project?	--
Are the land disbursers contended with the remuneration received?	--
Have any of the landowners who sold their land for the project gone landless?	--
What is the general perception about CGD Projects?	Positive
Other projects nearby or any other industry	The CGD project is coming in the major towns of the district. There are no other gas distribution project in the districts.

Source: TUVSUD Primary Survey

6 ANALYSIS OF ALTERNATIVES

Route selection is a process of identifying constraints, avoiding undesirable areas and maintaining the economic feasibility of the pipeline. Diversion of pipeline around obstacles can be very costly. The ideal route, of course, would be a straight line from the origin to the terminal point. However, physiographic, environmental, design and construction constraints usually alter the route

The pipeline route should be optimized based on the following considerations:

- Safety of public lives and property and safety of the pipeline from engineering and other considerations.
- Shortest pipeline length.
- Easy and favorable terrain condition free of large water bodies, low lying marshy lands, obstacles like ravines, depressions and unstable grounds, meandering rivers, etc.
- Ground profile for pipeline hydraulics and avoidance of steep rising and falling ground, hills and valleys having sloping right of way.
- Availability of infrastructure and access to the pipeline route during construction and maintenance.
- Environmental impact and avoidance of environmentally sensitive lands, such as reserved forests, marine parks, built-up areas, places of worship, burial and public events.
- Minimum crossing of existing pipelines, transmission lines, parallel alignment, etc.
- Minimum road, rail, river and canal crossings.
- Avoidance of rugged and intricate grounds with hard strata, exposed rocks, boulders and quarries.
- Existing and future developments in the region, such as roads, rail lines, canal network, reservoirs, townships, industrial units, etc.
- Scope for future expansion of the pipeline.

The Petroleum and Natural Gas Regulatory Board (PNGRB) was constituted under The Petroleum and Natural Gas Regulatory Board Act, 2006 (NO. 19 OF 2006) notified via Gazette Notification dated 31st March, 2006. The Act provide for the establishment of Petroleum and Natural Gas Regulatory Board to protect the interests of consumers and entities engaged in specified activities relating to petroleum, petroleum products and natural gas and to promote competitive markets and for matters connected therewith or incidental thereto.

Further as enshrined in the act, the board has also been mandated to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as and to ensure

uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country. Hence the project was acquired through the bidding process and the area, number of customers, total CNG stations were already mentioned in it. So the route selection was done within the allotted area.

The options for applying and analysis for alternatives was not a feasible option, as the deadlines have been already mentioned and the work was supposed to start from the date of signing the document. Since all the requirements in the projects were predefined, scope for alternate analysis was quite slim, as to which the route passes through mix and heavily populated area, eco-sensitive zones and the notified protected forest zones.

Currently the project is in conceptual stage and pipeline route are still being assessed and finalized.

7 PROJECT BENEFITS

7.1 CONTRIBUTION TO NATIONAL ENERGY SECURITY

Energy is the key input for economic growth and Indian Energy sector play a vital role in country's Economy. Energy is a key input to the production processes that transform inputs to goods and services. India became the third largest energy consumer in the world after United States and China. Key drivers for increasing energy demand in India are population growth, industrialization and urbanization. Energy security and sustainability are interdependent because emissions from energy consumption contributes to climate change in greater extend globally. Indian government is also committed to increase the share of natural gas in country's energy mix up to 15% by 2030 and Ministry of Petroleum and Natural Gas intervening with policy reforms in natural gas sector. India requires a sustained supply of energy to support its ambitious growth and welfare targets for the coming years. In a survey by NITI Aayog, it was noted that India's energy consumption will reach 2,300 million tonnes of oil equivalent (mtoe) by 2047 out of which natural gas will contribute 173 mtoe under the determined effect scenario.

According to the International Energy Agency(IEA), Indian gas market is considered one of the most growing energy markets in the world, the Agency expected that Indian gas demand will increase in the coming decades at 5.4% per annum over 2007-30 (IEA ,2009) reaching 132 BCM by 2030. India had about 43.8 TCF of proved natural gas reserves by the end of 2012; production of natural gas arrived in 2011, 2012 to 47.559 BCM, India was self-sufficient in natural gas until 2004, where it began to import liquefied natural gas from Qatar to meet the growing needs where India occupied the sixth rank globally in the import of natural gas. In spite of the Indian increase production of gas in 2010, an increase of up to more than 44%, but India and because of the high economic growth has increased the import at an annual rate of 10 % from 2001-2011. In 2011, India consumed 2.3 trillion cubic feet (TCF) which is equivalent to a quarter of the Indian natural gas needs. Qatar is India's main supplier of liquefied natural gas, where the parties signed long-term contracts to supply India around 7.5 million tons of LNG every year from Qatar for 25 years and the first shipments has reached to India in 2004.

