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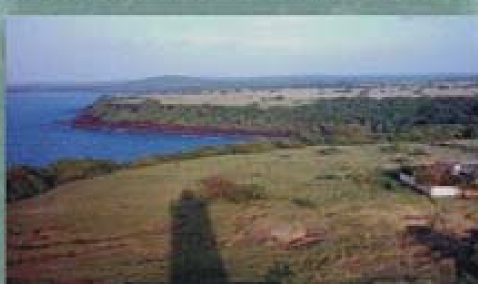
Environmental Impact Assessment for Proposed Nuclear Power Park at Jaitapur, District Ratnagiri, Maharashtra

Volume I: EIA Main Report

Sponsor :

Nuclear Power Corporation of India Limited, Mumbai.



National Environmental Engineering Research Institute
Nehru Marg, Nagpur 440 020

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Environmental Impact Assessment for Proposed Nuclear Power Park at Jaitapur, District Ratnagiri, Maharashtra

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FOREWORD

India is poised to go for peaceful use of nuclear energy in generating electricity, leading to sustainable development, conservation of conventional sources of energy and mitigation of environmental pollution.

India's efforts in pursuance of the above policy consistently in fairness and transparency has, recently, resulted in the waiver from "Nuclear Supply Group", enabling India to share nuclear trade with other countries in the field of peaceful use of nuclear energy. Immediately after the above event, India has signed bilateral agreements for such nuclear trade with USA, France and is in further process with Russia and other countries.

Presently, Nuclear Power Corporation of India Limited, under the Department of Atomic Energy, is operating 17 Nuclear Power Reactors with installed capacity of 4120 MWe. The present share of nuclear power of 4120 MWe is expected to increase to 7280 MWe by December, 2010 on completion of 6 projects under construction including one 500 MWe FBR type nuclear power plant by BHAVINI under Department of Atomic Energy.

The Department of Atomic Energy has three stage indigenously developed nuclear power generation programme which is being pursued for implementation. However, to meet the growing demand of electricity in the country, Government of India has decided to augment the contribution of nuclear power by importing nuclear power reactors from various countries having capacity of 1000 MWe and above and establish Nuclear Power Park of 8000 to 10000 MWe at different locations in the country. Accordingly, it is planned to have an installed capacity of 23000 MWe from indigenous and import route by the end of XIIth National Five year Plan.

In line with the above, Government of India has "in principle" approved 2 X 1000 MWe LWR type reactor at Jaitapur, Taluka Rajapur, District Ratnagiri, Maharashtra State in October 2005. However, in October 2009, Government of India has “in principle” approved setting up of 6 units of 1650 MWe each at Jaitapur site for utilization of its full potential. Accordingly, the site is planned to have 6 X 1650 MWe NPP units to be implemented in twin-mode construction in a period of 15 to 18 years so as to have a Nuclear Power Park of 10000 MWe at Jaitapur.

In order to assess the potential impacts arising due to setting up of Nuclear Power Reactors at Jaitapur site, NPCIL has assigned National Environmental Engineering Research Institute (NEERI) to undertake Environmental Impact Assessment Studies for various environmental components and to prepare an Environmental Management Plan for minimizing potential impacts.

This Environmental Impact Assessment Report contains the baseline data collected during summer, post monsoon and winter season (2006-07) for air, noise, water, land, biological environmental components, including radiological parameters and socio-economic conditions with a view to identifying, predicting and evaluating the potential impacts due to proposed activities. An Environmental Management Plan and Radiological and Emergency Response System have also been addressed in the report.

The impact assessment component in this report has been empowered by the studies especially carried out on certain important aspects such as thermal dispersion modeling, finalization of discharge points and prediction of temperature rise in sea due to the discharge of condenser cooling water in sea by CWPRS, Pune, HTL / LTL demarcation at Jaitapur, Maharashtra Coast by NIOT, *Chennai (Studies initiated by NPCIL), terrestrial biodiversity study by College of Forestry, Dapoli (Dist. Ratnagiri), and marine biodiversity and temperature tolerance of marine organisms by College of Fisheries, Ratnagiri (Studies initiated by NEERI).*

The co-operation and assistance rendered by the officers of NPCIL in preparation of this report are gratefully acknowledged.

T. Chakrabarti.

(Tapan Chakrabarti)
Director

Nagpur
February, 2010

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Chapter 1

Introduction

1.0 Purpose of the EIA report

The Government of India in principle accorded approval to establish 2x 1000 MWe LWR category Nuclear Power Plant (NPP) units at Jaitapur in Taluka Rajapur, Distt. Ratnagiri, Maharashtra State in October 2005. Although, Government of India accorded in principle approval for 2x 1000 MWe LWR category NPPs at Jaitapur site, however, owing to the advancement in the technology and in view of recent development in International scenario of NSG waiver, enabling India to have nuclear trade with other countries, Govt. of India has now in October 2009 "in principle" approved 6 x1650 MWe LWR NPPs at this location **(Annexure-XVI**, **Vol-II)** for utilization of its full potential. Thus the present Environmental Impact Assessment (EIA) study has been carried out by taking into account the inputs and impact due to 6 X 1650 MWe NPP units for obtaining environmental clearance from Ministry of Environment & Forests (MoEF).

Based on the authorization from Department of Atomic Energy (DAE), Govt. of India, vide letter No.2/14(1)/2005-Power/ 726 dated 20th October, 2005 (**Annexure-XIII**, **Vol-II**) actions for land acquisition and other pre-project activities including the action for obtaining Environmental Clearance from MoEF have been initiated by Nuclear Power Corporation of India Limited (NPCIL). Accordingly, the work of Environmental Impact Assessment (EIA) study was assigned to National Environmental Engineering Research Institute (NEERI), Nagpur vide work order no. NPCIL / AD (JP)/ EMS/ EIA / 2005 / M/ 133 dated 16th December, 2005.

1.1 Identification of Project and Project Proponent

In the year 1967, the Department of Atomic Energy formed Power Projects Engineering Division (PPED) and entrusted it with the responsibilities of design, construction and operation of the nuclear power plants. PPED was then converted into Nuclear Power Board (NPB), a unit of DAE, in 1984. In September 1987, with a view to shift nuclear power generation to commercial domain, NPB was converted under the Companies Act – 1956 into Nuclear Power Corporation of India Ltd. (NPCIL) as a Public Limited Company, under the administrative control of Department of Atomic Energy (DAE), with the objective of undertaking the activities of design, construction, operation and maintenance of nuclear power stations for generation of electricity in pursuance of the schemes and programme of Government of India under the provisions of Atomic Energy Act, 1962.

1.1.1 Historical Development of Nuclear Power Program in India and Present Status

India's first nuclear power station Tarapur Atomic Power Station, at Tarapur - Maharashtra Site, consisting of two Boiling Water Reactors was set up by a U.S. firm "General Electric" on a turnkey basis. These reactors commenced commercial operation in the year 1969. It was first nuclear power station in Asia outside the earstwhile Soviet Union. The unit capacity of 210 MWe at that time was the largest in the country.

The first 2 X 220 MWe Pressurized Heavy Water Reactors (PHWRs) in India were set up at Rawatbhata, Rajasthan in collaboration with Canada. Subsequently PHWRs of 2 X 220 MWe at Kalpakkam - Tamil Nadu, 2 X 220 MWe at Narora – U.P., 2 X 220 MWe at Kakrapar – Gujarat, 3 X 220 MWe at Kaiga – Karnataka, 2 X 220 MWe at Rawatbhata – Rajasthan and 2 X 540 MWe at Tarapur – Maharashtra have been designed, constructed & commissioned indigenously and are in operation. NPCIL / DAE, India has attained self reliance in the field of technology of designing, constructing and operating nuclear power plants with high capacity factor and safety records of international standards, complying with all the requirements of Atomic Energy Regulatory Board (AERB) and other statutory bodies. Some of the plants are adjudged the best operating stations by the international agencies such as World Association of Nuclear Power Operators (WANO).

In the year 2003, one more company – Bhartiya Nabhikiya Vidyut Nigam (BHAVINI) was formed for setting Prototype Fast Breeder Reactor (PFBR) and future fast breeder reactors. Chairman & Managing Director of Nuclear Power Corporation of India Limited is also the Chairman & Managing Director of BHAVINI. The construction of a 500 MWe PFBR at Kalpakkam – Tamil Nadu is in progress.

At present the total installed capacity of Nuclear Power is 4120 MWe (17 operating reactors) and total capacity of 3160 MWe (6 reactors including one Fast Breeder Reactor) are under construction viz. Kaiga – 4 and RAPP – 5 & 6 of 220 MWe each. PHWR, two units each of 1000 MWe PWRs at Kudankulam (KKNPP – 1 & 2), and 500 MWe FBR at Kalpakkam Tamil Nadu are under construction

Government of India, for the present, and "in principle" has approved in October, 2005 addition of 6800 MWe capacity through NPPs in different locations in the country, **including setting up of 2 X 1000 MWe PWR type Nuclear Power Plants (NPPs) at Jaitapur in Taluka Rajapur, District Ratnagiri, Maharashtra State** (as indicated in **Table 1.1**). The locations of various nuclear power plants under operation, the ongoing projects and approved projects are shown in **Fig. 1.1**.

Nuclear Power Corporation of India Limited (NPCIL) is the notified Project Proponent through authorization issued by DAE, Govt. of India vide letter no. 2 / 14(1) / 2005-Power / 726 dated 20th October,2005 (**Annexure-XIII, Vol-II** of **EIA Report**) for establishment of Jaitapur Nuclear Power Park.

Vision of NPCIL/ DAE

"To develop nuclear power technology and to produce nuclear power as a safe, environmentally benign and economically viable source of electrical energy to meet the increasing electricity needs of the country".

1.2 JNPP Site Selection

The Jaitapur site is considered suitable for setting up multi-unit NPPs of PWR category and approved by Government of India in October, 2005. The site selection is based on the recommendations of Site Selection Committee, (Constituted by Government of India / Department of Atomic Energy), which is one of the input among several other considerations to Atomic Energy Commission (AEC) and Govt. of India to take final decision on particular site. The site so selected is assigned to NPCIL through an authorization by Department of Atomic Energy to take further actions for obtaining statutory clearances from various agencies / Govt. Organizations to establish NPP units at such site. DAE Authorisation to NPCIL for

Jaitapur site is presented in **Annexure XIII**, **Vol. II** of EIA Report. The Site Selection Committee had surveyed the Jaitapur site to establish NPPs by analyzing the following parameters and submitted their recommendations to Govt. of India.

a. Location and General Area
b. Land availability
c. Available source of cooling water
d. Electrical System
e. Meteorology
f. Population Distribution
g. Land Use
h. Foundation Conditions & Seismicity
i. Flood Analysis & Safe grade elevation at site etc.
j. Solid Waste Management & Radiological Burden
k. Proper access for transportation of heavy / over dimensional equipment.
l. Environment aspects

The site selection committee, during process of site evaluation and while submitting their recommendations in September, 2002, had considered Jaitapur site suitable for setting up of three twin units of 1000 MWe LWRs and would hold good for same number of twin units modules of 700 MWe PHWRs or 500 MWe FBRs NPPs as well. However, with the present technological advancement, this coastal site is considered better suited for setting up of 6 x 1650 MWe PWR NPP units, as the Jaitapur Nuclear Power Project is proposed to be executed on an Inter-Governmental Agreement with Foreign Agency on technical co-operation basis.

Further at the time of site selection process, State Government had considered the availability of fresh Water requirement of proposed Plant & residential complex from Dam on Arjuna River. But with present uncertainty of meeting the requirement of fresh water from the above Dam and with the availability of advanced technology on desalination, NPCIL proposes to establish suitable Desalination Facility of sea water of appropriate capacity at Jaitapur site.

The following are some of the salient features of the proposed site for Nuclear Power Project:

(i) The adequate land required to set up multi unit NPPs at Jaitapur for plant site and residential complex is being acquired in one go. The brief details are given in the **Section 4.0** of **Summary EIA**. Most of the land being acquired for project site and residential complex is barren, with no physical displacement of any family.

(ii) Water availability and drawl of condenser cooling water from sea is assured at the site. Fresh water from Desalination facility of seawater of appropriate capacity shall be planned for meeting the fresh water supply requirement.

(iii) Foundation conditions are favorable with rocky substrata. Basaltic rock is available at a depth of 20 m from the ground. The site area lies in Seismic Zone-III in the Seismic Zoning Map of India (**Fig. 1.2**). The Map Showing the location of JNPP and the study area for EIA is given in **Fig. 1** and **Fig. 2** of **Summary EIA**. As per the studies carried out by ONGC, Dehradun; GSI, Nagpur; NGRI, Hyderabad, and Indian Institute of Geomagnetism (IIG), Mumbai, there is no active fault in the radius of 39 km around the JNPP site. As per AERB requirement, there should not be an active fault within a radius of 5 km from the site and as such, this requirement is met on the basis of above studies. Further, the Design value of Peak Ground Acceleration (PGA) prevailing at Jaitapur site for Safe Shutdown Earthquake (SSE) is being worked out for project implementation by GSI, Nagpur and the site is engineerable from the seismic consideration.

(iv) The average elevation of the site is about RL +24.5 m above the mean sea level. The detailed analysis / studies have been carried out by Central Water and Power Research Station (CWPRS), Pune to arrive at the safe grade elevation for proposed JNPP due to flood / tsunami. Safe grade elevation of +7.0 m with respect to Chart Datum has been recommended for proposed JNPP site. This safe grade elevation has been estimated considering the highest astronomical tidal level of +3.3 m, 2.5 m of tsunami or the 1000-year Return Period Storm Surge of

2.7 m, maximum wave set-up of 0.5 m and the free-board of 0.5 m. Hence the site is considered to be safe from flooding / tsunami view point. However, further studies will be carried out to fix grade level elevation at the design stage, taking into account the need to reduce pumping head.

(v) Power evacuation “in principle” is feasible initially for 3,300 / 2,000 MWe power from site depending on the capacity of the units. Appropriate transmission system for power evacuation will be taken up based on detailed studies, taking into account shares of beneficiary States. For additional units, power evacuation schemes would be finalized in consultation with appropriate State and Central Authority.

(vi) As per the census data of the year 2001, the average population density within 10 km around the site is estimated to be about 78 persons / sq .km. There are no population centers having a population of more than 10,000 within 10 km around the site.

(vii) The nearest National Highway is NH-17 at 38 km distance from the site. The nearest railway station Rajapur on Konkan Railway is about 60 km from site. Separate studies will be required to be carried out for improvements of roads for transport of normal consignment of NPP units at JNPP.

(viii) The Over Dimensional Consignment (ODC) of NPP equipments of JNPP will be transported by sea. A jetty is planned to be constructed at the site for loading and unloading of such equipments.

(ix) The proposed site for the project is rocky and almost barren with no sensitive species like mangroves are present upto 5 km from the site. No industries handling toxic chemicals or explosives are reported to exist within 10 km. There are no railways sidings or road transport depots within 10 km. There are no civil or military airports within 50 km around the site. There is landing ground at Ratangiri at radial distance of 40 km from the site, which can handle Dakotas. In general, the industrial activities in the area are practically negligible and as such, impact on environment arising out of human utilization is insignificant.

1.2.1 Brief Description of the Project

NPCIL intends to establish a Nuclear Power Park by installing 6x1650 MWe PWR category NPPs at this location in a phased manner. Required land is available for establishing the NPP and the residential complex at Jaitapur. The land being acquired for JNPP (site and residential complex) admeasuring around 938.026 ha is rocky with poor fertility and barren with small patches of agriculture. The land is non forest and is privately owned. There is no physical displacement of any family from the proposed land being acquired for the project (site and residential complex). Abundant sea water is available for Condenser Cooling and desalination plant. The project site is far away from urban area. The population density within 10 km around the site is estimated to be about 150 persons / sq. km. The average elevation of the site is about RL +24.5 m above mean sea level while the safe grade elevation is +7.0 m with respect to Chart Datum (as per the study of CWPRC, Pune)

1.3 Importance of JNPP to the Region / Country

The comparison of nuclear power plant with that of coal based thermal power plant with respect to fuel use and emissions of conventional pollutants indicate that the nuclear power plants do not generate conventional pollutants as can be seen from the **Fig. 1.3**. The radio-nuclides generated from nuclear power plants are handled, processed and disposed off carefully within the limits, which are specified by Atomic Energy Regulatory Board (AERB) of India.

The important factors affecting the operating economics of power generating technologies are capital cost, debt equity pattern, and interest during construction, discount rate and fuel choice. The analysis of economics of the technologies as on date reveals that nuclear power, in the long term, is an economical option particularly at locations away from coal – mines e.g. regions of western coast of India. Considering that the component of fuel cost relative to coal is lower in case of nuclear power accordingly, the escalation impact on tariff is also lower. Nuclear power in India has been established to be safe, reliable, clean & environment friendly and economically compatible with other sources of power generation of the NPP units in India. Therefore, establishment of JNPP in the western coast of the country assumes importance, as it will provide much needed electricity with minimal environmental impact and with comparable cost of electricity generation.

1.4 Scope of the Study

1.4.1 TOR Proposed by NPCIL

The Terms of Reference (TOR) of the study proposed by NPCIL are as given below:

a) Assessment of the present status of Air, Noise, Water, Land, Biological, Marine and Socio-economic components of environment including biodiversity and also parameters of human interest and health up to 25 km radius from the project site (**Fig. 1.4**).

b) Identification of potential impacts due to proposed Nuclear Power Park, residential complex and desalination plant (proposed to be installed at plant site) on various environmental components including biodiversity due to activities envisaged during construction and operational phases of the proposed project.

c) Prediction of significant impacts due to proposed nuclear power plant, residential complex and desalination plant (proposed to be installed at plant site) through identification, calibration and validation of appropriate mathematical/simulation models.

d) The database collected during the status survey should be utilized and additional data should be generated if required for calibrating the prediction models for the future dose/pollution level scenarios so as to enhance the reliability of the prediction.

e) Evaluation of impacts through appropriate evaluation technique and preparation of environmental impact statements based on the identification, prediction and evaluation of impacts.

f) Delineation of Environmental Management Plan (EMP) outlining preventive and control strategies for minimizing adverse impacts during construction and operational stages of the proposed project.

g) Formulation of environmental quality monitoring programs for construction and operational phases to be undertaken by the project proponent as per the requirements of the statutory authorities.

h) Radiological Risk assessment and emergency preparedness plan

1.4.2 Additional TOR by MoEF for Nuclear Power Park

The Expert Appraisal Committee for environmental appraisal of Nuclear Power Projects considered the EC proposal for JNPP during its meeting held on 2nd April, 2009. Based on the review of the documents submitted and the presentation made by the NPCIL, the Committee prescribed the following additional Terms of Reference (TOR) vide letter no. J-14011/1/2009-IA.II (N) dated 8th May, 2009 for incorporating the same in the EIA report already prepared for the above mentioned project: The compliance of the additional TOR in subject EIA report for illustration purpose is also presented below against each additional TOR.

Sr. No.	Additional TOR	Compliance Status
1	A Section on the site selection should be included in the EIA report	A brief description of the site selection process is presented in **Section 1.2** of **Chapter-1**.
2	It may be confirmed whether the proposed site conforms to the approved land use of the area. The necessary supporting documentation in this regard should also be provided.	The site conforms to the approved plan of Govt. of Maharashtra as explained in **Section 2.2.2**, **Chapter-2**. The supporting document is attached as in **Annexure-XIV**, **Vol-II** of **EIA report**.
3	The land use of the study area (separately for plant area and surroundings), which should, besides other, inter-alia also provide information on the Alphenzo mango plantation in the area.	The Alphenzo mango plantation is present sporadically upto a distance of 5 km from project site and near to the proposed residential complex site The details of trees present in the land being acquired for the project is presented in **Table 3.10.7** of **Chapter-3**. Moreover, the vegetation present in the study area (25 km) as given in the **Table 3.7.16** of **Chapter - 3** is only around 14%. Alphenzo mango orchards are distributed in many villages and are included in 14% vegetation cover.
4	The impact of the proposed project, if any, on the Alphenzo mango plantation should be brought out. The necessary supporting documentation / study reports, if any, should be provided	Since the project during operation phase does not emit SO_2, NOx or SPM, impacts due to these parameters is not envisaged. Impact due to radiation on mango plantation will also be negligible as background radiation level available in vegetation and surrounding environment are not going to be exceeded during operation phase as radiation emission will be regulated as per AERB norms.
5	The impact of cutting of hill at the proposed plant site, to make it compatible with safe grade elevation on the drainage of the area should be provided. The proposed safeguard measures to avoid flooding should also be incorporated in the EIA.	Impact of cutting of hill is given in **Section 4.5.5.3** of **Chapter 4**. Excavated material will be used in construction of breakwater and plant and any clay material or silt would be dumped in the sea beyond 20m depth contour sufficiently away from out all location. The details of coastal land proposed for the JNPP is given in **Section 4.2.3.1** of **Chapter 4** under

Sr. No.	Additional TOR	Compliance Status
		Land Environment. NPCIL will provide proper drainage design for the area for post-JNPP construction phase along with the necessary safeguard measures to avoid flooding. However, Detailed flood analysis including Tsunami studies carried out by CWPRS, Pune has been given in **Section 2.2.6 of Chapter 2**.
6	A detailed plan of disposal / management of solid waste likely to be generated as a result of cutting of hill (taking into account the quantity of waste to be generated) should be given.	All the material generated due to cutting excavation will be utilized in construction of breakwater, construction of plant and residential complex and other areas depending upon the quality of the excavated material. The details are provided in **Section 4.5.5.3 of Chapter-4**.
7	The marine ecology and the impact of the proposed activities on the same including creek ecosystem should be comprehensively covered in the EIA report. The impacts during construction phase as well as during operational phase including the impacts due to the thermal discharges should be covered.	Details are included in **Section 4.2.2.1.4** under Water Environment of **Chapter-4**. Suggestions of College of Fisheries, Ratnagiri and Compliance to Thermal Regulation are given in **Section 10.10.2.1.1**, and **10.10.2.1.2**, **Chapter-10**
8	Impact of construction of jetty including dredging, sediment movement on the marine environment should also be covered in the EIA report.	The impact of construction of jetty on marine environment will be insignificant. The details are given in **Section 4.5.5.2**, **Chapter 4**.
9	A plan for disposal of dredged material should be included.	Information given in **Section 4.5.5.3**, **Chapter 4** of this report and **Section 10.10.7**, **Chapter-10** under EMP for CRZ Impact.
10	The pre-operational baseline radiological survey need to be carried out and included in the EIA report.	Given in **Section 3.4.2**, **Chapter 3** under Results of Baseline Radiological Survey and full report is Presented as **Annexure-IX(a)**, **Vol –II** of **EIA Report**
11	CRZ map duly demarcating the HTL, LTL, the CRZ boundary by one of the authorized agencies should be included in the report. The plant layout should also be superimposed on the CRZ map.	CRZ Categorization and HTL / LTL Demarcation of JNPP Site given in **Section 3.7.10** of **Chapter 3** and Section **5.1** of **Summary EIA**. The work carried out by NIOT Chennai is enclosed as **Annexure VI** of **Vol. II** of **EIA Report**, and the map is given **in Fig. 5** of the **Summary EIA**
12	Location of any Sanctuary / National Park / Biosphere Reserve within 10 km of the proposed power plant should be indicated. A location map in this regard duly authenticated by Chief Wildlife Warden should also be provided	There is no Sanctuary / National Park / Biosphere reserve within 10 km of the proposed project. No Objection Certificate (NOC) from Forest Department is enclosed as **Annexure -XI** of **Vol. II of EIA** report. The necessary certificate from Chief Wildlife Warden is enclosed as **Annexure XII** of **Vol. II of EIA** report

Sr. No.	Additional TOR	Compliance Status
13	Detailed R&R plan / compensation to be paid to the land oustees should be given in the report. Besides compensation, details of the activities to be undertaken with financial outlays for the activities to be taken up in the area as part of CSR should also be provided.	R & R plan approved by State Government will be implemented. Details are given in **Section 7.3** of **Chapter-7** under Social Impact Assessment and R and R Plan and also in **Section 10.10.6.1** of **Chapter-10** and **Section 3.10.6** of **Chapter 3**.
14	Details of the stacks to be provided with the DG sets should be given in the EIA report. Details of the model used for air quality prediction and the input data used for modeling should be given in the EIA report.	The details of the stack & other parameters for DG sets are given in **Section 2.6.8**, **Chapter-2**. The modeling details are given in **Section 4.2.1.2** in **Chapter 4** of this report.
15	The baseline data collected (date wise) as well as their analysis should form part of the EIA report.	Baseline data and analysis included in **Chapter 3** and **4** and at other relevant places in different Chapters.
16	The dose commitment as given in the EIA report should be correlated with the emissions data.	Details are given in **Section 4.2.1.3** in **Chapter 4** and **Annexure IX(d)**, **Vol II**.
17	The issues raised during PH should also be addressed in the final EIA report.	Relevant issues raised during Public Hearing will be included in the report as an addendum.
18	A detailed plan for post project monitoring should be included in the EIA report. It should inter-alia include parameters to be monitored and their frequency. The parameters / data to be put in public domain and their frequency of updation should also be specified.	Details are included in **Chapter-6**

1.4.2.1 Additional TOR by MoEF for Residential Complex

In respect of the residential complex, the following TOR are prescribed for addressing the same in the EIA report.

Sr. No.	Additional TOR	Compliance Status
1	A site plan showing the project site and its surroundings with physical features and topographical details, such as land use, contours and drainage pattern, along with photographs of the site from all four sides, shall be examined in detail.	Details of land use and other details for JNPP Residential Complex are given in **Plates 2.8** to **2.17** of **Chapter-2 Section II**, **Section 2.10.1** of **Chapter-2**, and **Fig.4(a)** and **Fig. 4(b)** of **Summary EIA**
2	If the site is low lying and will require extra earth, examine the quantity required and identify the area from where the earth will be borrowed and whether any permission will be required or not.	The average elevation of the site is +24.5 m above the mean sea level, so the site is not low lying. Details of land are given in **Section II**, **Sub-Section 2.10.8.1** of **Chapter-2**
3	Examine in detail the proposed site with reference to impact on infrastructure covering	Details are given in **Section II**, **Sub-Section 2.10.8**, **2.11.2**, **2.12.8, 2.12.13** in

Sr. No.	Additional TOR	Compliance Status
	water supply, storm water drainage, sewerage, power, etc., and the disposal of treated/ raw wastes from the complex on land/water body and into sewerage system.	**Chapter-2** of this report
4	Carry out hydro-geological investigations including water quality and seek permission from Central Ground Water Authority for withdrawal of ground water.	Details of hydro-geological survey is given in **Section II**, **Subsection 2.10.3**, **Chapter 2** of this report
5	Consider soil characteristics and permeability for rainwater harvesting proposals, which should be made with due safeguards for ground water quality. Maximise recycling of water and utilisation of rainwater.	Details of soil characteristics and rainwater harvesting scheme is given in **Section II**, **Subsection 2.10.3.2** and **Section 2.12.8**, **Chapter-2** of **EIA Report**
6	Provision should be made for guard pond and other provisions for safety against failure in the operation of wastewater treatment facilities. Identify acceptable outfall for treated effluent.	A suitable guard pond will be provided, details of the same are given in **Section II**, **Subsection 2.12.13**, **Chapter-2** of **EIA Report**
7	Examine existing education and health facilities, police and other services and include adequate provisions in the proposal.	The details of the education and health facilities are given in **Section 3.10.2.2** & **3.10.2.4 of Chapter-3** and future plans in **Section II Subsection 2.12.12** of **Chapter 2** of **EIA Report**
8	Study the existing flora and fauna of the area and the impact of the project on them.	There will be insignificant impact on the Flora and fauna of the area due the project. Details of flora and fauna is given in **Section II, Subsection 2.10.7**, **Chapter-2** of **EIA Report**
9	Landscape plan, green belts and open spaces should be described.	Details of landscape / green belt are given in **Section II**, **Subsection 2.12.10**, **Chapter-2** of **EIA Report**
10	Assess soil erosion in view of the soil characteristics, topography and rainfall pattern.	There will not be any significant soil erosion. Details of soil erosion is given in **Section II**, **Subsection 2.11.3.1**, **Chapter-2** of this report
11	Application of renewable energy/alternate energy, such as solar and wind energy may be described including solar water heating. Provide for conservation of resources, energy efficiency and use of renewable sources of energy in the light of ECBC code.	Details are given in **Section II**, **Sub-Section 2.10.8.3** of **Chapter-2** of **EIA Report**
12	Arrangements for waste management may be described as also the common facilities for waste collection, treatment, recycling and disposal of all effluent, emission and refuse including MSW. Identification of recyclable wastes and waste utilisation arrangements may be made.	Waste water from Residential Complex is discussed in **Section 3.6.7.3**, **Chapter 3** and Sewage Treatment Plant (capacity: 1830 cu.m. /day) in **Section 2.12.13**, **Chapter 2** of **EIA Report**
13	Traffic management plan including parking and loading / unloading areas may be described. Traffic survey should be carried out both on weekdays and weekend.	Details are given in **Section II**, **Sub-Section 2.12.14** of **Chapter-2** of this report

Sr. No.	Additional TOR	Compliance Status
14	Use of local building materials should be described.	Local construction material will be used. Details are given in **Section II**, **Sub-Section 2.2.11** in **Chapter-2** of this report
15	Application of resettlement and rehabilitation policy may be described. Project affected persons should be identified and rehabilitation and resettlement plan should be prepared.	R & R plan approved by State Government will be implemented. Details are given in **Section 7.3** of **Chapter-7** and **Section 3.10.6** in **Chapter 3** of **EIA Report**
16	Examine separately the details for construction and operation phases both for Environmental Management Plan and Environmental Monitoring Plan	Details are given in **Section II**, **Sub-Section 2.11 & 2.12** in **Chapter-2** and **Chapter 6** of **EIA Report**
17	Examine and prepare in detail the Disaster Management Plan and emergency Evacuation Plan for natural and manmade disasters like earthquakes, cyclones/flooding, Tsunami and terrorists attack.	Details are given in **Section II**, **Sub-Section 2.12.15** of **Chapter-2** of **EIA Report**

The proposed TOR by NPCIL read in conjunction with additional TOR by MoEF are the final basis for the EIA study for the JNPP and the report has been prepared accordingly.

1.5 Additional Studies

In Addition, following special studies have been carried out by independent institutes / agencies, organized by NPCIL as well as NEERI for generation of important baseline data / specific information required for the subject EIA study.

(i) 2D Mathematical Model Studies for Thermal Dispersion of Condenser Cooling Seawater discharges from proposed Nuclear Power Project at Jaitapur, Ratnagiri, Dist. Maharashtra, by CWPRS, Pune (NPCIL)

(ii) HTL / LTL and CRZ Demarcation off Jaitapur Maharashtra Coast by NIOT, Chennai (NPCIL)

(iii) Status of Biodiversity in the area of 25 km around the project site by College of Forestry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri, Maharashtra (NEERI)

(iv) Baseline Marine Ecological Assessment of Sea around proposed Jaitapur Nuclear Power Project near village Madban District, Ratnagiri (Maharashtra) by College of Fisheries, Ratnagiri (NEERI)

(v) Pre–operational baseline radiological survey in the area of 30 km around the project site by HPD, BARC, in the year 2007 (NPCIL)

1.6 Role of AERB & MoEF on Establishment of a Nuclear Power Project

Since the inception of Atomic Energy Programme in the country, importance has been given to the adoption and maintenance of high safety standards. In order to enforce safety standards, the Government of India constituted AERB in November 1983. AERB is entrusted with the responsibilities for laying down safety standards and framing rules and regulations covering regulatory and safety functions envisaged under the Atomic Energy Act-1962. AERB has also been empowered as an enforcing agency in respect of implementation and monitoring aspects (including for industrial safety) of Factory Act – 1948.

While undertaking the activities of establishment and operation of nuclear power plant, the safety of workers, public and the environment is to be ensured, and this is achieved through compliance with the relevant provisions of the Atomic Energy Act-1962. AERB has developed safety standards, codes, guides and manuals for nuclear facilities, covering all aspects such as siting, design, construction, operation, quality assurance, de-commissioning and regulation thereof. The details of these are presented in **Table 1.2 (a)** to **1.2 (d)**.

Safety standards contain internationally accepted safety criteria for design, construction and operation of specific equipment, systems, structures and components of nuclear and radiation facilities. Safety codes are intended to establish objectives and to set minimum requirements that shall be fulfilled to provide adequate assurance for safety in nuclear and radiation facilities.

AERB strongly emphasizes and regulate the reduction in generation, treatment, handling, monitoring, disposal & safe storage of various radioactive waste generated in a Nuclear Establishment.

The major stages of AERB's consenting process for Nuclear Power Plants are as follows:

(a) Siting
(b) Construction
(c) Commissioning

(d) Operation

(e) De-commissioning

Safety in siting, construction, commissioning and operation of the NPPs is ensured by AERB through regulatory actions including granting of consent for activities and imposing of conditions on the applicant. Regulatory body performs its activities on the basis of its review and assessment. In general, a three-tier review process is followed by regulatory body before any major activity concerning Nuclear Power Project / station is granted consent.

The AERB also monitors the status on various statutory clearances. During various submissions and discussions with AERB, the status on stipulations on various statuary clearances and its compliance report is required to be submitted. During its regulatory inspections programme, the inspection team of AERB verifies the status of compliance of rules / stipulations at site.

1.6.1 Consent for Siting for the Proposed Project

The process of Siting for the proposed Jaitapur Nuclear Power Project (JNPP) involves consents from

- Ministry of Environment & Forests (MoEF)
- Atomic Energy Regulatory Board(AERB)

1.6.2 Consent for Siting from Ministry of Environment & Forests

In order to comply with the requirements of Ministry of Environment of Forests (MOEF), Government of India, The Nuclear Power Corporation of India Limited entrusted the work of “Environmental Impact Assessment Study (EIA)” to National Environmental Engineering Research Institute (NEERI), Nagpur with a view to establish the baseline status with respect to various environmental components viz. air, noise, water, land, biological and socio-economic including parameters of human interest and to evaluate and predict the potential impacts due to the proposed activities and advise Environment Management Plan.

1.6.3 Consent for Siting from AERB

The process of Siting Consent by AERB is based on the AERB Safety Code No. AERB/SC/S (Code of practice on Safety in Nuclear Power Plant Siting). This Safety Code defines the criteria for selection of sites for nuclear power plant, effects of site characteristics on plant and impact of nuclear power plant on site. The main objective of this siting consent review of AERB is from the point of view of Nuclear Safety to ensure safe construction and operation of the nuclear power plant and to provide protection of the public and environment against the radiological impact resulting from unlikely event of release of radioactive materials during operation. The objective is achieved by ensuring

a) The radiological risk to the nuclear power plant due to external events should not exceed the range of radiological risk associated with accidents of internal origin.

b) The possible radiological impact of a nuclear power plant on the environment should be acceptably low for normal operation and accident conditions and within the stipulated criteria for radiological safety.

For evaluating the suitability of the site for locating the Nuclear Power Plant, following are the major aspects that are considered.

i) Effect of external events (natural and man-induced) on the plant

ii) Effect of plant on environment and public

iii) Implementation of emergency procedures particularly protective counter measures in the public domain.

The Site Evaluation Committee conducts its review based on the AERB Safety Code No. AERB/SC/S.

1.6.4 Other Consents and Authorizations

The lists of consents / authorizations that have to be obtained and maintained for JNPP are given in **Table 1.3**. These authorizations / consents shall be obtained prior to start of construction or before the actual occurrence of the activity whichever is early.

1.7 Structure of the EIA Report

The structure of the EIA report has been made as per Appendix- III, of Environmental Clearance Notification -2006 (S. O. 1533). Accordingly, the subject EIA report has been organized in two volumes viz. **Volume-I**, which consists of main contents of the EIA studies, whereas the **Volume-II** contains the Appendices of the additional studies carried out by various independent institutes / agencies as mentioned in the preceding section, including other supporting documents, maintaining the structure as per Appendix-III as mentioned above.

The volume –I consists of the following chapters:

- Summary EIA

Chapter-1 Introduction

Chapter-2 Project Description

Chapter-3 Description of the Environment

Chapter-4 Anticipated Environmental Impacts and Mitigation Measures

Section –I: Prediction of Impacts on Environment

Section–II: Radiological Risk Assessment & Emergency Response System

Section –III: Prediction of Impacts under CRZ

Section IV: Assessment of Irreversible and Irretrievable Impacts and Significant Impacts

Chapter -5 Analysis of Alternatives (Technology & Site)

Chapter -6 Environmental Monitoring Program

Chapter -7 Additional Studies

Chapter -8 Project Benefits

Chapter -9 Environmental Cost Benefit Analysis

Chapter -10 Environnemental Management Plan

Chapter -11 Summary & Conclusions

Chapter -12 Disclosure of Consultants engaged

Bibliography

Volume –II

The volume –II contains additional study reports from the institutes / Agencies including supporting documents / Annexures of the main EIA study report as presented below.

Annexure No.	Particulars
I	National Ambient Air Quality Standards (NAAQS), 1994
II	Noise Standards (CPCB, 1998)
III	Indian Standards for Drinking Water (IS 10500 – 1991)
IV	Indian Standards for Industrial and Sewage Effluents Discharge, IS: 2490-1982
V(a)	Letter no. MMC/PRO/2009-1208 dated 17-04-2009 from CWPRS related to maximum

Annexure No.	Particulars
	temperature range at outfall, effect of excavation, construction and breakwater on sediment transport and disposal of excavated material
V(b)	2D Mathematical Model Studies for Dispersion of Condenser Cooling Water Discharge from Proposed Nuclear Power Plant at Jaitapur, Ratnagiri, Dist. Maharashtra, prepared by CWPRS, Pune (Technical Report No. 4492, October, 2008)
VI	Report on HTL / LTL Demarcation off Jaitapur Maharashtra Coast for Nuclear Power Corporation of India Limited, Mumbai, prepared by NIOT, Chennai (Report No. NIOT / C-1102/ NPCIL, November, 2007)
VII	Report on Status of Biodiversity at the Proposed Site of the Nuclear Power Plant at Jaitapur prepared by College of Forestry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri, Maharashtra (Report dated 20th February, 2008)
VIII	The Baseline Marine Ecological Assessment of Sea around Proposed Jaitapur Nuclear Power Project near village Madban District, Ratnagiri (Maharashtra) prepared by College of Fisheries, Ratnagiri (Report dated 31st March, 2008)
IX(a)	Pre-Operational Environmental Surveillance Around Proposed Jaitapur Nuclear Power Plant Site in Ratnagiri District (Maharashtra) prepared by Bhabha Atomic Research Centre, Mumbai, India. (2007) (Report no. BARC/2007/1/003)
IX(b)	HPD, BARC: Windrose for Jaitapur site, 1999-2003
IX(c)	HPD, BARC: Analysis of IMD Ratnagiri Data
IX(d)	HPD, BARC: Dose Apportionment for Jaitapur Site
X	Letter No. B/survey/land/1352/2005-2006,dated 27-10-2005 from the Office of Sub Divisional Forest Officer, Ratnagiri (Chiplun) for declaration of site as non-forest land
XI	Letter No. Survey/NOC/1617/06-07 dated 05-12-2006 from the Office of Sub Divisional Forest Officer, Ratnagiri (Chiplun) (No Objection Certificate)
XII	Letter No. Desk-23(2)/C. No. 43 / Survey/802/09-10 dated 02-07-2009 from PCCF (Wildlife) and Authenticated maps showing locations of JNPP, National Park/Sanctuary/Biosphere Reserve
XIII	DAE Authorization Letter no. 2/14(1)/2005-Power/726 dated 20-10-2005
XIV	Notification No. TPS 1290/CR 120/UD-12 dated 02-06-1995 by Urban Development Department, Mantralaya, Bombay related to regional and town planning for land use
XV	Notification dated 23-12-2005 from Divisional Commissioner, Konkan Division in relation to rehabilitation
XVI	Approval of Govt. of India for 6 x 1650 MWe units for Jaitapur Site vide letter no. 1/5(1)/2007-Power/S-66 dated October 08, 2009.
XVII	One Complete Season AAQ Data along with Data Monitoring

Note:

1. The figures / tables / plates appearing for the first time in Summary EIA or in any of the Chapters are not appended in subsequent chapters to avoid repetition.

2. The figures / tables / plates are identified by source and period except those prepared by NEERI, Nagpur during the study period of EIA (January 2006 to March, 2007).

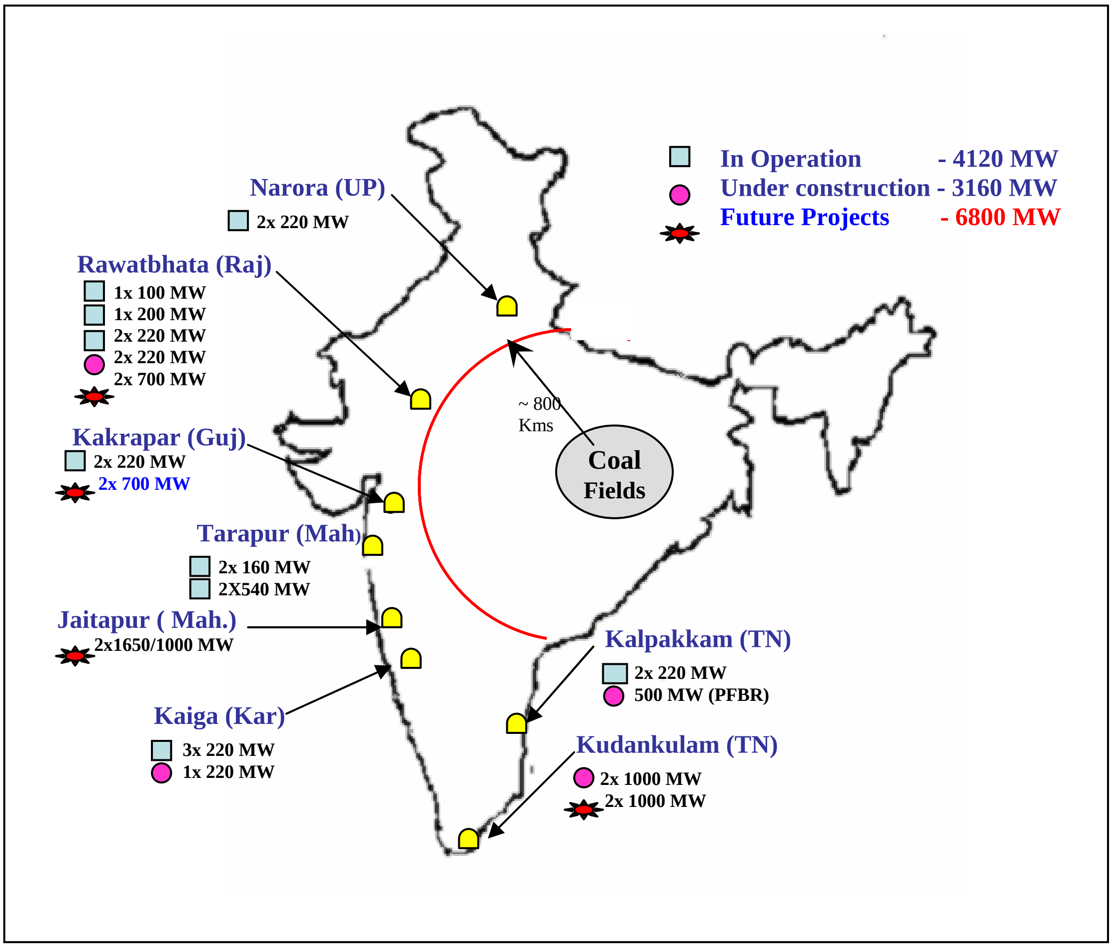
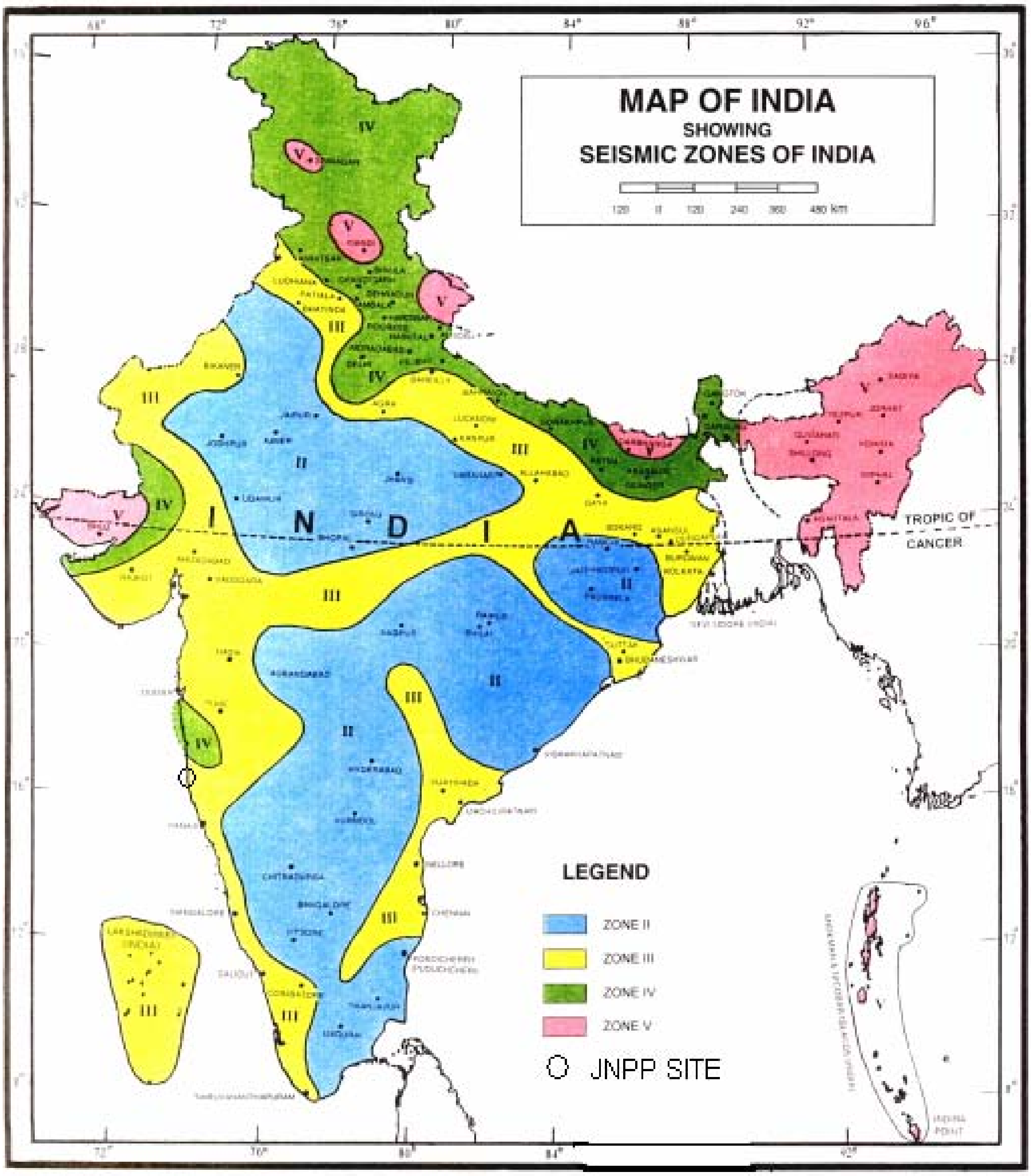


Fig. 1.1: Nuclear Power Plants in India

Note: As per present plan of Government of India, 6 x 1650 MWe Nuclear Power Park will be established at Jaitapur site in a phased manner.

IS 1893 (Part 1) : 2002



NOTE : Towns falling at the boundary of zones demarcation line between two zones shall be considered in High Zone.

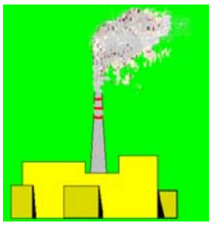
- Based upon Survey of India map with the permission of the Surveyor General of India.
- The responsibility for the correctness of internal details rests with the publisher.
- The territorial waters of India extend into the sea to distance of twelve nautical miles measured from the appropriate base line.
- The administrative headquarters of Chandigarh, Haryana and Punjab are at Chandigarh.
- The interstate boundaries between Arunachal Pradesh, Assam and Meghalaya shown on this map are as interpreted from the North-Eastern Areas (Reorganization) Act, 1971, but have yet to be verified.
- The external boundaries and coastlines of India agree with the Record/Master Copy certified by Survey of India.

Fig. 1.2: Seismic Zone Map of India

Fuel consumption

Waste production per year

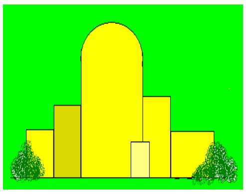
About 26 lakh tonnes of coal per year



- -65 lakh tonnes of CO_2
- -3 lakh tonnes of Ash
- -20,000 tonnes of SO_2
- -4000 tonnes of NO_x
- -400 tonnes of heavy metals

1000 MWe Coal fired power station

About 27 tonnes of low enriched UO_2 per year



- -27 tonnes high level waste, if reprocessed this gives 8 tonnes of waste to be disposed off
- -300 tonnes intermediate level waste
- -450 tonnes low level waste

1000 MWe Nuclear power station

Source: "Choosing the Nuclear Power Option: Factors to be considered", IAEA, Publication, 1998

Fig. 1.3: Comparison of Waste Production from Nuclear and Thermal Power Stations

Fig. 1.4: Study Area Showing Project Site and Road Network, Rivers and Villages

Table 1.1

Indian Nuclear Power Programme

Category of Units	Capacity (MWe)	Cumulative Capacity (MWe)
Operational Units		
Tarapur (TAPS) (Unit 1 and 2)	2 x 160	320
Rajasthan (RAPS) (Unit 1 and 2)	1 x 100+ 1 x 200	620
Kalpakkam (MAPS) (Unit 1 and 2)	2 x 220	1060
Narora (NAPS) (Unit 1 and 2)	2 x 220	1500
Kakrapar (KAPS) (Unit 1 and 2)	2 x 220	1940
Rajasthan (RAPS) (Unit 3 and 4)	2 x 220	2380
Kaiga (KGS) (Unit 1, 2 and 3)	3 x 220	3040
Tarapur (TAPS (Unit 3 and 4)	2 x 540	4120
Units under Construction		
Rajasthan (RAPP) (Unit 5 and 6)	2 x 220	4560
Kaiga (Unit 4)	1 x 220	4780
Kudankulam (KKNP) (Unit 1 and 2)	2 x 1000	6780
Fast Breeder Reactor, Kalpakkam (FBR)	1 x 500	7280
New Projects Approved		
Kakrapar (KAPP) (Unit 3 and 4)	2 x 700	8680
Kudankulam (KKNP) (Unit 3 and 4)	2 x 1000	10680
Jaitapur (Unit 1 and 2)	2 x 1650/1000	13980/12680
Rajasthan (RAPP) (Unit 7 and 8)	2 x 700	15380/14080

Table 1.2 (a)

Safety Codes/Guides for Regulation of Nuclear and Radiation Facilities

AERB Safety Code/Guide Number	Title
AERB/SG/G-1	Consenting Process for Nuclear Power Plants and Research Reactors: Documents Submission, Regulatory Review and Assessment of Consent Applications.
AERB/SG/G-2	Consenting Process for Nuclear Fuel Cycle and Related Industrial Facilities: Documents Submission, Regulatory Review and Assessment of Consent Applications.
AERB/SG/G-3	Consenting Process for Radiation Facilities: Documents Submission, Regulatory Review and Assessment Of Consent Applications.
AERB/SG/G-4	Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities.
AERB/SG/G-5	Role of Regulatory Body with respect to Emergency Response and Preparedness at Nuclear and Radiation Facilities.
AERB/SG/G-6	Codes, Standards and Guides to be Prepared by the Regulatory Body for Nuclear and Radiation Facilities.
AERB/SG/G-7	Regulatory Consents for Nuclear and Radiation Facilities: Contents & Format
AERB/SG/G-8	Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment

Table 1.2 (b)

Safety Codes/Guides for Nuclear Power Plant Siting

AERB Safety Code/Guide Number	Title
AERB/SC/S	Code of Safety in Siting of NPPs
AERB/SG/S-1	Meteorological Dispersion Modelling
AERB/SG/S-2	Hydrological dispersion of Radioactive Materials in relation to Nuclear Power Plant Siting
AERB/SG/S-3	Extreme value Analysis for Meteorological Parameters
AERB/SG/S-4	Hydrogeological Aspects related to NPP Siting
AERB/SG/S-5	Calculation Models for Dose from Concentrations
AERB/SG/S-6A	Design Basis Flood for Inland Sites
AERB/SG/S-6B	Design Basis Flood for Coastal Sites
AERB/SG/S-7	Man induced events and establishment of DBs
AERB/SG/S-8	Influence of Site Parameters on Emergency Preparedness
AERB/SG/S-9	Population Distribution and its Analysis
AERB/SG/S-10	Quality Assurance in Siting
AERB/SG/S-11	Design Basis Ground Motion for Nuclear Power Plant Sites

Table 1.2 (c)

Safety Codes/Guides for Operation of Nuclear Power Plants

AERB Safety Code/Guide Number	Title
AERB/SC/O	Code of Practice on Safety in NPP Operation
AERB/SG/O-1	Training & Qualification of Operating Personnel of NPPs
AERB/SG/O-2	ISI of NPPs
AERBSG/O-3	Operational Limits and Conditions for NPPs
AERB/SG/O-4	Commissioning of NPPs
AERB/SG/O-5	Radiation Protection during Operation of NPP
AERB/SG/O-6	Preparedness of the Operating Organization for Emergencies at NPPs
AERB/SG/O-7	Maintenance and Modifications of NPPs
AERB/SG/O-8	Surveillance of Items Important to Safety in NPPs
AERB/SG/O-9	Management of NPPs for Safe Operation
AERB/SG/O-10A	Core Management and Fuel Handling for Heavy Water Reactor Based NPPs
AERB/SG/O-10B	Core Management and Fuel Handling for Boiling Water Reactor Based NPPs
AERB/SG/O-11	Operational Management of Radioactive Effluents and Wastes Arising in NPPs
AERB/SG/O-12	Renewal Of Authorisation for Operation of NPPs
AERB/SG/O-13	Operational Experience Feedback for NPPs
AERB/SG/O-14	Life Cycle Management of NPPs
AERB/NF/SM/O-1	Probabilistic Safety Assessment Guidelines

Table 1.2 (d)

Safety Codes/Guides for Quality Assurance

AERB Safety Code/Guide Number	Title
AERB/SC/QA	Code of Practice on QA for Safety in NPPs
AERB/SG/QA-1	Quality assurance in the design of nuclear power plants.
AERB/SG/QA-2	Quality assurance in procurement of items and services for nuclear power plants.
AERB/SG/QA-3	Quality assurance in the manufacture of items for nuclear power plants.
AERB/SG/QA-4	Quality assurance during site construction of nuclear power plants.
AERB/SG/QA-5	Quality assurance during Commissioning and Operation of nuclear power plants.
AERB/SG/QA-6	Assessment of Implementation of QA Program
AERB/SG/QA-7	Establishing and Implementing QA Program
AERB/SG/QA-8	Non-conformance control and Corrective Actions
AERB/SG/QA-9	Documents and Records

Table 1.3

List of Consents / Authorizations

Sr. No.	Aspect	Legislation reference	Issuing authority
1.	Regulatory Consent for Siting	Atomic Energy Act 1962	AERB
2.	Regulatory Consents for Construction. • Excavation • First pour of concrete • Erection of Major Equipment	Atomic Energy Act 1962	AERB
3.	Regulatory Consents for Commissioning	Atomic Energy Act 1962	AERB
4.	Regulatory Consents for Operation	Atomic Energy Act 1962	AERB
5.	Regulatory Consents for Authorization for Power Generation.	Section 6 of Factory Act-1948 read in conjunction of Atomic Energy Act 1962	AERB
6.	Authorization for Storage and Import of Hazardous Chemicals	Manufacture, Storage & Import of Hazardous Chemicals Rule 1989 (Amendment Rule 2000)	AERB
7.	Authorization for safe disposal of Radioactive Waste	Atomic Energy Act 1962	AERB
8.	Authorization for transfer/safe disposal of Radioactive Waste	Atomic Energy Act 1962	AERB
9	Environmental Clearance	Environment Protection Act 1986	MoEF
10.	Consent to establish plant	Water Act 1974 and Air Act 1981	State Pollution Control Board
11.	Authorization for Storage and Disposal of Hazardous Waste	Hazardous Waste (Management, Handling & Transboundary Movement) Rule-2008	State Pollution Control Board
12.	Consent to Discharge Air	Air (Prevention & Control of Pollution) Act-1981	State Pollution Control Board
13.	Consent to Discharge Water	Water (Prevention & Control of Pollution) Act-1974 as amended up to 1978	State Pollution Control Board
14	Bulk Consumers of Batteries as per Form VIII of Batteries Rules 2001	Batteries (Handling and Management) Rule-2001	State Pollution Control Board
15	License to Import & Export Petroleum	Petroleum Act-1934	Chief Controller of Explosives
16.	License to store petroleum in tank or tanks in connection with pump out fit for filling motor conveyances	--	Chief Controller of Explosives
17.	License to Store Compressed Gas in Cylinders.	Storage of Gas Cylinder Act-1981	Chief Controller of Explosives
18	Inspection of Electrical Installations	Indian Electricity Act 1910/1948 & Indian Electricity Rules 1956	Central Electricity Authority.
19	Lifts / Elevators	State Lift and Escalator Rules (Latest)	Chief Inspector, Energy Department.
20.	Vehicle Registration / 'PUC'	Motor Vehicle Act-1936	Regional Transport Officer.
21.	Fixed & Portable Mobile / wireless hand sets	--	Ministry of Communication.

Chapter 2

Project Description

This chapter is presented in two sections, **Section –I**, presents the project description and **Section –II**, presents the description of the residential complex.

Section-I: Project Description

2.0 Need of the Project

Nuclear power is green and clean source of energy and very much necessary for India to complement the electricity production in the country which is mostly by thermal power plants (with 63.95% share) & are responsible for release of conventional pollutants, global warming, depletion of conventional sources of energy and associated impacts. The present share of nuclear power in total generation of electricity in the country is only 2.83% as on 31st July 2008. India is poised to go largely for peaceful use of nuclear energy in generating electricity, which resulted in the waiver from Nuclear Supplier Group, enabling India to have nuclear trade with other countries in the field of peaceful use of nuclear energy. India, thus, aims at increasing the share of nuclear energy to reach from the present 4120 MWe to 23000 MWe by the end of XIIth National Plan. The electricity genegrated by Jaitapur Nuclear Power Park (JNPP) will be supplied to the beneficiary states in westerns region with possibility of inter regional transfer.

2.1 Proposed Nuclear Power Park at Jaitapur

Based on the recommendation of Site Selection Committee (SSC), (appointed by Government of India), and, after taking into account the laid down site selection criterion for suitability of site for setting up of multi-units of NPPs of appropriate capacity, the Government of India has accorded in principle approval (as enumerated in **Section 1.1.1** of **Chapter-1**) for setting up NPP units at Jaitapur site. It is pertinent to mention that Jaitapur site has potential to set up NPPs of overall capacity of 10000 MWe. Accordingly, NPCIL intends to establish a Nuclear Power Park by installing 6 X 1650 MWe PWR category NPPs at this location in a phased manner.

2.2 Project Siting

2.2.1 Location and General Area

The site for Jaitapur Nuclear Power Park (JNPP) is situated in the area between Rajapur creek and Vijaydurg creek, about 40 km south of Ratnagiri, on the West Coast (**Fig. 1** as presented in **Summary EIA** of this report). Mumbai, the State capital is about 400 km away from the site by road (255 km radial). The 25 km radius study area is selected for EIA studies (as defined in **Fig. 2.1 (a), Chapter 3**, **Section 3.1** and **Fig. 1.4** of **Chapter -1**. At one corner of the site, Waghapur point lighthouse of Rajapur bay is situated. The nearest village to the site is Madban. The Plant Site Boundary Wall Layout of the site area is presented as in **Fig. 2.1 (b)**.

The Latitude and Longitude of the site are as follows:

Latitude : 16^{o} 34’ 38” N - 16^{o} 36’ 29” N

Longitude : 73^{o} 19’ 02” E - 73^{o} 20’ 48” E

The nearest Thermal Power Station to the site is at Dabhol, about 175 km north of the site where the installed generating capacity is 3 x 765 MWe. Unit 1 & 2 are already commissioned. The nearest major hydro-electric power station is at Koyna (about 100 km north east of the site) with an installed generating capacity of 1710 MWe.

2.2.2 JNPP Location, Land Profile and Land-use

Urban Development Department, Government of Maharashtra had Notified area around Jaitapur & surrounding area of 2000 ha for industrial purposes in regional plan for the development and use of land in the Ratnagiri – Sindhudurg Region as per Notification No. TPS 1290 / CR -120 / UD-12 dated June 2, 1995 under Maharshtra Regional and Town Planning Act 1966. A copy of the same is attached as **Annexure-XIV**, **Vol-II of EIA report**.

The photographs of JNPP plant site as well as residential complex site are shown in **Plate no. 2.1** to **2.7** and **Plate no. 2.8 to 2.17 along with Fig. 2.13** respectively. The satellite images and maps showing of actual land use pattern of the land being acquired for nuclear power plant and residential complex are presented in **Fig. 3(a)** & **3(b)** and **Fig. 4(a)** & **4(b)** respectively in **Summary EIA**.

In order to implement above plan and as a pre-project activity, NPCIL had submitted a request for acquiring land admeasuring to 970 Hectares (approximately) for its plant and residential complex with the State Government in October, 2005. The land, which is being acquired for locating NPP as well as residential complex would be adequate to meet the intent of establishment of multi-units of NPP at this location having over all capacity of 10000 MWe. The above land belongs to private owners, with no physical displacement. After completing the total process of Land Acquisition as per Land Acquisition Act of Maharashtra State, NPCIL is finally acquiring land admeasuring to 938.026 ha for JNPP site and residential complex.

Out of above, the land measuring 692.311 ha adjoining the sea is being acquired for JNPP to set-up all the planned PWR type units of proposed “Nuclear Power Park” of multi units. The present elevation of the site varies from RL + 20 m to RL + 29 m with an average elevation of about RL + 24.5 m. The brief details of present Land Use of the proposed plant site is presented in **Table 2.1**.

Further, land admeasuring to 245.715 ha is also being acquired which is located at a distance of about 5 km from the proposed site of nuclear power plant to set-up residential complex (JNPP residential complex). The brief details of present Land Use of the JNPP residential complex is presented in **Table 2.2** as given below.

It is pertinent to mention that the total land acquisition for JNPP site & residential complex, admeasuring to 938.026 ha, does not involve displacement of even single family. It may also be noted from above tables that most of the land is barren. The above land also does not fall under the category of forest land (copy of the NOC from Department of Forest vide **Letter No. B./Survey/Land/1352/2005-2006** dated 27.10.2005 is attached in the **Annexure-X**, **Vol -II** and vide **Letter No. Survey/NOC/1617/06-07** dated 05-12-2006 is attached in the **Annexure-XI**, **Vol II.**

Table 2.1

Details of Land for JNPP Plant Site

Sr. No.	Name of the Village	Type of Land (Area in Hectares and as percentage of Total)								Total land being acquired (Ha)	No. of Khatedars
		Bagayat (Irrigated)		Kharip		Varkas (fallow land)		Pot Kharaba (Barren)			
		Area	%	Area	%	Area	%	Area	%		
1	Madban	0	0%	62.074	8.99%	227.565	32.96%	400.762	58.05%	690.401	1719
2	Varilwada	0	0%	0	0.00%	0.380	19.90%	1.53	80.10%	1.910	22
Total		0	0%	62.074	8.97%	227.945	32.93%	402.292	58.11%	692.311	1741

Source: District Administration, Ratnagiri, May, 2008

Table 2.2

Details of Land for JNPP Residential Complex

Sr. No.	Name of the Village	Type of Land (Area in Hectares and as percentage of Total)								Total land being acquired (Ha)	No. of Khatedars
		Bagayat (Irrigated)		Kharip		Varkas (fallow land)		Pot Kharaba (Barren)			
		Area	%	Area	%	Area	%	Area	%		
1	Niveli	0	0%	2.031	2.80%	16.150	22.24%	54.433	74.96%	72.614	144
2	Karel	0	0%	5.025	7.11%	6.402	9.06%	59.259	83.83%	70.686	142
3	Mithgavane	0	0%	0.857	0.84%	10.270	10.03%	91.288	89.14%	102.415	118
Total		0	0%	7.913	3.22%	32.822	13.36%	204.98	83.42%	245.715	404

Source: District Administration Ratnagiri, May, 2008

2.2.3 Existing Water Drainage System at the Site

The proposed site for the Nuclear Power Park and residential complex is present on more or less flat island surrounded by creeks on north and south side and sea on western side with narrow connection with land. There is no river or rivulet in this area except gullies which carry run off water to the creek or sea during rainy season and remain dry during rest of the year. This system will be effectively integrated with the project layout & residential complex for an effective water drainage management at JNPP.

2.2.4 Available Source of Water

Water availability and drawl of condenser cooling water from sea is assured at the site. Fresh water from Desalination facility of seawater of appropriate capacity shall be planned for meeting the fresh water supply requirement. The details of water requirements and the water balance for the JNPP are provided in **Section 4.2.2.1.1** of **Chapter 4** of this report.

2.2.5 Seismicity Considerations

Foundation conditions are favorable with rocky substrata. Basaltic rock is available at a depth of 20 m from the ground. The site area lies in Seismic Zone-III in the Seismic Zoning Map of India (IS 1893, (Part -1, 2002). There is no active fault in the radius of 39 km around the JNPP site. The details of the seismicity of the site are presented in **Section 3.7.2** of **Chapter-3** and in **Section 1.2** and **Fig. 1.2** of **Chapter-1**.

2.2.6 Flood Analysis including Tsunami

The detailed analysis / studies have been carried out by Cental Water and Power Research Station (CWPRS), Pune to arrive at the safe grade elevation for proposed JNPP due to flood / tsunami. Safe grade elevation of +7.0 m with respect to Chart Datum has been recommended for proposed JNPP. This safe grade elevation has been estimated considering the highest astronomical tidal level of +3.3 m, 2.5 m of tsunami, the 1000-year Return Period Storm Surge of 2.7 m, maximum wave set-up of 0.5 m and the free-board of 0.5 m. The average site elevation is about 24.5 m above the mean sea level. Hence the site is considered to be safe from flooding / tsunami. However, studies will have to be carried out to fix grade level elevation above the safe grade elevation at the design stage, taking into account the need to reduce pumping head and also to be above Design Basis Flood (DBF) level.

2.2.7 Power Evacuation

Power evacuation is feasible for the power generated from all the six units of 1650 MWe, which are being implemented in a twin unit construction mode in phased manner. NPCIL has already initiated action by submitting a proposal to Central Electricity Authority (CEA), New Delhi, requesting to undertake power system studies and develop an appropriate power evacuation system with associated transmission scheme for implementation for JNPP site. Based on this study, the required transmission line will be constructed through Power Grid Corporation of India Limited (PGCIL), to evacuate power genrarted from JNPP to western region grid and transmitted to respective benefirciaries based on allocation of power by Government of India.

2.2.8 Population Density

As per the census data of the year 2001, the average population density within 10 km around the site is estimated to be about 96 persons / sq .km. There are no population centers having a population of more than 10,000 within 10 km around the site. The details of demographic profile of the area around the JNPP site are presented in **Section 3.10.2.1**, **Chapter - 3** of this report.

2.2.9 Access to the JNPP Site

The nearest National Highway is at Hativale junction on NH-17 (Mumbai-Goa Highway) at a distance of 38 km from site. Road from Hativale to Sonargadaga (26 kms) is State Highway (SH-113). Sonargadaga to Madban (4 km) is Major District Road (MDR). Madban to site, the road is yet to be constructed. Kolhapur station on the Central Railway is about 140 km and road from Kolhapur to site runs via Shahuwadi, Malkapur, Pali (via Amba Ghat), Lanja, Rajapur, Hativale. NH-4 (Mumbai-Pune-Bangalore-Madras road) passes through Kolhapur.

The nearest broad-gauge railway station is Rajapur of Konkan Railway. Nearest major port is at Madgaon 150 km south of site. This port is having all required facilities for handling heavy cargo. At a distance of 100 kms from project site, Ratnagiri port is having moderate facility to receive certain ODC and heavy cargo. Some of the ODC and heavy equipments could be received at these ports and transported by the barges to the temporary jetty at site. Alternatively ships having

RORO facility can anchor off shore near the site and discharge the heavy cargo for further transportation to the site.

The nearest airports are at Pune and Belgaum, about 100 km from Kolhapur. Kolhapur also has a small air-strip which is not being used at present for any commercial flights.

2.2.10 General Environment Neighbouring JNPP Site

No industries handling toxic chemicals or explosives are reported to exist within 10 km. There are no railway sidings or road transport depots within 10 km. There are no civil or military airports with 50 km around the site. There is a landing ground at Ratnagiri at a radial distance of 40 km from the site, which can handle Dakotas. As mentioned earlier, a lighthouse exists within the exclusion zone and hence administrative measures will be required for controlling the entry of small number of operators (7 persons) and they will be treated as radiological workers as per the requirements of emergency preparedness plan. In general, the industrial activity in the general area is practically negligible and as such, impact on the environment arising out of human activities is insignificant. Nearest International Border is at a distance of 800 km. There are no places of archeological/historical importance within a distance of 20 km radius from the plant except Vijaydurg Fort, which is located at a radial distance of approximately 5 km and around 120 km by road. It is to mention that no pollutants are released from propsed NPPs hence there won’t be any adverse impact on the Vijaydurg Fort.

2.2.11 Construction Facilities

Construction materials like stone, metal will have to come from Vatul about 60 km from site. Sand will have to be brought from Sangli, Haripur about 200 to 250 km from site. Good quality bricks are not available in this area. However, stone bricks from laterite can be obtained from number of sources in the region and can be used for the construction of the residential complex.

Ground water table is very low in the region. Special arrangements (including desalination plant) will be required to meet the fresh water requirements for construction and residential complex as there are no ready sources available close to site. Construction power of 10 MWe would be drawn from nearby sub-station of Maharashtra State Electricity Board near Jaitapur.

2.2.12 Proposed Schedule of Project Implementation

The proposed nuclear power park (6x1650 MWe) at Jaitapur will be implemented in a twin unit construction mode in phased manner within a span of 15-18 years. The first twin units of JNPP (2x 1650 MWe) are scheduled to be completed by the year 2016-17, which will generate electricity of 3300 MWe.

2.3 Technology and Process Description of Proposed PWR Category NPPs at Jaitapur

The proposed PWR is an evolutionary Pressurized Water Reactor with various advanced features. It has four-loop in Nuclear Steam Supply System with a rated power of 4,500 MWe. The primary system design, loop configuration, and main components are similar to those of currently operating PWRs, thus forming a proven foundation for the design.

The system under consideration is a global product with a basic set of common design features adaptable to the specific safety, regulatory and commercial requirements of each country in which it is established. The basic version shares the basic set of design features such as four redundant trains of emergency core cooling, a steel lined containment, Shield Building, and a core melt retention system for severe accident mitigation.

The Design features of the NPP address extensively the requisite safety features as following:

- The Reactor shall meet all the regulatory requirements of India and its designs have to be licensed by independent Regulatory Body.
- The plant shall be capable of operating with high performance, reliably and safely within Indian grid condition.
- It should have the latest design features and meet the latest international safety requirements.

- The plant will be based on the most reliable and safe PWR technology, which uses ordinary water for cooling and moderation purposes.

- Indian engineers / scientists will verify the designs, quality of equipment and witness necessary inspection and testing during manufacture and will also carry out construction and commissioning.

The PWRs proposed to be set up have all the features of the modern third generation technology similar to western designs in respect of philosophy, features and construction. The design of plant is consistent with the standard international practices for safety systems. The basic concept of defense in depth in this plant includes the use of redundancy, diversity, independence and fail safe design. In fact, design features of the PWR's proposed to be set up fall in the category of advanced Light Water Reactor (LWR) as per International Atomic Energy Agency (IAEA).

The design philosophy is based on the following objectives related to the current generation of PWRs:

- Increase redundancy and separation
- Reduce Core Damage Frequency (CDF)
- Reduce Large Release Frequency (LRF)
- Mitigate severe accidents
- Protect critical systems from external events
- Improve Man-Machine Interface (MMI)
- Extend response times for operator actions

A cornerstone of this design philosophy, the principle of "defense-in-depth," has been improved on all levels, resulting in:

- Reductions in radiological consequences and accident initiator frequencies

- Favorable transient plant behavior

- Simplification of the safety systems and functional separation

- Elimination of common mode failures by physical separation and diverse back-up safety functions

- Increased redundancy and arrangement of the redundant trains into separated divisions (The divisional separation is also extended to supporting features such as cooling water, power supply and Instrumentation and Control (I&C). The divisions are without interconnections, except for some normally closed headers, up to the connection to the primary or secondary circuit. In the event of a loss of one division by an internal hazard, the remaining divisions provide at least one full system capacity, taking into account a single failure.)

- Low sensitivity to failures, including human errors, by incorporation of adequate design margins; automation and extended times for operator actions; high reliability of the devices in their expected environment; and protection against common mode failures. (Response times for operator actions are increased by the larger Steam Generator (SG) inventory and Pressurizer (PZR) steam volume to ameliorate transients)

- Less sensitivity to human errors by optimized digital I & C systems and information supplied by state-of-the art operator information systems

- Consideration of operating concerns in the design phase to simplify and optimize operation

In order to ensure the safety of the reactors, a Defense in-depth Philosophy is followed in which there are three successive levels of safety. If one level fails, there is the next level to stop the event from developing into an accident. The basic level in the system is the preventive level in which accidents are prevented by adopting a sound design, good quality assurance practices and by deploying competent and trained operating personnel. In spite of this, if a failure occurs there is the protective level in which certain safety systems actuate automatically when important plant parameters, like temperature, pressure, power or radiation levels, transgress predetermined values to arrest development of accidents or minimize their effects. Some examples of such system are Reactor protection system, Shut-off rod system, Emergency electric supply system, etc.

Protective safety systems are quadruplicated (4 x 100%). It means, even though one channel would be sufficient, four independent channels have been provided for such systems. These systems have adequate redundancy, diversity and segregation to ensure their high reliability. If, finally, an accident sequence is not stopped on the protective level, there is the mitigation level, which ensures that any radiological releases to the environment stay within acceptable limits. For this purpose, the reactor is provided with leak tight double containment, inner containment, made up of 1.3 m thick pre-stressed concrete structure having 6 mm thick steel lining on the inside. Outer containment of sufficient thickness of Reinforced Cement Concrete (R.C.C) with inner space being kept at negative pressure. This containment is also provided with cooling systems and filters in order to ensure that any release to the atmosphere even in the case of an accident are within safe limits.

The Safety design is based primarily on deterministic analyses complemented by probabilistic analyses. The deterministic approach is based on the "defense-in-depth" concept, which comprises five levels:

Level of Defence in Depth	**Objectives**	**Innovation direction to enhance the levels of defence in depth**
1.	Prevention of abnormal operation and failures.	Enhance prevention by increased emphasis on inherently safe design characteristics and passive safety features.
2.	Control of abnormal operation and detection of failures.	Give priority to advanced control and monitoring systems with enhanced reliability, intelligence and limiting features.
3.	Control of accidents within the design basis.	Achieve fundamental safety functions by optimised combination of active & passive design features, limit fuel failures, increase grace period to several hours.
4.	Control of severe plant conditions, including prevention and mitigation of the consequences of severe accidents.	Increase reliability of systems to control complex accident sequences, decrease severe core damage frequency by at least one order of magnitude, and even more for urban-sited facilities.
5.	Mitigation of radiological consequences of significant releases of radioactive materials.	Emergency Preparedness Plan in Public Domain

All the above scenarios explained namely **Design Basis Accidents (DBAs)** and **Beyond Design Basis Accidents (BDBAs)** scenarios are thoroughly studied, analysed and detailed reports are generated as **Preliminary Safety Analysis Reports (PSAR)** and these reports will be submitted to Atomic Energy Regulatory Board (AERB) for review and approval for construction of Nuclear Power Project at Jaitapur.

Low probability events with multiple failures and coincident occurrences up to the total loss of safety-grade systems are considered in addition to the deterministic design basis. Representative scenarios are defined for preventing both core melt and large releases in order to develop parameters for risk reduction features. A probabilistic approach is used to define these events and assess the specific measures available for the management. Consistent with international and U.S. probabilistic safety objectives, the frequency of core melt is less than 10^{-5}/reactor-year including all events and all reactor states.

The values of overall Core Damage Frequency (CDF) will be within the design target of 1.0 E-6 /reactor-year for the reactor proposed to be set up at Jaitapur, which is below the acceptable limit of 1.0 E-5 /reactor-year as per International Atomic Energy Agency (IAEA) Safety Series No. 75 – INSAG-3, 1988.

The overall mean Large Release Frequency (LRF) of radioactive materials to the environment from a core damage event will be less than 10^{-7}/reactor-year.

Innovative features result in the low probability of energetic scenarios that could lead to early containment failure. Design provisions for the reduction of the residual risk, core melt mitigation, and the prevention of large releases are:

- Prevention of high pressure core melt by high reliability of decay heat removal systems, complemented by primary system Over Pressure Protection (OPP)
- Primary system discharge into the containment in the event of a total loss of secondary side cooling
- Features for corium spreading and cooling

- Prevention of hydrogen detonation by reducing the hydrogen concentration in the containment at an early stage with catalytic hydrogen recombiners.
- Control to the containment pressure increase by a dedicated Severe Accident Heat Removal System (SAHRS) consisting of a spray with recirculation through the cooling structure of the melt retention device
- Collection of all leaks and prevention of bypass of the confinement, achieved by a double-wall containment

External events such as an aircraft hazard, Explosion Pressure Wave (EPW), seismic events, missiles, tornado, and fire have been considered in the design of Safeguard Buildings and the hardening of the Shield Building.

2.4 Overview of the Design under Consideration

The tentative plot plan for six EPR units of 1650 MWe each as proposed at JNPP site is shown in **Fig. 6** in **Summary EIA**. The brief layout of reactor and other associated buildings as well as other facilities for twin unit of EPR is also shown in **Fig. 7** in **Summary EIA** of this report.

The design of JNPP is furnished with a four-loop, pressurized water, Reactor Coolant System (RCS) (composed of a reactor vessel that contains the fuel assemblies, a Pressurizer (PZR) including control systems to maintain system pressure, one Reactor Coolant Pump (RCP) per loop, one SG per loop, associated piping, and related control and protection systems (**Fig. 2.2**).

The RCS is contained within a concrete containment building. The containment building is enclosed by a Shield Building with an annular space between the two buildings. The pre-stressed concrete shell of the Containment Building lined with a steel liner from inner side and the Shield Building wall is reinforced concrete. The annular space (Annulus) between these two walls is kept at negative pressure to ensure that no uncontrolled releases are discharged to the atmosphere. The Containment and Shield Buildings comprise the Reactor Building. The Reactor Building is surrounded by four Safeguard Buildings and a Fuel building (**Fig. 2.3** & **Fig. 2.4**). The internal structures and components within the Reactor Building, Fuel Building, and two Safeguard Buildings (including the plant Control Room) are protected against aircraft hazard and external explosions. The other two Safeguard Buildings are not protected against aircraft hazard or external explosions; however, they are separated by the Reactor Building, which restricts damage from these external events to a single safety division.

Redundant 100% capacity safety systems (one per Safeguard Building) are strictly separated into four divisions. This divisional separation is provided for electrical and mechanical safety systems. The four divisions of safety systems are consistent with an N+2 safety concept. With four divisions, one division is out-of-service for maintenance and division can fail to operate, while the remaining two divisions are available to perform the necessary safety functions even if one is ineffective due to the initiating event.

In the event of a loss of off-site power, each safeguard division is powered by a separate Emergency Diesel Generator (EDG). In addition to the four safety-related diesels that power various safeguards, two independent diesel generators are available to power essential equipment during a postulated Station Blackout (SBO) event-loss of off-site AC power with coincident failure of all four EDGs.

Water storage for safety injection is provided by the In-containment Refueling Water Storage Tank (IRWST). Also inside containment, below the Reactor Pressure Vessel (RPV), is a dedicated spreading area for molten core material following a postulated worst-case severe accident.

The fuel pool is located outside the Reactor Building in a dedicated building to simplify access for fuel handling during plant operation and handling of fuel casks. As stated previously, the Fuel Building is protected against aircraft hazard and external explosions. Fuel pool cooling is assured by two redundant, safety-related cooling trains.

2.5 Reactor Fuel

The reactor core contains 241 nos. of Fuel Assemblies (FA), which will be of low enriched uranium arranged in a lattice pattern within the reactor core with the help of stainless steel supporting structure. The fuel is uranium-di-oxide enriched up to 5 wt% U^{235}. Spring-loaded upper block assembly keeps the fuel assemblies in their position. Loading and unloading of fuel is achieved with the help of specially designed fuelling machine positioned above the reactor. The Fuel and Fuel Clad forms the primary barrier against the release of radioactivity, generated in the reactor and is designed to ensure a high degree of integrity through out the life of the plant.

2.6 Core Design

2.6.1 Overall Features

The design has a rated core thermal power of 4,500 MWt. The main features of the core and its operating conditions result in a high thermal efficiency of the plant, low fuel cycle costs, and flexibility for extended fuel cycle lengths.

The reactor core consists of an array of 241 fuel assemblies with the following characteristics:

- A 17 x 17 lattice composed of 265 fuel rods mechanically joined in a square array
- Optimized and proven fuel rod design parameters
- Enrichment of up to 5 wt% U^{235}
- Gd_2O_3 integral burnable poison with Gd concentration of 2 wt% to 87 wt%
- Highly corrosion-resistant and low-growth M5TM cladding and tubing
- Monobloc TM guide thimbles to increase structural strength
- Low growth M5TM intermediate spacers
- Alloy 718 end spacers providing improved fuel rod support and flow-induced fretting resistance
- Debris-resistant robust FUELGUARDTM bottom nozzle
- Removable top nozzle for ease of assembly repair

2.6.1.1 Boron Concentration, Reactivity Coefficients, Shutdown Efficiency

The core design meets the safety objectives of providing stabilizing reactivity coefficients and an effective shutdown system.

The number of Gd rods and concentrations are adjusted to limit the critical boron concentration at beginning -of-cycle, hot zero power, all rods out; and to ensure that the moderator temperature coefficient under these conditions remains negative (including consideration of uncertainties).

2.6.1.2 Design of the Shutdown System

In the event of an accidental cool down, the shutdown system maintains subcriticality assuming one stuck rod after actuation of the reactor trip until conditions are reached for automatic boration with safety-related systems. The criterion is to reach subcriticality after reactor trip and cool down the RCS to 260^{0}C with consideration of an additional 500-pcm (Percentage Milli) margin for fuel management flexibility.

The shutdown system is sized to meet the initial conditions of accidents in accordance with the defined LCO as well as uncertainties in the design tools and measurement systems. LCO considered for this purpose include:

- The reactor power
- The initial insertion of control rods (maximum required negative reactivity inserted for control purposes)
- The initial axial power and Xe distributions

2.6.1.3 Reactor Coolant System

The RCS configuration is a conventional four-loop design. The RPV is located at the center of the Reactor Building and contains the core with fuel assemblies. The reactor coolant flows through the hot leg pipes to the SGs and returns to the RPV via the cold leg pipes by the RCPs. The PZR is connected to one hot leg via the surge line and to two cold legs by the spray lines. **Fig. 2.5** shows a flow schematic of the RCS and **Fig. 2.6** shows the layout of the RCS.

The RPV, PZR, SGs have relatively large volume-to-core power ratios and are individually discussed below. For the RPV, the volume between the elevation of the RPV nozzles and the top of the active core is larger to improve the mitigation of Small Break Loss of Coolant Accident (SBLOCAs) by prolonging the period until beginning of core uncovery or minimizing of core uncovery depth, if any. The increase in volume also contributes to an improvement in the mitigation of accidents during shutdown conditions, particularly in mid-loop operation (e.g., with loss of RHR), by extending the period for operator action.

For the PZR, larger volume provides the following benefit:

- An increase of both water and steam volume with associated pressure and level scaling is favorable in handling many types of transients. A single countermeasure actuated at one limit can more easily become fully effective before the next limit is reached (e.g., in certain load reduction one PZR spray valve, instead of two, is sufficient to stop the pressure increase). The result is a reduction of loads on relevant systems and components (i.e., a reduced number of load cycles).
- For normal operating transients, parameter changes (i.e., pressure, water level) are mild and thus the potential for reactor trips is minimized.
- For events such as loss of condenser, the actuation of PZR safety valves can be avoided altogether.
- For SBLOCAs, the time until core uncovery is prolonged.

For the SG, the larger volume of the secondary side provides the following advantages:

- For normal operating transients, smooth parameter changes (e.g. pressure and water level) are obtained and thus the potential for unplanned reactor trips is further reduced.
- For mitigation of Steam Generator Tube Rupture (SGTR) scenarios, a large steam space results in a significant time delay for a mitigating response prior to filling of the SG.
- The secondary side water inventory of the SG at full load satisfies the most limiting requirement of a total loss of feedwater supply (including emergency feedwater). In this scenario, time between reactor trip and loss of heat removal is greater than 30 minutes and is sufficient for operating personnel to recover feed water supply or initiate other countermeasures, such as primary side feed and bleed cooling.

The design for a non-isolable Main Stem Line Break (MSLB) considers the increased water inventory in the SGs and resultant higher potential of mass and energy release into the containment. The large containment volume accommodates the pressure response.

2.6.1.4 Principal Mechanical Components

2.6.1.4.1 Reactor Pressure Vessel (RPV)

The RPV is the main component of the RCS. The vessel is cylindrical, with a welded hemispherical bottom and a removable flanged hemispherical upper head with gasket. It is designed to provide the volume required to contain the reactor core, the control rods, the heavy reflector, and the supporting and flow-directing internals. The RPV nozzles are the fixed point of the RCS.

Fig. 2.7 is an outline drawing of the RPV. The RPV is made of low-alloy steel. The complete internal surface of the RPV is covered by stainless steel cladding for corrosion resistance.

2.6.1.4.2 Pressurizer (PZR)

The PZR consists of a vertical cylindrical shell, closed at both ends by hemispherical heads. It is constructed of ferritic steel, with austenitic steel, cladding on all internal surfaces in contact with the reactor coolant. **Fig. 2.8** shows a cutaway view of the PZR.

The main functional requirements of the PZR are summarized below.

- The PZR forms part of the RCPB and provides RCS volume control (it is the coolant expansion vessel of the RCS) and RCS pressure control.
- The large water volume in the PZR prevents the heaters from being uncovered during out-surges and is also large enough to compensate for coolant expansion between 0% and 100% power under normal conditions.
- The large steam volume accommodates RCS OPP requirements.
- The large steam volume prevents frequent actuation of the pressure control equipment during normal operation.
- The PZR is designed not to empty on a reactor trip or turbine trip.

2.6.1.4.3 Steam Generator

The SGs are vertical shell, natural circulation. U-tube heat exchangers with integral moisture separating equipment. They are also fitted with and axial economizer to provide increased steam pressure. **Fig. 2.9** shows a cutaway view of the SG.

The reactor coolant flows through the inverted U-tubes, entering and leaving nozzles located in the hemispherical bottom channel head of the SG. The bottom head is divided into inlet and outlet cambers by a vertical partition plate extending from the tube sheet.

The heat conveyed by the reactor coolant is transferred to the secondary fluid through the tube walls of the tube bundle. On the secondary side the feedwater is directed to the cold side of the tube sheet by an annular skirt in which feedwater is injected by the feedwater distribution ring.

The axial economizer directs all the feedwater to the cold leg side of the tube bundle and about 90% of the recirculated water to the hot leg. This is made possible by the double wrapper in the cold leg of the downcomer. Feedwater is routed to the cold leg of the tube bundle and a secondary side partition plate (that extends up to the sixth tube support plate) separates the cold leg and the hot leg sides of the tube bundle. The internal feedwater distribution system (ring with oblong-shaped holes and deflecting sheet) of the SG covers only about 180 degrees of the wrapper on the cold side. Once the feedwater reaches the bottom of the cold side the subcooled water makes a U-turn, flows up along the cold leg tube bundle between the wrapper ant the partition Plate, and is heated to a point where it boils. The steam-water mixture flows upward through the moisture separators and dryers and the dried steam exits the SG through the outlet nozzle located at the top of the SG elliptical head. This design enhances the heat exchange efficiency between the primary side and the secondary side and increase the outlet steam pressure by about 0.35 Mpa as compared with a boiler type SG with the same tube surface.

2.6.1.4.4 Reactor Coolant Pump

The RCPs are vertical, shaft single-stage, seal units, driven by air-cooled, three-phase induction motors. The complete unit is a vertical assembly consisting of (from top to bottom) a motor, a seal assembly, and a hydraulic unit. **Fig. 2.10** shows a cutaways view of the RCP.

Reactor coolant is pumped by an impeller attached to the bottom of the rotor shaft. Coolant is drawn up through the bottom ring of the impeller, and discharged through the diffuser and an exit nozzle located in the side of the casing.

2.6.1.5 Principal Fluid Systems

2.6.1.5.1 Conceptual Features

This section describes the conceptual features of the principal fluid systems of the design under consideration.

2.6.1.5.2 Safety Functions

The safety functions provided by the principal fluid systems are:

- Control of reactivity
- RCS inventory and integrity
- Residual heat removal

2.6.1.5.3 Reactivity Control

The fluid systems that ensure of contribute to reactivity control are the Extra Borating System (EBS), the Chemical and Volume Control System (CVCS), and the Safety Injection System (SIS).

2.6.1.5.4 RCS Inventory and Integrity

Fluid systems that ensure control of the RCS inventory are the CVCS and the SIS. Fluid systems or equipment that contribute to ensuring RCS integrity are those required for Over Pressure Protection (OPP) and those needed for cooling and supply of injection water to the RCP seals (since damage to an RCP seal could result in loss of RCS integrity). Cooling of RCP seals is provided by the Component Cooling Water System (CCWS), with injection water ensured by the CVCS. OPP of the RCS is ensured by the primary side OPP system

2.6.1.5.5 Residual Heat Removal

RHR from the SG secondary side is ensured by the Emergency Feedwater System (EFWS) and the secondary side OPP system. The Start-up and Shutdown System (SSS) also contributes to this function.

RHR from the primary side during shutdown conditions is ensured by the Residual Heat Removal System (RHRS) combined with the Low Head Safety Injection (LHSI) system.

2.6.1.5.6 Systems Required to Support Operation of Fluid systems

The cooling water support systems for the principal fluid systems are described below.

The CCWS consists of both a safety-related portion and a non-safety-portion. The safety-related portion has the same number of trains as the safety systems that require cooling by the CCWS. Common headers providing redundant and safety-grade isolation valves and train separation (as required during plant transients or accidents) connect both components of the CCWS.

The Essential Service Water System (ESWS) provides the heat sink for the CCWS and has the same number of trains as the CCWS.

2.6.1.5.7 Configuration of Systems

The following systems and their associated electrical power supply and I &C systems are arranged in a four-train configuration:

- SIS/RHRS
- EFWS
- CCWS
- ESWS

The four-train arrangement for the principal fluid systems, corresponding to the four-loop configuration of the RCS, leads to a simplified design concept for the fluid systems in that each system is connected to a single loop with no operator action required to balance flow between loops. This arrangement also allows flexibility and redundancy during plant shutdown conditions when capacity requirements for heat removal and other functions are reduced relative to the needs associated with normal power operations. The four-train configuration also offers the possibility of extending maintenance intervals on parts of the systems, which can be beneficial for instance; preventive maintenance or general repair requirements. For instance, preventive of one complete safety train can be performed during power operation.

The following systems are arranged in a two- train configuration:

- EBS
- Fuel Pool Cooling System (FPCS), in which two FPCS pumps operate in parallel in each of the two trains

The organization of the systems that provide injection of water into the RCS is given below.

Fig. 2.11 shows a schematic of the main fluid systems. Each of the systems identified above is described in more detail below.

2.6.2 Reactor Building and Supporting Systems

2.6.2.1 Reactor Building Structure

The Reactor Building consists of a cylindrical reinforced concrete outer Shield Building, a cylindrical post-tensioned concrete inner Containment Building with a 6 mm thick steel liner, and an annular space between the two buildings. The Shield building functions to protect the Containment Building form external hazards. The Containment Building contains the RCS and portions of associated structures, systems, and components. In the event of a LOCA or severe accident, the Containment Building severs from the release of stored energy.

The Rector Building is designed to withstand internal accidents as well as external hazards including the following: aircraft hazard, EPW, seismic events, missiles, tornado, and fire.

The common basemat of the Nuclear Island (the Reactor Building, Safeguard Buildings, and Fuel Building) ensures that overturning due to a seismic event or aircraft hazard will not occur.

The Shield Building is designed to withstand the potential effects of an external explosion.

MHSI	
Medium Head Safety Injection (MHSI) System	4 trains; cold leg injection
Accumulator	4 accumulators; cold leg injection
LHSI/RHR	
Low Head Safety Injection/Residual Heat Removal System	4 trains; cold leg injection for short term + cold and hot leg injection for long term
EBS	
Extra Borating System	2 trains; injection of borated water, cold leg Injection
IRWST	
In-Containment Refueling Water Storage Tank	Storage of borated water inside containment

The design pressure and temperature of the Containment Building are defined by the following events:

- Double-ended rupture of a reactor coolant pipe (Large Break (LB) LOCA)
- Main steam line break
- Severe accidents

2.6.2.2 Annulus

The annulus between the Shield Building and Containment Building is ventilated by the Annulus Ventilation System (AVS). During normal operation, transients and accidents, the AVS ensures a sub-atmospheric pressure of between 0.33 psi and 0.9 psi in the annulus by extraction and filtration through High Efficiency Particulate Air (HEPA) and iodine filters before release to the environment via the plant stack.

2.6.2.3 Containment Isolation

Containment isolation valve minimize the release of radioactive fluids to the environment in the event of an accident with fission product releases in the containment.

2.6.3 Condenser Cooling Sea Water Discharge

For the cooling water intake and cooling water discharge alternative arrangements and design solutions have been reviewed, based on scientific and research studies. Mathematical modeling has been done for scientific validation of the optimum layout and structural design of water intake/discharge structures.

The tasks of the study have been formulated as follows:

1. Assessment of the effect of various natural factors on water intake conditions
2. Prediction of alteration of hydro-, thermal- and lithodynamic processes
3. Analysis of layout and design alternatives of water intake for selection of the optimum alternative
4. Detailed analysis of hydrothermal and lithodynamic regimes of the proposed optimum solutions.

Many inputs have been considered for the study of sea water intake and discharge structures. The important inputs are given below:

i) Bathymetry Survey of the sea coast
ii) Tidal levels and currents
iii) Waves
iv) Wind
v) Water Temperature
vi) Salinity
vii) Mixing Characteristics
viii) Sediments
ix) Littoral Drift
x) Various codes, guides and standards

For design of each structure, various alternatives have been considered. Each Structure means all the sea water structure which includes

i) Caisson Structure which allows the water to be drawn from the bottom of the sea
ii) Sea Water Intake structure (Break water dyke)
iii) Fish protection facility structure
iv) Forebay
v) Pump house
vi) Discharge tunnel with appropriate diffuser at discharge point

At JNPP, sea water for various cooling purposes shall be drawn from the Jaitapur sea coast and discharged at the following combination of outfall distances during three stages of the project through underground tunnels as per the following stage wise plan for CCW outfall distances.

Stage	Operating Units	Outfall Distance
I	1 and 2	1.5 km
II	1, 2, 3 and 4	1.5 km 2.0 km
III	1, 2, 3 and 4 5 & 6	1.5 km 2.0 km 2.5 km

The figure showing the layout of proposed intake / outfall structure is presented as **Fig. 1.2 (A)** in **Volume II**, **V(b)** of this report.

2.6.4 Other Safety Related Buildings

2.6.4.1 General Description

The Nuclear Island consists of the Reactor Building, Safeguard Buildings and the Fuel Building, all of which are located on a common basemat. The Nuclear Auxiliary Building, two emergency Diesel Buildings, the Radioactive Waste Processing Building, and ESW intake structure are located on individual basemats. **Fig. 2.3** & **Fig. 2.4** show the general layout of the major Buildings.

Of these buildings and structure, those that are safety-related include the four Safeguard Buildings, the Fuel Building, the two Diesel Buildings that house the four EDGs and the two SBO generators, the vent stack, the ESW intake structure, the Nuclear Auxiliary Building, and the Radioactive Waste Processing Building. These safety-related buildings provide a physical arrangement that supports a four-train divisional separation for the integral systems and components.

Each train of the safety systems is protected against propagation of internal hazards (e.g. fire, high-energy line break, flooding) from one train to any other. This requirement leads to an allocation of each train into a specific area or division that is separated from the other trains. According to the number of trains, the four Safeguard Buildings correspond to the four safety divisions.

Both the structural design and physical arrangement of the buildings provide protection from both external and internal hazards. Additionally, all safety-related buildings are designed to withstand the effects of the SSE and a tornado.

The safety concept of aircraft hazard for the design under consideration is a combination of hardened structures and spatial separation and incorporates the following design considerations:

- Fully hardened by means of a protection shell for Safeguard Buildings 2 and 3, Reactor Building and Fuel Building
- The Main Control Room and the Remote Shutdown Station (RSS) are located inside the fully hardened Safeguard Buildings 2 and 3
- The inner structure of Safeguard Buildings 2 and 3 and the Fuel Building are decoupled from the outer protection walls to isolate the consequences of an aircraft hazard
- Safeguard Buildings 1 and 4 are physically separated, limiting potential destruction to only one division
- The main steam and feedwater valve stations are physically separated two-by-two to perform their safety functions in the event of an aircraft hazard
- Safety functions performed by systems installed in other buildings (e.g. emergency diesels and ESWS) are ensured by physical separation

All buildings and structures, including cooling water structures and the auxiliary structures for gas supply, auxiliary boiler and transformer foundation, are arranged based on economical optimization, hazard potential and operation factors.

The Turbine Building is independent from the Nuclear Island. The turbine itself is located in a radial position with respect to the Reactor Building to avoid the impact of a turbine missile.

The Switchgear Building which contains the power supply and the I&C for the balance of plant, is located next to the Turbine Building. Both buildings are designed on the basis of technical requirements and safety regulations and do not impact the Nuclear Island.

2.6.5 Spent Fuel Storage Facility

In all 241 numbers of fuel assemblies are loaded in each reactor core. The life cycle of each core is 18-24 months. At the end of 18-24 months, 33% of the fuel assemblies are transferred to spent fuel storage bay located near to the Reactor building and removed fuel assembly locations of the core are loaded with fresh fuel assemblies and the reactor is boxed up. Thus, during each refuelling outage the spent fuel generated is stored in the fuel pool as an interim storage facility. These spent fuel assemblies are later transferred from the reactor building to a separate spent fuel storage facility called **"Away From Reactor (AFR) facility"**, which will be located within the JNPP premises. In a Nuclear Power Plant, the fuel assemblies are used only to produce energy and then these are stored in the spent fuel bays as per IAEA and AERB requirements.

2.6.6 Auxiliary Systems

2.6.6.1 Fire Protection Systems

The fire protection design basis is focused to protect safety of the public, the environment and plant personnel from a plant fire and its potential effect on the safe reactor operation. The fire protection design basis is based on the concept of defense-in-depth. Relative to fire protection, defense-in-depth is achieved when an adequate balance of each of the following elements is provided:

- Fire prevention
- Rapidly detecting fires that do occur
- Promptly controlling and extinguishing fires that do occur, thereby limiting fire damage
- Providing an additional level of protection for structures, systems and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

The fire protection features are capable of providing reasonable assurance that, in the event of fire, the plant will not be subjected to an unrecoverable incident.

2.6.6.2 Steam Generator Blowdown System

The Steam Generator Blowdown System (SGBS) maintains the necessary quality of the water/steam cycle in conjunction with the nuclear sampling system. The radioactive and chemical characteristics of secondary-side water are kept within permissible limits during all plant operating conditions. SG secondary water is removed continuously, because the secondary side may contain impurities in the form of corrosion products, condenser in-leakage, or primary-to-secondary leakage contaminants. After treatment, the blowdown water is normally recycled to the condenser, except for exceptional cases when it is discharged to the liquid waste discharge system.

2.6.7 Waste Processing System

2.6.7.1 Gaseous Waste Processing System

Radioactive fission gases, among them and krypton, are generated in the reactor core. A portion of these gases is released to the reactor coolant if fuel cladding defects occur. Additionally, hydrogen is added to the reactor coolant by the CVCS for the purpose of oxygen control. Since the gases are dissolved in the reactor coolant, they are transported to various systems in the plant as a result of process fluid interchange. Because of the explosive nature of hydrogen in a mixture with oxygen, the amount of these gases in components of the auxiliary systems is controlled.

The GWPS performs the following tasks:

- Compensates for the level deviations of the free gas atmosphere in the connected tanks by injecting or accommodating the corresponding gas volume.
- Prevent the escape of radioactive gases from the connected components into the building air by maintaining a negative system pressure.
- Flushes components in which coolant degasification occurs with nitrogen in order to process the waste gases.
- Limits the hydrogen content in the system and in the flushed components to less than 4% by volume and the oxygen content to less than 0.1% by volume in order to prevent the formation of a combustible mixture. (This also prevents absorption of oxygen by the reactor coolant, thereby preventing corrosion in the RCS).
- Handles the excess gas flow rates arising from the several systems connected to the GWPS during start-up and shutdown of the plant.

The following safety functions are performed by the GWPS:

- Contamination isolation
- Activity retention and contribution to limiting release to the environment. The GWPS limits the hydrogen concentration in the connected systems in order to prevent the formation of explosive mixture and processes radioactive gaseous wastes so as to minimize personnel exposure to radiation. Performance of these tasks will effectively control the release of radioactive gaseous wastes to the environment through a stack of height 100 m to limit the total radiation exposure to personnel in accordance with the relevant regulation and ALARA standards.

2.6.7.2 Liquid Waste Processing System

During operation of the nuclear power plant, waste and liquid wastes are produce by system drains, leakage, flushing, and other processes. The design has liquid radioactive waste processing and storage system that performs the collection, short-term storage, processing, and cleaning of the waste streams produced by letdown, drainage, purge, venting, or leakage from systems in the controlled area.

The Liquid Waste Processing System is designed to perform the following tasks:

- Activity retention and limiting releases to the environment
- Selectively collect and segregate liquid effluents produced by the RCS, reactor auxiliary systems, reactor cavity and SFP, as well as all potentially contaminated liquids produced in the plant such as floor drains, laundry, and decontamination wastes
- Route the collected waste to the storage and processing facilities
- Manage, under administrative and automatic controls, the wastewater fed to the wastewater collecting tanks according to the collection, treatment, and discharge capacity of the Liquid Waste Processing System.

Total storage capacity for the system corresponds to the average quantity of effluents produced on a weekly basis.

Oil removal equipment is provided in radioactive liquid waste systems (sumps) prior to subsequent treatment.

The system provides for analysis of the contents of each storage tank and subsequent treatment so that the quality of the treated liquid is acceptable and can be discharged to the environment.

Prior to discharging the processed wastewater to the environment, the following tasks are performed by the system:

- Measuring the volumes of the liquid effluents to be released
- Measuring the activity of the liquid effluents to be released
- Determining and recording release rates

The processed wastewater is monitored during discharge. The discharge line is automatically isolated if an authorized limit is exceeded.

Processed water discharged to the environment via the Liquid Waste Processing /Storages System will comply with applicable regulations. The liquid wastewater can be pumped from the monitoring tank only if the concentration of radionuclides in the monitoring tank is in accordance with applicable discharge regulations.

2.6.7.3 Solid Waste Processing System

The solid Processing and Storage System is designed to handle and deal with solid Radioactive Waste generated in the controlled area during power operation, overhauls and refueling and to store the operational solid radioactive waste in the storage rooms.

2.6.7.3.1 Operational Solid Radioactive Waste

The Solid Radioactive Waste has to be treated and transformed into dry and suitable product, which is to be safely retained and prevented from entering the environment in the long term.

For this reason the solid Radioactive Waste is collected and treated in a suitable system.

2.6.7.3.2 Activated Metallic Waste

The instruments lances and RCCA drive shafts remain in the reactor building stored under water during outages. Should any of such items need to be stored during normal plant operation, they can be stored in the instrumentation lance compartment, which remains flooded in every plant state.

Large components such as lower core plate and heavy reflector are designed for full life of the plant. In case of unexpected event of the replacement of such equipment the dismantling (cutting into smaller pieces and putting into a special container) of the irradiated equipment is done underwater in the internal compartment of reactor pool and then the container is then stored at a specific place on the site.

2.6.7.4 Radioactive Waste Processing Building

The Radioactive Waste processing Building is used for the collection, storage, treatment and disposal of liquid and solid radioactive waste and is adjacent to the Nuclear Auxiliary Building. A basement extends underneath the entire building. The building has a total of seven full stories that contain all the components required for liquid and solid radioactive waste processing.

As with the Nuclear Auxiliary Building, there is a complete separation within the building between operating compartments and passageways on the one hand and equipment compartments, valve compartments and the connecting pipe ducts on the other. Areas of high activity are separated by means of compartments and the connecting pipe ducts on the other. Areas of high activity are separated by means of shielding facilities from areas of low or no activity. It is not necessary to pass through compartments with a high dose rate to enter ones with a lower dose rate.

The Radioactive Waste Building is designed against the SSE and a tornado. Isolation of the building is ensured if radioactivity is released inside the building and the basemat of the building is designed to be leak tight.

The Radioactive Waste Building is supported on a shallow reinforced-concrete slab foundation which is separated from the adjacent foundation of the Nuclear Auxiliary Building by a settlement joint permitting relative movement. The design of the outer and internal walls is based on the results of structural analyses and on requirements for radiation protection.

2.6.7.5 Domestic Solid Waste Management

Proposed residential complex is a residential complex for the employees of Jaitapur Nuclear Power Park. It consists of various categories of residential buildings and public buildings like school, club, guesthouse, hostels and hospital. A quantity of 0.06 cum of recyclable and 0.03 cum of kitchen waste is anticipated per flat per day. A suitable scheme shall be engineered ensuring meeting all the standard practices and requirements.

2.6.8 Diesel Building

There are two Diesel Buildings (DBs), which house all four Emergency Diesel Generators (EDGs) and the two Station Black Out (SBO) Diesel Generators sets along with their diesel fuel storage tanks. These two diesel building are located on opposite sides of the plant, providing physical separation for protection against external hazards. Each DB contain two redundant trains comprised of the main diesel generators for emergency power supply and one SBO diesel generator, fuel storage tanks (within a dedicated fire compartment), air cooling equipment and roof level silencer for diesel engines. Each DG set is provided with a suitably designed stack such that the flue gases from the DGs are emitted at height of between 17 to 30 m from the ground level, depending upon the KVA rating 1000 KVA to 7000 KVA rating to comply with the requirements of MoEF Notification GSR 489 (E) July, 2002. The diesel consumption will be 1500 litres/hr/d and test run of diesel is carried out for one hour once in a week.

2.6.9 Turbine Island Design

2.6.9.1 Turbine Building

The Turbine Building contains the components of the steam-condensate-feedwater-cycle, including the turbine and generator set. The Building is divided into two bays: the main bay with the turbine generator set, the condensate system, and the feedwater heating system; and the service bay with the deaerator, feedwater storage tank, and the feedwater pumps.

The steam and power conversion system includes the Main Steam System (MSS), the turbine generator, the main condenser, the feedwater system, the feedwater storage tank, and other auxiliary systems.

The main condenser the turbine exhaust and transfers the heat rejected in the cycle to the circulating water system. Regenerative feedwater heaters heat the condensate and the feed water and return it to the SGs. A feedwater storage tank is integrated into this cycle to deaerate and heat the condensate. This tank also provides a buffer volume to accommodate minor system transients.

The following parts of the steam and power conversion system have safety-related functions with respect to RHR:

- EFWS
- MSS inside the Nuclear Island
- MFWS inside the Nuclear Island

The Turbine Building is independent of the Nuclear Island such that internal hazards in the Turbine Building remain confined. The building is located in a radial position with respect to the Reactor Building to provide protection from turbine missile impact.