With the growing need for oil and gas in India since the nineties of the last century, the Indian government has worked to develop the oil and gas sector through the development of mechanisms of action and the issuance of new regulatory laws, 1993, private investors have been allowed to import and market liquefied petroleum gas (LPG) and kerosene freely, private investment is also allowed in lubricants, which are not subject to price controls. In the 11th Five Year Plan, the Indian government has focused in particular on the energy sector in order to self-reliance for energy resources, particularly oil and gas by encouraging of exploration and

extraction operations and reduce dependence on overseas. The government also worked on the development of oil and gas infrastructure such as pipelines, refinery, ports, and railways. India currently has 22 refineries with a capacity (215.066 MMTPA),17 refineries under public sector and 3 under private sector. The Indian government is also working to improve of the oil and gas pipelines, and in spite of networks of gas and oil pipelines are still weak but the government is seeking to develop it, in collaboration with private sector companies.

7.2 REDUCED RISKS & COSTS

Natural gas pipeline has been regarded as the most cost effective and safest channel of gas transportation and has extraordinary strategic significance for the country. Pipeline is regarded as the most cost effective and safest channel to transport the oil and gas from upstream oil field or port to the downstream users or refineries. The gas is significantly replaced by oil in all sectors i.e. power generation, domestic and transportation due to price hike in oil prices globally and cheaper availability of natural gas. During the last five years the oil import has reduced by 8 %. The other reason for that may be the availability of cheaper, safe and durable mode of gas transportation system (main and distribution network of pipeline), which is continuously expending.

The gas pipeline projects helps in reducing the travel cost in comparison to other resources and it is also very safe and cheaper for domestic, commercial and industrial uses. The proposed pipeline project would be very feasible and cost effective as it is totally underground and there will be continuous access to the gas for the use.

7.3 SOCIO- ECONOMIC DEVELOPMENT

The proposed project will create socio-economic development across the pipeline route and in the near vicinity as well. The project will provide employment during construction and operation phase to the local labours. Further, it also helps in the development across the project area by providing the CNG stations along the roads and gas pipeline supplies to the households and commercial establishments. The proposed project will provide 40 CNG stations and 01 LNG station throughout the project route due to which the local community can easily access the cheapest way for their transportation.

8 ENVIRONMENTAL MANAGEMENT & MONITORING PROGRAM

8.1 INTRODUCTION

The Environmental Management Plan (EMP) provides an essential link between predicted impacts and mitigation measures during implementation and operational activities. EMP outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or mitigate adverse environmental impacts, and the actions needed to implement these measures. The likely impacts on various components of environment due to the project during developmental activities have been identified and measures for their mitigation are suggested. The EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. For each attribute, or operation, which could otherwise give rise to impact, the following information is presented:

- A comprehensive listing of the mitigation measures
- Parameters that will be monitored to ensure effective implementation of the action.
- Timing for implementation of the action to ensure that the objectives of mitigation are fully met

The EMP comprises a series of components covering direct mitigation and environmental monitoring, an outline waste management plan and a project site restoration plan. Therefore, environmental management plan has been prepared for each of the above developmental activities.

8.2 ENVIRONMENT MANAGEMENT PLAN

Table 8-1: Environment Management Plan

Aspect	Impacts	Mitigation Procedure	Monitoring Action	Responsibility	Timing
Air Pollution	Dust generation	• Access limited to demarcated ROW and specified access roads. · Strict enforcement of project speed limits · • Reinstatement as early as practical · • Damping down of ROW · • Identification of areas of particularly sensitive receptors (e.g., villages or crops)	• Review and approval of the contractors Transport management plan, Pollution Prevention Management Plan, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction

	Metal Vapour Emissions	Ensure adequate ventilation and dispersion of vapours Ensure welding is undertaken by appropriately trained personnel	• Review and approval of the contractors Employment and Training Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Combustion gases (CO2, CO, NO2, NO, SO2, PM, CH4, VOCs)	• Maintenance of all vehicles and plant to meet relevant international standards and manufacturer's recommendations· • Monitoring of vehicle and plant emissions · • Optimization of plant running time (where appropriate)	• Review and approval of the contractors Transport management plan, Pollution Prevention Management Plan, Construction Camp Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance • Routine review of discharge monitoring data	AGL	• Throughout Construction Period