The main circulating water lines are routed in the basement of the Turbine Building. The low pressure (LP) drains cooler; the conventional closed cooling water system; and pumps that require a high suction head are located in the basement. The main condenser is positioned crosswise to the turbine axis and occupies the space below the LP turbine. The turbine oil system with main oil bank, filters, coolers, and pumps is installed in a dedicated fire zone below the turbine generator.

Two vertical moisture separator/reheaters are installed in front of the high pressure (HP) turbine and extend over several floors. Located within the main bay are LP and HP heaters, the vacuum pumps, and the generator auxiliary system. The MFW pumps will be located at appropriate elevation in the plant.

Additional LP and HP heater are arranged within the main bay on an intermediate floor elevation.

The generator bus ducts are located at the intermediate level and cross above the Turbine Building entrance bay and leave the building toward the generator transformer bank.

2.6.9.2 Turbine

The turbine generator is of the tandem compound design. Standard design consists of a double flow HP turbine and a six–flow low-pressure turbine solidly coupled to a three phase synchronous generator with a directly connected exciter.

2.7 Electrical System

The construction power of about 10 MWe can be drawn either from the existing 33 kV/11 kV sub-station in the near by area or likely to be available when the construction activities are taken up.

Start-up power can be drawn from nearby 220 kV grid sub-station at Karad and from existing Koyna Hydel Power Project

Power Evacuation for 6 X 1650 MWe is technically feasibly in stages and overall scheme will be finalized based on the CEA recommendations.

2.8 Desalination Plant

For JNPP, electric power based distillation technology called as “Mechanical Vapor Compression (MVC)” process has been adopted. The incoming sea water is pre-heated with minute dose of scale inhibiting additive and passed through a heat exchanger, where the heat in the discharged brine and product water is recovered. The sea water is then re-circulated and sprayed on the outside of a bundle of horizontal heat transfer tubes at a rate just sufficient to create thin continuous liquid films.

Product water generated by this technology is very close to DM water quality, and requires minimum further treatment to be used for plant DM water make up requirement. The schematic flow chart of the desalination process is shown in **Fig. 2.12**. Brine generated by this technology (MVC) has temperature only about 2 to 3 ^{0}C higher than intake sea water temperature. Very small quantities of chemicals are used to protect equipment from scaling and bio-fouling. The residual concentration of these chemicals will be within the allowable regulatory limits and are not harmful & bio-degradable. Salt concentration in brine typically shall be 2 to 3 times that of intake sea water. To dilute the salt concentration, the brine shall be mixed with condenser cooling sea water before discharging into sea. Because of this the temperature rise and salinity level will be comparable to intake sea water levels.

2.9 Mitigation Aspects & Environmental Standards of NPP at Jaitapur

The design as a whole complies with the requirements and trends in the requirements of the safety regulations, accepted worldwide and by AERB in developing the nuclear power installations.

2.9.1 Safety Objectives

The NPP meets the safety requirements if its radiation effect on the personnel, population and the environment under normal operating conditions and violation of normal operating conditions including the design basis accidents, does not result in any violations of the established exposure doses for the personnel and population, established values for releases and discharges and the content of radioactive substances in the environment and the radiological effects are limited during beyond design basis accident.

The permissible exposure doses for the personnel and for the population and when necessary, the permissible emissions and discharges and the content of radioactive substances in the environment are established in accordance with the codes and regulations adopted internationally, and also conforming to Indian safety regulations. The levies of exposure doses to the personnel at the NPP and to the population resulting from releases and discharge of any radioactive substances from the NPP must be below the established limits and as low level as is reasonably attainable. These are governed by AERB requirements.

2.9.2 Concept of Defense in Depth

This safety of the NPP is ensured due to consecutive implementation of the defense-in-depth concept; this protection concept implies a system of physical barriers on the way by which the ionizing radiation and radioactive substances can release into the environment. This system is used together with a complex of engineering and managerial measures for protecting these barriers and maintaining their effectiveness and measures for protecting the personnel, population and the environment.

The system of physical barriers of the NPP power unit incorporates: a fuel element, fuel element cladding, the pressure boundary of the reactor coolant and the containment.

The complex of engineering and managerial measures forms the following five levels of defense in depth.

1. Level 1 Conditions of siting to Nuclear Power Plant and prevention of anticipated operational occurrences.
2. Level 2 Preventing design basis accidents by the systems of normal operation.
3. Level 3 Preventing design basis accidents by safety systems.
4. Level 4 Control of beyond the design basis accidents
5. Level 5 Emergency planning.

All the above scenarios explained namely **Design Basis Accidents (DBAs)** and **Beyond Design Basis Accidents (BDBAs)** scenarios are thoroughly studied, analysed and detailed reports are generated as **Preliminary Safety Analysis Reports (PSAR)** and these reports will be submitted to Atomic Energy Regulatory Board (AERB) for thorough review and approval for construction of Nuclear Power Park at Jaitapur.

Level 1: Conditions of siting the NPP and prevention of anticipated operational occurrences

- Assessing and selecting a site suitable for placing the NPP
- Establishing a sanitary protection zone (exclusion zone) and an observation zone around the NPP in which the protective measures are planned
- Developing the design using a conservative approach with a mature internal self-protection feature of the reactor plant
- Ensuring the required quality of the systems (components) at the NPP and works being accomplished
- Operating the NPP in accordance with the requirements of the relevant normative documents, process stipulations and operating manuals
- Maintaining, the proper condition, the systems (components) essential for safety by timely detecting flaws, taking preventive measures, replacing the equipment that have worked out its operating resource

and establishing an efficient system for documenting the results of work and checks

- Selecting the personnel for the NPP and maintaining their required qualification level to ensure that they are properly acting under normal and abnormal operating conditions including pre- emergency situations, accidents and creation of safety culture

Level 2: Preventing design-basis accidents by the systems of normal operation

- Revealing deviations from normal operation and removing them
- Control under conditions of AOO

Level 3: Preventing beyond the design basis accidents by safety system

- Preventing initiating events from developing into design basis accidents and employing the safety systems
- Mitigating the consequences of the accidents whose prevention was not met with success by localizing the releasing radioactive substances

Level 4: Control of beyond the design basis accidents

- Preventing beyond the design basis accidents from their developing and mitigating their consequences
- Protecting the hermetic enclosure from destruction under beyond the design basis accidents and maintaining its service operability
- Returning the NPP into a controllable condition, in which the chain fission reaction is stopped, the nuclear fuel is continuously cooled and the radioactive substances are kept in the preset boundaries

Level 5: Emergency planning

- It consists of preparing and implementing when necessary, plans of emergency measures at the NPP site and beyond its boundaries,
- Emergency planning is a part of the concept of defense in depth. Emergency measures to be adopted at JNPP site is a mandatory requirement as per Atomic Energy Regulatory Board.
- This emergency plan and the implementation methodology have to be demonstrated before making the reactor critical with the close coordination between NPCIL, Environmental Survey Laboratory and

the State Authorities. The conduct of mock exercise is a mandatory requirement prior to making the reactor critical.

- The emergency preparedness plan is prepared by JNPP and it will be approved by the State Authorities.

The concept of defense-in-depth is conveyed at all phases or activities related to ensuring the NPP safety in the part touched by this kind of activities. Here, the strategy for preventing unfavorable initiating events, especially for the 1st and 2nd level is of primary importance.

In normal operating conditions, all of the physical barriers must be capable of functioning, whereas the measures on protecting them must be available. On detecting any problems in any of the barriers envisaged by the design or unavailability of measures for protecting it, the reactor plant must be shut down and measures for bringing the nuclear power unit in a safe state must be taken.

The engineering measures and managerial decisions meant for ensuring safety of NPP must be proven by the previous experience or tests, studies or operating experience with prototypes. Such an approach should be applied not only when developing the equipment and designing the NPP, but when manufacturing the equipment, constructing and operating the NPP and upgrading its systems (components) as well.

The design and the reliability of the systems (components) essential for safety, the documents and activities that have an effect on ensuring the safety of the NPP, all there must be subject of activities aimed at quality assurance.

2.9.3 Normative Basis

Jaitapur NPP project is being developed on the basis of the requirements of codes, standards and nuclear safety regulations as per the requirements of, International and other statutory bodies.

2.9.4 Radiation Dose Limits for NPP Workers/Public

2.9.4.1 Workers of NPP

The dose limits for occupational workers and members of public will be approved by AERB. AERB specifies that for occupational workers of NPP, an annual individual dose of 100 mSv over 5 years with less than 30 mSv in any year is imposed as effective maximum dose as per AERB requirements.

The adopted design of proposed reactor at JNPP is aimed at providing low dose rates work places and suitable ergonomics. This design can be described as “passive protection” ensures that further optimization of individual dose can be obtained during plant operation.

It is fully anticipated that an individual dose restraint of 5 mSv/year will be attained for normal operation.

2.9.4.2 Public

For members of public the upper limit of radiation exposure is 1 mSv/year (0.001Sv/year) as specified by AERB.

To achieve the above objective, the present design objective states “the limit for the dose commitment of an individual of the population, arising from normal operation of the nuclear power plant in period of one year is 0.1 mSv per unit **(Ref. Sections 4.2.1.2** and **4.2.2.2.3)**. Based on this limit, the release limits for radioactive materials during normal operation of the NPP Units are defined in **Chapter - 4**.

However, the design of the reactor and effective operating procedures will ensure that the annual effective dose due to emissions through air and releases through water routes considering all the exposure pathways to the members of public varies between 0.002 to 0.003 mSv/year per unit, which is well within the maximum designed dose limits per unit as defined in the above mentioned paragraphs.

2.9.5 Additional Safety Provisions

In addition to the high level of safety consciousness in the design of reactors, the nuclear industry takes great care in the selection and training of its operating personnel. Indian reactors are being operated to safety standards accepted internationally.

At each nuclear power station site, environmental survey laboratories are set up long before the plant goes into operation. These laboratories carry out analysis of background radioactivity in the area. The purpose is to establish the baseline radiation levels. Thereafter, when the power plant is commissioned and operated, the radiation levels in the environment are monitored regularly upto 30 km distance from the reactors. Within the exclusion boundary, continuous monitoring of radiation situation is done by automated environmental radiation monitoring system. This is being done at all the nuclear power plants in India on continuous basis.

It has been reassuring to note that there has been no adverse impact on the environment due to operation of the Nuclear Power Plants in India.

Plate 2.1: Light house on the North West of Project Site

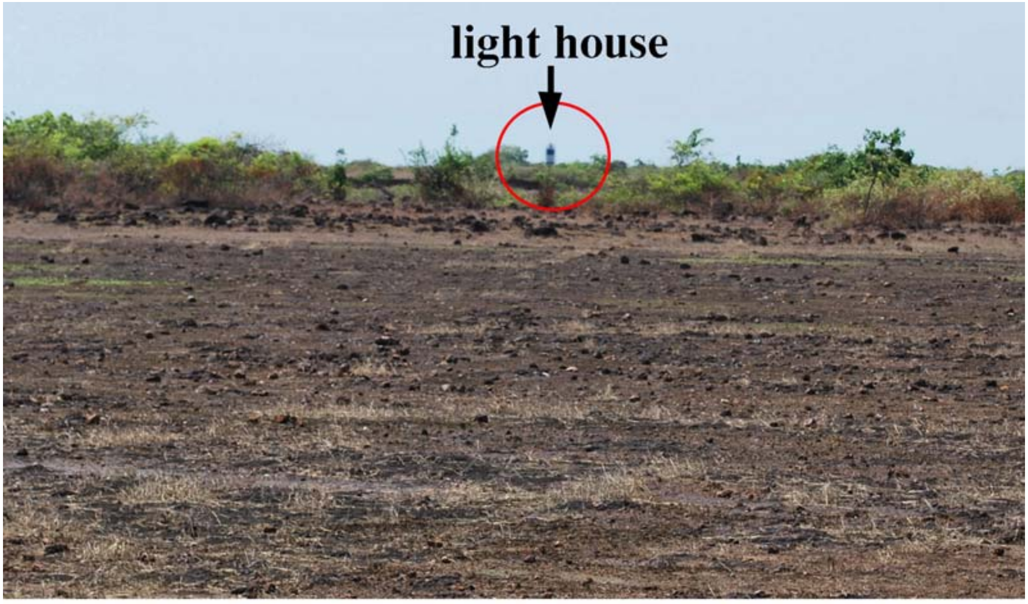


Plate 2.2: View of Plant Site Area from South Side with Light House on North West Side

Plate 2.3: View of Plant Site Area from Light House from N/W to S/E Direction

Plate 2.4: View of Plant Site Area from Light House from N to S Direction

Plate 2.5: View of Plant Site Area Showing Rocky Barren Land

Plate 2.6: View of Plant Site Area Showing Rocky Barren Land

Plate 2.7: View of Plant Site Boundary towards Jaitapur Creek

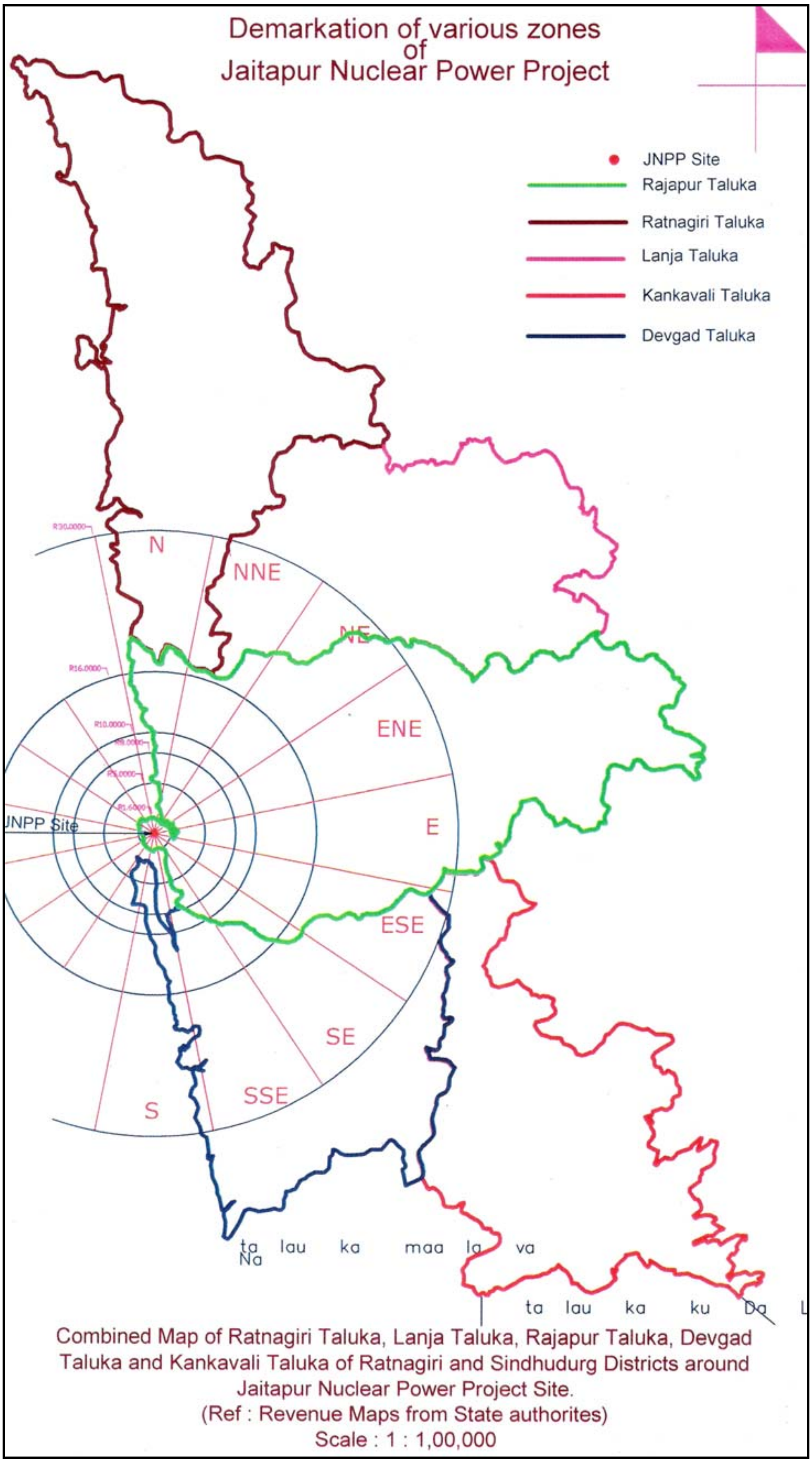


Fig. 2.1(a): Demarcation of Various Zones of Jaitapur Nuclear Power Park
(Radial Zone of 1.6 km, 5 km, 8 km, 10 km, 16 km, and 30 km)

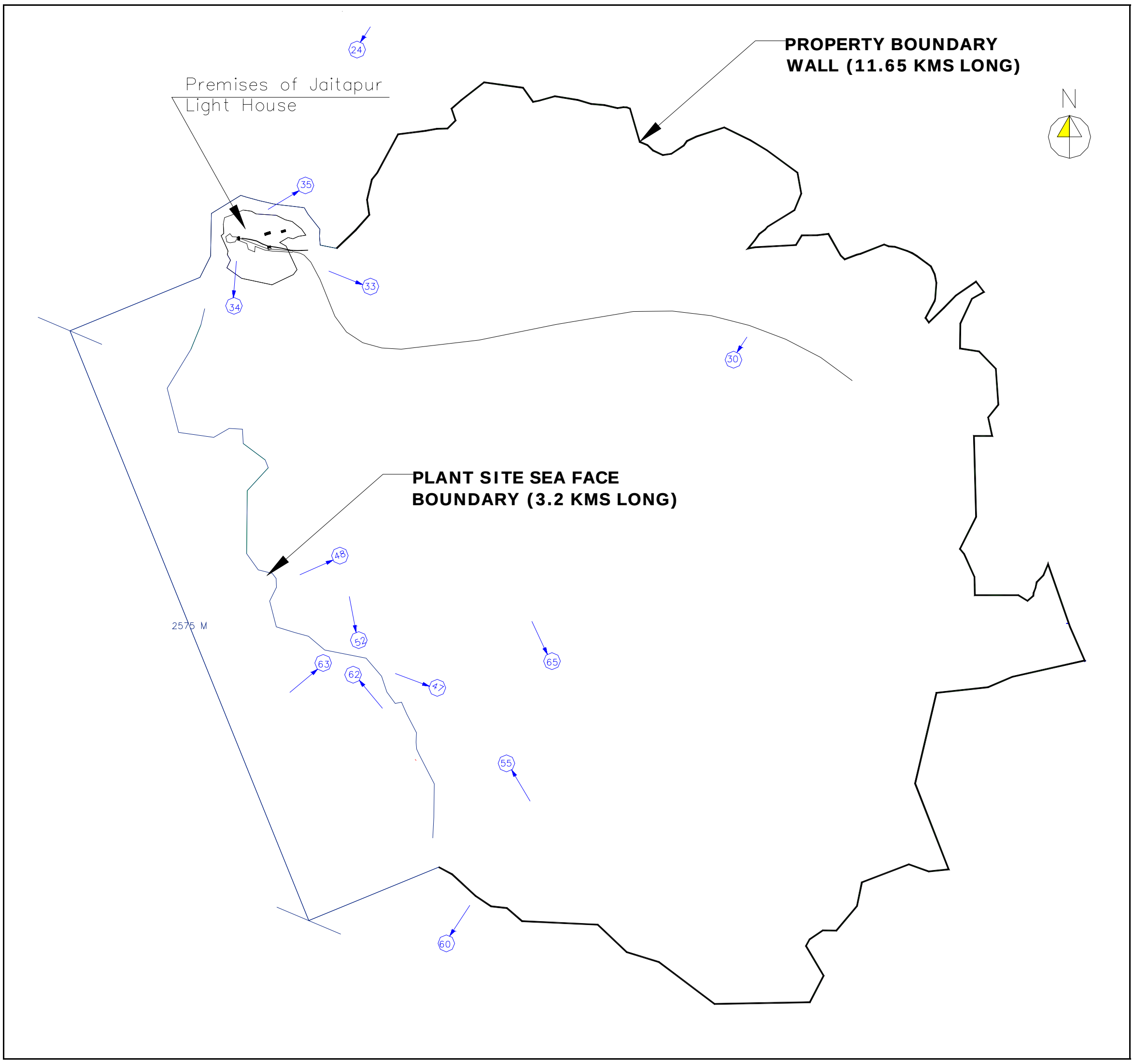


Fig. 2.1 (b): Plant Site Boundary Wall Layout with Waghapur Light House on N/W Side

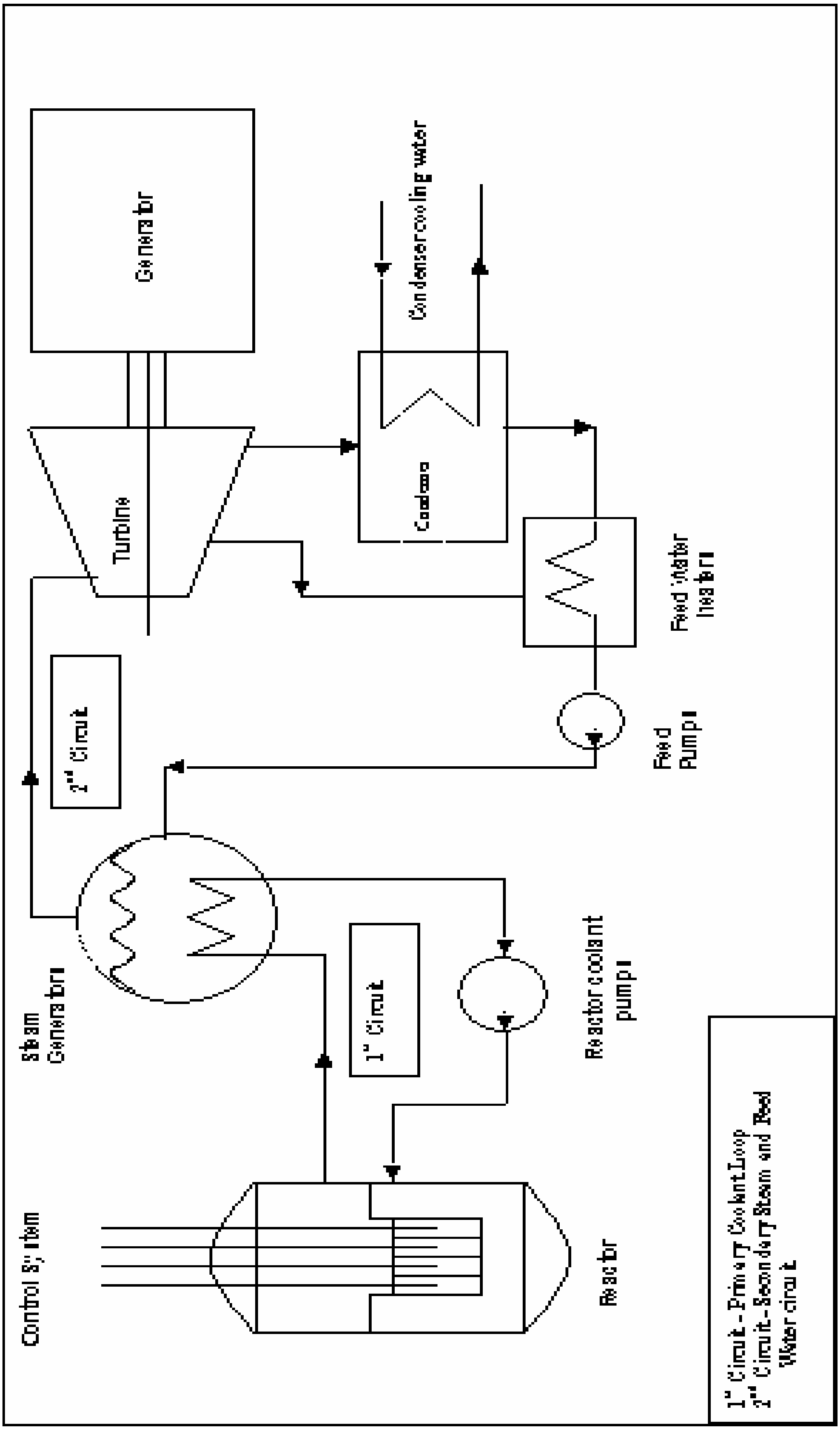


Fig. 2.2: Simplified Diagram of PWR

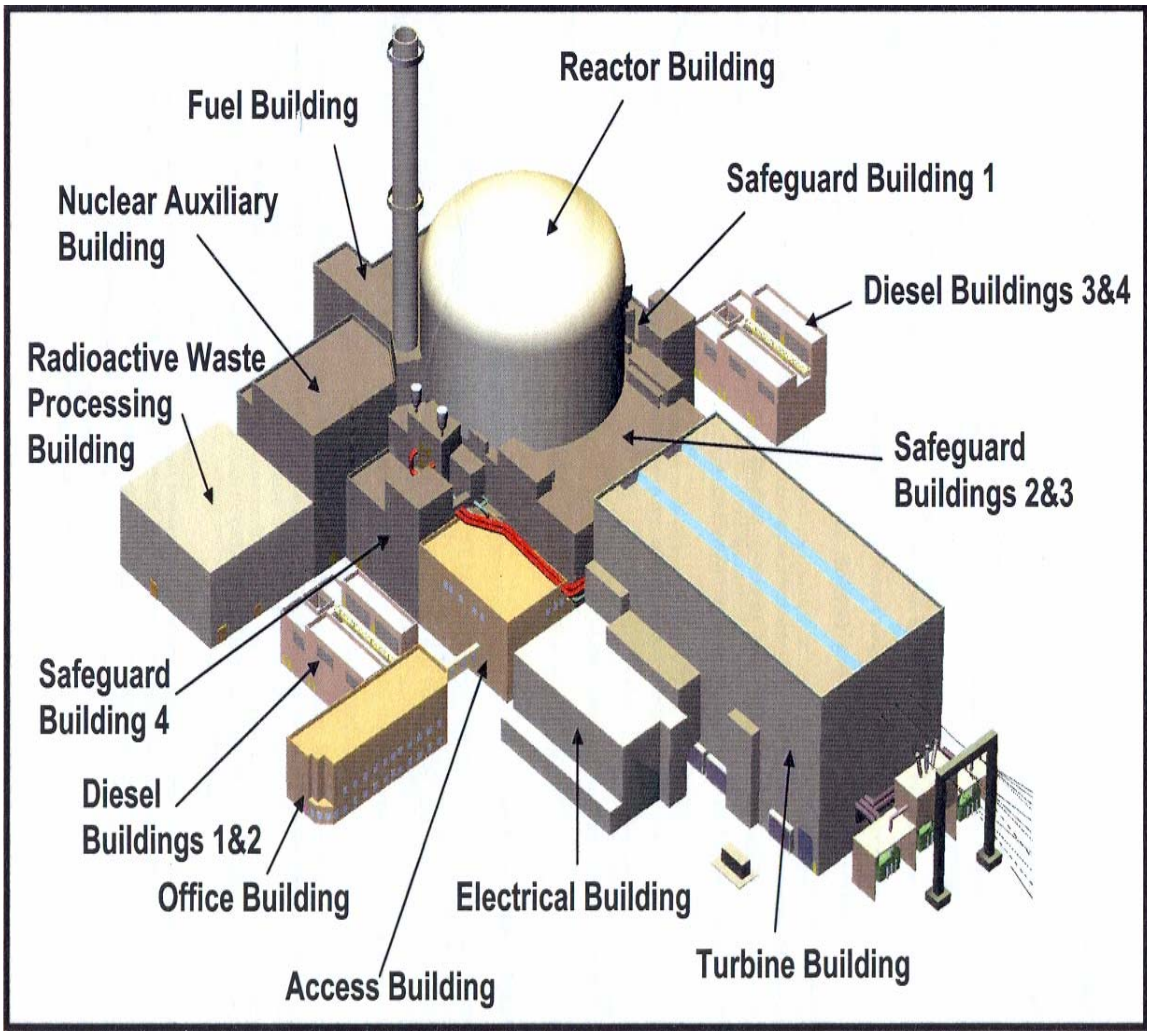


Fig. 2.3: Plant Configuration

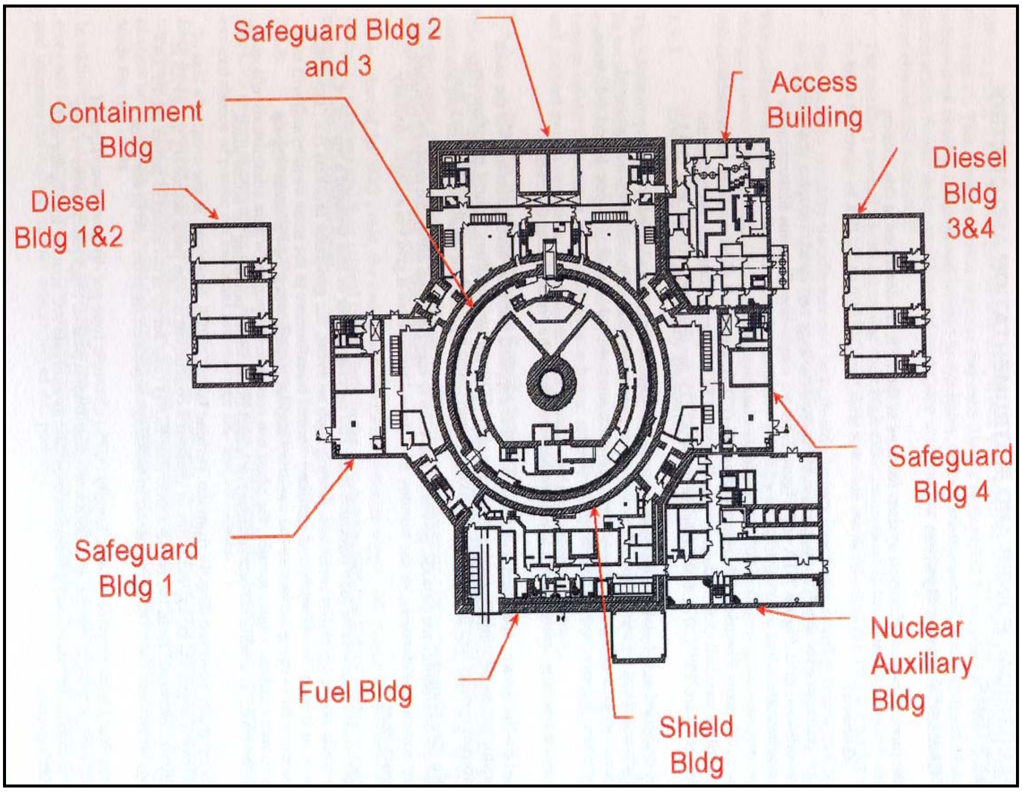


Fig. 2.4: Layout of Major Buildings

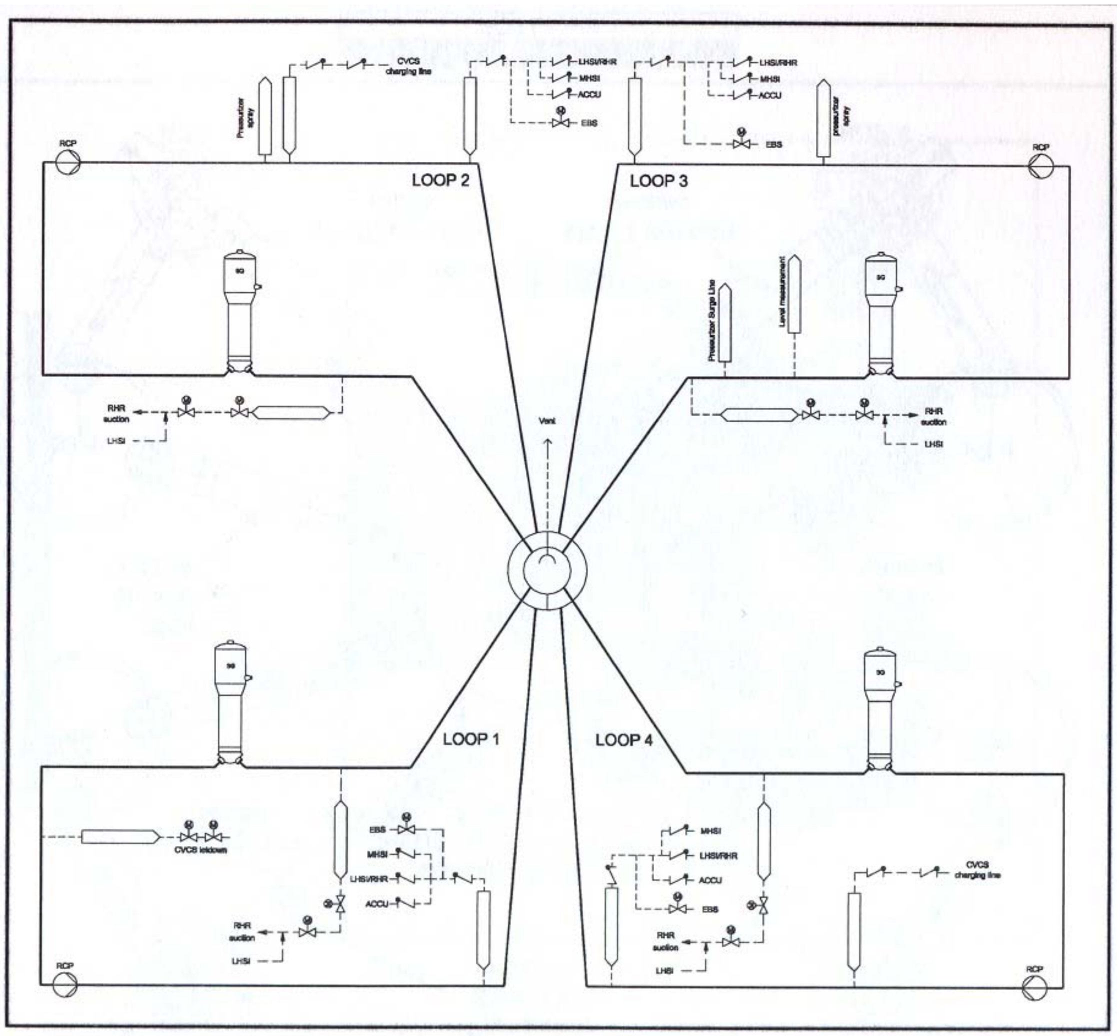


Fig. 2.5: Reactor Coolant System

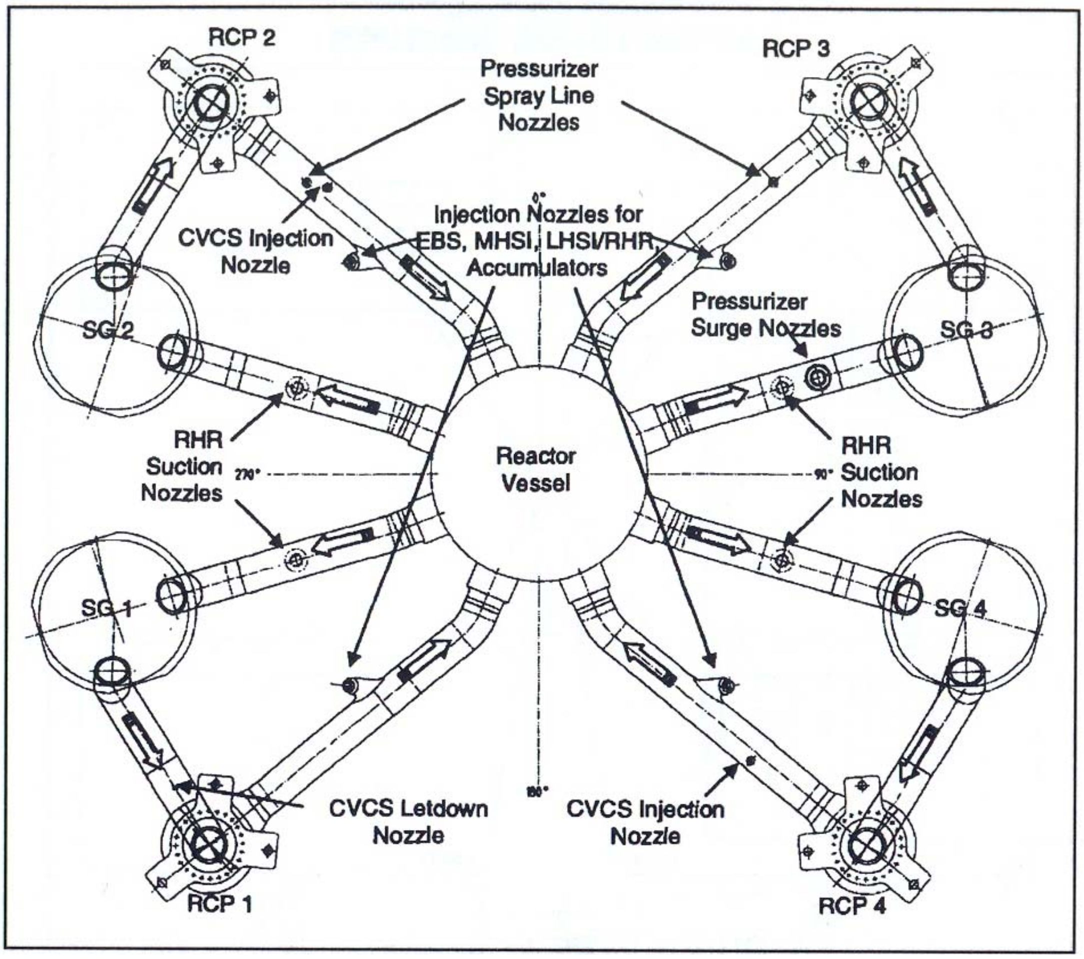


Fig. 2.6: RCS Layout

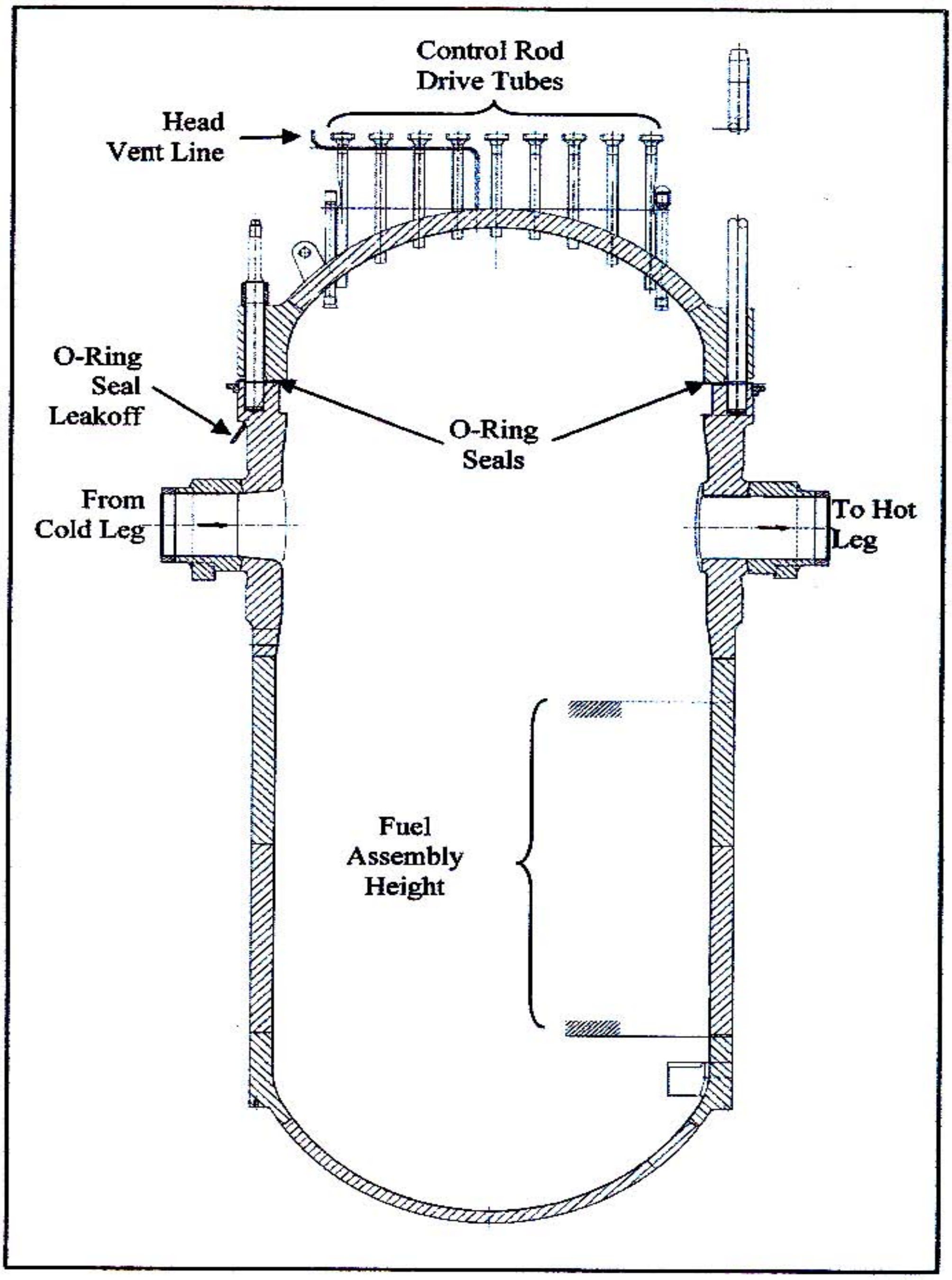


Fig. 2.7: Reactor Process Vessel

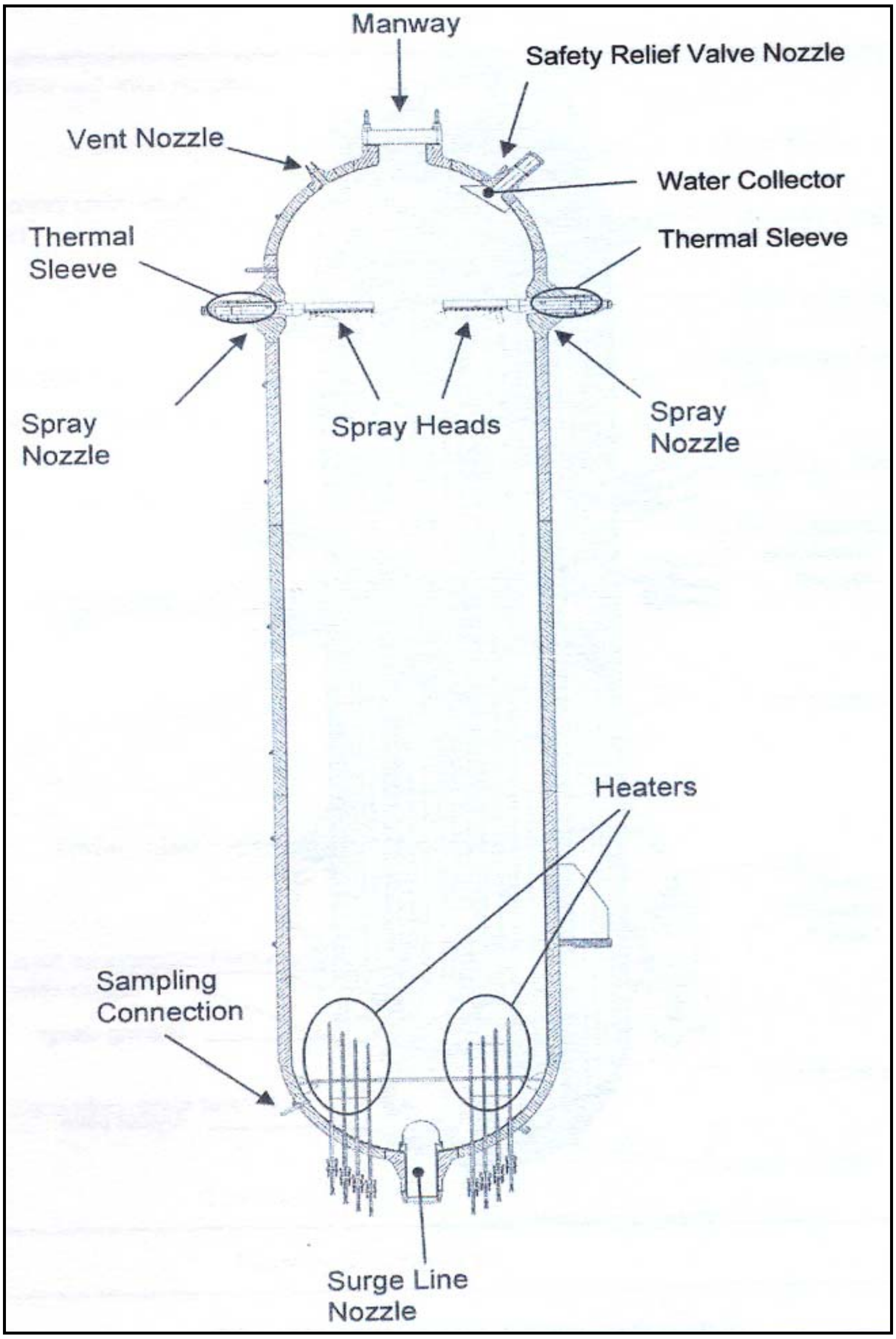


Fig. 2.8: Pressurizer (PZR)

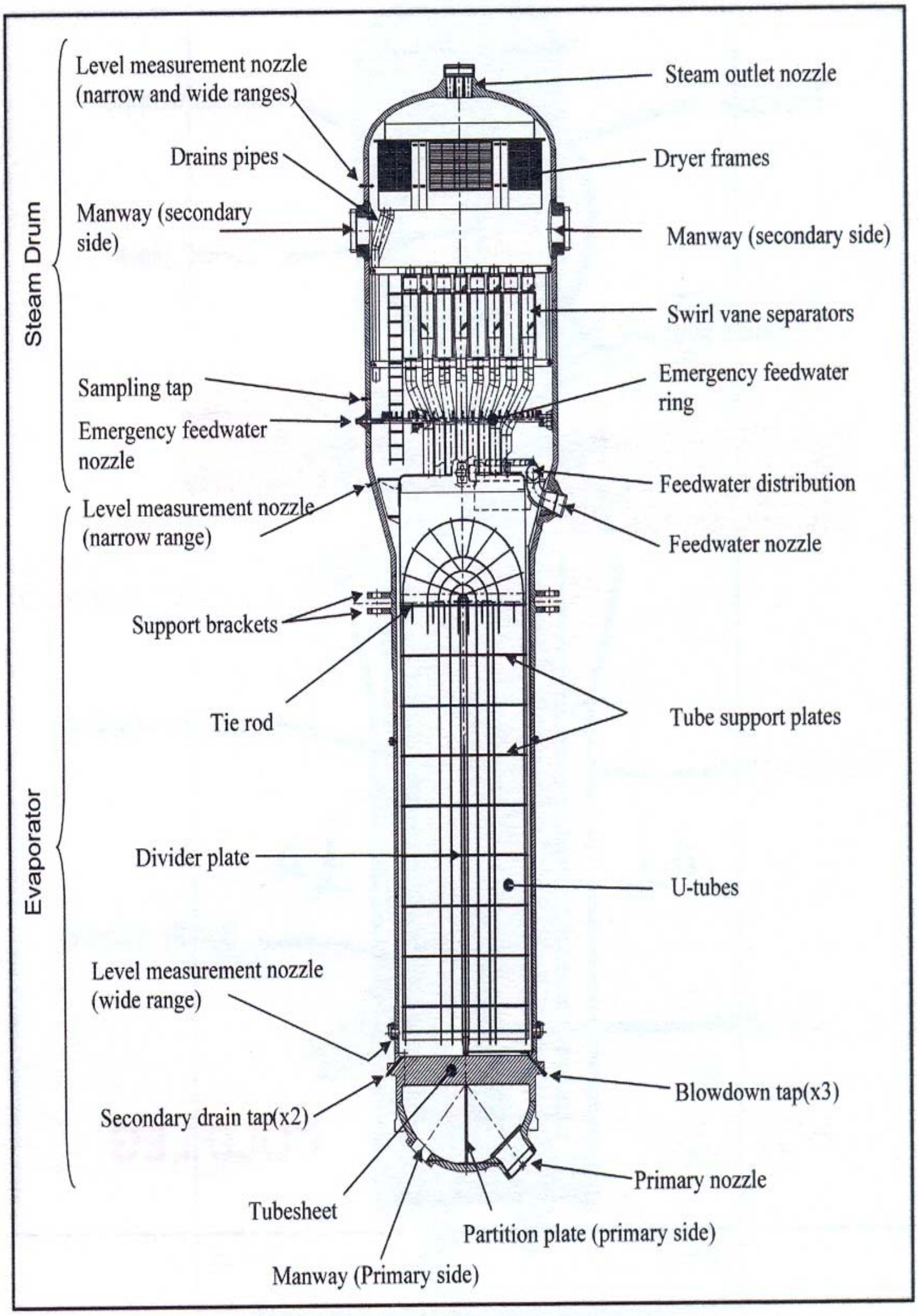


Fig. 2.9: Steam Generator (SG)

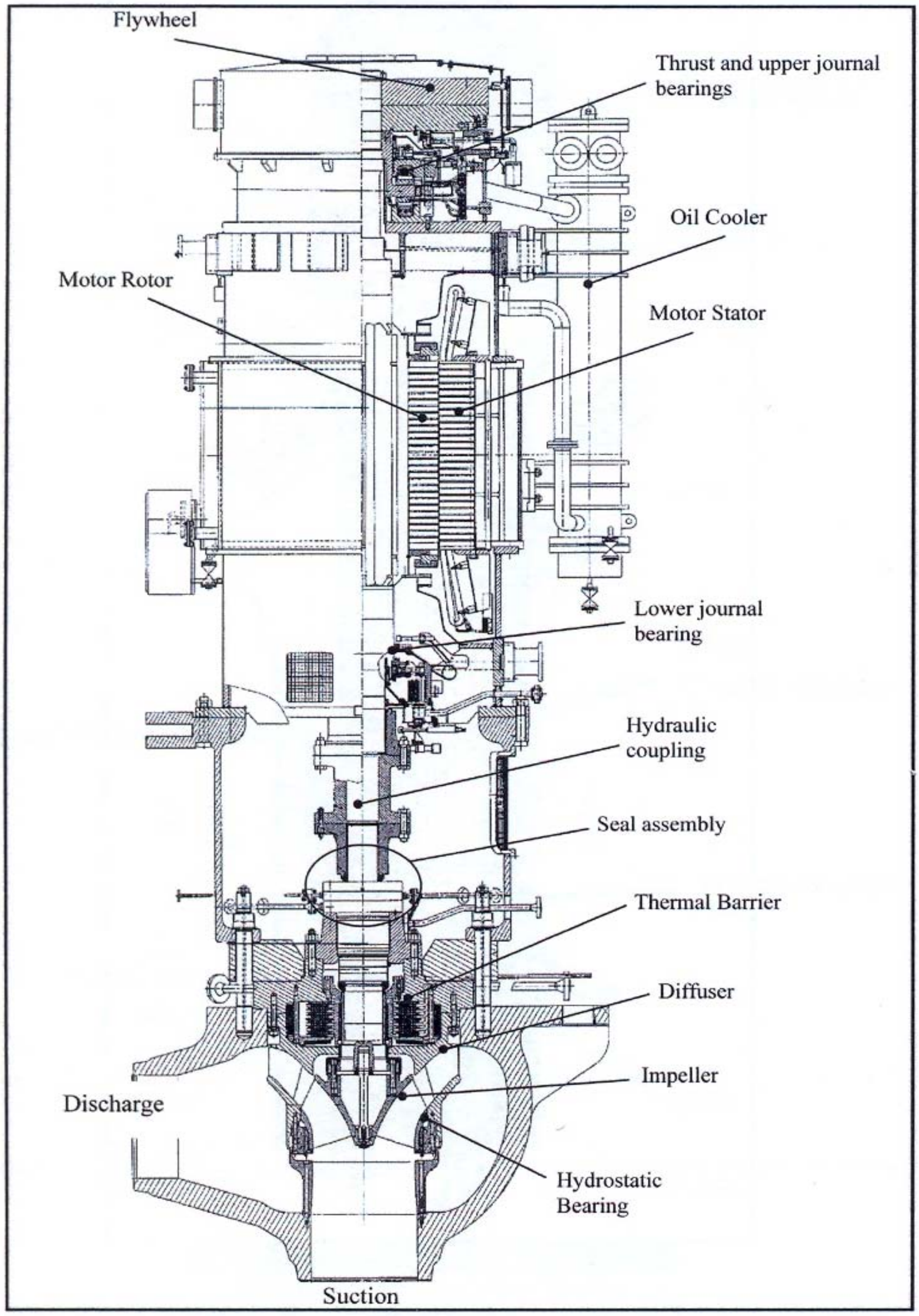


Fig. 2.10: Reactor Coolant Pump Assembly

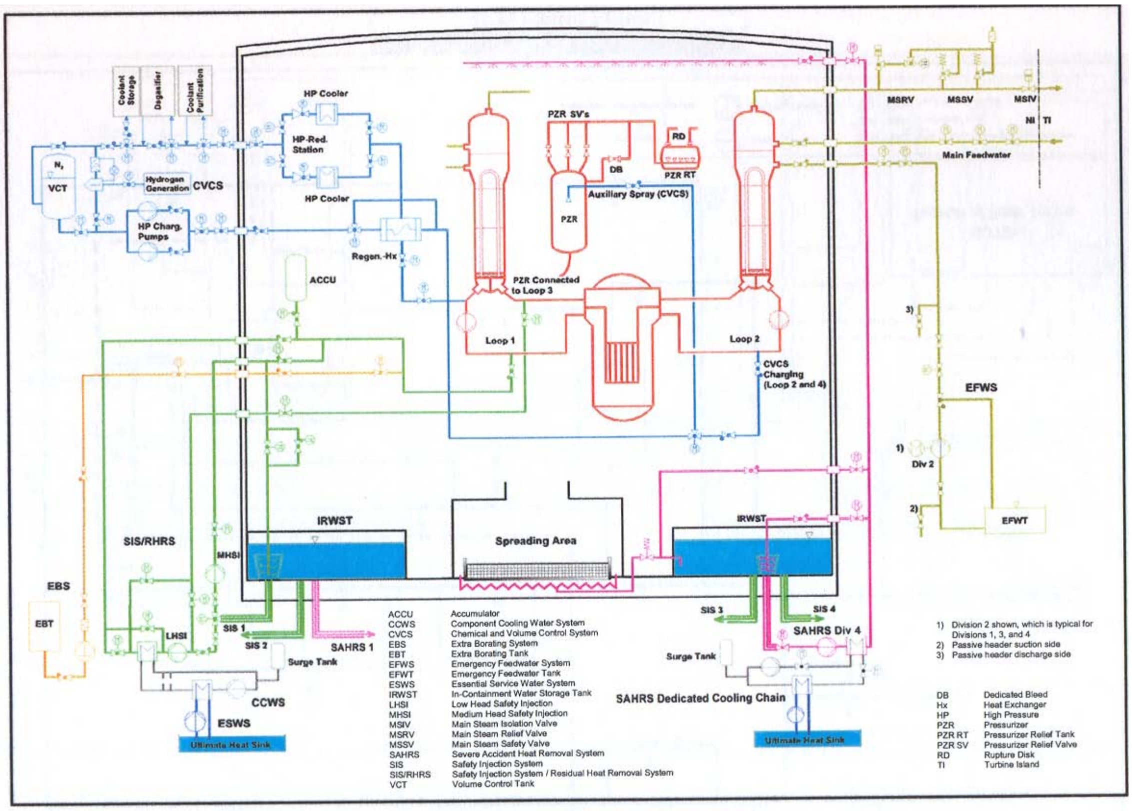


Fig. 2.11: Main Fluid Systems

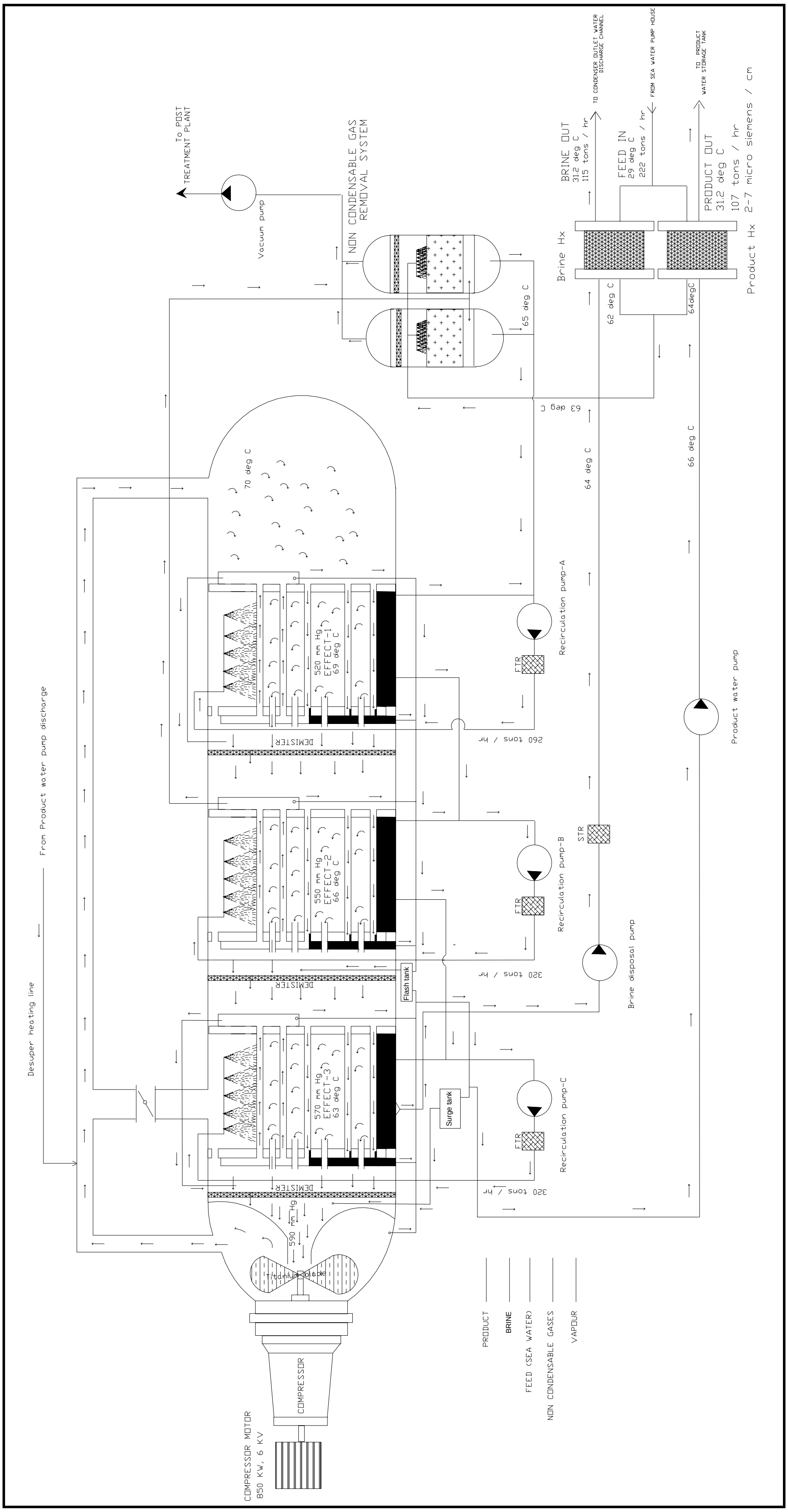


Fig. 2.12: Mechanical Vapor Compression Desalination Process

Section –II
Residential Complex of JNPP

2.10 Proposed JNPP Residential Complex

Nuclear Power Corporation of India Limited (NPCIL) has proposed to set up a Residential Complex at a distance of 5.5 km from the proposed project site. For this purpose, the land of three villages viz. Karel, Niveli and Mithgavane admeasuring 245.715 ha is being acquired. This is to mention that no families would be displaced from the land being acquired from these villages for JNPP residential complex.

The residential complex of Jaitapur Nuclear Power Park (JNPP) is an integral part of the project only and not commercial entity. Permanent employees, who are required for safe operation of JNPP will be allowed to reside in the above residential complex. Such residential complex for nuclear power plants are established in line with the requirements laid down as per Atomic Energy Act and Rules. Some of the mandatory facilities which are necessary to meet the NPP requirements during the operational phase of the NPPs are enumerated below:

(a) Environmental Survey Laboratory (ESL): An Environmental Survey Laboratory is required to be established outside the exclusion zone of the project before operation of the NPP commences to monitor regularly the environmental parameters during pre and post operational phase of the NPP. Hence, this facility is established in the residential complex of the project.

(b) Health Care and Decontamination Centre: Health care and decontamination centre for the occupational workers and permanent employees need to be established in the residential complex. This is a facility which will monitor the health of the employees on regular basis as per the requirements of AERB and during emergency situations will act as decontamination centre.

(c) Emergency Control Room – An emergency control room is to be established as a part of the emergency response system in case of off site emergency conditions of the plant.

(d) The above residential complex is meant for providing residential facilities only for the employees and other people, who will be required for regular operation and maintenance requirements of the plant as well as may be called for emergency and other essential duties at short notice.

In view of above, the proposed residential complex of the JNPP is not a private or a commercial residential colony, hence, considered as an integral part of the nuclear power park for all the purposes including Environmental Clearance.

2.10.1 Location

The site for Jaitapur Nuclear Power Park Residential Complex is situated in the area of villages Mithgavane, Niveli and Karel. It is about 40 km south of Ratnagiri, on the West Coast (**Fig. 1** as presented in **Summary EIA** of this report). Mumbai, the State capital is about 400 km away from the site by road (255 km radial).

2. 10.1.1 Land Profile and Land-use

Urban Development Department, Government of Maharashtra had Notified area around Jaitapur & surrounding area of 2000 ha for industrial purposes (which includes NPP units and associate residential complex) in regional plan for the development and use of land in the Ratnagiri – Sindhudurg Region as per Notification No. TPS 1290 / CR -120 / UD-12 dated June 2, 1995 under Maharshtra Regional and Town Planning & attached as **Annexure XIV**, **Vol. II** of this report.

The photographs of JNPP residential complex site are shown in **Plate 2.8** to **Plate 2.17** along with **Fig. 2.13**. The satellite image and map showing of actual land use pattern of the land being acquired for residential complex are presented in **Fig. 4(a)** & **4(b)** of the **Summary EIA**. NPCIL had submitted a request for acquiring land admeasuring to 245.715 Hectares (approximately) for its residential complex with the State Government in October, 2005. The land, which is being acquired, would be adequate to meet the land requirement for establishment of the residential complex for the required employees for all the six units of the proposed project. It is to mention that the required land belongs to private owners, with no physical displacement. The brief details of present Land Use of the JNPP residential complex is presented in **Table 2.2**.

The land notified for residential complex as well as for NPP units does not fall under the category of forest land (copy of the NOC from Department of Forest vide letter No.J.K.B./S./J./1352/2005-2006 dated 27.10.2005 is attached in the **Annexure-X**, **Vol -II** and Letter no. Survey/NOC/1617/06-07 dated 05-12-2006 is attached in the **Annexure XI**, **Vol. II**.

2. 10.2 Details of Residential Complex

There are no industrial establishments near the site. The whole area is plain area. The Residential Complex is being constructed to support maximum total population of 5500 persons, for planned strength of O & M manpower of 1100 persons per set of two units required for proposed type of NPP units. The Residential Complex will have residential quarters & other common facilities as per the tentative details given below, which may undergo few changes due to plant requirements:

1. Residential Quarters:

B	Type	-	108 houses
C	Type	-	648 houses
D	Type	-	210 houses
E	Type	-	52 houses
F	Type	-	2 houses

a) Sub - Total 1020 x 5 persons / house = 5100 persons

2. Service Personnel Hostel	(48 x 5)	= 240 persons
3. Senior Hostel		= 24 persons
4. Junior Hostel		= 48 persons
5. Officer's Hostel		= 48 persons
6. Guest House		= 40 persons
b) Sub- Total		**= 400 persons**
Total (a + b)		**= 5500 persons.**

Apart from this, the Residential Complex would have following facilities:

(i) Environmental Survey Laboratory (ESL)
(ii) Emergency Control Centre (Off site emergency)
(iii) Health Care / Decontamination Centre (Hospital)
(iv) School
(v) Club House / Community Hall
(vi) Shopping Complex

(vii) Maintenance Office

(viii) Water Treatment Plant

(ix) C.I.S.F. Residential complex

(x) Sewage treatment plant

(xi) Park, nursery, and plantations

(xii) Play Field

(xiii) Hockey and Football ground

(xiv) Police outpost

(xv) NPCIL Bus Depot

(xvi) Private bus stand

(xvii) Burial / Cremation ground

2.10.3 Hydrological and Geophysical Survey of Study Area

The hydrogeological and geophysical survey of the study area was carried out by Central Ground Water Board, Nagpur during initial survey of the site in 1989. The survey was carried out over an area of about 400 km^2 extending from the West coast to about 15 km East of the plant site, which includes the site for residential complex also. It has very rugged topography as the elevation ranges from sea level to 26.3 m above mean sea level. Multitude of small seasonal streams have dissected it resulting in narrow deep V-shaped valleys and flat topped low hills. The area is drained by Westerly flowing Muchkundi, Kodavali and Waghotan rivers which are tidal in their entire course. The average annual rainfall in the area is very high viz. 3215 mm during the months of June to September. However, a major part of this is lost as runoff due to rugged terrain and high gradients.

2. 10.3.1 Hydrogeology

Geologically the area is occupied by laterite formation which overlie basaltic lava flows of Deccan Traps at depths 30 to 40 m. The hill slopes and valleys show laterite screen over basalts. Laterite is reddish brown in colour, exhibits vermicular texture and is ferruginous. The rocks are joined and fractured with major joint directions being NW-SE, N-S, NE-SW, S-W, ENE-WSW, NNE-SSE. The basalt formation also has N-S and E-W trending joints besides horizontal joints.

Ground water occurs under water table conditions in laterite in Weathered, jointed / fractured zones and network of sinuous conduits in laterite. By nature of its origin this rock is porous, permeable and forms good aquifers. It is saturated during monsoon period as the rainfall in this area is very heavy. However due to moderate to good transmission, rough formation and high relief, movement of ground water is comparatively faster. This results in high seasonal variations in water levels in wells located in plateau. Ground water also occurs under confined conditions in the basaltic underline laterits. 55 wells were examined in the study area (Plateau and valley), which were mostly tapping laterite and weathered / transported laterite. The wells located in the plateau ranged in depth from 6.33 to 17.33 m below ground level in which depth to water ranged from 6.11 to 16.89 m below ground level during May –June 1989. The wells located in the valley slopes and lower valley area ranged in depth from 3.35 to 15.40 m below ground level in which depth of water table ranged from 2.45 to 15.26 m below ground level during May –June 1989.

The yield from such wells ranges between 5 to 20 m^3 per day, However, there are few wells which were tested and found to yield 80 to 100 m^3 /day. Heavy withdrawal from wells located near creeks has deteriorated the quality of water due to salt water intrusion. The redeeming feature is that the area is traversed by many lineaments, which are parallel to the trend of master joints in the area. The drainage pattern of the area is also found to generally follow the lineaments. Many springs are also observed along these lineaments. The rocks have good hydraulic parameters and are fully saturated by infiltration form heavy rainfall. However, high gradients, small plateau and deep narrow valleys facilitate increased ground water movement resulting in water level decline in March to June.

2. 10.3.2 Soil Characteristics

The major portion of the area is covered by laterite soil. The thickness of this varies from 1.5 m to 5 m. This soil is medium grained and reddish brown in colour.

2.10.4 Air Quality

Based on the meteorological data collected during three seasons from the area near to the residential complex, viz. summer 2006, post-monsoon 2006 and winter 2006-07 seasons, wind rose diagrams have been prepared and are presented in **Fig 3.5.2, 3.5.3** & **3.5.4** respectively of **Chapter-3**. The pre-dominant wind directions as recorded in summer season were from North-West and West, and their frequencies were 54.2% and 16.7% respectively. There was no calm condition during the study period in this area. During post-monsoon season pre-dominant wind directions were from South, South-West and West and their frequencies were 16.7%, 25% and 16.7% respectively. During winter pre-dominant wind directions were from North-West and North, and their frequencies were 16.7%, 25% respectively. The calm conditions were 8.3% and 16.7% in post monsoon and winter respectively.

2. 10.4.1 Ambient Air Quality Survey

The ambient air quality monitoring was carried out during summer, post-monsoon and winter seasons to assess the ambient air quality status near to the residential complex. SPM, PM_{10}, $PM_{2.5}$ as well as gaseous pollutants like SO_2 and NO_x were monitored on 24 hourly basis. The data collected was subjected to statistical analysis to arrive at various percentile values. The results were also compared with ambient air quality standards (**Annexure I, Vol. II**).

The ambient air quality status along with statistical interpretation during three seasons is reported in **Tables 3.5.4** to **3.5.21** in **Chapter -3**.

2. 10.4.2 Arithmetic Mean Values of Air Pollutants

In summer season, the arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.4**) at Padwe, which is close to residential complex ranged as follows:

SPM = 150 $\mu g/m^3$

PM_{10} = 48 $\mu g/m^3$

$PM_{2.5}$= 22 $\mu g/m^3$

SO_2 = 5 $\mu g/m^3$

NO_x = 28 $\mu g/m^3$

In Post monsoon season, the arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.5**) at Padwe, which is close to residential complex ranged as follows:

SPM = 52 $\mu g/m^3$

PM_{10} = 27 $\mu g/m^3$

$PM_{2.5}$=12 $\mu g/m^3$

SO_2 = 6 $\mu g/m^3$

NO_x = 10 $\mu g/m^3$

In winter season, arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.6**) at Padwe, which is close to residential complex ranged as follows:

SPM = 123 $\mu g/m^3$

PM_{10} = 29 $\mu g/m^3$

$PM_{2.5}$ = 13 $\mu g/m^3$

SO_2 = 7 $\mu g/m^3$

NO_x = 30 $\mu g/m^3$

Average values of PM_{10} and $PM_{2.5}$ are below stipulated standards of 100 $\mu g/m^3$ and 60 $\mu g/m^3$ for industrial, residential, rural and other areas respectively, (**Annexure I, Vol. II**).

2. 10.4.3 The 98th Percentile Values of Air Pollutants

The 98th percentile values of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NOx along with minimum and maximum concentrations at Padwe, which is close to residential complex ranged as follows (**Table 3.5.7 – 3.5.21**).

In summer season, the 98th percentile values of SPM (**Table 3.5.7**), PM_{10} (**Table 3.5.10**), $PM_{2.5}$ (**Table 3.5.13**), SO_2 (**Table 3.5.16**) and NO_x (**Table 3.5.19** are as follows:

SPM = 198 $\mu g/m^3$

PM_{10} = 77 $\mu g/m^3$

$PM_{2.5}$ = 35 $\mu g/m^3$

SO_2 = 8 $\mu g/m^3$

NO_x = 56 $\mu g/m^3$

In post-monsoon season the 98th percentile values of SPM (**Table 3.5.8**), PM_{10} (**Table 3.5.11**), $PM_{2.5}$ (**Table 3.5.14**), SO_2 (**Table 3.5.17**) and NO_x (**Table 3.5.20**) at Padwe, which is close to residential complex are as follows:

SPM = 78 $\mu g/m^3$

PM_{10} = 35 $\mu g/m^3$

$PM_{2.5}$ = 16 $\mu g/m^3$

SO_2 = 8 $\mu g/m^3$

NO_x = 16 µg/m^3

In winter season the 98th percentile values of SPM (**Table 3.5.9**), PM_{10} (**Table 3.5.12**), $PM_{2.5}$ (**Table 3.5.15**), SO_2 (**Table 3.5.18**) and NO_x (**Table 3.5.21**) at Padwe, which is close to residential complex are as follows:

SPM = 177 µg/m^3

PM_{10} = 42 µg/m^3

$PM_{2.5}$ = 19 µg/m^3

SO_2 = 8 µg/m^3

NO_x = 55 µg/m^3

Dust pollution in summer and winter season was observed to be due to relatively dry conditions and dust getting air borne due to winds and by vehicular movements and other activities. However, with the introduction of the project with effective EMP such as with good roads and green belt at the site, these values are expected to be on lower side around the residential complex site.

SO_2 and NO_x concentrations were observed to be well below the stipulated National Ambient Air Quality Standards of CPCB for residential/ rural areas. This is due to less vehicular transport and absence of any industry in study area.

2. 10.5 Water quality including Ground Water

2. 10.5.1 Physico-chemical Characteristics

Physico-chemical parameters along with biological indicators of pollution have been estimated at near Chauvanwadi (Arjuna River Estuary) for estuarine water and at Padwe for ground water quality, for ascertaining the baseline status of water environment near to the residential complex during summer, post monsoon and winter seasons and presented in **Table 3.6.2** to **3.6.10** of **Chapter - 3**.

2. 10.5.1.1 Estuarine Water

Physical Parameters

In summer season, for estuarine Water near Chauvanwadi (Arjuna River Estuary), the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) were observed as follows (**Table 3.6.2** of **Chapter - 3**).

pH	7.6
Temperature	31 °C
Turbidity	21 NTU
Total suspended solids (TSS)	39 mg/l
Total dissolved solids (TDS)	19425 mg/l

In post monsoon season, for estuarine water near Chauvanwadi (Arjuna River Estuary), the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) of sea water were observed as follows: (**Table 3.6.3** of **Chapter -3**).

pH	8.9
Temperature	30 °C
Turbidity	3 NTU
Total suspended solids (TSS)	6 mg/l
Total dissolved solids (TDS)	18187 mg/l

In winter season, for estuarine water near Chauvanwadi (Arjuna River Estuary), the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) of sea water were observed to be as follows (**Table 3.6.4** of **Chapter -3**).

pH	7.6
Temperature	24 °C
Total suspended solids (TSS)	8 mg/l
Total dissolved solids (TDS)	19900 mg/l
Turbidity	<1 NTU

Inorganic Parameters

In summer season, for estuarine water near Chauvanwadi (Arjuna River Estuary), inorganic parameters i.e. total alkalinity, chloride, sulphates and salinity were observed as follows (**Table 3.6.5** of **Chapter -3**).

Total alkalinity	81 mg/l
Chloride	7701 mg/l
Sulphate	2369 mg/l
Salinity	28 ‰

In post monsoon season, for estuarine water near Chauvanwadi (Arjuna River Estuary), inorganic parameters i.e. total alkalinity, total hardness, chlorides, sulphates, and salinity were observed to be as follows (**Table 3.6.6** of **Chapter -3**).

Total alkalinity	84 mg/l
Chloride	6332 mg/l
Sulphates	1638 mg/l
Salinity	15 ‰

In winter season, for estuarine water near Chauvanwadi (Arjuna River Estuary), inorganic parameters i.e. total alkalinity; chloride, sulphates, and salinity were observed to be as follows (**Table 3.6.7** of **Chapter - 3**).

Total alkalinity	75 mg/l
Chloride	6493 mg/l
Sulphates	2146 mg/l
Salinity	26 ‰

Nutrient Parameters

In summer season, for estuarine water Chauvanwadi (Arjuna River Estuary), nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, and Biochemical Oxygen Demand (B.O.D.) were as follows (**Table 3.6.8** of **Chapter -3**).

Nitrate	0.7 mg/l
Total phosphate	0.4 mg/l
Dissolved oxygen	6.5 mg/l
Biochemical oxygen demand (B.O.D.)	<3

In post monsoon season, for estuarine water Chauvanwadi (Arjuna River Estuary), nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, and Biochemical oxygen demand (B.O.D.) were as follows (**Table 3.6.9** of **Chapter -3**).

Nitrate	0.2 mg/l
Total phosphate	0.24 mg/l
Dissolved oxygen	6.5 mg/l
Biochemical oxygen demand	< 3 mg/l

In winter season, for estuarine water Chauvanwadi (Arjuna River Estuary), nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, Biochemical oxygen demand (B.O.D.) and were as follows (**Table 3.6.10** of **Chapter -3**).

Nitrate	0.2 mg/l
Total phosphate	0.3 mg/l
Dissolved oxygen	5.8 mg/l
Biochemical Oxygen Demand (BOD)	<3

It has been observed that the coastal water quality is good with less nutrients and no pollution.

2. 10.5.1.2 Ground Water

Groundwater quality was assessed through characterization of different parameters. at Padwe for ground water quality, for ascertaining the baseline status of water environment near to the residential complex during summer, post monsoon and winter seasons and presented in **Table 3.6.2** to **3.6.17** of **Chapter -3**.

Physical Parameters

In summer season, for ground water at Padwe, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed as follows (**Table 3.6.2** of **Chapter -3**).

pH	= 5.9
Temperature	= 30 ^{0}C
Turbidity	=7 NTU
TSS	= 20 mg/l
TDS	= 194 mg/l

In post monsoon season, for ground water at Padwe, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed as follows (**Table 3.6.3** of **Chapter -3**).

pH	= 8.8
Temperature	= 28 ^{0}C
Turbidity	= 1 NTU
TSS	= 4 mg/l
TDS	= 125 mg/l

In winter season, for ground water at Padwe, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed as follows (**Table 3.6.4** of **Chapter -3**).

pH	= 7.1
Temperature	= 22 ^{0}C
Turbidity	= 0.8 NTU
TSS	= 5 mg/l
TDS	= 129 mg/l

Inorganic Parameters

In summer season, for ground water at Padwe, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as follows (**Table 3.6.5** of **Chapter -3**).

Alkalinity	= 19 mg/l
Total hardness	= 67 mg/l
Ca-hardness	= 18 mg/l
Chloride	= 60 mg/l
Sulphate	= 3 mg/l
Sodium	= 36 mg/l
Potassium	= 4 mg/l

In post monsoon season, for ground water at Padwe, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as follows (**Table 3.6.6** of **Chapter -3**).

Alkalinity	= 62 mg/l
Total hardness	= 49 mg/l
Ca-hardness	= 35 mg/l
Chloride	= 13 mg/l
Sulphate	= 3 mg/l
Sodium	= 38 mg/l
Potassium	= 8 mg/l

In winter season, for ground water at Padwe, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as given below (**Table 3.6.7** of **Chapter -3**).

Alkalinity	= 36 mg/l
Total hardness	= 67 mg/l
Ca-hardness	= 16 mg/l
Chloride	= 9 mg/l
Sulphate	= 3 mg/l
Sodium	= 10 mg/l
Potassium	= 1 mg/l

Nutrient Parameters

In summer season for ground water at Padwe, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to be as given below (**Table 3.6.8** of **Chapter -3**).

Nitrate	= 11.0 mg/l
Total phosphate	= 0.3 mg/l
Dissolved oxygen	= 6.0 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

In post monsoon season for ground water at Padwe, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to be as follows (**Table 3.6.9** of **Chapter -3**).

Nitrate	= 0.9 mg/l
Total phosphate	= 0.25 mg/l
Dissolved oxygen	= 1.5 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

In winter season for ground water at Padwe, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to in the following range (**Table 3.6.10** of **Chapter -3**).

Nitrate	= 2.0 mg/l
Total phosphate	= 0.02 mg/l
Dissolved oxygen	= 5.2 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

2. 10.5.1.3 Heavy Metal Content

The heavy metal content in groundwater (**Table 3.6.11** to **3.6.13** of **Chapter -3**) was observed to be very low and below the stipulated limits for drinking water at Padwe during all the three seasons.

2. 10.5.1.4 Bacteriological Characteristics

The coliform group of bacteria is significant as a principal indicator of degree of pollution of water and is also indicative of the sanitary quality. The coliform density is now a criterion to assess the suitability of water for domestic and recreational uses. The coliform group belongs to the family of Enterobacteriaceae and includes all aerobic and facultative anaerobic, gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48 hrs at 35°C.

For estimation of bacterial contents in water samples, the standard test for the coliform group was carried out by the membrane filter (MF) technique. The MF technique involves direct plating for detection and estimation of total coliform and faecal coliform densities.

Estuarine Water

In summer, post monsoon and winter seasons, the total coliform density in estuary water at Chauvanwadi (Arjuna River Estuary), was observed as 7200 CFU/100 ml, 260 CFU/100 ml and 190 CFU/100 ml respectively whereas faecal coliform were detectable at different locations in levels ranging between 275 CFU/100 ml, 35 CFU/100 ml, and 20 CFU/100 ml respectively. These values indicated some amount of organic contamination in sea water. Please refer **Tables 3.6.14, 3.6.15** and **3.6.16** of **Chapter-3**.

Groundwater

In order to assess bacteriological quality of groundwater, for residential complex samples were collected at Padwe, which is near to the area earmarked for residential complex of JNPP. The bacteriological quality of the groundwater is presented in **Tables 3.6.14, 3.6.15** and **3.6.16** of **Chapter-3** for summer, post monsoon and winter seasons respectively.

In summer, post monsoon and winter seasons, Total Coliforms were found as 170 CFU/100 ml, 1900 CFU/100 ml, and 80 CFU/100 ml respectively whereas faecal coliforms were as 8 CFU/100 ml, 115 CFU/100 ml, and 18 CFU/100 ml respectively.

Comparison with Drinking water Quality Standards (Vol. II, Annexure III)

The Groundwater quality at Padwe in the area near to the site of the proposed residential complex of JNPP is good in comparison with Drinking water Quality Standards.

2. 10.5.2 Biological Characteristics

The study on biological parameters shall lead to detecting various factors contaminating or polluting the aquatic environment.

The phytoplankton and zooplankton are practically suitable choice of indicators of water quality due to ease of sampling, their cosmopolitan distribution and lot of available information on these groups. The monitoring for biological parameters is rapid, inexpensive and reliable requiring only biological examination of the water samples. The impact of pollution is directly reflected by the survival status of flora and fauna. Hence the biological data gives an overall picture of the subsequent effects of pollution.

2. 10.5.3 Assessment of Biological Quality of Water

Phytoplankton

The data on phytoplankton community estuarine and groundwater for summer season, post monsoon season and winter season is shown in **Tables 3.6.17** to **Table 3.6.22** of **Chapter-3**.

The population dynamics were estimated by phytoplankton count in no/ml in estuary water at Chauvanwadi (Arjuna River Estuary), which were observed in the range of 123-200 during study period (**Table 3.6.17, 3.6.19** and **3.6.21** of **Chapter-3**). Palmer's Pollution Indices (7-10) indicate oligotrophic water quality.

Groundwater samples were collected from Padwe dug wells, which is close to the residential complex site. The Shannon Weiner Diversity Index (SWDI) & phytoplankton count were found in the range of 1.584- 1.921 and 56-168 algae per ml respectively. PPI values (2-7) showed good quality of water but SWDI values (1.584 – 1.921) showed presence of organic contamination in groundwater samples.

Zooplankton

The data on zooplankton community for estuarine water and groundwater, for summer, post monsoon and winter seasons are shown in **Tables 3.6.23** to **3.6.28** of **Chapter -3**.

In estuarine water at Chauvanwadi (Arjuna River Estuary), the Shannon Wiener Diversity Index (SWDI) and zooplankton count varies between BDL - 2.07 and BDL-10000 nos/m^3 respectively (**Table 3.6.23, 3.6.25** and **3.6.27** of **Chapter -3**). The percentage composition reveals highest count for Rotifera & Copepoda. These values indicate that the estuarine at Chavanwadi near to Residential Complex is oligotrophic with low productivity.

The groundwater, at Padwe dug well showed presence of zooplankton counts, which were in the range of 800-1000 nos/m^3. The Shannon Weiner Diversity Index (SWDI) for ground water varies between 1.86 -1.906. These values showed that ground water is oligotrophic with low productivity.

2.10.6 Noise Environment Quality

Noise, often defined as unwanted sound, interferes with speech communication, causes annoyance, distracts from work, disturbs sleep and deteriorates quality of human life.

The noise levels were measured in residential, commercial and sensitive locations around the proposed residential complex of JNPP and were compared with stipulated CPCB standards, 1998 (**Vol II, Annexure II**).

Most of the villages in the area around the proposed site of residential complex are showing calm and quiet environment due to no major human activities except some traffic. The National Highway i.e. Mumbai to Goa passes through the town of Kharepatan is approximately 40 km away from the proposed site of residential complex. A State Highway (SH) joins the area. Vehicular movements on this SH are medium. Roads adjoining the villages with the SH are rural in nature with very less vehicular movements.

Noise levels recorded at residential areas, commercial areas and silence zones are presented in **Table 3.9.1** of **Chapter 3**. In residential areas, noise levels observed to be 48 dB(A) at Girye village, which is close to the proposed site of residential complex.

The noise levels at Mumbai-Goa highway were measured for day and night time on which around 1000 and 380 vehicles ply per hour during day and night time respectively. The background noise level was observed between 51-55 dB(A) which increases to 78 dB(A) at the time of passing of vehicles during day time and 69 dB(A) during night time as presented in the **Table 3.9.2** of **Chapter -3**.

The noise levels were observed to be below the stipulated standards at all places except at Mumbai – Goa highway at the time of high traffic density during day time as well as during night time.

2. 10.7 Status of Flora and Fauna

The existing status of the details of the flora and fauna around the residential complex was studied by College of Forestry, Dapoli University, Ratnagiri and NEERI, Nagpur. The proposed residential complex site of JNPP is mostly a barren stretch of land with sparse savanna vegetation. Only a part of land is covered with agriculture and orchards, the details of the same are presented in **Fig. 4(a)** & **4(b)** of the **Summary EIA**. The habitats in study area are shown in **Plate 3.8.1** and **3.8.2** of **Chapter-3**. The floristic survey in the area reveals low species composition representing poor gene pool because of human settlement in area. The vegetation in this area is mixed consisting of uneven-aged deciduous species.

The study area consists chiefly of hilly ranges. The vegetation here is mostly on slopes and usually scattered in patches. While, on lower slopes and flatter slopes of hills, many agricultural activities are performed. Much of the study area is under agricultural practices due to which domestic animals are predominantly found here. The vegetation cover is moderately good due to social plantation and agricultural practices, which forms the habitat of birds, reptiles, mammals and lower invertebrates. It is mentioned that bare minimum number of trees will be cut or uprooted, however, care will be taken to plant 2-3 times number of fresh trees in lieu of the trees cut or uprooted during the course of construction.

The major habitats of wildlife present in the study area are grassland, forest, mangroves, coastal scrubland (**Plate 3.8.2** of **Chapter-3**), rocky seashore and sandy beach (**Plate 3.8.10** and **3.8.11** of **Chapter-3**).

2. 10.8 Infrastructure Facilities and Requirement

2. 10.8.1 Land, Electricity and Construction Material

It is proposed to acquire about 245 Hectare land for residential complex. Majority of the land area is barren and rocky (Ref. **Section 2.10.1.1** of **Chapter 2**). The proposed site for Residential complex is not low lying so no extra earth will be required for land filling. During construction phase raw construction material is planned to be used from excavated material from plant site and from local sources. For development of the green belt landscape lawns and gardens soil of suitable quality and other local material will be brought from the nearby area.

A peak demand of 1 MVA per twin unit is envisaged. Thus a provision of feeding total load of 3 MVA for Jaitapur Residential Complex is considered. Accordingly, the residential complex is proposed to be fed through three substation of 1 MVA, 11 kV / 400 Volt rating. Location of these substations will be decided, while finalizing residential complex master plan.

2.10.8.2 Domestic Water Requirement for Residential Complex

The requirement of plant water as well as residential complex will met through a desalination plant as described in Section 2.8 of this Chapter. However, exercixe to examine the suiability of the ground water will be carried out to meet the domestic water requirement for the proposed residential complex of JNPP by drilling bore well at suitable locations in the land under acquisition by NPCIL for this complex. This will be implemented after resurveying the availability of the ground water to update the old data of the survey conducted in the year 1989. Based on above survey, if required, suitable permission would be obtained form the Central Ground Water Authority. The estimated domestic water requirement for residential complex is 500 m^3/ day/unit, which is included in the drinking and domestic water requirements as presented in **Table 4**, of **Summary EIA**.

2.10.8.3 Use of Renewable and Alternate Source of Energy

A detailed survey of the site will be carried out for preparing a feasibility analysis for use of renewable and alternate source of energy such as wind energy and solar energy. However, based on techno-economic considerations, public buildings such as guest houses, canteens, hospital etc may be provided with solar heaters and solar lights for street lighting. Additionally, use of energy efficient devices such as CFL etc. may be used for all public buildings in the residential complex.

2.11 Impacts Assessment

- **Construction Phase of the Residential Complex**

The construction of the residential complex of JNPP would be carried out in phased manner in line with the stage–wise project implementation. Accordingly, the impact from the residential complex is presented in the following paragraphs:

2.11.1 Impact on Air Quality and Noise Levels

There will be a temporary increase in number of transport vehicles for transport of construction material and machinery. These activities may have impact on air due to engine exhausts and emission of dust. This impact will be temporary during construction phase only and air pollutants will be diluted due to good wind speed (average daily wind speed range: 0-19 km/hr) in the coastal area. Moreover, the background levels of air pollutants are well below the stipulated standards due to meager human activity in the area and have good assimilative capacity to assimilate the temporary fluctuation in the emission of dust and exhaust gases during construction period.

The residential complex construction activity may contribute to slight increase of noise levels in the local area during constriction phase only, which will not have much impact on the background noise levels in the nearby villages.

- ## Operation Phase of the Residential Complex

2.11.2 Water Impact Assessment

2.11.2.1 Availability of Water

The fresh water from the desalination plant, proposed to be established at the project site, will be used for the purpose. The details of the proposed desalination plant are presented in **Section 2.8** of **Chapter -2**. Alternatively, the domestic water requirement for the proposed residential complex of JNPP may be met from the available ground water in the area by drilling bore well at suitable locations in the land under acquisition by NPCIL for this complex. This will be implemented after resurveying the availability of the ground water to update the old data of the survey conducted in the year 1989.

2.11.2.2 Impacts due to Domestic Wastewater

Domestic wastewater from residential complex will be treated and recycled / reused in a proper way. The detail design parameters of the sewage treatment plant (STP) are presented in **Section 2.12.13**, **Chapter 2** and the treated effluent will be utilized for irrigating plantation and green belt in the residential complex. The stabilized dried sludge cake obtained from STP will be utilized as manure for the plantation. Additionally, for storm water, a suitable scheme will be designed such that the storm water drain does not have any adverse impact on the water body rather it is collected and utilized through a rain water harvesting scheme as described in **Section 2.12.8**.

A guard pond will be provided in parallel to sewage treatment plant to store the domestic wastewater in case breakdown or failure of wastewater treatment facility. The guard pond will have capacity of 3700 m^3 storage area for retaining wastewater during repair of treatment plant.

2.11.3 Impact Assessment on Land Environment

At present, the proposed residential complex site is mostly barren with sparse vegetation in the form of grasses. However, with the introduction of the complex, the land use pattern of the area will improve with neat and clean project buildings, lawns and gardens. Therefore, there will be positive impact on existing landscape due to proper planning for landscaping, development of roads with avenue trees and green belt development in the residential complex making the landscape beautiful with lush green cover.

2.11.3.1 Assessment of Impact due to Soil Erosion

The residential complex site will be leveled and compacted. Subsequently, at suitable locations and identified places as per master plan, landscape gardens, lawns and rest of the vacant area will be developed as green belt with the fertile soil brought from the nearby areas and mixed with the manure generated from the municipal solid waste management plant at the residential complex of JNPP. Due to above activities and regular maintenance soil erosion will be minimal.

2.11.4 Biological Environment

The residential complex area is occupied by barren land with grasses and scrub vegetation. Thus development of the complex would not affect the green cover of the area on the contrary, plantation in residential complex area will result in increase in green cover and biodiversity of plants and birds in the area apart from creation of beautiful landscape.

2.11.5 Socio Economic Impact

- The proposed residential complex would generate direct and indirect employment opportunities as daily wage labors during construction, transportation activities, supply of raw materials, house hold activities, hotels, shops etc.
- Due to the proposed residential complex, there would be an overall development of the area and job opportunities, which may improve the quality of life in the region.
- Development in housing, education, medical, health, sanitation,

power supply, electrification and transport in the area around the proposed residential complex

2.12 Environmental Management Plan (EMP)

- **Construction Phase of Residential Complex**

2.12.1 Site Preparation

During construction of the residential complex the following aspects will be taken care of.

(i) Proper stock piling and back filling of the excavated soil.

(ii) All the disturbed land will be stabilized.

(iii) The top soil containing rich humus, soil will be utilized for development of greenbelt in and around the residential complex.

2.12.2 Air Environment

Vehicular emissions, dust and other sources of emissions can affect air quality in the localized area during the construction of residential complex. It will be ensured that both gasoline and diesel powered vehicles will be properly maintained to minimize air pollution.

2.12.3 Water Environment

The vehicle maintenance / washing area will be selected in such a way that it does not contaminate surface or ground water by accidental spillage of oil or unauthorized dumping of waste oil.

2.12.4 Land Environment

An effective house keeping needs to be established during construction phase. The solid wastes generated during construction phase will be collected and segregated and will not be disposed off on land. Combustible waste will be burnt in controlled manner, whereas bio-degradable waste will be sent for composting and non bio degradable should be disposed in secured land fills. During construction of the project, development of an effective green belt around the project and aesthetic considerations will be reviewed on regular basis.

2.12.5 Site Security

The residential complex will be secured by fencing and no unauthorized entry will be permitted in the construction area.

▪ Operation Phase of Residential Comlplex

2.12.6 Air and Noise Pollution

Air and noise pollution will be reduced by maintaining good quality roads in the residential complex along with traffic guidelines near sensitive areas like schools, colleges, hospitals and markets. Belt of avenue trees on both sides of the roads will be maintained apart from parks, tree plantation around public buildings and waste management areas. The commercial places like guest house, hostels, market place, and playing ground will be away from residential zones.

2.12.7 Wastewater Management

The sewage from residential complex would be treated to comply with the standards stipulated by MPCB and it will preferably be reused for gardening or plantations to the maximum possible extent.

2.12.8 Rain Water Harvesting

Rainwater harvesting is normally practiced for recharging ground water levels and provide water for human consumption, by collecting the rainwater from the roofs of the buildings and storm water drains into artificially constructed rainwater tanks. At Jaitapur Project residential complex, the average ground water level is 17 m below ground level. Accordingly, a suitable rainwater harvesting schemes will be worked out in consultation with a suitable agency.

2.12.9 EMP for Domestic Solid Waste

The domestic solid waste normally constitutes about 50% organic matter. This material can be composted to yield the compost, which can be used along with the chemical fertilizer in the surrounding farms. Studies carried out by various authorities have clearly shown that the yield that is obtained by using chemical fertilizers along-with compost is normally more than the yield obtained by the use of chemical fertilizer alone. Progressive farmers will hence readily accept to utilize the produced compost.

Composting

As the quantities of solid waste to be composted are small, the semi-mechanized method of composting will be used. For composting, suitable land (4 ha) will be identified at a low-lying area in the residential complex. The total area that will be required for this composting plant will be around 1.5 ha. In addition to the plant, a building will have to be provided to house the front end loaders and other equipments. The details of sanitary land filling design are presented in **Chapter-10**, **Section 10.10.3.1.1**.

2.12.10 Landscape Development and Roadside Plantation in Residential Complex

The residential complex site will be leveled and compacted. Subsequently, at suitable locations and identified places as per master plan, landscape gardens, and lawns will be developed with the fertile soil brought from the nearby areas and mixed with the manure generated from the municipal solid waste management plant at the residential complex of JNPP.

Roadside plantation plays a very important role for making the area green, increasing the shady area, increasing aesthetic value and for eco-development of the area. The approach roads in the residential complex can be planted with shade giving flowering trees in 10 m area on both sides of road with large trees, medium trees and shrubs alternating with each other. Besides this, all the local voluntary organizations will be encouraged to undertake massive plantation along the roadside at suitable places to uplift the regional ecosystem of the area.

2.12.11 Aquatic Component

All domestic waste / Sewage would be adequately treated and would be re-used for green belt development.

2.12.12 Socio-economic Environment EMP

The following measure would be adopted: -

- The hospital facility, which will cater to the needs of the project staff, will conduct medical camps, mobile dispensary, etc and in case of emergency availability of full hospital facility for the local inhabitants.

- The participation of local people in the project sponsored events such as sports tournaments; fairs etc. will be encouraged to develop & retain the goodwill of the people.

- Separate allocation of funds towards welfare activities for the local people.

- Some basic amenities, viz. education welfare, safe drinking water supply, street Lighting, roads facilities in the villages may be taken up by project authorities

- Educational programmes should be continued in the nearby villages viz. Books for students, computers for schools, construction of additional classrooms in Govt. school and Talent nature programme for the benefit of talented kids from economically poor background

- Construction of bus shelters in near by project villages

2.12.13 Guard Pond and Sewage Treatment Plant (1830 cu. m. /day)

The residential complex of JNPP will be provided with a guard pond and a sewage treatment plant (STP) for hold of slightly polluted water generated during various activities in the residential complex and treatment of sewage from the houses and other facilities. The design parameters of the STP shall be based on the conditions given in **Table 2.3**. The design criteria for different units in sewage treatment plant are given in **Table 2.4**.

The flow sheet of sewage treatment plant is shown in **Fig. 2.14**. The system comprises the following sections:

- **Primary Treatment**
  - ♦ Screen Chamber
  - ♦ Grit Chamber
  - ♦ Sewage Collection Sump
- **Biological Treatment**
  - ♦ Fluidized Bed Bio Reactor (FBR)
  - ♦ Clarisettler

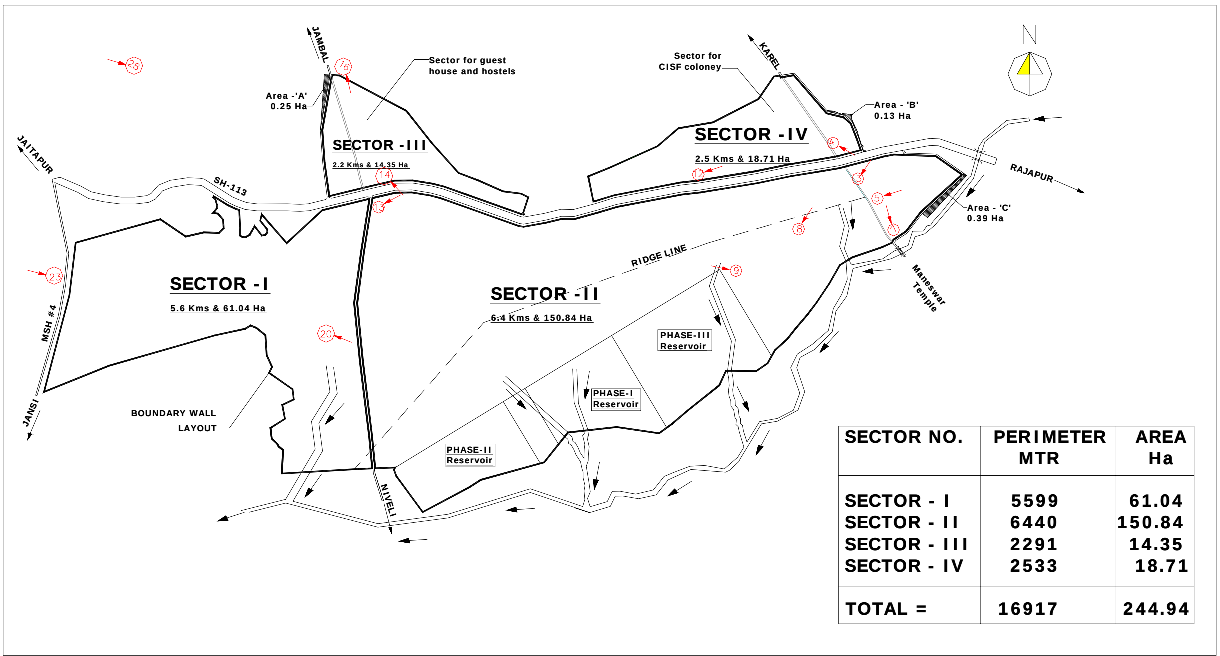
- **Tertiary Treatment**
  - ♦ Chlorine Contact Tank
  - ♦ Dual Media Filter
  - ♦ Activated Carbon Filter
- **Sludge Handling / Guard Pond**
  - The sludge drying beds / pond of suitable capacity will be designed to dry the sludge generated from the sewage treatment plant during its normal operation as well as its break down. In case of failure of the STP, the sewage will be pumped to the guard pond directly to allow the gravity settling of the solid waste / sludge. This sludge will be removed from the guard pond regularly and will be used as manure for development of green belt at the project site and residential complex.

2.12.14 Traffic Management

As per the master plan of the complex, no public road or highways (state or national) will be allowed to pass through the residential complex. The official and private vehicles of the employees will be parked in the residential complex at designated places and in the stilt area provided in the residential buildings. The roads will be provided with footpaths on both the sides of the roads and other essential road safety features. It is envisaged that there would not be any loading / unloading heavy machinery and component in the residential complex. All the official vehicles will be regularly checked and maintained for their road worthiness.

2.12.15 Disaster Management Plan for Residential Complex of JNPP

The residential complex is the integral part of the project as mentioned in **Section 2.10**. The risk assessment and emergency preparedness plan as presented in **Section-II**, **Chapter - 4** will be applicable to Residential Complex also. Hence during any emergency situations arising due to natural disasters and man made such as earthquake, cyclone/ flooding / tsunami and radiological emergencies will be dealt in line with the plan as presented in **Section-II** of **Chapter-4**.



SECTOR NO.	PERIMETER MTR	AREA Ha
SECTOR - I	5599	61.04
SECTOR - II	6440	150.84
SECTOR - III	2291	14.35
SECTOR - IV	2533	18.71
TOTAL =	16917	244.94

Fig. 2.13: Residential Complex Boundary Wall Layout

Plate 2.8: Land of Residential Complex on Either Side of State Highway 113 (June, 2009)

Plate 2.9: View of Sector- III from Jaitapur Village (June, 2009)

Plate 2.10: View of Jaitapur Creek from Sector – III (June, 2009)

Plate 2.11: View from SH -113 of Sector IV (June, 2009)

Plate 2.12: View of Sector - II from N-E Corner (June, 2009)

Plate 2.13: View Showing Sloping Profile of Sector - II (June, 2009)

Plate 2.14: View of Sector-I from East Side (June, 2009)

Plate 2.15: View of Sector-I from Coastal Highway (MSH-4) (June, 2009)

Plate 2.16: Photographs of the Proposed JNPP Residential Complex (Dec., 2005)

Plate 2.17: Photographs of the Proposed JNPP Residential Complex (Dec., 2005)

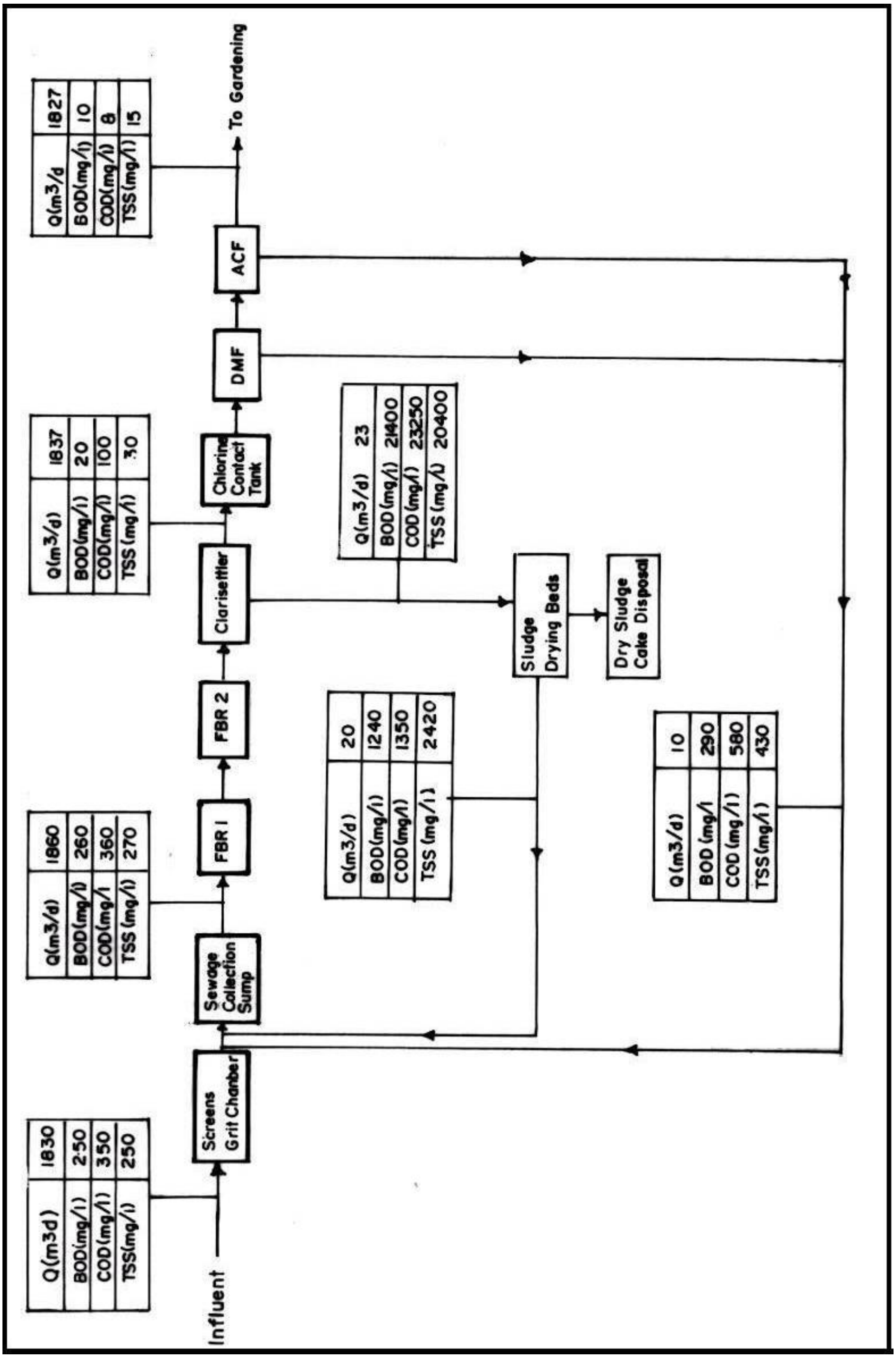


Fig. 2.14: Flow Sheet of Sewage Treatment Plant

DMF – Dual Media filter, ACF- Activated Carbon Filter, FBR- Fixed Bed Reactor

Table 2.3

Sewage Treatment Plant: Design Parameters (Total Flow: 1830 m^3/d)

Sr. No.	Parameters	Value		
		Before Treatment	After Treatment (Before Dual Media Filter)	After Treatment (After Carbon Filter)
1	pH	7.65	7 to 8	6.5 to 8
2	BOD (mg/l)	250	<20	5 to 10
3	COD (mg/l)	350	<100	50 to 80
4	TSS (mg/l)	250	<30	10 to 15

Table 2.4

Sewage Treatment Plant: Design Criteria

Sr. No.	Description of Treatment Units	Value to be Considered for Design	Range of Value Specified by the Codes
1	**Screen Chamber**		
	- Velocity through screen	0.75 m/sec	0.6 to 1.2 m/sec
	- Clear openings	20 mm	20 to 50 mm
2	**Grit Chamber**		
	- Detention time	60 sec	30 to 60 sec
3	**Sewage Collection Sump at STP**		
	- Detention time	6 hrs	6 to 8 hrs
	- Air requirement for mixing	750 to 800 m^3/d	0.9 m^3/m^3 of tank volume
4	**FBR (Two Stages)**		
	- Organic loading rate	3.2 to3.6 kg BOD/m^3/d	3.2 to 3.6 kg BOD /m^3 /d
	- Oxygen required	2.0 kgO_2/kg BOD removed	1.5 to 2.0 kg O_2/ kg BOD removed
	- Oxygen transfer efficiency	12 %	8 - 12 %
5	**Clarisettler**		
	- Detention time	12 - 2.0 hrs	15 - 2.0 hrs
6	**Sludge Drying Beds**		
	- Drying cycle	10 - 12 days	6 - 12 days
7	**Chlorine Contact Tank**		
	- Detention time	45 - 60 min	30 - 60 min
	- Dosage	To be maintained so that residual chlorine is 2ppm	

Chapter 3

Description of Environment

3.1 Identification of the Study Area

Impact of Nuclear Power Project (NPP) operations on surrounding environment is negligible. NPP does not release conventional air pollutants e.g. SO_2, NO_2 and SPM, but releases some amount of radioactive materials through air and water route. So for NPPs, assessing the radiation level at various distances from the project site is required to be monitored to demonstrate compliance with regulatory standards.

In normal operation of the proposed PWR category nuclear power plant, the impact zone would not be beyond 1.6 km, which would also hold good for off normal situations due to advanced technological features in built in the design of the reactor. However, on a conservative side, an area of 16 km around the plant is considered as emergency planning zone as per the requirements of AERB.

In view of the above specific characteristics for NPPs, the impact zone for the various environmental matrices for the present EIA study is identified as 16 km. However, for socio-economic aspects this zone is considered as 25 km (as per MoEF guidelines for thermal power plants). For trend monitoring/ surveillance of radiation doses to the members of public, various environmental samples are collected for dose estimation within a radial distance of 30 km from NPP by Environmental Survey Laboratory (ESL) of Health Physics Division (HPD), BARC. For the present Environmental Impact Assessment (EIA), the impact zone is depicted in **Fig. 1.4**

Chapter-1. The data for air, water, were collected for three seasons from the study zone as identified in the proceeding sections. It should be noted that for trend monitoring of the radiation doses sample location gets dispersed and sampling frequency generally reduces as the distance from the plant increases.

3.2 Identification of the Project Phases

The various phases of the project identified, which would affect the environment are as follows:

3.2.1 Siting

This is the first phase of the project activity and involves construction of the access road and site clearing. This phase of the project would not have any noticeable impact on the environment.

3.2.2 Construction & Commissioning

The construction of the power plant will have no significant impact due to various project activities such as transportation, excavation, construction and fabrication works. These impacts would be of localized nature and would be for period of construction. However, there will be positive impact in terms of more direct and indirect job opportunities for the local people. Some of the activities taken up during this phase such as development of the green belt, increased job opportunities will have positive impacts on local ecology and environment after the plant comes to operation. Marginal impacts are also anticipated on aesthetic environmental components. However, even during this phase a suitable environmental management plan will be implemented to maximize the positive impacts and minimize the negative impact.

3.2.3 Operation

During operation phase of the project, due to gaseous, liquid releases, disposal of solid waste, generation of noise etc., the various components of the environment such as air, water, land, noise, socio-economic may not have any significant impact as discharge values through these routes will be much below the safe limits specified by AERB. During this phase a proper and effective environmental management plan will be put in place to make the project environmentally benign. The generation of employment opportunity, social & community welfare measures will have long-term positive impact. It will provide much needed electricity with minimal environmental impact and with comparable cost of electricity generation.

3.3 Methodology for EIA

Environmental impact can be defined as any alteration of environmental conditions, which could be either adverse or beneficial, caused or induced by the set of project activities. Therefore, the present Environmental Impact Assessment (EIA) is also based on three sequential elements:

- Identification of Impacts based on baseline status of environment
- Prediction of Impacts due to proposed project activity and identification of mitigation measures
- Delineation of Environmental Management Plan

3.3.1 Identification of Impacts

In the process of identification of impacts, the existing status of environmental quality with respect to various identified parameters and those components of project activities, which have an effect, are characterized. These are analyzed for both beneficial and adverse impacts as a part of EIA process. The various factors considered in the impact identification of the project are as follows.

- Identification of the environmental parameters
- Identification of the impact zone
- Identification of the project phases
- Identification of the impact generating activities

The EIA of proposed JNPP site has been carried out through reconnaissance survey and assessment of baseline status of three seasons by identification, prediction and evaluation of impacts under each environmental component viz. air, noise, water, land, biological and socio-economic environment.

3.3.2 Identification of the Environmental Parameters

The various environmental parameters, which are identified and likely to be affected by the project activities, are as follows:

3.3.2.1 Air Environment

The radioactive gaseous releases such as Carbon-14, Iodine isotops, noble gases, Tritium, from the nuclear power plants may lead to radiation doses to man. The inter-relationships of these different exposure pathways through air route have been depicted in **Fig. 3.4.1**.

3.3.2.2 Water Environment

The liquid effluent discharges from the proposed project will involve conventional as well as radioactive liquid releases such as gross beta activity. Possible exposure pathways for releases from JNPP to aquatic environment are depicted in **Fig. 3.4.2**.

3.3.2.3 Land Environment

The existing land use pattern and soil characteristics may change due to the project activities.

3.3.2.4 Biological Environment

For biological environment, baseline data on flora and fauna, biological characteristics of aquatic bodies with respect to phytoplankton and zooplankton along with information and availability of common animals at various places around the project site have been considered.

3.3.2.5 Noise Environment

Noise is often defined as unwanted sound which interferes with various human activities and disturbs physical and mental peace, and sleep, thus, deteriorating quality of human environment.

3.3.2.6 Socio-economic Environment

Demographic pattern, population density per hectare, educational facilities, agriculture, income, fuel, medical facilities, health status, transport and entertainment centers and information related to health are required to determine the quality of life indices in the region.

3.4 Environmental Methodology and Radiological Environmental Status

The baseline status of environment with respect to the following two types of pollutants within the impact zone is essential and is also a primary requirement for impact assessment of proposed nuclear power plant under study.

- Conventional pollutants
- Radioactive pollutants

Such status would form the basis over which the anticipated impacts from proposed installation are super-imposed to derive final impacts on environment.

3.4.1 Methodology for Baseline Conventional Pollutants Status

The conventional parameters in air, water, land were monitored in the study zone as per the guidelines of CPCB / MPCB.

It is mentioned that there is no possibility of emission of conventional air pollutants viz. dust, SO_2 and NO_x during operation phase of the nuclear power plants. However, during operation of emergency power supply diesel generators for testing, operation of auxiliary boilers etc. conventional pollutants may be generated. Since the operation of these equipments is for a very short period and the exhaust of these are led through chimneys as specified by MPCB, these pollutants do not assume any significance. Only during construction phase of the nuclear power plant, these pollutants will be generated in a limited manner. Data about the prevailing background levels of Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM) and gaseous pollutants in the vicinity of nuclear power plant were collected to know the prevailing levels and for future reference.

Similarly, nuclear power plants do not generate liquid effluent having conventional pollutants, except that domestic waste water, which are treated as per the norms of State Pollution Control Board. However, as per the guidelines of MoEF, parametric values for water environment which includes surface water, ground water and sea water are monitored to establish the baseline status. Similarly, the baseline status of land, noise and socio –economic environment was established as per the norms of CPCB / MPCB / MoEF. The baseline study was carried out in summer (March to May 2006), post-monsoon (October, 2006), and winter (January, 2006).

3.4.2 Methodology for Baseline Radiological Status

The radioactive emissions / effluents / solid waste like any other pollutants once released to the environment within prescribed limits of AERB undergo dilution, dispersion and deposition process depending on the prevailing conditions and surrounding population may receive external and internal radiation doses through different routes (please refer **Fig. 3.4.1** and **Fig. 3.4.2**). The extent of the radiological impact depends on the physico-chemical properties of radioactive isotopes released into the environment, their concentrations and the type of radionuclide.

It is worth to note that there are natural radiation levels, which may vary from place to place and the local population receives a radiation dose due to the prevailing natural radiological conditions. Therefore, to know the natural existing radiation levels and radiation dose to the public through all the routes, pre operational radiation survey is conducted to establish the natural radiation levels over. This is essentially to estabilish a base line status and to note any significant variation during operating life of the plant.

Accordingly, a pre-operational baseline radiological status around the JNPP site has been carried out by Health Physics Division (HPD), BARC, Department of Atomic Energy between 10/4/2006 – 18/4/2006 & between 29/10/06 – 04/11/06. During this study, the external gamma radiation levels (in the air) & indirect radiation exposure (in the various components of environment) were measured at various locations within a radial distance of 30 km from the proposed site.

3.4.2.1 Components Selected For Sampling

Different types of environmental samples were collected from the terrestrial and aquatic environment of JNPP to estimate the levels of various radionuclides of natural (U-238, Th-232 and K-40) and fallout (Sr-90 and Cs-137) origin. **Table 3.4.1** and **Fig. 3.4.3** and **Fig 3.4.4** gives the details of samples collected during the surveillance from 43 locations. 20 to 100 liter fresh water and seawater, 1 kg soil/sediment, cereals and organism samples, 2 to 5 kg fresh vegetation samples were collected. These samples were processed and analysed by gamma spectrometry and radiochemical separation as per the prescribed standard procedures given in ERL/HPD Procedure Manual, 1998.

Additionally, the site specific items such as the Alphenzo (Happus) mango, which grow in this region (a few mango plantations are within 0-2 km), rice and ragi grown are consumed locally. Coconut, Betel nut, Cashew nut, Jackfruit and Cocum which are the other major crops from this region were selected for monitoring the radioactivity levels. In coastal area, fishing is carried out and the major fishing port is located at Sakhri Nate (within 5 km). There are many prawn breeding farms in the creeks towards south east, where small dams are made for the same purpose. Bricks locally known as “Chira” are made from laterite rocks are mostly used to build the houses in the region.

3.4.2.2 Radiation Monitoring Instruments

Radiation measurements were made in the study zone during the period 11/04/2006 – 18/4/2006 using FIELDSPEC Gamma radiation Monitor, Spectrometer & BICRON ANALYST and readings were taken 1m above ground level at least for 1 min at two-three places for one location. Range was taken for non-steady readings.

Instruments Used during the Survey

(i) Gamma Radiation Monitor & Spectrometer
Model: Field SPEC
S. No.: 02F3/887
Make: Target, Germany
Detector: Scintillator (NaI (Tl)1”x2”), G.M. Tube

(ii) Name: BICRON ANALYST
Modal: micro analyst
S. No.: B007Q
Make: Harshaw Bicron
Detector: Scintillator (NaI(Tl)

Calibration

Isotopic calibration performed with a J. L. Shepherd & Associates Model 28-6A calibrator, S/N 10081 and is traceable to NIST on 5-16-94 for various dose rates.

3.4.2.3 Results of Baseline Radiological Survey

Table 3.4.2 gives the physicochemical parameters analysed including uranium levels in various surface and ground water samples collected from different locations around JNPP. WTW make pH meter, and Laser based fluorimeter were used to analyse the water samples. The trace and major elements were estimated by using GBC make Atomic Absorption Spectrometer. The levels of these parameters are in the normal range.

The results of the radiological survey are presented in the various environmental components as suitable in the sections those follow and also the full report is enclosed as **Annexure-IX(a)** in **Volume II** of this report.

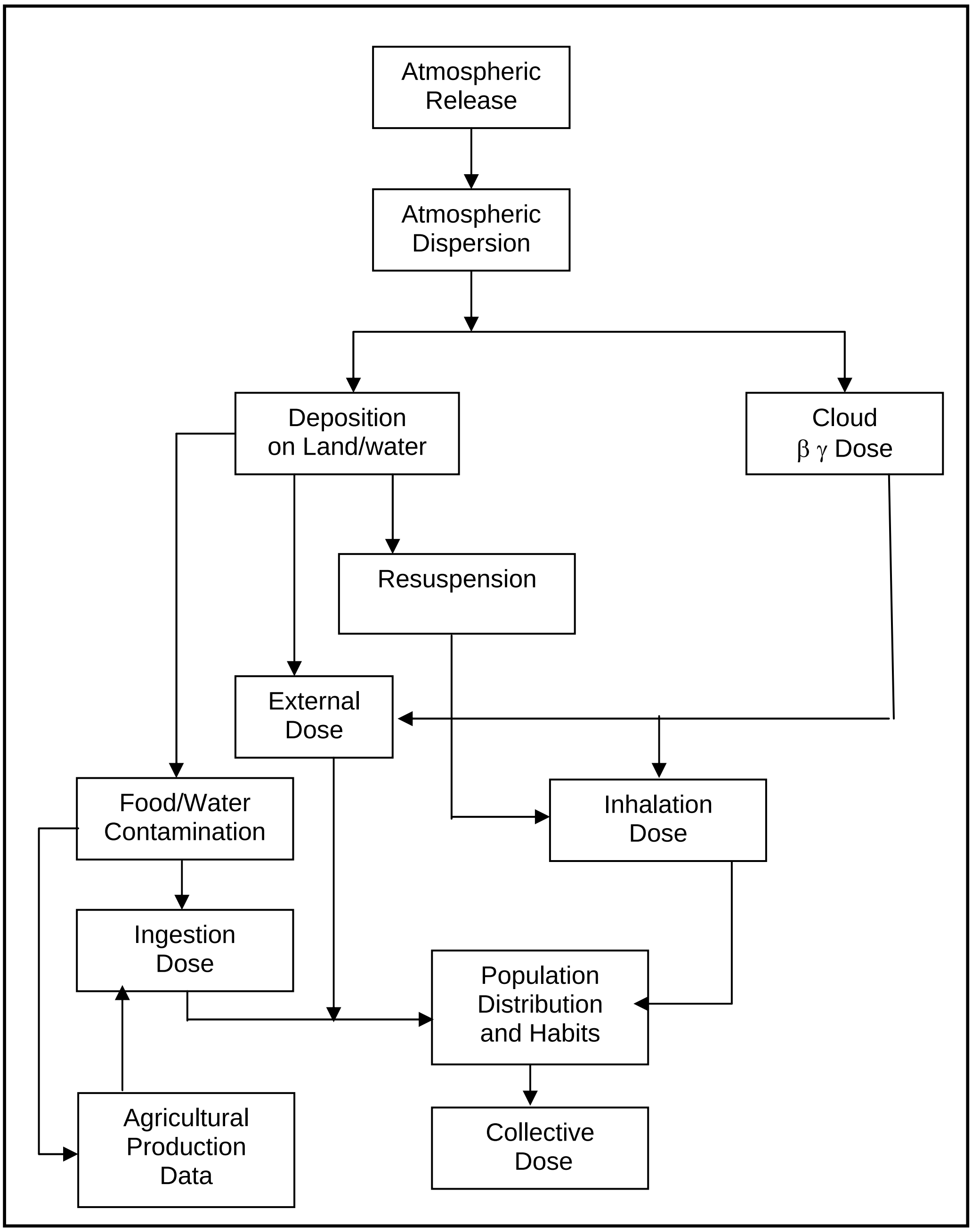


Fig. 3.4.1: Exposure Pathways for Atmospheric Releases from NPP

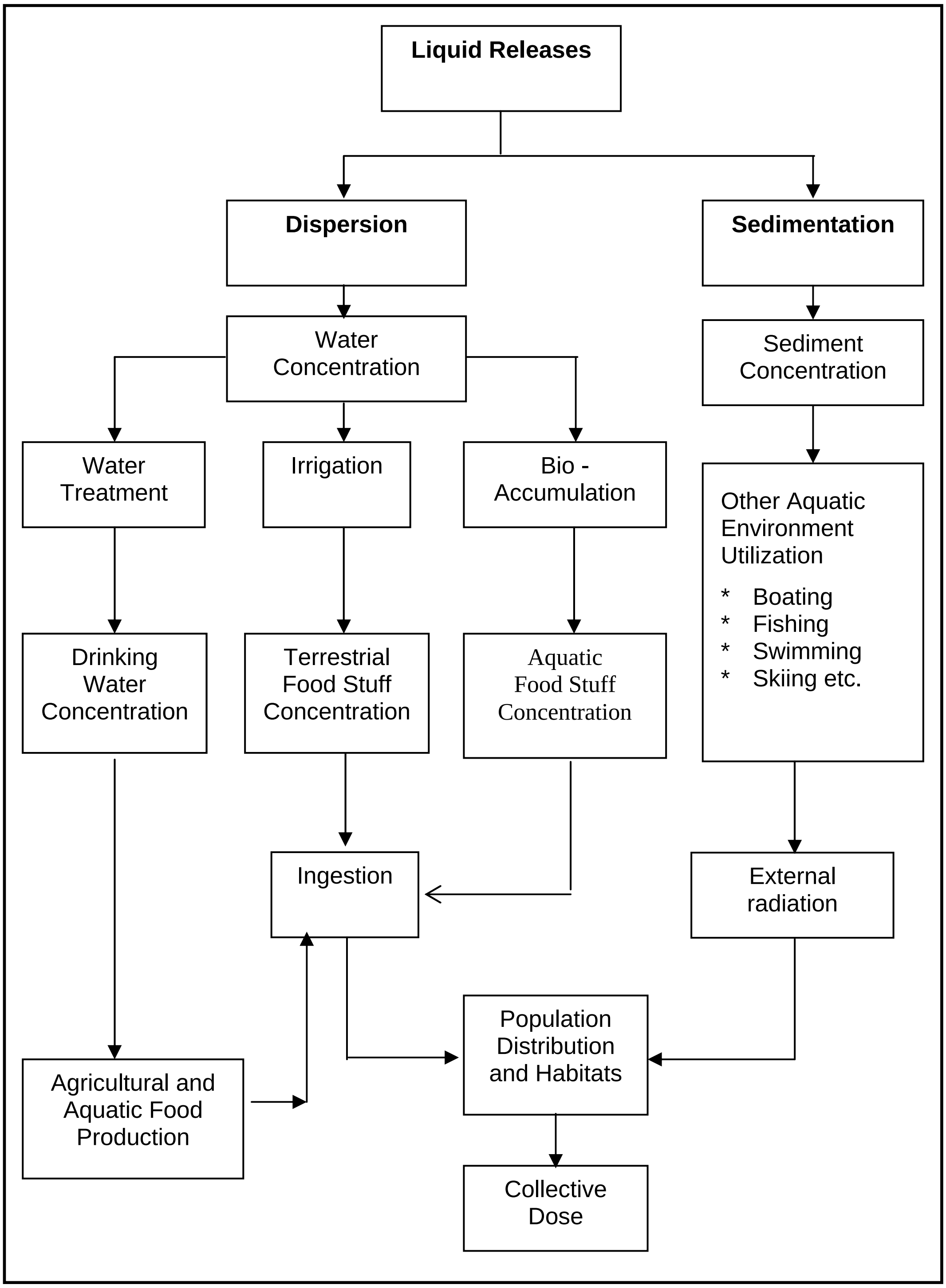


Fig. 3.4.2: Exposure Pathways for Releases by NPP to Aquatic Environment

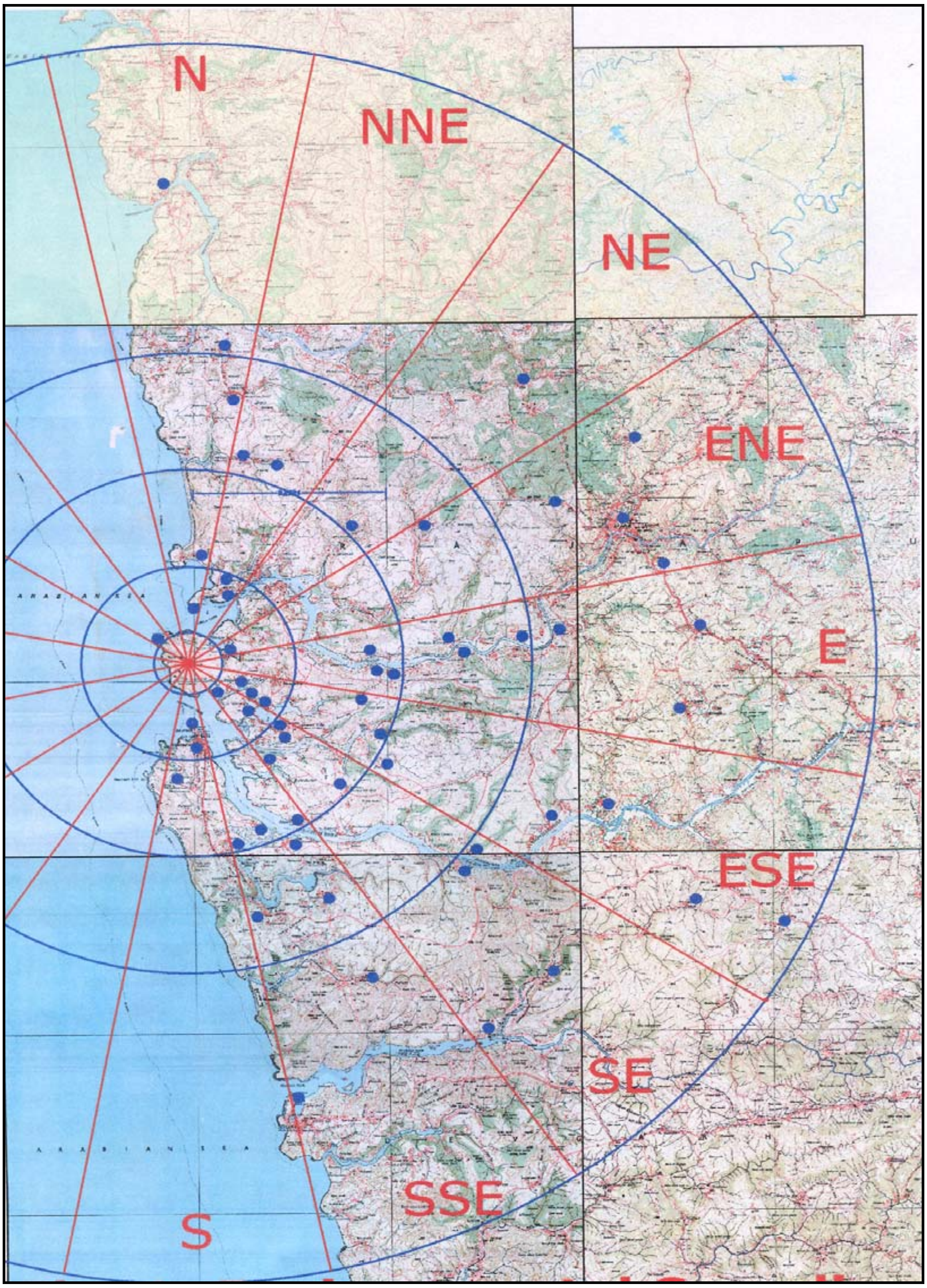


Fig. 3.4.3: View of Environmental Sampling Locations around Jaitapur Site for Baseline Radiological Survey

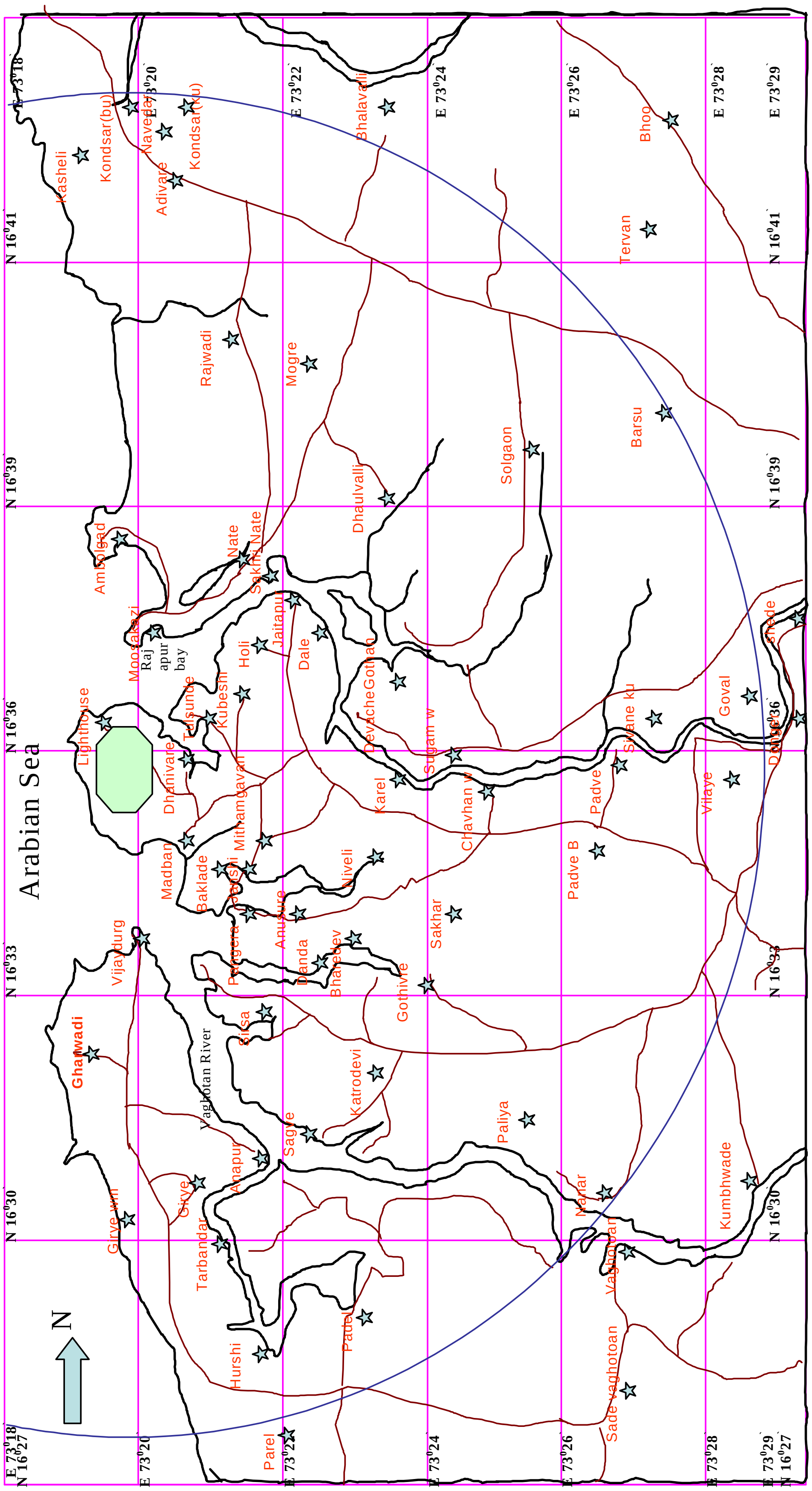


Fig. 3.4.4: Sampling Locations for Radiological Survey (October 29, 2006 to November 06, 2006)

Table 3.4.1

Details of Samples Collected from Different Locations for Baseline Radiological Survey (October-November 2006)

Sr. No.	Location	Distance (km)	Date of Collection	Type of samples
1.	Dhanivare	0-2	30/10/2006	Coconut, Rice, Soil, Rock, WW
2.	Kuveshi	0-2	30/10/2006	Banana Leaf, BW
3.	Light House (O)	0-2	30/10/2006	Grass, BW, SW , Soil, Shore Sand
4.	Madban	0-2	30/10/2006	Arvi Leaf, Rice, Pumpkin Red , Areca Nut, WW, SW, Shore Sand
5.	Tulsunde	0-2	30/10/2006	Fish (Pomfret, Vale)
6.	Ambolgad	2-5	02/11/2006	Coconut, WW
7.	Janshi	2-5	30/10/2006	Soil, WW
8.	MithGavane	2-5	30/10/2006	Pumpkin White, Soil
9.	Moosssakazi	2-5	02/11/2006	Green Algae, Grass, Shore Sand , Soil, SW
10.	Vijaydurg	2-5	01/11/2006	Grass, BW, SW , Soil
11.	Ansure	5-10	30/10/2006	Soil, WW
12.	Chavan Wadi	5-10	30/10/2006	Banana Leaf, RW, Rice
13.	Dande Wadi(T)	5-10	30/10/2006	Grass, Soil,
14.	Dhaul Valli	5-10	02/11/2006	WW
15.	Girye	5-10	01/11/2006	Raggi
16.	Jaitapur	5-10	30/10/2006	Pumpkin Red, SW
17.	Nate	5-10	02/11/2006	Fish (Bangdi, Kate)
18.	Neveli	5-10	30/10/2006	Soil
19.	Sirse	5-10	31/10/2006	Banana Leaf, Banana
20.	Sugamwadi	5-10	31/10/2006	Arvi Leaf, Smooth Guard
21.	Goval	10-16	31/10/2006	Soil, RW
22.	Hurshe	10-16	01/11/2006	Soil
23.	Nanar Wadi	10-16	31/10/2006	Rock
24.	Shivne	10-16	31/10/2006	Soil
25.	Solgaon	10-16	02/11/2006	Guava, Udad Dal, WW , Soil
26.	Thakurwad	10-16	01/11/2006	RW
27.	Tirlot	10-16	01/11/2006	Soil
28.	Adivare	16-32	02/11/2006	Padval
29.	Baparde	16-32	01/11/2006	Soil
30.	Devgarh	16-32	01/11/2006	Shore Sand, SW, Fish(Kap, Leapa)
31.	Hathivale	16-32	03/11/2006	Milk
32.	Juvathi	16-32	30/10/2006	Grass (Rice), Rice, Husk (Rice) , Soil, WW
33.	Kumbhe Wadi	16-32	31/10/2006	Raw Pappya, Kakdi, Soil , River Water

Sr. No.	Location	Distance (km)	Date of Collection	Type of samples
34.	Mond	16-32	01/11/2006	Prawn
35.	Nadan	16-32	01/11/2006	Grass, Soil
36.	Pata Goval	16-32	01/11/2006	Sooran
37.	Patharde	16-32	02/11/2006	Soil
38.	Pooran Garah	16-32	02/11/2006	SW
39.	Rajapur	16-32	03/11/2006	RW
40.	Rantale	16-32	02/11/2006	Rock
41.	Shede	16-32	31/10/2006	Soil
42.	Taral	16-32	31/10/2006	Raggi, Smooth Guard
43.	Unhale	16-32	03/11/2006	Hot Water Stream

Source: Health Physics Division, BARC
Note SW-Sea water, RW-River water, BW-Borewell water, WW-Well water

Table 3.4.2

Physicochemical Parameters of Water Samples from JNPP Site during Radiological Survey (October to November 2006)

Sr. No.	Location	Type	DOC	pH	Na	K	Ca	Mg	Sr	Fe	Zn	U
					ppm							Ppb
1	Hathivale	BW	03/11/2006	6.43	6.15	0.19	2.58	1.99	0.02	0.07	1.3	0.2
2	Kuveshi	BW	30/10/2006	6.97	4.45	1.18	1.93	1.52	0.15	<0.01	0.07	0.5
3	Light House	BW	30/10/2006	6.49	10.8	0.33	4.12	1.46	2.09	0.07	0.05	0.45
4	Rajapur	BW	02/11/2006	8.27	20	0.95	79	6.84	0.17	0.08	0.39	0.23
5	Sivne	BW	31/10/2006	6.9	4.73	0.12	1.55	1.27	<0.01	0.13	0.32	0.41
6	Vijaydurg	BW	01/11/2006	6.91	12.7	1.04	9.4	2.89	<0.01	0.01	5.38	0.25
7	Unhale	HWS	03/11/2006	8.11	85.5	8.9	9.3	9.13	0.54	0.02	0.06	0.24
8	Goval	RW	31/10/2006	6.93	4.8	0.05	1.04	0.55	<0.01	0.09	0.06	0.4
9	Goval	RW	31/10/2006	7.56	35.4	1.75	7.35	6.13	0.04	0.07	0.26	0.21
10	Kharepatan	RW	03/11/2006	7.28	4.92	0.67	5.69	3.43	0.07	0.18	0.15	0.34
11	Kumbh Wade	RW	31/10/2006	7.41	2.63	9.8	21.3	47.7	<0.01	0.04	0.11	0.53
12	Rajapur	RW	03/11/2006	7.43	9.54	0.68	6.59	3.92	0.08	0.04	0.26	0.24
13	Hathivale	SW	03/11/2006	7.46	8.36	0.47	22.1	12.4	0.09	0.02	0.67	0.35
14	Sugamwadi	SW	31/10/2006	7.14	4.46	0.14	3.3	1.59	<0.01	0.03	0.11	0.32
15	Adivare	WW	01/11/2006	7.3	9.36	0.56	2.7	3.85	0.06	0.09	0.21	0.4
16	Ambolgad	WW	02/11/2006	7.43	23.7	4.38	9.75	7.1	<0.01	0.06	0.33	0.4
17	Devachegothan	WW	02/11/2006	6.65	5.37	0.21	1.42	1.67	<0.01	<0.01	0.14	0.24
18	Devgarah	WW	01/11/2006	7.1	10.8	2.58	10.2	3.88	0.01	0.05	0.22	0.26
19	Dhanivare	WW	30/10/2006	6.89	6.39	0.24	2.31	1.93	<0.01	0.02	0.06	0.4
20	Dhaul Valli	WW	02/11/2006	6.61	5.74	0.1	1.82	1.06	<0.01	0.09	0.07	0.4
21	Goval	WW	31/10/2006	7.19	6.43	1.16	2.79	1.88	<0.01	0.11	0.48	0.36
22	Janshi	WW	30/10/2006	6.67	27.1	0.8	3.01	4.5	0.02	0.03	0.4	0.7
23	Juathi	WW	31/10/2006	7.28	8.19	3.76	4.11	2.75	<0.01	0.1	0.28	0.4
24	Madban	WW	30/10/2006	6.69	4.08	0.12	2.11	1.06	<0.01	<0.01	0.14	0.6
25	Mogre	WW	02/11/2006	5.72	7.12	0.16	0.49	1.7	<0.01	<0.01	0.08	0.4
26	Mond	WW	01/11/2006	7.69	15.2	4.21	6.69	5.35	<0.01	<0.01	0.09	0.3
27	Padel	WW	01/11/2006	7.26	7.95	0.47	1.57	3.06	0.07	0.1	0.31	0.34
28	Pathode	WW	02/11/2006	8.24	26.9	1.01	113	3.28	0.09	0.05	0.09	0.21
29	Rajwadi	WW	02/11/2006	7.96	7.78	0.12	0.76	1.34	0.03	0.12	0.14	0.4
30	Sol Gaon	WW	02/11/2006	6.75	6.26	3.64	3.54	2.73	0.15	0.05	0.22	0.2
31	Tirlot	WW	01/11/2006	6.57	6.36	0.06	1.13	2.65	0.02	<0.01	0.89	0.35

WW-Well water, SW-STREAM WATER,RW-River Water, BW-Bore well water, HWS-Hot water stream ND-not detected, NA-not analysed, DOC : day of collection

Source: Health Physics Division, BARC

3.5 Air Environment

3.5.1 Baseline Status of Air Environment With Respect to Conventional Pollutants

The ambient air quality depends upon the emission scenario, meteorological conditions and the background concentrations of the pollutants. The study on baseline ambient air quality status in the impact zone of the project is an essential and primary requirement for assessing the impacts on air environment due to proposed developmental activity. The study is necessary to identify environmentally significant issues prior to initiation of the proposed activity as well as to enumerate the potential critical environmental changes likely to occur when the project is commissioned. The environmental attributes and frequency of monitoring are presented in **Table 3.5.1**.

The baseline status of air environment includes identification of specific air pollutants expected to have significant impacts and assessing their existing levels in ambient air within the impact zone. The baseline status of air environment with respect to the identified conventional air pollutants can be established through air quality monitoring programme using methodically designed air monitoring network.

Micro-meteorological data collection is an indispensable part of any air pollution study. The meteorological data collected during ambient air quality monitoring is used for interpretation of baseline status and to simulate the meteorological conditions for prediction of impacts. The baseline studies for air environment within the impact zone were carried out through reconnaissance followed by ambient air quality monitoring programme and micro-meteorological study.

3.5.1.1 Design of Ambient Air Quality Monitoring Network

The studies on air environment consist of assessment of existing status of ambient air quality and collection of meteorological data to delineate the baseline status of the region. Representative selection of sampling locations is primarily guided by the topography and micro-meteorology of the region. A methodically designed ambient air quality-monitoring (AAQM) network covering 14 sampling locations was designed using the following criteria:

- Persistence of wind direction and speed
- Representation of regional background

The selected sampling locations are shown in **Fig 3.5.1**. The directions and distances of these locations with respect to project site are reported in **Table 3.5.3**. Various conventional pollutants such as Suspended Particulate Matter (SPM), Particulate Matter (PM_{10}), Particulate Matter ($PM_{2.5}$), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_x) were identified as significant parameters for ambient air quality monitoring. The standard methods used for sampling and analysis of different pollutants are summarized in **Table 3.5.2**.

3.5.1.2 Meteorology

The site is in the costal area and hence wind speeds are good. Mean wind speeds as measured from 1971 to 2003 at Ratnagiri about 40 km away from the site vary from 0 to 19 km/hr. Topography around the site is totally plain. In view of the plain topography associated with good wind speeds, dispersal of gaseous releases will be good. The predominant wind directions, as recorded at Ratnagiri from 1971 - 2003 are from W, E, NW and SW with their frequencies being 29%, 18%, 19.5% and 10.5% respectively. The calm conditions in this area are about 5% of the time, which is extremely good.

The baseline annual minimum and maximum values of meteorological data at Ratnagiri (1971- 2003) are as follows:

Year	Mean Temperature (°C)		Lowest Minimum Temperature (°C)	Highest Maximum Temperature (°C)	Relative Humidity (%)		Annual Rainfall (mm)
	Lowest	Highest			Minimum	Maximum	
1971-1980	18.0-27.6	28.2-34.3	14.8-25.7	29.5-37.9	52-92	42-92	1835.6-3747.6
1981-1990	17.7-27.4	27.9-34.7	14.0-26.1	29.0-37.8	51-90	48.95	1714.5-3880.5
1991-2000	17.6-27.7	28.2-34.2	11.5-24.5	29.1-39.6	50-89	42-91	2550.6-3836.7
2001-2003	14.0-23.7	28.3-34.9	14.0-23.7	29.9-39.4	48-88	53-91	2465.6-2923.2

Source: IMD, Ratnagiri

3.5.1.3 Micro-meteorology

The micro-meteorological conditions at the proposed project site regulate the transport and diffusion of air pollutants released into the atmosphere. The principal meteorological variables are horizontal convective transport (average wind speed and direction), vertical convective transport (atmospheric stability, mixing height) and topography of the area. The data on surface meteorological parameters (wind speed and direction) in the study area were collected using portable weather monitoring station. The sensors of this equipment were kept at about 10 m above ground level with free exposure to atmosphere. In addition, temperature and percentage humidity were also recorded simultaneously using a thermo hygrometer.

Based on the meteorological data collected during three seasons, viz. summer 2006, post-monsoon 2006 and winter 2006-07 seasons, wind rose diagrams have been prepared and are presented in **Fig 3.5.2**, **3.5.3** & **3.5.4** respectively. The pre-dominant wind directions as recorded at site in summer season were from North-West and West, and their frequencies were 54.2% and 16.7% respectively. There was no calm condition during the study period in this area. During post-monsoon season pre-dominant wind directions were from South, South-West and West and their frequencies were 16.7%, 25% and 16.7% respectively. During winter pre-dominant wind directions were from North-West and North, and their frequencies were 16.7%, 25% respectively. The calm conditions were 8.3% and 16.7% in post monsoon and winter respectively.

It is mentioned that meteorological measurements at the proposed site are also carried out by meteorological laboratory set up at the site by Health Physics Division (HPD), BARC. The meteorological measurements carried out by HPD, BARC are presented as 24 -hourly monthly average windrose for the period September 2006 to January, 2007 as presented in **Volume –II, Annexure-IX(a)** and for the period from 1999 to 2003 in **Volume –II, Annexure-IX(b)** and for the period 1969 to 2003 in **Volume –II, Annexure-IX(c)**. However, it should be noted that the data presented as in the above paragraphs are for seasonal average for summer, post monsoon and winter seasons.

3.5.1.4 Ambient Air Quality Survey

The ambient air quality monitoring was carried out for a period of two months each during summer (March to May 2006), post-monsoon (October, 2006) and winter (January, 2006) seasons to assess the ambient air quality status in the region. At all these sampling stations SPM, PM_{10} and $PM_{2.5}$ as well as gaseous pollutants like SO_2 and NO_x were monitored on 24 hourly basis. The data collected was subjected to statistical analysis to arrive at various percentile values. The results were also compared with ambient air quality standards (**Annexure I**, **Vol. II**). the detail raw data is given in **Annexure XVII** of **Volume II**.

3.5.1.5 Baseline Status

The ambient air quality status for fourteen sampling stations along with statistical interpretation during three seasons is reported in **Tables 3.5.4** to **3.5.21**. They represent the cross sectional distribution of baseline air quality status over the study area.

3.5.1.5.1 Arithmetic Mean Values of Air Pollutants

In summer season, the arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.4**) at all these stations ranged as follows:

SPM = 39-150 μg/m³
PM_{10}=14-66 μg/m³
$PM_{2.5}$=6-30 μg/m³
SO_2 = 3-5 μg/m³
NO_x = 4-45 μg/m³

In post monsoon season, the arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.5**) at all these stations ranged as follows:

SPM = 48-96 μg/m³
PM_{10} = 16-41 μg/m³
$PM_{2.5}$ = 4-19 μg/m³
SO_2 = 3-7 μg/m³
NO_x = 5-25 μg/m³

In winter season, arithmetic mean of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_x (**Table 3.5.6**) at all these stations ranged between as follows:

SPM = 73-140 μg/m³
PM_{10}= 17-60 μg/m³
$PM_{2.5}$= 8-27 μg/m³
SO_2 = 4-9 μg/m³
NO_x = 6-33 μg/m³

Average values of PM_{10} and $PM_{2.5}$ are below stipulated standards of 100 μg/m^3 and 60 μg/m^3 for industrial, residential, rural and other areas respectively, (**Annexure I**, **Vol. II**). There is no other source of dust except local vehicular activities, and natural dust getting air borne due to blowing wind.

3.5.1.5.2 The 98th Percentile Values of Air Pollutants

The 98[th] percentile values of 24 hourly concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2 and NOx along with minimum and maximum concentrations at all these stations are presented in the **Table 3.5.7 – 3.5.21**.

In summer season, the 98[th] percentile values of SPM (**Table 3.5.7**), PM_{10} (**Table 3.5.10**), $PM_{2.5}$ (**Table 3.5.13**), SO_2 (**Table 3.5.16**) and NO_x (**Table 3.5.19**) ranged as follows:

SPM = 75-198 μg/m3
PM_{10}= 26-108 μg/m³
$PM_{2.5}$= 12-49 μg/m³
SO_2 = 3-8 μg/m3
NO_x = 4-65 μg/m3

In post-monsoon season the 98[th] percentile values of SPM (**Table 3.5.8**), PM_{10} (**Table 3.5.11**), $PM_{2.5}$ (**Table 3.5.14**), SO_2 (**Table 3.5.17)** and NO_x (**Table 3.5.20)** ranged as follows:

SPM = 59-118 μg/m3
PM_{10}= 20-47 μg/m³
$PM_{2.5}$= 9-21 μg/m³
SO_2 = 4 -11μg/m3
NO_x = 6-36 μg/m3

In winter season the 98[th] percentile values of SPM (**Table 3.5.9**), PM_{10} (**Table 3.5.12**), $PM_{2.5}$ (**Table 3.5.15**),SO_2 (**Table 3.5.18)** and NO_x (**Table 3.5.21)** ranged as follows:

SPM = 78 -180 μg/m3
PM_{10}= 27-88 μg/m³
$PM_{2.5}$= 12-40 μg/m³
SO_2 = 5 -14 μg/m3
NO_x = 8-55 μg/m3

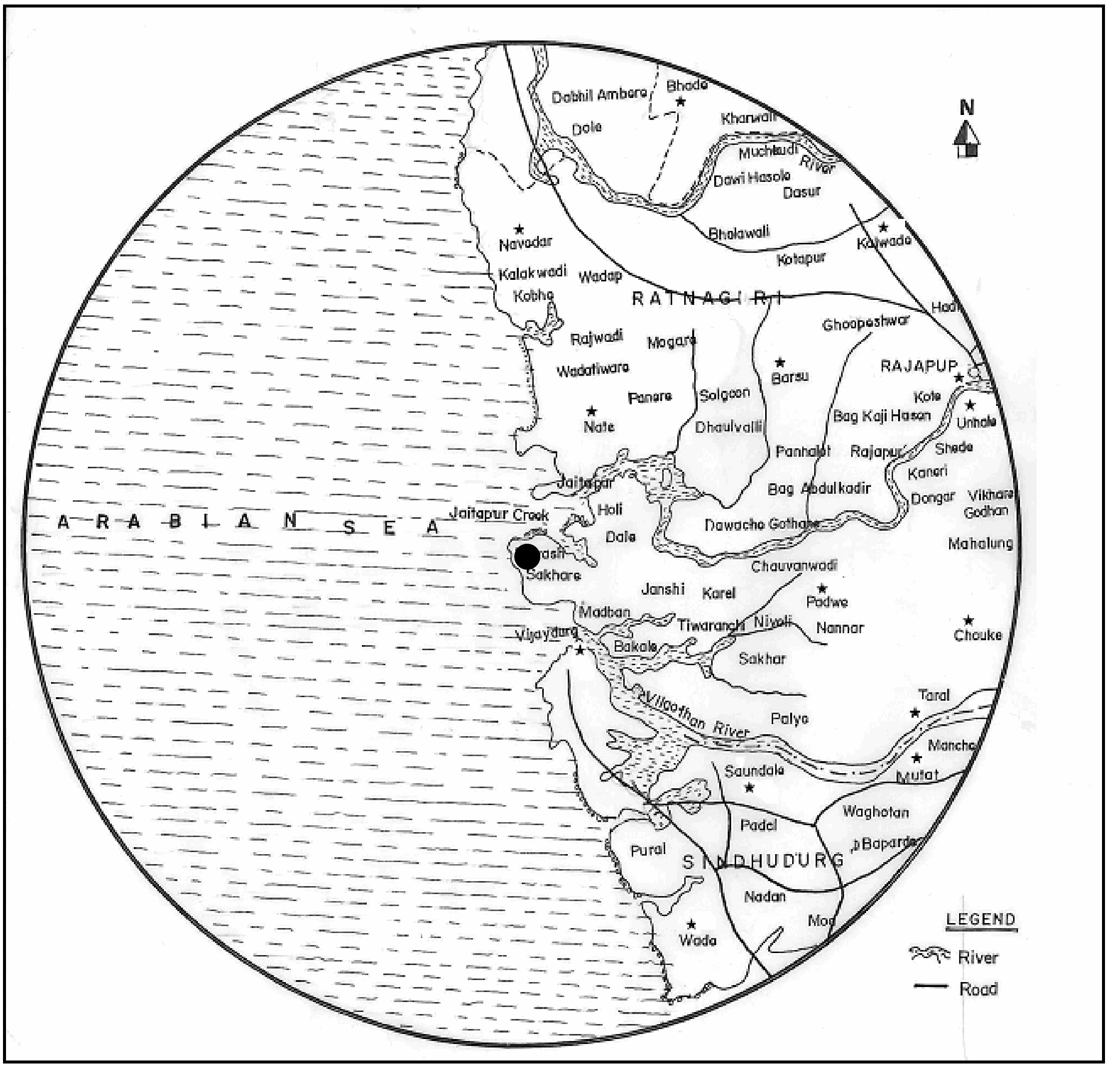
PM_{10}, $PM_{2.5}$, SO_2 and NO_x concentrations were observed to be well below the stipulated National Ambient Air Quality Standards of MoEF for industrial, residential, rural and other areas (November, 2009). This is due to less vehicular transport and absence of any industry in study area.

3.5.2 Baseline Status of Natural Radiation Levels

Tables 2 (a to **d)**, as appended in **Volume II, Annexure-IX(a)** presents the levels of natural gamma radiation exposure at various villages which were easily accessible during above survey within 0-5 km., 5-10 km, 10-15 km and 15-30 km respectively from the site.

Radiation levels within 0-2 km range were observed between 20-120 nSv/h with a maximum at Light house, Kuveshi and Dhanivare village. At 2-5 km, the range was between 40-200 nSv/h, with a maximum level being observed at Vijaydurg (top). At 5-10 km, it ranged between 60-200 nSv/h, the maximum being at Niveli (chira digging area). At 10-15 km, the levels were between <10-150 nSv/h and the maximum were observed at Khondsar (ku). Beyond 15kms upto 30 km, the radiation levels ranged between 20-150 nSv/h.

The results of the present observations of radiation levels are comparable to the preliminary radiation surveillance around the site carried out during April 2006. The levels are normal background and are comparable to those observed around the Mumbai region, which are in the range of 40-110 nSv/h.



★ Sampling Location
● Project Site

Fig. 3.5.1: Sampling Locations for Air Quality Monitoring in the Study Area

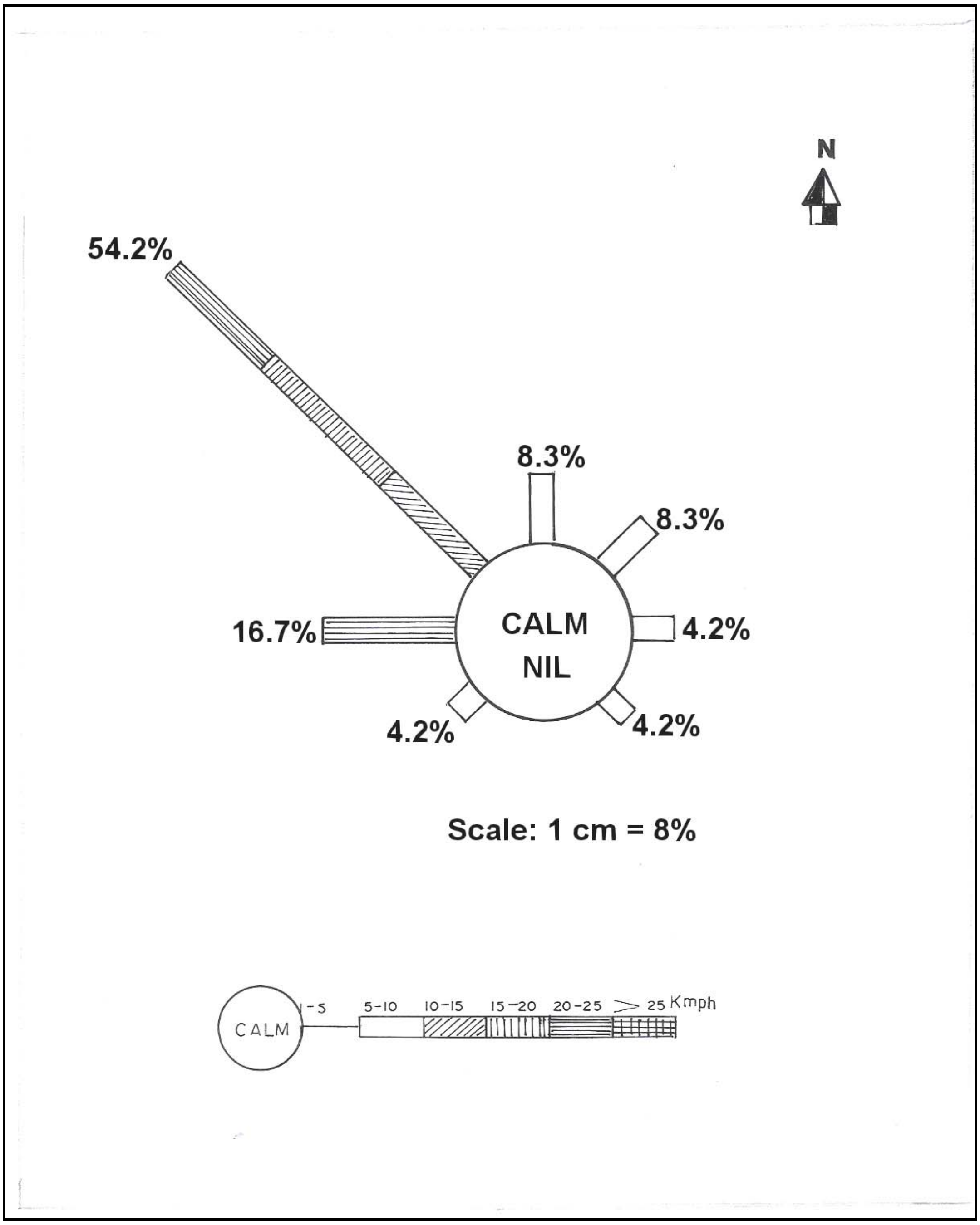


Fig. 3.5.2: Twenty Four Hourly Windrose Diagram for Summer, 2006

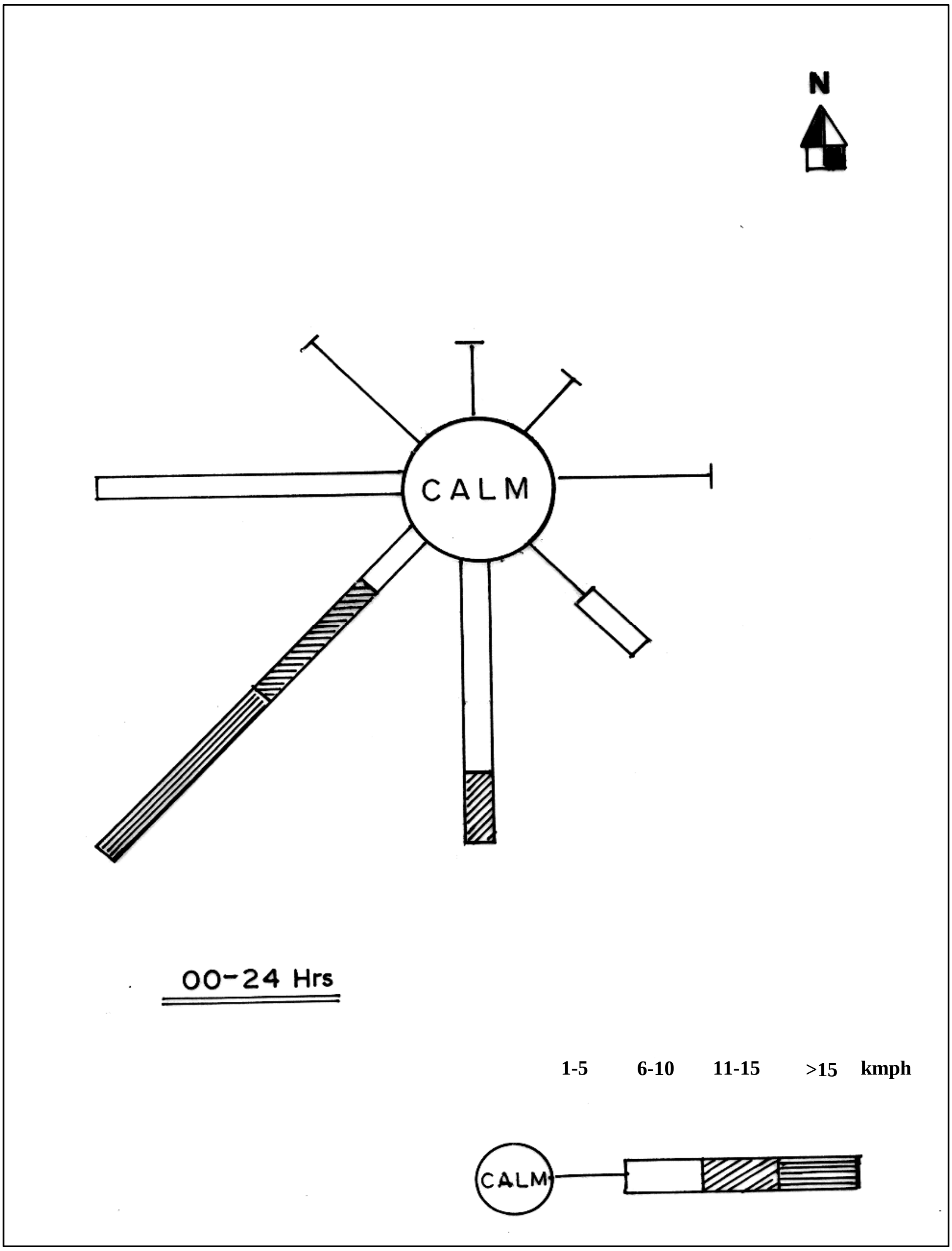


Fig. 3.5.3: Twenty Four Hourly Windrose Diagram for Post-Monsoon, 2006

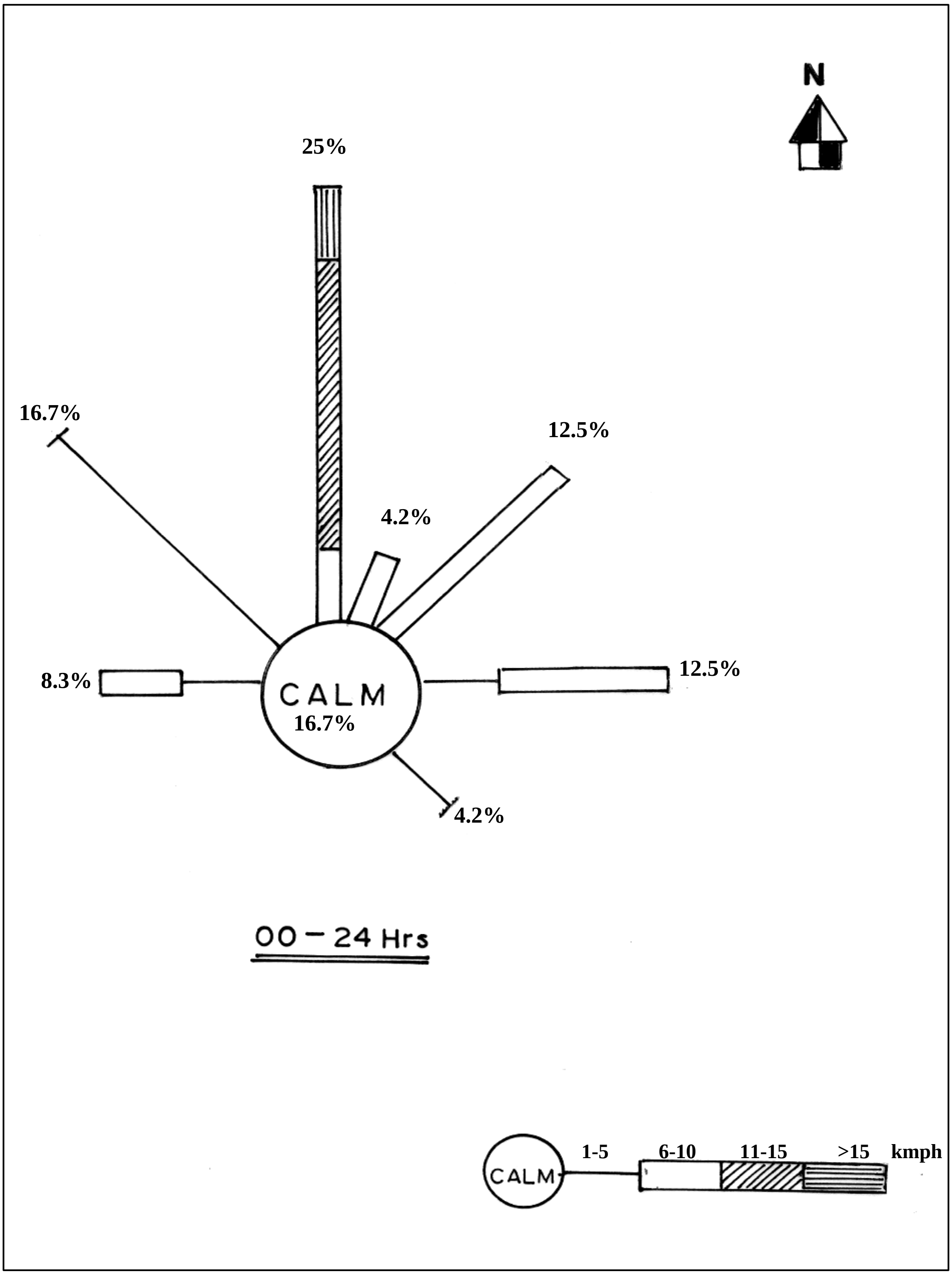


Fig. 3.5.4: Twenty Four Hourly Windrose Diagram for Winter, 2006-07

Table 3.5.1

Environmental Attributes and Frequency of Monitoring

Sr. No.	Attribute	Parameters	No. of Sampling Locations	Frequency of Monitoring / Data Collection
1	Ambient air quality	SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO	14	24 hourly samples uring study period of winter, summer and post monsoon seasons
2	Meteorology	Wind speed and direction, temperature, relative humidity and rainfall. Mixing Height	1	Historical data has been collected for IMD, for corroborating the data and planning the monitoring network for three seasons.
3	Surface water quality	Physical, chemical bacteriological and biological parameters.	9	Once during study period of winter, summer and post monsoon seasons.
4	Groundwater quality	Physical, chemical bacteriological and biological parameters.	9	Once during study period of winter, summer and post monsoon seasons
5	Ecology	Existing flora and fauna.	16	Through field visit during the study period and substantiated through secondary sources.
6	Noise levels	Noise levels in dBA	22	Hourly observation once during the summer season
7	Soil characteristics	Physical, chemical and biological parameters to assess agricultural and afforestation potential.	8	Sub surface composite samples collected once during the study period.
8	Land use / Land Cover	Land use for different land use classifications.	Winter season	Land use / Land Cover Analysis using satellite imaging and GIS Technique
9	Socio-economic Environment	Socio-economic characteristics, labour force characteristics, population statistics existing amenities in the study area and quality of life.	Study area & 61 stations for survey	Based on field surveys and data collected from secondary sources

Table 3.5.2

Techniques Used for Ambient Air Quality Monitoring

Sr. No.	Parameter	Technique	Technical Protocol	Minimum Detectable Limit (μg/m^3)
1	Suspended Particulate Matter	High Volume Sampler (Gravimetric method)	IS-5182 & CPCB	3.0
2	Respirable Particulate Matter	Respirable Dust Sampler (Gravimetric method)	IS-5182 & CPCB	3.0
3	Sulphur dioxide	Modified West and Gaeke Method	IS-5182 & CPCB	3.0
4	Nitrogen Oxide	Jacob & Hochheiser Method	IS-5182 & CPCB	3.0

Table 3.5.3

Ambient Air Quality Monitoring Stations (2006-07)

Sr. No.	Sampling Location	Direction	Approximate Aerial Distance (km)	Sampling Height above Ground Level (m)	Monitoring Season (S/ PM/ W)
		With respect to Proposed Project Site			
1.	Project site	-	0	2	S, PM, W
2.	Vijaydurg	SSE	6	2	S, PM, W
3.	Nate	NNE	8	5	S, PM, W
4.	Padwe	E	15	2	S, PM, W
5.	Barsu	NE	16	3	S, PM, W
6.	Navedar	N	16	2	S, PM, W
7.	Soundale	SE	17	2	S, PM, W
8.	Wada	SSE	21	3	S, PM, W
9.	Taral	ESE	22	2	PM, W
10.	Chouke	E	23	2	S, PM, W
11.	Rajapur	ENE	23	2	PM, W
12.	Unhale	ENE	23	2	S, PM, W
13.	Kelwade	NE	24	2	S, PM, W
14.	Bhade	NNE	24	2	S, PM, W

Table 3.5.4

Ambient Air Quality Status (Summer, 2006)

Unit: $\mu g/m^3$ 24 hourly average

Sr. No.	Sampling Location	24 Hrs. Average (Range)				
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_2
1	Project Site	72 (49-98)	26 (17-36)	12 (8-16)	3 (3-3)	4 (3-4)
2	Vijaydurg	97 (52-117)	46 (23-61)	21 (10-27)	3 (3-3)	29 (23-39)
3	Nate	110 (49-144)	44 (11-74)	20 (5-33)	3 (3-3)	18 (11-26)
4	Padwe	150 (80-198)	48 (17-79)	22 (8-35)	5 (3-8)	28 (4-57)
5	Barsu	132 (55-187)	48 (14-97)	22 (6-44)	3 (3-3)	4 (3-5)
6	Navedar	122 (41-191)	47 (18-76)	21 (8-34)	3 (3-4)	12 (8-16)
7	Soundale	120 (26-183)	66 (11-95)	30 (5-43)	4 (3-5)	44 (21-64)
8	Wada	138 (93-195)	64 (48-87)	29 (22-39)	5 (3-6)	45 (22-66)
9	Taral	120 (26-183)	66 (11-94)	30 (5-42)	5 (3-6)	44 (21-64)
10	Chouke	141 (98-187)	66 (36-87)	30 (16-39)	3 (3-4)	21 (16-30)
11	Rajapur	124 (75-190)	54 (33-78)	24 (15-35)	3 (3-3)	21 (12-26)
12	Unhale	72 (49-98)	26 (17-36)	12 (8-16)	3 (3-3)	4 (3-4)
13	Kelwade	124 (75-190)	54 (33-78)	24 (15-35)	3 (3-3)	21 (12-26)
14	Bhade	39 (13-76)	14 (6-26)	6 (3-12)	3 (3-3)	13 (8-18)

Note: Figures in the parenthesis indicate range of values

Table 3.5.5

Ambient Air Quality Status (Post monsoon, 2006)

Unit: $\mu g/m^3$ 24 hourly average

Sr. No.	Sampling Location	24 Hrs. Average (Range)				
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_2
1	Project Site	64 (14-115)	23 (6-43)	10 (8-19)	5 (3-7)	6 (3-10)
2	Vijaydurg	57 (47-69)	16 (11-23)	7 (5-10)	4 (3-6)	25 (13-37)
3	Nate	81 (50-119)	24 (14-38)	11 (6-17)	4 (3-5)	16 (11-19)
4	Padwe	52 (36-80)	27 (18-35)	12 (8-16)	6 (3-8)	10 (3-16)
5	Barsu	73 (48-119)	24 (16-38)	11 (7-17)	3 (3-4)	5 (3-6)
6	Navedar	51 (34-71)	16 (11-23)	7 (5-10)	5 (3-6)	10 (6-13)
7	Soundale	80 (61-99)	24 (15-33)	11 (7-16)	4 (3-5)	14 (6-14)
8	Wada	84 (66-98)	23 (17-28)	11 (8-13)	4 (3-7)	22 (11-32)
9	Taral	48 (31-59)	20 (9-20)	9 (4-9)	4 (3-4)	5 (3-9)
10	Chouke	85 (49-113)	30 (16-41)	4 (7-18)	6 (3-6)	20 (14-27)
11	Rajapur	96 (78-110)	41 (32-47)	19 (14-21)	7 (3-10)	9 (5-14)
12	Unhale	64 (14-115)	23 (6-43)	11 (3-19)	5 (3-7)	6 (3-10)
13	Kelwade	73 (51-97)	25 (18-33)	11 (8-15)	6 (3-11)	19 (13-23)
14	Bhade	59 (33-79)	18 (11-25)	8 (5-11)	4 (3-4)	13 (9-17)

Note: Figures in the parenthesis indicate range of values

Table 3.5.6

Ambient Air Quality Status (Winter, 2006-07)

Unit: $\mu g/m^3$ 24 hourly average

Sr. No	Sampling Location	24 Hrs. Average (Range)				
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_2
1	Project Site	80 (39-125)	29 (11-58)	13 (5-26)	5 (3-7)	8 (4-12)
2	Vijaydurg	101 (82-121)	17 (38-53)	8 (17-24)	7 (4-8)	33 (26-40)
3	Nate	106 (62-151)	47 (24-78)	21 (11-35)	6 (3-9)	23 (14-29)
4	Padwe	123 (73-180)	29 (19-43)	13 (9-19)	7 (3-8)	30 (14-56)
5	Barsu	111 (58-173)	41 (26-58)	21 (12-26)	4 (3-5)	7 (6-8)
6	Navedar	123 (79-163)	41 (23-67)	21 (10-30)	5 (3-8)	14 (10-19)
7	Soundale	119 (96-135)	34 (25-44)	11 (11-20)	5 (3-11)	14 (11-16)
8	Wada	140 (99-175)	58 (37-78)	26 (17-35)	9 (4-14)	22 (12-34)
9	Taral	77 (44-119)	20 (13-29)	9 (6-30)	4 (3-7)	6 (3-9)
10	Chouke	117 (82-182)	55 (26-89)	25 (12-40)	5 (3-11)	19 (14-33)
11	Rajapur	118 (103-177)	60 (35-87)	27 (16-39)	9 (6-13)	21 (11-31)
12	Unhale	80 (39-125)	29 (11-58)	13 (5-26)	5 (3-7)	8 (4-12)
13	Kelwade	126 (84-177)	47 (28-63)	21 (13-28)	7 (3-12)	20 (14-27)
14	Bhade	73 (69-78)	21 (15-27)	10 (7-12)	5 (4-6)	14 (9-21)

Note: Figures in the parenthesis indicate range of values

Table 3.5.7
Cumulative Percentiles of SPM (Summer, 2006)

Units: µg/m³ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles					Max.
			25%	50%	75%	95%	98%	
1.	Project site	49	60	72	85	96	97	98
2.	Vijaydurg	52	89	102	109	117	117	117
3.	Nate	49	104	110	130	137	141	144
4.	Padwe	80	116	160	187	198	198	198
5.	Barsu	55	108	135	151	187	187	187
6.	Navedar	41	102	128	142	184	189	191
7.	Soundale	26	92	132	155	180	182	183
8.	Wada	93	119	134	155	192	194	195
9.	Taral	26	96	117	147	180	182	183
10.	Chouke	98	127	142	156	184	186	187
11.	Rajapur	75	100	124	142	186	189	190
12.	Unhale	49	60	74	82	97	98	98
13.	Kelwade	75	104	121	140	186	189	190
14.	Bhade	13	27	36	50	74	75	76

Table 3.5.8
Cumulative Percentiles of SPM (Post-Monsoon, 2006)

Units: µg/m³ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles					Max.
			25%	50%	75%	95%	98%	
1.	Project site	14	25	54	83	108	112	115
2.	Vijaydurg	47	50	54	59	66	68	69
3.	Nate	50	51	74	96	116	118	119
4.	Padwe	36	37	47	55	74	78	80
5.	Barsu	48	50	55	82	113	116	119
6.	Navedar	34	36	48	58	70	70	71
7.	Soundale	61	64	73	89	98	99	99
8.	Wada	66	69	87	92	97	97	98
9.	Taral	31	35	52	55	58	59	59
10.	Chouke	49	55	89	100	111	112	113
11.	Rajapur	78	84	94	103	109	110	110
12.	Unhale	14	25	54	83	108	112	115
13.	Kelwade	51	54	69	84	97	97	97
14.	Bhade	33	37	57	71	78	79	79

Table 3.5.9
Cumulative Percentiles of SPM (Winter, 2006-2007)

Units: µg/m^3 Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	39	52	71	91	117	122	125
2.	Vijaydurg	82	86	95	108	118	120	121
3.	Nate	62	70	91	128	147	149	151
4.	Padwe	73	85	109	140	171	177	180
5.	Barsu	58	63	95	136	164	169	173
6.	Navedar	79	89	118	139	159	161	163
7.	Soundale	96	100	113	133	135	135	135
8.	Wada	99	109	131	158	172	174	175
9.	Taral	44	52	62	90	112	116	119
10.	Chouke	82	97	117	147	176	180	182
11.	Rajapur	103	111	118	125	168	176	177
12.	Unhale	39	52	71	91	117	122	125
13.	Kelwade	84	92	109	142	170	174	177
14.	Bhade	69	70	71	75	77	78	78

Table 3.5.10
Cumulative Percentiles of PM_{10} (Summer, 2006)

Units: µg/m^3 Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	17	17	26	28	34	35	36
2.	Vijaydurg	23	34	47	51	59	60	61
3.	Nate	11	26	43	55	67	72	74
4.	Padwe	17	32	45	58	74	77	79
5.	Barsu	14	23	41	52	94	108	117
6.	Navedar	18	24	42	51	76	76	76
7.	Soundale	11	53	70	82	93	94	95
8.	Wada	48	49	57	65	87	87	87
9.	Taral	11	54	68	87	92	93	94
10.	Chouke	36	59	68	74	85	86	87
11.	Rajapur	33	39	44	63	75	77	78
12.	Unhale	17	17	26	28	34	35	36
13.	Kalwade	33	39	44	63	75	77	78
14.	Bhade	6	7	11	14	24	26	26

Table 3.5.11

Cumulative Percentiles of PM_{10} (Post-Monsoon, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	6	9	21	28	40	42	43
2.	Vijaydurg	11	12	14	18	22	22	23
3.	Nate	14	14	19	30	37	37	38
4.	Padwe	18	20	25	31	34	35	35
5.	Barsu	16	17	21	27	36	37	38
6.	Navedar	11	12	13	17	22	23	23
7.	Soundale	15	17	20	27	32	33	33
8.	Wada	17	19	21	25	27	28	28
9.	Taral	9	11	15	18	19	20	20
10.	Chouke	16	19	28	36	40	41	41
11.	Rajapur	32	34	41	45	46	47	47
12.	Unhale	6	9	21	28	40	42	43
13.	Kalwade	18	19	23	29	32	33	33
14.	Bhade	11	12	17	22	25	25	25

Table 3.5.12

Cumulative Percentiles of PM_{10} (Winter, 2006-2007)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles					Max.
			25%	50%	75%	95%	98%	
1.	Project site	11	12	21	36	54	56	58
2.	Vijaydurg	38	40	42	48	52	53	53
3.	Nate	24	27	36	56	74	76	78
4.	Padwe	19	20	27	31	40	42	43
5.	Barsu	26	27	41	47	56	57	58
6.	Navedar	23	24	36	48	63	65	67
7.	Soundale	25	27	35	41	44	44	44
8.	Wada	37	43	52	67	76	77	78
9.	Taral	13	15	18	21	27	28	29
10.	Chouke	26	72	78	81	87	88	89
11.	Rajapur	35	40	51	70	83	86	87
12.	Unhale	11	12	21	36	54	56	58
13.	Kelwade	28	34	43	54	61	62	63
14.	Bhade	15	17	19	24	26	27	27

Table 3.5.13

Cumulative Percentiles of $PM_{2.5}$ (Summer, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	8	8	12	13	15	16	16
2.	Vijaydurg	10	15	21	23	27	27	27
3.	Nate	5	12	19	25	30	32	33
4.	Padwe	8	14	20	26	33	35	36
5.	Barsu	6	10	18	23	42	49	53
6.	Navedar	8	11	19	23	34	34	34
7.	Soundale	5	24	32	37	42	42	43
8.	Wada	22	22	26	29	39	39	39
9.	Taral	5	24	31	39	41	42	42
10.	Chouke	16	27	31	33	38	39	39
11.	Rajapur	15	18	20	28	34	35	35
12.	Unhale	8	8	12	13	15	16	16
13.	Kalwade	15	18	20	28	34	35	35
14.	Bhade	3	3	5	6	11	12	12

Table 3.5.14

Cumulative Percentiles of $PM_{2.5}$ (Post-Monsoon, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	3	4	9	13	18	19	19
2.	Vijaydurg	5	5	6	8	10	10	10
3.	Nate	6	6	9	14	17	17	17
4.	Padwe	8	9	11	14	15	16	16
5.	Barsu	7	8	9	12	16	17	17
6.	Navedar	5	5	6	8	10	10	10
7.	Soundale	7	8	9	12	14	15	15
8.	Wada	8	9	9	11	12	13	13
9.	Taral	4	5	7	8	9	9	9
10.	Chouke	7	9	13	16	18	18	18
11.	Rajapur	14	15	18	20	21	21	21
12.	Unhale	3	4	9	13	18	19	19
13.	Kalwade	8	9	10	13	14	15	15
14.	Bhade	5	5	8	10	11	11	11

Table 3.5.15

Cumulative Percentiles of $PM_{2.5}$
(Winter, 2006-2007)

Units: µg/m^3 Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	5	5	9	16	24	25	26
2.	Vijaydurg	17	18	19	22	23	24	24
3.	Nate	11	12	16	25	33	34	35
4.	Padwe	9	9	12	14	18	19	19
5.	Barsu	12	12	18	21	25	26	26
6.	Navedar	10	11	16	22	28	29	30
7.	Soundale	11	12	16	18	20	20	20
8.	Wada	17	19	23	30	34	35	35
9.	Taral	6	7	8	9	12	13	13
10.	Chouke	12	32	35	36	39	40	40
11.	Rajapur	16	18	23	32	37	39	39
12.	Unhale	5	5	9	16	24	25	26
13.	Kelwade	13	15	19	24	27	28	28
14.	Bhade	7	8	9	11	12	12	12

Table 3.5.16

Cumulative Percentiles of SO_2
(Summer, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	3	3	3	3	3	3	3
2.	Vijaydurg	3	3	3	3	3	3	3
3.	Nate	3	3	3	3	3	3	3
4.	Padwe	3	4	5	6	8	8	8
5.	Barsu	3	3	3	3	3	3	3
6.	Navedar	3	3	3	4	4	4	4
7.	Soundale	3	4	4	4	5	5	5
8.	Wada	3	5	5	6	6	6	6
9.	Taral	3	5	5	6	6	6	6
10.	Chouke	3	3	3	4	4	4	4
11.	Rajapur	3	3	3	3	3	3	3
12.	Unhale	3	3	3	3	3	3	3
13.	Kalwade	3	3	3	3	3	3	3
14.	Bhade	3	3	3	3	3	3	3

Table 3.5.17

Cumulative Percentiles of SO_2
(Post-Monsoon, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	3	3	4	6	7	7	7
2.	Vijaydurg	3	4	4	5	6	6	6
3.	Nate	3	3	3	4	5	5	5
4.	Padwe	3	4	4	7	8	8	8
5.	Barsu	3	3	3	4	4	4	4
6.	Navedar	3	3	4	6	6	6	6
7.	Soundale	3	3	3	4	5	5	5
8.	Wada	3	3	4	6	7	7	7
9.	Taral	3	3	3	4	4	4	4
10.	Chouke	3	3	3	6	6	6	6
11.	Rajapur	3	4	7	8	9	10	10
12.	Unhale	3	3	4	6	7	7	7
13.	Kelwade	3	3	4	6	10	11	11
14.	Bhade	3	3	3	4	4	4	4

Table 3.5.18

Cumulative Percentiles of SO_2
(Winter, 2006-2007)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles					Max.
			25%	50%	75%	95%	98%	
1.	Project site	3	3	4	6	7	7	7
2.	Vijaydurg	4	4	5	6	7	8	8
3.	Nate	3	4	4	7	9	9	9
4.	Padwe	3	4	4	7	8	8	8
5.	Barsu	3	4	4	5	5	5	5
6.	Navedar	3	4	5	6	7	8	8
7.	Soundale	3	3	3	5	10	10	11
8.	Wada	4	5	9	12	14	14	14
9.	Taral	3	3	3	4	6	7	7
10.	Chouke	3	3	3	6	10	10	11
11.	Rajapur	6	6	8	11	12	13	13
12.	Unhale	3	3	4	6	7	7	7
13.	Kelwade	3	3	5	9	11	12	12
14.	Bhade	4	4	4	5	6	6	6

Table 3.5.19

Cumulative Percentiles of NO_X
(Summer, 2006)

Units: µg/m^3 Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	3	4	4	4	4	4	4
2.	Vijaydurg	23	26	29	33	37	38	39
3.	Nate	11	15	18	21	25	26	26
4.	Padwe	4	22	30	33	53	56	57
5.	Barsu	3	4	4	5	5	5	5
6.	Navedar	8	11	12	13	14	15	16
7.	Soundale	21	37	42	53	63	64	64
8.	Wada	22	37	44	54	64	65	66
9.	Taral	21	37	42	53	63	64	64
10.	Chouke	16	19	21	24	27	29	30
11.	Rajapur	12	19	21	24	26	26	26
12.	Unhale	3	4	4	4	4	4	4
13.	Kelwade	12	19	21	24	26	26	26
14.	Bhade	8	12	13	15	17	18	18

Table 3.5.20

Cumulative Percentiles of NO_X
(Post-Monsoon, 2006)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles 25%	50%	75%	95%	98%	Max.
1.	Project site	3	3	4	7	9	10	10
2.	Vijaydurg	13	16	23	29	35	36	37
3.	Nate	11	13	15	17	19	19	19
4.	Padwe	3	5	9	12	15	16	16
5.	Barsu	3	3	4	5	6	6	6
6.	Navedar	6	7	9	12	13	13	13
7.	Soundale	6	7	10	12	13	13	13
8.	Wada	11	14	19	26	31	32	32
9.	Taral	3	3	4	5	8	9	9
10.	Chouke	14	15	19	22	26	27	27
11.	Rajapur	5	5	8	10	13	14	14
12.	Unhale	3	3	4	7	9	10	10
13.	Kelwade	13	15	19	21	22	23	23
14.	Bhade	9	10	12	14	16	17	17

Table 3.5.21

Cumulative Percentiles of NO_x
(Winter, 2006-2007)

Units: $\mu g/m^3$ Average. : 24 hrs.

Sr. No.	Sampling Location	Min.	Cumulative Percentiles					Max.
			25%	50%	75%	95%	98%	
1.	Project site	4	5	6	9	11	12	12
2.	Vijaydurg	26	27	33	36	39	40	40
3.	Nate	14	16	23	27	29	29	29
4.	Padwe	14	16	19	37	52	55	56
5.	Barsu	6	6	7	7	8	8	8
6.	Navedar	10	11	13	16	19	19	19
7.	Soundale	11	12	13	15	16	16	16
8.	Wada	12	15	18	23	30	34	34
9.	Taral	3	3	4	5	8	9	9
10.	Chouke	14	16	21	28	32	33	33
11.	Rajapur	11	13	18	26	30	31	31
12.	Unhale	4	5	6	9	11	12	12
13.	Kalwade	14	15	17	22	26	27	27
14.	Bhade	9	10	12	16	20	21	21

3.6 Water Environment

3.6.1 Baseline Status With Respect to Conventional Water Pollutants

Physico-chemical parameters have been determined to establish the baseline status of the existing sources of water such as groundwater and surface water. Samples were collected during summer (April, 2006), post monsoon (November, 2006) and winter season (January, 2007). Sampling locations for surface water and groundwater quality monitoring are shown in the **Fig. 3.6.1** and enlisted in **Table 3.6.1**.

In order to assess the quality of surface water, water samples were taken from two sea water stations, three estuarine water stations and four river water stations (Total nine stations). The groundwater quality was assessed by collecting representative samples from dug wells and hand pumps in 9 villages within the study area.

College of Fisheries, **Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth**, **Ratnagiri** was engaged to carry out the study of Marine biodiversity mapping. During this study, they have analysed sea water and sediments near light house. The report is appended at **Annexure –VIII** of **Vol. II**.

3.6.1.1 Physico-chemical Characteristics

Physico-chemical parameters along with biological indicators of pollution have been estimated for ascertaining the baseline status of water environment during summer, post monsoon and winter seasons and presented in **Table 3.6.2** to **3.6.10**.

3.6.1.2 Surface Freshwater

Physical Parameters

In summer season, for surface water the values of physical parameters viz. pH, temperature, turbidity, TSS and TDS were found in the range as follows **(Table 3.6.2)**.

pH	=	6.7-7.9
Temperature	=	31-34^{0}C
Turbidity	=	3-18 NTU
TSS	=	2-20 mg/l
TDS	=	60-187 mg/l

In post monsoon season, for surface water the values of physical parameters viz. pH, temperature, turbidity, TSS and TDS were found in the range as follows **(Table 3.6.3)**.

pH	=	7.7-8.5
Temperature	=	30-31 ^{0}C
Turbidity	=	4-17 NTU
TSS	=	1-20 mg/l
TDS	=	81-184 mg/l

In winter season, for surface water, the values of physical parameters viz. pH, temperature, turbidity, TSS and TDS were found in the range as follows **(Table 3.6.4)**.

pH	=	7.9-8.1
Temperature	=	26-27 ^{0}C
Turbidity	=	<1-2 NTU
TSS	=	1-12 mg/l
TDS	=	90-149 mg/l

Inorganic Parameters

In summer season, for surface water, Inorganic parameters viz. total alkalinity, total hardness, chlorides, sulphate, sodium and potassium were found in the range as follows (**Table 3.6.5**).

Total alkalinity	=	19-71 mg/l
Total hardness	=	22-57 mg/l
Chlorides	=	3-55 mg/l
Sulphate	=	4-12 mg/l
Sodium	=	5-32 mg/l
Potassium	=	3-11 mg/l

In post monsoon season, for surface water, Inorganic parameters viz. total alkalinity, total hardness, chlorides, sulphate, sodium and potassium were found in the range as follows (**Table 3.6.6**).

Total alkalinity	=	26-44 mg/l
Total hardness	=	20-47 mg/l
Chlorides	=	18-58 mg/l
Sulphate	=	1-23 mg/l
Sodium	=	11-43 mg/l
Potassium	=	2-10 mg/l

In winter season, for surface water, Inorganic parameters viz. total alkalinity, total hardness, chlorides, sulphate, sodium and potassium are found in the range as follows (**Table 3.6.7**).

Total alkalinity	= 50-66 mg/l
Total hardness	= 40-64 mg/l
Chlorides	= 6-36 mg/l
Sulphate	= 4-6 mg/l
Sodium	= 9-28 mg/l
Potassium	= 1-2 mg/l

Nutrient Parameters

In summer season, for surface water, nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand were in the range as follows (**Table 3.6.8**).

Nitrate	= 0.2-3.2 mg/l
Total phosphate	= 0.3-0.4 mg/l
Dissolved Oxygen	= 5.9-7.0 mg/l
Chemical Oxygen Demand	= <5-8.0 mg/l
Biochemical Oxygen Demand	= <3

In post monsoon season, for surface water, nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand were in the range as follows (**Table 3.6.9**).

Nitrate	= 0.1-0.4 mg/l
Total phosphate	= 0.11-0.25 mg/l
Dissolved Oxygen	= 6.0-8.3 mg/l
Chemical Oxygen Demand	= <5-6 mg/l
Biochemical Oxygen Demand	= <3 mg/l

In winter season, for surface water, nutrient and demand parameters viz. nitrate, total nitrogen, total phosphate, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand and oil and grease were in the range as follows (**Table 3.6.10**).

Nitrate	= 0.5-0.8 mg/l
Total phosphate	= 0.3 -0.4 mg/l
Dissolved Oxygen	= 5.6 -8.2 mg/l
Chemical Oxygen Demand	= <5 mg/l
Biochemical Oxygen Demand	= <3 mg/l

Comparison with Drinking Water Quality Standards (Volume II, Annexure III)

It was observed that the water quality of all the three rivers is good with no organic pollution and very less nutrients especially nitrates, except higher turbidity in Wagothan and Muchkundi rivers.

3.6.1.3 Sea Water and Estuarine Water

Physical Parameters

In summer season, for sea and estuarine Water, the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) were observed to be in the range as follows (**Table 3.6.2**).

	Sea Water	**Estuarine Water**
pH	7.8-8.0	6.7-7.6
Temperature	30-32^{0}C	31-32°C
Turbidity	2-3 NTU	3-21 NTU
Total suspended solids (TSS)	2-22 mg/l	3-39 mg/l
Total dissolved solids (TDS)	34687-34890 mg/l	16375-20787 mg/l

In post monsoon season, for sea and estuarine water, the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) of sea water were observed to be in the range as follows: (**Table 3.6.3**).

	Sea Water	**Estuarine Water**
pH	8.0 -8.4	8.3-8.9
Temperature	29-30 ^{0}C	29-31 °C
Turbidity	3-5 NTU	3-5 NTU
Total suspended solids (TSS)	5-6 mg/l	6-9 mg/l
Total dissolved solids (TDS)	28127-30385 mg/l	13154-18946 mg/l

In winter season, for sea and estuarine water, the physical characteristics i.e. pH, temperature, turbidity, total suspended solids (TSS), and total dissolved solids (TDS) of sea water were observed to be in the range as follows (**Table 3.6.4**).

	Sea Water	**Estuarine Water**
pH	7.8-8.0	7.5 -7.9
Temperature	24 ^{0}C	22- 28 °C
Total suspended solids (TSS)	3-4 mg/l	4-8 mg/l
Total dissolved solids (TDS)	32460-33470 mg/l	16750-19900 mg/l
Turbidity	< 1 NTU	<1 NTU

Inorganic Parameters

In summer season, for sea and estuarine water, inorganic parameters i.e. total alkalinity, chloride, sulphates and salinity were observed to be in the range as follows (**Table 3.6.5**).

	Sea Water	**Estuarine Water**
Total alkalinity	104-114 mg/l	21-87 mg/l
Chloride	15008-15320 mg/l	6172-8094 mg/l
Sulphate	364-365 mg/l	360- 369 mg/l
Salinity	34 ‰	26-28 ‰

In post monsoon season, for sea and estuarine water, inorganic parameters i.e. total alkalinity, total hardness, chlorides, sulphates, and salinity were observed to be in the range as follows (**Table 3.6.6**).

	Sea Water	**Estuarine Water**
Total alkalinity	63-76 mg/l	58-84 mg/l
Chloride	12033-14332 mg/l	6341-9101 mg/l
Sulphates	1025-1521 mg/l	1010-1638 mg/l
Salinity	32-33‰	15-18‰

In winter season, for sea and estuarine water, inorganic parameters i.e. total alkalinity; chloride, sulphates, and salinity were observed to be in the range as follows (**Table 3.6.7**).

	Sea Water	**Estuarine Water**
Total alkalinity	105-110 mg/l	75-97 mg/l
Chloride	14044-14666 mg/l	6493-7697 mg/l
Sulphates	1056-1764 mg/l	1124-2146 mg/l
Salinity	33-34 ‰	26 -28‰

Nutrient Parameters

In summer season, for sea and estuarine water, nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, and Biochemical oxygen demand (B.O.D.) were in the range as follows (**Table 3.6.8**).

	Sea Water	**Estuarine Water**
Nitrate	0.6 -0.8 mg/l	0.7-0.9 mg/l
Total phosphate	0.4-0.5 mg/l	0.3 – 0.4 mg/l
Dissolved oxygen	7.9 – 8.0 mg/l	5.9 – 6.5 mg/l
Biochemical oxygen demand (B.O.D.)	<3	<3

In post monsoon season, for sea and estuarine water, nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, and Biochemical oxygen demand (B.O.D.) were in the range as follows (**Table 3.6.9**).

	Sea Water	**Estuarine Water**
Nitrate	0.3 -0.5 mg/l	0.2-0.9 mg/l
Total phosphate	0.17-0.23 mg/l	0.24 – 0.70 mg/l
Dissolved oxygen	6.9 – 7.0 mg/l	6.0 – 6.5 mg/l
Biochemical oxygen demand	<3 mg/l	< 3 mg/l

In winter season, for sea and estuarine water, nutrient and demand parameters viz. nitrate, total phosphate, dissolved oxygen, Biochemical oxygen demand (B.O.D.) and were in the range as follows (**Table 3.6.10**).

	Sea Water	**Estuarine Water**
Nitrate	0.3 -0.6 mg/l	0.2-0.9 mg/l
Total phosphate	0.3-0.4 mg/l	0.3 – 0.5 mg/l
Dissolved oxygen	6.2 – 6.7 mg/l	5.3 – 6.7 mg/l
Biochemical oxygen demand (B.O.D.)	<3	<3

It has been observed that the coastal water quality is good with less nutrients and no pollution.

3.6.1.4 Ground Water

Groundwater quality was assessed through characterization of different parameters.

Physical Parameters

In summer season, for ground water, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed in the range as follows (**Table 3.6.2**).

pH	= 5.9-8.2
Temperature	= 27-31 ^{0}C
Turbidity	= 1-17 NTU
TSS	= 1-20 mg/l
TDS	= 60-1795 mg/l

In post monsoon season, for ground water, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed in the range as follows (**Table 3.6.3**).

pH	=	7.1-8.8
Temperature	=	28-30 ^{0}C
Turbidity	=	1-4 NTU
TSS	=	1-5 mg/l
TDS	=	36-1296 mg/l

In winter season, for ground water, the water quality parameters viz. pH, temperature, turbidity, TSS, and TDS are observed in the range as follows (**Table 3.6.4**). Jaitapur groundwater showed higher conductivity of 2370 μS/cm.

pH	=	7.1-8.3
Temperature	=	22-24 ^{0}C
Turbidity	=	<1-1.2 NTU
TSS	=	<1-5 mg/l
TDS	=	46-1618 mg/l

Inorganic Parameters

In summer season, for ground water, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as follows (**Table 3.6.5**).

Alkalinity	=	14-83 mg/l
Total hardness	=	29-402 mg/l
Ca-hardness	=	13-125 mg/l
Chloride	=	8-815 mg/l
Sulphate	=	3-34 mg/l
Sodium	=	6-392 mg/l
Potassium	=	1-35 mg/l

In post monsoon season, for ground water, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as follows (**Table 3.6.6**).

Alkalinity	=	9-122 mg/l
Total hardness	=	14-351 mg/l
Ca-hardness	=	7-138 mg/l
Chloride	=	5-725 mg/l
Sulphate	=	2-29 mg/l
Sodium	=	3-167 mg/l
Potassium	=	1-13 mg/l

In winter season, for ground water, inorganic parameters in terms of alkalinity, total hardness, Ca-hardness, chloride, sulphate, sodium and potassium are found to be as given below (**Table 3.6.7**). Groundwater from Jaitapur showed higher values of chlorides (693 mg/l), sulphates (101 mg/l), sodium (350 mg/l) and potassium (70 mg/l) which may be due to seawater ingress.

Alkalinity	= 27-91 mg/l
Total hardness	= 29-264 mg/l
Ca-hardness	= 11-181 mg/l
Chloride	= 5-693 mg/l
Sulphate	= 2-101 mg/l
Sodium	= 3-350 mg/l
Potassium	= 1-70 mg/l

Nutrient Parameters

In summer season, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to be in the following range **(Table 3.6.8**).

Nitrate	= 0.1-11.0 mg/l
Total phosphate	= 0.2-0.3 mg/l
Dissolved oxygen	= 2.5-6.0 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

In post monsoon season, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to in the following range **(Table 3.6.9**).

Nitrate	= 0.05-1.8 mg/l
Total phosphate	= 0.07-0.25 mg/l
Dissolved oxygen	= 1.5-5.6 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

In winter season, levels of nutrients in terms of nitrate, total phosphate, dissolved oxygen and B.O.D. were observed to in the following range **(Table 3.6.10)**.

Nitrate	= 0.1-3.0 mg/l
Total phosphate	= 0.01-0.04 mg/l
Dissolved oxygen	= 2.4-7.2 mg/l
Biochemical oxygen demand (B.O.D.)	= BDL

Comparison with Drinking water Quality Standards (Vol. II, Annexure III)

Groundwater quality was found to be good, however, in summer some of the dug wells showed higher dissolved solids at (1795 mg/l) and total hardness at Jaitapur (402 mg/l) showing the impact of sea water ingress to some extent.

3.6.1.5 Heavy Metal Content

The heavy metal content in groundwater, surface water and marine water (**Table 3.6.11** to **3.6.13**) was observed to be very low and below the stipulated limits for drinking water at most of the places during all the three seasons.

3.6.2 Bacteriological Characteristics

The coliform group of bacteria is significant as a principal indicator of degree of pollution of water and is also indicative of the sanitary quality. The coliform density is now a criterion to assess the suitability of water for domestic and recreational uses. The coliform group belongs to the family of Enterobacteriaceae and includes all aerobic and facultative anaerobic, gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48 hrs at 35°C.

For estimation of bacterial contents in water samples, the standard test for the coliform group was carried out by the membrane filter (MF) technique. The MF technique involves direct plating for detection and estimation of total coliform and faecal coliform densities.

3.6.2.1 Surface Water

Surface water quality was assessed by analyzing samples collected from different locations. The results are shown in **Tables 3.6.14**, **3.6.15** and **3.6.16** for summer season, post monsoon season and for winter season respectively.

In summer, post monsoon and winter seasons, the total coliform density in surface water was observed to be in the range of 367-7500 CFU/100 ml, 230-370 CFU/100 ml, and 85-255 CFU/100 ml respectively whereas faecal coliform were detectable at different locations in levels ranging between 40-655 CFU/100 ml, 20-80 CFU/100 ml, and 16-58 CFU/100 ml respectively. The water quality satisfies the Class C of surface water (Drinking water source with conventional treatment followed by disinfection) (IS2296: 1982). The levels of total coliform and faecal coliform are at normal level with slight organic pollution.

3.6.2.2 Sea Water and Estuarine Water

In summer, post monsoon and winter seasons, the total coliform density in sea water, estuary and creek water was observed to be in the range of 500-7200

CFU/100 ml, 140-690 CFU/100 ml and 115-190 CFU/100 ml respectively whereas faecal coliform were detectable at different locations in levels ranging between 28-275 CFU/100 ml, 10-50 CFU/100 ml, and 10-38 CFU/100 ml respectively. These values indicated some amount of organic contamination in sea water. Please refer **Tables 3.6.14**, **3.6.15** and **3.6.16**.

3.6.2.3 Groundwater

In order to assess bacteriological quality of groundwater, 9 samples were collected in the study area. The bacteriological quality of the groundwater is presented in **Tables 3.6.14**, **3.6.15** and **3.6.16** for summer, post monsoon and winter seasons respectively.

In summer, post monsoon and winter seasons, Total Coliforms were found in the range of 45-320 CFU/100 ml, BDL-1900 CFU/100 ml, and 20-138 CFU/100 ml respectively whereas faecal coliforms were in the range of BDL-16 CFU/100 ml, BDL-115 CFU/100 ml, and BDL-28 CFU/100 ml respectively. Ground water is slightly contaminated at few places. This may be due to human settlement with poor sanitation facilities around these places.

3.6.3 Baseline Radioactivity Levles in Water Environment

3.6.3.1 Baseline Radioactivity Levels in Fresh Water Samples

Table 7, as appended in **Volume II**, **Annexure-IX(a),** presents the activity levels of fallout and naturally occurring radionuclides in 17 fresh water samples collected from borewell, public well, hot water stream and river around JNPP site, Sr-90 concentration in borewell ranged from <1.0 mBq/l - 18 mBq/l. The hot water stream water sample showed Sr-90 as 15mBq/l whereas Sr-90 was less than the detection limit of 1.0 mBq/l in well and river water samples.

The Cs-137 levels in borewell water samples ranged from <1.0 mBq/l - 1.45 mBq/l. The hot stream water sample showed Cs-137 of 2.0 mBq/l. The Cs-137 in river water varied from <1.0 mBq/l - 3.2 mBq/l whereas it ranged between <1.0mBq/l - 8.0 mBq/l in well water samples. The Ra-226 and Ra-228 ranged from <0.1 mBq/l - 2.45 mBq/l and <1.0 mBq/l - 7.6 mBq/l respectively. The levels of above parameters are in the normal range.

3.6.3.2 Tritium in Water Samples

A total of 35 water samples were analysed for tritium activity. As shown in **Table 4**, as appended in **Volume II Annexure-IX(a)**, the tritium activity was less than the detection level of 1.0 Bq/l in water samples collected from river, stream and borewell. The tritium activity level ranged between <1.0 Bq/l - 3.2 Bq/l in water samples collected from public wells. The level of above parameter is in the normal range.

3.6.3.3 Radioactivity Levels in Sea Water Samples

Seven sea water samples were collected from various locations around site and analysed for different radionuclides. It is seen from **Table 5**, as appended in **Volume II**, **Annexure-IX(a)** that the concentration of Sr-90 in all the sea water samples is below the detection limit of 1.0 mBq/l. The activity due to Cs-137 ranges from <1.0 mBq/l - 1.75 mBq/l. A large volume of 100 liter seawater collected from light house was analysed for fallout activity due to Pu-239 + 240. The activity found was less than the detection limit of 4 µBq/l. The levels of naturally occurring Ra-226 and Ra-228 varied from 0.1 mBq/l – 4.0 mBq/l. The levels of above parameters are in the normal range.

3.6.4 Biological Characteristics

The study on biological parameters shall lead to detecting various factors contaminating or polluting the aquatic environment.

The phytoplankton and zooplankton are practically suitable choice of indicators of water quality due to ease of sampling, their cosmopolitan distribution and lot of available information on these groups. The monitoring for biological parameters is rapid, inexpensive and reliable requiring only biological examination of the water samples. The impact of pollution is directly reflected by the survival status of flora and fauna. Hence the biological data gives an overall picture of the subsequent effects of pollution.

Method

a) ***Phytoplankton Analysis***

The Lackey Drop (microtransect) Count Method (Lackey, 1938; Edmonson, 1969) is a simple method for obtaining counts of phytoplankton with considerable accuracy. Organisms are counted under microscope in strips on slide from a drop of centrifuged, decanted and concentrated volume of sample and number of individuals of each organism is counted in 45 x magnification. The number is expressed per ml of the sample. The formula is given as:

$$\text{No/ml} = \frac{Y \times 35 \times 25 \times X}{15} \qquad \text{-------------------------------- (3.6.1)}$$

Where,

- Y is average number of each organism per strip; it is the number of organisms divided by total number of strips observed for a sample
- 35 is number of microscopic strips in 18 mm length of cover slip
- 25 is number of drops making up for 1 ml in a pipette (number can vary according to type of pipette used)
- X is volume of concentrated sample after centrifuging and decanting supernatant water
- 15 is the volume in ml of water used for centrifugation

For studying community structure, the species are grouped in taxonomic classes and the percentages of groups are calculated from total counts of sample.

The diversity is calculated for each community by Shannon Wiener Diversity Index (SWDI). It is where proportion is obtained by dividing the number of individuals of species by total number of individuals in a sample for which $\log_2$ proportion is obtained from index table (Shannon, 1968).

$$d = -\sum_{i=1}^{n} (ni/N).\log_2(ni/N) \qquad \text{----------- (3.6.2)}$$

Where,

n = number of species

N = total number of individuals of all species

ni = number of individuals of “i” th species

d = Shannon Wiener Diversity Index

b) Zooplankton Analysis

Zooplankton density is always lesser than phytoplankton density; therefore around 20-50 L of water is passed through plankton net (mesh size 50 μm) to concentrate zooplankton. The entire water is centrifuged, decanted and concentrated to make 1 ml volume for observation in S-R (Sedgwick-Rafter) counting cell. The zooplankton is counted in 10x magnification. Its number per m^3 is expressed by the formula:

$$No/m^3 = \frac{C \times V_2}{V_1 \times V_3} \qquad \text{---------------------------} \ (3.6.3)$$

Where,

C = total number of counted individuals of species in a sample
V_1 = volume of concentrated sample through plankton net
V_2 = centrifuged, decanted and concentrated volume of sample in ml
V_3 = volume of grab sample in m^3 i.e. 20 L/1000

For studying community structure, the species are grouped in taxonomic classes and percentages of groups are calculated from total counts of sample. The diversity is calculated for each community by Shannon Wiener Diversity Index (SWDI).

$$d = -\sum_{i=1}^{n} (ni/N).\log_2(ni/N) \qquad \text{------------} \ (3.6.4)$$

Where,
n = number of species
N = total number of individuals of all species
ni = number of individuals of "i" th species
d = Shannon Wiener Diversity Index

Where proportion is obtained by dividing the number of individuals of a species by total number of individuals of all species for which $\log_2$ proportion is obtained by Index table (Shannon, 1968).

3.6.4.1 Assessment of Biological Quality of Water

Phytoplankton

The data on phytoplankton community in surface fresh water, seawater, estuarine water and groundwater for summer season, post monsoon season and winter season is shown in **Tables 3.6.17** to **Table 3.6.22**.

The population dynamics of surface fresh water were estimated by phytoplankton count in no/ml, which were observed in the range of 90-314 during study period (**Table 3.6.17**, **3.6.19** and **3.6.21**). The percentage composition of groups revealed highest amount of diatom (Clean water indicator) (30%-86.66%) followed by Chlorophyceae (polluted water indicator) (13.3%-70%). The species identified for phytoplankton are presented in **Tables 3.6.18**, **3.6.20** and **3.6.22**. The dominance of Bacillariophyceae in most of the surface water samples and low phytoplankton count and low value of Palmer's Pollution Indices (3-11) indicate oligotrophic water quality. But the presence of Chlorophyceae (13.3%-70.0%) in small amount indicate poor productivity due to limited enrichment. This is also supported by the value of Shannon Wiener Diversity Index ranging from 1.83-2.48.

Groundwater samples were collected from dug-wells and hand pumps. Only dug-well samples showed presence of phytoplankton count. The Shannon Weiner Diversity Index (SWDI) & phytoplankton count were found in the range of 1.37-2.15 and 47-202 algae per ml respectively. The phytoplankton showed the presence of diatoms (20%-85.7%), Chlorophyceae (20%-100%), Cyanophyceae (0%-16.6%) and Euglenophyceae (0%-25%). Though the diatoms were dominant in most of the samples, the presence of other groups indicated presence of some nutrient enrichment in ground water. PPI values (0-12) showed good quality of water but SWDI values (1.3-2.15) showed presence of organic contamination in groundwater samples.

The seawater and estuarine water showed low algal count (5-42 algae per ml), low PPI values (6-13), showing oligotrophic nature of water.however, sub dominance of Chorophyceae and Cyanophyceae and medium values of SWDI (1.37-2.6) indicated presence of some amount of nutrients in sea water.

Zooplankton

The data on zooplankton community for surface fresh water, sea water, estuarine water and groundwater, for summer, post monsoon and winter seasons are shown in **Tables 3.6.23** to **3.6.28**.

In surface fresh water and seawater/estuarine water, the Shannon Wiener Diversity Index (SWDI) and zooplankton count varies between 0.00-2.48 and BDL-14000 nos/m^3 respectively (**Table 3.6.23**, **3.6.25** and **3.6.27**). The percentage composition reveals highest count for Rotifera & Copepoda. These values indicate that the surface water is oligotrophic with low productivity.

In case of groundwater, only dug well samples showed presence of zooplankton counts, which were in the range of 0-3000 No/m^3. The Shannon Weiner Diversity Index (SWDI) for ground water varies between 0.00-2.26. These values showed that ground water is oligotrophic with low productivity. The list of identified zooplankton species is given in **Tables 3.6.24**, **3.6.26**, and **3.6.28** for summer, post monsoon and winter respectively.

3.6.5 Water Availability

Being a coastal site, seawater will be used on once-through basis for condenser cooling. Desalination facility of appropriate capacity will be planned for the fresh water supply to meet the freshwater requirement of the JNPP.

3.6.6 Water Drawal & Discharge

The average elevation of the site is about 24.5 m above the mean sea level. In this case approximate pumping head will be of the order of 24.5 m. Considering the need to adopt once through system of cooling for the condenser and reduce the energy required for pumping, it is possible to reduce the pumping head by suitably grading the site and housing the turbine system at a lower level. The seabed is rocky and it may be possible to adopt open channels for intake and discharge of seawater or open channel for intake and individual tunnel for discharge. Based on the sea bed contours near the site area, the length of the intake channel and the discharge point will be designed in line with the model study carried out by CWPRS **(Annexure –V(b)**, **Vol. II)** on re-circulation.

3.6.6.1 Thermal Water Pollution

In this regard, “2-D mathematical model studies” on thermal dispersion for discharges of Condenser Cooling Water to the sea from all the proposed six units of 1650 MWe with cooling water discharge rate of 100 m^3/s per unit have been carried out by **Khadakwasla Research Station, Central Water and Power Research Station (CWPRS)**, **Pune**. A report of the CWPRS is enclosed separately as **Annexure-V(b)** in **Volume II**. The input parameters such as the planned layout / arrangement of intake and outfall structure for all the 6 units (as shown in the attached drawing as a part of **Annexure-V(b)** in **Volume II**) and the other oceanographic data used for studies by CWPRS, Pune are based on the survey reports by National Institute of Oceanography, Goa, the published data and related national reports.

CWPRS has run the models for various options like intake from north side or intake from south side for all the six units with sets of variable length of underground discharge tunnels. CWPRS has suggested various length combinations of discharge tunnels per twin units. Accordingly, the optimum length of the tunnels for each twin unit's vis-à-vis design of the condensers will be implemented to ensure the compliance of MOEF requirement with regard to maximum temperature rise of 7 °C due to discharges of condenser cooling water at the point of discharge.

3.6.7 Wastewater

The wastewaters likely to be generated from the proposed nuclear power project are mainly from the processing units and the residential complex as also sanitary wastes from the canteen, toilets and bathrooms within the plant premises.

3.6.7.1 Radioactive Liquid Wastes from the Plant

The liquid radio active waste generated from the project will be classified into various categories depending upon the activity levels as per AERB guidelines. These wastes will be treated suitably so that the activity levels are much below the discharge limits specified by AERB.