	Vehicle movements	• Selection of appropriate routes for vehicles using public road network and project access roads · • Provision of environmental training for vehicle drivers and equipment operators · • Control of operational speeds and operating times · • Maintenance of vehicles and plant	• Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan and Employment and Training Management Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of traffic management and training processes	Contractor	• Throughout Construction Period
			• Collection and review of incident and near miss data	Contractor	• Throughout Construction Period
			• Spot checks on procurement and waste management processes Routine review of incident and near miss reports	AGL	• Throughout Construction Period
Noise Pollution	Noise emissions	• Control of vehicle and plant noise generation · • Control of operating hours · • Appropriate selection and maintenance of plant, vehicles and access routes · • Appropriate selection of construction techniques · • Community liaison	• Review and approval of the contractors Transport management plan, Construction Camp Management Plan, Pollution Prevention Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan,	AGL	• Pre-construction

		• Ensure environmental considerations are incorporated into the siting and design of camps · • Implement workforce education with respect to minimising disruptive activities. • Incorporate into the project induction training· • Implementation of camp rules including restrictions on noisy activities	Procurement and Supply Management Plan and detailed construction method statements.		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-monitoring
Water Pollution	Disposal of liquid wastes/water (Hydro test Specific Measures)	• Risk assessment to be undertaken before any chemical additives are used in hydro test water • Controlled discharge of water to reduce soil erosion Testing and treatment of water before discharge • Responsible disposal of waste	• Review and approval of the contractors Pollution Prevention Management Plan, Procurement and Supply Management Plan, Waste Management Plan, Infrastructure and Services Management Plan and detailed construction method statements	AGL	• Pre-construction

		water; no disposal of incompatible water in areas of groundwater or surface water vulnerability	• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Abstraction of Ground Water	• Sampling and analysis of water from existing boreholes · • Adherence to national and local licensing policy for abstractions · • Test-pumping of new abstractions and monitoring of impacts on existing abstractions · • Monitoring of water levels in wetlands • Ensure appropriate consolidation of backfill · • Implementation of erosion control measures • Ensure that groundwater disposal is undertaken in accordance with the Construction Environmental Management Plan· • Filter discharge if contains visible suspended solids ·	• Review and approval of the contractors Pollution Prevention Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction

		• Use of appropriate measures to minimise scour at the discharge point			
	Disruption of drainage / irrigation channels	• Undertake pre-construction surveys of irrigation and drainage systems as necessary to identify existing systems and devise temporary replacement measures if required, · • Undertake liaison with land owners/land occupiers/land users · • Include provisions for drainage/irrigation management	• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Increased flood risk	• Ensure that gaps are left in topsoil stacks to allow floodwater through · • Ensure the continued viability of pre-existing drainage and irrigation systems throughout the project	• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction

			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Disposal of trench-water	• Ensure that trench-water disposal is undertaken in an appropriate manner	• Review and approval of the contractors Pollution Prevention Management Plan, Waste Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Sediment release	• Avoid open cut river crossings during monsoon season· • Include environmental considerations in the selection of crossing design and choice of methodology	• Review and approval of the contractors Pollution Prevention Management Plan, Emergency Response Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction

			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Modified river flow		• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
Land & Soil	Use of raw materials & natural resources	• Development and implementation of procurement, supply and waste management procedures	• Review and approval of the contractors Procurement and Supply Management Plan and Waste Management Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of procurement and waste	Contractor	• Throughout Construction Period

			management processes		
			• Spot checks on procurement and waste management processes	AGL	• Throughout Construction Period
	Railway Crossing	• Mitigation measures to be formulated in conjunction with local railway department	• Review and approval of the contractors Transport management plan, Infrastructure and Services Management Plan, Community Liaison Management Plan, Community Safety Management Plan and Procurement and Supply Management Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Throughout Construction Period
	Potential for accidental spillage of hazardous	• Development and implementation of specific procedures for hazardous materials management	• Review and approval of the contractors Pollution Prevention Management Plan, Employment and Training Management Plan, Transport	AGL	• Pre-construction

	materials (e.g. lubrication fluids, oils, paints, diesel etc.).	• Minimisation of acquisition and storage of hazardous materials Training of personnel in safe use & handling of hazardous materials • Provision of appropriate spill response equipment and spill response training Rapid response in event of spillage	Management Plan, Procurement and Supply Management Plan, Waste Management Plan, Emergency Response plan, and construction method statements		
			• Recording and regular review of incidents and near misses	Contractor	• Throughout Construction Period
			• Routine monitoring, documentation and review of training, procurement, storage and waste management processes	Contractor	• Throughout Construction Period
			• Spot checks on contractor performance and record keeping Routine review of incident and near miss data.	AGL	• Throughout Construction Period
	Disturbance of land surface & vegetation	• Vehicle movements confined to defined access routes • Provision of environmental training to drivers and plant operators • Community liaison to discourage local use of ROW as road Common access routes to be used for pipeline were practical Traffic movements to be preceded by an assessment of ground conditions	• Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan and Community Safety Management Plan	Contractor	• Throughout Construction Period
			• Routine monitoring, documentation and review of traffic management and community liaison processes	Contractor	• Throughout Construction Period
			• Spot checks on traffic management, training and	AGL	• Throughout

			• community liaison processes. • Routine review of access route condition and adherence to defined access routes.		Construction Period
	Soil compaction	• Protection of soil storage areas from vehicle movements · • Protection of soil surface in areas of soft ground · • Provision of appropriate drainage and regular regrading	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Soil erosion	• Implementation of erosion control measures · • Compaction of soil stack surface to minimize erosion · • Preparation & implementation of approved crossing methods	• Review and approval of the contractors Pollution Prevention Management Plan, Reinstatement Plan and detailed construction method statements (with specific attention to those concerning river crossings)	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period

			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Loss of soil structure and fertility	• Ensure appropriate segregation, storage, management and reinstatement of stripped soil	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Loss of viability of soil seed bank	• Undertake an environmental review of the route to identify areas where preconstruction seed collection, harvesting of seeds from surrounding areas and/or the establishment of nursery crops should be carried out · • Ensure appropriate segregation, storage, management and reinstatement of topsoil	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and	AGL	• Pre-construction

			development of mitigation actions for sensitive sites		
	Modified topography	• Ensure that reinstatement is sympathetic to existing contours	• Review and approval of the contractors Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Disposal of surplus subsoil	• Ensure that the generation of surplus soil is minimised and that disposal is conducted appropriately · • Ensure that any potential subsoil disposal sites and disposal plans are subject to an environmental review prior to their adoption	• Review and approval of the contractors Waste Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary additional assessments and development of appropriate mitigation actions	AGL	• Pre-construction
	Disturbance of known/unknown	• Avoid construction in areas of known or suspected	• Review and approval of the contractors Pollution Prevention Management Plan,	AGL	• Pre-construction

	contaminated land	contamination as far as is practical · • Ensure that where contaminated land is encountered it is effectively managed	Waste Management Plan, Reinstatement Plan and detailed construction method statements		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary additional assessments and development of appropriate mitigation actions	AGL	• Pre-construction
	Potential for drilling fluid breakout/spillage (During HDD)	• Adequate geotechnical survey work conducted during design · • Risk assessment to be undertaken before drilling in vicinity of sensitive surface waters · • Storage of drilling muds in bunded area · • Avoid use of toxic chemicals in drilling fluid	• Review and approval of the contractors Pollution Prevention Management Plan, Emergency Response Plan, Waste Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation	AGL	• Pre-construction

			actions for sensitive sites		
Ecology	Loss of habitat	Development and implementation of: · • Environmental management plans· • Construction method statements (including clearance) • Transport Management (including route selection) • Reinstatement Plan Additional ecological surveys and translocation programmes	Review and approval of the contractor's management plans, detailed construction method statements and reinstatement plan	AGL	• Pre-construction
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
			Routine monitoring of species translocation programmes	AGL	Pre-construction and during construction in sensitive areas
	Impeded movement of wild animals, and domestic herds	• Ensure that gaps are left in soil stacks at strategic locations · • Leave gaps in welded strings at critical locations to allow passage of domestic herds ·	Review and approval of the contractors Community Liaison Management Plan, Infrastructure and Services Management Plan, detailed construction method statements and Reinstatement	AGL	• Pre-construction

		• Minimise interval between welding and ditching	Plan		
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
	Public & animal safety	• Erection of warning barriers where significant risk to public and livestock exists · • Installation of soft plugs in ditch with sloped edges to allow animal egress	Review and approval of the contractors Community Safety Management Plan, Infrastructure and Services Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
Social	Vehicle Movements	• Selection of appropriate routes for vehicles using public road network and project access roads · • Provision of environmental training for vehicle drivers and equipment operators · • Control of operational speeds and operating times · • Maintenance of vehicles and	Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan and Employment and Training Management Plan	AGL	• Pre-construction
			Routine monitoring, documentation and review of traffic management and training processes	Contractor	• Throughout construction period