Proposed Management System for Active Liquid Waste

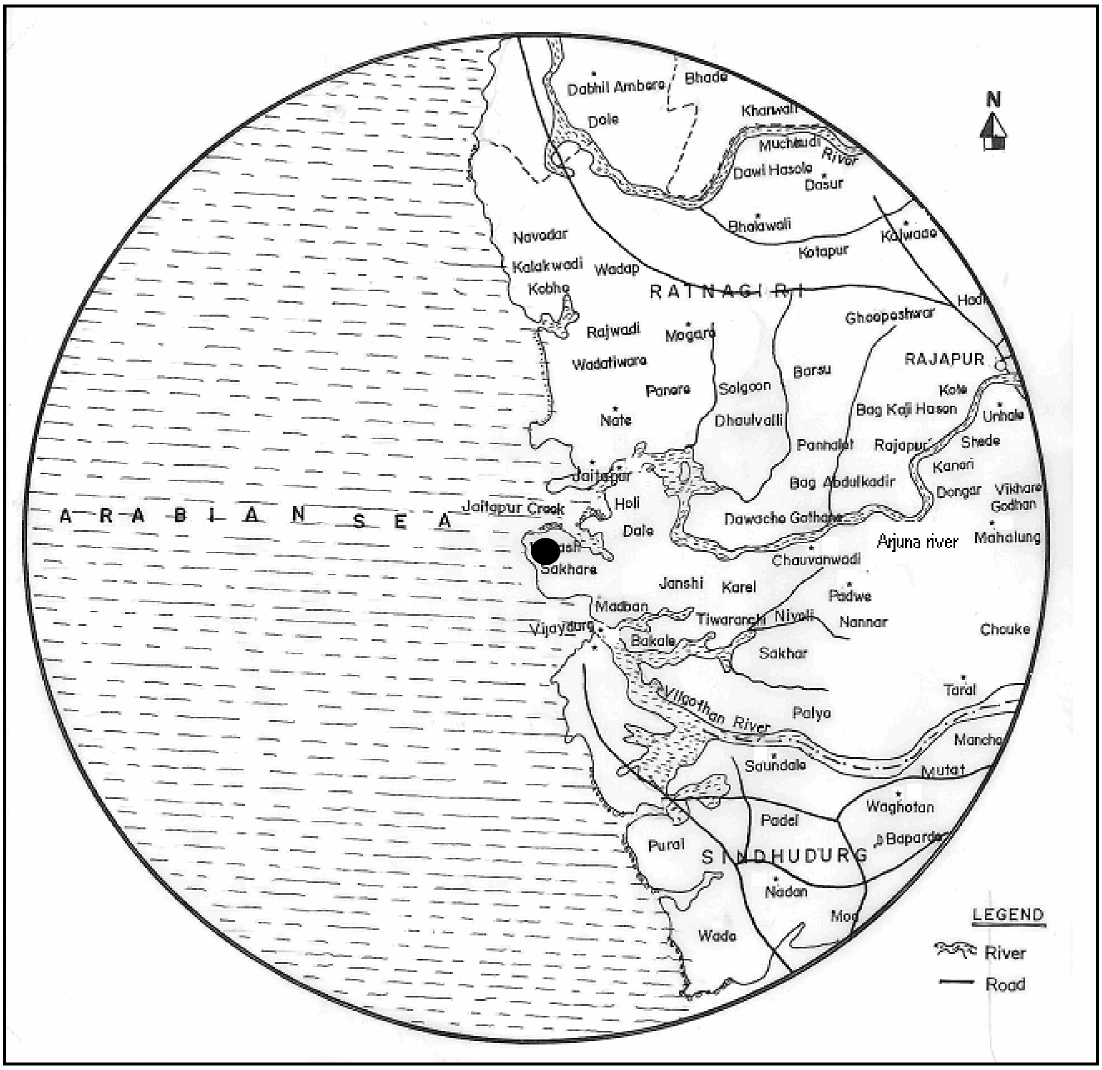
Liquid waste is not directly discharged in environment. It is processed and stored in waste management facility. The suitable provisions shall be engineered and it shall be ensured that final discharges are well within the stipulated specified discharge limits set by AERB.

3.6.7.2 Non- Radioactive Wastes

Under this category, the sources would be conventional type including domestic wastewater from the residential complex, canteen and sanitary wastes from toilets and bathrooms within the plant.

3.6.7.3 Wastewater from Residential Complex

A residential complex, which will be about 5 km from the plant site, has been proposed, for the staff and workers of proposed nuclear power plant. It is proposed to employ unskilled, skilled workers and O and M staff as also management officers. A sewage treatment plant to treat around 1830 m^3/d of domestic sewage comprising primary and secondary biological treatment based on either activated sludge system or oxidation ditch will be constructed. The treated wastewater from the STP will preferably be utilized on land for plantation in the residential complex and for green belt development around the nuclear power plant. The treated wastewater will satisfy the requirements of State Pollution Control Board as also the requirements contained in IS 2490-1982 (**Vol. II, Annexure-IV**).



★ Sampling Location

● Project Site

Fig. 3.6.1: Locations for Water Sampling in the Study Area

Table 3.6.1

Water Quality Sampling Locations

Sr. No.	Sampling location	Distance From Site (KM)	Direction
	Surface water		
	Sea Water		
1	Opposite Vijaydurg	6	S
2	Opposite Village Jaitapur	4	N
	Estuary Water		
3	Near Chauvanwadi (Arjuna River Estuary)	12	E
4	Near Saundale (Waghotan River Estuary)	16	SE
5	Near Dabhil Ambhore (Muchkundi River Estuary)	23	N
	River water		
6	Village Bhanawli (Muchkundi River)	19	NNE
7	Village Dasur (Muchkundi River)	23	NNE
8	Village Taral (Waghotan River)	21	SEE
9	Village Unhale (Arjuna River)	22	NEE
	Ground water		
	Hand Pump		
10	Vijaydurg	6	SSE
11	Mahalunge	22	E
	Dug Well		
12	Jaitapur	4	NNE
13	Nate	8	NE
14	Mogare	13	NE
15	Padwe	15	ESE
16	Nadan	21	SE
17	Waghotan	21	SE
18	Kelwade	24	NE

Table 3.6.2

Water Quality – Physical Parameters (Summer, 2006)

Sr. No.	Sampling Location	pH	Temp. (^oC)	Turbidity (NTU)	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Conductivity (µS/cm)
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	8.0	30	2	2	34687	69160
2	Opposite Village Jaitapur	7.8	32	3	22	34890	62340
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	7.6	31	21	39	19425	32930
4	Near Saundale (Waghotan River Estuary)	7.5	32	3	3	16375	27230
5	Near Dabhil Ambhore (Muchkundi River Estuary)	6.7	31	3	14	20787	37190
	River water						
6	Village Bhanawli (Muchkundi River)	6.7	33	18	11	60	115
7	Village Dasur (Muchkundi River)	7.2	34	3	2	67	95
8	Village Taral (Waghotan River)	7.9	31	5	20	183	255
9	Village Unhale (Arjuna River)	7.8	34	4	4	187	269
	Ground water						
	Hand Pump						
10	Vijaydurg	8.2	30	3	2	186	307
11	Mahalunge	7.9	29	2	3	148	290
	Dug Well						
12	Jaitapur	7.6	31	5	17	1795	3105
13	Nate	6.7	30	6	3	93	135
14	Mogare	7.1	29	3	4	95	147
15	Padwe	5.9	30	7	20	194	357
16	Nadan	7.4	27	17	20	188	290
17	Waghotan	8.2	28	1	9	152	210
18	Kelwade	6.7	28	6	1	60	80

Table 3.6.3

Water Quality-Physical Parameters (Post Monsoon, 2006)

Sr. No.	Sampling Location	pH	Temp. (°C)	Turbidity (NTU)	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Conductivity (μS/cm)
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	8.4	29	5	6	28127	50127
2	Opposite Village Jaitapur	8.0	30	3	5	30385	54252
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	8.9	30	3	6	18187	35186
4	Near Saundale (Waghotan River Estuary)	8.3	29	5	7	13154	23787
5	Near Dabhil Ambhore (Muchkundi River Estuary)	8.5	31	4	9	18946	33238
	River water						
6	Village Bhanawli (Muchkundi River)	7.7	31	4	1	81	156
7	Village Dasur (Muchkundi River)	8.2	30	11	8	94	177
8	Village Taral (Waghotan River)	8.5	31	17	20	184	295
9	Village Unhale (Arjuna River)	8.2	31	4	5	177	327
	Ground water						
	Hand Pump						
10	Vijaydurg	8.2	30	4	2	126	194
11	Mahalunge	8.1	28	1	1	143	243
	Dug Well						
12	Jaitapur	8.4	28	1	1	1296	2353
13	Nate	7.7	29	1	5	104	148
14	Mogare	7.1	30	2	3	36	69
15	Padwe	8.8	28	1	4	125	213
16	Nadan	8.3	29	1	1	136	249
17	Waghotan	8.6	29	1	2	115	226
18	Kelwade	8.2	29	1	2	121	189

Table 3.6.4

Water Quality – Physical Parameters (Winter, 2006-07)

Sr. No.	Sampling Location	pH	Temp. (^oC)	Turbidity (NTU)	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Conductivity (µS/cm)
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	8.0	24	<1	4	33470	65140
2	Opposite Village Jaitapur	7.8	24	<1	3	32460	64190
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	7.6	24	<1	8	19900	36180
4	Near Saundale (Waghotan River Estuary)	7.5	22	<1	6	16750	30450
5	Near Dabhil Ambhore (Muchkundi River Estuary)	7.9	28	<1	4	19787	35330
	River water						
6	Village Bhanawli (Muchkundi River)	7.9	27	<1	2	90	154
7	Village Dasur (Muchkundi River)	7.9	27	<1	1	99	186
8	Village Taral (Waghotan River)	8.1	26	2	12	149	279
9	Village Unhale (Arjuna River)	7.9	26	<1	1	101	183
	Ground water						
	Hand Pump						
10	Vijaydurg	8.1	23	1	1	143	242
11	Mahalunge	8.3	24	<1	1	121	206
	Dug Well						
12	Jaitapur	7.6	22	<1	<1	1618	2370
13	Nate	7.8	23	<1	1	162	234
14	Mogare	7.1	24	1.2	3	67	92
15	Padwe	7.1	22	0.8	5	129	229
16	Nadan	7.5	23	<1	1	46	80
17	Waghotan	8.1	22	<1	2	80	122
18	Kelwade	7.3	23	1.2	<1	50	68

Table 3.6.5

Water Quality – Inorganic Parameters (Summer, 2006)

Sr. No.	Sampling Locations	Total Alkalinity	Total Hardness	Calcium Hardness	Chloride	Sulphate	Sodium	Potassium	Salinity
		as $CaCO_3$							%
		mg/l							
	Surface water								
	Sea Water								
1	Opposite Vijaydurg	114	9465	1249	15008	364	9326	402	34
2	Opposite Village Jaitapur	104	9350	2100	15320	365	9160	330	34
	Estuary Water								
3	Near Chauvanwadi (Arjuna River Estuary)	81	5275	1600	7701	369	5300	290	28
4	Near Saundale (Waghotan River Estuary)	87	4250	1825	6172	365	4996	144	26
5	Near Dabhil Ambhore (Muchkundi River Estuary)	21	5075	1250	8094	360	6056	40	28
	River water								
6	Village Bhanawli (Muchkundi River)	19	22	12	8	4	5	3	-
7	Village Dasur (Muchkundi River)	36	23	11	3	5	8	5	-
8	Village Taral (Waghotan River)	71	55	26	41	9	32	11	-
9	Village Unhale (Arjuna River)	69	57	43	55	12	26	10	-
	Ground water								
	Hand Pump								
10	Vijaydurg	70	65	41	64	8	28	3	-
11	Mahalunge	55	46	36	35	4	16	1	-
	Dug Well								
12	Jaitapur	44	402	125	815	34	392	24	-
13	Nate	23	46	17	20	4	7	2	-
14	Mogare	14	34	15	30	5	11	1	-
15	Padwe	19	67	18	60	3	36	4	-
16	Nadan	23	154	66	8	7	66	35	-
17	Waghotan	83	101	59	20	3	11	1	-
18	Kelwade	20	29	13	8	6	6	1	-

Table 3.6.6

Water Quality- Inorganic Parameters (Post-monsoon, 2006)

Sr. No.	Sampling Locations	Total Alkalinity	Total Hardness	Calcium Hardness	Chloride	Sulphate	Sodium	Potassium	Salinity %
		as $CaCO_3$							
		mg/l							
	Surface water								
	Sea Water								
1	Opposite Vijaydurg	76	7906	776	12033	1025	6480	128	32
2	Opposite Village Jaitapur	63	7358	841	14332	1521	6938	192	33
	Estuary Water								
3	Near Chauvanwadi (Arjuna River Estuary)	84	5458	312	8332	1638	2356	169	15
4	Near Saundale (Waghotan River Estuary)	62	4176	234	6341	1010	1828	115	18
5	Near Dabhil Ambhore (Muchkundi River Estuary)	58	5912	325	9101	1424	2012	173	16
	River water								
6	Village Bhanawli (Muchkundi River)	26	23	17	21	4	20	2	-
7	Village Dasur (Muchkundi River)	38	47	40	18	1	11	3	-
8	Village Taral (Waghotan River)	44	29	30	58	23	43	10	-
9	Village Unhale (Arjuna River)	34	20	17	51	9	38	3	-
	Ground water								
	Hand Pump								
10	Vijaydurg	80	351	37	64	4	73	10	-
11	Mahalunge	122	86	55	11	6	28	4	-
	Dug Well								
12	Jaitapur	60	51	138	725	29	167	13	-
13	Nate	19	35	32	22	8	15	2	-
14	Mogare	9	14	7	6	2	3	1	-
15	Padwe	62	49	35	13	3	38	8	-
16	Nadan	83	62	43	14	3	22	3	-
17	Waghotan	58	41	43	5	2	33	6	-
18	Kelwade	49	39	35	23	10	13	6	-

Table 3.6.7

Water Quality- Inorganic Parameters (Winter, 2006-07)

Sr. No.	Sampling Locations	Total Alkalinity (as $CaCO_3$)	Total Hardness (as $CaCO_3$)	Calcium Hardness (as $CaCO_3$)	Chloride	Sulphate	Sodium	Potassium	Salinity %
		mg/l							
	Surface water								
	Sea Water								
1	Opposite Vijaydurg	110	6910	989	14666	1764	9635	350	33
2	Opposite Village Jaitapur	105	6592	582	14044	1056	9525	410	34
	Estuary Water								
3	Near Chauvanwadi (Arjuna River Estuary)	75	5944	1112	6493	2146	4740	290	26
4	Near Saundale (Waghotan River Estuary)	92	4365	494	6563	1989	3362	320	28
5	Near Dabhil Ambhore (Muchkundi River Estuary)	97	5635	659	7697	1124	4210	356	28
	River water								
6	Village Bhanawli (Muchkundi River)	57	52	28	6	5	9	1	-
7	Village Dasur (Muchkundi River)	59	40	19	8	4	17	1	-
8	Village Taral (Waghotan River)	66	64	30	36	5	28	2	-
9	Village Unhale (Arjuna River)	50	47	26	15	6	14	1	-
	Ground water								
	Hand Pump								
10	Vijaydurg	91	59	24	12	4	21	6	-
11	Mahalunge	74	29	21	7	3	24	1	-
	Dug Well								
12	Jaitapur	33	264	181	693	101	350	70	-
13	Nate	40	61	46	53	3	33	7	-
14	Mogare	39	29	18	5	5	7	1	-
15	Padwe	36	67	16	9	32	10	1	-
16	Nadan	33	32	12	11	4	19	5	-
17	Waghotan	57	61	57	5	2	3	1	-
18	Kelwade	27	29	11	6	3	9	1	-

Table 3.6.8

Water Quality - Nutrient and Demand Parameters (Summer, 2006)

Sr. No.	Sampling Location	Nitrate as N	Total Phos-phates	Dissolved Oxygen	Chemical Oxygen Demand	Biochemical Oxygen Demand	Oil & Grease
		mg/l					
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	0.6	0.5	7.9	-	< 3	0.3
2	Opposite Village Jaitapur	0.8	0.4	8.0	-	< 3	0.6
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	0.7	0.4	6.5	-	< 3	0.5
4	Near Saundale (Waghotan River Estuary)	0.7	0.4	5.9	-	< 3	0.8
5	Near Dabhil Ambhore (Muchkundi River Estuary)	0.9	0.3	6.2	-	< 3	0.3
	River water						
6	Village Bhanawli (Muchkundi River)	0.5	0.3	5.9	6.2	< 3	1.3
7	Village Dasur (Muchkundi River)	0.2	0.4	6.5	< 5	< 3	1.7
8	Village Taral (Waghotan River)	0.2	0.4	6.8	< 5	< 3	1.5
9	Village Unhale (Arjuna River)	3.2	0.3	7.0	8.0	< 3	1.7
	Ground water						
	Hand Pump						
10	Vijaydurg	0.1	0.3	2.5	< 5	-	-
11	Mahalunge	0.2	0.3	3.0	< 5	-	-
	Dug Well						
12	Jaitapur	0.9	0.3	4.7	< 5	-	-
13	Nate	2.0	0.2	4.5	< 5	-	-
14	Mogare	0.2	0.2	5.7	< 5	-	-
15	Padwe	11.0	0.3	6.0	< 5	-	-
16	Nadan	0.2	0.3	4.0	< 5	-	-
17	Waghotan	3.0	0.3	5.3	< 5	-	-
18	Kelwade	1.0	0.3	3.4	< 5	-	-

Table 3.6.9

Water Quality – Nutrient and Demand Parameters (Post Monsoon, 2006)

Sr. No.	Sampling Location	Nitrate as N	Total Phos-phates	Dissolved Oxygen	Chemical Oxygen Demand	Bio-chemical Oxygen Demand	Oil & Grease
		mg/l					
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	0.5	0.17	6.9	-	<3	0.8
2	Opposite Village Jaitapur	0.3	0.23	7.0	-	<3	0.3
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	0.2	0.24	6.5	-	<3	0.4
4	Near Saundale (Waghotan River Estuary)	0.2	0.70	6.3	-	<3	0.5
5	Near Dabhil Ambhore (Muchkundi River Estuary)	0.9	0.18	6.0	-	<3	0.4
	River water						
6	Village Bhanawli (Muchkundi River)	0.4	0.11	8.3	< 5	<3	1.03
7	Village Dasur (Muchkundi River)	0.1	0.25	6.0	6	<3	1.5
8	Village Taral (Waghotan River)	0.3	0.19	6.5	< 5	<3	1.3
9	Village Unhale (Arjuna River)	0.1	0.11	7.1	< 5	<3	1.5
	Ground water						
	Hand Pump						
10	Vijaydurg	0.2	0.14	2.0	<5	-	-
11	Mahalunge	0.05	0.22	4.3	<5	-	-
	Dug Well						
12	Jaitapur	0.3	0.18	5.5	<5	-	-
13	Nate	1.3	0.07	5.6	<5	-	-
14	Mogare	0.3	0.11	5.5	<5	-	-
15	Padwe	0.9	0.25	1.5	<5	-	-
16	Nadan	1.6	0.11	3.0	<5	-	-
17	Waghotan	0.5	0.12	4.8	<5	-	-
18	Kelwade	1.8	0.13	3.1	<5	-	-

Table 3.6.10

Water Quality – Nutrient and Demand Parameters (Winter, 2006-07)

Sr. No	Sampling Location	Nitrate as N	Total Phos-phates	Dissolved Oxygen	Chemical Oxygen Demand	Bio-Chemical Oxygen Demand	Oil & Grease
		(mg/l)					
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	0.3	0.4	6.7	-	<3	0.9
2	Opposite Village Jaitapur	0.6	0.3	6.2	-	<3	0.4
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	0.2	0.3	5.8	-	<3	0.5
4	Near Saundale (Waghotan River Estuary)	0.7	0.5	5.3	-	<3	0.8
5	Near Dabhil Ambhore (Muchkundi River Estuary)	0.9	0.4	6.7	-	<3	0.9
	River water						
6	Village Bhanawli (Muchkundi River)	0.5	0.3	8.2	< 5	<3	2.0
7	Village Dasur (Muchkundi River)	0.7	0.4	6.8	< 5	<3	1.9
8	Village Taral (Waghotan River)	0.8	0.4	5.6	< 5	<3	1.66
9	Village Unhale (Arjuna River)	0.5	0.4	7.9	< 5	<3	1.66
	Ground water						
	Hand Pump						
10	Vijaydurg	0.1	0.02	2.7	<5	-	-
11	Mahalunge	0.2	0.04	2.4	<5	-	-
	Dug Well						
12	Jaitapur	0.2	0.01	7.2	<5	-	-
13	Nate	3.0	0.01	5.8	<5	-	-
14	Mogare	0.9	0.03	6.9	<5	-	-
15	Padwe	2.0	0.02	5.2	<5	-	-
16	Nadan	1.0	0.01	6.0	<5	-	-
17	Waghotan	0.4	0.01	5.9	<5	-	-
18	Kelwade	2.0	0.04	6.1	<5	-	-

Table 3.6.11

Water Quality-Heavy Metals (Summer, 2006)

Sr. No.	Sampling Stations	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	Co
		mg/l								
	Surface water									
	Sea Water									
1	Opposite Vijaydurg	BDL	0.02	0.15	0.01	1.81	0.42	0.03	0.04	0.01
2	Opposite Village Jaitapur	0.05	0.05	0.20	0.16	1.90	0.37	0.03	0.03	0.00
	Estuary Water									
3	Near Chauvanwadi (Arjuna River Estuary)	0.04	0.01	0.03	0.25	1.80	0.42	0.02	0.03	0.03
4	Near Saundale (Waghotan River Estuary)	0.06	0.01	0.11	0.03	1.48	0.37	0.02	0.02	0.02
5	Near Dabhil Ambhore (Muchkundi River Estuary)	0.03	BDL	BDL	0.01	0.03	0.55	0.05	0.04	BDL
	River water									
6	Village Bhanawli (Muchkundi River)	BDL	BDL	0.01	BDL	0.02	0.40	0.04	0.04	BDL
7	Village Dasur (Muchkundi River)	BDL	BDL	0.01	BDL	0.03	0.34	0.02	0.01	BDL
8	Village Taral (Waghotan River)	0.05	0.01	BDL	BDL	0.02	0.01	0.01	0.06	0.01
9	Village Unhale (Arjuna River)	0.03	BDL	0.01	0.02	0.05	0.30	0.02	0.05	0.01
	Ground water									
	Hand Pump									
10	Vijaydurg	0.07	0.02	0.03	BDL	0.03	0.23	0.01	0.08	BDL
11	Mahalunge	0.07	0.01	0.02	0.02	0.05	0.45	0.01	0.30	0.01
	Dug Well									
12	Jaitapur	0.06	0.01	0.04	BDL	0.04	0.40	0.01	0.60	0.02
13	Nate	0.03	0.04	0.02	BDL	0.03	0.42	0.04	0.05	BDL
14	Mogare	0.04	0.02	0.03	BDL	0.02	0.12	0.06	0.70	BDL
15	Padwe	0.05	0.01	0.04	BDL	0.05	0.56	0.01	0.08	0.02
16	Nadan	0.03	0.01	ND	0.01	0.04	1.30	0.02	0.34	0.10
17	Waghotan	0.04	0.02	BDL	BDL	0.07	0.60	0.03	0.01	BDL
18	Kelwade	0.01	0.02	0.02	BDL	0.03	0.34	0.06	0.04	BDL

BDL: Below Detectable Limit

Table 3.6.12

Water Quality-Heavy Metals (Post Monsoon, 2006)

Sr. No.	Sampling Stations	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	Co
						mg/l				
	Surface water									
	Sea Water									
1	Opposite Vijaydurg	BDL	BDL	BDL	BDL	BDL	0.32	0.07	0.36	BDL
2	Opposite Village Jaitapur	BDL	BDL	0.02	BDL	0.01	1.07	0.09	0.19	BDL
	Estuary Water									
3	Near Chauvanwadi (Arjuna River Estuary)	0.01	BDL	0.05	0.02	0.06	0.35	0.19	6.33	0.01
4	Near Saundale (Waghotan River Estuary)	0.01	BDL	0.04	0.02	0.1	0.43	0.11	0.05	0.01
5	Near Dabhil Ambhore (Muchkundi River Estuary)	BDL	BDL	0.04	0.02	0.04	0.12	0.04	0.08	BDL
	River water									
6	Village Bhanawli (Muchkundi River)	BDL	ND	0.02	0.01	0.05	0.19	0.03	0.03	BDL
7	Village Dasur (Muchkundi River)	0.01	BDL	0.02	0.02	0.05	0.77	0.08	0.03	0.01
8	Village Taral (Waghotan River)	0.02	BDL	0.04	0.02	0.07	0.32	0.06	0.04	0.01
9	Village Unhale (Arjuna River)	BDL	BDL	0.02	0.01	0.02	0.35	0.04	0.03	BDL
	Ground water									
	Hand Pump									
10	Vijaydurg	0.03	BDL	0.10	0.02	0.08	1.92	0.09	0.08	0.02
11	Mahalunge	0.01	BDL	0.02	0.01	0.04	0.15	0.02	0.07	BDL
	Dug Well									
12	Jaitapur	0.02	BDL	0.05	0.02	0.04	0.25	0.09	0.13	0.01
13	Nate	0.02	BDL	0.01	0.01	0.03	BDL	0.01	2.23	BDL
14	Mogare	0.05	BDL	0.06	0.02	0.07	0.17	0.05	0.13	0.01
15	Padwe	0.01	BDL	0.03	0.02	0.06	0.09	0.13	0.18	0.01
16	Nadan	0.02	BDL	0.04	0.03	0.11	0.14	0.13	0.09	0.01
17	Waghotan	0.02	BDL	0.04	0.03	0.09	0.11	0.12	0.08	0.01
18	Kelwade	0.02	BDL	0.04	0.02	0.06	0.14	0.06	0.03	0.01

BDL: Below Detectable Limit

Table 3.6.13

Water Quality-Heavy Metals (Winter, 2006-07)

Sr. No.	Sampling Stations	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	Co
						mg/l				
	Surface water									
	Sea Water									
1	Opposite Vijaydurg	0.01	0.03	0.01	BDL	0.13	0.57	0.02	BDL	0.01
2	Opposite Village Jaitapur	0.01	0.04	0.03	0.02	0.16	0.45	0.03	0.03	0.02
	Estuary Water									
3	Near Chauvanwadi (Arjuna River Estuary)	BDL	BDL	0.01	BDL	0.09	0.91	0.07	BDL	0.01
4	Near Saundale (Waghotan River Estuary)	0.01	0.04	0.01	BDL	0.16	0.60	0.07	0.01	0.04
5	Near Dabhil Ambhore (Muchkundi River Estuary)	BDL	0.01	0.03	0.02	0.12	0.63	0.04	0.04	0.01
	River water									
6	Village Bhanawli (Muchkundi River)	0.01	0.01	BDL	BDL	0.05	1.24	0.05	BDL	0.01
7	Village Dasur (Muchkundi River)	0.01	0.02	0.01	0.01	0.05	0.43	0.04	0.03	0.01
8	Village Taral (Waghotan River)	BDL	0.01	0.04	0.02	0.03	1.05	0.10	0.04	0.01
9	Village Unhale (Arjuna River)	BDL	BDL	0.01	BDL	0.04	0.40	0.02	0.02	BDL
	Ground water									
	Hand Pump									
10	Vijaydurg	0.02	0.03	BDL	BDL	0.03	0.52	0.03	0.02	0.02
11	Mahalunge	0.03	0.04	0.02	0.01	0.05	3.86	0.04	0.07	0.03
	Dug Well									
12	Jaitapur	0.02	0.03	0.02	0.01	0.05	0.52	0.06	0.09	0.01
13	Nate	0.01	0.02	0.07	BDL	BDL	0.03	0.01	0.06	0.01
14	Mogare	0.01	0.01	0.01	0.01	BDL	0.13	0.01	0.03	BDL
15	Padwe	0.01	0.02	0.01	BDL	0.01	0.28	0.01	0.02	0.01
16	Nadan	0.02	0.03	BDL	BDL	0.04	0.30	0.01	0.05	0.01
17	Waghotan	0.03	0.04	0.03	0.24	0.05	2.90	0.09	0.59	0.03
18	Kelwade	BDL	BDL	BDL	BDL	BDL	0.42	0.01	0.02	BDL

BDL : Below Detectable Limit

Table 3.6.14

Water Quality – Bacteriological Parameters (Summer, 2006)

Sr. No.	Sampling Location	Total Coliform	Faecal
		CFU/100 ml	
	Surface water		
	Sea Water		
1	Opposite Vijaydurg	800	54
2	Opposite Village Jaitapur	800	135
	Estuary Water		
3	Near Chauvanwadi (Arjuna River Estuary)	7200	275
4	Near Saundale (Waghotan River Estuary)	500	28
5	Near Dabhil Ambhore (Muchkundi River Estuary)	1350	105
	River water		
6	Village Bhanawli (Muchkundi River)	6250	300
7	Village Dasur (Muchkundi River)	7500	655
8	Village Taral (Waghotan River)	367	40
9	Village Unhale (Arjuna River)	3000	36
	Ground water		
	Hand Pump		
10	Vijaydurg	65	BDL
11	Mahalunge	45	BDL
	Dug Well		
12	Jaitapur	130	BDL
13	Nate	235	BDL
14	Mogare	320	16
15	Padwe	170	8
16	Nadan	230	BDL
17	Waghotan	200	8
18	Kelwade	150	BDL

BDL: Below Detectable Limit

Table 3.6.15

Water Quality - Bacteriological Parameters (Post-monsoon, 2006)

Sr. No.	Sampling Location	Total Coliform	Faecal Coliform
		CFU/100 ml	
	Surface water		
	Sea Water		
1	Opposite Vijaydurg	140	25
2	Opposite Village Jaitapur	150	10
	Estuary Water		
3	Near Chauvanwadi (Arjuna River Estuary)	260	35
4	Near Saundale (Waghotan River Estuary)	250	10
5	Near Dabhil Ambhore (Muchkundi River Estuary)	690	50
	River water		
6	Village Bhanawli (Muchkundi River)	240	25
7	Village Dasur (Muchkundi River)	370	20
8	Village Taral (Waghotan River)	270	80
9	Village Unhale (Arjuna River)	230	20
	Ground water		
	Hand Pump		
10	Vijaydurg	BDL	BDL
11	Mahalunge	BDL	BDL
	Dug Well		
12	Jaitapur	180	10
13	Nate	1150	75
14	Mogare	390	40
15	Padwe	1900	115
16	Nadan	500	40
17	Waghotan	270	80
18	Kelwade	90	BDL

BDL : Below Detectable Limit
CFU : Colony Forming Unit
US : Upstream
DS : Down stream

Table 3.6.16

Water Quality - Bacteriological Parameters (Winter, 2006-07)

Sr. No.	Sampling Location	Total coliform	Faecal colifrom
		(CFU/100ml)	
	Surface water		
	Sea Water		
1	Opposite Vijaydurg	115	10
2	Opposite Village Jaitapur	120	15
	Estuary Water		
3	Near Chauvanwadi (Arjuna River Estuary)	190	20
4	Near Saundale (Waghotan River Estuary)	125	38
5	Near Dabhil Ambhore (Muchkundi River Estuary)	120	25
	River water		
6	Village Bhanawli (Muchkundi River)	125	20
7	Village Dasur (Muchkundi River)	255	20
8	Village Taral (Waghotan River)	85	16
9	Village Unhale (Arjuna River)	170	58
	Ground water		
	Hand Pump		
10	Vijaydurg	20	ND
11	Mahalunge	55	10
	Dug Well		
12	Jaitapur	138	28
13	Nate	50	BDL
14	Mogare	105	20
15	Padwe	80	18
16	Nadan	110	20
17	Waghotan	70	8
18	Kelwade	85	8

BDL: Below Detectable Limit

Table 3.6.17
Biological Parameters – Phytoplankton
(Summer, 2006)

Sr. No.	Sampling Locations	Phytoplankton no./ ml	Percentage Composition of Algal Group				Shannon Wiener Diversity Index*	Palmer's Pollution Index (PPI)+
			Bacillario-phyceae	Cyano-phyceae	Chloro-pyceae	Eugleno-phyceae		
	Surface water							
	Sea Water							
1	Opposite Vijaydurg	94	50.00	-	50.00	-	2.250	7
2	Opposite Village Jaitapur	176	73.34	-	26.66	-	1.888	7
	Estuary Water							
3	Near Chauvanwadi (Arjuna River Estuary)	200	52.94	23.52	23.52	-	2.225	7
4	Near Saundale (Waghotan River Estuary)	165	57.14	28.58	14.28	-	1.923	6
5	Near Dabhil Ambhore (Muchkundi River Estuary)	165	50.00	-	50.00	-	2.605	
	River water							
6	Village Bhanawli (Muchkundi River)	153	30.76	-	69.24	-	1.881	5
7	Village Dasur (Muchkundi River)	153	30.76	-	69.24	-	2.196	8
8	Village Taral (Waghotan River)	129	54.54	-	45.46	-	2.114	9
9	Village Unhale (Arjuna River)	118	30.00	-	70.00	-	2.170	3
	Ground water							
	Hand Pump							
10	Vijaydurg	NIL	-	-	-	-	-	-
11	Mahalunge	NIL	-	-	-	-	-	-
	Dug Well							
12	Jaitapur	82	-	-	100.00	-	1.556	2
13	Nate	59	-	-	100.00	-	1.370	2
14	Mogare	82	28.58	-	71.42	-	1.556	0
15	Padwe	71	33.34	-	66.66	-	1.584	2
16	Nadan	59	20.00	-	80.00	-	1.921	5
17	Waghotan	82	-	-	100.00	-	1.448	2
18	Kelwade	47	50.00	-	25.00	25.00	1.500	10

- : Not Detectable

+Ranges of Palmer's Pollution Index

<15: Indicate absence of organic pollution

15-20: Indicate presence of organic pollution

>20: Indicate presence of high organic pollution

***Ranges of Shannon Wiener Diversity Index:**

<1: highest level of impact

1-3: medium level of impact

>3: indicates absence of any impact

Table 3.6.18

Biological Parameters – Phytoplankton Species (Summer, 2006)

Bacillariophyceae	Cyanophyceae	Chlorophyceae	Euglenophyceae
Diatoma sp.	*Phormidium sp.*	*Actinastrum sp.*	*Euglena sp.*
Melosira sp.		*Ankistrodesmus sp.*	
Navicula sp.		*Aphanizomenon sp.*	
Nitzschia sp.		*Chlorococcum sp.*	
Pinnularia sp.		*Cosmarium sp.*	
Tabellaria sp.		*Penium sp.*	
		Selenastrum sp.	
		Spirogyra sp.	
		Staurastrum sp.	

Table 3.6.19

Biological Parameters – Phytoplankton (Post-monsoon, 2006)

Sr. No.	Sampling Locations	Phytoplankton no./ ml	Percentage Composition of Algal Group			Shannon Wiener Diversity Index*	Palmer's Pollution Index+ (PPI)
			Bacillario-Phyceae	Chloro-phyceae	Cyano-phyceae		
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	112	70.00	30.00	-	1.970	7
2	Opposite Village Jaitapur	56	100.00	-	-	1.370	7
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	123	36.36	27.28	36.36	2.114	10
4	Near Saundale (Waghotan River Estuary)	123	63.63	18.18	18.18	1.934	6
5	Near Dabhil Ambhore (Muchkundi River Estuary)	101	66.66	33.34	-	2.058	9
	River water						
6	Village Bhanawli (Muchkundi River)	90	37.50	62.50	-	2.156	8
7	Village Dasur (Muchkundi River)	90	62.50	37.50	-	1.906	6
8	Village Taral (Waghotan River)	112	60.00	40.00	-	2.245	9
9	Village Unhale (Arjuna River)	101	66.66	33.34	-	1.836	6
	Ground water						
	Hand Pump						
10	Vijaydurg	NIL	-	-	-	-	-
11	Mahalunge	NIL	-	-	-	-	-
	Dug Well						
12	Jaitapur	112	40.00	50.00	10.00	2.121	4
13	Nate	67	33.34	66.66	-	1.916	5
14	Mogare	78	42.86	57.14	-	1.556	3
15	Padwe	56	60.00	40.00	-	1.921	3
16	Nadan	90	62.50	37.50	-	1.781	3
17	Waghotan	101	66.66	33.34	-	1.836	5
18	Kelwade	112	40.00	60.00	-	1.921	3

- : Not Detectable

+**Ranges of Palmer's Pollution Index**

<15: Indicate absence of organic pollution
15-20: Indicate presence of organic pollution
>20: Indicate presence of high organic pollution

***Ranges of Shannon Wiener Diversity Index**

<1: Indicate maximum impact of pollution
1-2: Indicate medium impact of pollution
>2: Indicate lowest or no impact of pollution

Table 3.6.20

Biological Parameters – Phytoplankton Species (Post Monsoon, 2006)

Bacillariophyceae	Chlorophyceae	Cyanophyceae
Melosira sp.	*Ankistorodesmus sp.*	*Phormidium sp.*
Navicula sp.	*Actinastrum sp.*	
Nitzschia sp.	*Chlorococcum sp.*	
Pinnularia sp.	*Cosmarium sp.*	
Tabellaria sp.	*Spirogyra sp.*	
	Staurastrum sp.	

Table 3.6.21
Biological Parameters – Phytoplankton
(Winter, 2006-07)

Sr. No.	Sampling Locations	Phytoplankton no./ ml	Percentage Composition of Algal Group				Shannon Wiener Diversity Index+	Palmer's Pollution Index (PPI)*
			Bacillario-phyceae	Chloro phyceae	Cyno phyceae	Eugleno-phyceae		
	Surface water							
	Sea Water							
1	Opposite Vijaydurg	146	61.54	38.46	-	-	1.920	7
2	Opposite Village Jaitapur	179	50.00	50.00	-	-	2.451	6
	Estuary Water							
3	Near Chauvanwadi (Arjuna River Estuary)	157	71.44	14.28	14.28	-	2.124	8
4	Near Saundale (Waghotan River Estuary)	224	40.00	40.00	20.00	-	2.084	9
5	Near Dabhil Ambhore (Muchkundi River Estuary)	426	60.52	26.32	13.16	-	2.454	13
	River water							
6	Village Bhanawli (Muchkundi River)	202	66.66	33.34	-	-	1.903	10
7	Village Dasur (Muchkundi River)	269	62.50	37.50	-	-	2.489	11
8	Village Taral (Waghotan River)	168	86.66	13.34	-	-	2.089	7
9	Village Unhale (Arjuna River)	314	35.72	64.28	-	-	2.264	6
	Ground water							
	Hand Pump							
10	Vijaydurg	Nil	-	-	-	-	-	-
11	Mahalunge	Nil	-	-	-	-	-	-
	Dug Well							
12	Jaitapur	134	83.34	-	16.66	-	1.482	5
13	Nate	101	33.34	66.66	-	-	1.890	3
14	Mogare	157	85.72	-	-	14.28	1.876	12
15	Padwe	168	66.66	20.00	13.34	-	1.907	7
16	Nadan	202	50.00	50.00	-	-	2.131	3
17	Waghotan	90	62.50	37.50	-	-	1.562	3
18	Kelwade	146	61.54	30.76	7.70	-	2.157	8

- : Not Detectable

***Ranges of PPI (Palmer's Pollution Index)**

<15: Indicate absence of organic pollution

15-20: Indicate presence of organic pollution

>20: Indicate presence of high organic pollution

+Ranges of Shannon Wiener Diversity Index

<1: Indicate maximum impact of pollution or adverse factor

1-2: Indicate medium impact of pollution or adverse factor

>2: Indicate lowest or no impact of pollution or adverse factor

Table 3.6.22

Biological Parameters – Phytoplankton Species (Winter, 2006-07)

Bacillariophyceae	Chlorophyceae	Cynophyceae	Euglenophyceae
Diatoma sp.	*Ankistrodesmus* sp.	*Anabaena* sp.	*Chlamydomonas* sp.
Pinnularia sp.	*Actinastrum* sp.	*Aphanizomenon* sp.	
Melosira sp.	*Botryococcus* sp.	*Merismopedia* sp.	
Navicula sp.	*Chlorella* sp.		
Nitzschia sp.	*Closteridium* sp.		
Stephanodiscus sp.	*Chlorococcum* sp.		
Synedra sp.	*Cosmarium* sp.		
	Pediastrum sp.		
	Staurastrum sp.		
	Stigeoclonium sp.		

Table 3.6.23

Biological Parameters-Zooplankton (Summer, 2006)

Sr. No.	Sampling Locations	Zooplankton no. / m^3	Percentage Organism in Groups				Shannon Wiener Index*
			Copepoda	Rotifera	Cladocera	Nematoda	
	Surface water						
	Sea Water						
1	Opposite Vijaydurg	2200	50	50	-	-	1.26
2	Opposite Village Jaitapur	1100	82	9	9	-	1.69
	Estuary Water						
3	Near Chauvanwadi (Arjuna River Estuary)	9000	79	15	-	6	0.94
4	Near Saundale (Waghotan River Estuary)	5800	84	8	8	-	1.47
5	Near Dabhil Ambhore (Muchkundi River Estuary)	400	60	40	-	-	1.89
	River water						
6	Village Bhanawli (Muchkundi River)	100	-	100	-	-	0.00
7	Village Dasur (Muchkundi River)	100	-	100	-	-	0.00
8	Village Taral (Waghotan River)	8300	30	60	10	-	1.14
9	Village Unhale (Arjuna River)	1600	88	12	-	-	1.49
	Ground water						
	Hand Pump						
10	Vijaydurg	NIL	-	-	-	-	-
11	Mahalunge	NIL	-	-	-	-	-
	Dug Well						
12	Jaitapur	1000	80	20	-	-	1.98
13	Nate	700	71	29	-	-	1.92
14	Mogare	3000	92	8	-	-	1.26
15	Padwe	800	60	40	-	-	1.86
16	Nadan	900	100	-	-	-	0.00
17	Waghotan	700	86	4	10	-	2.12
18	Kelwade	300	67	33	-	-	1.67

- : Not Detectable

***Ranges of Shannon Wiener Diversity Index:**

<1: highest level of impact

1-2: medium level of impact

>2: indicates absence of any impact

Table 3.6.24

Biological Parameters-Zooplankton Species (Summer, 2006)

Phylum	Species
Copepoda	*Cyclops* sp.
	Nauplius larva
Rotifera	*Keratella* sp.
	Brachionus sp.
	Monostyla sp.
	Lepadella sp.
	Euchlanis sp.
	Filinia sp.
	Proales sp.
	Aspelta sp.
Cladocera	*Daphnia* sp.
Nematoda	*Rabditiform larva*

Table 3.6.25

Biological Parameters- Zooplanktons (Post Monsoon, 2006)

Sr. No.	Sampling Locations	Zooplankton no. / m^3	% of Organisms in Groups					Shannon Wiener Index*
			Protozoa	Copepoda	Rotifera	Cladocera	Nematoda	
	Surface water							
	Sea Water							
1	Opposite Vijaydurg	150	-	-	100	-	-	0
2	Opposite Village Jaitapur	2100	64	-	-	8	29	1.19
	Estuary Water							
3	Near Chauvanwadi (Arjuna River Estuary)	NIL	-	-	-	-	-	-
4	Near Saundale (Waghotan River Estuary)	150	-	100	-	-	-	0
5	Near Dabhil Ambhore (Muchkundi River Estuary)	65	-	70	-	30	-	1.78
	River water							
6	Village Bhanawli (Muchkundi River)	77	-	100	-	-	-	1.83
7	Village Dasur (Muchkundi River)	68	-	58	-	42	-	1.68
8	Village Taral (Waghotan River)	4513	-	20	48	32	-	2.12
9	Village Unhale (Arjuna River)	917	-	67	-	33	-	1.90
	Ground water							
	Hand Pump							
10	Vijaydurg	-	-	-	-	-	-	-
11	Mahalunge	-	-	-	-	-	-	-
	Dug Well							
12	Jaitapur	NIL	-	-	-	-	-	-
13	Nate	NIL	-	-	-	-	-	-
14	Mogare	NIL	-	-	-	-	-	-
15	Padwe	NIL	-	-	-	-	-	-
16	Nadan	NIL	-	-	-	-	-	-
17	Waghotan	NIL	-	-	-	-	-	-
18	Kelwade	1200	-	100	-	-	-	0

- : Not Detectable
*Ranges of Shannon Wiener Diversity Index:
<1: highest level of impact
1-2: medium level of impact
>2: indicates absence of any impact

Table 3.6.26

Biological Parameters-Zooplankton Species (Post Monsoon, 2006)

Phylum	Species
Nematoda	*Dilogastroid* sp.
Cladocera	*Daphnia magna*
Protozoa	*Paramecium bursaria*
	Stylonchia pustulata
Copepoda	*Microcyclops varicans*
	Cyclops strennus
Rotifera	*Trichocerca capncina*

Table 3.6.27

Biological Parameters – Zooplankton (Winter, 2006-07)

Sr. No.	Sampling Locations	Zooplankton no. / m^3	Percentage of Organisms					Shannon Wiener Diversity Index*
			Rotifera	Copepoda	Cladocera	Polychaeta	Macrura	
	Surface water							
	Sea Water							
1	Opposite Vijaydurg	8,000	50	50	-	-	-	2.25
2	Opposite Village Jaitapur	9,000	33	22	-	-	45	2.42
	Estuary Water							
3	Near Chauvanwadi (Arjuna River Estuary)	10,000	31	62	-	-	8	2.07
4	Near Saundale (Waghotan River Estuary)	12,000	33	66	-	-	-	2.05
5	Near Dabhil Ambhore (Muchkundi River Estuary)	14,000	28	50	11	11	-	2.48
	River water							
6	Village Bhanawli (Muchkundi River)	83	15	85	-	-	-	1.73
7	Village Dasur (Muchkundi River)	78	-	100	-	-	-	1.78
8	Village Taral (Waghotan River)	6600	35	65	-	-	-	1.66
9	Village Unhale (Arjuna River)	11,000	27	46	27	-	-	2.23
	Ground water							
	Hand Pump	Nil	-	-	-	-	-	-
10	Vijaydurg	Nil	-	-	-	-	-	-
11	Mahalunge							
	Dug Well	1200	8	50	42	-	-	1.82
12	Jaitapur	900	-	78	22	-	-	1.53
13	Nate	800	38	50	13	-		2.16
14	Mogare	1100	27	55	19	-	-	2.18
15	Padwe	800	38	63	-	-	-	1.91
16	Nadan	800	38	62	-	-	-	1.91
17	Waghotan	1000	36	50	14	-	-	2.27
18	Kelwade							

- : Not Detectable
*Ranges of Shannon Wiener Diversity Index:
<1: highest level of impact
1-2: medium level of impact
>2: indicates absence of any impact

Table 3.6.28

Biological Parameters-Zooplankton Species (Winter, 2006-07)

Group	Species
Rotifera	*Brachionus calciflorus*
	Brachionus sp.
	Euchlanis sp.
	Filinia sp.
	Keratella procurva
	Keratella vulga
	Keratella sp.
Cladocera	*Daphnia* sp.
Copepoda	*Cyclops* sp.
	Nauplius larva
Macrura	*Penaid nauplius*
	Shrimp nauplius
Polychaeta	*Chaetospora larva*

3.7 Land Environment

3.7.1 Geology

The proposed area for Jaitapur Nuclear Power Project lies very close to the lighthouse of the Rajapur bay, situated on a promontory. The site is located on a lateritic plateau along the seashore, to the south of the adjoining Rajapur Bay. The plateau region is mostly composed of the laterites, which are derived from original basaltic rock. These laterite rock exposures are light to dark brown in colour. The valley cuttings and borehole log indicate that laterites are 20-30 m thick, hard and spongy at the top with lithomarge clay in the middle and weathered basaltic rocks at the bottom. Fresh basaltic rocks are exposed in the nala cuttings at villages Dhaulwalli and Devache Gothane. These basaltic rocks are composed of horizontally disposed lava flows. Most of the lava flow units are predominantly massive.

From the point of view of founding the heavy structures, foundation will have to be provided by the basaltic rock below the laterite to a depth of 20-30 m and the underlying weathered zone, from the grade level. Actual depth of excavation will be known by sub-surface investigations undertaken by GSI at Jaitapur site.

Basalt as the foundation is adequate in strength to bear the heavy loads of the reactor structures and wherever joints are there, consolidation grouting may be necessary to seal the weak zones up to some depth. The seacoast at the site seems to be prone to erosion by breaker (waves) as evidenced by the large number of boulders strewn below the cliff. The proposed breakwall structure will act as a barrier to the sea waves and coastal area will be stabilised & completely protected. Therefore, coastal erosion will be nil.

3.7.1.1 Physiography of the Coastal Region of Konkan

The narrow strip of land, west of the Sahyadri up to the Arabian Sea on the west coast of India, is the coastal region of the Konkan. It is broader, about 50 km, in the north and narrower to about 30 km in width southwards. It is nowhere flat, being cut up by many east-west trending ridges, some of which reach right to the coast. The region is also traversed by several short rivers, with steep gradient, which have their origin in the Sahyadris. There are some small and narrow plateaus at different elevations in this region at places covered by laterite. The Sahyadris form the main watershed of the rivers of Peninsular India.

3.7.1.2 Drainage

The Sahyadri forms the major drainage systems in the Konkan and the central Maharashtra regions. The rivers in the Konkan region flow towards west. The physiographic features in coastal region are presented in the **Table 3.7.1**.

3.7.1.3 Climate

Three distinct seasons are recognized, viz. summer, rainy and winter. In summer the highest temperature ranges between 40° to 48°Celsius over a greater part of the State. In Konkan region weather is hot and humid. The coastal region of Konkan receives 2000-3000 mm rainfall.

3.7.1.4 Soils

In Konkan region, soil is mainly lateritic.

3.7.1.5 Evolution of Landforms in Coastal Region

Konkan coast exhibits fairly the types of landforms in this coastal region. A perusal of the list will indicate that most of them are erosional (cliff, cove, headland, reentrant) and some of them due to oscillations in sea level, abandoned cliff cove beach, dismembered streams drowned valley river island, stacks valley fill.

3.7.1.6 Stratigraphy

The stratigraphic succession of the different rock formations of the State are summarized in the **Table 3.7.2**.

3.7.1.7 Structure and Tectonics

The State of Maharashtra forms a part of the Indian Peninsular shield. It shows imprints of the structural and tectonic events the Peninsula has experienced.

The second group of lineaments has a conspicuous NW-SE trend and is represented by the Godavari group of lineaments, which includes Kadam, Godavari, Ghod, Bhima and Varna lineaments. These traverse across the entire Maharashtra plateau. All these lineaments, controlling the courses of major rivers, are considered as fault lineaments cutting the Deccan lava flows and are manifestations of Quaternary tectonic activity.

Lineaments

It is observed that in the State lineaments have NW-SE trend, which is major, followed by NE-SW. A few lineaments have N-S and E-W trend. The Azimuthal frequency diagram based on number and direction of lineaments shows that in west coast (Mumbai-Ratnagiri) the major trend is N-S followed by NE-SW. The density of lineaments is higher in Mumbai, Ratnagiri, Nasik and Dhule districts.

3.7.1.8 Geo-hydrology

The Laterites, high rainfall (3000 mm/year) and high relief of the landforms heavily influence groundwater around Jaitapur. The lateritic rock cover up to a depth of 20-30 m from the surface level seems to show poor retentivity, and hence no ground water saturated zone is found within this unit. Coupled with its poor retentivity, because of good drainage and consequent run-off towards the sea, due to hydraulic gradient, the lateritic zone may not hold much ground water potential. Perhaps, the saturation zone level may lie at the junction between the Laterite and the underlying weathered basalt. Such a zone has been picked up in a well-cutting below the cliff section, for the pump-house of the light house establishment, where the water level is at a depth of about 17 m below surface level. Here the water level fluctuates from about 14 m below ground level during post monsoon times to less than 18 m in the summer when it gets contaminated during post monsoon times. As such, geo-hydrological conditions at this site do not indicate good ground water potential as presented in the **Table 3.7.3**. Ground water conditions may not pose any problems for foundations.

3.7.2 Seismotectonics

The site area is in zone-III as per the seismic zoning map of India (IS-1893 Part-I-2002). Map showing Seismic Zones of India is reproduced in **Fig. 1.2** of the **Chapter 1**. The site area is on the southwestern fringes of Deccan Trap exposed on the land, which overlies the geologically older formations including Precambrian granite gneiss:

NW-SE trending deep-seated fault east of Sawantwadi was identified by ONGC (1968) at a distance of about 64 km to the east of the site area. This passes northward close to the N-S trending fault, which is the extension of Koyna Rift. The length of the later fault is about 540 km and it passes at a distance of about 76 km from the Jaitapur Site.

In view of what has been stated above, the nearest tectonic feature would be the ONGC delineated deep crustal fault at 64 km to the east of the site. The Koyna earthquake of 6.5 magnitude (December 10, 1967) is the maximum observed and recorded event in this region.

A preliminary study has also been made from the Micro earthquake data available from 'Koyna Bandhkam Authority'. The data has been analysed and plotted in the form of an epicentral map. From this study, it emerged that there is no earthquake activity around Jaitapur site in a radius of 39 km.

3.7.3 Baseline Status of Soil with Respect to Conventional Parameters

Total fifteen soil samples were collected from the study area within 25 km radial distance from project site. Location of these places are depicted in **Fig. 3.7.1** and summarised in **Table 3.7.4**. Representative soil samples from depth (0-15cm) were collected in April, 2006 from these villages and mining area for estimation of the physico-chemical characteristics of soil. Standard methods have been followed for the analysis of soil samples.

The International Pipette Method (Black, 1964) was adopted for determination of particle size analysis. The textural diagram was generated using "SEE Soil Class 2.0 version based on United States Department of Agriculture (USDA) classification of soils. Physical parameters such as bulk density, porosity and water holding capacity were determined by following KR Box Method (Keen and Raczkowski, 1921).

The chemical characteristics of soil were determined by preparing soil extract in distilled water in ratio 1:1 (Jackson, 1967). Organic matter was determined in terms of organic carbon by Walkley & Black method (1972). Fertility status of soil in terms of nitrogen and phosphorus and potassium was determined by Kjeldhal Method, Olsen's method (1954) and Flame photometer (Jackson, 1967) respectively.

3.7.4 Physical Properties of Soil

Air-dried and sieved samples were used for determination of physical properties of soil. Soil characteristics such as the particle size distribution in terms of percentage of sand, silt and clay are presented in **Table 3.7.5** and **Table 3.7.6**. The texture of the soil varies from loam to clay loam **Fig 3.7.2** Clay to clay loam is the prominent textural class in the impact zone. The physical characteristics of soils viz., particle size distribution, bulk density, porosity and water holding capacity are presented in **Table 3.7.6**.

The soil being of friable consistency, the bulk density of the soil in the study area is in the range of 1.20 - 1.35 g/cm^3 whereas the porosity and water holding capacity are in the range of (40.53-55.61 %) and (38.8-55.59%) respectively.

3.7.5 Chemical Properties of Soil

The collected soil samples were analysed for various chemical properties. The parameters selected were pH, electrical conductivity, soluble anions and cations, Cation Exchange Capacity (CEC), exchangeable cations, Exchangeable Sodium Percentage (ESP), nutrients and organic carbon content. The results are presented in **Table 3.7.7** to **Table 3.7.9**.

pH is an important parameter which indicates the alkaline or acidic nature of soil. Soil of all the villages of the study area are moderately acidic to moderately neutral in nature having pH in the range of 4.47 to 6.89 (**Table 3.7.7**). This pH range is low to moderately suitable for the growth of plants.

The soluble salts were determined from soil extract (1:1). The soluble salts are expressed in terms of electrical conductivity (EC). The EC for the soil samples are in the range of 0.059-0.133 mS/m (**Table 3.7.7**). The electrical conductivity of all soils is in the normal range.

The most important cations present in soluble state in the soil are calcium and magnesium. It is observed that calcium and magnesium are in the range of 1.01-1.07 meq/l and 0.18-0.70 respectively (**Table 3.7.7**). Sodium and potassium were found to be 0.040-0.089 meq/l and 0.04-0.19 meq/l respectively.

In general, the soil in the region has moderate adsorption capacity as evident from the cation exchange capacity which was found to be in the range of 14.34 - 21.47 cmol (p+) kg^{-1} of soil (**Table 3.7.8**).

Soils from all the villages are normal with respect of alkalinity as Exchangeable Sodium Percentage (ESP) was found from 0.001-0.003 (**Table 3.7.8**). The normal soil have ESP value <5.0. The presence of sodium in exchangeable form may have deleterious effect on the chemical and physical properties of soil.

Nutrient Status

Organic matter present in the soil influences the soil physical and chemical properties. Organic matter commonly accounts for one third or more of the cation exchange capacity of surface soils. It is also responsible for stability of soil aggregates.

Organic carbon, total nitrogen, phosphorous and potassium were found to be in the range as given below (**Table 3.7.9**). The soil in the area is mostly of medium quality with respect to organic carbon content but is of poor quality with respect to N, P and K.

Organic carbon	= 0.15 -0.62 %
Total nitrogen	= 126.2 – 256.2 Kg/ha
Phosphorous	= 16.2 – 21.2 Kg /ha
Potassium	= 126.8 – 146.2 Kg /ha

The relationships of CEC with Productivity and Absorptivity are shown in **Table 3.7.10** and **Table 3.7.11** respectively.

The trace metals present in the soil are presented in **Table 3.7.12**. The trace metal content is normal in the soil samples.

3.7.6 Soil Microbiology

Soil organisms play a key role in nutrient transformation, organic forms are transformed into their respective inorganic forms and plants are able to absorb them for their growth. Physical, chemical and physico-chemical characteristics of soil and its nutrient status influence the microbial population. Microorganisms in samples of soil are presented in the **Table 3.7.13**.

Various ecological cycles in the Rhizosphere zone of the plant depend upon microbiological population. The population of bacteria, fungi and actinomycetes are the vital components of soils and they help in maintaining their stability. Azotobacter are non-symbiotic nitrogen fixing micro-organisms and improve soil fertility by fixing nitrogen in soil. Fungi also constitute an important part of the microflora of normal soil. They are active in initial stages of decomposition of plant residues and actively participate in the process of soil aggregation.

Total viable microbial population per gram of soil varied from $70x10^6$-$190x10^6$ CFU. Different microflroa observed per gram of soil samples were fungi ($7x10^4$-$10x10^4$CFU), actinomycetes ($5x10^4$-$9x10^4$ CFU), *Rhizobium* ($3x10^4$-$10x10^4$CFU) and *Azotobacter* ($6x10^4$-$9x10^4$CFU). Soils are rich in diverse microbial flora and their beneficial activity would be enhanced under proper soil management and fertilizer application.

3.7.7 Baseline Radioactivity Levels in Soil, Rock and Sand Samples

18 soils, 3 shore deposited sand, 4 rock and one sediment samples were collected from various locations around site and analysed for natural and fallout activity contents. The samples were subjected to gamma spectrometry for estimation of U-238, Th-232, K-40 and Cs-137 and also analysed for Sr-90 by radiochemical separation. The results of analysis are presented in **Table 8**, as appended in **Volume II**, **Annexure-IX(a)**.

The concentration of naturally occurring radionuclides in rock samples ranged as follows:

Ra-226 = 51.5 Bq/kg - 86.5 Bq/kg
U-238 = 47.2 Bq/kg - 56.7 Bq/kg
Th-232 = 55.6 Bq/kg - 59.1 Bq/kg
K-40 = < 44 Bq/kg - 82.1 Bq/kg

U-238, Th-232 and K-40 levels in shore deposited sand were in the range of 7.4 Bq/kg - 13.1 Bq/kg and 4.4 Bq/kg - 7.8 Bq/kg and <44 Bq/kg - 135.9 Bq/kg respectively. The corresponding levels in shore sediments were 25.4 Bq/kg, 19.9 Bq/kg and 217.5 Bq/kg respectively. Ra-226 was less than the detection limit of 6.2 Bq/kg in all the sand samples whereas the sediment sample contained 41.3 Bq/kg.

The concentration of naturally occurring radionuclides in soil samples ranged as follows:

Ra-226 = < 6.2 Bq/kg - 132.4 Bq/kg
U-238 = 17.8 Bq/kg - 118.7 Bq/kg
Th-232 = 16.8 Bq/kg - 88.2 Bq/kg
K-40 = 99.2 Bq/kg - 474.8 Bq/kg

The fallout activity due to Sr-90 and Cs-137 were less than their detection limits of 0.8 Bq/kg in all the shore deposited sand and sediment samples. In soil samples these radionuclides ranged from <0.8 Bq/kg -10.9 Bq/kg and <0.8 bq/kg - 72.2 Bq/kg respectively. These are the normal levels in the Western region.

3.7.8 Land use Pattern Based on Census Data

The land use pattern in the district of Ratnagiri and Sindhudurg is presented in **Table 3.7.14**.

Within 10 km

About 60% of the area within 10 km around the site consists of the sea. Out of the remaining area 30% is barren, 6% is agricultural land and 4% is grasslands. No forests are reported to exist. The agricultural production in this area is sustained by rain-fed cultivation. The main crop is paddy with annual yields averaging to about 2 to 2.5 Tonnes/ha. The total produce of paddy is estimated to be about 4000 tonnes per annum. The land use for agriculture can be considered to be small in this area.

Within 1.5 km

About 55 ha land in this zone is used for agricultural activity. Paddy is the main crop and the total annual produce is estimated to be about 125 tonnes of paddy. The sea constitutes about 45 to 50% of the area within this zone. The remaining area is either barren or wasteland. The ownership of the land is mainly private.

3.7.9 Land use Pattern based on Remote Sensing Data

Remote Sensing technology has emerged as a powerful tool in providing reliable information on various natural resources at different levels of details in a spatial format. It has played an important role in effective mapping and periodic monitoring of natural resources environment.

With the availability of high resolution remote sensing data, newer areas of remote sensing applications have been identified, techniques of data processing have been improved and computer based image processing systems have become more effective.

Data Used

In order to strengthen the baseline information on existing landuse pattern, the following data at the latitude (16°22'-16°50') N longitude (73°04'-73°34') E (approx.) (The grid size is 7.4 km x 7.4 km) were used:

A. Remote sensing data

IRS P6 LISS III Scene

Path 095, Row 061 dated 21-Dec-2005; CD format

B. Collateral data

Toposheet No.: - 47H/5,47H/6,47H/7,47H/9,47H/10,47H/11

Detailed location map

Methodology

Salient features of Methodology are given below:

- Acquisition of Satellite data
- Data loading
- Data processing
- Geo-referencing Image
- Rectification
- Classification
- Ground Truthing / field Checks using Global Positioning System
- Masking

The spatial resolution and the spectral bands in which the sensor collects the remotely sensed data are two important parameters for any landuse survey. IRS P6 LISS III data offers spatial resolution of 23.5 m with the swath width of 141 x 141 km. The data is collected in four visible bands namely green (Band 2) (0.52-0.59μ), red (Band 3) (0.62-0.69μ), near Infrared (NIR) (Band 4) (0.77-0.89μ), Short wave infrared band (Band 5) (1.55-1.75μ) with orbit repeat period of 24 days (three days revisit). The shapes, sizes, colours, tone and texture of several geomorphic features are visible in IRS data. Four spectral bands provide high degree of measurability through band combination including FCC generation, bands rationing, classification etc. These features of the IRS data are particularly important for better comprehension and delineation of the landuse classes. Hence, IRS P6 LISS-III data has been used for landuse mapping.

The digital image processing was performed on EARDAS IMAGINE 8.7 System on high-configured computer. This software package is a collection of image processing functions necessary for pre-processing, rectification, band combination, filtering, statistics, classification etc. Apart from contrast stretching, there are large numbers of image processing functions that can be performed on this station.

The satellite data from the compact disc is loaded on the hard disk and by studying quick looks (the sampled image of the appropriate area), the sub-scene of the study area is extracted.

Supervised classification using all the spectral bands can separate fairly accurately, the different landuse classes at level II on the basis of the spectral responses, which involve the following three steps:

a) Acquisition of ground truth
b) Calculation of the statistics of training area
c) Classification using maximum likelihood algorithm

The training areas for classification were homogeneous, well spread throughout the scene with bordering pixels excluded in processing. Several training sets have been used through the scene for similar landuse classes. After evaluating the statistical parameters of training sets, the training areas were rectified by deleting no congruous training sets and creating new ones.

Results

Landuse refers to man's activities on land, utilitarian in nature whereas landcover denotes the vegetation cover, water body cover and artificial constructions etc.

The landuse/landcover classification system standardized by Department of Space, for mapping different agro-climatic zones has been adopted. This classification system has six major land use classes at level I and twenty-eight at level II **(Table 3.7.15)**. The six major classes at level I was further enunciated in the following six categories:

a) **Built up land**: This comprises areas of land covered by structures

b) **Agricultural land**: Land used for production of food, fiber, crop and plantation

c) **Forest**: This includes land such as dense or sparse evergreen forests, deciduous Forests and degraded forests.

d) **Wastelands**: Land having potential for development of vegetation cover but not being used due to constraint includes salt affected land, eroded land and water logged areas.

e) **Water bodies:** Area persistently covered by water such as rivers/streams, reservoirs / tanks, lakes / ponds and canals

f) **Others**: Grassland and snow covered land are included in this category.

Landuse / landcover distribution in the study area has been estimated as given below using the above classification system and digital analysis techniques.

Plate 3.7.1

It is the LISS III Image of proposed Site of Jaitapur, Ratnagiri district, Maharashtra. In the image, vegetation (plantation, shrub, forest) appears red, water bodies and river as blue/dull green. Attributes such as colour, tone, texture, shape and size are used to interpret the image visually. Morphologically the area is irregular and most of the part is hilly, which is surrounded by flat country. Water bodies are distributed throughout the whole area. In the FCC vegetation cover is marked with red color.

Muchkundi, Kodavli, Vaghotan, Phanse and Kharada River are the major Rivers, present in the study area.

Plate 3.7.2

It is the colour-coded output of supervised classification with colours assigned to various classes for proposed Site at Jaitapur, Ratnagiri district, Maharashtra. In this image, colours are assigned to various classes as given in legend .The landuse / landcover classification indicates half of the portion of study area covered by Ocean/River and it covers 54.24% area. It is assigned by dark blue color. **(Table 3.7.16)**.

Six different classes are identified, along with corresponding area. Water bodies are indicated by light blue colour, covers 0.01% area. Vegetation, which is spread all over area cover 14.46% and it, is assigned by light green color. Sand/Bare soil covers 0.26% and it is assigned by white color and 30.43% area covered by wasteland. Mangrove that is present near the river and seacoast covers 0.60% area and it is assigned by dark green color.

3.7.10 HTL / LTL Demarcation off Jaitapur Coast

The high and Low Tide line demarcation off Waghapur Head Land for the proposed Power Project was carried out as per the standard methodology of Survey of India. The work carried out by National Institute of Ocean Technology (NIOT), Chennai, is enclosed separately as **Annexure-VI in Vol II**, of this report. The coverage of HTL / LTL at the proposed revenue map of the project site is presented in **Fig. 5** of the **Summary EIA** of this report. The corresponding HTL/LTL demarcation superimposed on the plant layout for all the six and twin NPP units at JNPP Site are presented in **Fig. 6** & **Fig. 7** of the **Summary EIA** of this report.

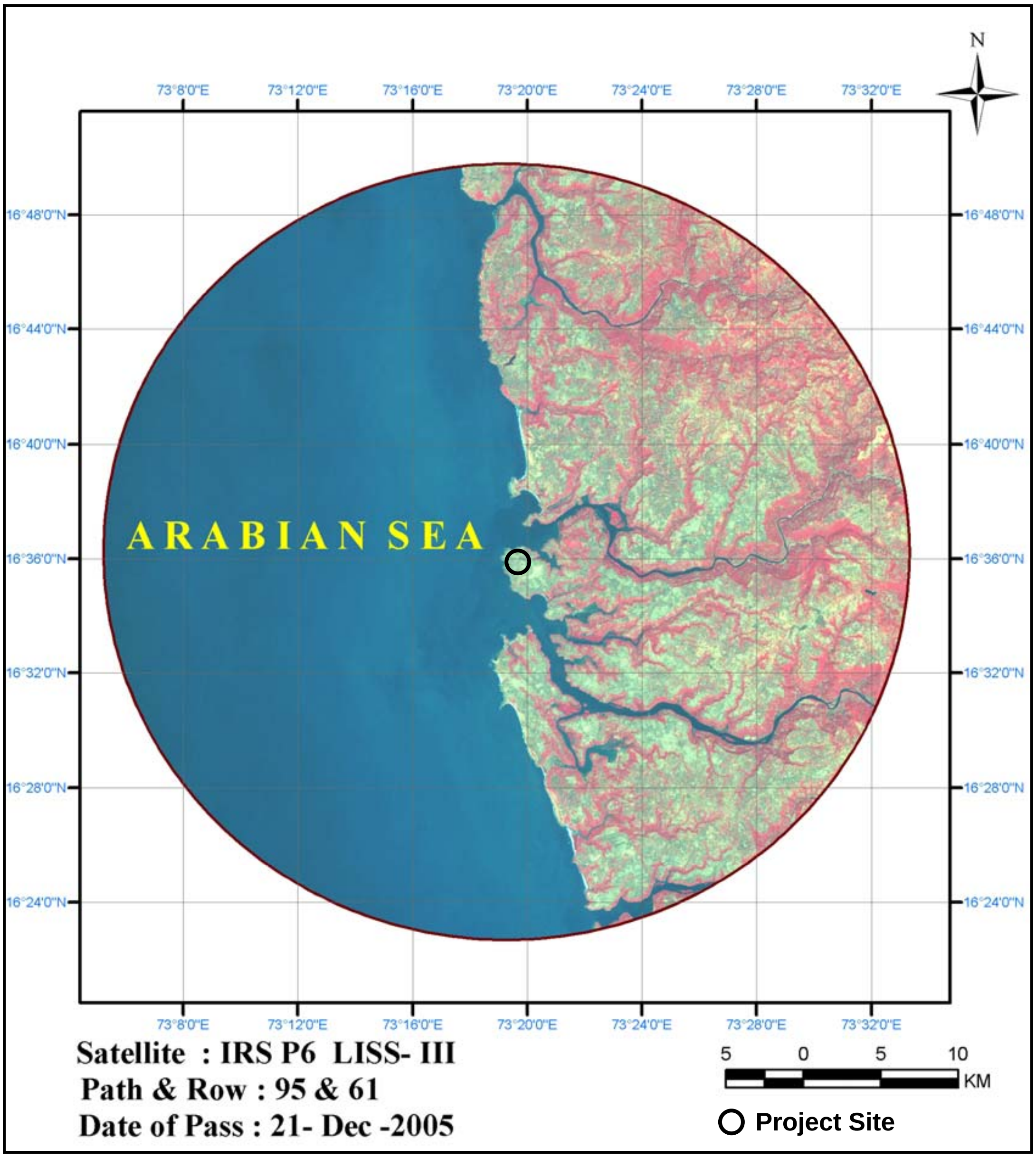


Plate 3.7.1: False Colour Composite of Study Area around Proposed Jaitapur Nuclear Power Park

(Grid Size: 7.4 km x 7.4 km)

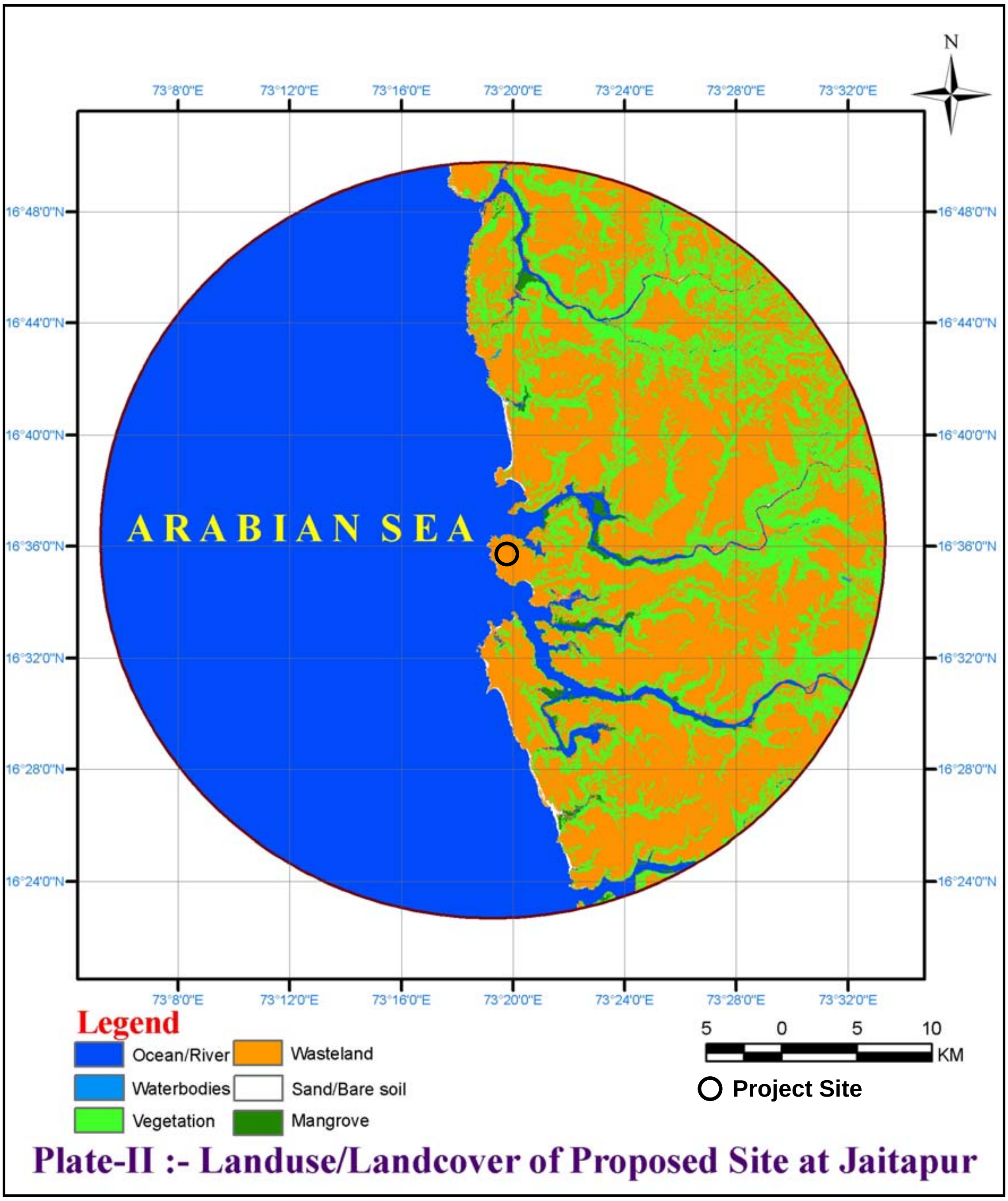
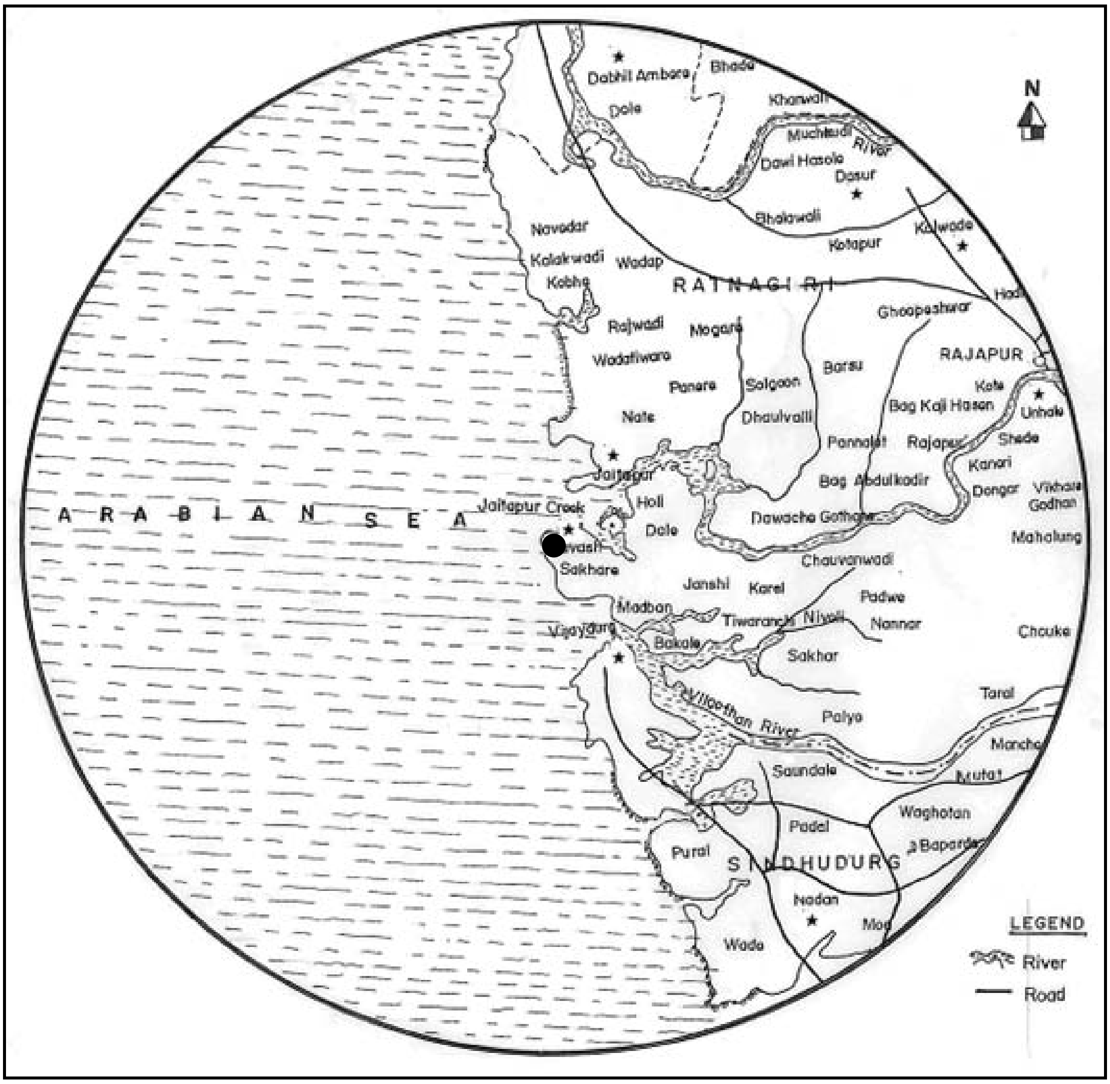


Plate 3.7.2: Landuse/Landcover of Study Area around Proposed Jaitapur Nuclear Power Park (Grid Size: 7.4 km x 7.4 km)



★ **Sampling Location**

● **Project Site**

Fig. 3.7.1: Locations for Soil Sampling in the Study Area

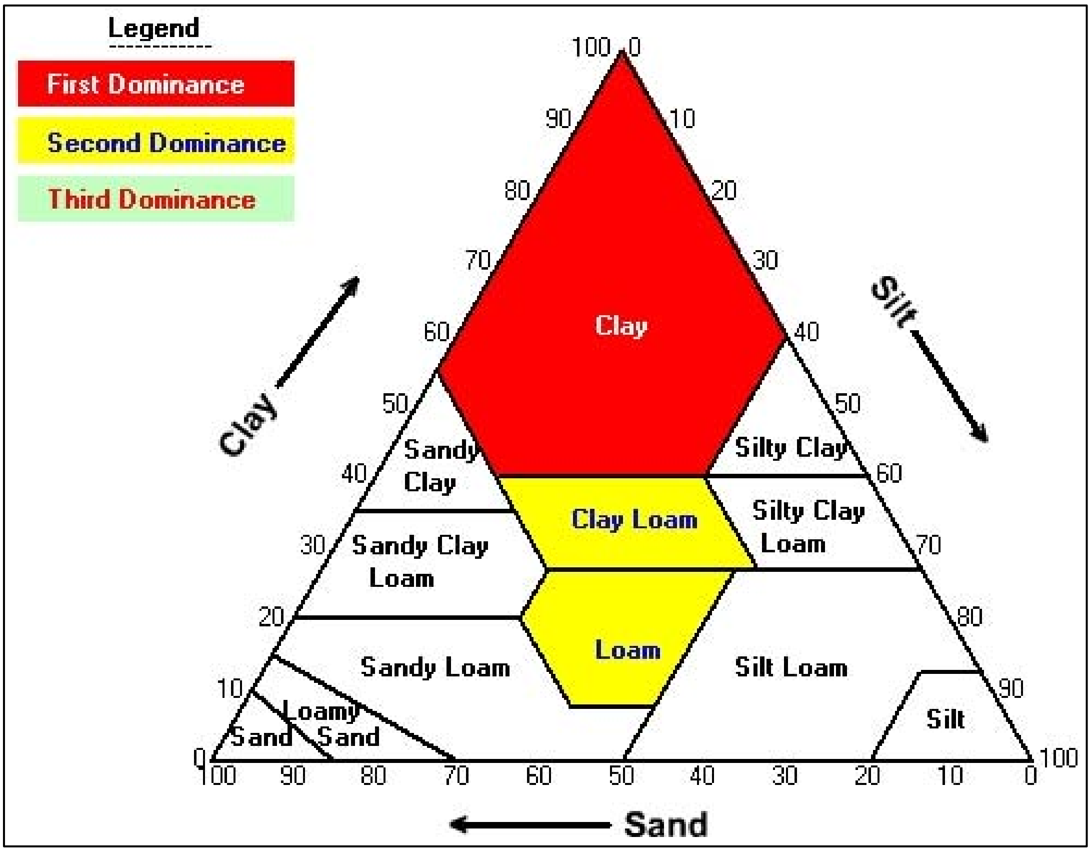


Fig. 3.7.2: Texture Diagram of Soils Collected from Study Area

Table 3.7.1

Physiographic Features in Coastal Basin of Maharashtra State

Basin Name	Geographical Area (Sq. km)	% of Total Area	Prominent Drainage and Hills	Areas Drained
Coastal Basin	31,650	10.38	Pinjal, Vaitarna, Bhatsai, Ulhas, Amba, Kundalika, Savitri, Vashishti, Shashtri and Keijvi etc. are prominent rivers. Draining to west coast Sahyadri hill range, Elevation 300-1600 m amsl	Ratnagiri & Sindhdurg districts.

Source: District Administration Ratnagiri, May, 2008

Table 3.7.2

Stratigraphic Sequence in Maharasthra

Stratigraphic sequence	**Age in million years**	**Representative rock formation**	**Geographic distribution**
Miocene Phiocene	1.65 - 23.5	Tertiary sediments, lignite, shales	Ratnagiri and Sindhudurg districts
Eocene-upper Cretaceous	34 -135	Deccan Trap basalt flows with Intertrappeans and Infratrappeans (Larnetas, Bagh beds)	Basalt flows cover most of the State from west of Nagpur and Chanrapur up to the Arabian sea coast excepting in the eastern parts of Nagpur, Bhandara- Chandrapur, Ratnagiri districts. Infratrappeans in parts of Nagpur and Chandrapur districts and Bagh Beds in Dhule district
Proterozoic	540-2500	Limestone, shales and sandstones (Vindhyan Supergroup) Penganga Beds, Limestones and shales (Pakal Group) Conglomerates, sandstones and shales (Kaladgi Group)	Ratnagiri and Sindhudurg districts
Archean	2500-3500	Sausar Group, Nandgaon Group, Sakoli Group Bailadila Group Amgaon Group Unclassified gneisses	Nagpur, Bhandara, Chandrapur, Gadchiroli, Ratnagiri and Sindhudurg districts Bhandara district Nagpur, Bhandara, Chandrapur, Gadchiroli, Ratnagiri and Sindhudurg districts

Source: District Administration Ratnagiri, May, 2008

Table 3.7.3

Distribution of Hydrogeological Units in Maharashtra and their Ground Water Potential

Geological Age	Stratigraphic Unit	Rock Formation	Districts & Hydrogeological Characters
UPPER CRETACEOUS TO EOCENE	DECCAN TRAPS	Basalt, Dolerite and other acidic derivatives of Basaltic Magma.	Occurs in all the districts except in Gadchiroli and Bhandara. Fractured and Vesicular layers are productive. Yield of dug wells varies from 5 to even 725 m^3/day.
PRECAMBRIAN SEDIMENTARIES	VINDHYANS CUDDAPAHS KALADGHIS	Sandstone, Limestone, Shale, and Conglomerates	Occurs in Ratnagiri, Chandrapur, Yavatmal, Gadchiroli, Sindhudurg, Wardha districts. Aquifer becomes productive by fractures and solution cavities. Yield of dug-wells ranges from 27 to 240 m^3/day during winter and from 13 to 27 m^3/day during summer.
ARCHAEANS	DHARWAD, IRON ORE SERIES, SAUSER SERIES, ARCHAEAN COMPLEX	Quartzite, Banded Hematite quartzite, Schist, Phyllite, Marble, Gneisse, Gondites, Intrusive Granites and Dolerite.	Occurs in Ratnagiri, Sindhudurg, Bhandar Gadchiroli, Chandrapur, Nagpur a Nanded districts. Ground water in the aquifers is controlled by degree weathering, fracturing and jointing. Yield dug-wells tapping these aquifer rang from 70 to 80 m^3/day during winter and between 10 and 33 m3/day during summe
TERTIARY	COASTAL SEDIMENTARIES, LATERITE	Sandstone, Lignite bearing Shale and Laterite.	Occurs in Ratnagiri, Sindhudurg and Kolhapur districts. This forms a distinct hydrogeological unit and yields good discharge to dug-wells.
PLEISTOCENE	BEACH DEPOSITS (COASTAL BEACH SANDS)	Sands, Sand rock and Conglomerate.	Occurs in Thane, Raigarh, Ratnagiri and Sindhudurg all along the konkan coast. The yield of the wells during summer ranges from 20 to 230m^3/day.
RECENT TO SUB-RECENT	RIVER ALLUVIUM (OTHER RIVERS)	Silts, Clays, Sands, Gravel and occasionally cobble beds.	Occurs in Thane, Ratnagiri, Sindhudurg, Jalgaon, Dhule, Nasik, Ahmadnagar, Satara, Sangli, Kolhapur, Jalna, Parbhani, Beed, Latur, Buldhana, Akola, Amravati, Wardha, Nagpur, Chandrapur, Gadchiroli. The yield of the dug-wells ranges from 13 to 56 m^3/day.

Source: District Administration Ratnagiri, May, 2008

Table 3.7.4

List of Soil Sampling Locations

Sr. No	Villages	Distance from Site (km)	Direction w.r.t. Site
1.	Jaitapur Light House	2	N
2.	Jaitapur	4	NNE
3.	Vijaydurg	6	SSE
4.	Nadan	21	SE
5.	Unhale	22	NEE
6.	Dobhil Ambhore	23	N
7.	Dasur	23	NNE
8.	Kelwade	24	NE

Table 3.7.5

Textural Class of Soil
(Summer, 2006)

Sr. No.	Sampling Stations	Particle size distribution (%)				Textural Class
		Fine Sand	Coarse Sand	Silt	Clay	
1.	Jaitapur Light House	12.92	31.42	22.86	32.8	Clay Loam
2.	Jaitapur	14.28	11.68	29.84	44.2	Clay
3.	Vijaydurg	17.98	13.60	26.00	42.4	Clay
4.	Nadan	26.36	17.00	15.44	41.2	Clay
5.	Unhale	15.58	9.22	31.40	43.8	Clay
6.	Dabhil Ambhore	18.00	21.02	18.18	42.8	Clay
7.	Dasur	13.78	32.24	29.18	24.8	Sandy Clay Loam
8.	Kelwade	13.38	14.26	29.16	43.2	Clay

Table 3.7.6

Physical Characteristics of Soil
(Summer, 2006)

Sr. No.	Sampling Locations	Bulk Density	Porosity	Water holding capacity
		(gm/cm^3)	%	%
1.	Jaitapur Light House	1.35	46.79	42.8
2.	Jaitapur	1.20	55.61	46.71
3.	Vijaydurg	1.31	43.08	52.2
4.	Nadan	1.35	44.56	51.4
5.	Unhale	1.25	49.82	52.2
6.	Dabhil Ambhore	1.26	40.96	55.59
7.	Dasur	1.28	44.32	38.8
8.	Kelwade	1.26	40.53	52.4

Table 3.7.7

Chemical Characteristics of Soil Extract
(Summer, 2006)

Sr. No.	Sampling Locations	pH	EC	Calcium	Magnesium	Sodium	Potassium
			mS/cm	meq/l			
1.	Jaitapur Light House	6.63	0.133	1.05	0.70	0.089	0.05
2.	Jaitapur	5.24	0.117	1.07	0.50	0.055	0.04
3.	Vijaydurg	4.47	0.064	1.01	0.6	0.077	0.11
4.	Nadan	5.03	0.064	1.02	0.6	0.079	0.13
5.	Unhale	5.15	0.063	1.03	0.2	0.063	0.14
6.	Dabhil Ambhore	6.89	0.086	1.04	0.22	0.040	0.04
7.	Dasur	5.48	0.059	1.04	0.18	0.048	0.09
8.	Kelwade	5.41	0.079	1.06	0.28	0.071	0.19

Table 3.7.8

Cation Exchange Capacity of Soil (Summer, 2006)

Sr. No.	Sampling Locations	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CEC	ESP (%)
		cmol (p^+) kg^{-1}					
1.	Jaitapur Light House	10.26	7.2	0.019	0.01	20.52	0.001
2.	Jaitapur	8.15	3.8	0.015	0.01	16.72	0.001
3.	Vijaydurg	10.03	7.6	0.003	0.02	18.24	0.002
4.	Nadan	10.05	6.8	0.031	0.02	19.09	0.002
5.	Unhale	8.26	4.2	0.035	0.02	17.95	0.002
6.	Dabhil Ambhore	10.36	6.8	0.013	0.01	21.47	0.001
7.	Dasur	10.18	5.6	0.022	0.01	18.24	0.001
8.	Kelwade	6.17	3.2	0.005	0.02	14.34	0.003

Table 3.7.9

Fertility Status of Soils in Study Area (Summer, 2006)

Sr. No.	Sampling Locations	Organic Carbon (%)	N	P_2O_5	K_2O
			Kg/ha.		
1.	Jaitapur Light House	0.60	250.8	21.2	138.8
2.	Jaitapur	0.62	256.6	16.2	128.4
3.	Vijaydurg	0.15	126.2	18.6	146.2
4.	Nadan	0.56	246.8	17.4	142.2
5.	Unhale	0.52	232.4	18.8	130.2
6.	Dabhil Ambhore	0.20	194.8	18.8	128.6
7.	Dasur	0.18	196.2	16.8	130.4
8.	Kelwade	0.19	180.4	16.2	126.8
	Level in poor soil	<0.5	<280	<23	<133
	Level in medium soil	0.5-0.75	280-560	23-57	133-337
	Level in fertile soil	>0.75	>560.0	>57.0	>337.0

Table 3.7.10

Relationship of CEC with Productivity (Summer, 2006)

CEC	Range (cmol (p^+) kg^{-1})	Productivity	Location Sr. Nos.
Very low	< 10	Very low	
Low	10 - 20	Low	2, 3, 4, 5, 8, 7
Moderate	21 - 50	Moderate	1, 6
High	> 50	High	

Table 3.7.11

Relationship of CEC with Adsorptivity (Summer, 2006)

CEC	Range (cmol (p^+) kg^{-1})	Adsorptivity	Location Sr. Nos.
Limited	<10	Limited	
Low	10-20	Moderate	2, 3, 4, 7, 8
Moderate	20-30	High	1, 6
High	> 30	Very high	

Table 3.7.12

Trace Metals Content in Soil (Summer, 2006)

Sr. No.	Sampling Location	Cd	Cr	Co	Cu	Ni	Pb	Mn	Zn
		mg/kg							
1.	Jaitapur Light House	1.77	12.65	1270	52.2	60	10.15	452	59.5
2.	Jaitapur	2.02	182	1235	56.5	93.5	19.9	595	61
3.	Vijaydurg	1.33	170	50	55	30.25	15.05	465	45.55
4.	Nadan	0.32	40.7	167.5	13.85	13.25	35.4	54.5	44.5
5.	Unhale	1.82	87.5	940	114	94.5	20.0	870	90
6.	Dabhil Ambhore	1.83	13.0	1470	96.5	70	15.6	1275	91
7.	Dasur	0.22	16.25	1780	131	103	20.75	1370	104
8.	Kelwade	1.73	23.55	1440	75	106.5	18.55	1040	82

Table 3.7.13

Microbiological Characteristics of Soil (Summer, 2006)

Sr. No.	Sampling Location	TVC	Fungi	Actinomycetes	Rhizobium	Azotobacter
			CFU/g			
1.	Jaitapur Light House	72×10^6	10×10^4	8×10^4	5×10^4	8×10^4
2.	Jaitapur	190×10^6	10×10^4	5×10^4	10×10^4	6×10^4
3.	Vijaydurg	106×10^6	7×10^4	7×10^4	6×10^4	9×10^4
4.	Nadan	109×10^6	7×10^4	6×10^4	3×10^4	7×10^4
5.	Unhale	143×10^6	9×10^4	5×10^4	4×10^4	6×10^4
6.	Dabhil Ambhore	130×10^6	10×10^4	9×10^4	4×10^4	8×10^4
7.	Dasur	70×10^6	9×10^4	6×10^4	4×10^4	6×10^4
8.	Kelwade	93×10^6	10×10^4	8×10^4	6×10^4	6×10^4

TVC : Total Viable Count
CFU : Colony Forming Unit

Table 3.7.14

Land Use Pattern Based on Census Data (Area in Ha)

Name of Taluka	Total Area	Forest	Irrigated	Unirrigated	Cultureable Waste	Area not Availed for Cultivation
Ratnagiri District						
Lanja	75528	1049	242	39475	14506	20256
Rajpur	127780	801	263	41206	69505	16005
Sindhdurg District						
Devgad	55033	3004	2000	11996	3043	34990
Total	258339	4854	2503	92677	87054	71251
Percentage		1.879%	0.969%	35.87%	33.69%	27.58%

Table 3.7.15

Land use/Land Cover Classification System within the Study Area

Sr. No.	Level – I		Level – II
1.	Built-up Land	1.1	Built-up land
		1.2	Road
		1.3	Railway
2.	Agricultural Land	2.1	Crop land
		2.2	Fallow (Residual)
3.	Forest	3.1	Evergreen/Semi-evergreen forest
		3.2	Deciduous forest
		3.3	Degraded/Scrub land
		3.4	Forest blank
		3.5	Forest plantation
		3.6	Mangrove
		3.7	Cropland in forest
4.	Wasteland	4.1	Salt affected land
		4.2	Waterlogged land
		4.3	Marshy/Swampy land
		4.4	Gullied/Ravinous land
		4.5	Land with or without scrub
		4.6	Sandy area (coastal and desert)
		4.6	Barren rocky/Stony Waste/sheetrock area
5.	Water bodies	5.1	River/Stream
		5.2	Lake/Reservoir
		5.3	Tank/Canal
6.	Others	6.1	Grassland/Grazing land
		6.2	Shifting cultivation
		6.3	Snow cover/Glacial area

Table: 3.7.16

Inventory of Landuse / Landcover within the Study Area (21-Dec-2005)

Sr. No.	Landuse/Landcover Classes	Area in (Sq. Km)	Area in (%)
1	Ocean / River	1064.394	54.24
2	Water bodies	0.263	0.01
3	Vegetation	283.811	14.46
4	Waste land	597.189	30.43
5	Sand / Bare soil	5.017	0.26
6	Mangrove	11.826	0.60
	Total	**1962.5**	**100**

Table 3.7.17

Talukawise Land (Hectares) Under Cultivation For Various Crops

Crops	Rajapur	Lanja	Kankavely
Rice	9,974	9,991	13,680
Vari	159	124	32
Nachni	1,891	1,839	136
Tuwar	26	25	-
Udid	56	11	65
Chilli	19	12	1
Betel nut	99	22	5
Green gram	629	1,279	1,579
Cashew nut	3,280	6,150	3,804
Groundnut	-	10	844
Til	63	227	-
Coconut	114	32	270

Source: Statistic Abstract Book, Ratnagiri and Sindhudurg District, year 2003-04

Table 3.7.18

Landuse Pattern (Hectare)

Taluka	Forest Land	Non-agricultural Land	Land not used for Agriculture	Fallow Land	Agriculture Land	Total
Rajapur	801	13,449	69,505	2,181	41,469	1,27,405
Lanja	1049	19,095	14,506	6,011	39,717	80,378
Kankavely	8997	12,771	26,613	4,876	24,240	77,497

Source: Statistic Abstract Book, Ratnagiri and Sindhudurg District year 2003-04

3.8 Biological Environment

3.8.1 Introduction

Study of biological environment is one of the important aspects for Environmental Impact Assessment, in view of the need for conservation of environmental quality and biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprises of both plant and animal communities which interact not only within and between themselves but also with the abiotic components viz. Physical and chemical components of the environment.

Generally, biological communities are the good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important in Environmental Impact Assessment for safety of natural flora and fauna. Information on the impact of environmental stress on the community structure serves as an inexpensive and efficient early warning system to check the damage to a particular ecosystem. The biological environment includes mainly terrestrial ecosystem and aquatic ecosystem.

Biological communities are dependent on the environmental conditions and resources of its location. It may change, if there is any change in the environment. A number of variables like temperature, humidity, rainfall, soils characteristic, topography, etc. are responsible for maintaining the homeostasis of the environment. A change in any one of these variables may lead to stress on the ecosystem. The animal and plant communities exist in their natural habitats in well-organized manner. Their natural settings can be disturbed by any externally induced anthropological activities or by naturally induced calamities or disaster. So, once this setting is disturbed, it becomes practically impossible or takes a longer time to come to its original state. Plants and animals are more susceptible to environmental stress. A change in the composition of biotic communities is reflected by a change in the distribution pattern, density, diversity, frequency, dominance and abundance of natural species of flora and fauna existing in the ecosystem. These changes over a span of time can be quantified and related to the existing environmental factors. The field observations on vegetation characteristics were made by using random observation method. The sensitivity of animal and plant species to the changes occurring in their existing ecosystem can therefore, be used for monitoring Environmental Impact Assessment studies of any project.

The assessment of fauna have been done on the basis of secondary data collected from different government departments like forest department, wildlife department, fisheries, etc.

The **study on terrestrial biodiversity** was outsourced to **College of Forestry of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra** and study on **marine and coastal biodiversity mapping** was outsourced to **College of Fisheries of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra** for ensuring participation of local experts and for enrichment of report. Their final report is based on their observations from January 2007 to December 2007. The report on terrestrial biodiversity and marine and coastal biodiversity are enclosed as **Annexure VII** and **VIII** respectively in **Vol. II**.

3.8.2 Study Area

The proposed project site is located at Jaitapur in Ratnagiri District, Maharashtra. The study area is delineated in 25 km radius from the project site. The proposed site is in Rajapur tehsil of Ratnagiri District but some part within 25 km radius also includes Lanja tehsil of Ratnagiri District and Deogarh tehsil of Sindhudurg District. The proposed plant site is adjoining the sea coast and is mostly a barren stretch of land with sparse savanna vegetation. At project site upto 5 km, only a sparse vegetation is present, howver, beyond 5 km, a part of land is covered with agriculture and orchards. The areas fall in the coastal belt, especially the estuarine stretch of Arjuna River near Jaitapur creek. Mangroves are found scattered along the fringes of the river and creek. However, they are 5-6 km away from the project site. A few patches of the degraded forest were observed on the hilly terrain. The habitats in study area are shown in **Plate 3.8.1** and **3.8.2.** Most of the land in the study area is used for agricultural and horticultural practices.

3.8.3 Methodology and Sampling Locations

The list of sampling stations is given in **Table 3.8.1** and **Fig. 3.8.1** for survey of flora and fauna and for validation of the data. For plant biodiversity survey, the study area was overlaid with a grid of 1 km mesh size covering the entire area of 25 km radius from the center. A total of 1250 cross-sectional points cover the terrestrial ecosystem around the study area. Among them 100 points have been selected using random numbers table (Panse & Sukhatme 1985) (**Fig. 3.8.2**) for evaluating the diversity and distribution of the floral and faunal components of the ecosystem. These points are surveyed by the team from College of Forestry, Dapoli for three seasons during the project period i.e. winter, summer and monsoon period of 2007.

The parameters for evaluating the phytosociology were recorded by laying quadrats of 10x10 m, 5x5 m and 1x1 m for trees, shrubs and herbs respectively. A total of 22 points were enumerated for their floral and faunal attributes during January, 2007. Basal area (diameter at breast height, DBH) was considered as an indicator of dominance of trees, while, collar diameter and number of tillers indicated dominance respectively for shrubs and herbs. Furthermore, the frequency, density, abundance, relative frequency, relative density and IVI were calculated using formulae given in Odum (1975).

The species were identified with the help of Flora of Maharashtra State (2000), Flowers of Sahyadri (2001) and Further Flowers of Sahyadri (2007).

Avifauna was assessed by using the McKinnon's Species Richness method (Javed and Koul 2002). In this, several species lists were prepared, each completed after recording a pre-determined number of species (10 in this case). A total of 11 lists were prepared at different localities in the study area during 15th to 24th January 2007 during early morning and late evening hours (6:30 to 9.00 am and 4.00 pm to 6.30 pm, respectively). Average time taken to complete one list was 95 minutes. The frequency, density, abundance, IVI, species richness Simpson's Diversity Index (D) and Shannon Index (H) was computed. Information on the species richness of the animals recorded in the working plan of Ratnagiri-Chiplun Sub Division for year 2002-03 to 2011-2012 was collected using a questionnaire which was taken to 32 villages and in every village one person was asked to fill in the questionnaire. The respondent information was plotted on the grid to map the distribution patterns of important species.

3.8.4 Terrestrial Biodiversity in Study Area

Major ecosystems

The major ecosystems of the study area are grassland, forest, patches of coastal mangrove flora, and agricultural land. The grasslands are extensive patches of grass cover on the lateritic plateaus mostly around the lighthouse. The study area is covered by forest area with villages and agricultural fields distributed among them (**Plate 3.8.1** and **Plate 3.8.2**).

Plant Biodiversity

Checklist of plants recorded in the study area is given in **Volume –II**, **Annexure VII**, **Appendix-I**. Glimpses of plant biodiversity are shown in **Plate 3.8.3.** Mangrove ecosystems in the study area are shown in **Plate 3.8.4**. The **Table 4.1 (Volume –II, Annexure VII)** presents the trees and their attributes at the sampling points in the study area. The tree attributes are same for both the monsoon and summer seasons as the sampling points were fixed and tree flora doesn't change over seasons. **Table 4.2**, **Table 4.3** and **Table 4.4 (Volume –II**, **Annexure VII)** present the attributes of shrubs, climbers and herbs in summer Season. A total of 23 shrub species, 24 climber species and 8 herb species were recorded in summer season.

Among the tree component, it is observed that there are more species with low IVI. The species namely *Terminalia paniculata* has had the highest IVI (27.69) followed by *Bridelia retusa* (25.65), *Memecylon umbellatum* (18.77), *Terminalia elliptica* (16.02), *Ficus bengalensis* (14.28) and *Mangifera indica* (13.26) and five species namely *Firmiana colorata, Dillenia pentagyna, Manilkara hexandra, Gardenia latifolia* and *Annona reticulosa* has the lowest IVI (0.19). Furthermore, more than 80% of trees, 50% of shrubs, 60% of climbers and 20% of herbs had IVI value less than 10. The most dominant trees in this region are *Terminalia paniculata, Terminalia tomentosa*, and *Memecylon umbellatum*. While *Acacia catechu, Morinda citrifolia, Tectona grandis,* and *Strychnos nux-vomica* are found in association and phytosociological order. Among shrubs, *Holarrhaena pubescens, Carrisa congesta, Zizyphus rugosa* and *Calycopteris floribunda* were the dominants. Among herbs, *Daedalcanthus roseus* and *Hemidesmus indicus* were observed to be dominants while *Dioscorea bulbifera* and *Smilax macrophylla* were dominants among the climbers.

Among shrub species in summer season, *Euphorbia antiquum* showed highest IVI values (41.02) followed by *Carissa congesta* (36.5), *Holarrhaena pubescens* (31.36) and *Barleria prionities* (30.59).

In herbs species in summer season, *Eranthemum roseus* had highest IVI (144.80) followed by *Cassia tora* (56.09) and *Nelsania sp.* (45.36). In climber species in summer season, *Smilax ovalifolia* showed highest IVI (43.8) followed by *Calycopteris floribunda* (38.79), *Jasminum malabaricum* (29.96) and *Hemidesmus indicus* (26.12). However it was least in case of *Ampelocissus erioclada and Cissus rependa (2.89).*

However, the shrubs, climber and herbaceous flora changes during seasons. The community attributes climbers, shrubs, and herbs are shown respectively in **Table 4.5**, **Table 4.6** and **Table 4.7 (Volume –II**, **Annexure VII)**. A total of 27 shrub species, 47 climber species and 77 herb species were recorded in summer season. **Fig. 3.8.3** shows the number of species recorded in shrubs, climbers and herbs during summer and monsoon in the study area.

In Monsoon, a total of 47 climber species were recorded. Among them *Smilax ovalifolia* (11.61), *Hemidesmus indicus* (11.39) and *Dioscorea bulbifera* (10.51) were widely distributed in the region. Among the 27 species of shrubs *Leea indica* (16.22), *Holarrhena pubescens* (15.88), *Carissa congesta* (13.60), *Helicteres isora* (12.01) and *Ixora coccinea* (11.82) had the highest Importance Value Index owing to their wide distribution. The 77 herb species were recorded and *Cassia tora* and *Daedalcanthus roseus* frequently occupied the lower canopy with their Importance Value Index of 9.98 and 7.42 respectively. The abundant ground flora in the study area during the monsoon season certifies the stress conditions developed in the dry periods owing to the low water holding capacity of the soil.

It is clear from the tables that the species diversity increases suddenly with the onset of the Monsoon. This increase is highly dramatic in case of herbaceous species which recorded around 900% increase in Monsoon flora over the summer flora.

A summary of the number of species recorded in each of these categories in the two seasons is presented in **Fig.3.8.4**. The number of species in consecutive ranges of IVI values for all the four groups are shown in this figure. This chart also presents a comparison of percentage of common species and rare species in all the groups.

Table 4.8 (Volume –II, Annexure –VII) shows the values of Simpson’s index and Shannon index along with the simplest index of diversity- the species richness. On Simpson’s scale, the diversity of trees in the study area is the highest followed by that of shrubs and climbers. But the diversity of herbs is relatively very low. This entirely corresponds with the species richness (S) of the respective group i.e. higher the number of species, higher the index. The Simpson's index for pooled data of all plants is the highest i.e. 97.48% which is typically highest.

However, the Shannon's index defies to follow the species richness to some extent. The most evident case is that of trees and climbers whose index values are of same order but the species richness is uncomparable. In case of pooled data also, the highest species richness doesn't make it highest on the Shannon index. This is because the Simpson's index gives more weightage to the rare species. This is if there are few rare species, the index will be higher and vice versa. Thus the shrubs have higher Shannon index because there are only 4 species i.e. 16% which can be called rare (less than 10 individuals in the entire sampling exercise) where as in case of trees the Shannon index is relatively lower because there are more than 50% species which can be called rare.

Seasonal Variation in Diversity of Forest Flora

Comparison of Seasonal Changes in Diversity Indices of the Major Groups of Flora in the Study Area is presented in **Table 4.8 (Volume –II, Annexure –VII)**. There was a marked increase in species richness during the monsoon sampling in case of herbs (890%), shrubs (11%) and climbers (51%). Furthermore, a high diversity of grasses (36 species) was observed in the entire study area and also in the grassland ecosystem surrounding the project site. The diversity indices in case of herbs, shrubs and climbers also increased in monsoon depicting that these emerged in the monsoon period. A more pronounced increase in Shannon-Wiener Diversity index was observed among the herbs (0.9512). Simpson's Diversity Index of the habits ranged from 0.909 (shrubs) to 0.946 (trees), while the Shannon Wiener's Diversity Index ranged form 0.788 (trees) to 0.945 (climbers). However, the diversity indices of the tree flora remained unaltered as the same quadrats were resampled in the monsoon season.