		plant	Collection and review of incident and near miss data	Contractor	• Throughout construction period
			Spot checks on procurement and waste management processes Routine review of incident and near miss reports	AGL	• Throughout construction period
	Partial road closure	• Use non-open trench crossing techniques for major roads · • Minimise duration of closure of roads and provide temporary access where necessary · • Use steel plates across trench to maintain access · • Institute temporary traffic control, where necessary · • Undertake community consultation	Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan, Community Safety Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
	Loss of boundaries	• Reinstatement of boundaries following construction · • Ensure consultation with landowners, occupiers and users	Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan and Reinstatement Plan	Contractor	• Throughout construction period
			Routine monitoring, documentation and review of traffic management and community liaison processes	Contractor	• Throughout construction period

			• Spot checks on community liaison processes. • Routine review of access route condition and adherence to defined access routes.	AGL	• Throughout construction period
	Grievance Redressal Mechanism	Community Grievance Process	Spot follow up of complaints recorded in complaints register to assess whether process has been carried out correctly.	AGL	• Monthly during Construction period
		Implementation of general construction mitigation measures	Spot checks at ROW, construction sites and affected communities to ensure mitigation measures are being implemented. This will look specifically at: · • Implementation of measures to avoid disruption to infrastructural services such as telecoms, electricity, gas and water. · • Implementation of community safety measures (fencing near residential areas, fencing on public trench crossings, warning lights and warning signs at open areas of trench).	AGL	Monthly for first 3 months. If implementation of mitigation measures is proceeding appropriately, reduce monitoring to bimonthly with review of written activity reports submitted on a weekly basis.

			• Suitable diversions are in place where necessary · • Dust and noise mitigation measures are in place · • Alternative water sources are provided as appropriate		
Health and Safety		Community Safety	• Spot monitoring of health and safety incidence rates for community members and full review of any serious incidents. • Spot monitoring of community traffic safety meetings	AGL	Monthly Two to three times in first four months and if training is seen as acceptable, revert to once every six months. If training is not of sufficient quality, then continue at two to three every four months.
		General Safety Measures during	Spot monitoring of implementation of safety measures during construction as outlined in 'Implementation of general construction mitigation measures', General Construction Impacts section above.	AGL	Monthly for first three months. If implementation of mitigation measures is proceeding appropriately, reduce monitoring to bimonthly with review of written activity reports submitted on a weekly basis
		Health and safety training	Monitor HR records to ensure training is provided to all workers and spot monitor all courses (general health and safety, safe driving training, job specific health	AGL	

			and safety) provided to ensure training is adequate		

8.3 MONITORING SCHEDULE

The objectives of monitoring are:

- To check effectiveness of mitigation measures
- To evaluate the adequacy of Environmental Impact Assessment
- To assess status of compliance to legal requirements
- To assess if the Environmental Management Plan needs revisions/ updating.

The proposed environmental monitoring program during both construction and operation phases of the project are given in Table below:

Table 8-2: Environment Monitoring program- Construction & Operation Phase

S. No	Component	Location	Parameters	Frequency
Construction Phase				
1	Stack emission characteristics	Stacks attached to emission sources (e.g. DG sets)	Stack monitoring for PM, SOx, NOx and HC	Once in a month
2	Ambient air quality	Nearest Residential Areas, and busy commercial locations	Ambient air quality parameters as per NAAQS viz. PM10, PM2.5,SOx, NOx, CO	Once in a month
3	Ground water quality (used as source of domestic water)	Point used for drinking water	Parameters listed in ISO:10500	Once in a month
4	Effluent quality	Discharge header of hydrotested pipeline/ tank	According to general discharge standards	As per requirement
5	Waste (including hazardous)	Construction sites and camps	Quantity/ volume generated and disposed	Once in a day
6	Equipment noise levels	1 m from DG set	dB(A)	Once in a month
7	Ambient noise levels	Nearest residential areas/ Silent zones etc	Ambient noise levels (Leqday & Leqnight)	Once in a month
Operation Phase				
8	Greenbelt development		Plant density, health, growth and survival rate	Once in 6 months
9	Waste (including hazardous)	At CNG stations	Quantity/ volume generated and	Once in a month

			disposed at new CNG facilities	
10	Effluent quality	At CNG stations	Monitoring of treated water from outlets of ETP & STP	Once in 6 months

9 SUMMARY & CONCLUSIONS

9.1 SUMMARY OF IMPACTS

Among the pipeline lifecycle stages of construction and operations, due to temporary nature of the pipeline laying/construction, most impacts are likely to be short term and reversible in nature. The impacts that shall be most significant and of primary concern are summarized in the subsequent sections.

9.2 IMPACT DUE TO PIPELINE ROUTE SELECTION

The proposed pipeline route has been so selected such that there are:

- Shortest length of the pipeline between source and destination points
- Avoidance of sensitive areas such as national parks, sanctuaries and wildlife corridors
- Minimum impact to reserve forests and other sensitive areas
- Minimum number of water crossings
- Minimum impact to the environment
- Avoidance of populated areas/ industrial area
- Easy access to the route during construction, operation and maintenance of the pipeline.

9.3 IMPACTS DURING CONSTRUCTION OF PIPELINE

- There will be no impact along any stretch as the pipeline route is not falling near any sensitive ecological area.
- Earth work excavation, embankment formation, transport of construction materials, handling, laying and jointing of pipelines - These activities would cause a general increase in levels of dust and suspended particulate matter in the ambient air. However, this increase in concentration would be of temporary nature and localized.
- Movement of vehicles for transportation of construction material – These activities would cause a marginal increase in the levels of oxides of nitrogen, carbon monoxide and hydrocarbons.
- Impact from sediments being washed into the water bodies while the pipeline is laid across them. The pipeline will not be laid in rainy season, which will avoid adverse impacts on water body.
- Drinking water for base camps will be made available through local supply system. The domestic sewage from the construction camps will be either disposed off into the local sewage system and if required, will be treated in soak-pits and septic tanks.
- Water consumption during hydro-testing of pipeline - Efficient use of water will be made to reuse test water in different test sections. Water will be tapped from different sources along the pipeline route, without unduly disturbing its normal users.

- At major crossings, Horizontal Directional Drilling (HDD) method will be deployed so there will be no disturbance to the natural water flow or cause any pollution to the water body. Hence there will not be any obstruction/damage to fishing, recreational and navigation activities. The pipeline will be laid at a minimum depth of 2.5 meter below the bed level of water crossings.
- The pipeline will be buried all along its length hence impact on land use pattern will be marginal and reversible.
- Some quantity of earth excavated for pipeline laying will become surplus after installation of the pipeline and may be required for disposal.
- However, as this excess of earth will be taken to low lying area for filling purpose, the aesthetics of the pipeline and soil quality will not be affected.
- Noise Generation - The major human settlements are along the pipeline route where the noise levels due to construction activities are estimated to be around 70-90 dB(A). Such onetime exposure is not expected to last for more than few weeks and shall not exceed the stipulated standards. The pipeline laying work would be done in night only as there is lots of traffic in day time and creates disturbance to the locals.
- Selection of the pipeline route has been done in such a way that eco-sensitive areas which may be affected during the construction of the pipeline are minimised.

9.4 IMPACTS DURING OPERATION OF PIPELINE

- No impact on any ecological sensitive area is envisaged during operation
- No air emissions will be generated during the operation phase.
- The compressing station enroute will be kept in a built-in-area that will reduce the noise level to minimum. The incremental noise level in the nearest village due to the proposed operations will be minimal.
- There will be no significant impact on ecological environment during the operational phase of the project.
- The probability of leakage will be significantly reduced by adoption of appropriate safety measures and SCADA system.
- The probability of leak from a pipeline is remote. Pipeline will be buried minimum 1.5 m in the cross-country section and 2.5 meter below the bed level at major crossings.

9.5 MITIGATION AND ENVIRONMENTAL MANAGEMENT PLAN

General

The mitigation measures to reduce environmental impacts, described in this EIA, can be divided into the following categories:

- Those which can be regarded as good working practice.
- Project decisions taken by AGL with environmental protection in mind.
- Such measures are designed to avoid, eliminate or reduce potential impacts that may occur to the environment in the course of the proposed activities.

Post Monitoring Program

The implementation of mitigation measures during construction and operation phases will be monitored. The monitoring plan would provide for periodic revision, if necessary, in light of the baseline status to indicate progress in project implementation and changing environmental conditions so as to provide a basis for evaluation of project impacts. The post monitoring program would include the following:

- Approved means of leak detection would be employed as per the provisions of Schedule I -E of PNGRB Regulations, 2008 and as per ASME B 31.8, Appendix - M.
- Regular and adequate patrolling of pipeline particularly at crossing locations and settlements.
- Monitoring of pressure, coating conditions and cathodic protection

9.6 CONCLUSIONS

There will be a beneficial effect from pipeline project that will directly and indirectly boost the living standards of the people, save foreign exchange and with increase in industrial activities, create more jobs in the local economy. Thus, it can be concluded on a positive note that after the implementation of the mitigation measures and EMP, the proposed activities of AGL will have negligible impact on environment and will improve economy of the nation.