Spatial Variations in the Flora

The spatial variation in floral diversity was obtained by segregating the sampling stations as per their distance from the actual plant site. The 25 km radial study area was divided into 5 zones i.e. A (0 to 5 km from the lighthouse – the centre of the study area), B (6 to10 km), C (11 to 15 km), D (16 to 20 km) and E (21-25 km). In these concentric circular zones as depicted in **Fig. 3.8.2**, respectively 9, 15, 23, 24 and 13 sampling stations of forest vegetation fell. The data collected from these stations was separately analysed for finding out the differences in diversity indices (Simpson's diversity index) of these circles. **Table 4.9 (Volume –II, Annexure –VII)** summarizes the findings of this exercise. The table clearly shows that the maximum diversity index across the categories of trees, shrubs, climbers & herbs gradually decreases from the distant zone to the nearest zone due to the rocky topography near coastal area. As a result, that the actual plant site is dominated by herbaceous vegetation whereas as we go away from the plant site, forest vegetation increases in composition. The 0-10 km zone represents the lowest values of diversity index suggesting that the overall diversity increases away from the actual plant site.

3.8.5 Structure and Composition of Flora

The floristic survey in this area reveals low species composition representing poor gene pool because of human settlement in area. The vegetation in this area is mixed consisting of uneven-aged deciduous species. The human population is dependent on agriculture and allied activities for their livelihood. The grazing activity by livestock is a common.

Grasses mainly cover open degraded land in the study area. Herbs and shrubs are abundant only during monsoon, whereas during rest of the year when the land turn dry, herbs cannot survive and become dry, wither and get wiped away from the vicinity.

Generally trees observed here have low stunted branches, diffuse crown and are mostly younger plants. Dependency of villagers on natural vegetation in this region is more for timber and firewood. The dependency on forest resources for firewood, fodder, grazing, etc. is less. Some medicinal plants were found, amongst which *Acacia catechu, Azadirachta indica, Cassia fistula* etc are important one. Commercial exploitation of medicinal plants is not the regular practice in this region. Only local inhabitants use the medicinal plants for curing the various ailments for their own sake.

3.8.6 Riverine Vegetation

Riverine vegetation is well known for its biodiversity and is less disturbed area. Three main Rivers flow from the study area are Muchkudi, Arjuna, and Waghotan River. The composition of vegetation cover is even-aged, mixed, deciduous natural vegetation. As most of the human population is depending on agricultural and allied activities for their livelihood, dependency on green resources is very less. However, for project purpose, no trees will be cleared as they are far away from the project area.

There are associations of lotus and water lily plants in most of the water bodies. Growing submerged are *Ceratophyllum*, *Utricularia*, *Chara*, etc., all forming a close tangle underneath, nearer the shore are *Ipomoea* sp. They often so closely cover portions of the margin that they are deceptive of solid ground beneath. Other tanks with shallow water and the river basin in dry weather exhibit reeds which grow in marshy soil, consisting of *Juncus*, *Scirpus*, *Cyperus* and *Typha* growing together and forming a close palisade of leaves over the surface of water. Large number of marshy plants grows in the places between the reeds and along the margin.

3.8.7 Fruit Trees around the JNPP

Around 5 km radial area around the JNPP is rocky and barren for most of the part with almost insignificant fruit trees. The fruit trees are present near the proposed plant site residential complex site. The details are given in **Table 3.10.7**. Only a few trees, essential for estabilishing residential complex of the project will be cut / uprooted, however, twice the number of trees cut will be planted in lieu of them.

3.8.8 Mangrove Ecosystem

Mangroves are a diverse group of salt tolerant plants growing in the inter-tidal estuarine zones above the mean sea level of sheltered coastal environments. The mangrove ecosystem in Jaitapur area is shown in **Plate 3.8.4**, which are quite far away (5-6 km) from the project site and none of them will be affected due to the project. The habitat of mangroves is often referred to as mangrove forest or ‘tidal forest’. These plants are constantly subjected to tidal flushing with the ability to live in salt water. Pneumatophores, supporting stilt roots and buttresses, salt excreting glands in the leaves and viviparous propagules are some of the several highly specialized and collectively well-known adaptations of this group. The advantage of the mangroves growing in a saline environment is the lack of other competing plant elements. A limited number of plants alone have evolved adapting to such inter tidal conditions. Pneumatophores are specialized root-like structures, which stick up out of the soil like straws for breathing, which are covered in lenticels. These “breathing tubes” reach heights of up to 30 centimeters, though some species have ones that reach over 3 meters high. The roots also contain wide aerenchyma to facilitate oxygen transport within the plant**. (Plate 3.8.5)**

The dominant Mangroves *Rhizophora sp.* (**Plate 3.8.6**)*, Avicennia sp., Acanthus sp* (**Plate 3.8.7***), Derris sp., Sonneratia sp.,* etc**.** are commonly recorded in the study area near the Jaitapur and Vijaypur creek in narrow belt. Mangrove patches were distributed along the coasts of the project site. These ecosystems are rich with 12 mangroves and mangrove associates (**Volume –II**, **Annexure –VII**, **Table 4.10**) and are dominated by *Aegiceras corniculatum* (34.22) and co-dominated by *Rhizophora mucronata* (31.52) and *Sonneratia caseolaris* (20.89). The mangrove forests are located along the edges of the creeks in the study area. Their value as habitat of wildlife is immense and they support a variety of wildlife as will be clear from the discussion in the chapter on Faunal Investigations.

3.8.9 Grassland Ecosystem

The grassland ecosystem (**Plate 3.8.2**) around the project site contained 36 species of which *Arundinella metzii, Glyphocloa acuminata, Glyphocloa ratnagirica, Glyphochloa santapaui, Ischaemum diplopogon, Ischaemum impressum and Icshaemum kingii* are endemic to this region. The list of these species is provided in **Table 4.11 (Volume –II**, **Annexure –VII)**.

The dominant species around the actual plant site are *Apluda mutica*, *Ischaemum impressum*, *Themeda triandra*. The local people use these grasses commonly as fodder for cattle. The other uses of these species include thatching of huts and rabing (burning dry plant material at nursery of paddy crop).

3.8.10 The Creeks

There are two major creeks located in the study area namely, Jaitapur creek and the Vijaydurg Creek. The Jaitapur creek is located at N 16^0 37” 46.1’ and E 73^0 22” 24.7’ having a length of 10 km and width of 300-500 m. This creek is at around 5 km to the North and North-West of the actual site of the JNPP. The ecosystem developed due to the mixing of fresh water (Arjuna River) and brackish water, sedimentation, humid climate and high rainfall in this creek facilitates the development of mangroves. Mangrove patches are found in the periphery of the creek and in the central portion, which are quite far away (5-6 km) from the project site and none of them will be affected due to the project.The mangroves are composed of *Avicennia officinalis, Avicennia marina, Excoecaria agallocha, Sonneratia caseolaris, Acanthus ilicifolius* and *Rhizophora mucronata*. Mangrove associates namely; *Calophyllum inophyllum, Thespesia lampas, Thespesia villosa* and *Derris eliptica* are distributed in the periphery of the ecosystem. The landward side of the creek contained components of moist deciduous forests. The slopes on the boundary of project site consists of vegetation composed of shrubs and trees of moist deciduous forests (**Plate 3.8.8**)

The Vijaydurg creek is having a width of 200m and length of 4-5 km and is located at N 16^0 33” 08.6’ and E 73^0 21” 11.7’. This creek is located at around 8 km to the South and South-West of the actual site of JNPP. Mangrove patches are distributed along this creek and have had the same composition as that of the Jaitapur creek, which are quite far away (5-6 km) from the project site and none of them will be affected due to the project. Along with them *Aegiceras corniculatu* and *Bruguiera gymnorhiza* were distributed below the canopy of *Avicennia officinalis.* Zonation of mangrove species was observed in the ecosystem with larger seed sized species like *Rhizophora mucronata* and *Sonneratia caseolaris* were distributed on the seaward side while small seeded species like *Avicennia officinalis* were found on the landward side of the forest due to variable tidal inundation present in the ecosystem.

3.8.11 Medicinal Plants in Study Area

The ethnologically or commercially important medicinal plant species are considered from environmental point of view. The conservation of medicinal plants means every species of plant in its actual habitat for protection and preservation. Conservation of biodiversity is a national and international agenda. Due to overexploitation of natural resources many of plant species have become extinct from the wild. The study area of Nuclear Power plant shows less important presence of medicinal plants in terms of quantity as there is very less forest area in the study region. However qualitatively out of total plants studied, 21 plant species including 10 trees, 6 herbs and 5 shrubs are of medicinal value (**Volume –II**, **Annexure –VII**, **Appendix -II)**. Some of the medicinal plants are shown in **Plate 3.8.9**.

The local communities directly influence the terrestrial ecosystems in the form of their access to fulfill the needs of collection of medicinal plants, as well as other economically important plants. The local community collects the medicinal plants from forest area, but their livelihood is not entirely dependent on collection of medicinal plants.

3.8.12 Threatened Plant Species

Threatened species are those found only in small numbers or those on the verge of extinction in the country. India has a list of threatened species in Red Data Book, published by the Botanical Survey of India.

The following recorded species were found to be placed in Red List under different threat categories as indicated against them (After Singh et al. 2000).

Kokan dipkadi *Dipcadi concanense* – Critically Endangered
Karete *Cucumis setosus* – Endangered
Dhal terda *Impatiens pulcherrima* – Vulnerable
Phonda terda *Impatiens tomentosa* – Vulnerable
Raan halad *Curcuma amada* – Vulnerable
Dudhi *Euphorbia concanensis* – Vulnerable

However, none of these species were found in the zone of 5 km radius from the project site. Therefore the establishment of NPP would not affect these species.

3.8.13 Fauna: Wildlife Survey

- **Habitat**

The study area consists chiefly of hilly ranges in study area. The vegetation here is mostly on slopes and usually scattered in patches. While, on lower slopes and flatter slopes of hills, many agricultural activities are performed. Much of the study area is under agricultural practices due to which domestic animals are predominantly found here. The vegetation cover is moderately good due to social plantation and agricultural practices, which forms the habitat of birds, reptiles, mammals and lower invertebrates.

The major habitats of wildlife present in the study area are grassland, forest, mangroves, coastal scrubland (**Plate 3.8.2**), rocky seashore and sandy beach (**Plate 3.8.10** and **3.8.11**). Their coastal scrublands are lining along the rough sea-coast where the beeches are absent. These comprise of low vegetation and support small mammalian species and several bird species. The birds like cormorants, Jungle crows use this habitat for roosting and from here they go on feeding onto the seashore. Mammals like civets, mongooses use this habitat for spending daytime and then they venture into nearby grasslands for foraging in the nights. This habitat is replaced near habitations by orchards of coconut and areca nut and also by the plantations of *Casuarina*. These orchards and plantations also support important bird species like the endangered White-bellied sea eagle.

The mangroves are found all along the lower reaches of the creeks. They form a typically wetland habitat supporting small felids, canids, bats and wetland birds. This is a typical roosting of habitat of several heron, egret species and also for rallids. The herons and egrets go to open water bodies for feeding whereas the rallids get a good supply of food in the mangrove forest itself. The bats are attracted to the fruits of the mangrove species and they also get to roost in the nearby coastal caves. Therefore bats assemble in these areas in large numbers. The other mammals are not found so frequently as the habitat is with wetland environment.

The forest is the most abundant habitat. This is basically dry deciduous forest towards the coast and moist deciduous forest towards the Western Ghats. This habitat supports a large variety of forest birds. The typical forest birds include different Doves & Pigeons, Mynas and Starlings, Flycatchers etc. These frugivorous and insectivorous birds get ample supply of food from the forest ecosystem. Predators like Shikra and Serpent Eagle are also found. The forest with its multiple strata provides different niches and breeding (nesting) sites to a variety of birds. A variety of small mammals, ungulates and their predators also take shelter in the forest. In the study area, the largest predator is Leopard. However, they are observed much fa away (around 10 km away) form the project site and which are quite far away (5-6 km) from the project site and none of them will be affected due to the project. It is at the apex of a complex pyramid comprising of ungulates, primates, small felids and canids.

Grasslands are the second common habitat of wildlife in the study area. It is also the major habitat at the actual plant site of NPP. The grasslands support birds like Raptors, Larks and small granivores. The key raptors are Brahminy kite, Harriers, Black kite etc. They depend on the rodent population and the serpents of this region. Other predators competing for the same food are wolves and foxes. The only difference is that the raptors are active during daytime and the predatory mammals during night.

The agriculture and fruit-orchards are not usually considered habitat of wildlife. However, the mango orchards provide excellent habitat to some of the rare species like Hornbills, Woodpeckers and Paradise flycatchers. Agricultural area also supports a large variety of small mammals. However, human disturbance reduces their frequency of occurrence

The study area was surveyed and the data on wild life and birds was collected. This data was supplemented by information obtained through enquiry with villages and secondary data collected from different sources. Efforts were made to collect as much possible information on the wildlife of the study area. Survey was continuously conducted for birds of the entire study area. Similarly, respondent-perception survey was conducted for presence/absence of mammals and other animals.

- **Mammals**

The mammal species recorded from the region are few. However, most are not populous as in some protected area. Therefore, application of any census method for estimation of their abundance over such a vast area would have been riddled with many challenges. The way out was to collect information on their distribution and depend on already published works to indicate their abundance.

A list of mammals found in the study area is prepared by using first-hand sightings by the study team, interaction with the local people and the working plan for the period 2002-20012 of the Ratnagiri-Chiplun Forest sub-division (Takalkar, 2002). This list is presented in **Table 5.1 (Volume –II, Annexure –VII)**. Their IUCN status as per Menon (2003) and their latest position in Wildlife (Protection) Act, 1972 Schedules is also given.

The species diversity of mammals i.e. 23 species is quite comparable with any area of same size. Given that Takalkar (2002) has mentioned only 19 species of mammals for the entire Ratnagiri-Chiplun sub-division. Both these numbers don't include many species of rats and bats which are rare and difficult to identify despite the fact that they form the bulk (upto 75%) of the mammalian fauna of any place. The status of mammals in the study area suggests that more than 50% species are classified as 'Lower Risk' by IUCN in its Red List. That means there is no immediate threat to their existence. Locally also, observations indicate, these species are abundant.

Some species like Leopard, Muntjack, Wolf etc which are placed in Schedule - I of the Wildlife (Protection) Act, 1972 are of major concern. The Wolf, being an animal of grasslands, is recorded from such habitats in the study area. Its habitat is also present on the actual site of the NPP. Many more habitats are available to wolves all along the coastline in the form of plateau grasslands. Its prey is also distributed there. However, none of them will be affected due to the project as exclusion zone of 1.6 km associated with the project will provid them a suitable habitate.

Leopard and Muntjack are animals of forest. They prefer dense vegetation. Hence their distribution is restricted to the forest areas which mainly lie on the Eastern side of the Mumbai-Goa highway – a far way site from the actual site of NPP.

Respondent perception was used to estimate the possibility of existence of different mammal species. A total of 32 respondents from different villages in the study area were asked whether a particular species was found in the nearby areas or not (**Volume –II**, **Annexure –VII**, **Fig. 5.2**). Fifteen species received a response of existence in excess of 75%. It suggests that most of the mammal species are common. Whereas those getting low response for presence are the rarer ones and not found all over the study area, like Leopard, Wolf, Otter etc.

Further, 28 species of mammals have been reported from the region in the working plan of Ratnagiri-Chiplun Sub-division. **Fig. 5.2 to Fig. 5.3 (Volume–II**, **Annexure-VII)** shows the presence-absence maps of the two important species i.e. leopard and wolf according to the respondent perception. The shaded area in the map shows the patches of study area where respondents believed these animals were present.

Wild life is very less in number due to anthropogenic activity. They are mostly present in forest areas outside the study area and may infrequently move in study area. The monkeys *Maccaca radiata, Semnopithecus entellus* were commonly observed. Mongoose was once observed in the study area. Other than these animals the domestic mammals viz., cow, buffaloes, cat, stray dogs, goat etc were seen in all the villages. The local interviews with the villagers, the langoors are the most frequent visitors in their fields and mango orchard.

Among insects, 22 species of insects have been recorded roaming the study area. The insect diversity is observed to be less due to anthropogenic activity. The list of insect species is given in **Table 3.8.2**.

- **Birds**

Birds are the easiest to survey and study. Therefore they were selected for detailed survey. Birds act as an indicator of environmental quality. The bird diversity and important bird species have also been used by NPCIL to promote the clean nuclear energy.

Table 5.2 (Volume–II, Annexure –VII) shows the comparison of bird diversity during monsoon/winter with that during Summer/winter. This is accomplished by comparing several indices of diversity of birds – species richness, Simpson's index and Shannon index. In addition, the slope of log-trendline of species discovery curve is also provided as another index (**Fig. 3.8.4**).

All the explorations in the study area revealed a total of 110 bird species. Out of these, 90 species feature in Summer/Winter data and 97 in Monsoon data. A list of all these species is provided in the next table. The indices indicate a very high diversity. The indices suggest that there is not much difference in the diversity of birds from season to season. Every index suggests a slightly higher diversity during Monsoon/Winter.

This diversity represents nearly 40% of the avifauna of the Ratnagiri district, 20% of the entire hotspot of the Western Ghats and 8% of the Indian subcontinent. This broad spectrum of avian species comprises of 41 families and 90 genera. This means the species are not dominated by only a few taxa as in cases of some wetlands. This is mainly because of the variety of habitats available in the study area.

The status of these bird species in the region was ascertained from Pande *et al.* (2003). Accordingly, 2 species are abundant, 68 are common, 20 uncommon, 8 species occasional, 9 rare, 1 vulnerable and 2 near-threatened. These numbers suggest that more than 35% species are anything but common and slightly less than 20% can be put in threatened categories. This may be due to the natural rarity of some species or population decline due to anthropogenic factors. The vulnerable species is the Common kestrel *Falco tinnunculus* whereas the two near-threatened species are Malabar Pied Hornbill *Anthracoceros coronatus* (though locally common) and Grey-headed fish eagle *Ichthyophaga ichthyatus*.

The sociological information about the bird community is given in **Table 5.3 (Volume –II**, **Annexure –VII)** and **Table 3.8.3.** The checklist of the birds recorded from the study area is given in **Table 3.8.3** including their common names, English name, abundance category and status according to Wildlife (Protection) Act, 1972.

- **Community Attributes of Birds**

The IVI was calculated for assessing the dominance status of each species in its community. The value of IVI gives information about the status and relationships of the species in different communities or in the same community over seasons or years. The species with higher IVI value are dominants in their community whereas those with low IVI values are rare ones. **Table 5.4 (Volume –II**, **Annexure –VII)** presents a similarity check on the dominant and rare species of the study area across the seasons. In case of dominant species, the overlap is 5 out of 7 i.e. 70%. In case of rare species, this overlap drops to 5 out of 12 i.e. 45%. The similarity index values for the two scenarios are 0.77 & 0.48 respectively. The high similarity of dominant species across the seasons indicates the predominance of residents as compared to the seasonal immigrants. These points to a general phenomenon that the seasonal migrants are the rare species in any stable community. It can be seen that many of the non-overlapping species in 'rare' group are migrants.

- **Migratory Bird Species**

During the two sampling efforts, there were 76 species which were recorded in both the times. The remaining 34 species were not recorded in one but recorded in other effort. This indicated a possible sampling error or emigration of that species during the period when it was not recorded. It is observed that that out of these 34 species, 22 species are migrants. Twelve of them are Local migrants i.e. migrating only a short distance. But the remaining six are winter migrants i.e. migrating from other parts of the country or even other countries. Some other winter migrant species not observed in the sampling but recorded from the study area are Common Redshank (*Tringa tetanus*), Green Shank (*Tringa nebularia*) and Osprey (*Pandion haliaetus*) etc. The status was obtained from Pande et al. (2003). These are basically small migratory species settling in the vicinity of mostly fresh-water bodies. They also do not migrate in large flocks like cranes. The migration status of some of the birds in study area is shown in **Table 5.5 (Volume –II**, **Annexure –VII)**. However, these migratory species are not having any habitate within 5-6 km radious from the project site.

- **Amphibians & Reptiles**

The species of amphibians and reptiles recorded during the study period from the study area are given in **Table 5.6 (Volume –II**, **Annexure –VII)**.

- **Butterflies**

The **Table 5.7 (Volume –II**, **Annexure –VII)** presents a list of butterfly species encountered during the study period in the study area (**Plate 3.8.12**).

- **Fish and Fishery**

The coast of Ratnagiri is well known for the rich variety of fishes. The fishing activities are carried during nine months from September to May. The commercially important varieties of fish available in large quantities are Bangada, Turli, Pedwa, Mushi, Shingada, pamphlet, Halva, Gedar, Surmai, Zinga, Dhoma, Bhing, Ghol, Karli. Beside these, clam and oysters are also available along the entire coastline mainly in creeks, backwaters and estuaries. The sea prawns are abundantly found in the district.

Pisces are the important constituent of the aquatic ecosystem. They are the main victims of the aquatic environmental changes. Inland fisheries in this region have not been observed. The presence of mangroves on the bank of river firmly supports the presence of fish fauna in those regions. The list of marine fish species is given in **Table 3.8.4**. The marine and inland fish production in study area is given in **Table 3.8.5** and **3.8.6** respectively.

3.8.14 Agriculture

Agriculture is, and always has been, an activity involving a close interaction with the environment. Soil, climate, topography, hydrological and biological conditions together, exerts a major control upon farming operations and profitability of agriculture.

Main agricultural crops grown in study area are Paddy (*Oryza sativa*), Millets includes namely Maize (*Zea mays*), Pulses, Groundnut (*Arachis hypogea*), Castor (*Ricinus communis*), etc. are included under oil seeds and are listed in **Table 3.8.7**. Productivity of the agricultural crops in this region is very low because of rainfed farming, low consumption of fertilizer, illiteracy, lack of improved agricultural technology and improper communication.

Horticulture is popular in the study area. The major horticultural trees in study area are mango, cashew nut and coconut. The year wise plantation of commercial crop trees is given in **Table 3.8.8**.

3.8.15 Marine and Coastal Biodiversity Mapping

NEERI had engaged College of Fisheries, Ratnagiri to carry out study on coastal diversity around the proposed nuclear power plant at Jaitapur with respect to plankton, benthos, fish, and diversity of fauna and flora along the shore line along with the physicochemical features of the coastal water during study period fro December 2007 to February 2008. College of Fisheries was also entrusted the job of interpretation of thermal impact on coastal and marine flora and fauna on the basis of information from secondary data and CWPRS study on prediction of thermal impact on coastal water.

Habitat

The coastal belt near proposed Jaitapur nuclear power plant consists of elevated rocky land. The coast on north near Jaitpur is rocky with a small stretch of white sand. The southern stretch near Madban has small beach of white sand and rocky coast on north side.

The inter-tidal zone of the coastal stretch under study was divided into three localities in order to understand the shoreline structure and biotic variation. The localities are designated as under

1. JN: This formed the sector of coast, just 1.5 km north east of the Jaitapur lighthouse.
2. JC: The locality of the shore, lying about 0.5 km south of the Jaitapur lighthouse.
3. JS: About 0.5 km long coastal line situated south of the Madban beach but north of Waghotan creek was the last segment of the belt.

The field visits were made in lowest low tide conditions to the above localities for making observations on the substratum and also the collection of biotic components representing the flora as well as fauna.

Coastal Biodiversity

- ### Mangrove Vegetation

Small patch of mangrove vegetation is found near Jaitapur creek near Jaitapur which is dominated by *Rhizophora macronata* and *Sonneratia alba* along with patchy distribution of *Acanthus ilicifolius*.

- ### Macro-algae

The northern stretch of location at 1.5 to 2 km was observed to be inhabitated by four species of seaweeds with the maximum abundance by the brown algal species *Sargassum tenerrimum* (60%) followed by *Padina tetrastomastica* (30%) (**Volume –II, Annexure –VIII, Table 2**.).

Near light house, *Sargassum tenerrimum* (dominant), *Padina tetrastomastica* (dominant), and *Caulerpa* (common) were recorded.

At Madban, 5 species of seaweeds were recorded with the abundance pattern as under.

1. *P. tetrastomasticus* (40%)
2. *S. tenerriumum* (40%)
3. *Dictyota dicotoma* (15%)
4. Others (5%)

- ### Shore Fauna

The faunistic shore components of the different localities of the study area represented five phyla viz. Arthopoda (Cl. Crustacea), Bryozoa, Mollusca (Bivalve and gastropods), Coelenterata (Corals and sea anemones) and Chordata (Fish and birds) (**Volume –II, Annexure –VIII, Table 3**).

The Jaitapur creek locality was dominated by *Babylonia spirata, Trochus radiatus* and *Bursa sp*. in terms of number. The bivalve species namely *Arca sp.* and *Paphia sp*. were moderate in abundance. Other mollusks were sporadic in occurrence. Among the crustaceans the crab *Graspus striagasus* was most abundant followed by *Thalamita* and *Xanthid species*. Under the phylum Chordata, single specimen of a bird species and rare occurrence of cichlid and gobid fish species was observed. No other phyla were represented in this locality.

In the JC locality the occurrence of sea slug (*Volvotella* sp.) and coral *Peorietes* sp. was sporadic. These were not recorded in other areas of observation. This locality displayed lowest faunistic diversity. Among them the gastropods *Turbo burneus* and the *Littorina sp.*were the most abundant; while the bryozoan colonies and the oyster species *Crossostea gryphodes* were in moderate numbers, other members of the fauna including four species of fish were scanty in abundance.

The southernmost locality near Madban notably represented maximum diversity of fauna, the shore being mixture of sandy as well as rocky components. The fauna was dominated by the large numbers of oyster and acorn barnacle settled as the rocky substratum, followed by the species of *Littorina (*gastropod) and *Matuta* (crab). The Donax sp. was the dominant bivalve in the sandy stretch of this locality. The moderate occurrence of the spats of bivalve *Perna viridis*, the gastropod *Murex* and the crab species of *Charybdis* was notable. The goose barnacle *Lepas* sp, .a sea anemone species and the bivalve Modiolus were observed to be the least common. A lot of tube formations with the sand and shell piece were recorded in the rocky segment.

Marine Biodiversity

Plankton Population

The variety wise abundance of phytoplankton is presented in **Table 6 (Volume –II, Annexure –VIII)**. It is seen that the diatom species of *Bacillaria* dominates the phytoplankton in all the localities of which peak value was noted at J4 (9500 no/l) followed by J8. The other species of diatom viz. *Navicula, Nitzschia* and *Chaetoceros* were next in abundance.

Considering the overall phytoplankton numbers, it was observed to be maximum at the station J8 while J3 recorded the lowest.

The zooplankton as seen from **Table 7 (Volume –II, Annexure –VIII)** was mainly composed of the copepod *Calanus* and the rotifer *Lecane* was next in dominance. The zooplankton content was maximum at J6. At J1, J6 and J7 the larval form of shrimp and crab also were present, although in low numbers.

Fish Abundance and Fish Catch

Of the three trawling zones J9 to J10 stretch recorded maximum fish catch of 59.4 kg/hr, which was mainly composed of *Legiognathus bindus, Lepturacanthus savala,* while the shrimp species were low in abundance (**Volume –II**, **Annexure –VIII**, **Table 8**).

The stretches J6-J7 and J3-J4 recorded comparatively lower catch viz. 41.50 and 44.7 kg/hr respectively. In the haul No.2 (J6-J7) *Atropus atropus* was predominated followed by *Neptunus* species while the *Metapenaeus dobsoni* was the lowest (0.1 kg/hr.).

The haul No.1 (Zone J3-J4) was mainly composed of *L. savala* and *A. atropus* at 6.0 kg/hr followed by *Lactarius lactarius* and *L. bindus*. The shrimp *Penaeus mergueinsis* made the lowest contribution in this stretch.

Benthos

The sediment sample collected from the sea transect studied did not have any phytobenthos. However the muddy substrata harboured few species of animals belonging to Polychaeta (Phylum: Annelida), Bivalvia (Phylum: Mollusca), and Amphipoda (Cl. Crustacea and Phylum. Arthpopoda)

Worms of *Nereis* at J1 represented the polycheates. In the mud sample at J4 bivalve shell pieces only could be recorded. A single amphipod species was present in J3.

Fisheries Scenario

The coastal stretch Jaitapur-Madban forms an important component of the district of Ratnagiri. Representing the southern segment, it has sea fishing as prominent traditional activity. About 35% of the population is engaged in active fishing both at Jaitapur and Madban. In this coastal region two fish landing centers are commercially important viz. Sakharinate and Tulsunde. The proportion of mechanized to non mechanized vessel is nearly 1:1.

The fish production trend analysis of the above marine fish landing centers (**Volume –II**, **Annexure –VIII**, **Table 11**) indicates fluctuating pattern. The fish quantity landed showing decline in the last two year 2004-05 and 2005-06. Pelagic varieties- sardine and mackerels and the demersal forms like shrimp, catfish, ribbon fish mainly contribute to the marine fish production of the region. The main fishing gear consists of trawl, gill net, purse seines and shore seines to a lesser extent. Oysters from the creek and rocks around form an important commodity in monsoon period (Jun-Sept).

There are two shrimp culture ponds currently in operation at Jaitapur and Dhaulwali with 3.20 and 2.0 ha. area respectively. A production of about 1.0 ton/ha has been reported from the above.

The main findings of the study, are summarized below:

1. The bottom & surface sea water temperature varied from 25 to 26.5 ^{0}C indicating well -mixed water due to ocean currents.

2. The seawater pH showed narrow fluctuation with values of 8.39- 8.78 ,

3. The levels of Dissolved Oxygen (DO) at the surface varied in the range 6.28-6.92 mg/l. Typically the DO declined with depth with a lowest value of 4.6 mg/l at the bottom water.

4. The nutrients in sea water especially phosphate and nitrate are very low indicate absence of pollution and low productivity of the seawater in the study area. Therefore, planktons are very less in amount.

5. The fish catch is low near the shore, which increases towards seaside with increase in depth.

6. The sensitive species in the study area like mangroves, present in the Jaitapur along the creek are quite far away (approximately 5 km) from the influencing area of the thermal plume from the project.

7. The thermal dispersion studies carried out by CWPRS shows that the maximum temperature rise of 4 - 5 ^{0}C will be confined to a limited area and hence will not adversely affect the native flora and fauna under normal ambient conditions.

3.8.16 Baseline Radioactivity Levels in Edible Items

3.8.16.1 Baseline Radioactivity levels in Vegetation Samples

Different varieties of vegetation samples grown around Jaitapur region were collected. The samples including edible vegetables like pumpkin, smooth guard, banana, cucumber, snake guard, arvi leaves, guava, papaya, coconut, Yam, beetle nuts and non edible vegetations such as banana leaves, grass etc. were analysed for various radionuclides of natural and fallout activity origin. The activity levels are given in **Table 9 [Volume –II**, **Annexure –IX(a)]** on fresh weight basis, which are comparable with the average parametric values observed in the western region of the country.

In case of edible vegetable samples the naturally occurring Ra-226 and Ra-228 levels varied between <0.004 Bq/kg - 1.3 Bq/kg (Pumpkin) and <0.04 Bq/kg - and 0.44 Bq/kg (smooth guard) respectively. K-40 ranged from 28.1 Bq/kg - 535.7 Bq/kg (arvi leaves) respectively. The concentration of Sr-90 in edible vegetables ranged between 0.04 Bq/kg - 0.2 Bq/kg (Pumpkin) whereas Sr-90 levels were below the detection limit of < 0.04 Bq/kg in other edible samples.

In case of other vegetable samples Ra-226, Ra-228 and K-40 levels varied between <0.004 Bq/kg - 0.5 Bq/kg (banana leaves), <0.04 Bq/kg and 122.8 Bq/kg - 476.3 Bq/kg (grass) respectively. The concentrations of Cs-137 varied between < 0.04 Bq/kg - 3.76 Bq/kg (grass) whereas Sr-90 levels were below the detection limit of < 0.04 Bq/kg.

3.8.16.2 Radioactivity levels in Cereal and Pulse Samples

Locally grown rice, ragi and black gram samples were collected and analysed for naturally occurring and fallout radionuclides. **Table 10 [Volume –II**, **Annexure –IX(a)]** gives the results of analysed samples. Ra-226, Ra-228 and K-40 levels varied between <0.02 Bq/kg - 5.1 Bq/kg, <0.2 Bq/kg - 3.7 Bq/kg and 29.8 Bq/kg - 243.6 Bq/kg dry weight respectively. The concentration of Sr-90 and Cs-137 ranged between < 0.2 Bq/kg - 0.7 Bq/kg dry weight.

3.8.16.3 Radioactivity Levels in Milk Sample

One milk sample collected from Hathivale village located beyond 15 km from the Jaitapur site was analysed for natural and fallout radionuclides. The results are given in **Table 11 (Volume –II**, **Annexure–IX(a)**. The Cs-137 was observed as 10.75 mBq/l whereas Sr-90 was less than the detection limit of 7 mBq/l.

3.8.16.4 Radioactivity Levels in Fish and Algae Samples

Seven different species of fish samples and one alga from the coastal regions were analysed and the results are given in **Table 6 (Volume –II**, **Annexure- IX(a))**. The activity levels due to long lived Sr-90 and Cs-137 in all the analysed samples were below their detection limits of 0.04 Bq/kg and 0.2 Bq/kg fresh edible weight respectively. The levels of naturally occurring Ra-226 and Ra-228 ranged between <0.004 Bq/kg - 0.32 Bq/kg and <0.04 Bq/kg - 0.16 Bq/kg respectively. The K-40 in fish samples ranged from about 22 Bq/kg - 120 Bq/kg. In case of algae only K-40 was detected as 70.9 Bq/kg fresh weight.

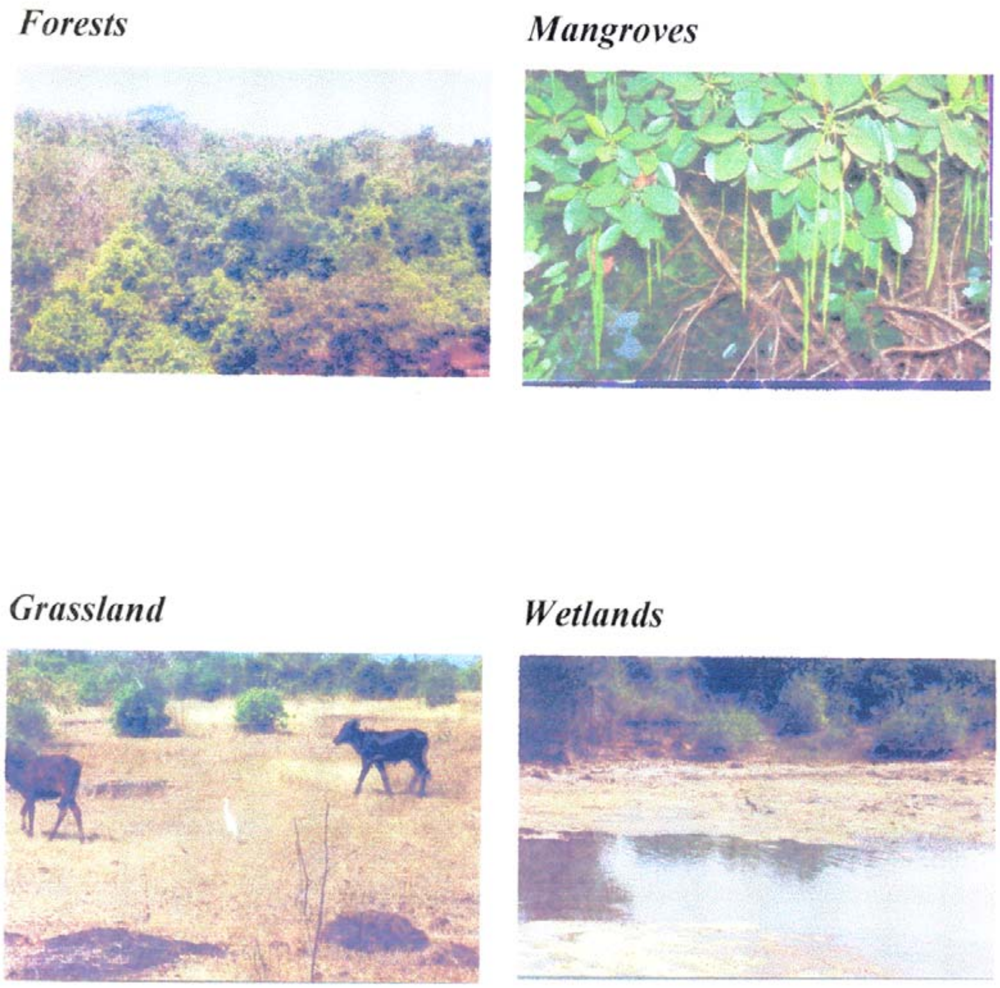


Plate 3.8.1: Wildlife Habitats beyond 5 km from the project site and upto 25 km study area from the project site

Wetland habitat in Creeks

Typical Hornbill Nest-site

Roosting & Nesting places for White-bellied Sea-Eagle

***Casuarina* trees – nesting sites of White-bellied Sea-Eagle**

Moist Deciduous Forest

Long Stretches of Grassland

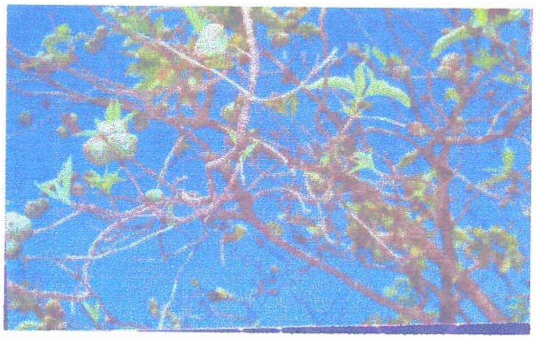
Semi-Evergreen Forest

Coastal vegetation

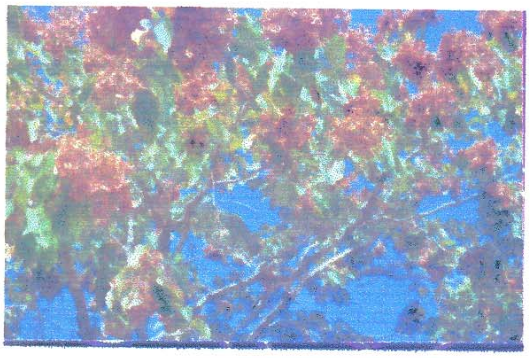
Plate 3.8.2: Wildlife Habitats beyond 5 km from the project site and upto 25 km study area from the project site

Mallotus philipensis

Morinda citrifolia



Terminalia paniculata



Cactus

Plate 3.8.3: Glimpses of Plant Biodiversity beyond 5 km from the project site and upto 25 km study area from the project site

The Look of vegetated hillsides along creeks

Mangroves in the Creek

Mangrove Island at Jaitapur

Pristine Mangrove Habitat

Regeneration of Mangroves

Mangrove biodivesity in the creek

Plate 3.8.4: Mangrove Ecosystem beyond 5 km from the project site and upto 25 km study area from the project site

Plate 3.8.5: Pneumatophores of Mangrove Trees

Plate 3.8.6: *Rhizophora* sp.

Plate 3.8.7: Avicennia sp.

All are beyond 5 km form the project site and upto 25 km study area from the project site

Plate 3.8.8: View of Plant Site Area Land Sloping to Sea with Vegetation

Achyranthes aspera

Gloriosa superba

Mucuna pruriens

Sida cordifolia

Nerium indicum

Urena lobata

Plate 3.8.9: Medicinal Plants beyond 5 km form the project site and upto 25 km study area from the project site

Plate 3.8.10: Rocky Shore near Project Site

Plate 3.8.11: Madban Sandy Beach around 3-4 km from the project site


Common Leopard


Common Evening Brown


Angled Pierrot


Lime Butterfly

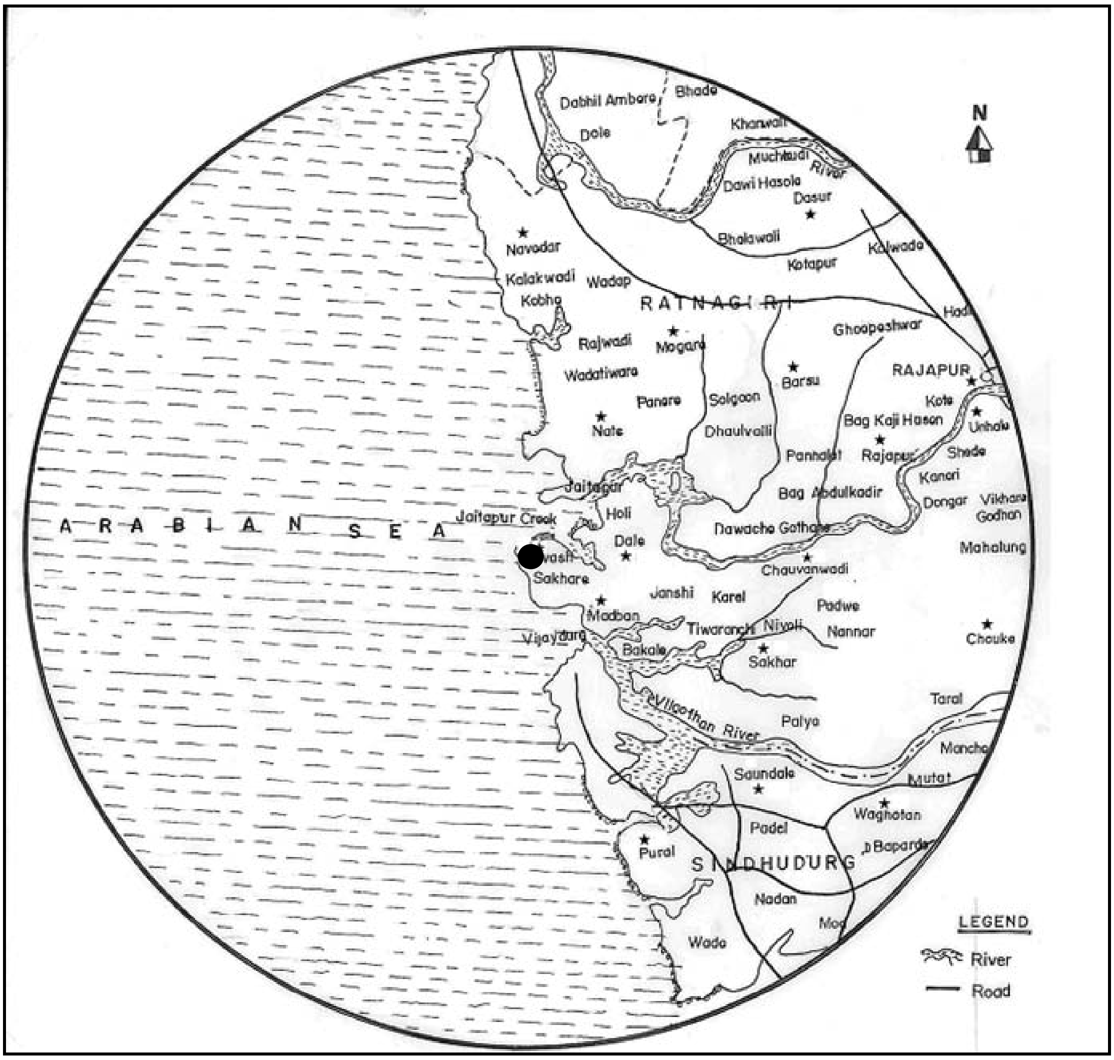

Common Mormon


Lemon Pansy


Common Sailor


Chocolate Pansy

Plate 3.8.12: Common Butterflies of the Proposed Site of JNPP



★ **Sampling Location**
● **Project Site**

Fig. 3.8.1: Sampling Locations for Biological Environment

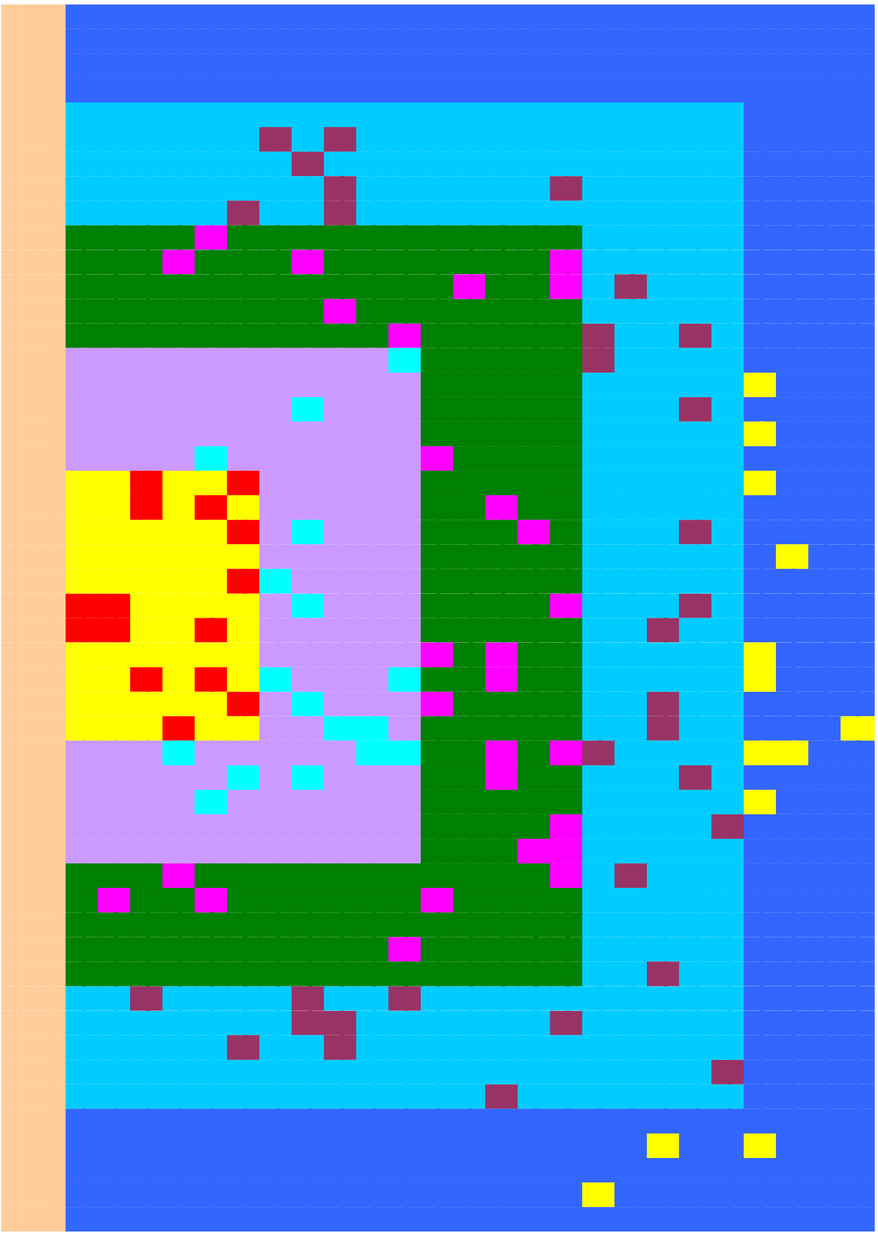


Fig. 3.8.2: Diagrammatic Representation of the Study Area and Sampling Stations for Survey of Plant Biodiversity

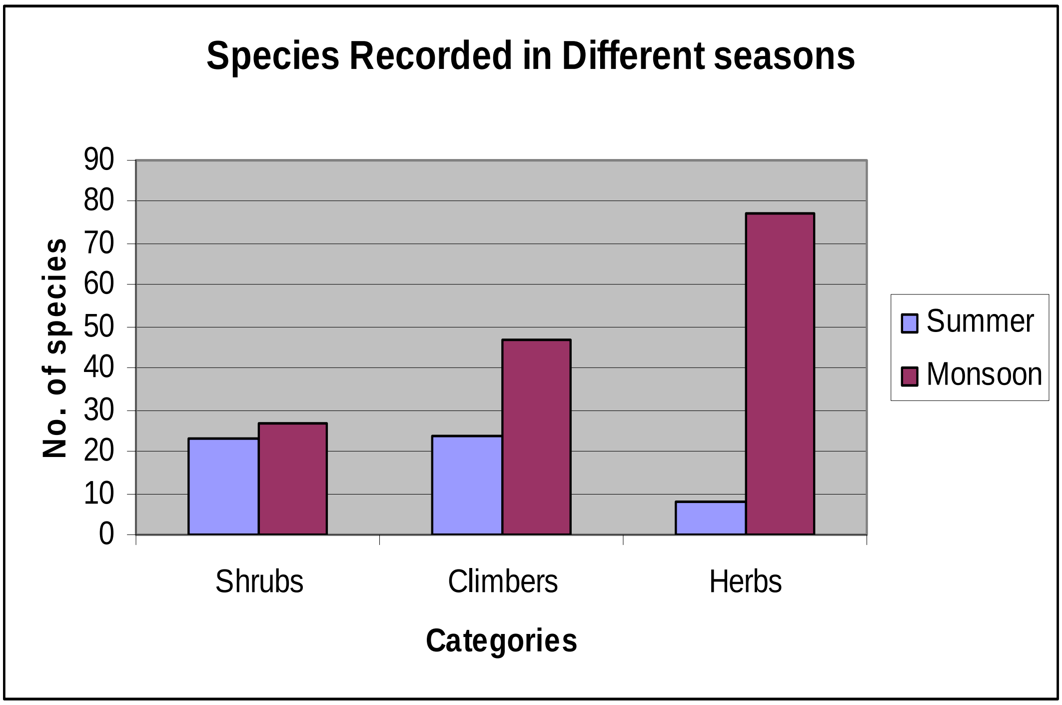


Fig. 3.8.3: Number of Species Recorded in Shrubs, Climbers and Herbs during Summer and Monsoon in the 25-km Radial Area of Jaitapur NPP Site

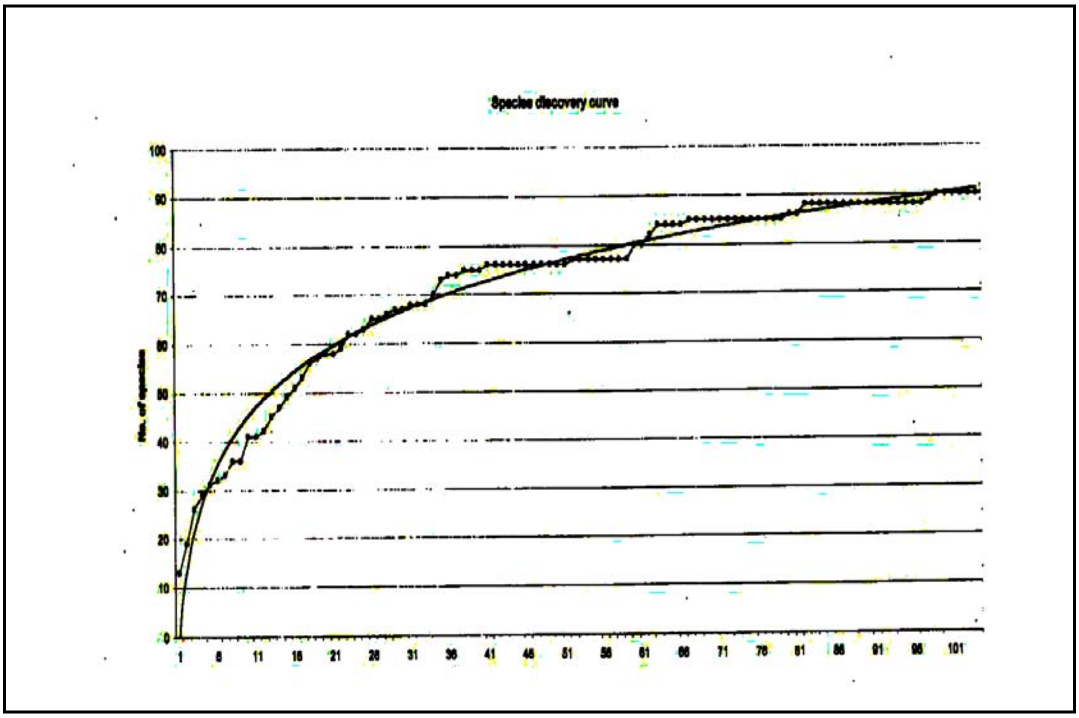


Fig. 3.8.4: Species Discovery for the Bird Sampling Effort

Table 3.8.1

List of Sampling Stations in the Study Area for Biological Survey

Sr. No.	Sampling Location	Distance from Site (km)	Direction w.r.t. Site
1.	Kuveshi	2	N
2.	Madban	3	SE
3.	Dale	5	E
4.	Nate	8	NE
5.	Chauvanwadi	12	E
6.	Sakhar	14	SE
7.	Magare	15	NNE
8.	Barsu	16	NE
9.	Saundale	16	SE
10.	Pural	17	SSE
11.	Navodar	18	N
12.	Rajapur	18	NE
13.	Waghotan	21	SE
14.	Chauke	22	SEE
15.	Unhale	22	NEE
16.	Dasur	23	NNE

Table 3.8.2

Common Insects Observed at and around Proposed Site of Nuclear Power Park at Jaitapur

Sr. No.	Common Name	Order
1.	Black cotton bug	Hemiptera
2.	Bumble bee	Hymenoptera
3.	Cashew root & stem borer	Coleopteran
4.	Charthorn grasshopper	Orthoptera
5.	Cockroach	Dictyoptera
6.	Dragon fly	Odonata
7.	Dung roller	Coleopteran
8.	Honey bee	Hymenoptera
9.	Horse fly	Diptera
10.	Leaf cutting bee	Hymenoptera
11.	Long horned grasshopper	Orthoptera
12.	Longicorn beetle	Lepidoptera
13.	Mole cricket	Orthoptera
14.	Mulberry silk moth	Lepidoptera
15.	Painted bug	Hemiptera
16.	Praying mantid	Dictyoptera
17.	Red cotton bug	Hemipter
18.	Short horn grasshopper	Hemiptera
19.	Cinnamon butterfly	Lepidoptera
20.	Wasps	Hymenoptera
21.	White grub (*Leucopholis lepidophora*)	Coleopteran
22.	White grub (*Annomala* sp.)	Coleopteran

Table 3.8.3

Checklist of Birds Recorded in the Study Area

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
1	Salunkhi	Jungle Myna	*Acridotheres fuscus*	Sturnidae	IVth	Common
2	Ganga Myna	Bank Myna	*Acridotheres ginginianus*	Sturnidae	IVth	Rare
3	Salunkhi, Myna	Common/ Indian Myana	*Acridotheres tristis*	Sturnidae	IVth	Common
4	Tutwar	Common Sandpiper	*Actitis hypoleucos*	Scolopacidae	IVth	Common
5	Subhaga	Common Iora	*Aegithina tiphia*	Irenidae	IVth	Common
6	Gawai Chandol, Bharat	Indian Small Sky Lark	*Alauda gulgula*	Alaudidae	IVth	Common
7	Dhiwar, Khandya	Small Blue Kingfisher	*Alcedo atthis*	Alcedinidae	IVth	Common
8	Lal Munia	Red Munia	*Amandava amandava*	Estrildidae	IVth	Uncommon
9	Lajri Pankombadi	White-Breasted Waterhen	*Amaurornis phoenicurus*	Rallidae	IVth	Common
10	Murari	Rufous-tailed Lark	*Ammomanes phoenicurus*	Alaudidae	IVth	Common
11	Kakan/ Kakner/ Garud	Malabar/ Indian- Pied Hornbill	*Anthracoceros coronatus*	Bucerotidae	Ist	Near threatened
12	Vanchak, Bhura Bagla, Kok	Indian Pond Heron/ Paddy Bird	*Ardeola grayii*	Ardeidae	IVth	Common
13	Pingala	Spotted Owlet	*Athene brama*	Strigidae	Ist	Common
14	Gai Gagla,	Cattle egret	*Bubulcus ibis*	Ardeidae	IVth	Common
15	Gulabi chimni	Common Rosefinch	*Carpodacus erythrinus*	Fringillidae	IVth	Uncommon
16	Bhardwaj, Sonkavla, Kukkudkumbha	Greater Coucal	*Centropus sinensis*	Cuculidae	IVth	Common
17	Bhil Kavda, Pachoo Kavda	Emerald Dove	*Chalcophaps indica*	Columbidae	IVth	Rare
18	Hirva Bulbul	Gold-fronted Chloropsis / Leafbird	*Chloropsis aurifrons*	Irenidae	IVth	Occasional
19	Kavdya Hareen	Pied Harrier	*Circus melanoleucos*	Accipitridae	IVth	Rare
20	Chatak	Pied crested cuckoo	*Clamator jacobinus*	Cuculidae	IVth	Common

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
21	Parwa	Blue-Rock Pigeon	*Columba livia*	Colimbidae	IV[th]	Common
22	Dayal, Dominga, Chitko	Oriental-Magpie Robin	*Copsychus saularis*	Muscicapidae	IV[th]	Common
23	Neelkhanth, Neelpankh	Indian Roller	*Coracias benghalensis*	Coraciidae	IV[th]	Uncommon
24	Motha Kahua	Large Cuckoo Shrike	*Coracina macei*	Compephagidae	IV[th]	Uncommon
25	Kahua	Black-headed Cuckooshrike	*Coracina melanoptera*	Campephagidae	IV[th]	Uncommon
26	Domkavla	Jungle Crow	*Corvus macrorhynchos*	Corvidae	IV[th]	Common
27	Kavla	Indian House Crow	*Corvus splendens*	Corvidae	IV[th]	Common
28	Pandharpotya Nartak	White-Bellied Blue Flycatcher	*Cyornis pallipes*	Muscicapidae	IV[th]	Uncommon
29	Neelang	Tickells Blue Flycatcher	*Cyornis tickelliae*	Muscicapidae	IV[th]	Common
30	Takachor, Bhera	Indian/ Rufous Treepie	*Dendrocitta vagabunda*	Corvidae	IV[th]	Rare
31	Maratha/ Kawdya Sutar	Yellow-Fronted Pied Woodpecker	*Dendrocopus mahrattensis*	Picidae	IV[th]	Common
32	Kotwal/ Bangda/ Kolsa/ Govinda	Black Drongo/ King Crow	*Dicrurus macrocerus*	Dicruridae	IV[th]	Common
33	Sonpathi Sutar	Lesser Golden Backed Woodpecker	*Dinopium benghalense*	Picidae	IV[th]	Common
34	Lahan Bagla, Chota Bagla, Mor Bagla	Little Egret	*Egretta garzetta*	Ardeidae	IV[th]	Common
35	Kapsi	Black shouldered Kite	*Elanus caeruleus*	Accipitridae	IV[th]	Common
36	Kokil/ Kokila	Asian Koel	*Eudynamys scolopacea*	Cuculidae	IV[th]	Common
37	Sasana, Laggad	Lagger Falcon	*Falco jugger*	Falconidae	IV[th]	Uncommon
38	Kharuchi	Common Kestrel	*Falco tinnunculus*	Falconidae	IV[th]	Vulnerable
39	Chitur, Tittir, Titur	Grey Francolin	*Francolinus pondicerianus*	Phasianidae	IV[th]	Occasional
40	Dongri,	Malabar-	*Galerida*	Alaudidae	IV[th]	Common

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
	Malabari Chandol	Crested Lark	*malabarica*			
41	Chakotri, Sakotri	Painted spourfowl	*Galloperdix lunulata*	Phasianidae	IVth	Uncommon (patchily)
42	Panbhingari	Small pratincole	*Glareola lactea*	Glareolidae	-	Uncommon
43	Jalmadgu, Meenaranka	Stork Billed Kingfisher	*Halcyon capensis*	Alcedinidae	IVth	Rare
44	Sheshari, Samudra Garud	White-Bellied Sea Eagle	*Haliaeetus leucogaster*	Accipitridae	Ist	Common
45	Brahminy Ghar	Brahminy Kite	*Haliastur indus*	Accipitridae	IVth	Common
46	Khandya, Kilkilya	White-Throated Kingfisher	*Halcyon smyrnensis*	Alcedinidae	IVth	Common
47	Karna	Malabar/ Indian Trogon	*Harpactes fasciatus*	Trogonidae	IVth	Rare
48	Dilwala Sutar	Heart Spotted Woodpecker	*Hemicircus canente*	Picidae	IVth	Rare
49	Kabra Khatik	Pied-Flycatcher Shrike	*Hemipus picatus*	Campephagidae	IVth	Occasional
50	Turebaaz Pangali	Crested Tree Swift	*Hermiprocne coronate*	Hermiprocnidae	IVth	Uncommon
51	Pawasha	Brainfever Bird	*Hierococcyx varius*	Cuculidae	IVth	Uncommon
52	Lalbudi Bhingri	Red rumped swallow	*Hirundo daurica*	Hirundinidae	IVth	Common
53	Pakoli	Cliff Swallows	*Hirundo fluvicola*	Hirundinidae	IVth	Common
54	Pakoli	Common Barn Swallow	*Hirundo rustica*	Hirundinidae	IVth	Common
55	Kala bulbul	Black bulbul	*Hypsipetes leucocephalus*	Pycnonotidae	IVth	Common
56	Garud	Grey Headed Fish Eagle	*Ichthyophaga ichthyaetus*	Accipitridae	IVth	Near threatened
57	Kajal	Yellow-browed bulbul	*Iole indica*	Pycnonotidae	IVth	Common
58	Hooman, Matsya Ghubad	Brown-Fish Owl	*Ketupa zeylonensis*	Strigidae	IVth	Uncommon
59	Naklya Khatik	Rufous Backed Shrike	*Lanius schach*	Laniidae	IVth	Common
60	Tambat, Pukpukya, Tuktuk	Coppersmith Barbet	*Megalaima haemacephala*	Capitonidae	IVth	Common
61	Kartuk, Kuturga	White Cheeked Barbet	*Megalaima viridis*	Capitonidae	IVth	Common

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
62	Kartuk	Brown Headed Barbet	*Megalaina zeylanica*	Capitonidae	IV[th]	Common
64	Bahira Popat/ Veda Raghu	Small Bee-Eater	*Merops orientalis*	Meropidae	IV[th]	Abundant
65	Ghar	Black Kite	*Milvus migrans govinda.*	Accipitridae	IV[th]	Common
66	Singing Bush Lark	Singing Bush Lark	*Mirafa cantillans*	Alaudidae	IV[th]	Common
67	Thorla Dhobi	Large/ Indian Pied Wagtail	*Motacilla maderaspatensis*	Motacillidae	IV[th]	Common
68	Suryapakshi	Purple Sun Bird	*Nectarinia asiatica*	Nectariniidae	IV[th]	Common
69	Kuree/Kural	Eurasian Curlew	*Numenius arquata*	Scolopacidae	IV[th]	Uncommon
70	Nakshidar lahan kudlya	Whimbrel	*Numenius phaeopus*	Scolopacidae	IV[th]	Uncommon
71	Raat Bagla	Night Heron	*Nycticorax nycticorax*	Ardeidae	IV[th]	Common
72	Dhanesh	Indian Grey Hornbill	*Ocyceros birostris*	Bucerotidae	IV[th]	Occasional to Rare
73	Haldya/ Kanchan/ Amrapakshi	Eurasian Golden Oriole	*Oriolus oriolus*	Oriolidae	IV[th]	Occasional
74	Kala-Dokya Haldya	Black Headed Oriole	*Oriolus xanthornus*	Oriolidae	IV[th]	Occasional
75	Ghar Chimni, Chimni	House Sparrow	*Passer domesticus*	Passeridae	IV[th]	Common,
76	Mor, Mayur	Indian Peafowl	*Pavo cristatus*	Phasianidae	I[th]	Common
77	Jungli Durlav	Jungle Bush Quail/ common Quail	*Perdicula asiatica*	Phasianidae	IV[th]	Common
78	Chota Nikhar	Small Minivet	*Pericrocotus cinnamomeus*	Campephagidae	IV[th]	Common
79	Madhadya Garud	Crested Honey Buzzard	*Pernis ptilorhynchus*	Accipitridae	IV[th]	Rare
80	Pankavla	Indian Shag	*Phalacrocorax fuscicolis*	Phalacrocoracidae	IV[th]	Uncommon
81	Pankavla	Little Coromorant	*Phalacrocorax niger*	Phalacrocoracidae	IV[th]	Common
82	Mungshya	Sirkeer Malkoha	*Phoenicophaeus leshenaultii*	Cuculidae	IV[th]	Occasional
83	Blue Capped Redstart	Blue Capped Redstart	*Phoenicurus coeruleocephalus*	Muscicapidae	IV[th]	Uncommon

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
84	Panphukti	Dusky warbler	*Phylloscopus collybita*	Muscicapidae	IV[th]	Common
85	Hirvi Panphutki	Greenish Leaf Warbler	*Phylloscopus trochioides*	Muscicapidae	IV[th]	Common
86	Navrang	Indian Pitta	*Pitta brachyuran*	Pittadae	IV[th]	Occasional
87	Sugran, Gavlan, Baya	Baya Weaver	*Ploceus philippinus*	Passeridae	IV[th]	Common
88	Popat, Raghu, Keer	Rose-ringed Parakeet	*Psittacula krameri*	Psittacidae	IV[th]	Common
89	Lalbudya Bulbul	Red-Vented Bulbul	*Pycnonotus cafer*	Pycnonotidae	IV[th]	Abundant
90	Shipai/ Narad Bulbul, Bulandi	Red-Whiskered Bulbul	*Pynonotus jocosus*	Pycnonotidae	IV[th]	Common
91	Nachra, Navhi	White Spotted Fantail Flycatcher	*Rhipidura albicollis*	Muscicapidae	IV[th]	Common
92	Rangeet Vatvatya	Common Stone Chat	*Saxicola torquata*	Muscicapidae	IV[th]	Occasional
93	Chirak/ Lalbudya	Indian Robin	*Saxicoloides fulicata*	Muscicapidae	IV[th]	Common
94	Grey Hooded Warbler	Grey Hooded Warbler	*Seicercus xanthoschistos*	Muscicapidae	IV[th]	Common
95	Panghada, Pannagad, Sarpari	Crested Serpent Eagle	*Spilornis cheela*	Accipitridae	-	Uncommon
96	Mor Ghaar/ Vydh/ Shendri Ghaar	Crested Hawk-Eagle	*Spizaetus cirrhatus*	Accipitridae	IV[th]	Uncommon
97	Nadi suray	River Tern	*Sterna aurantia*	Laridae	IV[th]	Common
98	Kavda/ Tipkya Kavda	Spotted Dove	*Streptopelia chinensis*	Columbidae	IV[th]	Common
99	Hola	Little brown dove	*Streptopelia senegalensis*	Columbidae	IV[th]	Common
100	Bamani myna	Brahminy Starling	*Sturnus pagodarum*	Sturnidae	IV[th]	Common
101	Bhordi, Gulabi Myna, Palas Maya	Rosy Starling	*Sturnus roseus*	Sturnidae	IV[th]	Common
102	Brahmani Badak, Chakrawak	Brahminy duck	*Tadorna ferruginea*	Anatidae	IV[th]	Common to occasional
103	Raan Khatik	Common wood Shrike	*Tephrodornis podicerianus*	Campephagidae	IV[th]	Common
104	Banpakhroo, Surangi, Swargiya	Asian Paradise-Flycatcher	*Terpsiphone paradise*	Muscicapidae	IV[th]	Uncommon

Sr. No.	Marathi Name	English Name	Scientific Name	Family	WPA Schedule	Abundance
	Nartak					
105	Raktasurama	Common Redshank	*Tringa totanus*	Scolopacidae	-	Common
106	Gosawi, Satbhai, Kekatya	Large Grey Babbler	*Turdoides malcolmi*	Muscicapidae	IV^{th}	Common
107	Kaloo	Eurasian Black Bird	*Turdus merula*	Muscicapidae	IV^{th}	Common
108	Titwi	Red-Wattled Lapwing	*Vanellus indicus*	Charadriidae	IV^{th}	Common
109	Maaltitwi	Yellow-wattled Lapwing	*Vanellus malabaricus*	Charadridae	-	Uncommon
110	Kadookhaoo, Shubhrakanthi Kastur	Orange Headed Thrush	*Zoothera citrinacyanotus*	Muscicapidae	IV^{th}	Common

* Abundance derived from Pande et al. (2003)
** WPA Schedule derived from Wild Life (Protection) Act, 1972

Table 3.8.4

List of Marine Fishes along the Coastal Belt of Ratnagiri District

Sr. No.	Common Name	Local Name	Scientific Name
Shellfishes			
1.	White prawn	Solat	*Penaeus indicus*
2.	White prawn	Solat	*Penaeus merguiensis*
3.	Tiger prawn	Tiger	*Penaeus monodon*
4.	Flower prawn	Flower	*Penaeus semisulcatus*
5.	Banana prawn	Polan	*Metapenaeus dobsoni*
6.	Brown prawn	Kapashi	*Metapenaeus monoceros*
7.	King prawn	Chaity	*Metapenaeus affinis*
8.	Marine shrimp	Tiny	*Parapenaeopsis stylifera*
9.	Marine shrimp	Goinar	*Solanocera indica*
10.	Marine shrimp	Ambad	*Paleomon teanopy*
11.	Marine shrimp	Jawala	*Acetes indicus*
12.	Scampi	Pocha	*Macrobrachium rosenbergii*
13.	Sand lobster	Shewand	*Thenus orientalis*
14.	Rock Jobster	Shewand	*Panulirus ornatus*
15.	Deep sea lobster	Shewand	*Puerulus spp.*
16.	Mud crab	Kurli	*Scylla serrata*
17.	Sea crab	Tin dole	*Portunus sanguinolentus*
18.	Sea crab	Mori	*Portunus pelagicus*
19.	Sea crab	-	*Charybdis cruciata*
Mollusks			
20.	Cuttle fish	Kawtya makul	*Sepia spp.*
21.	Squid	Makul	*Loligo spp.*
22.	Octopus	Shydya makul	*Octopus spp.*
Elasmobranchs			
23.	Sharp nosed shark	Son mushi	*Scoliodon sarakawor*
24.	Black tip shark	Balada	*Charcharnus melanopterus*
25.	Hammar head shark	Kanmushi	*Sphyma zygaena*
26.	Tiger shark	Waghawir	*Galeoocerus tigrinus*
27.	Guitar fish	Lanja	*Rynchobatus ojiddensis*
28.	Saw fish	Nalabi	*Pristis cuspidatus*
29.	Marbled sting ray	Waghya pakat	*Dasyatis uarnak*
30.	Whip tail sting ray	Pakat	*Himantura bleekeri*
31.	Bat ray	Boladh	*Ateomylaeus maculates*
32.	Javanese cow ray	Boladh	*Rhinoptera javanica*
Pomfrets			
33.	Silver pomfret	Saranga	*Pampus argenteus*

Sr. No.	Common Name	Local Name	Scientific Name
34.	White pomfret	Kalet	*Pampus chinensis*
35.	Black pomfret	Halawa	*Parastromateus niger*
Scombroides			
36.	Indian mackerel	Bangada	*Rastrelliger kanagurta*
37.	Seer fish	Suramai	*Scomberomorus guttatus*
38.	Seer fish	Towar	*Scomberomorus commersoni*
39.	Seer fish	Towar	*Scomberomorus lineolatus*
40.	Little tuna	Gedar/Kupa	*Euthynnus affinis*
41.	Yellow fin tuna	Gedar/Kupa	*Euthynnus albacares*
42.	Big eye tuna	Gedar/Kupa	*Euthynnus obesus*
43.	Skipjack tuna	Gedar/Kupa	*Euthynnus pelamis*
Perches			
44.	Red snapper	Kombada	*Lutjanus rosaceous*
45.	Blood Red snapper	Tamb	*Lutjanus sanguineus*
46.	Snapper	Chawari tamb	*Lutjanus johnii*
47.	Brown line reef cod	Hekaru	*Epinephelus maculates*
48.	Reef cod	Hekaru	*Epinephelus diacanthus*
49.	Target perch	Nawhera	*Therapon jarbua*
50.	Sea bass	Jitada/Khajura	*Lates calcarifer*
Sciaenids (Croakers)			
51.	Dhoma	Dhoma	*Otolithes argenteus*
52.	Croakers	Datari dhoma	*Otolithes soidada*
53.	Jew fish	Karkara	*Pomadasys maculatum*
54.	Ghol	Ghol	*Pseudasciaena diacanthus*
55.	Dori	Koth	*Otolithes brunneus*
Carangids			
56.	Scad	Tel bangada	*Alepes mate*
57.	Horse mackerel	Kat bangada	*Megalaspis cordyla*
58.	Leather skin mackerel	Falai	*Scomberoides lysan*
59.	Naked breast trevally	Khawalya bangada	*Decapterus ruselli*
Ribbon fish			
60.	Silver ribbon fish	Wakati	*Trichurius savala*
61.	Gray ribbon fish	Baga	*Trichurius hauineta*
Cat fish			
62.	Catfish	Diwal shingala	*Arius gagorides*
63.	Giant marine catfish	Petara shingala	*Arius thalassinus*
Sardine, Shad & Anchovy			
64.	Hilsa	Pala	*Hilsa ilisha*

Sr. No.	Common Name	Local Name	Scientific Name
65.	Giant herring	Bhing	*Hilsa toli*
66.	White sardine	Bhilagi	*Kowala coval*
67.	Golden anchovy	Mandeli	*Coilia dussumeri*
68.	Anchovy	Kati	*Thrissoceles mystax*
69.	Oil Sardine	Tarali	*Sardinella longiceps*
Flatfish			
70.	Indian turbot	Bhacus	*Psttodes erumei*
71.	Flounder	Repan	*Pscudorhombeus arsius*
72.	Sole	Data	*Paraplagusia bilineata*
Others			
73.	Barracuda	Toi	*Sphyraena jello*
74.	Indian Salmon	Rawas	*Eleutheronema tatradactylus*
75.	Bombay duck	Bombil	*Harpadon nehereus*
76.	Sickle fish	Chand	*Drepane punctata*
77.	Japanese thread fin	Rani masa/Chiri	*Nemipterus japonicus*
78.	Long spine bream	Chandwa	*Argyrops spinifer*
79.	Mullet	Boi	*Mugil cephalus*
80.	Pearl spot	Kharwat	*Etroplus suratensis*
81.	Scat	Wada	*Scatophagus argus*
82.	Silver bar	Karali	*Chirocentrus dorab*
83.	Eel	Wam	*Muraenesox talabonoides*
84.	Black eel	Kilis	*Mureaenapseudotsyrooide a*
85.	Mudskipper	Niwati	*Periophalmus scholsseri*

Source: Department of Fisheries, Ratnagiri

Table 3.8.5

Details of Marine Fishery in Year 2003-04

Talukas	Seashore Length (km)	Number of Villages engaged in Fishery	Number of Fish landing Centres	Production (metric tonnes)
Rajapur	18	17	3	11,351
Lanja	-	-	-	-
Kankauli	-	-	-	-

Source: Statistic Abstract Book, Ratnagiri and Sindhudurg District, 2003-04

Table 3.8.6

Details of Inland Fishery in Year 2003-2004

Talukas	Area available for Fishery (km^2)	Total area used for Fishery (km^2)	Production (metric tonnes)
Rajapur	27	26.48	7.50
Lanja	115	47.28	15.50
Kankauli	125.80	104.80	1.50

Source: Statistic Abstract Book, Ratnagiri and Sindhudurg District year 2003-04

Table 3.8.7

List of Common Crops in Study Area

Sr. No.	Crop	Botanical name
1	Paddy	*Oriza sativa*
2	Maize	*Zea maize*
3	Coconut	*Cocous nucifera*
4	Groundnut	*Arachis hypogea*
5	Banana	*Musa paradisica*
6	Cashewnut	*Anacardium occidentalis*
7	Arecanut	*Areca catechu*
8	Mango	*Mangifera indica*
9	Pulses	-

Table 3.8.8

Plantation of Commercial Crop Plants Under Horticultural Practices in Rajapur, Ratnagiri

(Values in ha)

Sr. No.	Year	Mango	Cashewnut	Coconut	Other	Total
1.	2000-01	334.89	696	13.73	1.31	104.93
2.	2001-02	318.67	408.71	21.93	9.3	758.61
3.	2002-03	22.61	269.83	169.19	3.64	512.27
4.	2003-04	164.05	222.67	3.68	11.92	402.32
5.	2004-05	88.15	165.8	6.88	5.22	266.05
6.	2005-06	185.27	232.16	8.55	6.9	432.88

Source: Taluka Agriculture Officer, Rajapur, Ratnagiri

3.9 Noise Environment

Noise, often defined as unwanted sound, interferes with speech communication, causes annoyance, distracts from work, disturbs sleep and deteriorates quality of human life.

3.9.1 Methodology and Baseline Environmental Status

The objective of survey of noise pollution around proposed atomic power project near Jaitapur, Maharashtra was to assess the existing levels of noise, and the impact of proposed project on the human settlements in 25 km radial area. Survey was carried out in the following steps:

- Reconnaissance survey
- Identification and communication of expected noise sources
- Measurement of baseline noise levels in the study area
- Present noise exposure of general population
- Measurement of prevailing noise levels due to vehicular movements

The noise meter, D-1426 (DAQE, USA), type 2230 (Bruel & Kjaer, Denmark), was used for monitoring noise. The noise levels were measured in residential, commercial and sensitive locations in the study area and were compared with stipulated CPCB standards, 1998 (**Vol II**, **Annexure II**).

3.9.2 Reconnaissance

A reconnaissance survey was conducted in summer 2006 with a view to establish the baseline status of the environment with respect to noise levels in the surrounding villages and other centres of human activities.

The proposed activity to be located is on a flat terrain and the most of the study area is undulating hilly terrain. On the northern side of project area, there is Rajapur Creek, where Kodavli River meets. Most of the villages are showing calm and quiet environment due to no major human activities except some traffic. The National Highway i.e. Mumbai to Goa passes through the town of Kharepatan is approximately 45 km away from the proposed site. A State Highway (SH) joins the area with the nearest town Tadare. Vehicular movements on this SH are medium.

Roads adjoining the villages with the SH are rural in nature with very less vehicular movements.

3.9.3 Background Noise Levels at Surrounding Residential and Commercial Zones

Background noise levels were monitored in human settlements of the villages within the study area. Locations for monitoring noise levels in the villages are shown in **Fig. 3.9.1**.

Noise levels recorded at residential areas, commercial areas and silence zones are presented in **Table 3.9.1**. Noise levels were monitored for residential and commercial areas in the study area. In residential areas, noise levels varied between 44-51 dB(A), and in commercial areas between 54-62 dB(A). At the proposed project site, the noise was observed to be 47-50 dB(A).

3.9.4 Noise level at Sensitive Receptors: Temple, Hospital and School premises

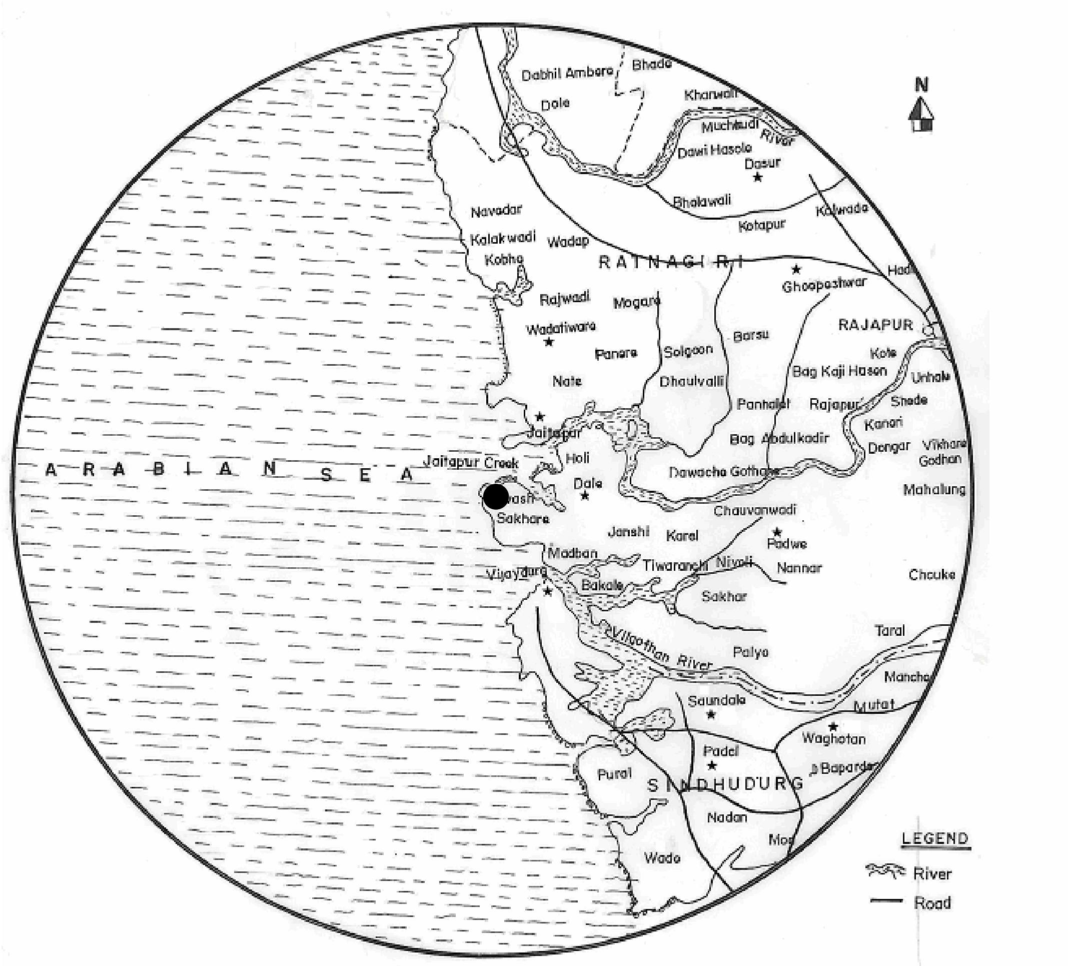
Most of the temples, schools and hospitals within the study zone are located 500-700 m away from the National and State highway. The noise levels at these receptors ranges between 41-43 dB(A).

3.9.5 Noise Levels near National Highway Outside Study Area

The noise levels at Mumbai-Goa highway were measured for day and night time on which around 1000 and 380 vehicles ply per hour during day and night time respectively. The background noise level was observed between 51-55 dB(A) which will increase to 78 dB(A) at the time of passing of vehicles during day time and 69 dB(A) during night time as presented in the **Table 3.9.2**.

3.9.6 Comparison of Noise Levels with CPCB Standards

The noise levels were observed to be below the stipulated standards at all places except at Mumbai – Goa highway at the time of high traffic density during day time as well as during night time.



★ Sampling Location

● Project Site

Fig. 3.9.1: Sampling Locations for Noise Environment

Table 3.9.1

Monitoring of Noise Levels in the Study Area (Summer, 2006)

S. No.	Sampling Locations	Distance From Site (km)	Direction	Leq dB(A)
	Industrial			
1.	Proposed JNPP Site	0	--	47-50
	Residential			
2.	Dale	3	N	48
3.	Vijaydurg	3	S	48
4.	Jaitapur	4	NNE	50
5.	Girye	5	E	48
6.	Vijaydurg Church	6	SSE	45
7.	Wadatiware	10	NNE	49
8.	Padwe	15	ESE	47
9.	Padwe temple	15	NEE	44
10.	Soundale	16	SE	47
11.	Padel	17	SE	49
12.	Ghoopeshwar	20	NE	51
13.	Waghotan	21	SE	48
14.	Dasur	23	NNE	48
	Commercial			
15.	Jaitapur	4	NNE	59
16.	Padwe	15	ESE	60
17.	Padel	17	SE	54
18.	Tadere	22	NE	62
19.	Hatiwale	24	E	55
	Silence Zones			
20.	Jaitapur, School	4	NNE	43
21.	Jaitapur Hospital	4	NNE	41
22.	Jaitapur temple	4	NNE	43

CPCB Noise Standards are as follows: Industrial Area = 75 dB (A), Commercial Area = 65 dB (A), Residential Area = 55 dB (A) and Silence Zone = 50 dB (A)

Table 3.9.2

Traffice Load and Noise Levels due to Vehicular Traffic (Summer, 2006)

Sr. No	Sampling Locations	Number of Heavy vehicle per hour	Number of Medium vehicle per hour	Number of Light vehicle per hour	Leq dB(A)
1	Mumbai-Goa National Highway (Day time)	225	255	525	78
2	Mumbai-Goa National Highway (Night time)	85	120	175	69

CPCB Noise Standards are as follows: Industrial Area = 75 dB (A), Commercial Area = 65 dB (A), Residential Area = 55 dB (A) and Silence Zone = 50 dB (A).

3.10 Socio Economic Environment

3.10.1 Introduction

The study of socio-economic component of environment incorporates various facets viz. demographic structure, availability of basic amenities such as housing, educational, health and medical services, occupation, water supply and sanitation communication and power supply, prevailing diseases in the region as well as features such as places of tourist attraction and monuments of archaeological importance. The study of these parameters helps in identifying predicting and evaluating the likely impacts due to the proposed project activity in that region.

3.10.2 Baseline Status

The survey has been carried out with the help of a pre-designed set of questionnaires. Adult (males and females) representing various communities were interviewed on judgmental or purposive basis. Data on following parameters has been collected for the study region:

1 Demographic structure

2 Infrastructure resources base

3 Economic attributes

4 Health status

5 Aesthetic attributes

6 Socio-economic status with reference to quality of life

7 Awareness and opinion of the people about the project activity.

The data is generated using secondary sources viz. Census records, district statistical abstract, official document and primary sources viz. Field survey and field observation.

3.10.2.1 Demographic Structure

The study area upto 32 km from the project site comprises 185 villages coming in Ratnagiri and Sindhudurg districts. The revenue map of the study area is enclosed in the back pocket on the back side of rear cover of this report. 135 villages are coming under Ratnagiri and 50 villages are coming in Sindhudurg district. NPP also proposes to have a residential complex and a suitable desalination plant for industrial and domestic use.

The salient features of human population in the study area (**Table 3.10.2**) are as follows:

- Total households in the study area are 39936
- Total population of the study area is 187952
- Sex ratio (No. females per 1000 males) is 1137
- The literacy rate in the study area is 64.64%
- The percentage of scheduled caste 1.25% and scheduled tribe 0.20% respectively
- Out of total population, 28.62% main workers, 17.51% are marginal workers and 53.87% non-workers

The AERB guideline permits natural population growth beyond exclusion zone. The baseline status of population is based on Primary Census Abstract 2001. A population center having more than 10,000 persons within 50 km radius from site is Rajapur and Ratnagiri which are at a radial distance of 18 and 40 km from the project site respectively.

The list of 61 villages in the study area selected for assessing the socioeconomic ststus on the basis of survey and/or secondary data along with their distance and direction with respect to project site is given in **Fig. 3.10.1** and **Table 3.10.1**. **Table 3.10.2** presents the total household, total population, density, sex ratio viz. scheduled caste, scheduled tribe population and number of literate around the site upto 32 km in the zones of 0-5 km, 5-8 km, 8-10 km, 10-16 km, 16-25 km and 25-32 km. The summarized demographic details are presented in **Table 3.10.3**.

3.10.2.2 Infrastructure Resource Base

Infrastructure resource base of the villages in the study area with reference to the basic amenities viz. Education, Medical, power supply, Drinking water etc. of selected villages in the study area are depicted in **Table 3.10.4**.

The salient features are:

- All villages have primary school and some villages are having middle and high school facility

- Jaitapur village has primary health center and rest of the villages avail this facility at distance of 5 to 10 km
- Drinking water sources are well, tube well and some villages has taps also
- Post offices, telegraph facility and phones are available in most of the village in the study area
- Bus facility is not so good in this region and most of the villages having kaccha road
- All villages having electricity supply but there are frequent power cuts.

3.10.2.3 Economic Attributes

Most of the main workers are engaged in agricultural and its allied activity. In the study area, mainly paddy crops are grown, and mango and cashew nut are the important cash crops. Among horticultural practices, mango especially Hapus (Alfanso) varieties of mango are grown in the study area. Many peoples in this area are engaged in plantation of mango and cashew nut **(Plate 3.10.1** and **Plate 3.10.2)**. Employment Pattern of the study area is shown in **Fig. 3.10.2**.

Within 30 km radius from site following fishing villages exists: Kasheli, Sakhari, Nate, Jaitapur, Juve, Tulsunde, Madban, Bekale, Wadap, Ingalwadi, Sagave, Katali, Purnagad, Goankhadi, Gawade-Ambhore and Ambolgad. Total active fishermen in the area are 2547 fishing yield is 16257 MT. per annum. No salt pans are reported to exist in the vicinity of the site within 5 km. Fishing activity is carried out in some villages. A photographic depiction of the same is presented in the **(Plate 3.10.3)**.

3.10.2.4 Health Status

Health of the people is not only a desirable goal, but it is also an essential investment in human resources. As per the National Health Policy (1983), Primary Health Care has been accepted as main instrument for achieving this goal of development and strengthening rural health infrastructure through a three-tier system, viz. Primary Health Sub Centres, Primary Health Centre (PHC) and Community Health Center (CHC), which have been established.

Lack of building, shortage of manpower and inadequate provision of drug supplies are hampering the operation of these units. The standards to be met according to National Health Policy are given below:

Population	Infrastructure	Personnel
1,00,000	Rural	Medical superintendent
25,000 – 30,000	1 PHC, 6 beds	2 Medical officers
3,000 – 5,000	1 Sub center	1 Auxiliary Nurse Midwife (ANM)

Health problems generally reported are attributed to improper sanitation, mosquito nuisance and water logging. Diarrhea is one of the most frequently occurring diseases. Birth, Death, Child Mortality Rate & Infant Mortality Rate (IMR) for Ratnagiri District are given in **Table 3.10.5**.

During the discussion with medical practitioner, it was revealed that Diarrhoea, Respiratory infections, Hypertension, Anemia, Asthma and Pulmonary diseases are the most prevalent disease in the study area shown in **Table 3.10.6**.

3.10.3 Socio-economic Status

3.10.3.1 Sampling Method

Socio-economic survey was conducted in 61 villages of the study area located in all directions with reference to the project site, which are shown in **Table 3.10.1**. Sarpanch of villages and respondent (Adult male-female) were chosen for the collection of awareness and opinion, by using judgmental or purposive sampling methods representing various socio-economic sections of the community. Whereever the survey was not possible due to unforeseen reasons viz. unavilabiolity of authoritative people or any othe difficulty in this remote area, the secondary data from government records was utilized for asseessmnet of socioeconomic status.

The survey methodology was a questionnaire incorporating questions regarding personal inventory, provisions of basic amenities, opinion and awareness about the project and aspirations about the project. Occupational stratification is prime parameters for sampling because each strata of the sample unit possess specific characteristics and their views and attitudes would reflect on the different parameters of quality of life. The data thus collected is compiled and analyzed to arrive at an overview of the present situation and the quality of life of the area surveyed.

3.10.3.2 Observations on Socio-economic Status

The salient findings on socioeconomic status are given below:

- 100% awareness regarding proposed project
- Most of the respondents are engaged in fishing and agricultural activities. Farming is the main occupation, a few respondent have service in government sector and most of other respondent are labour
- Land will be acquired from the villages, Madban, Warilvada, Karel, Niveli and Mithigavane villages
- The respondents whose land will be acquired for project are having apprehension on land acquisition.
- Wood, kerosene and LPG are the main source of fuels used for cooking purpose

3.10.4 Social Welfare & Community Development Programme

3.10.4.1 Around NPPs by NPCIL

The policy of NPCIL towards social welfare & community development aims at strengthening the bond between the project / station authorities and the local population in the vicinity of nuclear power plants.

The sphere of activities contains the contribution of NPCIL in the following areas:

Education – Gyan Gangothri Yojana
Health – Arogya Sudha Yojana
Community Welfare

1. Education – Gyan Gangothri Yojana

In this scheme social welfare activites, financial assistance for upgradation of educational facility and tools are provided to the school and colleges in the area around the project. A photographic view of the same is presented in **Plate 3.10.4** to **Plate 3.10.7**.

2. Health: Arogya Sudha Yojna

In this social welfare scheme, mobile clinics, medical camps and health care services are provided to the needy people in the area around the project. A photographic view of the same is presented in **Plate 3.10.8** and **Plate 3.10.9**.

3. Community Welfare Programme

In this scheme of social welfare activities, number of community development programs such as construction of community halls, drinking water facilities, roads, etc. in the area around the project. A photographic view of the same is presented in **Plate 3.10.10** to **Plate 3.10.12**.

3.10.4.2 Welfare Measures Proposed to be implemented by JNPP

Health Welfare:

Hepatitis 'B' vaccination to school & village children.

Educational Welfare:

Construction of school building, classroom, laboratory, compound wall, distribution of computers, notebooks, sports item, benches, laboratory equipment.

Drinking Water, Street Lighting, Roads etc.

Bore well, pipeline, motor & pumps, widening of roads, solar street lighting etc.

Development of local Entrepreneurs and industries

Fishermen:

- Life Jackets

Other Welfare activities

- Assistance for making bore-wells in local villages.
- Petrol pump started at Residential complex catering to project personnel and local public.
- Procurement of furniture for school, Russian flats, Guest house, Office etc. from local cottage industry.
- Allotment of shops in the shopping centres in the Residential complex for local villagers.
- Maintenance contract for house keeping the plant site & residential complex to local villagers.
- Financial help to the local people affected in the tsunami
- Books for students in schools in nearby villages.
- Construction of additional classrooms in Govt. school in nearby villages.
- Computers for schools in nearby villages
- Construction of bypass roads in the nearby villages
- Construction of bus shelters.

- Financing to State Govt. for widening and improvement of roads in the nearby area connecting to the National Highway.
- Talent nurture programme in our schools: for the benefit of talented kids from economically poor background in the near by area in our schools with full sponsorship upto 12th std

3.10.5 Cultural and Aesthetic Attributes

The nearest tourist attraction by study area is **Vijaydurg Fort**, which is, situated at aerial distance of around 5 km from the project site on SE direction across the creek (**Plate 3.10.13**)**.** The distance of Vijaydurg fort from project site by road is around 120 Km. Vijaydurg fort is the historical monument. Every year local and foreign tourists visit this monument. As project would not be emitting any conventional pollutants and the radiological releases will be much below the stipulated limits (around 10% of the specified limits) at a distance of 1.6 km from the project, there would not be any adverse impact on the fort & the near by area due to project activity.

3.10.6 Brief of Project Affected Families

Demographic Profile of Project Affected People

The land from five villages namely Karel, Niveli, Mithgavane, Madban and Warilvada is going to be acquired covering 938.026 hectare of land for plant site and residential complex. The details of type of land including trees being acquired for JNPP are presented in **Table 3.10.7**. No person from study area would be displaced for project activity. The socio-economic survey of the Project Affected Persons (PAPs) was undertaken. The opinion of the PAPs was obtained and they expressed the fear of losing sustenance consequent to loss of land. It is to mention that while establishing the project, only minimum number of trees will be removed from the plant site, moreover tree plantation will be carried out in the exclusion zone.

Almost all the Project Affected Persons (PAPs) in the study area have the knowledge about the land acquisition for the developmental activity and residential complex. They are also aware of the loss of land, especially their land holdings on which they depend by practicing agriculture.

Socio Economic Survey

- Almost all the Project Affected People have knowledge about the acquisition of land. The total land holdings likely to be acquired will be 938.026 hectares
- The main occupation of the Project Affected People is agriculture and they mainly depend on it for their lively hood

During survey, it was noticed that project affected people are having certain expectations from project authority that are stated below:

- Project authority should consult the villagers and Govt. of Maharashtra before estimating the cost of the agricultural land.
- Project authorities should improve infrastructural facilities to the people in surrounding villages viz. water, electricity etc.
- The Project Authorities should provide preference in employment for project-affected families in the category of unskilled and skilled workmen as per the need of the project. Every affected family must be helped in starting some gainful occupation/getting training to facilitate secondary employment in the region. Eligible persons should be given employment after considering their skills and capabilities and wages should be provided to them as fixed by the corporation.

R&R Programme Monitoring and Reporting Procedure

R&R committee meetings should be held on periodic basis in order to ensure incorporation of preference of the PAPs and resolve logistic problems in implementation of R&R Plans. The project co-ordinator with team members must meet every PAF to ensure the implementation of R&R programme from time to time. Six-monthly progress reports will be prepared and reviewed for evaluation. The Potential Evaluation Indicators for monitoring would be:

- Task completion as per schedule
- Identification of conflict among stakeholders, and its resolution
- Awareness of PAPs and their involvement in overall development and improvement in their quality of life

Resettlement and Rehabilitation Strategy

Divisional Commissionar, Konkan Division notified the villages Madban, Karel, Niveli ane Mithgavane as project affected villages for rehabilitation (Vide

Notification no. Rehabilitation/office-1/Jaitapur Project/CR-10/2005 dated 23-12-2005 as presented in **Annexure XV**, **Volume II**.

Based on National Policy on Resettlement and Rehabilitation for Project Affected Families, the Maharashtra State Govt. has constituted “State Rehabilitation Authority” at state level under State Govt. Resolution dated 17.03.2006.

Based on above resolution, the project proponent is required to sign MOU with Department of Rehabilitation, Maharashtra State. Accordingly, NPCIL has signed a MOU with Principal Secretary, Relief and Rehabilitation, Department of Revenue and Forest, Govt. of Maharashtra on 25th September, 2006, which has following provisions:

1. Base line Socio-Economic survey of the families affected by land acquisition will be carried out to prepare base line data for the above families.

2. Total loss of the land for all the families and its impact upon their livelihood will be ascertained through an independent agency to be appointed by Govt. of Maharashtra.

3. Based on above survey and assessment, a proper resettlement and rehabilitation plan will be jointly prepared and agreed by NPCIL and State Govt. The above plan will be approved by State Rehabilitation Authority for its implementation.

4. The above plan will be implemented by NPCIL through State Administration.

The implementation of above rehabilitation plan will be in addition to compensation to be paid to the each project affected family for the cost of land which is falling under different categories like agriculture, non-agriculture, bagachi, etc. The valuation of the land will be carried out by officials from Revenue, Agriculture and Horticultural Department & PWD of State Govt. for the respective type of the land. Based on above valuation, the award for the compensation will be issued by SLAO, Office of Collector, Ratnagiri (appointed for the purpose by the State Govt.). The above valuation will be based on the govt. notification applicable as on date for the purpose of deriving rates in each of above category of land.

Implementation of rehabilitation plan by NPCIL shall be closely monitored by State Govt.

3.10.7 Quality of Life

Quality of Life (QoL) is a term, which indicates overall status of socio-economic environment in a given area. Quality of Life (QoL) is defined as a function between “objective conditions” and “subjective attitudes” involving a defined “area” of concern.

The “objective conditions” are defined as numerically measurable artifacts of a physical, sociological event or economic event. Objective conditions may be defined as any number, which stands for a given quantity of a variable of interest so long as it is independent of subjective opinion.

“Subjective attitude” is primarily concerned with affective and cognitive dimensions. It is specifically concerned with ‘how aspects of cognition vary with variation in objective conditions.

Respondents opinion is transformed to a normal scale varying from 0 to 1 (value function curve) in which 0 corresponds to the lowest or least satisfactory measure and 1 corresponds to the highest. The normalized weights are assigned to each factor by ranked-pair wise technique by the expert group based on the secondary data and general observations.

The total transformed values of respondent’s opinion for ‘i’th factor (Qlij) is multiplied by normalized weight of ‘i’th factor. The summation of all the values multiplied by 1/p gives QoL(s).

Qli is the satisfactory level for ‘i’th factor assigned by the expert group (varying from 0 to 1) based on the observations. Qli is multiplied by Wi for ‘i’th factor and summation of all the values give the value of QoL(o).

The mean value of QoL(s) and QoL(o) is calculated to obtain QoL(c).

The Socio-economic Indicators for QoL Assessment are:

1. Income, Employment and Working Condition
2. Housing
3. Food
4. Clothing
5. Water Supply and Sanitation

6. Health
7. Energy
8. Transportation and Communication
9. Education
10. Environment and Pollution
11. Recreation
12. Social Security
13. Human Rights

I. Subjective Quality of life

In mathematical form it can be expressed as follows.

$$QoLs = 1/p \sum_{I=1}^{M} \sum_{j=1}^{p} Qiij \times Wi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10.1)$$

Where,

QoLs	=	Subjective quality of life index
p	=	No. of respondents, j = 1... p
m	=	No. of factors, I = 1... m
Qiij	=	Subjective quality index for i^{th} factor assigned by j^{th} respondent
$\sum$ Qiij	=	Subjective quality index for ith factor assigned by all respondents in an area
Wi	=	Normalised weight of the i^{th} factor

II. Objective Quality of life

$$QoLo = \sum_{i=1}^{i=n} QIi \times Wi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10.2)$$

Where,

QoLo	=	Objective quality of life index
n	=	No. of QoL Factors
I	=	1, 2, 3, … n
Qli	=	Satisfaction level (assigned by the expert group) for the i^{th} objective indicator
Wi	=	Normalized weight for i^{th} factor

III. Quality of Life (Cumulative Index)

$$QoLc = \frac{QoLo + QoLs}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10.3)$$

The subjective and objective QoL indices prior to commissioning of the project are presented in **Table 3.10.8**.

The average QoL index values are estimated as:

QoL (s) = 0.49

QoL (o) = 0.51

QoL (c) = 0.50

The average QoL index value for the study area is leaning towards satisfactory level due to good economic status like income, employment and also availability of basic needs, viz. food, clothing, and housing. The area lacking with medical, educational facilities and social security, besides water scarcity, inadequate irrigation, lack of sanitation, which are subjective conditions and are not much satisfactory as compared to objective conditions.