Annexures

Annexure 1: AGL QHSE Policy

adani
Gas

QUALITY, HEALTH, SAFETY & ENVIRONMENT POLICY

We, at **ADANI GAS LIMITED (AGL)** engaged in providing energy solution to the nation with efficient, environment friendly, safe & cost effective fuel.

"Safety first in everything we do at AGL" is an integral part of AGL culture

AGL firmly believes that all types of injuries, illness & incidents are preventable.

We at AGL are committed to ensure continuity of natural gas supply & reliability of services to the customers and also committed to demonstrate continual improvement in our Quality, Occupational Health, Safety & Environmental (QHSE) management performance by:

- Assessing needs & expectations of Interested Parties and satisfying them with continual improvement effort;
- Continual Improvement by reviewing and monitoring Organizational Context & Strategic Direction by use of process approach and risk based thinking;
- Adopt and implement the best available technology and systems from design to the delivery of gas to customers and also the work practices to reduce the QHSE risks as low as reasonably practicable and minimize the impact on environment; public and assets
- Integrate QHSE aspects in all our business processes;
- Pro-actively comply with all applicable legislation & other requirements; Establish, review and strengthen our QHSE Management Systems and CGD network integrity in an ongoing and auditable manner;
- Institutionalize practices for pollution prevention, waste avoidance an prevention of injury & ill health;
- Enhancing the competencies and commitment of employees through suitable training programs, involvement and motivation

We shall make this policy available to all our stakeholders.

Date: 05-11-2018

Suresh P Manglani
Chief Executive Officer

Annexure 2: EHS Organogram of AGL

adani Adani Gas Limited	EMERGENCY RESPONSE & DISASTER MANAGEMENT PLAN (ERDMP)	Doc. No. :HSE-102 Rev No : 01 Eff. Date: 01.03.15

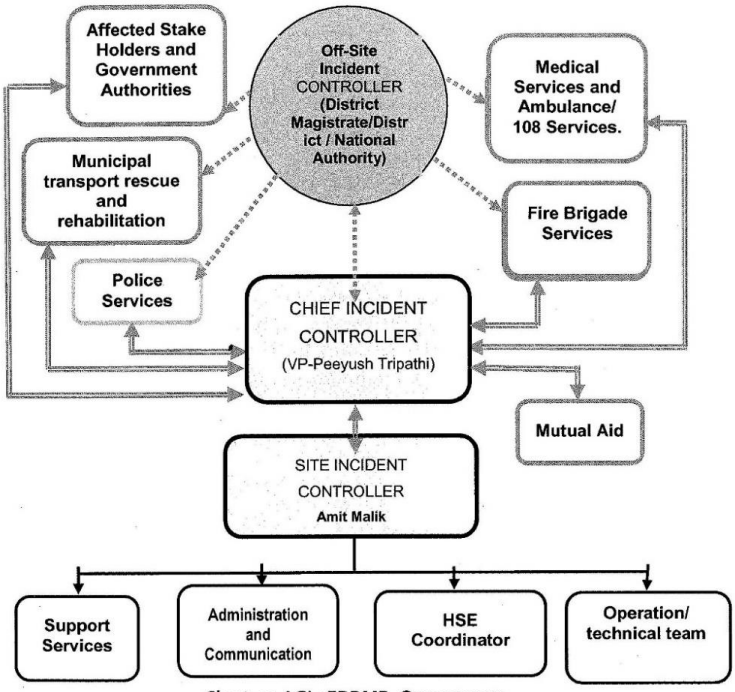


Chart-01-AGL: ERDMP- Organogram

Level – I
Level II
Level III

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Annexure 3: Mock Drill Format of AGL

adani Adani Gas Limited	EMERGENCY RESPONSE & DISASTER MANAGEMENT PLAN (ERDMP)	Doc. No. :HSE-102 Rev No : 00 Eff. Date: 01/03/15

adani Adani Gas Ltd.	EMERGENCY PREPAREDNESS MOCK DRILL RECORD

Mock Drill Date & Time : Mock Drill No. :

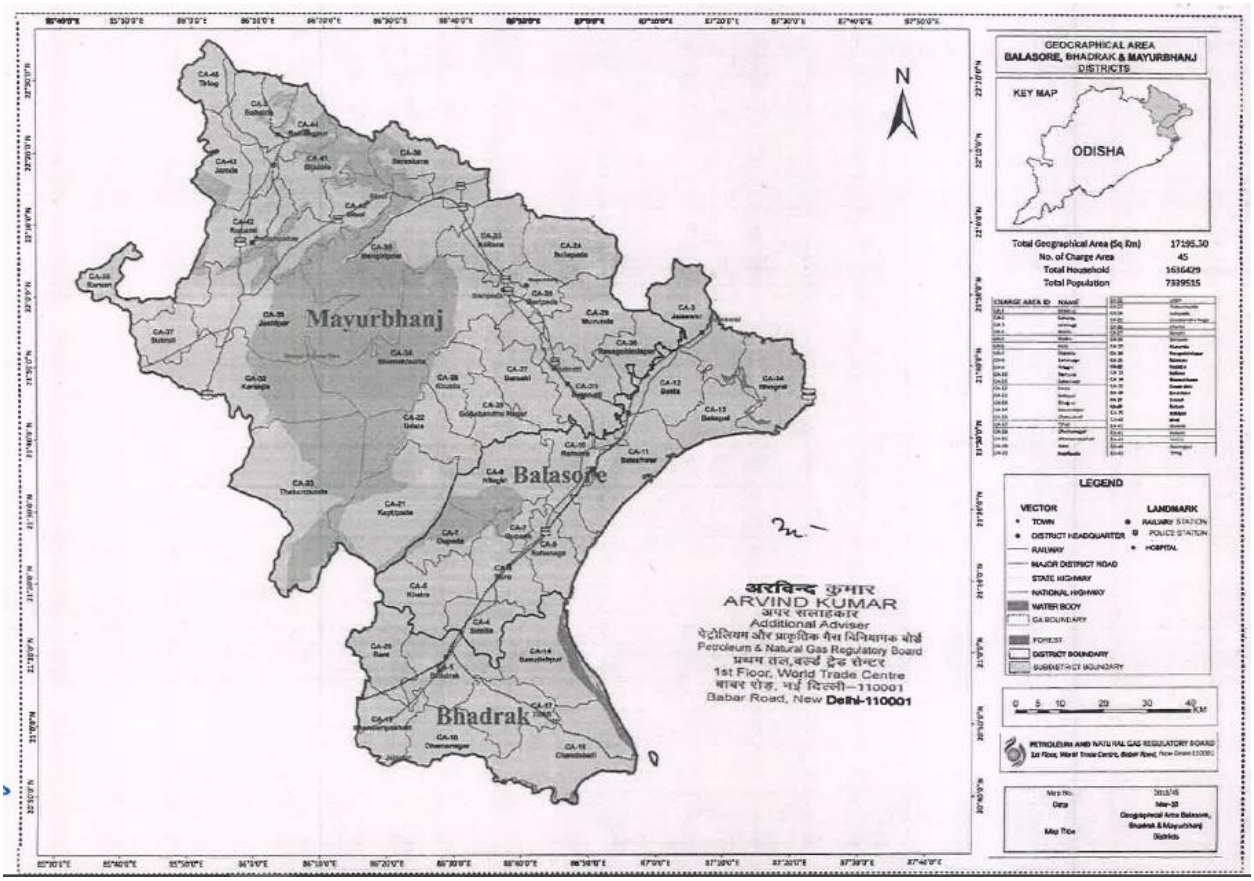
Sr. No.	Item Description	Standard Time	Time Start	Time End	Total Time Taken
1	Emergency Hooter / Operation of manual call points Started at [Time]	0 sec			
2	Evacuation started to Assembly Point at [Time]	60 sec			
3	Last person arrived at Assembly point at	Within 60 sec			
4	Activation of emergency control center	30 sec			
5	Information of incident to Emergency Team	10 sec			
6	Information to all key members at Perticular Location	45 sec			
7	Safe shut down activities in the plant	45 sec			
8	Fire Mitigation started by Security/members at [Time]	55 sec			
9	Fire Mitigation completed at [Time]	Within 55 sec			
10	Emergency vehicle arrival at entrance	Actual			
11	Head count started at [Time]				
12	Head count completed at [Time]				
13	Total Head Count				
14	Nearest Fire station distance from the site.				
15	Nearest hospital distance from the site				
16	Hooter for returning back to work started at				
17	Last person returned to work at				

Observations on overall preparedness effectiveness :

Area of Improvement of the Mock-drill exercise:

Action Planned to mitigate the draw backs:

Target Date	Person Responsible	Action Taken	Review By	Remarks [if any]

Report Prepared by: Report Reviewed by:

Annexure 4: Geographical Area and project detail