Plate 3.10.1: Mango Trees in Study Area

Plate 3.10.2: Cashew nut Trees in Study Area

Plate 3.10.3: Fishing Activities in Study Area

Plate 3.10.4: Gyan Gangothri Yojna at KKNPP

Construction of School Boundary Wall & Toiletry Blocks to Neighboring Schools

Construction of Class Room Building & Furniture to Neighboring Schools

Distributing Educational Aids to Students

Plate 3.10.5: Distribution of Note Books & Uniforms

Plate 3.10.6: Construction & Inauguration of Anu-Vikas Vidyalay, Dandi - Tarapur

Plate 3.10.7: Gyan Gangothri Yojna at KAPS - KAKRAPARA

Financial Assistance For Construction Of Additional Class Rooms

Presenting Stainless Steel Utensils In Mid-Day Meal Scheme

Presenting Science Lab Equipment To Primary School

Presenting Science Musical Instruments To Primary School

Plate 3.10.8: Arogya Sudha Yojna

Health is Wealth: Kudankulam's Motto

Regular Medical camps for neighboring villagers

Arogya Sudha At Kaiga

Medical Camps in progress

Plate 3.10.9: Medical Camp for Labourers at Tarapur




Ayurvedic Medical Camp Organized At Kakrapar

Plate 3.10.10: Welfare Measures by KKNPP


Construction of 17.6 km road from Anjugramam to Kudankulam and several connecting roads in the area


Installation of 10 Solar street Lights and 45 Sodium Street Lights to the neighbouring villages


Drinking Water Supply in the Neighbouring Villages

Plate 3.10.11: Women's Development

Mahila Kalyan Yojana at Kaiga

Distributing sewing machines to village women

General Welfare
Providing Infrastructure in Nearby Villages at Kaiga

Water Tank Constructed at Mallapur Village

Bridge constructed at Kuchegar Village

Plate 3.10.12: Water is precious: drinking water facilities at Schools and villages at Kaiga

Borewell installed at Kuchegar School

Water pipelines at Mallapur village

Better Catch For the Fishermen at Kaiga

One lakh fish seedlings being released to Kadra Reservoir

Protect The Earth. It Is the Only World We Have- Kaiga

Village School children participating in tree plantation programme as part of World Environment Day

Plate 3.10.13: View of Vijaydurg Fort from Plant Site Area

Fig. 3.10.1: Sampling Locations for Socio-economic Study by NEERI in the Study Area
(A3 Size)

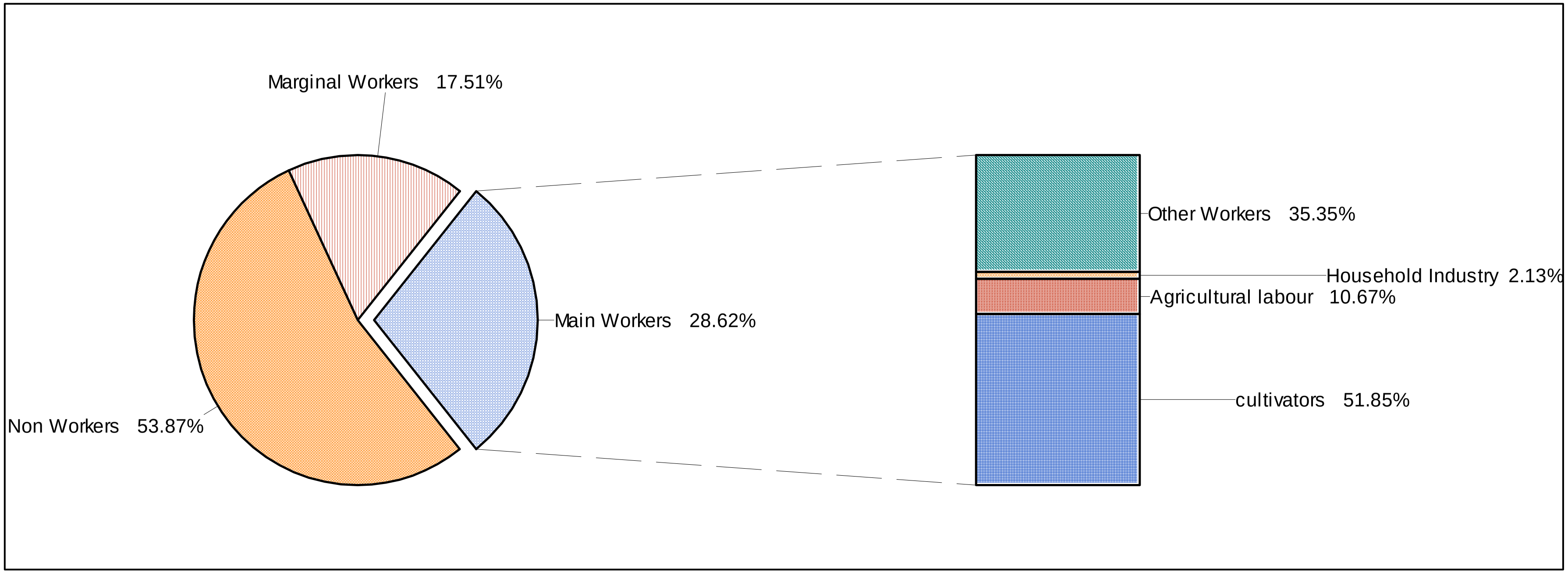


Fig. 3.10.2: Employment Pattern in Study Area

Note:
The census does not have a precise definition of unemployment, however National Sample Survey organization (NSSO) defined the unemployment or non workers as "Persons who owing to lack of work , had not worked but either sought work through employment exchanges, intermediaries, friends or relatives or by making applications to prospective employers or expressed their willingness or availability for work under the prevailing conditions of work and remuneration are considered as those who are *seeking or available for work (or unemployed).*

Table 3.10.1

Distance and Direction of the Villages Surveyed

Sr. No.	Villages	Distance(Km)	Direction
1.	Madban	1.5	SE
2.	Tulsavade	2.3	NE
3.	Kuveshi	3	ENE
4.	Jaitapur	3.5	NNE
5.	Holi	4	NE
6.	Mithgavane	4	ESE
7.	Dale	5	E
8.	Anantwadi	5.5	NN E
9.	Jambhulwadi	6	E
10.	Bandhawadi	6.2	SSE
11.	Vijaydurg	6.4	S
12.	Nate	7	NE
13.	Karel	8	ESE
14.	Kuvale	8	SSE
15.	Agarewadi	9	NE
16.	Rameshwar	9.2	S
17.	Kambale Lavgan	10	SSE
18.	Rajawadi	10	NNE
19.	Devache Gothane	10	E
20.	Sakhar	10.2	ESE
21.	Shengalwadi	11	E
22.	Solgaon	12.7	ENE
23.	Tirlot	12.9	SSE
24.	Wadapeth	13	SE
25.	Bag Abdul Kadir	13.5	ENE
26.	Nannar	13.5	ESE
27.	Navodar	13.5	N
28.	Shejavali	13.5	E
29.	Saundale	15	SE

Sr. No.	Villages	Distance(Km)	Direction
30.	Padel	15	SSE
31.	Kondsar Bk.	15	NN E
32.	Ghumewadi	15.4	NE
33.	Vilaye	15.8	E
34.	Rajapur	16	ENE
35.	Unhale	16	ENE
36.	Kalakawadi	16	NE
37.	Barsu	16	ENE
38.	Kunbiwadi	16.2	ESE
39.	Barsu	16.5	NE
40.	Pural	16.5	SSE
41.	Kaneri	17	E
42.	Dhopeshwar	17	ENE
43.	Kotapur	17.5	NE
44.	Dongar	17.5	E
45.	Panore	17.5	NNE
46.	Phanase	19	SSE
47.	Dorle	19.5	NN E
48.	Chauke	20	ESE
49.	Mahalunge	20	E
50.	Bag Kazi Husen	20	E
51.	Padvane	20.5	SSE
52.	Chikhale	22	NE
53.	Nanij	22.1	NN E
54.	Hativale	22.5	E
55.	Baparde	23	SE
56.	Sheel	23	ENE
57.	Juvathi	23.5	E
58.	Mond	24	SSE
59.	Roon	24.3	NE
60.	Dhaulvali	26.5	ESE
61.	Madheliwadi	28.5	E

Table 3.10.2

Demographic Structure in Study Area in Different Radial Zones (in kms) Around Project Site

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
0-5 Km Radial Zone										
Rajapur Tehsil										
Tulsavade	239	1206	534	672	0	0	624	555	182	469
Jaitapur	76	265	124	141	0	0	220	73	76	116
Kuveshi	206	797	358	439	0	0	544	216	224	357
Madban	130	437	196	241	0	0	317	137	134	166
Warilwade	101	414	182	232	0	0	284	178	50	186
Mithgavane	445	1816	829	987	17	3	1203	454	336	1026
Bakale	65	268	119	149	6	1	171	116	44	108
Holi	135	550	233	317	0	0	332	203	80	267
Chavhanwadi	86	391	162	229	0	0	232	160	21	210
Total	**1483**	**6144**	**2737**	**3407**	**23**	**4**	**3927**	**2092**	**1147**	**2905**
5-8 Km Radial Zone										
Rajapur Tehsil										
Ambolgad	206	619	244	375	0	0	374	109	239	271
Bandiwade	56	277	118	159	0	0	190	76	89	112
Math Kh.	57	284	136	148	0	0	152	79	89	116
Anantwadi	35	127	61	66	0	0	104	27	23	77
Sakhari Nate	739	4510	2387	2123	8	0	2702	1668	292	2550
Dale	172	668	299	369	4	5	451	48	301	319
Waghran	51	215	92	123	0	0	119	4	99	112
Jambhulwadi (N.V.)	59	277	125	152	0	0	146	139	0	138
Niveli	61	233	106	127	0	0	136	97	46	90
Janshi	96	403	169	234	0	0	254	106	103	194
Hatade	163	597	268	329	41	0	347	224	128	245
Bandhawadi	94	374	183	191	6	0	256	189	14	171
Devgad Tehsil										
Rameshwar	412	2191	1042	1149	8	0	1457	481	380	1330
Vijaydurg	408	1764	824	940	107	8	1375	232	181	1351
Total	**2609**	**12539**	**6054**	**6485**	**174**	**13**	**8063**	**3479**	**1984**	**7076**
8-10 Km Radial Zone										
Ratnagiari Tehsil										
Kambale Lavgan	132	561	253	308	0	0	314	312	40	209
Rajapur Tehsil										
Chavhatawadi	49	204	96	108	0	0	158	34	89	81
Shengalwadi	75	328	145	183	0	0	185	124	70	134
Pishedwadi	62	283	132	151	0	0	145	9	143	131

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
Burbewadi	162	633	239	394	0	0	353	263	17	353
Karel	54	205	93	112	0	0	120	65	50	90
Rajawadi	128	427	169	258	0	0	222	183	24	220
Ghumewadi	88	428	187	241	0	0	223	110	142	176
Pangari Bk.	157	634	275	359	0	0	403	313	24	297
Manjarewadi	77	371	170	201	0	1	189	162	25	184
Dasurewadi	77	396	150	246	0	0	201	146	79	171
Agarewadi	125	528	229	299	0	0	279	207	102	219
Bholewadi	48	233	118	115	0	0	191	100	15	118
Yashavantgad	85	425	213	212	0	0	268	143	10	272
Total	**1319**	**5656**	**2469**	**3187**	**0**	**1**	**3251**	**2171**	**830**	**2655**
10-16 Km Radial Zone										
Rajapur Tehsil										
Kumbhavade	313	1489	688	801	17	25	1004	664	99	726
Rajapur	2202	10499	5222	5277	171	38	8177	3263	582	6654
Wadapeth	198	885	429	456	34	4	636	245	149	491
Palekarwadi	79	382	182	200	11	0	241	210	17	155
Katradevi (sagave)	151	809	383	426	57	6	494	337	16	456
Bhandarwadi	88	428	187	241	0	0	223	110	142	176
Ganganwadi (N.V.)	87	370	157	213	0	0	247	25	177	168
Nanar	233	1086	525	561	8	0	655	602	54	430
Sakhar	333	1292	550	742	39	0	761	621	106	565
Madheliwadi	62	321	143	178	0	0	169	67	66	188
Kondwadi	241	1320	589	731	58	0	691	525	130	665
Takkewadi (N.V.)	89	415	187	228	0	0	283	54	177	184
Shejavali	124	564	236	328	16	0	348	304	17	243
Vilaye	111	492	232	260	20	1	345	217	54	221
Kasarwadi	124	593	279	314	0	0	324	121	178	294
Solgaon	493	2181	932	1249	24	0	1164	662	334	1185
Devache Gothane	291	1144	442	702	16	0	675	225	351	568
Bagavewadi	139	742	320	422	0	0	350	163	261	318
Bag Abdul Kadir	28	130	68	62	0	0	107	31	59	40
Unhale	200	999	463	536	0	0	601	242	276	481
Ambelkarwadi	158	664	285	379	0	0	360	142	160	362
Bhabalewadi	100	404	144	260	0	0	257	97	127	180
Khalchi Bhandarwadi	70	311	146	165	19	0	204	144	79	88
Kalakawadi	126	448	185	263	3	0	250	176	38	234
Kondsar Bk.	225	947	402	545	0	0	550	319	137	491

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
Devgad Tahsil										
Girye	536	2779	1317	1462	5	0	1914	814	325	1640
Gavane	173	777	367	410	38	0	464	30	399	348
Padel	638	3714	1782	1932	12	12	2546	461	915	2338
Tirlot	471	2370	1187	1183	76	12	1464	425	462	1483
Thakurwadi	219	1065	472	593	0	0	827	74	141	850
Kuvale	305	1301	604	697	31	6	844	370	173	758
Sandve	130	574	279	295	9	3	357	58	172	344
Total	**8737**	**41495**	**19384**	**22111**	**664**	**107**	**27532**	**11798**	**6373**	**23324**
16-25 Km Radial Zone										
Rajapur Tehsil										
Kunbiwadi	110	493	212	281	0	0	335	191	141	161
Guravwadi (N.V.)	66	335	171	164	0	0	193	154	69	112
Upale	245	1135	563	572	3	2	719	557	144	434
Ranewadi (N.V.)	70	290	129	161	0	0	134	94	59	137
Chauke	73	305	123	182	1	0	171	129	38	138
Mahalunge	168	653	304	349	20	0	371	183	233	237
Hativale	187	768	373	395	3	1	449	175	257	336
Juvathi	441	1940	894	1046	28	1	1161	602	478	860
Dongar	139	621	295	326	4	3	398	155	76	390
Vikhare Gothane	229	882	418	464	38	0	324	491	64	327
Kaneri	174	756	349	407	1	0	477	134	208	414
Shendewadi (N.V.)	90	406	175	231	0	0	217	206	30	170
Bag Kazi Husen	17	82	55	27	0	0	50	33	15	34
Dandewadi	114	446	197	249	2	6	308	68	131	247
Sheel	267	1407	629	778	11	0	811	270	498	639
Dhopeshwar	345	1786	878	908	51	0	966	522	386	878
Barsu	97	407	183	224	0	0	220	137	65	205
Tithavali (N.V.)	130	558	269	289	0	0	242	157	156	245
Paratvali	64	307	139	168	34	0	178	119	94	94
Pokalewadi (N.V.)	70	287	101	186	0	0	182	140	32	115
Gorulewadi	127	623	279	344	5	4	346	196	119	308
Dasur	112	485	228	257	23	0	347	148	71	266
Chikhale	106	449	180	269	23	0	219	93	163	193
Lanja Tehsil										
Lavgan	134	537	220	317	3	0	258	175	71	291
Khanavali	398	1632	736	896	72	0	967	567	221	844
Chinchurti	92	383	151	232	0	0	161	166	92	125

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
Panore	119	521	207	314	0	0	256	200	126	195
Kudewadi	71	320	149	171	0	0	211	59	150	111
Satavali	441	1971	910	1061	14	0	1294	545	276	1150
Musalmanwadi	113	588	235	353	0	0	329	144	36	408
Roon	259	1109	503	606	9	0	579	335	227	547
Ratnagiri Tehsil										
Kotavade	747	3090	1439	1651	30	15	2065	806	643	1641
Gavade Ambere	431	1924	848	1076	0	0	1288	171	648	1105
Jakimirya	409	1832	904	928	9	3	1441	509	98	1225
Bhandarwadi	9	39	20	19	0	0	27	11	2	26
Nanij	476	2154	1059	1095	0	0	1409	406	693	1055
Dorle	224	947	441	506	0	0	642	300	99	548
Patharat	94	427	192	235	0	0	241	151	67	209
Devgad Tehsil										
Pural	263	1274	600	674	25	0	864	61	140	1073
Phanase	156	783	357	426	0	4	590	109	212	462
Padvane	147	697	362	335	0	4	536	279	21	397
Wadetar	77	303	151	152	0	5	205	107	22	174
Nadan	360	2063	976	1087	5	0	1391	895	320	848
Waghivare	105	462	217	245	47	1	299	194	27	241
Chinchwad	98	361	151	210	0	0	248	38	29	294
Elaye	351	1687	802	885	100	10	1229	840	51	796
Mond	304	1671	819	852	47	70	1143	250	155	1266
Mondpar	216	1007	477	530	9	12	660	191	123	693
Kasaba Waghotan	72	344	168	176	1	2	282	44	49	251
Mouje Waghotan	207	1318	652	666	0	0	787	424	121	773
Juveshwar	179	1105	537	568	0	3	733	377	124	604
Baparde	263	1382	669	713	87	12	983	56	674	652
Wanivade	165	858	398	460	0	0	599	10	220	628
Pendhari	187	1066	499	567	0	8	668	476	148	442
Palekarwadi	215	1237	608	629	0	3	854	615	12	610
Manche	452	2274	1090	1184	21	11	1477	708	351	1215
Malpewadi	116	622	295	327	18	2	336	98	156	368
Total	**11391**	**53409**	**24986**	**28423**	**744**	**182**	**33870**	**15271**	**9931**	**28207**
25-32 Km Radial Zone										
Rajapur Tehsil										
Wadavali	183	768	350	418	0	0	506	379	158	231
Kala Savali	334	1386	587	799	5	0	807	662	67	657
Oni	255	1191	545	646	27	1	816	419	55	717
Rautwadi	286	1277	500	777	5	4	731	353	321	603

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
Mandrul	244	1103	502	601	13	0	525	473	109	521
Chuna Kolwan	115	592	275	317	0	0	327	175	222	195
Madhaliwadi (N.V.)	89	348	157	191	0	0	174	91	97	160
Khadakvali	89	418	171	247	0	0	259	73	174	171
Chikhalgaon	146	697	292	405	0	0	373	409	4	284
Gothane Doniwade	168	816	356	460	3	0	514	303	127	386
Saundal	215	949	467	482	12	0	543	419	135	395
Hasol Tarf Saundal	230	1148	509	639	7	0	617	497	158	493
Musalmanwadi (saundal)	141	814	394	420	0	0	564	318	56	440
Khalchi Bhandarwadi	70	311	146	165	19	0	204	144	79	88
Lanja Tehsil										
Wadi Limbu	229	894	432	462	28	8	450	276	172	446
Kot	306	1410	609	801	0	0	721	202	567	641
Waghrat	256	1100	476	624	36	0	556	335	227	538
Kangavali	174	824	357	467	0	0	480	135	228	461
Pateregaon	105	482	246	236	9	0	298	60	162	260
Isavali	251	1075	516	559	12	0	668	201	426	448
Ravari	124	495	201	294	0	0	305	293	0	202
Kheravse	172	816	412	404	0	0	464	434	14	368
Golavashi	202	1032	460	572	25	0	578	559	131	342
Vilavade	278	1205	539	666	0	0	788	470	16	719
Borivale	149	703	294	409	0	0	365	256	96	351
Ratnagiri Tehsil										
Marathwadi	120	482	244	238	8	0	362	150	17	315
Harchiri	492	2462	1148	1314	80	0	1384	536	722	1204
Madhaliwadi	113	436	197	239	0	0	185	162	86	188
Mavalange	305	1489	705	784	8	0	955	473	159	857
Natunde	30	116	51	65	0	0	92	33	0	83
Sheel	129	683	347	336	0	5	501	138	134	411
Thikan Soman	3	13	5	8	0	0	10	3	0	10
Kasarweli	313	1506	725	781	15	3	1083	479	157	870
Nalewathar	147	713	345	368	0	0	488	234	26	453
Ganeshgule	257	1096	525	571	0	0	765	256	224	616
Pavas	969	4977	2507	2470	32	3	3551	1168	562	3247
Nakhare	540	2560	1256	1304	19	7	1620	685	530	1345
Devgad Tehsil										
Korle	143	769	340	429	0	1	448	171	190	408
Dhalavali	235	1186	572	614	13	0	831	338	70	778

NAME	No_HH	TOT_P	TOT_M	TOT_F	P_SC	P_ST	P_LIT	MAINW_P	MARGW_P	NONW_P
Katvan	127	789	384	405	0	0	547	102	280	407
Patgaon	189	935	445	490	0	1	614	32	168	735
Undil	172	735	339	396	9	0	497	20	289	426
Phanasgaon	310	1437	642	795	9	0	911	542	155	740
Goval	201	963	458	505	0	0	575	190	191	582
Somlewadi	130	700	353	347	0	7	407	193	185	322
Vitthaladevi	209	931	447	484	8	9	605	356	112	463
Pavnai	147	856	420	436	4	0	576	33	380	443
Tembavali	218	962	462	500	0	0	713	216	170	576
Mahalunge	210	1030	469	561	0	0	642	464	79	487
Chandoshi	148	667	302	365	0	0	479	151	102	414
Rahateshwar	192	753	353	400	32	4	490	303	1	449
Wade	420	1862	878	984	20	1	1350	436	453	973
Dabhole	376	2136	1010	1126	21	1	1517	392	613	1131
Jamsande	1726	8521	4201	4320	255	9	6368	1895	1195	5431
Wareri	324	1706	817	889	0	0	1206	308	451	947
Mithmumbari	221	957	438	519	10	5	710	161	305	491
Kunkeshwar	312	1676	822	854	4	0	1219	328	529	819
Lingdal	106	473	223	250	5	0	341	13	217	243
Kankavali Tehsil										
Kajirde	52	278	112	166	1	0	191	63	106	109
Total	**14397**	**68709**	**32335**	**36374**	**754**	**69**	**44866**	**18960**	**12659**	**37090**
Grand Total	**39936**	**187952**	**87965**	**99987**	**2359**	**376**	**121509**	**53771**	**32924**	**101257**

Source: Census of Maharashtra C.D.2001, Revenue Department of Rajapur, Devged, Lanja, Ratnagiri and Kankavali Tahasil

No_HH : number of house hold; TOT_P: total population; TOT_M: total male; TOT_F: total female; P_SC: scheduled caste; P_ST: scheduled tribe; P_LIT: Literates; MAIN WOR_POP : main worker population; MARG WORK_POP: marginal worker population; NON_WORK_POP : non worker population

Table 3.10.3

Summary of Demographic Structure in Study Area (As per census 2001)

Demographic parameters	Details
Number of Districts	02
Number of Talukas	05
Number of Villages	185
Total No. of households	39936
Total population	187952
Sex ratio (No. of females per 1000 males)	1137
Scheduled Castes (%)	2359 (1.25%)
Scheduled Tribe (%)	376 (0.20%)
Literate (%)	121509 (64.64%)
Main workers (%)	53771 (28.62%)
Marginal workers (%)	32924 (17.51%)
Non workers (%)	101257 (53.87%)

Source: Primary Census Abstract –Census of Maharashtra – 2001 (CD)

Table 3.10.4

Infrastructure Resource Base of Ratnagiri and Sindhdurg Districts (As per Primary Census Abstract 2001)

District	Educational Institution	Medical Facilities	Power Supply	Source of Drinking Water							
				Tap	Hand pump	Tube well	Well	Tank, pond, lake	River, canal	Spring	Any other
Ratnagiri District											
Total	5274	1340	330572	150453	8722	10129	157201	4128	12378	22052	1542
Rural	4985	980	294524	122467	8487	8829	149198	4063	12308	21984	1194
Urban	289	360	36048	27986	235	1300	8003	65	70	68	348
Sindhudurg District											
Total	3,065	909	176,683	3,956	314	372	10,494	-	-	-	762
Rural	2,844	719	159,237	3,531	308	362	9,709	-	-	-	761
Urban	221	190	17,446	425	6	10	785	-	-	-	1

Note: Infrastructure Data of Sindhdurg of Tank, Pond, Lake, River, Canal, spring are not available in the Census. Above infrastructure facilites are for Population 1696777 in Ratnagiri District and for Population 868825 in Sindhudurg

Table 3.10.5

Yearly Record of Birth, Death and Infant and Child Mortality Rate (IMR) in Ratnagiri District

Sr. No.	Year	1998	2004	2006	2008
1	**2**	**3**	**4**	**5**	**6**
1	Birth Rate	22.3	18.0	14.5	13.2
2	Death Rate	7.6	6.4	9.7	10.2
3	Total Delivery Rate	2.5	2.1	1.8	1.73
4	Child Mortality	49	25	20.5	25.1
5	Infant Mortality	35.0	20.0	15.6	36.25

Table 3.10.6

Morbidity Status as Available in Study Area

Month	Cough	Diarrhoea	T.B.	S.T.D.	Injuries
January	93	40	03	04	98
February	114	36	05	06	64
March	131	56	02	14	87
April	100	59	04	13	76
May	80	68	01	-	129
June	126	72	01	22	114
July	121	71	07	-	69
August	131	41	03	06	116
September	95	67	02	15	45
October	57	31	02	06	70
November	102	49	01	16	78
December	83	40	05	-	56

Source: District Health Office Ratnagiri and Sindhdurg (Data for 2005)
Population in study area of Ratnagiri District 43137 and
Population in study area of Sindhdurg is 22864

Table 3.10.7

Details of Land including Trees being Acquired for Plant & Residential Complex of Jaitapur Nuclear Power Park

Table 3.10.8

Quality of Life Existing in Villages Surveyed

Sr. No.	Villages	QoL $_{(S)}$	QoL $_{(O)}$	QoL$_{(C)}$
1.	Kuveshi	0.54	0.56	0.55
2.	Madban	0.48	0.50	0.49
3.	Jaitapur	0.52	0.54	0.53
4.	Dale	0.52	0.54	0.53
5.	Nate	0.54	0.56	0.55
6.	Karel	0.46	0.48	0.47
7.	Rajawadi	0.46	0.48	0.47
8.	Dhaulvali	0.52	0.54	0.53
9.	Barsu	0.48	0.50	0.49
10.	Nannar	0.46	0.48	0.47
11.	Saundale	0.52	0.54	0.53
12.	Padel	0.54	0.56	0.55
13.	Pural	0.51	0.53	0.52
14.	Rajapur	0.56	0.58	0.57
15.	Navodar	0.51	0.53	0.52
16.	Kotapur	0.46	0.48	0.47
17.	Dongar	0.46	0.48	0.47
18.	Unhale	0.50	0.52	0.51
19.	Baparde	0.50	0.52	0.51
20.	Mond	0.53	0.55	0.54
21.	Holi	0.50	0.52	0.51
22.	Tulsavade	0.51	0.53	0.52
23.	Mithgavane	0.53	0.55	0.54
24.	Vijaydurg	0.52	0.54	0.53
25.	Anantwadi	0.46	0.48	0.47
26.	Jambhulwadi	0.48	0.50	0.49
27.	Bandhawadi	0.46	0.48	0.47
28.	Rameshwar	0.54	0.56	0.55
29.	Kambale Lavgan	0.50	0.52	0.51
30.	Shengalwadi	0.47	0.49	0.48
31.	Ghumewadi	0.46	0.49	0.48
32.	Agarewadi	0.47	0.48	0.47
33.	Wadapeth	0.45	0.43	0.48
34.	Sakhar	0.47	0.47	0.46
35.	Madheliwadi	0.45	0.49	0.48
36.	Shejavali	0.50	0.47	0.46
37.	Vilaye	0.53	0.52	0.51
38.	Solgaon	0.51	0.55	0.54
39.	Devache Gothane	0.45	0.53	0.52
40.	Bag Abdul Kadir	0.50	0.47	0.46
41.	Kalakawadi	0.50	0.52	0.51
42.	Kondsar Bk.	0.50	0.52	0.51
43.	Tirlot	0.51	0.53	0.52
44.	Kuvale	0.52	0.54	0.53

Sr. No.	Villages	QoL $_{(S)}$	QoL $_{(O)}$	QoL$_{(C)}$
45.	Kunbiwadi	0.50	0.52	0.51
46.	Chauke	0.47	0.49	0.48
47.	Mahalunge	0.49	0.51	0.50
48.	Hativale	0.50	0.52	0.51
49.	Juvathi	0.53	0.55	0.54
50.	Kaneri	0.51	0.53	0.52
51.	Bag Kazi Husen	0.46	0.48	0.47
52.	Sheel	0.52	0.54	0.53
53.	Dhopeshwar	0.53	0.55	0.52
54.	Dasur	0.49	0.51	0.50
55.	Chikhale	0.50	0.52	0.51
56.	Panore	0.50	0.52	0.51
57.	Roon	0.51	0.53	0.52
58.	Nanij	0.54	0.56	0.55
59.	Dorle	0.50	0.52	0.51
60.	Phanase	0.51	0.53	0.52
61.	Padvane	0.50	0.52	0.51
	Total	0.49	0.51	0.50

QoL$_{(S)}$ = Subjective Quality of Life

QoL$_{(O)}$ = Objective Quality of Life

QoL$_{(C)}$ = Cumulative Quality of Life

Chapter 4

Anticipated Environmental Impacts & Mitigation Measures

The predictions of impacts and mitigation measures have been assessed in the following four sections:

Section –I: Assessment and prediction of impacts due to proposed nuclear power park at Jaitapur.

Section –II: Radiological Risk Assessment & Emergency Response System

Section –III: The assessment and prediction of impacts under Coastal Regulation Zone (CRZ) for the proposed nuclear power park at Jaitapur

Section –IV: Assessment of Irreversible and Irretrievable Impacts and Significant Impacts

Section -I

The impacts on environment due to activities of the proposed project could be broadly divided into two parts as discussed in the chapter-1: -

1) Impact during project construction phase
2) Impact during operation phase of the project

3) Impact during decommissioning phase of the project

4.1 Impacts Assessment during Project Construction Phase

The construction of nuclear power plant of proposed magnitude would require large input from civil, mechanical aspects including transport, labour etc. The construction activity will be carried out over rocky barren area with basaltic rock upto 20 m depth.

4.1.1 Positive Impact on Landscape

There will be positive impact on existing landscape due to proper planning for landscaping, development of roads with avenue trees and green belt development around the project building making the landscape beautiful with lush green cover.

4.1.2 Impact Assessment for SPM arising out of Construction Activities

Fugitive Dust Model (FDM)

Impact on air due to engine exhausts and emission of dust as a result of temporary increase in number of transport vehicles and operation of heavy vehicles for transport of construction material and machinery and loading / unloading operations is envisaged. Fugitive Dust Model (FDM) is used to predict the ground level concentrations (GLCs) during construction activities.

Fugitive Dust Model (FDM) is used for predictions due to construction operations. The impact on air quality due to emissions from single source or a group of sources is evaluated by use of mathematical models. When air pollutants are emitted into the atmosphere, they are immediately diffused into surrounding atmosphere, transported and diluted due to winds. The air quality models are designed to simulate these processes mathematically and to relate emissions of primary pollutants to the resulting downwind air quality. The inputs include emissions, meteorology and surrounding topographic details to predict the impacts of conservative pollutants.

The Fugitive Dust Model (FDM) is a computerized air quality model specifically designed for computing concentration and deposition impacts due to fugitive dust sources. The sources may be point, line or area sources. The model has not been designed to compute the impacts of buoyant point sources, thus it contains no plume-rise algorithm. The model is generally based on the well-known

Gaussian Plume formulation for computing concentrations, but the model has been specifically adapted to incorporate an improved gradient-transfer deposition algorithm. Emissions for each source are apportioned by the user into a series of particle size classes. A gravitational setting velocity and a deposition velocity are calculated by FDM for each class. Concentration and deposition are computed at all user-selectable receptor locations. It should be noted that while FDM has the capability of treating 500 receptors, POSTZ can only accept 200 receptors, thus long-term sequential uses of FDM should carefully consider the number of receptors to be used.

The sources can be of three types: points, lines or areas. The line source and area source algorithms are based on algorithms in the CALINE3 Model (California Department of Transportation, 1979). For area sources, the user supplies the coordinates of the center and the dimension in the x and y directions. Area sources need not be square, but rather can be rectangular, up to an aspect ratio of 1 to 5 (ratio of width to length). Area sources with the length greater than five times the width must be divided in a series of area sources, or modeled as a line source. The model divides the area source into a series of line sources perpendicular to the wind direction. Emissions from all sources may be divided into a maximum of 20 particle size classes.

Prediction of Impacts due to Construction Activities

Following operations are considered during construction: Drilling, Blasting, Dozing, Loading trucks, Unloading trucks, loading & unloading of Quarry waste, Dumps, Active waste dumps, Haul road dust etc. Emission factors for different operations estimated as per USEPA Emission estimation manual. Fugitive Dust Model (FDM) is used for predictions due to construction operations. Maximum incremental GLC of SPM due to construction activities at project site is predicted to be 37 $\mu g/m^3$ which is within NAAQS for residential/industrial areas.

Reduced level emissions were predicted considering water sprinkling and wind breaking by green belts as a mitigation measure of environmental management plan. Efficiency of control methods is considered as per the USEPA standards for emission factors. With proper EMP, maximum incremental GLC of SPM due to construction activities at project site is found to be 15 $\mu g/m^3$. There will be a decrease of more than 50% of SPM concentration after employing control methods at various activities within the study area.

The ambient 98th percentile value of SPM levels in Winter (2006-07) is 122 μg/m^3. The resultant ambient concentration due to construction activity will be 159 μg/m^3 without implementation of EMP, while the same will be 137 μg/m^3 after implementation of EMP measures of dust control. as given in following table. Thus the SPM will be reduced by 86.16% by implementation of EMP. The resultant values of SPM are well below the stipulated standards for industrial and residential, rural & mixed use area. Moreover, the construction activity is a temporary phase and the dust levels will come down again after the construction phase would be over.

Site	Ambient SPM Level (98th percentile) Winter Season (2006-07	Without EMP		With EMP		NAAQS,1994	
		Predicted Concent-ration of SPM	Resultant SPM Concentration	Predicted Concent-ration of SPM	Resultant SPM Concent-ration with EMP	Industrial area	Residential, rural & mixed use area
Proposed project site.	122	37	159	15	137	500	200

* All values in μg/m^3

Impact Assessment for Gaseous Vehicular Emissions

Caline 4 model is used for predicting the contribution of vehicular/transport activities during construction phase of the project at project site. The impacts due to proposed Line sources i.e. vehicular emission during construction activity are predicted by using CL4 model. CL4 (Caltrans, 1989) is a dispersion model that predicts concentrations of pollutants emitted by vehicles i.e. Carbon Monoxide (CO), Oxides of Nitrogen (NOx) and hydrocarbons (HC) near roadways. CL4 is a simple line source Gaussian plume dispersion model and predicts air pollutant concentrations for averaging periods of 1 hour and 8 hour. The user defines the proposed roadway geometry, worst-case meteorological parameters, anticipated, traffic volumes, and receptor positions. The user must also define emission factors for each roadways link. CL4 is a graphical windows-based user interface, designed to ease data entry and increase the on-line help capabilities of CL4.

The purpose of the model is to assess air quality impacts near transportation facilities in what is known as the microscale region. Given source strength, meteorology, site geometry, and site characteristics, the model can reliably predict pollutant concentrations for receptors located within 500 meters of the roadways.

In this modeling exercise, 8 hourly concentrations of CO, NO_x, are predicted for the duration 10-17 Hrs, 18-01 Hrs and 02-09 Hrs.

CL4 divides individual highway links into a series of elements from which incremental concentration are computed and then summed to form a total concentration estimate for a particular receptor location. The receptor distance is measured along a perpendicular from the reactor to the roadway centerline. The first element is formed at this point as a square with sides equal to the line source width.

Thus, as element resolution becomes less important with distance from the receptor, elements become larger to permit efficiency in computation. The choice of the element growth factor as a function of roadway-wind angle (PHI) range represents a good compromise between accuracy and computational efficiency. Finer initial element resolution is unwarranted because the vertical dispersion curves used by CL4 have been calibrated for the link half – width (W2) distance from the element center point.

Each element is modeled as an “equivalent” finite line source (EFLS) positioned normal to the wind direction and centered at the element midpoint. A local x-y coordinate system aligned with the wind direction and originating at the element midpoint is defined for each element. The emissions occurring within an element are assumed to be released along the EFLS representing the element. The emissions are then assumed to disperse in a Gaussian manner downwind from the element. The length and orientation of the EFLS are functions of the element size and the angle (PHI, ϕ) between the average wind direction and highway alignment. Values of PHI = 0 or PHI = 90 degrees are altered within the program an insignificant amount to avoid division by zero during the FELS trigonometric computations.

CL4 treats the region directly over the highway as a zone of uniform emissions and turbulence. This is designated as the mixing zone, and is defined as the region over the traveled way (traffic lanes – not including shoulders) plus three meters on either side. The additional width accounts for the initial horizontal dispersion imparted to pollutants by the vehicle wake effect. Within the mixing zone, the mechanical turbulence created by moving vehicles and the thermal turbulence created by hot vehicle exhaust is assumed to predominate near the ground.

Prediction of Impacts

Following vehicles movement is considered for impact due to vehicular emissions: Trucks – 125; Excavator – 2; Loaders – 6; Drills – 3; Water Tanks – 3; Jeeps – 5; Dozer – 2; Grader – 1. Diesel is the main fuel used in these vehicles. US EPA emission factors are used for computing the pollutant emission rates. Prediction of impacts for CO and NO_x was made on 8 hourly bases up to a distance of 500 m on either side of the roads of project site.

The GLCs of CO and NOx are found to be less than 10 $\mu g/m^3$ and 5 $\mu g/m^3$ respectively. Thus, there is no significant impact due to vehicular emissions within the study area against stipulated standards of 80 $\mu g/m^3$ and 2000 $\mu g/m^3$ for NO_x and CO respectively. The background concentration of NO_x at project site is 8 $\mu g/m^3$, so resultant concentration of NO_x would be 13 $\mu g/m^3$ which is well below the stipulated standards (MoEF, 2009).

Impact due to Noise Pollution during Construction Phase

The movement of heavy vehicles and machinery and construction activity may contribute to noise pollution during construction phase. There will be impact of noise on construction workers, however the village people will not be affected due to long distance between plant and village.

Mitigation Measures

The machinery, vehicles (all types), blasting and construction activity may contribute to the noise level in the area for on-site workers, who will be provided noise protective ear muffs in high noise level zone. The green belt will be developed in exclusion zone in construction phase which will act as barrier to noise and dust generated during construction. The nearest village is at 2 km distance for the project site and the noise levels reaching the village will be very low and the impact due to above will be insignificant.

The regular maintenance and up keeping of construction machinery, heavy vehicles, dumpers, and trucks will be helpful in reducing gaseous emissions and noise. On site workers near noise producing source shall be provided ear muffs and the workers near construction site will be provided with helmets. The depth, charge and the matrix of the holes, delaying and decking of shots for blasting will be optimized to minimize and noise.

4.1.3 Impact on Environmental Sanitation

Temporary labour colonies, if not properly planned, may create environmental pollution, unsanitary conditions and health problems.

Mitigation Measures

The temporary labour colonies with adequate sanitary measures will be planned to minimize pollution of soil, water and public health problems.

4.1.4 Impact of Construction Activity on Coastal Ecology

The whole project site is plain rocky land with Basaltic rock available at a depth of about 20 m from the ground surface. The overburden will be mostly in the form of rock pieces, boulders etc. This will result in insignificant amount of turbidity in coastal water which will be diluted rapidly due to northward or southward currents of sea water during the year.

As the coastal area is poor in biodiversity and no sensitive habitat is present in coastal water, the biological impact will be insignificant.

Limited dredging will be carried out for maneuvering of small ships and barges at RoRo jetty and for laying down underground CCW discharge channels.

Inter tidal habitat area is too narrow near the project site due to elevated rocky land for marine organisms to develop leading to low biodiversity of benthic fauna, Low fish catch, except presence of a few sea weeds. Biodiversity is better on northern and southern direction away from the project site (**Vol II EIA Report**, **Annexure-VIII**). Thus due to activities during construction phase in CRZ would not affect coastal ecology.

The patches of mangrove flora is present at a distance of 5-6 km from the project site in the estuary of Kodavali River. The estuary is far away from site and will not be affected in any way by the project activity.

Mitigation Measures

The whole quantity of rocky overburden will be utilized for leveling of land in project area as well as in the construction of the project and break water structure. The overburden will be securely stored till it will be utilized as construction material.

The dredged sediment material will also be utilized in construction as well as for land filling and excess silt will be disposed off in deep sea.

The construction of water intake structure and proposed Jetty will be carried out by specialized engineering technology which does not produce turbidity in the coastal waters and marine flora, fauna and fisheries would not be affected.

Though, the patches of mangrove flora is present at a distance of 5-6 km from the project site, they will not be affected by the project activity, yet, special efforts will be made for the conservation and propagation of mangrove vegetation at suitable sites around the project area.

4.1.5 Impact of Construction and Operation of Jetty

As mentioned that the coastal area around the project site is not very productive and devoid of presence of any sensitive species. The proposed jetty, which will be of very small in size and will be situated inside the breakwater wall, therefore, Construction of Jetty will not have any adverse impact on the coastal environment. Moreover, the jetty, which will be used occasionally, will provide safe habitat for the marine organism in long span of time.

Small ships and barges will visit the site during construction period only to carry the imported instruments and equipments and will not be a continuous shipping activity and may not have impact on the coastal environment.

4.1.6 Impact of Construction on Sea Water Currents

As per the study carried out by CWPRS, the flow in the open sea near project site is unidirectional, either northerly or southerly. During non-monsoon period (March-May) and SW monsoon period (June-September), the flow is southward while during NE monsoon period (November-January), the flow is northward. In October-February, the flow is in transition.

The seaward boundary of the project construction is well aligned with the existing shoreline. Moreover, the discharge canals for disposal of condenser cooling water will be underground. Therefore, the project structures will put minimum resistance to the ocean currents which are parallel to the coast.

4.1.7 Impact Assessment due to Radiological Releases during Project Construction Phase

There will not be any radiological releases during the first phase of the twin unit construction of JNPP. Therefore, there will not be any impact on the environment due to radiological parameters during construction of the first phase of JNPP. However, during second & third phase of the twin unit construction, the first phase twin units and second phase twin units, already constructed will be under operation and hence will have radiological impact which has been described in the **Section 4.2.1.3**, **4.2.2.2** and **4.3.2.2**.

4.1.8 Improvement of Communication Facilities

During construction phase, the infrastructural facilities like roads, telephone, public transport will be improved in the area.

4.1.9 Availability of Direct Employment

Many local people including youths, contractors and small entrepreneurs would get direct / indirect employment during construction phase.

4.2 Impacts during Project Operation Phase

This section describes the environmental impact, considering phased construction and operation of all the six units of 1650 MWe in twin unit mode

4.2.1 Air Environment

The Air Environment will have impact due to conventional Air Pollutants and Radioactive Pollutants.

4.2.1.1 Impact Assessment due to Conventional Air Pollutants

As such, there is no possibility of emission of conventional air pollutants from nuclear power plants except during construction phase. Hence, the impacts of the proposed nuclear power plant on ambient air quality due to conventional air pollutants in that region will be insignificant. There will be marginal increase in conventional air pollutants levels due to increase in vehicular traffic and urbanization, which can be attributed to indirect impacts of the project in that region. However, these concentrations shall be within the prescribed limits of CPCB / MPCB as the proposed nuclear power project is not the source of conventional air pollution and present levels of conventional air pollutants are very low.

4.2.1.2 Prediction of Impacts of DG sets

There are two Diesel Buildings (DBs), each house two Emergency Diesel Generators (EDGs) and one Station Black Out (SBO) Diesel Generator sets along with their diesel fuel storage tanks. Each DB houses two DGs of 1000 KVA (DB1-DG1 & DB1-DG2 in DB1 and DB2-DG1 & DB2-DG2 in DB2) and one DG of 7000 KVA (DB1-DG3 and DB2-DG3) rating. These two diesel buildings are located on opposite sides of the plant, providing physical separation for protection against external hazards. Each DB contain two redundant trains comprised of the main diesel generators for emergency power supply and one SBO diesel generator, fuel storage tanks (within a dedicated fire compartment), air cooling equipment and roof level silencer for diesel engines. A common stack of 30 m will be provided to vent out the flue gases from the DGs of each DB. The stack height is estimated as per MoEF Notification GSR 489 (E) July, 2002 for estimation of stack height of DG set depending upon the KVA rating 1000 KVA to 7000 KVA. The diesel consumption will be from 270 to 1900 litres/hr depending on KVA rating and test run of DG is carried out for one hour once in a week.

In order to predict impacts on ambient air quality due to DG sets operation on regular and emergency basis proposed at JNPP site, data on emission scenario and micrometeorology data collected by NEERI and along with historical data collected from India Meteorology Department (IMD) were used to predict Ground Level Concentrations (GLCs) of SO_2, NOx and SPM.

Micro Meteorology

The hourly wind speed, solar insulation and cloudiness during the day whereas in the night, wind speed and cloudiness parameters were used to determine the hourly atmospheric stability Class A to F (Pasquill and Gifford).

The hourly stabilities were determined based on the technique suggested by Turner. Turner's system used for determining the stability classes is as follows:

For day or night: If total cloud cover (TC) = 10/10 and ceiling <7000 ft NR=0

For night-time (defined as period from one hour before sunset to one hour after sunrise):

a) If TC<4/10, use NR = -2

b) If TC>4/10, use NR = -1

For day time: Determine insulation class number (IN)

a) If TC<5/10, use NR=IN

b) If TC>5/10, modify IN by the sum of the following applicable criteria

If ceiling<7000 ft (2134m), modification = -2

If ceiling>7000 ft but <16000 ft (4877 m), modification = -1

If TC=10/10 and ceiling>7000 ft, modification = -1, and let modified value of IN=NR, except for day-time NR cannot be <+1

During winter winds were recorded from N, WNW, NE and E directions, thereby, projecting the impact zone in S-SSE-SSW sector with respect to the location of DG sets in JNPP site. Winds are found to be between 6-15 kmph from N; 6 – 10 kmph from NE and E during the 24 hours period. Calm winds are observed to be about 16.7% during the study period on 24 hourly basis (**Fig. 3.5.4** of **Chapter 3** in this report). The air quality model is run with hourly data of wind speed, wind direction, temperature, atmospheric stability and mixing height of the study period. The representative mean seasonal meteorological data are presented in tabular form.

SCREEN3 – Model Description

SCREEN3 is a screening model based on Gaussian plume modeling approach and is similar to ISCST3 model except for the meteorological data. SCREEN3 considers a meteorological matrix of different wind speed along with atmospheric stability classes and possible wind directions. This model is used for estimating pollutant impacts due to worst case meteorological conditions.

ISCST3 - Model Description

The impact on air quality due to emissions from single source or group of sources is evaluated by use of mathematical models. When air pollutants are emitted into the atmosphere, they are immediately diffused into surrounding atmosphere, transported and diluted due to winds. The air quality models are designed to simulate these processes mathematically and to relate emissions of primary pollutants to the resulting downwind air. The inputs needed for model development are emission load and nature, meteorology and topographic features, to predict the GLCs.

The **Industrial Source Complex – Short Term Version 3 (ISCST-3)** models has been developed to simulate the effect of emissions from the point sources on air quality. The **ISCST-3** model was adopted from the USEPA guidelines which are routinely used as a regulatory model to simulate plume dispersion and transport from and up to 100 point sources and 20000 receptors. **ISCST–3** is extensively used for predicting the Ground Level Concentrations (GLCs) of conservative pollutants from point, area and volume sources. The impacts of conservative pollutants were predicted using this air quality model keeping in view the plain terrain at and around the project site. The micrometeorological data monitored at project site during study period have been used in this model.

The **ISCST-3** model is, an hour-by-hour steady state Gaussian model which takes into account the following:

- Terrain adjustments
- Stack-tip downwash
- Gradual plume rise
- Buoyancy-induced dispersion
- Complex terrain treatment and consideration of partial reflection
- Plume reflection off elevated terrain
- Building downwash
- Partial penetration of elevated inversions
- Hourly source emission rate, exit velocity, and stack gas temperature

The **ISCST-3** model, thus, provides estimates of pollutant concentrations at various receptor locations.

The ISC short term model for stacks uses the steady-state Gaussian plume equation for a continuous elevated source. For each source and each hour, the origin of the source's coordinate system is placed at the ground surface at the base of the stack. The x axis is positive in the downwind direction, the y axis is crosswind (normal) to the x axis and the z axis extends vertically. The fixed receptor locations are converted to each source's coordinate system for each hourly concentration calculation. The hourly concentrations calculated for each source at each receptor are summed to obtain the total concentration produced at each receptor by the combined source emissions.

For a steady-state Gaussian plume, the hourly concentration at downwind distance x (meters) and crosswind distance y (meters) is given by:

$$\text{Concentration} = \frac{QKVD}{2\pi U_S S_Y S_Z} \exp\left[-0.5\left(\frac{y}{\sigma_y}\right)^2\right] \qquad \text{........(4.1)}$$

Where:

Q = pollutant emission rate (mass per unit time)

K = a scaling coefficient to convert calculated concentrations to desired units

V = vertical term

D = decay term

σ_y, σ_z = standard deviation of lateral and vertical concentration distribution (m)

u_s = mean wind speed (m/s) at release height

Equation (1) includes a Vertical Term (V), a Decay Term (D), and dispersion parameters (σ_y and σ_z). It should be noted that the Vertical Term includes the effects of source elevation, receptor elevation, plume rise, limited mixing in the vertical, and the gravitational settling and dry deposition of particulates (with diameters greater than about 0.1 microns).

The ISC model uses either a polar or a Cartesian receptor network as specified by the user. The model allows for the use of both types of receptors and for multiple networks in a single run. All receptor points are converted to Cartesian (X,Y) coordinates prior to performing the dispersion calculations. In the Cartesian coordinate system, the X axis is positive to the east of the user-specified origin and the Y axis is positive to the north.

The Vertical Term (V), which is included in the Equation, accounts for the vertical distribution of the Gaussian plume. It includes the effects of source elevation, receptor elevation, plume rise, limited mixing in the vertical, and the gravitational settling and dry deposition of particulates. In addition to the plume height, receptor height and mixing height, the computation of the Vertical Term requires the vertical dispersion parameter (σ_z).

Prediction of Impacts

SCREEN3 and ISCST3 models are used to predict the ground level concentrations (GLCs) of criteria pollutants: SO_2, NOx and SPM that are emitted from the DG sets during winter season. Prediction of GLCs has been carried for three scenarios of DG sets operations: (i) one hour operation for testing regularly in one week (DB1-DG1/DB1-DG2, DB1-DG3, DB1-DG1+DB1-DG2+DB1-DG3), (ii) emergency operation for 24 hours (DB1-DG3+DB2-DG3) and (iii) emergency operation of all DG sets (DB1-DG1+DB1-DG2+DB1-DG3+DB2-DG1+DB2-DG2+DB2-DG3). Sulphur content of diesel fuel is taken as 2% by weight in estimating the SO_2 emission rates. Emission rates of SPM are computed assuming the DG sets will be following norms of 50 ppm for particulate matter emissions for DG sets. The emissions of SO_2, NOx and SPM along with stack details, such as stack height, stack internal diameter, stack gas exit velocity and stack gas exit temperature, are given in **Table 4.1**. The meteorological data for winter season used in prediction of GLCs is given in **Table 4.2**.

Prediction of GLCs under Different Scenarios

(i) One hour operation for testing regularly in one week (DB1-DG1/DB1-DG2, DB1-DG3, DB1-DG1+DB1-DG2+DB1-DG3)

SCREEN3 model is used predict the one hour concentrations of SO_2, NOx and SPM from each DG set in DB1 when operated for one hour as a regular testing measure. The predicted GLCs are given **Table 4.3**. It is observed that one hour concentrations of SPM are very low and negligible even all DGs are tested parallelly. The GLCs of SO_2 and NOx are found to be low when DGs of 1000 KVA are operated, whereas the GLCs are high when DGs of 7000 KVA are operated. The total concentrations (one hourly) when all three DGs in one DB are operated are found to be 123 µg/m^3 for SO_2, 131 µg/m^3 for NOx and 4.6 µg/m^3 for SPM. These are found to be well within the NAAQS for residential areas when converted to 24 hourly averages viz. SPM 0.192 µg/m^3, SO_2 5.125 µg/m^3 and NOx 6.46 µg/m^3. Same concentrations can be attributed to DG sets in DB2.

(ii) Emergency operation for 24 hours (DB1-DG3+DB2-DG3)

ISCST3 model is used to predict the GLCs due to emergency operations of two 7000 KVA DGs (DB1-DG3+DB2-DG3) that are operated for 24 hours. The predicted GLCs are shown in the form of isopleths in **Fig. 4.1** to **4.3**. It is observed that the GLCs of SO_2, NOx and SPM are found to be 19.6 µg/m^3, 20.84 µg/m^3 and 0.72 µg/m^3 occurring at a distance of 1.1 Km in SSE direction. These are very well within NAAQS for residential areas.

(iii) Emergency operation of all DG sets (DB1-DG1+DB1-DG2+DB1-DG3+DB2-DG1+DB2-DG2+DB2-DG3)

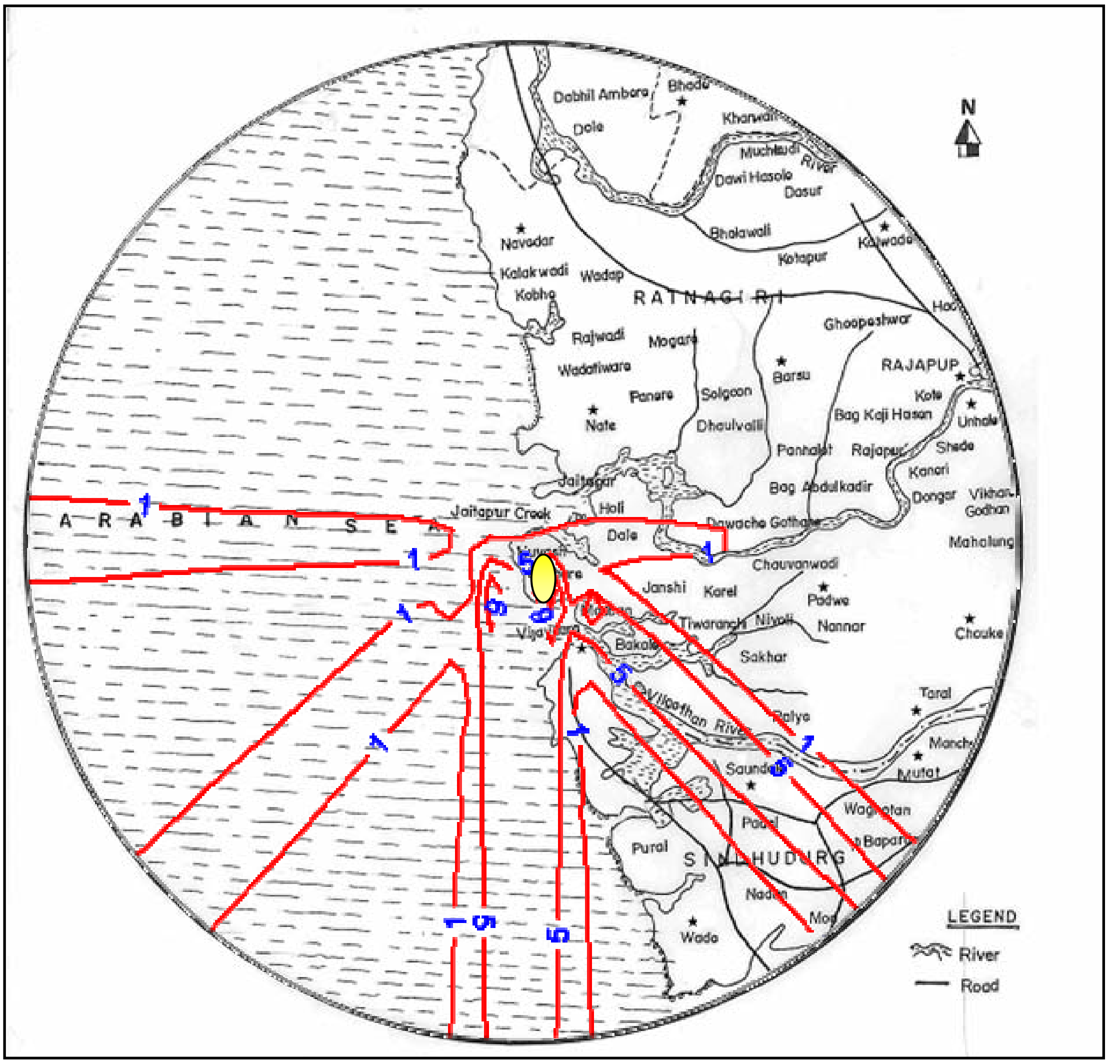
ISCST3 model is used to predict the GLCs due to emergency operations of all six (DB1-DG1+DB1-DG2+DB1-DG3+DB2-DG1+DB2-DG2+DB2-DG3) are perated for 24 hours. The predicted GLCs are shown in the form of isopleths in **Fig. 4.4 – 4.6**. It is observed that the GLCs of SO_2, NOx and SPM are found to be 25.2 µg/m^3, 26.8 µg/m^3 and 0.93 µg/m^3 occurring at a distance of 1.1 Km in SSE direction. These are very well within NAAQS for residential areas.

The results of all the three scenarios are summarized in following table.

Different Scenarios	Different Scenarios of operation	SPM	SO_2	NOx	Remarks
		µg/m^3			
	Ambient Concentrations	122.00	7.00	12.00	
Scenario i	Incremental concentration due to Weekly One hour operation of all DGs for regular testing	0.192	5.125	5.46	
	Resultant concentrations	**122.192**	**12.125**	**17.46**	**Below stipulated**

Different Scenarios	Different Scenarios of operation	SPM	SO_2	NOx	Remarks
		μg/m³			
					standards
Scenario ii	Incremental concentration due to Emergency operation of two 7000 KVA DGs for 24 hours	0.72	19.6	20.84	
	Resultant concentrations	**122.72**	**26.6**	**32.84**	**Below stipulated standards**
Scenario iii	Incremental concentration due to Emergency operation of all DG sets for 24 hours	0.93	25.2	26.8	
	Resultant concentrations	**122.93**	**32.2**	**38.8**	**Below stipulated standards**
	NAAQS for Industrial Area	500	120	120	
	NAAQS for Residential, Rural & Mixed use Area	200	80	80	

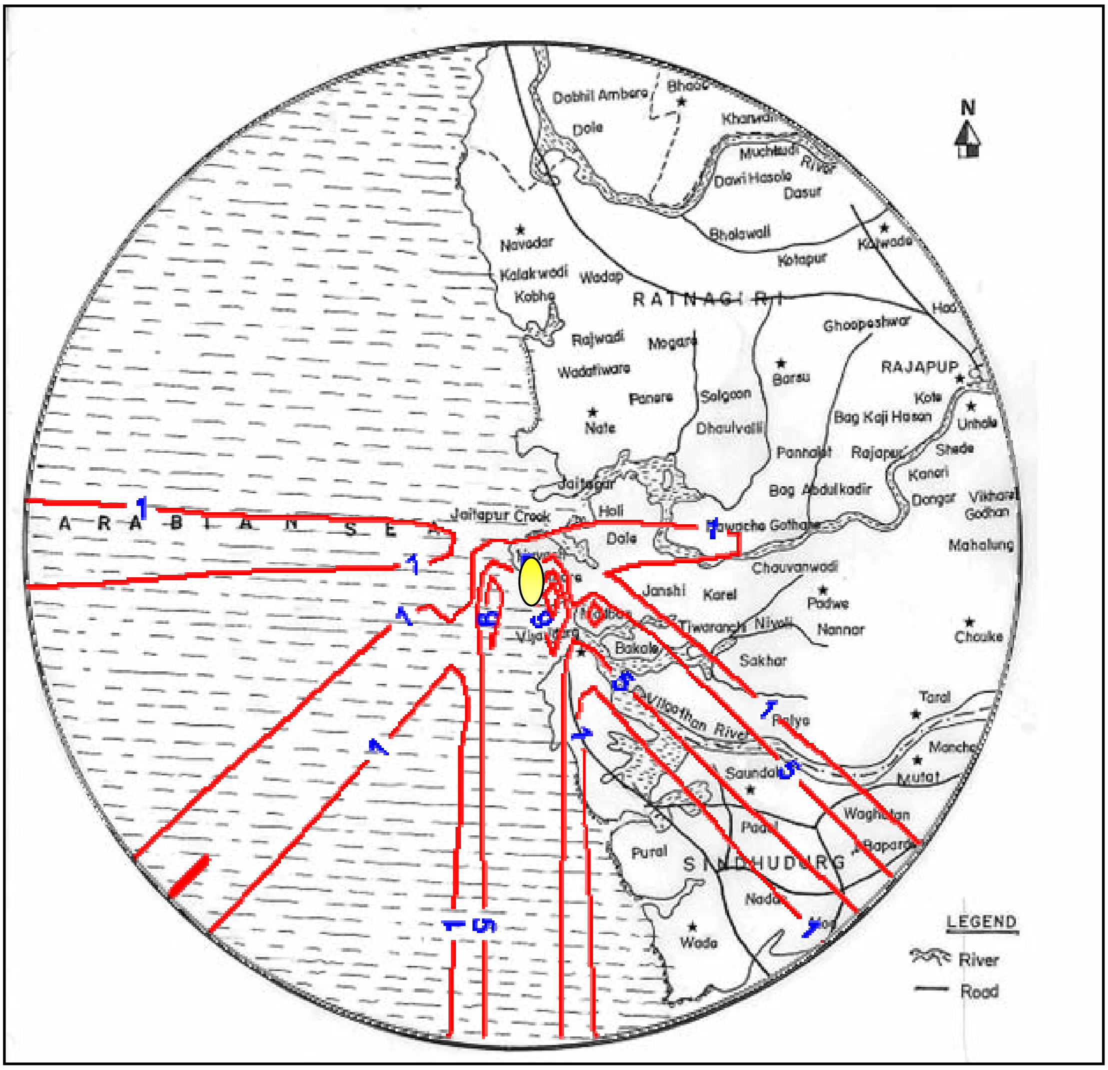
From the study it is interpreted that operation of these DG sets on regular for one hour testing as well as emergency basis for 24 hours will not impact the ambient air quality of the study area as the GLCs of criteria pollutants are well within the prescribed NAAQS for residential areas and also their occurrence is within the plant boundary only.



Project site

Max. GLC = 19.6 µg/m^3 at 1.1 Km in SSE direction

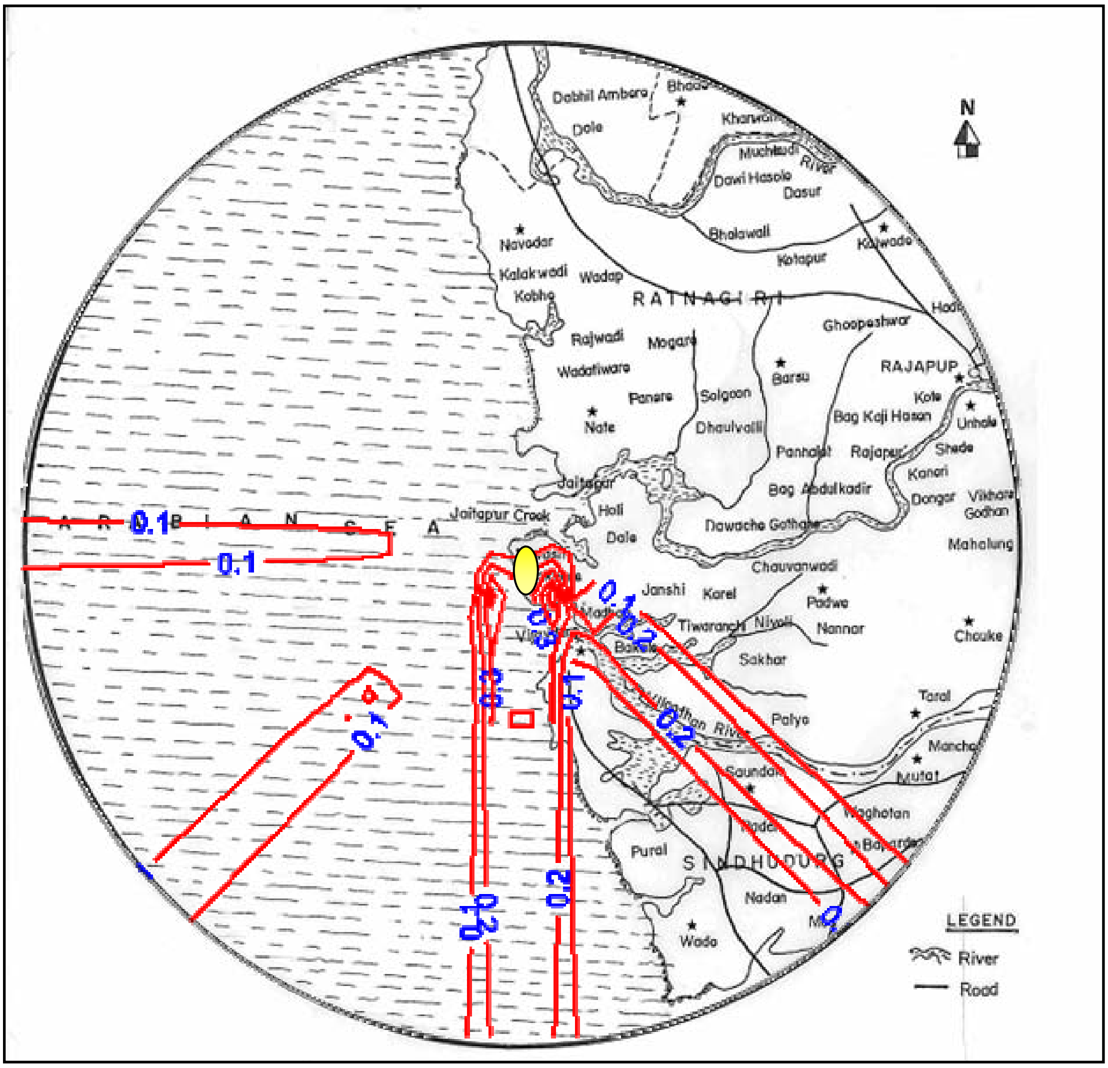
Fig.4.1: Incremental GLCs of SO_2 due to Emergency Operation of Two DG Sets of 7000 KVA (One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP



Project site

Max. GLC = 20.84 µg/m³ at 1.1 Km in SSE direction

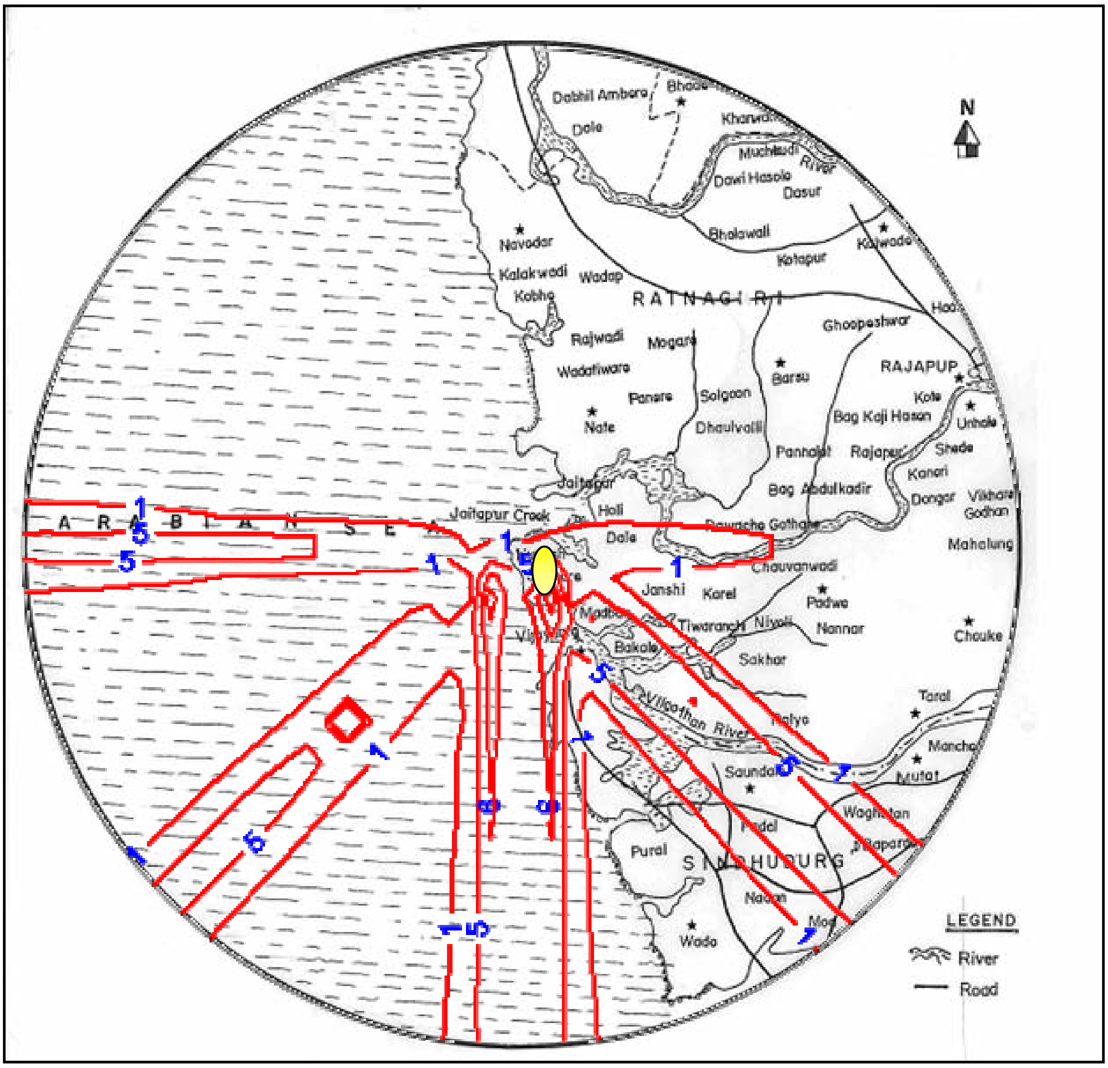
Fig.4.2 : Incremental GLCs of NOx due to Emergency Operation of Two DG Sets of 7000 KVA (One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP



Project site

Max. GLC = 0.72 µg/m^3 at 1.1 Km in SSE direction

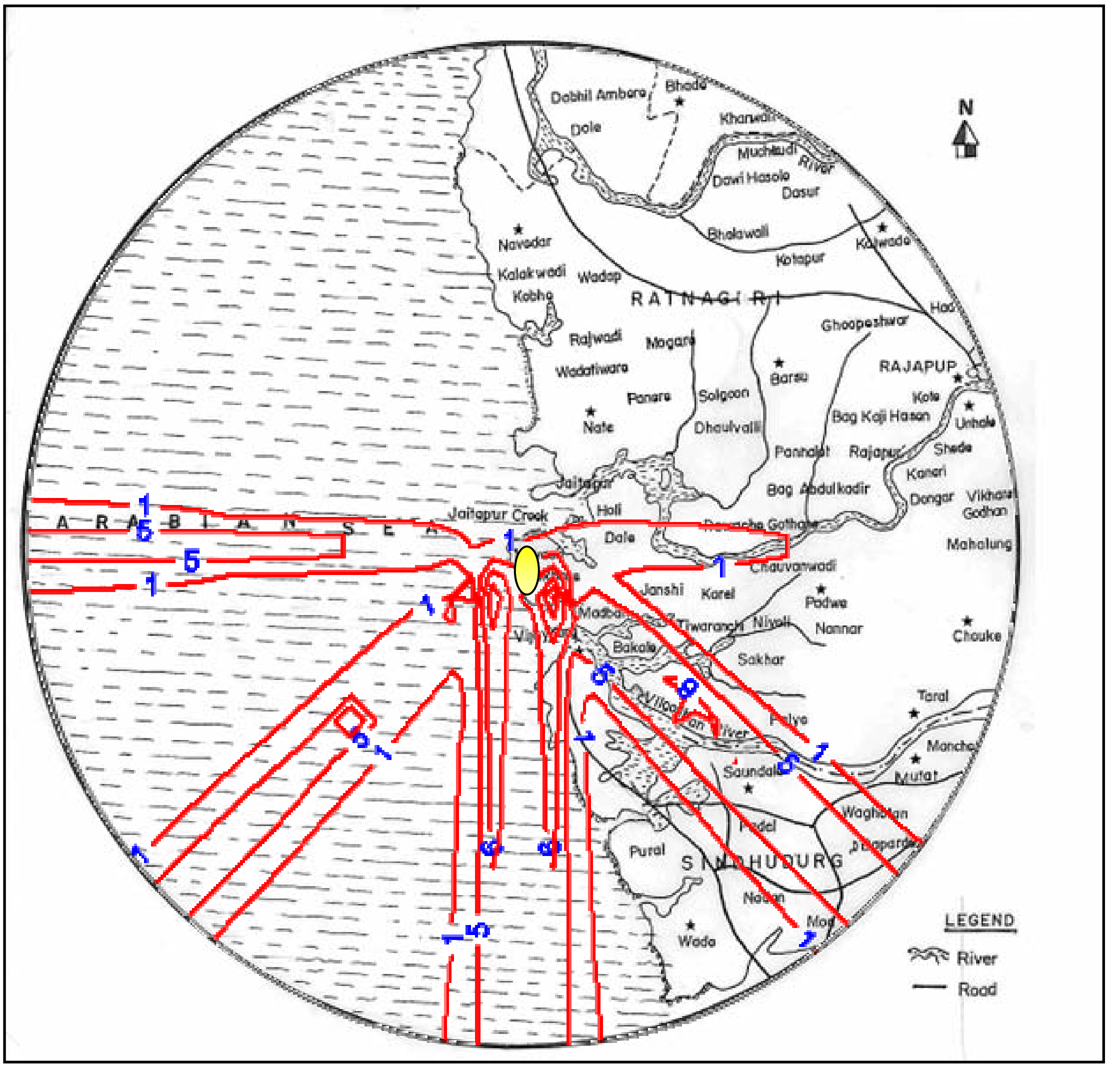
Fig.4.3 : Incremental GLCs of SPM due to Emergency Operation of Two DG Sets of 7000 KVA (One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP



Project site

Max. GLC = 25.2 µg/m^3 at 1.1 Km in SSE direction

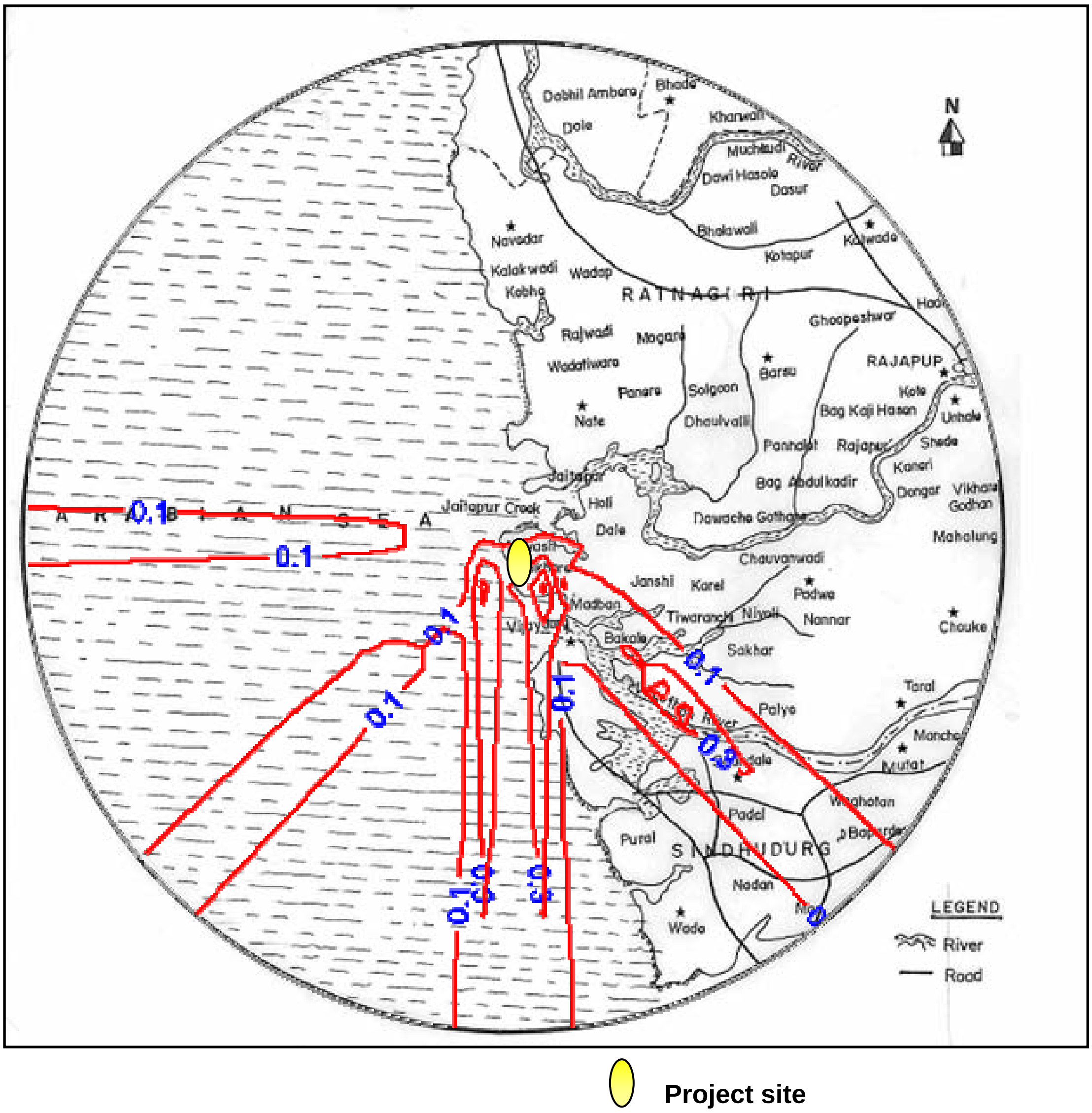
Fig.4.4: Incremental GLCs of SO_2 due to Emergency Operation of All DG Sets (Two DGs of 1000 KVA and One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP



Project site

Max. GLC = 26.8 µg/m^3 at 1.1 Km in SSE direction

Fig.4.5 : Incremental GLCs of NOx due to Emergency Operation of All DG Sets (Two DGs of 1000 KVA and One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP



Max. GLC = 0.93 µg/m^3 at 1.1 Km in SSE direction

Fig.4.6: Incremental GLCs of SPM due to Emergency Operation of All DG Sets (Two DGs of 1000 KVA and One DG of 7000 KVA Housed in Each DB) During Winter Season at JNPP

Table 4.1

Stack Emissions of DG Sets along with Details

Sr.No.	Stack Id	Capacity (KVA)	h (m)	d (m)	V (m/s)	T (K)	Emission rate (g/s)		
							SO_2	NOx	SPM
1	DB1-DG1	1000	30	1.2	20	623	2.44	2.60	0.09
2	DB1-DG2	1000	30	1.2	20	623	2.44	2.60	0.09
3	DB1-DG3	7000	30	1.2	20	623	17.10	18.20	0.63
4	DB2-DG1	1000	30	1.2	20	623	2.44	2.60	0.09
5	DB2-DG2	1000	30	1.2	20	623	2.44	2.60	0.09
6	DB2-DG3	7000	30	1.2	20	623	17.10	18.20	0.63

h – stack height; d – stack internal dimater; V – stack gas exit velocity; T – stack gas exit temperature

Table 4.2

Meteorological Data for Winter Season

Hrs.	Wind Direction (deg. From)	Wind Speed (m/s)	Ambient Temp. (K)	Atmospheric Stability Class	Mixing Height (m)
1	90	1.6	293.9	5	100
2	90	1.5	293.3	5	100
3	45	1.8	293.3	5	100
4	360	2.5	292.8	5	100
5	360	2.2	292.1	5	100
6	315	1.8	291.0	5	100
7	315	1.5	289.9	3	300
8	270	3.5	291.3	3	450
9	315	1.8	293.9	3	600
10	315	1.8	294.8	2	800
11	360	3.0	295.9	2	900
12	360	3.7	296.8	2	950
13	360	4.2	297.7	2	950
14	360	3.6	298.1	2	1000
15	360	3.7	298.3	2	900
16	315	2.5	298.6	3	700
17	360	3.8	297.7	3	600
18	360	4.6	295.9	4	400
19	360	2.8	294.5	5	200
20	360	2.7	293.8	5	200
21	360	2.6	293.3	5	100
22	45	1.8	292.9	5	100
23	45	1.9	293.3	5	100
24	315	1.5	292.9	5	100

Table 4.3

GLCs due to One Hour Operation for Testing Regularly in One Week

Pollutant Concentration (μg/m^3)	Scenario			
	DB1-DG1	DB1-DG2	DB1-DG3	DB1-DG1+DB1-DG2+DB1-DG3
SO_2	13.66	13.66	95.62	122.90
NOx	14.56	14.56	101.92	131.04
SPM	0.51	0.51	3.57	4.59

4.2.1.3 Impact Assessment due to Radioactive Emissions

During operation phase, the impacts from nuclear power projects to air environment would be mainly radiological type because of the release of radioactive gaseous emissions.

The following main gaseous radioactive components may be generated from the project during the operation phase.

Radio-nuclides through Air- Route

Fission Product Noble Gases (FPNGs)

$Iodine^{131}$

Particulates

Mitigation Measures

The actual releases will be regularly monitored and reviewed and will be far lower than the stipulated limits. The details of gaseous waste processing System and the typical annual discharges to comply with the dose apportionment are given below.

Gaseous Waste Processing

General Design

The Gaseous Waste Processing System (GWPS) is designed for all normal operating conditions of the plant. The details are presented in **Section 2.6.7.1**, **Chapter -2**.

The different systems connected to the GWPS consist mainly of tanks and vessels, which contain a variable volume of free gas.

Accordingly, there are two primary functions to be fulfilled:

- To compensate the level deviations of the free gas atmosphere in the connected tanks by the corresponding gas volume, injecting or accommodating.
- To purge components in which coolant degasification occurs in order to process the waste gases.

General Design Criteria:

- Prevent the release of radioactive gases from the connected systems and components into the atmosphere of the building; this is ensured by exhausting gases originating in the Reactor Coolant System and maintaining a sub-atmospheric pressure in the flushing part of the GWPS.

- Minimize the discharge of gases to the environment by using a closed loop GWPS in which the flushing gas nitrogen is reused after reduction of the H_2 and O_2 content at a value of approx. 0 to 0.3 % H_2 by volume and approx. 0 to 0.1% O_2 by volume.

- Hold up the radioactive gases (xenon, krypton) for a sufficient decay time and release to the Nuclear Auxiliary Building Ventilation System.

- Use activated charcoal for delaying the noble gases to reduce the necessary component volume of the delay line.

- Limit the oxygen concentration in the GWPS to <0.1 % by volume in order to prevent absorption of oxygen by the reactor coolant, which could cause corrosion in the Reactor Coolant System.

- Limit the hydrogen concentration in the GWPS to < 4 % by volume in order to prevent the formation of an explosive gas mixture with oxygen (the limits of flammability of such a mixture is 4% H_2 by volume and 5% O_2 by volume).

- Reduce the hydrogen and oxygen concentration in the flushing gas. For this purpose, a catalytic re-combiner is installed in the GWPS.

The noble gases Xenon and Krypton are retained in the delay line by adsorption until radioactivity has decayed to a level permissible for release to the vent stack of height 100 m. The lifetime of the charcoal is designed for an operation time of 60 years.

Aerosols, Iodine and Tritium are mainly retained in the liquid phase at the different coolers and at the waste gas compressor unit. Therefore they are not relevant for the design of the delay unit.

Typical Annual Gaseous Discharges

The following tables provide the expected annual releases of radioactive gases into the atmosphere per unit after filtering.

Radionuclides	Expected performance excluding operating contingencies	Maximum release
Tritium	500 GBq	3000 GBq
Carbon-14	350 GBq	900 GBq
Iodine isotopes	0.05 GBq	0.400 GBq
Noble gases	800 GBq	22 500 GBq
Other FP/AP	0.004 GBq	0.340 GBq

Dose Apportionment

The radiation dose apportionment from each unit of JNPP is given below. Also the report on The Preliminary Radiological Dose Apportionment for Jaitapur Site carried out by HPD BARC is enclosed as **Annexure-IX (d), Vol –II**. The report presents the dose apportionment up to unit level. However, dose apportionment for emitted radionuclide from the plant will be carried out once a detailed site specific meteorological data on hourly basis are available for the Jaitapur site. It is planned that the proposed Environmental Survey Laboratory (ESL), which will be set up at the Jaitapur site much before the plant operation will generate the required data. This whole scheme of dose apportionment will be approved by AERB.

<table>
<tr><td colspan="2">Dose limit of each site as per AERB = 1milli Sievert per year(from all routes)
Dose limit of each unit of JNPP= 0.1 milli Sievert per year(from all routes)</td></tr>
<tr><td colspan="2">Dose limit of each unit of JNPP from air route = 0.08 milli Sievert per year</td></tr>
<tr><td>Noble gases</td><td>0.06 milli Sievert per year</td></tr>
<tr><td>I^{131} and other gases</td><td>0.02 milli Sievert per year</td></tr>
</table>

Releases through air route will be constantly monitored and reviewed such that the actual releases are much less than the specified limits. Therefore, the impact on air environment due to radioactive discharges through air route will be insignificant.

4.2.2 Water Environment

4.2.2.1 Impact Assessment Due to Conventional Water Pollutants

4.2.2.1.1 Water Availability and Water Balance

Water Availability

The Jaitapur nuclear power project is proposed to be situated on the west coast of India. The seawater availability is plenty, however groundwater availability is less. The lateritic rock cover up to a depth of 20-30 m from surface level seems to show poor water retentivity hence no groundwater-saturated zone is found within this unit. The saturation zone level lie at the junction between the laterite and the underlying weathered basalt, which also fluctuates from 14 m below ground water level during post monsoon time to less than 18 m in summer. It gets contaminated during post-monsoon season.

Mitigation Measures

The groundwater and freshwater resources are limited in this area and are required to be conserved for public utility. Therefore, the seawater which is of good quality and is present in plenty will be used for JNPP. The details of water balance are given below.

Water Balance

Water requirement of the project for condenser cooling system would be met from seawater. The Process water, raw water and domestic water (for Plant Site and Residential complex) are proposed to be met from Desalination Plant of appropriate capacity to be installed at Plant Site of JNPP. The details of the desalination plant are described in **Section 2.8**, **Chapter-2** of this report.

The total water requirements, which include condenser cooling sea water, Desalination plant sea water and fresh water requirements for each unit of 1650 MWe JNPPs, is given in **Tables 3** and **4** of the **Summary EIA** of this report**.**

Sea water (8640000 m^3/day) will be used as condenser cooling water, which will be discharged after its circulation through condensers. Seawater 20000 m^3/d will be used for desalination plant with production of 6650 m^3/d freshwater and 13350 m3/d brine water. The brine water will be mixed with condenser cooling water before discharge in the sea.

Out of total freshwater produced, 2200 m^3/d will be used for drinking and domestic purpose, resulting in the formation of 1830 m^3/d of domestic sewage which will be treated in Sewage Treatment Plant and treated sewage will be used for development of green belt.

The remaining 4450 m^3/d fresh water will be utilized in plant as process water, service water and fire water. The wastewater from plant will be treated to remove radioactive and other impurities and then mixed with CCW before discharge in sea.

4.2.2.1.2 Impact due to Discharges from Desalination Plant

Brine generated by this technology (MVC) has temperature only about 2 to 3 ^{0}C higher than sea water intake temperature. Very small quantities of chemicals are used to protect equipment from scaling and bio-fouling. The residual concentration of these chemicals will be within the allowable regulatory limits and are not harmful & bio-degradable. Salt concentration in brine typically shall be 2 to 3 times that intake sea water. To dilute the salt concentration, the brine shall be mixed with condenser cooling sea water before discharging into sea. Because of this the temperature rise and salinity level will be comparable to intake sea water levels and hence will not have any impact on sea water due to discharges from desalination plant.

4.2.2.1.3 Impacts due to Domestic Wastewater

If domestic wastewater from residential complex, canteen and toilet is allowed to be disposed of in surface water viz. river, creek or coastal water without treatment, it may lead to deterioration of coastal water through eutrophication. Thus domestic wastewater needs to be treated and recycled/reused in a proper way.

Mitigation Measures

The domestic sewage will be treated in STP of proper capacity with arrangement for transport pipelines to carry treated sewage to irrigate green belt around the plant / to irrigate park and avenue plantations in the residential complex.

A guard pond of appropriate capacity would also be provided to store the domestic wastewater for a short period of 1 -2 days in case of breakdown of STP and the time required for repairs.

The sewage treatment plant (STP) has been designed as given in **Section 2.12.13**, **Chapter 2** and the treated effluent will be utilized for irrigating plantation in the residential complex and green belt in plant area. The stabilized dried sludge cake obtained from STP will be utilized as manure for the plantation.

Baseline data indicates that the coastal water quality as well as water quality of rivers in study area is oligotrophic in nature with slight organic contamination. The area is also important for local fisheries. These water bodies have, thus, large resilience and may undertake self-purification with limited quantity of waste. Thus, with implementation of proposed EMP as given in Chapter 7 would be helpful in maintaining the good water quality in surface water bodies of the study area.

4.2.2.1.4 Impacts of CCW Discharges on Water Quality and Biodiversity

The condenser cooling (CCW) sea is drawn from intake channel and it goes to chlorination plant for removal of sea weeds etc. This purified seawater passes through the condenser tubes and takes away the residual heat of condensate steam, before discharged to the sea through a specially designed underground outfall tunnel. The details are presented in **Section 2.6.3**, **Chapter-2**. It is mentioned that residual chlorine levels in the CCW at the outfall will be below stipulated limits of 0.5 ppm of MoEF. Hence there will be no impact on water quality and biodiversity of the sea environment due to residual chlorine of CCW discharges.

The stipulated standard of MoEF for thermal discharge in sea water is the maximum allowable rise of 7^0C in receiving sea water above ambient sea water temperature. This indicates that If the temperature rise exceeds 7^0C above ambient sea water temperature, the flora and fauna will be affected.

Mitigation Measures

The condenser cooling system is designed in such a way that the rise in seawater temperature across the condenser will be below 7^0C above the intake seawater temperature. Then, on the basis of the study carried out by CWPRS, Pune, the discharge channels are designed in such a way that the temperature rise of the receiving sea water will be below 4 ^{0}C at most of the places and around 4.9 ^{0}C at very small area near the discharge point. The literature survey as well as the laboratory studies carried out at NEERI indicate that the local fishes and the benthic and planktonic microflora and fauna are affected only above seawater temperature of 36 to 38^0C. The study by CWPRS predicted the temperature of receiving sea water at Jaitapur to be upto 33 to 34^0C. Therefore the marine flora and fauna will not be affected by discharge of CCW in seawater at Jaitapur. The College of Fisheries, Ratnagiri also recommended that the rise in temperature of receiving seawater should be maintained below 5^0C above ambient seawater temperature i.e. 34^0C to 35^0C (ambient maximum seawater temperature in winter 29^0C and in summer 30^0C at Jaitapur). The details of above mentioned study carried out by CWPRS is given below.

(a) Prediction of Temperatures of Coastal Water at Jaitapur due to Thermal Discharge

For assessing impact of elevated temperature on marine biota, it was prerequisite to predict temperature of receiving marine water. The CWPRS has conducted the studies using MIKE 21 model (HD & AD module) on water temperature considering the maximum rise in temperature of receiving coastal water upto 7 ^{0}C due to discharge of condenser cooling water (**Annexure-V(b)**, **Volume II**). Scenarios were generated for different seasons. A worst case scenario was generated, by taking a scenario where six units are discharging condenser cooling water (100 cubic m /s) at a temperature 7 °C rise across the condenser at a distance of 1.5 km for the first two units, 2 km for the second two units and at 2.5 km for the last two units. The resultant temperature rise ΔT at intake point near breakwater has been predicted to be below 2.5 ^{0}C– 3 ^{0}C at most of the places with around 4.0 -4.9 ^{0}C will be confined to a limited area of 0.28 km^2, when all the six units are operating and ocean currents are in transient state, which is the most severe conditions throughout the year. The rise in water temperature ΔT along the coast (northern and southern side) has been shown to be below 2 ^{0}C. Thus the maximum water temperature due to discharge of condenser cooling water will be 33 ^{0}C in winter (ambient max. 29 ^{0}C) and 34 ^{0}C in summer (ambient max. 30 ^{0}C) and 31 ^{0}C considering annual average temperature of 27 ^{0}C. Temperature increase is not predicted in creek waters and thus mangrove flora in the creek will not have any impact.

Detailed studies on marine bio-diversity and their temperature tolerance were carried out by College of Fisheries, Ratnagiri (**Annexure-VIII**, **Vol II**). The results indicated that this rise of ambient seawater temperature will not have any adverse impact on marine flora and fauna, including benthos.

(b) Effect of Predicted Water Temperature on Fish

Maximum rise in temperature of marine water near JNPP is predicted to be upto 33 ^{0}C to 34 ^{0}C after discharge of cooling water. Literature review indicates that at this temperature (**Table 4.4**), fish will not generally face any acute stress. Moreover, the influence of temperature is restricted to a maximum of 2 m depth due to low density of warm water (Hameed *et al.,* 2007). The fish may easily escape the undesirable temperature by moving to deep sea water near JNPP.

The literature survey was carried out and the temperature tolerance ranges for the genera and groups of aquatic organisms recorded in Jaitapur coastal seawater has been given in **Table 4.4**. According to DAE-BRNS Report 2004, the fish can tolerate ΔT of 10 ^{0}C, while NEERI (EIA Report 1993) reported temperature tolerance of fish from Dahanu upto 380C. Other reports on Indian marine fish indicate that fish is insignificantly affected at 35 ^{0}C temperature. DAE-BRNS Report, 2004 reported that most aquatic forms in tropical water can tolerate temperature upto 40 ^{0}C and that fish species mostly tolerate ΔT of 10 ^{0}C. According many Indian authors (**Bhattacharya, 1981, 1982, 1984; Battacharya and Kewalramani, 1973, 1975, 1976, Biebl, 1962**), zooplankton fauna and algae tolerate temperature upto 33 – 36 ^{0}C temperature. Bivalvia and gastropoda tolerate temperature upto 47.5 ^{0}C and 36.3 ^{0}C (**Fingerman & Fairbanks, 1956; Evans, 1948; Henderson, 1929**). It is observed from this table that most of the indigenous organisms start getting affected above 36-38 ^{0}C temperature of sea water.

(c) Thermal Ecological Studies Carried Out Under Project Sponsored by Department of Atomic Energy and Board of Research in Nuclear Sciences (DAE-BRNS) and National Environmental Engineering Research Institute (NEERI)

Under **DAE-BRNS Project**, 2000-2004, detail studies were carried out on the impact of thermal discharges from Madras Atomic Power Station (MAPS) on coastal waters of Kalpakkam. The ΔT was observed to be ~3 ^{0}C -5 ^{0}C in ~o.1 km^2 area in zone 1 and ΔT of 1 ^{0}C-3 ^{0}C in ~0.15 km^2 area in zone 2. It was observed that the thermal discharges did not affect the distribution of the physicochemical parameters of coastal water.

Most aquatic forms in tropics generally show an optimum temperature requirement of 25 ^{0}C-33 ^{0}C for their growth and development and they also tolerate temperature rise up to 40 ^{0}C, though higher temperatures above 40 ^{0}C are lethal (DAE-BRNS Report, 2004).

The algal species richness and their proportional abundance were not very different between the intake and outfall waters and the sediments, though species composition showed differences.

The field study on micro-algae distribution showed that power plant induced effect on phytoplankton is only localized. The coastal waters showed no indication of altered species composition or reduced phytoplankton standing stock. The reduction in phytoplankton observed during the transit of water through the cooling circuit (caused by thermal and chlorine stress) was not observed beyond the mixing point, due to rapid and effective mixing of the discharge with the coastal water.

Laboratory experiments to study the Thermal impact on native fishes of Dahanu creek area was carried out at NEERI (**NEERI- EIA Report 1993**) the results showed that the fish can exhibit normal behavior up to 35^{0}C and below for a longer period. When the temperature was gradually increased, the fish showed stress up to 40 ^{0}C. Fish lost balance at and above 40^{0}C temperature. The incipient lethal temperature was estimated as 38 ^{0}C.

In order to evaluate different scenarios, as may come across due to discharge of warm water during different tidal conditions, laboratory studies on the model fish *Sarotherodon mossambica* (average weight 59.3g; length 16.0 cm) which can tolerate wide range of salinity, were carried out (NEERI 1993). Besides estimating tolerance of extreme lethal temperature, the fish were exposed at different temperatures simulating various consequences (**Fig. 4.7**). Loss of equilibrium (LE) was determined as the time when a fish could not maintain its normal swimming position, while death was defined as the time when opercular activity and response to physical stimulus ceased.

(d) Study on Aquatic Biodiversity and Thermal Impact by College of Fisheries, Ratnagiri (Volume –II, Annexure-VIII)

The diagrammatic representation of marine biodiversity around proposed JNPP is presented in **Fig. 4.8**.

The Main Findings of the Study

1. The bottom & surface sea water temperature varied from 25 to 26.5 °C indicating well -mixed water due to ocean currents.
2. The seawater pH showed narrow fluctuation with values of 8.39- 8.78 ,
3. The levels of Dissolved Oxygen (DO) at the surface varied in the range 6.28- 6.92 mg/l. Typically the DO declined with depth with a lowest value of 4.6 mg/l at the bottom water.
4. The nutrients in sea water especially phosphate and nitrate are very low indicate absence of pollution and low productivity of the seawater in the study area. Therefore, planktons are very less in amount.
5. The fish catch is low near the shore, which increases towards seaside with increase in depth.
6. The sensitive species in the study area like mangroves, present in the Jaitapur along the creek are quite far away (approximately 5 km) from the influencing area of the thermal plume from the project.
7. The thermal dispersion studies carried out by CWPRS shows that the maximum temperature rise of around 5 ^{0}C will be confined to a limited area of 0.28 km^2, when all the six units are operating and ocean currents are in transient state, which is the most severe conditions throughout the year hence will not adversely affect the native flora and fauna under normal ambient conditions.

The study and literature glance indicates important points, which need to be considered as under,

1. The magnitude of temperature rise of the receiving water body (sea in this case) depends upon the mixing pattern and season.
2. The effect of warm water discharge are localized in nature and short term due to the coastal mixing processes bringing out horizontal and vertical distribution of the biota. However, it should be noted that alteration in the aquatic ecosystem could also be due to natural influences, which should be clearly differentiated from man -made activities.

3. The response of marine species would depend on acclimation period and the ambient temperature, as seen from the **Fig. 2** (**Volume –II**, **Annexure-VIII**) zones of activity and inactivity exist for the species under consideration
4. Stenberg, (1985) suggested that besides heat loading, the radioactive waste and chlorine also may appear as pollutant in the CCW from nuclear power plant. However, studies carried out at Kalpakkam site and other nuclear power plant sites in the country with advanced design features, indicates that radioactive and chlorine levels in the CCW are much below the stipulated limits and do not pose any impact on the marine ecosystem.

Conclusion

Above enumerations and thermal dispersion studies indicate that the marine aquatic food chain organisms will not be affected by the predicted maximum temperature rise of around 5 ^{0}C will be confined to a limited area of 0.28 km^2, when all the six units are operating and ocean currents are in transient state, which is the most severe conditions throughout the year. At this range of temperature rise above ambient temperature of water, most of the organisms are either not affected or get benefit of stimulation of metabolic activity. The marine biodiversity of the coastal stretch around proposed Jaitapur Nuclear Power Park is prepared and shown in **Fig 4.8**. When this figure is compared with thermal prediction in coastal water, it is observed that the temperature zone of 4 °C to 5 °C lie in low fish catch and low marine biodiversity area, while at other place temperature rise is mostly upto 1-3 °C. Further, no sensitive marine species have been recorded on the coastal area near JNPP site, however, mangrove flora is present in the estuary far away from the project site where no thermal impact is predicted and may not be affected by discharge of condenser cooling water.

4.2.2.2 Impact Assessment due to Radiological Releases through Water Route: Mitigation Measures

The main aim of mitigation measures is to design the plant to keep the radiological discharges through water route below stipulated standards. The details are given below.

The data provided hereafter gives indicative typical values of effective dose, critical exposure pathway and critical nuclide related to liquid waste of one Unit of NPP. The Liquid Waste Storage and Processing Systems are designed to store and process Liquid Waste Water accumulated into the controlled area during power operation, overhauls and refueling. The details are presented in **Section 2.6.7.2**, **Chapter 2**.

Average Amount of Liquid Waste expected ≈ 360 m^3/week, (which includes Tritium balance of about 45 m^3/week & regenerated / flushing water of about 70 m^3/week). The total expected liquid effluent discharges are about 1500 m^3/year. The systems are controlled from a separate local station. Due to retention equipment in the waste treatment plant and the mode of operation, activity releases less than 4 x 10^{10} Bq/y for radionuclide mixture without tritium and less than 6 x 10^{13} Bq/y for Tritium (H^3) are expected.

4.2.2.2.1 Typical Annual Liquid Discharges

The following table shows the expected annual and maximum discharge of radioactive substances released into the sea per unit.

Radionuclides	Expected performance excluding operating contingencies	Maximum release
Tritium	52 000 GBq	75 000 GBq
Carbon-14	23 GBq	95 GBq
Iodine isotopes	0.007 GBq	0.05 GBq
Other FP/AP	0.6 GBq	10 GBq

4.2.2.2.2 Laundry System

An active laundry is provided to decontaminate clothing and rubber wears such as lab coats, hand gloves, Shoe cover, coveralls etc received from the station. The laundry equipment is provided to take care of the entire washing load of contaminated protective wears from the plant on a single shift operation basis. However, increased load requirements, if any, during shutdown and other contingencies can be met by increasing the no. of shifts. This system is located in nuclear building very close to change room (point of generation) and new cloth issue room (point of utilization) thereby avoiding movement of contaminated clothing from change room to laundry system. The drain lines from these laundry machines are led to laundry waste collection sump from where it is pumped to laundry waste collection tank of dyke area.

4.2.2.2.3 Radioactive Concentrates Processing

The Radioactive Concentrates Processing System is designed to receive condition and process Liquid Radioactive Waste stored in storage tanks. The type of waste to be processed is evaporator concentrate, slurry, spent resins, and the liquid radioactive waste residues generated in water and waste waster treatment systems.

Typical Values: per unit

- Evaporator $\approx 20 m^3 /y$
- Slurry $\approx 2\ m^3/y$
- Spent resins $\approx 2.5\ m^3/y$

4.2.2.2.4 Radiation Dose Apportionment through Water Route

The radiation dose apportionment from each unit of JNPP is given below.

<table>
<tr><td colspan="2">Dose limit of each site as per AERB = 1milli Sievert per year (from all routes)
Dose limit of each unit of JNPP= 0.1 milli Sievert per year (from all routes)</td></tr>
<tr><td colspan="2">Dose limit of each unit of JNPP from water route = 0.02 milli Sievert per year</td></tr>
<tr><td>Radionuclide mixture without Tritium (H^3)</td><td>0.01 milli Sievert per year</td></tr>
<tr><td>Tritium (H^3)</td><td>0.01 milli Sievert per year</td></tr>
</table>

Releases through water route will be constantly monitored and reviewed such that the actual releases are much less than the specified limits. The above apportionment of dose through liquid will be reviewed and approved by AERB. It is mentioned that permissible AERB dose limit form all the units at the site is 1 mSv / year. Therefore, the impact on water environment due to radioactive discharges through water route will be insignificant.

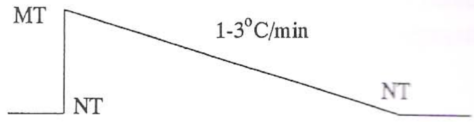
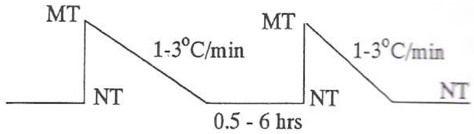
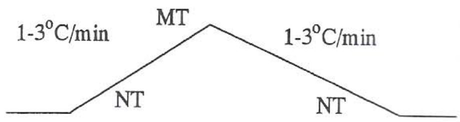
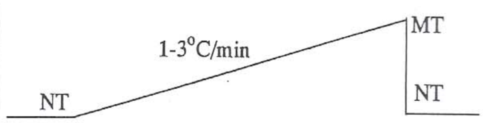
Sr. No.	Exposure/Consequences	Diagramatic Representation
1.	Maximum tolerable temperature	
2.	Sudden exposure to maximum temperature and then gradual decrease to normal temperature (Situation in between IIT & LT and LT & HT at different flow/dilution rates and for variable swimming rates of fauna)	
3.	Double exposure (The fishes survived during LT can again be exposed during HT or vice versa, after a lapse of different periods)	
4.	Gradual increase and decrease of temperature (The situation may happen during slag period i.e., at HT & LT, when there is no flow)	
5.	Gradual increase to maximum temperature and then sudden decrease to normal temperature (The condition when fishes move against current)	

Fig. 4.7: Exposure of Fish *Sarotherodon mossambica* at Different Temperatures under Different Consequences
(NT: normal temperature; MT: maximum temperature)

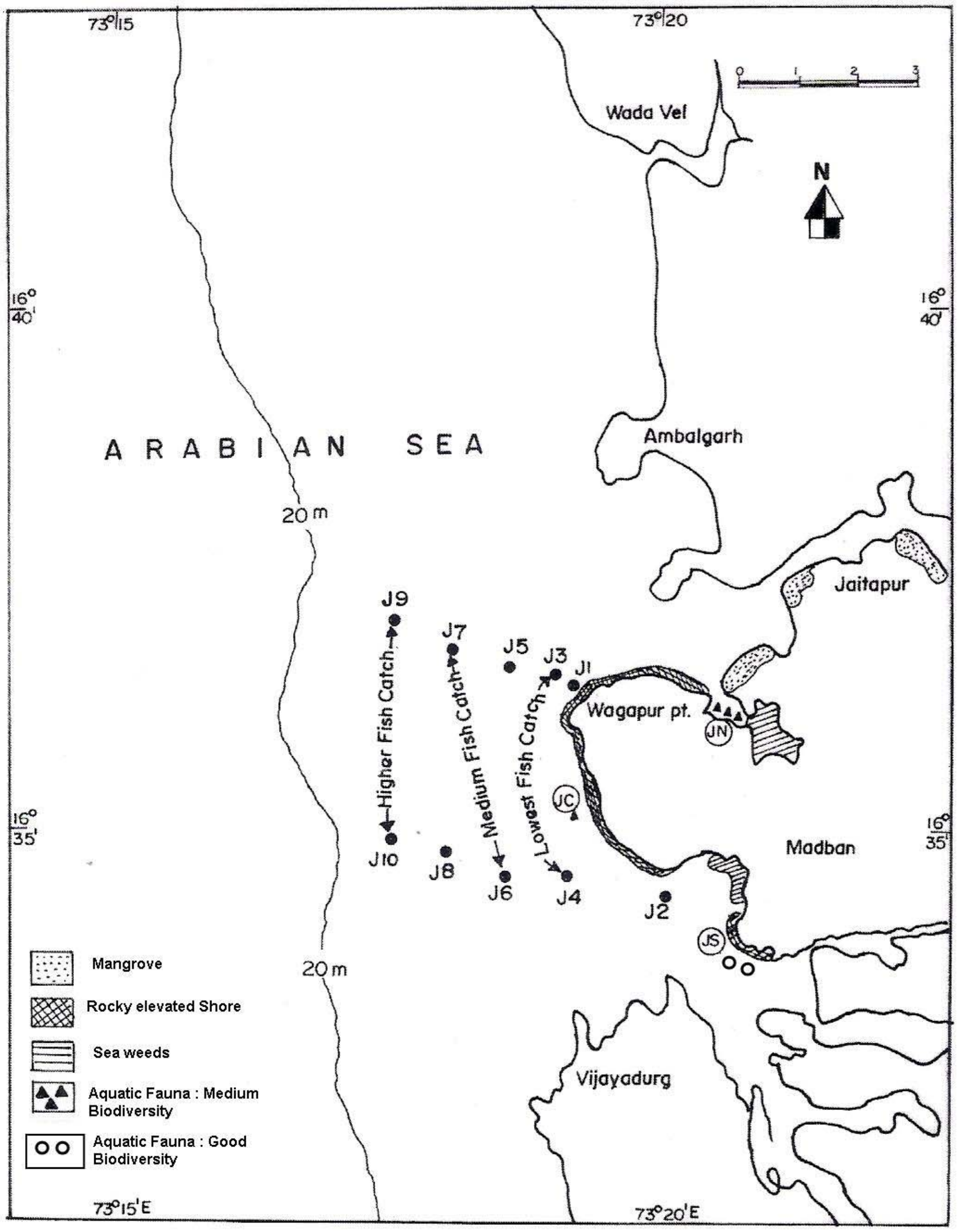


Fig. 4.8: Diagrammatic Representation of Marine Biodiversity around Proposed Jaitapur Nuclear Power Park

Table 4.4

Temperature Tolerance of Organisms Recorded at Jaitapur

Sr. No.	Group/Species	Maximum Temperature Tolerance	Reference
(A)	Zooplankton :		Bhattacharya, 1981, 1982, 1984; Bhattacharya and Kewalramani, 1973, 1975, 1976
	Copepods	33-35°C	
	Decapods	33-36°C	
(B)	Fish	35°C (insignificant impact)	Bhattacharya, 1981, 1982, 1984; Battacharya and Kewalramani, 1973, 1975, 1976
	Saurida tumbil (pre & post larvae of fish)	31°C	Kuthalingem, 1959
(C)	Most aquatic forms in tropical marine waters	40°C	DAE-BRNS Report, 2004
(D)	Fish species	ΔT of 10°C	DAE-BRNS Report, 2004
	Native Fishes of Dahanu Creek	38°C	NEERI-EIA Report 1993
(E)	*Bivalvia crapsostrea virginica*	47.5°C	Fingerman & Fairbanks, 1956
	Modiolus modiolus	36.3°C	Henderson, 1929
(F)	Gastropoda : *Littorina littoralis*	44.3°C	Evans, 1948
(G)	Algae		
	Enteromorpha flexuosa	35°C	Biebl, 1962
	Dictyota dichotoma	32°C	Biebl, 1962

4.2.3 Land Environment

4.2.3.1 Impact Assessment due to Change in Land-use

The coastal land proposed for the Jaitapur Nuclear Power Park is a flat terrain with small undulating soil. Most of the land in 15 km radius area is barren with elevation from RL + 20 m to RL + 29 m with an average elevation of about RL + 24.5 m. There is no river or streams over proposed site except gullies to carry rainwater runoff. The cultivated area is very small i.e. paddy and some mango plantations. Large area is covered by grassland. As present, the project site is barren with sparse vegetation in the form of grasses. However, with the introduction of the project, the land use pattern of the area will improve with neat and clean project buildings, lawns and gardens. The area in the exclusion zone around the project will be developed into a green belt as per the requirements of Maharashtra Pollution Control Board (MPCB). This will further improve the aesthetic and land use environment at the proposed project site.

4.2.3.2 Impact Assessment due to Radiological Solid Waste

Active solid waste is produced from different sections of nuclear power plants in the form of metallic and non metallic waste. These solid wastes need to be treated and disposed off properly for the protection of flora, fauna and human being.

Mitigation Measures

Treatment and disposal of radioactive solid waste at Jaitapur Nuclear Power Project will be carried out as per AERB requirements. The solid processing and storage system is designed to handle and deal with solid radioactive waste generated in the controlled area during power operation, overhauls and refueling and to store the operational solid radioactive waste in the storage rooms. The designed features are presented in **Section 2.6.7.3**, **Chapter 2**.

The operational solid radioactive waste generated per year is handled and stored in the drums / containers as described following.

Categorisation of solid waste storage drums:

Type I	: capacity 140 litre for resins & concentrates with different thickness
Type II	: capacity 350 litre for resins & concentrates with different thickness
Type III	: capacity 950 litre for resins & concentrates with different thickness
Type IV	: capacity 500 litre for filter cartridges with different thickness

Typical overall volume of waste to be treated for one year for TWO UNITS

Filter cartridges ≈ 300 Units

Spent resins ≈ 45 m^3 (high activity 10 m^3, medium activity 15 m^3, Low activity 10 m^3, very low activity 10 m^3)

Concentrates ≈ 30 m^3

Chemical waste ≈ negligible

Miscellaneous dry waste ≈ 420 m^3 (of which 85% is Compactable – reduction by the factor of 9 and 15 % is non- Compactable)

Average annual drum output for one year for two plant units

Type I: ≈ 120

Type II: ≈ 100

Type III: ≈ 200

Type IV: ≈ 150

ANS 55 (208 litres) Gallon metal drums ≈ 800

Spent resin or concentrate volume in different concrete drums

Type I: ≈ 340 litres of concentrates or ≈ 300 litres of spent resins

Type II: ≈ 130 liters of concentrates or ≈ 130 litres of spent resins

Type III: ≈ 50 liters of spent resins

Activated Metallic Waste

The instruments lances and RCCA drive shafts remain in the reactor building stored under water during outages. Should any of such items need to be stored during normal plant operation, they can be stored in the instrumentation lance compartment, which remains flooded in every plant state.

Large components such as lower core plate and heavy reflector are designed for full life of the plant. In case of unexpected event of the replacement of such equipment the dismantling (cutting into smaller pieces and putting into a special container) of the irradiated equipment is done underwater in the internal compartment of reactor pool and then the container is stored at a specified place called radioactive solid waste disposal site at the project site.

After sealing, the dose rate at outside surface of the drum / container will be <2 mSv/h. They are then placed in temporary storage area. After some time they are then stored in long-term storage area. The dose rate at outside surface of the drum will be <2 mSv/h. The dose rate outside the storage building will be < 0.75 mSv/h.

The radioactive waste depending upon the activity levels are burried in secured earth trenches, in steel containers which are immobilized in secured concrete vault. The solid waste disposal site is fenced, secured and designed to store waste for sufficiently long time of the order of 100 years. To ensure that the activity from the solid waste does not leach out to ground water, the activity levels in the ground water are periodically monitored and records maintained as per the requirements of AERB. Therefore, solid radioactive waste disposal with effective disposal mechanism will not have any adverse impact on the land and water components of the environment.

The existing environmental radioactivity levels are not expected to be changed due to operation of proposed nuclear plant. The design of the plant, radioactive monitoring and waste management systems are of highest quality as per international and national guidelines and the radioactive emissions from the stacks would be insignificant. Therefore the fallout would be minimum and land would not be exposed to radioactive pollutants.

4.2.4 Noise Environment

4.2.4.1 Impacts due to Stationary Noise Sources

The cumulative noise level at a particular location within the study area due to noise source can be computed by using Wave Divergence Model as given below:

$$L_{p2} = L_{p1} - 20 \log (r_2/r_1) - Ae_{1,2} \quad \text{- - - - - - - - - - - -} \quad \textbf{(4.2.4.1)}$$

where,

Lp2 and Lp1 are the noise levels at the distances r_2 and r_1 respectively from the source and Ae1, 2 is the excess attenuation along the path r_2-r_1 due to environmental absorption, scattering and other shielding effects. In the present case, excess attenuation was not considered.

Total noise level Lp (Total) due to all sources can be determined as follows:

$$Lp(Total) = 10 \log (10^{Lpa/10} + 10^{Lpb/10} + 10^{Lpc/10} + - -) \text{ - - - - - -} \quad \textbf{(4.2.4.2)}$$

where,

Lpa, Lpb, Lpc, are the noise levels at a sampling point due to sources A, B, C, etc.

The above-mentioned model is used for predicting increase in noise levels due to proposed unit in Jaitapur nuclear power plant. Cumulative noise levels considering sources in proposed Units are also predicted.

4.2.4.2 Identification of Sources of Noise in the Proposed Plant

The main sources of noise in the nuclear power plant are 1) Turbines, 2) Air Compressors, 3) Ventilation inlets, 4) Diesel Generators, 5) Pump House Equipments, 6) Chillers, 7) Vents, 8) Exhaust Fans and 9) Heavy and medium automobiles moving around the plant. The noise levels likely to be generated by these sources are presented in **Table 4.5**. It is likely that improved technology may further reduce the noise levels. Most of the machines will be working continuously round the clock during operation of the nuclear power plant. However, these machines would be housed in acoustic enclosures / buildings such that they would not be contributing any additional noise levels in the surrounding environment.

The noise level contours due to the noise sources in units of the proposed nuclear power plant without considering noise barriers are shown in **Fig. 4.9**. Without any barriers viz. buildings and green belt, it is predicted that the noise levels in the surrounding environment due to above said equipments of the proposed units at a distance of 500 m will be 52 dB(A) and at 1000 m will be 50 dB(A). It is also predicted that the noise levels from these sources at 2000 m distance will be <50 dB(A). Therefore, background noise levels in the nearest village i.e. Kuveshi located at a distance of 2 km will remain below 50 dB(A).

The maximum noise levels will occur at receptors located near all the proposed units which are predicted to be less than 60 dB(A) without any barriers viz. buildings. These noise levels would be significantly reduced when the barrier of building is considered at the time of operation of plant.

Considering the attenuation due to specially designed building within which noise generating machineries will be housed, the increase in noise levels will be around 1-2 dB(A) just outside the building of power plant. Thus, there will not be any change in the ambient noise levels due to operation of nuclear power plant in the nearest village Kuveshi at 2 km distance.

4.2.4.3 Prediction of Impacts on Community

Above discussion indicates that there will not be any increase in noise levels above ambient due to operation of the nuclear power plant in the nearest village Kuveshi at 2 km distance. Therefore the community will not be affected by the operation of the NPP at Jaitapur.

As the human settlement near to the plant site are relatively less and study area consisting of green belt and vegetation with very less vehicular density, the noise impact on surrounding population would be insignificant.

4.2.4.4 Prediction of Impact on Occupational Health

Equivalent sound pressure level, 8 hrs average, (L_{eq} 8 hrs), is used to describe exposure to noise in workplaces. The damage risk criteria for hearing loss, enforced by Occupational Safety and Health Administration, (OSHA) USA and stipulated by other organizations, is that noise levels upto 90 dB(A) are acceptable for eight hours exposure per day. Ministry of Labour, Government of India has also recommended similar criterion vide Factories Act, Schedule No. XXIV (Government Notification FAC/1086/CR-9/Lab-4, dated 8/2/1988).

The noise levels in the building are predicted to be 90 dB(A). However, the workers in the noise zone area will be provided with protective equipments like ear muffs and as a result the occupational exposure of the workers is reduced considerably within stipulated limits.

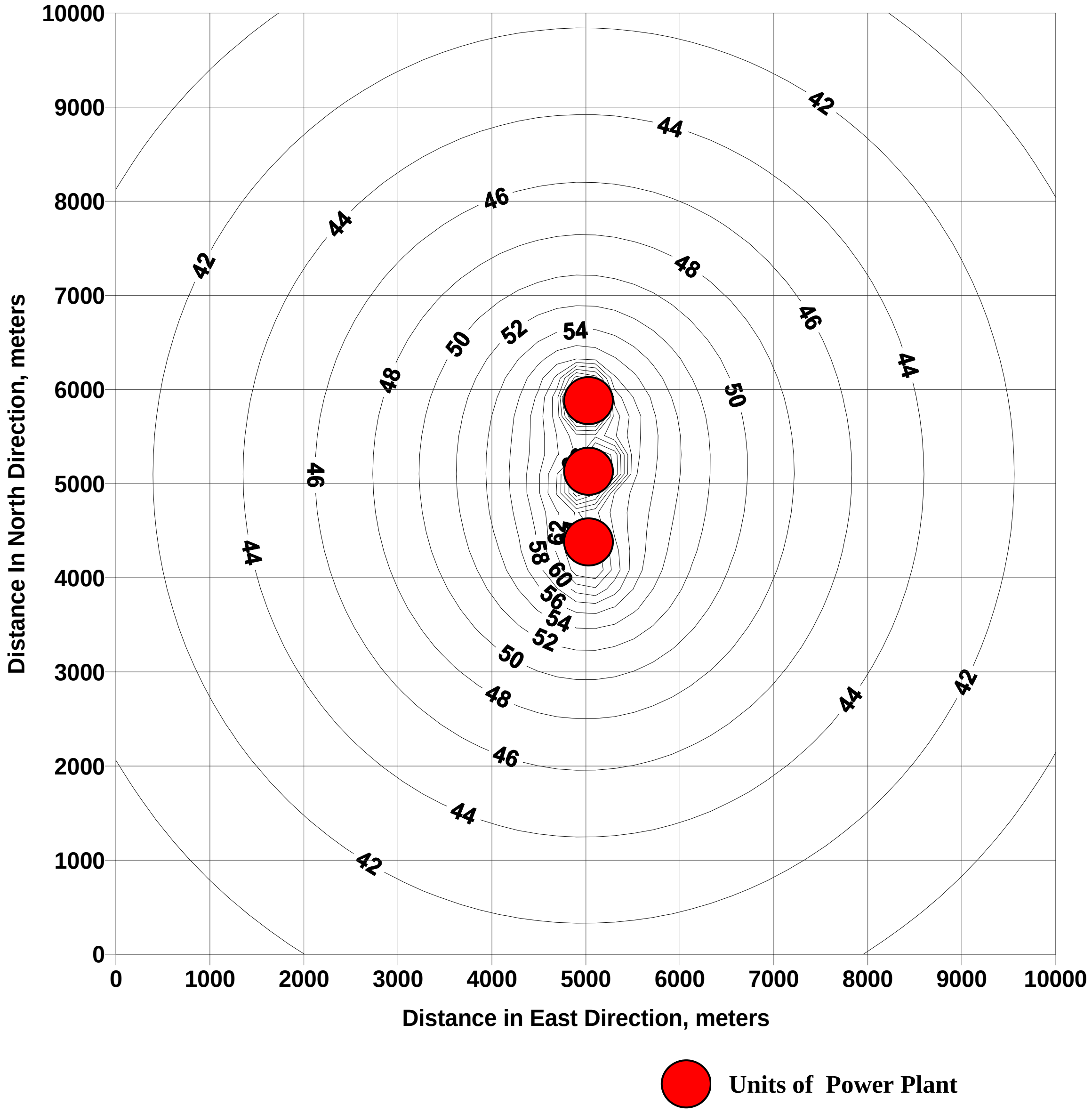


Fig 4.9: Predicted Noise Levels due to Noise Sources in the Proposed Nuclear Power Plant without Considering Attenuation due to Barriers Like Building and Greenbelt. The noise level in the building of NPP is predicted to be 95 dB(A)

Table 4.5

Main Sources of Noise from Different Equipments in Proposed NPP & Their Noise Levels

Sr. No.	Source	Noise Levels Range, dB(A)	Distance from Noise Source
1	Turbine	94 – 96	5 m
2	Diesel Generator	92 – 98	2 m
3	Air Compressor	92 – 98	2 m
4	Cooling Water Pump	89 – 95	2 m
5	Deaerator	92 – 94	2 m
6	Intake Ventilator	94 – 97	5 m
7	Exhaust Ventilator	92 – 96	2 m

Source: NPCIL

Note:

1. All the above-mentioned equipments will be housed in properly designed and engineered buildings, which will work as protective enclosures
2. The occupancy of human beings like occupational workers on continuous basis is not envisaged in the areas around these equipments

4.2.5 Biological Environment

The project area is occupied by barren land with grasses and scrub vegetation. Thus development of JNPP would not affect the green cover of the area on the contrary, JNPP has extensive developmental plan for green belt and plantation in plant and residential complex area resulting in increase in green cover and biodiversity of plants and birds in the area apart from creation of beautiful landscape.

There is no discharge of conventional pollutants in the aquatic environment; so marine fauna and flora would not be affected.

The thermal discharges of condenser cooling water would not exceed the stipulated standards and thus would not create stress on aquatic flora and fauna.

There is no sensitive ecosystem like National Park, Sanctuary or Biosphere Reserve within 10 km radial area around the JNPP (**Fig. 4.10**). The authenticated maps showing locations of JNPP, National Park/Sanctuary/Biosphere Reserve are included in **Annexure XII**, **Vol. II**. Thus, biodiversity would not be affected, on the contrary, would be enriched, due to plantation drive of JNPP.

The radioactive release due to operation of JNPP is expected to be insignificant and impact would be negligible. The discharge of liquid effluents from the plant will be within the stipulated limits of AERB therefore their impacts would be negligible.

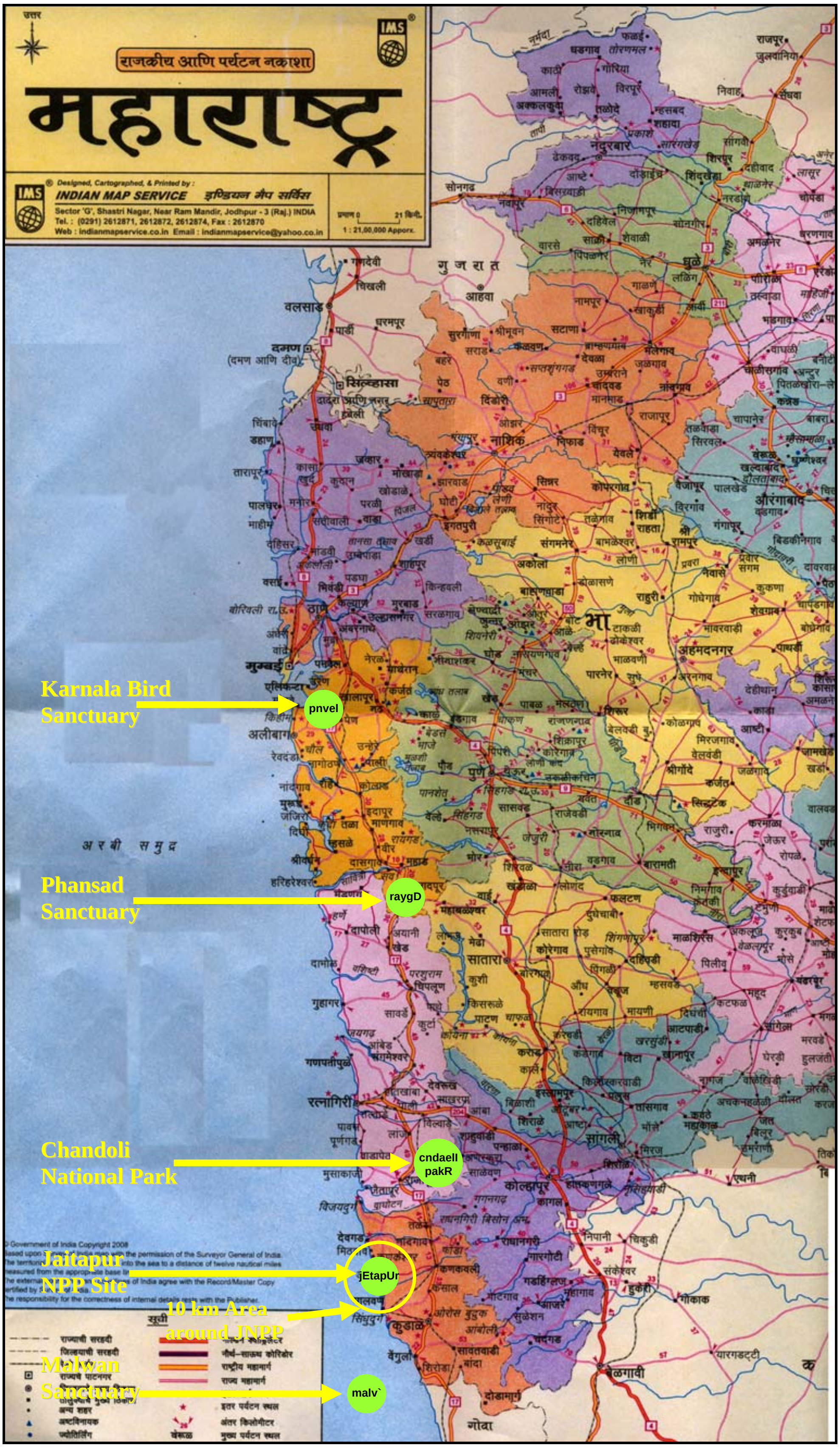


Fig. 4.10: Locations of National Parks & Sanctuaries nearest to Proposed Jaitapur Nuclear Power Park Site

4.2.6 Socio-economic Environment

4.2.6.1 Social Welfare & Community Development Programme around NPPs by NPCIL

The policy of NPCIL towards social welfare & community development aims at strengthening the bond between the project / station authorities and the local population in the vicinity of nuclear power plants.

4.2.6.2 Welfare Measures Proposed to be implemented around JNPP

Assistance in Educational Welfare Measures

- Assistance for Up-gradation of Schools facilities like classrooms, laboratories and other associated requirements.
- Providing computers, sports item, laboratory equipment etc.
- Introduction of the talent nurture schemes for students from nearby villages by providing admission to AECS schools of NPCIL for free education or by providing suitable scholarships.

Assistance in Health-Care Welfare Measures

- Organization of the regular medical camps for chronic ailments prevailing amongst the peoples of villages in and around JNPP.
- Proving consultancy and medicines as a part of preventive and promotive health care
- Hepatitis ‘B’ vaccination to school & village children.

Assistance in Community Welfare Measures

- Assistance in providing drinking water, street lighting, widening of roads, etc.
- Assistance in construction of general community infrastructure facilities.

Assistance in Development of Fisherman’s Welfare Measures

- Distribution of life jackets to fisherman for local costal villages around JNPP and release of fish seedlings into water bodies around JNPP
- Assistance in upgrading fishing facilities in area around JNPP.

4.2.6.3 Socio Economic Impact

Critically analyzing the baseline status of the socioeconomic profile and visualizing the scenario with the project, the impacts of the project would be varied nature. Prediction of qualitative impacts on socioeconomic environment is shown in **Table 4.6**. Expected change in subjective and cumulative quality of life (QoL) in the project region is presented in **Table 4.7** and **Table 4.8** respectively.

4.2.6.3.1 Beneficial Impacts

- The proposed project would generate indirect employment opportunities as daily wage labors during construction, transportation activities, supply of raw materials, auxiliary and ancillary works etc.
- The project has favorable ranking by the majority of the people surveyed and is looked upon as a step for further development of the area
- Due to the project there would be an overall development of the area and job opportunities, which may improve the quality of life in the region.
- Proposed project would help to fulfill the gap between demand and supply of electricity within the country and particularly in the region
- The electricity generated in plant will result in electrification of villages, development of irrigation facilities, drinking water supply, development of industries etc
- Development in housing, education, medical, health, sanitation, power supply, electrification and transport in the study area

4.2.6.3.2 Adverse Impacts

- Influx of workers during the project construction phases would impose marginal strain on the existing basic amenities within the study area
- Although low level generation of conventional pollutants may exists during the construction phase but with proper Environmental Management Plan (EMP), it will have insignificant impact on the environment

Table 4.6

Prediction of Qualitative Impacts on Socio-Economic Environment

Sr. No.	Parameter	Direct	Indirect	Reversible	Irreversible
1.	Employment	+	+	•	+
2.	Income	+	+	•	+
3.	Transport	•	+	•	+
4.	Education	•	+	•	+
5.	Medical facilities	•	+	•	+
6.	Communication	•	+	•	+
7.	Availability of power supply	+	•	•	+
8.	Sanitation	•	+	+	•
9.	Housing	•	+	•	+
10.	Health	•	+	+	•
11.	Agriculture	+	•	•	+
12.	Cost of living	•	+	•	+
13.	Business	+	+	•	+
14.	Per Capita Income	•	+	•	+

+ Positive Impact
- Negative Impact
• Insignificant

Table 4.7

Existing Quality of Life in Study Area during Year 2006

Sr. No.	Villages	$QoL_{(S)}$	QoL(s) after implementation of EMP and welfare measure
1.	Kuveshi	0.54	0.60
2.	Madban	0.48	0.53
3.	Jaitapur	0.52	0.55
4.	Dale	0.52	0.58
5.	Nate	0.54	0.57
6.	Karel	0.46	0.52
7.	Rajawadi	0.46	0.51
8.	Dhaulvali	0.52	0.55
9.	Barsu	0.48	0.52
10.	Nannar	0.46	0.50
11.	Saundale	0.52	0.56
12.	Padel	0.54	0.60
13.	Pural	0.51	0.54
14.	Rajapur	0.56	0.61
15.	Navedar	0.51	0.54
16.	Kotapur	0.46	0.51
17.	Dongar	0.46	0.51
18.	Unhale	0.50	0.53
19.	Baparde	0.50	0.55
20.	Mond	0.53	0.57
21.	Holi	0.50	0.56
22.	Tulsavade	0.51	0.53
23.	Mithgavane	0.53	0.56
24.	Vijaydurg	0.52	0.56
25.	Anantwadi	0.46	0.51
26.	Jambhulwadi	0.48	0.52
27.	Bandhawadi	0.46	0.50
28.	Rameshwar	0.54	0.57
29.	Kambale Lavgan	0.50	0.54
30.	Shengalwadi	0.47	0.50
31.	Ghumewadi	0.47	0.51
32.	Agarewadi	0.46	0.50
33.	Wadapeth	0.47	0.51

Sr. No.	Villages	QoL$_{(S)}$	QoL(s) after implementation of EMP and welfare measure
34.	Sakhar	0.45	0.49
35.	Madheliwadi	0.47	0.50
36.	Shejavali	0.45	0.49
37.	Vilaye	0.50	0.53
38.	Solgaon	0.53	0.56
39.	Devache Gothane	0.51	0.54
40.	Bag Abdul Kadir	0.45	0.47
41.	Kalakawadi	0.50	0.54
42.	Kondsar Bk.	0.50	0.55
43.	Tirlot	0.51	0.54
44.	Kuvale	0.52	0.55
45.	Kunbiwadi	0.50	0.53
46.	Chauke	0.47	0.51
47.	Mahalunge	0.49	0.53
48.	Hativale	0.50	0.54
49.	Juvathi	0.53	0.56
50.	Kaneri	0.51	0.54
51.	Bag Kazi Husen	0.46	0.50
52.	Sheel	0.52	0.55
53.	Dhopeshwar	0.53	0.56
54.	Dasur	0.49	0.53
55.	Chikhale	0.50	0.54
56.	Panore	0.50	0.55
57.	Roon	0.51	0.54
58.	Nanij	0.54	0.57
59.	Dorle	0.50	0.54
60.	Phanase	0.51	0.54
61.	Padvane	0.50	0.54
	Total	**0.49**	**0.53**

Qol(s) = Subjective Quality of Life

Table 4.8

Expected Change in Cumulative Quality of Life

Sr. No.	Villages	$QoL_{(C)}$	QoL(c) after implementation of EMP and welfare measure
1.	Kuveshi	0.55	0.59
2.	Madban	0.49	0.55
3.	Jaitapur	0.53	0.57
4.	Dale	0.53	0.56
5.	Nate	0.55	0.60
6.	Karel	0.47	0.52
7.	Rajawadi	0.47	0.52
8.	Dhaulvali	0.53	0.58
9.	Barsu	0.49	0.53
10.	Nannar	0.47	0.51
11.	Saundale	0.53	0.58
12.	Padel	0.55	0.60
13.	Pural	0.52	0.57
14.	Rajapur	0.57	0.61
15.	Navedar	0.52	0.56
16.	Kotapur	0.47	0.52
17.	Dongar	0.47	0.53
18.	Unhale	0.51	0.54
19.	Baparde	0.51	0.56
20.	Mond	0.54	0.59
21.	Holi	0.51	0.55
22.	Tulsavade	0.52	0.56
23.	Mithgavane	0.54	0.57
24.	Vijaydurg	0.53	0.56
25.	Anantwadi	0.47	0.51
26.	Jambhulwadi	0.49	0.55
27.	Bandhawadi	0.47	0.52
28.	Rameshwar	0.55	0.60
29.	Kambale Lavgan	0.51	0.55
30.	Shengalwadi	0.48	0.53
31.	Ghumewadi	0.48	0.53
32.	Agarewadi	0.47	0.52
33.	Wadapeth	0.48	0.52
34.	Sakhar	0.46	0.50
35.	Madheliwadi	0.48	0.52
36.	Shejavali	0.46	0.50
37.	Vilaye	0.51	0.55
38.	Solgaon	0.54	0.58
39.	Devache Gothane	0.52	0.56
40.	Bag Abdul Kadir	0.46	0.51

Sr. No.	Villages	$QoL_{(C)}$	QoL(c) after implementation of EMP and welfare measure
41.	Kalakawadi	0.51	0.55
42.	Kondsar Bk.	0.51	0.55
43.	Tirlot	0.52	0.56
44.	Kuvale	0.53	0.58
45.	Kunbiwadi	0.51	0.55
46.	Chauke	0.48	0.52
47.	Mahalunge	0.50	0.54
48.	Hativale	0.51	0.55
49.	Juvathi	0.54	0.58
50.	Kaneri	0.52	0.54
51.	Bag Kazi Husen	0.47	0.52
52.	Sheel	0.53	0.56
53.	Dhopeshwar	0.52	0.59
54.	Dasur	0.50	0.54
55.	Chikhale	0.51	0.55
56.	Panore	0.51	0.55
57.	Roon	0.52	0.56
58.	Nanij	0.55	0.59
59.	Dorle	0.51	0.55
60.	Phanase	0.52	0.56
61.	Padvane	0.51	0.55
	Total	**0.50**	**0.54**

Qol(c) = Cumulative Quality of Life

4.3 Impacts during Decommissioning Phase

At the end of the operating life of the operating units, which would be around 60 years for EPR type NPPs, proposed to be established at Jaitapur site, a detail decommissioning plan will be worked out. The process of decommissioning will start after the final shutdown of the plant and ends with the release of the site for a responsible organization as authorized by AERB or for unrestricted use by the public. The decommissioning plan will be prepared by NPCIL & approved by AERB and will be implemented as stated above. The plan will ensure that there will not be any radioactive releases in the public domain / environment, thus impact in the public domain due to decommissioning of the unit will be negligible.

Section -II

4.4 Radiological Risk Assessment & Emergency Response System

4.4.1 Introduction & Design Philosophy

The Pressurized Water Reactors (PWRs) proposed to be set up at Jaitapur have all the features of the modern third generation technology, similar to western designs in respect of philosophy, features and construction. The design of plant is consistent with the standard international practices for safety systems. The basic concept of defense in depth in this plant includes the use of redundancy, diversity, independence and fail safe design. In fact, design features of the PWR's proposed to be set up fall in the category of advanced Light Water Reactor (LWR) as per International Atomic Energy Agency (IAEA).

According to International Nuclear Safety Advisory Group, INSAG – 10 IAEA 1996 for water cooled reactors at power operation, the barriers confining the fission products are typically the fuel matrix, the fuel cladding, the boundary of the reactor coolant system and the containment system. Accordingly, there are five levels of defense in depth with objectives as briefly explained in **Section 2.3**, **Chapter 2** of this report.

4.4.2 Safety Objectives

The safety objective is to verify that the reactor and safety systems are properly designed and operated so that the occupational doses and dose to the members of public as a result of discharge of radioactive substances from the plant remain within the limits specified by AERB.

4.4.2.1 Safety Aspects of NPP at Jaitapur

All the radioactive sources in the plant which may lead to radioactive releases are identified and assessed for their hazard magnitude. However, the worst case scenario for any nuclear power plant is considered to be the damage of core where the fuel is loaded and a sustained chain reaction takes place in normal course of plant operation.

Accordingly, safety aspects are identified and evaluated by deterministic as well as by probabilistic assessment. Probabilistic safety assessment is seen as an extension of or complement to deterministic analyses. It systematically considers conceivable accident causes (Postulated Initiating Events (PIEs)) and for each initiating events, which can lead to core damage of different categories Core Damage Frequency (CDF) is calculated based on individual initiating events (IE) frequency. Through individual event sequence analysis for different IEs, it is estimated that the plant is provided adequate safety features and measures to mitigate or minimize any unsafe consequences.

As per AERB Safety Guide (SG-D-5), DBE (Design Basis Events) are categorized into four categories on the basis of their expected frequency of occurrence. Each of the DBE considered should be assigned to one of the following groups.

(1) Category-1 Events- Normal Operation, Operation transient and AOO
(2) Category-2 Events- Events of moderate frequency
(3) Category-3 Events- Events of low frequency
(4) Category-4 Events- Multiple failures and rare events.

Events not falling in any of the above categories are called BDBE (Beyond Design Basis Events).

The concept of defense-in-depth is conveyed at all phases or activities related to ensuring the NPP safety. Here, the strategy for preventing unfavorable plant damage state initiating events, especially for the 1st and 2nd level is of primary importance (details are provided in **Section 2.3** of **Chapter 2** of this report).

In normal operating conditions, all of the physical barriers must be capable of functioning, whereas the measures on protecting them must be available. On detecting any problems in any of the barriers envisaged by the design or unavailability of measures for protecting it, the reactor plant must be shut down and measures for bringing the nuclear power unit in a safe state must be taken.

The engineering measures and managerial, decisions meant for ensuring safety of NPP must be proven by the previous experience or tests, studies or operating experience with prototypes. Such an approach should be applied not only when developing the equipment and designing the NPP, but when manufacturing the equipment, constructing and operating the NPP and upgrading its systems (components) as well.

The values of overall Core Damage Frequency (CDF) will be within the design target of 1.0 E-6 /reactor-year for the reactor proposed to be set up at Jaitapur, which is below acceptable limit of 1.0 E-5 /reactor-year, as per International Atomic Energy Agency (IAEA) Safety Series No. 75 – INSAG-3, 1988.

4.4.2.2 Multi Barriers of Safety

The safety of the NPP is ensured by incorporating many barriers between the source and the receptor. Protection implies a system of physical barriers on the way by which the ionizing radiation and radioactive substances can release into the environment. This system is used together with a complex of engineering and managerial measures for protecting these barriers and maintaining their effectiveness and measures for protecting the personnel, population and the environment.

The system of physical barriers of the NPP power unit incorporates: a fuel element, fuel element cladding, the pressure boundary of the reactor coolant and the containment. An exclusion zone also provides a dilution of radioactivity before it is reaches to the public domain.

4.4.3 Radiological Objectives

The general principle applied is that, for the transients, incidents and accidents considered in the design (**Table 4.9**), the more frequent the event, the lower the radiological consequences must be.

The normal operating and transient conditions must not result in normal operating limits being exceeded. These operating conditions and transients are covered by the overall dose limit of 1.0 mSv /yr to the members of public at 1.6 km from the reactor i.e. the fence post of the exclusion zone.

The radiological objectives associated with other conditions viz. accidents (**Table 4.9**) to meet the appropriate reference dose limits under these conditions. For the above referred conditions, the maximum thyroid and whole body doses from NPP at a distance of 1.6 km would be kept well within the reference doses of 500 mSv to child thyroid and 100 mSv to an adult whole body as stipulated by AERB.

4.4.3.1 Radiological Aspects for NPP at Jaitapur

The radiological consequences to the public can be broadly divided into two categories i.e. during normal operation and during accident condition. During normal operations, the controlled release of radioactive materials is governed by the Effective Dose Limits (EDL), applicable to the members of public. EDL as stipulated by AERB is 1 mSv/year. There are mainly two routes of exposures i.e. air route and aquatic route. In accident conditions, the consequence depends on the accident scenario.

While siting nuclear power plants, three areas are defined as exclusion zone, sterilized zone and monitoring zone. Exclusion zone extends up to 1.6 kms, which will be under the exclusive control of the power station where no public habitation is allowed. The sterilized zone is the annulus between 1.6 kms and 5 kms radius from the reactors where natural growth is permitted but new expansion of activities which lead to enhance population growth are regulated. Whereas, the area from project to site 30 kms zone is the monitoring zone. The areas under plant zone, exclusion zone and sterilized zone for the JNPP Project are shown in **Fig. 4.11**.

For, Jaitapur Site, the methodology for calculation of doses during off normal situations will be as per AERB safety guide (AERB/SG/S-5D-21). The doses will be worked out by using the two types of dose conversion factors. For initial two hrs into the accident, the site-specific worst meteorological parameters are assumed to maximize the dose. For subsequent releases, time averaged dispersion parameters are used. The worst affected sector will be taken with no change in wind direction.

The maximum thyroid and whole body doses from NPP under abnormal situations at a distance of 1.6 km will be kept well within the reference doses of 500 mSv and 100 mSv as stipulated by AERB for thyroid and whole body respectively.

4.4.3.2 Radiation Protection Considerations

4.4.3.2.1 ALARA Policy

The radiation protection policy taken into account for design is to ensure that the individual dose of site personnel and members of the public does not exceed the dose limits set by the regulatory agency and is kept at a level As Low As

Reasonably Achievable (ALARA) and as per the requirements of AERB. The details are presented as in **Section 2.9.4**, **Chapter -2**.

This policy is embodied in the design, construction, operation, maintenance, in-service inspection, refueling, and non-routine activities.

4.4.3.2.2 General Design Considerations

General design considerations and methods employed to maintain in Plant occupational radiation exposures, in line with ALARA have two objectives:

- to minimize the amount of personnel time spent in radiation areas,
- to minimize radiation levels in routinely occupied Plant areas and in the vicinity of Plant equipment expected to require personnel attention.

Equipment and facility design are considered in maintaining occupational radiation exposures ALARA during plant operations including: normal operation, maintenance and repairs, refueling operations and fuel storage, in-service inspection and calibrations, radioactive waste handling and disposal, and other anticipated operational occurrences.

General equipment design considerations to minimize the amount of personnel time spent in a radiation area include:

- Reliability, durability, construction, and design features of equipment, components, and materials to reduce or eliminate the need for repair or preventive maintenance.
- Service convenience for anticipated maintenance or potential repair, including ease of disassembly and modularization of components for replacement or removal to a lower radiation area for repair,
- Redundancy of equipment or components to reduce the need for immediate repair when radiation levels may be high, and when no feasible method is available to reduce radiation levels,
- Provisions, where practicable, to remotely or mechanically operate, repair, service, monitor, or inspect equipment.

General facility layout design considerations to minimize the amount of personnel time spent in a radiation area include:

- locating equipment, instruments, and sampling stations which will require routine maintenance, calibration, operation, or inspection, for ease of access and minimum required occupancy time in radiation areas,
- laying out Plant areas to allow remote or mechanical operation, service, monitoring, or inspection of highly radioactive equipment,
- providing, where practicable, for transportation of equipment or components requiring service to a lower radiation area.

General facility layout design considerations directed towards minimizing radiation levels in Plant access areas and in the vicinity of equipment requiring personnel attention, include:

- separating radiation sources and occupied areas, where practicable (e.g., pipes or ducts containing potentially highly radioactive fluids, do not pass through occupied areas),
- providing adequate shielding between radiation sources, and access and service areas,
- where appropriate, separating equipment or components in service areas with permanent shielding,
- locating equipment, instruments and sampling sites in the lowest practicable radiation zone,
- providing means and adequate space for utilizing movable shielding for sources within the service area, when required,
- providing means for decontamination of service areas,
- providing means to control radioactive contamination and to facilitate decontamination of potentially contaminated areas.

4.4.3.3 Average Environmental Radiation Dose to the Members of Public at 1.6 Km Radius for Operating NPP's in India

As per the reports from Environmental Survey Laboratory (ESL), BARC, the average environmental radiation dose (micro Sievert per year) at 1.6 Km radius due to operation of Nuclear Power Plants in India 2000-2007 is given in the **Fig. 8** of the **Summary EIA**. The present AERB public domain dose limit is 1000 micro Sievert

/year. It may be seen that the public domain dose values in case of TAPS, RAPS and MAPS have been reported to be mostly below 50 micro Sievert / year (20 times lesser than stipulated standard). In the case of NAPS, KAPS and Kaiga, these value are in the range of 1.7 to 2.8 micro Sievert / year. This is also to mention that these values are excluding background natural radiation average dose of 2400 micro Sievert / year and medical exposures. This indicates that the exposure of public to the radiation is far below the stipulated limit in all the nuclear power plants in India.

4.4.4 Monitoring of Environment around NPP Site

At each nuclear power plant, Environmental Survey Laboratories are set up long before the plant goes into operation. These laboratories carry out analysis of background radioactivity in the area. The purpose is to establish the baseline radiation levels. Thereafter, when the power plant is commissioned and operated, the radiation levels in the environment are monitored regularly up to 30 km distance from the reactors. Within the exclusion boundary, continuous monitoring of radiation situation is done by automated environmental radiation monitoring system. This is being done at all the nuclear power plants in India on continuous basis.

It has been reassuring to note that there has been no adverse impact on the environment due to operation of the Nuclear Power Plants in India.

4.4.4.1 Environmental Survey Laboratory

An Environmental Survey Laboratory (ESL) will be set up for regular monitoring of environmental parameters throughout the operation of the plant.

The primary aim of the environment monitoring program is to assess the radiation exposure of public residing around Jaitapur site and to demonstrate that radiation exposure received by the member of the public is within the limit prescribed by the regulatory agency based on international guidelines

Objectives of Environmental Monitoring

- To generate environmental radiological database.
- To assess the possible dose commitments to the population due to operation of the nuclear power station.
- To determine control action during site / off site emergencies.

This requires detailed measurements on a number of environmental matrices for radioactivity content that may result from the release of radioactivity effluents during the normal operation of the nuclear facilities.

- Pre-operational survey
- Operational Survey
    - External Radiation
    - Radioactivity concentration in air & water.
    - Strontium, Cesium and Iodine activity in environmental matrices.

Type of Sample	**Number of Typical Samples Analyzed in a Year**
Surface water	500
Drinking water	200
Well water	400
Air Samples for tritium	500
Air samples for particulates	50
Goat Thyroid	50
Vegetables, milk, pulses, cereals, meat, eggs, fish, etc.	70
Weed, silt, soil, sediments, grass, leaves, etc.	40

Environmental Survey Laboratories (ESL) are located at each of the nuclear power project sites in the country. These ESLs are operated by an independent organization viz. Health Physics Division of Bhabha Atomic Research Centre. At the existing NPPs, ESLs have been collecting samples in the radius of 30 km from the plant site and their reports conclude that the dose to population at the fence resulting from the existing NPPs in the country is about 1.5% of the authorized dose limit, which is a small fraction of the natural background radiation. The doses at further distances are still lower.

4.4.5 Radiation Emergency Response System in Indian Nuclear Power Plants

The purpose of planning for on-site/off-site radiation emergency response is to ensure adequate preparedness for protection of the plant personnel and members of the public from significant radiation exposures in the unlikely event of a severe accident. The probability of a major accident resulting in the releases of large quantities of radioactivity is extremely small. The probability, however, can never be reduced to absolute zero and therefore this residual risk is sought to be mitigated by appropriate siting criteria and implementing suitable arrangements for emergency planning and preparedness.

As stipulated in AERB Safety Guide No. SG/HS-1, to limit the radiological consequences in public domain, the whole area around NPPs is divided into three domains based on severity of prevailing radiation fields subsequent to the accidental release of radioactivity. Appropriate intervention levels and derived intervention levels are assigned in advance for each domain so that off-site emergency counter-measures could be implemented in a pre-planned manner. Following counter-measures have been found suitable to deal with radiological emergency in the public domain.

- Iodine Prophylaxis administration
- Sheltering
- Evacuation
- Decontamination
- Control of food and water supplies
- Use of stored animal feed
- Decontamination of area

The selection of one or more of the above protective measures is based on the nature of the accident and its associated risk and in particular, time factor associated with these two factors.

The intervention levels as stipulated in AERB Safety Guide No. SG/HS-1 for protective measures are implemented at very low radiation levels, compared to radiation levels which cause serious injurious to persons receiving acute whole-body radiation exposure.

The requirements of emergency counter-measures in case of various DBE are assessed. Emergency counter-measures like distribution of iodine prophylaxis and sheltering would be needed based on intervention level.

The agencies responsible for carrying out remedial measures during the different categories of emergencies mentioned above are as follows:

Type of Emergency	Responsible Agency
Emergency Standby	Plant / Site Management
Personnel Emergency	
Plant Emergency	
Site Emergency	
Off-site Emergency	District authorities of the State Government having jurisdiction over the public domain affected by the accident, normally the District Collector.

Emergency Standby

Emergency standby is defined as abnormal plant conditions with potential to develop into accident situations, if timely preventive actions are not taken. During this situation pre-identified plant personnel are placed in a state of alert for implementing the emergency response procedure.

Personnel Emergency

When the radiological consequences of an abnormal situation are confined to some personnel working in a plant, without affecting the plant, it is described as a personnel emergency. For example, some of the plant personnel may be working at a location within the reactor building where the radiation field is significantly above prescribed limits for extended period resulting in their excessive radiation exposure. Some other examples of personnel emergency are given below:

- splashing of radioactive material on personnel while carrying out operation/maintenance in such a manner that excessive contamination, internal and/or external, has occurred or is suspected;
- high uptake of radioactive material has inadvertently occurred or is suspected;
- personnel contamination at levels exceeding prescribed limits;
- high external exposures has occurred or is indicated;
- the person is physically ill or incapacitated;
- exposed to a heavy chlorine dose in a chlorine plant.

Plant Emergency

When the radiological consequences of an abnormal situation are expected to remain confined to the plant, it is described as a plant emergency. This situation may arise during operation or shutdown maintenance of the reactor.

Site Emergency

An accidental release of radioactivity extending beyond the plant but confined to the site boundary (exclusion zone) constitutes a site emergency. An assessment of such a situation would imply that protective measures are limited to the exclusion zone. Site Emergency is declared and terminated by Site Emergency Director (SED). The protective measures in a Site emergency include evacuation from the affected parts of the site and also radiological monitoring of the environment in the Emergency Planning Zone (EPZ). The emergency reference level for on-site emergency is given below.

Off Site Emergency

An off-site emergency occurs when the radiological consequences of an emergency situation originating from NPP are likely to extend beyond the site boundary (exclusion zone) and into the public domain. For the purpose of planning off-site emergency, an emergency-planning zone (EPZ) up to 16-km radius is specified. There should be fixed criteria to determine an off-site emergency in terms of the release of radioactivity as indicated by the radiation monitoring system.

The protective measures in public domain shall be implemented by the District Officials under the supervision of the district collector or the divisional Commissioner, who shall be designated as the off-site Emergency Director (OED).

The manual on Off-site Emergency Response Plans would be issued by the State Level Emergency Response Committee. The manual shall specify the need of radiation impact assessment based on immediate, intermediate and long-term consequences according to space-time domain concept and the necessary intervention measures such as evaluation, sheltering and food control. Off-site emergency shall be declared and terminated by OED on the basis of technical assessment made by SED.

The Station Director JNPP is identified as the Plant Emergency Director (PED) and all the Superintendent and Health Physicist are the members of the plant Emergency Committees.

Consequent to the declaration of the site emergency the Station Director of JNPP handover the charge of Plant emergency director (PED) to Chief Superintendent and assumes the charge of Site Emergency Director (SED). The PED provides all plant related information to the SED and works as per the advice of the SED to mitigate the situation in the plant.

The SED is the Chairman of the Site Emergency Committee (SEC) and is responsible for convening the SEC, when the 1st report of the initiation of an emergency is received by SED. SED shall obtain technical inputs, such as particulars of the accident, from the members of the SEC. The decisions for declaration/termination of an emergency shall be based on inputs so obtained. The Site Emergency Organisation structure & the recommended plant emergency response action flow diagram are chalked out.

Consequent to the declaration of the Off-site emergency For JNPP, the District Collector, Ratnagiri will be the Off-site Emergency Director (OED). Its membership includes the chiefs of all public services relevant to the emergency management in the district and the Station Director of JNPP. The OED shall be the Chairman of the Off-site Emergency Committee (OEC) and is responsible for convening OEC when the report of the initiation of an emergency is received by OED. The Action Flow Diagram for the site/off-site emergencies and Information Flow Diagram for site/off-site emergencies have been chalked out.

The Shift Charge Engineer (SCE) on duty is among the first to learn about the occurrence of an off-normal situation. He shall evaluate the condition and the data on the basis of which an emergency may be declared / terminated. He shall notify SED about any condition which may warrant the declaration of an emergency.

Exercises

Emergency scenarios shall be developed to test emergency plans and operational response at all levels. Exercises and drills shall be conducted once in a quarter for Plant Emergency to see that the staffs are adequately trained and all the emergency equipment are kept in good conditions. At the end of each exercise/drill an evaluation of the response call shall be carried out to take care of any deficiency noticed. Site emergency exercise is carried out once in a year. Off-site Emergency exercise is carried out once in two years.

Emergency plan shall be reviewed at least once in five years, the improvements and updating procedures shall be implemented based on feed back and critiques from exercises.

Periodic exercises are conducted as per stipulation of AERB with the active participation of relevant state and public authorities. These exercises are witnessed by observers from Crisis Management Group (CMG), DAE, AERB, BARC and NPCIL-HQ.

Feed back is a very valuable aspect of the exercise of offsite emergency and authorities will resolve the deficiencies surfaced out and action plan will be chalked out depending upon the requirements.

The approved plan for JNPP will be ready before criticality of JNPP -unit1.

The nature and magnitude of response measures would depend on the specific category or extent of emergency. Though safety evaluation of an NPP relates to design basis, the JNPP emergency response plan shall be based not only on design basis events but also on accident conditions due to more severe events, even if they have a very low probability of occurrence. An analysis of such events and the projected radiological consequences specific to the NPP shall form the basis of response plan, so that the nature and magnitude of response actions could be established.

4.4.6 Emergency Preparedness System for JNPP

The documented emergency planning and preparedness program to be established and practiced for JNPP will be approved by AERB. This documented manual on emergency preparedness and response for JNPP will be in two volumes as follows:

Volume-I - Plant/Site Emergency Procedure.
Volume-II - Procedure for Off-Site Emergency.

The salient features of the emergency preparedness system for JNPP are elaborated in the following sections.

4.4.7 Volume-I Plant/Site Emergency Procedure

4.4.7.1 Emergency Organization and Responsibility

To effectively manage the emergency situation at JNPP, Jaitapur site Emergency Committee (JEC) consisting of Advisory Group, Service Group, Damage Control Group and Rescue Team will be established. The details of Jaitapur Emergency action flow diagram for site / off site emergencies is presented in **Fig. 4.4.2**.

4.4.7.2 Communication

The responsibility of communication during emergency lies with Communication Group. This group ensures that all communication equipment is kept functional at all time. It consists of Engineer- in -charge of the Plant, communication system, Telephone operators and wireless operator.

4.4.7.3 Resources and Facilities

Main Control Room conference room will be made into Plant Emergency Control Centre (PECC) and Station Director's Office will be converted in to Site Emergency Control Centre. These centers will be provided with communication facility within the JNPP site and outside agency.

The plant emergency equipment centre will be located at Administrative building or any suitable location and it will be augmented with ready to use equipment for the plant /site emergency. Normally Zone-II and Zone III area shower and wash room are to be used for emergency personnel decontamination purpose. However there will be a separate facility for casualty at Residential complex hospital when it is commissioned. A special emergency service vehicle fitted with two –way radio equipment and necessary monitoring & survey equipment will be available at all time under control of on duty Shift Charge- Engineer (SCE). Different assembly areas for different working groups will be identified inside the operating area or plant fencing and maintained for assembly in the event of an emergency. Emergency shelter locations will be identified for sheltering /evacuation due to emergency condition and the plant personnel shall proceed to the shelter areas in the event of an emergency.

4.4.7.4 Action plan for responding to Emergency

After hearing the emergency siren and announcement about emergency situation and or getting information of the same through telephone, all responsible members of the JEC shall proceed to Main control room/ PECC. Details of handling plant /on-site emergency situations will be documented and made available at PECC. The action flow diagram for on site and off site emergencies is given in **Fig. 4.12**.

4.4.8 Volume-II Procedure for Off-Site Emergency

This volume will provide guidelines for handling off-site emergency at JNPP and deals with emergency management organization, emergency equipment and facilities for handling the situation up to 16 km radius.

4.4.8.1 Emergency Planning Zones and Sectors

The area around the plant site is divided into various zones and sectors as described below for effective handling of the emergency situations:

In normal operation of the proposed PWR category nuclear power plant, the impact zone would not be beyond 1.6 km, which would also hold good for off normal situations due to advanced technological features in built in the design of the reactor. However, on a conservative side, an area of 16 km around the plant is considered as emergency planning zone as per the requirements of AERB as described below:

As per AERB requirements, the exclusion zone covers a distance of about 1.6 km around the plant site within which no habitation is permitted and is protected by security personal from state /central government agency/Central Industrial Security Force (CISF). The sterilized zone covers a distance from exclusion boundary at 1.6 km to 5 km radius around the plant site within which natural growth of population is permitted and unrestricted growth of population and development are controlled by state administration through administrative measures. The zone of 0 -16 km is termed as emergency planning zone (EPZ) and is divided in to 16 sectors marked as A to P in clockwise direction .

4.4.9 Frequency /Periodicity of Emergency Exercises

- Plant emergency Exercise – Quarterly
- Site emergency Exercise – Yearly

- Off-Site emergency Exercise – Two Yearly

4.4.10 Habitability of Control Rooms under Accident Conditions

The habitability of control rooms under accident conditions is ensured as indicated below:-

The habitability systems of the main control room (MCR) and supplementary control room (SCR) incorporate systems and equipment, protecting the operators from radioactive, toxic and harmful gases, aerosols and smoke, for creating safe normal habitability conditions permitting the operators to control the power unit and also to maintain it in a safe state even under emergency modes, including accidents involving the primary circuit loss of coolant.

4.4.10.1 Mode I – Normal Operating Conditions

In the normal mode, supply of outdoor air cleaned from dust is provided. Duration of mode I is not restricted. The air entering from outside is mixed with recirculation air, is cleaned on coarse and fine filters, cooled in the air cooler and by the fan along air ducts network is supplied to the room via fire-retarding ducts. The air from the rooms is withdrawn by exhaust fans and is supplied to the suction of the air conditioning systems and to plenum vent center. The difference between the amount of the plenum and recirculation air creates the required air head in the MCR rooms.

4.4.10.2 Mode II – Filtering/Ventilation Mode

The operation mode II is introduced automatically by indications of the radiation monitoring transducers on rise of radioactivity in the intake air more than ≥3·10-7 Gy/h, corresponding value of volume activity of iodine radionuclides 3·10 +2 Bq/m3. Mode II duration is not less than 10 hr - period required for bringing the unit to cool down state. The outdoor air flow rate is determined by the necessity to create a head in the MCR air-tight area, as well as providing of the personnel with the outdoor air meeting the sanitary (public health) standards (60 m3 per human being).

Outdoor air, now passes via filters, is cleaned, and supplied to suction of the air conditioning system. The air conditioning system continues functioning as in mode I.

4.4.10.3 Mode III – Mode of Total Isolation of the MCR Rooms

This mode is introduced during emergencies for a period permitting the external services of radiometric and chemical control to determine the content and concentration of toxic substances in the atmospheric air in the MCR conditioners air intake area.

Besides, mode III shall be introduced in case of the outdoor air contamination by toxic substances, carbon monoxide (in case of fire) and other harmful substances not retained by the absorbing filters. In mode III air-tight valves in the outdoor line close, the operator opens manually a valve on compressed air pipeline. On loss of power supply to the system the operator manually opens a valve on compressed air pipeline. The conditioning system continues operating for full recirculation.

To maintain the required pressure in the MCR rooms, compressed air from cylinders is used. The mode duration is assumed to be 4 h, without replenishment. With replenishment, the occupancy for indefinite period is possible. Storage location on the cylinders is decided considering this aspect.

By signals of external surveillance services the operator takes decision about the necessary mode of ventilation (I, II, III).

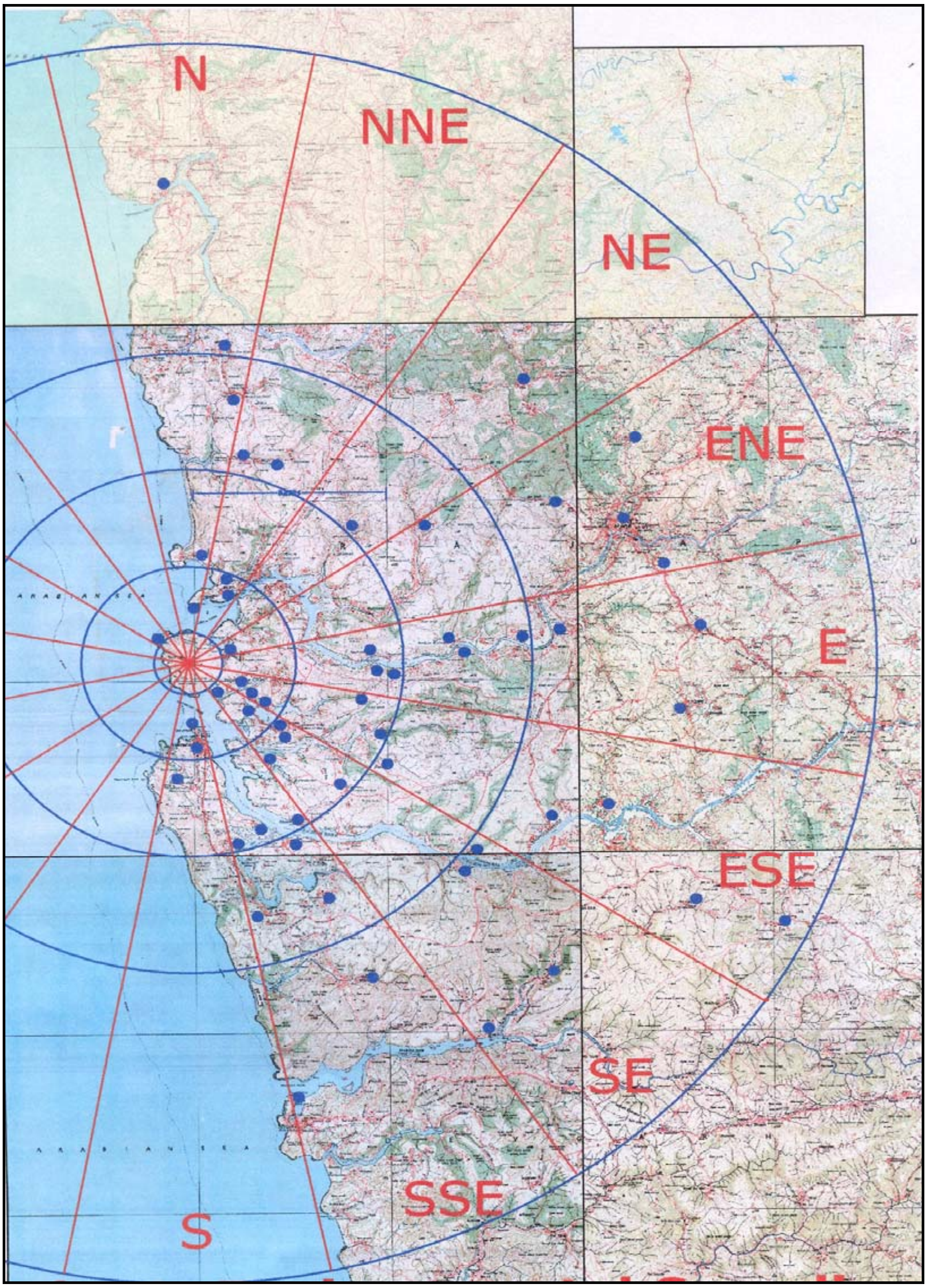


Fig. 4.11: Various Zones around Proposed Site of Jaitapur NPP

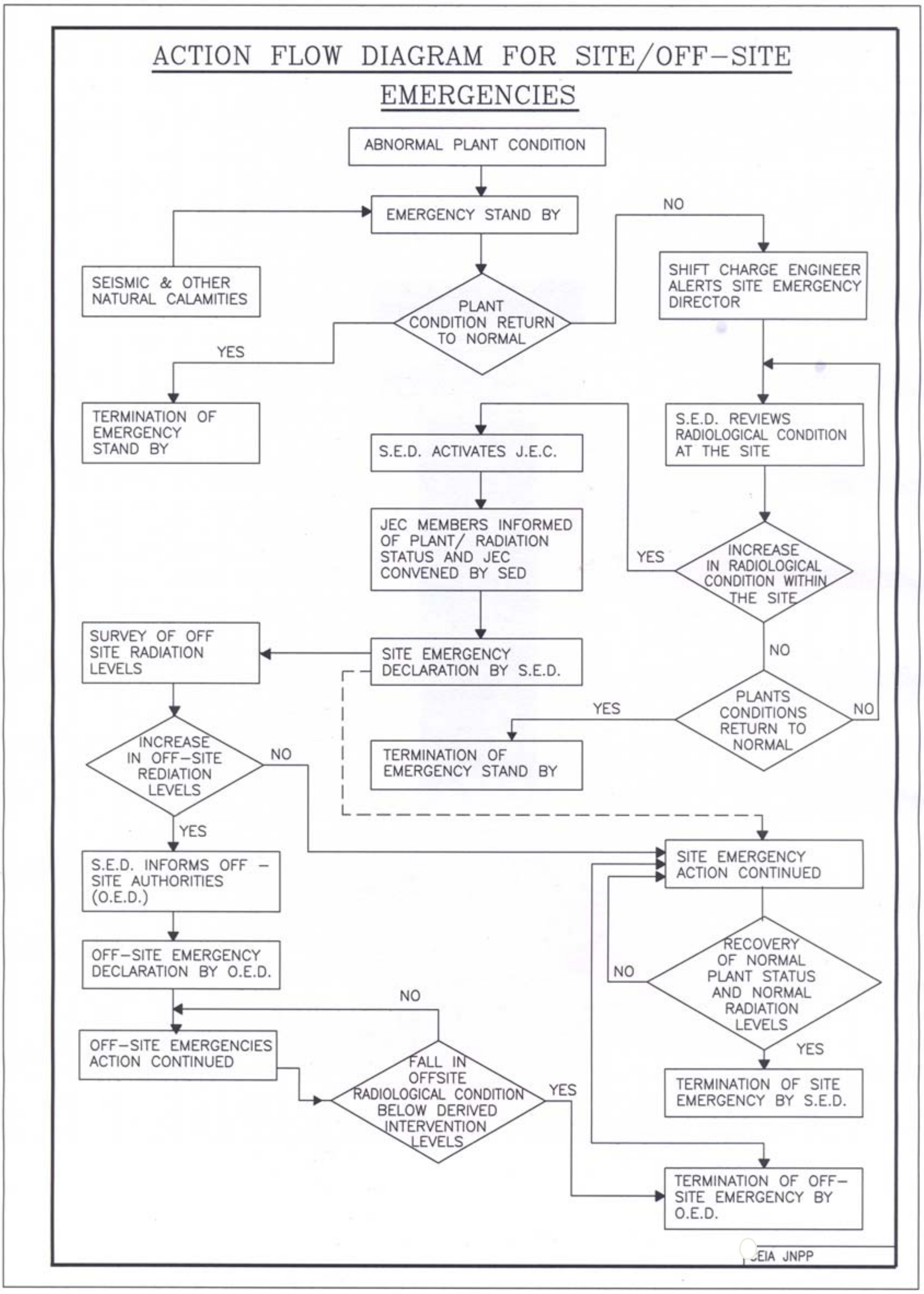


Fig. 4.12: Action Flow Diagram for Site / Off Site Emergencies

Table 4.9

Radiological Emergency and Risk to Public

Sr. No	Risk Categories	Affected Zone	Classification of Emergency/ agency for handling it	Risk to public
1	Normal operation	Nil	Nil	Nil
2	Operational deviations	Nil	Nil	Nil
3	Natural or any man made incidents/ accidents without release of radioactivity	Localized area inside the plant	Plant Emergency/ Plant management as per existing preparedness procedure	Nil
4	Natural or any man made incidents/ accidents which are DBA causing release of radioactivity	Hypothetical Incidents or accidents that causes impact within operating area or plant boundary	Plant Emergency/ Plant management as per existing preparedness procedure	Nil
5	Natural or any man made incidents/ accidents which are DBA causing release of radioactivity	Hypothetical Incidents or accidents that causes impact with in Plant boundary and within 1.6 km radius (Exclusion Zone)	On-Site Emergency/ Site/Plant management as per existing emergency preparedness procedure for on-site	Nil
6	Natural or any man made incidents/ accidents, which are beyond DBA causing release of radioactivity to environment.	Hypothetical Incidents or accidents that causes impact beyond 1.6 km radius (Exclusion Zone)	Off-Site Emergency/ off-Site emergency preparedness procedure/manual	Countermeasures are implemented to mitigate the consequences.

Section -III

The assessment and prediction of impacts for Coastal Regulation Zone (as per) due to the proposed nuclear power park at Jaitapur is enumerated below:

4.5 Environmental Impact Assessment for Coastal Regulation Zone (CRZ)

This proposed project is a coastal site project and thus falls under the purview of Coastal Regulation Zone (CRZ) Notification -1991 amended till October 2001. Accordingly, a detailed CRZ demarcation study has been carried out by National Institute of Ocean Technology (NIOT), Chennai. The report issued by NIOT, Chennai in November, 2007 is appended as **Annexure-VI**, **Volume-II**. The plot plan of all six units in proposed location with associated project facilities is superimposed on the CRZ zoning map for assessment of the environmental impact on CRZ due to the proposed project.

4. 5.1 Applicable Provisions of CRZ Notification to Projects Proposed by Department of Atomic Energy (DAE)

Costal Regulation Zone Notification dated 19th February, 1991 issued by the Ministry of Environment & Forests (MoEF) (under section 3 (1) and Section 3 (2) (v) of the Environment (Protection) Act, 1986 and Section 5(3)(d) of Environment (Protection) Rules, 1986) as amended till October 2001 declares the Coastal Stretches of seas, bays, estuaries, creeks, rivers and backwaters, which are influenced by tidal actions (on the land ward side) up to 500 m from the High Tide Line (HTL) and the intertidal land between the Low Tide Line (LTL) & HTL as Coastal Regulation Zone (CRZ). As per the provisions of Para `2` of MOEF notification vide S.O. 114 (E) in October 2001, the setting-up of new industries and expansion of existing industries and other activities are prohibited in CRZ, except for (a) those directly related to water front or directly need foreshore facilities and (b) Projects of Department of Atomic Energy (DAE).

However, under Para 3.0 for “Regulation of Permissible Activities”, of subject notification, the proposed Nuclear Power Park at Jaitapur under DAE, which also requires water front and foreshore facilities falls in CRZ and need to obtain

"Environmental Clearance" from MOEF as per amended notification of October 2001 on CRZ from MOEF.

The subject CRZ Notification defines HTL as the line on the land up to which the highest water line reaches during the spring tide. The MoEF guidelines stipulate that HTL / LTL be identified based on geomorphologic signatures in the field / satellite imageries / aerial photographs.

4. 5.2 Salient Features of the Project Site

The Jaitapur Nuclear Power Park (JNPP) will be located in the area between Rajapur creek and Vijaydurg creek, about 40 km south of Ratnagiri, on the West Coast. At one corner of the site in the north - west direction, Waghapur point lighthouse of Rajapur Bay is situated. The nearest village to the site is Madban

The Latitude and Longitude of the site are as follows:

Latitude : 16^{o} 34' 38" N - 16^{o} 36' 29" N

Longitude : 73^{o} 19' 02" E - 73^{o} 20' 48" E

A land measuring 692.301 ha adjoining the sea is available and being acquired for locating a Nuclear Power Park of 10,000 MWe capacity (NPPs of 6 x 1650 MWe or 10 x 1000 MWe PWRs).

Most of the site area is barren with laterite rocks without any vegetation and human activities. As per the baseline survey of land and marine area of proposed NPP carried out by NEERI, Nagpur and an exclusive report on "The Baseline Marine Ecological Assessment Study of Sea Around Proposed NPP", by College of Fisheries, Ratnagiri (The study report is appended as **Annexure-VIII** in **Volume-II**), the report has concluded that there are no suitable sites for roosting or breeding of the birds and marine species like tortoise etc. exists in the coastal zone around the project site. The intertidal area varies from 0 to 2.8 m in width and is rocky, therefore, no significant beach fauna and flora are present. The small patches of mangrove vegetation are at about 5 km north from the proposed project site. Fishing activities, salt pans etc are not being carried out in the CRZ area of the project site.

The elevation of the site varies from RL + 20 m to RL + 29 m with an average elevation of about RL + 24.5 m above the mean sea level. The safe elevation for west coast is 3.0 m. The final designed safe elevation of the project site would be decided considering the flood, tsunami, etc due to sea waves. Residential complex is also proposed at a distance of about 5 km in South East direction from the proposed site of nuclear power plant, and does not fall under CRZ.

4. 5.3 HTL / LTL Demarcation of Jaitapur Coast

High and Low Tide Line demarcation off Waghapur Head land for the proposed JNPP was carried out by National Institute of Ocean Technology (NIOT), Chennai.

The High tide level at the survey site was taken to be at +1.4 m (w. r. t mean sea level). The chart datum which is equivalent to Low tide line is at –1.4 m from MSL. These relations are derived from the tidal characteristics published on Naval Hydrographic Chart (NHO 213).

The MSL reference was recovered from permanent Bench Marks situated at Vijayadurg and Musakazi near the survey site. The tidal data from two tide gauges installed at Musakazi and Vijayadurg port were used for bathymetry reduction as well as confirmation of tidal characteristics. RTK-GPS reference station was set up along with radio telemetry and the field measurements were carried out with respect to the position and level of this Reference station.

The vertical control was tied to a permanent bench mark established by Survey of India. The survey consisted of spot leveling and positioning by moving the rover unit in profiles for HTL and bathymetry for LTL. The topographic survey was supplemented by the data from Survey of India. Based on combined data of topography and bathymetry, a digital terrain model was prepared and on which the High Tide Line was delineated at a level of +1.4m and Low Tide line at -1.4m from MSL.

The cadastral map issued by local revenue authorities has been superimposed on the HTL demarcation. The scaling and orientation of cadastral map were adjusted to match with the HTL for chart purposes.

The HTL/LTL demarcation superimposed on the revenue map of JNPP Site is presented as in **Fig. 5** of **Summary EIA** of this report in WGS-84 UTM coordinates.

4.5.4 Project Facilities Located in CRZ

The lay-out of 6 X 1650 MWe units indicating all the buildings, structures and other facilities of the project superimposed on HTL demarcation is presented in **Fig. 6** & **Fig. 7** of the **Summary EIA** of this report. From the study of the **Fig. 6** & **Fig. 7**, it is inferred that the following essential main plant buildings will be located in CRZ.

- i Reactor Buildings
- ii Safeguard Buildings
- iii Fuel Buildings
- iv Nuclear Auxiliary Buildings
- v Diesel Buildings
- vi Radioactive Waste Processing Buildings
- vii Electrical Buildings
- viii Turbine Buildings
- ix Pump House Buildings
- x Health Physics Buildings
- xi DM Water Plant
- xii Desalination Plant.
- xiii Fire Fighting Pumping Stations
- xiv Oil and Grease Storage
- xv Plant service Workshop/Ware-house
- xvi Interim storage for Solid Rad-Waste
- xvii Technical Services Building.

It is mentioned that some of the above mentioned buildings / facilities are common for all the units. These buildings are required to be constructed, on sea shore because of requirements of foreshore / water front facilities as well as in view of economic viability of the project. The total covered area for all the above mentioned essential buildings will be 1.5 km^2 (3 km x 0.5 km) for proposed plot plan for 6 units of 1650 MW each.

4. 5.5 Assessment of Impact on CRZ

4. 5.5.1 Impact on Coastal Line

The Jaitapur Nuclear Power Park (JNPP) requires water front and foreshore facilities for drawing and discharging condenser cooling sea water. Accordingly, the segment of coastal line of project site around 3 km length is required for constructing the intake water structures and associated break wall structures. In addition, the project will also require the construction of under sea bed condenser cooling water discharge tunnels of varying lengths from 1.5 km to 2.5 km. Therefore, the natural coastal area will have some of project structures. As the existing coastal line is elevated and rocky, it functions as a natural barrier to the ocean currents and waves. However, the proposed break water wall will also act as barrier to the sea waves and will not affect the natural function of the coastal line.

4. 5.5.2 Effect of Excavation of Intake Channel, Construction of RoRo Jetty and Breakwater on Sediment Transport

Detailed studies for tidal hydrodynamics in the region of Jaitapur are carried out by CWPRS, Pune and communicated vide their letter no. MMC/PROJ/2009 dated 17/4/2009 (**Annexure – V(a)**, **Volume –II**). The analysis of prototype data indicated that at Jaitapur mean spring and neap tidal ranges are of the order of 2.0 m and 1.0 m respectively. The current magnitude upto 0.4 m was observed in March / April, while it was up to 0.3 m/s in January/ February. The current flows were predominantly parallel to the shoreline with reversal in direction taking place depending on the phase of the tide. The monthly ocean circulation pattern indicated that near Jaitapur coast, the sea currents are northward during November- January and are southward during March – September. During the months of February and October, the currents are in transition.

For the proposed project, a breakwater of length of about 2300 m is proposed which is aligned with the configuration of the Jaitapur headland with opening towards north. All the six intakes are proposed to be installed in the channel created by the breakwater. The velocity in the channel is of the order of 0.5 m/s which is non scouring, non silting velocity. The RoRo jetty is proposed to be developed in the sheltered area of the breakwater and would be mounted on piles so that it would offer least resistance to the flow in the channel.

As regards effect of the proposed development on the sediment transport, no major siltation is expected in the intake channel since velocities are maintained at non scouring, non silting velocity. Some realignment of flow is expected at the tip of the breakwater and along the breakwater. However, since the breakwater layout is generally to the parallel to the configuration of the headland, no major change is siltation pattern is expected.

The littoral drift in the Jaitapur region is also low, which is of the order of 100,000 m^3/year with general direction towards North. Since the breakwater wall for the proposed project is almost parallel to the configuration of the headland and channel opening is towards North, the sediment transport in the region is expected to be minimum.

4. 5.5.3 Disposal of excavated material from main Plant, Intake Channel and Hot Water Discharge Tunnels

It is estimated that approximately around 11 million m^3 of excavated material will be generated from the main plant, intake structure, and outfall tunnel. It is planned to utilize the same in construction of breakwater, plant construction and other areas depending upon the quality of the excavated material. If there is any clay material / silt etc. in the excavated material, the same would be dumped in the sea beyond 20 m depth contour, sufficiently away from the outfall locations. It is observed that the sea currents off Jaitapur are generally parallel to the coastline throughout the year. The currents are towards north during November-January and are towards South during March-September. Therefore, the dumped material is expected to be transported in the deep sea with the sea currents and not move to the coastline. The dredged spoil would be dumped in the deep sea over a large area to avoid formation of heaps, so that effect of dumping of excavated material on the environment would be minimum.

4.5.5.4 Impact on Inter-tidal Region

The Jaitapur coastal area being rocky and elevated, the intertidal region is very narrow varying from 0 to 2.8 m width with mostly rocky beach. This intertidal region is poor in marine biodiversity of invertebrates, sea weeds etc. Therefore, the conversion of intertidal area into constructed area to locate the various facilities of the project in the small stretch will not affect the local marine ecosystem.

4. 5.5.5 Impact on Coastal Zone beyond HTL

The National institute of Ocean Technology (NIOT), Chennai, while carrying out the CRZ demarcation studies and also Department of Environment, State Government of Maharashtra, while granting NOC under CRZ -1991 Notification have classified the coastal zone around JNPP site as CRZ-III, which is undeveloped without any sensitive zones. Presently, this stretch of land with average elevation of RL +24.5 above the Mean Sea Level is rocky and barren without any habitation, vegetation or roosting and breeding sites of the birds and other species. It is also mentioned that the above area is not being used for salt pans and by the fishermen for any associated land based activities.

Therefore, conversion of this stretch of land for the construction of the essential facilities will not have any significant adverse impact on flora, fauna and human activities.

4.5.5.6 Impact on Sensitive Ecosystem

There is no sensitive eco-system in the intertidal area and 500 m coastal zone beyond HTL and also this area is not included in any national park or sanctuary. Therefore, the proposed project activity will not affect any sensitive ecosystem. It has been observed that a small patch of mangroves is present along the Jaitapur Creek at a distance of 5 km on the landward side in the northern direction from the proposed project site. It will not in any way be affected by the proposed project.

A brief description of the impacts, mitigation measures and environmental management plan for Jaitapur Nuclear Power Plant is given in **Table 5 and 6** in **Summary EIA**.

Section - IV

4.6 Assessment of Irreversible and Irretrievable Impacts and Significant Impacts

The proposed nuclear power project is environmentally friendly and all the irreversible/irretrievable/significant impacts are positive and leads to the betterments of environmental components including the socioeconomic component as described below.

Sr. No.	Component	Impact	Remark
A.	**Irreversible & Irretrievable Impacts**		
1.	Coastal Regulation Zone	Positive Impact	The rocky and barren land will be converted into beautiful landscape with beautiful buildings, parks and green belts, as well as protective function of sea cost from sea waves, tsunami and flood will be maintained by safe grade elevation of project site. The terrestrial biodiversity will be improved.
B.	**Significant Impacts**		
2.	Mangrove Vegetation	Positive impact due to proposed protection and conservation (Significance of 10 points)	The criteria for impact on mangrove vegetation on 10 point scale: 0 : No protection & conservation 5 : Only Protection of mangroves 10 : Protection & conservation of mangroves
3.	Socio-economic Aspect	Positive impact (highly significant) Change in QoL(c) from 0.50 to 0.54 before and after implementation of Social Welfare measures as given in EMP	Criteria : Change in QoL(c) before and after EMP i.e. application socioeconomic welfare measures No change : insignificant Change of 1 point : Less significant Change of 2 points : Medium significant Change equal to or > 3 : Highly significant

Chapter 5

Analysis of Alternatives (Technology & Site)

The Department of Atomic Energy (DAE) has an ongoing programme for development of Nuclear Power by pursuing different technologies. Accordingly, three stage programme for generation of nuclear power has been adopted.

The First Stage program involves utilization of available resource of natural Uranium in the country for generation of nuclear power by Pressurized Heavy Water Reactor (PHWR) technology.

The Second Stage program involves Fast Breeder Reactor (FBR) technology wherein plutonium is utilized, which is obtained by reprocessing spent fuel from PHWR units from first stage and at the same time using Thorium as blankets in these type of reactors, which will be converted into uranium.

The Third Stage involves use of uranium obtained from second stage and later on from third stage itself as fuel and thorium as blanket (which is available in abundance in India) and will be converted into uranium for long term energy generation.

In order to meet the growing demand of electricity in the country, Government of India has decided to enhance the share of nuclear power in overall electricity generation of the country. In order to meet the gap between supply and demand, it has been planned to generate nuclear power by importing reactors of LWR technology from various countries. A beginning has been made in this line by importing 2 x 1000 MWe VVER reactors of LWR technology from Russian

Federation, which are at the advanced stage of construction at Kudankulam, Tamil Nadu State. Due to International embargo, the above mission could not be further pursued in the past but as a sequel to the Nuclear Supplier Group (NSG) wavier during 2008 for having Civil Nuclear Trade by India with other countries, now doors are open to import reactors from various countries like Russian Federation, France, USA etc. These reactors of LWR technology have capacity varying from 1000 MWe to 1650 MWe depending on country of origin.

As such today our country has option for generating nuclear power by PHWR technology with capacity of 220 MWe to 700 MWe, FBR technology with capacity of 500 MWe and Advanced Heavy Water Reactor of 300 MWe capacity which is under launching stage by DAE. In addition, LWR technology of 1000 to 1650 MWe from various countries are available for establishing at various sites in India.

The sites for location of a Nuclear Power Plant is surveyed, selected and recommended by a Site Selection Committee constituted by Department of Atomic Energy, Government of India. The above Committee has members from various departments including one member from Ministry of Environment and Forest. The above committee has a standard procedure as prescribed by AERB for selection of the site covering all the studies, data, parameters which are necessary to meet the requirements to establish a nuclear power plant at a particular site. The nuclear power plants are located either on inland site like Rawatbhatta, Narora, Kakarpara, & Kaiga and the coastal sites like, Tarapur and Madras. The inland sites are assigned for reactor capacities varying from 220 MWe to 700 MWe. The above limit of the capacity of reactor is mainly due to requirement of cooling water as well as availability of infrastructure for transportation of heavy equipment of nuclear power plant. The coastal sites are assigned for reactor capacity of 1000 MWe and more because these units require huge amount of cooling water, which is available in abundance from the sea and availability of sea route for transportation of heavy equipment of nuclear power plant.

In line with the above program, Jaitapur Site has been identified as the site, which is having potential of setting up 6x1650 MWe LWRs. Jaitapur site has several favorable factors for locating 6 x 1650 MWe LWRs. Some of the major ones are summarized below and presented in details in **Section 1.2** of **Chapter -1**.

(a) Availability of sufficient cooling sea water.

(b) Foundation conditions are favorable with rocky strata with basaltic rock is available at a depth of 20 m from the ground.

(c) Power evacuation is feasible for around 10,000 MWe power from the site.

(d) No physical displacement of the members of the public

(e) Connectivity of the site via road and sea route.

Therefore, it is proposed to set up a Nuclear Power Park of 10000 MWe capacity at Jaitapur site with 6 units Light Water Reactors (LWRs) EPR of 1650 MWe at above site. Sea water requirements for cooling and desalination plant and fresh water requirements are worked out considering 1 unit of 1650 MWe.

Government of India has accorded in principal approval for taking up of pre project activities like land acquisition, obtaining environmental clearance & initiation of required studies, technical investigations required for setting up the proposed project at Jaitapur site.

The Light Water Reactors (LWRs) proposed to be set up at Jaitapur have all the features of the modern third generation technology, similar to western designs in respect of philosophy, features and construction. The design of plant is consistent with the standard international practices for safety systems. The emissions in water, air and land from proposed project will be within the limits prescribed by MPCB / AERB.

Chapter 6

Environmental Monitoring Program

Based on the baseline data collected on various environmental parameters and with the prediction of impacts, it is desirable to an environmental monitoring program to establish the trend of various environmental parameters and their compliance with the discharge limits specified by the regulating agencies. The details of the proposed environmental monitoring program is summarized below

6.1 Implementation & Monitoring

The various components of the environment needs to be monitored on regular basis as per the requirements of regulating agencies as well as for trend monitoring of the pollutants levels in various environmental matrices. At the project, an Environmental Management Apex Review Committee (EMARC) will be formed, which will review the effectiveness of environmental management system of the project / station in line with ISO-14001 & HSAS 18000 and monitor the effectiveness of Environmental Management Programs (EMP) implementation at the project.

EMARC will work out a schedule for monitoring and will meet regularly to review the effectiveness of the EMP implementation. The data collected on various EMP measures would be reviewed by this committee and if needed corrective action will be formulated for implementation. EMARC will form short term & long term plans for environmental issues, which require monitoring and effective implementation.

The environmental quality-monitoring program will be carried out in the impact zone with suitable sampling stations and frequency for radiological and non radiological parameters as identified in **Chapter-1**. Radiological and conventional parameters will be monitored by Environmental Survey Laboratory (ESL), which will be set up at the site, at least 18 months before operation of the plant units. For conventional pollutants the methods prescribed in "Standard Methods for Water and Wastewater Analysis" published by APHA (American Public Health Association), AWWA (American Water Works Association) & WPCF (Water Pollution Control Federation) will be adhered with. Some of these plans to be pursued by the JNNP are presented as follows:

6.2 Air Quality Monitoring

The following measures would be taken up for air quality monitoring on a regular basis:

(i) Installation of stack monitoring system for the sampling and monitoring of gaseous radioactive effluents on a continuous basis with alarm in the control room.

(ii) Monitoring of air activity levels in the air environment around the project as per the requirements of AERB.

(iii) Ambient air quality monitoring for conventional pollutants such as suspended particulate matter (SPM), sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2) as per the requirements of State Pollution Control Board.

(iv) Monitoring of micrometeorological data such as wind data, air temperature, relative humidity, rainfall and atmospheric dilution factor.

6.3 Water Quality Monitoring

Water quality is to be monitored for assessing potability as well as for its suitability for general uses. The following measures should be taken for water quality monitoring program:

(i) Online monitoring and sampling station for liquid effluent monitoring for radiological parameters.

(ii) Monitoring of Gross Beta gamma activity levels in lake water, aquatic organisms, weeds, silt, fish etc. as per AERB requirements

(iii) Monitoring of conventional pollutant levels at the liquid effluent discharge point as per the requirements of State Pollution Control Board.

6.4 Land Environment Monitoring

The following parameters proposed to be monitored for land environment

(i) Monitoring and review of the effectiveness & constant strengthening of green belt development in and around the project site and associated residential complex.
(ii) Monitoring of activity levels in dietary items, soil, & grass samples from the impact zone, as per AERB requirements
(iii) Monitoring of activity levels in goat thyroid from the impact zone
(iv) Measurements of external radiation exposure by TLDs.

6.5 Dose Assessment

The external, internal and total doses to the members of the public will be monitored and estimated at various distances from the project as per AERB's requirements.

6.6 Noise Environment Monitoring

Monitoring of noise levels should be undertaken as per the requirements of EP Act (1986) and AERB Factories Rules (1996). The noise monitoring results will be utilized to assess the efficacy of maintenance schedules of noise protection measures undertaken to reduce noise levels within the plant boundary.

6.7 House Keeping

The house keeping at the project site and residential complex should be effective and monitored on a regular basis.

6.8 Environmental Monitoring

The radiation exposures to occupational workers and the releases to the environment are controlled by the station and monitored by Health Physics Unit. The radioactivity levels in the public domain will be monitored by the Environmental

Survey Laboratory (ESL), BARC to ensure compliance with the regulatory requirements. It is added here that ESL at nuclear power project site should be set up two-three years before the start of the actual operation of the unit to generate pre-operational base line data for comparison as per AERB Safety Guide No. AERB/SG/O-9.

6.9 Staff Requirement for Environment Management

Considering the importance of the pollution control and environmental protection, a set of personnel shall be identified from Construction, Technical, Operations, Maintenance, Health Physics, Industrial Safety, Waste Management, Human Resource and Contract & Material Management Wings of the Project and Station Organizations who shall also work full time for implementation of various components of EMP such as the maintenance and operation of pollution control systems, monitoring of pollutants including radioactivity and development of green belt etc. Minimum number of personnel required for the project to meet the responsibilities associated with the implementation of EMP shall be as follows:

Environmental Survey Officer	:	1
Officer In Charge (Pollution Control) - Radiation Safety - Industrial Safety	:	2
Lab Chemist	:	2
Lab Assistant	:	2
Horticultural Adviser	:	1
(Work force may be drawn from casual labour for cleaning and watering of green belt, cleaning of storm water and other plant drains, housekeeping etc.		

The posts / titles given above are generic in nature. The organization may designate them differently to suit its convenience, so long as the functional responsibilities are fully met with.

In addition to this a separate Environmental Management Apex Review Committee (EMARC) will be organized comprising senior officers to ensure implementation of recommendations as per the EMP.

6.10 Operation and Maintenance of Pollution Control System

Normally persons engaged in production are also entrusted with operation and maintenance of pollution control systems. This may result in neglect of these systems as priority is given to production equipment. In view of this and the requirement of ensuring emission and ambient air and water standards, an officer of the plant shall be made responsible for the effective functioning of all pollution control systems. He will report to the Head of the Maintenance Department. Whenever required, he will draw crew from the main plant maintenance team for maintenance of pollution control system.

Since waste management is taken care by the fully dedicated Central Waste Management Facility, the requirements for effective treatment of radioactive waste and monitoring will be implemented as per AERB guidelines.

6.11 Monitoring of Pollution

Manpower will be provided for monitoring of pollutants. This group will directly report to Plant Management. It will also be responsible for implementation of measures suggested in EMP and all other environmental aspects.

As in the case of operation and maintenance, a dedicated team of health physics officials will be available to take care to monitor constantly radiation levels within the plant boundary. Likewise, Environment Survey Lab will meet the monitoring requirements in the public domain.

6.12 Environmental Management Apex Review Committee

An Environmental Management Apex Review Committee (EMARC) shall be constituted to review, assess and monitor the progress of Environment Management Plan implementation. Chief Construction Engineer / Chief Superintendent / Technical Services Superintendent of the Project / Station will head this committee. If necessary, the committee may invite experts from the plant or from outside. This group will meet once in a six months and monitor the progress made with respect to Environment Management Plan implementation and initiate necessary measures as and when required.

6.13 Budgetary Provisions

The budgetary provisions towards environmental monitoring program for the proposed project will be maintained. The details of the same are provided in the **Table 10.4** of **Chapter-10**.

6.14 Submission of Monitoring Reports to MoEF

As per the requirements, the status of environmental clearance stipulation implementation will be submitted to MoEF in hard and soft copy on 1st December and 1st June of every calendar year. These reports will be put up on MoEF web site as per their procedure and will be updated every six months. The conventional pollutants and radioactivity levels will be monitored on monthly basis and reports will be submitted to SPCB and to AERB respectively, as per the requirements.

Chapter 7

Additional Studies

In Addition, to the main EIA study, following additional special studies have been carried out by independent institutes/agencies, organized by NPCIL as well as NEERI for generation of important baseline data / specific information required for the subject EIA study. The details of the same are presented as follows:

7.1 Public Consultation

NPCIL is in the process of preparation of the required documents for Public Hearing in line with MoEF Notification. The Public Hearing will be organized by the State Pollution Control Board (SPCB) after receipt of application from NPCIL. The details of the proceedings of the public hearing will be incorporated in this section as an annexure in due course of time.

7.2 Risk Assessment

The risk assessment is an important component for Nuclear Power Project. Therefore, the subject is dealt in detail as presented in **Section –II-4.4** of **Chapter - 4** of this report.

7.3 Social Impact Assessment and R & R Action Plan

NPCIL had submitted a request to the office of the District Collector, Ratnagiri for acquisition of land admeasuring approximately 975 hectares in October, 2005, which includes land for site as well as for residential complex. After issue of various required Gazette Notifications under the Land Acquisition Act of Maharashtra State and joint survey of the proposed land, finally total land of 938.026 hectares with a break up of 692.311 hectares from Madban & Warilpada for Project Site and 245.715 hectares from the village Mithgavane, Karel & Niveli for residential complex is being acquired.

Further, in accordance with the decision taken initially with the State Government, NPCIL has signed a MOU with the Principal Secretary, R&R Department, Government of Maharashtra with regard to R&R plan for Project Affected Families (PAFs) which provides for preparation of joint R&R plan based on the baseline socio-economic survey by an independent agency YASHADA appointed by the State Government. R&R plan has been prepared, taking into account the data from interim proposal from YASHADA, Pune.

7.3.1 Rehabilitation and Resettlement Plan (R&R Plan) for PAFs

In addition to the compensation for acquired property, NPCIL proposes following Interim R&R Package for the Project Affected Families (PAFs) of JNPP in line with the best of the provisions of National Rehabilitation & Resettlement Policy 2007 vis-a-vis Maharashtra Project Affected Persons Rehabilitation act 1999 (Amended till date).

7.3.1.1 One time Cash Assistance

One time Cash Assistance shall be given in line with Section 3 (iii) of Maharastra GR No RPA-006/PK(4)/ R-1Dtd 17/04/2006 and as per Section 7.14 of National R&R Policy-2007.

7.3.1.2 Subsistence Allowance

Subsistence allowance is proposed to be given to PAFs for a period of one year from the date of possession of land as per Section 7.16 of National R&R Policy 2007.

7.3.1.3 Pension for Life to the Vulnerable Affected Persons

NPCIL shall, at its cost, arrange for annuity policies that will pay pension for life to the vulnerable affected persons as per Section 6.4(v) of National Rehabilitation & Resettlement Policy 2007 at a minimum amount of Rs. Five Hundred per month. The number of such vulnerable PAFs will have to be ascertained through the socio-economic survey by YASHADA.

7.3.1.4 Assistance for Employment, Self-employment and Labour

The R&R act of Maharashtra state and National R&R Policy 2007 has following Prevision for direct employment opportunities for PAFs.

i. As per the provisions of Section 4 of the GR No.RPA-2006/PK(4)/R-1 dated 17-04-2006 under Maharashtra RR Act 1999, each PAF who falls in the category of landless farmer, i.e. whose 100% land has been acquired for the project shall be provided certificate to this extent by SLAO, Ratnagiri to make him eligible to get a job against 5% quota available under State Government throughout the Maharashtra State for such people.

ii. As per the provisions of Section 7.13 .1 (a), the acquiring body shall give preference to the affected families – at least one person per nuclear family – in providing employment in the project, subject to the availability of vacancies and suitability of the affected person for the employment.

NPCIL proposes to provide direct employment opportunities as per National R&R Policy 2007 adhering to the guidelines of Government of India for the recruitment of the people to be employed in the particular project in various categories. The brief details of job opportunities are given below:

7.3.1.4.1 Direct Employment Opportunities with NPCIL

Preference will be given by NPCIL to one person per nuclear family of PAFs in providing employment in the project in categories as per details given below, subject to the availability of vacancies and the suitability of person for the employment.

7.3.1.4.2 Employment Opportunities with Contractors

A large Number of Contract labours would be required during, construction. This includes skilled, semi skilled and unskilled workers. Suitable provisions are proposed to be made in all contracts to the effect that the PAFs shall be given, preference in jobs as per their suitability and skill under the respective contract. Opportunities available may be as under.

7.3.1.4.3 Assistance in Training and Skill Development

As per the provisions of National R&R Policy 2007 and State R&R Act, NPCIL proposes to provide assistance, sponsoring, training for skill development to the wards of PAFs as well as to other meritorious students in the area around Jaitapur site for availing various job opportunities. In brief, the following are proposed:

(a) **Sponsoring Program:**

(i) NPCIL proposes to sponsor around 250 Nos. of meritorious students on SSC level with preference to PAFs for full time ITI course in different trades to develop such individual for employment. Such candidates will be given preference in the job at JNPP subject to their suitability and qualifying recruitment process.

(ii) NPCIL also proposes to sponsor about 10 Nos. of meritorious students from SSC level for full time Diploma course to develop them to acquire employment.

(b) **Scholarship Scheme:**

NPCIL also proposes to give scholarship to meritorious students (belonging to PAF category) during study at SSC level and higher courses.

(c) **Opportunities for Self Employment:**

NPCIL, as a policy, provides opportunities to PAFs for self employment during construction, operation and maintenance phase of the Plant. This also meets the provisions of National and State R&R Policy mentioned above. The brief details are given below:

(i) **Award of Small Value Contracts to "Registered local Societies":** NPCIL promotes formulation of Registered Societies consisting of members from local including Project affected families. These Societies are proposed to be given small value contracts for auxiliary services such as Housekeeping, Gardening, transport service etc. With the provisions to deploy as much Project affected persons in the project as possible. It is mentioned that as on date, two such Societies from the area around Jaitapur have already been registered.

These societies have been awarded the various contracts like: (i) contract for Housekeeping to maintain the Liaison Office-cum-transit Guest House of JNPP at Ratnagiri,

(ii) contract to meet transport service requirement of the Liaison Office at Ratnagiri and (iii) contract for providing fabricated wooden boxes for storage of bore-hole logs at the site.

(ii) **Allotment of shops in Residential Complex of JNPP:** NPCIL also propose to provide allotment of shops in Shopping Centre of Residential Complex at JNPP like Milk Vending, Barbershop, Washer man shop, Vegetable shops, Communication centre, Chemist shop etc. through Registered Societies.

(iii) **Other indirect business opportunities:** During the construction phase of NPP, various contractors will be executing works at Jaitapur site. They will be required to deploy contract labour in different categories depending on the requirement of skill etc. The strength of the percentage of contract labours will gradually increase from the beginning and at peak the number may increase to 5000 to 6000. All these labourers will be staying in the labour camp to be established inside the property boundary of JNPP site. Each of such family will be spending a minimum of Rs.1500 to 2000 per month to meet their day to day needs on grocery, milk, vegetable and other such items. In many cases, these needs have to be met locally and as such, the average expenditure per month on such account will be approximately Rs.1 Crore. Therefore, this will provide ample business opportunities to the local people around Jaitapur site.

7.4 Additional Studies for JNPP

In Addition, following special studies have been carried out by independent institutes/agencies, organized by NPCIL as well as NEERI for generation of important baseline data / specific information required for the subject EIA study. The details of these studies are presented in **Volume –II** of **EIA report** for JNPP.

(i) **2D Mathematical Model Studies for Thermal Dispersion of Condenser Cooling Seawater Discharges from Proposed Nuclear Power Project at Jaitapur, Ratnagiri, Dist. Maharashtra,** by CWPRS, Pune (NPCIL)

(ii) **HTL / LTL and CRZ Demarcation off Jaitapur Maharashtra Coast** by NIOT, Chennai (NPCIL)

(iii) **Status of Biodiversity in the Area of 25 km around the Project Site** by College of Forestry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri, Maharashtra (NEERI)

(iv) **Baseline Marine Ecological Assessment of Sea around proposed Jaitapur Nuclear Power Project near village Madban District, Ratnagiri (Maharashtra)** by College of Fisheries, Ratnagiri (NEERI)

(v) **Pre–operational Baseline Radiological Survey in the Area of 30 km around the Project Site** by HPD, BARC, in the year 2007 (NPCIL)

Chapter 8

Project Benefits

8.0 Economical Benefits of Nuclear Power

The important factors affecting the operating economics of power generating technologies are capital cost, debt equity pattern, and interest during construction, discount rate and fuel choice. The analysis of economics of the technologies as on date reveals that nuclear power, in the long term, is an economical option particularly at locations away from coal - mines. Considering that the component of fuel cost relative to coal is lower in case of nuclear power, accordingly, the escalation impact on tariff is also lower. Nuclear power in India has been established to be safe, reliable, clean & environmental friendly and economically compatible with other sources of power generation.

Comprehensive capabilities in the area of design, manufacture of equipment, construction, operation and maintenance have been established indigenously in nuclear power. Nuclear power in India has been established to be safe, reliable and is now producing electricity at comparable and economic rate. The current average tariff of NPCIL is Rs. 2.28 per kWh for all the operating plants. In fact, tariff of TAPS-1&2 (operating since the year 1969) is lower than Re 1.00 per kWh.

8.1 Levelised Lifetime Cost of Generation

Levelised lifetime costs have been evaluated at 2005-06 price level. The break-even discount rate for nuclear and coal-fired power, at which levelised costs are equal, works out to be 7.12% and the corresponding levelised cost Rs.1.78 per kWh. (Internal Report of Corporate Planning (CP), NPCIL-2005)

It is observed that levelised cost is very sensitive to discount rate. At 5% discount rate nuclear is cheaper than coal-fired and gas-fired power generation. However, at 10% discount rate coal-fired power becomes cheaper. The reason for nuclear power becoming costlier at higher discount rate is its high capital investment compared to that of coal-fired power plants and gas-fired power plants. However, the contribution of fuel cost is least in case of nuclear compared to others. This gives advantages to nuclear generation cost at current prices i.e. when effect of escalation is taken into account.

8.1.1 Effect of Distance from Pit-head on Cost of Generation

The coal price becomes almost double at distance of about 1200 km from pit-head. Thus the cost of power generation is very sensitive to distance from pit-head in case of coal-fired power. In case of nuclear, fuel transportation cost is insignificant when compared to that of coal.

The annual fuel requirement for each unit of 1650 MWe (LWR) power station is:

Nuclear	:	40 Tonnes
		(4 Trucks per annum of 10 Tonnes capacity each)
Thermal Coal	:	70,00,000 Tonnes
		(10 Trains per day of 2000 Tonnes capacity each)

The break-even discount rate for nuclear-vs-coal-fired power generation has been worked out at various distances from coal pit-head. The result shows that the nuclear power is favorable for regions located away from pit-head. About 90% coal reserves in India are located in Bihar, Jharkhand, Orissa, Madhya Pradesh and West Bengal. Thus the parts of the country, much away from coal mines, are economically better location for nuclear.

Further, for illustrative purpose, the costs of electricity generation from nuclear and coal-fired power at various locations from coal pit-head for the first eight years of operation are indicated in **Table 8.1**.

Table 8.1

Nuclear and Coal-Fired Power: Per Unit Cost in Paisa

Year of operation	Nuclear (Not affected by distance)	*Coal Plant*					
		Distance from pithead					
		500 Km	600 Km	700 Km	800 Km	900 Km	1000 Km
	Cost per unit (Paisa)						
1	260	234	243	251	260	268	276
2	266	241	250	259	268	277	286
3	273	249	258	268	277	286	295
4	281	257	267	276	286	296	305
5	288	265	275	286	296	306	316
6	270	254	264	275	286	297	307
7	279	263	274	285	297	308	319
8	288	272	284	296	308	320	332

It is observed that cost of coal-fired power generation is very sensitive to its location form pit-head. At very near to pit-head e.g. at about 500 km. Cost of nuclear generation is only marginally higher than the cost of coal-fired generation (about 1-25 paisa/kwh for about half the lifetime period). At a distance of about 700-800 km from pithead, nuclear is cheaper. Therefore, Jaitapur site, which is far away from the coal pit head and on the western coast is ideal site on economical considerations for locating nuclear power park.

The contribution of fuel cost is least in case of nuclear and this gives long term economic advantages to nuclear over others. It is to mention that the distance of the coal pit form Jaitapur site is around 1100 km, which makes the Jaitapur site cost competitive for establishing Nuclear Power Park.

8.2 Advantage in-terms of Energy Security

Energy security for the country is very important issue. After the oil price increase, France went in a big way for Nuclear Power. Energy security is one of the main reasons that Japan has also launched a large scale Nuclear Power Program. India has achieved maturity in design, manufacture, construction and safe operation of nuclear power plants as well as self sufficiency in the whole nuclear fuel cycle. The required fuel for JNPP will be imported as part of the overall package from the supplier of the nuclear power plants.

8.3 Advantage in terms of least Green House Gases (GHGs) Emissions

The comparison of nuclear power plant with that of coal based thermal power plant with respect to fuel use and emissions of conventional pollutants indicate that the nuclear power plants do not generate conventional pollutants as can be seen from the **Fig 8.1**. The radio- nuclides generated from nuclear power plants are handled, processed and disposed off carefully within the limits, which are specified by Atomic Energy Regulatory Board (AERB) of India.

Various control measures are foreseen to be brought to reduce the emissions of greenhouse gases, which are an unavoidable product of combustion of all fossil fuels. Nuclear power and renewable sources contribute very little to atmospheric carbon dioxide (one of the GHG) or sulfur and nitrogen oxide levels, as shown presented in the **Table 8.2** and comparative emissions and fuel requirements for a 1000 MWe plant are presented in **Fig. 8.1**.

Many of the Thermal Power Stations in developed as well as in developing countries are not meeting the current international control measures for emissions of green house gases, oxides of Nitrogen and Sulphur. Any measures for implementing these standards would increase the capital costs of the Thermal Power Plants, making Nuclear Power a clear favourite. Nuclear Power Plants have already adopted the prevailing international standards on radioactive emissions. The nuclear power can play an important role in reducing global emissions of greenhouse gases. Nuclear Power in the world is today avoiding some 8% additional CO_2 emissions that would occur if the electricity produced by nuclear power were to be produced by fossil fuels.

Table 8.2

Comparative CO_2 (GHG) Emissions from Various Energy Sources

Energy Sources	Gram CO_2/KWh	Ratio (over Nuclear
Small Hydro (Earth-filled dam type)	6	0.75
Nuclear	8	1
Geo-Thermal	11	1.38
Wind	20	2.50
Tidal	35	4.38
Solar	55	6.88
Gas	181	22.63
Oil	205	25.5
Coal	295	36.88

Source: Working Material for RCA Workshop on Economic and Financial Aspect of NPPs- MANILA (August 1997)

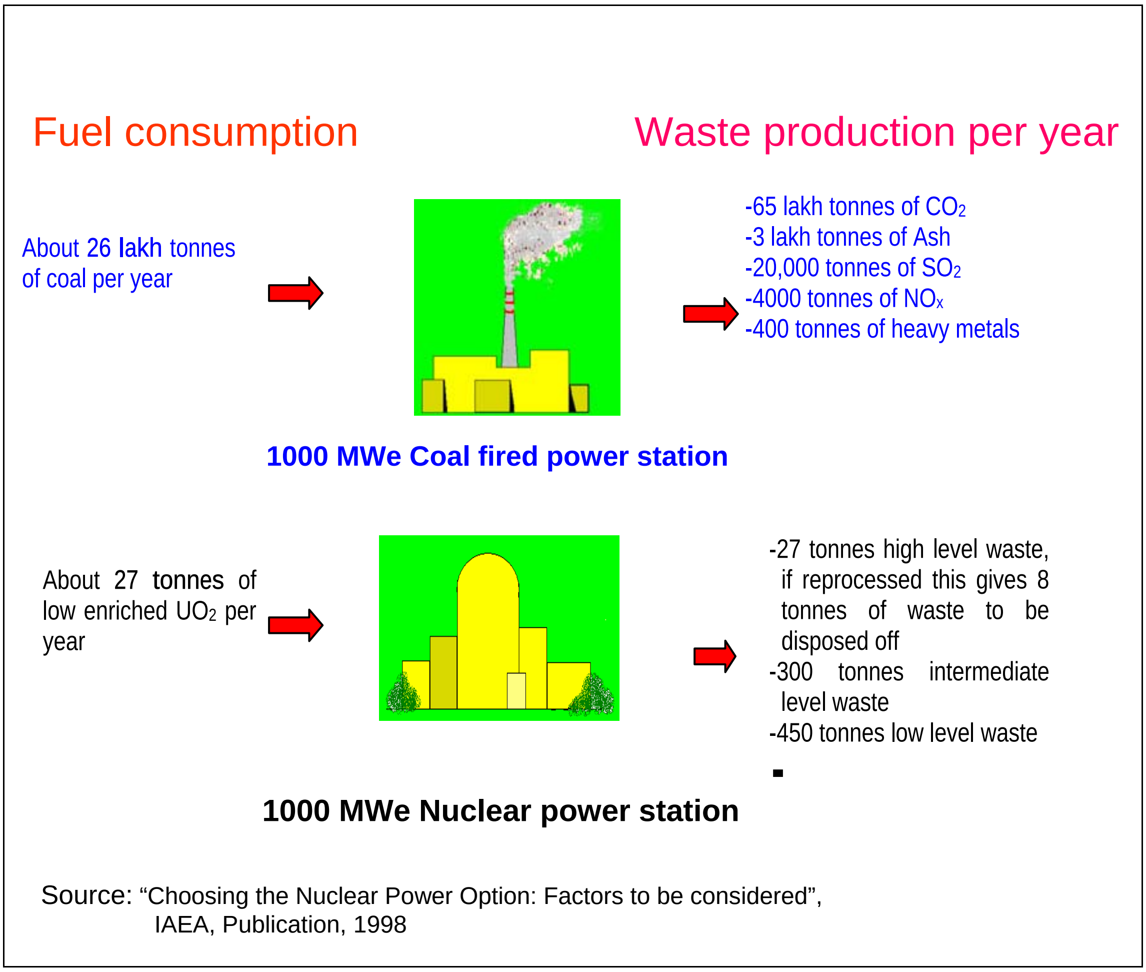


Fig. 8.1: Comparison of Waste Production from Nuclear and Thermal Power Stations

8.4 Environmental Sustainability of the Project

NPCIL's Nuclear Power Plants in India are amongst the safest plants from environmental and safety assessment point of view. The conventional pollutants viz. SO_2, NOx, SPM, RSPM are not emitted from the plants. Consequently, the environmental concerns such global warming, acid rain, green house effect, depletion of the ozone layer of the earth atmosphere are not associated with the JNPPs. Also with insignificant emission of conventional pollutants, JNPP will not at all affect the important monuments located nearby. However, with regards to minimization and mitigation of radiological risk, there are five distinct barriers between the radioactive material in the NPP and the environment to protect the public, flora and fauna and the environment, from radioactive releases. The fool-proof advanced technological systems would be adopted for segregating treating, processing and secured disposal of radioactive waste through air, liquid and solid waste routes as per AERB requirements.

8.5 Socio-Economic Development of the Region around JNPP

The establishment of Nuclear Power Park at Jaitapur for Power generation would provide electricity at a fairly competitive price and result in electrification of villages, development of irrigation facilities / drinking water supply, development of industries, overall development of area and consequent indirect and direct job opportunities which would finally result in improvement in the quality of life of people in the western region and especially in the area around the NPPs site.

The policy of NPCIL towards social welfare & community development aims at strengthening the bond between the project / station authorities and the local population in the vicinity of nuclear power plants. In line with this policy, NPCIL at the existing stations and projects has been carrying out number of community welfare activities in the following areas:

Education – Gyan Gangothri Yojana

Health– Arogya Sudha Yojana

Community Welfare

Some of the photographs depicting the above activities implemented by NPCIL at the existing NPPs Operating stations as well as projects are presented in the **Plate 3.10.4 - Plate 3.10.12** in **Chapter-3** of this report.

Accordingly NPCIL planned to implement above social and community welfare measures in area around the JNPP with the following action plan.

- NPCIL would contribute in implementing social welfare activities in collaboration with local Gram Panchayat, Block Development Office etc. for better development of area around JNPP.

- To minimize strain on existing infrastructure, adequate provision of basic amenities, viz. education, health, transport etc. would be made considering the needs of workforce and migrating population.

- Sanitation facilities in residential complex and labour colonies would be provided to ensure better hygiene and health

- Regular environmental awareness programs would be organised by NPCIL to impress upon the surrounding population about the beneficial impacts of the project and also about the measures being undertaken for environmental safety.

8.5.1 Socio Economic Benefits

Critically analyzing the baseline status of the socioeconomic profile and visualizing the scenario with the project, the impacts of the project would be varied nature. Prediction of qualitative impacts on socioeconomic environment is shown in **Table 4.6** in **Chapter 4** of this report. Expected change in subjective and cumulative quality of life (QoL) in the project region is presented in **Table 4.7** and **Table 4.8** respectively in **Chapter 4** of this report.

8.5.2 Other Tangible Benefits

- The proposed project would generate indirect employment opportunities as daily wage labors during construction, transportation activities, supply of raw materials, auxiliary and ancillary works etc.
- The project has favorable ranking by the people and is looked upon as a step for further development of the area

- Due to the project there would be an overall development of the area and job opportunities, which may improve the quality of life in the region.
- Proposed project would help to fulfill the gap between demand and supply of electricity within the country and particularly in the region
- The electricity generated in plant will result in electrification of villages, development of irrigation facilities, drinking water supply, development of industries etc
- Development in housing, education, medical, health, sanitation, power supply, electrification and transport in the study area

8.5.3 Direct Employment Opportunities with NPCIL

Preference will be given by NPCIL to one person per nuclear family of PAFs in providing employment in the project in categories as per details given below, subject to the availability of vacancies and the suitability of person for the employment.

8.5.4 Employment Opportunities with Contractors

A large Number of Contract labours would be required during, construction. This includes skilled, semi skilled and unskilled workers. Suitable provisions are proposed to be made in all contracts to the effect that the PAFs shall be given, preference in jobs as per their suitability and skill under the respective contract. Opportunities available may be as under.

8.5.5 Assistance in Training and Skill Development

NPCIL proposes to provide assistance, sponsoring, training for skill development to the wards of PAFs as well as to other meritorious students in the area around Jaitapur site for availing various job opportunities. In brief, the following are proposed:

8.5.6 Opportunities for Self Employment

NPCIL, as a policy, provides opportunities to PAFs for self employment during construction, operation and maintenance phase of the Plant. This also meets the provisions of National and State R&R Policy mentioned above. The brief details are given below:

8.5.6.1 Award of Small Value Contracts to "Registered Local Societies"

NPCIL promotes formulation of Registered Societies consisting of members from local including Project affected families. These Societies are proposed to be given small value contracts for auxiliary services such as Housekeeping, Gardening, transport service etc. with the provisions to deploy as much Project affected persons in the project as possible. It is mentioned that as on date, two such Societies from the area around Jaitapur have already been registered.

These societies have been awarded the various contracts like (i) contract for Housekeeping to maintain the Liaison Office-cum-transit Guest House of JNPP at Ratnagiri, (ii) contract to meet transport service requirement of the Liaison Office at Ratnagiri and (iii) contract for providing fabricated wooden boxes for storage of bore-hole logs at the site.

8.5.6.2 Allotment of Shops in Residential Complex of JNPP

NPCIL also propose to provide allotment of shops in Shopping Centre of Residential Complex at JNPP like Milk Vending, Barbershop, Washer man shop, Vegetable shops, Communication centre, Chemist shop etc. through Registered Societies.

8.5.6.3 Other Indirect Business Opportunities

During the construction phase of NPP, various contractors will be executing works at Jaitapur site. They will be required to deploy contract labour in different categories depending on the requirement of skill etc. The strength of the percentage of contract labours will gradually increase from the beginning and at peak the number may increase to 5000 to 6000. All these labourers will be staying in the labour camp to be established inside the property boundary of JNPP site. Each of such family will be spending a minimum of Rs.1500 to 2000 per month to meet their day to day needs on grocery, milk, vegetable and other such items. In many cases, these needs have to be met locally and as such, the average expenditure per month on such account will be approximately Rs.1 Crore. Therefore, this will provide ample business opportunities to the local people around Jaitapur site.

Chapter 9

Environmental Cost-Benefit Analysis

The establishment of a nuclear power project at any site in the country is approved by the Government of India based on number of considerations including environmental suitability of the site. Accordingly, Jaitapur site is approved in principle by Government of India. The site is barren and rocky and support only sparse vegetation / tree. Therefore, it will not involve loss of any significant number of trees from the site and hence no environmental loss will be there in terms of net productivity value. The cost of the project and expenditure on the implementation of the Environmental Management Plan (EMP) are presented in **Table 10.4** of **Chapter -10** of the report. Besides the tangible benefits, the project has got number of intangible benefits like no emissions of the green house gases, no adverse impact on environment, socio economic benefits to the local people and the region and enhancement of the energy security for the country. The details of the same are presented in **Sections 8.2** to **8.5** of **Chapter - 8** of this report. The establishment of 6x1650 MWe i.e. total 10,000 MWe electricity generation by JNPP at Jaitapur site, when operated at 90 % capacity factor will save annually around 2.91 million tonnes of CO_2, in comparison to coal thermal power plant, based on the input data given in **Table 8.2** of **Chapter - 8**.

Chapter 10

Environmental Management Plan

Based on the baseline data collected on various environmental parameters and with the prediction of impacts, an impact statement has been prepared. While preparing this statement, note was taken of the results for environmental surveys carried out by ESLs at the other operating units of NPCIL, which demonstrate that increase in background radioactivity levels due to operation of the nuclear power plant is insignificant (Details given in Para 4.3). The mean dose received by a hypothetical man at exclusion zone boundary of these plants is only a small fraction of the prescribed limit. The component-wise environmental impact statement is summarized below and tabulated in **Table 10.1** and **10.2**.

10.1 Air Environment

As far as conventional air pollutants are concerned viz. SPM, RPM, SO_2 and NOx, their concentrations in the ambient air at the proposed site were observed to be well within the prescribed limits. However, with the proposed construction activities of the project, concentrations of these air pollutants are expected to increase to some level in the impact zone. However, their concentration would not be crossing the prescribed limits for the following reasons.

(i) The small levels of emissions of the conventional pollutants will be mainly during construction phase mainly from operation of fossil fuelled construction machinery. The construction phase will be for about 5 years for any twin unit.

(ii) During the operation phase of the station, the operation of the main nuclear power plant does not release any conventional pollutants. However, the conventional pollutants emissions will take place from emergency power supply diesel generator, which will be operated, either for testing or for feeding power supply to safety related loads during short period of off-site power supply failure.

(iii) The existing reference values of the conventional pollutants are much below the prescribed limits; therefore, the construction/operation phase activities would not be contributing to the extent that values of these pollutants would cross the prescribed limits.

However, proper measurements of the conventional pollutants shall be done as per the guidelines of the regulating agencies.

During operation phase of the Jaitapur NPP, for radioactive gaseous emissions, effective treatment, control and review mechanism would be in place such that the limits for gaseous route specified by AERB would never be crossed. Moreover, ESL would regularly monitor the environmental doses to the members of public and report would be submitted to the regulating agencies.

10.2 Water Environment

The baseline data on water quality in the impact zone, for water sources such as surface water and ground water, indicate slight organic pollution of these resources due to anthropogenic activities of the surrounding population. Some of the well waters have been detected positive for faecal contamination due to absence of sanitation facilities and land disposal of domestic sewage practice at that village. Due to this, adverse impacts of low magnitude are imposed on groundwater sources and river waters. However, JNPP will have a proper treatment facility for domestic sewage and will monitor the quality of ground water at regular interval as per MPCB guidelines,

During construction phase of the Jaitapur NPP, waste materials, spillages of oils, paints, domestic waste from the workers colonies etc. may contribute to certain amount of water pollution. But these would be for a short duration. This requires an effective plan / measures during construction to protect the water resources from occurrence of adverse impacts, if any.

During the operational phase, the other source of impact to water bodies would be domestic sewage from plant & residential complex and heated effluent from the station. For the domestic effluents, a sewage treatment plant based on activated sludge process will be commissioned for both plant site as well as residential complex.

As far as condenser cooling water from the project is concerned, the proposed project would be adopting once through cooling system for condenser such that the resultant rise of sea water at the point of discharge will be less than 7^{o}C as per the exiting stipulation of MoEF (Thermal modeling by CWPRS, Pune). Therefore, thermal pollution due to discharge of condenser cooling water would not arise. Even heated effluent of small quantity from steam generator blow down system which may be unavoidable during the period when steam generator polishing system goes out of service, shall be mixed with other effluent in the effluent monitoring pond and before the discharge, all the parameters including temperature would be monitored and maintained as per the guidelines / requirements of MPCB/ MoEF (GOI).

The marine biodiversity study carried out by College of Fisheries, Ratnagiri and thermal impact study carried out by NEERI and by DAE-BRNS along with thermal dispersion studies of CWPRS, Pune indicate that the marine aquatic food chain organisms will not be affected by the predicted maximum temperature rise of around 5 ^{0}C will be confined to a limited area of 0.28 km^2, when all the six units are operating and ocean currents are in transient state, which is the most severe conditions throughout the year. At this range of temperature rise above ambient temperature of water, most of the organisms are either not affected or get benefit of stimulation of metabolic activity. Further, no sensitive marine species have been recorded on the coastal area near JNPP site, however, mangrove flora is present in the estuary far away from the project site and may not be affected by discharge of condenser cooling water.

During the operational phase of Jaitapur NPP, liquid radioactive effluents, and sewage effluents are expected to be generated. For radioactive effluents, there would be an effective storage, treatment / monitoring and review process for any discharges from the station. With this process in place, the liquid effluent releases would be much below the limits specified by AERB. Moreover, the activity levels in the water bodies would be independently monitored by ESL and reports would be submitted to the station / regulating agencies for trend monitoring and corrective action if any.

10.3 Land Environment

During construction phase of the proposed project at Jaitapur, an adverse impact of smaller level would be felt on land use pattern and topographical features of the area due to land clearing and enhanced labour activities.

During operation phase, the domestic solid waste would be treated by vermiculture composting; this would be utilized for green belt development and for enhancing the soil fertility.

The radioactive solid waste would have an effective treatment mechanisms backed by regular monitoring. Therefore, this would not have any significant impact on the land environment.

During operational phase, the releases of particulate matters would be almost zero and gaseous discharges through air route would be kept much below the permissible levels. There would be insignificant deposition on the soils. However, the radioactivity levels in different components of land environment such as soil, grass, vegetables, fruits, milk would be monitored for trend monitoring by ESL. Therefore, the impact on land due to air emissions would be insignificant in the impact Zone.

10.4 Biological Environment

The project site at Jaitapur and the surrounding area in Ratnagiri District has plain land with moist climate. The proposed nuclear power project area has barren fields with grassland and some scrub vegetation. The forests and fairly dense vegetation is only beyond 15 km radial distance in this area. There is no sensitive ecosystem like national park or sanctuary or biosphere reserve in or near about the project area. Therefore, the proposed NPP at Jaitapur may not adversely affect the existing green cover in the area, on the contrary, the plantations, which would be grown in the plant area, residential area as well as in the exclusion zone around the plant site will be helpful in increasing green cover in the area.

The mangrove wetland would be protected and promoted through plantation. This would have beneficial impact on marine fish, other fauna and planktons.

The temperature of condenser cooling water would be controlled so that temperature rise at discharge point would not be more than 7°C and would not affect the marine flora and fauna.

No conventional air pollutants would be released from the plant. However, domestic wastewater and solid waste would be treated and reused as irrigation water and manure respectively, thus would have positive impact on the green belt of the area.

10.5 Aesthetics

Aesthetic environment of the whole area is very good and it will not be affected adversely due to the proposed activity. Topographical features, however, will be affected during the construction phase for a short period of time of 5 yrs. However, during operation phase, water, air, land and aesthetics will show improvement. The landscape would become beautiful due to green belt, plantations and clean & smart buildings of Nuclear Power Plants.

The Vijaydurg fort, which is a place of tourism importance, is at a radial distance of 5-7 km away from the project site and would not be affected by the project activity.

10.6 Noise Environment

With the introduction of the Jaitapur NPP, like any mega project and its construction activities, the baseline noise levels will increase due to heavy earthmoving machineries, construction equipments and enhanced transportation activities. However, increase in ambient noise levels will be for the duration of the construction activities only. However, the employees and workers will be provided with noise protection devices such as ear muffs etc. to reduce the exposure to noise levels and also the construction site would be fenced properly, which will help in attenuating the noise levels reaching to public domain.

During operation phase of Jaitapur Nuclear Power Project, noise would be generated by equipments such as compressors, turbines, fans, pumps, air dryers, ventilators, DG sets etc. within the operating island. However, these equipments would be confined in the noise proof buildings, therefore, the baseline noise levels are not expected to increase due to introduction of the project. There may be occasional noise levels due to steam releases from SDVs for short duration.

However, the green belt in the exclusion zone of 1.6 km around the plant boundary would completely attenuate noise to background levels.

10.7 Socio-economic Environment

With the introduction of Jaitapur Project, an increase of around 10, 000 MWe of electricity for the Western region / country would be available. Thus, this would lead to cost-effective availability of electricity with little pollution load compared to any other power generating source. The introduction of the project would contribute to creation of job opportunity for local people, and improved education, transportation, medical facilities.

Also, the doses to the members of the public would be within the location based variation in the natural background radiation levels and will not have any adverse effect on their health status. Therefore, the project would have beneficial impact on the socio-economic component of the environment.

Based on the baseline environmental status of various environmental parameters and prediction of impacts with the introduction of the proposed Jaitapur Project, appropriate action plans have been formulated for minimizing the adverse impacts and enhancement of beneficial impacts. These have been presented in the form of an Environmental Management Plan under two separate phases i.e. during construction phase and operational phase. The various components of the same are summarized in **Table 10.2** and described below:

10.8 Plan of Safety in Design

The objective of plan of safety in design for the proposed project is protection of individuals, society and environment from undue radiation hazard. Accordingly, the design, construction and operation of project are aimed at achieving the following safety goals:

1. During routine operation, to minimize the radiation dose to plant personnel and to the members of public; so as not to exceed the dose limits specified by AERB.

2. To minimize the risk to public from release of radioactivity, if any, under abnormal and postulated accident conditions by incorporating

engineered safety features in the plant design with sufficient redundancy, diversity and meeting the requirements of AERB.

3. Incorporate emergency preparedness measures to deal with situations arising out of highly unlikely ‘beyond design basis accidents in line with AERB requirements.

4. To meet the Nuclear Security requirements as specified in AERB manual on Security.

10.8.1 Considerations of Natural Events in the Design

The design of the project will incorporate the requirements of seismicity and the consequences of flood on the safety of the proposed project. Accordingly, the design of the reactor and other structures are based on the requirements of earthquake design basis that are prescribed by the relevant Indian standards (IS-1893, Year 2002). Hence, all components, instruments and structures, will be qualified considering the requirements of Safe Shut down Earthquake (SSE) and Operating Basis Earthquake (OBE).

The basic requirement is the selection of suitable site with respect to seismicity and flood / tsunami disaster criteria. It has been observed that proposed site has been selected with reference to these and other factors as per the guidelines. The proposed site of NPP lies in Zone III as per the Seismic Map of India (IS – 2002). Based on the preliminary study made from the micro earthquake data available from “Koyna Bandhkam Authority”, it has emerged that there is no earthquake activity around Jaitapur site in a radius of 39 km. Thus, the site is suitable for nuclear power development activity from the seismicity considerations.

The safe grade elevation of +7.0 m with respect to Chart Datum has been recommended for proposed JNPP. This safe grade elevation has been estimated considering the highest astronomical tidal level of +3.3 m, 2.5 m of tsunami or the 1000 years Return Period Storm Surge of 2.7 m, maximum wave set-up of 0.5 m and the free-board of 0.5 m. The average site elevation is about 24.5 m above the mean sea level. Hence the site is considered to be safe from flooding / tsunami.

Table 10.1

Summary of Impacts, & Environmental Management Plan for Jaitapur Nuclear Power Project during Construction Phase

Phase of the Project	Sr. No.	Environmental Component	Impacts	Mitigation measures	Element of Environmental Management Plan
Construction Phase	1.1	Occupational health and safety	Hazards to workers	Occupational Safety and health measures	- Provision of proper occupational safety and health conditions -Provision of safety equipments -Regular medical check-up and treatment
	1.2	Air Environment	Only small levels of conventional pollutants for a period of 5 years, which will not cross the specified limits because of low values of background levels.	Maintenance of machinery, heavy vehicles and trucks	-Regular maintenance of the vehicles and equipment. -Regular monitoring of the levels of conventional pollutants as per MPCB requirements
	1.3	Water Environment	-Impact on aquatic system / ground water of small magnitude due to soil erosion & leaching. -Impact on aquatic system / ground water of small magnitude from construction workers colonies.	Proper sanitation and disposal of excavated soil and waste	- Stabilization of the excavated soil. - Provision of trenches around the stock pilings. - Provision of appropriate sanitary facilities for the construction workers. - Construction of oil and water separation facility.
.	1.4	Land Environment	Land pollution of small magnitude due to solid waste generation. Overburden and construction waste will also be produced	Management of solid waste and excavated soil & construction waste	- Effective house –keeping. -Effective collection & segregation of solid waste. -Composting of bio-degradable waste. -Disposal of non bio-degradable waste in secured land –fills. -Overburden will consists of rocky material and will be utilized for construction of breakwater wall, project building, and O.B. and construction waste will be used for land filling purpose

Phase of the Project	Sr. No.	Environmental Component	Impacts	Mitigation measures	Element of Environmental Management Plan
	1.5	Noise Environment	Higher Noise levels due to increased activities in a small zone.	- Isolation of project site - noise protection gadgets	- Project fence, green belt & exclusion zone will attenuate the noise levels considerably to reach to the public domain. - Employees and workers will be provided with ear muffs etc. for noise protection. - Rules & Regulations of Factories Act will be implemented.
	1.6	Socio-economic Environment	Beneficial effects out-weigh adverse effects on socio-economic environment.	- Job and employment to local people; - construction site to be fenced; - Social, cultural and infrastructural development	- Regular fumigation of the construction workers colonies. - Fencing of the construction site to check unauthorized entry. - Preference to local peoples in the job opportunities as per the norms.

Table 10.2

Summary of Impacts, & Environmental Management Plan for Jaitapur Nuclear Power Project during Operation Phase

Phase of the Project	Sr. No.	Environ-mental Component	Impact	Mitigation Measures	Element of Environmental Management Plan
Operation Phase.	2.1	Safety of Individual, society & Environment	Health Effects of Radiation	.Safety in plant design; Monitoring & compliance to radiological standards; Occupational safety,	-Safety in design as per AERB requirements. -Proper maintenance of exclusion zone and sterilized zone as per AERB requirements -Minimize the radiation doses as per specified limits of AERB -Adequate Engineered safety system with sufficient redundancy, diversity to deal with off –normal situations as per AERB requirements. -Hazard analysis and safety measures in place to reduce the undue risk to employees, members of public & environment as per AERB requirements -Regular monitoring of the radiological levels in different components in surrounding environment -Regular monitoring of personal radiation dose and regular health check-up of the workers - Rotation of places of duties - Occupational and safety training -EMP implementation and environmental monitoring programme to evaluate the effectiveness of environmental management system
	2.2	Radiological Pollution			Radiological Risk Assessment and Emergency Response System

Phase of the Project	Sr. No.	Environ-mental Component	Impact	Mitigation Measures	Element of Environmental Management Plan
	2.3	Air Environment	- Radioactive gaseous emissions of small magnitude. - No impact due to conventional pollutants.	Active gaseous waste processing; Compliance to standards; Monitoring-feedback-rectification system	-Effective program to control air emission at source. -Effective treatment to reduce the emission levels. -Provision of on line monitoring for taking appropriate measures. -Emissions much below the discharge limits of AERB -Regular maintenance of the vehicles -Regular monitoring of the levels of conventional pollutants as per MPCB requirements
	2.4	Water Environment	- Impact on aquatic system / ground water of small magnitude due to liquid effluent discharges. - Impact on marine aquatic system due to discharges of heated CCW.	Proper management of active and domestic wastewater; proper design of Condenser Cooling system and discharge channels for compliance to thermal discharge standards; Conservation of water	-Effective program to control liquid waste at source. -Effective collection & treatment of active liquid effluents. -Provision of on line monitoring for taking appropriate measures. -liquid effluent discharges much below the discharge limits of AERB. -Treatment of domestic waste and reuse of effluent for irrigation of plantation/green belt -Regular monitoring of the levels of conventional pollutants in liquid discharges as per MPCB requirements -Construction of oil and water separation facility. -Implementation of rain water harvesting measures. -Heated CCW would be maintained within 7 ^{0}C as per MOEF requirements -Proper rain water harvesting methods will be applied

Phase of the Project	Sr. No.	Environ-mental Component	Impact	Mitigation Measures	Element of Environmental Management Plan
	2.5	Land Environment	Land pollution of small magnitude due to solid waste. Generation.	Management of active and domestic solid waste; development of green belt	-Effective house keeping. -Effective collection & segregation of active solid waste. -Treatment & disposal of active solid waste as per AERB requirements -Composting of degradable solid waste. -Disposal of non-degradable solid waste in secured land fills. -Development of green belt around the plant and exclusion zone
	2.6	Biological Environment	Impact on terrestrial and marine flora and fauna	Discharges through air and water below stipulated levels; Conservation of mangroves	-Compliance to radiological standards for air and water -Treatment and disposal of active waste as per AERB requirements -Development of Green belt of diverse local trees and shrubs -Protection and conservation of mangrove patch on nearby sea shore -Control of eutrophication by treatment and reuse of wastewater -Regular monitoring of diversity and density of flora in green belt -Regular monitoring of radioactivity in biological samples collected from surrounding area
	2.7	Noise Environment	Noise levels due to plant activities.	Development of barriers to control noise in public domain; occupational safety measures	-Confinement of noise generating equipments. -Project fence, green belt & exclusion zone will attenuate the noise levels considerably to reach to the public domain. -Employees and workers will be provided with ear muffs etc. for noise protection. -Rules & Regulations of Factories Act will be implemented.

Phase of the Project	Sr. No.	Environ-mental Component	Impact	Mitigation Measures	Element of Environmental Management Plan
	2.8	Socio-economic Environment	Beneficial effects out-weigh adverse effects on socio-economic environment.	Awareness camps, health care; R & R plan; job and employment generation; Social, cultural and infrastructural development	-Regular fumigation of the plant & residential complex. -Implementation of social welfare measures for the local people including fishermen. -Enhancement of awareness about the project by plant visits, interactive Seminars, etc. -Fencing of the project site to check unauthorized entry in exclusion zone -Preference to local peoples in the job opportunities as per the norms. -Implementation of proper Resettlement and Rehabilitation plan for the benefit of project affected people -Ensure participation of local people in cultural events to create social harmony and goodwill
	2.9	Aesthetic environment	Quality of aesthetic environment will be improved	Improvement of vegetation cover and good roads	-The project area would be aesthetically adorable due to green belt, plantation, beautiful buildings, good roads etc. -The historical Vijaydurg fort or the natural mangrove vegetation patch along the nearby sea coast will not be affected by project activity

10.9 Environmental Management Plan (EMP) during Construction Phase

Following aspects require control mechanisms during the construction phase.

10.9.1 Site Preparation

During construction of the project, substantial quantity of soil and rock will be removed during excavation. The following aspects will be taken care of.

(i) Proper stock piling and back filling of the excavated soil.

(ii) All the disturbed land will be stabilized.

(iii) During dry weather condition, it will be necessary to control the higher dust levels created by the excavation, leveling and transportation activities.

(iv) The top soil containing rich humus, soil will be utilized for development of greenbelt in and around the project area.

10.9.2 Sanitation

During construction of the project, it will be ensured that the site is provided with sufficient sanitation facilities and supply of potable water.

10.9.3 Air Environment

Vehicular emissions, dust and other sources of emissions can affect air quality in the localized area during the construction of the project. It will be ensured that both gasoline and diesel powered construction vehicles and machines will be properly maintained to minimize air pollution.

10.9.4 Water Environment

The stock piling of waste material generated during excavation can be source of erosion and leaching, which may have impacts on aquatic system and / or groundwater. Programs will be implemented to stabilize the soil and if need arises trenches will be provided all around the stock pilings.

The vehicle maintenance / washing area will be selected in such a way that it does not contaminate surface or ground water by accidental spillage of oil or unauthorized dumping of waste oil. A facility will be constructed that separates the oil from the wastewater generated during vehicle washing and maintenance. The water collected in such a way will be reused before its final discharge.

10.9.5 Land Environment

An effective house keeping needs to be established during construction phase. The solid wastes generated during construction phase will be collected and segregated and will not be disposed off on land. Combustible waste will be burnt in controlled manner, whereas bio-degradable waste will be sent for composting and non bio degradable should be disposed in secured land fills. During construction of the project, development of an effective green belt around the project and aesthetic considerations will be reviewed on regular basis.

10.9.6 Noise Environment

During construction of the project, noise arising from blasting operations and operation of construction machinery such as concrete mixers and heavy earth moving machineries may constitute an additional stress on noise environment.

The employees as well as the construction workers of JNPP will be provided with suitable noise protective devices like earmuffs, whenever necessary. The noise level at the project site and around it should be monitored regularly and if it crosses the regulatory limits in the nearby villages, effective measures will be put into place for its possible reduction.

10.9.7 Site Security

The site will be secured by fencing and no unauthorized entry will be permitted in the construction area.

10.9.8 Industrial Safety at JNPP

During construction and operation phase of the project, all the project activities will be carried out as per the regulations covered under Atomic Energy (Factories) Rules 1996, Electricity Act and Rules, Explosives Act and Rules, Petroleum Act and Rules etc.

During Construction, the occupational Health aspects will be minimal as the work location is open and is of dynamic nature. The main hazard potential will be fall of person through a height, exposure to chemicals and noise, fall of material and electrical shocks etc. which will be addressed by built in engineered safety provisions. Accordingly, the construction workers will be provided compulsorily Personal Protective Equipments (PPE) depending upon the risks and use of Safety Helmet and Shoes will be must at the project construction sites. NPCIL will integrate separate safety clauses in the contract document for the project executing agencies to properly plan and to appropriately provide the cost factor such that safety of the personnel at project construction sites do not suffer for any reason. Safety coverage by professionals will be mandatory for the construction works and posting of safety officers for particular works will be must to enforce Industrial safety at the work sites. Such Safety officers and Safety supervisors will be arranged to technically report to the departmental Industrial Safety Head such that a direct guidance and monitoring of the contract works are made possible effectively.

Other worker friendly measures adopted in the construction of nuclear Power Plant works will be the compulsory induction and refresher training based on a syllabus monitored by the corporate office for each worker. The worker will be issued a gate pass only after undergoing the industrial safety training in which environmental management aspect will also be touched upon properly. Facility of drinking water, urinals, toilets and construction roads will be arranged in the beginning of the work itself. Similarly, provision of First aid measures both departmental and that of contractors' will be ensured in the beginning of the work itself. Establishment of Fire fighting facility will be another area where priority will be assured during the construction work.

During commissioning, operation and maintenance of the operating units, in addition to the industrial hazards, the occupational hazard is the exposure to ionizing radiation within prescribed limits which is governed by the Atomic energy Act and Radiation Protection Act and Rules. In order to minimize possibility of radiation exposure to the occupational workers, adequate safety measures are incorporated in the design, construction, operation and work practices of the plant including the systems associated with fuel handling and waste management. All the occupational workers undergo periodical medical check ups, bioassay sampling and whole body counting as applicable.

Only qualified engineers and technicians are recruited to carry out the design, construction, operation and maintenance (O & M) of the plant. All O & M personnel undergo mandatory training (at various levels) in the plant and related sub-systems of the plant through nuclear induction training. A committee consisting of a panel of experts and a representative from the regulatory agency evaluates designated operating staff for licensing. The qualification thus obtained will be renewed, periodically.

10.10 EMP during Operational Phase

10.10.1 Air Environment EMP

10.10.1.1 EMP for Conventional Air Pollutants

During the operational phase of the project, the emissions of conventional air pollutants will be negligible as there will not be any direct sources emitting such pollutants. However, ambient air quality needs to be monitored as per the requirements of the State Pollution Control Board for conventional pollutants.

10.10.1.2 EMP for Radiological Discharges through Air Route

- Air from ventilation stacks would be monitored on regular basis for Fission Product Noble Gases (FPNG), radioactive iodine and active particulate matter. The monitoring sensors shall be connected with the alarm system to indicate the levels of radioactive particulates exceeding permissible atmospheric release levels.

- The exclusion zone (1.6 km radius) around the power plant will be fenced as per AERB requirements. NPCIL would take precautionary measures such as adoption of proper land use plans and transport facilities for effective evacuation under emergency conditions in the sterilized zone of 1.6 km to 5km and beyond as per the requirements of AERB. However, no new industrial or any other set up is envisaged to be developed in the sterilized zone.

- During emergency conditions, appropriate emergency preparedness procedures shall be devised in advance and suitable measures shall be taken to ensure that radiation doses received by members of public and plant personnel are well within safe limits as prescribed by AERB.

10.10.2 Water Environment EMP

10.10.2.1 EMP for Conventional Water Pollutants

10.10.2.1.1 Suggestions of College of Fisheries, Ratnagiri

In view of the likely impact of the CCW waste water along the Jaitapur-Madban coast, following suggestions made by College of Fisheries, Ratnagiri, will be implemented by NPCIL.

- Suitable convective diffusion based CCW discharge system for diluting the heat load. Further, preferably, the resultant maximum rise of 5 ^{o}C of receiving body may be maintained to minimize the effect.
- The norms of water quality standards for CCW discharges should be adhered by the project.
- Monitoring of CCW discharges should be carried out regularly and impact on marine eco system if any should recorded following advanced techniques.

10.10.2.1.2 Compliance to Thermal Regulation

Further, the impact to the aquatic environment due to discharge of condenser cooling water into the Arabian Sea and its consequent impacts on aquatic life will be minimized. Accordingly, the condensers will be designed in such a way that the resultant temperature rise of the receiving water body will not be more than 7 ^{O}C in line with MoEF notification on CCW discharge temperature limits. However, this would also be monitored on continuous basis by NPCIL.

10.10.2.1.3 Wastewater

The sewage from the plant site & residential complex would be treated to comply with the standards stipulated by MPCB and it will preferably be reused for gardening or plantations to the maximum possible extent. The backwash water from filter media would be reused after settling for secondary purposes such as floor washing operations

10.10.2.1.4 Rain Water Harvesting

Rainwater harvesting is normally practiced for recharging ground water levels and provide water for human consumption, by collecting the rainwater from the roofs of the buildings and storm water drains into artificially constructed rainwater tanks. At Jaitapur Project site, the average ground water level is 17 m below ground level. For the Jaitapur Project and associated Residential complex, suitable rainwater harvesting schemes will be worked out in consultation with a suitable agency.

10.10.2.2 EMP for Radiological Liquid Discharges through Water Route

10.10.2.2.1 Treatment of Radiological Effluent

- In-plant control measures would be implemented to minimize the quantities of wastewater generation.
- For radio-active effluent from the project, an effective liquid waste management plan based on segregation of the waste, treatment, on line monitoring and regular review will be implemented as discussed in **Chapter 4**.
- Performance evaluation of wastewater treatment plant would be undertaken on regular basis to take corrective actions well in time.
- Trained personnel would be engaged for operating the effluent treatment plant.
- Wherever possible, treated effluent would be recycled and reused for watering plantations in order to conserve fresh water.

10.10.2.2.2 Water Quality Monitoring

The marine water quality and ground water quality of the area near the solid waste disposal site and in the impact zone will be regularly monitored as specified by AERB. In addition, the following measures will be carried out on a suitable frequency.

Evaluation of compliance of liquid discharges from the station as per AERB (Atomic Energy Regulating Board) approved discharge limits for radiological parameters and for non-radiological parameters as per MPCB limits.

10.10.3 Land Environment EMP

10.10.3.1 EMP for Conventional Solid Waste

10.10.3.1.1 EMP for Domestic Solid Waste

The domestic solid waste normally constitutes about 50% organic matter. This material can be composted to yield the compost, which can be used along with the chemical fertilizer in the surrounding farms. Studies carried out by various authorities have clearly shown that the yield that is obtained by using chemical fertilizers along-with compost is normally more than the yield obtained by the use of chemical fertilizer alone. Progressive farmers will hence readily accept to utilize the produced compost.

Composting

As the quantities of solid waste to be composted are small, the semi-mechanized method of composting will be used. For composting, suitable land (4 ha) will be identified at a low-lying area in the residential complex. The total area that will be required for this composting plant will be around 1.5 ha. In addition to the plant, a building will have to be provided to house the front end loaders and other equipments.

Sanitary Landfilling

The non-compostable material will be segregated from the residential complex solid waste for which composting cannot be carried out, and it will be disposed of by using sanitary landfilling. For the entire operation, adequate land would be made available. In general, the process involves filling of low-lying land. Normally, after the material is deposited at the site, it is spread, compacted and covered at the end of every day's operation with a layer of soil / earth. The soil / earth layer precludes the possibility of rats burrowing through it, fly breeding etc. Sanitary landfilling is normally carried out in 3 ways:

i) Trench Method

ii) Area Method

iii) Ramp Method

Trench method is normally used in the case of flat terrain or where the soil can be easily excavated.

Area method is suitable for irregular or marshy wasteland having a high level of groundwater as in such cases excavation for the more orderly method of trench and ramp types cannot be carried out.

Ramp method is commonly used in the case of flat or gently rolling areas.

Suggested Landfilling Method

It is envisaged that bulky wastes such as furniture etc., will be absent in solid wastes at Jaitapur Nuclear Power Project Residential complex. The suggested method of landfilling is as follows:

- A suitable site will be selected, which should have an all weather access road from existing main road to the point at which filling is to commence. This road can be prepared from construction and demolition waste, ash, clinker, etc. A small stock of this material should be maintained at the site for day to day repairs.
- At the site, there will be guiding flags to the spot/ location and the site should be demarcated for clear identification. For indicating height to which filling has to be done, 'sight rails' should be provided
- The filling will start from a point nearest to road. The solid waste transport vehicles will approach the point after reversing. Tipping vehicles can unload faster and hence assure a quicker out-turns. The dumped material can be spread and leveled manually by using rakes having a number of teeth. By using Ramp method, the filling will move progressively inside the site
- To indicate the point where vehicles will stop for unloading, a strong heavy wooden bumper bar can be provided
- To avoid the rear wheels of vehicles from sinking in the newly deposited mass, the area will be covered with steel or wooden sleepers.
- At the end of the day's operation, the waste will be covered.

10.10.3.1.2 Green Belt Development

Preparation of Greenbelt Plan Keeping in View the Selected Plant Species

Development of green belt around the JNPP is recommended to improve the aesthetic value of project area as well as to reduce the air pollutants around the plant. A land measuring 692.301 ha adjoining the sea is available for locating NPPs of 6x1650 or 10x1000 MWe PWRs. The peripheral 1.5 km radius area around the plant buildings, roads, pipelines etc. will be developed in green belt. NPCIL is committed to develop greenbelt in approximately one third of total area that is around 200 ha in nuclear power plant area. In residential complex area (245.715 ha), avenue plantation, garden and lawns will be developed over open spaces for aesthetic purpose.

Criteria for Selection of Species for Greenbelt

The plant species suitable for green belt development would be selected based on the following characteristics.

- Diverse fast growing local plants
- They should have thick canopy cover
- They should be perennial and evergreen
- They should have high sink potential for pollutants
- They should be efficient in absorbing pollutants without significantly affecting their growth.

Guidelines for Plantation

The plant species identified for greenbelt development should be planted using pitting technique. The pit size should be either 45 cm x 45 cm x 45 cm or 60 cm x 60 cm x 60 cm. Bigger pit size is prepared on marginal and poor quality soil. Soil used for filling the pit should be mixed with well decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45cm x 45 cm x 45 cm and 60 cm x 60 cm x 60 cm size pits respectively. The filling of soil should be completed at least 5-10 days before actual plantation. Healthy sapling of identified species will be planted in each pit.

The following major tree species are proposed for greenbelt development around the plant premises. Additional list of plant species is also given in **Table 10.3**, which can be added at proper place in green belt depending upon their height and as per their availability.

The break up of green belt from periphery for the nuclear power plant is given below:

20 m width	Tress of 10 – 20 m height	8 rows
10 m width	Trees of 5 – 10 m height	4 rows

The list of 10-20 m height trees for 20 m block area of greenbelt is given below:

Sr. No.	Name of Plant Species	Marathi Name	Symbol used to denote the plant
1.	*Terminalia chebula*	Harda	⌂
2.	*Acacia auriculiformis*	Australian babul	Ω
3.	*Tectona grandis*	Sagwan	∩
4.	*Azadirachta indica*	Neem	π
5.	*Calophyllum inophyllum*	Surangi	λ
6.	*Mangifera indica*	Amba	δ
7.	*Samania saman*	Rain tree	β
8.	*Ficus religiosa*	Pimpal	Ψ
9.	*Syzygium cumini*	Jambhul	σ
10.	*Tamarindus indica*	Chinch	φ
11.	*Terminalia bellerica*	Behra	ϕ

Shrubs selected for 20 m block area:

- *Vitex negundo*
- *Jatropha curcas*
- *Calotropis procera* (Madar)
- *Mussaenda glabrata*
- *Lawsonia inermis*
- *Holarrhaena pubescens*
- Zizyphus mauritiana

The lists of 5-10 m height trees for 10 m block area:

Sr. No.	Name of Plant Species	Marathi Name	Symbol used to denote the plant
1.	*Pongamia pinnata*	Karanj	Θ
2.	*Annona reticulata*	Ramphal	©
3.	*Bauhinia acuminata*	Kanchan	®
4.	*Cassia fistula*	Amaltash	•
5.	*Erythrina variegate*	Pangara	+
6.	*Ficus hispida*	Umbar	*

Shrubs selected for 10 m block area:

- *Clerodendron serratum* (Bharangi)
- *Holarrhaena pubiscens* (Pandhara kuda)
- *Ixora coccinia* (Bakara)
- *Jatropha* sp. (Ratanjyot/Vanerand)
- *Vitex negundo* (Nirgudi)
- *Calotropis procera* (Rui)

All the shrubs in the greenbelt are denoted by x as shown in **Fig. 10.1**. Which comply with the requirements of MoEF guidelines (CPCB (2000) *Guidelines for Development of Greenbelts* Published by CPCB, Delhi).

Roadside Plantation in Plant Premises and Residential complex

Roadside plantation plays a very important role for making the area green, increasing the shady area, increasing aesthetic value and for eco-development of the area. The approach roads to project site, residential complex, hospitals, etc. can be planted with shade giving flowering trees in 10 m area on both sides of road with large trees, medium trees and shrubs alternating with each other. JNPP should encourage all the local voluntary organizations to undertake massive plantation along the roadside at suitable places to uplift the regional ecosystem of the area.

Mangrove Plantation in Creeks

Mangrove vegetation is present in the Jaitapur creek at 5 km distance and in Vijaydurg creek at 8 km distance on the landward side away from coastal area. The mangrove species recorded are *Avicennia officinalis, Avicennia marina, Exocaecaria agallocha, Sonneratia caseolaris, Acanthus ilicifolius, Rhizophora mucronata, Aegiceras corniculata* and *Bruguiera gymnorhiza*. These mangrove patches are required to be protected from lopping by local people and need to be conserved through regular plantation of all mangrove species in degraded areas.

10.10.3.2 EMP for Radioactive Solid Wastes

The solid radioactive waste scheme for Jaitapur Nuclear Power Project will be designed to collect, segregate, and suitably pack solid waste generated in the active areas of the station. It is finally transferred to Waste Management Plant for treatment & disposal. The scheme of handling of radioactive solid waste is presented in **Chapter 4**.

Nuclear Power Plant

20 m

⌂ x x Ω x ∩ x x π x λ x x δ x β x xΨ x σ x x Φ x Øxx
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10-20 m height trees

10 m

2.5 m

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©x ® xx*x © xx ® x*xx ©x ® xx*x © xx ® x

4 m

5-10 m height trees

Fig. 10.1: Proposed Green Belt Design for JNPP

(The symbols are described in Section 7.2.6.3 of this report)

Table 10.3

Additional List of the Plant Species Suggested for Enrichment of Greenbelt

Sr. No.	Name of Plant	Marathi Name	Tree/Shrub	Height (m)
1.	*Acacia catechu*	Khair	Shrub	3
2.	*Acacia auriculiformis*	Australian babul	Tree	5
3.	*Albizia procera*	Kinhai	Tree	20
4.	*Artocarpus heterophyllus*	Phannas	Tree	10
5.	*Bauhinia acuminate*	Kanchan	Tree	7
6.	*Bauhinia racemosa*	Apta	Small tree	5
7.	*Calophyllum inophyllum*	Undi	Tree	18
8.	*Calotropis procera*	Mandare	Shrub	6
9.	*Casuarinas equisetifolia*	Suru	Tree	10
10.	*Clerodendrum serratum*	Bharangi	Shrub	5
11.	*Delonix regia*	Gulmohr	Tree	15
12.	*Dendrocalamus strictus*	Bhariyel, Bans	Shrub/tall perennial grass	12
13.	*Ficus benghalensis*	Vad	Tree	20
14.	*Ficus glomerata*	Umbar	Tree	15
15.	*Gardenia jasminoides*	Anant	Tree	5
16.	*Grewia serrulata*	Dhaman	Tree	10
17.	*Garcinia indica*	Kokam	Tree	8
18.	*Grewia nervosa*	Hasoli	Shrub	6
19.	*Ixora branchiate*	Malwa	Tree	8
20.	*Ixora coccinea*	Bakara/Devari	Shrub	6
21.	*Lagerstroemia mcrocarpa*	Nana Bondara	Tree	20
22.	*Mangifera indica*	Amba	Tree	15
23.	*Mammea suringa*	Suringi	Tree	18
24.	*Moringa oleifera*	Shevga	Tree	10
25.	*Mussaenda glabrata*	Sarvad	Shrub	2
26.	*Phyllanthus emblica*	Awla	Tree	8
27.	*Pithecellobium ducle*	Vilayati chinot	Tree	8

Sr. No.	Name of Plant	Marathi Name	Tree/Shrub	Height (m)
28.	*Sapium insigne*	Hura / Kirkind	Tree	10
29.	*Syzygium cumini*	Jambhul	Tree	20
30.	*Tamarindus indica*	Chinch	Tree	20
31.	*Terminalia chebula*	Hirda	Tree	15
32.	*Thespecia populneoides*	Bhendi	Tree	10
33.	*Writia tinctoria*	Kala Kuda	Shrub	2
34.	*Ziziphus mauritiana*	Bor	Tree	10

10.10.4 Biological Environment EMP

10.10.4.1 Aquatic Component

All domestic waste / Sewage would be adequately treated and would be re-used for green belt development to avoid disposal in water bodies and enrichment of nutrients, which may result in profound algal growth leading to eutrophication.

The radioactivity levels in the various elements of aquatic environment such as water, sand, benthos, phytoplankton, zooplankton, small fish, big fish etc. will be monitored regularly by ESL, BARC. One of the basic aims of this exercise will be to establish the trend of the radioactivity levels at various levels of aquatic food chain. At the other operating stations of NPCIL, it is observed that these levels are within the statistical variation of measurements only. Therefore, the radioactivity levels in the various elements of aquatic system are not expected to increase due to the introduction of the JNPP.

10.10.4.2 Terrestrial Component

The monitoring of the radioactivity levels in the various components of terrestrial environment will also be carried out regularly. The elements, which will be examined for radioactivity levels, will include

- Rice, Wheat, Pulses
- Millets
- Milk
- Fruits
- Vegetables
- Goat (different parts of the body)

At the existing operating nuclear power stations of NPCIL, it is observed that the radioactivity levels in all the above items are within the statistical variation of measurements only. Therefore, the radioactivity levels in the various elements of terrestrial environment are not expected to increase due to the introduction of the project.

10.10.4.3 Mitigation Measures

Further, following measures will be adopted to make the EMP more effective.

- Development of protective green belt in the exclusion zone of 1.6 Km around the project which would also act as a buffer zone.
- Effective treatment for wastewater from the station and residential complex as per the standards from regulating agencies and treated domestic sewage will be reused for irrigation of plantations and green belt development.
- Regular monitoring of physico-chemical and radiological parameters during construction and operation phase of the project.

10.10.5 Noise Environment EMP

All the noise generating machines/ equipment will be within confined places with and would be maintained with an effective maintenance plan on regular basis. Additionally, following measures would also be implemented with well defined control procedures.

The operator's cabins of machines particularly prone to noise would be acoustically insulated with special door and observation windows

The operators & other staff working in high-noise area would be provided with ear-muffs/ear-plugs and they should be properly trained to use the same

The duties of employees working in high noise area will be rotated systematically to avoid occupational health hazards

With the introduction of the present project, the noise levels in the surrounding environment are expected to increase by a small fraction of the present noise levels.

10.10.6 Socio-economic Environment EMP

A critical review of the socio-economic profile of the study area and the socio-economic survey conducted in the adjoining rural area of project has brought the following significant observations which are considered for preparing an effective EMP. It is envisaged that such an EMP would help in mitigating the adverse and unfavorable reactions of the people in the area towards the project. The following measure would be adopted: -

- The hospital facility which will cater to the needs of the project staff will be extended to the local rural inhabitants by conducting more medical camps, mobile dispensary, etc and in case of emergency availability of full hospital facility.
- The participation of local people in the project sponsored events such as sports tournaments; fairs etc. will be encouraged to develop & retain the goodwill of the people.
- Separate allocation of funds towards welfare activities for the local people.
- All the occupational workers will be provided with protective equipment as per the requirements and will be trained for both normal and abnormal conditions.
- Monitoring of the working environment will be carried out regularly to ensure that the design features of the plant and its mode of operation are such that the personnel are adequately protected.
- The occupational workers would go through mandatory medical checkups as per the requirements of AERB
- Records of doses received by the workers will be maintained as per the requirements.
- Some basic amenities, viz. education welfare, safe drinking water supply, street Lighting, roads facilities in the villages may be taken up by project authorities
- Special privilege should be given to Fishermen for Life Jackets for their safety
- For all the other welfare activities to be undertaken by the project authorities, viz. making bore-wells in local villages, Petrol pump started at Residential complex catering for local public, allotment of

shops in the Residential complex for local villagers, Financial help local people,

- Educational programmes should be continued in the nearby villages viz. Books for students, computers for schools, construction of additional classrooms in Govt. school and Talent nature programme for the benefit of talented kids from economically poor background
- Construction of bus shelters in near by project villages

10.10.6.1 R & R Plan EMP

The recommendations for smooth implementation of the Resettlement and Rehabilitation Plan are delineated below:

- Compensation should be provided earlier enough before commencement of project construction to the PAPs, for the loss of their land.
- Project authorities should ensure frequent meetings with the implementation and monitoring committee and teams to enable smooth implementation of all relief measures
- Project authorities should seek advice and help of local NGO's and other registered welfare bodies in the area. Their participation and involvement in the proposed development schemes shall be helpful in confidence building. This would also help in conflict resolution if any such, situation arises.
- The quality of the land to be given to PAPs will be considered as it may not hinder the economic status of the project affected people and affects their quality of life
- If the desirable quality of land required is not available, then the net profit or the annual income of the oustee must be considered.
- Land compensation must be given as per the government land rates considering the type of land, type of standing crops and production per person per hectare

10.10.7 EMP for CRZ Impact

It is inferred from the **Section 4.7.5** in **Chapter 4** of this report that the impact on the biotic and abiotic components of CRZ of Jaitapur project site due to the introduction of the proposed project will be insignificant. However, it is planned to take adequate precautions to control land erosion and leaching during dredging and construction of the project facilities. Further following measures are to avoid any potential impact as given below.

- Secured disposal of overburden with effective bunding and drainage for leachate water.
- Collection and treatment of leachate water through sedimentation and separation techniques before disposal.
- Complete reuse of overburden in the construction of project facilities and break water wall.
- Restoration and landscaping of the project area after construction.

10.10.8 Radiation Protection

The aim of radiation protection is to protect the individuals from radiation, while still allowing necessary activities from which radiation exposure might result. Two categories of exposure, viz., occupational exposure to radiation workers and exposure to members of the public are to be addressed. Apart from meeting the statutory limits, all efforts are made to keep the exposures as low as reasonably achievable (ALARA), taking into account the economic and social factors.

The radiation exposure limits for occupational workers to be followed for design and operation are specified by AERB. The dose limits applicable to the members of the public has already been discussed in the **Chapter 4**.

Compliance with dose limits will be ensured by providing adequate shielding to reactor components, coolant pipes, fuel handling equipment, etc., by proper zoning of the areas, implementation of suitable ventilation mechanism, and implementing access control etc.

The occupational exposure of persons engaged in operations, maintenance, waste management activities will be controlled by the elaborate radiation protection procedures in vogue as in other operating atomic power stations in the country. A Health Physics Unit will be established at the plant before operation starts to recommend and supervise radiation protection requirements. All the accessible areas of the plant are constantly monitored for ambient radiation levels and concentration of radioactivity in air. Area monitors with audio / visual alarm at preset levels are installed in accessible as well as shut down areas.

All the radiation workers are provided with personal monitoring devices to quantitatively estimate the dose received by them during the course of their work. The accumulated radiation dose is measured and added to the personal dose record of the individual.

All the occupational workers are subjected to whole body counting for detection and measurement of radioactive materials inside their body, which might have entered during the routine course of work. All these facilities will be available in-house in the laboratory manned by experts in the field before plant operation.

Any individual effective dose exceeding specified levels (10 mSv in a month or 15 mSv in a quarter or 20 mSv in a year) shall be investigated by a committee constituted by the station. Planned special exposures are permitted, provided cumulative exposure dose not exceed the annual limit.

10.10.9 Occupational Health & Safety

All the activities except those involving radiation exposures are governed by the rules and regulations prescribed in the Atomic Energy (Factories) Rules 1996.

Similarly, during commissioning, operation and maintenance of the plant, in addition to the industrial hazards, the occupational hazard is the exposure to ionizing radiation within prescribed limits. In order to minimize possibility of radiation exposure to the occupational workers, adequate safety measures are incorporated in the design, construction and operation of the plant and the associated systems such as fuel handling and waste management. All the occupational workers undergo annual medical examination in order to ensure their general health.

Only qualified engineers and technicians are recruited to carry out the design, construction, operation and maintenance (O & M) of the plant. All O & M personnel undergo mandatory training (at various levels) in the plant and related sub-systems of the plant. A committee consisting of a panel of experts and a representative from the regulatory agency evaluates designated operating staff for licensing. The qualification thus obtained has to be renewed, periodically.

10.10.10 Budgetary Provisions for EMP

The budgetary provisions towards Environmental Management Plan for the proposed project, by virtue of providing necessary measures towards safety of the occupational workers & members of the public both during normal operation of the plant as well as during accident conditions, pollution control & its monitoring, green belt development, and socio-welfare measures are given in **Table 10.4**.

Table 10.4

Budgetary Provision for EMP

	Pollution Control – Radiological aspects (Towards the cost of Nuclear safety systems, engineered safety features, consequence mitigating measures, waste treatment, management & storage, spent fuel storage, radiation emergency preparedness etc.)			
	- Non-recurring	:	Rs.	900 Crores
	- Recurring / Annum	:	Rs.	15 Crores

	Pollution Control – Conventional aspects			
	- Non-recurring	:	Rs.	15 Crores
	- Recurring / Annum	:	Rs.	30 Lakhs

	Environmental & Pollution Monitoring - Establishment of chemical & radio-chemical sampling & analysis, health physics & bioassay sampling & monitoring facilities etc. and enhancement of Environment Survey sampling & monitoring. (Radiological & non-radiological)			
	- Non-recurring	:	Rs.	3 Crores
	- Recurring / Annum	:	Rs.	60 Lakhs

	Green Belt Development			
	- Non-recurring	:	Rs.	3 Crores
	- Recurring / Annum	:	Rs.	30 Lakhs.

	Social Welfare Measures (Health & Water Supply Facilities, educational matters, area development / up gradation & Sanitation etc.)			
	- Non-recurring	:	Rs.	1.5 Crore
	- Recurring / Annum		Rs	30 Lakhs

	Total Investment on EMP			
	- Non-recurring	:	Rs.	922.5 Crores
	- Recurring / Annum	:	Rs.	16.5Crores

Note :
1. Capital cost of one unit of 1650 MWe is under finalization by Government of India.
2. 'Non-recurring' cost refers to the portion of capital cost of the proposed project based on estimation for 1000 MWe LWR units.
3. 'Recurring / Annum' cost refers to the revenue expenditure and does not include capital depreciation and interest on capital

Chapter 11

Summary & Conclusions

11.0 Summary

The summary of the environmental impact assessment report is presented as **Summary - EIA** in the beginning of the report on page numbers S-1 to S-57. This **Summary EIA** has been prepared for its circulation in the public domain as per the requirement of the MoEF, Notification No. S. O. 1533, 14^{th} September, 2006 on Environmental Clearance / Public Hearing. This **Summary EIA** has also been translated in local language (Marathi) and will be made available to the public at the time of public hearing.

11.1 Conclusions

The proposed project is environmental friendly and is proposed in accordance with the Government of India's Policy to promote the present share of nuclear energy in the country's total electricity production.

The present report is based on the work carried out by NEERI on environmental aspects as well as specialized studies carried out by Health Physics Division of BARC (Radiological studies), NIOT, Chennai (HTL/LTL demarcation), CWPRS, Pune (Modeling of thermal discharges), College of Forestry, Dapoli, District Ratnagiri (Terrestrial Biodiversity), College of Fisheries, Ratnagiri (Marine biodiversity and thermal impact on biodiversity).

The EIA report contains in-depth study on environmental quality and Comprehensive Environmental Management Plan to mitigate the impacts including Radiological Risk Assessment and Emergency Response System and Social Welfare

Commitment. **The project is technically, environmentally and socio-economically viable and highly beneficial at local level, state level and national level.** The summary of different aspects of the project is given below.

11.1.1 Suitability of Proposed Site

Jaitapur site has been recommended by the site Selection Committee appointed by Government of India, which is one of the input amongst several other considerations for in principal approval by the Government of India for taking up pre project activities including environmental clearance. The project site is a coastal site between Rajapur Creek and Jaitapur creek near Jaitapur in Rajapur taluka of Ratnagiri district. The land is non-forest land, rocky, barren, and privately owned with small patches of agriculture. Physical displacement of any family from the project site is nil. All the required resources are available at the proposed site. The site is at safe grade elevation from the point of tides, floods, tsunami and also present in Seismic Zone - III. It is also mentioned that the Projects of Department of Atomic Energy are under permissible activities in CRZ as per the provisions of Para `2` of MOEF notification for CRZ vide S.O. 114 (E) in October 2001. **Therefore, the Jaitapur site is viable for the development of Nuclear Power Park of 10,000 MWe capacity.**

11.1.2 Impact on CRZ

The project site comes under CRZ –III, which is undeveloped area with rocky barren land with no notified biologically sensitive ecosystem within 10 km radial area around JNPP. The scientific study indicates that the project development will not adversely affect the ocean currents, sediment transport, narrow intertidal area, and CRZ area of 500 m from HTL.

11.1.3 Monitoring of Radiological Parameters around JNPP

Comprehensive pre-operational radiological survey has been conducted by Health Physics Division (HPD) of Bhabha Atomic Research Centre during April, October and November, 2006 in the zone of radial distance of 32 km and the same will be continued till the life of JNPP for monitoring of radiation impacts and to establish that the radiation dose, in the public domain are within the prescribed limits of AERB.

11.1.4 Management of Conventional and Non-conventional Releases of Pollutants

JNPP is committed to the guidelines and standards given by AERB, Ministry of Environment and Forest (MoEF), and Maharashtra State Pollution Control Board. JNPP is governed by the guidelines, standards and the inspection schedules of AERB. The design of the plant will be done according to the guidelines to keep the radiological discharges through air and liquid routes below the stipulated levels of 1 mSv/year during normal operation. This is achieved by proposed elaborate treatment for active gaseous waste, active liquid and solid waste before discharges.

Some amount of conventional pollutants like dust and gaseous pollutants are produced for a short construction period, for which proper management plan has been prepared. The conventional pollutants releases from the plant during operation stage will be insignificant. The domestic sewage and solid waste from proposed residential complex, toilets and canteens will be treated and the treated sewage and digested manure will be used for green belt. Noise pollution will be reduced by development of different barrier i.e. acoustic covering of noise generation machineries, specially designed building in which the plant is enclosed, and exclusion zone of 1.6 km with green belt. Occupational exposure of noise will be reduced by providing protective gadgets to the workers working in the high noise zone.

The specific design of plant will only allow a rise of CCW temperature of <7 ^{0}C across the condenser and the design of discharge channels is such that the resultant temperature rise of receiving sea water body at discharge point does not exceed 5^{0}C above the ambient seawater temperature. The literature survey of the tolerances of local marine flora and fauna indicate that the marine biodiversity will not be affected at this temperature rise by the discharge of CCW.

The brine from desalination plant (13,350 m^3/d) will be mixed with CCW (86, 40,000 m^3/d) before discharge and will not thus affect the marine biodiversity.

11.1.5 Green Belt Development

Scientifically designed green belt will be developed in 1.6 km radial exclusion around the nuclear power plant. This will be helpful in reducing the conventional pollutants in the atmosphere as well as it will enhance the aesthetics and beauty of the landscape of the area.

11.1.6 Water Requirement and Water Balance

Only sea water will be used to meet the requirement of plant for condenser cooling and freshwater through desalination plant to conserve the freshwater resources.

11.1.7 Resettlement and Rehabilitation Plan

There is no physical displacement of PAFs from the land being acquired for Project site and the residential complex. In addition to the compensation for acquired property, NPCIL proposes R&R Package for the Project Affected Families (PAFs) of JNPP in line with the best of the provisions of National Rehabilitation & Resettlement Policy 2007 vis-a-vis Maharashtra Project Affected Persons Rehabilitation act 1999 (Amended till date)

11.1.8 Corporate Social Responsibility of NPCIL

The policy of NPCIL towards social welfare & community development aims at strengthening the bond between Project Authorities and local population in the vicinity of nuclear power plant. In line with this policy, NPCIL planned to implement social and community welfare measures aiming at improving the infrastructural facilities including education, health, employment and women & Children welfare.

11.1.9 Radiological Risk Assessment & Emergency Response System

The nuclear power plant is based on advanced technology. A defense in depth philosophy is followed in which there are five successive levels of safety. Number of engineered safety features has been included in the Nuclear Plant Design to enhance the safety of the plant. Processing systems for gaseous, liquid and solid waste are elaborate and effective in controlling releases of radioactivity and complying with the stipulated dose limits to the members of public and occupational workers. Emergency Plan is the part of the concept of Defense in Depth and it is executed jointly by NPCIL and State Authorities. Before making the plant critical and conduct of mock exercise is a mandatory requirement.

11.2 Remarks

The foregoing discussion indicates that the project is planned in such a way that it will not deteriorate the environment; on the other hand it will improve the environmental quality and uplift the socio economic environment of the region. The safety measures inbuilt in the design of the project will minimize the hazard if any. The safety analysis considers the worst case scenarios for risk assessment and emergency planning. There will be continuous monitoring, review and rectification system. The local people will be immensely benefited due to social welfare schemes proposed by NPCIL, which will result in the improvement in the quality of life.

Chapter 12

Disclosure of Consultants Engaged

12.1 NEERI Profile

NEERI (National Environmental Engineering Research Institute) is a Constituent Laboratory of CSIR (Council of Scientific & Industrial Research), India (Website: www.neeri.res.in) was established in 1958.

12.1.1 NEERI Mission and Vision

NEERI Mission

The Institute dedicates itself in the service of mankind by providing innovative and effective solutions to environmental and natural resource problems. It strives to enable individuals and organizations to achieve productive and sustainable use of natural resources on which all life and human activity depend. Highly skilled and motivated, the Institute strives for excellence in environmental science, technology and management by working hand in hand with its partners.

NEERI Vision

NEERI envisions a world in which:

- All individuals and Institutions have capacity to act in a manner that ensures achievement of sustainable environmental and economic goals.
- The natural balance is no longer threatened and all share the benefit of a healthy environment.

NEERI would continue to strive for:

- Leadership in environmental science, technology and management domestically and worldwide.

- Strong and effective working relationship with its partners in ensuring ecological health of all regions in India.

12.1.2 Mandate of NEERI

- To conduct R&D studies in environmental science and engineering.
- To render assistance to the industries of the region, local bodies etc. in solving the problems of environmental pollution.
- To interact and collaborate with academic and research institutions on environmental science and engineering for mutual benefit.
- To participate in CSIR thrust area and mission projects.

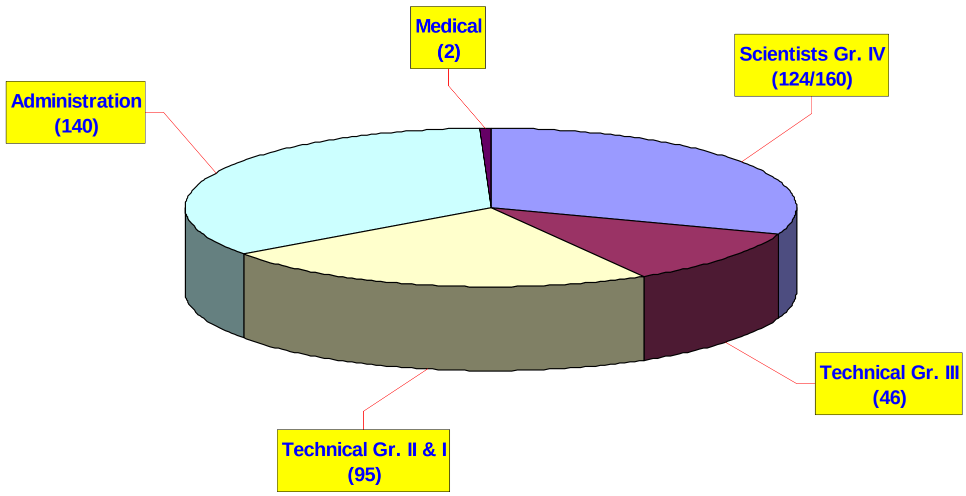
12.1.3 NEERI Activities

- **R&D Thrust Areas**
  - Environmental Monitoring
  - Environmental Modeling
  - Environmental Impact & Risk Assessment
  - Environmental System Design
  - Environmental Biotechnology
  - Environmental Genomics
  - Environmental Policy Analysis
- **Advisory**
  - Central Govt. Ministries
  - State Govt. Ministries
  - Industries
  - Judiciary

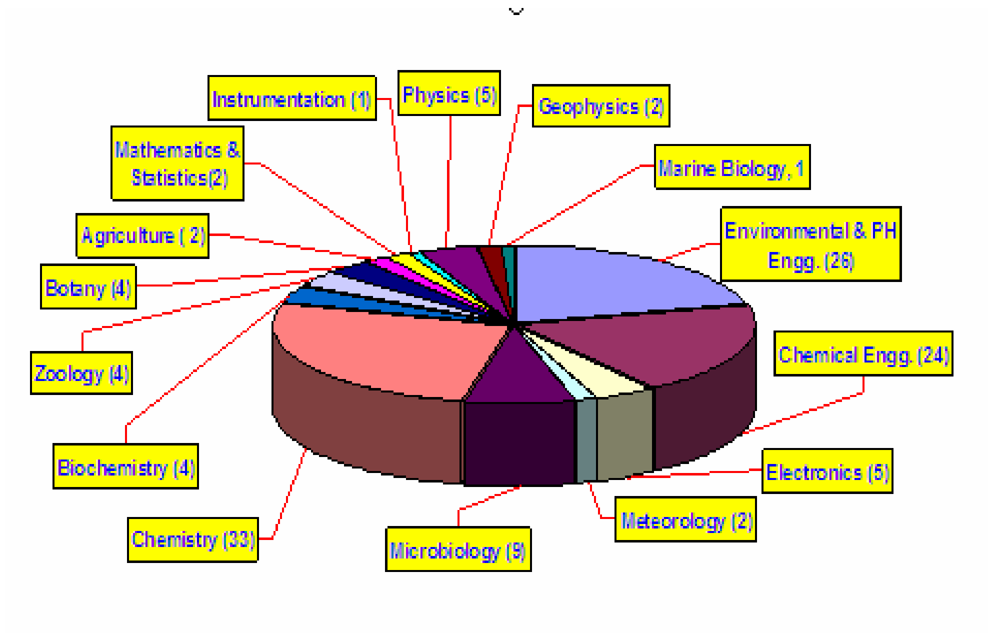
12.1.4 NEERI Services & Goods

- **Research intensive areas**
  - Air, Water, Wastewater, Soil (Land), Solid & Hazardous Waste
  - Environmental Biotechnology & Genomics
  - Environmental Materials
- **Public and strategic areas**
  - Environmental Monitoring
  - Environmental Policy Analysis
- **Socio-economic areas (urban & rural)**
  - Drinking water
  - Clean Air
  - Environment & Health
  - Advice to Central & State Government Agencies
  - Judiciary
- **Industry focus**
  - Environmental Monitoring, Management and Audit
  - Environmental Technology Assessment
  - Environmental Impact & Risk Assessment

12.1.5 NEERI Human Resources

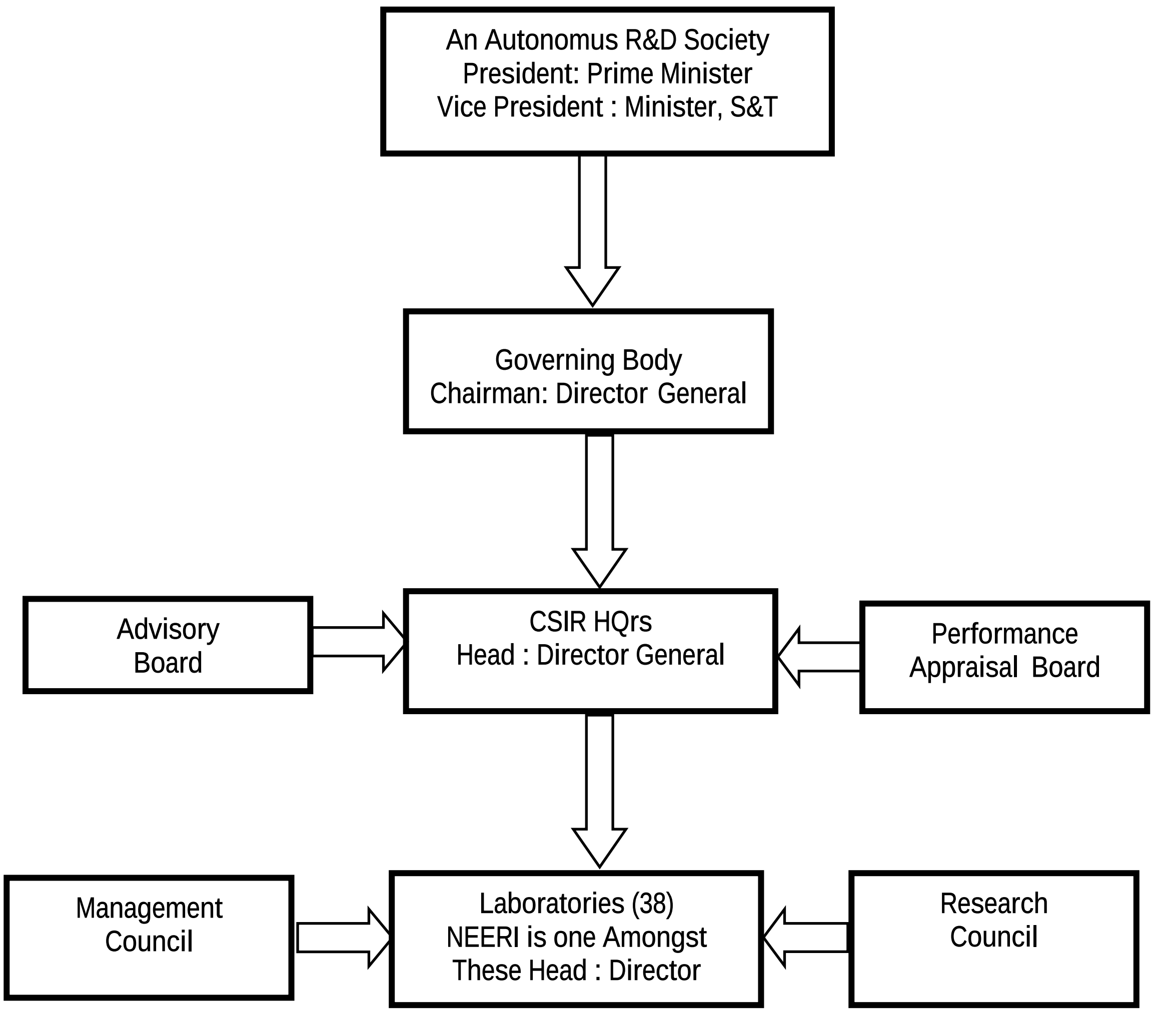


NEERI : Human Resources
Total : 407 (As on February, 2008)

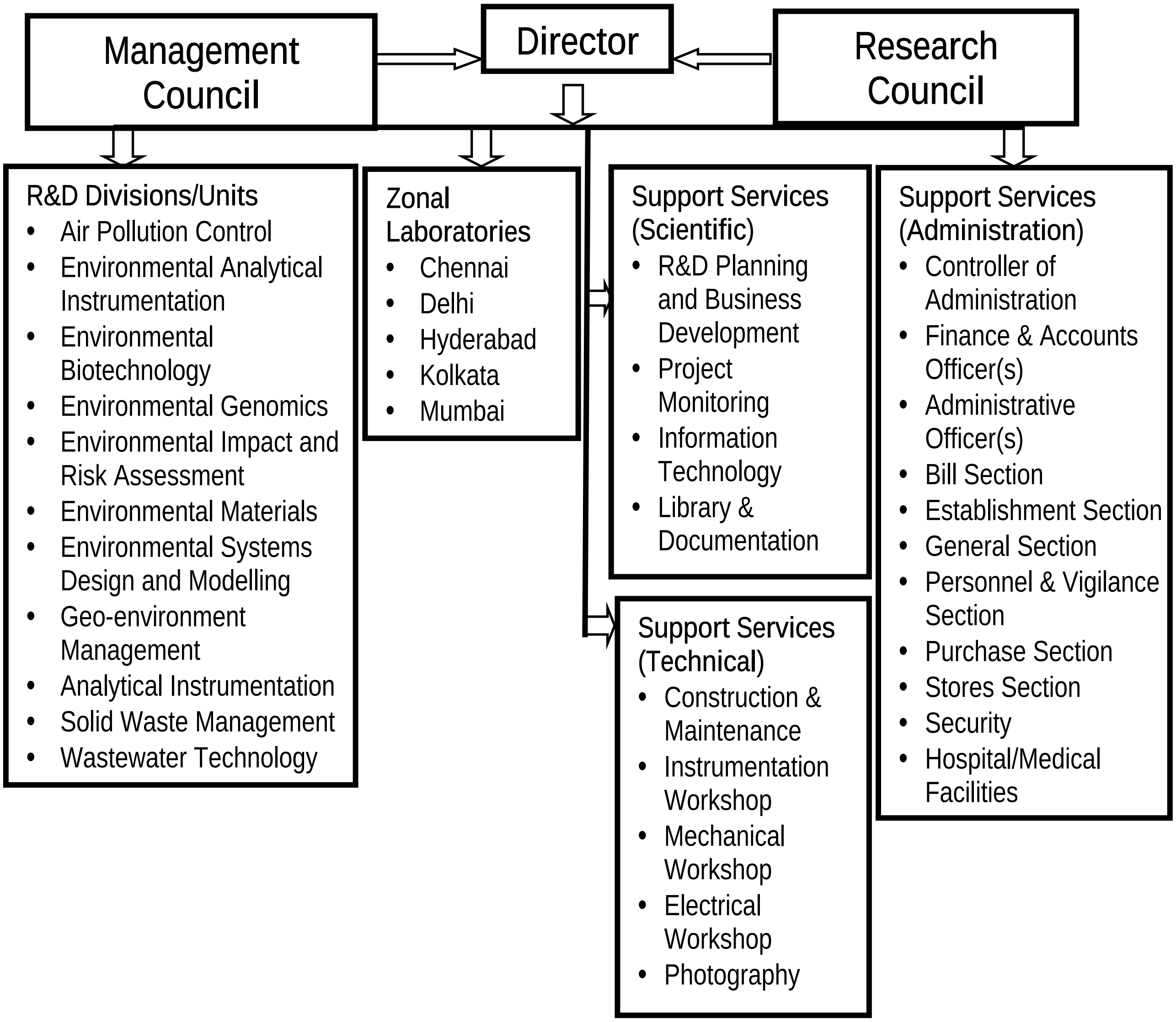


NEERI : Human Resource
(Scientific) (As on March 1, 2008)

12.1.6 Organisational Chart of CSIR and NEERI

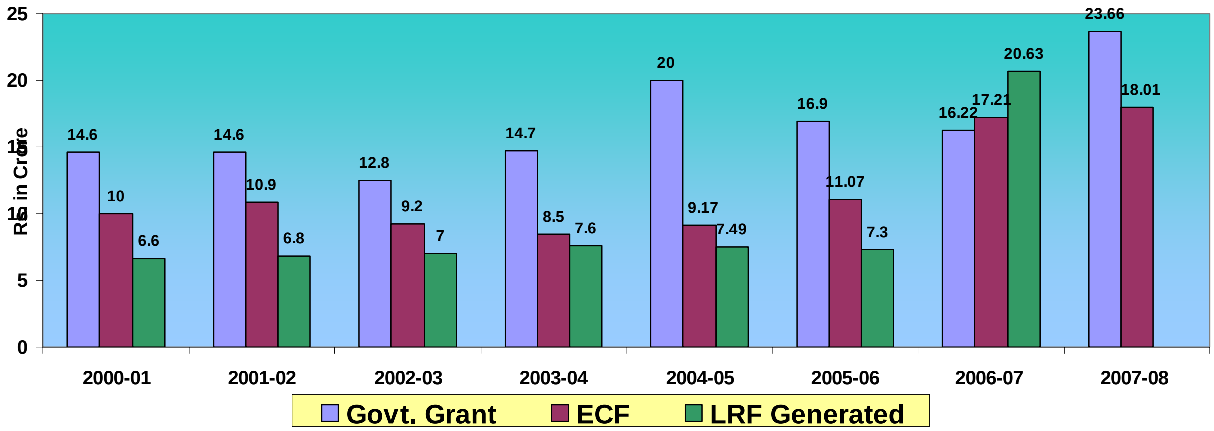


CSIR, India (Organisational Chart)



NEERI: Organisation Chart

12.1.7 Financial Resources of NEERI



Financial Resources (1999-2008) (Rs. in Crore)

(ECF- Environmental Consultancy Fund, LRF- Laboratory Reserve Fund)

12.1.8 Analytical Instruments, Computer Systems and Software at NEERI

12.1.8.1 Analytical Instrumentation Resource

- UV-VIS-NIR Spectrophotometer : Hitachi 330
- Atomic Absorption Spectrophotometer : GBC 904 A
- Fluorescence Spectrophotometers : Hitachi F-4000 & Hitachi F-4500
- Mercury Analyzers : Perkin Elmer MAS-50 A and MAS-50 B
- Gas Chromatographs : Perkin Elmer Autosystem – 5 nos.
- High Performance Liquid Chromatographs : Waters 204 and 501; Shimadzu – LC10
- Gas Chromatograph-Mass Spectrometer : Varian Saturn III
- Liquid Chromatograph-Mass Spectrometer-Mas Spectrometer : Quattro Ultima
- Ocean related studies : ADCP, CODAR, GPS, Ekmen Dredge, Reversible sampler, (Nishkin type) DRDF, Reversible thermometer, Tide Gauges
- Doppler SODAR
- Mini Sonde
- Microscopes
- Biolistic particle delivery system with accessories
- Gene Pulser II System with accessories & consumables
- Membrane Bioreactor Assembly
- Wet air Oxidation High pressure reactor
- Ground Penetrating Radar
- Multi Electrode resistivity Imaging system
- Ambient Ozone Analysers
- Eight Stage Cascade Impactor
- Microwave Furnace
- Catalyst Evaluation assembly with GC

- Simultaneous Inductively Coupled Plasma Atomic Emission Spectrometer (for Heavy Metals) : Perkin Elmer Optima 4100 DV
- Atomic Absorption Spectrometer (for Heavy Metals) : Perkin Elmer Analyst 800 with Auto Sampler and HGA Furnace
- Total Organic Carbon (TOC) Analyser: Thermo Euroglass TC 1200
- VOC Analyser : Photovac 2020 and Photovac Voyager for Analysis of VOCs in Ambient Air
- Carbon Analyser : Behr Labor Technis C-30-IRF

12.1.8.2 Computer Hardwares & Prepherials

Computer Hardware

- High performance computer systems configures around RISC workstations
- Sun Ultra Sparc Computer Station: Sun Ultra 1 Model 170
- Silicon Graphics 02 Workstations
- Silicon Graphics 2000 Workstations
- HP APOLLO 90001730 Workstations
- Personal Computers
- Laptop Computers
- Local Area Network

12.1.8.3 Supporting Software

- Geographic Information Systems – ARC INFO, MAP INFO
- Knowledge Based System – Prokappa
- Digital Image Processing – ERDAS, EASIPACE, PCI WORKS
- INGRES
- CADCORE
- SPSS
- IMSL
- COMPLIERS
- GRAPHICS
- MATLAB
- DIVAST

Softwares for Mathematical Modeling (Available at NEERI)

Air Environment

Model	Used for Predicting Impacts due to
PAL-DS	Point (stacks), area (quarry) and line (vehicular) sources in short range
ISCST-3	Point and area sources in short range
CALINE 4	Vehicular sources close to road
RTDM3.2	Point and area sources existing at rough terrain in short range
VALLEY	Point and area sources existing in valley in short range
MESOPUFF	Point and area sources in long range
CDM	Point and area sources in short range
RAM	Point and area sources in short range
BLP	Point and line sources in short range
SDM	Point and area sources existing in coastal region in short range
CAL3QHC	Vehicular sources close to road for Hydrocarbon Levels
ADAM	Point and area sources in long range
ADMS-3	Point and area sources in long range
PANACHE	Meteorological data and point, area & line sources in any range
MTDDIS	Point and area sources in long range
TAPM	Meteorological data and impacts due to point, area and line sources in short and long range

Noise Environment

Model	Used for Predicting Impacts due to
FHWA	Vehicular sources
Wave Divergence	Stationary sources

Aquatic Environment – Ground Water

Model	Used for Predicting Impacts due to
GMS	Flow, direction, contaminant transport in saturated and unsaturated zones, subsurface solute transport with aerobic and sequential anaerobic biodegeneration, remediation
FEMWATER/ LEWASTE	Stable contaminant transport & pollution, groundwater pollution and remediation
PATRIOT	Hydrology, stable contaminant transport & pollution and landuse management
PRZM3	Stable contaminant transport & pollution and landuse management, consequence of surface water pollution on groundwater
WhAEM2000	Risk of groundwater contamination, hydrology, stable contaminant transport & pollution

Aquatic Environment – Surface Water

Model	Used for Predicting Impacts due to
MIKE 11	One dimensional model for dam break analysis, sediment transport, ecological and water quality assessments in rivers and wetlands
MIKE 21	Two dimensional model for Environmental Impact Assessment of marine infrastructure, sediment and mud transport, spill analysis
MIKE 3	Three dimensional model for various applications in different water bodies for water pollutions studies
MIKE SHE	Integrated surface and groundwater modeling
ECO LAB	For ecological modeling in rivers wetlands, lakes, reservoirs, estuaries, coastal waters and sea
CORMIX	Software for simulation for fluid-flow mixing in different water bodies
EXAMS	Aquatic Chemistry & Biology in streams and sea
GCSOLAR	Photolysis, half life
HSCTM2D	Hydrology, sediment & contaminant transport in river and estuary
HSPF	Aquatic chemistry and biology sediment transport and deposition in rivers
OXYREF	Dissolved oxygen, respiration, ventilation
PLUMES	Available dilution, design of marine outfall
PRZM3	Hydrology, metals and pesticides prediction in surface water
QUAL2EU	Water quality in stream, planning, non-point sources
SED3D	Hydrodynamics, sediment transport, 3-D, lakes, estuary, harbour, coastal
SMPTOX3	Toxic-chemicals in streams, aquatic biology, combined sewers
SWMM	Aquatic biology, combine sewers, community discharge, rivers, streams
TMDL USLE	Soil and sediment loss, watershed management
Visual Plumes	Surface water, contaminant transport
WASP	Hydrodynamics, aquatic biology, toxicant dispersal, hydrology

Surface Water Runoff

Model	Used for Predicting Impacts due to
HEC-5	Flood hydrography, runoff estimation, catchment area treatment
HSPF	Hydrologic simulation in reservoir, nutrient growth
STORM	Urban watershed, storage/reservoir routing, sedimentation, erosion, reservoir chemistry

Ecology

Model	Used for Predicting Impacts due to
ECOMOD	Estuary linked reservoirs, tidal action, saltwater intrusion, in-stream and in-reservoir dissolved oxygen primary and secondary productivity estimation
LAKE-I	Thermal stratification primary and secondary productivity

Food Chain

Model	Used for Predicting Impacts due to
EGETS	Exposure levels and effects of contaminants on organisms which make food chain
LC50	Lethal concentration, LC50 toxicity levels

Multimedia

Model	Useful for Predicting Impacts due to
3MRA	Multimedia pathway, receptor exposure, risk assessment
MINTEQA2	Aquatic biology, multimedia pathway
MMSOILS	Multimedia pathway, exposure assessment
MULTIMED (1.01)	Environmental effects of waste disposal in one media to another surface & ground water

Dam Break Analysis

Model	Useful for Predicting Impacts due to
DAMBRK	Downstream flow simulation consequent to dam break

Risk Assessment

Model	Useful for Predicting Impacts due to
SAFETI 6.21 & 6.42V	Complete package for consequence analysis and risk analysis in onshore process engineering
PHAST 6.21 V & 6.42V	Complete package for consequence analysis in onshore process engineering

12.1.9 Clients of NEERI

12.1.9.1 Clients: International

- The World Bank
- Asian Development Bank
- United Nations Development Programme
- United Nations Environment Programme
- World Health Organization
- International Union of Conservation for Nature
- Danish International Development Agency
- Global Scan Technologies, Dubai
- Global Tech Safety & Environmental Consultancy, Dubai
- Dept. of Public Works and Highways (DPWH) / Environment and Social Services Office (ESSO), Philippines

12.1.9.2 Clients: Central Government

- Atomic Energy Regulatory Board
- Bharat Oman Refineries Limited
- Bharat Petroleum Corporation Limited
- Gas Authority of India Limited
- Hindustan Organic Chemicals Limited
- Hindustan Petroleum Corporation Limited
- Indian Oil Corporation Limited
- Indian Petrochemicals Corporation Limited
- Jawaharlal Nehru Port Trust
- Madras Refineries Limited
- Mangalore Refinery and Petrochemicals Limited
- Mumbai Port Trust
- National Aluminium Corporation Limited
- National Hydroelectric Power Corporation
- National Thermal Power Corporation Limited
- Nuclear Power Corporation India Limited
- Numaligarh Refineries Limited
- Oil India Limited
- Oil and Natural Gas Corporation Limited
- Rashtriya Chemicals & Fertilizers Limited
- Tuticorin Port Trust

12.1.9.3 Clients: State Government

- Gujarat Industrial Development Corporation Limited
- Gujarat Narmada Valley Fertilizers Company Limited
- Gujarat State Petroleum Corporation Limited

- Gujarat State Petronet Limited
- Kudremukh Iron Ore Company Limited
- Maharashtra State Electricity Board
- Tamilnadu Industrial Development Corporation
- Chattisgarh State Electricity Board

12.1.9.4 Clients : Private Industries (National)

- Alembic Pharmaceuticals Ltd.
- Asian Paints India Ltd.
- Andhra Sugars
- Ballarpur Industries Ltd.
- Dighi Port Pvt. Ltd.
- Dony Polo Petrochemicals Ltd.
- Electrosteel Castings Ltd.
- ESSAR Oil Ltd.
- Grasim Industries Ltd.
- Gujarat Pipavav Port Ltd.
- Gujarat Positra Port Infrastructure Ltd.
- Hazira Port Pvt. Ltd.
- Hindustan Oil Exploration Company Ltd.
- Jindal Vijaynagar Steel Pvt. Ltd.
- Paradeep Phosphates Ltd.
- Pipavav Ship Dismantling & Engineering Ltd.
- Reliance Petrochemical Ltd.
- Reliance Industries Ltd.
- Sahara India Pvt. Ltd.
- Saurashtra Chemicals Ltd.

- Search Chem Industries Ltd.
- Tata Petrodyne
- United Phosphorus Ltd.
- Zuari Industries Ltd.

12.1.9.5 Clients : Private Industries (Multi-National)

- British Gas International (India)
- Cairn Energy India Pty. Limited
- Command Petroleum, Australia
- Enron Oil & Gas India Limited
- Hindustan Oil Exploration Company Limited
- Hindustan Oman Petroleum Company Limited
- Niko Resources Limited
- Petro Energy Products Company India Limited
- Rio Tinto Orissa Mining Limited
- Shell India Private Limited
- South Asia LPG Company Limited (a JV of M/s Total Gas & Power India)
- Mitsui & Company, Japan
- OAO Gazprom, Russia
- Mosbacher India L.L.C

12.1.10 Studies with International Funding

- Construction of Middle Vaitarna Dam for Augmentation of Water Resources and Irrigation near Mumbai (WB) (1990-1993)
- Augmentation of Chennai Water Supply – a Project at New Veeranam, Tamilnadu (WB) (1994-1995)
- Construction of Aerated Lagoons and Selection of Marine Outfall Location (Worli) off Mumbai Coast (WB) (1994-1995)
- Water Quality Studies for Hyderabad Water Supply and Sanitation Project (WB) (1995-1990)
- Oceanographic Modeling Studies for Sewage Outfall Location (Bandra) off Mumbai Coast (WB) (1995-1998)
- Strengthening EIA capacity and environmental legislation in India (ADP) (1998-2000)
- Implementation off Master Tourism Plan in Andaman Islands (UNDP) (1999-2000)
- Design & Implementation of Information Network for Indian Centre for Cleaner Technologies (WB) (1999-2002)
- Planning for Coastal and Marine Environment under Gujarat State Environmental Action Programme (WB) (1999-2000)

- Development of National Guidance Manual & Support Manual on EIA Practices for Enhancing the Quality & Effectiveness of Indian EIA's (WB) (2002-2004)
- Water needs of Brahmani & Sabrmati river basins (ICID) (2002-2004)
- Technical Assistance to ESSO to Enhance the Management of Social and Environmental Safeguards for DPWH Projects, Manila, Philippines (WB) (2005-2007)

12.1.11 US-AEP AWARD TO NEERI


W13

UNITED STATES - ASIA ENVIRONMENTAL PARTNERSHIP

ENVIRONMENTAL LEADERSHIP AWARD

This award recognizes outstanding contributions made through working in partnership to improve the environment and quality of life for the people of Asia.

PRESENTED TO:

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE

Winston Bowman
Regional Environmental Director
USAID Regional Development Mission/Asia

Kris Easter
India Country Manager
US-Asia Environmental Partnership

Suneel Parasnis
India, Western Region Director
US-Asia Environmental Partnership

12.1.12 Conformity to ISO 9001:2000

DNV

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Certificate No. 01542-2005-AQ-BOM-RvA

This is to certify that
the Quality Management System
of

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE (NEERI)

at
Nehru Marg, Nagpur – 440 020, Maharashtra, INDIA
&
Zonal Labs at Mumbai, Hyderabad, Chennai, Delhi and Kolkata, INDIA

has been found to conform to the Quality Management System Standard:
ISO 9001:2000

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SCIENTIFIC AND TECHNOLOGICAL SOLUTIONS TO ENVIRONMENTAL AND NATURAL RESOURCE PROBLEMS HAVING SOCIETAL RELEVANCE BY EFFECTIVE RESEARCH AND DEVELOPMENT PROGRAMMES IN ENVIRONMENTAL SCIENCE AND ENGINEERING

Original Certification date:
2005-01-11

Place and date:
Chennai, 2005-01-12

This Certificate is valid until:
2008-01-11

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Lead Auditor

NRKKu
Krishnakumar N.R.
Management Representative

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12.1.13 Contact Persons:

DIRECTOR : Dr. T. Chakrabarti

Phone : +91 712 2249999

Fax : +91 712 2249900

GSM : +91 98232 79961

Email : director@neeri.res.in

DIRECTOR LEVEL SCIENTIST: Dr. S.R. Wate

Head, Environmental Impact & Risk Assessment Division

Phone : +91 712 2247844

Fax : +91 712 2249896

GSM : +91 98231 10987

Email : sr_wate@neeri.res.in

12.2 Consultants for Outsourced Studies

The following studies were outsourced by NEERI / NPCIL for participation of other expert agencies and for enrichment of the report.

12.2.1 Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

The university carries out extensive research related to rice, fruits, horticulture, fisheries and agricultural technology. It has fifteen off-campus research stations throughout the Konkan region. There are two Krishi Vigyan Kendras (Agricultural Science Centres) at Shirgaon (Ratnagiri) and Karjat (Raigad) providing education and training to local farmers. College of Fishery, Ratnagiri and College of Forestery, Dapoli are affiliated to this university and undertaken extensive research in aquatic and terrestrial ecology. **Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth** is an agricultural university at Dapoli in Ratnagiri district of the Indian state of Maharashtra. It was established on May 18, 1972 as Konkan Krishi Vidyapeeth, and got its present name on February 12, 2001. Its research centre at Karjat has developed some patented varieties of rice. Its major focus areas are rice, horticulture and fisheries. In 1997, it received the Best Institute Award of the Indian Council of Agricultural Research.

12.2.1.1 College of Forestry of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra

In main campus of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, the College of Forestry was established on 1st August 2005. It offers the B. Sc. Forestry Degree. B. Sc. Forestry is four year Degree course. There are only Two Forestry College in Maharashtra State. One in Dapoli and another located at Akola.College of Forestry, Akola (Dr.Panjabrao Deshmukh Krishi Vidyapith, Akola, Maharashtra, India). The college also undertake biodiversity survey of flora and fauna in the forest area on request.

The study on terrestrial biodiversity was outsourced to College of Forestry of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra. The report is based on their observations from January 2007 to December 2007. The report on terrestrial biodiversity and marine and coastal biodiversity are enclosed as **Annexure VII** in **Vol. II**.

12.2.1.2 College of Fisheries of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra

This college is affiliated to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth. It was established in 1981 and is the only college in the Maharashtra state to offer an undergraduate fisheries programme. Courses offered:

- B. F. Sc.
- M. F. Sc. (Aquaculture)
- M. F. Sc. (Fish Processing Technology)
- M. F. Sc. (Fisheries Resource Management and Extension Education)
- Ph. D. (Fisheries)

The college also undertake the work of survey of marine biodiversity on request.

The study on marine and coastal biodiversity mapping was outsourced to College of Fisheries of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra. The report is based on the observations from January 2007 to December 2007. The report on marine and coastal biodiversity is enclosed as **Annexure VIII** in **Vol. II** of this report.

12.2.2 Central Water and Power Research Station, Government of India, P.O.- Khadakwasla Research Station, Pune 24

Central Water and Power Research Station (CWPRS) is the premier national institute offering comprehensive R&D support to a variety of projects in the areas of water and energy resources development and water-borne transport. Since independence, the expansion of CWPRS has been synonymous with the growth of the nation. The recognition of CWPRS as the Regional Laboratory for the ESCAP in 1971 is a testimony to the quality of services offered by it. The UNDP aid delivered through projects in selected disciplines such as ship hydrodynamics, photo elasticity, hydro-machinery, coastal engineering, hydraulic instrumentation, earth sciences, hydraulic structures and information technology, upto the eighties, brought the Research Station on par with the leading hydraulic laboratories of the world. The capability of the Research Station has enhanced since then in the areas of thermal Modelling, computational hydraulics, remote sensing, hydraulic instrumentation and field investigations. The infrastructure developed with the above inputs over the successive Five Year Plans paved the way for further assistance by the UNDP in the areas of ‘Mathematical Modelling of Fluvial and Ocean Hydromechanics’ and ‘Automated Operation of Irrigation Canal Systems in the nineties. Nearly 90% of the research efforts are currently devoted to the study of government financed projects executed through various Central and State agencies.

The Mathematical Modelling Centre (Coastal And Offshore Engineering) of CWPRS, Pune, conducted the study on 2D Mathematical Model Studies for dispersion of condenser cooling water discharge from proposed nuclear power plants at Jaitapur, Ratnagiri Dist., Maharashtra. The details of the study are given as “Technical Report No. 4492 (Revision -1), October 2008” as **Annexure V(b)** in **Vol. II** of this report.

12.2.2.1 Areas of Activities

Hydrology and Water Resources Analysis:

The Hydrology and Water Resources Analysis Laboratory undertakes various water resources management studies such as those relating to simulation of probable maximum flood discharge, estimation of the flood levels, routing of the floods and reservoir operations, dam break flood analysis, design of the storm water drainage systems with the help of mathematical models, reservoir sedimentation, river channelisation, back water effects, optimization of water resources utilization, estimation of seepage, development of decision support systems, automated operation of irrigation canals, etc.

River Engineering

River Engineering Laboratory is responsible for studies relating to flood protection works, bank protection measures, coffer dams and diversion works, barrages and weirs, hydraulic design of bridges, sediment control and exclusion devices, siting of cooling water intakes along reverine water bodies, vortex prevention at intakes, design of canals and canal structures, flood routing and flood forecasting, studies on transportation of river detritus and transportation of solids in conduits and Inland Navigation.

Reservoir and Appurtenant Structures

Reservoir and Appurtenant Structures laboratory is responsible for efficient hydraulic design of spillways, gates, water conducting systems and other structures appurtenant to dams and reservoirs; crest and spillway profiles, energy dissipaters, protection works, high head gates, sluices and outlets, surge tanks, tunnels, penstocks and galleries, intakes for pumps and power plants, construction stage profiles for large dams etc.

Coastal and Offshore Engineering

The activities of the Offshore Engineering Group encompass Hydraulic design of ports and harbors, Design of maritime and off-shore structures including coastal protection works, Training of estuaries and tidal rivers, Evaluation of the effect of thermal discharge into the marine environment, Water quality and pollution due to waste disposal, intake / outfall studies for Hydraulic Model Studies for spillway and ski-jump bicket- Dhauliganga H.E Project, Uttar Pradesh power plants drawing seawater for cooling purposes, Inland water transport, Field data collection, Study of hulls and propellers, calibration of current meters, Navigation studies and Assessment of forces in mooring lines.

Hydraulic Machinery

Hydraulic Machinery Laboratory caters to contractual tests on turbines, pumps (including submersible pumps), calibration of flow measuring devices etc. measurement of critical performance parameters of large hydromachines like efficiency, flow rate etc. in the field and evolution of remedial measures to mitigate operational problems of large hydro machines, evolution of comprehensive designs of pumping systems inclusive of remedial measures to mitigate water hammer in pumping mains, the laboratory also contributes to evolution of hydraulic designs of pump intakes for thermal and nuclear power stations, large water supply systems, lift irrigation schemes etc.

Applied Earth Sciences

The applied Earth Sciences Laboratory undertakes various studies involving different disciplines like hydrogeology, Tracer Hydrology, Vibration Technology, Earthquake Engineering Research and Geophysics as relevant to a number of water resources, projects, development of ports, establishment of power plants etc.

Instrumentation and Control Engineering

Scientific analysis of natural processes, in nature or in the laboratory under simulated conditions, requires observation of various parameters by way of measurements. The Instrumentation and Control Engineering Laboratory at CWPRS is responsible for providing instruments for measurement of various hydraulic parameters, data acquisition, analysis and control systems. This laboratory is equipped with sophisticated systems for measurement, data acquisition and analysis. The Laboratory undertakes some field observations and data collection to provide essential and reliable data for use in physical/ mathematical models.

Foundations and Structures

The Foundation Structures Group consists of six divisions namely :

a. Photo elasticity Division

b. Model Engineering Division

c. Rock Mechanics Division

d. Soil and Concrete Division

e. Hydraulic Structures Research Division

f. Mathematics Division

The group undertakes model and prototype studies relating to foundation/ structural problems of dams, power houses, water conductor system, bridges, aqueducts, surge shafts, tunnels and rehabilitation of structures of national importance.

Water and Power Information System

Water and Power Information System caters to collection, storage, analysis and retrieval of information in the broad areas of Water and Power.

12.2.2.2 Research and Development Activities

Important R&D projects undertaken during the year 1999-2000 were as under :-

Hydrology and Water Resources Analysis

- Selection of site for the proposed Mega Power Project in Barh – Mokama Area
- Mathematical model studies for proposed storm water drainage system of south region of Vasai-Virar.
- Surface water yield analysis for INS Mandovi, Goa.
- Estimation of Vaitarna river flood Hydrographs and final Mathematical model studies for prediction of water levels in Vaitarna creek.
- Mathematical model studies for proposed storm water drainage system of Central and North region of Vasai- Virar.

River Engineering

- Hydraulic model studies for the Eastern Yamuna Canal (EYC) Head Regulator Section of Hathnikund Barrage.
- Mathematical model studies to assess the effect of proposed flood embankments along the river Godavari at Bhadrachalam, Andhra Pradesh.

- Flushing of deposition infront of intake of Nathpa Jhakri Project.
- Morphological studies of River Brahmaputra at Nagaghuli Maijan-Oakland area upstream of Dibrugarh Town, Assam.
- Protection works for river Parvati at Manikaran, Kullu, Himachal Pradesh.
- Protection works for right bank of river Beas from Harsipattan to Alampur bridge site, Himachal Pradesh.
- Morphological studies of river Brahmaputra at Palasbari-Gumi-Alikash Reach, Assam.
- Model studies for estimation of discharge distribution and flood heights in Mahanadi and Kathjuri river below Naraj, Orissa.
- Measurement of in-situ stresses and Deformability of rock mass in the approach tunnel of Ghatghar pumped storage scheme, Thane, Maharashtra.

Reservoir and Appurtenant Structures

- Hydraulic model studies for Dhauliganga dam spillway, Uttar Pradesh.
- Model studies for protection work for the river bank, down stream of Supa dam spillway, Kali Nadi, H.E. Project, Karnataka.
- Hydraulic model studies with extension of piers for Nathpa Jhakri Dam Spillway, Himachal Pradesh.
- Hydraulic model studies for temporary crest profile for 1999 construction stage of Sardar Sarovar Dam Spillway, Gujarat.
- Hydraulic model studies for spillway and ski-jump Bucket, Dhauliganga H.E. Project, Uttar Pradesh.
- Hydraulic model studies for flow conditions in the vicinity of trunnion axis of radial gates, Dhauliganga dam spillway, Uttar Pradesh.

Coastal and Offshore Engineering

- Mathematical model studies to assess the effect of proposed Flood embankments along the river Godavari at Eturnnagaram, Andhra Pradesh.
- Report on the field and model studies for the proposed oil/ fuel berth at Pirpau, Mumbai for Tata Electric Companies.
- Studies for Hydraulic aspects for cofferdam in Mormugao Bay for Engineering Offshore stockyard berth of M/s. MML
- Design of Rock bund for Catamaran Beach North of fisheries Harbour at Visakhapatnam.
- Studies for assessing effects of MCGM cofferdam across Mahim causeway.
- Physical model studies for development of outer harbour at Puthauvypeen and inner harbour facilities at Cochin Port.
- Storm wave hindcasting studies for estimating extreme wave conditions at Cochin.
- Mathematical model studies for improving entrance channel conditions at Bhavanapadu Fishing Harbour, Andhra Pradesh.
- Hydraulic model studies for chemical terminal at Jawaharlal Nehru Port, Mumbai.
- Field data collection and analysis for development of Bhavanapadu Fishing Harbour, Andhra Pradesh.
- Storm wave hindcasting and wave flume studies for immediate protective measures for the restoration of damaged breakwater at Porbandar Port.
- Wave flume studies for the permanent restoration of the damaged breakwater at Porbandar Port, Gujarat.
- Remedial measures to reduce wave transmission through south breakwater at Visakhapatnam port.

- Physical model studies to assess the impact of ship-lift system proposed by M/s Cochin Shipyard Ltd. In the Ernakulam Channel.
- Tidal hydraulic model studies for M/s Bharat Petroleum Corporation Ltd. at Kandla.
- Mathematical model studies for Alignment of proposed LNG jetty at Pipavav Port, Gujarat for M/s GPPL.
- Mathematical model studies for simulation of oil dispersion at New Mangalore Port for M.R.P.L. Project.
- Analysis of sea bed samples in approach channel and basin area in Mormugao Port.
- Model studies for the development of Kulpi Port project on the left bank of River Hugli, West Bengal.
- Tidal Hydraulic model studies for the conversion of virtual jetty of IOCL to permanent jetty at Kandla.
- 3-D Hydraulic model studies for improvement of wave Tranquility at OSTT in Visakhapatnam Port.
- Physical model studies for wave tranquillity near the proposed oil jetty with and without offshore island breakwater at Paradip Port, Orissa.

Ship Hydrodynamics

- Calibration of current meter for National Institute of Oceanography (NIO), Goa.
- Mathematical model studies for motions and mooring line and fender analysis for ships to be berthed at the jetty off Nagapattinam, Tamilnadu for M/s MRL.

Hydraulic Machinery

- Desk studies on the design of new pumping system of 200 MGD (900 MLD) capacity for Indore water supply project.
- Advice on selection of Air Vessel for Tekepar Lift Irrigation Scheme, Maharashtra.

- Investigations on the performance of Francis Turbine at Loktak Hydroelectric Project, Manipur.
- Field studies to determine C-Value of GRP pipe for M/s. Carbon Everflow Ltd., Nashik.
- Interim report on Inspection and testing of newly installed 660 mm NB orifice meter at Hindustan Organic Chemicals Ltd. (HOC) Rasayani.
- Mathematical model studies on ship motions at the Offshore Tank Terminal (OSTT) Berth, at Visakhapatnam Port Trust (VPT).

Earth Sciences

- A report on the monitoring of blast vibrations during quarry operations for Ennore Coal Port Project, Sholinghur, Tamil Nadu.
- Geophysical borehole logging for determination of in-situ properties of substrata at the rockfill dam site, Arkavathy reservoir project, Karnataka.
- Downhole seismic logging studies for Pipavav LNG Terminal, Rajula, Gujarat.
- Generation of design accelerograms for dynamic analysis of Ujjani Dam, Maharashtra.
- Ultrasonic Non-destructive studies for estimation of quality of in-situ concrete of 210 M.W. T.G. foundation of Unit No. 3, Khaperkheda Thermal Power Station, Nagpur, M.S.E.B., Maharashtra.
- Final report on underwater seismic reflection survey for Marali Port at Umargaon, Gujarat.
- Analysis of prototype data pertaining to gate operation of Farakka Barrage during low flow period for the years 1997-98.

Mathematical Modelling

- Mathematical model studies for flow circulation, siltation and disposal of dredged material for marine facility at Jamnagar, Gujarat.

- Mathematical model studies to investigate the behaviour of a 1,00,000 DWT moored vessel at the proposed multipurpose berth, Visakhapatnam Port Trust.
- Mathematical model studies for cooling water system for power station at Sikka, Jamnagar, Gujarat.
- Mathematical model studies for wave tranquility for development of harbour on the eastern side of Kalpendi island, Lakshadweep.
- Mathematical model studies for wave propagation for development of fisheries harbour at Ponnani, Kerala.
- Mathematical model studies to investigate the behaviour of a 50,000 DWT vessel at the proposed multipurpose berth, using SUC1450 H fender, Visakhapatnam port trust.
- Mathematical model studies for wave tranquility for development of outer and inner harbours at Cochin Port.
- Mathematical model studies for wave tranquility for extension of Rock bund for development at Catamaran Beach at Visakhapatnam Harbour.
- Physical model studies for evaluation of quantity of water recirculated through CW system of Trombay Thermal Power Station.
- Mathematical model studies for estimation of littoral drift and shoreline evolution for of Cochin Port according to Master Plan.
- Mathematical model studies for wave propogation for Development of Deep Sea Fisheries harbour at Agardanda, Maharashtra.
- Mathematical model studies to evaluate optimum width requirement of approach channel to Cochin Port for the manoeuvring of LNG tankers to the outer Harbour.
- Mathematical model studies for single diffuser system for captive power plant and De-Salination Plant of M/s L&T at Kovaya, Gujarat State.
- Mathematical model studies for littoral drift distribution and shoreline evolution for construction of Jetty off Nagapattinam.

12.2.2.3 Foundations and Structures

- The structural model studies on penstock bifurcation (External pressure gauge) Nathpa Jhakri H.E. project, Himachal pradesh.
- Soil Investigation for determining the extent of Sandy strata in the foundation to assess its effect on seepage and stability analysis of Maskinala earthen dam, Karnataka.
- Rock Mechanics Studies for the foundation of the spillway portion of Maskinala Dam, Karnataka.
- Analysis of instrumentation data for forecasting the deflection of Koyna dam, Maharashtra.
- Precooling of the constituents of mass concrete with fly ash, Indira Sagar dam, Madhya Pradesh.
- In-situ stresses and deformability of rock mass for 5 km long underground tunnel between Ruparel College and Dr. E. Moses Road, Mumbai, Maharashtra.
- Dynamic analysis of upper Vaitarna Dam, Maharashtra.
- Desk studies to determine optimum bottom width of cut off Trench for proposed subsidiary earthen bunds ‘C’ and ‘D’ of Telugu Ganga Project, Cuddapah, Andhra Pradesh.
- Studies on Hundri and Khadarbagh Aqueducts in connection with modernization programme, Andhra Pradesh.
- Monitoring of blast vibrations during construction of approach channel, tunnel and exit channel in 1st km of D.Devaraj Urs Canal Mysore, Karnataka.
- Studies on epoxy mortar for upgradation of sluice gates, Hirakud Dam, Orissa.
- Geo-technical studies of foundation rock material for Markandeya Dam, Karnataka.

- Temperature control studies for Roller Compacted concrete, Ghatgar Pumped Storage Scheme, Maharashtra.
- Soil Investigation and stability analysis for Sarai Naga Drain, Punjab.

12.2.2.4 Budget and Finance

During the year 1999-2000 the Research Station had a target of recovery of about Rs. 450 lakh of its Non-Plan expenditure of Rs. 1663 lakh through client sponsored applied studies. Activities under plan comprise execution of six ongoing schemes viz.

- Sediment Disposal Research
- Augmentation of Water & Power Supply
- Staff Colony Phase-III
- Hydrology Project
- Development and Application of Remote Sensing Techniques for Water Resources.
- Upgradation of Coastal and Offshore Data Collection Capabilities

Out of the six schemes in operation four are 'spillover' schemes from Eighth Plan and two have been recently sanctioned in July 1999. The total budget allocation for execution of these schemes during the year 1999-2000 was Rs. 3.50 crore, was revised as Rs. 3.00 crore at the revised estimate stage. Out of the six schemes in operation the schemes at seriatim 1 and 2 are likely to be completed during the year 2000-2001. Transfer of title for UN aid equipment of Rs. 9.4 lakh for the scheme of Automated Operation of Irrigation Canal System, completed on 31.12.1998, is to be effected during the current financial year as a committed liability. This could not be effected earlier since the necessary clearance and the relevant documents from UNDP and DEA were received only in August 1999.

12.2.3 National Institute of Ocean Technology, Chennai

The National Institute of Ocean Technology (NIOT) was established in November 1993 as an autonomous society under the Ministry of Earth Sciences, Government of India. NIOT is managed by a Governing Council and the Director is the head of the Institute.

The major aim of starting NIOT under the Ministry of Earth Sciences, is to develop reliable indigenous technology to solve the various engineering problems associated with harvesting of non-living and living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the land area of India.

High and Low Tide Line demarcation off Waghapur Head land for the proposed Power Plant of Nuclear Power Corporation of India Ltd was carried out by NIOT, Chennai. The details are given as "Report on HTL/ LTL Demarcation off Jaitapur Maharashtra Coast, November, 2007". The report is presented as **Annexure VI** in **Vol. II**.

12.2.3.1 Technology Projects - Deep Sea Mining

The deep ocean has abundant mineral resources like polymetallic nodules, cobalt rich manganese crust and hydrothermal deposits. Utilising this mineral wealth for the benefit of mankind will be the focus of ocean mining activities in this century. Deep sea technology and ocean mining group of NIOT has been actively involved in the development of technology for Polymetallic nodule mining from 6000m water depth. The Polymetallic nodules containing copper, cobalt, nickel and manganese are viewed as potential resources to meet the increasing demand for these metals in our country. India has a status of pioneer investor and has been allotted a site in the Central Indian Ocean Basin by the International Sea Bed Authority (ISBA) for exploration and exploitation of polymetallic nodules

12.2.3.2 Technology Projects - Desalination

The main area of focus of the group is the utilization of the ocean resources to find alternative technologies for fresh water and renewable energy. Currently the group is working on three specific areas, fresh water production using low temperature thermal desalination (LTTD) process, and energy production using two distinctly different processes, Ocean Thermal Energy Conversion and Wave Energy.

12.2.3.3 One of the Operational Programs at NIOT > National Data Buoy Programme

Systematic real-time meteorological and oceanographic observations are necessary to improve oceanographic services and predictive capability of short and long-term climatic changes. Time series observations are vital to improve the understanding of ocean dynamics and its variability. The existing systems for collecting the ocean related information are remote sensing, ships of opportunity and moored / drifting / profiling platforms. Among these the moored buoys play an important role in providing long-term, time series, surface / subsurface observations at a location.

Considering the importance of ocean observations to the country like India having a long coastline of about 7500 km and a vast oceanic area of 2.02 million sq. km of EEZ available for exploitation, Department of Ocean Development, Government of India has established the National Data Buoy Programme (NDBP) in 1997 at National Institute of Ocean Technology (NIOT) Chennai. A network of twelve data buoys has been established both in Arabian Sea and Bay of Bengal during the implementation period of 1997-2002, which has subsequently been increased to twenty five and poised for further growth.

12.2.4 Bhabha Atomic Research Centre, Mumbai, India

The **Bhabha Atomic Research Centre** (BARC) is India's primary nuclear research facility. It has a number of nuclear reactors, all of which are used for India's nuclear power and research programme.

BARC was started in 1954, as the **Atomic Energy Establishment, Trombay** (AEET), and became India's primary nuclear research centre, taking over charge of most nuclear scientists that were at the Tata Institute of Fundamental Research. After Homi J. Bhabha's death in 1966, the centre was renamed as the Bhabha Atomic Research Centre.

The first reactors at BARC and its affiliated power generation centres were imported from the west. India's first power reactors, installed at the Tarapur Atomic Power Plant (TAPP) were from the United States.

The primary importance of BARC is as a research centre. The BARC and the Indian government has consistently maintained that the reactors are used for this purpose only: Apsara (1956; named by the then Prime Minister of India, Jawaharlal Nehru when he likened the blue Cerenkov radiation to the beauty of the Apsaras (Indra's court dancers), CIRUS (1960; the "Canada-India Reactor" with assistance from Canada), the now-defunct ZERLINA (1961; Zero Energy Reactor for Lattice Investigations and Neutron Assay), Purnima I (1972), Purnima II (1984), Dhruva(1985), Purnima III (1990), and Kamini.

The plutonium used in India's 1974 nuclear test carried out in Pokhran in the Thar desert of Rajasthan (Peaceful Nuclear Explosion) came from CIRUS the primary charter of which was peaceful nuclear research. The 1974 test (and the 1998 tests that followed) gave Indian scientists the technological know-how and confidence not only to develop nuclear fuel for future reactors to be used in power generation and research, but also the capacity to refine the same fuel into weapons-grade fuel to be used in the development of nuclear weapons.

The BARC also conducts research in biotechnology at the Gamma Gardens, and has developed numerous disease resistant and high-yielding crop varieties, particularly groundnuts. There is also a great deal of research in Liquid Metal Magnetohydrodynamics for power generation.

On June 4, 2005, with the goal of encouraging research in basic sciences, BARC started the Homi Bhabha National Institute. Research institutions affiliated to BARC include IGCAR (Indira Gandhi Centre for Atomic Research), RRCAT (Raja Ramanna Centre for Advanced Technology), and VECC (Variable Energy Cyclotron Centre).

BUDGETORY ALLOCATION (Rs. in crores)					
	CAPITAL		REVENUE		TOTAL
	PLAN	NON-PLAN	PLAN	NON-PLAN	
Budget Estimates 2007-2008	629.10	0.00	13.66	632.29	**1275.05**
Final Grant 2007-2008	610.00	0.00	21.04	693.02	**1324.06**
Actual Exp. 2007-2008	599.61	0.00	19.33	683.16	**1302.10**
Budget Estimates 2008-2009	630.10	0.00	23.45	707.60	**1361.15**
Actual Exp. 2008-2009 (Up to May 2008)	55.53	0.00	4.63	154.54	**214.70**

The Environmental Studies Section, Health Physics Division conducted preoperational environmental surveillance around proposed Jaitapur Nuclear Power Plant Site in Ratnagiri District, Maharashtra in 2007 (Report No. : BARC/200711/003). The work is presented as **Annexure IX (a)**, **IX (b)**, **IX (c)** and dose apportionment in **IX (d)** of **Volume II**.